UNITED STATES OF AMERICA
UNITED STATES NUCLEAR REGULATORY COMMISSION

before the

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of PUBLIC SERVICE COMPANY NEW HAMPSHIRE, et al. (Seabrook Station, Units 1 and 2)	Docket Nos. 50-443 OL-1 50-444 OL-1 (On-site Emergency Planning and Safety Issues)

AFFIDAVIT OF NEWELL K. WOODWARD

I, NEWELL K. WOODWARD, being on oath, depose and say as follows:

1. I am an independent consultant retained by the Applicants to advise them with respect to issues related to the environmental qualification of Seabrook Station electrical equipment. I am currently employed by TENERA Engineering Services as a Senior Project Manager. I have previously testified in this proceeding. An updated statement of my qualifications and background is attached hereto and marked "A". I was the Project Engineer responsible for the final content, quality and conclusions of the Environmental Qualification (EQ) Files for Seabrook Station while employed at Impell Corporation, including EQ Filed No. 113-19-01, Revision 1, which is also NECNP Exhibit 4 of this proceeding.

2. This affidavit describes the environmental qualification test program for RG-58 Coaxial Instrument Cable completed by the Applicants on July 22, 1988. I assisted in the planning of this RG-58 cable test, personally monitored each phase of the test, and evaluated the test data and results.

3. The RG-58 coaxial instrument cable tested was manufactured by ITT Surprenant and is the same cable supplied to Seabrook Station under Purchase Order No. 9763-006-113-19 (NECNP Exh. 4, Reference 7). The cable test specimens were cut from a reel of cable stored in the station warehouse. They were colored black with a red trace and imprinted with a Cable Code of TA6Y. This is the same RG-58 cable addressed in EQ File No. 113-19-01, Revision 1 (NECNP Exh. 4).

4. The purpose of the test was to expose the RG-58 cable to the same or more severe environmental conditions that similar cables had been exposed to in previous testing (NECNP Exh. 4, Reference 2). The performance specification for the tested cable (coded TA6Y and colored black with a red trace) is the same as had been previously defined in EQ File No. 113-19-01 (NECNP Exh. 4, Reference 6 and Environmental Qualification Assessment Report (Checklist) Item 21 and Note 7). Briefly restated, cable that is colored black with a red trace must only remain intact (i.e., not short to ground) and not fail in a manner detrimental to plant safety when exposed to postulated plant environmental conditions. The cable

electrical characteristics which define what constitutes remaining intact are its ability to carry current and load during environmental exposure with no insulation failure resulting in a short to ground. The test measurements that demonstrate cable "intactness" are the continuous application of voltage and current during the LOCA simulation such that the leaking/charging current does not exceed one (1) ampere as monitored by a one (1) ampere breaker in the test circuit, and the ability of the test specimens to withstand a high-potential voltage withstand test at a rate of 80 VAC/mil of primary insulation thickness after all other sequential (i.e., thermal and radiation aging and LOCA) testing was complete.

5. During the LOCA simulation test, if the cable insulation degrades to the point of failure (does not remain intact), the current will increase above one (1) ampere as it flows through the insulation and shorts to ground, and the breaker will open. This insulation degradation is permanent and irreversible.

6. The high-potential voltage withstand test is not performed under accident environmental conditions. This test provides a basis to assess the overall performance of the cable once all environmental exposure is complete. This is a potentially destructive test where the cables are charged with 3,200 volts while immersed in water. Test results of no

cable failure (i.e., short to ground) demonstrate that no insulation failure occurred during the environmental testing, and this is further proof that the cable will remain intact when exposed to the Applicant's environmental conditions.

7. The cable was tested at NTS/Acton Laboratories in Acton, Massachusetts and at Isomedix, Inc. Whippany, New Jersey. The procedure is NTS/Acton Procedure No. 24843-89N, Revision 1, June 22, 1988 and the final Test Report is NTS/Acton Report No. 24843-89N-2, July 22, 1988 (References 10 and 2, respectively, of EQ File 113-19-02, attached hereto and marked "B"). A summary of the test program preparation, completion and an evaluation of the results is set forth below.

8. The test program was based on the environmental testing of similar cables in EQ File 113-19-01 (NECNP Exh. 4, Reference 2), and the conclusions and analyses in that EQ File that support the qualification of this cable for use in Seabrook Station. The environmental parameters to which the RG-58 cable was tested were the same or more severe than those applied in the previous test (NECNP Exh. 4, Reference 2). A summary comparison of the two test programs is as follows:

	NECNP Exh. 4 Reference 2	NTS/Acton Report No. 24843-89N-2
a. Thermal Aging:		
Temperature (°F/°C)	302/150	320/150
Duration (hours)	168	168
b. Radiation Aging:		
Total Integrated Dose (rads)	2.2×10^8	2.2×10^8
c. LOCA Simulation:		
Peak Temperature (°F)	390	420
Peak Pressure (PSIG)	113	115

9. As the Applicants' independent consultant, I monitored and managed all phases of the RG-58 cable test program, witnessed the recording of data at critical points, and evaluated the final results. I also prepared Revision 0 of EQ File No. 113-19-02, attached hereto and marked "B", wherein the environmental qualification of the RG-58 cable is now evaluated and satisfactorily documented for use in Seabrook Station. The following is a summary of the evaluation results regarding the test program and the bases for concluding that this testing is acceptable documentation in support of the environmental qualification of the RG-58 coaxial instrument cable for Seabrook Station.

a. The cable tested is the identical cable installed in the plant. The results of this test verified the statements of similarity used as the basis for qualification of this same cable in EQ File No. 113-19-01 (NECNP Exh. 4).

b. A baseline measurement of insulation resistance (IR) was made prior to the start of any testing. A comparison of the baseline data to the data recorded after the thermal and radiation aging tests shows only minute changes in the IR readings. Therefore, very little degradation occurred.

c. Once problems associated with the test circuitry were resolved, the test specimens remained energized with voltage, and leaking/charging current did not exceed one (1) ampere throughout the LOCA test. During the margin transient (first transient) portion of the test, problems with the test circuitry were observed. The in-line one (1) ampere fuse blew and when replaced, continued to blow whenever power to the cables was reapplied. However, insulation resistance (IR) and continuity readings taken for all samples showed that the cable insulation had not degraded; therefore, problem resolution centered on the test circuitry. At this time, it was observed that the ambient temperature of the test circuitry (i.e., wire, connections, fuses and resistors), the monitoring equipment, and IR bridge was approximately 125°F, as the outside air was about 100°F and the equipment was next to the LOCA autoclave. It was concluded that the internal heating of the entire test circuit and its components was the cause of the problem. All of the test circuitry and monitoring equipment was moved into an air conditioned space prior to the LOCA (second) transient. Once moved, the fuse never blew for the remainder of the test, the specimens remained energized with specified voltage and current, and all IR measurements stabilized. Because the test specimens did not remain energized for the entire duration of the margin transient, the margin transient was not used as a basis for LOCA qualification. The second, or LOCA test transient by itself was more than adequate to demonstrate cable qualification for specific plant conditions.

d. Insulation resistance (IR) varied during the initial high temperature phases of the LOCA test (second transient) but recovered to values within the same order of magnitude (i.e., 10^9 ohms) as were recorded prior to the LOCA transient. This variation in IR with temperature is typical of many cable tests and was in fact observed in the EQ File No. 113-19-01 test (NECNP Exh. 4, Reference 2). At no time did any shorts to ground occur. After the LOCA test, a visual inspection of the cable showed that a slight darkening of the outer jacket had occurred and that the samples had stiffened; however, no cracking or insulation failure was evident. It was concluded that no insulation failure occurred, no short to ground resulted, the cable carried continuous voltage and the leaking/charging current did not exceed one (1) ampere. Therefore, the cable will remain intact in Seabrook Station and not fail in a manner detrimental to plant safety when exposed to postulated worst case environmental conditions.

e. In accordance with IEEE Std. 383-1974, a high-potential voltage withstand test was administered to the cable specimens subsequent to the completion of all sequential environmental testing (i.e., forty (40) years of simulated thermal and radiation aging, one (1) year of simulated accident radiation exposure, and the equivalent of one (1) year of

LOCA and high humidity simulation). Voltage was applied to the specimens at a rate of 80 VAC/mil of insulation thickness while there were immersed in water, and all specimens withstood the test potential. Therefore, no insulation failure occurred during the environmental testing and this is further proof that the performance specification "remain intact" was met.

10. In conclusion, the exact RG-58 coaxial instrument cable supplied to Seabrook Station and qualified by similarity to RG-59 and RG-11 coaxial cable in EQ File No. 113-19-01 (NECNP Exh. 4) was tested to the same or more severe environmental conditions than those to which the RG-59 and RG-11 cable were tested (NECNP Exh. 4, Reference 2). The test program was conducted in accordance with the guidelines of IEEE Std. 323-1974 and 383-1974. The results show that when the RG-58 cable was exposed to test conditions designed to emulate the conditions to which similar cables were tested, the cable performed in a similar fashion, and therefore, the basis for the original similarity argument in EQ File No. 113-19-01 has been conclusively established. The RG-58 cable passed all tests, met established performance specifications, and will perform its function as required and not fail in a manner detrimental to plant safety when exposed to the harsh

environmental conditions occurring subsequent to design basis events.

Newell K. Woodward

Newell K. Woodward

Dated: September 9, 1988

Then personally appeared Newell K. Woodward, before and personally known to me, who, being first duly sworn, made oath that the foregoing statements are true to the best of his knowledge, information, and belief.

Notary Public
My Commission Expires: 4/23/93

WOODWARD AFFIDAVIT
ATTACHMENT A

NEWELL K. WOODWARD
Senior Project Manager

Education

B.S. Charter Oak College
Mechanical Engineering Major, University of Hartford
Nuclear Engineering, U.S. Naval Nuclear Power School

Summary of Experience

Mr. Woodward has been associated with the commercial and naval nuclear power industry for over eighteen years. He has extensive experience in nuclear power plant design, licensing, construction, operation, maintenance, refueling and emergency preparedness. He has supervised the design, procurement, installation, test, operation, maintenance and repair of nuclear power plant mechanical and electrical equipment. He has managed and performed technical work on various multidisciplinary issues including reactor vessel low temperature overpressure protection, equipment qualification and system interaction. Mr. Woodward has prepared testimony and been an expert witness in Atomic Safety and Licensing Board Hearings for PWR and BWR plants. He has also prepared plant operating and maintenance procedures, technical specifications, offsite emergency preparedness plans and procedures and prepared and given training courses and seminars on nuclear plant systems and equipment and regulatory and technical issues.

1986 - present: Senior Project Manager, TENERA Operating Company, L.P. (formerly TERA Corporation). Responsible for the management and technical performance of engineering projects in the areas of Equipment Qualification and Corrective and Preventive Maintenance, Fire Protection and Mechanical, Electrical, and Nuclear Engineering.

1980-86: Technical Manager, Systems Engineering, Impell Corporation. Responsible for the technical development and management of programs and services with respect to equipment qualification and systems engineering.

Supervising Engineer, Systems Engineering, Impell Corporation. Responsible for the management and technical performance of electrical and mechanical equipment qualification programs for PWR and BWR plants. Efforts associated with these programs included master equipment list preparation and review; system, equipment, and subcomponent part failure modes and effects analyses; in-plant field verification walkdowns; postulated environmental parameter definition; qualification analyses and auditable documentation file preparation; emergency operating procedure review, licensing submittal preparation; preparation of justifications for continued plant operation; NRC audit support and ASLB expert witness testimony; specification and evaluation of preventive maintenance requirements; maintenance and surveillance program and procedure review and revision; independent program and documentation file reviews; and impact reviews of NRC I&E notices and bulletins. Other associated efforts included the completion of a polymer material degradation study with respect to radiation and temperature in support of ASLB hearings for a BWR plant, and the preparation and presentation of equipment qualification training programs to utility management, engineering and technical personnel.

Lead Senior Engineer, Systems Engineering and Licensing, Impell Corporation. Prepared Pre-Construction Safety Analysis Reports for auxiliary and component cooling water systems based on event and fault free analyses for a British PWR plant.

Senior Engineer, Management Services, Impell Corporation. Prepared offsite emergency plans and procedures for Rockland and Orange Counties surrounding Indian Point. During the course of this assignment, Mr. Woodward interfaced with state and county officials as well as utility representatives in the development of offsite emergency plans and procedures.

1976-80 NSSS Design Engineer, Combustion Engineering, Incorporated. Responsible for the engineering analysis and technical support of special projects relating to the design and licensing of the Nuclear Steam Supply System (NSSS), secondary feedwater and steam supply systems, and auxiliary systems' interfaces. Specific efforts included the analysis, design, installation, operation and licensing of system backfits related to the reactor vessel low temperature overpressure protection issue, ATWS analyses, NSSS and auxiliary feedwater system design reviews, and technical specification preparation. Other efforts included participation in EPRI sponsored component failure and root cause analysis programs, the training of nuclear plant operators in the low temperature overpressure protection issue and an assignment to the Technical

Advisory Group at Three Mile Island subsequent to the March, 1979 event.

1974-76 Senior Quality Control Inspector, Morrison-Knudsen Company. During the overhaul, modification and refueling of several Naval Prototype PWR plants, Mr. Woodward was responsible for monitoring and certifying reactor plant servicing procedures; nuclear and non-nuclear welding and brazing; system and component testing, and pressure vessel and fuel lifting and handling equipment.

Shift Refueling Engineer, Morrison-Knudsen Company. Responsible for the preparation of reactor plant servicing procedures and for supervising the performance of various reactor plant modifications and refueling cycles.

Purchasing Agent, Morrison-Knudsen Company. Specified, procured, and expedited nuclear and non-nuclear materials, parts, and equipment.

1968-74 Machinist Mate First Class, US Navy. Mr. Woodward was qualified as an Engineering Watch Supervisor and was the Machinery Division Leading Petty Officer on a nuclear powered submarine.

Professional Affiliations

Pi Tau Sigma, Mechanical Engineering Honorary
American Nuclear Society
American Nuclear Society Standards Committee ANS 56.3

Technical Presentations

A Short Course on Advances in Equipment Qualification for Nuclear Facilities, Paris, France, March 1983.

NEWELL K. WOODWARD

Summary of Environmental Qualification Experience

Plant(s)	Experience Summary
Shoreham Nuclear Power Station (Long Island Lighting Co.)	Project Engineer for NSSS equipment Environmental Qualification Program (NUREG-0588 Cat. I & II).

- E.Q. File preparation for electrical and mechanical equipment.
- Preparation of mechanical equipment Master List.
- Verification of electrical equipment Master List.
- Field Verification Walkdown for NSSS and BOP equipment.
- Review of Emergency Operating Procedures.
- Specification of qualified replacement equipment.
- Audit of vendor maintained qualification documentation.
- Preparation and review of Justifications for Continued Operation.
- Impact review of I&E Notices and Bulletins.
- NRC audit and regulatory support.
- Atomic Safety and Licensing Board (ASLB) expert witness testimony.

Plant(s)	Experience Summary
Seabrook Station (Public Service Company of New Hampshire/Yankee Atomic Electric Company)	Project Engineer for NSSS and BOP equipment Environmental Qualification Program (NUREG-0588 Cat. I) . E.Q. File preparation for electrical and mechanical equipment. . Preparation of mechanical equipment Master List. . Verification of electrical equipment Master List. . Field Verification Walkdown of all equipment. . Review of I&E Notices and Bulletins. . Specification of qualified replacement equipment. . Preparation of Environmental Qualification Report (Program Description for NRC submittal) . Audit of vendor maintained qualification documentation. . NRC audit and regulatory support. . ASLB expert witness testimony.
Three Mile Island Unit 1 and Oyster Creek Nuclear Generating Station (GPU Nuclear Corporation)	Project Engineer/Technical Advisor for NSSS and BOP equipment Environmental Qualification Program (NUREG-0588 Cat. I and DOR Guidelines.) . E.Q. File preparation for electrical equipment.

Plant(s)	Experience Summary
	. Verification of electrical equipment Master List. . Field Verification Walkdown (OCNGS only.) . Specification of qualified replacement equipment. . Audit of vendor maintained qualification documentation. . Review of I&E Notices and Bulletins. . NRC audit and regulatory support.
Susquehanna Steam & Electric Station, Unit Nos. 1 and 2 (Pennsylvania Power & Light Company)	Project Engineer for E.Q. File Independent Review Program (NUREG-0588 Cat.I& II.) . Written review of electrical equipment E.Q. Files. . NRC audit and regulatory support. Technical reviewer for correction of E.Q. File deficiencies.
Comanche Peak Steam and Electric Station (TU Electric)	Auditor for Quality Assurance . Performed a technical audit of the E.Q. Program, including master list and environmental parameter design bases, E.Q. files, and plant implementation.
Beaver Valley Power Station, Unit No. 1 (Duquesne Light Co.)	Project Engineer for E.Q. File Independent Review Program (DOR Guidelines.) . Written review of electrical equipment E.Q. Files.
Beaver Valley Power Station, Unit No. 2 (Duquesne Light Co.)	Project Engineer for NSSS and BOP mechanical equipment Environmental Qualification Program

- E.Q. File preparation for mechanical equipment.
- Preparation of mechanical equipment Master List.

Perry Nuclear Power Plant (Cleveland Electric Illuminating Company)	Project Engineer for Polymer Degradation Study prepared in response to ASLB Intervenor questions regarding the degradation of polymer materials in elevated temperature and low level radiation environments. Work scope included the preparation of ASLB testimony. Project Manager/Technical Advisor for a Class I-E cable test program. Including preparation of test plan and final report.
Donald C. Cook Nuclear Plant Unit Nos. 1 & 2 (Indiana & Michigan Electric Company/ American Electric Power Service Corp.	Project Engineer for Thermal Aging and Surveillance/Maintenance Evaluation Program (DOR Guidelines) . Thermal aging life determination for NSSS and BOP electrical equipment . Written review/evaluation of plant programs and procedures with respect to the implementation of E.Q. related maintenance and an "on-going" qualification program. . Preparation of Plant Manager Instruction for Environmental Qualification of Safety-related Electrical Equipment.
Indian Point Station, Unit No. 2 (Consolidated Edison Company of N.Y.)	Project Engineer for an E.Q. Training Program for management, engineering, and plant technical personnel. Auditor for Quality Assurance. Performed an audit evaluation for completeness and technical accuracy of E.Q. Files. Effort included reviewing implementation of E.Q. into plant maintenance and procurement procedures.

