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April 14, 1983

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

Subject: Byron Station Units 1 and 2
Braidwood Station Units 1 and 2
Additional Information Concerning
Environmental Qualification Program
NRC Docket Nos. 50-454/455 and 50-456/457

Reference (a): B. J. Youngblood letter to D. L. Farrar dated March 15, 1983

Dear Mr. Denton:

Reference (a) requested that the Commonwealth Edison Company provide, by April 15, 1983, certain additional information concerning our Environmental Qualification Program for Byron and Braidwood Stations. The purpose of this letter is to provide the requested information.

Our FSAR will be amended to include the information contained in the Attachment to this letter as appropriate. Please address any questions you or your Staff may have concerning this matter to this office.

One (1) signed original and fifteen (15) copies of this letter with Attachment are provided for your use.

Very truly yours,

E. Douglas Swartz

E. Douglas Swartz
Nuclear Licensing Administrator

Attachment

cc: J. G. Keppler - RIII
RIII Inspectors - B/B

B001

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QUESTION 270.1

"Based on the information in your program, we are unable to determine if all of the systems and components requiring qualification have been identified. Provide the following additional information for our review.

a. A comparison of the systems in Table 3.2-1 of the FSAR with the systems containing equipment in a harsh environment in the June 17, 1982 submittal. Justification should be provided for the exclusion of safety-related systems in Table 3.2-1 from the environmental qualification program (e.g. not required for accident mitigation, all components located in a mild environment, etc.).

b. A list of the TMI Action Plan equipment currently in your program and its equipment I.D. number. If not in your program, describe the qualification status or your plans for qualification, including the schedule for completion of qualification in accordance with Category I of NUREG-0588.

c. Confirmation that all equipment defined by items 2a, b, and c of Appendix E, NUREG-0588 has been included in your review.

d. A justification for defining 'hot standby' as equivalent to the Class 1E term 'emergency shutdown.'

e. A clarification of the scope of the program as it relates to all units of the Byron/Braidwood Stations. For example, qualification of some equipment in Byron 2 (such as Rosemount transmitters and Bunker Ramo penetrations) and Braidwood has not been addressed in the environmental qualification submittal. The staff will review and evaluate only those plants for which adequate information is received.

f. Qualification data sheets for all equipment located in a harsh environment. Some items not currently addressed in the submittal are cable, splices, conduit, and MCC's."

RESPONSE

a. Table 2.1-1 of the EEQR (Equipment Environmental Qualification Report) lists all systems which contain Class 1E equipment located in both mild and harsh environmental zones. (Systems

with Class 1E equipment located in harsh environmental zones are designated with a superscript h). Class 1E equipment in mild zones is not excluded from the program. Identification sheets for the same are provided in Volume 4 of the EEQR.

A comparison of Table 3.2-1 of the FSAR and Table 2.1-1 of the EEQR is provided in Table Q270.1-1 with accompanying notes which disposition discrepancies.

b. Appendix E to the Byron/Braidwood FSAR presents the Byron/Braidwood response to the TMI Action Plan. A list of the specific Class 1E TMI Action Plan equipment which was not included in the qualification program identifying its Byron/Braidwood equipment ID number and its present qualification status is given in Table Q270.1-2. All equipment ID numbers which are not currently listed in the EEQR will be added in the next revision.

c. All equipment defined by Items 2a, b and c of Appendix E, NUREG 0588 has been included in the environmental qualification review. The appropriate NUREG-0588 category for each piece of equipment is identified in the EEQR on both the ID sheet and the equipment's data sheet.

d. The design and licensing of Byron/Braidwood are based on the capability to achieve hot standby conditions. This capability is described in the responses to RSB Questions 212.6, 212.47 and 212.154. The hot standby condition is a safe, stable condition which allows operator action or plant equipment repairs to be included in the procedure to proceed to a cold shutdown condition.

The Byron/Braidwood qualification program includes all Class 1E equipment required to bring the plant to a hot standby condition and/or mitigate the consequences of a postulated accident as denoted in Section 2.1 of the EEQR.

It was not intended to equate emergency shutdown to hot standby. Therefore, Section 1.0 of the EEQR will be revised as follows:

> "The equipment covered by this program includes equipment associated with systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, containment and core residual heat removal or otherwise essential in preventing significant release of radioactive material to the environment."

e. An informal copy of qualification data sheets for Unit 2 Class 1E equipment located in harsh environmental zones was submitted to the staff for review in January 1983. A docketed submittal will be forthcoming.

As a result of plant arrangement, equipment duplicated between Unit 1 and 2 is located in the same environmental zone (e.g., 1CC01PA is located in the same environmental zone as 2CC01PA) except the Rosemount Transmitters identified below.

Equipment, instrument and valve ID numbers for Byron are identical to those for Braidwood. Therefore, each ID number in EEQR (although listed only once) applies to both Byron and Braidwood except for items unique to one particular unit. There are no unique items in harsh environmental zones.

Rosemount transmitters with ID numbers 1FT-AF011 through 1FT-AF018 used for Byron/Braidwood Unit 1, are located in environmental zone A8. Rosemount Transmitters with ID numbers 2FT-AF011 through 2FT-AF018, used for Byron/ Braidwood Unit 2, are located in environmental zone A-10.

Replicate equipment was used for all four units (Byron 1 & 2 and Braidwood 1 & 2). The only equipment furnished with different model numbers are the electrical penetrations.

Conax penetrations are used exclusively for Byron and Braidwood Unit 1 and for two (2) Byron and Braidwood Unit 2 penetrations: 2LV09E and 2LV10E. Bunker Ramo penetrations are used for the balance of the Byron and Braidwood Unit 2 penetrations.

f. Environmental qualification reports for generic electrical items which do not have ID numbers have been reviewed for Byron and Braidwood under the same review process as described in the EEQR. Summary sheets for these generic items are enclosed for your review and will be incorporated into the next revision of the EEQR.

TABLE Q270.1-1

CLASS 1E SYSTEM
COMPARISON OF TABLE 3.2-1 of FSAR
AND TABLE 2.1-1 OF EEQR

SYSTEM CODE	FSAR	EEQR	NOTES
AF	X	X	
AP	X	X	
AR	X	X	
CC	X	X	
CQ		X	(1)
CS	X	X	
CV	X	X	
DC	X	X	
DG	X	X	
DO	X	X	
EF	X		(3)
FP		X	(2)
FW	X	X	
HT	X		(5)
IC		X	(1)
IP	X	X	
LV		X	(1)
MS	X	X	
NR	X	X	
OG		X	(6)
PA	X		(4)
PC	X		(6)
PL	X		(4)
PM	X		(4)
PR	X	X	
PS	X	X	
RC		X	(6)
RD			(9)
RE		X	(2)
RF		X	(2)
RH	X	X	
RP	X	X	(7)
RY	X	X	
SA		X	(2)
SD	X	X	
SH		X	(2)
SI	X	X	
SX	X	X	
TG	X		(8)
VA	X	X	
VC	X	X	
VD	X	X	
VE	X	X	
VP	X	X	
VQ		X	(2)
VX	X	X	
WO	X	X	

TABLE Q270.1-1 (Cont'd)

Notes

1. These systems are non-1E except for electrical penetrations. Table 3.2-1 will be revised to indicate that system does contain Class 1E equipment.

