

ANDRITZ HYDRO LIMITED

and

CANMEC INDUSTRIEL INC.

SUPPLY AND INSTALL SUBCONTRACT

Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment

Agreement No. CH0032-01

DATED AS OF JULY 10th, 2014



TABLE OF CONTENTS

Article 1 Interpretation 1

Article 2 Contractor’s Status 14

Article 3 Contractor’s Obligations 15

Article 4 Contractor’s Design Obligations 18

Article 5 Contractor’s Personnel 18

Article 6 Subcontracts 20

Article 7 Performance Security 21

Article 8 Policy on Ethics/Conflicts of Interest 22

Article 9 Compliance With Laws 23

Article 10 Company’s Obligations 23

Article 11 Role and Responsibilities of Company **Error! Bookmark not defined.**

Article 12 Compensation and Terms of Payment 25

Article 13 Taxes 31

Article 14 Audit and Records 33

Article 15 Health, Safety and Environmental Protection 34

Article 16 Access and Quality 38

Article 17 Warranty 39

Article 18 Contractor Insurance 42

Article 19 Workers Compensation 45

Article 20 Project Insurance 46

Article 21 Indemnification 47

Article 22 Site and Transport Route Conditions 51

Article 23 Title and Risk 52

Article 24 Completion and Delivery 54

Article 25 Substantial and Final Completion 56

Article 26 Changes in the Work 58

Article 27 Publicity Communications 61

Article 28 Confidentiality 61

Article 29 Patents, Trademarks, Copyrights 63

Article 30 Assignment 64

Article 31 Force Majeure 65

Article 32 Default and Termination 67

Article 33 Bankruptcy, Insolvency and Receivership 70

Article 34 Suspension 71

Article 35 Labour Relations72

Article 36 Liquidated Damages for Delay and Performance Incentives73

Article 37 Representations, Warranties and Covenants74

Article 38 Entirety of Agreement, Non Waiver77

Article 39 Dispute Resolution77

Article 40 Notices80

Article 41 Liens and Claims83

Article 42 Enurement, Time, Survival of Provisions83

Article 43 Counterparts84

Article 44 Performance Guarantees84



THIS AGREEMENT MADE as of the July 10, 2014

BETWEEN:

ANDRITZ HYDRO Ltd, a corporation duly incorporated pursuant to the laws of Quebec hereinafter referred to as "Company")

AND

Canmec Industriel Inc., a corporation duly incorporated pursuant to the laws of Quebec (hereinafter called "Contractor").

WHEREAS, Company has entered into an agreement (the **"Supply and Install Agreement"**) with the Muskrat Falls Corporation [, a body corporate constituted pursuant to the *Corporations Act, RSNL1990, c. C-36, as amended*, solely in its own right and not as agent of the Crown in right of the Owner of Newfoundland and Labrador, and having its head office at the City of St. John's, Owner of Newfoundland and Labrador for the supply and installation of Powerhouse and Spillway Hydro-Mechanical Equipment in connection with the Muskrat Falls Hydro project.

WHEREAS Company, (acting as principal and not as agent) wishes to appoint the Contractor to perform a subset of the Company's obligations under the Supply and Install Agreement, under and in accordance with the terms of this Agreement (the **"Agreement"** or the **"Supply and Install Subcontract"** .

WHEREAS, Contractor is engaged in the business of performing the type of work substantially set out herein and will provide all expertise, equipment, material and personnel to perform such work **WHEREAS** Company and Contractor wish to set out all the terms and conditions on which Contractor shall carry out the Work;

NOW THEREFORE, the Parties, each in consideration of the promises and agreements of the other, hereby agree as follows:

**ARTICLE 1
INTERPRETATION**

1.1 The following Exhibits are attached hereto and shall form and be read and construed as an integral part of this Agreement:

Exhibit	Description
1	Scope of Work
2	Compensation
3	Coordination Procedures
4	Supplier Document Requirement List
5	Health and Safety Requirements

Exhibit	Description
6	Environment and Regulatory Compliance Requirements
7	Quality Requirements
8	Subcontractors, Manufacturers and Material Sources
9	Interface and Milestone Schedule
10	Declaration of Residency
11	Owner Supplied Documents
12	Site Conditions
13	Provincial Benefits
14	Performance Security
15	Company Equipment Delivery Schedule
16	Supply and Install Agreement Extracts re Substantial Completion

- 1.2 For the purpose of this Agreement, except as is otherwise expressly provided or unless the context otherwise requires, the terms defined in this Article shall have the meanings assigned to them in this Article.
- (a) **"Acceptance"** means express acceptance, concurrence or consent in writing by Company and **"Accepted"**, **"Acceptable"** and **"Accept"** shall be construed accordingly.
 - (b) **"Aconex"** means a cloud based computer software program for communication that can be accessed via an internet connection and a web browser.
 - (c) **"Affiliate"** or **"Affiliate(s)"** has the meaning given to affiliate in the *Canada Business Corporations Act*, R.S.C. 1985, c. C-44 and includes any limited partnership whose general partner is an affiliate of Company under that Act.
 - (d) **"Agreement"** means this document, including the Exhibits as referenced in **Article 1.1**, originally executed or as they may from time to time be supplemented, amended, revised or otherwise modified in accordance with the applicable provisions of this document and the Exhibits.
 - (e) **"Applicable Laws"** means any laws, statutes, regulations, standards, codes, orders, directives or other rules enacted or issued from time to time by any Authority having jurisdiction over Contractor or Company or the activities carried out under this Agreement, including safety, occupational health, customs and excise, taxation, workers compensation, labour and environmental protection laws, statutes, regulations, standards, codes, orders, directives and other rules, including the collective agreement LCP-PT-MD-0000-LR-CT-0002-01 rev.3.

- (f) **"Approval"** means express acceptance, concurrence or consent in writing and **"Approve"** and **"Approved"** shall be construed accordingly.
- (g) **"Authority"** means any:
- (i) government or government department or agency;
 - (ii) municipality, local government authority or council;
 - (iii) other statutory authority;
 - (iv) fiscal or judicial body, commission, board, tribunal or agency; or
 - (v) other regulatory person or body;
- (excluding Company) having jurisdiction or authority in any way over Contractor or Company or the subject matter of the Agreement, including a right to impose a requirement or whose Approval is required with respect to the LCP or the Work.
- (h) **"Billing Information"** has the meaning ascribed thereto in **Article 12.6**.
- (i) **"Breach"** has the meaning ascribed thereto in **Article** Error! Reference source not found..
- (j) **"Business Day"** means a day that is not a Saturday, Sunday or any other day which is a statutory holiday in the Province of Newfoundland and Labrador.
- (k) **"Change"** means any of the following:
- (i) An addition to the Work;
 - (ii) A significant increase or decrease in quantities of items forming part or all of the Work;
 - (iii) A deletion of any part of the Work;
 - (iv) A revision or modification to any part of the Work already completed;
 - (v) A variation to the schedule for the completion of a Milestone including a delay in the performance of the Work resulting from an act or omission by Company Group;
 - (vi) A modification in, variation to or deviation from the requirements set out in this Agreement that impacts Contractor's costs and/or schedule, including presence of hazardous substance as stated in **Article 15.12** and **Article 15.13**;

but for greater certainty, a Change shall not include:



- (A) modifications, revisions or deviations to the requirements of the Agreement that are necessary to make the Work satisfy the performance requirements set out in Exhibit 1 – Scope of Work;
 - (B) any items that can reasonably be inferred as being included in the Work, including the advancement and development of the design of any element of the Work within the Contactor's responsibility under the Agreement;
 - (C) modifications, revisions or deviations to the requirements of Exhibit 1 – Scope of Work or any additional services that are requested by Company that are necessary because of delays attributable to Contractor Group;
 - (D) corrections or additional services that are required because of Contractor's breach of any of its representations, covenants, warranties, guarantees or other obligations under this Agreement, including corrections or additional services made necessary due to noncompliance with the Agreement, Applicable laws or the requirements of Authorities;
 - (E) the supply of any services, materials or equipment required to rectify any omissions, defects or deficiencies in the Work; or
 - (F) matters that might otherwise be grounds for alteration of a date for a completion of a Milestone but which coincide with any concurrent delay or other matter within Contractor's responsibility under this Agreement.
- (l) **"Change Order"** means an order or directive for a Change issued in the form set out in Exhibit 3 – Coordination Procedures and signed by Company.
 - (m) **"Change Request"** means a request for a Change issued in the form set out in Exhibit 3 – Coordination Procedures.
 - (n) **"Claim"** means damages (including punitive and exemplary damages), expenses, costs, losses, injuries, liabilities, claims, liens, judgments, settlements, awards, remedies, debts, expenses, causes of action, demands, court costs, legal fees or disbursements.
 - (o) **"Commissioning"** means the checks, inspections, activities and tests required by the Technical Specifications to verify that the portion of Work performs in accordance with the requirements of this Agreement and is safe for use and/or occupation, and Commission and Commissioned shall be construed accordingly.
 - (p) **"Company"** means Andritz Hydro Limited and its successors and permitted assigns.
 - (q) **"Company Group"** means collectively Company and Company's Other Contractors, and the respective Affiliates and Personnel of each of the foregoing.



- (r) **"Company's Other Contractors"** means all contractors and subcontractors of Company or its Affiliates, including all of their contractors and consultants (including any warranty surveyor or inspector) except Contractor and Subcontractors.
- (s) **"Company Representative"** means the person designated in accordance with **Article 10.4**.
- (t) **"Confidential Information"** has the meaning ascribed thereto in **Article 28.1**.
- (u) **"Contract Price"** means:
 - (i) the lump sum amount set out in Appendix A to Exhibit 2- Compensation, as the same may be adjusted from time to time by agreement between the Parties or in accordance with the terms of the Agreement, being the consideration for the satisfactory performance of the Work by Contractor in accordance with the Agreement.
 - (ii) for the purposes of the performance security requirements in **Article 7**, the Contract Price shall be the single lump sum in Canadian dollars specified in Appendix A to Exhibit 2- Compensation without adjustment from time to time by agreement between the Parties or in accordance with the terms of the Agreement ;
- (v) **"Contractor"** means the Person identified as Contractor on the first page of this Agreement and its successors and permitted assigns.
- (w) **"Contractor Group"** means Contractor and Subcontractors (including Subcontractor's subcontractors of every tier) and their vendors and suppliers and their respective Affiliates which are Subcontractors and Affiliates which have a direct or indirect involvement in the performance of the Work and respective Personnel of each of the foregoing.
- (x) **"Contractor's Items"** means all machinery, systems, fittings, parts, spare parts, apparatus, tools, materials, supplies and any other equipment or items which are necessary to be supplied by Contractor Group at their cost to perform the Work but excluding such things that are permanently installed or Delivered as part of the completed Work.
- (y) **"Contractor's Personnel"** means the Personnel to be provided by Contractor Group from time to time to perform the Work.
- (z) **"Contractor's Proprietary Information"** means information of a scientific or technical nature, including patented inventions, designs or trade secrets which Contractor employs in the course of performing the Work and is not otherwise required to be disclosed or delivered in accordance with other provisions in this Agreement.

- (aa) "**Contractor's Representative**" is the person nominated as such in accordance with **Article 5.5**.
- (bb) "**Court**" means a court of competent jurisdiction and includes the Supreme Court of Canada.
- (cc) "**Defect**" means any error, omission, deficiency, defect and/or failure in design, materials, engineering, workmanship, manufacture and/or installation.
- (dd) "**Deliver**", "**Delivered**" or "**Delivery**" means that point in time at which Contractor provides and Company takes physical possession of the Work (or any part), in accordance with **Article 24**.
- (ee) "**Dispute**" has the meaning ascribed thereto in **Article 39.1**.
- (ff) "**Drawings**" means the drawings set out in Exhibit 1 - Scope of Work.
- (gg) "**Effective Date**" means the date this Agreement is made as set out on page 1.
- (hh) "**Exhibits**" means the Exhibits forming part of this Agreement and identified in **Article 1.1**.
- (ii) "**Final Completion**" means that point in time when the Contractor has completed all the Work except for Warranty obligations.
- (jj) "**Final Completion Certificate**" has the meaning ascribed thereto in **Article 25.6**.
- (kk) "**Force Majeure**" has the meaning ascribed thereto in **Article 31.1**.
- (ll) "**Interface**" means:
 - (i) the supply or delivery of products, components or materials by Company's Other Contractors for use or installation by Contractor in the performance of the Work; and
 - (ii) the supply, provision or construction of any erection, structure or opening by Company's Other Contractors necessary for Contractor's performance of the Work.
- (mm) "**Good Utility Practice**" means the practices, methods and acts engaged in, or approved by, a significant portion of the electric utility industry in North America, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, are expected to accomplish the desired result at a reasonable cost consistent with good business, reliability, safety, environmental and expedition practices. Good Utility Practice is not intended to be limited to optimum practice, method or act to the exclusion of all others, but rather to include all practices, methods or acts generally accepted in North America.



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- (nn) **"HST"** means all amounts exigible pursuant to Part IX of the *Excise Tax Act* (Canada), R.S.C. 1985, c. E-15, including, for greater certainty, the taxes commonly referred to as the goods and services tax (GST) and the harmonized sales tax (HST).
- (oo) **"LCP"** means lower Churchill projects which include hydroelectric power developments on the lower Churchill River located in the Labrador portion of the Province of Newfoundland and Labrador and associated power transmission facilities.
- (pp) **"LEG2/96"** means the 1996 "Model 'Consequences' Defects Wording" published by the London Engineering Group.
- (qq) **Not used.**
- (rr) **"Lower Churchill Construction Projects Benefits Strategy"** means the policy, strategy, obligations and procedures set out in the document located at www.NR.Gov.NL.CA/NR/Energy/LCP_Benefits_Strategy.pdf.
- (ss) **"Milestone"** has the meaning ascribed thereto in Exhibit 3 – Coordination Procedures.
- (tt) **"Milestone Completion Certificate"** means the certificate described in **Article 24.7**.
- (uu) **"Milestone Completion Date"** means for each Milestone and provided the Contractor has satisfied the criteria set forth in **Article 24.7** the date of Notice sent by Contractor to Company under **Article 24.7**.
- (vv) **"Milestone Schedule"** means the schedule for performance of the Work (or any part) as set out in Exhibit 9 – Interface and Milestone Schedule, as the same may be amended from time to time by agreement of the Parties or otherwise in accordance with the provisions of the Agreement.
- (ww) **"Notice"** means a written communication that is required to be delivered in accordance with **Article 40**.
- (xx) **"Owner"** means Muskrat Falls Corporation.
- (yy) **"Owner Group"** means collectively Owner and Owner's Other Contractors, and the respective Affiliates and Personnel of each of the foregoing.
- (zz) **"Owner's Other Contractors"** means all contractors and subcontractors of Owner or its Affiliates, including all of their contractors and consultants (including any warranty surveyor or inspector) except Company, Contractor and Subcontractors.
- (aaa) **"Owner's Representative"** means the person designated in accordance with the Supply and Install Agreement to have the authority to act on behalf of Owner, commit Owner regarding matters under the Supply and Install Agreement,, receive



and issue Notices and perform such other duties and acts reserved to the Owner's Representative under the Supply and Install Agreement and this Agreement.

- (bbb) "**Owner Supplied Data**" means those documents listed in Exhibit 11 – Owner Supplied Documents, together with such other documents to be provided by Owner as shall be designated by Owner in writing from time to time.
- (ccc) "**Party**" means Company or Contractor, as the context requires, and "**Parties**" means Company and Contractor collectively.
- (ddd) "**Payment Certificate**" means the certificate for payment of all or any portion of the Contract Price that is issued by Contractor to Company for Approval by Company, all in accordance with **Article 12**.
- (eee) "**Payment Milestone**" means a Milestone identified in Exhibit 2 – Compensation for which payment of a portion of the Contract Price is to be made by Company to Contractor.
- (fff) "**Person**" means an individual, a partnership, a corporation, a trust, an unincorporated organization, a union, a government or any department or agency thereof and the heirs, executors, administrators, successors, assigns or other legal representatives of an individual, and words importing persons have a similar meaning.
- (ggg) "**Personnel**" means the directors, officers, employees, consultants, non-employed representatives and agents of a Person.
- (hhh) "**Privacy Law**" means the *Access to Information and Protection of Privacy Act*, S.N.L. 2002 c. A 1.1, and all other applicable federal or provincial laws relating to disclosure of information, and the privacy, confidentiality or use of any information, about individuals and corporations.
- (iii) "**Punch List**" means a list of Defects and/or items or parts of the Work that are not complete as of the date of Substantial Completion Certificate.
- (jjj) "**Quality Plan**" means the plan described in Exhibit 7 – Quality Requirements.
- (kkk) "**SIA Substantial Completion**" means substantial completion within the meaning of the Supply and Install Agreement, in respect of which the relevant provisions of the Supply and Install Agreement are reproduced herein and attached hereto as Exhibit 16- Supply and Install Agreement Extracts re Substantial Completion
- (lll) "**Site**" means the location for the performance of Work at the power plant, dam and/or immediate vicinity at Muskrat Falls, Labrador, as may be further described in Exhibit 1 – Scope of Work.

- (mmm) "**Standard of a Prudent Contractor**" means good faith performance of contractual obligations and exercising that degree of care, skill, diligence, prudence, workmanship and foresight expected from a skilled and experienced contractor engaged in the same type of undertaking, in similar circumstances or conditions and in compliance with all Applicable Laws and to the satisfaction of Authorities.
- (nnn) "**Subcontract**" means an agreement (including any supplement or amendment) entered into between Contractor and any Person in the manner and to the extent permitted under the terms of the Agreement by which Contractor engages such Person to perform any part of the Work.
- (ooo) "**Subcontractor**" means any Person engaged by Contractor to perform any part of the Work pursuant to a Subcontract, and shall include the successors and permitted assigns of any such Person.
- (ppp) "**Substantial Completion**" means that the Work has been completed to the extent specified in **Article 25.1**.
- (qqq) "**Substantial Completion Certificate**" means the certificate issued by Company in accordance with **Article 25.2**.
- (rrr) "**Supply and Install Agreement**" has the meaning ascribed thereto in the Recitals to this Agreement. **Supply and Install Subcontract**" means this Agreement.
- (sss) "**Suspension Expenses**" has the meaning ascribed thereto in **Article 34.2**.
- (ttt) "**Suspension Period**" has the meaning ascribed thereto in **Article 34.1**.
- (uuu) "**Tax**" or "**Taxes**" means any tax, fee, levy, rental, duty (including, for greater certainty, all customs duties, anti-dumping duties and countervailing duties), charge, royalty or similar charge including, for greater certainty, any federal, state, provincial, municipal, local, aboriginal, foreign or any other assessment, governmental charge, imposition or tariff wherever imposed, assessed or collected, and whether based on or measured by gross receipts, income, profits, sales, use and occupation or otherwise, and including any income tax, capital gains tax, fuel tax, capital tax, goods and services tax, harmonized sales tax, value added tax, sales tax, withholding tax, property tax, business tax, ad valorem tax, transfer tax, franchise tax, payroll tax, or excise tax, together with all interest, penalties, fines or additions imposed, assessed or collected with respect to any such amounts.
- (vvv) "**Technical Requirements**" means specifications, drawings, plans or other documentation of a technical or scientific nature, and tests, set out or referenced in the Exhibits.

(www) "**Technical Specifications**" or "**Specifications**" means the document contained in Exhibit 1 – Scope of Work.

(xxx) "**Term**" has the meaning ascribed thereto in **Article 1.18**.

(yyy) "**Warranty**" means Contractor's obligations set out in **Article 17**.

(zzz) "**Warranty Period**" and "**Warranty Periods**" have the meaning ascribed thereto in **Article 17.1**.

(aaaa) "**Warranty Work**" has the meaning ascribed thereto in **Article 17.5**.

(bbbb) "**Work**" means all design, engineering, labour, services and obligations to be performed and materials, equipment and products to be supplied by Contractor under the terms of this Agreement, as more particularly described in **Article 3** and Exhibit 1 – Scope of Work, including Changes and the provision of all Personnel, plant, supplies, facilities, documentation, records and other items necessary to the performance of such design, engineering, labour, services and obligations. Notwithstanding the above, the Work does not include the design, manufacture and transport to Site laydown area of the equipment and items supplied by Company.

(cccc) "**Worksite**" means any lands, waters and any other places on, under, over, in or through which the Work is to be performed, including design offices, workshops, onshore facilities, factories, fabrication facilities and places where Contractor Items are obtained, stored or used for the purposes of this Agreement.

- 1.3 The doctrine of *contra proferentem* shall not apply in the interpretation of this Agreement, meaning that if there is any ambiguous language in this Agreement it shall not be interpreted more strongly against the Party who prepared or drafted the ambiguous language.
- 1.4 Where reference is made to a direction, response, act, decision, determination, consent, waiver, approval, notice, request, or other communication of Company or to matters which must be satisfactory to Company, then, unless otherwise expressly stated, that matter is to be conducted or carried out at the sole discretion of Company.
- 1.5 Reference to any Party includes that Party's executors, administrators, substitutes (including persons taking by novation), successors and permitted assigns.
- 1.6 If an action pertaining to the administration of this Agreement, to Notices or to Disputes is required to be completed on a specified day which is not a Business Day, then the action shall be completed instead on the next Business Day.
- 1.7 Whenever in this Agreement the singular member or a masculine gender occurs the same shall be respectively construed as the plural, feminine or neuter and vice versa as the context or reference may require. Where a word is defined in this Agreement, a derivative of that word shall have a corresponding meaning.



- 1.8 Unless the context otherwise requires, reference to any Article is a reference to an Article or paragraph in this Agreement, and any reference to a Section is a reference to a Section or paragraph in an Exhibit.
- 1.9 The titles, headings, captions or indices shall not be used in any way in construing or interpreting any provisions of this Agreement.
- 1.10 Except as otherwise defined in this Agreement, words and abbreviations which have well known technical or trade meanings are used in the Agreement in accordance with such recognized meanings.
- 1.11 The recitals form part of and are incorporated into this Agreement.
- 1.12 The words "includes" and "including", whether or not used with the words "without limitation" or "but not limited to", shall not be construed to be limited by the specific enumeration of items but shall in all cases be without limitation and construed and interpreted to mean "includes without limitation" and "including without limitation".
- 1.13 Reference to any Act or legislation, or to a provision of an Act or legislation, is to the Act or legislation as amended and includes any statutory modification or re-enactment of it, a legislative provision substituted for it and any regulation, subordinate legislation or other statutory instrument issued under it.
- 1.14 If any provision in the Exhibits conflicts with a provision in the Articles of this Agreement, the provision in the Articles of this Agreement shall prevail. In the event that any provision in any of the Exhibits conflicts with any other provision in the Exhibits, priority shall be given in the order listed as follows:
- (a) Exhibit 1 - Scope of Work
 - (b) Exhibit 9 – Interface and Milestone Schedule
 - (c) Exhibit 2 – Compensation
 - (d) Exhibit 11 – Owner Supplied Documents
 - (e) Exhibit 7 - Quality Requirements
 - (f) Exhibit 3 - Coordination Procedures
 - (g) Exhibit 4 – Supplier Document Requirement List
 - (h) the remaining Exhibits in their numerical order by Exhibit number

except in respect of Technical Requirements, in which case the more stringent provision will prevail.

- 1.15 If the Standard of a Prudent Contractor conflicts with any other provision in this Agreement, the other provision in the Agreement shall prevail. Contractor shall give Notice to Company of any standard or requirement in this Agreement that Contractor considers is less stringent than the Standard of a Prudent Contractor.
- 1.16 The language of this Agreement shall be English and all communications and dealings under and the resolution of any disputes concerning this Agreement shall be conducted in the English language. All information, data or documentation of any nature that Contractor prepares in the performance of the Work, is required to submit to Company or is requested by Company to submit, shall be prepared in English.
- 1.17 Any Approval by Company or Acceptance by Company shall not waive Contractor's obligations under Applicable Laws or as outlined in this Agreement.
- 1.18 This Agreement shall be effective from the Effective Date and shall remain in full force and effect until the Work, and all Warranty obligations, is complete (the "Term"), unless earlier terminated in accordance with the provisions of this Agreement.
- 1.19 The illegality or unenforceability of any provision of this Agreement shall in no way affect the legality or enforceability of any other provision hereof. Any illegal or unenforceable provision shall be deemed severed from this Agreement and the remainder of this Agreement shall be construed and enforced as if this Agreement did not contain such illegal or unenforceable provision.
- 1.20 This Agreement shall be construed and the relations between the Parties determined in accordance with the Applicable Laws of Newfoundland and Labrador and Canada, including any limitation periods, and reference to such Applicable Laws shall not, by application of conflict of laws rules or otherwise, require the application of the Applicable Laws in force in any jurisdiction other than Newfoundland and Labrador. The Parties hereby irrevocably attorn to the Courts of the Province of Newfoundland and Labrador and Canada for the resolution of any dispute arising hereunder.
- 1.21 Except as expressly provided in the Agreement (including in the case of warranty and liquidated damages for delay) the rights and recourse of Company and Contractor contained in the Agreement are cumulative and not in the alternative unless otherwise provided. The exercise of any such rights or recourse shall not constitute a waiver or renunciation of any other rights or recourse. Except as expressly provided in the Agreement (including for the warranty and delay liquidated damages), the obligations imposed by the Agreement and the rights and remedies available thereunder are in addition to and not a limitation of any obligations, rights and remedies otherwise imposed or available by law.
- 1.22 Company is entering into this Agreement, and Contractor acknowledges that Company is entering into this Agreement, solely in its own right and not on behalf of or as agent of the Crown in right of the Province of Newfoundland and Labrador.
- 1.23 If Contractor is a joint venture or partnership of two or more Persons, all such Persons shall sign this Agreement and shall be jointly and severally liable to Company for all liabilities,



indemnities and obligations of Contractor under, and relating to, this Agreement. Such Persons shall designate in writing one of them to act as a partner in charge with authority to bind the joint venture or partnership, as the case may be. The composition or the constitution of the joint venture or partnership, as the case may be, shall not be altered without the prior consent of Company. If requested by Company, Contractor shall provide to Company a copy of the joint venture agreement or partnership agreement, as applicable, excluding its financial terms, and such agreement shall be subject to the provisions of **Article 28**.

1.24 OWNER

Contractor acknowledges that the ultimate user of the Work is Owner. Accordingly, the following shall apply, whether or not expressly stated elsewhere in this Agreement:

- (a) Contractor's warranties hereunder shall flow directly in favour of the Owner upon written notice by Company to Contractor of the assignment of the warranties to Owner. Until such notice has been given, such rights shall enure to the benefit of Company and Company shall have the right to enforce such warranties. This direct warranty to the Owner shall be in a form acceptable to Company;
- (b) All other rights of Company hereunder, including without limitation rights with respect to patents, trademarks, copyrights and other intellectual property, shall flow directly in favour of Owner upon written notice by Company to Contractor of the assignment of such rights. Until such notice has been given, such rights shall enure to the benefit of Company and Company shall have the right to enforce such rights;
- (c) Wherever this Agreement sets out obligations on the part of Contractor to indemnify and hold Company harmless, these shall be read also as enuring to the benefit of Owner upon written notice by Company to Contractor of the assignment of such rights. Until such notice has been given, such rights shall continue to enure to the benefit of Company and Company shall have the right to enforce such rights;
- (d) Wherever this Agreement sets out rights which Company may exercise, such as to audit books, records, expense reports and accounts, to audit and inspect worksites, or monitor Work in progress, or attend or participate in tests and inspections or to assign personnel to Contractor offices or facilities, such rights shall be read as applying also to the Owner where so notified in writing to Contractor by Company;
- (e) Company shall be deemed to be acting reasonably whenever, in making a decision or determination, or implementing a directive under this Agreement, it is implementing a correlative decision, determination or directive of the Owner under the upstream Supply and Install Agreement;
- (f) Owner Obligations:
 - (i) To the extent Owner is stated hereunder to be under any obligation unto Company or Company is in any way stated to benefit from any entitlement,



under the Supply and Install Agreement, from the Owner and such obligation or entitlement is related to the Work hereunder or the rights and obligations of Contractor, such entitlement or obligation shall for the purposes hereof be referred to as an Owner Obligation.

- (ii) In the event the Owner does not comply with any Owner Obligation, Contractor may upon the occurrence of such event or circumstance give notice of the same to Company. Such notice shall include full details of the relevant event or circumstance and such supporting documentation and information as Company may require. Contractor shall give such notice as soon as reasonably practical after it becomes aware of the event or circumstance and, unless Company elects to inform Contractor under Article 1.25(f)(iii) below, the Company's sole and exclusive obligation shall be to submit the issue to dispute resolution pursuant to Article 39.5 – *Consolidated Disputes*. For clarity, Company shall not be entitled to receive any entitlement or benefit in respect of the Owner's Obligation unless and until Company has received such entitlement or benefit from Owner.
- (iii) Within five (5) business days of receipt of the notice referred to in Article 1.24(f)(ii) above (or if Company reasonably requests further information with respect to the Owner Obligation, within five (5) business days of receipt by Company of such further information), Company may, in its sole discretion, inform Contractor that, in its view, it does not consider that the event(s) or circumstance(s) referred to in the notice may reasonably give rise or might reasonably have given rise to make a claim against Owner, provided that, if Contractor does not agree with Company, such matter may be referred to dispute resolution pursuant to Articles 39.1-39.4.

1.25 Unauthorized Contact with Owner

Except in the presence of Company, at the written direction of Company, with the prior written consent of Company in each instance, or as otherwise set out in Exhibit 3- Appendix A – *Coordination Procedures*, herein, neither the Contractor, the Contractor's Representative nor any other member of the Contractor Group or their respective Representatives, shall meet or otherwise communicate with Owner, any member of the Owner's Other Contractor's or the Company's Other Contractors or any of the Representatives of the foregoing.

ARTICLE 2 CONTRACTOR'S STATUS

- 2.1 In the performance of its obligations under this Agreement, Contractor is an independent contractor and neither Contractor nor Contractor's Personnel shall be employees of Company. Contractor's Personnel shall be under the direct supervision and control of Contractor and not of Company. Contractor accepts complete responsibility as the principal for Contractor's Personnel.



- 2.2 Contractor is not an agent of Company or an agent of any Affiliate of Company. Contractor shall not represent or hold itself out as an agent of Company or an agent of any Affiliate of Company.
- 2.3 This Agreement shall not constitute a joint venture or partnership of Company and Contractor or of Company and any Subcontractor.
- 2.4 Contractor acknowledges that it shall be carrying on business in the Province of Newfoundland and Labrador during the performance of the Work and agrees to comply with the registration and other relevant provisions of the *Corporations Act*, RSNL 1990, c. C-36.

ARTICLE 3
CONTRACTOR'S OBLIGATIONS

- 3.1 Contractor shall carry out all of its obligations under this Agreement and shall perform the Work, including:
- (a) any necessary design or engineering which is the responsibility of Contractor under this Agreement;
 - (b) all work required for the procurement, fabrication, manufacturing, construction, testing, transport, delivery, maintenance, storage, documentation, preservation, installation, commissioning, repair and remediation of the Work;
 - (c) provision of all supervision, services, labour, trades, drafting, accounting, purchasing, expediting, inspection, testing, Personnel, Contractor's Items, transportation, mobilization and demobilization required for the compliance with and fulfillment of all Contractor's obligations under this Agreement;
 - (d) provision and installation of all equipment, products and materials required by this Agreement at the Site;
 - (e) ensuring the Work conforms strictly as to quality and description with the particulars stated in Exhibit 1 - Scope of Work and Company Supplied Data and complies with all Applicable Laws;
 - (f) satisfaction of the performance requirements set out in Exhibit 1 – Scope of Work;
 - (g) provision of all documents as required under, and in accordance with, the terms of this Agreement;
 - (h) provision of any work not expressly detailed in this Agreement, but which is necessary for the performance of the Work in accordance with this Agreement;

- (i) rectification of any and all deficiencies as noted by Company, or any Authority before the start of the relevant Warranty Period and after such date as provided for in accordance with the Warranty; and
 - (j) completing the Work, and portions thereof, in accordance with Exhibit 9 - Interface and Milestone Schedule.
- 3.2 Contractor shall review and verify the details contained in the Exhibit 1 - Scope of Work, and Exhibit 11 - Owner Supplied Documents and represents that it has a full knowledge and understanding of the nature and the scope of the Work, and including weather and all other conditions at Worksites, excluding subsurface, geological and hydrological conditions, Contractor should reasonably have discovered based on the Standard of Prudent Contractor. Contractor shall advise Company of any errors, omissions and inconsistencies in this Agreement which Contractor should reasonably discover based on the Standard of Prudent Contractor and shall not proceed with any part of the Work affected by such until resolved by Company.
- 3.3 Contractor shall ensure the work it performs is sufficient to encompass all matters necessary for the proper and efficient fulfillment of Contractor's obligations under this Agreement. Without limitation, Contractor shall undertake the Work in accordance with Applicable Laws, this Agreement and as required by any Authority.
- 3.4 Contractor shall perform the Work to the Standard of a Prudent Contractor and shall ensure that Subcontractors shall perform to the same standard. Any material failure or any refusal or inability of Contractor to comply with the foregoing requirements shall constitute a breach of the terms and conditions of this Agreement. Contractor shall be solely responsible for any operations comprising the Work performed by Contractor Group.
- 3.5 Subject to **Article 10.3**, Contractor shall obtain and maintain all directions, guidelines, permits, certificates, authorizations, dispensations and licences of any type whatsoever necessary for the performance of the Work and shall comply with all Applicable Laws and requirements of Authorities. Contractor shall promptly notify Company in writing upon any discovery of a failure to adhere to the foregoing requirements in connection with the performance of the Work hereunder and shall defend, indemnify and hold Company Group harmless from and against all fines and penalties, as well as costs, expenses, rates and charges of Contractor Group and third parties, resulting from the failure of Contractor Group to comply with the foregoing requirements.
- 3.6 Contractor shall assist Company and provide necessary information and documents to support Company fulfilling Company's obligations set out in **Article 10.3** as well with respect to any matter herein stated to be required to be notified to or submitted by Company to Owner, the Owner's Representative or any third party.
- 3.7 Contractor shall comply with all lawful instructions of Company or Owner, as permitted herein, pertaining to the performance of the Work, as communicated through the Company Representative, or otherwise in accordance with this Agreement. The absence of instructions from Company shall not permit Contractor to avoid its duty to perform its




obligations under this Agreement. If Contractor fails to comply with a lawful instruction, then Company may at Contractor's sole risk and cost take whatever measures Company considers necessary to implement the instruction.

- 3.8 Company and Contractor shall cooperate with Company's Other Contractors, Personnel of Company Group, Owner, Owner's Other Contractors and Personnel of Owner Groupworking at the Worksites with a view to reducing interference with Company's Other Contractors, Company Personnel, Owner, Owner's Other Contractors or with the operations of Company or Owner.
- 3.9 Contractor shall at all times promptly take all steps necessary to maintain good labour relations with Contractor Personnel to the extent that such requirement is consistent with sound business practice in accordance with the Standard of a Prudent Contractor. Subject to **Article 31.1(c)**, the existence of any labour disturbance relating to Contractor Personnel shall not relieve Contractor of its obligations hereunder.
- 3.10 Contractor shall transfer all unused excess materials which could be made part of the permanent Work, if any, to Company at the completion of the Work or, at Company's option, such excess materials shall be sold by Contractor and any amounts realized from such sales shall be credited to Company as a deduction from the Contract Price.
- 3.11 Contractor shall take such action as Company and/or Owner may specify to enable Company and/or Owner to comply with all Applicable Laws to be complied with by Company and in particular, Applicable Laws governing the use of local personnel, goods and services, which are in effect or which may come into effect during the Term.
- 3.12 Subject to **Article 6.2**, Contractor shall not change any location or place of origin identified in the Agreement for fabrication, manufacture or sourcing of equipment, materials or products without the prior Approval of Company.
- 3.13 Contractor shall be responsible, at its cost, for maintaining such inventories of Contractor's Items as necessary so as to avoid interruptions in the performance of the Work.
- 3.14 Contractor shall not commence any Work involving permanent installation of any equipment, materials or products until Contractor has submitted to Company Representative and Company Representative has Accepted the health, safety and environmental plans required by **Article 15** and drawings marked "Issued for Construction" for the part of the Work to be performed.
- 3.15 Contractor agrees that all Contractors' Items may be subject to inspection and Acceptance from time to time by Company, Owner or any Owner appointee. Any Contractor Item which is rejected for not performing to standards set out in this Agreement or by Applicable Laws shall be immediately removed from the Worksite by Contractor and replaced with Contractor's Items performing to standards set out in this Agreement or by Applicable Laws at Contractor's cost.

ARTICLE 4
CONTRACTOR'S DESIGN OBLIGATIONS

- 4.1 The provisions of this **Article 4** shall only apply to any design, engineering or architectural requirements that are the responsibility of Contractor under this Agreement.
- 4.2 All parts of the Work required by Applicable Laws to be performed by licensed or registered professional engineers or architects shall be performed by registered professional engineers and architects. In particular, any drawings, including design, installation and construction drawings, specific to the Province of Newfoundland and Labrador must be stamped by professional engineers registered to practice in the Province of Newfoundland and Labrador.
- 4.3 In the engineering and design of any equipment, products or materials to be incorporated into the Work and in the performance of the Work, Contractor shall exercise the standard of care normally exercised by licensed or registered professional engineers or architects having specialized knowledge, expertise and experience in the design of similar work.
- 4.4 For all engineering and design Contractor Group shall employ only engineering and design personnel who have the requisite knowledge and skills through education, training and experience to perform the engineering and design assigned to them.
- 4.5 Contractor shall design and engineer the Work for a useful life that is not less than the minimum stated in the Technical Requirements.
- 4.6 Before the start of the relevant Warranty Period, Contractor shall promptly remedy any error, omission, ambiguity, inconsistency or inadequacy in engineering or design identified by Company in any Work and, after such date, as provided for in accordance with the Warranty.
- 4.7 Engineering and design review meetings will be scheduled and coordinated by Company in accordance with the provisions of Exhibit 3 – Coordination Procedures. Contractor shall attend all such engineering and design review meetings.
- 4.8 Contractor shall be solely responsible for all design and engineering for the Work for which it is responsible under this Agreement. Contractor shall not be relieved of its obligations under this Agreement by virtue of any Approval by Company or Acceptance by Company of Contractor's design and engineering or by virtue of a design and engineering review by Company Group.

ARTICLE 5
CONTRACTOR'S PERSONNEL

- 5.1 Contractor shall furnish and procure the numbers and classifications of Contractor's Personnel required to perform the Work. In the event Contractor fails to provide the numbers or classifications of Contractor's Personnel required in respect of the Work, Company may, at Contractor's sole expense, retain other contractors and deduct the costs associated with retaining such other contractors from the applicable compensation payable



by Company to Contractor for the period such positions remain unfilled by Contractor. In such circumstances, Contractor shall assume, indemnify and save Company harmless for all liabilities associated with the retention of such other contractors.

- 5.2 Contractor shall ensure that throughout the Term each of Contractor's Personnel has the qualifications, training and experience, and holds the licenses and certifications necessary to carry out assigned duties in the performance of the Work. Contractor shall furnish records of competence for all of Contractor's Personnel when requested to do so by Company.
- 5.3 Contractor shall immediately remove and/or replace, at Contractor's own expense, any of Contractor's Personnel if, in the sole judgment of Company, any of Contractor's Personnel:
- (a) ceases to carry out his or her duties in a manner satisfactory to Company or engages in misconduct, unsafe activities, or is incompetent or negligent;
 - (b) is certified by a medical practitioner as being medically unfit for the duties required of him or her; or
 - (c) risks impairing his or her usefulness in the performance of his or her duties through the use of alcohol or drugs.
- 5.4 Unless otherwise Approved by Company, Contractor shall replace, or cause to be replaced, at Contractor's own expense, any of Contractor's Personnel who is transferred or dismissed by Contractor or any Subcontractor, or leaves Contractor's or Subcontractor's employ.
- 5.5 Contractor shall nominate in writing one of Contractor's Personnel as Contractor's Representative. Contractor's Representative shall:
- (a) be in charge of Contractor's Personnel and shall supervise Contractor's Personnel and maintain strict discipline in order to ensure the timely and efficient performance of the Work, and shall notify Company in writing of the occurrence of or threat of any labour dispute involving Contractor's Personnel;
 - (b) have full authority to act on behalf of and bind Contractor on all labour and Contractor's Personnel issues which arise between Company and Contractor;
 - (c) supervise the performance of the Work;
 - (d) have the authority to commit Contractor to any course of action within the bounds of its rights and obligations under this Agreement; and
 - (e) be authorized to receive on behalf of Contractor any Notices, information or decisions of Company made pursuant to this Agreement.
- 5.6 If positions of Contractor's Personnel of key importance to the performance of the Work are listed in Exhibit 3 – Coordination Procedures, Contractor shall not change any Personnel in such positions without the prior Approval of Company. In the event any such key Personnel leave the service of Contractor, Contractor shall promptly use all commercially reasonable

efforts to retain suitably trained and experienced replacement key Personnel. In such circumstances, Company shall have the right, which shall be reasonably exercised by Company, to Approve such key Personnel. Contractor shall not retain such replacement key Personnel on a permanent basis without first obtaining Company's Approval, which shall not be unreasonably withheld or delayed.

- 5.7 Contractor shall be responsible for, and shall defend (and may settle with the Approval of Company, which Approval shall not be unreasonably withheld), protect, release, indemnify and hold Company Group and Owner Group harmless from and against all Claims of any nature incurred by Company Group in connection with the payment of Contractor's Personnel, including all compensation, medical costs, Taxes (including all Canadian and foreign payroll and withholding Taxes and remittances), unemployment insurance premiums, Canada pension plan contributions and other benefits of whatever nature or as may be applicable in any jurisdiction (including any jurisdiction where the Work is performed or where the Personnel reside or are employed) provided Contractor is given reasonable notice of any such Claim.

ARTICLE 6 SUBCONTRACTS

- 6.1 Subject to **Article 6.2** and **Article 6.3**, Contractor may employ Subcontractors to perform or support the performance of the Work or to furnish equipment to be provided by Contractor hereunder.
- 6.2 Contractor shall not Subcontract the whole of the Work. Subject to **Article 6.3**, Contractor may Subcontract for the supply of materials, services and minor fabrication for any single Subcontract up to a value of two hundred thousand dollars (\$200,000.00), without Company's prior Approval. Contractor shall obtain Company's Approval for any Subcontract with a value in excess of two hundred thousand dollars (\$200,000.00).
- 6.3 Subcontractors that are identified in Exhibit 8 – Subcontractors, Manufacturers and Material Sources are Approved by Company. Contractor shall not be entitled to replace Approved Subcontractors without the prior Approval of Company, which Approval shall not be unreasonably withheld. Contractor shall notify Company of its intent to replace an Approved Subcontractor. Company shall notify Contractor of its Approval or non-Approval within 7 days following Contractor's Notice, otherwise such replacement shall be deemed Approved.
- 6.4 Any Subcontract permitted under this **Article 6** shall not relieve Contractor of any of its duties, obligations, warranties, liabilities or responsibilities under this Agreement. Contractor shall be responsible for the acts, omissions and negligence of any delegate and any Subcontractors and any of their respective Personnel as fully as if they were the acts, omissions or negligence of Contractor's own Personnel.
- 6.5 Contractor shall oversee the performance of all Subcontractors and delegates and keep such records and accounts and furnish such reports and information relative to Subcontractors as

Company may reasonably request. No Subcontract shall bind or purport to bind Company. All Subcontracts shall contain:

- (a) a clear statement that Contractor is entering into such Subcontracts as principal and not as agent for any other Person; and
 - (b) a provision permitting the assignment of the Subcontract by Contractor to Company, at Company's option, without consent of Subcontractor.
- 6.6 Contractor shall ensure that any provisions of this Agreement which are required to be included in its Subcontracts have been so included. Contractor shall preserve and protect the rights of Company under this Agreement with respect to the Work to be performed by any Subcontractors so that the subcontracting thereof shall not prejudice such rights.
- 6.7 Contractor shall be responsible for, and shall defend (and may settle with the Approval of Company, which Approval shall not be unreasonably withheld), protect, release, indemnify and hold Company and Owner harmless from and against all Claims of any nature incurred by Company in connection with the payment of Subcontractor or Subcontractor's Personnel, including all compensation, medical costs, Taxes (including all Canadian and foreign payroll and withholding Taxes and remittances), unemployment insurance premiums, Canada pension plan contributions and other benefits of whatever nature or as may be applicable in any jurisdiction (including any jurisdiction where the Work is performed or where the Personnel reside or are employed) provided Contractor is given reasonable notice of any such Claim.

ARTICLE 7 PERFORMANCE SECURITY

- 7.1 Contractor shall deliver to Company within fifteen (15) Business Days of the Effective Date a performance bond and a payment and material payment bond using the forms CCDC 221 – 2002 and CCDC 222 – 2002 respectively (attached as Exhibit 14), which complies with Article 7.2 ("**Performance Bonds**"). Contractor shall maintain any such Performance Bonds at all times until two years following the date shown for completion of the Work on the Final Completion Certificate issued pursuant to Article 25.
- 7.2 The Performance Bonds required pursuant to **Article** Error! Reference source not found., shall:
- (a) be in effect as of the Effective Date;
 - (b) bond all of Contractor's obligations under this Agreement;
 - (c) strictly conform to the forms CCDC 221 – 2002 and CCDC 222 – 2002 (attached as Exhibit 14);

- (d) each be in the face amount of fifty percent (50%) of the Contract Price, prepaid and non-cancellable by the surety;
 - (e) be issued by a surety which has a minimum credit rating of A- by Standard & Poor's, or equivalent rating by Moody's, DBRS or Fitch; and
 - (f) include a guarantee for correction of faulty workmanship and construction deficiencies for a period of two (2) years from the date shown for completion of the Work on the Final Completion Certificate issued pursuant to **Article 25**.
- 7.3 The price for the Performance Bonds is the documented amount invoiced by the Surety to the Contractor plus five percent (5%), which is not included in the Contract Price and shall be paid to Contractor upon delivery to Company of the Performance Bonds together with a certified copy of the Surety's invoice. Increases in the Contract Price will result in an adjustment of the applicable premium payable to the Surety, such increase to be assumed by the Company via the payment of a surcharge to the Surety, provided, however, that no such surcharge shall be payable if the increase is less than five percent (5%) of the Contract Price or if the contract terminates within fifty (50) months of the issuance of the Performance Bonds.

ARTICLE 8 POLICY ON ETHICS/CONFLICTS OF INTEREST

- 8.1 Contractor, in performing its obligations under this Agreement, shall establish and maintain appropriate business standards, procedures and controls including those necessary to avoid any real or apparent impropriety or adverse impact on the interests of Company and its Affiliates. Company reserves the right to review such standards and procedures at any time during the Term.
- 8.2 Contractor agrees to perform the Work and to conduct its operations in a manner which is in accordance with all Applicable Laws, consistent with the highest of ethical standards, including the Nalcor Code of Business Conduct and Ethics set out in Exhibit 11 – Owner Supplied Documents, and to avoid any unlawful or unethical intervention in the political affairs of any country. Contractor agrees to cause all Subcontractors to adopt and enforce the foregoing policy.
- 8.3 Contractor shall not pay any commission or fee, or grant any rebate or make any loan to any Personnel of Company Group, Personnel of Owner or government official, or favour any Personnel of Company Group, Personnel of Owner or government official with any gift or entertainment of significant value or enter into any business arrangement with any Personnel of Company Group, Personnel of Owner or government official. Contractor agrees to cause all Subcontractors engaged in the performance of the Work to adopt and enforce the foregoing policy.



**ARTICLE 9
COMPLIANCE WITH LAWS**

- 9.1 In performing the Work and carrying out the provisions of this Agreement, Contractor shall comply with all Applicable Laws.
- 9.2 Company may from time to time require Contractor to provide to Company, and Contractor shall promptly so provide, evidence acceptable to Company that Contractor has in all respects complied with the obligations set forth in **Article 9.1**.
- 9.3 Subject to **Article 21.4**, Contractor shall defend (and may settle with the Approval of Company, which Approval shall not be unreasonably withheld), protect, release, indemnify and hold Company harmless from and against all Claims whatsoever, whether direct or indirect, which may be brought against Company or which Company may sustain, pay or incur as a result of any failure by Contractor to comply with its obligations under **Article 9.1** and **Article 9.2** provided Contractor is given reasonable notice of any such Claim.

**ARTICLE 10
COMPANY'S OBLIGATIONS**

- 10.1 Subject to the provisions of this Agreement, Company agrees to engage Contractor to perform the Work in accordance with the terms of this Agreement.
- 10.2 Company, through the Company Representative, shall provide to Contractor such instructions and information which can only be provided by Company. The provision of any such instructions or information shall not in any way relieve Contractor of any of its obligations under this Agreement.
- 10.3 Contractor acknowledges that pursuant to section 10.3 of the Supply and Install Agreement, Owner shall obtain all authorizations, permits and licenses required by Applicable Laws for the performance of the Work and which are required to be and can only be obtained in Owner's name.
- 10.4 Company shall designate a Company Representative who shall have authority to act on behalf of Company, commit Company regarding matters under the Agreement, receive and issue Notices and perform such other duties and acts reserved to the Company Representative under this Agreement. Contractor shall comply with the decisions, orders and instructions given by Company Representative in accordance with this Agreement. Company Representative shall confirm any decision, order or instruction in writing and any decision, order or instruction shall not be effective until such written confirmation has been received by Contractor. Company Representative shall be the interpreter of first instance of this Agreement.
- 10.5 Company Representative shall at all times during the Term have access to Contractor's Items and Worksites and may without limitation monitor the performance of the Work.

Contractor agrees that all Contractors' Items may be subject to inspection and Acceptance from time to time by Company Representative, Owner's Representative or any Authority. Any Contractor's Items which are rejected for not performing to standards set out in this Agreement or by Applicable Laws shall be immediately removed from the Worksite by Contractor and replaced with Contractor's Items Acceptable to Company Representative at Contractor's cost.

- 10.6 The Company Representative, by Notice to Contractor, may delegate any of their respective authority to any nominated deputy. Such Notice shall specify the precise authority of such deputy.
- 10.7 Company may change the Company Representative at any time at its sole discretion by Notice to Contractor.
- 10.8 Company will supply and deliver DAP Site laydown area (Incoterms 2010) specific equipment, products and materials for pick up (Contractor will use Company's crane at the laydown area so Contractor can load its trucks as needed) and installation by Contractor in accordance with Exhibit 1 - Scope of Work, , Exhibit 11 – Owner Supplied Documents and Exhibit 15 – Company Equipment Delivery Schedule. Any such equipment, products or materials supplied by Company to Contractor shall be in the care and custody of Contractor in accordance with Article 23 but shall remain the property of Company. Contractor shall not use any such equipment, products and materials supplied by Company except for the purpose for which they were intended under this Agreement, and Contractor shall be responsible for the proper care, handling and maintenance of all such equipment and materials and shall indemnify Company against any loss or damage.
- 10.9 Company Representative shall notify Contractor when the Site is available for permanent installation of any equipment, materials or products as part of the Work, and Contractor shall not commence any Work at the Site until such notification has been given.
- 10.10 Where the Agreement calls for the Acceptance or Approval by Company, Company's Representative, Owner or Owner's Representative or by any authorized Authority with respect to design, manufacture, installation, testing and commissioning of the Work, any such Acceptance or Approval is for general compliance with the Technical Requirements and does not relieve Contractor from satisfying all Technical Requirements. No inspection, review, Approval or Acceptance by Company Company's Representative, Owner or Owner's Representative or by any authorized Authority shall constitute a waiver, or acceptance nor shall it release Contractor from compliance with Contractor's obligations under this Agreement or Applicable Law.
- 10.11 Company shall review and comment on Contractor's submittals required as per Exhibit 4 – Supplier Document Requirements, document no. 505573-3321-45EL-0002 and Exhibit 11 – Owner Supplied Documents, document no. 505573-0000-37AG-I-0015, Rev 03 within twenty five (25) Business Days from the date Contractor submitted each of such submittals to Company.



**ARTICLE 11
NOT USED**

**ARTICLE 12
COMPENSATION AND TERMS OF PAYMENT**

- 12.1 As full compensation for the performance by Contractor of all its obligations under this Agreement, Company shall pay Contractor the Contract Price in accordance with the terms of this Agreement including Article 12, Exhibit 2 – Compensation and Exhibit 3 – Coordination Procedures. Only those rates and prices specifically identified in Exhibit 2 – Compensation shall be paid by Company and any costs not specifically identified in Exhibit 2 – Compensation shall be deemed to be included in such rates and prices.
- 12.2 Within thirty (30) days of the Effective Date, Company shall provide Contractor with a pro forma invoice that sets out all relevant Company cost codes and required information for billing. Contractor shall utilize said pro forma invoice and cost codes when billing Company.
- 12.3 Subject to Article 12.4 below, Compensation to Contractor shall be paid:
- (a) for installation Work (the sum of items 2.1, 3.3, 3.4, 4.3 and 4.4 of Appendix A to Exhibit 2- Compensation) monthly based on progress, and/or
 - (b) for supply Work (the sum of items 3.1, 3.2, 4.1 and 4.2 of Appendix A to Exhibit 2, Compensation) upon achieving a Payment Milestone,
- as further specified in Exhibit 2 – Compensation. Contractor shall be paid the portion of the Contract Price applicable to monthly progress or to a Payment Milestone following Approval by Company of a Payment Certificate and in accordance with the provisions of this Article 12.
- 12.4 Contractor shall provide, maintain and issue to Company, a detailed listing of the invoiced amounts of the Work and cash flow requirements regarding unbilled portions of the Work in accordance with the requirements set out in Exhibit 3 - Coordination Procedures. Contractor shall develop and present a format for the listing for Company Approval.
- 12.5 Contractor's invoices shall comply in all respects with Company's invoicing instructions as provided for in this Agreement, including Exhibit 2 – Compensation, Exhibit 3 – Coordination Procedures and Exhibit 13 - Provincial Benefits.
- 12.6 Invoices shall be accompanied by:
- (a) all relevant supporting documentation as Company may require to verify completion of the Work, the accuracy of the fees, charges and third party charges invoiced including copies of any relevant third party invoices, receipts and purchase orders;

- (b) timesheets Accepted by Company for any Work performed on a time and materials basis;
- (c) receiving reports and a summary page of all third party invoices, complete with summary sheet cross referring to all backup information; and
- (d) a sworn declaration, in the form set out in Exhibit 3 – Coordination Procedures, that Contractor has paid Subcontractors, vendors and suppliers all amounts properly due for work, services, materials and equipment supplied or performed and billed by the Subcontractors, vendors and suppliers and included in Contractor's prior invoices for which Payment Certificates or Milestone Completion Certificates have been Approved by Company.

(All invoicing requirements, information and documentation described in this **Article 12** shall be referred to as the "Billing Information". Billing Information should always comprise a summary sheet with cross referencing to all backup information which demonstrates a clear audit trail substantiating all charges presented on the invoice.)

12.7 Company shall not be required to pay any invoice from Contractor until complete Billing Information has been provided to Company. Company shall not be responsible or liable for any Claim arising from delays in payment due to Contractor not providing complete Billing Information.

12.8 Contractor shall submit an application for payment as follows:

- (a) For compensation based on monthly progress, Contractor shall issue to Company on the 25th day of each month during the performance of the Work, for Company's Approval, a Payment Certificate in the form set forth in Exhibit 3 – Coordination Procedures, that sets out:
 - (i) for Work items paid on a unit price basis, the number of units completed in the current month together with the unit price and total claimed for each unit price item;
 - (ii) for Work items paid on a lump sum basis, the percentage completed in the current month together with the amount claimed for each lump sum item based on the percentage completed less any amounts previously paid by Company for each such item;
 - (iii) for Work items paid on a reimbursable basis, Contractor will include, for Work executed during the current month, such reimbursable items accompanied by appropriate references to the Agreement covering such items and a summary sheet cross referencing such items to all relevant Billing Information to demonstrate a clear audit trail substantiating all such items presented with the Payment Certificate;



and accompanied by all relevant supporting documentation as Company may reasonably require to verify the progress achieved.

- (b) For compensation based on Payment Milestones, when Contractor considers that a Payment Milestone has been completed and the criteria for completion of that particular Milestone have been achieved, it shall issue to Company, for Company's Approval, a Payment Certificate in the form set forth in Exhibit 3 – Coordination Procedures, together with a Milestone Completion Certificate and all relevant supporting documentation as Company may reasonably require to verify the successful completion of the relevant Milestone criteria and achievement of the Payment Milestone.

12.9 Where payment is made for Work items on a unit price basis, the quantities of unit priced items in Exhibit 1 – Scope of Work and Schedule of Unit Prices in Exhibit 2 - Compensation are estimated quantities only. Any increase or decrease in the quantities of Work performed in respect of those items listed in Exhibit 1 – Scope of Work and Schedule of Units Prices in Exhibit 2 – Compensation shall not result in a change in the unit price for those items.

12.10 On receipt of a Payment Certificate, Company shall review it and the supporting documentation to determine if the percentage completed is accurate and/or if the Milestone has been achieved as the case may be. Company shall render its decision within ten (10) Business Days from receipt of a Payment Certificate from Contractor. If Company determines that:

- (a) For Work compensated on a monthly progress basis:
 - (i) the progress claimed in the Payment Certificate has been achieved, Company shall Approve the Payment Certificate; or
 - (ii) the progress claimed has not been achieved, Company shall amend the Payment Certificate to reflect the progress actually achieved and advise Contractor in writing the reasons for the revision, and Approve the revised Payment Certificate; and
- (b) For Work compensated on a Payment Milestone basis:
 - (i) the Milestone has been achieved, Company shall Approve the Payment Certificate; or
 - (ii) the Milestone has not been achieved, Company shall reject the Payment Certificate and advise Contractor in writing the reasons why the Milestone has not been achieved.

- 12.11 Upon receipt of a Payment Certificate Approved by Company, Contractor shall submit an invoice for the amount due as determined in accordance with Exhibit 2 – Compensation and the requirements of Exhibit 3 – Coordination Procedures. The invoice shall be supported by the Approved Payment Certificate and all Billing Information as Company may reasonably require.
- 12.12 Contractor shall address invoices to:
- Andritz Hydro Limited
6100, Transcanada Highway
Pointe Claire, Quebec
H9R 1B9
- ATTENTION: Accounts Payable
- 12.13 If any Change affects the Contract Price, Contractor may issue an invoice for the Work completed pursuant to the applicable Change Order, as follows:
- (a) For Change Orders carried out on a lump sum or unit price basis, Contractor shall comply with the requirements outlined in **Articles 12.5** through **12.12** in the same manner as if the completion of the Change Order Work is payable by monthly progress or constitutes a Payment Milestone.
- (b) For Change Orders carried out on a reimbursable basis, Contractor shall issue an invoice for that portion of the Change completed in the previous month, within ten (10) Days following the end of each month. Invoices in respect of such Changes shall be accompanied by all Billing Information including an executed copy of the relevant Change Order, a copy of time sheets Accepted by Company, daily progress reports and any other information as Company may require to verify the progress, completion and associated charges pertaining to the Change. The final invoice for reimbursable Changes shall also include any information as Company may reasonably require to verify the successful completion of the Change.
- 12.14 If Contractor fails to comply with the requirements of **Article 12.6**, the Work shall be deemed incomplete and Company may withhold monies otherwise payable to Contractor and/or return invoices to Contractor for resubmission until such information has been provided to the satisfaction of Company.
- 12.15 Within thirty (30) days following Company's receipt of a properly prepared invoice, accompanied by acceptable Billing Information in accordance with this **Article 12**, Company shall pay to Contractor the amount stated to be due, subject to all of the following:

- (a) Company shall be entitled to withhold from such payment any amount(s) permitted pursuant to **Article 12.16**.
 - (b) If Company disputes any item charged in any invoice, Company shall notify Contractor of the disputed item specifying the reason therefor. Payment of such disputed item shall be withheld until settlement of the dispute, provided that payment shall be made on the undisputed portion.
 - (c) Company shall be entitled to set off amounts which it owes to Contractor under this Agreement against amounts which Contractor owes to Company under this Agreement or any other agreement
 - (d) For any payments made by Company to Contractor by electronic transfer, Contractor shall provide Company with the necessary banking information to facilitate electronic transfer of funds to Contractor's bank. Any changes in Contractor's banking information or payment instructions shall be submitted in writing to the Company Representative. The Company shall not be held liable or responsible for errors or delays resulting from incorrect or delayed submission of changes in banking instructions.
- 12.16 Company shall be entitled to withhold payment, or to deduct from Contractor's compensation, any amounts associated with:
- (a) invoiced items reasonably disputed by Company;
 - (b) Contractor's failure to make payments promptly to Subcontractors, agents, or suppliers;
 - (c) Contractor's failure to remit or pay any Tax or make any other payment required under Applicable Laws where Company, acting reasonably, determines that any such remittance or payment may be assessed against Company;
 - (d) Defects in the Work not remedied;
 - (e) liens or claims filed or registered against property, or reasonable evidence indicating to Company the probability of claims or liens being filed or registered, with respect to the Work; and
 - (f) any other matter as permitted or required by Applicable Laws or as expressly provided in Exhibit 2 – Compensation, or elsewhere in this Agreement.

- 12.17 If either Party fails to make payments as they become due under the terms of this Agreement or under an award by arbitration or Court, interest at the three (3) month Treasury Bill rate, as published by the Bank of Canada for the period in question, on unpaid amounts will also be due and payable until payment. Interest will apply at the rate and in the manner prescribed by **Article 12.17** on the amount of any claim settled pursuant to **Article 39** from the date the amount would have been due and payable under this Agreement, had it not been in dispute, until the date it is paid.
- 12.18 For greater certainty, Contractor and Company acknowledge that, notwithstanding any other provision of this Agreement, any amounts payable by Company to Contractor pursuant to this **Article 12** are exclusive of any HST as payable pursuant to section 165 of the *Excise Tax Act* (Canada), R.S.C. 1985, c. E-15. If Contractor is required to collect from Company an amount of HST with respect to the provision of any goods or services supplied pursuant to this Agreement, then Company, subject to compliance by Contractor with this **Article 12**, shall pay the amount of such HST to Contractor.
- 12.19 Contractor represents and warrants that it is now and shall remain registered for the purposes of the HST in accordance with Part IX of the *Excise Tax Act* (Canada), R.S.C. 1985, c. E-15, for the Term and that its HST Registration number is **801102153 RT 0001**.
- 12.20 Contractor shall provide, at all times when any HST is required to be collected, such documents and particulars relating to the supply as may be required by Company to substantiate a claim for any input tax credits as may be permitted pursuant to the *Excise Tax Act* (Canada), R.S.C. 1985, c. E-15, in respect of such HST. Without limiting the foregoing, Contractor shall include on all invoices issued pursuant to this **Article 12** all of the following particulars:
- (a) HST registration number of Contractor;
 - (b) the subtotal of all taxable supplies;
 - (c) the applicable HST rate(s) and the amount of HST charged on such taxable supplies; and
 - (d) a subtotal of any amounts charged for any "exempt" or "zero-rated" supplies as defined in Part IX of the *Excise Tax Act* (Canada), R.S.C. 1985, c. E-15.
- 12.21 Notwithstanding any other provision in this Agreement, Company shall not be entitled to deduct or retain from each payment a ten percent (10%) holdback pursuant to the *Mechanics' Lien Act*, R.S.N.L 1990, c.M-3. Contractor waives any and all rights and remedies it may have or obtain under the provisions of the *Mechanics' Lien Act*, RSNL 1990, c.M-3,

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arising from the performance of the Work, including lien rights against any property of the Company and Owner wherever situated. Contractor shall use its best effort to include a provision in its Subcontracts that the Subcontractor waives any right or benefits the Subcontractor may have or obtain under the *Mechanics' Lien Act*, RSNL 1990, c.M-3, arising out of any services, labour, materials, products or equipment supplied or delivered for the Work by the Subcontractor. Contractor shall indemnify and hold Company harmless for any losses and costs suffered or incurred by Company arising out of a failure by Contractor to include such a waiver in Subcontracts.

- 12.22 Company's obligation to pay any amounts to Contractor under this Agreement is subject to the following terms and conditions, which are inserted for the sole benefit of Company and may be waived by Company in whole or in part in respect of any payment, without prejudicing the rights of Company at any time to assert such terms or conditions in respect of any subsequent payment, namely:
- (a) no notice of claim for lien shall have been given in connection with the Work or if a notice of such a claim for lien shall have been given, such claim shall have been released, vacated or, if applicable, removed from title or the claim shall have been secured through the delivery of a bond in respect of the full amount of the claim; and
 - (b) Company shall have received such other documents or satisfied such other conditions as Company may reasonably require and which are material to the Work.; and
- 12.23 The conditions set out in Article 12.4 have been met. If Contractor is requested by Company to travel to Austria for design reviews, Company shall reimburse at cost Contractor's reasonable hotel and air fare expenses.

ARTICLE 13 TAXES

- 13.1 Contractor acknowledges that it shall be carrying on business in the Province of Newfoundland and Labrador (and elsewhere as applicable) during the performance of the Work and agrees to prepare and to file in a timely manner all Tax returns or declarations required by any applicable Authority or Applicable Laws having jurisdiction over this Agreement or any portion thereof. Contractor shall lawfully discharge its Tax obligations.
- 13.2 Subject to the obligation of Company to pay HST pursuant to **Article 12.18**, Contractor shall pay all Tax and shall use its best efforts to ensure payment by Subcontractors of all Tax which may be lawfully assessed upon Owner, Contractor or any Subcontractor by any Authority having jurisdiction over Owner, Contractor, Subcontractor or this Agreement.

- 13.3 Contractor represents that Contractor's residence status for the purposes of Canadian income tax legislation is as set forth in Exhibit 10 – Declaration of Residency. Contractor shall advise Company of the country where Contractor is a resident for income tax purposes and shall give thirty (30) days' Notice to Company and obtain its prior written consent before making or allowing any change to its tax residency status. If Contractor obtains, and provides to Company a copy of, an income tax waiver from the Canada Revenue Agency (CRA) waiving a non-resident tax source deduction as may be required by Canadian income tax legislation, Company agrees not to withhold any such income tax deduction to the extent waived so long as the waiver is and remains in force. In any event, Contractor further agrees to be liable for all such Taxes and shall indemnify Company in respect thereof pursuant to **Article 21.8** of this Agreement.
- 13.4 If required by the Applicable Laws of any country having jurisdiction, Company shall have the right to withhold amounts, at the withholding rate specified by such Applicable Laws any compensation payable for the Work performed by Contractor Group, and any such amounts paid by Company to Owner or to an Authority pursuant to such Applicable Laws shall, to the extent of such payment, be credited against and deducted from amounts otherwise owing to Contractor hereunder. Contractor shall note on each invoice whether any portion of the Work covered by such invoice was performed inside or outside of Canada for the purposes of Canadian income tax legislation or such other information requested or required by Company to properly assess withholding requirements. At the request of Contractor, Company shall deliver to Contractor properly documented evidence of all amounts so withheld which were paid to the proper Authority for the account of Contractor.
- 13.5 Contractor shall supply and arrange for all Contractor's Personnel to supply Company with all information relating to the activities under this Agreement that is necessary to enable Owner, Company or its Affiliates to comply with the lawful demand for information by any Authority. In the event Contractor does not supply or take all steps to arrange for any Subcontractor to supply such information and, as a result, an Authority imposes a Tax or fine upon Owner, Company or any of its Affiliates, Contractor shall forthwith pay or reimburse Owner, Company or any of its Affiliates for such Tax or fine.
- 13.6 Subject to the obligation of Company to pay HST pursuant to **Article 12.18**, the Contract Price shall include, and Contractor shall be responsible for, all Taxes which Contractor or Company is obliged pursuant to Applicable Laws to pay and does pay, for the purchase, sale, importation and exportation of the Work, or Contractor's Items, or personal property of any member of Contractor Group. Except as otherwise expressly provided herein, Contractor shall be the "importer of record" for the purpose of importing into Canada all Contractor's Items and the Work, or any part thereof, and shall pay all Taxes payable in respect of all such importations.
- 13.7 Contractor shall obtain for the benefit of Company all available exemptions from or recoveries of Taxes and shall employ all prudent mitigation strategies to minimize the amounts of Taxes required to be paid in accordance with Applicable Laws. In the event Contractor obtains any rebate, refund or recovery in respect of any such Taxes, it shall

immediately be paid to Company to the extent that such amounts were paid by Company or reimbursed to Contractor by Company.

- 13.8 Notwithstanding any other provision of this Agreement, Contractor Group shall not make any statement, representation, filing, return or settlement regarding Taxes on behalf of Company to an Authority without the prior written consent of Company.
- 13.9 For greater certainty, Contractor and Company acknowledge that, notwithstanding any other provision of this Agreement, any amounts payable by Contractor to Company pursuant to this Agreement are exclusive of any HST payable pursuant to the *Excise Tax Act* (Canada), R.S.C. 1985, c. E-15 or any other Taxes exigible in respect of such amounts payable. If Company is required to collect from Contractor an amount of HST or other Taxes with respect to any such amounts payable pursuant to this Agreement, then Contractor shall pay the amount of such HST or other Taxes to Company. If the amounts payable by Contractor to the Company pursuant to this Agreement are deemed by any Applicable Law to include an amount of HST or other Taxes, the amount otherwise payable pursuant to this Agreement shall be increased to the extent necessary so that the amount payable to the Company, net of such HST or other Taxes, is equal to the amount that would have been payable to the Company if such HST or other Taxes were not deemed to have been included in such amount.
- 13.10 For greater certainty, anti-dumping duties, countervailing duties and the like shall, in all cases, be borne by Contractor. Should any such duties become payable by Company, provided Contractor is notified promptly of such by Company, Contractor shall be liable for and defend (and may settle with Company's Approval, which Approval shall not be unreasonably withheld), protect, release, indemnify and hold Company harmless from and against any such duties, together with any interest, penalties and reasonable costs related thereto, and Contractor shall immediately provide with sufficient funds to pay such duties and other amounts in full.

ARTICLE 14 AUDIT AND RECORDS

- 14.1 Contractor shall maintain, and shall require each Subcontractor to maintain, in accordance with generally accepted accounting principles and practices satisfactory to Company, books, records, expense accounts and accounts pertaining to the provision of the Work, including Contractor's and Subcontractors' personnel records, correspondence, instructions, plans, drawings, receipts, vouchers, memoranda, tapes, data, models, data stored in computer libraries and such other documentation and related systems of controls.
- 14.2 Contractor and Subcontractors shall preserve the documents, records, registers and systems of control described in **Article 14.1** during the provision of the Work and for a period of not less than seven (7) years after expiration or any termination of this Agreement or for such longer period as may be required under Applicable Laws. Thereafter, Contractor shall give no less than sixty (60) days' notice to Company of Contractor's or Subcontractors' intention



to destroy any of said documents and Company shall have the option to take possession of such records.

- 14.3 Company shall, at all times, have access to and be authorized to examine and make copies, including electronic copies, of all documents, records and systems of control set forth in **Article 14.1** and such other documents and systems as may be related and shall be authorized to interview Contractor's Personnel as may be necessary for an accurate audit and verification of general contract compliance.
- 14.4 Notification of any claims made or discrepancies disclosed by an audit performed pursuant to this **Article 14** shall be made in writing to Contractor. Contractor and Company shall diligently attempt to resolve and agree upon such audit claims or discrepancies. Upon an audit claim or discrepancy being resolved and agreed upon, Contractor shall forthwith reimburse Company for any monies due as a result of such agreement or determination. Company may set off any amounts owed to it by Contractor for audit claim or discrepancies against any payments owed to Contractor by Company.
- 14.5 Contractor shall not be reimbursed for any costs it may incur as a result of Company conducting an audit pursuant to this **Article 14**. All such audits shall be conducted during normal business hours of Contractor and Company shall give reasonable notice to Contractor of the audit and shall specify the matters which are the subject of the audit.
- 14.6 Within five (5) Business Days of Notice by Company to Contractor, Contractor shall deliver to Company the most recent annual audited financial statements of Contractor.

ARTICLE 15 HEALTH, SAFETY AND ENVIRONMENTAL PROTECTION

- 15.1 Contractor shall be responsible for ensuring the health and safety of all Contractor's Personnel who are engaged in the performance of the Work and also be responsible for environmental management. Without limiting the foregoing, Contractor shall:
- (a) ensure that all Contractor's Items are maintained in safe, sound and proper condition and capable of performing the function for which each is intended and meets all industry standards and Applicable Laws;
 - (b) cease all activities in the area of any identified health, safety or environmental problem until such problem is resolved;
 - (c) immediately report to Company all health, safety and environmental problems and hazards;
 - (d) provide sufficient supervision, instruction and resources to ensure that Contractor Group's Work execution and Worksites comply with all Applicable Laws and good environmental practices;

- (e) at its own expense and in accordance with Applicable Laws, supply and maintain Contractor's Personnel with personal protective equipment which shall be worn and used on all occasions as indicated by notices, instructions, good practice or as required by risk assessment;
- (f) conduct such drills and tests of Contractor's Items, equipment, Personnel and procedures to ensure that they are available, trained and in place, respectively, for immediate and effective action in the event of emergency;
- (g) comply with Company's emergency response requirements as described in Exhibit 11 – Owner Supplied Documents;
- (h) cooperate fully and comply with any directions given by Authorities, including the police, safety and environment regulatory officials and fire authorities; and
- (i) report to Company monthly training compliance and safety statistics as identified by Company.

15.2 Contractor shall develop and submit to Company for Acceptance a detailed health and safety plan for the Work which demonstrates that, in connection with Contractor's performance of the Work, Contractor has identified risks pertaining to the health and safety of Contractor's Personnel, and that effective controls are implemented to prevent accidents and health and safety threats. Contractor's plan shall:

- (a) satisfy the requirements of Exhibit 5 – Health and Safety Requirements;
- (b) be structured in accordance with various elements within the Work such as fabrication, transportation, installation and commissioning;
- (c) include measurable, achievable targets for health and safety performance, including: lost time frequency; total recordable frequency; injury severity data; and first aid cases;
- (d) comply with Owner's and/or Company's safety policies and procedures set out or described in Exhibit 11 – Owner Supplied Documents; and
- (e) comply with Applicable Laws and Exhibit 3 – Coordination Procedures.

15.3 Contractor shall develop and submit to Company for Acceptance a detailed environmental protection plan for the Work which demonstrates that, in connection with Contractor's performance of the Work at the Site, Contractor has identified risks pertaining to the environment and that effective controls are implemented to prevent threats and damage to the environment. Contractor's plan shall:

- (a) satisfy the requirements of Exhibit 6 – Environmental and Regulatory Compliance Requirements;

90
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- (b) be structured in accordance with various elements within the Work such as fabrication, transportation, installation and commissioning;
 - (c) include measurable, achievable targets for performance, including: performance criteria for environmental emissions and waste, and hazardous materials; and
 - (d) include an environmental management plan that satisfies the Technical Requirements and Applicable Laws.
- 15.4 Company shall Accept Contractor's plans required by **Article 15.2** and **Article 15.3** provided the plans comply with this Agreement, Applicable Laws and any ordinances, orders and decrees of any Authority having jurisdiction over health, safety and environmental compliance of the Work or the Worksite and any other requirements of Company.
- 15.5 Contractor shall comply with all such standards and the provisions of the plans required by **Article 15.2** and **Article 15.3**, along with any changes thereto as Contractor may be notified from time to time by Company, and all Applicable Laws relating to occupational health, safety and environmental protection. Contractor shall ensure that all Contractor's Personnel involved in the performance of the Work comply with the provisions of Contractor's health, safety and environmental plans and all Applicable Laws relating to occupational health, safety, and environmental protection. Contractor shall appoint a safety officer who shall assist Contractor in safety matters relating to Contractor's Personnel.
- 15.6 Contractor shall promptly investigate and report to Company and Authorities having jurisdiction any near miss incidents or any accidents resulting in injury, death or illness to any of Contractor's Personnel engaged in the performance of the Work, any criminal acts, any damage to property or any adverse impact on the environment and any release of substances hazardous to the environment.
- 15.7 Contractor shall submit to Company for Acceptance Contractor's drug and alcohol policy which shall be in compliance with Applicable Laws. Contractor shall ensure that Contractor's Personnel who are engaged in the performance of the Work, are familiar with, and comply with, Contractor's drug and alcohol policy.
- 15.8 Company shall have the right to suspend performance of the Work for as long as necessary to prevent or stop any violation of this **Article 15**. During such period of suspension, Contractor shall not demobilize from the Worksite. No compensation shall be payable to Contractor by Company and Contractor shall not be entitled to compensation for any costs it incurs as a result of the suspension.
- 15.9 Company and Owner each reserves the right to audit and inspect the Worksites to verify compliance with this Agreement, which audits and inspections may be performed by Company or Owner or such other third party as either Company or Owner may direct.
- 15.10 Notwithstanding **Article 40.6**, in the event Company declares an emergency with respect to any matter affecting health, safety, the environment or potential damage to or loss of

property, Contractor shall comply with verbal instructions issued by Company with respect to such emergency. Company shall confirm such instructions in writing at the first reasonable opportunity.

15.11 Subject to Section 2.6 of Exhibit 12 – Site Conditions, Contractor shall exercise all diligence to conduct operations under this Agreement in a manner that will prevent seepage, discharge or escape of debris. Contractor shall be responsible at its own costs to:

- (a) handle, dispose and/or cleanup those hazardous substances included in Contractor's Items;
- (b) handle, dispose and/or cleanup those hazardous substances disposed of or discharged on the Site by Contractor Group from Contractor's Items or other item used by Contractor in the performance of the Work;
- (c) remediate any environmental damage arising from the Work occurring prior to Final Completion, including the removal and cleanup of any pollution, debris and hazardous substances from Contractor's Items;
- (d) take such measures as are necessary in the circumstances to prevent or mitigate any environmental damage resulting from any pollution, seepage or discharge or escape of pollutants, debris and hazardous substances from the Work prior to Final Completion; and
- (e) take such measures that Contractor or Company is under instructions to take from the Owner or any Authority having jurisdiction to so instruct.

15.12 If Contractor:

- (a) encounters hazardous substances at the Site; or
- (b) has reasonable grounds to believe that hazardous substances are present in or on or under any of the Site which are not disclosed in the Exhibit 11 – Owner Supplied Documents or are present in or on or under or migrating from any other sites;

Contractor shall:

- (c) take all reasonable steps to secure such Site, including stopping the Work, to ensure that no individual suffers an injury, sickness or death and that no property is damaged or destroyed as a result of exposure to the presence of the hazardous substances;
- (d) immediately report the circumstances to Company in writing; and
- (e) report the circumstances to Authorities as required by Applicable Laws.

15.13 If hazardous substances are encountered during the Work, Contractor shall employ best practices and methods so as to minimize the costs of any work which may be required to

handle and dispose of the hazardous substances and any environmental cleanup and to meet the requirements of Applicable Laws or Authorities.

**ARTICLE 16
ACCESS AND QUALITY**

- 16.1 Company shall, in accordance with this **Article 16**, have the right to send Company Group Personnel to the Worksites to monitor the progress of the Work, including to any manufacturing facility operated by any member of Contractor's Group where any materials, components, equipment or product is being manufactured, fabricated or assembled for the Work. At all times during the Term, Contractor Group Personnel shall provide all requisite assistance to Company Group Personnel.
- 16.2 Company Group Personnel shall, at all times during the Term, be granted unrestricted right of access to inspect the Work and monitor all the Work in progress or Contractor Items utilized in connection with the creation or construction of the Work for the purpose of determining that the Work is being created or constructed in accordance with this Agreement.
- 16.3 Contractor, with the prior Acceptance of Company, shall permit representatives of Authorities to enter onto and inspect a Worksite, with reasonable advance notice and escorted access to the Work. Contractor may provide, and each such Person shall accept, reasonable safety and security measures implemented by Contractor. Contractor shall also promptly provide information reasonably requested by Company, Authorities or any of their representatives.
- 16.4 Contractor shall include appropriate provisions in all its Subcontracts and purchase orders to ensure the proper enforceability of the provisions of this **Article 16**.
- 16.5 No inspection, representation, responsibility or action of any Company Group Personnel hereunder shall relieve Contractor Group of any of its obligations or liabilities under this Agreement or operate as a waiver or release of the same.
- 16.6 Commencing on the Effective Date and throughout the Term, Contractor shall maintain a Quality Plan in respect of every aspect of the Work in accordance with Exhibit 7 – Quality Requirements.
- 16.7 Notwithstanding any Company, Authority or other third party inspection, testing or witnessing, Contractor shall be responsible for quality control, quality surveillance/inspection, testing and quality assurance of the Work to verify and be able to demonstrate compliance with the requirements of this Agreement. Contractor shall carry out its quality management activities in accordance with Exhibit 7 – Quality Requirements.
- 16.8 Contractor shall conduct tests on the Work in accordance and in compliance with the provisions of Exhibit 1 - Scope of Work, Quality Plan, Contractor's quality management



system, Company Supplied Data and Applicable Laws. Company shall have the right at all times to request and witness any such test on the Work contemplated by this **Article 16.8**.

- 16.9 Contractor shall rectify, at Contractor's sole cost, any failure to comply with the requirements of Exhibit 1 – Scope of Work and Applicable Laws that are identified during testing, commissioning and inspection of the Work.
- 16.10 Upon completion of work necessary to satisfy **Article 16.9** and at the request of Company, Contractor shall re-test the Work at Contractor's sole cost in order to confirm that the requirements of this Agreement are met. Company may further require Contractor to re-test, at Contractor's cost, all the Work similar to that Work which originally failed any tests or inspection unless such similar Work was previously subjected to the same tests and found satisfactory.
- 16.11 Before the relevant Warranty period, Company shall have the right to reject any Work, workmanship, equipment and documentation which do not conform to this Agreement. Contractor shall, at its sole expense, promptly remove any items so rejected and shall, in consultation with Company, immediately repair or replace the same at Contractor's option, providing such repair or replacement satisfies the Technical Requirements. Contractor shall carry out such further inspections or tests on other parts of the Work, as Company may require, to ensure that there are no similar parts of the Work that fail to conform with this Agreement unless such similar Work was previously subjected to the same tests and found satisfactory.

ARTICLE 17 WARRANTY

- 17.1 The warranty periods in respect of the each of the following portions of the Work shall be as follows (collectively, the "**Warranty Periods**" and each, a "**Warranty Period**"):
- (a) for spillway Work, the Warranty Period shall be the period of two (2) years commencing on the date when all stoplogs have been removed and are ready for operation;
 - (b) for all powerhouse draft tube Work, the Warranty Period shall commence when stoplogs are installed in units 1 & 2, bulkheads are installed in units 3 & 4, and when ready for water up of tailrace channel has been achieved and shall extend from that said date until the end of the period of two (2) years following the achievement of (Milestone M22 of the Milestone Schedule);
 - (c) for all intake Work, the Warranty Period shall commence when such intake Work is commissioned and ready for reservoir impoundment and shall extend from that said date until the end of the period of two (2) years following the achievement of Milestone M23 of the Milestone Schedule;
 - (d) for all other Work, the Warranty Period shall commence upon the date of Substantial Completion, such date being determined pursuant to **Article 25.2**, and

shall extend from that said date until the end of the period of two (2) years following the achievement of the date of Substantial Completion set out in the Supply and Install Agreement ("**SIA Substantial Completion**", as such term is more fully defined in Article 1.2 hereof; and

- (e) Notwithstanding anything contained elsewhere in this Agreement, this Warranty shall not apply to items supplied by Company, be it quality or performance warranty or any other warranty of any nature, other than warranty on installation by Contractor as specified in Articles 17.1(a) to 17.1(d).

17.2 Contractor shall perform all tests and take all measurements specified in Section 2 of the Technical Specifications to be made and taken during the Warranty Period.

17.3 For the duration of the Warranty Period, Contractor warrants:

- (a) all of the Work and Warranty Work, against any and all Defects; and
- (b) all of the Work and Warranty Work shall be fit for its intended use of controlling water flows (directly or indirectly).

17.4 For the avoidance of doubt, the provisions of this **Article 17** shall also extend to all portions of the Work and Warranty Work carried out by Subcontractors. Contractor shall cause to be extended to Company any applicable representations, warranties, guarantees and obligations with respect to design, engineering, materials, workmanship, equipment, tools and supplies furnished by its Subcontractors. All representations, warranties, guarantees and obligations of Subcontractors shall be:

- (a) so written as to survive all Company and Contractor inspections, tests and Approvals; and
- (b) extended to and be enforceable by Company, its successors and assigns.

If applicable, Contractor shall assign to Company all of Contractor's rights and interest in all extended warranties for periods exceeding the Warranty Period which were received by Contractor from any of its Subcontractors or vendors.

17.5 If, within the Warranty Period, any of the Work contains a Defect, Contractor, on receipt of Notice from Company, shall commence and diligently perform all services and work and supply all materials and equipment Contractor determines is required to remedy such Defect to the Standard of a Prudent Contractor at the times that Company directs so that it conforms to the requirements in the Agreement ("**Warranty Work**"). Company shall make that part of the Work containing the Defect available for repair by Contractor within 24 months from the date the Defect is discovered. If, for reasons outside Contractor's control, the Defect cannot be remedied at the times directed by Company and if Company Approves, Contractor shall provide a corrective action plan for review and Approval by Company. If Company rejects the corrective action plan, Contractor shall revise and re-submit the plan until the plan is Approved by Company. On Company's Approval of the

corrective action plan, Contractor shall commence and diligently perform all Warranty Work as is necessary to remedy the Defect in accordance with the corrective action plan.

- 17.6 During the period that Warranty Work is being performed, Contractor shall continue to cooperate with Company's Other Contractors and Company Personnel in accordance with **Article 3.8**.
- 17.7 If Contractor does not fulfill its requirements under this **Article 17** or fails to fulfill its requirements within the period set by Company, such period to be fixed reasonably, within three (3) Business Days of Notice to Contractor by Company, Company may have the Work which is the subject of the Notice from Company corrected by a third party at the sole cost of Contractor. Such recourse shall in no way relieve Contractor from its Warranty obligations.
- 17.8 Contractor shall not substitute any materials in performing Warranty Work without the prior Approval of Company.
- 17.9 All work required to be performed in accordance with the terms of this **Article 17** shall be performed at the expense of Contractor and shall not give rise to any right of Contractor to remuneration.
- 17.10 Contractor shall consult Company prior to taking any action to re-design, re-build and replace any Work which, within the Warranty Period, fails to meet the requirements of this Agreement where such action may affect Company's commercial operation or maintenance of the Work.
- 17.11 This Warranty is subject to the following additional terms and conditions:
- (a) Notwithstanding anything contained elsewhere in the Agreement, this Warranty shall apply to items manufactured and/or installed by Contractor, regardless of whether components or raw materials are supplied by Contractor or Subcontractors; and
 - (b) Subject to **Article 17.8** and **17.10**, Contractor shall have the option of repairing or replacing any Defects in the Work provided such repair or replacement meets all the requirements and specifications as outlined in this Agreement.
- 17.12 Unless otherwise instructed by Company, Contractor shall remove from the Site and dispose of any parts or equipment that have been replaced, and Contractor shall be solely responsible for all costs associated with such removal and disposal. Company shall have the option, to be exercised at its discretion, to retain ownership of removed and replaced parts, and upon exercising such option Company may use or dispose of the parts as Company shall deem fit.
- 17.13 Company shall notify Contractor in writing with reasonable promptness after discovery of any Defect in respect of which Contractor shall be obliged pursuant to this **Article 17** to

perform Warranty Work. Notice of any Defect discovered during the Warranty Period must be given to Contractor no more than sixty (60) days after the end of the Warranty Period.

- 17.14 Company, at its sole discretion, may retain independent third parties to inspect, test, review and/or observe the Work for compliance with this Agreement. Contractor, upon reasonable notice, shall provide such independent third parties access to the Work and to any facility in which any equipment or products are being manufactured for installation as part of the Work in order to permit the independent third parties to perform their duties.

ARTICLE 18 CONTRACTOR INSURANCE

- 18.1 Contractor will procure insurance policies in accordance with the requirements of **Article 18.3** from a financially sound insurance company and which is acceptable to Company, such acceptance not to be unreasonably withheld. If Contractor fails to procure such policies or fails to provide certificates of insurance confirming the coverage described in this **Article 18** in a form and with content acceptable to Company within the time specified in **Article 18.2**, or if any insurance is cancelled and not immediately replaced with comparable insurance to the satisfaction of Company, then Contractor shall be in default under **Article 32.2**.
- 18.2 Prior to commencing work at the Site or within thirty (30) Business Days following the Effective Date, whichever is earlier, Contractor shall submit to Company certificates of insurance evidencing the insurance required by **Article 18.3**. Failure of Company to advise Contractor of any insurance deficiencies shall not relieve Contractor of any liability related to its obligations under this **Article 18**.
- 18.3 Contractor shall at all times while conducting the Work carry at least the following insurance coverages with limits not less than those specified below, covering property and liability outside the scope of the insurance supplied by Company pursuant to **Article 20**. The cost of insurance procured by Contractor, including deductibles or self-insurance or policy retentions, shall be for the sole account of Contractor:

(a) Workers' Compensation

Workers' Compensation coverage for all of its Personnel engaged in the Work in accordance with the Applicable Laws of the jurisdictions in which the Work is performed. Contractor shall further ensure that non-residents working in Canada are fully covered by Workers' Compensation insurance and Employer's Liability insurance with such coverage including an extraterritorial benefits extension providing benefits at least equal to those provided by the jurisdiction in which the Work is performed.

(b) Employer's Liability

Employer's Liability insurance, with limits as required by Applicable Laws, but not less than Canadian five million dollars (\$5,000,000.00) covering each employee engaged in the Work.

(c) Comprehensive General Liability

Comprehensive General Liability insurance written on an occurrence basis with limits of not less than Canadian five million dollars (\$5,000,000.00) per occurrence for bodily injury (including death) and/or property damage including blanket contractual liability, sudden and accidental pollution liability for risks assumed by Contractor, broad form property damage, personal injury, contractor's protective liability, products and completed operations for a period of not less than twenty-four (24) months, contingent employer's liability and incidental medical malpractice.

(d) Automobile Liability Insurance

When not otherwise covered by Contractor's Comprehensive General Liability policy, Contractor shall obtain and maintain in effect automobile liability insurance covering all licensed vehicles whether owned, non-owned, leased or hired. Such insurance will provide a minimum combined single limit of liability for bodily injury and property damage of Canadian five million dollars (\$5,000,000.00) per occurrence.

(e) Owned and Non-owned Aircraft

If applicable and to the extent that aircraft are used in the performance of the Work, owned and non-owned aircraft liability insurance with a combined single limit of not less than Canadian ten million dollars (\$10,000,000.00). This insurance coverage may be provided by or through the owner or operator of aircraft used in the performance of the Work.

(f) Property

"All risks" property insurance covering all real and personal property which Contractor owns, leases or has in its care, custody or control and which is not otherwise insured by insurance obtained pursuant to **Article 20**, including all machinery and equipment to be used for the Work but not forming part of the Work.

(g) Property in Transit

Contractor shall provide property in transit insurance coverage for the replacement cost of equipment, goods, products and materials to be incorporated into the Work with such coverage to apply during transportation from Contractor's plant, factory

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or distribution centre to the location for Delivery, with a maximum deductible of Canadian two hundred fifty thousand dollars (\$250,000.00).

(h) Subcontractors

Contractor is required to ensure that each of the Subcontractors provides insurance similar to the foregoing, as well as insurance which:

- (i) is required by Applicable Laws; or
- (ii) is reasonably appropriate in respect of the Work to be performed.

When requested to do so by Company, Contractor shall provide or cause to be provided to Company certificates of insurance confirming such Subcontractor insurance policies. Contractor Group shall not perform Work during any period when any required policy of insurance is not in effect.

(i) Other

In addition to the insurance coverage specified in this **Article 18**, Contractor shall carry such other insurance policies and in such amounts:

- (i) as may be required in order to comply with Applicable Laws; and
- (ii) with regard to liabilities assumed under the Agreement or in respect of specific activities performed for the Work.

18.4 All insurance policies required by this **Article 18** shall be endorsed to waive insurer's rights of subrogation against Owner, Company and their Personnel, stockholders, successors, assigns and Affiliates. Except for this policy which is subject of **Article 18.3(d)**, liability policies required above shall name Owner, Company and their Personnel, stockholders, successors, assigns and Affiliates as additional insureds and shall contain cross liability and severability of interest provisions. Except with respect to the insurance coverage to be procured by Company pursuant to **Article 20**, all of Contractor's insurance policies shall operate as primary to any insurance policies maintained by Company and their Personnel, stockholders, successors, assigns and Affiliates.

18.5 Contractor shall provide Company thirty (30) days prior Notice of any contemplated cancellation or any material change in the insurance coverages required by this **Article 18**.

18.6 Contractor shall give Company prompt notification of any claim involving the Work with respect to any of the insurance policies referred to in **Article 18.3**, accompanied by full details of the incident giving rise to such claim. Contractor agrees to do all acts, matters and things as may be reasonably necessary or required to expedite the adjustment of any loss or damage covered by insurance so as to expedite the release and disposition of such insurance in the manner and for the purposes contemplated in this Agreement. If

requested by Company, Contractor shall advise Company in writing of the final resolution of any such insurance claims.

- 18.7 If requested by the other Party, a Party shall advise the other Party in writing of the final resolution of any insurance claims regarding the Work.
- 18.8 Company may reduce or waive all or any portion of these insurance requirements under circumstances where the Work to be performed does not require equivalent insurance coverage. Such reduction or waiver shall be obtained in writing and shall in no way reduce or waive Contractor's responsibility or liability for the Work.
- 18.9 Nothing in this **Article 18** shall or is intended to limit the liability of Contractor under any other provision of this Agreement. The provisions of this **Article 18** will not be interpreted as relieving Contractor of any of its obligations under this Agreement. Contractor may purchase, at its own expense, any additional insurance it deems necessary.

ARTICLE 19 WORKERS COMPENSATION

- 19.1 Prior to the performance of the Work at any Worksite within the Province of Newfoundland and Labrador, Contractor shall provide Company with Contractor's Workers' Compensation number and a letter of good standing in accordance with the Applicable Laws of the Province of Newfoundland and Labrador.
- 19.2 Contractor shall at all times pay, or cause to be paid, any assessment or contribution required to be paid pursuant to Applicable Laws relating to Workers' Compensation in respect of Contractor's Personnel and, upon failure to do so, authorizes Company, in addition to any other rights of Company under this Agreement, to withhold and remit on behalf of Contractor an amount equal to such assessment or contribution, including any interest and penalty assessed thereon.
- 19.3 Upon completion of Subcontract work, each Subcontractor who performed Work within the Province of Newfoundland and Labrador shall deliver to Company a clearance certificate from the Workplace Health, Safety and Compensation Commission of the Province of Newfoundland and Labrador.
- 19.4 Upon completion of the Work, Contractor and all Subcontractors who performed Work within the Province of Newfoundland and Labrador which have not previously provided evidence of compliance with **Article 19.3** above shall deliver to Company a clearance certificate from the Workplace Health, Safety and Compensation Commission of the Province of Newfoundland and Labrador.

**ARTICLE 20
PROJECT INSURANCE**

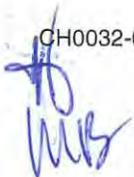
- 20.1 The Parties acknowledge that pursuant to Article 20 of the Supply and Install Agreement, the following insurance coverages shall be procured by Owner. The policies listed below will cover the Owner Group, Company Group, the Contractor Group and subcontractors of every tier (but not including vendors and suppliers except to the extent a vendor or supplier performs operations at the Site) as their interests and/or liabilities may appear:
- (a) Construction All Risk (CAR) insurance, including design defect coverage to LEG2/96 or better, subject to a limit of not less than the total Contract Price, attaching on or in place and in effect as of the Effective Date.
 - (b) Wrap-up Liability insurance, with Owner as the named insured and its Personnel, stockholders, successors, assigns and Affiliates as additional insureds, written on an occurrence basis with limits not less than Canadian fifty million dollars (\$50,000,000.00) per occurrence for bodily injury and/or property damage including contractual liability, broad form property damage, personal injury, contractor's protective liability, completed operations for a period of not less than twenty-four (24) months, contingent employer's liability, incidental medical malpractice, cross liability and severability of interest provisions.
 - (c) Pollution Liability insurance, with Owner as the named insured and its Personnel, stockholders, successors, assigns and Affiliates as additional insureds, written with limits not less than Canadian ten million dollars (\$10,000,000.00) per occurrence and in the aggregate.
- 20.2 Insurance policies required by this **Article 20** shall be endorsed:
- (a) to waive insurer's rights of subrogation against Company Group, Contractor Group and subcontractors of every tier (but not including vendors and suppliers except to the extent a vendor or supplier performs operations at the Site) and their stockholders, successors, assigns and Affiliates; and
 - (b) include Company Group, Contractor Group and subcontractors of every tier (but not including vendors and suppliers except to the extent a vendor or supplier performs operations at the Site) as additional insureds.
- 20.3 Contractor shall be responsible for deductibles under the Construction All Risk (CAR) policy of Canadian five hundred thousand dollars (\$500,000.00), under the Wrap-up Liability policy of Canadian one hundred thousand dollars (\$100,000.00), under the pollution liability policy of Canadian two hundred fifty thousand dollars (\$250,000.00), provided that:
- (i) Contractor shall not be responsible for deductibles arising from claims for damage or loss caused by earth quake or a Force Majeure event;

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- (ii) Contractor shall not be responsible for deductibles arising from claims for damage or loss caused by flood except Contractor shall be responsible for deductibles where the flood was caused or exacerbated by the acts or omissions of Contractor; and
 - (iii) to the extent a claim for damage or loss was caused by the negligence of Company Group, Company shall be responsible for that portion of the deductible which represents the proportion of fault attributable to Company.
- 20.4 The insurance policies required by **Articles 20.1** shall be in place and shall be maintained until a Final Completion Certificate has been issued, with any completed operations coverage to continue for twenty-four (24) months after the Final Completion Certificate has been issued as set out in the policy.
- 20.5 Contractor shall provide forty five (45) days prior Notice to Company of Contractor's intended date to commence Work at the Site, and seven (7) days prior to such date Company shall provide certificates of insurance to Contractor confirming that the policies of insurance required by this **Article 20** have been procured and are in effect. Upon written request from Contractor, Company shall provide a cover note summarizing insurance coverages and exclusions in the policies required by this **Article 20**.
- 20.6 Company shall provide thirty (30) days prior Notice to Contractor of any contemplated cancellation or any material change in the insurance coverages required by this **Article 20**.

ARTICLE 21 INDEMNIFICATION

- 21.1 The Parties hereby agree and acknowledge that if a provision in this **Article 21** conflicts with any other provision in this Agreement, the provision in this **Article 21** shall prevail.
- 21.2 For the purposes of this Agreement, any liability assumed or indemnity given by Contractor for the benefit of Company shall be deemed to be given by Contractor for the benefit of Company, its successors and assigns, Affiliates and Personnel.
- 21.3 Unless expressly otherwise limited or excluded herein, it is agreed and understood that the exculpatory clauses and indemnity obligations of each Party as provided in this Agreement shall apply to any and all Claims whatsoever incurred by the indemnified Party.
- 21.4 Subject to **Article 21.10** and **Article 23.6**, Company shall indemnify, keep indemnified and shall hold Contractor harmless from and against any and all Claims by a third party arising from bodily injury, death or damage to or loss of tangible third party property arising as a direct consequence of a breach or non-performance by Company of its obligations under this Agreement.

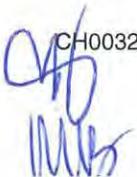


- 21.5 Contractor shall indemnify, keep indemnified and shall hold Company harmless from and against any and all Claims which Company may at any time sustain or incur by reason of or in consequence of any one or more of the following:
- (a) any negligent act or omission or wilful misconduct of Contractor Group or any licensee, invitee or Person acting on behalf of any of them in connection with or incidental to the performance of or default in any of Contractor's obligations under this Agreement.
 - (b) any inaccuracy in any representation or warranty made by Contractor Group, the guarantors or any other Person that delivers to Company any document or security instrument containing any such representation or warranty pursuant to this Agreement;
 - (c) any breach or non-performance by Contractor Group, or any licensee, invitee or Person acting on behalf of Contractor of any of the obligations of Contractor in respect of the performance of the Work,
 - (d) any Claims by any third party in contract, tort, under any statute or otherwise at law or in equity with respect to any bodily injury, death or property damage or loss of such third party property arising out of a breach of contract or negligent actions or omissions or wilful misconduct of Contractor Group or any licensee, invitee or Person acting on behalf of any of them in connection with or incidental to the Work;
 - (e) any action taken by Company to mitigate or cure a breach or non-performance by Contractor Group of any covenant or inaccuracy in any representation or warranty pursuant to the Agreement.
 - (f) any non-payment of amounts due and payable to Subcontractors, and Subcontractors' subcontractors, vendors and suppliers of every tier, resulting from furnishing of services, material, equipment, labour or otherwise in connection with the performance of Work;
 - (g) any Claim in respect of loss or damage to the property of Contractor Group however caused except to the extent the Claim was caused by the negligence or wilful act or omission by Company Group;
 - (h) any Claims in respect of personal injury or death of Contractor's Personnel except to the extent the Claim was caused by the negligence, or wilful act or omission of Company Group;
 - (i) any representation or holding out by Contractor that it is an agent of Company;
 - (j) any Claims, in contract, tort, under any statute or otherwise at law or in equity by any organisation involved in the LCP including Owner, Company's Other Contractor's and their subcontractors and vendors of every tier, Authorities and other entities



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- associated with the Work, with respect to any delays, costs, losses or damages incurred by such third party as a result of the actions or omissions of Contractor;
- (k) any Claims in contract, tort, under any statute or otherwise at law or in equity or any other adverse consequences suffered by Company arising due to Contractor's breach of Section 3.2.2.1 (a) of Exhibit 3- Appendix A –*Coordination Procedures*; or
 - (l) any Claims in contract, tort, under any statute or otherwise at law or in equity or any other adverse consequences suffered by Company arising pursuant to Section 3.2.2.1 (b) of Exhibit 3- Appendix A –*Coordination Procedures*.
- 21.6 Contractor shall include in all of its Subcontracts, a provision stating that Subcontractors shall defend, protect, release, indemnify and hold Company harmless from and against all Claims for the death of or bodily injury to Subcontractors and their respective Personnel, and for damage to or loss of the property of Subcontractors or their respective Personnel, except to the extent the Claims were caused by the sole negligence or wilful act or omission of Company Group.
- 21.7 Contractor shall be liable for and defend, protect, release, indemnify and hold Company harmless from and against all Claims (including any fine, penalty or demand of any Authority having jurisdiction) which may be brought against or suffered by Company or which Company may sustain, pay or incur, arising out of any failure by Contractor to comply with its obligations under **Article 15.11**.
- 21.8 Without limiting the generality of **Article 21.5**, and subject to the obligation of Company to pay HST pursuant to **Article 12.18**, Contractor shall be liable for and defend, protect, release, indemnify and hold Company harmless from and against:
- (a) any and all Taxes imposed by any Authority on any of Contractor Group in respect of this Agreement, and any and all Claims including payment of Taxes which may be brought against or suffered by Company or which Company may sustain, pay or incur in conjunction with the foregoing as a result of the failure by Contractor to pay any and all Taxes imposed as stated herein;
 - (b) any and all Taxes imposed by any Authority in respect of the Work, or Contractor's Items, or any other items used by Contractor Group in the performance of the Work, or in respect of any services performed by Contractor Group in respect of this Agreement, and any and all Claims (including Taxes) which may be brought against or suffered by Company or which Company may sustain, pay or incur in conjunction with the foregoing as a result of the failure by any member of Contractor Group to pay any and all Taxes imposed as stated herein; and
- 21.9 Unless provided otherwise herein, the liability and indemnities specified in this **Article 21** shall apply:
- (a) without regard to the characterization of any Claim, including the negligence or fault (whether sole, concurrent, gross (except when gross negligence or wilful misconduct



is expressly provided as an exception to a specific provision hereof), active or passive negligence) or otherwise or wilful act or omission and including strict liability, breach of contract, breach of duty (statutory or otherwise) and including any pre-existing conditions, of either Party or any other Person (including the Party or Person seeking indemnity);

- (b) whether or not any Claim is asserted to have arisen by virtue of tort, contract, quasi-contract, statutory duty, or any Applicable Laws;
- (c) whether or not any Claim is made or enjoyed by the Person sustaining the injury or loss or by the dependents, heirs, claimants, executors, administrators, successors, survivors or assigns of such Person.

21.10 The indemnities given in this **Article 21** shall apply, notwithstanding that the indemnified Party may be entitled to contribution thereto from any third party and notwithstanding such liability may relate to the negligence of a third party, provided that in such case the indemnifying Party shall be fully subrogated to the rights of the indemnified Party against such third party.

21.11 If a Claim by a third party is asserted in circumstances which give or may give rise to indemnification under this Article, the Party against whom the Claim is asserted (the "non-indemnifying Party") shall forthwith give Notice thereof to the other Party (the "indemnifying Party") and the indemnifying Party shall undertake the defence of such Claim. The indemnifying Party shall be entitled to retain legal counsel of its choice subject to the consent of the non-indemnifying Party, which consent shall not be unreasonably withheld. The Parties shall consult and cooperate in respect of such Claim and in determining whether such Claim and any legal proceedings relating thereto should be resisted, compromised or settled. Each Party shall make available to the other all information in its possession or to which it has access, and which it is legally entitled to disclose, which is or may be relevant to the particular Claim. The indemnifying Party shall provide the non-indemnifying Party with reasonable information as to the progress of such Claim on a regular basis. No such Claim shall be settled or compromised without the written consent of the indemnifying Party which consent shall not be unreasonably withheld. Notwithstanding the foregoing, if the indemnifying Party, within a reasonable time after Notice of any such Claim is given to it by the non-indemnifying Party, fails to defend such Claim, the non-indemnifying Party shall have the right to undertake the defence and compromise or settle such Claim on behalf of and for the account of the indemnifying Party.

21.12 Except for liquidated damages pursuant to **Article 36**, a Party has no responsibility and shall not be liable under this Agreement to the other Party for any Claim in respect of loss of profit, loss of revenue, business interruption, loss of business opportunity, loss of use, inability to operate at full capacity, cost of replacement power, whether foreseeable or not, or any similar indirect or consequential damages or losses resulting from, arising out of or in connection with the Work or any obligation pursuant to this Agreement howsoever caused.

21.13 The aggregate liability of Contractor, Contractor Personnel, Subcontractors and Affiliate for all Claims of any kind for any loss, damage, expense resulting from, arising out of or



connected with the Work or the performance or breach of this Agreement shall in no event exceed the sum of the Contract Price and actual insurance proceeds received from insurance to be maintained under this Agreement of such proceeds per occurrence and in the aggregate), except that the foregoing limitation of liability shall not apply to any Liquidated Damages payable pursuant to Art. 36.1, or to Claims arising from Contractor's wilful, deliberate or intentional breach of this Agreement and Contractor's indemnity obligations under this Agreement resulting from or arising out of:

- (a) Claims for personal injury (including death) suffered by third parties that are indemnified under **Articles 21.5(d)** and **21.5(h)**;
 - (b) Claims for property damage suffered by third parties that are indemnified under **Articles 21.5(d)** and **21.5(g)** with respect to Subcontractors only;
 - (c) fines and/or penalties imposed by any Authority but only and to the extent of amount of Taxes, fines and/or penalties imposed by any Authority that are indemnified under **Articles 3.5, 6.7, 9.3, 13.3** and **21.8**;
 - (d) Claims for infringement of patents and/or other intellectual property rights that are indemnified under **Article 29.3**; and
 - (e) Claims for any environmental damage or loss that are indemnified under **Article 21.7**.
- 21.14 The Contractor shall not be responsible for any damages caused by employees or representative of Company in relation to the Technical Assistance nor for any deficiencies or defective work performed by them under such Technical Assistance.
- 21.15 The limitations and exclusions of liability set forth in **Articles 21.12, 21.13** and **21.14** shall take precedence over any other provision of this Agreement and shall apply whether the liability arises in contract, tort (including negligence), warranty, strict liability, indemnity or otherwise.

ARTICLE 22 SITE AND TRANSPORT ROUTE CONDITIONS

- 22.1 Contractor shall inform itself fully as to the risks and contingencies and all other data, matters and things, local or otherwise, respecting the Site, transportation routes and any other aspects of the Work necessary to satisfactorily perform Contractor's obligations under this Agreement. Contractor shall be deemed to have been satisfied as to the suitability and availability of such Site, transportation routes including access routes to the Site, and all other aspects of the Work.
- 22.2 Contractor acknowledges and agrees that utilities and service connections may not be located as exactly shown on drawings provided by Company. Contractor shall satisfy itself fully as to the exact location of all utilities and service connections and shall, at no additional

cost, make such alterations to the Work as may be required to avoid conflicts in or damage to utilities and connections.

- 22.3 Contractor shall be solely responsible for determining the transport route for shipment of all equipment, materials and products Contractor requires to perform and complete the Work. Contractor shall conduct its own tests or investigations to satisfy itself as to all transport route conditions, including obstructions, road conditions, weight restrictions, size limitations and utilities. Contractor accepts all risks and contingencies associated with the shipment of all equipment, materials and products for the Work.
- 22.4 Subject to **Article 31**, Contractor waives its right to any claim against Company for additional compensation or any extension to a date for completion of performance of any part of the Work set out in the Milestone Schedule based on, resulting from or arising out of any differences between transport route conditions that may exist and those conditions that may have been assumed or anticipated by Contractor, including resulting from any assumptions, anticipations, misunderstandings or misinterpretation by Contractor of port, bridge or road conditions or from any information provided by Company.
- 22.5 Contractor shall bear all costs and charges for special and/or temporary rights which Contractor may require, including those for transport of components of the Work and access to a Worksite. Contractor shall also obtain, at Contractor's cost, any additional facilities outside a Worksite which Contractor may require for purposes of Work.
- 22.6 Subject to **Article 31**, Contractor shall be solely responsible for and assumes all risks associated with weather conditions at the Site, and the cost of performing the Work under all weather conditions experienced at the Site shall be included in the Contract Price.

ARTICLE 23 TITLE AND RISK

- 23.1 Contractor warrants good title to all Contractor's Items, consumables, goods and other items furnished by it under this Agreement and that they are free from any liens or encumbrances in favour of third parties. Risk of and in Contractor's Items shall remain with Contractor throughout the Term.
- 23.2 Subject to **Article 29**, title to the Work (or any part of the Work) performed, including all Contractor's documentation related to the Work, shall vest in Company as and when performed or prepared. Title to all equipment, materials and products to be supplied by Contractor or its Subcontractors for incorporation into the Work shall vest in Company as and when identified and designated for incorporation into the Work. Contractor shall identify, segregate in a secure area so far as possible and mark or otherwise identify all equipment, materials and products for incorporation into the Work as property of Company. Title to any items free issued to Contractor by Company, or to equipment supplied by Company DAP Muskrat Falls Site (Incoterms 2010) for installation by Contractor (including all related documentation), shall always remain vested in Company.



- 23.3 Company shall have the right, without prejudice to any other right it may have under the Agreement, to decline to pay for any part of the Work if Contractor is unable to provide evidence reasonably satisfactory to Company that title to the same has passed to Contractor or shall pass unconditionally to Company as provided in the Agreement, free from any liens or encumbrances in favour of any third parties.
- 23.4 Contractor shall cause the inclusion of terms consistent with the terms of **Articles 23.1, 23.2 and 23.3** in all Subcontracts so that Company and Contractor shall have the rights herein set forth with respect to each Subcontractor involved in the performance of the Work.
- 23.5 Contractor warrants to Company that Applicable Laws do not prevent Company from obtaining title to the Work in accordance with this **Article 23**.
- 23.6 Subject to **Article 17**, risk of and in the Work, including equipment supplied by Company DAP Muskrat Falls Site laydown area (Incoterms 2010) for installation by Contractor (and related documentation), shall be assumed by Company:
- (a) for spillway Work, when all stoplogs have been removed and are ready for operation;
 - (b) for all Powerhouse Draft Tube Work, upon the achievement of Milestone M22 of Milestone Schedule;
 - (c) for all Intake Work, upon the achievement of Milestone M23 of the Milestone Schedule;
 - (d) for all other Work, from the date of Substantial Completion ;

and Contractor shall assume the risk of and undertake the care and control of all other Work until Substantial Completion.

Company shall assume the risk for all equipment, materials and/or products located in the Site laydown area under its responsibility, care or control until picked up by Contractor.

- 23.7 Contractor shall make available to Company all data relating to the operation and performance of the Work in electronic media for use by Company during the Term and during the operation of the Work. Contractor shall undertake all reasonable efforts to ensure data is provided in a form fully useable to Company with well recognized industry standard applications, including the requirements of Exhibit 3 - Coordination Procedures and Exhibit 11 - Owner Supplied Documents. Where the software necessary to enable Company to fully utilize data is based in whole or in part on Contractor's proprietary information/software, Contractor shall grant Company and its Affiliates a non-exclusive, royalty free, irrevocable (except where Company or its Affiliate breaches the terms of this license and such breach cannot be rectified or remedied), and non-transferable license to such information/software for the purpose of the operation, maintenance, repair and refurbishment of the Work. Where such information/software is not proprietary to Contractor and obtained through usage of information/software leased or purchased from

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third parties, Contractor shall, subject to Company's Approval, arrange for and obtain for the benefit of Company and its Affiliates a non-exclusive, royalty free, irrevocable (except where Company or its Affiliate breaches the terms of this license and such breach cannot be rectified or remedied), and non-transferable license to use such information/software for the purpose of the operation, maintenance, repair and refurbishment of the Work to enable Company and its Affiliates to fully utilize data in accordance with the terms of this Agreement. All Contractor's costs associated with such provision are deemed to be included in the Contract Price and are not separately reimbursable.

- 23.8 Owner or Company, at their discretion and upon Notice to Contractor, may take possession of or use Work, and/or any part of the Work, at any time prior to Substantial Completion of such Work. If Owner or Company takes possession of or uses the Work following such Notice:
- (a) Company shall not be deemed to have Approved the Work or that part possessed or used;
 - (b) the Warranty obligations in **Article 17** shall apply except that the Warranty Periods for the Warranties in **Article 17.1** shall commence upon use of the part of the Work to which the Notice applies, notwithstanding the time for commencement in those Articles, and continue for the period specified in **Article 17**;
 - (c) Contractor shall not be relieved of its responsibilities and obligations under this Agreement;
 - (d) risk of loss of that part of the Work so possessed or used shall be assumed by Company on possession or use.

ARTICLE 24 COMPLETION AND DELIVERY

- 24.1 The Work shall be completed and Delivered to Company in accordance with the Milestone Schedule. In the event the Work (or any part) shall be tendered for Delivery before the applicable date in the Milestone Schedule, Company may, but shall not be obliged to, take Delivery of such Work. Any part of the Work ready for Delivery before the applicable date in the Milestone Schedule shall be stored and maintained by and at the expense of Contractor until Delivered to Company.
- 24.2 If Contractor fails to commence performance of the Work on the Effective Date or diligently proceed to complete the Work (or any part) for Delivery by the applicable date in the Milestone Schedule, Company may terminate the Agreement in accordance with **Article 32.1(c)** or may elect to continue with the Agreement if Contractor, in accordance with the provisions of **Article 24.3**, proposes an amended Milestone Schedule which is Approved by Company in a Change Order. Any changes to the Milestone Schedule pursuant to this **Article 24.2** and **Article 31** shall not result in an increase to the Contract Price or otherwise

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affect Company's rights to liquidated damages if a Milestone has not been achieved in accordance with the changed Milestone Schedule.

- 24.3 If Contractor has not or considers that it will not achieve a Milestone by the date specified in Exhibit 9 – Interface and Milestone Schedule:
- (a) Contractor shall, within ten (10) Business Days of determining that a Milestone will not be achieved, submit for review and comment by Company a written completion plan detailing steps Contractor shall take to complete all necessary Work to meet the requirements of the Milestone, and Company shall provide written comment to Contractor within ten (10) Business Days of receipt;
 - (b) Contractor shall then resubmit to Company within five (5) Business Days a revised completion plan addressing any comments provided by Company, and Company shall provide written comment within five (5) Business Days of receipt;
 - (c) Contractor shall revise or resubmit the completion plan within the time limits in paragraphs (a) and (b) above until Contractor has addressed all comments of Company; and
 - (d) Contractor shall then promptly provide the necessary services, labour, materials and equipment as may be required under the completion plan.
- 24.4 The preparation, review and revision of a completion plan and provision of services, labour, materials and equipment as required by the completion plan shall not relieve Contractor of its obligations to achieve a Milestone by the date specified in Exhibit 9 – Interface and Milestone Schedule or be the basis for an increase in compensation.
- 24.5 Delivery of the Work shall be performed in the manner specified in the Agreement. Except as specified otherwise in the Agreement, Contractor shall be responsible for and shall bear the cost of packaging, loading and/or carriage of the Work to the location for Delivery specified in the Agreement.
- 24.6 Contractor shall use its best efforts to include provisions corresponding to those contained in this **Article 24** in all Subcontracts.
- 24.7 When Contractor has completed all the Work required to achieve a Milestone of the Milestone Schedule and/or a Payment Milestone, Contractor may by Notice to Company request written confirmation that Contractor has satisfied all the requirements to achieve such Milestone (the "Milestone Completion Certificate").
- 24.8 In the event Contractor has satisfied the criteria set forth in **Article 24.7**, Company shall provide Contractor with the corresponding Milestone Completion Certificate in the form set forth in Exhibit 3 – Coordination Procedures, within thirty (30) days of Contractor's Notice under **Article 24.7**.



ARTICLE 25
SUBSTANTIAL AND FINAL COMPLETION

- 25.1 Substantial Completion of the Work shall have occurred if and only if all of the items in paragraphs (a) to (g), inclusive, of this **Article 25.1** have occurred to the satisfaction of Company in accordance with this Agreement:
- (a) the Work is ready for use or is being used for the purpose intended and is capable of achieving Final Completion at a cost of not more than two percent (2%) of the Contract Price;
 - (b) Contractor has delivered to Company all drawings, specifications, calculations, test data, performance data, equipment descriptions, equipment and system installation instruction manuals, integrated and coordinated operation and maintenance manuals, data, training aids required by this Agreement and, subject to **Article 26**, other technical documentation and information reasonably required by Company to use and maintain the Work;
 - (c) Company has prepared and delivered an updated Punch List to Contractor, which includes any minor items with respect to which Company has notified Contractor are incomplete or have Defects;
 - (d) Contractor has delivered to Company a Notice:
 - (i) detailing all outstanding Claims of Contractor under this Agreement with documentation sufficient in the opinion of Company to support such Claims, and Company shall not be liable to Contractor for any Claim under this Agreement which is not identified within that Notice; or
 - (ii) certifying that there are no other outstanding Claims;
 - (e) Contractor has delivered to Company the latest available clearance certificate from the Workers' Compensation Board of Newfoundland and Labrador that no assessments or other amounts are owing to the date therein specified;
 - (f) Contractor has removed all Contractor Group's Personnel, supplies, equipment, materials, rubbish and temporary facilities, except those reasonably required for completion of outstanding Punch List items, from the Worksite so that the Worksite is neat, clean and safe;
 - (g) there being no liens filed or registered pursuant to the *Mechanics' Lien Act*, RSNL 1990, c.M-3, with respect to or arising from the Work at that time.
- 25.2 When Contractor believes the requirements of Substantial Completion have been met, Contractor shall request from Company a Substantial Completion Certificate. Such request shall contain a declaration by Contractor that all the requirements of Substantial Completion have been met and a report of the results of any required tests for the Work



with sufficient detail to enable Company to determine whether Substantial Completion has been achieved. If all requirements of Substantial Completion have been met to the satisfaction of Company, the date of Substantial Completion shall be the later of (i) the date specified in Contractor's request, and (ii) the date when the requirements of Substantial Completion were met to the satisfaction of Company. Within 30 days after Substantial Completion has been achieved as provided above, Company shall issue a Substantial Completion Certificate to Contractor, which states the date of Substantial Completion and Contractor shall turn over control and operation of the Work to Company.

- 25.3 If Contractor fails to rectify any items on the Punch List as soon as practicable, Company may notify Contractor and ten (10) days after such Company's notice, Company may employ others to carry out the rectification, the cost thereof being for the account of Contractor, without affecting any Warranties.
- 25.4 If any item of Work on the Punch List is not completed by the date specified on the Punch List for such item, Company may notify Contractor and ten (10) days after such Company's notice, Company may complete or employ others to complete the item and deduct one hundred ten percent (110%) of the cost to complete such item from the holdback shown on the Punch List, without affecting any Warranty.
- 25.5 Contractor's access to and continued presence at the Worksite after the date of Substantial Completion shall be for the sole purpose of achieving Final Completion. In performing such work Contractor will use its best efforts not to inconvenience or interfere with Owner, Company and Company's Other Contractors.
- 25.6 When Contractor has completed all the Work in accordance with the terms of this Agreement, except Warranty obligations, Contractor may by Notice to Company request written confirmation that Contractor has fully performed all of the Work hereunder (the "**Final Completion Certificate**"). If all requirements of Final Completion have been met to the satisfaction of Company, the date of Final Completion shall be the later of (i) the date specified in Contractor's request, and (ii) the date when the requirements of Final Completion were met to the satisfaction of Company.
- 25.7 By submission of the Notice to Company for confirmation that Contractor has fully performed all of the Work pursuant to **Article 25.6**, Contractor agrees that, as of the date of the issuance of the Notice, Contractor waives, remises, releases and discharges Company of any and all Claims as of the date of the Notice that are known, ought to have been known or discoverable by reasonable means by Contractor, which Contractor has or may have relating to or arising out of this Agreement and the subject matter of this Agreement, and all facts and circumstances related to the Work, save and except:
- (a) any Claims previously submitted in writing prior to the date of the Notice, and remaining unresolved; and
 - (b) the balance of the Contract Price payable, if any, upon the issuance of the Final Completion Certificate.

- 25.8 Company shall not be obliged to issue the Final Completion Certificate until Contractor has fulfilled all of its Work obligations, including:
- (a) satisfied any liens, claims or encumbrances affecting Company's property in connection with the Work or Warranty Work in accordance with **Article 41**; and
 - (b) paid in full any and all outstanding obligations against the Work.
- 25.9 Upon Contractor satisfying the criteria set forth in **Article 25.8**, Company shall provide Contractor with the Final Completion Certificate in the form set forth in Exhibit 3 – Coordination Procedures within fifteen (15) days of Contractor's Notice under **Article 25.6** or Contractor demonstrating that it has satisfied the criteria set forth in **Article 25.8**, whichever is later.
- 25.10 The issuance of the Final Completion Certificate shall not release Contractor from the provisions of this Agreement which expressly or by their nature extend beyond the expiration or any termination of this Agreement.
- 25.11 Company shall pay Contractor the balance of the Contract Price for the Work in accordance with Article 12 less:
- (a) an amount to satisfy any liens registered against the property of Company arising out of Contractor Group's performance of the Work;
 - (b) any amount Company is entitled to set off against payment to Contractor;
 - (c) any amount payable by Contractor to Company under this Agreement; and
 - (d) any amounts required or permitted to be withheld by Company by Applicable Laws or this Agreement.

ARTICLE 26
CHANGES IN THE WORK

- 26.1 Company has the right to make a Change at any time and from time to time prior to the issuance of a Final Completion Certificate by issuing a Change Order. Compensation for a Change shall be determined in accordance with Exhibit 2 – Compensation and Exhibit 3 – Coordination Procedures.
- 26.2 Contractor shall not perform and shall not be entitled to any compensation for a Change without a Change Order issued by Company to Contractor for the Change.
- 26.3 Contractor will comply with the requirements of Exhibit 3 – Coordination Procedures in the development of the pricing, impacts on resources and schedule as it relates to such Change and present a comprehensive proposal covering the Change to Company for Approval.



- 26.4 Except to the extent expressly provided in a Change Order, no Changes shall vitiate or invalidate or be deemed to amend or be deemed to constitute a waiver of any provision of this Agreement. All Changes shall be governed by all the provisions of this Agreement. Changes will not result in any limitation of Contractor's Warranty under **Article 17**.
- 26.5 Contractor shall commence with and shall execute all Changes with all due diligence immediately upon receipt of a Change Order.
- 26.6 In the event the Parties fail to reach agreement on the pricing and impacts on resources and schedule with respect to a Change, Contractor shall perform the work specified in the Change Order as issued by Company and the Dispute will be handled in accordance with **Article 39**.
- 26.7 If Contractor considers that a Change is necessary or desirable, Contractor may request a Change Order by submitting a Change Request in writing to Company in accordance with the procedure set out in Exhibit 3 – Coordination Procedures.
- 26.8 If Contractor considers that an occurrence has taken place which constitutes a Change, then Contractor shall
- (a) within three (3) Business Days of an occurrence that arises at the Site, give written notice to Company describing the occurrence and the reason Contractor considers that the occurrence constitutes a Change;
 - (b) within ten (10) Business Days of an occurrence that arises at a location other than at the Site, give written notice to Company describing the occurrence and the reason Contractor considers that the occurrence constitutes a Change; and
 - (c) within twenty (20) days of the occurrence, request a Change Order
 - (i) quantifying the request by providing Company a Change Request in accordance with the procedure set out in Exhibit 3 – Coordination Procedures; or
 - (ii) if Contractor cannot complete the quantification of the request because the occurrence is ongoing as at the end of the twenty (20) day period, provide Company a reasonable estimate of the quantification of the request and shall provide the quantification promptly following the end of the occurrence.
 - (d) Company shall review such Change Request and notify Contractor of its decision within fifteen (15) Business Days. If Company and Owner:
 - (i) agree that the occurrence constitutes a Change, then Company shall issue a Change Order in respect of the Change;

- (ii) disagree that the occurrence constitutes a Change, Contractor shall proceed with the Work without delay and such continuation of the Work shall be without prejudice to Contractor's rights to advance a Dispute under **Article 39**.

If Contractor fails to comply with the conditions of this **Article 26.8**, it will relinquish its right to request a Change Order and waives any claim it may have for additional compensation and for an extension of time to complete a Milestone arising from the occurrence.

- 26.9 Changes shall be invoiced and paid for in accordance with **Article 12**, Exhibit 2 – Compensation and Exhibit 3 – Coordination Procedures. Cost of the work carried out under a Change Order will reflect any discounts, rebates, refunds or free material credits earned with purchase of material or other goods and services charged under a Change.
- 26.10 If the quantity of the Work is decreased or any part of the Work is deleted Contractor shall not be entitled to claim any indirect or consequential damages, including loss of profits or loss of revenue.
- 26.11 If at any time after the start of the work directed by a Change Order for which there was no agreement on price, Company and Contractor reach agreement on the adjustment to the Contract Price and any adjustment to Exhibit 9 – Interface and Milestone Schedule, this agreement will be recorded in an amendment to the Change Order issued by Company.
- 26.12 If there is a change in Applicable Laws which makes modifications to the Work necessary or advisable and which impacts cost of the Work or the Milestone Schedule, Contractor shall be entitled to a Change Order in accordance with this **Article 26**. Upon becoming aware of the change in Applicable Laws, Contractor shall promptly present to Company a proposal for such modifications required as a result of the change in Applicable Law. Contractor shall prepare and provide to Company the following with its proposal:
- (a) details of the effect, if any, on the costs of the Work;
 - (b) details of the impact, if any, on dates for completion of Milestones and/or the Technical Requirements; and
 - (c) details of the impact on the Contract Price.
- 26.13 Notwithstanding what is provided in the Agreement, Contractor shall have the right, at its sole discretion, to refuse to execute additional work when the total of Change Orders value emitted exceed 20% of the sum of items 2.1, 3.3, 3.4, 4.3 and 4.4 of Appendix A to Exhibit 2- Compensation.



**ARTICLE 27
PUBLICITY COMMUNICATIONS**

- 27.1 Contractor agrees that all public relation matters arising out of or in connection with the Work shall be the sole responsibility of Company. Contractor shall obtain Company's Approval of the text of any announcement, publication or other type of communication concerning the Work.
- 27.2 Contractor shall not advertise or issue any information, publication, document or article (including photographs or film) for publication or media releases or other publicity relating to the Work, the Agreement, the LCP, the Owner or Company's business and activities without Approval of Company except as may be required by Applicable Laws. Contractor shall promptly notify Company in advance of any such advertisement, issuance or publication that may be required by Applicable Laws.
- 27.3 Contractor shall refer to Company any enquiries from the media concerning the Work, the Agreement, the LCP, the Owner or Company's business and activities.
- 27.4 Contractor shall include in each Subcontract a provision that incorporates the terms of **Article 27.1, 27.2 and 27.3** such that those terms shall apply to each Subcontractor.

**ARTICLE 28
CONFIDENTIALITY**

- 28.1 The term "Confidential Information" shall mean all information and data, in whatever form, which a Party directly or indirectly acquires from the other Party or from the performance of the Work (including events witnessed by Contractor Group or Company Group and the Personnel of each of the foregoing in connection with the performance of the Work) and includes without limitation, Contractor's and Company's Proprietary Information. Confidential Information does not include information which:
- (a) prior to the time of disclosure or acquisition is lawfully in the public domain;
 - (b) after disclosure or acquisition becomes part of the public domain, through no act or omission on the part of a Party;
 - (c) prior to disclosure or acquisition was already lawfully in a Party's possession without limitation on disclosure to others;
 - (d) was obtained by a Party from a third party who is lawfully in possession of such information and is not subject to a contractual or fiduciary relationship with the other Party with respect to such information; or
 - (e) was independently developed by the receiving Party without the use of Confidential Information.



- 28.2 Contractor shall not disclose Company's Confidential Information (including photographs of activities of Company) to any third party nor use any of Company's Confidential Information without the Approval of Company. Notwithstanding the foregoing, Contractor may disclose Company's Confidential Information to its Affiliates, Subcontractors and the directors, officers, employees, contractors, legal counsel, consultants and advisers to whom disclosure is required to enable Contractor to perform its obligations or if required by Applicable Laws, provided Contractor has taken such reasonable and necessary precautions to prevent any of the foregoing parties from disclosing such information to any third party. Contractor shall adopt and follow precautionary measures with respect to Company's Confidential Information to ensure that it is not disclosed to third parties by any of Contractor Group, without the Approval of Company. Any Approval given by Company shall apply only to the specific request for Approval made by Contractor. If disclosure of Company's Confidential Information is required by Applicable Laws, Contractor shall promptly notify Company in advance of such disclosure unless prohibited by the Applicable Law.
- 28.3 Company shall not disclose Contractor's Confidential Information (including photographs of activities of Contractor) to any third party nor use any Contractor's Confidential Information without the Approval of Contractor. Notwithstanding the foregoing, Company may disclose Contractor's Confidential Information to its Affiliates and to Owner, and the directors, officers, employees, contractors, subcontractors, legal counsel, consultants and advisors of the foregoing to whom disclosure is required to enable Company to perform its obligations hereunder or if required by Applicable Laws, provided Company has taken such reasonable and necessary precautions to prevent any of the foregoing parties from disclosing such information to any third party. Company may disclose such necessary Contractor's Confidential Information to Company's and Owner's bankers and to financial institutions from whom Owner and Company may seek financing for the LCP. Company shall adopt and follow precautionary measures with respect to Contractor's Confidential Information to ensure that it is not disclosed to third parties by Company's Personnel, or others, without the Approval of Contractor. Any Approval given by Contractor shall apply only to the specific request for Approval made by Company. If disclosure of Contractor's Confidential Information is required by Applicable Laws, Company shall promptly notify Contractor in advance of such disclosure unless prohibited by the Applicable Laws.
- 28.4 To the extent a Party is subject to the provisions of the Privacy Law, all documents and other records in the custody of or under the control of that Party and its Affiliates, and in relation to the Work in the custody of or under the control of the other Party, will be subject to the Privacy Law. Subject to the limitations of the Privacy Law and to the extent it applies to each Party or its Affiliates, the confidentiality obligations contained in this Agreement shall apply.
- 28.5 Each Party who discloses Confidential Information of another Party to its Personnel shall ensure that any such Personnel are informed of the confidential nature of the information disclosed and that such Personnel comply with the Party's obligations under this **Article 28**.
- 28.6 **Article 28** does not apply to the disclosure of information by a Party in order to comply with any Applicable Law or legally binding order of any Court or Authority, as long as prior to


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such disclosure the disclosing Party gives Notice to the other Party with full particulars of the proposed disclosure.

- 28.7 Contractor acknowledges that Owner is subject to the access to information and Privacy Law pursuant to which the public may have access to Owner's records.
- 28.8 If requested by the disclosing Party, whether prior to or after the expiry or earlier termination of the Agreement, the receiving Party shall promptly deliver to the disclosing Party all Confidential Information in the custody, possession or control of the receiving Party or any of its Personnel except for one archival copy to be kept in the legal department of the receiving Party and accessed only by legal counsel in the case of a dispute over the content of such Confidential Information disclosure.
- 28.9 The breach of any of the conditions contained in this **Article 28** will be deemed to be a material breach of the Agreement.

ARTICLE 29 PATENTS, TRADEMARKS, COPYRIGHTS

- 29.1 Contractor grants to Company and their respective Affiliates worldwide, a non-exclusive, royalty-free, irrevocable (except where Company breaches the terms of this license and such breach cannot be rectified or remedied), perpetual, non-transferable license to use any of its intellectual property rights for the purposes of performance of the Work, the use and operation of any property resulting from the performance of the Work, for the purposes of interfacing the Work with equipment supplied by third parties and for servicing and maintaining such property, including to have service and maintenance by third parties.
- 29.2 Contractor agrees to disclose promptly to Company, all inventions or concepts which it or its Personnel may make as a result of the performance of the Work or which are wholly or in part based on or derived from the Work and which are based mainly or wholly on technical information supplied by Company. Company hereby assigns all rights, title and interest in and to such inventions, and to any design, specification, or drawings produced in the course of the performance of the Work to Contractor. Company agrees to execute or have executed all documents and to perform or have performed all such lawful acts as may be necessary to perfect Contractor's title to such inventions and, subject to reimbursement of all reasonable costs incurred, to assist Contractor in obtaining and maintaining patent coverage, trademark or copyright thereon throughout the world.
- 29.3 Contractor shall not incorporate anything in the Work that violates copyrights, patents, and trademarks that were registered as of the date of incorporation into the Work. Provided that the part of the Work which is subject of a claim of patent, copyright or trademark infringement and any uses of the Work associated therewith: 1) do not deviate from the Contractor's specifications; 2) have not been modified by Company or Company's Other Contractors; and 3) have not been designed in accordance with specifications provided or created by Company or Company's Other Contractors, Contractor agrees to indemnify and

96 UMB

hold Company Group safe and harmless from and against any and all claims, losses, damages, costs (including legal costs), expenses and liabilities of every kind and nature arising out of or from any claims of alleged infringement of patents, copyright and trademark covering the Work or claims of Contractor's alleged misappropriation of proprietary or protected rights covering the Work and any property, methods or processes furnished by Contractor so long as Contractor is given reasonable notice of such claims. Contractor shall have the right and option to fulfill its obligations to Company hereunder by: (a) defending against and settling such claims; (b) obtaining for Company the right to continue using such Work or part thereof; (c) eliminating any infringement by replacing or modifying all or part of the Work. Contractor shall require its Subcontractors to provide the same rights and protections for Company Group that Contractor is required to provide pursuant to this **Article 29.3**.

- 29.4 Not Used.
- 29.5 Subject to **Article 29.1, 29.2** and **29.6** and except for any intellectual property rights included in any of the following documents, all drawings, assembly procedures, process specifications, computer programs, documents and information developed by Contractor Group for the purposes of the Agreement or which may arise out of the performance of the Agreement by Contractor shall be the property of Company.
- 29.6 If, as a result of the performance of the Work, Contractor Group develop any inventions or concepts, all rights, title and interest in and to such inventions and to any design specification or drawings produced therefrom shall belong to Contractor.

ARTICLE 30 ASSIGNMENT

- 30.1 Company may assign this Agreement, or any part thereof, to:
- (a) any Affiliate; or
 - (b) with Contractor Approval, not to be unreasonably withheld, any successor to or replacement corporation of Company or similar entity in connection with any merger, consolidation or other reorganization of Company or transfer of all or any part of Company's assets other than as contemplated in paragraph (a) above; or
 - (c) Owner.
- 30.2 Following any assignment by Company pursuant to this **Article 30**, this Agreement may be re-assigned to Company without Contractor's Approval.
- 30.3 Contractor shall not assign any of its interest in this Agreement without the Approval of Company. Such Approval shall not release or relieve Contractor from any representation or warranty given by Contractor or any obligation to be performed on the part of Contractor

under this Agreement. Notwithstanding the foregoing, Contractor may at any time assign its interest in this Agreement to an Affiliate, provided that:

- (a) Contractor shall remain liable for any obligation to be performed on the part of Contractor under this Agreement, including Performance Guarantees, if the Affiliate fails to fulfill any such obligation;
- (b) the letter of credit shall remain in place, remain effective and available to Company in the event the Affiliate fails to fulfill Contractor's obligation under this Agreement; and
- (c) if the Affiliate has a tax residency status that is different than the tax residency status of Contractor as declared to Company in accordance with **Article 13.3** (or such subsequent tax residency Approved by Company in accordance with **Article 13.3**), Contractor has obtained the prior written approval of Company of the proposed assignment to the Affiliate.

30.4 In the event of a transfer by sale, assignment, amalgamation, merger, trust, operation of law or otherwise of any shares, interest or voting rights of Contractor which may result in the change of identity of the Person exercising *de facto* or *de jure* control over Contractor, the provisions of **Article 30.3** shall apply.

ARTICLE 31 FORCE MAJEURE

31.1 For the purposes of this Agreement, Force Majeure shall mean and be limited to the following:

- (a) acts of God, riot, civil unrest, civil disturbance (including blockades to and from the Site), war, acts of civil or military authority, epidemics, quarantine restrictions, acts of terrorism, sabotage or destruction by a third party (other than any contractor retained by or on behalf of the Party suffering the Force Majeure);
- (b) earthquake, fire, storms in excess of a one hundred (100) year storm or other natural physical disaster, but excluding other weather conditions as such regardless of severity;
- (c) except for strikes caused or contributed to by Contractor, strikes at a national, provincial or Site level, industrial disputes at a national, provincial or Site level, which affect a substantial or essential portion of the Work; and
- (d) maritime and aviation disasters.

31.2 Neither Contractor nor Company shall be responsible for any failure to fulfil any term or condition of this Agreement if and to the extent that such fulfilment has been delayed or

96 MB

rendered impossible by a Force Majeure occurrence of which the other Party has been notified in accordance with this **Article 31** and which is beyond the control and without the fault or negligence of the Party affected, and which by the exercise of reasonable diligence the said Party is unable to provide against. In the event of such a Force Majeure occurrence the Milestone Schedule shall be adjusted by the amount of the delay caused by the occurrence.

- 31.3 A Party may not rely upon the provisions of **Article 31.2**:
- (a) unless within three (3) Business Days of being made aware of the Force Majeure occurrence it has given Notice to the other Party of such Force Majeure and of the obligations expected to be affected thereby;
 - (b) unless it shall immediately take all such steps as may be commercially reasonable in the circumstances to cause the discontinuance of, and to minimize the effect of, the Force Majeure occurrence and resume performance of the obligation affected by the Force Majeure as soon as reasonably possible; and
 - (c) to the extent that and for so long as there would be concurrent delay to Work resulting from pre-existing matters within the responsibility or obligation of Contractor under this Agreement.
- 31.4 Where Company claims Force Majeure and is entitled to rely upon the provisions of **Article 31.2**, then no compensation shall be payable to Contractor during the period that the Force Majeure occurrence continues to prevent performance by Company. Where Contractor claims Force Majeure and is entitled to rely on the provisions of **Article 31.2**, then no compensation shall be payable to Contractor during the period that the Force Majeure occurrence continues to prevent performance by Contractor.
- 31.5 If Contractor is prevented from or delayed in performing any of its obligations as a result of an event of Force Majeure for a cumulative period of more than thirty (30) days or a consecutive period of more than fifteen (15) days during the Term, Company shall have the right thereafter to immediately terminate this Agreement upon giving Notice thereof to Contractor and Company shall have no further liability whatsoever to Contractor (except payment for Work performed prior to such termination and demobilization costs).
- 31.6 A Force Majeure occurrence shall in no circumstances entitle Contractor to an increase in the Contract Price.
- 31.7 During any period in which the performance of the Work is prevented because of Force Majeure, Contractor and Company shall mutually agree either (1) to continue maintaining Contractor's Items and Personnel at or near the Worksite, in which case Company will reimburse Contractor at the rates outlined in Exhibit 2 - Compensation which is intended to cover only those expenses incurred by Contractor as a direct result of such prevention of performance, or (2) to demobilize Contractor's Items and Personnel.

ARTICLE 32
DEFAULT AND TERMINATION

- 32.1 Company may, without prejudice to any other right or remedy that it may have against Contractor, by giving Notice to Contractor, immediately terminate this Agreement in the event that any of the following shall occur:
- (a) Contractor breaches any of its obligations under **Article 15**;
 - (b) Contractor becomes or is, in Company's reasonable opinion, likely to become insolvent or to go into liquidation;
 - (c) Contractor fails to execute the Work in accordance with Exhibit 9 – Interface and Milestone Schedule and has failed to commence and diligently pursue actions reasonably necessary to mitigate or remedy such failure within ten (10) Business Days after the Notice from Company;
 - (d) the Work or any material part thereof becomes an actual or constructive total loss prior to Delivery notwithstanding that the loss may have been caused by an event of Force Majeure;
 - (e) Contractor fails to procure or maintain the Performance Bonds in accordance with **Article 7**;
 - (f) Contractor is in breach of any other material obligations under this Agreement, including any terms, conditions, covenants, representations or warranties and has not commenced to rectify such breach within eight (8) Business Days after Notice thereof from Company or, after commencing to rectify such breach, is unable to rectify such breach within forty-five (45) days of Company's Notice; or
 - (g) Upon the occurrence of the circumstances set out in Article 31.5.
- 32.2 Notwithstanding **Article 32.1(f)**, if Company has provided seven (7) Business Days prior Notice to Contractor of the following applicable occurrence and Contractor has failed to remedy such occurrence within such eight (8) Business Day period, Company may, without prejudice to any other right or remedy that it may have against Contractor, by giving Notice to Contractor, immediately terminate this Agreement in the event that any of the following shall occur:
- (a) Contractor fails to make prompt payment for labour, materials, financing, skill or other services provided to Contractor by third parties in the performance of the Work;
 - (b) Contractor subcontracts or delegates any portion of the Work, or its obligations hereunder, without Company's Approval in accordance with **Article 6.2**;

9/6 MB

- (c) Contractor assigns this Agreement without Company's Approval pursuant to **Article 30.3**;
- (d) Contractor fails to obtain or maintain the insurance required in accordance with **Article 18**;
- (e) Contractor disregards reasonable instructions of Company.

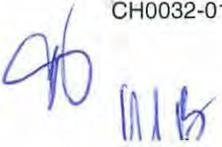
32.3 In the event Company terminates this Agreement pursuant to **Article 32.1** or **32.2**, Company may take title and possession of all Work and Company may complete the performance of the Work by whatever method it may deem expedient. In such case:

- (a) Company shall have no liability whatsoever to Contractor, except for any amounts payable up to the date of termination of this Agreement (plus those amounts payable pursuant to **Article 32.6** when Company terminates pursuant to **Article 32.1(d)** due an event of Force Majeure), subject to Company's rights of set off; provided that Contractor shall be reimbursed for all Work performed by Contractor, to the satisfaction of Company, prior to such termination;
- (b) subject always to considerations of health, safety and of the environment, Contractor shall discontinue performance of the Work and shall comply in full with Company's instructions regarding such termination;
- (c) Contractor shall use its best efforts to assign to Company or its nominee any Subcontracts, including any contracts related to Contractor Personnel or any equipment required to complete the Work;
- (d) subject to **Article 28** and **Article 29**, Contractor shall promptly deliver to Company all data, calculations and other materials associated with the Work, all on an appropriate medium, together with all drawings, specifications and other documents prepared or obtained by Contractor in connection with the Work and shall carry out Company's instructions concerning any cancellation or assignment of Subcontracts, purchase orders and any other matters arising out of this Agreement which Company decides are necessary or expedient; and
- (e) Contractor shall allow Company, or its nominees, full right of access to the Worksites so as to remove or perform Work.

32.4 Notwithstanding any other provision of this Agreement, Company may in its sole and absolute discretion and for any reason, including convenience of Company and without any fault or default on the part of Contractor, terminate this Agreement effective immediately upon giving Notice to Contractor or effective at a future date specified in the Notice; and, subject to Contractor complying with its obligations to protect persons and property from damage, Contractor shall cease the performance of the Work immediately upon receiving that Notice or upon any later date specified in that Notice.



- 32.5 Company may, without prejudice to any other right or remedy that it may have against Contractor, terminate this Agreement in the event that Contractor is prevented from or delayed in performing any of its obligations as a result of an event of Force Majeure pursuant to **Article 31.5** by giving Notice of termination to Contractor.
- 32.6 In the event Company terminates the Agreement pursuant to **Article 32.4** or **Article 32.5**, Company may take title and possession of all Work and complete the performance of the Work by whatever method it may deem expedient. In such case:
- (a) Company shall reimburse Contractor the aggregate value of all Work performed at the time of termination less the aggregate value of all amounts paid in relation to such Work. Company shall also pay Contractor a proportionate value of Work in progress or lump sum Change Orders by progress, wherein such proportionate value is determined by demonstrated Work progress, as agreed between the Parties, associated with the achievement of such Work in progress and lump sum Change Orders.
 - (b) For reimbursable Change Orders, Company shall reimburse Contractor for actual Work performed up to the date of termination, subject to Contractor compliance with **Article 12.13(b)**.
 - (c) Contractor shall clearly document and present to Company the costs incurred in the performance of the Agreement and the cancellation charges applicable to Subcontracts. In the event that costs incurred in the performance of the Agreement, together with the cancellation charges applicable to Subcontracts, are less than the amounts which have been previously paid to Contractor on account under the Agreement, Contractor shall reimburse Company in the amount of the difference within ten (10) Business Days of demand by Company following determination of the amount thereof.
 - (d) Contractor shall, prior to paying or agreeing to pay any cancellation charges pursuant to such Subcontracts, contracts and other agreements, submit to Company the amount of such charges for Approval. If and to the extent that Company does not Approve the amount of such charges, Contractor shall not pay the same and the Parties shall jointly negotiate with the relevant third party or parties in an attempt to reduce the amount thereof.
 - (e) In the event that the costs incurred in the performance of the Agreement are more than the amounts which have previously been paid to Contractor on account under the Agreement, Company shall reimburse Contractor in the amount of the difference within ten (10) Business Days of demand following determination of the amount thereof provided that Contractor has clearly documented the calculation resulting in such difference and has satisfied the requirements of paragraph (g) of this **Article 32.6**. In no event shall the aggregate of the amounts paid to Contractor under this Article exceed the Contract Price.



- (f) Subject always to considerations of health, safety and of the environment, Contractor shall discontinue performance of the Work and shall comply in full with Company's instructions regarding such termination.
 - (g) Subject to **Article 28** and **Article 29**, Contractor shall promptly deliver to Company all data, calculations and other materials associated with the Work, all on an appropriate medium, together with all drawings, specifications and other documents prepared or obtained by Contractor in connection with the Work and shall carry out Company's instructions concerning any cancellation or assignment of Subcontracts, purchase orders and any other matters arising out of this Agreement which Company decides are necessary or expedient.
 - (h) Contractor shall allow Company, or its nominees, full right of access to the Worksites so as to remove or perform Work.
- 32.7 The Parties acknowledge and confirm their respective obligations to make commercially reasonable efforts to mitigate any damages or costs arising from any termination of this Agreement.
- 32.8 Contractor has the right to suspend the Agreement for default or failure to make timely payment of undisputed amounts which continues after a notice and cure period, if the Company is adjudged bankrupt, or if a suspension exceeds 180 days. Contractor also has the right to terminate or suspend the Work upon any material breach by the Company of its obligations under this Agreement, including payment obligations.

**ARTICLE 33
BANKRUPTCY, INSOLVENCY AND RECEIVERSHIP**

- 33.1 Company shall have the right, without limiting any of its other rights or remedies, to terminate this Agreement immediately by giving Notice of termination to Contractor if:
- (a) Contractor or its assets becomes the subject of any proceeding (whether initiated by Contractor or another Person) under bankruptcy or insolvency laws, including proceedings under the *Companies' Creditors' Arrangement Act* (Canada), R.S.C. 1985, c. C-36; or
 - (b) Contractor becomes the subject of any proceeding for liquidation, reorganization or winding-up (whether initiated by Contractor or another Person); or
 - (c) a receiver or receiver-manager of all or any part of Contractor's assets is appointed by a Court or by any of its creditors; or
 - (d) Contractor commits an act of bankruptcy as defined in the *Bankruptcy and Insolvency Act* (Canada), R.S.C. 1985, c. B-3, or commits any other act or omission which would entitle any of Contractor's creditors to initiate a process or proceeding

to take possession of any of Contractor's assets or to have any of Contractor's assets distributed among such creditors.

- 33.2 If this Agreement is terminated by Company under **Article 33.1**, Company shall be entitled to withhold further payments to Contractor and set-off those payments against any amounts which Contractor owes or will owe to Company under this Agreement or any other agreement and Company reserves to itself all other rights, remedies and counterclaims to which it may be entitled hereunder or at law or equity.

ARTICLE 34 SUSPENSION

- 34.1 Company may at any time during the Term, at Company's sole discretion for any reason, suspend performance of the Work, or any part thereof, by giving Notice to Contractor (such period of suspension hereinafter "**Suspension Period**"). The Work shall be resumed by Contractor on a date as may be specified by Company in a Notice to Contractor. During the Suspension Period, Contractor shall properly protect and secure the Work as Approved in advance by Company. The Milestone Schedule shall be adjusted by the duration of the Suspension Period.
- 34.2 Subject to **Article 34.3** and **Article 34.4**, Company shall reimburse Contractor its reasonable expenses (which Contractor shall use its best efforts to mitigate) incurred in compliance with any suspension order and associated reinstatement order (the "**Suspension Expenses**"). Any such Suspension Expenses are to be subject to audit in accordance with **Article 14**. In no event shall Contractor be entitled to any compensation for items covered in **Article 21.12** that may have resulted from such suspension or reinstatement order.
- 34.3 Company shall have the right to suspend performance of the Work for as long as necessary to prevent or stop any contravention of **Article 15**. During such period of suspension, no Suspension Expenses shall be payable to Contractor by Company.
- 34.4 In case of suspension due to Contractor's failure to perform the Work in accordance with **Article 3**, Contractor shall not be entitled to Suspension Expenses incurred from the moment the Notice of suspension was given until a reinstatement order (if any) is given by Company but shall remain liable, without prejudice to Company's other rights under this Agreement.
- 34.5 Contractor shall cause all terms of this Article to be inserted in all Subcontracts so that Company and Contractor shall have the rights herein set forth with respect to all Subcontractors.

**ARTICLE 35
LABOUR RELATIONS**

- 35.1 Contractor acknowledges that some or all of Company's Other Contractors and their Subcontractors at a Worksite, and Owner's Other Contractors and their subcontractors, Personnel and subcontractors, may be union or non-union and that Company requires Contractor to ensure that labour peace shall be maintained. Contractor shall take all necessary precautions to avoid labour disputes and to minimize the disruption in the event of any dispute.
- 35.2 Contractor represents and warrants that no collective or other agreement with its Personnel or between its Subcontractors and their workers, and no expiry or termination of any such agreement, will adversely affect labour peace at the Worksites or delay Contractor's performance of the Work.
- 35.3 With respect to Work to be performed at the Site, Contractor represents and warrants that it and its Subcontractors, if unionized, have written agreements with the unions representing the workers employed by them that include provisions that non-affiliation rights in any collective agreement or pursuant to any statutory right will not be exercised in connection with the Work. Any and all such agreements shall be submitted to Company within three (3) Business Days of the Effective Date or of the date an agreement comes into effect.
- 35.4 With respect to Work to be performed at the Site, whenever Contractor has knowledge that any actual or potential labour dispute is delaying or threatening to delay the schedule and performance of the Work, Contractor shall immediately advise Company in writing, including all relevant information with respect to such dispute or potential dispute and potential impact on the schedule and performance of the Work.
- 35.5 Without restricting the generality of Company's right to terminate the Agreement, Company may, but is not obligated to, give Notice to Contractor requiring Contractor to terminate any Subcontract for work at the Site by giving three (3) days' notice to the Subcontractor if:
- (a) the workers of the Subcontractor, or anyone employed by or through the Subcontractor:
 - (i) declare or engage in a strike, a work stoppage or a refusal to supply material; or
 - (ii) engage in a slowdown or other concerted activity which restricts or limits or, is likely to restrict or limit, the progress or performance of the Work; or
 - (iii) picket or cause picketing to occur or support picketing by the refusal to Work, or continue to Work at or in the Worksites whether in support of lawful strike or for any other reason; or
 - (iv) does not comply with **Article 8**;



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or

- (b) the Subcontractor, or anyone engaged by or through the Subcontractor, imposes a lockout, lawful or unlawful, against their workers engaged in performing the Work.
- 35.6 With respect to Work to be performed at the Site, Contractor shall ensure that all Subcontracts allow termination in each of the events set out in **Article 35.5**.
- 35.7 With respect to Work to be performed at the Site, the sole cost and expense of preventing, avoiding or removing any of the matters or events giving rise to a labour disruption caused by Contractor Group with respect to Work at the Site relating to Contractor Group Personnel shall be borne by Contractor, who shall prevent, avoid and remove any and all such labour disruptions within five (5) days of the commencement of such disruptions, including making any necessary applications for injunctive or other relief to the Court.
- 35.8 Except for strikes, labour disputes or industrial disputes referenced in **Article 31.1(c)**, delays in the performance of the Work as a result of any strike, industrial dispute, labour disruption or labour dispute involving Contractor Personnel are to be considered as a delay attributable to Contractor, and for which Contractor shall not be entitled to compensation or an extension to the date for completion of a Milestone.

ARTICLE 36

LIQUIDATED DAMAGES FOR DELAY AND PERFORMANCE INCENTIVES

- 36.1 For each Milestone specified in Section 11.1 of Exhibit 2 – Compensation as being subject to liquidated damages, if Contractor fails to Deliver that part of the Work to achieve the Milestone by the date specified, Contractor shall pay Company as liquidated damages the full amount stipulated in Section 11.1 of Exhibit 2 – Compensation for each day, including any part thereof, of the delay of that Milestone, from that Milestone Date to the date the Milestone is achieved, unless the failure to achieve the Milestone is due to an event of Force Majeure, a Change affecting the Milestone or a Suspension Period.
- 36.2 Contractor's limit of liability for liquidated damages for delay payable by Contractor to Company pursuant to this **Article 36** shall be a maximum of three million dollars (CAD 3,000,000); provided that for any day for which Contractor is liable to pay liquidated damages to Company pursuant to **Article 36.1** for more than one (1) Milestone specified in Exhibit 2 – Compensation, Contractor shall only be liable to pay Company the largest liquidated damages rate applicable on that day.
- 36.3 The Parties agree that the liquidated damages determined in accordance with this **Article 36** are genuine pre-estimates of the likely damages that Company would incur as a result of Contractor's breach of contract for failure to achieve any of the Milestones specified in Section 11.1 of Exhibit 2 – Compensation by the respective date specified for such Milestones. The Parties agree that the liquidated damages set out in this **Article 36** are not intended and shall not be deemed to be penalties.

ab MB

- 36.4 Company shall have the right to payment by Contractor of liquidated damages from time to time by giving Notice to Contractor. Any such Notice shall specify the amount of such damages and Contractor shall pay the amount so specified within ten (10) Business Days of the date of such Notice. Failure by Company to give Contractor a Notice shall not constitute a waiver of Company's right to claim all liquidated damages under this **Article 36**.
- 36.5 Company has the right to set off any amount of liquidated damages, plus interest determined in accordance with **Article 12.17**, owed by Contractor to Company against any amount due or to become due from Company to Contractor under the Agreement.
- 36.6 Notwithstanding anything to the contrary in this Agreement, but subject to **Article 32.1(c)**, the Parties agree that the payment of liquidated damages pursuant to **Article 36.1** constitutes the sole and exclusive remedy of Company for failure by Contractor to complete the Work or any part thereof by the dates for completion of the Milestones in Exhibit 2 – Compensation and Exhibit 9 – Work and Milestone Schedule.

ARTICLE 37
REPRESENTATIONS, WARRANTIES AND COVENANTS

- 37.1 Contractor represents and warrants that during the Term:
- (a) it has the required skills, experience, facilities, equipment and capacity to perform the Work in a timely manner and in accordance with the terms of this Agreement, Applicable Laws, the Standard of a Prudent Contractor and sound industry accepted practices;
 - (b) all Contractor's Personnel involved in carrying out any of the Work have the qualifications, training and experience, and hold such valid licences and certificates of competence, as are required to carry out their duties in relation to the Work (including visas and work permits);
 - (c) each of Contractor's Items is of good quality, in good working condition, is in compliance with all Applicable Laws and is fit for its intended use as contemplated in this Agreement; and
 - (d) the making and performance of this Agreement are within its powers, have been duly authorized by all necessary action and do not and will not violate any Applicable Law or any provision of its governing documents.
- 37.2 Contractor covenants that during the Term it shall:
- (a) perform the Work in a diligent, safe, efficient and timely manner and in accordance with the Standard of a Prudent Contractor;

- (b) perform the Work continuously and in accordance with this Agreement, using only Contractor's Personnel and for the portions of the Work listed in Exhibit 8 - Subcontractors, Manufacturers and Material Sources using only Subcontractors named in that Exhibit;
- (c) use quality assurance programs in performing the Work which comply with the requirements of Exhibit 7 – Quality Requirements, all Applicable Laws and industry accepted practices;
- (d) schedule all long lead time equipment or products for manufacture at the earliest possible date;
- (e) not displace or set back in a manufacturing queue or production schedule the equipment or product to be manufactured for the Work in favour of another customer or client of Contractor following such equipment or product placement in a manufacturing queue or production schedule;
- (f) supply materials, equipment and products for installation into the Work that are new and meet or exceed the standards specified in this Agreement ;
- (g) maintain, at its sole risk, cost and expense, all Contractor's Items throughout the Term;
- (h) comply with, and ensure Contractor's Personnel and Subcontractors comply with, all health and safety requirements set out in Exhibit 5 – Health and Safety Requirements and Applicable Laws;
- (i) comply with, and ensure Contractor's Personnel and Subcontractors comply with, all environment and regulatory requirements set out in Exhibit 6 – Environment and Regulatory Compliance Requirements and Applicable Laws;
- (j) take all steps necessary to maintain good labour relations with Contractor's Personnel to the extent that such requirement is consistent with sound business practice;
- (k) comply, on a timely basis, with all instructions of Company consistent with the provisions of this Agreement, including health, safety and environmental instructions;
- (l) provide such reports, records, and other information relating to the performance of the Work as Company may request from time to time, including copies of the qualifications and credentials of Contractor's Personnel and Subcontractors and information relating to quality assurance programs, and permit Company to inspect Contractor's Items and Worksites, to enable Company to satisfy itself that Contractor is complying with the terms of this Agreement;



- (m) obtain for the benefit of Company all available exemptions and/or refunds from Taxes; and
 - (n) implement and maintain a cost effectiveness program ensuring all techniques proposed for the performance of the Work are or have been reviewed to ensure that they are cost effective.
- 37.3 Contractor warrants and acknowledges that it has reviewed and understands the Applicable Laws and Lower Churchill Construction Projects Benefits Strategy governing the use of personnel, goods and services in the Work. Contractor shall, throughout the Term, take such action as Company may specify to enable Company to comply with all Applicable Laws regarding the use of Canadian and Newfoundland and Labrador personnel, goods and services, including any Newfoundland and Labrador Benefits requirements and those requirements set forth in Exhibit 13 - Provincial Benefits of this Agreement. Where Contractor is permitted to subcontract, Contractor shall ensure that Subcontractors comply with such requirements. In addition, Contractor shall provide reports in the manner and format described in Exhibit 13 - Provincial Benefits of this Agreement throughout the term of this Agreement.
- 37.4 Contractor warrants and acknowledges that, except for the Technical Specifications, any information provided by Company or Owner prior to or after execution of this Agreement, including any and all reports, data, interpretations, recommendations and information, was prepared solely for the purpose of study to consider the general feasibility of the Work and not for the purpose of design, manufacture or installation. Company does not warrant and is not liable for the accuracy, sufficiency, adequacy, completeness or content of any such information or any information subsequently supplied by Company or by Engineer, all of which has been provided to Contractor for general information only and on the condition that such information shall not be relied on by Contractor except to the extent that Contractor has either fully satisfied itself as to its sufficiency and accuracy or has fully accepted all risks and contingencies associated with such information.
- 37.5 Contractor shall, maintain, at its sole risk, cost and expense, all Contractor's Items throughout the Term in the manner necessary to ensure that the warranties and covenants in **Article 37.1** and **Article 37.2** shall be true and accurate at all times during the Term. If any of Contractor's Items do not at any time conform to the warranties and covenants given in **Article 37.1** and **Article 37.2**, Contractor shall, at Contractor's sole expense, repair such Contractor's Items or replace with items which conform in all respects to such representations and warranties.
- 37.6 Contractor agrees that all of its representations, warranties and covenants contained in this Agreement are and shall be deemed to be material and shall be conditions of this Agreement.

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**ARTICLE 38
ENTIRETY OF AGREEMENT, NON WAIVER**

- 38.1 This Agreement, as executed by authorized representatives of Company and Contractor, constitutes the entire agreement between the Parties with respect to the matters dealt with herein. This Agreement replaces and supersedes all prior agreements, documents, writings and verbal understandings between the Parties in respect of the Work and there are no oral or written understandings, representations or commitments of any kind, express or implied, which are not expressly set forth herein.
- 38.2 No modification of this Agreement by Contractor or Company, either before or after the execution of this Agreement, shall be of any force or effect unless such modification is in writing, is expressly stated to be a modification of this Agreement and is signed by duly authorized representatives of each of the Parties, with the exception of the following Exhibits where changes to same may be issued solely by Company:
- (a) Exhibit 3 – Coordination Procedures;
 - (b) Exhibit 5 – Health and Safety Requirements;
 - (c) Exhibit 6 – Environment and Regulatory Compliance Requirements;
 - (d) Exhibit 10 – Declaration of Residency;
 - (e) Exhibit 11 – Owner Supplied Documents;
 - (f) Exhibit 12 – Site Conditions;
 - (g) Exhibit 13 – Provincial Benefits.
- 38.3 No waiver of any provision of this Agreement shall be of any force unless such waiver is in writing, is expressly stated to be a waiver of a specified provision of this Agreement and is signed by the Party to be bound thereby. Either Party's waiver of any breach of, or failure to enforce, any of the covenants, conditions or other provisions of this Agreement, at any time, shall not in any way affect or limit that Party's right thereafter to enforce or compel strict compliance with every covenant, condition or other provision hereof.
- 38.4 Each of the Parties shall, from time to time, at its own cost and expense, execute or cause to be executed all such further documents and do or cause to be done all things which are necessary to give effect to the provisions of this Agreement.

**ARTICLE 39
DISPUTE RESOLUTION**

- 39.1 Subject to Article 39.5 below, if any dispute, controversy, claim, question or difference of opinion arises between the Parties under this Agreement including an interpretation, enforceability, performance, breach, termination or validity of this Agreement ("**Dispute**"), the Party raising the Dispute shall give Notice to the other Party in writing within twenty

(20) days of the Dispute arising, and such Notice shall provide all relevant particulars of the Dispute.

39.2 Upon issuance of Notice of the Dispute, the Parties shall, acting in good faith and a commercially reasonable manner, attempt to resolve the Dispute in the following manner:

- (a) Within ten (10) days of the Notice, the senior project managers for each of Company and Contractor shall meet to attempt to resolve the Dispute;
- (b) If not resolved by senior project managers, the project sponsors or representative Vice Presidents for each of Company and Contractor will meet within twenty (20) days following the meeting of the project managers to attempt to resolve the Dispute; and
- (c) If not resolved by project sponsors or representative Vice Presidents, the Chief Executive Officers for each of Company and Contractor will meet within twenty (20) days following the meeting of the project sponsors or representative Vice Presidents to attempt to resolve the Dispute.

39.3 ARBITRATION:

- (a) If the Dispute is not resolved by the Parties within seventy (70) days from the date of delivery of the Notice of Dispute then either Party may require resolution of the Dispute by arbitration by providing written notice to the other Party ("**Arbitration Notice**") within ten (10) days of the date of the meeting of the Chief Executive Officers, and submitting such Dispute to arbitration in accordance with the provisions of the Arbitration Act of Newfoundland and Labrador [RSNL 1990 Chapter A-14, Amended 1995 c. 13, s. 2 (the "**Arbitration Act**")], and the provisions of this Section 39.3 (the "**Arbitration Procedure**") shall apply.
- (b) A single qualified and independent arbitrator knowledgeable in the subject matter of the Dispute shall be jointly appointed by the Parties to preside over the Arbitration Procedure. Should the Parties be unable to agree upon an arbitrator within twenty (20) Days of delivery of the Arbitration Notice, either Party may make a motion to the court designated in section 1.20 hereof (the "**Court**")] requesting that it appoint a single qualified and independent arbitrator knowledgeable in the subject matter of the Dispute to preside over the Arbitration Procedure, the whole in accordance with the rules of the Arbitration Act. The decision of the Court regarding the identity of the arbitrator shall be final and binding upon the Parties and the Parties agree that there shall be no appeal available to either or both of them to the decision of the Court in this regard. An arbitrator with the requisite qualifications that is appointed pursuant to this Article 39.3(b) is hereinafter referred to as the "**Arbitrator**".
- (c) Within ten (10) Business Days of the appointment of the Arbitrator, the Parties shall submit their written positions to the Arbitrator. Within five (5) Business Days of receiving the submissions of the Parties, the Arbitrator shall coordinate with the Parties hearing dates that shall occur no later than twenty (20) Business Days following the deadline for the Arbitrator's receipt of the Parties' submissions. Meetings and hearings



of the Arbitrator will take place either in the City and District of Montreal, Quebec. Subject to the foregoing, the Arbitrator may fix the date, time and place of meetings and hearings in the arbitration and will give all parties adequate notice of same. Subject to any adjournments which the Arbitrator allows, the final hearing will be continued on successive Business Days until it is concluded. All meetings and hearings will be in private unless the Parties agree otherwise and both Parties are entitled to be represented at any meetings or hearings by legal counsel. Either Party may examine and re-examine all its own witnesses at the arbitration and may cross-examine all of the other Party's witnesses.

- (d) The arbitration will be kept confidential and the existence of the proceeding and any element of it (including, but not limited to, any pleadings, briefs or other documents submitted and exchanged, and testimony or other oral submission and any awards) will not be disclosed beyond the Arbitrator, the Parties, their counsel, , and any person necessary to the conduct of the proceeding, except as may be lawfully required in judicial proceedings relating to the arbitration or otherwise.
- (e) The Arbitrator shall have the authority to award any remedy or relief that a court or judge of the Trial Division (Newfoundland and Labrador) could order or grant in the circumstances (including in respect of costs, in accordance with Section **Error! Reference source not found.** of this section 39.3), subject to and in accordance with this Agreement, including, specific performance of any obligation created under this Agreement, the issuance of an interim, interlocutory or permanent injunction, or the imposition of sanctions for abuse or frustration of the Arbitration Procedure.
- (f) The Arbitrator will make and send a decision in writing not later than twenty (20) Business Days after the conclusion of the hearing and, unless the Parties agree otherwise, will set out reasons for the decision.
- (g) The decision of the Arbitrator will be final and binding on the Parties and shall not be subject to judicial review or appeal; and
- (h) The Arbitrator's fees and disbursements, and the costs of arbitration, shall be assumed equally by the Parties, provided however that each Party shall be solely responsible for payment of the fees and disbursements of its counsel, representatives, mandataries or experts unless such fees and disbursements of its counsel, representatives, mandataries or experts otherwise expressly awarded in a final award by the Arbitrator.

39.4 Notwithstanding the existence of a Dispute and the referral of the Dispute to the resolution procedures in this **Article 39**, Company and Contractor shall, to the extent reasonably possible or unless advised in writing by Company to suspend or discontinue work, continue to perform their obligations under this Agreement without interruption or delay. The continuation of such performance shall in no way amount to a waiver of, or in any way prejudice, the position that is taken by the Parties in the Dispute. There shall be no extension to the date for completion of a Milestone by reason that a Dispute has been referred to the dispute resolution process in this **Article 39**.

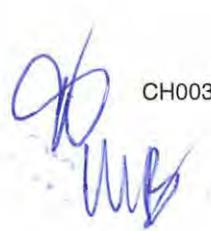
- 39.5 Consolidated Disputes: Notwithstanding **Articles 39.1 to 39.4**, where any Dispute relates to the same matter or is otherwise related to, or has issues in common with, a dispute between Company and Owner or a dispute arising under the Supply and Install Agreement, such Dispute shall be referred to the Dispute resolution procedure in the Supply and Install Agreement and the Contractor shall comply with such requirement and be bound by any decision or determination made under the Dispute resolution procedure in the Supply and Install Agreement. Contractor shall prepare promptly and fully all the documents, drawings, instructions, pleadings and any other information in the name of and on behalf of Company to reasonably enable Company to assert its rights and remedies under the Supply and Install Agreement.

ARTICLE 40
NOTICES

- 40.1 Unless otherwise specified in the Agreement, any Notice given or made pursuant to the Agreement shall:
- (a) be in writing;
 - (b) be marked to the attention of Contractor Representative, in the case of Contractor, or to Company Representative, in the case of Company;
 - (c) where given by Company, be signed or authorized by either Company Representative, an officer, a director or company secretary of Company, or a duly authorized representative of Company;
 - (d) where given by Contractor, be signed or authorized by either Contractor Representative, an officer, a director or company secretary of Contractor, or a duly authorized representative of Contractor; and
 - (e) be delivered by prepaid post, by hand, by Aconex or by facsimile to the Party to whom the Notice is addressed at its address specified in **Article 40.3** or such other address as that Party may have notified to the other Party.
- 40.2 A Notice will be taken to be duly given:
- (a) in the case of delivery by hand, when delivered
 - (b) in the case of delivery by post, five (5) Business Days after the date of posting (if posted to an address in the same country) or twenty (20) Business Days after the date of posting (if posted to an address in another country);
 - (c) in the case of delivery by facsimile, on receipt by the sender of a transmission control report from the sending machine showing the relevant number of pages and the correct destination facsimile machine number or name of the recipient and indicating that the transmission has been made without error;



- (d) in the case of delivery by Aconex, at the time and date recorded by Aconex for delivery to the recipient.



40.3 Any Notice given or made under the Agreement shall be delivered to the intended recipient by hand, post or facsimile to the address or facsimile number below or the address or facsimile number last notified by the intended recipient to the sender pursuant to **Article 40.7**:

(a) to Company:

Andritz Hydro Limited

6100 Transcanada Highway
Pointe Claire, QC
Canada H9R 1B9

ATTENTION: Mathieu Bertrand

E-mail: mathieu.bertrand@andritz.com

(b) to Contractor:

Groupe Canmec / Canmec Industriel
1750 La Grande
Chicoutimi (Qc)
G7K 1H7

ATTENTION : Eric Tremblay

E-mail: etremblay@canmec.com

40.4 Except where Notice is given using Aconex in accordance with **Articles 40.1, 40.2 and 40.3**, the Parties may use any other form of electronic mail for day to day communication but electronic mail shall not be used for and will not constitute Notice under the Agreement where the Agreement expressly requires that a Notice be given.

40.5 Any technical communications pertaining to the Work shall be between Company and Contractor Representative.

40.6 Except where expressly provided otherwise in the Agreement, verbal communications will not constitute formal communication or Notice under the Agreement and neither Party has any obligation to act on any verbal communication or instruction unless and until it is confirmed in writing. Any action taken by a Party based on verbal communications, instructions or assurances will be at that Party's sole risk and will be without liability to or recourse against the other Party.

- 40.7 A Party may, from time to time, give Notice to the other Party of any change to its address or facsimile number.

**ARTICLE 41
LIENS AND CLAIMS**

- 41.1 Without prejudice to the provisions of this **Article 41**, Contractor shall prevent the imposition of any liens, claims, encumbrances or attachments by or on behalf of any third party against Contractor's Items, the Work, Owner and Company property wherever located, or any portion thereof and any liens or attachments which nevertheless are imposed shall be promptly vacated and removed from title by Contractor, at Contractor's sole cost, and Contractor shall indemnify, defend and hold Company Group harmless from and against the same.
- 41.2 Contractor shall defend, protect, release, indemnify and hold Company Group harmless from and against, and shall keep Contractor's Items, Company's property, Worksites and Work thereon free and clear of all liens, charges, claims, assessments, fines and levies suffered, created, or committed by Contractor Group, save only liens or encumbrances created with the prior written consent of Company voluntarily in favour of financial organizations in connection with Contractor's obtaining reasonable, prudent and necessary financing. Company may post on any of Contractor's property such notices as it may desire to protect itself against such liens, claims, assessments, fines and levies.
- 41.3 Notwithstanding the efforts of Contractor hereunder, if Company suffers costs or expenses or becomes liable for payment as a result of the imposition of such liens or attachments, then without prejudice to any other rights or remedies available to Company, Company shall have the right to withhold and set off an amount equal to any such costs, expenses or payments incurred or made by Company from any payments due to Contractor hereunder.

**ARTICLE 42
ENUREMENT, TIME, SURVIVAL OF PROVISIONS**

- 42.1 This Agreement shall be binding upon the Parties, their permitted assignees and successors.
- 42.2 Time is of utmost importance.
- 42.3 The following provisions of this Agreement shall survive the termination or expiration of this Agreement and remain in full force and effect: **Articles 1.19, 1.20, 5.1, 5.7, 6.7, Error! Reference source not found., 7.1, 9.3, Article 12, Article 13, Article 14, Article 17, Article 21, Article 23, Article 24, Article 27, Article 28, Article 29, Article 32, Article 39, Article 41 and Article 44.**

**ARTICLE 43
COUNTERPARTS**

- 43.1 This Agreement may be executed in any number of counterparts and any Party may transmit by facsimile or email in portable document format to the other Party a copy of this Agreement executed by that Party, the receipt of which shall have the same force and effect as if the original thereof had in fact been delivered at the same time.
- 43.2 Any original, facsimile copy, portable document format or photocopy of this Agreement bearing one or more signatures on behalf of a Party shall be admissible against that Party in any legal proceeding as evidence of the execution and delivery of this Agreement by that Party and without the requirement to produce an executed original of the Agreement.
- 43.3 Each person signing the Agreement as an authorized representative of a Party hereby represents and warrants that he or she is duly authorized to sign the Agreement for that Party and that the Agreement will, upon having been so executed, be binding on that Party in accordance with its terms.

**ARTICLE 44
PERFORMANCE GUARANTEES**

- 44.1 Notwithstanding any other provisions of this Agreement, if during the performance tests performed by Contractor described in Exhibit 1 Scope of Work, Technical Specification, Section 48 13 20 Gates, Stoplogs and Trashracks, paragraph 2.8.8.4 performed after the achievement of Milestones M4, M22 and M23 of the Milestone Schedule, as the case may be, the Work does not meet the seal leakage rate described in Exhibit 1 Scope of Work, Technical Specification, Section 48 13 20 Gates, Stoplogs and Trashracks, paragraph 2.8.8.4, Contractor shall immediately repair the relevant part of the Work to correct the leakage and bring it within the values specified in Exhibit 1 Scope of Work, Technical Specification, Section 48 13 20 Gates, Stoplogs and Trashracks, paragraph 2.8.8.4.
- 44.2 If the performance test described in Exhibit 1 Scope of Work, Technical Specification, Section 48 13 20 Gates, Stoplogs and Trashracks, paragraph 2.8.8.4 reveals the Work meets the seal leakage rate described in that paragraph 2.8.8.4, then Contractor shall not have any further responsibility concerning the seal leakage rate.

SIGNATURE PAGE FOLLOWS



EXECUTED AS AN AGREEMENT:

For and on behalf of **Canmec Industriel Inc.**



Signature of Authorized Representative

ERIC TREMBLAY

Name of Authorized Representative



Signature of Authorized Representative

REMI ROY

Name of Authorized Representative

For and on behalf of **Andritz Hydro Ltd.**



Signature of Authorized Representative

DANIEL CARRIER

Name of Authorized Representative



Signature of Authorized Representative

MATHIEU BERTRAND

Name of Authorized Representative

EXHIBIT 1

SCOPE OF WORK

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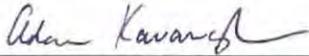
 SNC • LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT SCOPE OF WORK		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-SP- 0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EW-0001		02	27-Nov-2013	i

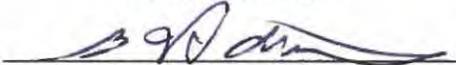
**LOWER CHURCHILL PROJECT
 MUSKRAT FALLS HYDROELECTRIC DEVELOPMENT**

CH0032

**SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY
 HYDRO-MECHANICAL EQUIPMENT**

SCOPE OF WORK

Prepared by: 
 Adam Kavanagh, Eng.
 Heavy Mechanical

Prepared by: 
 Gord Haines, P. Eng.
 Lead Engineer - Electrical

Prepared by: 
 Steve Chorny, P. Eng.
 Lead Engineer - Civil

Verified by: 
 Randolph Koob, P. Eng.
 Lead Engineer - Mechanical

Verified by: 
 Greg Snyder, P. Eng.
 Engineering Manager Hydro



 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT SCOPE OF WORK		Revision		Page
	Nalcor Doc. No. MFA-SN-CD-2000-ME-SP- 0001-01		D2	Date	
	SLI Doc. No. 505573-3321-45EW-0001		02	27-Nov-2013	

REVISION LIST

Revision					
N°	By	Appr.	Date	Revised pages	Remarks
D2	RK	 GS	27-Nov-2013	-	Update for Contract Award. See revision triangles.
D1	RK	GS	31-July-2013	-	Approved for Design
01/B2			01-Feb-2013	-	Issue for review
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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

**TABLE OF CONTENTS
SCOPE OF WORK**

1	GENERAL.....	2
1.1	Project Description.....	2
1.2	General Description of Package	3
1.3	Language and Units.....	6
1.4	Climatic Data	6
1.5	Hydrometeorological Data.....	7
2	SCOPE OF WORK	7
2.1	Work Included.....	7
2.2	Work Provided by Company's Other Contractors.....	22
2.3	Work Excluded.....	23
3	SPECIAL REQUIREMENTS	26
3.1	General.....	26
3.2	Site Conditions.....	27
3.3	Not Used.....	28
3.4	Environmental Requirements.....	28
3.5	Documents	28
3.6	Preservation, Mechanical Completion & Commissioning Requirements.....	29
3.7	Interface with Company's Other Contractors.....	30
3.8	Installation	30
3.9	Mobilization.....	31
3.10	Contractor's Temporary Facilities.....	32
3.11	Preparatory Work.....	33
3.12	Demobilization and Clean-up.....	33
3.13	not used.....	34
3.14	Survey requirements.....	34
3.15	Pre-Installation Surveys	34
3.16	Installation Survey	35
4	NOT USED.....	35

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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

1 GENERAL

1.1 PROJECT DESCRIPTION

1.1.1 The Lower Churchill Project (LCP), located on the Churchill River in the Province of Newfoundland and Labrador, Canada, consists of the Muskrat Falls Generating Station with a capacity of 824 MW (4 units of 206 MW), associated transmission lines, the Spillway, and Dams.

1.1.2 The project site of Muskrat Falls is located on the lower reaches of the Churchill River approximately 35 km west of the Town of Happy Valley – Goose Bay. Permanent access to the site is from the south shore, via a road extension from the existing Trans Labrador Highway. The Muskrat Falls Hydroelectric Development consists of the following main components:

- .1 Main access road, including upgrading and construction of over 22 km of new road with several stream crossings;
- .2 Approximately 20 km of site roads to be constructed to reach the main structures, laydown areas, accommodation complex, borrow areas and spoil disposal area;
- .3 1,500 person accommodation complex;
- .4 Contractor and Company's laydown areas;
- .5 Reservoir preparation including some 130 km of forest access road, forest harvesting, and bank stabilization;
- .6 Intake, Powerhouse, Spillway, Transition Dams, North RCC Dam and South Dam;
- .7 North Spur stabilization works;
- .8 Switchyards at Muskrat Falls and Churchill Falls;
- .9 High voltage overhead transmission lines and associated infrastructure; and
- .10 Environmental habitat (fish and terrestrial) protection, remediation and replacement.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

1.2 GENERAL DESCRIPTION OF PACKAGE

1.2.1 General

- .1 This Contract will be for the design, supply, installation, and commissioning of all Mechanical, Electrical and other associated Hydro-Mechanical equipment required for the Spillway, the Intake and the Draft Tube. The equipment and facilities will consist of fixed wheeled gates, bulkhead gates, trashracks, stoplogs, fixed and mobile wire rope hoists, hoist towers and buildings, trash cleaner, and electrical and mechanical auxiliaries in an electrical/control building on the dam crest with a backup diesel generator.
- .2 To accommodate river diversion some of the work will be staged and involve a mix of permanent and temporary work and equipment.
- .3 The work will also consist of supplying detailed documentation for design, quality control, and operation and maintenance for all work required by the Contract, and the provision for training of Company's personnel.

1.2.2 Spillway Equipment

- .1 The Spillway will have five bays each with a Spillway Gate and hoist and in its initial configuration will be used for diversion of the entire river during the construction phase of the project. In its final configuration the Spillway, when combined with overflow discharge at the North RCC Dam, will be able to pass the Probable Maximum Flood for this project.
- .2 In its initial configuration for river diversion each spillway bay will essentially be flat bottomed with the Spillway gate sill elevation at EL. 5.0 m. In its final configuration each spillway bay will have a parabolic rollway with the Spillway gate sill elevation at El. 18.0 m.
- .3 Each Spillway Gate will be operated with a wire rope hoist located in a hoist house located above the Spillway on towers. The Spillway Gates will be capable of operating long-term at any gate opening.
- .4 Each Spillway bay will have four sets of gate and stoplog guides. Starting from upstream guides are: stoplog guides for use after river diversion to enable the spillway rollway construction to be completed; another set of stoplog guides which will be used for the long-term maintenance of the Spillway after the rollways are constructed; guides for the Spillway Gates that will be used to regulate discharge through each bay; and a downstream set of stoplog guides that will be used both

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

for construction of the spillway rollways during diversion and for long-term maintenance.

- .5 The stoplogs to be used in the upstream two guides will consist of a combination of permanent and temporary stoplogs. During the river diversion phase there will be sufficient stoplogs to isolate up to two Spillway bays at one time to construct the rollways and in the final permanent configuration there will be sufficient stoplogs available to isolate one Spillway bay for long-term maintenance.
- .6 There will be sufficient downstream stoplogs to isolate two bays during the river diversion phase for construction of the rollways, and one set will be available for long-term maintenance.
- .7 The Spillway upstream stoplogs will be handled by the trash cleaner hoist.
- .8 Due to concerns about ice build-up during construction, and to facilitate installation and removal of the stoplogs in the winter, the upstream stoplogs are initially configured with upstream (water side) skinplate and seals, and after construction of the rollways, the permanent upstream stoplogs will have to be reconfigured to a downstream skinplate and seal arrangement.
- .9 The Spillway Gates guides and hoists will require modifications to change from the initial river diversion phase configuration to the final in service configuration after construction of each rollway and the change in Spillway Gate sill elevation.
- .10 Additional equipment to be ~~provided~~ ^{Installed} includes dogging devices for the gates and permanent stoplogs, lifting beams for each type of stoplog, ~~permanent and temporary heaters for ice control on the gates and stoplogs~~, lockout provisions for the Spillway Gates and Stoplogs, and access platforms, walkways and ladders.

1.2.3 Intake Equipment

- .1 The powerhouse intake will have four turbine/generator units with three intake bays per unit. From upstream to downstream each intake bay will have trashracks and guides, bulkhead gate guides, and an Intake Gate and guides. One set of bulkhead gates will be provided to isolate one bay of one unit to permit maintenance to be performed on the Intake Gate in that bay.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

- .2 The Intake gates will be operated by a wire rope hoist and will be used for the isolation of the water passages to perform maintenance on the turbine/generator. The Intake Gates will also be capable of opening under maximum differential head to fill the water passages and to close under maximum head and maximum discharge as part of an emergency shutdown sequence to protect the turbine and generator.
- .3 Additional equipment ~~provided~~ at the Intake includes dogging beams, lifting beams for the bulkhead gates and trashracks, ~~heaters for ice control in the Intake Gate shaft,~~ and lockout provisions for the Intake and Bulkhead gates. A concrete hoist house will be provided by Company's Other Contractor to house the Intake Gate hoists and all the necessary auxiliary equipment.

← to be installed

1.2.4 Draft Tube Equipment

- .1 Each of the four turbine/generator units will have two Draft Tube outlets. Each outlet will have a set of guides for stoplogs that will permit isolating the water passages for maintenance. Sufficient Draft Tube stoplogs will be provided to isolate two turbine/generator units or four (4) Draft Tube water passages.
- .2 A single Draft Tube Overhead Crane will be provided in the Draft Tube Gallery for handling of the stoplogs.
- .3 Additional equipment to be provided includes a stoplog lifting beam, provisions for storage of the stoplogs, and provisions for lockout when the stoplogs are installed.
- .4 A maintenance area will be provided in the Draft Tube Gallery to service the Draft Tube stoplogs, and a maintenance platform to service the Draft Tube Overhead Crane.
- .5 As the tailrace water level can quickly rise for a short period of time, to near the height of the walkway during a plant load rejection, the provision for lockout at each stoplog slot will have to be engaged, locked, and disengaged from the walkway to eliminate danger to workers. A water stop gate will be provided in the Draft Tube Gallery to move the stoplogs in and out of the maintenance area, but minimize flooding of the maintenance area at high water level.

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installed by
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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

1.2.5 ~~Trash-Cleaner~~

- ~~.1 A Trash-Cleaner will be provided to perform two functions. The Trash-Cleaner will be used for cleaning the trashrack panels, removing debris from the sediment trap in front of the intakes, and for removing floating debris along the entire length of the dam crest. The Trash-Cleaner will also be provided with a hoist that will be used for the handling of the Intake Bulkhead Gates, and the Spillway upstream Stoplogs.~~
- ~~.2 The Trash-Cleaner will travel on rails, provided by Company's Other Contractor, on the intake deck, across the Centre Transition Dam which has a curved section, and across the Spillway, and will be provided with a power supply cable and reel located immediately downstream of the upstream guardrail.~~

1.2.6 ~~Other Equipment and Facilities~~

- ~~.1 A Spillway Electrical Building will be provided to house a step-down transformer, AC distribution for the Spillway equipment, Spillway gate controls, and a backup diesel generator. This work will proceed in phases to accommodate the various stages of construction and river diversion and will involve a combination of permanent and temporary facilities.~~

1.3 LANGUAGE AND UNITS



1.3.1 The language used for all equipment or control system displays, nameplates, submittals, and documentation shall be English.

1.3.2 All designs and drawings shall be prepared in accordance with the International System of Units (SI units) and the units of measurement shall be the International System of Units (SI).



1.3.3 All digital or analog displays, instrument's graduations and inscriptions shall comply with the SI system.

1.4 CLIMATIC DATA

1.4.1 The Climatological Data is included in Exhibit 11: Company Supplied Documents.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

1.5 HYDROMETEOROLOGICAL DATA

1.5.1 Hydrometeorological data is summarized on Drawing MFA-SN-CD-2000-CV-DD-0003-01, in Exhibit 11: Company Supplied Documents.

2 SCOPE OF WORK

2.1 WORK INCLUDED



2.1.1 The work shall comprise, but not be limited to: the design, supply, final sizing, fabrication drawings, fabrication, shipment, erection and installation, interface management, ~~technical assistance of installation work performed by Company's Other Contractor,~~ start-up, field-testing and commissioning, operation and maintenance manuals, training, warranty and all other services and items specified herein, as specified in Exhibit 1 – Appendix A Technical Specifications, as shown in Exhibit 1 – Appendix C Drawings, and/or as necessary for construction start-up, operation during diversion, and final operation of the facilities presented in this package.

mechanical work only

mechanical work only

of the equipment supplied by Contractor

2.1.2 The work included shall be as follows, and as described in the Technical Specifications and Drawings:

mechanical work only

- .1 Design, fabrication, supply, installation, and commissioning of all permanent and temporary Hydro-Mechanical Equipment for the Powerhouse draft tube gates, Intake and the Spillway as detailed below (Note: All equipment shall be considered permanent unless specifically identified as temporary.);
- .2 Design, fabrication, supply, installation, and commissioning of ~~all Electrical Equipment associated with the power supplies and control systems for all permanent and temporary Hydro-Mechanical equipment for the Powerhouse draft tube gates, Intake and Spillway as detailed below;~~
- .3 Design, supply, fabrication and transportation of ~~all anchors and steel templates embedded in the primary concrete, as well as the bolts, tie-rods, washers, and nuts necessary for the installation and attachment to the formwork for all items supplied under the Contract;~~
- .4 ~~Technical assistance during installation of all supplied anchors installed by Company's Other Contractor including sign-off of Company's Other Contractors completion and quantity records related to the installation of embedded parts provided by Contractor;~~



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- .5 ~~Supply, installation, and commissioning of electrical auxiliaries in the Spillway Electrical Building and temporary electrical installations for the Spillway;~~
- .6 Design of all components, submission of all calculations and drawings for review and acceptance by Engineer, and the supply of all design notes, design criteria and drawings;
- .7 Final sizing of all supplied components, issue of manufacturing drawings for fabrication, and issue of installation drawings for construction;
- .8 Not Used;
- .9 Operation and Maintenance Manuals for all supplied equipment;
- .10 Supply of quality plans, quality procedures, Inspection and Test Plans (ITP's), and Record Sheets to cover all equipment during fabrication, assembly, and installation including complete documentation at the completion of all work;
- .11 Supply of required Capital Spare Parts; only for supplied equipment by Contractor
- .12 ~~Supply~~ ^{HANDLING} of test weights for load testing the hoists and cranes;
- .13 Commissioning and Test Procedures and Record Sheets for the commissioning of all permanent and temporary equipment; only for supplied equipment by Contractor
- .14 Connections, accessories or equipment not specifically mentioned in these specifications but which are necessary for the proper installation and/or operation of the equipment are considered to be an integral part of the Work and shall be designed and supplied by Contractor;
- .15 Onsite training of Engineer and Company staff, for forty (40) hours, for operators to be trained for operation and maintenance of the Spillway during the Diversion Phase; only for supplied equipment by Contractor
- .16 Onsite training of Company staff, for eighty (80) hours, for operators and maintenance staff to be trained for operation and maintenance of all equipment prior to hand-over; only for supplied equipment by Contractor
- .17 Not Used;
- .18 Not Used;
- .19 ~~Design, supply and installation~~ of grounding connections to all metallic surfaces, structures, equipment and embedded parts supplied by Contractor;



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		



.20 Supply and installation of grout for drilled anchors and base plates.

2.1.3 Spillway Hydro-Mechanical Equipment

The work included shall be as follows, and as described in the Technical Specifications and Drawings:

- .1 ~~Design~~, supply and installation of five (5) sets of embedded parts for the Spillway gate guides and seal faces, with each set including: two (2) side guides with upstream seal faces; two (2) embedded sill beam assemblies (one for diversion phase and one for final rollway configuration); and three (3) embedded tubes per embedded side guide for side guide heaters;
- .2 ~~Design and supply of five (5) sets of side steel liners on the piers for installation with anchors in primary concrete, installed by Company's Other Contractor, downstream of each Spillway gate;~~
- .3 ~~Design~~, supply and installation of five (5) sets of steel rollway liners ~~with anchors~~ in the final rollways, downstream of each Spillway gate, with the installation of concrete anchors in the rollway first stage concrete by Company's Other Contractor;
- .4 ~~Design~~, supply and installation of five (5) sets of embedded parts for the permanent stoplog guides and seal faces immediately upstream of the Spillway gates, with each set including: two (2) side guides with downstream seal faces; one (1) embedded sill beam assembly; and three (3) embedded tubes per embedded side guide for side guide heaters;
- .5 ~~Design~~, supply and installation of five (5) sets of embedded parts for the temporary upstream stoplog guides and seal faces at the furthest upstream position, with each set including: two (2) side guides with upstream seal faces; one (1) embedded sill beam assembly; and three (3) embedded tubes per embedded side guide for side guide heaters. Although these guides are for temporary operation during construction, the guides will remain as part of the permanent installation;
- .6 ~~Design~~, supply and installation of five (5) sets of embedded parts for the downstream stoplog guides and seal faces, with each set including: two (2) side guides with upstream seal faces; one (1) embedded sill beam assembly; three (3) embedded tubes per embedded side guide for side guide heaters; and guide extensions above the concrete up to El. 20.0 m to facilitate stoplog installation and storage. In this case upstream seal refers to the watered up (wet) side of the stoplog;

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- .7 ~~Design~~, supply and installation of a system for the storage/dogging of the ten (10) Spillway Type S1 Stoplogs in the five (5) stoplogs slots immediately upstream of the Spillway Gates;
- .8 ~~Design, supply and~~ installation of a system for the storage/dogging of the permanent Spillway Type S4 Stoplogs in the five (5) downstream stoplog slots;
- .9 ~~Design, supply and~~ installation of a temporary system for the storage/dogging of the temporary Spillway Type S4 Stoplogs adjacent to the Type S4 Stoplog permanent storage location;
- .10 ~~Design, supply and~~ installation of isolation and lockout provisions for the Spillway stoplogs when the Spillway bays are isolated;
- .11 ~~Design, supply, and technical assistance during installation performed by Company's Other Contractor, of all supplied anchors mounted on steel templates, downstream embedded angles, bolts, tie rods, washers, nuts, etc., required for all the embedded parts in the primary concrete and attachment to the formwork;~~
- .12 ~~Design, supply and installation of all anchors, steel templates, bolts, tie-rods, washers, nuts, etc., required for all the embedded parts in the second stage concrete;~~
- .13 Not Used; Installation →
- .14 ~~Design and supply~~ of one (1) set of Type S1 medium head stoplogs, consisting of ten (10) interchangeable sections, initially for temporary use in any two (2) of the furthest upstream stoplog guides, in combination with Types S2 and S3 Stoplogs, with the skin plate and seal on the upstream side; and for permanent use on their own in any one (1) of the stoplog guides immediately upstream of the Spillway Gates, with the skin plate and seals on the downstream side, with stoplog sections designed to be lifted with two (2) meters differential hydrostatic head; Installation →
- .15 ~~Design and supply~~ of two (2) sets of Type S2 low head temporary stoplogs, consisting of four (4) (estimated quantity - to be optimized by Contractor) interchangeable sections per set, with an upstream skin plate and seal, for combined use with Types S1 and S3 stoplogs in any two (2) of the furthest upstream stoplog guides, with stoplog sections designed to be lifted with two (2) meters differential hydrostatic load; Installation →
- .16 ~~Design and supply~~ of two (2) sets of Type S3 high head temporary stoplogs, consisting of eight (8) (estimated quantity: to be optimized by Contractor) interchangeable sections per set, with an upstream skin plate and seal, for combined use with Types S1 and S2 stoplogs in any two (2) of the furthest



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

upstream stoplog guides, with stoplog sections designed to be lifted with two (2) meters differential hydrostatic load; Installation



.17 ~~Design and supply~~ of one (1) set of Type S4 permanent stoplogs, consisting of five (5) interchangeable sections, with a upstream skin plate (on the downstream wet side) and seal, for use in any of the furthest downstream stoplog guides, with stoplog sections designed to be lifted with two (2) meters differential hydrostatic load; Installation



.18 ~~Design and supply~~ of one (1) set of Type S4 temporary stoplogs, consisting of five (5) interchangeable sections, with a upstream skin plate (on the downstream wet side) and seal, for use in any of the furthest downstream stoplog guides, with stoplog sections designed to be lifted with two (2) meters differential hydrostatic load;

.19 ~~Design, supply and~~ installation of one (1) lifting beam, for operation with the Trash Cleaner hoist, to install, remove, and store all of Types S1, S2, and S3 stoplogs when the Stoplogs are operating with upstream or downstream seals, including a lift beam storage stand;

.20 ~~Design, supply and~~ installation of one (1) lifting beam, for operation with a mobile crane, to install, remove, and store the Type S4 stoplogs, including a lift beam storage stand;

.21 ~~Design, supply and~~ installation of five (5) fixed wheel Spillway gates;

.22 ~~Design, supply and~~ installation of five (5) fixed wire rope hoists with controls for operating the Spillway gates before and after the rollways are constructed;



.23 ~~Design, supply, and technical assistance during installation performed by Company's Other Contractor, of all supplied anchors installed in primary concrete for hoist towers;~~

.24 Design, supply and installation of two (2) steel end towers to support the hoist bridge structures, each with enclosed stairways to access the hoists;

.25 Design, supply and installation of four (4) intermediate steel towers to support the hoist bridge structures;

.26 Design, supply and installation of five (5) fixed steel hoist bridge beam assemblies to support the Spillway gate hoists, auxiliary equipment, and hoist houses;

.27 Design, supply and installation of five (5) access walkways and ladders below the hoist bridge assemblies, with access from the hoist houses, to service the upper

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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

sheaves, the upper mechanical stops, and the lower sheaves when the gates are raised to the upper maintenance position;

- .28 Design, supply and installation of hoist houses for the Spillway gate hoists, ~~complete with auxiliary electrical and mechanical services~~ for the towers and enclosures;
- .29 ~~Design, supply and~~ installation of five (5) sets of walkways with gates and handrails, with each set consisting of one (1) walkway upstream and (1) walkway downstream of the Spillway Gates, mounted on the primary concrete, designed for workers to safely access and service the Spillway Gates and seals, with provision for Company's Other Contractor to mount cable trays on the downstream walkway handrails;
- .30 ~~Design, supply, and technical assistance during installation performed by Company's Other Contractor, of all supplied embedded anchors in primary concrete for the supplied walkways;~~
- .31 ~~Design, supply and~~ installation of handrails, and access gates, on the Spillway deck level at El. 45.5 m, downstream of the road guardrails supplied by Company's Other Contractor, along the tops of the piers for safe access to the stoplogs, gates, walkways between the piers, and gate access openings in the piers downstream of the towers, up to an interface point at the guardrails around the Spillway Electrical Building supplied by Company's Other Contractor;
- .32 ~~Design, supply and~~ installation of steel ladders and lockable access gates in the concrete access ways in the piers that provide access to the tops of each of the Spillway gates;
- .33 ~~Design,~~ supply and installation of Spillway Gate dogging devices, designed to dog the gate to service each set of wheels at a comfortable working level above deck level El. 45.5 m, to service the gate bottom seals, and to be capable of dogging the gate during construction of the rollways such that it does not interfere with construction;
- .34 ~~Design, supply and~~ installation of isolation and lockout provisions for the Spillway Gates, hoists and power supplies when being serviced or maintained or for when the water passages are being isolated;
- .35 Design, supply and installation of a general purpose electric hoist system, with power cord and pendant control, in the hoist house for maintenance purposes, designed to move equipment the full length of the hoist house, to the service zone and down to the level of the spillway deck at El. 45.5 m. The hoist system shall be single bridge type electric hoist that can access all equipment below 3000 kg;



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- ~~.36 Design, supply and installation of five (5) sets of permanent heaters with controls, six (6) per Spillway gate, for the Spillway gate embedded guides;~~
- ~~.37 Design and supply, and installation as required, of one (1) set of temporary heaters, six (6) per set, for use in any one set of upstream stoplog embedded guides as required during construction;~~
- ~~.38 Design and supply, and installation as required, of one (1) set of portable heaters, six (6) per set, for use in any one downstream stoplog embedded guides;~~
- ~~.39 Design, supply and installation of electrical auxiliaries on the hoist towers, including interior stairway lighting, and exterior deck lighting, receptacles, cable trays, and cable mounted on the towers;~~
- ~~.40 Design, supply and installation of control system, power and control cables associated with the permanent heaters for the Spillway gate guides;~~
- ~~.41 Design, supply and installation of a temporary control system, including power and control cables and all associated equipment, for the upstream stoplog guides temporary heaters including cables and supports to serve all of the upstream stoplog heater locations, which may include cabling to each location or cabling and cable supports designed to allow cabling to be relocated as required;~~
- ~~.42 Design, supply and installation of a temporary control system, including power and control cables and all associated equipment, for the downstream stoplog guides temporary heaters including cables and supports to serve all of the downstream stoplog heater locations, which may include cabling to each location or cabling and cable supports designed to allow cabling to be relocated as required;~~
- ~~.43 Design, supply and installation of the heat relief ventilation system for the Spillway hoist house and stair towers;~~
- ~~.44 Design, supply and installation of all electrical panels, electrical disconnects, MCC's, control equipment, power outlets, lighting, receptacles, and radiant heaters in the Spillway Gates hoist house and towers required for a fully operational Spillway;~~
- ~~.45 Design, supply and installation of feeder cables and control cables from Spillway Main MCC located in the Electrical Building, to the individual Spillway Gate MCCs located in the Spillway hoist houses;~~
- ~~.46 Design, supply and installation of control cables between the Spillway Electrical Building and the Spillway hoist houses;~~



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- ~~.47 Design, supply, and installation of electrical cable trays, conduit, and cabling in the Spillway hoist houses, on the hoist towers to the Spillway Electrical Building, in the Spillway Gates, and to the embedded guide heaters;~~
- .48 Conversion of permanent Type S1 stoplogs from upstream seals to use in the permanent upstream stoplog slots with downstream seals after all rollway construction is completed; ← the design shall allow for the stoplog to be used as is
- ~~.49 Transportation, installation, removal and storage of all Stoplogs required for isolating the Spillways for construction of the rollways and installation of the permanent sill beams and rollway steel plates;~~
- ~~.50 Transportation, installation, removal and storage of Stoplogs as required for testing and commissioning of the Spillway Equipment;~~
- .51 Design, supply and installation of modification of the Spillway Gate Hoists for operation of the Spillway Gates at the higher elevation after each rollway has been constructed;
- .52 Removal of the temporary stoplogs used for construction and transport to Company storage location;
- .53 Final storage of the permanent upstream Stoplogs in the Stoplog storage system;
- ~~.54 Design and supply of all required slings for the operation of any of the Stoplogs with a mobile crane;~~
- .55 Testing and commissioning of all supplied Spillway hydro-mechanical equipment, ~~and electrical and mechanical auxiliaries,~~ before and during the Diversion Phase, after each of the rollways are constructed, after final reservoir impoundment, and assistance during the commissioning of equipment supplied by Company's Other Contractor that interfaces with Contractors supplied equipment;
- ~~.56 Design, supply and installation of the fire alarm system in the spillway hoist house and stair towers connected to the fire alarm control panel in the Electrical Building. Fire alarm system shall include automatic detectors, manual stations, audible and visual alerting devices, and cabling;~~
- .57 Design, supply, and installation of guards around each hoist to prevent worker access to the operating equipment including the hoist drums, drive shafts, and couplings.



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

2.1.4 Intake Hydro-Mechanical Equipment

The work included shall be as follows, and as described in the Technical Specifications and Drawings:

- .1 ~~Design, supply and installation of twelve (12) sets of embedded parts for the Powerhouse Intake Trashracks guides, with each set including: two (2) side guides; and one (1) sill assembly;~~
- .2 ~~Design, supply and installation of twelve (12) sets of embedded parts for the Intake Bulkhead Gates guides and seal faces, with each set including: two (2) side guide assemblies and one (1) lintel beam assembly with downstream seals; and one (1) sill beam assembly;~~
- .3 ~~Design, supply and installation of twelve (12) sets of embedded parts for the Intake Gates guides and seal faces, with each set including: two (2) side guide assemblies and one (1) lintel beam assembly with upstream seals; and one (1) sill beam assembly;~~
- .4 ~~Design, supply, and technical assistance during installation performed by Company's Other Contractor, of all supplied anchors mounted on steel templates, bolts, tie rods, washers, nuts, etc., required for all the embedded parts in the primary concrete installation and attachment to the formwork;~~
- .5 ~~Design, supply and installation of all anchors, steel templates, bolts, tie-rods, washers, nuts, etc., required for all the embedded parts in the second stage concrete installation and attachment to the formwork;~~
- .6 Not Used;
- .7 ~~Design, supply and installation of twelve (12) sets of Intake Trashrack panels, one set for each water passage;~~
- .8 ~~Design, supply and installation of one (1) lift beam, for operation with a mobile crane, to install and remove the Trashrack panels;~~
- .9 ~~Design, supply and installation of one (1) set of Bulkhead Gates for isolation of any one Intake Gate, with the top Bulkhead Gate section designed with Teflon coated seals, and to be lifted with two (2) metres differential hydrostatic head;~~
- .10 ~~Design, supply and installation of isolation and lockout provisions for the Bulkhead Gate slots when a water passage is isolated;~~
- .11 ~~Design, supply and installation of one (1) lifting beam, for operation with the Trash Cleaner hoist, to install, remove, and store the Bulkhead Gate sections;~~



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- .12 ~~Design, supply and installation of dogging devices for the Bulkhead Gate sections and lift beam, designed to store the gates and lift beam below the Intake deck covers in the Bulkhead Gate slots;~~
- .13 ~~Design, supply and installation of twelve (12) sets of Intake Gates;~~
- .14 ~~Design, supply and installation of twelve (12) sets of wire rope hoists with controls for operating the Intake Gates;~~
- .15 ~~Design, supply and installation of twelve (12) sets of dogging devices for the Intake Gates, designed to dog the gates to service each set of wheels at a comfortable working level from the maintenance platform in the gate inspection gallery, to service the gate seals, and to service the sheave blocks from the platform under the hoist deck;~~
- .16 ~~Design, supply and installation of isolation and lockout provisions for the Intake Gates, hoists and power supplies when the gates are being used to isolate the water passages or being serviced or maintained;~~
- .17 ~~Design, supply and installation of twelve (12) sets of heaters with controls, one set at each gate hoist, to blow heated air into the gate shafts to keep the water surface in the gate slot free of ice;~~
- .18 ~~Design, supply and installation of four (4) sets of motor control centres (MCC's) and control panels for each set of three intake gate hoists;~~
- .19 ~~Design, supply and installation of power and control cables associated with all Intake Hydro-Mechanical;~~
- .20 ~~Testing and commissioning of all supplied Intake hydro-mechanical equipment, and electrical and mechanical auxiliaries, and assistance during the commissioning of equipment supplied by Company's Other Contractor that interfaces with Contractors supplied equipment;~~
- .21 ~~Design, supply and installation of twelve (12) sets of slot cover plates at each gate hoist, designed to protect personnel from suction pressure generated during gate emergency closure.~~
- .22 ~~Design, supply, and installation of guards around each hoist to prevent worker access to the operating equipment including the hoist drums, drive shafts, and couplings.~~



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

2.1.5 Powerhouse Draft Tube Hydro-Mechanical Equipment

QMB The work included shall be as follows, and as described in the Technical Specifications and Drawings:

- DESIGN*
1. ~~Design~~, supply and installation of eight (8) sets of embedded parts for the Draft Tube Stoplogs guides and seal faces, with each set including: two (2) side guide assemblies and one (1) lintel seal assembly with upstream seal faces; and one (1) sill beam assembly;
- 2. ~~Design, supply and installation~~ of four (4) sets of Draft Tube Stoplogs for the Powerhouse to isolate the draft tube water passages for two (2) turbine units, with the top stoplog sections designed with Teflon coated seals, and to be lifted with two (2) metres differential hydrostatic head;
- QMB* 3. ~~Design, supply and installation~~ of one (1) Overhead Crane, with Lifting Beam, or equivalent, to install, remove, and store the Powerhouse Draft Tube Stoplogs sections; Site condition are unknown Company to inform Contractor
- QMB* 4. ~~Design supply and installation of busbar conductors on the upstream wall of the Draft Tube Gallery, and a local disconnect, to provide power to the Draft Tube Crane;~~
- 5. ~~Design, supply and installation~~ of sixteen (16) sets of storage supports for the Draft Tube Stoplogs;
- 6. ~~Design, supply and installation~~ of a 2 m wide by 1 m high two door hinged water stop gate in the Draft Tube Gallery to allow movement of stoplogs to the Maintenance Area, and minimize flooding from a tailwater surge;
- 7. ~~Design, supply and installation~~ of isolation and lockout provisions for the stoplog slots when the Draft Tube water passages are isolated, with the isolation and lockout of each bay engaged, locked out, and disengaged from the walkways;
- 8. ~~Design, supply, and technical assistance during installation performed by Company's Other Contractor, of all supplied anchors mounted on steel templates, bolts, tie rods, washers, nuts, etc., required for all the embedded parts in the primary concrete installation and attachment to the formwork;~~
- 9. ~~Design, supply and installation of all anchors, steel templates, bolts, tie-rods, washers, nuts, etc., required for all the embedded parts in the second stage concrete installation and attachment to the formwork;~~
- 10. Not Used;



QMB

QMB



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT	Mechanical work only	
MFA-SN-CD-2000-ME-SP-0001-01_D2	Mechanical work only	0001_02

- .11 Testing and commissioning of all supplied hydro-mechanical equipment for the Draft Tube Stoplogs and Hoist, and assistance during the commissioning of equipment supplied by Company's Other Contractor that interfaces with Contractors supplied equipment.

2.1.6 Trash-Cleaning System

~~The work included shall be as follows, and as described in the Technical Specifications and Drawings:~~

- ~~.1 Design, supply and installation of one (1) combination Trash-Cleaning System and Stoplog/Bulkhead Gate handling hoist;~~
- ~~.2 Design, supply and installation of a cable guide for the power cable for the Trash Cleaner mounted on top of the upstream guard-rail along the intake roadway decks;~~
- ~~.3 Delivery of Trash-Cleaning System to site;~~
- ~~.4 Testing and commissioning of the Trash-Cleaning System, and assistance during the commissioning of equipment supplied by Company's Other Contractor that interfaces with Contractors supplied equipment.~~



2.1.7 Spillway—Electrical Auxiliaries

~~The work included shall be as follows, and as described in the Technical Specifications and Drawings:~~

- ~~.1 Supply and installation of the complete electrical distribution system for the Spillway required for the temporary operation of the Spillway during the Diversion Phase. This electrical distribution system will remain as permanent;~~
- ~~.2 Supply and installation of temporary 25 kV feeder cable and cable supports from the termination pole for Construction Power 25 kV Distribution Line to the incoming 25 kV disconnect switch;~~
- ~~.3 Supply and installation of two (2) 25 kV incoming load break disconnect switches;~~
- ~~.4 Supply and installation of dry type 1250 kVA, 25 kV 600/347 V transformer with off load tap changer;~~
- ~~.5 Supply and installation of the Spillway 600 V switchgear, including incoming circuit breakers from the dry type transformer and from the emergency generator, complete with automatic transfer and load management controls;~~



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- ~~.6 Supply and installation of 600 V Main Spillway MCC including the feeder units for the five (5) Spillway hoist house MCCs and motor starters and feeder units for auxiliary equipment, lighting and power distribution for the Spillway Electrical Building;~~
- ~~.7 Supply and installation of cable tray system for support of all power and control cables installed in the Spillway Electrical Building;~~
- ~~.8 Supply and installation of dry type distribution transformers, 600/347 V panelboards, and 208/120 V panelboards;~~
- ~~.9 Supply and installation of 125 V dc system including batteries, battery chargers, and panelboards;~~
- ~~.10 Supply and installation of lighting for the Spillway Electrical Building;~~
- ~~.11 Supply and installation of surface grounding system including ground bar, telecom ground bar, cable tray grounding, bonding of all electrical equipment, bonding of metal parts of non-electrical equipment and system and circuit grounding;~~
- ~~.12 Supply and installation of emergency lighting system for the Spillway Electrical Building including central emergency lighting equipment, remote heads and exit signs;~~
- ~~.13 Supply and installation of 600 kW emergency diesel generator;~~
- ~~.14 Supply and installation of emergency generator fuel tank (day tank);~~
- ~~.15 Supply and installation of manual transfer switch;~~
- ~~.16 Supply and installation of interlocked switch and power receptacle for connection of a mobile diesel generator;~~
- ~~.17 Supply and installation of safety switch in the Electrical Room for Trash Cleaning System power supply;~~
- ~~.18 Design, supply and installation of five (5) individual spillway gate controllers in the Electrical Room, and HMI (Human Machine Interfaces);~~
- ~~.19 Design, supply and installations of warning system, with outdoor horns to warn personnel of impending operation of Spillway gates;~~
- ~~.20 Design, supply and installation of Spillway fire alarm system, including detectors, manual stations, audible and visual alerting devices, cabling and fire alarm control panel;~~



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		



- ~~.21 Supply and installation of power and signal cables and junction boxes, for connection of CCTV cameras, telephones and Security and Access Control System (SACS) by Company's other contractors;~~
- ~~.22 Design, supply and installation of fibre optic and communications cabling on the Spillway between the Spillway Electrical Building and the Spillway hoist houses for both Diversion and Operation Phases;~~
- ~~.23 Design, supply and installation of fiber optic cable from 25 kV Construction Power termination pole to telecom panel in Spillway Electrical Building;~~
- ~~.24 Design, supply and installation of temporary 600 V power supply cables from the main MCC in Spillway Electrical Room to the temporary power supply termination point for the Trash Cleaning System for use during construction;~~
- ~~.25 Design, supply and installation of permanent 600 V power supply termination points at the north end of the Intake Deck for the Trash Cleaning System permanent power supply;~~
- ~~.26 Testing and commissioning of all supplied Spillway Electrical Building electrical auxiliaries, and assistance during the commissioning of equipment supplied by Company's Other Contractors that interfaces with Contractor's supplied equipment.~~
- ~~.27 Design supply and installation of 120 Vac UPS, including panelboard.~~
- ~~.28 Design supply and installation of 600 V copper busway between 25 kV / 600 V transformer and 600 V switchgear.~~
- ~~.29 Design supply and installation of cable trays between the outdoor installation near the diesel fuel tank (at elevation El. 15.00 m) and the spillway electrical building (at elevation El. 48.95 m).~~
- ~~.30 Design supply and installation of the buried conduits between 25 kV termination pole and the spillway steel structure including the trench for the conduits and buried cables, including concrete embedded conduit elbows.~~
- ~~.31 Design supply and installation of outdoor lighting at the diesel fuel tank area.~~
- ~~.32 Design supply and installation of Spillway Electrical Building exterior lighting, and the poles and lighting on the Centre Transition Dam.~~



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

2.1.8 ~~Spillway Electrical Building – Mechanical Auxiliaries~~

~~The work included shall be as follows, and as described in the Technical Specifications and Drawings:~~

- ~~.1 Supply and installation of the Diesel Generator Room ventilation and heating system;~~
- ~~.2 Supply and installation of the Electrical Room heat relief ventilation system;~~
- ~~.3 Supply and installation of the diesel generator engine exhaust system;~~
- ~~.4 Supply and installation of the diesel generator combustion air/heat relief intake system;~~
- ~~.5 Supply and installation of the diesel generator radiator exhaust/recirculation system;~~
- ~~.6 Supply and installation of the heating and ventilation control and monitoring system for the Spillway Electrical Building;~~
- ~~.7 Supply of one (1) portable motorized greasing unit and a cartridge grease gun;~~
- ~~.8 Testing and assistance with commissioning of all supplied Spillway Electrical Building mechanical auxiliaries, and assistance during the commissioning of equipment supplied by Company's Other Contractor that interfaces with Contractors-supplied equipment.~~

2.1.9 ~~Spillway Electrical Building – Structure~~

~~The work included shall be as follows, and as described in the Technical Specifications and Drawings:~~

- ~~.1 Supply and installation of the Spillway Electrical Building structure including all structural and miscellaneous steel;~~
- ~~.2 Supply and installation of exterior and interior building finishes including concrete floor, cladding, flashing, insulation, sealants, doors, partitions, and building penetrations for equipment and cable trays in addition to other items for a complete building system.~~



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

2.1.10 Fuel Storage System

~~The work included shall be as follows, and as described in the Technical Specifications and Drawings;~~



~~.1 Design, supply and installation of a diesel fuel storage system at the Spillway with a minimum 11,370 L concrete encased steel double wall above-ground fuel oil storage tank (ConVault 3000LP);~~

~~.2 Design, supply and installation of an automatic fuel pumping/return system to supply fuel from the fuel storage tank to the Spillway Diesel Generator fuel storage day tank;~~



~~.3 Not used;~~

~~.4 Design, supply and installation of fuel supply and return lines from the fuel storage tank to the Spillway Diesel Generator fuel storage day tank;~~



~~.5 Not used;~~

~~.6 Testing and commissioning of all supplied fuel storage system components, and assistance during the commissioning of equipment supplied by Others that interfaces with Contractors supplied equipment.~~



~~.7 Supply and installation of access stairs and platform for safe access to the fuel tank fill connection.~~

2.1.11 Alternatives (to be confirmed by Company)



~~.1 Not Used;~~

~~.2 Not Used;~~



~~.3 Supply and installation of form work and second stage concrete for embedded parts. All references to and requirements for this alternative scope in this Exhibit 1 do not apply unless this alternative is selected by Company.~~

2.2 WORK PROVIDED BY COMPANY'S OTHER CONTRACTORS

~~2.2.1 As an option, the Company's Other Contractor can supply concrete to Contractors, including the delivery of concrete from the batch plant to the pour location, to be used at the discretion of Contractor at a set rate. If this option is retained by the Contractor,~~

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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

the Company's Other Contractor will be acting as the Contractor's subcontractor for this specific work.

2.3 WORK EXCLUDED

2.3.1 General

- .1 Excavation for the intake, powerhouse, spillway, intake approach channel and discharge channel;
- .2 Upstream and downstream cofferdams;
- .3 Access roads to the project location;
- .4 Access roads into the worksite;
- .5 Access ramps to upstream of the Spillway; to upstream of the Intake; and to downstream of the Draft Tube;
- .6 Removal of access ramps and cofferdams;
- .7 Dewatering of the excavation and site sediment control;
- .8 Survey of Company's Other Contractor's work.



2.3.2 Spillway and Centre Transition Dam

The following are excluded from the scope of work:

- .1 Primary grounding;
- .2 First stage (primary) concrete; *AND SECONDARY CONCRETE*
- .3 Installation of the concrete anchors in first stage (primary) concrete for the embedded parts for the gate and stoplog side guides, sill seal beams, and lintel seal beams, and rollway plate anchors;
- .4 Installation of the steel side plate liners and concrete anchors in first stage concrete;
- .5 Installation of the primary anchors in first stage concrete for the Spillway hoist towers;

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- .6 Installation of the concrete anchors in first stage concrete for the supplied Spillway walkways;
- .7 Embedded rail anchors and rails for the Trash Cleaning System;
- .8 Guardrails mounted in primary concrete on the Spillway deck and piers;
- .9 Supporting steel, platform and concrete deck topping below the Spillway Electrical Building;
- .10 25 kV construction power supply up to the termination pole near the Spillway Electrical Building for operation of the Spillway for the Diversion Phase;
- .11 25 kV permanent power supply to the Spillway Electrical Building for permanent operation of the Spillway;
- .12 Cable trays for cable not supplied by this contract;
- .13 600 V power supply cables, DC power supply cable, control cables, and communication cables from Powerhouse up to the Spillway Electrical Building.
- .14 Spillway permanent bridges and downstream temporary bridge.

.15 Supply of the loads for the load tests

2.3.3 Intake

The following are excluded from the scope:

- .1 Main lighting, welding and convenience outlets;
- .2 Primary grounding;
- .3 First stage (primary) concrete; *AND SECONDARY CONCRETE* *SMB*
- .4 Installation of the concrete anchors in first stage (primary) concrete for the embedded parts for the gate, stoplog and trashrack side guides, sill seal beams, and lintel seal beams;
- .5 Installation of the concrete anchors in first stage concrete for the Intake Gate hoists;
- .6 Embedded rail anchors and rails for the Trash Cleaning System;
- .7 Guardrails, handrails and ladders mounted in primary concrete on the Intake deck, Intake hoist house, and Intake Gate maintenance platforms;



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- .8 Associated electrical and mechanical systems including power outlets, cable trays, radiant heating, ventilation, and piping systems in the Intake Hoist House;
- .9 600 V power supply cables from Powerhouse up to the Intake deck section for the Trash Cleaner power supply;
- .10 Trashrack head loss monitoring system.
- .11 Supply of the loads for the load tests



2.3.4 Powerhouse Draft Tube

The following are excluded from the scope:

- .1 Main lighting and convenience outlets;
- .2 Primary grounding;
- .3 First stage (primary) concrete;
- .4 Installation of the concrete anchors in first stage (primary) concrete for the embedded parts;
- .5 Walkways, guardrails, handrails and ladders in primary concrete in the Draft Tube Gallery;
- .6 Associated electrical and mechanical systems including power outlets, cable trays, radiant heating, ventilation, and piping systems in the Draft Tube Gallery;
- .7 Power supply cables: 600/347 Vac (3 wires, 60 Hz and 3 phases, four wires), 120/208 V (3 phases, four wires) and normal 120 V (1 phase, 60 Hz) and UPS.

.8 Supply of the loads for the load tests

~~**2.3.5 Spillway Electrical Building**~~

~~The following are excluded from the scope:~~

- ~~.1 Support plates and anchor bolts for the Spillway Electrical Building;~~

~~**2.3.6 Spillway Electrical Auxiliaries**~~

~~The Supply and Installation of the following are excluded from the scope:~~

- ~~.1 Telecom panel in the Spillway Electrical Building;~~



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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

- ~~.2 CCTV cameras and monitoring equipment;~~
- ~~.3 Telephones~~
- ~~.4 Security and Access Control System (SACS)~~
- ~~.5 Workstations for display of CCTV images in the Spillway Electrical Building;~~
- ~~.6 Connection and testing of the fibre optic cable between the 25-kV termination pole and the Spillway Electrical Building.~~

~~2.3.7 Spillway Electrical building – Mechanical Auxiliaries~~

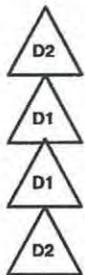
~~The following are excluded from the scope:~~

- ~~.1 Telecom panel switch router for the heating and ventilation system.~~

~~2.3.8 Fuel Storage System~~

~~The following are excluded from the scope:~~

- ~~.1 Main fuel storage tank foundations, concrete slab, and bollards;~~
- ~~.2 Not used;~~
- ~~.3 Not used;~~
- ~~.4 Steel access stairway to centre transition dam drainage gallery.~~



3 SPECIAL REQUIREMENTS

3.1 GENERAL

~~3.1.1 Contractor shall coordinate primary anchor design including size, spacing, length and installation sequence in first stage concrete with the Engineer, concrete and reinforcing drawings, and concrete contractor before the first stage concrete anchor concept is finalized and Accepted by the Engineer.~~

3.1.2 Site Information Drawings provided show general layout of the site and cofferdams around the work areas. Access ramps will be provided into the work areas by the Company's Other Contractors who are providing the site Excavation (CH0006) and the



Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

primary (first stage) concrete structures (CH0007) that can be used by the Contractor to access the work areas.

- 3.1.3 The overall project schedule requires that some of the work be performed during the winter period. The Contractor shall take all necessary measures for winter installation, including the use of heated shelters and the Contractor shall design, supply, install and remove temporary shelters.
- 3.1.4 Where an area is used by the Contractor as shelter for the execution of its work before the area is completed, it is the responsibility of the Contractor to supply, install and subsequently remove any temporary walls and enclosure as may be required.
- 3.1.5 All temporary works shall be designed by a professional engineer member of the PEGNL. The professional engineer shall be approved by the Engineer prior to starting any work. All designs and drawings shall be submitted to the Engineer for review and approval before starting of any work.
- 3.1.6 The Contractor shall supply install, operate, dismantle and remove from the site at the end of the work construction cranes of a capacity to suit the Contractor's needs.
- 3.1.7 The Contractor shall submit the required documentation to the Engineer for review and approval in accordance with the Technical Specification and Supplier Document Requirement List (SDRL).
- 3.1.8 Where there are conflicts between or within the Technical Specification, Drawings, Codes, Standards or Acts, priority shall be given to the more stringent.

3.2 SITE CONDITIONS

- 3.2.1 This Scope of Work Specification shall be read in conjunction with Exhibit 12 Site Conditions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

3.2.2 CONCRETE SUPPLY AT MUSKRAT FALLS



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~~1 A concrete batch plant will be installed at the Muskrat Falls work site by one of the Company's Other Contractor's, and Company will be negotiating a set price for this concrete supply to Company's Other Contractor. Contractor can choose to obtain concrete supply from this Company's Other Contractor's batch plant at the negotiated price or is free to seek alternative suppliers. Contractor shall indicate which option it chooses for the bid and provide details of alternate sources if that is the chosen option.~~



.2 Not Used.



.3 Not Used.



~~.4 Contractor shall be fully responsible for making arrangements with and payments to, Company's Other Contractor for concrete supply, as well as ensuring quality of concrete supplied and schedule of concrete supply meets Contractor's construction requirements.~~



3.3 NOT USED

3.4 ENVIRONMENTAL REQUIREMENTS



3.4.1 Contractor shall comply with the Technical Specification Section 01 35 43 – General Environmental Requirements and Environmental and Regulatory Compliance Requirements in Exhibit 6.



3.4.2 Prior to the start of site work, the Contractor shall prepare a Contract Specific Environmental Protection Plan (C-SEPP) for review and approval by the Engineer.

3.5 DOCUMENTS

3.5.1 Drawings Provided to the Contractor



.1 The Issued for Bid drawings issued with the Request for Proposal (RFP) are intended to indicate the location, type and scope of work to be carried out. They are not to be used for construction.

.2 At Contract award, approved Company supplied Drawings will be provided to the Contractor for design. The Contractor shall proceed with final design, and shall notify the Engineer of all differences and/or discrepancies with the drawings Issued for Bid.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

~~.3 With the Tender, and before the beginning of the work, the Contractor shall submit for the Engineer's acceptance, the drawings required as per Technical Specification and as provided in the SDRL (Exhibit 4 - Supplier Document Requirement List).~~



~~.4 The Contractor shall submit documentation as per approved supplier document register.~~

3.5.2 Drawings

- .1 The Drawings are included in Exhibit 1, Attachment 2.
- .2 The Drawings related to the work are Approved for Design.
- .3 Contractor shall only execute Works based on Contractor's Issued for Construction Drawings that have been Accepted by the Engineer, or based on Company Supplied Approved for Construction (AFC) drawings.

3.5.3 Technical Specification

The Technical Specification and performance requirements related to the Work are provided in Exhibit 1, Attachment 1.



3.5.4 Not used

3.6 PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS



3.6.1 For preservation, mechanical completion and commissioning requirements see Section 11 08 00 – Preservation, Mechanical Completion & Commissioning Requirements.



3.6.2 Records of preservation, mechanical completion, testing and commissioning requirements shall be provided for all electrical and mechanical equipment performed prior to delivery to site and at site.

3.6.3 Personnel shall be provided for Commissioning at site, and all labour, equipment and instrumentation necessary to operate, install/remove, and test all equipment supplied as part of this work to demonstrate that it meets the requirements of the contract.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

3.7 INTERFACE WITH COMPANY'S OTHER CONTRACTORS



3.7.1 Interfaces to be managed as per Exhibit 3, Coordination Procedure.

3.8 INSTALLATION

3.8.1 General

.1 Contractor shall be responsible for all activities necessary for installation of the Work including, activities required for:

of supplied equipment

.1 Transportation and offloading of all permanent equipment, spares, ancillary and installation equipment to Contractor's laydown area;

.2 Pre and post installation surveys;

.3 Installation of all components;

described in this Scope of Work

.4 Lifting operations;

.5 ~~Technical assistance during concreting of Contractor's supplied equipment by Company's Other Contractor;~~

of mechanical equipment

.6 Inspection, testing and commissioning; and

of mechanical equipment

.2 Cleaning and care of the facilities in its care, custody and control.

3.8.2 If any Contractor supplied equipment is unavailable, Contractor shall replace it with equipment Accepted by Engineer which shall be at least equivalent in quality and performance.

3.8.3 Contractor shall perform site reinstatement including, removal of all temporary works and debris dropped or discharged by Contractor including all installation aids and rigging.

3.8.4 Contractor shall perform constructability and hazard peer reviews with Engineer, Company's Other Contractors and Subcontractors prior to commencement of the Work.



mechanical equipment

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		

3.8.5 Contractor shall operate and maintain construction services based on a twenty-four (24) hour day - seven (7) day week for the duration of the Work.

3.8.6 On completion of the Work, all services shall be dismantled by Contractor and removed from the Muskrat Falls Worksite as part of Contractor's demobilization unless directed otherwise by Engineer.

3.9 MOBILIZATION

3.9.1 Mobilization shall include:

- .1 Provision of a pre-mobilization schedule covering all checking, testing and calibration activities;
- .2 Checking, testing and calibration of major items of equipment; *INSPECTION* *MB*
- .3 ~~Submission of test and survey reports;~~ *MB*
- .4 ~~Site preparation and readiness activities;~~ *MB*
- .5 Provision and Delivery of spares; of supplied equipment ←
- .6 ~~Modification and repairs, as necessary, for all parts of the Contractor's Items to enable them to correctly and safely perform their function;~~ *MB*
- .7 Loadout of equipment from Contractor's loadout facilities or nominated ports;
- .8 Set-up of Contractor's temporary facilities as described in Section 3.10 of this Exhibit 1;
- .9 Set-up and establish Contractor's offices at the Muskrat Falls Worksite.



3.9.2 Contractor is responsible for all mobilization of Contractor's Items and Personnel, required for the execution of the Work.

3.9.3 Engineer may, at its sole discretion, witness Contractor's mobilization and demobilization activities.

3.9.4 Contractor shall immediately advise Engineer of any change to the mobilization date.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

3.9.5 Daily notice shall be given the Engineer for each of the last fourteen (14) days prior to the actual mobilization date.

3.10 CONTRACTOR'S TEMPORARY FACILITIES

3.10.1 Contractor shall erect its offices and other buildings to carry out the Work, subject to securing prior Approval from Engineer.

3.10.2 Contractor shall undertake the supply, installation, operation and disassembly, including work required for all services necessary beyond the connecting points indicated by Engineer and as further detailed in Exhibit 12 - Muskrat Falls Worksite Conditions.

3.10.3 Any grading required, beyond the original grading, shall be at Contractor's account.

3.10.4 Plans for construction of temporary facilities shall be submitted to Engineer for Approval.

3.10.5 The installation of the buildings shall conform to Applicable Laws and the requirements set by Engineer.



3.10.6 Contractor shall submit to Engineer, for its Acceptance, all plans and specifications for all systems it shall require for the execution of the Work, and shall be submitted no later than fifteen (15) days before the start of installation Work.

3.10.7 Engineer has the right at all times, to inspect the temporary facilities of Contractor and at the Contractor's expense require any changes it deems necessary or not in accordance with plans Approved by Engineer.

3.10.8 From electrical connection points provided by Company as indicated in Exhibit 12 - Muskrat Falls Worksite Conditions, Contractor shall provide, install and maintain its own distribution network and provide circuit breakers, fuse holders and various required materials in order to protect the electric circuit and transformer for the power needs of its construction services and its facilities.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

3.10.9 The electrical connection work shall be done in accordance to applicable electrical codes and coordinated and Accepted by Engineer prior to connecting to the Company's network.

3.10.10 Engineer has the right at all times to inspect all temporary electrical systems installed by Contractor and at the Contractor's expense require any changes it deems necessary or not in accordance with plans Approved by Engineer.

3.11 PREPARATORY WORK

3.11.1 Contractor shall perform, prior to commencement of installation activities, all survey and preparatory operations as necessary to allow completion of the Work.

3.12 DEMOBILIZATION AND CLEAN-UP

3.12.1 Contractor shall be responsible for the removal of its entire temporary works, failed components and tooling from the Muskrat Falls Worksite, excluding temporary power facilities or as directed by the Engineer.

3.12.2 Contractor shall restore all areas of the Muskrat Falls Worksite, put at its disposal, to its original state or in a condition acceptable to the Engineer.

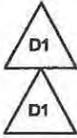
3.12.3 Any remedial operation that Engineer deems necessary shall be performed by Contractor.

3.12.4 Upon completion and acceptance of the Work, Contractor shall demobilize Contractor Items and Personnel.

3.12.5 Demobilization and clean-up shall be completed in accordance with the Exhibit 6 - Environmental and Regulatory Compliance Requirements.

3.12.6 Upon completion of the Work and during the demobilization process, Contractor shall dismantle all temporary electrical services that it installed and make them available for inspection and approval by Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		



3.13 NOT USED

3.14 SURVEY REQUIREMENTS

Survey and Installation of brass plugs by others

3.14.1 Contractor shall be responsible for all survey equipment and Personnel necessary to complete the Work.

3.14.2 Contractor shall plan and perform the survey and measurements activities in an optimal manner and in accordance with the Agreement.

3.14.3 Contractor shall prepare detailed procedures for all survey activities prior to, during and post installation, and the procedures shall describe all aspects of the survey activities including planning of operations, calibration, description and operation of all systems, checklists, survey works, processing of data and reporting.

3.14.4 All survey procedures shall be issued to Engineer for Acceptance.

3.14.5 Contractor's equipment and systems shall be well maintained and tested and shall utilize current technology.

3.14.6 Contractor shall be responsible for supply, installation, calibration and operation of all positioning systems and aids necessary to perform the Work.

3.14.7 Calibrations shall be fully documented and such documentation shall be provided to Engineer on request.

3.14.8 In the event of replacement or repair of any equipment, calibration procedures shall be repeated in full.

3.15 PRE-INSTALLATION SURVEYS

3.15.1 Prior to commencing any installation activities, Contractor shall carry out pre-installation surveys of the Worksite(s).

Lower Churchill Project Muskrat Falls Hydroelectric Development	SCOPE OF WORK	Rev. D2
CH0032		EXHIBIT 1
SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0001-01_D2		505573-3321-45EW-0001_02

3.15.2 Contractor shall be responsible for locating and confirming the position, configuration and status of the existing structures and items.

3.15.3 Contractor shall submit the results of the pre-installation survey(s) to Engineer for review and Acceptance.

3.16 INSTALLATION SURVEY

3.16.1 Contractor shall perform surveys during installation activities as required to ensure the correct installation of the Work in accordance with the requirements of the Agreement.

3.16.2 As-built Survey

- .1 Contractor shall perform an as-built survey of the Work.
- .2 Contractor shall provide Engineer with the results of the as-built survey and identify, for Engineer Acceptance, any remedial measures proposed.
- .3 All components requiring remedial works shall be re-surveyed as necessary to establish the final as-built system condition.



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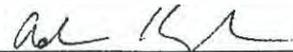
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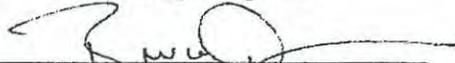
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	Nalcor Doc. No. MFA-SN-CD-2000-ME-SP-0002-01		D1	Date
	SLI Doc. No. 505573-3321-45EW-0002		00	14-Aug-2013
			Page	i

**LOWER CHURCHILL PROJECT
 MUSKRAT FALLS HYDROELECTRIC DEVELOPMENT**

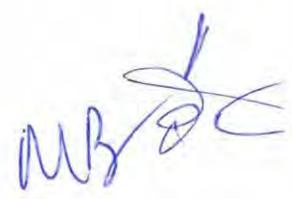
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**PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING
 REQUIREMENTS**

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	Nalcor Doc. No. MFA-SN-CD-2000-ME-SP-0002-01		D1	Date	Page
	SLI Doc. No. 505573-3321-45EW-0002		00	14-Aug-2013	ii

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N°	By	Appr.	Date	Revised pages	Remarks
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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS

TABLE OF CONTENTS

PART 1 GENERAL2

 1.1 SCOPE2

 1.2 DEFINITIONS2

PART 2 CONTRACTOR’S RESPONSIBILITIES4

 2.1 GENERAL RESPONSIBILITIES4

PART 3 MECHANICAL COMPLETION5

 3.1 GENERAL5

 3.2 MECHANICAL COMPLETION AT CONTRACTOR’S FACILITES6

 3.3 MECHANICAL COMPLETION AT SITE7

PART 4 PRESERVATION8

 4.1 PRESERVATION AT CONTRACTOR’S FACILITY8

 4.2 PRESERVATION AT SITE9

PART 5 COMMISSIONING9

 5.1 GENERAL9

 5.2 COMMISSIONING AT CONTRACTOR’S FACILITIES 10

 5.3 COMMISSIONING AT SITE 10

PART 6 MANUALS12

 6.1 GENERAL 12

 6.2 REQUIRED COMMISSIONING MANUAL CONTENTS: 12

PART 7 REPORTS13

 7.1 GENERAL 13

 7.2 MINIMUM REPORT CONTENTS 13

APPENDIX A – Minimum Commissioning Procedure Requirements For Hydro Mechanical Equipment.....14

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

PART 1 GENERAL

1.1 SCOPE



1.1.1 This section defines Contractors responsibilities and minimum technical requirements for mechanical completion, preservation and commissioning of the Powerhouse and Spillway Hydro-Mechanical Equipment

1.2 DEFINITIONS

1.2.1 Commissioning Check List (CCL) – the documentation approved by Engineer to record all Commissioning Static Checks and results carried out during commissioning.

1.2.2 Commissioning Procedure (CPR) – detailed step by step description of relevant multi-discipline, Dynamic Commissioning / System Commissioning activities carried out to prove the design and suitability for operation of a system or part system.

1.2.3 Commissioning Static Checks – shall mean all live / energized tests that are carried out after a section of Work has reached Mechanical Completion. These shall be completed in compliance with the specifications at Contractors / Suppliers facilities, factory tests and during installation and/or construction as soon as it is safe for commissioning Static Checks to commence initially on a single discipline basis.

1.2.4 Completions – shall mean all activities involved in Mechanical Completion, Preservation, and handover for commissioning, commissioning and turnover to Operations.

1.2.5 Dispatch Dossier – shall mean those documents required, as a minimum, to accompany goods released to Site from Contractors / Suppliers and fabricators. Procured Goods shall not be dispatched without Dispatch Dossier.

1.2.6 Dynamic Commissioning / Systems Commissioning – shall mean commissioning activities which simulate operations of a complete system or part system. These tests shall, as near as possible, be at full operating conditions in order to carry out operational performance tests to verify that the system / equipment performs in accordance with the design criteria, together with the recording of such tests. Such Dynamic Commissioning / Systems Commissioning shall be sufficient to allow systems, part system and/or equipment to be certified, turned over to Operations by the RFO team and rapidly brought into operational service by Operations, if not already operational.



1.2.7 Inspection Test Records (ITR) – the documentation approved by Engineer that defines all procedural checks and tests to be carried out by Contractor during Mechanical Completion.



1.2.8 Livening Up Notice (LUN) – a notification to all involved parties at Site that commissioning will start and that all further work on a particular system or part system shall be subject to permit to work procedures. The LUN shall contain descriptions and marked up drawings of which particular system or part system

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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

that will become live during commissioning. The method of work permit shall be the WPC (Work Protection Code) established by Company or the Contractor's Project Safety Management Plan if its requirements exceed the WPC.



1.2.9 MC Handover – the formal transfer of MC documentation and responsibility for part systems, systems, area / building or the complete facility defined on the MCC.

1.2.10 Mechanical Completion (MC) – shall reflect non-live / non-energized completion of specified systems and part systems in the specification for Work, while in storage and during installation or construction to the latest design drawings, specifications and Standards.



1.2.11 Mechanical Completion Certificate (MCC) – Issued by Contractor upon successful MC of a single discipline within a system or part system, thus allowing commencement of Commissioning Static Checks.

1.2.12 Operations – Company or its nominated representative responsible for Operation of the plant.

1.2.13 Part System Limits – clearly defined stand-alone scopes of work, which can be single or multi-discipline.

1.2.14 Preservation – shall mean those activities that are necessary to preserve the systems, part systems or equipment described in the specification before, during or after delivery, during MC and commissioning.



1.2.15 Project Completion System (PCS) is a computerized system for tracking status of MC and commissioning by individual tag, MC Pack or commissioning pack. This system is used to verify MC and commissioning of all equipment at Contractors /Suppliers facilities and /or Site. The PCS operating software shall be provided by Engineer and it shall be the responsibility of the Contractor / Supplier to input the requisite engineering and scope data to the database. This data shall be maintained and status updated by the Contractor on an on-going basis.

1.2.16 Punch List – a list of incomplete scope and / or deficiencies agreed between Contractor offering the equipment, system, or part system and RFO receiving the equipment, system, or part system.

1.2.17 Punch List A item – means that the deficiency noted is significant and is preventing the MC Handover or RFO Turnover process.

1.2.18 Punch list B item – means that the deficiency is minor in nature and is not preventing the MC Handover or RFO Turnover process.



1.2.19 Ready for Operations (RFO) – a team, led by Company, consisting of qualified personnel from Company, Engineer, Contractors and Suppliers.

1.2.20 RFO Turnover – the formal transfer of documentation and responsibility for operations and maintenance of part systems, systems, equipment, area / building or complete facility defined on the Turnover Certificate, from RFO to Operations.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002



- 1.2.21 Specification Compliance Sign-off List (SCL) - An itemized list prepared by Contractor, for each system or part system, highlighting all its technical design parameters and specifications needed for ease in verification and sign-off by Engineer and RFO.
- 1.2.22 Turnover and Commissioning Package (TCP) - Detailed document outlining all testing procedures and functional requirements for each system or part system, which are completed or near Completions, to verify its performance in accordance to design specifications.
- 1.2.23 Turnover Certificate (TOC) – Issued by RFO to Operations upon successful completion of system or part system commissioning activities, leaving the system or part system ready for Operations.
- 1.2.24 Work Protection Code (WPC) - A code of practice outlining principles and methods of safe work on electrical, mechanical and associated equipment that provides formal assurance that sources of hazardous electrical and/or mechanical energy on specified equipment has been removed. It is designed to constitute a set of minimal recommended procedural and safety requirements for a safe working environment for all workers authorized to perform work on electrical, mechanical and associated equipment.

