TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

February 19, 1985

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of)
Tennessee Valley Authority

Docket Nos. 50-390
50-391

By letter dated August 19, 1983, TVA provided, in accordance with 10 CFR 50.49 and NUREG-0588, information demonstrating compliance with the equipment qualification requirements for the Watts Bar Nuclear Plant (WBN) unit 1. By letters dated July 24 and August 14, 1984, TVA provided updated and additional information, respectively, to that submitted by the August 19, 1983 letter.

By letter dated December 20, 1984, TVA provided updated information to that submitted by the referenced letters and information formally addressing various NRC concerns and questions discussed in conference calls and meetings. As noted in the submittal, several of the NRC Staff concerns could not be fully addressed at that time due to the unavailability of information and/or the need for additional calculations/analyses.

It is TVA's understanding that the NRC Staff has completed its review of the Watts Bar unit 1 electrical equipment environmental qualification program. Questions and concerns resulting from the review have been discussed in conference calls on December 18, 1984, and January 25, February 7 and 11, 1985. The enclosure to this letter provides: (1) a discussion of the resolution or status of remaining open items discussed in the referenced conference calls (enclosure 1), (2) a thermal analysis on the use of an insulation blanket on postaccident monitoring instrumentation in the valve vault room (enclosure 2), (3) an update of equipment status concerning replacement of equipment before unit 1 fuel load (enclosure 3), and (4) justifications for interim operation (JIOs) and equipment qualification sheets (EQS) for the equipment discussed in enclosure 1 (enclosure 4).

As discussed and agreed in the conference call of February 7, 1985, TVA will provide revised or new EQSs by initial criticality for equipment required to be installed before fuel load. Formal revisions to the environmental qualification (EQ) report will be forwarded approximately three months after the issuance of the Watts Bar unit 1 operating license.

In order to avoid misinterpretations which could lead to unwarranted enforcement actions, TVA wishes to point out that TVA's preventive maintenance (PM) program entirely supersedes that information in the EQ report as a controlling document for PM requirements. Also, we wish to document our understanding that no

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Director of Nuclear Reactor Regulation February 19, 1985

extension request will be required to be submitted to NRC for that equipment which will not be fully qualified as of March 31, 1985. It is recognized, however, that adequate JIOs will be required for that equipment which is not fully qualified at the time of fuel load. These JIOs will be valid until November 30, 1985 at which time an extension request would need to be provided for any equipment which is not fully qualified.

If you have any questions concerning this matter, please get in touch with D. B. Ellis at FTS 858-2681.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. H. Shell

R. H. Shell
Nuclear Engineer

Sworn to and subscribed before me
this 19th day of Feb. 1985.

Paulette D. White
Notary Public

My Commission Expires 8-24-88

Enclosures (4)
cc: U.S. Nuclear Regulatory Commission (Enclosures)
Region II
Attn: Dr. J. Nelson Grace, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

DISCUSSION OF OPEN ITEMS

Listed below are the resolution or status of open items as mutually agreed upon between TVA and the NRC.

1. Recalculation of Primary Containment and Valve Vault Room Temperatures

   A. By letter dated Feburary 16, 1985, TVA responded to an NRC request for additional information regarding main steamline break (MSLB) accident analysis at the Watts Bar Nuclear Plant. Parts of TVA's response were prepared by Westinghouse Electric Corporation (W) who indicated that an analysis of the Watts Bar containment temperature response following a postulated MSLB was performed using a revised version of LOTIC-3 (WCAP-8354, Supplement 3) (described in detail in W's submittal to NRC dated September 10, 1984). W concluded that using the above mentioned model, the peak temperature from a postulated MSLB inside containment is less than the FSAR limiting break. Since the design temperature (327°F) was used for the environmental qualification of the affected equipment, the equipment's qualification will not be invalidated as a result of the MSLB inside containment reanalysis.

   B. A preliminary calculation based upon Catawba data for an MSLB inside the valve vault revealed a peak temperature greater than the design temperature TVA used for qualification. A safety evaluation was performed which demonstrated that all devices in the valve vault except certain post-accident monitoring (PAM) instrumentation would either fail safe or perform their safety functions before exceeding their qualification temperatures. The PAM instrumentation, as documented in EQS-NEB-XX-48, is protected from the peak temperatures by an insulation blanket which prevents the temperature at the instruments from exceeding the qualification temperature. A preliminary thermal analysis demonstrating the effectiveness of the thermal blanket is provided in Enclosure 2.

   Final resolution of this item will be provided before initial criticality.

2. NSSS Instrument Accuracies

   As previously stated in TVA's letter dated December 20, 1984, and in conference calls on January 25 and February 7, 1985, the wide range reactor coolant system pressure transmitters, steam line pressure transmitters, and containment pressure transmitters, all of which are NSSS PAM Instruments, were found not to meet the accuracy requirements established for PAM channels in FSAR 7.5-1. Nonconformance reports were written and corrective actions were determined. For the steam line pressure transmitters, the corrective actions are discussed under the comments on EQS-NEB-1-21 and -40. For the containment pressure transmitters, the corrective actions are discussed under the comments on EQS-NEB-30-27. Finally, for the wide range reactor coolant system pressure transmitters, a final 10CFR50.55(e) report was submitted to NRC on October 3, 1983 which provided justification for use of the transmitters presently installed.

3. Submergence

A safety evaluation was performed and submitted to NRC by letter December 20, 1984 on the submergence of all 10CFR50.49 equipment inside primary containment. For all submerged equipment inside containment required to operate and/or not fail for the specified Design Basis Accidents (DBA) causing the flooding, TVA has either removed the equipment, relocated the equipment above flood level, or has qualified the equipment for submergence. The only equipment required to be qualified for submergence are the wide range reactor coolant system (RCS) temperature detectors. The submergence qualified temperature detectors are to be installed before fuel load and are discussed on EQS-WBN-NEB-68-28 previously submitted to NRC.

4. Status Change List

Enclosure 3 is a list of unit 1 equipment which was status IV in table 1.1 of the October 1984 EQ report revision. All equipment on this list has either been replaced or will be replaced by fuel load or is no longer status IV for other reasons.

5. Generic Cable Qualification

In a conference call on December 18, 1984, NRC representatives stated that in general TVA's methodology of generically qualifying cables was unacceptable. However, the NRC stated that they would accept the generic qualification approach as justification for interim operation (JIO) until November 30, 1985. The JIOs for cables are contained in Enclosure 4. TVA is presently preparing a test program to fully qualify the cables. Furthermore, the Tefzel-insulated cable was omitted from this test program since TVA has informally submitted additional data to NRC consisting of a production MIL Specification and a copy of a letter to Du Pont requesting certification that all Tefzel insulation is essentially the same.

6. Resolutions of NRC Questions on Specific Equipment Qualification Sheets (EQS) in January 25 and February 7, 1985 Conference Calls

A. EEB EQSs

(1) EEB-0047

The actual elevations as requested by the NRC, not the floor elevations, are as follows for the identified devices:

1-FSV-30-15-B	EL. 737'
1-FSV-30-17-A	EL. 737'
1-FSV-30-56-A	EL. 735'
1-FSV-30-58-B	EL. 739' 8"

(2) EEB-0057 and 0073

These valve positioners are in testing at Wyle Labs. Scheduled completion date is March 1, 1985. TVA expects no problems with qualification of these devices.

(3) EEB-0058

All system 31 limit switches have been replaced with qualified switches. All system 90 limit switches will be replaced before fuel load with qualified switches.

(4) EEB-0060

All equipment in this EQS will be replaced with qualified equipment before fuel load.

(5) EEB-0076

TVA has determined that the equipment in this EQS is located in a mild environment and therefore will be removed from the 10CFR50.49 program.

(6) EEB-0085

All equipment on this EQS has been replaced with qualified equipment.

(7) EEB-0006

TVA confirms that the room mentioned in this EQS is air-conditioned at 75°F which is indicated by Note 12 on the Environmental Drawing 47E235-45 R0 (in EQ report).

(8) EEB-CSM-1

This EQS discussed the qualification of PLAS-DUX material that TVA was to use in sealing conduits. However, TVA has decided to use qualified Conax connectors instead. EQS EEB-CSM-1 was removed and replaced with the EQS EEB-CSC-1 in the last revision, stamped October 1984, of the EQ report previously submitted to NRC. EQS EEB-CSC-1 discusses the qualification of the Conax connectors.

(9) EEB-TB-1

NRC reviewed this EQS and had essentially three questions dealing with radiation, temperature, and use of Dow Corning RTV 3140 as a protective coating on the terminals of the terminal blocks (TBs). The three areas are addressed as follows:

a. Radiation - TVA had not done any radiation testing on the RTV, as stated in the EQS; however, TVA has manufacturer's radiation data on the RTV which indicated the material is acceptable for use after exposure to 1×10^8 rads. TVA is in the process of trying to obtain the necessary qualification data. If this is not possible, TVA will test the RTV before November 30, 1985. A JIO is contained in Enclosure 4.

b. Temperature - The EQS stated that the uncoated TBs were qualified to 342°F. Upon further review, TVA has determined that the uncoated TBs were only tested to 330°F, and the coated TBs to 342°F; however, both of these temperature limits envelope the maximum accident temperature of 327°F for which they must perform their safety function.

c. Use of RTV Coating on TBs - TVA uses the RTV 3140 coating on TBs located in harsh environment areas subject to moisture exposure either by conduit condensate, steam, or chemical spray.

(10) EEB-PNL-1

A thermal aging test (257°F for 1360 hours) was done on the equipment on the EQS which enveloped, with considerable margin, the design basis accident temperature of 197°F. The qualification of the equipment was based upon analysis and partial test data, as discussed on the EQS, not just analysis alone as implied by NRC in the conference call on January 25, 1985. The equipment on the EQS will be made part of TVA's Q-List and will be incorporated in TVA's maintenance and surveillance program.

(11) EEB-BD-1, -2, -3, -4 and EEB-MC-1, -2, -3, and -4

The EQSs submitted to NRC discussed in detail the construction and principles of operation on a generic basis of the circuit breakers and explained why the operation of the breakers for a cable fault during an accident will not be affected by aging or the higher temperature unless possibly speeding up the operation of the breakers.

TVA also believes that the thermal aging test discussed for EEB-PNL-1 provides additional support for the similar equipment on the EQS. The equipment on the EQS will be made part of TVA's Q-list and be incorporated in TVA's maintenance and surveillance program.

As an additional note, in a conference call with NRC representatives on February 11, 1985, NRC mentioned some failures of circuit breakers at Mississippi Power and Light (MPL). TVA will investigate the circuit breaker failure at MPL and its applicability to TVA's breakers and will report back to NRC at a later date. The NRC representatives involved in the call stated they will accept our present EQSs and JIOs until November 30, 1985. TVA will continue to work with NRC to resolve problems with TVA's methodology of circuit breaker qualification.

B. NEB EQS

(1) NEB-XX-6

All equipment on the EQS has been replaced with qualified equipment.

(2) NEB-1-21

TVA has reevaluated the equiment on the EQS and has determined that this equipment is located in a mild environment. It will be removed from the 10CFR50.49 program.

(3) NEB-30-27

All equipment on the EQS will be replaced with qualified equipment before fuel load.

(4) NEB-1-40

TVA has reevaluated the equipment on the EQS and has determined that this equipment is located in a mild environment. It will be removed from the 10CFR50.49 program.

(5) NEB-94-48

The incore thermocouple system is still not fully qualified. A new JIO is provided in Enclosure 4.

C. MEB EQS

(1) MEB-30-0001
MEB-30-0011
MEB-30-0012
MEB-30-0013
MEB-30-0015
MEB-30-0016
MEB-30-0017
MEB-30-0019
MEB-65-0030
MEB-65-0130
MEB-65-0132
MEB-65-0163

All equipment on these EQSs has been replaced with qualified equipment.

(2) MEB-30-0006
MEB-65-0009
MEB-65-0010

All equipment on these EQSs will be replaced with qualified equipment before fuel load.

(3) MEB-30-0002

The MEB Index Sheet in the EQ report referenced an EEB EQS-0066 which was not contained in the EQ report. EEB EQS-0066 was not contained in the EQ report because TVA had since reevaluated the equipment in the MEB EQS and had determined that this equipment is located in a mild environment and therefore was removed from the 10CFR50.49 program and the EQ report.

(4) MEB-30-0005

TVA has reevaluated the equipment on this EQS and has determined that this equipment is located in a mild environment and therefore will be removed from the 10CFR50.49 program.

(5) MEB-3-0111

TVA has reevaluated the qualification of the equipment in the EQS and has determined that this equipment is now qualified and therefore will not be replaced. The revised EQS showing the qualification of this equipment is contained in Enclosure 4.

7. New EQS, Not Previously Submitted to NRC

At the time of the submittal of the last revision of the WBN EQ report, October 1984, TVA, due to an oversight, did not submit an EQS for FT-72-13 and FT-72-34. TVA has recently installed qualified devices for these transmitters. The qualification of these devices are discussed in EQS-WBN-NEB-72-50 contained in Enclosure 4.

ENCLOSURE 2

THERMAL BLANKET ANALYSIS

POSTACCIDENT MONITORING THERMAL ANALYSIS

Barton transmitters are used to provide postaccident monitoring (PAM) of environmental conditions in the valve vault at Watts Bar Nuclear Plant (WBN). The environmental conditions which these PAM instruments were expected to experience were based upon an analysis which failed to consider the effects of steam superheating following steam generator tube uncovery during a main steam line break (MSLB). The inclusion of steam superheating produces peak environmental temperatures which exceed current PAM instrument qualification temperatures by 30 to 40°F. These instruments were recently insulated with a custom-designed 2-inch-thick thermal cover to protect them from the increased temperatures. A thermal analysis was performed to verify that temperatures seen by the insulated instrument are less than the environmental qualification profile. The results of this analysis are discussed below.

The thermal analysis of a PAM transmitter was performed using a two-dimensional axisymmetric HEATING5 (reference 1) model of the transmitter casing. The valve vault atmospheric temperature profile, which was used as the temperature forcing function input into the HEATING5 code, was constructed assuming that (1) peak superheating in the steam generator occurred instantaneously at time zero, (2) the duration of the peak atmospheric temperature was 20 minutes, and (3) the peak environmental temperature used in the analysis was 470°F. The preceding assumptions conservatively maximize the amount of heat transferred to the PAM instrument since (1) superheat is not generated until steam generator tube uncovery, (2) after the onset of superheat, a finite period of time will be required (depending on break size and auxiliary feedwater flow rate) before peak superheat and consequently peak temperature occurs; (3) auxiliary feedwater flow will be terminated by operator action at 10 minutes, thereby ensuring that superheat will be terminated almost immediately for a large break and within the 20-minute timeframe for small breaks; and (4) the peak atmospheric temperature used in the analysis was 20°F higher than was generated using vendor-supplied data. Therefore, the temperature forcing function is believed to be conservative. Additionally, the 1.5-watt heat generation rate of the instrument was included as an internal forcing function to simulate the operational heat load.

The heat transfer boundary conditions for the PAM instrument model were based upon the Uchida correlation during condensate heat transfer and upon convective heat transfer after the insulation surface temperature exceeded the steam saturation temperature. The maximum Uchida heat transfer coefficient (282 Btu/hrft^{2o}F) was conservatively assumed until the insulation surface temperature reached saturation and then a forced convection heat transfer coefficient based upon vendor-supplied blowdown data was used during the remainder of the blowdown. After the blowdown period, the heat transfer coefficient was chosen to be the larger of the turbulent free convection coefficient or the minimum Uchida heat transfer coefficient (2.0 Btu/hrft^{2o}F) for the remainder of the transient.

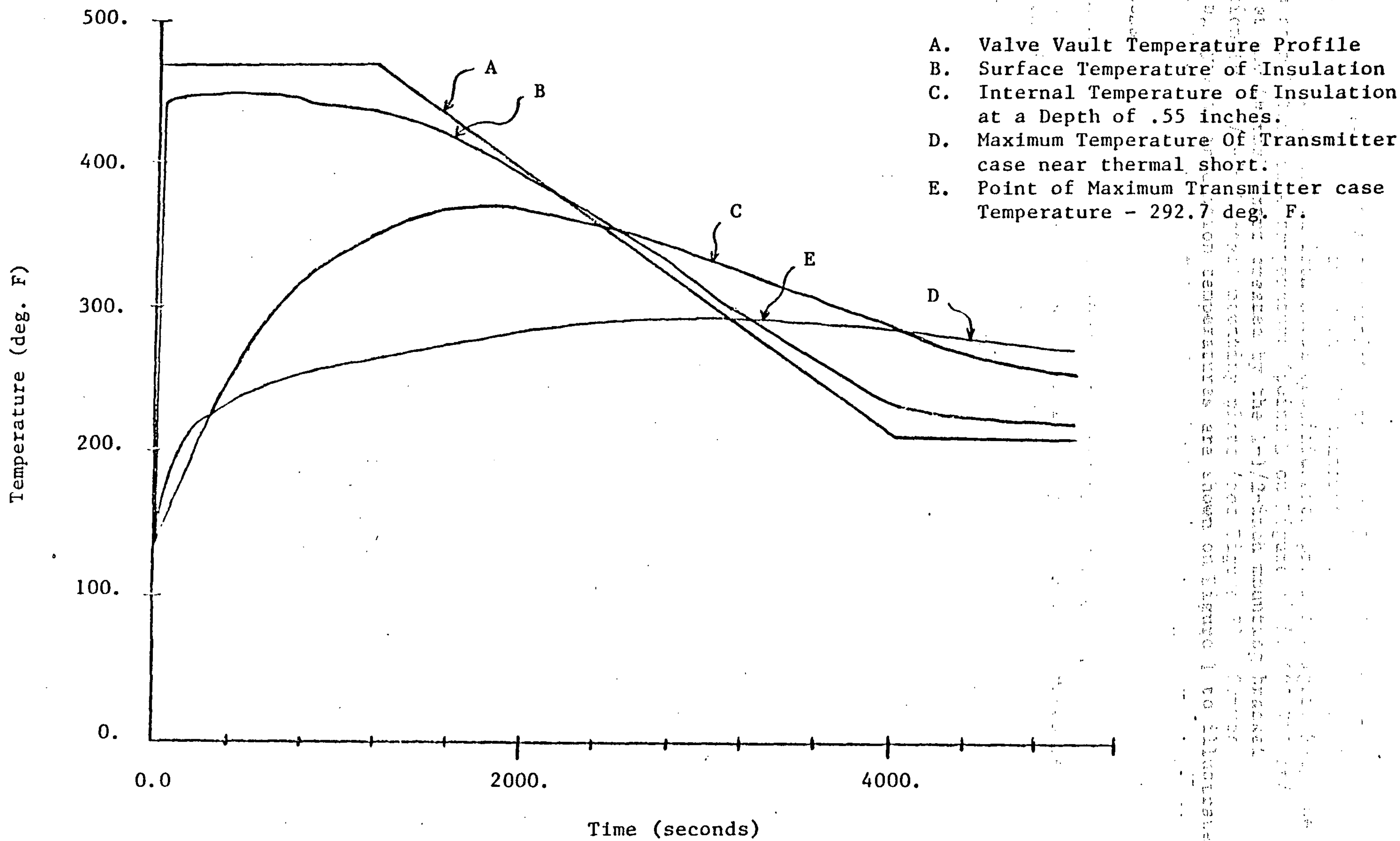
The results of the analysis are depicted in Figure 1 and clearly demonstrate that the peak temperature seen by the PAM transmitter casing (curve D) remains well within its environmental qualification profile (Figure 2). The maximum transmitter case temperature (point E on Figure 1) is 292.7°F and occurs at the thermal short created by the 1-1/2-inch mounting bracket connection to a 1/4-inch steel mounting plate (see Figure 3). Curves depicting typical insulation temperatures are shown on Figure 1 to illustrate that cooldown is occurring at the end of the transient.

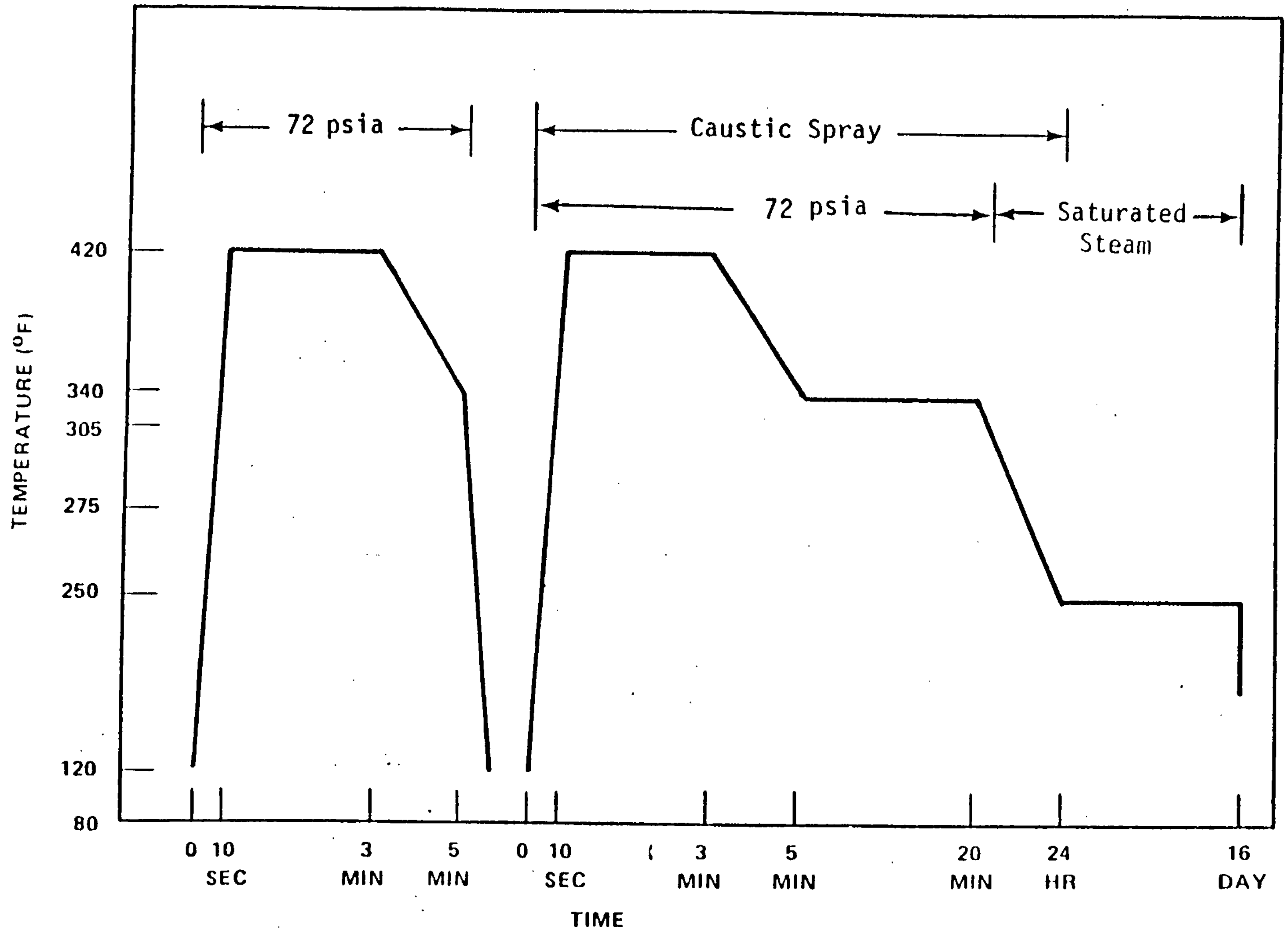
REFERENCES

1. Turner, W. D., et al., HEATING5-An IBM 360 Heat Conduction Program, ORNL/CSD/TM-15, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1977.

FIGURE 1

Temperature Profile of Insulated Barton Transmitter
During Postulated MSLB In Valve Vault





*Time between temperature transients must be at least one hour or until test units return to a steady state output. Time above 340°F must be five minutes or less.

Figure 2. Test Envelope for In-Containment -HELB
Barton Transmitters

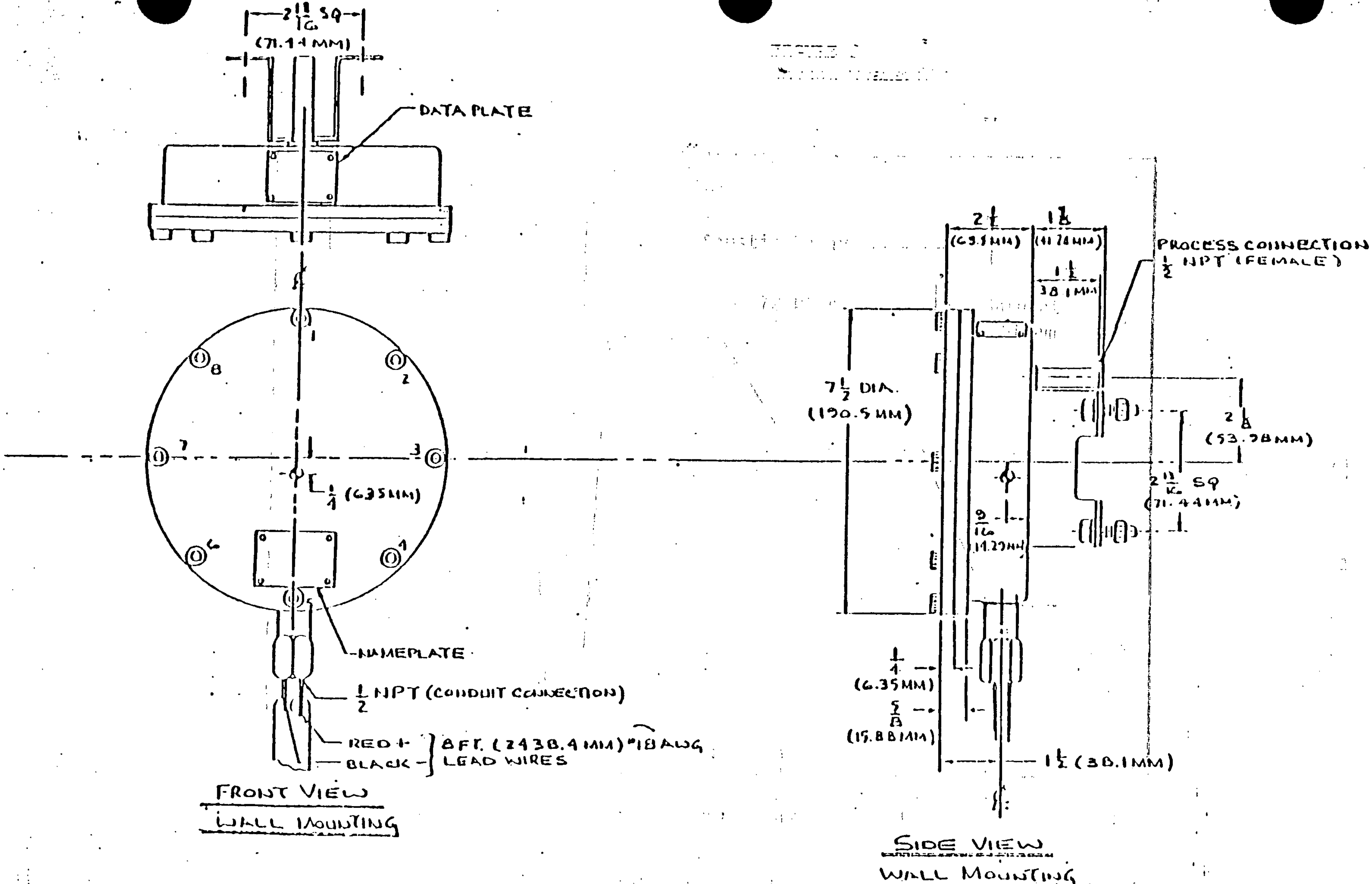


FIGURE 3
Barton Transmitters

ENCLOSURE 3

STATUS CHANGE LIST

REPLACEMENT LISTING

ID Number	Comments
1-PCV-1-12 (LS)	
1-PS-3-139A	
1-PS-3-139B	
1-PS-3-139D	
1-PS-3-144A	
1-PS-3-144B	
1-PS-3-144D	
1-FSV-30-2	
1-FSV-30-5	
1-FSV-30-28	
1-FSV-30-29	
1-FSV-30-60	
1-FSV-30-61	
1-FSV-30-62	
1-FSV-30-69	
0-HTR-30-147-A	
0-HTR-30-156-B	
1-MTR-30-190	
1-MTR-30-191	
0-TS-30-192B-A	
0-TS-30-193A-B	
1-FCV-31-305-B (LS)	
1-FCV-31-309-A (LS)	
1-FCV-31-326-A (LS)	
1-FCV-31-330-A (LS)	
1-FSV-62-77	
1-FSV-63-23	
1-FSV-63-38	
1-FSV-63-41	
1-FSV-63-42	
1-FSV-63-43	
1-FSV-63-84	
1-FSV-65-8	
1-FSV-65-10	
0-TS-65-16-A	
0-HTR-65-17-A	
1-FSV-65-24	
1-FSV-65-26	
1-FSV-65-27	
1-FSV-65-28A	
1-FSV-65-28B	
1-FSV-65-30	
0-TS-65-36-B	
0-HTR-65-37-B	
0-FSV-65-47A	
0-FSV-65-47B	

ID Number	Comments
1-FSV-65-51	
1-FSV-65-52	
1-FSV-65-53	
1-PSV-65-81A	
1-PSV-65-83-B	
1-FSV-67-170	
1-PT-68-66	
1-FSV-68-305	
0-MTR-70-33-B	
0-MTR-70-38-B	
0-MTR-70-46-A	
0-MTR-70-51-S	
0-MTR-70-59-A	
1-FCV-70-85 (LS)	
1-FCV-74-12	
1-FCV-74-24	
1-FSV-77-10	
1-FSV-77-17	
1-FSV-77-19	
1-FSV-77-20	
1-FSV-81-12	
1-FCV-90-107-A (LS)	
1-FCV-90-111-A (LS)	
1-FCV-90-113-A (LS)	
1-FCV-90-117-A (LS)	
1 CONT SPRAY PMP RM 1A-A CIR FAN MTR	
1 CONT SPRAY PMP RM 1B-B CIR FAN MTR	
2 EGTS RM CLR FAN A-A MTR	
2 EGTS RM CLR FAN B-B MTR	
1 RHR PMP RM 1A-A COOLER FAN MTR	
1 RHR PMP RM 1B-B COOLER FAN MTR	
1 PIPE CHASE CLR FANS 1A-A	
1 PIPE CHASE CLR FANS 1B-B	
1 SIS PMP RM CLR FANS 1A-A MTR	
1 SIS PMP RM CLR FANS 1B-B MTR	

REPLACEMENT LISTING (Continued)

ID Number	Comments
1 CENT CHG PMP RM CLRS 1A-A FAN MTR	
1 CENT CHG PMP RM CLRS 1B-B FAN MTR	
1 EL 692 PEN RM CLR FAN MTRS 1A-A, 1B-B	
1 EL 713 PENT RM CLRS FAN MTRS 1A-A, 1B-B	
1 EL 737 PENT RM CLRS FAN MTRS 1A-A, 1B-B	
0 CCS BOOSTER & SPENT FUEL PIT PMP CLR FAN MTRS 1A-A, 1B-B	

ENCLOSURE 4

<u>JIOs/ECS</u>

form TVA 10697 (EN DES 1-84)

EN DES CALCULATIONS

TITLE JUSTIFICATION FOR INTERIM OPERATION FOR ITT SURENANT TRIAXIAL CABLE (73C7-84595)		PLANT/UNIT WBN/1 and 2
PREPARING ORGANIZATION EEB	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST)	
BRANCH/PROJECT IDENTIFIERS WTU	Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in.	

Rev	(for MEDS' use)	MEDS accession number
R0		EEB '85 0211 916
R __		
R __		
R __		

APPLICABLE DESIGN DOCUMENT(S): N/A

SAR SECTION(S): N/A

UNID SYSTEM(S): Various

	Revision 0	Revision ___	Revision ___	Revision ___
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	R. L. Mills			
CHECKED	A.W. Thomas			
SUBMITTED	F. B. Rosenzweig/A			
DATE	2/11/85			
APPROVED	JJ Wagner			
List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

Use form TVA 10534 if more room required.

STATEMENT OF PROBLEM

The triaxial cable used in Class 1E circuits inside and outside containment, lacks documentation to prove its qualification in harsh environments.

ABSTRACT

Based on a combination of test data and engineering analysis, the triaxial cable has been shown to be acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification.

☐ Continuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center.

Microfilm and destroy. ☐

☐ Microfilm and return calculation to:

Address: W8D182 C-K

	Revision	1				
Preparer/Date	R.L. Mills 6-9-84	[illegible]				
Reviewer/Date	J.F. Wagner 6-11-84	[illegible]				

Unit No. 1 and 2
EQS No. EEB-CBL-18.1
TVA ID No.
~~WTC (Triaxial~~ Cable)
Rev 0

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model No. ITT Surprenant Division
Verification of Table Information (Table 3.11-8A, Sheet 1015)

X Equipment Type - The equipment has been identified as per TVA ID number designations (such as, MOV, SOV).

X Location - The location has been identified (such as, inside primary containment, annulus, individually cooled rooms, general spaces, or area affected by HELB outside primary containment).

X Component - A unique TVA ID number has been assigned (such as, 1-FSV-68-308).

X Function - A functional description of the component has been given (such as, steam generator blowdown).

X Contract No., Manufacturer, and Model No. - The contract number, manufacturer, and model number have been given.

X Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not)

Qualified Life (If equipment is qualified, indicate the qualified life with a numerical entry): See Appendix 1 R1

X Qualification Report and Method - A qualification report and the method of qualification has been identified on the Table Input Data Sheet (TIDS).

X Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

X Qualification by Similarity (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

NA Qualification of Several Exact Components (If applicable) - When an EQS is used for more than one item, a list of all exact components is given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

NA Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component.

Term of Interim Qualification ______
NCR No. ______

X Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation. R1

NCR No. WBNEEB8501

Preparer/Date R. L. Mills 2-5-85

Reviewer/Date J. J. Wagner 2/7/85

EEB-CBL-18.1
Appendix 1 Rev 1
Sheet 1 of 1

ITT Surprenant Division - Contract No. 73C7-84595

1. The triaxial cable consists of cross-linked polyethylene for the primary insulation and cross-linked polyolefin for the inner and outer jackets.

2. Cable is located outside the reactor building and outside the steam valve vault rooms where it is subject to the following possible environmental conditions:

	Normal/Abnormal	HELB
Temperature:	104°F/110°F	220°F
Relative Humidity:	80%/90%	100%
Pressure:	Atm	15.9 PSIA
Radiation:	$1x10^4$ rads	$1x10^8$ rads
Chemical Spray:	NA	NA

R1

3. The manufacturer tested samples of the cable in an autoclave to the following conditions:

Temperature	- 300°F
Pressure	- 67 PSIA
Relative Humidity	- 100%
Radiation	- $2x10^8$ rads prior to autoclave test (at rate of 1 megarad/hour to simulate 40 year life)
Chemical Spray	- Borated water, pH 8.0-8.5

The cable samples performed successfully in operational tests after the autoclave exposure.