2. These systems are non-1E except for containment isolation valves and are included in the generic category in Table 3.2-1, designated as PC, "Primary Containment Isolation."

3. Class 1E components in this system are identified by equipment numbers in various other systems included in Table 2.1-1 of the EEQR.

4. These systems were inadvertently omitted from Table 2.1-1 of the EEQR and will be included in a future revision.

5. This system currently does not contain any Class 1E components. Table 3.2-1 of the FSAR will be revised to delete this system in the next amendment.

6. This system contains Class 1E components and will be included in Table 3.2-1 of the FSAR in the next amendment.

7. The RP system is listed in both the FSAR and the EEQR. RP system equipment is not identified by an RP system code, but rather various system codes.

8. Table 3.2-1 of the FSAR lists the turbine stop valve limit switches as part of the TG system. Actually, they are part of the MS system. The FSAR will be revised accordingly.

9. The RD system was inadvertently omitted from the EEQR and the FSAR, and will be added in a future revision.

TABLE Q270.1-2

TMI ACTION PLAN EQUIPMENT STATUS

EQUIPMENT ID NUMBER	DESCRIPTION	MANUFACTURER AND MODEL	QUALIFICATION STATUS
1/2RC014A 1/2RC014B 1/2RC041C 1/2RC014D	Reactor Coolant System Vent (Solenoid Operated U/US)	Valcor #V526-6043-5	Complete review of Valcor Report for B/B applicability
1/2RY8000A 1/2RY8000B	Motor Operated Relief Isolation Valve with Positive Position Indication	Limitorque	Awaiting proposal from Westinghouse
1/2RY455A 1/2456	Pressurizer Power Operated Relief Valve Externally Mounted Limit Switch (For Positive Position Indication)	NAMCO EA180	Qualified by Westinghouse EQDP HE-3
1/2RY8010A 1/2RY8010B 1/2RY8010C	Pressurizer Relief & Safety Valves with Valve Mounted Reed Switch for Positive Position Indication	Copes Vulcan D-100-160 Crosby HP-BP-8E	Awaiting submittal of Vendor's Qualification Report
1FIS-AF022 1FIS-AF024 1FIS-AF026 1FIS-AF028	Auxiliary Feedwater Flow Transmitter	Barton 288A	Review Vendor submittal Qualification Report for B/B applicability
1/2RT-AR020 1/2RT-AR021	Containment High Range Area Monitors	General Atomic Co. RD-23 (Detector) RM-80 (Micro Processor) RM-23 (Remote Display)	Review Vendor submittal Qualification Report for B/B applicability

TABLE Q270.1-2 (Cont'd)

EQUIPMENT ID NUMBER	DESCRIPTION	MANUFACTURER AND MODEL	QUALIFICATION STATUS
1/2PT-PC004 1/2PT-PC005	Containment Pressure Transmitters	Barton 763	Qualified by Westinghouse EQDP-ESE-1
1/2LT-PC006 1/2LT-PC007 1/2LT-PC008 1/2LT-PC009	Containment H_2O Level Transmitter Containment Sump Level Transmitter	Barton 764	Qualified by Westinghouse EQDP-ESE-3
1/2PS26J 1/2PS28J	Containment H_2 Monitoring Equipment (Gas Analyzer & Monitor)	Sentry	Awaiting submittal of Vendor Qualification Report
1/2LE-RC019 1/2LE-RC020	Core Cooling Detection Instrumentation	Combustion Eng. & Westinghouse	Awaiting submittal of Vendor Qualification Plan

QUESTION 270.2

"Normal and accident environmental conditions must be defined for areas of the plant which experience a significant change in environment as a result of a LOCA or HELB. The following additional information is required to adequately define the environmental conditions:

a. The time-temperature profiles for high energy line breaks outside containment.

b. The definition of a 'harsh' environment used in the development of the EQ program. If equipment has been exempted from qualification because of exposure to low level doses of radiation, provide the justification for this practice. For equipment with solid state devices in environments with significant increases in doses and dose rates as a result of an accident, describe the methods of qualification or bases for exemption.

c. The postulated flood level inside containment and a reference (such as a section in the FSAR).

d. A modification to or justification for the main steam line break temperature profile inside containment used for qualification. The profile in your program is less severe than that approved by the staff in Section 6.2.1.1 of the Byron SER (NUREG-0876).

e. The methodology used for estimating the magnitude of the radiation environment for equipment under normal operating conditions.

f. An example of equipment specific calculations referenced in Section 4.2.1 of the submittal used to reduce the temperature required for qualification of equipment exposed to HELB's outside containment.

g. A profile for pressure vs. time inside containment for the accident duration.

h. The basis for the LOCA duration selected for equipment qualification.

i. Confirmation that random single failures of mitigation equipment have been assumed for high energy line breaks outside containment, to be consistent with 3.6.1 of the Byron SER."

RESPONSE

a. The time/temperature profiles for the high energy line break (HELB) areas outside containment may be found in Attachment C3.6 of the FSAR.

b. A harsh environment is defined as any area which will experience a significant change in one or more of the environmental parameters as a result of an accident. The parameters that are considered are temperature, pressure, humidity, caustic spray, radiation, and submergence.

   Harsh environments also include areas which are exposed to an abnormally high temperature, pressure, humidity, and/or total integrated radiation dose (TID) during normal plant operation.

   The equipment included in the harsh environment sections of the Byron/Braidwood EEQR is all the equipment that is located in an environmental zone with a TID of greater than 10^4 rads. None of the equipment in harsh environmental zones has been exempted from radiation qualification.

   The qualification for all Class 1E equipment with solid state components is reviewed to the same program described in the EEQR.

c. The actual flood level inside the containment is elevation 382 feet 2 inches. This flood level is documented in Attachment D3.6 of the Byron/Braidwood FSAR. (Attachment D3.6 was included as part of Amendment 40 to the FSAR.)

d. The accident temperature profile specified for the environmental qualification of safety-related electrical equipment located inside containment is that shown in Table 3.11-2 of the Byron/Braidwood FSAR. This profile envelopes all of the postulated pipe breaks and LOCA profiles shown in Chapter 6 of the Byron/Braidwood FSAR. The design analysis used to generate the temperature profiles shown in the FSAR was the COCO computer code, which is widely used in nuclear power plant containment analysis. Even though the staff calculated a slightly higher maximum temperature during the performance of the confirmatory analysis, we feel that the temperatures shown in Table 3.11-2 are conservative and therefore justifiable to use as the basis for in-containment qualification. In fact, the Byron SER states, "initial conditions and input data, including passive and active heat removal parameters, were conservatively chosen to produce the highest containment pressures and temperatures."

If the NRC chooses to review the Byron in-containment environmental qualification against the peak value of 330° F calculated by the confirmatory analysis performed using Contempt-LT/28 Code, it can be shown that the Byron in-containment Class 1E equipment is qualified for the peak temperature of 330° F with some margin. This is a result of margin that was included in the original environmental qualification testing.

e. On August 24, 1982, during a conference call involving Messrs. Akstulewicz and Chesnut of the NRC, T. Tramm of Commonwealth Edison Company, W. J. Johnson and J. D. Regan of Sargent & Lundy, information necessary to resolve this comment was communicated to the NRC. The following is a summary of information inserted in the Byron/Braidwood Qualification Report. Note that Section 3.3.3 of the current report will be changed to Section 3.3.4.