PART 2 CONTRACTOR’S RESPONSIBILITIES

2.1 GENERAL RESPONSIBILITIES



- 2.1.1 For all physical items within the boundaries of the Contractors Scope of Work, Contractor shall prepare plans, procedures, manuals, check sheets and reports for all completions activities. Contractor shall provide technical support, tools, spares and labour for completions activities.
- 2.1.2 Relevant documentation shall be submitted as per the agreed Supplier Document Register. Refer to Exhibit 3 section 12 Completions Coordination Procedure for full details.
- 2.1.3 Contractor’s Completions activities include but are not limited to the following:



1. Prepare Commissioning Manuals
2. Prepare Preservation Manuals
3. Perform initial preservations and packaging for shipment
4. Perform preservation, Mechanical Completion, Specification Compliance Verification, and Commissioning activities at Contractor’s/Supplier’s Works and prepare Dispatch Dossier
5. Prepare and complete a SCL for all supplied systems or part systems
6. Establish preservation and maintenance routines up to Handover of systems or part system upon completion of commissioning activities

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002



7. Carry out Mechanical Completion, document on Project standard forms, prepare punch lists prior to MC handover

8. Resolve punch lists items to satisfaction of Engineer



9. Provide spares recommendations and agreed spares as per agreed Supplier Document Register



10. Specify and provide commissioning tools, test equipment, first fills and consumables



11. Define commissioning pack test limits and mark up limits on drawings, system and part system limits to be provided by Engineer and agreed to by Contractor



12. Input data for the PCS database in the agreed format with MC inspection & test records, Mechanical Completion and Commissioning Packs, tag numbers and Commissioning Checklists for Commissioning Static Checks

13. Provide Dynamic Commissioning procedures



14. Provide supervision, labour and technical support for commissioning activities

15. Prepare Performance Test procedures and test limits

16. Conduct commissioning static/dynamic checks on equipment, systems or part systems and document on Project standard forms

17. Plan and conduct performance test and determine acceptability of systems performance

18. Rectify, at Contractor's expense, system deficiencies including those identified in performance testing



19. Prepare as-built mark ups.

PART 3 MECHANICAL COMPLETION

3.1 GENERAL

3.1.1 Contractor shall be responsible to carry out the MC inspections and tests and document these on the standard forms.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

3.2 MECHANICAL COMPLETION AT CONTRACTOR'S FACILITES



3.2.1 Engineer shall check and verify that the MC forms, allocated by Contractor, have been completed correctly and the MC Work is carried out prior to a shipping release.



3.2.2 Contractor shall be responsible to complete a Dispatch Dossier which would contain the MC documentation along with any handling and storage requirements. For full requirements refer to the SDRL.

3.2.3 MC at Contractor's or Suppliers' facilities is applicable, but not limited, to the following type of supply:

1. Supplier skid mounted packaged equipment, such as hoists, pumps, fans and electrical panels. These skids contain piping, instrument, electrical and mechanical equipment and in many cases have a local control cabinet which is wired and connected to the primary and final elements;
2. Control panels;
3. Switchgear and control centres;
4. Transformers and electrical equipment;
5. Electrical breakers, and disconnects;
6. Control monitoring and communication equipment;
7. Hydraulic gates, stop logs, trash racks, follower beams and embedded parts;
8. Trash Rack Cleaner;
9. Hydraulic Power Unit (HPU);
10. Cranes and hoisting machinery;
11. Pad-eyes and loose lifting equipment;
12. Diesel generators;
13. Rotating machinery skid mounted.

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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

3.3 MECHANICAL COMPLETION AT SITE



3.3.1 The MC requirement at the Site shall be completed in accordance with the installation drawings, Standards, codes and to good industry and construction practices. The MC activities shall be carried out in accordance with the MC procedures and documented on MC standard forms. The MC confirmations for the key disciplines shall include, but not limited to:

Structural Discipline

1. Visual inspection for complete and correct installation in accordance with the latest drawings.
2. Alignment checks.
3. Dimensional control inspections and tests.
4. Verification that the specified NDE/NDT checks have been performed.

Mechanical Discipline

1. Visual inspection of equipment for correct and completed installation in accordance with the latest drawings.
2. Internal inspections of tanks, exchangers, fans, ductwork, etc.
3. Inspections and verification of correct and complete installation of pipe work.
4. Verification of coatings.
5. Verification that the specified NDE/NDT checks on gates, stoplogs, hoists etc. have been performed
6. Verification of colour coding for pipes.
7. Numbering identification of all mechanical components.
8. Verification of embedded parts alignment and seals of hydraulic gates and stop logs.
9. Flushing of lube and hydraulic oil systems to a specified standard.
10. Assembly of trash cleaner

Electrical Discipline

1. Visual inspection of equipment for correct and completed installation in accordance with the latest drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

2. Verification of electrical cable pulling, glanding, termination and testing.
3. Numbering identification of all wiring and electrical equipment.
4. Insulation and continuity of cables.
5. Insulation and continuity testing of generators, transformers, motors, panels, distribution boards and other electrical equipment.
6. Grounding checks.
7. Motor rotation checks.
8. Lighting circuit testing and illumination checks.

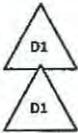
Instrument Discipline (Includes telecommunication)

1. Calibration and testing of instruments and telecommunication devices.
2. Visual inspection of equipment for correct and completed installation in accordance with the latest drawings.
3. Verification of electrical cable pulling, glanding, termination and testing.
4. Insulation and continuity testing of instrument / telecommunications cabling.

Civil / Architectural Discipline

1. Visual inspection of concrete structures for correct and completed installation in accordance with the latest drawings.
2. Verification of functionality of structural and architectural features (such as gates, doors, windows).

PART 4 PRESERVATION



Refer to exhibit 3 section 12 Completion Coordination Procedure for details

4.1 PRESERVATION AT CONTRACTOR'S FACILITY

4.1.1 The Contractor's Preservation requirements shall include the following:

1. All equipment and devices shall be protected for shipment;
2. Contractor shall perform the initial Preservation and document the Preservation carried out;



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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002



3. Not used;
4. Not used;
5. The Preservation documentation shall be included in the Dispatch Dossier and shall accompany the shipment;

4.2 PRESERVATION AT SITE



4.2.1 Contractor shall supply a long term preservation procedure detailing required storage location, preservation checks and maintenance for Contractor's scope of supply up until takeover by operations.



4.2.2 Contractor's Preservation requirements shall include the following:



1. Contractor shall be responsible for the preservation and protection of all scope of supply, inclusive of free issue and Supplier provided skid packages, equipment, material and devices.
2. Preservation procedures provided by the Supplier and the preservation requirement in the specifications outlined by Engineer shall be included.
3. Preservation documentation and records of preservation maintenance carried out shall be kept by Contractor and submitted for review as per the agreed Supplier Document Register.
4. Contractor shall energize any space heaters on receipt of equipment.
5. Contractor shall establish a preservation team to carry out the preservation requirement and to establish the preservation program up to the MC Handover of the equipment or system to RFO.
6. An inspection / check of preservation, damage shall be carried out by Contractor on receipt of equipment, materials, skid packages, fabricated elements and subassemblies. Deficiencies shall be noted and brought to the attention of Engineer for resolution.
7. Contractor shall store the equipment and material in the stipulated facility until ready for installation.



PART 5 COMMISSIONING

5.1 GENERAL

5.1.1 The following describes general requirements for commissioning. Specific tests related to the hydro-mechanical equipment are outlined in Appendix A.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

5.2 COMMISSIONING AT CONTRACTOR’S FACILITIES

- 5.2.1 The commissioning requirements at Contractor’s facilities shall be in accordance with the Factory Acceptance Testing (FAT) procedures accepted by Engineer.
- 5.2.2 Commissioning or FAT at Contractor’s /Supplier’s facility shall not be considered to be the final system commissioning, which can only be carried out when the equipment being tested is installed at Site and is connected up to the rest of the facility as per the system design.
- 5.2.3 FAT shall provide assurance that the equipment meets the design requirements and can meet the performance requirements.
- 5.2.4 Engineer, RFO and / or Operations will attend the FAT of key pieces of equipment, such as hoists’ stall tests, trash cleaner, diesel generator, electrical equipment, control and monitoring systems.
- 5.2.5 FAT and the inspections, tests and readings taken shall be documented and made available to Engineer/RFO as part of the Supplier documentation provided with the system and part system equipment. SCL for each system or part system prior to commissioning of such system and part systems shall be submitted to RFO for confirmation.

5.3 COMMISSIONING AT SITE



5.3.1 The commissioning activities at Site shall be conducted by Contractor utilizing Contractor supervision, Labour, test equipment / materials and technical support. Commissioning shall be witnessed by Engineer /RFO.

5.3.2 Commissioning at site shall include:

1. Commissioning Static Checks.
2. Dynamic Commissioning / System Commissioning.



5.3.3 Contractor shall complete Commissioning Static Checks and document on CCL. The CCLs shall be submitted as per the SDRL and shall be discipline based. Commissioning Static Checks shall include, but not be limited to:

1. High voltage injection test.
2. Power on tests.
3. Relay tests.
4. High potential tests.
5. Loop checks and logic function tests.

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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

6. Load tests.
7. HVAC air flow tests.
8. Pump tests.
9. Battery system backup tests.
10. Alarm settings and verification.
11. Valve position verification.
12. Pressure safety valve testing.
13. Rotation tests.
14. Lube and hydraulic oil cleanliness checks.
15. Opening/closing gates and stoplogs tests using the follower beams.
16. Start/stop motor testing.
17. Shutdown logic tests.
18. Control and monitoring offline checks.
19. Verification of intake gates emergency closure.
20. Diesel generator testing
21. Trash cleaner dry tests

5.3.4 Contractor shall provide technical support and labour to provide troubleshooting and resolution of deficiencies that may become evident during Dynamic Commissioning / System Commissioning.

5.3.5 Dynamic Commissioning / System Commissioning shall be performed when the Commissioning Static Checks are complete and the systems are ready for operational testing. The Dynamic Commissioning / System Commissioning activities shall include, but not be limited, to:

1. Water up tests during reservoir/ tailrace water impoundment.
2. Gate / Stop-log tests.
3. Trash cleaning system tests.
4. Start-up/shutdown tests.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

5. Trips and alarm tests.
6. Baseline data recording.
7. Electrical power distribution tests.
8. Verification of the functionality of the control and monitoring systems.

PART 6 MANUALS

6.1 GENERAL

- 6.1.1 For each piece of equipment supplied for the Project, and for all components, sub-systems and systems, a complete set of manuals for the start-up, testing, preservation and commissioning (“Commissioning Manuals”) shall be submitted, describing the required procedures in step-by-step detail.
- 6.1.2 For equipment which is incorporated into a sub-system or system, a separate Commissioning Manual for that piece of equipment is not required if all information required for that piece of equipment is included in the Commissioning Manual for the sub-system or system of which it is a part.
- 6.1.3 Commissioning Manuals shall be submitted as per the SDRL.

6.2 REQUIRED COMMISSIONING MANUAL CONTENTS:

- 6.2.1 A responsibility matrix covering every single action, process and procedure required to complete commissioning.
- 6.2.2 Name of commissioning coordinator and commissioning supervisor(s).
- 6.2.3 Settings, alignments, tolerances and all tests and checks required prior to first start-up, energization or rotation of a piece of equipment, sub-system or system.
- 6.2.4 Proposed commissioning schedules.
- 6.2.5 Checklists and record forms.
- 6.2.6 Where applicable, copies of the Commissioning Manuals from all equipment and systems suppliers providing their respective procedures for testing and commissioning shall all be integrated by the Contractor into the Commissioning Manual.
- 6.2.7 Visual inspections and checks.
- 6.2.8 Pre-start checks.
- 6.2.9 Start-up checks.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- 6.2.10 Where applicable, tests and inspections required prior to start-up of ancillary equipment.
- 6.2.11 Tests and inspections required prior to start-up of diesel generator .
- 6.2.12 Initial run, commissioning and test operation of the diesel generator.
- 6.2.13 Checks for conformity with the Contract documents and the approved design documents.
- 6.2.14 Tests and checks required for interconnection, in accordance with the Contract documents and in accordance with any requirements of the transmission system operator.
- 6.2.15 Calibrations or settings for instrumentation, including forms to be used for the recording of such measurements.
- 6.2.16 Safety procedures and instructions for all personnel involved in commissioning.
- 6.2.17 For commissioning of control systems instructions shall include: application of appropriate signals to verify the operation of each input; running of software; and verification of software, including diagnostics and interface modules.
- 6.2.18 Procedures and equipment for the measurement of station service load.

PART 7 REPORTS

7.1 GENERAL

- 7.1.1 Contractor shall prepare test reports for consolidating the results of each major test of phase of testing.
- 7.1.2 Test reports shall be submitted as per the agreed Supplier Document Register for site and factory tests.

7.2 MINIMUM REPORT CONTENTS

- 7.2.1 As a minimum, each of the final test reports shall include the following information:
 1. As-builts of all testing documentation;
 2. Detailed diary of all testing performed;
 3. Final equipment and control settings;
 4. Calibration data;
 5. Detailed results of all field tests, test data, including dimensional checks etc. for both pre-commissioning and commissioning tests;

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EW-0002
MFA-SN-CD-2000-ME-SP-0002-01		

6. Summary of the test conditions for all tests including status of equipment, ambient conditions, water levels etc.;
7. Deficiencies prior to and at completion of the testing;
8. Photographic record of all tests

APPENDIX A

**Minimum Commissioning Procedure Requirements For
Hydro Mechanical Equipment**

96
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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

TABLE OF CONTENTS
PRESERVATION, MECHANICAL, COMPLETION & COMMISSIONING REQUIREMENTS
APPENDIX A – MINIMUM COMMISSIONING PROCEDURE FOR HYDRO MECHANICAL EQUIPMENT

1 SCOPE16

 1.1 GENERAL..... 16

2 GATES AND STOPLOGS.....16

 2.1 DRY TEST FOR ALL ROLLER GATES AND EMBEDDED PARTS..... 16

 2.2 DRY TESTS FOR INTAKE BULKHEAD GATES 16

 2.3 DRY TESTS FOR SPILLWAY STOPLOGS 18

 2.4 DRY TESTS FOR DRAFT TUBE STOPLOGS 18

3 HOISTS AND CRANES19

 3.1 GENERAL..... 19

 3.2 DEFLECTION TESTS 20

 3.3 BRAKE TESTS..... 20

 3.4 BUMPER TESTS 20

 3.5 LOAD CELL TESTING..... 20

 3.6 SLACK ROPE DETECTION..... 20

 3.7 CONTROL TESTING 20

 3.8 TEST INSTRUMENTATION AND MONITORING 21

 3.9 INSPECTIONS 21

 3.10 LIFTING DEVICES LOAD TESTS 21

 3.11 Static COMMISSIONING TESTS..... 21

 3.12 100% RATED LOAD TESTS 22

 3.13 125% RATED LOAD TESTS 24

4 OPERATIONAL LOAD TESTING OF GATES24

 4.1 GENERAL..... 24

 4.2 SPILLWAY OPERATIONAL TESTING..... 24

 4.3 INTAKE GATES OPERATIONAL TESTING..... 25

5 IMMERSION AND ACCEPTANCE TESTING25

 5.1 GENERAL..... 25

6 TRASH RACK CLEANER26

 6.1 GENERAL..... 26

 6.2 Static COMMISSIONING TESTS..... 27

 6.3 COMMISSIONING TESTS..... 28

END OF SECTION29

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

PART 1 SCOPE

1.2 GENERAL



1.2.1 This Appendix is intended to provide minimum static and dynamic commissioning requirements for specialized Hydro Mechanical equipment.



1.2.2 Part systems are to be certified Mechanically Complete prior to start of Commissioning.

PART 2 GATES AND STOPLOGS

2.1 DRY TEST FOR ALL ROLLER GATES AND EMBEDDED PARTS

2.1.1 Following field full assembly and completion of all adjustments of the Intake Gates and the Spillway Gates to the satisfaction of Engineer, and prior to filling the forebay, Contractor shall carry out operational Dry Tests. These Dry Tests shall be carried out in accordance with the procedures Accepted by Engineer and will include as a minimum the following operations:

- .1 Lower the gate to the sill and raise it to its maximum height a minimum of three consecutive operations with stops and starts at certain intervals, and Contractor shall demonstrate that these operations can be carried out from all control points;
- .2 Verify proper operation of the gate and its auxiliary systems;
- .3 Verify proper operation of the embedded parts heating systems (Spillway Gate);
- .4 With the gate completely closed, verify the proper alignment and embedded part path clearances for all wheels, guide rollers, bearing bars, side guides etc. (at both sill elevations for Spillway Gates);
- .5 With the gate completely closed, verify the proper seal pre-compression every 0.6 m along every seal;
- .6 Verify the gap between the gate lip and the sill beam is within specified tolerances;
- .7 Verify gate is hanging vertically plumb when suspended;
- .8 Verify gate is not skewed sideways when sitting on the sill.

2.2 DRY TESTS FOR INTAKE BULKHEAD GATES

2.2.1 Following installation of the Intake Bulkhead Gates, and prior to filling the forebay, Contractor shall carry out operational Dry Tests. These Dry Tests shall be carried out in accordance with the procedures Accepted by Engineer, and will include as a minimum the following operations:

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- .1 Prior to Bulkhead Gate Dry Tests, lower the lifting beam in each bay to near the sill level and rise it to its maximum height stopping at two successive intervals while travelling both up and down. Verify proper operation of the lifting beam;
- .2 Use the lifting beam to engage a bottom Bulkhead Gate and lower it in each bay stopping at two successive intervals. Once supported over the sill beam; disengage the lifting beam hooks; raise the beam a few metres and lower it again; re engage the hooks; and hoist the Bulkhead Gate up to the maximum height stopping at two successive intervals. Verify proper operation of the lifting beam and the Bulkhead Gates during the test;
- .3 Using the lifting beam, install the entire set of Bulkhead Gates in each Bulkhead Gate slot. Verify proper operation of the lifting beam and the Bulkhead Gates during the entire test sequence;
- .4 With each set of Bulkhead Gates completely installed, verify in each slot the proper gate alignment and embedded parts clearances between the slide bars and their guide path; and that the clearances between the upstream, downstream and lateral shoes and their respective bearing paths. Verify that the Bulkhead Gate's leaf springs deflection is within specified tolerances;
- .5 Verify that the gap between the bottom Bulkhead Gate lip and the sill beam, and between each section, is within specified tolerances;
- .6 With the complete set of Bulkhead Gates installed, verify the proper seal pre-compression at every 0.6 m on each side of each Bulkhead Gate section, between each section, and along the lintel.

2.2.2 Store the Bulkhead Gates and lift beams on the dogging devices in each of the slots for verification.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

2.3 DRY TESTS FOR SPILLWAY STOPLOGS

2.3.1 Following installation of the Spillway Stoplogs and prior to filling the forebay, Contractor shall carry out operational Dry Tests. These Dry Tests shall be carried out in accordance with the procedures Accepted by Engineer, and will include as a minimum the following operations:

- .1 Prior to stoplog Dry Tests, lower the lifting beam in each bay to near the sill level and rise it to its maximum height stopping at two successive intervals while travelling both up and down. Verify proper operation of the lifting beam;
- .2 Use the lifting beam and engage a bottom stoplog and lower it in each bay stopping at two successive intervals. Once supported over the sill beam; disengage the lifting beam hooks; raise the beam a few metres and lower it again; re engage the hooks; and hoist the stoplog up to the maximum height stopping at two successive intervals. Verify proper operation of the lifting beam and the stoplogs during the test;
- .3 Using the lifting beam, install one full set of each type of stoplog in each stoplog slot. Verify proper operation of the lifting beam and the stoplogs during the entire manoeuvre;
- .4 With one set of stoplogs completely installed, verify in each slot the proper stoplog alignment and embedded parts clearances between the slide bars and their guide path; and that the clearances between the upstream, downstream and lateral shoes and their respective bearing paths. Verify that the stoplog leaf springs deflection is within specified tolerances;
- .5 Verify that the gap between the bottom stoplog lip and the sill beam, and between each section, is within specified tolerances;
- .6 With all sections installed, verify the proper seal pre compression at every 0.6 m on each side of each set of stoplogs, and every 3m along the sill seal between each stoplog, and every 3m along the lintel.

2.4 DRY TESTS FOR DRAFT TUBE STOPLOGS

2.4.1 Following installation of the Draft Tube Stoplogs and prior to filling the tailrace, Contractor shall carry out operational Dry Tests. These Dry Tests shall be carried out in accordance with the procedures Accepted by Engineer, and will include as a minimum the following operations:

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- .1 Prior to stoplog Dry Tests, lower the lifting beam in each bay to near the sill level and rise it to its maximum height stopping at two successive intervals while travelling both up and down. Verify proper operation of the lifting beam;
- .2 Use the lifting beam and engaged a bottom stoplog and lower the stoplog in each bay stopping at two successive intervals. Once supported over the sill beam; disengage the lifting beam hooks; raise the beam a few metres and lower it again; re engage the hooks; and hoist the stoplog up to the maximum height stopping at two successive intervals. Verify the proper operation of the lifting beam and the stoplogs during the manoeuvres;
- .3 Using the lifting beam, install one full set of each type of stoplog in each stoplog slot. Verify proper operation of the lifting beam and the stoplogs during the entire manoeuvre;
- .4 With one set of stoplogs completely installed, verify in each slot the proper stoplog alignment and embedded parts clearances between the slide bars and their guide path; and that the clearances between the upstream, downstream and lateral shoes and their respective bearing paths. Verify that the stoplog leaf springs deflection is within specified tolerances;
- .5 Verify that the gap between the bottom stoplog lip and the sill beam, and between each section, is within specified tolerances;
- .6 With the complete set of stoplogs installed in every draft tube slot ensuring that every set of stoplogs has been used at least once;
- .7 Verify that the gap between the bottom stoplog lip and the sill beam, and between each section, is within specified tolerances;
- .8 With all sections installed, for one combination of components, verify the proper seal pre compression at every 0.6 m on each side of each section, between each section, and along the lintel.

2.4.2 Using the overhead crane, store the stoplogs on the storage supports.

2.4.3 Verify operation of the lockout devices in each of the stoplog slots and check that the lifting beam cannot be inserted with the stoplog slot locked out.

2.4.4 At the completion of Dry Tests, as directed by Engineer, install all stoplogs in Draft Tubes of Units 1 and 2, and verify that all seals are seating correctly for tailrace water up.

PART 3 HOISTS AND CRANES

3.1 GENERAL

3.1.1 Prior to the start of any operational tests on the hoists and cranes, Contractor shall demonstrate that the tension in the wire ropes, for hoists that have independent wire ropes, is balanced, and that it may be necessary to have some load on the hoist to perform the verification.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

3.1.2 Wire rope balance shall be checked again after the hoist has run through a full operation cycle, and after all operational testing.

3.2 DEFLECTION TESTS

3.2.1 The deflection of the cranes and hoist girders shall be measured with the rated load in the middle of the span. This load shall be applied at least three (3) successive times before the measurement.

3.2.2 For the Intake Gate and Spillway Gate hoists the deflection shall be measured in the middle of the longest unsupported load member on the hoist structure itself.

3.3 BRAKE TESTS

3.3.1 All brakes (travel and hoisting) shall be tested under full load conditions, from maximum speed to rest, three (3) times in quick succession without overheating.

3.3.2 Where there are multiple hoist brakes they shall be tested individually.

3.3.3 The manual release lever on the Intake Gate hoists shall be tested including interlocks.

3.4 BUMPER TESTS

3.4.1 The bridge and trolley bumpers shall be impact tested against the end stops without load and at 40% of rated speed.

3.5 LOAD CELL TESTING

3.5.1 The load cell calibrations shall verified at no load, rated load, 125% test load, and intermediate loads between zero and rated load.

3.5.2 During the load cell verification the effect of hysteresis shall be measured and recorded.

3.5.3 During commissioning all overload protection shall be verified.

3.6 SLACK ROPE DETECTION

3.6.1 The slack rope detection system shall be tested prior to all load testing and again after the completion of all load testing. As part of this test the effects of the lifting beam shall be included where applicable.

3.7 CONTROL TESTING

3.7.1 All controls functions shall be tested thoroughly including combinations of control function where they may reasonably occur.

3.7.2 Where there are redundant controls such as pendants and radio control all the testing shall be repeated for all duplicate functions.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

3.7.3 Where there is redundancy, all interlocks shall be tested to ensure only one control position has control at any time.

3.8 TEST INSTRUMENTATION AND MONITORING

3.8.1 As a minimum during the operational and load testing the following shall be recorded:

- .1 Motor currents all phases;
- .2 Supply voltages and voltage drop during hoisting;
- .3 Brake current and voltages;
- .4 Travel speeds;
- .5 Hoisting and lowering speeds.
- .6 Depending on Contractor’s design and proposed Test Plan, Engineer may require additional test measurements.

3.9 INSPECTIONS

- 3.9.1 Prior to the start of the No Load tests, after the No Load tests, after the Rated Load test and again after the 125% Rated Load test, the hoists shall be thoroughly inspected by both Contractor and Engineer.
- 3.9.2 Contractor shall document all findings, deficiencies, unusual wear etc.
- 3.9.3 After the completion of all tests Contractor shall verify the torque on all key fasteners such as wire rope dead ends, sheave blocks, all fasteners that are primarily in tension, bumpers and end stops, drop stops, critical structural connections etc.

3.10 LIFTING DEVICES LOAD TESTS

- 3.10.1 Loose lifting devices such as lifting beams shall be load tested to 125% of their rated load.
- 3.10.2 Test Loads shall be within +0%, -4% of the required load.



3.11 STATIC COMMISSIONING TESTS

- 3.11.1 After erection and prior to proceeding with commissioning and operational tests, all hoisting equipment shall be operated under its own power and tests carried out to prove the following:

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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- .1 All clearances and alignments are in order; gearing is sufficiently quiet; all equipment is operating smoothly; and lubrication is adequate;
- .2 Operation of all control devices is satisfactory;
- .3 All limit switches are set and operate correctly;
- .4 All circuits, interlocks and sequences of operation are correct;
- .5 All protective devices operate satisfactorily;
- .6 Each movement of the crane is satisfactory;
- .7 Brakes are operating satisfactory;
- .8 Positioning markers and targets are correctly adjusted;
- .9 Travel of the trolley over the full range;
- .10 Travel of the bridge over the entire running length;
- .11 Raising over the maximum lifting height;
- .12 Lowering over the minimum lifting height at normal speed;
- .13 Lowering over the minimum lifting height at emergency speed (with fan brake);
- .14 Test that the hoist brakes individually;
- .15 Measure of all hoisting and travelling speeds;
- .16 Measure of hoisting speeds;
- .17 Verifying all limit switches;
- .18 Verifying all circuits, interlocks and sequences of operation are correct;
- .19 Verifying all protective devices operate satisfactorily;
- .20 Verifying alignment of the bumpers with the end stops;
- .21 Measurement of motor voltage and amperage for all operating scenarios.

3.11.2 All deficiencies shall be recorded during pre-commissioning, and deficiencies shall be corrected to the satisfaction of Engineer prior to proceeding with further testing and commissioning.

3.12 100% RATED LOAD TESTS

3.12.1 The following tests shall be performed with the rated load:

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- .1 Hoisting of the load at normal speed;
- .2 Lowering of the load at normal speed;
- .3 Lowering of the load at emergency speed;
- .4 Test that the hoist brakes individually support the load with loss of power to hoist motor;
- .5 Travel of the trolley over the full range;
- .6 Travel of the bridge over the available length;
- .7 Measure all travelling speeds;
- .8 Measure hoisting speeds;
- .9 Verifying all limit switches at rated speed;
- .10 Verifying all circuits, interlocks and sequences of operation are correct;
- .11 Verifying all protective devices operate satisfactorily.
- .12 Measurement of motor voltage and amperage for all operating scenarios.

3.12.2 During these tests the speeds shall be varied over their full range and maintained sufficiently long to demonstrate the adequacy of the system and that there are no unusual noises, over-heating or control problems. As part of these tests the load shall also be lifted, stopped, lifted again and stopped at least three times (3) in quick succession.

3.12.3 Contractor shall demonstrate that the Rated Load Test load is within +4%, -4% of the required weight.

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

3.13 125% RATED LOAD TESTS

3.13.1 The following tests shall be performed with the test load at 125% of the hoist rated capacity:



- .1 Hoisting of the load;
- .2 Lowering of the load;
- .3 Travel of the trolley over the full range;
- .4 Travel of the bridge over the available length;
- .5 Test that the hoist brakes individually support the load;
- .6 Measurement of motor voltage and amperage for all operating scenarios.

3.13.2 Contractor shall demonstrate that the 125% Test Load is within +0%, -4% of the required weight.

PART 4 OPERATIONAL LOAD TESTING OF GATES

4.1 GENERAL

- 4.1.1 Operational load testing shall be performed by Contractor under the supervision of Engineer.
- 4.1.2 Contractor shall provide procedures for operation load testing of the gates, but control of the gates will be by Engineer who will instruct Contractor when to perform each testing sequence.
- 4.1.3 Contractor shall supply personnel and equipment for the operational load testing.

4.2 SPILLWAY OPERATIONAL TESTING

- 4.2.1 The Spillway Gates will be tested with the following sequence:
 - .1 Partial testing at available head after the spillway entrance channel is watered up and the cofferdams removed in preparation for river closure;
 - .2 The Spillway Gates will remain fully open while the river is diverted through the Spillway
 - .3 After the river closure is complete the Spillway Gates will be closed and operated to water up the reservoir to Diversion Headpond Level (DHL);
 - .4 The Spillway Gates shall then be operationally tested for the Diversion Phase;
 - .5 When each set of Rollways are completed, the Spillway Gates will be adjusted for the new sill elevation, the gates closed and watered up, and shall be operationally tested again at the DHL;

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- .6 When the last two Spillway bays have their Rollways installed, the forebay will increase to the forebay Full Supply Level (FSL) and all Spillway Gates adjusted for the new sill elevation;
- .7 After the forebay is watered up to FSL, each Spillway Gate shall be operationally tested again for long term operation.

4.2.2 For the operational tests, the Spillway Gates shall be operated over their full opening to demonstrate that they are capable of operating and that there is no excessive vibration.

4.3 INTAKE GATES OPERATIONAL TESTING

- 4.3.1 All Intake Gates shall be closed and monitored during initial filling of the forebay for leakage, but will not be able to be operationally tested until Engineer schedules watering up of the downstream water passages.
- 4.3.2 For Operation testing, the Intake Gates shall be cracked to simulate filling of the water passages with full differential head.
- 4.3.3 The Intake Gates will be immediately closed against full head to simulate closure of the gates under full differential head.
- 4.3.4 The Intake Gates shall then be operated, closed, dewatered, and checked for leakage.
- 4.3.5 Emergency lowering test of a set of three intake gates shall be performed to shut in one unit against full turbine discharge. The set of gates are to be chosen by Engineer.
- 4.3.6 Operational load testing shall demonstrate during the testing that the load does not exceed the gate's and hoist's specifications.

PART 5 IMMERSION AND ACCEPTANCE TESTING

5.1 GENERAL

- 5.1.1 There will be a period of delay between Contractor completing the Dry Tests, and the commencing to water up by Company's other contractors. Contractor shall have a field representative available to witness the behaviour of all gates and stoplogs while being submerged during water up, and shall have crews available to deal with any deficiencies during water up.
- 5.1.2 Acceptance testing shall be performed by Contractor. These tests shall be carried out in accordance with procedures developed by Contractor, and submitted to and Accepted by Engineer. Records of Acceptance testing to be submitted as per the SDRL.
- 5.1.3 Testing after water up shall wherever possible be based on actual operations conditions, equipment under full hydrostatic load, and where not practical be based on simulated operating conditions that may happen during normal and emergency operation.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	-	Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- 5.1.4 Immersion and acceptance testing shall demonstrate that the equipment is operating normally and without excessive vibrations.
- 5.1.5 Immersion and acceptance testing shall include, but not be limited to, operation with and without flow where applicable, installation of components while watered up, de-watering water passages, operation of all ancillary equipment, testing of all hoisting equipment, testing of Trash Cleaner equipment, etc.
-  5.1.6 Leakage will be measured and compared against the permissible values stipulated in Technical Specification section 48 13 20.
-  5.1.7 Not used.

PART 6 TRASH RACK CLEANER

6.1 GENERAL

- 6.1.1 Contractor shall provide all personnel required to perform all testing and commissioning activities including operating, and perform any repairs or modifications necessary.
- 6.1.2 Contractor shall provide Site Technical Representation from the manufacturer, versed in all aspects of the equipment design and operation including hydraulic systems, controls etc.
-  6.1.3 Engineer may at their discretion witness all aspects of the work being performed by Contractor and will require advance notice of all testing and commissioning activities.
- 6.1.4 Every aspect of the equipment's functional capability shall be tested and commissioned.
- 6.1.5 All testing and commissioning activities shall be documented and at the Company's and/or Engineer's discretion shall be witness signed.
- 6.1.6 All testing and commissioning documentation, including any as built mark-ups, shall be provided to Engineer immediately upon completion of the commissioning (in draft form if necessary).
- 6.1.7 Any defects/deficiencies found during any aspect of the testing and commissioning shall be brought to the immediate attention of Engineer and if any require changes to the design or documentation previously accepted they shall be documented and submitted to Engineer for Acceptance prior to proceeding with any remedial work. Remaining testing and commissioning activities may be suspended by Engineer until defects/deficiencies are corrected.
- 6.1.8 Sequence of all testing and commissioning shall be performed to ensure all possible functionality and all reasonable worst case operating modes expected have been tested;
- 6.1.9 Engineer at his discretion may require aspects of the testing and commissioning to be repeated if modifications/adjustments are made after testing and commissioning has been performed.



Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

6.1.10 All as-built information known prior to commissioning shall be documented adequately for use during testing commissioning.



6.2 STATIC COMMISSIONING TESTS



6.2.1 Contractor shall define all static checks to be carried per equipment tag number and this shall form part of the commissioning procedure.



6.2.2 As part of the pre-commissioning checks and testing the Contractor shall, as a minimum, perform the following work:

- .1 Check of all wiring connections;
- .2 Check all piping connections;
- .3 Check/test/verify/calibrate all instrumentation, transducers, limit switches, position sensors, over load devices and all other electronic or indicating devices;
- .4 Check fasteners/connections on all key components that were shipped to site pre-assembled;
- .5 Check for leaks on all hydraulic equipment;
- .6 Check/test functionality and settings on all hydraulic equipment including, but not limited to, relief valve settings, flow rates, operating pressures, unloaders, pressure switches;
- .7 Check/test all safety and interlock devices;
- .8 Check and test all ancillary mechanical and electrical equipment, such as heaters, fans, lighting, etc;

Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002

- .9 Check/test all individual control and operating functions;
- .10 Check/test/verify all control functions from all locations;
- .11 Test installation and function in the dry of all cleaning heads and other attachments.
- .12 During all testing and operation the following shall be monitored by the Contractor;
- .13 Check for abnormal noise or vibration and overheating in machinery drive or hydraulic components;
- .14 Check for proper operation, freedom of movement, binding in all components;
- .15 Check electrical components for overheating;
- .16 At completion of the testing and pre-commissioning inspect for abnormal wear, damage, or inadequate lubrication;
- .17 Inspect and check cleanliness and levels of all fluids;
- .18 All deficiencies noted during pre-commissioning shall be corrected to the satisfaction of Engineer prior to proceeding with further testing and commissioning.

6.3 COMMISSIONING TESTS

6.3.1 Final commissioning tests shall be performed after the reservoir is impounded to full supply level of El. 39.0 m, and shall include demonstration tests of all Trash Cleaning System functions, followed by a 60-day trial operating period.

6.3.2 Contractor shall perform the following tests on the Trash Cleaning System:

- .1 The demonstration tests shall include two complete traverses of the full Powerhouse trashrack face, using first a shallow cleaning cycle across the face of the Powerhouse;
- .2 In a) above the cleaning system shall be operated in both manual and semi-automatic modes;
- .3 Operation shall include dumping of material into Company-supplied trash container. The second test cycle shall include a full-depth cleaning of the entire Powerhouse trashrack face, with alternating use of the manual and semi-automatic cleaning cycles;
- .4 Acceptance tests for the clam head operation shall be demonstration of the cleaner head removal, attachment of the clam head, clamming of the trench area upstream of the trashracks at elevation El. 39 m, for the full width of the Powerhouse Trashracks, followed by removal of the clam head and reattachment of the cleaner head;



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Lower Churchill Project Muskrat Falls Hydroelectric Development		Exhibit 1
CH0032	PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS	Rev: D1
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-SP-0002-01		505573-3321-45EW-0002



.5 Acceptance tests for the cleaning system storage function shall be a demonstration of a full traverse of the Powerhouse operating rails, operation of the end-of-travel limit controls on each end;



.6 Acceptance tests for the stoplog hoist shall at the Spillway and at the Intake shall be a demonstration of the hoist at all stoplogs slots and Bulkhead Gates slots with their respective lift beams;

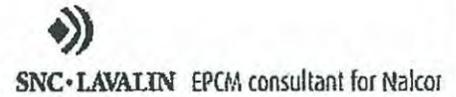
.7 Demonstration that the hoist hooks can be safely secured during operation of trash cleaning system.



6.3.3 Any incorrect operation of control or limit devices during the Performance Acceptance tests will require that the subject test be repeated.

END OF SECTION

Document Front Sheet



NE-LCP Contractor/Supplier	Contract or Purchase Number and Description: LC-G-0002 (Project 505573)		Contractor/Supplier Name: SNC-Lavalin Inc.		
	Document Title: Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment – Technical Document List			Total Number of Pages Incl. Front Sheet 8	
	Contractor/ Supplier Document Number:			Revision Number:	
	EPC(M) Document Number: 505573-CH0032-45AL-I-0001			Issue Number: 06	
	NE-LCP Document Number: MFA-SN-CD-2000-IM-LS-0003-01			NE-LCP Issue Number: B4	
	Approver's Signature: <i>Ad L...</i>		Date (dd-mmm-yyyy): 16-Jan-2014		Review Class:
Comments:			Equipment Tag or Model Number:		

NE-LCP or EPC(M)	REVIEW DOES NOT CONSTITUTE APPROVAL OF DESIGN DETAILS, CALCULATIONS, TEST METHODS OR MATERIAL DEVELOPED AND/OR SELECTED BY THE CONTRACTOR, NOR DOES IT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH CONTRACTUAL OR OTHER OBLIGATIONS. <input type="checkbox"/> 01 – REVIEWED AND ACCEPTED – NO COMMENTS <input type="checkbox"/> 02 – REVIEWED – INCORPORATE COMMENTS, REVISE AND RESUBMIT <input type="checkbox"/> 03 – REVIEWED - NOT ACCEPTED <input checked="" type="checkbox"/> 04 – INFORMATION ONLY <input type="checkbox"/> 05 – NOT REVIEWED			
	Lead Reviewer:	Date (dd-mmm-yyyy):	Project Manager:	Date (dd-mmm-yyyy):
	NE-LCP or EPC(M) Management: <i>[Signature]</i>	Date (dd-mmm-yyyy): 16-JAN-2014		
	General Comments:			

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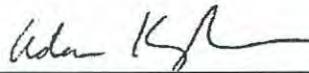
 SNC-LAVALIN	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST		Revision		Page
	SLI Doc. No. 505573-CH0032-45AL-I-0001	06	Date		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01	B4	16-Jan-2014		

LOWER CHURCHILL PROJECT

CH0032

**SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY
 HYDRO-MECHANICAL EQUIPMENT
 TECHNICAL DOCUMENT LIST**

Prepared by:



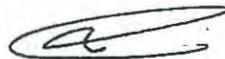
Adam Kavanagh, E.I.T.
 Package Engineer

Verified by:



Randolph Koob, P. Eng
 Lead Engineer

Approved by:



For Greg Snyder P. Eng
 Engineering Manager



 SNC-LAVALIN	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST		Revision		
	SLI Doc. No. 505573-CH0032-45AL-I-0001		06	Date	Page
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01		B4	16-Jan-2014	2

REVISION LIST

Revision					Remarks
N°	By	Verif.	Appr.	Date	
B4	AK	RK	GS	16-Jan-2014	Updated post Award - Contract Review
B3	AK	RK	GS	17-Dec-2013	Updated for Award
B2	AK	RK	GS	12-Dec-2013	For Award of full Contract
03	AK	RK	GS	09-Sep-2013	For Award
02	GD	RK	GS	05-Feb-2013	Addendum #4
01	JK	RK	GS	23-Jan-2013	Addendum #3
00	EC	RK	GS	15-Nov-2012	Issued for Bid.

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	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST			Revision		Page	
	SLI Doc. No. 505573-CH0032-45AL-I-0001			06	Date		3
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01			B4	16-Jan-2014		

TECHNICAL DOCUMENT LIST: TECHNICAL SPECIFICATION

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
AWARD	MFA-SN-CD-2000-ME-TS-0001-01	D2	N/A	N/A	POWERHOUSE AND SPILLWAY - HYDRO-MECHANICAL EQUIPMENT - TECHNICAL SPECIFICATION

TECHNICAL DOCUMENT LIST: SITE INFORMATION DRAWINGS

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
FOR INFORMATION	MFA-SN-CD-2000-CV-PL-0003-01	C2	0000-4G01	PLATE 01	MUSKRAT FALLS - GENERAL ARRANGEMENT OF WORKS - PLAN
FOR INFORMATION	MFA-SN-CD-0000-CV-PL-0004-01	C1	0000-4G01	PLATE 02	MUSKRAT FALLS - LOWER CHURCHILL RIVER - PLAN AND PROFILE
FOR INFORMATION	MFA-SN-CD-2000-CV-GA-0001-01	C2	0000-4G01	PLATE 03	MUSKRAT FALLS - ACCESS ROAD, ACCOMMODATIONS AND LAYDOWN AREAS
FOR INFORMATION	MFA-SN-CD-3000-GT-GA-0001-01	C1	0007-4G01	PLATE 01	MUSKRAT FALLS - INTAKE AND POWERHOUSE, SPILLWAY AND TRANSITION DAMS - GENERAL LAYOUT - PLAN
FOR INFORMATION	MFA-SN-CD-3000-GT-PL-0001-01	C1	0007-4G01	PLATE 02	INTAKE AND POWERHOUSE, SPILLWAY AND TRANSITION DAMS - LOCATION OF STRUCTURES - PLAN

TECHNICAL DOCUMENT LIST: SPILLWAY HYDRO-MECHANICAL EQUIPMENT

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-2400-ME-EL-0001-01	D1	0032-4501	PLATE 01	SPILLWAY - HYDRO-MECHANICAL - GENERAL ARRANGEMENT - ELEVATIONS AND SECTION
DESIGN	MFA-SN-CD-2400-ME-PL-0001-01	D1	0032-4501	PLATE 02	SPILLWAY - HYDRO-MECHANICAL - GENERAL ARRANGEMENT - PLAN AND SECTION
DESIGN	MFA-SN-CD-2400-ME-SE-0001-01	D1	0032-4501	PLATE 03	SPILLWAY - HYDRO-MECHANICAL - GENERAL ARRANGEMENT - SECTIONS
DESIGN	MFA-SN-CD-2420-ME-PL-0001-01	D1	0032-4501	PLATE 04	SPILLWAY - HYDRO-MECHANICAL - SPILLWAY GATES AND HOIST HOUSE - PLAN, ELEVATION AND DETAILS
DESIGN	MFA-SN-CD-2420-ME-EL-0001-01	D1	0032-4501	PLATE 05	SPILLWAY - HYDRO-MECHANICAL - UPSTREAM PERMANENT STOPLOGS - ELEVATION, SECTION AND DETAILS
DESIGN	MFA-SN-CD-2420-ME-EL-0002-01	D1	0032-4501	PLATE 06	SPILLWAY - HYDRO-MECHANICAL - UPSTREAM TEMPORARY STOPLOGS - ELEVATION, SECTIONS AND DETAILS
DESIGN	MFA-SN-CD-2420-ME-PL-0002-01	D1	0032-4501	PLATE 07	SPILLWAY - HYDRO-MECHANICAL - DOWNSTREAM STOPLOGS - PLAN, ELEVATION, SECTION AND DETAIL

TECHNICAL DOCUMENT LIST: INTAKE HYDRO-MECHANICAL EQUIPMENT

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-3200-ME-PL-0001-01	D1	0032-4502	PLATE 01	POWERHOUSE - HYDRO-MECHANICAL - GENERAL ARRANGEMENT - PLAN



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 SNC-LAVALIN	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST		Revision		
	SLI Doc. No. 505573-CH0032-45AL-I-0001		06	Date	Page
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01		B4	16-Jan-2014	4

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-3200-ME-SE-0001-01	D1	0032-4502	PLATE 02	POWERHOUSE - HYDRO-MECHANICAL - GENERAL ARRANGEMENT - ELEVATION AND SECTION
DESIGN	MFA-SN-CD-3240-ME-PL-0001-01	D1	0032-4502	PLATE 03	POWERHOUSE - HYDRO-MECHANICAL - INTAKE-TRASHRACKS - PLAN, ELEVATION, SECTION AND DETAIL
DESIGN	MFA-SN-CD-3240-ME-PL-0002-01	D1	0032-4502	PLATE 04	POWERHOUSE - HYDRO-MECHANICAL - INTAKE-TRASHRACKS - UNIT ARRANGEMENT - SECTIONS, ELEVATION AND DETAILS
DESIGN	MFA-SN-CD-3240-ME-PL-0003-01	D1	0032-4502	PLATE 05	POWERHOUSE - HYDRO-MECHANICAL - INTAKE-BULKHEAD GATES - PLAN, SECTIONS AND DETAIL
DESIGN	MFA-SN-CD-3240-ME-PL-0004-01	D1	0032-4502	PLATE 06	POWERHOUSE - HYDRO-MECHANICAL - INTAKE-BULKHEAD GATES - UNIT ARRANGEMENT - SECTIONS AND DETAIL
DESIGN	MFA-SN-CD-3240-ME-PL-0006-01	D1	0032-4502	PLATE 07	POWERHOUSE - HYDRO-MECHANICAL - INTAKE GATES - PLAN, SECTIONS AND DETAIL
DESIGN	MFA-SN-CD-3240-ME-PL-0007-01	D1	0032-4502	PLATE 08	POWERHOUSE - HYDRO-MECHANICAL - INTAKE GATES - UNIT ARRANGEMENT - PLAN, SECTIONS AND DETAILS

TECHNICAL DOCUMENT LIST: POWERHOUSE DRAFT TUBE HYDRO-MECHANICAL EQUIPMENT

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-3330-ME-PL-0001-01	D1	0032-4503	PLATE 01	POWERHOUSE - HYDRO-MECHANICAL - DRAFT TUBE STOPLOGS - ELEVATION, SECTIONS AND DETAILS
DESIGN	MFA-SN-CD-3330-ME-SE-0001-01	D1	0032-4503	PLATE 02	POWERHOUSE - HYDRO-MECHANICAL - DRAFT TUBE STOPLOGS - UNIT ARRANGEMENT - ELEVATION, SECTIONS AND DETAIL

TECHNICAL DOCUMENT LIST: TRASH CLEANING SYSTEM

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-2130-ME-GA-0002-01	D1	0032-4504	PLATE 01	SPILLWAY - HYDRO-MECHANICAL EQUIPMENT- TRASH CLEANER AND STOPLOG HANDLING - GENERAL ARRANGEMENT - PLAN, SECTIONS AND DETAIL

TECHNICAL DOCUMENT LIST: SPILLWAY – ELECTRICAL AUXILIARIES

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-3430-EL-SD-0002-01	C2	0000-4701	PLATE 01	ELECTRICAL SERVICES - IDENTIFICATION STANDARD
DESIGN	MFA-SN-CD-3430-EL-LS-0007-01	C1	0000-4701	PLATE 02	POWERHOUSE - ELECTRICAL SERVICES - LAYOUT LEGEND
DESIGN	MFA-SN-CD-3430-EL-LS-0006-01	C1	0000-4701	PLATE 03	POWERHOUSE - ELECTRICAL SERVICES DIAGRAM - LEGEND
DESIGN	MFA-SN-CD-2440-EL-SL-0004-01	D1	0032-4701	PLATE 01	SPILLWAY - DIVERSION PHASE - TEMPORARY POWER - SINGLE LINE DIAGRAM

	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST		Revision		Page
	SLI Doc. No. 505573-CH0032-45AL-I-0001		06	Date	
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01		B4	16-Jan-2014	

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-2440-EL-SL-0001-01	D1	0032-4701	PLATE 02	SPILLWAY - 600 VAC AUXILIARY - SINGLE LINE DIAGRAM
DESIGN	MFA-SN-CD-2400-EL-LD-0002-01	D1	0032-4701	PLATE 03	SPILLWAY - DIVERSION PHASE - CONTROL SYSTEM INTERFACE DIAGRAM
DESIGN	MFA-SN-CD-2440-EL-DD-0005-01	D1	0032-4701	PLATE 04	SPILLWAY - DIVERSION PHASE - 25 KV INCOMING LINE - GENERAL LAYOUT
DESIGN	MFA-SN-CD-2440-EL-DD-0012-01	D1	0032-4701	PLATE 05	SPILLWAY - DIVERSION PHASE - TEMPORARY POWER - DETAILS
DESIGN	MFA-SN-CD-2440-EL-LT-0002-01	D1	0032-4701	PLATE 06	SPILLWAY - DIVERSION PHASE - ELECTRICAL ROOM EQUIPMENT LAYOUT
DESIGN	MFA-SN-CD-2440-EL-PL-0002-01	D1	0032-4701	PLATE 07	SPILLWAY - DIVERSION PHASE - CABLE TRAY AND CONDUIT BETWEEN ELECTRICAL BUILDING AND OUTDOOR INSTALLATIONS
DESIGN	MFA-SN-CD-2440-EL-DD-0006-01	D1	0032-4701	PLATE 08	SPILLWAY - DIVERSION PHASE - SURFACE GROUNDING
DESIGN	MFA-SN-CD-2440-EL-LT-0004-01	D1	0032-4701	PLATE 09	SPILLWAY - DIVERSION PHASE - LIGHTING - LAYOUT AND DETAILS
DESIGN	MFA-SN-CD-2440-EL-LT-0004-02	D1	0032-4701	PLATE 10	SPILLWAY - DIVERSION PHASE - LIGHTING - LAYOUT AND DETAILS
DESIGN	MFA-SN-CD-2400-EL-SL-0001-01	D1	0032-4701	PLATE 11	SPILLWAY - DIVERSION PHASE - UPS AND 125 VDC DISTRIBUTION - SINGLE LINE DIAGRAM
DESIGN	MFA-SN-CD-2440-EL-SL-0003-01	D1	0032-4701	PLATE 12	SPILLWAY - 600 VAC MOTOR CONTROL CENTER - SINGLE LINE DIAGRAM - SHEET 1 OF 2
DESIGN	MFA-SN-CD-2440-EL-SL-0003-02	D1	0032-4701	PLATE 13	SPILLWAY - 600 VAC MOTOR CONTROL CENTER - SINGLE LINE DIAGRAM - SHEET 2 OF 2
DESIGN	MFA-SN-CD-3290-EL-SL-0001-01	D2	0032-4701	PLATE 14	INTAKE - 600 VAC MOTOR CONTROL CENTER - SINGLE LINE DIAGRAM
DESIGN	MFA-SN-CD-2440-EL-DR-0002-01	D1	0032-4701	PLATE 15	SPILLWAY - 600/347 V DISTRIBUTION - PANELBOARD SCHEDULES
DESIGN	MFA-SN-CD-2440-EL-DR-0003-01	D1	0032-4701	PLATE 16	SPILLWAY - 208/120 V DISTRIBUTION - PANELBOARD SCHEDULES
DESIGN	MFA-SN-CD-2400-EL-LD-0001-01	D1	0032-4701	PLATE 17	SPILLWAY - FINAL PHASE - CONTROL SYSTEM INTERFACE DIAGRAM
DESIGN	MFA-SN-CD-2440-EL-LT-0006-01	D1	0032-4701	PLATE 18	SPILLWAY - ELECTRICAL AUXILIARIES - INSTALLATION LAYOUT
DESIGN	MFA-SN-CD-3340-EL-DD-0045-01	D1	0032-4701	PLATE 19	SPILLWAY - ELECTRICAL BUILDING - CCTV, TELEPHONE, COMMUNICATION, FIRE ALARM AND SECURITY SYSTEMS - EQUIPMENT LAYOUT AND DETAILS
DESIGN	MFA-SN-CD-2440-EL-DD-0004-01	D1	0032-4701	PLATE 20	SPILLWAY - CCTV SYSTEM, TELEPHONE, COMMUNICATION AND SECURITY SYSTEM EQUIPMENT LAYOUT AND INSTALLATION DETAILS
DESIGN	MFA-SN-CD-2440-EL-LT-0008-01	D1	0032-4701	PLATE 21	SPILLWAY - DIESEL FUEL TANK AREA - ELECTRICAL LAYOUT
DESIGN	MFA-SN-CD-2440-EL-RT-0001-01	C2	0032-4701	PLATE 22	SPILLWAY - ELECTRICAL BUILDING - CABLE TRAY AND CONDUIT LAYOUT
DESIGN	MFA-SN-CD-3340-EL-LT-0014-01	C1	0032-4701	PLATE 23	POWERHOUSE - INTAKE DECK PLAN EL 45.50 - ELECTRICAL EQUIPMENT LAYOUT - SHEET 1 OF 2
DESIGN	MFA-SN-CD-3340-EL-LT-0014-02	C1	0032-4701	PLATE 24	POWERHOUSE - INTAKE DECK PLAN EL 45.50 - ELECTRICAL EQUIPMENT LAYOUT - SHEET 2 OF 2
DESIGN	MFA-SN-CD-3340-EL-DD-0020-01	C1	0032-4701	PLATE 25	POWERHOUSE AND SPILLWAY - LUMINAIRE TYPES - LIGHTING AND RECEPTACLES
DESIGN	MFA-SN-CD-3340-EL-DD-0019-01	C1	0032-4701	PLATE 26	POWERHOUSE AND SPILLWAY - INSTALLATION DETAILS - LIGHTING AND RECEPTACLES
DESIGN	MFA-SN-CD-3340-EL-DD-0003-01	C1	0032-4701	PLATE 27	POWERHOUSE - INSTALLATION DETAILS - SURFACE GROUNDING



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 SNC-LAVALIN	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST		Revision		
	SLI Doc. No. 505673-CH0032-45AL-I-0001		06	Date	Page
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01		B4	16-Jan-2014	6

TECHNICAL DOCUMENT LIST: SPILLWAY ELECTRICAL BUILDING – MECHANICAL AUXILIARIES

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-2000-ME-SC-0001-01	D1	0000-4B01	PLATE 01	GENERAL WORKS - SCHEMATIC AND DRAWING SYMBOLS - HVAC
DESIGN	MFA-SN-CD-3350-ME-LS-0003-01	C2	0007-4601	PLATE 01	GENERAL WORKS - EQUIPMENT AND SYSTEM CODES - LEGEND
DESIGN	MFA-SN-CD-3350-ME-LS-0004-01	C2	0007-4601	PLATE 02	GENERAL WORKS - EQUIPMENT NUMBERING AND INSTRUMENTATION SYMBOLS
DESIGN	MFA-SN-CD-2440-ME-PL-0001-01	D1	0032-4B01	PLATE 01	SPILLWAY - ELECTRICAL BUILDING - PLAN AND SECTIONS - HVAC
DESIGN	MFA-SN-CD-2440-ME-SC-0001-01	D1	0032-4B01	PLATE 02	SPILLWAY - ELECTRICAL BUILDING - SYSTEM SCHEMATIC AND DETAILS - HVAC
DESIGN	MFA-SN-CD-2440-ME-DD-0001-01	D1	0032-4B01	PLATE 03	SPILLWAY - ELECTRICAL BUILDING - EXHAUST SYSTEM AND SUSPENSION DETAILS - HVAC
DESIGN	MFA-SN-CD-2440-ME-SC-0002-01	D1	0032-4B01	PLATE 04	SPILLWAY - ELECTRICAL BUILDING - CONTROL AND INSTRUMENTATION SCHEMATIC - HVAC
DESIGN	MFA-SN-CD-2440-ME-DD-0002-01	D1	0032-4B01	PLATE 05	SPILLWAY - ELECTRICAL BUILDING - CONTROL AND INSTRUMENTATION DETAILS - HVAC

TECHNICAL DOCUMENT LIST: FUEL STORAGE SYSTEM

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN - Moved to Spillway - Electrical Auxiliaries section	MFA-SN-CD-2440-EL-PL-0003-01	D1	0032-4701	PLATE 24	SPILLWAY – DIVERSION PHASE – CABLE TRAY AND CONDUIT BETWEEN ELECTRICAL BUILDING AND OUTDOOR INSTALLATIONS
DESIGN - Moved to Spillway Electrical Auxiliaries section	MFA-SN-CD-2440-EL-LT-0008-01	D1	0032-4701	PLATE 25	SPILLWAY – DIESEL FUEL TANK AREA – ELECTRICAL LAYOUT
DESIGN – Moved to Spillway – Electrical Building – Structure section	MFA-SN-CD-2440-GV-PL-0001-01	C2	0032-4101	PLATE 08	SPILLWAY – DIESEL FUEL TANK – FOUNDATION PLAN AND DETAILS – CONCRETE

TECHNICAL DOCUMENT LIST: SPILLWAY ELECTRICAL BUILDING - STRUCTURE

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-2400-EN-LS-0001-01	D1	0032-4101	PLATE 01	POWERHOUSE, INTAKE AND SPILLWAY – GENERAL NOTES, LEGEND AND ABBREVIATIONS
DESIGN	MFA-SN-CD-2410-AR-PL-0001-01	D1	0032-4101	PLATE 02	SPILLWAY – ELECTRICAL BUILDING – PLANS AND ELEVATIONS - ARCHITECTURAL
DESIGN	MFA-SN-CD-2410-AR-SE-0001-01	D1	0032-4101	PLATE 03	SPILLWAY – ELECTRICAL BUILDING – SECTIONS - ARCHITECTURAL
DESIGN	MFA-SN-CD-2410-AR-DD-0001-01	D1	0032-4101	PLATE 04	SPILLWAY – ELECTRICAL BUILDING – DETAILS - ARCHITECTURAL
DESIGN	MFA-SN-CD-2410-ST-PL-0001-01	D1	0032-4101	PLATE 05	SPILLWAY – ELECTRICAL BUILDING – PLANS AND ELEVATIONS – STRUCTURAL STEEL
DESIGN	MFA-SN-CD-2410-ST-SN-0001-01	D1	0032-4101	PLATE 06	SPILLWAY – ELECTRICAL BUILDING – SECTIONS AND DETAILS – STRUCTURAL STEEL
DESIGN	MFA-SN-CD-2410-ST-DD-0001-01	D1	0032-4101	PLATE 07	MUSKRAT FALLS – SPILLWAY – HVAC BAFFLES – STRUCTURAL DETAILS – STRUCTURAL STEEL

 SNC-LAVALIN	CH0032 POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL DOCUMENT LIST		Revision		Page
	SLI Doc. No. 505573-CH0032-45AL-J-0001		06	Date	
	Nalcor Doc. No. MFA-SN-CD-2000-ME-LS-0003-01		B4	16-Jan-2014	

REVISION ISSUED FOR	NALCOR DOCUMENT No.	NALCOR REVISION	SUB PKG	Plate No.	DOCUMENT TITLE
DESIGN	MFA-SN-CD-2440-CV-PL-0001-01	C2	0032-4101	PLATE 08	SPILLWAY - DIESEL FUEL TANK - FOUNDATION PLAN AND DETAILS-CONCRETE

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
R05/M01/M05/M06/M10/M16/M29/Q05/Q11	Drawing	LG-DD-MFG-0001	Spillway Templates and Anchors- Manufacturing Record Book-1st Stage Embedded Parts		
B01	Drawing	MFA13-PG1-1000-01	Intake Gate - General Arrangement		
B01	Drawing	MFA13-PG1-1000-02	Intake Gate - General Arrangement		
B01	Drawing	MFA13-PG1-1000-03	Intake Gate - General Arrangement		
H03	Drawing	MFA13-PG1-1011	Intake Gate - Guide & Rails - Design Calculation	A	59
H03	Drawing	MFA13-PG1-1012	Intake Gate - Design - Gate Body		
B02/B05	Drawing	MFA13-PG1-1100-01	Intake Roller Gate Block Outs	B	1
B02/B05	Drawing	MFA13-PG1-1100-02	Intake Roller Gate Block Outs	B	1
D04	Drawing	MFA13-PG1-1105-01	Intake Roller Gate Anchor - Templates	B	1
D04	Drawing	MFA13-PG1-1105-02	Intake Roller Gate Anchor - Templates	B	1
D04	Drawing	MFA13-PG1-1105-03	Intake Roller Gate Anchor - Templates	B	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG1-1105-04	Intake Roller Gate Anchor - Templates	B	1
D04	Drawing	MFA13-PG1-1105-05	Intake Roller Gate Anchor - Templates	B	1
D04	Drawing	MFA13-PG1-1105-06	Intake Roller Gate Anchor - Templates	B	1
D04	Drawing	MFA13-PG1-1106-01	Intake Roller Gate Anchor - Hair Pins	B	1
D04	Drawing	MFA13-PG1-1106-02	Intake Roller Gate Anchor - Hair Pins	B	1
D04	Drawing	MFA13-PG1-1850	Intake Gate - Seals - Protection Covers		
D99	Drawing	MFA13-PG1-1910	Intake Gate - Primary Concrete Components - Painting Details		
B01	Drawing	MFA13-PG1-2000	Spillway Roller Gate - General Arrangement	B	1
B02	Drawing	MFA13-PG1-2100-01	Spillway Roller Gate-Block Outs	D	1
B02	Drawing	MFA13-PG1-2100-02	Spillway Roller Gate-Block Outs	D	1



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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG1-2101	Spillway Roller Gate-Block Outs Permanent Sill	D	1
D04	Drawing	MFA13-PG1-2105-01	Spillway Roller Gate-Block Outs Anchor Templates	D	1
D04	Drawing	MFA13-PG1-2105-02	Spillway Roller Gate-Block Outs Anchor Templates	D	1
D04	Drawing	MFA13-PG1-2105-03	Spillway Roller Gate-Block Outs Anchor Templates	D	1
D04	Drawing	MFA13-PG1-2106-01	Spillway Roller Gate-Block Outs Anchor Hair Pins	D	1
D04	Drawing	MFA13-PG1-2106-02	Spillway Roller Gate-Block Outs Anchor Hair Pins	D	1
B04	Drawing	MFA13-PG1-2110-01	Spillway Roller Gate-Embedded Parts-Temporary Assembly	A	1
B04	Drawing	MFA13-PG1-2110-02	Spillway Roller Gate-Embedded Parts-Temporary Assembly	A	1
B04	Drawing	MFA13-PG1-2110-03	Spillway Roller Gate-Embedded Parts-Temporary Assembly	A	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
K09	Drawing	MFA13-PG1-2111	Spillway Roller Gate - Embedded Parts - Temporary Measurement Plan		
D08	Drawing	MFA13-PG1-2113	Spillway Roller Gate - Embedded Parts - Transport / Marking / Tagging		
B04	Drawing	MFA13-PG1-2115-01	Spillway Roller Gate-Embedded Parts-Permanent Assembly	A	1
B04	Drawing	MFA13-PG1-2115-02	Spillway Roller Gate-Embedded Parts-Permanent Assembly	A	1
B04	Drawing	MFA13-PG1-2115-03	Spillway Roller Gate-Embedded Parts-Permanent Assembly	A	1
K09	Drawing	MFA13-PG1-2116	Spillway Roller Gate - Embedded Parts - Permanent - Measurement Plan		
D03	Drawing	MFA13-PG1-2120	Spillway Roller Gate-Embedded Parts-Temporary-Sill Beam	C	1
D04	Drawing	MFA13-PG1-2125-01	Spillway Roller Gate-Embedded Parts-Permanent-Sill Beam	C	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG1-2125-02	Spillway Roller Gate-Embedded Parts-Permanent-Sill Beam	C	1
D04	Drawing	MFA13-PG1-2125-03	Spillway Roller Gate-Embedded Parts-Permanent-Sill Beam	C	1
D03	Drawing	MFA13-PG1-2130-01	Spillway Roller Gate-Embedded Parts-Frame-Type I	C	1
D03	Drawing	MFA13-PG1-2130-02	Spillway Roller Gate-Embedded Parts-Frame-Type I	C	1
D03	Drawing	MFA13-PG1-2130-03	Spillway Roller Gate-Embedded Parts-Frame-Type I	C	1
D03	Drawing	MFA13-PG1-2135-01	Spillway Roller Gate-Embedded Parts-Frame-Type II	C	1
D03	Drawing	MFA13-PG1-2135-02	Spillway Roller Gate-Embedded Parts-Frame-Type II	C	1
D03	Drawing	MFA13-PG1-2135-03	Spillway Roller Gate-Embedded Parts-Frame-Type II	C	1
D03	Drawing	MFA13-PG1-2140-01	Spillway Roller Gate-Embedded Parts-Frame-Type III	C	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D03	Drawing	MFA13-PG1-2140-02	Spillway Roller Gate-Embedded Parts-Frame-Type III	C	1
D03	Drawing	MFA13-PG1-2140-03	Spillway Roller Gate-Embedded Parts-Frame-Type III	C	1
D03	Drawing	MFA13-PG1-2145-01	Spillway Roller Gate-Embedded Parts-Frame-Type IV	C	1
D03	Drawing	MFA13-PG1-2145-02	Spillway Roller Gate-Embedded Parts-Frame-Type IV	C	1
D03	Drawing	MFA13-PG1-2145-03	Spillway Roller Gate-Embedded Parts-Frame-Type IV	C	1
D03	Drawing	MFA13-PG1-2150-01	Spillway Roller Gate-Embedded Parts-Frame-Type V	C	1
D03	Drawing	MFA13-PG1-2150-02	Spillway Roller Gate-Embedded Parts-Frame-Type V	C	1
D03	Drawing	MFA13-PG1-2150-03	Spillway Roller Gate-Embedded Parts-Frame-Type V	C	1
D03	Drawing	MFA13-PG1-2150-04	Spillway Roller Gate-Embedded Parts-Frame-Type V	C	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D03	Drawing	MFA13-PG1-2150-05	Spillway Roller Gate-Embedded Parts-Frame-Type V	C	1
D03	Drawing	MFA13-PG1-2150-06	Spillway Roller Gate-Embedded Parts-Frame-Type V	C	1
D04	Drawing	MFA13-PG1-2155	Spillway Roller Gate-Embedded Parts-Side Plates	C	1
H03	Drawing	MFA13-PG1-2160	Spillway Roller Gate - Embedded Parts - Adit Door	A	1
D04	Drawing	MFA13-PG1-2350-01	Spillway Roller Gate - Gate Body - Upper Part		
D04	Drawing	MFA13-PG1-2350-02	Spillway Roller Gate - Gate Body - Upper Part		
D04	Drawing	MFA13-PG1-2450-01	Spillway Roller Gate - Dogging Device	A	1
D04	Drawing	MFA13-PG1-2450-02	Spillway Roller Gate - Dogging Device	A	1
D99	Drawing	MFA13-PG1-2910	Spillway Roller Gate - Primary Concrete Components - Painting Details	B	3
D99	Drawing	MFA13-PG1-2911	Intake Gate - Embedded Parts - Painting Details		

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
B01	Drawing	MFA13-PG1-2920-01	Spillway Roller Gate Maintenance Bridge Assembly		
B01	Drawing	MFA13-PG1-2920-02	Spillway Roller Gate Maintenance Bridge Assembly		
B02	Drawing	MFA13-PG1-2921	Spillway Roller Gate - Maintenance Bridge - Blockouts	A	1
D04	Drawing	MFA13-PG1-2922	Spillway Roller Gate - Maintenance Bridge - Blockouts - Anchors	A	1
D04	Drawing	MFA13-PG1-2923-01	Spillway Roller Gate Maintenance Bridge Steel Structure		
D04	Drawing	MFA13-PG1-2923-02	Spillway Roller Gate Maintenance Bridge Steel Structure		
D04	Drawing	MFA13-PG1-2924-01	Spillway Roller Gate Maintenance Bridge Handrails		
D04	Drawing	MFA13-PG1-2924-02	Spillway Roller Gate Maintenance Bridge Handrails		

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG1-2924-03	Spillway Roller Gate Maintenance Bridge Handrails		
D04	Drawing	MFA13-PG1-2925-01	Spillway Roller Gate Maintenance Bridge Grating		
D04	Drawing	MFA13-PG1-2925-02	Spillway Roller Gate Maintenance Bridge Grating		
B01	Drawing	MFA13-PG3-2000	Intake Bulkhead Gate - General Arrangement		
H03/H60/H07	Drawing	MFA13-PG3-2012	Intake Bulkhead Gate - Design Calculation - Gate Body		
B02	Drawing	MFA13-PG3-2100-01	Intake Bulkhead Gate - Block Outs	D	1
B02	Drawing	MFA13-PG3-2100-02	Intake Bulkhead Gate - Block Outs	D	1
B02	Drawing	MFA13-PG3-2100-03	Intake Bulkhead Gate - Block Outs	D	1
D04	Drawing	MFA13-PG3-2105-01	Intake Bulkhead Gate - Block Outs Anchor Templates	D	1
D04	Drawing	MFA13-PG3-2105-02	Intake Bulkhead Gate - Block Outs Anchor Templates	D	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-2105-03	Intake Bulkhead Gate - Block Outs - Anchor Templates	D	1
D04	Drawing	MFA13-PG3-2106	Intake Bulkhead Gate - Block Outs - Anchor	D	1
B04	Drawing	MFA13-PG3-2110-01	Intake Bulkhead Gate - Embedded Parts - Assembly		
B04	Drawing	MFA13-PG3-2110-02	Intake Bulkhead Gate - Embedded Parts - Assembly		
B04	Drawing	MFA13-PG3-2110-03	Intake Bulkhead Gate - Embedded Parts - Assembly		
D04	Drawing	MFA13-PG3-2120	Intake Bulkhead Gate - Embedded Parts - Sill Beam		
D04	Drawing	MFA13-PG3-2130	Intake Bulkhead Gate - Embedded Parts - Frame - Lower part		
D04	Drawing	MFA13-PG3-2130-02	Intake Bulkhead Gate - Embedded Parts - Frame - Lower part		
D04	Drawing	MFA13-PG3-2131-01	Intake Bulkhead Gate - Embedded Parts - Frame - Middle part		
D04	Drawing	MFA13-PG3-2131-02	Intake Bulkhead Gate - Embedded Parts - Frame - Middle part		



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MFA13

Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-2132-01	Intake Bulkhead Gate - Embedded Parts - Frame - Upper part		
D04	Drawing	MFA13-PG3-2132-02	Intake Bulkhead Gate - Embedded Parts - Frame - Upper part		
D04	Drawing	MFA13-PG3-2134	Intake Bulkhead Gate - Embedded Parts - Side Plate		
D04	Drawing	MFA13-PG3-2135	Intake Bulkhead Gate - Embedded Parts - Side Guide		
D04	Drawing	MFA13-PG3-2140	Intake Bulkhead Gate - Embedded Parts - Lintel Beam		
D04	Drawing	MFA13-PG3-2145	Intake Bulkhead Gate - Embedded Parts - Lockout Device		
D99	Drawing	MFA13-PG3-2910	Intake Bulkhead Gate- Primary Concrete Components - Painting Details		
B01	Drawing	MFA13-PG3-3000	Draft Tube Stoplog - General Arrangement		
B01 / B02 / B05	Drawing	MFA13-PG3-3100-01	Draft Tube Stoplog - Block Outs	B	1
B01 / B02 / B05	Drawing	MFA13-PG3-3100-02	Draft Tube Stoplog - Block Outs	B	1

201000 Muskrat Falls Gates Plus

Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
B01 / B02 / B05	Drawing	MFA13-PG3-3100-03	Draft Tube Stoplog - Block Outs	B	1
D04	Drawing	MFA13-PG3-3105-01	Draft Tube Stoplog - Block Outs - Anchor - Templates	B	1
D04	Drawing	MFA13-PG3-3105-02	Draft Tube Stoplog - Block Outs - Anchor - Templates	B	1
D04	Drawing	MFA13-PG3-3105-03	Draft Tube Stoplog - Block Outs - Anchor - Templates	B	1
D04	Drawing	MFA13-PG3-3106	Draft Tube Stoplog - Block Outs - Anchor	B	1
D99	Drawing	MFA13-PG3-3910	Draft Tube Stoplog - Primary Concrete Components - Painting Details		
B01	Drawing	MFA13-PG3-4000	Spillway Stoplogs S1 - General Arrangement	A	1
H03	Drawing	MFA13-PG3-4012	Spillway Stoplog S1 - Design Calculation - Sections + Lifting Beam		

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
B02	Drawing	MFA13-PG3-4100-01	Spillway Stoplog S1-Block Outs	D	1
B02	Drawing	MFA13-PG3-4100-02	Spillway Stoplog S1-Block Outs	D	1
B02	Drawing	MFA13-PG3-4100-03	Spillway Stoplog S1-Block Outs	D	1
D04	Drawing	MFA13-PG3-4105-01	Spillway Stoplog S1-Block Outs-Anchor Templates	E	1
D04	Drawing	MFA13-PG3-4105-02	Spillway Stoplog S1-Block Outs-Anchor Templates	E	1
D04	Drawing	MFA13-PG3-4105-03	Spillway Stoplog S1-Block Outs-Anchor Templates	E	1
D04	Drawing	MFA13-PG3-4106	Spillway Stoplog S1-Block Outs-Anchor Hair Pins	E	1
D04	Drawing	MFA13-PG3-4110-01	Spillway Stoplog S1-Embedded Parts-Assembly	A	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-4110-02	Spillway Stoplog S1-Embedded Parts-Assembly	A	1
D04	Drawing	MFA13-PG3-4110-03	Spillway Stoplog S1-Embedded Parts-Assembly	A	1
D04	Drawing	MFA13-PG3-4110-04	Spillway Stoplog S1-Embedded Parts-Assembly	C	1
D04	Drawing	MFA13-PG3-4120	Spillway Stoplog S1-Embedded Parts-Sill Beam	A	1
D04	Drawing	MFA13-PG3-4130-01	Spillway Stoplog S1-Embedded Parts-Frame-Type I	A	1
D04	Drawing	MFA13-PG3-4130-02	Spillway Stoplog S1-Embedded Parts-Frame-Type I	A	1
D04	Drawing	MFA13-PG3-4130-03	Spillway Stoplog S1-Embedded Parts-Frame-Type I	B	1
D04	Drawing	MFA13-PG3-4131-01	Spillway Stoplog S1-Embedded Parts-Frame-Type II	A	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-4131-02	Spillway Stoplog S1-Embedded Parts-Frame-Type II	A	1
D04	Drawing	MFA13-PG3-4132-01	Spillway Stoplog S1-Embedded Parts-Frame-Type III	A	1
D04	Drawing	MFA13-PG3-4132-02	Spillway Stoplog S1-Embedded Parts-Frame-Type III	A	1
D04	Drawing	MFA13-PG3-4132-03	Spillway Stoplog S1-Embedded Parts-Frame-Type III	B	1
D04	Drawing	MFA13-PG3-4133	Spillway Stoplog S1-Embedded Parts-Side Plates	A	1
D04	Drawing	MFA13-PG3-4134-01	Spillway Stoplog S1-Embedded Parts-Heating Boxes	A	1
D04	Drawing	MFA13-PG3-4134-02	Spillway Stoplog S1-Embedded Parts-Heating Boxes	A	1
D04	Drawing	MFA13-PG3-4140-01	Spillway Stoplog S1 - Gate Dogging Device		
D04	Drawing	MFA13-PG3-4140-02	Spillway Stoplog S1 - Gate Dogging Device		
D99	Drawing	MFA13-PG3-4910	Spillway Stoplog S1 - Primary Concrete Components - Painting Details		

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D99	Drawing	MFA13-PG3-4911	Spillway Stoplog S1 - Embedded Parts - Painting Details		
B01	Drawing	MFA13-PG3-5000	Spillway Stoplog S2 - General Arrangement	A	1
H03	Drawing	MFA13-PG3-5012	Spillway Stoplog S2 - Design Calculation - Sections		
B02	Drawing	MFA13-PG3-5100- 01	Spillway Stoplog S2-Block Outs	D	1
B02	Drawing	MFA13-PG3-5100- 02	Spillway Stoplog S2-Block Outs	D	1
B02	Drawing	MFA13-PG3-5100- 03	Spillway Stoplog S2-Block Outs	D	1
D04	Drawing	MFA13-PG3-5105- 01	Spillway Stoplog S2-Block Outs- Anchor Templates	E	1
D04	Drawing	MFA13-PG3-5105- 02	Spillway Stoplog S2-Block Outs- Anchor Templates	E	1
D04	Drawing	MFA13-PG3-5105- 03	Spillway Stoplog S2-Block Outs- Anchor Templates	E	1

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MFA13

Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-5106	Spillway Stoplog S2-Block Outs- Anchors	E	1
D04	Drawing	MFA13-PG3-5110-01	Spillway Stoplog S2-Embedded Parts-Embedded Parts-Assembly	D	1
D04	Drawing	MFA13-PG3-5110-02	Spillway Stoplog S2-Embedded Parts-Embedded Parts-Assembly	D	1
D04	Drawing	MFA13-PG3-5110-03	Spillway Stoplog S2-Embedded Parts-Embedded Parts-Assembly	C	1
D08	Drawing	MFA13-PG3-5113	Spillway Stoplog S2 - Embedded Parts - Transport / Marking / Tagging		
K09	Drawing	MFA13-PG3-5115	Spillway Stoplog S2 - Embedded Parts - Measurement Plan		
D04	Drawing	MFA13-PG3-5120	Spillway Stoplog S2-Embedded Parts-Sill Beam	C	1
D04	Drawing	MFA13-PG3-5130-01	Spillway Stoplog S2-Embedded Parts-Frame-Type I	C	1
D04	Drawing	MFA13-PG3-5130-02	Spillway Stoplog S2-Embedded Parts-Frame-Type I	A	1

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-5130-03	Spillway Stoplog S2-Embedded Parts-Frame-Type I	C	1
B02	Drawing	MFA13-PG3-5131-01	Spillway Stoplog S2-Embedded Parts-Frame-Type II	C	1
B02	Drawing	MFA13-PG3-5131-02	Spillway Stoplog S2-Embedded Parts-Frame-Type II	C	1
D04	Drawing	MFA13-PG3-5132-01	Spillway Stoplog S2-Embedded Parts-Frame-Type III	C	1
D04	Drawing	MFA13-PG3-5132-02	Spillway Stoplog S2-Embedded Parts-Frame-Type III	C	1
D04	Drawing	MFA13-PG3-5133-01	Spillway Stoplog S2-Embedded Parts-Frame-Type IV	C	1
D04	Drawing	MFA13-PG3-5133-02	Spillway Stoplog S2-Embedded Parts-Frame-Type IV	C	1
D04	Drawing	MFA13-PG3-5134-01	Spillway Stoplog S2-Embedded Parts-Frame-Type V	C	1
D04	Drawing	MFA13-PG3-5134-02	Spillway Stoplog S2-Embedded Parts-Frame-Type V	C	1

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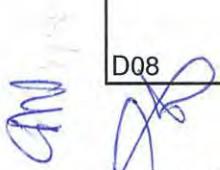

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-5134-03	Spillway Stoplog S2-Embedded Parts-Frame-Type V	C	1
D04	Drawing	MFA13-PG3-5135	Spillway Stoplog S2-Embedded Parts-Side Plates	C	1
D04	Drawing	MFA13-PG3-5136-01	Spillway Stoplog S2-Embedded Parts-Heating Boxes	C	1
D04	Drawing	MFA13-PG3-5136-02	Spillway Stoplog S2-Embedded Parts-Heating Boxes	C	1
D99	Drawing	MFA13-PG3-5910	Spillway Stoplog S2 - Primary Concrete Components - Painting Details		
D99	Drawing	MFA13-PG3-5911	Spillway Stoplog S2 - Embedded Parts - Painting Details		
B01	Drawing	MFA13-PG3-6000	Spillway Stoplog S3 - General Arrangement		
B01	Drawing	MFA13-PG3-7000	Spillway Stoplog S4-General Arrangement	A	1
B02	Drawing	MFA13-PG3-7100-01	Spillway Stoplog S4-Block Outs	D	1

201000 Muskrat Falls Gates Plus

Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
B02	Drawing	MFA13-PG3-7100-02	Spillway Stoplog S4-Block Outs	D	1
D04	Drawing	MFA13-PG3-7105-01	Spillway Stoplog S4-Block Outs-Templates	D	1
D04	Drawing	MFA13-PG3-7105-02	Spillway Stoplog S4-Block Outs-Templates	D	1
D04	Drawing	MFA13-PG3-7105-03	Spillway Stoplog S4-Block Outs-Templates	D	1
D04	Drawing	MFA13-PG3-7105-04	Spillway Stoplog S4-Block Outs-Templates	D	1
D04	Drawing	MFA13-PG3-7106	Spillway Stoplog S4-Block Outs-Anchors	E	1
B04	Drawing	MFA13-PG3-7110-01	Spillway Stoplog S4 - Embedded Parts - Assembly		
B04	Drawing	MFA13-PG3-7110-02	Spillway Stoplog S4 - Embedded Parts - Assembly		
B04	Drawing	MFA13-PG3-7110-03	Spillway Stoplog S4 - Embedded Parts - Assembly		
B04	Drawing	MFA13-PG3-7110-04	Spillway Stoplog S4 - Embedded Parts - Assembly		
D08	Drawing	MFA13-PG3-7113	Spillway Stoplog S4 - Embedded Parts - Transport / Marking / Tagging		



201000 Muskrat Falls Gates Plus

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
K09	Drawing	MFA13-PG3-7115	Spillway Stoplog S4 - Embedded Parts - Measurement Plan		
B04	Drawing	MFA13-PG3-7120	Spillway Stoplog S4 - Embedded Parts - Sill Beam	A	1
D04	Drawing	MFA13-PG3-7130-01	Spillway Stoplog S4 - Embedded Parts - Frame	A	1
D04	Drawing	MFA13-PG3-7130-02	Spillway Stoplog S4 - Embedded Parts - Frame	A	1
D04	Drawing	MFA13-PG3-7130-03	Spillway Stoplog S4 - Embedded Parts - Frame	A	1
D04	Drawing	MFA13-PG3-7130-04	Spillway Stoplog S4 - Embedded Parts - Frame	A	1
D04	Drawing	MFA13-PG3-7135-01	Spillway Stoplog S4 - Embedded Parts - Extended Guide		
D04	Drawing	MFA13-PG3-7135-02	Spillway Stoplog S4 - Embedded Parts - Extended Guide		
D04	Drawing	MFA13-PG3-7135-03	Spillway Stoplog S4 - Embedded Parts - Extended Guide		

201000 Muskrat Falls Gates Plus

Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-7140	Spillway Stoplog S4 - Gate Dogging		
D04	Drawing	MFA13-PG3-7200	Spillway Stoplog S4 - Side Guide Shoe		
D04	Drawing	MFA13-PG3-7210	Spillway Stoplog S4 - Counter Guide		
D04	Drawing	MFA13-PG3-7300-01	Spillway Stoplog S4 - Gate Body		
D04	Drawing	MFA13-PG3-7300-02	Spillway Stoplog S4 - Gate Body		
D04	Drawing	MFA13-PG3-7310-01	Spillway Stoplog S4 - Gate Body - Temporary		
D04	Drawing	MFA13-PG3-7310-02	Spillway Stoplog S4 - Gate Body - Temporary		
K09	Drawing	MFA13-PG3-7315	Spillway Stoplog S4 - Gate Body - Measurement Plan		
D04	Drawing	MFA13-PG3-7400	Spillway Stoplog S4 - Filling Valve		
B04	Drawing	MFA13-PG3-7600-01	Spillway Stoplog S4 - Lifting Beam - Assembly		
B04	Drawing	MFA13-PG3-7600-02	Spillway Stoplog S4 - Lifting Beam - Assembly		
D04	Drawing	MFA13-PG3-7610	Spillway Stoplog S4 - Lifting Beam - Connecting Rod + Hooks		

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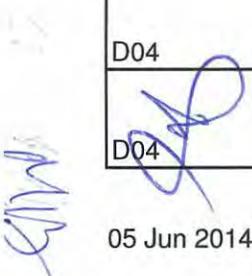
201000 Muskrat Falls Gates Plus

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG3-7620	Spillway Stoplog S4 - Lifting Beam - Landing Sensing Device		
D04	Drawing	MFA13-PG3-7630	Spillway Stoplog S4 - Lifting Beam - Side Guide Rollers		
D04	Drawing	MFA13-PG3-7635	Spillway Stoplog S4 - Lifting Beam - Plate Symbols		
D04	Drawing	MFA13-PG3-7700	Spillway Stoplog S4 - Stoplog Storage		
D04	Drawing	MFA13-PG3-7800	Spillway Stoplog S4 - Seals		
D04	Drawing	MFA13-PG3-7805	Spillway Stoplog S4 - Seals - Procurement		
D04	Drawing	MFA13-PG3-7850	Spillway Stoplog S4 - Seals - Protection Covers		
D99	Drawing	MFA13-PG3-7910	Spillway Stoplog S4 - Primary Concrete Components - Painting Details		
D99	Drawing	MFA13-PG3-7911	Spillway Stoplog S4 - Embedded Parts- Painting Details		
K24	Drawing	MFA13-PG3-7950	Spillway Stoplog S4 - Embedded Parts - Installation Procedure		

201000 Muskrat Falls Gates Plus

Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
B01	Drawing	MFA13-PG4-2000	Intake Trashrack- General Arrangement		
H03	Drawing	MFA13-PG4-2012	Intake Trashrack - Design Calculation - Panels and Lifting Beam		
B02	Drawing	MFA13-PG4-2100- 01	Intake Trashrack- Block Outs	B	1
B02	Drawing	MFA13-PG4-2100- 02	Intake Trashrack- Block Outs	B	1
D04	Drawing	MFA13-PG4-2105	Intake Trashrack - Block Outs - Templates	B	1
D04	Drawing	MFA13-PG4-2106	Intake Trashrack - Block Outs - Anchors	B	1
D04	Drawing	MFA13-PG4-2110- 01	Intake Trashrack - Embedded Parts - Assembly		
D04	Drawing	MFA13-PG4-2110- 02	Intake Trashrack - Embedded Parts - Assembly		
K09	Drawing	MFA13-PG4-2112	Intake Trashrack - Embedded Parts - Measurement Plan		
D04	Drawing	MFA13-PG4-2113	Intake Trashrack - Embedded Parts - Equipment Marking & Tagging		
D04	Drawing	MFA13-PG4-2120- 01	Intake Trashrack - Embedded Parts - Sill		



201000 Muskrat Falls Gates Plus

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG4-2120-02	Intake Trashrack - Embedded Parts - Sill		
D04	Drawing	MFA13-PG4-2320	Intake Trashrack - Horizontal Beam - Type 2		
D04	Drawing	MFA13-PG4-2330	Intake Trashrack - Horizontal Beam - Type 3		
D04	Drawing	MFA13-PG4-2340	Intake Trashrack - Horizontal Beam - Type 4		
D04	Drawing	MFA13-PG4-2350	Intake Trashrack - Horizontal Beam - Type 5		
D03	Drawing	MFA13-PG4-2500	Intake Trashrack - Panel		
K09	Drawing	MFA13-PG4-2501	Intake Trashrack - Panel - Measurement Plan		
D04	Drawing	MFA13-PG4-2510	Intake Trashrack - Panel - Bottom Type		
D04	Drawing	MFA13-PG4-2520	Intake Trashrack - Panel - Equipment Marking & Tagging		
B01	Drawing	MFA13-PG4-2600	Intake Trashrack - Lifting Beam - Assembly		
D04	Drawing	MFA13-PG4-2610	Intake Trashrack - Lifting Beam - Connecting Rod + Hooks		

201000 Muskrat Falls Gates Plus

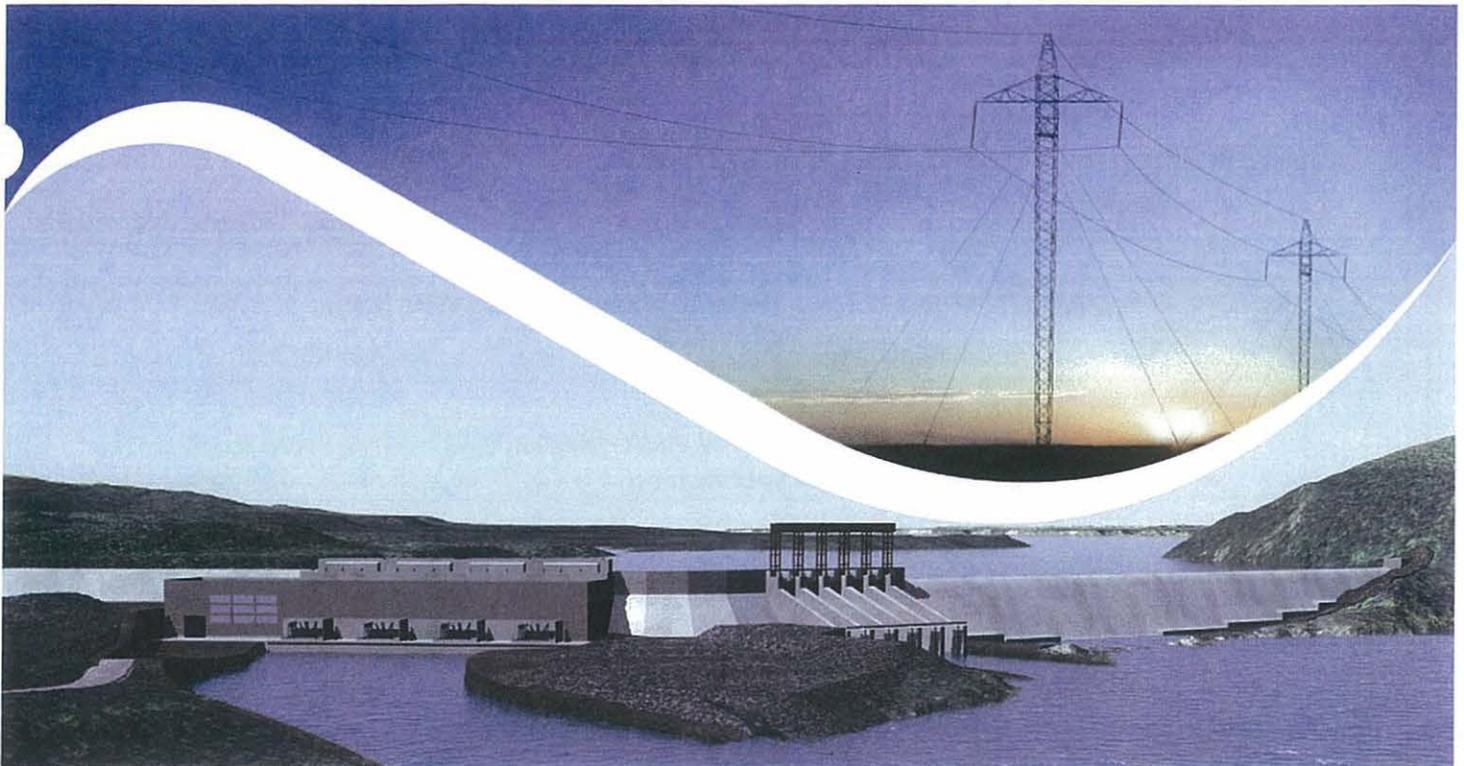
Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG4-2630	Intake Trashrack - Lifting Beam - Side Guide Roller		
D04	Drawing	MFA13-PG4-2640	Intake Trashrack - Lifting Beam - Plate Symbols		
D99	Drawing	MFA13-PG4-2910	Intake Trashrack - Primary Concrete Components- Painting Details		
K24	Drawing	MFA13-PG4-2950	Intake Trashrack - Embedded Parts - Installation Procedure		
B02/ B01	Drawing	MFA13-PG4-3100	Intake Trashrack		
D03	Drawing	MFA13-PG4-3300	Intake Trashrack - Horizontal Beam		
D03	Drawing	MFA13-PG4-3400	Intake Trashrack - Embedded Parts - Lower Tracks		
D03	Drawing	MFA13-PG4-3410	Intake Trashrack - Embedded Parts - Upper Tracks		
B01	Drawing	MFA13-PG6-1000	Intake Hoist - General Arrangement	A	1
B01	Drawing	MFA13-PG6-2000	Spillway Hoist- General Arrangement- General		
H14	Drawing	MFA13-PG9-4012	Spillway Hoist House - Design Calculation - Ladders and Walkways		

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201000 Muskrat Falls Gates Plus

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Contract Section :	Type:	Document No:	Title :	Revision :	Quantity page(s) :
D04	Drawing	MFA13-PG9-4100-01	Spillway Hoist House - Block Outs	A	1
D04	Drawing	MFA13-PG9-4100-02	Spillway Hoist House - Block Outs		1
D04	Drawing	MFA13-PG9-4105	Spillway Hoist House - Block Outs - Anchors	A	1
D03	Drawing	MFA13-PG9-4260	Spillway Hoist House - Embedded Parts for Pier Railways and Walkways		
	Contract Document	MFA-SN-CD-2000-ME-SC-0001-01	GENERAL WORKS - SCHEMATIC AND DRAWING SYMBOLS - HVAC		1



Muskrat Falls Project

Report Name: CH0032 – Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment

Volume 2

Technical Specifications



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Document Front Sheet



NE-LCP Contractor/Supplier	Contract or Purchase Number and Description: LC-G-0002 (Project 505573)		Contractor/Supplier Name: SNC-Lavalin Inc.		
	Document Title: Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment – Technical Specification			Total Number of Pages Incl. Front Sheet 1190	
	Contractor/ Supplier Document Number:			Revision Number: 03	
	EPC(M) Document Number: 505573-3321-45EW-0001			Issue Number:	
	NE-LCP Document Number: MFA-SN-CD-2000-ME-TS-0001-01			NE-LCP Issue Number: D2	
	Approver's Signature: <i>[Signature]</i>		Date (dd-mmm-yyyy): 12 Dec '13		Review Class:
Comments:			Equipment Tag or Model Number:		

NE-LCP or EPC(M)	REVIEW DOES NOT CONSTITUTE APPROVAL OF DESIGN DETAILS, CALCULATIONS, TEST METHODS OR MATERIAL DEVELOPED AND/OR SELECTED BY THE CONTRACTOR, NOR DOES IT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH CONTRACTUAL OR OTHER OBLIGATIONS.			
	<input checked="" type="checkbox"/> 01 – REVIEWED AND ACCEPTED – NO COMMENTS <input type="checkbox"/> 02 – REVIEWED – INCORPORATE COMMENTS, REVISE AND RESUBMIT <input type="checkbox"/> 03 – REVIEWED - NOT ACCEPTED <input type="checkbox"/> 04 – INFORMATION ONLY <input type="checkbox"/> 05 – NOT REVIEWED			
	Lead Reviewer: <i>[Signature]</i>	Date (dd-mmm-yyyy): 16-Dec-2013	Project Manager: <i>[Signature]</i>	Date (dd-mmm-yyyy): 16-DEC-2013
	NE-LCP or EPC(M) Management: <i>[Signature]</i>	Date (dd-mmm-yyyy): 16-Dec-2013		
	General Comments:			

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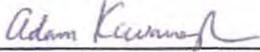
 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	i

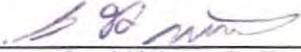
**LOWER CHURCHILL PROJECT
 MUSKRAT FALLS HYDROELECTRIC DEVELOPMENT**

CH0032

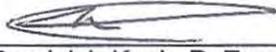
**SUPPLY AND INSTALL POWERHOUSE AND SPILLWAY
 HYDRO-MECHANICAL EQUIPMENT**

TECHNICAL SPECIFICATION

Prepared by: 
 Adam Kavanagh, E.I.T.
 Heavy Mechanical

Verified by: 
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Verified by: 
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Verified by: 
 Randolph Koob, P. Eng.
 Lead Engineer - Mechanical

Approved by: 
 Greg Snyder, P. Eng.
 Engineering Manager Hydro

PROVINCE OF NEWFOUNDLAND AND LABRADOR

 **PERMIT HOLDER**
 This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
 in Newfoundland and Labrador.
 Permit No. as issued by PEGNL NB458
 which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER

 Newfoundland and Labrador
RANDOLPH D. KOOB

 12 DEC 2013
 NEWFOUNDLAND & LABRADOR




 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	ii

Revision					
N°	By	Appr.	Date	Revised pages	Remarks
D2	RK <i>RK</i>	GS <i>GS</i>	04-Dec-2013		Issued for Award. See Section Index for sections that have been changed. Changes identified throughout the document with D2 revision triangles.
D1	RK	GS	06-Sep-2013		Issued for Design.
B2	RK	GS	06-02-2013		Issued for Addendum.
00	EC /RL	RS/RK	07-11-2012	ALL	Issued for Bid.

MB 96

 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	1

STATUS	DISCIPLINE	SECTION	TITLE	PAGES
		DIVISION 1	GENERAL REQUIREMENTS	
Updated	Environmental	01 35 43	General Environmental Requirements	17
		DIVISION 3	CONCRETE	
No Changes	Concrete	03 11 00	Concrete Formwork	14
No Changes	Concrete	03 20 00	Concrete Reinforcement	9
Updated	Concrete	03 30 00	Cast-In-Place Concrete	54
No Changes	Concrete	03 60 40	Grout	14
		DIVISION 5	METALS	
No Changes	Structural & Miscellaneous Steel	05 12 00	Structural Steel	25
No Changes	Structural & Miscellaneous Steel	05 50 10	Miscellaneous Metals & Embedded Parts	22
		DIVISION 6	WOODS AND PLASTICS	
No Changes	Architecture	06 10 00	Rough Carpentry	9
		DIVISION 7	THERMAL AND MOISTURE PROTECTION	
Updated	Architecture	07 13 26	Self Adhered Sheet Waterproofing	6
Updated	Architecture	07 21 13	Board Insulation	7
No Changes	Architecture	07 21 16	Blanket Insulation	4
No Changes	Architecture	07 21 20	Low Expanding Foam Sealant	4
No Changes	Architecture	07 21 29	Sprayed Insulation – Polyurethane Foam	5
No Changes	Architecture	07 26 00	Vapour Retarders	5
Updated	Architecture	07 27 00	Air Barriers	7
No Changes	Architecture	07 46 13	Preformed Metal Siding	6
Updated	Architecture	07 52 00	Modified Bituminous Membrane Roofing	16
No Changes	Architecture	07 62 00	Sheet Metal Flashing and Trim	5
No Changes	Architecture	07 72 69	Roof Anchors and Safety Restraints	6
No Changes	Architecture	07 84 00	Fire Stopping	8



 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		Page
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	

No Changes	Architecture	07 92 00	Joint Sealants	8
		DIVISION 8	OPENINGS	
Updated	Architecture	08 11 00	Metal Doors and Frames	10
No Changes	Architecture	08 31 00.01	Spillway Electrical BLDG - Access Doors - Mechanical	4
Updated	Architecture	08 51 00	Metal Windows	9
No Changes	Architecture	08 71 00	Door Hardware	14
Updated	Architecture	08 80 50	Glazing	7
		DIVISION 9	FINISHES	
No Changes	Architecture	09 21 16	Gypsum Board Assemblies	8
No Changes	Architecture	09 22 16	Non-Structural Metal Framing	4
No Changes	Structural & Miscellaneous Steel	09 90 00	Paint System For Structural Steel	11
No Changes	Architecture	09 91 23	Interior Panting	16
No Changes	Architecture	09 97 19	Painting Exterior Metal Surfaces	17
		DIVISION 11	EQUIPMENT	
No Changes	Commissioning	41-08-00	Preservation, Mechanical Completion & Commissioning Requirements (Removed from Technical Specification. Now a standalone document, MFA-SN-CD-2000-ME-SP-0002-01)	30
		DIVISION 23	HEATING, VENTILATING AND AIR CONDITIONING (HVAC)	
No Changes	HVAC	23 01 31	Spillway Electrical BLDG - Air Duct Cleaning for HVAC Systems	8
No Changes	HVAC	23 05 00	Spillway Electrical BLDG - Common Work Results for HVAC	6
No Changes	HVAC	23 05 01	Spillway Electrical BLDG - Use of HVAC Systems During Construction	3
No Changes	Piping	23 05 05	Installation of Pipework	5
No Changes	HVAC	23 05 13	Common Motor Requirements for HVAC Equipment	5
No Changes	Piping	23 05 17	Pipe Welding	6
No Changes	HVAC	23 05 48	Spillway Electrical BLDG - Vibration and Seismic Controls for HVAC Piping	8

mp 96

 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	3

			and Equip.	
No Changes	HVAC	23 05 53.01	Spillway Electrical BLDG - Mechanical Identification	8
No Changes	HVAC	23 05 93	Spillway Electrical BLDG - Testing, Adjusting and Balancing for HVAC	12
No Changes	HVAC	23 05 94	Spillway Electrical BLDG - Pressure Testing of Ducted Air Systems	4
No Changes	HVAC	23 07 13	Spillway Electrical BLDG - Duct Insulation	8
No Changes	HVAC	23 07 14	Spillway Electrical BLDG - Thermal Insulation for Equipment	8
No Changes	Piping	23 08 01	Performance Verification Mechanical Piping System	2
No Changes	Piping	23 11 13	Facility Fuel-Oil Piping	19
Updated	Piping	23 11 14	Fuel Storage Tank Electronic Monitoring Systems	18
No Changes	HVAC	23 31 13.02	Spillway Electrical BLDG - Metal Ducts - High Pressure to 2500 Pa	10
No Changes	HVAC	23 33 00	Spillway Electrical BLDG - Air Duct Accessories	7
No Changes	HVAC	23 33 14	Spillway Electrical BLDG - Dampers - Balancing	5
No Changes	HVAC	23 33 15	Spillway Electrical BLDG - Dampers - Operating	8
No Changes	HVAC	23 33 16	Spillway Electrical BLDG - Dampers - Fire and Smoke	6
Updated	HVAC	23 34 00	Spillway Electrical BLDG - HVAC Fans	10
Updated	HVAC	23 34 25	Spillway Electrical BLDG - Packaged Roof and Wall Exhausters	10
No Changes	HVAC	23 35 16	Spillway Electrical BLDG - Engine Exhaust System	5
No Changes	HVAC	23 37 13	Spillway Electrical BLDG - Diffusers, Registers and Grilles	6
No Changes	HVAC	23 37 20	Spillway Electrical BLDG - Louvres, Intakes and Vents	9
No Changes	HVAC	23 44 00	Spillway Electrical BLDG - HVAC Air Filtration	8
No Changes	HVAC	23 55 01	Spillway Electrical BLDG - Duct Heaters	7
No Changes	HVAC	23 82 33.05	Gate Guide Heaters	5
No Changes	HVAC	23 82 39.01	Unit Heaters - Electric	4



 SNC • LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	4

		DIVISION 25	INTEGRATED AUTOMATION	
Updated	HVAC Controls	25 33 01	Spillway Electrical BLDG - HVAC Controls and Instrumentation	49
		DIVISION 26	ELECTRICAL	
No Changes	Electrical	26 05 00	General Electrical Requirements	30
No Changes	Electrical	26 05 14	Power Cable (25000 V and 28000 V)	4
No Changes	Electrical	26 05 20	Wire and Box Connectors (0-1000 V)	3
No Changes	Electrical	26 05 21	Wires and Cables (0-1000 V)	9
No Changes	Electrical	26 05 22	Connectors And Terminations	3
No Changes	Electrical	26 05 28	Grounding - Secondary	12
No Changes	Electrical	26 05 29	Hangers And Supports For Electrical Systems	3
No Changes	Electrical	26 05 31	Splitters, Junction, Pull Boxes and Cabinets	4
No Changes	Electrical	26 05 32	Outlet Boxes, Conduit Boxes and Fittings	4
No Changes	Electrical	26 05 34	Conduits, Conduit Fastenings And Conduit Fittings	5
No Changes	Electrical	26 05 36	Cable Trays For Electrical Systems	4
No Changes	Electrical	26 05 43.01	Installation of Cables in Trenches and in Ducts	5
No Changes	Electrical	26 05 80	Fractional Horsepower Motors	3
No Changes	Electrical	26 05 81	Motors- 1 to 250 hp	6
No Changes	Electrical	26 09 23.01	Metering and Switchboard Instruments	6
No Changes	Electrical	26 09 24	Lighting Control Devices - Low Voltage	4
No Changes	Electrical	26 12 16	Dry Type, Medium Voltage Transformers	8
No Changes	Electrical	26 12 16.01	Dry Type Transformers Up to 600 V Primary	7
Updated	Electrical	26 13 17	Full Load Interrupter Switches to 25 kV	4
No Changes	Electrical	26 13 18	Primary Switchgear Assembly to 25 kV	9
No Changes	Electrical	26 18 41	Interlock Systems	4
Updated	Electrical	26 23 00	Low Voltage Switchgear	7

M/9H

 SNC-LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	5

No Changes	Electrical	26 24 16.01	Panelboards Breaker Type	5
Updated	Electrical	26 24 19	Motor Control Centres	8
No Changes	Electrical	26 25 00	Enclosed Bus Assemblies	4
Updated	Electrical	26 27 16	Electrical Cabinets and Enclosures	4
No Changes	Electrical	26 27 26	Wiring Devices	5
No Changes	Electrical	26 28 13.01	Fuses - Low Voltage	4
Updated	Electrical	26 28 16.01	Air Circuit Breakers	4
No Changes	Electrical	26 28 16.02	Moulded Case Circuit Breakers	4
No Changes	Electrical	26 28 20	Ground Fault Circuit Interrupters	4
No Changes	Electrical	26 28 23	Disconnect Switches - Fused and Non-fused	3
No Changes	Electrical	26 29 01	Contactors	3
No Changes	Electrical	26 29 03.01	Control Devices	6
Updated	Electrical	26 29 03.02	Control and Monitoring	10
No Changes	Electrical	26 29 03.03	Control and Monitoring - Hydro-Mechanical	32
Updated	Electrical	26 29 03.04	Spillway Automatic Transfer and Load Management System – Functional Description	6
No Changes	Electrical	26 29 10	Motor Starters to 600 V	8
No Changes	Electrical	26 29 23	Variable Frequency Drives	12
No Changes	Electrical	26 32 13.03	Installation of Power Generating Equipment	9
Updated	Electrical	26 32 13.04	Diesel Electric Generating Units (Liquid Cooled)	24
Updated	Electrical	26 33 16	Batteries and Battery Racks	6
No Changes	Electrical	26 33 43	Battery Chargers	5
No Changes	Electrical	26 33 53	Uninterruptible Power Systems Static (UPS)	12
No Changes	Electrical	26 50 00	Lighting	6
Updated	Electrical	26 52 00	Emergency Lighting	4
No Changes	Electrical	26 53 00	Exit Signs	5
No Changes	Electrical	26 56 19	Roadway Lighting	4

 SNC • LAVALIN	POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT TECHNICAL SPECIFICATION		Revision		
	Nalcor Doc. No. MFA-SN-CD-2000-ME-TS-0001-01		D2	Date	Page
	SLI Doc. No. 505573-3321-45EG-0001		03	11-Dec-2013	6

		DIVISION 28	ELECTRONIC SAFETY AND SECURITY	
No Changes	Security	28 16 00	Intrusion Detection	8
No Changes	Security	28 31 00.01	Multiplex Fire Alarm System	13
		DIVISION 33	UTILITIES	
No Changes	Fuel Storage Tank	33 56 13	Aboveground Fuel Storage Tanks	14
		DIVISION 48	Hydro Mechanical	
Updated	Hydro Mechanical	48 13 10	General Mechanical Requirements	39
Updated	Hydro Mechanical	48 13 20	Gates, Stoplogs and Trashracks	60
Updated	Hydro Mechanical	48 13 21	Hoists & Cranes	46
Updated	Hydro Mechanical	48 13 22	Trash Cleaning System	40

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 01 35 43
GENERAL ENVIRONMENTAL REQUIREMENTS

PART 1 GENERAL..... 2

 1.1 DESCRIPTION 2

 1.2 CONTRACTOR'S RESPONSIBILITIES - REGULATORY AGENCIES 2

 1.3 CONTRACT-SPECIFIC ENVIRONMENTAL PROTECTION PLAN (C-SEPP) 2

 1.4 LIST OF ACRONYMS AND ABBREVIATIONS 2

PART 2 PRODUCTS 3

 2.1 NOT USED 3

PART 3 EXECUTION 3

 3.1 ENVIRONMENTAL PROTECTION PROCEDURES 3

 3.2 NOT USED 4

 3.3 PROTECTION OF FISH HABITAT AND WATER QUALITY 4

 3.4 USE OF FRESH CONCRETE NEAR BODIES OF WATER 4

 3.5 CONCRETE PRODUCTION 5

 3.6 NOT USED 5

 3.7 STORAGE, HANDLING AND USE OF FUELS AND OTHER HAZARDOUS
 MATERIALS 5

 3.8 USE OF HAZARDOUS, TOXIC, OR DANGEROUS MATERIAL 11

 3.9 WASTE MANAGEMENT 12

 3.10 MARSHALLING YARDS 14

 3.11 DUST CONTROL 15

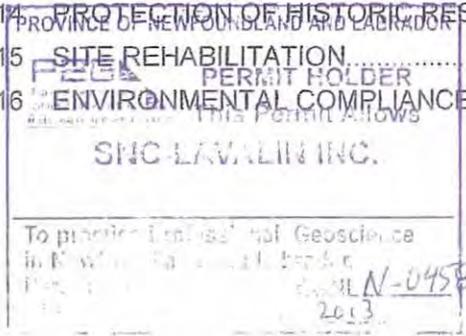
 3.12 WILDLIFE PROTECTION 15

 3.13 NOISE CONTROL 15

 3.14 PROTECTION OF HISTORIC RESOURCES 16

 3.15 SITE REHABILITATION 16

 3.16 ENVIRONMENTAL COMPLIANCE MONITORING 17



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 DESCRIPTION

1.1.1 The intent of the Environmental Requirements Specification is to detail the methods and procedures to be implemented during construction activities at the Lower Churchill Project to minimize any potential impacts on the environment.

1.2 CONTRACTOR'S RESPONSIBILITIES - REGULATORY AGENCIES

1.2.1 The Contractor shall refer to Exhibit 6 (Environmental and Regulatory Compliance Requirements). The Contractor is responsible for compliance with all applicable federal, provincial and municipal Regulations and By-Laws.

1.3 CONTRACT-SPECIFIC ENVIRONMENTAL PROTECTION PLAN (C-SEPP)

1.3.1 The Contractor shall refer to Exhibit 6 (Environmental and Regulatory Compliance Requirements) and documents provided in Exhibit 11, specifically the *Project-Wide Environmental Protection Plan (P-WEPP)* and *Contract-Specific Environmental Protection Plan Template*.

1.4 LIST OF ACRONYMS AND ABBREVIATIONS

- 1.4.1 ACA Ammoniacal Copper Arsenate
- 1.4.2 ACZA Ammoniacal Copper Zinc Arsenate
- 1.4.3 C-SEPP Contract-Specific Environmental Protection Plan
- 1.4.4 CAN/CGSB Canadian General Standards Board
- 1.4.5 CCA Chromated Copper Arsenate
- 1.4.6 CCME Canadian Council of Ministers of the Environment
- 1.4.7 CuN Copper Naphthenate
- 1.4.8 dB(A) Decibels in A-Weighted Measurements
- 1.4.9 DFO Fisheries and Oceans Canada
- 1.4.10 DNR Newfoundland and Labrador Dept. of Natural Resources
- 1.4.11 DOEC Newfoundland and Labrador Dept. of Environment and Conservation
- 1.4.12 ESCP Erosion and Sedimentation Control Plan

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.4.13 GAP Storage and Handling of Gasoline and Associated Product Regulations, 2003
- 1.4.14 GSC Newfoundland and Labrador Government Services Centre
- 1.4.15 HOST Heating Oil Storage Tank System Regulations NL Newfoundland and Labrador
- 1.4.16 OECD Organization for Economic Co-operation and Development
- 1.4.17 PA Pond Area
- 1.4.18 PCP Pentachlorophenol
- 1.4.19 P-WEPP Project-Wide Environmental Protection Plan
- 1.4.20 Qout Outflow Capacity
- 1.4.21 Us Sedimentation Velocity
- 1.4.22 TSS Total Suspended Solids
- 1.4.23 UOC Used Oil Control Regulations
- 1.4.24 WHMIS Workplace Hazardous Materials Information System

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 ENVIRONMENTAL PROTECTION PROCEDURES

3.1.1 The Contractor shall install all environmental protection procedures illustrated on the Contract Drawings in accordance with the design, installation, maintenance and removal procedures detailed below. The Contractor shall also adhere to these requirements when preparing the C-SEPP. The Contractor shall use the P-WEPP in Exhibit 11 as a guide when preparing the C-SEPP.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



3.2 NOT USED

3.3 PROTECTION OF FISH HABITAT AND WATER QUALITY

3.3.1 Federal and Provincial Legislation requires prescribed methods and procedures to be employed when carrying out such work as culvert or bridge installations, watercourse diversions, fording, fill placement at watercourses, and any other work which may alter or impact any watercourse, or the quality of the water therein. These requirements are detailed in Exhibit # 6 – “Environmental Compliance Requirements”.

3.4 USE OF FRESH CONCRETE NEAR BODIES OF WATER

3.4.1 The Contractor shall implement the following environmental protection procedures.

3.4.1.1 The Contractor shall prepare concrete spill response plan. The Plan will outline steps to be taken to minimize the impact on the environment from an accidental spill or release of concrete and/or grout into the environment during the transportation, handling or placement, before the concrete or grout has cured.



3.4.1.2 Not Used

3.4.1.3 Washwater from the cleaning of mixers, mixer trucks and concrete delivery systems shall be directed to a closed system aggregate rinsing sedimentation pond(s) in accordance with the referenced Codes of Practice.

3.4.1.4 In the event that water from the closed sedimentation system is intended for release, it shall first be tested for parameters related to any concrete additives used in the production of concrete (e.g. pH, total suspended solids). It shall also meet the limits specified by DOEC, and shall adhere to those portions of the Fisheries Act (SN1995 F12.1) that relate to fish habitat protection and pollution prevention.

3.4.1.5 When concrete is placed adjacent to a watercourse, all necessary precautions shall be taken to prevent the concrete from adversely affecting water quality. Whenever possible, fresh concrete shall not come in direct contact with the watercourse.

3.4.1.6 Standing water shall be removed prior to placing fresh concrete.

3.4.1.7 Formwork shall be made secure and tight to prevent leakage of fresh concrete into any adjacent waters.

3.4.1.8 Concrete delivery trucks or chutes shall not be washed within 100 m of any watercourse or watercourse.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.4.1.9 All necessary precautions shall be taken when handling related substances such as form coatings and concrete admixtures to prevent any spill or leakage of these substances.

3.5 CONCRETE PRODUCTION

3.5.1 Concrete production on site will be by Company's other contractor.

3.6 NOT USED

3.7 STORAGE, HANDLING AND USE OF FUELS AND OTHER HAZARDOUS MATERIALS

3.7.1 The Contractor shall comply with the following procedures related to Storage, handling and use of fuels and other hazardous materials.

3.7.1.1 All storage tank systems shall be constructed, installed, and operated in compliance with the Storage and Handling of Gasoline and Associated Products Regulations, 2003 (GAP regulations); the Heating Oil Storage Tank System Regulations, 2003 (HOST Regulations); or the Used Oil Control Regulations.

3.7.1.2 The Contractor shall ensure drip trays be used where appropriate, examples may include portable generators, dewatering pumps and portable refuelling pumps.

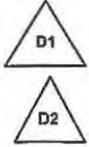
3.7.1.3 Contractors shall supply verification of storage tank registration to the Engineer prior to the commencement of work.

3.7.1.4 Mobile fuel tanks shall comply with the Transportation of Dangerous Goods Regulations, SOR/2008-34 which requires intermediate size containers to comply with the requirements of CAN/CGSB-43.146-2002. Mobile tanks shall be properly secured.

3.7.1.5 GAP regulation controlled storage tank systems shall be operated as per Section 18 of the Storage and Handling of Gasoline and Associated Products Regulations, 2003. This involves, but is not limited to, gauging or dipping, reconciliation of records and the proper maintenance of reconciliation records for a period of two years. Records shall be maintained for inspection by the Engineer, ESO and/or Government Service Centre Inspectors.

3.7.1.6 The operator of a storage tank system shall, within 30 days of known abandonment, empty the system of all products, remove the tank and associated piping from the ground, remove any contaminated soil, clean the area and restore the site to the satisfaction of the Engineer and in accordance with the criteria of the Government Services Centre.

3.7.1.7 All HOST regulation controlled tanks shall be double walled construction.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.2 The Contractor shall comply with the following Spill Reporting and Cleanup Procedures.

3.7.2.1 The Contractor, Sub-contractors, and their personnel shall take all necessary precautions to prevent the spillage, misplacement, or loss of fuels and other hazardous material.

3.7.2.2 The Contract shall prepare a Spill Response Plan.

3.7.2.3 The Contractor and Sub-contractors shall abide by the following measures in the event of a fuel or hazardous material spill:

3.7.2.3.1 Make every effort to stop leakage and contain contaminant flow.

3.7.2.3.2 Immediately notify the Engineer of all environmental incidents, including any loss of hazardous or controlled products. Any spill meeting the following criteria shall be reported immediately to the Canadian Coast Guard at 709-772-2083 or 1-800-563-9089:

3.7.2.3.2.1 Any spill on a natural water body (marine or freshwater); or

3.7.2.3.2.2 Any land-based spill:

3.7.2.3.2.2.1 Over 70 litres, or

3.7.2.3.2.2.2 Of any quantity that has the potential (e.g. by migrating through subsurface soil/bedrock/substructures, etc) to enter a natural water body, or

3.7.2.3.2.2.3 Of any quantity that has the potential to impact a privately owned property.

3.7.2.3.3 Report to the Engineer all releases to the environment of hazardous or controlled products, including those releases that are reportable to the Canadian Coast Guard. Once the spill is reported, the Engineer will liaise with other government agencies to provide additional information, as required.

3.7.2.3.4 Investigate and document in a written report, consistent with the format described in the Emergency Response Plan (which includes a spill response plan), all releases that require Canadian Coast Guard reporting. This report shall be prepared and submitted to the Engineer for distribution to applicable government agencies, including the Canadian Coast Guard and Government Service Centre. All other releases shall be investigated and documented.

3.7.2.3.5 Remove the contaminant from spill site by absorbent, pumping, or whatever method is appropriate and acceptable to the Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.7.2.3.6 Clean up the affected area in accordance Government Services Centre's requirements, and as directed by the Engineer. All waste materials generated during cleanup operations shall be disposed of at an approved waste disposal site.
- 3.7.2.3.7 Take all necessary action to ensure the incident does not recur.
- 3.7.2.3.8 Describe in a written report the cause of the spill, actions taken to control and contain it, remedial action, damage or contamination estimate, and any further action to be taken.
- 3.7.2.4 The Contractor shall apply the following criteria in reaching decisions on contaminant and clean-up procedures.
 - 3.7.2.4.1 Minimize danger to persons.
 - 3.7.2.4.2 Minimize pollution to watercourses and wetlands.
 - 3.7.2.4.3 Minimize the size of the area affected by a spill.
 - 3.7.2.4.4 Minimize the degree of disturbance to the area and watercourses during clean-up.
- 3.7.2.5 The Contractor shall dispose of any soil contaminated by small leaks of oil or lubricating fluids from equipment in a manner approved by the Engineer, and in accordance with the criteria of the Government Services Centre.
- 3.7.2.6 The Contractor shall have on site a suitable quantity of absorbent material which can be accessed quickly and effectively in the event of any hydrocarbon spill.
- 3.7.2.7 The Contractor shall advise fuel handling staff of its location and application.
- 3.7.3 The Contractor shall implement all necessary precautions to prevent and reduce spillage, misplacement or loss of fuels and other hazardous materials. These precautions shall include, but are not limited to:
 - 3.7.3.1 All fuel storage and handling shall be in accordance with the *Storage and Handling of Gasoline and Associated Products Regulations, 2003 (GAP Regulations)*. Necessary approvals shall be obtained from the Newfoundland and Labrador Department of Government Services.
 - 3.7.3.2 Bulk fuel storage (>2000 L) shall be established at least 100 m from any surface water. The storage of smaller quantities of fuel (i.e. 25 L or less) shall be permitted no closer than 15 m of a watercourse at approved sites.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.7.3.3 Water pump use and refueling may take place within 15 m of a watercourse in certain instances. However, water pumps to be used within 50 m of a watercourse should be equipped with a drip pan and lined with absorbent material to collect any oil and fuel leaks, or spills which may occur.
- 3.7.3.4 Handling and fuelling procedures shall comply with the *Storage and Handling of Gasoline and Associated Products Regulations, 2003*, WHMIS, applicable Sections of the *National Fire Code and Fire Prevention Act*, and any additional requirements brought forth by the Newfoundland and Labrador Department of Environment and Conversation (NLDOEC) to limit potential contamination of soil or water.
- 3.7.3.5 Used oils shall be collected, stored, transported, and disposed of as per requirements outlined in the *Used Oil Control Regulations (UOC Regulations)*. Companies engaged in collecting, transporting, storing, using, selling, handling, and/or disposing of used oil shall hold a valid certificate of approval issued by GSC or DOEC. Approvals shall be requested and obtained prior to the handling and disposal of used oils and a copy kept on file. Used oil shall be stored in a used oil storage tank meeting the requirements outlined in Sections 18 and 21 of the UOC Regulations. Used oil can be stored in 205 L drums as long as the quantity does not exceed 205 L; the drums are clearly marked "used oil"; the drum is 18 gauge steel; the drum has secondary containment; the top of the drum is equipped with a sufficient opening to prevent spillage during filling or emptying; the drum is equipped with venting if it is intended to be vacuumed out and; it complies with CAN/CGSB – 43.150.95 if the drum is to be transported by road.
- 3.7.3.6 Fuels and other hazardous materials shall be handled by trained and qualified persons in accordance with the manufacturer's instructions and government laws and regulations. Operators shall be in attendance for the duration of the refueling operation.
- 3.7.3.7 Fuel caches of helicopter fuels stored in 205 L drums shall be established within the Project area as required. All fuel caches shall be operated as per conditions of approvals from the Government Services Centre. All helicopter refueling shall be done at these locations if remote fuelling is required.
- 3.7.3.8 Gasoline for chainsaws and water pumps may be stored in approved 20 L metal storage containers.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.7.3.9 Regular inspections of hydraulic and fuel systems on machinery shall be performed by Project personnel, and leaks shall be repaired immediately upon detection. Servicing of mobile equipment on land shall not be performed within 50 m of a watercourse.
- 3.7.3.10 Any above-ground container, with the exception of those exempted under the *Storage and Handling of Gasoline and Associated Products Regulation, 2003*, shall be placed on an impervious mat and shall be surrounded by an impervious dyke of sufficient height (minimum height 0.6 m) to contain a specified amount of fuel.
- 3.7.3.11 Fuel storage areas and non-potable transfer lines shall be clearly marked or barricaded so that they will not be damaged by moving vehicles. The markers shall be visible under all weather conditions and barriers shall be constructed in compliance with the *Storage and Handling of Gasoline and Associated Products Regulations, 2003*.
- 3.7.3.12 Waste oils, lubricants and other used oil shall be disposed of at an approved disposal site. Waste oil shall be shipped for disposal on a monthly basis.
- 3.7.3.13 All storage tank systems shall be inspected on a regular basis as per Sections 18, 20 and 21 of the *Storage and Handling of Gasoline and Associated Products Regulations, 2003*.
- 3.7.3.14 Any soil contaminated by leaks or spills of any petroleum product from equipment shall be excavated, stored in an approved container and disposed of off-site at a licensed disposal site.
- 3.7.3.15 Smoking shall be prohibited within 50 m of a fuel storage area.
- 3.7.3.16 The Contractor shall be required to verify personnel qualifications as they pertain to this item and provide written confirmation of same to the Engineer. The Contractor shall supply a copy of the Material Safety Data Sheets (in accordance with the *Workplace Hazardous Materials Information System (WHMIS) Regulations* under the *Occupational Health and Safety Act*) to the Engineer of all hazardous, toxic or dangerous materials or substances which will be used during the course of the Agreement. Refueling operations shall be supervised at all times. Under no circumstances shall any refueling procedure be left unattended by the operator.
- 3.7.4 The Contractor shall implement the following Equipment Servicing Procedures.
 - 3.7.4.1 All heavy equipment maintenance shall be carried out using suitable fluid collection equipment and in a manner which ensures all waste material is collected and suitably disposed of.
 - 3.7.4.2 The Contractor shall ensure that all equipment is mechanically sound to avoid leaks of grease, oil, diesel, gasoline, and hydraulic and transmission fluids.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.4.3 The Contractor shall ensure that no servicing or washing of heavy equipment occurs adjacent to watercourses and designated wetlands. Fuelling, servicing or washing of equipment shall not be allowed within 100 m of a watercourse except within a refueling site approved by the Engineer.

3.7.4.4 The Contractor shall remove from the work area, and properly dispose of, all waste oil, filters, containers or other such debris at an approved waste disposal site.

3.7.5 Contractors shall at all times maintain in good condition at least one spill kit dedicated to each piece of fuel-powered equipment and absorbent material as required. Each spill kit shall be located on the equipment and stored in a weather-proof container. Each spill kit shall have an absorption capacity of no less than 23 litres. Examples of acceptable spill kits with various absorption capacities are as follows:

3.7.5.1 23 Litre Absorption Capacity

3.7.5.1.1 One (1) 10-litre bag Oclansorb®, or equivalent approved by Engineer;

3.7.5.1.2 Two (2) 4-mil heavy duty disposal plastic bag 30" * 48";

3.7.5.1.3 One (1) steel hand spade;

3.7.5.1.4 Two (2) 100mm * 1200mm Sorb Sox®, or equivalent approved by Engineer; and

3.7.5.1.5 Five (5) sorbent pads 3/8" * 17" * 19".

3.7.5.2 64 Litre Absorption Capacity

3.7.5.2.1 One (1) 13-litre bag Oclansorb®, or approved equivalent;

3.7.5.2.2 Ten (10) sorbent pads 3/8" * 17" * 19", or approved equivalent;

3.7.5.2.3 Two (2) 4-mil yellow heavy duty disposal bag 30" * 48";

3.7.5.2.4 One (1) steel hand spade;

3.7.5.2.5 Two (2) 4" * 4' Sorb Sox®, or approved equivalent; and

3.7.5.2.6 Two (2) 4" * 8' Sorb Sox®, or approved equivalent.

3.7.5.3 121 litre Absorption Capacity

3.7.5.3.1 Twenty five (25) sorbent pads 3/8" * 17" * 19";

3.7.5.3.2 Ten (10) 4-mil yellow heavy duty disposal bag, 30" * 48":

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.7.5.3.3 One (1) 44-litre bag Oclansorb®, or approved equivalent;
- 3.7.5.3.4 Eight (8) Sorb Sox® 4" * 4', or approved equivalent;
- 3.7.5.3.5 Five (5) Sorb Sox® 4" * 8', or approved equivalent;
- 3.7.5.3.6 Two (2) Spillows® 2" * 17" * 19", or approved equivalent;
- 3.7.5.3.7 One (1) spark resistant poly-shovel;
- 3.7.5.3.8 One (1) Sorb Sox® Boom 7" * 10', or approved equivalent; and
- 3.7.5.3.9 One (1) Pair of chemical resistant gloves.

3.8 USE OF HAZARDOUS, TOXIC, OR DANGEROUS MATERIAL

- 3.8.1 The Contractor shall implement the following procedures when working with hazardous, toxic or dangerous material.
 - 3.8.1.1 The Contractor shall comply with all requirements of the Workplace Hazardous Material Information System (WHMIS), and shall provide Material Safety Data Sheets (MSDS) for all hazardous materials and waste dangerous good as defined by the federal *Transportation of Dangerous Goods Regulations*.
 - 3.8.1.2 Hazardous material shall be stored at least 100 m away from all areas where drainage is directed into any watercourse or wetlands.
 - 3.8.1.3 Toxic or dangerous substances such as form release agents, fuels, concrete additives (including superplasticizers), and other such substances, shall be transported, stored, and handled with all necessary precautions so as to prevent any spillage from occurring.
 - 3.8.1.4 Drip pans shall be used at locations where such liquids are being drawn off in order to contain any minor spills, and as a safety measure for containment of a significant spillage.
 - 3.8.1.5 Batteries shall be stored in secure dyked areas (with no drains), suitably protected to prevent infiltration of rainwater, snow and meltwater.
 - 3.8.1.6 Any liquids, including acids, that drain into the dyked area shall be collected, handled and disposed of as a hazardous waste.
 - 3.8.1.7 All equipment on the Project site shall use only hydraulic fluids that classify as "biodegradable", unless the Contractor justifies in writing to the Engineer's satisfaction that it is not feasible because of:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.8.1.7.1 Technical or performance constraints,
- 3.8.1.7.2 Negative impacts on equipment warranties, and/or
- 3.8.1.7.3 Unavailability of biodegradable oils and lubricants.
- 3.8.1.8 The Contractor shall document the consideration of this issue in its bid documents providing, as a minimum, the following information:
 - 3.8.1.8.1 Cost differential in using biodegradable and non-biodegradable oils and lubricants;
 - 3.8.1.8.2 Life cycle cost differential for equipment maintenance and operation;
 - 3.8.1.8.3 Product specifications indicating the product meets the definition of "biodegradable" when tested in accordance with the OECD 301B Ready Biodegradability Test procedure; and
 - 3.8.1.8.4 Reasons (e.g. technical, market availability, equipment warranty provisions, etc) for not using biodegradable fluids, should that option be proposed.
- 3.8.1.9 The Contractor shall implement the following procedures when using hazardous materials near saltwater and freshwater areas (other than Protected Water Supply Areas).
 - 3.8.1.9.1 In areas of low water hardness (i.e., 15-25 mg/L-1 CaCO₃), pH 5.5 or less, and elevated background metals levels, or areas where metals-sensitive biota exist, ACA, ACZA and CCA shall not be used.
 - 3.8.1.9.2 Pentachlorophenol shall not be used in salt water environments.
 - 3.8.1.9.3 For temporary installation of wood structures (i.e. bridge abutments or wood poles) within 15 metres of a water body only untreated timber shall be used.
 - 3.8.1.9.4 For permanent installations, non-invasive materials such as concrete or steel shall be used.
 - 3.8.1.9.5 If use of untreated wood or alternative materials is not feasible or practical, approval by regulators is required prior to use of CCA, ACA, PCP and CuN.
 - 3.8.1.9.6 Protective measures outlined above under Protected Water Supply Areas, such as pole wrapping and pipe installation, may be considered; however, using these alternatives requires preapproval by regulatory agencies.

3.9 WASTE MANAGEMENT

- 3.9.1 The Contractor shall implement the following Solid Waste Disposal procedures.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.9.2 The Contractor shall review and comply with the provided Waste Management Plan (included in Exhibit # 11 of the Agreement) as required by the P-WEPP. The Waste Management Plan includes methods for the management, storage and disposal of both inert or non-hazardous wastes of various kinds (i.e. containers, filters, belts, scrap metals, domestic garbage, etc.), as well as hazardous wastes (i.e. used oils, solvents, paints, used/unused chemicals, old batteries, chemical based sludge, and contaminated soils and waters etc.).
 - 3.9.2.1 Hazardous (waste oils, petroleum products, chemicals etc.) and non-hazardous waste materials.
 - 3.9.2.2 The Contractor is responsible to collect and dispose of all waste produced by its employees and those of its Sub-contractors in a manner approved by the Engineer, and in accordance with the Newfoundland and Labrador Environmental Protection Act, Waste Management Regulations and Waste Diversion Regulations.
 - 3.9.2.3 The Contractor shall implement the following waste management related environmental protection procedures:
 - 3.9.2.3.1 Disposable wastes shall be stored in a leak proof container and disposed of at an existing approved municipal landfill site with the permission of the owner and/or operator.
 - 3.9.2.3.2 Recyclable materials shall be collected separately and provided to an approved recycling facility.
 - 3.9.2.3.3 Waste material shall not be deposited in any watercourse.
 - 3.9.2.3.4 Waste types shall be separated and appropriate receptacles shall be provided for the collection of recyclable materials including; aluminum, glass, paper, cardboard and plastic.
 - 3.9.2.3.5 Construction scrap and debris shall be separated into disposable and salvageable materials.
 - 3.9.2.3.6 Waste accumulated on the site prior to disposal shall be confined in animal-resistant containers so that it does not pose an environmental or health hazard or cause conflict with wildlife.
 - 3.9.2.3.7 Upon completion of the work, the Contractor shall, at its own expense, and to the satisfaction of the Engineer, dispose of, or remove from, the job site all construction plant, rubbish, unused material, including concrete forms, filter fabric material, sediment fencing, sand bags, and other equipment and materials belonging to it or used under its direction during the performance of the work. The site shall be left in a neat and clean condition.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.10 MARSHALLING YARDS

- 3.10.1 Any site proposed for a marshalling yard should be of low value with respect to its potential for other uses when compared to other lands in the area. Abandoned gravel pits, abandoned commercial enterprises, or other previously disturbed areas are preferred locations.
- 3.10.2 Any site shall be located so as to minimize potential traffic hazards. Incoming and outgoing vehicles should be able to merge safely with other traffic. Prior to the commencement of construction the Contractor shall submit a list of candidate sites, which shall be reviewed and approved by the Engineer and any other relevant agency.
- 3.10.3 The Contractor shall implement the following general environmental protection procedures.
 - 3.10.3.1 The marshalling yards and laydown areas used for equipment and material storage shall be located at least 30 m from any watercourse;
 - 3.10.3.2 Plans shall be reviewed prior to the commencement of construction so that equipment or material storage yards shall be located at least 30 m from any watercourse or designated wetland.
 - 3.10.3.3 Buffer zones are to be flagged prior to any disturbance activities.
 - 3.10.3.4 Natural vegetation is to be left in place where possible.
 - 3.10.3.5 Drainage from areas of exposed fill is controlled by grading or ditching and directed away from watercourses, whenever possible.
 - 3.10.3.6 Surface water is to be directed away from work areas by ditching, the runoff from these areas may require silt to be removed by filtration or other suitable treatment.
 - 3.10.3.7 The requirements for check dams or sediment traps to intercept runoff are determined in the field.
 - 3.10.3.8 Check dams shall be used, as required, to reduce runoff velocity from work areas where there is exposed soil.
 - 3.10.3.9 Areas to be exposed/disturbed shall be reduced to only what is required. Disturbed areas are to be graded to level grades and compacted. If required, erosion control matting may be required on exposed slopes prone to erosion.
 - 3.10.3.10 In areas where natural vegetation is to be removed, the vegetation layer shall be stored for possible use as erosion control material on exposed slopes.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.11 DUST CONTROL

- 3.11.1 The Contractor shall ensure that dust does not become a problem for adjacent property owners, construction site personnel, or create a hazard to vehicular traffic.
- 3.11.2 When required, or as directed by the Engineer, water or an acceptable dust suppressant such as calcium chloride shall be used by the Contractor on haul routes or other locations on the Project to control dust.

3.12 WILDLIFE PROTECTION

- 3.12.1 Work activities shall be undertaken in a manner that does not harass wildlife. Harassment is defined as any activity that would disrupt the normal behaviour of an animal. Any incidents that involve harassment of wildlife shall be reported to site management. Investigation of such incidents shall be completed and a report provided.
- 3.12.2 Firearms shall not be permitted on the construction site, unless authorized for use in control of nuisance animals. A policy of no hunting or fishing shall be in force for all personnel on the Project site.

3.13 NOISE CONTROL

- 3.13.1 The Contractor shall implement measures wherever possible to reduce potential effects arising from a variety of noise sources.
- 3.13.2 The Contractor shall regularly inspect exhaust systems on all vehicles and generators to ensure the equipment is in good operating condition.
- 3.13.3 The Contractor(s) shall also take measures so that workers are not exposed to noise levels above 85 dBA as per Occupational Health and Safety Guidelines.
- 3.13.4 The Contractor shall ensure that its workers shall wear proper personal protective equipment for hearing protection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.14 PROTECTION OF HISTORIC RESOURCES

3.14.1 The Contractor shall be aware that the *Historic Resources Act* (1985) requires the protection of archaeological sites and artefacts, and sets forth procedures to be followed in the event that either are found. The Contractor shall be aware of the following Sections of the Act:

3.14.1.1 Section 10(1) - A person who discovers an archaeological object in, on, or forming part of the land within the province shall report the discovery forthwith to the Minister stating the nature of the object, the location where it was discovered and the date of the discovery.

3.14.1.2 Section 10(2) - No person, other than the one to whom a permit has been issued under this Act, who discovers an archaeological object shall move, destroy, damage, deface or obliterate, alter, add to, mark or in any other way interfere with, remove or cause to be removed from the province that object.

3.14.1.3 Section 11(1) - The property in all archaeological objects found in, on or taken from the land within the province, whether or not these objects are in the possession of Her Majesty is vested in Her Majesty.

3.14.2 Should the Contractor encounter any archaeological remains, such as stone, bone or iron tools, concentrations of bone, fireplaces, house pits and/or foundations, work in the area of the find shall cease immediately. The Contractor shall immediately notify the Engineer, immediately upon discovery of any historic resources. The Engineer shall immediately notify The Company who in turn shall immediately notify the Historic Resources Division.

3.15 SITE REHABILITATION

3.15.1 The Contractor shall be aware that all areas of the construction sites shall require careful consideration of the landscape within which the work is taking place, to ensure that the correct rehabilitation approach is taken. The following general rehabilitation measures shall be implemented.

3.15.1.1 Rehabilitation shall be required for all temporary work;

3.15.1.2 No temporary buildings or structures associated with the work shall be left on site upon completion of the work;

3.15.1.3 All solid waste, including petroleum, oil and lubricant containers shall be removed from site;

3.15.1.4 Pre/Post occupation inspection shall be completed; and

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 01 35 43
CH0032	GENERAL ENVIRONMENTAL REQUIREMENTS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.15.1.5 The On-Site Environmental Monitor shall prepare a report for all sites documenting site conditions prior to disturbance and upon site abandonment and rehabilitation. Each report shall include a description of the condition of vegetation and other aspects of natural environment.

3.15.2 The Contractor shall implement the following rehabilitation measures specific to quarry and borrow areas:

3.15.2.1 Arrangements shall be made with the representatives of the Department of Natural Resources for an inspection to be conducted prior to abandonment of the site;

3.15.2.2 All equipment and material shall be removed from the site.

3.16 ENVIRONMENTAL COMPLIANCE MONITORING

3.16.1 Ongoing monitoring for compliance with regulatory requirements shall be conducted throughout the life of the Project by the Engineer. Dedicated on-site environmental monitors shall be present at the construction sites.

3.16.1.1 The Contractor shall not unduly restrict or impede the inspectors in the performance of their duties.

3.16.1.2 The Contractor shall be responsible for environmental performance and reporting, as required by provisions of any permits, authorizations or approvals.

3.16.1.3 The results of compliance monitoring shall be evaluated as part of the Project's environmental management system. Compliance instructions shall be issued by the Engineer, as required, ensuring compliance with all regulatory and contractual environmental requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 03 11 00
CONCRETE FORMWORK
TABLE OF CONTENTS**

PART 1 GENERAL	2
1.1 SCOPE OF WORK	2
1.2 WORK INCLUDED	2
1.3 RELATED SECTIONS	2
1.4 DEFINITIONS	3
1.5 REFERENCES	3
1.6 SITE CONDITIONS	4
1.7 QUALITY ASSURANCE	4
1.8 SUBMITTALS	5
PART 2 PRODUCTS	6
2.1 FORMWORK MATERIALS	6
2.2 FORM TIES	7
2.3 FORM COATINGS, SEALERS AND RELEASE AGENTS	7
2.4 FORMWORK LINER	7
PART 3 EXECUTION	7
3.1 FORMWORK DESIGN	7
3.2 FORMWORK PREPARATION	10
3.3 ERECTION OF FORMWORK	11
3.4 REMOVAL OF FORMWORK AND FALSEWORK	12
3.5 RE-USE OF FORMS	13
3.6 CONTRACTION JOINTS	13
3.7 SECONDARY CONCRETE FORMWORK	13
3.8 TOLERANCES	13
3.9 FIELD QUALITY CONTROL	14



MB976

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SCOPE OF WORK

- 1.1.1 This specification describes the requirements for the design, supply, erection and dismantling of formwork, shoring and scaffolding, including all labour, material, equipment and supervision needed to execute the work for cast-in-place concrete as shown on the drawings and described in the specifications.
- 1.1.2 This specification shall be read conjointly with CSA A23.1/A23.2. However, the requirements of this Specification supersede the corresponding ones of CSA A23.1/A23.2.

1.2 WORK INCLUDED

- 1.2.1 The work covered by this specification includes, without being limited to, the following:
 - 1.2.1.1 Design, supply, transportation to the site, unloading at the required locations, erection and dismantling of formwork and falsework;
 - 1.2.1.2 Supply of all material, labour, equipment and supervision;
 - 1.2.1.3 Production of formwork and shoring drawings and design calculations;
 - 1.2.1.4 Make provision in the formwork, where required, for the installation of inserts, sleeves, anchor bolts, embedded items and waterstops;
 - 1.2.1.5 Inspection and testing.

1.3 RELATED SECTIONS

- 1.3.1 Section: 03 20 00 Concrete Reinforcement
- 1.3.2 Section: 03 30 00 Cast-in-Place Concrete
- 1.3.3 Section: 03 60 40 Grout
- 1.3.4 Section: 05 50 10 Miscellaneous Metals and Embedded Parts
- 1.3.5 Section 48 13 10 General Mechanical Requirements
- 1.3.6 Section 48 13 20 Gates, Stoplogs and Trashracks



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 DEFINITIONS

1.4.1 The following are used in this Specification:

- 1.4.1.1 SDRL: Supplier Documentation Requirements List
- 1.4.1.2 MSDS: Material Safety Data Sheets
- 1.4.1.3 OSHA: Occupational Safety and Health Administration
- 1.4.1.4 LEED: Leadership in Environmental Design
- 1.4.1.5 VOC: Volatile Organic Compounds

1.5 REFERENCES

1.5.1 The Contractor shall comply with the rules and provisions of the listed Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.5.2 All work shall be in accordance with this specification and the requirements of the following codes and standards:

1.5.3 Canadian Standard Association (CSA)

- CSA A23.1-09/A23.2-09 Concrete Materials & Methods of Concrete Construction / Test Methods & Standard Practices for Concrete
- CAN/CSA S269.1-1975(R2003) Falsework for Construction Purpose
- CAN/CSA S269.3-M92 (R2008) Concrete Formwork
- CSA W47.1-03 (R2008) Certification of Companies for Fusion Welding of Steel
- CSA W178.2-08 Certification of Welding Inspectors.

1.5.4 Canadian General Standards Board (CGSB)

- CAN/CGSB 37-GP-9Ma Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing

1.5.5 American Society for Testing and Materials (ASTM)

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

ASTM C309-11

Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

1.5.6 Other Codes and References

- NBC 2010 National Building Code of Canada 2010 and the Supplement to the National Building Code of Canada
- ACI SP4 (2005) Formwork for Concrete
- ACI 347-04 Guide to Formwork for Concrete
- OHSA Occupational Health and Safety Act, Newfoundland and Labrador

1.6 SITE CONDITIONS

- 1.6.1 The Contractor is responsible for the verification of all dimensions, elevations and conditions on site prior to the execution of his shop drawings.
- 1.6.2 Any deviations, errors and site conditions which could adversely affect proper completion of the work shall be immediately reported to the Engineer for corrective action before preparing formwork drawings.

1.7 QUALITY ASSURANCE

- 1.7.1 The Contractor shall comply with an inspection program in conformance with ISO 9001:2008 requirements or equivalent.
- 1.7.2 The Contractor shall monitor the submitted quality control program, inspection and testing.
- 1.7.3 The Engineer reserves the right to inspect work at the fabrication plant at any time during the normal working hours. Provisions shall be made for such inspections, when requested.
- 1.7.4 Certifications
 - 1.7.4.1 The Contractor shall be certified by the CWB according to the requirements of CSA W47.1 Division 1 or Division 2, in accordance with CSA S16.
- 1.7.5 Substitutions

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.7.5.1 Complete technical data as to type, composition, strength, quality, finish, capacity, performance characteristics and other pertinent details will be required to determine the acceptability of a substitute item.
- 1.7.5.2 Substitution for a specified element shall only be considered if the element is not available or if it results in an improved detail or easier erection.
- 1.7.5.3 Substitution shall receive written approval from the Engineer prior to being implemented.

1.8 SUBMITTALS

- 1.8.1 The Contractor shall submit the required documentation to the Engineer for review and approval, in accordance with the Supplier Document Requirement List (SDRL).
- 1.8.2 The Contractor shall submit the following to the Engineer for review, prior to start of fabrication:
 - 1.8.2.1 Detailed schedule of fabrication and erection. The schedule shall amplify requirements of contract schedule and shall be updated on a regular basis. Schedule revisions shall be transmitted.
 - 1.8.2.2 Copy of ISO 9001:2008 registration or equivalent and the Quality Assurance Program along with Quality Control (inspection and testing) Program.
 - 1.8.2.3 CWB certificates of the welders, pointers and welding machine operators.
 - 1.8.2.4 CWB certificates for the inspectors in conformance with CSA W178.2.
 - 1.8.2.5 Welding procedures for shop welds. Procedures for field welding, if applicable, shall also be submitted.
 - 1.8.2.6 Field-bolting checking procedure.
 - 1.8.2.7 Design calculations of formwork, falsework:
 - 1.8.2.7.1 Formwork drawings indicating materials, arrangements of joints, ties, shores, liners, locations of embedded parts, pattern and treatments of tie holes and rates of pour.
 - 1.8.2.7.2 Formwork drawings and the associated design calculations shall bear the signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
 - 1.8.2.8 Shop and erection drawings, and bills of material with bolt lists.
 - 1.8.2.8.1 Shop drawings shall indicate the quantities, locations, top of steel elevations, spacing, sizes, profiles, steel grade, connections, including symbols and dimensions of welded joints, attachments, fasteners, galvanization or paint system and piece marks of members.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Any requirements for edge preparation for welds or machining requirements shall be clearly indicated.

- 1.8.2.8.2 Shop drawings shall include details of holes and fittings in components necessary for safety or to provide lifting and erection aids, as required.
- 1.8.2.8.3 Each shop drawing shall include a bill of material showing member piece marks, shape designations, number of pieces required, length, unit weight, total weight of each member, total weight of steel detailed on that drawing. It shall make reference to contract number, contract item number and related design drawing number.
- 1.8.2.8.4 Shop drawings shall be submitted only when their related design calculations have been reviewed.
- 1.8.2.8.5 Shop and erection drawings shall bear signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador. They shall also bear signature of a verifier.
- 1.8.2.8.6 Details of steelwork shall conform to the Canadian Institute of Steel Construction Handbook.
- 1.8.2.8.7 Engineer's drawings may be used as erection drawings, however the title block shall be replaced with a revised title block and the all professional seals shall be removed.
- 1.8.2.8.8 Erection drawings shall show piece marks, locations and details of field connections of members. They shall also indicate all A325 field bolts that need to be fully tensioned, in accordance with this Specification and the drawings.
- 1.8.2.8.9 In view of installation, shop drawings shall include details of all proposed additional reinforcement, bracing or otherwise stiffened metalwork.
- 1.8.2.9 Mill test certificates for all steel. The Contractor is responsible for the correlation between the material used and the mill test certificates.
- 1.8.2.10 Quality control and test reports, including radiographic films.
- 1.8.3 Submit Material Safety Data Sheets for each product required by OSHA to have an MSDS.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

- 2.1.1 Formwork materials shall be as follows:
- 2.1.2 Wood Forms

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.2.1 Wood forms of sound and dressed lumber sheeting or plywood in good condition and free from defects. Forming wood shall be free of loose knots, warping, etc.
- 2.1.2.2 Forming wood shall be in new condition; i.e., all corners and edges shall be intact and the surface shall be smooth with no delaminating.
- 2.1.2.3 All formwork for exposed surfaces shall be made of plywood panels at least 16 mm thick. Such panels shall measure 2 400 mm long by at least 600 mm wide wherever the dimensions so allow.
- 2.1.2.4 Matchboard and tongue and groove board shall only be permitted for non-exposed surfaces.
- 2.1.3 Metal forms of prefabricated steel construction.
- 2.1.4 Materials for concrete formwork shall be suitable to achieve the finish requirements for formed surfaces as specified in the pertinent section of the specification.

2.2 FORM TIES

- 2.2.1 Form ties shall be metal rods or bolts of sufficient strength for intended service. Form ties that leave irregular holes or lead to repair marks that detract from specified finishes are prohibited.

2.3 FORM COATINGS, SEALERS AND RELEASE AGENTS

- 2.3.1 Sealtight Duogard as manufactured by W.R. Meadows, form oil or approved equivalent for form coatings, sealers, and release agents shall be used.

2.4 FORMWORK LINER

- 2.4.1 Unless indicated otherwise on the drawings, formwork shall be covered with a formwork liner type Drainaform as manufactured by Texel Inc. or approved equivalent, between elevations 37.50 m and 40.00 m for all upstream surfaces, including the bulkhead and intake gate shafts, and between elevations 0.50 m and 7.00 m for all downstream surfaces. The formwork liner is only required where the surface is normally in contact with water in the reservoir, tailrace and discharge channels. The formwork liner shall be installed as per the manufacturer's recommendations.



PART 3 EXECUTION

3.1 FORMWORK DESIGN

- 3.1.1 Calculations and Drawings

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.1.1.1 Design of formwork shall take into account the following minimum criteria:
 - 3.1.1.1.1 Weights of fresh concrete for walls and slabs (concrete density and pour rate);
 - 3.1.1.1.2 Loads superimposed by equipment and scheduled placement methods;
 - 3.1.1.1.3 Wind loading;
 - 3.1.1.1.4 Cambers (whether specified on drawings or not) to remain within the allowable wall and slab deflections;
 - 3.1.1.1.5 Resistance, deflection, water tightness.
 - 3.1.1.1.6 Description of the material in the wood, steel or other type of forming system.
- 3.1.1.2 Detailed drawings showing all the information needed to fabricate and assemble formwork in compliance with CSA A23.1/A23.2. The drawings shall indicate:
 - 3.1.1.2.1 Formwork construction details with proposed ties and type of spreaders and all other relevant details such as bracing, support;
 - 3.1.1.2.2 Formwork construction methods;
 - 3.1.1.2.3 Embedded items, such as piping and miscellaneous metalwork.
- 3.1.1.3 All formwork drawings and associated design calculations shall bear the signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
- 3.1.2 Rigidity and Water Tightness
 - 3.1.2.1 Formwork shall be sufficiently strong and watertight to withstand concrete and wind loads as well as the forces applied by the construction method used, with special consideration given to the placement rate shown on the drawings, to ensure that the finished concrete conforms to the lines, shapes and dimensions of the members indicated on the drawings.
 - 3.1.2.2 Formwork shall be sufficiently watertight to prevent mortar bleeding, and shall be appropriately tied and braced to maintain the desired shape during concrete placement and remain straight until the concrete has set.
 - 3.1.2.3 Prefabricated steel or reinforced wood panel formwork shall conform to the rigidity, water tightness and quality requirements described herein.
 - 3.1.2.4 Forms shall produce dense concrete surfaces free of honeycombing, depressions and bulging.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		

- 3.1.2.5 All bracing and supports shall be of adequate strength and appropriately anchored for the purposes for which they were designed.
- 3.1.2.6 Formwork shall be cambered, where necessary, to account for deflections in order to meet the final concrete formline geometry.
- 3.1.2.7 Braces shall be located in a way that will allow the formwork to be removed without impact or damage to the concrete.
- 3.1.2.8 Corners and shoring shall be checked and corrected horizontally and vertically during concrete placement. Provide a control wire parallel to the plane of the wall when concreting walls.
- 3.1.2.9 Competent manpower shall be assigned to continuously check formwork alignment and conformity with the tolerances and make adjustments as needed during concreting.

3.1.3 Formwork Classification



3.1.3.1 Formwork is classified according to the finish and the quality of concrete surface required and the tolerances specified in this Specification. The various formwork classes shall conform to the drawings, specifications and stipulations to adequately provide finish tolerances as described in Section 03 30 00 clause 3.15.5

3.1.3.1.1 Class F1

3.1.3.1.1.1 Used to create surfaces that will be backfilled or will never be exposed. Formwork may be built with minimal roughness treatment

3.1.3.1.2 Class F2

3.1.3.1.2.1 Used to create exposed surfaces other than those described in other classes. Formwork shall be made in a way that will result in a concrete surface with uniform texture and appearance. The same material for all form walls of this class shall be used. Patching of formwork surface openings is prohibited.

3.1.3.1.3 Class F3

3.1.3.1.3.1 Used to create hydraulic flow surfaces where uniformity and alignment accuracy are required. Wood formwork for straight and curved surfaces shall be made of sound wood free of knots and irregularities that can be cut and cambered with precision to the profiles required without splitting or twisting, and shall keep the shape it is given.

3.1.3.1.4 Class F4

3.1.3.1.4.1 Used for secondary concrete formed surfaces. Same characteristics as Class F3 but with more stringent tolerances.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.4 Connectors and Separators

3.1.4.1 Connectors

3.1.4.1.1 Formwork vertical walls shall be connected to each other or to a solid mass of concrete or rock using metal fasteners. Using twisted wire for form ties is prohibited.

3.1.4.1.2 Use removable or snap-off metal ties, fixed or adjustable length, using devices which have holes no larger than 25 mm diameter in the concrete surface on exposed work.

3.1.4.1.3 Use only watertight types of form ties and spacers for all formwork provided for the works.

3.1.4.2 Separators

3.1.4.2.1 Wooden separators shall be removed as the concrete reaches their level. Concrete separators and separators comprising attachments shall be left in the concrete.

3.1.4.3 Ties shall be positioned so as not to impede concrete placement. They shall be installed in vertical planes with a reasonable horizontal distance between them. The ends of the attachments shall be cut 40 mm from the surface inside the concrete, even for concrete faces that are not exposed.

3.2 FORMWORK PREPARATION

3.2.1 Coatings, Sealers and Release Agents

3.2.1.1 To prevent concrete from adhering, the formwork surface shall be treated with a plastic material or swabbed with fresh, non-detergent mineral oil. Formwork shall be swabbed prior to erection. All necessary precautions to prevent the oil from coming in contact with the reinforcement shall be taken.

3.2.1.2 Coatings, sealers or release agents shall be applied according to manufacturers' directions to achieve specified cure and finish before erecting forms.

3.2.1.3 Forms shall be protected from dust and dirt.

3.2.2 Lift Limitation

3.2.2.1 Lift levels shall be horizontal and delimited by a moulding. Unless otherwise indicated on drawings, all corners shall be chamfered to 25 mm, whether or not the surfaces are exposed, unless otherwise indicated on the drawings.

3.2.2.2 When close tolerances are required for vertical walls constructed in more than one lift, the formwork shall be continuous between lifts to prevent mortar from bleeding out between the new formwork and the concrete from the previous lift.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.3 Formwork Cleaning

3.2.3.1 Openings shall be provided for cleaning inaccessible parts of the formwork.

3.2.3.2 Narrow formwork shall have openings at their base arranged in a way to allow clearing of all debris prior to concrete placement. Openings shall have a cover that can be installed and held in place by the pressure of the concrete. Similar openings shall be provided on approximately 3.0 m centres at the base of very high walls and other structures.

3.2.3.3 The inside of the formwork shall be cleaned immediately before the concrete is placed.

3.3 ERECTION OF FORMWORK

3.3.1 General

3.3.1.1 Make forms tight to prevent leakage of mortar.

3.3.1.2 Make a 25 mm. x 25 mm chamfer on external corners and edges of concrete exposed to view unless otherwise specified.

3.3.1.3 At all unformed construction joints and at cold joints which may unavoidably arise during concrete placement, wooden strips of minimum section, 50 mm by 50 mm, shall be secured to the inside of the forms at the location of each joint to ensure a uniform finish to the outside edges of any lift of concrete. The upper layer of concrete shall be worked up to and under these strips so as to provide smooth edges.

3.3.1.4 Do not fasten form ties to reinforcing steel or embedded parts.

3.3.1.5 Prevent form oil from contacting steel reinforcement, or contacting concrete surfaces on which additional concrete or any bonded coating shall be placed. Apply form oil before placing reinforcing.

3.3.1.6 Place and secure inserts, boxes and sleeves in formwork as required. Set screens with true and straight top edges to proper elevation. Form openings for all services passing through concrete members.

3.3.1.7 Provide temporary openings in forms in order to facilitate cleaning and inspection. Immediately before placing concrete, remove all foreign materials such as shavings, chips and sawdust from the forms. After cleaning, plug holes flush with the inside surfaces of the forms.

3.3.1.8 Install back-up strips in formwork material joints to prevent offsets and maintain a continuous plane across adjacent panels.

3.3.1.9 All formwork shall be inspected by the Engineer before concreting.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 REMOVAL OF FORMWORK AND FALSEWORK

3.4.1 General

- 3.4.1.1 Formwork and falsework shall not be removed until the concrete has developed sufficient strength to bear its dead weight and any construction or other loads that may be imposed.
- 3.4.1.2 Care shall be taken in dismantling of formwork and falsework to prevent any damage that may result from premature form stripping
- 3.4.1.3 Where required, the formwork lining, if used, may temporarily be left on the concrete so it can be used for water curing of concrete surfaces.
- 3.4.1.4 The Engineer shall be given advance notice of the intention to remove formwork and falsework in order to obtain his approval before proceeding. Unless otherwise authorized by the Engineer, the time prior to removal of formwork and falsework shall be as specified hereafter. Specific situations not covered in the articles hereafter shall be complemented by the requirements of ACI 347 – Clause 3.7.2.3.
- 3.4.1.5 Where the required concrete curing period is longer than the time for removal of formwork, continue curing method after form removal to complete the curing.
- 3.4.1.6 After the formwork is removed, the concrete shall be cured and protected in compliance with the Specification Section 03 30 00 Cast in Place Concrete.
- 3.4.1.7 Protect all sharp edges of concrete and maintain the integrity of the design. Remove complete sections of forms without exerting stresses against corners of sets, reveals, or prying against exposed concrete surfaces with tools of any description.

3.4.2 Delays for Removal of Formwork and Falsework

- 3.4.2.1 The following delays shall apply to the removal of formwork (form stripping) and falsework:
- 3.4.2.1.1 For vertical surfaces, formwork may be removed as follows:
- 3.4.2.1.1.1 Thin cross-sections (< 1.0 m) after 48 hours for GU cement concrete and after 72 hours for LH-M cement concrete;
- 3.4.2.1.1.2 Thick cross-sections (≥ 1.0 m) after 24 hours for GU cement concrete and after 48 hours for LM-H cement concrete.
- 3.4.2.1.2 For beams, arches and structural slabs, the concrete strength shall have attained 70% of its specified compressive strength and with a minimum of 14 days before removal of formwork and falsework, unless shown otherwise on the drawings.
- 3.4.2.1.3 In all cases, the concrete shall have attained sufficient strength to prevent it from being damaged by the form stripping work and all superimposed loads that may be applied.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

3.4.2.1.4 In all cases, the removal of formwork and falsework shall be authorized by the Engineer.

3.4.3 Repair of formed surfaces

3.4.3.1 Carry out repair of formed surfaces as required by the Engineer and in accordance with normal practice and CSA A23.1/A23.2.

3.5 RE-USE OF FORMS

3.5.1 Clean and repair forms, prior to re-use, to meet requirements for achieving specified concrete finishes. All holes for bolts and ties shall be plugged smooth and flush to the formwork surfaces. Lumber formwork may be reused as long as it is structurally sound and forming wood is in new condition, i.e. all corners and edges shall be intact and the surface shall be smooth with no delaminating. The formwork liner shall be used for only one (1) application, no reuse of formwork liners is permitted.



3.6 CONTRACTION JOINTS

3.6.1 Contraction joints shall be constructed at the locations shown on the drawings.

3.6.2 For formed contraction joints, a bituminous coating conformed to CAN/CGSB 37-GP-9Ma shall be applied over the formed surfaces up to a distance of 500 mm from any concrete face, in accordance with the manufacturer's instructions.

3.7 SECONDARY CONCRETE FORMWORK

3.7.1 A complete set of drawings of the formwork together with a detailed description of the proposed methods of handling and placing of the secondary concrete shall be submitted to the Engineer before concreting.



3.7.2 All secondary formwork shall be of Class F-4.

3.7.3 Formwork shall be firmly attached in place, braced and supported to resist the loads to which it is exposed, keeping its alignment and shape. Formwork shall be tight and shall not permit any leakage.

3.7.4 Formwork shall be fixed on primary concrete and not to the embedded parts.

3.8 TOLERANCES

3.8.1 Construction Tolerances

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 11 00
CH0032	CONCRETE FORMWORK	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.8.1.1 The Contractor is responsible for designing, executing, and maintaining the formwork within the required limits such that the structure, when completed, is in compliance with the tolerances specified in Specification Section: 03 30 00 Cast-in-Place Concrete.

3.8.1.2 As soon as a problem is detected, in order to prevent a recurrence of any non conformance, the Contractor shall submit to the Engineer, for approval, preventive and/or corrective measures with regard to materials, type of formwork, concrete placement methods, finishing methods, etc.

3.8.1.3 The Engineer reserves the right to place a hold on the work until such preventive and/or corrective measure proposals are reviewed and found to be satisfactory.

3.8.2 Survey Grid Point Tolerances

3.8.2.1 Unless identified elsewhere, the applicable tolerances are:

3.8.2.1.1 Planimetric: ± 2 mm;

3.8.2.1.2 Altimetric: ± 2 mm.

3.9 FIELD QUALITY CONTROL

3.9.1 The Engineer shall be notified on completion of formwork erection and fixing of the items specified herein. Approval shall be obtained before making final arrangements to place concrete.

3.9.2 The Contractor shall make inspections before and during concrete placements to ensure that formwork is correctly located, sufficiently rigid and tight, clean, surface treated, and free from snow, ice, and other foreign materials.

3.9.3 Formwork and fixed items shall be checked during placing of concrete to detect formwork movements and to verify that specified tolerances are not exceeded.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1	GENERAL	2
1.1	SCOPE OF WORK	2
1.2	RELATED SECTIONS	2
1.3	DEFINITIONS	2
1.4	REFERENCES	2
1.5	QUALITY ASSURANCE	4
1.6	SUBMITTALS	5
PART 2	PRODUCTS	5
2.1	REINFORCING STEEL	5
2.2	STEEL FIBRES	6
2.3	WELDED WIRE FABRIC	6
2.4	MISCELLANEOUS ACCESSORIES	6
2.5	MECHANICAL SPLICES	7
2.6	EPOXY COATING	7
PART 3	EXECUTION	7
3.1	DETAILING	7
3.2	STORAGE AND HANDLING	7
3.3	FABRICATION	8
3.4	MARKING	8
3.5	WELDING	8
3.6	FIELD QUALITY CONTROL	9
3.7	INSPECTION AND TESTING	9



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification establishes the minimum requirements for materials, detailing, supply, fabrication, inspection, delivery to the work site and installation of reinforcing steel, welded wire fabric, steel fibre reinforcement and miscellaneous accessories for Concrete Reinforcement.

1.1.2 Work Included

1.1.2.1 This specification applies to all operations associated with, but not necessarily limited to, the following:

1.1.2.1.1 Supply, detailing, fabrication, delivery, storage and installation of reinforcing steel bars, welded wire fabric and miscellaneous accessories;

1.1.2.1.2 Preparation of placing drawings and bill of materials (bar bending schedules);

1.1.2.1.3 Furnish welding materials and perform field/shop welding, if required;

1.1.2.1.4 Inspection and testing.

1.1.2.2 The Contractor shall supply all necessary equipment and maintenance thereof to perform the work outlined in this Specification.

1.2 RELATED SECTIONS

1.2.1 Section: 03 30 00 Cast-in-Place Concrete

1.2.2 Section: 05 50 10 Miscellaneous Metals and Embedded Parts

1.2.3 Section: 48 13 10 General Mechanical Requirements

1.3 DEFINITIONS

SDRL : Supplier Documentation Requirement List

MSDS : Material Safety Data Sheets

OSHA : Occupational Safety and Health Administration

1.4 REFERENCES

1.4.1 The Contractor shall comply with the rules and provisions of the listed Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 All work shall be in accordance with this specification and the requirements of the following codes and standards:

1.4.3 Canadian Standards Association (CSA):

CAN/CSA-G30.15-M92	Welded Deformed Steel Wire Fabric for Concrete Reinforcement
 CSA-G30.18-09	Carbon Steel Bars for Concrete Reinforcement
 CSA-A23.1-09/A23.2-09	Concrete Materials and Methods of Concrete Construction/ Test Methods and Standard Practices for Concrete
CAN/CSA-A23.3-04 (R2010)	Design of Concrete Structures
CSA W186-M1990 (R2007)	Welding of Reinforcing Bars in Reinforced Concrete Construction
Reinf Steel Institute of Canada:	
RSIC-2009	Reinforcing Steel Manual of Standard Practice

1.4.4 American Concrete Institute:

ACI SP-66-04	ACI Detailing Manual 2004
ACI 318-11	Building Code Requirement for Structural Concrete and Commentary.

1.4.5 American Society for Testing and Materials:

ASTM A 108-07	Standard Specification for Steel Bars, Carbon, Cold Finished
ASTM A 185/A 185M-07	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 497/A 497M-07	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- ASTM A 615/A 615M-12 Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
- ASTM A 775/A775M-07 Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
- ASTM A 820/A 820M-11 Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
- ASTM A 934/934M-07 Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
- ASTM C 1116/C 1116M-10a Standard Specification for Fiber Reinforced Concrete

1.4.6 American Welding Society

- AWS A5.1/A5.1M-04 Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
- AWS D1.1/D1.1M-10 Structural Welding Code.
- AWS D1.4/D1.4M-11 Structural Welding Code – Reinforcing Steel.

1.4.7 Other Codes and References:

- OHSA Occupational Health and Safety Act, Newfoundland and Labrador
- ISO 1000 SI Units and Recommendations for the use of their multiples and of certain other units.
- ISO 80000-1-09 Quantities and Units – Part 1: General Principles.

1.5 QUALITY ASSURANCE

1.5.1 Quality of work shall be controlled to meet the requirements of this Specification, referenced codes and standards, and other contract documents in effect on the date of contract.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.2 The Contractor shall follow a Quality Control Program during execution of the work. The program for reinforcing steel shall include but not limited to dimensional checks and visual inspection for cracks at bends.

1.5.3 Certification

1.5.3.1 The Contractor shall obtain and retain Certificates of Compliance for all products listed in Part 2 for the Engineer's review, when requested.

1.5.3.2 Suppliers of reinforcing steel shall be certified to ISO 9001:2008 or equivalent.

1.5.4 Substitutions

1.5.4.1 Complete technical data as to type, composition, strength, quality, finish, capacity, performance characteristics, and other pertinent details will be required to determine the acceptability of a substitute item.

1.5.4.2 Substitution for a specified element shall only be considered if the element is not available or if it results in an improved detail or easier erection.

1.5.4.3 Substitutions shall receive written approval from the Engineer prior to being implemented.

1.6 SUBMITTALS

1.6.1 The Contractor shall submit the required documentation to the Engineer for review and approval, in accordance with the Supplier Document Requirement List (SDRL).

1.6.2 The Contractor shall submit Material Safety Data Sheets for each product required by OSHA to have an MSDS.

1.6.3 The Contractor shall submit a Quality Control Program that will be followed during execution of the work, to the Engineer for approval, prior to fabrication.

1.6.4 The detailed Quality Assurance Plan shall include inspection and testing of all materials and workmanship.

1.6.5 Submit certification from manufacturer indicating fibers meet the requirements of ASTM C1116.

PART 2 PRODUCTS

2.1 REINFORCING STEEL

2.1.1 Materials and workmanship shall comply with CAN/CSA-A23.3.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



2.1.2 Reinforcing bars shall be uncoated Grade 400R, with specified yield strength of 400 MPa conforming to CSA G30.18.

2.1.2.1 Where welding is specified on the drawings, the reinforcing bars shall be uncoated Grade 400W, with specified yield strength of 400 MPa conforming to CSA G30.18.

2.1.3 All bars for the concrete reinforcement shall be deformed bars, unless noted otherwise.

2.1.4 With each shipment of reinforcing steel, the Contractor shall provide certified mill test reports showing chemical and physical analysis for each heat of each size of reinforcing steel delivered.

2.1.5 Procured reinforcing steel shall be separated and tagged according to mill test identification numbers.

2.2 STEEL FIBRES

2.2.1 Cold drawn deformed steel wire, minimum 60 mm long, conforms to ASTM A820, Type one (1).

2.2.2 Acceptable products: Dramix 3D65/60BG or approved equal

2.3 WELDED WIRE FABRIC

2.3.1 Welded steel wire fabric shall be deformed, unless noted otherwise on the drawings, and shall have minimum yield strength of 450 MPa.

2.3.1.1 Welded wire fabric shall be provided in flat sheets only.

2.4 MISCELLANEOUS ACCESSORIES

2.4.1 Reinforcing steel bar supports shall be submitted for approval by the Engineer.

2.4.2 Bar supports, including chairs, bolsters, spacers, and tie wire shall be standard products from an approved manufacturer of such items. Properly sized supports shall provide adequate concrete cover and shall be furnished in sufficient quantity, manufactured to serve their intended purpose, and capable of carrying imposed loads without measurable deflection or displacement of the reinforcing steel.

2.4.3 Annealed tie wire size 1.6 mm diameter or heavier shall be used for tying reinforcing steel.

2.4.4 The size and shape of bar supports shall be selected so that the bar is maintained in proper position with minimal movement during concrete placement. Where concrete blocks are used for support, their compressive strength shall be 35 MPa.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4.5 Metal bar supports shall not be used to support reinforcing steel in concrete placed against earth.

2.5 MECHANICAL SPLICES

2.5.1 Mechanical splices, such as Dywidag, Lenton or Dextra Bartec shall conform to the requirements shown on the design drawings.

2.6 EPOXY COATING

2.6.1 Epoxy coating shall conform to ASTM A 775.

2.6.2 With each shipment of epoxy coated reinforcing steel, provide written certificates for the powder coating and the coated bars in accordance with ASTM A 775 and ASTM A934.

PART 3 EXECUTION

3.1 DETAILING

3.1.1 Reinforcing steel shall be detailed in accordance with RSIC-2009 and/or ACI SP-66, unless noted otherwise on the design drawings.

3.1.2 Bars shall be jointed, by laps, couplers or welding as per CAN/CSA-A23.3 and CSA W186 and shall conform to the requirements shown on the design drawings.

3.1.3 Reinforcing steel placing drawings and bills of material (bar bending schedules) shall be prepared in accordance with RSIC-2009.

3.1.4 Placing drawings for bills of material shall be submitted to the Engineer for approval. The Engineer's approval shall be obtained prior to fabrication. The total weight of each size of bar shall be shown on each placing drawing.

3.1.5 Placing drawings and bills of material shall indicate the quantities, grade, locations, spacing, sizes, and piece marks of each bar to be fabricated and placed. Bills of material shall indicate bar piece marks, shape designations, number of bars required, length, unit weight and total weight of each bar as well as the total weight of steel.

3.1.6 All welds shall be shown using welding symbols in accordance with CSA W186. Field welded connections shall not be used, unless specifically approved by the Engineer.

3.2 STORAGE AND HANDLING

3.2.1 Before and after fabrication, reinforcing steel shall be stored off the ground and protected from dirt, grease, oil or other deleterious materials.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev: D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.2 Padded contact areas shall be provided on all systems used for handling epoxy coated reinforcing. Epoxy coated bars shall be banded with material that will not damage the coating

3.3 FABRICATION

3.3.1 Do not fabricate reinforcing steel until bar bending lists have been reviewed by the Engineer.



3.3.2 Fabrication of reinforcing steel shall conform to the requirements of CSA-A23.1/A23.2 and RSIC.

3.3.3 Bars shall be bent cold to the dimensions shown on the design drawings and the approved bills of material.

3.3.4 Welded wire fabric shall be furnished in flat sheets, unless prior approval is obtained from the Engineer.

3.3.5 Reinforcing steel shall not be heated or flame-cut.

3.4 MARKING

3.4.1 Each bundle of reinforcing steel bars shall be tagged after fabrication. The tag shall show the quantity, grade, size, piece mark, and suitable identification to allow checking, sorting, and placing.

3.4.2 Each bundle of flat sheets of welded wire fabric shall be tagged after fabrication. Tags shall show the piece mark, quantity, style designation, width and length.

3.4.3 Weatherproof tags that will remain legible for one year (minimum) when stored outside shall be used.

3.5 WELDING



3.5.1 Only reinforcing steel conforming to CSA-G30.18 Grade 400W shall be welded or tacked, when shown on the drawings. If welding or tacking is shown, the Contractor shall obtain prior approval from the Engineer of welding procedures, procedure qualification records, and inspection plan as per CSA-A23.1/A23.2 and CSA W186.

3.5.2 Welders shall be qualified in accordance with the requirements of CSA W186, or an approved equivalent. The Contractor shall maintain welder qualification records at the location where the work is being performed and make them available for review when requested.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 20 00
CH0032	CONCRETE REINFORCEMENT	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6 FIELD QUALITY CONTROL

- 3.6.1 All reinforcing and other embedments for the pour are to be in place, checked and inspected by the Contractor prior to review by the Engineer. Completeness of reinforcing and embedments is the responsibility of the Contractor.
- 3.6.2 Advise the Engineer at least 48 hours in advance for review of the reinforcing steel.
- 3.6.3 The Engineer's review does not relieve the Contractor of its responsibility for correctly placing and adequately supporting the reinforcing steel and embedded parts. During placement, the Contractor may be required to provide additional support to the reinforcing steel and embedded parts. The Contractor may be required to stop a concrete placement until any inadequacy in steel support is corrected.
- 3.6.4 The concrete pour will only be authorized after the Engineer has reviewed the steel.
- 3.6.5 Remove loose rust, scale or any other materials from surfaces of reinforcement and accessories that would, in the opinion of the Engineer, reduce their bond effectiveness. After placing, maintain reinforcement in clean condition.
- 3.6.6 Adjust reinforcement and embedments immediately before concrete is poured to ensure that bars and embedments are in correct position and are securely tied or otherwise secured to maintain position.
- 3.6.7 Field bending of bars is not permitted unless authorized by the Engineer in which case bending shall be done with and approved procedure and without heat. Bars shall not be re-bent. Bars which develop cracks or splits shall be replaced.
- 3.6.8 Reinforcing steel shall not be flame-cut.

3.7 INSPECTION AND TESTING

- 3.7.1 The Contractor shall provide inspectors to inspect material and workmanship in the fabrication shop.
- 3.7.2 The Contractor shall visually inspect all welding in accordance with CSA W186.
- 3.7.3 The Engineer reserves the right to inspect work in the fabrication shop at any time. The Contractor shall make provisions for such inspection, when requested.

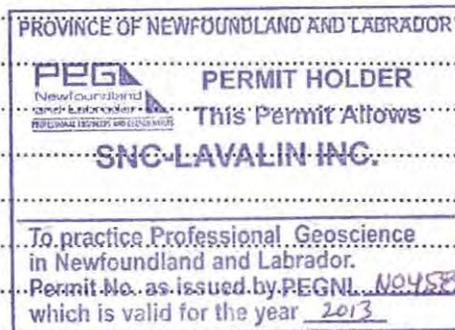
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 03 30 00
CAST-IN-PLACE CONCRETE
TABLE OF CONTENTS**

PART 1 GENERAL	3
1.1 SCOPE OF WORK	3
1.2 WORK INCLUDED	3
1.3 RELATED SECTIONS	3
1.4 DEFINITIONS	4
1.5 REFERENCES	4
1.6 QUALITY ASSURANCE	6
1.7 SUBMITTALS	7
PART 2 PRODUCTS	8
2.1 CEMENT	8
2.2 MIXING WATER	9
2.3 AGGREGATE	9
2.4 ADMIXTURES	17
2.5 SEALING COMPOUNDS	18
2.6 CURING COMPOUNDS	18
2.7 FLOOR HARDENERS	18
2.8 SUPPLEMENTARY CEMENTITIOUS MATERIALS	18
PART 3 EXECUTION	19
3.1 CONCRETE MIXES	19
3.2 PRODUCTION AND DELIVERY	22
3.3 CONCRETE QUALITY CONTROL	25
3.4 VERIFICATION PRIOR TO CONCRETING	28
3.5 CONCRETE HANDLING	31
3.6 CONCRETE PLACEMENT	33
3.7 CONCRETE CONSOLIDATION	34
3.8 SURFACE FINISHES	34
3.9 CONCRETE CURING AND PROTECTION	37
3.10 FORM STRIPPING	41



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.11 SURFACE TREATMENT AFTER FORMWORK REMOVAL 41

3.12 CONSTRUCTION JOINTS 42

3.13 CONTRACTION JOINTS 42

3.14 SECONDARY CONCRETE 43

3.15 CONSTRUCTION TOLERANCES 44

3.16 REPAIR OF DEFECTS 46

APPENDIX A..... 48

Handwritten initials: JB MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

PART 1 GENERAL

1.1 SCOPE OF WORK

- 1.1.1 This specification describes the requirements for the supply of all labour, material, equipment and supervision for concrete preparation, transportation and placement, needed to execute the work described on the drawings and in the specifications.
- 1.1.2 This Specification shall be read conjointly with CSA A23.1/A23.2. However, the requirements of this Specification supersede the corresponding ones of CSA A23.1/A23.2.

1.2 WORK INCLUDED

- 1.2.1 The work covered by this specification includes, without being limited to, the following:
 - 1.2.1.1 Supply of all material, labour, equipment and supervision needed to prepare concrete of the type and strength required by the contract documents and as shown on the drawings, and also the delivery to the work site and unloading at the required locations.
 - 1.2.1.2 In-plant and in-field testing of concrete strength and other properties, as applicable.
 - 1.2.1.3 Protection of concrete up to the delivery point, in hot or cold weather.
 - 1.2.1.4 Scarification of concrete surfaces to receive new concrete, except surfaces of primary concrete place by Company's other contractor.
 - 1.2.1.5 Not Used.
 - 1.2.1.6 Not Used.
 - 1.2.1.7 Labour, materials and facilities needed to place, cure and protect secondary concrete in hot or cold weather.
 - 1.2.1.8 Construction of required control and expansion joints.
 - 1.2.1.9 Repairing of any defective work.
 - 1.2.1.10 Cleaning of work areas.

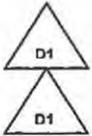
1.3 RELATED SECTIONS

- 1.3.1 Section: 01 35 43 General Environmental Requirements
- 1.3.2 Section: 03 11 00 Concrete Formwork
- 1.3.3 Section: 03 20 00 Concrete Reinforcement
- 1.3.4 Section: 05 50 10 Miscellaneous Metals and Embedded Parts



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



1.3.5 Section: 48 13 10 General Mechanical Requirements

1.3.6 Section: 48 13 20 Gates and Trashracks

1.4 DEFINITIONS

1.4.1 Engineer: The consulting Engineer or its representative.

1.4.2 Contractor: The entity responsible for the execution of the work covered by this Specification either directly or through Subcontractors.

1.4.3 SDRL: Supplier Documentation Requirement List.

1.4.4 MSDS: Materials Safety Data Sheets

1.4.5 OSHA: Occupational Safety and Health Administration

1.4.6 Primary concrete is equivalent to first stage concrete

1.4.7 Secondary concrete is equivalent to second stage concrete

1.4.8 GU cement: General use cement as per CSA A3001-08.

1.5 REFERENCES

1.5.1 The Contractor shall comply with the rules and provisions of the latest editions and amendments of the *listed* Codes and Standards. The Contractor shall seek approval from the Engineer prior to using equivalent other codes and standards.

1.5.1.1 Codes and Standards

1.5.1.1.1 All work shall be in accordance with this specification and the requirements of the following.

1.5.1.1.2 A copy of the CAN/CSA A23.1/A23.2 standards shall be kept on site at all times.

1.5.2 Canadian Standard Association (CSA)

CSA A3000-08	Cementitious Materials Compendium
CSA A23.1-09/A23.2-09	Concrete Materials & Methods of Concrete Construction / Test Methods & Standard Practices for Concrete
CAN/CSA S269.1-1975(R2003)	Falsework for Construction Purpose
CAN/CSA S269.3-M92(R2008)	Concrete Formwork
CAN/CSA A23.3-04(R2010)	Design of Concrete Structures



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.3 Canadian General Standards Board (CGSB)

- CAN/CGSB 37-GP-9Ma Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing
- CAN/CGSB-25.20-95 Surface Sealer for Floors



1.5.4 American Society for Testing and Materials (ASTM)

- ASTM C94/C94M-12 Standard Specifications for Ready-Mixed Concrete
- ASTM C150-12 Standard Specification for Portland Cement
- ASTM C227-10 Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)
- ASTM C260-10 Specifications for Air-Entraining Admixtures for Concrete
- ASTM C289-07 Standard Test Method for Alkali-Silica Reactivity of Aggregates (Chemical Method)
- ASTM C309-07-11 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- ASTM C457/C457M-11 Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- ASTM C494/C494M-11 Standards Specification for Chemical Admixtures for Concrete
- ASTM C685/C685M-11 Standard Specification for Concrete Made by Volumetric Batching for Continuous Mixing
- ASTM C1017/C1017M-07 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C1107-11 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- ASTM C1260-07 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
- ASTM D422-63 (2007) Standard Test Method for Particle Size Analysis of Soils
- ASTM C1293-8b Standard Test Method for Determination of Length Change of Concrete due to Alkali-Silica Reaction.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.5 Other Codes and References

- NBC 2010 National Building Code of Canada 2010 and the Supplement to the National Building Code of Canada
- ISO 1000 SI Units and Recommendations for the use of their multiples and of certain other units.
- ISO 31-0 Quantities and Units – Part 0: General Principles.
- ACI 347 Guide to Formwork for Concrete
- ACI 214 ACI Recommended Practice for Evaluation of Compression Test Results of Field Concrete

1.5.6 American Concrete Institute:

- ACI 347-04 Guide to Formwork for Concrete
- ACI 214R-11 Guide to Evaluation of Strength Test Results of Concrete
- ACI 305R-06 Guide to Hot Weather Concreting
- ACI 306R-10 Guide to Cold Weather Concreting
- ACI 318-11 Building Code Requirements for Structural Concrete and Commentary



1.6 QUALITY ASSURANCE

1.6.1 Quality of work shall be controlled to meet the requirements of this Specification, referenced codes and standards, and other contract documents in effect on the date of contract.



1.6.2 The Contractor shall prepare and submit a detailed statement of proposed quality control procedures for all aspects of the work. The Contractor shall follow a Quality Control Program during execution of the work. The program shall include inspection and testing of all materials as well as dimensional checks and visual inspection.



1.6.2.1 The Engineer will audit the Contractor's quality control program and will make independent tests. These tests shall be at the Company's expense, to verify that the material meets its intended purpose.



1.6.2.2 The Engineer may carry out additional construction audits during the progress of the Work. The Engineer's audit during construction shall in no way replace the Contractor's quality control program or relieve the Contractor from its contractual responsibility.

1.6.3 All chemicals used need to be accompanied by a "Material Safety Data Sheet" and recorded on a site hazardous record document to be kept at the facility offices. For a list of substances not to be used due to their toxicity and health risk, refer to Specification Section 01 35 43: General Environmental Requirements.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6.4 The Contractor shall obtain and retain Certificates of Compliance for all products listed in Part 2 for the Engineer's review, when requested.

1.6.5 Complete technical data as to type, composition, strength, quality, finish, capacity, performance characteristics, and other pertinent details will be required to determine the acceptability of a substitute item.

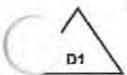
1.6.6 The Engineer reserves the right to accept or reject any proposed substitution.



1.6.7 Substitution for a specified element shall only be considered if the element is not available or if it results in an improved detail or better construction. Substitutions shall receive written approval from the Engineer prior to being implemented.



1.6.8 At each stage of preparation and construction, the Contractor's quality control representative shall complete the appropriate section of Concrete Placement Authorization Form and sign the appropriate section off when, but not before, he is satisfied that the portion of the work is satisfactorily completed. The Engineer shall be given the opportunity to audit each stage of the Work before commencement of the subsequent stage.



1.6.9 If the Engineer finds any portion of the preparation is not in accordance with the specification and/or good workmanship, the Contractor shall rectify the deficiency and no concrete shall be done until the deficiency is rectified.



1.6.10 The Contractor shall bring to the attention of the Engineer any defects in the work or departures from the Contract Documents that may occur during construction, provide recommended method to correct the defect and state recommendations in writing.

1.7 SUBMITTALS



1.7.1 The Contractor shall submit to the Engineer for approval, the Quality Control program that will be followed during the execution of the work.

1.7.2 The Contractor shall submit the following documentation to the Engineer for review and approval, in accordance with the supplier document Requirements List (SDRL).

1.7.3 Concrete Materials

1.7.3.1 Sources of supply of all cementitious materials proposed for the works and test reports for all cementitious materials verifying that the materials conform to the standards and requirements specified herein.

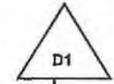
1.7.3.2 Sources of supply of all coarse and fine aggregates proposed for the Works and test reports on each size of aggregate verifying that the materials conforms to the standards and requirements specified herein.

1.7.3.3 Data sheets for all chemical admixtures proposed for the Work and certification that the admixtures conform to the standards and requirements specified herein.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- 1.7.3.4 Certification that the air entraining admixtures are compatible with the water reducing admixtures and the high range water reducing admixtures (super-plasticizer).
- 1.7.3.5 Source of the water for the concrete proposed for the Work and verification that the water conforms to the standards and requirements specified herein.
- 1.7.4 Placement Method
 - 1.7.4.1 The Contractor shall submit details of proposed methods of placing, consolidating, finishing, curing and protecting concrete and materials including measures to be taken during hot and cold weather and during precipitation, including proposed measures to control concrete temperatures and temperature differentials before, during and after placement. Submit details of proposed cooling measures to achieve required concrete delivery and curing temperatures in hot weather conditions and proposed measures to avoid bug holes in the concrete surface.
- 1.7.5 Equipment
 - 1.7.5.1 The Contractor shall submit a list of all equipment to be used in batching, transporting, placing, consolidating and finishing the concrete and grout, together with a list of proposed standby equipment.
- 1.7.6 Test Results
 - 1.7.6.1 Results for all testing to the Engineer within 24 hours of receipt.
- 1.7.7 Materials for Concrete Related Products
 - 1.7.7.1 Manufacturer's Specifications for the selected product for sealant, curing compound, releasing agent and other proprietary concrete-related products.
- 1.7.8 The Contractor shall provide a Material Safety Data Sheet for each product required by OSHA to have a MSDS.



PART 2 PRODUCTS

2.1 CEMENT

- 2.1.1 Cement shall be as defined in this Specification, conforming to the relevant referenced codes and standard specifications.
- 2.1.2 Portland cements type LH-M and type GU shall be used. Other types consisting of a blend of 35 to 40% LH-M with 10 to 15% GU and 50% Slag may also be used.
- 2.1.3 The cements shall have low alkalis content (no more than 0.6%).
- 2.1.4 Unless noted otherwise on the drawings, cement type GU shall be used.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 MIXING WATER

- 2.2.1 The water shall conform to Section 4.2.2 of CSA A23.1/A23.2.
- 2.2.2 Concrete mixing water shall be free of salts, alkalis, acids and suspended particulates in proportions that could adversely affect the quality of the concrete.

2.3 AGGREGATE

- 2.3.1 General
 - 2.3.1.1 Normal-density fine and coarse aggregate shall be used exclusively.
 - 2.3.2 Sampling and Testing Frequency
 - 2.3.2.1 Aggregate shall be sampled in accordance with the CSA A23.2-1A test method. Supplements A1 and A2 of this method shall apply.
 - 2.3.2.2 Aggregate samples shall be taken at the end of the conveyor when the aggregate materials are transported via a conveyor system (belt conveyor).
 - 2.3.2.3 The test method, frequency and sampled location are indicated in Table 1.
 - 2.3.2.4 When test results are non-conforming, the necessary corrective actions shall be taken, and conformance of the materials with the requirements shall be demonstrated by testing.
 - 2.3.2.5 Individual tests shall be carried out on coarse aggregate and fine aggregate, and also on the combination of coarse and fine aggregate as used on the site.
- 2.3.3 Normal-density fine aggregate
 - 2.3.3.1 Normal-density fine aggregate shall consist of natural sand.
 - 2.3.3.2 The Engineer may authorize the use of manufactured sand or stone screening as a replacement for part of the natural sand if it can be shown through test results that doing so will have no deleterious effects on the concrete, such as an increased demand for water to achieve a given slump, an increase in the amount of air entraining admixture needed to maintain a given air content, etc. The Engineer shall determine the replacement material percentage.
 - 2.3.3.3 The fine sand sieve analysis results shall fall within the limits specified in Table 2.
 - 2.3.3.4 During sandpit or sieving operations, the daily average (i.e. computed from the samples tested each day) sieve analysis distribution will be considered one lot for quality control purposes; the sampling frequency shall be as shown in Table 1.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.3.3.5 During concrete manufacturing, the average sieve analysis distribution representing the aggregate used daily will be considered one lot for quality control purposes; the sampling frequency shall be as shown in Table 1.
- 2.3.3.6 Deviation from the requirements of one or more sieves in an individual sieve analysis will not be considered non-conforming. However, the individual results shall be clearly identified "Acceptable", easily traceable, and the Engineer shall be notified.
- 2.3.3.7 The material will be considered non-conforming if there is a deficiency or excess on one or more sieves with respect to the average result of a lot (i.e. daily average).
- 2.3.4 Normal-density coarse aggregate
 - 2.3.4.1 Normal-density coarse aggregate shall consist of crushed rock or crushed natural gravel.
 - 2.3.4.2 For crushed natural gravel, the percentage by weight of aggregate fragmented by crushing and retained on a 5 mm sieve shall be greater than 80%.
 - 2.3.4.3 Coarse aggregate size shall be chosen based on the nominal dimensions given in Table 3, in conformance with the criteria of Sections 4.3.2.2 and 4.3.6 of CAN/CSA A23.1.
 - 2.3.4.4 Prepare 40-5 mm aggregate using either the three coarse aggregate gradings 40-20 mm, 20-10 mm and 10-5 mm, or the two coarse aggregate gradings 40-20 mm and 20-5 mm, combined at the batching plant in proportions that will ensure the sieve requirements of 40-5 mm coarse aggregate are met.
 - 2.3.4.5 Prepare 20-5 mm class aggregate directly or using two coarse aggregate classes, 20-10 mm and 10-5 mm, combined at the batching plant in proportions that will ensure the sieve requirements of 20-5 mm coarse aggregate are met.
 - 2.3.4.6 During coarse aggregate manufacturing, the daily average (i.e. computed from the samples tested each day) sieve analysis distribution for each manufactured size will be considered one lot for quality control purposes; the sampling frequency shall be as shown in Table 1.
 - 2.3.4.7 During concrete manufacturing, the combined average sieve analysis distribution determined by calculating the aggregates used daily will be considered one lot for quality control purposes; the sampling frequency shall be as shown in Table 1.
 - 2.3.4.8 Deviation from the requirements of one or more sieves in an individual sieve analysis will not be considered non-conforming. However, the individual results shall be clearly identified "Acceptable", easily traceable, and the Engineer shall be notified.
 - 2.3.4.9 The material will be considered non-conforming if there is a deficiency or excess on one or more sieves with respect to the average result of a lot (i.e. daily average).
 - 2.3.4.10 Prepare 80-5 mm aggregate using either the four (4) coarse aggregate gradings 80-40 mm, 40-20 mm, 20-10 mm and 10-5 mm, or the three (3) coarse aggregate gradings 80-40 mm,

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MB 96

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

40-20 mm and 20-5 mm, combined at the batching plant in proportions that will ensure the sieve requirements of 80-5 mm coarse aggregate are met.

2.3.5 Deleterious substances and physical properties

2.3.5.1 The results of test performed on separate samples, in conformance with the grading requirements given in Tables 2 and 3, shall not exceed the limits prescribed in Table 4 of this Specification. Deleterious substances and physical properties shall be determined in accordance with the test methods indicated in Table 4.

Table 1 - Aggregate Test Frequency

Material	Test & Method	Minimum Frequency ⁽⁵⁾	Location & Need
Fine aggregate	Petrographic examination CAN/CSA A23.2-15A	At least once per source ⁽¹⁾	Report less than 3 years old
	Qualitative tests ⁽²⁾ . See Table 4	Once per source	Report less than 1 year old
	Alkali-aggregate reactivity CAN/CSA A23.2-14A & 25A	Once a year for each source	Report less than 3 years old
	Absorption CAN/CSA A23.2-6A	Once a month	Batching plant
		At least 3 times per source ⁽⁴⁾	Sandpit
	Organic impurities CAN/CSA A23.2-7A	Twice per shift ⁽³⁾	Sandpit
		Once per shift	Batching plant
	Sieve analysis & fineness modulus. CAN/CSA A23.2-2A	Twice per shift and more often, if necessary	Sandpit
		Once per shift	Batching plant
	Specific gravity CAN/CSA A23.2-6A	Once a month	Batching plant
		At least 3 times per source ⁽⁴⁾	Sandpit
	Moisture content CAN/CSA A23.2-11A	Continuously	Batching plant
Bulk density CAN/CSA A23.2-10A	Once a month	Batching plant	
	At least 3 times per source ⁽⁴⁾	Sandpit	

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



Table 1 - Aggregate Test Frequency (continued)

Coarse aggregate	Petrographic examination CAN/CSA A23.2-15A	At least once per source ⁽¹⁾	Report less than 3 years old
	Alkali-aggregate reactivity CAN/CSA A23.2-14A & 25A	Once a year for each source	Report less than 3 years old
	Absorption CAN/CSA A23.2-12A	Once a month	Batching plant
		At least 3 times per source ⁽⁴⁾	Crusher
	Sieve analysis CAN/CSA A23.2-2A Fines < 80 µm CAN/CSA A23.2-5A	Twice per shift	Crusher
	Sieve analysis CAN/CSA A23.2-2A	Once per shift	Batching Plant
	Sieve analysis ⁽⁶⁾ CAN/CSA A23.2-2A	Twice per week (to check automated dosing)	After washing concrete on 5 mm sieve
	Specific gravity CAN/CSA A23.2-12A	Once a month	Batching plant
		At least 3 times per source ⁽⁴⁾	Crusher
	Bulk density CAN/CSA A23.2-10A	Once a month	Batching plant
		3 times at the beginning	Crusher
Fines < 80 µm CAN/CSA A23.2-5A	Once a month	Batching plant	
Fragmentation (Test for natural gravel; not expected to be used. If natural gravel is used, refer to the Engineer for an appropriate test)	At least once per source	Natural gravel only (if used)	

Notes: see next page

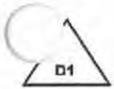
Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- Notes:⁽¹⁾ Each quarry, warehouse or storage area is considered an independent source. A quarry, warehouse or storage area is considered a unique source of material if the contents of said quarry, warehouse, or storage area are of homogeneous composition. If the quarry, warehouse or storage area contents are heterogeneous in composition, i.e. composed of more than one type of rock or materials of different origin, said quarry, warehouse or storage area is considered a multiple source and each source must be checked.
- (2) Qualitative tests are those described in Table 4 of this Specification.
 - (3) Shift: 10 hour period; night shift and day shift.
 - (4) Per period of continuous production.
 - (5) The minimum frequency may be changed with the Engineer's approval.
 - (6) The coarse aggregate sieve analysis obtained after washing the concrete mix on a 5 mm sieve shall not be used as a test for acceptance or rejection according to the requirements of Table 3. Such tests shall only be used to verify coarse aggregate automated dosing. One must take into account the fact that some of the particles in the stone will pass through the 5 mm sieve during washing, while some of the particles in the sand will be retained on the 5 mm sieve.

Table 2 – Fine Aggregate Grading Limits

Sieve dimension	Total weight passing in %	
	Concrete sand	Mortar sand
10 mm	100	-
5 mm	95 - 100	-
2.5 mm	80 - 100	100
1.25 mm	50 - 90	95 - 100
0.630 mm	25 - 65	60 - 85
0.315 mm	10 - 35	30 - 50
0.160 mm	2 - 10	10 - 30
0.080 mm	0 - 3 ⁽¹⁾	0 - 5

Notes: ⁽¹⁾ This limit may be extended to 5% in conformance with the requirements indicated at the bottom of Table 4.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3.6 Petrographic examination

2.3.6.1 A petrographic examination of the aggregate is required for each source or type of rock at the start of operations for each borrow source or quarry.

2.3.7 Aggregate approval

2.3.7.1 All the equipment required to manufacture the coarse aggregate, including washing systems, in order to conform with the grading requirements indicated in Table 3 (40-20, 20-10, 20-5A, 10-5A and 10-2.5A) shall be provided. Non-conforming aggregate shall be re-screened or washed, or both, to meet the grading requirements and the Table 4 requirement with regard to cleanliness at the 80 µm sieve.



Table 3— Coarse Aggregate Size

Nominal size of coarse aggregate (mm)	Total % by weight passing each sieve in mm										
	112	80	56	40	28	20	14	10	5	2.5	1.25
Group I	Group I grading requirements apply to the batching plant during concrete mixing										
40-5†	-	-	100	85 - 100	-	35 - 70	-	10 - 30	0 - 5	-	-
20-5††	-	-	-	-	100	85 - 100	50 - 90	25 - 60	0 - 10	0 - 5	-
10-5	-	-	-	-	-	-	100	85 - 100	0 - 20	0 - 5	-
10-2.5	-	-	-	-	-	-	100	85 - 100	10 - 30	0 - 10	0 - 5
Group II	Group II grading requirements apply to crushing										
40-20	-	-	100	90 - 100	25 - 60	0 - 15	-	0 - 5	-	-	-
20-10	-	-	-	-	100	85 - 100	40 - 60	0 - 20	0 - 5	-	-
20-5A	-	-	-	-	100	85 - 100	50 - 80	25 - 60	0 - 7	0 - 3	-
10-5A	-	-	-	-	-	-	100	85 - 100	0 - 12	0 - 3	-
10-2.5A	-	-	-	-	-	-	100	85 - 100	10 - 20	0 - 7	0 - 3

Notes: † To prevent segregation, aggregates that make up either of these grading shall be stockpiled and batched in two or more separate sizes selected from Group II.

†† Aggregates that make this grading shall be stockpiled and batched in either one size, or two separate sizes selected from Group II.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



Table 4 - Deleterious Substance Limits⁽¹⁾ & Physical Properties

Properties	Maximum % of total sample		Test method	Minimum frequency
	Fine aggregate	Coarse aggregate		
1- Basic requirements				
Clay lumps ⁽²⁾	1.0	0.3	CAN/CSA A23.2-3A	Once per source ⁽¹⁰⁾
Low density granular constituents ⁽³⁾	0.5	0.5	CAN/CSA A23.2-4A	Once per source ⁽¹⁰⁾
Fines passing the 80 µm sieve	3.0 ⁽⁴⁾	1.0 ⁽⁵⁾	CAN/CSA A23.2-5A	Once per sieve analysis during crushing Once a month at batching plant for coarse aggregate Once per sieve analysis for fine aggregate
Flat particles		25	CAN/CSA A23.2-13A, procedure B	Once per source ⁽¹⁰⁾
Elongated particles	-	45	CAN/CSA A23.2-13A, procedure B	Once per source ⁽¹⁰⁾
Flat & elongated particles	-	20	CAN/CSA A23.2-13A, procedure A	Once per source ⁽¹⁰⁾
Micro-Deval test ⁽⁶⁾	20	17	CAN/CSA A23.2-23A, CAN/CSA A23.2-29A	Once per source ⁽¹⁰⁾
Unconfined aggregate freeze/thaw test ⁽⁷⁾	-	6	CAN/CSA A23.2-24A	Once per source ⁽¹⁰⁾
Los Angeles abrasion loss test ⁽⁸⁾	N/A	50	CAN/CSA A23.2-16A, CAN/CSA A23.2-17A	Once per source ⁽¹⁰⁾
2- Alternative requirements to Micro-Deval test				
MgSO ₄ soundness losses ⁽⁹⁾	16	12	CAN/CSA A23.2-9A	Once per source ⁽¹⁰⁾

Notes: see next page

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- Notes: (1) The limits for deleterious substances not listed in this table, such as chert, schist, siltstone, sandstone or argillaceous limestone, will be specified by the Engineer so as to cover all deleterious substances known to exist in a given region. In the absence of such information, aggregate will be approved or rejected based on Section 4.2.3.9 of CAN/CSA A23.1.
- (2) Lumps of clay mean fine sedimentary substances, consolidated with aluminosilicates in aqueous form. This test does not apply to quarries with rock that is igneous by nature.
- (3) A liquid with a specific gravity of 2.0 is usually used to separate particles of coal or lignite. Liquids with specific gravities greater or less than 2.0 may be needed to identify other deleterious substances with a lower specific gravity.
- (4) This limit may be extended to 5% if the clay particles of less than 2 µm do not comprise more than 1% of the total fine aggregate sample. The amount of clay particles less than 2 µm must be determined by hydrometric analysis using the ASTM D422 test method, on a washed sample, on an 80 µm sieve.
- (5) In the case of crushed aggregate, if the particles passing the 80 µm sieve consist of crushing dust that is essentially free of clay or schist, the limit indicated above may be increased to 2.0% when used at the batching plant, and does not apply during crushing. Notwithstanding the limit of this requirement, when the aggregate is coated with an adherent substance and appears dirty, it shall be subjected to the following test to determine the adherence of the substance to the aggregate: Place a sample of the aggregate in calm water, shake the sample slightly, and remove it. If, after this test, 80% of the sample aggregate is clean, the aggregate is acceptable; otherwise, the aggregate will have to be washed.
- (6) Test method CAN/CSA A23.2-23A for testing fine aggregate is quick and extremely accurate. It also correlates closely with the more complicated and more variable MgSO₄ disintegration resistance test. For more information, refer to the document entitled: Micro-Deval Test for Evaluating the Quality of Fine Aggregate for Concrete and Asphalt, by C.A. Rogers, M. Bailey & B. Price. Transportation Research Board, Record No. 1301, 1991, pp. 68-76.
- (7) Test method CAN/CSA A23.2-24A for testing coarse aggregate provides good accuracy and an acceptable correlation with the MgSO₄ disintegration resistance test. For more information, refer to the document entitled: Development of an Unconfined Freeze-Thaw Test for Coarse Aggregate, by C.A. Rogers, S.A. Senior & D. Boothe, Ontario Ministry of Transportation, Engineering Materials Report EM-87, 1989.
- (8) Losses due to abrasion must not exceed 35% when the aggregate is used for construction of concrete roadways or other surfaces exposed to significant wear and tear.
- (9) The Micro-Deval test requirements for fine aggregate or the freeze-thaw requirements for coarse aggregate may be waived if the requirements of the MgSO₄ soundness losses are within limits.
- (10) Provided the source is homogeneous - shall be otherwise increased.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 ADMIXTURES

- 2.4.1 All admixtures shall be approved by the Engineer.
- 2.4.2 An authorization to use an admixture from a different manufacturer not previously approved shall be obtained from the Engineer.
- 2.4.3 The admixtures shall conform to CSA A23.1/A23.2 and shall be used in accordance with their manufacturer's instructions. They shall not contain calcium chloride, either by addition or via formation as the result of chemical reaction between the concrete components.
- 2.4.4 The use of an admixture shall not reduce the durability of the concrete or its resistance to freezing and thawing. The Supplier shall show, through appropriate tests, that none of the admixtures, used individually or in combination, have an adverse effect on the concrete final properties.
- 2.4.5 Workability admixtures shall conform to ASTM C494/C494M, and ASTM C1017.
- 2.4.6 Initial set retarding or accelerating admixtures shall conform to ASTM C494/C494M.
- 2.4.7 Air entraining admixtures shall conform to ASTM C260.
- 2.4.8 A viscosity admixture may be required for some classes of concrete. If so, it shall be approved by the Engineer.
- 2.4.9 Water reducing admixtures shall conform to ASTM C 494, Type A.
- 2.4.10 Super-plasticizers or high range water reducer admixtures shall not be used without prior approval by the Engineer. Slump of high-slump (flowable) concrete must not exceed 150 mm in order to prevent segregation. Approval for use of super-plasticizers or high range water reducer admixtures shall be limited to concrete having a specified slump of 50 – 100 mm.
- 2.4.11 Super-plasticizers shall conform to ASTM C 1017 and high range water reducer admixtures to ASTM C 494. Type F.
- 2.4.12 Super-plasticizers or high range water reducer admixtures shall not react adversely with the air entraining agent.
- 2.4.13 All other chemical admixtures are not authorized, unless approved by the Engineer for a specific use.
- 2.4.14 If admixtures are specified or if the Contractor proposes their use, the concrete mix shall be designed or redesigned incorporating the admixture, subject to prior approval from the Engineer. If requested, the Contractor shall supply additional test results indicating the effect the admixture has on such things as durability, workability, and segregation. These tests are in addition to those required by this Specification.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



2.5 SEALING COMPOUNDS

- 2.5.1 Surface sealers shall conform to CAN/CGSB-25.20 and shall not be manufactured or formulated with formaldehyde, mercury, lead, cadmium, hexavalent chromium or their compounds.
- 2.5.2 Sealing compound application shall be executed as per Manufacturer's instructions.
- 2.5.3 Acceptable sealers are as follows:
 - 2.5.3.1 Kure-N-Seal 30 ES by BASF;
 - 2.5.3.2 Floreseal WB 18 & 25 by SIKA;
 - 2.5.3.3 Decra-Seal Plus by W.R. Meadows;
 - 2.5.3.4 Or approved equal.

2.6 CURING COMPOUNDS

- 2.6.1 Curing compounds shall meet ASTM C309 requirements and shall be approved by the Engineer.
- 2.6.2 The use of curing compounds containing linseed oil is prohibited.
- 2.6.3 Curing compounds shall have low volatile organic compound emissions.

2.7 FLOOR HARDENERS

- 2.7.1 Concrete floor hardener shall be Sodium silicate or Magnesium fluosilicate type.
- 2.7.2 Acceptable floor hardeners are:
 - 2.7.2.1 Sikafloor 3S by SIKA;
 - 2.7.2.2 Or approved equal.

2.8 SUPPLEMENTARY CEMENTITIOUS MATERIALS

- 2.8.1 Supplementary cementitious materials, if permitted by the Engineer, shall conform to the following:
 - 2.8.1.1 Fly ash shall conform to Type F as defined in CSA A3001-08 Cementitious Materials for use in Concrete. Fly ash content, if used, shall not exceed 25% by weight of the total cementitious material.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.8.1.2 For each shipment of fly ash, obtain and retain a certified mill test report on chemical and physical properties confirming compliance with this Specification. Test reports shall be submitted for the Engineer's review upon request.
- 2.8.1.3 Silica fume content, if used, shall not exceed 10% by weight of the total cementitious material.
- 2.8.1.4 All approved supplementary cementitious materials shall comply with A3001-08. Cementitious Materials for use in Concrete.

PART 3 EXECUTION

3.1 CONCRETE MIXES

3.1.1 Submittals

3.1.1.1 The Contractor shall submit to the Engineer, for approval, tests reports certifying that the materials listed below meet the specified requirements:

3.1.1.1.1 portland cement;

3.1.1.1.2 slag;

3.1.1.1.3 admixtures;

3.1.1.1.4 aggregates;

3.1.1.1.5 mixing water;

3.1.1.1.6 supplementary cementitious materials.

3.1.1.2 The Contractor shall submit to the Engineer, for approval, a report to the effect that the mixing equipment, and other equipment and materials to be used in preparing the concrete, meet the requirements of CSA A23.1/A23.2.

3.1.2 Mix Design

3.1.2.1 The Contractor shall submit to the Engineer, for approval, a report concerning the concrete mix formulas and the results of the Compliance Tests as per Section 3.1.9 of this Specification. The report shall include the following information:

3.1.2.1.1 water-cement ratio;

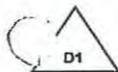
3.1.2.1.2 mix proportions with admixtures used;

3.1.2.1.3 order of mix ingredient incorporation (if important);

3.1.2.1.4 estimated average strength;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.1.2.1.5 hardened concrete air void characteristics per CSA A23.1/A23.2.
- 3.1.2.2 The applicable acceptance criteria shall be those given in CSA A23.1/A23.2.
- 3.1.3 Mix Classes
 - 3.1.3.1 Mixes shall conform to the classes given in the tables of Appendix A.
 - 3.1.3.2 Each class is proportioned to produce the required concrete strength, plasticity and workability for the purposes for which it will be used.
 - 3.1.3.3 Mixes shall meet the required standards throughout the course of the concreting work.
 - 3.1.3.4 New mix formula shall be submitted to the Engineer for approval, including the information requested in Compliance Tests as per Article 3.1.9 of this Section, at least three weeks prior to the start of its use.
- 3.1.4 Specified Strength
 - 3.1.4.1 The strength of concrete is specified by a Class letter, as indicated in Appendix A.
 - 3.1.4.2 The compressive strength corresponds to the strength at 28 days of normal curing for cement type GU and at 91 days for cement type LH-M.
- 3.1.5 Maximum Nominal Aggregate Size
 - 3.1.5.1 The maximum nominal aggregate size is specified by sub-classes, as indicated in Appendix A.
- 3.1.6 Slump
 - 3.1.6.1 The necessary slump is specified by sub-classes, as indicated in Appendix A.
- 3.1.7 Air-Entraining Admixture
 - 3.1.7.1 Unless otherwise stipulated by the Engineer, all mixes shall contain entrained air, as indicated in Appendix A.
 - 3.1.7.2 The entrained air specified in Appendix A is a function of the maximum aggregate size and is for a severe exposure to freeze-thaw cycles.
- 3.1.8 Equipment
 - 3.1.8.1 The mixing equipment and other equipment and material to be used in preparing the concrete shall meet the requirements of CAN/CSA A23.1.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.8.2 The equipment and mixing method shall provide accurate control of the ratios of cement, aggregate and water incorporated into each mix to produce mixes that are uniform and consistent over time.



3.1.9 Compliance Tests



3.1.9.1 Compliance tests shall be performed in order to verify that the concrete produced at the plant complies with the required properties given in the tables of Appendix A.

3.1.9.2 The tests pertain to the cement powder, mix formula and the mixing method and equipment. A new series of tests shall be carried out if any change is made to these parameters.

3.1.9.3 The tests shall be conducted using the mixing equipment to be employed on site.



3.1.9.4 The tests shall be performed prior to start of concreting operation.

3.1.9.5 Mix compliance with specification requirements shall be demonstrated through one test on each of the A2, B2 and B3 class concrete.

3.1.9.6 A test shall consist of at least 2 m3 of concrete mix.

3.1.9.7 Hardened concrete air voids shall be verified on a concrete sample of each test taken no sooner than 15 minutes after the super-plasticizer is added. The sample shall be taken after handling is completed with the mixing and placement method to be used in the planned concreting.



3.1.9.8 For cement type LH-M, compressive strength shall be obtained for each test as follows: two cylinders at 3 days, two at 7 days, two at 28 days and two at 91 days.

3.1.9.9 For cement type GU, compressive strength shall be obtained for each test as follows: two cylinders at 3 days, two at 7 days and two at 28 days.

3.1.10 Mixes for Pre-Defined Usages

3.1.10.1 Bond Mix

3.1.10.1.1 Bond mix to be used as a start layer on rock or concrete shall be of Class « X-3 » for a mix of Class X, where « X » represents the specified mix class A, B, BC, C, or D.

3.1.10.2 Fill Concrete Mix

3.1.10.2.1 Fill concrete shall be of the same Class as the structural concrete with which it is in contact, unless noted otherwise by the Engineer.

3.1.10.3 Mud Slab Mix

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.10.3.1 Mud slab mix shall be of the same Class as the structural concrete with which it is in contact, unless noted otherwise by the Engineer.

3.1.10.4 Lean Concrete Mix

3.1.10.4.1 Lean concrete shall be of Class D, unless noted otherwise by the Engineer.

3.1.10.5 CLSM Mix

3.1.10.5.1 Controlled low strength material (CLSM) mix shall be of Class X-2, unless noted otherwise on the drawings.



3.1.10.6 Concrete class mixed for pre-defined usages shall be supplied and placed as shown on the drawings.

3.2 PRODUCTION AND DELIVERY

3.2.1 General

3.2.1.1 Unless otherwise indicated herein, concrete shall be prepared and delivered in compliance with the requirements of CSA A23.1/A23.2.

3.2.2 Production

3.2.2.1 Mixing of Concrete



3.2.2.1.1 Concrete shall be mixed and placed in accordance with ASTM C94 and CSA A23.1 requirements.

3.2.2.1.2 The concrete shall be mixed using a stationary mixer.

3.2.2.1.3 Partial pre-mixes and truck mixes are not accepted.

3.2.2.2 Mixing Time

3.2.2.2.1 Mixing time shall conform to Section 5.2.3 of CAN/CSA A23.1. Any batch that has lost part of its plasticity due to over mixing shall be rejected.

3.2.2.3 Concrete Temperature



3.2.2.3.1 The temperature of the concrete at the time of placement shall be within the limits specified in Table 5 below.



3.2.2.3.2 The Maximum differential temperature within any part of the concrete during hydration shall be 20°C or less.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

 3.2.2.3.3 The maximum temperature within any part of the concrete during hydration shall be 65°C or less.

Table 5 – Concrete Temperature at Time of Placement

Smallest Element Dimension	Min. Temp. in °C ^{(1) (2)}	Max. Temp. in °C ⁽¹⁾
Less than 0.3 m	10	32
From 0.3 to 1.0 m	5	28
From 1.0 to 2.0 m	5	20
More than 2.0 m	3	12 ⁽³⁾
More than 2.0 m and indicated on drawings	3	7 ⁽³⁾

Notes: ⁽¹⁾ The temperatures given are the average of a pour.

⁽²⁾ The minimum temperature shall be aimed at.

⁽³⁾ May be exceeded when 100% of the water has been replaced by ice.

3.2.2.4 Cold Weather Concreting

3.2.2.4.1 It may be necessary to prepare concrete at a temperature slightly higher than the minimum limit specified in Table 5 to compensate for the temperature drop due to cooling of the concrete during transport.

3.2.2.4.2 In cold weather, the water may have to be heated. The water temperature shall not exceed 80°C.

3.2.2.4.3 The drum or bin of the trucks transporting the concrete shall be sufficiently insulated to minimize concrete temperature drop. Any concrete with a truck outlet temperature that is less than the lower limit specified in Table 5 shall be rejected.

3.2.2.5 Hot Weather Concreting

3.2.2.5.1 Unless otherwise indicated herein, concrete shall be prepared and transported in compliance with CSA A23.1.

3.2.2.5.2 Special attention shall be paid to ensure that the temperature of any concrete mixed in hot weather is kept as low as possible.

3.2.2.5.3 In hot weather, it may be necessary to prepare concrete at a temperature that is lower than the minimum limit specified to compensate for the rise in temperature due to heating of the concrete during transport.

3.2.3 Delivery

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.3.1 General

3.2.3.1.1 All concrete shall be delivered by a mixer truck or an agitator truck.

3.2.3.1.2 The delivery point for the freshly mixed concrete shall be as specified by the Contractor or as indicated on the drawings.

3.2.3.1.3 Any concrete found to be deficient upon delivery to the site shall be rejected.

3.2.3.1.4 Concrete shall be placed as soon as possible after mixing. The maximum time between initial mixing and placement shall be 120 minutes. Any concrete that has not been placed within this time frame or that has begun to set shall be rejected, unless set retardant admixtures are used in agreement with the Engineer.

3.2.3.2 Slump Adjustment

3.2.3.2.1 Refer to Section 3.3.2 of this Section for slump control.

 3.2.3.2.2 If the slump is less than the specified slump at the start of unloading, and no more than 60 minutes have elapsed between dosing and unloading, the slump may be adjusted as per the recommendation of CAN/CSA A23.1 and following the approval of the Engineer.

3.2.3.2.3 No slump adjustment is permitted when concrete is delivered by an agitator truck.

 3.2.3.2.4 Adding water or super-plasticizer to adjust the concrete characteristics is permitted as per the recommendations of CAN/CSA A23.1 and following the approval of the Engineer.

3.2.3.2.5 The amount of water or super-plasticizer added shall be approved and carried out under the supervision of the Contractor or a designated Field Engineer. It shall be recorded.

3.2.3.2.6 After slump adjustment, the measured slump shall conform to the specified slump.

3.2.3.3 Air Adjustment

3.2.3.3.1 Refer to Section 3.3.3 of this Specification for air content control.

3.2.3.3.2 Concrete shall be rejected if the measured entrained air does not conform to the specified limits.

3.2.3.3.3 Adjustment of the entrained air is permitted only if the measured entrained air is less than the percentage specified.

3.2.3.3.4 After air content adjustment, the measured air content shall conform to the specified air content.

3.2.3.4 Delivery Receipt

3.2.3.4.1 A delivery receipt containing the following information shall be provided for each truck.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

- 3.2.3.4.1.1 Concrete supplier's company name and concrete plant identification.
- 3.2.3.4.1.2 Date and the ID number of the delivery receipt.
- 3.2.3.4.1.3 Name of the ready mix truck operator.
- 3.2.3.4.1.4 Designation of the structure or part thereof.
- 3.2.3.4.1.5 Class of concrete and other relevant information (batch number, slump limits, air content, temperature, maximum nominal coarse aggregate size, admixtures).
- 3.2.3.4.1.6 Volume of concrete in cubic meters.
- 3.2.3.4.1.7 Truck number, cumulative volume for the on-going pour, the haul number, or all three.
- 3.2.3.4.1.8 Loading or start of constituent mixing time.
- 3.2.3.4.1.9 Time of arrival on site.
- 3.2.3.4.1.10 Time unloading begins.
- 3.2.3.4.1.11 Time unloading is complete.
- 3.2.3.4.1.12 The amount of super-plasticizer added after dosing and the signature of the Contractor's representative or Engineer's representative, who authorized the addition.



3.3 CONCRETE QUALITY CONTROL



3.3.1 Inspection and Testing



3.3.1.1 Concrete shall be inspected and tested by an independent laboratory appointed and paid by the Engineer.

3.3.1.2 Tests shall be carried out in compliance with CSA A23.1/A23.2.

3.3.1.3 Testing frequency shall be as indicated in Table 6.

3.3.2 Slump

3.3.2.1 Concrete slump shall not exceed the allowable limits indicated in Appendix A.

3.3.2.2 When the measured concrete slump is lower than the inferior limit specified, concrete is considered acceptable if the placement and consolidation methods are promptly adapted.

3.3.2.3 For each pour, the slump shall be verified for the first two loads. If the slump conforms to the specified percentage for both loads, the verification may subsequently be spaced every three loads, or every five loads if the pour rate exceeds 75 m³/h.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.3.2.4 If a load is later found non-conforming, the next one shall also be verified, and so on until two consecutive loads are conforming. Only then may the slump verification frequency be reduced again.
- 3.3.2.5 The above verification frequency shall be increased in case of lack of concrete uniformity or of doubt.
- 3.3.2.6 Slump verification shall also be made each time a concrete cylinder is taken for a strength test.
- 3.3.3 Air Content
 - 3.3.3.1 Air shall be entrained using an agent that produces a satisfactory network of air bubbles in the hardened concrete.
 - 3.3.3.2 Total air content at the time of concrete placement shall meet the requirements of Appendix A.
 - 3.3.3.3 Concrete air content shall be determined using the CAN/CSA A23.2-4C standard method.
 - 3.3.3.4 Entrained air concrete shall also meet the requirements of ASTM C457.
 - 3.3.3.5 For each pour, the entrained air shall be verified for the first two loads. If the air content conforms to the specified percentage for both loads, the verification may subsequently be spaced every three loads, or every five loads if the pour rate exceeds 75 m³/h.
 - 3.3.3.6 If a load is later found non-conforming, the next one shall also be verified, and so on until two consecutive loads are conforming. Only then may the air verification frequency be reduced again.
 - 3.3.3.7 The above verification frequency shall be increased in case of lack of concrete uniformity or of doubt.
 - 3.3.3.8 Entrained air verification shall also be made each time a concrete cylinder is taken for a strength test.
- 3.3.4 Temperature
 - 3.3.4.1 Temperature shall be verified each time slump or air or both is checked and also when concrete cylinder is taken for a strength test.
 - 3.3.4.2 Temperature measurement can be checked as often as required to insure compliance to standards.
- 3.3.5 Strength

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00 ,
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



3.3.5.1 For cement type LH-M, two cylinders shall be taken for the 3-day tests, two for the 7-day tests, two for the 28-day tests and two for the 91-day tests.

3.3.5.2 For cement type GU, two cylinders shall be taken for the 3-day tests, two for the 7-day tests and two for the 28-day tests.

3.3.5.3 For control purposes, strength tests shall be carried out on test cylinders prepared in compliance with CSA A23.1/A23.2-3C and verified in compliance with CSA A23.1/A23.2-9C.

3.3.5.4 Concrete will be accepted if it meets the CSA A23.1/A23.2 Section 4.4.6.6.1 requirements.

3.3.6 Other Tests

3.3.6.1 Tests on cement, admixtures and curing products shall be carried out in compliance with standardized CSA or ASTM practices, or those of other recognized concrete associations, and at the frequency established by the Contractor.

3.3.6.2 The compressive strength of in-place concrete, when it is required, shall be verified in compliance with CSA A23.1/A23.2, Section 4.4.6.2. The testing method shall be approved by the Engineer.

3.3.7 Acceptable non-conformity

3.3.7.1 A load with either non-conforming slump, air content or temperature, may be considered "acceptable" if the following conditions are met.

3.3.7.1.1 Only one of these three conditions exists:

3.3.7.1.1.1 measured concrete slump is not more than 10 mm above the upper limit specified; air content and temperature characteristics are conforming;

3.3.7.1.1.2 measured entrained air is no more than 0.2% outside the specified limits; slump and temperature characteristics are conforming;

3.3.7.1.1.3 measured temperature does not exceed the maximum specified by more than 5 °C; slump and air content characteristics are conforming; average temperature of the pour conforms to the requirements.

3.3.7.1.2 Total volume of "acceptable" concrete does not exceed 10% of the total pour volume. However, when the pour volume is less than 80 m³, total volume of "acceptable" concrete shall not exceed 8 m³ or a single load.



3.3.7.2 A non-conforming but "acceptable" load may be poured. It shall be registered as "acceptable".

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



3.3.7.3 A non-conforming and "not acceptable" load shall not be used. A non-conformance report shall be issued to the Contractor.



3.3.7.4 In both cases, the next load shall be verified until two consecutive loads are conforming.

Table 6 – Cast-in-Place Concrete Testing Frequency

Test	Frequency	Location and Need
Slump	Continuously; at each compressive strength test	At the delivery point
Entrained air at the concrete plastic state	Continuously; at each compressive strength test	At the delivery point
Entrained air at the concrete hardened state	2 per year for concrete classes A-2, B-2 and B3, and the most frequently used classes subjected to weather (freeze-thaw cycles).	Sample taken at the delivery point
Temperature	Continuously; at each compressive strength test.	At the delivery point
Compressive strength of 150 x 300 mm cylinders	Minimum one set of samples per shift, per 100 m ³ , per day, per element type and per concrete class.	Samples taken at the delivery point. Others, according to structural needs, site needs, etc.
Density of fresh concrete (unit weight)	Each time a sample is taken for a compressive strength test.	At the delivery point

3.4 VERIFICATION PRIOR TO CONCRETING



3.4.1 Concreting Placement Authorization Request



3.4.1.1 The Concreting Placement Authorization Request, duly completed, shall be submitted to the Engineer, at least 24 hours prior to each placement, giving all relevant information concerning the placement.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

-  3.4.1.2 Before submitting the Authorization Request, the Contractor shall make the necessary verifications comprising the following items:
 - 3.4.1.2.1 Characteristics of the concrete to be used.
 - 3.4.1.2.2 Reference to any change notice, or change to drawings.
 - 3.4.1.2.3 Concreting program, placement equipment (quantity and description) and hourly concreting rate.
 - 3.4.1.2.4 Temperature allowed at the point of discharge of plastic concrete.
 - 3.4.1.2.5 Presence on site of the equipment and material needed to place, consolidate, finish, cure and protect the concrete.
 - 3.4.1.2.6 Condition and cleanliness of formwork, rebar, embedded parts and concrete and rock surfaces.
 - 3.4.1.2.7 Waterstops condition: Refer to the "Quality Control" Section of the Waterstops specification.
 - 3.4.1.2.8 Ambient air temperature in the formwork and temperature of the rock or concrete that will come in contact with the fresh concrete.
 - 3.4.1.2.9 Installation compliance with formwork drawings, including shoring and scaffolding installed, with evidence that they were approved by an Engineer in accordance with relevant codes and standards.
 - 3.4.1.2.10 Installation compliance with reinforcing steel drawings and embedded part drawings.
 - 3.4.1.2.11 Condition of the soil under all foundations to ensure that the latter are resting on soil with satisfactory bearing capacity.
 - 3.4.1.2.12 Condition of the concrete against which the fresh concrete will be placed to ensure that all surfaces have been scarified in compliance with clause 3.8 Surface Finishes below.
 - 3.4.1.2.13 Survey checks have been done prior to placement.
 - 3.4.1.2.14 Weather protection, if required, is in place.
-  3.4.1.3 The Engineer shall approve and return the duly signed Concrete Placement Authorization Request to the Contractor, if everything conforms to the drawings and the specifications. Otherwise, the Engineer shall indicate on the unapproved Authorization Request the corrective measures that must be taken, and the Engineer shall verify them before authorizing concreting.
- 3.4.2 Formwork



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

-  3.4.2.1 Formwork shall conform to Specification Section: 03 11 00 Concrete Formwork.
-  3.4.2.2 to 3.4.2.6 Not used.
- 3.4.3 Surface Preparation Prior to Concreting
 - 3.4.3.1 The rock against which the fresh concrete will be placed shall be properly scaled and cleaned, and water seepage sources shall be adequately channelled.
 - 3.4.3.2 The wire mesh screen shall not be embedded in the concrete. It shall be removed and scrapped as the concrete lifts progress. Removal shall be carried out without damaging the rock consolidation bolts.
 - 3.4.3.3 After removing the wire mesh screen, the surface shall be scaled to remove any loose materials from the vaults and walls. Scaling shall be done manually, with a bar, by experienced personnel. All the material resulting from scaling shall be removed.
 -  3.4.3.4 Concrete surfaces (horizontal, vertical, inclined) against which concrete is to be placed shall have a surface finish as described in Clause 3.8 of this Specification.
 -  3.4.3.5 Before placing concrete on rock, soil or hardened concrete, the surface shall be carefully cleaned to remove all loose materials and foreign bodies, as well as any standing water. If the concrete is to be placed on soil, the surface shall be compacted to the density specified on drawings.
 - 3.4.3.6 The Contractor shall verify that the method of placing concrete on rock, or hardened concrete on a slope, has been reviewed.
 - 3.4.3.7 Placing concrete on a frozen surface is strictly prohibited.
- 3.4.4 Reinforcement and Embedded Items
 - 3.4.4.1 Concrete reinforcement and embedded or buried items shall be clean and free of dried concrete, oil and rust, and shall conform to the Specification Section: 03 20 00 and Section: 05 50 10 respectively.
 - 3.4.4.2 The spacing shown on the drawings between the reinforcement and formwork or outer surfaces shall be strictly respected. Reinforcement and embedded or buried items shall be solidly supported to prevent them from moving during concreting.
 -  3.4.4.3 Embedded parts and assemblies shall be placed securely and with care by the Contractor so that their positions are according to the drawings and meet the tolerances, where applicable.
 -  3.4.4.4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of all modifications from the Engineer before placing concrete.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5 CONCRETE HANDLING

3.5.1 General

3.5.1.1 Concrete shall be handled in a way that the properties of the fresh concrete delivered will not be altered at the time it is placed.

 3.5.1.2 For pumping and conveying, a compliance test shall verify that the properties of the concrete at the point of discharge meet the requirements of Appendix A. These compliance tests shall be performed a minimum of 12 weeks prior to the scheduled concreting date and whenever a new concreting setup/mix equipment is proposed, so that adjustments, if necessary, can be made prior to final date of pour.

3.5.2 Equipment

3.5.2.1 Handling equipment shall have the capacity and shape required to ensure a constant rate of concrete supply at its delivery point.

3.5.2.2 None of the handling equipment shall be supported on the formwork, unless the formwork design has taken such support into consideration.

3.5.2.3 None of the handling equipment shall be supported on the reinforcement or embedded parts.

3.5.2.4 All equipment shall have adequate capacity to prevent cold joints. Handling equipment shall be used in a way that will meet all the requirements of CAN/CSA A23.1 Section 7 and in compliance with the following sections.

3.5.3 Concrete Trucks

 3.5.3.1 Concrete trucks shall have chutes that are wide enough to allow concrete to be unloaded without clogging.

3.5.4 Chutes and Drops

 3.5.4.1 When the concrete drop is significant (lift > 1.5 m), provide chutes or hoses to conduct the concrete to the base of the formwork, thereby preventing it from segregating or "cascading" through the reinforcement.

3.5.4.2 Chutes shall be round and covered inside with a metal sheet. At the time of use, the slope shall be such that the concrete slides at low speed, without rolling, to prevent segregation.

3.5.4.3 Chutes or plastic or steel hoses shall have a diameter of at least 150 mm and shall be fitted with a collector funnel. The maximum allowable chute length is 9.0 m. When this length is exceeded, the concrete shall be received in another hopper.

3.5.5 Belt Conveyors



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.5.1 Belt conveyors shall be wide enough to prevent overflow and their slope shall be kept low enough to prevent the concrete from slipping on the belt surface.

3.5.5.2 The first conveyor shall have a loading hopper to prevent segregation and overflow. Conveyors shall be fitted with a scraper at the discharge point to prevent the loss of mortar. All conveyors, including the last one at the point of concrete discharge into the formwork, shall also have a small hopper at the discharge point. The hopper on the final conveyor shall be extended by a vertical hose long enough so that the concrete arrives vertically in the formwork with no segregation.



3.5.5.3 Complex conveyor systems will only be authorized if the properties of the concrete at the outlet of the system conform to the requirements of Clause 3.5.1 of this Section.

3.5.6 Hoppers

3.5.6.1 Hoppers shall have diameters large enough to allow concrete to flow without using a vibrator.

3.5.6.2 Hoppers for concrete classes with aggregates of nominal size less than or equal to 80 mm shall be metal and shall have a nominal diameter of 300 mm.

3.5.6.3 If the total drop height inside the supply line is greater than 9.0 m, the concrete shall be received in another hopper with a capacity of 0.75 m³ more than the volume of the supply line.

3.5.7 Concrete Pumps

3.5.7.1 Unless otherwise indicated on the drawings, concrete pumps may be used.

3.5.7.2 All types of pumps shall pump the specified concrete at acceptable rates, through the lines of required length, without significantly altering the mix dose.

3.5.7.3 The use of aluminum alloy hoses in the concrete transport system is prohibited as they chemically react with cement.

3.5.7.4 The pump line primer grout shall be of the same Class as the specified concrete Class (e.g. B-5 for Class B concrete).

3.5.7.5 The primer grout may be used if it represents a small percentage of the concrete to be poured and if no doubt exists concerning its quality. The specified concrete shall be vibrated to mix with the primer grout.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6 CONCRETE PLACEMENT

3.6.1 Preparation

 3.6.1.1 In addition to the items listed in Clause 3.4, "Verification Prior to Concreting", the following conditions shall also apply:

3.6.1.2 Surfaces shall be kept moistened for a minimum duration of three hours before concreting and shall be kept clean and free from dirt. This mainly applies to hardened concrete surfaces, rock and soil against which the concrete is to be placed.

3.6.1.3 Surfaces of niches and openings to be filled with concrete shall be cleaned out and washed before placing the secondary concrete.

3.6.1.4 Bonding agents shall only be used at the request of the Engineer.

3.6.2 Concreting

3.6.2.1 Concrete shall be placed as close as possible to its final position, in a way that will prevent any segregation or alteration of delivered concrete properties.

3.6.2.2 As a guiding rule, concrete should be placed at the lowest point first.

 3.6.2.3 When concrete is placed in a deep beam, a wall or a column, at the same time as the slab above, the vertical section, if deeper than 1.5 m shall be poured first and a delay between one and three hours shall be left for the concrete to settle before pouring the slab above. After this delay, the concrete must still be plastic enough to allow a complete mix with the slab concrete through re-vibration.

 3.6.2.4 Concreting on rock or on set concrete shall start with the use of a 150 mm layer of bond mix, as defined in Clause 3.1.10. Under the supervision of the Engineer, this first layer to be placed on the cleaned surface shall be of the concrete Class mix specified in Clause 3.1.10 and it shall be well-vibrated to achieve maximum bond.

3.6.2.5 Concreting shall continue in a non-stop manner and each layer shall be covered by concrete in a plastic state before its initial set commences.

3.6.2.6 Competent manpower shall be available on site during concreting to move and reinstall the bars, and make adjustments as needed.

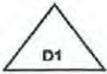
3.6.2.7 Competent manpower shall be available during concreting to check formwork and make adjustments as needed.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7 CONCRETE CONSOLIDATION

3.7.1 Equipment



3.7.1.1 Vibrator diameters and vibration frequency shall conform to Table 19 of CSA A23.1.



3.7.1.2 There shall be a few vibrators on the concreting site in addition to the number needed to do the work. Vibrators shall be in good operating condition.

3.7.1.3 Vibration frequency of each vibrator shall be verified at the beginning of the work and at least once a year.

3.7.2 Vibration

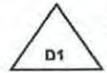
3.7.2.1 Concrete shall be consolidated in compliance with CSA A23.1/A23.2, Clause 7.2.5.2.

3.7.2.2 At least two vibrators shall be used for walls and beams – one to level the concrete immediately after it is placed and the other to consolidate it.

3.7.2.3 The distance between vibration points in general shall be approximately one to one-and-a-half times the observed radius of action.

3.7.2.4 The vibrator shall penetrate at least 150 mm into the previous layer. It shall then be slowly withdrawn at a speed of less than 100 mm per second.

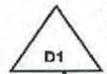
3.7.2.5 The vibrator shall not be used to move the concrete laterally.



3.7.2.6 The vibrator shall not come in contact with reinforcing steel or embedded items in the concrete.

3.8 SURFACE FINISHES

3.8.1 Concrete



3.8.1.1 Increasing surface concrete plasticity to facilitate finishing is prohibited. Rather, a lower slump class (e.g. B-3-A instead of B-3) shall be used to prevent bleeding and excess laitance.

3.8.1.2 Dusting freshly placed concrete surfaces with cement or a mixture of sand and cement before or during the finishing operations is prohibited.

3.8.2 Levelling

3.8.2.1 Regardless of the nature of the pour, the surface shall be compacted and levelled with a wooden or magnesium trowel to incorporate all the aggregate into the mass of concrete and remove any surface irregularities. After this initial levelling, the surface shall not be touched again before bleeding is complete.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.8.3 Un-Formed Surface Classification

3.8.3.1 The finishes for un-formed surfaces are classified in accordance with the quality of the concrete surface required and the tolerances as specified in Clause 3.15 Construction Tolerances. The various classes shall conform to the drawings, specifications and stipulations set forth below.

3.8.3.1.1 U1 (screeding, bull floating/darbying): refer also to CSA A23.1 Clause 7.5.3.

3.8.3.1.1.1 Obtained by levelling: serves as the first phase for U2 and U3 finishes or for concrete surfaces that will never be exposed. The concrete surface shall be levelled to remove all defects exceeding the specified tolerances.

3.8.3.1.2 U2 finish (Edging/grooving, floating): refer also to CSA A23.1 Clause 7.5.4.2.

3.8.3.1.2.1 Used to finish exposed surfaces or as a second phase for a U3 finish. After edging and grooving, the concrete surface shall be smoothed using a wooden or steel float, or a mechanical float, to provide a uniform surface meeting the specified tolerances. Floating shall not be excessive.

3.8.3.1.3 U3 finish (trowelling): refer also to CSA A23.1 Clause 7.5.4.3.

3.8.3.1.3.1 Used for concrete surfaces where a smooth and hard finish is required. The concrete surface shall be smoothed using a wooden or steel trowel, or a mechanical trowel, to provide a uniform surface meeting the specified tolerances. The first trowelling may produce the required uniform surface. In the case where the first trowelling is mechanical, at least another one shall be executed manually to eliminate the small defects. When the concrete surface is exposed to water current, the last trowelling shall be made with a wood trowel. A time interval shall separate each trowelling in order for the concrete to harden. As the surface hardens, the trowel size shall diminish while increasing progressively (applicable also to mechanical trowel) the tool angle and the pressure applied on it.

3.8.4 Scarification

3.8.4.1 Unless otherwise indicated on the drawings, all surfaces that are to be covered with concrete, formed or otherwise vertical, horizontal or sloped, shall be scarified after the concrete has set or after the forms are removed, using a jet of pressurized water, pressurized abrasive, water and air, or any other means approved by the Engineer, to remove laitance, expose coarse aggregate and obtain a roughness of at least 5 mm.

3.8.4.2 Non-formed surfaces to be scarified shall be wet with a surface retarder immediately after concreting in order to facilitate the scarification operation. The required time between concreting and scarification, as well as the jet pressure, shall be determined through tests and approved by the Engineer.

3.8.4.3 Formed surfaces to be scarified may be wetted with a surface retarder prior to concreting in order to facilitate the scarification operation. The surfaces shall have their forms stripped

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

after the required time between concreting and form removal. Scarification shall be carried out immediately after the forms are removed. The jet pressure shall be adjusted based on the concrete age hardness. For hardened concrete that has developed most of its strength, and depending on the type of nozzle used, this pressure could be as high as 70 MPa. The pressure to be used, based on the time after concreting, shall be determined through tests and shall be approved by the Engineer.

- 3.8.4.4 Application of surface retarder shall not be done close to embedded parts and reinforcing steel.
- 3.8.4.5 All dislodged aggregates shall be removed.
- 3.8.4.6 All surfaces to be scarified shall be inspected and approved by the Engineer after scarification is completed.
- 3.8.5 Floor Topping
 - 3.8.5.1 Bonded or monolithic type topping shall be executed as per the requirements of CSA A23.1 Clause 7.6 but the mix formula, slump, and water/cement ratio shall conform to the requirements of Specification Section: 03 30 00: Cast-in-Place Concrete.
 - 3.8.5.2 Bonded toppings shall be at least 75 mm thick.
 - 3.8.5.3 Monolithic toppings shall be 50 mm thick minimum and 150 mm maximum.
 - 3.8.5.4 In the case of bonded toppings, any support surface contamination shall be removed, preferably immediately before the topping is placed, by scarification as per this Specification or by percussion drill, in accordance with the Engineer's instructions.
 - 3.8.5.5 Concrete topping for trowel-finished interior concrete floors should not include an air-entraining admixture; the maximum air content for these concretes should normally be 3%. Higher air contents make the surface difficult to finish, and can lead to surface blistering and peeling during finishing.
- 3.8.6 Floor Hardener
 - 3.8.6.1 Floor hardener application shall be executed, where indicated on the drawings, as per Manufacturer's instructions.
 - 3.8.6.2 In the case of a non-metallic hardener, it may be required to reduce or remove air entrainment in the concrete.
 - 3.8.6.3 Concrete floor hardener shall not be used where concrete is exposed to freeze-thaw cycles and/or to de-icing salt.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.9 CONCRETE CURING AND PROTECTION

3.9.1 General

3.9.1.1 Curing shall conform to CSA A23.1 Clause 7.4

3.9.1.2 Concrete shall be protected against premature dry-out, excessive heat or cold, and damage, immediately after it is placed, and shall be kept at a relatively constant temperature with minimal moisture loss during the time needed for the cement to hydrate.

3.9.1.3 Horizontal concrete surfaces and any vertical surface to which fresh concrete must bind shall be water-cured.

3.9.1.4 Vertical concrete surfaces to which fresh concrete must not bind may be cured with a curing compound.

3.9.1.5 Specific curing restrictions, if required, are shown on the drawings.

3.9.2 Curing Period

3.9.2.1 Curing period shall be seven (7) consecutive days for GU cement concrete and ten (10) consecutive days for LH-M cement concrete.

3.9.3 Water Curing

3.9.3.1 Curing water temperature shall not be below 10°C.

3.9.3.2 The surface shall not be allowed to dry out during this time. Special care shall be taken in heated shelters.

3.9.4 Curing Compounds

3.9.4.1 All materials shall be approved prior to installation

3.9.4.2 In areas that are sheltered from inclement weather, resin and wax based products shall be used.

3.9.4.3 In areas exposed to inclement weather, chlorinated rubber-based products shall be used.

3.9.4.4 The product shall be applied immediately after the surface is finished or the formwork is removed, as the case may be.