4. Based on the above tests and our knowledge of the successful performance of other cables of this type construction after aging and environmental tests, we conclude that the results show that this cable will perform its safety function satisfactorily until the NRC's final compliance date for equipment qualification. At that time it will either be deemed qualified by virtue of testing by Wyle Laboratories or replaced with fully qualified cables. R1

014160.10

Prepared By: *R. L. Mills 6-9-84*

Reviewed By: *JA Wagner 6-11-84*

ITT SURPRENANT DIVISION
Clinton, Mass. 01510

Triaxial Cable per TVA7-84595 and ITT DAB-31Q-BAA

Sheet 1 of 4

Customer: *Ten. Valley Auth.*
Purchase Order No.: *7-84595*
Quantity: *96,228*

Manufacturing Order No.: *R1550*
D.P. Code Number: *DAB-31Q-BAA*
Date: *10/14/73*
Inspector: *L.R.*

Characteristic	Requirement	Results
Conductor		
Gauge	18 AWG	18 AWG.
Stranding	7/26	7/26
Type	Tin copper	TIN COPPER
Lay	.646" Nom.	ACCEPTED
O.D.	.048" Nom.	.048
Strand O.D.	.0159 + 3% - 1%	.0159
Elongation	15% Min.	19%
Strand D.C.R.	6.61 ohms	5.91 Ω
Primary Insulation		
Compound	L-6219	AS SPECIFIED
Color	clear	CLEAR
Min. Wall	.120	.120
[illegible]	.290 ± .005	.287
I.R.	10,000 megs/M'	4.8 X 10^6 megs/M'
Inner Shield		
Gauge	34 AWG	34 AWG.
Type	copper	COPPER
Ends	8	8
Carriers	24	24
Picks	6	6
O.D.	.317 Nom., .340 Max.	.317
Coverage	90% Min.	91.9%
Inner Jkt.		
Compound	L5890C	AS SPECIFIED
Color	Dark gray	DARK GRAY
Min. Wall	.025 Min.	.032
O.D.	.376 ± .007	.382
I.R.	100 megs/M'	1150 megs/M'
Outer Shield		
Gauge	34	34 AWG
Type	copper	COPPER
Ends	9	9
Carriers	24	24
Picks	8	8
Nom. O.D.	.403"	.406
Coverage	90% Min.	93.1%

Triaxial Cable per TVA7-84595 and ITT DAB-31Q-BAA

Characteristic	Requirement	Results
Overall Jkt.		
Compound	L5890C	AS SPECIFIED
Color	Dark gray	DARK GRAY
Wall Thickness	.028 Min., .031 Nom.	.0325
O.D.	.465 ± .010"	.471
Wt./1M'	139.0 lbs. approx.	140.1#
I.R.	1 meg/1M'	4320 meg/1M'
Spark Test	8 KV	8KV-ACCEPTED
Print	1 ft. intervals	< 1 ft.
	"84595 TVA WTU Triax	AS SPECIFIED
	RG11/U ITT Surprenant Div."	AS SPECIFIED
Continuity	6 volts D.C. (continuous)	CONTINUOUS
Dielectric Strength	10 KV cdr to shield	10KV - N.B.
	No breakdown	NO BREAKDOWN
	2 KV shield to shield	2KV - N.B.
Out of Roundness		
Primary Insul.	.285" - .295"	.283 - .286
Inner Jkt.	.369" - .383"	.376 - .380
Overall Jkt.	.455" - .475"	.467 - .469
	≤ 50% of diff. between min. & max. dia. specified	
Primary Insul.	.0050" Max.	.0015
Inner Jkt.	.0070" Max.	.0020
Overall Jkt.	.010" Max.	.0010
Corona	>5 KV	5500 V
Capacitance cdr to inner shld.	≤ 25 pf/ft.	20.91 pf/ft.
Attenuation	≤ 5 db/100' @ 400 MHZ	4.8dB/100'
Impedance	75 ± 3 ohms	74.2 Ω
Cold Bend	-40°C ± 2°C	AS SPECIFIED
	4" mandrel -20 hrs.	AS SPECIFIED
	15 ± 3 r.p.m. no cracks	NO CRACKS
Flow	18# wts - 4" mandrel	AS SPECIFIED
	Max. 15% change	5.1%
Flame	No drip or loss of circuit	AS SPECIFIED
	No flame travel	NO TRAVEL
	1 minute max. burn	15 SECS.
Water Absorption	5% increase cap.	N/A
	between 1 and 14 days	1.8%
	3% increase cap.	N/A
	between 7 - 14 days	0.3%
Primary T.S.	≥ 1500 PSI original	1800 PSI
Primary T.S. (aged)	≥ 75% of original	92.5%
Primary Elong.	≥ 200%	500%

Triaxial Cable per TVA7-84595 and ITT DAB-31Q-BAA

Characteristic	Requirements	Results
Prim. Elong (aged)	≥ 75% of origin.	100%
Overall Jkt. T.S.	≥1500 PSI origin.	1700 PSI
Overall Jkt. T.S. (aged)	75% of origin.	135%
Overall Jkt. Elong.	≥225%	300%
Overall Jkt. Elong. (aged)	75% of origin.	91.6%

Irradiated (6) @ 1 X 10^8 and (6) @ 2 X 10^8

Characteristic	1 X 10^8 RADS (6)	2 X 10^8 RADS (6)
Irradiated @	1X10^8 RADS	2X10^8 RADS
Temp. Medium	90°F - 110°F	90°F - 110°F
Stress on Samp.	SAMPLE WT. NEGLI.	SAMPLE WT. NEGLI.
Type Irr. Source	COBALT-60	COBALT-60
Kind of Irr.	GAMMA	GAMMA
Dosage Rate	1.0 megrads/HR.	1.0 megrads/HR.
Irr. Time	100	200
Total Dosage in Rads	100 megrads	200 megrads

Characteristic	Requirement	1 X 10^8 RADS (3)	(No req't. inform only) 2 X 10^8 RADS (3)
I.R. Pri. Insul.	6,000 megs/M'	25.0X10^{14} Ω/ft	1.325X10^{14} Ω/ft.
[illegible] Inner Jkt.	60 megs/M'	1.04X10^{12} Ω/ft.	4.24X10^{11} Ω/ft.
[illegible]. Outer Jkt.	.6 megs/M'	3.0X10^{12} Ω/ft.	1.75X10^{11} Ω/ft.
Capacitance	≤ 30 pf/ft.	20.64 pf/ft	20.8 pf/ft
Water Absorption			
Cap. Increase	≤10% 1-14 days	1.63%	10.4%
	≤5% 7-14 days	2.10%	5.85%
Impedance	75 ± 5 ohms	75.1 Ω	75 Ω
Pri. Insul. T.S.	≥1300 PSI	2150 PSI	2200 PSI
Pri. Elong	≥90%	110%	55%
Overall Jkt. T.S.	≥1500 PSI	3388 PSI	3572 PSI
Overall Jkt. Elong	≥ 60%	129%	42%
Flame	No drip or loss of cir.	No dripping	No dripping
	No flame travel	NO TRAVEL	NO TRAVEL
	1-min. max. burn	before 1-min	before 1-min.

Autoclave Contamination (3) unirrad, (3) irrad @ 1 X 10^8, (3) irrad @ 2 X 10^8

	Requirement	Result
a. Temperature	300°F	300°F
Pressure	-0.5 to + 12 psig	1 to 53 psig
Relative humidity	20% - 100%	Steam - 100%
pH (borated water)	8.0 - 8.5	8.0 - 8.5
Time lapse	15 min.	15 min.
b. Temperature	250°F	252°F
Pressure	-0.5 to + 12 psig	16.5 psig
Relative Humidity	20% - 100%	20% - 100%
pH (borated water)	8.0 - 8.5	8.0 - 8.5
Time lapse	240 hrs. (10 days)	240 HRS (10 days)

Triaxial Cable per TVA7-84595 and ITT DAB-31Q-BAA

Unirradiated Samples (3)	Requirement	Result
I.R. Pri. Insul.	10,000 megs/M'	>4.5 X 10^{14} Ω/ft.
I.R. Inner Jkt.	100 megs/M'	1.84 X 10^{12} Ω/ft.
I.R. Overall Jkt.	1 megs/M'	3.15 X 10^{12} Ω/ft.
Capacitance	≤ 30 pf/ft.	21.67 pf/ft.
Impedance	75 ± 5 ohms	75.0 Ω
Pri. Insul. T.S.	≥ 1000 PSI	1560 PSI
Pri. Elong.	≥ 125%	310%
Overall Jkt. T.S.	≥ 1000 PSI	2604 PSI
Overall Jkt. Elong.	≥ 150%	283%
Flame	No drip or loss of cir.	No drip or loss of cir.
	No flame travel	No travel
	1-min. max. burn	before 1-min.

Irradiated Samples	Requirement	1 X 10^8 RADS (3)	(No Req't for inform. only) 2 X 10^8 RADS (3)
I.R. Prim. Insul.	6000 megs/M'	3.2? X 10^{14} Ω/ft.	>3.80 X 10^{14} Ω/ft.
I.R. Inner Jkt.	60 megs/M'	3.36 X 10^{11} Ω/ft.	7.98 X 10^{11} Ω/ft.
I.R. Overall Jkt.	.6 megs/M'	8.10 X 10^{11} Ω/ft.	1.70 X 10^{11} Ω/ft.
Capacitance	≤ 30 pf/ft.	20.9 pf/ft.	23.6 pf/ft.
Impedance	75 ± 5 ohms	74.5 Ω	74.2 Ω
Pri. Insul. T.S.	≥ 1000 PSI	1670 PSI	1560 PSI
Pri. Insul. Elong.	≥ 50%	100%	50%
Overall Jkt. T.S.	≥ 1000 PSI	2917 PSI	2915 PSI
Overall Jkt. Elong.	≥ 40%	150%	54%
Flame	No drip or loss of cir.	No drip or cir. loss	No drip or cir. loss
	No flame travel	No travel	No travel
	1-min. max. burn	before 1-min.	before 1-min.

This is to certify that the data contained in this test report conforms with all customer specification requirements, in addition to ITT engineering drawings and specifications.

Louis B. Roberts
Q.C. Foreman

TEST	UNIRRADIATED	1×10^8 RADS	2×10^8 RADS	AUTOCLAVE TEST UNIRRADIATED	AUTOCLAVE TEST 1×10^8 RADS	AUTOCLAVE TEST 2×10^8 RA[illegible]
Impedance (ohms)	paragraph 9 74.2	paragraph 16d 75.1	paragraph 17 75.0	paragraph 19d 75.0	paragraph 20d 74.5	paragraph [illegible] 74.2
Primary Insulation Tensile Strength (PSI)	paragraph 14a 1800 Aged 92.5% origin	paragraph 16e 2150	paragraph 17 2200	paragraph 19e 1560	paragraph 20e 1670	paragraph [illegible] 1560
Primary Insulation Elongation (%)	paragraph 15a 300 Aged 100% of origin	paragraph 16f 110	paragraph 17 55	paragraph 19f 310	paragraph 20f 100	paragraph [illegible] 50
Jacket Tensile Strength (PSI)	paragraph 14b 1700 Aged 135% of origin	paragraph 16g 3388	paragraph 17 3572	paragraph 19g 2604	paragraph 20g 2914	paragraph [illegible] 296[illegible]
Jacket Elongation (%)	paragraph 15b 300% Aged 91.6% of origin.	paragraph 16h 129	paragraph 17 42	paragraph 19h 283	paragraph 20h 150	paragraph [illegible] 54
Insulation Resistance (ohm-feet) P / S / J	paragraph 4 4.8×10^6 megΩ/M' 1150 megΩ/M' 4320 megΩ/M'	paragraph 16a $>5.0 \times 10^{14}$ Ω/ft. 1.04×10^{12} Ω/ft 3.0×10^{12} Ω/ft	paragraph 17 1.325×10^{14} Ω/ft 4.24×10^{11} Ω/ft. 1.75×10^{11} Ω/ft.	paragraph 19a $>4.5 \times 10^{14}$ Ω/ft. 1.89×10^{12} Ω/ft. 3.15×10^{12} Ω/ft.	paragraph 20a 3.2×10^{14} Ω/ft 3.36×10^{11} Ω/ft. 8.7×10^{11} Ω/ft.	paragraph [illegible] $>3.6 \times 10^{1}$[illegible] 7.98×10^{11}[illegible] 1.7[illegible]$\times 10^{11}$[illegible]
Flame	paragraph 12 15 secs. No drip No travel No cir. loss	paragraph 16i before 1-min. No drip No travel No cir. loss	paragraph 17 before 1-min. No drip No travel No cir. loss	paragraph 19i before 1-min. No drip No travel No cir. loss	paragraph 20i before 1-min No drip No travel No cir loss	paragraph [illegible] before 1-[illegible] No dr[illegible] [illegible] No cir[illegible]
Capacitance (pF/foot)	paragraph 7 20.9	paragraph 16b 20.64	paragraph 17 20.80	paragraph 19b 21.67	paragraph 20b 20.9[illegible]	paragraph [illegible] 22.[illegible]

TVA 10697 (EN DES 1-84)

EN DES CALCULATIONS

TITLE JUSTIFICATION FOR INTERIM OPERATION FOR EPSJ FAMILY OF CABLES				PLANT/UNIT WBN/1 and 2
PREPARING ORGANIZATION EEB	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST)			
BRANCH/PROJECT IDENTIFIERS EPSJ	Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in.			
	Rev	(for MEDS' use)	MEDS accession number	
	RO		EEB '850123 921	
APPLICABLE DESIGN DOCUMENT(S) N/A	R__			
	R__			
SAR SECTION(S) N/A / UNID SYSTEM(S) Various	R__			

	Revision 0	Revision ___	Revision ___	Revision ___
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	L. L. Mill			
CHECKED	Don B. Aig			
SUBMITTED	Fred B Rosenzweig			
DATE	1-22-85			
APPROVED	H Wagner			
Use for 10634 room required: List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

STATEMENT OF PROBLEM

The EPSJ family of cables, used in Class 1E circuits outside containment, lack contract-specific documentation to prove their qualification in harsh environments.

ABSTRACT

Based on a combination of generic test data and engineering analysis, the EPSJ family of cables have been shown to be acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification.

☐ Continuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center.

☒ Microfilm and return calculation to: F. B. Rosenzweig

Microfilm and destroy. ☐

Address: W8D182 C-K

	Revision	1				
Preparer/Date	R. A. McInturff 12-11-81	[illegible]	[illegible]			
Reviewer/Date	J. F. Wagner 12-14-81	[illegible]	[illegible]			

Unit No. 1 and 2
EQS No. EEB-CBL-12
TVA ID No.
Type EPSJ Cable
Rev. 2

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model No. See Table 3.11-8A, sheet 1004
Verification of Table Information (Table 3.11-8A sheet 1004)

X **Equipment Type** - The equipment has been identified as per TVA ID number designations (such as, MOV, SOV).

X **Location** - The location has been identified (such as, inside primary containment, annulus, individually cooled rooms, general spaces, or area affected by HELB outside primary containment).

X **Component** - A unique TVA ID number has been assigned (such as, 1-PSV-68-308).

X **Function** - A functional description of the component has been given (such as, steam generator blowdown).

X **Contract No., Manufacturer, and Model No.** - The contract number, manufacturer, and model number have been given.

X **Abnormal or Accident Environment** - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X **Environment to Which Qualified** - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X **Category** - A category of a, b, c, or d has been defined for the equipment.

X **...eration and Accuracy Required and Demonstrated** - The operation ...d accuracy required and demonstrated have been defined.

...ualification Status (check if applicable, NA if not)

Qualified Life (If equipment is qualified, indicate the qualified life with a numerical entry): See Appendix 1 R2

X **Qualification Report and Method** - A qualification report and the method of qualification has been identified on the Table Input Data Sheet (TIDS).

...A **Environmental Analysis** - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

X **Qualification by Similarity** (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X **Qualification of Several Exact Components** (If applicable) - When an EQS is used for more than one item, a list of all exact components is given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

...A **Interim Qualification** (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component.

Term of Interim Qualification ______________________
NCR No. ______________________

... **Unqualified Component** - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation.

...o. WBNEEB8501 R2

Preparer/Date D.L. [signature] / 10-10-84 EEB-CBL-12, Rev. 1
Reviewer/Date [signature] 10-10-84 Appendix 1 Rev 1
Sheet 1 of 2

EPS Family (EPS, EPSJ, EPSMJ)

The EPS cables consist of ethylene-propylene rubber insulation with a chlorosulfonated-polyethylene jacket. This cable was constructed, tested, and accepted in accordance with TVA standard specification 25.016 - Flame-Retardant, Cross-Linked Polyethylene-Insulation, Low Voltage Wire and Cable and Ethylene-Propylene Rubber-Insualted, 5-15kV cable prior to January 1980 or TVA Standard Specification 25.015 - Ethylene-Propylene Rubber or Nonchlorinated, Mineral-Filled, Cross-linked, Polyethylene-Insulated, 5-15kV Cable after January 1980. TVA Standards 25.015 and 25.016 invoke the applicable portions of IPCEA Standards S-68-516 and 5-19-81 (such as physical properties, and methods of testing for tensile strength and elongation of the insulation and jacket materials). The TVA Specification included provisions for source inspection of factory testing and required submittal of certified test reports to assure compliance with the specification. The manufacture of all this cable was controlled by a TVA-approved vendor QA program.

The following LOCA/SLB tests are representative of the EPS cables which are presently installed:

The Okonite Company test report form G-3 dated September 7, 1977, "Qualification of Okoguard Ethylene-Propylene Rubber Insulation for Nuclear Plant Service." (See Appendix 2).

The Okonite Company test report form G-2 dated May 2, 1977, "Qualification of Okoguard Ethylene-Propylene Rubber Insulation for Nuclear Plant Service." (See Appendix 2).

Franklin Research Center Test Report F-C5160-1 dated May 21, 1980, Qualification Tests of Electrical Cables in a Simulated Loss-of-Coolant Accident (LOCA) Environment, Prepared for Collyer Insulated Wire (See Appendix 2).

The Okonite Company Engineering Report No. 355 dated September 17, 1981, "Main Steam Line Break Qualification Test on Okonite, Okonite-FMR, X-Olene-FMR and Okoguard Insulations" (See Appendix 2).

The test reports demonstrate that the EPS cables are suitable for Class 1E service in nuclear power generating stations in accordance with appropriate guidelines presented in IEEE Standards 323-1974 and 383-1974.

The LOCA/SLB tests included radiation at $2x10^8$ rads for the LOCA tests and $5.5x10^7$ rads for MSLB tests.

The tests included a LOCA at 346°F, 113 psig, 100% humidity and a MSLB at 455°F, 32 psig.

Preparer/Date R. L. Mills 1-15-85

Reviewer/Date J J Wagner 1-22-85

EPS Family (EPS, EPSJ, EPSMJ)

The tests included cable samples from the Okonite Company and Collyer Insulated Wire. The results of these tests adequately demonstrates that EPSJ cable manufactured by different vendors in accordance with the same specifications will perform similarly in the given DBE and that successful completion of the test is a function of the chemical properties of the insulation and jacketing compound and is not dependent on the manufacturer. Consistency in the chemical properties has been demonstrated by successfully completing the requirements of TVA Standard Specification 25.016 if manufactured prior to January 1980 or TVA Standard Specification 25.015 if manufactured after January 1980. This approach to generic cable qualification follows the general guidelines for type testing as outlined by IEEE 383-1974.

All EPSJ cables met or exceeded the construction, testing, and acceptance requirements of TVA Standard Specification 25.016 or 25.015. In addition representative samples of the EPSJ family of cables supplied to TVA by different manufacturers successfully passed LOCA/SLB.

In view of the above, we conclude that the results show that the EPSJ family of cables will perform their safety functions satisfactorily until the NRC's final compliance date for equipment qualification. At that time they will either be deemed qualified by virtue of testing by Wyle Laboratories or replaced with fully qualified cables. R2

034277.02

THE OKONITE COMPANY

Prepared by: D.L. Sculthorpe 10-10-84
Reviewed by: J.J. Wagner 10-10-84

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable: Okonite

QUALIFICATION OF OKOGUARD ETHYLENE-PROPYLENE RUBBER INSULATION FOR NUCLEAR PLANT SERVICE (5kV CABLE & FIELD SPLICE)

The Okonite Company's continuing Research and Development activities as a compounder of elastomeric materials has led to an evolutionary development of Okoguard to its present form as a clean, red dielectric. This evolutionary development has resulted in substantial improvements in physical strength, lower water absorption rates and higher dielectric strength over those experienced by the earlier excellent ethylene-propylene Okoguard formulations.

INDEX

Okonite Form No.	Title
(a)	Qualification of Okoguard Ethylene-Propylene Rubber Insulation and Field Splice Materials for Nuclear Plant Service
(b)	Aging, Radiation and LOCA Testing Okoguard Ethylene-Propylene Rubber Insulated Cables and Field Splice Materials for Nuclear Power Generating Stations
(c)	Moisture Resistance - Okoguard Ethylene-Propylene Rubber Insulated Cables

Loss of Coolant Accident Simulation

The unaged and radiated sample and thermally aged and radiated samples were then placed in a autoclave and subjected to the temperature-pressure profile for simulation of a LOCA condition as specified in the IEEE Std. No. 323-1974. This profile is shown in Figure II, attached. At the end of the 30 day exposure in the autoclave the samples were removed, bent around a mandrel not greater than 40 times the overall diameter and then subjected to a final 5-minute ac withstand test at 80 volts per mil while immersed in tap water at room temperature. The samples were then returned to the autoclave for an additional 100 day post LOCA test and maintained at 212 F, 0 psig, 100% relative humidity. At the end of this post LOCA period the samples were removed, again bent around a mandrel of 40 times the overall diameter and electrically tested at 80 volts per mil while immersed in tap water at room temperature.

Conclusion

The samples of Okoguard 5 kV cable with a field splice in place unaged and thermally aged to the Arrhenius curve shown in Figure I, were radiated to a total dosage of 200 megarads minimum, and then subjected to a LOCA condition as shown in Figure II, all in accordance with IEEE Standard 383-1974. Throughout the exposure the cables were energized with rated potential and current and insulation resistance measurements taken weekly. At the conclusion of the LOCA and post LOCA condition the cables were then subjected to and withstood an 80 V/mil ac proof test.

The satisfactory test results are evidence that the Okoguard insulation and a field splice made from Okoguard T-95 tape and Okonite #35 jacketing tape are suitable for the designed service in Nuclear Power Generating Plants.

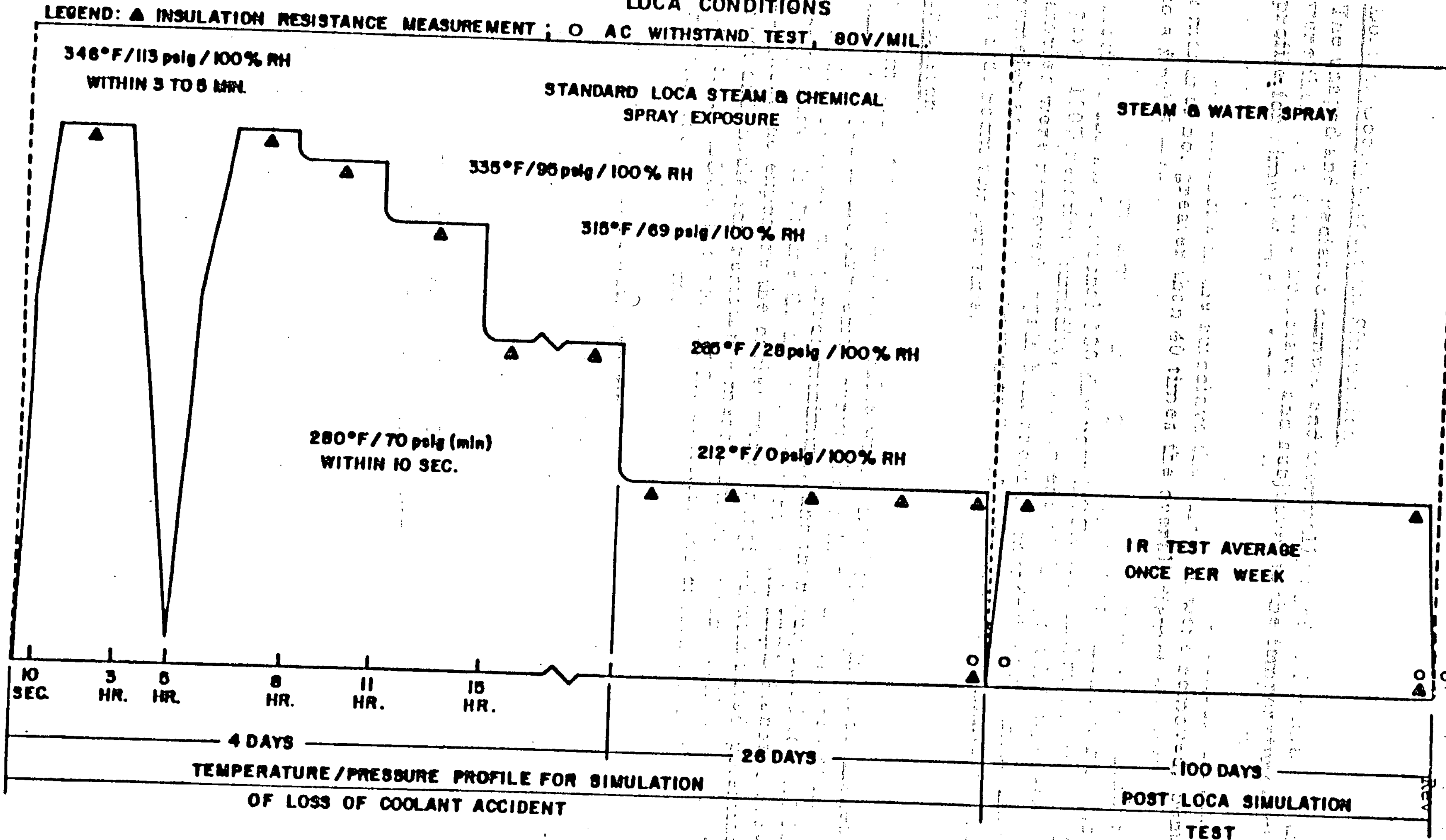
References

(1) IEEE Standard No. 383-1974
IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations, April 15, 1974

(2) IEEE Standard No. 323-1974
IEEE Standard for Qualifying Class IE Equipment for Nuclear Generating Stations, February 28, 1974

(3) IEEE Standard No. 323-A-1975
Supplement to the Foreword of IEEE 323-1974
IEEE Standard for Qualifying Class IE Equipment for Nuclear Generating Stations

FIGURE II CABLE QUALIFICATION TEST PROFILE FOR LIFE & LOCA CONDITIONS



THE OKONITE COMPANY

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable Okonite

QUALIFICATION OF OKOGUARD ETHYLENE-PROPYLENE RUBBER INSULATION FOR NUCLEAR PLANT SERVICE

The Okonite Company's continuing Research and Development activities as a compounder of elastomeric materials has led to an evolutionary development of Okoguard to its present form as a clean, red dielectric. This evolutionary development has resulted in substantial improvements in physical strength, lower water absorption rates and higher dielectric strength over those experienced by the earlier excellent ethylene-propylene Okoguard formulations.

INDEX

Okonite Form No.	Title
(a)	Qualification of Okoguard Ethylene-Propylene Rubber Insulation for Nuclear Plant Service
(b)	Aging, Radiation and LOCA Testing Okoguard Ethylene-Propylene Rubber Insulated Cables for Nuclear Power Generating Stations
(c)	Moisture Resistance - Okoguard Ethylene-Propylene Rubber Insulated Cables
(d)	Vertical Tray Flame Test - IEEE Standard #383

Figure I shows the Arrhenius curve for Okoguard insulation compared with that of Butyl insulation. Butyl was first introduced in 1946 and has had extensive use ever since. Examination of some of the original Butyl compounds shows that the materials are still flexible after twenty-five to thirty years of service. Realizing that Okoguard insulation is superior to that of Butyl by a factor of approximately six, it is logical to anticipate a life in excess of a generating station's designed life of 40 years.

Extrapolation of the plots to operational temperatures constructed from experimental data at high temperatures leads to very considerable errors in terms of life. We have consistently found extrapolation of experimental data to predict designed life results in far shorter predicted life than actually experienced by older, well-established materials in actual service.

Radiation Exposure Test Program

Samples of single conductor #4/0 AWG, .175" Okoguard insulation, were thermally aged to simulate 40 year design life condition. The aging was performed at 150C for three weeks, a point actually above the Arrhenius curve of .030" Okoguard insulation shown in Figure I. As pointed out above, use of the Arrhenius technique on thin wall, newer insulations compared with the same analysis on those of well established insulations which have excellent service records is a reliable method of demonstrating the desired 40 year life expectancy.

After aging the heavier wall 0.175" Okoguard insulation to the Arrhenius curve of Figure I we found the actual percentage elongation for the sample was in excess of 85% indicating the compound was still very viable. Using the Arrhenius techniques on the light wall samples permitted us to show the anticipated 40 year life expectancy by comparison with existing materials. Using the same technique on heavier walls that actually will be used in a generating station application at the same temperature time period and noting the very high percentage retention of elongation thus reinforces this expected life.

Loss of Coolant Accident Simulation

The thermally aged and radiated cables were then placed in an autoclave and subjected to the temperature-pressure profile for simulation of a LOCA condition as specified in the IEEE Standard No. 323-1974. This profile is shown in Figure II, attached. At the end of the 30 day exposure in the autoclave the samples were removed, bent around a mandrel not greater than 40 times the overall diameter and then subjected to a final 5-minute ac withstand test at 80 volts per mil while immersed in tap water at room temperature. The samples were then returned to the autoclave for an additional 100 day Post-LOCA test and maintained at 212F, 0 psig, 100% relative humidity. At the end of this Post-LOCA period the samples were removed, again bent around a mandrel of 40 times the overall diameter and electrically tested at 80 volts per mil while immersed in tap water at room temperature.

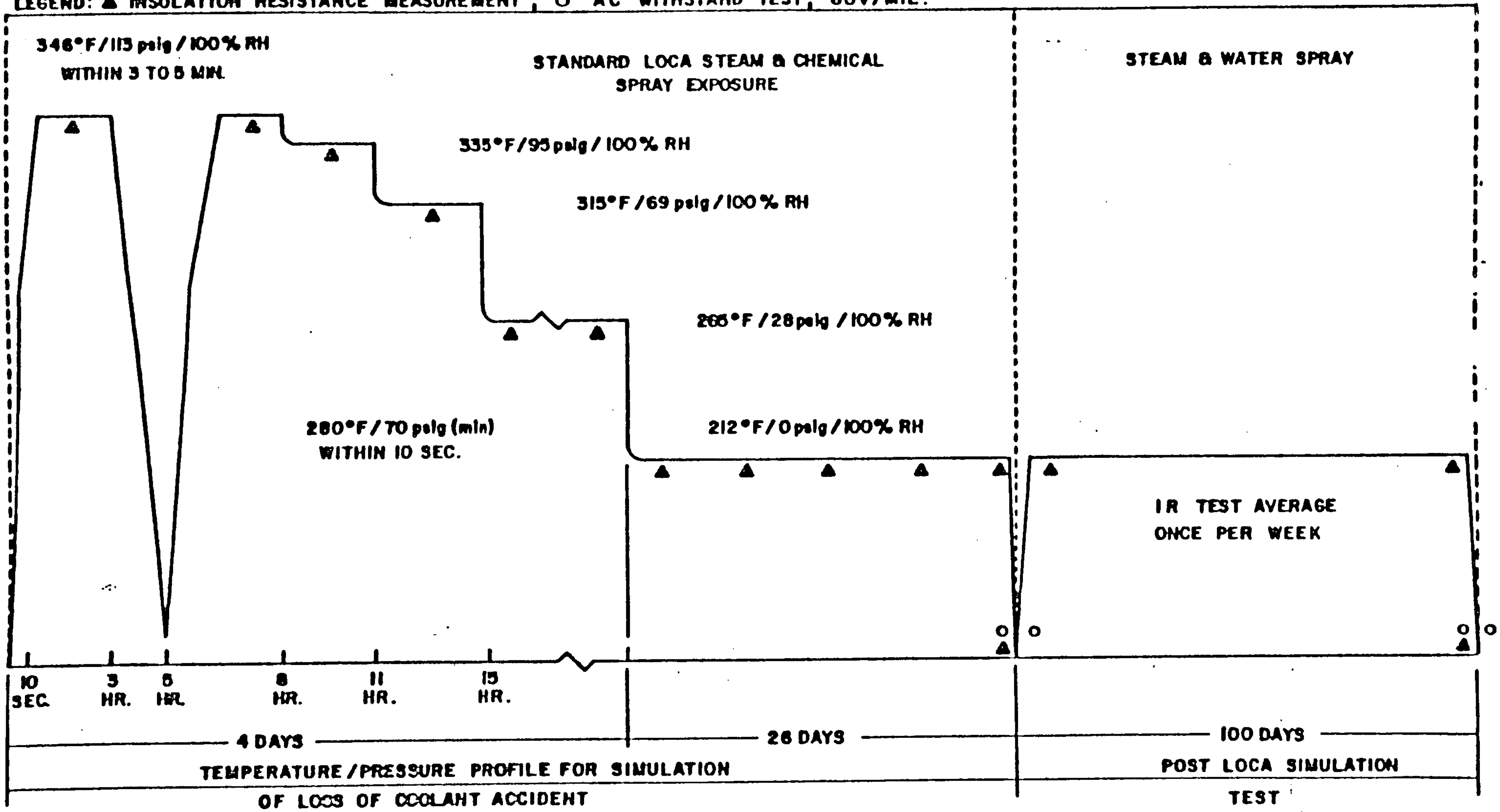
Conclusion

The Okoguard samples were thermally aged to the Arrhenius curve shown in Figure I radiated to a total dosage of 200 megarads minimum, and then subjected to a LOCA condition as shown in Figure II, all in accordance with IEEE Standard 383-1974. Throughout the exposure the cables were energized with rated potential and current and insulation resistance measurements taken weekly. At the conclusion of the LOCA and Post-LOCA condition the cables were then subjected to and withstood an 80V/mil ac proof test.

The satisfactory test results are evidence that Okoguard insulation is suitable for the

FIGURE II CABLE QUALIFICATION TEST PROFILE FOR LIFE & LOCA CONDITIONS

LEGEND: ▲ INSULATION RESISTANCE MEASUREMENT ; O AC WITHSTAND TEST, 80V/MIL.



QUALIFICATION TESTS OF ELECTRICAL CABLES IN A SIMULATED LOSS-OF-COOLANT ACCIDENT (LOCA) ENVIRONMENT

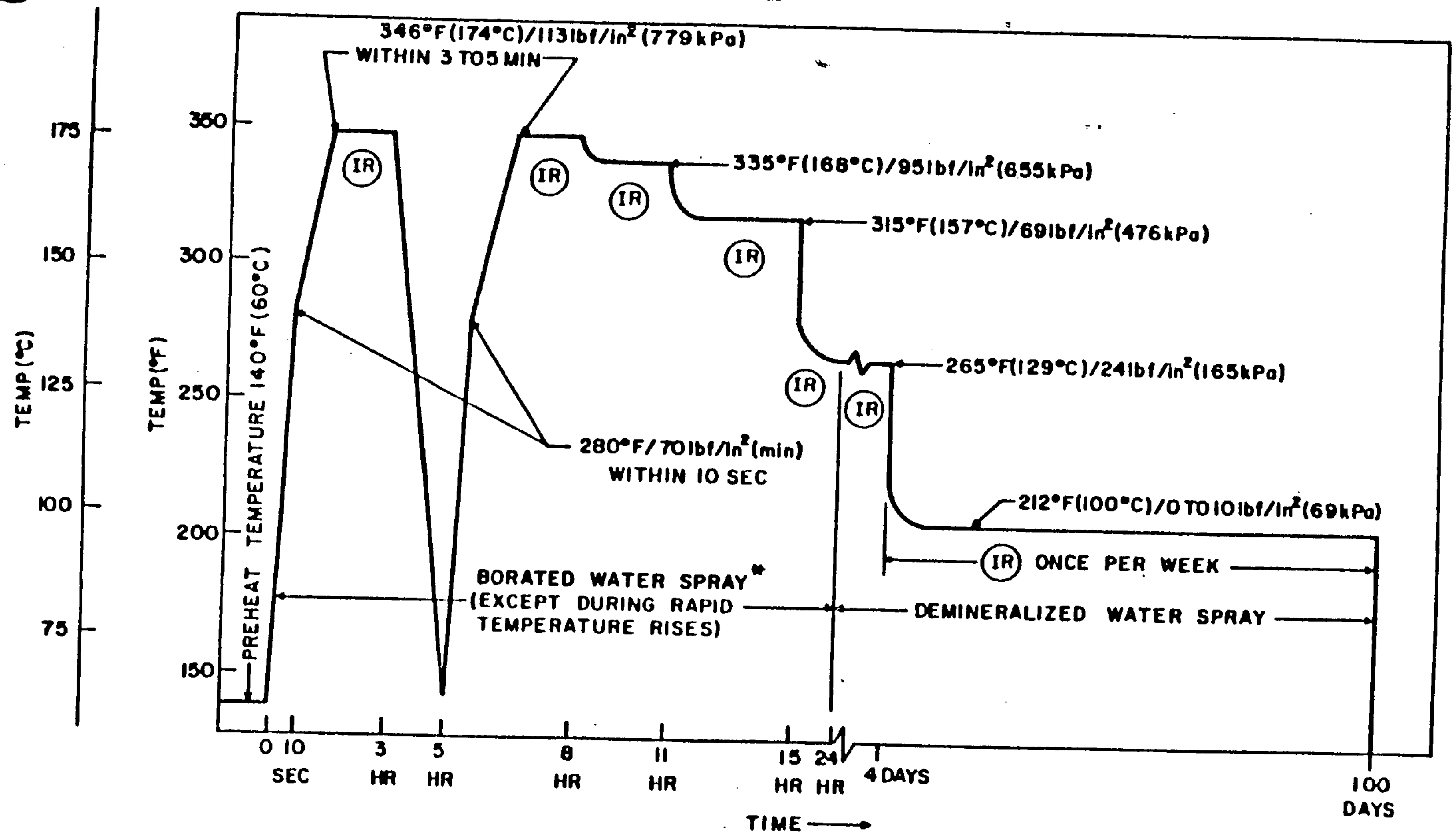
FRC FINAL REPORT
F-C5160-1

Prepared for

Collyer Insulated Wire
100 Higginson Avenue
Lincoln, Rhode Island 02865

May 21, 1980

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000



*Chemical-spray solution consisted of:

- o 3000 ppm boron as boric acid
- o 0.064 molar sodium thiosulfate
- o 100 ppm hydrazine
- o Sufficient sodium hydroxide to obtain pH = 10.5 @ 77°F (25°C)

(IR) = Insulation resistance

Temperature tolerance = ±5°F (3°C)

Pressure tolerance = ±5 lbf/in² (34 kPa)

Δ Except during initial temperature/pressure transients.