James A. Fitzpatrick Nuclear Plant (New York Power Authority)	Project Manager/Technical Advisor for the preparation of an E.Q. File for the HPCI Turbine Assembly (DOR Guidelines.)
Davis-Besse, Unit No. 1 (Toledo Edison Company)	Project Engineer for NSSS and BOP equipment Environmental Qualification Program (NUREG-0588 Cat. 1 and DOR Guidelines.) (9 month interim period only) . Addressed technical issues relating to the revision of E.Q. Files to resolve open items. . Revision of E.Q. Files

WOODWARD AFFIDAVIT

ATTACHMENT B

ELECTRICAL EQUIPMENT QUALIFICATION FILE NO. 113-19-02

CONTENTS

Public Service Company of New Hampshire

SEABROOK STATION

ENVIRONMENTAL QUALIFICATION OF ELECTRICAL EQUIPMENT

Electrical Equipment Qualification File No.: 113-19-02

Revision 0

Purchase Order No.:	9763-006-113-19
Manufacturer:	ITT Surprenant
Model Number:	RG-58 Coaxial
Equipment Type:	Instrument Cable

[signature] 9/8/88 [signature] 9/8/88

Prepared By — Date — Checked By — Date

[signature] 9/8/88

Approved By — Date

[signature] 9/8/88

Manager of Engineering Approval — Date

Record of Revisions

Revision	Description	Date
0	Original Issue	09/06/88

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LIST OF ATTACHMENTS

Reference	Title
1.	UE&C Specification No. 9763-006-113-19, Specification for Specialty Cable, 9/20/82 (Excerpts).
2.	NTS/Acton Report No. 24843-89N-2, Environmental Qualification Testing of Coaxial Instrument Cables (RG-58) for NHYD/PSNH, 7/22/88.
3.	VU-30454, ITT to UE&C, 8/23/82.
4.	New Hampshire Yankee Engineering Evaluation No. 88-026.
5.	FSAR, Seabrook Station, Amendment 61, November, 1986 (Excerpts).
6.	Record of Conversation between Chuck Greiman (UE&C) and N. K. Woodward (Impell), 10/8/85.
7.	UE&C Purchase Order No. SNH-744, 9763.006-113-19, 10/7/82 (Excerpts).
8.	SB-92605, UE&C to Impell, 2/13/85.
9.	Impell Letter No. 0570-032-NY-156, Summary of Class 1E Equipment Submerged as a Result of Design Basis Events, 2/?/86.
10.	NTS/Acton Procedure No. 24843-89N, Test Procedure for Environmental Qualification Testing of Coaxial Instrument Cables (RG-58) for NHYD/PSNH, Rev. 1, 6/22/88.

DCR - 88-79 CA Ø
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JOB NO 9763 102 — PUBLIC SERVICE OF NEW HAMPSHIRE — PART OF DWG. 9763-M-505300

CLASS 1E EQUIPMENT LIST — SEABROOK STATION — REV 020

SORT NO 01 SHEET 163 — UNIT 1 — DATE 09/03/87

SYSTEM EDE ELECTRICAL DISTRIBUTION EMERGENCY

REV NO	EQUIPMENT ID	SERVICE LEGEND / REMARKS	MANUFACTURER MODEL NO	BLDG ENV ZONE ENVIRONMENT	EQ FILE NO PO NO	SAFETY FUNCT OPER CODE	EVENT CODE	TRN/CH ACC CODE	START DUR CYCLES	REF SD REF DWG
15	EDE-CBL - 2	600 VOLT CONTROL CABLE	ANCNDA FR-EP	ALL HARSH	113-17-01 113-17	PWR A	ALL	ALL 51	CONT CONT	N/A 1310991
15	EDE-CBL - 3	INSTRUMENT CABLE	ANCNDA FR-EP	ALL HARSH	113-18-01 113-18	PWR A	ALL	ALL 51	CONT CONT	N/A 1310994
17	EDE-CBL - 4	COAXIAL CABLE	BRNDRX ULTROL	VARIOUS HARSH	113-06-01 113-06	PWR B	ALL	4A 51	CONT CONT	N/A 1310994
15	EDE-CBL - 4A	INSTRUMENT & T/C CABLE	BRNDRX ULTROL	ALL HARSH	113-06-02 113-06	PWR A	ALL	ALL 51	CONT CONT	N/A 1310994
15	EDE-CBL - 5	5KV CABLE	ANCNDA UNIBLEND EP	VARIOUS HARSH	113-01-01 113-01	PWR A	ALL	A,B 51	CONT CONT	74 1310991
18	EDE-CBL - 6A	INSTRUMENT CABLE; REMARKS: CABLE CODES UA1T, UA2T, UA3T, UA4T, TA1Y, TA2Y	ITT S ~~FR XLPE/EXANE~~	ALL HARSH	113-19-01 113-19	PWR A	ALL	~~ALL~~ A,B,3,4 51	CONT CONT	N/A 1310994
15	EDE-CBL - 7	INSTRUMENT CABLE	ITT S EXANE	ALL HARSH	113-20-01 113-20	PWR A	ALL	ALL 51	CONT CONT	N/A 1310994
18	EDE-CBL - 7A	THERMOCOUPLE CABLE	ITT S EXANE	VARIOUS HARSH	113-20-02 113-20	PWR A	ALL	A,B 51	CONT CONT	N/A 1310994
	EDE-CBL - 6B	INSTRUMENT CABLE; REMARKS: CABLE CODES UA6T, TA6T, TA6U	ITT S FR XLPE/EXANE	ALL HARSH	113-19-01 113-19	PWR B	ALL	AA 51	CONT CONT	N/A 1310994
	EDE-CBL - 6C	INSTRUMENT CABLE; REMARKS: CABLE CODE TA6Y	ITT S FR XLPE/EXANE	VARIOUS MILD	N/A 113-19	PWR E	ALL	AA 51	CONT CONT	N/A 1310994

DCR ITEMS

DCR ADDED ITEMS

EQUIPMENT SUMMARY EVALUATION

1.0 Description

The equipment under evaluation is RG-58 coaxial instrument cable manufactured by ITT Surprenant Division. This cable may be located in all areas of the plant, both inside and outside containment, and is evaluated for the composite worst case postulated environmental conditions in the plant. The RG-58 cable specified (Reference 1, Appendix A) and provided to the plant under Purchase Order No. 9763.006-113-19 (Reference 7) is marked with the cable code TA6Y and is black in color with a red trace. The RG-58 cable sequentially tested in Reference 2 was taken from the Seabrook site and is the same cable supplied to the plant and installed therein.

2.0 Conclusion

This equipment is qualified by sequential test for the postulated accident temperature, pressure, humidity, chemical spray and radiation dose and by test supplemented by analysis for the required operating time. This equipment has a qualified life of 40 years at 167°F(75°C).

Therefore, this equipment is qualified to the requirements of NUREG-0588, Category I.

3.0 Limitations

None.

4.0 Discussion

The RG-58 instrument cable that is installed in the plant is coded TA6Y, colored black with a red trace, and used in Train A Associated circuits (Reference 1, p. A1, Reference 7, and Reference 5). Its function when exposed to normal and accident environmental conditions is to only remain intact (i.e., not short to ground), and not fail in a manner detrimental to plant safety or accident mitigation (References 5 and 6).

The RG-58 cable specimens tested in Reference 2 were taken from the lot of cable supplied by ITT Surprenant to the plant. Therefore, the tested cable is the same cable installed in the plant. The coaxial cable construction consists of irradiation cross-linked polyethylene insulation, a braided metal shield, and an overall jacket of Exane, which is irradiation cross-linked polyolefin (Reference 1, Appendix B).

-Continued-

Although the RG-58 cable is instrument cable and will carry very low current loads in the plant, the 40 year qualified life has been conservatively evaluated at the design maximum continuous conductor temperature of 75°C (167°F) (Reference 1, p. B1; Reference 3, Item 3 and Reference 2, p. 6-1).

Submergence qualification is not required because these cables are not located in any areas of the plant where they would be submerged subsequent to design basis events (Reference 9).

During LOCA testing, the cable specimens were continuously energized and the 1.0 ampere specified current was not exceeded. The specimens also withstood a high potential voltage withstand test subsequent to all environmental testing, where the applied potential was 80 VAC/mil of insulation thickness for five minutes in water. Testing was performed in accordance with IEEE Std. 383-1974.

A vertical tray flame test has been conducted in accordance with Section 2.5 of IEEE std. 383-1974 (Reference 3, Item 5).

New Hampshire Yankee
Seabrook Station
Docket: 50-443

QUALIFICATION EVALUATION WORK SHEET

EQUIPMENT QUALIFICATION FILE NO. 113-19-02

Prepared By: [signature] Date: 9/8/88

Checked By: [signature] Date: 9/8/88

Equipment Description	Postulated Environment: Parameter	Postulated Environment: Value	Postulated Environment: Reference	Qualified Environment: Value	Qualified Environment: Reference	Qualification Method	Outstanding Items
Purchase Order No.: 9763-006-113-19 Equipment ID No(s).: EDE-CBL-6C	Operating Time	1 Year	1 p. 1	1 Year	5	Test and Analysis	None
	Peak Temperature (°F)	375	1 p. 1	420	2 p. 10-9	Test	None
Equipment Type: Instrument Cable	Peak Pressure (Psig)	60	1 p. 1	115	2 p. 10-9	Test	None
Manufacturer: ITT Suprenant Model Number: RG-58 Coaxial	Relative Humidity (%)	100	1 p. 1	100	2 p. 10-9	Test	None
	Chemical Spray (pH)	Boric Acid 1.2% by wt. pH = 7.5 to 10.5	1 p. 1	Boric Acid 1.7% by wt. pH = 10.5	2 p. 10-5 6	Test	None
Accuracy: Spec: N/A Demon: N/A	40 Year Normal Radiation Dose (Rads)	2.0×10^8	1 p. 3 Note 1	2.2×10^8	2 p. 8-2	Test	None
Limiting Environment:	1 Year Accident Radiation Dose (Rads)	-----	1 p. 3 Note 1				
Location: Containment (All Zones) Rad Zone: Primary Aux. Bldg. (PB-15A, PB-18) Note 1	Aging (°F/Years)	167/40 (75°C)	3 p. 2 4	167/40 (75°C)	2 p. 6-1 3 p. 2	Test and Analysis	None
Lowest Elevation: Note 2 Flood Level: Note 2 Above Flood Level: Note 2	Submergence	N/A	8 Note 2	N/A	N/A	N/A	None

Documentation References:

1. UE&C Drawing NO. 9763-F-300219, Revision 19, Service Environment Chart, 9/25/86.
2. NTS/Acton Report No. 24843-89N-2, Environmental Qualification Testing of Coaxial Instrument Cables (RG-58) for NHYD/PSNH, 7/22/88.
3. VU-30454, ITT to UE&C, 8/23/82.
4. UE&C Specification No. 9763-006-113-19, 9/20/82.
5. NHY Engineering Evaluation No. 88-026.
6. Seabrook E.Q. File No. 113-19-02, Assessment Checklist, Note 6.
7. SBU-92605, UE&C to Impell, 2/13/85.
8. SBU-96263, UE&C Letter, Flooding Study Matrix, 10/25/85.
9. Impell Letter No. 0570-032-NY-156, Summary of Class IE Equipment Submerged as a Result of Design Basis Events, 2/2/86.

Notes:

1. The limiting zones for radiation are PB-15A and PB-18. Zones PB-4 and PB-19 are excluded because no electrical equipment is installed in these areas (Reference 7).
2. Submergence qualification is not required because this equipment is not located in any plant area where it would be submerged during design basis events. (Reference 9).

ENVIRONMENTAL QUALIFICATION ASSESSMENT REPORT

Manufacturer: ITT Surprenant Division

Model Number: RG-58 Coaxial

Component: Instrument Cable

Reviewer's Conclusion

| X | Acceptable (i.e., this equipment meets the requirements of NUREG-0588, Category I)

| | Acceptable, providing the following special conditions are addressed

Special Conditions:

None.

Comments:

None

Prepared By:	[signature] Signature	9/8/88 Date
Checked By:	[signature] Signature	9/8/88 Date
Approved By:	[signature] Signature	9/8/88 Date

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LIST OF FIGURES

MAINTENANCE REQUIRED TO MAINTAIN QUALIFIED LIFE

None

DOCUMENTS REVIEWED FOR THIS REPORT

1. UE&C Specification No. 9763-006-113-19, Specification for Specialty Cable, 9/20/82.

2. NTS/Acton Report No 24843-89N-2, Environmental Qualification Testing of Coaxial Instrument Cables (RG-58) for NHYD/PSNH, 7/22/88.

3. VU-30454, ITT to UE&C, 8/23/82.

4. New Hampshire Yankee Engineering Evaluation No. 88-026.

5. FSAR, Seabrook Station, Amendment 61, November 1986.

6. Record of Conversation between Chuck Greiman (UE&C) and N. K. Woodward (Impell), 10/8/85.

7. UE&C Purchase Order No. SNH-744, 9763.006-113-19, 10/7/82.

8. SBU-92605, UE&C to Impell, 2/13/85.

9. Impell Letter No. 0570-032-NY-156, Summary of Class 1E Equipment Submerged as a Result of Design Basis Events, 2/2/86.

10. NTS/Acton Procedure No. 24843-89N, Test Procedure for Environmental Qualification Testing of Coaxial Instrument Cables (RG-58) for NHYD/PSNH, Rev. 1, 6/22/88.

*11. UE&C Drawing No. 9763-F-300219, Rev. 19, Service Environment Chart, 9/25/86.

*12. UE&C Drawing No. 9763-F.6.01.00.00, Calculation Matrix.

*13. SBU-96263, UE&C letter, Flooding Study Matrix, 10/25/85.

* Indicates a generic reference and is not contained in this file.

NUREG-0588, CATEGORY I QUALIFICATION REPORT REVIEW CHECKLIST

	YES	NO	NA	REFERENCE
I. SIMILARITY				
1. Have all Equipment ID's on the Master List associated with this EQ File number been addressed in the documentation?	X			QEWs Note 1
2. Is the documentation traceable to the plant equipment?	X			Reference 2, p. 3-1 Note 1
II. SIMULATED SERVICE CONDITIONS AND TEST DURATION				
3. Do the temperature/pressure/humidity test parameters meet or exceed the postulated accident environmental conditions? Make a copy of the test temperature envelope and superimpose it on the required accident environmental envelope. Assure that deviations between the two are justified in the documentation.	X			See Figure 1 and QEWs Note 2
4. Do the margins of the test profiles over the plant specific profiles conform to those suggested by IEEE 323-1974 and any applicable daughter standard for this equipment?	X			See Figure 1 and QEWs Note 2
5. Does the test operating time under the harsh environment equal or exceed the equipment's required operating time?	X			Reference 4

NUREG-0588, CATEGORY I QUALIFICATION REPORT REVIEW CHECKLIST

(continued)

	YES	NO	NA	REFERENCE
III. RADIATION				
6. Does the radiation dose, i.e., integrated dose, for normal operations and accident dose for the plant, fall within the envelope used in qualification?	X			Reference 2, p. 8-2 Note 3
7. Does the total integrated dose include Beta radiation? (Is Beta radiation addressed?)	X			Reference 3, p. 2, Item 6 Note 4
IV. AGING				
8. Are the thermal aging parameters chosen and used in the test supported by adequate documentation or references?	X			Reference 2, p. 6-1; Reference 3, p. 2, Item 3
9. Was mechanical and/or electrical cycling addressed?			X	
10. Is the qualified life (QL) explicitly stated?	X			Reference 2, p. 6-1; Ref. 3, p. 2, Item 3
11. Does the qualified life take into account the normal operating state of the equipment (i.e., energized)?	X			Note 5
V. CHEMICAL SPRAY				
12. Does the DBE qualification testing include chemical spray?	X			Reference 2, p. 10-5
13. Does the spray concentration and pH used in tests meet or exceed those to be used for the plant?	X			Reference 2, p. 10-5 Note 6

NUREG-0588, CATEGORY I QUALIFICATION REPORT REVIEW CHECKLIST

(continued)

	YES	NO	NA	REFERENCE
14. Was the spray testing done while under the extremes of pressure and temperature?	X			Reference 2, pgs. 10-5, 10-7
VI. SUBMERGENCE				
15. Does the test program include submergence tests?		X		Note 7
VII. SEISMIC				
16. Was the seismic testing/ analysis done on aged component or equipment?			X	Note 8
17. Did the seismic testing/ analysis address effects on age?			X	
VIII. FUNCTIONAL REQUIREMENTS				
18. Does the test plan/report specify an acceptance criteria for equipment performance?	X			Reference 2, p. 1-2 Note 9
19. Was an initial base line test done to establish reference performance characteristics?	X			Reference 2, p. 5-1
20. Is the accuracy demonstrated during testing equal to or better than that specified?			X	
21. Has the test/analysis established that this equipment can meet plant application specific performance requirements? (e.g. accuracy, response time)	X			Note 10

NUREG-0588, CATEGORY I QUALIFICATION REPORT REVIEW CHECKLIST

(continued)

	YES	NO	NA	REFERENCE
22. Review the test results on a relative comparison basis (i.e., performance parameters of the baseline tests versus those during the various tests). Were there any anomalies or major discrepancies?	X			Reference 2, pgs. 10-2, 10-10 Note 11
23. If so, was it satisfactorily explained in the report?	X			Reference 2, pgs. 10-2, 10-10 Note 11
IX. SEQUENCE				
24. Was the same test specimen subject to the entire test sequence including aging tests?	X			Reference 2, p. 4-1
25. Compare the test sequence performed for this report against your understanding of what test and procedures are required as per IEEE 323-1974 and any applicable daughter standard for this equipment. Do you believe the report meets the intent of these standards?	X			
X. TEST SET-UP				
26. Was the test measuring equipment (TME) calibration addressed in the report?	X			Reference 2, pgs. 8-1, 8-2 & 13-1
XI. MAINTENANCE REQUIREMENTS				
27. Are maintenance requirements and component replacement intervals specified to maintain qualified life?		X		

NUREG-0588, CATEGORY I QUALIFICATION REPORT REVIEW CHECKLIST

(continued)

	YES	NO	NA	REFERENCE
XII. INSTALLATION INTERFACES				
28. Have installation interfaces required to maintain qualification been identified in the test report? If yes, explain in a note.		X		Note 12
29. Has the actual plant installation been identified and evaluated?	X			Reference 9 Note 1

NOTES

1. This equipment has the ID number EDE-CBL-6C. Reference 1 (Appendix A) and Reference 7 identify the particular RG-58 cable specified and provided to the plant under Purchase Order 9763.006-113-19. The scope of this E.Q. File only concerns the RG-58 coaxial instrument cable listed in References 1 and 7 (cable code TA6Y). The RG-11 Triaxial and RG-11 and RG-59 coaxial instrument cables shown in References 1 and 7 are evaluated in E.Q. File 113-19-01.

