SNUPPS

Standardized Nuclear Unit Power Plant System

5 Choke Cherry Road
Rockville, Maryland 20850
(301) 869-8010

Nicholas A. Petrick
Executive Director

May 9, 1985

SLNRC 85-14 FILE: 0278
SUBJ: Equipment Qualification Justifications for Interim Operation (JIO)

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dockets No: STN 50-482 and STN 50-483

Reference: SLNRC 84-0135, dated December 21, 1984: Same Subject

Dear Mr. Denton:

Enclosed are revised pages to be inserted in the Justification for Interim Operation (JIO) submitted by the reference letter. This revision was necessitated by recent events during qualification testing of the splices used with the new-style Reference Junction Box (RJB) in the incore thermocouple circuits. At the present time, the new-style RJB is used only at Wolf Creek Generating Station Unit No. 1. Callaway Plant Unit No. 1 has the old-style RJB which is separately discussed in the reference letter.

The enclosure contains both proprietary and non-proprietary versions of the revised pages to be consistent with the JIO submitted by the reference letter.

Very truly yours,

NA Petrick

Nicholas A. Petrick

MHF/nld19a15
Attachment

cc:				
G. L. Koester	KGE	B. Little	USNRC/CAL
J. M. Evans	KCPL	G. C. Wright	USNRC/RIII
D. F. Schnell	UE	D. R. Hunter	USNRC/RIV
H. Bundy	USNRC/WC		

A048
1/1 Prop
1 Non Prop

Change: LPDR
NRC PDR
NSIC } Non Prop Only

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A048
1 Prop
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Enclosure

Instructions for Inserting Revised Pages Into
Interim Justification Position ESE-43 and ESE-44

A. Westinghouse Proprietary Class 2 version:

Remove	Insert
Page 4	Page 4, Rev. 5/85
Page 5	Page 5, Rev. 5/85
--	Page 8, Rev. 5/85

B. Westinghouse Class 3 version:

Remove	Insert
Page 4	Page 4, Rev. 5/85
Page 5	Page 5, Rev. 5/85
--	Page 8, Rev. 5/85

SNUPPS

Interim Justification Position for the Seismic and Environmental Qualification of the Incore Thermocouples, Connectors, Adaptors and Reference Junction Box

(ESE-43 and ESE-44)

The Class 1E thermocouples, connectors, adaptors, and the reference junction box located inside containment form part of a core exit temperature monitoring system to be qualified for use during and after a design basis LOCA, MSLB or seismic event. In addition to the accident environment to which components inside containment might be subjected, the thermocouple junctions in the reactor vessel are to be qualified for operation in the event that a LOCA might lead to inadequate core cooling (ICC). The DBE conditions to which the components are to be qualified, therefore, include a 384.9^{o}F peak temperature MSLB simulation (the Westinghouse generic profile up to 420^{o}F provides adequate margin for SNUPPS applications) with caustic spray and, for the thermocouple measuring junctions, a 2200^{o}F peak temperature inadequately cooled core simulation (which provides adequate margin over the SNUPPS required peak clad temperature).

The WRD qualification program is presently incomplete. Test sequence steps of accelerated thermal aging, normal radiation and seismic simulation have been completed on the connectors and adaptors but a retest is currently scheduled. The reference junction box has been aged, irradiated, and seismically tested as discussed below. The thermocouple test sequence has been completed. The status of completed testing and the justification for interim operation of the system are provided below.

Thermocouples

The thermocouples, including the measuring junctions and portions of stainless steel sheathed cable located inside the vessel, have been subjected to seismic and LOCA conditions and demonstrated successful performance during and after the dynamic simulations. Accelerated thermal aging was not required because there are no organic materials in the thermocouple and effects of high (normal) irradiation on the mechanical properties were evaluated and determined to not affect satisfactory performance of the sheath.

The seismic simulation test was conducted by shaker table using controlled multi-frequency test inputs. The thermocouples were subjected to five Operating Basis Earthquakes (OBE) and four Safe Shutdown Earthquakes (SSE).

The LOCA vibration simulation test was conducted by shaker table using random multi-frequency test inputs. The thermocouples were subjected to five seconds of random inputs at levels described by the power spectral density (PSD) plot.

Examples of the test response spectra (TRS) shown in Figures 1, 2, and 3 demonstrate adequate envelopment of the appropriate RRS for the OBE, SSE, and PSD test levels, respectively. The OBE RRS is two-thirds of the SSE RRS.

Throughout the test sequence no structural damage was observed and the thermocouples functioned properly.

The thermocouples have also been subjected to a 2200°F peak temperature inadequately cooled core simulation and demonstrated successful performance both during and after the tests.

Connectors

The thermocouple connector assemblies have been subjected to accelerated thermal aging and irradiation (gamma and beta) and seismic simulation. The test program is being repeated because the radiation test dose was not adequate to simulate the required Westinghouse generic post accident dose. Actual test dose applied was 60 mega rads of Gamma and 890 mega rads of Beta. Since SNUPPS requirements are 22.7 mega rads of Gamma and 152 mega rads of Beta the test dose applied did envelope SNUPPS requirements.