3.9.5 Protection for Concrete in Place

3.9.5.1 Protect exposed members from staining due to rusting of reinforcement projecting beyond construction joints.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.9.5.2 Take suitable measures to prevent spalling and cracking damage occurring to the structure due to water freezing in expansion joints, small holes, slots and depressions.
- 3.9.5.3 Keep area of completed concrete free from ice, water or snow throughout the duration of the Project.
- 3.9.5.4 Take measures as necessary to ensure that concrete temperatures and concrete temperature differential requirements are met.
- 3.9.5.5 Protect freshly placed concrete surfaces from wind and direct heat to minimize the possibility of plastic shrinkage cracking.
- 3.9.6 HOT AND COLD WEATHER PROTECTION
 - 3.9.6.1 General
 - 3.9.6.1.1 All freshly placed concrete shall be protected against dry-out, rain, cold or heat, in compliance with CSA A23.1 Clause 7.4.
 - 3.9.6.2 Temperature Verification
 - 3.9.6.2.1 Concrete Temperature shall be determined using thermocouples installed near the surface, at 50 mm from it, and also in the middle inside for mass concrete. Thermocouple and other data acquisition wires shall be inserted in conduits and end in a surface data acquisition box.
 - 3.9.6.2.2 When formwork has been removed, concrete surface temperature may be determined using a surface thermometer or an infrared one.
 - 3.9.6.2.3 Other temperature verification means may be employed, subjected to the Engineer's approval.
 - 3.9.6.2.4 The Contractor shall submit to the Engineer, for approval, a follow-up plan per element type, per structure part and per structure type in order to determine and record the ambient and concrete temperature of thin and massive (surface and internal) elements so as to ensure conformance with this Specification. On a daily basis, temperature data shall be collected, graphed and submitted to the Engineer by the Contractor.
 - 3.9.6.3 Cold Weather Protection
 - 3.9.6.3.1 Duration of Protection
 - 3.9.6.3.2 In cold weather (ambient temperature at or below 5°C), measures shall be taken to maintain the concrete surface temperature above 5°C for the duration of the curing period.
 - 3.9.6.3.3 Mass concrete elements shall be protected to limit the internal and external concrete temperature differential to within 20°C in order to minimize cracking.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.9.6.3.4 Concrete and ambient temperatures shall be monitored and recorded to determine if the maximum 20°C temperature differential is being met and to verify the compliance with the requirements of Table 21 of CSA A23.1-09.
- 3.9.6.3.5 A table and graph showing the temperature differential between the ambient and surface temperature of the concrete shall be prepared for each pour as well as the temperature differential between the core and the surface of concrete. Results shall be made available to the Engineer for review and approval.
- 3.9.6.3.6 Concrete shall be protected so that its temperature shall never fall below the freezing point before it has reached 10 MPa strength.
- 3.9.6.4 Frozen Surfaces
 - 3.9.6.4.1 Frozen surfaces shall be thawed out. The use of calcium chloride to thaw the bottom of formwork is prohibited.
 - 3.9.6.4.2 Concrete shall not be placed on or against any surface with a temperature below 5°C or any surface that could lower the concrete temperature below the minimum limits specified in Clause 3.2 of this Specification.
- 3.9.6.5 Equipment
 - 3.9.6.5.1 Heating equipment
 - 3.9.6.5.1.1 Provide an adequate number of heaters (boilers, smudge-pots etc) of sufficient capacity to heat the shelter so as to maintain the concrete at the required temperature.
 - 3.9.6.5.1.2 If equipment that emits carbon dioxide is used, the gas shall be exhausted outside the shelter; in no case shall carbon dioxide come in contact with the concrete.
 - 3.9.6.5.2 Ad-hoc Shelters
 - 3.9.6.5.2.1 Shelters of this type consist of canvas or tarpaulin covers on the surfaces of the structure. Such covers shall be fastened in place so that they will not be disturbed during the protection period.
 - 3.9.6.5.2.2 Framed shelters shall be high enough and wide enough to allow concrete to be placed, consolidated and surface-finished inside the shelter. Vertical clearance above the finished surface shall be at least 2.0 m.
- 3.9.6.5.3 Insulating Materials
 - 3.9.6.5.3.1 Insulating materials shall maintain their insulating properties when wet.
 - 3.9.6.5.3.2 For equivalence purposed, 25 mm of insulation is the insulation produced by a 25 mm thickness of material with a thermal strength of at least 0.60 m² °C/W.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.9.6.5.4 Types of Protection for Concrete in Place

3.9.6.5.4.1 Type I

3.9.6.5.4.1.1 All concrete surfaces exposed to air shall completely and effectively cover with 25 mm of insulation material. This type of protection may be used when there is only overnight freezing.

3.9.6.5.4.2 Type II

3.9.6.5.4.2.1 An ad-hoc shelter covering the entire structure and circulate warm air in the shelter and over the concrete, shall be prepared. This type of protection may be used when the outside temperature stays below the freezing point, but is not likely to drop below -12°C during the protection period.

3.9.6.5.4.3 Type III

3.9.6.5.4.3.1 All formwork and all surfaces exposed to air shall be covered with an effective insulating material so that the concrete retains its heat throughout the protection period. The insulating material shall be placed directly on the formwork and joints shall be effectively sealed. The insulation values shall be 75 mm. The inside surfaces of the formwork shall be at a temperature above 5°C when the concrete is placed. This type of protection may be used for any temperature swings.

3.9.6.5.4.4 Type IV

3.9.6.5.4.4.1 A framed shelter enclosing the entire structure and the inside of the shelter at the required temperature throughout the protection period shall be built. This type of protection may be used for any temperature variation.

3.9.6.5.5 Cooling after Protection

3.9.6.5.5.1 When the protection period is over the temperature of the concrete shall be lowered gradually, in accordance with CAN/CSA A23.1. Clauses 7.4.1.3 and 7.4.1.5.3.4. The purpose of this is to prevent concrete cracking that could occur at the end of the curing period due to a sudden change in temperature (thermal shock).

3.9.6.6 Hot Weather Protection

3.9.6.6.1 The hot weather concreting requirements shall confirm to CSA A23.1 Clause 7.4.

3.9.6.6.1.1 In hot weather, the temperature of the concrete shall be as low as possible when it is placed. Placement temperatures shall meet the requirements of Clause 3.2 of this Specification. The temperature of the concrete mass shall then be kept at a relatively low level by continuous spraying.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.10 FORM STRIPPING

3.10.1 Form removal shall be performed as per Specification Section 03 11 00: Concrete Formwork.

3.11 SURFACE TREATMENT AFTER FORMWORK REMOVAL



3.11.1 The Contractor shall inspect the concrete surfaces after formwork removal. Any damaged and non-confirming concrete shall be repaired in accordance with Clause 3.16.

3.11.2 Surface defects may consist of imperfections such as honeycombing, cracking, spalling of aggregate and exposure of reinforcing steel.

3.11.3 Metallic pieces shall be removed or cut at 40 mm inside the concrete surface.

3.11.4 Concrete surfaces that are non-visible and not exposed to water flow shall be left as is, except in the following cases:

3.11.4.1 Non-confirming concrete quality;

3.11.4.2 Tie-rod holes;

3.11.4.3 Depression deeper than 30 mm or more;

3.11.4.4 Exposure of reinforcing steel.

3.11.5 Other concrete surfaces shall be repaired in case of:

3.11.5.1 Non-confirming concrete quality;

3.11.5.2 Non-confirming surface finish tolerance due to abrupt surface defects (local irregularities of small length with respect to height or depth) such as offsets and fins exceeding 3 mm, caused by defective form lumber, loose knots in the forms or displaced form sheathing or sections;

3.11.5.3 Bug holes;

3.11.5.4 Exposed aggregates;

3.11.5.5 Insufficient edge chamfer;

3.11.5.6 Air holes more than 25 mm in depth or diameter;

3.11.5.7 For Class F1, F2, F3 and F4 formworks, entrapped air bubbles exceeding respectively 3%, 2%, 1% and 1% of the surface, considering 1 m² areas at a time.

3.11.6 Concrete surface repairs shall be made as soon as possible after the concrete has cured.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.12 CONSTRUCTION JOINTS

3.12.1 Location

3.12.1.1 Construction joints shall be permitted only at the locations shown on the drawings or approved by the Engineer. The Contractor may propose alternate locations for improving the schedule.

3.12.1.2 When the concrete has hardened to the point where a vibrator cannot be inserted (cold joints during concreting), the surface shall be considered as a construction joint. In such a case, the Engineer shall be informed immediately so as to permit him to take action and not delay subsequent work.

3.12.2 Execution

3.12.2.1 Construction joints shall be flared so that the surface of the concrete is inclined in a gentle slope towards the non-exposed side to prevent the build-up of laitance on the exposed side of the finished surface. The exposed edge of the joint shall be straight wherever it is visible.

3.12.2.2 All construction joints shall be finished and prepared for placement of the next lift in compliance with Clause 3.8 of this Section.



3.13 CONTRACTION JOINTS

3.13.1 Location

3.13.1.1 Contraction joints shall be constructed only at the locations shown on the drawings.

3.13.2 Execution

3.13.2.1 For unformed contraction joint, the joint shall be made using pre-shaped spacers installed in the fresh concrete or using a concrete saw. The upper portion of the joint shall be protected by sealing it with a sealing agent as shown on the Drawings. In all cases, the sealing agent shall be compatible with the joint fill material.

3.13.2.2 Saw-cut joints shall be cut as soon as the concrete surface has hardened sufficiently and before shrinkage cracks form. The proper time for cutting, normally 6 to 12 hours after placement of concrete, but would vary with the concrete class and is subject to approval by the Engineer on a placement by placement basis.

3.13.2.3 For treatment of formed contraction joints, refer to Specification Section: 03 11 00 Concrete Formwork.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.14 SECONDARY CONCRETE

3.14.1 Formwork

3.14.1.1 A complete set of drawings of the formwork together with a detailed description of the proposed methods of handling and placing of the secondary concrete shall be submitted to the Engineer before concreting.

3.14.1.2 All formwork shall be as specified in Specification Section 03 11 00: Concrete Formwork.

3.14.1.3 Formwork shall be firmly attached in place, braced and supported to resist the loads to which it is exposed, keeping its alignment and shape. Formwork shall be tight and shall not permit any leakage.

3.14.1.4 Formwork shall be fixed on primary concrete and not to the embedded parts.

3.14.2 Concreting

3.14.2.1 Concrete surfaces which will come in contact with the secondary concrete, except surfaces of concrete placed by Company's other contractor, shall be finished and prepared in compliance with Clause 3.8.4 of this Section.

3.14.2.2 Secondary concrete supplied for concreting of the embedded parts and grooves shall be of Class A-3, unless specified otherwise on the drawings.

3.14.2.3 No admixtures shall be added to the concrete without prior authorization of the Engineer. The impact of admixtures on the embedded steel parts shall be considered.

3.14.2.4 Secondary concrete shall be placed in such a way as to avoid displacement of embedded parts.

3.14.2.5 Secondary concrete shall be placed in a continuous operation at a maximum rate of 350 mm/hour, unless indicated otherwise by the embedded parts Manufacturer.

3.14.2.6 The minimum delay before removal of the formwork shall be as per Specification Section 03 11 00: Concrete Formwork.

3.14.2.7 The dimension of vibrator shall be 50 mm. There shall be no contact between vibrator and embedded parts, supports and anchors.

3.14.2.8 If there is an evidence or danger of displacement of the embedded parts, the Contractor shall stop the concreting or reduce the pouring rate and immediately advise the Engineer for further action.

3.14.2.9 Secondary concrete shall be of Class A-3, unless specified otherwise on the Drawings.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.15 CONSTRUCTION TOLERANCES

3.15.1 General

- 3.15.1.1 Unless otherwise indicated on the drawings, the concrete structural tolerances upon completion of the works shall conform to the requirements of this section.
- 3.15.1.2 General tolerances for the placement of angle irons and embedded items, other than embedded equipment parts whose tolerances are specified in the manufacturer's technical specifications, shall be as prescribed in Clause 6.7.3 of CSA A23.1/A23.2.
- 3.15.1.3 The Contractor is responsible for designing, executing, and maintaining the formwork within the required limits such that the structure, when completed, is in compliance with the specified tolerances of this Section and CSA A23.1.
- 3.15.1.4 Any concrete work not in compliance with the specified tolerances shall immediately be reported to the Engineer for the approval of the corrective action which may require removal or replacement of the concrete, depending on the severity of the non compliance.
- 3.15.1.5 As soon as a problem is detected, in order to prevent a recurrence of any non conformance, the Contractor shall submit to the Engineer, for approval, preventive and/or corrective measures with regard to materials, type of formwork, concrete placement methods, finishing methods, etc.
- 3.15.1.6 The Engineer reserves the right to place a hold on the work until such preventive and/or corrective measure proposals are reviewed and found to be satisfactory.

3.15.2 Survey Grid Point Tolerances

3.15.2.1 The applicable tolerances are:

- 3.15.2.1.1 planimetric: ± 2 mm;
- 3.15.2.1.2 altimetric: ± 2 mm.

3.15.3 Dimensional Tolerances

3.15.3.1 The applicable tolerances for dimensions or position are:

3.15.3.1.1 Dimension

3.15.3.1.1.1 The allowable deviation for a dimension equal to or less than 3 m is ± 3 mm. The allowable deviation for a dimension greater than 3 m is 0.1% of the dimension, up to a limit of 30 mm.

3.15.3.1.1.2 Elevation: ± 6 mm.



MB 9/0

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.15.4 Orientational Tolerances

3.15.4.1 Parallelism or deviation with respect to a theoretical profile :

3.15.4.1.1 1:500 maximum, up to a limit of 30 mm.

3.15.4.2 Perpendicularity :

3.15.4.2.1 1:500 maximum, up to a limit of 30 mm.

3.15.4.3 Horizontality :

3.15.4.3.1 1:500 maximum, up to a limit of 12 mm.

3.15.4.4 Verticality :

3.15.4.4.1 1:500 maximum, up to a limit of 30 mm.

3.15.5 Shape Tolerances

3.15.5.1 Water Runoff Surfaces :

3.15.5.1.1 The applicable tolerances for flatness (or waviness) of water runoff surfaces is 1:25.

3.15.5.2 Formed concrete surfaces shall conform to Table 7.

Table 7 – Formed Concrete Surface tolerances

Surface finish	Flatness tolerance	Joint tolerance
F1	30 mm	30 mm
F2	12 mm	8 mm
F3	5 mm	5 mm (measured perpendicular to current) 3 mm (measured parallel to current)
F4	5 mm (measured perpendicular to current) 3 mm (measured parallel to current)	5 mm (measured perpendicular to current) 3 mm (measured parallel to current)

Note: The surfaces shall be verified using a 1.5 m straight edge or a 1.5 m template for curved surfaces. For secondary concrete, the surfaces shall be checked by the straight line of 1.1 m.

3.15.5.3 Un-formed concrete surfaces shall conform to Table 8.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Table 8 – Un-formed Concrete Surface tolerances

Surface finish	Flatness tolerance	Joint tolerance
U1	20 mm	5 mm
U2	5 mm	0 mm
U3	5 mm	0 mm

Note: The surfaces shall be verified using a 3.0 m straight edge or a 3.0 m template for curved surfaces.

3.15.6 Verifications

3.15.6.1 Verifications include all inspections to be carried out to ensure that the established tolerances have been complied with.

3.15.6.2 Verifications shall be done following form removal, by the Contractor, and the results of these verifications shall be submitted to the Engineer.

3.15.7 Measuring instruments and conditions

3.15.7.1 Standard CSA A23.1/A23.2 applies.

3.16 REPAIR OF DEFECTS

3.16.1 Non-Conforming Materials and Workmanship

3.16.1.1 When sufficient evidence exists that defective workmanship has occurred or that non-confirming materials have been incorporated in the work, the Engineer may require concrete coring tests, inspections, surveys or other tests performed in order to help determine whether the Work must be repaired or replaced. If the work is found to be non-confirming, tests, inspections or surveys carried out under these circumstances, and required remedial work, shall be done at the expense of the Contractor.

3.16.1.2 Materials or workmanship, which fail to meet the specified requirements, may be rejected by the Engineer whenever found regardless of previous inspection. If rejected, non-confirming materials or Work incorporating non-confirming materials or workmanships shall be removed and replaced, or repaired, at the expense of the Contractor.

3.16.1.3 All materials and methods of repairs shall be submitted to the Engineer for review and approval prior to execution of the repair work.

3.16.2 Patching and Repair



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		



3.16.2.1 Patching and repair of defective areas of new concrete or where bolts, ties, nails or other similar metal inserts are present shall be repaired in accordance with Clause 7.7.3 of CSA-A23.1. All materials and methods of repair shall be submitted to the Engineer for review and approval prior to execution of the repair work.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

APPENDIX A

TABLES OF CONCRETE CLASSES

MB 96

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

CLASS A (35): Structural concrete heavily exposed to inclement weather (wetting and drying, freezing and thawing in a saturated state), water running at high speed, or de-icing salt

Designation	Specified compressive strength ⁽¹⁾ (MPa)	Maximum W/C ratio ⁽²⁾ (E/C)	Maximum coarse aggregate nominal size (mm)	Entrained air (%)	Placement slump (mm)	Location and use
A-1 (35-80) ⁽³⁾	35	0.45	80 ⁽⁵⁾	3-6	20-60	Walls, slabs and piers over 1.5 m thick in the spillway, control structure, etc.
A-2 (35-40)	35	0.45	40	4-7	50-100	Walls and piers from 0.3 to 1.5 m thick
A-2-A (35-40-A)	35	0.45	40	4-7	20-60	Slabs from 0.3 to 1.5 m thick
A-3 (35-20)	35	0.45	20	5-8	50-100	Walls less than 0.3 m in thickness
A-3-A (35-20-A)	35	0.45	20	5-8 ⁽⁴⁾	20-60	Slabs less than 0.3 m in thickness & toppings 50 mm or more in thickness
A-4 (35-10)	35	0.45	10	5-8	50-100	Special uses
A-4-A (35-10-A)	35	0.45	10	6-9	20-60	Floor toppings less than 50 mm in thickness
A-5 (35-5)	35	0.45	5	9-12	175-225	If required at cold joints



- Notes: (1) At 28 days for concrete with type GU cement.
At 91 days for concrete with type LH-M cement.
- (2) In some cases, the technical specifications may prescribe a minimum cement content dosage.
- (3) (35-80) means 35 MPa – 80 mm. The concrete classes indicated in this table may be modified, for example for thick elements, with the authorization of the Engineer, to obtain a higher early compressive strength with the same type of cement LH.
- (4) Maximum of 3% for interior topping use.
- (5) The 80 mm size aggregate is generally not planned to be used. However the Engineer may permit its use for specific conditions.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

CLASS B (30): Structural concrete moderately exposed to inclement weather (wetting and drying, freezing and thawing in a saturated state) or water running at moderate speed

Designation	Specified compressive strength ⁽¹⁾ (MPa)	Maximum W/C ratio ⁽²⁾ (E/C)	Maximum coarse aggregate nominal size (mm)	Entrained air (%)	Placement slump (mm)	Location and use
B-1 (30-80) ⁽³⁾	30	0.50	80 ⁽⁴⁾	3-6	20-60	Foundations, walls & slabs over 1.5 m thick
B-2 (30-40)	30	0.50	40	4-7	50-100	Foundations, walls from 0.3 to 1.5 m thick, penstocks
B-2-A (30-40-A)	30	0.50	40	4-7	20-60	Slabs from 0.3 to 1.5 m thick
B-3 (30-20)	30	0.50	20	5-8	50-100	Foundations, walls less than 0.3 m thick
B-3-A (30-20-A)	30	0.50	20	5-8	20-60	Slabs less than 0.3 m thick
B-4 (30-10)	30	0.50	10	6-9	50-100	Special uses
B-5 (30-5)	30	0.50	5	9-12	175-225	If required at cold joints

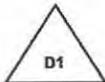


- Notes: (1) At 28 days for concrete with type GU cement.
At 91 days for concrete with type LH-M cement.
(2) In some cases, the technical specifications may prescribe a minimum cement content dosage.
(3) (30-80) means 30 MPa – 80 mm.
(4) The 80 mm size aggregate is generally not planned to be used. However, the Engineer may permit its use for specific conditions.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

CLASS BC (25): Structural concrete slightly exposed to inclement weather (wetting and drying, freezing and thawing, not in a saturated state) or water running at low speed



Designation	Specified compressive strength ⁽¹⁾ (MPa)	Maximum W/C ratio ⁽²⁾ (E/C)	Maximum coarse aggregate nominal size (mm)	Entrained air (%)	Placement slump (mm)	Location and use
BC-1 (25-80) ⁽³⁾	25	0.55	80 ⁽⁴⁾	3-6	20-60	Foundations, walls & slabs over 1.5 m thick
BC-2 (25-40)	25	0.55	40	4-7	50-100	Foundations, walls from 0.3 to 1.5 m thick, penstocks
BC-2-A (25-40-A)	25	0.55	40	4-7	20-60	Slabs from 0.3 to 1.5 m thick
BC-3 (25-20)	25	0.55	20	5-8	50-100	Foundations, walls less than 0.3 m thick
BC-3-A (25-20-A)	25	0.55	20	5-8	20-60	Slabs less than 0.3 m thick
BC-5 (20-5)	25	0.55	5	9-12	175-225	If required at cold joints

- Notes: (1) At 28 days for concrete with type GU cement.
At 91 days for concrete with type LH-M cement.
- (2) In some cases, the technical specifications may prescribe a minimum cement content dosage.
- (3) (25-80) means 25 MPa – 80 mm.
- (4) The 80 mm size aggregate is generally not planned to be used. However, the Engineer may permit its use for specific conditions.



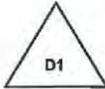
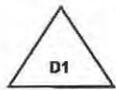
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

CLASS C (20): Structural concrete not exposed to inclement weather (wetting and drying, freezing and thawing) or running water

Designation	Specified compressive strength ⁽¹⁾ (MPa)	Maximum W/C ratio ⁽²⁾ (E/C)	Maximum coarse aggregate nominal size (mm)	Entrained air (%)	Placement slump (mm)	Location and use
C-1 (20-80) ⁽³⁾	20	0.60	80 ⁽⁴⁾	3-6	20-60	Foundations, walls & slabs over 1.5 m thick
C-2 (20-40)	20	0.60	40	4-7	50-100	Foundations, walls from 0.3 to 1.5 m thick, penstocks
C-2-A (20-40-A)	20	0.60	40	4-7	20-60	Slabs from 0.3 to 1.5 m thick
C-3 (20-20)	20	0.60	20	5-8	50-100	Foundations, walls less than 0.3 m thick
C-3-A (20-20-A)	20	0.60	20	5-8	20-60	Slabs less than 0.3 m thick
C-5 (20-5)	20	0.60	5	9-12	175-225	If required at cold joints

- Notes: (1) At 28 days for concrete with type GU cement.
At 91 days for concrete with type LH-M cement.
- (2) In some cases, the technical specifications may prescribe a minimum cement content dosage.
- (3) (20-80) means 20 MPa – 80 mm.
- (4) The 80 MM size aggregate is generally not planned to be used. However, the Engineer may permit its use for specific conditions.

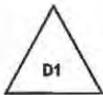
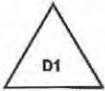


Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

CLASS D (15): Structural concrete not exposed to inclement weather (wetting and drying, freezing and thawing) or running water

Designation	Specified compressive strength ⁽¹⁾ (MPa)	Maximum W/C ratio ⁽²⁾ (E/C)	Maximum coarse aggregate nominal size (mm)	Entrained air (%)	Placement slump (mm)	Location and use
D-1 (15-80) ⁽³⁾	15	0.65	80	3-6	20-60	Very thick fill, over 1.5 m
D-2 (15-40)	15	0.65	40	4-7	50-100	Medium thick fill from 0.3 to 1.5 m
D-3 (15-20)	15	0.65	20	5-8	50-100	Thin layer fill for embedment of electrical conduits, etc.
D-5 (15-5)	15	0.65	5	9-12	175-225	If required at cold joints

- Notes: (1) At 28 days for concrete with type GU cement.
At 91 days for concrete with type LH-M cement.
- (2) In some cases, the technical specifications may prescribe a minimum cement content dosage.
- (3) (15-80) means 15 MPa – 80 mm.
- (4) The 80 MM size aggregate is generally not planned to be used. However, the Engineer may permit its use for specific conditions.



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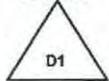
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 30 00
CH0032	CAST-IN-PLACE CONCRETE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

Undefined Class

Designation	Specified compressive strength ⁽¹⁾ (MPa)	Maximum W/C ratio ⁽²⁾ (E/C)	Maximum coarse aggregate nominal size (mm)	Entrained air (%)	Placement slump (mm)	Location and use
Dry mortar	30	0.35	5	If required	-	As stipulated in the Specification or on the drawings
Mortar or grout	30	0.45	5	If required	-	As stipulated in the Specification or on the drawings, for injecting under beam and column support plates
X-2	8	1,15	40	4-7	100-150	As stipulated in the Specification or on the drawings

Notes: (1)



(2)

At 28 days for concrete with type GU cement.

At 91 days for concrete with type LH-M cement.

Support plate, beam and column adjustment grout shall consist of Portland cement, sand, water and a non-ferrous expanding admixture as needed, approved by the Engineer.

Unless otherwise indicated by the Engineer, the sand/cement ratio shall not exceed 1.5/1.0. The admixture shall be used in compliance with the Manufacturer's recommendations

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 03 60 40
GROUT
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

1.1 SCOPE OF WORK..... 2

1.2 RELATED SECTIONS..... 2

1.3 DEFINITIONS..... 2

1.4 REFERENCES..... 3

1.5 GROUTING APPLICATIONS..... 4

1.6 QUALITY ASSURANCE..... 5

1.7 SUBMITTALS..... 6

PART 2 PRODUCTS..... 6

2.1 GENERAL..... 6

2.2 WATER, AGGREGATE, CEMENT AND CHEMICAL ADMIXTURES..... 6

2.3 SAND-CEMENT GROUT..... 7

2.4 NON-SHRINK CEMENT-BASED GROUT..... 7

2.5 NON-SHRINK EPOXY GROUT..... 8

PART 3 EXECUTION..... 8

3.1 DELIVERY, STORAGE AND HANDLING..... 8

3.2 SURFACE PREPARATION..... 9

3.3 FORMS..... 10

3.4 MIXING AND PLACING..... 10

3.5 FINISHING..... 12

3.6 CURING..... 12

3.7 SHIMS AND WEDGES..... 13

3.8 ANCHOR BOLTS AND PIPE SLEEVES..... 13

3.9 INSPECTION AND TESTING..... 13

3.10 GROUT QUALITY CONTROL..... 14

PROVINCE OF NEWFOUNDLAND AND LABRADOR

PEG PERMIT HOLDER
Newfoundland and Labrador
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL NO458
which is valid for the year 2013



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

PART 1 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification establishes the minimum requirements of materials and workmanship for furnishing, delivering, placing, finishing, curing, and testing of sand-cement grout, non-shrink cement-based grout and non-shrink epoxy grout.

1.1.2 Work Included

1.1.2.1 This specification applies to all operations associated with, but not necessarily limited to, the following:

1.1.2.1.1 Supply, mixing, placing, finishing and curing of cementitious or epoxy grout;

1.1.2.1.2 Surface preparation to receive grout;

1.1.2.1.3 Control joints and expansion joints, as indicated on the drawings;

1.1.2.1.4 Inspection and testing.

1.1.2.1.5 The Contractor shall supply all necessary equipment and maintenance thereof to perform the work outlined in this Specification.

1.2 RELATED SECTIONS

1.2.1 Section: 03 30 00 Cast-in-Place Concrete

1.2.2 Section: 05 50 10 Miscellaneous Metals and Embedded Parts

1.2.3 Section: 01 35 43 General Environmental Requirements

1.2.4 Section: 05 12 00 Structural Steel

1.3 DEFINITIONS

1.3.1 SDRL: Supplier Documentation Requirement List.

1.3.2 MSDS: Materials Safety Data Sheets

1.3.3 OSHA: Occupational Safety and Health Administration



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 REFERENCES

1.4.1 The Contractor shall comply with the rules and provisions of the listed Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.4.2 All work shall be in accordance with this specification and the requirements of the following codes and standards:

1.4.3 Canadian Standard Association (CSA):

- | | |
|--------------------------|--|
| CAN/CSA A3000-08 | Cementitious Materials Compendium |
| CSA A23.1-09/A23.2-09 | Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete |
| CAN/CSA A23.3-04 (R2010) | Design of Concrete Structures |



1.4.4 American Concrete Institute:

- | | |
|-------------|---|
| ACI 305R-06 | Guide to Hot Weather Concreting |
| ACI 306R-10 | Guide to Cold Weather Concreting. |
| ACI 318-11 | Building Code Requirement for Structural Concrete and Commentary. |

1.4.5 American Society for Testing and Materials:

- | | |
|---------------------|---|
| ASTM C33/C33M-11a | Standard Specification for Concrete Aggregates |
| ASTM C109/C109M-11b | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in; or 50-mm Cube Specimens) |
| ASTM C150/C150M-12 | Standard Specification for Portland Cement |
| ASTM C494/C494M-11 | Standard Specification for Chemical Admixtures for Concrete |
| ASTM C827/C827M-10 | Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from |

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Cementitious Mixtures

ASTM C 1107/C1107M-11

Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

ASTM C1019-10

Standard Test Method for Sampling and Testing Grout

1.4.6 Other Codes and References:

U.S. Army Corps of Engineers

CRD C 621

Specification for Non-shrink Grout

ISO 80000-1 (2009)

Quantities and Units – Part 1: General

1.5 GROUTING APPLICATIONS

1.5.1 Unless indicated otherwise on the drawings, the following criteria shall apply:

1.5.1.1 Sand-Cement Grout

1.5.1.1.1 Sand-cement grout shall be used for grouting of lightly loaded column base plates for miscellaneous structural and equipment supports, such as stairs, guardrails, skid-mounted equipment, small pumps, lube oil consoles, etc.

1.5.1.2 Non-Shrink Cement-Based Grout

1.5.1.2.1 This type of grout shall be used for grouting structural column base plates with or without shear keys seated in companion keyways formed in foundation piers, for sleeved anchor bolts designed to resist high shear forces, and for static equipment.

1.5.1.3 Non-Shrink Epoxy Grout

1.5.1.3.1 Non-shrink epoxy grout shall be used for reciprocating machines and in cases where high allowable bearing pressures are required, where dynamic loads due to impact and/or vibration are transmitted through the grout, and/or where chemical attack is possible.

1.5.1.3.2 In addition, this grout shall typically be used for bed plates or bases of centrifugal compressors, turbines, pumps, blowers, and associated drivers.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.2 Selection of Grout

1.5.2.1 Selection of type of grout shall be in accordance with the criteria given above, except as follows:

1.5.2.1.1 Grouting of all equipment supports shall be in accordance with manufacturer's recommendations.

1.5.2.1.2 It may be necessary to use non-shrink cement-based grout or non-shrink epoxy grout instead of sand-cement grout for certain applications where grout is subjected to temperatures above ambient, where vibrating loadings are encountered or when necessary to meet the required structural strength.

1.5.2.1.3 Non-shrink grout shall be selected based on the manufacturer's recommendations for the particular application.

1.5.2.1.4 Generally, epoxy grout shall not be exposed to temperatures exceeding 93°C (200°F) for general use or 65°C (150°F) for precision grouting of major mechanical equipment, unless the grout manufacturer recommends a lower value.

1.5.2.1.5 Proper grout details shall allow for expansion joints, grout cut backs, corner reinforcing or added epoxy depth at corners to prevent cracks. Expansion joints in epoxy grout shall be spaced at intervals less than or equal to 900 mm.

1.6 QUALITY ASSURANCE

1.6.1 Quality of work shall be controlled to meet the requirements of this Specification, referenced codes and standards, and other contract documents in effect on the date of contract.

1.6.2 The Contractor shall follow a Quality Control Program during execution of the work. The program shall include inspection and testing of all materials as well as dimensional checks and visual inspection.

1.6.3 All chemicals used need to be accompanied by a "Material Safety Data Sheet" and recorded on a site hazardous record document to be kept at the facility offices. For a list of substances not to be used due to their toxicity and health risk, refer to Specification Section 01 35 43: General Environmental Requirements.

1.6.4 The Contractor shall obtain and retain Certificates of Compliance for all products listed in Part 2 for the Engineer's review, when requested.

1.6.5 Substitutions

1.6.5.1 Complete technical data as to type, composition, strength, quality, finish, capacity, performance characteristics, and other pertinent details will be required to determine the acceptability of a substitute item.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6.5.2 Substitutions shall receive written approval from the Engineer prior to being implemented.

1.7 SUBMITTALS

1.7.1 The Contractor shall submit the required documentation to the Engineer for review and approval, in accordance with the Supplier Document Requirements List (SDRL).

1.7.2 The Contractor shall submit Material Safety Data Sheets for each product required by OSHA to have an MSDS.

1.7.3 The Contractor shall submit the Quality Control Program that will be followed during execution of the work, to the Engineer for approval.

PART 2 PRODUCTS

2.1 GENERAL

2.1.1 All materials shall be approved prior to installation.

2.1.2 Sand-cement grout may be proportioned on site or at the batch plant. Proprietary grout shall consist of pre-measured, pre-packaged materials supplied by the manufacturer, with the exception of water.

2.1.3 All grouts shall be non-corrosive, non-staining and resistant to effects of moisture.

2.1.4 Compressive strength of grout shall meet or exceed that of foundation concrete.

2.2 WATER, AGGREGATE, CEMENT AND CHEMICAL ADMIXTURES

2.2.1 Mixing Water

2.2.1.1 Water to be used in mixing grout shall conform to the requirements of CSA A23.1/A23.2.

2.2.1.2 Mixing water shall be free of salts, alkalis, acids, organic materials and contaminants in proportions that could adversely affect the quality of the grout.

2.2.2 Aggregate

2.2.2.1 Sand shall be as defined in CSA A23.1/A23.2 and shall conform to grading for fine aggregate 4.75 mm (No.4) to 150 mm (No. 100) sieve as per ASTM C 33.

2.2.3 Cement

2.2.3.1 Cement shall be Portland cement Type I or II conforming to ASTM C 150.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.4 Chemical Admixtures

2.2.4.1 Chemical admixtures shall comply with ASTM C 494.

2.3 SAND-CEMENT GROUT

2.3.1 Sand-cement grout shall consist of two parts sand for one part cement, by weight. Minimum 28 day compressive strength shall match or exceed that of the supporting concrete but shall not be less than 30 MPa.

2.3.2 Sand-cement grout shall have a maximum water-cement ratio of 0.40, by weight.

2.3.3 Sand-cement dry pack grout shall consist of two parts sand to one part cement, by weight, with just sufficient water to produce a stiff consistency that can be efficiently pushed into place without sagging.

2.4 NON-SHRINK CEMENT-BASED GROUT

2.4.1 Non-shrink cement-based grout shall be Grade C Combination Volume-Adjusting in accordance with ASTM C 1107.

2.4.2 Plastic volume change: Grout shall show no shrinkage (0.0%) and a maximum of 4.0% expansion at any time before initial set when tested in accordance with ASTM C 827.

2.4.3 Hardened volume change: Grout shall show no shrinkage (0.0%) and a maximum 0.2% expansion in the hardened state when tested in accordance with CRD-C621.

2.4.4 Compressive strength: Grout shall have a minimum compressive strength at 28 days of 50 MPa.

2.4.5 Initial set time: Grout shall achieve initial set in not less than 45 minutes when tested in accordance with ASTM C 1019.

2.4.6 Soundness: Grout shall contain no staining substances, no aluminum powder, no more than 0.05% chloride ions, nor other materials known to increase drying shrinkage and/or compromise durability.

2.4.7 Cement based non-shrink grout products listed below or approved equal shall be used:

2.4.7.1 SikaGrout 212 or Sikagrout 212 HP by Sika Corporation;

2.4.7.2 ChemRex/Master Builders (Masterflow 928).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5 NON-SHRINK EPOXY GROUT

- 2.5.1 Volume Change: Epoxy grout shall exhibit no shrinkage (0.0%) and a maximum of 4.0% expansion when tested in accordance with ASTM C 827, modified to use an indicator ball with a specific gravity between 0.9 and 1.1.
- 2.5.2 Compressive strength: Epoxy grout shall have a minimum compressive strength at 7 days of 70 MPa.
- 2.5.3 Heat Development: The peak exotherm of a 50 mm diameter by 100 mm high cylinder of grout shall not exceed 35°C (95°F) when tested at 24°C (75°F) material and laboratory temperatures.
- 2.5.4 Thermal expansion: Epoxy grout shall not exceed a coefficient of thermal expansion of 1.65 X 10⁻⁵ mm/mm/°C (30 X 10⁻⁶ in/in/°F).
- 2.5.5 Irritants: The use of epoxy grout which gives off noxious fumes or volatiles shall be prohibited.
- 2.5.6 Creep resistance: Manufacturer shall provide information on creep resistance including a description of the test method used.
- 2.5.7 Non-shrink epoxy grout products listed below or approved equal shall be used:
 - 2.5.7.1 Sikadur Hi-Mod 32 by Sika Corporation;
 - 2.5.7.2 ChemRex/Master Builders (Masterflow 648 CP Plus Grout);
 - 2.5.7.3 ChemRex/Master Builders (Masterflow 678 DP Plus Grout)

PART 3 EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- 3.1.1 Non-shrink cement-based grout and epoxy grout aggregate shall be delivered to the site in sound, dry packages. Epoxy grout liquid components shall be delivered in sealed hardener and resin containers. Alternatively, epoxy grout shall be delivered as a pre-packaged, pre-measured system.
- 3.1.2 All materials and pre-mixed grout in manufacturer's sealed containers, with labels legible and intact, shall be stored in a dry, weatherproof area at temperatures between 5 degrees C to 38 degrees C or within the temperature range recommended by the manufacturer. It is preferred that the grout be stored in a dry warehouse. If the grout must be stored outside, it shall be placed on pallets off the ground surface and completely covered with durable plastic sheeting. Any material which becomes damp or otherwise defective shall be removed from the site.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.3 Time of storage for non-shrink grout shall not exceed manufacturer's recommendation nor 10 months from the time of manufacture.



3.1.4 Opened bags or containers not used must be discarded.

3.2 SURFACE PREPARATION

3.2.1 Concrete surface on which grout will bear shall have attained its design strength prior to grouting

3.2.2 Concrete shall be sound and surfaces to be in contact with grout shall be free of oil, grease, paint, ice, laitance and other coatings and other deleterious substances. Surface shall be roughened by chipping, abrasive blasting or other mechanical means in order to expose coarse aggregate and to create irregular surface to which the grout will bond.

3.2.3 Prepared surface shall be cleaned of all dust and loose particles. After cleaning, foundation surface shall be tightly covered to keep it free of dust and oil.

3.2.4 Before grouting, equipment bases and base plates shall be leveled and aligned in accordance with the drawings and equipment manufacturer's recommendations. Base plate surfaces in permanent contact with grout shall be free of dirt, grease, paint, or other deleterious substances. If applicable, base plate cleaning shall comply with the grout manufacturer's specifications. Vent holes may be necessary in the base plate to eliminate air pockets.

3.2.5 Unless otherwise specified or shown on the drawings, the entire top surface of the foundation shall be grouted. Areas not to be grouted, such as oil pans or air circulation spaces, must be sealed off before the equipment is lowered into place. This may be accomplished with oakum or hemp rope, expandable fabric hose (such as canvas fire hose), rigid polyurethane foam, styrofoam or other soft compressible material.

3.2.6 When using a canvas fire hose, the hose shall be pressurized to a maximum of approximately 0.03 MPa (5 PSI) to avoid moving the equipment and affecting its alignment. Also, for epoxy grout, the fire hose shall be wrapped with polyethylene tape and coated with a heavy paste wax for ease of removal.

3.2.7 When using rigid polyurethane foam or styrofoam (do not use styrofoam for epoxy grout), allow 6mm per 25 mm of height for crush. The foam shall be installed prior to setting the equipment. To ensure a leak-proof joint, apply a bead of caulking compound on the mating surfaces of the concrete where it attaches to the foam and on the rigid foam where it attaches to the equipment bed plate.

3.2.8 Anchor bolts, leveling screws and other metal surfaces for which bond to the grout is not desirable shall be coated with approved varnish or wax or otherwise protected prior to placing grout.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



3.2.9 Equipment base plate surface shall be prepared in accordance with grout manufacturer's requirements in order to ensure bond of grout to base plate. For equipment purchased with a special coating on the base plate which is designed to bond to epoxy grout, confirmation from the grout manufacturer shall be obtained assuring that the grout will bond to the special coating.

3.2.10 When sand-cement grout is used, the roughened surface shall be thoroughly presoaked with clear, potable water and shall be damp for 24 hours prior to placement of grout. Covering concrete with continuously wet burlap and running a fine hose spray will generally yield satisfactory results. Excess water shall be removed from concrete surface and anchor bolt sleeves before grout is placed.

3.2.11 When using non-shrink cement-based grout, the roughened concrete surface shall be presoaked with clear, potable water in accordance with manufacturer's recommendations.

3.2.12 When non-shrink epoxy grout is used, all surfaces must be kept completely dry before grouting, unless otherwise specified by grout manufacturer.

3.3 FORMS

3.3.1 Where forms are required, they shall be designed for rapid, continuous and complete filling of the space to be grouted. Forms shall be of adequate strength to withstand the forces produced during placement of the grout.

3.3.2 Forms shall be caulked or sealed with tape to provide a water tight seal.

3.3.3 Forms shall extend a minimum of 25 mm above the bottom of the base plate being grouted and shall be placed no closer than 25 mm from the edge of the base plate. On the pouring side, the form shall extend at least 150 mm above the bottom of the base plate and shall be placed no closer than 50 mm from the edge of the base plate.



3.3.4 Forms for non-shrink cement-based grout shall be pre-treated with an acceptable mineral oil or coated with approved release agent such as Sealtight Duoguard manufactured by W.R. Meadows, to prevent grout adherence and absorption.

3.3.5 Forms for epoxy grout shall be lined with polyethylene or coated with heavy wax to prevent grout adherence and absorption.

3.3.6 All chamfered edges required in epoxy grouts shall be incorporated into the forms.

3.4 MIXING AND PLACING

3.4.1 Manufacturer's instructions shall be strictly followed for non-shrink cement-based-grout preparation, proportions, mixing, forming, and depth of pour, pouring, curing and protection.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.2 Grouting shall preferably be accomplished when ambient and mix temperatures are between 4.5°C (40°F) and 32°C (90°F) for cement-based grouts and between 10°C (50°F) and 32°C (90°F) for epoxy grouts. When temperatures are outside this range, the recommendations contained in CSA A23.1/A23.2 shall be followed for normal sand-cement grout. For non-shrink cement-based and epoxy grouts, manufacturer's recommendations shall be followed.
- 3.4.3 During hot weather installation, grout materials shall be stored at temperatures less than or equal to 21°C (70°F) throughout the 24 hours prior to grout installation. Surfaces that will come in contact with grout shall be shaded throughout the 24 hours prior to grout installation. Surfaces that will come in contact with grout shall have their temperatures reduced to values less than or equal to 32°C (90°F) with a cold water spray throughout the 1-hour prior to grout installation.
- 3.4.4 During cold weather installation, grout materials and elements to be grouted shall be maintained at temperatures between 21 degrees C to 24 degrees C throughout its thickness during and 48 hours after grouting.
- 3.4.5 Sand-cement grout shall be mixed as close as possible to the equipment to be grouted using a mortar mixer (with slow moving blades) wherever possible. For small quantities of epoxy grout, a clean and dry concrete wheelbarrow and mortar hoe may be used.
- 3.4.6 Sufficient manpower and equipment shall be available for rapid and continuous mixing and placing of grout. Sand-cement grout shall be mixed for 3 to 5 minutes after charging mixer then placed immediately. Mixed grout that remains standing shall be mixed at 5 minute intervals and then remixed for one minute before placing. Bedding grout that shows signs of stiffening or which has not been placed 30 minutes from time of initial mixing shall be discarded. Do not add water to grout mix after initial mixing.
- 3.4.7 Grout shall be mixed in quantities no greater than can be placed in the manufacturer's specified working time for the temperature at which the grout is being placed. Working time specified shall be considered a maximum value and any grout remaining after the specified working time has elapsed shall be discarded. Do not re-mix or re-temper stiffening grout. Any grout which shows evidence of initial set or entrapped air shall be discarded.
- 3.4.8 Once grout is mixed, it shall be placed continuously and rapidly, preferably from one side only, to avoid cold joints and minimize the chance of air entrapment. The grout level shall not drop below the equipment base. The grout fill location shall be moved only after the grout has filled past the new fill location. Expansion joint dividers shall be used to section off the maximum areas to be poured and worked at one time.
- 3.4.9 For flat base plates, grout shall be placed across the small dimension of the equipment base, from one long edge to the other, in one direction only. The use of a head box with an inclined plane to direct the grout across the compartment is recommended.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.10 For inverted "U" shaped base plates, such as pump base plates, the base shall contain a sufficient number of relief holes (one 3 mm minimum diameter hole per corner) or grout shall be poured from a 100 mm hole in the center of each compartment.

3.4.11 Use of a vibrator is not permitted. Also, grout shall not be placed when vibrations are being transmitted by the operation of other equipment. Such equipment must be shut down while grouting and kept idle for at least 24 hours or until the grout has set sufficiently.

3.4.12 Cement-based grout may be tamped or rodded to eliminate voids. Care shall be exercised, however, so that air is not introduced into the grout.

3.4.13 In making deep pours, epoxy grout shall generally be poured in thicknesses of 50 to 100 mm per layer. Minimum depth of pour is 50 mm. Depth of pour is dependent on the product selected and on ambient temperatures. Deeper or shallower pours may be made if permitted by the manufacturer's standards. The final layer, which is to adhere to the machine base, shall be limited to between 25 and 50 mm in thickness, measured from bottom of the machine base. Epoxy grout shall not be rodded.

3.4.14 Epoxy materials may be skin irritants or sensitizers. Avoid contact with eyes, skin, inhalation of vapours and ingestion.

3.5 FINISHING

3.5.1 Exposed surface of grout shall slope away from base plates.

3.5.2 After grout has set, apply finish coating, where required, over grout holes and vent holes.

3.5.3 Cement-based grouts shall be trimmed back to the lower edge of the base plate and tapered to the existing concrete at 45 degree angles once the grout has reached an initial set. Protruding edges shall also be cut back.

3.5.4 Epoxy grout cannot be trimmed after initial set. Top surfaces shall be finished to proper slope before initial set.

3.6 CURING

3.6.1 Grout shall be cured in accordance with the manufacturer's recommendations.

3.6.2 The temperature of the base plate, supporting concrete foundation and grout shall be maintained within the limits specified in article 3.4 of this Specification Section.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6.3 After placement, cement-based grout shall be protected from premature drying, excessively hot or cold temperatures and mechanical injury. Sand-cement grout shall be maintained with minimal moisture loss at relatively constant temperature for a minimum of 3 days. Following 36 hours of moist curing, a curing/sealing compound such as Sikaguard Clear Seal by Sika Canada Inc. or approved equivalent may be applied to all exposed surfaces. Curing of non-shrink cement-based grout shall be in accordance with manufacturer's instructions.

3.6.4 Since water interferes with proper curing of epoxy grouts, moist curing shall not be used. Curing for epoxy grout shall be in accordance with manufacturer's instructions.

3.6.5 Foundations shall be shaded from direct sunlight for at least 24 hours before and 48 hours after grouting.

3.6.6 Unless stated otherwise by the manufacturer, epoxy grouts shall be protected from sudden temperature change for 48 hours.

3.7 SHIMS AND WEDGES

3.7.1 Shims for machinery, where accessible, shall be blocked off and removed once the grout has hardened. The space left by the removal of shims shall be re-grouted with the specified grout. Shims for base plates for structural columns may be left in place.

3.7.2 If leveling screws are used to level equipment, the screws shall be coated and backed off after the grout has hardened so that machine loads are transmitted only through the grout.

3.8 ANCHOR BOLTS AND PIPE SLEEVES

3.8.1 For anchor bolt sleeves and pipe sleeves requiring grout, all surfaces shall be cleaned of oil, grease and foreign substances.

3.8.2 Where epoxy grout is used, anchor bolts shall be isolated from the grout by means of PVC pipe, rubber hose or polyethylene wrapped in several layers around the bolt. Annular space within anchor bolt sleeves shall be plugged with a sleeve seal to prevent epoxy grout entering the sleeved space.

3.8.3 Unless shown otherwise on the drawing, anchor bolts within sleeves and pipe sleeves which are to remain isolated shall be filled with a pliable material such as silicone rubber molding material.

3.9 INSPECTION AND TESTING

3.9.1 The following work shall be subject to the surveillance of the Contractor's inspector at all times:

3.9.1.1 Compliance of materials with requirements specified herein;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 03 60 40
CH0032	GROUT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.9.1.2 Preparation of existing surfaces to receive grout;

3.9.1.3 Placing of grouts.

 3.9.2 Surveillance performed by the Contractor's inspector shall not relieve either the Contractor performing the work or a supplier of material of any responsibilities connected with the quality of materials and satisfactory installation and performance of installed grout.

 3.10 **GROUT QUALITY CONTROL**

3.10.1 Inspection and quality control sampling and testing of grout shall be performed by the Contractor through the use of the services of a third party retained and paid by the Company.

3.10.2 Inspection and quality control sampling and testing of grout through the use of the services of a third party retained and paid by the Company shall not relieve either the Contractor or a supplier of material of any responsibilities connected with the quality and performance of the grout.

3.10.3 The compression strength of grout shall be determined on sample cubes (three cubes at one (1) day, three cubes at three (3) days, three cubes at seven (7) days and three cubes at (28) days).

3.10.4 Grout shall be sampled for each mix and for each working day.

END OF SECTION



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 05 12 00
STRUCTURAL STEEL
TABLE OF CONTENTS**

PART 1 GENERAL 2

1.1 SCOPE OF WORK 2

1.2 RELATED SECTIONS 3

1.3 DEFINITIONS 3

1.4 REFERENCES 4

1.5 SITE CONDITIONS 7

1.6 QUALITY ASSURANCE 8

1.7 SUBMITTALS 9

PART 2 PRODUCTS 10

2.1 GENERAL 10

2.2 STEEL 10

2.3 PROTECTIVE COATINGS 12

2.4 GROUT 12

PART 3 EXECUTION 13

3.1 DESIGN 13

3.2 FABRICATION 15

3.3 PROTECTIVE COATINGS 17

3.4 GALVANIZING 17

3.5 TRANSPORTATION, HANDLING AND STORAGE 18

3.6 INSTALLATION 19

3.7 QUALITY CONTROL, INSPECTION AND TESTING 23



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SCOPE OF WORK



1.1.1 The work described in this Specification includes all labour, material, equipment, inspection and testing services for the connection design, shop drawings, supply, fabrication, galvanization, transportation to site and erection of the structural steel.



1.1.2 The design, fabrication and installation of structural steel shall conform to this Specification and to CSA S16. However, if there are any discrepancies the requirements of this specification supersede the corresponding ones of Standard CSA S16.

1.1.3 Work included

1.1.3.1 The buildings and structures included are:

1.1.3.1.1 Spillway towers, hoist bridge structure, and hoist houses.

1.1.3.1.2 Walkway on the spillway.

1.1.3.1.3 Spillway Electrical Building.

1.1.3.2 The work includes but is not limited to the following:



1.1.3.2.1 Preparation and submittal of shop and erection drawings.

1.1.3.2.2 Analysis and design of all structural systems and components including design of connections.

1.1.3.2.3 Fabrication and supply of structural steel members, gratings, floor and roof decking, plates, bolts, chemical and/or expansion anchor bolts, and all other accessories required to execute the work.

1.1.3.2.4 Surface preparation of steels



1.1.3.2.5 Galvanizing.

1.1.3.2.6 On-site erection according to drawings and within the prescribed tolerances.

1.1.3.2.7 All shop and field welding and bolting.

1.1.3.2.8 All shims and adjustment pieces necessary for work execution.

1.1.3.2.9 Supply preparation and injection of non-shrink grout under base plates.

MB To

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

1.1.3.2.10 Pre-tensioning of the anchor bolts.



1.1.3.2.11 Work related to shop-painting and on-site touch-up after the completion of erection, including the bolts and connections. Refer to Section 09 90 00.

1.1.3.2.12 All inspections, tests and controls necessary for the follow-up of the quality control program.

1.1.3.2.13 As-built drawings.

1.1.3.2.14 Final clean-up of the site.

1.2 RELATED SECTIONS

1.2.1 Section 05 50 10: Miscellaneous Steel & Embedded Parts.

1.2.2 Section 01 35 43: General Environmental Requirements.

1.2.3 Section 03 11 00: Concrete Formwork

1.2.4 Section 03 20 00: Cast-in-Place Concrete

1.2.5 Section 03 60 40: Grout.

1.2.6 Section 48 13 10: General Mechanical Requirements.

1.2.7 Section 48 13 24 Hoists and Cranes

1.2.8 Section 09 90 00: Paint System for Structural Steel.



1.3 DEFINITIONS

1.3.1.1 LEED: Leadership in Energy and Environmental Design.

1.3.1.2 VDR: Vendor Data Requirements Form.

1.3.1.3 SDRL: Supplier Document Requirements List.

1.3.1.4 OSHA: Occupational Safety and Health Administration

1.3.1.5 VOC: Volatile Organic Compound.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

1.3.2 Structural components: Consists of rolled structural shapes, welded wide flange shapes, hollow structural sections, rods, bars and plates as described in CISC Handbook of Steel Construction.

1.3.3 Connecting material: Consists of welds, fasteners, splice plates, cleats, brackets, gussets, stiffeners, end connections, base plates, bearing plates, and other related items.

1.4 REFERENCES

1.4.1 The Contractor shall comply with the rules and provisions of the listed Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.



1.4.2 All work shall be accordance with this specification and the requirements of the following codes and standards:



1.4.3 Canadian Standard Association (CSA)

CSA A23.1-09/A23.2-09	Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete
CSA G30.18-09	Carbon Steel Bars for Concrete Reinforcement
CSA G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
CSA G189-1966 (R2003)	Sprayed Metal Coatings for Atmospheric Corrosion Protection
CSA S16-09	Design of Steel Structures
CAN/CSA S136-07	North American Specification for the Design of Cold-Formed Steel Structural Members
CSA W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)
CSA W48-06	Filler Metal and Allied Materials for Metal Arc Welding
CSA W47.1-03 (R2008)	Certification of Companies for Fusion Welding of



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Steel

- CSA W55.3-08 Certification of Companies for Resistance Welding of Steel and Aluminum
- CSA W178.1-08 Certification of Welding Inspection Organizations
- CSA W178.2-08 Certification of Welding Inspectors

1.4.4 Canadian General Standard Board (CGSB)

- CAN/CGSB-1.181-99 Ready-Mixed Organic Zinc-Rich Coating
- CAN/CGSB-48.9712-2006 Non-destructive Testing - Qualification and Certification of Personnel

1.4.5 American Society for Testing and Materials (ASTM)

- ASTM A108-07 Specification for Steel Bar, Carbon and Alloy, Cold Finished
- ASTM A36-08 Standard Specification for Carbon Structural Steel
- ASTM A123A/A123M-12 Standard Specification for Zinc (Hot Dipped Galvanized) Coatings On Iron and Steel Products
- ASTM A153/A153M-09 Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
- ASTM A194/A194M-11 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- ASTM A325-09 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- ASTM A384/A384M-07 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- ASTM A490-12 Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
- ASTM A500/A500M-10a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- ASTM A563-07a Standard Specification for Carbons and Alloy Steel Nuts
- ASTM A653/A653M-11 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- ASTM A759-10 Standard Specification for Carbon Steel Crane Rails
- ASTM A780/A780M-09 Standard practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
- ASTM C1107/C1107M-11 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics
- ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic and Electrical Insulating Materials
- ASTM D2240 Standard Test Method for Rubber Property-Durometer Hardness
- ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- ASTM E165-09 Standard Test Method for Liquid Penetrant Examination
- ASTM E433-71(R2008) Standard Reference Photographs for Liquid Penetrant Inspection
- ASTM E709-08 Standard Guide for Magnetic Particle Testing



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

ASTM F436-11 Standard Specification for Hardened Steel Washers

ASTM F1554-07a Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.4.6 Other Codes, references and organizations

AISC Design Guide 7-2004 American Institute of Steel Construction, Steel Design Guide Industrial Buildings- Roofs to Anchor Rods, 2nd ed.

NBC 2010 National Building Code of Canada 2010 and the Supplement to the National Building Code of Canada

CISC Handbook Handbook of Steel Construction, 10th edition, Canadian Institute of Steel Construction

CSSBI Canadian Sheet Steel Building Institute

CWB Canadian Welding Bureau

SSPC Steel Structures Painting Council

OSHA Occupational Safety and Health Administration

CISC/CPMA 1-73a Colour, Pigments Manufacturers Association – "A Quick-drying One-coat Paint for Use on Structural Steel"

ISO 9001:2008 Quality Management Systems - Requirements

1.4.7 Where there are conflicts between or within the Specifications, Drawings, Codes, Standards or Acts, the most stringent requirements shall be applied.

1.5 **SITE CONDITIONS**

1.5.1 The Contractor is responsible for verifying all dimensions, elevations and conditions on site prior to the execution of the work, including shop drawings and fabrication.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.5.2 Any deviations, errors and site conditions which could adversely affect proper completion of the work shall be immediately reported to the Engineer for corrective action before preparing shop drawings.
- 1.5.3 Adequate provisions shall be made in order to protect existing structures, roads, utilities and other property against damage and to avoid interference with other contractors and plant operations.
- 1.6 QUALITY ASSURANCE**
- 1.6.1 The Contractor shall comply with an inspection program in conformance with ISO 9001:2008 requirements or equivalent.
- 1.6.2 The Engineer shall monitor the submitted quality control program, inspection and testing.
- 1.6.3 The Engineer reserves the right to inspect work at the fabrication plant at any time during the normal working hours.
- 1.6.4 Quality of work shall be controlled to meet the requirements of this Specification the referenced codes and standards, and other contract documents in effect on the date of the contract.
- 1.6.5 The Contractor shall obtain and retain Certificates of Compliance for all products listed in Part 2 for the Engineer's review, when requested.
- 1.6.6 Certifications**
- 1.6.6.1 The Contractor shall be certified by the CWB according to the requirements of CSA W47.1, Division 1 or Division 2, in accordance with CSA S16.
- 1.6.7 Substitutions**
- 1.6.7.1 Substitution for a specified element shall only be considered if the element is not available or if it results in an improved detail or easier erection. The Engineer reserves the right to accept or reject any proposed substitution
- 1.6.7.2 Substitutions shall receive written approval from the Engineer prior to being enacted.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

1.7 SUBMITTALS



- 1.7.1 The Contractor shall submit the required documentation to the Engineer for review and approval, in accordance with the Supplier Document Requirement List (SDRL).
- 1.7.2 The Contractor shall submit the following to the Engineer for review and acceptance:
 - 1.7.2.1 Not Used.
 - 1.7.2.2 Not Used.
 - 1.7.2.3 Certificates of the Contractor welders, pointers and welding machine operators.
 - 1.7.2.4 Certificates for the inspectors in conformance with CSA W178.2.
 - 1.7.2.5 Welding procedures for shop welds. Procedures for field welding, if applicable, shall also be submitted.
 - 1.7.2.6 Field-bolting inspection procedure.
 - 1.7.2.7 Design calculations for all connections not detailed on the drawings.
 - 1.7.2.7.1 Design calculations shall bear signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
 - 1.7.2.7.2 Design calculations shall bear signature of a verifier who is a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
 - 1.7.2.8 Shop and erection drawings including steel deck, placing drawings and bills of material with bolt lists.
 - 1.7.2.8.1 Shop drawings shall indicate the quantities, locations, top of steel elevations, spacing, sizes, profiles, steel grade, connections, including symbols and dimensions of welded joints, attachments, fasteners, spacing of the fasteners for steel decking, paint system and piece marks of members. Any requirements for edge preparation for welds or machining requirements shall be clearly indicated.
 - 1.7.2.8.2 Shop drawings shall include details of holes and fittings in components necessary for safety or to provide lifting and erection aids, as required.
 - 1.7.2.8.3 Shop drawing shall include a bill of material showing member piece marks, shape designations, number of pieces required, length, unit weight, total weight of each member, total weight of steel detailed on that drawing. It shall make reference to contract number, contract item number and related design drawing number.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.7.2.8.4 Shop drawings shall be submitted only when their related design calculations have been reviewed.
- 1.7.2.8.5 Shop and erection drawings shall bear signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador. They shall also bear signature of a verifier.
- 1.7.2.8.6 Detailing shall conform to the CISC Handbook.
- 1.7.2.8.7 Not Used.
- 1.7.2.8.8 Erection drawings shall show piece marks, locations and details of field connections of members. They shall also indicate all A325 and A490 field bolts that need to be fully tensioned, in accordance with this specification and the drawings.
- 1.7.2.8.9 Shop drawings shall also include details of all additional reinforcing, bracing or stiffening members that may be required for erection purposes.
- 1.7.2.9 Mill test certificates for all steel components. The Contractor is responsible for the correlation between the actual material used and the corresponding mill test certificates.
- 1.7.2.10 Quality control and test reports, including radiographic films.
- 1.7.3 Not Used.
- 1.7.4 The Contractor shall submit stamped as-built drawings to the Engineer, after the completion of the work.



PART 2 PRODUCTS

2.1 GENERAL

2.1.1 All materials to be supplied for the permanent works shall be new and be subject to Engineer's approval. Except as otherwise specified herein, shown on the drawings, or otherwise approved, the materials shall conform to the standards listed hereafter.

2.2 STEEL

Rolled W and WT sections, WWF, Built-up sections CSA G40.20/G40.21, Grade 350W

Built-up sections for crane girders CSA G40.20 / G40.21, Grade 350 WT, Category

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

	including the stiffeners	2
	Steels exposed to the weather	CSA G40.20/G40.21, Grade 350WT, Category 4
	Hollow structural steel section	ASTM A500, Grade C, $f_y=345$ MPa
	Rolled plates	CSA G40.20/G40.21, Grade 350W, as indicated on the drawings
	Rolled C, MC, S, L sections	CSA G40.20/G40.21, Grade 300W
	Sag rods	CSA G40.20/G40.21, Grade 300W
	Shear connectors ("Nelson" Type)	ASTM A108, Grade C-1010/Grade 60 ksi minimum
	Rails	ASTM A759, type as shown on the drawings
	Rail clips and links	Refer to drawings
	Steel deck	ASTM A653-Grade 33 ksi with zinc thickness conforming to Z275
	Welding materials	CSA W48, E49xx
	Bolts	ASTM A325 or ASTM A490
	Nuts	ASTM A563
	Washers	ASTM F436
	Anchor bolts	ASTM F1554, Grade 55 ksi minimum. Unless otherwise noted (UNO)
	Rebar anchor bolts	Steel: CAN/CSA G30.18M Grade 400W. Threaded with Washer and Nuts
	Concrete anchors	HILTI type hot dip galvanized, expansion or chemical adherence or as indicated on the drawings

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

Gratings

National Association of Architectural Metal
Manufacturers (NAAMM) and CSA
G40.20/G40.21, Grade 250W

Guardrails

ASTM A53, Grade 240 MPa

2.3 PROTECTIVE COATINGS

2.3.1 The Contractor shall submit documentation of proposed Materials to the Engineer. Materials shall be of first grade and used strictly in accordance with the Technical Conditions and the manufacturer's written directions.



2.3.2 For protective coatings, refer to Section 09 90 00 – Paint System for Structural Steel, and Section 48 13 10 – General Mechanical Requirements.

2.4 GROUT



2.4.1 Grout for column base plates and beam bearing plates shall be non-ferrous, non-shrink, with a minimum compressive strength of 50 MPa at 28 days, unless noted otherwise on the drawings as Specified in Section 03 60 40.

2.4.2 Structural steel shall be installed at the proper elevation by using packs of levelling steel shims. Typical installation details shall be submitted to the Engineer for approval.

2.4.3 The use of levelling nuts under the base plates is not an acceptable practice.

2.4.4 Prior to placing the grout, the space underside the base plates shall be cleaned. The Grout shall be prepared and installed following the instructions of the Manufacturer. The shear pockets shall be attentively inspected to ensure they are not filled with water or ice.

2.4.5 Not Used.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 DESIGN



- 3.1.1 Structural analysis, design, erection and related steelwork shall be in accordance with this Specification, CSA S16 and the CISC Handbook.
- 3.1.2 Shop fabrication drawings shall be made based on design structural drawings marked "Issued for Construction".
- 3.1.3 Steel shall be marked in compliance with CSA S16 and CSA G40.20/G40.21.
- 3.1.4 Connections not detailed or otherwise noted on the drawings shall be shop welded or field bolted.
- 3.1.5 No field welding is permitted unless specified on the drawings, or as approved by the Engineer.
- 3.1.6 Design calculations and drawings shall bear the seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
- 3.1.7 Eccentric connections shall not be used unless it is impossible to detail a concentric connection.
- 3.1.8 Welds shall be designed in accordance with CSA W59 using the electric arc-welding methods.
- 3.1.9 Connection design detail shall avoid lamellar tearing problems.
- 3.1.10 Steel plates subjected to tension perpendicular to the plate surface shall be verified for through thickness properties.
- 3.1.11 Bolted connections shall be, unless indicated otherwise on the drawings:
 - 3.1.11.1 Designed of the bearing-type, assuming threads are included in shear planes;
 - 3.1.11.2 Designed using high strength bolts, minimum diameter of 3/4 inch, conforming to ASTM A325 or ASTM A490, using a minimum of 2 bolts per connection for angles and minimum 4 bolts for tees and HSS;



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.1.11.3 Tightened in accordance with CSA S16;
- 3.1.11.4 The bolts shall be black, excepted where indicated otherwise.
- 3.1.11.5 Bolts shall be touched-up using the paint system applied to the connected members.
-  3.1.12 Slip-resistant-type connections shall be provided when required by the analysis, only for members or connections having alternate forces and shall be designed assuming Class A contact for surfaces, unless noted otherwise on the drawings. The bolts of slip-resistant connections shall be pre-tensioned in accordance with CSA S16.
-  3.1.13 Connections shall be designed for actual load as determined by analysis, but shall meet the following minimum criteria:
 -  3.1.13.1 For the simply supported beams, the connections shall be designed for a shear equal or greater than 75% of the total uniform distributed load corresponding to the member capacity in bending, for the beam span shown and considering the beam laterally supported.
 - 3.1.13.2 For fixed beams, the connection shall be designed for 100% of the member bending capacity, in addition to the shear required.
- 3.1.14 Beam connections shall be designed as shown on the drawings. When not shown on the drawings, the beam connections shall be designed using either end plate or a pair of clip angles. A minimum thickness of 7, 9 mm shall be used for angles, a minimum thickness of 12 mm for end plates with a minimum of 6 mm for fillet welds. The connections shall be developed on minimum 75% of the beam depth.
- 3.1.15 In addition, the beam connections shall be designed also for the axial load shown on the drawings.
- 3.1.16 Struts and ties shall be connected for a minimum tension force of 100 kN, unless otherwise noted on the drawings.
-  3.1.17 Bracing including strut and tie connections shall develop the forces indicated on the drawings but not less than the probable tensile resistance, probable compressive resistance or forces corresponding to $R_d.R_o = 1.3$ (CSA S16-09, Sections 27.1.2 and 27.5.4.2).
- 3.1.18 Analysis and design of Hoist Towers and Hoist Support Beams include loads and loading combinations as described in Section 48 13 21 Hoists and Cranes.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FABRICATION

- 3.2.1 The start of fabrication shall be authorized by the Engineer. Authorization to proceed shall be interpreted as agreement of the Engineer with general conformity to specification and design drawings only and shall not imply verification of dimensions, sizes, or quantities.
- 3.2.2 Steelwork shall be fabricated in accordance with CSA S16 and the shop drawings. Provisions of CSA S16 Clause 28, "Shop and Field Fabrication and Coating", shall apply unless otherwise specified.
- 3.2.3 Components shall be fabricated such as to result in pieces as large as practicable that satisfy transportation clearances. Special measures for road or naval transportation have to be considered.
- 3.2.4 The dimensions shown on the drawings for the structural steel members are for 23 °C. The Contractor shall apply corrections for the steel dimensions depending on the effective temperatures at the fabrication time.
- 3.2.5 Members shall be cambered as shown on the drawings.
- 3.2.6 Built-up members shall be shop-fabricated within the tolerances of CSA S16, unless specified otherwise on the drawings.
- 3.2.7 Column splices and column base plate connections shall have a full bearing by milling and shall be in contact all over their intended contact surfaces, unless indicated otherwise on the drawings.
- 3.2.8 Splices not shown on drawings shall be submitted by the Contractor for review prior to fabrication.
- 3.2.9 Each steel member shall be marked and referenced on the erection drawings.
- 3.2.10 Not used.
- 3.2.11 Provide weld preparation where required for field welded connections and supply clips for fit-up and erection.
- 3.2.12 Nelson studs shall be welded complete penetration at the shop, unless indicated otherwise on the drawings, in accordance with the requirements of CAN/CSA W59.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.13 Open ends of HSS sections shall be sealed with 6 mm minimum cap plates, unless noted otherwise on drawings. 12 mm diameter venting holes shall be provided. These holes shall be at the member extremities and located in order to avoid any water entrapment inside the tubes.
- 3.2.14 Rough welds, sharp edges and corners shall be ground smooth and all weld spatters shall be removed.
- 3.2.15 Welds for galvanized steel shall be seal welded.
- 3.2.16 Hammer welding shall not be permitted.
- 3.2.17 Minimum cope radius shall be 20 mm, except where impracticable. Cope radius shall be ground to remove the visible heat affected zone and to create a smooth radius, free of nicks and notches.
- 3.2.18 Surface treatment shall be as follows:
 - 3.2.18.1 Structural steel shall be painted, except as otherwise noted.
 - 3.2.18.2 Not Used.
 - 3.2.18.3 Primed surfaces around connections shall be painted on site after final tightening of the bolts.
 - 3.2.18.4 Bolts, nuts and washers shall be galvanized only for the connections of galvanized steels, unless noted otherwise.
- 3.2.19 Refer to Section 09 90 00 Paint System for Structural Steel and Section 48 13 10 – General Mechanical Requirements for preparation of steel to be painted.
- 3.2.20 Refer to the “Galvanizing” article of this Section for preparation of steel to be galvanized.
- 3.2.21 Refer to the “Quality Control” article of this Section for the inspection of bolting, welding and studs.
- 3.2.22 Unless noted otherwise, steel deck shall be:
 - 3.2.22.1 of the type indicated on the drawings;
 - 3.2.22.2 galvanized in accordance with ASTM A653, zinc thickness Z275;



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		

- 3.2.22.3 in accordance with CAN/CSA S136 and the CSSBI recommendations;
- 3.2.22.4 supplied with mechanical connections, sheets, closure plates and pour stops.
- 3.2.23 The steel decking members shall span a minimum of 3 spans, unless noted otherwise on the drawings.
- 3.2.24 Each decking member shall be identified with a shipping mark as shown on the fabrication and erection drawings.
- 3.2.25 Final steelwork shall be free from distortion and defects detrimental to the appearance and/or the performance, to the Engineer's satisfaction.

3.3 PROTECTIVE COATINGS

- 3.3.1 Steel painting shall be in accordance with Section 09 90 00, Section 48 13 10, CSA S16, the paint Manufacturer's instructions and the applicable SSPC requirements.
- 3.3.2 to 3.3.17 Not used.

3.4 GALVANIZING

- 3.4.1 Steels specified to be galvanized, including bolts, nuts and washers, shall conform to ASTM A123/A123M and ASTM A153/A153M.
- 3.4.2 The galvanization of steels shall be done in one immersion.
- 3.4.3 In the event that steels specified to be galvanized exceed the dimensions of the immersion tanks available, those sections including their connecting bolts and washers, may be protected by metallization following prior approval of the Engineer. This procedure shall conform to CSA G189, with a minimum zinc protection thickness of 0.1 mm, which corresponds to 700 g/m². The metallization using a protection with aluminum is not acceptable.
- 3.4.4 All steels which are required to be galvanized shall have continuous seal welding all around their contact. The minimum welding dimension shall be 3 mm where capacity is not required for connection strength.
- 3.4.5 Before galvanizing, all weld spatter, rough welds, or sharp protrusion shall be removed by chipping and grinding. All welds shall then be sandblast cleaned in accordance with SSPC-SP10 "Near-white Blast Cleaning". The remaining surfaces shall be thoroughly



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		

cleaned of all loose mill scale, rust, oil, grease and weld flux deposits in accordance with SSPC-SP6 "Commercial Blast Cleaning".

- 3.4.6 Minimum quantity of galvanizing shall be 460 g/m² for nuts and bolts and 700 g/m² for all other parts, except steel wires.
- 3.4.7 Bolted connections for galvanized steels shall be made with galvanized bolts in accordance with ASTM A325. Washers and nuts shall have a compatible class and finish to the bolt finish as specified in ASTM A325.
-  3.4.8 Nuts shall be re-tapped after being galvanized and the threads of nuts left bare in accordance with ASTM A153/A153M-09.
- 3.4.9 Bolts conforming to ASTM A490 shall not be galvanized, by any method.
- 3.4.10 Welded connections of already galvanized steel components are not accepted.
- 3.4.11 Material shall be galvanized after all the fabrication, machining and shop work is completed, except as otherwise specified herein.
- 3.4.12 Appropriate measures shall be taken in order to ensure that frames or similar items of steelwork are not distorted during the galvanizing process, in accordance with ASTM A384 requirements. In this regard, submit to the Engineer details of all proposed additional reinforcement, bracing or otherwise stiffened metalwork for approval prior to proceeding with the relevant work.
- 3.4.13 The coating shall be clean, smooth and free from defects. Bare spots, loosely attached spelter, unevenness of coating and globules which may be broken in handling, shall be cause for rejection. If more than 5 percent of material is rejected, manufacture shall be stopped and the process altered so that satisfactory work could be produced.
- 3.4.14 Galvanizing inspection shall be as described in the "Quality Control" section of this Specification. Galvanization work found to be defective shall be corrected.
-  3.4.15 Galvanized surfaces damaged during transportation, handling and installation shall receive two coats of "Galvano Spray 70-45" by METAFUX.

3.5 TRANSPORTATION, HANDLING AND STORAGE

- 3.5.1 The Engineer shall give a written approval for each delivery on site.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.5.2 Federal, Provincial or Municipal transportation bylaws shall be respected.
- 3.5.3 Steelwork shall be handled and protected adequately for transportation and storage in order to avoid any damage. It shall be strengthened if needed.
- 3.5.4 Delivery slip shall have piece identification, description and dimensions.
- 3.5.5 Painted or galvanized surfaces shall not be stacked face to face. Wood blocks, polystyrene padding or other suitable materials shall be used as separator.
- 3.5.6 Nylon-type slings shall be used for lifting. Where it is necessary, lifting beams or cradles shall be used.
- 3.5.7 Steel shall be securely fastened with chains and blocking to transportation vehicle in order to prevent lateral movement. The edges of steelwork shall be protected with rubber, hessian or wood.
- 3.5.8 Small bundled sections shall not be loaded inside larger components.
- 3.5.9 Bolts, nuts and washers shall be shipped in metallic packaging and coated with protective oil. Bolts of different length or diameter shall be separated in several containers or bags, each one containing only identical type of pieces. All containers shall be properly labelled.
- 3.5.10 Wood blocks of convenient size shall be provided in order to ensure that the steel rests clear of ground, does not accumulate water and does not distort permanently.
- 3.5.11 Steel shall be unloaded at the designated location. Proper equipment and labour shall be employed to unload onto wood blocks without damage.

3.6 INSTALLATION

3.6.1 Stability

3.6.1.1 It is the Contractor's responsibility to determine construction procedures and sequence to ensure the integrity of the structure and its components during erection. This includes the addition of necessary and adequate shoring, sheeting, temporary bracing and other temporary structures required to resist all construction loads and additionally to comply with the provisions of the OHSa.

3.6.1.2 Temporary bracings shall be maintained in place if the permanent stability of the structure depends on work of other trades, until that work is completed.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6.2 Erection

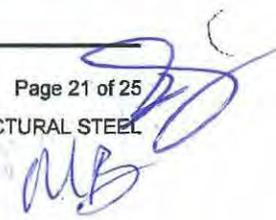
- 3.6.2.1 Unless otherwise noted herein, the structural steel shall be erected in accordance with this Specification, CSA S16, AISC-7, article 6.7.3 of CSA A23.1/A23.2, the CISC Code of Standard Practice and the approved erection drawings.
- 3.6.2.2 Alignment shall be in accordance with CSA S16 and as indicated on the drawings.
- 3.6.2.3 The Engineer shall approve any field cutting or altering of structural members not shown on the drawings.
- 3.6.2.4 Prior to final tightening of the bolted connections:
 - 3.6.2.4.1 Each section of structure shall be plumbed and aligned;
 - 3.6.2.4.2 Members shall be aligned and free of distortions and open joints.
- 3.6.2.5 Expansion and chemical anchors connecting loose steel to concrete work shall be installed where indicated on the drawings, according to Manufacturer's instructions.
- 3.6.2.6 No part of any new or existing structure shall be subject to erection loads which could in any way damage or cause permanent distortion to that part or any other part of the structure.
- 3.6.2.7 Any damage to the structural steel, including coating or errors in alignment or location shall be corrected.
- 3.6.2.8 Erection tolerance and inspection shall be as described in the "Quality Control" section of this Specification or as indicated on drawings.

3.6.3 Bolting

- 3.6.3.1 High-strength bolts shall be used for connections, unless indicated otherwise on the drawings.
- 3.6.3.2 For slip-resistant type connections, high strength bolts shall be pre-tensioned using turn-of-nut method in accordance with CSA S16 article 23.8.
- 3.6.3.3 Hardened washer shall be used under each nut.
- 3.6.3.4 All joint surfaces, including those adjacent to bolt heads and nuts, shall be free of burrs, dirt and other foreign material that inhibit solid seating of parts.
- 3.6.3.5 Do not drive drift pins with such force as to deform adjacent metal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.6.3.6 Drill any bolt holes missing from fabricated steel. Do not enlarge or make any hole by flame cutting.
- 3.6.3.7 Bolting inspection shall be as described in the "Quality Control" section of this Specification.
- 3.6.4 Field Welding
 - 3.6.4.1 Field welding shall be:
 - 3.6.4.1.1 Used only where shown on the drawings or as approved by the Engineer;
 - 3.6.4.1.2 In accordance with CSA W59;
 - 3.6.4.1.3 Executed by welders certified in accordance with CSA W59 and CSA W47.1.
 - 3.6.4.2 Welding inspection shall be as described in the "Quality Control" section of this Specification.
- 3.6.5 Base Plates
 - 3.6.5.1 Column base plates and beam bearing plates shall be set, shimmed levelled to correct positions and elevation shown on the drawings, subjected to the same quality control as described in the "Erection" section above.
 - 3.6.5.2 The final position of the base plates shall be approved by the Engineer.
 - 3.6.5.3 Any temporary support shall carry all construction loads imposed prior to base plate grouting.
 - 3.6.5.4 The base plate grout shall:
 - 3.6.5.4.1 Be placed after final alignment and levelling of the structure;
 - 3.6.5.4.2 Be placed on and under surfaces thoroughly cleaned and free from grease, oil, laitance, sawdust and other deleterious matter;
 - 3.6.5.4.3 Be mixed, placed, cured and finished in accordance with the grout Manufacturer's instructions;
 - 3.6.5.4.4 Be placed to cover the full area under base plates, completely surrounding anchor bolts, and filling cavities of shear pockets and sleeves;
 - 3.6.5.4.5 Be sloped at 45° outside the perimeter of the base plate, or have an equivalent base dimension.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.6.5.5 The anchor bolts of the columns shall be tightened to snug tight condition, after the grout has reached its full strength. After the completion of the structural steel erection, the anchor bolts shall be retightened in order to obtain the pretension in rods as required on the drawings.
- 3.6.6 Steel Deck
 - 3.6.6.1 Steel deck shall be installed in accordance with CSSBI requirements and the approved shop drawings.
 - 3.6.6.2 Closure plates shall be provided and fixed with screws.
 - 3.6.6.3 Steel deck shall be cut in shop following the shop drawings. Minor cuts may be done on Site at small openings.
 - 3.6.6.4 The roof deck shall be continuous on minimum 3 spans and the lapping in the longitudinal direction shall be of minimum 50 mm.
 - 3.6.6.5 The connections of the deck on structural steel shall be using self-tapping screws 6 mm diameter, installed at 305 mm maximum interval, unless noted otherwise on the drawings.
 - 3.6.6.6 For the ends of steel deck on the building perimeter, the maximum interval between the self-tapping screws shall be 152 mm.
 - 3.6.6.7 The wind suction and pressure, as per NBC and Site conditions, will be given on drawings by the Engineer. On this basis the Contractor shall determine the required interval between connectors, depending on the connector capacity.
 - 3.6.6.8 Steel deck connection on the structural steel by welding will be allowed only if it is specified on the drawings. In this case, the welding shall be in accordance with CSA W59.
 - 3.6.6.9 The overlapping joints, on lateral sides, shall be mechanically fastened at 450 mm intervals, unless noted otherwise on the drawings.
 - 3.6.6.10 Touch-up, wherever necessary, shall be done after the completion of work.
- 3.6.7 Errors and Misfit
 - 3.6.7.1 Fabrication errors discovered during erection shall be reported to the Engineer along with proposed correction methods.
 - 3.6.7.2 Minor misfit shall be corrected by reaming, cutting and chipping as part of work as approved by the Engineer.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.6.7.3 Flame cutting shall only be allowed on secondary members with written approval from the Engineer.
- 3.6.7.4 Cut edges shall be ground and painted or galvanized to match the surrounding finish.
- 3.6.7.5 Fitting up bolts or drift pins shall not be used to bring improperly fabricated members together.
- 3.6.7.6 Shims, packing or wedging shall not be used to correct imperfect work without written approval of the Engineer.
- 3.6.8 Touch-ups
 - 3.6.8.1 After installation, all field bolts, welds and any surface areas where the shop coat has been damaged during transportation, handling and installation, shall be cleaned, primed and repaired to its original state.
 - 3.6.8.2 Refer to the article 3.3 "Protective Coating" of this Specification Section for touch-up of painted steel.
 - 3.6.8.3 Refer to the article 3.4 "Galvanizing" of this Specification Section for touch-up of galvanized steel.
 - 3.6.8.4 During touch-up on the work site, equipment and floors shall be protected against spray splash or drops of paint or zinc products. All stains or spilled products on equipment, floors and walls shall be cleaned.
 - 3.6.8.5 Refer to Section 09 90 00 – Paint System for Structural Steel for touch-up of the Structural Steel connections and areas next to the supports of steel beams.
- 3.6.9 Final Clean-up
 - 3.6.9.1 Clean-up work site, remove all debris, shelters, equipment and surplus material prior to final acceptance of work.



3.7 QUALITY CONTROL, INSPECTION AND TESTING

- 3.7.1 Welds
 - 3.7.1.1 Inspection and testing of welding shall conform to CSA W59 using non-destructive test methods.
 - 3.7.1.2 Inspections and non-destructive tests shall be made by inspectors registered in conformance with CSA W178.2.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.1.3 Inspection and testing of studs shall conform to CSA W59.

3.7.1.4 Test of welds shall be performed as indicated in the following table.

Weld Type	Inspection	Level of Inspection
Complete joint penetration groove welds in tension (Butt joint)	Radiographic	100% of the length of each weld
Complete joint penetration Groove Weld in compression or shear (Butt joints)	Radiographic	50% of the length of each weld
Fillet Welds in tension members	Magnetic	For each element, 100% of the length of each weld
Fillet Welds (others)	Magnetic	For each element, 25% of the length of each weld
Complete joint penetration groove welds in tension members	Ultrasonic	100% of the length of each weld
Complete joint penetration groove welds in compression or shear members	Ultrasonic	For each element, 50% of the length of the weld

3.7.1.5 Faulty welding shall be repaired as specified in CSA W59.

3.7.1.6 If faults exceeding the provision of CSA W59 are found, then 100% of the welding length shall be tested. Make repairs and retest repaired areas; if faults found in repaired areas, repair and retest until no faults occur.

3.7.2 Bolted Connections

3.7.2.1 Inspection of high-strength bolted connections shall conform to CSA S16.

3.7.3 Painting



3.7.3.1 Refer to Section 09 90 00 – Paint System for Structural Steel.



3.7.3.2 to 3.7.3.6 Not used.

3.7.4 Galvanizing

3.7.4.1 Testing shall conform to the requirements of ASTM A123A/A123M-12.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 12 00
CH0032	STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.4.2 During galvanizing, the Engineer may carry out tests on the coating and analysis of the spelter, as considered necessary.

3.7.5 Erection

3.7.5.1 Tolerance, inspection and checking of structure for alignment, plumbness and elevation shall conform to the most stringent of CSA S16 and Chapter 19 of AISC-7, unless indicated otherwise on the drawings.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 05 50 10
MISCELLANEOUS METALS
AND EMBEDDED PARTS
TABLE OF CONTENTS**

PART 1 GENERAL 2

1.1 SCOPE OF WORK 2

1.2 RELATED SECTIONS 3

1.3 DEFINITIONS 3

1.4 REFERENCES 3

1.5 SITE CONDITIONS 6

1.6 QUALITY ASSURANCE 7

1.7 SUBMITTALS 8

PART 2 PRODUCTS 9

2.1 GENERAL 9

2.2 METALS 10

2.3 PROTECTIVE COATINGS 11

PART 3 EXECUTION 11

3.1 DESIGN 11

3.2 FABRICATION 13

3.3 PROTECTIVE COATINGS 15

3.4 GALVANIZING 15

3.5 TRANSPORTATION, HANDLING AND STORAGE 16

3.6 INSTALLATION 17

3.7 QUALITY CONTROL 20

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PEG
Newfoundland
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Professional Geoscientists

PERMIT HOLDER
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
which is valid for the year 2013



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SCOPE OF WORK



The work described in this Specification includes all labour, material, equipment, inspection and testing for the connection design, preparation of shop drawings, supply, fabrication, galvanizing, transportation to site and installation of the miscellaneous metals and embedded parts shown on the "Miscellaneous Steel" and/or Concrete drawings.

The design, fabrication and installation of miscellaneous steel shall conform to this Specification and to CSA S16. However, the requirements of this specification supersedes the corresponding ones of Standard CSA S16.

1.1.1 Work Included

- .1 This specification applies to all operations associated with, but not necessarily limited to, the following:
 - .1 Supply, fabrication, delivery, storage and installation of miscellaneous metals, embedded items and anchor bolts;
 - .2 Preparation and submittal of detailed shop drawings and erection drawings;
 - .3 Furnish welding materials and perform field and shop welding;
 - .4 Preparation, painting and furnish coating materials including cleaning and touch-up after fabrication;
 - .5 Clean and shop galvanize all embedded steel and anchor bolts, if indicated on the drawings;
 - .6 Supply all necessary equipment and maintenance thereof to perform the work outlined in this specification;
 - .7 Inspection and testing.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.2 RELATED SECTIONS

- .1 Section: 01 35 43 General Environmental Requirements
- .2 Section: 03 11 00 Concrete Formwork
- .3 Section: 03 20 00 Concrete Reinforcement
- .4 Section: 03 60 40 Grout
- .5 Section: 03 30 00 Cast-In-Place Concrete
- .6 Section 09 90 00 Paint System for Structural Steel
- .7 Section 48 13 10 General Mechanical Requirements



1.3 DEFINITIONS

- SDRL: Supplier Documentation Requirement List
- VDR: Vendor Documentation Requirement Form
- MSDS: Material Safety Data Sheets
- OSHA: Occupational Safety and Health Administration

1.4 REFERENCES

The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.4.1 All work shall be in accordance with this specification and the requirements of the following codes and standards:

1.4.2 Canadian Standard Association (CAN/CSA):

- CSA A23.1-09/A23.2-09 Concrete Materials & Methods of Concrete Construction / Test Methods & Standard Practices for Concrete
- CSA G30.18-09 Carbon Steel Bars for Concrete Reinforcement

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		



CSA G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
CSA G189-1966 (R2003)	Sprayed Metal Coating for Atmospheric Corrosion Protection
CSA S16-09	Design of Steel Structures
CAN/CSA S136-07 (R2012)	North American Specification for the Design of Cold-Formed Steel Structural Members
CAN/CSA S157/S157.1-05 (R2010)	Strength Design in Aluminum and Commentary
CSA W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)
CSA W48-06	Filler Metal and Allied Materials for Metal Arc Welding
CSA W47.1-09	Certification of Companies for Fusion Welding of Steel
CSA W47.2-11	Certification of Companies for Fusion Welding of Aluminum
CSA W55.3-08	Certification of Companies for Resistance Welding of Steel and Aluminum
CSA W178.1-08	Certification of Welding Inspection Organizations
CSA W178.2-08	Certification of Welding Inspectors

1.4.3 Canadian General Standards Board (CGSB):

CAN/CGSB-1.132-M90 Zinc Chromate Primer, Low Moisture Sensitivity

1.4.4 American Society for Testing and Materials (ASTM):

ASTM A36-08/A36M-08 Standard Specification for Carbon Structural Steel

ASTM A53-10/A53M-12 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- ASTM A108-07 Specification for Steel Bar, Carbon and Alloy, Cold finished
- ASTM A123/A123M-12 Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products
- ASTM A153/A153M-09 Standard Specification for Zinc Coating (Hot Dip) on Iron And Steel Hardware
- ASTM A240-11/A240M-12 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- ASTM A325-10/A325M-9 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength / Metric
- ASTM A384/A384M-07 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- ASTM A413/A413M-07 Standard Specification for Carbon Steel Chain
- ASTM A500/A500M-10a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- ASTM A563-07a Standard Specification for Carbons and Alloy Steel Nuts
- ASTM A572/A57-127 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- ASTM A653/A653M-11 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- ASTM A780/A780-09 Standard practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
- ASTM B209/A209M-03(R07) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- ASTM B221/B221M-12 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- ASTM B308/B308M-10 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

ASTM B429/B429-10	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM D1730-09	Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
ASTM E165-09	Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E433-71(2008)	Standard Reference Photographs for Liquid Penetrant Inspection
ASTM E709-08	Standard Guide for Magnetic Particle Testing
ASTM F436/F436M-11	Standard Specification for Hardened Steel Washers
ASTM F1554-07a	Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength

1.4.5 Other Codes, references and organizations:

NBC 2010	National Building Code of Canada 2010 and the Supplement to the National Building Code of Canada
OHSA	Occupational Health and Safety Act, Newfoundland and Labrador
CISC Handbook	Handbook of Steel Construction, 9th edition, Canadian Institute of Steel Construction
CSSBI	Canadian Sheet Steel Building Institute
CWB	Canadian Welding Bureau
SSPC	Steel Structures Painting Council
ISO 9001:2008	Quality Management System Requirements



1.5 SITE CONDITIONS



1.5.1 The Contractor is responsible for verifying all dimensions, elevations and conditions on site prior to the execution of his shop drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



1.5.2 The Contractor is responsible to inspect and verify that finish of surfaces on primary concrete are satisfactory prior to installation of second stage embedments.



1.5.3 Any deviations, errors and site conditions which could adversely affect proper completion of the work shall be immediately reported to the Engineer for corrective action before preparing shop drawings.

1.6 QUALITY ASSURANCE

1.6.1 The Contractor shall comply with a quality assurance/quality control program in conformance with ISO 9001:2008 requirements or equivalent.

1.6.2 The Contractor shall monitor the submitted quality control program, inspection and testing.

1.6.3 The Engineer reserves the right to inspect work at the fabrication plant at any time during the normal working hours. Provisions shall be made for such inspection, when requested.

1.6.4 Quality of work shall be controlled to meet the requirements of this specification, referenced codes and standards and other contract document in effect on the date of contract

1.6.5 The Contractor shall obtain and retain Certificates of Compliance for all products listed in Part 2, for the Engineer's review, when requested.

1.6.6 Certifications

- .1 The Contractor shall be certified by the CWB according to the requirements of CSA W47.1 Division 1 or Division 2, in accordance with CSA S16.
- .2 Suppliers of all materials and products shall be certified to ISO 9001:2008 requirements or equivalent.

1.6.7 Substitutions

- .1 Complete technical data as to type, composition, strength, quality, finish, capacity, performance characteristics, and other pertinent details will be required to determine the acceptability of a substitute item.
- .2 Substitution for a specified element shall only be considered if the element is not available or if it results in an improved detail or easier erection.
- .3 Substitutions shall receive written approval from the Engineer prior to being implemented.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

1.7 SUBMITTALS

1.7.1 The Contractor shall submit the required documentation to the Engineer for review and approval in accordance with the Supplier Documentation Requirements List (SDRL)

1.7.2 The Contractor shall submit the following to the Engineer, for review::



- .1 Not Used.
- .2 Not Used.
- .3 Certificates of the welders, pointers and welding machine operators.
- .4 Certificates for the inspectors in conformance with CSA W178.2.
- .5 Welding procedures for shop welds. Procedures for field welding, if applicable, shall also be submitted.
- .6 Field-bolting inspection procedure.
- .7 Design calculations for moment connections and splices, if any, not detailed on the drawings.
 - .1 Design calculations shall bear signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
 - .2 Design calculations shall also bear signature of a verifier who is a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
- .8 Shop and erection drawings, and bills of material with bolt lists.
 - .1 Shop drawings shall indicate the quantities, locations, top of steel elevations, spacings, sizes, profiles, steel grade, connections, including symbols and dimensions of welded joints, attachments, fasteners, galvanization or paint systems and piece marks of members. Requirements for joint preparation for welds or machining requirements shall be clearly indicated.
 - .2 Shop drawings shall include details of holes and fittings in components necessary for safety or to provide lifting and erection aids, as required.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Each shop drawing shall include a bill of material showing member piece marks, shape designations, number of pieces required, length, unit weight, total weight of each member, total weight of steel detailed on that drawing. Shop drawings shall make reference to the contract number, contract item number and related design drawing number.
- .4 Shop drawings shall be submitted only when their related design calculations have been reviewed and accepted.
- .5 Shop and erection drawings shall bear signature and seal of a qualified Professional Engineer registered in the Province of Newfoundland and Labrador. They shall also bear signature of a verifier.
- .6 Detailing of steelwork shall conform to the CISC Handbook.
- .7 Engineer's drawings may be used as erection drawings, however the title block shall be replaced with a revised title block and the all professional seals shall be removed.
- .8 Erection drawings shall show piece marks, locations and details of field connections of members. They shall also indicate all field bolts that need to be pretensioned in accordance with this Specification and the drawings as well as any field welding that may be required.
- .9 Shop drawings shall include details of all proposed additional reinforcement, bracing or otherwise stiffened metalwork that may be required for erection purpose.
- .9 Mill test certificate for all steel components. The Contractor is responsible for the correlation between the actual material used and the corresponding mill test certificates.
- .10 Quality control and test report.
- 1.7.3 The Contractor shall submit stamped as-built drawings to the Engineer at completion of work.
- 1.7.4 The Contractor shall submit Material Safety Data Sheets for each product required by OSHA to have an MSDS.

PART 2 PRODUCTS

2.1 GENERAL

- 2.1.1 All materials to be supplied for the permanent works shall be new and be subject to approval.
- 2.1.2 Except as otherwise specified herein, shown on the drawings or otherwise approved, materials shall conform to the following standards.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 METALS

Aluminum	ASTM B221, ASTM B209, ASTM B308 and ASTM B429. Alloy 6061-T6 temper, unless otherwise indicated on the drawings (reduced strength used for the design of welded parts)
Stainless steel	ASTM A-240, Types 304L or 316L, unless otherwise indicated on the drawings
Rolled W and WT sections	CSA G40.20/G40.21, Grade 350W
Rolled C, MC, S and L sections	CSA G40.2/G40.21, Grade 300W
Rolled plates	CSA G40.20/G40.21, Grade 350W
 Hollow structural steel sections	ASTM A500, Grade C, F _y = 345 mPa
Sag rods	CSA G40.20/G40.21, Grade 300W
Shear connectors (Nelson studs)	ASTM A108, Grade C-1010 / Grade 60 ksi minimum
Steel deck	ASTM A653-Grade 33 ksi with zinc thickness conforming to Z275
Grating	National Association of Architectural Metal Manufacturers (NAAMM) and CSA G40.20/G40.21, Grade 250W
 Checkered plates	ASTM A36 or CSA G40.21, Grade 300W (if indicated on the drawings)
Chains	ASTM A413, Grade 30 galvanized
Handrails/Guardrails	ASTM A53, Grade 240 MPa; Steel pipe size and schedule as indicated on the drawings
Welding materials	CSA W48, E49XX
Bolts	ASTM A325 Type 1
Nuts	ASTM A563



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Washers	ASTM F436
Anchor bolts	As indicated on the drawings
Concrete anchors	HILTI type hot dip galvanized, expansion or chemical adherence or as indicated on the drawings

2.3 PROTECTIVE COATINGS

2.3.1 The Contractor shall submit documentation of proposed materials to the Engineer. Materials shall be of first grade and used strictly in accordance with the Technical Conditions and the manufacturer's written directions.

2.3.2 For protective coatings, refer to Section 09 90 00 – Paint System for Structural Steel and Section 48 13 10 – General Mechanical Requirements.



PART 3 EXECUTION

3.1 DESIGN

3.1.1 General

- .1 General steelwork shall be designed in accordance with this Specification, CSA S16 and the CISC Handbook.
- .2 Aluminum handrails, if required, shall be designed in accordance with CAN/CSA S157.
- .3 Shop fabrication drawings shall be made based on structural drawings marked "Issued for Construction".
- .4 Connections not detailed on the Engineer's drawings shall be designed by a qualified Professional Engineer registered in the Province of Newfoundland and Labrador.
- .5 Steel shall be marked in compliance with CSA S16 and CSA G40.20/G40.21.
- .6 Connections not detailed or otherwise noted on the drawings shall be shop welded or field bolted.
- .7 No field welding is permitted unless specified on the drawings, or as approved by the Engineer.

Handwritten signatures in blue ink.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		

- .8 Welds shall be designed in accordance with CSA W59 using the electric arc-welding methods.
- .9 Eccentric connections shall not be used unless it is impossible to detail a concentric connection.
- .10 Connection design detail shall avoid lamellar tearing problems, where possible. Steel plates subjected to tension perpendicular to the plate surface shall be verified for through thickness properties.

3.1.2 Bolted Connections

- .1 Bolted connections shall be, unless indicated otherwise on the drawings:
 - .1 Designed of the bearing-type, assuming threads are included in shear planes;
 - .2 Designed using high strength bolts conforming to ASTM A325, using a minimum of two 5/8 inch diameter bolts per connection;
 - .3 Tightened in accordance with CSA S16.
- .2 Bolts shall be touched-up using the paint system applied to the connected members.

3.1.3 Connection Design

- .1 Beam connections shall be designed for the forces indicated on the drawings. However, the capacity of the connections shall be at least the greatest of 75% of the factored uniformly distributed load capacity in shear and 100% of the factored uniformly distributed load capacity in bending for a laterally supported beam of the span shown.
- .2 The minimum depth of the connections shall be 75% of the beam depth.
- .3 Bracing connections shall develop the forces indicated on the drawings. However, the capacity of the connections shall be at least the smallest of the net tension capacity of the member and 100% of its effective compression capacity.
- .4 Minimum gusset plate thickness shall be 10 mm, unless shown otherwise on the drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FABRICATION

3.2.1 General

- .1 The start of fabrication shall be authorized by the Engineer. Authorization to proceed shall be interpreted as agreement of the Engineer, in conformity with the specification and design drawings only, and shall not imply verification of dimensions, sizes, or quantities.
- .2 Steelwork shall be fabricated in accordance with CSA S16 and the shop drawings. Provisions of CSA S16 Clause 28, "Shop and Field Fabrication and Coating", shall apply unless otherwise specified.
- .3 Platforms, stairways and handrails shall be shop-assembled in the largest units suitable for shipping and handling. Ladder cages shall be shop-assembled on ladders.
- .4 Aluminum handrails shall be fabricated in accordance with CAN/CSA S157 and the shop drawings.
- .5 Measure fabrication dimensions assuming 18°C temperature.
- .6 Provide weld preparation where required for field welded connections and supply clips for fit-up and erection.
- .7 Nelson studs shall be welded at the shop, unless indicated otherwise on the drawings, in accordance with the requirements of CSA W59.
- .8 Open ends of HSS sections shall be sealed with 6 mm minimum cap plates, unless noted otherwise on drawings. 12 mm diameter venting holes shall be provided.
- .9 Rough welds, sharp edges and corners shall be ground smooth and all weld spatters shall be removed.
- .10 Welds for steel to be galvanized shall be seal welded.
- .11 Hammer welding shall not be permitted.
- .12 Minimum cope radius shall be 20 mm, except where impracticable. Cope radius shall be ground to remove the visible heat affected zone and to create a smooth radius, free of nicks and notches.
- .13 Shop splice of members shall not be permitted.
- .14 Anchor bolts shall be threaded as indicated on the drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .15 Checkered plate shall conform to ASTM A36 unless noted otherwise on the drawings with standard two-way raised pattern. The thickness shown on the drawings is nominal and does not include the height of the raised pattern.
- .16 Openings greater than 150 mm diameter for pipes and ducts in floor plates shall be reinforced as directed with sleeves, plates or other steel members.

3.2.2 Surface Treatment

- .1 Surface treatment shall be as follows.
 - .1 Miscellaneous steelwork, including bolts, nuts and washers, shall be galvanized, except otherwise noted.
 - .2 Non-galvanized pieces shall be painted, except where otherwise noted. Contact surfaces of connections shall be primed only over a surface extending 50 mm beyond the perimeter of the connection.
- .2 Refer to Section 09 90 00 – Paint System for Structural Steel for preparation of metalwork to be painted.
- .3 Refer to the “Galvanizing” Article 3.4 of this Specification Section for preparation of steel to be galvanized.

3.2.3 Steel Deck

- .1 Steel deck shall be:
 - .1 of the type indicated on the drawings;
 - .2 galvanized in accordance with ASTM A653, grade A;
 - .3 in accordance with CSA S136 and the CSSBI recommendations;
 - .4 supplied with mechanical connections, sheets, closure plates and pour stops.

3.2.4 Final metalwork shall be free from distortion and defects detrimental to the appearance, and performance and is subject to the Engineer’s approval.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 PROTECTIVE COATINGS

3.3.1 General

-  .1 Painting shall be in accordance with Section 09 90 00 – Paint System for Structural Steel, Section 48 13 10 – General Requirements, CAN/CSA S16, the paint Manufacturer’s instructions and the applicable SSPC requirements.
-  .2 Not used.
- .3 Graphite paint shall be used under crane rails.
- .4 Not used.
- .5 Not used.

3.3.2 to 3.3.11.3 Not used.

3.4 GALVANIZING

- 3.4.1** Steel specified to be galvanized, including bolts, nuts and washers, shall conform to ASTM A123/ASTM A123M and ASTM A153/A153M.
- 3.4.2** The galvanization of steel members and assemblies shall be done in one immersion.
- 3.4.3** In the event that steels specified to be galvanized exceed the dimensions of the immersion tanks available, those sections including their connecting bolts, nuts and washers may be protected by metallization, following the prior approval of the Engineer. This procedure shall conform to CAN/CSA G 189, with a minimum zinc protection thickness of 0.1 mm, which corresponds to 700 g/m². The metallization using a protection with aluminum is not acceptable.
- 3.4.4** All steels which are required to be galvanized shall have continuous seal welding all around their contact. The minimum welding dimension shall be 3 mm but this only where capacity is not required for connection strength.
- 3.4.5** Before galvanizing, all weld spatter, rough welds, or sharp protrusion shall be removed by chipping and grinding. All welds shall then be sandblast cleaned in accordance with SSPC-SP10 “Near-white Blast Cleaning”. The remaining surfaces shall be thoroughly cleaned of all loose mill scale, rust, oil, grease and weld flux deposits in accordance with SSPC-SP6 “Commercial Blast Cleaning”.
- 3.4.6** Minimum quantity of galvanizing shall be 460 g/m² for nuts and bolts and 700 g/m² for all other parts except steel wires.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

- 3.4.7 Bolted connections for galvanized components shall be made with galvanized bolts in accordance with ASTM A325. Washers and nuts shall have a compatible class and finish to the bolt finish as specified in ASTM A325.
- 3.4.8 Nuts shall be re-tapped after being galvanized and the threads of nuts left bare in accordance with ASTM A153/A153M.
- 3.4.9 Welded connections of already galvanized steel components are not accepted.
- 3.4.10 Material shall be galvanized after all the fabrication, machining and shop work is completed, except as otherwise specified herein.
- 3.4.11 Appropriate measures shall be taken in order to ensure that frames or similar items of steelwork are not distorted during the galvanizing process, in accordance with ASTM A384 requirements. If preventive work is required, details of all proposed additional reinforcement, bracing or otherwise stiffened metalwork shall be submitted to the Engineer for approval prior to proceeding with the relevant work.
- 3.4.12 The coating shall be clean, smooth and free from defects. Bare spots, loosely attached spelter, unevenness of coating and globules which may be broken in handling, will be cause for rejection. If more than 5 percent of material is rejected, manufacture shall be stopped and the process altered so that satisfactory work could be produced.
- 3.4.13 Galvanizing inspection shall be as described in the "Quality Control" section of this Specification. Galvanization work found to be defective shall be corrected.
- 3.4.14 Galvanized surfaces damaged during transportation, handling and installation shall receive two 30 micrometer DFT layers of "Galvano Spray 70-45" by METAFUX. Repairs shall be in accordance with ASTM A780-09.
- 3.5 **TRANSPORTATION, HANDLING AND STORAGE**
- 3.5.1 The Contractor shall give a written approval for each delivery on site.
- 3.5.2 Federal, Provincial or Municipal transportation bylaws shall be respected.
- 3.5.3 Metalwork shall be handled and protected adequately for transportation and storage in order to avoid any damage. It shall be strengthened if needed.
- 3.5.4 Delivery slip shall have piece identification, description and dimensions.
- 3.5.5 Metalwork shall be sent unassembled.
- 3.5.6 Each metalwork component shall be marked and referenced on the shop drawings.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.5.7 Painted or galvanized surfaces shall not be stacked face to face. Wood blocks, Styrofoam padding or other suitable materials shall be used as separator.
- 3.5.8 Nylon-type slings shall be used for lifting, unless the packaging prevents the slings to get into contact with the metalwork. Where it is necessary, lifting beams or cradles shall be used.
- 3.5.9 Metalwork shall be securely fastened with chains and blocking to transportation vehicle in order to prevent lateral movement. The edges of metalwork shall be protected with rubber, hessian or wood.
- 3.5.10 Small bundled sections shall not be loaded inside larger components.
- 3.5.11 Bolts, nuts and washers shall be shipped in metallic packaging and coated with protective oil. Bolts of different length or diameter shall be separated in several containers or bags, each one containing only identical type of pieces. All containers shall be properly labelled.
- 3.5.12 Wood blocks of convenient size shall be provided in order to ensure that the steel rests clear of ground, does not accumulate water and does not distort permanently.
- 3.5.13 Metalwork shall be unloaded at the designated location. Proper equipment and labour shall be employed to unload onto wood blocks without damage.

3.6 INSTALLATION

3.6.1 Stability

- .1 It is the Contractor's responsibility to determine construction procedures and sequence to ensure the integrity of the structure and its components during erection. This includes the addition of necessary and adequate shoring, sheeting, temporary bracing and other temporary structures required to resist all construction loads and additionally to comply with the provisions of the OHSA.
- .2 Temporary bracings shall be maintained in place if the permanent stability of the structure depends on work of other trades, until that work is completed.

3.6.2 Erection

- .1 Unless otherwise noted herein, miscellaneous metalwork shall be erected in accordance with this Specification, CSA S16, clause 6.7.3 of CSA A23.1/A23.2, the CISC Code of Standard Practice and the approved shop drawings.
- .2 Alignment shall be in accordance with CSA S16 and as indicated on the drawings.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 The Engineer shall approve any field cutting or altering of structural members not shown on the drawings.
- .4 Anchor bolt threads shall be wrapped and protected from damage during construction.
- .5 The embedded metalwork components shall be maintained in position, by means of temporary bracing, templates or otherwise, during concreting to avoid displacement. For embedded frames with covers, the method to keep the frame into place during concreting shall be submitted to the Engineer for review.
- .6 Prior to final tightening of the bolted connections:
 - .1 each section of structure shall be plumbed and aligned;
 - .2 members shall be aligned and free of distortions and open joints.
- .7 Expansion and chemical anchors connecting loose steel to concrete work shall be installed where indicated on the drawings, according to Manufacturer's instructions. Special precautions shall be taken not to drill holes through the reinforcing bars. Post installed anchors shall be approved by the Engineer.
- .8 No part of any new or existing structure shall be subject to erection loads which could in any way damage or cause permanent distortion to that part or any other part of the structure.
- .9 Any damage to the miscellaneous metalwork, including coating or errors in alignment or location shall be corrected.
- .10 Erection tolerance and inspection shall be as described in the "Quality Control" section of this Specification.



3.6.3 Bolting

- .1 High-strength bolts shall be used for connections, unless indicated otherwise on the drawings.
- .2 The high strength bolts in slip-critical type connections shall be pretensioned using the "Turn of the Nut" method, in accordance with CSA S16, clause 23.8.
- .3 Hardened washer shall be used under each nut.
- .4 All joint surfaces, including those adjacent to bolt heads and nuts, shall be free of burrs, dirt and other foreign material that inhibit solid seating of parts.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Do not drive drift pins with such force as to deform adjacent metal.
- .6 Drill any bolt holes missing from fabricated steel. Do not enlarge or make any hole by flame cutting.
- .7 Bolting inspection shall be as described in the "Quality Control" section of this Specification.

3.6.4 Field Welding

- .1 Field welding shall be:
 - .1 used only where shown on the drawings or as approved by the Engineer;
 - .2 in accordance with CSA W59;
 - .3 executed by welders certified in accordance with CSA W55.3 and CSA W47.1.
- .2 Welding inspection shall be described in the "Quality Control" section of this specification.

3.6.5 Steel Deck

- .1 Steel deck shall be installed in accordance with CSSBI requirements and the approved shop drawings.
- .2 Closure plates shall be provided and fixed with screws.
- .3 Steel deck shall be cut around the openings, columns, studs, etc.
- .4 Longitudinal lap joints shall be over a minimum 50 mm and be mechanically fastened at minimum 300 mm intervals, unless noted otherwise on drawings
- .5 Overlapping/Interlocking side joints shall be mechanically fastened at maximum 450 mm intervals, unless noted otherwise on the drawings.
- .6 Ends of steel deck shall be mechanically fastened to supporting beams at maximum 300 mm intervals, unless noted otherwise on the drawings.
- .7 Steel deck connection on the structural steel by welding will be allowed only if it is specified on the drawings. In this case the welding shall be in accordance with CSA W59.
- .8 Touch-up, wherever necessary, shall be done after the completion of work.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6.6 Errors and Misfit

- .1 Fabrication errors discovered during erection shall be reported to the Engineer along with proposed correction method.
- .2 Minor misfit shall be corrected by reaming, cutting and chipping as part of work as approved by the Engineer.
- .3 Flame cutting shall only be allowed on secondary members with written approval from the Engineer. Cut edges shall be ground and painted or galvanized to match the surrounding finish.
- .4 Fitting up bolts or drift pins shall not be used to bring improperly fabricated members together.
- .5 Shims, packing or wedging shall not be used to correct imperfect work without written approval of the Engineer.

3.6.7 Touch-ups



- .1 Refer to Section 09 90 00 – Paint System for Structural Steel for touch-up of painted steel.
- .2 Refer to the “Galvanizing” Article 3.4 of this Specification Section for touch-up of galvanized steel.
- .3 During touch-up on the work site, equipment and floors shall be protected against spray splash or drops of paint or zinc products. All stains or spilled products on equipment, floors and walls shall be cleaned.

3.6.8 Final Clean-up

- .1 Clean-up work site, remove all debris, shelters, equipment and surplus material prior to final acceptance of work.

3.7 QUALITY CONTROL

3.7.1 Welds

- .1 Inspection and testing of welding shall conform to CSA W59 using non destructive test methods.
- .2 Inspections and non-destructive tests shall be made by inspectors registered in conformance with CSA W178.2.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 Testing of welds shall be performed as indicated in the following table.

Weld Type	Inspection	Level of Inspection
Complete joint penetration groove welds in tension (Butt joint)	Radiographic	100% of the length of each weld
Complete joint penetration Groove Weld in compression or shear (Butt joints)	Radiographic	50% of the length of each weld
Fillet Welds in tension members	Magnetic	For each element, 100% of the length of each weld
Fillet Welds (others)	Magnetic	For each element, 25% of the length of each weld
Complete joint penetration groove welds in tension members ("T" and "L" joints)	Ultrasonic	100% of the length of each weld
Complete joint penetration groove welds in compression or shear members ("T" and "L" joints)	Ultrasonic	For each element, 50% of the length of the weld

.4 Faulty welding shall be repaired as specified in CSA W59.

.5 If faults exceeding the provision of CSA W59 are found, then test complete weld length. Make repairs and retest repaired areas; if faults found in repaired areas, repair and retest until no faults occur.

3.7.2 Bolted Connections

.1 Inspection and checking of high-strength bolted connections shall conform to CSA S16.

3.7.3 Studs

.1 Inspection and testing of studs shall conform to CSA W59.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 05 50 10
CH0032	MISCELLANEOUS METALS AND EMBEDDED PARTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.4 Painting



.1 Refer to Section 09 90 00 – Paint System for Structural Steel.



.2 3.7.4.2 to 3.7.4.6 Not used.

3.7.5 Galvanizing

.1 Testing shall conform to the requirements of ASTM A123/A123M-12.

.2 During galvanizing, the Engineer may carry out tests on the coating and analysis of the spelter, as deemed necessary.

3.7.6 Erection

.1 Inspection and checking of metalwork for alignment, plumbness and elevation shall conform to CSA S16, unless indicated otherwise on the drawings.

.2 Anchor bolts shall be positioned in accordance with the clause 6.7.3 of CSA A23.1/A23.2. Other embedded miscellaneous parts shall be positioned within a 6 mm tolerance, unless otherwise indicated on the drawings.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 06 10 00
ROUGH CARPENTRY
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

1.1 SECTION INCLUDES 2

1.2 RELATED REQUIREMENTS..... 2

1.3 REFERENCES 2

1.4 ACTION AND INFORMATIONAL SUBMITTALS 3

1.5 QUALITY ASSURANCE 4

1.6 DELIVERY, STORAGE AND HANDLING 4

PART 2 PRODUCTS 5

2.1 FRAMING STRUCTURAL AND PANEL MATERIALS 5

2.2 ACCESSORIES..... 5

PART 3 EXECUTION 7

3.1 EXAMINATION..... 7

3.2 PREPARATION..... 7

3.3 MATERIAL USAGE 8

3.4 INSTALLATION 8

3.5 CLEANING 9

3.6 PROTECTION 9

PROVINCE OF NEWFOUNDLAND AND LABRADOR

PEG **PERMIT HOLDER**
Newfoundland and Labrador
 PROFESSIONAL GEOSCIENTISTS ASSOCIATION

This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
 in Newfoundland and Labrador.
 Permit No. as issued by PEGNL N0458
 which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR
 MEMBER
Nathaniel Savary
 Nathaniel Savary, N/A
 Expires Dec 31, 2013
 Date: 07/24/13
 LICENSED TO PRACTICE
 ASSOCIATION OF ARCHITECTS

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SECTION INCLUDES

1.1.1 Wood Treatment: Materials and Applications for Wood Preservation

1.2 RELATED REQUIREMENTS

1.2.1 Section 07 52 00 – Modified Bituminous Membrane Roofing.

1.2.2 Section 07 92 00 – Joint Sealants.

1.3 REFERENCES

1.3.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.3.1.1 All work shall be in accordance with this specification and the requirements of the following.

1.3.2 American Standard for Testing and Materials (ASTM International)

1.3.2.1 ASTM C578-11b, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

1.3.2.2 ASTM C1289-12, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

1.3.2.3 ASTM C1396/C1396M-11, Standard Specification for Gypsum Board.

1.3.2.4 ASTM D1761-06, Standard Test Methods for Mechanical Fasteners in Wood.

1.3.2.5 ASTM F1667-11a, Standard Specification for Driven Fasteners: Nails, Spikes and Staples.

1.3.3 American Wood Preservers' Association (AWPA)

1.3.3.1 AWPA M2 - Standard for Inspection of Treated Wood Products.

1.3.3.2 AWPA M4 - Standard for the Care of Preservative Treated Wood Products.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.4 Canadian General Standards Board (CGSB)
 - 1.3.4.1 CAN/CGSB 11.3, Hardboard.
 - 1.3.4.2 CAN/CGSB 51.32, Sheathing, Membrane, Breather Type.
 - 1.3.4.3 CAN/CGSB 51.34, Vapour Barrier, Polyethylene Sheet for Use in Building Construction and amendment.
- 1.3.5 Canadian Standards Association (CSA International)
 - 1.3.5.1 CSA A123.2-03 (R2008), Asphalt Coated Roofing Sheets.
 - 1.3.5.2 CSA A247-M86, Insulating Fiberboard.
 - 1.3.5.3 CSA O80 Series, Wood Preservation.
 - 1.3.5.4 CSA O80.20-1.1, This Standard applies to the fire-retardant treatment of lumber by pressure processes.
 - 1.3.5.5 CSA O80.201, This Standard covers hydrocarbon solvents for preparing solutions of preservatives.
 - 1.3.5.6 CSA O121, Douglas Fir Plywood.
 - 1.3.5.7 CSA O141, Softwood Lumber.
 - 1.3.5.8 CSA O325, Construction Sheathing.
- 1.3.6 National Lumber Grades Authority (NLGA)
 - 1.3.6.1 Standard Grading Rules for Canadian Lumber.
- 1.3.7 Underwriters' Laboratories of Canada (ULC)
 - 1.3.7.1 CAN/ULC-S706, Standard for Wood Fibre Insulating Boards for Buildings.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- 1.4.1 Product Data:
 - 1.4.1.1 Submit manufacturer's instructions, printed product literature and data sheets for wood products and accessories and include product characteristics, performance criteria, physical size, finish and limitations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Quality Assurance Submittals

1.4.2.1 Quality assurance submittals:

1.4.2.1.1 For products treated with preservative and fire-retardant by pressure impregnation submit following information certified by authorized signing officer of treatment plant:

1.4.2.2 Information listed in AWWA M2 and revisions specified in CSA O80 Series, Supplementary Requirement to AWWA M2 applicable to specified treatment.

1.4.2.2.1 Moisture content after drying following treatment.

1.4.2.2.2 Acceptable types of paint, stain, and clear finishes that may be used over treated materials to be finished after treatment.

1.5 QUALITY ASSURANCE

1.5.1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

1.5.2 Plywood, particleboard, OSB and wood based composite panels in accordance with CSA and ANSI standards.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1.6.3 Storage and Handling Requirements:

1.6.3.1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

1.6.3.2 Store and protect wood from nicks, scratches, and blemishes.

1.6.3.3 Replace defective or damaged materials with new.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 2 PRODUCTS

2.1 FRAMING STRUCTURAL AND PANEL MATERIALS

2.1.1 Lumber: softwood, S4S (surfaced four sides), moisture content 19% (S-dry) or less in accordance with following standards:

2.1.1.1 CSA O141.

2.1.1.2 NLGA Standard Grading Rules for Canadian Lumber.

2.1.2 Framing and board lumber: in accordance with NBC

2.1.3 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:

2.1.3.1 Board sizes: "Standard" or better grade.

2.1.3.2 Dimension sizes: "Standard" light framing or better grade.

2.1.4 Plywood, OSB (oriented strandboard) and wood based composite panels: to CSA O325.

2.1.5 Douglas fir plywood (DFP): to CSA O121, standard construction.

2.1.6 Softwood Lumber: to CSA O141, standard construction.

2.1.7 Glass fibre board sheathing: non-structural, rigid, faced, fiberglass, insulating exterior sheathing board.

2.1.8 Gypsum sheathing: to ASTM C1396/C1396M.

2.2 ACCESSORIES

2.2.1 Exterior wall sheathing paper: to CAN/CGSB-51.32 single ply spunbonded olefin type impregnated as indicated.

2.2.2 Polyethylene film: to CAN/CGSB-51.34, Type 1, 0.15 mm thick.

2.2.3 Roll roofing: to CAN/CSA A123.2, Type S.

2.2.4 Air seal: closed cell polyurethane or polyethylene.

2.2.5 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

2.2.5.1 Sealants: VOC limit 250 g/L maximum.

Mb 90

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.6 General purpose adhesive: to CSA O112 Series.
- 2.2.6.1 VOC limit 200 g/L maximum.
- 2.2.7 Nails, spikes and staples: to ASTM F1667-11a.
- 2.2.8 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- 2.2.9 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.
- 2.2.10 Nailing discs: flat caps, minimum 25 mm diameter, minimum 0.4 mm thick, sheet metal, formed to prevent dishing. Bell or cup shapes not acceptable.
- 2.2.11 Fastener Finishes:
 - 2.2.11.1 Galvanizing: to ASTM A123/A123M or ASTM A653, use galvanized fasteners for exterior work, interior highly humid areas, pressure-preservative, and fire-retardant treated lumber.
 - 2.2.11.2 Stainless steel: use stainless steel where recommended by material manufacturer.
- 2.2.12 Wood Preservative:
 - 2.2.12.1 Preservative: to CSA-O80 Series, odourless, for stained finish.
 - 2.2.12.2 Preservatives: maximum VOC limit 350g/L.
 - 2.2.12.3 Fire Retardant: to CSA O80.20
 - 2.2.12.4 Solvent: to CSA-O80.201

97 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's written instructions.

3.1.1.1 Visually inspect substrate in presence of Engineer.

3.1.1.2 Inform Engineer of unacceptable conditions immediately upon discovery.

3.1.1.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 PREPARATION

3.2.1 Application: Preservative

3.2.1.1 Treat lumber to CSA O80 Series.

3.2.1.2 Following water-borne preservative treatment, dry material to maximum moisture content of 19%.

3.2.2 Application: Field Treatment

3.2.2.1 Treat exposed surfaces of material with wood preservative, before insulation

3.2.2.2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.

3.2.2.3 Comply with AWPA M4 and revisions specified in CSA O80 Series, Supplementary Requirements to AWPA M2.

3.2.2.4 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.

3.2.2.5 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.

3.2.2.6 Remove chemical deposits on treated wood to receive applied finish.

3.2.2.7 Treat material as follows:

3.2.2.7.1 Wood cants, fascia backing, curbs, nailers, sleepers on roof deck.

MB 96

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.2.7.2 Wood furring for on outside surface of exterior masonry and concrete walls.

3.3 MATERIAL USAGE

3.3.1 Roof sheathing:

3.3.1.1 Plywood, DFP sheathing grade square edge, 19 mm thick.

3.3.2 Exterior wall sheathing:

3.3.2.1 Plywood, DFP sheathing grade square edge, 16 mm thick.

3.3.2.2 Insulating fiberboard, Type II-Sheathing, panel edge 16 mm thick.

3.3.2.3 Glass fibre sheathing, RSI indicated, 25 mm thick.

3.3.2.4 Polyisocyanurate sheathing, RSI indicated, 25 mm thick.

3.3.2.5 Gypsum sheathing, panel edge, 16 mm thick.

3.3.3 Underlay:

3.3.3.1 Plywood, DFP standard grade square edge, 16 mm thick.

3.3.4 Electrical equipment mounting boards:

3.3.4.1 Plywood, DFP standard grade, square edge 19 mm thick.

3.4 INSTALLATION

3.4.1 Install members true to line, levels and elevations, square and plumb.

3.4.2 Construct continuous members from pieces of longest practical length.

3.4.3 Install spanning members with "crown-edge" up.

3.4.4 Select exposed framing for appearance. Install lumber and panel materials so that grade-marks and other defacing marks are concealed or are removed by sanding where materials are left exposed.

3.4.5 Install wall sheathing in accordance with manufacturer's printed instructions.

3.4.6 Install roof sheathing in accordance with requirements of National Building Code of Canada (NBC).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 06 10 00
CH0032	ROUGH CARPENTRY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.7 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding, electrical equipment mounting boards, and other work as required.
- 3.4.8 Install furring to support siding applied vertically where there is no blocking and where sheathing is not suitable for direct nailing.
 - 3.4.8.1 Align and plumb faces of furring and blocking to tolerance of 1:600.
- 3.4.9 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- 3.4.10 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized fasteners.
- 3.4.11 Install sleepers as indicated.
- 3.4.12 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- 3.4.13 Countersink bolts where necessary to provide clearance for other work.
- 3.4.14 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.
- 3.5 **CLEANING**
 - 3.5.1 Progress Cleaning: clean in accordance with General Requirements. Leave Work area clean at end of each day.
 - 3.5.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with General Requirements.
- 3.6 **PROTECTION**
 - 3.6.1 Protect installed products and components from damage during construction.
 - 3.6.2 Repair damage to adjacent materials caused by rough carpentry installation.

END OF SECTION



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 13 26
CH0032	SELF ADHERED SHEET WATERPROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 13 26
SELF ADHERED SHEET WATERPROOFING
TABLE OF CONTENTS**

PART 1 GENERAL.....2

 1.1 RELATED WORK.....2

 1.2 REFERENCES2

 1.3 SUBMITTALS2

 1.4 QUALITY ASSURANCE2

 1.5 QUALIFICATIONS.....3

 1.6 DELIVERY, STORAGE AND HANDLING3

 1.7 PROJECT ENVIRONMENTAL REQUIREMENTS3

 1.8 NOT USED3

PART 2 PRODUCTS.....3

 2.1 WATERPROOFING MATERIALS.....3

PART 3 EXECUTION4

 3.1 EXAMINATION.....4

 3.2 PREPARATION.....4

 3.3 INSTALLATION5

 3.4 PROTECTION OF WORK6

 3.5 INSPECTION.....6

PROVINCE OF NEWFOUNDLAND AND LABRADOR

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NEWFOUNDLAND AND LABRADOR
 MEMBER
Nathaniel Salfas
 Nathaniel Salfas, NLAA
 Expires Dec 31 2013
 Date: Nov 29 2013
 LICENSED TO PRACTICE
 ASSOCIATION OF ARCHITECTS

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 13 26
CH0032	SELF ADHERED SHEET WATERPROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED WORK

1.1.1 Section 07 92 00– Joint Sealants.

1.2 REFERENCES

1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.

1.2.1.1.1 Sealant and Waterproofer’s Institute – Sealant and Caulking Guide Specification.

1.3 SUBMITTALS

1.3.1 Submit manufacturer’s product data sheets.

1.3.2 Submit manufacturer’s installation instructions.

1.4 QUALITY ASSURANCE

1.4.1 Perform work in accordance with Sealant and Waterproofer’s Institute – Sealant and Caulking Guide Assurance program and requirements for materials and installation.

1.4.2 Perform Work in accordance with National Air Barrier Association – Professional Contractor Quality Assurance program and requirements for materials and installation.

1.4.3 Manufacturer’s Representative:

1.4.3.1 Inspect substrate prior to commencement of work, twice during application of membrane and at commissioning to ascertain that air/vapour barrier system is installed according to membrane manufacturer’s most current published specifications and details.

1.4.3.2 Provide technical assistance to applicator and assist where required in correct installation of membrane.

1.4.3.3 Provide certificate of quality compliance upon satisfactory completion of installation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 13 26
CH0032	SELF ADHERED SHEET WATERPROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.4 Maintain one copy of documents on site.

1.5 QUALIFICATIONS

1.5.1 Applicator: Company specializing in performing work of this section with minimum 5 years documented experience with installation of air/vapour barrier system. Complete installation must be approved by the material manufacturer.

1.5.2 Applicator: Company who is currently licensed by certifying organization must maintain their license throughout the duration of the project.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Deliver, store and handle materials in accordance with manufacturer's written instructions. Deliver membrane materials in factory wrapped packaging indicating name of manufacturer and product.

1.6.2 Clean and leave area as it was prior to spill.

1.6.3 Store roll materials on end in original packaging.

1.6.4 Store primers at temperature of 5° C and above to facilitate handling.

1.6.5 Keep solvent away from open flame and excessive heat.

1.7 PROJECT ENVIRONMENTAL REQUIREMENTS

1.7.1 Do not install solvent curing sealants or vapour release adhesive materials in enclosed spaces without ventilation

1.7.2 Ventilate enclosed spaces in accordance with manufacturer's instructions.

1.7.3 Maintain temperature and humidity recommended by materials manufacturer before, during and after installation.

1.8 NOT USED



PART 2 PRODUCTS

2.1 WATERPROOFING MATERIALS

2.1.1 Rolled, Self-Adhering, Waterproofing Membrane: Polymetric waterproofing membrane protected by release paper on cross-laminated polyethylene carrier film

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 13 26
CH0032	SELF ADHERED SHEET WATERPROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

with exposed polymeric membrane strips on both sides protected by pull-off release strips.

2.1.1.1 Membrane Physical properties

2.1.1.1.1 Thickness:

2.1.1.1.1.1 Carrier Film: 0.10 mm

2.1.1.1.1.2 Polymeric Membrane: 1.42 mm

2.1.1.1.2 Application: -5° and above

2.1.1.1.3 Elongation: min 300%

2.1.1.1.4 Tensile Strength:

2.1.1.1.4.1 Carrier Film: 40.7 MPa

2.1.1.1.4.2 Polymeric Membrane: 4.07 MPa

2.1.1.1.5 Puncture Resistance: 30 kg

2.1.1.1.6 Water vapour transmission: 5.72 ng/Pa.s.m²

2.1.1.1.7 Moisture Absorption 0.1% max.

2.1.1.1.8 Hydrostatic head 73.1 m water

2.1.1.1.9 Acceptable manufacturers: MEL-ROL by W.R. Meadows of Canada or Blueskin WP 200 or Soprema Sopraseal Stick 1100, or approved substitute.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verify that surfaces and conditions are ready to accept the work of this section.

3.1.2 Ensure all surfaces are clean, dry, sound, smooth, continuous and comply with membrane manufacturer's requirements.

3.1.3 Report any unsatisfactory conditions to the Engineer in writing.

3.1.4 Do not start work until deficiencies have been corrected.

3.2 PREPARATION

MB 96

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 13 26
CH0032	SELF ADHERED SHEET WATERPROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.1 Remove loose or foreign matter which might impair adhesion of materials.
- 3.2.2 Ensure all substrates are clean of oil or excess dust; all concrete surfaces free of large voids, spilled areas or sharp protrusions.
- 3.2.3 Ensure all substrates are free of surface moisture prior to application of membrane and primer.
- 3.2.4 Ensure metal closures are free of sharp edges and burrs.
- 3.2.5 Prime substrate surfaces to receive adhesive and sealants in accordance with manufacturer's instructions.
- 3.3 **INSTALLATION**
- 3.3.1 Install materials in accordance with manufacturer's instructions.
- 3.3.2 Over the properly prepared substrate surface apply primer with a roller and allow drying to a tacky surface. Prime only area to be covered in a working day. Reprime area not covered with membrane within 24 hours.
- 3.3.3 After primer has dried, using a hand roller firmly press the entire membrane onto the primed surface in strict accordance with membrane manufacturer's written instructions.
- 3.3.4 Ensure complete coverage of and adhesion of all substrates to receive membrane, including wall penetrations. Co-operate with other trades to ensure continuity of the membrane.
- 3.3.5 Overlap membrane 50 mm and carefully smooth out with a roller to ensure full continuous bond throughout overlaps without fissures or fishmouthing.
- 3.3.6 It is important that a complete water seal be achieved. Be responsible for the completeness of the membrane wherever it is not specifically detailed. Consult with Engineer if there is any doubt as to the integrity of the membrane, whether detailed or not.
- 3.3.7 In order to ensure a complete seal, seal membrane to all penetrations in an approved manner.
- 3.3.8 Apply a trowelled bead of mastic to all terminations of the membrane at the end of a day's work.
- 3.3.9 Do not enclose membrane until it has been inspected and approved by Engineer. Inform Engineer 48 hours prior to required inspection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 13 26
CH0032	SELF ADHERED SHEET WATERPROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 PROTECTION OF WORK

- 3.4.1 Protect finished work in accordance with manufacturer's instructions.
- 3.4.2 Do not permit adjacent work to damage work of this section.
- 3.4.3 Ensure finished work is protected from climatic conditions.

3.5 INSPECTION

- 3.5.1 Carefully inspect for continuity of waterproofing prior to placement of drainage board.
- 3.5.2 Repair all deficient membrane areas.
- 3.5.3 Misaligned or inadequately lapped seams, punctures or other damage must be repaired with a patch of membrane extending 50 mm in all directions from edge of damaged areas.
- 3.5.4 Cover membrane immediately after Engineer's inspection to protect from damage by other trades.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 21 13
BOARD INSULATION
TABLE OF CONTENTS**

PART 1 **General**.....2

 1.1 RELATED SECTIONS 2

 1.2 REFERENCES 2

 1.3 SUBMITTALS 3

 1.4 QUALITY ASSURANCE 3

PART 2 **Products**3

 2.1 INSULATION 3

 2.2 ADHESIVE 5

 2.3 ACCESSORIES 5

PART 3 **Execution**.....6

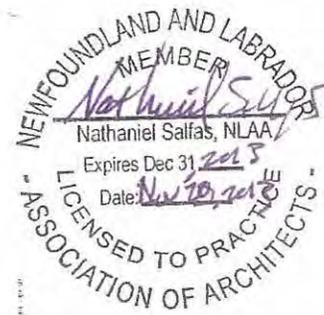
 3.1 MANUFACTURER'S INSTRUCTIONS 6

 3.2 WORKMANSHIP 6

 3.3 EXAMINATION 6

 3.4 RIGID INSULATION INSTALLATION 7

 3.5 CLEANING 7



AS
MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 03 30 00 – Cast-in-Place Concrete.
- 1.1.2 Section 07 27 00 – Air Barriers.
- 1.1.3 Section 07 46 13 – Preformed Metal Siding.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
 - 1.2.1.1 All work shall be in accordance with this specification and the requirements of the following:
 - 1.2.2 American Society for Testing and Materials International (ASTM)
 - 1.2.2.1 ASTM C 578: Standard Specification for Rigid Cellular Polystyrene Thermal Insulation.
 - 1.2.2.2 ASTM C591-12, Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - 1.2.2.3 ASTM C1289-12, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - 1.2.2.4 ASTM E96/E96M-10, Standard Test Methods for Water Vapour Transmission of Materials.
 - 1.2.3 Canadian General Standards Board (CGSB)
 - 1.2.3.1 CGSB 71-GP-24M, Adhesive, Flexible, for Bonding Cellular polystyrene Insulation.
 - 1.2.4 Underwriters Laboratories of Canada (ULC)
 - 1.2.4.1 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
 - 1.2.4.2 CAN/ULC-S704, Standard for Thermal Insulation Polyurethane and Polyisocyanurate, Boards, Faced.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.2.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

1.2.5.1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

1.3.1 Product Data:

1.3.1.1 Submit manufacturer's printed product literature, specifications and data sheets.

1.3.1.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets. Indicate VOC's insulation products and adhesives.

1.3.2 Manufacturer's Instructions:

1.3.2.1 Submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

1.4.1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.4.2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

PART 2 PRODUCTS

2.1 INSULATION

2.1.1 Foam Plastic Board Insulation under Concrete Slab

2.1.1.1 Extruded Polystyrene Board Insulation: Comply with ASTM C 578.

2.1.1.2 Type VI.

2.1.1.3 Minimum compressive strength: 275 kPa (40 psi).

2.1.1.4 Density: 29 kg/m³ (1.80 lb/ft³).

2.1.1.5 Size: 610 x 2440 mm.

2.1.1.6 Edge condition: ship-lapped.

2.1.1.7 Thickness: 100 mm supplied in one layer only – multiple layers are not permitted.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.1.8 RSI Value: 0.88 per 25 mm of thickness, with 90% lifetime limited warranty on thermal resistance (180 day real-time aging as mandated by ASTM C578, measured per ASTM C 518 at mean temperature of 75°F.

2.1.1.9 Blowing agent formulation: Shall be zero ozone depleting.

2.1.1.10 Warranty: Limited lifetime warranty covering all ASTM C578 physical properties.

2.1.1.11 Acceptable Product: Dow Chemical company Foamular 400, or approved substitute.

2.1.2 Foam Plastic Board Insulation Not Under Concrete Slab

2.1.2.1 Extruded polystyrene foam plastic insulation, unfaced, complying with ASTM C578.

2.1.2.2 Type: X

2.1.2.3 Minimum compressive strength: 172 kPa (25 psi).

2.1.2.4 Size: 1220 x 2440 mm.

2.1.2.5 Edge condition: square

2.1.2.6 Thickness: 38 mm unless noted otherwise.

2.1.2.7 RSI Value: 0.88 per 25 mm with 90 percent lifetime limited warranty on thermal resistance (180 day real-time aging as mandated by ASTM C578, measured per ASTM C518 at mean temperature of 75°F.

2.1.2.8 Water Absorption: Maximum 0.10 percent by volume per ASTM C272.

2.1.2.9 Surface Burning Characteristics (ASTM E84): Flame spread less than 25, smoke developed less than 450, certified by independent third party such as Underwriters Laboratories.

2.1.2.10 Blowing Agent Formulation: Shall be zero ozone depleting.

2.1.2.11 Fasteners: Provide preassembled screw/stress plate fasteners recommended by their manufacture for securing foam plastic insulating sheathing. Polymer or other corrosion-protected coated steel screw fasteners for anchoring sheathing to metal wall framing. Fastener length and size based on wall sheathing thickness and fastener manufacturer recommendation.



2.1.2.12 Not used.

2.1.2.13 Acceptable Product: Dow Chemical Company Foamular 250 or approved substitute.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.3 Rigid Cellular Polyisocyanurate:

2.1.3.1 Unfaced: to ASTM C591.

- 2.1.3.1.1 Type: 1.
- 2.1.3.1.2 Thickness: as indicated.
- 2.1.3.1.3 Size: 1200 x 2400 mm.

2.1.3.2 Faced: to ASTM C1289 and CAN/ULC C-S704.

- 2.1.3.2.1 Polyisocyanurate core: Type 1, facing 2.
- 2.1.3.2.2 RSI Value: 1.05 per 25 mm.
- 2.1.3.2.3 Shape: flat.
- 2.1.3.2.4 Thickness: as indicated.
- 2.1.3.2.5 Size: 1200 x 2400 mm.
- 2.1.3.2.6 Compressive Strength: 138 KPa.
- 2.1.3.2.7 Moisture Vapour Transmission: 1.5 ng/(Pa.s.m²).
- 2.1.3.2.8 Water Absorption: max. 1.5%.
- 2.1.3.2.9 Acceptable Product: Johns Manville AP Foil-Faced Manville, or Atlas Energy Shield, or approved substitute.

2.2 ADHESIVE

2.2.1 Adhesive: suitable for bonding insulation boards to substrates as indicated on drawings.

2.3 ACCESSORIES

2.3.1 Insulation clips: impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self locking type.

2.3.2 Joint Sealing Tape: air resistant pressure sensitive adhesive tape as recommended by insulation manufacturer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 WORKMANSHIP

3.2.1 Install insulation after building substrate materials are dry.

3.2.2 Install insulation to maintain continuity of thermal protection to building elements and spaces.

3.2.3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.

3.2.4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from CAN/CGA-B149.1 and CAN/CGA-B149.2 type B and L vents.

3.2.5 Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.

3.2.6 Offset both vertical and horizontal joints in multiple layer applications.

3.2.7 Do not enclose insulation until it has been inspected and approved by Engineer.

3.3 EXAMINATION

3.3.1 Examine substrates and immediately inform Engineer in writing of defects.

3.3.2 Prior to commencement of work, ensure:

3.3.2.1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.

Ab 76

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 13
CH0032	BOARD INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 RIGID INSULATION INSTALLATION

- 3.4.1 Apply adhesive to polyisocyanurate insulation board in accordance with manufacturer's recommendations.
- 3.4.2 Leave insulation board joints unbonded over line of expansion and control joints. Bond a continuous 150 mm wide 0.15 mm modified bituminous membrane over expansion and control joints using compatible adhesive and primer before application of insulation.
- 3.4.3 Carefully inspect for continuity of air barrier prior to placement of insulation.
- 3.4.4 Tape all insulation joints unless otherwise directed.

3.5 CLEANING

- 3.5.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 16
CH0032	BLANKET INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HUDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 21 16
BLANKET INSULATION
TABLE OF CONTENTS**

PART 1 GENERAL.....2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

1.4 QUALITY ASSURANCE 3

PART 2 PRODUCTS.....3

2.1 INSULATION 3

2.2 ACCESSORIES 3

PART 3 EXECUTION.....3

3.1 MANUFACTURER'S INSTRUCTIONS 3

3.2 INSULATION INSTALLATION 3

3.3 CLEANING 4

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PEG
Newfoundland
and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

PERMIT HOLDER
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR
MEMBER
Nathaniel Salfas
Nathaniel Salfas/NLAA
Expires Dec 31, 2013
Date: 10/11/2013
LICENSED TO PRACTICE
ASSOCIATION OF ARCHITECTS

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 16
CH0032	BLANKET INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HUDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

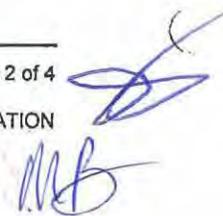
PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 06 10 00 - Rough Carpentry.
- 1.1.2 Section 07 26 00 – Vapour Retarders.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.
- 1.2.2 American Society for Testing and Materials International (ASTM)
- 1.2.2.1 ASTM C553-11, Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
- 1.2.2.2 ASTM C665-12, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- 1.2.2.3 ASTM C1320-10, Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
- 1.2.2.4 ASTM F1667-11a, Standard Specification for Driven Fasteners: Nails, Spikes and Staples.
- 1.2.3 Canadian Gas Association (CGA)
- 1.2.3.1 CAN/CGA-B149.1, Natural Gas and Propane Installation Code Handbook.
- 1.2.3.2 CAN/CGA-B149.2, Propane Storage and Handling Code.
- 1.2.4 Underwriters Laboratories of Canada (ULC)
- 1.2.4.1 CAN/ULC-S702, Standard for Mineral Fibre Insulation.
- 1.3 SUBMITTALS
- 1.3.1 Product Data:
- 1.3.1.1 Submit manufacturer's printed product literature, specifications and data sheets.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 16
CH0032	BLANKET INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HUDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.2 Manufacturer's Instructions:

1.3.2.1 Submit manufacturer's installation instructions.

1.4 **QUALITY ASSURANCE**

1.4.1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.4.2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

PART 2 **PRODUCTS**

2.1 **INSULATION**

2.1.1 Thermal batt and blanket mineral fibre:

2.1.1.1 Unfaced glass fiber thermal insulation to ASTM C665, Type 1, thickness and RSI value as indicated on drawings.

2.2 **ACCESSORIES**

2.2.1 Insulation clips: Impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self locking type.

2.2.2 Nails: galvanized steel, length to suit insulation plus 25 mm, to ASTM F1667-11a.

2.2.3 Staples: 12 mm minimum leg.

2.2.4 Tape: as recommended by manufacturer.

PART 3 **EXECUTION**

3.1 **MANUFACTURER'S INSTRUCTIONS**

3.1.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 **INSULATION INSTALLATION**

3.2.1 Install insulation to maintain continuity of thermal protection to building elements and spaces.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 16
CH0032	BLANKET INSULATION	Rev. D2
POWERHOUSE & SPILLWAY HUDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.2 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.

3.2.3 Do not compress insulation to fit into spaces.

3.2.4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls and CAN/CGA-B149.1 and CAN/CGA-B149.2 Type B and L vents.

3.2.5 Do not enclose insulation until it has been inspected and approved by Engineer.

3.3 CLEANING

3.3.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 20
CH0032	LOW EXPANDING FOAM SEALANT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 21 20
LOW EXPANDING FOAM SEALANT
TABLE OF CONTENTS**

PART 1 GENERAL.....2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

1.4 QUALITY ASSURANCE 2

1.5 SAFETY REQUIREMENTS 3

1.6 PROTECTION 3

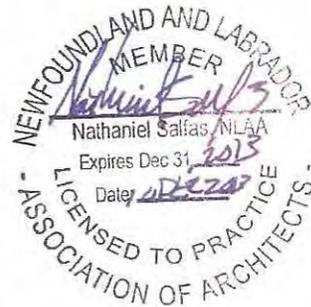
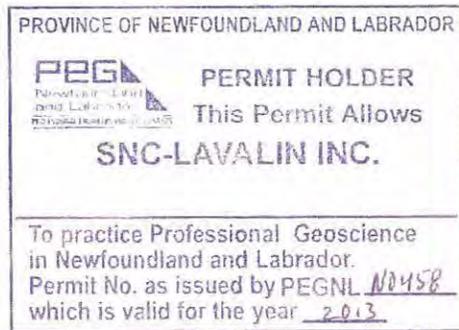
1.7 ENVIRONMENTAL REQUIREMENTS..... 3

PART 2 PRODUCTS.....3

2.1 MATERIALS 3

PART 3 EXECUTION.....4

3.1 APPLICATION..... 4



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 20
CH0032	LOW EXPANDING FOAM SEALANT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 07 26 00 – Vapour Retarders.
- .2 Section 07 27 00 – Air Barriers - Descriptive or Proprietary.

1.2 REFERENCES

1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

- .1 All work shall be in accordance with this specification and the requirements of the following.

1.2.2 Canadian Urethane Foam Contractors' Association Inc. (CUFCA)

1.2.3 Underwriters' Laboratories of Canada (ULC)

- .1 CAN/ULC-S101, Fire Endurance Tests of Building Construction and Materials.
- .2 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .3 CAN/ULC-S705.1, Standard for Thermal Insulation Spray Applied Rigid Foam, Medium Density, Material Specification.
- .4 CAN/ULC-S705.2, Standard for Thermal Insulation Spray Applied Rigid Foam, Medium Density, Installer's Responsibilities-Specification.

1.3 SUBMITTALS

1.3.1 Submit test reports, verifying qualities of foam sealant meet or exceed requirements of this specification.

1.3.2 Submit test reports in accordance with CAN/ULC-S101 for fire endurance and CAN/ULC-S102 for surface burning characteristics.

1.4 QUALITY ASSURANCE

1.4.1 Applicators to conform to CUFCA Quality Assurance Program.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 20
CH0032	LOW EXPANDING FOAM SEALANT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 SAFETY REQUIREMENTS

1.5.1 Protect workers as recommended by CAN/ULC-S705.2 and manufacturer's recommendations:

- .1 Workers must wear gloves, respirators, dust masks, eye protection, protective clothing when applying foam sealant.
- .2 Workers must not eat, drink or smoke while applying foam sealant.

1.6 PROTECTION

- 1.6.1 Ventilate area in accordance with manufacturer's instructions.
- 1.6.2 Ventilate area to receive insulation by introducing fresh air and exhausting air continuously during and 24 hours after application to maintain non-toxic, unpolluted, safe working conditions.
- 1.6.3 Provide temporary enclosures to prevent spray and noxious vapours from contaminating air beyond application area.
- 1.6.4 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.
- 1.6.5 Dispose of waste foam sealant daily in location designated by Engineer and decontaminate empty drums in accordance with foam sealant manufacturer's instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

1.7.1 Apply foam sealant only when surfaces and ambient temperatures are within manufacturers' prescribed limits.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Low expanding, one-component, polyurethane foam sealant, curing to a semi-rigid, closed cell urethane foam providing a RSI of 0.9 per 25.4 mm. To meet the following physical properties:

- .1 Density: 25.7 kg/m³
- .2 Compressive Strength Parallel @ 10%: 0.48-0.66 MPa
- .3 Tensile Strength: 0.71 MPa

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 20
CH0032	LOW EXPANDING FOAM SEALANT	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Water Vapour Transmission: 340 ng/Pa.m².5
- .5 Flame Spread: 20
- .6 Smoke Development: 70
- .7 VOC Content: Low-emitting

PART 3 EXECUTION

3.1 APPLICATION

- 3.1.1 Apply foam sealant to clean surfaces in accordance manufacturer's printed instructions. Surfaces to be free of dust, dirt, oil and other foreign materials.
- 3.1.2 Cover surfaces not intended to be foamed.
- 3.1.3 Apply foam sealant to perimeter of openings indicated and to thickness as recommended by manufacturer. Trim excess cured foam from finished area.
- 3.1.4 Cover exposed urethane foam sealants to protect from adverse affects from ultraviolet light (sunlight).

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 29
CH0032	SPRAYED INSULATION – POLYURETHANE FOAM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 07 21 29
SPRAYED INSULATION – POLYURETHANE FOAM
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

1.4 QUALITY ASSURANCE 3

1.5 SAFETY REQUIREMENTS 3

1.6 PROTECTION 3

1.7 ENVIRONMENTAL REQUIREMENTS..... 4

PART 2 PRODUCTS 4

2.1 MATERIALS 4

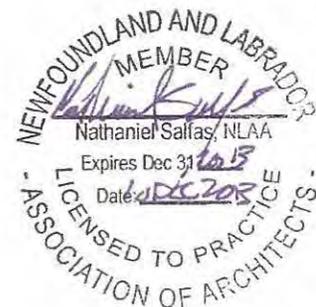
PART 3 EXECUTION 5

3.1 MANUFACTURER'S INSTRUCTIONS 5

3.2 APPLICATION 5

3.3 FIELD QUALITY CONTROL 5

3.4 CLEANING 5



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 29
CH0032	SPRAYED INSULATION – POLYURETHANE FOAM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 07 26 00 –Vapour Retarders
- 1.1.2 Section 07 27 00 – Air Barriers - Descriptive or Proprietary.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
 - 1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.
 - 1.2.2 Canadian Urethane Foam Contractors' Association Inc. (CUFCA)
 - 1.2.3 Underwriters' Laboratories of Canada (ULC)
 - 1.2.3.1 CAN/ULC-S101, Fire Endurance Tests of Building Construction and Materials.
 - 1.2.3.2 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - 1.2.3.3 CAN/ULC-S705.1, Standard for Thermal Insulation Spray Applied Rigid Foam, Medium Density, Material Specification.
 - 1.2.3.4 CAN/ULC-S705.2, Standard for Thermal Insulation Spray Applied Rigid Foam, Medium Density, Installer's Responsibilities-Specification.

1.3 SUBMITTALS

- 1.3.1 Product Data:
 - 1.3.1.1 Submit manufacturer's printed product data literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - 1.3.1.2 Submit two copies of WHMIS MSDS – Material Safety Data Sheets.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 29
CH0032	SPRAYED INSULATION – POLYURETHANE FOAM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.2 Test Reports

- 1.3.2.1 Submit certified test reports, from approved independent testing laboratories verifying qualities of insulation meet or exceed requirements of this specification.
- 1.3.2.2 Submit test reports in accordance with CAN/ULC-S101 for fire endurance and CAN/ULC-S102 for surface burning characteristics.
- 1.3.2.3 Submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.4 QUALITY ASSURANCE

- 1.4.1 Applicators are to conform to CUFCA Quality Assurance Program.
- 1.4.2 Qualifications:
 - 1.4.2.1 Installer: person specializing in sprayed insulation installations with minimum 5 years experience approved by manufacturer.
 - 1.4.2.2 Manufacturer: company with minimum 5 years experience in producing of material used for work required for this project, with sufficient production capacity to produce and deliver required units without causing delay in work.

1.5 SAFETY REQUIREMENTS

- 1.5.1 Protect workers as recommended by CAN/ULC-S705.2 and manufacturer's recommendations:
 - 1.5.1.1 Workers must wear gloves, respirators, dust masks, eye protection, protective clothing when applying foam insulation.
 - 1.5.1.2 Workers must not eat, drink or smoke while applying foam insulation.

1.6 PROTECTION

- 1.6.1 Ventilate area in accordance with manufacturer's instructions.
- 1.6.2 Ventilate area to receive insulation by introducing fresh air and exhausting air continuously during and 24 hours after application to maintain non-toxic, unpolluted, safe working conditions.
- 1.6.3 Provide temporary enclosures to prevent spray and noxious vapours from contaminating air beyond application area.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 29
CH0032	SPRAYED INSULATION – POLYURETHANE FOAM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6.4 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.

1.6.5 Dispose of waste foam daily in location designated by Engineer and decontaminate empty drums in accordance with foam manufacturer's instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

1.7.1 Apply insulation only when surfaces and ambient temperatures are within manufacturers' prescribed limits.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Insulation: spray polyurethane foam to CAN/ULC-S705.1, thickness and RSI value as indicated on drawings.

2.1.1.1 RSI: minimum 1.09 per 25 mm.

2.1.1.2 Density: 28 kg/m³, to ASTM D-1622.

2.1.1.3 Air barrier properties: to ASTM E-28:

2.1.1.3.1 @75 Pa: < 0.05 L/s/m²

2.1.1.3.2 @300 Pa: < 0.05 L/s/m²

2.1.1.4 Perm rating: to ATSM E-96:

2.1.1.4.1 25 mm thick: 149.3 ng/(m².Pa.s)

2.1.1.4.2 75 mm thick: 72.1 ng/(m².Pa.s)

2.1.1.5 Tensile Strength: 310 kPa, to ASTM D-1623

2.1.1.6 Compressive Strength: 158 kPa, to ASTM D-162,

2.1.1.7 Flame Spread: 25, to ASTM E-84

2.1.1.8 Smoke development: 200, to ASTM E-84

2.1.2 Primers: in accordance with manufacturer's recommendations for surface conditions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 21 29
CH0032	SPRAYED INSULATION – POLYURETHANE FOAM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 APPLICATION

3.2.1 Apply insulation to clean surfaces in accordance with CAN/ULC-S705.2 and manufacturer's printed instructions.

3.2.2 Use primer where recommended by manufacturer.

3.2.3 Apply sprayed foam insulation in thickness as indicated to seal all openings in exterior wall envelope to produce a continuous air/vapour barrier.

3.3 FIELD QUALITY CONTROL

3.3.1 Manufacturer's Field Services:

3.3.1.1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.4 CLEANING

3.4.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 26 00
CH0032	VAPOUR RETARDERS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 26 00
VAPOUR RETARDERS
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

PART 2 PRODUCTS 3

2.1 SHEET VAPOUR BARRIER 3

2.2 ACCESSORIES 3

PART 3 EXECUTION 3

3.1 INSTALLATION 3

3.2 EXTERIOR SURFACE OPENINGS 4

3.3 PERIMETER SEALS 4

3.4 LAP JOINT SEALS 4

3.5 ELECTRICAL BOXES 4

3.6 CLEANING 5



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 26 00
CH0032	VAPOUR RETARDERS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 03 30 00 – Cast-in-Place Concrete.
- 1.1.2 Section 06 10 00 – Rough Carpentry.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
 - 1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.
 - 1.2.2 Canadian General Standards Board (CGSB)
 - 1.2.2.1 CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.
 - 1.2.3 Underwriters Laboratories Canada (ULC)
 - 1.2.3.1 CAN/ULC S102, Method Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 SUBMITTALS

- 1.3.1 Product Data:
 - 1.3.1.1 Submit manufacturer's printed product literature, specifications and datasheet and include:
 - 1.3.1.1.1 Product characteristics.
 - 1.3.1.1.2 Performance criteria.
 - 1.3.1.1.3 Limitations.
 - 1.3.2 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 26 00
CH0032	VAPOUR RETARDERS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.3 Quality assurance submittals:

1.3.3.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3.3.2 Instructions: submit manufacturer's installation instructions and comply with written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

PART 2 PRODUCTS

2.1 SHEET VAPOUR BARRIER

2.1.1 Polyethylene film: to CAN/CGSB-51.34, 0.15 mm thick, with a water vapour permeance of not greater than 4.5 ng/(P.s.m²), and flame spread rating less than 150 to CAN/ULC S102.

2.2 ACCESSORIES

2.2.1 Joint sealing tape: air resistant pressure sensitive adhesive tape, type recommended by vapour barrier manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.

2.2.2 Sealant: compatible with vapour retarder materials, recommended by vapour retarder manufacturer, to Section 07 92 00 - Joint Sealants.

2.2.3 Staples: minimum 6 mm leg.

2.2.4 Moulded box vapour barrier: factory-moulded polyethylene box for use with recessed electric switch and outlet device boxes.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Ensure services are installed and inspected prior to installation of retarder.

3.1.2 Install sheet vapour retarder on warm side of exterior wall and ceiling assemblies prior to installation of gypsum board to form continuous retarder.

3.1.3 Use sheets of largest practical size to minimize joints.

3.1.4 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 26 00
CH0032	VAPOUR RETARDERS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 EXTERIOR SURFACE OPENINGS

3.2.1 Cut sheet vapour retarder to form openings and ensure material is lapped and sealed to frame.

3.3 PERIMETER SEALS

3.3.1 Seal perimeter of sheet vapour barrier as follows:

3.3.1.1 Apply continuous bead of sealant to substrate at perimeter of sheets.

3.3.1.2 Lap sheet over sealant and press into sealant bead.

3.3.1.3 Install staples through lapped sheets at sealant bead into wood substrate.

3.3.1.4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

3.4 LAP JOINT SEALS

3.4.1 Seal lap joints of sheet vapour barrier as follows:

3.4.1.1 Attach first sheet to substrate.

3.4.1.2 Apply continuous bead of sealant over solid backing at joint.

3.4.1.3 Lap adjoining sheet minimum 150 mm and press into sealant bead.

3.4.1.4 Install staples through lapped sheets at sealant bead into wood substrate.

3.4.1.5 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

3.5 ELECTRICAL BOXES

3.5.1 Seal electrical switch and outlet device boxes that penetrate vapour barrier as follows:

3.5.1.1 Install moulded box vapour barrier or wrap boxes with film sheet providing minimum 300 mm perimeter lap flange.

3.5.1.2 Apply sealant to seal edges of flange to main vapour barrier and seal wiring penetrations through box cover.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 26 00
CH0032	VAPOUR RETARDERS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6 CLEANING

3.6.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 27 00
AIR BARRIERS –
DESCRIPTIVE OR PROPRIETARY
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

1.1 SCOPE OF WORK..... 2

1.2 RELATED SECTIONS..... 2

1.3 REFERENCES..... 2

1.4 SUBMITTALS..... 3

1.5 QUALITY ASSURANCE..... 3

1.6 DELIVERY, STORAGE AND HANDLING..... 3

1.7 AMBIENT CONDITIONS..... 4

1.8 NOT USED..... 4

PART 2 PRODUCTS..... 4

2.1 SHEET MATERIALS..... 4

2.2 SEALANTS..... 4

PART 3 EXECUTION..... 5

3.1 MANUFACTURER'S INSTRUCTIONS..... 5

3.2 GENERAL..... 5

3.3 EXAMINATION..... 5

3.4 PREPARATION..... 5

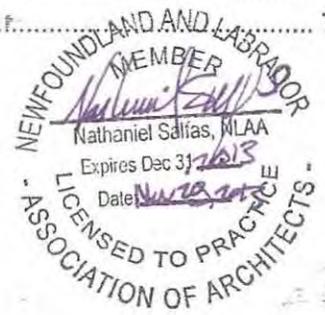
3.5 INSTALLATION..... 6

3.6 FIELD QUALITY CONTROL..... 6

3.7 CLEANING..... 6

3.8 PROTECTION OF WORK..... 6

3.9 SCHEDULES..... 7



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SCOPE OF WORK

1.1.1 Section Includes:

- 1.1.1.1 Material and installation methods, providing primary air barrier materials and assemblies.
- 1.1.1.2 Air barrier materials to provide continuous seal between components of building envelope and building penetrations

1.2 RELATED SECTIONS

- 1.2.1.1 07 92 00 – Joint Sealants

1.3 REFERENCES

- 1.3.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.3.2 All work shall be in accordance with this specification and the requirements of the following.
- 1.3.3 Canadian General Standards Board (CGSB)
 - 1.3.3.1 CAN/CGSB-19.13M, Sealing Compound, One Component, Elastomeric Chemical Curing.
 - 1.3.3.2 CAN/CGSB-19.18M, Sealing Compound, One Component, Silicone Base Solvent Curing.
 - 1.3.3.3 CAN/CGSB-19.24M, Multi-Component, Chemical Curing Sealing Compound.
 - 1.3.3.4 CGSB 19-GP-14M, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing.
- 1.3.4 Sealant and Waterproofer's Institute - Sealant and Caulking Guide Specification.
- 1.3.5 National Building Code of Canada (NBCC) – Part 5 – Environmental Separation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 SUBMITTALS

1.4.1 Product Data:

1.4.1.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.4.1.2 Submit WHMIS MSDS - Material Safety Data Sheets.

1.4.2 Quality Assurance Submittals: submit following in accordance with General Requirements.

1.4.2.1 Existing Substrate Condition: report deviations, as described in PART 3 - EXAMINATION in writing to Engineer.

1.4.2.2 Submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and maintenance instructions.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications:

1.5.1.1 Applicator: company specializing in performing work of this section with minimum 5 years documented experience with installation of air barrier systems.

1.5.1.1.1 Completed installation must be approved by the material manufacturer.

1.5.1.2 Applicator: company:

1.5.1.2.1 Currently licensed by National Air Barrier Association or certifying organization.

1.5.1.2.2 Must maintain their license throughout the duration of the project.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Deliver, store and handle materials in accordance with manufacturer's written instructions. Deliver membrane materials in factory wrapped packaging indicating name of manufacturer and product.

1.6.2 Avoid spillage: immediately notify Engineer if spillage occurs and start clean up procedures.

1.6.3 Clean spills and leave area as it was prior to spill.

1.6.4 Store roll materials on end in original packaging.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6.5 Store primers at temperatures of 5°C and above to facilitate handling. Keep Solvent away from flame and excessive heat.

1.7 **AMBIENT CONDITIONS**

1.7.1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.

1.7.2 Ventilate enclosed spaces in accordance with manufacturer’s instructions.

1.7.3 Maintain temperature and humidity recommended by materials manufactures before, during and after installation.

1.8 **NOT USED**

PART 2 PRODUCTS

2.1 **SHEET MATERIALS**

2.1.1 Sheet Seal: self-adhesive bitumen laminated to high-density polyethylene film, nominal total thickness of 1.0 mm.

2.1.1.1 Membrane Physical Properties:

2.1.1.1.1 Application: min 5°C

2.1.1.1.2 Service temperature: -40°C to 70°C

2.1.1.1.3 Elongation: min 200%

2.1.1.1.4 Tensile strength: min 2.4 mPa

2.1.1.1.5 Puncture resistance: min 178 N

2.1.1.1.6 Water vapour transmission: 2.8 ng/Pa.s.m² (0.05 perms)

2.1.1.1.7 Moisture absorption: 0.1%

2.1.1.1.8 Air leakage at 75 Pa: 0.02 L/Sm²

2.1.1.1.9 Air leakage of the 3000 Pa test: No change.

2.2 **SEALANTS**

2.2.1 Sealants are to be in accordance with Section 07 92 00 - Joint Sealants.

2.2.2 Primer: as recommended by sealant manufacturer.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.3 Substrate Cleaner: non-corrosive type recommended by sealant manufacturer.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 GENERAL

3.2.1 Perform Work in accordance with Sealant and Waterproofer's Institute - Sealant and Caulking Guide Specification requirements for materials and installation.

3.2.2 Perform Work in accordance with National Air Barrier Association - Professional Contractor Quality Assurance Program .

3.3 EXAMINATION

3.3.1 Verify that surfaces and conditions are ready to accept work of this section.

3.3.2 Ensure surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer's requirements.

3.3.3 Report unsatisfactory conditions to Engineer in writing.

3.3.4 Do not start work until deficiencies have been corrected.

3.4 PREPARATION

3.4.1 Remove loose or foreign matter, which might impair adhesion of materials.

3.4.2 Ensure substrates are clean of oil or excess dust; masonry joints struck flush, and open joints filled; and concrete surfaces free of large voids, spalled areas or sharp protrusions.

3.4.3 Ensure substrates are free of surface moisture prior to application of self-adhesive membrane and primer.

3.4.4 Ensure metal closures are free of sharp edges and burrs.

3.4.5 Prime substrate surfaces to receive adhesive and sealants in accordance with manufacturer's instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5 INSTALLATION

- 3.5.1 Install materials in accordance with manufacturer's instructions.
- 3.5.2 Secure sheet seal to masonry, concrete and gypsum board materials with self-adhesive continuous metal bar with anchors.
 - 3.5.2.1 Caulk with sealant to ensure complete seal.
 - 3.5.2.2 Position lap seal over firm bearing
- 3.5.3 Install sheet seal between window and door frames and adjacent wall seal materials with sealant or adhesive as per manufacturer's instructions.
 - 3.5.3.1 Caulk to ensure complete seal.
 - 3.5.3.2 Position lap seal over firm bearing.
- 3.5.4 Apply sealant within recommended application temperature ranges.
 - 3.5.4.1 Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.6 FIELD QUALITY CONTROL

- 3.6.1 Manufacturer's Field Services:
 - 3.6.1.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.
 - 3.6.1.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.7 CLEANING

- 3.7.1 Proceed in accordance with General Requirements
- 3.7.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.8 PROTECTION OF WORK

- 3.8.1 Protect finished work in accordance General Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 27 00
CH0032	AIR BARRIERS – DESCRIPTIVE OR PROPRIETARY	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.8.2 Do not permit adjacent work to damage work of this section.

3.8.3 Ensure finished work is protected from climatic conditions.

3.9 SCHEDULES

3.9.1 Wall Air/Vapour Barrier Over Exterior Surface of Gypsum Sheathing:

3.9.1.1 Place sheet seal Type G over sheathing surfaces with Adhesive Type E.

3.9.1.2 Seal with Type Y sealant.

3.9.2 Window Frame Perimeter:

3.9.2.1 Lap sheet seal Type H from wall air seal surface with 75 mm of full contact over firm bearing to window frame with 25 mm of full contact.

3.9.2.2 Edge seal with Type Z sealant.

3.9.3 Wall and Roof Junction:

3.9.3.1 Lap sheet seal Type J from wall seal material with 150 mm of contact over firm bearing to roof air seal membrane with 100 mm of full contact.

3.9.3.2 Seal with Type X sealant.

3.9.4 Roof System Air/Vapour Barrier Over Steel Deck:

3.9.4.1 Gypsum sheathing, taped joints, apply membrane air seal Type K over sheathing surfaces with Adhesive Type D

3.9.4.2 Edge seal membrane with Type Y sealant.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 46 13
CH0032	PREFORMED METAL SIDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 07 46 13
PREFORMED METAL SIDING
TABLE OF CONTENTS**

PART 1 GENERAL.....2

1.1 SECTION INCLUDES..... 2

1.2 RELATED SECTIONS..... 2

1.3 REFERENCES..... 2

1.4 SUBMITTALS..... 3

1.5 QUALITY ASSURANCE..... 3

1.6 WASTE MANAGEMENT AND DISPOSAL..... 3

PART 2 PRODUCTS.....4

2.1 STEEL CLADDING AND COMPONENTS..... 4

2.2 ACCESSORIES..... 5

2.3 FASTENERS..... 5

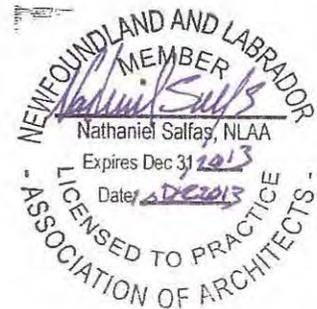
2.4 CAULKING..... 5

PART 3 EXECUTION.....5

3.1 MANUFACTURER'S INSTRUCTIONS..... 5

3.2 INSTALLATION..... 6

3.3 CLEANING..... 6



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 46 13
CH0032	PREFORMED METAL SIDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SECTION INCLUDES

1.1.1 Requirements for the installation of preformed metal cladding/siding.

1.2 RELATED SECTIONS

1.2.1 Section 06 10 00 – Rough Carpentry

1.2.2 Section 07 62 00 – Sheet Metal Flashing and Trim

1.2.3 Section 07 92 00 - Joint Sealants

1.2.4 Section 07 84 00 - Fire Stopping

1.3 REFERENCES

1.3.1 The Contractor shall comply with the rules and provisions of the listed Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.3.1.1 All work shall be in accordance with this specification and the requirements of the following.

1.3.2 American National Standards Institute (ANSI).

1.3.2.1 ANSI B18.6.4, Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws.

1.3.3 American Society for Testing and Materials International, (ASTM).

1.3.3.1 ASTM D2369-10 (2011), Test Method for Volatile Content of Coatings.

1.3.3.2 ASTM D2832-92 (2011) – Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.

1.3.3.3 ASTM D5116-09 – Standard Guide For Small-Scale Environmental Chamber Determinations of Organic Emissions From Indoor Materials/Products.

1.3.3.4 ASTM F1667-11A (2012) – Standard Specification for Driven Fasteners: Nails, Spikes and Staples.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 46 13
CH0032	PREFORMED METAL SIDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 SUBMITTALS

1.4.1 Product data: submit manufacturer's printed product literature, specifications and data sheets.

1.4.1.1 Submit two copies of WHMIS MSDS - Material Safety Data Sheets. Indicate VOCs for caulking materials during application and curing.

1.4.2 Shop Drawings:

1.4.2.1 Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, soffits, fascia, metal furring and related work.

1.4.3 Samples:

1.4.3.1 Submit duplicate 300 x 300 mm samples of siding material, of colour and profile specified.

1.4.4 Manufacturer's Instructions:

1.4.4.1 Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

1.5.1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.5.2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5.3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

1.6.1 Divert used metal cut-offs from landfill by disposal into the on-site metals recycling bin or removed for disposal at the nearest metal recycling facility.

1.6.2 Divert unused caulking, sealants, and adhesive materials from landfill through disposal at hazardous material depot.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 46 13
CH0032	PREFORMED METAL SIDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

PART 2 PRODUCTS

2.1 STEEL CLADDING AND COMPONENTS

2.1.1 Siding: to CGSB 93.4, Type A vertical, Class plain.

2.1.1.1 Finish coating: 10000 Series, two coat, polyvinylidene fluoride resin based system.

2.1.1.2 Colour: colour as selected by Engineer.

2.1.1.3 Gloss: medium.

2.1.1.4 Thickness: 0.65 mm base metal thickness.

2.1.1.5 Profile: preformed interlocking joints, profile CL 938 by Vic West, or approved equal.

2.1.2 Soffit: to CGSB 93.4, Class plain:

2.1.2.1 Finish coating: 10000 Series, two coat, polyvinylidene fluoride resin based system.

2.1.2.2 Colour: colour as selected by Engineer.

2.1.2.3 Gloss: medium.

2.1.2.4 Thickness: 0.65 mm base metal thickness.

2.1.2.5 Profile: flat sheet 'V' crimped for stiffness.

2.1.3 Fascia facings and exposed trim: to CGSB 93.4, Class plain:

2.1.3.1 Finish coating: 10000 Series, two coat, polyvinylidene fluoride resin based system.

2.1.3.2 Colour: colour selected Engineer.

2.1.3.3 Gloss: medium.

2.1.3.4 Thickness: 0.65 mm base metal thickness.

2.1.3.5 Profile: flat sheet "V" crimpod for stiffness, preformed with elongated slits and small perforations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 46 13
CH0032	PREFORMED METAL SIDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.4 Alternative Finish Coating:

2.1.4.1 VicWest "Weather X and Baycoat Perspectra" are acceptable equals to 10000 coating series.



2.1.5 Liner Sheet: to ASTM A653, with Z275 zinc coating, structural quality:

2.1.5.1 Light duty modified silicone finish



2.1.5.2 Factory formed flat or profiled, interlocking joints, shop installed seal material one side of joint. Profile CL508 by VicWest, or approved equal.

2.1.5.3 Thickness: 0.61 mm minimum base metal thickness

2.1.5.4 Color: color as selected by Engineer

2.2 ACCESSORIES

2.2.1 Exposed trim: inside corners, outside corners, cap strip, drip cap, undersill trim, starter strip and window/door trim of same material, colour and gloss as cladding.

2.3 FASTENERS

2.3.1 Nails to ASTM F1667-11a. Screws to ANSI B18.6.4. Purpose made aluminum alloy or stainless steel.

2.4 CAULKING

2.4.1 Sealants: Section 07 92 00 – Joint Sealants.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 46 13
CH0032	PREFORMED METAL SIDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 INSTALLATION

- 3.2.1 Install cladding in accordance with CGSB 93.5, and manufacturer's written instructions
- 3.2.2 Install continuous starter strips, inside and outside corners, edgings, soffit, drip, cap, sill and window/door opening flashings as indicated.
- 3.2.3 Install outside corners, fillers and closure strips with carefully formed and profiled work.
- 3.2.4 Install soffit and fascia cladding as indicated.
- 3.2.5 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.
- 3.2.6 Attach components in manner not restricting thermal movement.
- 3.2.7 Caulk junctions with adjoining work with sealant. Do work in accordance with Section 07 92 00 - Joint Sealants.
- 3.2.8 Touch-up field welds and burnt or scratched surfaces after completion of erection, with paint or cold galvanizing materials depending on base coating.

3.3 CLEANING

- 3.3.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 52 00
MODIFIED BITUMINOUS MEMBRANE ROOFING
TABLE OF CONTENTS**

PART 1 GENERAL	3
1.1 RELATED REQUIREMENTS.....	3
1.2 REFERENCES.....	3
1.3 PERFORMANCE REQUIREMENTS.....	4
1.4 SUBMITTALS.....	4
1.5 QUALITY ASSURANCE.....	5
1.6 FIRE PROTECTION.....	5
1.7 DELIVERY, STORAGE, AND HANDLING.....	5
1.8 FIELD CONDITIONS.....	6
1.9 NOT USED.....	6
PART 2 PRODUCTS	6
2.1 PERFORMANCE CRITERIA.....	6
2.2 THERMAL BARRIER AND AIR/VAPOUR BARRIER.....	6
2.3 INSULATION AND COVER BOARD COMPONENTS.....	6
2.4 BASE SHEET.....	8
2.5 CAP SHEET.....	9
2.6 ADHESIVE.....	10
2.7 BASE SHEET FLASHING.....	10
2.8 SEALERS.....	10
2.9 PRIMERS.....	10
2.10 FASTENERS.....	10
2.11 WALKWAYS.....	10
2.12 CARPENTRY.....	11
2.13 CANT STRIPS.....	11
2.14 ROOF DRAINS.....	11
PART 3 EXECUTION	11
3.1 QUALITY OF WORK.....	11
3.2 PROTECTION.....	11
3.3 EXAMINATION ROOF DECKS.....	12

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 EXPOSED MEMBRANE ROOFING APPLICATION (METAL ROOF DECK)12

3.5 ROOF PENETRATIONS.....15

3.6 CLEANING16

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 06 10 00 - Rough Carpentry.
- 1.1.2 Section 07 62 00 - Sheet Metal Flashing and Trim.
- 1.1.3 Section 07 92 00 - Joint Sealants.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
 - 1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.
 - 1.2.2 American Society for Testing and Materials (ASTM International)
 - 1.2.2.1 ASTM C1177/C1177M-08, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - 1.2.2.2 ASTM D6162-00a (2008), Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fibre Reinforcements.
 - 1.2.2.3 ASTM D6164-11, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
 - 1.2.3 Canadian General Standards Board (CGSB)
 - 1.2.3.1 CGSB 37.5, Cutback Asphalt Plastic Cement.
 - 1.2.3.2 CGSB 37-GP-9Ma, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
 - 1.2.3.3 CGSB 37-GP-15M, Application of Asphalt Primer for Asphalt Roofing, Dampproofing and Waterproofing.
 - 1.2.3.4 CGSB 37-GP-19M, Cement, Plastic, Cutback Tar.
 - 1.2.3.5 CAN/CGSB-37.29, Rubber- Asphalt Sealing Compound.
 - 1.2.3.6 CGSB 37-GP-56M-80b (A1985)], Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.2.3.7 CAN/CGSB-51.33-M89, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction.

1.2.4 Canadian Roofing Contractors Association (CRCA)

1.2.4.1 CRCA Roofing Specifications Manual-1997.

1.2.5 Canadian Standards Association (CSA International)

1.2.5.1 CSA A123.21-04, Standard Test Method for the Dynamic Wind Uplift Resistance of Mechanically Attached Membrane-Roofing Systems

1.2.6 Factory Mutual (FM Global)

1.2.6.1 FM Approvals - Roofing Products.

1.2.7 Underwriters Laboratories' of Canada (ULC)

1.2.7.1 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2.7.2 CAN/ULC-S704-03, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Compatibility between components of roofing system is essential.

1.3.2 Provide written declaration to Engineer stating that materials and components as assembled in system meet this requirement.

1.4 SUBMITTALS

1.4.1 Product Data:

1.4.1.1 Provide two copies of most recent technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.

1.4.1.2 Provide two copies of WHMIS MSDS data sheets, and indicate VOC content for primers, asphalt, sealers, and filter fabric.

1.4.2 Provide Shop Drawings:

1.4.2.1 Indicate flashing, control joints, tapered insulation details, roof drains, and all required roofing materials.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.4.2.2 Provide layout for tapered insulation.
- 1.4.3 Samples: submit two (2) sample 304.8 mm (12") long pieces of roofing insulation.
- 1.4.4 Manufacturer's Certificate: certify that products meet or exceed specified requirements.
- 1.4.5 Test and Evaluation Reports: submit laboratory test reports certifying compliance of membrane with specification requirements.
- 1.4.6 Manufacturer's Installation Instructions: indicate special precautions required for seaming the membrane.
- 1.4.7 Reports: indicate procedures followed, ambient temperatures and wind velocity during application.

1.5 QUALITY ASSURANCE

- 1.5.1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with 5 years documented experience approved by manufacturer.

1.6 FIRE PROTECTION

- 1.6.1 Fire Extinguishers: Maintain one stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for A, B and C class protection, size 9 kg on roof per torch applicator, 6 m of torch applicator.
- 1.6.2 Maintain fire watch for 2 hours after each day's roofing operations cease.

1.7 DELIVERY, STORAGE, AND HANDLING

- 1.7.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- 1.7.2 Storage and Handling Requirements:
 - 1.7.2.1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.
 - 1.7.2.2 Provide and maintain dry, off-ground weatherproof storage.
 - 1.7.2.3 Store rolls of felt and membrane in upright position. Store membrane rolls with salvage edge up.
 - 1.7.2.4 Remove only in quantities required for same day use.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7.2.5 Place plywood runways over completed Work to enable movement of material and other traffic.

1.7.2.6 Store sealants at +5 degrees C minimum.

1.7.2.7 Store insulation protected from daylight, weather and deleterious materials.

1.8 FIELD CONDITIONS

1.8.1 Ambient Conditions

1.8.1.1 Do not install roofing when temperature remains below -18 degrees C for torch application, or to manufacturers' recommendations for mop application.

1.8.1.2 Minimum temperature for solvent-based adhesive is -5 degrees C.

1.8.2 Install roofing on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.

1.9 NOT USED

PART 2 PRODUCTS

2.1 PERFORMANCE CRITERIA

2.1.1 Compatibility between components of roofing system is essential.

2.1.2 Provide written declaration to Engineer stating that materials and components, as assembled in system, meet this requirement.

2.1.3 Roofing System: to CSA A123.21 for wind uplift resistance.

2.2 THERMALBARRIER AND AIR/VAPOUR BARRIER

2.2.1 Thermal Barrier: Pre-primed glass mat faced gypsum panel non-asphaltic, highly filled proprietary heat-cured coating on one side, to ASTM C1177, 16 mm thick.

2.2.2 Air/ Vapour Barrier: Self adhering peel and stick air/vapour barrier composed of Styrene-Butadiene-Styrene (SBS) modified bitumen reinforced with high density polyethylene film, anti slip surface, minimum thickness 1.0 mm.

2.3 INSULATION AND COVER BOARD COMPONENTS

2.3.1 For sloped roof decks or roof structures, provide uniform thickness rigid insulation.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.3.2** For flat roof decks or roof structures, provide custom designed tapered insulation with minimum slope of 2.0 mm in 100 mm (2%). Taper insulation to drain, minimum RSI value at drain to be 4.0.
- 2.3.3** Expanded Polystyrene Insulation (EPS), Cover Board and Asphalt Recover Board:
 - 2.3.3.1** Expanded Polystyrene Insulation (EPS):
 - 2.3.3.1.1** To CAN/ULC-S701, Type 1, square edged.
 - 2.3.3.1.2** Insulation value thickness per cm based on values listed in the latest edition of NRC - Evaluation Listings.
 - 2.3.3.1.3** Provide two layers of insulation installed with staggered joints.
 - 2.3.3.2** Cover Board: Non-structural, glass mat faced gypsum panel with water-resistant core to ASTM C1177, 6.35 mm thick.
 - 2.3.3.3** Asphalt Recover Board: Semi-rigid asphalt roofing substrate composed of mineral core between glass fibre mats, 1200 x 1500mm sheets, minimum thickness 3.0 mm.
- 2.3.4** Extruded Polystyrene Insulation (XPS) and two layers of Asphalt Recover Board:
 - 2.3.4.1** Extruded Polystyrene Insulation (XPS):
 - 2.3.4.1.1** To CAN/ULC-S701, Type 2, square edged.
 - 2.3.4.1.2** Insulation value thickness per cm based on values listed in the latest edition of NRC - Evaluation Listings.
 - 2.3.4.1.3** Provide two layers of insulation installed with staggered joints.
 - 2.3.4.2** Two layers of Asphalt Recover Board: Semi-rigid asphalt roofing substrate composed of mineral core between glass fibre mats, 1200 x 1500mm sheets, minimum thickness 3.0 mm each.
- 2.3.5** Polyisocyanurate Insulation and Asphalt Recover Board:
 - 2.3.5.1** Polyisocyanurate Insulation:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3.5.1.1 To CAN/ULC-S704, glass reinforced felt facers, square edged and containing no CFC.

2.3.5.1.2 Insulation value thickness per cm based on values listed in the latest edition of NRC - Evaluation Listings.

2.3.5.1.3 Provide two layers of insulation installed with staggered joints.

2.3.5.2 Asphalt Recover Board: Semi-rigid asphalt roofing substrate composed of mineral core between glass fibre mats, 1200 x 1500mm sheets, minimum thickness 3.0 mm.

2.3.6 Total assembly RSI value:

2.3.6.1 Minimum average RSI value of assembly insulation components to be 7.0.

2.3.6.2 Insulation assembly components to consist of thermal barrier, insulation and cover board.

2.4 BASE SHEET

2.4.1 Base Sheet: to CGSB 37-GP-56M, polyester fibres to ASTM D6164, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven, polyester reinforcement, having nominal weight of 180 g/m².

2.4.1.1 Type 2, fully adhered.

2.4.1.2 Class C - plain surfaced.

2.4.1.3 Grade heavy duty service.

2.4.1.4 Top and bottom surfaces:

2.4.1.4.1 Polyethylene/ polyethylene.

2.4.1.5 Base sheet membrane properties:

2.4.1.5.1 Strain energy (longitudinal/transversal): 9.0/7.0 kN/m.

2.4.1.5.2 Breaking strength (longitudinal/transversal): 17.0/12.5 N/5 cm.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4.1.5.3 Ultimate elongation (longitudinal/transversal): 60/65 %.

2.4.1.5.4 Tear resistance: 60 N.

2.4.1.5.5 Cold bending at -30 degrees C: no cracking.

2.4.1.5.6 Softening point: \approx 110 degrees C.

2.4.1.5.7 Static puncture resistance: > 400.

2.4.1.5.8 Dimensional Stability: -0.3 / 0.3 %.

2.5 CAP SHEET

2.5.1 Cap Sheet: to CGSB 37-GP-56M, combination of polyester and glass fibres to ASTM 6162, Styrene-Butadiene-Styrene(SBS) elastomeric polymer, prefabricated sheet, glass and polyester reinforcement, having nominal weight of 250 g/m².

2.5.1.1 Type 1, fully adhered.

2.5.1.2 Class A-granule surfaced.

2.5.1.2.1 Colour for granular surface: light gray.

2.5.1.3 Grade heavy duty service.

2.5.1.4 Bottom surface polyethylene.

2.5.1.5 Cap sheet membrane properties:

2.5.1.5.1 Strain energy (longitudinal/transversal): 13.0/10.0 kN/m.

2.5.1.5.2 Breaking strength (longitudinal/transversal): 25.0/16.0 kN/m.

2.5.1.5.3 Ultimate elongation (longitudinal/transversal): 60/65 %.

2.5.1.5.4 Tear resistance: 80 N.

2.5.1.5.5 Cold bending at -30 degrees C: No cracking.

2.5.1.5.6 Softening point: \approx 110 degrees C.

2.5.1.5.7 Static puncture resistance: > 400.

2.5.1.5.8 Dimensional Stability: -0.2 / 0.2 %.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.6 ADHESIVE

2.6.1 Adhesive for securing overlay board and insulation: a single component moisture cured polyurethane adhesive dispensed from a portable disposable pre-pressurized container requiring no external power source.

2.7 BASE SHEET FLASHING

2.7.1 To CGSB 37-GP-56M, Type 2, Class C, Grade 2, non-woven polyester reinforced 180g/m², self-adhesive membrane with polyethylene top face and release film under face.

2.8 SEALERS

2.8.1 Mastic made of synthetic rubbers, plasticized with bitumen and solvents with aluminum pigments to provide greater resistance to U.V.

2.9 PRIMERS

2.9.1 For self-adhesive membranes: A blend of elastomeric bitumen, volatile solvents and adhesive enhancing resins used to prime porous and non-porous substrates such as gypsum board, wood, concrete or metal to enhance the adhesion of self-adhesive membranes at temperatures above -10°C.

2.9.2 For heat welded membranes: A blend of elastomeric bitumen, volatile solvents and adhesive enhancing additives used to prime concrete or metal substrates to enhance the adhesion of torch-applied membranes.

2.10 FASTENERS

2.10.1 Fasteners: minimum #14 mechanical fasteners made of case-hardened carbon steel with corrosion resistance coating, complying with FM standards.

2.10.2 75 mm diameter round or hexagon stress plates complying with CSA B35.3 and FM 4470 approval standards, diameter and lengths as required to suit total assembly thickness.

2.10.3 Ensure fasteners have the following deck penetration:

2.10.3.1 For metal decks: minimum 19 mm and maximum 25 mm longer than assembly being secured. Fasteners to engage metal deck top flange.

2.11 WALKWAYS

2.11.1 Walkways to consist of one additional ply of cap sheet membrane. Colour to be different from field membrane as selected by Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.12 CARPENTRY

2.12.1 Refer to Section 06 10 00 - Rough Carpentry.

2.13 CANT STRIPS

2.13.1 Cut from pressure-treated wood, 38 mm thick material, to measure 140 mm on slope.

2.14 ROOF DRAINS

2.14.1 As per mechanical specifications for Plumbing Specialties and Accessories.

2.14.2 Sump pan: 600 x 600 mm galvanized steel.

PART 3 EXECUTION

3.1 QUALITY OF WORK

3.1.1 Do examination, preparation and roofing work in accordance with Roofing Manufacturer's Specification Manual and CRCA Roofing Specification Manual, particularly for fire safety precautions.

3.1.2 Do priming in accordance with manufacturers written recommendations.

3.1.3 The interface of the walls and roof assemblies will be fitted with durable rigid material providing connection point for continuity of air barrier.

3.1.4 Assembly, component and material connections will be made in consideration of appropriate design loads.

3.2 PROTECTION

3.2.1 Cover walls and adjacent work where materials hoisted or used.

3.2.2 Use warning signs and barriers. Maintain in good order until completion of Work.

3.2.3 Clean off drips and smears of bituminous material immediately.

3.2.4 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.

3.2.5 Protect roof from traffic and damage.

3.2.6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed work and materials out of storage.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.7 Install insulation promptly to avoid possibility of condensation beneath vapour retarder.

3.2.8 Take necessary measures ensuring no penetration of the elements will occur to the building after commencement of work, including but not limited to water.

3.2.9 Only remove quantities of existing roofing material and install quantities of new roofing materials per day that can be covered with waterproofing membranes.

3.3 EXAMINATION ROOF DECKS

3.3.1 Inspect with Engineer deck condition including parapets, construction joints, roof drains, plumbing vents, and ventilation outlets to determine readiness to proceed.

3.3.2 Examine roof decks and immediately inform Engineer in writing of defects.

3.3.3 Prior to commencement of work ensure:

3.3.3.1 Decks are firm, straight, smooth, dry, and free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.

3.3.3.2 Curbs have been built. Coordinate height of roof curbs with Section 06 10 00 – Rough Carpentry.

3.3.3.3 Roof drains have been installed at proper elevations relative to finished roof surface.

3.3.3.4 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.

3.3.4 Do not install roofing materials during rain or snowfall.

3.4 EXPOSED MEMBRANE ROOFING APPLICATION (METAL ROOF DECK)

3.4.1 Thermal Barrier and Air/Vapour Barrier:

3.4.1.1 Place thermal barrier with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.4.1.2 Secure thermal barrier to metal deck using one (1) fastener per board, located at the centre of the board, fasteners to be FMRC approved. OR, apply beads of roofing adhesive to metal deck in accordance with manufacturer’s written instructions. Adhere thermal barrier in adhesive and walk-in thermal barrier to insure maximum contact with adhesive.

3.4.1.3 Fit butt edge joints in firm contact with one another.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.1.4 Prime all surfaces of thermal barrier to receive self-adhering modified bituminous sheet air/vapour barrier as per manufacturer's instructions.
- 3.4.1.5 Apply self-adhering modified bituminous sheet air/vapour barrier to thermal barrier in an overlapping shingle fashion. Stagger all vertical joints.
- 3.4.1.6 Align modified bituminous sheet air/vapour barrier, remove protective film and press firmly into place. Ensure minimum 50 mm overlap at all ends and side laps. Roll membrane, including seams, with counter top roller to ensure full contact.
- 3.4.2 Insulation
 - 3.4.2.1 Loosely lay layer of insulation over thermal barrier and air/vapour barrier. OR apply beads of roofing adhesive to air/vapour barrier in accordance with manufacturer's written instructions. Adhere insulation in adhesive and walk-in insulation boards to insure maximum contact with adhesive.
 - 3.4.2.2 Place boards in parallel rows with ends staggered, and in firm contact with one another.
 - 3.4.2.3 Cut end boards to suit.
 - 3.4.2.4 Install tapered insulation in accordance with reviewed shop drawings.
- 3.4.3 Cover Board Components (Expanded Polystyrene (EPS)):
 - 3.4.3.1 Loosely lay cover board over EPS insulation. OR, apply beads of roofing adhesive to insulation in accordance with manufacturer's written instructions. Adhere cover board in adhesive and walk-in cover boards to insure maximum contact with adhesive.
 - 3.4.3.2 Place boards in parallel rows with ends staggered and in firm contact with one another.
 - 3.4.3.3 Cut end boards to suit.
 - 3.4.3.4 Mechanically fasten asphalt recover board over cover board with plates and fasteners. OR, apply beads of roofing adhesive to cover board in accordance with manufacturer's written instructions. Adhere asphalt recover board in adhesive and walk-in asphalt recover boards to insure maximum contact with adhesive.
 - 3.4.3.5 Fit boards tight together. Stagger joints between asphalt recover board and cover board. Install fasteners/adhesive based on design wind uplift securement requirements, for the building site location, for insulation and cover board, in accordance with manufacturer's recommendations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.3.6 OR

3.4.3.7 Cover Board Components (Extruded Polystyrene (XPS):

3.4.3.7.1 Cover XPS insulation with two layers of asphalt recover board.

3.4.3.7.2 Place boards in parallel rows with ends staggered and in firm contact with one another.

3.4.3.7.3 Cut end boards to suit.

3.4.3.7.4 Mechanically fasten asphalt recover board with plates and fasteners. OR, apply beads of roofing adhesive for each layer of asphalt recover board in accordance with manufacturer's written instructions. Adhere each layer of asphalt recover board in adhesive and walk-in asphalt recover boards to insure maximum contact with adhesive.

3.4.3.7.5 Fit boards tight together. Stagger joints between layers of asphalt recover board. Install fasteners/adhesive based on design wind uplift securement requirements, for the building site location, for insulation and cover board, in accordance with manufacturer's recommendations.

3.4.3.8 OR

3.4.3.9 Cover Board Components (Polyisocyanurate (Polyiso)):

3.4.3.9.1 Cover Polyiso insulation with one layer of asphalt recover board.

3.4.3.9.2 Place boards in parallel rows with ends staggered and in firm contact with one another.

3.4.3.9.3 Cut end boards to suit.

3.4.3.9.4 Mechanically fasten asphalt recover board with plates and fasteners. OR, apply beads of roofing adhesive to insulation in accordance with manufacturer's written instructions. Adhere asphalt recover board in adhesive and walk-in asphalt recover boards to insure maximum contact with adhesive.

3.4.3.9.5 Fit boards tight together. Install fasteners/adhesive based on design wind uplift securement requirements, for the building site location, for insulation and cover board, in accordance with manufacturer's recommendations.

3.4.4 Base Sheet Application:

3.4.4.1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and reroll from both ends.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.4.2 Unroll and torch base sheet onto recover board taking care not to burn membrane or its reinforcement.

3.4.4.3 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.

3.4.4.4 Application to be free of blisters, wrinkles and fishmouths.

3.4.5 Cap Sheet Application:

3.4.5.1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, align and reroll from both ends.

3.4.5.2 Unroll and torch cap sheet onto base sheet taking care not to burn membrane or its reinforcement.

3.4.5.3 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum from those in base sheet.

3.4.5.4 Application to be free of blisters, fishmouths and wrinkles.

3.4.5.5 Do membrane application in accordance with manufacturer's recommendations.

3.4.6 Flashings:

3.4.6.1 Complete installation of flashing base sheet stripping prior to installing membrane cap sheet.

3.4.6.2 Torch, base and cap sheet onto substrate in 1 metre wide strips.

3.4.6.3 Lap flashing base sheet to membrane base sheet minimum 150 mm and seal by torch welding.

3.4.6.4 Lap flashing cap sheet to membrane cap sheet 250 mm minimum and torch weld.

3.4.6.5 Provide 75 mm minimum side lap and seal.

3.4.6.6 Properly secure flashings to their support, without sags, blisters, fishmouths or wrinkles.

3.4.6.7 Do Work in accordance with manufacturer's recommendations.

3.5 ROOF PENETRATIONS

3.5.1 Install roof drain pans, vent stack covers and other roof penetration Flashings and seal to membrane in accordance with the manufacturer's recommendations and details.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 52 00
CH0032	MODIFIED BITUMINOUS MEMBRANE ROOFING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENE		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.2 All new roof drains to be installed by certified plumber. Coordinate installation of roof drains so that work can be inspected by Engineer prior to commencement of remaining roof work.

3.6 CLEANING

3.6.1 Perform in accordance with General Requirements.

3.6.2 Remove bituminous markings from finished surfaces.

3.6.3 Check drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.

3.6.4 In areas where finished surfaces are soiled caused by work of this section, consult manufacturers of surfaces for cleaning advice and complying with their documented instructions.

3.6.5 Repair or replace defaced or disfigured finishes caused by work of this section.

END OF SECTION



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 62 00
CH0032	SHEET METAL FLASHING AND TRIM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 07 62 00
SHEET METAL FLASHING AND TRIM
TABLE OF CONTENTS**

PART 1 General..... 2

 1.1 RELATED SECTIONS 2

 1.2 REFERENCES 2

 1.3 SUBMITTALS 3

 1.4 DELIVERY, STORAGE AND HANDLING 3

PART 2 Products..... 3

 2.1 SHEET METAL MATERIALS 3

 2.2 PREFINISHED STEEL SHEET 3

 2.3 ACCESSORIES 4

 2.4 FABRICATION 4

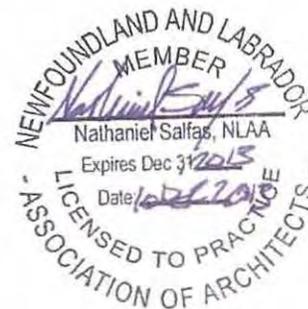
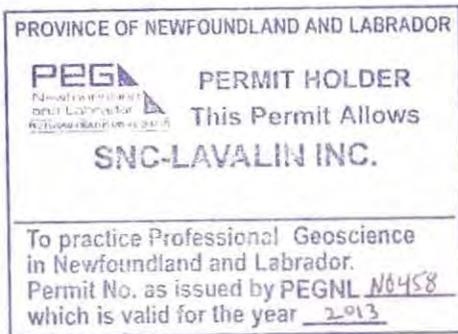
 2.5 METAL FLASHINGS 5

PART 3 Execution..... 5

 3.1 MANUFACTURER'S INSTRUCTIONS 5

 3.2 INSTALLATION 5

 3.3 CLEANING 5



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 62 00
CH0032	SHEET METAL FLASHING AND TRIM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 06 10 00 – rough Carpentry.
- 1.1.2 Section 07 52 00 – Modified Bituminous Membrane Roofing.
- 1.1.3 Section 07 92 00 – Joint Sealants.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.2.2 All work shall be in accordance with this specification and the requirements of the following.
- 1.2.3 The Aluminum Association Inc. (AAI)
 - 1.2.3.1 AAI-Aluminum Sheet Metal Work in Building Construction-2002.
 - 1.2.3.2 AAI DAF45-03, Designation System for Aluminum Finishes.
- 1.2.4 American Society for Testing and Materials International (ASTM)
 - 1.2.4.1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 1.2.4.2 ASTM A792/A792M-10, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - 1.2.4.3 ASTM D523-08, Standard Test Method for Specular Gloss.
 - 1.2.4.4 ASTM D822-01(2006), Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - 1.2.4.5 ASTM F1667-11a (2012), Standard Specification for Driven Fasteners: Nails, Spikes and Staples.
- 1.2.5 Canadian Roofing Contractors Association (CRCA)
 - 1.2.5.1 Roofing Specifications Manual 1997.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 62 00
CH0032	SHEET METAL FLASHING AND TRIM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.2.6 Canadian General Standards Board (CGSB)
- 1.2.6.1 CAN/CGSB-37.5, Cutback Asphalt Plastic Cement.
- 1.2.6.2 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.
- 1.2.7 Canadian Standards Association (CSA International)
- 1.2.7.1 CSA A123.3-05, Asphalt Saturated Organic Roofing Felt.

1.3 SUBMITTALS

1.3.1 Product Data:

- 1.3.1.1 Submit manufacturer's printed product literature for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- 1.3.1.2 Submit two copies WHMIS MSDS - Material Safety Data Sheets.

1.3.2 Samples:

- 1.3.2.1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.

1.4 DELIVERY, STORAGE AND HANDLING

- 1.4.1 Deliver, store and handle materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

- 2.1.1 Aluminum-zinc alloy coated steel sheet: to ASTM A792/A792M, commercial quality, grade 33 with AZ150 coating, regular spangle surface, 0.70 mm base metal thickness, pre-painted to CGSB-GP-71.

2.2 PREFINISHED STEEL SHEET

- 2.2.1 Prefinished steel with factory applied polyvinylidene fluoride.
- 2.2.1.1 Class F1S.
- 2.2.1.2 Colour as selected by Engineer from manufacturer's standard range.
- 2.2.1.3 Specular gloss: 30 units +/- 5 in accordance with ASTM D523.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 62 00
CH0032	SHEET METAL FLASHING AND TRIM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.1.4 Coating thickness: not less than 22 micrometres.
- 2.2.1.5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:
 - 2.2.1.5.1 Outdoor exposure period 2500 hours.
 - 2.2.1.5.2 Humidity resistance exposure period 5000 hours.

2.3 ACCESSORIES

- 2.3.1 Isolation coating: alkali resistant bituminous paint.
- 2.3.2 Plastic cement: to CAN/CGSB 37.5. Maximum VOC limit 50 g/L.
- 2.3.3 Underlay for metal flashing: No. 15 perforated asphalt felt to CSA A123.3.
- 2.3.4 Sealants: Section 07 92 00 – Joint Sealants. Maximum VOC limit 50 g/L.
- 2.3.5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.
- 2.3.6 Fasteners: of same material as sheet metal, to ASTM F1667-11a, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.
- 2.3.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- 2.3.8 Touch-up paint: as recommended by prefinished material manufacturer. Maximum VOC limit 50 g/L.

2.4 FABRICATION

- 2.4.1 Fabricate metal flashings and other sheet metal work in accordance with applicable CRCA 'FL' series details as indicated.
- 2.4.2 Fabricate aluminum flashings and other sheet aluminum work in accordance with AAI-Aluminum Sheet Metal Work in Building Construction.
- 2.4.3 Form pieces in 2400 mm maximum lengths. Make allowance for expansion at joints.
- 2.4.4 Hem exposed edges on underside 12 mm. Mitre and seal corners with sealant.
- 2.4.5 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- 2.4.6 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 62 00
CH0032	SHEET METAL FLASHING AND TRIM	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5 METAL FLASHINGS

2.5.1 Form flashings, copings and fascias to profiles indicated of 0.70 mm thick prefinished steel.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

3.2.1 Install sheet metal work in accordance with CRCA FL series details and as detailed.

3.2.2 Use concealed fastenings except where approved before installation.

3.2.3 Provide underlay under sheet metal. Secure in place and lap joints 100 mm.

3.2.4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips, as detailed.

3.2.5 Lock end joints and caulk with sealant.

3.3 CLEANING

3.3.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.3.2 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 72 69
CH0032	ROOF ANCHORS AND SAFETY RESTRAINTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 72 69
ROOF ANCHORS AND SAFETY RESTRAINTS
TABLE OF CONTENTS**

PART 1 GENERAL.....2

1.1 SECTION INCLUDES..... 2

1.2 RELATED SECTIONS..... 2

1.3 REFERENCES..... 2

1.4 SYSTEM DESCRIPTION..... 3

1.5 SUBMITTALS..... 3

1.6 SHOP DRAWINGS..... 3

1.7 QUALITY ASSURANCE..... 3

1.8 WELDERS' QUALIFICATIONS..... 3

1.9 SITE CONDITIONS..... 4

PART 2 PRODUCTS.....4

2.1 MATERIALS..... 4

2.2 FABRICATION..... 4

2.3 FABRICATION TOLERANCES..... 5

2.4 FINISHES..... 5

PART 3 EXECUTION.....5

3.1 EXAMINATION..... 5

3.2 PREPARATION..... 5

3.3 INSTALLATION..... 6

3.4 ERECTION TOLERANCES..... 6

3.5 PROTECTION OF FINISHED WORK..... 6

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To practice Professional Geoscience
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 Permit No. as issued by PEGNL N045B
 which is valid for the year 2013

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Nathaniel Salfas
 Nathaniel Salfas, NLAA
 Expires Dec 31 2013
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CH0032	ROOF ANCHORS AND SAFETY RESTRAINTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SECTION INCLUDES

1.1.1 Shop fabricated roof mounted personal safety restraints.

1.2 RELATED SECTIONS

1.2.1 Section 07 52 00 - Modified Bituminous Membrane Roofing.

1.2.2 Section 07 62 00 - Sheet Metal Flashing and Trim

1.3 REFERENCES

1.3.1 American Society for Testing and Materials International, (ASTM).

1.3.1.1 ASTM A167-99 (2009), Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

1.3.1.2 ASTM A500/500M-10a, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

1.3.2 Canadian Standards Association (CSA International).

1.3.2.1 CAN/CSA-G40.20/G40.21-98, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

1.3.2.2 CAN/CSA-G164-M92(R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3.2.3 CSA-W47.1-92(R2001), Certification of Companies for Fusion Welding of Steel Structures.

1.3.2.4 CSA-W55.3-65(R1998), Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.

1.3.3 Master Painters Institute (MPI).

1.3.3.1 Architectural Painting Specification Manual.

1.3.4 The Society for Protective Coatings (SSPC).

1.3.4.1 SP -2, Hand-Tool Cleaning.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 72 69
CH0032	ROOF ANCHORS AND SAFETY RESTRAINTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 SYSTEM DESCRIPTION

- 1.4.1 Personal Restraint Assembly: Posts, steel rope loops, and attachments to resist lateral forces of 3 kN at any point and in all directions, without damage or permanent set.

1.5 SUBMITTALS

- 1.5.1 Submit WHMIS MSDS - Material Safety Data Sheets

1.6 SHOP DRAWINGS

- 1.6.1 Indicate component profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
- 1.6.2 Indicate welded connections using standard welding symbols include net weld lengths.

1.7 QUALITY ASSURANCE

- 1.7.1 Submit design.
- 1.7.2 Submit Test Reports and substantiating engineering data and test results of previous tests by independent laboratory which purport to meet performance criteria, and other supportive data.
- 1.7.3 Design structural support framing components and site inspect the installation under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed [at the place where the Project is located in the Province of Newfoundland and Labrador, Canada.
- 1.7.4 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.
- 1.7.5 Co-ordinate the Work with installation of roofing assembly and sheet metal work.

1.8 WELDERS' QUALIFICATIONS

- 1.8.1 Welders Certificates: furnish welders' qualifications to Engineer.
- 1.8.2 Welding qualifications to be in accordance with CSA B51.
- 1.8.3 Employ qualified and licensed welders possessing certificates for each procedure to be performed from authority having jurisdiction.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 72 69
CH0032	ROOF ANCHORS AND SAFETY RESTRAINTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.8.4 Each welder to possess identification symbol issued by authority having jurisdiction.
- 1.8.5 Certification of companies for fusion welding of steel structures to be in accordance with CSA-W47.1.
- 1.8.6 Manufacturer Qualifications: company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.9 SITE CONDITIONS

- 1.9.1 Prior to start of work verify existing site conditions
- 1.9.2 Verify dimensions, tolerances, and method of attachment with other work.

PART 2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Steel Sections and Plates: CSA G40.20M/G40.21.
- 2.1.2 Steel Tubing: ASTM A500, Grade B.
- 2.1.3 Steel Rings: forged steel, ring thickness determined by imposed loads.
- 2.1.4 Steel Cable (between post travel restraints): minimum 13 mm diameter, spiral wound multi-strand stainless steel aircraft cable.
- 2.1.5 Bolts, Nuts, and Washers for Stainless Steel: stainless steel, matte finish.
- 2.1.6 Gaskets Under Anchors: neoprene pads, compatible with roof membrane, cut to size.
- 2.1.7 Welding Materials: CSA-W47.1 for materials being welded.
- 2.1.8 Shop Primer: Epoxy, anti-corrosive type, two coats.

2.2 FABRICATION

- 2.2.1 Fit and shop assemble items in largest practical sections, for delivery to site.
- 2.2.2 Fabricate items with joints tightly fitted and secured.
- 2.2.3 Continuously seal joined members by intermittent welds and plastic filler.
- 2.2.4 Grind exposed joints flush and smooth with adjacent finish surface.
- 2.2.4.1 Make exposed joints butt tight, flush, and hairline.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 72 69
CH0032	ROOF ANCHORS AND SAFETY RESTRAINTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.4.2 Ease exposed edges to small uniform radius.

2.2.5 Exposed Mechanical Fastenings: screws or bolts; consistent with design of component.

2.2.6 Furnish and install components required for anchorage of fabrications.

2.2.7 Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.3 FABRICATION TOLERANCES

2.3.1 Squareness: 3 mm maximum difference in diagonal measurements.

2.3.2 Maximum Deviation From Plane: 1.5 mm from 1 m.

2.4 FINISHES

2.4.1 Prepare uncoated steel (restraint post) surfaces: SSPC-SP 2, no more than 4 hours before applying epoxy primer.

2.4.2 Concealed steel anchors, clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

2.4.3 Do not prime surfaces in direct contact with concrete or where field welding is required.

2.4.4 Concealed Structural Components and Anchors: galvanize after fabrication to CAN/CSA-G164 to minimum 600 g/sq m galvanized coating.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verify existing conditions before starting Work.

3.1.2 Verify dimensions, tolerances, and method of attachment with other work.

3.2 PREPARATION

3.2.1 Supply and install steel items required to be cast into concrete or attached to steel framing as clean uncoated metal, with setting templates to appropriate sections.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 72 69
CH0032	ROOF ANCHORS AND SAFETY RESTRAINTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 INSTALLATION

- 3.3.1 Install items plumb and level, accurately fitted, free from distortion or defects.
- 3.3.2 Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- 3.3.3 Field weld components as indicated on shop drawings. Perform field welding.
- 3.3.4 Obtain approval from Engineer prior to site cutting or making adjustments not scheduled.
- 3.3.5 After erection, apply primer in accordance with MPI Painting Manual to: welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.
- 3.3.6 Thread aircraft cable through eye-lets at top of post, to linear roof coverage of post restraints; pressure crimp cable ends.

3.4 ERECTION TOLERANCES

- 3.4.1 Maximum Variation from Plum and Level: 6 mm.

3.5 PROTECTION OF FINISHED WORK

- 3.5.1 Protect finished Work from damage.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 07 84 00
FIRESTOPPING
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

1.1 RELATED WORK..... 2

1.2 RELATED SECTIONS..... 2

1.3 REFERENCES..... 2

1.4 DEFINITIONS..... 2

1.5 SUBMITTALS..... 3

1.6 QUALITY ASSURANCE..... 4

1.7 DELIVERY, STORAGE AND HANDLING..... 5

PART 2 PRODUCTS..... 5

2.1 MATERIALS..... 5

PART 3 EXECUTION..... 6

3.1 MANUFACTURER'S INSTRUCTIONS..... 6

3.2 PREPARATION..... 6

3.3 INSTALLATION..... 7

3.4 SEQUENCES OF OPERATION..... 7

3.5 FIELD QUALITY CONTROL..... 7

3.6 CLEANING..... 8

3.7 SCHEDULE..... 8

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To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL No 458
which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR
MEMBER
Nathaniel Galfas
Nathaniel Galfas, NLAA
Expires Dec 31 2013
Date: 08/20/13
LICENSED TO PRACTICE
ASSOCIATION OF ARCHITECTS

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CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED WORK

- 1.1.1 Fire stopping and smoke seals within mechanical assemblies (i.e. inside ducts, dampers) and electrical assemblies (i.e. inside cable trays) are specified in Division 23 and 26 respectively.
- 1.1.2 Coordinate work of this section with other sections as required properly executing the work and as necessary maintaining satisfactory progress of the work of other sections.

1.2 RELATED SECTIONS



- 1.2.1 Section 07 46 13 - Preformed Metal Siding.
- 1.2.2 Section 07 62 00 - Sheet Metal Flashing and Trim.
- 1.2.3 Section 09 21 16 - Gypsum Board Assemblies.

1.3 REFERENCES

- 1.3.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.3.2 All work shall be in accordance with this specification and the requirements of the following.
 - 1.3.2.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - 1.3.2.1.1 Material Safety Data Sheets (MSDS).
 - 1.3.3 National Building Code of Canada (NBC)
 - 1.3.3.1 Underwriter's Laboratories of Canada (ULC)
 - 1.3.3.1.1 ULC-S115-1995, Fire Tests of Fire stop Systems.

1.4 DEFINITIONS

- 1.4.1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.4.2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- 1.4.3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- 1.4.4 Tightly Fitted; (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): penetrating items that are cast in place in buildings of non-combustible construction or have "0" annular space in buildings of combustible construction.
- 1.4.4.1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.5 SUBMITTALS

- 1.5.1 Submittal shall in accordance with Exhibit 4 – Supplier Document Requirements List
- 1.5.2 Product Data:
 - 1.5.2.1 Submit manufacturer's printed product literature, specifications and datasheet for materials and prefabricated devices, and include product characteristics, performance criteria, physical size, finish and limitations, and installation instructions. Include documentation of ULC or cUL firestop systems to be used.
 - 1.5.2.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets.
- 1.5.3 Shop Drawings:
 - 1.5.3.1 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation.
 - 1.5.3.2 Construction details should accurately reflect actual job conditions.
- 1.5.4 Samples:
 - 1.5.4.1 Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for project.
- 1.5.5 Quality assurance submittals:
 - 1.5.5.1 Test reports: in accordance with CAN-ULC-S101 for fire endurance and CAN-ULC-S102 for surface burning characteristics.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.5.1.1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.

1.5.5.1.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5.5.1.3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.



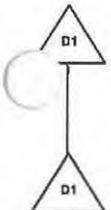
1.5.5.2 Submit manufacturer's engineering judgement identification number and drawing details when no ULC or cUL system is available. Engineering judgement must include both project name and Contractor's name who will install firestop system as described in drawing.

1.5.5.3 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.5.6 Mock-up

1.5.6.1 Construct mock-up showing service penetrations, fire separation and floor assemblies.

1.5.6.2 Allow 48h for inspection of mock-up by Engineer before proceeding with membrane work.



1.6 QUALITY ASSURANCE

1.6.1 Qualifications:

1.6.1.1 Installer: company and person specializing in fire stopping installations with 5 years documented experience approved by manufacturer.

1.6.2 Manufacturer's Representative:

1.6.2.1 A manufacturer's representative shall be on site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures and at commissioning stage to certify acceptance completed installation. Training shall be done as per manufacturer's written recommendations published in their literature and drawing details.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Packing, shipping, handling and unloading:

1.7.1.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.7.1.2 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, and ULC markings.

1.7.2 Storage and Protection:

1.7.2.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

1.7.2.2 Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

2.1.2 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.

2.1.2.1 Asbestos free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended

2.1.2.2 Fire stop system rating: as indicated on drawings.

2.1.2.3 Service penetration assemblies: systems tested by ULC or cUL in accordance with CAN-ULC-S115.

2.1.2.4 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.

2.1.2.5 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.

2.1.2.6 Non-curing, re-penetrable intumescent sealants, caulking or putty material for use with flexible cables or cable bundles.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.2.7 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- 2.1.2.8 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal. Consult with Engineer and damper manufacturer prior to installation ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
- 2.1.2.9 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe. No silicone based firestop are allowed to be applied on plastic pipes.
- 2.1.2.10 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- 2.1.2.11 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- 2.1.2.12 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- 2.1.2.13 Sealants for vertical joints: non-sagging.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PREPARATION

- 3.2.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
- 3.2.2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- 3.2.3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

3.3.1 Install fire stopping and smoke seal material and components in accordance with ULC certification or UL Products Certified for Canada (cUL) and manufacturer's certified tested system listing.

3.3.2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

3.3.3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

3.3.4 Tool or trowel exposed surfaces to neat finish.

3.3.5 Remove excess compound promptly as work progresses and upon completion.

3.4 SEQUENCES OF OPERATION

3.4.1 Proceed with installation only when submittals have been reviewed by Engineer.

3.4.2 Install floor fire stopping before interior partition erections.

3.4.3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.

3.4.4 Mechanical pipe insulation: certified fire stop system component. Ensure pipe insulation installation precedes fire stopping.

3.5 FIELD QUALITY CONTROL

3.5.1 Inspections: notify Engineer when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

3.5.2 Manufacturer's Field Services:

3.5.2.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

3.5.2.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 84 00
CH0032	FIRE STOPPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.2.3 Schedule site visits, to review work, as directed by Engineer.

3.6 CLEANING

3.6.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.6.2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.7 SCHEDULE

3.7.1 Fire stop and smoke seal at:

3.7.1.1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.

3.7.1.2 Edge of floor slabs at precast concrete panels.

3.7.1.3 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.

3.7.1.4 Openings and sleeves installed for future use through fire separations.

3.7.1.5 Around mechanical and electrical assemblies penetrating fire separations.

3.7.1.6 Rigid ducts: greater than 129 cm²: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

END OF SECTION




Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL..... 2

1.1 SECTION INCLUDES 2

1.2 RELATED SECTIONS 2

1.3 REFERENCES 2

1.4 SUBMITTALS 2

1.5 QUALITY ASSURANCE/MOCK-UP 3

1.6 DELIVERY, STORAGE, AND HANDLING 3

1.7 PROJECT CONDITIONS 3

1.8 ENVIRONMENTAL REQUIREMENTS 4

PART 2 PRODUCTS 4

2.1 SEALANT MATERIALS 4

2.2 SEALANT MATERIAL DESIGNATIONS 5

2.3 SEALANT SELECTION 6

2.4 JOINT CLEANER 6

PART 3 EXECUTION 6

3.1 PROTECTION 6

3.2 SURFACE PREPARATION 6

3.3 PRIMING 7

3.4 BACKUP MATERIAL 7

3.5 MIXING 7

3.6 APPLICATION 7

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PEGNL PERMIT HOLDER
Newfoundland and Labrador Professional Geoscientists and Land Surveyors Association
 This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
 in Newfoundland and Labrador.
 Permit No. as issued by PEGNL 110458
 which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR
 MEMBER
Nathaniel Salfas
 Nathaniel Salfas, NLAA
 Expires Dec 31 2013
 Date: 6 Dec 2013
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 ASSOCIATION OF ARCHITECTS

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SECTION INCLUDES

- 1.1.1 Materials, preparation and application for caulking and sealants.
- 1.1.2 Text to complete other various Sections containing sealant or caulking specifications, including Section 07 52 00 - Modified Bituminous Membrane Roofing.

1.2 RELATED SECTIONS

- 1.2.1 All Specification Sections containing sealant or caulking.

1.3 REFERENCES

- 1.3.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.3.2 All work shall be in accordance with this specification and the requirements of the following.
- 1.3.3 Canadian General Standards Board (CGSB)
- 1.3.3.1 CAN/CGSB-19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
- 1.3.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- 1.3.4.1 Material Safety Data Sheets (MSDS).
- 1.3.5 Transport Canada (TC)
- 1.3.5.1 Transportation of Dangerous Goods Act, 1992 (TDGA).

1.4 SUBMITTALS

- 1.4.1 Manufacturer's product data is to describe:
- 1.4.1.1 Caulking compound.
- 1.4.1.2 Primers.
- 1.4.1.3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
- 1.4.1.4 Installation instructions, surface preparation and product limitations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.4.2 Submit duplicate samples of each type of material and colour.
- 1.4.3 Cured samples of exposed sealants for each color where required to match adjacent material.
- 1.4.4 Manufacturer's instructions are to include installation instructions for each product used.

1.5 QUALITY ASSURANCE/MOCK-UP

- 1.5.1 Construct mock-up to show location, size, shape and depth of joints complete with back-up material, primer, caulking and sealant.
- 1.5.2 Mock-up will be used:
 - 1.5.2.1 To judge workmanship, substrate preparation, operation of equipment and material application.
- 1.5.3 Locate where directed.
- 1.5.4 Allow 24 hours for inspection of mock-up by Engineer before proceeding with sealant work.
- 1.5.5 When accepted, mock-up will demonstrate minimum standard of quality required for this Work. Approved mock-up may remain as part of finished Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- 1.6.1 Deliver, handle, store and protect materials in accordance with manufacturer's instructions.
- 1.6.2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.

1.7 PROJECT CONDITIONS

- 1.7.1 Environmental Limitations:
 - 1.7.1.1 Do not proceed with installation of joint sealants under following conditions:
 - 1.7.1.1.1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.
 - 1.7.1.1.2 When joint substrates are wet.

- 1.7.2 Joint Width Conditions:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7.2.1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

1.7.3 Joint Substrate Conditions:

1.7.3.1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.8 ENVIRONMENTAL REQUIREMENTS

1.8.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.

1.8.2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

1.8.3 Ventilate area of work as directed by Engineer by use of approved portable supply and exhaust fans.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

2.1.1 Sealants and Caulking compounds must:

2.1.1.1 Meet or exceed all applicable governmental and industrial safety and performance standards; and

2.1.1.2 Be manufactured and transported in such a manner that all steps of the process, including the disposal of waste products arising there from, will meet the requirements of all applicable governmental acts, by laws and regulations including, for facilities located in Canada, the Fisheries Act and the Canadian Environmental Protection Act (CEPA).

2.1.2 Sealant and caulking compounds must not be formulated or manufactured with: aromatic solvents, fibrous talc or asbestos, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium, barium or their compounds, except barium sulphate.

2.1.3 Sealant and caulking compounds must not contain a total of volatile organic compound (VOCs) in excess of 5% by weight as calculated from records of the amounts of constituents used to make the product.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.4 Sealant and caulking compounds must be accompanied by detailed instructions for proper application so as to minimize health concerns and maximize performance, and information describing proper disposal methods.
- 2.1.5 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- 2.1.6 When low toxicity caulks are not possible, confine usage to areas which off-gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off-gas time.
- 2.1.7 Where sealants are qualified with primers use only these primers.
- 2.1.8 Sealants acceptable for use on this project must be listed on CGSB Qualified Products List issued by CGSB Qualification Board for Joint Sealants. Where sealants are qualified with primers use only these primers.

2.2 SEALANT MATERIAL DESIGNATIONS

- 2.2.1 Urethanes One Part.
 - 2.2.1.1 Non-Sag to CAN/CGSB-19.13, Type 2.
- 2.2.2 Silicones One Part.
 - 2.2.2.1 To CAN/CGSB-19.13, mildew resistant.
- 2.2.3 Preformed Compressible and Non-Compressible back-up materials.
 - 2.2.3.1 Polyethylene, Urethane, Neoprene or Vinyl Foam.
 - 2.2.3.1.1 Extruded closed cell foam backer rod.
 - 2.2.3.1.2 Size: oversize 30 to 50 %.
 - 2.2.3.2 Neoprene or Butyl Rubber.
 - 2.2.3.2.1 Round solid rod, Shore A hardness 70.
 - 2.2.3.3 High Density Foam.
 - 2.2.3.3.1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.2.3.4 Bond Breaker Tape.

2.2.3.4.1 Polyethylene bond breaker tape which will not bond to sealant.

2.3 SEALANT SELECTION

2.3.1 Perimeters of exterior openings where frames meet exterior facade of building: Sealant type: CAN/CGSB-19.13.

2.3.2 Seal interior perimeters of exterior openings as detailed on drawings: Sealant type: CAN/CGSB-19.13.

2.3.3 Perimeters of interior frames, as detailed and itemized: Sealant type: CAN/CGSB-19.13.

2.4 JOINT CLEANER

2.4.1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

2.4.2 Primer: as recommended by manufacturer.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Protect installed work of other trades from staining or contamination.

3.2 SURFACE PREPARATION

3.2.1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.

3.2.2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair work.

3.2.3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

3.2.4 Ensure joint surfaces are dry and frost free.

3.2.5 Prepare surfaces in accordance with manufacturer's directions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 PRIMING

- 3.3.1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- 3.3.2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

- 3.4.1 Apply bond breaker tape where required to manufacturer's instructions.
- 3.4.2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

- 3.5.1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- 3.6.1 Sealant.
 - 3.6.1.1 Apply sealant in accordance with manufacturer's written instructions.
 - 3.6.1.2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - 3.6.1.3 Apply sealant in continuous beads.
 - 3.6.1.4 Apply sealant using gun with proper size nozzle.
 - 3.6.1.5 Use sufficient pressure to fill voids and joints solid.
 - 3.6.1.6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - 3.6.1.7 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - 3.6.1.8 Remove excess compound promptly as work progresses and upon completion.
- 3.6.2 Curing.
 - 3.6.2.1 Cure sealants in accordance with sealant manufacturer's instructions.
 - 3.6.2.2 Do not cover up sealants until proper curing has taken place.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 07 92 00
CH0032	JOINT SEALANTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 3.6.3 Cleanup.
- 3.6.3.1 Clean adjacent surfaces immediately and leave Work neat and clean.
- 3.6.3.2 Remove excess and droppings, using recommended cleaners as work progresses.
- 3.6.3.3 Remove masking tape after initial set of sealant.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 08 11 00
METAL DOORS AND FRAMES
TABLE OF CONTENTS**

PART 1	General	2
1.1	RELATED SECTIONS	2
1.2	REFERENCES	2
1.3	DESIGN REQUIREMENTS	3
1.4	SUBMITTALS	3
1.5	DELIVERY STORAGE AND HANDLING	4
1.6	QUALITY ASSURANCE	4
1.7	NOT USED	4
PART 2	PRODUCTS	4
2.1	MATERIALS	4
2.2	DOOR CORE MATERIALS.....	5
2.3	ADHESIVES	5
2.4	PRIMER.....	5
2.5	ACCESSORIES.....	5
2.6	FRAMES FABRICATION GENERAL	6
2.7	FRAME ANCHORAGE	7
2.8	FRAMES: WELDED TYPE	7
2.9	DOOR FABRICATION GENERAL	8
2.10	HOLLOW STEEL CONSTRUCTION	8
2.11	THERMALLY BROKEN FRAMES.....	9
PART 3	EXECUTION	9
3.1	INSTALLATION GENERAL	9
3.2	FRAME INSTALLATION	9
3.3	DOOR INSTALLATION.....	9
3.4	FINISH REPAIRS	10
3.5	GLAZING	10
3.6	COMMISSIONING	10

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PEG **PERMIT HOLDER**

Newfoundland and Labrador PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

This Permit Allows

SNC-LAVALIN INC.

To practice Professional Geoscience in Newfoundland and Labrador

Permit No. as issued by PEGNL N-0458

which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR

MEMBER

Nathaniel Salas

Nathaniel Salas, N.L.A.A.

Expires Dec 31, 2013

Date: Nov 20 2012

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 07 21 20 – Low Expanding Foam Sealant.
- 1.1.2 Section 07 92 00 - Joint Sealants.
- 1.1.3 Section 08 71 00 - Door Hardware.
- 1.1.4 Section 08 80 50 – Glazing.
- 1.1.5 Section 09 91 13 - Interior Painting.
- 1.1.6 Section 09 97 19 – Painting Exterior Metal Surfaces.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the listed Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.2.2 All work shall be in accordance with this specification and the requirements of the following.
- 1.2.3 American Society for Testing and Materials (ASTM) SUBMITTALS
 - 1.2.3.1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
- 1.2.4 Canadian General Standards Board (CGSB)
 - 1.2.4.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
 - 1.2.4.2 CGSB 41-GP-19Ma-84, Rigid Vinyl Extrusions for Windows and Doors.
- 1.2.5 Canadian Standards Association (CSA)
 - 1.2.5.1 G40.20-04/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - 1.2.5.2 CSA W59-03, Welded Steel Construction (Metal Arc Welding).
- 1.2.6 Canadian Steel Door Manufacturers' Association, (CSDMA).
 - 1.2.6.1 CSDMA, Specifications for Commercial Steel Doors and Frames, 2000.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.2.6.2 CSDMA, Recommended Selection and Usage Guide for Commercial Steel Doors, 1990.

1.2.7 National Fire Protection Association (NFPA)

1.2.7.1 NFPA 80-2010, Standard for Fire Doors and Fire Windows.

1.2.7.2 NFPA 252-03, Standard Methods of Fire Tests of Door Assemblies.

1.2.8 Underwriters' Laboratories of Canada (ULC)

1.2.8.1 CAN4-S104-M80, Fire Tests of Door Assemblies.

1.2.8.2 CAN4-S105-M85, Fire Door Frames Meeting the Performance Required by CAN4-S104.

1.2.8.3 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 DESIGN REQUIREMENTS

1.3.1 Design door assembly to withstand minimum 1,000,000 swing cycles in accordance with ANSI A151.1, with no failure of any design features of the door.

1.3.2 Design exterior frame assembly to accommodate to expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.

1.3.3 Maximum deflection for exterior steel entrance screens under wind load of 1.2 kPa not to exceed 1/175th of span.

1.3.4 Steel fire rated doors and frames: labeled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4-S104 and NFPA 252 for ratings specified or indicated.

1.3.5 Provide fire labeled frames for openings requiring fire protection ratings. Test products in conformance with CAN4-S104 and NFPA 252 and listed by nationally recognized agency having factory inspection services and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

1.4 SUBMITTALS

1.4.1 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed, louvred, arrangement of hardware and fire rating and finishes.

1.4.2 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings and reinforcing fire rating and finishes.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.4.3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.
- 1.4.4 Submit test and engineering data, and installation instructions.
- 1.4.5 Submit one 300 x 300 mm top corner sample of each type door.
- 1.4.6 Submit one 300 x 300 mm corner sample of each type of frame.
- 1.4.6.1 Show butt cutout, glazing stops.

1.5 DELIVERY STORAGE AND HANDLING

- 1.5.1 Deliver, store, handle and protect doors and frames in accordance with manufacturer's instructions.
- 1.5.2 Deliver, handle and store doors and frames at the job site in such a manner as to prevent damage.
- 1.5.3 Store doors and frames under cover with doors stored in a vertical position on blocking, clear of floor and with blocking between doors to permit air circulation.

1.6 QUALITY ASSURANCE

- 1.6.1 Conform to requirements to ANSI A117.1
- 1.6.2 Company specializing in manufacturing products specified with a minimum of five (5) years documented experience.



1.7 NOT USED

PART 2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Hot dipped galvanized steel sheet: to ASTM A653/A653M, ZF75, minimum base steel thickness in accordance with CSDMA Table 1 - Thickness for Component Parts.
- 2.1.2 Reinforcement channel: to CSA G40.20/G40.21, Type 44W, coating designation to ASTM A653/A653M, ZF75.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 DOOR CORE MATERIALS

2.2.1 Honeycomb construction:

2.2.1.1 Structural small cell, 24.5 maximum kraft paper "honeycomb", weight 36.3 Kg per ream minimum, density: 16.5 Kg/m³ minimum sanded to required thickness.

2.2.2 Stiffened: face sheets welded insulated core.

2.2.2.1 Expanded polystyrene: CAN/ULC-S701, density 16 to 32 kg/m³.

2.2.3 Temperature rise rated (TRR): core composition to limit temperature rise on unexposed side of door to 250°C at 60 minutes. Core is to be tested as part of a complete door assembly, in accordance with CAN4-S104, ASTM E152 or NFPA 252, covering Standard Method of Tests of Door Assemblies and listed by nationally recognized testing agency having factory inspection service.

2.2.4 Thermal Insulation material must:

2.2.4.1 Not require being labelled as poisonous, corrosive, flammable or explosive under the Consumer Chemical and Container Regulations of the Hazardous Products Act.

2.2.4.2 Be manufactured using a process that uses chemical compounds with the minimum zone depletion potential (ODP) available.

2.3 ADHESIVES

2.3.1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.

2.3.1.1 Adhesive: maximum VOC content 50 g/L to SCAQMD Rule 1168.

2.3.2 Polystyrene and polyurethane cores: heat resistant, epoxy resin based, low viscosity, contact cement.

2.4 PRIMER

2.4.1 Touch-up prime CAN/CGSB-1.181.

2.4.1.1 Maximum VOC limit 50 g/L to GC-03.

2.5 ACCESSORIES

2.5.1 Door silencers: single stud rubber/neoprene type.

2.5.2 Exterior top and bottom caps steel.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.5.3 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.
- 2.5.4 Door bottom seal: Section 08 71 00 – Door Hardware.
- 2.5.5 Metallic paste filler: to manufacturer's standard.
- 2.5.6 Fire labels: metal riveted.
- 2.5.7 Sealant: Section 07 92 00 – Joint Sealants.
- 2.5.7.1 Maximum VOC limit 240 g/L to SCAQMD Rule 1168.
- 2.5.8 Low expanding foam sealant: Section 07 21 20.
- 2.5.8.1 Provide low expanding, single component polyurethane foam sealant installed at head and jamb perimeter of door frame for sealing to building air barrier, vapour retarder and door frame. Foam sealant width to be adequate to provide required air tightness and vapour diffusion control to building air barrier and vapour retarder foam interior. Refer to Section 07 21 20 – Low Expanding Foam Sealant.
- 2.5.9 Glazing: Tempered and wired in accordance with Section 08 80 50 – Glazing.
- 2.5.10 Make provisions for glazing as indicated and provide necessary glazing stops.
- 2.5.10.1 Provide removable stainless steel glazing beads for dry glazing of snap-on type.
- 2.6 FRAMES FABRICATION GENERAL**
- 2.6.1 Fabricate frames in accordance with CSDMA specifications.
- 2.6.2 Fabricate frames to profiles and maximum face sizes as indicated.
- 2.6.3 Exterior frames: 1.2 mm welded, thermally broken type construction.
- 2.6.4 Interior frames: 1.2 mm welded type construction.
- 2.6.5 Blank, reinforce, drill and tap frames for mortised, template hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.
- 2.6.6 Protect mortised cutouts with steel guard boxes.
- 2.6.7 Prepare frame for door silencers, 3 for single door, 2 at head for double door.
- 2.6.8 Manufacturer's nameplates on frames and screens are not permitted.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.6.9 Conceal fastenings except where exposed fastenings are indicated.
- 2.6.10 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.

2.7 FRAME ANCHORAGE

- 2.7.1 Shim and anchor new doors in accordance with CAN/CSA A440.4.
- 2.7.2 Provide appropriate anchorage to floor and wall construction.
- 2.7.3 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.
- 2.7.4 Provide 2 anchors for rebate opening heights up to 1520 mm and 1 additional anchor for each additional 760 mm of height or fraction thereof.
- 2.7.5 Locate anchors for frames in existing openings not more than 150 mm from top and bottom of each jambs and intermediate at 660 mm o.c. maximum.

2.8 FRAMES: WELDED TYPE

- 2.8.1 Welding in accordance with CSA W59.
- 2.8.2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
- 2.8.3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- 2.8.4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- 2.8.5 Securely attach floor anchors to inside of each jamb profile.
- 2.8.6 Weld in two (2) temporary jamb spreaders per frame to maintain proper alignment during shipment.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.9 DOOR FABRICATION GENERAL

- 2.9.1 Doors: swing type, flush, with provision for glass and/or louvre openings as indicated.
- 2.9.2 Exterior doors: insulated, hollow steel construction. Interior doors: honeycomb hollow steel construction.
- 2.9.3 Fabricate doors with longitudinal edges locked seam. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.
- 2.9.4 Doors: manufacturers' proprietary construction, tested and/or engineered as part of a fully operable assembly, including door, frame, gasketing and hardware in accordance with ASTM E330.
- 2.9.5 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.
- 2.9.6 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.
- 2.9.7 Reinforce doors where required, for surface mounted hardware. Provide flush steel top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- 2.9.8 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- 2.9.9 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in strict conformance with CAN4-S104 ASTM E152 NFPA 252 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
- 2.9.10 Manufacturer's nameplates on doors are not permitted.

2.10 HOLLOW STEEL CONSTRUCTION

- 2.10.1 Form each face sheet for exterior doors from 1.2 mm sheet steel.
- 2.10.2 Form each face sheet for interior doors from 1.2 sheet steel.
- 2.10.3 Reinforce doors with vertical stiffeners, securely welded to each face sheet at 150 mm on centre maximum.
- 2.10.4 Fill voids between stiffeners of exterior doors with polystyrene core.
- 2.10.5 Fill voids between stiffeners of interior doors with honeycomb core.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.11 THERMALLY BROKEN FRAMES

- 2.11.1 Thermal break: rigid polyvinyl chloride extrusion conforming to CGSB 41-GP-19Ma.
- 2.11.2 Fabricate thermally broken frames separating exterior parts from interior parts with continuous interlocking thermal break.
- 2.11.3 Apply insulation.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

- 3.1.1 Install labelled steel fire rated doors and frames to NFPA 80 except where specified otherwise.
- 3.1.2 Install doors and frames to CSDMA Installation Guide.

3.2 FRAME INSTALLATION

- 3.2.1 Set frames plumb, square, level and at correct elevation.
- 3.2.2 Secure anchorages and connections to adjacent construction.
- 3.2.3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- 3.2.4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- 3.2.5 Caulk perimeter of frames between frame and adjacent material.
- 3.2.6 Maintain continuity of air barrier and vapour retarder.
- 3.2.7 Fill exterior frames with foam insulation.

3.3 DOOR INSTALLATION

- 3.3.1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Door Hardware.
- 3.3.2 Provide even margins between doors and jambs and doors and finished floor as follows.
 - 3.3.2.1 Hinge side: 1.0 mm.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 11 00
CH0032	METAL DOORS AND FRAMES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.2.2 Latch side and head: 1.5 mm.

3.3.2.3 Finished floor: 13 mm.

3.3.3 Adjust operable parts for correct function.

3.3.4 Install louvres where indicated.

3.4 FINISH REPAIRS

3.4.1 Touch up with primer finishes damaged during installation.

3.4.2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

3.5 GLAZING

3.5.1 Install glazing for doors and frames in accordance with Section 08 80 50 - Glazing.

3.6 COMMISSIONING

3.6.1 Contractor to instruct maintenance personnel in operation and maintenance of doors and hardware.

3.6.2 Confirm operation and function for all doors and hardware.

3.6.3 Commissioning will be witnessed by Engineer and Certificate will be signed by Contractor and Engineer.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 31 00.01
CH0032	SPILLWAY ELECTRICAL BLDG ACCESS DOORS - MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 08 31 00.01
SPILLWAY ELECTRICAL BLDG
ACCESS DOORS – MECHANICAL**

1. GENERAL..... 2

 1.1 RELATED SECTIONS..... 2

 1.2 SHOP DRAWINGS..... 2

 1.3 CLOSEOUT SUBMITTALS..... 2

 1.4 WASTE MANAGEMENT AND DISPOSAL..... 2

 1.5 DELIVERY, STORAGE AND HANDLING..... 2

2. PRODUCTS 2

 2.1 ACCESS DOORS..... 2

 2.2 EXCLUSIONS..... 3

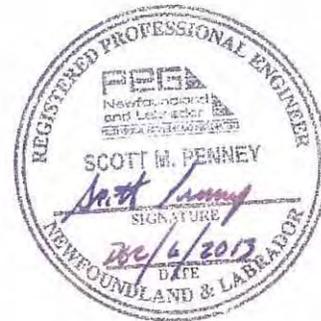
 2.3 FIRE RATED ACCESS DOORS..... 3

3. EXECUTION 4

 3.1 INSTALLATION..... 4

 3.2 LOCATION..... 4

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REGISTERED PROFESSIONAL ENGINEER
Newfoundland and Labrador
SCOTT M. PENNEY
SIGNATURE
28/6/2013
DATE
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 31 00.01
CH0032	SPILLWAY ELECTRICAL BLDG ACCESS DOORS - MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 23 01 31 – Air Duct Cleaning for HVAC Systems

1.2 SHOP DRAWINGS

1.2.1 Submit catalogue details for each type of door illustrating profiles, dimensions and methods of assembly.

1.3 CLOSEOUT SUBMITTALS

1.3.1 Provide maintenance data for cleaning and maintenance of stainless steel finishes for incorporation into operation and maintenance manual.

1.4 WASTE MANAGEMENT AND DISPOSAL

1.4.1 Separate and recycle waste materials.

1.4.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

1.4.3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling.

1.4.4 Divert unused metal materials from landfill to metal recycling facility as approved by the Company.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Deliver, store and handle materials in accordance with Manufacturer's instructions.

1.5.2 Apply temporary protective coating to finished surfaces. Remove coating after erection. Do not use coatings that will become hard to remove or leave residue.

1.5.3 Leave protective covering in place until final cleaning of building.

2. PRODUCTS

2.1 ACCESS DOORS

2.1.1 Sizes: Except as indicated otherwise, to be minimum sizes as follows:

.1 For body entry: 600 x 600 mm.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 31 00.01
CH0032	SPILLWAY ELECTRICAL BLDG ACCESS DOORS - MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 For hand entry: 300 x 300 mm.

2.1.2 Construction: Rounded safety corners, concealed hinges, screwdriver latch, anchor straps, able to open 180°.

2.1.3 Materials

- .1 Tiled surfaces and other special areas: Stainless steel with brushed satin or polished finish as directed by Company.
- .2 Other areas: Prime coated steel. Finish painting of primed access doors shall be the responsibility of the Contractor.

2.1.4 Access doors shall be supplied by the Mechanical Subcontractor for installation by the Contractor.

2.1.5 Acceptable products: Mifab, Zurn, or accepted equal.

2.2 EXCLUSIONS

2.2.1 Lay-in tile ceilings: use unobtrusive identification locators.

2.3 FIRE RATED ACCESS DOORS

2.3.1 Provide fire-rated access doors where access to concealed mechanical services is required in fire-rated walls and ceiling.

2.3.2 Maintain integrity of fire-rated separations.

2.3.3 Construction:

- .1 Door and trim: 18 ga. steel.
- .2 Return frame: 16 ga. steel.
- .3 Insulation: 47.6 mm thick mineral wool contained within door cavity.
- .4 Hinge: fully concealed, pivot type hinge, allowing opening to 170 degrees.
- .5 Latches: self-latching direct action lock, opposite hinge which will accept both key and knurled knob which shall be included with each door.
- .6 Inside panel release.

Handwritten signature/initials in blue ink.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 31 00.01
CH0032	SPILLWAY ELECTRICAL BLDG ACCESS DOORS - MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Finish: electrostatically-applied, baked grey enamel, over phosphate treated steel. This will serve as the prime coat. Finish paint coat to be applied in the field by the General Contractor.
- .8 Provide Type 304 stainless steel access doors with #4 satin finish where fire-rated access doors are installed in special areas such as tile or marble surfaces.
- .9 Acceptable products: National Fire Equipment Model WB-FR standard access door, Zurn, MIFAB, or accepted equal.

2.3.4 Access doors shall be supplied by the Mechanical Subcontractor for installation by the Contractor.

2.3.5 Cutting of wall and ceiling openings, framing of openings with metal stud and installation of 16 mm Type X fire-rated gyproc around the full perimeter of metal stud framing shall be the responsibility of the Contractor.

3. EXECUTION

3.1 INSTALLATION

3.1.1 Installation:

- .1 As per Manufacturer's instructions.

3.2 LOCATION

3.2.1 Location: Ensure that equipment is within view and accessible for operating, inspecting, adjusting, servicing without using special tools.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 08 51 00
METAL WINDOWS
TABLE OF CONTENTS**

PART 1 General 2

 1.1 RELATED REQUIREMENTS 2

 1.2 REFERENCES 2

 1.3 SUBMITTALS 3

 1.4 CLOSEOUT SUBMITTALS 4

 1.5 QUALITY ASSURANCE 4

 1.6 DELIVERY, STORAGE AND HANDLING 4

 1.7 NOT USED 5

PART 2 Products 5

 2.1 MATERIALS 5

 2.2 WINDOW TYPE AND CLASSIFICATION 5

 2.3 FABRICATION 6

 2.4 ALUMINUM FINISHES 6

 2.5 ISOLATION COATING 6

 2.6 GLAZING 7

 2.7 HARDWARE 7

 2.8 AIR BARRIER AND VAPOUR RETARDER 7

PART 3 Execution 7

 3.1 EXAMINATION 7

 3.2 INSTALLATION 7

 3.3 CLEANING 9

 3.4 PROTECTION 9

PROVINCE OF NEWFOUNDLAND AND LABRADOR

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 07 21 20 – Low Expanding Foam Sealant.
- 1.1.2 Section 07 26 00 - Vapour Retarders.
- 1.1.3 Section 07 92 00 - Joint Sealants.
- 1.1.4 Section 08 80 50 - Glazing.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.2.2 All work shall be in accordance with this specification and the requirements of the following.
 - 1.2.2.1 Aluminum Association (AA)
 - 1.2.2.1.1 Designation System for Aluminum Finishes (2003).
 - 1.2.2.2 Canadian General Standards Board (CGSB)
 - 1.2.2.2.1 CAN/CGSB-1.40-97, Anticorrosive Structural Steel Alkyd Primer.
 - 1.2.2.2.2 CAN/CGSB-79.1-M91, Insect Screens.
 - 1.2.2.3 Canadian Standards Association (CSA International)
 - 1.2.2.3.1 CSA-A440-00/A440.1-00(R2005), A440-00, Windows / Special Publication A440.1-00, User Selection Guide to CSA Standard A440-00, Windows. CAN/CSA-A440.2-09, Fenestration Energy Performance.
 - 1.2.2.3.2 CAN/CSA-Z91-02(R2008), Health and Safety Code for Suspended Equipment Operations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3 SUBMITTALS

1.3.1 Product Data:

1.3.1.1 Submit manufacturer's instructions, printed product literature and data sheets for windows and include product characteristics, performance criteria, physical size, finish and limitations.

1.3.2 Shop Drawings:

1.3.2.1 Indicate materials and details in full size scale for head, jamb and sill, profiles of components, interior and exterior trim, junction between combination units, elevations of unit, anchorage details, location of isolation coating, description of related components, and exposed finishes, fasteners, and caulking. Indicate location of manufacturer's nameplates.

1.3.3 Samples:

1.3.3.1 Submit for review and acceptance of each unit.

1.3.3.2 Samples will be returned for inclusion into work.

1.3.3.3 Submit one representative model of each type window.

1.3.3.4 Include frame, sash, sill, glazing and weatherproofing method, insect screens, surface finish and hardware. Show location of manufacturer's nameplates.