   The RG-58 cable tested was taken from a reel of cable supplied under Purchase Order 9763.006-113-19 (Reference 7) and stored at the Seabrook site. Reference 2, p. 3-1 details the cable tested and shows the same (TA6Y) cable code as specified in Reference 1 (Appendix A) and supplied to the plant (Reference 7). Therefore, the Reference 2 document is the report of actual sequential testing of the same RG-58 coaxial cable used in the plant.

2. Figure 1 shows a comparison of the worst case (inside containment) postulated accident temperature versus time profile (Design Envelope) to the LOCA test temperature profile. The test profile plotted is the second transient, or LOCA test (Reference 2, p. 10-9). The margin transient was not plotted because the cable was not completely energized for the duration of this transient due to overheating problems associated with the test monitoring and power supply equipment (Reference 2, p. 10-10). Additionally, the Figure 1 test profile was plotted with a 40 second shift to the left to envelope the initial rise of the plant accident profile.

   The Figure 1 comparison plot demonstrates that the test was more severe than, and conservatively envelopes, the postulated plant design temperature envelope. Deviations between the test and postulated profile are only for a duration of 150 and 200 seconds and are considered insignificant given the test time above 400°F and the overall increased temperatures of the test versus the plant profile. Further, if the actual LOCA/MSLB profile (Reference 11, p. 1, Figure 2) was plotted instead of the accident design envelope, then no deviations would be found. Therefore, the test temperature conditions are considered more than adequate in demonstrating the qualification of the RG-58 cable should it be exposed to the plant postulated worst case harsh environmental temperatures during LOCA or MSLB.

   The margins of the test over the plant specific profiles suggested by IEEE Std. 323-1974 for temperature (+15°F) and pressure (+10%) were met during testing. Reference 4 shows adequate margin with respect to test duration and specified equipment operating time.

3. The limiting environmental zones for radiation are zones PB-4, PB-15A, PB-18 and PB-19 (Reference 11). There is no Class 1E electrical equipment in zones PB-4 and PB-19 (Reference 8); therefore, the maximum total integrated normal and/or accident radiation dose for which

NOTES
(continued)

qualification must be demonstrated is the 2.0×10^8 rads found in zones PB-15A and PB-18 (Reference 11). Per Reference 2, p. 8-2, the cable test specimens received a minimum total dose of 2.2×10^8 rads.

4. Total integraded dose has been simulated by exposure to gamma field radiation. Beta radiation doses are less significant than gamma radiation doses due to the low penetration power of beta in comparison to gamma rays of equivalent energy. Therefore, the ionization caused by gamma radiation will be at least equal to or more severe than beta exposure and the use of a gamma field to simulate beta plus gamma in-plant exposure is acceptable.

5. The qualified life of the cable has been conservatively evaluted at the cable design maximum continuous conductor temperature of 75°C (167°F) (Reference 2, p. 6-1, Reference 3, Item 3 and Reference 1, p. B1). The RG-58 cable is instrument cable and will only carry very low current loads in the plant. Therefore, the normal operating state of the cable will be one of little or no conductor heat rise, and the use of the maximum continuous conductor temperature to establish qualified life is conservative.

6. To convert from parts per million (ppm) of Boron to percentage concentration of boric acid by weight, multiply ppm by the ratio of the molecular weight of boric acid (H_3BO_3) to that of Boron by 100. Therefore:

$$\text{ppm} \times \frac{\text{molecular weight of Boric Acid}}{\text{molecular weight of Boron}} \times 100 =$$

$$\frac{3000}{10^6} \times \frac{61.8}{10.8} \times 100 = 1.7\%\ H_3BO_3 \text{ by weight}$$

7. Submergence qualification is not required because these cables are not located in any areas of the plant where they would be submerged subsequent to design basis events (Reference 9).

8. The seismic qualification of cable is not required by IEEE Std. 383-1974.

9. Test acceptance criteria is stated in Reference 2, p. 1-2 based on the requirements of IEEE stds. 383-1974. This criteria is acceptable with respect to demonstrating the satisfactory performance of the RG-58 cable when exposed to plant specific normal and accident environmental conditions. In the Reference 10 (p. 5-2) Test Plan, an additional acceptance criterion for the insulation resistance (IR) (1×10^6 ohms) of the primary insulation is also stated for baseline testing. This criterion was used to ensure that the cable specimens were not damaged during delivery from the plant to the test laboratory. Further, if any IR value of less than 1.0×10^6 ohms was measured for the primary insulation during testing, it was evaluated by plant I&C personel.

NOTES
(continued)

10. In the Reference 2 (p. 1-2) test report, test acceptance criteria are identified in accordance with IEEE Std. 383-1974. These criteria were established based on the use of this RG-58 cable as Train A Associated cable in the plant. Reference 1 (p. A1), Reference 7, and Reference 2 (p. 3-1) establish this cable as being colored black with a red trace.

References 5 and 6 establish that this is a Train A Associated cable and the performance requirements are to carry voltage and current (remain intact) when exposed to accident environmental conditions and not fail in a manner detrimental to plant safety. The failure mode is defined as insulation failure resulting in a short to ground of the conductor. The performance requirements are met if the acceptance criteria in the Reference 2 (p. 1-2) test report are met. Further, the insulation resistance measurements made during each test phase and during the LOCA simulation can be compared with the baseline results as an indicator of insulation performance.

An analysis of the test results shows the following:

a. With the exception of a portion of the initial margin transient, all specimens remained energized with 600 volts and the 1.0 amp specified current. The specimens were not continuously energized during the margin transient because of problems associated with the test setup (Reference 2, p. 10-10). Further, the margin transient was not used to envelope the plant profile, as sufficient margin existed in the LOCA or second transient (See Figure 1 and Note 2).

b. The specimens withstood the post-test high potential voltage withstand test with an applied potential of 80 VAC/mil of insulation thickness (3200 VAC) for five minutes in water after being wrapped around a mandrel having a diameter of approximately forty times the cable insulation diameter.

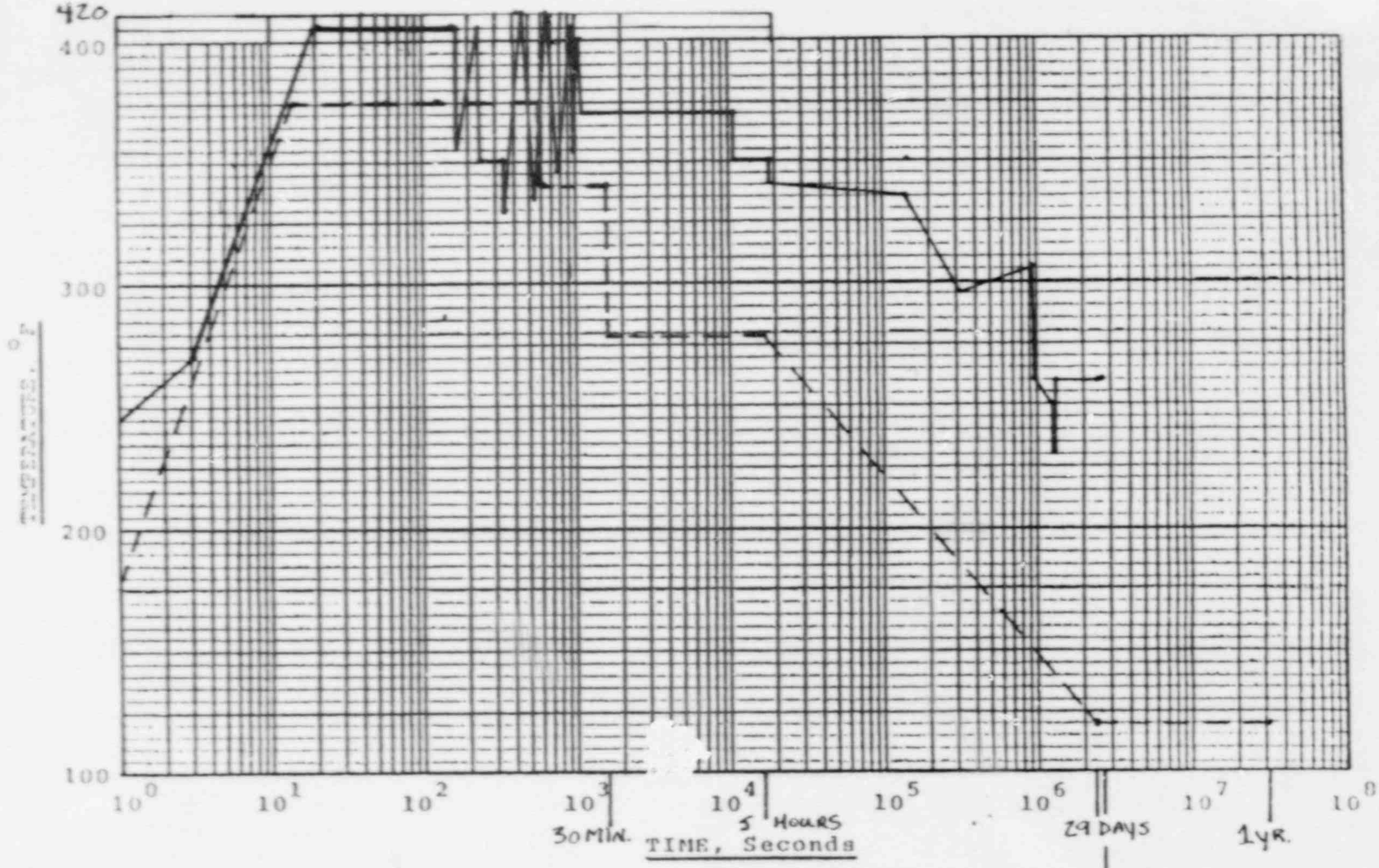
c. Insulation resistance (IR) showed very little permanent variation from the baseline measurements to the final post 30 day LOCA test results. The IR for several specimens dropped in the range of 10^5 ohms with one as low as 4.1×10^4 ohms (Speciment #2 @ t = 15.4 hrs.). However, the variation of IR with temperature is a trait observed in many cable tests and was expected. All specimens returned to at least 10^6 ohms by 18.5 hours into the test, with values on the order of 10^9 ohms measured at the end of the test. The low IR values recorded during the margin transient were the result of test setup overheating, as discussed in Reference 2, p. 10-10. Overall, the measured IR demonstrates the integrity of the cable throughout the test sequence.

NOTES
(continued)

In summation, acceptance criteria was defined, plant specific performance criteria was met, and the test results show that the RG-58 cable will perform its function during postulated plant environmental conditions and will not fail in a manner detrimental to plant safety.

11. The two anomalies resulting from the test (Reference 2, pgs. 10-2 and 10-10) were due to the rough handling of the test specimens and the overheating of the test monitoring circuit, respectively. Each is adequately described and resolved in the test report, and none of them had any impact on the satisfactory test results.

12. Although no specific requirements are specified to maintain the qualification of the cable, it is apparent that qualified splices and terminations are required for the cables to be qualified for use in the plant. The qualification of splices and terminations are addressed as generic items in separate qualification files.



KEY

——— Qualification Test (REF. 2, p. 10-9)**

- - - - Postulated Accident (REF. 11, p. 1, FIGURE 2)

** TEST PROFILE PLOTTED IS LOCA (2ND TRANSIENT) ONLY. TIME SCALE IS PLOTTED WITH A 40 SECOND SHIFT TO LEFT (e.g. 1ST PEAK TO 410°F IS PLOTTED AT t = 20 SEC. INSTEAD OF ACTUAL TEST TIME = 60 SEC.)

Seabrook Station: EQ Assessment Report		
Figure 1: Temperature Profile Comparison		
	JOB NO EQ FILE NO 113-19-02	PAGE 13 OF 13

Reference 1

EQ FILE No 113-19-02

REFERENCE 1

THIS DOCUMENT IS NUCLEAR SAFETY RELATED

UNITED ENGINEERS & CONSTRUCTORS INC.

30 SOUTH 17TH STREET

PHILADELPHIA, PENNSYLVANIA 19101

SPECIFICATION

FOR

SPECIALTY CABLE

FOR

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

SEABROOK STATION

UNITS 1 & 2

REVISIONS						
No.	Date	Prep.	Checked	Q/A	SDE	PEM

Specification No. 9763-006-113-19

Date: 9/20/82

Prepared: G W Morris
G.W. Morris

Checked: DW Knox
D. W. Knox

Q/A Review: S E Rubenstein
S. E. Rubenstein

Approved: G M Aggarwal
G. M. Aggarwal

Approved: D H Rhoads
D. H. Rhoads

APPENDIX A

BILL OF MATERIAL

SEABROOK STATION UNITS 1 & 2

SPECIALTY CABLE

(1) ITEM NO.	(2) MINIMUM CABLE VOLTAGE	(3) TYPE CABLE (FUNCTION)	(4) CONDUCTOR COLOR	(5) OVERALL JACKET COLOR	(6) CONDUCTOR SIZE AWG (STRAND)	(7) NUMBER CONDUCTORS	(8) SHIELD TYPE (COVERAGE)	(9) PURCHASE ORDER QTY-FEET	(10) CABLE CODE
1.	2500 vdc	Triaxial (RG-11,	N/A	Red	#18 (7x)	1	Braid (90% Min.)	25,000	UA1T
2.	2500 vdc	Triaxial (RG-11,	N/A	White	#18 (7x)	1	Braid (90% Min.)	25,000	UA2T
3.	2500 vdc	Triaxial (RG-11,	N/A	Blue	#18 (7x)	1	Braid (90% Min.)	7,000	UA3T
4.	2500 vdc	Triaxial (RG-11,	N/A	Yellow	#18 (7x)	1	Braid (90% Min.)	7,000	UA4T
5.	2500 vdc	Triaxial (RG-11,	N/A	Black With Red Trace	#18 (7x)	1	Braid (90% Min.)	60,000	UA6T
6.	2500 vdc	Coaxial (RG-11,	N/A	Black With Red Trace	#18 (7x)	1	Braid (90% Min.)	5,000	TA6T
7.	1000 vac	Coaxial (RG-58,	N/A	Black With Red Trace	#21 (19x)	1	Braid (90% Min.)	60,000	TA6Y
8.	1000 vac	Coaxial (RG-59,	N/A	Red	#24 (7x)	1	Braid (95% Min.)	5,000	TA1Y
9.	1000 vac	Coaxial (RG-59,	N/A	White	#24 (7x)	1	Braid (95% Min.)	5,000	TA2Y
10.	1000 vac	Coaxial (RG-59,	N/A	Black With Red Trace	#24 (7x)	1	Braid (95% Min.)	5,000	TA6U

BILL OF MATERIAL

SEABROOK STATION UNITS 1 & 2

SPECIALTY CABLE

(1) ITEM NO.	(11) *TYPE INSULATION	(12) PRIMARY INSULATION THICK (MILS)	(13) SECONDARY INSULATION THICK (MILS)	(14) DIA. OVER 1ST BRAID SHLD. OR 1/C DIA. (IN.)	(15) DIA. OVER 2ND BRAID SHLD. (INCHES)	(16) ** TYPE JACKET	(17) JACKET THICKNESS (MILS)	(18) OVERALL OUTSIDE DIA. (IN.)	(19) MIN. BEND RADIUS (IN.)
1.	FR-XLP	122	27	.317"	.404"	FR-XLPO	30	.470" ± .010	5.5"
2.	FR-XLP	122	27	.317"	.404"	FR-XLPO	30	.470" ± .010	5.5"
3.	FR-XLP	122	27	.317"	.404"	FR-XLPO	30	.470" ± .010	5.5"
4.	FR-XLP	122	27	.317"	.404"	FR-XLPO	30	.470" ± .010	5.5"
5.	FR-XLP	122	27	.317"	.404"	FR-XLPO	30	.470" ± .010	5.5"
6.	FR-XLP	122	N/A	.317"	N/A	FR-XLPO	40	.397" ± .015	5.0"
7.	FR-XLP	40	N/A	.138"	N/A	FR-XLPO	29	.195" ± .005	2.5"
8.	FR-XLP	61	N/A	.173"	N/A	FR-XLPO	34	.242" ± .008	3.0"
9.	FR-XLP	61	N/A	.173"	N/A	FR-XLPO	34	.242" ± .008	3.0"
10.	FR-XLP	61	N/A	.173"	N/A	FR-XLPO	34	.242" ± .008	3.0"

*FR-XLP; Flame Retardant Cross-Linked-Polyethylene

**FR-XLPO; Flame Retardant Cross-Linked Polyolefin

BILL OF MATERIAL

SEABROOK STATION UNITS 1 & 2

SPECIALTY CABLE

(1) ITEM NO.	(20) MAXIMUM SIDEWALL PRESS.-LB/FT.R.	(21) MAXIMUM PULLING TENSION-LBS.	(22) CABLE WEIGHT LBS/LINEAR FT.	(23) SHIPPING QTY. REELS	(24) UNIT #1 LENGTH PER REEL-FT.	(25) SHIPPING QTY. REELS	(26) UNIT #2 LENGTH PER REEL-FT.	(27) TOTAL SHIPPING LENGTH-FT.
1.	150	150	.145					
2.	150	150	.145					
3.	150	150	.145					
4.	150	150	.145					
5.	150	150	.145					
6.	75	75	.102					
7.	40	40	.029					
8.	40	40	.042					
9.	40	40	.042					
10.	40	40	.042					

APPENDIX B

SELLER'S DATA

		TRIAXIAL COAXIAL
1)	Minimum allowable temperature during installation	-30 °C
2)	Maximum continuous conductor temperature	75 °C
3)	Maximum emergency overload conductor temperature	130 °C
4)	Maximum short circuit conductor temperature	250 °C
5)	Percent copper conductivity at [illegible]	96 %
6)	State if copper conductors are coated or uncoated	Coated
7)	State the type insulation: a) by Seller's trade name	None
	and [illegible] b) by generic name	Polyethylene
8)	State the insulation curing process	Irradiation Cross-linked
9)	Does the stated insulation contain fillers? Give the generic chemical names and purposes of major fillers	YES
10)	State the type of cover: a) by Seller's trade name	Exane
	b) by generic name	Polyolefin
11)	State the cover curing process	Irradiation Cross-linked
12)	Does the stated cover contain fillers? Give the generic chemical names and purposes of major fillers	Yes — %
13)	Give the percentage halogen content of insulation by weight	8 %

14) Give the percentage halogen content of covers by weight ___13.5___ %

15) State cable interstices materials by generic names ___N/A___

16) Is the conductor insulation fire-retardant? ___YES___

17) Is the completed cable fire retardant? ___YES___

18) Insulation physical & aging properties

Tensile strength, unaged, LBS./SQ. IN. ___1600___

Ultimate elongation, unaged ___200___ %

Aging 150°C 168 Hrs: Tensile Strength, LBS./SQ. IN. ___1400___

Elongation ___150___ %

Ozone resistance after 24 Hrs at ozone concentration of 0.025 to 0.030% (% x vol.) ___Pass___

19) Insulation electrical properties at room temp. (15.6°C) and IPCEA thickness

Insulation resistance megohm constant ___50,000___

Dielectric power factor ___N/A___ %

Dielectric constant ___2.5___

20) Electroendosmosis test - Insulation electrical properties at quoted thicknesses and voltage stress after 26 weeks immersion at 90°C with a constant negative 600 volt dc potential applied (IPCEA EM-60 Method)

Dielectric power factor ___N/A___ %

Dielectric constant ___N/A___

Stability factor ___N/A___

21) Give the guaranteed radiation resistance in terms of total integrated rad dose, rad dose rate, cable life in years. Does this radiation resistance include a design basis event? Explain.