The connector components are made of Ryton R-4, designed to tolerate high radiation exposure. Additionally, the metal outer sheath provides some shielding against exposure. Based on these facts, the additional radiation exposure is not anticipated to cause any changes in the previous successful test results.

The seismic simulation test was conducted by shaker table using controlled multi-frequency test inputs. The connectors were subjected to five Operating Basis Earthquakes (OBE) and four Safe Shutdown Earthquakes (SSE).

The LOCA vibration simulation test was conducted by shaker table using random multi-frequency test inputs. The connectors were subjected to five seconds of random inputs at levels described by the PSD plot.

Examples of the test response sepctra (TRS) shown in Figures 4, 5, and 6 demonstrate adquate envelopment of the appropriate RRS for the OBE, SSE, and PSD test levels, respectively. The OBE RRS is two-thirds of the SSE RRS.

Throughout the test sequence no structural damage was observed and the connectors functioned properly.

A confidence test of the effects of a LOCA environment on a new LEMO connector has shown no effect on the accuracy of the thermocouple reading. The confidence test consisted of two separate tests. In the first test two LEMO connectors were connected to two thermocouples at room temperature with a recorder attached to monitor results. One connector was dipped in a solution of 2750 ppm boron adjusted to a pH of 10.7 at 25°C with sodium hydroxide. The other connector was left exposed to a normal atmosphere. During the 24 hour exposure period both channels of output maintained an accurate output. The second test was set up on the same manner except that the thermocouples were placed in a 400°F oven and the connectors were both placed in a dry test vessel. One connector was fitted with Raychem splice material to provide a watertight seal. A 24 hour steam test on the connectors was performed (this would be the same test conditions used for all HELB testing as discussed in Westinghouse WCAP 8587 Methodology for Qualifying Westinghouse WRD Supplied NSSS Safety Related Electrical Equipment). During this 24 hour test, again both channels of output maintained an accurate output. These results are considered relevant to the question of performance of aged qualification units because the tendency for moisture to enter the unprotected connectors is the same for both new and aged samples. No evidence exists to suggest that the connectors will be more sensitive to LOCA effects. Pending completion of the entire sequence of connector tests, the results of the LOCA test of new connectors lend confidence of successful performance of the installed connectors. This LEMO connector is the same as those installed at the SNUPPS plants. Refer to SLNRC 84-0034 of February 23, 1984 for additional information.

Thermoelectric Connectors

At Callaway Plant, the interface with SNUPPS supplied organic thermocouple extension cable consists of Thermoelectric connectors reinforced with Raychem heat shrink tubing to prevent separation. The connectors have been subjected to the same accelerated thermal aging, irradiation and seismic simulation as the LEMO connectors with successful results. Since the design basis accident sequence has not been performed, a 24 hour confidence test was run on unaged Thermoelectric connectors with heat shrink tubing attached. Two Thermoelectric connectors were connected to thermocouples placed in a 400°F oven. A 24 hour steam test (utilizing the same HELB test conditions as discussed in WCAP 8587) was performed on the connectors. Both channels maintained an accurate output throughout the test except for two periods where the outputs exhibited fluctuations. These fluctuations coincided with oscillations in the chamber pressure due to a malfunctioning control valve. Post-test evaluation indicated that one of the connectors was in poor condition and it is postulated that the pressure oscillations may have caused a differential pressure on the Raychem tubing which expanded it and allowed movement between the connector contacts. Since these rapid pressure oscillations are not typical plant environmental conditions, it is concluded that the tested connectors would have performed through a 24 hour period post accident. The tested Thermoelectric connector is the same as those installed at Callaway Plant.

Splices and Adaptors

The splices which are used with the new-style Reference Junction Box are qualified as part of the ESE-43 program. The discussion of the Reference Junction Box below notes that the qualification program required a design change to improve the environmental sealing of the box. The installation of the improved new-style box requires a splice between the mineral insulated cable (which is part of the box) and the organic thermocouple extension cable which is used in the circuits for thermocouples and Reference Junction Box resistance temperature detectors (RTDs) in the SNUPPS design. The splice consists of an Amp connector bonding the two wire ends(four wire ends for RTD circuits), covered by Raychem heat shrink tubing. The entire splice area is

surrounded by Dow Corning 738 sealant which is enclosed in a metal outer sheath. The potting adaptors are developed by brazing a 0.25 inch diameter by 1.5 inch long cylinder onto a short piece of mineral insulated (MI) cable. The cylinders are of stainless steel for the thermocouple adaptors and of brass for the RTD adaptors. After brazing the extension wires inside the cylinder, it is filled with a potting material which insulates the brazed joint and seals the MI cable. The RTD adaptors which were installed with the new-style RJB at Wolf Creek do not contain the specified brass cylinders; however, the brass cylinders will be installed at Wolf Creek prior to exceeding 5% of rated thermal power.