1.3.3.5 Include 150 mm long samples of head, jamb, sill, meeting rail, and mullions to indicate profile.

1.3.4 Test and Evaluation Reports:

1.3.4.1 Submit test reports from approved independent testing laboratories, certifying compliance with specifications, for:

1.3.4.1.1 Windows classifications.

1.3.4.1.2 Anodized finish and weathering characteristics.

1.3.4.1.3 Insect screens.

1.3.4.1.4 Air tightness.

1.3.4.1.5 Water tightness.

1.3.4.1.6 Wind load resistance.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.4.1.7 Condensation resistance.
- 1.3.4.1.8 Safety drop - vertical sliding windows only.
- 1.3.4.1.9 Block operation - sliding windows only.
- 1.3.4.1.10 Sash strength and stiffness - operable casement or projecting.
- 1.3.4.1.11 Ease of operation - windows with operable lights.
- 1.3.4.1.12 Sash pull-off - vinyl windows.
- 1.3.4.1.13 Forced entry resistance.
- 1.3.4.1.14 Mullian deflection - combination and composite windows.

1.4 CLOSEOUT SUBMITTALS

- 1.4.1 Operation and Maintenance Data: submit operation and maintenance data for windows for incorporation into manual.

1.5 QUALITY ASSURANCE

- 1.5.1 Certifications: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- 1.6.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- 1.6.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- 1.6.3 Storage and Handling Requirements:
 - 1.6.3.1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - 1.6.3.2 Store and protect windows from nicks, scratches, and blemishes.
 - 1.6.3.3 Replace defective or damaged materials with new.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



1.7 NOT USED

PART 2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Materials: to CSA-A440/A440.1 supplemented as follows.
- 2.1.2 All windows by same manufacturer.
- 2.1.3 Sash: aluminum thermally broken.
- 2.1.4 Main frame: aluminum thermally broken.
- 2.1.5 Glass: sealed units in accordance with Section 08 80 50 - Glazing.
- 2.1.6 Screens: to CAN/CGSB-79.1.
 - 2.1.6.1 Insect screening mesh: count 18 x 14.
 - 2.1.6.2 Fasteners: tamper proof.
 - 2.1.6.3 Screen frames: aluminum colour to match window frames.
 - 2.1.6.4 Mount screen frames for interior replacement.
- 2.1.7 Exterior metal sills and aluminum facings: extruded aluminum of type and size to suit job conditions; minimum 3 mm thick, complete with joint covers, jamb drip deflectors, chairs, and anchoring devices.
- 2.1.8 Isolation coating: alkali resistant bituminous paint.
- 2.1.9 Sealants: in accordance with Section 07 92 00 – Joint Sealants.

2.2 WINDOW TYPE AND CLASSIFICATION

- 2.2.1 Types:
 - 2.2.1.1 Combination fixed and vented: with insulating glass.
 - 2.2.1.2 Fixed: with insulating glass.
 - 2.2.1.3 Screens: on ventilating portion of windows as indicated.
- 2.2.2 Classification rating: to CSA-A440/A440.1.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.2.1 Air tightness: A3.
- 2.2.2.2 Water tightness: B3.
- 2.2.2.3 Wind load resistance: C3.
- 2.2.2.4 Condensation resistance: Temperature Index, I40.
- 2.2.2.5 Forced Entry: F1.
- 2.2.2.6 Insect Screens: S1.
- 2.2.2.7 Glazing: G1.

2.3 FABRICATION

- 2.3.1 Fabricate in accordance with CSA-A440/A440.1 supplemented as follows:
- 2.3.2 Fabricate units square and true with maximum tolerance of plus or minus 1.5 mm for units with a diagonal measurement of 1800 mm or less and plus or minus 3 mm for units with a diagonal measurement over 1800 mm.
- 2.3.3 Face dimensions detailed are maximum permissible sizes.
- 2.3.4 Brace frames to maintain squareness and rigidity during shipment and installation.
- 2.3.5 Finish steel clips and reinforcement with 380 g/m² zinc coating to [ASTM A123/A123M.

2.4 ALUMINUM FINISHES

- 2.4.1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
- 2.4.1.1 Clear anodic finish: designation AA- M12, C22, A31.

2.5 ISOLATION COATING

- 2.5.1.1 Isolate aluminum from following components, by means of isolation coating:
 - 2.5.1.1.1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
 - 2.5.1.1.2 Concrete, mortar and masonry.
 - 2.5.1.1.3 Wood.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.6 GLAZING

2.6.1 Glaze windows in accordance with CSA-A440/A440.1 and Section 08 80 50 – Glazing.

2.7 HARDWARE

2.7.1 Hardware: stainless steel or white bronze sash locks and aluminum handles to provide security and permit easy operation of units.

2.7.2 Locks: provide operating sash with spring loading locking device, to provide automatic locking in closed position.

2.7.3 Include special keyed opening device for windows normally locked.

2.7.4 Where windows latching devices are located in excess of 1900 mm above floor level: Equip projected units with roto operators with locking handle.

2.7.5 Tie back and life line anchors: to CAN/CSA-Z91, 2 per window.

2.8 AIR BARRIER AND VAPOUR RETARDER

2.8.1 Provide low expanding, single component polyurethane foam sealant installed at head, jamb and sill perimeter of window for sealing to building air barrier, vapour retarder and window frame. Foam sealant width to be adequate to provide required air tightness and vapour diffusion control to building air barrier and vapour retarder foam interior. Refer to Section 07 21 20 – Low Expanding Foam Sealant.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's written instructions.

3.1.1.1 Visually inspect substrate in presence of Engineer.

3.1.1.2 Inform Engineer of unacceptable conditions immediately upon discovery.

3.1.1.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

3.2.1 Window installation:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.1.1 Install in accordance with CSA-A440/A440.1.
- 3.2.2 Install shims between windows and building frame at each installation screw location. Shim and fasten windows in accordance with manufacturer's recommendations and CAN/CSA A440.4.
- 3.2.3 Sill installation:
 - 3.2.3.1 Install metal sills with uniform wash to exterior, level in length, straight in alignment with plumb upstands and faces. Use one piece lengths at each location.
 - 3.2.3.2 Cut sills to fit window opening.
 - 3.2.3.3 Secure sills in place with anchoring devices located at end joints of continuous sills and evenly spaced 600 mm on centre in between.
 - 3.2.3.4 Fabricate and install sills to provide minimum 2% slope away from window.
 - 3.2.3.5 Fasten expansion joint cover plates and drip deflectors with self tapping stainless steel screws.
 - 3.2.3.6 Maintain 6 to 9 mm space between butt ends of continuous sills. For sills over 1200 mm in length, maintain 3 to 6 mm space at each end.
- 3.2.4 Caulking:
 - 3.2.4.1 Seal joints between windows and window sills with sealant. Bed sill expansion joint cover plates and drip deflectors in bedding compound. Caulk between sill upstand and window-frame. Caulk butt joints in continuous sills.
 - 3.2.4.2 Apply sealant in accordance with Section 07 92 00 - Joint Sealants. Conceal sealant within window units except where exposed use is permitted by Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 51 00
CH0032	METAL WINDOWS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 CLEANING

- 3.3.1 Progress Cleaning: Leave Work area clean at end of each day.
- 3.3.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.4 PROTECTION

- 3.4.1 Protect installed products and components from damage during construction.
- 3.4.2 Repair damage to adjacent materials caused by window installation.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 08 71 00
DOOR HARDWARE
TABLE OF CONTENTS**

PART 1 GENERAL.....2

1.1 SECTION INCLUDES 2

1.2 RELATED REQUIREMENTS..... 2

1.3 REFERENCES 2

1.4 SUBMITTALS 4

1.5 QUALITY ASSURANCE 5

1.6 DELIVERY, STORAGE AND HANDLING 5

PART 2 Products6

2.1 HARDWARE ITEMS 6

2.2 DOOR HARDWARE 6

2.3 FASTENINGS..... 9

2.4 KEYING10

2.5 FINISHES10

2.6 ABBREVIATIONS, FINISH SYMBOLS AND TERMS.....10

PART 3 Execution.....12

3.1 MANUFACTURER'S INSTRUCTIONS12

3.2 INSTALLATION12

3.3 EXAMINATION13

3.4 FIELD QUALITY CONTROL13

3.5 ADJUSTING13

3.6 CLEANING13

3.7 PROTECTION14

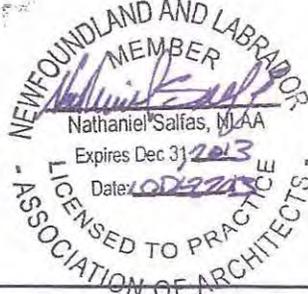
3.8 HARDWARE GROUPS14

PROVINCE OF NEWFOUNDLAND AND LABRADOR



PERMIT HOLDER
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
which is valid for the year 2013



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SECTION INCLUDES

- 1.1.1 Furnish, deliver and install all finish hardware necessary for all doors, also hardware as specified herein and as enumerated in Hardware Groups and as indicated and required by actual conditions at the project site.
- 1.1.2 Mechanical hardware shall include the furnishing of all necessary screws, bolts, expansion shields and all other devices necessary for the proper application of the hardware.

1.2 RELATED REQUIREMENTS

- 1.2.1 Section 08 11 00 - Metal Doors & Frames.

1.3 REFERENCES

- 1.3.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
- 1.3.2 All work shall be in accordance with this specification and the requirements of the following.
- 1.3.3 Standard hardware location dimensions in accordance with Canadian Metric Guide for Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door and Frame Manufacturers' Association:
- 1.3.3.1 CAN/CGSB-69.17/ ANSI/BHMA A156.2-2003, Bored and Preassembled Locks and Latches.
- 1.3.3.2 CAN/CGSB-69.18/ANSI/BHMA A156.1-2000, Butts and Hinges.
- 1.3.3.3 CAN/CGSB-69.19/ANSI/BHMA A156.3-2001, Exit Devices.
- 1.3.3.4 CAN/CGSB-69.20/ANSI/BHMA A156.4-2000, Door Controls - Closers.
- 1.3.3.5 CAN/CGSB-69.21/ANSI/BHMA A156.5-2001, Auxiliary Locks and Associated Products.
- 1.3.3.6 CAN/CGSB-69.22/ANSI/BHMA A156.6-2005, Architectural Door Trim.
- 1.3.3.7 CAN/CGSB-69.23/ANSI/BHMA A156.7, Template Hinge Dimensions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.3.8 CAN/CGSB-69.24/ANSI/BHMA A156.8-2005, Door Controls - Overhead Stops and Holders.
- 1.3.3.9 CAN/CGSB-69.28/ANSI/BHMA A156.12-2005, Interconnected Locks and Latches.
- 1.3.3.10 CAN/CGSB-69.29/ANSI/BHMA A156.13-2002, Mortise Locks and Latches.
- 1.3.3.11 CAN/CGSB-69.32/ANSI/BHMA A156.16-2002, Auxiliary Hardware.
- 1.3.3.12 CAN/CGSB-69.34/ANSI/BHMA A156.18-2006, Materials and Finishes.
- 1.3.3.13 ANSI/BHMA A156.22-1996, Door Gasketing Systems.
- 1.3.3.14 ANSI/BHMA A156.26-2000, Continuous Hinges.
- 1.3.3.15 ANSI/BHMA A156.28-2000, Keying Systems.
- 1.3.3.16 ANSI/BHMA A156.31-2001, Electric Strikes.
- 1.3.3.17 ANSI/BHMA A156.21-2001, Thresholds.
- 1.3.3.18 ANSI/DHI A115, Steel Door Preparation Standards.
- 1.3.3.19 ANSI/DHI A115.IG, Installation Guide for Doors and Hardware.
- 1.3.3.20 DHI Abbreviations & Symbols.
- 1.3.3.21 National Building Code Canada.
- 1.3.3.22 National Fire Code Canada.
- 1.3.3.23 NFPA 80, Fire Doors and Windows.
- 1.3.3.24 NFPA 101, Life Safety Code.
- 1.3.3.25 NFPA 105, Smoke & Draft B Control Door Assemblies.
- 1.3.3.26 NFPA 252, Fire Tests of Door Assemblies.
- 1.3.4 Canadian Steel Door and Frame Manufacturers' Association (CSDFMA)
 - 1.3.4.1 CSDFMA Recommended Dimensional Standards for Commercial Steel Doors and Frames - 2009.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 SUBMITTALS

1.4.1 Product Data:

1.4.1.1 Submit manufacturer's instructions, printed product literature and data sheets for door hardware and include product characteristics, performance criteria, physical size, finish and limitations.

1.4.2 Samples:

1.4.2.1 Submit for review and acceptance of each unit.

1.4.2.2 Samples will be returned for inclusion into work.

1.4.2.3 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.

1.4.2.4 After approval samples will be returned for incorporation in Work.

1.4.3 Hardware List:

1.4.3.1 Submit contract hardware list.

1.4.3.2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.

1.4.4 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.4.5 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4.6 Acceptable Alternates:

1.4.6.1 Alternates as listed in Part 2 must match the specified product in design, quality, price group, function and size.

1.4.7 Closeout Submittals:

1.4.7.1 Provide operation and maintenance data for door closers, locksets, door holders, electrified hardware, and fire exit hardware.

1.4.7.2 Maintenance Materials Submittals:

1.4.7.3 Extra Stock Materials: Supply maintenance materials in accordance with General Requirements.

1.4.7.4 Tools: Supply 2 sets of wrenches for door closers, locksets, and fire exit hardware.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 QUALITY ASSURANCE

- 1.5.1 Comply with standards specified.
- 1.5.2 Products used in the work of this section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to Engineer.
- 1.5.3 Hardware supplier shall have on staff a qualified Architectural Hardware Consultant, recognized by the Door and Hardware Institute, or a person with equivalent qualifications to assist installers and direct detailing, processing and delivery of material.
- 1.5.4 Hardware for doors in fire separations and exit doors shall be certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- 1.5.5 Where required and indicated, supply hardware which is in compliance with The Government of Newfoundland and Labrador Building Accessibility Regulations.
- 1.5.6 Prior to supplying hardware items, review hardware groups and report to the Engineer any hardware specified which is not in compliant with regulatory agencies.

1.6 DELIVERY, STORAGE AND HANDLING

- 1.6.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- 1.6.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- 1.6.3 Package items of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- 1.6.4 Storage and Handling Requirements:
 - 1.6.4.1 Store materials off ground, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - 1.6.4.2 Store and protect door hardware from nicks, scratches, and blemishes.
 - 1.6.4.3 Protect prefinished surfaces with wrapping and/or strippable coating.
 - 1.6.4.4 Replace defective or damaged materials with new.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 2 PRODUCTS

2.1 HARDWARE ITEMS

2.1.1 Only door locks and latch sets listed on ANSI/BHMA Standards list are acceptable for use on this project.

2.1.2 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

2.2.1 Locks and latches:

2.2.1.1 Bored and preassembled locks and latches: to CAN/CGSB-69.17/ANSI/BHMA A156.2, series 4000 bored lock, grade 1, designed for function and keyed as stated in Hardware Schedule.

2.2.1.2 Interconnected locks and latches: to CAN/CGSB-69.28/ANSI/BHMA A156.12, series 5000 interconnected lock, grade 1, designed for function and keyed as stated in Hardware Schedule.

2.2.1.3 Mortise locks and latches: to CAN/CGSB-69.29/ANSI/BHMA A156.13, series 1000 mortise lock, grade 1, designed for function and keyed as stated in Hardware Schedule.

2.2.1.4 Knobs and lever handles: plain design.

2.2.1.5 Roses: round.

2.2.1.6 Normal strikes: box type, lip projection not beyond jamb.

2.2.1.7 Cylinders: key into keying system as directed.

2.2.1.8 Finished to BHMA 626.

2.2.2 Butts and hinges:

2.2.2.1 Butts and hinges: to CAN/CGSB-69.18/ANSI/BHMA A156.1, designated by letter A and numeral identifiers, followed by size and finish, listed in Hardware Schedule.

2.2.3 Continuous Hinges:

2.2.3.1 Continuous hinges to ANSI/BHMA A156.26.

2.2.3.2 Hinges shall be standard or heavy duty as indicated.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.3.3 Hinges shall be full height complete with installation aids and fasteners to suit door and frame conditions.
- 2.2.3.4 Hinges shall be complete with sufficient number and gauge of wires to operate or monitor as per hardware group notes.
- 2.2.3.5 Hinges shall be complete with factory prepared access panel to all concealed wiring.
- 2.2.3.6 Hinges shall be complete with necessary options to meet fire ratings as indicated in door schedule.
- 2.2.3.7 Quantity size and width of hinges in accordance with manufactures recommendations and ANSI/BHMA A156.26.
- 2.2.3.8 Specified Acceptable Alternates

<u>Pemko</u>	<u>ABH</u>	<u>Stanley</u>	<u>Gallery Lawrence</u>
CFM83SLFHD	A110	661HD	CH941/CH951

- 2.2.4 Exit devices:
 - 2.2.4.1 To CAN/CGSB-69.19, function, grade and finish as per schedule. .
 - 2.2.4.2 Exit devices of Rim type with push pad design, non-handed, field sizable with approved labelling as required or as indicated in the door schedule.
 - 2.2.4.3 Exit devices shall be complete with all devices to operate as per the functions indicated in the Hardware Group.
 - 2.2.4.4 Exit devices shall be complete with glass bead conversion kits to suit door lite cut-outs.
 - 2.2.4.5 Lever trim shall be complete with thru-bolted mechanism.
 - 2.2.4.6 Electric Exit devices shall be of matching design with functions as noted in Hardware Groups.
 - 2.2.4.7 Electric Exit devices shall be complete with all necessary relays power supplies and devices to operate as per the notes with the Hardware Group.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.4.8 Specified Acceptable Alternates

<u>Dorma</u>	<u>Von Duprin</u>	<u>Sargent</u>	<u>Lawrence</u>
9300	99L	19-8888	8810S/F

2.2.5 Door Closers and Accessories:

2.2.5.1 Door controls (closers): to CAN/CGSB-69.20/ANSI/BHMA A156.4, designated by letter C and numeral identifiers listed in Hardware Schedule.

2.2.5.2 Closers of narrow slim line design complete rack and pinion hydraulic action.

2.2.5.3 Closers complete with adjustable backcheck unless noted otherwise.

2.2.5.4 Closers equipped with full cover, as noted by model number in Hardware Groups, complete with secure and concealed mounting screws.

2.2.5.5 All manual closers with manufacturer's twenty-five (25) year warranty.

2.2.5.6 Barrier free openings shall be equipped with closers that meet all requirements of the National and Provincial Codes.

2.2.5.7 Adapter plates as noted in Hardware Groups are used for added reinforcing as well as door and frame conditions. Adapter plates shall be added to any opening if required to suit field conditions or door design.

2.2.5.8 Closers shall include all necessary Arm Brackets, Cush arm supports and blade stop spacers to suit door swing, frame reveals or stop conditions.

2.2.5.9 Size and hand closers prior to site delivery in accordance with the Manufactures recommendations.

2.2.5.10 Closers capable of field adjustment of at least fifteen (15) percent.

2.2.5.11 Degree of opening to be as shown on the plans and indicated on the reviewed Hardware Groups.

2.2.5.12 Finish as stated in Hardware Groups.

2.2.5.13 Specified Acceptable Alternates

<u>Dorma</u>	<u>LCN</u>	<u>Sargent</u>	<u>Stanley</u>	<u>Lawrence</u>
8600	1460	1430	D-3550	825BC
8900	4000	281	D-4550	8016BC

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.6 Auxiliary locks and associated products: to CAN/CGSB-69.21/ANSI/BHMA A156.5, designated by letter E and numeral identifiers listed in Hardware Schedule. Key into keying system as noted.

2.2.7 Architectural door trim: to CAN/CGSB-69.22, designated by letter J and numeral identifiers listed in Hardware Schedule.

2.2.7.1 Door protection plates: 1.27 mm thick stainless steel, finished to BHMA 630.

2.2.7.2 Push plates: 1.27 mm thick stainless steel, finished to BHMA 630.

2.2.7.3 Push/Pull units: stainless steel, finished to BHMA 630.

2.2.8 Auxiliary hardware: to CAN/CGSB-69.32, designated by letter L and numeral identifiers listed in Hardware Schedule.

2.2.8.1 Combination stop and holder, wall or floor mounted: finished to BHMA 626.

2.2.8.2 Surface bolts lever extension flush bolt: finish to BHMA 626.

2.2.9 Door bottom seal: heavy duty, door seal of extruded aluminum frame and hollow closed cell neoprene weather seal, surface mounted with drip cap, closed ends, and clear anodized finish.

2.2.10 Thresholds: to ANSI/BHMA A156.21, extruded aluminum mill finish, serrated surface, with lip and vinyl door seal insert.

2.2.11 Weather-stripping:

2.2.11.1 Head and jamb seal:

2.2.11.1.1 Extruded aluminum frame and solid closed cell neoprene insert, clear anodized finish.

2.2.12 Astragal: overlapping, extruded aluminum frame with vinyl insert, finished to match doors.

2.3 FASTENINGS

2.3.1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.

2.3.2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.

2.3.3 Exposed fastening devices to match finish of hardware.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3.4 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.

2.3.5 Use fasteners compatible with material through which they pass.

2.4 KEYING

2.4.1 Doors, padlocks and other locks to be master keyed as noted in Hardware Schedule. Prepare detailed keying schedule in conjunction with Engineer.

2.4.2 Supply keys in triplicate for every lock in this Contract.

2.4.3 Supply 6 master keys for each master key or grand master key group.

2.4.4 Stamp keying code numbers on keys and cylinders.

2.4.5 Supply construction cores.

2.4.6 Hand over permanent cores and keys to Engineer.

2.5 FINISHES

2.5.1 Following finishes are indicated in hardware groups.

<u>BHMA</u>	<u>CAN MATERIAL</u>	<u>FINISH</u>
626	C26D Brass/Bronze	Satin Chrome
628	C28 Aluminum	Satin Alum, Anodized
630	C32D Stainless Steel	Satin Stainless Steel
652	C26D Steel	Plated Satin Chrome
689	Al All	Painted Aluminum
	Alum Aluminum	Mill Finish
	TMDFF (to match door and frame finish)	

2.6 ABBREVIATIONS, FINISH SYMBOLS AND TERMS

2.6.1 Abbreviations:

ALD ALF	Aluminum Door and Frame
ATMS STMS	Arm/Strike to Template with Machine Screws
BC	Back Check
B3E or B4E	Bevelled 3 or 4 Sides
BTB	Back to Back Mounted
C to C, C/L	Centreline to Centreline

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

CYL	Cylinder (of a lock)
CIF	Channel Iron Frame
CMK	Construction Master Key
DA	Double Action
DEG	Degree (of opening)
DEL	Delayed Action
DR	Door
FBB or BB	Ball Bearing Hinge
FS FSE	Fail Safe Fail Secure
FTMS 1/2TMS	To Template with full or 1/2 Machine Screws
GMK	Grand Master Key
MK or MKD	Master Keyed
KA KD	Keyed Alike Keyed different
HMD PSF	Hollow Metal Door Pressed Steel Frame
LH RH	Left Hand Right Hand
LHR RHR	Left Hand Reverse Right Hand Reverse
NRP	Fixed non removable hinge pin
TMS	To Template with Machine Screws

2.6.2 Terms:

AHC	Architectural Hardware Consultant
ANSI	American National Standards Institute, Inc.
CDC	Certified Door Consultant
CSA	Canadian Standards Association
CSC	Construction Specifications Canada
DHI	Door and Hardware Institute

2.6.3 Finishes:

<u>BMHA</u>	<u>CAN.</u>	<u>MATERIAL</u>	<u>FINISH</u>
619	C15	Brass/Bronze	Stain Nickel
628	C28	Aluminum	Satin Alum. Anodized
630	C32D	Stainless Steel	Satin Stainless Steel
652	C626	Steel	Plated Satin Chrome
689	AL	ALL	Painted Aluminum ALU
	ALUM	Aluminum	Mill Finish

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- 3.1.2 Furnish metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- 3.1.3 Furnish manufacturers' instructions for proper installation of each hardware component.

3.2 INSTALLATION

- 3.2.1 Install hardware to standard hardware location dimensions in accordance with CSDFMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction).
- 3.2.2 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- 3.2.3 Install key control cabinet.
- 3.2.4 Use only manufacturer's supplied fasteners.
- 3.2.4.1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.
- 3.2.5 Remove construction cores when directed by Engineer. Install permanent cores and ensure locks operate correctly.
- 3.2.6 Closers shall be installed according to Manufactures templates and installation instructions. Unless required otherwise installation shall be on pull side of door. Out swing doors shall be on push side using top jamb or parallel arm installation.
- 3.2.7 Where closer or arm is installed on door sex bolts, finished to match other hardware, will be used.
- 3.2.8 Degree of opening to be as shown on the plans and indicated on the reviewed hardware schedule.
- 3.2.9 Wiring Diagrams:
 - 3.2.9.1 Provide any special information, voltage requirements and wiring diagrams to other trades requiring such information.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 EXAMINATION

- 3.3.1 Visit site prior to start of installation of hardware.
- 3.3.2 Visit will include examination of openings, site conditions and materials for conditions that prevent proper application of finish hardware.
- 3.3.3 Installation will imply conditions for installation acceptable hardware contractor to accept responsibility.

3.4 FIELD QUALITY CONTROL

- 3.4.1 Hardware contractor to have a qualified AHC representative from the manufacturer/supplier on site at Substantial Completion Inspection and at commissioning of the finished hardware. Cost of the visits to be included in contract.

3.5 ADJUSTING

- 3.5.1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- 3.5.2 Lubricate hardware, operating equipment and other moving parts.
- 3.5.3 Adjust door hardware to ensure tight fit at contact points with frames.
- 3.5.4 Where hardware is found defective, repair or replace or correct as desired by inspection reports.

3.6 CLEANING

- 3.6.1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- 3.6.2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
- 3.6.3 Remove protective material from hardware items where present.
- 3.6.4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 71 00
CH0032	DOOR HARDWARE	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7 PROTECTION

- 3.7.1 Protect installed products and components from damage during construction.
- 3.7.2 Repair damage to adjacent materials caused by door hardware installation.

3.8 HARDWARE GROUPS

3.8.1 Provide hardware as specified in the previous articles in sets according to the following groups:

3.8.2 HG-01 (2 Exterior Doors):

Item #1 - 1 Single door	(914 x 2134 x 45 mm - HM)	
- 1 Continuous Hinge	CFM83SLFHD1	628
- 1 Exit Device	98EO US26D	626
- 1 Cylinder	1E72S2RP	626
- 1 Closer	4041 Rw/PA AL	628
- 1 Bracket	4040-18	689
- 1 Door Contact	A-4103	Std
- 1 Sweep	3452CNB 914 mm	628
- 1 Weather strip	319 CS 914 mm x 2134 mm	628
- 1 Threshold	2005AP 914 mm	628

- Note:
 - Free Exiting at all times.
 - Doors locked and unlocked by key.
 - Doors can be manually dogged open for push/pull operation
 - Confirm actual size of threshold from site conditions.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

SECTION 08 80 50
GLAZING
TABLE OF CONTENTS

PART 1 GENERAL.....2

1.1 RELATED SECTIONS..... 2

1.2 REFERENCES..... 2

1.3 SYSTEM DESCRIPTION 3

1.4 SUBMITTALS..... 3

1.5 QUALITY ASSURANCE..... 3

1.6 NOT USED..... 4

1.7 ENVIRONMENTAL REQUIREMENTS 4

PART 2 PRODUCTS.....4

2.1 MATERIALS: FLAT GLASS 4

2.2 MATERIALS: SEALED INSULATING GLASS 4

2.3 MATERIALS..... 5

2.4 ACCESSORIES 5

PART 3 EXECUTION.....6

3.1 MANUFACTURER'S INSTRUCTIONS..... 6

3.2 EXAMINATION 6

3.3 PREPARATION..... 6

3.4 INSTALLATION: EXTERIOR – WET/DRY METHOD (PERFORMED TAPE AND SEALANT)..... 6

3.5 CLEANING..... 7

3.6 PROTECTION OF FINISHED WORK 7

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PEG PERMIT HOLDER
Newfoundland and Labrador
Professional Geoscientists

This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N-04528
which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR
MEMBER
Nathaniel Sallas
Nathaniel Sallas, NLAA
Expires Dec 31, 2013
Date: 20 Nov 12
LICENSED TO PRACTICE
ASSOCIATION OF ARCHITECTS

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 07 92 00 – Joint Sealants.
- 1.1.2 Section 08 11 14 – Metal Doors and Frames.
- 1.1.3 Section 08 51 13 – Aluminum Windows.

1.2 REFERENCES

- 1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.
 - 1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.
- 1.2.2 American National Standards Institute (ANSI).
 - 1.2.2.1 ANSI/ASTM E330, Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- 1.2.3 American Society for Testing and Materials (ASTM)
 - 1.2.3.1 ASTM C542, Specification for Lock-Strip Gaskets.
 - 1.2.3.2 ASTM D2240, Test Method for Rubber Property – Durometer Hardness.
- 1.2.4 Canadian General Standards Board (CGSB).
 - 1.2.4.1 CAN/CGSB-12.1, Tempered or Laminated Safety Glass.
 - 1.2.4.2 CAN/CGSB-12.3, Clear Float Glass
 - 1.2.4.3 CAN/CGSB-12.5, Mirrors, Silvered.
 - 1.2.4.4 CAN/CGSB-12.8, Insulating Glass Units.
 - 1.2.4.5 CAN/CGSB-12.11, Wired Safety Glass.
- 1.2.5 Canadian Standards Association (CSA).
 - 1.2.5.1 CSA A440.2, Energy Performance Evaluation of Windows and Sliding Glass Doors.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.2.5.2 CSA Certification Program for Windows and Doors.

1.2.6 Flat Glass Manufacturers Association (FGMA).

1.2.6.1 FGMA Glazing Manual.

1.2.7 Laminators Safety Glass Association (LSGA).

1.2.7.1 LSGA Laminated Glass Design Guide.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements:

1.3.1.1 Provide continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:

1.3.1.1.1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.

1.3.1.2 Size glass to withstand wind loads, dead loads and positive and negative live loads as measured in accordance with ANSI/ASTM E330n and NBC latest edition.

1.3.1.3 Limit glass deflection to 1/200 with full recovery of glazing materials.

1.4 SUBMITTALS

1.4.1 Product Data:

1.4.1.1 Submit manufacturer's printed product literature, specifications and data sheet.

1.4.2 Manufacturer's Instructions:

1.4.2.1 Submit manufacturer's installation instructions.

1.4.3 Closeout Submittals:

1.4.3.1 Provide maintenance data including cleaning instructions for incorporation into manual specified in General Requirements.

1.5 QUALITY ASSURANCE

1.5.1 Perform work in accordance with FGMA Glazing Manual IGMAC and Laminators Safety Glass Association – Standards Manual for glazing installation methods. Maintain one (1) copy of each standard document on site.

1.5.2 Provide shop inspection and testing for glass.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.3 Provide certificate of quality compliance from manufacturer.

1.6 **NOT USED**

1.7 **ENVIRONMENTAL REQUIREMENTS**

1.7.1 Install glazing when ambient temperature is 10°C minimum. Maintain ventilated environment for 24 hours after application.

1.7.2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

PART 2 PRODUCTS

2.1 MATERIALS: FLAT GLASS

2.1.1 Float glass: to CAN/CGSB-12.3, Glazing quality, 5 mm minimum thickness.

2.1.2 Safety glass: to CAN/CGSB-12.5, transparent, 6 mm thick.

2.1.2.1 Type 2 - tempered

2.1.2.2 Class B - float

2.1.2.3 Category - 11

2.1.3 Wired glass: to CAN/CGSB-12.11, 6 mm thick.

2.1.3.1 Type 1- Polished both sides (transparent)

2.1.3.2 Wire mesh - style 3, square.

2.2 MATERIALS: SEALED INSULATING GLASS

2.2.1 Insulating glass units: to CAN/CGSB-12.8, double unit, minimum 25 mm overall thickness (as per NBC for window area and climatic conditions.)

2.2.1.1 Glass: to CAN/CGSB-12.3

2.2.1.2 Glass thickness: minimum 6 mm each light (as per NBCC calculations for window area and climatic conditions.)

2.2.1.3 Inter-cavity space thickness: 13 mm.

2.2.1.4 Glass coating: surface number 2 (inside surface of outer light), low "E".

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.1.5 Inert gas: argon.

2.2.1.6 Light transmittance: minimum 0.70.

2.2.2 Insulating glass units for exterior doors: to CAN/CGSB-12.8, double unit, minimum 25 mm overall thickness (as per NBC for window area and climatic conditions.)

2.2.2.1 Glass: to CAN/CGSB-12.1, tempered.

2.2.2.2 Glass thickness: minimum 6 mm each light (as per NBC for glass area and climatic conditions.)

2.2.2.3 Inner-cavity space thickness: 13 mm.

2.2.2.4 Glass coating: surface number 2 (inside face of outer light), low "E".

2.2.2.5 Inert gas: argon.

2.3 MATERIALS

2.3.1 Sealant: 07 92 00 – Joint Sealants.

2.4 ACCESSORIES

2.4.1 Setting blocks: Neoprene, 80-90 Shore A durometer hardness to ASTM D2240, minimum 100 mm x width of glazing rabbet space minus 1.5 mm x height.

2.4.2 Spacer shims: Neoprene, 50-60 Shore A durometer hardness to ASTM D2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self adhesive on one face.

2.4.3 Glazing tape: Preformed butyl compound with integral resilient tube spacing device, 10-15 Shore A durometer hardness to ASTM D2240; coiled on release paper; black colour.

2.4.4 Glazing splines: resilient polyvinyl chloride, extruded shape to suit glazing channel retaining slot, colour as selected.

2.4.5 Glazing clips: manufacturer's standard type.

2.4.6 Lock-strip gaskets: to ASTM C542.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 EXAMINATION

3.2.1 Verify that openings for glazing are correctly sized and within tolerance.

3.2.2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.3 PREPARATION

3.3.1 Clean contact surfaces with solvent and wipe dry.

3.3.2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.

3.3.3 Prime surfaces scheduled to receive sealant.

3.4 INSTALLATION: EXTERIOR – WET/DRY METHOD (PREFORMED TAPE AND SEALANT)

3.4.1 Perform work in accordance with FGMA Glazing Manual and Laminators Safety Glass Association - Standards Manual for glazing installation methods.

3.4.2 Cut glazing tape to length and set against permanent stops, 6 mm below sight line. Seal corners by butting tape and dabbing with sealant.

3.4.3 Apply heel bead of sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete continuity of air and vapour seal.

3.4.4 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.

3.4.5 Rest glazing on setting blocks and push against tape and heel of sealant with sufficient pressure to attain full contact at perimeter of light or glass unit.

3.4.6 Install removable stops with spacer strips inserted between glazing and applied stops 6 mm below sight line.

3.4.7 Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing, maximum 9 mm below sight line.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 08 80 50
CH0032	GLAZING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.8 Apply cap bead of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.5 CLEANING

3.5.1 Perform cleaning after installation to remove construction and accumulated environmental dirt.

3.5.2 Remove traces of primer, caulking.

3.5.3 Remove glazing materials from finish surfaces.

3.5.4 Remove labels after Work is complete.

3.5.5 Clean glass using approved non-abrasive cleaner in accordance with manufacturer's instructions.

3.5.6 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.6 PROTECTION OF FINISHED WORK

3.6.1 After installation, mark with an "X" by using removable plastic tape or paste. Do not mark heat absorbing or reflective glass units.

END OF SECTION




Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES
TABLE OF CONTENTS**

PART 1 GENERAL2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 3

1.4 DELIVERY, STORAGE AND HANDLING 3

1.5 AMBIENT CONDITIONS..... 3

PART 2 PRODUCTS4

2.1 MATERIALS 4

PART 3 EXECUTION.....4

3.1 EXAMINATION 4

3.2 ERECTION 4

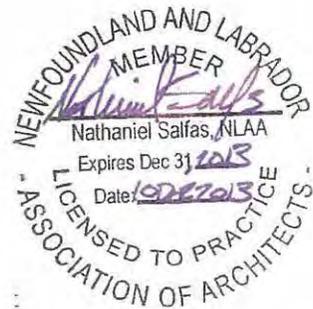
3.3 APPLICATION 5

3.4 INSTALLATION 6

3.5 CLEANING 7

3.6 PROTECTION 8

3.7 SCHEDULES..... 8



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL**1.1 RELATED REQUIREMENTS**

- 1.1.1 Section 06 10 00 – Rough Carpentry.
- 1.1.2 Section 07 21 16 – Blanket Insulation.
- 1.1.3 Section 09 22 16 – Non-Structural Metal Framing.
- 1.1.4 Section 07 84 00 – Fire Stopping.

1.2 REFERENCES**1.2.1 ASTM International**

- 1.2.1.1 ASTM C475 02 (2007), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- 1.2.1.2 ASTM C840 08, Standard Specification for Application and Finishing of Gypsum Board.
- 1.2.1.3 ASTM C1002 07, Standard Specification for Steel Self Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- 1.2.1.4 ASTM C1047 09, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
- 1.2.1.5 ASTM C1177/C1177M [08], Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- 1.2.1.6 ASTM C1178/C1178M 08, Standard Specification for Glass Mat Water Resistant Gypsum Backing Board.
- 1.2.1.7 ASTM C1396/C1396M-09a, Standard Specification for Gypsum Wallboard.

1.2.2 Association of the Wall and Ceilings Industries International (AWCI)

- 1.2.2.1 AWCI Levels of Gypsum Board Finish-97.

1.2.3 Underwriters' Laboratories of Canada (ULC)

- 1.2.3.1 CAN/ULC S102 07, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Product Data:

1.3.1.1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

1.4.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.4.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1.4.3 Storage and Handling Requirements:

1.4.3.1 Store gypsum board assembly's materials level off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

1.4.3.2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.

1.4.3.3 Protect from weather, elements and damage from construction operations.

1.4.3.4 Handle gypsum boards to prevent damage to edges, ends or surfaces.

1.4.3.5 Replace defective or damaged materials with new.

1.5 AMBIENT CONDITIONS

1.5.1 Maintain temperature 10°C minimum, 21°C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.

1.5.2 Apply board and joint treatment to dry, frost free surfaces.

1.5.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 2 PRODUCTS

2.1 MATERIALS



2.1.1 Abuse Resistant board: to ASTM C79, thickness indicated on drawings, Type Ultra Code, 1200 mm wide x maximum practical length, ends square cut, edges squared.

2.1.2 Metal furring runners, hangers, tie wires, inserts, and anchors: to CSA A82.30, galvanized.



2.1.3 Drywall furring channels: 0.5 mm base steel thickness galvanized steel channels for screw attachment of gypsum board.

2.1.4 Steel drill screws: to ASTM C1002.

2.1.5 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, zinc coated by hot dip process, 0.5 mm base thickness, perforated flanges, one piece length per location.

2.1.6 Sealants: in accordance with Section 07 92 00 Joint Sealants.

2.1.7 Joint compound: to ASTM C475, asbestos free.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assembly's installation in accordance with manufacturer's written instructions.

3.1.1.1 Visually inspect substrate in presence of Engineer.

3.1.1.2 Inform Engineer of unacceptable conditions immediately upon discovery.

3.1.1.3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Engineer.

3.2 ERECTION

3.2.1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.

3.2.2 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.3 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- 3.2.4 Install work level to tolerance of 1:1200.
- 3.2.5 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, and grilles.
- 3.2.6 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.
- 3.2.7 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- 3.2.8 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.
- 3.2.9 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.
- 3.2.10 Furr openings and around built in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- 3.2.11 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

- 3.3.1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work has been approved.
- 3.3.2 Apply single and/or double layer gypsum board to metal furring or framing using screw fasteners for first layer, and screw fasteners for second layer. Maximum spacing of screws 300 mm on centre.
 - 3.3.2.1 Single Layer Application:
 - 3.3.2.1.1 Apply gypsum board on ceilings prior to application of walls to ASTM C840.
 - 3.3.2.1.2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - 3.3.2.2 Double Layer Application:
 - 3.3.2.2.1 Install gypsum board for base layer and exposed gypsum board for face layer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.2.2.2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.

3.3.2.2.3 Apply base layers at right angles to supports unless otherwise indicated.

3.3.2.2.4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.

3.3.3 Apply 12 mm diameter bead of fire-rated sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut outs around electrical boxes, ducts, in partitions where perimeter sealed with fire-rated sealant.

3.3.4 Install gypsum board on walls vertically to avoid end butt joints. At high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire rated assemblies require vertical application.

3.3.5 Install gypsum board with face side out.

3.3.6 Do not install damaged or damp boards.

3.3.7 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

3.4.1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.

3.4.2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated.

3.4.3 Install insulating strips continuously at edges of gypsum board and casing beads abutting door frames, to provide thermal break.

3.4.4 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.5 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:

3.4.5.1 Levels of finish:

3.4.5.1.1 Level 0: no tapping, finishing or accessories required.

3.4.5.1.2 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable.

3.4.5.1.3 Level 2: not applicable.

3.4.5.1.4 Level 3: not applicable.

3.4.5.1.5 Level 4: not applicable.

3.4.5.1.6 Level 5: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; apply a thin skim coat of joint compound to entire surface; surfaces smooth and free of tool marks and ridges.

3.4.6 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.

3.4.7 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.

3.4.8 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

3.4.9 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

3.4.10 Mix joint compound slightly thinner than for joint taping.

3.4.11 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.

3.4.12 Allow skim coat to dry completely.

3.4.13 Remove ridges by light sanding or wiping with damp cloth.

3.5 CLEANING

3.5.1 Progress Cleaning: Leave Work area clean at end of each day.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:09 21 16
CH0032	GYPSUM BOARD ASSEMBLIES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.6 PROTECTION

3.6.1 Protect installed products and components from damage during construction.

3.6.2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

3.7 SCHEDULES

3.7.1 Construct fire rated assemblies where indicated.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 22 16
CH0032	NON-STRUCTURAL METAL FRAMING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING
TABLE OF CONTENTS**

PART 1 GENERAL..... 2

 1.1 RELATED SECTIONS 2

 1.2 REFERENCES 2

 1.3 QUALITY ASSURANCE 2

PART 2 PRODUCTS 3

 2.1 MATERIALS 3

PART 3 EXECUTION 3

 3.1 ERECTION 3

 3.2 CLEANING 4

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 MEMBER
Nathaniel Salfas
 Nathaniel Salfas, NLAA
 Expires Dec 31, 2015
 Date 02/20/15
 LICENSED TO PRACTICE
 ASSOCIATION OF ARCHITECTS

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 22 16
CH0032	NON-STRUCTURAL METAL FRAMING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 07 92 00 – Joint Sealants.
- 1.1.2 Section 09 21 16 – Gypsum Board Assemblies.
- 1.1.3 Section 07 84 00 – Fire Stopping.



1.2 REFERENCES

1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.

1.2.2 American Society for Testing and Materials International, (ASTM).

1.2.2.1 ASTM C645-00, Specification for Non-structural Steel Framing Members.

1.2.2.2 ASTM C754-00, Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.

1.2.3 Canadian General Standards Board (CGSB).

1.2.3.1 CAN/CGSB-1.40-97, Primer, Structural Steel, Oil Alkyd Type.

1.2.4 Canadian Standards Association

1.2.4.1 CAN/CSA-S136-07 (R2012), North American Specification for the design of Cold-Formed Steel Structural Members.



1.3 QUALITY ASSURANCE

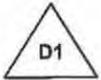
1.3.1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.3.2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 22 16
CH0032	NON-STRUCTURAL METAL FRAMING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 2 PRODUCTS

2.1 MATERIALS



2.1.1 Non-load bearing channel stud framing: to CSA S136, stud size as indicated on drawings, roll formed from 2.46 mm thickness, hot-dipped galvanized steel sheet minimum Z275 coating, for screw attachment of gypsum board or other panel material. Knock-out service holes at 460 mm centres.



2.1.2 Floor and top tracks: to CSA S136, in widths to suit stud sizes, 50 mm minimum flange height, min Z275 zinc coating.

2.1.3 Acoustical sealant: to Section 07 92 00 – Joint Sealants.

2.1.4 Insulating strip: rubberized, moisture resistant 3 mm thick foam strip, 12 mm wide, with self sticking adhesive on one face, lengths as required.

PART 3 EXECUTION

3.1 ERECTION



3.1.1 Align tracks at floor and top and secure at 600 mm on centre maximum.

3.1.2 Allow minimum deflection gap of 19 mm for double track or slotted single top track.

3.1.3 Install damp proof course under stud shoe tracks on slabs-on-grade.

3.1.4 Place studs vertically at 400 mm on centre and not more than 50 mm from abutting walls, and at each side of openings and corners. Position studs in tracks at floor and top. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.

3.1.5 Erect metal studding to tolerance of 1:1000.

3.1.6 Attach studs to bottom and top tracks using screws.

3.1.7 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.

3.1.8 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.

3.1.9 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 22 16
CH0032	NON-STRUCTURAL METAL FRAMING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.10 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.

3.1.11 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.

3.1.12 Provide 40 mm stud or furring channel secured between studs for attachment of fixtures, equipment or accessories.

3.1.13 Install steel studs or furring channel between studs for attaching electrical and other boxes.

3.1.14 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs.

3.1.15 Install continuous insulating strips to isolate studs from uninsulated surfaces.

3.2 CLEANING

3.2.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

SECTION 09 90 00
PAINT SYSTEM FOR
STRUCTURAL STEEL
TABLE OF CONTENTS

PART 1 GENERAL 2

1.1 SCOPE OF WORK..... 2

1.2 RELATED SECTIONS..... 2

1.3 DEFINITIONS..... 2

1.4 REFERENCES..... 2

1.5 GENERAL REQUIREMENTS..... 4

1.6 QUALITY ASSURANCE 4

1.7 SUBMITTALS..... 4

PART 2 PRODUCTS..... 5

2.1 MATERIALS 5

PART 3 EXECUTION..... 6

3.1 GENERAL 6

3.2 ENVIRONMENTAL CONDITIONS..... 8

3.3 SURFACE PREPARATION 8

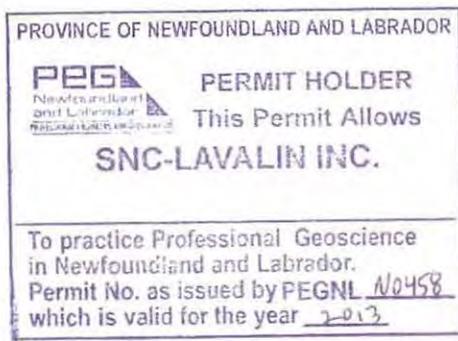
3.4 DRY FILM THICKNESS 9

3.5 ADHESION TEST..... 9

3.6 INSPECTION..... 9

3.7 TOUCH-UPS AND REPAIRS ON SITE 10

3.8 COATING HOT-DIP GALVANIZED SURFACES 10



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MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SCOPE OF WORK

- 1.1.1 This specification covers the requirements for materials, surface preparation, application and workmanship for protective coatings to be applied to the structural steel as shown on the drawings.
- 1.1.2 Paint and Coating are used interchangeably.
- 1.1.3 Refer also to Section 48 13 10 – General Mechanical Requirements for additional coating requirements.

1.2 RELATED SECTIONS

- 1.2.1 Section 01 35 43 - General Environmental Requirements
- 1.2.2 Section 05 12 00 - Structural Steel
- 1.2.3 Section 05 50 10 - Miscellaneous Metals and Embedded Parts
- 1.2.4 Section 48 13 10 – General Mechanical Requirements

1.3 DEFINITIONS

- 1.3.1 LEED: Leadership in Energy and Environmental Design.
- 1.3.2 VDR: Vendor Data Requirements Form.
- 1.3.3 SDRL: Supplier Document Requirement List.
- 1.3.4 OSHA: Occupational Safety and Health Administration.
- 1.3.5 VOC: Volatile Organic Compound.
- 1.3.6 DFT: Dry Film Thickness.

1.4 REFERENCES

- 1.4.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 All work shall be in accordance with this specification and the requirements of the following codes and standards:

1.4.3 ASTM International Inc.

- ASTM D3276 Standard Guide for Painting Inspectors (Metal Substrates)
- ASTM D4414 Standard Practice for Measurement of Wet Film Thickness by Notch Gages
- ASTM D4417 Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
- ASTM D4541 Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers

1.4.4 Society for Protective Coatings

- SSPC PA1 Shop, Field and Maintenance Painting of Steel
- SSPC PA2 Measurement of Dry Film Thickness with Magnetic Gages
- SSPC PS Guide 8 Guide to Top Coating Zinc-Rich Primers
- SSPC AB1 Mineral and Slag Abrasives
- SSPC AB2 Cleanliness of Recycled Ferrous Metallic Abrasives
- SSPC AB3 Ferrous Metallic Abrasive
- SSPC SP1 Solvent Cleaning
- SSPC SP3 Power Tool Cleaning
- SSPC SP10 Near-White Blast Cleaning
- SSPC SP11 Power Tool Cleaning To Bare Metal
- SSPC SP16 Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steel, and Non-Ferrous Metals
- SSPC Vis 1 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
- SSPC Vis 3 Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning

1.4.5 National Association of Corrosion Engineers

- NACE RP0287 Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1.5 GENERAL REQUIREMENTS

- 1.5.1 All paint application shall be done in shop and not at site, except for the repairs and other touch-ups.
- 1.5.2 All costs associated with recoating due to failure of meeting the painting specification shall be borne by the Contractor.
- 1.5.3 The Contractor shall acquaint himself with the requirements of this specification. The Contractor shall be required to inspect and monitor the work of surface preparation and painting workers under his direction.
- 1.5.4 The Contractor shall maintain a daily log of ambient temperature, relative humidity, work progress, measured paint film thickness, and other information pertinent to the painting work.

1.6 QUALITY ASSURANCE

- 1.6.1 The Contractor shall comply with an inspection program in conformance with ISO 9001:2008 requirements or equivalent.
- 1.6.2 The Engineer will monitor the approved quality control program and the inspection and testing plan.
- 1.6.3 The Engineer reserves the right to inspect work at the fabrication plant at any time during the normal working hours.
- 1.6.4 Quality of work shall be controlled to meet the requirements of this specification, the referenced codes and standards, and other contract documents in effect on the date of the contract.

1.7 SUBMITTALS

- 1.7.1 The Contractor shall submit the required documentation to the Engineer for review and approval, in accordance with the Supplier Document Requirements List (SDRL).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1.7.2 All painting related activities shall be incorporated into the fabrication plan. The Contractor shall prepare a detailed painting procedure including (but not limited to) the information listed below for approval:

- .1 Detailed Scope.
- .2 Surface Preparation.
- .3 Materials (including technical data sheets and MSDS).
- .4 Application.
- .5 Inspection Procedures and Documentation.
- .6 Provision for handling and storage of paints and coatings at the shop or the site.
- .7 Plans for conformance to National, Provincial or Local Environment Law.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

2.1.1.1 Paint that is part of the system shall be supplied by the same manufacturer to assure compatibility.

2.1.1.2 Intermediate and top coats shall be tinted to clearly differentiate them from the previous coat.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.2 Paint System

2.1.2.1 The coating to be applied to the structural steel shall consist of the following:

FOR INTERNAL ATMOSPHERIC CONDITION

LAYER	DFT (µm)
Primer: - Organic zinc rich epoxy	75 - 100
Finish: - High-build epoxy polyamide	125 - 150
Total	200 - 250

FOR EXTERNAL ATMOSPHERIC CONDITION

LAYER	DFT (µm)
Primer: - Epoxy polymeric amine	125 - 150
Finish: - Aliphatic acrylic polyurethane	75 - 100
Total	200 - 250

2.1.2.2 All coating products are subject to approval by the Engineer.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Steel specified to be painted shall be prepared and painted in the shop, unless noted otherwise on the drawings.

3.1.2 Finish paint colors shall be approved by the Engineer.

3.1.3 Thinners shall not be used, unless specified otherwise by the paint Manufacturer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.1.4 The following surfaces shall not be painted:

- .1 Corrosion resistant steel surfaces, i.e., stainless steel and galvanized steels (unless noted otherwise on drawings or in the specifications for special items);
- .2 Metal surfaces of copper, bronze and similar finished materials;
- .3 Machine finished or field weld areas. However, such surfaces shall be protected with a rust preventive coating and painted after the erection is completed;
- .4 Areas of embedded parts which will be in contact with concrete, however, these surfaces shall be cleaned of all rust and scale.

3.1.5 Shop painting shall not be done at ambient air temperatures lower than 7°C.

3.1.6 Paint shall not be applied:

- .1 On surfaces whose having a temperature lower than 4°C or whose temperature is 10°C below the ambient air;
- .2 On surfaces whose temperature causes blistering or porosity of the paint;
- .3 on contaminated surfaces;
- .4 In dusty or windy conditions, fog or mist, or when it is raining, snowing or other inclement weather;
- .5 On an earlier coat of paint that has not thoroughly dried and hardened.

3.1.7 Contact surfaces of connections shall not be primed nor painted over a surface extending 50 mm beyond the perimeter of the connection.

3.1.8 In the shop, or for large surfaces on site, the paint shall be applied with a an airless paint sprayer under a pressure in conformance with the paint Manufacturer's recommendations.

3.1.9 On site, on small surfaces, the paint shall be applied with a roller, brush or airless paint sprayer in conformance with the paint manufacturer's recommendations.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.10 Finished surfaces shall be clean, smooth, without blisters, laps, waves, softening or adherence loss.

3.1.11 Galvanized guardrails which are indicated to be painted safety yellow shall be lightly sweep blasted to create a surface profile of 25-50 micrometers, but without removing the galvanizing, and coated with a surface tolerant epoxy having a minimum dry film thickness of 150-200 micrometers.

3.2 ENVIRONMENTAL CONDITIONS

3.2.1 Blast cleaning shall not be done on any surface that is moist or that may become moist before the application of a primer.

3.2.2 Blast cleaning and paint application shall not be permitted when metal surface temperature is less than 3°C above the dew point or when the relative humidity of the air is greater than 85%.

3.2.3 The ambient temperature, surface temperature, relative humidity and dew point shall be recorded and presented as part of final painting work report.

3.3 SURFACE PREPARATION

3.3.1 Where not specified in Section 48 13 10 – General Mechanical Requirements, surface preparation shall be in accordance with the following.

3.3.2 Surface preparation cleanliness shall be evaluated in accordance with SSPC-Vis 1

3.3.3 All structural steel shall be blast-cleaned in accordance with SSPC-SP10 Near-White Blast Cleaning.

3.3.4 Surface profile shall be verified in accordance with NACE RPO 287 or ASTM 04417. The result shall be recorded and presented as part of final painting work report.

3.3.5 All surface of galvanized steel to be painted shall be prepared according to SSPC-SP16.

3.3.6 Any foreign matter deposited after completion of surface preparation shall be removed prior to painting. In the event that rusting occurs, prepare surfaces again to conform to the requirements above.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.7 Aluminum surfaces shall be prepared in accordance with the following requirements:

- .1 Mechanical treatment: ASTM D1730 Type D, no steel wool or brush, or steel particles.
- .2 Solvent cleaning: ASTM D1730 Type A.
- .3 Chemical conversion and primer: CAN/CGSB-1.132.

3.4 DRY FILM THICKNESS

- 3.4.1 Dry film thickness measurements shall be made of each coat such as primer and finish coat of the total system, in accordance with the procedure established by SSPC-PA2.
- 3.4.2 The DFT measurements shall be recorded and presented as part of final painting work report.

3.5 ADHESION TEST

- 3.5.1 Adhesion shall be checked on separate test specimen in accordance with ASTM D4541. The bond strength between substrate and primer, primer and finish coat shall be at least 2 MPa.
- 3.5.2 A separate test panel specimen shall be prepared in parallel to the coating of the substrate. One panel carbon-steel plate dimension (150 x 150 x 10 mm) for each lot of pieces.
- 3.5.3 The adhesion tests result shall be presented as part of final painting work report.

3.6 INSPECTION

- 3.6.1 Compliance with this specification shall be checked by the Inspector during the entire course of surface preparation and application of the coating system.
- 3.6.2 Work shall not proceed with the next step of the system sequence (i.e. surface preparation, priming, finish coat application) until the previous work has been inspected and approved by the Inspector.
- 3.6.3 Magnetic gauges used to check the dry film thickness shall be in accordance with SSPC PA2-73T.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6.4 Qualified and experienced inspectors shall be provided to continuously monitor all phases of work including:

- .1 Surface preparation;
- .2 Pre-treatment;
- .3 Paint mixing and authorized paint thinning;
- .4 Application of coating systems; and
- .5 Inspection of coatings.

3.7 TOUCH-UPS AND REPAIRS ON SITE

- 3.7.1 Touch-ups, whenever necessary, shall be done after the completion of work. All damaged coating shall be repaired prior to project completion.
- 3.7.2 The touch-ups shall be done with the same paint system specified in paragraph 2.1.2.
- 3.7.3 Painted surfaces damaged during transportation, handling and installation shall be prepared in accordance with SSPC-SP1 and SSPC-SP3 prior to applying the specified paint system. The touch-ups shall be in conformance with the painting manufacturer's procedure.
- 3.7.4 All field welded connection surfaces shall be prepared in accordance with the SSPC-SP11 Power Tool Cleaning to Bare Metal prior to applying the DFT for the specified paint system.
- 3.7.5 Unpainted surfaces around connections shall be prepared to SSPC-SP11 Power Tool Cleaning to Bare Metal and painted with the same paint system (i.e. primer and finish coats) after final tightening of the bolts. The DFT requirement as per article 3.4 shall apply.

3.8 COATING HOT-DIP GALVANIZED SURFACES

- 3.8.1 Zinc coated surfaces shall be painted yellow only if security colour is required.
- 3.8.2 The following painting system shall be applied for interior atmospheric condition:
- .1 Epoxy polyamide paint: DFT: 40 – 50 µm.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 90 00
CH0032	PAINT SYSTEM FOR STRUCTURAL STEEL	Rev: D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.8.3 The following painting system shall be applied for exterior atmospheric condition:

- .1 Epoxy polyamide paint: DFT: 40 – 50 µm;
- .2 Aliphatic acrylic polyurethane: DFT: 40 – 50 µm.

END OF SECTION

Go MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 09 91 23
INTERIOR PAINTING
TABLE OF CONTENTS**

PART 1 GENERAL2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 QUALITY ASSURANCE 2

1.4 SCHEDULING 2

1.5 SUBMITTALS 3

1.6 MAINTENANCE..... 3

1.7 DELIVERY, STORAGE AND HANDLING 4

1.8 SITE CONDITIONS 6

PART 2 PRODUCTS7

2.1 MATERIALS 7

2.2 COLOURS..... 9

2.3 MIXING AND TINTING 9

2.4 GLOSS/SHEEN RATINGS10

2.5 INTERIOR PAINTING SYSTEMS10

2.6 SOURCE QUALITY CONTROL11

PART 3 EXECUTION.....11

3.1 MANUFACTURER'S INSTRUCTIONS11

3.2 GENERAL11

3.3 EXAMINATION11

3.4 PREPARATION12

3.5 APPLICATION13

3.6 MECHANICAL/ELECTRICAL EQUIPMENT15

3.7 FIELD QUALITY CONTROL15

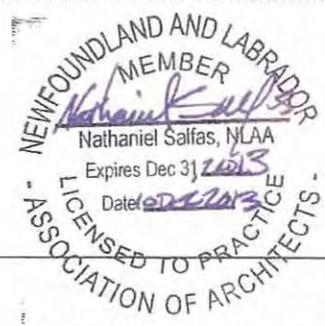
3.8 RESTORATION.....16

PROVINCE OF NEWFOUNDLAND AND LABRADOR



PERMIT HOLDER
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL 110458
which is valid for the year 2013



[Handwritten signatures and initials]

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 08 11 00 – Metal Doors and Frames.
- 1.1.2 Section 09 21 16 – Gypsum Board Assemblies.

1.2 REFERENCES

- 1.2.1 Environmental Protection Agency (EPA)
 - 1.2.1.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - for Surface Coatings.
- 1.2.2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - 1.2.2.1 Material Safety Data Sheets (MSDS).
- 1.2.3 Master Painters Institute (MPI)
 - 1.2.3.1 MPI Architectural Painting Specifications Manual 2004.
- 1.2.4 Society for Protective Coatings (SSPC)
 - 1.2.4.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

1.3 QUALITY ASSURANCE

- 1.3.1 Qualifications:
 - 1.3.1.1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.
 - 1.3.1.2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.
 - 1.3.1.3 Apprentices: working under direct supervision of qualified trades person in accordance with trade regulations.

1.4 SCHEDULING

- 1.4.1 Submit work schedule for various stages of painting to Engineer for review. Submit schedule minimum of 48 hours in advance of proposed operations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Obtain written authorization from Engineer for changes in work schedule.

1.5 SUBMITTALS

1.5.1 Product Data:

1.5.1.1 Submit product data and instructions for each paint and coating product to be used.

1.5.1.2 Submit product data for the use and application of paint thinner.

1.5.1.3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS). Indicate VOCs during application and curing.

1.5.2 Samples:

1.5.2.1 Submit full range colour sample chips to indicate where colour availability is restricted.

1.5.2.2 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.

1.5.2.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5.2.4 Manufacturer's Instructions:

1.5.2.4.1 Submit manufacturer's installation and application instructions.

1.6 MAINTENANCE

1.6.1 Extra Materials:

1.6.1.1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels.

1.6.1.2 Quantity: provide one four litre can of each type and colour of finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

1.6.1.3 Delivery, storage and protection: comply with Engineer requirements for delivery and storage of extra materials.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Packing, Shipping, Handling and Unloading:

1.7.1.1 Pack, ship, handle and unload materials in accordance with manufacturer's written instructions.

1.7.2 Acceptance at Site:

1.7.2.1 Identify products and materials with labels indicating:

1.7.2.1.1 Manufacturer's name and address.

1.7.2.1.2 Type of paint or coating.

1.7.2.1.3 Compliance with applicable standard:

1.7.2.1.4 Colour number in accordance with established colour schedule.

1.7.3 Remove damaged, opened and rejected materials from site.

1.7.4 Storage and Protection:

1.7.4.1 Provide and maintain dry, temperature controlled, secure storage.

1.7.4.2 Store materials and supplies away from heat generating devices.

1.7.4.3 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.

1.7.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

1.7.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

1.7.7 Remove paint materials from storage only in quantities required for same day use.

1.7.8 Fire Safety Requirements:

1.7.8.1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.

1.7.8.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.7.8.3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.
- 1.7.9 Waste Management and Disposal:
 - 1.7.9.1 Separate waste materials for recycling.
 - 1.7.9.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - 1.7.9.3 Place materials defined as hazardous or toxic in designated containers.
 - 1.7.9.4 Ensure emptied containers are sealed and stored safely.
 - 1.7.9.5 Unused coating materials must be disposed of at official hazardous material collections site as approved by Engineer.
 - 1.7.9.6 Paint, stain and wood preservative finishes and related materials (thinners, and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.
 - 1.7.9.7 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
 - 1.7.9.8 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
 - 1.7.9.9 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:
 - 1.7.9.9.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.
 - 1.7.9.9.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - 1.7.9.9.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - 1.7.9.9.4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.
 - 1.7.9.9.5 Empty paint cans are to be dry prior to disposal or recycling (where available).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.8 SITE CONDITIONS

1.8.1 Heating, Ventilation and Lighting:

1.8.1.1 Ventilate enclosed spaces.

1.8.1.2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.

1.8.1.3 Where required provide continuous ventilation for seven days after completion of application of paint.

1.8.1.4 Provide minimum lighting level of 323 Lux on surfaces to be painted.

1.8.2 Temperature, Humidity and Substrate Moisture Content Levels:

1.8.2.1 Unless specifically pre-approved written approval by Specifying body or Paint Inspection Agency Authority and product manufacturer, perform no painting when:

1.8.2.1.1 Ambient air and substrate temperatures are below 10 degrees C.

1.8.2.1.2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.

1.8.2.1.3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.

1.8.2.1.4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.

1.8.2.1.5 Rain or snow is forecasted to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

1.8.2.1.6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can withstand 'normal' adverse environmental factors.

1.8.2.2 Perform painting work when maximum moisture content of the substrate is below:

1.8.2.2.1 Allow new concrete and masonry to cure minimum of 28 days.

1.8.2.2.2 15% for wood.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.8.2.2.3 12% for plaster and gypsum board.
- 1.8.2.3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".
- 1.8.2.4 Test concrete, masonry and plaster surfaces for alkalinity as required.
- 1.8.3 Surface and Environmental Conditions:
- 1.8.3.1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
- 1.8.3.2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
- 1.8.3.3 Apply paint when previous coat of paint is dry or adequately cured.
- 1.8.4 Additional interior application requirements:
- 1.8.4.1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
- 2.1.2 Provide paint materials for paint systems from single manufacturer.
- 2.1.3 Only qualified products with E2 "Environmentally Friendly" rating are acceptable for use on this project.
- 2.1.4 Conform to latest MPI requirements for interior painting work including preparation and priming.
- 2.1.5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.
- 2.1.6 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.7 Provide paint products meeting MPI "Environmentally Friendly" E1 ratings based on VOC (EPA Method 24) content levels.
- 2.1.8 Use MPI listed materials having minimum E2 rating where indoor air quality (odour) requirements exist.
- 2.1.9 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:
 - 2.1.9.1 Water based, water soluble, water cleanup.
 - 2.1.9.2 Non flammable, biodegradable.
 - 2.1.9.3 Manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
 - 2.1.9.4 Manufactured without compounds which contribute to smog in the lower atmosphere.
 - 2.1.9.5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- 2.1.10 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- 2.1.11 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.
- 2.1.12 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:
 - 2.1.12.1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - 2.1.12.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.
- 2.1.13 Water borne paints and stains, recycled water borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" E2 rating.
- 2.1.14 Recycled water borne surface coatings to contain 50% post consumer material by volume.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.15 Recycled water borne surface coatings must not contain:

2.1.15.1 Lead in excess of 600.0 ppm weight/weight total solids.

2.1.15.2 Mercury in excess of 50.0 ppm weight/weight total product.

2.1.15.3 Cadmium in excess of 1.0 ppm weight/weight total product.

2.1.15.4 Hexavalent chromium in excess of 3.0 ppm weight/weight total product.

2.1.15.5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 COLOURS

2.2.1 Engineer will provide Colour Schedule after Contract award.

2.2.2 Colour schedule will be based upon selection of two base colours and two accent colours.

2.2.3 Selection of colours from manufacturer's full range of colours.

2.2.4 Where specific products are available in restricted range of colours, selection based on limited range.

2.2.5 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

2.3.1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Engineer for tinting of painting materials.

2.3.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

2.3.3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water based paints.

2.3.4 Thin paint for spraying in accordance with paint manufacturer's instructions.

2.3.5 Re mix paint in containers prior to and during application to ensure break up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 GLOSS/SHEEN RATINGS

2.4.1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

Gloss Level 1 - Matte Finish (flat)	Max. 5	Max. 10
	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 2 - Velvet Like Finish	Max.10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi Gloss Finish	35 to 70	
Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

2.4.2 Gloss level ratings of painted surfaces as indicated.

2.5 INTERIOR PAINTING SYSTEMS

2.5.1 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.

2.5.1.1 INT 5.3A - Latex 3 finish.

2.5.2 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:

2.5.2.1 INT 9.2A - Latex 3 finish (over latex sealer).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.6 SOURCE QUALITY CONTROL

- 2.6.1 Perform following tests on each batch of consolidated post-consumer material before surface coating is reformulated and canned. Testing by laboratory or facility which has been accredited by Standards Council of Canada.
 - 2.6.1.1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.
 - 2.6.1.2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.
 - 2.6.1.3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 GENERAL

- 3.2.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- 3.2.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

- 3.3.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Engineer damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- 3.3.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.3 Maximum moisture content as follows:

3.3.3.1 Stucco, plaster and gypsum board: 12%.

3.3.3.2 Concrete: 12%.

3.4 PREPARATION

3.4.1 Protection:

3.4.1.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non staining covers or masking. If damaged, clean and restore surfaces as directed by Engineer.

3.4.1.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

3.4.1.3 Protect factory finished products and equipment.

3.4.2 Surface Preparation:

3.4.2.1 Remove electrical cover plates, light fixtures, surface hardware on doors, and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.

3.4.3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

3.4.3.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths, or compressed air.

3.4.3.2 Wash surfaces with a biodegradable detergent, and bleach where applicable, and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

3.4.3.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

3.4.3.4 Allow surfaces to drain completely and allow to dry thoroughly.

3.4.3.5 Prepare surfaces for water based painting, water based cleaners should be used in place of organic solvents.

3.4.3.6 Use trigger operated spray nozzles for water hoses.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.3.7 Many water based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water based paints.
- 3.4.4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.
- 3.4.5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
 - 3.4.5.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.
 - 3.4.5.2 Apply wood filler to nail holes and cracks.
 - 3.4.5.3 Tint filler to match stains for stained woodwork.
- 3.4.6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- 3.4.7 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes, blowing with clean dry compressed air, or vacuum cleaning.
- 3.4.8 Touch up of shop primers with primer as specified.
- 3.4.9 Do not apply paint until prepared surfaces have been accepted by Engineer.

3.5 APPLICATION

- 3.5.1 Method of application is to be as approved by Engineer. Apply paint by brush, roller, air sprayer, or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.
- 3.5.2 Brush and Roller Application:
 - 3.5.2.1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - 3.5.2.2 Work paint into cracks, crevices and corners.
 - 3.5.2.3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.5.2.4 Brush and/or roll out runs and sags, and overlap marks. Rolled surfaces free of roller tracking and heavy stipple.
- 3.5.2.5 Remove runs, sags and brush marks from finished work and repaint.
- 3.5.3 Spray application:
 - 3.5.3.1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - 3.5.3.2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - 3.5.3.3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.
 - 3.5.3.4 Brush out immediately all runs and sags.
 - 3.5.3.5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.
- 3.5.4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- 3.5.5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- 3.5.6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- 3.5.7 Sand and dust between coats to remove visible defects.
- 3.5.8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- 3.5.9 Finish inside of cupboards and cabinets as specified for outside surfaces.
- 3.5.10 Finish closets and alcoves as specified for adjoining rooms.
- 3.5.11 Finish top, bottom, edges and cut-outs of doors after fitting as specified for door surfaces.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6 MECHANICAL/ELECTRICAL EQUIPMENT

- 3.6.1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.
- 3.6.2 Boiler room, mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
- 3.6.3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- 3.6.4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- 3.6.5 Do not paint over nameplates.
- 3.6.6 Keep sprinkler heads free of paint.
- 3.6.7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- 3.6.8 Paint fire protection piping red.
- 3.6.9 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- 3.6.10 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch up as required, and paint conduits, mounting accessories and other unfinished items.
- 3.6.11 Do not paint interior transformers and substation equipment.

3.7 FIELD QUALITY CONTROL

- 3.7.1 Standard of Acceptance:
 - 3.7.1.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
 - 3.7.1.2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
 - 3.7.1.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 91 23
CH0032	INTERIOR PAINTING	Rev. D2
Powerhouse & Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.7.2 Field inspection of painting operations to be carried out by independent inspection firm as designated by Engineer.
- 3.7.3 Advise Engineer when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- 3.7.4 Cooperate with inspection firm and provide access to areas of work.
- 3.7.5 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Engineer.
- 3.8 RESTORATION**
- 3.8.1 Clean and re install hardware items removed before undertaken painting operations.
- 3.8.2 Remove protective coverings and warning signs as soon as practical after operations cease.
- 3.8.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- 3.8.4 Protect freshly completed surfaces from paint droppings and dust to approval of Engineer. Avoid scuffing newly applied paint.
- 3.8.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Engineer.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 09 97 19
PAINTING EXTERIOR METAL SURFACES
TABLE OF CONTENTS**

PART 1 GENERAL	2
1.1 RELATED REQUIREMENTS.....	2
1.2 REFERENCES.....	2
1.3 SUBMITTALS.....	2
1.4 QUALITY ASSURANCE.....	3
1.5 SCHEDULING OF WORK.....	4
1.6 EXTRA MATERIALS.....	4
1.7 DELIVERY, HANDLING AND STORAGE.....	4
1.8 SITE REQUIREMENTS.....	6
1.9 WASTE MANAGEMENT AND DISPOSAL.....	7
PART 2 PRODUCTS	8
2.1 MATERIALS.....	8
2.2 COLOURS.....	9
2.3 MIXING AND TINTING.....	10
2.4 GLOSS/SHEEN RATINGS.....	10
2.5 EXTERIOR PAINTING SYSTEMS.....	11
PART 3 EXECUTION	11
3.1 GENERAL.....	11
3.2 EXAMINATION.....	11
3.3 PREPARATION.....	12
3.4 APPLICATION.....	13
3.5 FIELD QUALITY CONTROL.....	16
3.6 CLEANING.....	16
3.7 PROTECTION.....	16

PROVINCE OF NEWFOUNDLAND AND LABRADOR


PERMIT HOLDER
 This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL: 110458
which is valid for the year 2013

NEWFOUNDLAND AND LABRADOR
MEMBER

Nathaniel Salfas
Nathaniel Salfas, NLAA
Expires Dec 31, 2013
Date: 10/22/12

LICENSED TO PRACTICE
ASSOCIATION OF ARCHITECTS

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 08 11 00 – Metal Doors and Frames.

1.2 REFERENCES

1.2.1 The Contractor shall comply with the rules and provisions of the *listed* Codes and Standards. The Contractor shall obtain written approval from the Engineer prior to using other equivalent codes and standards.

1.2.1.1 All work shall be in accordance with this specification and the requirements of the following.

1.2.2 Environmental Protection Agency (EPA)

1.2.2.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings).

1.2.3 Master Painters Institute (MPI)

1.2.3.1 Exterior Structural Steel and Metal Fabrications, 2007.

1.2.3.1.1 EXT 5.1D, Alkyd.

1.2.3.1.2 EXT 5.1G, Polyurethane, Pigmented (over epoxy zinc rich primer and high build epoxy).

1.2.3.1.3 EXT 5.4, Aluminum.

1.2.4 Society for Protective Coatings (SSPC)

1.2.4.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

1.2.5 National Fire Code of Canada.

1.3 SUBMITTALS

1.3.1 Submit in accordance with General Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.2 Product Data:

1.3.2.1 Submit manufacturer's instructions, printed product literature and data sheets for [painting exterior metal surfaces] and include product characteristics, performance criteria, physical size, finish and limitations.

1.3.2.2 Submit 2 copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety data Sheets (MSDS).

1.3.3 Samples:

1.3.3.1 Submit for review and acceptance of each unit.

1.3.3.2 Samples will be returned for inclusion into work.

1.3.3.3 Upon request, Engineer will furnish qualified products list of paints.

1.3.3.4 Paints that do not appear on MPI Approved Products List must be approved by Engineer before use on project. When it is proposed to use non-qualified paint, submit 2L sample of paint to Engineer at least 2 weeks prior to commencement of painting for analysis and acceptance. Mark samples with name of project, its location, paint manufacturer's name and address, name of paint, MPI standard number and manufacturers paint code number.

1.3.3.5 Enable Engineer to take 1L samples of each paint delivered to site, one sample from manufacturer's containers and one sample from painters' pot.

1.3.4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.3.5 Test Reports: Submit test reports showing compliance with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

1.4.1 Contractor shall have a minimum of five years proven satisfactory experience. When requested, provide a list of last three comparable jobs including, job name and location, specifying authority, and project manager.

1.4.2 Qualified journeyman shall be engaged in painting work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.

Page 3 of 17



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.4.3 Conform to latest MPI requirements for exterior painting work including preparation and priming.
- 1.4.4 Materials (primers, paints, coatings, fillers, thinners, solvents, etc.) shall be in accordance with MPI Painting Specification Manual "Approved Products" listing and shall be from a single manufacturer for each system used.
- 1.4.5 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Engineer.
- 1.4.6 Standard of Acceptance:
 - 1.4.6.1 Walls: No defects visible from a distance of 1000 mm at 90° to surface.
 - 1.4.6.2 Ceilings: No defects visible from floor at 45° to surface when viewed using final lighting source.
 - 1.4.6.3 Final coat is to exhibit uniformity of colour and uniformity of sheen across full surface area.
- 1.5 SCHEDULING OF WORK**
 - 1.5.1 Submit work schedule for various stages of painting to Engineer for approval. Submit schedule minimum of 48 hours in advance of proposed operations.
 - 1.5.2 Obtain written authorization from Engineer for changes in work schedule.
 - 1.5.3 Schedule painting operations to prevent disruption of occupants in and about the building.
- 1.6 EXTRA MATERIALS**
 - 1.6.1 Submit one 4 litre can of each type and colour of finish coating. Identify colour and paint type in relation to established colour schedule and finish formula.
 - 1.6.2 Deliver to Engineer and store where directed.
- 1.7 DELIVERY, HANDLING AND STORAGE**
 - 1.7.1 Deliver, store and handle materials in accordance with manufacturer's instructions.
 - 1.7.2 Deliver and store materials in original containers, sealed, with labels intact.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7.3 Labels shall clearly indicate:

1.7.3.1 Manufacturer's name and address.

1.7.3.2 Type of paint or coating.

1.7.3.3 Compliance with applicable standard.

1.7.3.4 Colour number in accordance with established colour schedule.

1.7.4 Remove damaged, opened and rejected materials from site.

1.7.5 Provide and maintain dry, temperature controlled, secure storage.

1.7.6 Observe manufacturer's recommendations for storage and handling.

1.7.7 Store materials and supplies away from heat generating devices.

1.7.8 Store materials and equipment in a well ventilated area with temperature range 7°C to 30°C.

1.7.9 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

1.7.10 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Engineer. After completion of operations, return areas to clean condition to approval of Engineer.

1.7.11 Remove paint materials from storage only in quantities required for same day use.

1.7.12 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.

1.7.13 Fire Safety Requirements:

1.7.13.1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.

1.7.13.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

1.7.13.3 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.8 SITE REQUIREMENTS

1.8.1 Heating, Ventilation and Lighting:

1.8.1.1 Ventilate enclosed spaces.

1.8.1.2 Perform no painting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10°C for 24 hours before, during and after paint application until paint has cured sufficiently.

1.8.1.3 Where required, provide continuous ventilation for seven days after completion of application of paint.

1.8.1.4 Provide temporary ventilating and heating equipment where permanent facilities are not available.

1.8.1.5 Perform no painting work unless a minimum lighting level of 323 Lux is provided on surfaces to be painted. Adequate lighting facilities shall be provided by General Contractor.

1.8.2 Temperature, Humidity and Substrate Moisture Content Levels:

1.8.2.1 Unless specifically pre-approved by Engineer and, applied product manufacturer, perform no painting work when:

1.8.2.1.1 ambient air and substrate temperatures are below 10°C.

1.8.2.1.2 substrate temperature is over 32°C unless paint is specifically formulated for application at high temperatures.

1.8.2.1.3 substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.

1.8.2.1.4 the relative humidity is above 85% or when dew point is less than 3°C variance between air/surface temperature.

1.8.2.1.5 rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

1.8.3 Surface and Environmental Conditions:

1.8.3.1 Apply paint finish only in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		

- 1.8.3.2 Apply paint only to adequately prepared surfaces and to surfaces within moisture limits noted herein.
- 1.8.3.3 Apply paint only when previous coat of paint is dry or adequately cured.
- 1.8.3.4 Apply paint finishes only when conditions forecast for entire period of application fall within manufacturer's recommendations.
- 1.8.3.5 Do not apply paint when:
 - 1.8.3.5.1 Temperature is expected to drop below 10°C before paint has thoroughly cured.
 - 1.8.3.5.2 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.
 - 1.8.3.5.3 Surface to be painted is wet, damp or frosted.
- 1.8.3.6 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.
- 1.8.3.7 Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.
- 1.8.3.8 Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.

1.9 WASTE MANAGEMENT AND DISPOSAL

- 1.9.1 Separate waste materials for reuse and recycling in accordance with General Requirements.
- 1.9.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- 1.9.3 Place materials defined as hazardous or toxic in designated containers.
- 1.9.4 Ensure emptied containers are sealed and stored safely.
- 1.9.5 Unused paint, coating materials must be disposed of at official hazardous material collections site as approved by Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.9.6 Paint, stain and wood preservative finishes and related materials (thinners, and solvents) are regarded as hazardous products and are subject to regulations for disposal.
- 1.9.7 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- 1.9.8 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- 1.9.9 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:
 - 1.9.9.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.
 - 1.9.9.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - 1.9.9.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - 1.9.9.4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.
- 1.9.10 Empty paint cans are to be dry prior to disposal or recycling (where available).

PART 2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Paint materials listed in the latest edition of the Master Painters Institute (MPI) Approved Products List (APL) are acceptable for use on this project.
- 2.1.2 Paint materials for each coating formula to be products of a single manufacturer.
- 2.1.3 Low odour products: whenever possible, select products exhibiting low odour characteristics. If two products are otherwise equivalent, select the product with the lowest odour. Only qualified products with E2 or E3 "Environmentally Friendly" rating are acceptable for use on this project.
- 2.1.4 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids, shall:
 - 2.1.4.1 Be water-based, water soluble, water clean-up.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.4.2 Be non-flammable
- 2.1.4.3 Be manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
- 2.1.4.4 Be manufactured without compounds which contribute to smog in the lower atmosphere.
- 2.1.4.5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- 2.1.5 Water-borne surface coatings must be manufactured and transported in a manner that steps of processes, including disposal of waste products arising therefrom, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada, Fisheries Act and Canadian Environmental Protection Act (CEPA).
- 2.1.6 Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- 2.1.7 Water-borne surface coatings must have a flash point of 61.0°C or greater.
- 2.1.8 Both water-borne surface coatings and recycled water-borne surface coatings must be made by a process that does not release:
 - 2.1.8.1 Matter in undiluted production plant effluent generating a 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.
 - 2.1.8.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.
- 2.1.9 Water-borne paints must meet a minimum "Environmentally Friendly" E2 rating.
- 2.2 **COLOURS**
 - 2.2.1 Engineer will provide Colour Schedule after Contract award.
 - 2.2.2 Selection of colours will be from manufacturer's full range of colours.
 - 2.2.3 Where specific products are available in a restricted range of colours, selection will be based on the limited range.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.4 Second coat in a three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

2.3.1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed only with Engineer's written permission.

2.3.2 Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.

2.3.3 Where thinner is used, addition shall not exceed paint manufacturer's recommendations. Do not use kerosene or any such organic solvents to thin water-based paints.

2.3.4 Thin paint for spraying according in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Engineer.

2.3.5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

2.4.1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following values:

Gloss Level /Category	Units @ 60°	Units @ 85°
G1 - matte finish	0 to 5	max. 10
G2 - velvet finish	0 to 10	10 to 35
G3 - eggshell finish	10 to 25	10 to 35
G4 - satin finish	20 to 35	min. 35
G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 - high gloss finish	> 85	

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4.2 Gloss level ratings of painted surfaces shall be as specified herein.

2.5 EXTERIOR PAINTING SYSTEMS

2.5.1 The following paint formulas require a three coat finish as indicated in the MPI Architectural Painting Specifications Manual.

2.5.2 Structural Steel and Metal Fabrications:

2.5.2.1 EXT 5.1J - Pigmented polyurethane finish (over high build epoxy).

2.5.3 Galvanized Metal: not chromate passivated

2.5.3.1 EXT 5.3D - Pigmented polyurethane finish for use in high contact/high traffic areas.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Perform preparation and operations for exterior painting in accordance with MPI Painting Specifications Manual except where specified otherwise.

3.1.2 Apply all paint materials in accordance with paint manufacturer's written application instructions.

3.2 EXAMINATION

3.2.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for painting exterior metal surfaces installation in accordance with manufacturer's written instructions.

3.2.1.1 Visually inspect substrate in presence of Engineer.

3.2.1.2 Carry out tests to determine existence of lead base paint on existing exterior metal surfaces.

3.2.1.3 If lead exists stop work and report findings to Engineer.

3.2.1.4 Inform Engineer of unacceptable conditions immediately upon discovery.

3.2.1.5 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 PREPARATION

3.3.1 Remove existing loose and rusted paint from exterior metal surfaces.

3.3.2 New metal surfaces:

3.3.2.1 Clean surfaces of new metal to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and foreign substances in accordance with the following:

3.3.2.1.1 Commercial blast cleaning: to SSPC-SP 6.

3.3.2.1.2 Solvent cleaning: to SSPC-SP 1.

3.3.2.1.3 Hand tool cleaning: to SSPC-SP 2.

3.3.2.1.4 Power tool cleaning: to SSPC-SP 3.

3.3.2.1.5 Brush-off blast cleaning: to SSPC-SP 7.

3.3.2.1.6 Near White Blast Cleaning: to SSPC-SP 10/NACE No. 2.

3.3.2.2 Commercial blast clean rusted and bare metal surfaces where existing paint system has failed.

3.3.2.3 Brush-off blast clean remaining metal surfaces to be painted.

3.3.2.4 Scrape edges of old paint back to sound material where remaining paint is thick and sound, feather exposed edges.

3.3.3 Compressed air to be free of water and oil before reaching nozzle.

3.3.4 Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes, by blowing with clean dry compressed air, or by vacuum cleaning.

3.3.5 Apply paint after prepared surfaces have been accepted by Engineer.

3.3.6 Prior to starting paint application ensure degree of cleanliness of surfaces is to SSPC-Vis1.

3.3.6.1 Apply primer, paint, or pre-treatment after surface has been cleaned and before deterioration of surface occurs.

3.3.6.2 Clean surfaces again if rusting occurs after completion of surface preparation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.7 Mixing paint:

- 3.3.7.1 Do not dilute or thin paint for brush application.
- 3.3.7.2 Mix ingredients in container before and during use and ensure breaking up of lumps, complete dispersion of settled pigment, and uniform composition.
- 3.3.7.3 Do not mix or keep paint in suspension by means of air bubbling through paint.
- 3.3.7.4 Thin paint for spraying according to manufacturer's written instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Engineer.

3.3.8 Number of paint coats:

- 3.3.8.1 New metal surfaces.
 - 3.3.8.1.1 Shop: 2 primer coats to minimum dry film thickness of 35 microns per coat.
 - 3.3.8.1.2 Field: 2 alkyd enamel or aluminum paint coats to minimum dry film thickness of 25 microns per coat.
- 3.3.8.2 Repainting existing metal surfaces.
 - 3.3.8.2.1 One primer coat to minimum dry film thickness of 35 microns to bare and commercial sand blasted areas.
 - 3.3.8.2.2 Two alkyd enamel or aluminum paint coats to minimum dry film thickness of 25 microns per coat.

3.4 APPLICATION

- 3.4.1 Manufacturer's Instructions: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- 3.4.2 Apply paint by spraying, brushing, or combination of both. Use sheepskins or daubers when no other method is practical in places of difficult access.
- 3.4.3 Use dipping or roller coating method of application when specifically authorized by Engineer in writing.
- 3.4.4 Caulk open seams at contact surfaces of built up members with material approved by Engineer, before second undercoat of primer is applied.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.5** Where surface to be painted is not under cover, do not apply paint when:
 - 3.4.5.1 Air temperature is below 5 degrees C or when temperature is expected to drop to 0 degrees C before paint has dried.
 - 3.4.5.2 Temperature of surface is over 50 degrees C unless paint is specifically formulated for application at high temperatures.
 - 3.4.5.3 Fog or mist occur at site; it is raining or snowing; there is danger of rain or snow; relative humidity is above 85%.
 - 3.4.5.4 Surface to be painted is wet, damp or frosted.
 - 3.4.5.5 Previous coat is not dry.
- 3.4.6** Supply cover when paint must be applied in damp or cold weather. Supply, shelter, or heat surface and surrounding air to comply with temperature and humidity conditions specified. Protect until paint is dry or until weather conditions are suitable.
- 3.4.7** Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.
- 3.4.8** Apply each coat of paint as continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- 3.4.9** Brush application:
 - 3.4.9.1 Work paint into cracks, crevices and corners and paint surfaces not accessible to brushes by spray, daubers or sheepskins.
 - 3.4.9.2 Brush out runs and sags.
 - 3.4.9.3 Remove runs, sags and brush marks from finished work and repaint.
- 3.4.10** Spray application:
 - 3.4.10.1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - 3.4.10.2 Provide traps or separators to remove oil and water from compressed air and drain periodically during operations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.10.3 Keep paint ingredients properly mixed in spray pots or containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
- 3.4.10.4 Apply paint in uniform layer, with overlapping at edges of spray pattern.
- 3.4.10.5 Brush out immediately runs and sags.
- 3.4.10.6 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray. In areas not accessible to spray gun, use brushes, daubers or sheepskins.
- 3.4.10.7 Remove runs, sags and brush marks from finished work and repaint.
- 3.4.11 Shop painting:
 - 3.4.11.1 Do shop painting after fabrication and before damage to surface occurs from weather or other exposure.
 - 3.4.11.2 Spray paint contact surfaces of field assembled, bolted, friction type joints with primer coat only. Do not brush primer after spraying.
 - 3.4.11.3 Do not paint metal surfaces which are to be embedded in concrete.
 - 3.4.11.4 Paint metal surfaces to be in contact with wood with either full paint coats specified or three shop coats of specified primer.
 - 3.4.11.5 Do not paint metal within 50 mm of edge to be welded. Give unprotected steel one coat of boiled linseed oil or other approved protective coating after shop fabrication is completed.
 - 3.4.11.6 Remove weld spatter before painting. Remove weld slag and flux by methods as specified in paragraph 3.2.3 Metal Surfaces to be Re-painted.
 - 3.4.11.7 Protect machine finished or similar surfaces that are not to be painted but that do require protection, with coating of rust inhibitive petroleum, molybdenum disulphide, or other coating approved by Engineer.
 - 3.4.11.8 Copy previous erection marks and weight marks on areas that have been shop painted.
- 3.4.12 Field painting:
 - 3.4.12.1 Paint steel structures as soon as practical after erection.

Page 15 of 17 



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.12.2 Touch up metal which has been shop coated with same type of paint and to same thickness as shop coat. This touch-up to include cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas.
- 3.4.12.3 Field paint surfaces (other than joint contact surfaces) which are accessible before erection but which are not to be accessible after erection.
- 3.4.12.4 Apply final coat of paint after concrete work is completed or as directed by Engineer. If concreting or other operations damage paint, clean and repaint damaged area. Remove concrete spatter and droppings before paint is applied.
- 3.4.12.5 Where painting does not meet with requirements of specifications, and when so directed by Engineer remove defective paint, thoroughly clean affected surfaces and repaint in accordance with these specifications.

3.4.13 Handling painted metal:

- 3.4.13.1 Handle painted metal after paint has dried, or when necessary for handling for painting or stacking for drying.
- 3.4.13.2 Scrape off and touch up paint which is damaged in handling, with same number of coats and kinds of paint as were previously applied to metal.

3.5 FIELD QUALITY CONTROL

3.5.1 Site Tests, Inspections:

- 3.5.1.1 Upon completion of the painting procedures test for dry film reading and evaluate the results as per SSPC-PA 2.

3.6 CLEANING

- 3.6.1 Progress Cleaning: clean in accordance with General Requirements.
- 3.6.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with General Requirements.

3.7 PROTECTION

- 3.7.1 Protect painted surfaces from damage during construction.
- 3.7.2 Protection of surfaces:
 - 3.7.2.1 Protect surfaces not to receive paint.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 09 97 19
CH0032	PAINTING EXTERIOR METAL SURFACES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO- MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.2.2 Prevent contamination of cleaned surfaces by salts, acids, alkalis, corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats of paint. Remove contaminants from surface and apply paint immediately.

3.7.2.3 Protect cleaned and freshly painted surfaces from dust to approval of Engineer.

3.7.3 Repair damage to adjacent materials caused by painting exterior metal surface application installation.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 01 31
SPILLWAY ELECTRICAL BLDG
AIR DUCT CLEANING FOR HVAC SYSTEMS**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 CONTRACTOR'S QUALIFICATION 2

 1.3 CONNECTED WORK 2

2. PRODUCTS 2

 2.1 EQUIPMENT 2

 2.2 CLEANING PRODUCTS..... 3

 2.3 ACCESS DOORS 3

3. EXECUTION 3

 3.1 PRE-CLEANING 3

 3.2 CLEANING 4

 3.3 POST CLEANING 5

 3.4 ENGINEER'S INSPECTION 6

APPENDIX A – LIST OF EQUIPMENT

APPENDIX B – LIST OF PRODUCTS AND APPLICATIONS

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Newfoundland and Labrador
Professional Geoscientists Association

This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL No 458
which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER
Newfoundland and Labrador
Professional Engineers Association

SCOTT M. PENNEY
Scott Penney
SIGNATURE
Dec 16/2013
DATE
NEWFOUNDLAND & LABRADOR

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 New ductwork and related HVAC equipment supplied and installed under this Contract shall be cleaned in accordance with this specification section.

1.2 CONTRACTOR'S QUALIFICATION

1.2.1 Cleaning work shall be carried out by a firm specialized in cleaning of ventilation equipment and accessories. The HVAC system cleaning Subcontractor shall provide a list of the five (5) latest cleaning projects carried out, indicating clients' names and contacts.

1.2.2 The HVAC system cleaning Subcontractor shall be a certified member of a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems. (National Air Duct Cleaners Association (NADCA), or accepted equal.)

1.2.3 The HVAC system cleaning Subcontractor shall have a minimum of one (1) air system cleaning specialist (ASCS) on staff, certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems (NADCA, or accepted equal.)

1.3 CONNECTED WORK

1.3.1 The HVAC system cleaning Subcontractor shall include in his quotation all related work such as dismantling or removal of ceilings, installation of access doors, moving and covering furniture, protecting floors or equipment, unless otherwise directed by the Engineer.

1.3.2 Provide architectural access doors in solid walls and ceilings as required by cleaning operations.

1.3.3 Provide architectural work (demolition/repair/painting) required for the installation of the new access doors. Repair finish to match existing.

1.3.4 Provide access doors in ductwork as required by cleaning operations.

2. PRODUCTS

2.1 EQUIPMENT

2.1.1 MAC2500 system (or equal) complete with 860 kPa minimum air compressor.

2.1.2 Industrial type vacuum cleaner with HEPA filters.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.3 Adjustable mechanical rotary brush.
- 2.1.4 Specialized Robotic Duct Cleaning System, Brandy II.
- 2.1.5 Refer to list of equipment in Appendix "A" of this specification section.

2.2 CLEANING PRODUCTS

- 2.2.1 All cleaning products to comply with the requirements of LEED® credits EQ 4.1 and EQ 4.2.
- 2.2.2 All cleaning products used shall meet current standards and regulations. The HVAC system cleaning Subcontractor shall supply data sheet on toxicity for each product used. All products shall be accepted by the Engineer.
- 2.2.3 To prevent system unbalance, yellowing of walls and to maintain air quality, the use of varnish, glue and other sealants attaching dust to the surface is strictly prohibited.
- 2.2.4 During the execution of the work, the HVAC system cleaning Subcontractor shall use non-polluting products, having no adverse effect on equipment, premises nor environment. Products shall not be toxic, carcinogenic nor offensive to occupants.
- 2.2.5 Acceptable products for each application (see Appendix "B" of this specification section).

2.3 ACCESS DOORS

- 2.3.1 Access doors in ductwork shall meet specification Section 23 33 00 - Air Duct Accessories.
- 2.3.2 Access doors for solid walls and ceilings shall meet specification Section 08 31 00.01 - Access Doors - Mechanical.

3. EXECUTION

3.1 PRE-CLEANING

- 3.1.1 Video inspection and recording shall be done with a remote robot, utilizing DVD format, for optimum clarity. This shall include a mechanical inspection of safety equipment and ventilation filtration components.
- 3.1.2 Before commencement of cleaning activities, the HVAC system cleaning Subcontractor shall submit to the Engineer for review a cleaning schedule indicating the description of equipment to be cleaned and the cleaning procedures to be utilized.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 CLEANING

3.2.1 Ductwork:

- .1 Metallic ductwork shall be cleaned employing robotic direct contact brushing. The cleaning of the ductwork shall employ a proprietary set of motorized brushes that are designed to operate and fit within the size and conditions of the ductwork. These brushes shall contact the ductwork on all four sides simultaneously, providing a work method that ensures particulate removal of a quality superior to traditional compressed air and hand vacuuming. These brushes shall render the interior surface of ductwork to its original clean, smooth condition. In addition, specialized robotic tracked vehicles shall be used to provide video scanning and direct contact cleaning where applicable.
- .2 Both pressurized and cellular foam gaskets shall be employed in the ductwork during cleaning to ensure the loosened particulate is directed to the HEPA filtration units and not allowed to enter the workplace. As a secondary safety precaution in specialized areas, sterilized sheets shall be used as drop cloths.
- .3 A proprietary HEPA filtered vacuum air handling machine shall be employed to exhaust contaminants from the ductwork as they are removed from the ductwork surfaces by robotic direct contact brushes and robots.
- .4 All vacuum units shall utilize high efficiency absolute filters (better than 99.997% retention at 0.3 microns).
- .5 All particulate captured by the HEPA filtration units shall be contained and disposed of at an approved site.

3.2.2 Fans, air handling units and energy recovery units:

- .1 Supply, exhaust and return air fans shall be vacuumed utilizing HEPA filtered vacuum equipment.
- .2 Fans and fan housings shall be cleaned utilizing HEPA filtered vacuum equipment.
- .3 Filter trays and housings shall be vacuumed utilizing HEPA filtered vacuum equipment.
- .4 Mixing plenums shall be vacuumed utilizing HEPA filtered vacuum equipment.
- .5 Heating coils, cooling coils and heat recovery cores shall be vacuumed utilizing HEPA filtered vacuum equipment. In addition, coils shall be washed with high pressure air and will have their fins combed with coil combs.

3.2.3 Fire dampers:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 All vacuuming and cleaning shall be performed with HEPA filtered vacuum equipment. Improper fit and air leakage associated with equipment mounting shall be identified and reported.
- .2 Fusible links shall be identified and replaced, if required.

3.2.4 Ventilation diffusers, registers and grilles:

- .1 All ventilation diffusers, registers and grilles shall be cleaned utilizing HEPA filtered vacuum equipment.
- .2 Mark original settings of mechanism before cleaning.

3.2.5 Access openings:

- .1 Robotics shall be used to provide access to the ventilation duct distribution system at all existing outlets to minimize damage to the mechanical integrity of the ventilation systems.
- .2 Cut openings in ductwork and install new duct access doors as required to facilitate cleaning operations.
- .3 Duct access doors shall meet specification Section 23 33 00 – Air Duct Accessories.

3.2.6 Air intake louvres:

- .1 Air intake louvers and screens shall be vacuumed utilizing HEPA filtered vacuum equipment.

3.2.7 Dampers:

- .1 Manual balancing dampers and automatic control dampers shall be cleaned utilizing HEPA filtered vacuum equipment.
- .2 Mark original settings of mechanism before cleaning.

3.3 POST CLEANING

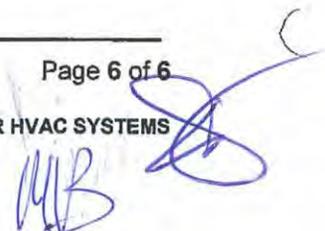
3.3.1 Inspection and documentation:

- .1 After the cleaning procedure is complete, a visual inspection shall again be performed by the robot which shall provide a DVD video of the cleaned ductwork.
- .2 All mechanical deficiencies noted in the robotic inspections shall be identified.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 ENGINEER'S INSPECTION

- 3.4.1 The HVAC system cleaning Subcontractor shall permit free access to the Engineer for the inspection of ongoing work. The HVAC system cleaning Subcontractor shall provide all required assistance to the Engineer during these inspections.
- 3.4.2 The HVAC system cleaning Subcontractor shall supply remote controlled equipment for the Engineer to visualize progress of HVAC systems cleaning, as required.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPELLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

APPENDIX "A"
LIST OF EQUIPMENT

Commercial vacuum cleaner 85 L/S:

- Standard filter.

Industrial vacuum cleaner 99 L/S:

- HEPA filter
- 45 to 170 litre tank.

Pick-up unit under vacuum:

- HEPA filter
- 151 litre mobile tank 200, 250, 300, 350 mm hoses
- 104 to 1181 L/S blower.

Brushes with telescopic handle:

- 100, 150, 175, 225, 300, 350 mm.
- 4.87 m reach.

Rotary electric brushes with adapter:

- 100, 150, 175, 225, 300, 350 mm
- Rotation adaptor
- Suction adapter.

Manual brushes in various sizes:

- Manual atomizer
- Electric atomizer
- Stiff brush for coils
- 827 kPa air compressor
- Vacuum cleaner for liquids.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 01 31
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT CLEANING FOR HVAC SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

APPENDIX "B"
LIST OF PRODUCTS AND APPLICATIONS

CC800
(degreaser)
Distributed by: DMCD Distribution

Turning vanes
Dampers
Filter sections
Fan sections
Louvers
Drainage pans
Plenums
Mixing boxes

Neutrac
(Neutral detergent, no acid, no alkali)
Distributed by: Lalema Inc

Grilles
Diffusers
Deflectors

CC200
Distributed by: DMCD Distribution

Coils

ET100 (vinyl base)
Distribution by : DMCD Distribution

Coating for acoustic insulation

END OF SECTION



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 00
CH0032	SPILLWAY ELECTRICAL BLDG COMMON WORK RESULTS FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 05 00
SPILLWAY ELECTRICAL BLDG
COMMON WORK RESULTS FOR HVAC**

1. GENERAL..... 2

 1.1 RELATED SECTIONS 2

 1.2 SUBMITTALS 2

 1.3 QUALITY ASSURANCE 4

 1.4 MAINTENANCE..... 4

 1.5 DELIVERY, STORAGE, AND HANDLING 5

2. PRODUCTS 5

 2.1 MATERIALS 5

3. EXECUTION 5

 3.1 PAINTING, REPAIRS AND RESTORATION 5

 3.2 CLEANING 5

 3.3 FIELD QUALITY CONTROL 5

 3.4 DEMONSTRATION 6

 3.5 PROTECTION 6

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To practice Professional Geoscience
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Permit No. as issued by PEGNL NO458
which is valid for the year 2013



REGISTERED PROFESSIONAL ENGINEER
Newfoundland and Labrador
SCOTT M. PENNEY
Scott Penney
SIGNATURE
Dec 6/2013
DATE
NEWFOUNDLAND & LABRADOR

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 00
CH0032	SPILLWAY ELECTRICAL BLDG COMMON WORK RESULTS FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

1.1.2 Section 09 91 23 – Interior Painting.

1.2 SUBMITTALS

1.2.1 Shop drawings; submit drawings stamped and signed for approval.

1.2.2 Shop drawings to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances.

1.2.3 Shop drawings and product data accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Acoustical sound power data, where applicable.
- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.

1.2.4 Use Mechanical Contractors Association of Canada (MCAC) "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.2.5 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into operations and maintenance manual.
- .2 Operation and maintenance manual approved by, and final copies deposited before final inspection.
- .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 00
CH0032	SPILLWAY ELECTRICAL BLDG COMMON WORK RESULTS FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
- .4 Operation instruction for systems and component.
- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93- Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual for approval.
 - .2 Make changes as required and re-submit as directed.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 00
CH0032	SPILLWAY ELECTRICAL BLDG COMMON WORK RESULTS FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.8 Site records:

- .1 One (1) set of mechanical drawing AutoCAD files shall be provided. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
- .2 Transfer information weekly to reproducible, revising reproducible to show work as actually installed.
- .3 Use different colour for each service.
- .4 Make available for reference purposes and inspection.

.9 As-built drawings:

- .1 Prior to start of Testing, Adjusting and Balancing (TAB) for HVAC, finalize production of as-built drawings.
- .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .3 Submit for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed Mechanical AutoCAD as-built drawings CD with Operation and Maintenance Manuals.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 QUALITY ASSURANCE

- 1.3.1 Quality Assurance: in accordance with Quality Requirements.
- 1.3.2 Health and Safety Requirements: perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.4 MAINTENANCE

- 1.4.1 Furnish spare parts as specified.
- 1.4.2 Provide one set of special tools required to service equipment as recommended by manufacturers.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 00
CH0032	SPILLWAY ELECTRICAL BLDG COMMON WORK RESULTS FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Waste Management and Disposal:

1.5.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 MATERIALS

2.1.1 All materials used on this project shall be new and CSA approved unless noted otherwise.

2.1.2 All electrical equipment and wiring shall be in accordance with CSA C22.1, The Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

3. EXECUTION

3.1 PAINTING, REPAIRS AND RESTORATION

3.1.1 Do painting in accordance with Section 09 91 23 - Interior Painting.

3.1.2 Prime and touch up marred finished paintwork to match original.

3.1.3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

3.1.4 Ferrous supports and site fabricated work shall be primed.

3.1.5 Apply cold galvanizing to all galvanized surfaces which have been field welded, burned or cut.

3.2 CLEANING

3.2.1 Clean interior and exterior of all systems including strainers.

3.3 FIELD QUALITY CONTROL

3.3.1 Site Tests: conduct following tests in accordance with Quality Requirements and submit report as described in 1.2 - SUBMITTALS.

.1 Submit tests as specified in other sections of this specification.

3.3.2 Manufacturer's Field Services:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 00
CH0032	SPILLWAY ELECTRICAL BLDG COMMON WORK RESULTS FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in 1.2 - SUBMITTALS.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in 1.3 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

- 3.4.1 The Company shall use equipment and systems for test purposes prior to acceptance. Contractor to supply labour, material, and instruments required for testing.
- 3.4.2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- 3.4.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- 3.4.4 Instruction duration time requirements as specified in appropriate sections.
- 3.4.5 The Company may record these demonstrations on video tape for future reference.

3.5 PROTECTION

- 3.5.1 Protect equipment and system openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 01
CH0032	SPILLWAY ELECTRICAL BLDG USE OF HVAC SYSTEMS DURING CONSTRUCTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 23 05 01
SPILLWAY ELECTRICAL BLDG
USE OF HVAC SYSTEMS DURING CONSTRUCTION**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 USE OF SYSTEMS 2

2. PRODUCTS (NOT USED)..... 3

3. EXECUTION (NOT USED)..... 3

PROVINCE OF NEWFOUNDLAND AND LABRADOR

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PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

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REGISTERED PROFESSIONAL ENGINEER

PEG
Newfoundland
and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

SCOTT M. PENNEY

Scott Penney
SIGNATURE

Dec 16 / 2013
DATE

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 01
CH0032	SPILLWAY ELECTRICAL BLDG USE OF HVAC SYSTEMS DURING CONSTRUCTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. General

1.1 SUMMARY

1.1.1 Use of HVAC systems during construction.

1.2 USE OF SYSTEMS

1.2.1 Use of new and/or existing permanent heating and/or ventilating systems for supplying temporary heat or ventilation is permitted only under the following conditions:

- .1 Entire system is complete, pressure tested, cleaned.
- .2 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
- .3 There is no possibility of damage from any cause.
- .4 Supply ventilation systems are protected by a minimum of MERV 11 filters, which shall be inspected daily, changed every week or more frequently as required.
- .5 Return systems have approved filters over all openings, inlets, outlets.
- .6 All systems will be:
 - .1 Operated as per manufacturer's recommendations or instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
- .7 Warranties and guarantees are not thereby relaxed.
- .8 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Company.
- .9 Refurbish entire system before project completion; clean internally and externally, restore to "as- new" condition, and replace filters in air systems.

1.2.2 Filters specified in this section are over and above those specified in other sections of this project.

1.2.3 Exhaust systems are not included in any approvals for temporary heating or ventilation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 01
CH0032	SPELLWAY ELECTRICAL BLDG USE OF HVAC SYSTEMS DURING CONSTRUCTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 05
CH0032	INSTALLATION OF PIPEWORK	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 23 05 05
INSTALLATION OF PIPEWORK**

TABLE OF CONTENTS

PART 1 GENERAL.....2

1.1 RELATED SECTIONS.....2

1.2 REFERENCES.....2

1.3 QUALITY ASSURANCE.....2

1.4 WASTE MANAGEMENT & DISPOSAL.....2

PART 2 PRODUCTS (NOT USED).....3

PART 3 EXECUTION.....3

3.1 CONNECTIONS TO EQUIPMENT.....3

3.2 CLEARANCES.....3

3.3 DIELECTRIC COUPLINGS.....3

3.4 PIPEWORK INSTALLATION.....3

3.5 FLUSHING OUT OF PIPING SYSTEMS.....4

3.6 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK.....5

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 05
CH0032	INSTALLATION OF PIPEWORK	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 23 11 13 – Facility Fuel-Oil Piping.

1.2 REFERENCES

1.2.1 Canadian General Standards Board (CGSB):

1.2.1.1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.2.2 Newfoundland and Labrador Government Regulations:

1.2.2.1 Newfoundland and Labrador Regulations 58/03 - The storage and handling of gasoline and associated product regulations.

1.2.2.2 Nalcor Energy Engineering Directive # CF-ED-004 – Diesel System Installation and Abandonment Engineering Directive.

1.3 QUALITY ASSURANCE

1.3.1 Installers to be certified to journeyperson and approved by the authority having jurisdiction.

1.4 WASTE MANAGEMENT & DISPOSAL

1.4.1 Separate and recycle waste materials in accordance with local municipal regulations.

1.4.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.4.3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling.

1.4.4 Divert unused metal material from landfill to metal recycling facility approved by Owner.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 05
CH0032	INSTALLATION OF PIPEWORK	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CONNECTIONS TO EQUIPMENT

- 3.1.1 In accordance with manufacturer's instructions unless otherwise indicated.
- 3.1.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

3.2 CLEARANCES

- 3.2.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- 3.2.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, and components.

3.3 DIELECTRIC COUPLINGS

- 3.3.1 General: Compatible with system, to suit pressure rating of system.
- 3.3.2 Locations: Where dissimilar metals are joined.
- 3.3.3 Dielectric Unions are not to be used for purposes of disassembly where disassembly is required. Provide Dielectric union or couplings and separate non-dielectric union.

3.4 PIPEWORK INSTALLATION

- 3.4.1 Installation by certified journeyperson.
- 3.4.2 Socket welded fittings as specified in Section 23 11 13 – Facility Fuel-Oil Piping.
- 3.4.3 Protect openings against entry of foreign material.
- 3.4.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- 3.4.5 Assemble piping using fittings manufactured to ANSI standards.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 05
CH0032	INSTALLATION OF PIPEWORK	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.4.6 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
- 3.4.6.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- 3.4.7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- 3.4.8 Install concealed pipework to minimize furring space, maximize headroom, and conserve space.
- 3.4.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- 3.4.10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- 3.4.11 Group piping wherever possible and as indicated.
- 3.4.12 Ream pipes, remove scale and other foreign material before assembly.
- 3.4.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- 3.4.14 Provide for thermal expansion as required.
- 3.4.15 Valves:
 - 3.4.15.1 Install in accessible locations;
 - 3.4.15.2 Remove interior parts before soldering;
 - 3.4.15.3 Install with stems above horizontal position unless otherwise indicated;
 - 3.4.15.4 Valves accessible for maintenance without removing adjacent piping;
 - 3.4.15.5 Install valves as indicated and as required for a code compliant system.
 - 3.4.15.6 Install piping in accordance with 23 11 13 – Facility Fuel-Oil Piping.
- 3.5 **FLUSHING OUT OF PIPING SYSTEMS**
 - 3.5.1 In accordance with Section 23 11 13 - Facility Fuel-Oil Piping

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 05
CH0032	INSTALLATION OF PIPEWORK	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition.

3.6 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

3.6.1 Advise Engineer, 48 hours minimum prior to performance of pressure tests.

3.6.2 Pipework: Test as specified in relevant sections of other sections or Divisions, Nalcor Engineering Directive and in accordance with Newfoundland and Labrador Regulations 58/03, whichever is more stringent.

3.6.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of other Divisions.

3.6.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

3.6.5 Conduct tests in presence of Engineer.

3.6.6 Pay costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.

3.6.7 Insulate or conceal work only after approval and certification of tests by Engineer.

3.6.8 Provide test reports for all piping installed under this contract to Engineer for review. Reports to include the following:

3.6.8.1 Date of test;

3.6.8.2 Witness to test;

3.6.8.3 Pipe tested (i.e. pipe type, size, material, service and location);

3.6.8.4 Test duration;

3.6.8.5 Test pressure;

3.6.8.6 Test results;

3.6.8.7 Signatures of all involved in test including Engineer.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 13
CH0032	SPILLWAY ELECTRICAL BLDG COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 05 13
SPILLWAY ELECTRICAL BLDG
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 REFERENCES 2

 1.3 SUBMITTALS 2

 1.4 QUALITY ASSURANCE 2

 1.5 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 3

 2.1 GENERAL 3

 2.2 MOTORS 3

 2.3 TEMPORARY MOTORS..... 4

 2.4 DRIVE GUARDS 4

3. EXECUTION 4

 3.1 MANUFACTURER'S INSTRUCTIONS 4

 3.2 INSTALLATION 4

 3.3 FIELD QUALITY CONTROL 4

 3.4 CLEANING 5

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CH0032	SPILLWAY ELECTRICAL BLDG COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Electrical motors, drives and guards for mechanical equipment and systems.

1.2 REFERENCES

1.2.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

- .1 ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).

1.2.2 Model National Energy Code for Buildings (MNECB).

1.2.3 National Electrical Manufacturers Association (NEMA).

1.2.4 U.S. Department of Energy (DOE) Energy Policy Act (EPACT).

1.3 SUBMITTALS

1.3.1 Product Data:

- .1 Shop Drawings: Submit drawings stamped and signed for approval.
- .2 Quality Control: in accordance with Quality Requirements.
 - .1 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into operations and maintenance manual.

1.4 QUALITY ASSURANCE

1.4.1 Quality Assurance: in accordance with Quality Requirements.

1.4.2 Health and Safety Requirements: perform construction occupational health and safety in accordance with Health and Safety Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 13
CH0032	SPILLWAY ELECTRICAL BLDG COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.5.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 GENERAL

- 2.1.1 Motors 1 HP and above shall be NEMA premium efficiency.
- 2.1.2 Motors below 1 HP shall be standard efficiency in accordance with the Energy Policy Act (EPACT) and the requirements of ASHRAE 90.1.
- 2.1.3 All electrical equipment and wiring shall be in accordance with CSA C22.1, The Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

2.2 MOTORS

- 2.2.1 Provide motors for mechanical equipment as specified.
- 2.2.2 Motors shall be NEMA design B unless otherwise noted.
- 2.2.3 Motors shall be insulation Class B unless otherwise noted. Class B insulated motors shall have a motor insulation temperature rating of 130°C with an allowable temperature rise at full load with 1.0 service factor of 80°C and an allowable temperature rise at 1.15 service factor of 90°C. The reference ambient temperature shall be 40°C. The 10°C temperature differential between the allowable maximum temperature shall provide a "hot spot" allowance for the interior of the motor winding.
- 2.2.4 All motors shall be suitable for variable torque application unless otherwise noted.
- 2.2.5 All motors to have minimum 1.15 service factor unless otherwise noted.
- 2.2.6 See mechanical data sheets for motor HP and voltage.
- 2.2.7 All motors to be squirrel cage induction motors unless otherwise noted.
- 2.2.8 All motors to be continuous duty rated.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 13
CH0032	SPILLWAY ELECTRICAL BLDG COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.9 All motor enclosures to be TEFC unless otherwise noted.

2.2.10 Motors shall be regreaseable and shall have bearings with a minimum L10 life of 200,000 hrs.

2.3 TEMPORARY MOTORS

2.3.1 If delivery of specified motor will delay completion or commissioning work, install motor accepted by the Company for temporary use. Work will only be accepted when specified motor is installed.

2.4 DRIVE GUARDS

2.4.1 Guard for flexible coupling:

- .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
- .2 Securely fasten in place.
- .3 Removable for servicing.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

3.2.1 Fasten securely in place.

3.2.2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

3.3.1 Site Tests: conduct following tests in accordance with Quality Requirements and submit report as described in 1.3 - SUBMITTALS.

- .1 As specified in other sections of this specification.

3.3.2 Manufacturer's Field Services:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 13
CH0032	SPELLWAY ELECTRICAL BLDG COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in 1.3 - SUBMITTALS.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in 1.4 - QUALITY ASSURANCE.

3.4 CLEANING

- 3.4.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 17
CH0032	PIPE WELDING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

SECTION 23 05 17

PIPE WELDING

TABLE OF CONTENTS

PART 1 GENERAL 2

 1.1 RELATED SECTIONS 2

 1.2 REFERENCES 2

 1.3 QUALIFICATIONS 3

 1.4 QUALITY ASSURANCE 3

 1.5 APPLICATION 4

PART 2 PRODUCTS 4

 2.1 ELECTRODES 4

PART 3 EXECUTION 4

 3.1 WORKMANSHIP 4

 3.2 INSTALLATION REQUIREMENTS 4

 3.3 INSPECTION AND TESTS – GENERAL REQUIREMENTS 4

 3.4 SPECIALIST EXAMINATIONS AND TESTS 5

 3.5 DEFECTS CAUSING REJECTION 6

 3.6 REPAIR OF WELDS WHICH FAILED TESTS 6

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 17
CH0032	PIPE WELDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 23 05 05 – Installation of Pipework.
- 1.1.2 Section 23 11 13 – Facility Fuel-Oil Piping.

1.2 REFERENCES

- 1.2.1 American Society for Testing and Materials (ASTM):
 - 1.2.1.1 ASTM E709, Standard Guide for Magnetic Particle Examination.
- 1.2.2 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - 1.2.2.1 ANSI/ASME B31.9, Building Services Piping.
 - 1.2.2.2 ANSI/ASME Boiler and Pressure Vessel Code:
 - 1.2.2.2.1 Section V: Non-destructive Examination.
 - 1.2.2.2.2 Section IX: Welding and Brazing Qualifications.
- 1.2.3 American National Standards Institute/American Water Works Association (ANSI/AWWA):
 - 1.2.3.1 ANSI/AWWA C206, Field Welding of Steel Water Pipe.
- 1.2.4 American Welding Society (AWS):
 - 1.2.4.1 AWS C1.1, Recommended Practices for Resistance Welding.
 - 1.2.4.2 AWS D1.1/D1.1M, Structural Welding Code – Steel.
 - 1.2.4.3 AWS Z49.1, Safety Welding, Cutting and Allied Process.
 - 1.2.4.4 AWS W1, Welding Inspection Handbook.
- 1.2.5 Canadian General Standards Board:
 - 1.2.5.1 CAN/CGSB-48.2, Spot Radiography of Welded Butt Joints in Ferrous Materials.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 17
CH0032	PIPE WELDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.2.6** Canadian Standards Association (CSA International):
 - 1.2.6.1 CSA W48 Series, Filler Metals and Allied Materials for Metal Arc Welding.
 - 1.2.6.2 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
 - 1.2.6.3 CSA-W117.2, Safety in Welding, Cutting and Allied Processes.
 - 1.2.6.4 CSA W178.1, Certification of Welding Inspection Organizations.
 - 1.2.6.5 CSA W178.2, Certification of Welding Inspectors.
- 1.2.7** Provincial regulations:
 - 1.2.7.1 Province of Newfoundland and Labrador, Boiler, Pressure Vessel and Compressed Gas Regulations.
- 1.3 QUALIFICATIONS**
 - 1.3.1** Welders:
 - 1.3.1.1 Welding qualifications in accordance with CSA B51.
 - 1.3.1.2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - 1.3.1.3 Furnish welder's qualifications to Engineer/Architect.
 - 1.3.1.4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - 1.3.2** Inspectors:
 - 1.3.2.1 Inspectors qualified to CSA W178.2.
- 1.4 QUALITY ASSURANCE**
 - 1.4.1 Registration of welding procedures in accordance with CSA B51 and Provincial regulations.
 - 1.4.2 Copy of welding procedures available for inspection.
 - 1.4.3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 17
CH0032	PIPE WELDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 APPLICATION

- 1.5.1 Pipe steel support assemblies.
- 1.5.2 Socket welded piping, valves and fittings.

PART 2 PRODUCTS

2.1 ELECTRODES

- 2.1.1 Electrodes: in accordance with CSA W48 Series.

PART 3 EXECUTION

3.1 WORKMANSHIP

- 3.1.1 Welding: in accordance with ANSI/ASME B31.9, ANSI/ASME Boiler and Pressure Vessel Code, Section IX and ANSI/AWWA C206, using procedures conforming to AWS C1.1, and special procedures specified elsewhere in Division 23 and applicable requirements of provincial authority having jurisdiction.

3.2 INSTALLATION REQUIREMENTS

- 3.2.1 Identify each weld with welder's identification symbol.
- 3.2.2 Backing rings:
 - 3.2.2.1 Where used, fit to minimize gaps between ring and pipe bore.
- 3.2.3 Fittings:
 - 3.2.3.1 NPS 2 and smaller: install welding type sockets.
 - 3.2.3.2 Branch connections: install welding tees or forged branch outlet fittings.

3.3 INSPECTION AND TESTS – GENERAL REQUIREMENTS

- 3.3.1 Review weld quality requirements and defects limits of applicable codes and standards with Engineer/Architect before work is started.
- 3.3.2 Formulate "inspection and Test Plan" in co-operation with Engineer/Architect.
- 3.3.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 17
CH0032	PIPE WELDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.4 SPECIALIST EXAMINATIONS AND TESTS

3.4.1 General:

3.4.1.1 Perform examinations and tests by specialist engaged by Contractor, qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Engineer/Architect.

3.4.1.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.

3.4.1.3 Inspect and test welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and spot or full gamma ray radiographic (hereinafter referred to as "radiography") or magnetic particle tests. As per applicable reference standard or as specified.

3.4.2 Hydrostatically test welds to requirements of ANSI/ASME B31.9 and/or requirements of specification Section 23 05 05 – Installation of Pipework or Section 23 11 13 – Facility Fuel – Oil Piping whichever is greater.

3.4.3 Visual examinations: include entire circumference of weld externally and wherever possible internally. All welds to be visually inspected.

3.4.4 Failure of visual examinations:

3.4.4.1 Upon failure of a weld by visual examination, perform additional testing as directed by Engineer/Architect of total of up to 10% of all welds performed by the welder responsible for the weld failure, selected by Engineer/ Architect by either radiographic or magnetic particle tests depending upon weld type.

3.4.5 Full radiographic tests for piping system.

3.4.5.1 Spot radiography to CAN/CGSB-48.2.

3.4.5.1.1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Engineer/Architect from welds which would be most difficult to repair in event of failure after system is operational.

3.4.5.2 Radiographic film:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 17
CH0032	PIPE WELDING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.5.2.1 Identify each radiographic film with date, location, name of welder, and submit to Engineer/Architect. Replace film if rejected because of poor quality.

3.4.5.3 Interpretation of radiographic films:

3.4.5.3.1 By qualified radiographer.

3.4.5.4 Failure of radiographic tests:

3.4.5.4.1 Extend tests to all welds by welder responsible for failed welds.

3.4.6 Full magnetic particle tests for piping systems:

3.4.6.1 Magnetic particle testing to ASTM E709.

3.4.6.2 Procedure as outlined above for radiography.

3.5 DEFECTS CAUSING REJECTION

3.5.1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessel Code.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

3.6.1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

END OF SECTION

96
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 05 48
SPILLWAY ELECTRICAL BLDG
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT**

1. GENERAL 2

 1.1 SUMMARY 2

 1.2 RELATED SECTIONS 2

 1.3 REFERENCES 2

 1.4 SUBMITTALS 2

 1.5 QUALITY ASSURANCE 3

 1.6 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 3

 2.1 GENERAL 3

 2.2 HANGERS 3

 2.3 SEISMIC CONTROL MEASURES 4

3. EXECUTION 6

 3.1 MANUFACTURER'S INSTRUCTIONS 6

 3.2 INSTALLATION 6

 3.3 FIELD QUALITY CONTROL 7

 3.4 CLEANING 7

 3.5 SYSTEM DESIGN 7

 3.6 SUBMITTALS 8

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPELLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1. GENERAL

1.1 SUMMARY

1.1.1 Section includes:

- .1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 RELATED SECTIONS

1.2.1 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

1.2.2 Section 23 34 00 – HVAC Fans

1.3 REFERENCES

1.3.1 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS)

1.3.2 National Building Code of Canada (NBC)

1.3.3 American Society of Civil Engineers (ASCE/SEI):

- .1 ASCE/SEI-7, Minimum Design Loads for Buildings and Other Structures.

1.3.4 Canadian Standards Association (CSA)

- .1 CSA 5832 – Seismic Risk Reduction of Operational and Functional Components (OFCs) of Building

1.3.5 Sheet Metal And Air Conditioning Contractors' National Association (SMACNA)

- .1 Seismic Restraint Manual – Guidelines for Mechanical Systems

1.4 SUBMITTALS

1.4.1 Shop drawings.

- .1 Shop drawings; submit drawings stamped and signed for approval.
- .2 Provide separate shop drawings for each isolated system, complete with performance and product data.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .3 Seismic control/restraint system shop drawings shall be sealed by a professional engineer registered in the Province of Newfoundland and Labrador.
- .4 Provide detailed drawings, calculations and layouts of seismic control measures.

1.4.2 Quality assurance submittals: submit following in accordance with Quality Requirements.

- .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
- .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.5 QUALITY ASSURANCE

1.5.1 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 GENERAL

- 2.1.1** Size and shape of bases type and performance of vibration isolation to be as indicated.

2.2 HANGERS

- 2.2.1** To be utilized to isolate suspended sources of audible and inaudible sound and vibration such as inline pumps, inline fans, piping and ductwork.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.2 Shipped to site fully assembled and ready for installation in threaded metal rod suspension systems.
- 2.2.3 Free standing, large diameter, laterally stable steel springs in series with an elastomer-in-shear insert, assembled into a stamped or welded bracket.
- 2.2.4 Hanger shall incorporate a high deflection, colour coded spring element with load transfer plate and a 10 mm deflection elastomeric isolator.
- 2.2.5 Minimum lateral stiffness of 1.2 times the rated vertical stiffness.
- 2.2.6 Specially designed spring load plate shall prevent the possibility of short circuiting.
- 2.2.7 Hangers shall allow a support rod misalignment through a 30° arc without short circuiting.
- 2.2.8 Hanger brackets shall be capable of carrying a 500% overload without failure.
- 2.2.9 Rated hanger deflection shall be 25 mm.
- 2.2.10 Hanger bracket and spring element to be epoxy powder coated.
- 2.2.11 Acceptable product: Vibron Model SRH, Korfund, Vibro-Acoustics, or accepted equal.

2.3 SEISMIC CONTROL MEASURES

2.3.1 General:

- .1 Design seismic control measures to meet requirements of the current National Building Code of Canada (NBC). The building is defined as a post-disaster building as per Section 1.4.1.2, Div. A, NBC. The Seismic Restraint System (SRS) shall be designed as per Section 4.1.8.18, Div. B, NBC. The area specific seismic data used for the calculations such as acceleration at ground level for 0.2 seconds and 1 second shall be per Appendix C, Climatic and Seismic Information for Building Design in Canada, Div. B, NBC.
- .2 All systems and equipment shall remain operational during and after earthquakes. Design shall conform to SMACNA and CSA-S832. Performance objective to be "Functional (F)" and performance level to be "high" according to Section 5.2.4 of CSA-S832.
- .3 The design calculations, drawing and details shall be performed and sealed by a professional engineer registered in the Province of Newfoundland and Labrador. These shall be submitted for approval, including shop drawings and Technical Data Sheets.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

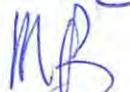
- .4 Seismic Restraint System shall be from one manufacturer.
- .5 Seismic control system to work in every direction.
- .6 Fasteners and attachment points to resist same maximum load as seismic restraint.
- .7 Drilled or power driven anchors and fasteners are not permitted.
- .8 No equipment, equipment supports or mounts shall fail before failure of structure.
- .9 Supports of cast iron or threaded pipe not permitted.
- .10 Seismic control measures not to interfere with integrity of fire stopping.

2.3.2 Static Equipment:

- .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
- .2 Suspended equipment:
 - .1 Use one or more of the following methods:
 - .1 Install tight to structure.
 - .2 Cross brace in every direction.
 - .3 Brace back to structure
 - .4 Cable restraint system
- .3 Seismic Restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.
 - .3 Prevent sway in horizontal plane, "knocking" in vertical plane, sliding and buckling in axial direction.

2.3.3 Vibration Isolated Equipment:

- .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm of clearance during normal operation of equipment and systems between seismic restraint and equipment.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.

2.3.4 Piping Systems:

- .1 Fire protection systems: to NFPA 13.
- .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
- .3 Compatible with requirements for anchoring and guiding of piping systems

2.3.5 Bracing methods:

- .1 Structural angles or channels
- .2 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance:** comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- 3.2.1** Seismic control measures to meet requirements of NBC.
- 3.2.2** Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- 3.2.3** Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- 3.2.4** Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS 4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and Over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.5 Support ductwork connected to mechanical equipment with isolation hangers with 25 mm minimum static deflection as follows:

- .1 All ductwork within mechanical rooms.
- .2 All ductwork within first 3 points of support from rotating equipment

3.2.6 All duct connections to mechanical equipment shall be made with flexible duct connectors.

3.2.7 Where isolation is bolted to floor, use vibration isolation rubber washers.

3.2.8 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level before isolation adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

3.3.1 Manufacturer's Field Services:

- .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
- .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 Upon completion of installation.
 - .3 Submit manufacturer's reports to Company within 3 days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.

3.3.2 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, recommend remedial action.

3.4 CLEANING

3.4.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.5 SYSTEM DESIGN

3.5.1 The isolation materials manufacturer shall be responsible for the proper submission of isolators to accomplish the specified minimum static deflections, for all isolators, based on the actual weight distribution of equipment to be isolated. Confirm acceptability of

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 48
CH0032	SPILLWAY ELECTRICAL BLDG VIBRATION & SEISMIC CONTROLS FOR HVAC PIPING & EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

specified minimum static deflection based upon the natural frequency of the rotating equipment.

3.5.2 The Mechanical Subcontractor shall furnish a complete set of accepted shop drawings of all mechanical equipment to receive vibration isolation and seismic control devices to the vibration isolation and seismic control manufacturer, based upon which the selection of vibration isolators and seismic restraint system will be completed. The shop drawings to be furnished shall include operating weights of the equipment and the distribution of weight at support points.

3.5.3 The Mechanical Subcontractor shall furnish a complete layout of ductwork and piping, showing size or weight and support points of the ductwork and piping systems, to the vibration isolation and seismic control manufacturer, for selection and layout of isolation hangers and seismic restraint system.

3.6 SUBMITTALS

3.6.1 Shop drawings:

.1 The Mechanical Subcontractor shall have prepared by the vibration isolation and seismic control manufacturer, and shall submit for acceptance, drawings showing the construction of the isolation devices to be used, including specific selection of isolators for the equipment to be furnished for this project, and shall include a tabulation of the design data for each isolator, including spring O.D., free operating, and solid heights, and ratio of horizontal to vertical stiffness, and other required data to clearly indicate that the specified isolator types and minimum static deflections are provided for the system submitted.

.2 The Mechanical Subcontractor shall have prepared by the vibration isolation and seismic control manufacturer, and shall submit for acceptance; drawings, design calculations, details, shop drawings and technical data sheets for the seismic restraint system. The calculations shall be sealed and signed by a professional engineer registered in the Province of Newfoundland and Labrador.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 05 53.01
SPILLWAY ELECTRICAL BLDG
MECHANICAL IDENTIFICATION**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 RELATED SECTIONS 2

 1.3 REFERENCES 2

 1.4 SUBMITTALS 2

 1.5 QUALITY ASSURANCE 2

 1.6 DELIVERY, STORAGE, AND HANDLING 2

2. PRODUCTS 3

 2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES 3

 2.2 SYSTEM NAMEPLATES 3

 2.3 IDENTIFICATION OF PIPING SYSTEMS 4

 2.4 DUCTING IDENTIFICATION 6

 2.5 CONTROLS COMPONENTS IDENTIFICATION 6

 2.6 LANGUAGE 6

3. EXECUTION 6

 3.1 MANUFACTURER'S INSTRUCTIONS 6

 3.2 TIMING 6

 3.3 INSTALLATION 6

 3.4 NAMEPLATES 7

 3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS 7

 3.6 CLEANING 8

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Materials and requirements for the identification of piping systems, duct work, valves and controls, including the installation and location of identification systems.
- .2 Sustainable requirements for construction and verification.

1.2 RELATED SECTIONS

1.2.1 Section 09 91 23 - Interior Painting.

1.3 REFERENCES

1.3.1 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
- .2 CAN/CGSB-24.3, Identification of Piping Systems.

1.4 SUBMITTALS

1.4.1 Product Data:

- .1 Submittals: submit drawings stamped and signed for approval.

1.5 QUALITY ASSURANCE

1.5.1 Quality assurance: in accordance with Quality Requirements.

1.5.2 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, shipping, handling and unloading:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

2.1.1 Metal or plastic laminate nameplate mechanically fastened to each piece of tagged equipment by manufacturer.

2.1.2 Lettering and numbers to be raised or recessed.

2.1.3 Information to include, as appropriate:

- .1 Equipment: Manufacturer's name, model, size, serial number, capacity.
.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

2.2.1 Colours:

- .1 Hazardous: red letters, white background.
.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

2.2.2 Construction:

- .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

2.2.4 Locations:

.1 Terminal cabinets, control panels: Use size # 5.

.2 Equipment in Mechanical Rooms: Use size # 9.

2.3 IDENTIFICATION OF PIPING SYSTEMS

2.3.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3.2 Pictograms:

- .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.

2.3.3 Legend:

- .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

2.3.4 Arrows showing direction of flow:

- .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
- .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
- .3 Use double-headed arrows where flow is reversible.

2.3.5 Extent of background colour marking:

- .1 To full circumference of pipe or insulation.
- .2 Length to accommodate pictogram, full length of legend and arrows.

2.3.6 Materials for background colour marking, legend, arrows:

- .1 Peel and stick markers and arrows held in place with pressure sensitive tape.
 - .1 Acceptable product: Seton OPTI-Code pipe markers and arrows held in place with Seton 59653 40 mm wide pressure sensitive tape, Brady, or accepted equal.

2.3.7 Colours and Legends:

- .1 Where not listed, obtain direction from Company.
- .2 Colours for legends, arrows, to following table:

Background colour	Legend, arrows
Green	WHITE

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Equipment Drainage	Green	Equip. Drain
Control Panels, Devices and Conduit for low voltage		To Section 25 33 01 – HVAC Controls and Instr. control wiring

2.4 DUCTING IDENTIFICATION

2.4.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

2.4.2 Colours: black or co-ordinated with base colour to ensure strong contrast

2.4.3 Identifying system: e.g. Supply FAN-VSG-0001, Exhaust FAN-VSE-0001

2.5 CONTROLS COMPONENTS IDENTIFICATION

2.5.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in section 25 33 01 – HVAC Controls and Instrumentation.

2.5.2 Inscriptions to include function and (where appropriate) fail-safe position, component ID name.

2.6 LANGUAGE

2.6.1 Identification to be in English.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

3.2.1 Provide identification only after all painting specified in Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

3.3.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

3.4.1 Locations:

- .1 In conspicuous location to facilitate easy reading and identification from operating floor.

3.4.2 Standoffs:

- .1 Provide for nameplates on hot and/or insulated surfaces.

3.4.3 Protection

- .1 Do not paint, insulate or cover in any way.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

3.5.1 On long straight runs in open areas in equipment rooms, galleries, tunnels: At not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

3.5.2 Adjacent to each change in direction.

3.5.3 At least once in each small room through which piping or ductwork passes.

3.5.4 On both sides of visual obstruction or where run is difficult to follow.

3.5.5 On both sides of separations such as walls, floors, partitions.

3.5.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

3.5.7 At beginning and end points of each run and at each piece of equipment in run.

3.5.8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.

3.5.9 Identification to be easily and accurately readable from usual operating areas and from access points.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 53.01
CH0032	SPILLWAY ELECTRICAL BLDG MECHANICAL IDENTIFICATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 CLEANING

- 3.6.1 Upon completion and verification of performance of installation, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 05 93
SPILLWAY ELECTRICAL BLDG
TESTING, ADJUSTING AND BALANCING FOR HVAC**

1. GENERAL	2
1.1 SUMMARY	2
1.2 DEFINITIONS	2
1.3 QUALIFICATIONS OF TAB PERSONNEL.....	3
1.4 PURPOSE OF TAB	4
1.5 EXCEPTIONS.....	5
1.6 CO-ORDINATION.....	5
1.7 PRE-TAB REVIEW	5
1.8 START-UP.....	5
1.9 OPERATION OF SYSTEMS DURING TAB	5
1.10 START OF TAB	6
1.11 APPLICATION TOLERANCES	6
1.12 ACCURACY TOLERANCES.....	7
1.13 INSTRUMENTS.....	7
1.14 SUBMITTALS	7
1.15 PRELIMINARY TAB REPORT	7
1.16 TAB REPORT.....	7
1.17 VERIFICATION.....	8
1.18 SETTINGS.....	9
1.19 COMPLETION OF TAB	9
1.20 AIR SYSTEMS.....	9
1.21 OTHER TAB REQUIREMENTS.....	9
2. PRODUCTS (NOT APPLICABLE)	10
3. EXECUTION	10
3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING	10
3.2 MEASUREMENTS.....	11
3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING	11
3.4 RECORD AND REPORT DATA.....	12

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

- 1.1.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- 1.1.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this Section.
- 1.1.3 This Section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results. In addition carry out acoustical testing as identified below.
- 1.1.4 Test, adjust, and balance the following mechanical systems:
- .1 Supply air systems (2440-FAN-VSG-0001).
 - .2 Return air systems (2440-FAN-VSG-0001).
 - .3 Exhaust air systems (2440-FAN-VSE-0001, 2440-FAN-VSE-0002).

1.2 DEFINITIONS

- 1.2.1 Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
- .1 The balance of air and water distribution.
 - .2 Adjustment of total system to provide design quantities.
 - .3 Electrical measurement.
 - .4 Verification of performance of all equipment and automatic controls.
 - .5 Acoustical testing of finished systems.
- 1.2.2 Test: To determine quantitative performance of equipment
- 1.2.3 Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- 1.2.4 Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.2.5 Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- 1.2.6 Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data sheets should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- 1.2.7 Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- 1.2.8 Main: Duct or pipe containing the system's major or entire fluid flow.
- 1.2.9 Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- 1.2.10 Branch main: Duct or pipe serving two or more terminals.
- 1.2.11 Branch: Duct or pipe serving a single terminal.
- 1.3 QUALIFICATIONS OF TAB PERSONNEL**
 - 1.3.1 Submit names of personnel certified to perform TAB within 90 days of award of contract.
 - 1.3.2 Provide documentation confirming qualifications, successful experience.
 - 1.3.3 Test and Balance Technician's Qualifications: minimum 3-years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.
 - 1.3.4 Agency Qualifications:
 - .1 Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
 - .2 The independent testing, adjusting, and balancing agency shall be certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project and shall have at least one Technician certified by NEBB or AABC as a Test and Balance Technician.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.5 Codes and Standards:

- .1 NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- .2 AABC: "National Standards For Total System Balance".
- .3 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Handbook, HVAC Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.

1.3.6 Recommendations and suggested practices contained in the TAB Standard: mandatory.

1.3.7 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

1.3.8 Use TAB standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

1.3.9 Where instrument manufacturer calibration recommendations are more stringent than those listed in the TAB standard, use manufacturer's recommendations.

1.3.10 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

- .1 For systems or system components not covered in TAB standard, use TAB procedures developed by TAB Specialist.
- .2 Where new procedures and requirements are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or SMACNA), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

1.4.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.

1.4.2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.5 EXCEPTIONS

1.5.1 TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.

1.6 CO-ORDINATION

1.6.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.

1.6.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.7 PRE-TAB REVIEW

1.7.1 Review contract documents before project construction is started and confirm in writing adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

1.7.2 Review specified standards and report in writing all proposed procedures which vary from standard.

1.7.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7.4 Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Company, Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.8 START-UP

1.8.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

1.8.2 Follow special start-up procedures specified elsewhere in other Divisions.

1.9 OPERATION OF SYSTEMS DURING TAB

1.9.1 Operate systems for length of time required for TAB and as required by Company for verification of TAB reports.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.9.2 Systems operation: systems shall be fully operational prior to beginning procedures.

1.10 START OF TAB

1.10.1 Notify Company 7 days prior to start of TAB.

1.10.2 Start TAB when building is essentially completed, including:

- .1 Installation of ceilings, doors, windows, other construction affecting TAB.
- .2 Application of weatherstripping, sealing, caulking.
- .3 All pressure, leakage, other tests specified elsewhere in other Divisions.
- .4 All provisions for TAB installed and operational.

1.10.3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Proper thermal overload protection in place for electrical equipment.
- .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.

1.11 APPLICATION TOLERANCES

1.11.1 Do TAB to following tolerances of design values:

- .1 HVAC systems: plus 5%, minus 5%.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.12 ACCURACY TOLERANCES

1.12.1 Measured values to be accurate to within plus or minus 2% of actual values.

1.13 INSTRUMENTS

1.13.1 Prior to TAB, submit list of instruments to be used together with serial numbers.

1.13.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

1.13.3 Calibrate within 3 months of TAB. Provide certificate of calibration.

1.14 SUBMITTALS

1.14.1 Submit, prior to commencement of TAB:

- .1 Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- .2 Sample Forms: Submit sample forms, if other than those standard forms prepared by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) are proposed.

1.15 PRELIMINARY TAB REPORT

1.15.1 Draft report: Upon completion of testing, adjusting, and balancing procedures, prepare draft report on the approved forms. Draft report may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft report in the same manner specified for the final report. Submit 2 complete sets of draft report. Only 1 complete set of draft report will be returned with comments.

1.16 TAB REPORT

1.16.1 Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Technician. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems.

1.16.2 Final Report: Upon verification and approval of draft report, prepare final report, type written, and organized and formatted as specified below. Submit 2 complete sets of final report.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.16.3 Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:

- .1 General Information and Summary
- .2 Air Systems
- .3 Hydronic Systems
- .4 Special Systems.

1.16.4 Report Contents: Provide the following minimum information, forms and data:

- .1 **General Information and Summary:** Inside cover sheet to identify testing, adjusting, and balancing agency, the Company, Technician, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Technician. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
- .2 The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- .3 **Calibration Reports:** Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.17 VERIFICATION

1.17.1 Reported results subject to verification by the Company.

1.17.2 Provide manpower and instrumentation to verify up to 30 % of reported results.

1.17.3 Number and location of verified results to be at discretion of the Company.

1.17.4 Bear costs to repeat TAB as required to satisfaction of the Company.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.18 SETTINGS

- 1.18.1 After TAB is completed to satisfaction of the Company, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- 1.18.2 Permanently mark settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.19 COMPLETION OF TAB

- 1.19.1 TAB to be considered complete when final TAB Report received and accepted.

1.20 AIR SYSTEMS

- 1.20.1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.
- 1.20.2 Do TAB of systems, equipment, components, controls specified in other Divisions.
- 1.20.3 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
- 1.20.4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- 1.20.5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, amperage and volts for each stage of electrical heating coils.
- 1.20.6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
- .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- 1.20.7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).
- ### 1.21 OTHER TAB REQUIREMENTS

- 1.21.1 General requirements applicable to work specified in this paragraph:

- .1 Qualifications of TAB personnel: as for air systems specified in this section.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Quality assurance: as for air systems specified in this section.

1.21.2 Building pressure conditions:

- .1 Adjust HVAC systems, airflow rates to specified values to achieve proper building pressurization.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

3.1.1 Before operating the system, perform these steps:

- .1 Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
- .2 Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and control system.
- .3 Compare design to installed equipment and field installations.
- .4 Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
- .5 Check filters for cleanliness.
- .6 Check dampers for correct and locked position, and control system for completeness of installation before starting fans.
- .7 Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- .8 Determine best locations in main and branch ductwork for most accurate duct traverses.
- .9 Place outlet dampers in the full open position.
- .10 Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
- .11 Lubricate all motors and bearings.
- .12 Check fan belt tension.

Handwritten signatures:



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPILLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

.13 Check fan rotation.

3.2 MEASUREMENTS

- 3.2.1 Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- 3.2.2 Provide instruments meeting the specifications of the referenced standards.
- 3.2.3 Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- 3.2.4 Apply instrument as recommended by the manufacturer.
- 3.2.5 Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- 3.2.6 When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- 3.2.7 Take all reading with the eye at the level of the indicated value to prevent parallax.
- 3.2.8 Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- 3.2.9 Take measurements in the system where best suited to the task.

3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING

- 3.3.1 Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- 3.3.2 Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- 3.3.3 Patch insulation, ductwork, and housings, using materials identical to those removed.
- 3.3.4 Seal ducts and piping, and test for and repair leaks.
- 3.3.5 Seal insulation to re-establish integrity of the vapor barrier.
- 3.3.6 Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 05 93
CH0032	SPELLWAY ELECTRICAL BLDG TESTING, ADJUSTING, AND BALANCING FOR HVAC	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.7 Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.4 RECORD AND REPORT DATA

3.4.1 Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as accepted on the sample report forms.

3.4.2 Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

END OF SECTION

96 MB

Lower Churchill Project	TECHNICAL SPECIFICATION	SECTION: 23 05 94
CH0032	SPILLWAY ELECTRICAL BLDG PRESSURE TESTING OF DUCTED AIR SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 05 94
SPILLWAY ELECTRICAL BLDG
PRESSURE TESTING OF DUCTED AIR SYSTEMS**

1. GENERAL..... 2

 1.1 RELATED SECTIONS 2

 1.2 GENERAL 2

 1.3 TIMING 2

 1.4 EXCLUSIONS..... 2

 1.5 REFERENCES 2

 1.6 TEST PROCEDURES 2

 1.7 TESTING AGENCY 3

 1.8 VERIFICATION..... 3

 1.9 TEST INSTRUMENTS..... 3

 1.10 SYSTEM LEAKAGE TOLERANCES 3

 1.11 REPORT FORMS 4

 1.12 PRESSURE TEST REPORTS..... 4

2. PRODUCTS 4

3. EXECUTION 4

 3.1 EXECUTION..... 4

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PEG PERMIT HOLDER
Newfoundland and Labrador
Professional Geoscientists
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER
Newfoundland and Labrador
Professional Engineers Association

SCOTT M. PENNEY
Scott Penney
SIGNATURE
Dec 16/2013
DATE
NEWFOUNDLAND & LABRADOR

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Lower Churchill Project	TECHNICAL SPECIFICATION	SECTION: 23 05 94
CH0032	SPILLWAY ELECTRICAL BLDG PRESSURE TESTING OF DUCTED AIR SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 23 31 13.02 – Metal Ducts – High Pressure to 2500 Pa
- 1.1.2 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

1.2 GENERAL

- 1.2.1 This section is applicable to all sections of duct over 5 m in length, forming part of a supply, return or exhaust ductwork system.
- 1.2.2 All ductwork installed on this project as outlined in Item 1.2.1 above shall be pressure tested unless it is part of the exclusions outlined in Item 1.4 below.

1.3 TIMING

- 1.3.1 Ducts to be tested before installation of insulation or any other form of concealments.
- 1.3.2 Test after seals have cured.
- 1.3.3 Test when ambient temperature will not affect effectiveness of seals, gaskets, etc.

1.4 EXCLUSIONS

- 1.4.1 Flexible connections to diffusers

1.5 REFERENCES

- 1.5.1 SMACNA HVAC Air Duct Leakage Test Manual

1.6 TEST PROCEDURES

- 1.6.1 Maximum lengths of ducts to be tested during any one individual test to be consistent with the capacity of the test equipment being utilized
- 1.6.2 Section of duct to be tested to include:
- .1 Fittings, branch ducts, tap-ins.
- 1.6.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- 1.6.4 Base partial system leakage calculations on Reference Standard
- 1.6.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage

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MB

Lower Churchill Project	TECHNICAL SPECIFICATION	SECTION: 23 05 94
CH0032	SPILLWAY ELECTRICAL BLDG PRESSURE TESTING OF DUCTED AIR SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7 TESTING AGENCY

1.7.1 Installing Contractor or certified NEBB/AABC TAB agency

1.8 VERIFICATION

1.8.1 Engineer to witness tests and to verify reported results.

1.8.2 Testing results to be certified by the same TAB agency accepted by Engineer to undertake TAB on this project

1.9 TEST INSTRUMENTS

1.9.1 Testing agency to provide instruments for tests.

1.9.2 Test apparatus to include:

- .1 Fan capable of producing required static pressure.
- .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
- .3 Flow measuring instrument compatible with the orifice plate.
- .4 Calibration curves for orifice plates used
- .5 Flexible duct for connecting to ductwork under test.
- .6 Smoke bombs for visual inspections.

1.9.3 Test apparatus to be accurate to within $\pm 3\%$ of flow rate and pressure.

1.9.4 Submit details of test instruments to be used to Engineer at least three months before anticipated start date.

1.9.5 Test instruments to be calibrated and certificate of calibration deposited with Engineer no more than 28 days before start of tests.

1.9.6 Instruments to be recalibrated every six months thereafter.

1.10 SYSTEM LEAKAGE TOLERANCES

1.10.1 As outlined in SMACNA HVAC Air Duct Leakage Test Manual for the applicable duct static pressure class, seal class, and leakage class in each instance. The applicable duct pressure class shall be determined from the external static pressure in the air handling unit and fan data sheets. The listed external static pressure is not the duct




Lower Churchill Project	TECHNICAL SPECIFICATION	SECTION: 23 05 94
CH0032	SPILLWAY ELECTRICAL BLDG PRESSURE TESTING OF DUCTED AIR SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

pressure class. Consult the SMACNA HVAC Air Duct Leakage Test Manual for further clarification in this matter.

1.10.2 Evaluation of test results to use surface area of duct test section and pressure in duct as basic parameters.

1.11 REPORT FORMS

1.11.1 Submit proposed report form and test report format for acceptance. Do not start tests until acceptance received in writing.

1.12 PRESSURE TEST REPORTS

1.12.1 Prepare report of results and submit within 24 hours of completion of tests. Include:

- .1 Schematic of entire system.
- .2 Schematic of section under test showing test site.
- .3 Required and achieved static pressures.
- .4 Orifice differential pressure at test sites.
- .5 Permissible and actual leakage flow rate (L/s) for test sites.
- .6 Witnessed certification of results.

1.12.2 Include test reports in final TAB report for Commissioning Manual.

2. PRODUCTS

(Not Applicable)

3. EXECUTION

3.1 EXECUTION

3.1.1 Carry out trial leakage test to demonstrate workmanship.

3.1.2 After acceptance of trial leakage test, proceed with installation of remaining ductwork

3.1.3 Test each entire duct system in sections. Section size to be tested shall only be limited by the capabilities of the testing equipment.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 23 07 13
SPILLWAY ELECTRICAL BLDG
DUCT INSULATION**

1. GENERAL..... 2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 DEFINITIONS 3

1.4 SHOP DRAWINGS 3

1.5 MANUFACTURERS' INSTRUCTIONS 3

1.6 QUALIFICATIONS 3

1.7 DELIVERY, STORAGE AND HANDLING 3

1.8 QUALITY ASSURANCE 4

1.9 WASTE MANAGEMENT AND DISPOSAL..... 4

1.10 ENVIRONMENTAL REQUIREMENTS..... 4

2. PRODUCTS 4

2.1 FIRE AND SMOKE RATING 4

2.2 INSULATION 5

2.3 JACKETS 5

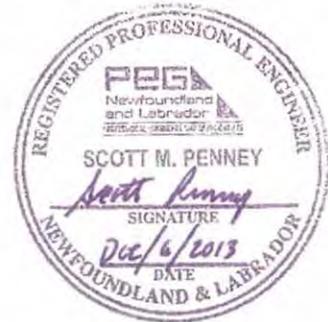
2.4 ACCESSORIES 6

3. EXECUTION 7

3.1 PRE-INSTALLATION REQUIREMENTS 7

3.2 INSTALLATION 7

3.3 DUCTWORK INSULATION SCHEDULE 7



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 23 05 53.01 – Mechanical Identification.
- 1.1.2 Section 23 31 13.02 – Ductwork Metallic to 2500 Pa.

1.2 REFERENCES

- 1.2.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- 1.2.2 American Society for Testing and Materials International, (ASTM)
- .1 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .2 ASTM C518, Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- .3 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- .4 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .5 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
- .6 ASTM C921, Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .7 ASTM B209, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- 1.2.3 Canadian General Standards Board (CGSB)
- .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
- 1.2.4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- 1.2.5 Underwriters Laboratories of Canada (ULC)

ab mb

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies

1.2.6 Model National Energy Code of Canada for Buildings (MNECB)

1.2.7 International Standards Organization (ISO):

.1 ISO 9000 – Quality Standards

1.3 DEFINITIONS

1.3.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces

.2 "EXPOSED" - will mean "not concealed" as defined herein

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories

1.3.2 TIAC Codes:

.1 CRD: Commercial Round Ductwork,

.2 CRF: Commercial Rectangular Finish.

1.4 SHOP DRAWINGS

1.4.1 Submit for acceptance manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.5 MANUFACTURERS' INSTRUCTIONS

1.5.1 Installation instructions to include procedures used and installation standards achieved.

1.6 QUALIFICATIONS

1.6.1 Installer: certified in performing work of this section, and have at least 5 years successful experience in this size and type of project, qualified to standards of TIAC.

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.7.2 Protect from weather and construction traffic.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7.3 Protect against damage from any source.

1.7.4 Store at temperatures and conditions recommended by manufacturer.

1.7.5 Any water damaged insulation shall be removed and replaced by the contractor at no additional costs to the contract.

1.8 QUALITY ASSURANCE

1.8.1 Insulation materials must be manufactured at facilities certified and registered with an approved registrar to conform to ISO 9000 quality standards

1.9 WASTE MANAGEMENT AND DISPOSAL

1.9.1 Separate and recycle waste materials in accordance with municipal regulations.

1.9.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.9.3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.9.4 Divert unused metal materials from landfill to metal recycling facility.

1.9.5 Divert unused adhesive material from landfill to official hazardous material collections site.

1.9.6 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.10 ENVIRONMENTAL REQUIREMENTS

1.10.1 Insulation adhesives, mastics and cements shall be applied only in ambient conditions (i.e. temperature and relative humidity) which are within the published guidelines of the insulation manufacturer.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

2.1.1 In accordance with CAN/ULC-S102:

- .1 Maximum flame spread rating: 25.
- .2 Maximum smoke developed rating: 50.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 INSULATION

2.2.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

2.2.2 Thermal conductivity:

- .1 Rigid mineral fibre board:
- .2 "K" factor of 0.032 w.m.°C at mean ambient temperature of 24°C when tested in accordance with ASTM C612, Type 1A and 1B, rigid.

2.2.3 TIAC Code C-1: Rigid mineral fibre to ASTM C612 with factory applied vapour retarder jacket to CGSB.51-GP-52Ma:

- .1 Density: 96.11 kg/m³
- .2 Installed "R" values:
 - .1 25 mm thick: 0.73 m²-°C/w.
 - .2 50 mm thick: 1.45 m²-°C/w.
- .3 Sound absorption coefficients when tested in accordance with ASTM C423, Type A mounting, as follows:

	<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1000 Hz</u>	<u>2000 Hz</u>	<u>4000 Hz</u>
25 mm thick	0.10	0.35	0.85	1.04	1.05	1.03
50 mm thick	0.38	0.93	1.10	1.07	1.07	1.07

- .4 Noise reduction coefficient: 0.80 for 25 mm thick and 1.05 for 50 mm thick.
- .5 Acceptable product: Johns-Manville Series 800 spin-glass, Type 817 with FSK reinforced foil and paper (Foil - Scrim-Kraft), Manson, Owens-Corning, Knauf, or accepted equal.

2.3 JACKETS

2.3.1 Canvas:

- .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Acceptable product: S. Fattal Thermocanvas, or accepted equal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3.2 Aluminum:

- .1 To ASTM B209 with moisture barrier.
- .2 Thickness: 0.50 mm sheet.
- .3 Finish: Stucco embossed or corrugated.
- .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick 304 stainless steel.
- .5 Acceptable product: Ideal Products Aluminum jacketing with polysurlyn moisture retarder, or approved equal.

2.4 ACCESSORIES

2.4.1 Vapour retarder lap sealer:

- .1 Solvent based, non-flammable wet, fire-resistant dry.
- .2 Acceptable product: Monsey Bakor 230-39, Foster, Childers or accepted equal.

2.4.2 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

- .1 Acceptable product: Duro Dyne, Dyn Air or accepted equal.

2.4.3 Contact adhesive: quick setting:

- .1 Non-flammable, rubberized emulsion based adhesive.
- .2 Acceptable product: Monsey Bakor 200-38, Foster, Childers or accepted equal.

2.4.4 Canvas adhesive: washable.

- .1 Fire resistive, heavy duty resin emulsion insulation lagging coating.
- .2 Acceptable product: Monsey Bakor 120-09, Foster, Childers or accepted equal.

2.4.5 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

- .1 Acceptable product: Duro Dyne, Dyn-Air or accepted equal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3. EXECUTION

3.1 PRE-INSTALLATION REQUIREMENTS

3.1.1 Pressure testing of ductwork systems complete, witnessed and certified.

3.1.2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

3.2.1 Install in accordance with TIAC National Standards.

3.2.2 Apply materials in accordance with manufacturer's instructions and as indicated.

3.2.3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

3.2.4 Supports, Hangers in accordance with Section 23 31 13.02 - Ductwork Metallic to 2500 Pa:

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

3.2.5 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.3 DUCTWORK INSULATION SCHEDULE

3.3.1 Insulation types and thicknesses: Conform to following table:

	<u>TIAC Code</u>	<u>Vapour Retarder</u>	<u>Thickness</u>
All fresh air, mixed air and supply air duct associated with 2440-FAN-VSG-0001 from intake up and including the duct mounted heating coil	C-1	Yes	50 mm
Generator room exhaust air duct and plenum	C-1	Yes	50 mm
Diesel generator intake plenum and ductwork	C-1	Yes	50 mm

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 13
CH0032	SPILLWAY ELECTRICAL BLDG DUCT INSULATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

	<u>TIAC Code</u>	<u>Vapour Retarder</u>	<u>Thickness</u>
Diesel generator exhaust/recirculation plenum and ductwork	C-1	Yes	50 mm
Exhaust ductwork associated with 2440-FAN-VSE-0001/0002 within 3 m of exterior wall penetration.	C-1	Yes	50 mm
Electrical room fresh air intake plenum and ductwork including filter housing	C-1	Yes	50 mm

3.3.2 The insulation table above represents types and material thicknesses for thermal insulation mounted on the exterior of ductwork.

3.3.3 Utilize metal corners on all exposed rectangular ducts/plenums to be insulated.

3.3.4 Finishes: conform to following table:

Indoor, concealed	None
Indoor, exposed	Aluminum CRF/3 and CRD/4

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 07 14
SPILLWAY ELECTRICAL BLDG
THERMAL INSULATION FOR EQUIPMENT**

1. GENERAL..... 2

1.1 RELATED SECTIONS 2

1.2 REFERENCES 2

1.3 SHOP DRAWINGS 3

1.4 QUALIFICATIONS 3

1.5 DELIVERY, STORAGE AND HANDLING 3

1.6 QUALITY ASSURANCE 3

1.7 WASTE MANAGEMENT AND DISPOSAL 3

1.8 ENVIRONMENTAL REQUIREMENTS..... 4

2. PRODUCTS 4

2.1 FIRE AND SMOKE RATING..... 4

2.2 INSULATION 4

2.3 JACKETS 6

2.4 ACCESSORIES 6

3. EXECUTION 7

3.1 PRE- INSTALLATION REQUIREMENTS 7

3.2 INSTALLATION 7

3.3 EQUIPMENT INSULATION SCHEDULES..... 8

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CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 23 05 53.01 – Mechanical Identification.

1.2 REFERENCES

1.2.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):

- .1 ANSI/ASHRAE/IESNA 90.1 SI, Energy Standard for Buildings except Low-Rise Residential Buildings.

1.2.2 American Society for Testing and Materials (ASTM International):

- .1 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .2 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- .3 ASTM C449/C449M, Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .4 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .5 ASTM C518, Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- .6 ASTM C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- .7 ASTM C921, Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .8 ASTM B209, Specification for Aluminum Alloy Sheet and Plate.

1.2.3 Canadian General Standards Board (CGSB)

- .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

1.2.4 Thermal Insulation Association of Canada (TIAC)

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.1 National Insulation Standards.

1.2.5 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

1.2.6 International Standards Organization (ISO):

.1 ISO 9000 - Quality Standards.

1.3 SHOP DRAWINGS

1.3.1 Submit for acceptance manufacturer's catalogue literature related to installation and fabrication of joining recommendations.

1.4 QUALIFICATIONS

1.4.1 Installer to be specialist in performing work of this section, and have at least 5 years successful experience in this size and type of project, qualified to standards of TIAC.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.5.2 Protect from weather and construction traffic.

1.5.3 Protect against damage from any source.

1.5.4 Store at temperatures and conditions recommended by manufacturer.

1.5.5 Any water damaged insulation shall be removed and replaced by the Contractor at no additional cost to the Contract.

1.6 QUALITY ASSURANCE

1.6.1 Insulation material must be manufactured at facilities certified and registered with an approved registrar to conform to ISO 9000 quality standards.

1.7 WASTE MANAGEMENT AND DISPOSAL

1.7.1 Separate and recycle waste materials in accordance with municipal regulations .



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.7.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- 1.7.3 Collect and separate for disposal: paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan
- 1.7.4 Divert unused metal materials from landfill to metal recycling facility.
- 1.7.5 Divert unused adhesive material from landfill to official hazardous material collections site.
- 1.7.6 Do not dispose of unused adhesive material into sewer systems, lakes, or streams, onto the ground or in other locations where it will pose health or environmental hazard.

1.8 ENVIRONMENTAL REQUIREMENTS

- 1.8.1 Insulation adhesives, mastics and cements shall be applied only in ambient conditions (i.e. temperature and humidity) which are within the published guidelines of the insulation manufacturer.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

- 2.1.1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- 2.2.1 Mineral Fibre: Includes glass fibre, rock wool, slag wool.
- 2.2.2 Thermal conductivity:
 - .1 Rigid mineral fibre board:
 - "K" factor of 0.035 W/m.°C at mean ambient temperature of 24°C when tested in accordance with ASTM C612, Type 1A and 1B, rigid.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Rigid molded calcium silicate:

"K" factor as described in table below in accordance with ASTM C177, ASTM C518 and ASTM C335.

Mean Temp °C	38	93	149	204	260	316	371
Conductivity W/m-°C	0.053	0.058	0.064	0.071	0.079	0.087	0.096

2.2.3 TIAC Code A-2: Rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

- .1 Thermal properties to requirements of ASTM C533.
- .2 Pre-formed, high temperature, abuse-resistant pipe and block insulation.
- .3 Composed of hydrous calcium silicate for use on systems operating up to 650°C.
- .4 Inorganic, noncombustible, asbestos free.
- .5 Flame spread / smoke developed ratings of 0/0.
- .6 Acceptable product: Industrial Insulation Group Thermo-12 Gold, Manson, Owens-Corning, Knauf or accepted substitute.

2.2.4 TIAC Code C-1: Rigid mineral fibre board to ASTM C612 with factory applied vapour retarder jacket to CGSB.51-GP-52Ma:

- .1 Density: 96.11 kg/m³.
- .2 Installed "R" values:
 - .1 25 mm thick: 0.73 m².°C/W.
 - .2 50 mm thick: 1.45 m².°C/W.
- .3 Sound absorption coefficients when tested in accordance with ASTM C423, Type A mounting, as follows:

	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
25 mm thick	0.10	0.35	0.85	1.04	1.05	1.03
50 mm thick	0.38	0.93	1.10	1.07	1.07	1.07

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Noise reduction coefficient: 0.80 for 25 mm thick and 1.05 for 50 mm thick.
- .5 Acceptable product: Johns-Manville Series 800 spin-glass, Type 817 with FSK reinforced foil and paper (Foil - Scrim-Kraft), Manson, Owens-Corning, Knauf, or accepted substitute.

2.3 JACKETS

2.3.1 Canvas:

- .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .1 Acceptable manufacturer: S. Fattal Thermo Canvas, or accepted substitute.

2.3.2 Aluminum:

- .1 To ASTM B209 with moisture barrier.
- .2 Thickness: 0.50 mm sheet
- .3 Finish: Stucco embossed or corrugated.
- .4 Jacket banding and mechanical seals: 12mm wide, 0.5 mm thick 304 stainless steel.
- .5 Acceptable products: Ideal Products Aluminum jacketing with polysurlyn moisture retarder, or accepted substitute.

2.4 ACCESSORIES

2.4.1 Vapour retarder lap sealer :

- .1 Solvent based, non-flammable wet, fire-resistant dry.
- .2 Acceptable product: Monsey Bakor 230-39, Foster, Childers, or accepted substitute.

2.4.2 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum:

- .1 Acceptable product: Duro Dyne, Dyn Air, or accepted substitute.

2.4.3 Contact adhesive: quick setting:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Non-flammable, rubberized emulsion based adhesive.
- .2 Acceptable product: Monsey Bakor 200-38, Foster, Childers, or accepted substitute.

2.4.4 Canvas adhesive: washable

- .1 Fire resistive, heavy duty resin emulsion insulation lagging coating.
- .2 Acceptable product: Monsey Bakor 120-09, Foster, Childers, or accepted substitute.

2.4.5 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation:

- .1 Acceptable product: Duro Dyne, Dyn-Air, or accepted substitute.

2.4.6 Glass or fabric reinforcing cloth:

- .1 Open weave, high strength, resin treated, fibreglass cloth.
- .2 Thread count of 10 x 10 strands per square inch.
- .3 Thickness: 0.20 mm.
- .4 Weight: 2.2 ounces per square yard.
- .5 Acceptable product: Childers Chil-Glas #10 glass fibre reinforcing mesh.

3. EXECUTION

3.1 PRE- INSTALLATION REQUIREMENTS

- 3.1.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.
- 3.1.2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

- 3.2.1 Install in accordance with TIAC National Standards

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 07 14
CH0032	SPILLWAY ELECTRICAL BLDG THERMAL INSULATION FOR EQUIPMENT	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Hot equipment: To TIAC code 1503-H.
- .2 Cold equipment: to TIAC code 1501-C.

3.2.2 Provide vapour retarder as recommended by manufacturer.

3.2.3 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

3.2.4 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

3.2.5 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

- .1 Hangers, supports outside vapour retarder jacket.

3.3 EQUIPMENT INSULATION SCHEDULES

3.3.1 Hot Equipment:

- .1 TIAC code A-2 with air gap, mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.1 Thicknesses:

- .1 Diesel Generator Silencer/Muffler: 50 mm.

3.3.2 Cold equipment:

- .1 TIAC Code C-1 with mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh and covered with a vapour barrier coating.

.1 Thicknesses:

- .1 Electrical Room Intake Filter Housing: 50 mm.

3.3.3 Finishes:

- .1 TIAC code CDR/4 aluminum jacket for the TIAC Code A-2 insulated systems.
- .2 TIAC code CRF/3 aluminum jacket for the TIAC Code C-1 insulated systems.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 08 01
CH0032	PERFORMANCE VERIFICATION MECHANICAL PIPING SYSTEM	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		

SECTION 23 08 01

PERFORMANCE VERIFICATION MECHANICAL PIPING SYSTEM

TABLE OF CONTENTS

PART 1 GENERAL.....2

 1.1 RELATED SECTIONS.....2

 1.2 FUEL OIL SYSTEMS.....2

 1.3 REPORTS.....2

PART 2 PRODUCTS (NOT APPLICABLE).....2

PART 3 EXECUTION (NOT APPLICABLE).....2

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 08 01
CH0032	PERFORMANCE VERIFICATION MECHANICAL PIPING SYSTEM	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 23 11 13 – Facility Fuel-Oil Piping.

1.2 FUEL OIL SYSTEMS

1.2.1 Environmental protection systems:

1.2.1.1 Test oil storage tank leakage detection system using Manufacturer's recommended procedures.

1.2.1.2 Test spill protection and over-fill protection systems using Manufacturer's recommended procedures.

1.2.2 Operational Tests:

1.2.2.1 Charge system and verify operation.

1.2.2.2 Verify adequacy of flow rates and pressure from storage facilities to generator.

1.2.2.3 For further details refer to relevant sections of Mechanical Division.

1.2.2.4 Ensure foot valves and shut off valves are operating properly.

1.2.3 Notify authorities having jurisdiction to enable witnessing of tests as required.

1.2.4 Test all systems and equipment in accordance with Newfoundland and Labrador regulation 58/03 - Storage and Handling of Gasoline & Associated Products Regulations as well as CCME – Environmental Code of Practices for Aboveground & Underground Storage Tank Systems Containing Petroleum & Allied Petroleum Products, or elsewhere as specified.

1.3 REPORTS

1.3.1 Provide testing reports as requested by Engineer or Authority having jurisdiction.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 23 11 13
FACILITY FUEL-OIL PIPING**

TABLE OF CONTENTS

PART 1 GENERAL	2
1.1 SUMMARY	2
1.2 RELATED SECTIONS	2
1.3 REFERENCES	2
1.4 SUBMITTALS TO ENGINEER	4
1.5 QUALITY ASSURANCE	4
1.6 DELIVERY, STORAGE & HANDLING	5
PART 2 PRODUCTS	5
2.1 FUEL OIL PIPE (ABOVE GROUND)	5
2.2 FITTINGS	5
2.3 BALL VALVES	6
2.4 AUTOMATIC CLOSING BALL VALVES	6
2.5 FLEXIBLE BRAIDED HOSE	7
2.6 PIPE COATING	8
2.7 DUPLEX FUEL OIL TRANSFER PUMP PACKAGE	8
2.8 FOOT VALVE	10
2.9 VACUUM BREAKER	10
2.10 SOLENOID VALVE:	11
2.11 FLOW METER	11
PART 3 EXECUTION	13
3.1 INSTALLATION	13
3.2 FIELD QUALITY CONTROL	17

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 To practice Professional Geoscience
 in Newfoundland and Labrador.
 Permit No. as issued by PEGNL: No. 458
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Section includes:

1.1.1.1 Materials and installation for light fuel oil piping from oil tanks to generator set.

1.2 RELATED SECTIONS

1.2.1 Section 23 05 05 – Installation of Pipework.

1.2.2 Section 23 05 17 – Pipe Welding

1.2.3 Section 23 08 01 – Performance Verification of Mechanical Piping Systems.

1.2.4 Section 33 56 13 – Aboveground Fuel Storage Tanks.

1.3 REFERENCES

1.3.1 American Petroleum Institute:

1.3.1.1 Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Division 1 and Division 2. API Recommended Practice 500.

1.3.2 American Society of Mechanical Engineers (ASME):

1.3.2.1 ASME-B1.20.1, Thermal Threads, General Purpose (Inch).

1.3.2.2 ASME-B16.3, Malleable-Iron Threaded Fittings.

1.3.2.3 ASME-B16.11, Forged Fittings, Socket Welding and Threaded.

1.3.2.4 ASME-B16.34, Valves-Flanged, Threaded and Welding End.

1.3.2.5 ASME-B31.1, Power Piping.

1.3.2.6 ASME-B40.100, Pressure Gauges and Gauge Attachments.

1.3.3 American Society for Testing and Materials (ASTM):

1.3.3.1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.3.2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- 1.3.3.3 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
- 1.3.4 Canadian Standards Association (CSA):
 - 1.3.4.1 CAN/CSA-B139, Installation Code for Oil Burning Equipment.
 - 1.3.4.2 CAN/CSA-B140.0, General Requirements for Oil Burning Equipment.
- 1.3.5 CCME (Canadian Council of Ministers of the Environment) Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.
- 1.3.6 CNRL -58/03 – Storage and Handling of Gasoline and Associated Products Regulations under the Environmental Protection Act.
- 1.3.7 Health Canada/Workplace Hazardous Materials Information Systems:
 - 1.3.7.1 Material Safety Data Sheets (MSDS).
- 1.3.8 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS):
 - 1.3.8.1 MSS SP-58, Standard for Pipe Hangers and Supports – Materials, Design and Manufacture.
 - 1.3.8.2 MSS SP-69, Standard for Pipe Hangers and Supports – Selection and Application.
 - 1.3.8.3 MSS SP-79, Standard for Socket Welding Reducer inserts.
 - 1.3.8.4 MSS SP-80, Bronze Gate, Globe, Angle and Check Valves.
 - 1.3.8.5 MSS SP-83, Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded.
 - 1.3.8.6 MSS SP-89, Pipe Hangers and Supports – Fabrication and Installation Practices.
- 1.3.9 National Fire Protection Association (NFPA):
 - 1.3.9.1 NFPA 30, Flammable and Combustible Liquids Code.
- 1.3.10 National Fire Code of Canada, Latest Edition.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.11 Nalcor Energy Engineering Directive # CF-ED-004 – Diesel System Installation and Abandonment Engineering Directive.

1.4 SUBMITTALS TO ENGINEER

1.4.1 Product Data:

1.4.1.1 Submit Manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

1.4.1.2 Indicate on Manufacturer's catalogue literature the following: valves, piping and fittings.

1.4.2 Submit WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.

1.4.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

1.4.4 Certificates: submit certificates signed by Manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4.5 Instructions: submit Manufacturer's installation instructions.

1.4.6 Closeout submittals: Submit operation, maintenance and engineering data and incorporate into Operation and Maintenance Manual.

1.5 QUALITY ASSURANCE

1.5.1 Pre-Installation Meeting: Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.

1.5.1.1 Verify project requirements.

1.5.1.2 Review installation and substrate conditions.

1.5.1.3 Co-ordination with other building subtrades.

1.5.1.4 Review Manufacturer's installation instructions and warranty requirements.

1.5.2 Trades people to have journey person qualifications.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6 DELIVERY, STORAGE & HANDLING

1.6.1 Waste Management and Disposal:

- 1.6.1.1 Separate waste materials for reuse and recycling in accordance with municipal regulations.
- 1.6.1.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- 1.6.1.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling.
- 1.6.1.4 Separate for reuse and recycling and place in designated containers, steel, metal and plastic waste.
- 1.6.1.5 Place materials defined as hazardous or toxic in designated containers.
- 1.6.1.6 Handle and dispose of hazardous material in accordance with Canadian Environmental Protection Act (CEPA), Transportation of Dangerous Goods Act (TDGA), Regional and Municipal regulations.
- 1.6.1.7 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
- 1.6.1.8 Unused paint, coating materials must be disposed of at official hazardous material collection site as approved by Engineer.
- 1.6.1.9 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

PART 2 PRODUCTS

2.1 FUEL OIL PIPE (ABOVE GROUND)

- 2.1.1.1 Steel: to ASTM A53/A53M, Schedule 40, seamless, socket welded end connections.

2.2 FITTINGS

2.2.1 Steel:

- 2.2.1.1 Forged Steel, Class 3000 Socket welded fittings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.1.2 Unions: Forged Steel, Class 3000 Socket Welded to MSS-SP-83.

2.2.1.3 Nipples: Schedule 40, to ASTM A53/A53M.

2.3 BALL VALVES

2.3.1 To be installed to isolate equipment, at tank supply connections, at supply line where it enters the building and elsewhere as indicated in the NFC and CSA B139 documents.

2.3.2 Ball valves shall be a fire safe design to API 607 complete with graphite packing and gaskets.

2.3.3 Socket welded end connections.

2.3.4 Shall be able to be closed against the supply of fuel.

2.3.5 Three-piece construction, carbon steel ASTM A216 Grade WCB Phosphate Coated.

2.3.6 13.78 MPa (gauge) WOG, cold non-shock.

2.3.7 Stainless steel trim and hardware.

2.3.8 Stainless steel vented ball.

2.3.9 Blowout proof system.

2.3.10 Statically grounded ball, stem and body.

2.3.11 Two position locking.

2.3.12 Valves shall be suitable for outdoor service.

2.3.13 Acceptable manufacturers: NIBCO KM-590-CS-R-66-FS-LL, Apollo, Jenkins, Milwaukee, Newman Hattersly, Kitz, Toyo, Crane, or approved equal.

2.4 AUTOMATIC CLOSING BALL VALVES

2.4.1 To be installed on fuel tank supply line adjacent to tank and on fuel oil supply line adjacent to the generator set and elsewhere as indicated in CSA B139 & NFC.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.4.2 Valve shall permit automatic closing of fuel oil supply line in the event of a fire. Valve shall include UL listed thermal links that melt at 74° C allowing the valve to close tightly and shall be able to be manually opened or closed.
- 2.4.3 Ball valve type.
- 2.4.4 Valve shall be suitable for outdoor service.
- 2.4.5 Socket welded end connections.
- 2.4.6 Bronze body and disc. Carbon steel construction, suitable for use with diesel fuel oil.
- 2.4.7 Valve shall be factory mutual (FM) approved.
- 2.4.8 Fully ported.
- 2.4.9 Maximum working pressure of 861kPa.
- 2.4.10 Valves shall be in accordance with ULC S651.
- 2.4.11 Acceptable manufacturers: Essex TA Series or approved equal.
- 2.5 **FLEXIBLE BRAIDED HOSE**
- 2.5.1 Austenitic 300 series stainless steel.
- 2.5.2 End connections: Union end connections.
- 2.5.3 Hose to be line size.
- 2.5.4 Minimum Length: 600mm.
- 2.5.5 Maximum rated working pressure: 1,034 KPa @ 21° C.
- 2.5.6 Flexible hoses to be suitable for outdoor service.
- 2.5.7 Install at fuel oil tank connections, day tank connections and generator set connections.
- 2.5.8 Hose shall be in accordance with ULC/ORD C536.
- 2.5.9 Acceptable manufacturers: Fire-Shield Hose Master, Swagelok, or approved equal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.6 PIPE COATING

2.6.1 Pipe to be field primed and painted in accordance with Nalcor Engineering Directive.

2.7 DUPLEX FUEL OIL TRANSFER PUMP PACKAGE

2.7.1 Factory piped, duplex pumping package.

2.7.1.1 Pump package shall be complete with two (2) pressure relief valves; full port ball type isolating valves at unit inlet and outlet to isolate each pump; lift type check valves for each pump outlet; in-line type check valves for each pump inlet; one (1) combination high/ low pressure switch on the common discharge; one (1) full port ball type isolating shut off valve mounted at the common discharge header; two (2) liquid filled pressure gauges with needle type isolating valves; two (2) liquid filled compound suction gauges with needle type isolating valves; a cast iron basket type suction strainer with 60 mesh stainless steel screen for each individual pump; and all necessary schedule 80 piping to allow for a complete duplex assembly. Pump package set shall be assembled on a 6mm fabricated epoxy lined steel base with a 50 mm drip lip all around to extend under all pumps, valves, strainer, and fittings at pumps.

2.7.1.2 Pumps shall be positive displacement, self-priming heavy duty rotary helical gear type pumps.

2.7.1.3 Microprocessor-based Programmable Logic Control Strategy, Nema4X Enclosure, UL/CSA LISTED; Main Disconnect, Magnetic Motor Starters, Hand-Off-Auto Selector Switches, Pilot Lights for 'Power On', Motor 'Run' and Motor 'Trip', Terminal Strip, Pump Failure Pilot Light and Manual Reset, Audible Alarm Buzzer and Silence Push Button, High and Low Pressure Cut Outs/ Red Pilot Light/ Reset, Provisions for Main Tank and Day Tank Status (High Level, Critical High Level, Low Level within the day tank and high level and low level within the main tank) with Red Pilot Lights and Dry Alarm Contacts for each, and provision for all alarms to signal at BAS / EMCS. Control panel shall also switch operation of pumps from lead to lag to maintain equal run times on the equipment.

2.7.1.3.1 Pressure sensing device shall be installed and shall shut pumps down when the pressure falls below or rises above the normal operating pressure.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.7.1.3.2 Duplex pumping system shall come complete with level sensing devices for both the main tank and the day tank. Provide a four (4) level control switch and a separate critical high level switch for the day tank. Provide a two (2) level control switch for the main tank.
 - 2.7.1.3.2.1 Floats to be of stainless steel construction.
 - 2.7.1.3.2.2 Floats shall come complete with a 2" MNPT connection and junction box.
 - 2.7.1.3.2.3 Switch assemblies shall be certified to CAN/CSA Std. C22.2 No. 1010-1, CAN/CSA Std. C22.2 No. 30. Assembly shall also conform to UL1203 and ANSI/ISA S82-3.
 - 2.7.1.3.2.4 The four level switch shall control the systems as follows:
 - 2.7.1.3.2.4.1 High level – set at 95% of day tank volume, shall indicate high level alarm and stop all pumps.
 - 2.7.1.3.2.4.2 Stop pumps level – set at 90% of day tank volume and stops all pumps.
 - 2.7.1.3.2.4.3 Lead pump start level – set at 75% of day tank volume, start lead pump.
 - 2.7.1.3.2.4.4 Low level – set at 65% of day tank volume, shall indicate low level alarm and start lag pump.
 - 2.7.1.3.2.5 The single critical high level switch in the day tank shall stop all power to the fuel pump system and shall be set for 97% of the day tank volume.
 - 2.7.1.3.2.6 The two-level switch in the main tank shall indicate a high level alarm at 95% of the tank volume and indicate a low level alarm at 25% of the tank volume and stop pumps.
- 2.7.1.3.3 Pumping system operation shall be controlled by the level sensing devices located in the day tank and main tank and shall automatically maintain the fuel level in the day tank.
- 2.7.1.3.4 Pump control panel shall be used to open the solenoid on the main tank whenever the pumps are in operation.
- 2.7.1.3.5 Pump control panel shall accept a signal from the day tank control panel to stop pumping if the day tank experiences a leak within the secondary containment area.
- 2.7.1.3.6 Entire system shall be suitable for installation in an unheated enclosure where ambient conditions will vary from -50° C during the winter to 40° C in the summer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.7.1.4 Pumping package shall be complete with a NEMA 4X stainless steel enclosure to house entire package. Enclosure shall be weatherproof as it will be located outside and shall be corrosion resistant. Enclosure shall be suitably rated for hazardous locations if it is located within such an area.

2.7.1.5 Pump Criteria:

2.7.1.5.1 Liquid: Diesel fuel oil.

2.7.1.5.2 Flow rate: 0.063 L/S.

2.7.1.5.3 Pressure: 413kPa.

2.7.1.6 Acceptable manufacturers: Pumps - Albany Model 03GC61412; Strainers - Albany Model Simplex Series; Controller - DUCON Series Duplex Fuel Oil Management Control Center; Pump package - Albany Model FODUP/03GC/BS Duplex Fuel Oil Transfer Pumpset, Preferred Utilities, or approved equal.

2.8 FOOT VALVE

2.8.1 Install at bottom of tank suction lines as indicated.

2.8.2 Valve to be double poppet type.

2.8.3 Valve to be of bronze construction with lapped-in seats.

2.8.4 Flat poppets.

2.8.5 20 mesh monel screen.

2.8.6 Acceptable manufacturers: Preferred Utilities Manufacturing Corporation or approved equal.

2.9 VACUUM BREAKER

2.9.1 Brass body with threaded ends.

2.9.2 Stainless steel ball.

2.9.3 EPN "O" ring seat.

2.9.4 Positive bubble tight closing.

2.9.5 Suitable for pressure up to 2.07 mPa.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.9.6 Valve shall be installed to prevent vacuums within the system as per code requirement.
- 2.9.7 Acceptable manufacturers: Model VB, Preferred Utilities MFG Corp or approved equal.
- 2.10 **SOLENOID VALVE:**
- 2.10.1 Solenoid valve shall be suitable for operating pressures and diesel fuel oil piping applications.
- 2.10.2 Normally closed hung piston design.
- 2.10.3 Solenoid valve shall open upon receipt of an electronic signal.
- 2.10.4 Valve shall operate on 120 Volt AC. Operation on other voltages shall be factory options.
- 2.10.5 Viton seal.
- 2.10.6 Continuous duty Class H standard coil with other available options, as required to suit installation.
- 2.10.7 Zero pressure differential required for operation.
- 2.10.8 Integral thermal relief.
- 2.10.9 Watertight enclosure and rated for a variety of hazardous locations, NEMA 3, 4X, 7 and 9; groups C and D.
- 2.10.10 Cast bronze body.
- 2.10.11 Provide strainer with 100 mesh screen upstream of solenoid valve.
- 2.10.12 Acceptable manufacturers: Morrison Bros. Co, Model 710 or approved equal.
- 2.11 **FLOW METER**
- 2.11.1 Turbine type flow meter suitable use with diesel fuel oil with a flow rate in the range of 1.9 to 45425 LPM.
- 2.11.2 NPT end fittings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.11.3 Stainless steel body construction with 17-4 PH stainless steel hydraulically balanced rotor and metal ball bearings.
- 2.11.4 Linearity: +/- 0.5%.
- 2.11.5 Repeatability: +/- 0.1%.
- 2.11.6 Temperature Range: -276° C to 232° C.
- 2.11.7 Pressure Drop: 34 kPa at nominal rated flow.
- 2.11.8 Furnished with standard fluid calibration.
- 2.11.9 Complete with mounting boss and pickup coil for totalizer.
- 2.11.10 Complete with totalizer as follows:
 - 2.11.10.1 Input power: 5 to 48 VDC, Reverse Polarity Protected.
 - 2.11.10.2 Internal Power: D Lithium Battery.
 - 2.11.10.3 Temperature Rating: Operating: -30° C to 75° C and Storage: -40° C to 85° C.
 - 2.11.10.4 Enclosure: Explosion Proof Aluminum.
 - 2.11.10.5 Serial Communications: RS-232 (optional).
 - 2.11.10.6 Signal Input: Magnetic, RF Modulated (external power required), Pulse.
 - 2.11.10.7 Temperature Compensation: Two Wire RTD (optional).
 - 2.11.10.8 Outputs: Scaled Pulse, Rate (4-20 mA), Alarm (optional).
 - 2.11.10.9 Approvals: NMI approved, meets all Handbook 44 requirements for cryogenics.
- 2.11.11 Acceptable manufacturers: Liquid Controls Group, Sponsler Precision Turbine Meter with IT 400 totalizer: or approved equal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Install materials and equipment as required and in accordance with Nalcor Engineering Directive and Section 23 05 05 – Installation of Pipework, supplemented as specified herein. In addition, install materials and equipment in accordance with CAN/CSA-B139, CAN/CSA-B140.0, ASME B31.9, NFC and CCME documents.

3.1.2 All devices and components shall be rated for use within the space classification they are installed in. Refer to API Recommended Practice 500 for additional information on hazardous locations near fuel systems.

3.1.3 Piping:

3.1.3.1 Provide Non-Destructive Examination (NDE) report for welding of exterior fuel oil piping. Unless specifically stated to the contrary, fabrication, assembly and welding shall conform to ASME B31.1. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until it has been inspected, tested, and approved. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected and building structural shall not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically required, vertical piping shall run plumb and straight and parallel to walls. Piping connected to equipment shall be installed to provide flexibility for vibration. Adequately support and anchor piping so that strain from weight of piping is not imposed on the equipment.

3.1.3.2 Clearances for welding:

3.1.3.2.1 Provide clearances from walls, ceilings, and floors to permit the installation of joints. The clearances shall be at least 150 mm for pipe sizes NPS 4 and less, 250 mm for pipe sizes over NPS 4, and sufficient in corners. However, the specified clearances shall not waive requirements for welders to be qualified for the positions to be welded.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.3.3 Cleaning and flushing procedures:

3.1.3.3.1 Before jointing and erection of piping, thoroughly clean interiors of pipe sections and components. In steel pipe, loosen scale and other foreign matter by rapping sharply and expel by wire brush and swab. Blow out steel pipe and components with compressed air at 689 kPa (gage) or more. Maintain cleanliness by closure of pipe openings with caps or plugs. Before making final terminal connections, blow out complete system with compressed air at 689 kPa (gage) or more.

3.1.3.4 Changes in pipe size:

3.1.3.4.1 Use reducing fittings for changes in pipe size. The use of bushings shall not be permitted. In horizontal lines, NPS 2½ inches and larger, reducing fittings shall be of the eccentric type to maintain the bottom of the lines in the same plane.

3.1.3.5 Drainage and flexibility:

3.1.3.5.1 Piping shall be free of unnecessary pockets and shall be installed level. Provide flexibility by use of fittings, loops and offsets in piping. Install branches at top of a main to prevent carryover of foreign matter. Provide lockable drain valves at all system low points to facilitate complete system drain down.

3.1.4 Welding procedures:

3.1.4.1 Perform welding in accordance with qualified procedures using qualified welders and welding operators. Do not perform welding when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Engineer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members shall be in accordance with AWS D1.1/D1.1M.

3.1.4.2 Cleaning for welding:

3.1.4.2.1 Surfaced to be welded shall be free from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth and free from defects which might affect proper welding. Clean each layer of weld metal thoroughly by wire brushing, grinding, or chipping prior to inspection or deposition of additional weld material.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.4.3 Welding of valves:

3.1.4.3.1 Disassemble valves subject to damage from heat during welding and reassemble after installation. Open valves off the seat when not subject to heat damage during welding; do not backseat valve.

3.1.5 Threaded joints:

3.1.5.1 Cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Threads shall be smooth, clean, and full cut. Apply thread tape to male threads only. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed.

3.1.6 Valves:

3.1.6.1 Install valves at the locations indicated and elsewhere as required for the proper functioning of the system and as required by CCME, NFC and CSA B139.

3.1.6.2 Install valves with items upright or horizontal unless approved otherwise by Engineer.

3.1.7 Hangers and supports:

3.1.7.1 Selection, fabrication and installation of piping hangers and supports shall conform to MSS SP-58, MSS SP-69 and MSS SP-89, except that spacing of the hangers and supports shall be as per Table I.

3.1.7.2 Table I - Maximum Span for Pipe (Meters)

NPS	Std. Wt. Steel Pipe Schedule 40
1/2	1.50
3/4	1.75
1	2.00
1 1/2	2.30
2	2.60

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2 ½	2.80
3	3.10
3 ½	3.35
4	3.5
6	4.20
8	4.70
10	5.20
12	5.55

3.1.8 Pressure gauges:

- 3.1.8.1 Provide pressure gauge with a ¼ NPS Schedule 40 pipe nipple and quarter turn mini-ball valve, installed between the gauge and the line.
- 3.1.8.2 Provide compound pressure gauges at suction of fuel oil pumps.

3.1.9 Strainers:

- 3.1.9.1 Provide 60 mesh stainless steel basket strainers at each fuel pump suction.
- 3.1.9.2 At time of project substantial completion, clean out basket strainers.

3.1.10 Equipment installation:

- 3.1.10.1 Install piping in a manner that does not place a strain on any of the equipment.

3.1.11 Cleaning of system:

- 3.1.11.1 Clean the various system components before final closing as the installations are completed. Remove foreign matter from equipment and surrounding areas. Preliminary or final tests shall not be permitted until the cleaning is completed to the satisfaction of the Engineer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.12 Unions:

3.1.12.1 Provide unions where necessary to permit easy disconnection of piping and apparatus, and as indicated.

3.1.13 Identification of piping:

3.1.13.1 Identify piping in accordance with Nalcor Engineering Directive, CSA B139 and NFCC.

3.1.14 Flexible Connections:

3.1.14.1 Flexible connections shall be installed in accordance with manufactures recommendations in locations indicated.

3.2 FIELD QUALITY CONTROL

3.2.1 Welding examinations:

3.2.1.1 Contractor shall perform visual examinations to detect surface and internal discontinuities in completed welds as per specification Section 23 05 17 - Pipe Welding. Verify piping welds meet the acceptance criteria. Visually examine all welds. When examination indicates defects in a weld, joint, the weld shall be repaired by a qualified welder. Remove and replace defects as specified in ASME B31.9, unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Whenever a defect is removed, and repair by welding is not required, blend the affected area into the surrounding surface, eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, examine the area by the same methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, re-examine the repaired area by radiography for butt welded joints or magnetic particle analysis for socket welded joints as per specification Section 23 05 17 - Pipe Welding. Any indication of a defect shall be regarded as a defect unless re-evaluation by surface conditioning and re-examination shows that no unacceptable defects are present. The use of any foreign material to mast, fill in, seal, or disguise welding defects will not be permitted.

3.2.1.2 Upon failure of a weld by visual inspection, carry out radiographic or magnetic particle inspections as applicable of up to 10% of all welds performed by the welder responsible for the failed weld. The individual welds selected for radiographic examination shall be chosen by the Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.2 Testing:

3.2.2.1 General requirements, testing:

3.2.2.1.1 Perform testing after cleaning. Contractor shall provide everything for tests. Tests shall be subject to the approval of the Engineer.

3.2.2.2 Hydrostatic tests:

3.2.2.2.1 Preliminary preparation:

3.2.2.2.1.1 Remove or isolate from the system the fuel pump, fuel storage tank, generator, instruments, and equipment which would be damaged by water during hydrostatic tests and reinstall after successful completion of tests.

3.2.2.2.2 Performance of hydrostatic tests:

3.2.2.2.2.1 Vent or flush air from the piping system. Pressurize system for 10 minutes with water at 689 kPa, then reduce to design working pressure and check for leaks and weeps. Install a test pressure gauge in the piping system to observe any loss in pressure. Maintain required test pressure for a sufficient length of time to enable an inspection of all joints and connections.

3.2.2.2.3 System fill:

3.2.2.2.3.1 After satisfactory completion of hydrostatic pressure test, blow system dry with clean, oil-free compressed air, and fill with service fluid. Flush for a minimum of 2 hours with the service fluid. Remove and clean basket strainers at completion of flushing exercise. Dispose of fuel oil used for flushing in accordance with requirements of authority having jurisdiction.

3.2.2.2.3.2 The Contractor shall be responsible to provide fuel oil for flushing purposes. The Contractor shall also be responsible for all costs associated with disposal of fuel oil used for flushing purposes.

3.2.2.3 Operational tests:

3.2.2.3.1 Test fuel oil equipment as in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 13
CH0032	FACILITY FUEL-OIL PIPING	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.2.4 Check entire installation is approved by Authority having jurisdiction.
- 3.2.2.5 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tool and equipment.
- 3.2.2.6 Provide testing reports as requested by Engineer or authority having jurisdiction.

END OF SECTION




Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 23 11 14
FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS
TABLE OF CONTENTS**

PART 1 GENERAL.....2

1.1 SUMMARY2

1.2 RELATED SECTIONS.....2

1.3 REFERENCES.....2

1.4 SHOP DRAWINGS.....3

1.5 DELIVERY, STORAGE AND HANDLING.....3

PART 2 PRODUCTS3

2.1 OPERATIONAL SPECIFICATIONS.....3

2.2 PRODUCT SPECIFICATIONS/CAPACITIES11

PART 3 EXECUTION.....16

3.1 MANUFACTURER'S SUPPORT/FIELD SERVICE.....16

3.2 DOCUMENTATION.....17

3.3 NOT USED.....18

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in Newfoundland and Labrador.
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SUMMARY

- 1.1.1 This specification details the requirements for furnishing and installing an electronic monitoring system for above grade double wall storage tanks for diesel fuel.
- 1.1.2 This specification describes specifically a continuous monitoring and leak detection system.

1.2 RELATED SECTIONS

- 1.2.1 Section 33 56 13: Aboveground Fuel Storage Tanks

1.3 REFERENCES

- 1.3.1 The fuel storage tanks monitoring system shall meet all applicable standards and regulatory agency requirements including, but not limited to, the standards and requirements of the following:
 - 1.3.1.1 American National Standards Institute (ANSI).
 - 1.3.1.2 American Petroleum Institute (API).
 - 1.3.1.3 American Society for Testing and Materials (ASTM).
 - 1.3.1.4 Environmental Protection Agency (EPA).
 - 1.3.1.5 National Fire Protection Agency (NFPA).
 - 1.3.1.6 Canadian Standards Association (CSA).
 - 1.3.1.7 Canadian Underwriters Laboratories Inc. (CUL).
 - 1.3.1.8 Canadian Electrical Code Part 1 C22.1-98.
 - 1.3.1.9 Canadian Council of Resource and Environment Ministers Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products.
 - 1.3.1.10 National Fire Code of Canada.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 SHOP DRAWINGS

1.4.1 Submittals:

- 1.4.1.1 Submit product data for all materials specified in this section.
- 1.4.1.2 Submit operation and maintenance data and incorporate into Operations and Maintenance Manual.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Waste Management and Disposal:

- 1.5.1.1 Separate and recycle waste material in accordance with municipal regulations.

PART 2 PRODUCTS

2.1 OPERATIONAL SPECIFICATIONS

2.1.1 In-tank leak detection:

- 2.1.1.1 The system shall utilize in-tank probes based on the magnetostrictive principle for liquid level measurement and in-tank leak detection.
- 2.1.1.2 The tank gauges shall be capable of performing a static tank tightness test to an accuracy of 0.37 L/h with at least a 98% probability of detection [P(D)] and no more than 1% probability of false alarm [P/(FA)].
- 2.1.1.3 The system shall have the ability to be programmed to run a static 0.74 L/h quick leak test. The static leak test will take one hour and commence 30 minutes after the last dispensing cycle or five hours from the last delivery, whichever is greater.
- 2.1.1.4 The system shall have the ability to conduct automatic continuous statistical leak detection tests without the need to shut down tanks for scheduled test times.
- 2.1.1.5 The system shall continuously collect product height and temperature information from each tank and, without input from any other source, utilize dynamic pattern analysis to determine when idle periods in each respective tank begin and end. Idle time information thus collected shall be transferred to the systems database for qualification.
- 2.1.1.6 The system shall be capable of evaluating after each idle period the quality of information stored in the database. The idle period qualification shall consider

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

noise factors affecting the idle time such as dispensing, deliveries, temperature changes, temperature stratification and evaporation.

- 2.1.1.7 The system shall be capable of dynamically qualifying the idle time data and selecting the best available data to perform a 0.74 L/h tank tightness evaluation.
- 2.1.1.8 The system shall employ the use of dynamic feedback variables in the algorithm to evaluate the noise factor patterns associated with a tank, thus tailoring the algorithms to each individual tank.
- 2.1.1.9 The system shall perform a new 0.74 L/h tank tightness evaluation as each new piece of idle period data is added to the database.
- 2.1.1.10 The system, when operated in the continuous statistical leak detection mode, shall be third-party certified. The test shall meet or exceed U.S. EPA standards with a 99% probability of detecting a 0.74 L/h leak and less than 0.1% probability of false alarm. It shall meet federal, provincial and local compliance requirements for monthly monitoring.
- 2.1.1.11 In conjunction with having the ability to perform a continuous statistical leak test, the monitoring system shall have the ability to perform a static leak test to an accuracy of 99% probability of detecting a leak and 1% probability of false alarm.
- 2.1.2 Environmental compliance reports:**
 - 2.1.2.1 The system shall have the ability to provide a record of the last three occurrences of each type of alarm or warning condition detected by the system.
 - 2.1.2.2 The system shall provide the following types of reports related to environmental compliance matters:
 - 2.1.2.2.1 System status messages.
 - 2.1.2.2.2 In-tank warning and alarm messages.
 - 2.1.2.2.3 In-tank tightness evaluation report.
 - 2.1.2.2.4 Liquid sensor warning and alarm messages.
 - 2.1.2.2.5 Normally-closed sensor warning and alarm conditions.
 - 2.1.2.2.6 Hydrostatic sensor warning and alarm conditions/high or low liquid level conditions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.2.2.7 External input messages.
- 2.1.2.2.8 Discriminating containment sump sensor warning and alarm messages.
- 2.1.2.2.9 Software module alarm message.
- 2.1.3 Product inventory control (tank gauging):
 - 2.1.3.1 The tank management system shall collect product height and temperature data from magnetostrictive level sensors and compute gross and temperature-compensated net litres for each tank. The operator may choose from inventory or delivery information to generate a complete set of inventory or delivery printed reports.
 - 2.1.3.2 The system shall automatically generate an inventory increase report when a delivery of product to a tank has taken place. The report shall include the time and date of the delivery, the starting volume in the tank, the ending volume in the tank, the starting temperature of the fuel, the ending temperature of the fuel, and the inventory increase amount.
 - 2.1.3.3 The system shall have the ability to store up to the ten most recent inventory increases in memory for business management purposes.
- 2.1.4 Inventory management reports:
 - 2.1.4.1 General:
 - 2.1.4.1.1 The system shall monitor inventory in metric units and produce a combination of automatic and manual reports for each tank, which include the following information:
 - 2.1.4.1.1.1 Fuel volume.
 - 2.1.4.1.1.2 Fuel height.
 - 2.1.4.1.1.3 Water height.
 - 2.1.4.1.1.4 Fuel temperature.
 - 2.1.4.1.1.5 Ullage.
 - 2.1.4.1.1.6 Temperature – compensated fuel volume.
 - 2.1.4.1.1.7 Last inventory increase amount.
 - 2.1.4.1.1.8 Last in-tank leak test results.
 - 2.1.4.1.1.9 Time and data.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.4.1.1.10 Tank identification.
- 2.1.4.1.1.11 Fuel type identification.
- 2.1.4.1.1.12 90% ullage.
- 2.1.4.1.2 A printout of the inventory status report shall be generated any time the operator presses the print button while the system is in the normal operating mode or generated automatically three times a day with the information stored in memory.
- 2.1.4.1.3 The system shall provide an automatic delivery report, programmed to print from 1 to 99 minutes after bulk delivery to a tank is complete. The information shall include product label, date, starting and ending time, starting and ending volumes, temperature of the fuel as well as the net volume increase. The information shall be available in metric units.
- 2.1.4.1.4 The system shall be able to generate reports in a display/printer format as well as a computer format upon demand.
- 2.1.4.2 Fuel management reports:
 - 2.1.4.2.1 The system shall be able to generate fuel management reports in a display/printer format as well as a computer format upon demand via the RS-485 serial communications interface.
 - 2.1.4.2.2 A printout of the fuel management status report shall be generated any time the operator presses the print button while the system is in the normal operating mode either on the front panel of the console, or on the personal computer to which the console is directly connected via the RS-485 interface.
 - 2.1.4.2.3 The system shall provide a report outlining the current inventory, usage and the number of days of fuel remaining.
- 2.1.5 Communications:
 - 2.1.5.1 General:
 - 2.1.5.1.1 The tank monitoring system shall provide the ability to communicate with locally attached electronic devices through an RS-485 port or remote locations via an internal modem. The system shall provide data in a display or packed computer data format.
 - 2.1.5.1.2 The communications protocol shall be the Manufacturer's standard serial communications protocol.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.5.1.3 The tank monitoring system shall provide all reports available on the integral printer through the communications port. These shall include all reports associated with inventory management, environmental compliance and diagnostics/troubleshooting.
- 2.1.5.1.4 The system shall provide for setup and configuration through the communications port using the Manufacturer's standard serial communications protocol.
- 2.1.5.2 Serial communications:
 - 2.1.5.2.1.1 The system shall provide an RS-485 communications interface for data transmission to a locally attached computer.
- 2.1.5.3 Auto-dial site fax modem:
 - 2.1.5.3.1 The tank monitoring system shall provide an internal auto-dial fax 2400/1200/300 baud, Hayes-compatible modem, with twin snap in RJ-11 jacks for direct data transmission over phone lines, capable of transmitting information directly to a fax machine, PC or teletype.
 - 2.1.5.3.2 The auto-dial fax/modem shall include the following capabilities:
 - 2.1.5.3.2.1 Dial up to eight user-programmed phone numbers.
 - 2.1.5.3.2.2 Transmit up to 16 user selected reports to each phone number. The reports can consist of:
 - 2.1.5.3.2.2.1 System status;
 - 2.1.5.3.2.2.2 Inventory information;
 - 2.1.5.3.2.2.3 Deliveries;
 - 2.1.5.3.2.2.4 Tank leak test results;
 - 2.1.5.3.2.2.5 Sensor status;
 - 2.1.5.3.2.2.6 Alarm Histories.
 - 2.1.5.3.2.3 Program calling times and schedules for each of the eight phone numbers
 - 2.1.5.3.2.4 Selectable automatic dialling to report any alarm condition immediately. The call shall be immediate on alarm occurrence, selectable by alarm type and assignable any or all of the eight user-programmed phone numbers.
 - 2.1.5.3.2.5 Selectable fax/computer/teletype compatibility. In addition to automatically dialling out at pre-programmed times or to report an alarm condition, the system shall have the ability to receive calls form a PC to query the tank monitoring system for information.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.5.3.2.6 The answer/receive mode shall be selectable with provisions for enabling or disabling the answer mode for telephone line sharing applications.

2.1.6 Input/Output devices:

2.1.6.1 Output relay module:

2.1.6.1.1 The system shall provide the ability to enable external audible/visual alarms or control external devices through a relay contact closure.

2.1.6.1.2 The system shall provide 4 Form C contact relays per interface module.

2.1.6.1.3 The system shall provide the ability to interface up to 8 relay output modules per system for a total of 32 relays.

2.1.6.1.4 The system shall provide the ability to program the relay in either a Normally Open or Normally closed orientation.

2.1.6.1.5 The system shall provide the ability to assign in-tank, sensor, external input, or system alarm conditions to a select relay.

2.1.6.1.6 The system shall provide the ability to designate a 20-character label to a device connected to the output relay through system programming.

2.1.7 Alarms

2.1.7.1 The tank monitoring system shall provide an audible and visual indication of all system, in-tank leak, and external sensor alarm conditions.

2.1.7.2 The system alarm conditions shall include:

2.1.7.2.1 Maximum product level.

2.1.7.2.2 High level limit.

2.1.7.2.3 Overfill alarm.

2.1.7.2.4 High water alarm.

2.1.7.2.5 Second high water alarm.

2.1.7.2.6 Delivery needed alarm.

2.1.7.2.7 Low limit.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.7.2.8 Theft.
- 2.1.7.2.9 Periodic warning and alarm.
- 2.1.7.2.10 Annual warning and alarm.
- 2.1.7.3 The tank monitoring system shall provide an audible and visual alarm indication for in-tank leak failures (11.3 L/h, 0.37 L/h and 0.74 L/h) and external sensor leak failures (fuel, water, sensor out).
- 2.1.7.4 In conjunction with providing an audible and visual alarm, the system shall have the ability to print out all alarm conditions to the integral thermal printer.
- 2.1.7.5 The system shall have the ability to send all alarm conditions to the RS-485 serial communications port for data transmission to a central computer. The system shall have the ability to transmit the alarm condition immediately or program a delay time before sending. The system shall also have the ability to enter a repeat function in the programming to repeat sending the alarm condition.
- 2.1.7.6 The system shall have the ability to automatically dial out and transmit system, in-tank leak, and external sensor alarm conditions to a fax machine.
- 2.1.7.7 The system shall provide the Operator with the ability to disable the audible portion of an alarm but the visual alarm shall not be disabled until the alarm condition has been corrected.
- 2.1.7.8 The system shall be equipped with external audible and visual alarms. The external alarm boxes shall be manufactured in watertight gasketed enclosures for installation in an outdoor environment. The external alarm boxes shall interface to the tank monitoring system via internal relays.
- 2.1.7.9 The system shall have the ability to store up to three alarm occurrences in memory. The Operator shall have the ability to print the alarm history and alarm status on the integral printer as well as retrieve alarm history and alarm status through the communications interface (RS-485, or 2400/1200/300 baud auto-dial fax/modem).
- 2.1.8 Setup (startup/installation):
 - 2.1.8.1 The system shall contain parameter-driven software to adapt the tank monitor to site specifications. The parameters must be enterable in assigned fields at the time of system startup. In addition, the parameters must be field updatable so that changes in tank diameter/dimensions as well as site specifications can be added.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.8.2 The system shall provide the use of a security code to prohibit unauthorized entry to the systems set-up parameters. The system security code shall be a six-digit number entered through the front-panel keyboard or through the external communications interface. The security code shall have the capability of containing alpha or numeric characters.
- 2.1.8.3 A four-line, 24-character custom location header to identify the site must be user-programmable. The header must appear automatically on inventory status reports, leak detection reports and automatic delivery reports each time they are printed.
- 2.1.8.4 Set-up parameters shall include the following:
 - 2.1.8.4.1 System setup data.
 - 2.1.8.4.2 Communications setup data.
 - 2.1.8.4.3 In-tank setup data.
 - 2.1.8.4.4 Fuel management setup.
 - 2.1.8.4.5 In-tank leak test setup data.
 - 2.1.8.4.6 Liquid sensor setup data.
 - 2.1.8.4.7 2-wire C.L. (Type A) setup data.
 - 2.1.8.4.8 3-wire C.L. (Type B) setup data.
 - 2.1.8.4.9 External input setup data.
 - 2.1.8.4.10 Output relay setup data.
- 2.1.9 Diagnostics/Troubleshooting.
 - 2.1.9.1 All diagnostic information shall be generated by the system itself. The system shall not allow the user to change or enter diagnostic information in any way. The following diagnostic information shall be included in the system:
 - 2.1.9.1.1 Probe diagnostics:
 - 2.1.9.1.1.1 Probe type.
 - 2.1.9.1.1.2 Serial number.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.9.1.1.3 Probe length.
- 2.1.9.1.1.4 Dry and wet calibration values.
- 2.1.9.1.2 System diagnostics:
 - 2.1.9.1.2.1 Software revision level.
 - 2.1.9.1.2.2 Software part number.
 - 2.1.9.1.2.3 Software creation date.
- 2.1.9.1.3 Fuel management diagnostics:
 - 2.1.9.1.3.1 Days of fuel remaining.
 - 2.1.9.1.3.2 Average consumption per day.
 - 2.1.9.1.3.3 Last day consumption.
 - 2.1.9.1.3.4 Predicted daily consumption.
- 2.1.9.1.4 In-tank diagnostics.
- 2.1.9.1.5 In-tank leak results.
- 2.1.9.1.6 Liquid sensor diagnostics.
- 2.1.9.1.7 Discriminating containment sump sensor diagnostics.
- 2.1.9.1.8 Alarm history report.
- 2.1.10 Reports:**
 - 2.1.10.1 The system shall provide the capability to print diagnostic information on the system's integral printer for hard-copy documentation and historical record keeping.
- 2.2 PRODUCT SPECIFICATIONS/CAPACITIES**
 - 2.2.1 Console:**
 - 2.2.1.1 The console shall be wall mounted using external mounting tabs.
 - 2.2.1.2 The console shall be equipped with a two-line, 24-character liquid crystal display for on-site viewing of all inventory, leak detection and alarm information.
 - 2.2.1.3 The console shall be equipped with a 24-button front-panel keyboard with control and alphanumeric functions for programming, operating and reporting functions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.1.4 The console shall be equipped with three front-panel indicators to provide a visual indication of power on, warning and alarm conditions.
- 2.2.1.5 The console shall be equipped with an integral, 24-character, thermal report printer with built-in take-up spool for hard-copy documentation of inventory, leak detection, alarm information, and facsimile transmission confirmation.
- 2.2.1.6 The console shall be equipped with a back-up battery to maintain all programming information as well as inventory, leak detection and alarm information in the event of a power outage.
- 2.2.1.7 The console shall be a modular design to accept additional business management, leak detection and communications features in the future.
- 2.2.1.8 The console shall be equipped with four 44 mm diameter conduit knockouts on the top and bottom of the monitor for rigid conduit entry into the monitor. Two conduit entries (top and bottom) shall be designated for the intrinsically safe compartment, and two conduit entries (top and bottom) shall be designated for the high-power compartment.
- 2.2.1.9 The console shall be separated into three compartments for:
 - 2.2.1.9.1 Intrinsically safe wiring and devices.
 - 2.2.1.9.2 High-power wiring and devices.
 - 2.2.1.9.3 Communications wiring and devices.
- 2.2.1.10 The console shall have an internal quick-disconnect connector for 120 Vac wiring to the console for ease of installation, service and troubleshooting.
- 2.2.1.11 The console shall be equipped with the ability to communicate directly with an external printing device or PC. The system shall also have the ability to communicate with a remote device via the telephone lines.
- 2.2.1.12 The console shall be capable of communication in English.
- 2.2.1.13 The console shall be equipped with internal audible and visual warning and alarm indicators.
- 2.2.1.14 The console shall be intrinsically safe with Canadian Standards Association (CSA), and Canadian Underwriters Laboratories (CUL) approval.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.1.15 The console shall be mounted and wired according to the manufacturer-supplied installation manuals, with all underground intrinsically safe field wiring enclosed in dedicated conduit and separate from all other wiring.
- 2.2.1.16 The console shall continuously monitor all probes and sensors, reporting not only normal operating conditions, but also system malfunctions or failures.
- 2.2.2 Modules:
- 2.2.2.1 General:
- 2.2.2.1.1 The tank monitoring system shall incorporate a modular design to allow the factory installation of system features to meet specific application requirements as well as field installation/modification of features at a later date to meet changing business, environmental compliance or regulatory requirements.
- 2.2.2.1.2 The modular design shall consist of one console with the ability to accept plug-in modules. The console shall be divided into three compartments to separate and house plug-in modules for intrinsically safe devices, high power devices and communications devices.
- 2.2.2.1.3 The interface of additional enclosures to the original console shall not be considered a modular design.
- 2.2.2.2 Module compartments:
- 2.2.2.2.1 The system shall have the ability to contain up to eight modules in the high-powered area of the console. The modules to be supplied for this specific application shall consist of:
 - 2.2.2.2.1.1 A four-relay output interface module that can be programmed to actuate external alarm devices when assigned alarm limits are exceeded or alarm conditions are identified.
 - 2.2.2.2.2 The system shall have the ability to contain up to eight modules in the intrinsically safe area of the console. The modules to be supplied for this specific application shall consist of:
 - 2.2.2.2.2.1 A four-input probe interface module compatible with the magnetostrictive probe.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.2.2.3 The system shall have the ability to contain up to three modules in the communications compartment of the console. The modules to be supplied for this specific application shall consist of:

2.2.2.2.3.1 An RS-485 interface module providing data transmission to a computer, or printing device.

2.2.2.2.3.2 A SiteFax 2400/1200/300 baud modem interface module with twin snap in jacks for direct data transmission over the phone lines, utilizing the Hayes command set, with the ability to automatically call a fax machine based on the occurrence of an alarm condition or a pre-programmed report transmission time.

2.2.3 Probes:

2.2.3.1 The probe shall be capable of utilizing shielded gas and oil resistant wire between 14 AWG and 18 AWG for field connections.

2.2.3.2 There shall be no more than two conductors between the probe and control console.

2.2.3.3 The probe shall be capable of performing a leak detection test to 0.37 L/h or higher.

2.2.3.4 Third-party certification is required in accordance with the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems" (0.74 L/h monthly monitoring).

2.2.3.5 Third-party certification is required in accordance with the U.S. EPA's "Volumetric Tank Tightness Testing Method" (0.37 L/h annual tank tightness test).

2.2.3.6 A cap and ring kit, available from the manufacturer, shall be supplied with each oil tank probe for easy installation and removal.

2.2.3.7 The probe shall use digital communications protocol format for maximum RF/EMF resistance immunity.

2.2.3.8 The probes serving above ground storage tanks shall be supplied with AST installation kits.

2.2.4 Communications:

2.2.4.1 Auto-dial site fax modem:

2.2.4.1.1 The modem shall utilize the standard Hayes command set.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.4.1.2 The modem shall have the capability of automatically switching between 2400, 1200 and 300 baud.
- 2.2.4.1.3 The modem shall utilize two snap-in RJ-11 jacks for phone line interface.
- 2.2.4.1.4 The system shall have the ability to program in up to eight phone numbers assigned to a fax/modem module.
- 2.2.4.1.5 The system shall have the ability to enter in up to 20 characters maximum for the destination phone number.
- 2.2.4.1.6 The destination type shall be fax, teletype or computer, selectable by destination.
- 2.2.4.1.7 The system shall be capable of redialling a location from three to 99 times, selectable by destination.
- 2.2.4.1.8 The system shall be capable of redial intervals from one to 60 minutes, selectable by destination.
- 2.2.4.1.9 The system shall call immediately on an alarm occurrence selectable by alarm type, assignable by destination.
- 2.2.4.1.10 The system shall allow for answer/receive disabling for line sharing applications.
- 2.2.4.2 RS-485 serial communication interface:
 - 2.2.4.2.1 The system shall have the capability to communicate directly with a computer, teletype or printer.
 - 2.2.4.2.2 The system shall provide direct interface via an industry Standard Pin connector using standard RS-485 serial communications hand-shaking signals.
- 2.2.5 Acceptable manufacturers:
 - 2.2.5.1 Veeder-Root or approved equal Fuel Storage Tank Monitoring System, as specified including the following:
 - 2.2.5.1.1 One (1) TLS-350 Plus console with printer.
 - 2.2.5.1.2 One (1) CSLD software enhancement module.
 - 2.2.5.1.3 One (1) four input probe interface module.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.5.1.4 One (1) four relay output interface module.
- 2.2.5.1.5 One (1) dual port RS-232/RS-485 interface module.
- 2.2.5.1.6 One (1) SiteFax interface module.
- 2.2.5.1.7 One (1) magnetostrictive probe sized to suit tank.
- 2.2.5.1.8 One (1) magnetostrictive probe installation kit to suit.
- 2.2.5.1.9 One (1) above ground storage tank installation kit for magnetostrictive probe to suit.
- 2.2.5.1.10 One (1) NPS 4 riser cap and ring kit.
- 2.2.5.1.11 One (1) overfill alarm.
- 2.2.5.1.12 One (1) alarm acknowledgement switch.
- 2.2.5.1.13 One (1) interstitial sensor to suit main fuel tank.
- 2.2.5.1.14 All other components as required for a complete working system.

PART 3 EXECUTION

3.1 MANUFACTURER'S SUPPORT/FIELD SERVICE

3.1.1 Technical support:

3.1.1.1 The Manufacturer shall provide technical phone support available to customers from 8:00 a.m. to 7 p.m. EST on a daily basis.

3.1.2 Field service:

3.1.2.1 The Manufacturer shall provide a Field Service Representative to provide on-site customer support and training, as well as overseeing the installation of the tank monitoring system by the installation Contractor.

3.1.2.2 The Manufacturer's Field Service Representative shall be available for on-site training of company maintenance personnel on installation, programming and troubleshooting of the tank monitoring system.

3.1.2.3 The Manufacturer shall have a Newfoundland field service staff.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.3 Warranty registration and checkout form:

3.1.3.1 The Manufacturer shall provide a certified Field Service Representative to start up the fuel storage tank monitoring system.

3.1.3.2 The start up shall consist of installation checkout, operation checkout and customer training on use of the equipment.

3.1.3.3 The Manufacturer's Field Service Representative shall complete a warranty registration and check out form to properly document the site information to include:

3.1.3.3.1 Installation location.

3.1.3.3.2 Installer.

3.1.3.3.3 Equipment identification.

3.1.3.3.4 Tank information.

3.1.3.3.5 Leak detector information.

3.1.3.3.6 Start-up field service representative information.

3.1.3.3.7 Customer approval.

3.1.4 ISO-9000:

3.1.4.1 The Manufacturer shall maintain an ISO-9001 rating ensuring quality management of design, manufacturing, training and technical documentation.

3.2 **DOCUMENTATION**

3.2.1 Manuals:

3.2.1.1 The Manufacturer shall supply product documentation that addresses the following categories as additional support:

3.2.1.1.1 Site preparation and installation instructions.

3.2.1.1.2 System setup instructions.

3.2.1.1.3 System operating instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 11 14
CH0032	FUEL STORAGE TANK ELECTRONIC MONITORING SYSTEMS	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.1.1.4 Probe installation instructions.
- 3.2.1.1.5 Individual module installation instructions.
- 3.2.1.1.6 Product data sheets.
- 3.2.1.1.7 Troubleshooting and repair manuals.
- 3.2.1.1.8 Wiring diagrams which include the following:
 - 3.2.1.1.8.1 Identification of all devices and equipment terminals, and all external connection terminal blocks.
 - 3.2.1.1.8.2 All external wiring connections with approved wire colours and circuit designations.
 - 3.2.1.1.9 Serial communications manuals.
- 3.2.2** Third-party certification:
 - 3.2.2.1 The Manufacturer shall supply third-party documentation for all products certifying that performance meets or exceeds EPA requirements.
- 3.2.3** Authorized service personnel listing:
 - 3.2.3.1 The Manufacturer shall supply a formal list of all local authorized distributors and service contractors for sales, installation, training and support.
- 3.3** **NOT USED**



END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 31 13.02
SPILLWAY ELECTRICAL BLDG
METAL DUCTS – HIGH PRESSURE TO 2500 Pa**

1. GENERAL	2
1.1 SUMMARY	2
1.2 RELATED SECTIONS	2
1.3 REFERENCES	2
1.4 SUBMITTALS	3
1.5 QUALITY ASSURANCE	3
1.6 DELIVERY, STORAGE AND HANDLING	3
2. PRODUCTS	4
2.1 SEAL CLASSIFICATION	4
2.2 SEALANT	5
2.3 TAPE	5
2.4 DUCT LEAKAGE	5
2.5 FITTINGS	5
2.6 FIRESTOPPING	6
2.7 GALVANIZED STEEL (RECTANGLUAR).....	6
2.8 STAINLESS STEEL	7
2.9 HANGERS AND SUPPORTS	7
3. EXECUTION	8
3.1 GENERAL	8
3.2 HANGERS	9
3.3 WELDED DUCT	9
3.4 SEALING AND TAPING.....	10
3.5 HEAVY GAUGE DUCT	10
3.6 LEAKAGE TESTS/COMMISSIONING	10

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 This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
 in Newfoundland and Labrador.
 Permit No. as issued by PEGNL N0488
 which is valid for the year 2013.

REGISTERED PROFESSIONAL ENGINEER

PEG
Newfoundland
and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

SCOTT M. PENNEY

Scott Penney
SIGNATURE

Dec 6/2013
DATE

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section includes:

- .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

1.2 RELATED SECTIONS

- .1 Section 07 84 00 – Firestopping
- .2 Section 23 05 94 – Pressure Testing of Ducted Air Systems.

1.3 REFERENCES

1.3.1 American Society for Testing and Materials (ASTM)

- .1 ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .2 ASTM A621/A621M, Specification for Steel Sheet and Strip, Carbon, Hot-Rolled, Drawing Quality.
- .3 ASTM A653/A653M, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .4 ASTM A924, Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-Dip Process.
- .5 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

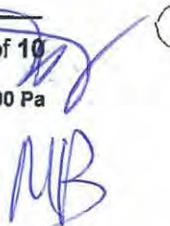
1.3.2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

1.3.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.3.4 National Fire Protection Agency (NFPA)

- .1 NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .2 NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

1.3.5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .2 SMACNA HVAC Duct Leakage Test Manual.
- .3 IAQ Guidelines for Occupied Buildings Under Construction.

1.3.6 Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC S110, Fire Tests for Air Ducts.

1.4 SUBMITTALS

1.4.1 Submit shop drawings and product data for acceptance.

1.4.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets for the following:

- .1 Sealants.
- .2 Tape.
- .3 Proprietary Joints.

1.5 QUALITY ASSURANCE

1.5.1 Certification of Ratings:

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.5.2 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.
- .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Protect on site stored or installed absorptive material from moisture damage.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

1.6.2 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 SEAL CLASSIFICATION

2.1.1 Classification as follows:

<u>Maximum Pressure Pa</u>	<u>SMACNA Seal Class</u>
1000 to 2500	A
750	B
500	C
250	C
125	C

2.1.2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

- .2 Class B: longitudinal seams, transverse joints made airtight with sealant, tape or combination thereof.
 - .3 Class C: transverse joints made air tight with gaskets, sealant, tape or combination thereof. Longitudinal seams unsealed.
- 2.1.3** Duct systems seal classification required shall be determined from external static pressure listed in fan and air-handling equipment datasheets. This shall be the seal class used to determine acceptable air leakage when carrying out the duct testing specified in Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- 2.1.4** Irrespective of the SMACNA specified sealing methodology for the respective duct static pressure construction class, all rectangular and round duct shall be sealed to a minimum of Class B with all transverse and longitudinal seams sealed.
- 2.2 SEALANT**
- 2.2.1** Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.
- .1 Acceptable product: Dura-Dyne S-2, Foster, Childers, Monsey Bakor, or accepted equal.
- 2.3 TAPE**
- 2.3.1** Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
- .1 Acceptable product: Dura-Dyne FT-2, Foster, Childers, Monsey Bakor, or accepted equal.
- 2.4 DUCT LEAKAGE**
- 2.4.1** In accordance with SMACNA HVAC Duct Leakage Test Manual and specification Section 23 05 94 - Pressure Testing of Ducted Air System.
- 2.5 FITTINGS**
- 2.5.1** Fabrication: to SMACNA.
- 2.5.2** Radiused elbows:
- .1 Rectangular: Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius or five piece. Centreline radius: 1.5 times diameter.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

2.5.3 Mitred elbows, rectangular:

- .1 Single or double thickness turning vanes

2.5.4 Branches:

- .1 Rectangular main and branch: with 45° entry on branch.
- .2 Round main and branch: enter main duct at 45° with conical connection.
- .3 Rectangular main and round branch: choice of either 45° main duct entry with conical connection or spin-on connection.
- .4 Provide volume control damper in branch duct near connection to main duct.
- .5 Main duct branches: with volume control damper.

2.5.5 Transitions:

- .1 Diverging: 20° maximum included angle.
- .2 Converging: 30° maximum included angle.

2.5.6 Offsets:

- .1 Full short radiused elbows as indicated.

2.5.7 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.6 FIRESTOPPING

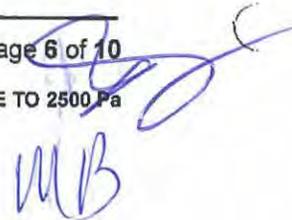
2.6.1 Retaining angles around duct, on both sides of fire separation.

2.6.2 Firestopping material and installation must not distort duct. Leave room between fire damper sleeve and wall opening for thermal expansion in the event of a fire event.

2.6.3 Material and installation within annular space between ducts, fire damper sleeves and adjacent fire separation.

2.7 GALVANIZED STEEL (RECTANGULAR)

2.7.1 Lock forming quality: Z90 zinc coating.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

2.7.2 Thickness, fabrication and reinforcement: metal gauges, transverse joint type and required reinforcement in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2005 Version, for the external static pressure listed in the air-handling equipment datasheets.

2.7.3 Steel thickness and zinc coating class is to be factory stenciled on the steel.

2.7.4 All longitudinal joints to be Pittsburgh Lock type unless otherwise indicated. See Item 3.3 of this specification section.

2.8 STAINLESS STEEL

2.8.1 Application:

- .1 All ductwork/plenums associated with diesel generator intake and diesel generator radiator exhaust/recirculation
- .2 Intake and exhaust plenums directly behind wall mounted louvers.

2.8.2 To ASTM A480/A480M, Specification for General Requirements for Flat Rolled Plate, Sheet and Strip, Type 304.

2.8.3 Thickness, fabrication and reinforcement: metal gauges, transverse joint type and required reinforcement in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible 2005 Version, for the external static pressure listed in the fan and air-handling equipment datasheets.

2.8.4 #2B mill finish.

2.8.5 All longitudinal joints in rectangular duct to be Pittsburgh Lock type unless otherwise indicated. See Item 3.3 of this specification section.

2.8.6 All longitudinal joints in round duct to be either butt welded or lap and seam welded.

2.9 HANGERS AND SUPPORTS

2.9.1 Strap hangers: of same material as duct. See detail on drawings for strap hanger material thickness and strap hanger spacing.

2.9.2 Extend strap hangers down side and turn under 25 mm fastening securely to side and underside of duct.

2.9.3 Hanger configuration: to ASHRAE and SMACNA.

2.9.4 Support vertical ducts with angles screwed to duct and bearing on building structure.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

2.9.5 Hangers: black carbon steel angle (primed) with black carbon steel rods to ASHRAE and SMACNA. See detail on drawings for angle iron size and thickness, rod diameter, and angle spacing.

2.9.6 Upper hanger attachments:

- .1 Open web steel joist: plate washer secured to bottom angle of OWSJ.
 - .1 Acceptable product: Myatt Figure 545 plate washer, Grinnell, Hunt, or accepted equal.
- .2 Horizontal steel joist and steel beams: standard C-clamp secured to joist angle.
 - .1 Acceptable product: Myatt Figure 568 C-clamp, Grinnell, Hunt, or accepted equal.
- .3 For concrete ceiling: manufactured carbon steel heavy duty ceiling clips.
 - .1 Acceptable product: Myatt Figure 515, Grinnell, Hunt, or accepted equal.
- .4 Upper attachment Unistrut: Suspension from ceiling mounted Unistrut channel.
 - .1 Acceptable product: Unistrut P1010 channel nuts with spring size to accept 12 mm diameter threaded rod.

2.9.7 Hanger support rod:

- .1 Horizontal roof and floor applications: continuous threaded rod.
 - .1 Acceptable product: Myatt Figure 434, Grinnell, Hunt, or accepted equal.

3. EXECUTION

3.1 GENERAL

- 3.1.1** Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE and SMACNA.
- 3.1.2** Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- 3.1.3** Support risers in accordance with ASHRAE and SMACNA.
- 3.1.4** Install breakaway joints in ductwork on sides of fire separation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

3.1.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

3.2 HANGERS

3.2.1 Strap hangers: install in accordance with SMACNA and drawings, whichever is more stringent.

3.2.2 Angle hangers: complete with locking nuts and washers.

3.2.3 Hanger spacing: in accordance with ASHRAE, SMACNA and drawings, whichever is more stringent

3.2.4 All duct upper hanger attachment assemblies to be of galvanized finish.

3.2.5 Supply and install steel supports where none exist and are required to accommodate suspension of ductwork.

3.2.6 Upper attachment Unistrut: Suspension from unistrut channel

- .1 Acceptable Manufacturers: Unistrut P1010 Channel nuts with spring sized 12 mm diameter threaded rod

3.3 WELDED DUCT

3.3.1 Provide welded duct for the following:

- .1 All ductwork/plenums associated with diesel generator intake and diesel generator radiator exhaust/recirculation.
- .2 All horizontal duct servicing wall mounted exhaust fans back 1.5 m from connection to fan.
- .3 Sheet metal intake and exhaust plenums directly behind wall mounted louvers.
- .4 All horizontal duct back 1.5 meters from sheet metal intake and exhaust plenums
- .5 All fresh air intake ducting for Electrical Room

3.3.2 Form bottom of horizontal duct without longitudinal seams.

3.3.3 All longitudinal seams and traverse joints shall be soldered or welded.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 31 13.02
CH0032	SPILLWAY ELECTRICAL BLDG METAL DUCTS – HIGH PRESSURE TO 2500 Pa	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-MS-TS-0001-01		505573-3321-45EG-0001

3.4 SEALING AND TAPING

- 3.4.1 Apply sealant to outside of joint to manufacturer's recommendations.
- 3.4.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.5 HEAVY GAUGE DUCT

- 3.5.1 All ducting to be of minimum 18 gauge for ducts over 550 mm in width and 20 gauge for ducts at or under 550 mm in width.

3.6 LEAKAGE TESTS/COMMISSIONING

- 3.6.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air System.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 33 00
SPILLWAY ELECTRICAL BLDG
AIR DUCT ACCESSORIES**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 REFERENCES 2

 1.3 SUBMITTALS 2

 1.4 QUALITY ASSURANCE 3

 1.5 DELIVERY, STORAGE AND HANDLING 3

2. PRODUCTS 3

 2.1 GENERAL 3

 2.2 FLEXIBLE CONNECTIONS 3

 2.3 ACCESS DOORS IN DUCTS 4

 2.4 TURNING VANES 4

 2.5 INSTRUMENT TEST PORTS 4

 2.6 SPIN-ON COLLARS 5

 2.7 OPEN ENDED DUCT PROTECTION 5

3. EXECUTION 5

 3.1 INSTALLATION 5

 3.2 CLEANING 7

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Scott Penney
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Dec/6/2013
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

1.2 REFERENCES

1.2.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

- .1 Material Safety Data Sheets (MSDS).

1.2.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

- .1 SMACNA – HVAC Duct Construction Standards – Metal and Flexible.

1.3 SUBMITTALS

1.3.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
- .2 Submit WHMIS MSDS, indicate VOCs for adhesive and solvents during application and curing.

1.3.2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3.3 Instructions: submit manufacturer's installation instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.4 Closeout Submittals: submit maintenance and engineering data for incorporation into operations and maintenance manual.

1.4 QUALITY ASSURANCE

1.4.1 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
- .4 Separate for reuse and recycling and place in designated containers steel, metal, and plastic waste in accordance with Waste Management Plan (WMP).
- .5 Divert unused metal materials from landfill to metal recycling facility.

2. PRODUCTS

2.1 GENERAL

2.1.1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

2.2.1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.

2.2.2 Material:

- .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C, density of 1.3 kg/m². Fabric consisting of PTFE films reinforced with high strength fibreglass substrate.
- .1 Acceptable product: Papco Texflex, Dura-Dyne, Dyn Air, or accepted equal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Canvas connections will not be accepted.

2.3 ACCESS DOORS IN DUCTS

- 2.3.1** Door: two panel design with inner and outer panels pressed from 24 gauge galvanized mild steel for sizes 200mm x 125mm, 300mm x 150mm, and 450mm x 250mm and 22 gauge galvanized mild steel for sizes 550mm x 350mm and 650mm x 450mm. Standard thickness shall be nominal 25 mm.
- 2.3.2** Insulation: 20 mm thick insulation totally contained between door panels. Insulation shall have a density of 40 Kg per cubic meter.
- 2.3.3** Seal: extruded seal with welded seam incorporating an integral flexible hollow tube for low leakage performance fitted between the two door panels for strength and stability.
- 2.3.4** Frame: pressed one piece dual flange/frame from 24 gauge galvanized mild steel for all sizes. Frame to be pre-punched for duct mounting.
- 2.3.5** Latches: zinc plated steel progressive cam fasteners and fastening clamps, two sets for sizes 200mm x 125mm and 300mm x 150mm, four sets for size 450mm x 250mm, and six sets for sizes 550mm x 350mm and 650mm x 450mm. Cam fasteners to be positioned at strategic locations for optimum closure, and low leakage.
- 2.3.6** Security chain: retaining safety chain is to be fitted to both door and frame to alleviate damage or injury.
- 2.3.7** Suitable for mounting in insulated and non-insulated ducts both internal and external.
- 2.3.8** Flat oval shape.
- 2.3.9** Provide complete with cut-out templates for duct.
- 2.3.10** Doors to be tested to 2 kPa static pressure and shall conform to American and British leakage standards DW 144 Class A and C.
- 2.3.11** Acceptable product: Air Management Inc. (AMI) ACC Series, AST, or accepted equal.

2.4 TURNING VANES

- 2.4.1** Factory or shop fabricated single and double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST PORTS

- 2.5.1** 1.6 mm thick steel zinc plated after manufacture.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5.2 Cam lock handles with neoprene expansion plug and handle chain.

2.5.3 28 mm minimum inside diameter. Length to suit insulation thickness.

2.5.4 Neoprene mounting gasket.

2.5.5 Acceptable product: Duro-Dyne IP1 or IP2, Dyn Air, or accepted equal.

2.6 SPIN-ON COLLARS

2.6.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

2.6.2 Sheet metal thickness to corresponding round duct standards.

2.7 OPEN ENDED DUCT PROTECTION

2.7.1 To be used during construction.

2.7.2 Co-extruded polyethylene, green in colour, designed to adhere to galvanized steel, 600% elongation, 2.5 mil thickness, 13.1 lbs/in tensile strength.

2.7.3 Acceptable product: Ductmate Proguard, or accepted equal.

3. EXECUTION

3.1 INSTALLATION

3.1.1 Flexible connections:

.1 Install in following locations:

.1 Outlet connection of diesel generator radiator.

.2 Inlets and outlets of inline fan 2440-FAN-VSG-0001.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.1.2 Access doors and viewing panels:

- .1 Size:
 - .1 200mm x 125mm one hand or sight.
 - .2 300mm x 150mm one hand and sight.
 - .3 450mm x 250mm both hands and sight.
 - .4 550mm x 350mm full body entry.
 - .5 650mm x 450mm full body entry plus ladder.
- .2 Locations:
 - .1 Fire dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Elsewhere as indicated.

3.1.3 Instrument test ports.

- .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations.
 - .1 For traverse readings:
 - .1 Inlets and outlets of fan systems.
 - .2 Main and sub-main ducts.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 00
CH0032	SPILLWAY ELECTRICAL BLDG AIR DUCT ACCESSORIES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 And as indicated.

.2 For temperature readings:

.1 At outside air intakes.

.2 In mixed air applications in locations as approved by Engineer.

.3 At inlet and outlet of coils.

.4 Downstream of junctions of two converging air streams of different temperatures.

.5 And as indicated.

3.1.4 Turning vanes:

.1 Install in accordance with recommendations of SMACNA and as indicated.

3.1.5 Utilize covering protection over all open end ducts during construction. This includes suspended ducts under construction as well as ductwork temporarily stored on floor on construction site awaiting installation.

3.2 CLEANING

3.2.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 14
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - BALANCING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 33 14
SPILLWAY ELECTRICAL BLDG
DAMPERS - BALANCING**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 REFERENCES 2

 1.3 SUBMITTALS 2

 1.4 QUALITY ASSURANCE 2

 1.5 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 3

 2.1 GENERAL 3

 2.2 MANUAL BALANCING DAMPERS 3

3. EXECUTION 4

 3.1 MANUFACTURER'S INSTRUCTIONS 4

 3.2 INSTALLATION 4

 3.3 CLEANING 5

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 14
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - BALANCING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

1.2 REFERENCES

1.2.1 Sheet Metal and Air Conditioning National Association (SMACNA)

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.2.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

1.3.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .2 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .3 Indicate the following:
 - .1 Specifications.
- .4 Quality assurance submittals:
 - .1 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: Submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

1.4.1 Health and Safety Requirements:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 14
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - BALANCING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's instructions.

1.5.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 GENERAL

- 2.1.1 Manufacture to SMACNA standards.

2.2 MANUAL BALANCING DAMPERS

2.2.1 Rectangular:

- .1 Frame: for units under 914 mm wide x 305 mm high the frame shall be 22 gauge galvanized steel. For units over 914 mm wide x 305 mm high the frame shall be 18 gauge steel formed into a structural hat channel shape with tabbed corners for reinforcement.
- .2 Blades: for units under 914 mm wide x 305 mm high the blades shall be single skin, 22 gauge galvanized steel with center 'V' groove for reinforcement. For units over 914 mm wide x 305 mm high the blades shall be single skin 18 gauge galvanized steel with three longitudinal grooves for reinforcement.
- .3 Bearings: corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
- .4 Axles: round, screwed into the damper blade.
- .5 Provide single blade dampers for ducts up to 914 mm wide x 305 mm high . Provide multiple blade dampers for ducts larger than 914 mm wide x 305 mm high in either direction.
- .6 Maximum size single section: 1219 mm wide x 1219 mm high .
- .7 Minimum size: 127 mm wide x 102 mm high .
- .8 Dampers are to be supplied approximately 6 mm smaller than given duct dimensions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 14
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - BALANCING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.9 Acceptable product: Air Management Inc. (AMI) Model MD2005, Ruskin, or accepted equal.

2.2.2 Round:

- .1 Frame: 20 gauge galvanized steel, 178 mm long.
- .2 Blade: single skin 20 gauge galvanized steel.
- .3 Bearings: corrosion resistant molded synthetic type.
- .4 Axle: control shaft shall extend beyond the frame through a factory mounted, locking hand quadrant. Axle to be 10 mm square shape.
- .5 Maximum damper size: 508 mm diameter .
- .6 Minimum damper size: 102 mm diameter .
- .7 Dampers are to be supplied approximately 6 mm smaller than given duct dimensions.
- .8 Maximum temperature: 121°C.
- .9 Acceptable product: Air Management Inc (AMI) Model MD200R, Ruskin, or accepted equal

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- 3.2.1 Install where indicated.
- 3.2.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- 3.2.3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- 3.2.4 Runouts to registers and diffusers: located as close as possible to main ducts.
- 3.2.5 All dampers to be vibration free.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 14
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - BALANCING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.6 Ensure damper operators are observable and accessible.

3.3 CLEANING

3.3.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 15
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - OPERATING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 23 33 15
SPILLWAY ELECTRICAL BLDG
DAMPERS - OPERATING**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 RELATED SECTIONS 2

 1.3 REFERENCES 2

 1.4 SUBMITTALS 2

 1.5 QUALITY ASSURANCE 3

 1.6 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 3

 2.1 MULTI-LEAF DAMPERS 3

3. EXECUTION 5

 3.1 INSTALLATION 5

 3.2 CLEANING 5

APPENDIX A - DATASHEETS

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CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - OPERATING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

1.2 RELATED SECTIONS

- .1 Section 23 33 00 – Air Duct Accessories.

1.3 REFERENCES

1.3.1 American Society for Testing and Materials International (ASTM)

- .1 ASTM A 653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.3.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.4 SUBMITTALS

1.4.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.

- 1. Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

- .2 Indicate the following:

- 1. Performance data
- 2. Specifications

1.4.2 Quality assurance submittals: submit following

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 15
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - OPERATING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.3 Closeout Submittals:

- .1 Provide maintenance data for incorporation into operation and maintenance manual.

1.5 QUALITY ASSURANCE

1.5.1 Health and Safety Requirements:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.5.2 Certificates:

- .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 MULTI-LEAF DAMPERS

2.1.1 Parallel blade at intakes and exhausts of two position control applications (i.e. full open or closed). Opposed blade at intakes and exhausts of mixed air application (i.e. economizer mixing boxes). Return dampers shall be parallel blade.

2.1.2 Refer to Data Sheets for details such as type, blade action, size and performance data.

2.1.3 All dampers, including those associated with the diesel generator, shall be supplied and installed by the Mechanical Subcontractor.

2.1.4 Insulated aluminum dampers, applicable to dampers: 2440-MD-VSE-0001, 2440-MD-VSE-0002, 2440-MD-VSE-0003, 2400-MD-VSG-001, 2440-MD-VSG-0003, 2440-MD-VSG-0005 and 2440-MD-VSG-0006.

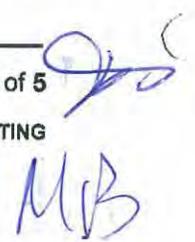
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 15
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - OPERATING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .1 Frames: extruded aluminum (6063T5) damper frame not less than 2.03 mm in thickness. Damper frame to be 101 mm deep and shall be insulated with extruded polystyrene 0.035 RSI/mm on four sides when installed "flanged to duct". All dampers on this project to be "flanged to duct" type. Entire frame shall be thermally broken by means of two polyurethane resin pockets, complete with thermal cuts.
- .2 Blades: air-foil, aluminum extrusions (6063T5) shall be thermally broken and internally insulated with non-cfc, expanded polyurethane foam RSI 1.16. Complete blade shall have an insulating factor of RSI 0.40 and a temperature index of 80.
- .3 Bearings shall be composed of Celcon/polycarbonate.
- .4 Blade gaskets and side seals shall be silicone for extreme cold temperature application. Adhesive or clip-on type blade seals shall not be approved. Seals shall remain flexible down to -73°C.
- .5 Operator: supplied and installed by the Controls Subcontractor.
- .6 Linkage hardware: installed in frame side and constructed of aluminum and corrosion resistant, zinc and nickel plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- .7 Performance:
 - .1 Leakage: in closed position to be less than 40 L/s per m² against 1 kPa differential static pressure standard air.
 - .2 Pressure drop: at full open position (600 mm x 600 mm) shall not exceed 10 Pa at 5.1 m/s.
- .8 Dampers shall be designed for operation in temperatures ranging between -73°C and 85°C.
- .9 Acceptable product: Tamco Series 9000 ECT, Honeywell, Johnson, Ruskin, Alumavent, or accepted equal.

