# SP AUSNET – KILMORE EAST FIRE

## ESSENTIAL TESTS NOT YET UNDERTAKEN REGARDING CAUSE OF THE CONDUCTOR FAILURE

### Overview

- The conductor has been tested in two ways only: by HRLT under a high powered microscope (permitting qualitative analysis), and using a profilometer (permitting quantitative analysis) as arranged by Professor Jones of Monash University. The conclusions from each test have been extensively criticized by the respective experts in relevant fields.
- A so-called reconstruction of the helical termination was also undertaken by HRLT as part of its investigation work. That, however, was only for the purposes of assessing whether inspection of the conductor was adequate,[1] not the cause or causes of its failure.
- Proposed Key Finding at para 11.19 attributes conductor fatigue to three discrete matters (misaligned termination, vibration, lack of dampers), none of which derives from the above tests, or which has been tested or investigated scientifically yet.
- Further, much of the evidence dealt with a depression and white layering on the conductor, and its possible influence. That is not an aspect of the above key finding.
- According to HLRT's representative, Better, a "whole range" of variables had to come together for the conductor to "collapse".[2] Not testing any one of these variables throws doubt on the others. Here, *none* of the variables in the above key finding suggested as causative has been tested; nor has any other variable identified in the course of the evidence.
- The expert evidence revealed the need for extensive testing across (as Better suggested) a broad range of variables.
- No relevant testing on these variables has to-date been performed.
- Conclusions by HRLT on cause or causes of conductor failure remain therefore conjecture.
- It follows that based on the current evidence there can be no findings as to cause of the conductor failure – noting that the RC may wish to identify key variables/issues raised by the experts as to *possible* causes of the conductor failure.
- The key possible causative aspects identified during the evidence which have not been the subject of testing are summarised below.

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[1] Better, T11,319: 19-24
[2] Better, T11,338:18-30

| No. | Issue | Whether Test Performed | Need for testing | Whether test could be performed |
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| **Role (if any) of helical misalignment** | | | | |
| 1. | Whether the helical misalignment had any effect/impact on the conductor | No.[3] | Yes. Better expressed a mere belief based on his experience alone, that the helical misalignment had a part to play.[4] This was mere scientific conjecture.[5] Jones said that the misalignment was likely to have a minimal effect, but no-one had performed any tests in that regard.[6] | Yes. Better gave evidence that it could have been tested,[7] noting that it would take a lot of work and time.[8] |
| 2. | Whether the helical misalignment could change the end condition of the helical wrap so as to influence the vibration of the conductor (vibrational mode). | No.[9] | Yes. Better's evidence was that the misalignment would have significantly altered the end conditions of the span and was likely to have influenced the vibrational modes.[10]<br><br>However, Better accepted that the highest he could put it was that the misalignment "could have" led to increased vibration and increased cyclic stressing.[11]<br><br>Jones's evidence was that in the absence of scientific evidence, HRLT's conclusions as to the effect of the misaligned termination were conjecture.[12] | Yes. Such a test could be undertaken in half a day.[13] |

[3] Better, T11,351:10-24
[4] Better, T11,351:21-24
[5] Jones, T11,837:3-11
[6] Jones, T11,845: 3-7
[7] Better, T11,351:10-20
[8] Better, T11,351:17-20
[9] Better, T11,351:10-20
[10] Better, T11,317:1-5
[11] Better, T11,337:22-29

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| 3. | Whether, despite the helical misalignment, the helical termination assembly (universal joints) provided sufficient flexibility to reduce stress on the conductor. | No.[14] | Yes. Better expressed the view that he doubted that the joints would provide sufficient flexibility.[15] Jones expressed doubt that the helical misalignment would have much effect on the degree of freedom at the end of the strain insulator.[16] It was unclear to him whether there would be an effect.[17] | Yes. A test could readily be performed to compare the stress with and without the misalignment. |
| 4. | The significance (if any) of the distance between the helical misalignment and the stress fracture. | No.[18] | Yes. Jones gave evidence that the distance between the misalignment and the stress fracture was relevant to whether the misalignment might affect the stress on the conductor.[19] His evidence was that no-one had tested this and therefore conclusions were mere conjecture.[20] | Yes. Jones referred in this regard to St Venant's theorem which would facilitate testing in this regard.[21] |
| **Role (if any) of depression and/or white layer on conductor** | | | | |
| 5. | The cause of the depression and white layer on the conductor near pole 39. | No. | Yes. Better gave evidence that further work was needed to determine the cause of the depression and the white layer.[22] Better acknowledged that lightning was a possible cause[23] albeit very unlikely.[24] Better said he was "puzzled" by the white layer.[25] The origins of the depression was unknown and Better opined that it could be | Yes. Better's evidence was that it was not so much that relevant tests had not been carried out but rather that scientific evidence was simply not available.[28] Better considered that such inquiry was in any event outside the scope of his brief.[29] |