(See LOCA Data)

22) Copper Mirror Corrosion Test (ASTM D2671)

Insulation, Aging 121°C, 16 Hrs. percent transparency	5 %
Jacket, Aging 121°C, 16 Hrs. percent transparency	5 %
Other organic material (specify) percent transparency	N/A %

23) State effect of pulling lubricant, MINEARLLAC H-2B (BENTONITE), on cable properties. Applicable to coax & triax only. Recommend wire lube, y-er or velocity bentonite (ivory snow flakes cheapest & best)

24) State the IPCEA specification(s), or other specifications, applicable to the design, manufacture, and testing of the proposed insulation and covers.

MIL-C-17

25) Fire Analysis

Auto ignition temperature of complete cable, °F — Approx. 1200°F

Heating value of combustibles (insulation, jacket, fillers etc.) BTU/LB. — 9100

State oxygen index of cable insulation, fillers and cover.

27

26) Does cable contain asbestos in any form? NO

27) Give type and tradename of cable end seal to be provided Dip Seal Plastic - DS 5749 - Yellow

Reference 2

NTS

E.Q. FILE No. 113-19-02
REFERENCE 2

Test Report No. 24843-89N-2 Page Nos. ____

TEST REPORT

FOR

ENVIRONMENTAL QUALIFICATION TESTING OF
COAXIAL INSTRUMENT CABLES (RG 58)

FOR

NEW HAMPSHIRE YANKEE
A DIVISION OF PUBLIC SERVICE
P.O. BOX 300
SEABROOK, NH 03874

Purchase Order No. 61917

Prepared by: Timothy J. Rotti (signature) Date 22 July 88
Timothy J. Rotti, Associate Engineer
NTS/Acton
533 Main Street, Acton, MA 01720

Reviewed and
Approved by: Keith G. Whittles (signature) Date 22 July 88
Keith G. Whittles, Engineering Manager
NTS/Acton

KT/RPT/2484389N.NH2

TABLE OF CONTENTS

1.0 PURPOSE AND ACCEPTANCE CRITERIA

1.1 Purpose

The purpose of this document is to describe the testing which was conducted during environmental qualification testing of ITT Surprenant RG 58 Coaxial Cable supplied by New Hampshire Yankee. Section 3.0 of this report provides specific identification of the subject test specimens.

The intent of the test program is to demonstrate the ability of the coaxial cables to perform satisfactorily during and following exposure to postulated in-service and end-of-life accident environment simulations.

As detailed herein, the cable qualification program was conducted in accordance with the guidelines of IEEE Std. Nos. 323-1974 and 383-1974. The tested environmental conditions reported herein are based on the test sequence, duration and environmental parameters reported in Franklin Research Report No. F-A5550-8. Per the stipulation of New Hampshire Yankee, the vertical flame test described within Section 2.5 of IEEE 383-1974 was not required for any test specimen.

The subject program was conducted in accordance with the provisions of NTS/Acton's Quality Assurance Manual. This fact ensured compliance with all pertinent provisions of 10CFR, Part 21, 10CFR, Part 50, 49 and 10CFR, Part 50, Appendix B.

NTS

1.0 PURPOSE AND ACCEPTANCE CRITERIA (continued)

Ten cable samples were submitted for testing. Six of the ten samples were subjected to aging tests (thermal and radiation aging). The remaining four samples were retained as unaged items to be subjected only to LOCA tests.

The LOCA testing was completed using four aged and four unaged cable specimens. The remaining two aged specimens were set aside as spares prior to LOCA testing. The eight tested specimens were divided into two groups (specimens 1,2,7 and 8 in Group 1 and specimens 4,6,9 and 10 in Group 2). the Group 1 specimens were subjected to only the first fifteen days of LOCA exposure. The Group 2 specimens continued though the entire thirty day test duration.

This report documents only the testing of the 30-Day LOCA test group. The 15-Day LOCA test group program is documented in NTS/Acton Test Report No. 24843-89N-1.

1.2 Acceptance Criteria

the test specimens were considered to have met the requirements of IEEE STD 383-1974, Section 2.4, if they (a) remained energized with client specified potential and current during the steam, chemical-spray, and high-humidity exposure, and (b) passed a final bend test at a diameter 40 times the cable diameter and an ac high-potential-withstand test at 80 V per mil

1.0 PURPOSE AND ACCEPTANCE CRITERIA (continued)

1.2 Acceptance Criteria (continued)

of insulation thickness. It was assumed that the first criterion was met if the total leakage/charging current of the specimens connected to an energizing source for potential did not exceed approximately 1.0 A.

2.0 REFERENCE REGULATIONS AND DOCUMENTS

2.1 New Hampshire Yankee Purchase Order No. 61917.

2.2 IEEE383-1974 Institute of Electrical and Electronics Engineers, Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

2.3 IEEE323-1974 Institute of Electrical and Electronics Engineers, Standard for Qualifying Class Electric Equipment for Nuclear Power Generating Stations.

2.4 10CFR50 Appendix B - Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants (1973).

2.5 10CFR21 - Reporting of Defects and Noncompliance (1977).

2.6 10CFR50.49 - Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants.

2.7 NEP 160 - Environmental Qualification (EQ) Program.

2.8 Franklin Research Institute Report Number F-A5550-8, dated January 14, 1983

2.9 NTS/Acton Test Procedure No. 24843-89N, Revision 1

2.10 Attachment 1 to NTS/Acton Report Numbers 24843-89N-1 and 24843-89N-2; four LOCA profile thermal chart recordings.

2.11 Attachment 2 to NTS/Acton Report Numbers 24843-89N-1 and 24843-89N-2; Visicorder oscillographic recordings of test item electrical loading during LOCA.

2.12 Attachment 3 to NTS/Acton Report Numbers 24843-89N-1 and 24843-89N-2; Z-Fold Chart Recording of thermal aging exposure.

2.13 NTS/Acton Test Report Number 24843-89N-1.

3.0 TEST ITEM DESCRIPTION

Each cable was inspected upon its receipt at NTS/Acton to document the pre-test condition of each test item. Each item was tagged with a unique identification number. This number remained unchanged throughout the test program.

The test specimen description is as follows:

Cable Type:	RG-58 type coaxial cable with 0.040 inch thick irradiation cross-linked polyethylene insulation and 0.029 inch thick Exane (irradiation cross-linked polyolefin) jacket
Manufacturer:	ITT Surprenant
Cable Code:	TA6Y (Seabrook Cable Code)
Cable Color:	Black w/ Red Tracer
Sample Length:	Fifty (50) feet
No. of Samples:	Ten (10)

The test samples were numbered one through ten and were divided into test groups as follows:

Group No.	Aged	Unaged
1	1, 2	7, 8
2	3, 4	9, 10
3(Spares)	5, 6	N/A

NTS

4.0 TEST SEQUENCE

Following receipt and inspection, the cables were subjected to environmental and performance testing in the following sequence:

1) Baseline Functional
2) Thermal Aging
3) Post Thermal Aging Functional
4) Irradiation
5) Post-Irradiation Functional
6) Cable Preparation and LOCA Setup
7) LOCA Simulation (First 15 Days)
8) Post-15-Day LOCA Functional on Group 1 only
9) LOCA Simulation (Second 15 Days)
10) Post-30-Day LOCA Functional on Group 2 only

Unaged test specimens 7, 8, 9 and 10 were not subjected to the thermal aging, post thermal aging functional or radiation aging tests. However, these specimens were subjected to post-irradiation functional testing because these functional tests were completed after the samples were fixtured in the autoclave prior to the start of the LOCA test sequence.

The scope of this report covers the testing on Group 2 test items. NTS/Acton Test Report No. 24843-89N-1 covers testing on the Group 1 test items.

NTS

5.0 BASELINE FUNCTIONAL

Subsequent to receipt and inspection at NTS/Acton, the cables were subjected to Baseline Functional Testing.

The cables were wrapped around steel mandrels having a diameter of approximately twenty times the cable diameter. Each test item was secured to its mandrel via Sager TY25M Tyraps. A minimum cable length of ten feet was in contact with the mandrel surface. The cable ends were trimmed to permit electrical measurements.

5.1 Continuity Check

Using an ohmmeter, the conductor and shield of each cable was checked for continuity. The results were recorded on test data sheets (see Section 16.0).

5.2 Insulation Resistance

Insulation resistance measurements were made between the center conductor and the shield, and between the shield and the mandrel. The insulation resistance tests were performed by applying a 500 Vdc potential to the conductor for a minimum of one minute, measuring the insulation resistance, and then repeating the test for the shield. The insulation resistance was measured using an I.R. Bridge and the results were recorded on data sheets (see Section 16.0).

6.0 THERMAL AGING

Subsequent to the Baseline Functional Test, the cables were subjected to thermal aging at a temperature of 302°F for 168 hours. The cables were placed in a forced hot air aging chamber as attached to the mandrels. Test Sample Nos. 1, 2, 3, 4, 5 and 6 were in the aging oven during the aging process. Samples 7 through 10 were retained as unaged samples and subjected only to baseline and post-irradiation (pre-LOCA) functional tests and the LOCA tests.

Aging temperature was recorded continuously on a strip chart recorder.

The thermal aging parameters were based on the following information provided by New Hampshire Yankee:

Design Conductor Temp.=	167°F (75°C)
Weak-Link Material =	Irradiation Cross-linked Polyethylene
Activation Energy =	1.26eV (150°C)
Aging Temperature =	302°F
Aging Time =	168 hours
Qualified Life =	40 years

The listed design conductor temperature, activation energy, aging time and temperature specified are based on existing qualification data provided by the manufacturer for the identical cable insulation and jacketing materials tested in Reference 2.8.

NTS

7.0 POST THERMAL AGING FUNCTIONAL

Following completion of thermal aging testing, the test cables were removed from the aging chamber. The samples were observed to be not as pliable as they were prior to the aging process and they were slightly discolored (darkened). the cable jacket showed no visible signs of cracking and the cable code, manufacuter's name, model number and rating and red tracer were clearly readable.

The samples were subjected to identical functional tests as those specified for baseline functional testing, except that the cables and mandrels were submerged in tap water in a 50 gallon plastic drum for a minimum of one hour prior to measuring insulation resistance, and the insulation resistance of the shield was measured between the shield and the water. All results are included on the data sheets in Section 16.0.

A New Hampshire Yankee representative was present at NTS/Acton to witness the post-thermal aging functional test.

8.0 RADIATION

Subsequent to the post-thermal aging functionals, test samples 1, 2, 3, 4, 5, and 6 were packaged in two cardboard boxes. They were placed carefully in paper insulation to protect the samples during shipping and handling. The boxes containing the test samples were shipped to Isomedix's radiation facility in Whippany, New Jersey and tested in the sealed boxes.

At Isomedix, the specimens were exposed to a Cobalt-60 gamma field at a minimum dose rate of 0.73×10^6 rads per hour providing a minimum T.I.D. of 2.2×10^8 rads. Halfway through the exposure, the specimens were rotated 180 degrees to insure a more uniform dose.

Dosimetry was performed using Harwell Red Perspex dosimeters, utilizing a Bausch and Lomb Model 1001 Spectrophotometer as the readout instrument, or an equivalent dosimetry system. This system which is calibrated directly with Atomic Energy of Canada, Limited (AECL) is traceable to NBS. A copy of the correlation report is available upon request. Irradiation was conducted at ambient temperature and pressure for the Isomedix facility. A certificate of irradiation is included herein.

COMPONENT IRRADIATION CERTIFICATION

CUSTOMER: NTS - ACTON P.O. NO. 21841 - A

AIR EQUIV. REQUIRED DOSE (MRADS) 220

RATE NOT TO EXCEED (MRADS/HR) < 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
6	N/A	1,2,3,4,5,6	Wire On Pipe

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 220.2 MRADS MAX. 224.83 MRADS

DOSE RATE (AIR): MIN. 0.73 MRADS/HR MAX. ________ MRADS/HR

TOTAL EXPOSURE HOURS: 307.7

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY X NONE N/A

DATE IN: 5/31/88 DATE OUT: 6/9/88

DOSIMETRY:

DOSIMETER TYPE: HARWELL 4034 BATCH AR TOLERANCE ±8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B & L SPECTRONIC 1001

SERIAL NO. 0715493N CALIBRATION DATE: 3/31/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L. De Carlo

TITLE: General Manager DATE 6-10-88

ISOMEDIX (NEW JERSEY), INC.

9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

Report No. 24843-89N-2

NTS

10.0 LOCA SIMULATION

The following test was performed to simulate the postulated LOCA at the end of the cable service life.

10.1 Calibration Run

Prior to performing the LOCA test, a calibration run was performed to demonstrate system capability. The calibration run was performed to the transient conditions.

10.2 Test Fixturing

Each cable test specimen was previously wrapped around a steel mandrel whose outside diameter was approximately twenty (20) times that of each test item (Section 5.2).

Four aged specimens and four unaged specimens were placed in the LOCA Chamber. The eight specimens were divided into two groups, each group having two aged and two unaged specimens.

10.0 **LOCA SIMULATION** (continued)

10.2 **Test Fixturing** (continued)

The fixtured test units were placed over horizontal metal rails inside NTS/Acton Test Autoclave No. 1. The loose portions of the cable samples were rested on a horizontal metal perforated plate.

The cable ends were trimmed to permit electrical connection to a terminal strip immediately outside the chamber. The cable specimens were of sufficient length to allow each specimen to be brought through a sealed autoclave penetration (three part alumina epoxy) without need for any special connection within the autoclave. The minimum test specimen length physically located in the autoclave was 30 feet. Monitoring wires were connected to the terminal block at the chamber and then run to a remote monitoring/load setup in the temperature-controlled LOCA control room. The monitoring setup schematic is included in Section 15.0.

Test specimens 1,2,7, and 8 (Group 1) and 3,4,9 and 10 (Group 2) were originally to be fixtured in the autoclave. However, specimens 5 and 6 were inadvertently installed instead of specimens 3 and 4, and specimen 5 was damaged during fixturing and replaced by specimen 4.

10.0 LOCA SIMULATION (continued)

10.2 Test Fixturing (continued)

The Inadvertent use of specimens 5 and 6 (designated spares) had no impact on the satisfactory outcome of the test because all of the aged samples (Nos. 1,2,3,4,5 and 6) were equally tested to environmental conditions prior to the LOCA sequence. The original designation of specimens 5 and 6 as spares prior to the start of any testing was purely arbitrary.

Upon the fixturing of all specimens in the autoclave and the preparation of the penetrations, specimen 5 was found to be mangled and its outer jacket, metal shield, insulation and conductor severed where the cable is secured to the mandrel with the tywrap. This mechanical damage was judged to be the result of mishandling during fixturing in the autoclave because the separation of the metal shield and conductor would not be environmentally induced. Therefore, specimen 5 was removed and replaced by specimen 4.

10.3 Test Condition Monitoring

NTS/Acton used three (3) Type "J" thermocouples to monitor the LOCA simulation test. One thermocouple (T_1) was placed approximately 2" from the steam outlet, one thermocouple (T_2) was placed one inch off the test fixture

10.0 **LOCA SIMULATION** (continued)

10.3 **Test Condition Monitoring** (continued)

on the left hand side near the steam outlet, and one thermocouple (T_3) was placed on the right hand side furthest from the steam outlet approximately one inch off the test fixture.

Autoclave pressure was monitored using a calibrated pressure transducer.

All four chamber monitoring channels were continuously recorded on a Gould thermal strip chart recorder.

10.4 **Test Item Loading**

The test cable conductors were wired in series and energized with an AC potential of 600V at a test current of 1.0 ampere. The cable shields, mandrel and test vessel were at ground potential. The test circuit was assembled such that the applied potential would be interrupted if the leaking/changing current exceeds approximately 1.0A. This was accomplished by inclusion of an in-line fuse.

10.5 **Test Item Monitoring**

The test items were energized as detailed in Section 10.4 during the LOCA simulation with the following exception:

10.0 LOCA SIMULATION (continued)

10.5 Test Item Monitoring (continued)

The circuit was de-energized to perform I.R. measurements as detailed in Sections 5.0 and 7.0, at the following test intervals. (See figure on page 10-7):

1) After interconnection of the test specimens and placement of the sample sets on the base fixture, test specimens submerged.

2) At a test temperature of 346°F, at approximately the 1.5 hour mark.

3) At a minimum of once per day during LOCA.

4) After LOCA, at ambient conditions, while still fixtured in the autoclave, with the specimens covered with water.

Voltage drop across the monitoring circuit load was monitored continuously during the test and recorded on visicorder paper.