2.1.5 Non-insulated dampers, applicable to dampers: 2440-MD-VSG-0002 and 2440-MD-VSG-0004:

- .1 Frames: extruded aluminum (6063T5) damper frame not less than 2.03 mm in thickness. Damper Frames to be 101 mm deep. All dampers on this project to be "flanged to duct" type
- .2 Blades: Extruded aluminum (6063T5), interlocking blades, air foil profiles, complete with extruded EPDM blade gaskets. Frame seals shall be extruded silicone. Adhesive or clip-on type blade seals shall not be accepted.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 15
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS - OPERATING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .3 Bearings shall be composed of Celcon-Polycarbonate.
- .4 Linkage: hardware shall be installed in frame side and be constructed of aluminum and corrosion resistant zinc and nickel plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- .5 Operator: supplied and installed by the Controls Subcontractor.
- .6 Performance:
 - 1. Leakage: In closed position to be less than 15.2 L/s per m² against 0.25 kPa differential static pressure
 - 2. Pressure drop: At full open position (1200 mm x 1200 mm) shall not exceed 4 Pa at 5.1 m/s.
- .7 Acceptable product: Tamco 1000 Series, Honeywell, Johnson, Ruskin, Alumavent, or accpeted equal.

3. EXECUTION

3.1 INSTALLATION

- 3.1.1 Install where indicated.
- 3.1.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- 3.1.3 Seal multiple damper modules with silicon sealant.
- 3.1.4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- 3.1.5 Ensure dampers are observable and accessible.
- 3.1.6 Provide jackshafts and/or damper jumpers, depending upon application, to connect multiple damper modules. Quantity of jackshafts and jumpers to be determined by damper supplier.

3.2 CLEANING

- 3.2.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 DAMPERS - OPERATING
 APPENDIX A - DATASHEETS

SECTION: 23 33 15
 505573-3321-45EG-0001-00

Equipment Number	2440-MD-VSE-0001	2440-MD-VSE-0002	2440-MD-VSE-0003
General:			
Manufacturer	Tamco	Tamco	Tamco
Type	Insulated Alum.	Insulated Alum.	Insulated Alum.
Model	9000 ECT	9000 ECT	9000 ECT
Area Served	Elect. Rm. Exhaust	Elect. Rm. Exhaust	Elect. Rm. Intake
Construction	Aluminum	Aluminum	Aluminum
Blade Action	Parrallel	Parrallel	Parrallel
Duct Dimensions:			
Width (mm)	350	350	600
Height (mm)	350	350	600
Multiple Modules	No	No	No
Performance:			
Maximum Airflow (L/s)	800	800	1600
Face Velocity (m/s)	6.5	6.5	4.4
Pressure Drop (Pa)	48.5	48.5	7.8
Estimated Torque Req. (N-m)	1.6	1.6	3.1
Actuator:			
Instrument Number	2440-Z-VSE-0001	2440-Z-VSE-0002	2440-Z-VSE-0003
Manufacturer	Belimo	Belimo	Belimo
Type	Spring Return	Spring Return	Spring Return
Model	LF24-S US	LF24-S US	LF24-S US
Multiple Actuators	No	No	No
Control Action	On / Off	On / Off	On / Off
Spring Return	Yes	Yes	Yes
Action when De-energized	Close	Close	Close
Torque (N-m)	4	4	4
Power Supply	24 VAC	24 VAC	24 VAC
Max Power Consumption ea. (VA)	7.0	7.0	7.0
Control Input	N/A	N/A	N/A
Position Feedback	No	No	No
Auxilliary Switches	1 SPDT, 3A @ 250V	1 SPDT, 3A @ 250V	1 SPDT, 3A @ 250V
Remarks	-	-	-

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 DAMPERS - OPERATING
 APPENDIX A - DATASHEETS

SECTION: 23 33 15
 505573-3321-45EG-0001-00

Equipment Number	2440-MD-VSG-0001	2440-MD-VSG-0002	2440-MD-VSG-0003
General:			
Manufacturer	Tamco	Tamco	Tamco
Type	Insulated Alum.	Non-insul. Airfoil Ctrl	Insulated Alum.
Model	9000 ECT	1000	9000 ECT
Area Served	Gen. Rm. Intake	Gen. Rm. Return	Gen. Rad. Outdoor
Construction	Aluminum	Aluminum	Aluminum
Blade Action	Opposed	Parrallel	Parrallel
Duct Dimensions:			
Width (mm)	450	600	3000
Height (mm)	600	450	2000
Multiple Modules	No	No	4 - 1500x1000
Performance:			
Maximum Airflow (L/s)	400	320	20853
Face Velocity (m/s)	1.5	1.2	3.5
Pressure Drop (Pa)	3.2	0.0	10.2
Estimated Torque Req. (N-m)	1.6	2.3	12.8
Actuator:			
Instrument Number	2440-Z-VSG-0001	2440-Z-VSG-0002	2440-Z-VSG-0003
Manufacturer	Belimo	Belimo	Belimo
Type	Spring Return	Spring Return	Spring Return
Model	LF24-MFT-S US	LF24-MFT-S US	AFB24-S
Multiple Actuators	No	No	Yes (4)
Control Action	Modulating	Modulating	On / Off
Spring Return	Yes	Yes	Yes
Action when De-energized	Close	Open	Open
Torque (N-m)	4	4	20
Power Supply	24 VAC	24 VAC	24 VDC
Max Power Consumption ea. (VA)	5.0	5.0	7.5
Control Input	2-10 VDC	2-10 VDC	N/A
Position Feedback	2-10 VDC	2-10 VDC	No
Auxilliary Switches	1 SPDT, 3A @ 250V	1 SPDT, 3A @ 250V	2 SPDT, 3A @ 250V
Remarks	-	-	Controlled by D.G.

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 DAMPERS - OPERATING
 APPENDIX A - DATASHEETS

SECTION: 23 33 15
 505573-3321-45EG-0001-00

Equipment Number	2440-MD-VSG-0004	2440-MD-VSG-0005	2440-MD-VSG-0006
General:			
Manufacturer	Tamco	Tamco	Tamco
Type	Non-insul. Airfoil Ctrl	Insulated Alum.	Insulated Alum.
Model	1000	9000 ECT	9000 ECT
Area Served	Gen. Rad. Recirc.	Gen. Rad. Exhaust	Gen. Rm. Exhaust
Construction	Aluminum	Aluminum	Aluminum
Blade Action	Opposed	Parrallel	Opposed
Duct Dimensions:			
Width (mm)	3000	4000	450
Height (mm)	1300	2400	450
Multiple Modules	2 - 1500x1300	4 - 2000x1200	No
Performance:			
Maximum Airflow (L/s)	20853	20853	400
Face Velocity (m/s)	5	2.2	2
Pressure Drop (Pa)	6.1	5.0	5.4
Estimated Torque Req. (N-m)	17.8	20.4	1.2
Actuator:			
Instrument Number	2440-Z-VSG-0004	2440-Z-VSG-0005	2440-Z-VSG-0006
Manufacturer	Belimo	Belimo	Belimo
Type	Spring Return	Spring Return	Spring Return
Model	AFB24-MFT-S	AFB24-S	LF24-MFT-S US
Multiple Actuators	Yes (2)	Yes (4)	No
Control Action	Modulating	On / Off	Modulating
Spring Return	Yes	Yes	Yes
Action when De-energized	Close	Open	Close
Torque (N-m)	20	20	4
Power Supply	24 VAC	24VDC	24 VAC
Max Power Consumption ea. (VA)	10.0	7.5	5.0
Control Input	2-10 VDC	N/A	2-10 VDC
Position Feedback	2-10 VDC	No	2-10 VDC
Auxilliary Switches	2 SPDT, 3A @ 250V	2 SPDT, 3A @ 250V	1 SPDT, 3A @ 250V
Remarks	-	Controlled by D.G.	-

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 16
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS – FIRE AND SMOKE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 23 33 16
SPILLWAY ELECTRICAL BLDG
DAMPERS – FIRE AND SMOKE**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 RELATED SECTIONS 2

 1.3 REFERENCES 2

 1.4 SUBMITTALS 2

 1.5 QUALITY ASSURANCE 3

 1.6 MAINTENANCE..... 3

 1.7 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 4

 2.1 FIRE DAMPERS (IN WALL OR FLOOR) 4

3. EXECUTION 5

 3.1 MANUFACTURER'S INSTRUCTIONS 5

 3.2 INSTALLATION 5

 3.3 CLEANING 5

 3.4 COMMISSIONING..... 5

APPENDIX A - DATASHEETS

PROVINCE OF NEWFOUNDLAND AND LABRADOR

PEG
Newfoundland
and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

PERMIT HOLDER
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
which is valid for the year 2013



Handwritten initials: MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 16
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS – FIRE AND SMOKE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

Fire and smoke dampers, and fire stop flaps.

1.2 RELATED SECTIONS

- .1 Section 23 33 00 – Air Duct Accessories

1.3 REFERENCES

1.3.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

- .1 ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.3.3 Underwriters Laboratories of Canada (ULC)

- .1 CAN4-S112, Fire Test of Fire Damper Assemblies.
.2 ULC-S505, Fusible Links for Fire Protection Service.
.3 ULC-555, Standard for Fire Dampers.

1.4 SUBMITTALS

1.4.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
.1 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

Indicate the following:

- .1 Fire dampers.
.2 Operators.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 16
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS – FIRE AND SMOKE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Fusible links.
- .4 Design details of break-away joints.

1.4.2 Quality assurance submittals; submit the following:

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

Instructions: submit manufacturer's installation instructions.

1.4.3 Closeout Submittals:

- .1 Provide maintenance data for incorporation into operation and maintenance manual.

1.5 **QUALITY ASSURANCE**

1.5.1 Health and Safety Requirements: Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.5.2 Certificates:

- .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.6 **MAINTENANCE**

1.6.1 Extra Materials:

- .1 Provide maintenance materials.
- .2 Provide the following:
 - .1 Six fusible links of each type.

1.7 **DELIVERY, STORAGE, AND HANDLING**

1.7.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.7.2 Waste Management and Disposal:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 16
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS – FIRE AND SMOKE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 FIRE DAMPERS (IN WALL OR FLOOR)

2.1.1 Applicable to Fire Damper: 2440-FD-VSE-0001.

2.1.2 Furnish and install, at locations shown on plans, fire dampers constructed and tested in accordance with the current edition of UL555 Standard for Fire Dampers. Dampers up to 5.95 m² for vertical mount and 2.32 m² for horizontal mount shall be classified for dynamic closure to a minimum 12.1 m/s and 996 Pa static pressure for horizontal air flow, air flow up and air flow down. Velocity and pressure ratings shall include both in-duct and no-duct installations. Each fire damper shall be marked with a UL Classified 1½ hour fire protection rating, the maximum velocity/pressure rating for each horizontal and vertical installation and "for use in dynamic systems". Dampers marked "for use in static systems only" are not permitted. In addition, each dynamic fire damper shall include a 74°C fusible link. Each dynamic fire damper shall include an integral roll formed steel sleeve and retaining angles furnished by the damper manufacturer to ensure appropriate installation. Submittal information shall include the fire protection rating, maximum velocity/pressure ratings and the manufacturer's UL installation instructions. Each fire damper shipment shall include the same UL installation instructions. The dampers shall be installed in accordance with these instructions.

2.1.3 Rectangular fire dampers to be Style 'B' with blades out of airstream for reduced airflow restriction, 80-90% free area.

2.1.4 Round fire dampers to be style WR, welded, 90-95% free area, round enclosure. The wall sleeve shall be rectangular and the blades shall be out of the airstream for reduced airflow restriction.

2.1.5 Vertical and horizontal closure spring operation for assured closure under air flow (i.e. fans on) in HVAC systems.

2.1.6 Shall meet all UL and NFPA criteria for primary fire dampers installed in walls with fire resistive rating of less than 3 hours.

2.1.7 Provide integral sleeves of sufficient length to full, span wall or floor assembly opening.

2.1.8 Fire dampers in metal stud walls or supported in wall or floor openings with metal stud framing shall have such framing installed in accordance with the damper manufacturer's recommendations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 33 16
CH0032	SPILLWAY ELECTRICAL BLDG DAMPERS – FIRE AND SMOKE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.9 Acceptable product: Ruskin Model DIBD2 (1½ hr.), Nailor, Controlled Air, Air Management Inc. (AMI), or accepted equal.

3. EXECUTION

3.1 MANUFACTURER’S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

3.2.1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.

3.2.2 Provide duct mounted and wall and/or ceiling mounted access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories. All ceiling and wall mounted access doors required to gain access to fire dampers and linkages shall be supplied by the Mechanical Subcontractor for field installation by the Contractor. These doors shall be shop primed for field painting by the Contractor. All duct mounted access doors shall be supplied and installed by the Mechanical Subcontractor.

3.2.3 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

3.2.4 Install break-away joints of approved design on each side of fire separation.

3.2.5 Supply fire damper with integral sleeve and retaining angles.

3.3 CLEANING

3.3.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 COMMISSIONING

3.4.1 Verify dampers are in open position.

3.4.2 Confirm fusible links are acceptable.

3.4.3 Confirm firestopping is complete.

END OF SECTION

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 DAMPERS - FIRE AND SMOKE
 APPENDIX A - DATASHEETS

SECTION: 23 33 16
 505573-3321-45EG-0001-00

Equipment Number	2440-FD-VSE-0001
General:	
Manufacturer	Ruskin
Type	Curtain - Dynamic
Model	DIBD2
Area Served	Elect. Rm. Intake
Style	"B" Out of Airstream
Damper Orientation	Vertical
Duct Dimensions:	
Width (mm)	1000
Height (mm)	1000
Multiple Modules	Yes
Performance:	
Maximum Airflow (L/s)	1600
Face Velocity (m/s)	1.6
Details:	
Separation Rating	2 hr
Damper Rating	1-1/2 hr
Remarks	-

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 23 34 00
SPILLWAY ELECTRICAL BLDG
HVAC FANS**

PART 1 GENERAL2

1.1 SUMMARY2

1.2 RELATED SECTIONS2

1.3 REFERENCES2

1.4 MANUFACTURED ITEMS3

1.5 SUBMITTALS3

1.6 QUALITY ASSURANCE4

1.7 MAINTENANCE4

1.8 DELIVERY, STORAGE, AND HANDLING4

1.9 ENVIRONMENTAL REQUIREMENTS5

1.10 NOT USED5

PART 2 PRODUCTS5

2.1 FANS GENERAL5

2.2 IN-LINE CENTRIFUGAL - BELT DRIVEN5

PART 3 EXECUTION7

3.1 MANUFACTURER'S INSTRUCTIONS7

3.2 FAN INSTALLATION8

3.3 CLEANING8

3.4 COMMISSIONING8

**APPENDIX A
DATA SHEET**



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL**1.1 SUMMARY****1.1.1 Section Includes:**

- .1 Fans, motors, accessories, and hardware for commercial use.

1.2 RELATED SECTIONS

- .1 Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
- .2 Section 23 33 00 – Air Duct Accessories.
- .3 Section 23 05 48 – Vibration and Seismic Control for HVAC Piping and Equipment.

1.3 REFERENCES**1.3.1 Air Conditioning and Mechanical Contractors (AMCA)**

- .1 AMCA 99, Standards Handbook.
- .2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
- .3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

1.3.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

- .1 ANSI/AMCA 210/ASHRAE 51, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

1.3.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.3.4 American Bearing Manufacturer's Association (ABMA)

- .1 ANSI/AMBA 9, Load Ratings and Fatigue Life for Ball Bearings.
- .2 ANSI/AMBA 11, Load Ratings and Fatigue Life for Roller Bearings.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 MANUFACTURED ITEMS

1.4.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

1.5 SUBMITTALS

1.5.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .2 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

1.5.2 Shop Drawings:

- .1 Submit shop drawings and product data.

1.5.3 Provide:

- .1 Fan performance curves showing specific point of operation, with flow, static pressure and horsepower clearly plotted.
- .2 Sound rating data for the eight octave bands.
- .3 Dimensional data
- .4 Installation procedures
- .5 Filter free velocity, initial & final static pressure, MERV rating.

1.5.4 Indicate:

- .1 Motors, sheaves, bearings, shaft details
- .2 Minimum performance achievable with variable speed controllers.

1.5.5 Quality assurance submittals:

- .1 Submit the following.
- .2 Instructions: submit manufacturer's installation instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.6 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manual.

1.6 QUALITY ASSURANCE

- 1.6.1** Health and Safety Requirements: perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.7 MAINTENANCE

1.7.1 Extra Materials:

- .1 Provide maintenance materials.
 - .1 Spare parts to include:
 - 1. Matched sets of belts for each fan. For fans driven by a single belt a "set" is to be defined as a single belt.
 - 2. One set of filters for start-up and commissioning, one set for the building occupancy (final filters) and one spare set of filters for each equipment.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals
 - .2 Belts
 - .3 Addresses of suppliers
 - .4 List of specialized tools necessary for adjusting, repairing or replacing
 - .5 Filters

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions. For long term storage follow manufacturer's installation, operations and maintenance manual.

1.8.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

1.9 ENVIRONMENTAL REQUIREMENTS

- 1.9.1 Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, bearings lubricated and fan has been run under observation.



1.10 NOT USED

PART 2 PRODUCTS

2.1 FANS GENERAL

- 2.1.1 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data as indicated on data sheets.

- 2.1.2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

- 2.1.3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.

- 2.1.4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal.

2.1.5 Motors:

- .1 In accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment supplemented as specified herein.
- .2 For use with variable speed controllers where specified.
- .3 Sizes as indicated on data sheets.

- 2.1.6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Control for HVAC Piping and Equipment.

- 2.1.7 Flexible connections: to Section 23 33 00 – Air Duct Accessories.

2.2 IN-LINE CENTRIFUGAL - BELT DRIVEN

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 2.2.1 Applicable to Fan 2440-FAN-VSG-0001.
- 2.2.2 Casings: heavy duty housing and drive enclosure, internal structural supports and bracing constructed of galvanized steel. Assembly complete with two bolted access panels and integral duct connection flanges. Casing finish to be factory standard.
- 2.2.3 Impeller: aluminum construction, backward inclined centrifugal type, non-overloading operation. Wheel to be statically and dynamically balanced. The wheel cone shall be carefully matched to the inlet cone for precise running tolerances.
- 2.2.4 Provide fan assembly complete with insulated housing of 25 mm thick acoustic insulation for noise reduction and condensation control. Insulation shall be constructed of fibreglass liner.
- 2.2.5 Fan to be pre-wired to external mounted junction box supplied complete with unit. Factory mounted disconnect switches are not required, disconnects shall be supplied and installed by the electrical subcontractor.
- 2.2.6 Supports:
 - .1 Wall bracket/floor mounted: support brackets bolted to bottom of casing. Provide unit complete with standard spring isolators sized to match the weight of the fan. Standard spring isolators shall be supplied integral with the fan for field installation.
- 2.2.7 Bearings: heavy duty, pillow block ball bearings. Bearings shall be designed for minimum L10 life in excess of 80,000 hours. Provide internal bearing cover, easily removable for servicing.
- 2.2.8 Belt drive:
 - .1 Provide internal belt fairing, insulated external belt and motor cover.
 - .2 Machined cast iron pulley factory set to the required RPM and adjustable for final system balancing.
 - .3 Drive sized for 150% of driven horsepower.
 - .4 Fan shaft to be ground and polished steel sized so that the first critical speed is at least 25% over the maximum operating speed.
 - .5 Belts to be static free and oil resistant.
- 2.2.9 Performance criteria: see data sheets.
- 2.2.10 Motors:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Carefully matched to the fan load.
- .2 Mounted out of the airstream.
- .3 Provide adjustable motor mount.
- .4 External belt/motor cover to be acoustically insulated.
- .5 Heavy duty ball bearing type.
- .6 Adjustable motor pulley.
- .7 Totally enclosed fan cooled (TEFC) motor enclosure.

2.2.11 Inlet filter box:

- .1 Applicable to filter box: 2440-FR-VSG-0001
- .2 Provide factory assembled single unit by fan manufacturer for installation on inlet of fan.
- .3 Configuration shall be V-Bank for increased area and reduced pressure drop, and face velocity.
- .4 Filters shall be M.E.R.V. 8, 51 mm thick, pleated panel filters.
- .5 Performance: See fan data sheets
- .6 Provide inlet filter box compete with insulated housing of 25 mm thick acoustic insulation for noise reduction and condensation control. Insulation shall be constructed of fiberglass liner.
- .7 Removable access panels on both sides for filter replacement.

2.2.12 Acceptable product: Greenheck BSQ Series in-line centrifugal c/w inlet filter box, Trane, Barry Blower, Penn, Industrial Air, Sheldons, Acme, Loren Cook, Jencofan, Twin City Fans, or accepted equal.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FAN INSTALLATION

- 3.2.1 Install fans as indicated, complete with resilient mountings, flexible electrical leads and flexible connections in accordance with Section 23 33 00 – Air Duct Accessories.
- 3.2.2 Provide sheaves and belts required for final air balance.
- 3.2.3 Bearings and extension tubes to be easily accessible.
- 3.2.4 Access doors and access panels to be easily accessible.

3.3 CLEANING

- 3.3.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 COMMISSIONING

- 3.4.1 Confirm sequence of operations with control system.
- 3.4.2 Verify balancing report.
- 3.4.3 Check filter status. Install clean filters. Verify tight fit with minimal air leakage.
- 3.4.4 Confirm damper operation. Ensure dampers operate freely and sufficient damper motors are provided.
- 3.4.5 Verify dampers seal tight when closed.
- 3.4.6 Ensure cleaning is complete.
- 3.4.7 Confirm heating coil capacity. Measure inlet and outlet temperatures.
- 3.4.8 Confirm fire alarm interlocks.
- 3.4.9 Confirm belt tension and confirm it is within manufacturer's recommendations.
- 3.4.10 Verify fan balance and confirm within tolerance.
- 3.4.11 Verify bearing lubrication.
- 3.4.12 Verify ease of accessibility for maintenance.
- 3.4.13 Demonstrate maintenance required and training.
- 3.4.14 Confirm installation as per manufacturer's instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 00
CH0032	SPELLWAY ELECTRICAL BLDG HVAC FANS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.15 Confirm correct fan rotation.

3.4.16 Measure and record motor voltage and amperage.

END OF SECTION

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 HVAC FANS
 APPENDIX A - DATASHEETS

SECTION: 23 34 00
 505573-3321-45EG-0001-00

Equipment Number	2440-FAN-VSG-0001
General:	
Manufacturer	Greenheck
Type	Centrifugal Inline
Model	BSQ-130HP-7
Area Served	Generator Room
Construction	Standard
Drive	Belt
Coating	Standard
Performance:	
Airflow (L/s)	400
Static Pressure (Pa)	372 ESP + 16.2 Filter
Speed (RPM)	1903
Electrical Data:	
Motor (HP)	3/4
Voltage (Volts)	575
Phase	3
Frequency (Hz)	60
Enclosure	TEFC
Motor Speed (RPM)	1725
Windings	1
Options:	
Disconnect	No
Curb	N/A
Backdraft Damper	No
Vibration Isolation	Standing Spring Isolators
Filters	Yes - See Remarks
Birdscreen	N/A
Other	Insulated Housing
Sound Power (dB):	
63 Hz	83
125 Hz	78
250 Hz	78
500 Hz	72
1000 Hz	64
2000 Hz	65
4000 Hz	61
8000 Hz	57
Sones	12.6
Remarks	2440-FR-VSG-0001 Sloped Filter Box - 51mm Pleated Filters, MERV 8.

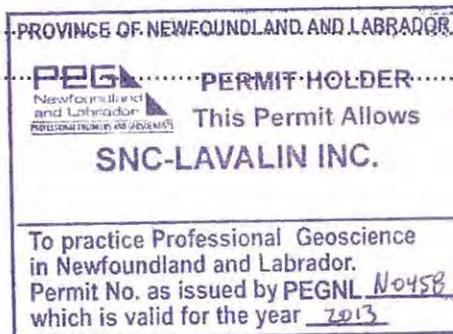
Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 34 25
SPILLWAY ELECTRICAL BLDG
PACKAGED ROOF AND WALL EXHAUSTERS**

PART 1 GENERAL	
1.1 SUMMARY	2
1.2 RELATED SECTIONS	2
1.3 REFERENCES	2
1.4 MANUFACTURED ITEMS	3
1.5 SUBMITTALS	3
1.6 QUALITY ASSURANCE	4
1.7 MAINTENANCE	5
1.8 DELIVERY, STORAGE AND HANDLING	5
1.9 ENVIRONMENTAL REQUIREMENTS	5
1.10 NOT USED	6
PART 2 PRODUCTS	6
2.1 CENTRIFUGAL SIDEWALL EXHAUSTER - BELT DRIVEN	6
PART 3 EXECUTION	7
3.1 MANUFACTURER'S INSTRUCTIONS	7
3.2 EXAMINATION	7
3.3 PREPARATION	7
3.4 INSTALLATION	7
3.5 SYSTEM START-UP	8
3.6 ADJUSTING	8
3.7 CLEANING	8
3.8 PROTECTION	8
3.9 COMMISSIONING	8
3.10 RIGGING	9



**APPENDIX A
DATA SHEET**



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Section includes:

- .1 Fans, motors, accessories and hardware for packaged roof and wall exhausters

1.2 RELATED SECTIONS

- 1.2.1 Section 23 05 13 – Common Motor Requirements for HVAC Equipment
- 1.2.2 Section 23 33 00 – Air Duct Accessories
- 1.2.3 Section 23 33 15 – Dampers - Operating

1.3 REFERENCES

1.3.1 Air Movement and Control Association (AMCA):

- .1 99 - Standards Handbook.
- .2 200 - Publication, Air Systems.
- .3 201 - Publication, Fans and Systems.
- .4 202 - Publication, Troubleshooting.
- .5 203 - Publication, Field Performance Measurement of Fan Systems.
- .6 211 - Publication, Certified Ratings Program - Product Rating Manual for Fan Air Performance.
- .7 300 - Standard Reverberant Room Method for Sound Testing of Fans.
- .8 311 - Publication Certified Ratings Program - Product Rating Manual for Fan Sound Performance.
- .9 99-2408 - Operating Limits for Centrifugal Fans.

1.3.2 Air Movement and control Association. (AMCA), American National Standards Institute (ANSI):

- .1 204 - Standard Balance Quality and Vibration Levels for Fans.

Lower Churchill Project Muskra Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 210 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

1.3.3 American National Standards Institute (ANSI):

.1 11 - Method of Evaluating Load Ratings of Bearings.

1.3.4 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

- .1 Chapter 45 - 2003 Handbook, HVAC Applications.
- .2 Chapter 7 - 2001 Fundamentals handbook, Sound-Vibration.
- .3 Chapter 32 - 2001 Fundamentals handbook, Duct Design.
- .4 Chapter 18 - 1992 HVAC System and Equipment handbook, Fans.

1.3.5 National Fire Protection Association (NFPA):

.1 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.3.6 Underwriters Laboratories (UL):

- .1 507 - Electric Fans.
- .2 705 - Standard Power Ventilators.

1.4 MANUFACTURED ITEMS

1.4.1 Catalogued or published ratings for manufactured items: obtain from tests carried out by manufacturer or those ordered by manufacturer by independent testing agency signifying adherence to codes and standards in force.

1.5 SUBMITTALS

1.5.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheets. Include product characteristics, performance criteria, and limitations.
- .1 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS)

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.2 Shop Drawings:

- .1 Submit shop drawings and product data.

1.5.3 Provide:

- .1 Fan performance curves showing specified point of operation flow, static pressure and horsepower clearly plotted.
- .2 Sound rating data for the eight octave bands
- .3 Installation procedures
- .4 Outlet velocity
- .5 Clearly indicate AMCA certification
- .6 Dimensional Data

1.5.4 Quality Assurance Submittals:

- .1 Submit the following.
- .2 Instructions: Submit manufacturer's installation instructions

1.5.5 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manual.

1.6 **QUALITY ASSURANCE**

1.6.1 Health and Safety Requirements: Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.6.2 Performance ratings: conform to AMCA Standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210 and AMCA Standard 300 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air performance seal.

1.6.3 Each fan shall be given a balancing analysis which shall be applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance shall be 0.05 ounces (Balance grade of G6.3).

1.6.4 Comply with the National Electrical Manufacturer's Association (NEMA), standards for motors and electrical accessories.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7 MAINTENANCE

1.7.1 Extra Materials:

- .1 Provide maintenance materials.
 - .1 Spare parts to include:
 - 1. Matched set of belts for each fan. For fans driven by a single belt a "set" is to be defined as a single belt

1.7.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

- .1 Bearings and seals
- .2 Belts
- .3 Addresses of suppliers
- .4 List of specialized tools necessary for adjusting, repairing or replacing

1.8 DELIVERY, STORAGE AND HANDLING

1.8.1 Packaging, Shipping and Handling:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Storage: store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's installation, operations and maintenance manual.

1.8.2 Waste Management and Disposal:

- .1 Construction/demolition waste management and disposal: Separate waste materials for reuse and recycling.

1.9 ENVIRONMENTAL REQUIREMENTS

1.9.1 Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, bearings lubricated and fan has been test run under observation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



1.10 NOT USED

PART 2 PRODUCTS

2.1 CENTRIFUGAL SIDEWALL EXHAUSTER – BELT DRIVEN

2.1.1 Applicable to Fans 2440-FAN-VSE-0001 & 2440-FAN-VSE-0002

2.1.2 Construction:

- .1 Housings: heavy gauge aluminum complete with rigid internal support structure.
- .2 Impeller: aluminum backward inclined, non-overloading, statically and dynamically balanced. Wheel cone shall be matched to the Venturi for maximum efficiency.
- .3 Drive frame assembly shall be constructed of heavy gauge steel. Drive shall be sized for a minimum of 150% of the driven horsepower. Pulleys shall be of the cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. Belts shall be static free and oil resistant.
- .4 Provide bird guard of rigid wire mounted on the fan's discharge perimeter.
- .5 Provide without integral backdraft damper. Fans shall be equipped with an operable damper installed at the inlet of the fan by the Mechanical Subcontractor.
- .6 Permanently lubricated and sealed pillow block ball bearings selected for a minimum L10 life in excess of 100,000 hours at maximum catalogued operating speed.
- .7 Motor and drive components to be installed out of the airstream.
- .8 First critical speed to be at least 25% over the maximum operating speed.
- .9 Solid polished steel shaft.
- .10 Motor and drive shall be supported on vibration insulators.

2.1.3 Mounting:

- .1 A leak proof fan housing shall be constructed with a one piece windband with an integral rolled bead for additional strength.
- .2 Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the unit

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.4 Electrical:

- .1 All motors over 1 HP to be NEMA premium efficiency. Motors below 1 HP to be standard efficiency EPACT.
- .2 All motors to be open drip proof (ODP) unless otherwise indicated.
- .3 Provide electric motors in voltages and horsepowers indicated.
- .4 All motors to have 1.15 service factor (minimum)
- .5 Supply fans pre-wired internally to a factory supplied and installed disconnect switch.
- .6 Motors to be carefully matched to the fan load.
- .7 Accessories:
 - .1 Supply each fan complete with initial belt for operation as well as one (1) spare belt.
- .8 Acceptable manufacturers: Greenheck CWB Series, Penn, ACME, Jenn, Loren Cook.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 EXAMINATION

- 3.2.1 Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.3 PREPARATION

- 3.3.1 Ensure roof/wall openings are square, accurately aligned, correctly located, and in tolerance.

3.4 INSTALLATION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.1 Install fans system as indicated on the manufacturer's Installation, Operation and Maintenance Manual (IOM) and contract drawings.

3.4.2 Install fans in accordance with manufacturer's instructions.

3.5 SYSTEM START-UP

3.5.1 Refer to manufacturer's Installation, Operation, and Maintenance Manual (IOM)

3.6 ADJUSTING

3.6.1 Adjust exhaust fans to function properly.

3.6.2 Adjust belt tension.

3.6.3 Lubricate bearings.

3.6.4 Adjust drive for final system balancing.

3.6.5 Check wheel overlap.

3.7 CLEANING

3.7.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.8 PROTECTION

3.8.1 Protect installed product and finished surfaces from damage during construction.

3.8.2 Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion.

3.9 COMMISSIONING

.1 Confirm sequence of operations with control system.

.2 Verify balancing report.

.3 Confirm damper operation. Ensure dampers operate freely and sufficient damper motors are provided.

.4 Verify dampers seal tight when closed.

.5 Ensure cleaning is complete.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 34 25
CH0032	SPILLWAY ELECTRICAL BLDG PACKAGED ROOF AND WALL EXHAUSTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 Confirm fire alarm interlocks.
- .7 Measure belt tension and confirm it is within manufacturer's recommendations.
- .8 Verify fan balance and confirm within tolerance.
- .9 Verify bearing lubrication.
- .10 Verify ease of accessibility for maintenance.
- .11 Demonstrate maintenance required and training.
- .12 Confirm installation as per manufacturer's instructions.
- .13 Confirm correct fan rotation.
- .14 Measure and record motor voltage and amperage.

3.10 RIGGING

3.10.1 All costs associated with lifting fans into final location shall be borne by the Mechanical Subcontractor.

END OF SECTION

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CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECT BLDG
 PACKAGED ROOF WALL EXHAUSTERS
 APPENDIX A - DATASHEETS

SECTION: 23 34 25
 505573-3321-45EG-0001-00

Equipment Number	2440-FAN-VSE-0001	2440-FAN-VSE-0002
General:		
Manufacturer	Greenheck	Greenheck
Type	Centrifugal Sidewall	Centrifugal Sidewall
Model	CWB-161HP-10	CWB-161HP-10
Area Served	Electrical Room	Electrical Room
Construction	Standard	Standard
Drive	Belt	Belt
Coating	Standard	Standard
Performance:		
Airflow (L/s)	800	800
Static Pressure (Pa)	434	434
Speed (RPM)	1552	1552
Electrical Data:		
Motor (HP)	1	1
Voltage (Volts)	575	575
Phase	3	3
Frequency (Hz)	60	60
Enclosure	TEFC	TEFC
Motor Speed (RPM)	1725	1725
Windings	1	1
Options:		
Disconnect	Yes	Yes
Curb	N/A	N/A
Backdraft Damper	No	No
Vibration Isolation	N/A	N/A
Filters	No	No
Birdscreen	Yes	Yes
Other	-	-
Sound Power (dB):		
63 Hz	77	77
125 Hz	75	75
250 Hz	79	79
500 Hz	72	72
1000 Hz	68	68
2000 Hz	69	69
4000 Hz	67	67
8000 Hz	61	61
Sones	13.9	13.9
Remarks	-	-

Page 1 of 1


Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 35 16
CH0032	SPILLWAY ELECTRICAL BLDG ENGINE EXHAUST SYSTEM	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 23 35 16
SPILLWAY ELECTRICAL BLDG
ENGINE EXHAUST SYSTEM**

1. GENERAL..... 2

1.1 SUMMARY 2

1.2 REFERENCES 2

1.3 MANUFACTURED ITEMS 2

1.4 SUBMITTALS 2

1.5 QUALITY ASSURANCE 3

1.6 MAINTENANCE..... 3

1.7 DELIVERY, STORAGE, HANDLING AND UNLOADING 3

2. PRODUCTS 4

2.1 NO. 2 FUEL OIL PRESSURE STACK CHIMNEY 4

2.2 ACCESSORIES..... 4

3. EXECUTION 5

3.1 INSTALLATION - GENERAL 5

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To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
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REGISTERED PROFESSIONAL ENGINEER

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SCOTT M. PENNEY

Scott Penney
SIGNATURE

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CH0032	SPILLWAY ELECTRICAL BLDG ENGINE EXHAUST SYSTEM	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section includes:

- .1 Diesel generator set engine exhaust stack

1.2 REFERENCES

1.2.1 Underwriters' Laboratories of Canada (ULC).

1.2.2 National Fire Protection:

- .1 NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
- .2 NFPA 211, Standard for Chimneys, Fire Places, Vents, and Solid Fuel-Burning Appliances.

1.3 MANUFACTURED ITEMS

1.3.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

1.4 SUBMITTALS

1.4.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheets. Include product characteristics, performance criteria and limitations
- .1 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS)

1.4.2 Submit shop drawings and product data.

1.4.3 Clearly indicate following:

- .1 Methods of sealing sections.
- .2 Methods of expansion.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 35 16
CH0032	SPILLWAY ELECTRICAL BLDG ENGINE EXHAUST SYSTEM	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Details of thimbles.
- .4 Bases/Foundations.
- .5 Supports.
- .6 Rain caps.
- .7 Installation procedures.

1.4.4 Quality assurance submittals:

- .1 Submit the following.
- .2 Instructions: Submit manufacturer's installation instructions

1.4.5 Closeout submittals:

- .1 Provide operation and maintenance data for incorporation into operation and maintenance manual.

1.5 **QUALITY ASSURANCE**

- 1.5.1** Health and safety requirements: perform construction operational health and safety in accordance with Health and Safety Requirements

1.6 **MAINTENANCE**

- 1.6.1** Provide operation and maintenance data for incorporation into operation and maintenance manual.

1.7 **DELIVERY, STORAGE, HANDLING AND UNLOADING**

1.7.1 Packaging, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions
- .2 Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's installation, operations and maintenance manual.

1.7.2 Waste management and disposal:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 35 16
CH0032	SPILLWAY ELECTRICAL BLDG ENGINE EXHAUST SYSTEM	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Construction and demolition waste management and disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 NO. 2 FUEL OIL PRESSURE STACK CHIMNEY

- 2.1.1 ULC labelled, 540°C rated, No. 2 fuel oil.
- 2.1.2 Sectional, prefabricated, double wall with 100 mm insulation, mated fittings and couplings.
 - .1 Liner: 316 Stainless steel.
 - .2 Shell: aluminized steel up to roof-line and 316 stainless steel at roof penetration and above roof.
 - .3 Outer seal between sections: outer channel band.
 - .4 Inner seal between sections: inner vee band with high temperature sealant.
 - .5 Inside diameter: 305 mm
- 2.1.3 Acceptable manufacturers: Selkirk Metalbestos Model IPS; Security Chimney, Van Packer Company.

2.2 ACCESSORIES

- .1 Flat roof tall cone flashing for chimney (TFC4).
- .2 Storm collar for tall cone flashing (SCC4)
- .3 Flip top for termination of chimney (FLC4). Canadian version suitable for cold weather application.
- .4 Provide drain tee cap at base of vertical stack secured directly to bottom of 45° lateral tee fitting. Drain connection shall be 1 NPT (TCC4).
- .5 Provide 45° lateral tee connection in horizontal breeching (JLC4).
- .6 Provide 45° elbow at base of stack (EL45C4).
- .7 Provide closure ring at top of stack prior to installation of flip top (CRC4).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 35 16
CH0032	SPILLWAY ELECTRICAL BLDG ENGINE EXHAUST SYSTEM	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .8 Provide explosion relief valve (ERC4).
- .9 Provide flange adapter at outlet of silencer and connection to explosion relief valve (FDC4).
- .10 Provide lined bellows expansion joint (BJC4).
- .11 Provide manifold tee (MTC4).
- .12 Provide plate support assemblies at exit of lined bellows and at base of vertical stack (PAC4).
- .13 Provide full angle ring guide (FRC4).
- .14 Provide installation lengths as required.
- .15 For the purpose of the proposal, the estimated vertical stack length shall be 4 metres. The actual required length to be field confirmed by the Mechanical Subcontractor before ordering.
- .16 Provide hangers and supports as required.
- .17 Provide miscellaneous steel supports to support the plate support assemblies on either side of lateral tee. The supply and installation of this miscellaneous support steel shall be the responsibility of the Mechanical Subcontractor and not the engine exhaust system supplier.
- .18 Provide insulated roof curb sized to suit the chimney roof penetration. The supply of the roof curb shall be the responsibility of Contractor. Installation shall be the responsibility of the Contractor.

3. EXECUTION

3.1 INSTALLATION - GENERAL

3.1.1 Support chimney as indicated.

3.1.2 Install flashing on chimney penetrating roof.

3.1.3 Stack flashing shall be flashed into the roof by the Contractor. Cutting of roof penetration shall also be the responsibility of the Contractor.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 13
CH0032	SPILLWAY ELECTRICAL BLDG DIFFUSERS, REGISTERS AND GRILLES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 37 13
SPILLWAY ELECTRICAL BLDG
DIFFUSERS, REGISTERS AND GRILLES**

1. GENERAL..... 2

1.1 SUMMARY 2

1.2 REFERENCES 2

1.3 SYSTEM DESCRIPTION..... 2

1.4 SUBMITTALS 2

1.5 QUALITY ASSURANCE 3

1.6 DELIVERY, STORAGE, AND HANDLING 3

1.7 MAINTENANCE..... 3

2. PRODUCTS 3

2.1 GENERAL 3

2.2 MANUFACTURED UNITS 4

2.3 SUPPLY GRILLES AND REGISTERS..... 4

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS 4

2.5 DIFFUSERS 4

3. EXECUTION 4

3.1 MANUFACTURER'S INSTRUCTIONS 4

3.2 INSTALLATION 4

3.3 CLEANING 5

APPENDIX A - DATASHEETS

PROVINCE OF NEWFOUNDLAND AND LABRADOR

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in Newfoundland and Labrador.
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SCOTT M. PENNEY

Scott Penney
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CH0032	SPILLWAY ELECTRICAL BLDG DIFFUSERS, REGISTERS AND GRILLES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section includes:

- .1 Supply, return and exhaust grilles, diffusers and registers for commercial use.

1.2 REFERENCES

1.2.1 American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE).

- .1 ASHRAE 70, Method of Testing for Rating the Performance of Air Ducts and Outlets.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.4 SUBMITTALS

1.4.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .2 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data sheets (MSDS).
- .3 Indicate following:
 - .1 Capacity
 - .2 Throw and terminal velocity
 - .3 Noise criteria
 - .4 Pressure drop
 - .5 Neck velocity

96
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 13
CH0032	SPILLWAY ELECTRICAL BLDG DIFFUSERS, REGISTERS AND GRILLES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Quality assurance submittals: submit following.

- .1 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

1.5.1 Health and Safety Requirements: perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

1.7 MAINTENANCE

1.7.1 Extra Materials:

- .1 Provide maintenance materials.
- .2 Include:
 - .1 Keys for volume control adjustment
 - .2 Keys for air flow pattern adjustment.

2. PRODUCTS

2.1 GENERAL

2.1.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated in data sheets.

2.1.2 Frames:

- .1 Full perimeter gaskets.
- .2 Plaster frames where set into plaster or gypsum board.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 13
CH0032	SPILLWAY ELECTRICAL BLDG DIFFUSERS, REGISTERS AND GRILLES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 Concealed fasteners.

2.1.3 Concealed manual volume control damper operators as indicated.

2.1.4 Colour: as per data sheets.

2.1.5 Acceptable product: E. H. Price, Titus, Nailor, Carnes, Airvector, Anemostat, Kreuger, Metalaire, or accepted equal.

2.2 MANUFACTURED UNITS

2.2.1 Grilles, registers and diffusers of same generic type to be product of one manufacturer.

2.3 SUPPLY GRILLES AND REGISTERS

2.3.1 See data sheets.

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS

2.4.1 See data sheets.

2.5 DIFFUSERS

2.5.1 See data sheets.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

3.2.1 Install in accordance with manufacturer's instructions.

3.2.2 Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible.

3.2.3 Bolt grilles, registers and diffusers in place

3.2.4 Provide concealed safety chain on each grille, register and diffuser.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 13
CH0032	SPILLWAY ELECTRICAL BLDG DIFFUSERS, REGISTERS AND GRILLES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 CLEANING

3.3.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

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CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECT BLDG
 DIFFUSERS, REGISTERS GRILLES
 APPENDIX A - DATASHEETS

SECTION: 23 37 13
 505573-3321-45EG-0001-00

Equipment Number	GR-01	GR-02
General:		
Manufacturer	Price	Price
Type	Heavy Duty Louvered Return	Heavy Duty Louvered Supply Adj.
Model	95/L/A	920/L/A
Area Served	Various Return / Exhaust	Various Supply
Construction	Steel	Steel
Finish	B12 - White	B12 - White
Details:		
Frame	-	-
Mounting	Surface / Exposed Duct	Surface / Exposed Duct
Module Size	-	-
No. of Slots or Cones	0	0
Discharge Pattern	0° Deflection	-45° to 45° Deflection
Fastening	Countersunk Screws	Countersunk Screws
Accessories	-	-
Remarks	-	-

96
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 20
CH0032	SPILLWAY ELECTRICAL BLDG LOUVRES, INTAKES AND VENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 37 20
SPILLWAY ELECTRICAL BLDG
LOUVRES, INTAKES AND VENTS**

1. GENERAL..... 2

 1.1 SUMMARY 2

 1.2 REFERENCES 2

 1.3 SYSTEM DESCRIPTION..... 2

 1.4 SUBMITTALS 3

 1.5 QUALITY ASSURANCE 3

 1.6 DELIVERY, STORAGE, AND HANDLING 4

2. PRODUCTS 4

 2.1 FIXED LOUVRES - ALUMINUM 4

3. EXECUTION 5

 3.1 MANUFACTURER'S INSTRUCTIONS 5

 3.2 INSTALLATION 5

 3.3 CLEANING 6

APPENDIX A - DATASHEETS

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PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

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SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0458
which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER

PEG
Newfoundland
and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS

SCOTT M. PENNEY

Scott Penney
SIGNATURE

Dec 16 / 2013
DATE

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 20
CH0032	SPILLWAY ELECTRICAL BLDG LOUVRES, INTAKES AND VENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Mechanical louvers.

1.2 REFERENCES

1.2.1 American Society for Testing and Materials International (ASTM)

- .1 ASTM E 90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 ASTM A653/A653M, Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

1.2.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.2.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.2.4 Heating, Ventilating, and Air-conditioning Manufacturers Association (HEVAC).

1.2.5 Building Services Research and Information Association (BSRIA).

1.2.6 American Architectural Manufacturers Association (AAMA)

- .1 AAMA 605.2, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.
- .2 Provide product certificate signed by the louver manufacturer certifying that their products comply with the specified requirements and have been tested in accordance with the HEVAC Technical Specification by the accredited laboratories at the Building Services Research and Information Association (BSRIA).

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 20
CH0032	SPILLWAY ELECTRICAL BLDG LOUVRES, INTAKES AND VENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 SUBMITTALS

1.4.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .1 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.
 - .4 Dimensions
 - .5 Mullion spacing.
 - .6 Structural supports.
 - .7 Retention clips.
 - .8 Louvre effectiveness at stopping rain penetration.
 - .9 Free air velocity at onset of beginning water penetration in accordance with AMCA water test (i.e. 3.18 mL of water per square meter of louver free area during a 15 minute test period).

1.4.2 Quality assurance submittals: submit following.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- 1.5.1 Health and Safety Requirements: perform construction occupational health and safety in accordance with Health and Safety Requirements.
- 1.5.2 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 20
CH0032	SPILLWAY ELECTRICAL BLDG LOUVRES, INTAKES AND VENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.3 Air performance, water penetration: provide louvers complying with performance requirements indicated by testing manufacturer's stock units of height and width indicated. Wall louvers shall be tested according to the HEVAC Technical Specification "Laboratory Testing and Rating of Weather Louvres When Subject to Wind Driven Rain".

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

2. PRODUCTS

2.1 FIXED LOUVRES - ALUMINUM

2.1.1 Applicable to louvres: 2440-LV-VSG-0001, 2400-LV-VSG-0002, 2440-LV-VSG-0003, 2440-LV-VSG-0004 and 2440-LV-VSE-0001.

2.1.2 General: furnish and install where shown on the drawings horizontal, drainable sightproof, storm resistant, fixed blade louvres with extruded aluminum frames and blades, designed to collect and drain water to exterior of sill by means of multiple gutters in blades and channels in jambs and mullions.

2.1.3 Material: frame and blades to be fabricated from 6063-T5 aluminum alloy. Blades to be minimum 1.52 mm thick extrusions and frames to be minimum 2.03 thick.

2.1.4 Louvre thickness: 100 mm.

2.1.5 Blade: storm resistant blade with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

2.1.6 Mullions: at 1500 mm maximum centres.

2.1.7 Fasteners: stainless steel nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.

2.1.8 Sill flashing: provide louvre sill flashing 102 mm high by full depth of louvre formed from minimum 1.27 mm thick aluminum. Sill flashing pan to have continuously welded side panels.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 20
CH0032	SPILLWAY ELECTRICAL BLDG LOUVRES, INTAKES AND VENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.9 Screen: louvre to be furnished with a heavy duty bird screen and frame of 19 mm x 2.33 mm intercrimp aluminum wire and heavy duty 2.28 mm thick aluminum frame, rewirable. The screen to be 14.3 mm front to back and have a free area of 76.9%. Bird screen to be held in place with #8 stainless steel sheet metal screws. Screen to be mounted at back of louvre and to have mill finish.
- 2.1.10 Finish: louvre shall be finished with an inhibitive thermo-cured primer, 0.2 mil minimum dry film thickness, and a thermo-cured fluorocarbon coating containing Kynar 500 resin, 1.0 mil minimum thickness. All aluminum shall be thoroughly cleaned, etched and given a chromated conversion pre-treatment before application of the Kynar/Hylar coating. The coating shall receive a bake cycle of 17 minutes at 232°C. All finishing procedures shall be one continuous operation in the plant of the manufacturer. Manufacturer to furnish an extended 20 year limited warranty for the Kynar/Hylar coating. This limited warranty shall begin on the date of Project Completion.
- 2.1.11 Colour: to be selected by Company.
- 2.1.12 Performance requirements: the louvre manufacturer shall submit certified test data from a Building Services Research and Information Association (BSRIA) accredited testing laboratory. The louvre shall be tested at a rain fall rate of 75 mm/hr and an exterior wind velocity directed into the face of the louvre of 13 m/s. The test data must show that, at a ventilation rate of 0.00 m³/s, the louvre effectiveness ratio meets or exceeds 98.3%. The test louvre size shall be 1016 mm x 1016 mm.
- 2.1.13 Supports: louvre manufacturer shall supply complete with the louvre and sill flashing pan, clip angles constructed of aluminum. These clip angles shall be installed by the Mechanical Subcontractor.
- 2.1.14 Design criteria: see data sheets.
- 2.1.15 Acceptable product: Construction Specialties Model RS-4300, Penn, Ruskin, Air Balance Inc., American Warming and Ventilating, NCA, Nailor, Airlite, Ventex, or accepted equal.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- 3.2.1 In accordance with manufacturer's and SMACNA recommendations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 37 20
CH0032	SPILLWAY ELECTRICAL BLDG LOUVRES, INTAKES AND VENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.2 Reinforce and brace as indicated.

3.2.3 Anchor securely into opening. Seal with caulking around to ensure weather tightness.

3.3 CLEANING

3.3.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
**SPILLWAY ELECTRICAL BLDG
 LOUVERS, INTAKES AND VENTS**
 APPENDIX A - DATASHEETS

SECTION: 23 37 20
 505573-3321-45EG-0001-00

Equipment Number	2440-LV-VSE-0001	2440-LV-VSG-0001
General:		
Manufacturer	Construction Specialties	Construction Specialties
Type	Storm Resistant Fixed Horz.	Storm Resistant Fixed Horz.
Model	RS-4300	RS-4300
Area Served	Electrical Room Intake	Diesel Generator Rad. Intake
Louver Dimensions*:		
Width (mm)	1000	4000
Height (mm)	1200	3500
Depth (mm)	100	100
Performance:		
Maximum Airflow (L/s)	1600	20853
Free Area Velocity (m/s)	2.84	3.17
Pressure Drop (Pa)	27.4	34.5
Details:		
Finish	Kynar 500 / Hylar 5000	Kynar 500 / Hylar 5000
Color	Selected During Shop Dwg.	Selected During Shop Dwg.
Birdscreen	Yes	Yes
Remarks		
* All louver dimensions are nominal, hard conversions from imperial dimensions. Exact opening sizes required for installation shall be forwarded to the Contractor by the Mechanical Subcontractor.		

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CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 LOUVERS, INTAKES AND VENTS
 APPENDIX A - DATASHEETS

SECTION: 23 37 20
 505573-3321-45EG-0001-00

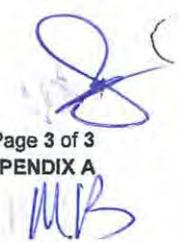
Equipment Number	2440-LV-VSG-0002	2440-LV-VSG-0003
General:		
Manufacturer	Construction Specialties	Construction Specialties
Type	Storm Resistant Fixed Horz.	Storm Resistant Fixed Horz.
Model	RS-4300	RS-4300
Area Served	Generator Room Intake	Diesel Generator Rad. Exhaust
Louver Dimensions*:		
Width (mm)	450	4000
Height (mm)	750	2400
Depth (mm)	100	100
Performance:		
Maximum Airflow (L/s)	400	20853
Free Area Velocity (m/s)	2.52	4.63
Pressure Drop (Pa)	21.4	50.6
Details:		
Finish	Kynar 500 / Hylar 5000	Kynar 500 / Hylar 5000
Color	Selected During Shop Dwg.	Selected During Shop Dwg.
Birdscreen	Yes	Yes
Remarks	-	-
* All louver dimensions are nominal, hard conversions from imperial dimensions. Exact opening sizes required for installation shall be forwarded to the Contractor by the Mechanical Subcontractor.		

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 LOUVERS, INTAKES AND VENTS
 APPENDIX A - DATASHEETS

SECTION: 23 37 20
 505573-3321-45EG-0001-00

Equipment Number	2440-LV-VSG-0004
General:	
Manufacturer	Construction Specialties
Type	Storm Resistant Fixed Horz.
Model	RS-4300
Area Served	Generator Room Exhaust
Louver Dimensions*:	
Width (mm)	450
Height (mm)	600
Depth (mm)	100
Performance:	
Maximum Airflow (L/s)	400
Free Area Velocity (m/s)	3.16
Pressure Drop (Pa)	23.5
Details:	
Finish	Kynar 500 / Hylar 5000
Color	Selected During Shop Dwg.
Birdscreen	Yes
Remarks	-
* All louver dimensions are nominal, hard conversions from imperial dimensions. Exact opening sizes required for installation shall be forwarded to the Contractor by the Mechanical Subcontractor.	



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 44 00
SPILLWAY ELECTRICAL BLDG
HVAC AIR FILTRATION**

1. GENERAL..... 2

1.1 SUMMARY 2

1.2 RELATED SECTIONS 2

1.3 REFERENCES 2

1.4 MANUFACTURED ITEMS 2

1.5 SUBMITTALS 2

1.6 QUALITY ASSURANCE 3

1.7 MAINTENANCE..... 3

1.8 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 4

2.1 GENERAL 4

2.2 FILTER HOUSING..... 4

2.3 PLEATED PANEL FILTER..... 5

2.4 FILER GAUGES – DIAL TYPE 6

3. EXECUTION 6

3.1 MANUFACTURER'S INSTRUCTIONS 6

3.2 FILTER HOUSING/FILTER INSTALLATION..... 6

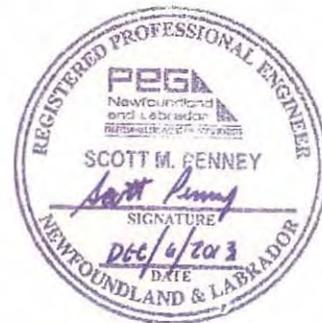
3.3 FILTER GAUGES 6

3.4 CLEANING 7

3.5 COMMISSIONING..... 7

APENDIX A - DATASHEETS

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REGISTERED PROFESSIONAL ENGINEER
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Newfoundland and Labrador
SCOTT M. PENNEY
Scott Penney
SIGNATURE
DEC/4/2013
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Filters, filter gauges and filter housing for inline fresh air supply filters.

1.2 RELATED SECTIONS

- .1 Section 23 07 14 – Thermal Insulation for Equipment

1.3 REFERENCES

1.3.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

- .1 ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

1.3.2 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.

1.3.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.4 MANUFACTURED ITEMS

1.4.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

1.5 SUBMITTALS

1.5.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .1 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

1.5.2 Shop Drawings:

- .1 Submit shop drawings.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Indicate following:
 - .1 Filter housing dimensions
 - .2 Filter face velocity
 - .3 Initial & final static pressure
 - .4 MERV rating

- 1.5.3 Quality assurance submittals: submit following .
 - .1 Instructions: submit manufacturer's installation instructions.

- 1.5.4 Closeout Submittals
 - .1 Provide maintenance data for incorporation into operation and maintenance manual.

- 1.6 **QUALITY ASSURANCE**
- 1.6.1 Health and Safety Requirements: perform construction occupational health and safety in accordance with Health and Safety Requirements.

- 1.7 **MAINTENANCE**
- 1.7.1 Extra materials:
 - .1 Provide maintenance materials.
 - .1 One set of filters for start-up and commissioning, one set for the building occupancy (final filters) and one spare set of filters for each equipment.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Address of suppliers
 - .2 List of specialized tools necessary for adjusting, repairing or replacing
 - .3 Filters

- 1.8 **DELIVERY, STORAGE, AND HANDLING**
- 1.8.1 Packing, shipping, handling and unloading:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Storage: store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's installation, operations and maintenance manual.

1.8.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling .

2. PRODUCTS

2.1 GENERAL

- 2.1.1 Media: suitable for air at 100% RH and air temperatures between -40°C and 50°C.
- 2.1.2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated on datasheets.
- 2.1.3 Pressure drop when clean and dirty, sizes and thickness: as indicated on datasheets.

2.2 FILTER HOUSING

2.2.1 Applicable to filter housing: 2440-FR-VSE-0001.

2.2.2 General:

- .1 Filter housing shall be a single stage filter system consisting of 16-gauge galvanized steel enclosure, aluminum filter mounting tracks in a V-bank configuration, dual access doors, static pressure tap, filter sealing gaskets and door seals. In-line housing depth shall not exceed 711 mm

2.2.3 Construction:

- .1 The housing shall be constructed of 16-gauge galvanized steel with pre-drilled standing flanges, Z-channel corner post construction, and shall be weatherproof and suitable for outdoor installation.
- .2 The housing shall accept 51 mm deep nominal filters. The filter tracks shall be of aluminum construction and shall be an integral component of the housing. The tracks shall have fin seals to eliminate filter air bypass and ribs to allow filters to slide easily in the filter tracks.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Dual access doors, swing-open type, shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star style knobs and replaceable door hinges.
- .4 The housing shall include a pneumatic fitting to allow the installation of a static pressure gauge to evaluate pressure drop across any combination of installed filters.

2.2.4 Performance:

- .1 Leakage at rated airflow, upstream to downstream of filter shall be less than 1% at 744 Pa. Leakage into or out of the housing shall be less than 0.5% at 744 Pa.
- .2 Accuracy of pneumatic pressure fitting, when used to evaluate a single-stage shall be accurate within +/- 3% at 149 Pa.

2.2.5 Acceptable product: Camfil Farr V-bank Glide/Pack, AAF or approved equal.

2.3 PLEATED PANEL FILTER

2.3.1 Applicable to filter housing: 2440-FR-VSE-0001.

2.3.2 General:

- .1 Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic media, welded wire media support grid, and beverage board enclosing frame.
- .2 Sizes shall be as noted on datasheets.

2.3.3 Construction:

- .1 Filter media shall be a cotton and synthetic blend, lofted to a uniform depth of 3.8 mm and formed into a uniform radial pleat.
- .2 A welded wire grid, spot-welded on 25 mm centers and treated for corrosion resistance shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation.
- .3 An enclosing frame of no less than 28-point high wet strength beverage board shall be provided. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3.4 Performance:

- .1 The filter shall have a minimum efficiency reporting value of MERV 8 when evacuated under the guidelines of ASHRAE standard 52.2. it shall also have a MERV-A of 8 when tested per Appendix J of the same standard, the media shall maintain or increase in efficiency over the life of the filter.
- .2 Filter initial and final static pressure resistance: see datasheets
- .3 The filter shall have an energy cost index (ECI) value of five stars.
- .4 Filter shall be classified by Underwriters Laboratory as UL Class 2.
- .5 Filter manufacturer shall guarantee the integrity of the filter pack to 500 Pa.

2.3.5 Acceptable product: Camfill Farr 30/30, AAF Perfect Pleat Ultra or accepted equal.

2.4 FILER GAUGES – DIAL TYPE

2.4.1 Applicable to filter gauges: 2440-PDI-VSG-0001 and 2440-PDI-VSE-0001

2.4.2 Each filter bank shall be furnished with a magnehelic filter gauge with a 121 mm O.D. white static pressure dial with black figures and zero pointer adjustment.

2.4.3 Acceptable product: Dwyer Series 2000 Air Filter Gauge or accepted equal.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 FILTER HOUSING/FILTER INSTALLATION

3.2.1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.2.2 Replace filter set following commissioning with final filter set.

3.2.3 Complete filter housing insulation in accordance with Section 23 07 14 – Thermal Insulation for Equipment.

3.3 FILTER GAUGES

3.3.1 Install type as indicated across each filter bank in approved and easy readable location.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 44 00
CH0032	SPILLWAY ELECTRICAL BLDG HVAC AIR FILTRATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

3.4 CLEANING

3.4.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.5 COMMISSIONING

3.5.1 Check for filter status, install clean filters.

3.5.2 Ensure filter housing is clean..

3.5.3 Verify filters fit tight with minimal air leakage.

3.5.4 Verify ease of accessibility for maintenance.

3.5.5 Demonstrate maintenance required and training.

3.5.6 Confirm correct installation as per manufacturer's instructions.

END OF SECTION

CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 HVAC AIR FILTRATION
 APPENDIX A - DATASHEETS

SECTION: 23 44 00
 505573-3321-45EG-0001-00

Equipment Number	2440-FR-VSE-0001
General:	
Manufacturer	Camfil Farr
Type	Inline Duct Housing
Model	V-Bank Glide Pack
Area Served	Electrical Room
Housing Dimensions:	
Width (mm)	914
Height (mm)	692
Length (mm)	711
Performance:	
Airflow (L/s)	1600
Housing Inlet Velocity (m/s)	2.53
Filter Face Velocity (m/s)	1.44
Details:	
Quantity	2 - 300x600, 2 - 600x600
Model	30/30
Type	Pleated Panel
Thickness (mm)	51.00
Rating	MERV 8
Static Pressure - Intial (Pa)	32
Static Pressure - Final (Pa)	248
Remarks	-
Note: 2440-FR-VSG-0001 is included integral with fan 2440-FAN-VSG-0001.	


 Page 1 of 1


Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 55 01
CH0032	SPILLWAY ELECTRICAL BLDG DUCT HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 23 55 01
SPILLWAY ELECTRICAL BLDG
DUCT HEATERS**

1. GENERAL..... 2

1.1 SUMMARY 2

1.2 RELATED SECTIONS 2

1.3 REFERENCES 2

1.4 SUBMITTALS 2

1.5 QUALITY ASSURANCE 3

1.6 DELIVERY, STORAGE, AND HANDLING 3

2. PRODUCTS 4

2.1 DUCT HEATERS 4

3. EXECUTION 5

3.1 INSTALLATION 5

3.2 COMMISSIONING 5

APPENDIX A – DATASHEETS

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Scott M. Penney
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 55 01
CH0032	SPILLWAY ELECTRICAL BLDG DUCT HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1. GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Materials and application of electric duct heaters.

1.2 RELATED SECTIONS

1.2.1 Section 26 05 00 – General Electrical Requirements.

1.3 REFERENCES

1.3.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No. 46, Electric Air-Heaters.

1.3.2 Department of Justice Canada (Jus.)

- .1 Canadian Environmental Protection Act (CEPA)

1.3.3 Transport Canada (TC)

- .1 Transportation of Dangerous Goods Act (TDGA)

1.4 SUBMITTALS

1.4.1 Submit product data and include:

- .1 Element support details.
- .2 Heater: total kW rating, voltage, phase.
- .3 Number of stages.
- .4 Rating of stage: rating, voltage, phase.
- .5 Heater element watt/density and maximum sheath temperature.
- .6 Maximum discharge temperature.
- .7 Physical size.
- .8 Unit support.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 55 01
CH0032	SPILLWAY ELECTRICAL BLDG DUCT HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .9 Performance limitations.
- .10 Clearance from combustible materials.
- .11 Internal components wiring diagrams.
- .12 Minimum operating airflow.
- .13 Pressure drop, operating and minimum airflow.

1.5 QUALITY ASSURANCE

1.5.1 Health and Safety:

- .1 Perform construction occupational health and safety in accordance with Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .6 Ensure emptied containers are sealed and stored safely.
- .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

MB 90

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 55 01
CH0032	SPILLWAY ELECTRICAL BLDG DUCT HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2. PRODUCTS

2.1 DUCT HEATERS

2.1.1 Duct heaters: flange type or insert type. Applicable to duct heater: 2440-HC-VSG-0001

2.1.2 To carry CSA Approval.

2.1.3 Elements:

- .1 Coils machine crimped into stainless steel terminals extending at least 25mm into the air stream.
- .2 All terminal hardware shall be stainless steel.
- .3 Coils shall be supported by ceramic bushings staked into the supporting brackets.
- .4 Helical coils of 80% nickel, 20% chromium, Type A wire.

2.1.4 Frames: Heater frames and boxes shall be corrosion resistant steel.

2.1.5 Terminal box:

- .1 NEMA 1 general purpose enclosure.
- .2 Hinged, latching cover.
- .3 Multiple concentric knockouts to accept field wiring.
- .4 Terminal blocks to accommodate field wiring.
- .5 All internal wiring to be complete with 105°C rated insulation.

2.1.6 Ratings:

- .1 Heaters to be rated for voltage, phase, and KW capacity as indicated on datasheet.
- .2 All three phase heaters to have equal, balanced, three phase stages.
- .3 Supply heaters with both fixed and proportional heating stages to provide for close discharge air temperature control. Engineer to accept staging design of heating coil prior to construction.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 55 01
CH0032	SPILLWAY ELECTRICAL BLDG DUCT HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.1.7 Controls:

- .1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring.
- .2 Controls to include:
 - .1 Magnetic contactors.
 - .2 Fixed differential pressure switch.
 - .3 Manual and automatic reset high limit.
 - .4 Control transformers.
 - .5 Solid state relays.
 - .6 Door interlocked disconnect switch (non-fused).
 - .7 HRC load fuses.
 - .8 Electronic hybrid step controller.
 - .9 Heater to be controlled by 0 – 10 VDC remote control signal from the building control system

2.1.8 Performance: see data sheets.

2.1.9 Provide heater complete with protective screens on inlet/outlet.

2.1.10 Acceptable Product: Thermolec, Neptronic, or accepted equal.

3. EXECUTION**3.1 INSTALLATION**

3.1.1 Make power and control connections in accordance with CSA C22.2 No.46. Install in accordance with manufacturer's instructions.

3.2 COMMISSIONING

3.2.1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

3.2.2 Confirm heating coil operation. Measure and record inlet and outlet temperatures.

3.2.3 Measure and record voltage and amperage for coil at varying control points.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 55 01
CH0032	SPILLWAY ELECTRICAL BLDG DUCT HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.2.4 Demonstrate maintenance required and training.

3.2.5 Confirm correct installation as per manufacturer's instructions.

END OF SECTION

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CH0032 - Powerhouse and Spillway
 Hydro-Mechanical Equipment
 MFA-SN-CD-2000-ME-TS-0001-01

TECHNICAL SPECIFICATION
 SPILLWAY ELECTRICAL BLDG
 DUCT HEATERS
 APPENDIX A - DATASHEETS

SECTION: 23 55 01
 505573-3321-45EG-0001-00

Equipment Number	2440-HC-VSG-0001
General:	
Manufacturer	Thermolec
Type	Slip-In
Model	Thermo-V
Area Served	Generator Room
Coil Material	Nickel Chrome Alloy
Duct Dimensions:	
Width (mm)	450
Height (mm)	450
Performance:	
Airflow (L/s)	400
Velocity (m/s)	1.98
Static Pressure (Pa)	25
Entering Air Temp (°C)	-2.6
Leaving Air Temp (°C)	21.8
No of Fixed Stages	0
Fixed Stage Output ea. (kW)	0
SCR Stage Output (kW)	12
Total Capacity (kW)	12
Heat Density (kW/m ²)	59.3
Electrical Data:	
Voltage (Volts)	600
Phase	3
Frequency (Hz)	60
Controls:	
Control Type	SCR
Control Signal	0-10 VDC
Remarks	-

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 33.05
CH0032	GATE GUIDE HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 23 82 33.05
GATE GUIDE HEATERS
TABLE OF CONTENTS**

1 **GENERAL**.....2

 1.1 RELATED SECTIONS 2

 1.2 DEFINITIONS 2

 1.3 REFERENCES 2

 1.4 ACTION AND INFORMATIONAL SUBMITTALS 2

 1.5 CLOSEOUT SUBMITTALS 3

2 **PRODUCTS**.....3

 2.1 GATE GUIDE HEATERS 3

 2.2 CONTROLS..... 4

3 **EXECUTION**4

 3.1 INSTALLATION 4

 3.2 FIELD QUALITY CONTROL 4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 33.05
CH0032	GATE GUIDE HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 05 21 – Wires and Cables (0-1000 V)
- .3 Section 26 24 19 – Motor Control Centres
- .4 Section 26 29 03.02 – Control and Monitoring
- .5 Section 26 29 03.02 – Control and Monitoring – Hydro-Mechanical

1.2 DEFINITIONS

- .1 DHL Diversion Supply Level
- .2 FSL Full Supply Level
- .3 MI Mineral Insulated

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 130, Requirements for Electrical Resistance Heating Cables and Heating Device Sets.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Exhibit 4 – Supplier Document Requirements List. Include product characteristics, performance criteria, and limitations.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 33.05
CH0032	GATE GUIDE HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Quality assurance submittals: submit following in accordance with Exhibit 4 – Supplier Document Requirements List.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit operation and maintenance data for heating cable in accordance with Exhibit 4 – Supplier Document Requirements List
- .2 Record layout of cables in poured-in-place concrete or in pipe sleeves embedded in concrete, indicating depth of cables.

2 PRODUCTS

2.1 GATE GUIDE HEATERS

- .1 Mineral Insulated (MI) Heating Cables.
 - .1 Stainless steel sheathed heating cables to Section 26 05 21 - Wires and Cables (0 - 1000 V).
 - .2 Heaters to be fed from 600V, 3 phase supply.
- .2 Temperature Controller
 - .1 Electronic single loop temperature controller with capability for modulation
 - .2 Suitable for 100 Ohm platinum RTD temperature sensor input.
 - .3 Output to match solid state relay or power controller.
- .3 Solid State relay



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 33.05
CH0032	GATE GUIDE HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Electronic solid state relay (SSR) rated 600 V with current rating suitable for heater rating.
- .2 SSR can be combined with the temperature controller.

2.2 CONTROLS

- .1 Remote high temperature cut-out.
- .2 Gate guide RTD temperature sensors for each heating circuit.
- .3 Provide power to controllers as required.
- .4 Controllers and SSRs shall be installed in individual control enclosures or located in a heater control panel with other controllers and SSRs.
- .5 Controllers and SSRs may also be installed in the Hoist MCCs.

3 EXECUTION

3.1 INSTALLATION

- .1 Install heaters and controls as indicated and in accordance with manufacturer's instructions.
- .2 Make power and control connections.
- .3 For the Spillway gate guide heaters and the Spillway upstream Stoplog guide temporary heaters, added length of cold leads for the MI heater cables, and support cables if required, shall be provided for operation of the guide heaters when the reservoir is at DHL during the Diversion Phase, and when the reservoir is as FSL for long term operation.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 33.05
CH0032	GATE GUIDE HEATERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Ensure that heaters and thermostatic controls operate correctly.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 39.01
CH0032	UNIT HEATERS - ELECTRIC	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 23 82 39.01
UNIT HEATERS - ELECTRIC
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED SECTIONS	2
1.2	REFERENCES	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS	2
1.4	CLOSEOUT SUBMITTALS.....	3
2	PRODUCTS	3
2.1	UNIT HEATERS	3
2.2	CONTROLS.....	3
3	EXECUTION	4
3.1	INSTALLATION	4
3.2	COMMISSIONING.....	4



96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 39.01
CH0032	UNIT HEATERS - ELECTRIC	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 23 09 33 - Electric and Electronic Control System for HVAC.
- .2 Section 26 05 00 - General Electric Requirements.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.46, Electric Air-Heaters.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Submit product data sheets for unit heaters. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Mounting methods.
 - .4 Physical size.
 - .5 kW rating, voltage, phase.
 - .6 Cabinet material thicknesses.
 - .7 Limitations.
 - .8 Colour and finish.
- .3 Submit product data sheets for unit heaters.
 - .1 Include product characteristics, performance criteria, physical size, limitations and finish.
- .4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence and cleaning procedures.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 39.01
CH0032	UNIT HEATERS - ELECTRIC	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for unit heaters for incorporation into manual in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 UNIT HEATERS

- .1 Unit heater: to CSA C22.2 No.46, horizontal discharge complete with adjustable louvers finished to match cabinet or vertical discharge cone type with cone diffusers as indicated.
- .2 Fan type unit heaters with built-in high-heat limit protection, fan-delay switches.
- .3 Fan motor: totally enclosed, permanently lubricated ball bearing type with resilient mount.
 - .1 Built-in fan motor thermal overload protection.
- .4 Hangers: as indicated.
- .5 Elements: mineral insulated steel sheath with aluminum, continuous helical brazed fins.
- .6 Cabinet: steel, 1.6 mm thick, fitted with brackets for rod or wall mounting.
 - .1 Phosphatized and finished with 2 coats baked enamel in beige colour.

2.2 CONTROLS

- .1 Wall mounted thermostats: low voltage electronic type.
- .2 Unit heaters shall be complete with control transformers, 24 V control circuit and 24 V relay.

76
MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 23 82 39.01
CH0032	UNIT HEATERS - ELECTRIC	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Suspend unit heaters from ceiling or mount on wall as indicated. Provide mounting bracket as required.
- .2 Install thermostats in locations indicated.
- .3 Make power and control connections.

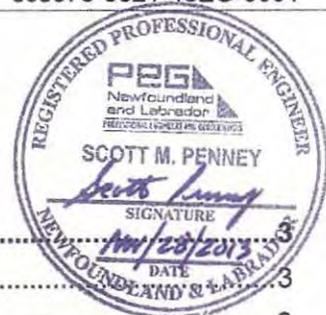
3.2 COMMISSIONING

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.
- .2 Test cut-out protection when air movement is obstructed.
- .3 Test fan delay switch to assure dissipation of heat after element shut down.
- .4 Test unit cut-off when fan motor overload protection has operated.
- .5 Ensure heaters and thermostatic controls operate correctly.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 25 33 01
SPILLWAY ELECTRICAL BLDG
HVAC CONTROLS AND INSTRUMENTATION**



PART 1 GENERAL		
1.1 RELATED SECTIONS		3
1.2 SCOPE		3
1.3 SYSTEM DESCRIPTION		3
1.4 QUALIFICATIONS		5
1.5 SUBMITTALS		5
1.6 HEALTH AND SAFETY		7
1.7 WASTE MANAGEMENT AND DISPOSAL		7
1.8 MAINTENANCE MATERIALS		8
1.9 NOT USED		8
1.10 DELIVERY		8
PART 2 PRODUCTS		8
2.1 SOFTWARE - GENERAL		8
2.2 PROGRAMMABLE LOGIC CONTROLLER (PLC) DESIGN DESCRIPTION		10
2.3 PLC MAIN HARDWARE		11
2.4 PLC POWER		13
2.5 PLC PROGRAM STORAGE		13
2.6 PLC INPUTS / OUTPUTS - GENERAL		15
2.7 PLC INPUTS / OUTPUTS - SPECIFIC		16
2.8 PLC NETWORKING AND COMMUNICATIONS		17
2.9 PANEL MOUNT PC		18
2.10 HMI TOUCHSCREEN		19
2.11 SOFTWARE - GRAPHICAL OPERATOR INTERFACE		20
2.12 TEMPERATURE TRANSMITTERS		24
2.13 A/C CURRENT SENSOR		26
2.14 DIFFERENTIAL PRESSURE TRANSDUCER		27
2.15 ELECTRIC ISOLATION RELAY		27
2.16 CONTROL TRANSFORMER		28



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.17 HIGH TEMPERATURE Switch (FIRESTAT)28

2.18 LOW TEMPERATURE SWITCH (Freezestat).....29

2.19 AUTOMATIC CONTROL DAMPERS30

2.20 DAMPER ACTUATORS (GENERAL)30

2.21 SMALL DAMPER ACTUATOR (TWO POSITION).....31

2.22 SMALL DAMPER ACTUATOR (MODULATING).....32

2.23 LARGE DAMPER ACTUATOR (TWO POSITION).....33

2.24 IARGE DAMPER ACTUATOR (modulating).....33

2.25 LOCAL CONTROL PANELS.....34

PART 3 EXECUTION35

3.1 PLC Interfacing and Peripherals35

3.2 PLC Programming Techniques36

3.3 DYNAMIC ANIMATED COLOUR GRAPHIC DISPLAYS.....39

3.4 FACTORY TESTING40

3.5 INSTALLATION40

3.6 TEMPERATURE transmitters41

3.7 PANELS42

3.8 FIELD MOUNTED TRANSMITTERS AND SENSORS42

3.9 FIELD QUALITY CONTROL.....42

3.10 FIELD POINTS TESTING43

3.11 IDENTIFICATION OF EQUIPMENT44

3.12 INPUT/OUTPUT POINTS LIST.....44

3.13 TRAINING44

3.14 SEQUENCE OF OPERATION.....45

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 23 05 00 - Common Work Results for HVAC

1.2 SCOPE

1.2.1 Provide and install the master and slave programmable logic controllers in accordance with drawings and specifications. The PLC to include but not necessarily be limited to power supply with integral surge protection, back-up non-volatile memory card, microprocessor, graphic touch screen interface, input and output ports, interface modules, control cables, panel mount personal computer, HMI software, and field control devices.

1.2.2 Interfacing operator workstation shall be located remotely from this building. Operator workstation shall not be included in this contract. Remote access to the HVAC PLC system shall be over the internet using a web browser such as Explorer.

1.2.3 Provide peripheral devices, transducers, and transmitters required for control and monitoring functions.

1.2.4 Provide all required control cabling in accordance with drawings and Section 1.3 System Description.

1.2.5 Provide all required software.

1.2.6 The PLC control system shall be furnished, installed, serviced, and guaranteed by the Controls Subcontractor. This work shall include but shall not be limited to programming, shop drawing development, supervision, commissioning, calibration, testing, instruction of operating personnel, and development of operation and maintenance manual.

1.3 SYSTEM DESCRIPTION

1.3.1 The Controls Subcontractor shall be responsible to supply and install a complete control system to service the Spillway Electrical Building HVAC System. The PLC system shall be integrated into a complete system with remote monitoring.

1.3.2 The control system architecture shall be a master/slave arrangement. The master PLC shall be located in the Generator Room. It shall communicate with one (1) slave PLC: located in the Electrical Room.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.3 A Company supplied operator work station (OWS) shall be installed on site remote to the Spillway Electrical Building. A full development version of Thrihedral VTS HMI software shall be supplied by the Controls Subcontractor and installed on this computer. The licence shall be for a 1000 tag version of the software. This computer shall act as the back-up server.
- 1.3.4 A panel mounted PC shall be installed in the cabinet of the master PLC in the Generator Room of the Spillway Electrical Building. A full development version of the Thrihedral VTS HMI software shall be supplied by the controls contractor and installed on this computer. The licence shall be a 1000 tag version of this software. This computer shall be the main server.
- 1.3.5 Each licensed version of VTS shall be provided with the following options:
 - .1 Alarm dialer to send alarms via email or pager.
 - .2 VTS internet client monitoring tool.
 - .3 VTS internet server/client option.
- 1.3.6 The OWS and the panel mount PC shall be interconnected via a fibre optic link supplied and installed by the Company.
- 1.3.7 Remote communication to one (1) concurrent internet client shall be provided. The internet client OWS shall not require VTS software to be installed. During the initial connection between the internet server and the internet client, an Active-X software package shall be downloaded onto the internet client OWS which shall give full monitoring and control capabilities to the internet client.
- 1.3.8 The primary internet server shall be the panel mounted PC in the generator room of the Spillway Electrical Building. The back-up internet server shall be the remote OWS.
- 1.3.9 All power wiring required to service equipment supplied by the Controls Subcontractor shall be supplied and installed by the Electrical Subcontractor. This shall include all conduit.
- 1.3.10 All control wiring required to service equipment supplied by the Controls Subcontractor shall be supplied and installed by the Controls Subcontractor. The Controls Subcontractor shall be responsible to supply and install the conduit to carry this wiring.
- 1.3.11 The mounting of all control cabinets supplied by the Controls Subcontractor shall be the responsibility of the Controls Subcontractor.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.12 All wiring terminations at equipment supplied by the Controls Subcontractor shall be the responsibility of the Controls Subcontractor to undertake.
- 1.3.13 The installation of pressure transmitters, damper actuators, temperature transmitters, etc., supplied by the Controls Subcontractor shall be the responsibility of the Controls Subcontractor.
- 1.3.14 All combination magnetic motor starters shall be supplied and installed by the Electrical Subcontractor unless otherwise indicated.
- 1.3.15 Provide a touch screen panel mount personal computer for local annunciation, status monitoring, and changing of system set points, at the PLC cabinet in the Generator Room.
- 1.3.16 Provide a HMI touch screen for local annunciation, status monitoring, and changing of systems set points, at the slave PLC cabinet in the Electrical Room.
- 1.3.17 Supply PLC system to service the project with input/output capacity as outlined in drawings.

1.4 QUALIFICATIONS

- 1.4.1 The Controls Subcontractor shall have designed and installed a minimum of five (5) similar PLC - based systems within the past ten (10) years.
- 1.4.2 Provide to Engineer list of installations with similar equipment requirements demonstrating compliance. Provide project title, client name, and contact telephone number.

1.5 SUBMITTALS

- 1.5.1 Submit product data. Submittals shall include the following:
 - .1 Clear concise description of control philosophy.
 - .2 Detailed description of how control philosophy shall be implemented in the programming. Description shall be in English language with detailed flow charts and logic diagrams to clearly describe how each device is controlled.
 - .3 Clear identification of configuration data different from default values not in PLC.
 - .4 List of all adjustable set point parameters complete with assigned address.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .5 Dimension drawing of components.
 - .6 Schematic and wiring diagrams indicating all components, input and output locations, terminal points, and points of interconnection.
 - .7 List of components.
 - .8 Product bulletins.
 - .9 Certified Test Reports.
- 1.5.2** Provide operation and maintenance data for incorporation into operation and maintenance manual.
- .1 Provide material to cover the following items:
 - .1 Equipment documentation:
 - .1 General Description
 - 1. Logic diagrams and description
 - .2 Associated instrumentation manual
 - .3 Peripheral equipment manual
 - .4 Components manual:
 - .1 Components standardized identification
 - .2 Manufacturer's and catalogue numbers
 - .3 Contractor's references
 - .2 Software documentation:
 - .1 Operator's programming manuals.
 - .2 User's documentation.
 - .3 Programmer's references.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		

.3 Drawings and diagrams:

.1 Inter-elements and terminals wiring diagrams and external cabling diagrams consisting of:

- .1 Inter-modules and inter-elements cable list
- .2 AC and DC power distribution
- .3 Functional blocks
- .4 Card layout
- .5 External cabling terminals
- .6 Grounding
- .7 Signal conditioning

.4 Diagnostic and hardware-checking programs:

.1 For each diagnostic program supply:

- .1 Description and use
- .2 Instruction listing

.2 Delivery of final documents to coincide with systems 90% completion and should final documents not be available at the time, manuals suitable for personnel training shall be prepared and delivered. In this case, the final documents to be delivered before Substantial Completion of the system.

1.6 HEALTH AND SAFETY

1.6.1 Perform construction occupational health and safety in accordance Health and Safety Requirements.

1.7 WASTE MANAGEMENT AND DISPOSAL

1.7.1 Separate and recycle waste materials.

1.7.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

46 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.7.3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.7.4 Divert unused metal materials from landfill to metal recycling.

1.8 MAINTENANCE MATERIALS

1.8.1 The Controls Subcontractor shall supply a recommended spare parts list for a two-year operating period.

1.9 NOT USED

1.10 DELIVERY

1.10.1 Equipment shall be handled and stored in accordance with manufacturer's instructions. Specialized storage instructions shall be included with equipment at time of shipment.

PART 2 PRODUCTS

2.1 SOFTWARE - GENERAL

2.1.1 Provide all software required for a complete operating system. All PLC software to be provided as an integral part of the PLC, and not dependent upon any other computer device for execution.

2.1.2 The system shall be set up such that screen development, associated logic development, and custom report development for the entire system can be modified from a remote location via an internet based connection utilizing remote configuration techniques. Changes in configuration made at this location shall be electronically transferable to any and all nodes on the network, as selected by the developer, without requiring the developer to physically go to the nodes. It shall not be necessary to have the development key installed on the node to which the modifications are transferred.

2.1.3 Program functions shall include contacts, coils, timers, counters, floating point mathematical functions, shift registers, bit and word operations.

2.1.4 All programs shall execute automatically without need for operator intervention, and shall allow user customization. Programs shall be applied to devices as required and as described in the system sequence of operation. The PLC system shall be able to



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		

execute configured processes defined by the user to automatically perform calculations and control routines.

- 2.1.5 Remote support shall be configured such that all systems on the network are accessible utilizing an internet based connection.
- 2.1.6 The system shall be configured in such a manner to ensure it cannot be rendered inoperable.
- 2.1.7 At all times, operators shall be able to perform control actions. It shall not be necessary to wait for alarms to be posted, or any other function to be performed before operators are able to input commands to the system irrespective of what other tasks the operating system is performing.
- 2.1.8 All functionality shall be supported simultaneously. It shall not be necessary for an operator to discontinue logging of trend data to generate reports.
- 2.1.9 Process Inputs and Variables: It shall be possible to use any of the following in a confined process:
 - .1 Any system-measured point data or status.
 - .2 Any calculated data.
 - .3 Any results from other processes.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.10 Process Triggers: Configured processes may be triggered based on any combination of the following:

- .1 Time of day.
- .2 Calendar date.
- .3 Other processes.
- .4 Events (point alarms).

2.2 PROGRAMMABLE LOGIC CONTROLLER (PLC) DESIGN DESCRIPTION

2.2.1 Applicable to main controllers: 2440-MC-VSE-0001 and 2440-MC-VSG-0001

2.2.2 A major consideration of the controller system shall be its all-in-one design, with I/O expansion. This allows the user to quickly and easily install, service and replace the controller and expansion modules if necessary. The supplier must have available a number of I/O options for the controller that include:

- .1 Power: 120Vac, 24Vdc.
- .2 Inputs: 120Vac, 240Vac, 24V dc sink, 24Vdc source, 4-20ma Analog , 0-10v Analog, RTD and Thermocouple.
- .3 Outputs: Relay (some of which must have individual isolation), 24Vdc source, 4-20ma Analog, 0-10v Analog and TRIAC.

2.2.3 The controller must be part of a larger family of packaged and modular programmable controllers that provide program transport (ability to move a customer's program between platforms in both directions), and also share programming tools, a common instruction set, and common communications to serial based devices (computers, electronic operator interfaces, etc).

2.2.4 All hardware of the controller shall operate at an ambient temperature of -20° to 60°C (-4° to 140°F), with an ambient temperature rating for storage of -40° to +85°C (-40° to +185°F).

2.2.5 The controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.

2.2.6 The controller shall have at least two dedicated serial ports which support RS-232-C signals. These ports must be capable of local and remote (via modem) programming, troubleshooting and data manipulation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.7 The controller shall have at least one dedicated serial port which supports RS-485 signals. This port must be capable of local and remote programming, troubleshooting and data manipulation.
- 2.2.8 The controller shall have at least one RJ-45 port which supports 10/100 Mbps EtherNet/IP. This port must be capable of local and remote programming, troubleshooting and data manipulation.
- 2.2.9 The controller system shall be designed and tested to operate in high electrical noise environments, and must meet or exceed:
 - .1 EN 61000-4-2 (ESD Immunity).
 - .2 ENV 50204 (Radiated Immunity).
 - .3 EN 61000-4-3 (Radiated RF Immunity).
 - .4 EN 61000-4-4 (Fast Transient Immunity).
 - .5 EN 61000-4-5 (Surge Transient Immunity).
 - .6 EN 61000-4-6 (Conducted RF Immunity).
 - .7 EN 55011 (Conducted and Radiated Emissions).
 - .8 EN 61000-4-11 (Line Related Tests).
- 2.2.10 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.

2.3 PLC MAIN HARDWARE

- 2.3.1 The CPU shall be a self-contained unit, and will be capable of displaying Ladder Rung program execution through its RS-232/RS-485 and EtherNet/IP communication ports. The CPU will control all I/O scanning and communications servicing.
- 2.3.2 All components of the controller system shall be housed in a single chassis. (Power supply, embedded I/O circuitry, CPU, Memory and communications shall be resident in one enclosure.)
- 2.3.3 The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.3.4 The packaged controller shall be designed to operate in a free air flow environment. (Convection cooling only, no fans or other air moving devices shall be required).
- 2.3.5 The controller shall provide a simple embedded Human Machine Interface (HMI). This HMI must provide the ability to monitor/change user data and also to display messages and data to the user. The ability to receive numeric input from the HMI which can be utilized by the controller's program must also be supported.
- 2.3.6 The controller must provide a mechanism to manually set the communication port to a known state (factory out of box preferred). Systems that do not provide a mechanism to manually set the communications port to a known state are not acceptable.
- 2.3.7 The controller must provide at least two digital trim potentiometers that are accessible from the front of the controller while the controller is operating.
- 2.3.8 The controller must support front accessible memory modules that can be inserted or removed while the system is operating (in run).
- 2.3.9 The main front panel of the controller shall include the following indicators:
 - Power, Run, Fault, Force
- 2.3.10 Processor mode shall be selected by a command from a programming device. Available settings must include modes:
 - RUN Control program executing.
 - PROGRAM Controller not executing, user program can be uploaded or downloaded.
 - SINGLE SCAN TEST The PLC scans and solves the user program once, does NOT control the real world outputs, and stops.
 - CONTINUOUS SCAN TEST The PLC continuously scans the user program, but does NOT control the real world outputs.
- 2.3.11 Non-volatile memory shall store the operating system, user program, and all user data to protect against memory loss in the case of power loss or system shut-down.
- 2.3.12 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 PLC POWER

2.4.1 The packaged controller shall operate in compliance with one of two types of electrical service:

- .1 120/240 VAC, single phase, in power systems that operate on 50/60 Hz. It must be capable of auto-detect to operate with either of these AC voltages or frequencies without the user needing to jumper or setup the unit.
- .2 24V dc Class 2 SELV.

2.4.2 All AC powered controllers with 24Vdc inputs must be capable of supplying a minimum of 24Vdc at 200ma. This can be used to provide external 24Vdc power for input devices (sensors, switches etc.).

2.4.3 The onboard power supply must be capable of supplying all necessary power to all subsystems (CPU, Memory, local I/O, etc.) in addition to a minimum of 7 expansion I/O modules, without external wiring.

2.4.4 The power supply shall provide surge protection, isolation, and power outage carry-over of at least 1 cycle of the AC line.

2.4.5 In cases where the AC line is especially unstable or subject to unusual variations it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.

2.4.6 At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

2.4.7 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.

2.5 PLC PROGRAM STORAGE

2.5.1 The program storage medium shall be a solid state non-volatile type.

2.5.2 The controller shall be capable of addressing up to a minimum of 10K data words, where each word is comprised of 16 data bits.

2.5.3 Available user memory shall consist of a minimum of 20K words of program and data.

2.5.4 Controller shall support up to 128K bytes for data logging.

2.5.5 Controller shall support up to 64K bytes for recipe storage.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.5.6** The controller must provide the capability to use a non volatile memory module that can be inserted or removed while power is applied to the controller.
- 2.5.7** The memory module must support the ability to selectively protect multiple areas of user data from being overwritten if/when a download occurs.
- 2.5.8** Memory modules must be capable of write once read many operations. This is a write once feature that if enabled inhibits a user from clearing the program currently stored in the memory module.
- 2.5.9** The memory module must support automatic program download whenever power is applied.
- 2.5.10** The memory module must support the ability to detect if a fault is present during the power up sequence, if a fault is present download the program that is in the memory module and enter the run mode. If a fault is not present the controller proceeds normally without memory module intervention.
- 2.5.11** The operator should be able to backup memory, including data and program logic onto a CD, DVD, hard disk, or memory module.
- 2.5.12** The packaged controller system must be capable of storing the following data:
- .1 External Output Status.
 - .2 External Input Status.
 - .3 Timer Values.
 - .4 Counter Values.
 - .5 Signed Integer Numbers (16 bit).
 - .6 Signed Integer Numbers (32 bit).
 - .7 Binary data (bit, BCD, HEX).
 - .8 ASCII String Data.
 - .9 Internal Processor Status Information.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.5.13 The above listed data shall be distinguishable to the CPU by the addressing format. Management of the data into memory subsections shall be an automatic function of the CPU operating system. Data can be displayed in Binary, Hexadecimal, or Decimal. Function-specific data such as processor status shall have dedicated displays that annotate the meaning of specific control bits and words within them and allow for selective control where appropriate.
- 2.5.14 If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program.
- 2.5.15 The controller must support a minimum of 12 pulse inputs. Pulse inputs allow a fast signal to be captured and held long enough for the controller to detect the signal, once read the signal is automatically reset.
- 2.5.16 The number of times that a normally open (N.O.) and/or normally closed (N.C.) contact of an address can be programmed shall be limited only by the memory capacity to store these instructions.
- 2.5.17 Ladder logic programs must have immediate access to the sub elements of control structures (timers, counters, sequencers etc.) by word (presets, accumulators etc.) and bit (status bits).
- 2.5.18 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.

2.6 PLC INPUTS / OUTPUTS - GENERAL

- 2.6.1 A minimum of 4 isolated digital input groups, 1 isolated analog input group, 6 isolated digital output groups and 1 isolated analog output group shall be located on the self-contained controller. At least 4 relays shall be individually isolated.
- 2.6.2 The system must support at least 112 discrete I/O points using expansion I/O modules.
- 2.6.3 Isolation shall be between all internal logic and external circuits.
- 2.6.4 Each input and output point shall have a visual indicator to display ON/OFF status.
- 2.6.5 All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.6.6 Inputs shall have adjustable filter time constants to improve input performance in high speed applications, and to limit the effects of voltage transients.

2.6.7 The system must support 7 expansion modules (input / output, discrete or analog).

2.6.8 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.

2.7 PLC INPUTS / OUTPUTS - SPECIFIC

2.7.1 The controller manufacturer shall offer input/output hardware consisting of the following types:

2.7.2 Standard Inputs:

- .1 Inputs: 120Vac, 240Vac, 24V dc sink, 24Vdc source, 4-20ma Analog , 0-10v Analog, RTD and Thermocouple.

2.7.3 High Speed Counters:

- .1 Each controller with 24Vdc inputs must have at least 3 high speed counters (HSC) capable of detecting a 100 kHz pulse stream built onboard.
 - .1 Each HSC must be capable of detecting pulses as narrow as 5 microseconds (100 kHz) and directly control (turn on or off) controller outputs independent of the processor scan.
 - .2 Each HSC must be cable of detecting single ended inputs, quadrature inputs, and high speed inputs with external controls (hold and reset).
 - .3 Each HSC must be completely configurable (input filters, modes of operation, etc.) using computer based software. Runtime control of the HSC must be allowed through commands (instructions) in the user (ladder) program (Reset accumulator, change presets, change output patterns and setpoints, enable/disable HSC operation etc).
 - .4 Data and status within each HSC must also be accessible from external devices through the controller's communication ports.

2.7.4 High Speed Inputs:

- .1 Each controller with 24Vdc inputs must have at least 12 inputs that can catch and hold for one inputs scan a 5 microsecond input signal.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Each controller with 24Vdc inputs must have 4 high speed inputs capable of generating an input interrupt. When used for input interrupt functionality, the controller must be capable of executing a predefined range of logic. Each input must be configurable to run its own user defined block of logic.

2.7.5 Standard Outputs:

- .1 Outputs: Relay (some of which must have individual isolation), 24Vdc source, 4-20ma Analog, 0-10v Analog and Triac
- .2 Relay outputs for DC devices which operate at 5 to 125Vdc, with 2 amp continuous current capacity at 24Vdc and 1 amp continuous current capacity 125Vdc.
- .3 Relay outputs for AC devices which operate at 5 to 264Vac with 5 amp continuous current capacity for UL508 up to 40°C (3A above 40°C) and 3 amp continuous current capacity for UL1604, Class 1, Division 2, Hazardous Locations, Groups A, B, C, D.

2.7.6 High Speed Output:

- .1 Each controller with 24Vdc outputs must have at least 3 high speed outputs. The outputs must be capable of generating PTO (pulse train output) signals. The PTO signals must be capable of generating motion profiles using either trapezoid or S curve acceleration and deceleration profiles.
- .2 The outputs must also be configurable for PWM (pulse width modulated) signals. When configured for PWM the controller must provide trapezoid acceleration/deceleration of either the frequency or duration portions of the PWM waveform.

2.7.7 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.

2.8 PLC NETWORKING AND COMMUNICATIONS

- 2.8.1** The controller shall support direct connection to a programming computer equipped with a standard RS-232 serial port.
- 2.8.2** The controller shall support direct connection to a programming computer equipped with a standard RS-485 port.
- 2.8.3** The controller shall support direct connection to a programming computer equipped with a standard 10/100Mbps EtherNet/IP port.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.8.4 The controller shall support direct connection to a modem for remote programming functionality
- 2.8.5 The packaged controller shall support full function peer to peer communications (program management, controller to controller messaging, etc.):
 - .1 When directly connected by an RS-232 cable, RS-485 cable or Ethernet cable
 - .2 A "local" (hard wired) peer to peer network that supports up to 32 devices
- 2.8.6 The controller shall directly support EtherNet/IP peer-to-peer messaging.
- 2.8.7 The controller family shall support connectivity with DeviceNet. The controller must provide DeviceNet slave I/O functionality to a DeviceNet master, peer to peer messaging over DeviceNet, explicit messaging support over DeviceNet.
- 2.8.8 The controller shall support ½ duplex slave communications on a network capable of at least of 250 nodes. The ½ duplex network shall support program upload/download, monitoring, and peer to peer (slave to slave) communications.
- 2.8.9 The controller shall support connectivity to up to 31 other devices across a DH-485 network.
- 2.8.10 The controller shall support the DF1 Radio Modem protocol.
- 2.8.11 The controller shall support Modbus RTU master and slave communications.
- 2.8.12 The controller shall support bi-directional ASCII communications to send initialization strings to a modem, text with embedded data to a printer or terminal, receive ASCII from smart scales, bar code devices, etc.
- 2.8.13 The controller shall provide the ability to change the RS-232 communications port between the out of box factory default settings, and the user configuration settings. This operation must be allowed to occur at any time.
- 2.8.14 The controller must support baud rates from 300 to 38.4k baud.
- 2.8.15 Acceptable products: Allen Bradley, Omron, Panasonic, or accepted equal.
- 2.9 **PANEL MOUNT PC**
 - 2.9.1 Application:
 - .1 Panel mount PC, located in Generator Room

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPELLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.9.2 Description:

- .1 Touchscreen Panel Mount PC; 8GB CF Solid State Computer; Performance Model: Core Duo 1.2GHz; 1GB DDR2 RAM; CD/DVD-RW.

2.9.3 Monitor Selection:

- .1 Bulletin: 6181F Solid-State Computers
- .2 Monitor Size: 15-inch TFT Display
- .3 Screen Type: Touch Screen
- .4 Display: Bezel Aluminum
- .5 Package: Performance Package
- .6 Operating System: Microsoft Windows XP Professional
- .7 Voltage: 120/240V AC

2.9.4 Acceptable product: Allen Bradley 6181F-15TPXP, Omron, Panasonic, or accepted equal.

2.10 HMI TOUCHSCREEN

2.10.1 Application:

- .1 HMI touchscreen for slave PLC located in Electrical Room

2.10.2 Description:

- .1 6" Color (Transmissive CSTN) Touchscreen

2.10.3 Component Data:

- .1 Size: 6 inches
- .2 Operator Input: Touch Screen
- .3 Display Type: Color

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.10.4 Controller Information:

- .1 Control Interface: Ethernet
- .2 Component Port: Ethernet

2.10.5 Acceptable products: Allen Bradley 2711C-T6C, Omron, Panasonic or accepted equal.

2.11 SOFTWARE - GRAPHICAL OPERATOR INTERFACE

2.11.1 Alarms:

- .1 The system shall provide capability of changing alarm levels, and adding alarms while maintaining system operation.
- .2 Annunciation shall be provided immediately following occurrence of an alarm. The annunciator shall continue to indicate until the alarm is acknowledged.
- .3 Alarm printer control shall be provided on an "Alarm Disable" screen. Operators shall be able to select any portion of the historical alarm log for printing by specifying the start and end time. Operators shall be able to specify the alarm type for inclusion in the alarm print out. Alarms not specified shall not be printed.
- .4 An historical alarm log shall be maintained for a period of 45 days. The system shall automatically erase historical alarm log data older than 45 days.
- .5 The alarm types which shall be supported are as follows:

.1 TYPE 1 - SYSTEM CRITICAL ALARMS

Alarm condition results in a window being displayed describing the alarm condition and what immediate action the operator should take. To clear the pop-up window, an operator must click on an acknowledge button on the pop-up. The historical alarm log shall record when first triggered in yellow, when acknowledged in red, and when cleared in green. The alarm log shall indicate the date, time and description of the alarm condition. An alarm condition shall be communicable to an auto-dialer if not acknowledged within 2 minutes.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 TYPE 2 - SYSTEM DISCRETE ALARMS

Alarm conditions are generated in the PLCs and shall latch in alarm state until acknowledged. The alarm shall remain on the screen until cleared in the field. The historical alarm log shall record when first triggered in red, when cleared in blue, but shall not log when acknowledged. The historical alarm log shall indicate the date, time and description of the alarm condition.

.3 TYPE 3 - CONTROL SYSTEM LOGICAL AND ANALOG ALARMS

Alarm conditions are based upon logical conditions and analog values. The alarm shall latch in alarm state until acknowledged and shall remain on the screen until cleared in the field. The historical alarm log shall record when first triggered in yellow, when cleared in green but shall not log when acknowledged. The alarm log shall indicate the date, time and description of the alarm condition.

.4 TYPE 4 - STATUS EVENTS

These events are logged by the alarm printer. These alarms shall not require acknowledgement and shall not display on the alarm banner. The alarms shall be viewable on the historical alarm log in dark blue. The alarm log shall not log when the trigger returns to the off state. The alarm log shall indicate the date, time and description of the status event.

- .6 Operators shall be able to lock alarms in the state at run-time from an "Alarm Control" screen such that the alarm continues to display on the screen as active irrespective of the actual alarm condition in the field. When alarms have been locked, all screens shall display a warning that alarms have been locked.
- .7 Operators shall be able to change alarm levels for those alarms at run-time from an "Alarm Control" screen such that the alarm continues to display on the screen as active irrespective of the actual alarm condition in the field.
- .8 Operators shall be able to disable those alarms at run-time from the "Alarm-Control" screen such that the alarm will not be triggered irrespective of the actual alarm condition in the field. When alarms have been disabled, all screens shall display a warning that alarms have been disabled.

2.11.2 Trending:

- .1 The system shall be configured to record, recall and simultaneously graph a minimum of four (4) analog trends over any specified time base.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 A trend screen selection box shall allow an operator to select separate trend periods for each of the two trend charts displayed on the screen by entering the time and date for which the information is required.
- .3 Each trend, scale and legend shall be clearly displayed using different colours.
- .4 Real time trends shall scroll from right to left.
- .5 The printing shall be performed in conjunction with tasks on the control system simultaneously as a plot is generated and printed.
- .6 The following trending shall be provided:
 - .1 TYPE 1 - SHORT TERM

Accessible for a period of not less than 30 days. The sample interval shall be 1 minute.
 - .2 TYPE 2 - HISTORICAL ANALOG

Logged at 30 minute intervals using a sample interval of 1 minute. Provision for discontinuation data logging on a trend by trend basis during pre-defined periods by changing a single data point in the control logic for each trend to be disabled. Record maximum, minimum, total and average values.
 - .3 TYPE 3 - HISTORICAL EVENTS

The system shall log event trends including runtimes, number of starts and stops, and specific alarm occurrences. Provision shall be made for disabling data logging during pre-defined periods by changing a data point in control logic for each trend to be disabled.
- .7 It shall be possible to add no less than 10 additional trends to each trend type without disabling data collection for trends already defined or changing the database configuration.
- .8 Provision shall be made for removal of individual trends from each trend type without disabling other trends already defined or changing the database,
- .9 Trend removal shall not place restrictions on accessibility of information previously stored on the system.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.11.3 Historical:

- .1 The system shall use a report function point as the report generator.
- .2 The data, once stored by the database server shall be accessible by Microsoft Excel or Access.
- .3 The software shall recognize database gaps caused by system shutdown or disabling of portions thereof due to power failure, or system maintenance, by indicating the data is not available. Missing data shall not restrict access to data preceding or following the gap.
- .4 Security measures shall be implemented in order to ensure data integrity. Only supervisory staff with knowledge of the appropriate passwords shall be able to access data in the historical database.
- .5 The database shall provide for the storage of 3 months (minimum) of data on-line all times.
- .6 It shall be possible to report the values of analog trends and average, maximum and minimum values for analog trends between certain hours, on specified days of the week, during specified months, during specified years.

2.11.4 Reports:

- .1 The system shall be configured to allow "Ad-hoc" inquiries of historical data simply by entering the necessary parameters into a pre-defined spreadsheet template.
- .2 Spreadsheet templates shall be provided to automate the generation of monthly summary reports, annual summary reports, monthly equipment run-time reports, annual equipment run-time reports, monthly chemical usage reports, annual chemical usage reports, monthly operational reports.
- .3 The network data collection workstation shall be equipped with a CD-R/W drive. All reports configured via the report point shall be directed and stored on a R/W disk. The operator shall have the ability to make backup copies of data.

2.11.5 Screen Development:

- .1 All screen development shall be fully windows compliant and make optimal use of pop-up windows, scroll bars, and push buttons.
- .2 It shall be possible to perform all control actions with a mouse type pointing device.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Devices shall be animated to show them as running and shall change colour to indicate status where feasible.
- .4 Pop-up windows shall be used to display additional information and/or to allow set point selection and operational changes.
- .5 Any and all information shall be capable of being displayed on more than one screen and be simultaneously displayed in more than one format (eg: bar chart and analog format).
- .6 Critical dialogue box overlay pop-up windows shall be used to enable changes to devices shown on the underlying screen. The pop-up box shall support keyboard data entry, mouse, pick-up and dynamic mouse scroll bars for selection of analog input values.

2.11.6 Security:

- .1 It shall not be possible to modify system configuration, without having sufficient security clearance.
- .2 Four distinct system security levels shall be provided as follows:
 - .1 Level 1 - Supervision only.
 - .2 Level 2 - Supervision and control.
 - .3 Level 3 - Supervision, control and access to the operating system.
 - .4 Level 4 - Configuration, supervision, control and access to the operating system.

2.12 TEMPERATURE TRANSMITTERS

2.12.1 General:

- .1 All temperature sensors shall 100 ohm platinum RTDs.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.12.2 Space Temperature Transmitters; Applicable to 2440-TT-VSG-0004 and 2440-TT-VSE-0001:

.1 Vandalproof Transmitters:

- .1 100 ohm platinum Type RTD, IEC 751, 385 Alpha, thin film.
- .2 Wall mount.
- .3 Stainless steel plate.
- .4 Dimensions: to suit standard concealed electrical wall enclosure.
- .5 4-20mA output.
- .6 Temperature range: 0 to 50°C (transmitter).
- .7 Power supply: 15 to 35 VDC or 22-32 VAC.
- .8 Connections: 2 or 3 wire.
- .9 Accuracy: ±0.1% of span.
- .10 Acceptable product: Greystone TE500AS21A2, BAPI, Honeywell, Johnson Controls, Veris, or accepted equal.

2.12.3 Duct temperature transmitters; applicable to 2440-TT-VSG-0001, 2440-TT-VSG-0002, and 2440-TT-VSG-0003

.1 Insertion

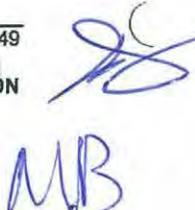
- .1 100 ohm, platinum Type RTD, IEC 751, 385 Alpha, thin film.
- .2 Duct mount.
- .3 ABS enclosure.
- .4 450 mm probe length.
- .5 304 Stainless steel probe material.
- .6 Sensor to be encapsulated in 6.35 mm outside diameter probe.
- .7 4-20mA output

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .8 Temperature range: 0 to 100°C (transmitter).
- .9 Accuracy: ±0.1% of span.
- .10 Power supply: 15 to 35 VDC or 22 to 32 VAC.
- .11 Connections: 2 or 3 wires.
- .12 Acceptable product: Greystone TE500B-2F21A3, BAPI, Honeywell, Johnson Controls, Veris, or accepted equal.

2.13 A/C CURRENT SENSOR

- 2.13.1 Applicable to current sensors: 2440-IT-VSG-0001, 2440-IT-VSE-0001 and 2440-IT-VSE-0002.
- 2.13.2 Solid state current sensing transducer that converts a primary circuit current to a proportional output signal.
- 2.13.3 Maximum input current: 80/120/180 Amps continuous.
- 2.13.4 Three (3) selectable ranges:
 - .1 Low: 0-10 Amps.
 - .2 Mid: 0-20 Amps.
 - .3 High: 0-50 Amps.
- 2.13.5 Environment: -30°C to 70°C, 0-95% RH non-condensing.
- 2.13.6 Response time: 100 mS (0-90%).
- 2.13.7 Material: self-extinguishing ABS.
- 2.13.8 Split core design.
- 2.13.9 Dimensions: 70 x 87 x 30 mm.
- 2.13.10 Output: 0-10 Vdc.
- 2.13.11 Induction powered.
- 2.13.12 Accuracy: ±1% full span.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.13.13 Frequency: 40-100 Hz.

2.13.14 Protection circuitry: reverse voltage protected and output limited.

2.13.15 Acceptable product: Greystone SC-551-1, Veris, BAPI, Honeywell, Johnson Controls, or accepted equal.

2.14 DIFFERENTIAL PRESSURE TRANSDUCER

2.14.1 Application: Filter Pressure Drop; applicable to: 2440-PDT-VSG-0001 and 2440-PDT-VSE-0001

2.14.2 Measured Variable: Differential Pressure.

2.14.3 Power Supply: 12-24 VDC/24VAc

2.14.4 Output Signal: 4-20 mA

2.14.5 Pressure Range: 124 Pa to 1240 Pa.

2.14.6 3 Wire Connection.

2.14.7 Accuracy: +/- 1% F.S.O.

2.14.8 Overpressure: 138 kPa

2.14.9 Operating Humidity: 90%R.h. non-condensing

2.14.10 Load Resistance: 250 ohm

2.14.11 Operating Temperature: -25°C to 70°C

2.14.12 Acceptable Product: Autotron 860D-30, Veris, BAPA, Honeywell, Johnson Controls or accepted equal.

2.15 ELECTRIC ISOLATION RELAY

2.15.1 Supply and install relays with SPDT contacts capable of switching:

.1 15 Amps at 120 VAC and with a 24 VAC coil rated at 46 mA.

.2 10 Amps at 110 VAC and with a 120 VAC coil rated at 9.2 mA.

.3 7.5 Amps at 100 VAC and with a 110 VAC coil rated at 21.8 mA.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.15.2 Provide each relay with a NEMA 1 general purpose electrical enclosure with lockable cover sized to suit. Terminals shall be plug-in/solder type.

2.15.3 Acceptable product: Omron General Purpose LY2 Relays, Honeywell, Johnson Controls, or accepted equal.

2.15.4 Controls Subcontractor to determine appropriate relay to utilize for each respective application.

2.16 CONTROL TRANSFORMER

2.16.1 Comply with NEMA Standard DC20-1992 for voltage-regulating ability.

2.16.2 CSA certified.

2.16.3 Energy limiting winding.

2.16.4 Primary voltage: 120/1/60.

2.16.5 Secondary voltage: 24 VAC.

2.16.6 Transformer VA capacity to be sized by contractor to suit the application. Do not exceed 100 VA on any one (1) single low voltage control transformer.

2.16.7 Provide independent control transformer for PLC controllers with full wave rectifiers.

2.16.8 Provide separate control transformer for actuators controlled from PLC controller with full wave rectifiers.

2.16.9 Acceptable product: Marcus Indoor Type MC enclosed style single phase transformer, Honeywell, Johnson Controls, or accepted equal.

2.17 HIGH TEMPERATURE SWITCH (FIRESTAT)

2.17.1 Where shown on the drawings or described in the sequences of operation for individual systems, provide high temperature cut-out to shut down respective fan system. Applicable to: 2440-TSH-VSG-0001.

2.17.2 Rod and tube type sensing element.

2.17.3 Two position manual reset type.

2.17.4 Set at 57°C to shut down fan equipment.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.17.5 UL approved.
- 2.17.6 Switch action: SPST open high.
- 2.17.7 Range: -4°C to 102°C.
- 2.17.8 Range adjuster: knob.
- 2.17.9 Electric rating: 125 VA @ 24 to 600 VAC.
- 2.17.10 Acceptable product: Johnson Controls A25AN-1, Honeywell, Greystone, Veris, BAPI, or accepted equal.
- 2.18 LOW TEMPERATURE SWITCH (FREEZESTAT)**
- 2.18.1 Where shown on the drawings or described in the sequence of operation for individual systems, provide low temperature cut-out to shut down respective fan system. Applicable to: 2440-TSL-VSG-0001
- 2.18.2 4 wire, 2 circuit contact block with two (2) sets of isolated contacts.
- 2.18.3 Contacts shall be long-life, snap-acting. Contacts switch action shall be open low.
- 2.18.4 Range: -10 to 15°C.
- 2.18.5 Range adjustment: screw driver slot.
- 2.18.6 Manual reset type with setpoint adjustment.
- 2.18.7 6 m long 3.2 mm diameter vapour charged sensing element installed completely across either air handling unit casing internal cross section or duct cross section.
- 2.18.8 When any 300 mm long section of the element senses a temperature as low as the setpoint, the contacts shall open.
- 2.18.9 Set at 0°C to shut down fan equipment.
- 2.18.10 Electrical: pilot duty 125 VA @ 24 to 600 VAC.
- 2.18.11 Acceptable product: Johnson Controls A70HA-1C, Honeywell, Greystone, Veris, BAPI, or accepted equal.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.19 AUTOMATIC CONTROL DAMPERS

- 2.19.1 Low leakage: all control dampers shall be low leakage type unless otherwise specified.
- 2.19.2 Damper construction: specified in Section 23 33 15 – Dampers – Operating.
- 2.19.3 All control dampers are to be the responsibility of the Mechanical Subcontractor. The Controls Subcontractor shall be responsible to supply and install electric damper actuators.

2.20 DAMPER ACTUATORS (GENERAL)

- 2.20.1 Electronic actuation shall be provided.
- 2.20.2 The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 27 mm when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.
- 2.20.3 The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
- 2.20.4 For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
- 2.20.5 All spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.
- 2.20.6 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. All proportional actuators shall provide a 2 to 10 VDC position feedback signal.
- 2.20.7 All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.20.8 All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 6.7 N-m torque capacity shall have a manual crank for this purpose.
- 2.20.9 All proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
- 2.20.10 Actuators shall be provided with a conduit fitting and a minimum 1 m long electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
- 2.20.11 Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
- 2.20.12 Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of project completion. Manufacturer shall be ISO9001 certified.

2.21 SMALL DAMPER ACTUATOR (TWO POSITION)

- 2.21.1 Provide in following locations:
 - .1 2440-Z-VSE-0001
 - .2 2440-Z-VSE-0002
 - .3 2440-Z-VSE-0003
- 2.21.2 Direct coupled, spring return.
- 2.21.3 Provide complete with mounting bracket and screws.
- 2.21.4 95 degree angular rotation.
- 2.21.5 4 N-m torque capacity.
- 2.21.6 Running time for 95 degree stroke rotation to be 75 seconds.
- 2.21.7 Power supply: 24 VAC.
- 2.21.8 Power consumption: 5 watts running, 2.5 watts holding.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.21.9 Transformer sizing: 7 VA.
- 2.21.10 Control signal: on/off SPST.
- 2.21.11 Provide complete with auxiliary switch, SPDT rated 3A @ 250 VAC.
- 2.21.12 Acceptable product: Belimo LF24-S US, Honeywell, Johnson Controls, or accepted equal.
- 2.22 SMALL DAMPER ACTUATOR (MODULATING)**
- 2.22.1 Provide in following locations:
 - .1 2440-Z-VSG-0001
 - .2 2440-Z-VSG-0002
 - .3 2440-Z-VSG-0006
- 2.22.2 Direct coupled, spring return.
- 2.22.3 Provide complete with mounting bracket and screws.
- 2.22.4 95 degree angular rotation.
- 2.22.5 4 N.m torque capacity.
- 2.22.6 Running time for 95 degree stroke rotation to be 150 seconds.
- 2.22.7 Power supply: 24 VAC.
- 2.22.8 Power consumption: 2.5 W running, 1.0 watts holding
- 2.22.9 Transformer sizing: 5 VA.
- 2.22.10 Control signal: 2-10 VDC.
- 2.22.11 Input Impedance: 100,000 ohm for 2-10 VCD (0.1 mA)
- 2.22.12 Provide complete with 2-10 VDC, 0.5 mA maximum feedback position signal.
- 2.22.13 Provide complete with one (1) SPDT auxiliary switch rated 3A @ 250 VAC.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.22.14 Acceptable product: Belimo LF24-MFT-S US, Honeywell, Johnson Controls, or accepted equal.

2.23 LARGE DAMPER ACTUATOR (TWO POSITION)

2.23.1 Provide in the following locations:

- .1 2440-Z-VSG-0003 (4 total)
- .2 2440-Z-VSG-0005 (4 total)

2.23.2 Direct coupled, spring return.

2.23.3 Provide complete with mounting bracket and screws.

2.23.4 95 degrees angular rotation.

2.23.5 20 N.m torque capacity.

2.23.6 Running time for 95 degree stroke rotation to be 75 seconds.

2.23.7 Power supply: 24 VAC.

2.23.8 Power consumption: 5 watts running, 2.5 watts holding.

2.23.9 Transformer sizing: 7.5 VA.

2.23.10 Control signal: on/off SPST

2.23.11 Provide complete with two (2) SPDT auxiliary switches rated 3A @ 250 VAC.

2.23.12 Acceptable product: Belimo AFB24-S, Honeywell, Johnson Controls, or accepted equal.

2.24 LARGE DAMPER ACTUATOR (MODULATING)

2.24.1 Provide in the following locations:

- .1 2440-Z-VSG-0004 (2 Total)

2.24.2 Direct coupled, spring return

2.24.3 Provide complete with mounting bracket and screws

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.24.4 95 degree angular rotation
- 2.24.5 20 N.m torque capacity
- 2.24.6 Running time for 95 degree stroke rotation to be 75 seconds.
- 2.24.7 Power supply: 24 VAC
- 2.24.8 Power consumption: 7.5 watt running, 3 watt holding.
- 2.24.9 Transformer sizing: 10 VA
- 2.24.10 Control signal: 2-10 Vdc
- 2.24.11 Input impedance: 100,000 ohm for 2-10Vdc (0.1 mA)
- 2.24.12 Provide actuator with 2-10 Vdc, 0.5 ohm mA maximum feedback position signal
- 2.24.13 Provide complete with two (2) SPDT auxiliary switches rate 3A @ 250 VAC
- 2.24.14 Acceptable product: Belimo AFB24-MFT-S, Honeywell, Johnson Controls or accepted equal.

2.25 LOCAL CONTROL PANELS

- 2.25.1 Applicable to control panels: 2440-CP-VSE-0001 and 2440-CP-VSG-0001.
- 2.25.2 All control panels shall be factory constructed by the PLC supplier, incorporating the control system manufacturer's standard designs and layouts. Control panels shall be NEMA 4 fully enclosed, with hinged door, and key-locking latch.
- 2.25.3 In general, the control panels shall consist of the PLC controller(s), and I/O devices - such as relays, transducers, and so forth - that are not required to be located external to the control panel due to function.
- 2.25.4 All I/O connections on the PLC shall be extended to a numbered, colour-coded, and labelled terminal strip for ease of maintenance and expansion. Wiring to I/O devices shall be made from this terminal strip.
- 2.25.5 All other wiring in the panel, internal and external, shall be made to additional line or low voltage colour-coded and labelled terminal strips. Low and line voltage wiring shall be segregated. All terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.25.6 All wiring for every control panel shall follow a common colour-coded format. All terminal strip colour coding and numbering shall follow a common format. All wiring shall be neatly installed in plastic trays or tie-wrapped.

2.25.7 Wiring terminations from field control devices to PLC controllers inside local control panels shall be the responsibility of the Controls Subcontractor.

PART 3 EXECUTION

3.1 PLC INTERFACING AND PERIPHERALS

3.1.1 The programming means shall be a Microsoft Windows based desktop/portable.

3.1.2 Programming software must run on Windows 98/ME/NT/2000/2003 Server/XP, Vista, or Windows 7 environments.

3.1.3 The programming software and the controller shall support online editing.

3.1.4 The programming terminal shall be compatible for interfacing with an electrical service of either 120 VAC, 50/60 Hz. or 220 VAC, 50/60 Hz.

3.1.5 The terminal shall provide for selecting the communication rate between 110 and 38400 baud for RS-232-C communications.

3.1.6 The programming terminal shall be capable of displaying a rung consisting of a maximum of seven (7) series elements and six (6) parallel elements.

3.1.7 The means to indicate contact or output status shall be by intensification or color change of the contact or output on the CRT screen. Each element's status shall be shown independently, regardless of circuit configuration.

3.1.8 The controller system shall be able to interface with a data terminal which is RS-232-C compatible (up to 38400 baud) to generate hard copy logic diagrams and/or message generation.

3.1.9 The system shall have the capability to interface to a CD, DVD and/or a hard disk for loading a user program into, or recording the contents of, the processor's memory. It shall be possible to load or record the entire contents or selected portions of memory.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.10 The controller must also have a small easy to use operator interface (OI) specifically designed to enhance operator interaction with the control system. The OI device should be panel mountable. Features required are menuing capabilities, security features, active display of data, limit test of entered data, and scaling of data to and from the controller. The system should make use of intuitive on screen programming features. All OI programs must be capable of being saved to disk and transported to other OI devices or programming computers. OI programs should be transferred via a RS-232 serial communications link between the computer and the OI device.

3.2 PLC PROGRAMMING TECHNIQUES

3.2.1 The programming format shall be relay ladder diagram.

3.2.2 It shall be possible to program a maximum instruction matrix containing as many as 128 instructions.

3.2.3 The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.

3.2.4 It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, provided there is sufficient memory to accommodate these additions.

3.2.5 It shall be necessary to issue a two part command in order to delete all relay ladder rungs from memory. This will provide a safeguard wherein the operator must verify their intentions before erasing the entire program.

3.2.6 Latch functions shall be internal and programmable.

3.2.7 The system shall have the capability to address up to 10K words of data.

3.2.8 The system must support up to 255 data files. Each data file must be configurable from 1 to 255 data elements, and type (timers, counters, integer (16 or 32bit), string, message or PID) Any number of timers, counters and internal bits up to a maximum of 10k words of data.

3.2.9 All management of instructions and data in memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment, down-increment or both. All timer and counter data must be accessible from the ladder program and also any communications device.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.2.10 Timer instructions shall include selectable time bases in increments of 1.0, 0.01, and 0.001 second. The timing range of each timer shall be from 0 to 32,767 increments. It shall be possible to program and display separately the timer's preset and accumulated values.
- 3.2.11 The controller shall use a signed integer data format. The signed integer format (-32,768 to +32,767) must be used throughout the controller, (counters, storage registers, math operations etc).
- 3.2.12 The controller shall support signed integer math functions consisting of addition, subtraction, multiplication, division, scale with parameters, and square root.
- 3.2.13 Instructions shall be provided for file manipulation instructions such as "file fill", "first in-first out", "last in-first out" shall be supported by the system. Four function math instructions and instructions for performing "logical OR", "logical AND", "exclusive OR", and comparison instructions such as "less than", "greater than", and "equal to" shall be included within the system. All instructions shall execute on either single words, double words or files.
- 3.2.14 The system shall contain instructions for reading, writing, and manipulation of ASCII data. Instructions such as string extraction, concatenation, and byte swapping of data.
- 3.2.15 The system shall contain instructions which will construct synchronous 16 bit word shift registers. Additional instructions shall be provided to construct synchronous bit shift registers.
- 3.2.16 The controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.
- 3.2.17 The controller shall have an instruction which will allow the programmer to display a combination of bits, integers and strings to the embedded HMI and optionally to receive bits, integers, or long integers from the HMI.
- 3.2.18 In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The processor will support nesting of subroutines. The program format as displayed on the CRT shall clearly define the main program and all subroutines.
- 3.2.19 The program format shall display all instructions on a CRT programming panel with appropriate mnemonics to define all data entered by the programmer. The system shall be capable of providing a "HELP" instruction which when called by the

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

programmer will display on the CRT a list of instructions and all data required to enter an instruction into the system memory.

- 3.2.20 At the request of the programmer, data contained in system memory shall be displayed on the CRT programming panel. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status. Ladder logic rungs shall be displayed on the CRT with rung numbers in sequential order.
- 3.2.21 The system shall have the capability to enter rung comments above ladder logic rungs. These comments may be entered at the same time the ladder logic is entered.
- 3.2.22 It shall be possible to manually set (force) either on or off all hardwired input or output points. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.
- 3.2.23 The execution of the program logic shall be accelerated by scanning the rung only until a positive decision as to the state of the outputs has been made. In many cases this will mean skipping over logic elements if the output condition has been predetermined.
- 3.2.24 A means to program a fault recovery routine shall exist. When a major system fault occurs in the system, the fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.
- 3.2.25 An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 32767 milliseconds in 1 msec increments. This routine must be able to close an asynchronous control loop consisting of 32 Input points, 32 output points, 100 contact/coils, 10 addition instructions, 10 subtraction instructions and 32 circular comparison (Limit) instructions while never exceeding a 3 millisecond interval. The measurement of this interval is from after the Input filter delay time to the time that the physical outputs start to transition.
- 3.2.26 The ability to program ladder logic via symbols from the global database of the packaged controller shall exist.
- 3.2.27 The CPU shall support indirect addressing of inputs and outputs, along with all data table words (integer, binary, timers, and counters) for the software instruction set.
- 3.2.28 The system shall support both bit and word level diagnostic instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.29 To facilitate conditional event detection programming, output instructions shall include a "one shot" instruction which may be triggered on the low-to-high (rising) rung condition.

3.2.30 The processor shall support Master Control Reset (Relay) type functionality to selectively disable sections of relay ladder logic.

3.3 DYNAMIC ANIMATED COLOUR GRAPHIC DISPLAYS

3.3.1 System displays shall show all analog and binary object types within the system.

3.3.2 Provide dynamic system graphics incorporating all analog and binary object types within the system. The graphics shall incorporate all controls as indicated on the drawings and specified herein. The graphics shall include but shall not be limited to the following:

- .1 The floor plan of the Electrical Spillway Building shall indicate all PLC controllers, all controlled mechanical and electrical equipment, all electric starters and control panels, room names and numbers, etc. All equipment and controllers shown on floor plan shall be considered as 'hot' key, such that clicking on that particular item shall bring up the full colour graphic associated with that item.
- .2 HVAC system associated with 2440-FAN-VSG-0001.
- .3 Diesel generator/recirculation damper system
- .4 Heat relief system associated with 2440-FAN-VSE-001 and 2440-FAN-VSE-0002

3.3.3 Colour graphic displays, and system schematics shall be provided in order to optimize system performance analysis, speed alarm recognition, and simplify user interaction. The Controls Subcontractor shall fully configure the colour graphics and plot all associated control/monitoring points on the screen. Electronic copies of all colour graphics screens shall be provided to the Engineer for approval. The process shall be on-going during the control system installation to enable the Engineer to properly review the graphics. It is the intention that the colour graphic submissions occur frequently throughout the control system construction period so that the Engineer can comment on and revise the graphics until a satisfactory product is achieved.

3.3.4 Dynamic values and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.3.5 The 'As-Built' sequence of operation in text form shall be available for each piece of equipment on its respective graphic through activation of a dedicated 'sequence' button. The text files shall be Microsoft Word documents.
- 3.3.6 The operator graphical interface shall allow users to access the various system schematics via a graphical penetration scheme, menu selection, or text-based commands. The operator shall be able to point to and click on a piece of equipment and display an animated flow diagram of the equipment, with all control and monitoring points associated with that piece of equipment, including set points. Set points shall be capable of being overridden or modified from this screen.
- 3.3.7 The windowing environment shall allow the user to simultaneously view several graphics at the same time to analyze total system operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

3.4 FACTORY TESTING

- 3.4.1 Standard factory test reports on system components shall be provided for engineers approval.
- 3.4.2 Three (3) copies of factory test reports required for submittals.

3.5 INSTALLATION

- 3.5.1 Install PLC equipment, cabling, control, and peripheral devices in accordance with drawings and manufacturer recommendations.
- 3.5.2 The Controls Subcontractor shall provide the services of a certified factory-trained manufacturer's representative to assist in the installation and start-up of the equipment specified under this section for a minimum period of five (5) working days. The manufacturer's representative shall provide technical direction and assistance in general assembly of equipment, connections and adjustments, and testing of the assembly and all system components. Provide name and credentials of manufacturer's representative to Engineer for review prior to arrival on site. Engineer reserves right to approve or disapprove of manufacturer's representative.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.3 The following minimum work shall be performed by the Controls Subcontractor under the technical direction of the manufacturer's service representative:

- .1 Install logic programming.
- .2 Start-up/Run/Check programming scheme.
- .3 Check proper operation of PLC.

3.5.4 A qualified factory-trained manufacturer's representative shall certify in writing that all equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.5.5 The Controls Subcontractor shall provide three (3) copies of the manufacturer's representative's certification.

3.5.6 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

3.5.7 Temperature transmitters, controllers, relays: install in CSA 2 enclosures or as specified. Provide for electrolytic isolation in all cases when dissimilar metals make contact.

3.5.8 Support field-mounted transmitters as required.

3.5.9 Install wall mounted devices and control tubs on plywood panel properly attached to wall. Supply and installation of plywood shall be the responsibility of the Contractor. Plywood shall be good one side. Plywood panels shall be painted by the Contractor to match the wall colour onto which they are to be mounted.

3.6 TEMPERATURE TRANSMITTERS

3.6.1 Stabilize to ensure minimum field adjustments or calibrations.

3.6.2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.

3.6.3 Outdoor installation:

- .1 Protect from solar radiation and wind effects.
- .2 Install in CSA 4X enclosures.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.6.4 Duct installations:

- .1 Do not mount in dead air space.
- .2 Location to be within sensor vibration and velocity limits.
- .3 Thermally isolate elements from brackets and supports so as to respond to air temperature only.
- .4 Support sensor element separately from coils, filter racks.

3.7 PANELS

- 3.7.1** Arrange for conduit and tubing entry from top, bottom or either side.
- 3.7.2** Use modular multiple panels if necessary to handle all requirements.
- 3.7.3** Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- 3.7.4** Identify wiring and conduit clearly.

3.8 FIELD MOUNTED TRANSMITTERS AND SENSORS

- 3.8.1** Support properly.
- 3.8.2** Install wall mounted devices on plywood panel attached properly to wall.

3.9 FIELD QUALITY CONTROL

- 3.9.1** The Controls Subcontractor shall demonstrate that the system is functioning within the specified criteria.
 - .1 Demonstration is to validate 100% of the data points operation and include the operation of 100% of the connected field points.
- 3.9.2** Engineer or representative may use any device or material provided under this contract or otherwise to make tests before Final Acceptance.
- 3.9.3** The Controls Subcontractor shall be responsible for any equipment damage or injury during testing.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.9.4 Provide the full commissioning of the system after all equipment is in operation. Commissioning to include a completed detailed calibration and functional check of every separate point, together with a complete run-through of all functions on all systems connected to ensure that all equipment, systems and circuits are functioning as specified. Commissioning to include but not limited to:

- .1 Confirm all control points are connected and operating.
- .2 Confirm all equipment controlled by the control system are functioning properly.
- .3 Confirm all sensors are calibrated and installed correctly.
- .4 Verify all sequences. Provide all necessary additional programming required to achieve a fully functional system.
- .5 Verify all control system alarms.
- .6 Verify all graphical representations.
- .7 Review maintenance procedures with manufacturer's representative and provide training.



3.9.5 Not used.



3.9.6 Not used.

3.10 FIELD POINTS TESTING

3.10.1 This step shall verify that all of the installed points receive or transmit the correct information. All binary input points are to be tested using the HAND / OFF / AUTOMATIC selector switch on the associated motor starter or by manually jumpering across the field device contacts.

3.10.2 All analog output points shall be tested using a command from the operator workstation to modulate the output device from minimum calibrated signal to maximum calibrated output.

3.10.3 All analog input points are to be tested by comparing the reading obtained through the operator workstation or portable terminal to the value of an independent testing meter.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.11 IDENTIFICATION OF EQUIPMENT

- 3.11.1 Identify each piece of control equipment with sticker identifying the equipment and functions with a letter and number designation.
- 3.11.2 Sticker shall be minimum size 75 mm x 25 mm of plastic construction with white lettering. Stickers shall be securely attached to the control devices and equipment by adhesion.

3.12 INPUT/OUTPUT POINTS LIST

- 3.12.1 Provide all analog and binary object types as required to provide control system as outlined on the drawings and described in the systems operating sequences.
- 3.12.2 See Input/Output Schedules for the PLC on drawings.

3.13 TRAINING

- 3.13.1 The Controls Subcontractor to provide practical instruction for personnel designated by the Company. Such instruction to emphasize operation and operational maintenance of the entire system and must be carried out on site.

3.13.2 Phase 1:

- .1 This session of training is to introduce the concepts of programmable logic control methods and equipment. It is intended that this session lay the ground work for the following session. The topics to be covered are as follows:
 - .1 Introduction to Programmable Logic Control.
 - .2 System overview.
 - .3 Identification of Control Components.
 - .4 Review of shop drawings for the building.
 - .5 Detailed discussion of sequences of operation.
 - .6 Walk through of mechanical and electrical.

76
MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.13.3 Time period shall be 8 hours (1 day) and shall commence when the installation is 80% complete. This phase of training shall not require the systems to be fully functional, but is intended to give the attendees a familiarity with the equipment being installed and a solid ground work for Phase 2.

3.13.4 Phase 2:

- .1 This session of training shall consist of a complete review of the control system as installed. The Controls Subcontractor shall ensure that at the conclusion of this training the field operating staff are competent to carry out the monitoring and control of the mechanical systems installed.
- .2 Time period shall be 8 hours (1 day) and shall commence within 1 month of completion. This phase of the training is intended to highlight any deficiencies in the operators understanding of the control system and identify if further training shall be required.

3.14 SEQUENCE OF OPERATION

3.14.1 Fan 2440-FAN-VSG-0001:

- .1 The HVAC system is an indoor, recirculatory style system complete with an economizer, filter section, electric heating coil, and supply fan. The system shall function to heat and ventilate the Generator Room. The addition of the economizer shall allow the system to provide free cooling when available.
- .2 The description of operation for the system is as follows:
 - .1 When the fan is shut down, the outdoor air and exhaust air dampers are closed, and the return air damper is open. When the fan is shut down, all alarm change of state processing associated with the fan shall be suspended.
 - .2 The fan is stopped/started by a binary output from the PLC. The schedule of operation of the unit shall be provided by the Company and shall be integrated into software by the Controls Subcontractor. Outside the schedule of operation, the fan shall be started on a call for space heating.
 - .3 The supply fan starter control circuit shall have the following devices wired in series:
 - .1 Firestat (Discharge Duct)
 - .2 Low Limit Thermostat on leaving side of heating coil.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Fire alarm Shut Down Contact If all of these devices are in their closed positions, then the start circuit to the supply fan is completed.
- .4 When the unit is started, the outdoor air and exhaust dampers shall commence to open and the normally open return air damper shall commence to close. A PI control loop shall control the 0-10 VDC control output to each of the three (3) dampers. The PI loop output shall be ramped from 0 to 100% over a two minute period. Simultaneously another reverse PI control loop shall attempt to maintain the mixed air temperature at set point. The PLC shall select the lowest of the two outputs to control the damper actuators. After the two minute ramp has timed out after start-up the PLC shall control the economizer dampers off of mixed air temperature only.
- .5 The supply air temperature shall be controlled by the Generator Room space temperature sensor. The PLC shall be responsible for resetting the unit discharge air temperature. The SAT limits shall be as follows:

SAT

13°C (min)

18.3°C (max)

- .6 Supply air temperature control:
 - .1 The exhaust, outdoor and return air dampers shall be modulated to maintain a mixed air temperature equal to the supply air set point less an adjustable offset to account for fan heat. An initial value of 2°C shall be input into the PLC to account for this offset. This offset shall be adjustable.
 - .2 The heating coil has two (2) modes of operation, which are dependent on the mixed air temperature:
 - Mode 1: mixed air temperature is more than 2°C below the supply air set point less the offset. The heating coil signal increases as the supply air temperature falls below set point and decreases as the supply air temperature rises above set point.
 - Mode 2: mixed air temperature is not more than 2°C below the supply air set point less the offset. The heating coil output is set to 0%.
- .7 The fan shall be equipped with a high limit thermostat in the supply duct to shut the unit down should it detect temperatures exceeding 57°C.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .8 A low limit thermostat in the leaving air side of the electric heating coil shall be set to open at 0°C. If this thermostat opens the supply fan will be de-energized. This device is to be manually reset.
- .9 The supply fan filter bank is to be equipped with a differential pressure transducer, which shall measure the differential pressure across each filter bank and signal an alarm to the OWS if the measured differential pressure exceeds the pre determined set point. This set point shall be user adjustable and initially set at 248 kPa. This alarm shall be classified as a HVAC minor alarm and notification with a digital output shall be made to the main control room.
- .10 An AC current sensor in the fan starter shall provide an analog input to the PLC proportional to the current draw of the fan motor for fan status indication. If the fan is commanded on and no current is detected at the AC current sensor within 30 seconds, then an alarm event shall register at the OWS. This alarm shall be classified as HVAC major alarm and notification via a digital output shall be made to the main control room.
- .11 The system shall be capable of free cooling through economizer damper modulation. The space temperature and outdoor air temperature shall be used to determine if free cooling is available.
- .12 The minimum economizer position shall be set to 20% to provide minimum fresh air.
- .13 A single flat plate temperature transmitter shall be installed in the Generator Room.
- .14 Space temperature set point shall be adjustable from the OWS. The preliminary occupied set point shall be 5°C. The preliminary unoccupied set point shall be 5°C.
- .15 The space temperature shall be monitored for extremes at all times. The space maximum and minimum temperatures shall be user adjustable from the OWS. The preliminary space maximum temperature shall be 50°C and the preliminary space minimum temperature shall be 0°C. If these limits are exceeded, respective alarms shall be generated at the OWS. These alarms shall be classified as HVAC major alarms and notification via a digital output shall be made to the control room.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.14.2 Diesel Generator Radiator Dampers:

- .1 The outdoor air and exhaust air damper actuators (8 total) shall be spring return, normally opened, two position dampers. These dampers shall be controlled from the start circuit for the diesel generator and shall not be controlled by the PLC. These dampers shall be powered closed when the diesel generator is not in operation and opened via a relay linked to the start command from the diesel generator.
- .2 A normally opened contact from the start command relay shall be used to provide indication of diesel genset operation to the PLC.
- .3 The recirculation air damper actuators (2 total) shall be spring return, normally closed, modulating dampers. These dampers shall be controlled from the PLC based on space temperature. When the start command signal is received, the recirculation damper shall be modulated with a PI loop to maintain the space temperature at set point. When the start command signal is absent these dampers shall be closed.

3.14.3 Fans 2440-FAN-VSE-0001 & 2440-FAN-VSE-0002:

- .1 These fans serve as the heat relief exhaust system for the Electrical Room.
- .2 These fans shall be started/stopped by the PLC.
- .3 A single flat plate temperature transmitter shall be installed in the Electrical Room.
- .4 The fans shall be controlled in a two-stage lead/lag arrangement based on the deviation from space temperature set point. A PI loop shall attempt to maintain the space at set point. At 50% signal the lead fan shall start and at 100% signal the lag fan shall start. The lag fan shall be stopped at 50% and the lead fan shall be stopped at 0%. The designation of lead/lag shall be alternated based on run hours between both exhaust fans. Total run hours for each fan shall be displayed on the system graphic.
- .5 A fire alarm contact shall be provided in each fan start circuit to prevent operation during a fire.
- .6 When either exhaust fan is commanded on the receptive exhaust damper is energized and an isolation relay is energized for the intake damper. Either exhaust fan is capable of opening the common intake damper. Once the exhaust damper and intake dampers are fully open, the exhaust fan end switch shall make and the intake end switch isolation relay shall make, thereby allowing control power to energize the fan contactor coil and start the fan.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 25 33 01
CH0032	SPILLWAY ELECTRICAL BLDG HVAC CONTROLS AND INSTRUMENTATION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 The fan shall remain energized and run continuously until it is de-energized by the PLC.
- .8 An AC current sensor in each fan starter shall provide an analog input to the PLC proportional to the current draw of the fan motor for fan status indication. If the fan is commanded on and no current is detected at the AC current sensor within 30 seconds, then an alarm event shall register at the OWS. These alarms shall be classified as HVAC minor alarms and notification via a digital output shall be made to the main control room.
- .9 The intake filter bank is to be equipped with a differential pressure transducer which shall measure the differential pressure across the filter bank and signal an alarm to the OWS if the measured differential pressure exceeds the pre-determined set point. This set point shall be user adjustable and initially set at 248 Pa. This alarm shall be classified as a HVAC minor alarm and notification via a digital output shall be made to the main control room.
- .10 The space temperature shall be monitored for extremes at all times. The space maximum and minimum temperatures shall be user adjustable from the OWS. The preliminary space maximum temperature shall be 40°C and the preliminary space minimum temperature shall be 0°C. If these limits are exceeded, respective alarms shall be generated at the OWS. These alarms shall be classified as HVAC major alarms and notification via digital output shall be made to the main control room.

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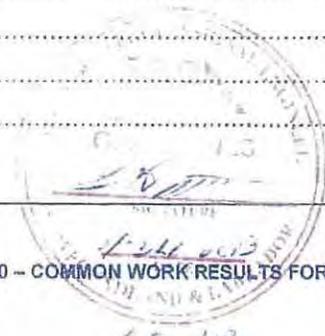
Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS

SECTION 26 05 00

GENERAL ELECTRICAL REQUIREMENTS

1	GENERAL.....	PROVINCE OF NEWFOUNDLAND AND LABRADOR	3
1.1	GENERAL	REGULATORY PERMIT HOLDER	3
1.2	RELATED REQUIREMENTS.....	This permit allows	4
1.3	REFERENCES	STC-1-2015-111	4
1.4	DEFINITIONS.....		6
1.5	SUBMITTALS	To practice Professional Geoscience in Newfoundland and Labrador	7
1.6	DESIGN REQUIREMENTS	Permit to be issued by REGNL. 10/1/17	7
1.7	POWER SUPPLIES (LOW VOLTAGE).....	which is valid for the year 2017	7
1.8	ARC FLASH HAZARD		8
1.9	SAFETY SCREENING EQUIPMENT.....		8
1.10	PROVISION FOR EQUIPMENT LOCKOUT AND ISOLATION		8
1.11	SEISMIC DESIGN REQUIREMENTS.....		9
2	PRODUCTS		10
2.1	MOTORS.....		10
2.2	STARTERS AND CONTACTORS		11
2.3	MOLDED CASE CIRCUIT BREAKERS		11
2.4	PILOT DEVICES.....		12
2.5	INSTRUMENT AND METERS		14
2.6	TERMINAL BLOCKS		14
2.7	TEST FACILITIES AND TRIP ISOLATION		16
2.8	SMALL WIRING INTERNAL TO EQUIPMENT		17
2.9	LOW VOLTAGE POWER AND CONTROL CABLES.....		19
2.10	CONDUIT		21
2.11	CABLE TRAYS.....		22
2.12	CUBICLES AND CONTROL PANELS		22
2.13	LOCAL DISCONNECT SWITCHES.....		24
2.14	EQUIPMENT IDENTIFICATION		25
2.15	ALARM CONTACTS.....		26



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION26

3.1 INSTALLATION26

3.2 NAMEPLATES AND LABELS26

3.3 INTERCONNECTION OF EQUIPMENT26

3.4 FUTURE ACCESS.....27

3.5 INTERFERENCE.....27

3.6 LOCKING ARRANGEMENTS.....27

3.7 CO-ORDINATION OF PROTECTIVE DEVICES.....28

3.8 FIELD QUALITY CONTROL.....28

3.9 CLEANING30

Handwritten initials: JB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 GENERAL

- .1 This Section defines the common electrical requirements applicable to the design, manufacture, testing, transport and delivery to Worksite, storage, installation, commissioning, and setting out of the electrical work requirements for the equipment described in these specifications.
- .2 If Contractor offers materials, equipment, design, calculations or tests which are in conformity with Standards other than those specified, Contractor shall submit full details of the differences between the proposed Standards and the specified Standard shall be supplied for Engineer's review and Acceptance.
- .3 The Work shall include all labor, materials, parts and accessories that, even though not individually specified, are necessary to implement, operate and maintain a complete facility.
- .4 All electrical equipment shall be adequately identified by securely attaching properly sized lamacoid labels. Equipment, cables and wiring identification numbering scheme shall be in accordance with documents MFA-SN-CD-3350-ME-LS-0003-01 and MFA-SN-CD-33430-EL-SD-0002-01. All design drawings shall properly reflect the identification numbering scheme.
- .5 The materials, parts and accessories shall be supplied, installed and tested prior to Acceptance of the work.
- .6 Electrical Equipment must be approved in accordance with the requirements of:
 - .1 CSA standards; or
 - .2 Other recognized documents, where such CSA standards do not exist or are not applicable; or

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Electrical equipment is considered approved when:
- .1 The equipment has been certified by a certification organization accredited by the Standards Council of Canada as a certification body, and bears that organization's certification mark as evidence of having conformed to the appropriate Canadian Standards Association (CSA) standards established under the provisions of the Canadian Electrical Code; or
 - .2 The equipment has been field evaluated to CSA SPE 1000 by an inspection body accredited by the Standards Council of Canada as an inspection body.

1.2 RELATED REQUIREMENTS

- .1 MFA-SN-CD-2000-ME-SP-0002-01; Preservation, Mechanical Completion and Commissioning Requirements.

1.3 REFERENCES

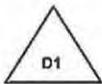
1.3.1 Unless otherwise specified in the Contract, the equipment covered by these specifications shall be in accordance with the latest issue of the following Standards at the time of contract award. Should conflict occur between the Standards mentioned below, the most stringent requirements shall govern.

1.3.2 Canadian Standards Association (CSA International)

- .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .2 CSA C22.2 No. 0.3. Test Methods for Electrical Wires and Cables.
- .3 CSA C22.2 No. 0.4. Bonding and Grounding of Electrical Equipment
- .4 CSA C22.1 No. 0.8. Safety Function for Electronic Technology

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 CSA C22.2 No. 14. Control Equipment
- .6 CSA C22.1 No. 16. Insulated Conductor for Electronic Equipment
- .7 CSA C22.2 No. 35. Extra Low Voltage Control Cables
- .8 CSA C22.2 No. 38. Thermoset Insulated Wire and Cables
- .9 CSA C22.2 No. 45. Rigid Conduit
- .10 CSA C22.2 No. 75. Thermoplastic insulated Wire and Cable
- .11 CSA C22.2 No. 100. Motors
- .12 CSA C22.2 No. 126. Cable Tray Systems
- .13 CSA C22.2 No. 131. Teck Cables
- .14 CSA C22.2 No. 158. Terminal Blocks
- .15 CSA C22.2 No. 239. Control and Instrumentation Cables
- .16 CAN/CSA-C22.3 No. 1, Overhead Systems.
- .17 CAN/CSA-C22.3 No. 7, Underground Systems.
- .18 CAN3-C235. Preferred Voltage Levels for AC Systems, 0 to 50,000 V.



1.3.3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

- .1 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
- .2 IEEE C37.1. IEEE Guide for Protective Relays Application to Power Transformer
- .3 IEEE C37.90. Relay and Relay Systems Associated with Electrical Apparatus

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 IEEE C37.91. Guide for Protective Relay Applications to Power Transformers
- .5 IEEE 1584. Guide for Performing Arc-Flash Hazard Calculations

1.3.4 International Electrotechnical Commission (IEC)

- .1 IEC 60059. Standard Current Ratings
- .2 IEC 60073. Indicator Lamp Colors
- .3 IEC 60144. Degree of Protection of Enclosures for Low-Voltage Switchgear and Control gear
- .4 IEC 60255. Electric Relays
- .5 IEC 60270. Partial Discharge Measurement
- .6 IEC 60391. Wire Identification
- .7 IEC 60529. Classification of Degrees of Protection Provided by Enclosures
- .8 IEC 60617. Graphical Symbols for Diagrams
- .9 IEC 61850. Communication Networks and Systems for Power Utility Networks

1.3.5 National Electrical Manufacturers Association

- .1 NEMA MG-1. Motors and Generators
- .2 NEMA MG-2. Safety Standards for Motors and Generators

1.4 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
- .2 AC – alternating current.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

.3 DC – direct current.

1.5 SUBMITTALS

.1 Submittals: in accordance with Exhibit 4 Supplier Documents Requirements List.

1.6 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .3 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .4 Language operating requirements: provide identification nameplates and labels for control items in English.

1.7 POWER SUPPLIES (LOW VOLTAGE)

- .1 Equipment and devices requiring electric power shall be built in agreement with the following power supply parameters:
 - .1 600 Vac, 60 Hz, 3 phases, 4 wire-power circuits (Neutral Solidly Grounded).
 - .2 120 Vac, 60 Hz, single phase.
 - .3 125 Vdc, control and relay protection circuits.
 - .4 48 Vdc, telecommunication equipment.
- .2 Contractor shall clearly indicate voltage, current and power requirements for each item of equipment.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .3 The voltages available to Contractor are 600 Vac, 120 Vac and 125 Vdc. Any voltage required internal to equipment other than specified above shall be Contractor's responsibility.
- .4 Equipment shall be suitable for AC voltage variations of plus or minus 10% and frequency variations of plus or minus 5%.
- .5 Equipment shall be suitable for DC voltage variations of plus 15% to minus 20%.

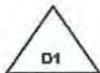
1.8 ARC FLASH HAZARD

- .1 If applicable, an arc flash hazard analysis in accordance with IEEE 1584 will be prepared by Engineer for all electrical systems. However the actual equipment detailed characteristics to perform arc flash analysis shall be supplied in time by Contractor
- .2 The electrical systems shall be designed such that the results of the arc flash hazard analysis do not exceed 8 cal/cm² (category 2).

1.9 SAFETY SCREENING EQUIPMENT

- .1 Ensure the safety clearances of any live part of the equipment which is not in a grounded screen enclosure are as specified. Where these clearances are not obtainable with an accepted arrangement of the equipment, provide grounded screen enclosures or partitions to prevent contact with any live part. Ensure that the maximum size of screen openings is a square of 25 mm x 25 mm.
- .2 Provide the means of access to the guarded or screened area with interlocking equipment.

1.10 PROVISION FOR EQUIPMENT LOCKOUT AND ISOLATION



- 1.10.1 All devices that could conceivably be required to be isolated for maintenance, protection of personnel, access to equipment etc. shall be designed to be lockable and that the

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

lockable location itself shall be visible and safe to access. All energy sources related to the equipment to be maintained shall be designed to be isolated and locked out;

- 1.10.2 Electrical isolating devices including breakers, safety switches, starters and fuse holders, that are installed on circuits rated higher than 110 V shall be pad lockable;
- 1.10.3 Electrical isolating devices that are installed on circuits rated higher than 300 V shall be equipped with a means of visually verifying isolation when in the open position, without exposing the circuit conductors or parts;
- 1.10.4 A means of visual verification is preferred on electrical isolating devices that are installed on circuits rated higher than 100 V and up to 300 V;
- 1.10.5 Every device capable of being isolated and locked out shall be capable of being locked with a standard 1-1/2" padlock with 6 mm dia. shackle, even if the device has a built in key lock. Each of these lockout points shall be capable of supporting the weight of multiple lockout hasps and padlocks;
- 1.10.6 Where a blocking device is required as part of the isolation and lockout of equipment, this device shall be designed to withstand 150% of any load that could inadvertently be applied to it.
- 1.10.7 Three phase disconnect switches shall be installed within sight of, but not more than 9 m away from, all motors and equipment connected to 600 V and above. The disconnect switches shall have visual confirmation and be capable of being pad lockable open or closed.

1.11 SEISMIC DESIGN REQUIREMENTS

1.11.1 Electrical Equipment and Systems

- .1 All electrical equipment and systems shall remain fully operational immediately after a seismic event without any intervention.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev. D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



1.11.2 Seismic Loads

- .1 All electrical equipment and systems, except for that in the spillway hoist building and towers, shall be designed to withstand seismic horizontal acceleration of 0.091 g.

1.11.3 Electrical Equipment and Systems in Spillway Hoist Building and Towers

- .1 The design of electrical equipment and systems to be installed in the spillway hoist building and towers, shall be based on a horizontal ground acceleration of 0.091 g at the tower base and applying the appropriate amplification factors based on the NBCC assuming that there shall be no permanent deformation in any part of the structure after a seismic event.

2 PRODUCTS

2.1 MOTORS

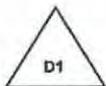
- .1 Contractor shall be fully responsible for determining that the motor duty cycle, rating, performance, tests and mechanical arrangements are all entirely relevant and in Good Utility Practice.
- .2 Motors shall be squirrel cage, totally enclosed and fan cooled (TEFC), 1.15 service factor. AC motors of 1/4 HP and larger shall be 3 phase. AC motors shall be sized so that calculated horsepower requirements do not exceed the "HP" rating stamped on nameplate. Motors shall be high efficiency type, except those used for intermittent service.
- .3 The insulation system shall be Class F or higher, but in each case temperature rises shall be limited to Class B on continuous full rated load.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .4 Sealed ball or roller bearings shall be used. Vertical shaft motors shall have thrust bearings accepted by Engineer.
- .5 The terminal box shall be weatherproof (NEMA 4) and firmly fixed to the motor frame. Terminal boxes shall be suitable for the connectors of CSA Teck cables or liquid-tight flexible metal conduit. There shall be a ground terminal inside the terminal box for grounding the bare ground conductor of cables.
- .6 Local disconnecting means shall be provided for all motors.
- .7 Motors shall meet EEMAC/NEMA and CSA Standards.

2.2 STARTERS AND CONTACTORS

- .1 Motor starters shall be equipped with contactors and have short circuit protection and disconnecting devices. All starters shall be of one manufacture.
- .2 Starters and contactors shall be suitable for direct on line starting, continuous duty. They shall be installed in motor control centers for indoor installation and weatherproof enclosures (NEMA 4X) for outdoor installation. Enclosures shall be complete with provision for locks, for cable gland, bus bars, internal wiring, terminal strips, etc. The starters of the Essential Services MCC shall be required to ride out a short power interruption when power returns on the 25 kV system with the diesel generator supplying the essential loads.
- .3 Starters and contactors shall be capable of satisfactory operation, without damage, when the voltage is down to 85 percent of nominal and up to 110 percent of nominal.



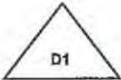
2.3 MOLDED CASE CIRCUIT BREAKERS

- .1 Molded case circuit breakers shall be one, two or three pole as required, having thermal time delay and instantaneous trip. They shall have ground fault trips where required. They shall be rated for the available fault currents. All breakers shall be

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

visible break or have observation windows and shall have a provision for locks. Derating factors of CSA shall apply to these breakers where applicable.

- .2 Circuit breakers used in conjunction with motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover, so that the cover cannot be opened unless the circuit breaker is open. The interlock shall be defeatable for trouble shooting purposes. The circuit breakers shall comply with the applicable CSA/IEEE/ANSI Standards.



- .3 Molded Case Circuit Breakers shall be in accordance with Section: 26 28 16.02, Molded Case Circuit Breakers.

2.4 PILOT DEVICES

- .1 Pilot devices such as selector switches, push button stations and thermostats shall be of heavy duty type, and where mounted outdoors they shall be housed in weatherproof enclosures especially designed for the environment.
- .2 Electrical contacts for control, alarm and shutdown shall have a capacity of not less than 5 A at 125 Vdc.
- .3 Provide LED indicating lamps, colored as necessary.
- .4 Each switching and grounding device shall be provided with all necessary auxiliary switches, contactors and mechanisms for indication, protection, control, interlocking, supervisory and other services as required. All auxiliary switches shall be wired to a suitable terminal strips whether they are in use or not.
- .5 Provide heavy duty contacts for all auxiliary switches and ensure they have a positive wiping action when closing.
- .6 Provide discharge resistors when required, to prevent undue arcing during the operation of the contactors.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .7 Provide all relays in accordance with applicable CSA/IEEE/ANSI Standards and of a type accepted by Engineer. Mark relays associated with the three phases with the appropriate phase color and mark all fuses and label links. Mount the relay elements, fuses or links associated with the A, B and C phases on the left, middle and right respectively, when viewed from the front of the panel.
- .8 Design all the equipment to withstand vibrations without damage from earthquakes.
- .9 Ensure all relays have sufficient thermal capacity for continuous energization.
- .10 Provide control, indication and selector switches, and rotary type switches, all with enclosed contacts which are accessible by the removal of covers.
- .11 Provide control push buttons where specified.
- .12 Ensure "Close" or "Start" actions of all switches are clockwise (as seen from the front) and that the opposite actions are counter-clockwise.
- .13 Provide contacts in operating and control switches, limit switches, auxiliary relays, etc., of adequate rating for the voltage and current to be carried. Ensure all 125 Vdc switches have making, conducting and breaking capacity of at least 0.4 A at 125 Vdc and L/R 40 ms. Provide the required number of positions, maintained and momentary contacts as necessary.
- .14 Take measures to reduce over voltages due to breaking circuits containing inductances to such values that they do not cause any damage to the equipment or its functions.
- .15 Provide colors of indicating lights per IEC Publication 60073.
- .16 Ensure that fuse and link carriers and bases are of molded insulating materials that respect CSA requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev. D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .17 Engrave the operating and indicating devices with "C" for "Close" and "O" for "Open". If color coding is employed, "Close" or "Closed" shall be red and "Open" shall be green.

2.5 INSTRUMENT AND METERS

- .1 All instruments and meters with the exception of the synchronoscope and incoming and run voltmeters shall be digital type. All instruments and meters shall be heavy-duty industrial type, dustproof and capable of withstanding severe shock or vibration. The instruments shall comply with applicable CSA/IEEE/ANSI Standards.

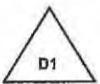
2.6 TERMINAL BLOCKS

- .1 Terminal blocks on custom panels and relay panels shall be States, Type NT, sliding link ZWM-250, as manufactured by the States Manufacturing Company for CT circuits, VT circuits, main 120 Vac feeder to the panel and main 125 Vdc feeder to the panel.

- .2 States type terminal blocks shall be used on all CT and VT circuits as well as 120 Vac and 125 Vdc circuits.



- .3 In telecommunication panels, the terminal blocks shall be Phoenix UDK series, knife disconnect type or accepted equivalent.



- .4 Terminal blocks for status and telemetry points shall be Phoenix UDK series, knife disconnect type. All other terminal blocks shall be Phoenix UDK series.

- .5 When terminal blocks are mounted such that the links are in a vertical position, the sliding link shall drop open when loose, except for CT circuits where the link shall drop closed.

- .6 Terminal blocks shall be arranged in groups of not more than twelve (12) terminals, to facilitate wiring and identification. Terminal blocks for CT and VT leads shall be arranged in groups of four (4) terminals.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Each terminal shall have marker strip, and be discretely marked. Duplication of terminal identification for any one panel or cubicle will not be accepted.
- .8 Terminal strips shall be spaced at not less than 200 mm on centers. For rear access panels and cubicles, mount the terminals vertically at the sides of the cubicles and set them at an angle toward the rear doors to give easy access to terminations and to enable the wire numbers to be read without difficulty. For wall mounted junction boxes and for front access rack panels, mounting the terminals vertically in rows across the panel is the preferred method. Horizontal mounting in rows down the panel may be acceptable following layout submission.
- .9 The bottom of the terminal strips shall be at least 200 mm above the glanding point for incoming cables.
- .10 Terminal strips shall be provided with pairs of terminals for incoming and outgoing wires and do not connect more than two wires to any one terminal. They shall be sized appropriately for the size of cable (external) and wire (internal) used. Double layer terminals shall not be used for any function.
- .11 Separate terminal strips shall be provided for all power, controls, instruments, meters and relays requiring external connection.
- .12 The panel wiring shall be connected to one side of the terminal strip with the opposite side reserved for outgoing cable connections.
- .13 Adequate space shall be provided on both sides of the terminal blocks for connecting wires and for wire markers. Where practical, arrange terminals for external connections for consecutive connection of conductors within one cable. At least 20% spare terminals shall be provided in each panel or cubicle.
- .14 Terminations shall be grouped according to function (CT, VT, Trip, Alarm, etc.) and remote equipment. Provide labels on the fixed portion of the terminal strips showing the function of the group.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .15 Covers shall be provided with insulating material, preferably transparent, on terminal strips on which connections for circuits with a voltage equal to or greater than 200 volts are terminated.
- .16 The use of terminal strips to provide junction points for wires which are not required in the associated cubicle shall be avoided.

2.7 TEST FACILITIES AND TRIP ISOLATION

- .1 In addition to the test facilities provided on each relay and on the protection signaling equipment, provide, for each CT and VT system group, one AC type test block.
- .2 Provide test facilities to enable complete isolation of the group of relays from the instrument transformers without affecting other devices on the same circuit. Also provide facilities to use test plugs either to inject test current or voltage into the relay group or to check the actual currents and voltages being supplied from the instrument transformers. Provide the necessary test plugs on a one per type basis and ship these with the panels.
- .3 Equip all CT disconnection points with shorting facilities on the CT side of the disconnection point. Provide CT ground links to ground the CT neutral on the CT side of this disconnection point. Ensure that each CT and/or VT circuit is normally grounded at one point only. Provide this ground at the VT for VT circuits and at the first protection panel for CT circuits. In differential circuits, provide facilities to temporary ground the ungrounded CTs if disconnected from the normal CT ground point.
- .4 The AC type test block shall be ABB Flexitest Switches.
- .5 Provide test facilities to enable complete isolation of each relay (IEDs and auxiliary relays) for all DC signals input and output, such as trip signals and breaker failure initiation signals. Also provide facilities to use test plugs either to inject test voltage



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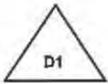
Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

or to check the actual voltages being supplied. Blocking switches ABB type FT-1 (FT-1X if needed) shall be used.

2.8 SMALL WIRING INTERNAL TO EQUIPMENT



.1 Control wiring in switchgear and motor control centers shall be Anixter M22759/16 (Tefzel).



.2 Internal protection panel wiring shall be Anixter M22759/16-14-0 single conductor, #14A AWG, multi-strand wire, 600V (Anixter M22759/16-12-0, #12 AWG to be used for CT wiring in panel).

.3 Sensitive control circuits shall be effectively shielded against extraneous signals and interference.

.4 Wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point.

.5 Splices are not acceptable. Wire runs shall be neatly tucked inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipment.

.6 Proper wiring raceways shall be installed, in panels and cubicles. Wiring shall be neatly tucked in the troughs. Sufficient slack shall be left at component terminals to permit rearrangement of connections between the terminals on any particular component. Raceways shall be sized so that sufficient space is provided for external wiring.

.7 All shield drain wires shall be individually terminated with the cable shield being maintained as close as possible to point of termination. Insulation between shields shall be maintained up to the point of termination and at remote end where shields are not grounded.

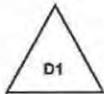
Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .8 Except where Standards allow otherwise, equipment of different voltages (i.e. 600 Vac, 120 Vac, 125 Vdc) housed in the same panel or cubicle shall be separated by suitable barriers to segregate equipment with different voltage rating. The barrier shall be of sheet steel or of flame retardant, non-metallic, insulating material. A protective cover shall be provided on any exposed 600 V terminals together with a warning label.
- .9 The dependent both end marking system of wire identification, as defined in IEC 60391 shall be used in all panels and equipment junction boxes, terminal boxes, etc. Colored wire or colored wire markers shall be used to specifically identify CT and VT wires and their phase identification. Green striped wire shall be used for all isolated ground connections. Black or white wire markers and black wire shall be used for other circuits.
- .10 The wire markers used shall be made of insulating material with a glossy finish to prevent adhesion of dirt. Ensure that they are not affected by moisture or oil and are clearly and permanently marked (white on black or black on white or color). Temporary marking shall be prohibited.
- .11 The same wire numbers shall not be re-used in the same panel on wires forming connections which are not directly connected in series or parallel.
- .12 As far as is reasonably possible, group all outgoing wiring by function with those going to a common destination allocated to adjacent terminal blocks. Submit terminal block configurations for Engineer's Review and Acceptance.
- .13 All power, control and protection and low level signal wiring shall be physically separated from each other in the raceways. Control and protection wiring associated with the Group A shall be kept separate from the Group B system wiring as far as practical. Provide separate raceways for power cables and mark the working voltage of each power circuit on the associated terminal strips.

96
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .14 Cabling for indicating instruments and other devices producing transducer level outputs (4-20 mA) shall be wired using individually shielded wires. Provide one (1) extra terminal per pair of terminals for the grounding of this shield noting that the shield may only be actually grounded at one end.
- .15 The overall armor of incoming cables shall be connected to ground at both ends of all cable runs by a suitable method and/or cable terminator accepted by Engineer.
- .16 The wiring diagrams or terminal block layouts for panels and cubicles shall be drawn as viewed from the direction of normal access (back for rear access panels, front for front access rack terminals and cubicles, back for swing racks). Show the terminal strips as arranged in service on drawings. Terminal block wiring tables listed in an equivalent manner may be used subject to the Acceptance of Engineer.
- .17 The following identification colors shall be used for all CT, VT and grounding connections in panel or equipment wiring:



DESIGNATION	COLOUR
A phase (R)	Red
B phase (S)	Yellow
C phase (T)	Blue
AC neutral	Black
DC positive	Red
DC negative	Black
Ground	Green or Bare
Isolated Ground	Green Stripe

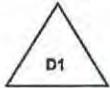
2.9 LOW VOLTAGE POWER AND CONTROL CABLES



- .1 Power cables shall be XLPE insulated TECK 90, with stranded copper conductors, aluminum interlocking armor with black PVC sheath overall and ground wire. Power cables shall be 1000 V grade.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 The conductors of power cables shall have a minimum size of No. 12 AWG.
- .3 Control cables shall be armored multi-conductors, -40°C, fire retardant FT4, TECK type PVC insulation with overall spirally shielded copper shield and gray PVC sheath overall and shall be in accordance with CSA C22.2 No. 239. Control cables shall be 600 V grade.
- .4 Control cable conductors shall be stranded, annealed, soft bare copper wire in accordance with CSA C22.2 No. 239.
- .5 Except for VT and CT circuits, the conductors of control cables shall be a minimum of No. 14 AWG. Current transformer circuits shall be minimum No. 8 AWG unless smaller sizes are justified by calculation as detailed in a Design Brief submitted for review and Acceptance by Engineer. The minimum for potential transformers circuits No. 12 AWG.
- .6 Instrument cables shall be multi-conductor, -40°C, fire retardant FT4, TECK type PVC insulation with overall spirally shielded copper shield gray PVC sheath overall and shall be in accordance with CSA C22.2 No. 239. Instrument cables shall be 600 V grade.
- .7 Instrument cable conductors shall be twisted pair or triad, stranded, annealed, tinned soft bare copper wire in accordance with CSA C22.2 No. 239, with minimum size AWG 16.
- .8 Each twisted pair or triad shall have individual shield, either with spirally shielded copper, or with aluminum Mylar tape and tinned and stranded copper drain wire.
- .9 Cabling from devices which are not required in the various control system controllers but are defined as being required in the ECC I/O lists and require connection to the RTU shall be run directly to the telecommunication panel.
- .10 Teck power and control cables shall meet CSA-C22.2 No. 131 Standard.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .11 Conductors shall be rated for a 40°C ambient temperature, also rated according to cable spacing and other requirements of the Canadian Electrical Code.
- .12 Teck cable connectors (glands) shall be watertight to CSA requirements.
- .13 Cables shall be tagged at each end just before entering cubicles.
- .14 Low voltage power cables shall be suitably color coded in accordance with CSA Standard.
- .15 Cables shall be run in cable trays with separation between power and control and protection cables and between Group A and Group B cabling, and/or conduits.

2.10 CONDUIT

- .1 Exposed conduit shall be of galvanized rigid steel conforming to CSA C22 .2 No. 45 - Rigid Conduits, and shall run parallel to the structural lines. Suitable conduit fittings and covers shall be used. The Conduit shall be fastened using malleable iron pipe straps spaced to Code requirements. Minimum size shall be 21 mm (3/4 inch).
- .2 Supports for conduit, cables and fittings shall be removable and clamped to the building structure. Conduit in the powerhouse substructure shall be fastened to steel inserts in the concrete. In no circumstances shall any part of the building, steelwork or otherwise, be drilled, cut or welded without prior Acceptance by Engineer.
- .3 Bends in conduit shall be made cold and the radius of bends shall not be less than nine times the conduit diameter. No bend shall be permitted to flatten the conduit.
- .4 Wherever conduit crosses a structural expansion/contraction joint, accepted expansion fittings and couplings with bonding jumpers shall be provided.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.11 CABLE TRAYS

- .1 Cable tray shall be Class D1, heavy duty ladder type, galvanized steel, 300 mm rung spacing, maximum spacing of 3 meters between hangers, all bends to be made with accepted fittings.
- .2 Tray covers shall be installed in dusty areas, outdoors and under grating and walkways.
- .3 Separate trays shall be used for power, control and instrumentation cables. Any control cables run in trays containing power cables shall be separated by barriers (dividers). Also separate different circuits (600 volts AC, 120 volt AC, 125 volts DC) of power cables by barriers when they are in the same main runs of trays. Any 15 kV cables shall be in separate trays.
- .4 Trays shall not be filled or loaded beyond seventy (70 %) percent of their ratings. Conductor ampacities shall be in accordance with cable spacing as stipulated in the Canadian Electrical Code (de-rating factors as applicable). Cable ties are required for neatness and security; ground continuity shall be maintained throughout the tray systems and associated hangers; and trays shall be fastened to the hangers. Cable trays shall meet the requirements of CSA, C22.2 No. 126.

2.12 CUBICLES AND CONTROL PANELS

- .1 Cubicle and control panel enclosures shall be of sheet steel, rigid, self supporting construction and supplied with channel bases.
- .2 Cubicles shall be fitted with close fitting, hinged, lift off doors and shall be capable of being opened through 180 degrees except for the rectifier cubicle door where 135 degrees is acceptable. The doors shall be provided with integral lock and master key.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Cubicles and panels shall have provision for cable glands and provide adequate working clearance for the termination of cables. The cables and wiring shall enter from bottom or top as required.
- .4 The cubicles and panels shall be adequately ventilated, if required, by screened vents or louvers, which shall be so placed as not to impair the overall appearance. Equipment shall be provided with suitable drainage for condensation and shall be designed to be free from pockets where moisture can collect. Cable entries shall be sealed type. An accepted UL fire stop shall be provided where cables enter enclosures.
- .5 Where required, anti-condensation heaters shall be fitted in cubicles or panels containing control and/or relay equipment. They shall also be installed in all junction boxes and mechanism boxes located outdoor. The heaters shall be suitable for 120 Vac, 60 Hz operation and be controlled by humidistat. The design shall be such that when the equipment is in service, the maximum permitted rise in temperature for the equipment shall not be exceeded.
- .6 For interconnections between A and B protection panels suitable fire-stops shall be installed to prevent internal panel fires spreading from one panel to the other.
- .7 Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.
- .8 Cubicles and panels shall be provided with a ground bus approximately 25 mm x 5 mm copper bar extending throughout the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables.
- .9 All instruments, devices, buses and other equipment involving three phase circuits shall be arranged and connected in accordance with phase arrangement

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

(applicable CSA and EEMAC). Electrical clearances shall conform to applicable Standards.

- .10 Instruments, control buttons and indicating lamps shall be flush mounted on the panels. Relays and other devices sensitive to vibration shall not be installed on doors or hinged panels, and no equipment shall be installed on rear access doors.
- .11 Control panels and cubicles shall be supplied with switched interior lights, socket outlets and jacks with provision for connection to the station telephone system. Modern low energy, low heat, bulbs shall be used. Compact fluorescent light (CFL) are acceptable.
- .12 The interior of all cubicles and panels shall have a matt white finish unless specified otherwise. Exterior finish shall be ANSI 61 light grey unless specified otherwise.
- .13 Cubicles and panels shall be securely fastened or anchored.
- .14 Equipment such as switchgear shall be installed level. Horizontality and flatness tolerances shall be indicated on the drawings.



2.13 LOCAL DISCONNECT SWITCHES

- .1 Disconnect switches in NEMA 4 enclosures, NEMA 4X for outdoor and inside Spillway and Intake Hoist houses, shall be installed within sight of motors and all equipment connected to 347/600 V and above, but not more than 9 m. The disconnect switches shall have visual confirmation and be capable of being padlocked open or closed. The disconnect switches shall also comply with Arc Flash Hazard requirements of Section 1.8.
- .2 These switches shall be in accordance with the Canadian Electrical Code, and they shall have a current rating applicable for the motor.
- .3 Grounding:



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Contractor shall provide grounding terminals on all the equipment supplied under the Contract and shall connect these terminals to the station ground grid.
- .2 Cable sheaths shall be grounded in accordance with the requirements of CSA C22.1.

2.14 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with [nameplates] [and] [labels] as follows:
 - .1 Nameplates: lamicooid 3 mm thick plastic engraving sheet, matt white finish face, black core, lettering accurately aligned and engraved into core, mechanically attached with self tapping screws.

- .2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6mm high letters

- .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be approved by Engineer prior to manufacture.
- .5 Allow for minimum of twenty-five (25) letters per nameplate and label.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.15 ALARM CONTACTS

2.15.1 All alarm contacts shall be of galvanically isolated Form C type or as otherwise accepted for example, two separate contacts (one N.O. and one N.C.). Where required, relays shall be provided as contact multipliers.

2.15.2 Electronic Equipment

- .1 Electronic equipment and components shall meet applicable CSA Standards including CSA C22.2 No. 1, C22.2 No. 16, C22.2 No. 0.8.
- .2 Enclosure in electrical room shall be EEMAC 1 as a minimum.
- .3 All inputs to sensitive electronic equipment shall be protected per IEEE Standards, (C37.90, C37.91).

3 EXECUTION

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 and CSA C22.3 No. 7 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 INTERCONNECTION OF EQUIPMENT

- .1 All interconnecting wiring shall be provided between the various items of the equipment included in this Contract.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Unless otherwise specified, all cables for external connection shall be provided complete with cable glands. Contractor shall terminate these cable conductors on the terminals of equipment. Contractor shall cooperate with Company's Other Contractors of related equipment in order to ensure the correct functioning of related equipment and instrumentation.

.3 Contractor shall develop a numbering system for all interconnecting cables. Contractor shall use these cable numbers to identify the cables on the drawings and cable schedules for the equipment.

3.4 FUTURE ACCESS

.1 All equipment shall have suitable access for easy removal/replacement.

3.5 INTERFERENCE

.1 Portable communication devices such as "walkie-talkies" shall not affect the operation of any equipment supplied under this Contract.

3.6 LOCKING ARRANGEMENTS

.1 Provide any necessary interlocks for all plant and equipment that may endanger the Operator, maintenance staff or the system itself.

.2 Provide arrangements for:

.1 Locking each equipment cover, door, guard or screen in the closed position.

.2 Locking each disconnect and ground switch mechanism in the open or closed positions.

.3 Locking all switchgear shutters and withdrawable circuit breakers in the withdrawn, isolated or grounded positions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Ensure that keys for locking or padlocking each device are distinct from all other keys. If the keys are part of a master key sequence, divide by function and submit the total scheme for review and Acceptance by Engineer. Provide labels for all keys.

3.7 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.8 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in Exhibit 4 – Supplier Document Requirements List: phase and neutral currents on panelboards, dry-type transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with document, MFA-SN-CD-2000-ME-SP-0002-01; Preservation, Mechanical Completion and Commissioning Requirements.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .3 Lighting and its control.
- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 Systems: control and monitoring, water level measurement, fire alarm system and intrusion detection.
- .6 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
- .7 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
- .8 Check resistance to ground before energizing.
- .9 Carry out tests in presence of Engineer.
- .10 Provide instruments, meters, equipment and personnel required to conduct tests.

.3 **Manufacturer's Field Services:**

- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in Exhibit 4 – Supplier Documents Requirements List.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 00
CH0032	GENERAL ELECTRICAL REQUIREMENTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.9 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- .3 Leave work area clean at the end of each day.
- .4 Final Cleaning: upon completion remove surplus material, tools and equipment.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 14
CH0032	POWER CABLE (25000 V and 28000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS

SECTION 26 05 014

POWER CABLE (25000 V AND 28000 V)

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

 1.4 DELIVERY, STORAGE AND HANDLING 2

2 **PRODUCTS**..... 2

 2.1 CONCENTRIC NEUTRAL POWER CABLES (28000 V)..... 2

 2.2 TECK POWER CABLE (25000 V)..... 3

3 **EXECUTION** 4

 3.1 INSTALLATION 4

 3.2 FIELD QUALITY CONTROL 4

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PROFESSIONAL ENGINEERS ASSOCIATION

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This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL N0438
which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER
Newfoundland and Labrador
REG. NO. 11758

G. W. HAINES

G. W. Haines
SIGNATURE

11-01-2013
DATE

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 14
CH0032	POWER CABLE (25000 V and 28000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 25 05 00 – General Electrical Requirements

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA-C22.2 No. 131, Type TECK 90 Cable.
.2 CAN/CSA-C61089, Round Wire Concentric Lay Overhead Electrical Stranded Conductors.

1.2.2 National Electrical Manufacturers' Association (NEMA)/Insulated Cable Engineers Association (ICEA)

- .1 ICEA S-93-639/NEMA WC74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- 1.3.1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.
1.3.2 Provide product data in accordance with Exhibit 4 – Supplier Document Requirements List.
1.3.3 Quality assurance submittals: in accordance with Exhibit 4 – Supplier Document Requirements List.

1.4 DELIVERY, STORAGE AND HANDLING

- 1.4.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

2 PRODUCTS

2.1 CONCENTRIC NEUTRAL POWER CABLES (28000 V)

- .1 Concentric neutral power cable: to ICEA S-93-639/NEMA WC74.
.2 Single copper conductor, size as indicated.
.3 Semi-conducting strand extruded shield.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 14
CH0032	POWER CABLE (25000 V and 28000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Class 2 compact round.
- .5 Insulation: cross-linked thermosetting polyethylene material or ethelene propylene rubber rated 90°C and 28 kV for 100% voltage level.
- .6 Semi-conducting insulation shielding layer.
- .7 Copper neutral wires applied helically over insulation shield equivalent to full capacity.
- .8 Separator tape over neutral wires.
- .9 Extruded orange PVC jacket rated minus 40°C.



2.2 TECK POWER CABLE (25000 V)

- .1 Cable: to CSA-C22.2 No. 131 and in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Bare copper grounding conductor, size as indicated in CSA C22.2 No. 131 for phase conductor size.
- .3 Copper circuit conductors, size and number as indicated.
- .4 Strand shielding Insulation: chemically cross-linked thermosetting polyethylene rated RW90 25 kV to ICEA S-93-639/NEMA WC74.
- .5 Insulation: cross linked thermosetting polyethylene material or ethylene propylene rubber rated 90°C and 25 kV for 100% voltage level.
- .6 Insulation shielding: semi-conducting non-metallic tape over insulation and helical wrapped wire shield over tape to ICEA S-93-639/NEMA WC74.
- .7 Separator tape over conductor assembly.
- .8 Inner jacket of PVC.
- .9 Interlocked aluminum armour.
- .10 Overall orange PVC jacket rated minus 40°C.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 14
CH0032	POWER CABLE (25000 V and 28000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Install power cable in ducts and manholes as indicated and in accordance with manufacturer's instructions.
- .2 Install power cable in trenches as indicated.
- .3 Provide supports and accessories for installation of high voltage power cable.
- .4 Install stress cones, terminations and splices in accordance with manufacturer's instructions
- .5 Install grounding in accordance with Section: 26 05 28 – Grounding - Secondary.
- .6 Provide cable identification tags and identify each phase conductor of power cable.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Use of qualified tradespersons for installation, splicing, termination and testing of high voltage power cables.
- .3 Use qualified personnel to test high voltage power cable. Submit test result and inspection certificate.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 20
CH0032	WIRE AND BOX CONNECTORS (0 – 1000 V)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

SECTION 26 05 20
WIRE AND BOX CONNECTORS (0-1000 V)
TABLE OF CONTENTS

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS	2
1.4	CLOSEOUT SUBMITTALS.....	2
1.5	DELIVERY, STORAGE AND HANDLING	2
2	PRODUCTS	3
2.1	MATERIALS	3
3	EXECUTION	3
3.1	INSTALLATION	3

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Permit No. as issued by PEGNL N0458
which is valid for the year 2013



REGISTERED PROFESSIONAL ENGINEER
PEG
Newfoundland and Labrador
REGIONAL PROFESSIONAL ENGINEERS
G. W. HAINES
SIGNATURE
DATE 11-05-2013
NEWFOUNDLAND & LABRADOR

REV. D2

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 20
CH0032	WIRE AND BOX CONNECTORS (0 – 1000 V)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 CSA International CAN/CSA-C22.2 No.18, Outlet Boxes, Conduit Boxes and Fittings.

- .1 CAN/CSA-C22.2 No.65, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).

1.2.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

- .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.1 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.5.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1.5.3 Storage and Handling Requirements:

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 20
CH0032	WIRE AND BOX CONNECTORS (0 – 1000 V)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations.
- .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.

2.1.1 Clamps or connectors TECK cable as required to: CAN/CSA-C22.2 No.18.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Remove insulation carefully from ends of conductors and cables and:

- .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
- .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
- .3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS

SECTION 26 05 21

WIRES AND CABLES (0 – 1000 V)

PART .1 GENERAL..... 2

 1.1 Related Requirements 2

 1.2 References 2

 1.3 Product Data..... 2

PART .2 PRODUCTS 2

 2.1 Building Wires..... 2

 2.2 Teck 90 Cable..... 3

 2.3 Mineral-Insulated (MI) Cables 3

 2.4 Control Cables 4

 2.5 Mineral-Insulated (MI) Heating Cables 4

PART .3 EXECUTION 5

 3.1 General Cable Installation..... 5

 3.2 Installation of Building Wires 5

 3.3 Installation Of Teck 90 Cable (0-1000 V) 6

 3.4 Installation Of Mineral-Insulated Cables..... 6

 3.5 Installation Of Control Cables 6

 3.6 Field Quality Control 6

APPENDIX 1 - TABLE 1 - CABLE CONDUCTOR COLOURS..... 7



9/6 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

PART .1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Section: 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .4 Section: 26 05 36 - Cable Trays for Electrical Systems.
- .5 Section: 26 05 43.01 – Installation of Cables in Trenches and in Ducts.

1.2 REFERENCES

- .1 CSA C22.2 No. 35 – Extra-low Voltage Control Circuit Cable
- .2 CSA C22.2 No. 38, Thermoset-insulated Wires and Cables
- .3 CSA C22.2 No. 75 – Thermoplastic-insulated Wires and Cables
- .4 CSA C22.2 No. 124, Mineral-insulated Cable
- .5 CSA C22.2 No. 129, Neutral Supported Cables
- .6 CSA C22.2 No. 131, Type TECK 90 Cable
- .7 CSA C22.2 No 239, Control and Instrumentation Cables

1.3 PRODUCT DATA

- .1 Provide product data in accordance with Exhibit 4 – Supplier Document Requirements List.

PART .2 PRODUCTS

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type TWH rated at 600 V.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Neutral supported cable: 2 or 3 phase insulated conductors of Aluminum and one neutral conductor of Aluminum steel reinforced, size as indicated. Type: NS90 Insulation: Type NSF-2 flame retardant rated 600 V.

2.2 TECK 90 CABLE

- .1 Cable: in accordance with Section: 26 05 00 - General Electrical Requirements.

2.2.1 Conductors:

- .1 Grounding conductor: copper.
- .2 Circuit conductors: copper, size as indicated.

2.2.2 Insulation:

- .1 Cross-linked polyethylene XLPE.
- .2 Rating: 600 V.

2.2.3 Inner jacket: polyvinyl chloride material.

2.2.4 Armour: interlocking aluminum.

2.2.5 Overall covering: thermoplastic polyvinyl chloride, compliant to FT-4 flame test rating.

2.2.6 Fastenings:

- .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
- .2 Channel type supports for two or more cables at 1500 mm centers.
- .3 Threaded rods: 6 mm diameter to support suspended channels.

2.2.7 Connectors:

- .1 Watertight, approved for TECK cable.

2.3 MINERAL-INSULATED (MI) CABLES

- .1 Conductors: solid bare soft-annealed copper, size as indicated.
- .2 Insulation: compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Outer covering: annealed seamless copper, Type MI rated 600 V, 250°C.
- .4 Overall jacket: none.
- .5 Two hour fire rating.
- .6 Connectors: watertight factory installed and tested approved for MI cable.
- .7 Termination kits: field installed approved for MI cable

2.4 CONTROL CABLES

2.4.1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:

- .1 Insulation: thermoplastic.
- .2 Overall covering: thermoplastic jacket.

2.4.2 Type: low energy 300 V control cable: solid or stranded annealed copper conductors sized as indicated LVT: soft annealed copper conductors, sized as indicated:

- .1 Insulation: PVC.
- .2 Shielding: metallized tapes over each pair.
- .3 Overall covering: PVC jackets.

2.4.3 Type: 600 V stranded annealed copper conductors, sizes as indicated:

- .1 TECK 90 with interlocking aluminum armour.
- .2 Insulation: cross-linked polyethylene type RW90 (x-link).
- .3 Shielding: metallized tapes over conductors.
- .4 Overall covering: grey thermoplastic jacket.



2.5 MINERAL-INSULATED (MI) HEATING CABLES

- .1 All gate guide heating applications shall use factory-terminated, mineral insulated (MI) cables.
- .2 MI cable shall be magnesium oxide insulated with an Incoloy 825 sheath. The heated section of the cable shall be joined to a cold lead also made of Incoloy 825.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Each cable shall be factory-terminated to the required length, consisting of the lengths required for the gate guide section, plus an allowance for areas of additional heat loss such as supports, etc. plus a reasonable excess to allow for field variations. The cold lead section shall be seven feet long minimum or sufficient to reach the power connection junction box.

PART .3 EXECUTION

3.1 GENERAL CABLE INSTALLATION

- .1 Install cable in trenches in accordance with Section: 26 05 43.01 – Installation of Cables in Trenches and in Ducts.
- .2 Lay cable in cable trays in accordance with Section: 26 05 36 - Cable Trays for Electrical Systems.
- .3 Terminate cables in accordance with Section: 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .4 Cable Colour Coding: to Appendix 1.
- .5 Conductor length for parallel feeders to be identical.
- .6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .8 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .9 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.



3.2 INSTALLATION OF BUILDING WIRES

3.2.1 Install wiring as follows:

- .1 In conduit systems in accordance with Section: 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 In underground ducts in accordance with Section: 26 05 43.01 – Installation of Cables in Trenches and in Ducts.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Overhead service conductors in accordance with CSA C22.3 No 7 – Underground Systems.

3.3 INSTALLATION OF TECK 90 CABLE (0-1000 V)

- .1 Group cables wherever possible on channels.
- .2 Install cable exposed, securely supported by straps or hangers.

3.4 INSTALLATION OF MINERAL-INSULATED CABLES

- .1 Install cable exposed, securely supported by straps or hangers.
- .2 Support 2 hour fire rated cables at 1 m intervals.
- .3 Make cable terminations by using factory-made kits.
- .4 Cable terminations: use thermoplastic sleeving over bare conductors.
- .5 Where cables are buried in cast concrete or masonry, provide sleeves for cables.
- .6 Do not splice cables unless indicated.

3.5 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in cabletrays, underground ducts or by direct burial.
- .2 Ground control cable shield.

3.6 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 – General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



APPENDIX 1 -
TABLE 1 - CABLE CONDUCTOR COLOURS

CABLE CONDUCTOR COLOURS	
dc Supplies	(+) - Red
	(-) - Black
	GND - Bare or Green
120Vac 2-wire single Phase Supplies	L - Black
	N - White
	GND - Bare or Green
120Vac 3-wire single Phase Supplies	L - Black
	L - Red
	N - White
	GND - Bare or Green
240Vac 2-wire single Phase Supplies	L1 - Black
	L2 - Red
	GND - Bare or Green
240Vac 3-wire single Phase Supplies	L1 - Black
	L2 - Red
	N - White
	GND - Bare or Green
208Vac 2-wire Supplies	L1 - Black
	L2 - Red
	GND - Bare or Green
Lighting Circuit "Switch Legs"	Switched Hot - Black
	Constant Hot - Red
	GND - Bare or Green
Lighting Circuit 3-way Switch "Travelling Wires"	Traveller 1 - Black
	Traveller 2 - Red
	Traveller 3- White (Note 1)
	GND - Bare or Green
Triads	1 - Black
	2 - Red
	3 - White
	Shield Drain Wire - Bare
Instrumentation Cable	1-Black



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



CABLE CONDUCTOR COLOURS	
(Note 2)	1- White
	Shield Drain Wire - Bare
	2-Black
	2- White
	Shield Drain Wire - Bare
	3-Black
	3- White
	Shield Drain Wire - Bare
	4-Black
	4- White
	Shield Drain Wire - Bare
Control/Indication/Alarm Circuits (Note 3)	Black
	Red
	Blue
	Orange
	Yellow
	Brown
	Red w/ Black Tracer
	Blue w/ Black Tracer
	Orange w/ Black Tracer
	Yellow w/ Black Tracer
	Brown w/ Black Tracer
Black w/ Red Tracer	
Shield drain wire - Bare	
208/600Vac 3phase Circuits	A - Red
	B - Black
	C - Blue
	N - White (if required)
	GND - Bare or Green
PT Circuits	A - Red
	B - Yellow

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 21
CH0032	WIRES AND CABLES (0-1000 V)	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



CABLE CONDUCTOR COLOURS	
(Note 4)	C - Blue
	N - Black
CT Circuits (Note 5)	A - Red
	B - Yellow
	C - Blue
	N - Black
Ground	Green or Bare
Isolated Ground	Green w/ Yellow Stripe

Notes:

- 1: If white wire is not a constant neutral, it shall be marked with black tape at all entrances of all switch boxes
- 2- Additional pairs will be numbered in increasing order
- 3- Additional Conductors as per Table E-2 of ANSI/ICEA S-73-532/ NEMA WC 57 - Standard for control, thermocouple extension, and instrumentation cables.
- 4- PT conductor colours will follow the same colour standard as 3 phase power circuits but each conductor will be clearly marked with a 1/2" visible Red band or wire marking sleeve.
- 5- CT conductor colours will follow the same colour standard as 3 phase power circuits but each conductor will be clearly marked with a 1/2" visible Yellow band or wire marking sleeve.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 22
CH0032	CONNECTORS AND TERMINATIONS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 05 22
CONNECTORS AND TERMINATIONS
TABLE OF CONTENTS**

1 **GENERAL**..... 2

 1.1 SECTION INCLUDES..... 2

 1.2 RELATED REQUIREMENTS..... 2

 1.3 REFERENCES 2

 1.4 PRODUCT DATA..... 2

2 **PRODUCTS** 2

 2.1 CONNECTORS AND TERMINATIONS 2

 2.2 CABLE CONNECTORS..... 3

3 **EXECUTION** 3

 3.1 INSTALLATION 3

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in Newfoundland and Labrador.
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 22
CH0032	CONNECTORS AND TERMINATIONS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for connectors and terminations.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements
- .2 Section 26 05 14 – Power Cable (25000 V and 28000 V).
- .3 Section 26 05 21 – Wires and Cables (0-1000 V).

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No 65, Wire Connectors.
 - .2 CSA C22.2 No.41, Grounding and Bonding Equipment.
- .2 Institute of Electrical and Electronics Engineers (IEEE)
 - .1 IEEE Std. 48 – IEEE Standard for Testing Procedures and Requirements for Alternating Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 76k kV and Extruded Insulation Rated 2.5 kV through 500 kV.

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 CONNECTORS AND TERMINATIONS

- .1 Copper long barrel compression connectors to CSA C22.2No. 65 as required sized for conductors.
- .2 Contact aid for aluminum cables where applicable.
- .3 Cable terminations for shielded power cables to IEEE Std. 48 as required for voltage and sized for conductors.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 22
CH0032	CONNECTORS AND TERMINATIONS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 CABLE CONNECTORS

- .1 All Teck cable shall be terminated with aluminum, watertight, NEMA 4 cable connectors made in accordance with CSA 22.2 No. 18.3. Tech cable connectors shall be Thomas & Belts, Star Teck (ST) Series.



- .2 All tray cable shall be terminated with aluminum, watertight, NEMA 4 cable connectors. Tray cable connectors shall be Thomas & Belts, Silver Grip – TCF Series.

3 EXECUTION

3.1 INSTALLATION

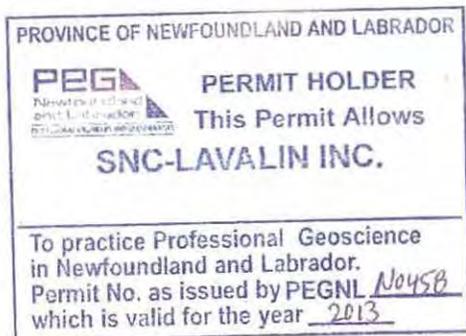
- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2 No.41 and Section 26 05 28 – Grounding – Secondary.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 05 28
GROUNDING – SECONDARY

1	GENERAL	2
1.1	RELATED SECTIONS	2
1.2	REFERENCES	2
1.3	DEFINITIONS	3
1.4	SUBMITTALS	3
1.5	DELIVERY, STORAGE AND HANDLING	3
2	PRODUCTS	4
1.6	EQUIPMENT	4
3	EXECUTION	6
1.7	INSTALLATION	6
1.8	FIELD QUALITY CONTROL	12



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

.1 Section: 26 05 00 – General Electrical Requirements



.2 Section: 26 05 21 – Wires and Cables (0-1000 V)

1.2 REFERENCES



1.2.1 The latest revision of the Specifications, Codes and Standards at the date of Award shall be used.

1.2.2 ASTM International (ASTM)

.1 ASTM B3 Standard Specification for Soft or Annealed Copper Wire

.2 ASTM B8, Standard Specification for Concentric-Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft

.3 ASTM B187, Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes

1.2.3 Canadian Standards Association (CSA International)

.1 CSA C22.1, Canadian Electrical Code, Part 1

.2 CSA C22.2 No. 0.4, Bonding of Electrical Equipment

.3 CSA C22.2 No. 41, Grounding and Bonding Equipment

1.2.4 Institute of Electrical and Electronics Engineers (IEEE)

.1 IEEE 837 Standard for Qualifying Permanent Connections Used in Substation Grounding



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3 DEFINITIONS



.1 Primary Ground Connection

An exposed pigtail or loop installed by the Company's Other Contractors as part of the embedded/buried grounding system.

1.4 SUBMITTALS



1.4.1 Provide submittals in accordance with Section: 01 33 00 - Submittal Procedures.

1.4.2 Submit product data in accordance with Exhibit 4 – Supplier Document Requirements List.

1.4.3 Product Data

.1 Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.



1.4.4 Closeout Submittals

.1 Submit operation and maintenance data for grounding equipment for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.5.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1.5.3 Storage and Handling Requirements:



.1 Materials shall be stored indoors, in dry locations and in accordance with manufacturer's recommendations.

.2 Defective or damaged materials shall be replaced with new.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Equipment - General

- .1 All material shall be new and conform to the applicable ASTM, CSA and IEEE standards.

2.1.2 Conductors

- .1 Bare grounding conductors, soft drawn copper, size as indicated, shall be used for embedded grounding and interconnection of metal structures and miscellaneous metals, equipment, and grounding connections.
- .2 Insulated grounding conductors shall be soft drawn copper, insulation type TW, size as indicated.
- .3 Conductors shall be minimum Class B stranded. Conductor stranding shall be ASTM B8 – Class C for applications subject to significant vibration or requiring frequent bending or flexing such as wiring onto hinged doors.
- .4 Tinned copper conductors shall be used for grounding and bonding aluminum structures or equipment.
- .5 Grounding conductors on equipment rated 600 V and higher, shall be #6 AWG minimum and shall equal or exceed that of the service ground in the cable supplying the equipment.

2.1.3 Connectors

- .1 Grounding conductor connectors shall be in accordance with IEEE 837.
- .2 Connectors shall be of the mechanically bolted type or compression type.
- .3 Ground lugs for wire sizes #2 AWG and larger shall be of the of compression type, *NEMA 2-hole, intended for wire sizes as indicated.*



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



.4 Ground lugs for wire sizes smaller than #2 AWG shall be either NEMA 2-hole or NEMA 1-hole, and compression or mechanical type.



.5 Clamps for connecting ground conductors to electrically conductive pipe shall be supplied and installed, and sized as indicated.

2.1.4 Ground Bus



.1 Ground bus shall be of copper bar in accordance with ASTM B187, sizes as indicated, and be complete with insulated supports, fastenings, and connectors.

2.1.5 Grounding Hardware and Accessories



.1 All accessories necessary for grounding system shall be non-corroding, and of type, size, and material as indicated. Accessories include but are not necessarily limited to:

- a) Grounding and bonding bushings,
- b) Protective type clamps,
- c) Bonding jumpers and straps,
- d) Thermite welded (exothermic) type conductor connectors, and
- e) Exothermic equipment: complete exothermic equipment including moulds, weld metal, crucible, mould support clamps for making all connections for ground grid and tails for all terminations for equipment to be grounded.

.2 All grounding clamps and other hardware and accessories shall be specifically designed for their intended purpose.

2.1.6 Wire Marking

.1 Green with yellow stripe conductor insulation shall be used for all isolated ground wiring.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Green conductor insulation or bare conductors shall be used for all other ground wiring, and as indicated.

3 EXECUTION

3.1 INSTALLATION



3.1.1 Delivery Storage and Handling

- .1 Delivery, storage and handling of materials shall be carried out in order to prevent contamination, corrosion or damage to the materials.

3.1.2 Pre-Installation Examination

- .1 The Contractor shall verify that the conditions of the substrate (previously installed under other Sections or Contracts) are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.
- .2 The Contractor shall visually inspect substrate in the presence of the Engineer.
- .3 The Contractor shall inform the Engineer of any unacceptable conditions, immediately upon discovery.
- .4 The Contractor shall proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Engineer.

3.1.3 General

- .1 The finished installation shall form a complete and permanent, continuous grounding and bonding system that incorporates all electrodes, conductors, connectors and accessories,
- .2 The finished grounding and bonding system shall be in accordance with CSA C22.1 Part 1, CSA C22.2 No. 0.4 and the requirements of the local authority having jurisdiction.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



.3 Grounding connections shall be made in a radial configuration only, with connections terminating at a *Primary Ground Connection*. Loop connections are not acceptable.



3.1.4 Conductors

.1 Conductors shall be installed as shown on drawings.



.2 Conductors shall be thoroughly cleaned to bright metal before making connections.

.3 Exposed grounding conductors shall be protected from mechanical injury.

.4 In order to be protected from physical injury and be able to sustain short circuit forces to which they may be subjected, grounding conductors shall be securely attached to surfaces on which they are carried using robust cable clamps and hardware, spaced at no more than 1 m intervals.

3.1.5 Connectors

.1 Connectors shall be installed in accordance with manufacturer's instructions and Section: 26 05 22 – Connectors and Terminations.



.2 Mechanical connectors shall be used for making grounding connections to equipment provided with lugs.



.3 Soldered joints are not acceptable.



.4 Exothermic connections shall be made in accordance with the manufacturer's instructions.

3.1.6 Grounding Bus



.1 Copper grounding bus shall be mounted on insulated supports on the walls of electrical rooms and communication equipment rooms as indicated.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.7 System and Circuit Grounding

- .1 The Contractor shall install system and circuit grounding connections to the neutrals of secondary 600 V systems.
- .2 The Contractor shall install system and circuit grounding connections to the neutrals of 600 V primary distribution transformers, and 600/347 V and 208/120 V distribution panels.
 - a) The neutral bus of all 3-phase, 4-wire distribution panelboards shall be connected to their grounding bus with wire sizes in accordance with CSA C22.1, Part 1.
 - b) On diesel generators, the neutral / wye point of the generator shall be connected to ground in accordance with Section: 26 32 13.04 – Diesel Electric Power Generating Equipment.

3.1.8 Cables and Conduits

- .1 Grounding of Power Cable Shields and Armour
 - a) Power cable shields and armour shall be grounded at both ends for three-conductor, three-phase power cables unless otherwise specified.
 - b) Power cables shields and armour shall be grounded at the supply end only for single one-conductor power cables unless otherwise specified. A Non-metallic entry plate shall be provided at the load end.
- .2 Grounding of Control Cable Shields and Armour
 - a) Control cable shields and armour shall be grounded at the signal source end only unless otherwise specified.
 - b) Shields and armour of control cables to field devices shall be grounded at the DCS/PLC end only.




Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- c) Shields and armour of control cables between powerhouse and switchyard shall be grounded at both ends as indicated.
 - d) Data highway/digital communication cables shall be grounded in accordance with the connected equipment manufacturer's instructions.
- .3 Separate, insulated ground wires shall be run in all conduits.
- .4 Flexible conduits shall have bonding wires installed and connected at both ends to the grounding bushing, solder less lug, clamp or cup washer and screw. The bonding wire shall be cleated neatly to the exterior of the flexible conduit.

3.1.9 Equipment Grounding

- .1 Grounding connections shall be installed to all equipment installed under this contract. Typical equipment to be grounded includes, but is not necessarily limited to:

- a) Service equipment,
- b) Transformers,
- c) Switchgear,
- d) Motor control centres (MCCs),
- e) Diesel Generators,
- f) Distribution panelboards,
- g) Cable trays.
- h) Duct systems,
- i) Frames of motors,



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro- Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- j) Starters,
 - k) Control panels,
 - l) Outdoor lighting, and
 - m) Building steel work.
- .2 The 600 V switchgear and 600 V MCC assemblies each include an internal grounding bus complete with one (1) pad at each end for connecting secondary grounds. Each pad on the ground bus shall be connected to a *Primary Grounding Point* using a single #4/0 AWG grounding conductor. To provide redundant ground current paths, each of the two conductors shall be connected to a different *Primary Grounding Point*.
- .3 Exposed metallic parts of diesel generators shall be bonded and grounded in accordance with Section: 26 32 13.04 – Diesel Electric Power Generating Equipment.
- .4 Distribution transformers, rated 600-600/347 V and 600-208/120 V shall be shall be connected to a *Primary Grounding Point* using a single #2/0 AWG grounding conductor.
- .5 Distribution panelboards, shall be grounded using a single grounding conductor, sized as follows:
- a) 100 A panels - #6 AWG
 - b) 225 A panels - #2 AWG
 - c) 400 A panels - #2/0 AWG
- .6 Electrical equipment in electrical rooms and IT equipment in communication equipment rooms shall each be grounded to the ground bus with individual, bare,



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

stranded copper connections unless indicated otherwise. Insulated conductors (for isolated ground connections) shall be used where indicated. Grounding conductor size shall be size #2/0 AWG unless indicated otherwise.



- .7 Cable trays shall include grounding conductor(s) along their full length. The grounding conductor shall be connected to a *Primary Grounding Point* at both ends and at intervals not exceeding 15 m. The cable tray shall be bonded to the grounding conductors at each end, and at intervals not exceeding three sections of cable tray. Grounding conductor size shall be in accordance with CSA C22.1 Part 1, Rule 12-2208 (b), #4/0 AWG minimum in cable tray containing power cables, and #2/0 AWG minimum in all others.
- .8 Flexible ground straps shall be installed across all bus duct enclosure joints, where such bonding is not inherently provided with the equipment.
- .9 Separate ground conductors shall be installed and connected to all outdoor lighting standards.
- .10 Metallic architectural components, including metal wall panels, door frames and doors shall be connected to ground by welding minimum #6 AWG copper conductors to them.
- .11 Metallic piping (water, oil, air, etc.) shall be connected to ground at a minimum of two (2) locations and using a minimum conductor size of #2 AWG.
- .12 Metallic equipment platforms and work platforms shall be grounded as follows:
 - a) Grounding conductors on platforms shall be #2/0 AWG minimum.
 - b) The periphery of each platform shall be bonded to ground. Each peripheral column shall be bonded to the ground conductor and each peripheral beam shall be bonded to the column via a jumper.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 28
CH0032	GROUNDING - SECONDARY	Rev: D2
Powerhouse and Spillway Hydro- Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- c) Individual gratings shall be bonded to a ground conductor. Individual gratings are defined as welded sections. Bolted sections of grating are not considered to be one grating. Gratings up to 1.5 meters at their largest dimension can be grounded at a single central point. Larger gratings should be grounded at two diametrically opposite corners. Bonding between platform levels must be continuous. Individual gratings may be bonded using #6 AWG minimum, providing the conductor is protected from mechanical injury.
- d) All handrail sections shall be bonded to ground. Removable handrails shall be bonded using jumper from the removable section to the fixed part. This jumper must be readily removable and replaceable.

3.1.10 Communication Systems



.1 Telephone grounding systems shall be as indicated and in accordance with the telephone company's requirements.



.2 Grounding systems for fire alarm, communication, access control, intrusion alarm and CCTV systems shall be installed as indicated.

3.2 FIELD QUALITY CONTROL



.1 Tests and checks shall be performed in accordance with Section: 26 05 00 - General Electrical Requirements.

.2 Ground continuity and resistance tests shall be performed using methods appropriate to site conditions and acceptable to the Engineer and the local authority having jurisdiction over the installation.

.3 Tests shall be performed before energizing the electrical system.

.4 Ground fault indicators shall be disconnected during tests



END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 29
CH0032	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

TABLE OF CONTENTS

1 **GENERAL**..... 2

1.1 **RELATED SECTIONS** 2

2 **PRODUCTS** 2

2.1 **SUPPORT CHANNELS** 2

3 **EXECUTION** 2

3.1 **INSTALLATION** 2

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 29
CH0032	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 05 34 – Conduits, Conduit Fastening and Conduit Fitting
- .3 Section 26 05 36 – Cable Trays for Electrical Systems

2 PRODUCTS

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

3 EXECUTION

3.1 INSTALLATION

- .1 Secure equipment to masonry and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
- .7 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
- .8 Two-hole steel straps for conduits and cables larger than 50 mm.
- .9 Beam clamps to secure conduit to exposed steel work.
- .10 Suspended support systems:



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 29
CH0032	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
- .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .11 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .12 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .13 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .14 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .15 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.
- .16 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 31
CH0032	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

SECTION 26 05 31
SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
TABLE OF CONTENTS

1 GENERAL..... 2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

2 PRODUCTS..... 2

2.1 SPLITTERS 2

2.2 JUNCTION AND PULL BOXES 3

2.3 CABINETS..... 3

3 EXECUTION 3

3.1 SPLITTER INSTALLATION 3

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION 3

3.3 IDENTIFICATION 4



REV. D2

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 31
CH0032	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.1, Canadian Electrical Code, Part 1.
- .2 CSA C22.2 No. 40, Cutout, Junction and Pull Boxes.
- .3 CAN/CSA C22.2 No. 76, Splitters.
- .4 CAN/CSA C22.2 No. 94.1, Enclosures for Electrical Equipment, Non-environmental Considerations.
- .5 CAN/CSA C22.2 No 94.2, Enclosures for Electrical Equipment, Environmental Consideration

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 SPLITTERS

- .1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Terminations: main and branch lugs or connection blocks to match required size and number of incoming and outgoing conductors as indicated.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 31
CH0032	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on covers.

2.3 CABINETS

- .1 Construction: welded sheet steel, aluminum, or stainless steel, hinged door, handle, lock 2 keys and catch.
- .2 Type E Empty: surface return flange flush overlapping sides mounting as indicated.
- .3 Type T Terminal: surface return flange or flush overlapping sides mounting as indicated containing sheet steel backboard.

3 EXECUTION

3.1 SPLITTER INSTALLATION

- .1 Mount plumb, true and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Install terminal blocks as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 31
CH0032	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00 - General Electrical Requirements.
- .2 Identification Labels: size 2 indicating voltage and phase or as indicated.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 32
CH0032	OUTLET BOXES, CONDUIT BOXES AND FITTINGS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

SECTION 26 05 32

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

TABLE OF CONTENTS

1 **GENERAL**..... 2

 1.1 RELATED SECTIONS..... 2

 1.2 REFERENCES..... 2

 1.3 SUBMITTALS..... 2

2 **PRODUCTS**..... 2

 2.1 OUTLET AND CONDUIT BOXES GENERAL..... 2

 2.2 GALVANIZED STEEL OUTLET BOXES..... 2

 2.3 MASONRY BOXES..... 3

 2.4 CONCRETE BOXES..... 3

 2.5 FLOOR BOXES..... 3

 2.6 CONDUIT BOXES..... 3

 2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE..... 3

 2.8 FITTINGS - GENERAL..... 3

 2.9 SERVICE FITTINGS..... 4

3 **EXECUTION**..... 4

 3.1 INSTALLATION..... 4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 32
CH0032	OUTLET BOXES, CONDUIT BOXES AND FITTINGS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – General Electrical Requirements
- .2 Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.1, Canadian Electrical Code, Part 1.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted conduit, minimum size 102 x 54 x 48 mm.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 32
CH0032	OUTLET BOXES, CONDUIT BOXES AND FITTINGS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

- 2.4.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

- .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 73 mm for receptacles and communication outlets.
- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 27 mm conduit. Minimum size: 73 mm deep.

2.6 CONDUIT BOXES

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.8 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 32
CH0032	OUTLET BOXES, CONDUIT BOXES AND FITTINGS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.9 SERVICE FITTINGS

- .1 Above floor service fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for 1 duplex receptacle. Bottom plate with two knockouts for centered or offset installation.
- .2 Above floor service fitting made of 2 piece die cast aluminum with brushed aluminum housing finish to accommodate two communication/data receptacles.

3 EXECUTION

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 34
CH0032	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS

SECTION 26 05 34

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1 **GENERAL** 2

 1.1 SCOPE OF WORK..... 2

 1.2 RELATED SECTIONS..... 2

 1.3 REFERENCES..... 2

2 **PRODUCTS**..... 3

 2.1 CONDUITS..... 3

 2.2 CONDUIT FASTENINGS..... 3

 2.3 CONDUIT FITTINGS..... 3

 2.4 EXPANSION FITTINGS FOR RIGID CONDUIT 3

 2.5 FISH CORD..... 3

3 **EXECUTION**..... 4

 3.1 MANUFACTURER'S INSTRUCTIONS..... 4

 3.2 INSTALLATION..... 4

 3.3 CONDUITS IN CAST-IN-PLACE CONCRETE..... 4

 3.4 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE 5

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REGISTERED PROFESSIONAL ENGINEER
PEG
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PROFESSIONAL ENGINEERS
G. W. HAINES
G. W. HAINES
SIGNATURE
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 34
CH0032	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SCOPE OF WORK

1.1.1 The work described in this Section includes the supply of all labour, equipment and materials necessary for the supply and installation of conduits, in compliance with the drawings and as specified herein or as required by the Engineer.

1.1.2 The work includes but is not limited to the following:

- .1 Supply and installing the in the Powerhouse, the Spillway and the north and centre transition dams.

1.2 RELATED SECTIONS

- .1 Section 03 30 00 - Cast-in-Place Concrete.
- .2 Section 26 05 00 – General Electrical Requirements.

1.3 REFERENCES

1.3.1 All materials and equipment to be incorporated in the Work shall conform to the latest applicable standards and codes as specified in the Contract Documents. Where a particular standard or code is referred to, that standard or code shall, unless otherwise stated, be the edition in effect thirty (30) days prior to the closing date of submission of tenders.

- .1 Canadian Standards Association
 - .1 CAN/CSA C22.2 No.18.1 Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2 No. 18.3 Conduit, Tubing and Cable Fittings
 - .3 CSA C22.2 No. 18.4 Hardware for the Support of Conduit, Tubing and Cable
 - .4 CSA C22.2 No.45.1 Rigid Metal Conduit - Steel.
 - .5 CSA C22.2 No.56 Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit.
 - .6 CSA C22.2 No.83.1 Electrical Metallic Tubing - Steel.
 - .7 CSA C22.2 No.211.2 Rigid PVC (Unplasticized) Conduit.
 - .8 CAN/CSA C22.2 No.227.1 Electrical Nonmetallic Tubing.
 - .9 CAN/CSA C22.2 No.227.2.1 Liquid Tight Flexible Nonmetal Conduit.
 - .10 CAN/CSA C22.2 No.227.3 Nonmetallic Mechanical Protection Tubing (NMPT).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 34
CH0032	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2 PRODUCTS

2.1 CONDUITS

- 2.1.1 Rigid metal conduit: to CSA C22.2 No.45.1, hot dipped galvanized steel threaded.
- 2.1.2 Epoxy coated conduit: to CSA C22.2 No.45.1, with zinc coating and corrosion resistant epoxy finish inside and outside.
- 2.1.3 Rigid PVC conduit: to CSA C22.2 No.211.2.
- 2.1.4 Liquid Tight Flexible metal conduit: to CSA C22.2 No.56, aluminum and liquid tight flexible metal.
- 2.1.5 Flexible PVC conduit: to CAN/CSA C22.2 No.227.3.

2.2 CONDUIT FASTENINGS

- 2.2.1 One-hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm
- 2.2.2 Channel type supports for two or more conduits at 2.5 m on centre.
- 2.2.3 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

- 2.3.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit
- 2.3.2 Factory "ells" where 90° bends are required for 125 mm and larger conduits.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- 2.4.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion
- 2.4.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- 2.4.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- 2.5.1 Material: Polypropylene

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 34
CH0032	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with the manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions and datasheets.

3.2 INSTALLATION

3.2.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

3.2.2 Use rigid hot dipped galvanized steel threaded conduit where specified.

3.2.3 Use epoxy coated conduit above ground where indicated.

3.2.4 Use rigid PVC conduit underground and in corrosive areas where specified and /or indicated.

3.2.5 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

3.2.6 Mechanically bend steel conduit over 21 mm dia.

3.2.7 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

3.2.8 Install fish cord in empty conduits.

3.2.9 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

3.2.10 Dry conduits out before installing wire.

3.3 CONDUITS IN CAST-IN-PLACE CONCRETE

3.3.1 Locate to suit reinforcing steel. Install in centre one third of slab

3.3.2 Protect conduits from damage where they stub out of concrete.

3.3.3 Install sleeves where conduits pass through slab or wall.

3.3.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

3.3.5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.

3.3.6 Encase conduits completely in concrete with minimum 40 mm concrete cover.

3.3.7 Organize conduits in slab to minimize crossovers.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 34
CH0032	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

3.4.1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 36
CH0032	CABLE TRAYS FOR ELECTRICAL SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 05 36
CABLE TRAYS FOR ELECTRICAL SYSTEMS
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED SECTIONS	2
1.2	REFERENCES	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS	2
2	PRODUCTS	2
2.1	CABLE TRAY	2
2.2	SUPPORTS.....	3
2.3	IDENTIFICATION	3
3	EXECUTION	3
3.1	INSTALLATION	3
3.2	CABLES IN CABLE TRAY	4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 36
CH0032	CABLE TRAYS FOR ELECTRICAL SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.1, Part 1 – Canadian Electrical Code.
- .2 CAN/CSA C22.1 No.126.1, Metal Cable Tray Systems.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA VE 1, Metal Cable Tray Systems.
- .2 NEMA VE 2, Cable Tray Installation Guidelines.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4 Identify types of cable trays used.
- .5 Show actual cable tray installation details and suspension system.

2 PRODUCTS

2.1 CABLE TRAY



- .1 Cable trays and fittings: to NEMA VE 1 and CAN/CSA C22.1 No. 126.1 and 126.2.
- .2 Ladder Ventilated type, Class D to CAN/CSA C22.2 No.126.1 and 126.2.
- .3 Trays: galvanized steel, 150, 300, 450, 600, 750, mm wide with depth of 150 mm and 30 cm rung spacing.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 36
CH0032	CABLE TRAYS FOR ELECTRICAL SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reducers where required, manufactured accessories for cable tray supplied.



.1 Radii on fittings: 300 mm minimum for instrumentation and low voltage distribution cable trays and 600 mm for tray containing power cables rated at 600 V and above.



.5 Solid covers shall be provided for cable trays installed outdoors on cable trays under grating walkways and for a minimum distance of 2 m above the floor cable trays installed vertically.

.6 Barriers where different voltage systems are in same cable tray.

.7 Ground cable trays with #2 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.

.8 Provide fire stop material at firewall penetrations.

2.2 SUPPORTS

.1 Provide splices, supports for a continuously grounded system as required.

2.3 IDENTIFICATION



.1 Nameplates and labels shall be in accordance with Section: 26 05 00 – General Electrical.

.2 Cable trays shall be identified at each turn, on each side of all passages through walls and floors and stencilled every ten (10) m in 50 mm high characters.

3 EXECUTION

3.1 INSTALLATION

.1 Install complete cable tray system in accordance with NEMA VE 2.

.2 Support cable tray on one or both sides.

.3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.



.4 The cable tray installation shall be FM Global compliant.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 36
CH0032	CABLE TRAYS FOR ELECTRICAL SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 CABLES IN CABLE TRAY

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 Secure cables in cable tray at 3 m centers with nylon ties.
- .4 Identify cables with size 2 nameplates at point where they enter or leave the cable tray and on both sides of wall and floor penetrations.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 43.01
CH0032	INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 26 05 43.01
INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS
TABLE OF CONTENTS**

1 **GENERAL**..... 2

 1.1 RELATED SECTIONS 2

 1.2 REFERENCES 2

2 **PRODUCTS** 2

 2.1 CABLE PROTECTION..... 2

 2.2 MARKERS..... 2

3 **EXECUTION** 2

 3.1 DIRECT BURIAL OF CABLES 2

 3.2 CABLE INSTALLATION IN DUCTS 3

 3.3 MARKERS..... 4

 3.4 FIELD QUALITY CONTROL 4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 43.01
CH0032	INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

- .1 Canadian Standards Association, (CSA International)
- .2 Insulated Cable Engineers Association, Inc. (ICEA)

2 PRODUCTS

2.1 CABLE PROTECTION

- .1 38 x 140 mm planks pressure treated with copper naphthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 MARKERS

- .1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.
- .2 Wooden post type markers: 89 x 89 mm, 1.5 m long, pressure treated with copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing cable or conduit to indicate depth and direction of duct and cable runs.
- .3 Nameplate: aluminum anodized 89 x 125 mm, 1.5 mm thick mounted on wooden post with mylar label 0.125 mm thick with words Cable, Joint or Conduit with arrows to indicate change in direction.

3 EXECUTION

3.1 DIRECT BURIAL OF CABLES

- 3.1.1 After sand bed specified in Section 31 23 33.01 - Excavating, Trenching and Backfilling, is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- 3.1.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 43.01
CH0032	INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.

- .1 Make splices and terminations in accordance with manufacturer's instructions using approved splicing kits.

3.1.4 Underground cable splices not acceptable.

3.1.5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.

3.1.6 Cable separation:

- .1 Maintain 75 mm minimum separation between cables of different circuits.
- .2 Maintain 300 mm horizontal separation between low and high voltage cables.
- .3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
- .4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.
- .5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
- .6 Install treated planks on lower cables 0.6 m in each direction at crossings.

3.1.7 After sand protective cover specified in Section 31 23 33.01 - Excavating, Trenching and Backfilling is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.

3.2 CABLE INSTALLATION IN DUCTS

- .1 Install cables as indicated in ducts.
 - .1 Do not pull spliced cables inside ducts.
- .2 Install multiple cables in duct simultaneously.
- .3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 43.01
CH0032	INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .5 Before pulling cable into ducts and until cables are properly terminated, seal ends of non-leaded cables with moisture seal tape.
- .6 After installation of cables, seal duct ends with duct sealing compound.

3.3 MARKERS

- .1 Mark cable every 150 m along cable and duct runs and changes in direction.
- .2 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .3 Install wooden post type markers.
- .4 Lay concrete markers flat and centred over cable with top flush with finish grade.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests.
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
 - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.




Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 43.01
CH0032	INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 High Potential (Hipot) Testing.
- .4 Conduct hipot testing in accordance with manufacturer's recommendations.
- .7 Leakage Current Testing.
 - .1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.
 - .2 Hold maximum voltage for specified time period by manufacturer.
 - .3 Record leakage current at each step.
- .8 Provide Engineer with list of test results showing location at which each test was made, circuit tested and result of each test.
- .9 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 80
CH0032	FRACTIONAL HORSEPOWER MOTORS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 05 80
FRACTIONAL HORSEPOWER MOTORS
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED SECTIONS.....	2
1.2	REFERENCES.....	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS.....	2
1.4	CLOSEOUT SUBMITTALS:.....	2
2	PRODUCTS	3
2.1	FRACTIONAL HORSEPOWER MOTOR.....	3
3	EXECUTION	3
3.1	MANUFACTURER'S INSTRUCTIONS.....	3
3.2	INSTALLATION.....	3
3.3	FIELD QUALITY CONTROL.....	3

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 80
CH0032	FRACTIONAL HORSEPOWER MOTORS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No. 100, Motors and Generators.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA MG1, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Product Data: product characteristics, performance criteria, physical size, horsepower, watt rating, limitations and finish.
- .3 Shop drawings:
 - .1 Indicate dimensions, recommended installation procedure, wiring diagrams, sizes and location of mounting bolt holes and recommended support method.
- .4 Quality Assurance Submittals:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS:

- 1.4.1 Provide maintenance data for fractional horsepower motors for incorporation into manual specified in Exhibit 4 – Supplier Document Requirements List.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 80
CH0032	FRACTIONAL HORSEPOWER MOTORS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2 PRODUCTS

2.1 FRACTIONAL HORSEPOWER MOTOR

- .1 Non-hazardous locations: to CSA C22.2 No. 100 and NEMA MG1.
- .2 Motor with inherent overheating protectors.

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install wiring, flexible connections and grounding.
- .2 Check rotation before coupling to driven equipment.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 81
CH0032	MOTORS: 1 to 250 HP	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 26 05 81
MOTORS: 1 TO 250 HP

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES.....	2
1.3	SUBMITTALS.....	2
1.4	CLOSEOUT SUBMITTALS:.....	3
2	PRODUCTS	3
2.1	MATERIALS.....	3
2.2	CORROSION PREVENTION AND FINISH PAINTING.....	3
2.3	RATING.....	3
2.4	MOTOR TYPE.....	4
2.5	DESIGN LETTERS.....	4
2.6	APPLICATION.....	4
2.7	PERFORMANCE CHARACTERISTICS.....	4
2.8	INSULATION.....	4
2.9	LOCKED ROTOR KVA PER HP.....	4
2.10	DIRECTION OF ROTATION.....	5
2.11	BEARINGS.....	5
2.12	MOTOR MOUNTING AND TERMINAL HOUSING.....	5
2.13	SHAFT.....	5
2.14	STARTING METHOD.....	5
2.15	ACCESSORIES.....	5
3	EXECUTION	5
3.1	MANUFACTURER'S INSTRUCTIONS.....	5
3.2	INSTALLATION.....	5
3.3	FIELD QUALITY CONTROL.....	6

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Page 1 of 6

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 81
CH0032	MOTORS: 1 to 250 HP	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No. 100, Motors and Generators.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA MG1, Motors and Generators

1.3 SUBMITTALS

- .1 Submittals: in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Shop drawings:
 - .1 Indicate:
 - .1 Overall dimensions of motor.
 - .2 Shaft centreline to base dimension.
 - .3 Shaft extension diameter and keyway, coupling dimensions and details.
 - .4 Fixing support dimensions.
 - .5 Dimensioned position of ventilation openings. Details of ventilation duct attachments.
 - .6 Terminal box location and size of terminals.
 - .7 Arrangement and dimensions of accessories.
 - .8 Diagram of connections.
 - .9 Starting current and relative data necessary for use in design of motor starting equipment.
 - .10 Speed/torque characteristic.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 81
CH0032	MOTORS: 1 to 250 HP	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.11 Weight.

.12 Installation data.

1.4 CLOSEOUT SUBMITTALS:

- 1.4.1 Provide maintenance data for motors for incorporation into manual specified in Exhibit 4 – Supplier Document Requirements List.
- 1.4.2 Data necessary for maintenance of motors.
- 1.4.3 Manufacturer’s recommended list of spare parts.

2 PRODUCTS

2.1 MATERIALS

- .1 Motors:
 - .1 Non-hazardous locations: to CSA C22.2 No. 100 and NEMA MG1.
 - .2 Lead markings: to NEMA MG-1.

2.2 CORROSION PREVENTION AND FINISH PAINTING

- .1 Provide equipment resistant to corrosion from severe moisture conditions.

2.3 RATING

- .1 Motor:
 - .1 Single speed: horsepower and speed as required for driven equipment.
 - .2 Two speed: routings as required for driven equipment.
 - .3 575 V, 3 phase, 60 Hz.
 - .4 Frame size: in accordance with NEMA MG1.
 - .5 Enclosure: totally enclosed fan cooled (TEFC).
 - .6 Operation: required for driven equipment.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 81
CH0032	MOTORS: 1 to 250 HP	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 MOTOR TYPE

- .1 Squirrel cage, unless indicated otherwise.

2.5 DESIGN LETTERS



- .1 Polyphase squirrel cage induction motors design B, unless indicated in other specific sections of the technical specification.

2.6 APPLICATION

- .1 Motor suitable for driving connected mechanical equipment.

2.7 PERFORMANCE CHARACTERISTICS

- .1 Full load torque: as required.
- .2 Locked rotor torque: as required.
- .3 Pull-up torque: as required.
- .4 Breakdown torque: as required.
- .5 Pull-out torque: as required.
- .6 Pull-in torque: as required.
- .7 Efficiency: premium high efficiency.
- .8 Service factor: 1.15.
- .9 Time rating: continuous.

2.8 INSULATION

- .1 Class: F.
- .2 Ambient temperature: 40°C.
- .3 Temperature rise: Class B.

2.9 LOCKED ROTOR KVA PER HP

- .1 Locked rotor kVA per hp, code letter G.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 81
CH0032	MOTORS: 1 to 250 HP	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.10 DIRECTION OF ROTATION

- .1 Direction of rotation as required for driven load.

2.11 BEARINGS

- .1 Antifriction type bearings, fitted with readily accessible facilities for lubrication while motor running or stationary.

2.12 MOTOR MOUNTING AND TERMINAL HOUSING

- .1 Horizontal floor mounting, assembly F-1 or F-2.
- .2 Vertical flange mounting with thrust bearing.
- .3 Slide rails for motor mounting.

2.13 SHAFT

- .1 Shaft extension to match driven load.

2.14 STARTING METHOD

- .1 Terminate winding connection necessary for appropriate starting method and identify in motor terminal box.

2.15 ACCESSORIES

- .1 Shaft extension: as necessary for accessories.
- .2 Space heater: for hoist motors and other motors installed in outdoor environment, sized in accordance with manufacturer's recommendation, 120 V, single phase.
- .3 Include anchor devices and setting templates.

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Dry out motor if dampness present in accordance with manufacturer's instructions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 05 81
CH0032	MOTORS: 1 to 250 HP	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Install motor on driven machinery. Rigid, plumb and square, using only lifting facilities provided.
- .3 Make wiring connections.
 - .1 Use liquid tight PVC jacketed flexible conduit between rigid conduit and motor.
- .4 Make flexible conduit long enough to permit movement of motor over entire length of slide rails.
- .5 Check for correct direction of rotation, with motor uncoupled from driven equipment.
- .6 Align and couple motor to driven machinery to manufacturer's instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.

END OF SECTION

M.B.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 23.01
CH0032	METERING AND SWITCHBOARD INSTRUMENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

SECTION 26 09 23.01

METERING AND SWITCHBOARD INSTRUMENTS

TABLE OF CONTENTS

PART .1 GENERAL..... 2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

PART .2 PRODUCTS 2

2.1 METER..... 2

2.2 METER SOCKET..... 2

2.3 METERING INSTRUMENT TRANSFORMER CABINET 3

2.4 TEST TERMINAL BLOCKS 3

2.5 METERING TRANSDUCERS, CONVERTERS 3

2.6 INDICATING INSTRUMENTS..... 3

2.7 INSTRUMENT SELECTOR SWITCHES..... 3

2.8 MULTI-FUNCTION POWER METERING UNITS..... 4

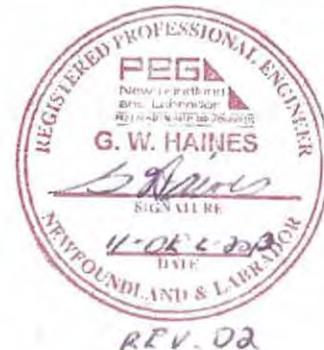
2.9 MULTI-FUNCTION POWER QUALITY MONITORING UNITS..... 4

2.10 SHOP INSTALLATION 5

PART .3 EXECUTION 6

3.1 METERING INSTALLATION..... 6

3.2 FIELD QUALITY CONTROL..... 6



Handwritten initials: JF MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 23.01
CH0032	METERING AND SWITCHBOARD INSTRUMENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART .1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 CSA International

- .1 CAN3-C17, Alternating - Current Electricity Metering.

1.3 SUBMITTALS

- 1.3.1 Submit in accordance with Section Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for metering and switchboard instruments and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Include meter and instrument, outline dimensions, panel drilling dimensions and installation cutout template.

PART .2 PRODUCTS

2.1 METER

- .1 Combination energy and demand meter: to CAN3-C17.
- .2 Accuracy: $\pm 2\%$.
- .3 Flush switchboard case.
- .4 Ratings: as indicated.
- .5 Register: self contained pulse contacts for transmitting signal.
- .6 Allow for remote sensing.

2.2 METER SOCKET

- .1 Meter socket to suit meter with automatic current transformer shorting devices when meter removed.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 23.01
CH0032	METERING AND SWITCHBOARD INSTRUMENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.3 METERING INSTRUMENT TRANSFORMER CABINET

- .1 Sheet steel CSA type 1 enclosure to accommodate potential and current transformers.

2.4 TEST TERMINAL BLOCKS

- .1 Test terminal blocks: as required.

2.5 METERING TRANSDUCERS, CONVERTERS

- .1 Transducers with 4 – 20 mA output for DCS as indicated.

2.6 INDICATING INSTRUMENTS

- .1 Analogue or digital indicating instruments: 1% accuracy, switchboard mounting, flush, case size 87 by 112 mm rectangular 180 degrees scale, operated from instrument transformers.
 - .1 Ammeter: true RMS range as indicated.
 - .2 Voltmeter: true RMS range as indicated.
 - .3 Wattmeter: range as indicated.
 - .4 Varmeter: range as indicated.
 - .5 Frequency meter: 0-60 Hz.
 - .6 Power factor meter: 1.0 -0-1.0
 - .7 Synchroscope: range as indicated.

2.7 INSTRUMENT SELECTOR SWITCHES

- .1 Voltmeter and Ammeter selector switches: rotary, multi-position, maintained contacts, panel mounting, round notched handle, rated to suit instruments, nameplate marked as indicated to coincide with each rotary position. Ammeter selector switches designed to preclude opening of current circuits.
- .2 Four position ammeter selector switches identified "off-A-B-C".
- .3 Four position voltmeter selector switches identified "A-B, B-C, C-A, off".
- .4 Seven position voltmeter selector switches identified "A-B, B-C, C-A, off, A-N, B-N, C-N".

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 23.01
CH0032	METERING AND SWITCHBOARD INSTRUMENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8 MULTI-FUNCTION POWER METERING UNITS

2.8.1 Basic multi-function power metering units with the following features:

- 
- .1 Inductive voltage transformer connected voltage inputs for 600 V systems and above.
 - .2 Current transformer current inputs.
 - .3 True RMS measurement of 3 phase average 1% accuracy of:
 - .1 Voltage
 - .2 Current
 - .3 Frequency
 - .4 Power factor
 - .5 Active power, total and per phase
 - .6 Apparent power, total and per phase
 - .7 Reactive power, total and per phase
 - .8 Active energy, total and per phase
 - .9 Apparent energy, total and per phase
 - .10 Reactive energy, total and per phase
 - .4 Local display.



2.8.2 The multi-function power metering unit shall be Schneider Electric, Power Logic ION 7300.

2.9 MULTI-FUNCTION POWER QUALITY MONITORING UNITS

2.9.1 Power metering and monitoring units for customer metering for distribution systems with the following features:

- 
- .1 Inductive voltage transformer connected voltage inputs for 600 Vac systems and above.
 - .2 Current transformers and current inputs.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 23.01
CH0032	METERING AND SWITCHBOARD INSTRUMENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 True RMS measurement of 3 phase average .05% accuracy of:
 - .1 Voltage
 - .2 Current
 - .3 Frequency
 - .4 Power factor
 - .5 Active power, total and per phase
 - .6 Apparent power, total and per phase
 - .7 Reactive power, total and per phase
 - .8 Active energy, total and per phase
 - .9 Apparent energy, total and per phase
 - .10 Reactive energy, total and per phase
 - .11 Voltage and current harmonic distortion for total and individual harmonics.
 - .12 Active power demand.
 - .13 Apparent power demand.
 - .14 Relative power demand.
- .4 Waveform capture.
- .5 Event logging with time stopping.
- .6 Trending.
- .7 Communication: RS 485 Modbus RTU.



2.9.2 The Multi-function power quality monitoring unit shall be Schneider Electric, Power Logic ION 7300.

2.10 SHOP INSTALLATION

- .1 Install meters and instrument transformers in separate compartment of switchboard.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 23.01
CH0032	METERING AND SWITCHBOARD INSTRUMENTS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Install instruments on switchboard.
- .3 Ensure adequate spacing between current transformers installed on each phase.
- .4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.

PART .3 EXECUTION

3.1 METERING INSTALLATION

- .1 Install meters and instruments in location free from vibration and shock.
- .2 Make connections in accordance with diagrams.
- .3 If applicable, ensure power factor corrective equipment connected on load side of meter.
- .4 Connect meter and instrument transformer cabinets to ground.
- .5 Locate meters within 9 m of instrument transformers. Use 32 mm conduit or armored cable for interconnections.
 - .1 Use separate conduit or cable for each set of current transformer connections, exclusive for metering.

3.2 FIELD QUALITY CONTROL

- .1 Conduct tests in accordance with Section 26 05 00 - General Electrical Requirements and in accordance with manufacturer's recommendations.
- .2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- .4 Perform tests to obtain correct calibration.
- .5 Do not dismantle meters and instruments.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 24
CH0032	LIGHTING CONTROL DEVICES - LOW VOLTAGE	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

SECTION 26 09 24

LIGHTING CONTROL DEVICES – LOW VOLTAGE

TABLE OF CONTENTS

1 **GENERAL**..... 2

1.1 SUMMARY 2

1.2 SUBMITTALS 2

1.3 TEST REPORTS 2

2 **PRODUCTS**..... 3

2.1 MATERIALS 3

2.2 REMOTE CONTROL SWITCHES 3

2.3 LOW VOLTAGE RELAYS 3

2.4 CONTROL TRANSFORMER..... 3

2.5 MANUAL CONTROL 3

3 **EXECUTION** 4

3.1 INSTALLATION 4

3.2 FIELD QUALITY CONTROL 4

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REGISTERED PROFESSIONAL ENGINEER

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 24
CH0032	LIGHTING CONTROL DEVICES - LOW VOLTAGE	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Materials and installation for low voltage control system designed to provide remote switching of lighting loads by use of:
 - .1 Low voltage momentary contact switches.
 - .2 Low voltage relays.
 - .3 Manual switch control

1.1.2 Related Requirements

- .1 Section 26 05 00 - General Electrical Requirements.
- .2 Section 26 50 00 - Lighting

1.2 SUBMITTALS

1.2.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Exhibit 4 – Supplier Document Requirements List. Include product characteristics, performance criteria, and limitations.

1.2.2 Shop Drawings:

- .1 Submit shop drawings in accordance with Exhibit 4 – Supplier Document Requirements List.

1.2.3 Closeout Submittals:

- .1 Submit maintenance data in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3 TEST REPORTS

- .1 Submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties.
- .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 24
CH0032	LIGHTING CONTROL DEVICES - LOW VOLTAGE	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 Manufacturer's Instructions: submit manufacturer's installation instructions.

2 PRODUCTS

2.1 MATERIALS

.1 Control system: by one manufacturer and assembled from compatible components.

2.2 REMOTE CONTROL SWITCHES

.1 Single pole, double throw, momentary contact, heavy duty, rated 3 A, 25 V, centre pivot rocker action with pilot lights where indicated.

2.3 LOW VOLTAGE RELAYS

- .1 Electrically operated by momentary impulse, mechanically latched until activated.
- .2 Two coil solenoid type with one coil to close relay contacts and one coil to open relay contacts.
- .3 Operating voltage: 24 V, ac.
- .4 Load contacts: 20 A, 120 or 347 V, ac.
- .5 Auxiliary contacts for pilot light.
- .6 Coloured pre-stripped leads.

2.4 CONTROL TRANSFORMER

.1 Low voltage power Class 2, input 120 or 347 V, AC, 60 Hz, output 35 VA at 24 V.

2.5 MANUAL CONTROL

- .1 Individual remote control switches as indicated.
- .2 Eight circuit manual master selector switch mounted in 100 mm square box with:
 - .1 Master lock-out switch.
 - .2 Individual red jewelled pilot lights.
- .3 Nine circuit manual dial-type master selector.
- .4 Twelve circuit manual dial-type master selector.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 09 24
CH0032	LIGHTING CONTROL DEVICES - LOW VOLTAGE	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - General Electrical Requirements.
- .2 Actuate control units in presence of Engineer to demonstrate lighting circuits are controlled as designated.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 26 12 16
DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS

1	GENERAL	2
1.1	SECTION INCLUDES.....	2
1.2	RELATED REQUIREMENTS.....	2
1.3	REFERENCES.....	2
1.4	ACTION AND INFORMATIONAL SUBMITTALS.....	2
1.5	CLOSEOUT SUBMITTALS.....	3
2	PRODUCTS	4
2.1	OPERATING CHARACTERISTICS.....	4
2.2	TECHNICAL REQUIREMENTS.....	5
2.3	TECHNICAL CHARACTERISTICS.....	5
2.4	ENCLOSURE.....	6
2.5	WINDINGS.....	6
2.6	ACCESSORIES.....	7
2.7	EQUIPMENT IDENTIFICATION.....	7
3	EXECUTION	8
3.1	INSTALLATION.....	8
3.2	FIELD QUALITY CONTROL.....	8

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which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER
PEGNL
Newfoundland and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
G. W. HAINES
G. W. Haines
SIGNATURE
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials and components for dry type transformers from 1000 V up to 34.5 kV primary, equipment identification and transformer installation.

1.2 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.

1.3 REFERENCES

1.3.1 Canadian Standards Association (CSA)

- .1 CAN/CSA C9, Dry-Type Transformers.
- .2 CAN/CSA-C802.2, Minimum Efficiency Values for Dry Type Transformers.
- .3 CAN/CSA – C6044-I, Instrument Transformers – Part 1: Current Transformers
- .4 CAN/CSA - C60044-I, Instrument Transformers – Part 2: Inductive Voltage Transformers

1.3.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

- .1 EEMAC GL1-3, Power Transformer and Reactor Bushings.
- .2 CSA C22.1, Canadian Electrical Code, Part 1 (21st Edition), Safety Standard for Electrical Installations.

1.3.3 Institute of Electrical and Electronics Engineers (IEEE)

- .1 IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers.
- .2 IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers

1.4 ACTION AND INFORMATIONAL SUBMITTALS

1.4.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for transformers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4.3 Shop Drawings:

- .1 Indicate on drawings:
 - .1 Dimensions showing enclosure, mounting devices, terminals, taps, internal and external component layout.
 - .2 Technical data for transformer:
 - .1 kVA rating.
 - .2 Primary and secondary voltages.
 - .3 Frequency.
 - .4 Three phase.
 - .5 Polarity or angular displacement.
 - .6 Full load efficiency.
 - .7 Regulation at unity pf.
 - .8 BIL.
 - .9 Insulation type.
 - .10 Sound rating.

- 1.4.4 Factory Test Submittals: submit standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9.

1.5 CLOSEOUT SUBMITTALS

- 1.5.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- 1.5.2 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.3 Operation and maintenance instructions to include:

- .1 Tap changing.
- .2 Recommended environmental conditions.
- .3 Recommended periodic inspection and maintenance.
- .4 Bushing replacement.

2 PRODUCTS

2.1 OPERATING CHARACTERISTICS

- .1 Primary Voltage A:
 - .1 Nominal Operating Voltage 25kV
 - .2 Maximum Rated Voltage 27 kV r.m.s
 - .3 Nominal System Frequency 60 Hz
 - .4 Number of Phases 3
 - .5 Lightning Impulse Withstand Voltage 150 kV peak
 - .6 Power Frequency Withstand Voltage 50 kV r.m.s
 - .7 Short-circuit current 25 kA
- .2 Secondary Voltage
 - .1 Nominal Operating Voltage (V) 600
 - .2 Maximum Rated Voltage (V r.m.s.) 660
 - .3 System Earthing Solidly Grounded
- .3 Auxiliary Power Supply
 - .1 AC supply voltage for motors 600 V, 3-ph, 60HZ
 - .2 AC supply voltage for power receptacles 120 V, 1-ph, 60 Hz
 - .3 DC supply voltage for protection equipment 125 V d.c.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 TECHNICAL REQUIREMENTS

2.2.1 Design Considerations

- .1 The transformers shall be capable of withstanding, without injury, the mechanical and thermal stresses produced by external short circuits on the terminal of any winding for duration of two (2) seconds. They shall be designed for short circuit withstand capability as per the relevant standards.
- .2 In the event of sudden disconnection of the load, the transformers shall be capable of operating at a voltage approximately 25% above the rated voltage for a period of one (1) minute and 40% above the rated voltage for a period of five (5) seconds.
- .3 Transformers shall be of low loss (copper and steel) design.