Figure 4. Temperature/Pressure Profile for Simulation of Loss-of-Coolant Accident (LOCA) Environment

THE OKONITE COMPANY
Ramsey New Jersey U.S.A.

September 17, 1981

ENGINEERING REPORT NO. 355

MAIN STEAM LINE BREAK QUALIFICATION TEST ON OKONITE, OKONITE-FMR, X-OLENE-FMR AND OKOGUARD INSULATIONS

Introduction

A design basis event (DBE) main steam line break test (MSLB) was
performed on Okonite, Okonite-FMR, X-Olene-FMR, and Okoguard in-
sulations. These insulations have previously been qualified for
nuclear plant use in prior LOCA tests. The purpose of the MSLB
was to determine if these insulations could maintain an electrical
load during such an event. The test profile was based on a
customer's postulated MSLB parameters with margin added. IEEE
Standards 383-1974 and 323-1974 were incorporated in the test pro-
gram.

As described in this report, qualification testing was performed
by Isomedix, Inc. and Approved Engineering Testing Laboratories in
two MSLB tests. These tests are documented in report numbers 558-
1021 (September 22, 1980) and 558-1077 (April 8, 1981) and are avail-
able for audit at Okonite headquarters.

Conclusion

All four insulations were qualified to the MSLB-DBE described
herein. All samples met the specific performance requirements
established prior to testing. These requirements are described
in the body of this report.

Procedure

Qualification to the MSLB-DBE for all four insulations was accom-
plished in two tests. Okoguard, Okonite-FMR and X-Olene-FMR were
tested in the first MSLB test. Okonite insulation was qualified
in the second test.

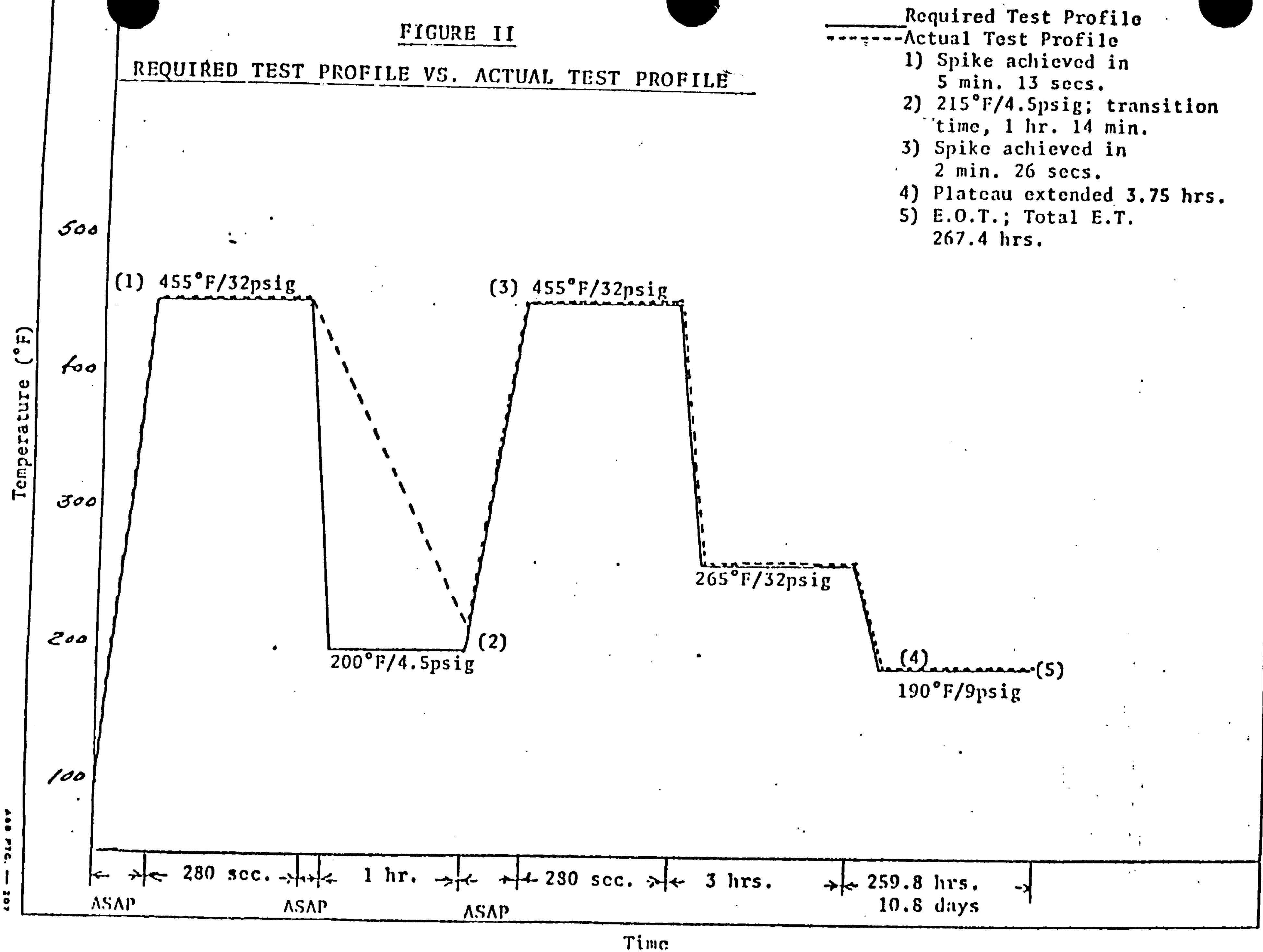
With the exception of sample preparation and thermal aging, the
first test was performed by Isomedix, Inc. Okonite was respon-
sible for sample preparation and aging. In the second test Okonite
again performed the sample preparation and thermal aging. Isomedix
was contracted for irradiation services. AETL performed the MSLB
and post MSLB tests. For both tests, the reports were written by
AETL.

The following samples were selected for testing.

Set	Description
(A)	5kV, 1/C #6 AWG (7X) bare copper, .020" extruded semicon-ducting screen, .090" extruded Okoguard EPR, .030" extruded semiconducting insulation screen, .005" bare copper shield-ing tape: Four samples - fifteen feet (effective). Reference No. 01-3663-1

FIGURE II

REQUIRED TEST PROFILE VS. ACTUAL TEST PROFILE



form TVA 10697 (EN DES 1-84)

EN DES CALCULATIONS

TITLE: JUSTIFICATION FOR INTERIM OPERATION FOR CP FAMILY OF CABLES	PLANT/UNIT: WBN/1 and 2
PREPARING ORGANIZATION: EEB	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST)

BRANCH/PROJECT IDENTIFIERS: CP

Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in.

Rev	(for MEDS' use)	MEDS accession number
R0		EEB '850123 · 920
R __		
R __		
R __		

APPLICABLE DESIGN DOCUMENT(S): N/A

SAR SECTION(S): N/A

UNID SYSTEM(S): Various

	Revision 0	Revision ___	Revision ___	Revision ___
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	R. L. Mills			
CHECKED	Don B. Arp			
SUBMITTED	Francis E Rosenzweig			
DATE	1-22-85			
APPROVED	J. L. Wagner			
List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

Use form 10634 if room req...

STATEMENT OF PROBLEM

The CP family of cables, used in Class 1E circuits outside containment, lack contract-specific documentation to prove their qualification in harsh environments.

ABSTRACT

Based on a combination of generic test data and engineering analysis, the CP family of cables have been shown to be acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification.

☐ Continuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center.

☐ Microfilm and destroy.

☒ Microfilm and return calculation to: F. B. Rosenzweig

Address: W8D182 C-K

Revision 0	R1	R2	R3	R4
Preparer/Date R. A. [illegible] 12-11-81	[illegible] 10/14/[illegible]	RLM 1-5-8[illegible]		
Reviewer/Date J. F. Wagner 12-14-81	JFW 10/10/[illegible]	JFW 1-22-8[illegible]		

Unit No. 1 and 2
EQS No. EEB-CBL-9
TVA ID No:
CP Family
Rev 2

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model Number See Table 3.11-8A, Sheets 1000 and 1001

Verification of Table Information (Table 3.11-8A Sheets 1000 and 1001)

X Equipment Type - The equipment has been identified as per TVA ID number designations (e.d., MOV, SOV, etc.).

X Location - The location has been identified (E.G., Inside Primary Containment, Annulus, Individually Cooled Rooms, General Spaces, or area affected by HELB outside primary containment).

X Component - A unique TVA ID number has been assigned (e.g., 1-FSV-63-308).

X Function - A functional description of the component has been given (e.g., Steam Generator Blowdown).

X Contract No., Manufacturer, and Model No. - The contract number, manufacturer, and model number has been given.

X Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not) Qualified Life See Appendix i | R2

X Qualification Report and Method - A qualification report and the method of qualification has been identified.

NA Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

X Qualification by Similarity (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (If applicable) - When an EQS is used for more than one item, a list of all exact components are given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

N/A Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component. Term of Interim Qualification ______

NCR No: ______

R2 X Unqualified Component-(Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation.

NCR No. WBNEEB8501

Prepared by: R.L. Mills 1/15/85

Reviewed by: J. F. Wagner 1/22/85

CP Family (CPJ, CPJJ, and CPSJ)

The CP family of cables consist of cross-linked polyethylene insulation and polyvinyl-chloride jacketing. All cable of this type was constructed, tested, and accepted for use in accordance with TVA Standard Specification 25.016 - Standard Specification for Cross-linked Polyethylene Insulated Wire and Cable. TVA Standard 25.016 invokes the applicable portions of IPCEA Standards (such as physical properties, and methods of testing for tensile strength and elongation of the insulation and jacket materials). The TVA Specification included provisions for source inspection of factory testing and required submittal of certified test reports to assure compliance with the specification. Cable manufactured since 1971 was controlled by a TVA approved QA program.

The following LOCA/SLB tests are representative for the CP family of cables which are presently installed.

Wyle Laboratory Test Report 43854-3 dated April 26, 1978, Qualification Test on eight cable splice Assemblies (cable assemblies comprised of CPJ cable). (See appendix 2).

Wyle Laboratory Test Report 17513-1 dated January 24, 1984, Containment Accident Test Program on Electrical Cabling and Splices. (See Appendix 2).

The test reports show a baseline functional test was first performed and passed. Then functional tests were performed and passed after the radiation test, after the temperature aging test, and after the LOCA/SLB test.

The tests included radiation at 1.13×10^8 rads.

The tests included temperature aging at 130°C for 2576 hours.

The tests included a LOCA/SLB at 325°F, 55 psig, 100 percent humidity.

NOTE: One sample of CPJJ (Plastic wire and cable) received 1.68×10^8 rads and temperature aging at 130°C for 5152 hours.

Preparer/Date R. L. Mills 1/15/85	EEB-CBL-9, Rev. 1	
Reviewer/Date J. F. Wagner 1/22/85	Appendix 1 Rev 2	
	Sheet 2 of 2	

CP Family (CPJ, CPJJ, and CPSJ)

The tests included cable samples from General Electric, Okonite Company, and Plastic Wire and Cable. This cross section of cable manufacturers represented in the tests adequately demonstrated that the CP family of cables will perform similarly in the given DBE. The variety of vendors used also proved that successful completion of the test is a function of the chemical properties of the insulation and jacketing compound and is not dependant on the manufacturer. Consistency in the chemical properties has been demonstrated by successfully completing the requirements of TVA Standard Specification 25.016. This approach to generic cable qualification follows the general guidelines for type testing as outlined by IEEE 383-1974.

All cables of the CP family met or exceeded the construction, testing, and acceptance requirements of TVA Standard specification 25.016. In addition representative samples of the CP family of cables supplied to TVA by different manufacturers successfully passed LOCA/SLB testing. In view of the above, we conclude that the results show that the CP family of cables will perform their safety functions satisfactorily until the NRC's final compliance date for equipment qualification. At that time they will either be deemed qualified by virtue of testing by Wyle Laboratories or replaced with fully qualified cables. R2

Rev. 0 Rev. 1

Prepared by: R. A. [signature] 12-11-81 DST/10-11-84

Reviewed by: [signature] 12-14-81 [initials] 10-11-84

EEB-CBL-9
Appendix 2
Sheet 1 of 10
Rev 1

QUALIFICATION TEST REPORT

ON

EIGHT CABLE SPLICE ASSEMBLIES

TO BE USED AT

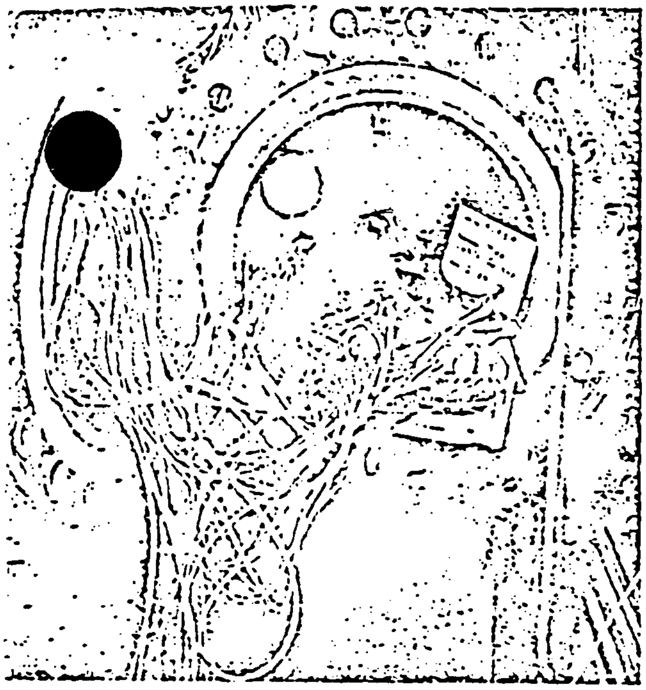
BROWNS FERRY NUCLEAR POWER PLANT

UNIT 3

VOLUME I OF I

FOR

TENNESSEE VALLEY AUTHORITY
DIVISION OF POWER PRODUCTION
804 EDNEY BUILDING
CHATTANOOGA, TENNESSEE 37401



NEQ
Nuclear Environmental Qualification

Test Report

Appendix 2
Sheet 2 of 10
Rev 1

REPORT NO. 43854-3

WYLE JOB NO. 43854

CUSTOMER P. O. NO. 77P8-147972

PAGE 1 OF 189 PAGE REPORT

DATE April 26, 1978

SPECIFICATION (S) See Paragraph 5.0

1.0 CUSTOMER Tennessee Valley Authority, Division of Power Production

ADDRESS 804 Edney Building
Chattanooga, Tennessee 37401

2.0 TEST SPECIMEN Cable Splice Assemblies (to be used at Browns Ferry Nuclear Power Plant, Unit 3, Athens, Alabama)

3.0 MANUFACTURER Fabricated by TVA

4.0 SUMMARY

Eight (8) Cable Splice Assemblies were subjected to a Qualification Test Program to verify their electrical integrity to perform their intended function during or after the environmental tests specified herein. The Cable Splice Assemblies tested are to be used inside containment at Unit 3 of Browns Ferry Nuclear Power Plant. A description of each Cable Splice Assembly is shown in Paragraph 6.0 of this report.

The test program was performed as specified in Reference 5.1 and in accordance with Reference 5.2 to satisfy the requirements for qualifying Class IE electrical equipment for use at Browns Ferry Nuclear Power Plant. The following table lists the tests, testing sequence, and test results that comprise the Qualification Test Program.

STATE OF ALABAMA } ss.
COUNTY OF MADISON

Alabama Professional Engineering License #7112

William W. Holbrook, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

[signature]

SUBSCRIBED and sworn to before me this 27th day of April, 1978

[signature]

Notary Public in and for the County of Madison, State of Alabama.

My Commission expires June 3, 1980

TEST BY Special Projects

PROJ. ENGINEER [signature] D. F. Hatmaker

WYLE Q. A. [signature] L. M. Davies

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

[illegible].0 SUMMARY (CONTINUED)

TESTS, TESTING SEQUENCE, AND TEST RESULTS

Wyle Specimen Tag No.	Radiation	Temperature Aging	Accident (LOCA)	Complied with Requirements	Did Not Comply with Reqiments
1A	X		X	X	
1B			X	X	
2A	Spare	Spare	Spare	Spare	Spare
2B	Spare	Spare	Spare	Spare	Spare
3A			X	X	
3B	X		X	X	
4A		X	X	X	
4B		X	X	X	
5A	X	X	X	X	
5B	X	X	X	X	

Note: Test specimens with an "A" suffix are 250 VDC operating splices.
Test specimens with a "B" suffix are 480 VAC operating splices.

SUMMARY (CONTINUED)

This final test report contains the following Sections. The Qualification Program was performed in the sequence indicated by the Section numbers.

Section I	Baseline Functional Tests
Section II	Nuclear Radiation
Section III	Post Radiation Functional Tests
Section IV	Temperature Aging Test
Section V	Post Temperature Aging Functional Tests
Section VI	Accident Test
Section VII	Post Accident Functional Tests
Section VIII	Dimensional Tests
Section IX	Post Test Inspection

5.0 REFERENCES

5.1 Contract Number 77P8-147972, Qualification Testing, Browns Ferry Nuclear Power Plant, Tennessee Valley Authority.

5.2 Tennessee Valley Authority Test Procedure for Proposed Browns Ferry Cable Splices.

6.0 TEST ITEM AND TEST EQUIPMENT DESCRIPTION

6.1 Test Item Description

Four (4) each of two (2) different types of Cable Splice Assemblies were tested during this test program. Both types were fabricated by TVA personnel and are to be used inside containment at Browns Ferry Nuclear Generating Station, Unit 3.

The two types of Cable Splice Assemblies are described as follows:

The 480 VAC Cable Splice Assembly consists of four (4) single cables of No. 10 CPJ wire, spliced to four (4) single cables of No. 12 Vulkene insulated wire, spliced to four (4) single cables of No. 10 CPJ wire. Five (5) of these assemblies were fabricated. Only four (4) were tested. One (1) Assembly was a spare.

The 250 VDC Cable Splice Assembly consists of a seven (7)-conductor cable, wire size No. 10, with CPJJ insulation, spliced to seven (7) single conductor cable, wire size No. 10, with CPJJ insulation.

6.0 TEST ITEM AND TEST EQUIPMENT DESCRIPTION (CONTINUED)

6.1 Test Item Description (Continued)

Five (5) of these Assemblies were fabricated. Only four (4) were tested. One Assembly was a spare.

The test splices were butt splices covered with Raychem Heat Shrinkable Sleeving.

All test items were fabricated under field conditions by TVA personnel at Browns Ferry Nuclear Power Plant and delivered to Wyle Laboratories for test. The test splices in each Cable Assembly were wired by Wyle so when loaded all splices were in series. TVA provided the lead wires for each test item assembly to which Wyle connected a load and power supply.

6.2 Test Equipment Description

Test equipment, from sensor to final readout device, was selected to provide the accuracies specified below:

- Chamber Temperature ± 5°F
- Chamber Pressure ± 5 psig
- Voltage ± 3%
- Current ± 3%

Test equipment used for these tests is shown on Instrumentation Equipment Sheets located in the appendices to the appropriate sections of this report.

Curve Code	Explanation
△	Con[illegible] response to a postulated LOCA as defined in GE Letter No. G-EB-6120 to G.D. [illegible] of TVA dated Aug [illegible], 1976, and GE Letter No. G-ER-6130 to R.R. Patterson of TVA dated May [illegible], 1976.
○	Containment response to a postulated 0.5 ft² steam line break as defined in Figure Q[illegible] of the Response to AEC Questions Dated March [illegible], 1971, contained in Volume 6 of the [illegible] FSAR.
○	Pin connector environmental qualification curve drawn to encompass the postulated LOCA and 0.5 ft² steam line break, containment response curves △ and ○ and to be used in pin connector testing after [illegible].

NUMERICAL CODE LEGEND

Code Number	Associated Curve	Pressure (psig)	Temperature (°F)	[illegible]
1	△	50	295	N/R
2	○	55	325	N/R
3	○	24	32[illegible]	N/R
4	○	20	325	start 0.033°F/min decrease for [illegible] minutes
5	○	20	30[illegible]	start 0.6°F/min and 0.1[illegible] psig/min decrease for 40 minutes
6	○	20	28[illegible]	N/R
7	○	20	230	start 0.5°F/hr decrease for the remainder of test
8	○	10	[illegible]	N/R
9	○	5	22[illegible]	N/R
10	○	2	219	N/R
11	○	0	216	N/R

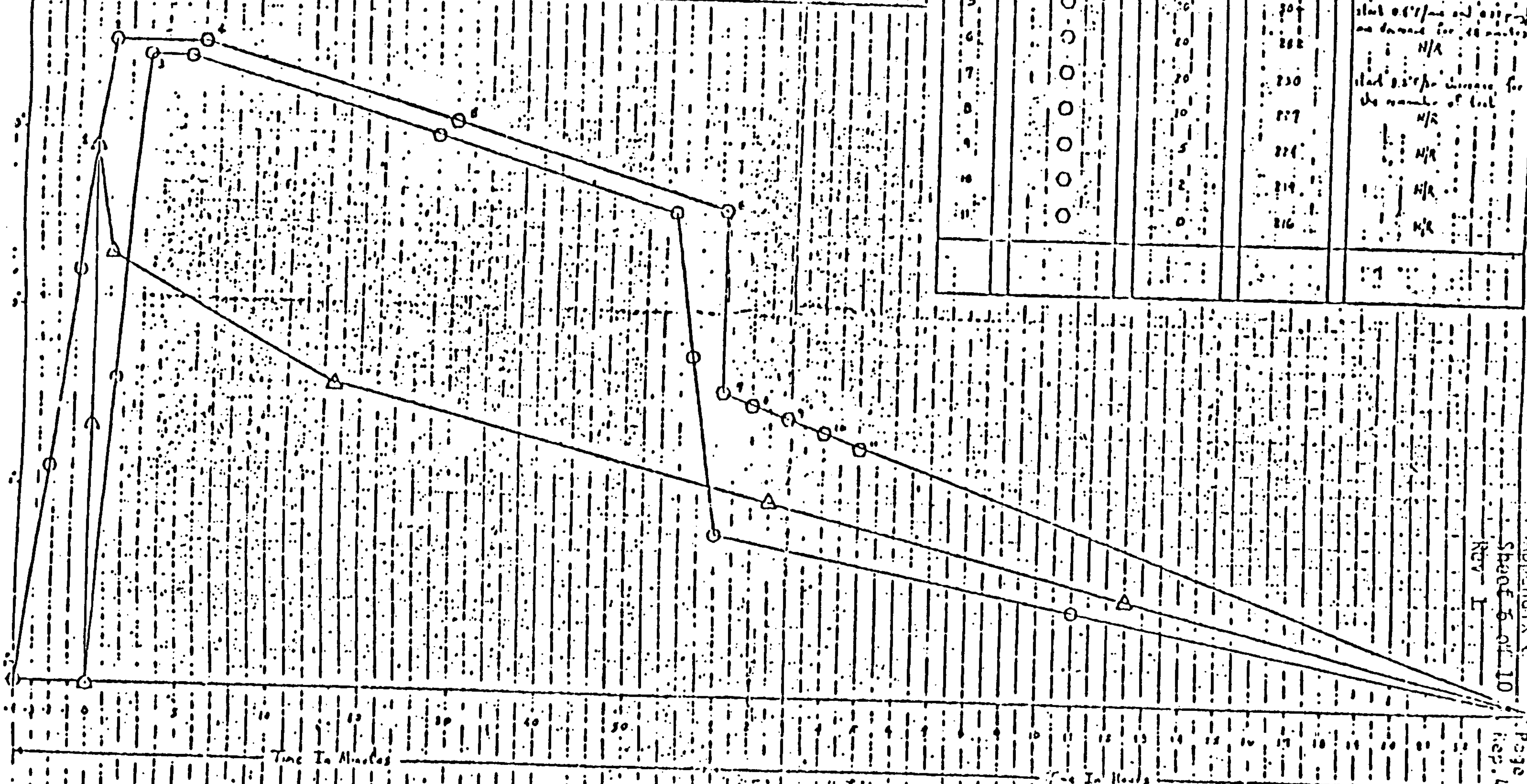


FIGURE 3 - ACCIDENT ENVIRONMENTAL QUALIFICATION CURVE

CONTAINMENT ACCIDENT TEST PROGRAM

ON

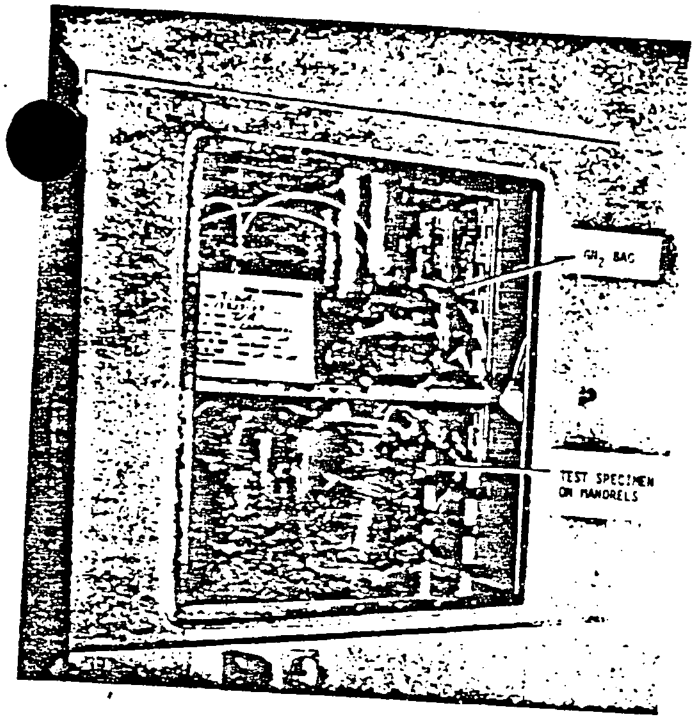
ELECTRICAL CABLING AND SPLICES

FOR USE IN

BROWNS FERRY NUCLEAR POWER GENERATING STATION

for

Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902



Test Report

REPORT NO. 17513-1

WYLE JOB NO. 17513

CUSTOMER P. O. NO. TV-56071A

PAGE i OF 331 PAGE REPORT

DATE January 24, 1984

SPECIFICATION (S)
WLTP 17460-2, Rev. C
dated January 8, 1984

1.0 CUSTOMER Tennessee Valley Authority

ADDRESS 400 West Summit Hill Drive, Knoxville, TN 37902

2.0 TEST SPECIMEN Electrical cabling and splices, single and multiconductor, 12 through 34 AWG

3.0 MANUFACTURER See Paragraph 6.0

4.0 SUMMARY

Several generic cabling types and splices of various manufacture were subject to a test program to evaluate the adequacy of their design to perform their required functions in Class 1E systems at Browns Ferry Nuclear Power Generating Station Units 1, 2 and 3. The test items are described in detail in Paragraph 6.0 of this section.

STATE OF ALABAMA }
COUNTY OF MADISON } ss. Alabama Professional Engineer Reg. No. 7948

Frederick M. Sittason, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SEAL [signature]

SUBSCRIBED and sworn to before me this 13th day of Jan., 1984
[signature: Patricia A. Phillips]
Notary Public in and for the State of Alabama at large.
My Commission expires Jan. 30, 1985

(DN271)

PREPARED BY [signature] 1/23/84
G. A. Carbonneau

APPROVED BY [signature] 1-24-84
Johnson

WYLE Q. A. W. B. Roberts [signature] 1/24/84
W. B. Roberts

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
HUNTSVILLE, ALABAMA

TEST SPECIMEN DESCRIPTION (CONTINUED)

6.1 Continued)

Test Item No.	Specimen Description
1.3	One length (not less than 10 feet) of No. 12 AWG single conductor, TVA type PXJ Mark WDV-1 cable, containing a stranded copper conductor (7 strands/0.0305-inch), insulated by a 0.030-inch thick layer of ethylene propylene rubber. The assembly is covered with a chlorosulfonated polyethylene (0.015-inch thick) exterior jacket. The cable is manufactured by the American Insulated Wire Company and is rated for 600 volts, 31 amperes maximum, and a maximum conductor temperature of 90°C.
1.4	One length (not less than 10 feet) of No. 12 AWG 3-conductor, TVA Type PXMJ Mark WGC-1 cable, containing 3 stranded copper conductors (7 strands/0.0305 inch). Each conductor is insulated by a 0.030-inch thick layer of flame retardant crosslinked polyethylene. The assembly is covered with a chlorosulfonated polyethylene (0.045-inch thick) exterior jacket. The cable is manufactured by the Essex Group and is rated for 600 volts, 31 amperes maximum, and a maximum conductor temperature of 90°C.
1.5	One length (not less than 10 feet) of No. 12 AWG single conductor, TVA type CPJ Mark WDV cable, containing a stranded copper conductor (7 strands/0.0305 inch), insulated by a 0.030-inch thick layer of crosslinked polyethylene. The assembly is covered with a polyvinyl chloride exterior jacket. The cable is manufactured by the Okonite Company and is rated for 600 volts, 31 amperes maximum and a maximum conductor temperature of 90°C.
1.6	One length (not less than 10 feet) of No. 12 AWG 2-conductor, TVA type CPJJ Mark WLB cable, containing stranded copper conductors (7 strands/0.0305 inch), insulated by a 0.030-inch thick layer of crosslinked polyethylene and a 0.015-inch thick layer of polyvinyl chloride. The assembly is covered with a polyvinyl chloride (0.045-inch) exterior jacket. The cable is manufactured by Plastic Wire and Cable and is rated for 600 volts.

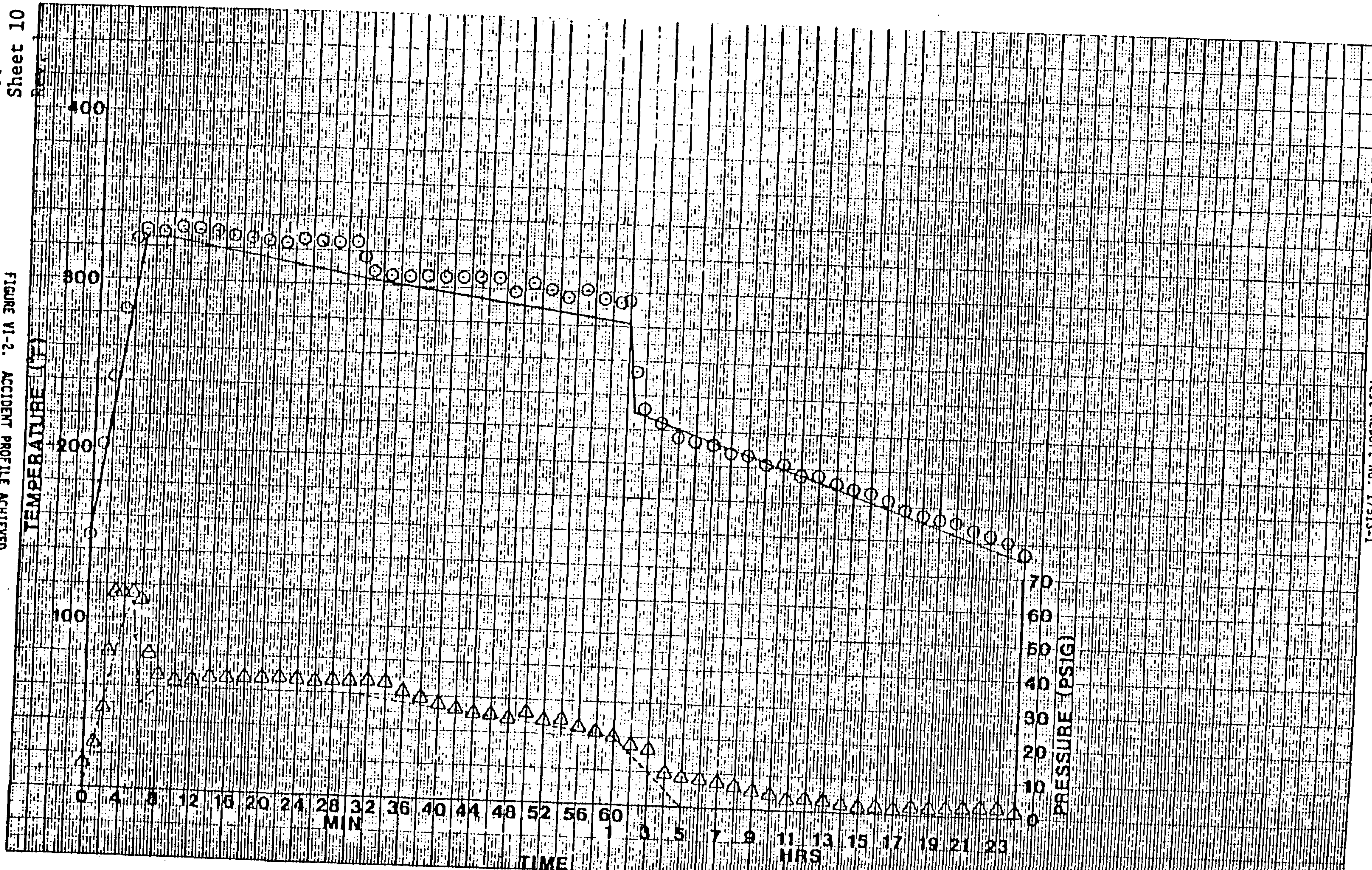


FIGURE VI-2. ACCIDENT PROFILE ACHIEVED

form TVA 10697 (EN DES 1-84)

EN DES CALCULATIONS

TITLE JUSTIFICATION FOR INTERIM OPERATION FOR PX FAMILY OF CABLES	PLANT/UNIT WBN/1 and 2

PREPARING ORGANIZATION	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST)
CH/PROJECT IDENTIFIERS PX	Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in.

	Rev	(for MEDS' use)	MEDS accession number
	RO		EEB '85 0123 922
APPLICABLE DESIGN DOCUMENT(S) N/A	R __		
	R __		
SAR SECTION(S) N/A / UNID SYSTEM(S) Various	R __		

	Revision 0	Revision __	Revision __	Revision __
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	L. L. Mills			
CHECKED	Don B. Arp			
SUBMITTED	Francis E Rosenzweig			
DATE	1-22-85			
APPROVED	J Wagner			
List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

Use form TVA 10634 if mo... room require...