3.3.3 Normal Operation Exposure

Equipment located in areas containing radiation sources during normal operation may accumulate a significant level of radiation exposure prior to the design basis accident. Bounding values of normal operation exposure are established by using the dose rate modeling techniques described above and the following:

1) Source terms are based on defective cladding on 1% of the fuel rods as described in FSAR Section 12.2.

2) For areas containing no radiation sources, the design dose rate shown in FSAR Section 12.3 is used.

3) The period of operation is 40 years.

f. The time/temperature profiles referenced in Section 4.2.1 of the EEQR are for normal conditions only, in lieu of aging to 40 years at maximum temperature. Equipment specific calculations have not been used to reduce the temperature required for qualification of equipment exposed to HELB's outside containment.

g. The pressure profile used for in containment qualification is given in Table 3.1-1 of the EEQR. Section 3.2.1.1 presently includes only the peak pressure value. This section will be revised to include the entire containment accident pressure profile (50 psig for the first 20 minutes, saturated steam thereafter).

h. Specific postaccident operability requirement for each device are developed from the following guidelines:

Equipment	Required Postaccident Operability
1. Equipment necessary to perform trip functions.	5 minutes
2. Equipment that is located outside containment, is accessible, and can be repaired, replaced, or recalibrated.	2 weeks
3. Equipment located inside containment and is required for post-accident monitoring.	4 months (this number is based on an acceptable amount of time to allow the instrument to be repaired, replaced, or recalibrated or an equivalent indication obtained)
4. Equipment that is located inside containment, is inaccessible, or cannot be repaired, replaced or recalibrated.	1 year
5. Equipment located in a mild environment following an accident.	Continuous

i. Section 3.2.2.2 of the submittal will be revised as follows to clarify further the Byron/Braidwood program for qualification of equipment outside containment exposed to elevated temperature resulting from HELB's:

3.2.2.2 High Energy Line Break (HELB)

High energy line breaks in the auxiliary building have been identified and analyzed in accordance with Standard Review Plan, Section 3.6. High energy lines are defined as pipes in which the fluid temperature exceeds 200° F

or the pressure exceeds 275 psig during normal plant operation. Breaks are postulated in these lines. The resulting temperature, pressure and humidity conditions are included in the environmental qualification program. The potential for pipe whip and jet impingement effects has been investigated and additional protective features incorporated where required.

Section 3.6 of the FSAR and the response to Question 010.40 describe the approach used to evaluate high energy line break effects. The results of the subcompartment analyses are included in Attachment A3.6 of the FSAR. The high temperatures and pressures predicted in the subcompartments are not an equipment qualification concern because the object of compartmentalization of safety equipment was to ensure that a high energy line failure will not result in additional failures which would violate the plant design basis. The plant is designed such that capability to safely shut down is maintained following an initiating event and the resulting failures, plus an independent single active failure. To verify that this design approach has been successful, the high energy line break conditions are included as accident conditions for the applicable environmental zones in Table 3.1-1 and equipment in these zones are qualified to the accident conditions if they are required to function in the accident scenario. For environmental zones in which the conditions are not affected by high energy line breaks, the normal levels are specified as the accident conditions in Table 3.1-1.

The only area identified as experiencing elevated temperatures and/or pressure beyond normal or abnormal conditions following a high energy line break are, with one exception, subcompartments. The subcompartments have been designed such that failure of a high energy line in the subcompartment will not result in failures beyond the single train of a safety system which is in the subcompartment. As an example, Zone A13g, the centrifugal charging pump rooms, are predicted to reach a temperature of 190° F in the event of a break in the charging pump discharge lines. The resulting harsh environment affects only equipment in the failed charging train. All safety equipment used to mitigate the break is unaffected by the harsh environment.

Back flow from system is prevented by redundant check valves. The loss of charging function can be mitigated by use of the redundant centrifugal charging pump, the positive displacement charging pump, isolation of the letdown system, or either of the safety injection pumps, any of which could be assumed to fail without affecting plant safety. None of these options for mitigation are

affected by the harsh environment in the charging pump room. As a result, the plant design basis is valid in spite of harsh environments caused by high energy line breaks and no equipment must be qualified for the harsh environments which result from high energy line breaks in auxiliary building subcompartments.

The only area other than the subcompartments which could experience an elevated temperature is the upper area of Zone A13, the containment piping penetration area. A break in a three-inch letdown line in the chemical and volume control system could release steam into this area which has no natural ventilation. The temperature would then increase above the environment specified for this area. The only safety-related items in this area are isolation valves on the safety injection and essential service water systems which are not required to function in this accident and are redundant, and an isolation valve on the failed line which will fail in the closed position. The break flow is limited to 120 gallons per minute by orifices. Immediate indications of the break will be supplied by two main control board alarms (high flow and high letdown heat exchanger outlet temperature). The plant can then be safely shut down without the equipment which would be affected by the increased temperature.

QUESTION 270.3

"In your response to Question 040.2, various items of equipment were described as being submerged during an accident. Provide equipment identification numbers so that this equipment can be correlated with your most recent submittal."

RESPONSE

The response to FSAR Question 040.2 lists the following equipment as being located in the containment building and possibly subject to a flood condition in the event of a LOCA accident:

1/2PL50J	1/2PL77JA
1/2PL52J	1/2PL77JB
1/2PL57J	1/2PL77JC
1/2PL66J	1/2PL79JA
1/2PL67J	1/2PL79JB
	1/2PL79JC

The Class 1E instruments mounted on these local control panels and required to perform a Class 1E function during normal operation and/or during or after an accident are as follows:

1/2LT459	1/2PT403
1/2LT460	1/2PT405
1/2LT461	1/2PT455
1/2LT501	1/2PT456
1/2LT502	1/2PT457
1/2LT503	1/2PT458
1/2LT504	
1/2LT527	
1/2LT537	

These instruments have been relocated to an elevation not subject to submergence. Therefore, submergence qualification for these instruments is not required.

The response to Question 040.2 will be revised to be consistent with the above in the next amendment.

QUESTION 270.4

"For equipment qualified with less than a one hour margin, discuss the approach utilized to justify this deviation and provide one example for a specific item of equipment."

RESPONSE

Section 3.8.2 of the EEQR will be revised as follows to resolve the question of demonstrating a margin of one hour in operating time. The data necessary to support a margin of at least one hour will be part of the equipment qualification file.

3.8.2 Margin Included in Operating Time

The operability requirements for each piece of Class 1E equipment is the length of time the equipment is required to remain functional during accident mitigation. A margin of at least one hour of the equipment operating time has been included in the qualification program for each piece of applicable Class 1E equipment.

Some equipment, e.g., transmitters, was not specified to maintain trip function accuracy requirements for longer than five minutes post-accident. However, peak HELB temperatures will be reached within the specified operability time. The operability time was conservatively established based on the reactor trip engineered safeguards function performed by each equipment item considering what consequences failure of the device would have on the operator and the mitigation of the event. Margins for trip function requirements are contained in the HELB envelopes which encompass a full spectrum of break sizes and are also justified by the fact that the signal generated by the sensor is "locked-in" by the protection system and will not reset should the sensor fail after the designated trip time requirement. Most of the equipment was also specified and qualified for much longer post-accident monitoring function times to slightly reduce accuracy requirements.

