WOLF CREEK
NUCLEAR OPERATING CORPORATION

Bart D. Withers
President and
Chief Executive Officer

April 12, 1988

WM 88-0077

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Reference: Letter dated February 2, 1988 from L. J. Callan, NRC, to B. D. Withers, WCNOC
Subject: Docket No. 50-482: Response to Unresolved Item in Inspection Report 50-482/87-37

Gentlemen:

Attached is a detailed response to unresolved item (482/8737-01) as requested in the reference. The unresolved item concerns heat shrinkable tubing.

If you have any questions please contact me or Mr. O. L. Maynard of my staff.

Very truly yours,

BDWithers

Bart D. Withers
President and
Chief Executive Officer

BDW/jad

Attachment

cc: B. L. Bartlett (NRC), w/a
R. D. Martin (NRC), w/a
P. W. O'Connor (NRC), 2 w/a

IE01
1/1

**RESPONSE TO UNRESOLVED ITEM 482/8737-01
CONCERNING HEAT SHRINKABLE TUBING**

PARAGRAPH 2.b.(6)(a): INSTRUMENTATION CABLE SPLICES

ITEM: Generic - Raychem recommends that cut ends of shrink tubing be smooth and free from jagged edges or nicks. Numerous tubing was identified with jagged edges.

RESPONSE

The Raychem Corporation was contacted concerning the guideline included in the product installation pamphlet that the cut be smooth with no "jagged" edges or nicks. The theory is that additional stresses may be placed on the material during temperature excursions above the splice material transition level which could occur during a loss-of-coolant accident (LOCA) or main steam line break (MSLB). The temperature excursion may lead to a failure at high stress areas.

Based on the discussions with Raychem Wolf Creek Nuclear Operating Corporation (WCNOC) does not consider the jagged edge a qualification concern for the reasons provided below.

1. The statement is a recommendation based on theory rather than actual test results. While theory tells us that failures will originate at high stress locations (i.e. at jagged edges), tests performed by Raychem and the industry reveal that the concern is not backed by test data. No test failures of Raychem heat shrink tubing have been attributed to jagged edges.

2. During installation Raychem splices are subjected to temperatures in excess of either a LOCA or MSLB environment at Wolf Creek Generating Station (WCGS). If high temperature would cause a failure to occur in a splice with severe "jagged" edges, it would most probably occur during the installation process rather than under accident conditions. The fact that the splices at WCGS survived the high temperature excursion during installation without failure provides assurance that the splices would also survive accident conditions.

3. The smallest diameter of the splice is generally at the edge of the Raychem splice. Hence, the material is closest to its "recovered" diameter at this location and therefore the internal stresses on the material are minimum. This further explains why no failures have been observed on edges which were not perfectly smooth.

ITEM: Penetration ZNI-279

- Seal lengths of 1 1/2 inch were identified on Scheme 3BBI15EA
- WCSF-200 tubing appears too small for the 0.5 inch X 0.6 bolted connection on Scheme 3BBI15EA
- A bare conductor was exposed at the cable breakout on Scheme 3BBI15DA
- A shim appears to be needed on one end of a splice in Scheme 3BBI15DA

RESPONSE:

Wyle Laboratory Qualification Test Report No. 17859-02P (Reference 1) satisfactorily demonstrates the environmental qualification for Raychem WCSF-N splices with seal lengths as short as 0.5 inch for instrumentation circuits. Therefore, seal lengths of 1.5 inch identified on Scheme 3BBI15EA are not a qualification concern. Test report 17859-02P is reflected in Equipment Qualification Work Package (EQWP) E-01013 and is summarized in a letter dated November 20, 1987 (Reference 2). However, the splices have been replaced in accordance with Raychem recommendations.

The splice identified which appeared to have a bolted connection of approximately 0.5 inch by 0.6 inch with a WCSF-200-N sleeve was determined to have been sized in accordance with Raychem recommendations.

Scheme 3BBI15DA is for BB-FT-446, reactor coolant system (RCS) flow transmitter loop 4. As documented in the Updated Safety Analysis Report (USAR) Table 3.11(B)-3, this transmitter is classified as NUREG-0588 Appendix E Category C for LOCA and MSLB and Category D for high energy line break (HELB), therefore it is not required to be environmentally qualified. Additionally, the bare conductor has been identified as a shield wire and is of no safety concern.