STATEMENT OF PROBLEM

The PX family of cables, used in Class 1E circuits outside containment, lack contract-specific documentation to prove their qualification in harsh environments.

ABSTRACT

Based on a combination of generic test data and engineering analysis, the PX family of cables have been shown to be acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification.

☐ ...tinuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center.

Microfilm and destroy. ☐

☒ Microfilm and return calculation to: F. B. Rosenzweig

Address: W8D182 C-K

	Revision 0	R1	R2	R3	R4
Preparer/Date	E.A. McInturff 12-11-81	DLS 10/1/84	RLM 1-15-85		
Reviewer/Date	J.F. Wagner 12-14-81	RGW 10-11-84	JPW 1-22-85		

Unit No. 1 and 2
EQS No. EEB-CBL-13
TVA ID No:
Type PXJ and PXMJ Cable
Rev 2

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model Number See Table 3.11-8A, sheets 1008 thru 1011B

Verification of Table Information (Table 3.11-8A Sheets 1008 thru 1011B)

X Equipment Type - The equipment has been identified as per TVA ID number designations (e.d., MOV, SOV, etc.).

X Location - The ~~location has been~~ identified (E.G., Inside Primary Containment, Annulus, Individually Cooled Rooms, General Spaces, or area affected by HELB outside primary containment).

X Component - A unique TVA ID number has been assigned (e.g., 1-FSV-68-308).

X Function - A functional description of the component has been given (e.g., Steam Generator Blowdown).

X Contract No., Manufacturer, and Model No. - The contract number, manufacturer, and model number has been given.

X Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

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X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

R2 Qualification Status (check if applicable, NA if not) Qualified Life See Appendix 1

X Qualification Report and Method - A qualification report and the method of qualification has been identified.

NA Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

X Qualification by Similarity (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (If applicable) - When an EQS is used for more than one item, a list of all exact components are given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

N/A Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component. Term of Interim Qualification ______

NCR No. ______

R2 X Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation.

NCR No. WBNEEB8501

Prepared by: DL Sculthorpe 10-11-84

Reviewed by: J J Wagner 10-11-84

EEB-CBL-13, Rev. 1
Appendix 1 Rev. 2
Sheet 1 of 2

PX Family (PXJ and PXMJ)

The PX family of cables consist of cross-linked polyethylene or ethylene propylene rubber, and the jacket is chlorosulfonated-polyethylene or chlorinated-polyethylene. All cable of this type was constructed, tested, and accepted for use in accordance with TVA Standard Specification 25.016 - Standard Specification for Low-Voltage Wire and Cable with Flame-Retardant, Cross-Linked Polyethylene or Ethylene-Propylene Rubber insulation. TVA Standard Specification 25.016 invokes the applicable portions of IPCEA Standards; such as, physical properties, and methods of testing for tensile strength and elongation of the insulation and jacketing materials. The TVA Specification included provisions for source inspection of factory testing and required submittal of certified test reports to assure compliance with the specification. Manufacture of all installed cable was controlled by a TVA approved QA program.

The following LOCA/SLB tests are representative of the PX family of cables which are presently installed.

Franklin Institute Test Report F-C4113 dated May 1975. (Brand-Rex Company) (See Appendix 2).

Rockbestos Company Test Report dated July 1977 and revised November 26, 1977 "Qualification of Firewall® III Class 1E Electric Cables (Chemically Cross-linked Insulation) (See Appendix 2).

Franklin Institute Test Report No. F-C5120-1 dated August 19, 1980, (Brand Rex Company) "Qualification Tests of Electrical Cables in a Simulated Steam Line Break (SLB) and Loss-of-Coolant Accident (LOCA) Environment" (See Appendix 2).

Essex Project Report Number PE-53 dated May 7, 1980 "Main Steam Line Break (MLSB) Test on Aged and Irradiated Cable Specimens." (See Appendix 2).

Franklin Institute Test Report F-C4997-1 dated December 1978 "Qualification Tests of Electrical Cables in a Simulated Steam-Line-Break and Loss-of-Coolant-Accident Environment (American Insulated Wire Corporation (See Appendix 2).

The Okonite Company Test Report N-1 dated July 3, 1978 "Qualification of Okonite Ethylene-Propylene Rubber Insulation for Nuclear Plant Service" (See Appendix 2).

The Okonite Company Test Report FN-2 dated October 28, 1980, "Qualification of Okonite-FMR Flame Retardant Ethylene-Propylene Rubber Insulation for Nuclear Plant Service" (See Appendix 2).

Prepared by: R.L. Mills 1-15-85

Reviewed by: J.F. Wagner 1-22-85

PX Family (PXJ and PXMJ)

The Okonite Company Engineering Report No. 355 dated September 17, 1981, "Main Steam Line Break Qualification Test on Okonite, Okonite-FMR, X-Olene-FMR and Okoguard Insulations" (See Appendix 2).

Franklin Institute Report F-C4836-2 dated January 1978, "Qualification Tests of Flame-Guard FR-EP Instrumentation and Control Class 1E Electric Cables in a Simulated Steam-Line-Break and Loss-of-Coolant Accident Environment" (Anaconda Company) (See Appendix 2).

The test reports demonstrate that PXJ and PXMJ cables manufactured to meet the requirements of TVA Standard Specification 25.016 are suitable for Class 1E service in accordance with appropriate guidelines presented in IEEE Standards 323-1974 and 383-1974.

The tests included radiation at $2x10^8$ rads except the Okonite MSLB Engineering Report 355 included radiation at $55x10^7$ rads.

The tests included a LOCA/SLB at 346°F, 113°psig 100 percent humidity and MSLB's at 455°F, 32 psig (Okonite) and at 440°F (Essex).

These tests included cable samples from Brand-Rex Company, Rockbestos Company, Essex International, Inc., American Insulated Wire Corp., The Okonite Company, and Anaconda Company. This cross section of cable manufacturers represented in the tests adequately demonstrated that the PX family of cables will perform similarly in the given DBE. The variety of vendors used also proved that successful completion of the test is a function of the chemical properties of the insulation and jacketing compound and is not dependent on the manufacturer. Consistency in the chemical properties has been demonstrated by successfully completing the requirements of TVA Standard Specification 25.016. This approach to generic cable qualification follows the general guidelines for type testing as outlined by IEEE 383-1974.

All cables of the PX family met or exceeded the construction, testing, and acceptance requirements of TVA Standard Specification 25.016. In addition representative samples of the PX family of cables supplied to TVA by different manufacturers successfully passed LOCA/SLB testing. In view of the above, we conclude that the results show that the PX family of cables will perform their safety functions satisfactorily until the NRC's final compliance date for equipment qualification. At that time they will either be deemed qualified by virtue of testing by Wyle Laboratories or replaced with fully qualified cables. R3

034279.03

Prepared by: DL Southorpe 10-11-84

Reviewed by: J J Wagner 10-11-84

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Technical

Final Report
F-C4113

Report

QUALIFICATION TESTS OF ELECTRIC CABLES FOR CLASS 1E SERVICE IN NUCLEAR POWER PLANTS

Prepared for

BRAND-REX COMPANY
A PART OF Akzona INC.
WILLIMANTIC, CONNECTICUT

May 1975

THE FRANKLIN INSTITUTE RESEARCH LABORATORIES
THE BENJAMIN FRANKLIN PARKWAY • PHILADELPHIA PENNSYLVANIA

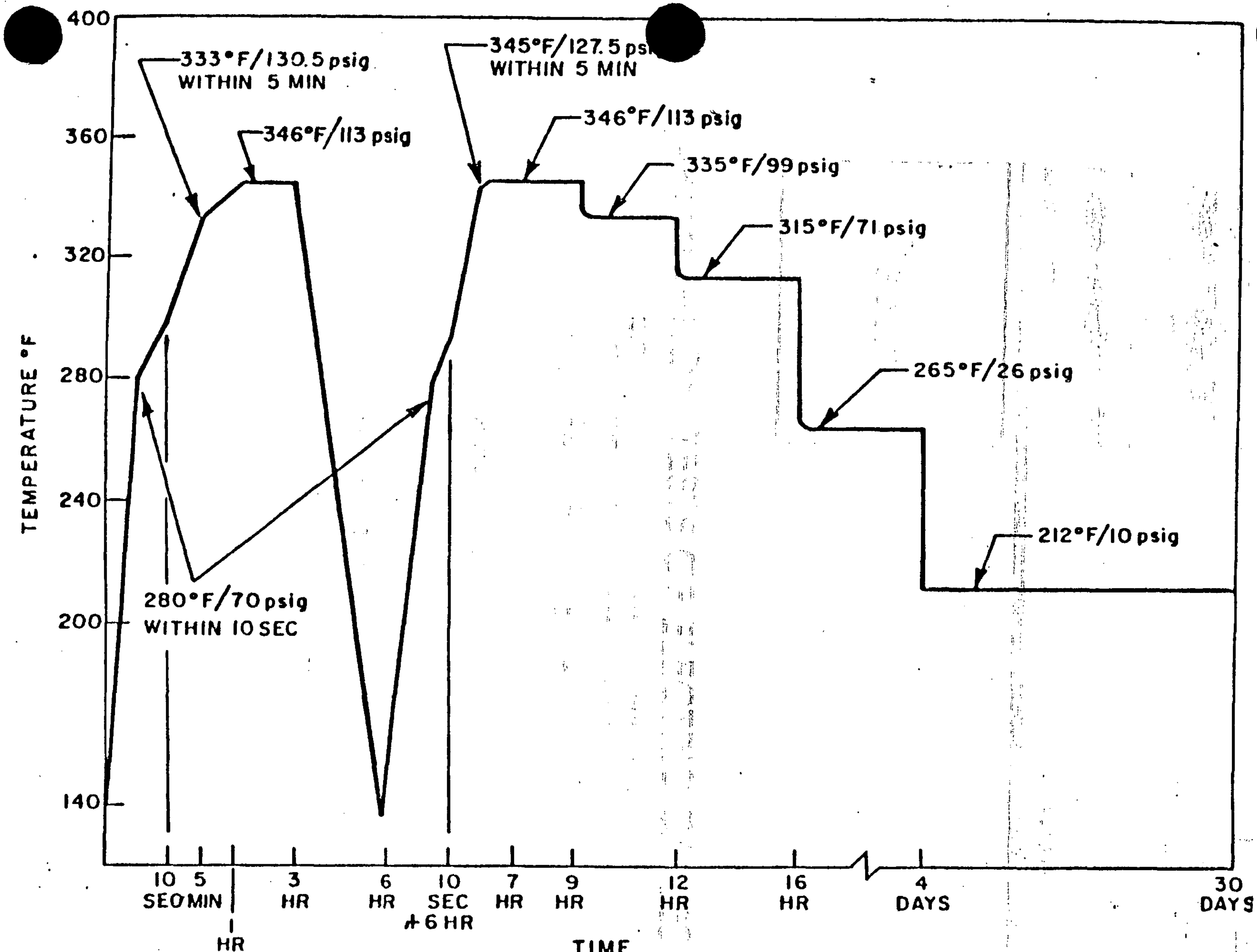

Figure 4. Actual Temperature/Pressure Profile for Simulation of LOCA

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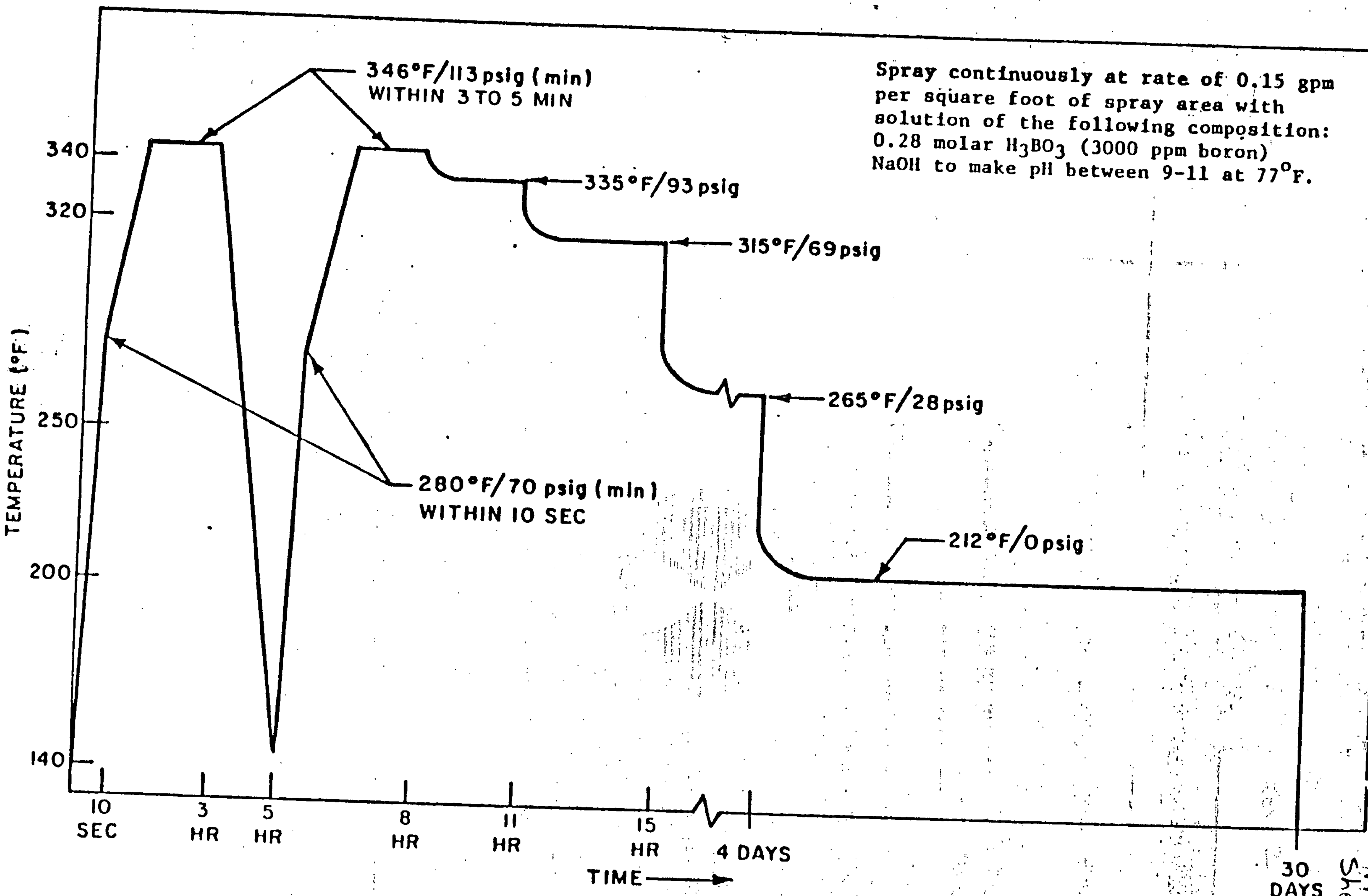
QUALIFICATION OF FIREWALL® III CLASS 1E ELECTRIC CABLES

(Chemically Cross-Linked Insulation)

THE ROCKBESTOS COMPANY
New Haven, Ct. 06504

July 7, 1977
Revised Nov. 26, 1979

LOCA Pro



LOCA PROFILE

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QUALIFICATION TESTS OF ELECTRICAL CABLES IN A SIMULATED STEAM LINE BREAK (SLB) AND LOSS-OF-COOLANT ACCIDENT (LOCA) ENVIRONMENT

FRC Final Report
F-C5120-1

Prepared for

BRAND-REX COMPANY
A PART OF Akzona INC.
WILLIMANTIC, CONNECTICUT 06226
PHONE 203 423-7771

August 19, 1980

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

1. SUMMARY OF SALIENT FACTS

FRC Project No.	Report Title:
C5120	QUALIFICATION TESTS OF ELECTRICAL CABLES IN A SIMULATED STEAM LINE BREAK (SLB) AND LOSS-OF-COOLANT ACCIDENT (LOCA) ENVIRONMENT

Conducted and Reported By:	Conducted for:
Franklin Research Center The Parkway at Twentieth Street Philadelphia, PA 19103	Brand-Rex Company Industrial and Electronic Cable Division Willimantic, CT 06226
Report Date: August 19, 1980	**Period of Test Program:** August through December 1979

Objective:

To demonstrate performance of electrical cables for Class 1E service in nuclear power generating stations in accordance with guidelines presented in IEEE Stds 323-1974 and 383-1974.[1]

Equipment Tested:

Eighteen electrical cables (four 1/C #16 AWG, two 2/C #2 AWG, six 1/C #12 AWG, three 7/C #12 AWG, and three 1/C #2 AWG) with crosslinked polyethylene (XLPE) insulation and jacketing materials of Hypalon on multiconductor cables. A complete description is provided as Table 1 herein.

Elements of Program:

The specimens were divided into three groups for thermal aging: One group of eight specimens was unaged, a second group of seven specimens was thermally aged for 168 hours (7 days) at 136°C (277°F), and the third group of three specimens was thermally aged for 168 hours (7 days) at 158°C (317°F). All specimens were exposed to 200 Mrd of gamma irradiation (air equivalent dose) from a cobalt-60 source at a rate less than 1 Mrd/h and then to a steam/chemical-spray environment simulating a combined steam line break (SLB) and loss-of-coolant accident (LOCA) and the cooldown following the SLB/LOCA. The simulated SLB/LOCA exposure included two rapid rises in temperature/pressure to 385°F (196°C)/ 66 lbf/in^2 (455 kPa), two 10-minute dwells at those peak temperatures, followed by decreasing temperatures to a final 20-day dwell at 230°F (110°C)/10 lbf/in^2 (69 kPa). The total simulated SLB/LOCA duration was 30 days. A chemical solution (6200 ppm boron, 50 ppm hydrazine, sufficient sodium triphosphate to obtain a pH of 8.5, followed by sufficient sodium hydroxide to obtain a pH of 10.0 at room temperature) was sprayed on the specimens at the rate of 0.27 gpm per square foot (11 L/min per square meter),[2] starting at the completion of the 10-minute dwells at 385°F (196°C). The cables were electrically energized with ac potentials of 300 and 600 V, and currents of 10, 25, and 120 A (as appropriate) during the 30-day SLB/LOCA exposure. Final tests consisted of a 40X diameter bend test and a 5-minute ac high-potential-withstand test at 80 V per mil (3150 V/mm) of insulation.

Summary of Test Results:

<u>SLB/LOCA Exposure</u> - Fourteen of the 18 specimens remained energized except for short periods. See Remarks.

<u>Final High-Potential-Withstand Tests</u> - All specimens withstood a high-potential-withstand test with a leakage/charging current of less than 300 mA. See Remarks.

<u>Remarks</u> - Failure of four specimens to remain energized during the SLB/LOCA exposure (see above) was possibly caused by problems with test vessel penetrations; the problems were not considered to be indicative of the cable performance nor of conditions in a nuclear power generating station.[3] Note that all specimens withstood a final high-potential-withstand test.

[1] Full citations are provided in the text.

[2] See Section 4.5 for description of spray area calculation.

[3] A supplemental letter report is available which discusses the test methods and the reasons for intermittent cable deenergizing.

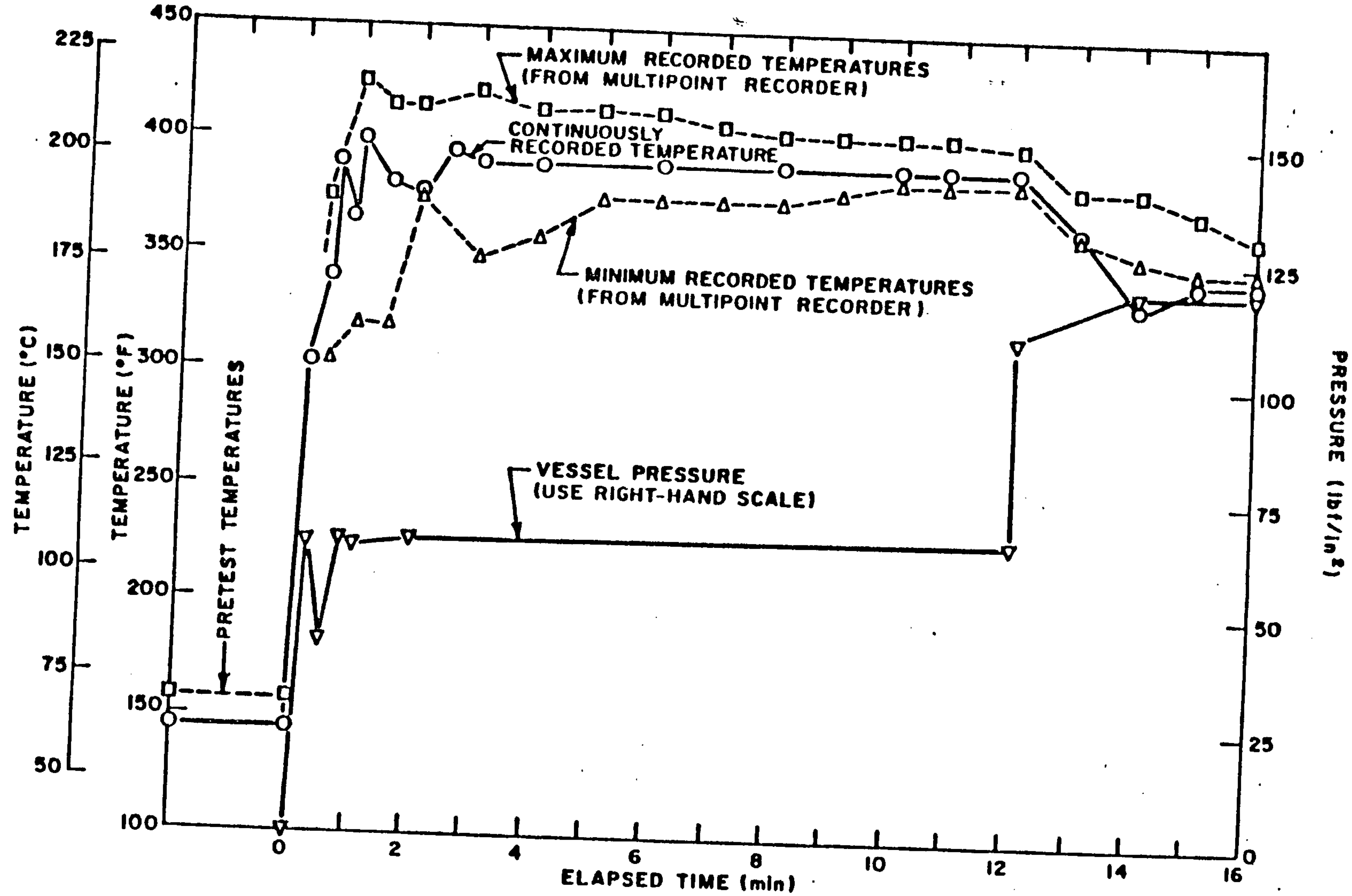

Figure 6. Actual Temperature and Pressure Profile of First SLB/LOCA Transient

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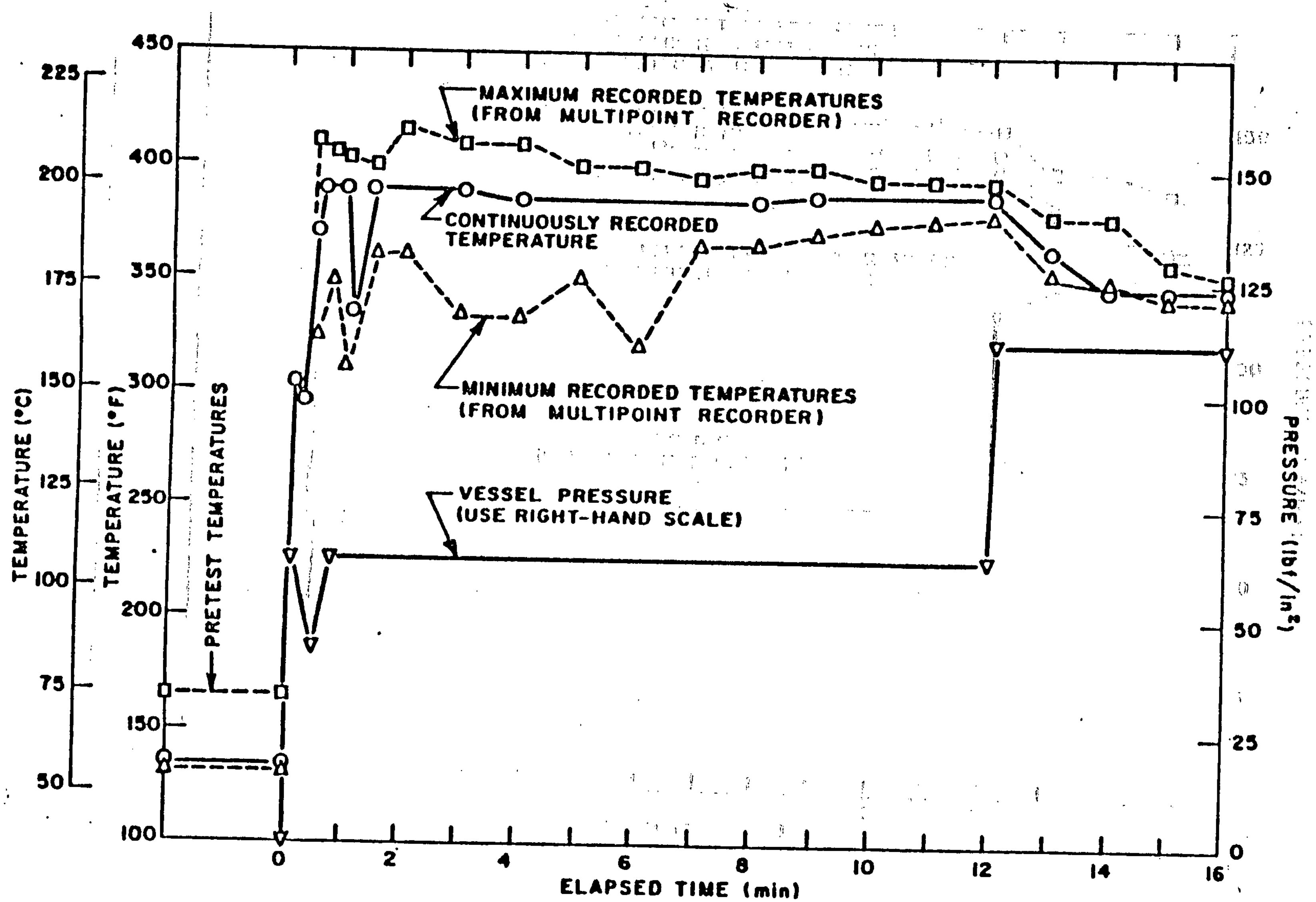

Figure 7. Actual Temperature and Pressure Profile of Second SLB/LOCA Transient

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ESSEX GROUP, INC.

POWER CONDUCTOR DIVISION

PROJECT REPORT

Report Number : PE-53

Date: May 7, 1980

APPROVED
This approval does not relieve the Contractor from any part of his responsibility for the correctness of design, details and dimension.
TENNESSEE VALLEY AUTHORITY
Date SEP 23 1980
V.W. CHANDLER

TITLE:

MAIN STEAM LINE BREAK (MSLB)

Test On Aged And Irradiated Cable Specimens

PROCEDURE:

Manufacture and prepare samples of Class 1E cable for aging and subsequent submittal to Isomedix, Inc. for irradiation and simulation of Main Steam Line Break Temperature and Pressure Profile.

CONCLUSION:

Specimens of Class 1E EP insulated conductor having successfully withstood the effects of heat aging to 40 years at 90C, irradiation to a level of 2.05 x 10^8 Rads (Co_{60}) and a MSLB temperature and pressure profile according to the requirements of the TVA Specification are judged to be fully qualified for service according to the referenced specifications.

REFERENCE:

TVA Specification 25.016 Item 93 Contract 6-825722
Isomedix Radiation Certification
Essex Arrhenius Plot (Class 1E EP)

Respectfully submitted,

J. L. Steiner
Chief Engineer

SEQUOYAH

80-827320-1

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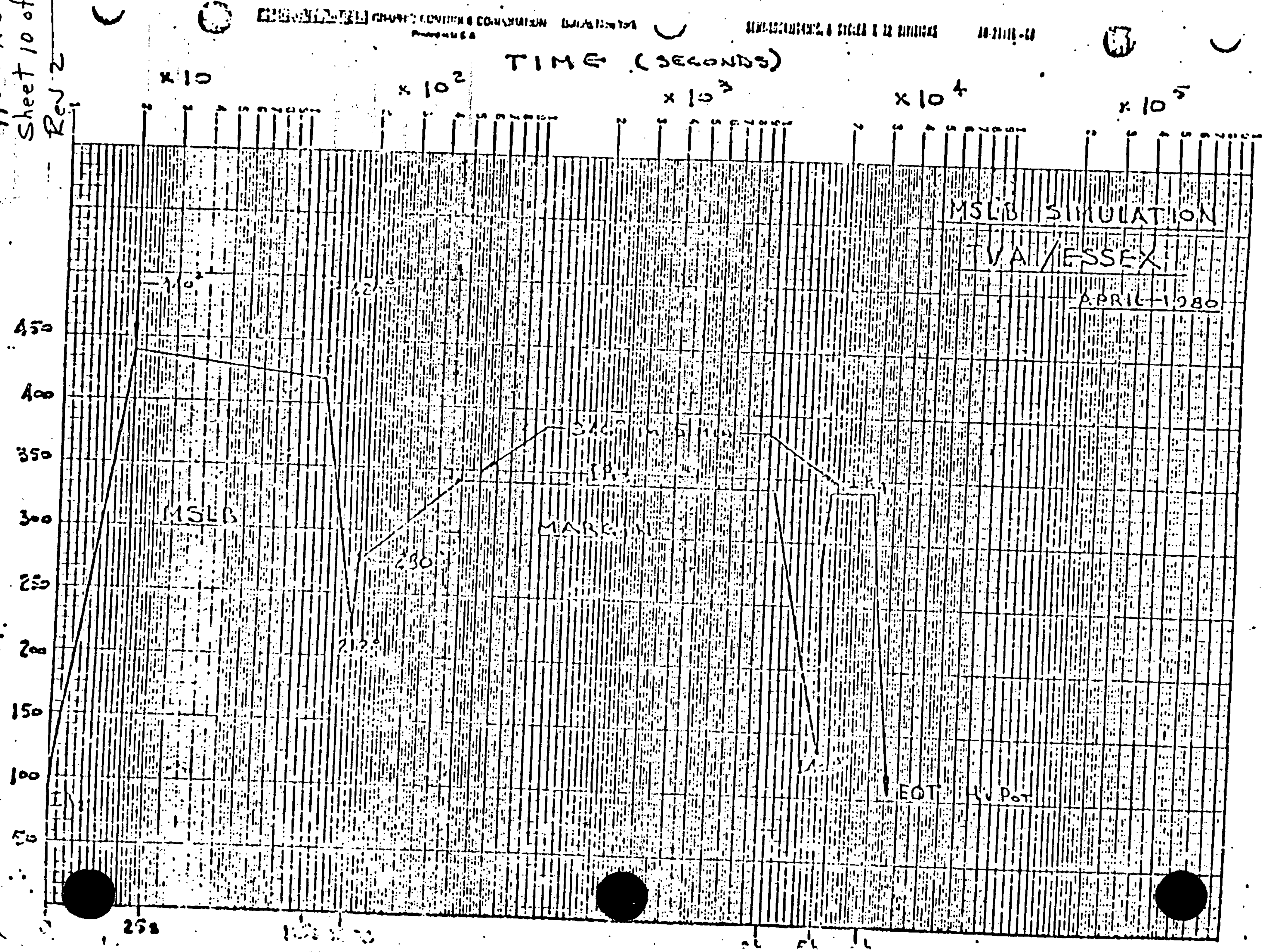

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Qualification Tests of Electrical Cables in a Simulated Steam-Line-Break and Loss-of-Coolant-Accident Environment

FRC Final Report
F-C4997-1

HARTSVILLE - PHIPPS BEND

APPROVED
This approval [illegible] the Contractor from any part of [illegible] for the [illegible] and [illegible].
[illegible] VALLEY [illegible]
MAY 20 1980
[illegible] CHANDLER

Prepared for

American Insulated Wire Corporation
Pawtucket, Rhode Island

December 1978

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

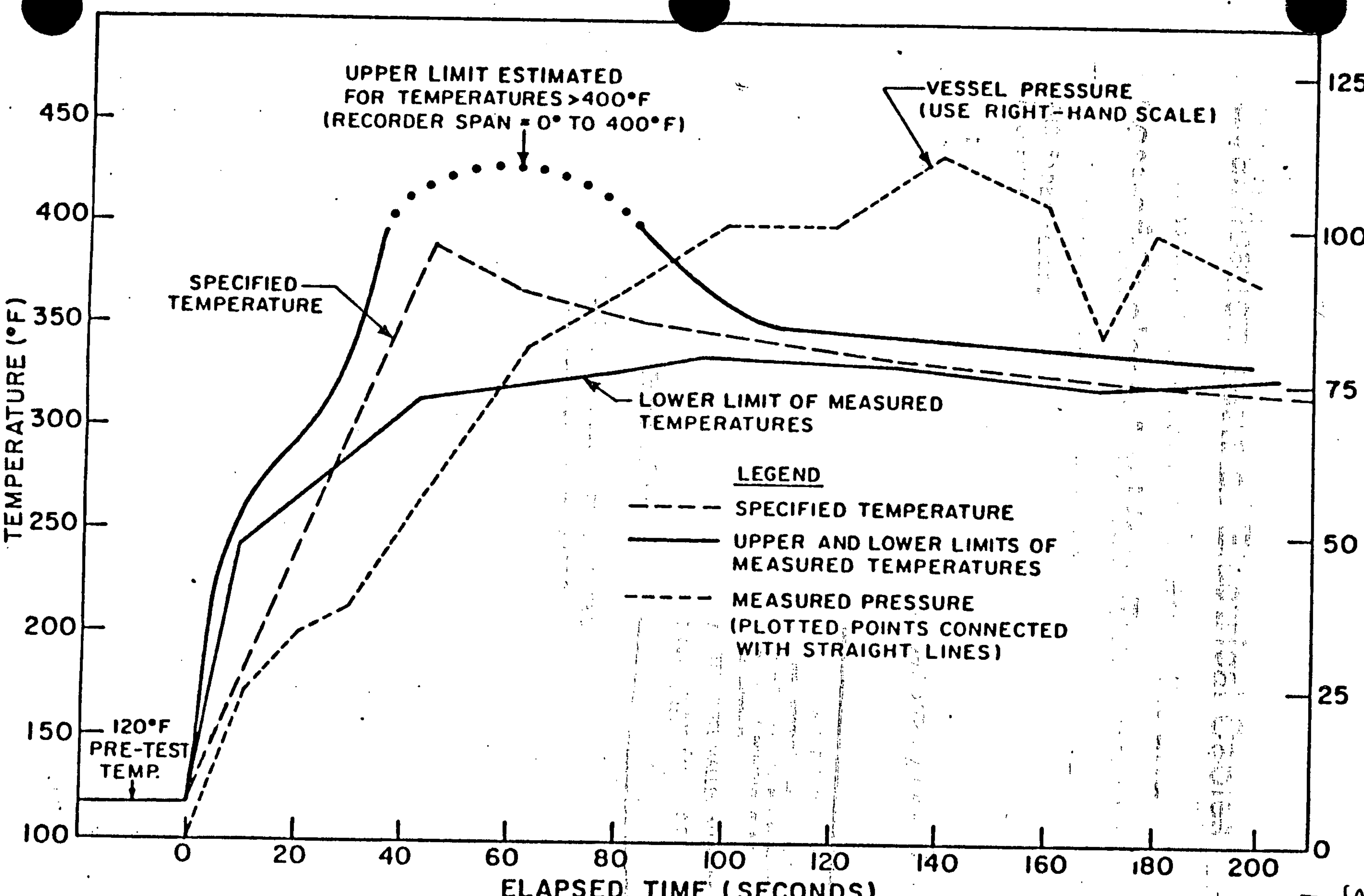

Figure 7. Plot of Temperature and Pressure for First 200 Seconds of S/C Exposure

S-5

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THE OKONITE COMPANY

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable. Okonite

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QUALIFICATION OF OKONITE ETHYLENE-PROPYLENE RUBBER INSULATION FOR NUCLEAR PLANT SERVICE

The Okonite Company's continuing Research and Development activities as a compounder of elastomeric materials has led to an evolutionary development of Okonite dielectric. This insulation is fully capable of meeting all aging, moisture, radiation and flame test requirements of IEEE Standard No. 383 and is therefore capable of nuclear plant application.