QUESTION 270.5

"Describe your conformance with the test sequence defined in IEEE 323-1974, Section 6.3.2 for harsh environment equipment."

RESPONSE

For equipment required to operate in a harsh environment the preferred test sequence is that recommended by IEEE-323-1974. When a more severe sequence is identified, the more severe sequence is used in lieu of the sequence in IEEE-323-1974. Test sequences are described and justified in Qualification Data Packages, which will be available for review at the audit.

Subsection 3.11.2 of the FSAR will be revised in the next amendment to delete the reference to IEEE 323-1971 and replace it with IEEE 323-1974.

QUESTION 270.6

"Describe in general terms the program to be utilized for detecting age-related degradation in equipment, including that caused by synergistic and low dose rate effects. The methods for determining the items to be inspected or parameters to be measured and the frequency of examination should be discussed. Provide specific information on your approach for cables located inside containment."

RESPONSE

Equipment located in harsh environments is qualified to address potential age related degradation. Accelerated aging techniques (Arrhenius principle) are used to simulate age. Based on this data, components with limited life are then maintained or replaced through an Equipment Qualification Maintenance and Surveillance Program to be implemented at Byron/Braidwood stations. Data for this program is derived from Qualification Data Packages and mnaufacturer's recommendations. Additional existing maintenance programs will supplement this program.

1. Technical Specification requirements will verify through performance tests that equipment is functional (will be included in Chapter 16 of the FSAR).

2. Vibration monitoring will be used to do comparative testing against established baselines on rotating equipment.

3. Lubrication Program

4. Instrument Calibration/Surveillance Program

5. Inservice Inspection Programs on pumps, valves and welds per Section XI of ASME Boiler and Pressure Vessel Code.

A history/trending program will be applied to the maintenance programs to detect changes in operability.

Known low dose rate effects and synergisms are included in the environmental qualification program.

QUESTION 270.7

"No explanation of accelerated aging methodology is presented in your program. Provide a description of the procedures utilized."

RESPONSE

The effects of aging on the Class 1E equipment was addressed for all pieces of equipment identified in the EEQR. Aging was addressed by either performing accelerated aging on the equipment or by developing an aging analysis program to evaluate the stresses imposed on the equipment which degrade performance. The objective of an aging analysis is to determine a qualified life of the equipment. An examination is performed to determine which of the materials is susceptible to aging by either heat (thermal), radiation, or both heat and radiation, and then determine the qualified life for the most susceptible material. Arrhenius techniques were utilized in the determination of qualified life. The qualified life for the most susceptible material/component would be used to establish a periodic replacement schedule if the qualified life is less than 40 years.

Details of specific equipment are available in the Qualification Data Packages which are available for review at the audit.

For NSSS Class 1E equipment the aging evaluation program is described in Appendix B to WCAP-8587. Accelerated Thermal aging parameters are described in Appendix D to WCAP-8587. Both documents are available for review.

QUESTION 270.8

"The following discrepancies or omissions were noted in the equipment qualification data sheets:

a. Operating times are insufficient as listed. The specific post accident operating time requirement and qualified operating time should be listed.

b. Some Limitorque valve operators and other equipment do not have model numbers listed.

c. Accuracy requirements are omitted for some equipment.

d. Five of the NSSS items considered to be fully qualified are still undergoing testing or analysis."

RESPONSE

a. Operating time requirements are incorporated in notes explaining the qualification operating time for applicable pieces of equipment. Data sheets can be revised, if necessary, to reference the required operating time under the Plant Design column as well as the qualification column.

   Data sheets showing specified and/or qualified operating time as "continuous" means that the equipment must remain functional at all times during normal, accident, and post-accident conditions. The actual length of time that the equipment is demonstrated to be qualified for during post-accident conditions is clarified by specific notes on the data sheets.

b. Data sheets for Limitorque motor operators have been revised to show model numbers instead of serial numbers.

   Model numbers are omitted on certain data sheets because some equipment manufacturers do not assign model numbers to equipment such as panels, junction boxes, large motors, electrical penetrations, etc. In such cases, the information given under the model number entry is whatever identifiable information is available.

c. Accuracy requirements, where applicable, have been provided in the remarks under the Qualification Accuracy column.

d. The following portions of EEQR Subsection 4.2.2.1 will be revised as follows to properly summarize the qualification of the equipment:

4.2.2.1 Qualification Status

A. Qualified

1. EQRE HE-1 - Safety-Related Valve Electric Motor Operators: Qualification Group A

   ...The Westinghouse generic qualification program for valve electric motor operators is still in progress. Operators that will be qualified to the "new" report have been ordered and will be available for use on Byron as required.

2. EQRE HE-2 - Safety-Related Solenoid Valves: Qualification Group A

   Evaluation of the test reports is based on data for solenoid valves to be installed in the Byron/ Braidwood Stations. The solenoid valves currently installed will be replaced with models identical to the ones qualified under the Westinghouse generic program prior to fuel loading.

3. EQRE HE-3 - Safety-Related Externally Mounted Limit Switches: Qualification Group A

   It is anticipated that seals as required by the test for the electrical connections will not be required for the DBE environmental conditions at Byron Station. A test to verify the capability of the limit switches to survive the DBE environment without seals will be performed or seals as required by the test report will be installed with the limit switches. The limit switches located outside the containment that will not be exposed to HELB conditions will not require seals.

4. EQRE HE-4 - Safety-Related Valve Electric Motor Operators: Qualification Group B

   The motor operators located outside the containment in harsh radiation environment are to be qualified by this EQRE. Radiation levels specific to the actuator location in Zone A13C have been calculated

to reduce the specified radiation levels from $1X10^7$ rads to a maximum of $3.7X10^6$ rads (including 10% margin) which is enveloped by the test level of $4X10^6$ rads.

5. EQRE ESE-1 - Pressure Transmitters: Qualification Group A

   Evaluation of the test reports is based on data for the transmitters to be installed. The transmitters currently installed will be replaced with models identical to the ones qualified under the Westinghouse generic program which have already been shipped to the Byron Station.

6. EQRE ESE-3 - Differential Pressure Transmitters: Qualification Group A

   Evaluation of the test reports is based on data for the transmitters to be installed. The transmitters currently installed will be replaced with models identical to the ones qualified under the Westinghouse generic program which have already been shipped to the Byron Station.

QUESTION 270.9

"The description of the qualification program for safety-related mechanical equipment in Section 3.11 of the FSAR is not sufficient for demonstrating compliance with General Design Criteria 1 and 4 of Appendix A and Sections III, XI, and XVII of Appendix B to 10 CFR Part 50. Provide the following additional information for our review:

a. Confirmation that harsh environment mechanical components in the safety-related systems identified in your June 17, 1982 submittal for electrical equipment have been included in a design verification program.

b. The criteria utilized for demonstrating qualification of the equipment and their bases.

c. The current status of this equipment with respect to the above requirements. If design verification to the applicable criteria is complete, so indicate. If additional review and evaluation are required, described the tasks to be performed and the schedule for their completion."