Notes taken during the NRC inspection indicate the scheme that had the missing shim was 3BBI15AA (not 3BBI15DA) for BB-FT-416, RCS flow transmitter loop 1. As documented in USAR Table 3.11(B)-3, this transmitter is classified as NUREG-0588 Appendix E Category C for LOCA and MSLB and Category D for HELB. Since failure of this transmitter during an accident is not a Qualification concern, rework of the splice is not required.

PARAGRAPH 2.b.(6)(b): CONTROL CABLE SPLICES

ITEM: J-Box SJ-HV-0005 - Seal lengths of 0.25 and 0.30 were identified. Also, one splice had a split approximately 1/2 inch long through the outer sleeve.

RESPONSE:

The WCGS acceptance criteria for seal length in control circuits utilized during the control circuit inspection in late 1987 was 0.5 inch. This figure was conservatively developed based on Wyle tests 17859-02P (Reference 1) and 17859-02B (Reference 3) after consideration of a 50 sample inspection performed on control circuit splices at WCGS. Note the referenced tests included splices with seal lengths down to 0.125 inch with acceptable results for WCGS control circuits. EQWP E-1013 currently reflects the acceptance of 0.125 inch seal length for control circuits.

The control circuit splice with the 1/2 inch split has been replaced in accordance with Raychem recommendations. The split outer sleeve is considered an isolated case since it was found in one out of over 600 splices examined. In addition, Wyle report 17859-02P (Reference 1) documents the qualification testing of a splice of similar configuration; a severe split in the Raychem sleeve which exposed the conductor. The test results satisfactorily demonstrates the qualification of the previous splice configuration since the leakage current of 35 ma measured during the testing would not affect the operation of valve SJ-HV-0005 under accident conditions.

ITEM: J-Box SJ-HV-0012 - WCSF-115 shrink tubing, without a shim, was installed over a 0.06 inch Conax. This is beyond the use range of the shrink tubing.

RESPONSE:

Per vendor drawing, the Conax wire has a 0.064 inch diameter conductor with 0.009 inch thick Kapton insulation, giving an outside diameter of 0.082 inch. The Raychem recommended minimum diameter for WCSF-115-N sleeving is 0.110 inch.

Wyle test report 17859-02B (Reference 3) documents testing of WCSF-115-N material on Kapton insulated wire with an outside diameter of 0.066 inch. A leakage current of 10 ma was measured during testing. As indicated in EQWP E-01013, control circuits at WCGS can with stand leakage currents of at least 50 to 100 ma. Therefore, test results satisfactorily demonstrate the qualification of the control circuit splice configuration. Wyle test report 17859-02B is reflected in EQWP E-01013.

PARAGRAPH 2.b.(6)(c): POWER CABLE SPLICES AND MOTOR CONNECTIONS

ITEM: Hydrogen Mixing Fan Motor CGN03D

- It could not be determined visually whether or not the motor connections included a molded kit to seal around individual conductors, and the work package which documented installation of the connections was not available for review.

- Shrink tubing was installed over braided insulation.

- Shrink tubing over one connector had been nicked.

RESPONSE:

All motor leads for the hydrogen mixing fans have a braided nomex insulation with a varnish impregnated braided sleeve. During the environmental testing of the hydrogen mixing fans, the motor connections were directly exposed to the accident environment. Therefore, the three items noted above which address nuclear grade Raychem splices are not qualification concerns at WCGS.

Although Raychem splices on CGN03D connections are not required for qualification, Wyle test report 17859-02B (Reference 3) documents the testing of Raychem material applied to both impregnated and non-impregnated braided wires. The maximum leakage current measured during the testing was 157 ma which is acceptable for the power circuits of interest.

The work request which documents the installation of the hydrogen mixing fan motor CGN03D connections utilizing NMCK-3V-35-00 motor kits in accordance with design documents is available for review at WCGS. In addition, although not a qualification concern, the nick in the shrink tubing has been repaired.

ITEM: Penetration ZNE-268 (Containment Cooling Fan)

- WCSF-500 shrink tubing used in this penetration was too small for the lug and bolt size and for the 1.15 inch cable.
- The seal length over all splices was approximately 1 inch rather than 2 inches as recommended by Raychem.
- Bolt pads were not used as required even though bolt length and tang widths for all connections were greater than 0.87 inch.