The above components were thermally aged to a simulated qualified life of one year then subjected to 80 Mrads of gamma radiation. This was followed by a LOCA/HELB simulation of steam and chemical spray enveloping a 400°F peak temperature with spray content as described in WCAP-8587. The post accident simulation enveloped SNUPPS requirements of six months at 120°F.

Due to the nature of the splice and potting adaptors and the method of installation, the splice and potting adaptors would not be subjected to any stresses which would cause concern during a seismic event. However, seismic testing of aged samples has been completed to Westinghouse generic envelopes.

LOCA/HELB test results are as follows: the splice and hardline adaptors, both stainless steel thermocouple and brass RTD, maintained the signal throughout the test period. Signal deviations of a maximum magnitude of 20°F were noted at various times during the LOCA/HELB simulation.

Reference Junction Box (Old-Style)

The Reference Junction Box (RJB) has been aged, irradiated and seismically tested successfully. The seismic simulation test was conducted on a shaker table using multi-frequency test inputs. The equipment was subjected to five (5) Operating Basis Earthquake (OBE) and four (4) Safe Shutdown Earthquake (SSE) events. The required SSE level is shown in Figure 8, and the required OBE level is 2/3 SSE. The T/C RJB was mounted to a rigid test fixture utilizing procedures provided in the Technical Manual for the Model (WX-34072 T/C Reference Junction Box). The mounting hardware (mounting blocks and spacers, bolts, nuts, and washers) used for mounting the T/C RJB was supplied with the T/C RJB.

Examples of test response spectra (TRS) shown in Figures 7 and 8 demonstrate adequate envelopment of the appropriate RRS for the OBE and SSE test levels, respectively. Throughout the entire test sequence no structural damage was observed and the RJB functioned properly. However, a problem discovered prior to the LOCA test has altered the test program. During an external pressurization test it was discovered that the NEMA enclosure was not leak tight and would allow steam to enter the box during the LOCA test. Previous tests had revelaed that RTD lead wires exposed to a steam environment would result in a substantial drop in the insulation resistance thus affecting the accuracy of the RTD. An attempt was made to seal the entire box with a silicone potting compound and perform a confidence test. If the potting method proved to be successful during the LOCA test, a new box was to be modified with the potting and the test program repeated.

During the confidence test of the potted box the measured insulation resistance dropped substantially on all three RTD's indicating the potting had not sealed the box and that the RTD lead wires were being exposed to steam and caustic spray. However, a review of the data revelaed little effect on the accuracy of the system (approximately 1%). WRD will continue the investigation of the apparent independence of insulation resistance and RTD performance. Present areas of investigation include the significance of data acquisition circuit variations and possible electro-chemical effects resulting from test measurement voltages in the presence of an electrolyte, such as the $H_3BO_3/NaOH$ caustic spray. Similar results are described by N. J. Selley in an "Experimental Approach to Electrochemistry". In conjunction with the investigation, the validity of existing IR measurement techniques used in establishing performance is being evaluated.

The confidence test performed on the potted box demonstrated that the probability of obtaining a true environmental seal on the box by this method was low and was not required for successful performance. After removal of the potting material from the qualification test unit, the LOCA test was repeated and followed by a post-accident simulation. This post-accident simulation was performed for 168 hours at 230°F.

Upon completion of the test program it was realized that because of the inadequate seal it would not be possible to take credit for Beta-shielding. This lack of shielding increased the required TID for the post-accident simulation to meet Westinghouse generic requirements. The test dose administered was adequate to simulate the 40 year normal operating dose prior to a seismic event.

Because of the inadequate seal, a concern has been raised over long term corrosion effects and potential hydrogen buildup to volatile levels due to containment spray reacting with the internal aluminum structure. However, confidence and LOCA testing with steam and chemical spray have not shown evidence of chemical residue in the box which is believed to be due to the rapid equalization of pressure in the box. Therefore, this is a postulated concern not demonstrated to occur during previous qualification testing.

In the interim, the results of testing to date demonstrate acceptable seismic qualification and short term post-accident environmental operation of the existing box design for SNUPPS application.

Reference Junction Box (New-Style)

Attachment 1 is a draft Equipment Qualification Data Package (EQDP) which addresses environmental and seismic qualification of the new-style RJB. The EQDP is considered to be a JIO in accordance with subparagraph (i) (2) of 10 CFR Part 50.49.

Summary of Results for New-Style RJB Components

The testing of the components of the core exit temperature monitoring system located inside containment demonstrated that the signal was maintained although errors were experienced at various times during the test. For example, as noted above, the splices and adaptors experienced a signal deviation of 20°F during HELB/LOCA simulation. Westinghouse performed an evaluation of the errors experienced during qualification testing. Simply summing the maximum errors measured during the component test programs yields a total error somewhat less than 75°F. An error of this magnitude is sufficient to provide an acceptable indication of Inadequate Core Cooling which only demands accuracies within approximately 200°F. However, information for other potential applications of the thermocouple system, such as subcooling calculations, should be derived from the more accurate wide range reactor coolant system hot leg temperature measurement which uses RTDs qualified under Westinghouse program ESE-6.