2.3 TECHNICAL CHARACTERISTICS

- .1 Rated Power 1250 kVA
- .2 Type of Cooling ANN
- .3 Number of Phases 3
- .4 Nominal Frequency 60 Hz
- .5 Rated Voltage:
 - .1 High Voltage (H.V.) Winding 24, 940 V
 - .2 Low Voltage (L.V.) Winding 600 Y/347 V
- .6 Off load taps: 2x ± 2.5% taps (2FCAN + 2FCBN)
- .7 Winding Insulation Level:
 - .1 High Voltage (H.V.) Winding 125 kV BIL
 - .2 Low Voltage (L.V.) Winding 10 kV BIL
- .8 H.V. Winding Connection Delta
- .9 L.V. Winding Connection Star connected and neutral solidly grounded
- .10 Vector Group Dyn11



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .11 Winding Insulation Vacuum Pressure Impregnated (VPI)
- .12 Insulation Class 220°C
- .13 Temperature Rise 115°C
- .1 H.V. CTs One (1) set 1200/600:5A, C400
- .2 L.V. Neutral CTs One (1) 1200/600:5A, C400
- .3 Transformer impedance 5.5% @ 1250 kVA

2.4 ENCLOSURE

- .1 Fabricated from sheet steel with drip shield.
- .2 Bolted removable panels for access to tap connections, enclosed terminals and other accessories.
- .3 High Voltage Conductor entry:
 - .1 Entry for busbars from close coupled 25 kV Primary Switchgear.
 - .2 Bushings: EEMAC GL1-3.
- .4 Entry for 600 V busway.
- .5 Designed for floor mounting complete with mounting holes for anchor bolts.
- .6 Indoor, ventilated, self cooled type. Temperature of exposed metal parts not to exceed 65°C rise,

2.5 WINDINGS

2.5.1 Primary and secondary coils:

- .1 Copper
- .2 Nomex insulation, vacuum pressure impregnated with high temperature polyester resin

2.5.2 Coil and core assembly:

- .1 Taps located at front of coils for accessibility.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5.3 Sound level: not to exceed 68 dB.

2.6 ACCESSORIES

- .1 Winding temperature monitoring system, which shall include embedded temperature detectors in each winding.
- .2 Wiring and terminal box for protective devices.
- .3 Digital type winding temperature indicator with alarm and trip contacts.
- .4 Provision only for fans for forced air cooling, with thermostat control] [with temperature indicator sequence contacts control.
- .5 Two (2) grounding terminals: outside of enclosure.
- .6 The core shall be grounded



- .7 Portable (Safety) Grounds attachment points shall be provided on the terminals of each of the three (3) high voltage windings. Attachment points shall be Maclean Power Systems 20 mm ball studs or equivalent, tested in accordance with CAN/ULC-61230, Live Working – Portable Equipment for Grounding and Bonding. The Transformer and enclosure shall be designed such that maintenance staff can easily and safely gain access to the ground attachment points while keeping all parts of their person a minimum distance of 900 mm from any part of the 25 kV circuit.

2.6.1 Suitable provision for lifting of the complete transformer and the transformer core and coils assembly (hoisting eyes) shall be incorporated in to the design. Each enclosure shall be supplied with the necessary elements for moving and maintenance, including hauling attachment points.

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Equipment labels: nameplate size 7.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16
CH0032	DRY TYPE, MEDIUM VOLTAGE TRANSFORMERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

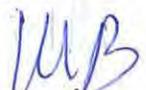
3.1 INSTALLATION

- .1 Locate, install and ground transformer in accordance with manufacturer's instructions.
- .2 Set and secure transformers in place, rigid plumb and square.
- .3 Connect primary bushings to high voltage circuit.
- .4 Connect secondary terminals to secondary feeder cable.
- .5 Energize transformers and check secondary no-load voltage.
- .6 Wire one set of contacts on winding temperature monitoring system to sound alarm.
- .7 Wire alarm contacts on winding temperature indicator to sound alarm when excessive temperature reached.
- .8 Connect sequence contacts of temperature indicator:
 - .1 First contact closure: start fan. (future)
 - .2 Second contact closure: sound alarm.
 - .3 Third contact closure: trip secondary breaker.
- .9 Use torque wrench to adjust internal connections in accordance with manufacturers' recommended values.
- .10 Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.

END OF SECTION



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS

SECTION 26 12 16.01

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

PART 1 GENERAL..... 2

1.1 SECTION INCLUDES 2

1.2 RELATED SECTIONS 2

1.3 REFERENCES 2

1.4 ACTION AND INFORMATIONAL SUBMITTALS 2

1.5 QUALITY ASSURANCE 3

1.6 DELIVERY, STORAGE, AND HANDLING 4

1.7 COORDINATION 4

PART 2 PRODUCTS 4

2.1 GENERAL TRANSFORMER REQUIREMENTS 4

2.2 DISTRIBUTION TRANSFORMERS 4

2.3 OPTIONS TO ADDRESS NFPA 70E/CSA-Z462 ARC FLASH STANDARD 6

2.4 EQUIPMENT IDENTIFICATION 6

2.5 SOURCE QUALITY CONTROL 6

PART 3 EXECUTION 6

3.1 EXAMINATION 6

3.2 INSTALLATION 7

3.3 CONNECTIONS 7

3.4 FIELD QUALITY CONTROL 7

3.5 ADJUSTING 7

3.6 CLEANING 7



Handwritten signature/initials in blue ink.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 RELATED SECTIONS

- .1 Section: 26 05 00 - General Electrical Requirements.
- .2 Section: 26 05 22 – Connectors and Terminations.
- .3 Section: 26 05 20 – Grounding - Secondary.

1.3 REFERENCES

1.3.1 Canadian Standards Association (CSA International)

- .1 CAN/CSA-C22.2 No.47, Air-Cooled Transformers (Dry Type).
- .2 CSA C9, Dry-Type Transformers.
- .3 CSA C22.2, No. 94.1, Enclosures for Electrical Equipment, Non-environmental Considerations.
- .4 CSA C22.2, No. 94.2, Enclosures for Electrical Equipment, Environmental Considerations.
- .5 CSA C802.2, Minimum Efficiency for Dry-Type Transformers

1.3.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA TP2, Standard Test method for Measuring the Energy Consumption of Distribution Transformers.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

1.4.1 Submit Product Data for each type and size of transformer indicated in accordance with Exhibit 4 – Supplier Document Requirements List.

- .2 Physical: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

.3 Efficiency Data

1. No load and full load losses per CSA C802.2.
2. Linear load Efficiency data @ 1/6, 1/4, 1/2, 3/4, & full load.
3. Linear Load Efficiency @ 35% loading tested per NEMA TP-2.
4. Efficiency under K7 load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.

1.4.2 Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

.1 Wiring Diagrams: Power, signal, and control wiring.

1.4.3 Qualification Data: For testing agency.

1.4.4 Source quality-control test reports.

1.4.5 Field quality-control test reports.

1.4.6 Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

1.5.1 Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

1.5.2 Source Limitations: Obtain each transformer type through one source from a single manufacturer.

1.5.3 Electrical Components, Devices and Accessories: Listed and labelled as defined to Canadian Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5.4 Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.7 COORDINATION

1.7.1 Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases.

1.7.2 Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.1 GENERAL TRANSFORMER REQUIREMENTS

- .1 Description: Factory-assembled and tested, air-cooled units for 60 Hz service
- .2 Cores: Grain-oriented, non-aging silicon steel.
- .3 Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.2 DISTRIBUTION TRANSFORMERS

2.2.1 Type: ANN

2.2.2 Three phase, rating and voltage ratio as indicated.

2.2.3 Cores: One leg per phase.

2.2.4 Enclosure: CSA C 22.2, No. 94, Type 2 Drip Proof inside the Spillway Electrical Building and Type 3R inside Intake and Spillway Hoist Houses.

- .1 Core and coils shall be impregnated within resin compound, sealing out moisture and air.

2.2.5 Transformer Enclosure Finish: Comply with CSA C22.2, No. 94.2.

- .1 Finish Color: ANSI 61 Light Grey.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.6 Taps for Transformers smaller than 3 kVA: None.
- 2.2.7 Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- 2.2.8 Taps for Transformers 25 kVA and larger: Two 2.5 percent taps above and four 2.0 percent taps below normal full capacity.
- 2.2.9 Insulation Class: 220°C, UL-component-recognized insulation system with a maximum of 115°C rise above 40°C ambient temperature.
- 2.2.10 K-Factor Rating: Transformers shall be K-Factor 7 or higher rated and comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
 - .1 Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - .2 Indicate value of K-factor on transformer nameplate.
- 2.2.11 Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize inter-winding capacitance.
 - .1 Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - .2 Include special terminal for grounding the shield.
 - .3 Shield Effectiveness:
 - 1. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - 2. Common-Mode Noise Attenuation: Minimum of minus 120 dB at 0.5 to 1.5 kHz; minimum of minus 65 dB at 1.5 to 100 kHz.
 - 3. Normal-Mode Noise Attenuation: Minimum of minus 52 dB at 1.5 to 10 kHz.
- 2.2.12 Wall Brackets: Manufacturer's standard brackets.
- 2.2.13 Fungus Proofing: Permanent fungicidal treatment for coil and core.
- 2.2.14 Low-Sound-Level Requirements: CSA C9 standard sound levels when factory tested according to IEEE C57.12.91.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.3 OPTIONS TO ADDRESS NFPA 70E/CSA-Z462 ARC FLASH STANDARD

2.3.1 Lockable Hinged Front Access Doors

- .1 Allows safe and rapid access to the transformer without the need to undo multiple screws and handle heavy metal cover plates that are in close proximity to live electrical points.
- .2 Doors shall be able to be secured using a padlock.

2.4 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section: 26 05 00 – General Electrical Requirements.
- .2 Label Size: 7.
- .3 Nameplate wording shall include equipment tag number, voltage ratio and source circuit identification.

2.5 SOURCE QUALITY CONTROL

- .1 Test and inspect transformers according to IEEE C57.12.91.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.
- .2 Verify that field measurements are as needed to maintain working clearances required by CSA C22.1 and manufacturer's written instructions.
- .3 Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- .4 Verify that ground connections are in place and requirements in Section: 26 05 28 – Grounding – Secondary have been met.
- .5 Proceed with installation only after unsatisfactory conditions have been corrected.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION:: 26 12 16.01
CH0032	DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 INSTALLATION

- .1 Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as required to meet codes applicable to project.
- .2 Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project.

3.3 CONNECTIONS

- .1 Ground equipment according to Section: 26 05 28 – Grounding – Secondary.
- .2 Connect wiring according to Section: 26 05 22 – Connectors and Terminations.

3.4 FIELD QUALITY CONTROL

- .1 Conduct tests in accordance with Section: 26 05 00 – General Electrical Requirements.
- .2 Remove and replace units that do not pass tests or inspections and retest as specified above.

3.5 ADJUSTING

- .1 Record transformer secondary voltage at each unit. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding name plate voltage plus 10 percent and not being lower than name plate voltage minus 3 percent at maximum load conditions.
- .2 Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- .1 Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 17
CH0032	FULL LOAD INTERRUPTER SWITCHES TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 26 13 17
FULL LOAD INTERRUPTER SWITCHES TO 25 kV

1 GENERAL 2

1.1 RELATED REQUIREMENTS 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

1.4 CLOSEOUT SUBMITTALS 2

2 PRODUCTS 2

2.1 LOAD INTERRUPTER SWITCH 2

2.2 FABRICATION 3

3 EXECUTION 3

3.1 INSTALLATION 3

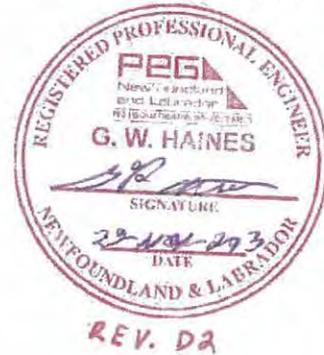
3.2 FIELD QUALITY CONTROL 4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 17
CH0032	FULL LOAD INTERRUPTER SWITCHES TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 13 18 – Primary Switchgear Assembly to 25 kV

1.2 REFERENCES

1.2.1 CSA International

- .1 CSA C22.2 No.193, High-Voltage Full-Load Interrupter Switches.

1.2.2 Electrical Equipment Manufacturers Association of Canada (EEMAC)

- .1 EEMAC G8-2, Switchgear Assemblies

1.3 SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for interrupter switches and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for interrupter switches for incorporation into manual.

2 PRODUCTS

2.1 LOAD INTERRUPTER SWITCH

- .1 Load Interrupter Switch: to CSA C22.2 No.193.
- .2 3-pole, quick-make, quick-break assembly, stored energy operating mechanism manual operated, assembled on welded steel base.
- .3 Continuous full load rating: 600 A, load interrupting rating: 600 A, at 25 kV.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 17
CH0032	FULL LOAD INTERRUPTER SWITCHES TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Nominal voltage rating: 25 kV.
- .5 Maximum rated voltage: 27 kV.
- .6 Dielectric strength test voltage: 60 kV.
- .7 Rated momentary current: 40 kA, asymmetrical.
- .8 Rated two-second short-time current: 25 kA, symmetrical.
- .9 125 kV BIL.
- .10 Interphase barriers.
- .11 Non-removable operating handle c/w provision for pad locking and key interlock.
- .12 Power fuses: 400 A maximum.
- .13 Power fuses supplied: 65E, minimum 16 kA, symmetrical interrupting capacity
- .14 Enclosure: CSA Enclosure Type 1 with gaskets and filters on ventilation openings..
- .15 Include viewing windows that permits full view of the position of all three switch blades.
- .16 Kirk key Interlocks with features as follow:
 - .1 Fuse is only accessible after switch is opened.
 - .2 Switch can be closed only after fuse access door is closed.
 - .3 Interlock main switch and standby supply switch to allow only one out of the two switches to be closed.



2.2 FABRICATION

- .1 Factory assemble and adjust 3 pole gang operated switch, operating assembly, interphase barriers and interlocks.

3 EXECUTION

3.1 INSTALLATION

- .1 Install load interrupter switches in accordance with the drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 17
CH0032	FULL LOAD INTERRUPTER SWITCHES TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Check switch contact resistance with low resistance meter.
- .3 Megger switch across each pole, from pole to pole, and from pole to ground.

END OF SECTION

46 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 26 13 18
PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES.....	2
1.3	SUBMITTALS.....	2
1.4	CLOSEOUT SUBMITTALS.....	3
1.5	QUALITY ASSURANCE.....	3
1.6	EXTRA MATERIALS.....	4
2	PRODUCTS	4
2.1	MATERIALS.....	4
2.2	PRIMARY SWITCHGEAR.....	4
2.3	PRIMARY ENCLOSURE.....	4
2.4	BUS BARS.....	5
2.5	GROUNDING.....	6
2.6	LOAD INTERRUPTER SWITCH.....	6
2.7	INTERLOCKS.....	6
2.8	PRIMARY INSTRUMENTS.....	7
2.9	OWNER METERING.....	7
2.10	INDICATOR LIGHTS.....	7
2.11	FINISHES.....	7
2.12	EQUIPMENT IDENTIFICATION.....	7
2.13	WARNING SIGNS.....	7
2.14	SOURCE QUALITY CONTROL.....	8
3	EXECUTION	8
3.1	INSTALLATION.....	8
3.2	FIELD QUALITY CONTROL.....	8

PROVINCE OF NEWFOUNDLAND AND LABRADOR

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REV. D2
Page 1 of 9

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 12 16 – Dry Type Medium Voltage Transformers.
- .3 Section: 26 13 17 – Full Load Interrupter Switches to 25 kV

1.2 REFERENCES

1.2.1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

- .1 ANSI/IEEE C57.12, General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

1.2.2 CSA International

- .1 CSA C22.2 No.14, Industrial Control Equipment.
- .2 CSA C22.2 No.31, Switchgear Assemblies.
- .3 CSA C22.2 No.193, High-Voltage Full-Load Interrupter Switches.
- .4 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

1.2.3 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

- .1 EEMAC G1-1, Indoor and Outdoor Switch and Bus Insulators.
- .2 EEMAC G8-3.3, Metal-Enclosed Interrupter Switchgear Assemblies.

1.2.4 National Electrical Manufacturers Association (NEMA)

1.3 SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for switchgear assembly and include product characteristics, performance criteria, physical size, finish and limitations.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Primary switchgear assembly to include:

- .1 Enclosure.
- .2 Load interrupter switches.
- .3 Power fuses.

1.3.3 Shop Drawings:

- .1 Indicate on drawings:
 - .1 Floor anchoring method and dimensioned foundation template. Dimensioned cable entry and exit locations.
 - .2 Dimensioned cable termination height.
 - .3 Dimensioned position and size of busbars and details of provision for extension.
 - .4 Dimensioned positions of main connections, including air clearances and support insulators.
 - .5 Layout of internal and front panel components suitably identified.
 - .6 Time current characteristics curves of protection devices.

1.3.4 Certificates:

- .1 Submit manufacturer's test routine and type certificates.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for primary switchgear assembly for incorporation into manual.

1.5 QUALITY ASSURANCE

- .1 Submit manufacturer's type test certificates indicating switchgear cubicles and components tested as integrated assembly.
- .2 Submit test procedures, at least 10 days prior to testing.
- .3 Submit production test results before equipment is shipped from factory.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6 EXTRA MATERIALS

1.6.1 Submit spare parts list in accordance with Exhibit 4 – Supplier Document Requirements List.

1.6.2 Include:

- .1 1 set power fuses of each type installed.
- .2 6 of each type of indicator light bulbs installed.

2 PRODUCTS

2.1 MATERIALS

- .1 Switchgear assembly: to CSA C22.2 No.31.
- .2 Steel for cubicles: to CSA G40.21.
- .3 Insulators: to CSA C22.2 No.58.
- .4 Enclosure finish to manufacturer's standard.

2.2 PRIMARY SWITCHGEAR

- .1 Primary switchgear: indoor, 27 kV, 600 A, 3 phase, 3 wire, short circuit capacity 16 kA, BIL 125 kV.

2.3 PRIMARY ENCLOSURE

- .1 Primary enclosure: metal enclosed free standing, floor mounted, dead front, indoor CSA Enclosure Type 12 cubicle unit. Constructed from rolled flat steel sheets.
- .2 Switchgear shall be close coupled with medium voltage transformer specified in Section: 26 12 16 and as indicated on drawings.
- .3 Ventilating louvres: vermin and insect proof with easily replaceable fiberglass filters.
- .4 Use non-corrosive bolts and hardware.
- .5 Access from front and back.
- .6 100 mm steel channel sills for base mounting in single length common to multi-cubicle switchboard.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Full height outer doors, gasketed, hinges on left side, provision for multiple padlocking. Three point latch, stops, to open at least 135 degrees with viewing windows of transparent shatterproof material for inspection of disconnecting switch position.
- .8 Hinge doors on same side.
- .9 Gaskets on removable covers.
- .10 Allow for future extension on both sides indicated of cubicle unit.
- .11 Inner door: hinged and bolted mesh steel screens to prevent inadvertent contact with exposed live parts, to open at least 90 degrees.
- .12 Storage container on inside surface of compartment capable of accommodating 3 spare fuses.
- .13 Include spare fuses.
- .14 Metal pocket with weatherproof envelope and 1 set of drawings and diagram prints on inside surface of door.
- .15 Space heaters: 120 V, 250 W, 60 Hz, single phase, low watt density complete with thermostat breaker in each cubicle.
- .16 Interior lamp and lampholder in each cubicle with externally mounted switch c/w wire guard.
- .17 Receptacle: 120 V, single phase, 60 Hz, U-ground, duplex in each cubicle.
- .18 Provide access control as follows:
- .19 Equip doors providing access to interrupter switches with fuses with mechanical interlock to guard against:
 - .1 Opening door if interrupter switch on source side of fuse is closed.
 - .2 Closing interrupter switch if door is open.

2.4 BUS BARS

- .1 Three phase insulated busbars, continuous current rating 600 A extending full width of multi-cubicle switchboard suitably supported on insulators.
- .2 Main connections between busbars, major switching components and fuses of continuous current rating to match major switching components.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .3 High conductivity copper for busbars and main connections.
- .4 Provision for extension of bus on both sides of unit without need for further drilling or field preparation.
- .5 Brace busbar system including ground bus to withstand stresses resulting from short circuit currents specified.
- .6 Silver surfaced joints, secured with non-corrosive bolts and Belleville washers, tightened with torque wrench in accordance with manufacturer's recommendations.
- .7 Identify phases of busbars by suitable marking.
- .8 Busbar connectors when switchgear shipped in more than one section.

2.5 GROUNDING

- .1 Copper ground bus not smaller than 50 x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.
- .2 Lugs at each end for size 4/0 AWG grounding cable.
- .3 Bond non-current carrying parts, including switchgear framework, enclosure and bases to ground bus.
- .4 Portable (Safety) Grounds attachment points shall be provided on each MV terminal. Attachment points shall be Maclean Power Systems 20 mm ball studs or equivalent, tested in accordance with CAN/ULC-61230, Live Working – Portable Equipment for Grounding and Bonding. The switchgear and enclosure shall be designed such that maintenance staff can easily and safely gain access to the ground attachment points while keeping all parts of their person a minimum distance of 900 mm from any part of the 25 kV circuit.



2.6 LOAD INTERRUPTER SWITCH

- .1 Load interrupter switch in accordance with Section: 26 13 17.

2.7 INTERLOCKS

- .1 Interlocks in accordance with Section: 26 18 41.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.8 PRIMARY INSTRUMENTS

- .1 Instrument in accordance with Section: 26 09 23.01.

2.9 OWNER METERING

- .1 Owner metering in accordance with Section: 26 09 23.01.

2.10 INDICATOR LIGHTS

- .1 Include long life LED indicator lights rated for control voltage to CSA C22.2 No.14.
- .2 Include push to test lights with transparent plastic cover.

2.11 FINISHES

- .1 Apply finishes in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Cubicle exteriors: ANSI 61 light grey.
- .3 Cubicle interiors: white.
- .4 Supply two (2) spray cans touch up paint.



2.12 EQUIPMENT IDENTIFICATION

- .1 Equipment identification in accordance with Section: 26 05 00 - General Electrical Requirements.

2.12.1 Nameplates:

- .1 Switchgear designation: label - white plate, black letters, size 7, engraved.
Individual cubicle designations: labels - white plate, black letters, size 5, engraved.

2.13 WARNING SIGNS

- .1 Include warning signs in accordance with Section: 26 05 00 - General Electrical Requirements].

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.14 SOURCE QUALITY CONTROL

- .1 Engineer will witness standard factory testing of complete switchgear assembly, including operation of switches and controls.
- .2 Notify Engineer in writing, 10 days prior to testing, that equipment is ready for inspection.

3 EXECUTION

3.1 INSTALLATION

- .1 Set and secure switchgear assembly in place on channel base, rigid, plumb and square.
- .2 Make field connections in accordance with manufacturer's recommendations.
- .3 Connect ground bus to building system ground.
- .4 Render entire assembly rodent and insect proof by means of plates, screens, and grouting.
- .5 Ensure fixed housing into which interrupter moving carriage enters, is plumb.
- .6 Check factory made connections for mechanical security and electrical continuity.
- .7 Check fuse sizes against shop drawings.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Operate load interrupter closing and tripping mechanisms, to verify correct functioning.
- .3 Check insulation of switchgear assembly with DC Hi-Pot tester in accordance with manufacturer's approved methods. If values are not satisfactory, clean, and dry switchgear and repeat tests until readings acceptable to Engineer.
- .4 Check insulation of switchgear assembly with 1000V megger. If values not satisfactory, clean, and dry switchgear and repeat tests until readings acceptable to Engineer.
- .5 Check phase rotation of each feeder.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 13 18
CH0032	PRIMARY SWITCHGEAR ASSEMBLY TO 25 kV	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 Place primary switchgear in service and check meter readings to ensure proper functioning of instruments and satisfactory phase balance of loads.
- .7 Check fuses for correct type and rating.
- .8 Check for grounding and neutral continuity between station ground and system neutral.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 18 41
CH0032	INTERLOCK SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 18 41
INTERLOCK SYSTEMS
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES	2
1.3	SUBMITTALS	3
2	PRODUCTS	3
2.1	INTERLOCK SYSTEMS	3
3	EXECUTION	4
3.1	INSTALLATION	4
3.2	FIELD QUALITY CONTROL.....	4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 18 41
CH0032	INTERLOCK SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 13 17 - Full Load Interrupter Switches to 25 kV
- .3 Section 26 13 17 - Full Load Interrupter Switches to 25 kV
- .4 Section 26 13 18 - Primary Switchgear Assembly to 25 kV
- .5 Section 26 23 300 – Low Voltage Switchgear
- .6 Section 26 28 16.01 – Air Circuit Breakers
- .7 Section 26 28 16.02 – Molded Case Circuit Breakers
- .8 Section 26 23 300 – Low Voltage Switchgear
- .9 Section 26 24 19 – Motor Control Centres
- .10 Section 26 29 10 – Motor Starters to 600 V.

1.2 REFERENCES

1.2.1 Institute of Electrical and Electronics Engineers (IEEE)

- .1 IEEE C37.20.1, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
- .2 IEEE C37.20.2, Standard for Metal-Clad and Station-Type Cubicle Switchgear.
- .3 IEEE C37.35, Guide for the Application, Installation, Operation, and Maintenance of High-voltage Air Disconnecting and Interrupter Switches.
- .4 IEEE 241, Recommended Practice for Electric Power Systems in Commercial Buildings.
- .5 IEEE 1015, Blue Book IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

1.2.2 CSA International

- .1 CSA C22.2 No.31, Switchgear Assemblies.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 18 41
CH0032	INTERLOCK SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3 SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for interlock systems and include product characteristics, performance criteria, physical size, finish and limitations.

2 PRODUCTS

2.1 INTERLOCK SYSTEMS

- .1 Mechanical interlocks between two power circuit breakers located in adjacent cells to prevent:
 - .1 Standby power breaker closing unless normal power breaker is open.
 - .2 Normal power breaker closing unless standby power breaker is open.
- .2 Electrical interlock between normal power circuit breaker and standby power circuit breaker to prevent:
 - .1 Standby power breaker closing unless normal power breaker is open.
 - .2 Normal power breaker closing unless standby power breaker is open.
- .3 Kirk key interlocks, Type F for load interrupter switch and Type D for switchgear cubicle door to prevent:
 - .1 Opening cubicle door for access to fuses while load interrupter is in closed position.
 - .2 Closing load interrupter while cubicle door is open.
- .4 Kirk key interlocks, Type T, key transfer with Type F for main isolating switch and feeder circuit breakers or load interrupters to prevent:
 - .1 Opening isolating switch until all [circuit breakers] [load interrupters] are open.
 - .2 Closing any or all [circuit breakers] [load interrupters] while isolating switch is open.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 18 41
CH0032	INTERLOCK SYSTEMS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Kirk key interlocks, Type F for normal load interrupter switch and standby load interrupter switch to prevent:
 - .1 Standby power breaker closing unless normal power breaker is open.
 - .2 Normal power breaker closing unless standby breaker is open.
- .6 Kirk key interlocks Type F for normal power breaker and standby power breaker to prevent:
 - .3 Standby power breaker closing unless normal power breaker is open.
 - .4 Normal power breaker closing unless standby breaker is open.
- .7 Key interlocks mounted in switchgear so that interlocks cannot be removed when circuit breaker or load interrupter switch is in closed position.

3 EXECUTION

3.1 INSTALLATION

- .1 Install interlocks in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 23 00
LOW VOLTAGE SWITCHGEAR

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES.....	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS.....	2
1.4	CLOSEOUT SUBMITTALS.....	3
2	PRODUCTS	3
2.1	MATERIALS.....	3
2.2	RATING.....	3
2.3	DESCRIPTION.....	3
2.4	ENCLOSURE.....	3
2.5	BUSBARS.....	4
2.6	GROUNDING.....	5
2.7	AIR CIRCUIT BREAKER.....	5
2.8	MOULDED CASE CIRCUIT BREAKERS.....	5
2.9	INSTRUMENTS.....	5
2.10	INSTRUMENT TRANSFORMERS.....	5
2.11	FINISHES.....	5
2.12	EQUIPMENT IDENTIFICATION.....	5
2.13	ARC FLASH REDUCTION MAINTENANCE SYSTEM.....	6
2.14	PROVISIONS FOR ISOLATION (LOCKOUT).....	6
3	EXECUTION	6
3.1	INSTALLATION.....	6
3.2	FIELD QUALITY CONTROL.....	7



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements
- .2 Section: 26 28 16.01 – Air Circuit Breakers
- .3 Section: 26 25 00 – Enclosed Bus Assemblies
- .4 Section: 26 09 23.01 – Metering and Switchboard Instruments

1.2 REFERENCES

1.2.1 CSA International

- .1 CSA C22.2 No.31, Switchgear Assemblies.
- .2 CAN/CSA C60044.1, Instrument Transformers – Part 1: Current Transformers.
- .3 CAN/CSA C60044.2, Instrument Transformers – Part 2: Inductive Voltage Transformers.

1.2.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

- .1 EEMAC G8-3.3, Metal Enclosed Interrupter Switchgear Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for low voltage switchgear and include product characteristics, performance criteria, physical size, finish and limitations.

1.3.3 Shop Drawings:

- .1 Indicate on drawings:
 - .1 Floor anchoring method and foundation template;
 - .2 Dimensioned bus and cable entry and exit locations;
 - .3 Dimensioned position and size of bus;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Overall length, height and depth of complete switchgear;
- .5 Dimensioned layout of internal and front panel mounted components.

1.3.4 Certificates:

- .1 Submit certified factory test results;
- .2 Submit certified type test results.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for low voltage switchgear and components for incorporation into manual.

2 PRODUCTS

2.1 MATERIALS

- .1 Switchgear assembly: to CSA C22.2 No.31.

2.2 RATING

- .1 Secondary switchgear: indoor, 600 V, 3 phase, 60 Hz, minimum short circuit capacity 35 kA (rms symmetrical), current rating as indicated.

2.3 DESCRIPTION

- .1 All low voltage switchgear shall be Eaton, Magnum DS.

2.4 ENCLOSURE

- .1 Main incoming sections to contain:
 - .1 Air circuit breaker sized as indicated;
 - .2 Digital metering system to Section: 26 09 23.01 - Metering and Switchboard Instruments.
- .2 Distribution sections to contain:
 - .1 Air circuit breaker sized as indicated;

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Copper bus, from main section to distribution sections including vertical bussing.
- .3 Blanked off spaces with bus stabs and hardware for mounting future units.
- .4 Metal enclosed, free standing, floor mounted, dead front, indoor, CSA Enclosure 1A cubicle unit.
- .5 Ventilating louvres: vermin, insect proof with easily replaceable fibre glass filters.
- .6 Access from front and rear.
- .7 Steel channel sills for base mounting.
- .8 Provision for future extension on right or left side as indicated.
- .9 Include manually operated breaker lifting device mounted on the top of the switch gear.
- .1 Where air circuit breakers are mounted in multiple cubicles, lifting device to travel on rail on top of switch board.
- .10 Space heater: 120 V, 250 W, 60 Hz, single phase, in each cubicle, complete with thermostat and disconnect switch.
- .11 Receptacle: 120 V, single phase, 60 Hz, duplex, U-ground, in each cubicle.
- .12 Infrared inspection ports shall be provided on the back of the enclosure to inspect switchgear buses.



2.5 BUSBARS

- .1 Three phase and 100% rated insulated busbars, continuous current rating as indicated, self-cooled, extending full width of multi-cubicle switch board, suitably supported on insulators.
- .2 Main connections between bus and major switching components to have continuous current rating to match major switching components.
- .3 Busbars and main connections: 99.30% minimum conductivity copper.
- .4 Allow for extension of bus on both sides of unit without need for further drilling or preparation in field.
- .5 Silver surfaced joints, secured with non-corrosive bolts and Belleville washers.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 Identify phases of busbars by suitable marking.
- .7 Busbar connectors, when switchboard shipped in more than one section.

2.6 GROUNDING

- .1 Copper ground bus not smaller than 50 mm x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.
- .2 Lugs at each end for size 4/0 AWG grounding cable.

2.7 AIR CIRCUIT BREAKER

- .1 Shall be in accordance with Section: 26 28 16.01 – Air Circuit Breakers.

2.8 MOULDED CASE CIRCUIT BREAKERS

- .1 Shall be in accordance with Section: 26 28 16.02 – Moulded Case Circuit Breakers.

2.9 INSTRUMENTS

- .1 Shall be in accordance with Section: 26 09 23.01 – Metering and Switchboard Instruments.

2.10 INSTRUMENT TRANSFORMERS

- .1 Current Transformers shall be in accordance with CAN/CSA C60044.1.
- .2 Potential Transformer shall be in accordance with CAN/CSA C60044.2.

2.11 FINISHES

- .1 Apply finishes in accordance with Section: 26 05 00 - General Electrical Requirements:
 - .1 Cubicle exteriors ANSI 61 light grey;
 - .2 Cubicle interiors white.

2.12 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Nameplates:

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 White plate, black letters, size 7;
- .2 Complete switchgear labelled: equipment tag numbers, voltage, system configuration and main bus ampacity;
- .3 Main cubicle labelled: "Main Breaker";
- .4 Distribution units labelled with Motor Control Centre (MCC) or load equipment tag numbers.

2.13 ARC FLASH REDUCTION MAINTENANCE SYSTEM



- .1 Switchgear shall be provided with arc flash protection systems:
 - .1 Arc flash protection system shall be the Maintenance Mode Arc Flash Reduction system;
 - .2 A door-mounted selector switch shall be provided to arm the arc flash reduction maintenance mode;
 - .3 The selector switch shall be lockable;
 - .4 A door-mounted light shall be provided to indicate that the function is on;
 - .5 Dry contact shall be provided for remote supervision by the powerhouse operator.

2.14 PROVISIONS FOR ISOLATION (LOCKOUT)

2.14.1 The following provisions for isolation shall be in accordance with Section: 26 05 00 General Electrical Requirements:

- .1 All circuit breakers shall be capable of being padlocked in the "disconnected" position;
- .2 All circuit breakers shall be capable of being padlocked in the "test" position;
- .3 All circuit breaker compartment shutters shall be capable of being padlocked in the "closed" position.

3 EXECUTION

3.1 INSTALLATION

- .1 Locate switchgear assembly as indicated and bolt to floor.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 23 00
CH0032	LOW VOLTAGE SWITCHGEAR	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Connect main power supply to main breaker.
- .3 Connect back up power supply to breaker.
- .4 Connect load side of breakers in distribution cubicles to distribution feeders or directly to bus of close coupled MCC.
- .5 Check factory made connections for mechanical security and electrical continuity.
- .6 Run two grounding conductor 4/0 AWG green insulated copper from ground bus to electrical room ground bar.
- .7 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 – General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 16.01
CH0032	PANELBOARDS BREAKER TYPE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 24 16.01
PANELBOARDS BREAKER TYPE

1 **GENERAL**..... 2

 1.1 SECTION INCLUDES..... 2

 1.2 RELATED SECTIONS..... 2

 1.3 REFERENCES..... 2

 1.4 ACTION AND INFORMATIONAL SUBMITTALS..... 2

2 **PRODUCTS**..... 2

 2.1 PANELBOARDS..... 2

 2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES..... 3

 2.3 BREAKERS..... 3

 2.4 EQUIPMENT IDENTIFICATION..... 4

 2.5 PROVISIONS FOR ISOLATION (LOCKOUT)..... 4

3 **EXECUTION**..... 4

 3.1 INSTALLATION..... 4

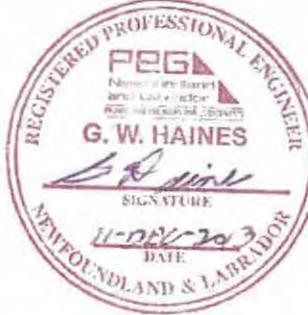
 3.2 FIELD QUALITY CONTROL..... 5

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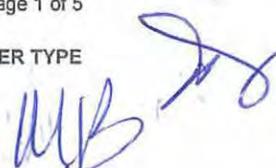


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REV. D2



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 16.01
CH0032	PANELBOARDS BREAKER TYPE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 28 21 - Moulded Case Circuit Breakers.
- .3 Section: 26 05 29 – Hangers and Supports for Electrical Systems



1.3 REFERENCES

1.3.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2No.29, Panelboards and enclosed Panelboards.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2 PRODUCTS

2.1 PANELBOARDS



- .1 Panelboards: to CSA C22.2 No.29
- .2 Panelboards shall be Eaton, Power-R-Line.
- .3 Install circuit breakers in panelboards before shipment.
- .4 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .5 250 and 600 Vac panelboards: bus and breakers rated for 14 kA, and 18 kA (symmetrical) interrupting capacity or as indicated on drawings.
- .6 125 Vdc panelboards: rated 250 Vdc, bus and breakers rated for 5 kA (symmetrical) interrupting capacity or as indicated on drawings.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 16.01
CH0032	PANELBOARDS BREAKER TYPE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .8 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .9 Two keys for each panelboard and key panelboards alike.
- .10 Aluminum bus with neutral of same ampere rating as mains.
- .11 Mains: suitable for bolt-on breakers.
- .12 Trim with concealed front bolts and hinges.
- .13 Trim and door finish: baked ANSI 61 light grey enamel.



2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES

- .1 125 mm relay section on one or both sides of panels as indicated for installation of low voltage remote control switching components.
- .2 125 Vdc and 48 Vdc panelboard assemblies to include relays, meters and control devices as indicated on the drawings.
- .3 Double stack panels as indicated.
- .4 Contactors in mains as indicated.
- .5 Feed through lugs as indicated.

2.3 BREAKERS

- .1 Breakers: to Section: 26 28 26.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Engineer.
- .5 Lock-on devices for receptacles, fire alarm, clock outlet, emergency, door supervisory, intercom, stairway, exit and night light circuits.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 16.01
CH0032	PANELBOARDS BREAKER TYPE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section: 26 05 00 – General Electrical Requirements.
- .2 Nameplate for each panelboard size 4 engraved with equipment tag number and voltage.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.5 PROVISIONS FOR ISOLATION (LOCKOUT)

2.5.1 The following provisions for isolation shall be in accordance with Section: 26 05 00 - General Electrical Requirements.



- .1 Panelboards shall be equipped with permanently mounted devices suitable for padlocking breakers securely in the "Off" position.
- .2 Panelboards for use on 600/347 Vac shall be equipped with visi-break type circuit breakers.

3 EXECUTION

3.1 INSTALLATION



- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Surface mounted panelboards shall be mounted on support channels in accordance with Section: 26 05 29 - Hangers and Supports for Electrical Systems. Where practical, panelboards shall be grouped on common channels.
- .3 Mount panelboards to height specified in Section: 26 05 00 - Common Work Results – Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

970 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 16.01
CH0032	PANELBOARDS BREAKER TYPE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

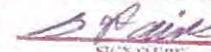
**TABLE OF CONTENTS
SECTION 26 24 19
MOTOR CONTROL CENTRES**

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES	2
1.3	SUBMITTALS	3
1.4	EXTRA MATERIALS.....	3
2	PRODUCTS	3
2.1	SUPPLY CHARACTERISTICS	3
2.2	GENERAL DESCRIPTION	4
2.3	VERTICAL SECTION CONSTRUCTION.....	4
2.4	SILLS.....	5
2.5	BUSBARS	5
2.6	GROUND BUS	5
2.7	INCOMING SECTIONS	6
2.8	MOTOR STARTERS AND DEVICES.....	6
2.9	STARTER UNIT COMPARTMENTS.....	6
2.10	WIRING IDENTIFICATION	7
2.11	EQUIPMENT IDENTIFICATION	7
2.12	FINISHES	7
2.13	SOURCE QUALITY CONTROL.....	7
3	EXECUTION	8
3.1	INSTALLATION	8
3.2	FIELD QUALITY CONTROL	8

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PEG
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G. W. HAINES

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22 Nov 2013
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REV. D2

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 09 23.01 – Metering and Switchboard Instruments.
- .3 Section: 26 29 10 – Motor Starters to 600V.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No. 14, Industrial Control Equipment
- .2 CSA C22.2 No 234, Motor Control Centres

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA ICS 1-2000 - Industrial Control and Systems: General Requirements
- .2 NEMA ICS 1.1 - Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
- .3 NEMA ICS 1.3 - Preventive Maintenance of Industrial Control and Systems Equipment
- .4 NEMA ICS 2 - Controllers, Contactors and Overload Relays Rated 600 V
- .5 NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600V
- .6 NEMA ICS 2.4 - NEMA and IEC Devices for Motor Service-A Guide for Understanding the Differences
- .7 NEMA ICS 4 - Application Guideline for Terminal Blocks
- .8 NEMA ICS 5 - Control Circuit and Pilot Devices
- .9 NEMA ICS 6 - Enclosures
- .10 NEMA ICS 12.1 - Industrial Control and Systems: Profiles of Networked Industrial Devices-Part 1: General Rules

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .11 NEMA ICS 18 - Motor Control Centers
- .12 NEMA ICS 19 - Diagrams, Device Designations and Symbols

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Submit product data sheets for sills, busbars and compartments. Include product characteristics, physical size and finish.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures
- .4 Submit shop drawings and indicate:
 - .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable and bus duct entry and exit locations.
 - .5 Dimensioned position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.
- .5 Closeout Submittals: provide operation and maintenance data for motor control centre for incorporation into manual specified in Exhibit 4 – Supplier Document Requirements List.
- .6 Include data for each type and style of starter.

1.4 EXTRA MATERIALS

- .1 Provide spare parts list in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 SUPPLY CHARACTERISTICS

- .1 600 V, 3 phase, 3 wire, with horizontal and vertical ground buses.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.2 GENERAL DESCRIPTION

- .1 All motor control centres to be products of Eaton, Freedom 2100 MCC.
- .2 Compartmentalized vertical sections with common power busbars.
- .3 Floor mounting, free standing, enclosed dead front.
- .4 Indoor CSA Type 12 enclosure.
- .5 Class 1, Type B.
- .6 Motor Control Centers shall include the following features to reduce arc flash hazard:
 - .1 Arc-containment latches on all doors.
 - .2 Automatic shutters on plug-in structures.
 - .3 Insulating covers on horizontal and vertical bus bars.
 - .4 Communication port in the door.
 - .5 Finger safe barriers.
 - .6 Isolation guards for starters, fuses, transformers and disconnects.
 - .7 Not used.



2.3 VERTICAL SECTION CONSTRUCTION

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Each vertical section divided into compartment units, minimum 305 mm high.
- .3 Each unit to have complete top and bottom steel plate for isolation between units.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.
- .5 Vertical wireways complete with doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables or busway to enter at top as indicated.
- .8 Provision for outgoing cables to exit via top or bottom.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, complete with hardware and instructions for re-assembly.

2.4 SILLS

- .1 Continuous 100 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 BUSBARS

- .1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - .1 Main horizontal busbars: as indicated.
 - .2 Branch vertical busbars: as indicated.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 42 kA rms symmetrical or as indicated.
- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 GROUND BUS

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.7 INCOMING SECTIONS

2.7.1 MCCs Close Coupled to Switchgear

- .1 Motor Control Centres close coupled with Lower Voltage Switchgear incoming sections as indicated on drawings.
- .2 Motor Control Centres shall include bus transition sections if required with bus connection between the incoming sections and the Motor Control Centre horizontal bus.

2.7.2 Standalone MMCs

- .1 Standalone MCCS shall include incoming drawout moulded case circuit breakers as indicated on drawings.
- .2 Incoming moulded case circuit breakers shall include facility to be padlocked in the disconnected position.

2.7.3 MCC Metering

- .1 Incoming sections from all sources shall include one (1) Multi-function Power Quality Monitoring Unit in accordance with Section: 26 09 23.01 – Metering and Switchboard Instruments.

2.8 MOTOR STARTERS AND DEVICES

- .1 In accordance with Section 26 29 10 – Motor Starters to 600 V.

2.9 STARTER UNIT COMPARTMENTS

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
 - .1 Engaged position - unit stabbed into vertical bus.
 - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed. Pushbuttons and indicating lights mounted on door front.
- .6 Devices and components by one manufacturer to facilitate maintenance.
- .7 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.10 WIRING IDENTIFICATION

- .1 Provide wiring identification in accordance with Section: 26 05 00 - General Electrical Requirements.

2.11 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section: 26 05 00 - General Electrical Requirements].
 - .1 Motor control centre main nameplate: size No. 7, engraved with equipment name, equipment tag number and voltage.
 - .2 Individual compartment nameplates: size No. 5, engraved with load identification.

2.12 FINISHES

- .1 Apply finishes in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Paint motor control centre exterior ANSI 61 light grey and interiors white.

2.13 SOURCE QUALITY CONTROL

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 24 19
CH0032	MOTOR CONTROL CENTRES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Engineer to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

3 EXECUTION

3.1 INSTALLATION

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure correct overload relay are installed and set as indicated.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 hours period.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 25 00
CH0032	ENCLOSED BUS ASSEMBLIES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 26 25 00
ENCLOSED BUS ASSEMBLIES
TABLE OF CONTENTS**

1 **GENERAL**..... 2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

2 **PRODUCTS** 2

2.1 BUSWAYS CHARACTERISTICS 2

2.2 FEEDER TYPE BUSWAYS 3

2.3 CABLE BUS..... 3

3 **EXECUTION** 3

3.1 INSTALLATION 3

3.2 FIELD QUALITY CONTROL..... 4

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G. W. Haines
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 25 00
CH0032	ENCLOSED BUS ASSEMBLIES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 23 00 – Low Voltage Switchgear.
- .3 Section 26 24 19 – Motor Control Centres.

1.2 REFERENCES

1.2.1 CSA International

- .1 CSA C22.2 No.27, Busways. (Tri-national standard, with UL 857-, - NMX-J-148-ANCE).
- .2 CSA C22.2 No. 38 – Thermostat-insulated Wires and Cables

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit in accordance with Section [01 33 00 - Submittal Procedures].

1.3.2 Product Data:

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
 - .1 Catalogue information and detail drawings.

1.3.3 Shop Drawings:

- .1 Indicate in detail exact routing of busways throughout building and in relation to column lines and structural slabs and walls. Provide voltage drop test results for each size of busway.

2 PRODUCTS

2.1 BUSWAYS CHARACTERISTICS

- .1 Full capacity neutral.
- .2 Unventilated or ventilated in CSA Enclosure 1 housing.
- .3 Low impedance type, or cable bus.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 25 00
CH0032	ENCLOSED BUS ASSEMBLIES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Joints: silver-plated and of bolt type construction.
- .5 Designed for one length or fitting to be removable without disturbing rest of run.
- .6 Cold rolled copper bars with 98% minimum conductivity.
- .7 Internal fire barriers at floor/wall penetrations complete with flanges.
- .8 Expansion joints on vertical and horizontal busway runs at locations recommended by manufacturer and where busway crosses building expansion joint.
- .9 Fittings, factory manufactured to suit type of busway used and as indicated transformer tap-offs, elbows, tees, offsets, flanged end connections, to switchboards and motor control centres.
- .10 Hangers to suit mounting position and type of busway, edgewise, flatwise or vertical.

2.2 FEEDER TYPE BUSWAYS

- 2.2.1 Feeder type busways: to CSA C22.2 No.27, low impedance.

2.3 CABLE BUS

- .1 Cable bus to: CSA C22.2 No. 27
- .2 Current carrying conductors shall have insulation rated for 90°C in accordance with CSA C22.2 No. 38.
- .3 The conductors shall be phased and supported to maintain low impedance and assure mechanical strength to prevent cable movement or damage under short circuit current.
- .4 Conductors shall be of continuous length and be pulled in place after the bus enclosure is in place.

3 EXECUTION

3.1 INSTALLATION

- .1 Install busway, cable bus and associated fittings, supports and accessories in accordance with manufacturer's recommendations.
- .2 Space hangers in accordance with manufacturers recommendations. Maximum spacing 3 m.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 25 00
CH0032	ENCLOSED BUS ASSEMBLIES	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Tighten busway joint bolts to loading recommended by busway manufacturer.
- .4 Cover busways with plastic envelope until building is clean and bus ready to be meggered and energized.
- .5 Torque single bolt sandwich type busway as recommended by manufacturer. Only retorquer single bolt sandwich type busway if procedure documented or approved by manufacturer in writing.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.
- .2 Megger bus duct in presence of Engineer and have readings approved.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 16
CH0032	ELECTRICAL CABINETS AND ENCLOSURES	Rev : D1
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 26 27 16
ELECTRICAL CABINETS AND ENCLOSURES**

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

 1.4 CLOSEOUT SUBMITTALS..... 2

2 **PRODUCTS**..... 2

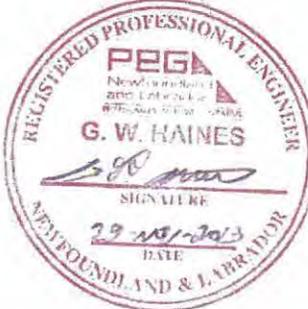
 2.1 MATERIALS 2

3 **EXECUTION** 3

 3.1 INSTALLATION 3

 3.2 FIELD QUALITY CONTROL 4

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REV. D2

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 16
CH0032	ELECTRICAL CABINETS AND ENCLOSURES	Rev : D1
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 CSA International

- .1 CAN/CSA C22.2 No.94.1, Enclosures for Electrical Equipment, Non Environment Considerations.
- .2 CAN/CSA C22.2, No 94.2, Enclosures for Electrical Equipment, Environmental Considerations.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

2 PRODUCTS

2.1 MATERIALS

- .1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA C22.2 No. 94.2, size as indicated.
- .2 CSA Type Enclosures for indoors and for outdoor installations shall be according to the following table:



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 16
CH0032	ELECTRICAL CABINETS AND ENCLOSURES	Rev : D1
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

Minimum Requirements for Electrical Equipment Enclosures			
Equipment	Intake and Spillway Outdoor	Intake and Spillway Hoist Houses	Spillway Electrical Building
Main Switchgear/MCC	N.A.	N.A	NEMA 1A
MCCs	N.A.	NEMA 12	NEMA 12
Panelboards	N.A.	NEMA 3R	NEMA 12
600V Transformers	N.A.	NEMA 3R	NEMA 2 Drip Proof
MV Switchgear and Transformer	N.A.	N.A.	NEMA 1 type with gasket and filters on ventilation opening
Small Equipment and Enclosures	NEMA 4X	NEMA 4X	NEMA 12
Control Panel Enclosures	NEMA 4X	NEMA 4X	NEMA 12

D1

D2

- .3 Removable enclosure panels with formed edges galvanized steel external fasteners removable only from inside enclosure.
- .4 Equip enclosure with removable back panel for mounting terminal blocks and electrical components.
- .5 Cover: tamperproof, bolt-on, domed to shed water.
- .6 Door: 3 point latching, with padlocking means.
- .7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.
- .8 Door interlocks: as indicated.
- .9 Enclosure construction such as to allow configuration of single or ganged enclosures.
- .10 Enclosure capable of being shipped in knocked-down condition.

3 EXECUTION

3.1 INSTALLATION

- .1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 16
CH0032	ELECTRICAL CABINETS AND ENCLOSURES	Rev : D1
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Mount equipment in enclosure.
- .3 Label electrical cabinets and enclosure to Section: 26 05 00 - General Electrical Requirements.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 – General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 26
CH0032	WIRING DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 27 26
WIRING DEVICES
TABLE OF CONTENTS**

1	GENERAL	2
1.1	SECTION INCLUDES.....	2
1.2	RELATED REQUIREMENTS.....	2
1.3	REFERENCES.....	2
1.4	ACTION AND INFORMATIONAL Submittals.....	2
2	PRODUCTS	2
2.1	SWITCHES.....	2
2.2	RECEPTACLES.....	3
2.3	SPECIAL WIRING DEVICES.....	3
2.4	WIRING DEVICES FOR COMPUTER ROOMS.....	4
2.5	COVER PLATES.....	4
3	EXECUTION	4
3.1	INSTALLATION.....	4
3.2	FIELD QUALITY CONTROL.....	5

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REV. D2

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 26
CH0032	WIRING DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SECTION INCLUDES

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.3 REFERENCES

1.3.1 Canadian Standards Association (CSA International)

- .1 CSA-C22.2 No.42.1, General Use Receptacles, Attachment Plugs and Similar Devices.
- .2 CSA-C22.2 No.42, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
- .3 CSA-C22.2 No.55, Special Use Switches.
- .4 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 SWITCHES

- .1 15 A, 120 V and 347 V, single pole, double pole, three-way, four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.
- .2 Manually-operated general purpose ac switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 26
CH0032	WIRING DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Ivory toggle.
- .6 Specification grade.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No.42 with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 Ivory urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity, configuration and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.

2.3 SPECIAL WIRING DEVICES

- .1 Special wiring devices:
 - .1 Clock hanger outlets, 15 A, 125 V, 3 wire, grounding type, suitable for No. 10 AWG for installation in flush outlet box.
 - .2 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lens flush type.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 26
CH0032	WIRING DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 WIRING DEVICES FOR COMPUTER ROOMS

- .1 As indicated.

2.5 COVER PLATES

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Switches:

- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .3 Mount toggle switches at height in accordance with Section 26 05 00 – General Electrical Requirements.

3.1.2 Receptacles:

- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles at height in accordance with Section 26 05 00 - General Electrical Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 27 26
CH0032	WIRING DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

3.1.3 Cover plates:

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 13.01
CH0032	FUSES – LOW VOLTAGE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 28 13.01
FUSES – LOW VOLTAGE
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED SECTIONS	2
1.2	REFERENCES	2
1.3	SUBMITTALS	2
1.4	DELIVERY AND STORAGE	2
1.5	MAINTENANCE MATERIALS.....	2
2	PRODUCTS	3
2.1	FUSES GENERAL.....	3
2.2	FUSE TYPES	3
2.3	FUSE STORAGE CABINET	3
3	EXECUTION	4
3.1	INSTALLATION	4

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CH0032	FUSES – LOW VOLTAGE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – General Electrical Requirements..
- .2 Section 26 28 23 – Disconnect Switches – Fused and Unfused
- .3 Section 26 29 10 – Motor Starters to 600 V

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA)

- .1 CSA C22.2 No.248.4, Low Voltage Fuses Part 4: Class CC (Bi-National Standard with, UL 248-4 (1st Edition).
- .2 CSA C22.2 No.248.8, Low Voltage Fuses Part 8: Class J (Bi-National Standard with, UL 248-8 (1st Edition).
- .3 CSA C22.2 No.248.10, Low Voltage Fuses Part 12: Class L (Bi-National Standard with, UL 248-10 (1st Edition).
- .4 CSA C22.2 No.248.12, Low Voltage Fuses Part 12: Class R (Bi-National Standard with, UL 248-12 (1st Edition).

1.3 SUBMITTALS

- 1.3.1 Submit fuse performance data characteristics for each fuse type and size above 600 A. Performance data to include: average melting time-current characteristics.

1.4 DELIVERY AND STORAGE

- 1.4.1 Ship fuses in original containers.
- 1.4.2 Do not ship fuses installed in switchboard.
- 1.4.3 Store fuses in original containers in storage cabinet moisture free location.

1.5 MAINTENANCE MATERIALS

- 1.5.1 Provide spare parts in accordance with Exhibit 4 – Supplier Document Requirements List.
- 1.5.2 Three spare fuses of each type and size installed above 600 A.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 13.01
CH0032	FUSES – LOW VOLTAGE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.3 Six spare fuses of each type and size installed up to and including 600 A.

2 PRODUCTS

2.1 FUSES GENERAL

2.1.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

2.1.2 Fuses: product of one manufacturer for entire project.

2.2 FUSE TYPES

2.2.1 Class L fuses (formerly HRC-L).

- .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .2 Type L2, fast acting.

2.2.2 Class J fuses (formerly HRCI- J).

- .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .2 Type J2, fast acting.

2.2.3 Class R -R fuses (formerly HRCI- R). For UL Class RK1 fuses, peak let-through current and its' peak let-through values not to exceed limits of UL 198E-1982, table 10.2.

- .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
- .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

2.2.4 Class -CC fuses (formerly HRCII- C).

2.3 FUSE STORAGE CABINET

2.3.1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 00 – General Electrical Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 13.01
CH0032	FUSES – LOW VOLTAGE	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install fuses in mounting devices immediately before energizing circuit. Ensure correct fuses fitted to physically matched mounting devices.
 - .1 Install Class R rejection clips for HRCI-R fuses.
- 3.1.2 Ensure correct fuses fitted to assigned electrical circuit.
- 3.1.3 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
- 3.1.4 Install spare fuses in fuse storage cabinet.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.01
CH0032	AIR CIRCUIT BREAKERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 28 16.01
AIR CIRCUIT BREAKERS
TABLE OF CONTENTS**

1 **GENERAL**.....2

 1.1 SECTION INCLUDES..... 2

 1.2 RELATED REQUIREMENTS..... 2

 1.3 REFERENCES 2

 1.4 ACTION AND INFORMATIONAL SUBMITTALS 2

2 **PRODUCTS**.....2

 2.1 AIR CIRCUIT BREAKER 2

 2.2 OPTIONAL FEATURES..... 3

3 **EXECUTION**.....4

 3.1 INSTALLATION 4

 3.2 FIELD QUALITY CONTROL..... 4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.01
CH0032	AIR CIRCUIT BREAKERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for air circuit breakers.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - General Electrical Requirements.
- .2 Section 26 23 00 - Low Voltage Switchgear.

1.3 REFERENCES

1.3.1 Institute of Electrical and Electronics Engineers (IEEE)

- .1 IEEE C37.13, Low Voltage AC Power Circuit Breakers Used in Enclosures.
- .2 IEEE C37.16, Preferred Ratings, Related Requirements and application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below)

1.3.2 Canadian Standards Association (CSA)

- .1 CSA C22.2 No. 5, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.3.3 National Electrical Manufacturers Association (NEMA)

- .1 NEMA C37.50, Switchgear – Low-Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- 1.4.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- 1.4.2 Include time-current phase protection co- ordination characteristic curves for breakers.
- 1.4.3 Include type test results and certificates.

2 PRODUCTS

2.1 AIR CIRCUIT BREAKER

- 2.1.1 Air circuit breaker to: to IEEE C37.13.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.01
CH0032	AIR CIRCUIT BREAKERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.2 Drawout type, 600 V class.

- .1 Continuous current rating: as indicated.
- .2 Trip rating: as indicated.
- .3 Interrupting rating: as indicated kA, rms symmetrical.
- .4 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Equipped with long, short, instantaneous, ground fault function and phase overload and ground fault indication (LSIG).
- .5 Breakers with normal stored energy, closing mechanism to provide quick-make operation for all ratings.
- .6 Breakers with motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and isolating switch to isolate power supply to spring charging motor.
- .7 Breakers with on-off indicator and spring charged/discharged indicator for local indication and contacts for remote indication.
- .8 Interlocks to prevent circuit breaker drawout when in closed position and to prevent closing unless fully engaged or in test position.

2.2 OPTIONAL FEATURES

- .1 Shunt trip.
- .2 Auxiliary switches: 4 N.O., 4 N.C.
- .3 Undervoltage tripping device with instantaneous trip.
- .4 Alarm switch.
- .5 Pilot light.
- .6 Control relays
- .7 Remote close.
- .8 Lockout devices.
- .9 Padlocking provision.
- .10 Operation counter.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.01
CH0032	AIR CIRCUIT BREAKERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .11 Trip unit equipped with Arc Flash Reduction Maintenance Mode Function (ARMs).

3 EXECUTION

3.1 INSTALLATION

- .1 Install air circuit breakers as indicated.
- .2 Connect main secondary service to line terminals of breaker.
- .3 Connect load terminals of breaker to feeders.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.02
CH0032	MOULDED CASE CIRCUIT BREAKERS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 28 16.02
MOULDED CASE CIRCUIT BREAKERS

1 GENERAL.....2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

2 PRODUCTS.....2

2.1 BREAKERS GENERAL 2

2.2 THERMAL MAGNETIC BREAKERS DESIGN A..... 3

2.3 MAGNETIC CIRCUIT BREAKERS DESIGN B 3

2.4 CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS
DESIGN C..... 3

2.5 SOLID STATE TRIP BREAKERS DESIGN C 3

2.6 OPTIONAL FEATURES..... 3

2.7 ENCLOSURE 4

3 EXECUTION4

3.1 INSTALLATION 4

3.2 FIELD QUALITY CONTROL..... 4

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CH0032	MOULDED CASE CIRCUIT BREAKERS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 24 16.01 – Panelboards – Breaker Type
- .3 Section: 26 24 19 – Motor Control Centres

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA)

- .1 CSA C22.2 No. 5, Circuit Breakers - Moulded Case Switches and Circuit Breaker Enclosures .

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers an include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Include time-current characteristic curves for all circuit breakers.

2 PRODUCTS

2.1 BREAKERS GENERAL

- .1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .2 Common-trip breakers: with single handle for multi-pole applications.
- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .4 Instantaneous trip circuit breakers (motor circuit protector) intended to provide motor short circuit only.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 14 kA symmetrical rms interrupting capacity rating or as indicated on drawings.

9/6 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.02
CH0032	MOULDED CASE CIRCUIT BREAKERS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .7 Molded Case Circuit Breakers cases, on breakers rated 347 V and above, shall be equipped with viewing windows for visible verification of open contacts by maintenance and operating staff.

2.2 THERMAL MAGNETIC BREAKERS DESIGN A

- 2.2.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 MAGNETIC CIRCUIT BREAKERS DESIGN B

- .1 Moulded case circuit breakers to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection. These devices will be used as motor circuit protectors.

2.4 CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS DESIGN C

- .1 Thermal magnetic breakers with current limiters
- .1 Time current limiting characteristics of fuses limiters coordinated with time current tripping characteristics of circuit breaker.
 - .2 C-ordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker.

2.5 SOLID STATE TRIP BREAKERS DESIGN C

- 2.5.1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous (LSIG) tripping for phase and ground fault short circuit protection.

2.6 OPTIONAL FEATURES

- 2.6.1 Include as indicated on drawings:

- .1 Shunt trip.
- .2 Auxiliary switch.
- .3 Motor-operated mechanism.
- .4 Under-voltage release.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 16.02
CH0032	MOULDED CASE CIRCUIT BREAKERS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 On-off locking device.
- .6 Handle mechanism.

2.7 ENCLOSURE

- .1 Mounted in CSA Type 1 enclosure, sprinkler proof as indicated.



- .2 Molded Case Circuit Breakers intended for use as isolating points for lockout/tagout shall be capable of being padlocked in the closed position in accordance with Section: 26 05 00 – General Electrical Requirements.

3 EXECUTION

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 – General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 20
CH0032	GROUND FAULT CIRCUIT INTERRUPTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

SECTION 26 28 20

GROUND FAULT CIRCUIT INTERRUPTERS

TABLE OF CONTENTS

1 **GENERAL**..... 2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 SUBMITTALS 2

1.4 CLOSEOUT SUBMITTALS..... 2

1.5 DELIVERY, STORAGE AND HANDLING 2

2 **PRODUCTS** 3

2.1 MATERIALS 3

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER 3

2.3 GROUND FAULT PROTECTOR UNIT 3

2.4 PUMP PROTECTION PANEL..... 3

3 **EXECUTION** 4

3.1 EXAMINATION 4

3.2 INSTALLATION 4

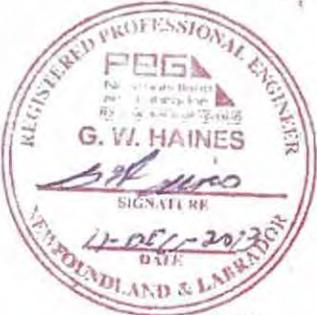
3.3 FIELD QUALITY CONTROL..... 4

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 20
CH0032	GROUND FAULT CIRCUIT INTERRUPTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 CSA International

- .1 CAN/CSA C22.1 – Canadian Electrical Code, Part 1.
- .2 CAN/CSA C22.2 No.144, Ground Fault Circuit Interrupters.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

1.3 SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

.1 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for ground fault circuit interrupters and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 20
CH0032	GROUND FAULT CIRCUIT INTERRUPTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect ground fault circuit interrupters from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.1 MATERIALS

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA C22.2 No.144.
- .2 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

- .1 Single pole Class A ground fault circuit interrupter for 15 and 20 A, 120 V, 1 phase circuit c/w test and reset facilities.
- .2 Single and 2-pole ground fault circuit interrupter for 15 A, 20 A, 120/208 V, 1 phase with 30 mA setting for protection of heat tracing and heater circuits.

2.3 GROUND FAULT PROTECTOR UNIT

- .1 Self-contained with 15 A, 120 V Class A ground fault circuit interrupter and duplex receptacle complete with:
 - .1 Solid state ground sensing device.
 - .2 Facility for testing and reset.
 - .3 CSA Enclosure 1, surface or flush mounted with stainless steel face plate.

2.4 PUMP PROTECTION PANEL

- .1 Ground fault personnel protection panel for submersible pump circuits rated as indicated to match pump motor rating with the following features:
 - .1 Test button, ground indicator light, reset button.
 - .2 Line and load terminal blocks and control terminal block for wiring to starter control.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 20
CH0032	GROUND FAULT CIRCUIT INTERRUPTERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Unit sensitivity: 10 mA.
- .4 CSA Enclosure 1, surface mounted for dry indoor applications and CSA Enclosure 4X for wet indoor or outdoor applications.
- .5 Contact rating: 5 A, 120 V, 60 Hz.
- .6 Fused resistive type artificial neutral.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for ground fault circuit interrupters installation in accordance with manufacturer's written instructions.
- .2 Visually inspect substrate in presence of Engineer.
- .3 Inform Engineer of unacceptable conditions immediately upon discovery.
- .4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

- .1 Do not ground neutral on load side of ground fault relay. Pass phase conductors including neutral through zero sequence transformers.
- .2 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.
- .3 Demonstrate simulated ground fault tests.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 23
CH0032	DISCONNECT SWITCHES – FUSED AND NON-FUSED	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS
SECTION 26 28 23
DISCONNECT SWITCHES – FUSED AND NON-FUSED

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

2 **PRODUCTS** 2

 2.1 DISCONNECT SWITCHES 2

 2.2 SAFETY TRANSFER SWITCHES 3

 2.3 EQUIPMENT IDENTIFICATION 3

3 **EXECUTION** 3

 3.1 INSTALLATION 3

 3.2 FIELD QUALITY CONTROL 3



MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 23
CH0032	DISCONNECT SWITCHES – FUSED AND NON-FUSED	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International).

- .1 CAN/CSA C22.2 No.:4, Enclosed Switches.
- .2 CSA C22.2 No.:39, Fuseholder Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 DISCONNECT SWITCHES



- .1 Fusible, and non-fusible, horsepower rated disconnect switch in CSA Enclosure to CAN/CSA C22.2 No.:4 size as indicated. Refer to Section: 26 27 16 for the minimum requirements of the electrical equipment enclosures.
- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section: 26 28 13.01 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.:39 suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 Disconnect switch enclosures shall include a window to view switch blades to visually observe isolation.
- .8 Disconnect switches shall include one (1) NO/NC contact for hardwired safety interlock.
- .9 ON-OFF switch position indication on switch enclosure cover.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 28 23
CH0032	DISCONNECT SWITCHES – FUSED AND NON-FUSED	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.2 SAFETY TRANSFER SWITCHES



2.2.1 A safety transfer switch shall be provided to transfer power supply from the emergency generator to the alternate portable generator. The transfer switch shall be provided with the following characteristics:

- .1 The safety transfer switch shall be an Eaton Heavy Duty, Double-Throw switch.
- .2 The switch shall be 600 Vac, 800 A, double-throw switch for two-source connections and one intermediate 'OFF' position.
- .3 Non-fusible horsepower rated safety disconnect switch in CSA Enclosure as indicated in Section: 26 27 16 of this technical specification.
- .4 Provision for padlocking in 'OFF' position.
- .5 Mechanically interlocked door to prevent opening when handle is in 'ON' position.
- .6 Disconnect switch enclosure shall include a window to view switch blades to visually observe isolation.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section: 26 05 00 - General Electrical Requirements.
- .2 Indicate equipment tag number and name of load controlled on size 4 nameplate.

3 EXECUTION

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses as indicated.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section: 26 05 00 – General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 01
CH0032	CONTACTORS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 29 01
CONTACTORS
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS	2
1.4	CLOSEOUT SUBMITTALS.....	2
2	PRODUCTS	2
2.1	CONTACTORS.....	2
2.2	EQUIPMENT IDENTIFICATION	3
3	EXECUTION	3
3.1	INSTALLATION	3
3.2	FIELD QUALITY CONTROL.....	3

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 01
CH0032	CONTACTORS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements
- .2 Section 26 09 03.01 – Control Devices

1.2 REFERENCES

1.2.1 CSA International

- .1 CSA C22.2 No.14, Industrial Control Equipment.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.1 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for contactors and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for contactors for incorporation into manual.

2 PRODUCTS

2.1 CONTACTORS

- .1 Contactors: to CSA C22.2 No.14.
- .2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
- .3 Fused switch combination contactor as indicated.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 01
CH0032	CONTACTORS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .5 Mount in CSA Enclosure 1 unless otherwise indicated.
- .6 Include following options in cover:
 - .1 Red indicating lamp.
 - .2 Hand-Off-Auto selector switch.
- .7 Control transformer: in accordance with Section 26 29 03.01 - Control Devices, factory wired and installed in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 00 - General Electrical Requirements.
- .2 Size 4 nameplate indicating equipment tag number and name of load controlled as indicated.

3 EXECUTION

3.1 INSTALLATION

- .1 Install contactors and connect power wires and auxiliary control devices.
- .2 Identify contactors with nameplates or labels indicating panel and circuit number.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.01
CH0032	CONTROL DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 26 29 03.01
CONTROL DEVICES
TABLE OF CONTENTS**

1 GENERAL..... 2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

1.4 CLOSEOUT SUBMITTALS..... 2

2 PRODUCTS 2

2.1 AC CONTROL RELAYS 2

2.2 RELAY ACCESSORIES 3

2.3 OILTIGHT LIMIT SWITCHES..... 3

2.4 SEALED CONTACT OILTIGHT LIMIT SWITCHES..... 3

2.5 SOLID STATE TIMING RELAYS 4

2.6 INSTANTANEOUS TRIP CURRENT RELAYS 4

2.7 OPERATOR CONTROL STATIONS..... 4

2.8 PUSHBUTTONS..... 4

2.9 SELECTOR SWITCHES..... 4

2.10 INDICATING LIGHTS 5

2.11 CONTROL AND RELAY PANELS 5

2.12 CONTROL CIRCUIT TRANSFORMERS 5

2.13 THERMOSTAT (LINE VOLTAGE) 5

3 EXECUTION 5

3.1 INSTALLATION 5

3.2 FIELD QUALITY CONTROL..... 6

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.01
CH0032	CONTROL DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements
- .2 26 29 03.02 – Control and Monitoring
- .3 26 29 03.03 – Control and Monitoring – Hydro-Mechanical Equipment

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA)

- .1 CSA C22.2 No.14, Industrial Control Equipment.

1.2.2 National Electrical Manufacturers Association (NEMA)

- .1 NEMA ICS 1, Industrial Control and Systems: General Requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for control devices and include product characteristics, performance criteria, physical size, finish and limitations.

1.3.3 Shop Drawings:

- .1 Include schematic, wiring, interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for control devices for incorporation into manual.

2 PRODUCTS

2.1 AC CONTROL RELAYS

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.01
CH0032	CONTROL DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .2 Convertible contact type: contacts field convertible from NO to NC, electrically held with solid state timer as indicated. Coil rating: as indicated. Contact rating: as indicated.
- .3 Sealed contact type: electrically held. Coil rating: as indicated. Contact rating: as indicated.
- .4 Universal pole type: electrically held, convertible from NO to NC by changing wiring connections. Coil rating: as indicated. Contact rating: as indicated.
- .5 Fixed contact plug-in type: general purpose low coil current. Coil rating: as indicated. Contact rating: as indicated.

2.2 RELAY ACCESSORIES

- .1 Standard contact cartridges: normally-open - convertible to normally-closed in field.
- .2 Socket bases and DIN mounting rails for plug-in type relays.

2.3 OILTIGHT LIMIT SWITCHES

- .1 Snap action type: roller, rod, or fork lever, top side push or wobble stick actuator, CSA type 1 enclosure. Contact rating as indicated.
- .2 Surface mounted.
- .3 Standard contact block.

2.4 SEALED CONTACT OILTIGHT LIMIT SWITCHES

- .1 Lever type switches: roller, fork or rod operated, single or double pole, double throw. Contact rating: as indicated.
- .2 Push type switches: actuated by rod or plunger located on side of operating head, spring return single pole, double throw. Contact rating: [ass indicated.
- .3 Wobble stick cat whisker type switches: actuated by rod or stick extending from tip of operating head. Moving rod in any direction operates contacts. Single pole, double throw. Contact rating: as indicated.
- .4 Lever operated: time delay switch: adjustable time delay from 1/2 s to 15 s plus 25%. Contact rating: as indicated. Plug-in construction switches: CSA Type 4, two or four circuit, lever, push or wobble stick type, contact rating: as required.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.01
CH0032	CONTROL DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5 SOLID STATE TIMING RELAYS

- .1 Construction: ac operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.
- .2 Operation: on-delay or off-delay.
- .3 Potentiometer: self contained to provide time interval adjustment.
- .4 Supply voltage: 120 or 24 V, ac, 60 Hz.
- .5 Temperature range: minus 50 degrees C to plus 60 degrees C.
- .6 Output contact rating: maximum voltage 300 V ac or dc. Current: as indicated.
- .7 Timing ranges: minimum 0.5 s, maximum 60 s.

2.6 INSTANTANEOUS TRIP CURRENT RELAYS

- .1 Enclosure: CSA Type 1
- .2 Contacts: NO, NC automatic reset with adjustable tripping point.
- .3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.
- .4 Contact rating: as indicated.

2.7 OPERATOR CONTROL STATIONS

- .1 Enclosure: CSA Type 1 or 4, surface mounting:

2.8 PUSHBUTTONS

- .1 Illuminated, heavy duty. Operator type as indicated. 1-NO and 1-NC contacts rate as indicated, labels as indicated. Stop pushbuttons coloured red, mushroom head, provision for locking in depressed position labelled "emergency stop".

2.9 SELECTOR SWITCHES

- .1 Maintained or spring return to neutral position, 2 or 3 position labelled as indicated heavy duty, operators wing lever, contact arrangement as indicated, rated as indicated.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.01
CH0032	CONTROL DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.10 INDICATING LIGHTS

- .1 Standard LED type, push-to-test, lens colour: as indicated, supply voltage: as indicated, labels as indicated.

2.11 CONTROL AND RELAY PANELS

- .1 CSA Type 1 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.12 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: 208 or 240 V, 60 Hz ac.
- .3 Secondary: 120 V, ac.
- .4 Rating: to meet control load requirements plus 50 VA.
- .5 Secondary fuse: as required.
- .6 Close voltage regulation as required by magnet coils and solenoid valves.

2.13 THERMOSTAT (LINE VOLTAGE)

- .1 Wall mounted, for exhaust fan control.
- .2 Full load rating: 8 A at 120 V AC.
- .3 Temperature setting range: 10 degrees C to 30 degrees C.
- .4 Thermometer Range: 10 degrees C to 30 degrees C.
- .5 Markings in 5 degree increments.
- .6 Differential temperature fixed at 20 degrees C.

3 EXECUTION

3.1 INSTALLATION

- .1 Install pushbutton stations, control and relay panel, control devices and interconnect as indicated.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.01
CH0032	CONTROL DEVICES	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical requirements.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032		Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment	CONTROL AND MONITORING	
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 29 03.02
CONTROL AND MONITORING



1	GENERAL	2
1.1	SCOPE OF WORK.....	2
1.2	RELATED SECTIONS.....	2
1.3	REFERENCES.....	2
1.4	DEFINITIONS.....	3
1.5	SUBMITTALS.....	3
2	PRODUCTS	3
2.1	DOCUMENTATION.....	3
2.2	SYSTEM REQUIREMENTS.....	3
2.3	FLEXIBILITY.....	3
2.4	RELIABILITY.....	4
2.5	COMMUNICATION PROTOCOL.....	4
2.6	CONTROLLER PROGRAMMING AND PROGRAM LANGUAGES.....	4
2.7	SOFTWARE.....	5
2.8	POWER SUPPLY.....	5
2.9	EVENTS AND ALARMS LIST.....	5
2.10	TIME TAGGING.....	6
2.11	ALARMS AND DISPLAYS.....	6
2.12	CENTRAL PROCESSING UNITS.....	7
2.13	INPUT / OUTPUT (I/O) SYSTEM.....	7
2.14	FIBRE OPTIC CABLE AND OPTICAL DISTRIBUTION FRAME (ODF).....	9
2.15	NETWORK SWITCHES.....	10
2.16	PANELS.....	10

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification is for the requirements for control and monitoring equipment for the Muskrat Falls hydroelectric power station plant.

1.2 RELATED SECTIONS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 29 03.01 – Control Devices
- .3 Section: 26 29 03.03 – Control and Monitoring – Hydro-Mechanical Equipment

1.3 REFERENCES

1.3.1 The last revision of the Specifications, Codes and Standards at the date of Award must be used.

1.3.2 Canadian Standards Association (CSA)

1.3.3 ANSI – American National Standard Institute

- .1 ANSI Y32.2 Graphic Symbols
- .2 ANSI C37.90A Surge Withstand Tests for Protective Relays and Relay Systems
- .3 ANSI C39.1 Indicating Instrumentation

1.3.4 IEEE - Institute of Electrical and Electronics Engineers (IEEE)

- .1 IEEE C37.21 Standard for Control switchboards (ANSI)
- .2 IEEE C37.90.1 Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI).
- .3 IEEE 1010 IEEE Guide for Control of Hydroelectric Power Plants
- .4 IEEE 1249 IEEE Guide for Computer-Based Control for Hydroelectric Power Plant Automation
- .5 IEEE 1428 Guide for Installation Methods for Fiber-Optic Cables in Electric Power Generating Stations and in Industrial Facilities
- .6 IEEE 1613 Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

.7 IEEE 1646 Standard Communication Delivery Time Performance Requirements for Electric Power Substation Automation

1.3.5 IEC – International Electrotechnical Commission

- .1 IEC 60414 Safety requirements for indicating and recording electrical instruments and their accessories
- .2 IEC 62270 Control Systems for Hydroelectric Stations
- .3 BS-89, IEC 60051 Indicating instruments

1.4 DEFINITIONS

- .1 PLC – Programmable Logic Controller
- .2 HMI – Human Machine Interface

1.5 SUBMITTALS

1.5.1 Provide submittals in accordance with Section: 01 33 00 - Submittal Procedures.

2 PRODUCTS

2.1 DOCUMENTATION

2.1.1 The documentation shall include the control and monitoring system configuration and points list preparation as applicable for the system being supplied, the appropriate control sequences and automated sub-routines, panel layout drawings and the AC and DC wiring diagrams and schematics necessary for the interconnection of equipment.

2.2 SYSTEM REQUIREMENTS

2.2.1 Only those systems which are complete, fully integrated and have a proven field operation record shall be provided. The systems shall utilize heavy industrial/utility grade components. The PLCs shall be Allen-Bradley.

2.3 FLEXIBILITY

2.3.1 The system design shall be based on the use of functional modules leading to a flexible system which is easy to modify and reconfigure.

2.3.2 The design shall allow the addition or deletion of controls, indications, tele-metering points, alarms, etc., in a simple manner. It shall be possible to carry out system



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

modifications of the type defined above without removing the overall system from service.

2.3.3 To facilitate point name changes the data base structural point identifiers shall be independent of the display names used in the data logs and on the screen displays.

2.3.4 The flexibility shall extend beyond the hardware aspect, such as flexibility to provide easy and quick changes on workstation display pages, format of the loggers, etc.

2.4 RELIABILITY

2.4.1 The system shall be designed for operation under the specified ambient climatic conditions and electrical conditions. No reduction of system reliability shall occur due to system modification and expansion.

2.4.2 All systems shall be fail safe. A component failure shall not cause the issue of a false command, set point value change or instruction.

2.4.3 All system components shall have proven reliability. Mean time between failure figure shall be provided for the system and the individual components (circuit modules).

2.4.4 The control and monitoring equipment shall have a system for detection and alarm of faults in its own circuits.

2.5 COMMUNICATION PROTOCOL

2.5.1 The protocol used for communication shall be an open and proven protocol.

2.6 CONTROLLER PROGRAMMING AND PROGRAM LANGUAGES

2.6.1 The application programs shall be written in a high level functional block language and summarized on program flow charts. Each functional element shall be represented as a building block with inputs and outputs.

2.6.2 Application programming shall be performed by connecting inputs and outputs of a functional block to other functional blocks or to process I/O. It shall be possible to print graphic documentation of the applicable programs.

2.6.3 The structure of the application programs shall be based on the functional structure of the system. It shall be possible to give different program modules in one process controller different cycle times and priorities.

2.6.4 It shall be the responsibility of Contractor to develop the detailed points list, control logic, sequence logic, etc. for the system, as appropriate for the most effective operation of the system as a whole. This shall include inputs from systems supplied by Company's Other

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

Contractors and shall, in some cases, require the specification of data and control interfaces to those devices provided by Company's Other Contractors.

2.6.5 Contractor shall be responsible for design cooperation with all Company's Other Contractors.

2.7 SOFTWARE

2.7.1 Contractor shall be responsible for in-house software Quality Assurance. Once the software programming and testing is complete the software shall be locked (or compiled). All software development shall be done by Contractor's experienced software team. Evidence of that experience shall be supplied in the bid documents.

2.7.2 The control and monitoring equipment shall be provided completely programmed and tested at the factory to meet all functional requirements. All software required to support all hardware and all integrated system requirements shall be provided factory programmed. This shall include, but not be limited to, operating system software, communications software, application software, system configuration software, diagnostic software and support software for applications development.

2.7.3 All software shall be documented. Updates for all software shall be provided to Company without cost for five (5) years. Support for all software shall be provided to Company for fifteen (15) years after commercial acceptance. All software provided shall be licensed to Company.

2.8 POWER SUPPLY

2.8.1 All components of the control system shall be powered from dual 125 Vdc power supplies, one from each of the two station batteries. In case of devices mounted on moving equipment, each device shall have dual power supplies and can be fed from a single source (AC or DC).

2.8.2 As the station shall normally be operated remotely with minimum day staff in attendance, facilities shall be provided to shut down any non-essential loads when the station is unoccupied.

2.8.3 To save battery power all local control panel displays shall be de-activated except when local control is activated or an operator requests a display activation. In the latter case the display shall be de-activated after a set time.

2.9 EVENTS AND ALARMS LIST

2.9.1 Events and alarms on the event log display pages shall be presented in chronologically ordered lists. When on any other display page the number of alarms or status change displays shall be settable between 0 to at least 5 and shall be shown in a separate area

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

of the display. These events shall be circular, so that a new event overwrites the oldest one.

- 2.9.2 The printout of an event, when requested, shall occupy one line and include the date, time of day, signal description and signal status. The date shall be given as year, month and day and the time shall be given as hours, minutes and seconds and tens of milliseconds.
- 2.9.3 Digital input status changes shall be time-tagged to the nearest 10 ms after the change is sensed at the process controller's local input system. Since all controllers shall be connected to the GPS clock system used as an external time reference source, the available time precision shall be better than 10 ms but the time tag of all events listed shall be rounded to 10 ms.
- 2.9.4 The process alarm list shall at least contain the most recent 500 alarms. Alarms shall be removed from the alarm list when they are acknowledged by the operator and when the alarm condition has disappeared. Alarms shall also be indicated on all displays as a latest unacknowledged alarm line, and as status indications with red colour in displays with dynamic data from the object concerned. Flashing until the alarm is acknowledged, and then steady as long as the alarm condition persists.
- 2.9.5 Alarms shall be acknowledged by placing the cursor on the alarm line and then pressing a dedicated key. Alarms shall be acknowledged also from the process alarms list page by page.

2.10 TIME TAGGING



- 2.10.1 General status changes sensed at the local I/O interfaces and internally generated set point "marks" shall be time tagged with an accuracy of +/- 10 ms with respect to the time reference source. Specifically identified Sequence of Events (SOE) points shall be similarly time tagged to +/- 1 ms.

2.11 ALARMS AND DISPLAYS

2.11.1 Colours

- .1 Consistent use of colours is of prime importance to the operator. The colours that shall be used are suggested below. These shall be finalized during detailed design in accordance with Company's Standards:

Task	Colour
Response to the operator's entry on the dialog line	White
Indication of the selected equipment	White

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Event and alarm blocking and error message	Yellow
Alarms	Red
Normal status	Green

2.11.2 Audible Alarms

- .1 If an equipment and/or function goes to an alarm status, a buzzer shall be activated if the system is in local mode. The alarm shall be silenced by pressing a dedicated key.

2.12 CENTRAL PROCESSING UNITS

2.12.1 The process controllers shall have Central Processing Units (CPU) based on a high performance 32 or 64 bit microprocessor. The system software shall be stored in read only memory (EPROM or Flash-PROM) modules. The application software shall be stored in Read/Write Memory (RWM) with battery backup, the battery replacement schedules shall be defined. The application programs shall be executed cyclically in three priority levels. The cycle times shall normally be selectable between 10 ms and 2 s.

2.12.2 Supervisory functions shall automatically monitor system operation. Supervisory functions shall include a real time watchdog, back-plane bus supervision, memory checking and power supply voltage supervision. Faults shall be indicated with LEDs on relevant board, with system error messages reported to the HMI. The process controller shall have a real time clock and calendar. When connected to the network, the system clock shall be automatically synchronized with other nodes of the network with an accuracy of 10 ms or less.

2.13 INPUT / OUTPUT (I/O) SYSTEM

2.13.1 General

- .1 All controllers shall be provided with sufficient I/O modules to cover the number and types of I/O required for each controller. Spare I/O shall also be provided as the list shall be completed only during the detailed engineering stage. The I/O modules shall provide 20% spares of each types of I/O used for each controller once design is finalized.
- .2 The modules shall include analog and digital measurement and status/alarm point inputs and outputs. These modules are used to capture all the control and measurement system status and alarm point change data included in the systems supplied.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.13.2 Measurement Data

.1 Analog Measurement Data Input

- .1 Analog Inputs (AI) shall be scanned with a cycle time selectable between 100 ms and 20 s. A process dead band shall be definable for each input. If the input value has not changed more than the dead band since the previous update, no updating or further processing shall take place.
- .2 Each AI shall be capable of having four unique alarm limits, two low and two high, assigned to it. These limits shall be initially entered by the database programmer, but shall be capable of being changed by the operator, online, from the HMI. The limits shall be provided with hysteresis individually definable for each input channel.
- .3 The AI module shall convert analog process signals to digital values. The AI module shall include analog to digital converter and programmable gain amplifier. The input shall be 4-20 mA. An alternate signal level can be used subject to review and Acceptance by Engineer.
- .4 Analog signals shall be scaled and converted to engineering units after being scanned and prior to being stored in the database.

2.13.3 Digital Data Input

- .1 Digital instrumentation providing direct measurement data outputs using protocols shall have the same equivalent performance as quoted above.
- .2 Digital measurement signals shall be scaled and converted to engineering units after being scanned and prior to being stored in the database.

2.13.4 Digital Status and Alarm Inputs

.1 Digital Input (DI) modules

- .1 These inputs shall be from "dry", electrically independent contact circuits from various locations. The DI module shall convert contact states into digital values. Each DI module group shall have a dedicated microprocessor to support the time tagging requirements. The DI module shall include a filter to eliminate contact bounce and electromagnetic interference. The available voltage level shall be 125 Vdc for all external input functions.
- .2 The updating of DI shall be event driven, meaning that only a change in state of an input shall result in updating of the database. In addition to the event driven updating, a cyclic updating every fifth second shall be provided. All status changes shall be time tagged on receipt.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 24 Vdc for control functions shall be acceptable only for signals passing between panels in the same line up. Dependant on a final analysis of these lower voltage I/Os, make or break contacts may need to be applied. Signals between panels at different locations, such as between the spillway and intake controllers and the associated switchgear and gate mechanism shall be 125 Vdc.

2.13.5 Digital Status and Alarm Data Input

- .1 Digital equipment and IEDs providing direct status and alarm data point outputs using protocols shall have the same equivalent performance as quoted above and carry a time stamp initiated at the device appropriate to the event being monitored.

2.13.6 Analog and Digital Measurement (Set Point) and Status (Control) Outputs

- .1 Analog Output (AO) modules shall have a digital to analog converter and the output shall be 4-20 mA. An alternate signal level can be used subject to review and Acceptance by Engineer as appropriate to the setpoint input on the device. Digital setpoint and command outputs using protocols shall be provided as appropriate to the equipment to be controlled.
- .2 Digital Output (DO) control modules shall be relay type output contacts that shall be powered at the field devices from the 125 Vdc system. Output configuration shall provide the maximum possible separation between the DC circuit fed from the A and B battery systems. All 125 Vdc terminations shall be provided with NEMA 1 protection level with access door open.

2.14 FIBRE OPTIC CABLE AND OPTICAL DISTRIBUTION FRAME (ODF)

2.14.1 Fibre Optic Cable

- .1 Where control, status and alarms points are concentrated in a separate location remote I/O modules may be used and these shall be connected to the main or subcontrollers via fibre optic cables. All cables shall be protected in buried duct raceways or conduit.
- .2 The fibre optic contained in the multi-fibre cables shall be of a single mode type, G.652 standard. The construction of the cable shall be of an all-dielectric loose tube type and shall include a minimum two (2) spare fibre pairs in addition to any spares provided in the manufacturing process.
- .3 The fibre optic cables shall be terminated at an ODF with an appropriate fan-out kit and ST type connectors.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.02
CH0032	CONTROL AND MONITORING	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.14.2 Optic Distribution Frame (ODF)

- .1 The panels shall be of a rack-mount type. All optical adapters provided within the ODFs shall be of ST type.

2.15 NETWORK SWITCHES

- 2.15.1 Network switches shall be ruggedized industrial grade switches, RuggedCom or equivalent accepted by Engineer.

2.16 PANELS

2.16.1 General



- .1 The process controllers shall be modular and mounted in 19-inch subracks. The subracks, power supplies, associated termination equipment, etc. shall be installed in panels. The panels shall be of the free standing, metal enclosed type, with a minimum protection class of NEMA-2 increasing to NEMA-4X in areas where water leakage is possible. Refer to Section: 26 27 16 for the minimum requirements for electrical equipment enclosures. The panels shall be provided with facilities for top and bottom cable access. The front of each panel section shall be furnished with a hinged metal frame with a 19-inch wide opening for equipment mounting. A full length door shall be provided on the outside of the hinged frame.
- .2 All process connections wired directly to the panel shall be screw terminals located inside the panels.
- .3 Remote I/O units shall be totally enclosed in junction boxes, complete with brackets for DINrail mounting. All external connections shall be plug detachable screw terminals. All remote I/O and sub-controllers shall be powered from the same 125 Vdc supply as the associated main controller.
- .4 Electrical isolation type terminals shall be provided for inputs to the control equipment panels for test and maintenance purposes.
- .5 The number of cables coming into each panel shall be considered during the design such as not to exceed the space available in each panel. A maximum of 40 cables and up to 500 connections per panel shall be allowed.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS

SECTION 26 29 03.03

CONTROL AND MONITORING - HYDRO-MECHANICAL

1	GENERAL		
1.1	Scope of Work		
1.2	Related Sections		
1.3	References		3
1.4	Definitions		4
1.5	Submittals		4
2	SPILLWAY GATE CONTROL		4
2.1	General Requirements		4
2.2	Gate Positions		5
2.3	Local Control Panel		6
2.4	Gate PLC Panel		8
2.5	General Spillway Controller		9
2.6	ECC and Powerhouse Control Room		10
2.7	Instrumentation		11
2.8	Brake Control		11
2.9	Horn Warning System		11
3	SPILLWAY GATE HEATING CONTROL		12
3.1	General		12
3.2	Gate Heating		13
3.3	Embedded Parts Heating		14
4	INTAKE GATE CONTROL		15
4.1	General Requirements		15
4.2	Gate Positions		16
4.3	Local Control Panel		16
4.4	PLC Panel		19
4.5	ECC and Powerhouse Control Room		20
4.6	Instrumentation		21
4.7	Brake Control		22



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.8 Initial Filling22

4.9 Emergency close22

4.10 Horn.....23

5 SPILLWAY AND INTAKE GATES COMMON REQUIREMENTS23

5.1 Instrumentation23

5.2 Brake Control.....25

6 DRAFT TUBE HOIST CONTROL.....25

6.1 General.....25

6.2 Instrumentation25

7 TRASH RACK HOIST CONTROL26

7.1 General.....26

7.2 Control Panel.....26

7.3 Radio Remote Control27

7.4 Instrumentation28

8 SPILLWAY HOIST BUILDING MAINTENANCE CRANE.....28

8.1 General.....28

8.2 Instrumentation28

**9 DRAFT TUBE, TRASH CLEANER AND MAINTENANCE CRANE COMMON
REQUIREMENTS29**

9.1 Control.....29

9.2 Instrumentation30

9/6 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SCOPE OF WORK

1.1.1 This specification describes the requirements for control and monitoring of the hydro-mechanical equipment for the Muskrat Falls hydroelectric power station plant.

1.2 RELATED SECTIONS

- .1 Section: 26 05 00 – General Electrical Requirements
- .2 Section: 26 29 03.01 - Control Devices;
- .3 Section: 26 29 03.02 – Control and Monitoring.
- .4 Section: 26 29 03.04 - Spillway Automatic Transfer and Load Management System - Functional Description

1.3 REFERENCES

1.3.1 The last revision of the Specifications, Codes and Standards at the date of Award shall be used.

1.3.2 Canadian Standards Association (CSA)

1.3.3 ANSI – American National Standard Institute

- .1 ANSI Y32.2 Graphic Symbols
- .2 ANSI C37.90A Surge Withstand Tests for Protective Relays and Relay Systems
- .3 ANSI C39.1 Indicating Instrumentation

1.3.4 IEEE - Institute of Electrical and Electronics Engineers (IEEE)

- .1 IEEE C37.21 Standard for Control switchboards (ANSI)
- .2 IEEE C37.90.1 Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI).
- .3 IEEE 1010 IEEE Guide for Control of Hydroelectric Power Plants
- .4 IEEE 1249 IEEE Guide for Computer-Based Control for Hydroelectric Power Plant Automation

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 IEEE 1428 Guide for Installation Methods for Fiber-Optic Cables in Electric Power Generating Stations and in Industrial Facilities
- .6 IEEE 1613 Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations
- .7 IEEE 1646 Standard Communication Delivery Time Performance Requirements for Electric Power Substation Automation

1.3.5 IEC – International Electrotechnical Commission

- .1 IEC 60414 Safety requirements for indicating and recording electrical instruments and their accessories
- .2 IEC 62270 Control Systems for Hydroelectric Stations
- .3 BS-89, IEC 60051 Indicating instruments

1.4 DEFINITIONS

- 1.4.1 DCS – Distributed Control System.
- 1.4.2 ECC – Energy Control Centre.
- 1.4.3 HMI – Human Machine Interface.
- 1.4.4 MCC - Motor Control Centre.
- 1.4.5 PLC – Programmable Logic Controller.
- 1.4.6 SWC - Surge Withstand Capability.
- 1.4.7 TRIAC - Bidirectional triode thyristor.

1.5 SUBMITTALS

- 1.5.1 Provide submittals in accordance with Exhibit 4 Supplier Documents Requirements List.

2 SPILLWAY GATE CONTROL

2.1 GENERAL REQUIREMENTS

- 2.1.1 Each gate control shall be completely independent. The failure of an individual gate control shall have no impact on the other gates.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 2.1.2 Each gate shall be controlled by a dedicated PLC.
- 2.1.3 Each gate shall have a local control panel at the hoist house located adjacent to the hoist. The local control panel shall control the gate through the PLC located in the spillway electrical building. The buttons and selector switches on the local control panel shall be hardwired back to the PLC panel to allow control of the gate through the PLC.
- 2.1.4 Safety functions, such as the slack rope detection device, shall be hardwired to the motor starter control circuit.
- 2.1.5 Any function which disables the hoist motor shall apply the brakes.
- 2.1.6 Status and commands between the spillway hoist house and the PLCs (located in the spillway electrical building) shall be through hardwired connections.
- 2.1.7 It shall be possible to control and monitor each gate from 5 different locations:
 - .1 Local control panel at the spillway hoist house;
 - .2 Gate PLC panel at the spillway electrical building;
 - .3 General spillway control panel at the spillway electrical building (supplied by Company's Other Contractor);
 - .4 Powerhouse control room (supplied by Company's Other Contractor);
 - .5 ECC (Energy Control Centre) located in St, John's, NL (supplied by Company's Other Contractor).

2.2 GATE POSITIONS

2.2.1 The following table describes the spillway gate position terminology that will be used in this section of the specification:

SPILLWAY GATE POSITIONS	
Position	Description
Extreme upper limit	The highest position the gate could reach. If the gate reaches this position it will be stopped by a switch operated by a counterweight hinged arm which would be hit by a striker mounted on the gate.
Maintenance upper limit	The highest position the gate could reach under normal maintenance mode. If the gate reaches this position it will be stopped by a limit switch.
Full open	Full open position under normal mode of operation, the gate is fully out of the water.
Closed	Normal closed position in which the water passage is completely blocked

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

	with the gate resting on the sill.
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2.3 LOCAL CONTROL PANEL

2.3.1 Each gate shall have a local control panel. The local control panel shall be located adjacent to the hoist in the hoist house. The local control panel shall be insulated on all faces and heated. Heating shall be supervised.

2.3.2 A LOCAL-REMOTE-MAINTENANCE selector switch shall be located on the control panel. The LOCAL position shall allow control of the gate hoist from the local control panel. The REMOTE position shall allow control of the gate hoist from the remote locations. The MAINTENANCE position shall allow the gate to be raised beyond the full open position. The MAINTENANCE position shall also allow the cable drum to keep turning after the gate has reached the closed position.

2.3.3 The following push-buttons shall be installed on the control panel:

- .1 INCREMENTAL RAISE;
- .2 INCREMENTAL LOWER;
- .3 STOP;
- .4 JOG RAISE;
- .5 JOG LOWER;
- .6 OVERRIDE;
- .7 HORN;
- .8 EMERGENCY STOP;
- .9 TEST LAMPS;
- .10 RESET.

2.3.4 The INCREMENTAL RAISE and INCREMENTAL LOWER push-buttons shall raise or lower the gate by an incremental distance of 1 meter. The incremental distance shall be adjustable. The gate shall stop automatically after travelling the incremental distance without operator intervention.

2.3.5 When the JOG RAISE or JOG LOWER button is pressed, the hoist shall move as long as the button is pressed and shall stop if the button is released.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING – HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 2.3.6** The EMERGENCY STOP button shall be of the mushroom type and hardwired to the motor starter. This function shall be latching and reset by pressing the RESET button on the panel. A light shall be activated on the panel to signal that the EMERGENCY STOP button was pressed.
- 2.3.7** When the selector switch is in the MAINTENANCE position, pressing the JOG RAISE button shall allow raising the gate past the full open position but the gate shall stop at the maintenance upper limit.
- 2.3.8** To permit jogging the gate past the maintenance upper limit (to test the extreme upper limit switch) or to keep turning the cable drum after the gate has reached the close position (to test the slack rope system), the selector switch shall be at the MAINTENANCE position and both the OVERRIDE button and JOG RAISE / LOWER shall be pressed at the same time. The OVERRIDE button shall only function when the selector switch is at the MAINTENANCE position. The gates cannot be raised above the extreme upper limit.
- 2.3.9** When the HORN button is pressed, the horn shall sound for 5 minutes (adjustable).
- 2.3.10** The following conditions shall be indicated by lights on the control panel:
- .1 Slack rope;
 - .2 Hoist overload;
 - .3 Extreme upper limit;
 - .4 Maintenance upper limit;
 - .5 Motor overload;
 - .6 Hoist Energized;
 - .7 Gate in "closed" position;
 - .8 Gate in "full open" position;
 - .9 Brake Status;
 - .10 Unbalance wire rope load;
 - .11 Emergency Stop.
- 2.3.11** The following displays shall be mounted on the control panel:

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Gate position (digital indication);
- .2 Total hoist load;
- .3 Horn timer.

2.3.12 A mechanical gate position indicator shall be installed on each hoist and shall be mechanically connected to the wire rope drum. Its dial shall be easily readable from the local control panel location. It shall be graduated in metres and centimetres and shall indicate the position of the bottom of the gate above the sill up to its uppermost position.

2.4 GATE PLC PANEL

2.4.1 Each gate shall have a gate PLC panel. The gate PLC panel shall be located in the spillway electrical room.

2.4.2 A touch screen HMI shall be mounted on the panel. The status of gate shall be presented in the form of graphical displays, reports, alarms and event lists. Graphical diagrams shall be used for the representation of the operation of the gates. The HMI shall replicate all the functions and indications described in the previous section for the local control panel. All the functions of the heating control panel described in 3 shall also be replicated on the HMI. All indications and alarms shall continue to be displayed on the touch screen HMI when the panel is set to remote.

2.4.3 A LOCAL-REMOTE selector switch shall be located on the panel. The LOCAL position shall allow control of the gate from the touch screen HMI. The REMOTE position shall allow control of the gate from the general spillway control panel, powerhouse control room or ECC.

2.4.4 An EMERGENCY STOP push-button, mushroom type and hardwired to the motor starter, shall be provided on the panel. This function shall be latching and reset by pressing a RESET button that shall be installed on the panel. An indication on the screen shall signal that the EMERGENCY STOP button was pressed.

2.4.5 Only the INCREMENTAL RAISE and LOWER, the STOP and the HORN functions shall be available from the gate PLC panel HMI. The maintenance functions shall not be allowed from the gate PLC panel.

2.4.6 Dual (redundant) communication links shall be provided between each spillway gate controller and the general spillway controller (supplied by Company's Other Contractor). The critical alarms between each spillway gate controller and the general spillway controller shall be hardwired. The alarms to be hardwired shall be submitted for Acceptance by Engineer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING – HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5 GENERAL SPILLWAY CONTROLLER

- 2.5.1 There will be one general spillway controller which will be located in the spillway electrical building and which will be supplied by Company's Other Contractor at the final stage of the project. The general spillway controller will not be available at the diversion stage.
- 2.5.2 The general spillway controller will be a microprocessor based, local monitoring and control system that will provide monitoring and control of the 5 spillway gate controllers over a redundant communication protocol link with the critical alarms hardwired.
- 2.5.3 The general spillway controller will communicate to the powerhouse control room all alarms and status data from each of the spillway gates.
- 2.5.4 The spillway alarms and indications points to be sent to the general spillway controller shall include for each gate, but not be limited to, the following:
- .1 Spillway gate position indication;
 - .2 Spillway gate fully opened;
 - .3 Spillway gate fully closed;
 - .4 Spillway gate travelling;
 - .5 Emergency spillway gate stop initiated;
 - .6 Spillway gate slack rope;
 - .7 Spillway gate extreme upper limit;
 - .8 Spillway gate maintenance upper limit;
 - .9 Spillway gate hoist overload;
 - .10 Spillway hoist motor overload;
 - .11 Power failure - dc;
 - .12 Power failure - ac;
 - .13 PLC failure;
 - .14 Low temperature (control panel, MCC and hoist components);

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .15 Gate in local control indication;
- .16 Horn activated.

2.5.5 The spillway control points to be received from the general spillway controller shall include for each gate, but not be limited to, the following:

- .1 Gate incremental raise command;
- .2 Gate incremental lower command;
- .3 Stop command;
- .4 Horn.

2.5.6 Power Supply

- .1 The permanent electrical supply shall be sized to feed the heating load of three (3) spillway gates, supply power to one (1) gate hoist motor and the spillway auxiliary electrical services;
- .2 A diesel generator, located in a dedicated generator room next to the spillway electrical room, shall provide emergency power to the spillway critical loads. The diesel generator shall be sized to supply the heating load of two (2) spillway gates and supply power to one (1) gate hoist motor. The diesel generator shall start automatically upon loss of normal power and shut-down once normal power is restored;
- .3 The general spillway controller will assign which 3 gates will be heated in normal condition and which 2 gates will be heated in emergency condition (diesel generator supply);
- .4 The individual gate PLCs shall activate or deactivate the heating system based on the command received from the general spillway controller.
- .5 For a detailed functional description of the Automatic Transfer and Load Management System, refer to Section: 26 29 03.04, Spillway Automatic Transfer and Load Management System - Functional Description of this technical specification.



2.6 ECC AND POWERHOUSE CONTROL ROOM

2.6.1 The same functionalities available at the general spillway controller will be available at the powerhouse control room and at the ECC (Energy Control Centre) located in St. John's, NL, through communication links to the general spillway controller.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING – HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.7 INSTRUMENTATION

2.7.1 For the instrumentation requirements, refer to section 5.1.

2.8 BRAKE CONTROL

2.8.1 For the brake control requirements, refer to section 5.2.

2.9 HORN WARNING SYSTEM

2.9.1 If the INCREMENTAL RAISE button is pressed on a gate that is not already spilling (i.e. a gate which is closed), the following takes place:

- .1 Step 1: INCREMENTAL RAISE button is pressed for a gate which is closed;
- .2 Step 2: Horn sounds for 5 minutes (adjustable) and gate movement is blocked during this period;
- .3 Step 3: After the step 2 time is completed, the gate moves the incremental amount, the horn keeps sounding while the gate is moving and the horn sounds for an additional 5 minutes (adjustable) after the gate has stopped moving.

2.9.2 If the JOG RAISE button is pressed on a gate that is not already spilling (i.e. a gate which is closed), the following takes place:

- .1 Step 1: JOG RAISE button is pressed for a gate which is closed;
- .2 Step 2: Horn sounds for 10 minutes (adjustable) and gate movement is initially blocked;
- .3 Step 3: After a 5-minute delay (adjustable) the JOG RAISE function becomes active. The gate shall move if the JOG RAISE button is pressed but only if the horn is still sounding;
- .4 Step 4: Gate moves as long as the JOG RAISE button is pressed, horn keeps sounding while the gate is moving and the horn sounds for an additional 5 minutes (adjustable) after the JOG RAISE button has been released.

2.9.3 If a gate is already spilling and a raise button is pressed (either JOG RAISE or INCREMENTAL RAISE) the gate shall move as commanded and the horns shall simultaneously sound for 5 minutes (adjustable).

2.9.4 If a subsequent raise is initiated before the 5 minutes have been completed the raise command shall be acted on but the horn shall continue sounding and the horn timer shall reset for 5 minutes (adjustable).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.9.5 When in maintenance mode, the horn and timer shall be disabled.

3 SPILLWAY GATE HEATING CONTROL

3.1 GENERAL

- 3.1.1 Each gate heating control shall be completely independent. The failure of an individual gate heating control shall have no impact on the other gates.
- 3.1.2 Gate heating control shall be achieved through bidirectional triode thyristor (TRIAC) modules and temperature controllers.
- 3.1.3 The gate heating controller shall be independent from the gate PLC and shall be located in the spillway hoist house.
- 3.1.4 The gate heating control shall have 4 heating modes: OFF, SUMMER, AUTO and BYPASS, as described below.
- 3.1.5 The heating mode of the gate and of the embedded parts shall be independent; it shall be possible to assign a different heating mode to the gate and the embedded parts.
- 3.1.6 The gate PLC, located in the spillway electrical building, shall assign the gate heating mode.
- 3.1.7 Each gate shall have a heating control panel. The heating control panel shall be located adjacent to the hoist local control panel in the hoist house. The heating control panel shall allow selection of the heating mode through the gate PLC located in the spillway electrical building. The selector switches on the local control panel shall be hardwired back to the PLC panel to allow selection of the heating mode through the PLC. The heating control panel shall be insulated on all faces and heated and the heating shall be supervised.
- 3.1.8 A LOCAL-REMOTE selector switch shall be located on the heating control panel. The LOCAL position shall allow selection of the heating mode from the local heating control panel. The REMOTE position shall allow selection of the heating mode from the remote locations.
- 3.1.9 The heating control panel shall have two (2) OFF-SUMMER-AUTO-BYPASS selector switches, one for the gate heating mode selection and one for the embedded parts heating mode selection.
- 3.1.10 When a gate is being opened or closed, its heating system shall be disabled to limit the peak demand on the electrical supply system.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.2 GATE HEATING

3.2.1 A temperature sensor located inside the gate shall provide the temperature measurement to the gate heating control system.

3.2.2 A backup temperature sensor shall be located inside the gate to detect a low temperature and trigger an alarm.

3.2.3 A selector switch with OFF-SUMMER-AUTO-BYPASS positions shall be provided on the heating control panel. At the OFF position the heating of the gate shall be disabled. At the SUMMER position the gate shall be heated at 10% (adjustable) power constantly no matter what the temperature is. At AUTO position the gate shall be heated with power proportional to the demand (modulated) through a TRIAC circuit. At the BYPASS position, the gates shall be heated at full power through a contactor installed in parallel with the TRIAC circuit. The BYPASS mode shall be available in case of failure of the TRIAC circuit and shall allow gate heating in case maintenance is required on the TRIAC circuit.

3.2.4 The heating control panel shall have the following indicating lights:

- .1 Gate heating system energized;
- .2 Gate heating in summer mode;
- .3 Gate heating in auto mode;
- .4 Gate heating in bypass mode;
- .5 Gate heater alarm (one per heater);
- .6 Gate low temperature alarm.

3.2.5 The following push-buttons will be installed on the control panel:

- .1 TEST LAMPS;
- .2 RESET.

3.2.6 The heating system shall send the following signals for each gate for remote monitoring, but not limited to:

- .1 loss of power;
- .2 loss of control power;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Gate heater alarm (one per heater);
 - .4 High and low temperature alarms inside the gate at each heater;
 - .5 Position of the selector switch;
 - .6 Temperature reading inside the gate;
 - .7 Low temperature of the control panel.
- 3.2.7 An alarm for heating lower than 10% shall be installed to ensure that the system is functional. This alarm system shall be composed of a current transducer and a device which can detect the presence of current with a dry contact for remote alarm.
- 3.3 EMBEDDED PARTS HEATING**
- 3.3.1 A temperature sensor shall be installed in contact with an embedded part to supply temperature reading to the heating control system.
- 3.3.2 A temperature sensor shall be installed with each heating element in order to provide an alarm in case of failure of the heating system.
- 3.3.3 A selector switch with OFF-SUMMER-AUTO-BYPASS positions shall be provided on the heating control panel. At the OFF position the heating of the embedded parts shall be disabled. At the SUMMER position the embedded parts shall be heated at 10% (adjustable) power constantly no matter what the temperature is. At AUTO position the embedded parts shall be heated with power proportional to the demand (modulated) through a TRIAC circuit. At the BYPASS position, the embedded parts shall be heated at full power through a contactor installed in parallel with the TRIAC circuit. The BYPASS mode shall be available in case of failure of the TRIAC circuit and shall allow embedded parts heating in case maintenance is required on the TRIAC circuit.
- 3.3.4 The heating control panel shall have the following indicating lights:
- .1 Embedded part heating system energized;
 - .2 Embedded part heating in summer mode;
 - .3 Embedded part heating in auto mode;
 - .4 Embedded part heating in bypass mode;
 - .5 Embedded part heating system failure.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3.5 The following push-buttons shall be installed on the control panel:

- .1 TEST LAMPS;
- .2 RESET.

3.3.6 The heating system shall send the following signals for remote monitoring:

- .1 Embedded part heating system failure;
- .2 Loss of control power;
- .3 Low temperature of the control panel;
- .4 Position of the selector switch.

4 INTAKE GATE CONTROL

4.1 GENERAL REQUIREMENTS

- 4.1.1** A dedicated PLC shall be provided for every generating unit. Each PLC shall control the three (3) hoists related to the generating unit.
- 4.1.2** The control of the intake gate hoists for each generating unit shall be completely independent. The failure of a PLC shall have no impact on the other generating units.
- 4.1.3** Each hoist shall have a local control panel located adjacent to the hoist. The local control panel shall control the gate through the PLC. The buttons and selector switches on the local control panel shall be hardwired back to the PLC panel to allow control of the gate through the PLC.
- 4.1.4** Safety functions, such as the slack rope detection device, shall be hardwired to the motor starter control circuit.
- 4.1.5** Except for the emergency close function, any function which disables the hoist motor shall apply the brakes.
- 4.1.6** The emergency close protection function shall be a hardwired, 125 Vdc circuit, which shall cause all 3 intake gates associated to a generating unit to drop. The circuit shall allow for connection of trip signals from the powerhouse control and protection system.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.1.7 It shall be possible to control and monitor each gate from 4 different locations:

- .1 Local control panel adjacent to the hoist;
- .2 PLC panel located in the intake gate building near the hoists;
- .3 Powerhouse control room (supplied by Company's Other Contractor);
- .4 ECC (Energy Control Centre) located in St. John's, NL (supplied by Company's Other Contractor).

4.2 GATE POSITIONS

4.2.1 The following table describes the intake gate position terminology that will be used in this section of the specification:

INTAKE GATE POSITIONS	
Position	Description
Extreme upper limit	The highest position the gate could reach. If the gate reaches this position it will be stopped by a switch operated by a counterweight hinged arm which would be hit by a striker mounted on the gate.
Maintenance upper limit	The highest position the gate could reach under normal maintenance mode. If the gate reaches this position it will be stopped by a limit switch.
Full open	Full open position under normal mode of operation, the gate is fully out of the water.
Cracked	The gate is open by a small amount to allow filling up the water passages.
Closed	Normal closed position in which the gate completely blocks the water passage.

4.3 LOCAL CONTROL PANEL

4.3.1 The local control panel shall be insulated on all faces and heated. Heating shall be supervised.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING – HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 4.3.2** A LOCAL-REMOTE-MAINTENANCE selector switch shall be located on the local control panel. The LOCAL position shall allow control of the gate hoist from the local control panel. The REMOTE position shall allow control of the gate hoist from the PLC panel, powerhouse DCS or ECC. The MAINTENANCE position shall allow the gate to be raised beyond the full open position. The MAINTENANCE position shall also allow the cable drum to keep turning after the gate has reached the closed position.
- 4.3.3** The following push-buttons shall be installed on the control panel:
- .1 RAISE;
 - .2 LOWER;
 - .3 OVERRIDE;
 - .4 STOP;
 - .5 EMERGENCY STOP;
 - .6 EMERGENCY CLOSE;
 - .7 TEST LAMPS;
 - .8 RESET.
- 4.3.4** When the selector switch is in the REMOTE position only the EMERGENCY CLOSE and EMERGENCY STOP functions shall be available at the local control panel. All other functions shall be disabled.
- 4.3.5** When the selector switch is in the LOCAL position, the RAISE button shall move the gate to the full open position from any position below full open. The initial filling logic described in section 4.8 shall over ride this function. The gate shall stop automatically when the full open position has been reached without operator intervention. If the gate is in full open position or above the full open position, no action shall be taken if the RAISE button is pressed.
- 4.3.6** When the selector switch is in the LOCAL position, the LOWER button shall move the gate to the closed position from any position. The gate shall stop automatically when the close position has been reached without operator intervention. If the gate is closed, no action shall be taken if the LOWER button is pressed.
- 4.3.7** When the selector switch is in MAINTENANCE position, the RAISE and LOWER buttons shall allow the gate to be jogged past the full open position but the gate shall stop at the maintenance upper limit. In MAINTENANCE mode the initial filling logic shall not apply.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.3.8 To permit jogging the gate past the maintenance upper limit (to test the extreme upper limit switch) or to keep turning the cable drum after the gate has reached the close position (to test the slack rope system), the selector switch shall be at the MAINTENANCE positions and both the OVERRIDE button and RAISE / LOWER shall be pressed at the same time. The OVERRIDE button shall only function when the selector switch is at the MAINTENANCE position.

4.3.9 The STOP button shall only stop programmed movement, it shall not stop an emergency close command.

4.3.10 The EMERGENCY STOP button shall be of the mushroom type and hardwired to the motor starter. Emergency stopping of the three (3) intake gates shall be triggered by pressing the EMERGENCY STOP button on any of the local control panel associated to a generating unit. This function shall be latching and reset by pressing the RESET button on the panel. A light shall be activated on the panel to signal that the EMERGENCY STOP button was pressed.

4.3.11 The EMERGENCY CLOSE button shall be a covered button and hardwired to the motor starters and the brakes. Emergency closing of the three (3) intake gates shall be triggered by pressing the EMERGENCY CLOSE button on any of the local control panel associated to a generating unit. The emergency closing shall disable the hoist motors and release the brakes and shall send a signal to the unit controller to initiate a unit shutdown. The gates shall close by gravity with the lowering speed controlled by the fan brake. This function shall be latching and reset by pressing the RESET button on the panel. A light shall be activated on the panel to signal that the EMERGENCY CLOSE button was pressed.

4.3.12 The following conditions shall be indicated by lights on the control panel:

- .1 Gate in "closed" position;
- .2 Initial filling completed;
- .3 Gate in "full open" position or above.

4.3.13 The following displays shall be mounted on the control panel:

- .1 Gate position (digital indication);
- .2 Load on the cables.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

4.4 PLC PANEL

- 4.4.1 Four (4) PLC panels shall be installed, one per generating unit. Each PLC panel shall contain a PLC, controlling the three (3) hoists related to a generating unit. Each PLC panel shall also house an HMI touch screen to allow control and monitoring of the gate hoists.
- 4.4.2 The PLC panels will be located in the non-heated intake gate building, near the hoists. The PLC panels shall be insulated on all faces and heated to maintain an inside temperature adequate for the electronic equipment it contains. The PLC panels shall have an external door and all temperature sensitive equipments, such as the touch screen and PLC, shall be mounted inside the panel. A separate thermostat shall be supplied to send an alarm, with an adjustable threshold, to report a low temperature condition in the panel.
- 4.4.3 A LOCAL-REMOTE selector switch shall be located on the panel exterior door. The LOCAL position shall allow control of the three (3) hoists from the touch screen HMI. The REMOTE position shall allow control of the gates from the powerhouse DCS (Distributed Control System) or from the ECC.
- 4.4.4 An EMERGENCY STOP button shall be located at the PLC panel. An alarm on the HMI shall signal that the EMERGENCY STOP button was pressed. The EMERGENCY STOP button shall be of the mushroom type and hardwired to the motor starter. Emergency stopping of the three (3) intake gates shall be triggered by pressing the EMERGENCY STOP button associated to a generating unit. This function shall be latching and reset by pressing the RESET button on the panel.
- 4.4.5 An EMERGENCY CLOSE button shall be located at the PLC panel. An alarm on the HMI shall signal that the EMERGENCY CLOSE button was pressed. The EMERGENCY CLOSE button shall be a covered button and hardwired to the motor starters and the brakes. Emergency closing of the three (3) intake gates shall be triggered by pressing the EMERGENCY CLOSE button associated to a generating unit. The emergency closing shall disable the hoist motors and release the brakes and shall send a signal to the unit controller to initiate a unit shutdown. The gates shall close by gravity with the lowering speed controlled by the fan brake. This function shall be latching and reset by pressing the RESET button on the panel.
- 4.4.6 A touch screen HMI shall be mounted in the panel. The status of equipments, for the three (3) gates, shall be presented in the form of graphical displays, reports, alarms and event lists. Graphical diagrams shall be used for the representation of the operation of the gates.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.4.7 The HMI shall replicate all the functions and indications described in the previous section for the local control panel. The HMI shall also display, for the three (3) gates, the following additional information, but not limited to:

- .1 Status of all limit switches (position, slack rope, balanced rope, extreme upper limit, etc.);
- .2 Brake status;
- .3 Emergency stop status;
- .4 Emergency close status;
- .5 Motor starter status;
- .6 Initial filling timer;
- .7 Pressure readout;
- .8 Local/Remote/Maintenance status;
- .9 Heater status.

4.4.8 All indications and alarms shall continue to be displayed on the touch screen HMI when the panel is set to remote.

4.4.9 The Maintenance functions shall not be available from the PLC panel HMI.

4.4.10 A communication link, through fibre optic, shall be provided between each gate PLC and the unit controller (supplied by Company's Other Contractor) located in the powerhouse.

4.5 ECC AND POWERHOUSE CONTROL ROOM

4.5.1 It shall be possible to control and monitor the intake gates from the powerhouse control room or from the ECC (Energy Control Centre) located in St. John's, NL.

4.5.2 The intake gate alarms and indication points to be sent to the control room and ECC shall include for each gate, but not be limited to, the following:

- .1 Intake gate position indication;
- .2 Intake gate full open;
- .3 Intake gate closed;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Intake gate cracked;
- .5 Intake gate travelling;
- .6 Intake passage filling in progress;
- .7 Intake gate trip isolated;
- .8 Emergency Close initiated;
- .9 Emergency Stop initiated;
- .10 Intake gate slack rope;
- .11 Intake gate extreme upper limit;
- .12 Intake gate maintenance upper limit;
- .13 Intake gate hoist overload;
- .14 Intake hoist motor overload;
- .15 Power failure - ac;
- .16 Power failure - dc;
- .17 Control panels low temperature;
- .18 PLC failure;
- .19 Local or maintenance mode selected;
- .20 Heater status.

4.5.3 The intake gate control points to be received from the control room and ECC shall include for each gate, but not be limited to, the following:

- .1 Intake gate emergency close to be hardwired from the protection system only;
- .2 Intake gate close.

4.6 INSTRUMENTATION

4.6.1 For the instrumentation requirements, refer to section 5.1.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.6.2 For the intake gate, the cracked position shall be controlled by the PLC using the continuous position indication. The rotary limit switch shall act as a backup to stop the gate at the cracked position in case of PLC failure.

4.7 BRAKE CONTROL

4.7.1 For the brake control requirements, refer to section 5.2.

4.7.2 There shall be an electrical interlock to prevent the gate from being raised if the brake lever is in the released position.

4.8 INITIAL FILLING

4.8.1 Initial filling of the water passage shall be accomplished by cracking one gate. It shall be possible to use any gate for initial filling. The PLC shall only act on the command from the first gate and ignore raise commands from the other gates. Upon reception of a raise command, the PLC shall open the gate to approximately 150 mm, this amount shall be adjustable. All subsequent raise commands shall be disabled on all gates. Raise commands shall only be re-enabled when 2 conditions are met: downstream pressure switch activated and 20 minute timer (adjustable). It shall only be possible to start initial filling from the local control panel or PLC panel. Once the water passage initial filling has been completed, open commands for the remaining two intake gates associated to the water passage shall bypass the initial filling sequence.

4.9 EMERGENCY CLOSE

4.9.1 When the selector switches on the local control panels and intake PLC panel are in REMOTE position, the emergency close signal from the powerhouse protection system and from the EMERGENCY CLOSE buttons located at the hoist house shall cause the gates to close.

4.9.2 When the selector switch at one of the local control panels or at the intake PLC panel is in the LOCAL position, the emergency close signal from the powerhouse protection system shall be blocked but the EMERGENCY CLOSE buttons located at the hoist house shall be enabled. The selection of the LOCAL position shall send an alarm to the powerhouse control system.

4.9.3 When the selector switch at one of the local control panels is in the MAINTENANCE position, the emergency close function shall be blocked. The selection of the MAINTENANCE position shall send an alarm to the powerhouse control system.

4.9.4 It shall not be possible to stop an emergency close command with the EMERGENCY STOP or STOP button, regardless of the position of the selector switch.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING – HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.10 HORN

4.10.1 When the EMERGENCY CLOSE or EMERGENCY STOP button is pressed from any location a horn or buzzer shall sound in the intake building. The amount of time the horn sounds shall be adjustable.

5 SPILLWAY AND INTAKE GATES COMMON REQUIREMENTS

5.1 INSTRUMENTATION

5.1.1 Each gate shall be equipped with instrumentation to provide the following functionalities, but not limited to:

- .1 Continuous position indication;
- .2 Extreme upper limit detection;
- .3 Maintenance upper limit detection;
- .4 Full open position detection;
- .5 Close position detection;
- .6 Slack rope detection;
- .7 Hoist load indication;
- .8 Balanced wire rope loads detection.

5.1.2 For gate position indication, the following devices shall be provided:

- .1 One digital absolute continuous position indicator with a minimum precision of 5 mm. The device shall be mounted in a heated weatherproof metallic enclosure;
- .2 One cam-type rotary limit switch, driven through suitable gearing from the hoist drum, with a minimum of 8 adjustable contacts.

5.1.3 For the extreme upper limit, the following device shall be provided:

- .1 One power limit switch, installed in the motor supply circuit. This switch shall directly de-energize the motor supply and apply the brakes when the gate has over-travelled due to a fault on the maintenance upper limit switch. The switch shall be operated by a counterweight hinged arm which will be hit by a striker mounted on the gate. The switch shall be located such that it can be reset by maintenance personnel from a safe location without requiring fall arrest protection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.1.4 For the maintenance upper limit position, the following device shall be provided:

- .1 One device, independent from the extreme upper limit switch, which shall stop the gate if it over-travels the maintenance upper limit position. This device shall stop the gate before it reaches the extreme upper limit through a contact hardwired to the motor starter.

5.1.5 For the full open position, the following device shall be provided:

- .1 The full open position shall be obtained from the position indication devices or a different device Accepted by Engineer.

5.1.6 For the close position and the hoist load, the following device shall be provided:

- .1 A load cell shall be installed on each dead end or alternate location Accepted by Engineer. The load cell shall provide continuous read-out to the display on the local control panel and to the PLC. A high load setting shall be used for overload protection and shall stop the gate. The load cell shall be provided with dry contacts with adjustable thresholds and a contact shall be hardwired to the motor starter to stop the hoist on overload in case of a PLC failure. A lower limit programmable setting shall be used to detect gate close position (for example <25% normal lowering load).

5.1.7 For slack rope detection, the following device shall be provided:

- .1 A slack rope detection system, independent from the load cell used for normal close position and hoist load indication, shall be installed. This system shall act as a backup to stop the gate in case of failure of the load cell. A contact shall be hardwired to the motor starter to stop the hoist in case a slack rope is detected.

5.1.8 For balanced wire rope loads, the following device shall be provided:

- .1 A system shall be provided to detect load unbalance between the wire ropes. This system shall stop the hoist through a contact hardwired to the motor starter in case of load unbalance.

5.1.9 Activation of the maintenance upper limit, extreme upper limit and hoist overload limit switches shall disable any further raise signals.

5.1.10 Activation of the slack rope detection limit switch shall disable any further lowering commands.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.2 BRAKE CONTROL

5.2.1 The brake control circuit shall be designed to minimize arcing on the contacts when the brake release coil is de-energized. If a damping circuit is used, it shall be designed such that the brake will come on immediately when the supply to the 125 Vdc brake release coil is removed.

6 DRAFT TUBE HOIST CONTROL

6.1 GENERAL

6.1.1 The draft tube hoist will be located in a sheltered non-heated space. All control components shall be designed to function in outdoors conditions.

6.1.2 The draft tube hoist shall be controlled only from a pendant control located on the upstream side of the hoist.

6.1.3 The pendant cord shall be long enough to allow the operator to stand on either side of the gate plus an extra 2 meters. A convenient place to wrap the excess length of cord and to hang the pendant shall be provided on the hoist. The pendant shall be water proof.

6.1.4 All travel and hoist functions shall be variable speed; the speed shall be controlled from the pendant.

6.1.5 The pendant shall have as a minimum the buttons described in section 9.1.

6.1.6 Any function which disables the hoist motor shall apply the brakes.

6.2 INSTRUMENTATION

6.2.1 The draft tube hoist instrumentation shall be as described in section 9.2.

6.2.2 In addition, the following device shall be supplied to detect that the hoist bridge is at the end of the rail:

- .1 The movement of the bridge shall be limited at both extremities of the rails by proximity switches. The proximity switches shall prevent the bridge from hitting the bumpers at the end of the rails.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

7 TRASH RACK HOIST CONTROL

7.1 GENERAL

- 7.1.1 The trash rack hoist will be located outside under the trash cleaner gantry structure. All control components shall be designed to function in outdoor conditions.
- 7.1.2 It shall be possible to control the trash rack hoist from a control panel or a radio remote control.
- 7.1.3 All travel and hoist functions shall be variable speed; the speed shall be controlled from the control panel or radio remote control. The north/south maximum travel speed shall be programmable.
- 7.1.4 An interlock shall block the hoist function unless the trash cleaner platform is parked and the boom is retracted.
- 7.1.5 An interlock shall block the trash cleaner function if there is a load on the hoist and the hoist is not fully raised.
- 7.1.6 Any function which disables the hoist motor shall apply the brakes.

7.2 CONTROL PANEL

- 7.2.1 The control panel shall be insulated on all faces and heated. Heating shall be supervised and shall generate an alarm in case of failure. The control panel shall be mounted inside a weatherproof and lockable enclosure.
- 7.2.2 The trash rack hoist control panel shall be located on a platform on the access stairway/ladder near the roadway level where the operation of the hoist can be safely viewed for all operations.
- 7.2.3 A 2-position selector switch (PANEL-RADIO REMOTE) shall be located on the panel to allow control from the panel or from the radio remote control.
- 7.2.4 A 3-position selector switch (CLEAN-OFF-HOIST) shall be supplied. The CLEAN position shall enable the trash cleaner. The HOIST position shall enable the hoist function. The OFF position shall block both the trash cleaner and the hoist functions. An identical 3-position selector switch shall be located in the trash cleaner cab. Both selector switches, in the cab and at the control panel, must have the same selection for the selection to be active.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

7.2.5 The following conditions, as a minimum, shall be indicated by lights on the control panel:

- .1 Slack rope;
- .2 Hoist overload;
- .3 Extreme upper limit;
- .4 Normal upper limit;
- .5 Motor overload;
- .6 Hoist Energized;
- .7 Unloaded position;
- .8 Lower limit position;
- .9 Brake Status;
- .10 Unbalance wire rope load;
- .11 Cab selector switch position.

7.2.6 The control panel shall have, as a minimum, the buttons described in section 9.1.

7.2.7 There shall be, in addition to the EMERGENCY STOP button on the control panel and the radio remote control, one EMERGENCY STOP button on each leg of the trash cleaner gantry. The EMERGENCY STOP buttons on each leg of the gantry shall be of the mushroom type and hardwired to the gantry drive starter. All EMERGENCY STOP buttons shall be latching and reset by pressing the RESET button on the panel. A light shall be activated on the panel to signal that the EMERGENCY STOP button was pressed.

7.3 RADIO REMOTE CONTROL

7.3.1 The radio remote control shall be stored inside the operators cab and be provided with 2 battery packs and 2 chargers.

7.3.2 The radio remote control shall have, as a minimum, the buttons described in section 9.1.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

7.4 INSTRUMENTATION

7.4.1 The trash cleaner hoist instrumentation shall be as described in section 9.2. The load cell display shall be clearly visible from the operating platform and from the ground when the hoist is operated.

8 SPILLWAY HOIST BUILDING MAINTENANCE CRANE

8.1 GENERAL

8.1.1 The spillway hoist building maintenance overhead crane will be located in a sheltered non-heated space. All control components shall be designed to function in outdoors conditions.

8.1.2 The maintenance crane shall be controlled only from a pendant control.

8.1.3 All travel and hoist functions shall be variable speed; the speed shall be controlled from the pendant.

8.1.4 The pendant shall have as a minimum the buttons described in section 9.1.

8.1.5 Any function which disables the crane motor shall apply the brakes.

8.2 INSTRUMENTATION

8.2.1 The maintenance crane instrumentation shall be as described in section 9.2.

8.2.2 In addition, the following device shall be supplied to detect that the crane is at the end of the rail:

- .1 The movement of the crane shall be limited at both extremities of the rails by proximity switches. The proximity switches shall prevent the crane from hitting the bumpers at the end of the rails.

90 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

9 DRAFT TUBE, TRASH CLEANER AND MAINTENANCE CRANE COMMON REQUIREMENTS

9.1 CONTROL

9.1.1 The hoist control shall have a minimum of 10 buttons/controls:

- .1 ON;
- .2 OFF;
- .3 RAISE;
- .4 LOWER;
- .5 TRAVEL IN THE UPSTREAM DIRECTION;
- .6 TRAVEL IN THE DOWNSTREAM DIRECTION;
- .7 TRAVEL IN THE NORTH DIRECTION;
- .8 TRAVEL IN THE SOUTH DIRECTION;
- .9 EMERGENCY STOP;
- .10 DISENGAGE HOOKS.

9.1.2 The RAISE, LOWER and all TRAVEL buttons shall be jog functions, the hoist shall move as long as the button is pressed and shall stop if the button is released.

9.1.3 The DISENGAGE HOOKS button shall, where applicable, allow freeing the lifting beam from the gate.

9.1.4 The EMERGENCY STOP button shall be of the mushroom type and hardwired to the motor starter.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

9.2 INSTRUMENTATION

9.2.1 The following table describes the hoist position terminology that will be used in this section of the specification:

HOIST POSITIONS	
Position	Description
Extreme upper limit	The highest position the hoist could reach. If the hoist reaches this position it will be stopped by a switch operated by a counterweight hinged arm which would be hit by a striker.
Normal upper limit	The highest position the hoist could reach under normal condition. When the hoist reaches this position it will be stopped by a limit switch.
Unloaded position	Position at which there is no load on the hoist and the wire rope becomes slack. The hoist will be stopped by the slack rope detection device.
Lower limit	Lowest position the hoist is allowed to reach. A limit switch will automatically stop the hoist if this lower limit is exceeded.

9.2.2 Each hoist shall be equipped with instrumentation to provide the following functionalities, but not limited to:

- .1 Extreme upper limit;
- .2 Normal upper limit;
- .3 Unloaded position;
- .4 Lower limit;
- .5 Hoist load;
- .6 Slack rope;
- .7 Balanced wire rope loads;
- .8 Overspeed detection.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

9.2.3 For the extreme upper limit, the following device shall be provided:

- .1 One power limit switch, installed in the motor supply circuit. This switch shall directly de-energize the motor supply and apply the brakes when the hoist has over-travelled due to a fault on the normal upper limit switch. The switch shall be operated by a counterweight hinged arm which will be hit by a striker. The switch shall be located such that it can be reset by maintenance personnel from a safe location without requiring fall arrest protection.

9.2.4 For the normal upper limit, the following device shall be provided:

- .1 One limit switch, of a type Accepted by Engineer, which shall stop the hoist when the normal upper limit position has been reached.

9.2.5 For the unloaded position and slack rope detection, the following device shall be provided:

- .1 A slack rope detection system, independent from the load cell used for hoist load indication, shall be installed. This system shall automatically stop the hoist when any wire rope becomes unloaded. A contact shall be hardwired to the motor starter to stop the hoist lower function in case a slack rope is detected.

9.2.6 For the lower limit detection, the following device shall be provided:

- .1 A limit switch, independent from the slack rope detection system, shall stop the hoist at the lower limit to maintain the minimum required rope wrap on the drum.

9.2.7 For the hoist load, the following device shall be provided:

- .1 There shall be a load cell on each dead end or alternate location Accepted by Engineer with a large display on the hoist (100 mm characters minimum). The load cell shall have programmable thresholds that shall trigger an audible alarm and stop the hoist when the threshold is exceeded. The load cell shall be provided with dry contacts with adjustable thresholds and a contact shall be hardwired to the motor starter to stop the hoist on overload. If the hoist is stopped due to an overload condition, it shall be allowed to go down only and the overload condition must be cleared when the load reduces to 90% of the rated load.

9.2.8 If there are multiple wire ropes, the following balanced wire rope loads device shall be provided:

- .1 A system shall be provided to detect load unbalance between the wire ropes. This system shall stop the hoist through a contact hardwired to the motor starter in case of load unbalance and trigger an audible alarm.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.03
CH0032	CONTROL AND MONITORING - HYDRO-MECHANICAL	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

9.2.9 For overspeed detection, the following shall be provided:

- .1 The hoist shall be equipped with two (2) brakes. There shall be an overspeed detector which shall automatically apply the secondary brake in case of an overspeed condition. In case of overspeed, the brake shall be latched and reset manually only.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.04
CH0032	SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM - FUNCTIONAL DESCRIPTION	Rev. D2
POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD 2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS

SECTION 26 29 03.04

**SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM -
FUNCTIONAL DESCRIPTION**

PART .1 GENERAL..... 2

1.1 INTRODUCTION 2

1.2 RELATED DOCUMENTS 2

1.3 DEFINITIONS..... 2

1.4 ABBREVIATIONS..... 2

PART .2 SPILLWAY FACILITIES 2

PART .3 INSTALLED POWER AT THE SPILLWAY 3

3.1 SPILLWAY MCC CONNECTED LOADS ARE AS FOLLOWS: 3

PART .4 SPILLWAY MANUAL/AUTOMATIC TRANSFER AND LOAD MANAGEMENT 3

4.1 AUTOMATIC TRANSFER SYSTEM 3

4.2 LOAD MANAGEMENT SYSTEM 4



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.04
CH0032	SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM - FUNCTIONAL DESCRIPTION	Rev. D2
POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT MFA-SN-CD 2000-ME-TS-0001-01		505573-3321-45EG-0001

PART .1 GENERAL

1.1 INTRODUCTION

The objective of this document is to describe the requirements for the automatic transfer scheme and load management of the spillway loads. Three modes of operation are considered in this document:

- .1 Normal operation: The Spillway Main Switchgear/MCC is supplied by the 25 kV power supply through the step down transformer.
- .2 Emergency supply: The Spillway Main Switchgear/MCC is supplied by the emergency diesel generator;
- .3 Diesel Generator Load Test: The Spillway Main Switchgear/MCC is supplied by the emergency diesel generator for load testing of the diesel generator.

1.2 RELATED DOCUMENTS

- .1 Section: 26 09 03.04 – Control and Monitoring Hydro-Mechanical.

1.3 DEFINITIONS

1.3.1 Diversion Phase

The period during project construction that the river is diverted through the Spillway and maintained at the diversion head pond level, before the reservoir is impounded to full supply level for operation of the Powerhouse.

1.4 ABBREVIATIONS

- .1 MCC – Motor Control Center
- .2 PLC – Programmable Logic Controller
- .3 ECC – Energy Control Center

PART .2 SPILLWAY FACILITIES

The spillway installation includes five bays of Rollway Gates. Each gate has its own hoist individually powered by a 600V MCC located in the hoist house. Each of these individual hoist MCC's are fed from the Spillway Main Switchgear/MCC installed in the Spillway electrical room. The Spillway Main Switchgear/MCC shall be fed by a normal 600V 3 phase AC source and backed up by an emergency diesel generator set installed next to the Spillway electrical room. The circuit breaker of the emergency diesel generator set is electrically interlocked with the 600 Vac normal supply circuit

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.04
CH0032	SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM - FUNCTIONAL DESCRIPTION	Rev. D2
POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD 2000-ME-TS-0001-01		505573-3321-45EG-0001

breaker (reference drawing - Spillway Single Line Diagram MFA-SN-CD-2440-EL-SL-0001-01).

PART .3 INSTALLED POWER AT THE SPILLWAY

3.1 SPILLWAY MCC CONNECTED LOADS ARE AS FOLLOWS:

- a. Hoisting: five (5) rollway gates;
- b. Heating: All Gate's wheels, guides, service gates for five (5) bays;
- c. Heating of the five (5) hoist motors & five (5) gear boxes;
- d. Spillway hoist housings and electrical building heating & monorail motors;
- e. Heating of the upstream and downstream stop logs & guides;
- f. Spillway indoor & outdoor lighting; and
- g. North RCC Dam heating/ventilation & lighting loads.

Note: The Hoist house will not be heated. Instead localized radiant type heaters will be used for the hoist house.

PART .4 SPILLWAY MANUAL/AUTOMATIC TRANSFER AND LOAD MANAGEMENT

4.1 AUTOMATIC TRANSFER SYSTEM

In normal operation the Spillway Main Switchgear/MCC is fed by the 25 kV normal power supply through the 25-0.6 kV step-down transformer. Upon unavailability of the normal power supply, an automatic transfer system shall open the normal supply incomer circuit breaker and send a signal to start the emergency diesel generator. Once the diesel generator is ready to load, the transfer system shall close the emergency supply incomer circuit breaker to supply the Main Switchgear/MCC bus. All spillway loads are de-energized during supply transfer operations. Once the emergency supply circuit breaker is closed, the spillway electrical room essential loads and the load feeders, that are not equipped with a magnetic contactor (42), are energized. After a short delay, the system shall close only the Gate MCC outgoing circuit breakers (maximum two (2) of the five (5) Gate's MCCs) that are selected for the emergency operation mode.

Upon return of the normal power supply, the automatic transfer system shall open the emergency supply incomer circuit breaker, and close the normal power supply incomer circuit breaker. After a short delay, the system shall close only the Gate MCC outgoing circuit breakers (maximum three (3) of the five (5) Gate's MCCs) that are

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.04
CH0032	SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM - FUNCTIONAL DESCRIPTION	Rev. D2
POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD 2000-ME-TS-0001-01		505573-3321-45EG-0001

selected for normal operation mode. After a delay, a signal is sent to the diesel generator control panel to initiate the stop procedure.

The following conditions shall block the automatic transfer:

- Any protection trip of the incomer circuit breakers, and
- When the Manual/Auto selector switch (mounted on the Main Switchgear/MCC) of the Automatic Transfer System is on Manual.

4.2 LOAD MANAGEMENT SYSTEM

4.2.1 Normal Operation

The 25-0.6 kV step down transformer shall be sized to feed the heating of three (3) spillway gates, to supply power to one (1) gate hoist motor and to supply the spillway electrical auxiliary services. In addition to these loads, upstream and downstream stop log heating for one (1) gate shall be considered during the diversion phase plus the supply of the North Dam HVAC and lighting loads. It is the contractor's responsibility to ensure the transformer capacity fulfills the above operational requirements.

The automatic transfer system of the Main Switchgear/MCC shall also perform load management of the connected loads due to the limited size of the step down transformer. The transformer loading shall be monitored by the load management system to ensure the total load does not exceed the capacity of the transformer. If the total load reaches a certain limit, alarms shall be initiated. Automatic load shedding actions might also be required.

Load management shall be based on the gate operation mode selected by the operator. The selection of the Gate operation mode shall be possible from the gate PLC control panel. An "ON-OFF" selector shall allow for the selection of the gate operation mode.

When the gate selector is switched to the ON position, the load management system shall send a signal to close the outgoing feeder circuit breaker supplying the corresponding Gate MCC.

When the gate selector is switched to the OFF position, the load management system shall send a signal to open the outgoing feeder circuit breaker supplying the corresponding Gate MCC. A block close signal shall also be maintained on the closing circuit of the outgoing feeder circuit breaker to block remote close commands. In this mode, the Gate MCC is not supplied and only the Hoist House general loads and lighting loads will remain functional since they are fed by the Main Switchgear/MCC.

46 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.04
CH0032	SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM - FUNCTIONAL DESCRIPTION	Rev. D2
POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD 2000-ME-TS-0001-01		505573-3321-45EG-0001

A LOCAL-REMOTE selector switch shall be located on the Gate PLC control panel of each gate. The LOCAL position shall allow selection of the gate operation mode from the Gate PLC control panel only. The REMOTE position shall allow selection of the gate operation mode from the Spillway Main Controller, the Powerhouse control room and the ECC. The Remote mode will be functional only at the final phase.

The system shall have the following functionality:

- Gate selection shall be possible from four (4) different locations as follows:
 1. Gate PLC control panel;
 2. Spillway Main Controller supplied by Company's Other Contractor;
 3. Powerhouse control room (supplied by Company's Other Contractor); and
 4. ECC (Energy Control Center) located in St John's, NL (supplied by Company's Other Contractor).
- In normal operation it shall be possible to enable (or to select) only three (3) of the five (5) Gate MCCs at the same time.
- In addition to the Spillway Main Controller, each Gate PLC controller shall provide indication of selection status of the other Gates.
- The Gate selection shall be operational at the diversion phase and remain operational at the final stage.



4.2.2 Emergency Operation

The diesel generator shall be sized to supply the heating of two (2) spillway gates, operation of one (1) hoist motor of the selected gates, the day tank fuel transfer pump, and other essential loads such as emergency lighting, diesel generator room heating, supply and exhaust fans, and other loads connected to essential load distribution panels in the spillway electrical room. It is the contractor's responsibility to ensure the emergency diesel generator capacity fulfills the above operational requirements.

Non essential general loads such as normal lighting, the monorail crane, and the trash cleaner gantry crane are not supplied in emergency operation mode.

Because of the limited capacity of the emergency diesel generator (approximately 600 kW), the Automatic Transfer and Load Management System shall manage the load of the emergency diesel generator to ensure it remains within the generator's capacity. The load management system of the Spillway Main Switchgear/MCC automatically switches on only those essential loads that are required for the safety of the installation.

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78

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 03.04
CH0032	SPILLWAY AUTOMATIC TRANSFER AND LOAD MANAGEMENT SYSTEM - FUNCTIONAL DESCRIPTION	Rev. D2
POWERHOUSE AND SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD 2000-ME-TS-0001-01		505573-3321-45EG-0001

Similar to the normal operation mode, the load management of the Gate MCCs is performed by the Automatic Transfer and Load Management System of the Main Switchgear/MCC. As for the normal operation mode, the load management shall be based on the gate operation mode selected by the operator. The selection of the Gate operation mode shall be possible from the gate PLC control panel. An "ON-OFF" selector shall allow for the selection of the gate operation mode. The same LOCAL-REMOTE selector described in section 4.2.1 controls the local/remote selection of the gates in the emergency operation mode.

In emergency operation mode, the system shall have the following functionality:

- Gate selection shall be possible from four (4) different locations as follows:
 1. Gate PLC control panel;
 2. Spillway Main Controller;
 3. Powerhouse control room (supplied by Company's Other Contractor); and
 4. ECC (Energy Control Center) located in St John's, NL (supplied by Company's Other Contractor).
- In emergency operation it shall be possible to enable only two (2) of the five (5) Gate MCCs at the same time.
- In addition to the Spillway Main Controller, each Gate PLC controller shall provide indication of selection status of the other Gates.
- The Gate selection shall be operational at the diversion phase and remain operational at the final stage.



4.2.3 Diesel Generator Load Test

The diesel generator load test mode is very similar to the emergency operation mode. Essentially, the load conditions are identical to those described for the emergency mode.

The diesel generator load test shall be initiated locally from the diesel control panel.

In addition to load management, this operation mode shall initiate load transfer from the normal supply to the emergency supply.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 26 29 10
MOTOR STARTERS TO 600 V
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES.....	2
1.3	SUBMITTALS.....	3
1.4	CLOSEOUT SUBMITTALS.....	3
2	PRODUCTS	4
2.1	MATERIALS.....	4
2.2	MANUAL MOTOR STARTERS.....	4
2.3	FULL VOLTAGE MAGNETIC STARTERS (FVNR).....	4
2.4	FULL VOLTAGE REVERSING MAGNETIC STARTERS (FVR).....	5
2.5	FULL VOLTAGE CONTACTORS (FVC).....	6
2.6	FULL VOLTAGE FEEDER UNITS.....	6
2.7	FULL VOLTAGE HEATER CONTROL UNITS.....	6
2.8	CONTROL TRANSFORMER.....	7
2.9	ACCESSORIES.....	7
2.10	FINISHES.....	7
2.11	EQUIPMENT IDENTIFICATION.....	7
3	EXECUTION	7
3.1	INSTALLATION.....	7
3.2	FIELD QUALITY CONTROL.....	8



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – Common Work Results for Electrical
- .2 Section 26 24 19 – Motor Control Centres
- .3 Section 26 29 23 – Variable Frequency Drives
- .4 Section 26 09 23.01 – Metering and Switchboard Instruments

1.2 REFERENCES

1.2.1 National Electrical Manufacturers Association

- .1 NEMA ICS 1-2000 - Industrial Control and Systems: General Requirements
- .2 NEMA ICS 1.1 - Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
- .3 NEMA ICS 1.3 - Preventive Maintenance of Industrial Control and Systems Equipment
- .4 NEMA ICS 2 - Controllers, Contactors and Overload Relays Rated 600 V
- .5 NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600V
- .6 NEMA ICS 2.4 - NEMA and IEC Devices for Motor Service-A Guide for Understanding the Differences
- .7 NEMA ICS 4 - Application Guideline for Terminal Blocks
- .8 NEMA ICS 5 - Control Circuit and Pilot Devices
- .9 NEMA ICS 6 - Enclosures
- .10 NEMA ICS 7 - Adjustable Speed Drives
- .11 NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems
- .12 NEMA ICS 12.1 - Industrial Control and Systems: Profiles of Networked Industrial Devices-Part 1: General Rules

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .13 NEMA ICS 14 - Application Guide for Electric Fire Pump Controllers
- .14 NEMA ICS 15 - Instructions for the Handling, Installation, Operation and Maintenance of Electric Fire Pump Controllers Rated Not More Than 600 V
- .15 NEMA ICS 16 - Motion/Position Control Motors, Controls and Feedback Devices
- .16 NEMA ICS 18 - Motor Control Centers
- .17 NEMA ICS 19 - Diagrams, Device Designations and Symbols
- .18 NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems

1.3 SUBMITTALS

1.3.1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.3.3 Shop Drawings:

- .1 Provide shop drawings for each type of starter to indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

1.4.1 Provide maintenance materials in accordance with Exhibit 4 – Supplier Document Requirements List.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Submit operation and maintenance data for each type and style of motorstarter for incorporation into maintenance manual.

1.4.3 Extra Materials:

- .1 Provide listed spare parts for each different size and type of starter.
 - .1 Contacts, stationary – Quantity 3.
 - .2 Contacts, movable - Quantity 3.
 - .3 Contacts, auxiliary - Quantity 1.
 - .4 Control transformer[s] - . Quantity 1.
 - .5 Operating coil - Quantity 1.
 - .6 Fuses - Quantity 2.

2 PRODUCTS

2.1 MATERIALS

- .1 Starters: NEMA standards.

2.2 MANUAL MOTOR STARTERS

2.2.1 Single and three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 One or three overload heaters or relays, manual reset, trip indicating handle.

2.2.2 Accessories:

- .1 Toggle switch or pushbutton: heavy duty labelled as indicated.
- .2 Indicating light: heavy duty type with LED lamps of colour as indicated.
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS (FVNR)

2.3.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Contactor solenoid operated, rapid action type.
 - .2 Electronic motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- 2.3.2** Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:
- .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- 2.3.3** Accessories:
- .1 Pushbuttons and selector switches: heavy duty labelled as indicated.
 - .2 Indicating lights: heavy duty type and color as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.
- 2.4 FULL VOLTAGE REVERSING MAGNETIC STARTERS (FVR)**
- 2.4.1** Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
- .1 Two - 3 pole magnetic contactors mounted on common base.
 - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
 - .3 Three phase electronic overload relays manual reset.
- 2.4.2** Accessories:
- .1 Pushbuttons and selector switches: heavy duty labelled as indicated.
 - .2 Indicating lights: heavy duty type with LED lamps of color as indicated.
 - .3 Speed control: as indicated.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.5 FULL VOLTAGE CONTACTORS (FVC)

2.5.1 Units with magnetic contactors of size and rating and enclosure type as indicated, with components as following:

- .1 Moulded case circuit breakers with door mounted operating handle locking in "OFF" position with up to three padlocks.
- .2 Provision for preventing switching to "ON" position while unit door open.
- .3 Contactor, solenoid operated, rapid action type.
- .4 120 V control transformer.
- .5 Independent locking of unit door.

2.5.2 Unit accessories

- .1 Red LED light to indicate that circuit is energized.

2.6 FULL VOLTAGE FEEDER UNITS

2.6.1 Units with moulded case circuit breakers of rating indicated with the following components and features:

- .1 Moulded case circuit breaker with door mounted operating handle.
- .2 Locking in "OFF" position with up to three padlocks.
- .3 Provision for preventing switching to "ON" position while unit door is open.
- .4 Red LED light to indicate that circuit is energized.

2.7 FULL VOLTAGE HEATER CONTROL UNITS

2.7.1 Units with moulded case circuit breakers of rating indicated with the following components and features:

- .1 Moulded case circuit breaker with door mounted operating handle.
- .2 Locking in "OFF" position with up to three padlocks.
- .3 Provision for preventing switching to "ON" position while unit door is open.
- .4 Single loop temperature controller.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Triac power control unit.
- .6 Red LED light to indicate that circuit is energized.

2.8 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.9 ACCESSORIES

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, LED type and colour as indicated.

2.10 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 – General Electrical Requirements.

2.11 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - General Electrical Requirements.
- .2 Magnetic starter designation label, white plate, black letters, size 5 engraved as indicated.

3 EXECUTION

3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 10
CH0032	MOTOR STARTERS TO 600 V	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 29 23
VARIABLE FREQUENCY DRIVES
TABLE OF CONTENTS**

1 **GENERAL**.....2

1.1 SCOPE 2

1.2 RELATED SECTIONS 2

1.3 REFERENCES 2

1.4 ACTION AND INFORMATIONAL SUBMITTALS 2

1.5 CLOSEOUT SUBMITTALS 3

2 **PRODUCTS**.....4

2.1 GENERAL 4

2.2 RATINGS..... 5

2.3 CONSTRUCTION..... 5

2.4 OPERATOR INTERFACE..... 6

2.5 PROTECTIVE FEATURES 7

2.6 CONTROL INPUTS AND OUTPUTS 8

2.7 CONTROL FUNCTIONS AND ADJUSTMENTS10

2.8 COMMUNICATIONS11

2.9 FACTORY TESTING12

3 **EXECUTION**12

3.1 INSTALLATION12

3.2 FIELD QUALITY CONTROL12

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SCOPE

- .1 This specification shall apply to the materials, design, fabrication, inspection, and testing of 600 V Variable Frequency Drives (VFD) used to control the speed and torque of NEMA design B induction motors.
- .2 Ensure VFD is suitable for the motor loads of the equipment actually purchased by the Contractor.

1.2 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.
- .2 Section 26 24 19 – Motor Control Centres
- .3 Section 26 29 00 – Motor Starters to 600 V.

1.3 REFERENCES

1.3.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No. 14-M91—Industrial Control Equipment

1.3.2 Institute of Electrical and Electronic Engineers (IEEE)

- .1 IEEE 519-1992 – Guide for Harmonic Content and Control

1.3.3 National Electrical Manufacturers Association (NEMA)

- .1 NEMA ICS 7—Industrial Control and Systems Adjustable Frequency Drives
- .2 NEMA ICS 7.1—Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Frequency Drives
- .3 NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems
- .4 NEMA MG1—Motors and Generators

1.4 ACTION AND INFORMATIONAL SUBMITTALS

1.4.1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List

1.4.2 Product Data:

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-CV-TS-0001-01		

- .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.4.3 Shop Drawings:

- .1 Provide shop drawings in accordance with Exhibit 4 - Supplier Document Requirements List
- .2 Dimensioned front view elevation
- .3 Dimensioned floor plan
- .4 Dimensioned top view
- .5 Unit control schematics and wiring diagrams
- .6 Nameplate schedule
- .7 Cable entry/exit locations
- .8 Assembly ratings, including short circuit, voltage, and continuous current ratings
- .9 Major component ratings
- .10 Minimum clearances to other equipment.
- .11 Frequency spectrum for harmonic currents at line side of filter (where provided) at 50% and 100% of rated load.
- .12 Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD). The VFD manufacturer shall provide calculations specific to the installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE electrical system standard 519. All VFDs shall include a minimum of 3% equivalent impedance reactors. VFDs shall include some form of active mitigation.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Provide operation and maintenance data for VFDs for incorporation into manual.

1.5.2 Operation and maintenance manuals shall include as a minimum for each type and style of VFD.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

2 PRODUCTS

2.1 GENERAL

- .1 All VFDs shall be a solid state AC to AC inverter controlled device utilizing the latest isolated gate bipolar transistor (IGBT) technology. The VFD shall utilize Direct Torque Control (DTC) as the primary motor control, employing an inner loop torque control strategy that mathematically determines the optimal motor torque and flux every 25 microseconds. The VFD must also provide an optional motor control operational mode for scalar of V/Hz operation.
- .2 The VFDs will be incorporated into a motor control centre (MCC) or be fed from a MCC and be protected by circuit breakers. Manufacturer shall indicate recommended breaker size.
- .3 VFDs shall include:
 - .1 Steady state speed accuracy within 1/10th the slip without an encoder, for process repeatability.
 - .2 100% motor torque from zero speed available for acceleration with the VFD continuous current rating or equal in accordance with B6 to or greater then the motor full load amp rating.
 - .3 At and below 90% speed, 100% torque is achievable even with 10% low line voltage.
 - .4 Ability to limit torque to protect the mechanical system with a common single torque setting above and below field weakening.
 - .5 Ability to provide torque in % of motor shaft torque (with in +/- 4% linearity) on the VFD control panel, analog output or via field bus of actual.
 - .6 Have available the ability to operate in open loop torque control, with an ability to switch between speed and torque control on the fly with the change of state to a digital input.
 - .7 Have an ability to share load or speed between two or more induction AC motors connected to the same system, when those motors are controlled by separate VFDs.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

2.2 RATINGS

- 2.2.1 The VFD shall be designed for heavy-duty applications and in accordance with applicable datasheets.
- 2.2.2 The VFD shall be rated to operate from 3-phase power at 600 Vac +10/-10%. The overvoltage trip level shall be a minimum of 30% over nominal, and the undervoltage trip level shall be a minimum 35% under the nominal voltage.
- 2.2.3 The VFD shall be rated to operate from input power from 58Hz to 63Hz.
- 2.2.4 Output voltage and current ratings shall match the adjustable frequency operating requirements of standard NEMA design A or NEMA design B motors.
- 2.2.5 The Heavy Duty overload current capacity shall be 150% of rated current for one (1) minute out of five (5) minutes.
- 2.2.6 The VFD efficiency shall be 98% or better of the full rated capability of the VFD at full speed and load.
- 2.2.7 The VFD shall be capable of starting when fed from temporary diesel generator (nominal size of 750 kVA).
- 2.2.8 Drive rated for a minimum fault current of 35 kA Sym. I.C.

2.3 CONSTRUCTION

- 2.3.1 All models shall provide a complete, ready-to-install solution.
- 2.3.2 IGBT power technology shall be used. This technology shall be used for all power and voltage ranges offered by the Contractor.
- 2.3.3 The VFD shall offer microprocessor based control logic that is isolated from power circuitry.
- 2.3.4 The VFD shall use the same main control board for all ratings.
- 2.3.5 Control connections shall remain consistent for all power ratings.
- 2.3.6 Include coated circuit boards as standard
- 2.3.7 Include integrated internal AC line reactor or DC choke
- 2.3.8 Offer option internally mounted braking chopper for use in dynamic braking with 100% continuous duty operation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

2.3.9 Desired optional features shall be furnished and mounted by the VFD manufacturer and shall also be available as field installable kits as an alternative. All optional features shall carry all of the necessary certifications as described above. Field installed kits shall not affect the VFD's certification.

2.3.10 Provide equipment identification in accordance with Section 26 05 00 - General Electrical Requirements. Nameplates shall be permanently attached with screws.

2.3.11 The enclosure shall have appropriate warning labels.

2.3.12 A panel mounted non-resettable elapsed-time meter to measure operating hours with a minimum 6 digits display.

2.4 OPERATOR INTERFACE

2.4.1 The VFD shall be equipped with a front mounted operator control panel consisting of a four- (4) line by 20-character back-lit alphanumeric LCD display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, Reset, Menu navigation and Parameter select/edit.

2.4.2 The control panel shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

2.4.3 The display of the control panel shall have the following features:

- .1 The LCD display shall have contrast adjustment provisions to optimize viewing at angle.
- .2 All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
- .3 During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. The selection shall include at least the following values:
 - .1 Speed/torque in percent (%), RPM or user-scaled units
 - .2 Output frequency, voltage, current and torque
 - .3 Power and kilowatt hours
 - .4 Heatsink temperature and DC bus voltage

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

- .5 Status of discrete inputs and outputs
- .6 Values of analog input and output signals
- .7 Values of PID controller reference, feedback and error signals
- .8 The control panel shall be used for local control, for setting all parameters, and for stepping through the displays and menus.
- .9 A copy function to upload and store parameter settings from an VFD and download stored parameter settings to the same VFD or to another VFD shall exist.
- .10 An intelligent start-up assistant shall be provided as standard. The Start-up routine will guide the user through all necessary adjustments to optimize operation.
 - .1 The Start-Up routine shall include "plug and produce" operation, which automatically recognizes the addition of options and fieldbus adapters and provides the necessary adjustment assistance.
 - .2 The Start-Up routine shall prompt the user for Motor Nameplate Data including power, speed, voltage, frequency and current.
 - .3 An auto-tune function shall identify the optimal motor tuning parameters for typical applications.
 - .4 An auto-tune function shall also be available to tune the PID speed regulator loop. Manual adjustments shall also be allowed.
 - .5 A selection of at least six (6) pre-programmed application macro parameter sets shall be provided to minimize the number of parameter adjustments required during start-up. Macros offered shall include Factory Default, Hand/Auto, PID Control, and Torque Control. A selection of two (2) user defined macros shall also be available.
 - .6 Selection shall be offered for both 2-wire and 3-wire Start/Stop control.

2.5 PROTECTIVE FEATURES

- 2.5.1 For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the VFD's fault history.
- 2.5.2 The VFD shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

- 2.5.3 Output short circuit and ground fault protection rated for 35,000 amps without relying on line fuses shall be provided per UL508C.
- 2.5.4 Motor phase loss protection shall be provided.
- 2.5.5 The VFD shall provide electronic motor overload protection qualified per UL508C.
- 2.5.6 Protection shall be provided for ac line or dc bus overvoltage and undervoltage.
- 2.5.7 The VFD shall protect itself against input phase loss.
- 2.5.8 A power loss ride through feature shall allow the VFD to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
- 2.5.9 Stall protection shall be programmable to provide a warning or stop the VFD after the motor has operated above a programmed torque level for a programmed time limit.
- 2.5.10 Underload protection shall be programmable to provide a warning or stop the VFD after the motor has operated below a selected underload curve for a programmed time limit.
- 2.5.11 Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
- 2.5.12 Input terminals shall be provided for connecting a motor thermistor (PTC type) to the VFD's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.

2.6 CONTROL INPUTS AND OUTPUTS

2.6.1 Discrete Inputs

- .1 Minimum of six (6) discrete inputs shall be provided.
- .2 A minimum of six (6) of the inputs shall be independently programmable with function selections (run/stop using 2 wire or 3 wire control, hand-off-auto, etc.).
- .3 Inputs shall be designed for use with either the VFD's internal 24 Vdc supply or a customer supplied external 24 Vdc supply.

2.6.2 Discrete outputs

- .1 Minimum of three (3) form C relay contact outputs shall be provided
- .2 All outputs shall be independently programmable to activate with at least 30 function selections including;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

- .3 Operating conditions such as drive ready, drive running, reversed and at set speed
- .4 General warning and fault conditions
- .5 Adjustable supervision limit indications based on programmed values of operating speed, speed reference, current, torque and PID feedback.
- .6 Relay contacts shall be rated to switch 2 Amps at 24 Vdc or 120 Vac.

2.6.3 Analog Inputs

- .1 Minimum of two (2) analog inputs shall be provided:
 - .1 At least one (1) must support bi-polar voltage input
 - .2 Resolution of analog inputs must be at least 11bit total resolution
- .2 Inputs shall be independently programmable to provide signals including speed / frequency reference, torque reference or set point, PID set point and PID feedback / actual.
- .3 A differential input isolation amplifier shall be provided for each input.
- .4 Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion.
- .5 If the input reference is lost, the VFD shall give the user the option of the following. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
 - .1 Stopping and displaying a fault
 - .2 Running at a programmable preset speed
 - .3 Hold the VFD speed based on the last good reference received
 - .4 Cause a warning to be issued, as selected by the user.
- .6 When inputs are used as speed references, reference signal processing shall include increase/decrease floating point control and control of speed and direction using a "joystick" reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

2.6.4 Analog Outputs

- .1 Minimum of two (2) 0 / 4-20 mA analog outputs shall be provided.
- .2 Outputs shall be independently programmable to provide signals proportional to output function selections including output speed, frequency, voltage, current and power.

2.7 CONTROL FUNCTIONS AND ADJUSTMENTS

- 2.7.1 Output frequency shall be adjustable between 0Hz and 300Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.
- 2.7.2 Stop mode selections shall include coast to stop and ramp to stop.
- 2.7.3 The VFD shall be capable of controlling deceleration of a load without generating an overvoltage fault caused by excessive regenerated energy. Overvoltage control on deceleration shall extend the ramp time beyond the programmed value to keep the amount of regenerated energy below the point that causes overvoltage trip.
- 2.7.4 The VFD shall be capable of starting into a rotating motor with or without existing magnetic flux on the motor regardless of the motor direction. From the time the start signal is given to the VFD to the time the VFD has control of the motor shall not exceed two (2) seconds. Once the VFD has control of the motor it will then accelerate or decelerate the motor to the active reference speed without tripping or faulting or causing component damage to the VFD. The VFD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
- 2.7.5 The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
- 2.7.6 Control functions shall include two (2) sets of acceleration and deceleration ramp time adjustments with linear and an s-curve ramp time selection.
- 2.7.7 Speed control functions shall include:
- .1 Adjustable min/max speed limits.
 - .2 Selection of up to 15 preset speed settings for external speed control.
 - .3 Three sets of critical speed lockout adjustments.
 - .4 A built-in PID controller to control a process variable such as pressure, flow or fluid level.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-CV-TS-0001-01		

- .5 Functions shall include flux optimization for optimizing energy efficiency and limit the audible noise produced by the motor by providing the optimum magnetic flux for any given speed / load operating point.
- .6 The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for VFD acceleration from zero speed without signaling a false underload condition.

2.7.8 Three (3) programmable critical frequency lockout ranges shall be provided to prevent the VFD from operating the load continuously at an unstable speed.

2.7.9 The VFD shall offer software to select the VFDs action in the event of a loss of the primary speed reference.

2.7.10 The VFD shall have fifteen (15) internal adaptive programming blocks capable of twenty (20) different functions. These blocks shall be connectable to VFD's actual signals and functions allowing the user to tailor the VFD to the specific application requirements without additional hardware. These blocks shall be programmable through the standard operator panel and through the use of programming software.

2.8 COMMUNICATIONS

2.8.1 The VFD shall be capable of communicating with other VFDs or controllers via a serial communications link. A variety of communications interface modules for the typical overriding control systems shall be available.

2.8.2 The VFD shall have a Modbus/TCP interface module for remote interrogation by a DCS or PLC controller. Vendor shall indicate all drive parameters that are accessible from this interface.

2.8.3 Interface modules shall mount directly to the VFD control board or be connected via fiber optic cables to minimize interference and provide maximum throughput.

2.8.4 I/O shall be accessible through the serial communications adapter. Serial communication capabilities shall include, but not be limited to:

- .1 Run-Stop control
- .2 Hand-Off-Auto Control
- .3 Speed Adjustment
- .4 PID (proportional/integral/derivative) control adjustments

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 29 23
CH0032	VARIABLE FREQUENCY DRIVES	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-CV-TS-0001-01		505573-3321-45EG-0001

- .5 Current Limit
- .6 Accel/Decel time adjustments

2.8.5 The VFD shall have the capability of allowing the overriding controller to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information.

2.8.6 A connection shall also be provided for personal computer interface. Software shall be available for VFD setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of VFD performance.

2.9 FACTORY TESTING

2.9.1 The manufacturer's standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of CSA and NEMA standards. Results from the test shall be provided with closeout submittals.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1** Install in accordance with Manufacturer's installation instructions and recommendations.
- 3.1.2** Confirm power lugs and VFD can accommodate motor cables.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements and manufacturer's instructions.
- .2 Operate switches drives and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of drives, contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 32 13.03
INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT
TABLE OF CONTENTS**

1 GENERAL2

1.1 RELATED REQUIREMENTS 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

1.4 QUALIFICATIONS 3

2 PRODUCTS3

2.1 MATERIALS 3

2.2 INSULATION 4

3 EXECUTION.....4

3.1 LOCATING AND MOUNTING 4

3.2 ALIGNMENT CHECK 4

3.3 FUEL SUPPLY SYSTEM 5

3.4 BATTERIES AND CHARGER 5

3.5 EXHAUST SYSTEM 6

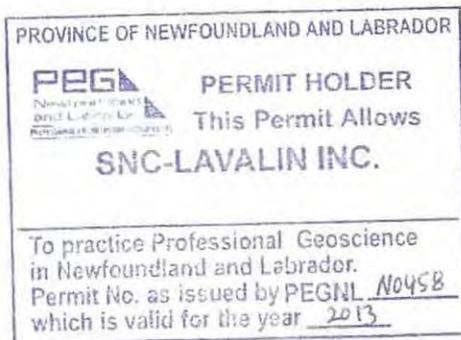
3.6 COOLING AND VENTILATION..... 6

3.7 CONTROL AND TRANSFER PANEL 6

3.8 ADDITIONAL WORKS 7

3.9 FIELD QUALITY CONTROL 7

3.10 SYSTEM STARTUP 7



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

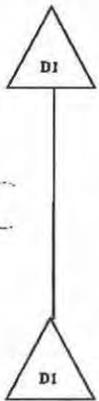
- .1 Section 23 11 13 – Facility Fuel Oil Piping
- .2 Section 23 11 14 – Fuel Storage Tank Electronic Monitoring System
- .3 Section 26 05 00 – General Electrical Requirements.
- .4 Section 26 32 13.04 – Diesel Electric Generating Units (Liquid Cooled)
- .5 Section 33 56 13 – Above Ground Fuel Storage Tanks

1.2 REFERENCES

- 1.2.1 CCME (Canadian Council of Ministers of the Environment) Environmental Code of Practice for Above Ground and Underground Storage Tank Systems containing Petroleum and Allied Petroleum products
- 1.2.2 CNRL – 58/03 Storage and Handling of Gasoline and Associated Product Regulations under the Environmental Protection Act.
- 1.2.3 Nalcor Energy Engineering Directive # CF-ED-004 – Diesel System Installation and Abatement Engineering Directives.
- 1.2.4 National Fire Code of Canada (NFCC)
- 1.2.5 CSA International
 - .1 CSA B139, Installation Code for Oil-Burning Equipment.
 - .2 CSA C282, Emergency Electrical Power Supply for Buildings.
- 1.2.6 U.S. Coast Guard Equipment List (USCG)
 - .1 164.009, Non-Combustible Materials.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- 1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.



96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for generating equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 QUALIFICATIONS

- 1.4.1 Use qualified diesel electric technician.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Include materials as follows:

- .1 Conduits and boxes as required.
- .2 Fuel lines, fittings and components as required. All materials and components in accordance with Section 23 11 13 – Facility Fuel Oil Piping.
- .3 Fuel oil transfer system in accordance with 23 11 13 – Facility Fuel Oil Piping.
- .4 ULC automatic fire shut-off valve.
- .5 Fuel tank and day tank as specified in Section 33 56 13 - Aboveground Fuel Storage Tanks
- .6 Primary fuel filter/water separator.
- .7 Fuel storage tank monitoring system as specified in Section 23 11 14 – Fuel Storage Tank Electronic Monitoring System.
- .8 Insulation for exhaust system.
- .9 Electrical components as indicated.
- .10 Wiring material.
- .11 Antifreeze, ethylene glycol.
- .12 Manual IPU bypass switch. Wiring and materials, including necessary rigid steel conduits and fittings for making connections.
- .13 The power circuit cables will be sized in accordance with Section 26 05 21 – Wires and Cables (0-1000 V).



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.14 The control circuit cables will not be less than No. 14, RW90, conductors, colour or number coded.

.15 Electronic governor control cable shall be minimum size No. 16 stranded copper conductor, shielded complete with drain wire and overall PVC jacket.

.16 Battery cable shall be welding cable type, extra flexible, rope stranded copper conductor with neoprene oil-resistant insulation, sized to limit voltage drop to 5% at time of peak load.

2.2 INSULATION

2.2.1 Removable fibreglass jacket insulation rated for 650 degrees C minimum with stainless lacing hooks and wires.

.1 Enclose jacket on inside by stainless steel mesh with outside cover silicone coated or aluminized fibreglass cloth: to USCG approved Non-Combustible Materials No. 164.009.

2.2.2 Calcium Silicate removable insulation rated for 650 degrees C with exterior stainless steel protective cover and fastenings.

3 EXECUTION

3.1 LOCATING AND MOUNTING

3.1.1 Locate unit as indicated.

3.1.2 Fit and adjust isolators in accordance with manufacturer's installation and adjustment instruction bulletin contained in unit manual.

3.1.3 Do not bolt housings to foundation if isolator housing feet are equipped with 6 mm rubber sound pads.

3.2 ALIGNMENT CHECK

3.2.1 Since Engine-generator shaft alignment is adjusted at factory, check to ensure that no change has occurred due to shipment and handling.

3.2.2 Where engine and generator housings are close coupled and instruments at hand are not suitable for measuring alignment within confines of housings, just loosen engine and generator hold down bolts and ensure that each foot is carrying proportionate amount of weight and feet are level on base plate.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.3 FUEL SUPPLY SYSTEM



3.3.1 Fuel tanks shall be designed, constructed and installed in accordance with CSA B 139, CNRL 58/03 and NFCC.

3.3.2 Inspect thoroughly fuel tank and lines to confirm they are clean and free of foreign material before connecting fuel system.



3.3.3 Install primary fuel filter/water separator, servicing shut-off valves and other system components as per Nalcor engineering directive, NFCC, CCME, CNRL – 58/03, CSA B139 requirements as well as manufacturers' recommendations. Provide 3 spare filter elements.

3.3.4 Install ULC automatic fire shut-off valve. Locate upstream of any combustible fuel system component.

3.3.5 Install supply and return fuel lines between engine and fuel day tank. Install flexible sections between the engine and fixed end of fuel lines from fuel tank, using materials supplied with unit.



3.3.6 Piping, devices, fuel transfer system shall be as per Section 23 11 13 – Facility Fuel Oil Piping.



3.3.7 Neatly install fuel lines parallel or perpendicular to building lines with no kinks or dents.

3.3.8 Fuel oil monitoring system shall be in accordance with Section 23 11 14 - Fuel Storage Tank Electronic Monitoring System.



3.4 BATTERIES AND CHARGER

3.4.1 For dry charged batteries, activate in accordance with manufacturer's instructions manual prior to installation.

3.4.2 For wet batteries, inspect individually each battery cell and check electrolyte level.

- .1 Check charge condition by measuring temperature and specific gravity of electrolyte.
- .2 Consult manufacturer's instructions for recommended readings.
- .3 If readings are lower, give batteries freshening charge until readings are reached.

3.4.3 Locate batteries as indicated and ensure batteries are accessible for service.

- .1 Run and protect cables to starting motor using cables supplied with unit.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.4 Install battery charger on wall, adjacent to batteries and make connection to batteries.

3.4.5 Clean connections and tighten securely.

3.4.6 Install removable plexiglass cover on batteries.

3.5 EXHAUST SYSTEM

3.5.1 Install exhaust pipe and silencer using material supplied with unit. Arrange silencer above and approximately in line with engine exhaust manifold with exhaust tail pipe protruding through thimble in wall.

3.5.2 Extend exhaust pipe 1 metre minimum beyond outside wall.

3.5.3 Support silencer with hangers so no weight or stress is applied to engine exhaust manifold or turbocharger.

3.5.4 Install flexible exhaust pipe between silencer and manifold.

3.5.5 Install exhaust system fireproof insulating material, after test run.

3.6 COOLING AND VENTILATION

3.6.1 Install air outlet and inlet louvres and hoods in their respective openings.

3.6.2 Install louvre motors and linkages, adjust to ensure louvres are tight in closed position and give free damper movements from fully closed to fully open.

3.6.3 Where canvas boot is not provided, maintain 13 mm clearance between radiator and air outlet duct.

3.6.4 Mount thermostat as indicated.

3.6.5 Install conduits and junction boxes and make connections from louvre motors to thermostat and to 120/24 V ac transformer.

3.6.6 Fill engine radiator with water/ethylene glycol antifreeze mix good for -50 degrees C.

3.6.7 Install remote radiator including piping, valves, fittings and pumps as indicated.

3.7 CONTROL AND TRANSFER PANEL

3.7.1 Locate panels as indicated.

3.7.2 Make control and power circuit connections as indicated. Identify cables at both ends.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.3 Tag with slip-on wire maker, each wire end with number corresponding to number in panel.

3.7.4 Make terminations with self-insulated terminals of flanged fork or ring type.

3.8 ADDITIONAL WORKS

3.8.1 Complete any additional work as instructed by Engineer to:

- .1 Ensure equipment is safe to operate.
- .2 Provide complete and operating system.

3.9 FIELD QUALITY CONTROL

3.9.1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

3.9.2 Qualified diesel electric technician to: inspect and verify that installation of interruptible power unit is acceptable and complete. Provide inspection report to the Engineer.

3.9.3 Commissioning: supervise site commissioning of diesel electric generator unit by qualified diesel electric technician.

3.9.4 Develop and submit commissioning report including time delay settings, operational set points and adjustment ranges.

3.10 SYSTEM STARTUP

3.10.1 Preparation: before starting unit, carry out thorough mechanical and electrical inspection of equipment, and perform following checks and adjustments:

- .1 Disconnect battery cables from batteries to prevent accidental starting.
- .2 Turn engine several revolutions by means of hand-barring devices to ensure parts are free and there are no obstructions to its running.
- .3 Check engine/generator alignment readings to ensure they match readings attained at time of manufacture. Check fluid levels and top up as necessary. Pre-lubricate engine and turbochargers as recommended by engine manufacturer. Install drip pan beneath engine.
- .4 Confirm cooling system antifreeze is effective to at least minus 40 degrees C.
- .5 Check belts for correct tension and adjust as necessary.
- .6 Check and grease points.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Check and tighten properly nuts, bolts.
- .8 Confirm safety guards are in place and properly secured.
- .9 Check linkages for damage and freedom of movement.
- .10 Check fuel supply system for leakage.
- .11 Ensure fuel supply and fuel injection systems are properly primed.
- .12 Check and tighten properly electrical connections.
- .13 Check starting battery electrolyte level specific gravity and for proper installation.
- .14 Check battery charger for proper operation and adjust as necessary.
- .15 Carry out generator winding insulation resistance test. If reading is unacceptable, carry out recognized drying procedure. Do not start unit until satisfactory reading has been achieved.
- .16 Check jacket coolant heater for proper operation.
- .17 Complete additional preparations deemed necessary.

3.10.2 Performance verification: on completion of start-up preparations, take following action:

- .1 Have at hand, during initial start-up, means for choking off air supply to engine air induction manifold in event of engine run away or other emergency.
- .2 Reconnect starting battery cables to starting battery.
- .3 Start unit only in presence of Engineer and allow to warm up. Stop unit if abnormal conditions are encountered.
- .4 Check for and correct leakage from exhaust system, fuel system, cooling system, and lubricating oil system.
- .5 Adjust vibration isolators.
- .6 Observe and confirm lubricating oil pressure and coolant temperature are within limits and no harmful vibration or sounds are evident.
- .7 Ensure voltage is within operating parameters and automatic voltage regulator is operating correctly.
- .8 Ensure manual voltage control is operating correctly.

Handwritten initials: *96 MB*

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.03
CH0032	INSTALLATION OF ELECTRIC POWER GENERATING EQUIPMENT	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .9 Ensure frequency is within operating parameters and electronic governor is operating correctly.
- .10 Check engine air ventilation system for proper operation.
- .11 Check operation of engine-mounted protective sensing devices and adjust as necessary.
- .12 Check phase sequence of normal power supply and ensure emergency power supply are in same sequence.
- .13 Check operation of electronic controller protection, transfer, timing, metering, and annunciator functions and adjust as necessary.
- .14 Check operation and calibration of analog metering and adjust as necessary.
- .15 Apply electrical load, read the metres, and correlate these readings.
- .16 Demonstrate:
 - .1 Unit start, transfer to load, retransfer to normal power, unit shutdown, on "automatic" control. Unit start, transfer to load, retransfer to normal power, unit shutdown, on "test control". Unit start and shutdown, on "engine start" control.
 - .2 Unit cranking, start, and shutdown by means of engine-mounted key switch.
 - .3 Run unit on full (nameplate) load for minimum period of 8 hours to show load-carrying capability, stability of voltage and frequency, and satisfactory performance of engine ventilating system to provide adequate cooling, exhaust system.
 - .4 Every 1/2 hour carry out and record readings on Test Chart.
- .17 Perform additional tests as required by Engineer to confirm unit is operating satisfactorily.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

TABLE OF CONTENTS

SECTION 23 32 13.04

DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)

1 **GENERAL**.....2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 OPERATING REQUIREMENTS 5

1.4 ACTION AND INFORMATIONAL SUBMITTALS 5

1.5 CLOSEOUT SUBMITTALS..... 7

1.6 MAINTENANCE MATERIAL SUBMITTALS..... 8

2 **PRODUCTS**.....9

2.1 DIESEL GENERATOR SETS 9

2.2 DUTY AND THROUGHPUT10

2.3 MOUNTING10

2.4 CONTROLS.....11

2.5 LIFTING LUGS11

2.6 NOISE CONTROL REQUIREMENT11

2.7 DETAILED TECHNICAL REQUIREMENTS.....12

2.8 AC GENERATOR REQUIREMENTS.....19

2.9 GENERATOR CONTROL PANEL21

2.10 REMOTE ALARM/STATUS CONTACTS.....23

2.11 SURFACE TREATMENT23

2.12 EQUIPMENT IDENTIFICATION, MARKING AND LABELLING24

3 **EXECUTION**24

3.1 NOT USED24

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To practice Professional Geoscience
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 which is valid for the year 2013

REGISTERED PROFESSIONAL ENGINEER

PEGNI
Newfoundland and Labrador Professional Geoscientists

G. W. HAINES
 SIGNATURE

11-08-2013
 DATE

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS



- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 06 31 – Not used.
- .3 Section 26 32 13.03 – Installation of Electrical Power Generating Equipment.
- .4 Section 33 56 13 – Above Ground Fuel Storage Tanks.

1.2 REFERENCES

1.2.1 Codes, Standards and Regulations

1.2.2 Design and fabricate components and equipment in accordance with the latest editions of the following authorities and technical organizations, as applicable.

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CSA	Canadian Standards Association
CWS	Canadian Welding Society
EEMAC	Electrical Equipment Manufacturers Association of Canada
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
ISO	International Organization for Standardization
NEMA	National Electric Manufacturers Association
NFPA	National Fire Protection Association
OHSA	Occupational Health and Safety Act of Newfoundland and Labrador

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

ULC Underwriters' Laboratories of Canada

WHSCC Workplace Health, Safety and Compensation Commission
of Newfoundland and Labrador

- 1.2.3 The design and fabrication of equipment and components shall conform to the requirements of recognized standards.
- 1.2.4 The latest edition of a code or standard shall govern.
- 1.2.5 Equipment is required to carry the CSA mark with a CSA declaration of conformity provided.
- 1.2.6 Specific Standards
- 1.2.7 Unless otherwise stated in this specification, the gensets shall be designed, manufactured, tested, and supplied in accordance with the latest edition of all applicable standards listed in this specification. In case of conflict between standards, such conflicts shall be brought to the attention of the Engineer for clarification and determination.

- ANSI C37.13 Low Voltage AC Power Circuit Breakers Used In Enclosures
- ANSI C37.16 Preferred Ratings, Related Requirements And Application Recommendations For Low Voltage Power Circuit Breakers And AC Power Circuit Protectors
- ANSI C37.17 Trip Devices For AC And General Purpose DC Low Voltage Power Circuit Breakers
- CSA B139 Installation Code for Oil Burning Equipment
- CSA C22.1 Canadian Electrical Code - Part I
- CSA C22.2 No. 31 Switchgear Assemblies
- CSA C22.2 No. 127 Equipment and lead wires
- CSA C22.2, No. 100 Motors and Generators
- CSA-C282 Emergency Electrical Power Supply for Buildings.

Handwritten initials: db MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

DIN 6271	Reciprocating Internal Combustion Engine Driven Alternating Current Generator Set
NEMA C37.50	Test Procedures For Low Voltage AC Power Circuit Breakers Used In Enclosures
NEMA MG-1	Motors and Generators
NEMA MG-2	Safety Standard and Guide for Selection, installation and use of Electric Motors and Generators
IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE 115	Guide for Test Procedures for Synchronous Machines, Parts I and II
IEEE 43	Recommended Practice for Testing of Insulation Resistance of Rotating Machinery
ISO 8528	Reciprocating Internal Combustion Engine Driven Alternating Current Generator Set Performance
ISO 9000 Series	Quality System Standards
ISO 3046	Reciprocating Internal Combustion Engines - Performance
ANSI/MH 5.1	Basic Requirements for Cargo Containers
ISO/TC 104	Requirements for Cargo Containers
Newfoundland and Labrador Regulations	Storage and Handling of Gasoline and Associated Products Regulations, 2003

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3 OPERATING REQUIREMENTS

1.3.1 The environmental conditions at the Muskrat Falls site under which the equipment is required to operate satisfactory are as follows:

Elevation	Less than 100 m ASL			
Temperatures	Outdoors	Minimum:	- 48°C	Design - 50°C Design + 40°C
		Maximum:	30°C	
		Daily Average (July)	15.4°C	
		Daily Average (Jan)	-18.1°C	
	Average:	- 4°C		
	Indoors	Minimum	5°C	Design 5°C
Maximum		40°C	Design 40°C	
Seismic Level	Peak Ground Acceleration (PGA) 0.091g			Design PGA = 0.091g
Wind and Icing	Maximum wind speed			Design – 160 km/hr
	Radial ice			Design – 25 mm

1.4 ACTION AND INFORMATIONAL SUBMITTALS

1.4.1 Submit submittals in accordance with Exhibit 4 – Supplier Document Requirements List.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Product Data:

- .1 Provide manufacturer's printed product literature, specifications and data sheets for generating units and include product characteristics, performance criteria, physical size, finish and limitations.



1.4.3 Not used.

1.4.4 Shop Drawings

- .1 Submit general outline drawing of complete assembly showing engine, radiator and generator mounting, exhaust, recirculating and intake air louvre arrangement, exhaust gas silencer and pipe arrangement, locations of fuel and lubricating oil filters, fuel supply and return line connections, lubricating oil drain valve, radiator and coolant drain valves, air cleaner, engine instrument panel, starting motor, power and control junction boxes, engine and generator mounting feet. Indicate on drawings:
 - .1 Horizontal and vertical dimensions.
 - .2 Minimum door opening required for moving unit.
 - .3 Head room required for removal of piston and connecting rod.
 - .4 Weight of engine, generator, baseplate, radiator and exhaust silencer.
- .2 Identify exact locations and details where necessary of interconnecting services to permit final engineering by Engineer.
- .3 Baseplate construction details and materials.
- .4 Transfer and bypass system: make, model, type.
- .5 Outline and layout of panels.
- .6 Schematic and wiring diagrams of engine, generator, control panel, complete with interconnecting wiring diagrams.
- .7 Single line diagram showing all breakers, switches, metering and protective relays.
- .8 Field wiring diagrams.
- .9 Complete bill of materials, including manufacturer's name, catalogue numbers and capacity.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5 CLOSEOUT SUBMITTALS

1.5.1 Provide maintenance data for diesel generating units for incorporation into manual specified in Exhibit 4 – Supplier Document Requirements List.

1.5.2 Provide in English for incorporation into instruction manuals as follows:

- .1 Complete set of accepted shop drawings.
- .2 Factory test data of engine, generator, exciter, control logic, metering and other pertinent test data.
- .3 Maintenance and operation bulletins for:
 - .1 Engine and Accessories.
 - .2 Generator.
 - .3 Voltage Regulator and Accessories.
 - .4 Exciter.
 - .5 Permanent magnet generator if installed.
 - .6 Battery charger.
 - .7 Speed Governor.
 - .8 Starting Motor.
 - .9 Batteries.
 - .10 Ventilating Equipment.
 - .11 Timers, Relays, Meters.
 - .12 Power Circuit Breakers.
 - .13 Controller, Contactors.
 - .14 Other Accessories.
- .4 Submit original brochures; photocopies are not acceptable.
 - .1 Include technically relevant data.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Complete sequence of system operation.
- .6 Complete bill of materials including nameplate data of equipment and accessories.

1.5.3 Forward, two weeks prior to factory tests, one copy of instruction manual to Engineer.

1.6 MAINTENANCE MATERIAL SUBMITTALS

1.6.1 Provide maintenance spare parts list in accordance with Exhibit 4 – Supplier Document Requirements List.

- .1 Extra Material/Spare Parts: provide the following:
 - .1 One spare control circuit breaker per rating.
 - .2 Twenty four spare indicating light bulbs per rating.
 - .3 One spare control relay and socket per rating and contact arrangement.
 - .4 One spare contactor operating coil.
 - .5 One set of contacts (3) for transfer contactor.
 - .6 Six fuel filter elements for each type of fuel filter/water separator.
 - .7 Six lubricating oil filter elements.
 - .8 Three air cleaner elements.

1.6.2 Provide conclusive evidence that Canadian distributor has been established and will stock in Canada spare parts likely to be required during normal life of engine.

1.6.3 Tools:

- .1 Supply suitable engine barring device and battery manufacturer's standard set of tools for battery service.
 - .1 Battery service tools to include hydrometer, one plastic bottle for topping up purposes and one insulated battery terminal wrench.
- .2 Provide complete set of specialized tools required for proper care, adjustment and maintenance of equipment supplied.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2 PRODUCTS

2.1 DIESEL GENERATOR SETS

2.1.1 General Requirements

- .1 The diesel gensets will be used as a stand-by power system for the spillway for the Muskrat Falls hydroelectric power station. The diesel gensets will be used as prime power supply for the spillway during periods when the 25 kV construction power supply is unavailable and as a standby power supply after permanent power has been installed. The diesel gensets shall be suitable for operation in parallel with other generators. We have specified diesel gensets for Prime Running Power which is defined as supplying power to varying electrical load for unlimited hours. Prime Running Power (PRP) is in accordance with ISO 8528.
- .2 Consequently, reliable, fast starting with rapid load capabilities is of prime importance. Diesel gensets shall be capable of supplying 100% load within 30 seconds.
- .3 The diesel gensets shall be designed for demand load of 600 kW.
- .4 This specification identifies the minimum requirements, and does not in any way relieve the Supplier of the responsibility to provide the design and equipment for a safe code compliant reliable operating system. The design will include, but not be limited to:
 - .1 Engine, generator and accessory modules;
 - .2 A local generator control panel;
 - .3 A radiator and cooling system;
 - .4 Fuel day tank;
 - .5 Provide diesel gensets capable of delivering rated kW at 0.8 pf under the specified load conditions, and an overload capability of 10% for one hour in each consecutive 12-hour period in accordance with ISO 3046-1.
 - .6 Main fuel oil storage tank.
 - .7 Fuel oil storage tank monitoring system.
 - .8 Fuel oil piping distribution system.
 - .9 Fuel oil pumping system to transfer fuel from main tank on spillway up to day tank within the spillway generator room.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2 DUTY AND THROUGHPUT

- 2.2.1 Gensets covered under this specification are intended to be used in limited stand-by duty, meaning they will essentially operate as a reliable backup power source in case of temporary outage of the normal power source.
- 2.2.2 To be rated for Prime Running Power (PRP) duty, a generator set shall meet the conditions listed below, under the manufacturer's recommended maintenance schedule and overhaul schedule.
- 2.2.3 Capable of operating continuously at 100% of its rated power while supplying a variable electrical load while operating for an unlimited number of hours per year .
- 2.2.4 The permissible average power output over 24 hr operation shall not exceed 70% of PRP.
- 2.2.5 The generator set shall accept 100% of rated load in one step.

2.3 MOUNTING

- 2.3.1 Provide a common base for generator and engine, rigid heavy duty steel, machined pads, capable of maintaining alignment during transportation, installation and operation. If necessary, accommodate crankcase oil drainpipe.
- 2.3.2 Vibration isolators shall support the base and assembly and shall be steel spring type, complete with levelling bolts, externally adjustable mechanical side snubbers and sound dampening pads as required.
- 2.3.3 Install the cooling radiator in one end of the container, complete with louvers as required for weather protection and devices to deflect the hot air in an upward direction.
- 2.3.4 Mount the Generator Control Panel in a control compartment of the enclosure.
- 2.3.5 A day tank shall be installed inside the Spillway Generator Room.
- 2.3.6 Provide suitable facilities for the exit of the power cables and control wiring from the container.
- 2.3.7 Provide readily available fuel connections on the outside of the container, individually tagged or marked.
- 2.3.8 The main fuel oil storage tank and pumping system shall be located on the spillway.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4 CONTROLS

2.4.1 The diesel generator set shall be arranged for:

1. Remote start and shutdown of the gensets by means of remote signal initiated by dry contacts.
2. Manual start and shutdown of the gensets by means of local switches on the generator control panel.
3. Outputs and alarms annunciated locally on the generator control panel, with outputs for the following:
 - .1 Warning of generator set abnormal conditions;
 - .2 Alarms for device or function failure; and
 - .3 Warning of generator set critical alarms and shutdown for annunciation on remote control systems.



2.5 LIFTING LUGS

2.5.1 Provide all assemblies and components with suitable lifting lugs to allow for easy off-loading and installation at site.

2.5.2 It is intended that the generator set be shipped as a complete unit in its container. Items such as silencer or other such devices or equipment which must be shipped loose shall be provided with lifting lugs as required for field handling and installation.

2.5.3 All lifting lugs shall be load tested.

2.5.4 Provide lifting instructions and drawings to prevent damage to the enclosure and equipment when lifting.

2.6 NOISE CONTROL REQUIREMENT

2.6.1 The noise level of the equipment shall not exceed 75 dBA as measured at any point 15.25 m (50 feet) from the outdoor enclosures when operating at 100% of rated load.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.7 DETAILED TECHNICAL REQUIREMENTS

2.7.1 Engine Requirements

- .1 Provide the diesel engine of the four-stroke, cold start, compression ignition type, turbo-charged where indicated, running at the speed indicated, complete with SAE flywheel. The engine shall drive the generator directly through a flexible coupling.
- .2 Supply a direct injection engine suitable for starting in the ambient conditions indicated in article 1.5.
- .3 Provide jacket water heaters to circulate heat to the engine when the engine is shut down, so that the engine is warm at all times and suitable for quick start after signal initiation.
- .4 The diesel generator set shall be capable of delivering rated kW at 0.8 power factor under the conditions indicated, and for the service duty specified. The rated power specified shall be considered a minimum value. Supplier shall use the data and requirements listed herein to determine the recommended power rating. The equipment proposed by Supplier shall have the largest rating of the two; either the specified minimum rating or the Supplier's recommended rating.
- .5 Confirm the stated power rating by engine manufacturer's published data and performance curves.
- .6 The engine to be capable of operating continuously, without detrimental effect to the engine, with loads down to 30% of rated capacity for extended periods of time.
- .7 Size the engine to drive all the engine auxiliaries and the generator at the required speed and output over the full range of ambient conditions.
- .8 The engine shall start reliably without manual priming under all temperature conditions. The engine shall be capable of delivering full power within no more than 30 seconds of start-up.
- .9 Supply all standard accessories and gauges. The accessories shall include but shall not be limited to those listed in subsequent sections.
- .10 Provide engine oil drip trays, minimum 1.5 mm thick galvanized steel, with 50 mm lip, located between the base and the vibration isolators, extended to protect floor.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.7.2 Speed Control

- .1 Provide the engine with an electronic speed governor, Woodward or approved equivalent, which shall bring the engine up to rated speed as soon as the engine starts and after start, control the speed of the engine so that the frequency regulation of the generator is not exceeded, from no-load to full load. Steady state speed band shall be +/-0.25% with no-load to full load speed droop of 0% (isochronous). Speed droop shall be manually adjustable over 0 to 10% range to permit load sharing in a manual parallel operation with capability for isolated or multiple engine parallel operation. Provide input for remote adjustment of speed droop.
- .2 Provide the engine with a separate over-speed device, to stop the engine in the event the governor is not able to keep the speed below the allowable safe speed for the engine and generator.

2.7.3 Fuel Oil System

- .1 Main fuel storage tank and day tank shall be in accordance with Section 33 56 13 – Aboveground Fuel Storage Tanks. Fuel oil system shall be in accordance with Section 23 11 13 – Facility Fuel Oil Piping. Fuel oil monitoring system shall be in accordance with Section 23 11 14 – Fuel Storage Tank Electronic Monitoring System
- .2 Main tank shall be sized for three (3) days operation of 600 kW diesel genset at prime running power 75% load. Fuel storage is for spillway diesel generating unit.
- .3 Provide the individual double walled fuel day tank for generator, of sufficient capacity for at least 8 hours of continuous running at Standby 75% load rating. Provide flexible piping for connection to the tank. Day tank shall include leak detection system.
- .4 Main tank and day tank shall be ULC and CSA certified and entire fuel system must meet the Newfoundland Storage and Handling of Gasoline and Associated Products (GAP) Regulations 2003, National Fire Code of Canada, CSA B139 Installation Code for Oil Burning Equipment and Canadian Council of Ministers of the Environment (CCME) Environmental Code of Practice for Aboveground and Underground Storage Tank System containing Petroleum and Allied Petroleum Products requirements. Fuel system shall be tested in accordance with section 28 of GAP Regulations prior to initial operation or as elsewhere specified, whichever is more stringent.
- .5 Provide the main fuel storage tank and day tanks with the following accessories and gauges:



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .1 Fuel oil flow meter;
- .2 Normal and emergency vents;
- .3 Overflow;
- .4 Drain connection with manual isolation valve;
- .5 Magnestriuctive type fuel tank level indicator;
- .6 Nipple in top of tank suitable sized to accomodaet the fuel tank level indicator;
- .7 Dip port;



- .8 Fuel tank low level switch.
- .9 Fuel spill containment sump
- .10 Overfill protection device
- .11 Interstitial space monitor well and monitoring device;
- .12 Foot Valve
- .13 Other accessories as specified in NFCC, CSA B139 and CCME documents.

- .6 Provide data outlining the type and size of fuel piping connections required along with required fuel flow rate and fuel supply pressure and calculations demonstrating the fuel consumption rates per hour for operation under normal operating conditions.
- .7 Provide the engine with an engine mounted fuel oil strainer, replaceable filter, with sediment catchment, fuel pressure gauge and fuel pump to provide fuel from the day tank to the engine.
- .8 Engine shall be equipped with individual, high pressure unit injectors. Engines with rotary distributor fuel injection pumps shall not be accepted.
- .9 Fuel supply lines from the fuel pump to the injectors shall be of heavy wall design and secured to the engine to prevent damage from chafing or vibration.
- .10 All other rigid fuel lines shall be of high grade steel tubing.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .11 Flexible fuel lines shall be service rated for not less than 150°C and the greater of 150 psi or 1.25 times the maximum developed fuel pressure. Hoses shall be "Parker Paraflex" 4690 flexible metal hose with braided stainless steel cover or approved equal. Fuel lines shall be routed and secured to minimize stresses and prevent fuel line abrasion or fatigue failure when subjected to engine vibration.
- .12 Fusible link shut-off valve shall be provided on each unit that automatically closes in the event of a fire.
- .13 Solenoid valve shall be provided on the main fuel tank. Solenoid valve shall be electrically rated to suit the hazard application.



2.7.4 Fuel Specification

- .1 Engines shall be approved by manufacturer for the continuous use of low sulphur, low lubricity Type "A" fuel as specified in CAN/CGSB-3.517. Design the engines to provide rated performance utilizing this fuel.

2.7.5 Lubricating Oil System

- .1 Engines shall be compatible and warranted for use with a standard API Service, SAE viscosity grade of crankcase lubricating oil. Where lubricating oils must meet additional manufacturer specifications, approved oils shall be available in Canada from major suppliers. A list of specifications and approved manufacturers shall be provided by the Supplier,
- .2 Include the following equipment for the lubricating oil system:
 - .1 Engine driven oil pump;
 - .2 Full flow lubricating oil filter with removable element and spring return bypass valve and centrifugal oil cleaner capable of removing grit and carbon as small as 0.1 µm;
 - .3 Oil cooler;
 - .4 Oil sump of adequate capacity, with oil drains line and valve;
 - .5 First filling of lubricating oil, shipped in separate containers;
 - .6 Sump to capture any oil/diesel leakage; and
 - .7 Oil fill port shall be accessible without removal of any components and shall allow addition of oil while engine is running.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Size the oil cooler to provide an adequate supply of cooled oil to the engine when the engine is fully loaded and the ambient temperature is at its maximum.
- .4 Provide the lubrication system with an engine mounted pressure gauge with alarm contact. A second contact shall shut the engine down and provide an alarm on loss of oil pressure.
- .5 The engine shall be kept in a state of readiness for rapid starting and, if required, low-density engine and/or oil heaters shall be provided, complete with control thermostats.

2.7.6 Engine Cooling System

- .1 Provide an outdoor type radiator mounted on the generator set base, suitable for cooling 110% of engine load in a 40°C ambient with a 20% fouling factor when using a 50/50 glycol-water coolant mixture, c/w all necessary valves and fittings.
- .2 Radiator cores shall be constructed using copper finned, brass or copper tubes and be capable of withstanding at least 150 kPa internal pressure. The core shall include suitable connections for draining.
- .3 Size the cooling system and engine driven circulating pump to provide adequate cooling for the engine under the conditions of full load and maximum ambient temperature.
- .4 Provide an automatic temperature-regulating valve with bypass feature, located in the jacket cooling outlet manifold, AMOT or approved equal, and a temperature gauge c/w alarm and trip contacts.
- .5 Provide water pipes, flexible hoses, support brackets, etc. and drain cocks to permit the complete system to be drained.
- .6 Cooling system shall include aftercooler if required.
- .7 Jacket water cooling lines shall be of rigid pipe. Rubber coolant hoses shall be replaced with custom fit seamless, schedule 10 stainless steel pipe with beaded ends and flexible couplings.
- .8 Flexible couplings shall be of reinforced, high temperature materials. The design of connections shall prevent separation by internal pressure.
- .9 Piping and temperature control valves for intercooler and oil cooler.
- .10 Engine coolant heater shall be provided.
- .11 Thermometers as required for monitoring.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.7.7 Exhaust System

- .1 Include a critical grade silencer exhaust system with all required flanges, flexible bellows between the exhaust manifold and silencer, condensate drain cock and plug, spark arrester, complete with flexible connections to exhaust vent.
- .2 Any necessary 304 stainless steel exhaust piping of a Y configuration to combine dual exhaust manifolds, if so equipped, into a single outlet complete with flexible pipe to accommodate thermal expansion between branches (slip joints on any portion of the exhaust are not acceptable).
- .3 Exhaust outlet shall be fitted with an ISO class 150 flange for connection to exhaust stack, or provided with an ISO adapter.
- .4 Provide an insulating blanket or open mesh safety guard for operator protection on the exhaust manifold, piping and other hot surfaces.
- .5 Size the silencer so that back pressure on the engine, operating at full load will not exceed the engine manufacturer's recommended value.

2.7.8 Air Intake System

- .1 Provide dry type, replaceable, heavy-duty intake air filter with pre-cleaner, complete with flexible connections.
- .2 Provide a control system with relays as required to open the enclosure air intake louvers for combustion, and cooling air required by the generator set.

2.7.9 Engine Starting and Stopping System

- .1 Provide the engine with an electric dc starting motor equipped with a positive solenoid-operated engaging gear. Locate the starter in an accessible location.
- .2 Provide the engine with a suitable battery charger and 24 Vdc heavy-duty lead acid battery with hard rubber case and corrosion resistant battery rack with supporting legs. Size the battery capacity to permit 5 consecutive cold start attempts, in an ambient temperature of 5°C, without battery voltage reduction below 75% of rated output. Provide the cable connection between the battery and the engine, a hydrometer and a bracket.
- .3 Control system shall include manual and automatic starting. Upon receipt of the remote starting signal, the starting system shall automatically crank the engine. If the engine has not started after 3 successive cranking cycles, with 30 second rest between each cranking cycle, the starting system shall automatically shut-down, and give a malfunction alarm locally and to the remote control system.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Mount meters, circuit breakers and control switches on the front of the generator control panel.

2.7.10 Engine Instrument Panel

- .1 Mount the instrument panel on the engine, equipped with indicating, alarm/shutdown devices and operator devices with functions required by the Specification. Vibration isolators shall be provided.
- .2 All sensors shall be adjustable type with settings sealed by locknuts, directly accessible for ease of maintenance and replacement. Solid-state speed switch shall be direct mechanical drive from the generator. Provide cranking cut-out back-up protection utilizing an oil pressure sensor.
- .3 All operator devices (switches, push buttons, and LED type indicating lights with a common push-to-test pushbutton) shall be heavy duty, oil-tight.

2.7.11 Engine Wiring and Terminal Box

- .1 Provide heat and oil resistant wiring for engine safety and control devices, run in harnesses secured to the engine, and terminated in an engine mounted terminal box. Identify all wires at each termination, corresponding to schematic and wiring diagrams, with wire markers by Panduit or approved equal.
- .2 All control wiring on the engine shall be #14 AWG stranded copper, type TEW, 600 V rating with black insulation, UL listed AWM (Style 1015). All wiring shall be run in automatic loom wiring trough and securely mounted to prevent contact with hot engine parts. All engine wiring shall be clearly labelled to correspond with the wiring diagrams.
- .3 The wiring for all RTD interconnections on the engine shall be #16 AWG (7W) soft tinned stranded copper, 1 pair triad, 300 V rated c/w shield wire and PVC jacket rated for 100°C.
- .4 The wiring for thermocouple interconnection on the engine shall be #20 AWG (7W) soft tinned stranded copper, c/w duplex insulated brown Teflon jacket rated for 260°C. The wire shall be designated as ANSI Type K with conductor insulation colour coded accordingly. Both a male and female, high temperature connector, Omega Type HST-K, shall be used for connection between the thermocouple wire and the Type K thermocouple.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .5 Engine junction box shall be minimum 450 x 450 mm square and 150 mm deep, NEMA 4, oil tight c/w captive screws. It shall be located at the generator end, right side as viewed from the generator end and shall not interfere with engine/generator maintenance. Location shall be confirmed at the drawing review stage. Wire raceways to the engine junction box shall be provided with enough slack in order to mount it, if necessary, on a separate stand at the generator end of the genset skid.
- .6 Furnish separate junction boxes for 24 Vdc and 120 Vac powered circuits.

2.7.12 Drive Coupling

- .1 Provide a torsionally rigid flexible steel disc type coupling for connecting the single bearing generator to the engine with SAE housing. Provide details of the coupling in the Tender.

2.8 AC GENERATOR REQUIREMENTS

2.8.1 Rating and Characteristics

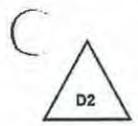
- .1 Generator output voltage shall be 600 V.
- .2 Not used.

2.8.2 Power Connections

- .1 The windings shall be star connected. The phase and neutral ends of the windings shall be brought to a terminal box, where the neutral connection shall be made. The neutral of the generator shall be solidly grounded.

2.8.3 Construction

- .1 Provide a brushless type synchronous generator with salient poles, damper (amortisseur) windings, drip-proof enclosure and protective screen. It shall be of the single bearing type designed for connection to the engine flywheel by means of a flexible disc type coupling. The bearings shall be anti-friction type, 100,000 hours minimum.
- .2 Stator and rotor windings insulation shall be minimum NEMA Class H and rated for 105°C temperature rise at +40°C ambient temperature. All winding insulation shall include vacuum pressure impregnation (VPI).
- .3 The stator shall be provided with a single phase anti-condensation space heater.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Six 100-Ω platinum type resistance temperature detectors (RTD's) shall be provided and equally spaced around the stator winding.
- .5 Design the generator to be capable of withstanding, in an emergency, the maximum speed that can be reached before the over-speed device shuts down the engine. Design for a maximum over-speed of 25% for 2 minutes.

2.8.4 Excitation System

- .1 Provide the excitation system of the brushless type, utilizing a rotating rectifier assembly mounted on the generator shaft. The diodes shall be field removable. Provide a permanent magnet type pilot exciter to give assured voltage build-up without field flashing.
- .2 In the event of a short circuit on the output of the generator, the excitation system shall provide sufficient field current so that the level of the fault current is sufficiently high (300% minimum for 10 seconds) to operate the protective relays. Series boosting shall be provided.
- .3 Control the excitation system automatically by a solid state, automatic voltage regulator, and manually from a potentiometer. Both modes of operation shall have the range to control the output of the generator to the specified % of rated voltage over the complete load range, from no load to full load condition. When the switch is in the automatic position, the generator shall build up voltage automatically as soon as the generator approaches synchronous speed.
- .4 Provide a Manual/Auto Switch for the excitation system, and a DC Field voltmeter.

2.8.5 Voltage Regulator

- .1 Provide an automatic voltage regulator (AVR), solid-state type, with fail-safe feature to ensure that no over-voltage will occur if the regulator fails. Include three phase sensing, protection against fault during under-speed running, and capable of voltage build-up without batteries.
- .2 Steady state voltage regulation shall be ± 0.5%.
- .3 Generator and AVR shall be suitable for supplying loads with significant harmonic content such as variable frequency drives, solid state starters and similar items.
- .4 Provide the AVR with digital controls mounted on the front of the Generator Control Panel.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Design the AVR to control the output voltage of the generator to within a set point accuracy range as indicated for a change in load from no load to full load at rated power factor. The voltage regulator shall restore the generator output voltage to steady state operation within two (2) seconds following a sudden load change.
- .6 The voltage regulator shall be suitable for paralleling of multiple diesel gensets without requiring any interconnecting wires between regulators.
- .7 Protect the automatic voltage regulator and excitation system with fuses and breakers.
- .8 Locate the AVR inside the generator control panel.

2.8.6 Voltage Harmonic Distortion

- .1 The ac generator shall be so designed to create very low distortion on the output voltage waveform.
- .2 The deviation factor of the open-circuit line-to-line terminal voltage of synchronous generators shall not exceed 0.1.
- .3 The balanced telephone influence factor (TIF) based on the weighting factors given in NEMA MG 1 article 32.11.3 shall not exceed 150.

2.9 GENERATOR CONTROL PANEL

2.9.1 Construction

- .1 Provide a generator control panel, located on the generating unit or for separate mounting, to include all control, protection, metering, communication and alarms required for the proper control and safety functions required.
- .2 Control panel constructed of minimum 2 mm thick sheet steel, dead front, weather proof construction, and provide hinged, gasketed, pad-lockable, front access doors, 120° opening arc, or a desk-type panel with vertical panels for instruments, annunciators and metering.
- .3 Provide a full width, tin plated copper ground bus at the bottom of the panel.

2.9.2 Controls and Metering

- .1 Provide the panel with all controls, metering, protective devices and alarms, necessary for the safe and proper operation of the system. All devices shall be completely accessible from the front of the panel.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 The following protective functions shall be provided:
- .1 Generator over and under voltage;
 - .1 Generator over current;
 - .2 Loss of voltage sensing;
 - .3 Generator over load; and
 - .4 Generator over excitation.
 - .3 Connect the protective devices to numbered terminal blocks. Include in the alarm system an alarm horn, silence and reset buttons and one main contact for remote annunciation signifying that an alarm is present. Design the alarm system to operate from the diesel starting battery.
 - .4 Provide the electrical system meters of digital design with metric scales, flush mounted on the front of the Generator Control Panel, readily removable. The elapsed time meter shall be 5-digit, calibrated in hours and tenths of an hour.
 - .5 Provide a normally open contact which shall instantaneously close when the diesel set is ready to accept load. Wire the contact to a terminal blocks.

2.9.3 Wiring

- .1 Wire the generator control panel, with all points for external connections brought out to numbered terminal blocks. All control wiring minimum #14 AWG stranded copper, type TEW, 600 V rating with black insulation, UL listed AWM (Style 1015) in accordance with CSA C22.2 No. 127. Wiring shall be not smaller than #12 AWG for power and #10 AWG for CT wiring, complete with heat and flame resistant type insulation. Insulation colour shall be black for all panel wiring except ground connections which shall be green.
- .2 Use extra flexible conductors for wiring to door mounted equipment.
- .3 Arrange wiring in neat bundles, with adequate wrapping and supports, or install in wiring duct as required. Maintain 120 Vac and 24 Vdc wiring in separate bundles or wiring duct. Number the end of each wire in accordance with the wiring diagrams, using suitable oil resistant indelible tags or ferrules.
- .4 Provide the necessary terminal blocks, including 20% spares, on the generator set and the Generator Control Panel for the termination of all external wiring.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.9.4 Power Supply for Auxiliaries

- .1 A 208 V, 3-phase ac power shall be provided. This supply shall be utilized by the Supplier to distribute power to the various auxiliary devices, including heaters, lights, etc.

2.9.5 Identification and Labelling

- .1 Provide engraved Lamicoid nameplates, white background with 5 mm minimum black letters for internal and external components, secured with stainless steel screws. Stick-on labels are not acceptable.
- .2 Warning signs shall be engraved Lamicoid, red background with 12 mm minimum white letters, indicating sources of supply, points of isolation and that engine may start automatically at any time. Secure with stainless steel screws.

2.10 REMOTE ALARM/STATUS CONTACTS

- .1 The following alarm and status contacts shall be provided for remote equipment use. All contacts shall be type Form C, rated 10 A @ 120/240 Vac or 30 Vdc resistive maximum, and shall be wired to suitably sized terminal blocks for customer use:
 - .1 Engine Running Quantity 2
 - .2 Engine Generator Common Fail Alarm Quantity 2
 - .3 Gnerator Breaker Position (open/closed) Quantity 2

2.11 SURFACE TREATMENT

- .1 Treat all metallic surfaces to prevent corrosion due to the presence of surface moisture.
- .2 Prior to painting remove all rust, scale and grease. Apply two coats of primer to all surfaces except those otherwise corrosion treated, finished or machined.
- .3 Shop paint surfaces in accordance with the manufacturer's standard for the conditions specified. Do not paint rubber and PVC hoses, wiring harnesses or machined surfaces.
- .4 Painting of the equipment shall be Supplier's standard for the conditions specified.
- .5 Do not apply paint to any stainless steel or galvanized part.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 32 13.04
CH0032	DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.6 Supply a quantity of finish pain for field touch-up.

2.12 EQUIPMENT IDENTIFICATION, MARKING AND LABELLING

- .1 Fit and assemble work in the shop, where possible. Where final assembly in the shop is not possible, part assemble in the shop and match-mark the component parts to ensure proper assembly on site.
- .2 Identify individual pieces in accordance with the identification schedule used on the shop drawings and bill of materials to clearly indicate their location in the work for installation.
- .3 Main fuel storage tank and day tanks shall include ULC label. Provide the generator set with a stainless steel nameplate including The Company's equipment number, the manufacturer, model no., serial no., year of manufacture, design code, size/rating, speed, power supply, etc. These overall assembly nameplates are in addition to the individual component labels.

3 EXECUTION

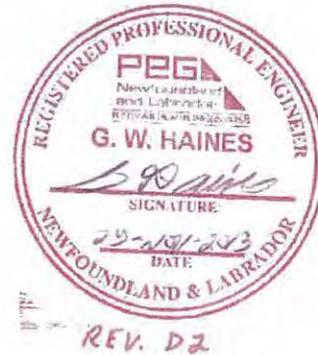
3.1 NOT USED

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 16
CH0032	BATTERIES AND BATTERY RACKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 33 16
BATTERIES AND BATTERY RACKS
TABLE OF CONTENTS**

1	GENERAL	2
1.1	SUMMARY	2
1.2	REFERENCES	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS	2
1.4	CLOSEOUT SUBMITTALS.....	3
1.5	NOT USED	4
2	PRODUCTS	4
2.1	MATERIALS	4
2.2	BATTERY CHARACTERISTICS.....	4
2.3	LEAD ACID BATTERIES	4
2.4	ACCESSORIES.....	5
2.5	BATTERY RACK	5
3	EXECUTION	6
3.1	INSTALLATION	6
3.2	FIELD QUALITY CONTROL.....	6



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 16
CH0032	BATTERIES AND BATTERY RACKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- .1 Materials and installation for storage batteries and racks.

1.1.2 Related Sections:

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 33 43 – Battery Chargers

1.2 REFERENCES

1.2.1 American National Standards Institute (ANSI)/Underwriters Laboratories (UL).

- .1 ANSI/UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.2.2 Canadian Standards Association (CSA International).

- .1 CAN/CSA C22.1, Canadian Electrical Code Part 1 – Safety Standard for Electrical Installations.
- .2 CAN/CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

1.2.3 Institute of Electrical and Electronic Engineers (IEEE).

- .1 IEEE 484, IEEE Recommended Practices for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications.
- .2 IEEE 485, IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
- .3 IEEE 450, Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submittals in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Submit shop drawings and product data to include:

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 16
CH0032	BATTERIES AND BATTERY RACKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Dimensioned sketch showing battery rack, individual battery cells, recommended aisle space, headroom, assembly and anchoring of rack.
- .2 Shipping weights.
- .3 Individual battery cells, type, size, Ahr capacity at 2 hours discharge rate, electrolyte, materials for container, cover, separators, retainers, posts and inter-cell connectors.
- .4 Specific gravity at full charge and 25 degrees C.
- .5 Cell charge and discharge curves of voltage, current, time and capacity.
- .6 Derating factor for temperature range (plus 5 degrees C to plus 35 degrees C).
- .7 Maximum short circuit current.
- .8 Maximum charging current recommended for fully discharged condition.
- .9 Full charge voltage per cell.
- .10 Fully discharged voltage per cell.
- .11 Hydrogen generation and ventilation requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for storage batteries and racks for incorporation into manual specified in Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operation, maintenance and repair.
- .3 Installation details of battery rack, individual cells, inter-cell connectors.
- .4 Replacement instructions for individual cells.
- .5 Electrolyte handling.
- .6 Parts lists with catalogue numbers, and names and addresses of suppliers.
- .7 Factory test records.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 16
CH0032	BATTERIES AND BATTERY RACKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



1.5 NOT USED

2 PRODUCTS

2.1 MATERIALS

- .1 Steel for battery racks: to CAN/CSA-G40.20.

2.2 BATTERY CHARACTERISTICS

- .1 Nominal battery voltage, full charge, 125 V.
- .2 Designed to supply load current of 40 A for 2 hours.
- .3 Minimum end voltage: 1.75 V per cell after discharge at rated load for period specified.
- .4 Capable of being recharged in period of 12 hours to not less than 95% full charge after supplying rated load for period specified, with no harmful effects on battery, including leaking or foaming of electrolyte.
- .5 Battery to deliver specified output at 25 degrees C, in ambient temperature from 5 degrees C to 35 degrees C.

2.3 LEAD ACID BATTERIES

- .1 Type: Absorptive glass microfibre (AGM) valve regulated lead acid (VRLA).
- .2 Electrolyte: solution of sulphuric acid.
- .3 Cell containers: transparent plastic fire retardant.
- .4 Electrolyte level lines: high and low on container surfaces.
- .5 Cover: one piece molded plastic, flame retardant to ANSI/UL 94.
- .6 Plate retainers: fibreglass.
- .7 Plate separators: fibreglass.
- .8 Vents: plastic screw flame arrestor type.
- .9 Posts: bolted type with 2 stainless steel nuts and bolts per cell.
- .10 Inter-cell connectors: lead plated copper, bolted to battery posts.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 16
CH0032	BATTERIES AND BATTERY RACKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .11 Bolt holes slightly oversized to facilitate cell replacement.
- .12 Connectors, bolts and nuts: corrosion resistant.
- .13 Cells: of identical construction and from same production run.
- .14 Batteries: in clean state with no evidence of electrolyte on outside of cell containers.

2.4 ACCESSORIES

- .1 Two (2) spare intercell connectors, nuts and bolts.

2.5 BATTERY RACK

- .1 One (1) tier, size as indicated. Bottom tier minimum 120 mm above floor.
- .2 Frames: angle iron with welded joints ground smooth.
- .3 Rails: steel channels, bolted to frames.
- .4 Insulate rails from cells.
- .5 Insulated from ground and floor.
- .6 Free standing - not bolted to floor.
- .7 Primed and epoxy painted to prevent corrosion.
- .8 Corrosion resistant bolts and hardware.
- .9 Configuration permitting any one cell to be removed without removing any other cell.
- .10 Dimensions of space available as indicated.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 16
CH0032	BATTERIES AND BATTERY RACKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Install battery rack as indicated on drawings.
- .2 Install battery cells on rack.
- .3 Clean posts and connectors and apply no-oxide grease.
- .4 Install inter-cell connectors, and hand tighten nuts in accordance with manufacturer's instructions.
- .5 Using torque wrenches, tighten nuts in accordance with manufacturer's recommended value.
- .6 Connect battery to load circuit.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with section 26 05 00 – General Electrical Requirements.
- .2 Check battery voltage of each cell or units in accordance with manufacturer's instructions.
- .3 Float charge battery for 16 hours to ensure battery fully charged and in stable condition.
- .4 Discharge battery at rated load for 2 hours.
- .5 Check battery voltage at terminals and voltage of each cell or units.
- .6 Recharge battery to full charge.
- .7 Check battery voltage and voltage of each cell or units.
- .8 Leave battery in fully charged state.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 43
CH0032	BATTERY CHARGERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 26 33 43
BATTERY CHARGERS
TABLE OF CONTENTS**

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

 1.4 CLOSEOUT SUBMITTALS..... 2

2 **PRODUCTS** 3

 2.1 PERFORMANCE REQUIREMENTS..... 3

 2.2 CHARGER CHARACTERISTICS 3

 2.3 ACCESSORIES..... 3

 2.4 ENCLOSURE 4

 2.5 EQUIPMENT IDENTIFICATION 4

3 **EXECUTION** 5

 3.1 INSTALLATION 5

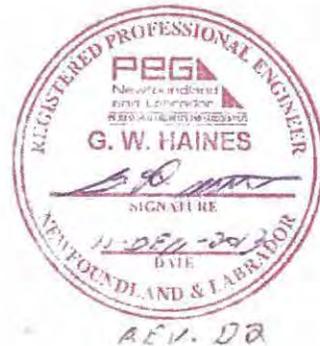
 3.2 FIELD QUALITY CONTROL..... 5

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 43
CH0032	BATTERY CHARGERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 33 16 – Batteries and Battery Racks

1.2 REFERENCES

1.2.1 CSA International

- .1 CAN/CSA C22.2 No.107.2, Battery Chargers.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for battery chargers and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Charger data: type and capacity, battery charging sequence, current-time data for Silicon Controlled Rectifier (SCR) protective devices, estimated noise level, metering, alarms, controls and efficiency.

1.4 CLOSEOUT SUBMITTALS

1.4.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.4.2 Operation and Maintenance Data: submit operation and maintenance data for battery chargers for incorporation into manual.

1.4.3 Operation and maintenance instructions covering design elements, construction features, component functions and maintenance requirements to permit effective operation, maintenance and repair.

1.4.4 Copy of approved shop drawings.

1.4.5 Technical description of components.

1.4.6 Parts lists with catalogue numbers and names and addresses of suppliers.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 43
CH0032	BATTERY CHARGERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- .1 Automatically maintain battery in fully charged state while mains power available. Maintain DC float voltage within plus or minus 1% of setting.
- .2 Float charging rate such that after battery has provided full power output for specified duration, charger returns battery to 95% of fully charged state in 12 hours, while supplying normal battery load.
- .3 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 hours, to return unit to float charge.
- .4 Manual adjustment of float charge voltage with range plus or minus 5%.
- .5 Manual adjustment of equalizing charge voltage.
- .6 Automatic current limiting adjustable between 80 and 120% of normal rating.
- .7 Audible noise level not to exceed 65 dBA at 1.5 m.

2.2 CHARGER CHARACTERISTICS

- .1 Battery charger: to CAN/CSA C22.2 No.107.2.
- .2 Input: 600 Vac, 3 phase, 4 wire, 60Hz.
- .3 Output: TBA A, DC at 125 V, DC, ripple voltage less than 2 %.

2.3 ACCESSORIES

- .1 AC voltmeter: switchboard type, accuracy plus or minus 2% of full scale, to measure rectifier input voltage.
- .2 DC voltmeter: switchboard type, accuracy plus or minus 2% of full scale, to measure rectifier output voltage.
- .3 AC ammeter: switchboard type, accuracy plus or minus 2% of full scale, to measure rectifier output current.
- .4 DC ammeter: switchboard type, accuracy plus or minus 2% of full scale, to measure rectifier output current.
- .5 Relay and alarm for ac power failure with time delay to prevent alarm during short power outages.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 43
CH0032	BATTERY CHARGERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 Low DC voltage alarm.
- .7 High DC voltage alarm and high DC voltage automatic shutdown.
- .8 Ground detector relay and alarm.
- .9 Equalizing timer: automatic reset type for unattended stations, 28 day period.
- .10 LEDs mounted on front to indicate: failure AC power, low DC voltage, high DC voltage, and no rectifier output.
- .11 Alarms: audible alarm when any LED indicates trouble. Silence pushbutton not to extinguish trouble light.
- .12 Common LED, test switch and one common Form C alarm contact.
- .13 Temperature compensation system for voltage output, including remote, battery mounted, temperature sensor.
- .14 DC output voltage and DC output current transducer with 4-20 mA output.

2.4 ENCLOSURE

- .1 Dead front free standing sheet steel, 2.5 mm thick minimum CSA Enclosure Type 1.
- .2 Access from front.
- .3 Convection ventilated.
- .4 Meters, indicating lamps and controls group mounted on front panel.
- .5 Allow for handling by forklift or sling.
- .6 Apply finish in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.5 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Use size 4 nameplates for major components such as input breakers, output breaker.
- .3 Use size 2 nameplates for mode lights alarms, meters.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 43
CH0032	BATTERY CHARGERS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Locate and install battery charger as indicated.
- .2 Connect input terminals to AC mains.
- .3 Connect output terminals to battery.

3.2 FIELD QUALITY CONTROL

- .1 Perform Tests in accordance with Section 26 05 00 – General Electrical Requirements.
- .2 Energize battery charger and operate until battery shows full charge.
- .3 Discharge battery to full discharge condition.
- .4 Recharge battery, recording DC voltage and current once per hour for 8 hours. Test battery to ensure it has reached at least 95% full charge.
- .5 Continue charging to ensure charger changes from bulk rate to float charge rate.
- .6 Demonstrate that automatic timer controls charging and correctly transfers from equalize to float charge after selected period.
- .7 Simulate faults to demonstrate that alarm lights and audible alarms are performing as designed.
- .8 At end of tests, with battery in fully charged condition, operate charger on "float" for minimum period of 24 hours to ensure stable condition is reached and held.

END OF SECTION

46 ANB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 33 53
UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)

1 GENERAL..... 2

1.1 SECTION INCLUDES..... 2

1.2 RELATED REQUIREMENTS..... 2

1.3 REFERENCES..... 2

1.4 ACTION AND INFORMATIONAL SUBMITTALS..... 2

1.5 PROTECTION OF SYSTEMS..... 3

1.6 CLOSEOUT SUBMITTALS..... 4

1.7 MAINTENANCE MATERIAL SUBMITTALS..... 4

2 PRODUCTS..... 4

2.1 SYSTEM DESCRIPTION..... 4

2.2 PERFORMANCE..... 4

2.3 UNINTERRUPTIBLE POWER SYSTEM..... 6

2.4 ELECTRICAL REQUIREMENTS..... 7

2.5 ENCLOSURE..... 8

2.6 INVERTER..... 9

2.7 STATIC BYPASS SWITCH..... 10

2.8 FINISHES..... 11

2.9 EQUIPMENT IDENTIFICATION..... 11

3 EXECUTION..... 12

3.1 INSTALLATION..... 12

3.2 FIELD QUALITY CONTROL..... 12

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 SECTION INCLUDES

- .1 120 Vac Uninterruptible Power System (UPS) consisting of an inverter and bypass facilities. UPS will be fed from the station battery.

1.2 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 33 16 – Batteries and Battery Racks.

1.3 REFERENCES

1.3.1 CSA International

- .1 CAN/CSA-C813.1, Performance Test Method for Uninterruptible Power Supplies.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

1.4.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.4.2 Product Data: include information as follows:

- .1 Catalogue information.
- .2 Shipping weight.
- .3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.
- .4 Description of system operation, referenced to schematic diagram, for:
 - .1 Manual control during initial start-up and load transfer to bypass and back to inverter output.
 - .2 Inverter.
 - .3 Bypass.
- .5 Estimate with supporting data for Mean Time to Repair factor (MTTR).
- .6 Full load kVA output at 0.8% lagging power factor.
- .7 Efficiency of system at 25%, 50%, 75% and 100% rated load.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .8 Type of ventilation: natural or forced.
- .9 Inverter:
 - .1 Type and catalogue number.
 - .2 DC current at minimum battery voltage to produce full load AC output.
- .10 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.
- .11 Cooling air required in m³/s.
- .12 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.

1.4.3 Shop Drawings:

- .1 Include outline schematics showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

1.5 PROTECTION OF SYSTEMS

1.5.1 Circuit breakers in system used to isolate it from load and from 125 Vdc battery input for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during Work on inverter.

1.5.2 Automatic circuit breakers and protection included in:

- .1 DC input to inverter.
- .2 AC input to bypass.
- .3 Inverter output.

1.5.3 Surge suppressors:

- .1 To protect system against supply voltage switching transients.
- .2 To protect internal circuits where necessary against voltage transients.

1.5.4 Current limiting devices, with panel front indication of device operation, to protect inverter SCR's.

1.5.5 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.6 CLOSEOUT SUBMITTALS

- 1.6.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- 1.6.2 Operation and Maintenance Data: submit operation and maintenance data for uninterruptible power systems static (UPS) for incorporation into manual.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit spare parts list in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Include:
 - .1 Four (4) sets of each type and size of fuses used.
 - .2 Four (4) sets indicating lamps.

2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 All UPS equipment to be products of Gentec.

2.1.1 System to consist of:

- .1 Invertor Cubicle.
- .2 Bypass Switch.
- .3 Controls and meters.

2.1.2 Ensure system uses normal power supply mains and battery to provide continuous, regulated AC power to isolated load.

2.1.3 Equipment: capable of operating continuously and unattended.

2.1.4 Ensure that Uninterruptible Power Systems (UPS) is compatible with equipment that it feeds.

2.2 PERFORMANCE

2.2.1 Normal operation:

- .1 System operates on 125 Vdc station battery power when battery voltage is within +/-10 % of nominal value.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.2 AC Emergency Operation:

- .1 System transfers automatically:
 - .1 When manually selected at control panel.
 - .2 When 125 Vdc power fails.
 - .3 When battery voltage varies more than 10 % from nominal.
 - .4 When 125 Vdc power is restored and battery voltage is within 10 % of nominal, system automatically supplies loads from the inverter and resynchronizes with AC supply emergency;
 - .5 Slew rate of frequency during transition period of system output automatically synchronizing with AC supply emergency and return to its internal frequency to be set between 0.5 to 1.0 Hz per second.

2.2.3 Internal Static Bypass operation:

- .1 Ensure system can be bypassed for maintenance purposes, automatically by manual selection at control panel to connect load directly to AC supply. Transfer without load interruption and leaving inverter energized.
- .2 Load transfer from AC emergency supply back to system automatically by manual selection at control panel when maintenance completed.
- .3 Automatic transfer of load to AC emergency supply in not more than 1/4 cycle including sensing with inverter left energized but disconnected from load in case of:
 - .1 Inverter overloaded.
 - .2 Short circuit in load.
- .4 Automatic retransfer of load to system without load interruption when above conditions disappear.
- .5 Automatic transfer of load to AC transfer supply in not more than 1/4 cycle including sensing and shutdown of inverter in case of inverter internal malfunctions.
- .6 Automatic transfer of load to AC emergency supply without load interruption and inverter shutdown in case of:
 - .1 Over temperature harmful to system

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Loss of forced ventilation
- .3 Low voltage of DC supply to ventilator
- .7 Bypass capable of closing onto and withstanding momentary fault current of 800% of rating for 0.01 s.

2.3 UNINTERRUPTIBLE POWER SYSTEM

2.3.1 Input power:

- .1 125 Vdc.
- .2 Normal supply from 125 Vdc station battery.
- .3 Emergency supply from 120/208 Vac emergency panel board.

2.3.2 Output power:

- .1 Single phase, 125 Vac, 2 wire, grounded neutral, 60 Hz.
- .2 Full load output at 0.8 power factor lagging 5 kVA.
- .3 Overload capability: 125% of rated full load current at 0.8 power factor and rated voltage for 10 minutes.
- .4 Frequency - nominal 60 Hz:
 - .1 Adjustable from 58.5 to 61.5 Hz.
 - .2 Maximum variation from set value under load changes, including transients, 0.3 Hz maximum.
 - .3 Drift from set value - after two months normal operation within ambient temperature range of 0°C to 40°C, not to exceed 0.6 Hz.
- .5 Output voltage control:
 - .1 Continuously adjustable on load at least 5% from rated value.
 - .2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of AC input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within [3] Hz.
- .4 Harmonics over entire load range:
 - .1 Total RMS value not to exceed 5% RMS value of total output voltage.
 - .2 Single harmonic not to exceed 3% of total output voltage.
- .5 Proper angular phase relation maintained within 4 electrical degrees at up to 20% load unbalance.
- .6 Efficiency: Overall system efficiency at rated load not less than 90%.
- .7 Interference suppression:
 - .1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.
 - .2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.

2.4 ELECTRICAL REQUIREMENTS

2.4.1 In accordance with Section: 26 05 00 – General Electrical Requirements.

- .1 Provide test required for on-site alignment, for determination of faulty sub-assemblies or printed circuit cards, including indication of oscillator pulse and operation of voltage control.
- .2 No battery other than main battery input incorporated in design.
- .3 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.
- .4 Variable resistors: fine adjustment, rheostat type.
- .5 Phasing marked on input and output terminals, viewed from front of equipment:
 - .1 Left to right.
 - .2 Top to bottom.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Front to back.
- .6 Indicator lamps: long life LED or neon, rated for continuous duty.
- .7 Solid state circuits used where more reliable than mechanical timers or control relays.
- .8 Standard components available from commercial sources used throughout, with 10 years minimum shelf life.
- .9 Arrangement to permit easy removal of defective components to facilitate servicing, by replacing with stock spares.
- .10 Small components, related to specific function, removable plug-in modular sub-assembly or printed circuit card.
- .11 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.
- .12 Components and sub-assemblies accurately made for interchangeability.

2.5 ENCLOSURE

- .1 Dead front free standing sheet steel 2.5 mm minimum thick, CSA Enclosure 1.
- .2 Access from front only.
- .3 Meters, indicating lamps and controls group mounted in panel front.
- .4 Panel front enclosed by hinged doors to prevent tampering and to protect instruments and controls during shipping.
- .5 Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with 2 keys.
- .6 Hinges to permit doors to be lifted off cubicle.
- .7 Cubicle height: 1.8 m maximum.
- .8 External cable connections at top of cubicle through bolted plate for drilling at site to suit.
- .9 Ambient temperature range during operation +5°C to +35°C. Natural or forced ventilation as required.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .10 For forced ventilation power from inverter output and fan directly driven by single phase motor mounted on vibration isolators.
- .11 Each enclosure to have redundant fans, with fan failures alarmed. Air inlet and outlet openings protected with screens and metal guards.
- .12 Disposable air filters on fan cooled enclosures. Method of attachment and opening locations to make removal convenient and safe.
- .13 Maximum operating sound level not to exceed 80 db(A) as measured on sound level meter with A weighting and slow response, at distance of 1.8 m.
- .14 Enclosure frames interconnected by ground bus with ground lug for connection to ground.

2.6 INVERTER

- 2.6.1 One (1) 5 kVA DC to AC inverters are required to supply power to the 120 Vac essential service panelboards as indicated.
- 2.6.2 The inverter unit shall be solid-state, fully automatic, having DC input compensation, DC to AC isolation, load regulation and inherent current limiting.
- 2.6.3 Inverter shall comprise a static transfer switch and a 'no-break' DC to AC static inverter suitable for operation for the normal/alternate voltages. Transfer to and from the 125 Vdc supply shall be automatic and bumpless.
- 2.6.4 The DC input shall be monitored by a DC-fused voltmeter and a shunt-operated DC ammeter. The essential services power supply AC output shall be monitored by an AC voltmeter, an AC ammeter and a frequency meter. There should be an indication on each inverter panel and an analog signal for remote indication.
- 2.6.5 Alarm contacts connected to separate terminals shall be provided for annunciation of the following conditions:
 - .1 inverter failure;
 - .2 static transfer switch failure;
 - .3 total loss of output voltage (on manual bypass);
 - .4 overload;
 - .5 under voltage / overvoltage.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.6.6 Meters:

- .1 AC voltmeter: switchboard type, accuracy +/-2% of full scale, to measure inverter output voltage with [7] position selector switch to select phase to neutral, [phase to phase], off.
- .2 AC ammeter: switchboard type, accuracy +/-2% of full scale, to measure inverter output current with [4] position selector switch to select [each] phase and off.
- .3 Wattmeter: switchboard type, accuracy +/-2% of full scale to measure inverter load.
- .4 Frequency meter: switchboard type, scale 58 to 62 Hz, pointer type, to measure inverter output frequency.
- .5 Synchroscope: with switch to check inverter output potential against supply mains potential.

2.6.7 Output disconnect: bolt-on, moulded case, single pole circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

2.6.8 Meters and controls: grouped on front panel.

2.7 STATIC BYPASS SWITCH

- .1 Solid state closed circuit automatic transfer switch.
- .2 Logic unit with normal source voltage sensors, which monitor overvoltage under voltage and loss of voltage.
- .3 High speed automatic transfer from normal voltage to alternate source when:
 - .1 Normal source voltage lost: transfer time and sensing 1/4 cycle;
 - .2 Normal source: under voltage at 80% of nominal value; adjustable.
 - .3 Normal source: over voltage at 110% of nominal value.
 - .4 Loss of normal source static switch continuity.
 - .5 Short circuit on normal source [blows normal source fuse] [trips normal source breaker].

9/10
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Return to normal source:
 - .1 When normal source remains within return voltage limits of 95% to 110% of nominal value (adjustable) for approximately 1 s timing interval, circuit checks voltage balance and phase synchronization, then initiates return with zero switching time.
- .5 Switch position lights and contacts.
- .6 Synchronizing verification light.
- .7 Manual reset pushbutton.
- .8 Transfer test switch.
- .9 Alternate power source monitor light.
- .10 Accessories:
 - .1 Manual bypass switch for maintenance and testing without load disturbance.
 - .2 Continuity monitor: automatic transfer to alternate source in event of static switch discontinuity.
 - .3 Alternate power source loss alarm contacts.

2.8 FINISHES

2.8.1 Apply finishes in accordance with Section: 26 05 00 – General Electrical Requirements.

2.8.2 Cubicles:

- .1 Inside finish: white.
- .2 Exterior finish: [manufacturer's standard color].
- .3 Exterior hardware and trim: corrosion resistant and not requiring painting such as stainless steel or aluminum.

2.9 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section: 26 05 00 - General Electrical Requirements
- .2 For major components such as AC input breaker, inverter breakers, bypass switch: size 4 nameplates.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 33 53
CH0032	UNINTERRUPTIBLE POWER SYSTEMS STATIC (UPS)	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 For mode lights, alarms, meters: size 2 nameplates

3 EXECUTION

3.1 INSTALLATION

- .1 Locate UPS cubicles, as indicated.
- .2 Assemble and interconnect components to provide complete UPS as specified.
- .3 Connect 125 Vdc station battery to main input terminal.
- .4 Connect UPS output to load.
- .5 Start-up UPS and make preliminary tests to ensure satisfactory performance.

3.2 FIELD QUALITY CONTROL

3.2.1 Perform tests in accordance with Section: 26 05 00 - General Electrical Requirements and CAN/CSA-C813.1.

3.2.2 Provide:

- .1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.
- .2 Dummy load adjustable to 150% of system rated output.

3.2.3 Notify Engineer 10 working days in advance of test date.

3.2.4 Tests:

- .1 Inspection of cubicles.
- .2 Inspection of electrical connections.
- .3 Inspection of installation of remote mode lights and alarms.
- .4 Demonstration of system start-up and shut-down.
- .5 Run UPS for minimum period of 4 hours at full rated load to demonstrate proper operation with 125 Vdc station input, Emergency 120 Vdc supply and no 120 Vac emergency supply.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 50 00
CH0032	LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 50 00
LIGHTING
TABLE OF CONTENTS**

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

 1.4 ACCEPTABLE PRODUCTS 2

2 **PRODUCTS** 3

 2.1 BALLASTS 3

 2.2 FINISHES 5

 2.3 LUMINAIRES..... 5

 2.4 OPTICAL CONTROL DEVICES..... 5

3 **EXECUTION** 5

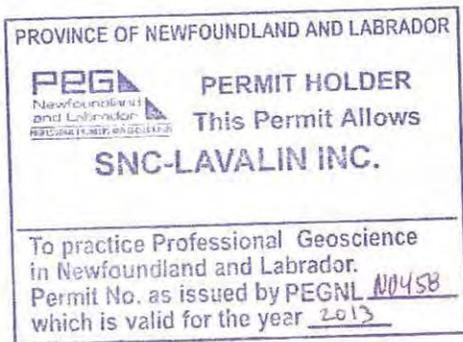
 3.1 INSTALLATION 5

 3.2 WIRING 5

 3.3 LUMINAIRE SUPPORTS 5

 3.4 LUMINAIRE ALIGNMENT..... 5

 3.5 FIELD QUALITY CONTROL..... 6



REV. D2

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 50 00
CH0032	LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 American National Standards Institute (ANSI)

- .1 ANSI C82.1, Electric Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.
- .2 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.

1.2.2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

- .1 ANSI/IEEE C62.41, Surge Voltages in Low-Voltage AC Power Circuits.

1.2.3 American Society for Testing and Materials (ASTM)

- .1 ASTM F1137, Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

1.2.4 United States of America, Federal Communications Commission (FCC)

- .1 FCC (CFR47) EM and RF Interference Suppression.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Engineer.