10.6 Chemical Spray

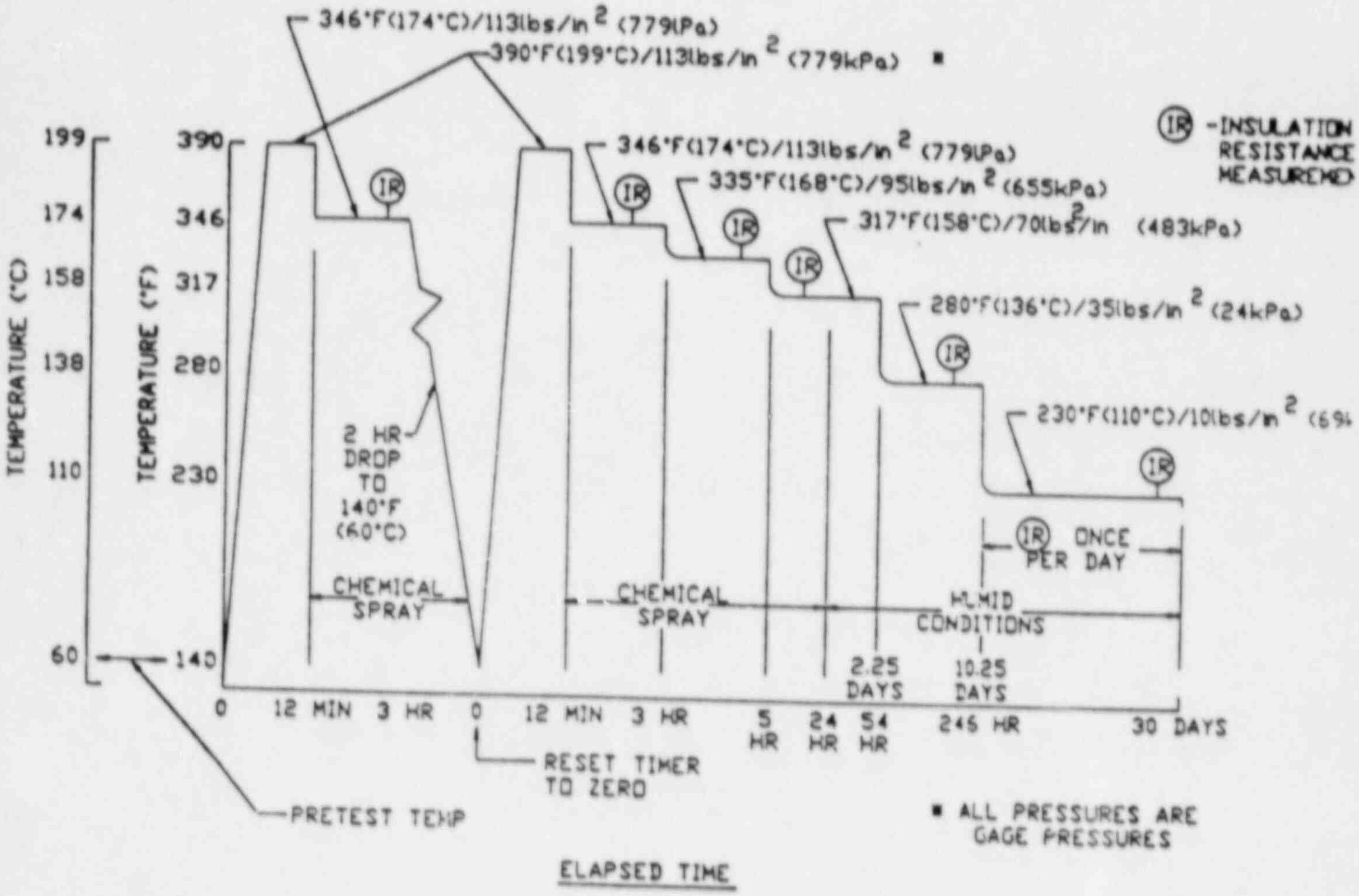
The test cables were subjected to a chemical-spray exposure in accordance with the profile shown in the following figure.

Fresh chemical spray was used for a minimum of one (1) hour at each dwell at 346°F(174°C); thereafter, the spray solution was recirculated from the pool of solution collected in the bottom of the vessel. The chemical spray consisted of 3000 ppm boron as boric acid, 0.064 molar

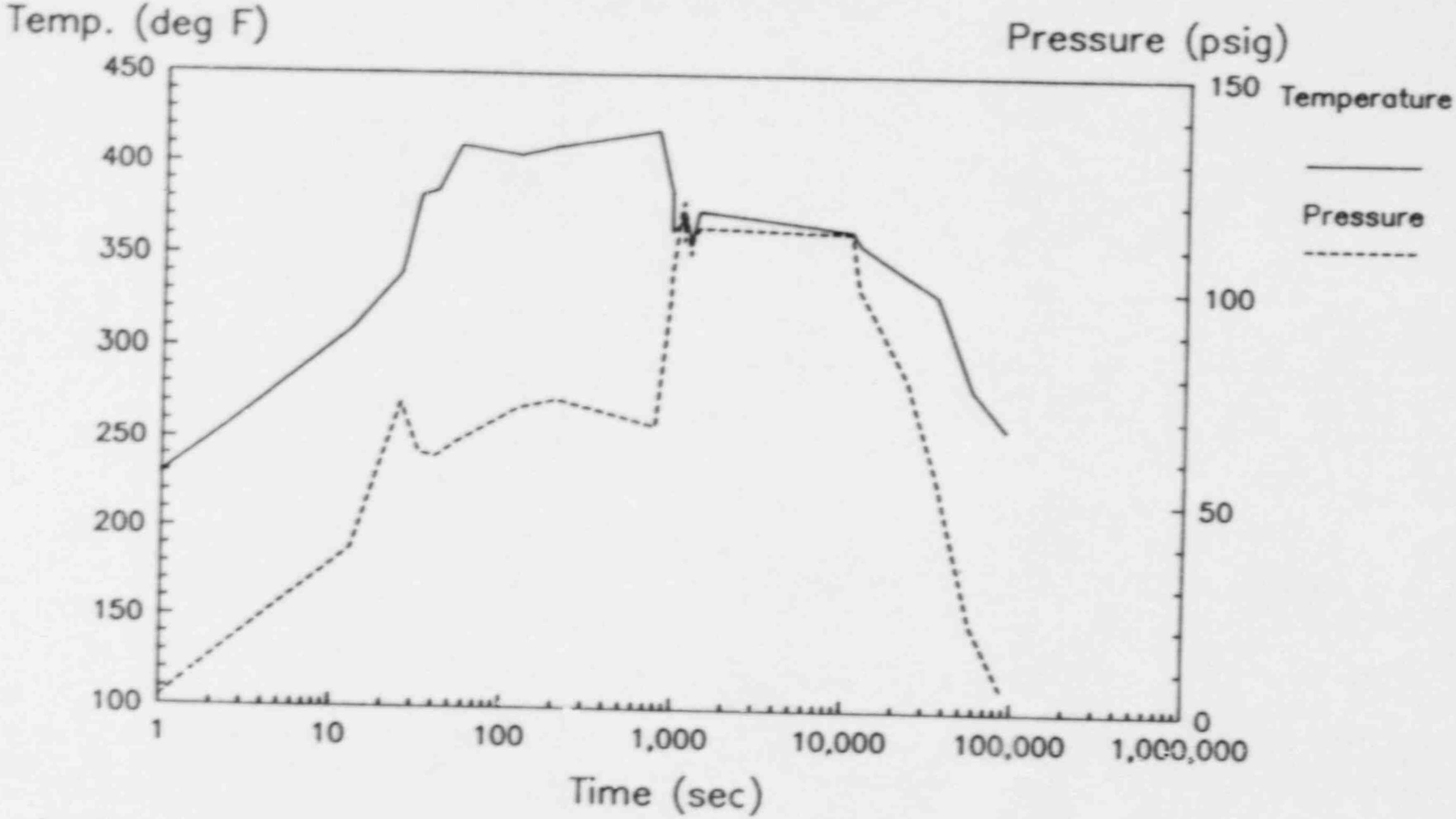
10.0 LOCA SIMULATION (continued)

10.6 Chemical Spray (continued)

sodium thiosulfate, and sufficient sodium hydroxide to obtain a pH of 10.5 at room temperature. The spray was applied at a total flow rate of 0.63 gal/min, which was calculated to provide a spray intensity of approximately 0.15 (gal/min)/ft^2 over the cylindrical area of the mandrels.

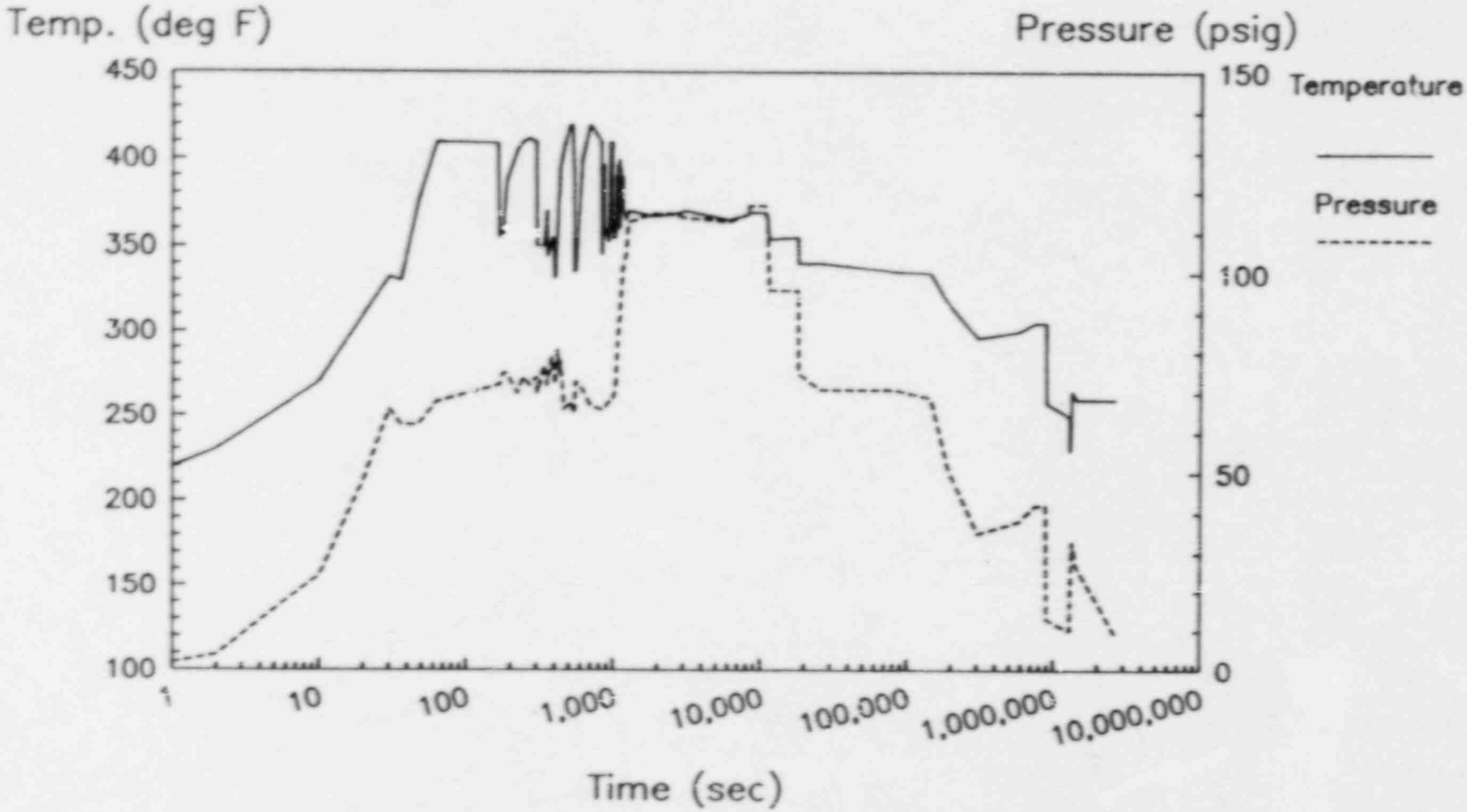

346°F(174°C)/113lbs/in² (779kPa)
390°F(199°C)/113lbs/in² (779kPa) *
IR -INSULATION RESISTANCE MEASURED
346°F(174°C)/113lbs/in² (779kPa)
335°F(168°C)/95lbs/in² (655kPa)
317°F(158°C)/70lbs/in² (483kPa)
280°F(136°C)/35lbs/in² (24kPa)
230°F(110°C)/10lbs/in² (69
TEMPERATURE (°C)
TEMPERATURE (°F)
199
174
158
138
110
60
390
346
317
280
230
140
2 HR DROP TO 140°F (60°C)
CHEMICAL SPRAY
CHEMICAL SPRAY
IR ONCE PER DAY
HUMID CONDITIONS
2.25 DAYS
10.25 DAYS
0
12 MIN
3 HR
0
12 MIN
3 HR
5 HR
24 HR
54 HR
245 HR
30 DAYS
RESET TIMER TO ZERO
PRETEST TEMP
* ALL PRESSURES ARE GAGE PRESSURES
ELAPSED TIME

New Hampshire Yankee
LOCA Test
Margin Transient



Starting Conditions:
Temp @ t0= 120
Pres @ t0= 0

New Hampshire Yankee
LOCA Test



Starting Conditions:
Temp @ t0= 130
Pres @ t0= 0

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NTS

10.0 LOCA SIMULATION (continued)

10.7 LOCA Simulation

The LOCA Simulation consisted of injecting steam into the autoclave to achieve the temperature/pressure profile shown in the figure. Subsequent to achieving the transient condition the chemical condensate submerged NTS/Acton's immersion heater and saturated conditions were maintained by the immersion heater.

All eight specimens were subjected to the margin transient and 15 days of the 30-day LOCA test. At the 15 day mark, the LOCA test was interrupted and both groups of specimens were subjected to an immersed insulation resistance test. Group 1 was then removed and subjected to a voltage withstand test. The remaining four samples (Group 2) were then subjected to the remaining 15 days of the 30-day LOCA test.

During the margin transient the in-line fuse blew at 3850 seconds into the test; however, no cable failure could be found. The fuse was replaced and blew again at 5000 seconds. Again the fuse was replaced; however, it blew whenever power was applied. Insulation resistance readings taken in all samples showed no failures had occurred and therefore, the resolution of this problem centered on the test setup.

10.0 LOCA SIMULATION (continued)

10.7 LOCA Simulation (continued)

In pursuit of a resolution to the fuse problem, it was noted that the test circuit connections, fuses and resistors, monitoring equipment and IR bridge were all located adjacent to the autoclave in an open area outside of the air conditioned autoclave control room. With outside air temperatures in the order of 100°F and the autoclave operating, the temperature of the air around the equipment circuitry was estimated to be at least 125°F. It was therefor concluded that fuse problems were heat related and that all equipment would be moved inside the air conditioned control room after the completion of the margin transient. Once moved into the control room, the fuse never blew during the remainder of the test. Further, the cooling of the IR bridge resulted in stabilized readings.

NTS

11.0 POST LOCA FUNCTIONALS

Post-LOCA functional testing consisted of immersed insulation resistance testing and voltage withstand testing. These post-LOCA functional tests were conducted on specimen group two at the end of the thirty days of LOCA test.

A New Hampshire Yankee representative was present to witness all Post-LOCA activities and specimen handling.

Voltage Withstand Test

The cables were removed from the mandrels, straightened and then re-wrapped around mandrels having a diameter of approximately forty times the cable diameter. The cables and mandrels were immersed in tap water and subjected to a voltage withstand test for five (5) minutes at a potential of 80 Vac/mil (3200 Vac). The leakage current was measured after five (5) minutes of energization and recorded on a data sheet.

NTS

12.0 RESULTS AND CONCLUSIONS

Results

Comparison of functional test data for the aged samples and unaged samples shows some acceptable decrease in insulation ability due to the thermal aging and irradiation. Also, during LOCA, some decrease in insulation property was observed, however, the insulative ability of the inner insulation recovered to a point which is actually better than the unaged samples. This characteristic has been demonstrated in other cable test programs.

The mechanical properties of the aged samples were degraded by exposure to the environmental conditions. It should be noted, however, that the aged samples were handled more than the unaged samples and that despite excess handing coupled with insulation embrittlement, the cables performed satisfactorily. Also, the mandrel diameter used during the test program was slightly less than the minimum bend specified by the manufacturer, constituting an overtest of the mechanical properties of the insulation materials.

The cable specimens maintained continuity throughout the test program and demonstrated their ability to carry the specified potential and current continuously throughout the LOCA exposure. The inner insulation of each sample withstood a 80V per mil (3200 Vac) High potential withstand test.

