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AUDIT OF THE ENVIRONMENTAL QUALIFICATION OF SAFETY-
RELATED ELECTRICAL EQUIPMENT AT THE BYRON UNITS 1
AND 2 AND BRAIDWOOD UNITS 1 AND 2

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AUDIT OF THE ENVIRONMENTAL QUALIFICATION OF
SAFETY-RELATED ELECTRICAL EQUIPMENT AT
BYRON UNITS 1 AND 2, AND BRAIDWOOD UNITS 1 AND 2

Docket Nos. 50-454, -455, -456, and -457

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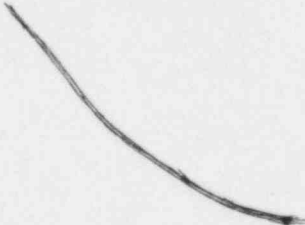
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ABSTRACT

Byron Units 1 and 2, and Braidwood Units 1 and 2 were audited to determine the environmental qualification of safety-related electrical equipment. Results of the audit are summarized in this report.



NRC FIN No. A6415--Equipment Qualification Case Reviews

SUMMARY

An audit of the environmental qualification of safety-related electrical equipment at Byron Units 1 and 2, and Braidwood Units 1 and 2 was conducted by a team composed of representatives of the Reliability and Statistics Branch of EG&G Idaho, Inc., and the Nuclear Regulatory Commission (NRC) staff. Qualification deficiencies for individual equipment items are provided in Appendix A. Summaries of the central file reviews are provided in Appendix B. It was concluded from the audit that the applicant must supply additional information to the staff before a determination of acceptability can be made.

FOREWORD

This report is supplied as part of the "Equipment Qualification Case Reviews" being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Engineering, Equipment Qualification Branch by EG&G Idaho, Inc., Reliability and Statistics Branch.

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AUDIT OF THE ENVIRONMENTAL QUALIFICATION OF
SAFETY-RELATED ELECTRICAL EQUIPMENT AT
BYRON UNITS 1 AND 2, AND BRAIDWOOD UNITS 1 AND 2

1. INTRODUCTION

Equipment which is used to perform a necessary safety function must be demonstrated to be capable of maintaining functional operability under all service conditions postulated to occur during its installed life for the time it is required to operate. This requirement, which is embodied in General Design Criteria 1 and 4 of Appendix A and Sections III, XI, and XVII of Appendix B to 10 CFR 50, is applicable to equipment located inside as well as outside containment. More detailed requirements and guidance relating to the methods and procedures for demonstrating this capability has been set forth in 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," and NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." This NUREG supplements IEEE Standard 323-1974, and various NRC Regulatory Guides and industry standards.

On June 21-24, 1983 a team comprised of representatives of the Reliability and Statistics Branch of EG&G Idaho, Inc., and the NRC staff conducted an audit of the environmental qualification of safety-related electrical equipment for Byron Units 1 and 2, and Braidwood Units 1 and 2 Nuclear Stations. The work effort consisted of: (1) a pre-audit review of the licensee's submittal, (2) an audit of the licensee's central files for selected equipment items, and (3) an onsite visual inspection of the equipment items at Byron Units 1 and 2. Qualification deficiencies for individual equipment items are provided in Appendix A. Summaries of the central file reviews are provided in Appendix B.

2. BACKGROUND

NUREG-0588 was issued in December 1979 to promote a more orderly and systematic implementation of equipment qualification programs by industry and to provide guidance to the NRC staff for its use in ongoing licensing reviews. The positions contained in this report provide guidance on (1) how to establish environmental service conditions, (2) how to select methods which are considered appropriate for qualifying equipment in different areas of the plant, and (3) other specific topics such as margin, aging, and documentation.