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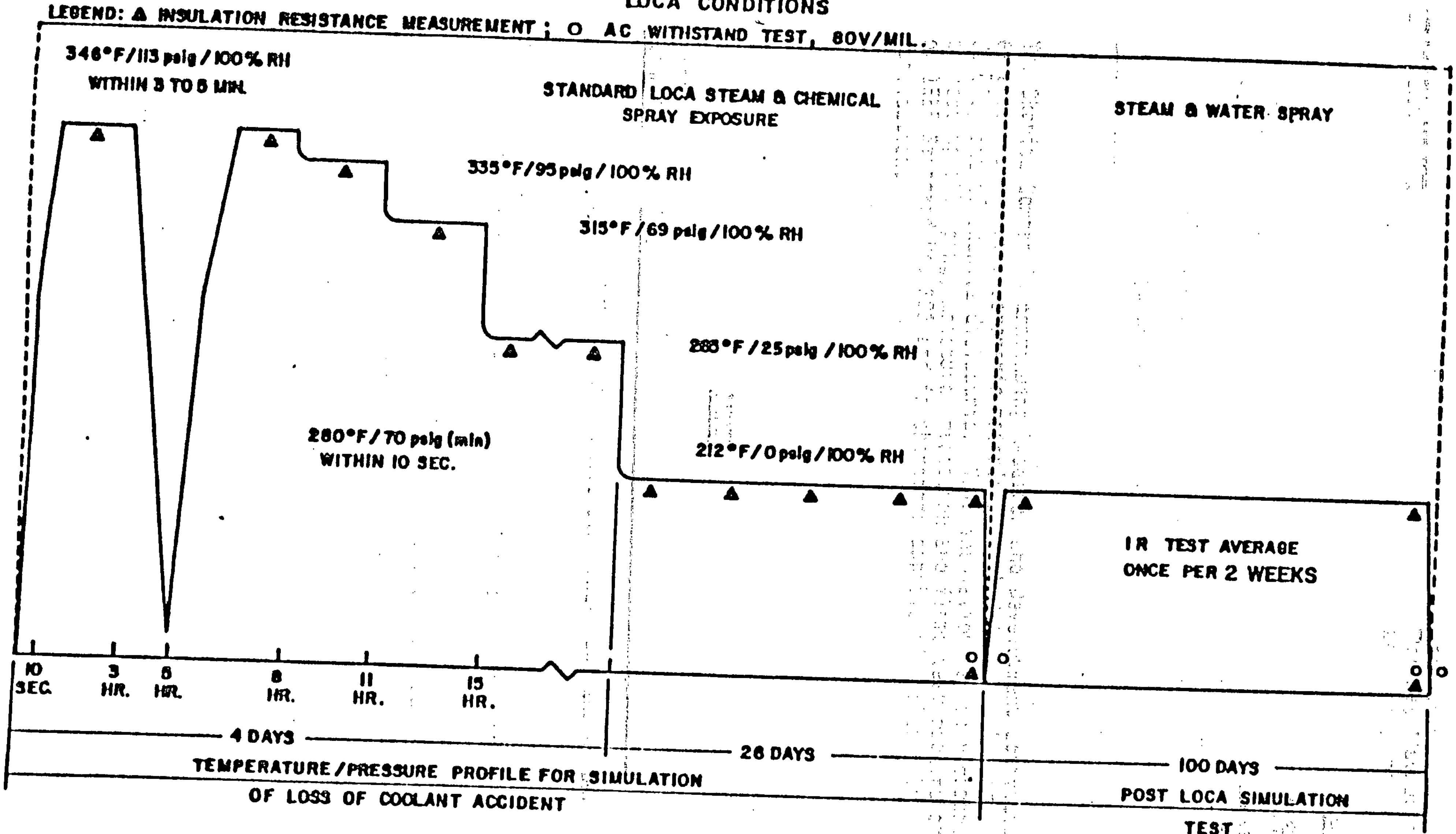
FIGURE II CABLE QUALIFICATION TEST PROFILE FOR LIFE & LOCA CONDITIONS



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THE OKONITE COMPANY

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable: Okonite

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QUALIFICATION

OF

OKONITE-FMR FLAME RETARDANT ETHYLENE-PROPYLENE RUBBER INSULATION FOR NUCLEAR PLANT SERVICE

Qualification for nuclear plant service has been performed at Okonite on samples of Okonite-FMR insulated wire. Okonite-FMR is a flame and moisture resistant ethylene propylene rubber which was formulated and compounded by Okonite. This insulation is fully capable of meeting all the aging, radiation, moisture, and flame test requirements as stipulated in IEEE Standard 383-1974. Based on the test results presented in this report, Okonite-FMR is qualified for nuclear plant applications.

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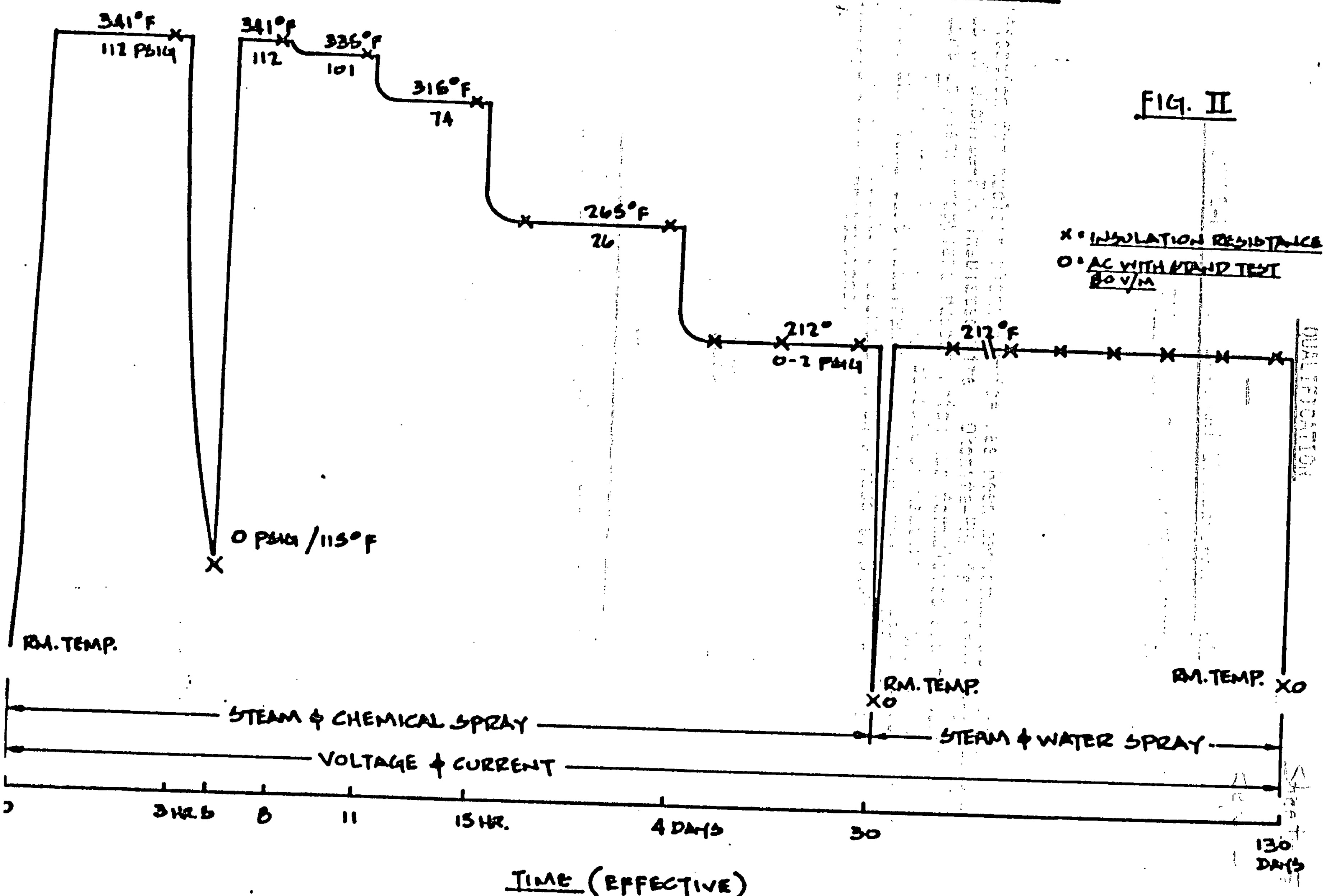
CABLE QUALIFICATION TEST PROFILE FOR SEQUENTIAL LOCA 1078-6

FIG. II



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COMPANY
Ramsey New Jersey 07446

September 17, 1981

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ENGINEERING REPORT NO. 355

MAIN STEAM LINE BREAK QUALIFICATION TEST ON OKONITE, OKONITE-FMR, X-OLENE-FMR AND OKOGUARD INSULATIONS

Introduction

A design basis event (DBE) main steam line break test (MSLB) was performed on Okonite, Okonite-FMR, X-Olene-FMR, and Okoguard insulations. These insulations have previously been qualified for nuclear plant use in prior LOCA tests. The purpose of the MSLB was to determine if these insulations could maintain an electrical load during such an event. The test profile was based on a customer's postulated MSLB parameters with margin added. IEEE Standards 383-1974 and 323-1974 were incorporated in the test program.

As described in this report, qualification testing was performed by Isomedix, Inc. and Approved Engineering Testing Laboratories in two MSLB tests. These tests are documented in report numbers 558-1021 (September 22, 1980) and 558-1077 (April 8, 1981) and are available for audit at Okonite headquarters.

Conclusion

All four insulations were qualified to the MSLB-DBE described herein. All samples met the specific performance requirements established prior to testing. These requirements are described in the body of this report.

Procedure

Qualification to the MSLB-DBE for all four insulations was accomplished in two tests. Okoguard, Okonite-FMR and X-Olene-FMR were tested in the first MSLB test. Okonite insulation was qualified in the second test.

With the exception of sample preparation and thermal aging, the first test was performed by Isomedix, Inc. Okonite was responsible for sample preparation and aging. In the second test Okonite again performed the sample preparation and thermal aging. Isomedix was contracted for irradiation services. AETL performed the MSLB and post MSLB tests. For both tests, the reports were written by AETL.

The following samples were selected for testing.

Set	Description
(A)	5kV, 1/C #6 AWG (7X) bare copper, .020" extruded semiconducting screen, .090" extruded Okoguard EPR, .030" extruded semiconducting insulation screen, .005" bare copper shielding tape: Four samples - fifteen feet (effective). Reference No. 01-3663-1

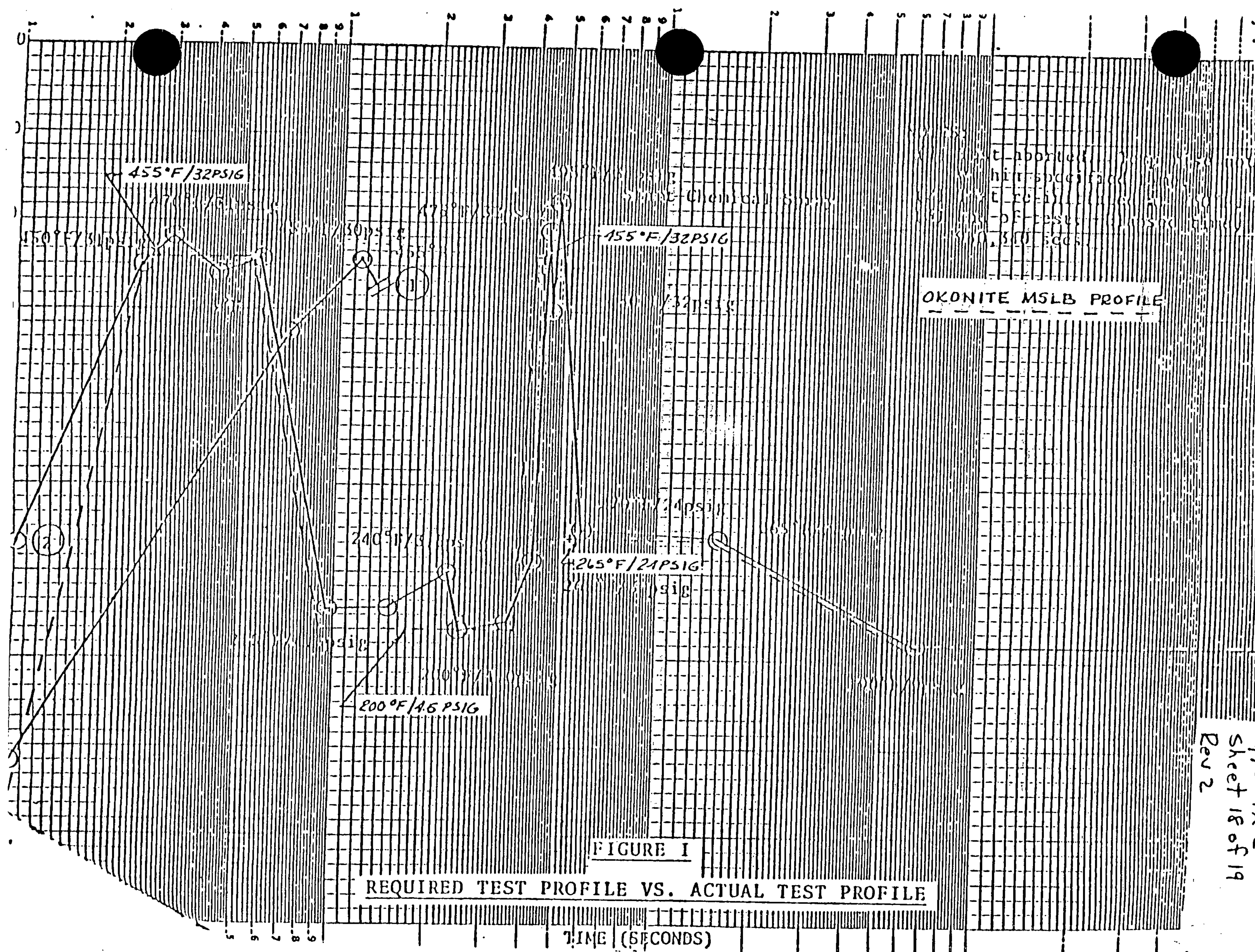

FIGURE I

REQUIRED TEST PROFILE VS. ACTUAL TEST PROFILE

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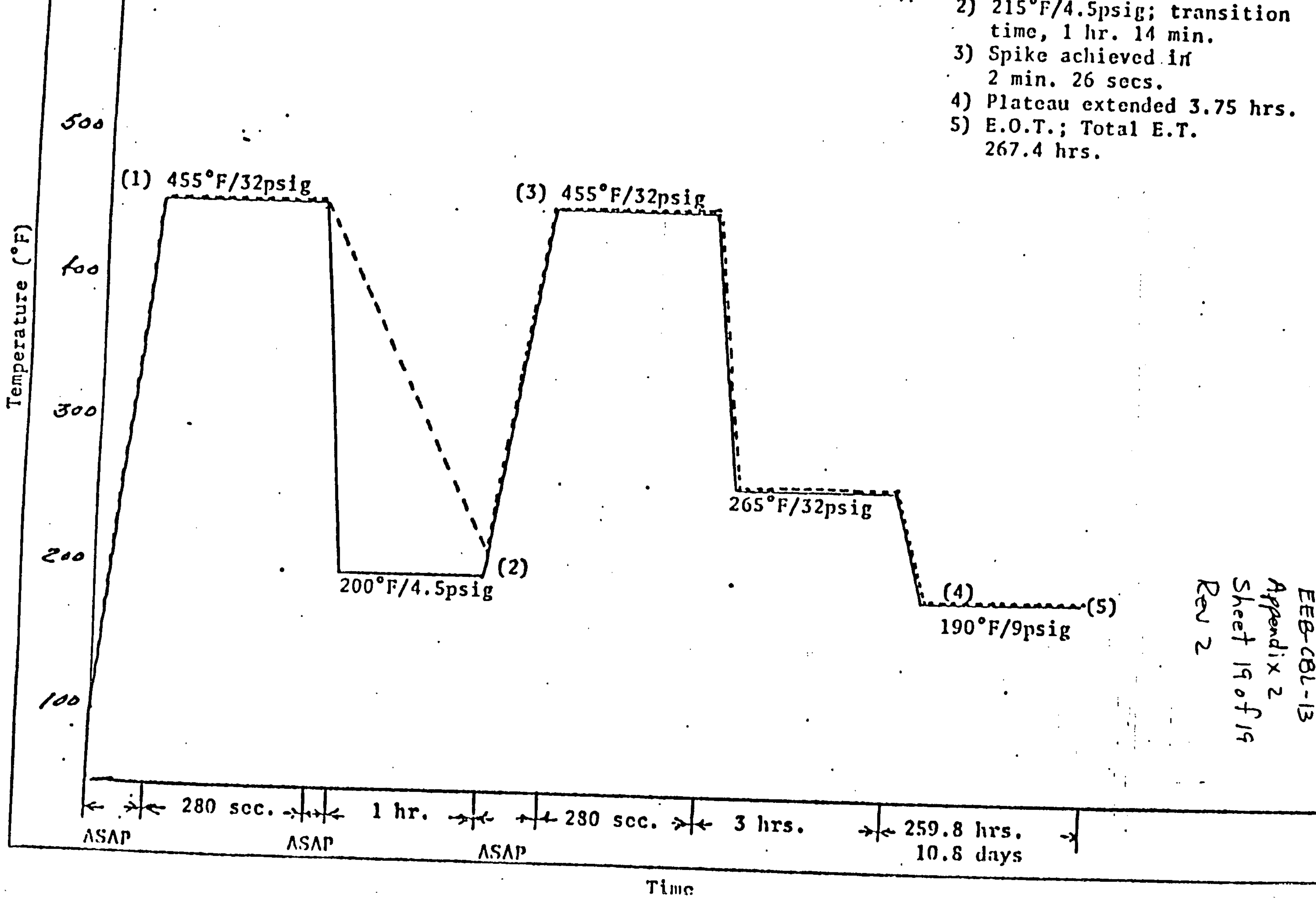
FIGURE II

REQUIRED TEST PROFILE VS. ACTUAL TEST PROFILE



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form TVA 10697 (EN DES 1-84)

EN ES CALCULATIONS

TITLE JUSTIFICATION FOR INTERIM OPERATION FOR PJJ FAMILY OF CABLES	PLANT/UNIT WBN/1 and 2

PREPARING ORGANIZATION EEB	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST)		
BRANCH/PROJECT IDENTIFIERS PJJ	Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in.		
	Rev	(for MEDS' use)	MEDS accession number
	R0		EEB '850123 923
APPLICABLE DESIGN DOCUMENT(S) N/A	R__		
	R__		
SAR SECTION(S) N/A / UNID SYSTEM(S) Various	R__		

	Revision 0	Revision ____	Revision ____	Revision ____
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	R.L. Mills			
CHECKED	Don B. Arp			
SUBMITTED	Francis B. Rosenzweig			
DATE	1-22-85			
APPROVED	J. Wagner			
List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

Use form TVA 10634 if more room required.

STATEMENT OF PROBLEM

The PJJ family of cables, used in Class 1E circuits outside containment, lack contract-specific documentation to prove their qualification in harsh environments.

ABSTRACT

Based on a combination of generic test data and engineering analysis, the PJJ family of cables have been shown to be acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification.

☐ Continuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center.

☒ Microfilm and return calculation to: F. B. Rosenzweig

Microfilm and destroy. ☐

Address: W8D182 C-K

Revision 0	R1	R2	R3	R4
Preparer/Date R. A. McInturff 12-11-81	DGA 10-10-84	RLM 1-7-85		
Reviewer/Date J F Wagner 12-14-81	[illegible]	[illegible] 1-22-85		

Unit No. 1 and 2

EQS No. EEB-CBL-15

TVA ID No:

Type PJJ Cable

Rev 2

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model Number See Table 3.11-8A, Sheets 1005, 1006, and 1007

Verification of Table Information (Table 3.11-8A Sheets 1005, 1006, and 1007)

X Equipment Type - The equipment has been identified as per TVA ID number designations (e.d., MOV, SOV, etc.).

X Location - The location has been identified (E.G., Inside Primary Containment, Annulus, Individually Cooled Rooms, General Spaces, or area affected by HELB outside primary containment).

X Component - A unique TVA ID number has been assigned (e.g., 1-FSV-68-308).

X Function - A functional description of the component has been given (e.g., Steam Generator Blowdown).

X Contract No., Manufacturer, and Model No. - The contract number, manufacturer, and model number has been given.

X Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

R2 Qualification Status (check if applicable, NA if not) Qualified Life see Appendix 1

X Qualification Report and Method - A qualification report and the method of qualification has been identified.

X Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

NA Qualification by Similarity (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (If applicable) - When an EQS is used for more than one item, a list of all exact components are given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

N/A Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component. Term of Interim Qualification ____

NCR No. ____

2 X Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation.

NCR No. WBNEEB8501

Preparer/Date D.B. Aup 10/10/84

Reivewer/Date J F Wagner 10-10-84

EEB-CBL-15
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Sheet 1 of 2

Type PJJ Cable

PJJ type cables consist of a polyethylene insulation and polyvinyl-chloride jacket. All cable of this type was constructed, tested, and accepted for use in accordance with TVA Standard Specification 25.013 - Standard Specification for Polyethylene - Insulated Wire and Cable. TVA Standard Specification 25.013 invokes the applicable portions of IPCEA Standards (such as physical properties and methods of testing for tensile strength and elongation of the insulation and jacket materials). The TVA specification included provisions of source inspection of factory testing and required submittal of certified test reports to assure compliance with the specification.

The following qualification tests are representative for the PJJ cables which are presently installed.

Wyle Laboratory Test Report 17503-1 dated January 6, 1984, Nuclear Environmental Qualification Test Program on Sequoyah Nuclear Power Station Control Equipment and Cables. The test included cable manufactured by Plastic Wire and Cable Corporation. See Appendix 2.

Wyle Laboratory Test Report 17501-1 dated March 12, 1982, Nuclear Environmental Qualification Test Program on Four Sets of Polyethylene/ Polyvinyl-Chloride Insulated Control Cable. The test included cable manufactured by Plastic Wire and Cable Corporation. See Appendix 2.

Wyle Laboratory Test Report 17508-1 dated November 22, 1982, High Energy Line Break Test Program on Two Control Equipment/Cable Assembly Test Sets. The test included cables manufactured by Plastic Wire and Cable Corporation and Cerro-Rockbestos. See Appendix 2.

The test reports show a baseline functional test was first performed and passed. Then functional tests were performed and passed after the radiation test, after the temperature aging test, and after LOCA/SLB test.

The tests include radiation at $1x10^8$ rads.

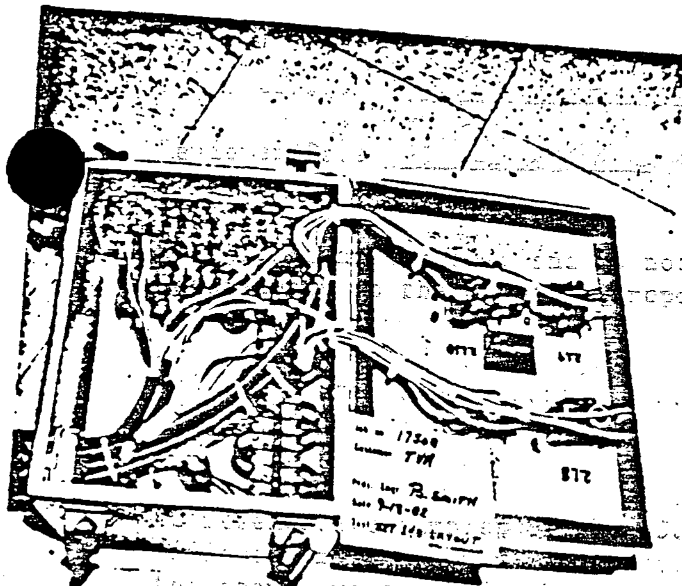
The tests include temperature aging at 110°C for 31 hours, then temperature was increased to 120°C for 1019.5 hours. This represents aging equivalent to 40-year life with an ambient temperature of 120°F. The aging time and temperatures were based on Arrhenius techniques.

The tests include LOCA/SLB at 330°F, 9.5 PSIG.

The cross section of cable manufacturers represented in these tests adequately demonstrated that PJJ cable will perform similarly in the given DBE. The variety of vendors used also proved that succcessful completion of of the tests is a function of the chemical properties of the insulation and jacketing compound and is not dependent on the manufacturer. Consistency in the chemical properties has been demonstrated by successfully completing the requirements of TVA Standard Specification 25.013. This approach to generic cable qualification follows the general guidelines for type testing as outlined by IEEE 383-1974.

All cables of the PJJ family met or exceeded the construction, testing, and acceptance requirements of TVA Standard Specification 25.013. In addition, representative samples of the PJJ family of cables supplied to TVA by different manufacturers successfully passed LOCA/SLB testing. In view of the above, we conclude that the results show that the PJJ family of cables will perform their safety functions satisfactorily until the NRC's final compliance date for equipment qualification. At that time they will either be deemed qualified by virtue of testing by Wyle Laboratories or replaced with fully qualified cables. R3

044279.11



NEQ
Nuclear Environmental Qualification

Test Report

REPORT NO. 17508-1

WYLE JOB NO. 17508

CUSTOMER P. O. NO. TV-56071A

PAGE i OF 299 PAGE REPORT

DATE November 22, 1982

SPECIFICATION (S) See References in Paragraph 5.0

Prepared by: D. B. Ayp 10/10/84
Reviewed by: J R Wagner 10-11-84

1.0 CUSTOMER Tennessee Valley Authority (TVA)

ADDRESS 400 Commerce Avenue, Knoxville, Tennessee 37902

2.0 TEST SPECIMEN Two (2) Control Equipment/Cable Assembly Test Sets with Cabling, Splices, Terminal Blocks and Control Devices.

3.0 MANUFACTURER TVA

4.0 SUMMARY

Two (2) Control Equipment/Cable Assembly Test Sets, described in Paragraph 6.0, were subjected to a High Energy Line Break (HELB) Test Program to confirm the adequacy of design to perform their required functions under abnormal conditions, as specified herein.

The test items are for installation in the Browns Ferry Nuclear Power Units 1, 2, and 3, Tennessee Valley Authority.

The purpose of the test program was to subject various generic cable types, splices, terminal blocks, and control devices to various steam temperature and pressure profiles resulting from HELB as defined for Browns Ferry, Units 1, 2 and 3 by TVA.

STATE OF ALABAMA }
COUNTY OF MADISON } ss.

California Profession Eng.
Reg. No. 2635

James F. Gleason, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SEAL James F. Gleason

SUBSCRIBED and sworn to before me this 22nd day of November 1982

Notary Public in and for the State of Alabama at large.

My Commission expires June 15, 1983

PREPARED BY B. Smith
B. Smith

APPROVED BY F. Johnson
F. Johnson

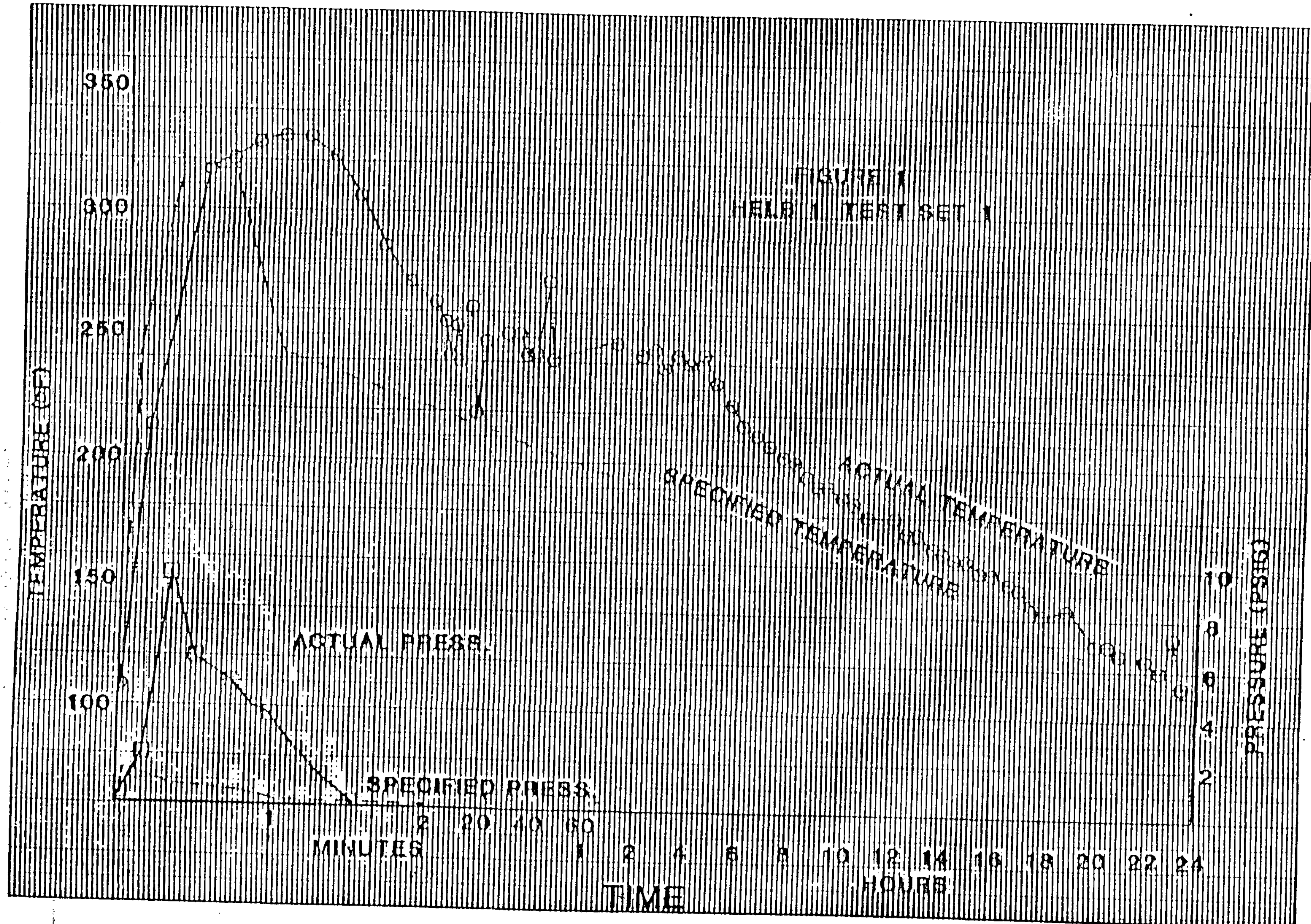
WYLE Q. A. T. Stinson 12/2/82
T. Stinson

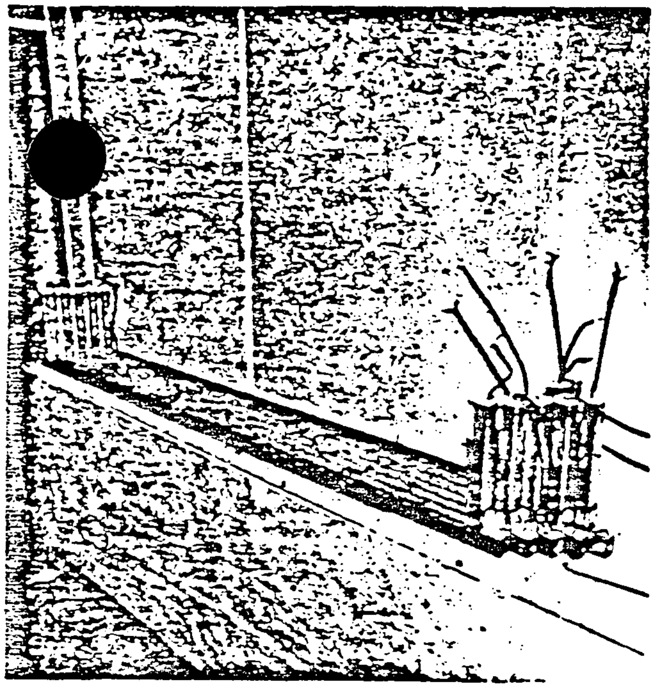
WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

TEST SPECIMEN DESCRIPTION (Continued)

Item	Description
1.2	One (1) length (of not less than 10 feet) of No. 14 AWG, 1/C, TVA Type PN, Mark WCA cable (conductor A), containing a stranded copper conductor (7 strands/ .0385 inch), insulated by a .030-inch thick layer of polyethylene. The assembly is jacketed with a nylon (.004-inch thick) exterior jacket. The cable is rated for 600 volts, 33 amperes maximum, and a maximum conductor temperature of 75°C.
1.3	One (1) length (of not less than 10 feet) of No. 14 AWG, 2-conductor, TVA Type PJJ (conductors B and C, Mark WHB cable, containing a stranded copper conductor (7 strands/.024 inch), insulated by a polyethylene (.030-thick)/polyvinyl chloride (.010-inch thick) layer. The assembly is jacketed with a polyvinyl chloride (.045-inch thick) exterior jacket. The cable is manufactured by the Plastic Wire and Cable Corporation and is rated for 600 volts, 19 amperes maximum and a maximum conductor temperature of 75°C (40°C ambient plus 35°C heat rise).
1.4	Cable-splice assembly, consisting of the following:
1.4.1	One (1) length (of not less than 10 feet) of No. 16 AWG, 2-conductor (conductors D and E), Mark WVA cable, containing a stranded copper conductor (7 strands/ .0192 inch), with a tinned coating. Each conductor is insulated by a .020-inch thick high density polyethylene layer. The conductor arrangement consists of a twisted pair, 2-1/2 inches or less lay, with a shield consisting of .001-inch thick Mylar and a No. 18 AWG tinned and stranded (7 strands) drain wire. The assembly is jacketed with a polyvinyl chloride (.050-inch thick) exterior jacket. The cable is manufactured by Cerro-Rockbestos and is rated for 600 volts with instrument current at an ambient temperature of 120°F.
1.4.2	Three (3) Raychem WCSF heat shrink insulated splices, consisting of the following: o (2) Raychem WCSF-115-6-N insulated splice, consisting of a crosslinked polyolefin sleeve (.08-inch thick) coated with a heat-activated crosslinked adhesive (Type N). The sleeve is 6 inches long and is rated for a maximum of 600 volts @ 90°C (continuous operating temperature).

FIGURE 1
HELB 1 TEST SET 1





NEQ

Nuclear Environmental Qualification

Test Report

REPORT NO. 17501-1

WYLE JOB NO. 17501

CUSTOMER P. O. NO. TV-56071-A

PAGE i OF 143 PAGE REPORT

DATE March 12, 1982

SPECIFICATION (S) WLTP 17460-21, Rev. B

1.0 CUSTOMER Tennessee Valley Authority

ADDRESS 400 Commerce Avenue, Knoxville, TN 37902

2.0 TEST SPECIMEN Polyethylene/Polyvinylchloride Insulated Control Cable

3.0 MANUFACTURER Plastic Wire and Cable Corporation

4.0 SUMMARY

Four (4) sets (total of 8 cables) of Polyethylene/Polyvinylchloride Insulated Control Cable, described in Paragraph 6.0, were subjected to the test program described in Wyle Laboratories' Test Procedure 17460-21, Revision B, and Paragraph 7.0. It was demonstrated that the specimens possessed sufficient integrity to withstand the required test program and meet the acceptance criteria. Test Item 3.0 experienced a dielectric breakdown during the Post-Radiation Mandrel Bend Test at 480 VAC (both conductors to ground and conductor to conductor). The test was performed for information and margin assessment only.

STATE OF ALABAMA }
COUNTY OF MADISON } ss.