[12] Jones, T11,836:31 – T11,837:11
[13] Jones, T11,844:14 -26
[14] Better, T11,351:10-24
[15] Better, T:11,315: 3-25
[16] Jones, T11,834:27-T11,835:9
[17] Jones, T11,836:13-17
[18] Jones, T11,834: 10-17
[19] Jones, T11,768: 23-29; T11,769: 25-28
[20] Jones, T11,834: 10-17
[21] Jones, T11,768: 22-29
[22] Better, T11,314: 4-7; T 11,343:9-12, T11,307:20-21
[23] Better, T11,317:22-31;T11,318:1-6; T,11,341:2-15
[24] Better, T11,355: 18
[25] Better, T11,339:23-24

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| | | | the result of either abrasive action of the helical termination wires, or lightning strikes (as above).[26] Better concluded that one would need to do a "heck of a lot" more investigation to be guaranteed that it was one or the other.[27] | |
| 6. | Whether the depression and white layer on the conductor near pole 39 had anything to do with the conductor failure. | No. | Yes. Better's evidence was that the depression and the white layer contributed significantly to the "initiation and the fatigue failure."[30] Better considered that the presence of the indentation was critical and the formation of the white layer as most likely critical to the fracture of the conductor strands.[31] HRLT performed no tests to substantiate these claims. | Yes. |
| 7. | Whether conductors on other spans of the Pentadeen spur demonstrated similar depressions and wearing at the relevant contact points with helical terminations. | No. | This test could have been easily undertaken. No explanation has been given by HRLT for it not being done. | Yes. Simple inspection of other parts of the spur. |
| **Role (if any) of wind conditions and effect (if any) of Aeolian vibration (if any) on conductor** | | | | |
| 8. | Whether prevailing wind conditions between poles 38 and 39 would or might | No.[32] | No testing has been done to determine whether such vibration was or is present. Better regarded such a test as being outside HRLT's role,[33] yet HRLT was prepared to | Yes. Better agreed testing/monitoring for such vibration would give more information about the conductor, how it might behave in the future, and how much |

[26] Investigation into the failure of a 12.7kV SWER Conductor Pentadeen Spur, Kilmore East: VPO.001.039.0016 at 0036
[27] Better, T11,307:15-23
[28] Better, T11,342.27-11,343.8
[29] Better, T11,343:9-22
[30] Better, T11,338:18-20
[31] Better, T11,339:25-27
[32] Better, T11,348:18-T11,349:9
[33] Better, T11,348:18-24

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| | induce vibration or high loads on the conductor. | | assume the presence of Aeolian vibration. That is not scientifically disciplined.<br><br>Better told the RC that testing for such vibration should be done.[34] | damage it had already received.[35] Large sections of the conductor were and are available for such testing. |
| **Role/effect (if any) of fitting dampers on conductor** | | | | |
| 9. | Whether fitting dampers to the conductor could or would have avoided conductor failure. | No.[36] | Better/HRLT concluded that the absence of dampers could have contributed to the cyclic stress from wind-induced vibration at the point of failure,[37] and that a damper would have significantly altered the cyclic stress.[38]<br><br>Better accepted that the highest he could put it was that the absence of dampers on the conductor "could have" led to increased vibration and increased cyclic stressing.[39]<br><br>Better did not undertake any such testing because he considered it to be outside the scope of the HRLT investigation, at least at this time.[40] His evidence was mere conjecture that vibration could have caused conductor fractures and dampers could have reduced cyclic stress on the conductor. | Yes. Better accepted that "damper efficiency" testing could have been done.[41] |

[34] Better, T11,349: 1-3
[35] Better, T11,348: 25-31; T11,349: 1-5
[36] Better, T11,350:22-31; T11,351:1-9
[37] Better, T11,317; HRLT Report entitled Investigation into the Failure of a 12.7kV SWER Conductor Pentadeen Spur, Kilmore East – Report No: HLC/2009/344 – VPO.001.039.0016, at 35
[38] Better, T11,317
[39] Better, T11,337:22-29
[40] Better, T11,348: 18-24
[41] Better, T11,350.22-11,351:9

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| **Analysis of fracture profile of conductor** | | | | |
| 10. | Whether the fracture profile of the conductor suggested low or high amplitude vibrations had affected the conductor. | Preliminary tests done. | Jones had profilometer tests done in lieu of HRLT doing so as HRLT considered that doing so was outside the scope of their investigations.[42]<br><br>Jones's evidence was that further standard tests were necessary to assess fatigue profile of the small flaws typical of those in the conductor, as that would give an idea of the loads on the conductor.[43] He also suggested the need for testing for "critical fracture toughness" of the conductor.[44] None of those tests have been done.[45] | Yes. |

Freehills

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[42] Jones, T11,843:11-16
[43] Jones, T11,843:22-27
[44] Jones, T11,843: 28-29
[45] Jones, T11,844: 4