In February 1980 the NRC requested certain near term Operating License (OL) applicants to review and evaluate the environmental qualification documentation for each item of safety related electric equipment and to identify the degree to which their qualification programs comply with the staff positions discussed in NUREG-0588. IE Bulletin 79-01B "Environmental Qualification of Class 1E Equipment," issued January 14, 1980, and its supplements dated February 29, September 30, and October 24, 1980 established environmental qualification requirements for operating reactors. This bulletin and its supplements were provided to OL applicants for consideration in their review. A final rule on environmental qualification of electric equipment important to safety for nuclear power plants became effective on February 22, 1983. This rule, Section 50.49 of 10 CFR Part 50, specifies the requirements to be met for demonstrating the environmental qualification of electrical equipment important to safety located in a harsh environment. In accordance with 10 CFR 50.49, the electrical equipment in Byron Units 1 and 2, and Braidwood Units 1 and 2 may be qualified in accordance with the acceptance criteria specified in Category I of NUREG-0588.

The qualification requirements for mechanical equipment are principally contained in Appendices A and B of 10 CFR 50. The qualification methods defined in NUREG-0588 can also be applied to mechanical equipment.

3. PURPOSE

The purpose of this audit is to evaluate the adequacy of Byron Units 1 and 2, and Braidwood Units 1 and 2 environmental qualification program for electric equipment important to safety as defined in 10 CFR 50.49, and for safety-related mechanical equipment. A discussion of open items, as well as any unresolved issues, is provided in this report.

4. SCOPE

The scope of this report includes an evaluation of the completeness of the list of equipment to be qualified, the criteria which they must meet, the environments in which they must function, and an assessment of the qualification documentation for the equipment. The principal area of review was the qualification of safety-related equipment which must function in order to prevent or mitigate the consequences of a loss-of-coolant accident (LOCA) or high energy line break (HELB) inside or outside of containment, while subjected to the harsh environments associated with these accidents.

5. EVALUATION

General areas of concern which remain as a result of both the audit and the pre-audit review are as follows:

1. During the plant walkdown, it was noted that some equipment items that were located below flood level were not qualified for submergence during a LOCA. These items need to be either relocated above flood level or qualified for submergence. The applicant must conduct a plant walkdown inside containment and identify all essential equipment and interfaces which are below flood level and provide documentation to show: (a) items not qualified for submergence have been relocated above flood level and (b) items not relocated, that have not previously been qualified for submergence, are now qualified.

2. The Qualification Data Sheets (QDS) did not reflect current information (i.e. specified environments), did not agree with equipment installed, did not agree with their respective data sheets and lacked information regarding submergence and equipment environment (harsh vs. mild).

The applicant agreed there were problems with the data sheets but had not determined corrective action by the end of the audit. These discrepancies should be addressed, and corrective action documented and made available for review.

3. The QD sheets for additional equipment items, including TMI Action Plan Equipment and generic electrical items, were not available.

Specific areas of concern regarding the equipment that was reviewed during the audit are:

1. Confirmation that Rosemount 1153 Series B transmitter will be replaced at proper intervals should be provided.
2. Comparison of the postulated chemical spray conditions with the actual tested conditions for the Reliance fan motor for Reactor Containment Forced Cooling (RCFC) is required. This comparison should be made available for review.
3. The Conax Electrical Penetrations require insulation resistance measurement data during LOCA exposure tests. The applicant indicated, during the audit, that this information was available from the vendor. This information, along with surveillance information on monitoring the long term condition of the penetrations, should be included in the plant file for qualification acceptance.
4. The Anchor/Darling Main Steam Isolation Valve file lacks information in several areas (pressure, temperature, operating

time etc.) to adequately determine qualification. This file should be reviewed in detail, revised, and made available for a re-review.

5. The Marathon 1600 series terminal block file that was reviewed only covered terminal blocks used for control circuits. This file lacked information on insulation resistance values during LOCA test conditions. Also the leakage current during the LOCA test appeared to be too high for instrumentation applications. The applicant should provide acceptable insulation resistance values as measured during LOCA conditions for those terminal blocks used for control applications and complete specifications and testing for terminal blocks used in instrumentation applications.
6. Information is required on surveillance techniques to monitor the long term condition of Okonite EPR insulated cable and Dekorad instrumentation cable located inside containment.