RESPONSE

a,b. Response to parts a and b have previously been sent to the NRC on January 14, 1983 (See CECo letter to the NRC, T. R. Tramm to H. R. Denton, dated January 14, 1983).

c. The program for BOP equipment is about 30% complete and is scheduled to be completed by March, 1985.

QUESTION 270.10

"Equipment whose design adequacy cannot be confirmed by fuel load must be justified for interim operation until qualification is complete. The information needed to justify interim operation is defined in the proposed rule 50.49 (issued in January) and is required a minimum of sixty days prior to fuel load."

RESPONSE

Equipment which is not fully qualified to Category I of NUREG-0588 by fuel load will be justified for interim operation until qualification is complete.

SUMMARY SHEET FOR INSTRUMENT CABLES

TYPES OF EQUIPT.	SPECIFICATION NO.	QUALIFICATION TEST REPORT NO.
Multi-conductor, paired, stranded/solid, shielded & jacketed instrument cables 600V & below	F/L-2852	Qualification test of electric cables under simulated LOCA/DBE by sequential exposure to environments of radiation, thermal aging, steam & chemical spray (Samuel Moore-Dekoron Division)

MANUFACTURER	MODEL NOS.
Eaton Corp. - Samuel Moore Operations Dekoron Division	Trade Name - Dekorad Cables

ENVIRONMENT SPECIFIED

	Temp. (°F)	Relative Humidity (%)	Press (psig)	Max. Integ. Exposure (Rads)
Normal	65-122	70	-0.1 to +0.3	
Abnormal	NA	NA	NA	NA
Accident.	320^{O}/10-180 sec. 270^{O}/5-20 min. 170^{O}-155^{O}/1-20 days 155^{O}/120-365 days	100	50/0-20 min. Saturated-Up to 1 yr.	$2.0X10^{8}$

Chemical Spray: 0.15 GPM/ft^2 of sprayed surface area
Alkaline NaOH/Boric Acid, pH-8.5 to 10.5

SUMMARY SHEET FOR INSTRUMENT CABLES (CONT'D)

ENVIRONMENT QUALIFIED

	Temp (°F)	Relative Humidity (%)	Press (psig)	Max. Integ. Exposure (Rads)
Normal	127			25 MRads
Abnormal	340-0 to 3 hrs. 240-3 to 5 hrs. 340-5 to 8 hrs. 320-8 to 11 hrs. 300-11 to 15 hrs. 250-15 hrs. to 4 days 200-4 to 100 days	100	105-0 to 3 hrs. atm - 3 to 5 hrs. 105-5 to 8 hrs. 75- 8 to 11 hrs. 55-11 to 15 hrs. 15-15 hrs. to 4 days 10-4 to 100 days	175 MRads NOTE: Total radiation dose at LOCA- 200 MRads.

Chemical Spray Rate - 0.15GPM/FT^2 of solution:

Start 20 secs. after steam exposure and continue up to 30 days — 3000ppm H_3BO_3; 0.064 molar $Na_2S_2O_3$ buffered with NaOH to a ph of 9-11

OPERABILITY REQUIREMENT

Cables must be capable of carrying its electrical loads/signals with neither loss of continuity nor loss of shielding from outside interference capability at specified normal and abnormal environment for a 40 yr. life.

Additionally, must be capable of withstanding a DBE and 1 yr. Post/DBE without degrading its electrical capability below specified requirement.

OPERABILITY DEMONSTRATED

The tested cables demonstrated their capability of performing its required function after a simulated 40 yr. life at the specified normal and abnormal service condition.

During the simulated LOCA environment tested cables withstood the simulated environment without degradation to its electrical capability below specified requirement.

QUALIFICATION METHOD

The qualification of cables was by type test summarized as follows:

Test Samples - A total of 12 samples, of which two (2) represent the cables supplied at Byron/Braidwood Stations. These two were; 16 gauge; 7 strand tinned copper conductors with 20 mil EPDM extruded primary insulation; 10 mil Hypalon extruded conductor jacket; conductors twisted together; 0.85 mil aluminum/mylar tape shield (25% overlap) and 16 gauge, 7 strand tinned copper drain wire; 45 mil Hypalon extruded outer jacket. Total length of each is 35 feet.

NOTE: The cables supplied to Byron and Braidwood facilities have much higher capabilities than the test specimen as they are made with 3.0 mil Alum/mylar tape shield as compared to the samples 0.85 mil Alum/mylar tape shield.

Thermal Aging - Six (6) of the specimen were aged at Samuel Moore facilities at 121°C for 7 days which were calculated using Arrhenius principle to have an equivalent life of 40 years at an ambient temperature of 127°F.

Radiation Aging - Initial radiation exposure to the specimen was at a total of 25.5 MRads, which was accomplished by exposing specimen for 34.0 hrs. at a dose rate of 0.75 MRads/hour. Next irradiation was done by exposing samples to a rate of 0.75 MRads/hr. for 234.4 hours which has a total of 175.8 MRads.

Total integrated dose of radiation exposure from a Co-60 gamma source for the samples is 200 MRads.

Seismic - Not Applicable.

LOCA SIMULATION

Performance/Acceptance Criteria - Test Samples must (a) carry connected load at rated voltage during the LOCA exposure duration, (b) withstand the Post LOCA withstand test (40XOD bend), and dielectric withstand test as outlined in IEEE 383 paragraph 2.4.4.

Variables Monitored - Temperature, pressure, relative humidity, voltage, current and insulation resistance were monitored. After LOCA simulation, voltage withstand test at 2X rated voltage and 80 VAC/mil per IEEE 383 was conducted on the cables.

Test Equipment - Appendix B to Isomedix Test Report lists the instruments used at Isomedix and their corresponding calibration.

Test Results - Values from each test conducted demonstrates the specimen capability to withstand the environment simulated without loss of electrical continuity and insulation capability.

FLAME TEST - Test cables passed the fire testing of IEEE 383 Sects. 2.5.4 & 2.5.6. Therefore, cables will not propagate fire.

QUALIFIED LIFE - Cables have an equivalent life of 40 years of continuous operation at 127°F Ambient.

TEMPERATURE - The subject cables are qualified for ambient temperature of 127°F.

RELATIVE HUMIDITY - The cables are qualified for 100% RH.

RADIATION - Per Radiation Certification from Isomedix, the total radiation dose the cables withstood was 201.3 MRads. Thus, it is qualified for 200 MRads at a dose rate of 0.75 Rads/hr.

PRESSURE - Specimens were subjected to a pressure environment that envelopes specified. Therefore, subject cables are qualified to specified pressures.

LOCA - Temperature, pressure, relative humidity and chemical spray specified were all enveloped by the simulated environment. Total LOCA duration was 100 days as against specified 365 days. The above shorter duration was justified by a more severe condition (2-340°F, 100 psig peak). Calculations using the Arrhenius principle applied to the consumed life ratio presented in the report justified the 100 days LOCA duration.

MARGIN - The LOCA simulation had; +15°F margin over specified, 110% on pressure, 278.6% Post LOCA exposure.

CONCLUSION - Based on the above simulated test, we therefore conclude that the testing demonstrates a 40 year qualified life for inside containment at the Byron/ Braidwood Nuclear Stations.