13.0 TEST EQUIPMENT LIST

TEST EQUIPMENT LIST

INVENTORY NUMBER: RE389
ITEM: TEMPERATURE RECORDER
MANUFACTURER: OMEGA
MODEL NO.: RD250-24
SERIAL NUMBER: EA59A017
RANGE: -100 TO +400°F
ACCURACY: ±2.5°F
CALIBRATION DUE: 11/88

INVENTORY NUMBER: CH325
ITEM: HI TEMP. OVEN
MANUFACTURER: DUVAL
MODEL NO.: N/A
SERIAL NUMBER: CH325
RANGE: AMBIENT TO 600°F
ACCURACY: ±2°F
CALIBRATION DUE: UWCE

INVENTORY NUMBER: ZB327
ITEM: MEGOHMMETER
MANUFACTURER: GENERAL RADIO
MODEL NO.: 1862C
SERIAL NUMBER: 2477
RANGE: 0.5 MEGOHMS TO 2 M MEGOHMS, 100/500 VOLTS
ACCURACY: ±3%
CALIBRATION DUE: 06/88

INVENTORY NUMBER: PA312
ITEM: HI-POT
MANUFACTURER: ASSOCIATED RESEARCH
MODEL NO.: 404
SERIAL NUMBER: 404570
RANGE: 60 Hz, 0-2.5 KVA
ACCURACY: ±5%
CALIBRATION DUE: 10/88

INVENTORY NUMBER: ML574
ITEM: DIGITAL MULTIMETER
MANUFACTURER: FLUKE
MODEL NO.: 8840A
SERIAL NUMBER: 4382012
RANGE: DC VOLTS: 0-1500
AC VOLTS: 0-750
AC+DC CURRENT: 0-2 AMPS
RESISTANCE: 0-20 MEGOHMS
ACCURACY: SEE MFGR'S MANUAL
CALIBRATION DUE: 11/88

INVENTORY NUMBER: PI391
ITEM: DIGITAL PH METER
MANUFACTURER: ORION RESEARCH
MODEL NO.: 701A
SERIAL NUMBER: A52810
RANGE: 6 TO 8 PH
ACCURACY: ±.002 PH, ±.1mV
CALIBRATION DUE: 05/89

INVENTORY NUMBER: PI402
ITEM: DIGITAL PRESSURE INDICATOR
MANUFACTURER: JAY
MODEL NO.: 3502-8
SERIAL NUMBER: 10306
RANGE: 0 TO 150 PSI
ACCURACY: ±1.0 PSI
CALIBRATION DUE: 07/88

INVENTORY NUMBER: PI403
ITEM: DIGITAL PRESSURE INDICATOR
MANUFACTURER: JAY
MODEL NO.: 3502-8
SERIAL NUMBER: 10307
RANGE: 0 TO 350 PSI
ACCURACY: ±1.0 PSI
CALIBRATION DUE: 07/88

INVENTORY NUMBER: PI404
ITEM: DIGITAL PRESSURE INDICATOR
MANUFACTURER: JAY
MODEL NO.: 3502-8
SERIAL NUMBER: 10308
RANGE: 0 TO 150 PSI
ACCURACY: ±1.0 PSI
CALIBRATION DUE: 07/88

INVENTORY NUMBER: PI406
ITEM: PRESSURE GAUGE
MANUFACTURER: U.S. GAUGE
MODEL NO.: 0-160
SERIAL NUMBER: N/A
RANGE: 0 TO 160 PSI
ACCURACY: ±1.0 PSI
CALIBRATION DUE: 07/88

NTS

INVENTORY NUMBER: PI415
ITEM: FLOW METER
MANUFACTURER: FISHER & PORTER
MODEL NO.: 10A1755
SERIAL NUMBER: 8103A1004
RANGE: 0.2 TO 1.9 GPM
ACCURACY: ±3%
CALIBRATION DUE: 07/88

INVENTORY NUMBER: PI416
ITEM: FLOW METER
MANUFACTURER: FISHER & PORTER
MODEL NO.: 10A1755
SERIAL NUMBER: 8103A1004
RANGE: 0.2 TO 1.9 GPM
ACCURACY: ±3%
CALIBRATION DUE: 07/88

INVENTORY NUMBER: PI443
ITEM: PRESSURE TRANSDUCER
MANUFACTURER: C.J. ENTERPRISES
MODEL NO.: CJDL-4010
SERIAL NUMBER: 1917
RANGE: 0 TO 150 PSI
ACCURACY: ±2%
CALIBRATION DUE: 07/88

INVENTORY NUMBER: PI449
ITEM: PRESSURE TRANSDUCER
MANUFACTURER: VIATRAN
MODEL NO.: 218-28
SERIAL NUMBER: 173475
RANGE: 0 TO 200 PSI
ACCURACY: ±.5% SPAN
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TI326
ITEM: DIGITAL TEMPERATURE INDICATOR
MANUFACTURER: OMEGA
MODEL NO.: 199
SERIAL NUMBER: 19843
RANGE: -245 TO +199°F
ACCURACY: ±1.5°F
CALIBRATION DUE: 07/88

NTS

INVENTORY NUMBER: TI334
ITEM: DIGITAL TEMPERATURE INDICATOR
MANUFACTURER: OMEGA
MODEL NO.: 199
SERIAL NUMBER: 19862
RANGE: -245 TO +199°F
ACCURACY: ±1.5°F
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TI352
ITEM: DIGITAL TEMPERATURE INDICATOR
MANUFACTURER: OMEGA
MODEL NO.: 199
SERIAL NUMBER: 43242
RANGE: -178 TO +1400°F, TYPE "J"
0.1F RESOLUTION
ACCURACY: ±1.5°F
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TI375
ITEM: DIGITAL TEMPERATURE INDICATOR
MANUFACTURER: OMEGA
MODEL NO.: 650JX
SERIAL NUMBER: NONE
RANGE: -245 TO +1999°F
ACCURACY: ±1°F
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TP338
ITEM: THERMOCOUPLE PROBE
MANUFACTURER: OMEGA
MODEL NO.: TYPE J
SERIAL NUMBER: NONE
RANGE: -300 TO 1600°F
ACCURACY: ±2.2°F OR ±.75%
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TP340
ITEM: DUAL THERMOCOUPLE PROBE
MANUFACTURER: OMEGA
MODEL NO.: TYPE J
SERIAL NUMBER: NONE
RANGE: -300 TO 1600°F
ACCURACY: ±2.2°F OR ±.75%
CALIBRATION DUE: 07/88

NTS

INVENTORY NUMBER: TP342
ITEM: THERMOCOUPLE PROBE
MANUFACTURER: OMEGA
MODEL NO.: TYPE J
SERIAL NUMBER: NONE
RANGE: -300 TO 1600°F
ACCURACY: ±2.2°F OR ±.75%
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TP343
ITEM: THERMOCOUPLE PROBE
MANUFACTURER: OMEGA
MODEL NO.: TYPE J
SERIAL NUMBER: NONE
RANGE: -300 TO 1600°F
ACCURACY: ±2.2°F OR ±.75%
CALIBRATION DUE: 07/88

INVENTORY NUMBER: TP352
ITEM: THERMOCOUPLE PROBE
MANUFACTURER: OMEGA
MODEL NO.: TYPE J
SERIAL NUMBER: NONE
RANGE: -300 TO 1600°F
ACCURACY: ±2.2°F OR ±.75%
CALIBRATION DUE: 09/88

INVENTORY NUMBER: RENTAL
ITEM: TYPE J THERMOCOUPLE AMP
MANUFACTURER:
MODEL NO.: TYPE J
SERIAL NUMBER: 016139B
RANGE:
ACCURACY:
CALIBRATION DUE: 03/89

INVENTORY NUMBER: RENTAL
ITEM: TYPE J THERMOCOUPLE AMP
MANUFACTURER:
MODEL NO.: TYPE J
SERIAL NUMBER: 045097B
RANGE:
ACCURACY:
CALIBRATION DUE: 03/89

INVENTORY NUMBER: RENTAL
ITEM: DC AMP
MANUFACTURER:
MODEL NO.:
SERIAL NUMBER: 1450985
RANGE:
ACCURACY:
CALIBRATION DUE: 03/89

14.0 PHOTOGRAPHS

Test Specimen Mounting, Steam Inlet
Thermocouple Locations, One of Two Spray Nozzles

PRE-LOCA TEST

Epoxy Feedthroughs in 12 Inch Side Flange,
Viewed from Inside Autoclave

PRE-LOCA TEST SETUP

Test Specimens 9 and 10 (Unaged Specimens)

Test Specimens 9, 10, 4, 6, and 2 (Left to Right)
And all Excess Cable

POST 15-DAY TEST

NTS

Epoxy Feedthroughs and Excess Cable

POST 15-DAY TEST

15.0 LOG SHEETS

YANKEE A DIV. OF

PUBLIC SERVICE OF N.H.

JOB # 24843-89N PCP 917 5-6-88

T. ROSS

K. WATTLES

5-6-88 REC 10 COAX INSTRUMENT CABLE TEST SAMPLES. RECEIVING INSPECTION COMPLETED AND SAMPLES MARKED WITH TAGS AND S/N MARKERS S/N'S 1-10.

EACH SAMPLE WRAPPED AROUND A STEEL MANDREL APPROX 3½" DIA. APPROX 10' OF CABLE ON MANDREL. TOTAL LENGTH OF SAMPLE 50 FT. [redacted] THE SAMPLES ARE SECURED TO THE MANDRELS USING SAGER TY25M TYWRAPS.

2:30 DICK BERGERON AND NEWELL WOODWARD ARRIVE TO WITNESS BASELINE TESTING OF COAX INSTRUMENT CABLES.

TEST EQUIPMENT:

ZB 327	CAL DUE 6/88	MEGOHMMETER
ML 574	CAL DUE 5/88	DIGITAL MULTIMETER
FM 326	CAL DUE 6/88	

TEST PROCEDURE:

TESTING IN ACCORDANCE WITH T1, R2 AND R3 OF JOB # 24843-89N.

BASELINE FUNCTIONAL TESTING WILL CONSIST OF CONTINUITY CHECK AS PER PARA 2.1 OF T1 AND INSULATION RESISTANCE AS PER PARA 2.2 OF T1. REFER TO DATA SHEETS

3:00 START CONTINUITY TEST

3:15 CONTINUITY TEST COMPLETE SEE DATA SHEET FOR RESULTS.

3:20 START INSULATION RESISTANCE TEST. LAB AMBIENT = 80 °F

4:00 INSULATION RESISTANCE COMPLETE SEE DATA SHEETS FOR RESULTS.

THE EQUIPMENT USED ON THIS TEST HAS BEEN EXAMINED AND MEETS CALIBRATION REQUIREMENTS.

QA

DATE 5/6/88

000

N.H. YANKEE A DIV. OF PUBLIC SERVICE OF N.H 000

JOB# 24843-89N P.O. 61917

5-6-88
T. Rome
K. [illegible]

4:00 TEST SAMPLES SET UP IN TEMPERATURE CHAMBER FOR THERMAL AGING TEST. SIX(6) OF THE SAMPLES WILL BE SUBJECTED TO THERMAL AGING SAMPLES 1,2,3,4,5,6 WILL BE SUBJECTED TO THERMAL AGING.

THERMAL AGING CONDITIONS 302°F (150°C) FOR 168 HOURS. AS PER R2 THERMAL AGING PARAMETERS.

THE EQUIPMENT USED ON THIS TEST HAS BEEN EXAMINED AND MEETS CALIBRATION REQUIREMENTS.

QA [signature]

DATE 5/6/88

TEST EQUIPMENT

RE 389 CAL DUE 5/88 TEMP RECORDER.
CH 325 UWCE. TEMP CHAMBER

4:15 CHAMBER POWER ON START TO 302°F (150°C)

[signature: Richard Bergeron] 5/6/88

2000: CHECKED CHAMBER TEMPERATURE AND SET POINT. ADJUSTED DOWN.

5.8.88 8:35 AM
CHECKED CHAMBER TEMPERATURE AND SET POINT. ADJUSTED DOWN, SET TOO HIGH.

5-9-88 - 7:30 AM
CHECKED CHAMBER TEMPERATURE AND SET POINT.
(~~ADJUSTED UP, SET TOO LOW~~) NO ADJUSTMENT NEEDED.

11:30 AM
CHECKED CHAMBER TEMPERATURE AND SET POINT. ADJUSTED UP, SET TOO LOW

[redacted]ANKEE A DIV OF PUBLIC SERVICE OF N.H

24843-89N P.O 61917.

5-9-88
T. ROTH
K. WHITHAM.

1:00 pm
CHECKED CHAMBER TEMPERATURE AND SET POINT
NO ADJUSTMENT NEEDED

7:30 pm
CHECKED CHAMBER TEMPERATURE AND SET POINT
NO ADJUSTMENT NEEDED.

8:00 am RECORDER RAN OUT OF PAPER DURING THE NIGHT. PAPER ADDED CHAMBER TEMPERATURE AND SET POINT CHECKED NO ADJUSTMENT NEEDED.

4:00 PM
CHECKED CHAMBER TEMPERATURE AND SET POINT
NO ADJUSTMENT NEEDED

6:00 AM
CHECKED CHAMBER TEMPERATURE AND SET POINT
NO ADJUSTMENT NEEDED

⇒ 6:00 AM
CHECKED CHAMBER TEMPERATURE AND
SET POINT NO ADJUSTMENT NEEDED.

6:00 PM 168 HRS AT 302°F COMPLETE. CHAMBER SHUT DOWN AND DOOR OPENED TO ALLOW UNITS TO COOL.

OBSERVATIONS - SOME STIFFENING & DARKENING OF THE SAMPLE INSULATION.

UH. YANKEE A DIV OF PUBLIC SERVICE of N.H.

JOB # 24843-89N P.O 61917 Tim [illegible]

POST THERMAL AGING FUNCTIONAL TEST.
TESTING IN ACCORDANCE WITH T1, R2 AND 23 OF JOB# 24843-89N.

POST THERMAL AGING FUNCTIONAL TEST'S WILL CONSIST OF CONTINUITY CHECK AS PER PARA 2.1 OF T1 AND INSULATION RESISTANCE AS PER PARA 2.2 OF T1. REFER TO DATA SHEETS FOR RESULTS.

[illegible signature] 5/14/88

TEST EQUIPMENT

THE EQUIPMENT USED ON THIS TEST HAS BEEN EXAMINED AND MEETS CALIBRATION REQUIREMENTS.

ML 574 CAL DUE 5/88
ZB 327 CAL DUE 6/88
FM 326 CAL DUE 6/88

QA [signature]
DATE 5/15/88

5/14/88
6:00 AM
THE SIX (6) TEST SAMPLES REMOVED FROM CHAMBER. THE SAMPLES ARE ~~[illegible]~~ STIFF AND WERE SLIGHTLY STUCK TO EACH OTHER IN THE CHAMBER.

7:15 AM DICK BERGERON AND NEWELL WOODWARD ARRIVED TO WITNESS TESTING.
POST THERMAL AGING TESTING WILL INCLUDE 1 HR SOAK IN WATER, THEN MEASUREMENTS MADE WITH UNITS SUBMERGED. ([illegible] MEASUREMENTS MADE WITH UNIT SUBMERGED ONLY MINUTES).

7:55 STARTED CONTINUITY TEST.
8:05 COMPLETED CONTINUITY TEST

[7:55 AM START 1 HR SOAK IN H_2O]
LAB TEMP 76°F

8:55 Complete 1 hr soak start I.R test
9:20 complete I.R test.

SEE DATA SHEETS FOR RESULTS.

UNIT'S PACKAGED AND SENT TO ISOMEDIX N.J.

N.H YANKEE A DIV OF PUBLIC SERVICE OF N.H.

JOB # 24843-89N P.O # 61917

T. ROH
KWHITTLES

CUSTOMER APPROVAL TO SHIP ITEMS 1-6 TO ISOMEDIX, WHIPPANY, N.J. FACILITY FOR RADIATION TESTING:

2.2 X10^8 RADS GAMMA (AIR, DOSE RATE NOT-TO-EXCEED 1X10^6 RADS/HOUR

[signature]
N.H. YANKEE REPRESENTATIVE

June 9, 1988

POST RADIATION TEST'S

The Items were returned from Isomedix's Whippany N.J. FACILITY by N.H. Yankee Public service of N.H.

VISUAL EXAMINATION

UNIT #1 IS STIFF AND DISCOLORED THE TIEWRAPS THAT ATTACH ~~THE~~ SAMPLE TO THE mandrel are dried out.

UNIT #2 IS STIFF, DISCOLORED AND some permanent bends are now present in the sample. These bends will not be forcibly straightened.

UNIT #3 STIFF, DISCOLORED AND PERMANENT bends are present

UNIT #4 STIFF, DISCOLORED AND permanent BENDS.

UNIT #5 STIFF, DISCOLORED AND PERMANENT BENDS

UNIT #6 STIFF DISCOLORED AND PERMANENT BENDS.

POST RADIATION, PRE LOCA FUNCTIONAL TESTS WILL BE PERFORMED AFTER THE UNITS ARE INSTALLED IN THE AUTOCLAVE. Page 15-6

N.H. YANKEE A DIV OF PUBLIC SERVICE OF N.H

JOB# 24843-89N P.O# 61917

0008

T Roth
K WAITHLPS.

6/14/88

FUNCTIONAL TESTS ON THE SAMPLES ARE COMPLETE RESULTS ARE ON DATA SHEETS. SAMPLE #2 HAD SHIELD TO MANDREL IR OF 1.4 meg Ω USING DVM ML 574 THE IR BRIDGE INDICATED A SHORT AT BOTH 100V AND 500 V.

TEST EQUIPMENT.

Rental

0161398 TYPE J THERMOCOUPLE AMP DUE 3/89
045097B TYPE J THERMOCOUPLE AMP DUE 3/89
1450985 D.C AMP DUE 3/89

LOCAL

TP 343, 342, 338, 340, 352 DUE 11/88 TYPE J TC.
PI 449, 448 DUE 7/88 PRESSURE XDUCER
PI 391 DUE 5/89 PH METER.
TI 352, 334, 375, 376 DUE 7/88 TYPE J DIGITAL TEMP IND.
PI 402, 403, 404, 406 DUE 7/88 PRESSURE READOUT.
PI 415, 416 DUE 7/88 FLOW METER.

ML 574 DUE 11/88 DVM
ZB 327 - DUE 6/88 IR BRIDGE.
PA 320 D.W.C.E HYPERTRONICS.

THE EQUIPMENT USED ON THIS TEST HAS BEEN EXAMINED AND MEETS CALIBRATION REQUIREMENTS.
QA [signature]
DATE 6/13/88

ACID MIXTURE.

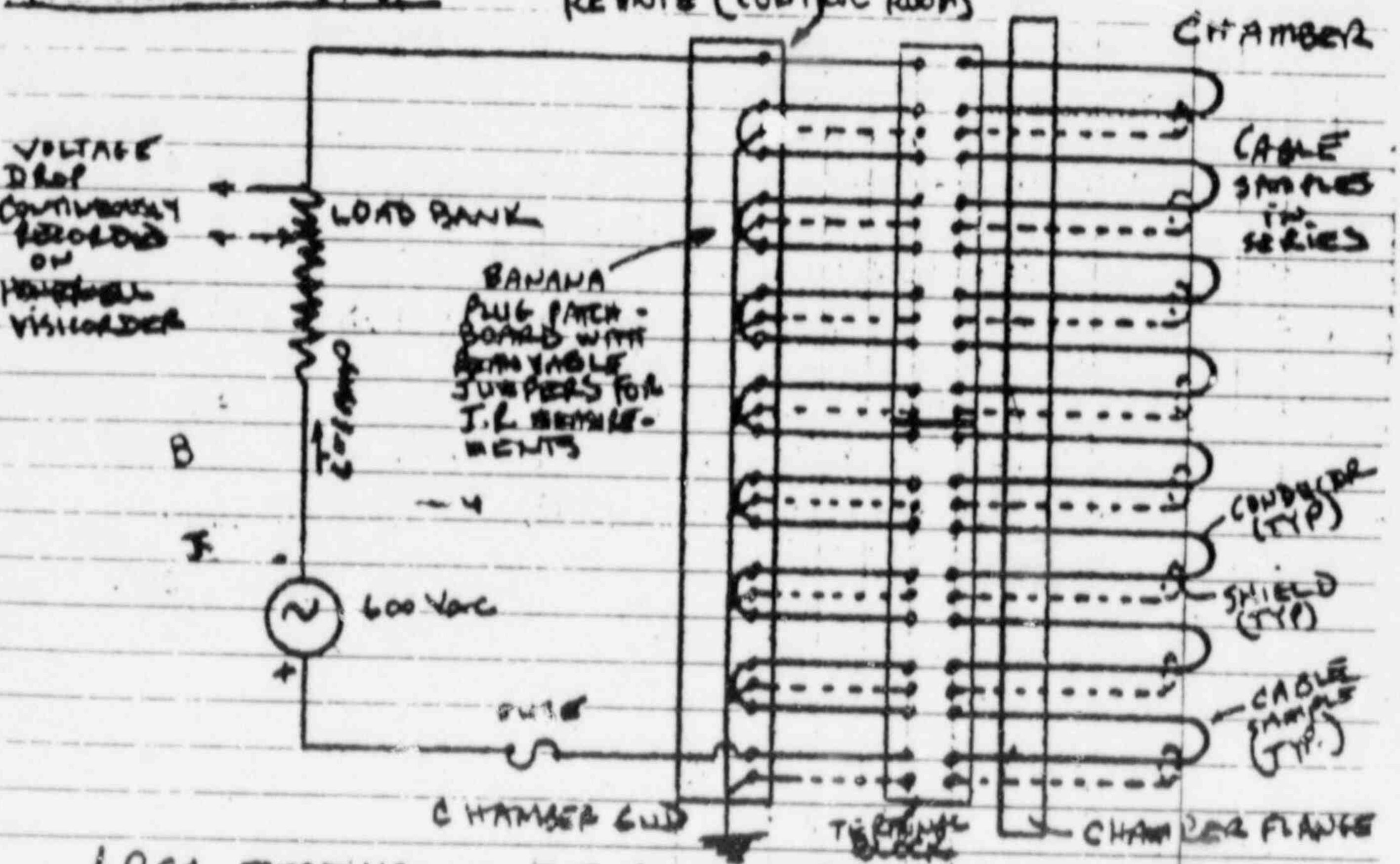
500 GALS OF H_2O
BORIC ACID - H_3BO_3 33,391.10 Grams
SODIUM THIOSULFATE - $Na_2S_2O_3$ 19,148.8 Grams
SODIUM HYDROXIDE - NaOH ADD TO BUFFER TO 10.5 PH.