6. CONCLUSIONS

As a result of the audit it was concluded that the Byron Units 1 and 2, and Braidwood Units 1 and 2 environmental qualification program was not complete. The licensee must supply additional information to the staff before a determination of acceptability can be made.

7. REFERENCES

1. Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment, NUREG-0588.
2. IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations, IEEE Std. 323-1974.
3. Environmental Qualification Report for Class 1E Equipment, Byron Units 1 and 2, and Braidwood Units 1 and 2, Commonwealth Edison Co.

APPENDIX A
EQUIPMENT QUALIFICATION STATUS

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EQUIPMENT QUALIFICATION STATUS

NOTES

1. The review of the Q.D. sheets was done by selecting one or two Q.D. sheets for each different equipment type. Comments on one Q.D. sheet may apply to many more sheets.
2. Generic concerns mentioned earlier are not usually mentioned under comments.
3. Commonwealth Edison Company (CECO) evaluation codes are:

Q	Qualified
Q.I.P.	Qualification in Progress
I.J.	Interim Justification
CAT.A,B,C,D	Category designation per NUREG-0588, Appendix E.

APPENDIX A

Item Number	Equipment	Manufacturer	Model	Q.D.S Number	CECO Evaluation	Comments
1.	Limit switch	NAMCO	EA 180 Series	B156	Q	Submergence deficiency.
				B101	Q	Aging and replacement part deficiency.
			EA 170 Series	B054	Q	Operating time deficiency.
2.	Solenoid	ASCO	NP-8320A 186E	B080	Q	
			NP-8320A 183E	B131	Q	Submergence deficiency.
			NP-8320A 184E	K506	Q	
			NP-831 654E	B-150	Q	Submergence deficiency.
3.	Valve operator	Limatorque	SMB Series	A017	Q	Qualified life claimed 40 years @ 115°F, maximum normal temperature is 130°F.
				A020	Q	Westinghouse thermal lag analysis MDQ-EQ-148 (6-1-82).
			Numbered series (270571) for example	A051	Q	Thermal lag analysis (non Westinghouse?), submergence NA but elevation below flood level. Model number given appears to be serial number.
4.	Hydraulic operator	Borg Warner	P/N 38971	D000	Q.I.P.	5 second qualification time is short, 325° for 3 hours an error.
5.	Hydraulic operator	Anchor Darling		D004	Q	Documentation deficiencies in temperature, temperature profile, pressure, operating time, time period after the accident during which failure must not occur, wrong component identification, and no model number.
6.	Hydraulic operator	Borg Warner	ISO Valve	D072	I.J.	Replacement ordered, not specified or qualified.
7.	Hydraulic operator	Borg Warner	DWG No. 85460	D010	I.J.	Interim justification adequate.

APPENDIX A (continued)

Item Number	Equipment	Manufacturer	Model	Q.D.S Number	CECO Evaluation	Comments
8.	Electrical penetration	Conax		W 537	Q CAT.B	No model number, no test model number. Are penetrations all identical?
				W 655	Q CAT.A	
9.	Containment spray pump motor	Westinghouse	Frame: 5809P Type LLD	W 553	Q	Remark GRJR068 does not apply. Qualification method by analysis only.
10.	Centrifugal charging pump motor	Westinghouse	S.O. 75F 32350	W 554	Q	What has been done to qualify bearings and lubricant to 10^7 RADS? Qualification by partial type test and analysis.
11.	Junction box	Borg Warner		W 622	Q.I.P.	Junction boxes are a part of feed water isolation valves--no model number given--qualification to 0588 CAT.B while F.W.I.V. is CAT.A? Qualification figures given with no reference.
12.	Junction box	Connectron	NU-2	W 661	Q	Junction boxes are a part of main steam isolation valves, no pressure qualification, 0588 CAT.B while associated MSIV is CAT.A.
13.	Junction box	Westinghouse		W 669	CAT.C	Why is this on the equipment qualification list?
14.	Terminal block in local instrument panel in containment	System Control	Marathon 1600 series	W 705	Q	Terminal blocks used for instrumentation and control applications need insulation resistance data for control applications. Need complete test data for instrumentation applications.
15.	Junction box power range neutron detector	Westinghouse	W/L 236 86	W 672	Q.I.P.	
16.	RHR pump motor	Westinghouse	SO 74F 1282	W 735	Q	See Item 10 comments.
17.	Safety injection pump motors	Westinghouse	SO 74F 18601	W-741	Q	See Item 10 comments.
18.	Auxiliary building HVAC supply fan	Reliance	350 HP Type RB Class F	W-756	CAT D	Accident dose of 10^6 RADS does not agree with CAT.D designation.