SUMMARY SHEET FOR OKONITE CABLES

TYPE OF EQUIPMENT	PROCUREMENT SPECIFICATION	SAFETY CATEGORY	LOCATION
600V Cable	F/L-2823	Will experience design basis accident and must function to mitigate said accident	Auxiliary Bldg Containment

MANUFACTURER	MODEL NO.	QUALIFICATION REPORT NO.
Okonite	Okonite EPR Insulated Cable	Okonite Report No. NQRN-1A

ENVIRONMENT

	Temp(°F)	Relative Humidity(%)	Press(psig)	Maximum Integrated Exposure(rad)
Normal	122	20-50	-0.1 to 0.3	1.1×10^7
Abnormal	NA	NA	NA	NA
Accident 320°/10-180 secs. 270°/5-20 min. 170°-155°/1-20 days 155°/120-365 days		100	50/0-20 min. saturated/ 20 min-1yr.	

ENVIRONMENT QUALIFIED

	Temp(°F)	Relative Humidity(%)	Press(psig)	Maximum Integrated Exposure(rad)
Normal	122	100%	Atm	-
Accident	345-3hrs 345-3hrs 335-3hrs 315-4hrs 265-3days, 9hrs 212-126 days	Saturated Steam	112-3hrs 112-3hrs 95-3hrs 69-4hrs 24-3days, 9hrs 0-126days	2×10^8

Chemical: Spray — Alkaline NAOH/Boric Acid, pH-8.5 to 10.5 Spray Rate of .15 GPM/Ft.^{2} of surface area sprayed.

Chemical: Spray — .28 molar H_3BO3
.064 molar $Na_2S_2O_3$
NaOH approx. .59% to make pH of 10.5 @ 77°F
Spray Rate - 0.5GPM/Ft.^{2} of sprayed surface.

OPERABILITY REQUIREMENT

Cables are required to carry their rated electrical loads under normal service conditions without loss of electrical continuity over a 40 year life plus accident and 1 year post LOCA environment.

OPERABILITY DEMONSTRATED

The qualification report demonstrates that the cables will perform their intended functions under normal and accident conditions.

QUALIFICATION METHOD:

Qualification was by type testing summarized as follows:

Test Sample - 1/c unjacketed 600V, #12, 7x, tinned copper, .030" extruded Okonite (EPR) insulation. Two 25 ft samples: one unaged, one thermally aged.

Thermal Aging - The cable sample was thermally aged for 3 weeks at 150°C in order to simulate 40 yrs. at 90°C (50°C ambient with 40°C rise).

Radiation Aging - Cable samples were exposed to a minimum of 201 megarads of cobalt 60 radiation at a rate of .67 to .75 megarads per hour for 300 hours.

Seismic - Not applicable

Performance/Acceptance Criteria - Sample must a) maintain electrical load through entire LOCA profile, b) withstand the 30 day and 130 day post-LOCA voltage withstand test ((40xOD) bend, 80V.mil ac) in accordance with IEEE 383-1974.

Variables Monitored - During testing: temperature, pressure, voltage and current are monitored. In addition, capacitance, % PF and IR tests were performed prior to and after testing. A dielectric test was also performed after 130 day post LOCA simulation.

Test Equipment - The instruments used during testing are listed in Appendix Five of the report. Calibration records are available at manufacturer for audit upon request.

Test Results - Values for the variables monitored during testing demonstrate that the cable samples maintained their electrical continuity throughout the required testing.

Anomalies -

1. The accident environment to which the cables were subjected, envelope the required temperature ramp for the first 21 hours. The specified environment requires an additional 1 year at 150°F. The samples were subjected to 3 days 9 hours at 265° and 126 days at 212°F following the initial 15 hours. Based on the Arrhenius technique, the 126 days at 212°F is equivalent to 10 years at 150°F.

Maintenance & Surveillance - None required

Flame Test - Samples were subjected to and passed the flame test in accordance with IEEE 383-1974.

CONCLUSION:

Time - The subject cables are qualified for 40 years of continuous operation.

Temperature - The subject cables are qualified for a service temperature of 90°c (50°c ambient, 40°c rise)

Radiation - The subject cables were exposed to 201-225 megarads applied in 300 hours at a rate of .67 to .75 megarads/hour. Cables are considered qualified for the specified $2x10^8$ rads.

Pressure - The cables were subjected to a pressure environment which envelopes the specified pressures and are considered qualified for same.

Humidity - Through exposure to saturated steam during LOCA testing, the cables are considered qualified for the required maximum 100% relative humidity.

LOCA - The test profile envelopes the requirements of time, temperature, humidity and pressure. The cables are qualified for the peak temperatures of 325°F with 6.1% margin and peak pressure of 50 psig with 100% margin. The cables are qualified for the post LOCA exposure of 150°F for one year with 1000% margin on time or 28% margin on temperature.

We conclude, based on the above, that the testing performed demonstrates a 40 year qualified life for inside containment at the Byron/Braidwood Nuclear Stations.

BYRON/BRAIDWOOD - UNITS 1 & 2
SUMMARY SHEET FOR 600V POWER & CONTROL CABLE
(ROCKBESTOS FIREWALL SIS)

TYPE OF EQUIPMENT	PROCUREMENT SPECIFICATION	SAFETY CATEGORY	LOCATION
600V Switchboard wire	F/L-2823	Will experience design basis accident and must function to mitigate said accident	Containment/Auxiliary Building

MANUFACTURER	MODEL NO.	QUALIFICATION REPORT (Rockbestos)
Rockbestos	Firewall SIS	Qualification of Firewall III Class 1E Electric Cables

ENVIRONMENT SPECIFIED

	Temp(^{o}F)	Relative Humidity(%)	Press(psig)	Maximum Integrated Expos.(rad)
Normal	122	20-50	-0.1 to 0.3	
Abnormal	NA	NA	NA	NA
Accident:				
	320°/10-180 secs. 270°/5-20 mins. 170°-155°/1-20 days 155°/120-365 days	100	50/0-20 min. saturated/20 min-1yr.	

Chemical Spray: Alkaline NAOH/Boric Acid ph 8.5-10.5 At a rate of 0.15 GPM/ft^2

ENVIRONMENT QUALIFIED

	Temp(^{o}F)	Relative Humidity(%)	Press(psig)	Maximum Integrated Expos.(ra
Normal	122	100	ATM	
Accident:				
	346(2)3hr.		113	$2x10^8$
	335+315+265 3hr 4hr 3days 9hrs		93-69-28	
	212-26days		0	
	200-100 days (See Anomaly #1)	100		

Chemical Spray: Boric Acid Spray, 9-11ph at rate of .15 gal/min/ft^2

OPERABILITY REQUIREMENT

Cables are required to carry their rated electrical loads under normal service conditions without loss of electrical continuity over a 40 year life plus accident and one year post LOCA environment.

OPERABILITY DEMONSTRATED

The qualification report demonstrates that the cables will perform their intended functions under normal and accident conditions.

ACCURACY/RESPONSE TIME REQUIREMENT — N/A

ACCURACY/RESPONSE TIME DEMONSTRATED — N/A

QUALIFICATION METHOD:

Qualification was by type-testing summarized as follows:

Test Sample - 1/c #12, 600V, 30 mils of Flame Retardant XLPE Insulation. Three samples of 10 ft.

Thermal Aging - The cables were thermally aged for 1300 hours at 150°C to simulate 40 years life at 90° (50°C Ambient, 40°C rise).