SEE DATA SHEET FOR CALCULATIONS.

N.H. YANKEE A DIV OF PUBLIC SERVICE OF N.H. 0009

JOB# 24843-89N P.O.# 61917 T Roth K.W. Hatches

MONITORING SET UP



LOCA TESTING TO BE CONDUCTED IN ACCORDANCE WITH MARKED-UP TEST PROCEDURE 24843-89N.

NHY REPRESENTATIVE APPROVAL [signature] 6/13/88

6/13/88
4:30 pm MAIN PROFILE STARTED. 390°F 66 psig WAS ACHIEVED this condition was MAINTAINED FOR 12 min. AT THE 12 min MARK CHEMICAL SPRAY WAS INITIATED AND THE TEMP WAS DROPPED TO 346°F, THE PRESSURE WAS INCREASED TO 113 psig. (SATURATED CONDITIONS). AT THE 3850 sec (1+ hr) MARK THE INLINE FUSE ON THE MONITORING SET UP BLEW THE FUSE WAS REPLACED AND ALL SAMPLES TESTED NO FAILURES. AT APPROX 5000 sec (1.4 hr) MARK THE FUSE BLEW

Page 15-9 →

N.H YANKEE A DIV OF PUBLIC SERVICE OF N.H.

JOB # 24843-89N P.O # 61917.

T. Roti
K. Whitles
G. Drain.

6/14/88 INITIAL INSPEC
THE CHEMICAL SPRAY. A MUCH CLOSER INSPECTION WILL BE MADE WHEN CHAMBER TEMP ALLOWS.

MONITORING SETUP.
THE MONITORING SET UP WILL BE MOVED INTO THE OFFICE AREA. THIS WILL KEEP THE TEST EQUIPMENT AT A MORE STABLE TEMPERATURE CONDITION.

6/14/88 5:00 PM THE LOCA PROFILE WAS INITIATED. Temp and pressure were achieved. Experienced some trouble controlling the exhaust valve. Manual control station is most likely plugged with dirt. The chart recording show temp variations this is due to the use of superheated steam, and the introduction of saturated steam while trying to maintain the temp.

At the 12 min mark of the profile spray was initiated and chamber conditions were adjusted to 346°F 113 psig these are saturated conditions. A water slug in the saturated line cause temp variations, along with the spray.

8:00PM 3HR mark (10,800 sec) chamber conditions adjusted to 336°F 95 PSIG.

16,200 sec mark start recirc of spray, cal rod power on.

10:00 pm 5HR (18,000 sec) Chamber conditions lowered to 317°F 70 PSIG. The cal rod was used to try and maintain these conditions.
Cal rod will not hold conditions very stable. Boiler must be used to inject steam to maintain pressure.

N.H Yankee A Div of Public Service of N. H.

Job# 24843-89N P.O# 61917 T. Both K. Withers

IR Readings

IR and continuity readings were taken prior to the start of the profile. A set of readings was taken at the terminal block the test samples terminate at. A second set was taken at the terminal block in the office this was done to determine the effect the added cable will have on the readings (Approx 30 feet of test cable was added) The data sheets are in the data book.

IR readings were taken @ 6300 seconds, 3.8 hours 15.4 hours, 17.4 hours, 18.3 hours once a day for the remainder of test. Note readings will be taken with a DVM IE 0 readings at 100V & 500V on IR bridge.

6/16/88

10:05AM IR readings taken just prior to chamber condition adjustment to 280°F 95 PSIG

6/17/88 I.R readings taken and sent to D. Bergeron & Woody.

6/18/88 Readings taken, chart paper in visicorder changed, acid condensate added to chamber. Notice spikes on visicorder chart when power applied.

6/19/88 Readings will be taken daily and results will be on data sheets.

6/24/88 1:00pm chamber conditions adjusted to 230°F 10 PSIG. Condensate added just prior to adjusting conditions.

16.0 DATA SHEETS

National
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DATA SHEET

Job Number 24843-89N

Date MAY 6, 1980 Page 1 of 2

Customer NEW HAMPSHIRE YANKEE, DIVISION OF: Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Continuity (BASELINE)

Mode of Operation Non- operating, unpowered

Remarks T. ROTTI, K. WHITTLES, N. WOODWARD, R. BERGERON

ML 574

	CABLE NO.		CONTINUITY, Ω			
			CENTER	SHIELD		
	1		0.563	0.197		
	2		0.569	0.205		
	3		0.572	0.204		
	4		0.580	0.207		
	5		0.579	0.210		
	6		0.584	0.212		
	7		0.569	0.205		
	8		0.570	0.204		
	9		0.573	0.209		
	10		0.569	0.205		

Test Technician T. ROTTI

Test Engineer K. WHITTLES

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DATA SHEET

Job Number [redacted]843 - 89N

Date MAY 6, 1986 Page 2 of 2

Customer NEW [redacted]PSHIRE YANKEE, DIVISION OF: Public [redacted]rvice of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coa[redacted] Instrument Cables

Model/Serial Number RG 58

Test Insulat[redacted] [redacted]esistance (BASELINE)

Mode of Operation Mandrel

Remarks T. [redacted] K. WHITTLES, N. WOODSEHEN R. [redacted]GERON

I.R. @ 500 Vdc for 1 minute

ZB 327, FM 326

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				Ω		Ω	
		1		> 2x10^12		7x10^11	
		2		> 2x10^12		> 1 x10^12	
		3		2x10^12		> 1 x10^12	
		4		> 1.5x10^12		8x10^11	
		5		> 2x10^12		> 2 x10^12	
		6		> 1 x10^12		7x10^11	
		7		> 4.5x10^11		> 1 x10^12	
		8		> 1x10^12		> 5x10^11	
		9		2x10^12		> 1 x10^12	
		10		> 2 x10^12		> 5x10^11	

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. ROTTI

Test Engineer K. WHITTLES

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DATA SHEET

Job Number 24843-89N

Date May 14, 1988 Page 2 of 2

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Act Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Immersed Mandrel in WA

Remarks POST THERMAL AGING (1 HOUR IMMERSION) I.R. @ 500 Vdc for 1 minute

T. Rotti, K. Whittles, R. Bergeron, N. Woodward ZB 327 FM 326

	CABLE NO.		I.R. C-S *		I.R. S-M *
			Ω		Ω
	1		>20x10^11		>3.5x10^11
	2		>20x10^11		>3.0x10^11
	3		>20x10^11		>3.5x10^11
	4		>20x10^11		>3.0x10^11
	5		>20x10^11		>3.5x10^11
	6		>20x10^11		>2.0x10^11
	7		N/A		N/A
	8		N/A		N/A
	9		N/A		N/A
	10		N/A		N/A

* C-S: center conductor to shield

S-M: shield to mandrel

NOTE: - LEAD FROM I.R. BRIDGE WAS IMMERSED IN WATER FOR THE S-M I.R. TESTS.

Test Technician T. Rotti

Test Engineer K. Whittles

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DATA SHEET

Job Number 24843-89N

Date JUNE ~~9~~ 10, 1988 Page 1 of 2

Customer Public Service of N[illegible] Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Continuity

Mode of Operation Non- operating, unpowered

Remarks POST RADATION FUNCTIONAL TEST / PRE-LOCA
T. Rotti, K. Whittles, N. Woodward

ML 574

	CABLE NO.		CONTINUITY			
			Center	Shield		
	1		.659 Ω	.287 Ω		
	2		.670 Ω	.285 Ω		
	3		X	X		
	4		.628 Ω	.275 Ω		
	5		X	X		
	6		.629 Ω	.262 Ω		
	7		.624 Ω	.262 Ω		
	8		.659 Ω	.267 Ω		
	9		.629	.269		
	10		.609 Ω	.260		

Test Technician T. Rotti

Test Engineer K. Whittles

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DATA SHEET

Job Number 24843-89N

Date 6.10.88 Page ___ of ___

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acto Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks POST-RADIATION / PRE-LOCA
T. ROTTI, K. WHITTLES, N. WOODWARD

I.R. @ 500 Vdc for 1 minute, immersed in water for 1 hour

		CABLE NO.		I.R. C-S *		I.R. S-M *	
		1		$>1 \times 10^{11}$		$>1.5 \times 10^{9}$	
		2		3×10^{10}		0 @ 500 Vdc 0 @ 100 Vdc	~1.4 ... with ...
		3		X		X	
		4		3×10^{11}		2×10^{9}	
		5		X		X	
		6		$>2 \times 10^{11}$		$>1.5 \times 10^{9}$	
		7		4×10^{10}		$>2 \times 10^{10}$	
		8		5×10^{10}		7.8×10^{9}	
		9		4×10^{10}		4×10^{9}	
		10		5×10^{10}		$>2.5 \times 10^{10}$	

* C-S: center conductor to shield
S-M: shield to mandrel

NOTE: CHAMBER CONDITIONS DURING THIS TEST WERE 85-90°F, ~100% R.H.

Test Technician T. Rotti

Test Engineer K. Whittles

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DATA SHEET

Job Number 24843-89N

Date 6.13.88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance /During LOCA

Mode of Operation Mandrel

Remarks During Margin Transient @ t = 5400 Seconds

I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(28 327)	(ML 574)	(28 327)	(ML 574)
	1		500 Vdc = 0 100 Vdc = 0	3.0 x 10^5	500 Vdc = 0 100 Vdc = 0	2.9 x 10^4
	2		3.0 x 10^8		↓	4.0 x 10^4
	3		X		X	
	4		2.5 x 10^7		↓	4.8 x 10^4
	5		X		X	
	6		1.0 x 10^7		↓	1.8 x 10^4
	7		500 Vdc = 0 100 Vdc = 0	4.0 x 10^6		4.0 x 10^5
	8		3.5 x 10^8			1.7 x 10^5
	9		500 Vdc = 0 100 Vdc = 0	7.8 x 10^4		1.3 x 10^5
	10		4.0 x 10^6		↓	1.5 x 10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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DATA SHEET

Job Number 24843-89N

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance During LOCA

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks Measurements made during Margin Transient, t = 10,800 (end of transient)

	CABLE NO.		I.R. C-S *		I.R. S-M *
			(ZB 327)		
	1		1.1 x 10^6		X
	2		500 Vdc = 0 100 Vdc = 0		X
	3		X		X
	4		3.0 x 10^7		X
	5		X		X
	6		1.2 x 10^6		X
	7		500 Vdc = 0 100 Vdc = 0		X
	8		3.0 x 10^8		X
	9		500 Vdc = 0 100 Vdc = 0		X
	10		500 Vdc = 0 100 Vdc = 0		X

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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DATA SHEET

Job Number 24843-89N

Date 6·14·88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Continuity

Mode of Operation Non- operating, unpowered

Remarks Post Margin transient, after new set up, chamber @ 108°F, oper T. Rotti, N. Woodward, R. Bergeron (ML574)

		CABLE NO.		CONTINUITY	(Ω)		
				CENTER	SHIELD	CENTER	SHIELD
		1		0.665	0.258	0.937	
		2		0.634	0.328	1.045	
		3		X	X	X	
		4		0.640	0.272	0.940	
		5		X	X	X	
		6		0.646	0.259	0.[illegible]41	REMOTE TEST SET UP WILL NOT ALLOW THIS READING
		7		0.630	0.258	0.924	
		8		0.644	0.264	1.147	
		9		0.640	0.235	1.185	
		10		0.628	0.235	1.161	
				at chamber		remote set up	

Test Technician T. Rotti

Test Engineer K. Whittles

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DATA SHEET

Job Number 24843-89N

Date 6·14·88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks Post margin transient
After new set up, chamber open @ 108°F (ZB 327)

	CABLE NO.		I.R. C-S * (AT CHAMBER)	I.R. C-S* (REMOTE)	I.R. S-M * (AT CHAMBER)	I.R. S-M* (REMOTE)
	1		7.0×10^9	5.0×10^9	1.7×10^9	1.8×10^9
	2		4.0×10^9	2.4×10^9	2.0×10^7	1.7×10^7
	3		X	X	X	X
	4		6.8×10^9	5.4×10^9	3.0×10^9	3.4×10^9
	5		X	X	X	X
	6		8.0×10^9	6.6×10^9	5.0×10^9	3.5×10^9
	7		8.4×10^9	5.0×10^9	1.5×10^9	1.9×10^9
	8		1.0×10^{10}	5.5×10^9	1.6×10^9	1.9×10^9
	9		7.8×10^9	5.4×10^9	1.8×10^9	2.6×10^9
	10		9.2×10^9	4.0×10^9	2.2×10^9	2.4×10^9

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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533 Main Street
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DATA SHEET

Job Number 24843-89N

Date 6·14·88 Page ___ of ___

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acto Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks SECOND TRANSIENT

I.R. @ 500 Vdc for 1 minute

T = 6300 sec 346°F 113 PSIG ZB327 MLS

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			REMOTE		REMOTE	
	1		2.2×10^7		500 Vdc = 0 100 Vdc = 0	2.5x1 W/DV
	2		5.3×10^7		500 Vdc = 0 100 Vdc = 0	1.4x1 W/DV
	3		X		X	X
	4		6×10^7		500 Vdc = 0 100 Vdc = 0	1.3x1 W/DV
	5		X		X	X
	6		2.2×10^7		500 Vdc = 0 100 Vdc = 0	1.0x1 W/DVM
	7		3.5×10^8		500 Vdc = 0 100 Vdc = 0	1.7x1 W/DVM
	8		3.9×10^8		500 Vdc = 0 100 Vdc = 0	2.1x1 W/DVM
	9		2.4×10^7		500 Vdc = 0 100 Vdc = 0	7.4x W/DVM
	10		3.5×10^8		500 Vdc = 0 100 Vdc = 0	9.6x W/DVM

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. Rotti

Test Engineer K. Whittles

EMC FORM

NTS

National
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Acton Division
533 Main Street
Acton, MA 01720

DATA SHEET

Job Number 24843-89N

Date 6·14·88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks T = 3.8 hours

I.R. @ 500 Vdc for 1 minute

ZB 327

ML57

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB 327)		(ZB 327)	(ML57
		1		8.5×10^6		500 Vdc = 0 100 Vdc = 0	1.5 x 10 W/OVL
		2		1.1×10^7		↓	1.2 x 10 W/OVL
		3		X		X	X
		4		9.5×10^7		↓	1.4 x 10 W/OVL
		5		X		X	X
		6		7.2×10^6		↓	1.4 x 10 W/OVL
		7		3.5×10^8		↓	5.4 x 1 W/OVL
		8		3.2×10^8		↓	5.6 x W/OV
		9		2.0×10^8		↓	4.8 x 10 W/OVL
		10		3.8×10^8		↓	5.1 x 10 W/OVL

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. Rossi

Test Engineer K. Whittles

EMC FORM

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DATA SHEET

Job Number 24843-89N

Date 6 15 88 Page ______ of ______

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks t = 15.4 hours

I.R. @ 500 Vdc for 1 minute

chamber T = 317°F, P = 70 psig

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				2B 327	ML 574		ML 574 DVM
		1		0.6×10^6	0.99×10^6 (DVM)	0 @ 500 Vdc 0 @ 100 Vdc	1.6×10^4
		2		4.1×10^4		↓	2.6×10^4
		3		X		X	X
		4		1.5×10^8		↓	3.7×10^4
		5		X		X	X
		6		1.8×10^5		↓	1.1×10^5
		7		4.0×10^8			1.9×10^4
		8		5.0×10^8			2.3×10^4
		9		3.9×10^8			1.6×10^4
		10		4.0×10^8		↓	2.2×10^4

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. Rossi

Test Engineer K. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks I.R. check @ t = 62,500 sec = 17.4 hours

I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *
			(ZB 327)	(ML 574)	
	1		500 Vdc = 0 100 Vdc = 0	4.0×10^5	
	2		500 Vdc = 0 100 Vdc = 0	2.2×10^5	
	3				
	4		1.45×10^8		
	5				
	6		500 Vdc = 0 100 Vdc = 0	3.8×10^5	
	7				
	8				
	9				
	10				

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks I.R. checks @ 18.3 hours

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB 327)	(ML 574 DVM)	(ZB 327)	(ML 97. DVM)
		1	1.2×10^6 →	RFW ~~2.8×10^6~~	2.8×10^6	500 Vdc: 0 100 Vdc - 0	4.2×10^5
		2		500 Vdc: 0 100 Vdc - 0	0.6×10^6	↓	3.5×10^5
		3		X		X	
		4		1.5×10^8		↓	1.0×10^6
		5		X		X	
		6		1.2×10^6	4.0×10^6	↓	1.1×10^6
		7		3.8×10^8			4.5×10^5
		8		5.0×10^8			4.3×10^5
		9		4.0×10^8			5.0×10^5
		10		3.6×10^8		↓	5.0×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [signature]

Test Engineer K. Whittles

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks @ T = 105,290 sec = 1045 hrs
T = 322 °F, P = 77 Psig