APPENDIX A (continued)

Item Number	Equipment	Manufacturer	Model	Q.D.S Number	CECO Evaluation	Comments
19.	HVAC control panel	Johnson Controls		W 760 W 826 W 829	CAT D Q.I.P.	No model number. See Item 18 comments.
20.	Auxiliary building HVAC exhaust fan	Reliance	500 HP Class F Type RB1	W 764	Q	None
21.	Auxiliary building HVAC exhaust booster fan	Reliance	75 HP Class H Type RH	W 768	Q	None
22.	HVAC starter panel	Johnson Controls		W 789	Q.I.P.	No model number.
23.	Cubicle cooler fan	Westinghouse	3 HP Class H	W 801 W 822	Q Q	Radiation values inaccurate.
24.	Primary containment vent system RCFC fan	Reliance	Part No. 600287-52	W 859	Q	Require chemical spray flow rate and chemical composition used for environmental testing to support qualification.
25.	Level transmitter	Barton	752	B524	Mild	Q.D.S. states qualification will be addressed with mild environment equipment. It is not listed there, so it is not addressed.
26.	Radiation detectors	General Atomics	RD-23 RD-142	W006	Q.I.P.	
27.	Flow indicating switch	Barton	288A FS 35	N543	Q.I.P.	
28.	Hand switch	Westinghouse	OT2	G416	Q.I.P.	Part of Johnson Controls Qualification Program.
29.	Pressure switch	United Electric	J302-S164 PS 167	Y000	Q.I.P.	
30.	Level transmitter	Barton	764 Lot 4	B503	Q	Submergence testing still in progress, relocation possible, post LOCA accuracy of 16% ok? Should be qualification in progress.

APPENDIX A (continued)

Item Number	Equipment	Manufacturer	Model	Q.D.S Number	CECO Evaluation	Comments
31.	Pressure transmitter	Barton	763	X037	Q	See Item 30 comments.
32.	Flow transmitter	Barton	752	T588	CAT C.	Reactor coolant flow transmitters--is CAT.C correct for DBE? (LOCA)
33.	Pressure transmitter	Veritrac	76 PH2	X029	Q.I.P.	
34.	R.T.D.	RDF	DWG 21204 Rev. 10	Q216	Q	Accuracy information not supplied.
35.	Pressure transmitter	Barton	386	X005	Q.I.P.	Johnson Controls Qualification Program.
36.	Flow controller	Love	54 8187 8115	N502	Q.I.P.	Johnson Controls Qualification Program.
37.	Flow transmitter	Hays	252A	1515	Q.I.P.	Johnson Controls Qualification Program.
38.	Positioner	ITT	NH 95 NH 91	J500 J504	Q.I.P.	Johnson Controls Qualification Program.
39.	Pressure switch	Solon	7PS/7P2	A557	Q.I.P.	Johnson Controls Qualification Program.
40.	Differential pressure transmitter	Hays	T00252	A629	Q.I.P.	Johnson Controls Qualification Program.
41.	Differential pressure relay	Moore Industries	ADM M0538	A643	Q.I.P.	Johnson Controls Qualification Program.
42.	Position light	Westinghouse	EZC IL508	1010	Q.I.P.	Johnson Controls Qualification Program.
43.	Temperature switch	United Electric	C3030-103 T5504	5026	Q.I.P.	Johnson Controls Qualification Program.
44.	Instrument Cables	Eaton Corp.	Dekorad Cables	Summary Sheet	Q	Require method to monitor long term aging/ degradation.
45.	Power Cable	Okonite	Okonite EPR Insulated Cable	Summary Sheet	Q	Require method to monitor long term aging/ degradation.