Radiation Aging - Cable samples were exposed to a minimum of 201 megarads of cobalt 60 radiation at a rate of .65/.78 megarads per hour for 78/188 hours.

Seismic - Not Applicable

Performance/Acceptance Criteria - Sample must a)maintain electrical load through entire LOCA profile, b)withstand the 30 day and 100 day post-LOCA voltage withstand test ((40XOD) bend, 80V/mil ac) in accordance with IEEE 383-1974.

Variables Monitored - During testing: temperature, pressure, voltage and current are monitored.

Test Equipment - The instruments used during testing are listed in Appendix VII attached to Rockbestos letter dated April 29, 1982. Calibration records are available for audit on request at Rockbestos Company at Newhaven, Connecticut.

Test Results - Values for the variables monitored during testing demonstrate that the cable samples maintained their electrical continuity throughout the required testing.

Anomalies -

1. The accident environment to which the cables were subjected, envelope the required temperature ramps for the first 30 days. The specified environment requires an additional one year at 150°F. The samples were subjected to 100 days at 200°F following the initial 30 days. Based on the Arrenius technique, the 100 days at 200°F is equivalent to eight years at 150°F. Therefore, it is qualified at the specified temperature and time.

Maintenance & Surveillance - None Required

CONCLUSION

Time - The subject cables are qualified for 40 years of continuous operation.

Temperature - The subject cables are qualified for a service temperature of 90°C (50°C ambient, 40°C rise)

Radiation - The subject cables were exposed to 201 megarads applied at a rate of .65 to .78 megarads/hour. Cables are considered qualified for the specified $2x10^8$ rads

Pressure - The cables were subjected to a pressure environment which envelopes the specified pressures and are considered qualified for same.

Humidity - Through Post-LOCA exposure of 100% Relative Humidity at 200°F for 100 day , the cables are considered qualified for the required maximum 100% Relative Humidity.

LOCA - The test profile envelopes the requirements of time, temperature, humidity and pressure. The cables are qualified for the peak temperatures of 325°F with 6.1% margin and peak pressure of 50 psig with 100% margin. The cables are qualified for the post LOCA exposure of 150°F for one year with 800% margin on time and 19% margin on temperature.

We conclude, based on the above, that the testing performed demonstrates a 40 year qualified life for inside containment at the Byron/Braidwood Nuclear Stations.

BYRON/BRAIDWOOD - UNITS 1 & 2

SUMMARY SHEET FOR TERMINAL BLOCKS

MANUFACTURER	MODEL NO.	QUALIFICATION REPORT
Marathon	Series 6000 & 1600	Wyle Report No. 45C11-1

ENVIRONMENT SPECIFIED

	Temp. (^{o}F)	Relative Humidity(%)	Press(psig)	Maximum Expos.(rads)
Normal	122	20-50	-0.1 to 0.3	$2x10^{8}$
Abnormal:	NA	NA	NA	NA
Accident:	320°/10-180 secs. 270°/5-20 min. 170°-155°/1-20 days 155°/120-365 days	100	50/0-20 min. saturated/ 20 min/1 yr.	

Chemical Spray: Spray rate of .15 GPM/ft^2 of sprayed surface
Alkaline NaOH/Boric Acid pH between 8.5 & 10.5

SUMMARY SHEET FOR TERMINAL BLOCKS (CONT'D)

ENVIRONMENT QUALIFIED

	Temp. (F^o)	Relative Humidity(%)	Press(psig)	Max. Integ. Exposure(RADS)
Normal	122	0-90	-0.1-0.3	Included in Accident
Abnormal	345-1st 3hr. 345-2nd 3hr. 325-next 3hr. 250-following 3hr. 325-last 27hr.		50-1st 3hr 50-2nd 3hr. 45-next 6hr 25-following 3.5hr 20-last 27hr.	

Chemical Spray:

Alkaline NaOH/Boric Acid
pH between 8.5 and 10.5.
Due to facility limitation, which has been concurred, the initial apray rate for the 1st and 2nd 3hr was approximately 0.04 gpm/ft^2; at the 6hr point was increased to 0.5 gpm/ft^2.

OPERABILITY REQUIREMENT

Terminal blocks should be capable of performing its required function which is to conduct, insulate, isolate and terminate electricity under normal nuclear plant service conditions over a 40 year life and in addition, be able to withstand a DBA and DBE/OBE without degrading its required function.

OPERABILITY DEMONSTRATED

The test report, demonstrates the terminal blocks (Series 1600 and 6000 type 6012 DJ, 600V, 75A, fixed barrier, 12-point) capacity to perform its required function up to 40 years at normal nuclear plant environment and withstand a DBA and DBE/OBE without degrading its integrity to perform requirement.

QUALIFICATION METHODS

Performance/Acceptance Criteria: Specimen must: (a) Maintain a safe insulation resistance value throughout the entire LOCA profile, (b) pass the post LOCA continuity and insulation resistance test, (c) pass the post radiation and thermal aging insulation resistance and continuity tests.

Variables Monitored: Temperature, pressure, continuity and leakage current were monitored during the test. Insulation resistances were also measured after thermal aging, radiation exposure, seismic and LOCA simulation.

Test Results: Visual inspections and values obtained during and after each test demonstrates the specimens capability and endurance to the simulated environments.

Maintenance & Surveillance: Non Required

Thermal Aging: Specimens have been thermally aged at an accelerated aging temperature of 120°C for 932 hours.

Pressure: Test specimens were subjected to pressure environment that enveloped specification.

Humidity: On the qualification plan, it was justified that Relative Humidity has negligible affect on the specimen aging. In LOCA simulation however, the introduction of chemical spray into the chamber demonstrated that the terminal blocks are qualified for 100% RH.

CONCLUSION

Qualified Life: Specimen having been subjected to an accelerated aging temperature at 120°C for 932 hours simulated 88 years of life at 122°F.

Temperature: The subject terminal blocks are qualified to an ambient temperature of 122°F.

Relative Humidity: Introduction of spray during LOCA, demonstrated that the terminal blocks are qualified for 100% RH.

Radiation: Specimen having been irradiated to 200 M Rads is therefore qualified at that radiation dose.

LOCA: Specified LOCA temperature, pressure, RH and chemical spray were all enveloped by the simulated. Total duration was however less (27 hours). The shorter duration was justified by a more severe environmental condition (2 peaks at 345°F for 3 hours each and 50 psig). Calculation using Arrhenius principle, using lowest activation energy of all of the components of the specimen has resulted in an equivalent duration of three years at the specified 325°F.

Based on the above, we therefore conclude that the testing performed demonstrated a 40-year qualified life for inside containment at the Byron/Braidwood Nuclear Station.

BYRON/BRAIDWOOD - UNITS 1 & 2
SUMMARY SHEET FOR INSTRUMENT CABLE SPLICES

TYPE OF EQUIPMENT

Nuclear penetration splice kit made of Raychem's WCSF materials

SPECIFICATION NO.

F/L-2852

QUALIFICATION REPORT NO.

Raychem Final Report F-C4033-3

MANUFACTURER

Raychem Corporation

MODEL NOS.