1.3.2 Photometric data to include: VCP Table and spacing criterion and luminaire coefficient of utilization (CU) tables.

1.3.3 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 ACCEPTABLE PRODUCTS

1.4.1 Luminaires described in drawings identify quality, performance criteria and other parameters, as indicated for this Contract. Named fixtures are acceptable with modifications and accessories, as indicated.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 50 00
CH0032	LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4.2 Fixtures from other manufacturers may be acceptable provided:

- .1 Appearance and lighting performance are similar.
- .2 Quality is equal or better.
- .3 Lamp and ballast criteria remain the same.
- .4 The fixture is provided with modifications and accessories to provide a complete product in keeping with the intent of the project.
- .5 Approval in writing is obtained from the Engineer for substitution.

2 PRODUCTS

- .1 High pressure sodium lamps to be - clear, ED18, 150, 400 Watt, mogul base, 30,000 hour lamp life, 54,000 initial lumens; or as indicated.
- .2 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, rapid or instant start to suit application, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI 80; or as indicated.
- .3 Metal halide lamps to be - clear, BT37, 400 Watt, mogul base, horizontal burn, 4100 K, 15,000 hour lamp life, 36,000 initial lumens, CRI65, open or enclosed type to suit the luminaire; or as indicated.
- .4 Compact fluorescent lamps to be - 18 Watt, G24q-2 base, 12,000 hour lamp life, 12,000 initial lumens, 4100 K, CRI 80; or as indicated.

2.1 BALLASTS

2.1.1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic.

- .1 Rating: 120 or 347 V, 60 Hz, as indicated, for use with 2-32W, T8 octron imperial lamps.
- .2 RFI/EMI suppression circuit to: FCC (CFR47) Part 18, sub-part C, Class A and Part 15, sub-part B, Class B.
- .3 Totally encased and designed for 40 °C ambient temperature.
- .4 Power factor: minimum 98 % with 98% of rated lamp lumens.
- .5 Crest factor: 1.5 maximum.
- .6 Capacitor: thermally protected.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 50 00
CH0032	LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Thermal protection: non-resettable on coil.
- .8 Harmonics: 10 % maximum THD.
- .9 Operating frequency of electronic ballast: 20 khz minimum.
- .10 Total Circuit Power: 62 Watts.
- .11 Ballast Factor: greater than 0.90.
- .12 Sound rated: Class A.
- .13 Mounting: integral with luminaire.
- .14 Be warranted by manufacturer for five years.

2.1.2 Metal halide ballast:

- .1 Rating: 60 Hz voltage as indicated, for use with metal halide lamp as indicated. Provide circuitry for standby light to provide light for starting and restart.
- .2 Totally encased and designed for 40 °C ambient temperature.
- .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
- .4 Type: constant wattage auto-transformer or solid state.
- .5 Input voltage range: plus or minus 10% of nominal.
- .6 Minimum starting temperature: minus 29 °C at 90% line voltage.
- .7 Mounting: outdoor integral with luminaire.
- .8 Current crest factor: 1.7 maximum current.

2.1.3 High pressure sodium ballast: to ANSI C82.4.

- .1 Rating: 60Hz voltage as indicated, for use with high pressure sodium lamps, as indicated.
- .2 Totally encased and designed for 40 °C ambient temperature.
- .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
- .4 Type: reactor or solid state with matching igniter as recommended by manufacturer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 50 00
CH0032	LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Input voltage range: plus 10% to minus 10% of nominal.
- .6 Minimum starting temperature: minus 34 °C at 90% line voltage.
- .7 Mounting: outdoor integral with luminaire.
- .8 Current crest factor: 1.7 maximum current.

2.2 FINISHES

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

2.3 LUMINAIRES

- .1 As indicated on drawings. Provide 10% spare lamps of each type.

2.4 OPTICAL CONTROL DEVICES

- 2.4.1 As indicated in luminaire schedule on drawings.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Locate and install luminaires as indicated. Install lamps in all fixtures.

- .1 Provide adequate support to suit ceiling system.

3.2 WIRING

- 3.2.1 Connect luminaires to lighting circuits.

- .1 Install flexible conduit for vertical power supply drop to luminaires as indicated. Horizontal wiring using flexible conduit is not permitted.

3.3 LUMINAIRE SUPPORTS

- 3.3.1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.

3.4 LUMINAIRE ALIGNMENT

- 3.4.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- 3.4.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 50 00
CH0032	LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5 FIELD QUALITY CONTROL

3.5.1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 52 00
CH0032	EMERGENCY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 50 00
EMERGENCY LIGHTING
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES	2
1.3	ACTION AND INFORMATIONAL SUBMITTALS	2
1.4	CLOSEOUT SUBMITTALS.....	2
1.5	NOT USED	2
2	PRODUCTS	2
2.1	EQUIPMENT	2
2.2	WIRING OF EMERGENCY LUMINARIES	3
3	EXECUTION	4
3.1	INSTALLATION	4
3.2	FIELD QUALITY CONTROL	4

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REGISTERED PROFESSIONAL ENGINEER

PEG
Newfoundland and Labrador
Professional Engineers and Geoscientists

G. W. HAINES

G. W. Haines
SIGNATURE

22-Nov-2013
DATE

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 52 00
CH0032	EMERGENCY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2
- .3 Section 26 33 53 – Uninterruptible Power Systems Static (UPS)
- .4

1.2 REFERENCES

1.2.1 CSA International

- .1 CSA C22.2 No.141, Emergency Lighting Equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.
- .2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

1.5 NOT USED

2 PRODUCTS

2.1 EQUIPMENT

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 600 V, 3 phase, AC.
- .3 Output voltage: 347 V, single phase, AC.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 52 00
CH0032	EMERGENCY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Operating time: 90 minutes.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Battery disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON'.
- .10 Lamp heads: emergency lighting will use identical luminaries to those used for normal lighting.
- .11 Cabinet: floor mounted for CSA Type 1 enclosure. Removable or hinged front panel for easy access to batteries.
- .12 Finish: Manufacturer's standard.
- .13 Auxiliary equipment:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Test switch.
 - .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 ac input and ac output terminal blocks inside cabinet.
 - .7 RFI suppressors.

2.2 WIRING OF EMERGENCY LUMINARIES

- .1 Conduit: type in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: type in accordance with Section 26 05 21 - Wires and Cables (0-1000 V), sized as indicated.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 52 00
CH0032	EMERGENCY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Install unit equipment and remote mounted fixtures.
- .2 Direct heads.
- .3 Connect exit lights to unit equipment.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.

END OF SECTION

MB 96

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 53 00
CH0032	EXIT SIGNS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 26 53 00
EXIT SIGNS

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATONAL SUBMITTALS 2

2 **PRODUCTS** 2

 2.1 STANDARD UNITS 2

 2.2 SELF-POWERED UNITS..... 3

 2.3 SELF-LUMINOUS SIGNS..... 4

 2.4 DESIGN..... 4

3 **EXECUTION** 5

 3.1 MANUFACTURER'S INSTRUCTIONS 5

 3.2 INSTALLATION 5

 3.3 FIELD QUALITY CONTROL..... 5

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REGISTERED PROFESSIONAL ENGINEER
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Newfoundland and Labrador
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G. W. HAINES
G. W. Haines
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 53 00
CH0032	EXIT SIGNS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section: 26 05 00 – General Electrical Requirements.
- .2 Section: 26 52 00 – Emergency Lighting.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA C22.2 No.141, Unit Equipment for Emergency Lighting.
- .2 CSA C860, Performance of Internally-Lighted Exit Signs.

1.2.2 National Fire Protection Association (NFPA)

- .1 NFPA 101, Life Safety Code.

1.3 ACTION AND INFORMATONAL SUBMITTALS

- .1 Provide submittals in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.3.2 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and disposal.

2 PRODUCTS

2.1 STANDARD UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple LED, 347 V over 500,000 hours with an average brightness of 3000 candela.

MB 9/16

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 53 00
CH0032	EXIT SIGNS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Include "running man" pictograms in accordance with CSA C22.2 No. 141, Annex B and with directional arrows as indicated.
- .7 Downlight: white glass in bottom of unit.
- .8 Face plate to remain captive for relamping.

2.2 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple LED, 347 V over 500,000 hours.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Include "running man" pictograms in accordance with CSA C22.2 No. 141, Annex B and with directional arrows as indicated.
- .7 Downlight: white glass in bottom of unit.
- .8 Face plate to remain captive for relamping.
- .9 Supply voltage: 347 Vac.
- .10 Output voltage: 12 or 24 Vdc.
- .11 Operating time: 90 minutes minimum.
- .12 Recharge time: 12 hours
- .13 Battery: sealed, maintenance free.
- .14 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .15 Solid state transfer circuit.
- .16 Signal lights: solid state, for 'AC Power ON' condition.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 53 00
CH0032	EXIT SIGNS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .17 Lamp heads: integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.
 - .1 Lamp type: as indicated.
- .18 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.
 - .1 Removable or hinged front panel for easy access to batteries.
- .19 Cabinet: finish: standard.
- .20 Auxiliary equipment:
 - .1 Lamp disconnect switch.
 - .2 Test switch.
 - .3 AC/DC output terminal blocks inside cabinet.
 - .4 RFI suppressor.
 - .5 Cord and single twist-lock plug connection for AC power supply.

2.3 SELF-LUMINOUS SIGNS

2.3.1 Exit lights:

- .1 No power source or wiring required, spark free.
- .2 Constructed: metal and plastic.
- .3 Source of energy: tritium gas emits constant low energy beta particles to excite phosphor coating on inside of tube.
- .4 Viewing distance: in accordance with NFPA.
- .5 Dispose of lights at end of lifespan as Hazardous Waste.

2.4 DESIGN

- .1 Recessed wall, end to wall, ceiling mounting.
- .2 Single or double face with face plate to remain captive for relamping.
- .3 Arrow: right or left as indicated.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 53 00
CH0032	EXIT SIGNS	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Wireguard.

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section: 26 05 00 – General Electrical Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 56 19
CH0032	ROADWAY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 26 56 19
ROADWAY LIGHTING
TABLE OF CONTENTS**

1 **GENERAL**..... 2

 1.1 RELATED REQUIREMENTS..... 2

 1.2 REFERENCES 2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

2 **PRODUCTS** 2

 2.1 STEEL POLES 2

 2.2 LUMINAIRE MOUNTING BRACKETS 3

 2.3 LUMINAIRES 3

3 **EXECUTION** 4

 3.1 INSTALLATION 4

 3.2 FIELD QUALITY CONTROL 4

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G. W. HAINES
 SIGNATURE

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CH0032	ROADWAY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 50 00 - Lighting

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

- .1 CSA A14, Concrete Poles.
- .2 CSA C22.2No.206, Lighting Poles.
- .3 CAN/CSA-O15-[90(R1999), Wood Utility Poles and Reinforcing Stubs.
- .4 CSA O80 Series-[97], Wood Preservation.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit product data in accordance with Exhibit 4 – Supplier Document Requirements List.

2 PRODUCTS

2.1 STEEL POLES

2.1.1 Steel poles: to CSA C22.2No.206 designed for underground wiring and:

- .1 Mounting on concrete anchor base.
- .2 Style: monotube, minimum 6.0 mm thick, tapered round.
- .3 Tenon-top, galvanized steel suitable for two luminaire mounting brackets.
- .4 Access handhole 1000 mm above pole base for wiring connections, with welded-on reinforcing frame and bolted-on cover. Hand hole size: 50 x 125 mm
- .5 Size: as indicated.
- .6 Anchor bolts: four (4) steel with "L" bend, shims, nuts and covers, dimensioned as indicated on drawings.
- .7 Finish: polyester powder coat. Colour to be advised during shop drawing review.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 56 19
CH0032	ROADWAY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .8 Grounding lug inside hand hole.
- .9 Load ratings for combined assembly of pole, based on luminaire:
 - .1 Maximum wind load 160 kph @ 1.3 gust factor, no ice.
 - .2 Maximum ice load: 38 mm radial, no wind.
 - .3 Combined load: 120 kph wind 2 1,3 gust factor and 25 mm radial ice.

2.2 LUMINAIRE MOUNTING BRACKETS

2.2.1 Mounting brackets steel for specified luminaires:

- .1 Tenon-top for number of luminaires as indicated.
- .2 Tenon-top 101 mm diameter or as required by luminaire, height as required by the luminaire.

2.3 LUMINAIRES

2.3.1 Luminaire with cast aluminum weatherproof housing and:

- .1 Lamp type: HPS, wattage: 150 W.
- .2 Ballast: 347 V, one lamp, in accordance with Section 26 50 00 - Lighting.
- .3 Optical assembly:
 - .1 For high pressure sodium lamps:
 - .1 Reflector: sheet aluminum with Alzak finish.
 - .2 Refractor: one piece prismatic glass.
 - .3 Gasket: seal between refractor and housing.
- .4 Light Distribution:
 - .1 By adjusting position of lamp socket.
- .5 Self-locking latches of stainless steel and aluminum.
- .6 Factory wired including integral ballast terminated at terminal block.

MB 9/10

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 26 56 19
CH0032	ROADWAY LIGHTING	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Install poles true and plumb, complete with brackets in accordance with manufacturer's instructions.
- .2 Install luminaires on pole and install lamps.
- .3 Check luminaire orientation, level and tilt.
- .4 Connect luminaire to lighting circuit. Perform tests in accordance with Section 26 05 00 - General Electrical Requirements.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - General Electrical Requirements.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**SECTION 28 16 00
INTRUSION DETECTION
TABLE OF CONTENTS**

1	GENERAL	2
1.1	RELATED REQUIREMENTS.....	2
1.2	REFERENCES	2
1.3	SUBMITTALS	2
1.4	CLOSEOUT SUBMITTALS.....	3
2	PRODUCTS	3
2.1	MATERIALS	3
3	EXECUTION	7
3.1	INSTALLATION.....	7
3.2	FIELD QUALITY CONTROL.....	7
3.3	ADJUSTING	8

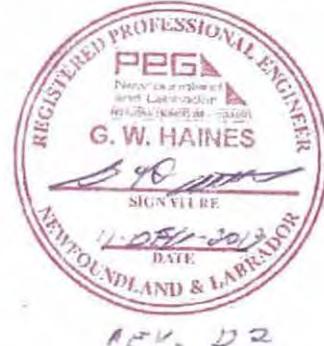
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.

1.2 REFERENCES

1.2.1 Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC-S304, Signal Receiving Centre and Premise Burglar Alarm Control Units.
- .2 CAN/ULC-S306, Intrusion Detection Units.
- .3 ULC-S318, Standard for Power Supplies for Burglar Alarm Systems.
- .4 ULC-C634, Guide for the Investigation of Connectors and Switches for Use with Burglar Alarm Systems.

1.2.2 Underwriters' Laboratories (UL)

- .1 UL 603, Power Supplies For Use With Burglar-Alarm Systems.

1.3 SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for control panels, detection accessory devices and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit:
 - .1 Functional description of equipment.
 - .2 Technical data for devices.
 - .3 Device location plans and cable lists.
 - .4 Devices mounting location detail drawings.
 - .5 Typical devices connection detail drawings.




Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.3 Shop Drawings:

- .1 Shop drawings to indicate project layout, mounting heights and locations, wiring diagrams, detection device coverage patterns, contact operating gaps,.
- .2 Submit zone layout drawing indicating number and location of zones and areas covered.

1.3.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .1 Submit UL Product Safety Certificates.

1.3.5 Test and Evaluation Reports:

- .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

1.4.1 Operation and Maintenance Data: submit maintenance data for incorporation into manual specified in Section [01 78 00 - Closeout Submittals].

- .1 Include:
 - .1 System configuration and equipment physical layout.
 - .2 Functional description of equipment.
 - .3 Instructions of operation of equipment.
 - .4 Illustrations and diagrams to supplement procedures.
 - .5 Operation instructions provided by manufacturer.
 - .6 Cleaning instructions.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Design Criteria:

- .1 Design intrusion detection system using only ULC/UL listed products.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Design intrusion detection system as a non certified alarm system.
- .3 Design system as a modular access control, alarm monitoring system expandable, and easily modified for inputs, outputs and remote control stations.
 - .1 Design components in accordance with CAN/ULC-S306 and be capable of:
 - .1 Annunciating undesirable, abnormal or dangerous condition.
 - .2 Prioritizing alarms by alarm type; i.e. panic/duress, intrusion and tamper.
 - .3 Determining zone where alarm occurred.
 - .4 Annunciating power failure and power restoration.
 - .5 Annunciating low battery condition.
 - .6 Operate continuously for minimum period of 4 hours in the event of a power failure.
- .4 Equip control panels with continuous tamper detection on door and wall.
 - .1 Tamper detection to trigger alarm.
- .5 Design system with:
 - .1 Alarm masking.
 - .2 Remote maintenance or diagnostics with password activation and callback modem.
 - .3 Unique identifier for each authorized person.
 - .4 Arming and disarming capabilities: manual and automatic by time of day, day of week, or by operator command.
 - .5 Support both manual and automatic responses to alarms entering system.
 - .6 Each alarm capable of initiating different functions of camera, homing, and activation of remote devices, audio switching, door control and card or pin validation.
 - .7 Zone or alarm location annunciated at monitoring station.
- .6 Communications link: security level of I to CAN/ULC-S304.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .7 Signal link: security level of I to CAN/ULC-S304.
- .8 Alarm condition: design system to provide maximum time for an alarm to be communicated of 90 seconds from alarm initiation to annunciation at remote monitoring location.
- .9 Junction boxes: tamper proof with continuous tamper-detection capability.
- .10 Design system power supplies rated to provide cumulative load of all systems components plus safety factor of 50% or greater.

2.1.2 Control Panel: ULC approved, expandable [and designed for multiplexed expansion].

- .1 Zones (protection inputs): 8.
- .2 Fixed zones: 8.
- .3 Expandable: 8 - 32 zones.
- .4 Number of user codes required: 10.
- .5 Number of areas/partitions required: 10.
- .6 Keypads: LCD (liquid crystal display).
- .7 Alarm: monitored.
- .8 System: wired.
- .9 Integrated with sub systems access control.
- .10 Number of programmable outputs required: 5.
- .11 System supervision: telephone line, battery and AC powered.
- .12 Siren output.
- .13 Number of devices per zone: as required.

2.1.3 Detection Accessories:

- .1 Passive Infrared Detectors (PIR's): ULC approved, digital.
 - .1 Coverage pattern: as required/indicated.
 - .2 Temperature requirement: as required/indicated.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Tamper switch.
- .4 Mounting: wall or ceiling.
- .2 Glass break detector: ULC approved, complete with tamperproof switch and be designed to meet temperature and mounting requirements of project.
 - .1 Coverage pattern: as required/indicated.
- .3 Dual passive infrared and microwave: ULC approved, complete with tamperproof switch, and be designed to meet temperature and mounting requirements of project.
 - .1 Coverage pattern: as required/indicated.
- .4 Contacts : ULC approved.
 - .1 Mounting: surface.
 - .2 Mounting locations: door, window, or overhead door.
 - .3 Operating gap: 9.5 mm.
 - .4 Security level: [high security] [biased].
 - .5 Type: magnetic [biased] [balanced].
- .5 Vibration or shock sensors: as required/indicated.
- .6 Photo electric beams: as required/indicated.
- .7 Notification devices:
 - .1 Siren: 15 watt.
 - .2 Speaker complete with driver voice annunciator.
- 2.1.4 Communications: telephone line digital dialer.
- 2.1.5 Environmental monitoring: design system for detection of smoke/heat, temperature humidity and flood.
- 2.1.6 Connectors and switches: to ULC-C634.
- 2.1.7 Power supplies: to ULC-S318 or UL 603.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3 EXECUTION

3.1 INSTALLATION

- .1 Install panels, intrusion detection system and components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.
- .2 Install panels, intrusion detection system and components secure to walls, ceilings or other substrates.
- .3 Install required boxes in inconspicuous accessible locations.
- .4 Conceal conduit and wiring.

3.2 FIELD QUALITY CONTROL

3.2.1 Perform verification inspections and test in the presence of Engineer.

- .1 Perform tests in accordance with Section 26 05 00 – General Electrical Requirements.
- .2 Provide necessary tools, ladders and equipment.
- .3 Ensure appropriate subcontractors, manufacturer's representatives and security specialists are present for verification.

3.2.2 Visual verification: objective is to assess quality of installation and assembly and overall appearance to ensure compliance with Contract Documents. Visual inspection to include:

- .1 Sturdiness of equipment fastening.
- .2 Non-existence of installation related damages.
- .3 Compliance of device locations with reviewed shop drawings.
- .4 Compatibility of equipment installation with physical environment.
- .5 Inclusion of all accessories.
- .6 Device and cabling identification.
- .7 Application and location of ULC approval decals.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 16 00
CH0032	INTRUSION DETECTION	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.3 Technical verification: purpose to ensure that all systems and devices are properly install and free of defects and damage. Technical verification includes:

- .1 Measurements of coverage patterns
- .2 Connecting joints and equipment fastening.
- .3 Compliance with manufacturer's specification, product literature and installation instructions.

3.2.4 Operational verification: purpose to ensure that devices and systems' performance meet or exceed established functional requirements. Operational verification includes:

- .1 Operation of each device individually and within its environment.
- .2 Operation of each device in relation with programmable schedule and or/specific functions.

3.3 ADJUSTING

- .1 Adjust all components for correct function.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION: 28 31 00.01
MULTIPLEX FIRE ALARM SYSTEM**

1 GENERAL 2

1.1 RELATED REQUIREMENTS..... 2

1.2 REFERENCES 2

1.3 ACTION AND INFORMATIONAL SUBMITTALS 2

1.4 CLOSEOUT SUBMITTALS..... 3

2 PRODUCTS..... 3

2.1 DESCRIPTION 3

2.2 SYSTEM OPERATION: SINGLE STAGE - SIGNALS ONLY 5

2.3 CONTROL PANEL..... 6

2.4 POWER SUPPLIES..... 7

2.5 INITIATING/INPUT CIRCUITS..... 7

2.6 ALARM OUTPUT CIRCUITS 8

2.7 AUXILIARY CIRCUITS 8

2.8 WIRING 8

2.9 MANUAL ALARM STATIONS..... 9

2.10 AUTOMATIC ALARM INITIATING DEVICES..... 9

2.11 AUDIBLE SIGNAL DEVICES 10

2.12 VISUAL ALARM SIGNAL DEVICES 10

2.13 END-OF-LINE DEVICES 10

2.14 REMOTE ANNUNCIATORS 10

2.15 GRAPHIC DISPLAY 10

2.16 AS-BUILT RISER DIAGRAM 10

2.17 ADDRESSABLE CONTROL/MONITOR MODULES 11

2.18 ISOLATION MODULES 11

2.19 ACCEPTABLE MANUFACTURERS 11

3 EXECUTION..... 11

3.1 INSTALLATION 11

3.2 FIELD QUALITY CONTROL 12

PROVINCE OF NEWFOUNDLAND AND LABRADOR

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96

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – General Electrical Requirements.
- .2 Section 26 05 21 – Wires and Electrical Cables (0 – 1000 V).
- .3 Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

1.2 REFERENCES

1.2.1 Government of Canada

- .1 National Building Code of Canada

1.2.2 Underwriter's Laboratories of Canada (ULC)

- .1 CAN/ULC-S524, Standard for the Installation of Fire Alarm Systems.
- .2 CAN/ULC-S526, Visible Signal Devices for Fire Alarm Systems, Including Accessories.
- .3 CAN/ULC-S527, Standard for Control Units for Fire Alarm Systems.
- .4 CAN/ULC-S528, Manual Stations for Fire Alarm Systems, Including Accessories.
- .5 CAN/ULC-S529, Smoke Detectors for Fire Alarm Systems.
- .6 CAN/ULC-S530, Heat Actuated Fire Detectors for Fire Alarm Systems.
- .7 CAN/ULC-S531, Standard for Smoke Alarms.
- .8 CAN/ULC-S537, Standard for the Verification of Fire Alarm Systems.

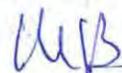
1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List.

1.3.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for multiplex fire alarm system and include product characteristics, performance criteria, physical size, finish and limitations.





Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3.3 Shop Drawings:

- .1 Indicate on shop drawings:
 - .1 Detail assembly and internal wiring diagrams for control units.
 - .2 Overall system wiring diagram identifying initiating zones, and signaling circuits; terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.

1.4 CLOSEOUT SUBMITTALS

- 1.4.1 Submit in accordance with Exhibit 4 – Supplier Document Requirements List..
- 1.4.2 Operation and Maintenance Data: submit operation and maintenance data for fire alarm system for incorporation into manual. Include:
 - .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
 - .4 List of recommended spare parts for system.

2 PRODUCTS

2.1 DESCRIPTION

- 2.1.1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- 2.1.2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to control room.
- 2.1.3 Zoned, non-coded single stage].

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.4** Modular in design to allow for future expansion.
- 2.1.5** Operation of system shall not require personnel with special computer skills.
- 2.1.6** System to include:
- .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
 - .2 Power supplies.
 - .3 Initiating/input circuits.
 - .4 Output circuits.
 - .5 Auxiliary circuits.
 - .6 Wiring.
 - .7 Manual and automatic initiating devices.
 - .8 Audible and visual signalling devices.
 - .9 End-of-line resistors if required.
 - .10 Local annunciator.
 - .11 Historic event recorder.
- 2.1.7** Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- 2.1.8** Power supply: to CAN/ULC-S524.
- 2.1.9** Audible signal devices: to CAN/ULC-S524.
- 2.1.10** Visual signal devices: to CAN/ULC-S526.
- 2.1.11** Control unit: to CAN/ULC-S527.
- 2.1.12** Manual pull stations: to CAN/ULC-S528.
- 2.1.13** Thermal detectors: to CAN/ULC-S530.
- 2.1.14** Smoke detectors: to CAN/ULC-S529.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.1.15 Smoke alarms: to CAN/ULC-S531.

2.1.16 Regulatory Requirements:

- .1 Subject to Provincial Fire Commissioner approval.
- .2 Subject to FC inspection for final acceptance.
- .3 Electrical inspection approval.
- .4 System components: listed by ULC and comply with applicable provisions of NBCC, and meet requirements of local authority having jurisdiction.

2.2 SYSTEM OPERATION: SINGLE STAGE - SIGNALS ONLY

2.2.1 Actuation of any alarm initiating device to:

- .1 Cause electronic latch to lock-in alarm state at central control.
- .2 Indicate zone of alarm at central control unit.
- .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
- .4 Transmit signal to fire control room.
- .5 Cause air conditioning and ventilation fans to shut down or to function to provide required control of smoke movement.
- .6 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .7 Cause elevators to return to floor of egress, or to alternate floor, as required.

2.2.2 Acknowledging alarm: indicated at central control unit.

2.2.3 Ensure that it is possible to silence signals by "alarm silence" switch at control unit, after 60 seconds period of operation.

2.2.4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.

2.2.5 Actuation of supervisory devices to:

- .1 Cause electronic latch to lock-in supervisory state at central control unit [and data gathering panel/transponder].

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Indicate respective supervisory zone at central control unit and at [remote annunciator] [display].
- .3 Cause audible signal at central control unit to sound.
- .4 Activate common supervisory sequence.

2.2.6 Resetting alarm or supervisory device not to return system indications/functions back to normal until control unit has been reset.

2.2.7 Trouble on system to:

- .1 Indicate circuit in trouble at central control unit.
- .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.

2.2.8 Trouble on system: suppressed during course of alarm.

2.2.9 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 CONTROL PANEL

2.3.1 Central control unit (CCU).

- .1 Suitable for DCLA communication style: to CAN/ULC-S524.
- .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
- .3 Minimum capacity of 250 addressable monitoring and 250 addressable control/signal points.
- .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
- .5 Integral power supply, battery charger and standby batteries.
- .6 Basic life safety software: retained in non volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (i.e. zone labels, priorities) and changing of system operation software.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
- .8 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating. Support up to 2 RS-232-C I/O ports. CCU output: parallel ASCII.
- .9 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
- .10 Software and hardware to maintain time of day, day of week, day of month, month and year.

2.4 POWER SUPPLIES

- 2.4.1 120 V, 60 Hz as primary source of power for system.
- 2.4.2 Voltage regulated, current limited distributed system power.
- 2.4.3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- 2.4.4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- 2.4.5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
- 2.4.6 Standby batteries: sealed, maintenance free.
- 2.4.7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

2.5 INITIATING/INPUT CIRCUITS

- 2.5.1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLA configuration to central control unit.
- 2.5.2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.
- 2.5.3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.5.4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA configuration to central control unit.

2.5.5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

2.6 ALARM OUTPUT CIRCUITS

2.6.1 Alarm output circuit: connected to signals, wired in class B configuration to central control unit.

.1 Signal circuits' operation to follow system programming; capable of sounding horns] continuously]. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.

.2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.7 AUXILIARY CIRCUITS

2.7.1 Auxiliary contacts for control functions.

2.7.2 Actual status indication (positive feedback) from controlled device.

2.7.3 Alarm on system to cause operation of programmed auxiliary output circuits.

2.7.4 2 sets of separate contacts for elevator capture to main floor of egress and to alternate floor of egress.

2.7.5 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.

2.7.6 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system.

.1 Timing circuit: controlled by CCU.

2.7.7 Auxiliary circuits: rated at 2 A, 24 Vdc or 120 Vac, fuse-protected.

2.8 WIRING

2.8.1 Multi-conductor cable assemblies with dedicated bonding wire CSA FAS 105 and FT4 rated. Standard of Acceptance: Nexans Securex II.

2.8.2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8.3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.

2.8.4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

2.8.5 Fire alarm cables to be run in EMT conduit unless indicated otherwise.

2.9 MANUAL ALARM STATIONS

2.9.1 Addressable manual pull station.

- .1 Pull lever, break glass rod, surface or semi-flush wall mounted type, single action, single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.10 AUTOMATIC ALARM INITIATING DEVICES

2.10.1 Heat detectors, fixed temperature, non- restorable, rated 57 degrees C.

2.10.2 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 degrees C, rate of rise 8.3 degrees C per minute.

- .1 Electronics to communicate detector's status to addressable module/transponder.
- .2 Detector address to be set on detector in field.

2.10.3 Addressable smoke detector.

- .1 Ionization and photo-electric type.
- .2 Electronics to communicate detector's status to addressable module/transponder.
- .3 Detector address to be set on detector in field.

2.10.4 Addressable variable-sensitivity smoke detectors.

- .1 Ionization and photo-electric] type. Electronics to communicate detector's status to addressable module/transponder.
- .2 Detector address to be set on detector in field.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Sensitivity settings: 3 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
- .4 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.

2.11 AUDIBLE SIGNAL DEVICES

- 2.11.1 Horns: 94 db, semi-flush mounted in finished areas, 24 V dc.
- 2.11.2 Exterior horns to be weatherproof design, mounted in PVC yard hood.

2.12 VISUAL ALARM SIGNAL DEVICES

- 2.12.1 Strobe type: flashing white, 24 V dc.
- 2.12.2 Designed for surface mounting on [ceiling] [walls] [as indicated].
- 2.12.3 Semi-flush mounted in finished areas.

2.13 END-OF-LINE DEVICES

- 2.13.1 End-of-line devices to control supervisory current in signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel.

2.14 REMOTE ANNUNCIATORS

- 2.14.1 LCD remote type annunciator providing information similar to that on control panel display. Locate as indicated.

2.15 GRAPHIC DISPLAY

- 2.15.1 Provide passive graphic display, to be mounted adjacent to the main fire alarm control panel. Plastic laminate type, black artwork on white background; approximate size: 600x600 mm.

2.16 AS-BUILT RISER DIAGRAM

- 2.16.1 Fire alarm system riser diagram: in glazed frame minimum size 600 x 600 mm.
- 2.16.2 Provide complete riser diagram indicating all devices in relative position on communications loop. Indicate each device location by grid reference and room name.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.16.3 Locate riser diagram in electrical room.

2.17 ADDRESSABLE CONTROL/MONITOR MODULES

2.17.1 Addressable modules with address set in the field for control/monitoring of external circuits.

2.17.2 Applications: ventilation unit shut down, sprinkler device monitoring

2.18 ISOLATION MODULES

2.18.1 Isolation modules for segmenting of fire detecting loops if required.

2.19 ACCEPTABLE MANUFACTURERS

2.19.1 Acceptable manufacturers shall be:

- .1 Mircom
- .2 Simplex Grinnell
- .3 Edwards
- .4 Notifier

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install systems in accordance with CAN/ULC-S524.

3.1.2 Run all fire alarm wiring in conduit.

3.1.3 Install central control unit and connect to ac power supply, standby power.

3.1.4 Install manual alarm stations and connect to alarm circuit wiring.

3.1.5 Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

3.1.6 Connect alarm circuits to main control panel.

3.1.7 Install horns and visual signal devices and connect to signalling circuits.

3.1.8 Connect signalling circuits to main control panel.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.1.9** Install end-of-line devices at end of signalling circuits.
- 3.1.10** Install remote annunciator panels if required and connect to annunciator circuit wiring.
- 3.1.11** Install door releasing devices if required.
- 3.1.12** Install remote relay units to control fan shut down.
- 3.1.13** Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- 3.1.14** Room detection system.
- .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals and visual alarms.
 - .3 Connect fire suppression systems to control panel.
- 3.1.15** Splices are not permitted.
- 3.1.16** Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- 3.1.17** Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- 3.1.18** Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- 3.2 FIELD QUALITY CONTROL**
- 3.2.1** Perform tests in accordance with Section 26 05 00 - General Electrical Requirements and CAN/ULC-S537.
- 3.2.2** Fire alarm system:
- .1 Test such device and alarm circuit to ensure manual stations, thermal and smoke detectors and sprinkler system transmit alarm to control panel and actuate [general alarm and ancillary devices.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of systems.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 28 31 00.01
CH0032	MULTIPLEX FIRE ALARM SYSTEM	Rev: D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Addressable circuits system style DCLA:

.1 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

.2 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**SECTION 33 56 13
ABOVEGROUND FUEL STORAGE TANKS
TABLE OF CONTENTS**

PART 1 GENERAL2

 1.1 RELATED REQUIREMENTS.....2

 1.2 REFERENCES.....2

 1.3 ACTION AND INFORMATIONAL SUBMITTALS3

PART 2 PRODUCTS.....5

 2.1 CONCRETE ENCASED STEEL ABOVEGROUND FUEL OIL STORAGE TANK
 (DOUBLE WALL).....5

 2.2 DOUBLE WALL DAY TANK9

 2.3 GROUNDING AND BONDING13

 2.4 FOOT VALVE.....13

 2.5 METALLIC PIPING, VALVES, AND FITTINGS.....13

PART 3 EXECUTION13

 3.1 INSTALLATION.....13

 3.2 FIELD QUALITY CONTROL.....14

 3.3 TOUCH-UP.....14

 3.4 LEVEL GAUGE SYSTEM.....14

 3.5 LEAK DETECTION SYSTEM14

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To practice Professional Geoscience
in Newfoundland and Labrador.
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		
		505573-3321-45EG-0001

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 11 13 – Facility Fuel-Oil piping
- .2 Section 23 11 14 – Fuel Storage Tank Electronic Monitoring Systems.
- .3 Section 26 05 00 – General Electrical Requirements.
- .4 Section 26 05 28 – Grounding – Secondary.

1.2 REFERENCES

- 1.2.1 American National Standards Institute (ANSI):
 - 1.2.1.1 ANSI/NFPA-329, Handling Underground Releases of Flammable and Combustible Liquids.
 - 1.2.1.2 ANSI/API 650, Welded Steel Tanks for Oil Storage.
- 1.2.2 American Petroleum Institute (API):
 - 1.2.2.1 API STD 653, Tank Inspection, Repair, Alteration, and Reconstruction.
- 1.2.3 Canadian Council of Ministers of the Environment (CCME):
 - 1.2.3.1 CCME-PN1326, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.
- 1.2.4 Department of Justice Canada (Jus):
 - 1.2.4.1 Canadian Environmental Protection Act,(CEPA).
- 1.2.5 Canadian Standards Association (CSA)/CSA International:
 - 1.2.5.1 CAN/CSA-B139, Installation Code for Oil Burning Equipment.
- 1.2.6 The Master Painters Institute (MPI):
 - 1.2.6.1 Architectural Painting Specification Manual.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 1.2.7 Nalcor Energy Engineering Directive # CF-ED-004 – Diesel System Installation and Abandonment Engineering Directive.
- 1.2.8 National Research Council/Institute for Research in Construction:
 - 1.2.8.1 NRCC 38727, National Fire Code of Canada (NFC).
 - 1.2.9 Newfoundland and Labrador:
 - 1.2.9.1 Regulation 58/03, Storage and Handling of Gasoline and Associated Products Regulations.
 - 1.2.10 Transport Canada (TC):
 - 1.2.10.1 Transportation of Dangerous Goods Act (TDGA).
 - 1.2.11 Underwriters' Laboratories of Canada (ULC):
 - 1.2.11.1 ULC/ORD. C 142.5 "Concrete Encased Steel Aboveground Tank Assemblies for Flammable and Combustible Liquids".
 - 1.2.11.2 ULC-S601, Aboveground Horizontal Shop Fabricated Steel Tanks.
 - 1.2.11.3 CAN/ULC-S602, Aboveground Steel Tanks for Fuel Oil and Lubricating Oil.
 - 1.2.11.4 CAN/ULC – S653 "Aboveground Steel Contained Tank Assemblies for Flammable and Combustible Liquids".
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS**
 - 1.3.1 Submit shop drawings in accordance with Exhibit 4 – supplier Document Requirements List.
 - 1.3.2 Indicate details of construction, appurtenances, installation, and leakage detection system.
 - 1.3.3 Shop drawings to detail and indicate following as applicable to project requirements. Submit manufacturers product data to supplement shop drawings.
 - 1.3.3.1 Size, materials and locations of ladders, ladder cages, catwalks and lifting lugs.
 - 1.3.3.2 Tank capacity, size and location of fittings.
 - 1.3.3.3 Environmental compliance package accessories.
 - 1.3.3.4 Decals, type size and location.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.3.5 Accessories: provide details and manufacturers product data.
- 1.3.3.6 Size, material and location of manholes.
- 1.3.3.7 Size, materials and locations of railings, stairs, ladders and walkways.
- 1.3.3.8 Finishes.
- 1.3.3.9 Electronic accessories: provide details and manufacturers product data.
- 1.3.3.10 Insulation types, locations and RSI values.
- 1.3.3.11 Piping, valves and fittings: type, materials, sizes, piping connection details, valve shut-off type and location.
- 1.3.3.12 Anchors: description, material, size and locations.
- 1.3.3.13 Level gauging: type and locations.
- 1.3.3.14 Ancillary devices: provide details and manufacturer's product data.
- 1.3.3.15 Leak detection system, type and locations, and alarm system.
- 1.3.3.16 Grounding and bonding: provide details of design, type, materials and locations.
- 1.3.3.17 Corrosion protection: provide details of design, type, materials and locations.
- 1.3.3.18 Field-erected AST overfill-protection systems: provide details of design, type, materials and locations.
- 1.3.3.19 Containment system for spills and overfills: provide details, materials used, and locations.
- 1.3.4 Provide maintenance data for tank appurtenances and leakage detection system for incorporation into manual specified in Exhibit 4 – Supplier Document Requirements List.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 2 PRODUCTS

2.1 CONCRETE ENCASED STEEL ABOVEGROUND FUEL OIL STORAGE TANK (DOUBLE WALL)

- 2.1.1 Provide packaged, factory fabricated and tested fuel oil storage tank, as specified.
- 2.1.2 Fuel oil storage tank and fuel transfer piping shall meet the requirements of Newfoundland and Labrador Regulation 58/03, Storage and Handling of Gasoline and Associated Products Regulations, CCME and National Fire Code.
- 2.1.3 Tank shall be tested and listed in accordance with the following:
 - 2.1.3.1 UL-142, aboveground steel tanks for flammable and combustible liquids.
 - 2.1.3.2 UL-2085, two-hour furnace fire test and two hour simulated pool fire test for insulated and protected tanks.
 - 2.1.3.3 UL-2085 and UFC test Standard (Article 79 or Appendix # A-II-F-1, for both Vehicle Impact Protection and Projectile Resistance).
 - 2.1.3.4 UL-2085, Protected aboveground tanks for flammable and combustible liquids.
 - 2.1.3.5 UL-2085, Non-Metallic Secondary Containment protected tanks for flammable and combustible liquids with secondary containment Emergency Venting by "Form of Construction".
 - 2.1.3.6 CAN/ULC – S601 (ORD – 142.18), Standard for shop fabricated steel aboveground horizontal tanks for flammable and combustible liquids.
 - 2.1.3.7 CAN/ULC – S655 (ORD – C 142.16) standard for protected aboveground tank assemblies for flammable and combustible liquids.
 - 2.1.3.8 CAN/ULC – (ORD – C 142.5), Standard for concrete encased aboveground tank assemblies for flammable and combustible liquids.
 - 2.1.3.9 CAN/ULC – (ORD – C 142.16), the furnace burn requirements for two hour fire rating.
 - 2.1.3.10 CAN/ULC – (ORD – C 142.25), the open (pool) fire testing for two-hour flammable liquid fire test.
 - 2.1.3.11 CAN/ULC – (ORD – C 142.23), for aboveground tanks for used oil.
 - 2.1.3.12 The requirement for Uniform Fire Code (UFC) for two-hour (firewall) test.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.3.13 To be tested and certified by the California Air Resources Board (CARB) for Balance Phase 1 and Phase II Vapor Recovery including methanol and ethanol.
- 2.1.3.14 High Explosive (HE) Blast Resistance: The tank system design shall be the subject of a Blast Effects Analysis (BEA) for resistance under the following blast load scenarios:
 - 2.1.3.14.1 22.7 kg HE man-portable improvised explosive device (MPIED) at the standoff distance of 1.52 meters.
 - 2.1.3.14.2 227 kg HE vehicle-born improvised explosive device (VBIED) at the standoff distance of 6.1 meters.
- 2.13.14.3 A vapor cloud explosive (VCE) with a load of 68.95 kPa.
- 2.13.14.4 The BEA shall conclude that the tank system will resist the explosive loads and remain intact, without failure of the primary tank or expectation of leakage. Movement of the tank shall not exceed 50 mm. The engineering consultants performing the BEA shall be a nationally recognized firm with over 10 years' experience offering comprehensive services related to blast and impact effects analysis, explosive safety design, vulnerability assessments and threat mitigation.
- 2.1.4 Tank Construction:
 - 2.1.4.1 The primary steel tank shall be rectangular in shape and have continuous welds on all exterior seams, manufactured in accordance with UL listing requirements and UL standard 142.
 - 2.1.4.2 The primary steel tank shall be pressure tested at 34.5 kPa for 24 to 48 hours.
 - 2.1.4.3 The primary steel tanks shall have normal and emergency vent system as per NFPA 30 Code Requirements and National Fire Code Requirements.
 - 2.1.4.4 The protected and insulated AST system shall have a thru-tank leak detector tube to allow for physical checkup monitoring capability between the primary and the secondary containment. The leak detector tube shall be capable of accepting an interstitial leak detection sensor from the fuel storage tank electronic monitoring system specified in section 23 11 14. – Fuel Storage Tank Electronic Monitoring Systems.
 - 2.1.4.5 The primary steel tank shall be pressurized at 34.5 kPa during concrete encasement.
 - 2.1.4.6 The outer surface of the primary steel tank shall be covered by a minimum of 6.4mm thick Styrofoam insulation panels.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 2.1.4.7 The secondary containment shall be impervious to corrosion, including damage or failure due to microbial infestation. The secondary containment shall consist of a 0.76mm thick High-Density Polyethylene membrane enclosing the steel tank and insulation material.
- 2.1.4.8 The primary steel tank and the secondary containment shall be encased in 150mm monolithic reinforced concrete, with minimum design strength of 27.5 and 34.5 MPa at 28 days depending on the tank size. The concrete design shall include the following for long-term durability: air entertainment, water reducing admixture, and steel reinforcement. Concrete encasements with seams will not be approved.
- 2.1.4.9 The protected and insulated AST system shall be of concrete exterior and a continuous and visually verifiable monolithic pour on top, bottom, ends, and sides and contain no cold joints or heat sinks. The AST must be shop fabricated and tested in accordance with the UL listing.
- 2.1.4.10 No steel or insulating material shall come in contact with the concrete or other corrosive material.
- 2.1.4.11 All openings shall be from the top only.
- 2.1.4.12 All exposed metal with the exception of stainless steel must be powder coated to inhibit corrosion.
- 2.1.4.13 The protected and insulated AST system shall include a 56.7 liter powder coated or stainless steel, UL listed spill containment sump, and shall include a normally closed valve to release spilled product into the primary steel tank. Spill containment which routes the spilled product into the interstitial area will not be approved. Containment sump shall be designed, built and approved in conformance with ORD C 107.21 – Under Dispenser Sumps. Spill containment shall also include a fill port with a tight fitting, locking fill cap. Fill port shall be equipped for attachment of a liquid/vapor tight connection when filling.
- 2.1.4.14 The protected and insulated AST system shall have a coated concrete exterior to resist weather and reflect sunlight.
- 2.1.4.15 The protected and insulated tank system shall be warranted by the manufacturer against defects in material or workmanship for 30 years following the delivery of the tank.
- 2.1.4.16 The protected and insulated AST systems design shall have been in use for a minimum of twenty (20) years.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 2.1.4.17 The protected and insulated AST system shall have two (2) bolts for connecting grounding conductors for lightning protection in accordance with NFPA 780 and the National Fire Code of Canada.
- 2.1.4.18 Tank shall be equipped with an overfill protection device suitable for aboveground fuel oil storage tanks supplied under pressure by hose and nozzle from a fuel oil pumper truck. Device shall be in accordance with CCME and ORDC 58.15 "Overfill Protection Devices for Flammable Liquid Storage Tanks".
- 2.1.4.19 Tank shall be suitable for and shall be equipped with monitoring ports for electronic fuel oil leak detection of the interstitial space and shall include a nipple suitably sized to accept a magnestrictive probe for level sensing and inventory control. Tank shall also be equipped with a separate port for the level sensing switch as monitored by the duplex pumping system. This port shall accept a 2" Male NPT fitting.
- 2.1.4.20 Liquid shall be able to be removed from the interstitial space.
- 2.1.4.21 Tank shall come equipped with a foot valve, drop tube and electric solenoid valve. The solenoid valve shall be controlled along with the duplex fuel oil pumping package by the liquid level in the fuel oil day tank located in the spillway generator building.
- 2.1.5 Accessories:
 - 2.1.5.1 Access stair/platform c/w handrail for filling and inspection of tank.
 - 2.1.5.2 Level gauge.
 - 2.1.5.3 Emergency vent.
 - 2.1.5.4 Dipstick and gauge chart. Dipstick to be tank mounted in lockable enclosure.
 - 2.1.5.5 Lifting lugs.
 - 2.1.5.6 Pipe support brackets on ends and top of tank.
 - 2.1.5.7 600mm diameter inspection manway.
 - 2.1.5.8 Normal vent.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.1.6 Capacity:
- 2.1.6.1 Tank shall be sized for three (3) days operation of a 600kv diesel generator at prime running power 75% load.
- 2.1.6.2 Storage volume shall be 11,370 liters minimum.
- 2.1.7 Dimensions/Weight:
- 2.1.7.1 Length: 3429mm.
- 2.1.7.2 Width: 2438mm.
- 2.1.7.3 Height: 2222mm.
- 2.1.7.4 Weight (dry): 16136 kg.
- 2.1.8 Acceptable manufacturers: Convault 3000 LP or approved equal.

2.2 DOUBLE WALL DAY TANK

- 2.2.1 General:
- 2.2.1.1 Summary:
- 2.2.1.1.1 These specifications describe requirements for a fuel day tank system consisting of an indoor fuel tank and an Electronic Control module (ECM) to monitor the fuel level within the day tank. The fuel day tank system shall monitor the fuel level and provide alarms where specified within. The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions of the site. It shall include all equipment to safely support the full demands of the generator set and be designed for unattended operation.
- 2.2.1.2 Codes and Standards:
- 2.2.1.2.1 The fuel day tank and all associated equipment and components shall be manufactured in accordance with the following applicable standards:
 - 2.2.1.2.1.1 UL-142 Aboveground Flammable Liquid Tanks.
 - 2.2.1.2.1.2 CAN/ULC-S601-07 Steel Aboveground Tanks for Flammable Combustible Liquids.
 - 2.2.1.2.1.3 UL-508 Industrial Control Equipment (ECM).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- 2.2.1.2.1.4 American Welding Society (AWS) – Welders certified AWS standards D 1.1 / D 1.1M.
- 2.2.1.2.1.5 The day tank and all associated equipment and component shall be in accordance with CSA B139, and NFCC.
- 2.2.1.3 Manufacturer shall warrant material and workmanship for a minimum of 1 year from date of shipment.
- 2.2.2 Size:
 - 2.2.2.1 Tank shall be sized for 8 hours operation of the generator set at standby 75% load rating. Refer to specification Section 23 32 13.04 – Diesel Electric Generating Units (Liquid Cooled) for Generator Details.
 - 2.2.2.2 Capacity: 1325 Litres minimum.
- 2.2.3 Construction:
 - 2.2.3.1 Fuel Day Tank shall be made of heavy gauge steel construction. Tank shall include welded steel top cover. Tank shall be coated with rust inhibitor within the inner tank, primed and finish painted on the external tank. The installing contractor shall provide schedule 40, ASTM A 53, black iron pipe connections to the day tank fittings. All connections to be made with pipe union to facilitate tank service/removal. The tank shall include at a minimum the following fittings:
 - 2.2.3.1.1 1" NPT generator supply.
 - 2.2.3.1.2 1" NPT generator return.
 - 2.2.3.1.3 NPT fitting for emergency vent, sized per the requirements of NFPA 30 and UL-142/ULC-S601.
 - 2.2.3.1.4 1" NPT Overflow. (Return to main tank).
 - 2.2.3.1.5 2" NPT normal vent.
 - 2.2.3.1.6 4 ½ square inspection port with manual fuel level gauge and manual fill cap.
 - 2.2.3.1.7 1" NPT basin drain.
 - 2.2.3.1.8 1" NPT fuel oil inlet from main tank.
 - 2.2.3.1.9 Day tank shall have a drop tube for generator supply connection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 2.2.3.1.4 Day tank shall be equipped with two ports to each except a 2" MNPT fitting for the level control switches that control the duplex pumping system.
- 2.2.3.2 The tank shall be provided with atmospheric (normal) vent cap with screen and emergency pressure relief vent sized per the requirements of NFPA 30 and UL 142 / ULC S601.
- 2.2.3.2.1 Emergency vent cap shall be spring-pressure operated. Opening Pressure shall be 3.45kPa: full opening pressure 17.2 kPa. Flow rate shall be marked on top of each vent.
- 2.2.4 Design Requirements:
- 2.2.4.1 Fuel Day Tank Control and Status Display:
- 2.2.4.1.1 The microprocessor-based electronic control module (ECM) shall be supplied with the tank. The day tank fuel level control shall be completed by level sensing devices supplied with the duplex pumping system. The day tank ECM shall indicate fuel level and alarms only. The ECM shall receive a signal from a single electrical analog float sensor. The ECM shall be provided with the following indication: fuel level, alarm, function and existing warning and shutdown conditions and be located within a Type 1 zinc-plated enclosure for indoor use. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. All warnings shall be provided with normally open and normally closed, dry contacts for remote annunciation.
- 2.2.4.1.2 The following alarm and status conditions are required as a minimum:
- 2.2.4.1.2.1 Fuel Level Display.
 - 2.2.4.1.2.1.1 Full – 100% Green LED Indicator.
 - 2.2.4.1.2.1.2 95% - Green LED Indicator.
 - 2.2.4.1.2.1.3 85% - Green LED Indicator.
 - 2.2.4.1.2.1.4 75% - Yellow LED Indicator.
 - 2.2.4.1.2.1.5 50% - Yellow LED Indicator.
 - 2.2.4.1.2.1.6 25% - Yellow LED Indicator.
 - 2.2.4.1.2.1.7 10% - Yellow LED Indicator.
 - 2.2.4.1.2.1.8 Empty – 6% - Red LED Indicator.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

2.2.4.1.3 Alarm Display:

2.2.4.1.3.1.1 High Fuel – 106% or greater capacity.

2.2.4.1.3.1.2 Low Fuel – 62% of Capacity.

2.2.4.1.3.1.3 Critical Low Fuel – 6% of Capacity.

2.2.4.1.3.1.4 Fuel within containment.

2.2.4.1.3.1.5 ECM Functional – Tank Fault.

2.2.4.1.3.2 Function Display:

2.2.4.1.3.2.1 Power on – This button activates the ECM after the Off button has been depressed. On any initial power up condition, after a power outage, the ECM shall be in an on condition.

2.2.4.1.3.3 Remote Contact Connections.

2.2.4.1.2.4.1 Tank Fault (ECM Functional)/Fuel in Containment (Shared) / Loss of Power.

2.2.4.1.2.4.2 Critical High Fuel – 106% or greater capacity.

2.2.4.1.2.4.3 Pump Running Option – Indicating supply pump is in operation.

2.2.4.1.2.4.4 High Fuel – 106% if capacity.

2.2.4.1.2.4.5 Low Fuel – 62% of capacity.

2.2.4.1.2.4.6 Critical Low Fuel – 6% of capacity.

2.2.4.1.2.4.7 Pump control for remote mounted pumps.

2.2.4.1.2.4.8 Shut down of remote mounted pumps at 90% of capacity.

2.2.4.1.2.5 Mode:

2.2.4.1.2.5.1 On – Power available to ECM.

2.2.4.1.2.5.2 Off – Turns off power with ECM.

2.2.4.1.2.6 Start-up test switch shall test contacts for high, low, critical low, ECM functional and containment switch to assure wiring of remote contacts is correct.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.5 Fuel Containment:

2.2.5.1 The fuel day tank shall include a welded steel containment basin to prevent escape of fuel in the event of a tank rupture, sized at a minimum of 150% of the tank capacity. The basin shall be primed and finish painted.

2.2.5.1.1 Containment Basin:

2.2.5.1.1.1 The containment basin shall consist of a welded heavy gauge steel structure. The containment tank shall feature a welded steel top with an emergency pressure relief vent sized per the requirements of NFPA 30, UL 142 / ULC S601 and NFC. Emergency vent cap shall be spring-pressure operated. Opening pressure shall be 3.45 kPa; full opening pressure shall be 17.2 kPa. Limits shall be marked on top of each vent. Leak detection switch shall be wired into the electronic control module (ECM). This shall indicate an alarm condition and will shut down the remote supply pump(s) in case of a fuel leak into the containment basin.

2.2.6 Acceptable manufacturers: Tramont TRS or approved equal. Provide day tank package with control panel and without integral pump.

2.3 GROUNDING AND BONDING

2.3.1 Provide grounding for tank.

2.3.2 To Section 26 05 28 – Common Grounding - Secondary.

2.4 FOOT VALVE

2.4.1 To be provided within main tank and day tank.

2.4.2 As specified in Specification Section 23 11 13 – Facility Fuel-Oil Piping.

2.5 METALLIC PIPING, VALVES, AND FITTINGS

2.5.1 In accordance with Section 23 11 13 – Facility Fuel-Oil Piping.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Install main and day tank and all piping, fittings, accessories and associated systems in accordance with Nalcor Engineering Directive and National Fire Code of Canada, CCME, CSA B139 (as applicable), Newfoundland and Labrador Regulation 58/03, Storage and Handling of Gasoline and Associated

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 33 56 13
CH0032	ABOVEGROUND FUEL STORAGE TANKS	Rev : D2
Powerhouse and Spillway Hydro-Mechanical Equipment		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

Products Regulations, provincial regulations and manufacturer's recommendations.

3.1.2 Position tank(s) using lifting lugs and hooks, and where necessary use spreader bars. Do not use chain in contact with tank walls.

3.1.3 Provide all registrations and permits as required by Provincial regulations.

3.1.4 All tank venting shall terminate outside the building and in accordance with CCME, NFC, CSA B139 and CNRL 58/03.

3.2 FIELD QUALITY CONTROL

3.2.1 Test tank(s) in accordance with Newfoundland and Labrador Regulation 58/03, Storage and Handling of Gasoline and Associated Products Regulations.

3.2.2 Test tank(s) for leaks to requirements of authority having jurisdiction and in presence of authority having jurisdiction.

3.2.3 Commission in accordance with Section 26 05 00-General Electrical Requirements.

3.3 TOUCH-UP

3.3.1 Where coating is damaged touch-up original coating material.

3.4 LEVEL GAUGE SYSTEM

3.4.1 Provide leak and vapour proof caulking at connections.

3.4.2 Calibrate system.

3.5 LEAK DETECTION SYSTEM

3.5.1 Install in accordance with manufacturer's recommendations. Refer to specification Section 23 11 14 – Fuel Storage Tank Electronic Monitoring Systems.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

TABLE OF CONTENTS
SECTION 48 13 10
GENERAL MECHANICAL REQUIREMENTS



PART 1	GENERAL		3
1.1	DESCRIPTION AND SCOPE OF WORK	PROVINCE OF NEWFOUNDLAND AND LABRADOR	3
1.2	DEFINITIONS	PERMIT HOLDER	3
1.3	ABBREVIATIONS	This Permit Allows	4
1.4	DOCUMENTATION	SNC-LAVALIN INC.	6
1.5	RESPONSIBILITY		6
1.6	ENGINEERING CERTIFICATION	To practice Professional Geoscience in Newfoundland and Labrador	7
PART 2	DESIGN REQUIREMENTS	Permit No. as issued by PEGNL No 452 which is valid for the year 2013	7
2.1	APPLICABLE STANDARDS		7
2.2	HYDRAULIC DATA AND GENERAL DIMENSIONS		8
2.3	DESIGN LIFE		11
2.4	ALLOWABLE STRESSES AND DEFLECTIONS		11
2.5	CLIMATIC DESIGN CRITERIA		12
2.6	NOISE LEVEL		12
2.7	MAINTENANCE		12
2.8	EQUIPMENT LOCKOUT AND ISOLATION		13
2.9	INTERCHANGEABILITY		13
2.10	PACKAGING AND TRANSPORT		13
2.11	NAMEPLATES, EQUIPMENT MARKING and TAGGING		14
2.12	SPARE PARTS		15
2.13	CONSENTS, AUTHORIZATION AND PERMITS		16
2.14	INTERFACES AND COORDINATION		16
2.15	SCHEDULING AND PLANNING		17
2.16	LOGISTICS		17
2.17	COMPANY SUPPLIED ITEMS		18
2.18	INSTALLATION CONSTRAINTS		18
2.19	ELECTRICAL REQUIREMENTS		18

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 3 ENGINEERING 18

3.1 ENGINEERING - GENERAL 18

3.2 NOT USED 19

3.3 SYSTEM ENGINEERING 19

3.4 DETAILED ENGINEERING 20

3.5 NOT USED 21

PART 4 STORAGE, PRESERVATION AND PREPARATION 21

4.1 STORAGE SECURITY AND PROTECTION 21

4.2 PRESERVATION AND MAINTENANCE 22

4.3 PREPARATION FOR TRANSPORTATION 22

4.4 TRANSPORTATION OF EQUIPMENT 22

4.5 LIFTING DEVICES FOR SHIPPING AND INSTALLATION 23

PART 5 MATERIALS, FABRICATION AND INSPECTION 23

5.1 MATERIALS 23

5.2 FABRICATION 24

5.3 INSPECTION 31

PART 6 INSPECTION AND VERIFICATION 36

6.1 INSPECTION 36

**PART 7 PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS
36**

PART 8 QUALITY MANAGEMENT 37

PART 9 HEALTH, SAFETY, ENVIRONMENT AND SECURITY 37

PART 10 APPENDIX A – EQUIPMENT NUMBERS 39

10.1 A1 INTRODUCTION 39

APPENDICES:

APPENDIX A – EQUIPMENT NUMBERS

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 DESCRIPTION AND SCOPE OF WORK

- 1.1.1 This specification details the general technical requirements for the supply and install of the Powerhouse and Spillway Hydro-Mechanical Equipment for the Muskrat Falls hydroelectric power station.
- 1.1.2 This document shall be read in conjunction with "Lower Churchill Project Muskrat Falls Hydroelectric Development – CH0032 - Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment - Scope of Work - MFA-SN-CD-2000-ME-SP-0001-01/505573-3321-45EW-0001", Part 2, Exhibit 1.

1.2 DEFINITIONS

1.2.1 Diversion Phase

- .1 The period during project construction that the river is diverted through the Spillway and maintained at the diversion headpond level, before the reservoir is impounded to full supply level for operation of the Powerhouse;

1.2.2 Full Supply Level (FSL)

- .1 Operating reservoir level;

1.2.3 Diversion Headpond Level (DHL)

- .1 The reservoir water level that is maintained during the Diversion Phase while the facility is constructed;

1.2.4 Probable Maximum Flood (PMF)

- .1 The maximum flood the Muskrat Falls facility is designed for;

1.2.5 Tailwater Level (TWL)

- .1 The range of water levels in the river downstream of the facility;

1.2.6 Gate or Stoplog Orientation

- .1 With the water passage dewatered;
- .1 an upstream seal or skinplate is located on the wet side,
- .2 a downstream seal or skinplate is located on the dry side.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.3 ABBREVIATIONS

AAIST	Association for Iron and Steel Technology
ABMA	American Bearing Manufacturers Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISE	Association of Iron and Steel Engineers
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASD	Allowable Stress Design
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BHN	Brinell Hardness Number
CAD	Computer Aided Drafting
CCTV	Closed Circuit Television
CEMA	Canadian Electrical Manufacturer's Association
CGSB	Canadian Government Specifications Board
CMAA	Crane Manufacturers Association of America
COG	Center of Gravity
CP	Corrosion Protection
CRN	Change Request Notice
CSA	Canadian Standards Association
CWB	Canadian Welding Bureau
DHL	Diversion Headpond Level

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

DPR	Daily Progress Reports
EEMAC	Electrical and Electronic Manufacturers Association of Canada
FAT	Factory Acceptance Test
FMEA	Failure Mode and Effects Analyses
FSL	Full Supply Level
HDPE	High Density Polyethylene
HIRA	Hazard Identification Risk Assessment
HS&E	Health, Safety, and Environmental
IEEE	Institute of Electrical and Electronics Engineers
IRN	Inspection Release Note
ISO	International Organization for Standardization
IT	Information Technology
ITP	Inspection and Test Plan
LCP	Lower Churchill Project
LSD	Limit States Design
LSL	Low Supply Level
MCC	Mechanical Completion Certificate
MCITR	Mechanical Completion Inspection Test Records
MOC	Management of Change
MSDS	Material Safety Data Sheet
NBCC	National Building Code of Canada
NCR	Non-conformance Report
NDT	Non-Destructive Testing
NEMA	National Electrical Manufacturers Association

WIB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- NLOHS NL Occupational Health and Safety
- NPT National Pipe Thread
- OSHA Occupational Safety and Health Administration
- PHA Process Hazard Analysis
- PMF Probable Maximum Flood
- PTFE Polytetrafluoroethylene
- RAM Reliability and Maintainability
- RTD Resistance Temperature Detectors
- S.I. Systeme International
- SAE Society of Automotive Engineers
- SCM Supply Chain Management
- SDRL Contract Data Requirements List
- SIT System Integration Testing
- SSPC Steel Structures Painting Council
- USACE US Army Corp of Engineers

1.4 DOCUMENTATION

1.1 Documentation shall comply with Part 2, Exhibit 4 - Supplier Document Requirement List and as described below.



1.4.1 Not used.

1.5 RESPONSIBILITY



1.5.1 The specifications are not intended to describe in complete detail the methods of construction of the various parts of the work, and remains the responsibility of Contractor, to furnish equipment which shall meet the requirements of the Agreement.

1.5.2 Engineer has determined the general arrangement of the facility including water passage dimensions, the type and location of gates, their mode of operation, the first stage concrete blockout dimensions, and the type and general arrangement of the hoisting mechanisms, which shall not be modified.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.5.3 Contractor shall carry out final design of the equipment described in these Specifications and supply all necessary engineering for fabrication, erection and commissioning until final acceptance of equipment.

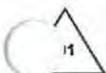
1.5.4 The design and fabrication, erection, testing, commissioning, and operation shall conform to the basic criteria, codes and standards described herein and shall not be modified without acceptance of Engineer.

1.5.5 The dimensions of pockets or slots provided in the first stage concrete and all other dimensions of the structure shall not be modified.

 **1.5.6** The location and the physical characteristics of the anchors placed in the first stage concrete shall be determined by Contractor and coordinated with the Engineer, and first stage (primary) concrete and reinforcing drawings before the first stage concrete anchor concept is finalized and Accepted by the Engineer.

 **1.5.7** Not used.

1.6 ENGINEERING CERTIFICATION

 **1.6.1** All design drawings and documents shall be sealed by a professional engineer registered in the Province of Newfoundland and Labrador.

1.6.2 All temporary installation electrical drawings shall be submitted for Engineer's review and Acceptance.

1.6.3 All design drawings and documents; for Site construction work, such as formwork, scaffolding, tooling and rigging, lift plans etc., for all permanent platforms/walkways/handrills, for all fall restraint/protection, for spillway towers, shall be sealed by a professional engineer who is a member of Newfoundland and Labrador Professional Engineers and Geoscientists Association.

PART 2 DESIGN REQUIREMENTS

2.1 APPLICABLE STANDARDS

2.1.1 Codes and Standards

.1 All Work shall be designed, manufactured, tested and supplied in accordance with the latest edition of all applicable Standards and Regulations listed in the relevant sections. In case of any conflict between Standards, such conflict shall be brought to the attention of Engineer for clarification and determination.

.2 Contractor shall be responsible for bringing to the attention of Engineer the impact of any subsequent revisions or published amendments to the referenced codes, standards and regulations, which have a bearing on execution of the Work.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 In addition, the layouts shall comply with any laws or regulations of local authorities, and in the event of conflicting requirements, the most stringent shall apply.

2.2 HYDRAULIC DATA AND GENERAL DIMENSIONS

2.2.1 Main Hydrologic and Hydraulic Parameters. The main hydrologic and hydraulic parameters used for the project are as follows:

- .1 Design Flow – Probable maximum flood: 25,060 m³/s
- .2 Reservoir level for PMF: El. 45.10 m
- .3 Reservoir Full Supply Level (FSL): El. 39.0 m
- .4 Reservoir Low Supply Level (LSL): El. 38.50 m
- .5 Reservoir level for landside generated wave (from FSL): El. 41.00 m
- .6 Reservoir level when overtopping North Dam (from FSL): El. 41.5 m
(at plant rated flow with Spillway Gates closed)
- .7 Diversion Phase reservoir Headpond Level (DHL) winter: El. 25.00 m
- .8 Diversion Phase reservoir Headpond Level (DHL) summer: El. 24.00 m
- .9 Minimum tailwater level: El. 1.44 m
- .10 Maximum normal Tailwater Level (TWL) (open water): El. 3.64 m
- .11 Maximum tailwater level (winter with ice cover): El. 7.00 m
- .12 Tailwater level for PMF: El. 12.28 m

2.2.2 Spillway Structure (River Diversion Phase)

- .1 Water passage width at gates: 10.50 m
- .2 Top of embedded guide's elevation: El. 45.50 m (nominal)
- .3 Furthest upstream Stoplog sill elevation: El. 5.00 m

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Upstream Stoplog sill elevation: Not Installed
- .5 Spillway Gate sill elevation: El. 5.00 m
- .6 Downstream Stoplog sill elevation: El. 4.10 m
- .7 Top of furthest upstream stoplogs elevation (DHL): El. 28.50 m
- .8 Top of furthest upstream stoplogs elevation (FSL): El. 40.95 m

2.2.3 Spillway Structure (Operation Phase)

- .1 Water passage width at Intake Gates: 10.50 m
- .2 Top of embedded guide's elevation: El. 45.50 m (nominal)
- .3 Upstream Stoplog sill elevation: El. 17.80 m
- .4 Spillway Gate sill elevation: El. 18.00 m
- .5 Downstream Stoplog sill elevation: El. 4.10 m
- .6 Top of upstream stoplogs elevation: El. 41.10 m
- .7 Top of Spillway Gate elevation: El. 41.00 m
- .8 Top of downstream stoplogs elevation: El. 15.00 m

2.2.4 Powerhouse Intake Structure

- .1 Number of turbine/generator units: 4
- .2 Number of intake hydraulic passages per unit: 3
- .3 Width of structure: 142.00 m
- .4 Unit spacing: 35.50 m
- .5 Deck elevation: El.45.50 m

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.6 Unit rated flow: 640 m³/s

2.2.5 Intake Trashracks

- .1 Width of hydraulic passages at trashrack: 7.05 m
- .2 Sill elevation: El.-2.20 m
- .3 Top of embedded guides elevation: El. 45.50 m
- .4 Velocity at gross area of trashracks: 1.1 m/s
- .5 Top of embedded guide's elevation: El. 45.50 m (nominal)

2.2.6 Intake Gates

- .1 Width of hydraulic passages at Intake Gates: 6.50
- .2 Sill elevation: El. -6.08 m
- .3 Top of embedded guide's elevation: El. 45.50 m (nominal)

2.2.7 Intake Bulkhead Gates

- .1 Width of hydraulic passages at bulkhead gates: 6.50
- .2 Sill elevation: El. -3.70 m
- .3 Top of embedded guide's elevation: El. 45.50 m (nominal)

2.2.8 Powerhouse Draft Tube Structure

- .1 Number of Draft Tube hydraulic passages per unit: 2
- .2 Width of hydraulic passages at stoplogs: 11.3125 m
- .3 Sill elevation: El. -27.45 m
- .4 Lintel elevation (J seal bulb centre): El. -17.08



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Top of embedded guide's elevation: El. 6.50 m (nominal)
- .6 Top of maintenance gallery elevation: El. 8.00 m (nominal)
- .7 Top of walkway elevation: El. 9.00 m (nominal)
- .8 Length of Draft Tube gallery 156.60 m
- .9 Powerhouse crane rail elevation El. 12.20 m
- .10 Crane rail centre distance 7.5 m

2.3 DESIGN LIFE

2.3.1 The hydro-mechanical equipment shall be conservatively designed to have the following minimum operating time before replacement:

- .1 Protection, control and remote control equipment 20 years
- .2 Ancillary mechanical and electrical systems 30 years
- .3 Hoists, structures, and major components 50 years

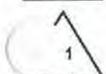
2.4 ALLOWABLE STRESSES AND DEFLECTIONS

2.4.1 General

- .1 Contractor shall be responsible for design of all components to the relevant standards, and prudent utility practice, for spillways and hydro-electric facilities but the following design criteria shall be used as a minimum guideline.
- .2 All design criteria in this document is based on Allowable Stress Design (ASD) methodology. If Contractor would like to use Limit States Design (LSD) methodology as an alternative to ASD for some or all the design work then Contractor shall submit a proposal for Acceptance by Engineer explaining for each component methodology and all design criteria, with justification demonstrating that the proposed methodology and criteria meets all this specifications intended requirements. The LSD shall be based on CSA S16, CSA W59 and NBCC.
- .3 Allowable stresses shall be based on the von Mises-Hencky criteria.



2.4.2 Not Used



2.4.3 Not Used

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.4.4 Not Used

2.5 CLIMATIC DESIGN CRITERIA

2.5.1 The following climatic data shall be used for the design of the Hydro-Mechanical Equipment unless indicated otherwise in the Technical Specifications.

	Air	Water
Temperature	Maximum: +40°C	Maximum: +25°C
	Minimum: -40°C	Minimum: 0°C
Humidity	100%	
Snow Load	2.5 kN/ m ²	
Ice Cover on Exposed Surface	25 mm thick	
Wind Velocity for Structure Design (max.)	130 km/h	

2.5.2 Other Climatological Data is included in Exhibit 11 Company Supplied Documents, for reference.

2.6 NOISE LEVEL

2.6.1 For permanently installed equipment such as hoist components, noise levels on individual equipment shall not exceed 80 dBA continuous (as opposed to impulsive noise or impact noise) measured at 1 meter from the equipment.



2.6.2 When multiple pieces of equipment producing high noise level are required to be in close proximity and the resulting combined noise levels are above 85 dBA, engineered noise reduction enclosures shall be required to reduce overall noise levels to the permissible level of 85 dBA. Attenuation measures shall be proposed including acoustic enclosures, signs and barriers to ensure noise exposure meets the requirements of the CCOHS for the jurisdiction of Newfoundland and Labrador.



2.7 MAINTENANCE

2.7.1 The design of the hydro-mechanical equipment shall be such that replacement and general maintenance may be undertaken with a minimum of time and expense.

2.7.2 The layout of equipment shall be such that for routine maintenance the inspection, lubrication, adjustments and light repairs can be performed without the need of special equipment/tools, scaffolding, person lifts, etc., or disassembly of other equipment/structures to gain access.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8 EQUIPMENT LOCKOUT AND ISOLATION

- 2.8.1 All devices that could conceivably be required to be isolated for maintenance, protection of personal, access to equipment etc. shall be designed to be lockable and that the lockable location itself is safe to access. All energy sources related to the equipment to be maintained shall designed to be isolated and locked out.
- 2.8.2 Every device capable of being isolated and locked out shall be capable of being locked with a standard size padlock or a standard size scissor clip even if the device has a built in key lock. Each of these lockout points shall be capable of supporting the weight of many pad locks and scissor clips.
- 2.8.3 Devices that do have built in locks shall be provided with 4 sets of keys.
- 2.8.4 Where a blocking device is required as part of the isolation and lockout of equipment this device shall be design to withstand 150% of any load that could inadvertently be applied to it.

2.9 INTERCHANGEABILITY

- 2.9.1 The components serving the same functions shall be interchangeable.
- 2.9.2 This interchangeability shall be possible without refinishing of the replacement elements.
- 2.9.3 All mechanical and electrical apparatus and accessories serving the same functions shall be purchased from the same manufacturer.

2.10 PACKAGING AND TRANSPORT

- 2.10.1 Packaging and transport shall comply with Documentation, Packaging, Marking and Shipping Instructions, GP-5500-FO-01-E, in Part 2, Exhibit 11 – Company Supplied Documents and as specified below.
- 2.10.2 Handling and shipping requirements shall be taken into account during the design, and the parts shall be reinforced using cross bracing in order to avoid deformation during shipping, handling and installation.
- 2.10.3 All machined surfaces shall be protected against inadvertent damage during shipping, handling and installation.
- 2.10.4 All machined carbon steel surfaces shall be coated with a suitable rust preventative.
- 2.10.5 The design of components shall be such that these components can be fabricated in sections which conform to the shipping requirements of the Ministry of Transport or those of the railway companies, whichever is applicable.
- 2.10.6 All components shall be suitably indentified to facilitate delivery, off loading and possible temporary storage at site.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.10.7 Small components being supplied and delivered for installation by Company's Other Contractor shall be crated with the part descriptions and quantities clearly indicated on the outside of the crate.

2.11 NAMEPLATES, EQUIPMENT MARKING AND TAGGING

2.11.1 General

- .1 All equipment including gates, stoplogs, trashrack panels; as well as ancillary equipment, such as electrical panels, junction boxes, doors, fans/heaters etc. shall be identified and labelled, and shall be provided with equipment numbers to be provided by Company.

2.11.2 Hoists and Ancillary Equipment

- .1 A nameplate shall be supplied for all hoisting equipment and mounted in a location Accepted by Engineer. The nameplate shall be easy to read and clearly show the following information:
 - .1 Contractor's name,
 - .2 Name or identification of equipment (to be provided by Company),
 - .3 Year of manufacture or installation,
 - .4 Rating particulars, hoisting limits, and general dimensions where applicable.
- .2 In addition for all traveling hoists the rated loads shall be displayed on the hoists and sheave blocks in large characters visible from both sides.
- .3 In addition to their nameplate all lifting beams and/or hook blocks shall have their Working Load Limit (WLL) displayed in large characters on both sides that are easily readable from the floor level or operating walkways.
- .4 All information and instructions shall be in English.
- .5 Hoist ratings shall be in metric tonnes and shall be spelled out in full on all devices.

2.11.3 Gates, Stoplogs, and Trashrack Nameplates

- .1 Nameplates shall be provided and attached to the gates, stoplogs and trashrack panels.
- .2 The nameplate shall be designed as follows:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

<p>(EQUIPMENT NAME/DESIGNATION) (Equipment Number) Weight _____ tonnes Serial No. _____ – Part No. _____ (Manufacturing Date) YYYY-MM</p>

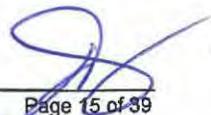
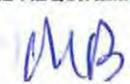
- .3 Equipment shall have equipment numbers as provided by the Engineer.
- .4 The nameplate shall be 0.5 mm stainless steel plates a minimum of 105 mm long by 60 mm high, with 4.5 mm high stamped lettering, and securely anchored to the equipment in a location that is easily accessible, but protected from damage due to operation or outside weather conditions when stored or when being transported.
- .5 Nameplate lists shall be submitted to the Engineer for review and acceptance prior to manufacture of the nameplates.
- .6 Where components must be installed in a specific order, the components shall be so identified with raised characters (by welding or bolted on) on the component side most likely to be visible to the installation crews, and the characters shall be a minimum of 150 mm high and painted to contrast the background.

2.11.4 Gates, Stoplogs and Trashrack Panel Marking

- .1 In addition to the above nameplate the component designation for all gates and stoplogs shall be painted on with stencils on the side of the component most likely visible during normal operation with 150 mm high characters.
- .2 For temporary equipment the designation, number, weight, installation sequence, and match mark lettering, shall be painted on with stencils using 150 mm high characters.

2.12 SPARE PARTS

- .1 Contractor shall provide, maintain, and replenish all required capital spares and agreed recommended spares as required for completion of the Work, including commissioning spares.
- .2 All spares as delivered to the Worksite shall be delivered to Company on completion of Work.
- .3 A complete list of recommended spares shall be provided by Contractor for Acceptance by Engineer prior to supply.
- .4 Required capital spares, as provided in accordance with the Technical Specification, shall be subject to replacement by Contractor at Contractor's sole cost should such capital spares be required for use in the completion of Work.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 All spare parts shall be interchangeable, with and of the same materials and quality, as the corresponding original parts as described in the specifications.
- .6 Spares shall be complete with instruction manuals for the equipment, and for installation of all spares and accessories.
- .7 All spare parts shall be suitably packaged and crated for long-term storage. Contractor shall provide storage instructions and an estimated shelf life for every part.
- .8 Any fasteners/seals/keepers etc. that are required for the installation of the spare shall be provided with the spares.

2.13 CONSENTS, AUTHORIZATION AND PERMITS

- .1 Contractor shall perform Work in compliance with the requirements of Exhibit 6 - Environment and Regulatory Compliance Requirements.
- .2 Contractor shall obtain and maintain all other authorizations, permits, dispensations, consents and licenses, required by Applicable Laws to enable it to perform the Work and which are required to be or can be obtained in Contractor's name.
- .3 In accordance with the Agreement, Contractor shall be responsible for customs clearance, import permits, Work validations, Work permits and operating licenses, and other requirements that are essential to the Work during all phases of the Work.

2.14 INTERFACES AND COORDINATION

- .1 Contractor shall, as part of the services related to interface management, manage and coordinate all interfaces both internally and externally with Engineer, Contractors, Subcontractors and Company's Other Contractors.
- .2 Contractor shall appoint a technical interface coordinator who shall be responsible for management of interface activities as the Contractor's focal point for interface coordination, communication, response, close out and reporting.
- .3 The Engineer and Contractor coordinators shall manage all hard and soft interfaces during execution of the Work.
- .4 Contractor shall establish a document control procedures defining how interface information is collected, maintained, tracked, controlled and documented.
- .5 Contractor shall also provide standard formats for documents regarding interface management.
- .6 Contractor shall be responsible for preparation and management of all interface documentation, including procedures, minutes of meetings, interface registers, datasheets and drawings.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.7 Contractor will ensure that interface management requirements outlined herein are included in all Subcontracts, such that the all interfaces provided by Subcontractors are properly coordinated.

2.15 SCHEDULING AND PLANNING

2.15.1 Contractor shall meet all planning and scheduling requirements for all Work in accordance with and as otherwise defined in the requirements of Exhibit 3 – Coordination Procedure.

D2

2.15.2 The Contractor shall coordinate through the Engineer the execution of the Work and that of its Subcontractors with Company's Other Contractors involved in close proximity of its assigned work area. To this effect, Contractor shall review its schedule and make provisions for coordination of the Work to avoid any interference with the work of Company's Other Contractors and with the general orderly progress of the project.

2.15.3 When planning and executing the Work, Contractor shall take into consideration the following work by Company's Other Contractors:

- .1 All civil works;
- .2 All embedded elements required during the first phase of reinforced concrete placement;
- .3 All balance of plant (BoP), erection of equipment, conduits, cables and piping not included in the Work; and
- .4 All concurrent installation of plant electrical and mechanical equipment not included in the Work.

2.15.4 As may be required for execution of the project, Engineer may, from time to time, issue instructions to Contractor to ensure adequate coordination of the Work as a whole.

2.15.5 Contractor shall allow access at all times on the loading areas, and in close proximity of its assigned work area, for Company's Other Contractors.

2.16 LOGISTICS

D2

2.16.1 Contractor shall be responsible for shipment and transportation of all Contractor's Items, material, equipment, Contractor Personnel, cargo and freight in Contractor's care, custody and control.

2.16.2 Contractor shall be responsible for logistics support during all phases of the Work in accordance with the Agreement, including the requirements of Exhibit 12 - Muskrat Falls Worksite Conditions.

D2

2.16.3 Not used,

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

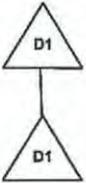
2.17 COMPANY SUPPLIED ITEMS

2.17.1 Contractor shall take receipt of Company supplied items defined in Exhibit 12 –Muskrat Falls Worksite Conditions prior to commencement of installation.

2.18 INSTALLATION CONSTRAINTS

2.18.1 Contractor shall comply with all of Engineer’s requirements for construction at the Muskrat Falls Worksite and in accordance with Exhibit 12 – Muskrat Falls Worksite Conditions.

2.19 ELECTRICAL REQUIREMENTS



2.19.1 Design to be completed in accordance with requirements of;

- .1 Electrical divisions, supplemented by this section; and
- .2 CSA C22.1 and CSA C22.2.

PART 3 ENGINEERING

3.1 ENGINEERING - GENERAL

3.1.1 Contractor shall manage engineering activities in accordance with documentation included in Exhibit 3 – Coordination Procedure.

3.1.2 Contractor shall perform all design/engineering as required and provide all engineering documents, drawings, specifications, engineering data, reports, analyses, studies and anything necessary for the completion of the Work, including:

- .1 Work required to enable Contractor and its Subcontractors to design, procure materials and equipment, and to fabricate, assemble, inspect, test, preserve, store, transport, offload, loadout, install and commission the Work in accordance with the requirements set forth in the Agreement;
- .2 Verify that all Work to be Delivered meets the requirements set forth in the Agreement;
- .3 Perform constructability analyses, hazard analyses and other such risk assessments as necessary to complete the Work;
- .4 Provide all required procedures for testing, mobilization, installation, commissioning, demobilization, start-up, maintenance and operation;
- .5 Provide to Engineer all information required for interfaces;
- .6 Provide all documentation and engineering data requested by Engineer;



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.7 Acceptance of Company Supplied Documents including the documentation provided in Exhibit 11 – Company Provided Documents.

3.1.3 All engineering of the Work shall be performed by qualified Personnel and Contractor shall use the necessary tools, such as computers and recognized and verified computer programs, to perform the engineering Work in a professional and timely manner and in accordance with the Agreement, Applicable Laws and Good Utility Practice.

3.1.4 Engineer may, at its sole discretion Accept any or all of Contractor's engineering in accordance with the provisions of the Agreement however such Acceptance or lack thereof does not relieve Contractor of any of its obligations.

3.1.5 All engineering performed by Contractor and Subcontractors shall adhere to the requirements of the professional engineering body, "Professional Engineers and Geoscientists Newfoundland and Labrador".



3.2 **NOT USED**

3.3 **SYSTEM ENGINEERING**

3.3.1 Contractor shall support system engineering for the Work. This will include:

- .1 Co-ordination and verification of interfaces between Contractor, Subcontractors, Engineer and Company's Other Contractors;
- .2 Verification that the Work is free of defects; and
- .3 Ensure that the Work is in compliance with the Agreement requirements.



3.3.2 Contractor shall clearly identify all internal interdependencies and all interdependencies between Engineer and Company's Other Contractors involved in the Work and comprising of matters pertaining to Delivery from one Worksite to another, installation and inter-discipline design documentation compatibility.

3.3.3 Contractor shall perform system engineering to verify system integrity when changes to the design occur.

3.3.4 Contractor shall ensure that Personnel in key positions, including, project engineers and the construction manager(s) specific to Worksite are participants in all phases of the Work. Contractor shall establish an effective engineering review process to achieve same.

3.3.5 Contractor shall verify the suitability of all tooling, installation aids and ancillary equipment, via analytical means and system integration testing.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4 DETAILED ENGINEERING

3.4.1 General

- .1 Contractor shall perform all analyses and design required for completion of the Work, and shall produce all required engineering documents.
- .2 Detailed engineering shall also include, all analyses required by Authorities and Engineer, in accordance with Agreement as necessary to ensure the Work is technically acceptable and fulfills all obligations of the Agreement.
- .3 Any design changes required due to a failure to meet specification, shall be implemented as part of the Work and shall not constitute Change to the Work.
- .4 Contractor shall prepare detailed specifications for the Work as a part of Contractor's detailed engineering.
- .5 Contractor shall perform detailed engineering analysis at extreme and nominal conditions to support its designs and ensure that all criteria are met.

3.4.2 Tools

- .1 Contractor shall develop, design and supply the required tools, necessary to perform the Work, as well as provide all documentation required for said tooling, all in accordance with the requirements of Appendix A - Technical Specifications of this Exhibit 1.
- .2 All tools required for operation and maintenance of the Work shall become property of the Company on completion of the Work.
- .3 Contractor shall ensure that all tools are fully refurbished prior to completion and handover of the Work to Company.



3.4.3 Materials

- .1 Not used.
- .2 If material selection for specific components is not covered by the requirements outlined in Exhibit 1 – Scope of Work and its associated Appendices, Contractor is responsible for selection of a suitable material which is subject to Engineer Acceptance.
- .3 Any substitution for the materials described by the listed standards shall be proven by a series of tests to be equal or superior to the standardized materials, and shall be subject to Acceptance by Engineer.
- .4 Contractor shall provide, for Engineer review and Acceptance, details of records to be provided by Contractor to demonstrate that materials supplied meet Engineer's and Contractor's requirements.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.4 Safety, Environmental Compliance and Reliability Analysis

- .1 Contractor shall undertake safety, environmental compliance and reliability analysis of the Work to achieve the following objectives:
 - .1 Demonstrate that the Work is conducted in a safe manner and fulfills all obligations and requirements set forth by the Applicable Laws and the Agreement;
 - .2 Demonstrate that the Work is conducted in compliance with Applicable Laws and guidelines and conditions of environmental assessment release;
 - .3 Support detailed design decisions in the cases where alternative designs are considered or where the detailed design alters from original plans; and
 - .4 Identify critical components for specific follow-up or specific safety qualification programs.
- .2 Contractor shall submit plans and procedures to demonstrate that safety and environmental considerations are built into the Work. The plans and procedures shall include, but not be limited to:
 - .1 Implementation and verification of all safety and environmental requirements into the Work through all phases of the Work including, installation, commissioning, start-up and operation; and
 - .2 Internal checklist and procedures for safety design review.
- .3 Contractor shall conduct failure mode and effects analyses (FMEAs) on the Work.
- .4 Contractor shall conduct reliability and maintainability (RAM) analysis for the Work.
- .5 Contractor shall perform and attend preliminary hazard analysis (PHA), operability reviews, hazard identification and risk assessment (HIRA) and any other safety risk assessments as necessary for the Work. Such activities shall also meet the requirements of Company defined action tracking system.



3.5 NOT USED

PART 4 STORAGE, PRESERVATION AND PREPARATION

4.1 STORAGE SECURITY AND PROTECTION

4.1.1 Contractor shall be responsible for all storage and security of the Work.

4.1.2 Not used.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.1.3 Contractor shall also provide protection to avoid damage to the Work during manufacturing, testing, loadout, transport, storage, lifting, and installation.

4.2 PRESERVATION AND MAINTENANCE

4.2.1 Contractor shall perform all tasks required to ensure preservation and maintenance of the Work.

4.2.2 Contractor shall develop preservation procedures and perform preservation activities for the Work.

4.2.3 Contractor shall ensure the preservation requirements of Subcontractors' equipment are maintained.

4.2.4 Contractor shall monitor the implementation and results of Contractor's and Subcontractors' preservation programs.

4.2.5 Contractor shall include requirements of preservation to Work performed by Subcontractors to ensure that Subcontractors provide the necessary information for preservation, storage, protection and maintenance of preservation for the equipment supplied.

4.3 PREPARATION FOR TRANSPORTATION

4.3.1 Contractor shall obtain Acceptance from Engineer prior to shipment of Work or any part thereof.

4.3.2 Contractor shall carry out packing and preparation prior to shipping and ensure that all equipment and tools are secured in a safe manner.

4.3.3 The equipment, accessories and all other spare and ancillary equipment shall be packed and shipped to allow installation sequence and operational flexibility.

4.4 TRANSPORTATION OF EQUIPMENT

4.4.1 Contractor shall be responsible for transportation equipment, including logistics, management and transportation between all Worksites.

4.4.2 Engineer or Company's Other Contractors will have the right to stop any lift or load-out if, in their opinion, operations are or could be unsafe, are outside of the procedure parameters or damage to the Work could occur.

4.4.3 Contractor shall be responsible for loadout and seafastening of the Work as required for shipping and shall perform all design, engineering, supply of material, fabrication and installation required for the loadout and seafastening.

4.4.4 Contractor shall also perform all design and engineering related to offloading the Work at the location for mobilization nominated by Contractor.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 4.4.5 Contractor shall satisfy the requirements of the marine warranty surveyor and independent verifying body, Authorities and Engineer, as required.
- 4.4.6 Contractor shall transfer the Work onto the Contractor shipping equipment or vessel in accordance with the accepted mobilization manual.
- 4.4.7 Contractor shall, at all times, be responsible for organizing, managing and executing the loadout and offloading operations.
- 4.4.8 Contractor shall carry out all necessary voyage protection of the Work to prevent transit damage during transportation to and offloading at the location for mobilization nominated by Contractor.
- 4.4.9 Contractor shall develop criteria and procedures for voyage protection, which shall be submitted to Engineer for Acceptance.
- 4.4.10 Contractor shall be responsible for transportation equipment, including logistics, management and transportation between all Worksites and the location for mobilization nominated by Contractor.

4.5 LIFTING DEVICES FOR SHIPPING AND INSTALLATION

- 4.5.1 Contractor shall provide all lifting devices for all equipment for shipping and installation, and shall include certified lifting aid arrangements, lifting slings and shackles.
- 4.5.2 Lifting devices shall be in accordance with the requirements of the applicable local regulations, or as detailed in these specifications whichever is more stringent.

PART 5 MATERIALS, FABRICATION AND INSPECTION

5.1 MATERIALS

5.1.1 General

- .1 Materials used for the fabrication of all permanent elements shall be new.
- .2 All materials shall conform to the standards specified herein or to similar standards proposed by Contractor and Accepted by Engineer.
- .3 Before the fabrication begins, Contractor shall submit to Engineer, all mill test certificates for the material supplied.
- .4 If Contractor fails to produce such certificates, Contractor shall have similar tests made, at its own expense, in a laboratory Accepted by Engineer.
- .5 The material of each component shall be specified on the drawings, and the accepted standard identified, the number of this standard, the grade or class used, the alloy or

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

pertinent chemical analysis and any special requirements concerning heat treatment and tests.

- .6 The mechanical and chemical characteristics of the materials shall be determined in accordance with the requirements of the chosen standards and in accordance with the special requirements specified in this specification and on the drawings Accepted by Engineer.
- .7 Contractor shall prepare and deliver to Engineer without additional cost, any specimen representative of the materials which Engineer may require before or during fabrication and during erection of the equipment at Site.
- .8 Acceptance by Engineer of the materials proposed for the fabrication of the equipment in no way relieves Contractor from the obligation to satisfy all requirements of these specifications and does not eliminate the possibility of subsequent rejection of materials judged defective.
- .9 For sliding pieces which are in contact, it is not permitted to use stainless steel on stainless steel or stainless steel on carbon steel, or vice versa.

5.1.2 Low Temperature and Impact Energy

- .1 CSA G40.20/G40.21 Type WT - Weldable Notch-Tough Steel, shall have minimum impact values for Charpy Vee notched specimens of 27 Joules at -20° C.

5.1.3 Fasteners

- .1 A design torque or tension shall be established and documented on drawings or in manuals for all fasteners including anchors and shall be recorded during assembly and installation.
- .2 The design torque or tension of all fasteners shall take into consideration the uncertainty in the chosen torquing or tensioning method.
- .3 As a minimum a chemical thread lock shall be applied to all fasteners. Fasteners subject to rotation, such as on wheels or sheaves, shall also be mechanically locked. Lockwashers do not meet this criterion.
- .4 For stainless steel threads where the Contractor does not recommend using a chemical locking compound some form of anti-galling lubricant, such as "Loctite nickel anti-seize 771" shall be used.



5.2 FABRICATION

5.2.1 General Requirements

- .1 The fabrication of any component of Contractor's supply shall conform to the fabrication drawings Accepted by Engineer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.2.2 Cast Steel

- .1 All casting shall be true to pattern, well finished, homogeneous and free from blow holes, porosity, hard spots, shrinkage defects, cracks or other visible defects.
- .2 Castings shall be cleaned to the satisfaction of Engineer.
- .3 Un-machined casting surfaces shall be free from foundry irregularities such as projections, ridges, hollows, honey-combing, and pockmarks or chip marks so that they will not require surface smoothing operations prior to painting.
- .4 All surface finishes of castings, machined or not, as well as special requirements with respect to general or local non-destructive testing shall be indicated on Contractor detail drawings.
- .5 Samples prepared for mechanical testing shall be attached to each casting.
- .6 The number and dimensions of the test samples and the areas for removal the samples shall be subject to Acceptance of Engineer.
- .7 Casting shall not be repaired without Acceptance of Engineer, and such Acceptance can be given only if it is evident that, once repaired, the defect will not affect the strength, the machining or the end use of the component.
- .8 Casting repair shall be by welding only, but no weld repair shall be made following final stress relief.
- .9 If there is doubt as to its quality with respect to the specifications and drawings, Engineer may require non-destructive tests on any component.
- .10 Any component presenting too many segregation of impurities or alloys at critical points will be rejected.

5.2.3 Forged Steel

- .1 Ingots used for forgings shall be free from all defects which may affect their strength and durability such as welds, flaws, pipes, cracks, scales, fins, porosity, hard spots, non-metallic inclusions and segregation.
- .2 If there are any doubts as to the quality of the ingots, Engineer may require non-destructive testing of all ingots to be used in the forging operations.
- .3 The largest permissible fillets shall be used at each change of section.
- .4 All surface finishes of forgings, machined or not, shall be indicated on Contractor detail drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 Forgings shall have their heat number stamped in such a way as to be easily readable after assembly.
- .6 Contractor shall submit to Engineer all reports of chemical analyses and mechanical tests when the materials are received at the shop.

5.2.4 Welding

- .1 All welding shall conform to CSA W59.
- .2 All welding on load carrying members shall be carried out in the shop.
- .3 In general, only seal welding shall be permitted at Site.
- .4 No full penetration welding will be allowed at site.
- .5 Any field welding shall receive prior Acceptance by Engineer.
- .6 Welding procedures and welders shall have been Accepted by Engineer and qualified by the Canadian Welding Bureau in accordance with the requirements of CSA W47.1.
- .7 Contractor shall submit welding procedures with proof that qualification tests have been carried out for each type of joint.
- .8 No work shall be undertaken prior to Engineer's Acceptance of the welding procedures, the welding machine operators and the welders.
- .9 Welding electrodes shall conform to the requirements of CSA W48.1.
- .10 Low hydrogen electrodes shall be used.
- .11 Electrodes having absorbed moisture shall be rejected.
- .12 Plates to be welded shall be carefully cut in size.
- .13 The dimensions and the shape of the edges to be welded shall be such that they permit proper fusion and full penetration.
- .14 Exposed parts shall be continuously welded on all sides.
- .15 Welding shall not be carried out when the temperature of the base metal is below 10°C.
- .16 If the base material is below 10°C, all surfaces within a radius of 75 mm of the point to be welded shall be preheated in accordance with CSA W59 and maintained at this temperature throughout the operation.
- .17 Preheat temperatures shall be measured using tempilsticks or other means Accepted by Engineer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .18 Peening of welds will not be permitted.
- .19 A strip 50 mm wide on each side of the joint to be welded shall be cleaned to eliminate all rust, grease and scale.
- .20 Welded construction parts having machined surfaces to ensure a correct alignment, shall be stress relieved by heat treatment or vibratory stress relief before machining.
- .21 The stress relief procedure for welded components shall be specified in the welding procedure or on the drawings and shall be submitted to Engineer for Acceptance.
- .22 Galvanized components shall be seal welded. Where design of weldment to be galvanized does not require a continuous weld for the integrity of the joint, a seal weld shall be employed to seal the remainder of the joint.



5.2.5 Weld Inspection Requirements

- .1 Contractor shall carry out, at his own expense, the following inspections:

<u>Type of Weld</u>	<u>Type of Inspection</u>	<u>Extent of Inspection</u>
All welds	Visual	100%
Tension flange butt welds	Radiographic	20%
Compression flange butt welds and skin plate acting as a beam flange	Radiographic	5%
Web splice butt welds	Magnetic particle or dye penetrant test	10%
Fillet welds	Magnetic particle or dye penetrant test	10%

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 All unacceptable defects shall be removed to sound metal.
- .3 All weld repairs shall be 100% inspected by the method used originally.
- .4 If defects are found the untested area shall be tested to the same Extent of Inspection as indicated above and repeated as necessary until no defects are found.

5.2.6 Fabrication Tolerances

- .1 Fabrication tolerances shall be such that they permit easy installation and adjustment of the parts according to the erection tolerances specified in these specifications, without modification at Site, but the fabrication tolerances shall not exceed half of the specified final tolerances after installation in all cases where parts concerned are adjusted at Site.
- .2 Inspection of the machining tolerances shall be independent of the machining methods.
- .3 Machining equipment shall only be used to inspect the tolerances, if validity of this method has been demonstrated to, and accepted by, Engineer.
- .4 Surface machining shall be checked based on readings taken at least every 300 mm.

5.2.7 Coating and Galvanizing

.1 General Requirements

- .1 All permanent equipment included in Contractor's supply shall be coated with paint or hot dip galvanized as specified hereafter.
- .2 All temporary equipment shall be de-greased, all loose scale removed, and a shop primer applied as per coating manufacturer's recommendations.
- .3 Contractor shall take all the necessary measures in the stage of design and fabrication methods, that the surfaces to be coated should have sufficient access to enable the preparation on the surface, application of paint and quality control in accordance with this specification.
- .4 All surface preparation and coating shall be carried out in the shop.
- .5 Any area damaged during handling, transportation and erection shall be touched-up at Site by Contractor and shall meet the requirements of these specifications.

96
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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

5.2.8 Surface Preparation and Coating

.1 Surface Preparation

- .1 Painted and coated surfaces shall be prepared to manufacturer's recommendation, or as specified below, whichever is more stringent, as Accepted by Engineer.
- .2 Rough welds and sharp edges shall be smoothed by grinding and weld spatter shall be removed.
- .3 The surfaces shall be blast cleaned to the finish specified for each paint system in the clause 5.2.8.2.2 below.
- .4 The sand blasted surfaces shall be inspected to visual standard SSPC-VIS 1.

.2 Coating

- .1 The prepared coated surfaces shall receive a minimum of two (2) coats of high build epoxy paint.
- .2 The approved coating systems shall be as follows:
 - .1 Interior Structural Steel: Refer to Section 09 90 00
 - .2 Exterior Structural Steel: Refer to Section 09 90 00
 - .3 Immersion Service (gates, stoplogs, embedded parts):
 - .1 Surface Preparation: Abrasive Blast to SSPC-SP-10 Near White Metal;
 - .2 Primer: One coat Amercoat 240 Surface Tolerant Multi-Purpose Epoxy Coating at 250 – 300 um DFT;
 - .3 Topcoat: One coat Amercoat 240 Surface Tolerant Multi-Purpose Epoxy Coating at 250 – 300 um DFT.
 - .4 Interior of Gates (Spillway):
 - .1 Surface Preparation: Abrasive Blast to SSPC-SP-10 Near White Metal;
 - .2 Primer: One coat Amercoat 68HS Zinc Epoxy Primer at 50 – 75 um DFT;
 - .3 Topcoat: One coat Amerlock 2 Surface Tolerant Epoxy Coating at 150 – 200 um DFT.
- .3 The application and the drying time shall comply with the paint manufacturer's recommendations.
- .4 All coating used for a system shall come from the same manufacturer.
- .5 Not used.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 Method of coating shall assure the uniform coating, and shall avoid any excess of coating due to local accumulations and drips.
- .7 If problems of excess coating arise, and no action is taken to improve the method of application, Engineer can require removing all coatings and recoating and shall be at Contractor's expense.
- .8 The first coat shall be of a different colour than the finishing coat to make the application easier.
- .9 Instrument calibration, measurement of the dry film thickness, and the acceptance criteria, shall be performed according to SSPC-PA2.

5.2.9 Coating Touch-ups

- .1 All coating touch-ups shall be done according to the coating system and the requirements detailed in this technical specification, except with regards to surface preparation and visual inspection.
- .2 The surface preparation shall be done by power tool according to the requirements of SSPC-SP3.
- .3 Visual inspection shall be done according to the requirements of SSPC-VIS 1 ST-3.
- .4 In the case of major touch-up to be done on Site, Engineer may require that surface preparation be done by sand blasting.
- .5 For coating touch-ups after final completion, Contractor shall supply to Engineer twenty (20) litres of each type and colour of the same paint as used.

5.2.10 Inspection

- .1 Surface preparation inspection shall be done immediately prior to the coating application in the presence of an authorized representative of Engineer.
- .2 For each coating layer, Contractor shall obtain authorization from Engineer before proceeding with its application.
- .3 The coated surface, after all coating is completed, is subject to Acceptance by Engineer.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.2.11 Galvanising

- .1 Components to be galvanized shall be prepared and hot dip galvanized in accordance with CSA G164, ASTM A384 and A385.
- .2 Touch-up of galvanized components shall be carried out with Galvicon, or an equivalent Accepted by Engineer.

5.3 INSPECTION

5.3.1 Standards for Non-Destructive Testing

- .1 Unless otherwise requested by Contractor and Accepted by Engineer, all non destructive testing of materials shall be carried out in accordance with the following specifications:

5.3.2 Welded Components

- .1 Radiographic Method:
 - Procedure as per CSA W59
 - Acceptance criteria as per CSA W59
- .2 Ultrasonic Method:
 - Procedure as per CSA W59
 - Acceptance criteria as per CSA W59
- .3 Magnetic Particle Method:
 - Procedure as per ASTM E709
 - Acceptance criteria as per CSA W59
- .4 Dye Penetrant Method:
 - Procedure as per ASTM E165
 - Acceptance criteria as per CSA W59
- .5 Visual control:
 - Acceptance criteria as per CSA W59

5.3.3 Casting Components

- .1 Radiographic Method:
 - Procedure as per ASTM E94
 - Acceptance criteria as per ASTM E186, E280 and E446
- .2 Ultrasonic Method:
 - Procedure as per ASTM E114
 - Acceptance criteria as per ASTM A609 Level II

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Magnetic Particle Method: - Procedure as per ASTM E709
 - Acceptance criteria as per ASTM E125 Type 1, 2, 3, 4 and 5.
- .4 Liquid Penetrant Method: - Procedure as per ASTM E165
 - Acceptance criteria as per ASTM E433, permissible surface indication NIL

5.3.4 Forged Components

- .1 Ultrasonic Method: - Procedure as per ASTM A388
- .2 Magnetic particle Method: - Procedure as per ASTM A275
- .3 Contractor shall supply Engineer with the testing methods, and prove by preliminary tests that these conform to the effectiveness and validity of each method.
- .4 All non-destructive test requirements shall be clearly specified by Contractor on its drawings.

5.3.5 Radiographic Inspections

- .1 Radiographic inspection with X-ray machines or radioactive isotopes will be permitted.
- .2 Limitations in the use of each method are outlined in ASTM, ASME and CSA W59 standards.
- .3 X-ray machines shall be used in preference to isotope cameras whenever possible.
- .4 Single control kilovolt-milliampere X-ray machines shall not be used without the express Acceptance of Engineer.
- .5 All operators and technicians of levels I, II and III shall hold a certificate of competence issued by CGSB, but this certificate is only valid if renewed each year.
- .6 Radiographic plates shall be interpreted only by a specialist certified by CGSB.
- .7 The specialist shall be classified at least at level II and shall have relevant experience on NDT techniques and the interpretations of the related results, but shall be responsible for interpretation only, as the final decision on Acceptability shall rest with Engineer.
- .8 Radiographic plates will be accepted once they comply with the conditions specified in ASTM E94.
- .9 All welds which are rejected on the basis of this standard shall be repaired or replaced by an acceptable weld.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.3.6 Ultrasonic Inspections

- .1 Ultrasonic inspection of cast, forged and welded parts, as a substitution or completion for radiographic inspection is acceptable if an inspection program is presented together with evidence to prove the validity of the proposed method, all subject to Engineer's prior Acceptance.
- .2 Whenever radiographic inspection of welds is not possible, as in the case of welds on certain angular and back-plated parts, Contractor shall demonstrate the validity of the ultrasonic method by inspecting a test sample which has been prepared by identical methods.
- .3 Ultrasonic testing shall only be acceptable if carried out with equipment of recognized brand.
- .4 Welds, castings and forgings shall be inspected by direct contact of the probe with the surface.
- .5 Under special conditions, ultrasonic inspection by immersion of forged parts may be required.
- .6 Whenever angled probing is used, the angle of incidence shall be suitable for the thickness of the part, and shall be as recommended in ASTM or CSA W59 Standards.
- .7 Equipment shall be calibrated regularly on a test sample containing flaws similar to those being sought.
- .8 The ultrasonic method shall not be used until technical literature describing the process, proposed methods, equipment sensitivity, probes, etc., is submitted to Engineer together with proof of the competence of Contractor's technicians.
- .9 Inspection reports with supporting drawings, sketches and photographs shall be submitted to Engineer, together with all details, needed, to reproduce accurately any ultrasonic test, at any time.
- .10 Preparation of ultrasonic inspection procedures shall only be carried out by technicians who hold a competence certificate under the category CGSB - Level III.
- .11 Technicians of CGSB - Level II and Level III are competent to interpret the test results, but then the final decision on Acceptance will remain with Engineer.

5.3.7 Complementary Inspections

- .1 Complementary inspection of castings, forgings and welded joints may be carried out using magnetic particle and dye penetrant methods.
- .2 Magnetic particle and dye penetrant methods shall conform to the requirements of CSA W59 and ASTM E165.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Magnetic particle and dye penetrant methods are only acceptable for detection of flaws on the surface of component or welds.
- .4 Striations and irregularities shall be removed before testing.
- .5 For dye penetrant examination, the surface shall be conditioned or effectively cleaned before the application of the penetrant.
- .6 Magnetic particle examination shall be so conducted that surface deterioration or burning does not occur at electrode contact points.
- .7 Current intensity, duration of application and orientation of the magnetic field shall be according to standards.
- .8 A magnetic field intensity meter shall be used regularly.
- .9 Provision shall be made for demagnetization for components if residual magnetism is a potential problem.
- .10 Tests shall be conducted and results interpreted only by operators and technicians Accepted and certified by CGSB.
- .11 Final Acceptance rests with Engineer.

5.3.8 Inspection of Welded Components

- .1 All welds shall be inspected in accordance with the requirements of these specifications.
- .2 If, for a given case, radiographic inspection is impossible because of difficulties of access, ultrasonic examinations Accepted by Engineer may be used.
- .3 Neither incomplete penetration nor lack of fusion shall be accepted.
- .4 For all statically and dynamically loaded welds, porosity or inclusions shall not exceed the limits imposed by CSA W59.
- .5 Welding flaws exceeding the limits specified shall be gouged to sound metal and the gouged sections shall be checked by non-destructive testing (magnetic particle or other procedure) to Engineer's satisfaction.
- .6 Repair welding will only be permitted after the flaw has been shown to be completely eliminated.
- .7 All repair welds shall be completely radiographed.
- .8 The welding inspector shall be qualified according to CSA W178.2 and shall be of the proper level to perform the inspection.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.3.9 Inspection of Castings

- .1 Castings of all major components shall be inspected in the foundry after cleaning and removal of all flaws, and before commencement of any repair welding.
- .2 Cast parts shall also be inspected following repairs and heat treatments, and during and after machining.

5.3.10 Inspection of Forgings

- .1 Forgings of all major components shall be inspected at the forging plant in the ingot stage and after forming, cleaning and removal of defects, but prior to any repair welding.
- .2 The forgings shall also be inspected following repairs and heat treatments, and during and after machining.

5.3.11 Shop Assembly and Tests

- .1 Prior to shipment, the equipment shall be fully shop assembled to demonstrate to the satisfaction of Engineer that all requirements of the specifications and of the design and fabrication indicated on the drawings Accepted by Engineer have been satisfied, and a shipping release has been provided by Engineer to the Contractor for each assembly. Where full assembly is not practical due to shop space limitations, all interfaces shall be proven by completing sub-assemblies or dimensional survey of completed components and preparation of an as-built model. Verification shall be subject to Engineer's Acceptance. All alignment critical equipment must be factory assembled and tested (rotating equipment etc.)
- .2 Following Engineer's Acceptance, these assemblies will be dismantled to satisfy the transportation requirements.
- .3 The components shall be match-marked and doweled to facilitate reassembly in the field.
- .4 The number of bolts and dowels shipped to Site shall exceed by at least 4% the calculated requirements in the shop.
- .5 Each piece of equipment shall be subjected to the necessary shop tests to demonstrate proper operation of all components prior to Engineer's Acceptance for shipment to Site.
- .6 These tests shall include at least one motorized test for a minimum duration of one hour in order to demonstrate the operating ability of all mechanisms and gearings.
- .7 In addition, stalling tests shall be carried out on the hoists.
- .8 In case of damage during the shop testing Contractor shall improve the concept and repeat the test prior to shipment.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .9 Prior to the tests described above, Contractor shall submit for Engineer's Acceptance a detailed procedure including a description of the assembly and the sequence of operations.
- .10 Following the tests, Contractor shall submit the results to Engineer for Acceptance.
- .11 All equipment not included in the supply but necessary for carrying out the tests shall be supplied by Contractor.
- .12 Shipping to Site shall be authorized only once the equipment has undergone all the required tests.
- .13 Engineer's Acceptance to ship does not relieve Contractor of his responsibilities in regard to final Acceptance.
- .14 Any malfunction of the equipment following field erection will remain Contractor's sole responsibility, and Contractor shall carry out any necessary repairs or adjustments, after having received Engineer's Acceptance to do so.

PART 6 INSPECTION AND VERIFICATION

6.1 INSPECTION

- .1 The Work shall be subject to inspection by Engineer and Company's Other Contractors.
- .2 Contractor shall prepare inspection and test plans to cover the full range of activities required to complete the Work, including all manufacturing, installation and testing activities. ITP's shall identify:
 - .1 The specific verification activities planned for each process activity, including the characteristics to be inspected and tested at each point;
 - .2 The procedures and acceptance criteria to be used; and
 - .3 Any special tools, techniques or Personnel required.

6.1.2 Company's independent verifying body, supplier and purchaser surveillance levels shall be indicated by use of hold, witness and review points on ITP's.

6.1.3 Contractor shall submit ITP's to Engineer for Acceptance in accordance with the requirements of the Agreement.

PART 7 PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS

7.1.1 Preservation, Mechanical Completion & Commissioning Requirements noted herein are defined in MFA-SN-CD-2000-ME-SP-0002-01 Preservation, Mechanical Completion & Commissioning Requirements.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 8 QUALITY MANAGEMENT

- 8.1.1 Contractor shall comply with all quality requirements of Exhibit 11 - Company Provided Documents and Exhibit 7 – Quality Requirements.
- 8.1.2 Contractor shall have an effectively implemented quality management system that shall, as a minimum, be compliant with the requirements of ISO 9001: 2008 – Quality Management System Requirements.
- 8.1.3 Contractor shall retain complete records that demonstrate the Work provided meets all the specified requirements and that the quality management system is effective, all in accordance with the requirements outlined in Exhibit 7 – Quality Requirements.
- 8.1.4 Contractor shall report all non-conformances generated in the engineering, manufacturing, fabrication, installation, and service delivery process in accordance with the requirements outlined in Exhibit 7 – Quality Requirements.
- 8.1.5 Engineer may at its sole discretion, perform surveillance and use other verification tools to verify the performance of Contractor Group to ensure compliance with relevant quality requirements in all areas during the execution of the Work.

PART 9 HEALTH, SAFETY, ENVIRONMENT AND SECURITY

- 9.1.1 Contractor shall comply with all environment, health, safety and security requirements of Exhibit 5 – Health and Safety Requirements and Exhibit 6 - Environment and Regulatory Compliance Requirements.
- 9.1.2 Contractor shall have an effectively implemented safety management system that shall, as a minimum, meet the requirements of the Agreement.
- 9.1.3 Engineer shall have the right to perform surveillance and use other verification tools to verify the performance of Contractor Group to ensure compliance with relevant HS&E and security requirements in all areas during the execution of the Work.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**APPENDIX A
EQUIPMENT NUMBERS**

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 10
CH0032	GENERAL MECHANICAL REQUIREMENTS	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 10 APPENDIX A – EQUIPMENT NUMBERS

10.1 A1 INTRODUCTION

To be provided by Engineer.

END OF SECTION

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 48 13 20
GATES, STOPLOGS AND TRASHRACKS**



PART 1	GENERAL	3
1.1	DESCRIPTION AND SCOPE OF WORK	3
1.2	RELATED SECTIONS	3
PART 2	DESIGN REQUIREMENTS	3
2.1	APPLICABLE STANDARDS	3
2.2	ALLOWABLE STRESSES AND DEFLECTIONS	7
2.3	FLOW INDUCED VIBRATION	11
2.4	ICE LOAD	11
2.5	SEISMIC LOADS	11
2.6	MINIMUM MATERIAL THICKNESSES	11
2.7	FRICTION COEFFICIENTS	12
2.8	COMPONENT DESIGN REQUIREMENTS	13
PART 3	TECHNICAL REQUIREMENTS	34
3.1	SPILLWAY GATES	34
3.2	SPILLWAY STOPLOGS	39
3.3	INTAKE GATES	41
3.4	INTAKE BULHEAD GATE	42
3.5	POWERHOUSE DRAFT TUBE STOPLOGS	43
3.6	TRASHRACKS	45
3.7	DRAFT TUBE GALLERY MAINTENANCE AREA WATER STOP GATES	46
3.8	COATINGS SCHEDULE	47
3.9	SHOP ASSEMBLY AND TESTS	48
PART 4	ERECTION, CONCRETING AND FIELD TESTS	49
4.1	GENERAL	49
4.2	FINAL TOLERANCES AFTER INSTALLATION OF GATE AND STOPLOG EMBEDDED PARTS AND GATES	53

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PEG PERMIT HOLDER
Newfoundland and Labrador
This Permit Allows
SNC-LAVALIN INC.

To practice Professional Geoscience
in Newfoundland and Labrador.
Permit No. as issued by PEGNL 10458
which is valid for the year 2013

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

PART 5 PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS
53

5.1 GENERAL 53

APPENDICES:

APPENDIX A – GATE AND STOPLOG SEALS

APPENDIX B – TOLERANCES

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 DESCRIPTION AND SCOPE OF WORK

- 1.1.1 This section of the specification details the requirements for gates, stoplogs, trashracks and embedded parts for the Muskrat Falls Hydroelectric Development.
- 1.1.2 This document shall be read in conjunction with "Lower Churchill Project Muskrat Falls Hydroelectric Development – CH0032 - Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment - Scope of Work - MFA-SN-CD-2000-ME-SP-0001-01/505573-3321-45EW-0001", Part 2; Exhibit 1.

1.2 RELATED SECTIONS

-  .1 Section 03 30 00 Cast In Place Concrete
- .2 Section 03 60 40 Grout
- .3 Section 48 13 10; General Mechanical Requirements
- .4 Section 48 13 21; Hoist and Cranes
- .5 Section 48 13 22; Trash Cleaning System
-  .6 MFA-SN-CD-2000-ME-SP-0002-01; Preservation, Mechanical Completion & Commissioning Requirements
-  .7 Section 23 82 33.05; Gate Guide Heaters
-  .8 Section 26 29 03.03; Control and Monitoring – Hydro-Mechanical

PART 2 DESIGN REQUIREMENTS

2.1 APPLICABLE STANDARDS

2.1.1 Codes and Standards

The following standards shall apply to the Work described in this document.

- .1 ANSI Standard B4a Tolerances, Allowances and Gauges for Metal Fits
- .2 ANSI C42.30 Definitions of Electrical Terms
- .3 ANSI/ABMA STD 9 Load Ratings and Fatigue Life for Ball Bearings
- .4 ANSI/ABMA STD 11 Load Ratings and Fatigue Life for Roller Bearings



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 ASME B1.1 Unified Inch Screw Threads
- .6 ASME B1.13 Metric Screw Threads: M Profile
- .7 ASTM A275 Standard Practice for Magnetic Particle Examination of Steel Forgings
- .8 ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion during Hot-Dip Galvanizing of Steel Assemblies
- .9 ASTM A385 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- .10 ASTM A388 Standard Practice for Ultrasonic Examination of Steel Forgings
- .11 ASTM A609 Standard Practice for Castings, Carbon, Low Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof
- .12 ASTM E94 Standard Guide for Radiographic Examination
- .13 ASTM E114 Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing
- .14 ASTM E125 Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings
- .15 ASTM E165 Standard Practice for Liquid Penetrant Examination for General Industry
- .16 ASTM E186 Standard Reference Radiographs for Heavy-Walled (2 to 4½-in. (50.8 to 114-mm)) Steel Castings
- .17 ASTM E280 Standard Reference Radiographs for Heavy-Walled (4½ to 12-in. (114 to 305-mm)) Steel Castings
- .18 ASTM E433 Standard Reference Photographs for Liquid Penetrant Inspection
- .19 ASTM E446 Standard Reference Radiographs for Steel Castings up to 2 in. (50.8 mm) in Thickness
- .20 ASTM E709 Standard Guide for Magnetic Particle Testing
- .21 AWS D1.1 Structural Welding Code
- .22 CAN/CGSB 48.9712 Non-destructive Testing; Qualification and Certification of Personnel

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .23 CGSB 1-GP-12C Standard Paint Colors
- .24 CSA A-23.1 Concrete Materials and Methods of Concrete Construction
- .25 CSA A-23.2 Test Methods and Standard Practices for Concrete
- .26 CSA A-23.3 Design of Concrete Structures
- .27 CSA C22.1 Canadian Electrical Code
- .28 CSA C22.2 Safety Standards for Electrical Equipment
- .29 CSA G164 Hot Dip Galvanizing of Irregularly Shaped Articles Metals and Metal Products
- .30 CSA S16 Design of Steel Structures
- .31 CSA S269.3 Concrete Formwork
- .32 CSA W47.1 Certification of companies for fusion welding of steel
- .33 CSA W48 Filler Metals and Allied Materials for Metal Arc Welding
- .34 CSA W59 Welded Steel Construction - Metal Arc Welding
- .35 CSA W178.2 Certification of Welding Inspectors
- .36 CSA Z85 Abbreviations for Scientific and Engineering Terms
- .37 NBCC National Building Code of Canada
- .38 NLOHS Occupational Health and Safety Regulation of Newfoundland & Labrador
- .39 SSPC PA2 Procedure for Determining Conformance to Dry Coating Thickness Requirements
- .40 SSPC SP3 Power Tool Cleaning
- .41 SSPC SP10 Near-White Metal Blast Cleaning
- .42 SSPC VIS 1 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
- .43 ANSI/ASSE Z359.4 Fall Protection Code: Safety Requirements for Assisted-Rescue and Self-Rescue Systems.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.2 Allowable Stresses - Normal Conditions

.1 General Mechanical and Structural Design

- .1 For all the normal loading conditions specified in this document, the allowable stresses on equipment and their support structures shall not exceed 90% of the allowable stresses given in CSA S16-1969 and CSA W59 for all permanent works, and shall not exceed 100% of the allowable stresses given in CSA S16-1969 and CSA W59 for all temporary works.
- .2 Gate Wheels and Wheel Paths
- .3 The Hertz contact stresses between the gate wheels and the wheel paths shall satisfy the following requirements:
 - .1 The maximum compressive stresses, shall not exceed the lesser of 6.9 times the minimum Brinell hardness of the softer material $BHN \times 6.9 = MPa$ (or 1725 MPa);
 - .2 The maximum shear stresses, shall not exceed the lesser of 2.4 times the minimum Brinell hardness of the softer material $BHN \times 2.4 = MPa$ (or 620 MPa);

.2 Concrete

- .1 The allowable stresses shall not exceed 90% of those specified in standards CSA A-23.3 or the requirements below whichever is more conservative.
- .2 The bearing pressure transmitted to the concrete by the downstream flange of the embedded beam supporting the wheel path for wheeled gates, or the bearing bar for non-wheeled gates and stoplogs, shall not exceed the following values:
 - .1 If $L > L'/4$, the bearing pressure allowed is 13.2 MPa
 - .2 If $L < L'/4$, the bearing pressure allowed is 8.8 MPa
- .3 Where:
 - .1 L = the minimum distance measured in line parallel with the downstream bearing face of the rear flange between the edge of the flange and the water passage.
 - .2 L' = the width of the rear flange assuming a uniform and symmetrical load distribution about the web of the beam.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 The above assumes:

- .1 The effective rear flange width shall be limited by the allowable bending stress at the intersection of the flange with the web,
- .2 100% of the wheel load is transferred to the downstream embedded flange,
- .3 Wheel load is distributed vertically at 45 degrees from the point of contact with the track to the downstream side of the embedded flange.

.3 Gate and Stoplog Skin Plate

- .1 The maximum combined stress resulting from the combined action of the skin plate and the beams and stiffeners to which it is welded shall not exceed 120% of the allowable stress, however, the bending and shear stresses taken individually shall not exceed 100% of the allowable stresses.

.4 Welded Joints

.1 Shop Welds

- .1 The strength of a full penetration butt welded joint shall be such that the stresses in the weld do not exceed the following percentage of the permissible stresses in the weakest of the materials to be welded:
 - .1 100% of the allowable stresses in the lower strength material when the joint is subjected to thermal heat treatment and 100% radiography;
 - .2 95% of the allowable stresses in the lower strength material when the joint is subjected only to 100% radiography;
 - .3 90% of the allowable stresses in the lower strength material when the joint is subjected only to the thermal heat treatment;
 - .4 85% of the allowable stresses in the lower strength material when the joint is neither radiographed nor thermally heat treated.

.2 Field Welds

- .1 For all field welded joints the stresses in the welds shall not exceed 80% of those permitted for Shop Welds as listed above, unless 100% NDT has been performed and Accepted by Engineer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.5 Other Components

- .1 The average stresses in bushings shall not exceed 20 MPa.
- .2 For elements not covered by a specific standard the allowable stresses shall not exceed 33% of the yield strength or 20% of the ultimate strength of the material whichever is the most conservative.

2.2.3 Allowable Stresses – Abnormal Conditions

.1 Extreme Water Levels and Seismic Events

- .1 For extreme water levels and seismic events the allowable stresses on the structural elements may be increased by up to 33% above those specified in Clause 2.2.2, but in no case exceeds 90% of the yield strength of the material, whichever is the most conservative.
- .2 Concrete: The allowable stresses shall not exceed 90% of those specified in standards CSA A-23.3, but concrete bearing stresses shall not exceed 23.6 MPa in any case.

.2 Gate, Stoplog or Trashrack Jamming

- .1 In the case where a component jams in its respective guides for whatever reason the maximum stresses induced in the equipment shall not exceed the following:
 - .1 75 % of the yield strength of the material when the load is applied to all lifting points;
 - .1 90 % of the yield strength of the material when there is a partial failure of the hoisting mechanism (for example broken wire rope) or lifting device; (Note, depending on design of the hoist this may be the result of a symmetric or asymmetric load case.)
 - .2 Bearing pressure of 19.3 MPa on the second stage concrete.

.3 Dogging Device Overload

- .1 When only one dogging device is engaged, the stresses shall not exceed those given in clause 2.2.2.5. Operationally, applying the full load to a single dogging device is considered an abnormal condition; however, no increase in allowable stress is permitted.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.2.4 Allowable Deflections

- .1 The deflections in the various components under the normal loading conditions shall not exceed 1/800 of span.
- .2 In addition to the above for all top seal applications, for the worst case hydrostatic loading condition, the deflection at the seal location shall not exceed the allowable seal deformation, cause the seal to be crushed, and result in transmission of loads to the embedded parts.

2.3 FLOW INDUCED VIBRATION

- .1 The Contractor shall demonstrate that there is at least a 2:1 factor of safety against flow induced vibration exciting the natural frequency of any component for all operating conditions.

2.4 ICE LOAD

- .1 The ice load shall be a line load of 150 kN/m over the width of the gate applied to the gate at any depth up to 600 mm down from the water surface at the most conservative point for all possible water levels. The ice load shall be applied as part of the normal loading to the Spillway gates and all Spillway stoplogs.

2.5 SEISMIC LOADS

- .1 The seismic loads that are to be applied to all gates and permanent stop logs shall be calculated using the equations established by Westergaard in "Hydrodynamic Pressures on Dams Due to Horizontal Earthquake Effects", US Bureau of Reclamation, Engineering Monograph 11.
- .2 The equipment shall be designed to withstand seismic horizontal acceleration of 0.091 g.

2.6 MINIMUM MATERIAL THICKNESSES

- .1 The minimum material thickness of the equipment components shall be:
 - .1 Gates, Stoplogs, and Trashracks
 - .1 Structural element: 10 mm
 - .1 Non-structural elements: 8 mm
 - .2 Seal mounting bars after machining: 10 mm
 - .3 Seal clamping bars: 10 mm



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Embedded Parts

- .1 Exposed or partially exposed embedded parts: 12 mm
- .2 Structural embedded parts: 8 mm
- .3 Non-structural embedded parts: 6 mm
- .4 Stainless steel sealing strip after machining: 10 mm

2.7 FRICTION COEFFICIENTS

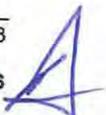
- .1 The following minimum friction coefficients shall be used in calculations of vertical loads acting on the gate or stoplog:

Material	Static	Dynamic
Self-lubricated bushings*:	0.15	0.10
Anti-friction bearing:	0.02	0.01
Rubber seals on stainless steel:	1.50	0.80
PTFE coated seals on stainless steel*	0.15	0.10
Wet steel on wet steel (non-lubricated)	0.40	0.20
Rolling friction	0.75 mm	0.75 mm

* Or the manufacturer's recommended value, whichever is higher.

- .2 The friction coefficient for PTFE and rubber seals on stainless steel shall be used to determine the normal capacity of the lifting equipment as follows:
- .1 For Intake Gate hoists: PTFE seal friction on 90% of the seals and rubber seal friction on the lower 10% of the seals;
 - .2 For Spillway Gate hoists: PTFE seal friction on 80% of the seals and rubber seal friction on the lower 20% of the seals;
 - .3 For other gates and stoplogs: rubber seal friction.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8 COMPONENT DESIGN REQUIREMENTS

2.8.1 General

- .1 The gates and the embedded parts shall be designed such that the deformations, deflections, elongations, oscillations and vibrations, under the action of the loads to which they are submitted, shall not result in a malfunction, deterioration or a permanent deformation of the loaded components or assemblies.
- .2 Anchor design including size, spacing, length and installation sequence shall be coordinated with the Engineer, concrete and reinforcing, and concrete contractor before the first stage concrete anchor concept is finalized and Accepted by the Engineer.

2.8.2 Embedded Parts

.1 Design Loads

.1 Guides for Gates, Stoplogs, and Trashracks

- .1 All embedded parts, including the tie rods to the primary anchors, shall be designed to resist the most unfavourable combination of loading conditions described below:
 - .1 All normal and abnormal loads exerted on to the embedded parts;
 - .2 Any additional hydrodynamic loads caused by flowing water;
 - .3 All possible lifting and friction loads;
 - .4 All forces due to the worst combination of tolerances;
 - .5 Wheeled gate embedded parts, including the anchors and the tie-rods connected to the anchors, shall be designed to withstand a load equal to 100% of the maximum load exerted by the wheels and induced by breaking of the concrete under the embedded beams supporting the wheels, along a frictionless 45° plane with respect to the centerline of the wheel path distributed over a 90° cone from the point of wheel contact with the track up to the depth where overlap occurs;
 - .6 All other embedded parts, including the tie-rods which connect them to the anchors, shall be designed to withstand a lateral load equal to 30% of the maximum normal and abnormal hydrostatic loads exerted by the wheels or bearing bars;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Loads exerted by the seepage of water between first stage and second stage concrete under the maximum steady state head applied on tie-rods and embedded parts;
 - .8 Loads exerted by the seepage of water between second stage concrete and the embedded parts under the maximum steady state head applied on tie-rods and embedded parts;
 - .9 Loads exerted by a jammed gate or stoplogs when raising or lowering;
 - .10 The embedded parts, including tie-rods and anchors, shall be designed to withstand the forces induced during concreting by a fluid concrete pressure assuming the height of lift not to exceed 2 m and the concrete density to be 2400 kg/m³ (not be combined with any other loading condition);
 - .11 Mass of all the components;
 - .12 Impact loads.
- .2 Spillway Steel Water Passage Liners
- .1 The steel water passage liners and anchors installed on the spillway walls and rollway shall be designed to resist the most unfavourable combination of loading conditions described below;
 - .1 Loads exerted by the seepage of water between second stage concrete and the steel liner under the maximum steady state head;
 - .2 Loads induced during concreting by a fluid concrete pressure;
 - .3 Any additional hydrodynamic loads caused by flowing water;
 - .2 If the steel water passage liner is not self supporting, and is relying on some other component for support, then these support loads shall be added to the design loads for the respective components.
 - .3 The steel water passage liner shall be sufficiently anchored in first stage concrete to avoid deformation under the specified conditions.
 - .4 Embedded angle assemblies shall be provided, to be turned over to the Engineer and installed by Company's Other Contract in the first stage concrete, to anchor the downstream end of the Spillway transition plates and the upstream ends of the Spillway steel water passage liners before second stage concrete is poured.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.5 Downstream transition plates shall be designed to be welded to the embedded gate guide liner plate and the embedded angles placed in the first stage concrete.

.2 Anchor Assemblies

.1 General

- .1 Anchor assemblies include all components required to be embedded, or to facilitate embedment, in first stage and second stage concrete for all embedded parts including but not limited to side guides, sill beams, lintel beams, and steel liners.
- .2 Contractor shall design and supply the first stage concrete anchorage system to resist the loads imposed by the trashracks, bulkhead gates, intake gates, draft tube stoplogs, spillway gates and spillway temporary and permanent stoplogs through their respective embedded parts. The loading cases and assumptions are defined in the Sections dedicated to each type of equipment.
- .3 The anchoring system shall be appropriate for the installation and alignment of the embedded guides within the specified tolerances before and after embedment in the second stage concrete.
- .4 The embedment depth of the all anchors shall be in accordance with Appendix D of the National Building Code of Canada (NBCC).
- .5 The anchor material and associated hardware shall be ASTM A307 or ASTM A325 or equivalent. ASTM A193 Type B7 is an acceptable equivalent for high strength embedded rods and its associated hardware. Higher grades of steel such as ASTM A490 are not permitted.
- .6 Contractor shall supply all bolts, screws, nuts and washers required to attach the anchors to the embedded guides and to the formworks.
- .7 Detail drawings of the anchors and calculations of the capacity of the anchorage system shall be submitted to Engineer for review and acceptance.
- .8 Anchor design including size, spacing, length and installation sequence shall be coordinated with the Engineer and concrete contractor before the first stage concrete anchor concept is finalized and Accepted by the Engineer

.2 First Stage Concrete

- .1 The number of anchors, and fasteners shipped to Site shall be at least 4% in excess of the number calculated from the drawings.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .2 Contractor shall provide all anchors and related components, for embedment in first stage concrete by Company's other contractor, including primary anchors, steel templates, and fasteners to mount the anchors/templates to the formwork.
- .3 In order to facilitate the alignment of the embedded guides, the load carrying anchors shall be of the adjustable hairpin type, allowing for an angular adjustment of ± 5 degrees in all directions of the tie rods and ensuring the transmission of the load in pure tension in the tie rods. The anchor design shall take into account that the primary anchors will be installed within a tolerance of ± 6 mm. Typical anchor arrangements are shown on the drawings for information.
- .4 For positioning anchors, «U» or «J» type anchors are acceptable,
- .5 The anchor spacing shall not exceed 600 mm. The horizontal and vertical anchor spacing shall not be less than 250 mm.
- .6 The anchors and tie rods shall not be less than 22 mm in diameter. Anchors and tie rods of a given diameter shall be of the same material and capacity to ensure compatibility and avoid confusion during installation.
- .7 Mechanical or chemical anchors are not permitted for anchoring of the temporary and permanent equipment
- .8 Contractor shall shall provide technical assistance during the installation of the anchors in first stage concrete and accepting the Work of Company's Other Contractor to proceed with placement of first stage concrete.
- .9 Contractor shall protect the threads of anchors supplied for primary concrete from concrete contamination during first stage concrete pour.
- .10 The primary anchors to be installed in first stage concrete shall be mounted on steel templates (plates or channels) designed to install a series of anchors at the correct spacing, and to be mounted on the formwork for ease of installation in first stage concrete by Company's Other Contractor. The steel templates shall be approximately 3 m in length for handling and for use over one concrete pours. Sequential templates shall bolt together, and shall be match marked.
- .11 The primary anchors to be embedded in first stage concrete shall be designed to be installed by Company's other contractor within tolerances of ± 6 mm.
- .12 The installation of any reinforcing, dowelling, or anchors into first stage concrete, after first stage concrete has been poured, and before second stage concrete is poured, shall be provided and installed by Contractor.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 Second Stage Concrete

- .1 Contractor shall supply and install all tie-rods, spherical nuts and washers required for attaching embedded parts to primary anchors in first stage concrete and adjusting the embedded parts.
- .2 Contractor shall supply and install any additional anchors that the design requires to be embedded in second stage concrete and/or to be drilled into first stage concrete.
- .3 The design of second stage concrete shall indicate whether additional reinforcing is needed in second stage concrete.
- .4 Forms for placing second stage concrete shall be designed to be supported by first stage concrete, or if the forms are designed to be attached to the embedded parts then the embedded parts shall be specifically designed to support the concrete forms.

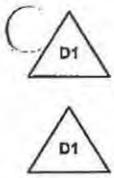
.4 Water stops

- .1 Water stops shall be provided on the pressurized side of the second stage concrete interface with the embedded steel part for the spillway gate side guides and sill beams and lintel beams.
- .2 Water stops shall be comprised of non-bentonite, modified chloroprene rubber and self expanding when exposed to water and, suitable for the design head, complete with an appropriate adhesive, Acceptable to the Engineer.

.3 Guides

.1 General

- .1 The guides shall consist of upper guides, lower guides, sill and lintel beams, and steel liners and all shall be of welded construction.
- .2 The choice of the materials for the sliding, rolling, guiding, sealing and contact faces on the guides shall be such that there will be no risk of any jamming or galling on any component.
- .3 The seal paths, wheel and bearing bar paths, guide roller paths, shoe/bumper paths and lintel beams, shall all have adequate transitions to allow the gate or stoplog to enter into, and move in, the guides without damage or wear to any component.
- .4 The gates and stoplogs shall be fully guided over the entire height of the guides and sufficiently constrained to eliminate damage to seals or any other



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

component, jamming, and excessive movement due to external forces, such as currents, wind etc., when hanging free.

- .5 All splices in the guides, connections between sill beams and lintel beams to the guides, steel liner plates, and any others joints requiring proper alignment, shall be bolted connections with machined flanged mating faces. All joints exposed to the water passage shall be seal welded.
- .6 All welded joints shall be ground flush for joints in the main water passage and on rolling, sliding and contact surfaces.
- .7 Final machining of the guides shall be performed after all fabrication has been completed and after all components have been stress relieved.

.2 Lower Guides

- .1 The lower guides shall consist of the steel liner, sill beam, embedded side guides, lintel beam where applicable, seal paths, wheel and guide roller paths, and bumper paths.
- .2 The lower side guide seal paths, wheel and guide roller paths and bumper paths shall extend over the entire height of the lower guides and shall be fully machined.
- .3 The hydraulic profile transition downstream of the guides in the water passages shall be offset to limit cavitation with a transition as described in USACE Hydraulic Design Chart 212-1/1 (<http://chl.erdc.usace.army.mil/hdc>), and as shown on the Drawings.
- .4 The lower guide slots shall be completely steel lined over their entire height. The guide slot steel lining shall have a radius ending tangent to the adjacent water passage profile.

.5 Upper Guides

- .1 Upper guides that are embedded in concrete are not required to be fully steel lined. However, if not fully steel lined, adequate means shall be provided to ensure proper installation and alignment.
- .2 Upper guides that are required to extend beyond the concrete shall be designed as a rigid structure such that any deflections do not impede the operation of the gate or stoplog.

.6 Wheel Paths

- .1 The wheel paths shall be corrosion resistant alloy steel with hardness between 235 and 270 BHN. These roller paths shall be machined over their

Handwritten signature and initials in blue ink.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

full length. The wheel paths shall be at least 12 mm wider on each side than the width of the contact ellipse between the wheel and the wheel path calculated for the maximum load condition.

.7 Seal Path

- .1 All seal paths and seating strips shall consist of stainless steel machined over their entire length with a minimum of 10 mm thickness of material remaining after machining.
- .2 The seal paths and seating strips shall be seal welded along their entire length on all sides.

.8 Guide Heaters

- .1 Where heating of the guides is specified, the guides shall have embedded heating element ducts in each of the side guides over the full length of the embedded guide designed to receive tubular heating elements of a standard size and positioned to keep the guides clear of ice.
- .2 A minimum of three (3) heating element ducts shall be provided in each side guide; one (1) for heating the guide on the wet side and two (2) for heating the guide on the dry side.
- .3 These heating element ducts shall be designed to be watertight with a water tight cover.
- .4 At the junction of two heater duct sections, the ducts shall have an overlap section to provide a backing for the seal welds.
- .5 The bottom end of the heater ducts shall be provided with a drain accessible from the dry side.
- .6 The required tubular heating elements shall each have a heating capacity of 500 Watts per lineal meter.
- .7 Each guide shall be equipped with a temperature measurement duct capable of holding a standard sized RTD for temperature measurement and the duct shall extend at least 3 m down the guides below the FSL. The duct shall be attached in such a way to ensure good thermal conductivity between the guide and duct. The duct shall be located on the side of the guide that contains the single heating element duct.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Lintel Beam

- .1 There shall be a smooth transition on the top edge of the lintel beam and seating strip to permit gradual engagement of the top seal such that there is no risk of being damaged.
- .2 The lintel beam shall be installed in second stage concrete.

.5 Sill Beam

- .1 The upper surface of the sill beams shall be stainless steel, shall nominally be flush with the finished concrete surface except for the seal and weight supporting faces which shall be horizontal in the flow direction. In no case shall any part protrude above the nominal hydraulic profile.
- .2 The sill beams shall be installed in second stage concrete.
- .3 For the spillway the sill beam shall be continuously welded to the steel downstream water passage liners.

.6 Grouting

- .1 All embedded components shall have provisions for venting air during grouting and concrete pouring, and shall be plugged and seal welded after completion of the installation.
- .2 Voids shall be injected with a non-shrink cement grout Accepted by Engineer.
- .3 All bases for ancillary equipment, such as storage devices, platforms, dogging devices etc., anchored to the concrete deck shall be grouted.

2.8.3 Gate and Stoplog

.1 Normal Design Load Conditions

- .1 All gates and stoplogs shall be designed in such a way that the stresses in each component are less than the maximum permissible stresses for the most unfavourable combination of loading conditions described below: Normal loading condition shall consist of the following loads applied simultaneously:
 - .1 hydrostatic pressure as specified for the specific component;
 - .2 mass of the component itself and all components acting on it,
 - .3 all possible lifting and friction loads acting during normal (not jammed) raising or lowering;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 ice loading as described in Clause 2.4 for spillway gates and stoplogs only;
 - .5 for Spillway gates and stoplogs an allowance for the accumulation of ice and debris on the gates;
 - .6 for Spillway gates and stoplogs ice loading caused by freezing in the guides on unheated gates and guides;
 - .7 lateral loads from wheels or bumper bars;
 - .8 for Spillway and Intake gates all hydrodynamic forces acting on the gate in motion, during normal (not jammed) opening and closing throughout the range of upstream and downstream water levels;
 - .9 a corrosion allowance of 1.5 mm minimum shall be added to the thickness of the skinplates on the Intake and Spillway gates, but the corrosion allowance shall not be used in the design of the structure.
- .2 The design of gates and stoplogs on the spillway shall take into account deflections and loading due to movement of the piers for normal combined pier deflections of +/-13 mm from flow in adjacent spillway bays with one water passage isolated.

.2 Abnormal Design Load Conditions

- .1 Abnormal loading condition shall consist of the following loads applied independently:
 - .1 Abnormal hydrostatic pressure as specified for the specific component and if overtopped, taking into account any additional adverse hydrostatic or hydrodynamic forces (flow, negative pressure, etc.) acting on the downstream side.
 - .1 Added pressure exerted by the water on the gate in the event of an earthquake corresponding to a normal load condition reservoir level.
 - .2 All forces resulting from possible jamming of the component in the guides with the hoist motor producing its maximum breakdown torque, operating at rated voltage, and assuming a 100% mechanical efficiency of the hoist.
 - .3 For the Spillway and Intake gates this load shall be applied simultaneously with the normal hydrostatic pressure.
 - .4 The locations where the jamming forces are applied shall consider the component and hoist specific designs taking into account all possible scenarios as broken wire rope, failed guiding system on component or

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

lifting device, debris etc. The resulting load case may result in symmetric or asymmetric loading.

.2 The design of guiding devices on the spillway shall take into account deflections and loading due to movement of the piers for abnormal combined pier deflections of +/-17 mm with the addition of earthquake forces.

.3 General Design Requirements

- .1 Gates and stoplogs shall be designed in such a way that the stresses in each component are less than the maximum permissible stresses for the most unfavourable combination of loading conditions.
- .2 All gates and stoplogs (components) shall be of the welded construction type and be watertight in every respect.
- .3 The horizontal beams shall be so spaced that each carries an equal hydrostatic load.
- .4 The skin plate and horizontal main beams shall be connected at each end to vertical end girders. Diaphragms and stiffeners shall be used, as required, to stiffen the gate structure.
- .5 All welding shall be continuous.
- .6 The design shall ensure that the skin plate acts in conjunction with the main beams and the stiffeners to which it is welded.
- .7 A minimum of four 100 mm diameter drainage holes shall be provided in the web of each horizontal beam, and the bottom plate, to ensure the drainage. If the beam web is divided by stiffeners then there shall be at least one drain per section.
- .8 Where gates are required to be sectionalised for shipping the individual gate sections shall be assembled on Site by bolted connections, with fitted bolts or dowels for alignment, and sealed with a watertight weld.
- .9 In the event of a failure of a wire rope the component shall be capable of being lowered to a safe position, including dogging devices or the sill, for repair.

.4 Gate Bottom

- .1 If the gate or stoplog is installed where the waterway invert hydraulic profile is sloping, the lower section(s) shall be designed to accommodate the sloping face both physically and hydraulically.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 For the Intake and Spillway gates, the bottom of the gates shall be designed to avoid harmful hydrodynamic loads and extreme downpull forces, including the use of vents in the gate bottom plate.
- .3 The lower lip (contact face) of the Intake and Spillway gates shall have a machined stainless steel layer with a minimum thickness of 3 mm.

2.8.4 Trashracks

.1 Design Load Conditions

- .1 All trashrack components shall be designed to withstand, without exceeding the allowable stresses, the most unfavourable combination of loading conditions described below:

Loading Condition	Description
.1 A	Mass of the trashrack and its accessories
.2 B	Weight of trash
.3 C	All possible lifting and friction forces
.4 D	All forces resulting from possible jamming (see Clause 2.9.3.2)
.5 E	Uniform hydrostatic pressure differential corresponding to 6 m of water corresponding to a partial blockage of the trashracks
.6 F	Horizontal impact of 16 kN, applied simultaneously on four (4) bars at any location of the trashrack surface
.7 G	Vibration due to water flow velocity through the bars
.8 H	Loads imposed by a trash cleaning system
.9 I	Accumulation of 5 mm of frazil ice on all surfaces

.2 Load Cases

- .1 Load Case 1: Normal Load $A + E + F + G + H$
- .2 Load Case 2: Normal Load $A + E + F + G + I$
- .3 Load Case 3: Normal Load $A + B + C$

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Load Case 4: Abnormal Load A + B + C + D

.3 General Design Requirements

.1 The design of the trashracks shall include calculations of stresses, deflections, buckling and vibration for all loading cases taking into account the following criteria:

.1 The design flow velocity (flow/net opening area) between trashrack bars under clean conditions shall not exceed 1.5 m/s at rated flow.

.1 The weight of the trashracks shall exceed all forces resisting installation, including friction and buoyancy by a minimum of 25%.

.2 The formation of frazil ice shall be considered in the design.

.3 Calculations for trashrack bars shall include a check for lateral buckling.

.4 Bars shall be spaced to have a clearance of 100 mm between each bar.

.5 The nose of bars shall be rounded to reduce frictional forces and frazil ice formation.

.6 Trashrack bar thickness shall not be less than 10 mm and a depth not less than 110 mm.

.7 The depth of bar section shall not be more than 12 times its thickness.

.8 A corrosion allowance of 1.5 mm minimum shall be used in the design of the trashrack bars.

.2 Trashrack bars and horizontal stiffeners shall be designed to eliminate interference with the trash rake.

.3 The structure of the trashracks shall be designed to withstand a lateral load of 30% of the maximum hydraulic load exerted on them.

.4 A vibration analysis shall be performed both with and without the corrosion allowance and with and without 5 mm of frazil ice covering all surfaces. Turbine maximum discharge of 640 m³/s plus 20%, or 768 m³/s, shall be used to verify vibration parameters through the trashrack bars.

.5 The maximum weight of any component shall not exceed 18,000 kg including the weight of the lifting beam and friction forces.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Head Losses

- .1 The trashracks shall be designed to minimize head losses across the trashracks.
- .2 The Contractor shall provide calculations and/or test data from prior installations, to be submitted for Acceptance by Engineer, for the expected head loss demonstrating that it is within the value provided with the bid.

2.8.5 Wheel Assemblies

.1 General Requirements

- .1 Wheel assemblies consist of; wheel rim, eccentric axles, axle locking device, anti-friction bearings, seals, greasing point, bearing cover, and any other hardware required for the wheel to function such as fasteners, washers, etc.
- .2 The number of wheels and their spacing shall be fixed in such a way that each wheel carries an equal hydrostatic load for the normal loading conditions.
- .3 The wheel assembly shall permit easy operation of the gate without undue deflection, vibration, or overstress.
- .4 All wheel assemblies shall be designed to resist the stresses generated by:
 - .1 The worst possible combination of loads acting on the gates;
 - .2 A simultaneous lateral thrust of 30% of the maximum radial wheel load, applied at the wheel periphery.
 - .3 Failure of a single wheel axle locking device at any location, allowing the eccentric axle to rotate, shall not cause adjacent wheel locking devices to fail, or result in permanent deformation of the gate structure.
 - .4 Failure/seizure of a single wheel bearing shall not prevent the gate from being raised for repairs.

.2 Wheel Rims

- .1 The main wheels shall be of ASTM A504 forged steel construction with the rolling surface hardened to between 321 and 363 BHN.
- .2 Wheel rims shall be 50 BHN points higher than the wheel paths.
- .3 The hardening depth of the wheel rim shall be greater than or equal to twice the depth of the maximum shear stresses location.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 The wheel rim width shall not be less than the value given by the following formula:

$$W = \frac{P}{F_p \cdot D}$$

Where: W = wheel rim width in mm

P = wheel load in N

D = wheel diameter in mm

F_p = Maximum allowable stresses on the wheel projection in MPa. F_p may be increased by 33% for abnormal wheel load conditions.

Where:

$$F_p = \frac{0.169 \cdot (BHN) - 15.169}{3}$$

BHN = Brinell hardness number

- .5 However, the width W shall not be less than the length of the major axis of the ellipse of contact plus 25 mm, taking into account the deflection of the gate.
- .6 The rolling surface of the wheels shall be crowned sufficiently to accommodate the worst case deflection of the gates.
- .7 The ratio of the curvature radius of the wheel crowned surface to the radius of the wheel shall not be greater than eight (8), and the value of the curvature radius shall not be greater than 3,000 mm.
- .3 Anti-Friction Bearings
- .1 All main wheels shall be mounted on conical roller bearings fabricated by a reputable manufacturer.
- .2 The roller bearings shall be kept in place and be protected on each side of the wheel by removable steel covers having watertight seals to both contain the wheel bearing grease and to prevent water ingress around the cover and axle. The covers shall be stainless steel.
- .3 The bearing assembly (wheel, bearing, and axle) shall be designed to accommodate the design lateral loading.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Wheel Axles

- .1 The wheels shall be mounted on fixed axles held mechanically in the vertical end girders of the gates.
- .2 The wheel axles shall be machined with no less than 3.0 mm eccentricity relative to the machined bearing surface to permit alignment of the wheels during assembly.
- .3 Following adjustment of the wheels, the axles shall be mechanically fixed to prevent rotation and loss of adjustment.

.5 Lubrication

- .1 All wheels axles shall have provisions for greasing the bearings.
- .2 The wheel bearing grease points shall have stainless steel tubes connecting them to two central banks of fittings easily accessible from the top of each gate.
- .3 A means of flushing the grease through the entire assembly shall be provided.
- .4 In order to prevent any damage from vibration, the grease tubes must be supported and protected along their entire length by a channel or other structural element.

2.8.6 Bearing Bars

- .1 Gate sections and stoplogs, that do not have wheels, and trashrack panels, shall be provided with bearing bars that cover the full height of the section and transmit the load to the bearing surface of the embedded parts.
- .2 The material for the bearing bars shall be selected as to ensure that no galling takes place between the bearing bar and the bearing surface of the embedded parts. A non-corrosive material shall be used for bearing bars on permanent gates or stoplogs, however, steel may be used for bearing bars on temporary gates or stoplogs. Submitted calculations shall show the bearing bar material does not gall with the slots' bearing surface.
- .3 The bearing bars shall have a radius to accommodate gate deflection.
- .4 The design of the bearing bars shall include a lateral side thrust equal to 30% of the normal condition loading applied to each side.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8.7 Guiding Devices

.1 General

- .1 All components (which includes gates, stoplogs, and trashrack sections), shall be provided with guiding devices that control and guide the assembly throughout their entire range of travel to prevent jamming during normal raising and lowering, to prevent inadvertent contact with other equipment or structures, and to help keep the assembly centred laterally in the guides.
- .2 The design of all guiding devices shall take into account loading due to worst case sliding friction, impact loads, seized wheel or guide roller, jamming while raising or lowering, indirect loads such as ice, and a simultaneous side load equal to 100% of the highest in plane load applied where the device contacts the guide.
- .3 The design of lateral guiding devices on the spillway shall take into account deflections and loading due to lateral movement of the piers and be operable for normal combined lateral pier deflections of +/-13 mm from flow in adjacent spillway bays with one water passage isolated, and for abnormal combined lateral pier deflections of +/- 17 mm with the addition of earthquake forces, and be capable of withstanding those deflections without damage.
- .4 Anywhere there is the possibility of sliding contact, the materials used shall be selected to minimise friction and to eliminate the possibility of galling.
- .5 For the purpose of design of the guiding device itself, jamming during lowering or raising, due to debris, seized wheels or high sliding friction possibly due to damaged seals, and failed wire rope, shall be considered as a normal loading condition.
- .6 In the case of a jammed component, regardless of what caused the jam including a failed wire rope, the guiding device shall permit the component to be lowered to a safe position (dogging devices and/or sill).

.2 Lateral Guide Rollers and Guide Shoes

- .1 Guiding devices shall be provided as a minimum at the four (4) corners on all individual assemblies to properly guide the component laterally in the guides and reduce the possibility of jamming. The guiding devices shall be designed to accommodate the worst case lateral loading as described for the guiding devices above.
- .2 The Intake and Spillway Gates shall be provided with lateral guide rollers assemblies that use preloaded springs to effectively guide the gate during its descent, keep the gate vertical, keep the gate centred, and ensuring that the bottom of the gate makes good contact with the sill.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Guide roller assemblies shall consist of carbon steel rollers, stainless steel axles, self lubricated bushings and thrust mechanisms, stainless steel thrust surfaces, and axle seals.
- .4 The self lubricated bushings shall be one of Orkot, Kamatics, or Delrin. The Contractor may propose an alternate material and submit to the Engineer for Acceptance.
- .5 The spring guide roller assemblies shall have a range of motion of +/-6 mm under normal operating conditions where "zero" corresponds to the gate centred in the guides with the guide rollers contacting the guides, and shall be capable of bottoming out on guide shoes without damage.
- .6 As a minimum guide shoes shall be provided for all other gates, gate sections, stoplogs, and trashrack panels to limit the lateral movement of the assembly to 6 mm from the centred position but guide roller assemblies may also be used.
- .7 The lateral guide shoes sliding surfaces shall be a suitable bronze or HDPE material, and Accepted by the Engineer.

.3 Upstream/Downstream Guide Shoes and Springs

- .1 Guiding devices shall be provided as a minimum at the four (4) corners on all individual assemblies to properly guide the component in the guides and reduce the possibility of jamming.
- .2 For all Bulkhead Gate sections and stoplogs with seals located on the downstream side, the guiding devices shall have leaf springs located on the upstream side to pre-load the seals against the guides, and the force applied by the leaf springs shall be sufficient to ensure there is at least 95% contact of the seal with the guides.
- .3 Guide shoes shall be provided to limit the spring compression so the springs are not damaged by over-compression.
- .4 For all gate sections and stoplogs with seals located on the upstream side, guide shoes shall be provided on the upstream side of each section to prevent damage to the seals and galling of the seal clamp bars on the embedded guide sliding surfaces.
- .5 The guide shoes sliding surfaces shall be a suitable bronze of HDPE material, and Accepted by the Engineer.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8.8 Seal Assemblies

.1 Seal Type and Configuration

- .1 The Bulkhead gate and stoplog side and lintel (for those components that have lintels) seals shall be elastomeric bulb J-seals.
- .2 The bottom seals of multi-section gates or stoplogs shall be elastomeric bulb J-seals.
- .3 Lintel seals for the Intake Gates shall be double stem bulb seals
- .4 The bottom gate seals, in contact with the sill, shall be an elastomeric flat seal.
- .5 For Spillway gates, the bottom gate seals shall be located downstream of the skin plate. In this case the side and sill seals shall be connected with a block of sealing rubber.
- .6 Sealing between individual gate sections and between stoplogs shall use elastomeric bulb J-seals.
- .7 See Appendix A for details on seals properties.

.2 Contact Faces

- .1 All seal contact faces (side guides, lintel beams, sill beams, and joints between gate and stoplog sections) shall be stainless steel and fully machined.

.3 Seal Attachment

- .1 The seals shall be securely fastened to the component sections by stainless steel clamping plates, stainless steel seating plates and stainless steel bolts, nuts and washers.
- .2 The diameter of the bolts shall be a minimum of 16 mm and they shall be spaced between 75 and 100 mm.
- .3 The clamp bolts shall be Nitronic 60 type stainless steel fasteners.
- .4 The seal attachment/clamping plates shall be designed to provide the required pre-load to prevent movement of the seal within the clamping mechanism, permit free movement of the seal to minimize leakage, and still provide adequate support to the seal to counteract hydraulic and friction forces.
- .5 The seals shall have a minimum of 4.5 mm initial unloaded deflection with the gate or stoplog installed in the guides.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .6 The bottom of the side and sill seals shall have 3 mm compression.
- .7 The edges of the clamp plates and skinplate shall be chamfered to prevent damage to the seals.
- .8 The seating plates to which the seals are bolted shall be fully machined.

.4 Seal Leakage

- .1 The seal leakage shall not exceed 3 L/min/metre of total seal length (around perimeter and between sections) on each water passage assembly.

.5 Seal Jointing

- .1 Joints to be made by Contractor either in the shop or at Site shall be reduced to the minimum and shall be limited to joints which cannot be made by the seal manufacturer because of transportation limitations.
- .2 Bulb seal corners shall be moulded by the seal manufacturer.
- .3 Detailed drawings showing the location of the joints and describing the jointing procedure shall be submitted to Engineer for Acceptance.
- .4 The joints shall be hot vulcanized, and made according to the specifications by the seal manufacturer.
- .5 Joints shall be clear of any holes in the leg of the seal provided for attaching the seal to the gate.
- .6 Vulcanization shall be carried out with the two (2) extremities secured in an alignment die.

2.8.9 Dogging Devices

- .1 The dogging mechanism shall be designed in such a way as to ensure personnel safety during operations and maintenance of all equipment and shall be lockable in both the extended and retracted positions.
- .2 As a minimum the dogging devices shall be designed to support 125% of the maximum possible dead weight distributed to both sides evenly as a normal load case and 100% of the maximum possible dead weight acting on one side only as an abnormal load case.
- .3 All dogging devices shall be designed such that they can be easily installed and removed; and safely performed by one person.

96 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 Anchors for the dogging beams can be embedded in second stage concrete, or if embedded in first stage concrete shall be provided to Engineer for installation by Company's Other Contractor.
- .5 The dogging beam supports shall be design as to not point load the edge of the concrete. The dogging beam supports shall either be located sufficiently away from the edge to avoid shearing the corner of the concrete edge or be provided with additional plates and reinforcement to be included in first stage concrete.
- .6 Systems using cantilever gate wheels as dogging devices are not acceptable.



2.8.10 Lifting Points

- .1 For use in Guides
 - .1 All lifting points for use with lifting devices and/or hoists with component in guides shall be designed for the maximum normal and abnormal design hoisting loads. The resulting design load, regardless of origin, shall be assessed as a normal load.
 - .2 All lifting points shall be designed with due consideration for their respective lifting devices and/or hoists.
 - .3 The lifting points shall be located within 5 mm of the component centre of gravity when hanging freely. Design briefs shall be provided to demonstrate that all the gate weights and centre of gravity of the fully assembled gate is within five (5) mm of the lifting point's vertical plane.



.2 For General Handling

- .1 A minimum of two lifting lugs shall be provided on each component section for general handling during transportation, off loading and erection, when the gate is vertical or horizontal with the intent that a minimum of 2 lifting lugs would be used for any lift.
- .2 The design load for each individual lug shall be 100% of the dead weight taking into consideration appropriate lifting and sling angles.
- .3 Lifting points that are to be used for hanging the gate or stoplog vertically shall be located within 5 mm of the gate or stoplog centre of gravity when hanging freely.

2.8.11 Fasteners and Dowelling

- .1 Bolted connections shall be design according to CSA S16 Standard. Bolted connections maybe either friction or shear type except as detailed below.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Where fastener torque is critical the design of the fastener, or joint, shall take into consideration the uncertainty in the selected torquing or tensioning method.
- .3 Where components are to be removed, and are part of routine or reasonably expected maintenance, the fastener design shall be of the shear type and designed such that precise torquing or tensioning of the fastener is not required. All other connections shall be friction type.
- .4 All joints where alignment is critical shall incorporate locating dowels or fitted fasteners.
- .5 Use of ASTM A490 bolts are not allowed where moisture is present.

2.8.12 Storage Provisions

- .1 Gate and stoplogs sections that require storage on the ground or in a stand when not in use shall have a convenient means of being placed in the storage location and shall be designed to be stable without the need for additional blocking or lateral supports.
- .2 Gate and stoplogs that are not stored in their respective guides shall be provided with lateral supports to prevent accidental overturning as an additional safety precaution.
- .3 The contact point between the component and the ground or stand shall be HDPE or rubber bolted to the component.
- .4 Gate and stoplogs sections shall be provided with a means to prevent the seals from being compressed or damaged during handling or storage.

2.8.13 Greasing System

- .1 For all components to be greased the greasing nipples shall be Alemite button head type, No. 1186 with 1/4 inch NPT. Bearings/axles shall incorporate grooves to ensure proper distribution of the grease. The greasing shall be designed for a pressure of 13.5 MPa.
- .2 Two (2) battery powered grease guns, complete with battery chargers and spare batteries for each, shall be provided that are suitable for lubricating all greasing points on all equipment supplied for this contract and capable of operating at a minimum of 48.5 MPa.
- .3 The battery powered grease guns shall be heavy duty industrial grade using high voltage lithium-ion batteries.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

2.8.14 Spare Parts

- .1 Required Spare Parts shall include the following:
 - .1 Two (2) complete wheel assemblies of each type;
 - .2 Four (4) sets of anti-friction bearings of each type in addition to bearings provided with wheel assemblies;
 - .3 Two (2) complete guide roller assemblies of each type including springs;
 - .4 One (1) leaf spring of each type;
 - .5 Length of J seal of each type sufficient for one (1) complete gate or stoplog requiring the longest seal;
 - .6 Length of flat seal of each type sufficient for two (2) complete gates or stoplogs requiring the longest seal;
 - .7 Four (4) moulded J -seal corners of each type;
 - .8 One (1) Spillway gate blower/heater.
 - .9 One (1) complete set (six (6) heaters) of Spillway gate side guide heaters.
- .2 Contractor shall provide a list of Recommended Spare Parts that Contractor would recommend Company purchase as an option.

2.8.15 Tooling

- .1 Contractor shall design and supply maintenance tooling and jigs necessary to safely remove wheel assemblies, and replace wheel bearings, for both the Spillway and Intake gates.

PART 3 TECHNICAL REQUIREMENTS

3.1 SPILLWAY GATES

3.1.1 Hydrostatic Design Load Conditions

- .1 Normal Load: Hydrostatic pressure corresponding to a reservoir level of El. 39.0 m.
- .2 Abnormal Load: Hydrostatic pressure corresponding to a water level of El. 41.5 m.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.2 General Design Criteria

- .1 The Spillway gates shall have fixed wheels, with upstream skin plates and seals, and operated by wire rope hoists.
- .2 The Spillway gates shall be designed to open and close against flow and operate continuously at any opening, and at any reservoir elevation up to the maximum level.
- .3 The Spillway gates shall be designed so that they can be closed from any opening, at any reservoir elevation, under 80% of their own weight considering the worst combination of all opposing forces.
- .4 The Spillway gates and guides shall be designed so that the gate can be repeatedly closed at emergency closure speed (on the fan brake only), in the wet or dry, such that there is no damage.
- .5 The Spillway gate guide sill elevation will initially be at El. 5.0 m during the diversion phase of the project and raised to El. 18.0 m as part of the final rollway construction.
- .6 Each Spillway gate shall be provided with heaters for winter operation of the gates but shall be designed such that the gates can be left unheated year round without any deterioration.
- .7 The Spillway gates shall be designed to withstand 0.5 m overtopping of the gates without structural damage to the gates or lower sheave blocks.
- .8 A corrosion allowance of 1.5 mm minimum shall be added to the skinplate on the Spillway gates.

3.1.3 Guides

- .1 The lower guides shall extend from the sill beam to the top of the embedded guides. The lower guides shall be steel lined over their entire height, steel liners on the transition walls downstream of the embedded guides in the water passages shall be welded to the downstream face of the embedded guides and the steel angles embedded in downstream corner in primary concrete as shown on the drawings.
- .2 The hydraulic profile transition specified in Clause 2.8.2.3.2.3 shall be fabricated in steel for the entire height of the lower guides and shall be an integral part of the lower guides complete with stiffeners and welded to angles embedded in first stage concrete.
- .3 The upper guides shall extend up the hoist towers such that the gates are adequately guided in all directions when opening up to their maximum elevation and shall be designed for all possible loading conditions such as, but not limited to,



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

hydraulic loads due to a partially opened gate, wind loads, seismic loads, jamming loads, tower deflections etc.

- .4 The upper guides shall be designed such that a gate could be completely removed without cutting or grinding components or welds.
- .5 The upper guides shall include conveniently removable sections and other such provisions for performing maintenance on the gates such as wheel removal and repair, guiding device removal and repair, gate seals replacement etc.

3.1.4 Steel Liners

- .1 The final concrete rollways downstream of all Spillway gates shall be lined with steel over 3 metres in the downstream direction on the rollway and up the piers to a height of 3 metres above the sill.
- .2 The steel liner on the rollway shall conform to the parabolic hydraulic profile of the rollway.
- .3 The steel liner shall have stiffeners and anchors as required to meet all the design requirements and shall be continuously welded to the guides and sill beam, and shall be ground smooth after welding.
- .4 The steel liner shall be flush with the concrete surface.
- .5 The steel liner shall be a minimum of 19 mm thick.

3.1.5 Spillway Gate Heating

- .1 The Spillway gates shall be heated a minimum of 500 W per square metre of projected gate area (estimated 121 kW per gate).
- .2 The Spillway gates shall be enclosed and sealed on the downstream face with panels, consisting of insulated coated metal cladding, so that the gates can be heated.
- .3 Contractor shall submit details on panel materials to Engineer for Acceptance.
- .4 The panel insulation shall be a minimum 38 mm thick of water resistant, non-flammable, non-toxic rigid insulation attached by studs.
- .5 The installation shall be airtight and watertight such that rain, mist, and splashing cannot get into the heated enclosure and there is minimal uncontrolled air leakage.
- .6 The panel design shall minimize any thermal bridging.
- .7 The panels shall be designed to withstand 0.5 m overtopping of the gates.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .8 The top horizontal beam shall have insulation of the same type as the downstream face, and shall have mechanical protection over the entire surface to allow access to the top of the gate for maintenance, and to the access hatch, without causing damage to the insulation.
- .9 The inside of the gates shall have permanent heating using a minimum of two (2) blower heater units located in the upper part of the gate and capable of maintaining a minimum temperature of 5°C at any point in the gate. The blower heater units shall be equipped with thermal overloads.
- .10 Two (2) temperature sensors shall be provided in each gate to control the separate heaters and the temperature sensors shall provide temperature indication and heater status to the gate PLC for remote monitoring. Temperature sensors in the gates shall be designed for operation in a moist environment.
- .11 Ventilation ducts provided with adjustable outlets shall ensure the distribution of hot air from the heaters to maintain the required temperature throughout the gate and to re-circulate hot air around each wheel assembly. Wheel assemblies shall have rubber baffles to minimize heat loss.
- .12 Two 100 mm diameter pipe intake air vents shall be installed equally spaced on top of the gate, one at each end, to reduce condensation build up inside the gate. Each vent shall be equipped with a 180 degree elbow to prevent ingress of precipitation.
- .13 Heated exhaust air shall be directed to the sheave assemblies located at the top of the gate.
- .14 The heater's electrical terminals shall be accessible from inside the gate or by removing a watertight cover.
- .15 Maintenance and repairs of the heaters shall be from inside or through sealed waterproof panels.
- .16 The top of the sheaves shall be closed and sealed around cables to conserve heat.
- .17 Due to concerns of ice build up during the Diversion Phase, insulation panels shall not be installed on the bottom 2 m as a temporary measure. Instead a removable waterproof metal plate of sufficient thickness to resist downstream ice load forces shall be used to replace the bottom 2 m of insulated panels. The permanent bottom 2 m of insulated panels shall be installed after each rollway has been completed. Contractor shall be responsible for installing additional temporary heaters in the lower section of the Spillway gates that maybe necessary to keep the gates from freezing during the Diversion Phase.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



.18 Design to be completed in accordance with requirements of;

- .1 Electrical Divisions, supplemented by this section.
- .2 CSA C22.1 and CSA C22.2.

3.1.6 Spillway Gate Guide Heating

- .1 The guides shall be provided with heating element ducts and permanent heaters in all of the ducts. Each heating element shall be equipped with a thermocouple for temperature measurement.

3.1.7 Dogging Devices

- .1 The gate dogging devices shall be designed and provided to suspend the gate at multiple elevations, to allow inspection and replacement of each set of wheels, and inspect the lower lip of the gate at a comfortable level, all from the spillway deck at El. 45.5 m and without the use of scaffolding. Systems using cantilever gate wheels as dogging devices are not acceptable.



3.1.8 Miscellaneous Devices and Accessories

- .1 In addition to the main elements already described, Contractor shall provide all necessary devices and accessories for the optimum operation of the gate, in order to satisfy the requirements of these specifications including, but not limited to:
 - .1 The Spillway gates shall be provided with attachment points for fall arrest personnel safety equipment for use during gate maintenance, including one at the top of each gate ladder.
 - .2 The gates shall be provided with bolted on guard rails going all around the top of the gates to give a safe access for maintenance including convenient gated access points.
 - .3 Bolted permanent bases for a portable davit arm shall be provided on the top of gate, near the access hatches and ladders, capable of injured worker extraction from inside the gate.
 - .4 Each gate shall be supplied with a ladder inside the gate to permit access over the entire height of the gate.
 - .5 The ladder shall be fabricated in sections; each separate section shall be installed in an offset pattern between the webs.
 - .6 A manhole shall be provided in the web of each horizontal beam with the uppermost one having a watertight cover.
 - .7 The webs shall be adequately reinforced around the ladder openings.

MSB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .8 One access door with watertight cover shall be supplied on the lower part of the downstream plate of each gate to provide access to the rollway when the gate is closed, or to provide entry to the gate from El. 45.5 m when the gate is fully raised to the maintenance position.
- .9 All bolting holding the manhole and access door cover seals shall be stainless steel, and all parts subject to removal shall be non-corrosive materials.
- .10 Covers for the manholes and access doors shall be hinged, lockable, capable of being opened without help of tools, have no loose pieces, and be capable of being latched in the open position.
- .11 Wind seals shall be provided, made of oil resistant, reinforced rubber; having a minimum thickness of 12 mm; designed to close the gap between the downstream end-girder and the embedded parts over the full height, and over the top of the gate wheels, in order to reduce heat losses;
- .12 Wind seals shall be mounted on brackets welded downstream of the gate.
- .13 All gate and sheave components shall be of sufficient strength to withstand 0.5 m overtopping of the gates without damage.

3.2 SPILLWAY STOPLOGS

3.2.1 Hydrostatic Design Load Conditions

- .1 Spillway Stoplogs Upstream of Spillway Gates
 - .1 Normal Load: Hydrostatic pressure corresponding to a water level of El. 39.0 m.
 - .2 Abnormal Load: Hydrostatic pressure corresponding to a water level of El. 41.5 m.

.2 Spillway Stoplogs Downstream of Spillway Gates

- .1 Normal Load: Hydrostatic pressure corresponding to a water level of El. 12.50 m.

3.2.2 General Design Criteria

- .1 Permanent Stoplogs Located Upstream of Spillway Gates (type S1 on drawings)
 - .1 During the diversion phase of the project these stoplogs shall be designed and configured with upstream skinplates and seals, and will only be used in the farthest upstream stoplog guides, and then after the rollway construction has been completed, they shall be converted to downstream skinplates and seals



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

and thereafter will only be used in the guides closest to the upstream side of the Spillway gates.

- .2 The stoplog guides immediately upstream of the Spillway gates shall be equipped with a dogging device that permits two stoplogs to be stored at the very top of each guide.
- .3 Handling of these stoplogs in both sets of guides shall be by the trash cleaner's underhung travelling hoist using a lifting beam.
- .2 Temporary Stoplogs Located Upstream of Spillway Gates (types S2 and S3 on drawings)
 - .1 These stoplogs shall be designed with upstream skinplates and seals (wet side), and will only be used in the farthest upstream stoplog guides.
 - .2 These stoplogs do not require any stainless steel components or fabrications.
 - .3 Handling of these stoplogs shall be by the trash cleaner's underhung travelling hoist using a lifting beam.
- .3 Permanent Stoplogs Located Downstream of Spillway Gates (type S4 on drawings)
 - .1 These stoplogs shall be designed with upstream skinplates and seals (wet side), and will only be used in the farthest downstream stoplog guides.
 - .2 Handling of these downstream stoplogs shall be by mobile crane using a lifting beam.
 - .3 The stoplog guides shall be equipped with a dogging device that permits one stoplog to be stored at the very top of each guide such that the bottom of the stoplog does not protrude below the bottom of the permanent downstream bridge.
- .4 Temporary Stoplogs Located Downstream of Spillway Gates (type S4 on drawings)
 - .1 Same requirements as 3.2.2.3 except these stoplogs do not require any stainless steel components or fabrications.
 - .2 A storage location and method shall be provided for storing the temporary stoplogs when not in use, and shall be Acceptable to Engineer.

3.2.3 Guides

- .1 All stoplog guides shall be considered permanent works and all design criteria for permanent works shall apply.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .2 All lower guides shall extend from the sill beam to the top of the embedded guides. All permanent and temporary spillway lower guides shall be steel lined over their entire height, steel liners on the transition walls downstream of the embedded guides in the water passages shall be welded to the downstream face of the embedded guides and the steel angles embedded in downstream corner in primary concrete as shown on the drawings, the upstream permanent spillway stoplog embedded parts require steel liners on the downstream transitions above El. 17.8 m.
- .3 The downstream stoplogs shall have guide extensions above the concrete up to El. 20.0 m to facilitate stoplog installation and storage.
- .4 All stoplog guides shall have embedded heating element ducts with the ability to install heating elements as needed.

3.3 INTAKE GATES

3.3.1 Hydrostatic Design Load Conditions

- .1 Normal Load: Hydrostatic pressure corresponding to a reservoir level of El. 39.0 m.
- .2 Abnormal Load: Hydrostatic pressure corresponding to a water level of El. 45.1 m resulting from a PMF.

3.3.2 General Design Criteria

- .1 The Intake gate shall be a fixed wheeled gate with upstream skin plate and seals and operated by wire rope hoists.
- .2 The Intake gates will normally be raised and lowered under no flow conditions; however, the gates shall be designed so that they can be closed individually or simultaneously against maximum flow and maximum head under 80% of their own weight considering the worst combination of all opposing forces.
- .3 The Intake gates and guides shall be designed so that the gate can be repeatedly closed at emergency speed (on the fan brake only), in the wet or dry, such that there is no damage.
- .4 The maximum expected flow through each generating unit is approximately 1035 m³/s and occurs during turbine runaway.
- .5 The filling of the water passage shall be done by cracking one gate open to about 150 mm.
- .6 The Intake gate shaft will be used as the air vent during water passage filling, dewatering, and closure at maximum flow.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 The gate shall be provided with bolted on guard rails going all around the top of the gate to give a safe access for maintenance.
- .8 A corrosion allowance of 1.5 mm minimum shall be added to the skinplate of the Intake Gates.
- .9 The gate shall be provided with attachment points for fall arrest personnel safety equipment for use during gate maintenance, and shall be provided at the top, as well as the bottom, of the gate ladders.
- .10 A permanent base for a davit arm shall be provided on the top of gate, near the ladders.
- .11 A davit arm, rated for injured worker extraction, shall be provided.

3.3.3 Guides

- .1 The lower guides shall extend from the sill beam to the floor of the inspection gallery (El. 23.0 m). The lower guides shall be steel lined over their entire height, steel liners on the transition walls downstream of the embedded guides in the water passages shall be welded to the downstream face of the embedded guides and the steel angles embedded in downstream corner in primary concrete as shown on the drawings.



3.3.4 Dogging Devices

- .1 Dogging devices shall be provided to dog the Intake gates at 2 locations: with the first dogging device located at El. 42.5 m in the upper maintenance position; and the second at El. 23.0 m at the maintenance gallery.
- .2 At El. 42.5 m, the gate and dogging device shall be capable of being dogged to facilitate work on the hoist including disconnection of the sheaves.
- .3 At El. 23.0 m, the gate and dogging device shall be designed and provided to suspend the gate at multiple levels such that each wheel can be easily serviced including being removed, and the gate seals accessed and replaced without the use of scaffolding. Systems using cantilever gate wheels as dogging devices are not acceptable.



3.4 INTAKE BULHEAD GATE

3.4.1 Hydrostatic Design Load Conditions

- .1 Normal Load: Hydrostatic pressure corresponding to a reservoir level of El. 39.0 m.
- .2 Abnormal Load: Hydrostatic pressure corresponding to a water level of

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

El. 41.5 m.

3.4.2 General Design Criteria

- .1 The Bulkhead Gates shall be of the sliding type with downstream skin plate and downstream seals.
- .2 The Bulkhead gates shall be sectionalised and designed for installation and removal under hydraulically balanced conditions using the trash cleaner's underhung travelling hoist and a lifting beam.
- .3 The top section of the gate shall include a filler valve operated by the lifting beam's own weight to equalize the water pressure on both sides of the gate prior to opening.
- .4 The filler valve shall be 300 mm diameter.
- .5 The air vent between the Bulkhead Gate and the Intake Gate will be provided by Company's Other Contractor.

3.4.3 Guides

- .1 The Intake bulkhead lower guides shall extend from the sill to a minimum of 300 mm above the lintel. The lower guides shall be steel lined over their entire height, steel liners on the transition walls downstream of the embedded guides in the water passages shall be welded on the downstream face of the embedded guides and the steel angles embedded in downstream corner in primary concrete as shown on the drawings.



3.4.4 Dogging Devices

- .1 Dogging devices shall be provided to dog each of the Bulkhead gate sections, and the Bulkhead gate lift beam, in the Bulkhead Gate shafts below the deck hatches.
- .2 The dogging device shall be designed to facilitate installation and removal, and when not in use the individual gate sections shall be dogged in separate guides.

3.5 POWERHOUSE DRAFT TUBE STOPLOGS

3.5.1 Hydrostatic Design Load Conditions

- .1 Normal Load: Hydrostatic pressure corresponding to a water level of El. 7.00 m.
- .2 Abnormal Load: Hydrostatic pressure corresponding to a PMF water level of El 12.50 m.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.5.2 General Design Criteria

- .1 The draft tube stoplogs shall be of the sliding type with downstream (dry side) skin plate and seals.
- .2 Each bay will consist of four sections: a bottom section; two (2) intermediate sections; and a top section with a lintel seal.
- .3 The stoplog sections shall be designed for installation and removal in hydraulically balanced conditions.
- .4 Two (2) seating plates shall be welded on the bottom of each upper stoplog section to ensure that the stoplog sections are vertically aligned in the gate slots and the lintel seal engages.
- .5 The embedded guides shall have matching supports installed for the top stoplog seating plates.
- .6 The draft tube stoplogs shall be stored on storage supports above the water passage in the draft tube gallery upstream of the guides.
- .7 The draft tube gallery will be housed in a concrete structure under the transformer deck with a floor level at El. 6.50 m, with the overhead crane and the lifting beam.
- .8 The draft tube stoplogs sections shall be raised and lowered by means of an under-running crane and a dedicated lifting beam, and operating on rails provided by Company's Other Contractor.

3.5.3 Guides



- .1 The draft tube stoplog lower guides shall extend from the sill to a minimum of 300 mm above the lintel. The lower guides shall be steel lined over their entire height, steel liners on the transition walls downstream of the embedded guides in the water passages shall be welded to the downstream face of the embedded guides and the steel angles embedded in downstream corner in primary concrete as shown on the drawings.
- .2 The draft tube stoplog upper guides shall extend from the top of the lower guides up to El. 6.5 m, and the top of the lower guides shall be designed with transitions to accept the stoplogs with operators located on the walkways at El. 9.0 m.

3.5.4 Storage Devices

- .1 For the storage of the stoplogs, sixteen support sets (two per hydraulic passage) shall be provided.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 The storage supports shall be anchored on the generator side of the embedded stoplog guides on the pier walls.
- .3 The supports shall hold the stoplog vertically and shall protect the seals.
- .4 The supports shall be designed to facilitate handling of the stoplog sections by the overhead crane.
- .5 Support surfaces in contact with stoplog sections shall have a thick plastic or rubber pad attached to it.
- .6 Stainless steel expansion type anchors and bolts, Accepted by the Engineer, shall be used for installation of the supports and rubber bumpers.
- .7 Support plates shall be welded on the bottom of each stoplog section to support the stoplogs on storage supports.
- .8 The support plates shall have adequate dimensions to prevent the overturning of the stoplog section.
- .9 A portable support stand shall be provided to support the bottom stoplogs sections when set on a flat surface, or for service in the maintenance gallery.

3.5.5 Lockout

- .1 Lockable protection device shall be provided to prevent the Draft Tube stoplogs from being removed after they are installed in the guides and the device shall be safe and convenient to apply from the walkway level at El. 9.00 m.
- .2 The protection device could consist of some form of hinged device that covers one or both sides of the side guides to prevent the lifting beam from being installed.
- .3 The protection device shall not prevent the lifting beam or hoist from being used on another unit.

3.6 TRASHRACKS

3.6.1 General

- .1 As a minimum Trashrack bars shall be rectangular with a rounded nose (more hydraulically efficient shapes may be used) and be uniformly spaced.
- .2 The Trashracks in each bay shall consist of a series of smaller sections (panels) stacked vertically.
- .3 Each Trashrack panel shall be a welded steel fabrication.
- .4 All Trashrack sections, except the top, shall be identical and interchangeable.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .5 The top of the upper Trashrack section shall be sloped at a minimum 45°, as shown on the Drawings, to provide a smooth hydraulic transition and reduce the likelihood of debris accumulation.
- .6 Each section of the Trashracks shall consist of horizontal beams between vertical side plates.
- .7 The top Trashrack panels shall have the horizontal beams inclined 30 degrees down from horizontal to reduce resistance to flow.
- .8 Secondary horizontal support members shall be provided as necessary to reduce the lateral support distance between the vertical bars to meet vibration criteria.
- .9 The vertical Trashrack bars shall be chamfered at each end so that Trash Cleaner will smoothly transition from panel to panel.
- .10 Trashrack panels shall include alignment pins, or equivalent, to ensure once installed the vertical bars are aligned in both planes between panels.
- .11 Closed sections shall have a 1.5 mm corrosion allowance on all interior surfaces.
- .12 Trashrack sections will be installed and removed using a mobile crane and lifting beam.
- .13 The trashrack guides shall be designed to centre the bottom panel in the guide to ensure the panels stack correctly.

3.6.2 Guides

- .1 The Trashrack guides shall include a rounded nose on the upstream side that matches, and is tangent and flush to, the rounded concrete pier nose.
- .2 The rounded nose shall extend laterally to meet a projected plane extending from the back of the slot.
- .3 The rounded nose shall have sufficient ribs to maintain rigidity of the structure with holes to facilitate concrete placement.

3.7 DRAFT TUBE GALLERY MAINTENANCE AREA WATER STOP GATES

3.7.1 General

- .1 The Draft Tube gallery water stop gates shall be designed to withstand a transient tailwater level up to EL 9.3 m that can occur during a plant full load rejection.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



3.7.2 Anchors

- .1 The water stop gates shall be mounted on the first stage concrete wall with concrete anchors, or embedded anchors in first stage concrete, and shall be submitted to and Accepted by the Engineer.
- .2 If first stage concrete anchors are used, they shall be provided to Engineer for installation by Company's Other Contractor, with technical assistance during installation by Contractor.

3.7.3 Criteria

- .1 Not used.
- .2 The water stop gates shall be hinged and shall provide adequate sealing around the gate that the water level in the maintenance area during a tailwater surge is safe for personnel working in the maintenance area.
- .3 The water stop gates shall have secure latches to withstand maximum water levels, and shall be designed to be opened for passage of the stoplogs.
- .4 Fall restraint anchors shall be provided on both sides of the gate for worker protection when the gates are opened.

3.8 COATINGS SCHEDULE

- .1 Coatings shall be as follows:

Gates, Stoplogs, Trashracks	All surfaces Epoxy paint colour XXX (colour)
Embedded Parts - Surfaces in contact with the concrete	Uncoated
Embedded Parts - Surfaces exposed	All surfaces Epoxy paint colour XXX (colour)
All accessories, such as ladders, walkways, platforms, handrails/guard rails and all hardware, not forming integral part of the main structure and liable of being dismantled, such as connection bolts, supports, heating equipment, pipes, etc.	Hot dip galvanized

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.9 SHOP ASSEMBLY AND TESTS

- .1 Prior to shipment, the gates shall be shop assembled to demonstrate to the satisfaction of Engineer that all requirements of the specifications and of the design and fabrication indicated on the drawings Accepted by Engineer have been satisfied.
- .2 The gates (includes stoplogs) and the embedded parts shall be shop assembled as follows:
 - .1 Gates: complete assembly of each gate including wheels, guiding assemblies, and seals;
 - .2 Not Used.
 - .3 Embedded parts: complete assembly of each full length side guide.
- .3 Following Engineer's Acceptance, these assemblies shall be dismantled to satisfy the transportation requirements.
- .4 The components shall be match-marked and doweled to facilitate reassembly in the field.
- .5 The number of bolts and dowels shipped to Site shall exceed by at least 4% the calculated requirements in the shop.
- .6 In case of damage during the shop testing Contractor shall improve the concept and repeat the test prior to shipment.
- .7 Prior to the tests described above, Contractor shall submit for Engineer's Acceptance a detailed procedure including a description of the assembly and the sequence of operations.
- .8 Following the tests, Contractor shall submit the results to Engineer for Acceptance.
- .9 All equipment not included in the supply but necessary for carrying out the tests shall be supplied by Contractor.
- .10 Shipping to Site shall be authorized only once the equipment has undergone all the required tests.
- .11 Engineer's Acceptance to ship does not relieve Contractor of his responsibilities in regard to final acceptance.
- .12 Not used.
- .13 Not used.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 4 ERECTION, CONCRETING AND FIELD TESTS

4.1 GENERAL

- .1 All the equipment covered by these specifications shall be installed, concreted, pre-commissioned and subjected to the required contractual tests by Contractor.
- .2 Contractor is fully responsible for the execution of all works according to the tolerances required and according to the drawings, installation procedures and verification previously established and submitted to Engineer's Acceptance.
- .3 Contractor shall supply all necessary equipment such as portable cranes, slings, jacks, tooling, welding equipment, structures, bracings and temporary shelters, formworks, instrumentation and test equipment, spares, and all the other necessary equipment to complete all installation and all required tests.
- .4 All measurements taken as part of the installation of Contractor's work shall be submitted to Engineer for Acceptance.
- .5 Any of the surface work whose tolerances have not been maintained after concreting shall be corrected by grinding or by any other means Accepted by Engineer in such a way as to bring the dimensions to within the specified tolerances, however, no correction shall be carried out without the Acceptance of Engineer.
- .6 Contractor shall also provide the necessary supplies in order to perform second stage concreting of embedded parts, and shall perform the required testing.
- .7 Contractor shall supply and place the grout, necessary for the concrete embedment.
- .8 All modifications, re-work, repairs etc. required by Contractor to complete the work shall be subject to the Engineer's Acceptance prior to the start of the work.
- .9 When selecting the erection methods, Contractor shall be responsible to take into account the load limitations imposed by the roads, structures, and bridges.

4.1.1 Installation of Embedded Parts

- .1 All embedded parts shall be cleaned thoroughly by Contractor before being placed.
- .2 Any grease, paint or other substances that may affect the proper curing of concrete shall be removed.
- .3 Contractor shall witness the installation of the primary anchors in first stage concrete, and shall sign off on the acceptability of the anchors before embedded in each concrete pour.
- .4 Contractor shall install and carry out the general alignment of all embedded parts of gates and stoplogs to be embedded in second stage concrete.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 In the event the anchors are not in compliance with specified tolerances after concrete embedment, Contractor shall propose an appropriate and economical corrective method.
- .6 In case of conflict, Engineer reserves the right to impose a corrective method on Contractor to modify the embedded parts, at Company's expense, to match to the primary anchor design.
- .7 Contractor shall carry out complete measurements of the embedded parts before and after concreting, in order to show to Engineer's satisfaction that the tolerances have been met before and after concreting.
- .8 No concreting shall be undertaken before the Acceptance of Engineer.
- .9 All measurements and dimensions of the work carried out by Contractor shall be submitted to Engineer for verification.
- .10 Engineer shall carry out control measurements before giving authorization for concreting and before final acceptance of the Work.
- .11 As soon as Contractor obtains authorization from Engineer, Contractor shall start concreting without any delay.
- .12 After all concrete has been placed Contractor shall check for, and fill, all voids behind embedded parts using a procedure, and grout, accepted by Engineer.
- .13 Contractor shall submit for Acceptance, fabrication control methods for embedded parts and show to the satisfaction of Engineer that the tolerances specified will be met during assembly and after concreting.
- .14 Machined surfaces shall be checked based on readings taken at least every 300 mm.
- .15 Surfaces for which the specified tolerances are less than 1 mm shall be checked based on readings taken at least every 300 mm.
- .16 For other surfaces for which the tolerance was specified, tolerances shall be checked based on readings taken at least every 600 mm.

4.1.2 Concrete Works

- .1 The concrete works shall include, without being limited to, the following activities:
 - .1 The preparation of first stage concrete surfaces before second stage concreting, and before the installation of embedded parts;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 The handling, the positioning, the consolidation, the finishing of surfaces including the construction, the erection, the maintenance and the removal of all formwork and scaffolding required for the installation and second stage concreting for embedded parts.

.2 The concrete works shall conform to CSA Standard A-23.1, A-23.2, A-23.3, A-269.3.

4.1.3 Preparation of the Surfaces before Concreting



- .1 Following the roughening performed by Company's other contractor, Contractor shall carefully clean and wash the first stage concrete surfaces which will come in contact with second stage concrete, and cleaning shall be done until the surfaces are completely clean and free from particles and debris.
- .2 Nuts of the bolts shall be free of any dirt.
- .3 Anchor bolts shall be cleaned and oiled to facilitate the adjustment of the embedded parts.
- .4 Oiling of forms shall be carried out with precaution to not contaminate the concrete.

4.1.4 Concreting and Formworks



- .1 The concrete for concreting of the embedded parts shall be of Class A-3, as specified in the Section 03 30 00.
- .2 Contractor shall advise Engineer before each concrete pour, at least 48 hours in advance.
- .3 Concrete of Class A-3 shall not be replaced to favour the use of special construction technique.
- .4 Admixtures shall not be added to the concrete without the prior Acceptance of Engineer.
- .5 Not less than 30 days prior to the installation of embedded parts, Contractor shall submit to Engineer for Acceptance a complete set of drawings of the formwork together with a detailed description of the proposed methods of handling and placing of second stage concrete.
- .6 Second stage concrete shall be placed in such a way as to limit shrinkage of concrete and avoid displacement of embedded parts.
- .7 The rate of pouring shall never exceed 350 mm/hour for the lower lateral guides and 500 mm/hour for upper lateral guides.
- .8 Engineer reserves the right to stop concreting any time if it is obvious that embedded parts have been or are in danger of being displaced.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .9 The minimum delay before removal of the formworks shall be at least 48 hours.
- .10 Vibrators of 50 mm diameter shall be used during concrete pours.
- .11 There shall be no contact between vibrator and embedded parts, supports and anchors.
- .12 Engineer can also reduce the rate of pouring to allow Contractor execution or work of a good quality.
- .13 All concrete which has not been placed in conformity with the requirements of Engineer must be removed and replaced at Contractor's expense.
- .14 Contractor shall choose his equipment in such a way as to be able to place concrete Class A-3.
- .15 All formwork shall be Class F-4, made of sound wood, free of knots and irregularities.
- .16 Formwork shall be firmly attached in place, braced, and supported to resist the loads on which it is exposed keeping its alignment and shape.
- .17 Formwork shall be tight and shall not permit leakage of grout.
- .18 Formwork shall be supported by adjacent first stage concrete, but shall never be attached to the embedded parts, embedded parts anchors, or tie-rods.
- .19 The finish required for form surfaces shall be Class F-4, and must conform to the requirements and tolerances specified in Section 03 30 00, Table 7.
- .20 Not Used
- .21 All defects must be repaired by Contractor as stipulated in the same specification.



4.1.5 Field Control of Concrete Quality

- .1 All concrete tests shall be by Engineer or by its representative.
- .2 Samples of fresh concrete will be obtained at the placement site by Engineer.
- .3 Contractor shall provide assistance as required by Engineer in securing and transporting samples. Contractor shall supply all concrete to the extent needed for testing by Engineer.

4.1.6 Grouting

- .1 Grouting shall be carried out according to Technical specification Sections 48 13 21 and 03 60 40.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.2 FINAL TOLERANCES AFTER INSTALLATION OF GATE AND STOPLOG EMBEDDED PARTS AND GATES

- 4.2.1 Tolerances specified in the Appendix B shall be met after the final installation of embedded parts and gates.
- 4.2.2 Machined surfaces shall be smooth and free of any scratches.
- 4.2.3 Damaged surfaces shall be repaired so as to meet the specified tolerances.
- 4.2.4 At the joint between different sections of the embedded parts, the guide and the adjacent surfaces shall be smooth.

PART 5 PRESERVATION, MECHANICAL COMPLETION & COMMISSIONING REQUIREMENTS

5.1 GENERAL

5.1.1 Preservation, Mechanical Completion & Commissioning Requirements noted herein are defined in MFA-SN-CD-2000-ME-SP-0002-01 Preservation, Mechanical Completion & Commissioning Requirements.



5.1.2 **END OF SECTION**

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs and Trashracks	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

APPENDIX A
GATE AND STOPLOG SEALS



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs and Trashracks	Rev: D2 505573-3321-45EG-0001
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		

1 GATE AND STOPLOG SEALS

1.1 INTRODUCTION

1.1.1 This document applies to the design, manufacture, handling and storage of the elastomeric type seals for all the gates and stoplogs.

1.2 GENERAL REQUIREMENTS

1.2.1 All gate seals shall be manufactured in moulds of the correct cross section. Extruded seals will not be permitted;

1.2.2 Single and double stem seals shall have a solid bulb.

1.2.3 The side and top seals for the Intake Gates, Spillway Gates, Upper Bulkhead Gates and Upper Draft Tube Stoplogs shall be provided with a coating of fluorocarbon (PTFE) sheath bonded to the sealing surface of the bulb and the external surface of the sheath shall be free of adhering or bonded rubber;

1.2.4 Where it is not possible to provide seals in one length, the separate component lengths shall be tight butted in the shop. The fraying ends shall be cut at right angles, and dressed slightly longer than required to ensure a tight joint;

1.2.5 The horizontal bottom seals on each gate section shall be designed and installed with a tolerance of ± 0.5 mm straightness over the full length.

1.2.6 Dimensional tolerances of the joint, in section, must be $\pm 5\%$ relative to the dimensions specified. For a given gate or stoplog, the dimensional tolerances of the joint, in section, should not vary by more than 2% over the entire length of the joint.

1.2.7 All the corner pieces must be one piece moulded pre-cast in the factory by the manufacturer of the seals. The length of each branch of the angle shall be approximately 300 mm.

1.3 MATERIALS

1.3.1 Elastomer

- .1 Seals shall be manufactured of a vulcanized elastomeric material without cloth or other fibre internal reinforcement. Their composition should include components (agents) to help the resistance to immersion, weather (climatic) conditions, abrasion and aging.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs and Trashracks	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .1 Seals must have the following physical properties when tested in accordance with the latest revision of the corresponding ASTM Standard:

<u>Property:</u>	<u>Limit:</u>	<u>ASTM Method of Testing:</u>
Tensile strength	21 MPa	D412
Ultimate elongation	450% minimum	D412
Durometer hardness (Shore Type A)	60 to 70	D883
	40 to 50 rectangular	D2240
Water absorption (70°C) for 48 hours	3% maximum by weight	D471
Compression set	30% maximum	D395
Tensile strength after Oxygen Bomb Ageing	80% minimum of original tensile strength	D572

1.3.2 Fluorocarbon (PTFE) Coating

- .1 Fluorocarbon cladding shall be permanently fixed to the rubber joint. The minimal thickness of the cladding shall be 1.5 mm.
- .2 The fluorocarbon shall have the following properties:
- .1 Tensile strength 14 MPa minimum
 - .2 Elongation 250% minimum
 - .3 Friction coefficient 0.15 maximum
- .3 A sample of one of the extremities of each section of the moulded seal covered of fluorocarbon cladding shall be subjected to an adhesion test according to ASTM D413 (using either the machine method or the deadweight method):
- .4 Cladding shall be able to withstand a minimum load of 53 N per cm of width.
- .5 Load shall be applied to an angle of 90 degrees of the elastomeric surface.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs and Trashracks	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

1.4 CONNECTIONS (JOINTS)

1.4.1 General Requirements

- .1 Joints shall be designed to avoid, or at least minimize, the number of connections to be performed, both in the workshop and to Site.
- .2 The transition pieces between different parts such as the angles shall be hot vulcanized to one of the straight portions, by one of the branches, and shall be done by the manufacturer of the seals.
- .3 Straight portions shall be provided wherever possible and in one piece.
- .4 Detailed drawings showing the location and type of joints to be executed by Contractor, both in the workshop or at Site, shall be submitted to the Engineer for review and acceptance prior to the commencement of work.

1.4.2 Vulcanized Connections

- .1 All connections performed by Contractor and manufacturer of the seals shall be hot vulcanized.
- .2 The two ends to be connected shall be cut at 90° with respect to the thickness and width.
- .3 The cut shall avoid holes in the legs of the seal where ever possible to allow attachment to the gate.
- .4 The vulcanization shall be executed by holding firmly the two ends to be connected in a jig designed for that purpose.

1.5 HANDLING AND TRANSPORTATION

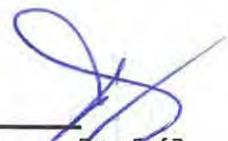
- 1.5.1 Special care shall be taken during handling and transport of seals to avoid damage to the fluorocarbon coating.
- 1.5.2 Folding of seals is permitted only on the manufacturer's written recommendation.
- 1.5.3 The joints shall be handled or shipped in straight lengths and securely fastened to rigid packaging to prevent accidental folding during handling.

1.6 STORAGE

- 1.6.1 Seals supplied as spares shall be suitably packaged and crated for long-term storage. Contractor shall provide storage instructions and an estimated shelf life

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**APPENDIX B
 TOLERANCES**



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



Table 1: Tolerances of embedded parts before and after secondary concrete installation - Intake and Spillway Gates

Embedded Parts	Position or Dimension (mm)	Verticality T (mm/height)	Horizontally T (mm/length)	Flatness T (mm)	Straightness T (mm/m)	Parallelism T (mm)	Perpendicularity (mm)
<ul style="list-style-type: none"> Sill Beams <ul style="list-style-type: none"> ❖ Sealing surfaces 	± 2 (*)		0.25 (**)		0.1/2.0		
<ul style="list-style-type: none"> Lateral Guides <ul style="list-style-type: none"> ❖ Guiding surfaces for main wheels. ❖ Sealing surfaces. ❖ Lateral surfaces for the main wheel paths and the seal sealing plates. ❖ Upstream, downstream and lateral guiding surfaces. Lintels <ul style="list-style-type: none"> ❖ Sealing Surface 	± 2 (*) ± 2 (*) ± 2 (*) ± 2 (*) ± 2 (*)	0.75 0.75 1.5 3.0			0.15/2.0 0.1/2.0 1.5/3.0 0.25/2.0 0.75/Length		
Gates	Position or Dimension (mm)	Verticality T (mm/height)	Horizontally T (mm/length)	Flatness T (mm)	Straightness T (mm/m)	Parallelism T (mm)	Perpendicularity (mm)
<ul style="list-style-type: none"> Contact points of the main wheels for any position of wheels. 					0.2 .01/length		
<ul style="list-style-type: none"> Sealing surfaces. 				3.0 (at the 4 corners)	0.15/2.0 0.4/length		
<ul style="list-style-type: none"> Bottom edge (steel). 					0.1/length	0.15	1.0 (***)
<ul style="list-style-type: none"> Gap between edge and sill. 	0.15						

(*) The position tolerances are established with respect to the axes of the opening and shall be respected throughout the entire length of the embedded parts.

(**) This tolerance applies to the longitudinal and transversal directions.

(***) This tolerance of perpendicularity is defined in respect to the line linking the contact points of the main wheels.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 20
CH0032	Gates, Stoplogs & Trashracks	Rev: D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



Table 2: Tolerances of embedded parts before and after secondary concrete installation- Stoplogs and Bulkhead Gates

Embedded Parts	Position or Dimension (mm)	Verticality T (mm/height)	Horizontally T (mm/length)	Flatness T (mm)	Straightness T (mm/m)	Parallelism T (mm)
<ul style="list-style-type: none"> Sill Beams <ul style="list-style-type: none"> Sealing surfaces. Bearing support vs. sealing surfaces 	± 2 (*) + 0.25; -0		0.25 (**)		0.15/2.0	
<ul style="list-style-type: none"> Lateral Guides <ul style="list-style-type: none"> Sealing surfaces. Guiding surfaces for the bearing bars. Guiding surfaces of the bearing paths for lateral guide shoes. Guiding surfaces for the leaf springs and the upstream guiding shoes. 	± 2.0 (*) ± 2.0 (*) ± 2.0 (*) ± 2.0 (*)	0.75 0.75 3.0 3.0			0.25/2.0 0.25/2.0 1.5/3.0 1.5/3.0	
<ul style="list-style-type: none"> Lintels <ul style="list-style-type: none"> Sealing surfaces. 	± 2.0 (*)				0.25/2.0 0.75/Length	
Gates and Stoplogs	Position or Dimension (mm)	Verticality T (mm/height)	Horizontally T (mm/length)	Flatness T (mm)	Straightness T (mm/m)	Parallelism T (mm)
<ul style="list-style-type: none"> Bearing bars 					0.4/length	
<ul style="list-style-type: none"> Surfaces for attachment of seals. 					0.4/length	
<ul style="list-style-type: none"> Surfaces of the bearing bars vs. machined surface for the seals 						0.75
<ul style="list-style-type: none"> Gate corner measured at the bearing bars extremities 				3.0		

(*) The position tolerances are established with respect to the axes of the opening and shall be respected throughout the entire length of the embedded parts.

(**) This tolerance applies to the longitudinal and transversal directions.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

**TABLE OF CONTENTS
SECTION 48 13 21
HOISTS AND CRANES**



PART 1 GENERAL	4
1.1 DESCRIPTION AND SCOPE OF WORK.....	4
1.2 RELATED SECTIONS.....	4
1.3 GENERAL CONDITIONS.....	4
PART 2 DESIGN REQUIREMENTS	5
2.1 APPLICABLE STANDARDS.....	5
2.2 ALLOWABLE STRESSES AND DEFLECTIONS.....	9
2.3 RATED AND DESIGN LOADS.....	12
PART 3 DESIGN CRITERIA	17
3.1 GENERAL.....	17
3.2 ELECTRICAL REQUIREMENTS.....	17
3.3 FASTENERS AND DOWELLING.....	18
3.4 WIRE ROPES.....	18
3.5 WIRE ROPE DRUMS.....	18
3.6 DRUM DOGGING DEVICE.....	19
3.7 SHEAVES AND SHEAVE BLOCKS.....	19
3.8 TENSION EQUALISING SYSTEM.....	20
3.9 HOIST BASES.....	20
3.10 HOOKS.....	21
3.11 TRAVEL WHEEL ASSEMBLIES.....	21
3.12 BUMPERS, END STOPS AND RAIL SWEEPS.....	21
3.13 DROP STOPS.....	22
3.14 SPEED REDUCERS/GEAR BOXES, BEARINGS AND SHAFTS.....	22
3.15 DRIVING SYSTEMS.....	23
3.16 HOIST HOLDING BRAKE.....	23
3.17 HOIST HOLDING SECONDARY BRAKE.....	23



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.18 HOIST FAN BRAKES24

3.19 BRIDGE TRAVEL BRAKES24

3.20 TROLLEY TRAVEL BRAKES24

3.21 BRAKE LININGS25

3.22 LUBRICATION.....25

3.23 LIFTING LUGS26

3.24 HAND RAILS/PLATFORMS/WALKWAYS/STAIRS/LADDERS/GATES/FALL
PROTECTION.....26

3.25 PROTECTIVE GUARDS.....27

3.26 LIFTING BEAMS28

3.27 TRACK MARKERS AND ALIGNMENT SYSTEM29

3.28 CONCRETE/GROUT/ANCHORS29

3.29 HOIST LIMIT SWITCHES30

3.30 MISCELLANEOUS LIMIT SWITCHES.....30

3.31 LOAD SENSING DEVICES30

3.32 POSITION INDICATOR.....30

3.33 SPARE PARTS.....31

3.34 TOOLING31

PART 4 TECHNICAL REQUIREMENTS31

4.1 SPILLWAY GATE HOISTS31

4.2 SPILLWAY GATE HOIST TOWERS AND APPURTENANT STRUCTURES32

4.3 GATE GUIDES35

4.4 ANCHORS AND GROUTING35

4.5 STAIRWAY, LADDERS, WALKWAYS, AND HANDRAILS36

4.6 INTAKE GATE HOISTS38

4.7 TRASH CLEANER HOIST39

4.8 DRAFT TUBE CRANE.....41

4.9 SPILLWAY MAINTENANCE CRANE.....43

4.10 ADDITIONAL LIFTING BEAMS43

PART 5 COATINGS SCHEDULE.....43

PART 6 ERECTION AND FIELD TESTS44

6.1 GENERAL44

6.2 GROUTING45

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

6.3 INSTALLATION MEASUREMENTS45

6.4 DRIVE SYSTEMS ALIGNMENT CHECKS.....46

6.5 PRESERVATION, MECHANICAL COMPLETION & AND COMMISSIONING
 REQUIREMENTS46

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 DESCRIPTION AND SCOPE OF WORK

- 1.1.1 This section of the specification details the requirements for hoist and cranes and associated equipment for the Muskrat Falls Hydroelectric Development.
- 1.1.2 This document shall be read in conjunction with "Lower Churchill Project Muskrat Falls Hydroelectric Development – CH0032 - Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment - Scope of Work - MFA-SN-CD-2000-ME-SP-0001-01/505573-3321-45EW-0001", Part 2, Exhibit 1.

1.2 RELATED SECTIONS

- .1 Section 05 12 00 Structural Steel
- .2 Section 05 50 10 Miscellaneous Metals and Embedded Parts
- .3 Section; 48 13 10 General Mechanical Requirements
- .4 Section; 48 13 20 Gates, Stoplogs and Trashracks
- .5 Section; 48 13 22 Trash Cleaning System
- .6 Section; 11 08 00 Mechanical Completion, Commissioning & Turn-Over Requirements
- .7 Section; 26 29 03.03 Control and Monitoring – Hydro-Mechanical

1.3 GENERAL CONDITIONS

- 1.3.1 Contractor shall be responsible for the final design of the hoists and cranes. However, the design, manufacture, operation and erection shall conform to the basic criteria, requirements, codes and standards detailed in these Specifications, and especially to the CSA B167 Standard and, for the details this standard does not specifically cover, to the recommendations of CMAA No. 70 Specifications.
- 1.3.2 The clearances, hook approaches and elevations shown on the drawings for some elements of the hoist are the minimum acceptable limits and Contractor's design, insofar as possible, shall provide increased clearances and reduced hook approaches regarding equipment and physical limits, as well as additional vertical hoist travel.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 1.3.3 All hoists shall be designed to maximise the lifting height within the available headroom and as such shall consider the load being lifted, such as lifting beam, gate etc. and design the hoist to accommodate its overall shape.
- 1.3.4 All electrical equipment, and mechanical equipment that is not designed to be submerged, shall be protected from the weather considering both precipitation and wind.
- 1.3.5 The hoists shall be able to operate under full load without excessive noise and undue vibration. All movements shall be continuous and smooth. Slipping of the load shall not occur at any time. The hoists shall be designed in such a way that it will not endanger personnel and nearby installations.
- 1.3.6 Safety and lock out requirements shall be taken into account in all aspects of Contract's design and implementation.
- 1.3.7 Without in any way detracting from performance, the hoists shall have an aesthetic appearance with clean lines and a neat and tidy arrangement of cables and mechanisms, and enclosed where ever possible.
- 1.3.8 All construction details shall be elaborated so that there be no accumulation of water or debris on the structures, and so that all surfaces can be easily accessible for inspection and maintenance. Use of enclosed steel sections (HSS), instead of open steel section (WF or C), minimizes water and debris accumulation areas within the hoist structure.
- 1.3.9 All lubricated equipment located over water shall have drip trays or another means acceptable to Engineer to prevent any leakage entering the waterways.

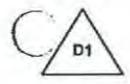
PART 2 DESIGN REQUIREMENTS

2.1 APPLICABLE STANDARDS

2.1.1 Codes and Standards

The following standards shall apply to the Work described in this document.

- .1 AGMA 260.02 Design of Components – Enclosed Gear Drives – Bearings, Bolting, Keys and Shafting
- .2 AGMA 420.04 American Gear Manufacturers Association Standard
- .3 AGMA 6001-E08 Design and Selection of Components for Enclosed Gear
- .4 Drives



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .5 AISE No 7 Technical Report No. 7, Specifications for Ladle Hooks
- .6 ANSI Standard B4a Tolerances, Allowances and Gauges for Metal Fits
- .7 ANSI C42.30 Definitions of Electrical Terms
- .8 ANSI/AGMA 2001 C95 Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
- .9 ANSI/ASME HST-4 Performance Standard of Overhead Electric Wire Rope Hoists
- .10 ANSI/ABMA STD 9 Load Ratings and Fatigue Life for Ball Bearings
- .11 ANSI/ABMA STD 11 Load Ratings and Fatigue Life for Roller Bearings
- .12 ASME B1.1 Unified Inch Screw Threads
- .13 ASME B1.13 Metric Screw Threads: M Profile
- .14 ASME B15.1 Safety Standard for Mechanical Power Transmission
- .15 ASME B30.2 Overhead and Gantry Cranes
- .16 ASME B30.7 Winches (formerly Base Mounted Drum Hoists)
- .17 ASME B30.20 Below the Hook Lifting Devices
- .18 ASME BTH-1 Design of Below the Hook Lifting Devices
- .19 ASTM A275 Standard Practice for Magnetic Particle Examination of Steel Forgings
- .20 ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- .21 ASTM A385 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- .22 ASTM A388 Standard Practice for Ultrasonic Examination of Steel Forgings
- .23 ASTM A609 Standard Practice for Castings, Carbon, Low Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .24 ASTM E94 Standard Guide for Radiographic Examination
- .25 ASTM E114 Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing
- .26 ASTM E125 Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings
- .27 ASTM E165 Standard Practice for Liquid Penetrant Examination for General Industry
- .28 ASTM E186 Standard Reference Radiographs for Heavy-Walled (2 to 4½-in. (50.8 to 114-mm)) Steel Castings
- .29 ASTM E280 Standard Reference Radiographs for Heavy-Walled (4½ to 12-in. (114 to 305-mm)) Steel Castings
- .30 ASTM E433 Standard Reference Photographs for Liquid Penetrant Inspection
- .31 ASTM E446 Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness
- .32 ASTM E709 Standard Guide for Magnetic Particle Testing
- .33 AWS D1.1 Structural Welding Code
- .34 CAN/CGSB 48.9712 Non-destructive Testing; Qualification and Certification of Personnel
- .35 CGSB 1-GP-12C Standard Paint Colors
- .36 CMAA 70 Specifications for Top Running Bridge and Gantry type Multi Girder Electric Overhead Travelling Hoists
- .37 CMAA 74 Specifications for Top Running and Under Running Single Girder Electric Overhead Cranes
- .38 CSA A-23.3 Design of Concrete Structures
- .39 CSA B167 Overhead travelling hoists: Design, inspection, testing, maintenance, and safe operation
- .40 CSA C22.1 Canadian Electrical Code

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .41 CSA C22.2 Safety Standards for Electrical Equipment
- .42 CSA G4 Steel Wire Rope for General Purpose and for Mine Hoisting and Mine Haulage
- .43 CSA G164 Hot Dip Galvanizing of Irregularly Shaped Articles Metals and Metal Products
- .44 CSA S16 Design of Steel Structures
- .45 CSA W47.1 Certification of companies for fusion welding of steel
- .46 CSA W48 Filler Metals and Allied Materials for Metal Arc Welding
- .47 CSA W59 Welded Steel Construction - Metal Arc Welding
- .48 CSA W178.2 Certification of Welding Inspectors
- .49 CSA Z85 Abbreviations for Scientific and Engineering Terms
- .50 NBCC National Building Code of Canada
- .51 NLOHS Occupational Health and Safety Regulation of Newfoundland Labrador
- .52 SSPC PA2 Procedure for Determining Conformance to Dry Coating Thickness Requirements
- .53 SSPC SP3 Power Tool Cleaning
- .54 SSPC SP10 Near-White Metal Blast Cleaning
- .55 SSPC VIS 1 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
- .56 ANSI/ASSE Z359.4 Fall Protection Code: Safety Requirements for Assisted-Rescue and Self-Rescue Systems.



2.1.2 Materials

All materials used in the different elements of the supply shall conform to the standards identified below:

- .1 Anchors for Towers ASTM A320 Type L7, 4140 or ASTM A193 Type B7
- .2 Bolts, studs and nuts ASTM A307, ASTM A325, ASTM A193, A194

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Bronze Bushings ASTM B584
- .4 Bronze subject to stress ASTM B21, Alloy 464, Semi Hard (such as bolts and nuts)
- .5 Castings ASTM A27
- .6 Forgings ASTM A668
- .7 Guide Rollers CSA G40.20/G40.21 700 QT
- .8 Guide Roller Axles ANSI 430 or ASTM A276, type 304
- .9 Helical Springs SAE 5160
- .10 Stainless Steel Shafts ASTM A473, ASTM A564, AISI 431, A276
- .11 Steel Shafts/Gears AISI 3140, 4140, 4340
- .12 Structural Steel ASTM A36, ASTM A992, CSA G40.20-04/G40.21-04 Type W or WT
- .13 Structural Steel for Hoist Towers and Bridges CSA G40.20-04/G40.21-04 Type WT
- .14 Steel for Wheels ASTM A504, Class C
- .15 Stainless Steel Fasteners ASTM F593
- .16 Stainless Steel Tubing ASTM A269
- .17 Stainless Steel ASTM A176, ASTM A240, ASTM A276, (sheet & strip)

2.2 ALLOWABLE STRESSES AND DEFLECTIONS

2.2.1 General

- .1 Contractor shall be responsible for design of all components to the relevant standards, and prudent utility practice, for spillways and hydro-electric facilities but the following design criteria shall be used as a minimum guideline.
- .2 All design criteria in this document is based on Allowable Stress Design (ASD) methodology.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 If Contractor would like to use Limit States Design (LSD) methodology as an alternative to ASD for some or all the design work then Contractor shall submit a proposal to Engineer for Acceptance explaining methodology and all design criteria, with justification demonstrating that the proposed methodology and criteria meets all this specifications intended requirements.
- .4 The LSD shall be based on CSA S16, CSA W59 and NBCC.
- .5 Allowable stresses shall be based on the von Mises-Hencky criteria.

2.2.2 Normal Operating Condition

.1 General Mechanical and Structural Design

- .1 For all the normal loading conditions specified in this document, the allowable stresses on equipment and their support structures shall not exceed 90% of the allowable stresses given in CSA S16-1969, CSA B167, CMAA-70, and CSA W59.

.2 Wire Rope

- .1 The design load in wire rope shall not exceed 20% of the nominal breaking strength of the wire rope.

.3 Welded Joints

.1 Shop Welds

- .1 The strength of a full penetration butt welded joint shall be such that the stresses in the weld do not exceed the following percentage of the permissible stresses in the weakest of the materials to be welded:

- .1 100% of the allowable stresses in the lower strength material when the joint is subjected to thermal heat treatment and 100% radiography;

- .2 95% of the allowable stresses in the lower strength material when the joint is subjected only to 100% radiography;

- .3 90% of the allowable stresses in the lower strength material when the joint is subjected only to the thermal heat treatment;

- .4 85% of the allowable stresses in the lower strength material when the joint is neither radiographed nor thermally heat treated.

.2 Field Welds

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 For all field welded joints the stresses in the welds shall not exceed 80% of those permitted in Clause 2.2.2.3.1 unless 100% NDT has been performed and Accepted by Engineer.
- .3 Fasteners
 - .1 For all mechanical fasteners the allowable stresses/loads shall not exceed 90% of those permitted by CSA Standard S16 or 100% of CMAA 70 whichever is more conservative.
- .4 Hooks
 - .1 AISE Standard No. 7 shall be used in the determination of allowable stresses for hooks and lift blocks, with no additional safety factors applied.
- .5 Bushings
 - .1 The average stresses in self-lubricated bushings shall not exceed the lesser of 20 MPa or the manufacturer's recommended design stress.
- .6 Other Mechanical Components
 - .1 For elements not covered by a specific standard the allowable stresses shall not exceed 33% of the yield strength, or 20% of the ultimate strength of the material, whichever is the most conservative.
- .7 Concrete
 - .1 The allowable stresses shall not exceed 90% of those specified in standards CSA A-23.3.

2.2.3 Abnormal Operating Conditions

- .1 General
 - .1 For abnormal loading conditions such as jamming, broken wire rope, seismic events, and test loads, the allowable stresses on the structural elements may be increased by up to 33% above those specified in Clause 2.2.2, but in no case exceeds 90% of the yield strength of the material, subject to the exceptions specifically identified below. In addition concrete bearing and shear stresses shall not exceed 90% of the allowable factored stress in any case.
 - .2 Hoist Structure and Lifting Beams
 - .1 For the cases of;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Jamming of a gate, stoplog, trashrack section, or a lifting beam, where the load being applied to the hoist structure is asymmetric, or,
- .2 One wire rope breaks,
- .3 The allowable stresses maybe increased up to 90% of the elastic limit of the material used.

.3 Wire Rope

- .1 The design load in wire rope shall not exceed 50% of the nominal breaking strength of the wire rope and the stress in any individual wire shall not exceed 90% of the ultimate strength of the rope including stresses induced by bending of the wire ropes, calculated in accordance with the following formula:

$$f = \frac{E d_w}{D}$$

- Where:
- f = bending stress in MPa;
 - E = Elasticity modulus of wire rope (assume 200000 MPa);
 - d_w = largest wire diameter in mm;
 - D = pulley pitch diameter in mm.

- .2 The forces in the ropes due to a stalled motor shall not exceed 50% of the rope breaking strength.
- .3 If one rope is broken, the safety factor of the remaining ropes shall not be less than 2.



2.2.4 Allowable Deflection

The deflection of the main girders under rated load shall not exceed 1/1000 of their span.

2.3 RATED AND DESIGN LOADS

2.3.1 Hoist Rated Load

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Definitions:
 - .1 Basic Load – Capacity required to actually lift the component considering all possible load contributions.
 - .2 Rated Load – Equal to the Basic Load multiplied by a factor to provide some additional hoisting capacity and to accommodate unbalanced head on specific hoists.
- .2 The Basic Load shall be the sum of all the following and shall be based on conservative estimates of the parameters taking into account the uncertainty in the estimation of the parameter:
 - .1 Weight of the heaviest component to lifted;
 - .2 Weight of the associated lifting beam and any other required lifting apparatus;
 - .3 All sliding friction including the effects of hydrostatic loads where applicable;
 - .4 Static friction including the effects of hydrostatic loads where applicable;
 - .5 All rolling friction including the effects of hydrostatic loads where applicable;
 - .6 The effects of friction in all sheaves;
 - .7 Additional loading due to any guide misalignment or gate skewing;
 - .8 Downpull where applicable;
 - .9 All transient hydrodynamic forces where applicable;
 - .10 Ice loading on exposed unheated surfaces and in the gate slots where applicable.
- .3 The Basic Load shall exclude any buoyancy effects.
- .4 The hoist Rated Load shall be equal to the Basic Load x Kh where Kh is:
 - .1 Kh = 1.10 for the Spillway and Intake Gate hoists.
 - .2 Kh = 1.20 for the Draft Tube Crane and Trash Cleaner hoist.
 - .3 Kh = 1.25 for the Spillway Maintenance Hoist

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



.5 Friction forces used to evaluate hoist rated load shall be calculated using the hydrostatic pressure corresponding to Reservoir Level of El. 41.5m.

2.3.2 Impact Factor

.1 An impact factor of 1.25 shall be applied to the Hoist Rated Load and used in the analysis of the design of all components.

2.3.3 Weight of components

.1 The design load for the supporting structure shall include 110% of the weight of all hoisting and structural components.

2.3.4 Sheave Friction

.1 The design of the hoists, including the wire ropes, shall include the effects of friction in the sheaves.

2.3.5 Seismic Loads

.1 All equipment, except for the spillway hoist building and towers, shall be designed to withstand seismic horizontal acceleration of 0.091 g.

.2 Spillway Hoist Building and Towers

The design of the spillway hoist building and towers, shall be based on a horizontal ground acceleration of 0.091 g at the tower base and applying the appropriate amplifications factors based on the NBCC assuming that there shall be no permanent deformation in any part of the structure after a seismic event.

2.3.6 Wind Snow and Ice Loads

.1 See Section 48 13 10, Clause 2.3.

2.3.7 Gate Jamming Loads

.1 Gate jamming loads shall be based on the hoist motor producing its maximum breakdown torque of 210% using a torque rated motor, operating at rated voltage, and assuming a 100% mechanical efficiency of the hoist and reeving.

2.3.8 Hoist and Lifting Beam Load Cases

.1 Normal Load Cases

.1 Case H1 Hoist rated load

.2 Abnormal Load Cases

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 Case H2
 - .1 Gate jamming with symmetrical loading (all components intact).
- .2 Case H3A
 - .1 Gate jamming with asymmetric loading (only one side of gate suspended) – one wire rope broken.
- .3 Case H3B
 - .1 Gate jamming with symmetrical loading (both sides of gate still suspended) – This case is applicable to the spillway gates with one of four wire ropes broken.
 - .2 Note: Depending on the design it is anticipated that only one of Case 3A or 3B will apply.
- .4 Case H4
 - .1 Raising a test load (125% of rated load).
- .5 Case H5
 - .1 Seismic event with load (Case H1) hoisted, constrained from swinging, and stationary.

Note for the Spillway Maintenance Hoist(s) only Load Cases H1 and H4 apply.

2.3.9 Spillway Hoist Tower Load Cases

- .1 Normal Load Cases
 - .1 Case T1
 - .1 All gates being raised simultaneously (H1 loading condition), plus
 - .2 Wind, Snow and Ice Loads applied to the towers.
 - .2 Case T2
 - .1 All gates raised to their normal full open position (El. 39.0 m) (H1 loading condition), plus
 - .2 Wind, Snow and Ice Loads applied to the towers, plus



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Wind Load on the Gates (lateral load shared between embedded parts and tower).
- .3 Case T3
 - .1 One gate being raised to its maximum height (H1 loading condition with gate at highest elevation), plus
 - .2 A second adjacent gate raised to normal full open position (El.39.0 m) (H1 loading condition), plus
 - .3 Wind, Snow and Ice Loads applied to the towers, plus
 - .4 Wind load on all open gates.
- .2 Abnormal Load Cases
 - .1 Case T4
 - .1 Seismic event with one gate raised (stationary) to its maximum position (for the worst case gate hoist location), plus
 - .2 Wind, Snow and ice loads applied to the towers, plus
 - .3 Wind Load on open gate.
 - .2 Case T5
 - .1 Case H2 hoisting loading with side guide roller jamming at mid tower height, plus
 - .2 A second adjacent gate raised to normal full open position (El.39.0 m), plus
 - .3 Wind, Snow and Ice Loads applied to the towers, plus
 - .4 Wind load on all open gates.
 - .3 Case T6
 - .1 Case H3A and/or H3B loading with side guide roller jamming at mid tower height, plus
 - .2 A second adjacent gate raised to normal full open position (El.39.0 m), plus
 - .3 Wind, Snow and Ice Loads applied to the towers, plus
 - .4 Wind load on all open gates.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.4 Case T7

.1 Case H4 loading on one hoist with no load on adjacent hoists (for the worst case gate hoist location).

.3 Floor Loading

- .1 Spillway hoist building floor shall be designed to sustain a minimum uniformly distributed load of 7.5 kPa and the heaviest component in the hoist house for operation and for disassembly for service and maintenance.
- .2 Walkways, stairs, platforms, and passageways shall be designed to sustain a uniformly distributed load of 5 kPa.
- .3 Outdoor walkways shall be designed to sustain a uniformly distributed load of 5 kPa, plus ice and snow load.

PART 3 DESIGN CRITERIA

3.1 GENERAL

- 3.1.1 All hoists shall be of welded steel construction composed of open type structural shapes.
- 3.1.2 All structures shall be designed to equalise loading of main structural members and avoid asymmetric deflections and twisting.
- 3.1.3 The hoists shall be designed such that the wheel loading are equalized for each component and where wheels are in groups are articulated to equalize the load on each wheel in that group.
- 3.1.4 All structural and mechanical elements of the hoists shall be designed to withstand maximum stalling torque of the motors without damage.
- 3.1.5 All hoists shall remain fully operational immediately after a seismic event without any intervention.
- 3.1.6 All hoist mechanisms shall be capable of operating up to 300% of rated speed without damage.

3.2 ELECTRICAL REQUIREMENTS

- 3.2.1 Hoist motors shall be torque rated and certified at 200% +/- 10% over rated torque of the hoists.
- 3.2.2 Hoist motors used on hoist with fan brakes shall be designed for 300% over the rated speed.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.3 Design to be completed in accordance with requirements of;

- .1 Electrical Divisions, supplemented by this section;
- .2 CSA C22.1 and CSA C22.2.

3.3 FASTENERS AND DOWELLING

- 3.3.1** Bolted connections shall be design according to CSA S16.
- 3.3.2** Bolted connections maybe either friction or shear type except as detailed below.
- 3.3.3** Where fastener torque is critical, the design of the fastener or joint shall take into consideration the uncertainty in the selected torque or tensioning method.
- 3.3.4** Where components are to be removed, and are part of routine or reasonably expected maintenance, the fastener design shall be of the shear type and designed such that precise torque or tensioning of the fastener is not required.
- 3.3.5** All other connections shall be friction type.
- 3.3.6** All joints where alignment is critical shall incorporate locating dowels or fitted fasteners.
- 3.3.7** Use of ASTM A490 bolts are not allowed where moisture is present.

3.4 WIRE ROPES

- 3.4.1** The wire ropes shall be manufactured of galvanized improved plow steel with synthetic fibre core. They shall meet CSA G4 requirements of the 6 x 19 classification.
- 3.4.2** The wire ropes shall be impregnated with lubricant during fabrication.
- 3.4.3** The wire rope system shall be equalized and arranged to prevent reverse bending.
- 3.4.4** Wire ropes shall be rotation resistant if used with a swivel on the dead end fitting, or shall be of a proven wire rope classification if rope rotation or a swivel is used.

3.5 WIRE ROPE DRUMS

- 3.5.1** Wire rope drums shall be designed for a single layer of wire rope with machined grooves.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.5.2 Drums with two wire ropes shall have left and right hand rope lays for symmetrical tension on the gates through the full range of travel.
- 3.5.3 Drums shall have a minimum of three (3) wraps of wire rope when the hoist is at its lowest point and shall have a minimum of two (2) free grooves when the hoist is at its high point.
- 3.5.4 The wire rope dead ends on the hoist drums shall have a minimum of two (2) clamps.
- 3.5.5 The pitch diameters of the drums shall not be less than the values indicated for Class A in CSA Standard B167 but in no case shall be less than 30 times the wire rope diameter.
- 3.5.6 The drums shall have inspection ports on each end large enough to easily view all parts of the drum, and the inspection port shall be equipped with bolt on covers.

3.6 DRUM DOGGING DEVICE

- 3.6.1 The Intake Gate and Spillway Gate hoists shall be provided with drum dogging devices to allow disengagement of any hoist component when the gates are supported on the mechanical gate dogging devices.
- 3.6.2 The drum dogging devices shall shear if the gate weight or motor power is applied to the hoist with no damage to any other component.
- 3.6.3 Application of the drum dogging devices shall not involve the removal of any part of the safety guards.
- 3.6.4 The drum dogging devices shall have limit switches to disengage power to the motor when the drum dogging device not fully disengaged.
- 3.6.5 The drum dogging devices shall have pins to secure the dogging device in the disengaged position, and have provision to be lockable in both the engaged and disengaged position.

3.7 SHEAVES AND SHEAVE BLOCKS

- 3.7.1 The sheaves shall be fitted with grease-lubricated sealed roller bearings on stainless steel axles.
- 3.7.2 Each sheave shall be equipped with an independent greasing point.
- 3.7.3 The bearing seals shall prevent both the leakage of the lubricant and the ingress of water and contaminants.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.7.4 The sheave axles shall be locked in position with stainless steel keeper plates and stainless steel bolts.
- 3.7.5 Sheave pitch diameter shall be according to CSA Standard B167, but shall be a minimum of 30 times the wire rope diameter but could be reduced to a minimum of 24 times the wire rope diameter, if the classification for the hoists allows the use of sheaves to this diameter, and a signed certification is provided from the wire rope manufacturers that the wire ropes provided can be operated for the life of the facility at the minimum design operating temperatures, and shall be machined in the groove.
- 3.7.6 To prevent corrosion, the pulley groove shall be covered with grease compatible with the grease used for the rope.
- 3.7.7 The fleeting angles for the rope sheaves shall not exceed 2½ degrees during normal working hoist travel and shall not exceed 3½ degrees over the full range of operation.
- 3.7.8 Sheave blocks shall be provided with a means for preventing the ropes from leaving the groove when the load is released.
- 3.7.9 Hoist usage for Intake Gates is estimated at ten (10) open/close cycles per year, and hoist usage for the Spillway Gates is estimated at eighty (80) open/close cycles per year.



3.8 TENSION EQUALISING SYSTEM

- 3.8.1 For hoists with multiple drums, or 2 falls off one drum, and where the wire ropes are not required to be independent, a means of equalising the tension in the wire ropes shall be provided. Either equalising sheaves or equalising beams are acceptable. In the case of equalising beams the dead ends of the wire rope shall be spelter socketed.
- 3.8.2 For hoists that have multiple independent wire ropes some means of adjusting the wire ropes to balance the tension shall be provided. A means shall be provided to verify that the tension is balanced as part of normal maintenance. Limit switches shall be provided to provide an alarm indication that the ropes are out of balance by a preset limit. If equalizing sheaves are used on two independent ropes, load cells shall be provided on each rope to indicate and alarm if the load is unbalanced.

3.9 HOIST BASES

- 3.9.1 The hoist bases shall have machined pads for the mounting of all major components requiring precision alignment such as motors, gearboxes, brakes,

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

bearings supports etc., and the hoist bases shall be machined after all welding has been completed.

3.9.2 The design of the bases shall incorporate shims so as to permit both up and down adjustments.

3.9.3 Jacking screws shall be incorporated for facilitating alignment adjustments both vertically and horizontally.

3.9.4 Components shall be doweled after all alignment has been completed. Use of stop-blocks is acceptable for large components requiring final assembly and alignment in the field. Factory aligned equipment shall be doweled.



3.10 HOOKS

3.10.1 For hoists that have hooks, the hooks shall be equipped with safety latches to prevent disengagement of the slings and shall have a swivelling thrust bearing.

3.10.2 Hooks shall be easily removable by means of a steel pin.

3.11 TRAVEL WHEEL ASSEMBLIES

3.11.1 All travel wheels shall be double flanged tapered and shall be designed to prevent derailment.

3.11.2 The rolling surface of the wheel shall have a slightly higher hardness than that of the rails.

3.11.3 The wheels shall have grease lubricated roller bearings complete with seals and shall be designed for easy removal.

3.11.4 Provision shall be made for lifting or jacking trucks or trolleys to change a wheel.

3.12 BUMPERS, END STOPS AND RAIL SWEEPS

3.12.1 Bridge trucks and trolleys shall be provided with suitable removable rail sweeps at each end so as to be effective in both directions of travel.

3.12.2 Each end of the bridge trucks and trolleys shall be provided with an elastomeric type bumper, or an alternative Accepted by Engineer, and end stops, designed to absorb the kinetic energy of the bridge or trolley at 40% rated speed without damage.

3.12.3 The bridge and runways shall be fitted with end stops capable of withstanding the impact of the trolley or bridge at rated speed assuming the energy damping bumper has failed and does not absorb any energy.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.12.4 Where the runway and end stops are supplied by Company's Other Contractor, Contractor shall provide to Engineer the design loads and bumper details on the related trolley or bridge for the use with solid end stops.

3.13 DROP STOPS

3.13.1 The hoists shall incorporate drop stops that prevent the hoist from dropping more than 10 mm in the event of a failure of any combination of wheel assemblies.

3.13.2 Drop stops shall be removable on under-hung hoists.

3.14 SPEED REDUCERS/GEAR BOXES, BEARINGS AND SHAFTS

3.14.1 All speed reductions shall be performed by fully enclosed geared speed reducers.

3.14.2 All speed reducers shall be designed to perform under all conditions of loading without undue noise, overheating or vibration.

3.14.3 Speed reducer/gear box drain holes shall be equipped with a stop valve and a threaded plug linked to the pipe with a chain, and the drain holes shall allow easy drainage of the gear boxes.

3.14.4 Oil levels shall be clearly readable from outside the speed reducer/gear box with graduated sight glasses or dip sticks.

3.14.5 Shafts shall be supported by anti-friction bearings. Where helical gears are used, bearings are to be suitably designed for all thrust loads. Ball and roller bearings shall be selected in accordance with the bearing manufacturer's recommendations and shall provide a minimum life expectancy, in accordance with CSA Standard B167.

3.14.6 All speed reducer bearings shall be lubricated (self lubricated bearing shall not be used without acceptance by Engineer).

3.14.7 If any drive train includes long shafts, the dimensions of the shafts shall be such as to minimize vibration.

3.14.8 Drive couplings shall be of the sealed grease lubricated flexible type and be capable of accommodating the worst case misalignment of the components.

3.14.9 All speed reducers/gear boxes shall be equipped with heaters.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.15 DRIVING SYSTEMS

3.15.1 The driving mechanisms for the bridge and the trolley shall be provided with fluid couplings or electronic progressive starting devices to allow a progressive acceleration and a precise positioning of the bridge and trolley.

3.15.2 Drive systems shall be configured for ease of access and ease of maintenance.

3.16 HOIST HOLDING BRAKE

3.16.1 All hoists shall be equipped with an electromagnetic drum holding brake that is mechanically actuated and electrically released.

3.16.2 The brake shall be operated by a quick action direct current 125 Vdc solenoid.

3.16.3 The brake shall be mounted directly on the gear reducer inlet shaft in such a way that the motor can be removed with the hoist holding the load.

3.16.4 The drum brake shall be of the 'Elevanja' type or an equivalent Accepted by Engineer.

3.16.5 Braking torque shall be capable of holding 150% of the full load torque of the motor.

3.16.6 The brake on its own shall be capable of holding the load at any position during raising or lowering operations, and stop the load during emergency lowering.

3.16.7 The brake shall be self adjusting to compensate for wear.

3.16.8 The brake shall not lose its effectiveness due to heating if operated frequently over a short period of time.

3.16.9 Brake mechanism sliding contact surfaces shall be made of corrosion resistant and galling resistant materials.

3.17 HOIST HOLDING SECONDARY BRAKE

3.17.1 Where specified, the hoist shall be equipped with second brake in addition to the Hoist Holding Brake that will act as a backup to the Hoist Holding Brake. This brake shall have at least the same capability and operating characteristics as the Hoist Holding Brake and additionally shall activate by an over-speed detector. This brake shall operate simultaneously with the Hoist Holding Brake.

3.17.2 This brake design may be identical to the Hoist Holding Brake mounted on the opposite end of the motor input shaft on the gear reducer, or alternatively may also be a disk type brake(s) located on the main hoist drum(s).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.17.3 This secondary brake shall allow the Hoist Holding Brake to be removed with the hoist holding the load.

3.18 HOIST FAN BRAKES

3.18.1 Where specified fan brakes shall be provided to limit the lowering speed to a maximum of 200% of the normal motor operated lowering speed but no less than 175% of the normal motor operated speed.

3.18.2 The fan brake shall be installed directly on an extension of an input shaft on the gear reducer.

3.18.3 The fan brake speed shall be controlled by an adjustable damper on the air inlet with the damper nominally at its mid-adjustment to get the specified speed, and once adjusted, the damper position shall be semi-permanently fixed by some means (such as tack welding) to avoid accidental adjustment.

3.18.4 The fan brake air inlet shall be covered by a non-flat (box like rectangular, cylindrical etc.) Protective screen that shall be at least 2.5 times the area of the fan inlet.

3.18.5 The fan brake air outlet shall be directed away from personnel walkways or equipment, and provided with a protective screen.

3.19 BRIDGE TRAVEL BRAKES

3.19.1 The bridge drive system shall be equipped with a proportional braking system, mechanically applied and electrically released.

3.19.2 When powered down these brakes shall act as the parking brake and be capable of holding the bridge position against lateral loads appropriate to the specific hoist (wind, seismic, within rail out of level tolerance while loaded, etc.).

3.19.3 Brake mechanism sliding contact surfaces shall be made of corrosion resistant and galling resistant materials.

3.20 TROLLEY TRAVEL BRAKES

3.20.1 The trolley drive system shall be equipped with mechanically applied and electrically released braking system.

3.20.2 When powered down these brakes shall act as the parking brake and be capable of holding the trolley position against lateral loads appropriate to the specific hoist (wind, seismic, within rail out of level tolerance while loaded, etc.).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.20.3 Brake mechanism sliding contact surfaces shall be made of corrosion resistant and galling resistant materials.

3.21 BRAKE LININGS

3.21.1 Brake linings shall be of the REDCO RBW or RNAW type, or an equivalent Accepted by Engineer.

3.22 LUBRICATION

3.22.1 Bearings shall be grease lubricated. All mechanisms shall be periodically lubricated and fitted with grease nipples.

3.22.2 All the nipples which are hard to reach shall be extended with independent tubes grouped together at easily accessible points, and tubes shall be supported and protected on their whole length.

3.22.3 All grease nipple fittings shall be of Alemite type No. 1186 with 6 mm (1/4 in) NPT pipe threads.

3.22.4 The grease nipples for the electrical brakes shall be of the Alemite type No. 1627B.

3.22.5 Peep holes shall enable checking the greasing efficiency for each lubricated component.

3.22.6 In general, gears shall be splash lubricated.

3.22.7 Oil reservoirs shall be fitted with easily accessible dip rods or sight glasses, drain plugs and oil breathers.

3.22.8 All lubricated items not enclosed in sealed gear boxes shall be grease lubricated.

3.22.9 Drip pans shall be provided wherever necessary so as to contain leaked oil and grease.

3.22.10 All lubricants shall be of the winter-summer type, and they shall not lose their properties under the specified temperature ranges.

3.22.11 In addition to the information provided in the Operating and Maintenance Manual, Contractor shall supply and install a lubrication chart printed or engraved on an anodized aluminum plate and installed in a visible place on the hoist Accepted by Engineer.

3.22.12 This chart shall specify:

- .1 The list of lubrication points;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 The type and make of lubricant to be used for each point;
- .3 The names of at least three (3) manufacturers capable of supplying each lubricant;
- .4 The lubrication cycle for each point.



3.22.13 Not used.

3.23 LIFTING LUGS

- 3.23.1** All major components of the hoists (trolleys, trucks, gear boxes, motors, frames etc.) shall have lifting lugs for installation and removal.
- 3.23.2** The lifting lugs shall be designed such that sub-components do not necessarily have to be removed to perform the lift.
- 3.23.3** The lifting lugs shall be designed considering such things as available lifting height, access, sling angles, centre of gravity etc. and shall be sized for a minimum of 200% of the expected load.

3.24 HAND RAILS/PLATFORMS/WALKWAYS/STAIRS/LADDERS/GATES/FALL PROTECTION



- 3.24.1** Handrails/platforms/walkways/ladders/gates/fall protection shall conform to the requirements in Section 05 50 10.
- 3.24.2** Hand rails, platforms, walkways, stairs, ladders, gates, and safety equipment such as attachment points for fall arrest/protection etc., shall be provided as necessary to give safe access to all components that will or could need inspection, maintenance and repair.
- 3.24.3** Stairways are preferred. Ladders may be used only where it is impossible to provide a stairway.
- 3.24.4** Unless otherwise stipulated, all platforms and their supports shall be designed for distributed loads of 5 kPa.
- 3.24.5** Fixed steel ladders or stairways shall be provided in accordance with Newfoundland and Labrador Occupational Health and Safety Regulations where necessary to afford access for operation and maintenance of the equipment. Ladders shall not exceed 7.5 m in length and suitable platforms with handrails shall be provided between each length. Where a ladder does not extend above a floor or platform level, hand grips or other suitable means of support shall be provided.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.24.6 Protective cages shall be provided for ladders longer than 4.5 m, starting at 2.44 m from base of ladder.
- 3.24.7 Ladder rungs shall be of the anti-skid type and stringers not less than 300 mm apart.
- 3.24.8 Stairways shall be provided with handrails and shall have a slope not greater than 45°.
- 3.24.9 Walkways and platforms at any height shall be equipped with handrails and toe-boards in accordance with Newfoundland and Labrador Occupational Health and Safety Regulations.
- 3.24.10 Handrails shall be provided where ever necessary for the safety of personnel; shall consist of at least two horizontal tubular members; shall be approximately 1100 mm above floor level.
- 3.24.11 The handrails and supports shall be designed to withstand vertical and horizontal uniformly distributed loads of 750 N/m applied simultaneously on the top of the railing.
- 3.24.12 Openings in the handrails shall be closed by spring closure gates with latches; chains shall not be used.
- 3.24.13 All fall arrest/protection anchors, and mountings for other equipment such as Davit arms, shall be permanently installed.
- 3.24.14 All hand rails, platforms, walkways, stairs, and ladders shall be removable at any location where access to the equipment for maintenance would be restricted.
- 3.24.15 Spring loaded gates with latches shall be provided anywhere there is a fall hazard.
- 3.24.16 All walkways and access points shall have a minimum width of 0.9 m.