APPENDIX A (continued)

Item Number	Equipment	Manufacturer	Model	Q.D.S Number	CECU Evaluation	Comments
46.	Switchboard Wire	Rockbestos	Firewall SIS	Summary Sheet	Q	None
47.	Cable Splice	Raychem Corp.	WCSF-070-N WCSF-650-N WCSF-300-N WCSF-200-N	Summary Sheet	Q	None
48.	Electrical Penetration	Bunker Ramo Corp.		W915	Q	Submergence deficiency
49.	Flow Transmitter	Rosemount	1153DP5E22PB	1539	Q	To be replaced at proper intervals.
50.	Current Relay Signal Converter	Masoneilan	8005A	M012	Q.I.P.	No data listed

APPENDIX B
SUMMARIES OF CENTRAL FILE REVIEWS

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Dekorad Instrument Cable

This cable is used throughout Byron Units 1 and 2, and Braidwood Units 1 and 2.

The specified accident parameters are: temperature, 320°F; pressure 50 psig; relative humidity, 100%; chemical spray, borated water spray, pH 8.5 to 10.5; radiation, 2.0×10^8 rads TID; and operating time, 12 months.

Environmental testing has been performed on similar cable and is reported in Commonwealth Edison Co., Environmental Qualification File 25C, for Dekorad Instrument Cable. The maximum environmental parameters to which the tested cables were exposed are: temperature, 340°F; pressure, 105 psig; relative humidity, 100%; chemical spray, 10.5 pH; radiation, 2.0×10^8 rads TID, and an operating time of 100 days with justification to encompass the specified operating time of 12 months. The cables were aged for 7 days at 121°C, and a life of >40 years at 127°F was calculated using Arrhenius methodology.

It is concluded that the Dekorad instrument cable is qualified for the specified environment. Documentation to support this conclusion is contained in the applicant's qualification file. However, the applicant should supply information on how they intend to monitor the effects of long term aging/degradation of this cable.

Reliance Fan Motor Model TEA-01 150/100 H.P.

This motor is located inside containment in environmental Zone 6. The fan motor is installed in the primary containment ventilation system and is

used to dissipate heat during normal operation and lower temperature and pressure during a DBA.

The specified accident parameters are: temperature, 320°F; pressure, 40 psig; humidity, 100%; chemical spray, borated water spray, pH 8.5-10.5; radiation, 2×10^8 rads TID; and operability time, 30 days post LOCA.

Environmental testing of a similar motor is recorded in the Joy Manufacturing Co. Test Report No. X-604 and appendices. The test parameters are temperature, 415°F; pressure; 78 psi; humidity, 100%; radiation, 2×10^8 rads TID, test duration, 423 days; aging was at 415°F for 100 hours. Testing and analysis was used to obtain a qualified life of 40 years.

A statement from the applicant concerning the chemical spray flow rate and chemical composition used for environmental testing is needed to support qualification. The applicant stated this information will be forwarded to the NRC.

Rosemount Differential Pressure Transmitter,
Model 1153 DP5E22PB, Series 1153-B

This transmitter is located in the Auxiliary Building and is used as a flow transmitter in the Auxiliary Feedwater System.

The specified accident parameters are: temperature, 140°F; pressure, atmospheric; humidity, 70%; radiation, 1×10^4 rads TID; and operability, continuous.

Environmental testing of this transmitter is recorded in Rosemount Test Report No. 108026.