WCSF-115-6-N and WCSF-200-6N (Test specimen)
WCSF-070-N, WCSF-650-N) Byron/Braidwood supplied
WCSF-300-N, WCSF-200-N) splice kits (rated 1kv)

ENVIRONMENT SPECIFIED

	Temp. (F^{O})	Relative Humitidy(%)	Press (psig)	Max. Integ. Exposure (Rads)
Normal	65-122	70 0.	-0.1 to +0.3	
Abnormal	NA	NA	NA	NA
Accident	320^{O}/10-80 sec. 270^{O}/5-20 min. 170^{O}-155^{O}/1-20 days 155^{O}/120-365 days		50/0-20 min. saturated/ 20 min-lyr.	2×10^{8} w/max rate 1.6×10^{6}/hr.

Chemical Spray:

Spray rate - 0.15 GPM ft.^{2} of sprayed surface area

SUMMARY SHEET FOR INSTRUMENT CABLE SPLICES (CONT'D)

ENVIRONMENT QUALIFIED

	Temp. (°F)	Relative Humidity %	Press (psig)	Max. Integ. Exposure (Rads)
Normal	194			5×10^7
Abnormal	351-1st 10 hr. 275-next 4.5 days 212-next 26 days	Sat. Steam	70-1st 10 hr. 31-next 4.5 days 10-next 26 days	1.5×10^8 Note: 203.75 MRads. TID per radiation certification

Chemical Spray:

Spray rate - 0.15 GPM/Ft.^{2} of spray area
Duration - simultaneous with steam and irradiation up to 30 days.
Composition - solution of: 3,000 ppm of $H_3\ BO_3$
0.064 molar $Na_2S_2O_3$ adjusted with
NaOH to pH of 9.5 to 11.0.

OPERABILITY REQUIREMENT

Splice kit material must be compatible with cable insulation within the cables specified normal and abnormal environment up to the normal plant life of 40 years. Additionally, splice kit materials must be capable of withstanding a DBE and up to a year of post DBE environment without degradation of its integrity to perform its required function.

OPERABILITY DEMONSTRATED

The results of the test conducted by the cable manufacturer (Samuel Moore-Eaton), which include thermal aging, irradiation and LOCA simulation using the cable's qualification test parameters, demonstrates compatibility between splice kit material and cable. Qualification test conducted by splice kits manufacturer (Raychem), using specimens of different types of splices, sizes and cable products, but with splice kit material (WCSF) the same as that supplied to Byron/Braidwood demonstrates the splice kit material capability to withstand harsher simulated accident environment.

The splice kits manufacturer's test also simulated the equivalent to a 40 year normal nuclear power plant life plus a LOCA and a post-LOCA of one year duration.

QUALIFICATION METHOD

Both compatibility demonstration and qualification test of splice kits were by type test summarized as follows:

Test Samples: Compatibility test samples consist of 2/C #16 7 strand tinned copper conductors with a splice on one (1) conductor (black) overlapped by a splice on the jacket; another sample was 2/C #16 tinned, 7 strand copper conductors with both conductor spliced. Raychem's WCSF-070-N sleeves were slipped over the reconnected conductors and WCSF-200-N sleeving was slipped onto the cable over splice area.

Qualification test by Raychem had six (6) specimen of different size cables using different type connectors. On all of the specimen Raychem's Thermofit WCSF splice kits were used.

Thermal Aging: Qualification test commenced with combined thermal (150°C) and radiation aging for seven (7) days. With 50% retention of original elongation as end of the life, an Arrhenius plot was constructed on which the accelerated aging temperature of 150°C has an equivalent life of 40 years @ 90°C. The heat of activation for the thermal oxidation of WCSF compound was calculated to be 29K cal/mole.

Cable manufacturer compatibility test also thermally aged their spliced specimen at 121°C for 7 days. Using Arrhenius equation this is calculated to be equivalent to 40 years at 127°F.

Radiation Aging: Qualification test had radiation aging simultaneous with thermal. Total exposure 5×10^7 Rads - Compatibility test had their samples irradiated prior to thermal aging. Total accumulated dose was 25 MRads gamma.

Seismic: Not Applicable

LOCA SIMULATIONS

Performance/Acceptance Criteria: **Compatibility test** - Test samples must show that no detrimental affect would occur between the cables and the splice materials during and after the simulated environments.

Qualification Test: Test samples must (a) Maintain electrical load during the simulation, (b) pass insulation resistance test, (c) pass high-potential test after performed bending requirement and (d) pass both (b)& (c) tests while immersed in water.

Variables Monitored: Both test (compatibility and qualification) monitored similarly temperature pressure, relative humidity, current and insulation resistance. Both tests also had their test samples energized and loaded during test. At the conclusion of their respective test, both also had their samples subjected to the IEEE 383 standard post LOCA test.

Environment Simulated: **Compatibility test** - Test samples underwent an accident radiation dose of 175.8 MRads. prior to exposure to LOCA simulation. LOCA simulated profile all enveloped specified parameters. Post LOCA duration of 26 days as compared to 1 year specified is, justified by a higher temperature maintained during post LOCA (200°F, 10 psig tested vs. 150°F, 5 psig specified). The tested environment had an equivalent of 17.71% of qualified life consumed, whereas specified environment has 5.5% of qualified life consumed.

Qualification test - Raychem test samples were exposed to a simultaneous environment of steam, chemical spray and radiation dose of 1.5×10^8. LOCA simulated profile enveloped specified parameters. Post-LOCA duration of 26 days as compared to 1 year specified is, however, justified by a higher temperature maintained during post LOCA simulated (212°F, 10 psig tested vs. 150°F, 5 psig specified).

Both tests had their respective samples thermally and radiation aged prior to this test.

Test Results: Values from both tests demonstrates that no detrimental effects occur between splice materials and cable insulating materials. The bend (40 x OD) tests results further demonstrate splice capability to withstand simulated environment without detrimental effect.

Time: Compatibility test subjected the test samples to an accelerated aging temperature of 121°C for 7 days. Using Arrhenius equation, this is equivalent to 40 years at an ambient temperature of 127°F.

Qualification test by Raychem aged their specimen, WCSF compound, at 136°C, 150°C, 162°C and 175°C for 4,500 hours, 1,570 hours, 521 hours and 194 hours respectively where retention of original elongation was 50% (considered end of life). Based from Raychem's Report EDR 2001 (8/10/78) calculation, the specimen (WCSF compound) has an equivalent life of 40 years at a service temperature of 90°C.

Temperature: The subject splice kits are qualified for a service temperature of 90°C. Compatibility test had a qualified compatibility temperature of 127°F ambient.

Relative Humidity: Splice kits were exposed to a saturated steam environment, thus it is qualified at specified 100% RH.

Radiation: Certification of radiation from Isomedix indicated that Raychem's Qualification test samples had a T.I.D. of between 197.7 to 209.8 MRads. Dose rates were approximately 0.224 MRads/hr.

Compatibility test samples which were also irradiated at Isomedix had a T.I.D. of 200 MRads. Dose rates were 0.75 MRads/Hr. for aging and DBE. Therefore, splice kits are qualified at specified radiation dose of 200 MRads.

Pressure: The splice kits are considered qualified to 70 psig.

Conclusion: It is concluded that both the qualification and compatibility test demonstrate a 40 year qualified life for inside containment at the Byron/Braidwood Nuclear Stations.