Ala. Professional Eng.
Reg. No. 8256

Flavous R. Johnson, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

[signature]

SUBSCRIBED and sworn to before me this 12th day of April, 1982

[signature]

Notary Public in and for the State of Alabama at large.

My Commission expires June 13, 1983

PREPARED BY [signature] Robert Minadeo

APPROVED BY [signature] Herschel Jordan

WYLE Q. A. [signature] Tom Stinson

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

6.0 EQUIPMENT DESCRIPTION

The testing was performed on TVA Type PJJ Cable, mark letters WHB, 2/C, No. 14 AWG Control Cable, manufactured by Plastic Wire and Cable Corporation and supplied by TVA. The cable is polyethylene insulated (.020" thk) with a polyvinylchloride jacket (.010" thk), rated at 105°C, wrapped around each individual conductor. Both conductors are then wrapped, as an assembly, by a second polyvinylchloride exterior jacket (.045" thk). The cable is rated for 75°C maximum continuous conductor operating temperature.

6.1 Test Specimens

Four (4) sample sets of cable, as described in Paragraph 6.0, were utilized for the purpose of this test program. Each sample set was prepared by Wyle Laboratories. Preparation of the cable samples consisted of the assembling of 1.5" Unistrut galvanized channel with an overall length of 8 feet plus two upstanding channel sections (one at either end of the 8-foot section) to form a "U" shaped cable tray. Lengths of cable (approx. 12 feet) were then cut and placed into the channel and secured with plastic cable ties. Each of the eight (8) channels contained one two-conductor cable. The ends of the cable, approximately 0.5 to 1 inch, were stripped of insulation to facilitate the necessary test measurements. The cables remained in the trays throughout the test until the Post-Test Inspection Mandrel Bend Test.

7.0 TEST PROGRAM SEQUENCE

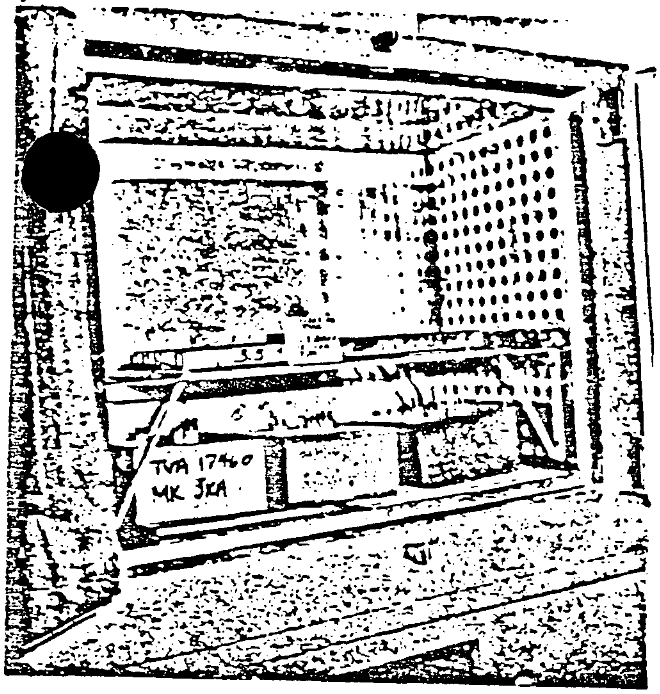
The test program for each sample set was performed in the following sequence.

7.1 Sample Set 1

- Functional Test
- Accident Radiation Exposure (Item 1.0)
- Functional Test
- Post Test Inspection

7.2 Sample Set 2

- Functional Test
- Radiation Aging - 3 Test Specimens (Items 2.0, 3.0, 4.0)
- Functional Test
- Thermal Aging - 3 Test Specimens (Items 2.0, 3.0, 4.0)
- Functional Test
- Accident Radiation Exposure - 3 Test Specimens (Items 2.0, 3.0, 4.0)
- Functional Test
- Post-Test Inspection



NEQ

Nuclear Environmental Qualification

Test Report

REPORT NO. 17503-1

WYLE JOB NO. 17503

CUSTOMER P. O. NO. TV-56071A

PAGE i OF 529 PAGE REPORT

DATE January 6, 1984

SPECIFICATION (S) See Paragraph 5.0

1.0 CUSTOMER Tennessee Valley Authority

ADDRESS 400 West Summit Hill Drive, Knoxville, TN 37902

2[illegible]ST SPECIMEN Control equipment consisting of terminal blocks, pushbutton operators, selector switches and contact blocks and various cables

3.0 MANUFACTURER Various (see Paragraph 6.0)

4.0 SUMMARY

Four (4) junction boxes, twenty-four (24) terminal block assemblies, ten (10) pushbutton operators, five (5) selector switches, seventy-two (72) contact blocks, fifteen (15) legend plates, and sixteen (16) cables, hereinafter called the specimens, were subjected to a Nuclear Environmental Qualification Program as specified in References 5.1, 5.2, and 5.3. The Qualification Program was conducted in accordance with Reference 5.4.

(DN261)

STATE OF ALABAMA } ss.
COUNTY OF MADISON }

Alabama Professional Engineer Reg. No. 7948

Frederick M. Sittason, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

[illegible] Frederick M. Sittason

[illegible]ED and sworn to before me this 11 day of January 1984

Ruthie Cantrell Perry

Notary Public in and for the State of Alabama at large.

My Commission expires 10 April, 1985

Wyle shall have no liability for damages of any kind to person or property, including special or consequential damages, resulting from Wyle's providing the services covered by this report.

PREPARED BY Don Smith 1/6/84
Don Smith

APPROVED BY [signature] 1/9/84

WYLE Q. A. W. B. Roberts 1/11/84
W. B. Roberts

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
HUNTSVILLE, ALABAMA

TEST SPECIMEN AND TEST EQUIPMENT DESCRIPTIONS (CONTINUED)

6.1.1 Control Equipment (Continued)

- Items 1.12.2, 2.12.2, 3.12.2, and 4.12.2 - (1) red pushbutton operator (CH10250T115); (4) contact blocks, 2-pole, 1 normally open and 1 normally closed (CH10250T1); and (1) large size legend plate, part number 10250TM81.

- Items 1.13, 2.13, 3.13, and 4.13 - Four (4) Cutler-Hammer 10250 Type T, oil-tight, three position selector stations, to be panel mounted. Each station consists of the following components: (1) 3-position selector switch, part number CH10250T 304; (4) contact blocks (normally open and normally closed, part number CH10250T48); (1) large size legend plate, part number 10250TM81.

- Item 4.14 - One (1) Square D, Type K, Class 9001, heavy-duty, oil-tight pushbutton station, to be panel mounted. The station consists of the following components:

- Item 4.14.1 - (1) illuminated green pushbutton operator (9001-K1L-1G); (4) normally open contact blocks (KA-2); (4) normally closed contact blocks (KA-3); (1) large size legend plate, part number 9001-KN-299.

- Item 4.14.2 - (1) red pushbutton operator (9001-KR-2R); (4) normally open contact blocks (KA-2); (4) normally closed contact blocks (KA-3); (1) large size legend plate, part number 9001-KN-299.

- Item 4.15 - One (1) Square D, Type KS, Class 9001, heavy-duty, oil-tight selector station, to be panel mounted. The station consists of the following components: (1) 3-position selector switch, Type KS, part number 9001-KS-52FB; (4) normally open contact blocks (KA-2); (4) normaly closed contact blocks (KA-3); (1) large size legend plate, part number 9001-KN-299.

6.1.2 Cables

- Item 1.2, 2.2, 3.2, and 4.2 - Four (4) No. 14 AWG, 2-conductor, TVA Type PJJ Mark WHB cable, containing a stranded copper conductor (7 strands/0.024 inch), insulated by a polyethylene (0.020" thick)/polyvinyl chloride (0.010" thick) layer. The assembly is jacketed with a polyvinyl chloride (0.045" thick) exterior jacket. The cable is manufactured by the Plastic Wire and Cable Corporation and is rated for 600 volts at 19 amperes maximum, and has a maximum conductor temperature of 75^{o}C (40^{o}C ambient plus 35^{o}C heat rise).

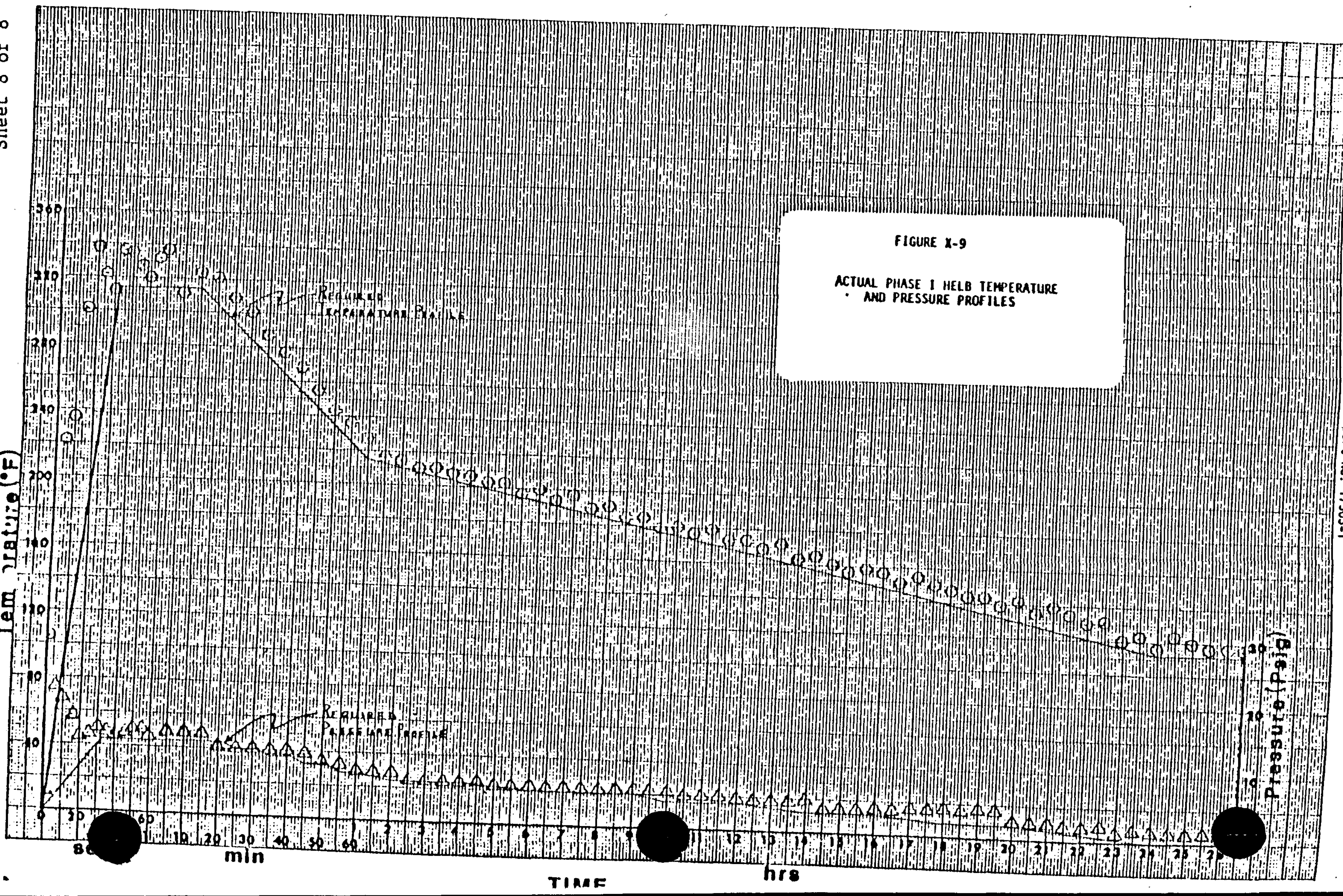


FIGURE X-9

ACTUAL PHASE I HELB TEMPERATURE AND PRESSURE PROFILES

form TVA 10697 (EN DES 1-84)

DES CALCULATIONS

TITLE JUSTIFICATION FOR [illegible] OPERATION FOR MS CABLES (CONTRACTS 85259 AND 85947)		PLANT/UNIT WBN/1 and 2
EPARING ORGANIZATION EEB	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST)	
ANCH/PROJECT IDENTIFIERS MS	Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in.	

Rev	(for MEDS' use)	MEDS accession number
R0		EEB '850123 924
R __		
R __		
R __		

APPLICABLE DESIGN DOCUMENT(S): N/A

SAR SECTION(S): N/A

UNID SYSTEM(S): Various

	Revision 0	Revision ___	Revision ___	Revision ___
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	R.L. Mills			
CHECKED	Don B. Ayp			
SUBMITTED	F. B. Rosenzweig			
DATE	1-22-85			
APPROVED	A Wagner			
List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

Use form TVA 10634 if more room required.

STATEMENT OF PROBLEM

The MS cables (manufactured by Belden and Times on contracts 85259 and 85947, respectively) used in Class 1E circuits outside containment, lack contract-specific documentation to prove their qualification in harsh environments.

ABSTRACT

Based on a combination of generic test data and engineering analysis, the MS cables have been shown to be acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification.

☐ ntinuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center.

Microfilm and destroy. ☐

☒ Microfilm and return calculation to: F. B. Rosenzweig

Address: W8D182 C-K

Preparer/Date R.L. Mills 1-22-85

Reviewer/Date J F Wagner 1-22-85

EQS No. WBNEEB-CBL-16.2
Appendix 1 Rev 0
Sheet 1 of 2

MS CABLES

Belden Corporation (contract 85259)

This cable is XLPE insulated with a CPE jacket. The qualification report that applies is Isomedix (Component Test Division) test report dated February 1976, "Qualification Test of Electric Cables Under a Simulated LOCA/DBE by Sequential Exposure to Environments of Radiation, Steam, and Chemical-Spray." The test showed that the cable is qualified for the following conditions:

a. Temperature: 346°F
b. Pressure: 113 psig
c. Radiation: $2x10^8$ rads gamma
d. Humidity: 100%
e. Chemical Spray: 3000 ppm boron, pH 9.0-11.0
f. Qualified Life: 40 years

Although no thermal aging was performed on the cable samples prior to the test, the XLPE was required via TVA's specification to meet certain physical and electrical requirements for this type material. Since it met or exceeded those requirements, the material can be expected to perform adequately in an accident qualification test after thermal aging, as other tests on XLPE insulation has proven. The above conditions envelop all areas of the plant in which the cables are located and perform safety-related functions.

Times Wire and Cable Company (contract 85947)

This cable is insulated with thermoplastic rubber and jacketed with polyether polyurethane. The test report that applies is Times Wire and Cable Company's test report dated April 14, 1975, "Qualification Test Report for Class 1E Shielded Instrument Cable." The test results showed that the cable is qualified for the following conditions:

a. Temperature: 300°F
b. Pressure: 25 psig
c. Radiation: $2x10^8$ rads gamma
d. Humidity: 100%
e. Chemical Spray: Boric acid in water, pH 8.5
f. Qualified Life: 40 years

The tested conditions envelop all areas of the plant in which the cables are located and perform safety-related functions. Thermal aging was not performed prior to the test. However, tensile and elongation measurements taken on the insulation on other samples of the cable which were thermally aged (121°C for 168 hours) showed that heat aging has little or no effect on the cable.

Preparer/Date R. L. Mills 1-22-85

Reviewer/Date J F Wagner 1-22-85

EQS No. WBNEEB-CBL-16.2
Appendix 1 Rev 0
Sheet 2 of 2

Based on the above, we conclude that the Belden and Times MS cables will perform their safety functions satisfactorily until the NRC's final compliance date for equipment qualification. At that time they will either be deemed qualified by virtue of testing by Wyle Laboratories or replaced with fully qualified cables.

	Revision					
Preparer/Date	R. L. Mills 1-15-85	/	/	/	/	/
Reviewer/Date	J. T. Wagner 1-22-85	/	/	/	/	/

Unit No. 1 and 2
EQS No. EEB-CBL-16.2
TVA ID No.
Type MS Cable

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model No. See Appendix 1
Verification of Table Information (Table 3.11-8A, Sheets 1012 and 1013)

X Equipment Type - The equipment has been identified as per TVA ID number designations (such as, MOV, SOV).

X Location - The location has been identified (such as, inside primary containment, annulus, individually cooled rooms, general spaces, or area affected by HELB outside primary containment).

X ___ Component - A unique TVA ID number has been assigned (such as, 1-FSV-68-308).

X Function - A functional description of the component has been given (such as, steam generator blowdown).

X Contract No., Manufacturer, and Model No. - The contract number, manufacturer, and model number have been given.

X Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not)

Qualified Life (If equipment is qualified, indicate the qualified life with a numerical entry): See Appendix 1

X Qualification Report and Method - A qualification report and the method of qualification has been identified on the Table Input Data Sheet (TIDS).

X Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

N/A Qualification by Similarity (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (If applicable) - When an EQS is used for more than one item, a list of all exact components is given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

N/A Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component.

Term of Interim Qualification ______________________
NCR No. ______________________

X Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation.

NCR No. WBNEEB8501

	Revision 0	R1	R2	R3	R4
Preparer/Date	R L Mills 12/10/81	RLM 5-9-84	RLM 2-12-85		
Reviewer/Date	J J Wagner 12/14/81	6-11-84	2-13-85		

Unit No. 1 and 2

EQS No. EEB-TB-1

TVA ID No:

Terminal Blocks

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model Number See EEB-TB-1, Appendix 1

Verification of Table Information (Table *Appendix 1)

X Equipment Type - The equipment has been identified as per TVA ID number designations (e.g., MOV, SOV, etc.).

X Location - The location has been identified (E.G., Inside Primary Containment, Annulus, Individually Cooled Rooms, General Spaces, or area affected by HELB outside primary containment).

NA Component - A unique TVA ID number has been assigned (e.g., 1-FSV-68-308).

X Function - A functional description of the component has been given (e.g., Steam Generator Blowdown).

X Contract No., Manufacturer, and Model No. - The contract number, manufacturer, and model number has been given.

X Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not) Qualified Life See Appendix 1

X Qualification Report and Method - A qualification report and the method of qualification has been identified.

X Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

X Qualification by Similarity (If applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (If applicable) - When an EQS is used for more than one item, a list of all exact components are given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

NA Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component. Term of Interim Qualification ______.

NCR No. ______

X Unqualified Component-(Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation. R2

NCR No. WBNEEB8503

Prepared by: R.L. Mills/2-13-85

Reviewed by: D.R. [illegible] 2-13-85

Terminal Blocks

The terminal blocks are of the following types: General Electric Company types EB-5, EB-25, and CR-151B. They are all similar in physical size and configuration. They are comprised of single piece molded, phenolic material with washer head binding screws for circuit wire connections and rated for 30 amps and 600 volts (7500V breakdown voltage). All terminal blocks are mounted in gasketed enclosures that provide additional isolation from other adverse conditions of the surrounding environment. In addition, terminal blocks located inside containment, the north and south steam valve rooms, the turbine driven auxiliary feedwater room, the RHR heat exchanger rooms, and the RHR pump rooms (areas in which the blocks may be exposed to moisture by either condensate in conduit or steam/chemical spray from an accident) have been coated with Dow Corning RTV coating to protect them from moisture and corrosion. The enclosures for the terminal blocks in these areas have holes drilled in them to allow moisture to drain and to prevent the enclosures from collapsing in the event of increased pressure during an accident. R5 R5

The blocks are composed of cellulose-filled phenolic material.(1) For purposes of conservatism, all these blocks are assumed to be composed of paperfilled phenolic material which is the least radiation resistant type of wood product filled phenolics(2). This material retains at least 50 percent(2) of its physical properties (elongations, tensile strength, etc.) at gamma radiation doses of $1x10^8$ rads. In addition, a sample of an EB-5 terminal block passed a LOCA qualification test performed by the Limitorque Corporation after a gamma radiation exposure of 204 megarads.(7)

Samples of uncoated CR-151B terminal blocks have passed an environmental qualification test performed by Wyle Laboratories(3) in the sequence indicated below:

a. Radiation aging to $2.75x10^5$ rads gamma at a maximum dose rate of $1.0x10^4$ rads per hour to simulate a 10-year life.

b. Thermal aging at 110°C for 1000 hours to simulate a 445-year life.(6)

c. Seismic qualification.

d. Accident qualification at the following conditions: 240°F, 16.4 psia, 100 percent relative humidity.

Also referenced in the Wyle report was the failure of uncoated CR-151B and 10987 terminal blocks at the following conditions:

a. Radiation aging to $1.1x10^6$ rads gamma at a maximum dose rate of $1.0x10^4$ rads per hour to simulate a 40-year life.

b. Thermal aging at 110°C for 4000 hours to simulate a 1,780-year life.[6]

c. Seismic qualification.

d. Accident qualification testing at the following conditions: 330°F, 26.8 psia, 100 percent relative humidity.

The failure mode of the blocks was terminal to terminal or terminal to ground breakdown. This occurrence was attributed to extreme corrosion buildup on the terminals during the thermal aging process, which created a conductive path for short circuits when contact with moisture (steam) occurred during the test. We attribute the buildup of corrosion on the terminals to thermal aging, since gamma radiation has no effect on metallic materials.

Tests performed by Wyle[4] in September 1982 demonstrated that unaged (and uncorroded) specimens of the EB-25 blocks were capable of passing a similar profile to the one that the 40-year blocks failed. Since the 445-year thermally aged specimens, which passed the less extreme profile, exhibited only a mild discoloration and not the extreme corrosion seen on the 1780-year thermally aged blocks, we conclude that the failure mechanism will not be on the equipment at all during their required 40-year service life, and they are capable of passing the higher profile.

R5

Also, CR-151B terminal blocks have passed an environmental qualification test performed by Wyle Laboratories[5] in the sequence indicated below:

a. Radiation aging to $5.5x10^5$ rads gamma at a maximum dose rate of $1.0x10^4$ rads per hour to simulate a 20-year life.

b. Thermal aging at 110°C for 2,000 hours to simulate an 890-year life.[6]

c. Terminal block coating with Dow Corning RTV 3140.

d. Accident qualification testing at the following conditions: 342°F, 29 psia, 100 percent relative humidity, and a chemical spray of 2,000 ppm boron.

Based on the above, we conclude that terminal blocks in areas where moisture will not occur are qualified for at least 40 years in their service environments. The Dow Corning RTV coating is useful after exposure to 100 megarads of radiation.[8] It lacks thermal aging qualification documentation, but based on the result of the above qualification test, we conclude that the terminal blocks in areas subject to moisture exposure are acceptable for performance of Class 1E operation until the NRC's final compliance date for equipment qualification. The coating will be qualified by corrective action taken under NCR WBNEEB8503.

(1) Letter dated February 24, 1978, from General Electric Company to D. A. Ross, Jersey Central Power and Light Company.

(2) Radiation data from the Battelle Memorial Institute Radiation Effects Information Center Report No. 21, dated September 1, 1961, "The Effect of Nuclear Radiation on Elastomeric and Plastic Components and Materials," by R. W. King, N. J. Broadway, and S. Palinchak.

(3) Wyle Laboratories Test Report No. 17503-1, dated January 6, 1984, "Nuclear Environmental Qualification Test Program on Sequoyah Nuclear Power Station Control Equipment and Cables."

(4) Wyle Laboratories Test Report No. 17508-1, dated November 22, 1982, "High Energy Line Break (HELB) Test Program on Two (2) Control Equipment/Cable Assembly Test Sets."

(5) Wyle Laboratories Test Report No. 17523-1, dated June 20, 1984, "Nuclear Environmental Qualification Test Program on Sealants for Class 1E Devices and GE Terminal Blocks."

(6) TVA Design Calculation dated May 21, 1984 (EEB 840522 921).

(7) Limitorque Corporation Test Report No. B0119, dated July 1, 1982, "Qualification Type Test Report of Multi-Point Terminal Strips for Use in Limitorque Valve Actuators for PWR Service."

R5 (8) Dow Corning publication entitled "Selection Guide to Electrical/Electronic Materials From Dow Corning," Form No. 01-207a-77.

*Table	Sheet
3.11-4	1000
3.11-5	1000
3.11-6	1000
3.11-7	1000
3.11-8	1000, 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1010, 1011, 1012, 1013

Unit No. 1
EQS No. WBN-MEB-3-0
TVA ID No.
See Appendix 1

	Revision	R1	R2	R3	R4
Preparer/Date	[illegible] 6/6/83	[illegible]	[illegible]		
Reviewer/Date	[illegible]	[illegible]	[illegible]		

EQUIPMENT QUALIFICATION SHEET (R3)

Manufacturer and Model No. Limitorque SB-4
Verification of Table Information (Table 3-11-8 Sheet WBN-MEB-102)

x Equipment Type - The equipment has been identified as per TVA ID number designations (such as, MOV, SOV).

x Location - The location has been identified (such as, inside primary containment, annulus, individually cooled rooms, general spaces, or area affected by HELB outside primary containment).

x Component - A unique TVA ID number has been assigned (such as, 1-FSV-68-308).

x Function - A functional description of the component has been given (such as, steam generator blowdown).

x Contract No., Manufacturer, and Model No. - The contract number, manufacturer and model number have been given.

x Abnormal or Accident Environment - All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables by references to figures from tables.

x Environment to Which Qualified - The environment to which the equipment has be qualified is addressed in either the tables or the environmental analysis attached.

x Category - A category of a, b, c, or d has been defined for the equipment.

x Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not)

Qualified Life (If equipment is qualified, indicate the qualified life with a numerical entry): 40 YEARS

x Qualification Report and Method - A qualification report and the method of qualification has been identified on the Table Input Data Sheet (TIDS).

x Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

x Qualification by Similarity (If applicable) - A justification for qualificati by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

x Qualification of Several Exact Components (If applicable) - When an EQS is us for more than one item, a list of all exact components is given as an appendi with all references to appropriate tables with justification for qualificatio considering all the above factors.

NA Interim Qualification (If applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component.

Term of Interim Qualification ____________
NCR No. ____________

NA Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for non-qualification, and justification of continued operation.
NCR No. ____________

Sheet No. WBN-MEB-3-0111
Revision No. 1
Appendix 1
Sheet 1 of 1

TVA ID No.	Table
1-FCV-3-33	3.11-8
1-FCV-3-47	3.11-8
1-FCV-3-87	3.11-8
1-FCV-3-100	3.11-9

Prepared by: D.J. Cox 6/12/84

Reviewed by: J W Hodges 6/12/84

LJS1.10

These operators are required to operate in the environments as shown on TVA drawing 47E235-76R0, and summarized below:

Operational Condition	Temp °F	Rel. Hum.	Pressure (PSIA)	40 Year Radiation (rads)	Integrated Acc. Dose (rads)
1 Avg.	120	35%	Atm(-)	NA	NA
Max.	130	50%	Atm(-)	3.5×10^5	NA
Min.	80	20%	Atm(-)	NA	NA
2 Max.	140	100%	Atm	NA	NA
Min.	40	10%	Atm(-)	NA	NA
3	NA	NA	NA	NA	$< 1 \times 10^4$
4	325	100%	25.16	NA	NA
5	NA	NA	11.4	NA	NA

The centerline pipe elevation of 731'-0" would indicate that these actuators would be submerged during a maximum level flood. However, these actuators are only required during normal system operation (reference FSAR Section 10.4.7.1). Since the plant would be shutdown during a maximum level flood this condition will not affect the qualification of these components.

Radiation exposure is not applicable for a HELB outside primary containment. We conclude that the radiation exposure at this location will not detrimentally affect these actuators and is not a factor in the balance of this evaluation.

The applicable environmental test report for these valve operators is The Franklin Institute Research Laboratories report F-C3271. A detailed review of F-C3271 has been made by TVA's Office of Engineering. The test component, a Limitorque SMB-0-25 operator, was not thermally aged, mechanically aged, seismically tested, or irradiated prior to the environmental test. The environmental test consisted of a 12-hour exposure to an environment of saturated vapor, beginning with the introduction of steam and a temperature rise to about 212°F, for approximately 6 hours followed by a temperature drop to about 155°F for 6 hours. The pressure was maintained at 7 inches water gage throughout the test. The performance of the operator was monitored periodically throughout the test by cycling under load and measurement of insulation resistance on all power and control leads periodically during the test.

Limitorque Valve Actuator Qualification Report B0058, section 4.1.4 states "Generic qualification means qualifying a group (family) of actuators by subjecting a valve actuator representative of the family to the aging and environmental criteria indicated in this report . . . The size SMB-0 actuators is an average, mid-size unit, and all other sizes of the type SMB, SB, SBD, and SMB/HBC are also deemed qualified. All sizes are constructed of the same materials with components designed to equivalent stress levels, same clearances and tolerances with the only difference being in physical size which varies corresponding to the differences in unit rating."

Report B0058, section 3.2.2 states: ". . . thermal aging is a function of the thermal rating of the material in question. When considering the phenolic insulation material used for switches, U.L. was the only reference that could be found that addresses thermal rating/life of plastics.

Underwriter's Laboratory has conducted detailed studies into many phenolics deriving a published temperature index. This index is considered the maximum temperature at which the material can be used continuously. An article titled "A New Temperature Index: Who Needs It" published in September 1970 in "Modern Plastics" discusses the index and indicates how it was established. The article indicates that the temperature index was established at the point where the property of impact strength, tensile strength, or dielectric strength reduced to one-half of its new value at the conclusion of 6×10^4 hours.

The switch material we are using is a molded phenolic which has a temperature index of 150°C. Since a valve actuator is an intermittent operating device and does not run continuously, it would be safe to assume the aging characteristic follows the 10°C rule.

Considering a 60°C ambient as the base for an aging temperature, the switch material would reach its 50% property (the same base as U.L. used) in 3.07×10^7 hours. Forty year life would represent 1.2% of available life. Since degradation would be directly proportional to life, it becomes obvious that degradation would be negligible. . ."

The subject operators are designed, constructed, and generically similar to the operators tested in Limitorque report B0003, except for the addition of the motor brakes. The environmental test portion of this qualification test (B0003) consisted of a 16-day exposure to an environment of saturated vapor. The test temperature was 250°F for about 24 hours and 200°F for 15 days. The pressure was maintained at a range of 25 psig to 10 psig. See Appendix 3 for the actual test temperature/pressure/time profile. Operator was meggered and cycled during the test.

Report B0058, section 4.4 states ". . . parameters have been established to accommodate the possibility of a Main Steam Line Break driving containment chamber temperatures up to 492°F for a short period of time (few minutes). Pressures remain substantially the same. Due to the heavy metal sections of the actuator, which act as a heat sink, Limitorque theorized that the internal areas of the actuator would not exceed saturated steam temperature during the few minutes it would be exposed to the high superheated temperature. In interest of verifying this theory, Limitorque conducted a 6 hour superheat test subjecting an actuator to superheated temperatures of up to 385°F at a pressure of 66 psig. The actuator was not connected electrically to permit use of thermocouples on limit switches and in several locations in the limit switch compartment. Report B0027 describes the test and proved the actuator acts as a heat sink, maintaining saturated steam temperatures corresponding to the test chamber pressure, even with elevated ambient temperatures for short durations of time."

Report B0027, sections 3.3.1 and 3.3.2 states "The Limitorque Valve Actuator and motor consists of a heavy mass of metal that acts as a heat sink with a limited surface area which retards the heating of internal components and lengthens the time required to establish thermal equilibrium with the outside ambient. Superheat is an unstable steam state that readily collapses into a saturated steam condition when exposed to a suitable heat sink. Since the motor magnet wire and actuator switches are in such close proximity to heavy metal sections, the ambient temperatures in both the actuator and motor would tend to stabilize at saturated steam temperatures until the entire metal structure reaches the saturated steam temperature."

The operator subjected to the superheat test was an SMB-00, which weighs about 200 pounds. The operator covered by this EQS is an SB-4 which weighs about 2000 pounds. The SB-4 has about a 10 times greater mass than the tested operator and therefore has greater heat sink capabilities. This fact in itself will lend to additional conservatism in the conclusions reached in report B0027, when they are applied to the SB-4 operator.

FCV-3-33 and FVC-3-100 are located in the south valve vault and will have the following environment during a HELB.

a. 323°F for 12 minutes at 25.18 psia.
b. Temperature and pressure linearly decrease until 24 hours into the event, after which they stabilize at approximately 100°F.

FCV-3-47 and FCV-3-87 are located in the north valve vault and will have the following environment during a HELB.

a. 325°F for 12 minutes at 23.17 psia.
b. Temperature and pressure linearly decrease until 24 hours into the event, after which they stabilize at approximately 100°F.

The saturated steam temperature for each valve vault is:

South valve vault at 25.18 psia = 242.25°F
North valve vault at 23.17 psia = 236.66°F

These temperatures were obtained from the 1967 ASME Steam Tables, Appendix 4, and rounding up to the next higher listed pressure.

Based on the conclusions reached by report B0027 the operator internals would not exceed approximately 237°F, the saturated steam temperature in the north valve vault, and approximately 242°F, the saturated steam temperature in the south valve vault.

The operator will absorb a specific quantity of heat, due to its mass and limited surface area, without raising the temperature of the motor and internal components above the saturated steam temperature. The time duration which the operator can withstand higher temperatures can be estimated by proportion. Appendicies 5 and 6 are the calculations indicating the estimated time the operators could be subjected to the maximum ambient accident temperature without the temperature of the motor and internal components exceeding the maximum saturated steam temperature. Results are shown below.

South valve vault = 41.75 minutes
North valve vault = 43.81 minutes

The ambient temperature in the valve vaults at these times into the event is approximately 240°F to 245°F and will be at 200°F 60 minutes into the event. So no additional heat transfer will occur from the vault environment to the operator, and the operator will also begin its cooling progression.

These valves are required to close automatically within 5 minutes into an accident on the safety injection (SI) signal and remain closed for the duration of the accident to isolate feedwater flow to the steam generators. Operator closure time is 6.5 seconds after receipt of signal to close.

TVA has performed a failure evaluation for equipment in the steam vaults for failure due to superheating following steam generator tube uncovery (NEB 840904 221) (see appendix 7).

Assumption b on page 3 of this failure evaluation applies to steam line breaks resulting in a steam line differential pressure signal greater than or equal to 100 psi. At this condition an SI signal would be generated.

When the SI signal is generated, reactor trip, containment isolation, feedwater isolation, and automatic startup of the auxiliary feedwater system will occur within approximatly 2 to 3 minutes, assuring a successful unit shutdown.

This failure evaluation concluded that the subject valves will close on a feedwater isolation signal which is generated by an SI signal.

TVA requires the use of multi-strip terminal blocks in the operators. These terminal blocks were tested at 138°C (280°F) for 300 hours as shown in Limitorque test report B0119.

These operators contain VITON seals and gaskets (see appendix 11). We have performed a thermal analysis on the VITON material using the assumptions which we have summarized below:

1. The material activation energy chosen was the lowest value obtained in a document search. This was done to ensure the conservatism of the analytical results.

2. The materials were evaluated against the forty (40) year service life plus a one hundred (100 day) accident condition.

3. The maximum normal environmental temperature was used to determine the expected life of the material. The life of the material lost during an accident was determined. From these two (2) analyses, a usable life was obtained.

4. For nonmetallic materials the time-temperature degradation process can be defined by a single temperature reaction that follows the Arrhenius equation.

Based on the above TVA has determined an expected usable thermal life for the VITON seals as shown below (see appendices 8, 9, and 10).

Expected Life (years) - Accident Life (years) = Usable Life (years)

47,182.28 - 1.57 = 47,180.71

These actuators have motor brakes. The function of the motor brakes is to absorb the interia produced by these fast closing valve operators. Failure of the brakes could cause the stem to grind into the seat of the valve thus causing leakage and possible damage to the valve, but only after repeated closing operation without the brakes. The failure of the brakes will not prevent the valve from performing its safety function, unless the valve has been operated repeatedly after failure of the brakes. Surveillance procedures at WBN provide for inspection of these valves. These procedures would identify any failure of the brakes. The brakes will be replaced as a part of our maintenance program as needed.

Based on the above we conclude the following:

a. The subject operators are generically similar to those operators tested in reports B0003 and B0027.
b. Motor and internal components will not exceed saturated steam temperatures, reference report B0027.
c. Similar operators were tested and qualifed to 250°F at 25 psig (39.7 psia) and 100% relative humidity, reference Limitorque report B0003, and to 212°F at 7 inches of water with saturated vapor, reference Limitorque report F-C3271.
d. Valve will perform its intended safety function within the prescribed timeframe to assure successful unit shutdown.
e. Failure of the motor brakes will not prevent the valve from performing its safety function.
f. The operators are qualified for their intended service.