RESPONSE:

Wyle test report 17859-02B (Reference 3) documents the testing of Raychem WCSF-N material with hold-outs of 4.14. The hold-out is defined to be the ratio of the effective diameter of the splice configuration to the fully recovered diameter of the Raychem material used in the splice. No failures were observed during the test even though the 0.5 inch long No. 10 bolt used in the test presented a sharp edge to the shrink material. Leakage currents, although not critical to these power circuits, were a maximum of 15 ma at 132 VAC. While this test demonstrates the adequacy of using Raychem material with large hold-outs, because the leakage currents were measured at 132 VAC versus the nominal 277 VAC to ground at WCGS, the minimum wall thickness of 0.065 inch for power cables allowed by ICEA Standard S-66-524 has been used to calculate a more conservative allowable hold-out for the low voltage power splices. By solving the equation in Section 2.4.5 of the Raychem WCSF-N Application Guide (Reference 4), an acceptable hold-out of 3.43 has been calculated. This hold-out of 3.43 yields 1.949 inches for the maximum effective outside diameter for power circuit applications for WCSF-500-N.

With the maximum tang width of 1.76 inches used on the 500 MCM cable, a maximum equivalent diameter of 1.949 inches yields the maximum acceptable bolt length of 2.035 inches. Using the minimum wall thickness calculated from ICEA Standard S-66-524, the maximum outside dimension is 2.185 inches. This acceptance criteria is considerably greater than the Raychem criteria used during the NRC inspection. Also, the specific penetration examined, ZNE-268, is located outside containment in room 1410. The only harsh environment parameter for this room is radiation, and even then the accident dosage is only 1.6E6 rads. Since this radiation level is orders of magnitude below the tested level of 2.0E8 rads and since the splices are not exposed to high temperatures during accident conditions, it is WCNOC's position that the splices in penetration ZNE-268 will not be adversely affected by the LOCA environment.

Wyle test report 17859-02B (Reference 3) documents the testing of Raychem WCSF-N splices with seal lengths as short as 0.125 inch for low voltage power circuits. The test results adequately demonstrates the qualification of the splices in low voltage power circuits with seal lengths of approximately 1 inch at WCGS.

Raychem recommends the use of a bolt pad when the bolt length or tang width exceeds 0.87 inch. The purpose of the pad is twofold: 1) to keep the adhesive out of the threads in the bolted connections and 2) to provide additional assurance that the splice material will not fail at high stress areas during accident conditions.

Adhesive in the threads of the connection is not a safety concern and need not be addressed here. The following is justification for the WCGS installation in regards to item 2:

1. Using a long bolt (or wide tang) without a bolt pad may increase the stresses in the splice material leading to failure during accident conditions with elevated temperatures. However, it should be noted that the 0.87 inch dimension recommended by Raychem was not established based on testing, and was essentially arbitrary. As mentioned above, Wyle has successfully tested Raychem WCSF-115-N material on a 0.50 inch long No. 10 bolt. This configuration, with its calculated hold-out of 1.414 over the untrimmed bolt is at least as severe as using WCSF-500-N material on a 0.87 inch long 3/8 inch bolt, which has a calculated hold-out of 1.74.

2. During installation, the Raychem splices are subjected to temperatures in excess of what will be seen during either a LOCA or MSLB environment at WCGS. If high temperatures cause a failure of splices to occur in those situations with bolts longer than 0.87 inch and without bolt pads, it follows that WCGS should have had installation problems in those splices where the Raychem criteria were not strictly followed. Lack of installation problems provides additional assurance that the WCGS installations are adequate.

3. At WCGS, low voltage power splices in electrical penetrations are generally separated physically from each other and from ground. A failure of the splices, even to the point of exposing the conductors, would not be a concern since expected leakage currents have been shown to be acceptable for WCGS applications. Note the containment cooling fan motors were tested with splices directly exposed to the harsh LOCA environment and, although measured IR's were low, the motors performed their safety functions acceptably.

References:

1. "Qualification Test Program on Raychem Nuclear Cable Splices, Okonite Tape Splices, and Kerite Splices as Installed on Various Wire Insulations at Commonwealth Edison Company's Zion, Byron and Braidwood Nuclear Generating Stations", Wyle Laboratories Test Report No. 17859-02P, Revision A

2. Letter WM 87-0309 dated November 20, 1987 from B. D. Withers, WCNOC, to NRC

3. Qualification Test Program on Raychem Nuclear Cable Splices, Okonite Tape Splices, Kerite Tape Splices, Scotch Tape Splices and Amp Butt Splices as Installed on Various Wire Insulations at Commonwealth Edison Company's LaSalle, Dresden, and Quad Cities Generating Stations", Wyle Laboratories Test Report No. 17859-02B, Revision A, August, 1987

4. Raychem WCSF-N Application Guide, Revision 1, August 1983