UNCLE GNARLEY

Opinions On Newfoundland Politics That Bite

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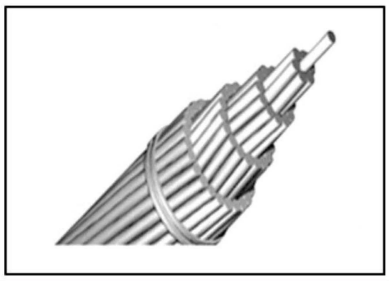
DESIGN ENGINEER BAFFLED BY EXTENT OF MUSKRAT TL FLAW REPORTED BY CBC

Guest Post Written by J. P. Schell, P. Eng (Retired)

On June 18, 2016, I received an e-mail from Jim Gordon, P. Eng. (Retired) attached to which was a CBC News item entitled "Nalcor investigates inconsistent patterns on Muskrat Falls transmission lines". Gordon, who has frequently commented on aspects of the Muskrat Falls project on the Uncle Gnarley Blog, asked what I thought of the issue. My comments are as follows.

From the pictures included in the CBC News item it is apparent the outer strands of the line were squeezed too close together, causing one strand to "pop out" by an amount which is about half the strand diameter as shown in the photo. (Source: CBC)

Transmission line conductors are formed by wrapping aluminum wire strands around a central wire as illustrated in the image below. (Source: internet). Layers of strands are added, with the wrap direction alternating to avoid line coiling, until the desired thickness is attained.



There are three situations where a "popped out" strand could have occurred: a) during stringing, b) during transportation, and c) in the factory. The CBC item indicated that approximately 170 km of the DC transmission line had been strung before the work was halted, which represents about 340 km of conductor.

During the stringing operation it is difficult to understand how one strand of conductor could "pop out". It might be possible because of an accidental mishandling on one reel, but not on about 300 to 400 reels, one after the other. There is nothing in any stringing procedure that can conceivably cause this to occur, reel after reel after reel.

That the problem occurred during transportation is also difficult, if not impossible, to comprehend. Certainly, it will not happen during normal shipping or even very rough shipping. If the reel breaks in transportation, or pieces are damaged and fall off, the conductor is often damaged. What does not happen to the conductor is a condition where over the full length of the reel, one and only one strand "pops out".

The only logical place for this to happen is in the factory during the stranding procedure.

When each strand comes off its reel or spool, it is fed into a stranding machine where it is preformed and coiled around the layer below it, layer after layer, until the final layer is completed. As the first conductor is formed, all the procedures are (presumably) checked, measured, and corrected as necessary, until the output from the stranding machine meets the specification. Then the production run can commence after which, to a great extent, automation takes over.

Obviously, sometime during the stranding procedure, something must have occurred that

caused this one strand to be incorrectly coiled and it continued, reel after reel after reel, without stopping until at least 340 km of conductor had been fabricated. Possibly it even continued for the full production run.

Now what?

If the conductor is replaced there will be a significant delay of not less than 6 months, and possibly a year or more. There will be a large cost associated with the defective wire which was likely paid up front. In addition, protracted and expensive lawsuits may ensue. The first question that needs to be asked is this: is this flaw acceptable? The question that follows is: if it is not acceptable, can it be repaired *in situ*?

On the question of acceptability and *in situ* repair, I will confirm that I am not a conductor expert, so my comments are opinions, not statements of fact. Nevertheless, I would comment as follows:

At the location of the clamps and dampers this strand will tend to be squeezed, distorted and flattened. As a result, the strand will be weaker than its companion strands; it will be more prone to breaking. If it breaks, the conductor's overall strength will be correspondingly weakened and the broken strand could slide or work its way out of the clamps. If that happens, it will unravel.

Because the strand has "popped out" of the conductor, it is probably very slightly longer than its companion strands and therefore will tend to act somewhat differently. Rain or dew or similar could get under the strand and freeze, thus pulling the strand even further from the conductor, thus allowing weather better access to the inner strands and isolating the strand even further from the conductor.

Because this strand has "popped out", it then becomes a target for being picked upon during the stringing process. If anything adverse is going to happen, it will happen to this strand. In other words, it is a target for distortion, for getting "in the way", and for breaking. I would not be surprised if reports were made of strands having broken during stringing.

All conductors, if the wind speed and wind direction are just right and are blowing along the strands, have a tendency to gallop. Galloping occurs if the lifted strand funnels the wind just enough such that the elongated shape becomes an airfoil — just slightly more prone to fly.

Is there a solution to the problem? First, I would state that I do not agree with a remedial action such as tightly winding an aluminum tape or equivalent around the conductor in a direction counter to the stranding. There are just too many things that could go wrong with it.

This line will be in service for more than 50 years — probably closer to 100 years — and under very severe weather conditions. This one odd-ball strand will be the one around which problems will tend to occur. For this reason, it would be my opinion that the conductor should be replaced. For major transmission lines, like those delivering power from Muskrat Falls, there is just too much at risk if they are not.

Under the very reasonable presumption that the flaw did originate in the factory, at the stranding machine, there are many questions that need to be asked. All are related to two, which are fundamental. First, why wasn't it picked up sooner? And second: how was it that a decision to stop the work wasn't made until most, if not all, of the conductor had been shipped and 170 km of the HVDC line was strung?

Under normal circumstances, it is difficult to comprehend how 340 km (or even possibly the full production run) of flawed conductor could be allowed to leave the factory. While it is recognized that the process, once started, is essentially fully automated, it is difficult to understand how reel after reel after reel could be stranded and packaged and shipped without being picked up by normal factory quality assurance procedures. One might accept the possibility of one or two defective reels, but not more.