Prepared By: T.R. Witmer 2/7/85

Reviewed By: H.W. Jl 2/8/85

TEMPERATURE PROFILE

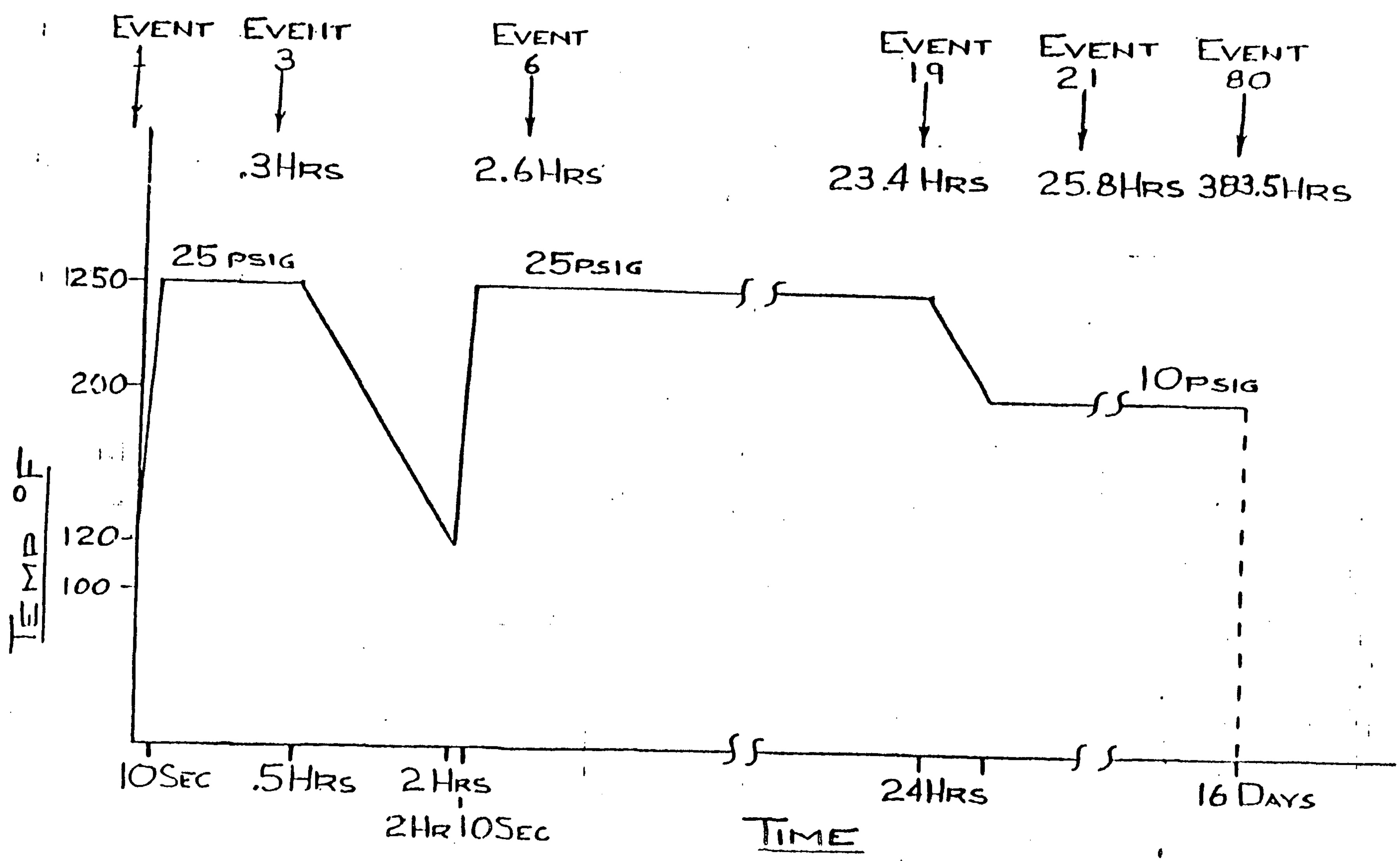


FIGURE 1

1967 ASME STEAM TABLES

SECOND EDITION

THERMODYNAMIC AND TRANSPORT PROPERTIES OF STEAM

comprising

TABLES AND CHARTS FOR STEAM AND WATER

calculated using
THE 1967 IFC FORMULATION FOR INDUSTRIAL USE
in conformity with
THE 1963 INTERNATIONAL SKELETON TABLES
as adopted by the
Sixth International Conference on the Properties of Steam

prepared by
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for
The ASME Research Committee on Properties of Steam

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Table 2. Properties of Saturated Steam and Saturated Water (Pressure)

Press.	Temp.	Volume, ft³/lbm			Enthalpy, Btu/lbm			Entropy, Btu/lbm × R			Energy, Btu/lbm	
psia	F	Water v_f	Evap. v_{fg}	Steam v_g	Water h_f	Evap. h_{fg}	Steam h_g	Water s_f	Evap. s_{fg}	Steam s_g	Water u_f	Steam u_g
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	298.2	1105.2
99.0	327.10	0.017732	4.4556	4.4734	297.8	889.2	1187.0	0.4733	1.1302	1.6036	297.5	1105.0
98.0	326.38	0.017724	4.4988	4.5166	297.0	889.8	1186.8	0.4724	1.1320	1.6044	296.7	1104.9
97.0	325.63	0.017716	4.5429	4.5606	296.2	890.4	1186.6	0.4714	1.1338	1.6052	295.9	1104.8
96.0	324.88	0.017708	4.5878	4.6055	295.5	891.0	1186.4	0.4704	1.1356	1.6061	295.2	1104.6
95.0	324.13	0.017700	4.6337	4.6514	294.7	891.5	1186.2	0.4694	1.1375	1.6069	294.4	1104.5
94.0	323.37	0.017692	4.6805	4.6982	293.9	892.1	1186.0	0.4684	1.1393	1.6078	293.6	1104.3
93.0	322.61	0.017684	4.7282	4.7459	293.1	892.7	1185.9	0.4674	1.1412	1.6086	292.8	1104.2
92.0	321.84	0.017675	4.7770	4.7947	292.3	893.3	1185.7	0.4664	1.1431	1.6095	292.0	1104.0
91.0	321.06	0.017667	4.8268	4.8445	291.5	893.9	1185.5	0.4654	1.1450	1.6104	291.2	1103.9
90.0	320.28	0.017659	4.8777	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	290.4	1103.7
89.0	319.49	0.017651	4.9296	4.9473	289.9	895.2	1185.0	0.4633	1.1489	1.6122	289.6	1103.6
88.0	318.69	0.017642	4.9827	5.0004	289.0	895.8	1184.8	0.4622	1.1509	1.6131	288.8	1103.4
87.0	317.89	0.017634	5.0370	5.0546	288.2	896.4	1184.6	0.4611	1.1529	1.6140	287.9	1103.3
86.0	317.08	0.017625	5.0925	5.1101	287.4	897.0	1184.4	0.4601	1.1549	1.6150	287.1	1103.1
85.0	316.26	0.017617	5.1493	5.1669	286.5	897.7	1184.2	0.4590	1.1569	1.6159	286.2	1102.9
84.0	315.43	0.017608	5.2073	5.2249	285.7	898.3	1184.0	0.4579	1.1590	1.6169	285.4	1102.8
83.0	314.60	0.017600	5.2667	5.2843	284.8	899.0	1183.8	0.4568	1.1611	1.6178	284.5	1102.6
82.0	313.75	0.017591	5.3276	5.3451	283.9	899.6	1183.5	0.4556	1.1632	1.6188	283.7	1102.4
81.0	312.90	0.017582	5.3898	5.4074	283.0	900.3	1183.3	0.4545	1.1653	1.6198	282.8	1102.3
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	281.9	1102.1
79.0	311.17	0.017565	5.5189	5.5364	281.3	901.6	1182.8	0.4522	1.1696	1.6218	281.0	1101.9
78.0	310.29	0.017556	5.5858	5.6034	280.3	902.3	1182.6	0.4510	1.1718	1.6229	280.1	1101.7
77.0	309.41	0.017547	5.6544	5.6720	279.4	902.9	1182.4	0.4498	1.1741	1.6239	279.2	1101.5
76.0	308.51	0.017538	5.7248	5.7423	278.5	903.6	1182.1	0.4486	1.1763	1.6250	278.3	1101.4
75.0	307.61	0.017529	5.7969	5.8144	277.6	904.3	1181.9	0.4474	1.1786	1.6260	277.3	1101.2
74.0	306.69	0.017519	5.8710	5.8885	276.6	905.0	1181.6	0.4462	1.1809	1.6271	276.4	1101.0
73.0	305.77	0.017510	5.9469	5.9645	275.7	905.7	1181.4	0.4449	1.1833	1.6282	275.4	1100.8
72.0	304.83	0.017501	6.0250	6.0425	274.7	906.4	1181.1	0.4437	1.1856	1.6293	274.5	1100.6
71.0	303.89	0.017491	6.1051	6.1226	273.7	907.1	1180.8	0.4424	1.1880	1.6304	273.5	1100.4
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	272.5	1100.2
69.0	301.96	0.017472	6.2721	6.2896	271.7	908.5	1180.3	0.4398	1.1929	1.6327	271.5	1100.0
68.0	300.99	0.017463	6.3592	6.3767	270.7	909.3	1180.0	0.4385	1.1954	1.6339	270.5	1099.8
67.0	299.99	0.017453	6.4488	6.4662	269.7	910.0	1179.7	0.4372	1.1979	1.6351	269.5	1099.6
66.0	298.99	0.017443	6.5410	6.5584	268.7	910.8	1179.4	0.4358	1.2005	1.6363	268.5	1099.3
65.0	297.98	0.017433	6.6359	6.6533	267.6	911.5	1179.1	0.4344	1.2031	1.6375	267.4	1099.1
64.0	296.95	0.017423	6.7337	6.7511	266.6	912.3	1178.9	0.4330	1.2058	1.6388	266.4	1098.9
63.0	295.91	0.017413	6.8345	6.8519	265.5	913.0	1178.6	0.4316	1.2084	1.6401	265.3	1098.7
62.0	294.86	0.017403	6.9384	6.9558	264.4	913.8	1178.2	0.4302	1.2112	1.6413	264.2	1098.4
61.0	293.79	0.017393	7.0456	7.0630	263.3	914.6	1177.9	0.4287	1.2139	1.6427	263.1	1098.2
60.0	292.71	0.017383	7.1562	7.1736	262.2	915.4	1177.6	0.4273	1.2167	1.6440	262.0	1098.0
59.0	291.62	0.017372	7.2705	7.2879	261.1	916.2	1177.3	0.4258	1.2196	1.6453	260.9	1097.7
58.0	290.50	0.017362	7.3886	7.4059	259.9	917.0	1177.0	0.4243	1.2224	1.6467	259.8	1097.5
57.0	289.38	0.017351	7.5106	7.5280	258.8	917.8	1176.6	0.4227	1.2254	1.6481	258.6	1097.2
56.0	288.24	0.017340	7.6369	7.6543	257.6	918.7	1176.3	0.4212	1.2284	1.6495	257.4	1097.0
55.0	287.08	0.017329	7.7676	7.7850	256.4	919.5	1175.9	0.4196	1.2314	1.6510	256.2	1096.7
54.0	285.90	0.017319	7.9030	7.9203	255.2	920.4	1175.6	0.4180	1.2345	1.6524	255.0	1096.4
53.0	284.71	0.017307	8.0433	8.0606	254.0	921.2	1175.2	0.4163	1.2376	1.6539	253.8	1096.2
52.0	283.50	0.017296	8.1888	8.2061	252.8	922.1	1174.9	0.4147	1.2408	1.6555	252.6	1095.9
51.0	282.27	0.017285	8.3398	8.3571	251.5	923.0	1174.5	0.4130	1.2441	1.6570	251.3	1095.6
50.0	281.02	0.017274	8.4967	8.5140	250.2	923.9	1174.1	0.4112	1.2474	1.6586	250.1	1095.3
49.0	279.74	0.017262	8.6597	8.6770	248.9	924.8	1173.7	0.4095	1.2507	1.6602	248.8	1095.0
48.0	278.45	0.017250	8.8293	8.8465	247.6	925.7	1173.3	0.4077	1.2542	1.6619	247.4	1094.7
47.0	277.14	0.017238	9.0058	9.0231	246.2	926.6	1172.9	0.4059	1.2577	1.6636	246.1	1094.4
46.0	275.80	0.017226	9.1898	9.2070	244.9	927.6	1172.5	0.4040	1.2613	1.6653	244.7	1094.1
45.0	274.44	0.017214	9.3816	9.3988	243.5	928.6	1172.0	0.4021	1.2649	1.6671	243.3	1093.8
44.0	273.06	0.017202	9.5819	9.5991	242.1	929.5	1171.6	0.4002	1.2686	1.6689	241.9	1093.5
43.0	271.65	0.017189	9.7911	9.8083	240.6	930.5	1171.2	0.3983	1.2724	1.6707	240.5	1093.1
42.0	270.21	0.017177	10.0100	10.0272	239.2	931.5	1170.7	0.3962	1.2763	1.6726	239.0	1092.8
41.0	268.74	0.017164	10.2392	10.2563	237.7	932.6	1170.2	0.3942	1.2803	1.6745	237.5	1092.4
40.0	267.25	0.017151	10.4794	10.4965	236.1	933.6	1169.8	0.3921	1.2844	1.6765	236.0	1092.1
39.0	265.72	0.017138	10.7315	10.7487	234.6	934.7	1169.3	0.3900	1.2885	1.6785	234.5	1091.7
38.0	264.17	0.017124	10.9964	11.0136	233.0	935.8	1168.8	0.3878	1.2928	1.6806	232.9	1091.3
37.0	262.58	0.017111	11.2752	11.2923	231.4	936.9	1168.2	0.3856	1.2972	1.6827	231.3	1090.9
36.0	260.95	0.017097	11.5689	11.5860	229.7	938.0	1167.7	0.3833	1.3017	1.6849	229.6	1090.5
35.0	259.29	0.017083	11.8788	11.8959	228.0	939.1	1167.1	0.3809	1.3063	1.6872	227.9	1090.1
34.0	257.58	0.017069	12.2063	12.2234	226.3	940.3	1166.6	0.3785	1.3110	1.6895	226.2	1089.7
33.0	255.84	0.017054	12.5529	12.5700	224.5	941.5	1166.0	0.3760	1.3159	1.6919	224.4	1089.2
32.0	254.05	0.017039	12.9205	12.9376	222.7	942.7	1165.4	0.3735	1.3209	1.6944	222.6	1088.8
31.0	252.22	0.017024	13.3110	13.3280	220.8	943.9	1164.8	0.3709	1.3260	1.6969	220.7	1088.3
30.0	250.34	0.017009	13.7266	13.7436	218.9	945.2	1164.1	0.3682	1.3313	1.6995	218.8	1087.9
29.0	248.40	0.016993	14.1699	14.1869	217.0	946.5	1163.5	0.3654	1.3368	1.7022	216.9	1087.4
28.0	246.41	0.016977	14.6437	14.6607	214.9	947.9	1162.8	0.3626	1.3425	1.7050	214.9	1086.8
27.0	244.36	0.016961	15.1515	15.1684	212.9	949.2	1162.1	0.3596	1.3483	1.7080	212.8	1086.3
26.0	242.25	0.016944	15.6969	15.7138	210.7	950.6	1161.4	0.3566	1.3544	1.7110	210.6	1085.8
25.0	240.07	0.016927	16.2845	16.3014	208.5	952.1	1160.6	0.3535	1.3607	1.7141	208.4	1085.2

Table 2. Properties of Saturated Steam and Saturated Water (Pressure)

Press. psia	Temp. F	Volume, ft³/lbm Water v_f	Evap. v_{fg}	Steam v_g	Enthalpy, Btu/lbm Water h_f	Evap. h_{fg}	Steam h_g	Entropy, Btu/lbm × R Water s_f	Evap. s_{fg}	Steam s_g	Energy, Btu/lbm Water u_f	Steam u_g
[illegible]	240.07	0.016927	16.284	16.301	208.52	952.1	1160.6	0.3535	1.3607	1.7141	208.44	1085.2
24.[illegible]	238.95	0.016918	16.596	16.613	207.39	952.8	1160.2	0.3518	1.3639	1.7157	207.31	1084.9
24.0	237.82	0.016909	16.919	16.936	206.24	953.6	1159.8	0.3502	1.3672	1.7174	206.17	1084.6
23.5	236.66	0.016900	17.256	17.273	205.07	954.3	1159.4	0.3485	1.3706	1.7191	205.00	1084.3
23.0	235.49	0.01689[illegible]	17.608	17.624	203.88	955.1	1159.0	0.3466	1.3740	1.7208	203.81	1084.0
22.5	234.29	0.016882	17.974	17.991	202.67	955.9	1158.6	0.3451	1.3775	1.7226	202.60	1083.7
22.0	233.07	0.016873	18.356	18.373	201.44	956.7	1158.1	0.3433	1.3811	1.7244	201.37	1083.4
21.5	231.83	0.016863	18.756	18.772	200.18	957.5	1157.7	0.3415	1.3847	1.7262	200.12	1083.0
21.0	230.57	0.016854	19.174	19.190	198.90	958.4	1157.3	0.3396	1.3885	1.7281	198.84	1082.7
20.5	229.28	0.016844	19.611	19.628	197.60	959.2	1156.8	0.3377	1.3922	1.7300	197.54	1082.3
20.0	227.96	0.016834	20.070	20.087	196.27	960.1	1156.3	0.3358	1.3962	1.7320	196.21	1082.0
19.5	226.62	0.016824	20.551	20.568	194.91	960.9	1155.8	0.3338	1.4002	1.7341	194.85	1081.6
19.0	225.24	0.016814	21.057	21.074	193.52	961.8	1155.3	0.3318	1.4043	1.7361	193.47	1081.2
18.5	223.84	0.016803	21.590	21.607	192.11	962.7	1154.8	0.3297	1.4085	1.7383	192.05	1080.9
18.0	222.41	0.016793	22.151	22.168	190.66	963.7	1154.3	0.3276	1.4129	1.7405	190.60	1080.5
17.5	220.96	0.016782	22.743	22.760	189.18	964.6	1153.8	0.3255	1.4173	1.7428	189.12	1080.1
17.0	219.44	0.016771	23.365	23.385	187.66	965.6	1153.2	0.3232	1.4219	1.7451	187.61	1079.7
16.5	217.90	0.016760	24.031	24.048	186.11	966.6	1152.7	0.3209	1.4265	1.7475	186.06	1079.2
16.0	216.32	0.016749	24.733	24.750	184.52	967.6	1152.1	0.3186	1.4314	1.7500	184.47	1078.8
15.5	214.70	0.016738	25.479	25.496	182.88	968.6	1151.5	0.3162	1.4363	1.7525	182.84	1078.3
15.0	213.03	0.016726	26.274	26.290	181.21	969.7	1150.9	0.3137	1.4415	1.7552	181.16	1077.9
14.696	212.00	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	180.12	1077.6
14.5	211.32	0.016714	27.121	27.138	179.48	970.7	1150.2	0.3111	1.4468	1.7579	179.44	1077.4
14.0	209.56	0.016702	28.027	28.043	177.71	971.9	1149.6	0.3085	1.4522	1.7607	177.67	1076.9
13.5	207.75	0.016689	28.997	29.014	175.89	973.0	1148.9	0.3058	1.4579	1.7636	175.84	1076.4
13.0	205.88	0.016676	30.040	30.057	174.00	974.2	1148.2	0.3029	1.4638	1.7667	173.96	1075.9
12.5	203.95	0.016663	31.163	31.180	172.06	975.4	1147.5	0.3000	1.4698	1.7699	172.02	1075.3
12.0	201.96	0.016650	32.377	32.394	170.05	976.6	1146.7	0.2970	1.4762	1.7731	170.02	1074.8
11.5	199.89	0.016636	33.693	33.710	167.98	977.9	1145.9	0.2938	1.4827	1.7766	167.94	1074.2
11.0	197.75	0.016622	35.125	35.142	165.82	979.3	1145.1	0.2906	1.4896	1.7802	165.79	1073.6
10.5	195.52	0.016607	36.689	36.705	163.59	980.7	1144.2	0.2872	1.4968	1.7839	163.55	1072.9
10.0	193.21	0.016592	38.404	38.420	161.26	982.1	1143.3	0.2836	1.5043	1.7879	161.23	1072.3
9.5	190.80	0.016577	40.293	40.310	158.84	983.6	1142.4	0.2799	1.5121	1.7920	158.81	1071.6
[illegible]	188.27	0.016561	42.385	42.402	156.30	985.1	1141.4	0.2760	1.5204	1.7964	156.28	1070.8
[illegible]	185.63	0.016545	44.716	44.733	153.65	986.8	1140.4	0.2719	1.5292	1.8011	153.63	1070.0
8.0	182.86	0.016527	47.328	47.345	150.87	988.5	1139.3	0.2676	1.5384	1.8060	150.84	1069.2
7.5	179.93	0.016510	50.277	50.294	147.93	990.2	1138.2	0.2630	1.5482	1.8112	147.91	1068.4
7.0	176.84	0.016491	53.634	53.650	144.83	992.1	1136.9	0.2581	1.5587	1.8168	144.81	1067.4
6.5	173.56	0.016472	57.490	57.506	141.54	994.1	1135.6	0.2530	1.5699	1.8229	141.52	1066.5
6.0	170.05	0.016451	61.967	61.984	138.03	996.2	1134.2	0.2474	1.5820	1.8294	138.01	1065.4
5.5	166.29	0.016430	67.232	67.249	134.26	998.5	1132.7	0.2414	1.5951	1.8365	134.24	1064.3
5.0	162.24	0.016407	73.515	73.532	130.20	1000.9	1131.1	0.2349	1.6094	1.8443	130.18	1063.1
4.8	160.52	0.016398	76.383	76.400	128.47	1001.9	1130.4	0.2321	1.6155	1.8477	128.46	1062.5
4.6	158.73	0.016388	79.493	79.509	126.69	1003.0	1129.7	0.2292	1.6219	1.8512	126.68	1062.0
4.4	156.89	0.016379	82.876	82.893	124.84	1004.1	1128.9	0.2262	1.6286	1.8548	124.83	1061.4
4.2	154.96	0.016368	86.57	86.59	122.92	1005.2	1128.1	0.2231	1.6355	1.8586	122.90	1060.8
4.0	152.96	0.016358	90.63	90.64	120.92	1006.4	1127.3	0.2199	1.6428	1.8626	120.90	1060.2
3.8	150.88	0.016347	95.09	95.11	118.83	1007.6	1126.5	0.2165	1.6504	1.8669	118.82	1059.6
3.6	148.70	0.016336	100.04	100.06	116.63	1008.9	1125.6	0.2129	1.6584	1.8713	116.63	1058.9
3.4	146.41	0.016324	105.55	105.57	114.36	1010.3	1124.6	0.2091	1.6669	1.8760	114.35	1058.2
3.2	144.00	0.016313	111.73	111.75	111.95	1011.7	1123.6	0.2051	1.6759	1.8810	111.94	1057.5
3.0	141.47	0.016300	118.71	118.73	109.42	1013.2	1122.6	0.2009	1.6854	1.8864	109.41	1056.7
2.8	138.78	0.016287	126.66	126.67	106.73	1014.7	1121.5	0.1964	1.6956	1.8921	106.73	1055.8
2.6	135.93	0.016274	135.78	135.80	103.88	1016.4	1120.3	0.1917	1.7065	1.8982	103.87	1054.9
2.4	132.88	0.016260	146.39	146.40	100.84	1018.2	1119.0	0.1865	1.7183	1.9048	100.83	1054.0
2.2	129.61	0.016245	158.86	158.87	97.57	1020.1	1117.6	0.1810	1.7311	1.9121	97.56	1053.0
2.0	126.07	0.016230	173.74	173.76	94.03	1022.1	1116.2	0.1750	1.7450	1.9200	94.03	1051.8
1.8	122.22	0.016213	191.84	191.85	90.18	1024.3	1114.5	0.1684	1.7604	1.9288	90.18	1050.6
1.6	117.98	0.016196	214.31	214.33	85.95	1026.8	1112.7	0.1611	1.7775	1.9386	85.94	1049.3
1.4	113.26	0.016178	243.00	243.02	81.23	1029.5	1110.7	0.1529	1.7969	1.9498	81.23	1047.8
1.2	107.91	0.016158	280.95	280.96	75.90	1032.6	1108.5	0.1436	1.8192	1.9628	75.89	1046.1
1.0	101.74	0.016136	333.59	333.60	69.73	1036.1	1105.8	0.1326	1.8455	1.9781	69.73	1044.1
0.9	98.24	0.016124	368.41	368.43	66.24	1038.1	1104.3	0.1264	1.8606	1.9870	66.24	1042.9
0.8	94.38	0.016112	411.67	411.69	62.39	1040.3	1102.6	0.1195	1.8775	1.9970	62.39	1041.7
0.7	90.09	0.016099	466.93	466.94	58.10	1042.7	1100.8	0.1117	1.8966	2.0083	58.10	1040.3
0.60	85.218	0.016085	540.0	540.1	53.245	1045.5	1098.7	0.1028	1.9186	2.0215	53.243	1038.7
0.50	79.586	0.016071	641.5	641.5	47.623	1048.6	1096.3	0.0925	1.9446	2.0370	47.621	1036.9
0.40	72.869	0.016056	792.0	792.1	40.917	1052.4	1093.3	0.0799	1.9762	2.0562	40.916	1034.7
0.35	68.939	0.016046	898.6	898.6	36.992	1054.6	1091.6	0.0725	1.9951	2.0676	36.991	1033.4
0.30	64.484	0.016040	1039.7	1039.7	32.541	1057.1	1089.7	0.0641	2.0168	2.0809	32.540	1032.0
0.2[illegible]	59.323	0.016032	1235.5	1235.5	27.382	1060.1	1087.4	0.0542	2.0425	2.0967	27.382	1030.3
0.20	53.160	0.016025	1526.3	1526.3	21.217	1063.5	1084.7	0.0422	2.0738	2.1160	21.217	1028.3
0.15	45.453	0.016020	2004.7	2004.7	13.498	1067.9	1081.4	0.0271	2.1140	2.1411	13.498	1025.7
0.10	35.023	0.016020	2945.5	2945.5	3.026	1073.8	1076.8	0.0061	2.1705	2.1766	3.025	1022.3
0.08865	32.018	0.016022	3302.4	3302.4	0.0003	1075.5	1075.5	0.0000	2.1872	2.1872	0.000	1021.3

North Valve Vault

Calculation to determine estimated time at maximum accident temperature operator could be subjected to without the temperature of the motor and internal components exceeding the maximum accident saturated steam temperature.

Maximum accident temperature = 325°F
Maximum accident pressure = 23.17 psia
Maximum accident saturated steam temperature = 236.66°F

Evaluated temperatures and time durations conservatively taken from figure 25 on TVA drawing 47E235-76 R0.

for additional conservatism in the calculation it was assumed that the operator mass is at maximum accident saturated steam temperature.

$$(T_1 - T_s)(D_1) + (T_2 - T_s)(D_2) = (T_1 - T_s)(D_3)$$

Where:

T_1 = maximim accident temperature
T_2 = accident profile temperature
T_s = maximum accident saturated steam temperature
D_1 = accident profile time duration at T_1 for evaluation
D_2 = accident profile time duration at T_2 for evaluation
D_3 = time duration the operator could be subjected at T_1

T_1 = 325°F
T_2 = 250°F
T_s = 237°F
D_1 = 41 mins
D_2 = 19 mins
D_3 = X mins

$$(325^oF - 237^oF)(41 \text{ mins}) + (250^oF - 237^oF)(19 \text{ mins}) = (325^oF - 237^oF)(X \text{ mins})$$
$$X = 43.81 \text{ minutes}$$

Therefore the operator could be subjected to a ambient temperature up to 325°F for approximately 43.81 minutes without the motor and operator internals exceeding the maximum accident saturated steam temperature.

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South Valve Vault

Calculation to determine estimated time at maximum accident temperature operator could be subjected to without the temperature of the motor and internal components exceeding the maximum accident saturated steam temperature.

Maximum accident temperature = 323°F
Maximum accident pressure = 25.18 psia
Maximum accident saturated steam temperature = 242.25°F

Evaluated temperatures and time durations conservatively taken from figure 26 on TVA drawing 47E235-76 R0.

For additional conservatism in the calculation it was assumed that the operator mass is at maximum accident saturated steam temperature.

$$(T_1 - T_s)(D_1) + (T_2 - T_s)(D_2) = (T_1 - T_s)(D_3)$$

Where:

T_1 = maximim accident temperature
T_2 = accident profile temperature
T_s = maximum accident saturated steam temperature
D_1 = accident profile time duration at T_1 for evaluation
D_2 = accident profile time duration at T_2 for evaluation
D_3 = time duration the opeator could be subjected at T_1

T_1 = 323°F
T_2 = 250°F
T_s = 243°F
D_1 = 40 mins
D_2 = 20 mins
D_3 = X mins

$$(323°F - 243°F)(40 \text{ mins}) + (250°F - 243°F)(20 \text{ mins}) = (323°F - 243°F)(X \text{ mins})$$
$$X = 41.75 \text{ minutes}$$

Therefore the operator could be subjected to a ambient temperature up to 323°F for approximately 41.75 minutes without the motor and operator internals exceeding the maximum accident saturated steam temperature.

Form TVA 10697 (EN DES 1-84)

EN DES CALCULATIONS

TITLE Safety Evaluation of Superheated Steam in the Steam Valve Vault		PLANT/UNIT WBN 1&2
PREPARING ORGANIZATION EN DES/MEB	KEY NOUNS (Consult MEDS CIS DESCRIPTORS LIST) Steam Valves	
BRANCH/PROJECT IDENTIFIERS	Each time these calculations are issued, preparers must ensure that the original (RO) MEDS accession number is filled in. Rev (for MEDS use) MEDS accession number: RO 840907D0089 MEB '840904 221	
APPLICABLE DESIGN DOCUMENT(S)	R __	
	R __	
SAR SECTION(S) 15.2 / UNID SYSTEM(S) N/A	R __	

	Revision 0	Revision __	Revision __	Revision __
ECN NUMBER (Enter "N/A" if there is no ECN)	N/A			
PREPARED	RK Freeman			
CHECKED	YPLagstead			
SUBMITTED	APBianco			
DATE	9/4/84			
APPROVED	LHChin			
List all pages added by this revision.				
List all pages deleted by this revision.				
List all pages changed by this revision.				

Use form TVA 10534 if more room required.

STATEMENT OF PROBLEM

The current design temperature of 325°F for the valve vault was based on the assumption that the steam in the steam generator was at saturated conditions. Westinghouse reevaluated this assumption and determined that the steam in the steam generator becomes superheated from exposure to uncovered tubes.

Determine the safety implications of superheated steam of approximately 460°F in the steam valve vault caused by steam generator tube uncovery from a main steamline break.

ABSTRACT

When the superheated steam was included in the temperature profile for the main steam valve vault, the current equipment qualificaton temperatures were exceeded. Based on the thermohydraulics of the break blowdown, all safety functions will be performed before the equipment qualification temperatures are exceeded except for the PAM instrumentation. The design basis of the auxiliary feedwater system will be exceeded; however, for the steamline break, one auxiliary feedwater pump to one steam generator is adequate for maintaining a safe shutdown. Some mitigative action will be required for the PAM instruments to assure their operation for at least one hour.

☒ Continuation sheet(s) used.

☐ Microfilm and store calculation in MEDS Service Center. Microfilm and destroy. ☐

☒ Microfilm and return calculation to: A. P. Bianco Address: W10A35 C-K

E84222.01

Purpose: Determine the safety implications of superheated steam in the steam valve vault caused by SG tube uncovery from a mainsteamline break.

References:

1. Superheated steam inside containment, NCR WBNNEB8335 (NEB 831221 854)

2. Superheated steam inside the steam valve vault, NCR WBNNEB8603 (NEB 840517 855)

3. M[illegible]iple SG blowdown, NCR GENNEB8211 (NEB 831220 852)

Assumptions

The following assumptions have been discussed with Westinghouse and will be used in the analysis to describe the effects of a spectrum of steam line breaks in the valve vaults. Westinghouse is currently performing sensitivity studies to verify these assumptions.

a. If a steam line break is very small such that no safety injection (SI) signal is initiated then there will be no significant SG tube uncovery and no additional superheat will be generated.

b. If a small steam line break results in an SI signal, then superheating can occur due to the break. Before superheating can be generated significant tube uncovery must take place which will take approximately two to three minutes to occur. When the SI signal is generated, reactor trip, containment isolation, feedwater isolation, and automatic startup of the auxiliary feedwater (AFW) system will occur within approximately two to three minutes, assuring a successful unit shutdown. Thus the necessary safety functions will be performed prior to significant changes in the environment for which the components are qualified.

c. For large steam line breaks, no appreciable superheat will occur because of the entrained liquid in the discharge and because the blowdown rate is so rapid that there is little time for the mixture to become superheated.

d. Consistent with assumption (b), this evaluation will assume a 0.86 ft^2 break using the blowdown rates from Duke's Catawba plant. A temperature profile is given in the appendix.

Discussion

For all break sizes in the range of assumption (a), no events beyond the design basis will occur. The feedwater controls will detect the steam/feedwater flow mismatch caused by the break and increase feedwater flow to the affected steam generator loop. Since the main feedwater pumps are oversized, feedwater flow to the affected loop will most likely keep up with the increase flow demand and a reactor trip on low SG level and high steam/feedwater flow mismatch will not occur. Therefore, the possibility of uncovering the SG tubes and producing superheating will be precluded, and no safety concerns will exist. If a reactor trip does occur, it would likely be associated with the overpower or overtemperature trips and not low-low SG level. For conservatism, the reactor is assumed to trip on low-low SG level which would result in the minimum secondary side water inventory. The low-low level trip will initiate a reactor trip and automatically startup of the AFW system. The reactor trip will also initiate a turbine-generator trip. Assuming offsite power and the steam dump valves are available, MFW isolation will occur quickly (in about one minute) as the reactor coolant system (RCS) T_{avg} decreases to 564°F. If offsite power is unavailable, the SG safety valves will automatically decrease RCS T_{avg} to the no-load value. After MFW isolation and reactor trip have occured, the AFW system will maintain SG level, provided that two AFW trains are available for decay heat removal. If only one AFW train is available, SG tube uncovery will occur. However, the AFW system will delay the onset of superheating until much later into the event. The increased time delay will ensure that all safety-related functions will be performed prior to initiation of superheating.

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Therefore, it is concluded that this break spectrum is within the design basis of the plant and a detailed consideration of each item in the valve vault need not be evaluated.

Discussion

For the break spectrum in assumption (b), significant superheating can occur and a detailed consideration of each item in the valve vault must be evaluated to determine if the plant can be safely cooled down and maintained in a hot stable condition. The details of this evaluation are given below.

For the break spectrum in assumption (c), no appreciable superheating will occur and, therefore, a detailed evaluation of each item in the valve vault is not required.

Electrical Features

1. SG PORV Backup Emergency Control Solenoid Valves

1,2-PSV-1-6A&B	SG-1
13A&B	SG-2
24A&B	SG-3
31A&B	SG-4

In the event of an MSLB (within the valve vault), there is a high probability that the non-safety-related automatic control loop associated with the PORV on the intact loop will fail due to the harsh environment and cause the PORV to stick open. This event could result in a multiple SG blowdown event (see NCR GENNEB8211) and the loss of the auxiliary turbine-driven pump to provide emergency feedwater if the break occurred in the south valve vault. However, an MSLB is an overcooling event and best estimate analysis performed by Westinghouse has indicated that for multiple SG blowdowns that are bounded by the FSAR large MSLB the plant can be safely cooled down and stabilized with one motor-driven AFW pump providing minimum flow to one SG. Note that this is true only for an overcooling event. Therefore, since overcooling events are postulated, these solenoid valves need not operate to mitigate an MSLB.