3.24.17 Not Used

3.25 PROTECTIVE GUARDS

- 3.25.1 All rotating parts with the exception of the hoist drums shall be equipped with removable protective guards with handles for easy removal.
- 3.25.2 Where necessary, the guards shall be equipped with windows for inspection and maintenance.
- 3.25.3 Attachment screws and nuts shall be stainless steel.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.25.4 A protective guard shall protect all the friction brakes from contamination from dripping and condensation from the hoists covers, lubricants from other components etc. but still allow adequate ventilation for cooling.
- 3.25.5 Removable protective guard rails, with wire mesh, shall be provided at the hoist drums, designed to stop anyone from being able to reach the drum or wire rope by reaching over, through, or around the guard.
- 3.25.6 The guard rails shall have lockable gates if quick access is required to hoist components.
- 3.26 **LIFTING BEAMS**
- 3.26.1 The lifting beams shall be provided with an efficient guiding system which shall utilize the gate and stoplog guides.
- 3.26.2 Lifting beams shall conveniently and easily be connected to the respective hoist or crane, if not direct connected to the hoist.
- 3.26.3 In the case where a lifting beam must be used with a mobile crane, the lifting beam shall be supplied with all rigging required to perform the various lifts and be designed to not overly restrict the type of crane or means of connection to the crane.
- 3.26.4 Lifting beams shall have one or two (2) hooks, with corresponding lifting point, or points, on the component, and if two hooks are used shall be linked by connecting rods to a release lever. Alternates shall be subject to Acceptance by Engineer.
- 3.26.5 Lift beam hooks shall automatically engage lifting point, or points, on the component sections, under the lift beam self weight.
- 3.26.6 Lift beams shall be fitted with guide rollers and other such guiding devices as required to ensure the beam is properly guided in the embedded parts, eliminating any risk of the beam or component jamming while raising or lowering.
- 3.26.7 All rotating parts shall be fitted with specified self-lubricating bushings with seals running on stainless steel or corrosion resistant steel pins, and pins shall be locked in position by means of keeper plates and fixing bolts;
- 3.26.8 Where applicable the lifting beam shall be equipped with a mechanism that operates the filler valve, and the weight of the lifting beam shall be sufficient to open the valve;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.26.9 The automatic disengagement mechanism of the lifting beam hooks shall consist of a cable wound around a drum that is driven by an electric powered torque motor.
- 3.26.10 At the lower torque, the mechanism shall take up the cable slack while the lifting beam is going up or down. At the upper torque, the mechanism shall apply sufficient tension in the cable so as to disengage the hook, or hooks, from the lifting lugs of the gate sections. The lifting beam hooks shall slide under the lifting lugs under their own weight.
- 3.26.11 The release mechanism shall be designed such that the hook, or hooks, cannot be released by the torque motor cable, or manually, when the weight of the lifted load is being carried by the hooks.
- 3.26.12 The motor and the disengagement of the hook, or hooks, shall be controlled manually from the control panel with the help of push-buttons.

3.27 TRACK MARKERS AND ALIGNMENT SYSTEM

- 3.27.1 The Draft Tube Crane and trash cleaner shall have alignment systems to facilitate the operator locating the hoists over the centre of all the gates and stoplogs. The alignment systems shall consist of markers and pointers that:
 - .1 provide both longitudinal and upstream/downstream positioning,
 - .2 are clearly visible by the operator from their normal operating position,
 - .3 are protected from damage and not be a trip hazard to personnel,
 - .4 are adjustable over a 50 mm range,
 - .5 are clearly indentified,
 - .6 are fabricated from stainless steel plates and fasteners and of the reflecting type used for signs.
- 3.27.2 The pattern and colours shall be submitted to Engineer for Acceptance.
- 3.27.3 Contractor shall supply and install an electronic alignment system that will be complementary to the manual positioning system and that will enable the operator of the crane to position definitely the lifting beam above the gates guides and within ± 3 mm of its true position.

3.28 CONCRETE/GROUT/ANCHORS

- 3.28.1 Grouting shall be carried out according to this Section and 03 60 40.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.29 HOIST LIMIT SWITCHES

- 3.29.1 See Section 26 29 03.03 for a description of the limit switches.
- 3.29.2 Once adjusted, the upper extreme limit switches shall be semi-permanently fixed by track welding an equivalent after the completion of all testing.

3.30 MISCELLANEOUS LIMIT SWITCHES

- 3.30.1 Each brake shall have one (1) limit switch to indicate brake application.
- 3.30.2 As per Clause 4.6.2.4 the Intake Gate hoist shall have a limit switch that performs an interlock function for the manually operated brake lever.

3.31 LOAD SENSING DEVICES

- 3.31.1 All hoists shall be equipped with a slack rope detection device except for the Spillway Maintenance hoist in the Spillway Hoist Tower.
- 3.31.2 For the Intake Gate hoist and the Spillway Gate hoist the slack rope detection device shall stop the hoist motor in the event of a sudden reduction in rope tension, and trigger point for the slack rope detection device shall be no more than 5% of the rated load.
- 3.31.3 For the Draft Tube Crane and Trash Cleaner hoist the slack rope detection device shall provide indication only, and the trigger point for the slack rope detection device shall be no more than 1.5 x the lifting beam weight.
- 3.31.4 All hoists shall be equipped with load cells with local displays indicating the hoist load in metric tonnes.
- 3.31.5 For the Spillway Gate and Intake Gate hoists, and the Draft Tube Crane, the load cells shall have programmable outputs to disconnect the electrical power to the motor nominally set to 120% of the design load when lifting, or to 90% of the design load during lowering.

3.32 POSITION INDICATOR

- 3.32.1 All hoists shall be equipped with a digital position indicator that will indicate the height of the load above the lowest position.
- 3.32.2 The intake hoist shall have mechanical indication of gate height above the sill, and indicate normal open position and upper maintenance position.
- 3.32.3 The position indicator's display shall be clearly visible from the operator's position.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.32.4 The indicators shall be graduated in metres and decimetres.
- 3.32.5 For the Trash Cleaner crane and Draft Tube Crane, the position indicator shall display when the lifting beam is at each bulkhead gate or permanent stoplog position.
- 3.32.6 Rulers, a minimum of 175 mm wide, shall be provided on the Spillway Gate guides to indicate Spillway Gate opening, shall be visible from the upstream walkways with black on white increments and numbering, and shall be graduated in metres and decimetres.

3.33 SPARE PARTS

- 3.33.1 Required spare parts shall include the following:
 - .1 One (1) set of brake pads for each type of brake;
 - .1 One (1) set of each type of sheave;
 - .2 Two (2) sets of each type of bearings;
 - .3 Two (2) sets of each type of coupling;
 - .4 20 Litres of each type of gear box oil;
 - .5 One (1) brake solenoid of each type;
 - .6 One (1) torque rated motor for the Intake Gates;
 - .7 One (1) torque rated motor for the Spillway Gates.
- 3.33.2 Contractor shall provide a list of Recommended Spare Parts that the Contractor would recommend the Company purchase as an option.

3.34 TOOLING

- 3.34.1 Contractor shall design and supply maintenance tooling, jigs and special rigging necessary to safely remove components from the hoists and cranes.

PART 4 TECHNICAL REQUIREMENTS

4.1 SPILLWAY GATE HOISTS

4.1.1 General

- .1 The hoists shall be capable of raising, lowering and sustaining the Spillway Gates in any position at the maximum reservoir water level.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .2 Each of the Spillway Gates shall be operated by a wire rope hoist with two drums, with two independent wire ropes on each drum, with each wire rope having its own independent dead end designed if any one of the four wire ropes failed the hoist would still be able to raise or lower the gate to the dogging devices or the sill.
- .3 The normal raising and lowering speed of the gates shall be between 0.9 and 1.2 m/min.

4.1.2 Hoist Brakes

- .1 The Spillway Gate hoists shall each have primary and secondary holding brakes and a fan brake.

4.2 SPILLWAY GATE HOIST TOWERS AND APPURTENANT STRUCTURES

4.2.1 General

- .1 The hoist house, stair towers and associated structures shall be designed and constructed to the requirements specified herein, or to the requirements of the attached Civil and Architectural Sections, whichever is more stringent and the design shall be submitted and Approved by the Engineer.

4.2.2 Hoist Bridge Structures

- .1 The hoist machinery for each surface gate shall be mounted on a steel bridge structure spanning each spillway opening.
- .2 The hoist bridge structures shall be structural steel members, and designed to support the hoist house, the gate hoists, the electrical equipment and the bridge structure can be integral with hoist frames.
- .3 One end of each hoist bridge structure shall be provided with free thermal expansion capability at the mounting points on the towers, as required for temperature changes for the outdoor ambient conditions, but shall prevent upstream or downstream movement and if sliding pads are required they shall be self-lubricating.
- .4 One end of each hoist bridge structure shall be pinned to the tower to prevent movement relative to the tower when subjected to lateral or longitudinal forces.
- .5 Design of the free expansion ends and the pinned ends shall permit free rotation of the hoist bridge structure ends resulting from bending loads.
- .6 The hoist bridge structure deck shall be covered with a raised pattern steel plate of not less than 8 mm thick, suitably stiffened.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .7 Sufficient openings shall be provided in the floor of the hoist structure to allow safe access to equipment below for maintenance.
- .8 The bridge deck shall be completely closed and weatherproof with only the openings necessary for the hoist ropes and maintenance hatches if so required.
- .9 Conveyor belt strips, 12 mm thick, shall be bolted around the wire rope openings to restrict outside air from entering the hoist house.
- .10 The hoist bridge deck shall be cantilevered out from the tower as shown on the Drawings, and a covered hatchway shall be provided with an opening of suitable size for hoisting and lowering items in the hoist house, by means of the overhead maintenance crane, to the level of the spillway road deck.
- .11 The hatchway in the hoist bridge deck shall have adequately size covers to move different size equipment, except the hoist drums, and shall have handrails with kick plates around the hatchway, and shall have fall protection tie-off points at convenient locations if the handrails have to be removed.

4.2.3 Hoist House

- .1 The hoist house shall be provided over the entire length of hoist bridge structure for full protection from the weather.
- .2 The hoist house shall consist of structural steel framework and coated sheet metal cladding. The Spillway hoist house shall not be insulated.
- .3 Provision shall be made to accommodate thermal expansion and contraction of the structure.
- .4 The hoist house shall be installed in sections so an individual roof section can be removed to service a hoist, and all equipment and cable trays in the hoist house shall be independently supported from the removable roof sections to ease hoist removal.
- .5 The hoist house shall be large enough for the hoists, electrical and control panels, the maintenance crane, lighting and cable trays, and walkways.
- .6 The hoist house shall extend over the cantilevered end of the hoist bridge structure as shown on the Drawings, and an overhead bridge crane shall be provided of suitable size for hoisting and lowering any items in the hoist house, except the hoist drums, to the level of the spillway road deck.
- .7 A walkway, a minimum of one (1) m wide or wider as necessary, shall be provided along one of the side of the hoist bridge structures, and clear access shall be



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

provided to all parts of the hoist machinery in the hoist house for maintenance and repairs.

- .8 Metal cladding shall be pre-painted on exposed side, and shall meet the following requirements, or an equivalent Accepted by Engineer:
 - .1 Galvanized steel sheet commercial grade, conform to ASTM A525, class 90, with Z275 zinc coating, CL 6025R profile by VICWEST, or an equivalent Accepted by Engineer; thickness 0.76 mm (gauge 22); Steelcolour prefinished '10,000' series from STELCO inc.; color slate blue QC 184;
 - .2 Metal flashings, counter flashings, closure, parapet copings and other exposed metal pieces shall be pre-painted sheet metal of same quality as metal cladding; thickness 0.76 mm (gauge 22).
 - .3 Pre-painted stainless steel screws conforming to CSA 935.3 with and without washers shall be used.
 - .4 Screws shall have same colour as exterior siding.
 - .5 The sealant for exterior liner sheet shall be conform to CGSB 19-GP-24 such as Dymeric from "TREMCO" or an equivalent Accepted by Engineer.
 - .6 The spacing on the supporting girts and purlins shall be such that the deflection under load will not exceed 1/180 of the span.
- .9 Contractor shall confirm with Engineer the final specifications of the cladding before purchasing.
- .10 One window, 0.75 m x 1.2 m shall be provided on both sides of the hoist house in each spillway bay.
- .11 The windows shall be of a type that may be opened a safe distance, and shall be of transparent tempered and safety wired glass with galvanized steel frame painted similar to the cladding.
- .12 Ventilators shall be provided to prevent humidity and accumulation of frost inside the hoist house.
- .13 Electric radiant heaters shall be provided in front of each hoist/motor location, and control panel for winter access to the equipment.
- .14 Power cables to and instrumentation cables from the Spillway gates shall be provided with a single heavy duty sheathed weather proof cable hung from the hoist bridge on the downstream side of the gates. The cable shall have at least three (3) spare pairs of conductors capable of the highest load. The anchoring on

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

each end of the cable shall be non-abrasive and accommodate movement and flexing of the cable. Potential abrasive contact points on the structure or gates shall be eliminated.

4.2.4 Hoist Towers



- .1 Hoist Towers shall conform to the requirements in Section 05 50 10.
- .2 Each tower shall be made of structural steel and shall consist of columns stiffened with bracing designed for static and dynamic loads from the hoist structure and from the gates.
- .3 Structural connections shall be shop welded or bolted with high strength bolts.
- .4 Bolted structural connections shall be friction type connections.
- .5 The spillway hoist tower anchoring system shall be designed to apply a pre-stress sufficient to avoid surface separation under the worst overturning condition. The system shall permit the levelling of the towers followed by the tensioning of the anchor studs and subsequent grouting.

4.3 GATE GUIDES

4.3.1 The Spillway hoist towers shall have upper guides for the gates as described in Section 48 13 20.



4.3.2 The gate guides shall be designed for lateral loads from gate jamming or a broken wire rope, and the guides can be designed to yield or transfer loads to the towers.

4.4 ANCHORS AND GROUTING

4.4.1 The towers and lateral guides shall be securely anchored to first stage concrete on the piers with adjustable, galvanized rod-anchors, designed and supplied by Contractor.



4.4.2 The embedded anchors shall be provided to Engineer for installation and embedment of the anchors in first stage concrete by Company's Other Contractor, according to Contractor's layout drawing and installation procedures with technical assistance by Contractor during installation.

4.4.3 Contractor shall mount the anchors on templates to facilitate the attachment of these anchors to the forms and reinforcing steel for embedment.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		



- 4.4.4 Contractor shall be responsible for technical assistance during the installation of the anchors in first stage concrete and accepting the Work of Company's other contractor to proceed with placement of first stage concrete.
- 4.4.5 Contractor shall supply and grout the anchor bolts for towers and column base plates of the structure.
- 4.4.6 During grouting operation of the anchor bolts for towers, the holes shall be completely filled with grout, of a type and mixture Accepted by Engineer.
- 4.4.7 Before grouting operation, all accumulation of water shall be removed from the holes by means of a compressed air jet.
- 4.4.8 Grouting operation shall not be carried out before mixing of sufficient quantity of grout necessary to completely fill the grout holes.
- 4.4.9 Grout under the base plates of the towers shall be pre-mixed grout, 'SikagROUT 212', or an equivalent Accepted by Engineer.
- 4.4.10 During cold weather, the foundation of the towers shall be heated to at least 20°C for five (5) days or to 10°C for seven (7) days before grouting, with cold weather protection methods that are accepted by Engineer.

4.5 STAIRWAY, LADDERS, WALKWAYS, AND HANDRAILS



- 4.5.1 Access to the hoist house shall be by means of stairways located in the two enclosed end towers.
- 4.5.2 The stair towers shall be completely enclosed by a weatherproof metal cladding of the same type as used for the hoist house walls. The Spillway stair towers shall not be insulated.
- 4.5.3 Single pane windows, 900 mm by 900 mm, with tempered and safety wired glass, shall be provided at each stair landing on the upstream or downstream face of the covered stair towers over their full height.
- 4.5.4 The stairs and landings for the stairway shall be made with raised pattern floor plates.
- 4.5.5 The stairs and landings shall have complete hand railings and kick plates.
- 4.5.6 The access doors to the enclosed towers shall be of the hollow metal type, mounted on a steel frame having an opening size no less than 0.9 m x 2.15 m.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 4.5.7 Covered hatchways shall be provided through the hoist bridge deck, with caged ladders to suspended walkways under the hoist bridge structures for access to the upper sheave blocks and the top of the fully raised gates.
- 4.5.8 These covered hatchways and suspended walkways shall have full handrails, kick plates, gates and fall protection tie off points.
- 4.5.9 These covered hatchways shall be located near the control panels so the hatchway covers can be opened to be able to observe gate operation from the hoist house.
- 4.5.10 Handrails and latched access gates shall be provided on the Spillway deck level, downstream of the road guardrails supplied by Company's Other Contractor, along the tops of the piers for safe access to the stoplogs, gates, walkways between the piers, and gate access openings in the piers downstream of the towers, up to an interface point at the guardrails around the Spillway Electrical Building that are supplied by Company's Other Contractor;
-  4.5.11 Handrails and latched access gates will be provided by Company's other contractor around the top of the concrete access ways in the piers that provide access to the tops of each of the Spillway gates;
- 4.5.12 Lockable gates shall be provided in the concrete access ways where they exit the piers to access the tops of the gates.
- 4.5.13 The ladders and hatch covers for concrete access ways in the piers will be provided and installed by Company's other contractor.
- 4.5.14 Walkways shall be provided, with handrails, kickplates and latchable gates, upstream and downstream of the Spillway gates between the piers to provide access to the piers, towers and guide heaters, to service the gate bottom seal, and to access the lower gate hatches when the gates are in the raised position.
-  4.5.15 Any anchors and inserts for the handrails that are required to be installed in first stage concrete shall be provided to Engineer for installation by Company's Other Contractor with Contractor's technical assistance during installation. As an alternative, Contractor may core and grout handrails and sleeves.
-  4.5.16 The stairwells shall have three (3) convenient panel doors, 600 wide by 900 high, 2 on the south tower upstream and downstream and one on the north tower upstream, accessible from the stairway landings, for accessing equipment (video cameras and horns by Company's Other Contractor) mounted on the outside of the towers at the locations shown on the Drawings.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.6 INTAKE GATE HOISTS

4.6.1 General

- .1 At the maximum differential head the hoists shall be capable of raising the Intake Gate from the fully closed position to approximately 150 mm open, to fill the water passages, and to lower the Intake Gate from fully open to fully closed at maximum discharge as part of an emergency turbine/generator shutdown sequence.
- .2 Each of the Intake Gates shall be operated by a wire rope hoist with two drums, with two independent wire ropes on each drum, with each wire rope having its own independent dead end designed if any one of the four wire ropes failed the hoist would still be able to raise or lower the gate to the dogging devices or the sill.
- .3 The hoists shall have two drums, each with an independent wire rope, and wire rope dead end designed if one of the wire ropes failed it would still be possible to lower the gate to the dogging devices or the sill.
- .4 The normal parking position for the hoists will be with the bottom of the gate about 300 mm above the lintel.
- .5 The fully raised position will be with the bottom of the gate raised to above the inspection gallery floor at EL. 23.00 m, or the top of the gate raised for access from the ventilation shaft floor at El. 42.50 m.
- .6 The normal raising and lowering speed shall be between 0.9 and 1.2 m/min.

4.6.2 Hoist Brakes

- .1 The Intake Gate hoists shall each have primary and secondary holding brakes and a fan brake.
- .2 Release of the hoist holding brake shall be possible by a manual lever to initiate closing of the gate with the fan brake in the absence of control power.
- .3 The manual lever shall be designed to be capable of being latched in the released position.
- .4 There shall be a limit switch on the brake assembly that indicates that the brake manual lever is in the release position, and shall block the gate from being raised.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.6.3 Mechanical Safety Isolation

- .1 The hoist shall be designed such that the coupling between the motor and gearbox can be routinely and easily removed as part of normal isolation and lock out of the Intake Gates when the gates are in the down position.
- .2 The arrangement shall include a lockable cover or panel or barrier that prevents the re-installation of the coupling.

4.6.4 Gate Slot Heaters

- .1 Heaters shall be provided to keep the water surface in the Intake Gate slots clear of ice for winter design conditions.
- .2 Heaters shall be mounted to blow heated air from below the Intake Gate hoists, and can be mounted on the hoist frames or attached to the guides or concrete.
- .3 Mechanical and electrical components shall be located above PMF water level.
- .4 Ducting shall be provided to distribute the heated air at the water surface at FSL.
- .5 Ducting and heaters shall be designed to withstand high air flows in the ventilation passages during an Intake Gate emergency closure with the generating unit still operating.

4.6.5 Gate slot cover plates (El.45.50)

- .1 Cover plates shall be designed to withstand negative pressures up to 500 Pa during Intake Gate emergency closure.
- .2 Cover plates shall be provided with sealed openings around upper sheave blocks and wire ropes.



4.7 TRASH CLEANER HOIST

4.7.1 General

- .1 The Trash Cleaner support structure will be equipped with an under-hung hoist, designed to connect to the Spillway Stoplog Lifting Beam or the Intake Bulkhead Gate Lifting Beam, and used to install, remove and store all the Spillway upstream temporary and permanent Stoplogs, and the Intake Bulkhead Gates.
- .2 The Trash Cleaner hoist block, or blocks, shall be connected directly to the lifting beams via pins.
- .3 The hoist lift points shall securely connect to the Trash Cleaner's downstream gantry structure when the hoist is not being used.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

4.7.2 Hoist Brakes

- .1 The Trash Cleaner hoist shall have two holding brakes; a hoist holding brake and a hoist holding secondary brake.

4.7.3 Speeds

- .1 The trolley travel speed shall be not less than 5 m/min; and the hoisting speed shall not be less than 3 m/min.
- .2 The hoist shall have variable frequency drives for the hoist and trolley travel drives.

4.7.4 Movements

- .1 Minimum movements at rated capacity:
 - .1 Vertical movement: 3 mm
 - .2 Trolley travel: 6 mm

4.7.5 Lifting Beams for Bulkhead Gate and Spillway Stoplogs

- .1 Two lifting beams shall be provided for use with the Trash Cleaner hoist.
- .2 Bulkhead Gates Lifting Beam
 - .1 The first lifting beam shall be for the Intake Bulkhead Gates and shall be supplied with a dogging device for storage in the Bulkhead Gate guides.
 - .2 For the purpose of lock out, the Bulkhead Gates lifting beam shall be capable of being locked in the gate slot.
 - .3 The Bulkhead Gate lifting beam shall be designed to operate the fill valve in the top section of the Bulkhead gates.
- .3 Spillway Stoplogs Lifting Beam
 - .1 The second lifting beam shall be for the Spillway stoplogs located upstream of the Spillway gates.
 - .2 The Spillway stoplogs lifting beam shall be capable of being used for all the permanent and temporary upstream stoplogs and as such shall also work with a mobile crane for use during construction.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 However, Contractor may at their choosing provide two (2) separate stoplog lifting beams; one permanent to be used with the Trash Cleaner and the permanent stoplogs only, and a second temporary stoplog lifting beam for the temporary stoplogs.
- .4 The Spillway stoplogs lifting beam(s) shall be provided with a storage stand mounted on the piers at the location shown on the Drawings.

4.8 DRAFT TUBE CRANE

4.8.1 General

- .1 The Draft Tube overhead crane shall consist of a wire rope hoist mounted on a motorized trolley, and a bridge structure travelling on one level runway.
- .2 Engineer will supply and install the rails (Beth 104), clips, anchors, runway end stops, and all other parts required for the runway (Beth 104), with a runway gauge (centre to centre distance) of 7500 mm.
- .3 The crane shall be compact and with very low headroom in order to fit the space available, and shall provide easy and direct access to the components requiring maintenance, as shown in the drawings.
- .4 The crane shall be accessible for maintenance from the maintenance platform or maintenance gallery provided by Company's Other Contractor and as shown on the drawings, with adequate provisions provided for worker safety.
- .5 The cranes shall be provided with maintenance platforms on the bridge and trolley for safe access to all components if the crane is in the maintenance area, or if the crane requires emergency maintenance anywhere in the Draft Tube Gallery.
- .6 The Draft Tube Crane shall be connected directly to the lifting beam and be equipped with a torque motor driven cable release mechanism for releasing the lift beam from the stoplogs.
- .7 Permanent lighting shall be provided below the trolley providing adequate illumination of the stoplog slots and the top of the stoplogs, and on the bridge crane providing illumination of the walkway.



4.8.2 Hoist Brakes

- .1 The Draft Tube Crane shall have two holding brakes on its hoist; a hoist holding brake, and a hoist holding secondary brake.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.8.3 **Speeds**

- .1 The bridge travel speed shall be not less than 30 m/min; the main trolley travel speed shall be not less than 5 m/min; and the hoisting speed shall not be less than 3 m/min.
- .2 The crane shall have variable frequency drives for the hoist and the trolley and bridge travel drives.

4.8.4 **Movements**

- .1 Minimum movements at rated capacity:
 - .1 Vertical movement: 3 mm
 - .2 Trolley travel: 6 mm
 - .3 Bridge travel: 6 mm

4.8.5 **Equipment Elevations**

- .1 Top of rail level: El. 12.19 m
- .2 Maximum water level in gallery (PMF): El. 12.28 m
- .3 Maximum surge water level in gallery: El. 9.3 m

4.8.6 **Lifting Beam**

- .1 The Draft Tube Crane shall be provided with a direct connected lifting beam for use with the Draft Tube stoplogs.

4.8.7 **Runway Bus Conductor**

- .1 The electrical supply shall be through bus bars installed along the hoist upstream rail. The supply bus shall be heated, 600 V 3-phase, three copper conductors plus one for grounding (coloured green). Two additional conductor bars shall be supplied for signalling to supervise heating of the motors, brakes and gear boxes.
- .2 The main conductor bars shall include the expansion joints and the anchor points taking into account the powerhouse joints and the maximum ambient temperature differential in the powerhouse.
- .3 The contacts and bus conductor bars shall be capable of carrying the rated current continuously, without overheating, and withstand short circuit currents. The voltage drop over the entire length of the bus conductor and through to the connection to the hoist motor shall not be more than 1.5%.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.9 SPILLWAY MAINTENANCE CRANE



4.9.1 A three (3)MT electric overhead crane shall be supplied in the Spillway Gate hoist house for maintenance purposes.



4.9.2 The maintenance crane shall run the full length of the hoist house, capable of moving any single operating component (except the hoist drums and gearboxes) in the hoist house to the level of the spillway deck level at the south end of the spillway hoist house.

4.9.3 The crane shall have two holding brakes; a hoist holding brake and a hoist holding secondary brake.

4.9.4 The crane shall be pendant controlled with power provided from a conductor bars mounted independent of the hoist house removable roof sections.

4.9.5 A limit switches shall be provided on both ends of the runway beam, to slow down and stop trolley travel at both ends of the hoist house runway rails.

4.9.6 The hoist beams shall be capable of being removed with the hoist house removable roof sections, with end stops and travel limit switch contacts provided for when the rail sections are removed.

4.10 ADDITIONAL LIFTING BEAMS

4.10.1 In addition to the lifting beams already specified, the two following additional lifting beams shall be provided:

- .1 For handling the Downstream Spillway Stoplogs;
- .2 For handling the Intake Trashrack panels.

4.10.2 These beams require nylon rope retraction lines, or an alternative design, to allow the hooks to be disengaged when the components are lowered into position. This design shall be safe and convenient for one person to operate and if required may use a manual winch to operate.

4.10.3 Both these lifting beams shall be designed for use with a mobile crane.

PART 5 COATINGS SCHEDULE

5.1.1 Coating and galvanizing shall be according to Section 48 13 10.

5.1.2 Coatings shall be as follows:

- .1 Spillway and Intake Hoisting Equipment All surfaces Epoxy paint colour XXX

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 Trash Cleaner Hoist All surfaces Epoxy paint colour XXX
- .3 Draft Tube Hoist All surfaces Epoxy paint colour XXX
- .4 Spillway Maintenance Hoist(s) All surfaces Epoxy paint colour XXX
- .5 Spillway Maintenance Hoist(s) Runway(s) All surfaces Epoxy paint colour XXX
- .6 Spillway Hoist House and stairwell – Interior Walls colour XXX
- .7 Spillway Hoist House and stair well – Exterior colour XXX
- .8 Spillway Hoist House – Interior Floors colour XXX
- .9 Spillway Hoist Tower Superstructure and all Accessories and Attachments Hot dip galvanized
- .10 Spillway Hoist House Bridge Hot dip galvanized
- .11 All Safety Equipment or Protective Components such as; Fan Guards/Grills, Rotating Equipment Guards, Lockout Devices etc. colour XXX
- .12 All accessories, such as ladders, walkways, platforms, handrails/guard rails and all hardware, not forming integral part of the main structure and liable of being dismantled, such as connection bolts, supports, heating equipment, pipes, etc. Hot dip galvanized

PART 6 ERECTION AND FIELD TESTS

6.1 GENERAL

- .1 All equipment supplied and installed by Contractor, shall be installed, pre-commissioned and subjected to the required contractual tests by Contractor.
- .2 Contractor shall carry out full pre-commissioning and commissioning as required in MFA-SN-CD-2000-ME-SP-0002-01.
- .3 Contractor shall be fully responsible for providing all the equipment necessary, such as portable cranes and tooling, instrumentation, test weights, spares etc., to complete all the installation and required field tests.
- .4 All measurements taken as part of the installation of Contractor's work shall be submitted to Engineer for Acceptance.



Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .5 All modifications, re-work, repairs etc. required by Contractor to complete the work shall be subject to the Engineer's Acceptance prior to the start of the work.
- .6 Contractor shall supply and place all the grout required to complete the installation.
- .7 When selecting the erection methods, Contractor shall be responsible to take into account the load limitations imposed by the roads, decks, and bridges.

6.2 GROUTING

6.2.1 Grouting shall be carried out according to Section 03 60 40.

6.3 INSTALLATION MEASUREMENTS

6.3.1 General

- .1 Contractor shall measure and record relevantly installation measurements as each component is installed, and shall provide a record of each set of installation measurements for inclusion in the records for Mechanical Completion, see Section 48 13 10, Clause 7.
- .2 The following measurements shall, as a minimum, be recorded and provided to the Engineer for Acceptance.

6.3.2 Common

- .1 Gearbox backlash.
- .2 Holding brake clearance or reference measurement.
- .3 Fan brake minimum clearances and thrust clearance.
- .4 Fastener torque for all components.
- .5 Coupling alignment.
- .6 Sheave thrust clearances.
- .7 Alignment of bumpers relative to stops (where applicable).

6.3.3 Fixed Hoists

- .1 Drum, gearbox, brake and motor shaft alignments (XYZ offsets).
- .1 Drum level

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 21
CH0032	HOISTS AND CRANES	Rev. D2
POWERHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.2 Sheave block position relative to gate slot and gate connection points.

6.3.4 Bridge Cranes

- .1 Bridge wheel base and track including diagonals.
- .2 Trolley wheel base and track including diagonals.
- .3 Bridge level.
- .4 Minimum clearance to fixed objects over entire travel path.

6.3.5 Monorail

- .1 Beam level.
- .2 Minimum clearance to fixed objects over entire travel path.

6.4 DRIVE SYSTEMS ALIGNMENT CHECKS

6.4.1 All drives systems, including hoists, trolley drives and bridge drives, shall have their alignments verified and witnessed after each component is installed, prior to the start of all testing and one of each type of coupling shall have the alignment checked again after all testing has been completed.



6.5 PRESERVATION, MECHANICAL COMPLETION & AND COMMISSIONING REQUIREMENTS



6.5.1 Preservation, mechanical completion and commissioning requirements noted herein are defined in MFA-SN-CD-2000-ME-0002-01 – Preservation, Mechanical Completion and Commissioning Requirements.

END OF SECTION

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

**TABLE OF CONTENTS
SECTION 48 13 22
TRASH CLEANING SYSTEM**



PART 1 GENERAL	3
1.1 DESCRIPTION	3
1.2 RELATED SECTIONS	3
PART 2 DESIGN REQUIREMENTS	3
2.1 STANDARDS, CODES AND LEGISLATION.....	3
2.2 SEISMIC LOADS	7
2.3 MINIMUM MATERIAL THICKNESSES	7
PART 3 TECHNICAL REQUIREMENTS	7
3.1 COMPONENT DESIGN CRITERIA	7
3.2 DESIGN.....	8
3.3 EXPECTED VOLUMES OF TRASH AND DEBRIS.....	9
3.4 PERFORMANCE REQUIREMENTS.....	9
3.5 GENERAL SYSTEM CONFIGURATION REQUIREMENTS	12
3.6 GANTRY CONFIGURATION REQUIREMENTS.....	13
3.7 MACHINE DECK CONFIGURATION REQUIREMENTS	14
3.8 OPERATOR CAB CONFIGURATION REQUIREMENTS	15
3.9 MACHINERY ENCLOSURE CONFIGURATION REQUIREMENTS	16
3.10 ARTICULATED ARM CONFIGURATION REQUIREMENTS	16
3.11 CLEANER HEAD AND CLAM BUCKET CONFIGURATION REQUIREMENTS	17
3.12 HYDRAULIC SYSTEM CONFIGURATION REQUIREMENTS.....	19
3.13 ELECTRIC POWER CONFIGURATION REQUIREMENTS.....	20
3.14 POWER QUALITY	20
3.15 POWER CABLES	20
3.16 POWER CABLE TAKE-UP AND PAY-OUT SYSTEM.....	22
3.17 INSTRUMENTATION CONFIGURATION REQUIREMENTS	22
3.18 OPERATOR INTERFACE CONFIGURATION REQUIREMENTS.....	24



Handwritten initials: AB MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.19 CONTROL REQUIREMENTS.....25

3.20 LIGHTING AND ALARM REQUIREMENTS.....27

3.21 DESIGN LIFE AND MAINTENANCE INTERVALS.....28

3.22 SUBMITTALS29

PART 4 PRODUCTS34

4.1 MACHINE GUARDS34

4.2 HYDRAULIC PRESSURE SYSTEM35

4.3 GANTRY DRIVE.....38

4.4 COATINGS SCHEDULE.....38

PART 5 EXECUTION39

5.1 TOLERANCE.....39

5.2 PRESERVATION, MECHANICAL COMPLETION AND COMMISSIONING
REQUIREMENTS39

5.3 FIELD TRAINING.....39

5.4 NOT USED40

Handwritten signature and initials in blue ink, including 'MB' and a large stylized signature.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

PART 1 GENERAL

1.1 DESCRIPTION

1.1.1 This section includes all Work necessary for design, fabrication, delivery, installation, testing and commissioning of the Trash Cleaning System at the Muskrat Falls Project. Work shall include the design, fabrication, installation and commissioning of a custom trash cleaning system for the Muskrat Falls Powerhouse used to clean the Intake Trashracks, remove floating debris from in front of the Intakes and remove debris from the Debris and Sediment Trap in front of the Intake structures. The Trash Cleaning System shall also have an under-hung hoist for handling the powerhouse Bulkhead Gates and the Spillway stoplogs, as shown on the Drawings

1.1.2 This document shall be read in conjunction with "Lower Churchill Project Muskrat Falls Hydroelectric Development – CH0032 - Supply and Install Powerhouse and Spillway Hydro-Mechanical Equipment - Scope of Work - 505573-3321-45EW-0001/ MFA-SN-CD-2000-ME-SP-0001-01, Part 2, Exhibit 1.

1.2 RELATED SECTIONS

- .1 Section 48 13 10; General Mechanical Requirements
- .2 Section 48 13 21; Hoist and Cranes
- .3 Sections 11 08 00: Preservation, Mechanical Completion and Commissioning Requirements
- .4 Design to be completed in accordance with requirements of:
 - 1. Electrical Divisions, supplemented by this section
 - 2. CSA C22.1 and CSA C22.2



PART 2 DESIGN REQUIREMENTS

2.1 STANDARDS, CODES AND LEGISLATION

2.1.1 Unless otherwise stated in the Specification, the equipment shall be designed, manufactured, tested and supplied in accordance with the latest edition of all applicable Standards listed below. In case of any conflict between Standards, such conflict shall be brought to the attention of Engineer for clarification and determination.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .1 AGMA 260.02 Design of Components – Enclosed Gear Drives – Bearings, Bolting, Keys and Shafting
- .2 AGMA 420.04 American Gear Manufacturers Association Standard
- .3 AGMA 6001-E08 Design and Selection of Components for Enclosed Gear Drives
- .4 AISC American Institute of Steel Construction
- .5 ANSI Standard B4a Tolerances, Allowances and Gauges for Metal Fits
- .6 ANSI B4.1 Positional Fits and Tolerance for Cylindrical Parts
- .7 ANSI C42.30 Definitions of Electrical Terms
- .8 ANSI/AGMA 2001 C95 Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
- .9 ANSI/ABMA STD 9 Load Ratings and Fatigue Life for Ball Bearings
- .10 ANSI/ABMA STD 11 Load Ratings and Fatigue Life for Roller Bearings
- .11 ASME B15.1 Safety Standard for Mechanical Power Transmission
- .12 ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .13 ASTM A143 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
- .14 ASTM A153/153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .15 ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- .16 ASTM A385 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- .17 ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .18 AWS D1.1 Structural Welding Code
- .19 CGSB 1-GP-12C Standard Paint Colors
- .20 CMAA 70 Specifications for Top Running Bridge and Gantry Type Multiple Girder Electrical Overhead Travelling Cranes
- .21 CSA B167 Overhead Travelling Cranes – Design, Inspection, Testing, Maintenance and Safe Operation
- .22 CSA C22.1 Canadian Electrical Code
- .23 CSA C22.2 Safety Standards for Electrical Equipment
- .24 CSA G4 Steel Wire Rope for General Purpose and for Mine Hoisting and Mine Haulage
- .25 CSA G164 Hot Dip Galvanizing of Irregularly Shaped Articles Metals and Metal Products
- .26 CSA G189 (R2003) Sprayed Metal Coatings for Atmospheric Corrosion Protection
- .27 CSA S16 Design of Steel Structures
- .28 CSA W59 Welded Steel Construction - Metal Arc Welding
- .29 CSA Z85 Abbreviations for Scientific and Engineering Terms
- .30 IEEE SP1122 The Authoritative Dictionary of IEEE Standards Terms
- .31 NBCC National Building Code of Canada (Walkways, Platforms, Handrails and Ladders)
- .32 NEMA AB1 Moulded Case Circuit Breaker
- .33 NEMA MG-1 Motors and Generators
- .34 NLOHS Occupational Health and Safety Regulation of Newfoundland & Labrador
- .35 SSPC PA2 Procedure for Determining Conformance to Dry Coating Thickness Requirements
- .36 SSPC SP3 Power Tool Cleaning

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev. D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .37 SSPC SP10 Near-White Metal Blast Cleaning
- .38 SSPC VIS 1 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

2.1.2 All materials used in manufacturing and finishing processes shall be approved for use in Canada.

2.1.3 All materials used in the different elements of the supply shall conform to the standards of the Canadian Standards Association, the Society of Automotive Engineers, the American Society for Testing and Materials, the American Iron and Steel Institute and any other standard enumerated below.

2.1.4 Any substitution for the materials described by these standards shall be proven, by a series of tests to the satisfaction of Company, to be equal or superior to the standardized materials.

2.1.5 The following standards shall be used for materials, fabrication and inspection:

- .1 Bronze Bushings ASTM B584
- .2 Bronze subject to stress ASTM B21, Alloy 464, Semi Hard (such as bolts and nuts)
- .3 Bolts, studs and nuts ASTM A307, ASTM A325, ASTM A193, A194
- .4 Castings ASTM A27
- .5 Forgings ASTM A668
- .6 Fixed Axles for the Guide Rollers ANSI 430 or ASTM A276, type 304
- .7 Helical Springs SAE 5160
- .8 Piping ASTM A53
- .9 Stainless Steel Shafts ASTM A473, ASTM A564, AISI 431
- .10 Steel Shafts AISI 3140, 4140, 4340
- .11 Structural Steel ASTM A36, ASTM A992
CSA G40.20-04/G40.21-04
- .12 Steel for Wheels ASTM A504, Class C
- .13 Stainless Steel Tubing ASTM A269

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.1.2 Manufacturer's Qualifications

- .1 The manufacturer of this equipment shall demonstrate the following minimum qualifications:
 - .1 Ten (10) years experience in design and fabrication of custom trash cleaning equipment for hydroelectric and water supply intake structures;
 - .2 Design and manufacture of at least one (1) operating trash cleaning system that shall have all of the following operating characteristics:
 - .1 Operation to water depth of thirty-five (35) meter or greater;
 - .2 Hydraulic cylinder driven articulated trash cleaner rake;
 - .3 Pivoting machine deck with enclosed control car and operating enclosure;
 - .4 Electric motor driven gantry substructure;
 - .5 Experience with under-hung hoists.

3.2 DESIGN

- 3.2.1** The materials used in the construction of the equipment shall be new, of high quality and selected particularly to meet the duties required. The material specification shall be indicated in Contractor's detailed drawings. All workmanship shall be of highest quality throughout in order to ensure smooth operation under all possible operating conditions, and the design, dimensions and materials selection of all parts shall be such that the stresses to which they may be subjected shall not render them liable to distortion or damage under the most severe conditions encountered in service.
- 3.2.2** The Trash Cleaning System shall be designed to be stable for the worst case combined operating conditions including but not limited to; mass of structure, all load/radius/height lifting combinations, hoist loads, wind, seismic, and snow load with a factor of safety against overturning of at least 1.5.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.2.3 The system shall operate without restriction or limits under the following conditions:

- .1 The trash cleaning system should be capable of operating with a water velocity of 1.1 meter per second (m/s) normal to the trashrack, based on the gross area of the intake, combined with water sweeping velocity across the face of the racks of 0.5 m/s;
- .2 High ambient electrical noise and electromagnetic interference conditions caused by adjacent power transmission lines (315 kV) and cable runs (25 kV).

3.3 EXPECTED VOLUMES OF TRASH AND DEBRIS

3.3.1 The majority of the trash and debris that is expected to enter the reservoir will occur during the first months after impoundment. Another significant influx of trash and debris into the reservoirs during the first five years of operation will occur during spring thaw due to ice clearing.

3.3.2 Studies indicate the net potential volume of trash and debris that may have to be managed in the Muskrat Falls reservoir during the first years of operation ranges from approximately 40,000 m³ to 95,000 m³.

3.4 PERFORMANCE REQUIREMENTS

3.4.1 Operating Requirements

- .1 The trash cleaner is expected to be used 3 to 5 times a week when the reservoir is free of ice for approximately 3 years, and 3 to 5 times a month thereafter;
- .2 The under-hung hoist located on the trash cleaning system is expected to be used daily during construction and commissioning and approximately 10 to 20 times a year during the long-term operation of the facility.

3.4.2 Trash Cleaning System Requirements

- .1 The Trash Cleaner shall be designed to effectively clean the entire Trashrack area covering the full height of the racks between the sill and lintel elevations shown on the Drawings, while traversing the full length of the Intake in either direction;
- .2 The Trash Cleaner shall be designed to remove floating debris that collects in front of the Intake;
- .3 The Trash Cleaner shall be designed to visually inspect the Sediment and Debris Trap that covers the area 9.9 m wide in front of the Intake Trashracks, and be designed to remove submerged debris from the Debris and Sediment Trap;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .4 The Trash Cleaner shall be able to move the debris into four (4) meter high mobile or stationary trash receptacles on the Intake road deck or into a barge moored in front of the Intake;
- .5 The trash Cleaner shall be designed to withstand loads from the hoist for handling the Spillway stoplogs and Intake Bulkhead Gates (see Section 48 13 21 for description of hoists).

3.4.3 Trash Materials

- .1 Three types of trash and debris that can impact the operation of the plant were identified:
 - .1 Floating debris that can accumulate on the water surface;
 - .2 Submerged debris that can accumulate on the Trashracks;
 - .3 Debris that can accumulate in the Debris and Sediment Trap in front of the intakes;
- .2 The Trash Cleaner shall effectively rake debris from the Trashracks and remove debris as sticks, branches and tree sections up to 600 mm in diameter from the reservoir surface or the Debris and Sediment Trap, and logs and tree roots, as well as removing boulders, gravel and sediment from the Debris and Sediment Trap;
- .3 The Trash Cleaner shall also handle man-made trash including tires, plastics, log boom float, drums, boats, and other floating debris, without damage to the rake system.

3.4.4 Cleaning Head Capacity and Reach

- .1 The Trash Cleaner heads and buckets shall be able to grab, hold and lift a 2500 kg wet load of trash materials or debris in the Sediment Trap, anywhere in the cleaning area upstream of the Intake at a sixteen (16) meter radius from the centre of the gantry rails, at the water depths indicated on the Drawings, and move the debris onto the Intake Deck;
- .2 The Trash Cleaner heads and buckets shall be able to grab, hold and lift a 5000 kg object or wet load of trash materials or debris from the Sediment Trap, anywhere in the cleaning area upstream of the Intake at a ten (10) meter radius from the centre of the gantry rails, at the water depths indicated on the Drawings, and move the debris onto the Intake Deck;

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



- .3 Cleaning heads and buckets shall have ability to move upstream of the trashracks and powerhouse concrete face a minimum of ten (10) meters meter at any elevation;
- .4 For floating debris, the cleaning heads and buckets shall be able to grasp and remove floating debris in the forebay through a one hundred twenty degree (120°) arc and move debris into the Intake Deck;
- .5 When operating with the Trash Cleaner cleaning head to move trash up the face of the trashrack, the Trash Cleaner shall develop an upward cleaning force, parallel to the face of the trashrack, of 50 kN minimum.

3.4.5 Operating Speeds

- .1 The trash cleaning system shall have the following operating speeds:
 - .1 Primary cycle time of twenty (20) minutes or less for one (1) complete down-up raking cycle over the full Trashrack height, beginning with the cleaner head over the trash receptacle on the roadway, raking the Trashrack face three (3) times, with the cleaner head having dumped the raked material into the trash receptacle each time it travels up the Trashracks;
 - .2 Ability to operate in cleaning mode continuously within the environmental conditions specified herein;
 - .3 Surface debris grab and dump cycle time of five (5) minutes or less beginning with the cleaner head over the trash receptacle on the roadway, through the pivot of the Trash Cleaner perpendicular to the powerhouse face, grappling of floating debris, and ending with the cleaner head having dumped the collected material into the trash receptacle;
 - .4 Telescopic arm extend and retract speeds not less than twenty (20) metre per minute (m/min);
 - .5 Gantry travel speed not less than twenty (20) m/min.
- .2 Change-over time not more than two (2) hours for removing and installing different cleaning heads and buckets, assuming the Trash Cleaner operator and a crew of two mechanics.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.4.6 Control Functions

- .1 The Trash Cleaner shall have manual and semi-automatic control functions:
 - .1 Manual operation shall be used for surface debris removal, large debris removal in front of the Trashrack or in the Debris and Sediment Trap, and moving debris from the water surface into debris receptacles, operated from the operator's cab;
 - .2 Semi-automatic operation shall be used for one vertical sweep of the trashrack cleaning head or buckets, starting with the cleaner head just above the water surface, travelling in either direction one cleaner head width, and the cleaning head travelling to the base of the trashracks, up the trashrack face or across the Debris and Sediment Trap, and back to the water surface, with each cycle initiated from the operator in the operator's cab;
- .2 For hoist control refer to Specification Section 26 29 03.03.
- .3 A three position selector switches (CLEAN-OFF-HOIST) shall be provided in the operator cab, and at the hoist as described in Section 26 29 03.03, to prevent hoisting and cleaning operations to occur at the same time;
- .4 There shall be interlocks to prevent the under-hung hoist from operating if the hydraulic arm is not fully retracted and the rotating deck is not in the normal parking position, or to prevent cleaning cycles if the hoist is not in a safe parked position.

3.4.7 Underwater Surveillance Camera

- .1 An underwater video camera and sufficient underwater lighting shall be installed on the telescopic boom to observe the area around the base of the cleaning heads or buckets down to the bottom of the Debris and Sediment Trap, and view the trashracks.

3.5 GENERAL SYSTEM CONFIGURATION REQUIREMENTS

- 3.5.1** The basic machinery configuration shall include a traveling gantry system that supports a rotating machine deck that includes an operator cab, machinery enclosure, articulated operating arm and cleaner head.
- 3.5.2** The Intake deck, Centre Transition Dam deck, and Spillway deck will be an operating area, the use of which shall not be compromised by the addition of the trash cleaning system.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.5.3 The Trash Cleaner gantry structure shall allow vehicle/load clearances of 3.75 m wide x 5 m height and 7 m wide x 4 m height and shall allow clearance for handling of stoplogs and Bulkhead Gates.
- 3.5.4 The overall system shall operate on electric power supplied from the Spillway Electrical Building during the Diversion Phase, and then moved to the power termination points at the north end of the Intake building, at the locations shown on the Drawings.
- 3.5.5 All other power requirements needed for operation of the Trash Cleaner, or the under-hung hoist, shall be developed at the Trash Cleaner via transformers to lower voltages, direct current power supplies, batteries, hydraulic systems, etc.
- 3.5.6 The Trash Cleaner shall include a PLC (Programmable Logic Controller) for control and monitoring system.
- 3.5.7 The Trash Cleaner shall be configured to stand idle for long periods of time, with internal heaters, control standby functions and internal environmental controls that will allow a rapid re-start operation and after prolonged periods of inactivity.
- 3.5.8 Long term storage of the Trash Cleaner in the storage area shown on the Contract Drawings shall be possible without any moisture, thermal or weather damage to the system components.
- 3.5.9 The Trash Cleaner shall provide all of the operating functions described in this specification and on the Drawings, without the need for special tools, handling devices, or procedures to be used.
- 3.5.10 All special tools for maintenance of the system shall be provided as part of the equipment supplied.
- 3.5.11 The system shall include, wherever feasible, devices necessary to eliminate the possibility of pinch points between moving and stationary components on the Trash Cleaner.
- 3.5.12 Where elimination of pinch points is not feasible, guard rails, warning lights, audible warning and signage shall be used.
- 3.6 **GANTRY CONFIGURATION REQUIREMENTS**
- 3.6.1 The gantry shall be constructed of welded and bolted steel shapes and plates using box sections to provide a neat appearance, minimize painting, and prevent areas for bird and insect nesting or roosting.
- 3.6.2 The gantry construction shall allow field assembly by bolting, with no field welding required.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.6.3 The gantry shall incorporate ladders and walkways that allow safe personnel access to the operator's cab, to the equipment enclosures and to all points where maintenance or inspection is required.
- 3.6.4 All walkways and ladders shall comply with applicable safety codes.
- 3.6.5 The gantry system shall travel along the Intake deck, Centre Transition Dam Deck, and Spillway deck, as shown on the Drawings, with ability to travel through the curve, and with clearances for vehicles passing by and under the gantry, and past adjacent walls and concrete structures, as shown on the Drawings.
- 3.6.6 The gantry and gantry rail arrangement will allow full cleaning coverage of the face of all twelve (12) generating unit Trashracks, and coverage of floating and submerged debris.
- 3.6.7 Gantry structure shall be provided with shock absorbing end-of-travel bumpers, designed to contact end stops provided by Company's Other Contractor, at 40% of rated travel speed to reduce impact loads at the end of travel at each ends of both rails.
- 3.6.8 Radar sensors, or equivalent, shall be provided at the four corners the Trash Cleaner gantry structure to slow the Trash Cleaner to crawl speed and stop the Trash Cleaner before impact when the Trash Cleaner nears the end-of-travel bumpers or any other object that could cause impact with the Trash Cleaner.
- 3.6.9 Parking locks shall be provided on the Trash Cleaner, to manually clamp to the rails, capable of preventing motion under worst case weather conditions.
- 3.6.10 Gantry shall travel on double flanged steel wheels of a size matched to the intake deck rails, 175 lbs/yd crane rail, as shown on the Drawings.
- 3.6.11 A load equalizing system shall be provided if any support leg of the gantry structure has more than one (1) wheel.
- 3.6.12 Wheels shall be independently driven by heavy duty synchronized electrical motors, powered by Variable Frequency Drives (VFDs).
- 3.7 **MACHINE DECK CONFIGURATION REQUIREMENTS**
 - 3.7.1 The machine deck shall be a fabricated steel platform supporting the machinery enclosure, operator cab, articulated boom, walkways, and shall resist all operating forces developed by the trash cleaning system during all operating modes and conditions.

MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.7.2 The machine deck shall ride on steel rollers around a hardened steel circular raceway at the top of the gantry structure, and shall be provided with counter-rollers or overturning bearings to resist any overturning loads on the machine deck.

3.7.3 The turning motion of the machine deck shall be provided by a hydraulic oil-driven motor that engage a rim gear on the raceway, all configured in such a way that the drive mechanism and gearing are protected from debris, loose materials and any items that might be dropped or misplaced during maintenance or operation, with safe design to eliminate danger point for operation and maintenance personnel.

3.8 OPERATOR CAB CONFIGURATION REQUIREMENTS

3.8.1 The cab shall be mounted on, and rotate with, the machine deck.

3.8.2 The cab shall be generously sized to allow the operator to sit or stand while operating the trash cleaning system.

3.8.3 A rain-proof door shall be provided.

3.8.4 The cab shall have windows, at least two of which can be opened for air circulation, shall be tinted, and shall be fitted with roll-down polarized film protective shades extending to the top of the seat back.

3.8.5 The operator cab windows shall be designed to allow an unrestricted view of trash cleaning operations, and shall be sloped back to restrict rain build up on the windows.

3.8.6 The operator's seat shall swivel to allow easy access and orientation of the operator during use.

3.8.7 There shall always be safe access/egress to/from the cab to the ground level regardless of the position of the machine deck.

3.8.8 A heater, multi-speed ventilation fan, and a thermostatically controlled refrigerated air conditioning system shall be provided in the cab.

3.8.9 The heater shall be configured to allow use of the heater at low outputs during storage and inactivity of the system.

3.8.10 The heating system shall include adjustable defrost vents for clearing of moisture from the windows.

3.8.11 The HVAC system shall be capable of maintaining a cab interior temperature of twenty (20) degrees Celsius, with the range of environmental conditions specified herein.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.8.12 Operating controls in the cab shall be positioned to allow easy access and manipulation by the operator.

3.8.13 Human Machine Interface (HMI) and underwater camera display shall be easily viewed and accessible from the operator's seat and on an adjustable base to be pivoted and moved for ease of viewing by the operator.

3.8.14 Three (3) duplex electrical outlets 120 Vac, 20A, shall be provided in the cab, at locations Accepted by Engineer.

3.9 MACHINERY ENCLOSURE CONFIGURATION REQUIREMENTS

3.9.1 The machinery enclosure shall be a fabricated metal housing, attached to the machine deck, and shall house the hydraulic pressure system, drive motors and other machinery in a weather-protected enclosure.

3.9.2 The enclosure shall be generously sized to allow maintenance work inside the enclosure.

3.9.3 All openings in the enclosure shall be screened and louvered to prevent the entry of rain, insects, and birds.

3.9.4 All enclosed spaces shall be heated and cooled as necessary to protect equipment during operative and idle periods.

3.9.5 Maximum sound levels in the cab shall be 50dB.

3.9.6 The machine enclosure shall include sumps, drain pans or similar features that will serve as a secondary containment structure for all leakage from any hydraulic oil system component, including tubing, pipe, and hose that is contained in the enclosure.

3.9.7 The active volume of the secondary containment shall be at least one hundred-ten percent (110%) of the total oil volume in the hydraulic system.

3.10 ARTICULATED ARM CONFIGURATION REQUIREMENTS

3.10.1 The articulated arm shall consist of a main boom, and multiple telescopic arm segments.

3.10.2 All parts shall be fabricated steel weldments.

3.10.3 The arm shall be designed to provide the full range of cleaning coverage, as specified herein and as shown on the Drawings.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.10.4 All telescope/retract functions of the arm shall be provided by hydraulic cylinders (not wire rope).
- 3.10.5 Hydraulic cylinders and their associated hose and tubing shall be housed within the arm and boom segments.
- 3.10.6 Guide rollers between the telescopic sections shall be stainless steel cam-follower or similar rollers, with permanently sealed anti-friction bearings or shall be self-lubricated sliding pad bearings, Orkot, Kamatics, or an alternative Accepted by Engineer.
- 3.10.7 Access panels shall be provided to allow maintenance of mechanical and hydraulic assemblies.

3.11 CLEANER HEAD AND CLAM BUCKET CONFIGURATION REQUIREMENTS

3.11.1 The system shall be provided with:

- .1 A trashrack cleaning head, 2.4 m wide, with an opposing gripper/cover covering at least ninety percent (90%) of the head width, for cleaning of trash and debris from the face of the Trashracks with a replaceable plastic wearing face surface of sufficient thickness, width, and material properties to provide a design life of the plastic not less than five (5) years, based on the specified cleaning cycles of the Powerhouse trashracks;
- .2 A 2.4 m wide articulated bucket with an opposing gripper/cover covering at least ninety percent (90%) of the bucket width for cleaning the Debris and Sediment trap and collecting floating debris;
- .3 An articulated clam bucket for gripping large floating and submerged debris.

3.11.2 The cleaning devices shall be articulated sufficiently to permit aligning the device with the trash being removed, and with the trash receptacle.

3.11.3 The closed articulated bucket shall be designed to drag across the Debris and Sediment Trap to pick up small boulders, gravel and sediment, and close securely so sediment and gravel is retained and not washed out of the bucket by the water flow in front of the Trashracks.

3.11.4 The trashrack cleaning head and articulated clam bucket shall be a steel fabrication with an open framework to contain trash while draining away water from the trash when the head is above the water surface.

3.11.5 Lifting capacities and limits shall be clearly marked on the boom at the hook points and in the operator's cab at the controls;

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- 3.11.6 Control of the cleaning devices, both opening/closing and rotation shall be by hydraulic cylinders located at the end of the lowest telescopic arm section.
- 3.11.7 All cleaning devices, except the trashrack cleaning head, shall have a freely suspended intermediate section between the connection to the telescopic boom and the device that will minimize shock or damage in the case of contact with the structure or the floor of the Debris and Sediment Trap.
- 3.11.8 The structural and oil-hydraulic connections between the telescopic boom and the cleaning devices shall be configured to allow easy removal and replacement of the heads without the need for special tools, hoists, cranes or other handling equipment. Oil line connections shall be by quick disconnect, zero (0) leakage fittings.
- 3.11.9 Structural connections shall be by pin and clevis, latch/lock mechanisms or similar, that does not require a large number of threaded or precision fasteners to attach and remove the heads.
- 3.11.10 If oil hoses and oil tubing must be exposed, hose shall have braided stainless steel jackets or similar protection from damage or disconnection.
- 3.11.11 Trash cleaning heads shall be as follows:

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

Area	Debris	Bucket Type
Intake Trashracks Intake Debris Trap	Logs, Branches Branches, Debris	Trashrack cleaning head; 2.4 m wide with 3 closure blades
Intake Surface Intake Debris Trap	Floating Debris Logs, Roots, Sand, Gravel, Branches	Clam bucket; 2.0 m wide by 1.2 m deep
	Sand, Gravel	Closed bucket; 2.4 m wide with closure plate

Notes:

- .1 Clam bucket customized for the lifting capacity of Trash Cleaner, with added top closure plates.
- .2 Closed bucket customized with solid plate to drag debris near the Intake concrete face to raise debris to the surface, or for later debris removal with the clamshell bucket.

3.12 HYDRAULIC SYSTEM CONFIGURATION REQUIREMENTS

- 3.12.1 The hydraulic system shall be a self-contained hydraulic oil pressure system of sufficient size to allow continuous trash cleaning operation. The system shall provide pressurized oil for operation of the articulated arm, telescopic arm, cleaner head, and other components of the cleaning system.
- 3.12.2 The nominal operating pressure of the system shall not exceed 27,500 kPa. Hydraulic pressure shall be supplied by two primary motor-pump-filter sets, such that the system can continue operation (at reduced speeds) if one motor-pump set is out of service.
- 3.12.3 The system shall operate with biodegradable hydraulic oil Accepted by Company. Contactor shall include biodegradable oil data sheet, a list of reference projects where this product was used as well as specific maintenance requirements associated with the proposed oil.
- 3.12.4 The oil system shall have heaters and chillers as needed to allow continuous cleaning operation in the ambient temperature ranges specified herein.
- 3.12.5 All motions of the boom, telescopic arms, grippers, and the machine deck pivot shall be controlled by proportional control valves to ensure smooth starts and stops of all movement functions.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.13 ELECTRIC POWER CONFIGURATION REQUIREMENTS

3.13.1 Power will be furnished at 600 Vac, 3 phase, 60 Hz for operation of the cleaning system at two (2) locations as shown on the Drawings. For electrical requirements see electrical section of this specification.

3.13.2 These two (2) power feeds shall be the only source of electric power for the trash cleaning system.

3.14 POWER QUALITY

3.14.1 All equipment connected to AC circuits shall be protected from power surges.

3.14.2 Equipment shall meet the requirements of IEEE C62.41 or other Engineer Accepted standard.

3.14.3 Furnish properly sized filter reactors on each VFD drive input and output if recommended by the drive manufacturer.

3.14.4 Performance of the reactors shall be as required by the drive manufacturer.

3.15 POWER CABLES

3.15.1 Power shall be delivered from fixed electrical disconnect provided in the Spillway Electrical Buildings adjacent to the gantry rails for operation of the hoist during the Diversion phase.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001



3.15.2 Power cables from the trash cleaning system shall extend to the electrical disconnects provided by Company's Other Contractor in the Intake building adjacent to the gantry rails for long term operation. The power cable from the trash cleaning system shall be suitable for pulling through embedded conduit provided by Company's Other Contractor under the concrete decks as shown on the Drawings. A suitable device to hold the power cable shall be provided where the power cable exits the conduit to allow movement of the trash cleaning system.

3.15.3 A motor-powered electrical cable take-up and pay-out spool shall be provided on the upstream side of the gantry as shown on the Drawings.



3.15.4 Cable take-up and pay-out guides shall be provided on the gantry to ensure that the cable lies straight within the cable guideway to be mounted on the upstream guardrails that are supplied by Company's Other Contractor.

3.15.5 The normal operation of cable take-up and pay-out functions shall be automated as part of the gantry movement control.

3.15.6 Manual control of the motorized cable take-up and pay-out shall be provided to allow extension or retraction of the power cable if needed.

3.15.7 Power feeds to the machine deck and machinery enclosure shall be via cable designed for repetitive bending and rotation, with extra-fine conductor wires, strain restraints and cable grips as required.

3.15.8 Cable lengths shall be adequate for the furthest system position from the normal operation feed point on the Intake deck, plus the distance through the buried conduit to the permanent disconnect switch in the Intake Hoist House, plus an additional ten (10) m.

3.15.9 Cable shall be sized to carry the maximum demand load of the system, plus twenty percent (20%) over capacity, and shall be adequately oversized so the voltage drop along the cable at maximum demand does not exceed two percent (2%).

3.15.10 "Kellm" style vertical supports shall be provided as required for type "W" cord to relieve stress on cable terminals.

3.15.11 The cable reel shall provide automatic take-up and release of cable while traveling, and shall be equipped with full capacity collector rings and brushes for each conductor (three (3) phases plus ground).

3.15.12 The cable reel shall be weatherproof NEMA Type.

3.15.13 The take-up and release features shall function with both of the feed points, as indicated on the Contract Drawings.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.15.14 To facilitate maintenance and repairs, and ensure safety, the cable reel system shall be designed so it is capable of being maintained by crews working on the dam deck, and in no circumstances shall crews be required to work over the water.

3.15.15 Cable Reel Manufacturer: Insul-8 motor drive reel, or an alternative Accepted by Engineer.

3.16 POWER CABLE TAKE-UP AND PAY-OUT SYSTEM

3.16.1 The power cable take-up and pay-out system shall be a motor driven cable reel system with a spiral motor cable reel, as manufactured by Stemmann-Technik, GMBH, CONDUCTIX/Insul8, or alternate accepted by Engineer. This system shall have the following features and components:

- .1 Spiral cable reel with capacity for full range of travel on powerhouse intake deck and spillway;
- .2 Diverting unit without tension control;
- .3 Roller bow;
- .4 Type "W" power supply cord for use with the cable reel.

3.17 INSTRUMENTATION CONFIGURATION REQUIREMENTS

3.17.1 Instrumentation and control devices shall be manufactured and installed to allow easy adjustment, troubleshooting, and replacement of devices. Surge protection, optical isolators, or equivalent signal conditioning equipment shall be used wherever needed to ensure reliable instrument signals and control functions in the ambient electrical noise and interference condition environment specified herein.

3.17.2 Where position monitoring devices are required for operator safety, avoidance of structures and avoidance of motions that could damage the trash cleaning system, a redundant set of instruments and control functions shall be provided. This redundant set of instruments and control functions shall be completely independent from the PLC control system and shall remain functional in case of PLC failure.

3.17.3 Gantry Travel

- .1 The movement and position of the gantry shall be monitored via a PLC based gantry position monitoring system, with location markers on the concrete deck or cableway for precise cleaning of all trashracks and for installing / removing bulkhead gates and spillway upstream stoplogs.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 This system shall allow the gantry to be positioned within 2.5 cm of the correct location for cleaning of the trashracks.
- .3 The position monitoring system shall also monitor the areas where the Trash Cleaner is near the buildings or areas with light standards, to maintain a safe clearance.
- .4 Limit switches and end-of-travel position contacts shall be provided.
- .5 The following main motions of the cleaning system shall be monitored by position transducers:
 - .1 Position of gantry along deck rails;
 - .2 Position of the main boom arm;
 - .3 Position of the telescopic arm;
 - .4 Stroke of the telescoping arm;
 - .5 Rotation of the machine deck.
- .6 Position of cleaner head on the trashracks or in the Debris and Sediment Trap, with this position developed in software and displayed on the operator interface in the operators cab.

3.17.4 Emergency System Stop

- .1 Red mushroom cap push buttons shall be provided to stop related motion of the pieces of machinery that could cause injury to workers, including but not limited to the gantry drives, the rotation of the trash cleaning system machinery deck, and movement of the articulating arm.
- .2 The mushroom cap push buttons shall be provided at the four corners of the Trash Cleaner gantry structure, at the hoist control platform, at access points onto and off of the machinery deck, at pinch points, and in the operators cab.
- .3 The operation of the red mushroom cap push buttons shall be independent of the PLC and functional in case of PLC failure.

3.17.5 Cleaner Head Pressure on Trashrack

- .1 A system of pressure transducers shall be used to provide cleaner head pressure against the trashrack face.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .2 The system shall be designed to limit the pressure of the trashrack cleaning head on the Trashrack to no more than 50kN.

3.18 OPERATOR INTERFACE CONFIGURATION REQUIREMENTS

3.18.1 Manual Control Devices (Outside PLC)

- .1 A manual control system, independent of the touchscreen control and PLC, shall be provided at the HPU to allow manual operation of the system in case of touchscreen or PLC failure.
- .2 This manual system shall allow a shutdown of the cleaning operation and movement of the system to the storage area for repair of the PLC, without the cleaner head graphical position feedback or semi-automatic cleaning system functions.

3.18.2 Touchscreen Control

- .1 Normal operation of the system shall be provided by a touchscreen control interface in the operator cab that allows manual and semi-automatic system operation.
- .2 The touchscreen shall be visible while looking at the trash boom, within plus or minus fifteen degrees ($\pm 15^\circ$). The touchscreen shall be reasonably sized for ease of operation and the screen size shall be Accepted by Engineer.
- .3 This screen shall report the following functions:
 - .1 Selected operating mode;
 - .2 Cleaner head position relative to trashrack (graphical and numerical display);
 - .3 Cleaner head elevation;
 - .4 Cleaner head gripper or clam head finger position (open/closed);
 - .5 Time counter for remaining cycle time;
 - .6 Cleaner head pressure on trashrack face;
 - .7 Top-of-boom elevation;
 - .8 Condition monitoring of cleaning system (hydraulic pressure, system temperatures, run-time hours, alarm status, etc);

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.9 Location of trash cleaning system on intake deck (which cleaning position of which generating unit).

3.18.3 Underwater Camera Display

.1 A monitor shall be provided in the operator cab for viewing the underwater surveillance camera.

3.19 CONTROL REQUIREMENTS

3.19.1 Manual Cleaning System Operation

.1 Manual control of all boom, telescopic arm, cleaning head operation, machine deck pivot and other functions shall be possible in manual mode from the operator cab.

3.19.2 Semi-Automatic Trashrack Cleaning System Operation

.1 Semi-automatic control shall include a single-command initiation of one trash cleaning system operating cycle, beginning with the gantry at any cleaning position. The sequence shall include:

- .1 Rotation of the machine deck to the cleaning position;
- .2 Opening of the cleaner head gripper and tilt of the cleaner head to the cleaning angle;
- .3 Extension of the boom and telescopic arm to the full-down position;
- .4 Movement of the cleaner head against the rack, developing the setpoint cleaner head pressure against the rack;
- .5 Vertical cleaning of the face of the trashrack to a point at the top of the rack face (this point shall be user-adjustable);
- .6 Closing of the cleaner head gripper;
- .7 Retraction of the telescopic arm and boom rotation to lift the cleaner head free of the water surface (this point shall be user-adjustable);
- .8 Pause and wait for one of the following actions:
 - .1 Operator terminates semi-automatic cleaning control;
 - .2 Operator manually operates boom and gantry to place collected trash into a receptacle;

46 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

.3 Operator moves the control lever in the direction of the next cleaning position and the Trash Cleaner gantry automatically travels to and stops at the next cleaning position, which includes rotating the machine deck to a safe travel position and moving to the next water passage if that is the next position to be cleaned.

.9 The trash cleaner is ready for another semi-automatic cleaning cycle initiated by the operator.

3.19.3 Operation with Other Cleaning Device Attachment

.1 With any of the other cleaning devices (buck, clamshell, gripper) connected to the telescopic arm, the cleaning system shall allow manual operation of the cleaning device, to the depths and area extents shown on the Drawings. When in this mode, the position of the device (elevation and position relative to the trashrack face) shall be graphically and numerically displayed on the controller touchscreen.

3.19.4 Hoist Operation for Bulkhead Gates and Spillway Stoplogs

.1 Hoist operation shall be possible at any point on the spillway and powerhouse intake deck rails, with the trash cleaning machine deck locked in the parked position.

.2 The hoist shall be designed as specified in Section 48 13 21 and 26 29 03.03.

3.19.5 Alarm and Warning Functions

.1 The Trash Cleaning System control system shall include a complete group of alarm and warning functions that shall:

- .1 Prevent damage to any system component due to overload or overextension;
- .2 Notify operator of any operating problem or undesirable condition within the trash cleaning system (high temperature, low fluid level, etc); and,
- .3 Warn operators when the machinery is near its limits of travel.
- .4 Warn operators when the machinery is near structures.

.2 Alarms shall be both audible and visual alarms, with a record of alarm indications logged as part of the PLC control system operation.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

3.20 LIGHTING AND ALARM REQUIREMENTS

3.20.1 Trash Cleaner Lighting Systems

- .1 Where flood lights or area lighting is specified, the light fixtures shall be sized and located to furnish the following light levels:
 - .1 Floodlights with: 550 lux at the working surface below the cleaning system (0.75 m above the intake deck; and 550 lux minimum on the hoist to provide lighting on the stoplogs and gate slots
 - .2 Lighting with 300 lux at the floor area of enclosures and access areas.
 - .3 Operator cab interior lights providing a minimum of 400 lux at floor area, sufficient for reading, with switch near door, minimum two (2) florescent fixtures;
 - .4 Low level illumination of controls, for night operation of system.
- .2 Access Lighting: Walkway and ladder illumination, three (3) way switched at cab and at concrete deck access entry point to the system.
- .3 Under Gantry and Hoist Lighting: Illumination of area under gantry for safe vehicle passage after dark, minimum (4) four floodlights, with a three (3)-position switch (off-on-photocell). Floodlights: 550 lux minimum at the working surface below the hoist (0.75 m above the deck);
- .4 Motion Alarm Lighting: Flashing yellow area lights on each side of gantry for warning during gantry travel or machine deck rotation;
- .5 Work Area Lighting: Illumination of area near boom, the telescopic arm, and hoist for night operation of system. Minimum four (4) four-hundred (400) watt halogen fixtures, switched from cab.
- .6 Machinery Enclosure Lighting: Florescent interior lights for proper illumination of all equipment, switched from a point near the primary access door.
- .7 Intake Deck Lighting: Illumination of the left and right side deck areas, from light fixtures on the gantry, two fixtures on each side. Each side lighting circuit shall be independently switched using a three-way circuit, with switches on the gantry leg accessible from the intake deck, and switches in the operator cab.
- .8 Equipment Enclosure Lighting: Fluorescent interior lights for all equipment cabinet interiors, switched from a point near the access door of each enclosure.

9/6 MB

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .9 Emergency Exit Lighting: Battery operated emergency exit lighting that illuminates the exit pathway extending from the operator cab, across the machine deck and down the access ladder or stair on the gantry. This lighting system shall illuminate upon loss of electric power in the trash cleaning system.
- .10 Red lights visible on the deck from all sides to indicate that the system is powered up.
- .11 Audible Alarm: The trash cleaning system shall have a siren for gantry movement and for rotation of the machine deck.

3.21 DESIGN LIFE AND MAINTENANCE INTERVALS

3.21.1 Design Life:

- .1 Hydraulic System Fixed Components (tubing, fittings, cylinders, valves and all accessories): Thirty (30) years or 20,000 operating hours;
- .2 Hydraulic System Renewable Components (cylinder seals, pump seals, motor seals, and similar items): Ten (10) years or 10,000 operating hours;
- .3 Rollers, Bearings, Gear Systems, Telescopic Arm Guide Rollers and Similar Items: Thirty (30) years or 20,000 operating hours, except that all bearings shall have a B10 operating life of not less than 100,000 hours;
- .4 Hydraulic oil minimum life of 4 years or 1000 operating hours.

3.21.2 Maintenance Intervals

- .1 The trash cleaning system shall be designed for the following maintenance intervals:
 - .1 Weekly inspection of system during operating season;
 - .2 Monthly minor maintenance (check of fluid levels, temperatures, lubrication, etc) during operating season;
 - .3 Annual maintenance for renewing fluids, transducer calibration, filter replacement, control function checks, etc.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.22 SUBMITTALS

3.22.1 General

- .1 Before proceeding with manufacture of trash cleaning systems, submit to Engineer/Company for review and approval: design brief, Contractor's Shop Drawings, and catalog cut sheets to demonstrate fully that all parts will conform to the provisions and intent of this Section and related Sections, and to the requirements related to installation, operation, and maintenance.

3.22.2 Procedures

.1 Work Plan

- .1 Submit detailed Work Plans for the Muskrat Falls's erection of the trash cleaning system, including a description of work activities, illustrative diagrams, and suggested schedule. Submit detailed Work Plans for installation and testing of the trash cleaning system along with Contractor's Shop Drawings to demonstrate that the proposed design is consistent with the intended approach regarding installation and testing. Submit revised, detailed Work Plans for erection and installation of trash cleaning system prior to delivery.

.2 Field Assembly Instructions

- .1 Submit detailed step-by-step instructions for un-crating, fit-up, assembly and installation of the trash cleaning system. Include diagrams of all crane picks above 1000 kg in weight, with specific pick points for the components. Provide interconnection diagrams for all required wiring connections. Provide all torque, alignment tolerances, and recommended adjustments for connections and moving components.

.3 Construction Quality Control Plan (CQC Plan)

- .1 Submit for review and approval a CQC Plan in accordance with the Submittal Schedule, Administrative Requirements, before proceeding with manufacture of the trash cleaning system.

.4 Inspection and Test Plan

- .1 Submit for review and approval a Shop and Field Inspection and Test Plan in accordance with the Submittal Schedule, Administrative Requirements, before proceeding with manufacture and installation of trash cleaning system.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.22.3 Drawings

- .1 Drawings showing all necessary dimensions and fabrication details, complete Bill of Materials (including the type and grade of materials), details of welded and bolted joint connections, tolerances, surface finishes, non-destructive examinations, and other pertinent details, shall be submitted to Engineer for review and Acceptance.
- .2 Detail Drawings (including but not limited to):
 - .1 General arrangement drawings for trash cleaning system assembly showing clearances, capacities, speeds, pertinent dimensions, weights, wheel loads, etc. Drawings showing clearances shall clearly detail the relationship of the trash cleaning system with respect to existing and proposed powerhouse features;
 - .2 Trash cleaning system clearance diagrams;
 - .3 Installation and erection (field assembly) drawings for trash cleaning system and accessories;
 - .4 Load diagrams for operation of the hoist;
 - .5 Subassembly drawings of gantry, machine deck, machinery enclosure, operator cab, boom, telescopic arm, cleaner head, clam head and other subassemblies;
 - .6 Details of trash cleaning system structures, translation devices, cab, walkways, ladders, and enclosures;
 - .7 Details of gantry traversing motion machinery, motors, brakes, speed reducers, bearings, shafts, wheels, couplings, etc;
 - .8 Details of bumpers, parking devices, and trash cleaning system accessories;
 - .9 Details of end of travel bumpers and wheel stops;
 - .10 Details and equipment arrangement in operator's cabs;
 - .11 Details of lubrication systems;
 - .12 Details of hydraulic system including hydraulic schematic, all operating set point pressures and calculated pressures required for system operation;
 - .13 Details of power conductors and cable take-up and pay-out system;

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .14 Details of trash cleaning system lighting;
- .15 Detailed list of limit switches, anti-collision devices, control devices and other instrumentation with all settings delineated;
- .16 Locations and layout of all electrical equipment, including cabinets, motors, brakes, controls, and interconnection conduits;
- .17 Weights of items shall be included;
- .18 Each cabinet or equipment housing, with locations and sizes of external equipment, conduit drilling, cabinet mounting means, hinges, latches, and locks;
- .19 Conduit type and size; locations of the conduits, fittings, splice and junction boxes; and the number and the sizes of conductors in each conduit;
- .20 Controls arrangements and components;
- .21 Electrical schematics and wiring diagrams for the power and control system, showing all components interconnects for power, control, monitoring, and protective circuits. The wiring diagrams shall indicate the wiring for individual items of equipment within all panels and equipment items, terminal board connections, wire designations, and sizes and types of wire. The wiring diagrams shall also show all connections between individual panels, and between panels and separately located items;
- .22 Wiring interconnection diagrams showing interconnecting cable between each piece of equipment and termination details for each of the cables. Interconnection drawings shall be furnished for all control and power cable to be installed by Contractor;
- .23 Controller program details shall be submitted for review and approval. The programming shall be fully annotated with sufficient information for determining operation of the system. Flow type logic diagrams of the control system showing all logic flow from the controlling devices to the controlled devices;
- .24 Match marking drawings;
- .25 Nameplates;
- .26 Foundation Loadings: Diagrams shall be provided for loads transferred from trash cleaning system to the supporting runway structure at the Intake, Centre Transition Dam and Spillway for all load cases.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

3.22.4 Catalogue Data

- .1 Product specifications, descriptive literature, and performance data for items of standard manufacture.

3.22.5 Spare Parts Lists

- .1 Required Capital Spare Parts shall be provided as follows:
 - .1 One (1) HPU motor and pump;
 - .2 Two (2) sets replaceable plastic scrapers on the cleaning head, along with fasteners;
 - .3 Four (4) hydraulic quick connects of each size and type;
 - .4 One (1) gantry drive motor;
 - .5 Two (2) complete sets of each type of brake shoes;
 - .6 Two (2) sets of wheel bearings;
 - .7 One (1) set of bearings for the rotating platform;
- .2 A Recommended Spare Parts list shall be provided by Contractor, and shall list and price components individually for possible purchase at Engineer's option as a part of the Contract.
- .3 All Spare Parts shall be interchangeable with, and of the same materials and workmanship as the corresponding parts of the equipment furnished.
- .4 Capital Spare Parts and Spare Parts ordered by Engineer shall be individually packaged for indefinite storage indoors at the powerhouse, and each part shall be marked with its description and purpose on the outside of the packaging.
- .5 Capital Spare Parts and Recommended Spare Parts ordered by Engineer shall be delivered into stores as directed by Engineer. Delivery shall be deemed to be complete when the packages have been opened by Contractor, their contents checked by a representative of Engineer and the parts re-protected and repacked by Contractor to the satisfaction of Engineer.
- .6 Where Spare Parts have been used by Contractor during the construction, Commissioning or guarantee periods, such Spare Parts shall be replaced by Contractor at its own cost at the earliest possible date.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

- .7 Contractor shall maintain at Worksite an adequate supply of spare parts for commissioning to avoid any schedule delay.

3.22.6 Tools

- .1 Contractor shall provide any specialty tools used for the initial installation of the equipment and necessary for dismantling, adjustment and maintenance of the equipment. The cost of these tools shall be included in the Contract Price and shall be handed over to Engineer after Commissioning.
- .2 Each tool shall be in good working condition and marked with its size and/or purpose. If, in the opinion of Engineer, any tool is excessively worn or damaged when handed over, Contractor shall provide an adequate replacement. Tools shall be stored in a suitable container.

3.22.7 Reports and Documentation

.1 Work Plans

- .1 Submit detailed Work Plans for erection of the trash cleaning system, including a description of work activities, illustrative diagrams, and schedule.
- .2 Submit detailed Work Plans for installation and testing of the trash cleaning system along with Contractor's Shop Drawings to demonstrate that the proposed design is consistent with the intended approach regarding installation and testing.

.2 Material test certificates (mechanical and chemical properties)

- .3 Shop and Field Inspection Plan: Submit Contractor's plan of inspection to be performed at key stages of assembly and testing of equipment, with applicable illustrations, diagrams, check sheets, and procedures, for fit-up, dimensional correctness, alignment, and sequential checkout, startup, testing, and operation of equipment.

- .4 Shop test report: Shop test record, including shop assembly and inspection check sheets for fit-up, dimensional correctness, alignment, functional tests, and other checks.

- .5 Certification Records: Submit copies of all shop and field inspection records and reports.

- .6 Packing and shipping procedures

- .7 Installation instructions

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		505573-3321-45EG-0001
MFA-SN-CD-2000-ME-TS-0001-01		

.8 Operation and Maintenance Manuals: Submit complete sets of O&M manuals containing the manufacturer's operating and maintenance instructions for each piece of equipment and the integrated trash cleaning system.



.9 Not used.

.10 Certificate of Compliance

.11 Certificate of Proper Installation

.12 Closeout submittals

.13 Schedules

.14 Field test report

PART 4 PRODUCTS

4.1 MACHINE GUARDS

4.1.1 All exposed moving parts shall be provided with guards in accordance with the applicable safety requirements. Such safety devices shall meet or exceed federal, state and municipal requirements.

4.1.2 The Contractor shall furnish equipment with suitable guards and safety devices designed to protect persons against contact with moving parts and hazardous surfaces.

4.1.3 Fabricate guards of 2 mm (minimum) steel, 13 mm opening in expanded metal screen to provide visual inspection of moving parts without removal of the guard.

4.1.4 Guards shall be painted after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts.

4.1.5 Openings shall be provided in the guard for access to the lubricating fittings and may require provisions to extend lube fittings through guards.

4.1.6 Cut-outs and holes through guard screen shall be reinforced.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.2 HYDRAULIC PRESSURE SYSTEM

4.2.1 Hydraulic Pressure Unit, (HPU)

- .1 The HPU reservoir shall be sized for a minimum active volume of two hundred percent (200%) of rod return volume. The HPU reservoir shall be Joint Industry Conference (JIC) type and shall be designed to prevent the intrusion of foreign matter and precipitation water.
- .2 Fluid level shall be visible in a sight gage over the normal operating range with high and low levels marked.
- .3 A filler-breather assembly, filling strainer, drain valve, and air filter shall be provided. Intake and return lines shall be routed to near the bottom of the reservoir.
- .4 Means for accessing the tank interior shall be provided such that the entire interior can be inspected and cleaned.
- .5 The reservoir interior shall be painted with a multiple coat oil-resistant paint system, per the manufacturer's standard practice.
- .6 A low level alarm float switch and an extreme low oil level pump shutoff switch shall be provided, in addition to all pressure switches required for pump control.
- .7 A reservoir temperature switch shall be furnished and installed.
- .8 The system shall allow gravity drainage of ninety-eight percent (98%) of the oil volume.
- .9 A low watt density electric heater shall be provided to maintain temperature in the HPU above 15°C with the minimum ambient air temperature specified herein.
- .10 An oil cooler shall be provided to limit the maximum oil operating temperature to 65°C with the maximum ambient air temperature specified herein.

4.2.2 Hydraulic Cylinders

- .1 Hydraulic cylinders shall be of welded marine grade (suitable for wet locations) construction.
- .2 The rod shall be 17-4 pH stainless steel, grade H-1100 with a hard chrome plate 0.025 mm minimum thickness after grinding and polishing to a 0.2032 µm (micron) finish.

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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

- .3 Cylinder working pressure shall not to be less than one hundred fifty percent (150%) of the rated system operating pressure.

4.2.3 Hydraulic Tubing and Fittings

- .1 Hydraulic tubing shall be seamless Type 304 stainless steel tubing aircraft quality per MIL-T or AMS specifications.
- .2 Fittings shall be bite-type compression fitting, SWAGELOK or equal. Tubing sizes shall be sufficient to meet pump manufacturer's suction pressure requirements and to prevent starvation, undue temperature rise or pressure losses.
- .3 Fluid velocities shall be 1.2 m/s maximum in suction lines and 3 m/s maximum in other lines. Tubing clamps shall be Parker Parklamp Standard and Twin series clamps or equal.
- .4 Attach clamps shall be attached to steel structures by welding with clamp weld plates or by threaded fasteners and clamp mounting rails.
- .5 Tubing clamps shall be provided within 0.3 m of all tube terminations and every 2.4 m, along each tubing run.

4.2.4 Hydraulic Hose and Fittings

- .1 Hose shall have a minimum burst pressure of four (4) times the operating pressure.
- .2 Hose shall be provided at connections to each hydraulic cylinder or as needed to limit excessive loading on tube sections.
- .3 Fittings shall be quick disconnect, non-spill stainless steel, Parker FS Series 316 Non-Spill, or equal, fitting size to match hose size.

4.2.5 Hydraulic Pumps and Motors

- .1 Pumps shall be variable volume piston pumps (Parker Series PV or an alternative Accepted by Engineer) with a minimum capacity of one hundred ten percent (110%) percent of the maximum calculated system oil requirement at the rated operating pressure.
- .2 For motor requirements, see Section 26 05 81 – Motors 1 to 250 hp.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.2.6 Accessories

- .1 A pressure relief valve shall be provided on the discharge side of the pump.
- .2 A 10 micron filter shall be provided on the pump outlet, and a fine mesh filter shall be provided on the pump inlet.
- .3 Dirty filter alarms shall be provided.
- .4 A minimum 76.2 mm diameter liquid filled pressure gage with shutoff valve and snubber, visible from the front of the enclosure, shall be provided for monitoring system pressure.

4.2.7 Hydraulic Equipment Enclosure

- .1 The hydraulic equipment shall be contained within the overall machinery enclosure in a manner that prevents oil mist and vapours from contaminating electrical devices, walkway areas and other non-hydraulic equipment in the overall machinery enclosure.
- .2 The hydraulic equipment enclosure shall be a steel enclosure (or partition within the overall machinery enclosure) that contains the pumps, motors, control valves, and other devices.

4.2.8 HPU Power and Controls

- .1 Motor power feeds, control power, and instrumentation cabling should be adequately separated from each other. Remote device connections shall be terminated at a terminal strip in the control enclosure, labelled to correspond to the electrical connection diagram.
- .2 Local controls and indication shall be provided for the following:
 - .1 Indicating lights to show pump operation (ON/OFF);
 - .2 Indicating lights to show low system pressure alarm;
 - .3 Indicating light to show low reservoir level alarm;
 - .4 Indicating light to show high reservoir temperature;
 - .5 Hand-Off-Auto control switch(es) for manual operation of pump(s).

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.3 GANTRY DRIVE

4.3.1 Brake Control

- .1 Type: Electrically released, spring set brakes, released by means of an electro-mechanical contactor that supplies full voltage to the brake coil when a directional command is issued.
- .2 Brake Operation: Upon release of a directional command, one (1) of the following sequences shall occur:
 - .1 Brake sets immediately due to de-energizing of the brake contactor and the controller immediately goes to zero (0) output;
 - .2 Controller decelerates the motor to zero (0) speed using dynamic braking over a programmable time ramp and then sets the holding brake by de energizing the brake contactor;
 - .3 Selection of either of the above brake operating methods is programmable.

4.4 COATINGS SCHEDULE

4.4.1 Coating and galvanizing shall conform to Section 48 13 10, Clause 5.2.8.

4.4.2 Coatings shall be as follows:

Main Structure	All surfaces Epoxy paint colour XXX
Hydraulic arm and any submerged parts	Hot dip galvanized
All accessories, such as ladders, walkways, platforms, handrails/guard rails and all hardware, not forming integral part of the main structure and liable of being dismantled, such as connection bolts, supports, heating equipment, pipes, etc.	Hot dip galvanized
Hydraulic equipment	Different colour than the main structure
Safety equipment	Epoxy paint colour XXX

4.4.3 Surface preparation and application shall be as specified in Section 48 13 10, Clause 5.2.8.

Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

4.4.4 Colour schedule to be provided by Company.

PART 5 EXECUTION

5.1 TOLERANCE

5.1.1 Tolerances shall be selected by Contractor to meet the precision required for the proper operation of the equipment, considering the nature and function of the part. All tolerances shall be indicated on Contractor's Shop Drawings and submitted for review.

5.1.2 Contractor shall establish finer shop tolerances, if necessary, to meet the specified performance or operational requirements or for interchangeability of spare parts. All tolerances shall be selected with due considerations to the nature and function of the parts and to the corresponding accuracy required to secure proper operation, but shall not exceed the tolerances specified.

5.2 PRESERVATION, MECHANICAL COMPLETION AND COMMISSIONING REQUIREMENTS

5.2.1 Preservation, mechanical completion and commissioning requirements noted herein are defined in MFA-SN-CD-2000-ME-SP-0002-01 – Preservation, Mechanical Completion, Commissioning Requirements.

5.3 FIELD TRAINING

5.3.1 Field training for Company's operating staff shall be carried out on site by qualified individuals familiar with the installation, operation, and maintenance of the trash cleaning system furnished under this Contract.

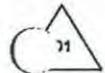
5.3.2 An individual from the trash cleaning system manufacturer shall conduct the training.

5.3.3 Training shall be required for twelve (12) Company employees during two (2) sessions of approximately eight (8) hours before the trash cleaning system is ready for the Diversion Phase.

5.3.4 Training shall be required for twelve (12) Company employees during two (2) sessions of approximately eight (8) hours when the trash cleaning system is ready for turnover for Substantial Completion of the project.

5.3.5 Field Training Operations and Maintenance (O&M) Manuals shall be provided for each employee participating in the training.

5.3.6 Company reserves the right to record such training for future internal use.



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Lower Churchill Project Muskrat Falls Hydroelectric Development	TECHNICAL SPECIFICATION	SECTION: 48 13 22
CH0032	TRASH CLEANING SYSTEM	Rev: D2
POWEHOUSE & SPILLWAY HYDRO-MECHANICAL EQUIPMENT		
MFA-SN-CD-2000-ME-TS-0001-01		505573-3321-45EG-0001

5.3.7 Training shall include:

- .1 Classroom activities and hands-on type training with the actual equipment;
- .2 Operating and troubleshooting the equipment to return it to service;
- .3 All required maintenance activities; including preventative maintenance as well as corrective procedures.



5.4 NOT USED

END OF SECTION

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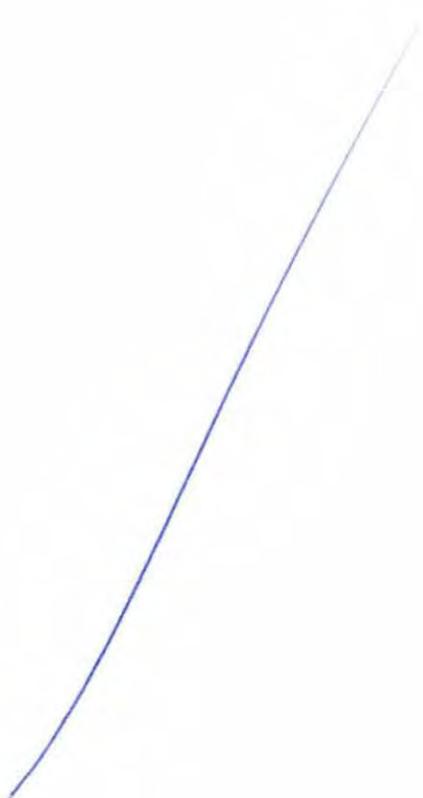
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EXHIBIT 2
COMPENSATION



1 GENERAL

- 1.1 Company shall compensate Contractor for the Work, in accordance with the provisions of this Agreement. Subject to any additional compensation pursuant to a Change Order, only those lump sum amounts, unit rates and prices specifically identified in this Exhibit 2 shall be paid by Company to Contractor for the Work and costs not identified are deemed to be included in the lump sum amounts, unit rates and prices for the Work. Company does not guarantee a minimum or a maximum amount of Work.
- 1.2 All lump sum amounts, rates and prices stated in this Exhibit 2 shall be all-inclusive to meet all requirements outlined in this Agreement.
- 1.3 No payment in excess of the agreed Contract Price will be made without a formal Change Order to the Agreement. The actual final agreed costs for all Work will be drawn down against the agreed Contract Price and Contractor shall be responsible for monitoring its actual costs against the Contract Price on a weekly basis.
- 1.4 Invoices shall be issued by Contractor in accordance with Article 12 of the Agreement, Exhibit 2 – Compensation, Exhibit 3 – Coordination Procedures and Exhibit 13 – Provincial Benefits.

2 FIXED LUMP SUM

- 2.1 The following provisions in this Section 2 apply only to Work completed on a lump sum basis.
- 2.2 All of the payment items stated in Appendix A – Schedule of Price Breakdown of this Agreement are fixed price and their aggregate total will form the fixed lump sum price of the Agreement.
- 2.3 Each item stated in Appendix A – Schedule of Price Breakdown shall include all elements necessary to achieve completion of the item, whether specifically identified, or whether inherent in the Work.
- 2.4 Pursuant to Article 12 of the Agreement, payment for each item shall be on a lump sum basis and shall be made progressively as the Contractor has satisfied the requirements of each payment item and in accordance with the Milestone Payment Schedule attached as Appendix B to this Exhibit 2
- 2.5 Before making its application for payment under the Agreement, the Contractor shall submit to the Company a schedule of values of the various parts of the Work and totalling the full amount of the fixed lump sum price. The schedule shall be used as a guideline for applications for payment.



- 2.6 Measurement of lump sum price items shall be undertaken on a monthly basis (or as required) by Contractor and Company. Progress achieved against each item from the schedule of values and/or milestone event and approved by Company shall form the basis of interim measurement and payment of each lump sum. Only Company approved lump sum progress payments shall be invoiced by Contractor.

3 UNIT PRICES

- 3.1 The following provisions in this Section 3 apply only to Work completed on a unit price basis.
- 3.2 Where applicable, full compensation for Unit Price Work shall be determined in accordance with the Unit Prices set forth in Appendix A – Schedule of Price Breakdown, or as otherwise agreed between Company and Contractor.
- 3.3 Any quantities of units estimated are not guaranteed, as independent circumstances shall control actual quantities performed and payment shall only be for actual quantities of Work installed and not any estimated quantities. There are no provisions in this Agreement for adjustment of the Unit Prices due to installed quantity variances (increases/decreases) from the estimated quantities.
- 3.4 Measurement of unit price items shall be undertaken on a monthly basis (or as required) by Contractor and Company. Such measurement shall form the basis of all progress and final payments for unit price Work. Only Company approved unit price measurement shall be invoiced by Contractor.
- 3.5 Unless otherwise specifically stated, all Unit Prices shall be complete and inclusive of all costs required for the Work.

4 NOT USED

5 REIMBURSABLE WORK

- 5.1 The following provisions in this Section 4 apply only to Work completed on a reimbursable basis.
- 5.2 Where applicable, full compensation to Contractor for full and complete performance of any Work performed on a reimbursable basis shall be the sum of the following costs and mark-ups:
- (a) Sum of Contractor's Labour Rates, detailed in Appendix D – Personnel Rate Schedule multiplied by approved hours of Work, detailed on timesheets approved by Company;

- (b) Sum of Contractor's Equipment Rates, detailed in Appendix E – Equipment Rate Schedule multiplied by approved hours of use, detailed on timesheets approved by Company; and,
- (c) Company approved material expenses, travel and mileage expenses, and third party expenses.

Contractor shall advise Company in writing when it has expended seventy-five percent (75%) of the total estimated price.

The Labour and Equipment Rates will not be adjusted for any reason whatsoever except as a result of the issuance of a Change Order by Company.

5.3 When Contractor is requested to purchase materials on a reimbursable basis:

- (a) All actual costs to Contractor for materials supplied for incorporation into the permanent facility, excluding consumables, expendables, and small tools which cost Contractor less than \$2,000.00 Canadian or as listed in Appendix D – Personnel Rate Schedule shall be at actual invoiced cost to Contractor (exclusive of tax), including transportation to Site, as substantiated by invoices certified paid or by such documentation as may be required by Company, plus a mark-up of 15%.
- (b) Contractor shall solicit a minimum of three bids for material purchases of \$30,000.00 Canadian and greater.
- (c) Contractor shall supply a copy of supplier's invoice with each Invoice.
- (d) Company reserves the right to provide, at no cost to Contractor, materials, equipment, services, supplies or incidentals required to perform the Work.

5.4 When Contractor is requested to supply equipment on a reimbursable basis:

- (a) All costs of Contractor for Contractor-owned equipment shall be at the rates set forth in Appendix E – Equipment Rate Schedule.
- (b) When Contractor's equipment does not resemble the equipment having rental rates listed in Appendix E – Equipment Rate Schedule the agreed rental rate shall be incorporated into the Agreement by Change Order prior to rental.
- (c) All costs of Contractor for equipment which is rented from third parties and does not resemble the equipment having rental rates listed in Appendix E – Equipment Rate Schedule must be approved by Company in writing prior to rental and shall be

at actual cost to Contractor, including transportation to Site, as substantiated by invoices certified paid or by such documentation as may be required by Company plus a mark-up of 15%

- (d) For reimbursable Work, Company reserves the right to substitute and provide, at no cost to Contractor, equipment to perform the Work. Contractor shall not be allowed to claim for loss of profit and/or any other of its own costs resulting from such substitution by Company.

5.5 When Contractor requires third party services to assist with Work being performed on a reimbursable basis:

- (a) Contractor shall secure Company pre-approval of any third party services, materials, tools, supplies and consumables that are required for the performance of the Work and are additional to that which is included in the rates and lump sum prices outlined herein. Company shall reimburse Contractor for the actual, documented and necessary costs of such materials, tools, supply, consumables, equipment and/or services.
- (b) All third party services provided for performance of the Work which has been previously approved by Company shall be at actual cost to Contractor of such third party service provided by others plus a mark-up of 15%
- (c) In no instance shall the third party rates plus mark-up exceed Contractor's rates for similar work or equipment.
- (d) To be eligible for reimbursement, invoicing for third party services shall be fully supported by Billing Information and any other documentation that Company may reasonably require.

5.6 Travel, including travel time and mileage are included in the Contract Price.

The Company shall provide room and board for Contractor's planned workforce and staff on Site.

5.7 For all Work carried out on a reimbursable basis, Contractor shall prepare Time Sheets for all personnel, equipment, material and third party services assigned to the performance of the Work which will be approved and signed daily by the Company's Representative. Copies of time sheets shall accompany all Contractor invoices.

5.8 When Contractor uses assets of an associated company (i.e, common ownership, subsidiary, strategic partner, licensee, etc.) to undertake reimbursable Work then only one (1) mark-up shall be allowed on the actual associated company base cost for the Work.



6 OPERATIONAL SPARES

Appendix C of this Exhibit 2 details Contractor's recommended two (2) year operational spares and the associated unit prices. For the Term of the Agreement, Owner may, at its sole discretion, purchase any number and any type of operational spares listed in Appendix C – Operating Spares Price Schedule of this Exhibit 2, at the unit prices outlined therein.

The unit prices specified shall include all costs associated with design, manufacture, testing, preservation, storage, transport and delivery of the spares and all associated documentation. Spares shall be delivered to the Site in accordance with Incoterms 2010, Delivered Duty Paid (DDP). Supply shall be deemed to be complete upon delivery of the operational spares and all associated documentation.

Owner will issue an Owner Approved Change Order to Contractor covering all purchases of operating spares.

7 CHANGES

Whenever possible, Changes will be evaluated and agreed by the Parties on a lump sum basis. In the event that the Parties cannot agree on a lump sum price for a Change, Contractor will present Company with a cost estimate of the Change, based on the rates and prices in Appendices A, C and D. Where Changes are carried out on a reimbursable basis, Contractor shall ensure that it provides a copy of the associated Company Approved Change Order, along with all documentation necessary which clearly supports the charges submitted for payment and clearly demonstrates achievement of criteria, progress of the Change Work, or achievement of the Milestones contained therein, as the case may be.

Rates and prices outlined in Appendices A, C and D will apply only for increases in the Work. For decreases in the Work, the Parties will negotiate the cost of the scope reduction on a lump sum basis.

8 STANDBY TIME

When the Work is suspended by Company for a reason that is not related to the Contractor's performance of the Work, the Company shall compensate the Contractor for documented standby costs which are incurred by the Contractor and approved by Company. For all standby time approved by Company, Contractor shall prepare daily time sheets for all labour and equipment assigned to the performance of the Work, which will be reviewed, and if approved, signed by the Company's Representative. Copies of time sheets shall accompany all Contractor invoices. Rates outlined in

Appendix E – Equipment Standby Rate Schedule shall apply when Contractor submits an invoice for payment of equipment standby costs. Payment for such standby will be limited to not more than eight hours in a twenty-four hour day or forty hours in a week.

No compensation will be allowed for equipment that is inoperable due to breakdown, unavailability, or the like. No payment will be allowed for equipment that is not operating because the work has been suspended by the Contractor for his own reasons.

9 MILESTONE PAYMENT SCHEDULE

Appendix B of this Exhibit 2 includes the Milestone Payment Schedule provided by Contractor. Company will pay the Milestone payments due to Contractor upon successful completion of Milestone which shall be accompanied by all relevant supporting documentation as Company may require to verify completion of the progress.

10 PROJECT LABOUR AGREEMENT

A Project Labour Agreement (PLA) and Special Project Order (SPO) declaration are in force at the Site.

The Contractor shall be bound to the terms of the PLA, become a member of the Project Employers' Association and name at least one (1) staff person to be responsible for daily Labour Relations matters at the Site. Prior to working at Site, all Contractor's Personnel will be required to attend an LCP (Owner) Site orientation session that includes health, safety and environment obligations; human resources policies, including respectful workplace, cultural sensitivity, gender equity and diversity; labour relations, including PLA overview, site standards, corrective action and dispute resolution.

Appendix F of this Exhibit 2 details the estimated trade person-hours which shall be an accurate estimate of the person-hours required by trade classification to complete the Scope of Work.

11 LIQUIDATED DAMAGES FOR DELAY AND PERFORMANCE INCENTIVES

11.1 Liquidated Damages

Contractor is responsible to achieve completion of all Milestones in accordance with the Milestone Schedule. For certain Milestones, as listed below, Company has made a reasonable and genuine pre-estimate of the damages that it would suffer (Liquidated Damages) if these particular Milestone dates are not achieved. If Contractor fails to achieve any of these Milestones by the associated Milestone dates listed in the Milestone Schedule or below, as the case may be, Contractor shall pay Company, as liquidated damages and not as a penalty, the amount listed for each and every calendar day by which the completion of such Milestone is delayed.

EXHIBIT 2 - APPENDIX A
SCHEDULE OF PRICE BREAKDOWN



EXHIBIT 2 - APPENDIX B
MILESTONE PAYMENT SCHEDULE

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EXHIBIT 2 - APPENDIX C
OPERATING SPARES PRICE SCHEDULE



EXHIBIT 2 - APPENDIX D
PERSONNEL RATE SCHEDULE



EXHIBIT 2 - APPENDIX E
EQUIPMENT RATE SCHEDULE



EXHIBIT 2 - APPENDIX F

ESTIMATED TRADE PERSON-HOUR SCHEDULE



EXHIBIT 3

COORDINATION PROCEDURES

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TABLE OF CONTENTS

1 INTRODUCTION..... 2
2 EARLY ACTIVITIES AND GENERAL EXECUTION..... 2
3 ORGANIZATION, ADMINISTRATION AND REPORTING 4
4 INTERFACE MANAGEMENT 12
5 PROCUREMENT AND MATERIAL MANAGEMENT 13
6 COST MANAGEMENT 14
7 SCHEDULE MANAGEMENT 14
8 CHANGES TO THE WORK 21
9 RISK MANAGEMENT..... 25
10 ENGINEERING AND TECHNICAL DOCUMENTATION 26
11 CONSTRUCTION MANAGEMENT 28
12 INVOICING AND PAYMENT..... 30

- Appendix A – Change Request
- Appendix B – Change Order
- Appendix C – Request and Final Completion Certificate
- Appendix D – Payment Certificate
- Appendix E – Site Query (SQ)
- Appendix F – Site Instruction (SI)
- Appendix G – Engineering Change Notice (ECN)
- Appendix H – Not Used
- Appendix I – Substantial Completion Certificate
- Appendix J - Milestone Completion Certificate
- Appendix K – Not Used
- Appendix L – Statutory Declaration
- Appendix M – Concession Request Process & Form

1 INTRODUCTION

This Exhibit 3 – Coordination Procedures is intended to govern Contractor and Company in the administration and management of the Agreement.

Contractor shall use its own systems, methods and procedures in the administration of the Work. However, Company has certain requirements regarding Agreement administration, monitoring and coordination, consistency and project controls with which Contractor shall comply. These requirements are described in this Exhibit 3. Where necessary, Contractor shall adapt its own systems, methods and procedures to satisfy such Company requirements.

It is Company's intention that Company and Contractor work together to mutually agree on a set of methods and procedures for performing the Work. In this regard, Company will require a series of meetings in Company offices immediately following Effective Date. During the meetings, Contractor and Company will review Contractor's proposed methods and procedures for executing the Work. Following this review, the Parties will agree on any modifications to Contractor's methods and procedures required to satisfy the requirements of this Exhibit 3.

The following additional Exhibits have been provided to specify Company requirements and Contractor responsibilities with respect to Health and Safety Requirements (Exhibit 5), Environmental and Regulatory Compliance Requirements (Exhibit 6), Quality Requirements (Exhibit 7), Site Conditions (Exhibit 12) and Provincial Benefits (Exhibit 13).

2 EARLY ACTIVITIES AND GENERAL EXECUTION

2.1 SCOPE

This Section 2 sets forth minimum early activities associated with preparation for execution as well as general execution activities.

2.2 OBJECTIVES

Contractor shall employ a systematic management approach to the Work embracing sound management principles, including:

- a) Finalization of an Execution Plan as it pertains to the Work (as described in Section 2.4 below); and
- b) Understanding of and alignment with Company's objectives, priorities, and philosophies with the aim of Contractor developing appropriate plans and procedures.

2.3 CONTRACTOR DUTIES

Contractor shall:

- a) Review Contractor's proposed Execution Plan with Company. Update the plan with all Accepted changes and enhancements and maintain on an ongoing basis;
- b) Participate in meetings, as scheduled by Company, to mutually agree on methods and

procedures for performing the Work. Meetings shall be held in Company or Owner offices and may be scheduled to begin within fourteen (14) days of the Effective Date and shall be completed within forty-five (45) days of the Effective Date;

- c) Provide all information requested by Company to support Company's appraisal of Contractor's performance of the Work, including performance of Subcontractors. Such information may include, without limitation, Contractor's systems, methods and procedures for performing the Work; copies of calculations, working drawings, specifications, purchase requisitions and recommendations (if applicable); estimates; labor productivity data; schedules; procedures; and alternative studies;
- d) Contractor shall maintain close management alignment with Company during execution of the Work;
- e) Actively support and participate in project reviews as required by Company and as they relate to the Work.

2.4 SPECIFIC REQUIREMENTS

Early Deliverables

A list of all early deliverables and the timing of their submission to Company is specified in Exhibit 4 - Supplier Document Requirements List.

Execution Plan

Contractor shall make all changes based on Company's comments and submit a final Execution Plan to Company for Acceptance by the date specified in Exhibit 4 – Supplier Document Requirements List. The Execution Plan will serve as the basis for developing the detailed plans for the Work.

The Execution Plan shall:

- a) Document the results of the overall planning process for the Work. The Execution Plan is a framework from which will evolve execution strategies and approaches, work plans, risk identification and mitigation plans, detailed procedures, organizational structures, logic networks, schedules and other material needed by Contractor's Personnel to develop execution details and Contractor's plans for the Work, including detailed fabrication and construction plans;
- b) Document Contractor's objectives, priorities and philosophies that are based on and consistent with Company's objectives, priorities and philosophy for the Work; and
- c) Outline formalized processes to be employed to identify broad strategic issues, evaluate impact, develop mitigation measures/action plans, and to follow-up on results of mitigation measures/action plans.

Contractor shall maintain the Execution Plan as a living, working document. Changes to such plan will be subject to the review and Approval of Company. As changes arise, Contractor shall identify and document critical issues and/or potential constraints that could adversely affect the accomplishment of Company's objectives for the Work and shall submit such changes to

9/6/03

Company for Approval.

Coordination Teams

As one of the early project activities, coordination teams will be established at various levels within Contractor's and Company's organizations. Contractor and Company will mutually agree on the composition of each team and agree on the frequency of meetings. If there is a failure to agree on such composition and/or frequency, Company Representative shall have the authority to determine these matters.

The initial meetings of the coordination teams will be to:

- a) Develop positive working relationships between team members;
- b) Develop plans to meet objectives, guidelines for individual and team behaviors, and teamwork, and determine Contractor / Company success criteria;
- c) Identify and review, as appropriate by team, challenging areas or areas of opportunity which require special attention; and
- d) Establish the initial framework for the specific plans for the Work as referenced in this Exhibit 3.

3 ORGANIZATION, ADMINISTRATION AND REPORTING

3.1 CONTRACTOR DUTIES

Contractor shall:

- a) Submit proposed, and Accepted or Company Approved organization charts, identifying key positions required for executing the Work. These shall be included within the Execution Plan;
- b) Provide information required by Company and seek Company's Approval on matters as required by the Agreement;
- c) Participate in regular meetings with Company and Company's Other Contractors to discuss the status of the Work, methods for resolving problems encountered or anticipated, and other topics pertinent to the Work;
- d) Produce timely, accurate and consistent progress reports for the Work that facilitate proactive management of the Work;
- e) Provide to Company Group Personnel offices, logistical support and facilities at Contractor's offices and the Worksite(s), as outlined in the Agreement and as required by Company;

3.2 SPECIFIC REQUIREMENTS

3.2.1 CONTRACTOR ORGANIZATION

Within the time specified in Exhibit 4 - Supplier Document Requirements List, and to be included in the Execution Plan, Contractor shall submit a description of its project organization for the Work indicating clear lines of decision making, authority and responsibility addressing as

a minimum the following:

- a) Project management organization;
- b) Health and Safety management organization both at home office and for the Worksite(s);
- c) Quality management organization, including Quality Manager, Worksite(s) quality organizations and vendor inspection organization;
- d) Engineering management organization;
- e) Technical Interface management;
- f) Newfoundland and Labrador Benefits Management;
- g) Regulatory and environment organization(s);
- h) Procurement organization, including purchasing, subcontracting and material management for both Contractor's home office and for the Worksite(s);
- i) Project controls including cost and schedule management for both Contractor's home office and for the Worksite(s);
- j) Technical organization, including engineering, design, constructability and document control;
- k) Construction Worksite(s) including engineering support, planning, cost and schedule control, material management, quality, safety and construction operations (including field supervision);
- l) Completions organization; and
- m) Start-up organization.

Each organization within the overall organization of the Work shall have key Personnel assigned and have designated authority and responsibility for the given portion of Work.

For each position designated as being key Personnel, the following information shall be provided:

- a) Roles and responsibilities;
- b) Job titles;
- c) Approval authority assigned to each position;
- d) Contact address(es) and telephone number(s); and
- e) Candidate's most recent resume.

Contractor shall update the organization charts, contact addresses and phone numbers as changes occur to the Work, as Contractor's overall organization changes or as requested by Company.

The organization charts shall clearly indicate how and to whom Contractor's organization for the Work reports in its home and/or any affiliated offices and the relationship of Contractor's organization for the Work to its corporate and/or departmental organization.

Listed below are Contractor's key Personnel for the management, control and execution of the Work. Contractor shall maintain up-to-date organization charts, which shall be submitted to Company in the event of changes.

9/16/13

POSITION DESCRIPTION (TITLE)	
Contractor’s Representative	Jean-David Turcotte
Project Engineer	Pierre-Luc Gauthier
System Engineer – Hydro-Mechanical Equipment	Bruno Blackburn
Commercial Manager	Jean-David Turcotte
Documentation Control	Pascale Girard
Project Scheduler	Jean-David Turcotte
Quality Manager / Vendor Quality Planner	Nadia Neron
H&S Manager	TBD
Environmental Manager	Christian Bernier
Site Coordinator / Site Manager	Christian Bernier
Equipment Manager	N/A
HSE Site officer	TBD

Key Personnel shall be assigned on a full time basis and be committed to continue until Substantial Completion in order to maintain continuity. The appointment, transfer and replacement of key Personnel shall be subject to Company’s prior Acceptance.

3.2.2 CORRESPONDENCE AND COMMUNICATION REQUIREMENTS

3.2.2.1 Unauthorized Contact with Owner

- (a) Except in the presence of Company, at the written direction of Company, with the prior written consent of Company in each instance, or as otherwise set out in this Exhibit 3, neither the Contractor, Contractor’s Personnel, the Contractor’s Representative nor any other member of the Contractor Group or their respective Representatives or personnel, shall meet or otherwise communicate with Owner, any member of the Owner’s Other Contractor’s or the Company’s Other Contractors or any of the Representatives or Personnel of the foregoing.
- (b) Notwithstanding the foregoing, in certain circumstances to be determined at Company’s sole discretion, where Company deems it appropriate or expedient for Contractor’s Representative to deal directly with Owner’s Representative, the Contractor may do so with Company’s prior written consent. However, in such cases, the Contractor shall assume sole risk and liability for any Claims, costs or other negative consequences arising from Contractor’s actions or omissions in this regard and Contractor shall indemnify and hold Company harmless against the same. The situations contemplated herein shall relate to minor changes in the Work not involving adjustments to the Contract Price and implemented in discussion with Owner on the Site, or other similar situations, provided that in all cases, the contemplated situations are ones in which Contractor’s action cannot bind Company in any way. For purposes of clarity and illustration only, if Contractor undertakes an action which may give rise to

a Change, it must inform Company of the same in accordance with this Agreement and Contractor shall assume all risk and liability, and shall indemnify and holds Company harmless, for the consequences of any failure to do so.

3.2.2.2 Correspondence and Notices

Company and Contractor shall jointly establish a correspondence plan and procedures which shall be periodically updated and kept current.

Contractor acknowledges that Aconex shall be utilized to manage all written communication between Company and Owner. Aconex is an electronic document management system which is a secure, on-line platform for storing, managing and distributing project information that can be accessed via an internet connection and a web browser (www.aconex.com). The implementation of Aconex Mail will be coordinated during the kick-off meeting between Owner and Company.

The Aconex module, "LCP Rev Controlled", will be utilized for all technical documentation to be submitted to Owner (refer to the document entitled "LCP Supplier Document Requirements" provided in Exhibit 11 - Company Supplied Documents).

Administration:

Contractor acknowledges the following document and correspondence submittal requirements and shall, in submitting documentation and correspondence to Company, do everything necessary to enable Company to comply with these requirements.

- A. All formal correspondence and notices relating to the Supply and Install Agreement shall be exchanged between Company's Representative and Owner's Representative, using official letterhead and submitted c/o Owner's Document Control via Aconex and shall carry the following: subject, date, and reference correspondence. Letters will be, to the degree possible, specific to one subject matter.
- B. All deliverables, as defined in the Agreement, shall be exchanged between Company's Representative and Owner's Representative to be defined per each deliverable.
- C. All Agreement deliverables shall be submitted to Owner's Representative, c/c Company Document Control via Aconex, using a uniquely numbered document transmittal.
- D. All information exchanged shall be managed in accordance with Coordination Procedures, Section 14 – Information Management and all associated standards and procedures.

3.2.2.3 Company and Contractor Representatives

All formal correspondence, documents and Agreement deliverables required by the Agreement, including this Exhibit 3, from Contractor to Company shall be addressed to the Company Representative. Likewise all correspondence from Company to Contractor shall be sent to

Contractor's Representative.

3.2.2.4 Company Representative

The Company Representative has the responsibility of managing the Agreement on behalf of Company, including Approval of Changes, amendments to the Agreement and issuance and receiving of Notices.

The Company Representative has the authority to stop the Work for the purposes of safety, quality and risk of damaging Company property under the care, custody and control of Contractor. Notification of stoppage can be addressed verbally, and then supported by writing. Contractor shall resume Work when appropriate actions are addressed to the satisfaction of Company. No compensation will be provided for Work stoppages of this nature.

The Company Representative may delegate any of his or her responsibilities to any nominated deputy. Notice of delegation shall be provided to Contractor's Representative in writing.

3.2.2.5 Contractor's Representative

Contractor shall appoint a Contractor's Representative for the Work, who shall have full authority to receive instructions and administer the Agreement for and on behalf of Contractor, in addition to those authorities stated in the Articles of the Agreement.

The Contractor's Representative shall have the responsibility for receiving, acknowledging, countersigning and returning any instructions, decisions, Notices, authorizations and acknowledgements to Contractor under the Agreement, in addition to those responsibilities stated in the Articles of the Agreement. Contractor's Representative shall also be responsible for administering, monitoring, reviewing and coordinating all aspects of the Work on behalf of Contractor.

Contractor's Representative may delegate any of his or her responsibilities to any nominated deputy upon prior Notice to the Company Representative. Notifications, information, authorizations, acknowledgements and decisions from any such nominated deputy shall be as if from Contractor's Representative.

3.2.3 REPORTS AND MEETINGS

Contractor shall submit reports to Company on the progress of engineering, procurement, construction and completions, and on the status of other activities for the Work as otherwise provided below and other provisions in this Exhibit 3 (See Section 7.7 for further details).

Weekly Report

Contractor shall submit a weekly report ("Weekly Report"), which shall reflect the current status of the Work, progress and issues. The timing, format and content shall be as agreed

between Contractor and Company, but shall address the following as a minimum:

- Brief summary of status of the Work;
- Management and administration;
- Significant items planned for the following weeks;
- Health, safety and environment;
- Quality management;
- Highlights and concerns including any required and implemented corrective action in all of the following main areas:
 - engineering
 - procurement
 - manufacturing
 - fabrication
 - construction
 - installation
 - completions;
- Interface activities;
- Status of Change Requests; and
- Receipt of major components and/or materials at the Site.

Monthly Progress Report

Contractor shall submit a monthly progress report (“Monthly Progress Report”) based on a cut-off date of the 25th of each month.. The timing of the submission of this report shall be by close of business no later than the 1st calendar day of the following month. The first Monthly Progress Report shall be issued not later than forty-five (45) calendar days after the Effective Date. The format and content of the Monthly Progress Report shall be as agreed between Contractor and Company, but shall address the following as a minimum:

- a) Highlights, in bullet point style, of the significant accomplishments achieved and issues addressed during the reporting period;
- b) A description of problems or delays encountered or anticipated, and corrective actions initiated or contemplated to counteract or minimize the effect of such problem, together with the results of any corrective actions already taken;
- c) The Worksites’ safety status including health and safety statistics for the past month and for the Work to date. The content and format for the safety statistics are provided in Exhibit 5 – Health and Safety Requirements. Major safety problems shall be highlighted and action plans to improve conditions outlined. Safety initiatives undertaken during the past month and/or planned for the forthcoming month shall be discussed;
- d) Short narrative covering all significant events during the reporting period;
- e) Management, including mobilization, systems implementation, procedures development and other administrative activities;
- f) Current status of the Work. Progress data (progress curves, histograms, productivity information and Summary Schedules) shall be provided on graphs which show actual versus planned progress as further described in Section 7 of this Exhibit 3 for: (i) engineering, (ii) equipment and materials orders, (iii) equipment and materials deliveries at

the Worksite(s), (iv) construction, (v) completions and (vi) overall Work progress. For activities that are behind schedule, an analysis of reasons for the slippage shall be included, together with a description of actions to be taken to recover;

- g) All constructability issues;
- h) The quality status including quality statistics for the past month and for the Work to date;
- i) Interface management status;
- j) Cost and financial reports as defined and/or specified in Sections 6 and 12 of this Exhibit 3;
- k) The status of planning, scheduling and schedule control, including coverage of relevant activities called for within Section 7 of this Exhibit 3;
- l) The status of Changes, if any, and the corresponding current value of the Contract Price including the effect of Change Orders and Change Requests;
- m) The status of procurement and subcontracting, including placement of Subcontracts, status of spare parts orders, performance of Subcontractors (including Subcontractors' subcontractors of every tier), and Subcontract administration matters;
- n) The status of items involving Authorities such as inspections, approvals, permits, clearances and licenses, as further described in Exhibit 6 - Environmental and Regulatory Compliance Requirements;
- o) Provincial Benefits report as described in Exhibit 13 – Provincial Benefits;
- p) Monthly risk report consisting of the following:
 - A structured narrative that describes major risk activities and events during the reporting period containing major changes in the Risk Register (as defined in Section 9.1(c) below) with a focus on medium and high level risks;
 - Highlights of five (5) to seven (7) most important package risk management activities and events; and
 - An updated Risk Register (as defined in Section 9.1(c) below); and
- q) Status of planned tests and/or hold points.

Final Contract Report

A final report summarizing the Work shall be submitted by Contractor to Company Representative for Approval, the content and timing of which shall be specified by Company Representative.

Meetings

Meetings of key Contractor's Personnel, Company Representative and/or Company Personnel, shall be held regularly. At its discretion, Company may also require Contractor's presence at meetings to take place with the Owner, and the number and identity of the appropriate Contractor's Personnel to attend such meetings will be determined by Company with input from Contractor.

Monthly and weekly progress meetings will be held, details of format and content of which will be determined by Company.

Company may hold other meetings with Contractor to discuss matters of technical, interface

management, health, safety, environmental, design, quality, verification, certification, documentation, engineering data, cost, accounting, scheduling, construction, progress and the like, and as may be otherwise required for the Work and the Agreement. Contractor shall ensure sufficient and appropriate qualified Personnel are available to attend.

In general, meetings shall adhere to the following guidelines:

- a) The agenda items for any meeting will be issued to the Parties no less than two Business Days prior to such meeting. Company and Contractor shall ensure, in accordance with their respective responsibilities, that reports, reproducible documentation and forward planning information relating to agenda items are issued in sufficient time to allow adequate preparatory study and evaluation;
- b) The meeting will address only the items covered by the agenda and any other minor topics relevant to the Parties and subject concerned;
- c) In those instances where matters of urgency need to be addressed, Company and Contractor will make every effort to address such items at the earliest opportunity; and
- d) It shall be the responsibility of Contractor to record minutes of all meetings unless otherwise instructed by Company. Minutes should be brief, indicate with whom the responsibility for action lies, the date the action was assigned and the date required for completion of such action. Minutes should also state the results of assigned actions outlined in previous minutes, including the actual date of completion of the action.

Photographs

Contractor shall provide photographs as Company may request of sufficient quality for possible inclusion in Company's publications depicting significant activities and general progress of the Work.

3.2.4 INFORMATION SYSTEMS AND TECHNOLOGY (IS/IT)

Contractor shall:

- a) establish and maintain an IS/IT infrastructure and associated computing environment to ensure overall reliability, performance and security control;
- b) provide access, for Company and Company Personnel, to any software applications and supporting services required in order for Company to perform their work;
- c) maintain an upgrade path for electronic formats that will keep data formats compatible with that of Company;
- d) securely transfer data and information electronically to Company on a timely basis using industry recognized standards, processes, systems and methodologies;
- e) ensure control practices and risk mitigation plans are in place to provide protection and safeguard for all data and information related to the Work including but not limited to access management, data corruption, data loss, backup and disaster recovery procedures; and
- f) provide to Company a description of the IS/IT support organization and how it is structured to support the Work.

3.2.5 DATA

All documentation and information, including correspondence, notes reports, information identified and/or required by the Agreement, drawings, specifications, schedules, weekly, bi-weekly and/or monthly reports, databases, records, videos, photos and other documents (hereinafter collectively referred to as "Data") shall be made available to Company in electronic PDF format, native file format as well as hard copy. The transfer of Data will be by storage medium such as optical or magnetic discs. Contractor shall undertake all reasonable efforts to ensure Data is provided in a form fully useable to Company with well recognized industry standard applications.

3.2.6 FACILITIES AND SERVICES FOR COMPANY PERSONNEL

Facilities Provided for Company by Contractor

- A. Where individual Company Personnel are assigned to Contractor office(s) for extended periods of time, office space and office equipment (no computer) shall be provided to the standard afforded to Personnel of equal organizational level within the Contractor's organization.
- B. Where individual Company Personnel are required to visit other Contractor office(s), temporary space shall be provided, which shall include a fully equipped (no computer) office space with phone and internet connections.

4 INTERFACE MANAGEMENT

Contractor shall manage external interfaces with other organizations involved in the LCP, including Owner, Company Representative, Company's Other Contractors and their subcontractor(s) and vendor(s) of every tier, Authorities and other entities associated with the Work. Refer to Scope of Work Specification for further information on interfaces at each of the worksites.

4.1 OBJECTIVES

Contractor shall:

- a) Have primary responsibility for managing technical and execution interfaces and thus coordinating its activities with other organizations as required to effectively accomplish the Work;
- b) Identify major interfaces early in the Work through a structured process;
- c) Define the interface information needed for the Work. Contractor and other interfacing entities (including originating and responding organizations) shall then agree on roles, responsibilities and timing for providing agreed upon information or actions;
- d) Ensure that all communications with other organizations shall be clear, accurate, timely and consistent to accomplish their intended purpose of transferring information between organizations or ensuring agreed action is taken to progress the Work;
- e) Ensure that interface resolution issues with potential for impacts to cost or schedule shall

be identified quickly and communicated to all interfacing entities, including Company, in order to minimize their impact; and

- f) Cooperate with Company and comply with the requirements of Company's interface management system as it relates to the Work.

4.2 SPECIFIC REQUIREMENTS

Contractor shall:

- a) Develop an interface management plan and shall implement systems and methodology for ensuring the identification of originators and responders, quality, accuracy and timeliness of interface information;
- b) Incorporate the schedules for submittal of its deliverables (as determined by interface management activities) as Milestones in Contractor's schedule for the Work. Contractor shall manage compliance with such Milestones accordingly;
- c) Schedule and participate in interface coordination meetings with Company, Company's Other Contractor(s), and their subcontractor(s) and vendor(s) of every tier, and other organizations, as required to properly manage interfaces; and
- d) Regularly advise Company on the status of resolution of interface issues. Contractor shall promptly elevate unresolved interfaces and interface issues to Company for resolution.

5 PROCUREMENT AND MATERIAL MANAGEMENT

Contractor shall maintain records of materials procured for the Work. Company will have the right to carry out periodic inspection of all Contractor's storage and inventory control records for the Work as well as physical spot checks of all material held in storage.

A logistics and transportation plan shall be produced by Contractor and submitted to Company by the date specified in Exhibit 4 – Supplier Document Requirements.

5.1 COMPANY SUPPLIED ITEMS

Contractor shall:

- a) Receive from Company any Company supplied items associated with the Work and unload, unpack, inspect, and confirm receipt and condition of receipt by issuing a material receiving report to Company confirming Contractor acceptance of items and the condition of items at the time of acceptance;
- b) Ensure that all materials are used correctly and no materials are substituted without prior Company Approval;
- c) Be responsible for the security and safe keeping, in accordance with good industry practice and Company's and the manufacturers guidelines/instructions for preservation and storage, any Company supplied items associated with the Work and ensure all items are visually marked as being provided for the Work;
- d) Maintain index records and account for any Company supplied items received and installed, and the remaining surplus and scrap. The index shall, at a minimum, include description, part number, serial number, storage location, status and receipt date;

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- e) Be responsible for any costs incurred as a result of Contractor's failure to properly store, preserve and protect Company supplied items.

Company shall:

- a) If applicable, supply Company supplied items complete with available documentation to demonstrate traceability and quality assurance to Contractor; and
- b) Have the right to inspect Company supplied items at Contractor's and Subcontractor's storage location(s) and storage records at any time without prior Notice. Such inspection shall not relieve the Contractor of any responsibility for the accountability and safe keeping of Company supplied items.

6 COST MANAGEMENT

Cost Control of Accounts

Company will provide cost control accounts to Contractor within thirty (30) days of the Effective Date. The cost control accounts will be cross referenced to the compensation amounts outlined in Exhibit 2 – Compensation.

Cost Report

Contractor shall submit an estimated incurred cost flow report, consistent with the control accounts and payment elements contained in Exhibit 2 – Compensation based upon a cut-off date of the 25th of the month. This report shall be by month for the duration of the agreement (monthly forecast of incurred cost) and shall be submitted by the 17th of each month. Accordingly, the final five day period of the month shall be estimated. It is understood the Contractor will not disclose any of its actual costs. The report will provide approximate dollar amounts in a format similar to the reports generated under contract CH0030.

Contractor shall prepare a finance report to be included as a section of the Monthly Progress Report. Reporting will be consistent with the control accounts and payment elements contained in Exhibit 2 – Compensation. Contractor shall submit to Company a sample cost report for Company's Approval. In general, the finance report shall address the following as a minimum:

- a) Contract Price and all changes thereto;
- b) Forecast final Contract Price (previous period, current period and monthly variance);
- c) Reimbursable cost status, if applicable;
- d) Change Order status;
- e) Contract incurred cost flow described above (actual/forecast); and
- f) Invoice and payment status, including cash flow forecast by currency.

7 SCHEDULE MANAGEMENT

This Section 7 sets forth the minimum requirements for Contractor's planning, scheduling, measurement and reporting of physical progress, and schedule control activities for the Work.



7.1 DEFINITIONS

- a. **Earned Value Management**: A method to measure the value of Work performed. Earned value uses current budgets and progress-to-date to show whether the incurred values are on budget and/or whether the tasks are ahead or behind the Approved Control Schedule. A method for measuring Work productivity and performance; it compares the effort of Work that was actually expended with what was physically completed.
- b. **Control Schedule (CS)**: The Control Schedule forms the basis to measure progress in which cost, schedule, scope and other performance criteria are formally compared against the Approved Control Schedule Baseline Document for assessment of progress and performance. The Control Schedule forms the benchmark for comparison and identification of cost and schedule deviations. The Control Schedule shall represent the total Work execution and interfaces with others (Milestones, key dates, design, procurement, regulatory, fabrication and manufacturing, transportation, installation, construction and completion – both static, dynamic and support to operations) covering the entire duration of the Work, and includes roll-up details of all Contractor's schedules. The Control Schedule is to be a schedule network, which is calculated using the critical path method. Contractor will ensure that the Control Schedule aligns with Exhibit 9 – Interface and Milestone Schedule. The Control Schedule shall be developed using Primavera (P6 or later version) or equivalent. If software other than Primavera is used, the native file shall have the capability to be easily converted to Primavera P6 and shall be subject to the Acceptance of Company.
- c. **Milestone**: The start or completion of an activity in the performance of the Work and which is identified as such in Exhibit 9 – Interface and Milestone Schedule.
- d. **Control Schedule Baseline Document (CSBD)**: A series of schedules, s-curves, histograms, tables and narrative which together form the basis of the plan to complete the Work. The Control Schedule Baseline Document is updated and re-issued following re-baselining of the Control Schedule. The CSBD includes the Control Schedule, as well as critical and near-critical path(s). The Control Schedule Baseline Document shall provide supporting documentation to the Control Schedule. It shall include all baseline assumptions regarding schedule durations, logic, installation rates, progress weighting and relevant material as deemed necessary by Company.
- e. **Summary Schedule (SS)**: The Summary Schedule incorporates all Milestones and is a roll-up of schedule information from the detailed Control Schedule such as engineering, procurement, construction, fabrication, installation and completions (static and dynamic to be shown separately) and any subject deemed necessary by the Company to adequately convey a rollup or the CS.
- f. **Schedule Development and Control Plan (SDCP)**: A formal document providing the approach to planning and schedule control including schedule development, analysis,

forecasting, reporting, corrective action and the method for incorporation of Changes. The SDCP addresses the scheduling interfaces between Contractor and Subcontractors, as well as Contractor and Company. In particular, the plan shall provide a detailed description of Contractor's progress measurement system including how Contractor measures, verifies and reports physical progress of each major activity of the Work (such as engineering, procurement, fabrication, manufacturing, permitting, transportation, construction/installation and completion).

- g. **Monthly Cut-Off Date:** The month end date that Contractor uses as a basis to compile its progress during the month. The Monthly Cut-off Date will be agreed between Contractor and Company based on the nature of the Work. If there is a failure to agree on such date, Company shall have the authority to determine the date.
- h. **Monthly Risk Statement:** Indicates the major risks identified during the month that could represent a threat to the success of the Work, the contemplated mitigation measures for newly identified risks and the actions status pertaining to mitigation measures proposed for previously identified risks.
- i. **Monthly Progress Report:** The monthly report which is described in Section 3.2.3 of this Exhibit 3.
- j. **Weekly Report:** The weekly report which is described in Sections 3.2.3 and 7.7 of this Exhibit 3.

7.2 CONTRACTOR DUTIES

With respect to planning, scheduling and schedule control of the Work, Contractor shall:

- a) Prepare, implement and maintain a Schedule Development and Control Plan (SDCP) in accordance with the date specified in Exhibit 4 – Supplier Document Requirements List for the Work using methods and procedures that are in accordance with Good Utility Practice;
- b) Analyze and calculate earned quantities, man-hours and costs, and forecast and report the progress of the Work using industry recognized Earned Value Management practices as compared to current Work plans and overall schedule, summarizing the results of the schedule analysis in the Monthly Progress Report, which shall include a Milestone listing with target dates and current forecast dates;
- c) Develop recovery plans and associated schedules if slippage is apparent, or as required by Company. Recovery plans will be reviewed with Company and implemented upon Company's Acceptance. Recovery plans will be monitored and adjustments made as needed to keep the Work on schedule;
- d) Incorporate the results of progress measurement and related status information into schedule forecasts, Weekly Reports and Monthly Progress Reports, as required under the Agreement;
- e) Provide access to all details of schedule preparation, progress measurement and schedule updates when requested by Company;
- f) Make changes in the schedule preparation, progress measurement and schedule control

- procedures at Company's request;
- g) Utilize agreed Company's progress measurement definition strategy. Actual progress shall be based on physical Work completed measured against the current Work;
 - h) Provide Company with the Control Schedule (CS) with the baseline estimate that will hold the mechanism of measuring progress in hard copy and electronic form, in accordance with the date specified in Exhibit 4 – Supplier Document Requirements List. The native electronic file shall include all information necessary to duplicate Contractor's schedule, progress measurement analysis and resource requirements. In addition to the electronic file, the schedule software settings, calendar definitions and application generated scheduling report shall be included;
 - i) Take the initiative to propose potential corrective actions whenever there is an identified trend which indicates that a Milestone will not be achieved or indicates an opportunity to shorten the overall schedule, or counteract potential schedule slippages; and implement the action(s) as Accepted by the Company; and
 - j) Provide a Control Schedule Baseline Document (CSBD) in accordance with the date specified in Exhibit 4 – Supplier Document Requirements List, with all supporting documentation. The (CSBD) shall be re-issued each time the (CS) is re-baselined.

7.3 SCHEDULE DEVELOPMENT AND CONTROL PLAN (SDCP)

Contractor's Schedule Development and Control Plan shall cover all areas of schedule development and control, including development, analysis, forecasting, reporting and corrective action. In particular, the plan shall provide a detailed description of Contractor's progress measurement system.

Contractor's Schedule Development and Control Plan will, at a minimum, include:

- a) How Contractor's detailed schedule and current Work plans will be developed, reviewed and updated;
- b) Methodology that Contractor will use to analyze and forecast the progress of the Work relative to current schedules;
- c) How interface management will be addressed. Interface management includes all key internal interfaces within the Work as well as all key interfaces between the Contractor, Subcontractors and Company's Other Contractors. The plan will define how interfaces are identified, stewarded and their status reported;
- d) How interfaces, outside of Contractor's control, could impact the Control Schedule;
- e) The number, types, uses, frequency of updates (and responsibility for updates) and level of detail for each of the various schedules the Contractor intends to use to control the Work;
- f) Methods for analyzing critical path and conducting float analysis;
- g) Procedure for re-baselining the Control Schedule (subject to Company's Acceptance);
- h) Coding system for schedules;
- i) The methods that will be used to measure physical progress of each of the various activities or groups of activities in engineering, procurement logistics, fabrication, manufacturing, installation, construction and completions. Methods for engineering shall specifically address use of computer aided design and drafting (CADD), both 2D and 3D;
- j) Procedures within Contractor's organization for review and verification of progress

- measurement information prepared at each Worksite;
- k) The methods to control over progressing of activities; and verification methods confirming that all activities reported as 100% complete are actually complete;
 - l) The method for recognizing the impact of rework on apparent progress, during engineering, procurement, fabrication, construction and completions and the method for specifically progressing and tracking the Work;
 - m) The methods and procedures for incorporating the effects of Changes on the assessment of progress;
 - n) The method for weighting and combining individual and overall progress measurements to arrive at the discipline and overall progress assessments for engineering, procurement, fabrication, installation, completions and other major activities related to the Work. Progress weightings shall be subject to Company's review and Acceptance, and once Accepted shall not be changed without Company's prior Acceptance; and
 - o) Contractor plans to manage and report receipt of materials and/or components at the Worksites.

7.4 CONTROL SCHEDULE BASELINE DOCUMENT (CSBD)

Contractor shall prepare and submit to Company for its review and Acceptance the Control Schedule Baseline Document in hard copy, portable document format (PDF) and native electronic format. All information required to reproduce the Control Schedule Baseline Document including scheduling software settings, working calendars, application time conversion factors, and precedence and scheduling output reports from the scheduling software, will be included with the submission.

The Control Schedule Baseline Document shall be organized into an overall summary section and a detailed section for each component of the Work (such as engineering, procurement, manufacturing, fabrication, testing and handover). Each section shall be organized as follows:

- a) Assumptions underpinning the execution methodology and Control Schedule, as well as any issues that may impact the Work. This section will also include the basis for any planned changes to the Control Schedule;
- b) Summary Schedule;
- c) Progress curve and table;
- d) Critical and sub-critical path(s); and
- e) Detail schedule.

7.5 CONTROL SCHEDULE (CS)

A detailed Control Schedule for the Work will be prepared by the Contractor and submitted to Company for Approval. Contractor shall develop the Control schedule in accordance with Company's work breakdown structure and code of accounts for the Work. The detailed schedule will contain sufficient detail to demonstrate how all activities affect the, Work and Exhibit 9 – Interface and Milestone Schedule.



The Control Schedule will show activities that provide sufficient detail in all areas of Work execution (such as Milestones, key dates, design, procurement, fabrication, manufacturing, transportation, installation, construction, completions and all relevant interfaces) to enable monitoring and control of the Work. Schedule forecasts will give a complete and accurate representation of the current status of the Work, including impacts from delays and advancements, Change Orders and the consequences of productivity.

7.6 GENERAL SCHEDULING AND PROGRESS REQUIREMENTS

Contractor's planning, scheduling and schedule control activities for the Work will, at a minimum, include the following:

- a) A time-scaled critical path method (CPM) logic network that shall set forth the order and estimated times by which planned activities are to be completed. This network shall identify the critical and subcritical paths (a subcritical path is defined as any series of activities whose completion is within one (1) week of the critical path completion). The logic network shall clearly indicate all restraints and interrelationships and shall incorporate Exhibit 9 – Interface and Milestone Schedule;
- b) A description of those activities associated with material sources, Subcontractors and fabrication. All interfaces will be incorporated into the Control Schedule;
- c) All schedule and progress information (CS, SS, tables, histograms, s-curves, document register, procurement plan, manufacturing schedule and support documentation) shall be issued on a monthly basis;
- d) Progress measurements such that the physical progress of the Work can be related easily to the Control Schedule activities. Progress shall be evaluated on discrete, identifiable deliverables for each Work activity weighted by budgeted person hours or other methods to determine a total percent for each activity. Physical progress measurement relates to the assessment of the proportion of actual Work accomplished towards completion of given components of the Work;
- e) The ability to assess progress for all progress earning activities required for each component of Work, regardless of source. As additional progress earning components are identified, they will be added to the base level of Work through the change management process, to be accomplished and progress measured and reported;
- f) Indicate the schedule calendars used to develop the schedule including, daily work hours, work week, shift schedule, scheduled facility shutdowns (if any) and holidays. Any planned non-work periods shall be clearly indicated and a narrative shall be supplied indicating the period of non-work and the rationale for the non-work period;
- g) Show status of all interfaces within the components of the Work (such as engineering, procurement, manufacturing, fabrication, construction and completions);
- h) Exclude home office and field support functions, such as project management, coordination, engineering office follow-up during construction, construction and fabrication management and supervision, warehousing, material handling and clean-up, from physical progress measurements;
- i) Produce and maintain a schedule network that is logically linked, with a minimal number of constraints utilized. Where constraints are required, the fewest possible constraints necessary to meet the required objective will be used. The reason for the constraint shall

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be noted in the notebook file for that activity. Constraints that affect the backward pass calculation of the network (“Mandatory Finish”, “Mandatory Start”, “Finish On Or Before”, “Start On Or Before”, “Finish On”, “Start On”) are to be strictly avoided, unless Accepted by Company;

- j) Use of activity lags is discouraged. Where the use of lags is considered, Contractor shall consider if the use of an activity to represent the lag is a reasonable representation of the condition being modeled. If a lag is used, the reason and rationale for the lag shall be noted in the notebook file for that activity;
- k) Scheduling option that retains the current logic (“retained logic”) of activities started out of sequence will be used. Where necessary, the logic for those activities for which the relationship is no longer applicable will be manually changed;
- l) Schedule time forecasting shall not be based upon the percentage of schedule completed. The scheduling control software function for linking remaining duration and such percentage shall be disabled;
- m) Control Schedule will be structured to provide five (5) activity code fields, for summarization and reporting purposes, for exclusive use by Company. Each code field will be ten (10) characters in length and will be titled LCP1, LCP2, LCP3, LCP4 and LCP5. Company will provide the applicable coding to Contractor for inclusion within these code fields. Contractor will populate and maintain these code fields for all schedule activities;
- n) Schedule calendars and activity codes will be prefixed with the six character package identifier and a dash (for example, “CD0502-”). This is to prevent potential data errors in the Company’s planning system;
- o) Schedule activity descriptions shall clearly identify the work associated with the activity, and shall be consistently applied throughout the schedule;
- p) Activity durations shall not, in general, exceed twice the update frequency;
- q) Start to Finish (SF) relationship types shall be avoided;
- r) Open ends within the schedule network shall be avoided;
- s) Network logic shall be consistently applied throughout the schedule;
- t) The “Work Breakdown Structure” (WBS) shall not be the only coding system used within the schedule network. Activity codes are required to enable effective schedule development, review and analysis;
- u) Gantt or bar chart displays shall have the current schedule bar assigned to position 1, with the baseline schedule bar assigned to position 2; and
- v) Company will have access to all supporting documentation.

7.7 PROGRESS REPORTING

Contractor shall provide Weekly Reports and Monthly Progress Reports as described in Section 3 of this Exhibit 3 and, with respect to progress reporting, as more fully detailed below:

- a) Weekly Reports shall include the following:
 - An updated resourcing plan showing the resources assigned to the project in accordance with the Contractor’s Organization Chart Progress table including quantities/statistics for current engineering, procurement, and fabrication/construction/installation/completions activities;



- b) Monthly Progress Reports shall include the following:
- Planning and schedule control reports will be updated and issued monthly. Reports shall include the Control Schedule, Summary Schedule, tables, resource histograms, progress s-curves, document register, procurement plan, manufacturing schedule and support documentation. Contractor shall supply a copy of the schedule using Primavera (P6 or later version) or equivalent, as well as hard copy format. If software other than Primavera is used, the native file shall have the capability to be easily converted to Primavera P6 and shall be subject to the Acceptance of Company;
 - Deviations from schedule in time or progress, reasons for delays and deviations with recommended actions for recovery;
 - Status of planned tests and/or hold points;
 - Tabulation of project man-hours addressing planned, actual and forecast at completion;
 - Progress table including quantities/statistics for current engineering, procurement, and fabrication/construction/installation/completions activities; and
 - Identification of critical and sub-critical path(s).

8 CHANGES TO THE WORK

8.1 INTRODUCTION

This Section 8 sets forth minimum requirements for identifying and processing Changes in support of Article 26 of the Agreement and Exhibit 2 - Compensation.

Changes will be initiated in one of two ways:

- a) by completing a Change Request, in the form as attached to this Exhibit 3 as Appendix A – Change Request; or
- b) by the issuance of a Change Order.

Contractor shall specify its assessment of cost and schedule impacts in each Change Request or proposal presented in accordance with this Section 8.

If Company issues a Change Order to proceed with a Change on a reimbursable basis, Contractor shall prepare daily time sheets for Company's signature covering such Change and submit them to the Company within twenty four (24) hours where the Change is performed on Site, or within one (1) week where the Change was performed elsewhere, after such Change has been performed. Company's signature of Contractor presented time sheets shall not commit Company to any particular payment in respect of the Change, but shall serve as a record of events in the eventual resolution of any difference of opinion between Company and Contractor regarding the cost or schedule impacts of the Change. Contractor shall also present details of its assessment of any effect of the Change on the Control Schedule. Neither Company's issuance of such a Change Order or Contractor's performance of Change Work pursuant to such Change Order shall prejudice the Party's respective position regarding the appropriate compensation and/or schedule impact of such Change Work. Changes performed

on a reimbursable basis will be priced and paid for as per Sections 3, 4, 5, 6 and 7 of Exhibit 2 - Compensation.

Company will be entitled to an equitable reduction in the Contract Price and/or an equitable adjustment of the Control Schedule in respect of any reduction in the Work pursuant to a Change Order and in accordance with the provisions of Article 26 of the Agreement, Exhibit 2 - Compensation and this Exhibit 3.

Contractor is not entitled to recover any costs related to preparation and administration of Change Orders, responses to Change Requests or preparation of Change Requests.

Each Change Order shall be deemed to take full account of the cumulative effects on the Contract Price and of all prior Change Orders.

8.2 COMPANY REQUESTED CHANGES

Company may issue a Change Order directly to Contractor or may request a proposal from Contractor for a contemplated Change through Company by issuance of a Change Request.

Upon receipt of a Change Request from Company, Contractor shall prepare a proposal for the Change Request and submit it within five (5) Business Days to Company for further processing. Contractor's proposal shall include:

- a) A detailed execution methodology for the proposed Change;
- b) A detailed schedule for the execution of the Change and the impact on the Control Schedule;
- c) a lump sum price for the Change (if Contractor proposes any other method of compensation it shall provide its rationale for that method); and
- d) Details of the impact on the Execution Plan, the Quality Plan, the health and safety plan referenced in Article 15.2 of the Agreement and the environmental protection plan referenced in Article 15.3 of this Agreement.

If Contractor cannot present the proposal for the Change Request to Company within five (5) Business Days of the receipt of the relevant Change Request from Company, Contractor shall promptly notify Company and provide reasons for the delay and the date the proposal will be ready. Contractor shall not unduly delay submission of the proposal to Company. Company, at its sole discretion, can reject any proposal not submitted in accordance with the requirements outlined herein.

Company will review Contractor's proposal within ten (10) Business Days and either Accept and return a Change Order (in the form as attached to this Exhibit 3 as Appendix B - Change Order) for Contractor execution or reject the proposal for resubmission or cancellation.

8.3 CONTRACTOR IDENTIFIED CHANGES

Contractor may request a Change by submitting a Change Request to Company. The Change Request will include:

- a) A detailed explanation of why Contractor considers that a Change has occurred along with detailed support to enable Company to easily evaluate and assess the merits of the Change Request. Contractor shall specify the relevant provision(s) of the Agreement which it interprets as the basis for the Change Request;
- b) A detailed schedule for the execution of the Change and the impact on the Control Schedule;
- c) a lump sum price for the Change (if Contractor proposes any other method of compensation it shall provide its rationale for that method); and
- d) Details of the impact on the Execution Plan, the Quality Plan, the health and safety plan referenced in Article 15.2 of the Agreement and the environmental protection plan referenced in Article 15.3 of the Agreement.

Contractor has the responsibility to identify, by the issuance of a Change Request, any change to the Work that it believes to be necessary for environmental integrity, or that will benefit Company or Owner in terms of capital or operating cost, or improved performance flexibility, safety or operation of the Work.

8.4 CONCESSION REQUEST

A Concession Request is a written authorization to deviate from specified contractual technical requirements.

Use of a Concession Request is to ensure that any deviation from codes, approved drawings, specifications and standards as agreed in the Contractual documents (Agreement) is defined, documented and distributed in a controlled and timely manner.

Concession Request is not required for “Non-Technical” deviations, which will be processed by Change Request.

A Concession Request is initiated by Contractor on the “Concession Request” Form (Appendix M).

Concession Request process referring to Appendix N.

8.5 CHANGE ORDER PRICE

Contractor’s proposed price for any Change will generally be stated as a lump sum price. Contractor shall provide substantiation, as Company may reasonably request, regarding such proposed price. Each lump sum price for a Change shall be determined using the rates and prices outlined in Exhibit 2 - Compensation or on a basis to be agreed between Company and

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Contractor if there are no applicable rates in Exhibit 2 – Compensation.

For any Change proposed to be compensated on a reimbursable basis, Contractor shall include an estimated total price for the Change in the Change Request or in its proposal in response to a Change Request. Changes performed on a reimbursable basis will be priced in accordance with Exhibit 2 – Compensation.

Each Change Order shall fully define the terms of payment and invoicing provisions. Contractor shall not be entitled to additional compensation in respect of:

- a) Personnel already assigned full time to the Work, except when such Personnel are paid overtime, shift premiums or their assignment to the Work is extended, specifically in relation to the Change; and
- b) Contractor's Items already assigned full time to the Work, except when the hire period of rented items is extended specifically in relation to the Change.

8.6 CHANGE IMPACT ON CONTROL SCHEDULE

Contractor will submit to Company, all necessary information to support any proposed impact of a Change on the Control Schedule, in both hard copy and electronic format. The information shall include detailed critical path analysis, identification and full accounting for the use of float and the current Control Schedule.

Each Change Order shall be deemed to take full account of the cumulative effects on the Control Schedule and all prior Change Orders.

Contractor shall update the Control Schedule for Company's Approval within five (5) Business Days after Company's issuance of any Change Order affecting the Control Schedule.

8.7 CHANGE REGISTER

Contractor shall maintain, fully updated at all times, a register of all Change Requests and Change Orders. The register will include:

- a) Change Request number and date;
- b) Change Order number and date and reference to a Change Request;
- c) Concession Request number and date
- d) Potential change list
- e) Brief description of the Change;
- f) Status of Change Request, Concession Request, potential change and Change Order;
- g) Value;
- h) Effects on Control Schedule; and
- i) Brief description of the basis for the Change Request.

Each Change Request will be identified by means of a unique sequential reference number beginning with 1000 for any Change Request issued by Company, and 2000 for any Change

Request issued by Contractor. Each Change Order will be identified by means of a unique reference number, which will be assigned by Company.

All Change Orders that affect the Control Schedule shall be individually detailed, by reference number and summary description, in the successive Control Schedule updates issued by Contractor for Company's Approval.

Contractor shall submit the Change register in the Monthly Progress Report or more frequently as required by Company.

9 RISK MANAGEMENT

Requirements for ongoing risk management and reporting will be agreed between Contractor and Company at the kick-off meeting. Depending on the nature of the Work, Company shall have the authority to specify the type of risks (such as schedule, quality, cost, safety and environmental) which shall be reported by Contractor.

9.1 RISK MANAGEMENT REQUIREMENTS

- a) Contractor shall establish and implement a risk management system to identify, address and manage safety, health and environment, cost, schedule, quality and other execution risks, for the duration of the Work.
- b) Contractor's risk management system shall be based on the following principals:
 - All risks shall be identified and captured in the Risk Register (as defined in Section 9.1(c) below);
 - All risk scenarios shall be evaluated for elimination or mitigation through appropriate measures; and
 - All higher and medium risk scenarios and associated risk management strategies shall be communicated and accepted by the appropriate level of Contractor's management.
- c) Contractor's risk management system shall include the following features:
 - Contractor shall develop a risk management plan indicating the formal risk process to be followed during Work execution, with risk assessment approach and frequency. The plan shall also include assessments required for safety, health and environment and execution risks referenced elsewhere in this Exhibit 3;
 - Contractor shall develop and maintain a risk register ("Risk Register") to capture all details required to monitor identified risks. The format and content shall be subject agreed to by Contractor and Company. It shall be submitted as part of the Monthly Progress Report, along with other reporting requirements specified within this Exhibit 3;
 - Contractor shall perform risk assessments using qualified and knowledgeable Personnel. Contractor shall consult with Company regarding meeting target levels of safety. Contractor shall also include active involvement of Company's Personnel and external expertise, as appropriate;

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- Risk assessments and recommended prevention and/or mitigation measures shall be formally documented in the Risk Register;
 - Risk mitigation and prevention strategies for assessed risks in the higher and medium categories are required to be reviewed for acceptability by specified levels of Contractor's and Company's management. These strategies shall be supported by formal actions captured in an action log and be appropriate to the nature and magnitude of the risk, with decisions and updates clearly documented;
 - Results of formal risk assessments shall be considered in the preparation or review of emergency response plans and procedures; and
 - Follow-up processes to ensure that decisions have been implemented shall be formally documented and maintained in an action log. At a predetermined frequency, compliance reviews shall be undertaken to verify that formal risk assessments and follow-up actions are implemented.
- d) Where appropriate, Company shall be invited to observe and/or participate in risk assessments performed by Contractor. Results of risk assessments related to the Work shall be distributed to Company upon completion of any of the assessments included within Contractor's risk management plan.
- e) Contractor shall also participate in risk assessments conducted by Company or Company's Other Contractors when these risk assessments relate to activities for which interfaces exist with the Work or where Contractor is involved.

10 ENGINEERING AND TECHNICAL DOCUMENTATION

10.1 INTRODUCTION

This Section sets forth minimum requirements for engineering coordination in support of the Agreement, including Article 3 – Contractor's Work Obligations, and Document No. 505573-0000-37AG-I-0015 -- Directions to Contractors / Supplier Document Requirements for Contractor.

10.2 GENERAL REQUIREMENTS

- a) As part of the requirement in Section 2.4 to submit its execution plan for the Work, Contractor shall include a detailed engineering management plan for the first 90 days following the Effective Date. This plan will address planning activities, staff, offices and other resource mobilization, software acquisition and schedule development.
- b) It is the responsibility of Contractor to maintain an electronic system for monitoring, recording and tracking all revisions and changes to drawings and documentation.
- c) Any Documents (as defined in section 10.4 below) which require Approval of any Authority, will be submitted to such Authority by Contractor for Approval, unless otherwise agreed.
- d) All applicable Documents shall be marked "Issued for Construction" or similar status, prior to commencement of fabrication, manufacture, construction or installation of the Work.

e) Contractor shall not commence any Work involving permanent installation of any equipment, materials or products until Contractor has submitted to Company and Company has accepted the Health, Safety and Environmental plans required by Article 15 of the Agreement.

10.3 DESIGN CONTROL

Contractor shall establish and implement a system to control Engineering activities in order to ensure achievement of a satisfactory level of quality and compliance with requirements including those of all Authorities and the Agreement.

Contractor's Engineering control activities shall include the following:

- a) Implement a system for (internal) discipline checking, including the use of check lists where appropriate, to substantiate compliance with the requirements of Authorities, Agreement requirements and Supplier and Subcontractor requirements. Discipline checks shall be documented and traceable
- b) Ensure that all aspects of the design (including Supplier information) are systematically verified
- c) Ensure that there is no conflict between documents, and
- d) Systematically record, for each revision of all documents, originator, checker, Contractor and approval signatures, and, where required, Company Acceptance or Approval, and to incorporate comments as required during the checking and approval processes.

10.4 COMPANY REVIEW AND APPROVAL OF CONTRACTOR DOCUMENTS

Throughout this Section and elsewhere in the Agreement, wherever there is a stated requirement for Approval or Acceptance by Company of a Contractor drawing, procedure, specification or other documentation (**Document**), this shall mean:

- (a) Contractor shall carry out its internal inter-discipline checking (IDC) to verify the quality of the Document. Contractor will verify product requirements, catalogue numbers and similar data and that Contractor has checked and coordinated each Document with the requirements of the Work and of the Agreement
- (b) After Contractor's IDC, and subject to the Document being free of significant "holds", Contractor shall issue the Document for Company's Approval.
- (c) Related engineering required to allow Company to review each Document must be made available by Contractor, if not already in Company's possession.
- (d) Contractor shall revise the Document to take account of Company's comments as part of the Work.
- (e) Contractor must get Company's Approval of the Document before it is issued for implementation.
- (f) Company will review and return Documents in accordance with the schedule agreed upon.

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- (g) Company's review is for conformity to the requirements of the Agreement design concept and for general arrangement only.
- (h) Company's review will not relieve Contractor of responsibility for errors or omissions in any Document submitted by Contractor or for meeting all requirements of the Agreement unless Company expressly notes the Acceptance of a deviation on the Document.
- (i) Upon Company's request, Contractor will revise and resubmit Documents which Company reasonably rejects as inconsistent with the Agreement unless otherwise directed by Company. Contractor will notify Company in writing of any revisions to the resubmission other than those requested by Company.
- (j) Company shall have the right to raise additional comments at any time to address Contractor's errors and omissions and Contractor shall incorporate such comments into the Work.

10.5 TECHNICAL QUERY PROCEDURE

Requests for clarification or guidance related to technical details contained within Company Supplied Data, shall be formally presented by Contractor to Company as a Site Query (SQ). Refer to Section 11 below for details on the use of an SQ.

11 CONSTRUCTION MANAGEMENT

11.1 OBJECTIVES

In executing the Work, Contractor shall assign experienced and qualified project management Personnel and craft workers with demonstrated skills during the field work / construction phase of the Work and provide continuity of such Personnel throughout the execution of the Work;

- a) Maintain adequate controls and oversight during the field work / construction phase of the Work to ensure conformance with all requirements of the Agreement;
- b) Minimize Work execution risks and risks to Company's assets;
- c) Develop adequate contingency and recovery plans to mitigate impacts on schedule of unforeseen events (e.g. weather events); and
- d) Provide Worksite(s) that are safe, secure and free of industrial health hazards.

11.2 CONTRACTOR'S DUTIES

With respect to the Work, Contractor shall:

- a) Plan and co-ordinate the design, fabrication, transportation, installation, construction and completions of the Work with Company to ensure all interfaces are identified and managed;
- b) Identify execution risks and develop mitigation plans and procedures covering all reasonable events during the field work / construction phases;

- c) Conduct all engineering for field work, fabrication, transportation, construction and completions as stipulated in the Agreement;
- d) Prepare, maintain and implement:
 - emergency preparedness and response procedures;
 - detailed fabrication, construction, transportation and material management plans for major Worksites;
 - security measures at the Worksite; and
 - a health and safety program;
- e) Provide all construction and installation equipment, tools and temporary facilities required to perform the Work;
- f) Provide Personnel and facilities for all field testing, inspection, supervision and coordination activities associated with the Work;
- g) Support Company's construction management activities related to the Work.

11.3 SITE QUERY (SQ)

The Site Query (SQ) process, as described in this Exhibit 3, shall be used by Contractor to facilitate the timely resolution of minor engineering and construction problems encountered at the Worksites. The SQ is used to formally transmit and co-ordinate technical queries with Company and to document the resolution to the query. Company shall not be involved in answering Site Queries which are entirely within Contractor's own responsibility.

Contractor may raise an SQ (in the form attached as Appendix E - Site query (SQ)) to clarify Technical Requirements which require a formal response. The SQ will include separate sections for Contractor's query and for Company's response. Any relevant documents that might assist those assigned to respond to the query in understanding the issue should be included or referenced with mark-ups as required. Contractor's SQ shall be approved by an appropriate level of authority within Contractor's organization and submitted formally to Company (distribution list to be provided). Contractor shall assign an SQ number based upon the Accepted numbering system which will be provided to the Contractor.

Company shall review the SQ and provide a response within the appropriate section of the SQ. It will be Contractor's responsibility to implement any actions associated with the response. Responses may simply be explanatory in nature and require no additional action. Where appropriate, an SQ response may be accompanied by a Site Instruction (in the form attached as Appendix F - Site Instruction) or an Engineering Change Notice (in the form attached as Appendix G - Engineering Change Notice (ECN)). An SQ will remain open until any associated actions have been completed, to the satisfaction of Company.

Open SQs shall be reviewed at weekly Site meetings in order to resolve all matters relating to their resolution.



11.4 SITE INSTRUCTION (SI)

The Site Instruction (SI) process, as described in this Exhibit 3, shall be used to provide a formal record of an instruction or verbal agreement originated directly at Site from Company to the Contractor.

SIs (in the form attached as Appendix F - Site Instruction) will be provided to address the following items (examples only):

- a) Instructions to Contractor related to safety or quality;
- b) Confirmation of verbal instructions/notifications;
- c) Site administration;
- d) Reporting requirements;
- e) Work clarification; and
- f) Instruction subsequent to a Site Query response.

Open SIs shall be reviewed at weekly meetings in order to resolve all matters relating to their implementation.

11.5 ENGINEERING CHANGE NOTICE (ECN)

The Engineering Change Notice (ECN) process, as described in this Exhibit 3, will be followed by Company to highlight the issuance of any engineering design change to the Contractor whenever:

- a) Issued for Construction (IFC) drawings or specifications are revised after their issue to Contractor;
- b) New IFC drawings or specifications are issued that are not listed in Exhibit 1 - Scope of Work; and
- c) IFC, sketches, documents or any such typical instructions are issued.

Company will generate an ECN, using the form found in Appendix G - Engineering Change Notice (ECN) of this Exhibit 3, to describe and communicate Issued for Construction (IFC) document changes to the Contractor. These changes will be described on the ECN form and accompanied by the associated drawings, specifications, sketches and related documents for implementation by Contractor. Where an ECN is the result of an SQ or a SI, it will reference the relevant document. The ECN will be assigned a unique number by Company for future reference and reporting.

12 INVOICING AND PAYMENT

12.1 OBJECTIVES

Contractor shall submit accurate, complete and detailed invoices that reflect the Work completed by Contractor, in a format that will be established by the Company and with the necessary supporting/verification documentation to enable Company to efficiently attest the invoices and recommend Approval and payment of Contractor's invoices by Company, and all in

accordance with the Articles of the Agreement.

12.2 CONTRACTOR'S DUTIES

- a) Contractor shall submit invoices in accordance with the Agreement complete with Company Approved Payment Certificates and all supporting/verification documentation Acceptable to Company.
- b) Contractor shall submit to Company, a monthly report that summarizes invoices submitted and payments made, along with applicable dates of both the invoices and the payments and other pertinent information that Company may require.
- c) Contractor shall submit to the Company, each month, a cash forecast report for the following three (3) months. This report shall be submitted by the 25th day of every month.

12.3 PROCEDURAL REQUIREMENTS

- a) Contractor shall submit to Company one original invoice, along with one (1) PDF copy of the invoice and all required Billing Information.
- b) Each invoice is to be organized such that it is easily understood and:
 - contains a clear description of the completed Work being invoiced;
 - the charges can be easily and efficiently verified against the Agreement and the Billing Information; and
 - all charges are clearly cross referenced to the Billing Information.
- c) All invoice amounts shall be detailed based on Company's code of accounts.
- d) The invoice shall include the following information:
 - Contractor's name, address and tax identification number (HST registration number);
 - Invoice date and invoice number;
 - Agreement number and name;
 - Charges detailed by code of accounts along with cumulative value of all invoices for the Agreement detailed by Company's code of accounts;
 - Adjustments, if any, from prior invoices;
 - Subtotal, tax (HST applicable to the invoice) and total;
 - Complete and accurate supporting documentation, including without limitation Billing Information and any other pertinent information that Company may require to verify completion of the Work, the accuracy of the fees, charges and third party charges; complete with a summary sheet cross referencing all supporting documentation to the charges covered on the invoice;
 - Approved Payment Certificate (in the form as stated in Appendix D - Payment Certificate);
 - If Contractor is a non-resident, in accordance with Exhibit 10 – Declaration of Residency, Contractor shall note on each invoice whether any portion of the Work covered by such invoice was performed inside or outside of Canada for the purposes of Canadian income tax legislation, or such other information requested or required by Company to properly assess withholding requirements; and
 - Where appropriate, Change Order amounts may be shown separately and the invoice

will itemize charges associated with each Change Order, including without limitation, a detailed description of each item being invoiced. A copy of the Change Order shall accompany the invoice.

- e) Before Company pays an invoice, Company may request clarification or substantiation in relation to any charges on the invoice and Contractor shall promptly comply with any such request. Invoice review meetings (or pre-payment meetings) may be held to agree on charges to be included on an invoice.
- f) If an invoice is deemed incorrect by Company, Company is entitled to reject such invoice and shall provide reasons for the rejection.
- g) A Final Completion Certificate will be required before final payment will be made. When Contractor believes the requirements of Final Completion have been satisfied, as described in Article 25 of the Agreement, Contractor shall request by Notice a Final Completion Certificate. Such request shall be in the form as contained in Appendix C - Request and Final Completion Certificate.

Invoicing for Change Work

Contractor shall submit separate invoices for Changes, unless Company Accepts otherwise, with the Change Order number and date mentioned on the invoice. Invoicing provisions shall be specified on each Change Order. All Changes shall be subject to the compensation provisions and payment terms set out in Article 12 of the Agreement, Exhibit 2 – Compensation and Exhibit 3.

Contractor will not invoice Company for any amounts which result in the cumulative amount invoiced being greater than the lump sum price indicated on a Change Order.

Under no circumstances will Contractor present invoices for a Change, nor will Company compensate Contractor for any Change, in the absence of a Change Order.

Banking Information

- a) Payments of invoices shall, where possible, be made by electronic funds transfer to Contractor's bank account, as specified in writing by Contractor to the Company.
- b) Any changes in Contractor's banking information or payment instructions shall be submitted in writing to the Company Representative. The Company shall not be held responsible for errors or delays resulting from incorrect or delayed submission of changes in banking instructions by Contractor.

APPENDIX A
CHANGE REQUEST



LOWER CHURCHILL PROJECT	CHANGE REQUEST
------------------------------------	-----------------------

Agreement No: _____	CHR No. _____ (Reference)
Agreement Title: _____	Rev. No: _____
Company: _____	CHO No. _____
Contractor/Supplier: _____	Date: _____

Description of Change Request and Reason (attach all supporting information):

Supporting information that forms part of this Change Request:

Description of impact on Control Schedule:

Revised Finish Date:

Lump sum price (or estimated cost) and adjustment to the Contract Price:

Item	Description	UOM	QTY	Unit Price	Extended Price

Value of this Change Request: \$

ORIGINATOR **COMPANY** **CONTRACTOR/SUPPLIER**

Title	Name	Signature	Date

OTHERS REVIEW

Title	Name	Signature	Date

APPENDIX B

CHANGE ORDER

YB MB

LOWER CHURCHILL PROJECT	CHANGE ORDER Between Company and Contractor/Supplier
------------------------------------	---

Agreement No: _____	CHO No. _____
Agreement Title: _____	Rev. No: _____
Company: _____	CHR No. _____
Contractor/Supplier: _____	Date: _____

Description of Change:

Supporting information that forms part of this Change Order:

Change Includes: <input type="checkbox"/> Price <input type="checkbox"/> Schedule Adjustment Type: <input type="checkbox"/> Lump Sum <input type="checkbox"/> Unit Rate <input type="checkbox"/> Fixed Amount <input type="checkbox"/> Estimate <input type="checkbox"/> Reimbursable	Original Contract Price _____ Previous Change Orders Price _____ This Change Order Price _____ Total Contract Price to Date \$ _____
--	---

Impact on Control Schedule:
Revised Finished Date: _____

This Change Order shall form and be read and construed as an integral part of the above-noted Agreement. The above adjustment to the Contract Price constitutes full compensation (including all impact costs) to the Contractor/Supplier for the above Change.

Issued by Company: _____ Supply Chain Manager or Delegate Name: _____ Signature: _____ Date: _____ Company Representative Name: _____	Acknowledgement of Contractor/Supplier Receipt: _____ Signature: _____ Name: _____ Date: _____
--	--

APPENDIX C

REQUEST FOR FINAL COMPLETION CERTIFICATE

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REQUEST FOR FINAL COMPLETION CERTIFICATE

Agreement No.: _____

Agreement Title: _____

Contractor: _____

To Engineer:

In accordance with Article 25 of the Agreement, Contractor hereby confirms that it has completed the Work and all the requirements of Final Completion (as described in the Agreement) have been met, all in accordance with the Agreement, excluding its Warranty obligations.

Contractor agrees that, as of the date of its confirmation below, the Contractor waives, remises, releases and discharges the Company of any and all Claims that are known, ought to have been known or discoverable by reasonable means by the Contractor, which Contractor has or may have relating to or arising out of this Agreement and the subject matter of this Agreement, and all facts and circumstances related to the Work, save and except:

- a) Only those Claims previously submitted by Contractor in writing and remaining unresolved prior to the date of Contractor's below confirmation, as listed below:

_____;

and

- b) The balance of the Contract Price payable, if any, upon the issuance of this Final Completion Certificate.

Contractor Confirmation:

Contractor confirms it has completed the Work in accordance with the above-noted Agreement.

By: _____
Contractor Representative

Acknowledgement of Engineer Receipt:

By: _____
Engineer

Date:

FINAL COMPLETION CERTIFICATE

Agreement No.: _____

Agreement Title: _____

To Contractor:

Company hereby confirms that the Date of Final Completion of the Work is **[date]**.

By: _____
Company Representative

Date:



APPENDIX D

PAYMENT CERTIFICATE



PAYMENT CERTIFICATE

Date: _____
 Agreement #: _____
 Agreement Title: _____
 Contractor: _____

Milestone / Monthly Progress
 Payment Description: _____

Milestone / Monthly Progress
 Payment Amount: _____

Work Executed for Monthly Progress / Milestone Completion criteria and status (list below):

Contractor:

Contractor hereby notifies Company that it considers that it has executed the associated Work or met the criteria for achieving the above-noted Milestone(s) and requests Company Approval.

By: _____
 Contractor Representative

Date:

Company Approval:

Company hereby Approves this Payment Certificate. Company Approval of this Payment Certificate does not relieve Contractor of any of its obligations under the Agreement.

By: _____
 Company Representative

Date:

APPENDIX E

SITE QUERY (SQ)

MB



APPENDIX F

SITE INSTRUCTION (SI)



LOWER CHURCHILL PROJECT	SITE INSTRUCTION (SI)
------------------------------------	------------------------------

Company: <input type="text"/>	Date <input type="text"/>	Rev. <input type="text"/>	Page of <input type="text"/>
Project Name & Location: <input type="text"/>	Site Instruction No. <input type="text"/>		
Contractor: <input type="text"/>	<i>DISTRIBUTION (NAME PLUS DISCIPLINE OR COMPANY)</i> From: <input type="text"/> To: <input type="text"/> Copies to: <input type="text"/>		
Agreement No.: <input type="text"/>			
Agreement Title: <input type="text"/>			
Plant Area / Bldg No.: <input type="text"/>			
Reference Specification: <input type="text"/>			
Reference Drawing No.: <input type="text"/>			

The Contractor agrees that by signing acceptance of this Site Instruction, the contents hereof do not contain or imply any additional money or schedule effect in the above-noted Agreement whatsoever.

Instruction:

Reason:

	TITLE	NAME	SIGNATURE	DATE
Prepared by:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Accepted by:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

DISTRIBUTION

<input type="checkbox"/> File	<input type="checkbox"/> Planner	<input type="checkbox"/> Resident Engineer
<input type="checkbox"/> Contractor	<input type="checkbox"/> Estimator	<input type="checkbox"/> Contracts Administrator
<input type="checkbox"/> Area Construction Manager	<input type="checkbox"/> Chief Inspector	<input type="checkbox"/> Commissioning
<input type="checkbox"/> Environment	<input type="checkbox"/> Cost Controller	<input type="checkbox"/> Other _____
<input type="checkbox"/> QA Coordinator	<input type="checkbox"/> Document Control (site)	<input type="checkbox"/> Other _____

LCP-SN-CD-0000-SC-FR-0045-01

Handwritten signature/initials in blue ink.

APPENDIX G

ENGINEERING CHANGE NOTICE (ECN)

NA


Lower Churchill Project	Engineering Change Notice (ECN)	Page 1 of 2	
		Revision	
		No.	Date
		00	

Company: Project:	ECN No.:
----------------------	----------

Agreement No.	Contractor
Agreement Title	

Distribution		
From	To	Copy to

Summary Description of Changes

Instruction to Contractor	
<input type="checkbox"/> Submit impact on contractual terms prior to proceeding with the work	<input type="checkbox"/> Lump Sum
	<input type="checkbox"/> Unit Price
	<input type="checkbox"/> Cost Plus
<input type="checkbox"/> No impact on the contractual terms, proceed with the work	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
<input type="checkbox"/>	

Received by Contractor		
_____ Name	_____ Signature	_____ Date

	Title	Name	Signature	Date
Prepared by:				
Reviewed by:				
Approved by:				

LCP-SN-CD-0000-SC-FR-0046-01

APPENDIX H

NOT USED

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APPENDIX I

SUBSTANTIAL COMPLETION CERTIFICATE

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Substantial Completion Certificate

Agreement No: _____
 Agreement Title: _____
 Contractor: _____

To Company:

In accordance with Article 25.2 of the Agreement, Contractor hereby confirms that it has completed all requirements in the Agreement to achieve Substantial Completion as of _____ (“Substantial Completion Date”). Substantial Completion shall be effective as of the Substantial Completion Date upon the execution and issuance of this Substantial Completion Certificate.

Delivered by Contractor:

By: _____
 Contractor Representative

Date:

Company Confirmation:

Company confirms Contractor has achieved Substantial Completion in accordance with the Agreement as of the Substantial Completion Date. This certificate does not relieve the Contractor of its contractual responsibilities for repairing all minor deficiencies as a part of the Work.

By: _____
 Company Representative

Date:

APPENDIX J

MILESTONE COMPLETION CERTIFICATE

9/10/13

MILESTONE COMPLETION CERTIFICATE

Date: _____
 Agreement #: _____
 Agreement Title: _____
 Contractor: _____

Milestone Description: _____

Milestone Amount: _____

Milestone Completion criteria and status (list below):

Contractor:

Contractor hereby notifies Company that it considers that it has met the criteria for achieving this Milestone(s) and requests Company Approval

By: _____
Contractor Representative

Date:

Company Approval:

Company hereby Approves this Milestone Completion Certificate.

Company Approval of this Milestone Completion Certificate does not relieve Contractor of any of its obligations under the Agreement.

By: _____
Company Representative

Date:

Handwritten signature in blue ink, possibly initials 'MR' and a stylized signature below it.

APPENDIX K

NOT USED

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APPENDIX L

STATUTORY DECLARATION

MR
DP

STATUTORY DECLARATION – ACCOMPANYING INVOICE FOR PAYMENT

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CANADA)	IN THE MATTER OF THE AGREEMENT
)	BETWEEN COMPANY AND
PROVINCE OF NEWFOUNDLAND)	[CONTRACTOR] DATED AS OF [DATE] FOR
AND LABRADOR)	THE [DESCRIPTION OF WORK] BEING
)	AGREEMENT NO. [INSERT NO.] (the
)	"Agreement")

I, [●], of the City of [●], in the [Province]/[State] of [●],[Country], do solemnly declare that:

1. I am the [title] of [full legal name of Contractor] and as such have personal knowledge of the facts set out in this Declaration.
2. Defined terms used in this Statutory Declaration but not defined in this Declaration have the meanings given to those terms in the Agreement.
3. All (a) payments due to Subcontractors, (b) wages and benefit payments due to any of the Contractor's Personnel, and (c) Taxes, contributions, premiums, allowances and remittances due to any Authority, pension fund, benefit plan or union fund in accordance with a collective agreement or Applicable Laws, have been paid in a timely manner on or before the date of the Invoice and associated Payment Certificate to which this Declaration relates, subject to any withholdings or holdbacks required by Applicable Laws.
4. Title to the applicable part of the Work will pass to Company in accordance with Article 27 of the Agreement.
 - (a) There are no known outstanding Claims under the Agreement, including Claims by Contractor against Company, except for those Claims which have already been communicated to Company in a timely manner in the form of Notice required by the Agreement and which are described and listed in the Appendix to this Declaration, including an estimate of the value of each such Claim; or
 - (b) There are outstanding Claims, including Claims by Contractor against Company, which have not been communicated to Company and each of these Claims is described and listed in the Appendix to this Declaration and is delivered to Company in a timely manner, and there are no other known outstanding Claims under the Agreement, except for those Claims which have already been communicated to Company in a timely manner in the form of Notice required by the Agreement and which are described and listed in the Appendix to this Declaration, including an estimate of the value of each such Claim.
6. The last application for payment for which we have received payment is No. _____ dated the _____ day of _____, 20__.

I make this Declaration conscientiously believing it to be true and knowing it is of the same force as if made under oath.

DECLARED before me at the City of)
[•],)
in the [Province]/[State] of)
[•],)
[Country])
on [Month], [Date], 20[•])
)
)

Name:
A Commissioner, etc.

Declarant

APPENDIX M

CONCESSION REQUEST FORM

MB
[Signature]

Lower Churchill Project	CONCESSION REQUEST (Construction Contract)
--------------------------------	--

CONTRACTOR:	Page 1 of 2	
Agreement Title:	Date	Concession Request (Construction) No.
Agreement Number:		
Plant Area / Bldg No.:	<i>DISTRIBUTION (NAME PLUS DISCIPLINE OR COMPANY)</i>	
Type of Materials:	From:	
Tag / Part No.:	To:	
	Copies to:	
Drawings No.:	TYPE <input type="checkbox"/> Electrical	
Specification No.:	<input type="checkbox"/> Documentation <input type="checkbox"/> Welding	
Quantity involved:	<input type="checkbox"/> Fabrication <input type="checkbox"/> Contractor	
	<input type="checkbox"/> Mechanical <input type="checkbox"/> Civil / Architectural	
	<input type="checkbox"/> Instruments <input type="checkbox"/> Structural	
	<input type="checkbox"/> Material <input type="checkbox"/> Other	
	<input type="checkbox"/> Code / specification Specify:	

1. BY CONTRACTOR / VENDOR

Description of concession (attach applicable documentation):

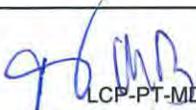
Requirements:

Proposed action and justification (attach applicable documentation):

- Adverse Consequences:
- | | |
|--|---|
| 1. Cost:
1.1 Contractor / Vendor:
1.2 Subcontractor:
1.3 LCP Team:
1.4 Company (Operations): | 2. Schedule:
3. Warranty:
4. Quality Control:
5. Other
Specify: |
|--|---|

If no cost or schedule impact is identified on this form, then in accordance with Article 38.3 of the Articles of Agreement, the signatures on behalf of Contractor and Company constitute the express written waiver for the concession requested, including the proposed action, as specified on this form.

	TITLE	NAME	SIGNATURE	DATE
Requested by: Contractor / Vendor	_____	_____	_____	_____



Lower Churchill Project	CONCESSION REQUEST (Construction Contract)
--------------------------------	--

Contractor Name & Location :	Agreement Number :	Page 2 of 2
Concession Request (Construction) No.		

2. REVIEWS

Possible Quality Control implications: by Area Construction Manager/Resident engineer /Package Lead

Accepted
 Conditional Acceptance
 Rejected

	TITLE	NAME	SIGNATURE	DATE
Approved by:	_____	_____	_____	_____
Approved by:	_____	_____	_____	_____

DISCIPLINE	NAME	SIGNATURE	DATE	RECOMMENDED		REMARKS
				YES	NO	
Civil & Architectural				<input type="checkbox"/>	<input type="checkbox"/>	
Electrical				<input type="checkbox"/>	<input type="checkbox"/>	
Instrumentation				<input type="checkbox"/>	<input type="checkbox"/>	
Mechanical				<input type="checkbox"/>	<input type="checkbox"/>	
Structural				<input type="checkbox"/>	<input type="checkbox"/>	
Project Controls				<input type="checkbox"/>	<input type="checkbox"/>	
Procurement				<input type="checkbox"/>	<input type="checkbox"/>	
Construction				<input type="checkbox"/>	<input type="checkbox"/>	
Commissioning				<input type="checkbox"/>	<input type="checkbox"/>	
Area Manager				<input type="checkbox"/>	<input type="checkbox"/>	

Recommendation supported by: Component Engineering Manager

Accepted
 Conditional
 Rejected

Operation Impact? Yes No

	TITLE	NAME	SIGNATURE	DATE
Approved by:	_____	_____	_____	_____

3. APPROVALS

Approval by Company (Operations) (If applicable):

Approval
 Rejected

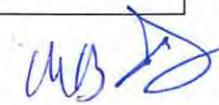
	TITLE	NAME	SIGNATURE	DATE
Approved by:	_____	_____	_____	_____

4. CLOSE OUT

Inspection Required Yes No

Comments:

	Title	Name	Signature	Date
Reviewed by:				
Approved by:				

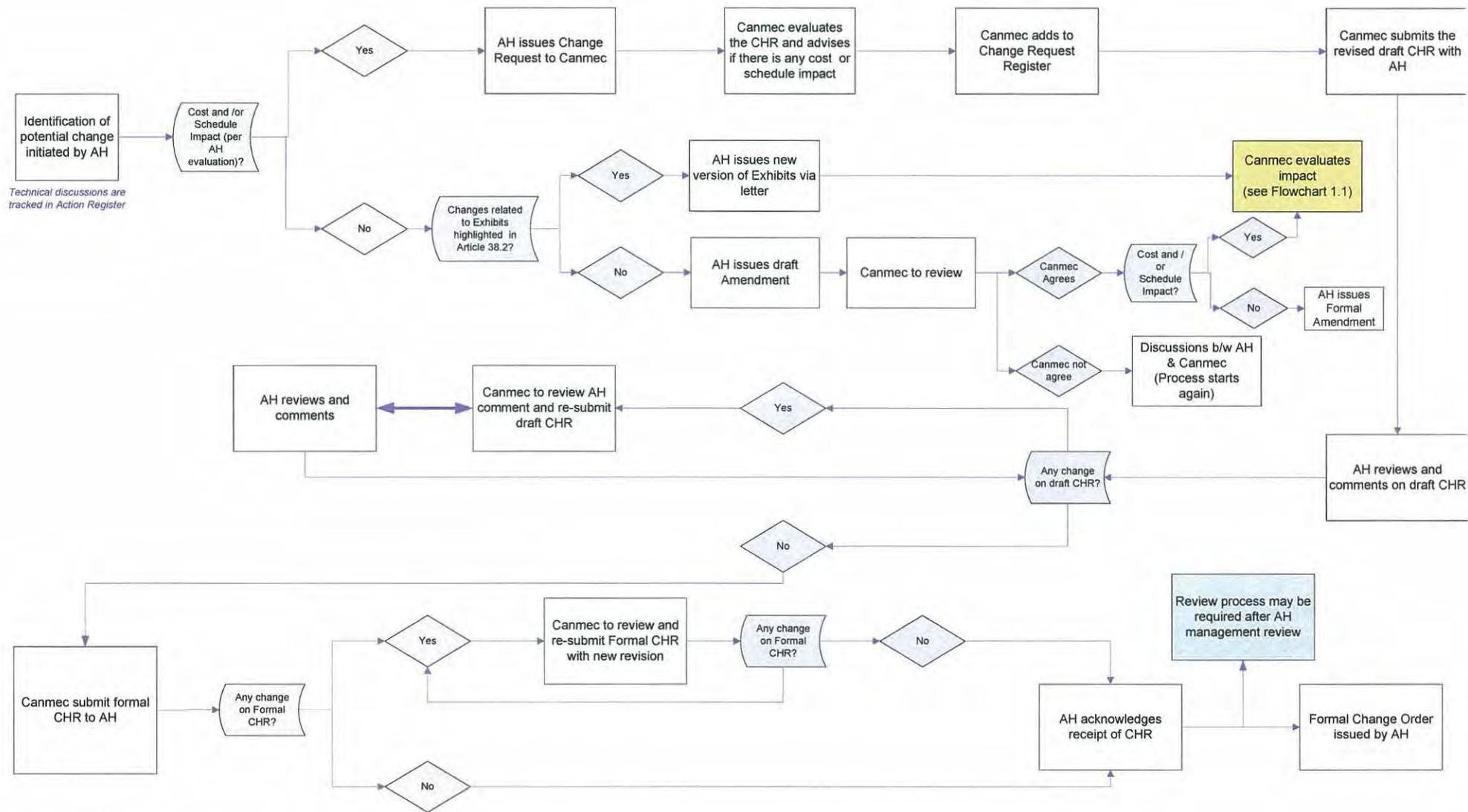


APPENDIX N

CONCESSION REQUEST PROCESS FLOWCHART



Muskrat Falls Gates (CH0032) – Concession Request, Change Request and Change Order Process – Preliminary Changes Initiated by AH (Flow Chart 1.2)



CHR: Change Request
CHO: Change Order

Muskkrat Falls Gates (CH0032) – Concession Request, Change Request and Change Order Process – Preliminary Changes Initiated by Canmec (Flow Chart 1.1)

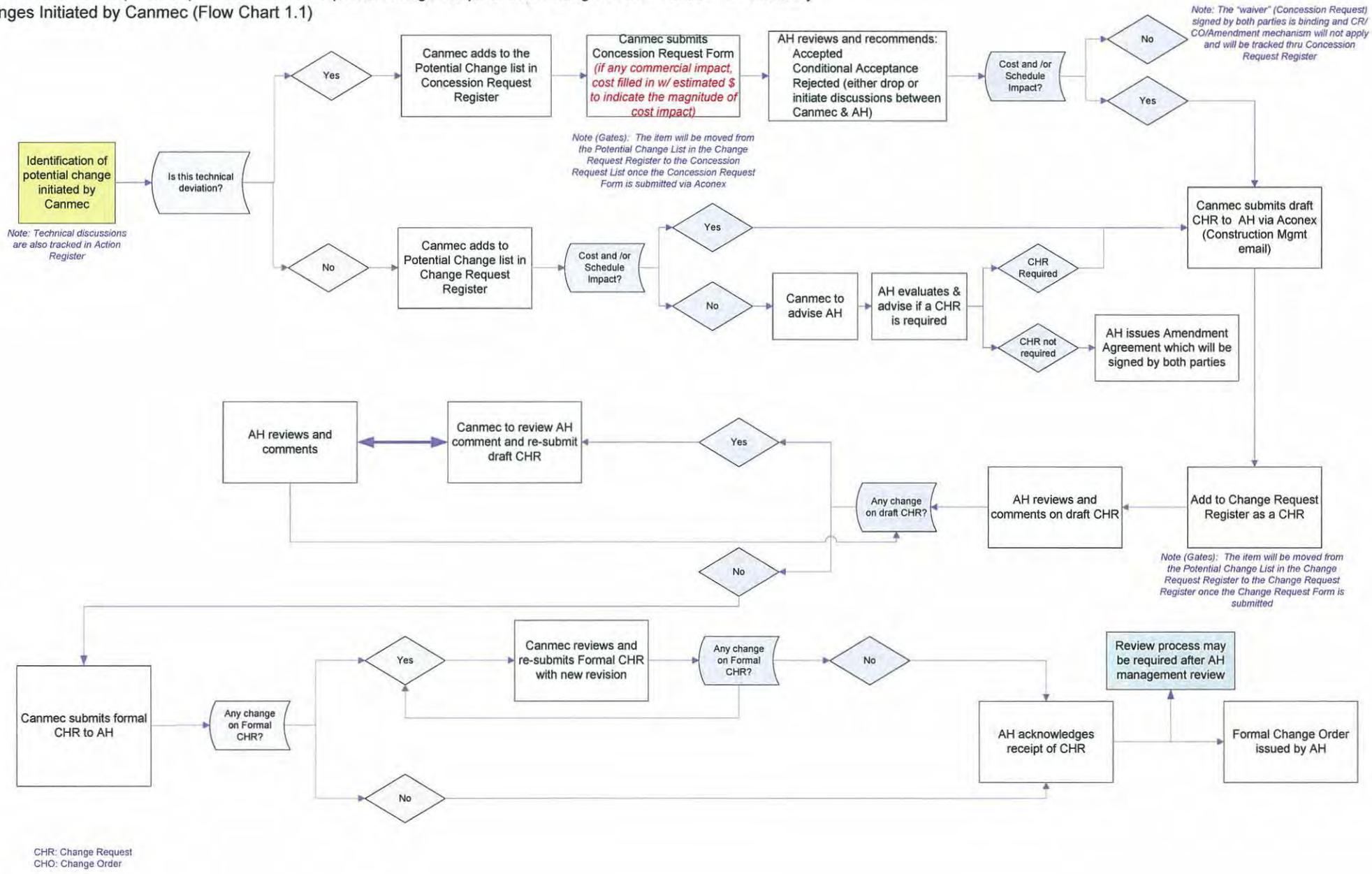


EXHIBIT 7

QUALITY REQUIREMENTS



1.0 Introduction

Without limiting the generality and application of the Agreement, Contractor will abide by and ensure Contractor Group abides with the quality requirements set forth in this Agreement.

2.0 Quality Objectives

The following quality objectives have been established for Contractor:

- a) Work will comply with the quality requirements of the Agreement;
- b) Quality management systems will ensure early and proactive identification of process or product failure so as to prevent problems before they occur or minimize rework, cost and schedule impacts, and to identify potential failures, opportunities for improvement and best practices;
- c) Equipment and materials procured and installed are consistent with Exhibit 1 – Scope of Work;
- d) Construction is carried out in accordance with established construction standards and methods;
- e) Completion activities are executed in accordance with the procedures and manuals covering those activities;
- f) Documentation of objective evidence of conformance to the requirements is maintained and recorded during the execution of the Work.

3.0 Definitions, Terms and Abbreviations

ISO 9001:2008	Quality Management Systems – Requirements
ITP	Inspection and Test Plan
NCR	Nonconformity Report
PMI	Positive Material Identification
QA/QC	Quality Assurance/Quality Control
QMS	Quality Management System
QP	Quality Plan
SDRL	Exhibit 4 - Supplier Document Requirements List

4.0 Contractor’s Responsibilities

- a) Contractor shall comply with and ensure that Contractor Group complies with requirements outlined in this Exhibit 7.
- b) The Contractor shall ensure that Contractor Group implement the quality activities described in this Exhibit.
- c) Contractor shall demonstrate the implementation of its quality program and the compliance of its Works with the requirements of the Agreement.
- d) In accordance with Article 16 of the Agreement, Contractor shall provide the right of access to Company Group Personnel, to the Work sites to monitor the progress of

the Work.

- e) Contractor shall provide acceptable office accommodation, including internet connections for the Engineer's inspectors and expeditors. The level of involvement of inspectors and expeditors shall be determined by Engineer.
- f) Contractor shall ensure that documents requiring a registered Professional Engineer's seal and signature shall be in accordance with the Engineers and Geoscientists Act and the by-laws of the Professional Engineers and Geoscientists – Newfoundland and Labrador (refer to www.pegnl.ca).

5.0 Quality Management System

Contractor shall have an effectively implemented and maintained QMS for the execution of the Work. The QMS shall, at a minimum, be formally documented and compliant with the requirements of ISO 9001:2008. The QMS shall emphasize building quality into the Work through the use of documented control processes that incorporate activities necessary to assure quality.

The QMS shall be supported by an established quality organization with qualified resources, and formally documented control procedures to effectively administer and implement the requirements.

Prior to subcontracting any Work, Contractor shall demonstrate to Engineer that the selected company has a quality management system that complies with the provisions of ISO 9001:2008. Contractor shall not Subcontract any part of the Work to a company that does not meet the standards established by the ISO 9001:2008.

6.0 Quality Organization

Contractor shall appoint a quality representative, empowered by management with freedom and authority to:

- a) oversee the management of quality for the Work;
- b) management of quality issues and their resolution; and
- c) ensure compliance with the Agreement.

Contractor shall provide details of the QA/QC organization it intends to employ at the Worksites. Contractor shall appoint sufficient qualified Personnel to ensure that the quality management system, specifically the quality control and inspection activities, including those pertaining to any part of the Work provided by Contractor Group, are achieved.

7.0 Quality Documents

The SDRL identifies specific quality documentation required from Contractor, as along with defining the required submission dates and form of submission. The SDRL and

instructions for Contractor document requirements are contained in document 505573-0000-37AG-I-0015, Supplier/Contractor Document Requirements located in Exhibit 11 – Company Supplied Documents. Contractor shall ensure that it meets all quality documentation requirements outlined in the Agreement.

8.0 Quality Plan

8.1 General Requirements

Contractor shall submit a QP, prepared in accordance with this Exhibit 7, to the Engineer for review and Acceptance. The QP shall include all aspects of the Work. All QP revisions are subject to review and Acceptance by Engineer prior to being implemented. Contractor shall:

- a) Develop and maintain a QP stating the procedures, processes, resources and sequence of quality activities related to the Work;
- b) Mandate one person to be responsible for development, approval and follow up of the QP;
- c) Ensure QP review and revisions by Contractor Personnel comprising representatives of all affected disciplines; and
- d) Upon request, provide Engineer with the procedures and instructions to which the QP refers.

8.2 Quality Plan Content

The Quality Plan shall:

- a) Accurately reflect the planning implemented by Contractor to comply with the Agreement;
- b) Apply the guidelines of ISO 10006:2003 - Quality Management Systems – Guidelines for Quality Management in Projects;
- c) Document any non-applicable requirement or any provision in the QP that does not comply with quality system requirements;
- d) Identify each of the main stages of execution for each of the deliverable elements of the Work.
- e) At a minimum, the QP shall contain the following:
 - Scope;
 - Quality objectives;
 - Definitions, terms and abbreviations;
 - Organization chart and quality related roles and responsibilities associated with all phases of the Work phases;
 - Management review of Subcontracts;
 - Documentation and records management;
 - Listing all control procedures required to perform the Work (current and to be developed)

- f) The QP shall provide detailed descriptions of:
- Responsibilities of Contractor's management related to QA/QC activities;
 - The systems and procedures Contractor will use to ensure that quality is an intrinsic part of all aspects of the Work;
 - Reviews, approvals required and checks and inspections to be conducted, including responsibilities and the timing of the required checks and inspections in the Work sequence;
 - How procurement documents will be prepared to properly establish quality requirements with Subcontractors. Contractor shall require that Contractor Group prepare a product specific or service specific quality plan for of the Subcontracted Work;
 - How companies, that Contractor proposes to Subcontract any part of the Work, will be evaluated and selected to ensure they have the requisite resources, tools, procedures, and quality capabilities to meet established requirements;
 - How ITPs will be prepared. Each ITP shall include a list of the specifications that must be met, describe the tests that will be performed to ensure compliance, and identify who will perform the tests. Each plan shall identify inspections and QA/QC steps that will be taken by Contractor Group;
 - How records will be maintained to demonstrate that all design, materials, equipment, and construction conforms to established requirements and how and in what form the records will be submitted to the Engineer;
 - How nonconformities, concessions and waivers shall be controlled and resolved including the process that will be used, the Personnel responsible for administering the process and the information flow through Contractor's organization for resolution;
 - How all instruments used for testing and inspection will be properly certified, including PMI devices, equipment for calibrating instrumentation, hydrostatic test gauges;
 - The auditing, appraising, sampling techniques, reviews and reporting Contractor intends to carry out for the Work to confirm the effectiveness of the QA/QC activities, and that the QMSs are indeed delivering the quality required;
 - How Contractor plans to meet requirements for PMI, source inspection and field quality control, including the frequency of testing, the locations where the testing will be conducted (e.g., Contractor Worksites, upon receipt at Worksites, following installation), and the type(s) of testing equipment to be used;
 - Control procedures that adequately address the controls required for quality activities;
 - Acceptance and rejection criteria applicable to the activity and approval requirements.

8.3 Quality Audits and Management Reviews

Contractor shall provide a schedule of quality audits (both internal and external) and

quality management system reviews to be performed during execution of the Work. The schedule of quality audits shall identify those planned audits of Contractor Group.

The schedule of audits shall be provided to Engineer on the later of four (4) weeks before start of Work execution or two (2) weeks after the Effective Date.

Contractor shall report progress, on a monthly basis, on implementing any actions that arise from the audits or management system reviews.

8.4 Surveillance of Sub-suppliers And Subcontractors

Contractor shall perform surveillance and inspection of Contractor Group as well as review and approve dossiers provided by the Contractor Group to ensure that the requirements of the Agreement have been met.

Contractor shall identify planned verification activities used to assess and manage Contractor Group to ensure compliance with requirements.

The verification activities shall be documented in the QP and reported monthly together with the progress on audits and management reviews.

9.0 Inspection and Test Plans

9.1 General Requirements

Contractor shall develop and submit its inspection and test plan (ITP), which shall include those of its Subcontractors, for review and Acceptance by the Engineer on the later of four (4) weeks before start of Work execution or two (2) weeks after the Effective Date.

The ITPs shall cover all aspects of the Work to be executed by Contractor Group and shall implement and maintain all quality activities described therein.

Contractor will notify Engineer of all hold and witness points ten (10) Business Days prior to the scheduled date of such activity. Contractor will reconfirm the scheduled date of such activity seventy-two (72) hours prior to commencement. The Contractor shall identify upcoming hold and witness points for the next six (6) months in the Monthly Progress Report.

9.2 Inspection and Test Plan Content

Contractor is required to follow the instructions below in preparing the ITPs, and is asked to note that the Engineer review will be based on these instructions.

a) Identification

- Code the ITP, identify the revision and date;
 - Identify the Company, project and sector;
 - Identify the Agreement, as well as the component, discipline or system to which the ITP applies; and
 - Identify the Personnel responsible for quality, at all Worksites.
- b) Work Items and Steps
- These are normally copied from the elements of the Contractor' Group's detailed Work schedule. Complimentary or specific details may be required; and
 - Contractor shall ensure ITPs, as far as practical, follow the normal sequencing of the Work. ITPs shall identify the stages requiring approval, inspection and testing hold and witness points;
- c) Control Activities
- The control points, including their summary description (inspection, verification, tests) shall be inserted in the detailed Work schedule.
- d) Responsibilities
- Identify Contractor Personnel responsible for control activities.
- e) Frequency
- Specify the percentage, frequency or sampling rate applicable to the control points.
- f) Reference to Specifications
- Control activities shall refer to applicable drawings, specification sections and/or specifications/codes;
 - Identify parameters and characteristics that will be mainly considered in the controls;
 - For each control, identify and note down the criteria and/or tolerances for approval.
- g) Procedures Used
- Identify the procedures or instructions developed by Contractor or Subcontractors to perform control and testing.
- h) Control Equipment
- Describe and identify the equipment to be used for quality control. Users shall provide evidence of the calibration status.
- i) Checklists
- The information identified above can be recorded in a checklist prepared by Contractor. The checklists shall be appended.
- j) Forms
- Identify the forms to be used to record the control point results and append them to the ITP. The recorded results will constitute an inspection or testing report.
- k) Engineer's Control Points
- The type of control points, namely: witness, hold or documentation review will be identified during ITP review by the Engineer.
- l) Quality Records



- Identify the types of records to be included in the quality records, to be submitted to the Engineer, and include the applicable standard table of contents.

m) Remarks

- Include all other relevant information that may be useful in carrying out the ITP.

9.3 Final Inspection and Declaration Of Completion

Appendix A - Declaration of Installation and Inspection Completion (Declaration) of this Exhibit 7 will be completed by Contractor upon completion of aspects of the Work. Contractor shall confirm that these aspects of Work are complete, comply with the requirements outlined in the Agreement, that all related quality records have been submitted to Engineer and confirm that Engineer carry out its final inspection on that aspect of Work.

Upon receipt of a Declaration, Engineer will conduct a final inspection of the aspect of Work described therein and, if necessary, issue a deficiency list if it is determined that the aspect of Work is not complete or includes elements that do not comply with the requirements of the Agreement.

When Contractor has corrected all deficiencies and the quality records are accepted by Engineer, the Declaration will be accepted by Engineer and an Accepted copy will be return to Contractor.

10.0 Nonconformity Reporting

Contractor shall submit, to Engineer for review and Acceptance, its nonconformity, corrective action, preventive action procedure(s) and resolution reporting form.

Contractor will ensure that all nonconformities, which shall take on the definition of noncompliance with a requirement of ISO 9000:2005 Quality Management Systems – Fundamentals and Vocabulary, are recorded, investigated and resolved to Engineer's satisfaction.

All Contractor Group Personnel shall have a responsibility to identify apparent nonconformities arising from the execution of the Work.

Contractor shall maintain a register of all applicable and open nonconformity reports. The status of all NCRs shall be reported in the Monthly Progress Report.

Contractor's NCR form may be used but, at a minimum, it shall contain the following:

- a) Project number;
- b) NCR number;
- c) Supplier;



- d) Project name/location;
- e) Purchase order/contract number;
- f) Product description (including part #, serial # and tag #);
- g) Date opened;
- h) Date closed;
- i) NCR description;
- j) Action by;
- k) Status;
- l) Root cause analysis;
- m) Resolution proposed; and
- n) Resolution Implemented.

Contractor shall identify Personnel responsible for verifying and resolving NCRs.

11.0 Quality Records

Contractor's quality records shall include, as a minimum, the following documents:

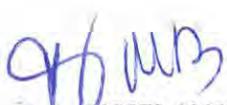
- a) Inspector qualifications (quality control);
- b) Welder's qualifications ;
- c) Checklists;
- d) Relevant inspection and testing reports;
- e) Materials analysis certificates, when required;
- f) Steel works certificates;
- g) Paint specification sheet, when required;
- h) Identification and traceability documentation;
- i) Authorized deviations;
- j) Closed out nonconformity reports, corrective and preventive actions;
- k) Completed test packages;
- l) Preservation records;
- m) Declarations to Authorities, when required;
- n) As-built drawings;
- o) As-built specifications;
- p) As-built bills of material;
- q) Various required manuals;
- r) All Accepted Declaration of Installation and Inspection Completion forms (Appendix A); and,
- s) Shipping authorization.

Quality records shall be retained for the later of five (5) years after commissioning or five (5) years after the expiration of the Warranty. During this period, the quality records shall be available to Engineer and Company.

12.0 Engineer's Activities

Engineer shall, at its sole discretion, perform certain QA/QC activities, the performance of which shall not relieve Contractor of its responsibilities under this Agreement or its overall responsibility for quality of the Work performed by Contractor Group. These QA/QC activities may include:

- a) Audit of Contractor's QA/QC program and include any or all of the following:
 - Review of Contractor's documented QA/QC plans and procedures;
 - Random review of Contractor's procurement documents for inspection and specification content;
 - Review of Contractor's specific equipment inspection and test plans in relation to specification requirements;
 - Review of inspector's surveillance and nonconformance reports, Contractor's deviation log, procedure approval logs;
 - Receipt of inspection discrepancy reports and field inspection reports;
 - Review of activities undertaken by Contractor Group.
- b) Independent source inspections. Results of Engineer source inspections will be made available to Contractor and Contractor shall address and resolve any issues arising from these inspections;
- c) Review and assessment of Contractor Group quality plans and ITPs;
- d) Review and assessment of Contractor's control procedures and audit schedule, monitor compliance and monitor resolution of any issues raised;
- e) Participation in selected pre-inspection and pre-production meetings;
- f) Conducting oversight of Contractor's quality activities including Contractor Group inspection activities, field inspection and surveillance activities, along with participation in inspection and test stages outlined in Accepted ITPs;
- g) Review and acceptance of NCRs where proposed dispositions do not result in meeting specifications;
- h) Other activities as deemed appropriate by Engineer.



APPENDIX A

DECLARATION OF INSTALLATION AND INSPECTION COMPLETION



	DECLARATION OF INSTALLATION AND INSPECTION COMPLETION	
Declaration No.: _____		Date: _____
Prepared by Contractor: _____		
Contract No.: _____ Contract Title: _____		
WORK DESCRIPTION: _____ _____ _____		
UNRESOLVED DEFICIENCIES: _____ _____		
<p>This document certifies that the works described above have been completed, inspected and tested in accordance with Contract requirements, and that all quality records have been finalized and sent to the Engineer.</p> <p>Notes:</p>		
Contractor: Signature: _____ Date: _____	Engineer: Signature: _____ Date: _____	



EXHIBIT 9

INTERFACE AND MILESTONE SCHEDULE



Contractor shall comply with the requirements outlined in Part 2, Exhibit 9 - Work and Milestone Schedule. Contractor's schedule shall clearly indicate bidder's work plans and methods, as well as interfaces with other parties. Contractors Control Schedule Baseline Document shall align with this Exhibit 9.

The schedule shall be provided in portable document format (PDF) and native electronic format. Unless otherwise approved by Company, the native file shall be generated from the Primavera planning software.



Interface and Milestone Schedule			
Milestone No.	Interface No.		Date
General			
M1		Contract Award	10 July 2014
M2		Substantial Completion of the Work	1 May 2018
Spillway			
	I1A	Upstream of Spillway ready for start of Hydromechanical Works	16 Feb 2015
	I1B	Downstream of Spillway ready for start of Hydromechanical Works	1 Aug 2015
M4		Spillway all hydro-mechanical commissioned and ready for river diversion	1 Feb 2016
M5		Bay No. 1 Installation of Upstream and Downstream Stoplogs Complete	20 Sep 2016
M6		Bay No. 1 Rollway Ready for Installation of Sill Beams and Modification of the Gates	14 Mar 2017
M7		Bay No. 1 Stoplogs Removed and Ready for Operation	11 Apr 2017
M8		Bay No. 2 & 4 Installation of Upstream and Downstream Stoplogs Complete	21 Oct 2017
M9		Bay No. 2 & 4 Rollway Ready for Installation of Sill Beams and Modification of the Gates	18 Mar 2018
M10		Bay No. 2 & 4 Stoplogs Removed and Ready for Operation	15 Apr 2018
M11		Bay No. 3 & 5 Installation of Upstream and Downstream Stoplogs Complete	16 May 2017
M12		Bay No. 3 & 5 Rollway Ready for Installation of Sill Beams and Modification of the Gates	20 Sep 2017
M13		Bay No. 3 & 5 Stoplogs Removed and Ready for Operation	16 Oct 2017
Powerhouse			
	I7	Service Bay Draft Tube Gallery Ready for start of Hydromechanical Installation	1 Aug 2015
	I8	Unit 1 – Draft Tube Structure Ready for start of Hydromechanical Installation	1 Oct 2015
	I9	Unit 2 – Draft Tube Structure Ready for start of Hydromechanical Installation	12 Nov 2015

Interface and Milestone Schedule			
<u>Milestone No.</u>	<u>Interface No.</u>		<u>Date</u>
	I10	Unit 3 - Draft Tube Ready for start of installation of Hydromechanical Installation	21 Jan 2016
	I11	Unit 4 – Draft Tube Ready for start of installation of Hydromechanical Installation	3 Mar 2016
M22		All Draft Tube hydro-mechanical work complete, stoplogs installed in units 1 & 2, Bulkheads installed in units 3 & 4, and ready for water up of tailrace channel	25 June 2016



<u>Milestone No.</u>	<u>Interface No.</u>		Date
Intake			
	I12	Unit 1 – Intake Structure Ready for start of Hydromechanical Intallation	1 Apr 2016
	I13	Unit 2 – Intake Structure Ready for start of Hydromechanical Installation	30 Jun 2016
	I14	Unit 3 – Intake Structure Ready for start of Hydromechanical Installation	28 Sep 2016
	I15	Unit 4 – Intake Structure Ready for start of Hydromechanical Installation	3 Jan 2017
M23		All Intake hydro-mechanical work (including trash cleaner) commissioned and ready for reservoir impoundment	8 Jul 2017

Interface I1A, 16 Feb 2015**Spillway and Related Works required for upstream guides installation and concreting, including:**

- Completion of Spillway Invert;
- Completion of Spillway piers and walls (upstream 2/3 portion only), including upstream bridge;
- Spillway Upstream Channel free for Hydro-Mechanical Contractor CH0032 occupation.

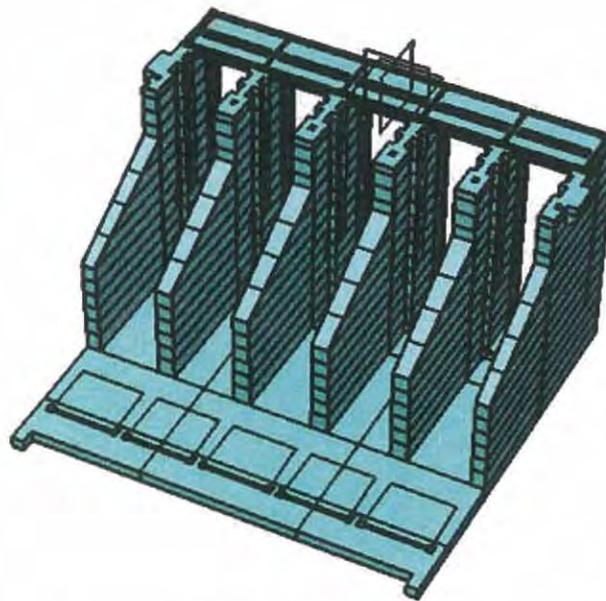


Figure 1 Spillway – Upstream Construction

Handwritten signature

Interface I1B, 1 Aug 2015

Spillway and related works required for downstream stoplog guides, gates and hoists installation, including:

- Completion of Spillway piers and walls (downstream 1/3) including both Downstream Bridges and Access Ramp Retaining Wall;
- Completion of North Transition Dam;
- Completion of Northern 2 Monoliths of Center Transition Dam including the Electrical Building Platform;
- Completion of Spillway concrete Discharge Channel Phase 1;
- Completion of Separation Wall;
- Spillway Discharge Channel free for CH0032 occupation.

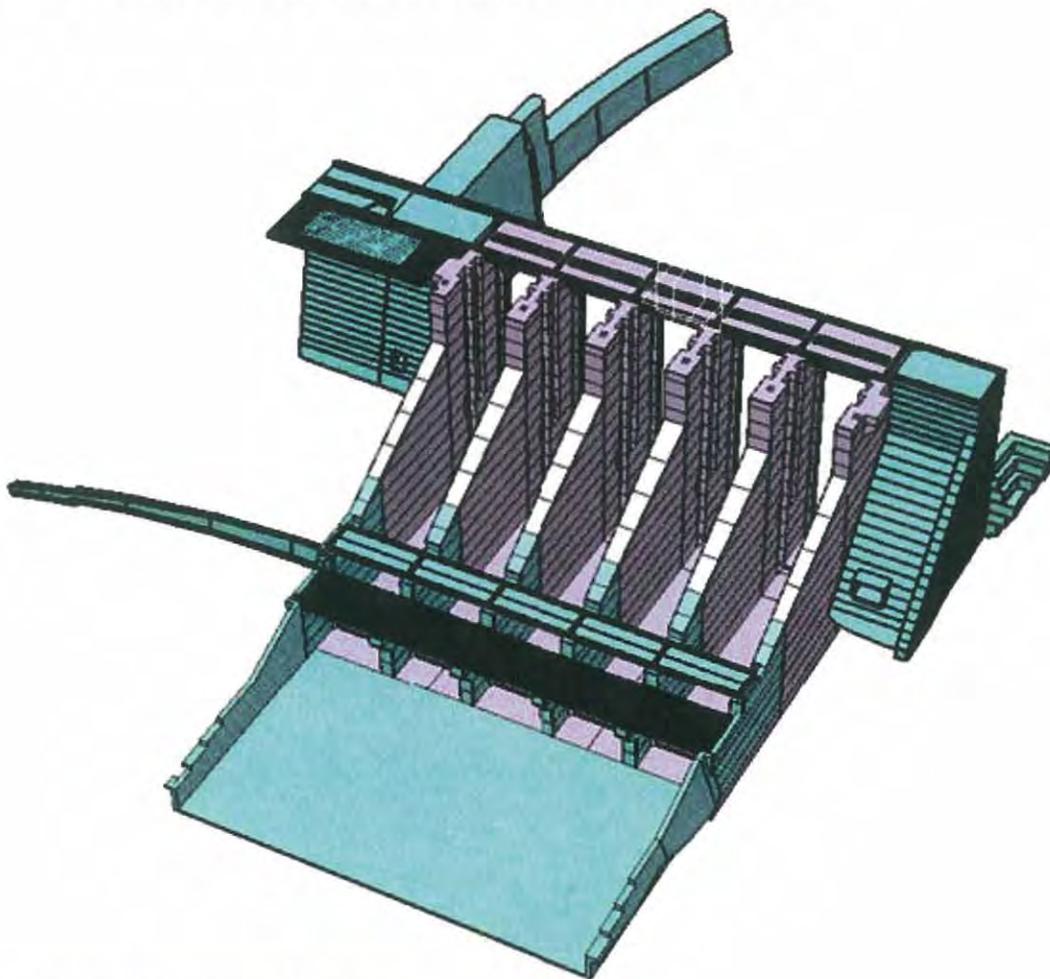
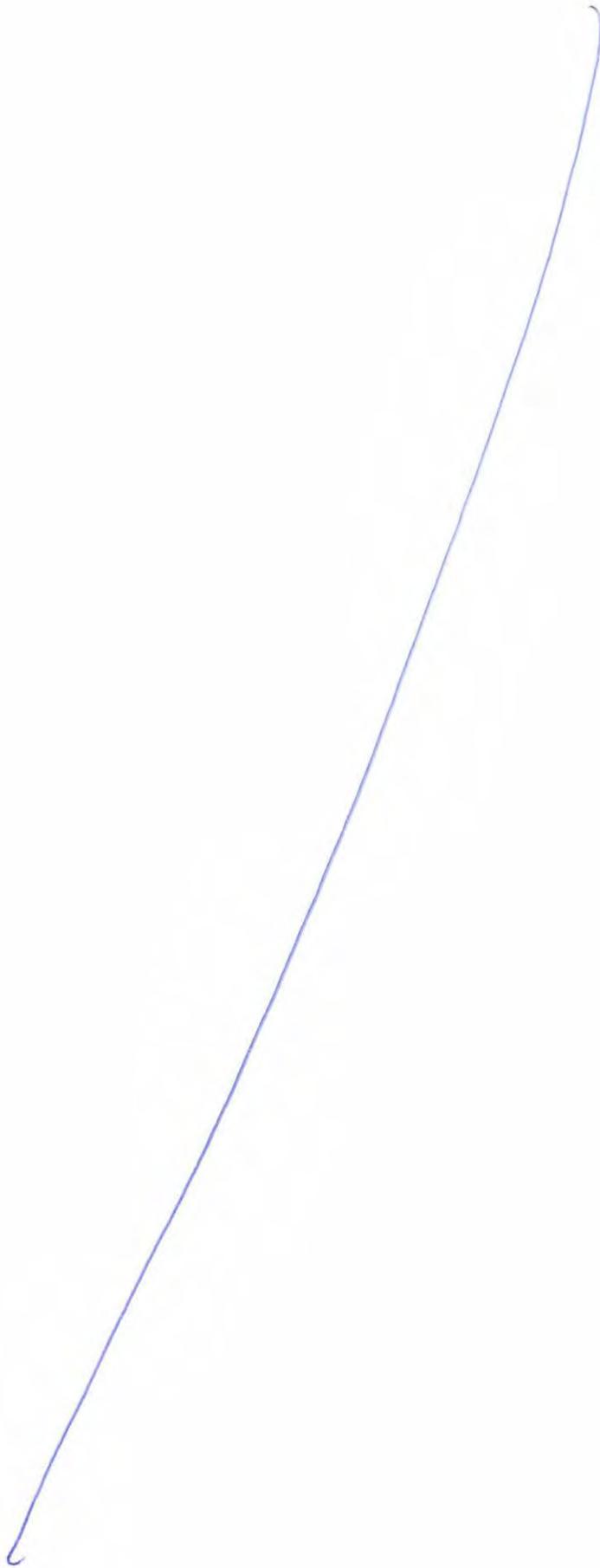
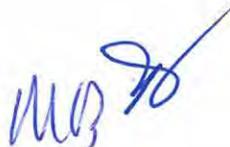


Figure 2 Spillway – Downstream Construction



HAB

**EXHIBIT 12
SITE CONDITIONS**

A handwritten signature in blue ink, appearing to be 'MB' followed by a stylized flourish.

1 CONTRACTOR'S WORK AREA**1.1 Site Location**

The Site location is indicated on the drawings provided in Exhibit 1 and more specifically on the following drawings:

Nalcor Document No.	Title
SNC-Lavalin Document No.	
MFA-SN-CD-0000-CV-PL-0004-01	Muskrat Falls - Lower Churchill River –Plan and profile
505573-300A-41DD-0003-	
MFA-SN-CD-3000-GT-GA-0001-01	Muskrat Falls - Intake and Powerhouse, Spillway and Transition Dams - General Layout Plan
505573-3331-41DD-0100	
MFA-SN-CD-2000-CV-GA-0001-01	Muskrat Falls - Access Roads, Accommodations and Laydown Areas
505573-300A-41DD-0012	

1.2 Area for Contractor Site Administration Office

The Owner will provide the Contractor with an area adjacent to the Administration Complex, for the installation of the Contractor's main Site administration office. Utilities, such as potable water, sewage and electrical services will be made available for this office. It is the Contractor's responsibility to hook up these services except for electrical power hook-up which will be performed by the Owner. Notwithstanding the above, Company will provide to Contractor free of charge 6 offices at Company's Site office complex.

1.3 Contractor Laydown Area

The Owner will provide a laydown area to the Contractor in the Owner's Laydown Area, with an area of approximately five thousand square meters (5,000 m²), to install its temporary facilities and storage. The Owner's Laydown Area is shown on the Drawings in Exhibit 1, Attachment 2. The precise locations available for the Contractor's use will be subject to the Company's approval.

1.4 Work Area

The Contractor will be permitted to install its trailers, containers and other temporary buildings for its own use in close proximity of its work areas. The precise locations will be subject to the Owner's approval.

1.5 Work Areas Free of Obstruction and Maintained

1.6.1 During the execution of the Work, the Contractor shall keep the Site reasonably free from all unnecessary obstruction and shall store or dispose of any Contractor's equipment and surplus materials and clear away and remove from the Site any wreckage, rubbish or temporary works no longer required.

Unless otherwise provided elsewhere in the Agreement, the Contractor shall, throughout the construction period, maintain its work area, laydown areas and passage ways in order to permit the safe movement of pedestrians and vehicles at all times.

1.6.2 The Owner will maintain all main access roads, including occasional grading of roads, snow removal and sanding of permanent access roads. The limits of the main permanent access road are provided for on the drawings. The Company accepts no responsibility with regards to the quality of the services.

1.6.3 All maintenance and snow removal within the Contractor's work area and in the immediate vicinity of its temporary facilities and storage areas in the Owner's Laydown Area shall be the Contractor's responsibility. The Contractor will obtain materials for sanding from designated sand and gravel deposits located within the Site Area as directed by the Owner.

1.6 Signage

The Contractor shall be responsible to install on its temporary roads all the traffic signs to inform road users, ensure their safety and facilitate traffic. The signage shall comply with the requirements of the Technical Specification, Section 01 55 00 "Roads and Contractor's Laydown Area".

Only standard safety bulletin boards and safety signs used to identify the Owner, Company, designated representatives and the Contractor, shall be allowed on the Site, with prior approval of the Owner.

1.7 Construction Services

The Contractor shall operate and maintain construction services on the basis of seven (7) days a week, 24 hours a day for the duration of his contract. At the end of the Agreement, all the facilities of construction services shall be dismantled by the Contractor and remain its property, unless otherwise indicated. The Company and the Owner have, at any time, the right to inspect the provisional facilities of the Contractor and require changes as he deems necessary, at the expense of the Contractor. The Contractor shall submit to the Company, for acceptance, drawings and specifications of any construction services or installations that it intends to install in its working areas twenty (20) working days before the commencement of their installation, or as agreed upon with the Company.

1.8 Clearance of Site on Completion

Upon Substantial Completion of the Work, the Contractor shall clear away and remove from that part all Contractor's Equipment, surplus material, rubbish and temporary Works



of every kind, and leave such part of the Site and Works clean and in a workmanlike condition to the satisfaction of the Owner and the Company.

2 SERVICES PROVIDED TO AND BY THE CONTRACTOR, OWNER AND/OR COMPANY

2.1 Electrical Power Supply

2.1.1 Services Provided by the Owner

Owner will provide electrical power to the Worksite. The Contractor will be provided free of cost with electrical power supply at the following sites for the execution of its work:

1. One in close proximity of the Owner's Laydown Area (three-phase 600 V supply);
2. One at the Powerhouse area (three-phase 600 V supply);
3. One at the Spillway (three-phase 600 V supply);

The Contractor's total electrical load shall not exceed 500 kW.

The Contractor shall limit voltage dip on starting motors to 20% at the supply point based on Owner supplied transformers listed above with standard impedance.

The Contractor shall provide, install, maintain and remove upon completion of the Work at Contractor's cost all necessary equipment for Contractor's temporary electrical power requirements in the Work from the three (3) power supply points indicated above.

The Contractor shall show at any time to the Owner that it shall not exceed a power load factor of zero point nine (0.9), either by measurement or by the installation of adequate protective devices. The Contractor shall make all necessary arrangements with the Owner for its connections to those 3 power points. The work associated with the initial connection and final disconnection will be made by the Owner at the expense of the Owner. The Contractor shall supply to the Owner the following information prior to connection to the main power system:

1. Single line diagrams
2. Protection systems on equipment and lines (relays, fuses, etc. with calculations and calibrations)
3. Cabling sizes and calculations

The Owner will make every effort to maintain an uninterrupted supply of electric power, but Owner cannot guarantee that there will be no interruption during the duration of the Work. Company and Owner will not be responsible for any cost to Contractor for such interruptions, variations in voltage or frequency or damage arising thereof. The Contractor shall take the necessary measures to meet its needs in case of emergency.

2.1.2 Services Provided by the Contractor

The Contractor shall be responsible to provide its own power supply over and above the quantity supplied by the Owner, as necessary to execute its work and to provide power to its facilities, such as offices, workshops, etc. and sub-contractors' (if any) needs. The Contractor shall include the costs thereof in its lump sum prices.

2.2 Lighting

The Contractor shall be responsible to provide all lighting required for its work areas.

When work is done at night or when the day light is down, the contractor shall provide a minimum of 300 Lux, and the Contractor shall ensure sufficient lighting for the execution of the Work in satisfactory, efficient and secure conditions or as specified from time to time in Exhibit 1. All ducts and power lines for lighting and other electrical services shall be installed and maintained in a safe manner, fixed securely and placed as far as possible from transmission cables.

2.3 Potable Water

Potable water will be supplied by the Owner to the Contractor at a central location inside the Accommodation Complex. The Contractor shall be responsible to pick-up the water at this point and provide all necessary equipment to distribute to the different places at the Work site. The Contractor shall be responsible to meet all standards as per the Project's Health and Safety Plan.

2.4 Industrial Water

The Contractor shall be responsible to provide its own supply of industrial water, either by pumping from rivers or streams or by wells.

2.5 Heating and Ventilation

The Contractor shall be responsible for the heating and ventilation of its facilities and for any other heating required for the execution of its work. The thermal environment and ventilation of its facilities shall be in accordance with Occupation Health and Safety Regulations.

2.6 Dewatering and Sediment Control

The civil contractor (CH0007) maintains its own pumping and dewatering systems in its work areas. This includes the construction, operation and maintenance of sedimentation ponds.

The Contractor shall manage, in its work areas, the rain and snow melting water, and any water the Contractor might generate by its Work, but only during installation of the sill plates and modifications of the spillway rollways for the block outs. The Contractor shall pump such water out of its work areas towards wells (not to Owner's civil contractor's sediment ponds) provided by Owner (or Owner's other contractors) located in proximity to each of Contractor's work areas. The Contractor shall not perform any sediment control. For the purpose of this section, a Contractor work area is where the Contractor is actually performing the type of work described above. At any other time, the Contractor shall have no responsibility to manage any water. Furthermore, the Contractor shall have no responsibility to control any other source of water, including leakage of the cofferdams installed by Owner (or Owner's other contractors). Owner or Owner's other contractor shall turn over each of Contractor's work areas in a sufficiently dry condition to

allow uninhibited access to Contractor for the installation of temporary facilities and execution of the Work according to Contractor's procedures.

2.7 Sanitary Facilities

The Owner will provide wash cars in sufficient quantities. The Contractor shall locate such facility at the most convenient place(s) in Contractor's Site and relocate them from time to time as the need arises. The Owner will provide all waste collection, all stipulated sanitary cleaning required and all associated consumables and water supply.

2.8 Cleaning of Lunch Rooms and Offices

The Contractor shall be responsible for all the cleaning of its offices, lunchrooms, workshops and all other workplaces under its responsibility on a regular basis. Lunchroom, however, shall be cleaned after each meal or break. Such services may be subcontracted by the Contractor, at his own expenses, to the on-site Owner's catering contractor, subject to the Owner's approval.

2.9 Waste Management

Reference is made to the Waste Management Plan Doc No: LCP-SN-CD-0000-EV-PL-0005-01 for a detailed description.

The Contractor shall investigate the availability of local solid and liquid waste collection and disposal services. The Contractor shall ensure their waste management program has integrated the availability of these services.

The Owner will provide domestic trash containers to be placed at the Owner's Laydown Area on the Site. The Owner is responsible for the supply, installation and periodic replacement as required.

The Contractor shall be responsible for collecting all recoverable waste refuse and packing material the Contractor generates, and for disposing it within the appropriate containers (clearly identified as to its restricted content) provided by the Contractor. If the Contractor fails to take the necessary measures to comply with and/or fulfill this obligation, the Company or the Owner will notify the Contractor in writing to take immediate corrective action. If the Contractor does not comply after notification by the Company or the Owner, the Company or the Owner will have these task completed and back-charge the costs to the Contractor.

The Contractor shall be responsible for:

Disposal of materials from the Hazardous Waste Storage Area (HWSA) to approved facilities;

Diversion of Recyclable metals from landfill disposal, collection and pickup by metals recycler and;

Collection, storage, and subsequent disposal at approved facilities of Construction waste and demolition debris.

Solid and liquid waste management is an important component of the Contractors performance. Solid and liquid waste management is a challenge in Labrador as a result of the climate, and limited management and disposal options. The Contractor must plan their solid and liquid waste management programs carefully. Provided below is a partial list of potential waste management resources. It is the Contractor's responsibility to ensure its solid and liquid waste management programs are complete.

- Potential Waste Management Resources Town of Happy Valley – Goose Bay , Municipal Landfill (4 km from town on Northwest River Road : 709 896-3321
- Pardy's Waste Management - 84A Glencoe Drive, Mount Pearl NL: 709-782-2003
- Hickey's Construction – 5 Broomfield Ave. Happy Valley Goose Bay: 709-896-3250
- J.J.' s Trucking – 16 Hillcrest Road Happy Valley Goose Bay: 709-896-5552
- Roger's Group -15 Churchill Dr. Happy Valley Goose Bay: 709-896-5041
- Woodward's – 16 Loring Dr. Happy Valley Goose Bay: 709-896-2421
- Recyclex Inc. (Hazardous Waste) – Montreal QC: 514-355-4148

2.10 Operation and Maintenance of Temporary Construction Services

The Contractor shall operate and maintain temporary construction services (such as, but not limited to, dewatering, electrical power , etc.) on the basis of seven (7) days a week, 24 hours a day for the duration of his contract. At the end of the contract, all the facilities of construction services shall be dismantled by the Contractor and remain its property, unless otherwise indicated. The Company and the Owner have, at any time, the right to inspect the provisional facilities of the Contractor and require changes, for safety or environmental reasons as he deems necessary, at the expense of the Contractor. The Contractor shall submit to the Company and the Owner, for acceptance, drawings and specifications of any construction services or installations that it intends to install in its working areas twenty (20) working days before the commencement of their installation, or as agreed upon with the Company and the Owner.

3 FUEL AND FUEL MANAGEMENT

3.1 Fuel Supply

A fuel station for vehicles will be located at the Owner's Laydown Area. Diesel fuel and gasoline will be available. Contractor will be charged the actual market rates at the time of the purchase.

The Contractor shall on a monthly basis and at the 1st of every month, submit to the Company and the Owner its estimated fuel needs for the next 3 months, in order to ensure adequate supply.

The Contractor shall make arrangements with the onsite fuel supplier for its terms of payment for fuel purchased at the Site.

During the execution of the Work, the Contractor shall be responsible for its own fuel needs. The Company and the Owner assume no liability and the Contractor is responsible for all cost associated with its fuel requirements.

3.2 Fuel Management

The Contractor shall submit a monthly fuel delivery report on all fuel consumed during the month. Refer to Exhibit 6, Appendix C for the report format. The report shall be submitted to the Company no later than 7 days following the end of the month.

4 TELECOMMUNICATIONS

Owner will provide Contractor with access to the Owner's telecommunication systems and services at the Muskrat Falls construction site for business requirements. Telecommunication systems and services include, but not limited to, the following:

- Land Mobile Radio System (LMRS): Owner will deploy a single LMRS for use by Owner, Company and all Contractors and Subcontractors at the Muskrat Falls construction site. The Owner will grant access to the Contractor and Subcontractors to the infrastructure of the radio communications system. It will be the responsibility of the Contractor and its Subcontractors to acquire at its own cost the mobile and portable equipment and accessories (portable radios portable mobile radios, antennas, chargers, etc). The mobile and portable radios will be available from the same Telecommunications Services Provider (TSP) appointed by the Owner for the LMRS.
- Telephone Services: Owner will deploy a single wire based Telephone System at the Muskrat Falls construction site. The Contractor shall advise Owner of the required number of offices it will utilize at site and Owner will provide one telephone for every Contractor Office. Contractor shall provide Owner with a Contractor office forecast on a monthly basis for the duration of the Contractors contract.
- Cellular and Mobile Internet Services: The Owner is not deploying a cellular and mobile internet solution. However, the local telecommunication company has some cellular coverage at the Muskrat Falls construction site.
- Internet Services: Owner will provide Contractor with a single wired Internet connection at the Contractor's designated office area. It is the Contractors responsibility to distribute this Internet connection to individual Contractor's offices and devices. The Contractor is also responsible for Operation, Administration, Maintenance and Provisioning of its internal Local Area Network

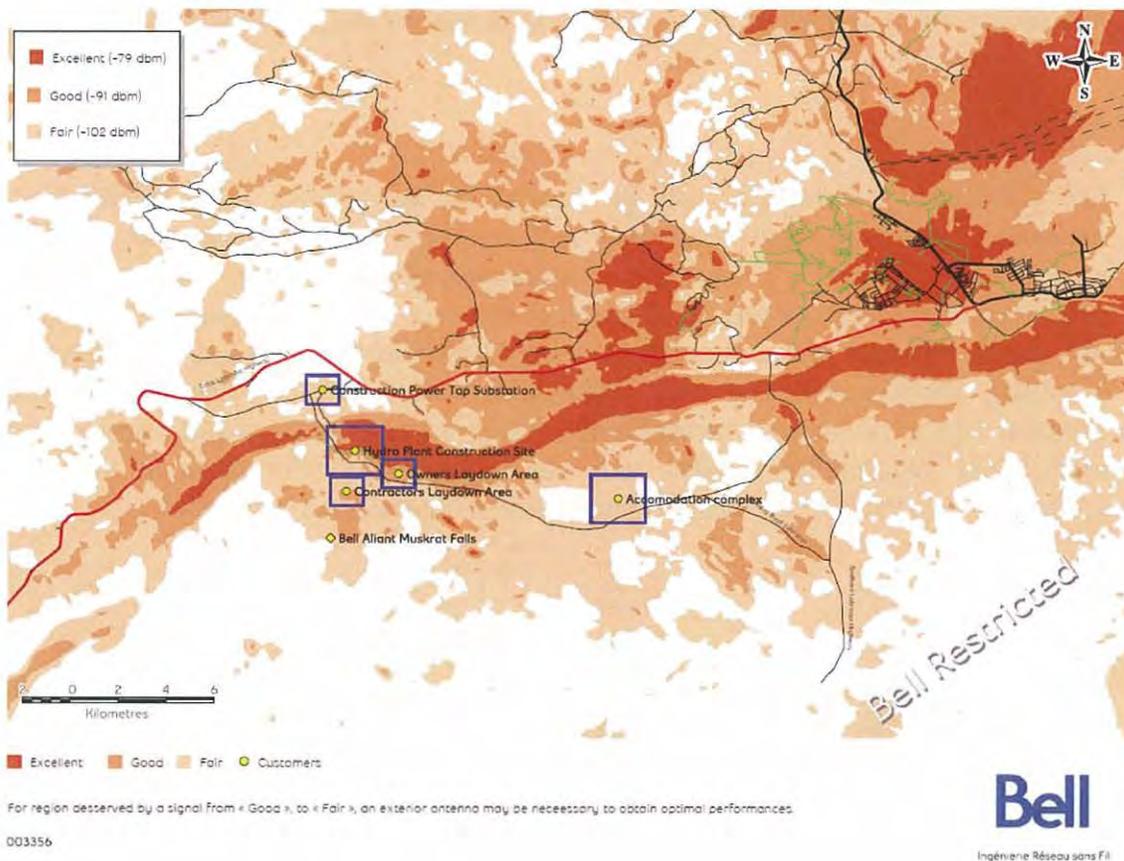


and end user devices, such as computers and printers, in its designated office area.

Owner will provide Contractor staff with Quality of Life telecommunication systems and services during non-work hours. Recreational systems and services will include, but not limited to, the following:

- **Television Services:** A television will be provided in each dormitory room and designated public areas of the accommodations complex.
- **Telephone Services:** A wired telephone will be provided in each dormitory room and designated public areas of the accommodations complex.
- **Internet Services:** A physical internet connection will be provided in each dormitory room, and wireless internet will be provided in the dormitory modules and designated public areas of the accommodations complex.

HSPA Coverage Map - MF Area



5 ACCOMODATION COMPLEX

5.1 Accommodations

5.1.1 General

The Owner will provide an Accommodation Complex, located approximately 10 km from the Muskrat Fall Site. At the Accommodation Complex the Owner will provide room and board free of charge for the mandatory use by the Contractor's staff and its Personnel, as authorized by the Owner. The number of employees eligible for lodging services is limited to the resources indicated in the Construction Schedule submitted by the Contractor in its Proposal. The Contractor shall submit to the Owner at least thirty (30) days in advance, all reasons for any forecasted increases in manpower. The Owner does not undertake to accept such requests, however, the Owner may, at its sole discretion and subject to availability, approve these forecasted increases in manpower.

The Contractor's Personnel will be mobilized at the Muskrat Site in compliance with Owner Policy.

Employees are to be provided with identification card with photograph issued by the Owner on their first day on site. This will then permit camp registry and room assignment, free access to the camp cafeteria and main gate ingress and egress when required.

5.1.2 Rooms

The Contractor's Personnel will be housed in dormitories with rooms for single occupancy, including toilet, washbasin and a double occupancy (shared) shower. Each dormitory is supplied with heating and indoor and outdoor lighting and is equipped with washers and dryers placed at the disposal of its occupants. The occupants may, however, not use the washer and dryers for cleaning work clothes. Contractor is responsible for providing washers and dryers for cleaning work clothes of its Personnel. The Owner provides free cable services, local phone services, internet services and a television set for each room. No private satellite antenna is permitted. The costs of long distance telephone calls shall be the responsibility of each Contractor's Personnel.

5.1.3 Board

Two (2) hot meals are served every day in the cafeteria (breakfast and supper). The cold meal for the middle of the work shift is available to the Contractor's Personnel during the previous meal at the cafeteria.

5.2 Emergency Services

The Owner will provide a third party medical service provider, fully-equipped first aid room and emergency vehicles for contractors' access, free of charge.

The Owner will provide an emergency vehicle on the Site. The emergency vehicle will be operated and maintained by the Owner.

5.3 Security Services

The Owner will maintain a security service for the protection of all facilities and property. Regular security patrols will take place within the camp boundaries to protect its facilities, equipment and residents.

The Company and the Owner take no responsibility for any loss or damage of any kind incurred by Contractor's Personnel.

5.4 Fire Protection

The Owner will provide overall fire-fighting capacity for the Worksite, while Contractor shall be responsible for fire prevention and fire watch activities for the Work.

5.5 Recreation

Recreation facilities will be made available to the Contractor's Personnel.

5.6 Banking Services

An ATM banking machine will be made available to the Contractor's Personnel.

5.7 Convenience Store

The Contractor's Personnel will have access to a small convenience store offering variety items deemed appropriate for construction site. The Contractor's Personnel are responsible for the cost of all purchases.

5.8 Drugs and Alcohol

The Site shall be drug and alcohol free, in accordance with the requirements of LCP-PT-MD-0000-LR-SD-0001-01, Standard for Drug and Alcohol.

Every employee of the Contractor shall be drug and alcohol free while at work.

In addition, employees and Contractor shall not be permitted to possess or sell prohibited drugs or alcohol or, be in possession of any item or piece of equipment for the use of or administration of a prohibited drug at the Site.

The objective of the requirements contained in this Policy is to improve the safety of staff, Contractors and customers through reducing the risk created by the use of drugs and alcohol in the workplace.

6 PROHIBITION OF COMMERCIAL TRADE

Commercial activities are prohibited on the Site.

7 RESPONSIBILITY OF THE CONTRACTOR

The Contractor is responsible for any and all replacement costs of items assigned to the Contractor's Personnel during their assignment at the Site.

8 TRANSPORT



8.1 Private Vehicles

Private vehicles are not allowed on the Site or Accommodation complex.

8.2 Access to Site

The Site is accessible as follows:

8.2.1 By Road

The Site is located approximately thirty (38) km from the town of Happy Valley-Goose Bay (HV-GB). The route follows the Trans Labrador Highway for approximately ten (10) km south of HV-GB and a gravel road of approximately twenty (20) km which leads to the Owner's Laydown Area.

8.2.2 Port Facilities

The Happy Valley-Goose Bay and Cartwright port facilities are accessible by road to Site. Contractor is responsible for obtaining, from the appropriate Authority, the restrictions and requirements in using those facilities and associated services.

8.2.3 Bridges

The Contractor is responsible for completing a logistics study to determine any restrictions in shipping material and equipment to and from the Site.

8.2.4 By Air

The Site is serviced by the Happy Valley - Goose Bay airport. Air transport of passengers is provided by various commercial airlines such as:

1. Air Canada
2. Air Labrador
3. INNU Mikun Airlines
4. PAL (Provincial Airlines)

The Contractor shall be responsible for all airline bookings for all travel needs of the Contractor's personnel.

The Contractor shall be responsible for all transportation cost and expenses of the Contractor's personnel to and from Goose Bay Airport and other destinations, wherever they may be located.

8.3 Transportation to the Site

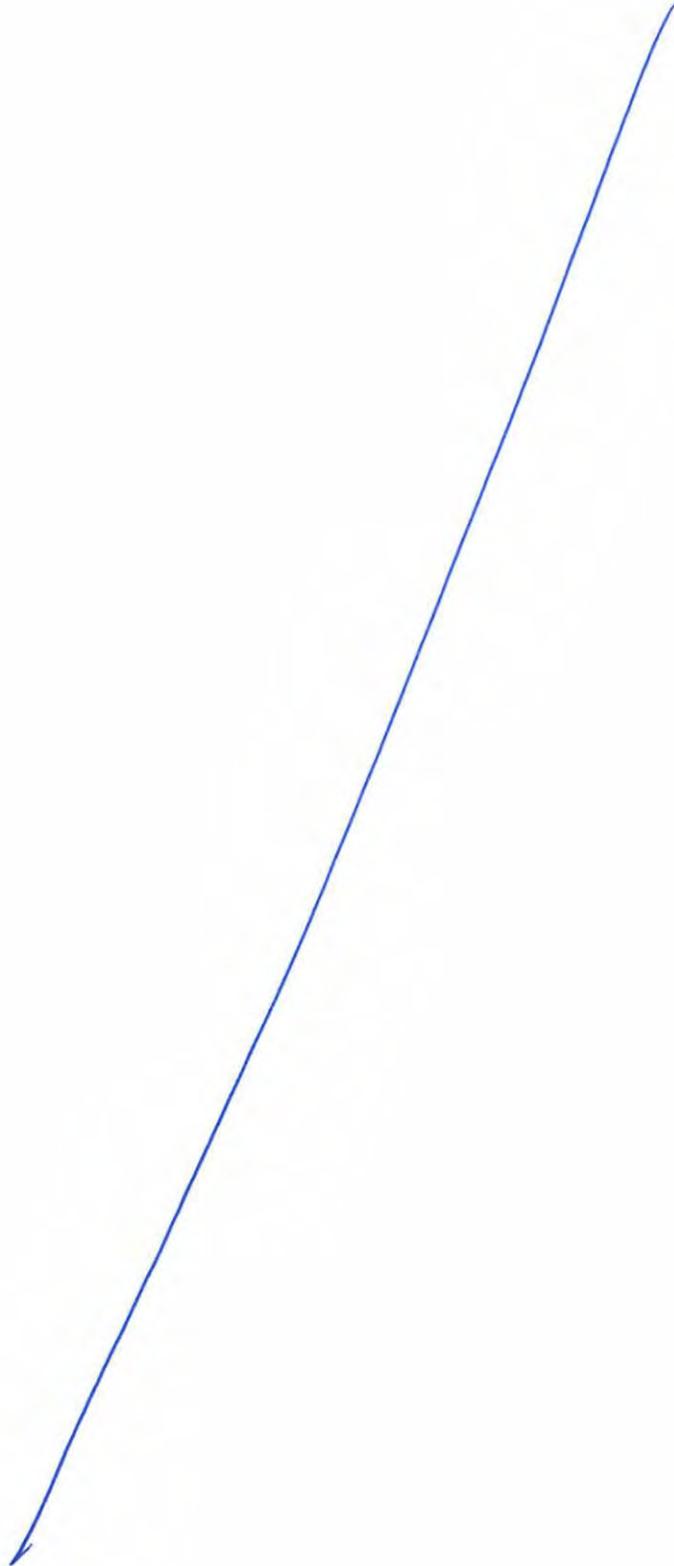
The Owner will provide mandatory scheduled bus service between Goose Bay, North West River and Sheshatshiu and between Goose Bay, Goose Bay Airport and the Accommodation Complex to transport all Contractor's Personnel and their personal belongings.

Company and Owner take no responsibility for any inconvenience that may be caused due to normal mechanical failure, adverse weather conditions or other causes out of its control.

The Contractor shall be responsible for transportation between the Goose Bay or other place and the Site for any material, equipment, tools, or other requirements associated with the Work.

8.4 Transportation between the Accommodations Complex and Work Locations.

The Contractor is responsible to provide the necessary transportation of the Contractor's Personnel between the Accommodations Complex and Work locations on the Site.



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