The factory process is basic. The conductor for each reel is viewed by the factory work crews who attach the start conductor to the reel, cut and fix in place the end conductor, and apply the lagging. They would know it was a flawed conductor, particularly as the problem occurred reel after reel after reel. Such a situation would not speak highly of the supplier's internal quality assurance procedures.

If, on the other hand, the factory QA did pick up the flaw, then someone in management had to have let it go, knowing that the flawed product would be shipped. It seems obvious that the shipment would not have taken place if the purchaser's inspector was knowledgeable and doing a good job.

Presumably the purchaser (Nalcor, the Owner? SNC-Lavalin, the Engineer?) hired an

independent and qualified inspector to undertake the factory inspection. If the supplier's factory is located overseas, or if the conductor's place of origin is suspect, then the necessary for a diligent inspection process is absolutely mandatory.

That said, 340 km (or more) of flawed conductor having left the factory, it is apparent that the inspector, if there was one, was lax in his undertaking. We might ask: What were his terms of reference? Who wrote them? Nalcor? SNC-Lavalin? Was he supposed to inspect and pass each reel before shipment? Did the inspector make daily visits? Weekly? Monthly? Did he have the authority to stop production? Was he not required to make the purchaser aware of the flaw? On what basis did he "approve" the conductor? What did his inspection reports say? For that matter, do any inspection reports exist?

It is indeed curious that even though the supplier had to know that his conductor was flawed, it was shipped anyway, and presumably paid for in full.

What was happening during stringing is another story. It is impossible to believe that it wasn't almost immediately noticed, particularly when it was happening reel after reel.

Valard should have seen it first. Their crews removed the lagging, connected the conductor to the pullers, manned the reel brakes and, ultimately, took the conductors off the pulleys and attached the clamps, spacer dampers and dead-ends.

Presumably, the Owner's (Nalcor's) and/or the Engineer's (SNC-Lavalin's) inspectors were on site, along with Valard QA personnel. Almost immediately, qualified inspectors would have recognized the problem and informed the Owner. If an inspector wasn't on site, the Owner's Engineer would have had to have been informed of that circumstance, too. Valard, or any contractor, most assuredly would have reported this flaw if for no other reason than that they would not want to be responsible for installing material that they knew was faulty or potentially contained a serious flaw. It is simply not in any contractor's interest to install a product which they know or suspect will have to removed and reinstalled at their own expense.

In short, from almost the very beginning of the stringing process, the Owner's Engineer at least had to have been aware that something was not right with the conductor. Yet, the stringing continued.

The disturbing conclusion is that Valard had to have been told to continue stringing. Equally disturbing is that Valard was likely informed that, though the conductor was flawed, the flaw was acceptable and that Valard could continue stringing without consequence to the Company. Logic dictates that the installation was approved in writing.

About 4–5 months after 170 km of line was strung, the stringing was finally halted. The CBC News item does not say what inspired this decision. Whatever it was had to have been serious. Likely, the decision was made because the popped-out strand continually unravelled as the stringing processed. It might have become obvious that the conductor — potentially the entire shipment — was flawed, and the whole batch unusable.

Again, the role of the Inspector/Engineer in the QA process is disturbing. So many questions demand answers. Was the stringing being closely monitored? When did the unravelling, or other problems, first occur? How often did it happen? Was it reported? If so, how was it reported? Did it show up as just another item in the Inspector's routine inspection reports, or was it serious and passed up the line?

The stringing continued for several months. The implication is that the Engineer did not consider the flaw to be serious. If he did, he may not have insisted that the work be stopped, which, admittedly, is a decision he has the right to make.

The role of the Owner was also disturbing. The decision to continue with the stringing had to have originated with the Owner. Was the decision the result of pressure to maintain the schedule and to avoid cost overruns? Did no one pay attention to reparation costs that would only increase as the stringing continued? Did no one consider the inevitable problems that would occur having installed this flawed conductor?

This massive failure of Quality Assurance can only enlarge an already serious problem of cost overruns on the Muskrat Falls project. Mistakes of such magnitude, and the reasons why they occurred, deserve proper airing. Those responsible must be held to account.

At the risk of repetition, perhaps the CBC will ask Nalcor the following: First, what was the role of the Engineer/Inspector in allowing, potentially, a full shipment of flawed conductor to leave the factory? Second, what was the role of the Engineer in allowing a conductor, possessing a flaw, to be continually installed for several months? And thirdly, what was the role of the Owner in allowing a flawed product to be installed on his transmission line?

Editor's Note:
J.P. (Joe) Schell is a Professional Engineer with over 55 years of transmission line experience with Shawinigan Engineering, Montreal Engineering [Monenco] including, for 20 years, as a private Consultant. He has experience in all aspects of TL design from initial studies and evaluations to detailed design and construction supervision. Schell has worked on projects in all the Canadian provinces, the Yukon and the NW Territories.

Internationally, Mr. Schell has worked on TL projects in over 25 countries. He was the lead TL engineer with ShawMont Newfoundland in St John's for the design of the Bay D'Espoir island wide transmission system, the lead designer for the 69 kV Marble Mountain project for Deer Lake Power, and other lines in Newfoundland.

Other career credits include lead transmission line engineer in the study stages of the Sete Quedas 13,200 mw hydro development, Brazil. He was the lead TL design engineer for a 400 kV super grid project in Iraq. Prepared contract documents for the 400 kV line from Shiraz to Sirjan in Iran and provided assistance to the World Bank, in Washington, related to the rebuilding of the high voltage transmission system in Lebanon.

Schell also provided design assistance to SNC-Lavalin in St John's for the early stages of the Muskrat Falls hvdc project.

Posted by Des Sullivan at Monday, June 27, 2016
Reactions: funny (0) interesting (0) informative (1)

Labels: Inconsistent patters on Muskrat TL, J.P. Schell, Muskrat Falls Project, P.Eng. (Retired)