Even though no safety problems result from the failure of this equipment, the licensing documentation (FSAR) does not support this conclusion. In order to meet the system functional requirements as described in the FSAR, this equipment must perform its safety function for the duration of the event. However, since the peak temperature in the valve vaults exceeds the qualification temperature of most all safety-grade equipment currently available, it may not be possible to obtain qualified replacement equipment.

2. SG PORV Limit Switches

1,2-PCV-1-5(LS)	SG-1
12(LS)	SG-2
23(LS)	SG-3
30(LS)	SG-4

These limit switches are used only to provide SG PORV status indication in the main control room (MCR). Since the PORVs are not required to operate to mitigate an MSLB, the limit switches need not operate to provide MCR indication.

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3. **MSIV Vent Solenoid Valves**

1,2-FSV-1-4A,B,D,E,G,H SG-1
11A,B,D,E,G,H SG-2
22A,B,D,E,G,H SG-3
29A,B,D,E,G,H SG-4

For breaks that will generate an MSIV closure signal, the vent solenoid valves will accomplish their protection function of venting the MSIVs prior to significant changes in the environment for which the components are qualified. If the break does not generate an MSIV closure signal, it may generate an SI signal and superheating can occur. The harsh environment caused by superheating will have an adverse effect on the solenoid valves. If the harsh environment caused the solenoid valves to fail in such a manner that the MSIVs were to close, no safety concerns will result because the SG safety relief valves will dump the excess energy to the atmosphere. If the harsh environment caused the solenoid valves to fail in such a manner that the MSIVs cannot be closed, no safety concerns will exist. The reason is that since no MSIV closure signal was generated, the break must be relatively small. For relatively small breaks, the break flow will be choked regardless of the number of SGs supplying the break. Thus, the overcooling transient resulting from the failure of the MSIVs to close will be bounded by the FSAR large MSLB. Since the break will affect only two SGs, AFW can be isolated to the affected SGs and flow established to the intact SGs. The intact SGs will then be used to cooldown and stablize the plant. Even if a single failure of an MSIV on an intact SG was coupled with the failure of the MSIVs in the open position on the faulted SGs, the plant can still be cooled down. As noted in item 1, plant cooldown can be maintained with minimum AFW to one SG. Since two motor-driven AFW pumps are available AFW can be supplied to any intact SGs. However, due to the inherent design of the MSIVs, a failure that would cause the valves to remain open is extremely unlikely since there are two trains of solenoid valves with either train capable of closing the valves and any expected solenoid valve failures would, therefore, be in the de-energized position which would cause the valves to close. This design feature will ensure that the intact SGs can be isolated from the faulted SG(s). Therefore, it is concluded that whether or not the vent solenoid valves function, plant safety will not be jeopardized.

Even though no safety problems result from the failure of this equipment, the licensing documentation (FSAR) does not support this conclusion. In order to meet the system functional requirements as described in the FSAR, this equipment must perform its safety function for the duration of the event. However, since the peak temperature in the valve vaults exceeds the qualification temperature of most all safety-grade equipment currently available, it may not be possible to obtain qualified replacement equipment.

4. MSIV Test Solenoid Valves

1,2-FSV-1-4F&J SG-1
11F&J SG-2
22F&J SG-3
29F&J SG-4

For breaks that will generate an MSIV closure signal, the test solenoid valves will accomplish their protective function of maintaining a vent path for the MSIVs prior to significant changes in the environment for which the components are qualified. If the break does not generate a MSIV closure signal, but does generate an SI signal due to high steam line differential pressure, superheating may occur. The harsh environment caused by superheating will have an adverse effect on the solenoid valves. However, the test solenoid valves are normally in the de-energized position and it is unlikely that the harsh environment will cause the test solenoid valves to go to the energized position which would block the MSIV vent paths. Even if this did occur, plant safety will not be jeopardized for the reasons given in item 3. Therefore, it is concluded that the MSIV test solenoid valves will not fail in such a manner that would jeopardize plant safety.

Even though no safety problems result from the failure of this equipment, the licensing documentation (FSAR) does not support this conclusion. In order to meet the system functional requirements as described in the FSAR, this equipment must perform its safety function for the duration of the event. However, since the peak temperature in the valve vaults exceeds the qualification temperature of most all safety-grade equipment currently available, it may not be possible to obtain qualified replacement equipment.

5. Main Steam Line Warming Solenoid Valves

1,2-FSV-1-147 SG-1
148 SG-2
149 SG-3
150 SG-4

For breaks that will generate an MSIV closure signal, the warming valves will close, if open, and remain closed. The solenoid valves are used only during startup and are normally in the de-energized mode. It is very unlikely that the harsh environment will cause the solenoid valves to re-energize and re-open the warming valves.

If the break does not generate an MSIV closure signal, but does generate an SI signal, the solenoid valves will most likely remain in the de-energized mode. Even if for some reason the solenoid valves were to fail in the energized mode causing the warming valves to be open, plant safety will not be jeopardized for the reasons given in item 3. Therefore, it is concluded that the steam line warming solenoid valves will have no effect on the plant's ability to mitigate an MSLB event.

6. Main Steam Line Warming Valve Limit Switches

1,2-FSV-1-147(LS) SG-1
148(LS) SG-2
149(LS) SG-3
150(LS) SG-4

The limit switches are used in the warming valve seal-in circuits to maintain the valves in the open position upon actuation from the MCR. Following an MSLB (large or small), the limit switches may fail and allow the warming valves to re-open after the MSIV closure signal is reset. However, if this were to occur, plant safety will not be jeopardized for the reasons give in item 3.

7. SG Blowdown Isolation Solenoid Valves

1,2-FCV-1-7 SG-1
14 SG-2
25 SG-3
32 SG-4

Upon receipt of a containment isolation signal, these solenoid operated valves will perform their intended safety function prior to significant changes in the environment for which the components are qualified. After the valves have performed their intended safety function, the harsh environment caused by superheating may cause the valves to fail. Since the MSLB occurs outside of containment, there is no potential release of radioactive material through the blowdown lines and, therefore, no need for containment isolation. For these reasons, it is concluded that these solenoid valves have no effect on the plant's ability to mitigate an MSLB.

8. Auxiliary Feed Pump Turbine (AFPT) Steam Supply Switchover Valves

1,2-FCV-1-15 SG-1 Supply
16 SG-4 Supply

These valves supply steam to the AFPT. If an MSLB causes the failure of either valve, plant safety is not jeopardized. AFW flow to one SG is an adequate heat sink to cool down and maintain the plant in a stable condition. See item 1.

Even though no safety problems result from the failure of this equipment, the licensing documentation (FSAR) does not support this conclusion. In order to meet the system functional requirements as described in the FSAR, this equipment must perform its safety function for the duration of the event. However, since the peak temperature in the valve vaults exceeds the qualification temperature of most all safety-grade equipment currently available, it may not be possible to obtain qualified replacement equipment.

9. AFPT Steam Supply Isolation Valves

1,2-FCV-1-17 Train A
18 Train B

These valves are used to isolate the steam supply to the AFPT in the event of a steam supply line break in the AFPT room. Since the break is in the valve vault, these valves are not required to operate. The valves are normally open and it is unlikely that the harsh environment will cause the valves to close. Even if the valves were to close, plant safety will not be jeopardized because the AFPT is not needed to mitigate a steam line break. See item 1.

10. MFW Isolation Valves

1,2-FCV-3-33	SG-1
47	SG-2
57	SG-3
100	SG-4

These valves will close on a feedwater isolation signal which is generated by an SI signal. In accordance with assumption (b), these valves will close before superheated steam is generated. Since these are motor-operated valves, the valves are expected to fail "as-is" and will not re-open.

11. MFW Upper Tap Isolation Valves

1,2-FSV-3-236A	SG-1
236B	SG-1
239A	SG-2
239B	SG-2
242A	SG-3
242B	SG-3
245A	SG-4
245B	SG-4

These solenoid valves deenergize on a feedwater isolation signal which in turn causes the air to vent off the FCVs isolating the upper feedwater tap from MFW. In accordance with assumption (b), these solenoid valves will have performed their safety function (close the FCV) before superheated steam is generated. Since the solenoid valves deenergize to perform their safety function it is unlikely that the harsh environment would cause both solenoids to fail in the energized position. In addition, there is a check valve to prevent AFW from backflowing into the MFW if the FCV fails to close.

12. MFW Check Valve Bypass

1,2-FSV-3-185 SG-1
186 SG-2
187 SG-3
188 SG-4

The valves are used only during unit startup and deenergize on a feedwater isolation signal which is generated by an SI. In accordance with assumption (b), these solenoid valves will have performed their safety function (close the FCV before superheated steam is generated. Since the solenoid valves deenergize to perform their safety function it is unlikely that the harsh environment would cause the solenoids to fail in the energized position. In addition, the MFW isolation is upstream of the check valve so if this valve does not close MFW isolation is not breached.

13. SG Level Control Valve Positioners and Solenoid Valves

1,2-LCV-3-174 SG-1 LCV Positioner
175 SG-4 LCV Positioner

1,2-LSV-3-174 SG-1 LCV Solenoid Valve
175 SG-4 LCV Solenoid Valve

The valve positioners and solenoid valves are used to control level in SG-1 and SG-4 by throttling the feedwater supply from the AFPT. They are both located in the south valve vault. In the event of a steam line break, the valve positioners may fail open or closed. However, during a steam line break most of the AFW flow will be directed to the faulted loop and it is not expected that during this time SG-1 or SG-4 would overfill. After the operator has taken corrective action to isolate the faulted loop at 10 minutes into the event, AFW flow will be re-distributed to the intact SGs. The intact SG's PORVs are assumed not to have failed open. After the levels are brought up in the intact SG, the LCVs will start to throttle and overfilling may occur in SG-1 or SG-4 if an LCV has failed open. The operator has adequate time to detect the overfilling through SG level, high-level alarms, and AFW flow and take corective action. These actions could include the following:

a. Place the turbine-driven pump speed control in the manual mode and throttle back pump flow.

b. Trip the AFPT (based on item 1, the AFPT is not needed to mitigate this event).

The solenoid valves are normally de-energized to allow their associated LCVs to be modulated by their respective level controllers. During a steam line break, the solenoid valves may fail due to superheating, but should not cause the LCVs to close since the solenoids are in the deenergized state. The valve positioner or diaphram may fail causing the

LCVs to close. For a steam line break this is an acceptable consequence because flow from the turbine-driven pump is not needed to mitigate the event. (See item 1.)

Therefore, in either case, failure of the valve positioners or solenoid valves in the adverse direction will not jeopardize plant safety.

* Even though no safety problems result from the failure of this equipment, the licensing documentation (FSAR) does not support this conclusion. In order to meet the system functional requirements as described in the FSAR, this equipment must perform its safety function for the duration of the event. However, since the peak temperature in the valve vaults exceeds the qualification temperature of most all safety-grade equipment currently available, it may not be possible to obtain qualified replacement equipment.

14. Main Steam Header Pressure Transmitters

1,2-PT-1-9A&B	SG-2	(PAM)
20A&B	SG-3	(PAM)

These devices are used in the steam line differential pressure trip circuits to provide an SI signal in the event of an MSLB or feedwater line break. The pressure differential is set at 100 lb/in^{2}d. For a small steam line break which results in superheating, a pressure differential signal will be initiated to generate an "SI" signal prior to significant changes in the environment for which the components are qualified (assumption b). The pressure transmitters are postaccident monitoring (PAM) devices and are used by the operator to detect the faulted SG loop(s) and take corrective action. For the transmitters located in the valve vault, the equipment's environmental qualification will be exceeded within approximately two to three minutes of the event and the transmitters are expected to fail.

However, these transmitters must be qualified to operate for at least one hour in the harsh environment to enable the operator to take mitigative action and bring the plant to a stable condition. The transmitters may be moved from the valve vault or insulated to protect them from the high temperatures to allow at least one hour of operation without exceeding the transmitter's qualification temperature.

15. AFW Pipe Break Detection on Turbine Driven Pump

1,2-PS-3-140B	SG-3
150B	SG-2
160A&B	SG-1
165A&B	SG-4

The pressure switches (PSs) are to detect a depressurized SG and automaticaly isolate AFW from the turbine-driven pump to the SG. The PSs are for an enhancement to safety, but are not required for the mitigation of an event. If a PS fails that closes the associated LCV on the turbine pump, the motor driven pumps are available. If the PS fails so it does not close the LCV, the operator has adequate time to take manual actions (see item 13).

16. Local Handswitches on MFW Isolation Valves

1,2-HS-3-33B SG-1
87B SG-3
100B SG-4
2-HS-3-47B SG-2

When a feedwater isolation signal is generated there is an interlock that blocks the valve from being opened. The valve will have closed before superheated steam is generated so the HS will not have failed before the valve has closed. There is no failure mode of the HS that could cause the valve to reopen.

17. Cables

All cables entering the valve vaults are terminated in the valve vaults. Therefore, overheating these cables will not affect any components which have not been previously analysed for the superheat condition. It will be assumed that the associated components will fail prior to cable failures. However, this assumption must be verified to ensure that the cable insulations will not melt and flow at the bends and short out before the associated components have performed their protective function.

Assuming that the safety functions for the components located inside the valve vaults will be completed prior to insulation failures, it will be considered incredible for cable failure to degrade or reverse a completed safety function (i.e., cause motor-operated valve to change position or re-energize a solenoid valve).

Mechanical Features

18. Steam Generator PORVs

1,2-PCV-1-5 SG-1 PORV
12 SG-2 PORV
23 SG-3 PORV
30 SG-4 PORV

In the event of a small steam line break the superheating may cause the diaphrams on the PORVs to rupture. If this occurred, the air pressure on the valves will bleed off and the valves will close due to spring action. This is a fail-safe position. However, if the harsh environment were to cause the valves to stick open due to mechanical failures (including failures within the valve positioner or operator), the consequences would be the same as described in item 1. Since the consequences in item 1 were acceptable, it is concluded that failure of the PORVs in either the open or closed position will not jeopardize plant safety.

19. Main Steam Isolation Valves

1,2-PCV-1-4	SG-1 MSIV
11	SG-2 MSIV
22	SG-3 MSIV
29	SG-4 MSIV

The MSIVs are Wye-type valves controlled by a cylinder-type valve operator. The cylinder-type valve operator consists of a piston operating in a pressure-tight cylinder using air to open the valve and a combination of venting and spring action to close the valve. Seals between the piston and the cylinder wall and the piston rod and the end cap are used to prevent leakage of air out of the cylinder housing. In the event of a small steam line break, the superheating may cause the seals to leak. This action will bleed the air pressure off the piston causing the MSIV to close. This is a fail-safe position. However, if the harsh environment were to cause the MSIVs to stick open due to mechanical failures in the cylinder-type valve operator, the consequences would be the same as described in item 3. Since the consequences in item 3 were acceptable, it is concluded that failure of the MSIVs in either the open or closed position will not jeopardize plant safety.

20. SG Safety Relief Valves

522 thru 526	SG-1
517 thru 521	SG-2
512 thru 516	SG-3
527 thru 531	SG-4

The harsh environment caused by a small steam line break will not adversely affect the safety relief valves. The safety relief valves are spring loaded and as the temperature increases in the valve vault, the valve spring constant will decrease which will cause a decrease in the lift pressure. The decrease is not considered significant and is in the safe direction (i.e., they will lift at a lower pressure, thereby giving extra margin in overpressure protection).

21. MFW Upper Tap Isolation Valve

1,2-FCV-3-236	SG-1
239	SG-2
242	SG-3
245	SG-4

The feedwater isolation signal will be generated for all breaks t t will cause superheated steam to be generated (see assumptions a and b). The valves will be closed before any superheated steam is generated. The superheated steam may cause the diaph ams on the valves to rupture so the valves will remain closed due to spring action. There is no known failure mode due to the harsh environment that would cause the valve to reopen. Thus, the MFW isolation function is maintained.

22. MFW Check Valve Bypass Valve

1,2-FCV-3-185 SG-1
186 SG-2
187 SG-3
188 SG-4

These valves are open only during unit startup. If a break occurs, an SI is generated which closes the valve. The valve will have closed before superheated steam is generated. The superheated steam may cause the diagrams on the valves to rupture so the valves will remain closed due to spring action. There is no known failure mode due to the harsh environment that would cause the valve to reopen.

Civil Features

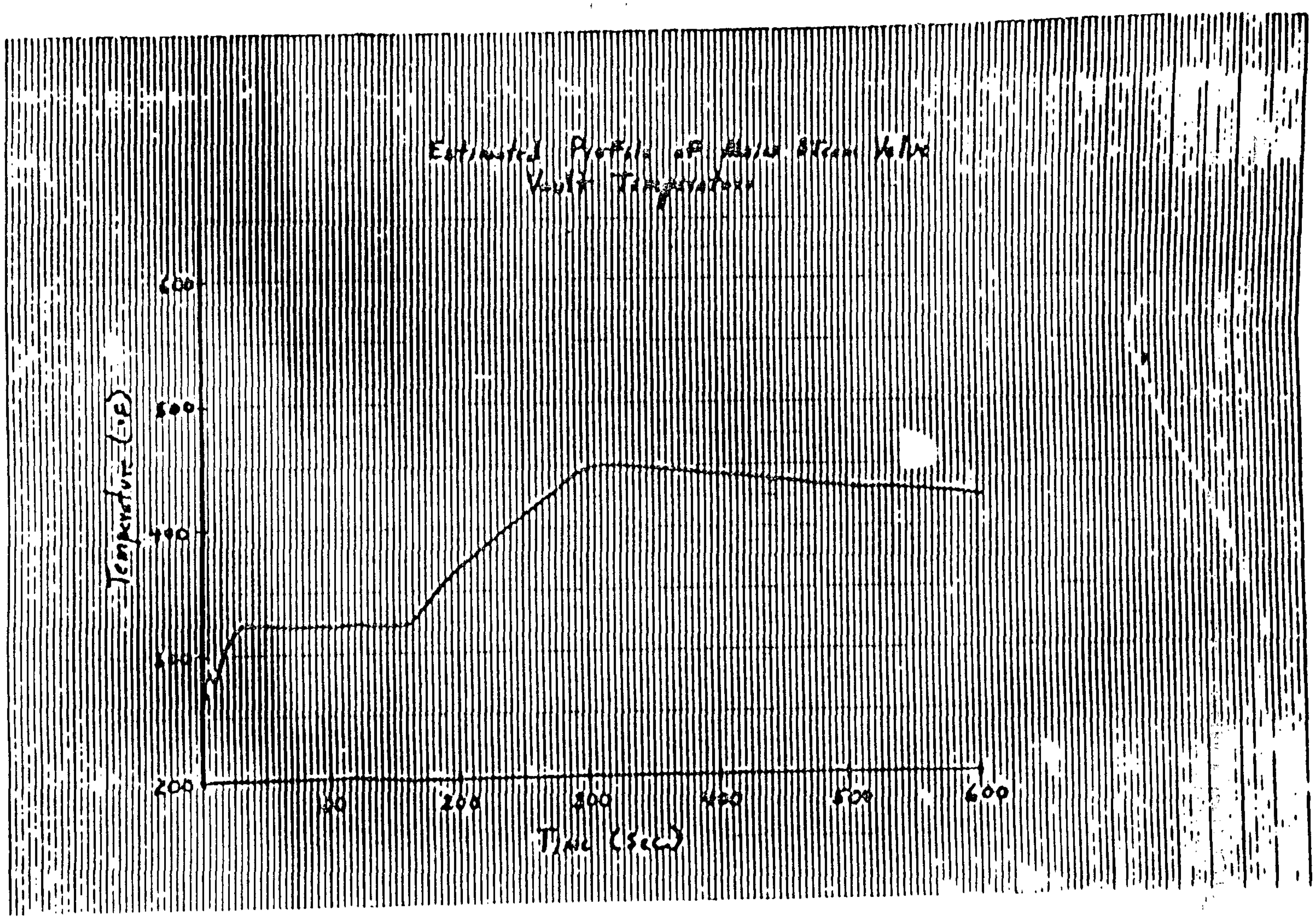
23. Concrete Walls and Structural Steel

The structural steel frames and embedded plates anchored to the concrete were analyzed and it was concluded that they will undergo localized yielding with some concrete spalling or cracking from the forces induced by the increased temperature from the MSLB. The localized yielding will not result in the collapse of the structrual steel which could cause damage to other safety-related systems within the valve vault. It was assumed that the structural steel would not need to withstand seismic loading following an MSLB. Repair work to the structural steel will be necessary after an MSLB to restore the structured integrity of the steel frame.

General Conclusion

The design basis for the AFW system may be exceeded during a small MSLB. However, minimum AFW flow to one intact SG is sufficient to mitigate an overcooling event. The PAM instrumentation must be protected against the increased temperatures in the valve vault to assure operability for at least one hour.

2244



APPENDIX

[illegible]

MATERIAL CLASSIFICATION .... ELASTOMER
[illegible] MEB-3-0111

[illegible] .... [illegible]

RADIATION THRESHOLD .... 5.0E[illegible]
LIBRARY CODE 261-83

TEMPERATURE RATING .... 204[illegible]
SOURCE .... MFR.

QUALIFICATION ANALYSIS REPORT

COMPONENT NAME....: [illegible]
MANUFACTURER......: [illegible]
PART NUMBER.......: [illegible]
[illegible] WBN-MEB-3-0111 [illegible]

COMPONENT OPERATIONAL LIMITATIONS:

TEMPERATURE.......... * * NOT SPECIFIED * *
VOLTAGE.............. * * NOT SPECIFIED * *
CURRENT.............. * * NOT SPECIFIED * *
CYCLE LIFE........... * * NOT SPECIFIED * *

RADIATION REQUIREMENTS DURING NORMAL SERVICE LIFE :

GAMMA...............NONE
BETA................NONE
NEUTRON.............NONE

RADIATION REQUIREMENTS DURING DESIGN BASIS EVENT (DBE) :
GAMMA...............NONE
BETA................NONE
NEUTRON.............NONE

QUALIFIED LIFE BASED ON THE FOLLOWING :

	AGING TEMPERATURE (DEG C)	AGING TIME AT THIS TEMP (HRS)
1	0.00	0.0

	ENVIRONMENTAL TEMP. (DEG.C)	PERCENT OF TIME AT THIS TEMP. (%)
1	54.44	100.0

EXPECTED LIFE BASED ON THE FOLLOWING : 54.44 (DEG.C)

- - - - THIS ANALYSIS CONSISTS OF 1 MATERIALS - - - -

MATERIAL LIST FOR : OPERATOR

DESCRIPTION		TEMP. RATING	ACTIVATION ENERG	RADIATION THRESHOLD	QUALIFIED LIFE (YRS	EXPECTED LIFE
ITEM DESCRIPTION	: O-RINGS & SEALS	[illegible]	[illegible]	5.00E+06	0.00	[illegible]
COMMERCIAL NAME	: VITON E60	[illegible]				
GENERIC NAME	: FLUOROCARBON					
MANUFACTURER	: DUPONT					
MATERIAL TYPE	: ELASTOMER					
FAILURE PARAMETER	: MECHANICAL					
MATERIAL THICKNESS	: N/A					

[illegible] DEGRADATION EQUIVALENCY ANALYSIS [illegible] MAIN STEAM LINE BREAK, AND MAIN STEAM LINE BREAK [illegible] SYSTEM OPERATOR INPUTS THE REQUIRED TEMPERA- [illegible] TEMPERATURE (OF A LOWER TEMP- [illegible] THE EQUIVALENT TIME AT A DESIGNA- [illegible] FOR THE BASE TEMPERATURE; [illegible] SYSTEM OPERATOR MAY ALTER THIS VALUE AS DESIRED.

[illegible] TEMPERATURE [illegible] 130.00

[illegible] DAYS [illegible] 100.00

ACTIVATION ENERGY (EV): 1.16

TEMPERATURE (F)	DURATION (SECONDS)
325.00	1200.00
300.00	1200.00
250.00	1200.00
200.00	23400.00
175.00	19800.00
150.00	21600.00
125.00	18000.00
100.00	8553600.00

OPERABILITY VS ACCIDENT: .00 SECONDS
.00 DAYS

EQUIVALENT TIME: 571.31 DAYS
13711.33 HOURS

VITON
EQS WBN-MEB-3-0111

LIMITORQUE CORPORATION

5114 Woodall Road • P O Box 11318 • Lynchburg Virginia 24506
Telephone — 804-528-4400 • Telex — 82-9448

October 23, 1984

Tennessee Valley Authority
400 W. Summit Hill Drive
Knoxville TN 37902

Attention: Mr. Daryl Cox - W7C162 C-K

Subject: Technical Information
Contract No. 81Z26-829681
RD-950429

Gentlemen:

Regarding subject purchase order, we are pleased to provide the following information:

1. Our records indicate that the SB actuators, supplied on our Order Number 3A1783-A, include Viton seals and O-rings.

2. Our records indicate that the following actuators include Buna N seals and O-rings:

Limitorque O/N	Actuator S/N
366860-A	183949 to 952
366860-B	184112 to 115

3. Our records indicate that the actuators listed in Item (2) above include limit switches and torque switches of equivalent materials to those included in the actuators qualified in report B0003. The temperature index would therefore be equivalent.

Very truly yours,

LIMITORQUE CORPORATION

J. B. Drab

J. B. Drab
Special Projects Engineer

JBD:dr

MEB '84 1127 025

11/27/84--DFC:PL
cc: C. A. Chandley, W7C126 C-K
MEDS, W5B63 C-K

SENT NOV 28 1984

Revision	01	02	03	Unit No. 1

Preparer/Date Alan W Bucci 2/7/85
Reviewer/Date Emmanuel Bailey 2/7/85

EQS No. WBN-NEB-72-50
TVA ID No.
FT-72-13
FT-72-34

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model No. Barton 752
Verification of Table Information (Table 3.11-8)

X Equipment Type - The equipment has been identified as per TVA ID number designations (such as MOV, SOV).

X Location - The location has been identified (such as, inside primary containment, annulus, individually cooled rooms, general spaces, or area affected by HELB outside primary containment).

X Component -A unique TVA ID number has been assigned (such as 1-FSV-68-308).

X Function - A functional description of the component has been given (such as steam generator blowdown).

X Contract No., Manufacturer, and Model No. -The contract number, manufacturer, and model number have been given.

X Abnormal or Accident Environment -All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not)

Qualified Life (If equipment is qualified, indicate the qualified life with a numerical entry): 10 years

X Qualification Report and Method - A qualification report and the method of qualification has been identified on the Table Input Data Sheet (TIDS).

X Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

N/A Qualification by Similarity (if applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (if applicable) - When an EQS is used for more than one item, a list of all exact components is given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

N/A Interim Qualification (if applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component.
Term of Interim Qualification ____
NCR No. ____

N/A Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for nonqualification, and justification of continued operation.
NCR No. ____

E95031.01

Preparer/Date [signature] 2/2/85

Reviewer/Date [signature] 2/8/85

WBN-NEB-72-50
Appendix 1, Rev. 0
Sheet 1 of 1

The subject transmitters are qualified based on WCAP 8587, supplement 1, EQDP-ESE-4 and WCAP 8687, supplement 2, EQTR-E044.

The transmitters are located in the Auxiliary Building on elevation 713 feet and in room A28. They are required to operate for the following environmental conditions:

	Normal	Accident
Temperature (^{o}F)	104	110[(1)]
Humidity (%)	80	N/A
Pressure (lb/in^2a)	Atm	N/A
Radiation (rads)	3.504×10^5 (40 years)	1×10^4

(1) This condition could exist up to 30 days.

The transmitters are qualified to the following environmental conditions:

Temperature - $130^{o}F$
Humidity - 95%
Pressure - Atm
Radiation - 1×10^5 rad

The transmitters are required to operate during and up to 30 days following a LOCA. The required normal and accident environments are less severe than the environment to which the transmitters are qualified for, except for the total 40-year integrated dose of radiation.

The transmitters will see 8760 rads a year plus a possible 1×10^4 accident dose which would yield a qualified life of 10 years.

Based on the above discussion, these transmitters are qualified for at least 10 years.

References:

1. EN DES Calculation - 0588 Cat. and Oper. Time (Sys. 72 - NEB 840411 223)

2. Environment Drawing 47E235-61

3. FSAR figure 12.3-5

4. WCAP-8687, Suplement 2 - EQTR-E04A; Barton Differential Pressure Transmitter - Qualification Group B, Rev. 2 (NEB 850130 354)

5. WCAP-8587, Supplement 1 - EQDP-ESE-4; Differential Pressure Transmitter - Qualification Group B, Rev. 6 (NEB 840807 357)

Revision	01	02	03
Preparer/Date	Alan W. Lewis 6/8/84	AWL 10/11/84	AWL 2/8/85
Reviewer/Date	David L. Kirby 6/8/84	DLK 10/11/84	JCG 2/11/85

Unit No. 1&2
EQS No. WBN-NEB-94-48
TVA ID No.
See Appendix 1

WBN EQUIPMENT QUALIFICATION SHEET (EQS)

Manufacturer and Model No. Westinghouse
Verification of Table Information (Table 3.11-4)

X Equipment Type - The equipment has been identified as per TVA ID number designations (such as MOV, SOV).

X Location - The location has been identified (such as, inside primary containment, annulus, individually cooled rooms, general spaces, or area affected by HELB outside primary containment).

X Component - A unique TVA ID number has been assigned (such as 1-FSV-68-308).

X Function - A functional description of the component has been given (such as steam generator blowdown).

X Contract No., Manufacturer, and Model No. -The contract number, manufacturer, and model number have been given.

X Abnormal or Accident Environment -All abnormal or accident environmental conditions applicable to this equipment have been identified either in tables or by references to figures from tables.

X Environment to Which Qualified - The environment to which the equipment has been qualified is addressed in either the tables or the environmental analysis attached.

X Category - A category of a, b, c, or d has been defined for the equipment.

X Operation and Accuracy Required and Demonstrated - The operation and accuracy required and demonstrated have been defined.

Qualification Status (check if applicable, NA if not)

Qualified Life (If equipment is qualified, indicate the qualified life with a numerical entry): N/A

X Qualification Report and Method - A qualification report and the method of qualification has been identified on the Table Input Data Sheet (TIDS).

X Environmental Analysis - An environmental analysis has been done, attached to the EQS, and independently reviewed by the responsible organization.

N/A Qualification by Similarity (if applicable) - A justification for qualification by similarity is attached to the EQS considering all the above factors and referenced to the appropriate tables.

X Qualification of Several Exact Components (if applicable) - When an EQS is used for more than one item, a list of all exact components is given as an appendix with all references to appropriate tables with justification for qualification considering all the above factors.

X Interim Qualification (if applicable) - (Open item) - Component has been determined to be qualified only for a limited interim operation, an NCR has been written, and plan of action has been determined to yield a qualified component.
Term of Interim Qualification November 1985
NCR No. WBNNEB8410

N/A Unqualified Component - (Open item) - (If applicable) - Component has been determined to be unqualified; the following is attached to EQS: NCR number, reason for nonqualification, and justification of continued operation.
NCR No.

E64160.01

Component

1-WTE-94-1
2-WTE-94-1
1-WTE-94-2
2-WTE-94-2
1-WTE-94-3
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1-WTE-94-42
2-WTE-94-42

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<u>Component</u>

1-WTE-94-43
2-WTE-94-43
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2-WTE-94-45
1-WTE-94-46
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1-WTE-94-65
2-WTE-94-65

Appendix 2 contains the justification for interim operation. This justification is based on Westinghouse letter WAT-D-6376 (NEB 850201 610).

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The Class 1E thermocouples, cables, connectors, 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 an inadequate core cooling (ICC). The DBE conditions to which the components are to be qualified, therefore, include a 327°F peak temperature MSLB simulation (the Westinghouse generic profile up to 420°f provides adequate margin for the Watts Bar application) with caustic spray and, for the thermocouple measuring junctions, a 2200°F peak temperature inadequately cooled core simulation (which provide adequate margin over the Watts Bar PCT of 2171°F).

The Westinghouse qualification program is presently incomplete. The thermocouple and reference junction box test sequence has been completed and approved test reports have been submitted to TVA by Westinghouse. The test sequence steps of accelerated thermal aging, normal radiation, and seismic simulation have been completed on the connectors, but a retest is under way and is scheduled to be completed the end of February 1985. The splices have undergone a confidence test consisting of radiation and 24-hour HELB test. The status of completed testing and the justification for interim operation of the system is 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 were considered in developing dynamic test inputs.

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.

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

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A length of thermocouple cable will be included in the upcoming qualification test for the connectors and Reference Junction Box splice. Since this is mineral-insulated cable with a stainless steel sheath, there are no organic materials in the cable that would be susceptible to radiation thermal aging. The cable being tested has potting adaptors (metal tubes brazed to the cable and filled with potting compound) on both ends to provide a sufficient size diameter to facilitate a swagelock seal on the cable ends. The cable will be sealed to a Reference Junction Box on one end and the splice on the other end.

LEMO Connectors

The thermocouple LEMO 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 postaccident dose. The test criteria of the connectors/adaptors and the mineral-insulated cable is that they maintain a continuous signal with no effect on the accuracy of the system.

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.

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 in 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 conductor 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 tendancy for moisture to enter the unprotected connectors is the same for

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Reviewer/Date David L. Kirby 6/8/84 JCG 2/11/85 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 new LEMO connector is the same as those installed at Watts Bar.

Reference Junction Box Splices

The splices which are to be used on the new-style Reference Junction Box are also being qualified as part of the ESE-43 program which is presently not completed. The qualification program of the Reference Junction Box 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) to the organic thermocouple extension cable. The splice consists of an Amp connector bonding the two wire ends, 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 sealant has excellent thermal qualities, (long-term exposure to -85°F to 360°F will not degrade its performance), good dielectric properties, and when broken down is not corrosive. A confidence test, consisting of radiation to 165 Mrads gamma and 1290 Mrads beta plus a 24-hour steam test (utilizing the same HELB test conditions as discussed in WCAP 8587) was performed on two samples of the splice. One splice exhibited an intermittent output which upon disassembly proved to be a bad crimp on one wire. The monitoring system for the other splice recorded an unexplainable offset for three minutes during the 24-hour test. Since upon inspection both splices appeared satisfactory (with the exception of the bad crimp), the confidence test is judged to have proven the capability of the splice to perform satisfactorily thru the entire test sequence.

Due to the nature of the splice and the method of installation, the splice would not be subjected to any stresses which would cause concern during a seismic event.

Pending completion of the entire sequence of tests on the final connection system, the results of the LOCA test of new connectors lend confidence of successful performance of the installed equipment.

Reference Junction Box (RJB)

The RJB have been subjected to seismic and Design Basis Event High Energy Line Break condition required to simulate normal and accident operation of the unit over its expected life. The test phases included: thermal aging, gamma radiation, simulated seismic events and HELB/postaccident tests.

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The seismic simulation test was conducted by shaker table using controlled multi-frequency multi-axis test inputs. The equiment was tested a minimum of five OBE and four SSE conditions.

The thermal aging tests look at the age-sensitive components of the RJB. The age-sensitive copmonents were installed in the aging oven and thermally aged at 120°C. The age-sensitive components and the aging time are listed below:

Phase I

Material	Temperature	Time	Activation Energy
Epoxy	120°C	522 hours	1.000 eV
Silicone Rubber	120°C	25.8 hours	1.460 eV
Silicone Laminate	120°C	180.4 hours	1.161 eV
RNF100 Heat Shrink Tubing	120°C	92.9 hours	1.263 eV

Phase II

Material	Temperature	Time	Activation Energy
Silicone Rubber	120°C	26 hours	1.460 eV

The RJB was irradiated to 1.65×10^8 rads to cover both gamma and beta dose equivalent radiation.

Maintenance

The incore thermocouple system will be included in our Qualification Maintenance Program.

References

1. WCAP-8687, Supp. 2-E44A, RO*
2. WCAP-8587, Supp. 1-EQDP-ESE-44A, RO*
3. WCAP-8687, Supp. 2-E43A, RO*
4. WCAP-8587, Supp. 1-EQDP-ESE-43A, RO*
5. Westinghouse letter WAT-D-6376 (NEB 850201 610)

*These WCAPs were submitted to TVA by Westinghouse letter WAT-D-6332 (NEB 850115 602).

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