The test parameters are: temperature, 318°F; pressure, 73 psig; humidity, 100%; radiation, 2.2×10^7 rads TID; test duration, 8 hours at 318°F, 58 hours at 265°F post DBE 14 days at 150°F and 23 days at 203°F; aging was at 203°F for 47 days. Test and analysis was used to develop a

qualified life of 8 2/3 years. The applicant stated the entire transmitter will be replaced at given intervals to maintain qualified equipment installation for 40 years.

It is concluded that the Rosemount Transmitter is environmentally qualified as stated and must be replaced at proper intervals.

Marathon Terminal Block Model 1600

These terminal blocks are used to terminate instrument and control cables in the local instrument panel inside containment.

The specified accident parameters are: temperature, 320°F; pressure, 50 psig; humidity, 100%; chemical spray, borated water spray, pH of 8.5-10.5; radiation, 2×10^8 rads TID; and operability time, continuous.

Environmental testing of this type of terminal block is recorded in Wyle Test Report No. 45611-1.

The test parameters are: temperature, 345°; pressure, 50 psig; humidity, 100%; chemical spray, 0.5 GPM/sq. ft. of NAOH Boric Acid with a pH of 8.5-10.5; radiation, 2×10^8 rads TID; and test duration; 27 hours at 325°F; extended to three years at 325°F by Arrhenius calculations using 2 peaks of 345°F for 3 hours each. Testing and analysis was used to obtain a qualified life of 40 years.

A remaining concern is that the applicant stated these terminal blocks are being used for instrumentation terminations as well as control applications. It appears the test was conducted for the latter because the leakage current acceptance level is excessive for the instrumentation terminations. In addition insulation resistance data during LOCA testing was not present in the test report.

Okonite EPR Insulated Cable

This cable is used throughout Byron Units 1 and 2, and Braidwood Units 1 and 2.

The specified accident parameters are: temperature, 320°F; pressure, 40 psig; relative humidity; 100%; chemical spray, borated water spray pH 8.5 to 10.5; radiation, 2.0×10^8 rads TID; and operating time, 12 months.

Environmental testing has been performed on similar cable and is reported in Okonite Report No. NQRN-1A. The maximum environmental parameters to which the tested cables were exposed are: temperature, 345°F; pressure, 112 psig; relative humidity, 100%; chemical spray, 10.5 pH; radiation, 2.0×10^8 rads TID; and operating time, 12 months. The cables were aged for 21 days at 105°C, and a life of >40 years at 90°C was calculated using Arrhenius methodology.

It is concluded that the Okonite EPR insulated cable is qualified for the specified environment. Documentation to support this conclusion is contained in the applicant's file. However, the applicant should supply information on how they intend to monitor the effects of long term aging/degradation on this cable.

Anchor Darling Hydraulic Valve Operator, Equipment No. 1MS001A

This valve operator is located in the steam tunnel and is used to actuate the main steam isolation valves. The specified accident parameters are: temperature, 325°F; pressure, 23 psig (changed to 19.7 PSI during the audit); relative humidity 100%; radiation 1.0×10^4 rads TID; and operating time, 10 seconds.

Testing on a similar actuator is detailed in Anchor Darling Test Report No. QR-10. Temperature testing was at a peak calculated value of 328°F for 3 minutes followed by 284°F for 24 minutes. A second identical cycle followed with A.C. solenoids substituted for D.C. solenoids. The test was conducted with steam at atmospheric pressure. Pressure testing

was completed by separate operational testing of a similar assembly which involved the lowering of inlet air pressure. Radiation aging at 2.5×10^6 rads TID bounded the specified dose. Accelerated thermal aging, utilizing Arrhenius methodology, showed a variable qualified life for various components. This resulted in a 40 year qualified life if certain components are changed out at specified intervals.

Documentation deficiencies included changing the specified pressure during the audit, lack of a known or specified operating time and a time that failure must not occur, lack of documentation concerning possible failure modes, erroneous identification of the wrong terminal block as a value accessory, and varied values for the temperature profiles.

In conclusion, the review indicated that inadequate information was contained in the review package to assure qualification. This file should be revised to address these deficiencies and submitted for review.

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