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB 327)	(ML574)	(ZB 327)	(ML574)
		1		2.3×10^6	—	500 Vdc = 0 100 Vdc = 0	3.2×10^4 ~~1.1×10^4~~
		2		1.2×10^8	—	↓	3.8×10^4
		3		X		X	
		4		1.4×10^8	—	↓	1.1×10^4
		5		X		X	
		6		3.5×10^7	—	↓	4.6×10^4
		7		2.6×10^8	—	↓	7.3×10^3
		8		3.6×10^8	—	↓	2.9×10^3
		9		2.9×10^8	—	↓	2.0×10^4
		10		2.6×10^8	—	↓	5.5×10^3

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [signature]

Test Engineer K. Whittier

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks @ t = 142,210 seconds
T = 317°F, P = 70 psig

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB327)	(ML574)	(ZB327)	(ML574)
	1		1.1x10^6	—	500 Vdc = 0 100 Vdc = 0	3.9x10^4
	2		2.4x10^6	—	↓	4.1x10^4
	3		X		X	
	4		1.7x10^8	—	↓	1.8x10^4
	5		X		X	
	6		2.2x10^6	—	↓	8.0x10^3
	7		4.4x10^8	—	↓	1.2x10^4
	8		6.8x10^8	—	↓	8.5x10^3
	9		5.0x10^8	—	↓	2.8x10^4
	10		4.5x10^8	—	↓	1.0x10^4

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. Rossi

Test Engineer K. Whittier

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks t = 191,300 seconds. (10:05 pm)

I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(2B 327)	(ML 574)	(2D 327)	(ML 574)
	1		2.1×10^7	—	500 Vdc = 0 100 Vdc = 0	1.3×10^5
	2		6.4×10^5 @ 500 Vdc 8.2×10^6 @ 100 Vdc		↓	3.4×10^4
	3		X		X	
	4		2.9×10^8	—	↓	8.3×10^4
	5		X		X	
	6		2.0×10^7	—	↓	6.2×10^4
	7		7.3×10^8	—		4.1×10^3
	8		9.0×10^8	—		8.6×10^3
	9		6.7×10^8	—		1.3×10^4
	10		5.7×10^8	—	↓	5.6×10^3

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [signature]

Test Engineer [signature]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks 230,270 sec
8:58 AM

		CABLE NO.		I.R. C-S *		I.R. S-M *	ML 574
				28-327		28 327	
		1		3.5×10^7		[illegible]	2.5×10^5
		2		2×10^6		↓	3.0×10^4
		3					
		4		3.5×10^8		↓	1.1×10^5
		5					
		6		5×10^7		↓	1.2×10^5
		7		7.8×10^8			3.1×10^4
		8		1.2×10^9			3.2×10^4
		9		5×10^8			6×10^3
		10		7.4×10^8		↓	2.3×10^4

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician (signature)

Test Engineer (signature)

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				Z8327		Z8327	ML574
		1		8×10^{7}		500V 0:0 100V 0:0	5.4×10^{5}
		2		0	4.5×10^{3}	↓	2.5×10^{4}
		3				X	
		4		7.4×10^{8}		↓	1.8×10^{5}
		5				X	
		6		8×10^{8}		↓	2.0×10^{5}
		7		1.8×10^{9}		↓	5.8×10^{4}
		8		24×10^{9}		↓	6.1×10^{4}
		9		6×10^{8}		↓	3.4×10^{4}
		10		1.5×10^{9}		↓	5.7×10^{4}

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [signature]

Test Engineer [signature]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 437,000 sec 6:25 PM

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
			28327			28327	mc 574
		1		2×10^8		500 Vdc = 0, 100 Vdc = 0	4.8×10^5
		2		3×10^6		↓	2.2×10^4
		3					
		4		5×10^8		↓	1.9×10^5
		5					
		6		2.5×10^8		↓	2.3×10^5
		7		9.2×10^8			5×10^4
		8		1.6×10^9			5.3×10^4
		9		7.4×10^8			3.4×10^4
		10		1.0×10^9		↓	5.0×10^4

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [illegible]

Test Engineer [illegible]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 502,870 secs 12:35pm

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				ZB327		ZB327	ML 574
		1		1.8×10^8		500VDC ≈ 0 100VDC ≈ 0	$.72 \times 10^6$
		2		1.2×10^6		↓	1.8×10^3
		3					
		4		5×10^8		↓	$.53 \times 10^6$
		5					
		6		5×10^7		↓	$.40 \times 10^6$
		7		9×10^8		↓	$.17 \times 10^6$
		8		1.4×10^9		↓	$.18 \times 10^6$
		9		7×10^8		↓	$.16 \times 10^6$
		10		9.6×10^8		↓	$.17 \times 10^6$

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [illegible]

Test Engineer [illegible]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 575895 icc 8:55 AM

I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			Z8327		Z8327	ML595
	1		1.4x10^8		[illegible]	.68x10^6
	2		3x10^6		↓	2.9x10^3
	3		X		X	
	4		4x10^8		↓	.50x10^6
	5		X		X	
	6		11x10^7			.51x10^6
	7		9x10^8			.17x10^6
	8		1.5x10^9			.17x10^6
	9		7.4x10^8			.16x10^6
	10		11x10^9		↓	.15x10^6

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [signature]

Test Engineer [signature]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 661,840 sec 9:00AM

I.R. @ 500 Vdc for 1 minute

CABLE NO.	I.R. C-S *		I.R. S-M *	
	ZB327		ZB327	ML545
1	1.7x10^8		[illegible]	.71x10^6
2	1.4x10^6		↓	1.2x10^3
3	X		X	
4	5x10^8		↓	.42x10^6
5	X		X	
6	3x10^7		↓	.50x10^6
7	10x10^8			.17x10^6
8	1.7x10^9			.16x10^6
9	8x10^8			.15x10^6
10	11x10^9		↓	.16x10^6

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [illegible]

Test Engineer [illegible]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks [illegible] 8:20 Am

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				ZB329		ZB327	ML545
		1		1.5×10^8		[illegible]	$.75 \times 10^6$
		2		3×10^6		↓	1.2×10^3
		3		X		X	
		4		5×10^8		↓	$.37 \times 10^6$
		5		X		X	
		6		6×10^8		↓	$.62 \times 10^6$
		7		5×10^8		↓	$.16 \times 10^6$
		8		10×10^8		↓	$.16 \times 10^6$
		9		5×10^8		↓	$.16 \times 10^6$
		10		7×10^8		↓	$.15 \times 10^6$

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician [signature]

Test Engineer [signature]

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(28 327)		(28 327)	(ML 545)
	1		6.0 x10^6		500 Vdc = 0 100 Vdc = 0	6.7x10^5
	2		3.5x10^6		↓	253.5
	3		X		X	
	4		5.2x10^8		↓	3.2x10^5
	5		X		X	
	6		5.8x10^8		↓	4.4x10^5
	7		8.4x10^8			1.4x10^5
	8		1.6x10^9			1.4x10^5
	9		8.2x10^8			9.8x10^4
	10		1.4x10^9		↓	1.0x10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti, B. Drain

Test Engineer K. G. Whittles

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks Prior to condition change 10:45 PM

I.R. @ 500 Vdc for 1 minute

CABLE NO.	I.R. C-S *	I.R. S-M *	
	(28327)	(28327)	(ML 545)
1	3.0×10^6	500 Vdc = 0 100 Vdc = 0	4.0×10^5
2	3.0×10^6	↓	2.6×10^3
3	X	X	
4	5.2×10^8	↓	6.1×10^5
5	X	X	
6	5.5×10^8	↓	6.0×10^5
7	8.8×10^8		3.7×10^4
8	1.5×10^9		3.8×10^4
9	7.4×10^8		1.0×10^5
10	1.2×10^9	↓	1.0×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 3:00 AM

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	(m.54
		1		2.5×10^6		500 Vdc = 0 100 Vdc = 0	4×10^5
		2		3.0×10^6		↓	2.0x10
		3					
		4		5.4×10^8		↓	5.8x1(
		5					
		6		5.2×10^8		↓	5.7x10
		7		8.0×10^8			3.2x1(
		8		1.5×10^9			3.2x1(
		9		7.2×10^8			1.0x10
		10		1.0×10^9		↓	1.0x10

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Act[illegible] Test Procedure 24843-89M

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 7:45 PM

I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(28327)		(28327)	
	1		1.2×10^9		500 Vdc = 0 100 Vdc = 0	3.8 x[illegible]
	2		1.0×10^8		↓	5.3 x[illegible]
	3		X		X	
	4		2.0×10^9		↓	4.0 x 1[illegible]
	5		X		X	
	6		1.1×10^9		↓	2.9 x 1[illegible]
	7		1.8×10^9		↓	3.0 x 1[illegible]
	8		3.0×10^9		↓	3.0 x 1[illegible]
	9		2.0×10^9		↓	2.7 x 1[illegible]
	10		2.5×10^9		↓	2.9 x 10

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 6:30 AM (243°F, 10.5 Psig)

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	(ML5·
		1		1.2×10^9		500 Vdc = 0 100 Vdc = 0	5.1x1
		2		2.0×10^6		↓	5.3x
		3		X		X	
		4		1.9×10^9		↓	4.1x1
		5		X		X	
		6		1.2×10^9		↓	4.0x1
		7		1.8×10^9		↓	3.2x1(
		8		2.5×10^9		↓	3.0x1(
		9		2.2×10^9		↓	2.7x1(
		10		2.5×10^9		↓	2.9x..

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Actc Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks (243 °F, 10.3 Psig) I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(28327)		(28327)	(ML 5[illegible]
	1		1.1 x 10^9		500 Vdc = 0 100 Vdc = 0	2.5 x 1[illegible]
	2		2.0 x 10^6		↓	1.0 x 10
	3		X		X	
	4		1.7 x 10^9		↓	2.1 x 1[illegible]
	5		X		X	
	6		1.2 x 10^9		↓	2.0 x 10[illegible]
	7		1.9 x 10^9		↓	2.0 x 10[illegible]
	8		2.5 x 10^9		↓	2.0 x 10[illegible]
	9		2.2 x 10^9		↓	2.0 x 10
	10		2.5 x 10^9		↓	2.0 x 10[illegible]

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Act Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks (243 °F, 10.2 psig) I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	(#LS
		1		1.3×10^9		1.6×10^6	1.4x
		2		1.5×10^9		500 Vdc = 0 100 Vdc = 0	1.3x
		3					
		4		1.5×10^9		5.0×10^5	1.1x10
		5					
		6		1.1×10^9		2.0×10^5	1.7x
		7		2.0×10^9		500 Vdc = 0 100 Vdc = 0	2.0x
		8		2.5×10^9		↓	2.0x1
		9		1.9×10^9		↓	1.8x1
		10		2.0×10^9		↓	2.0x1

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acto
Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks 4:00 PM 1 hour before 15 day shutdown

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	(ML57-
		1		1.2x10^9		1.6x10^6	1.1x10
		2		1.5x10^9		500 Vdc = 0 100 Vdc = 0	1.5x10
		3		X		X	
		4		1.5x10^9		1.6x10^6	1.5x10
		5		X		X	
		6		1.2x10^9		2.0x10^6	1.2x10
		7		1.8x10^9		500 Vdc = 0 100 Vdc = 0	2.0x10
		8		2.4x10^9		↓	2.0x10
		9		1.8x10^9		↓	1.8x10
		10		1.9x10^9		↓	2.0x10

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Ac[illegible] Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks Measurements taken @ chamber. t= 106°F, 0 psig

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	
		1		6.0x10^9		2.0x10^8	
		2		3.0x10^9		1.0x10^6	
		3		X		X	
		4		5.0x10^9		8.0x10^8	
		5		X		X	
		6		2.5x10^9		2.5x10^8	
		7		3.0x10^9		3.5x10^6	
		8		4.5x10^9		1.3x10^6	
		9		3.0x10^9		2.5x10^6	
		10		4.0x10^9		2.5x10^6	

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Act Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

I.R. @ 500 Vdc for 1 minute

Remarks Measurements taken remote (106°F, 0 psig)

CABLE NO.	I.R. C-S *	I.R. S-M *
	(28327)	(28327)
1	3.5x10^9	2.5x10^8
2	2.5x10^9	1.0x10^6 (8 struck, 6 KGW)
3	X	X
4	4.0x10^9	5.0x10^8
5	X	X
6	2.4x10^9	3.0x10^7
7	3.0x10^9	4.0x10^6
8	4.0x10^9	1.5x10^7
9	3.5x10^9	2.5x10^6
10	4.0x10^9	3.0x10^6

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Actc Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks Post 15 Day test, after 1 hour soak (at chamber)

I.R. @ 500 Vdc for 1 minute

CABLE NO.	I.R. C-S	I.R. S-M *	
	(28327)	(28327)	
1	5.0×10^9	1.5×10^8	
2	6.0×10^9	500 Vdc = 0 100 Vdc = 0	6.1×10
3			
4	4.5×10^9	$> 1 \times 10^8$	
5			
6	3.5×10^9	$> 2.0 \times 10^7$	
7	6.5×10^9	3.5×10^6	
8	1.0×10^{10}	1.4×10^7	
9	5.0×10^9	3.0×10^6	
10	6.5×10^9	2.5×10^6	

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acto
Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel

Remarks Post 15 Day test, after 1 hour soak (remote)

I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	(MLS7
		1		7.4×10^9		$>5.0 \times 10^7$	
		2		4.5×10^9		500 Vdc = 0 100 Vdc = 0	>5.0
		3		X		X	
		4		6.2×10^9		$>1.0 \times 10^7$	
		5		X		X	
		6		4.5×10^9		$>1.0 \times 10^8$	
		7		6.4×10^9		3.5×10^6	
		8		1.0×10^{10}		1.4×10^7	
		9		6.0×10^9		3.5×10^6	
		10		7.0×10^9		2.5×10^6	

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer PUBLIC SERVICE OF NEW HAMPSHIRE

Specification IEEE 323, IEEE 383, NTS/ACTON Test Procedure 24843-89N

Test Sample Coaxial Cable

Model/Serial Number RG 58

Test Dielectric Strength

Mode of Operation Mandrel

Remarks 3200 Vac for 5 min(Immersed)

	CABLE NO.		CENTER COND TO SHIELD leakage current			
	1		2.2mA AC			
	2		2.4mA AC			
	7		2.8mA AC			
	8		2.9mA AC			

Test Technician [signature]

Test Engineer [signature]

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10

Remarks Chamber T = 251°F, P = 28 psig

I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *
			(28327)		(28327)
	1		X		X
	2		X		X
	3		X		X
	4		2.8x10^9		1.8x10^6
	5		X		X
	6		1.9x10^9		1.5x10^6
	7		X		X
	8		X		X
	9		3.2x10^9		1.6x10^6
	10		4.0x10^9		1.7x10^6

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10)

I.R. @ 500 Vdc for 1 minute

Remarks Chamber T = 249 °F, P = 22 psig

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB 327)		(ZB327)	(ML574)
		1		X		X	
		2		X		X	
		3		X		X	
		4		2.5×10^9		1.6×10^6	
		5		X		X	
		6		2.0×10^9		1.8×10^6	
		7		X		X	
		8		X		X	
		9		2.7×10^9		500 Vdc = 0 100 Vdc = 0	1.0×10^5
		10		3.9×10^9		500 Vdc = 0 100 Vdc = 0	1.1×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

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Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10

I.R. @ 500 Vdc for 1 minute

Remarks

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB327)		(ZB327)	(ML574
	1					
	2					
	3					
	4		2.4x10^9		1.2x10^6	
	5					
	6		1.9x10^9		1.8x10^6	
	7					
	8					
	9		2.5x10^9		500Vdc=0 100 Vdc=0	1.0x10^5
	10		3.8x10^9		500Vdc=0 100 Vdc=0	1.0x10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1

I.R. @ 500 Vdc for 1 minute

Remarks

CABLE NO.	I.R. C-S *	I.R. S-M *	
	(ZB327)	(ZB327)	
1	X	X	
2	X	X	
3	X	X	
4	2.5×10^9	1.8×10^6	
5	X	X	
6	1.9×10^9	500 Vdc = 0 100 Vdc = 0	1.9×10^4
7	X	X	
8	X	X	
9	2.4×10^9	500 Vdc = 0 100 Vdc = 0	1.9×10^5
10	3.0×10^9	500 Vdc = 0 100 Vdc = 0	2.0×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1

Remarks I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB327)		(ZB327)	(MLS4
	1		X		X	
	2		X		X	
	3		X		X	
	4		3.0×10^9		1.8×10^6	
	5		X		X	
	6		2.5×10^9		500 Vdc = 0 100 Vdc = 0	8.0 x 10
	7		X		X	
	8		X		X	
	9		3.4×10^9		500 Vdc = 0 100 Vdc = 0	1.8×10^5
	10		3.0×10^9		500 Vdc = 0 100 Vdc = 0	1.9×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843 89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10

Remarks I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	(ML547
		1					
		2					
		3					
		4		2.5×10^{9}		2.0×10^{6}	
		5					
		6		2.0×10^{9}		500 Vdc = 0 100 Vdc = 0	4.7×10^{3}
		7					
		8					
		9		2.4 × [illegible]		500 Vdc = 0 100 Vdc = 0	1.6×10^{5}
		10		2.5 × 1[illegible]		500 Vdc = 0 100 Vdc = 0	1.7×10^{5}

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1(

Remarks I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB 327)		(ZB327)	(ML 547
	1		X	X	X	
	2		X	X	X	
	3		X	X	X	
	4		1.8×10^9		500 Vdc = 0 100 Vdc = 0	4.5×10^3
	5		X	X	X	
	6		1.6×10^9		500 Vdc = 0 100 Vdc = 0	6.0×10^3
	7		X	X	X	
	8		X	X	X	
	9		1.7×10^9		500 Vdc = 0 100 Vdc = 0	1.5×10^5
	10		1.6×10^9		500 Vdc = 0 100 Vdc = 0	1.6×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10

Remarks I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB327)		(ZB327)	(ML574
	1		X	X	X	
	2		X	X	X	
	3		X	X	X	
	4		1.6×10^9		500 Vdc = 0 100 Vdc = 0	4.2×10^3
	5		X	X	X	
	6		1.6×10^9		500 Vdc = 0 100 Vdc = 0	5.0×10^3
	7		X	X	X	
	8		X	X	X	
	9		1.7×10^9		500 Vdc = 0 100 Vdc = 0	1.2×10^5
	10		1.4×10^9		500 Vdc = 0 100 Vdc = 0	1.4×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

EMC FORM 2

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1[illegible]

Remarks I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB 327)		(ZB327)	(ML574
	1		X		X	
	2		X		X	
	3		X		X	
	4		1.9 x 10^9		500 Vdc = 0 100 Vdc = 0	5.4 x 10^3
	5		X		X	
	6		1.6 x 10^6		500 Vdc = 0 100 Vdc = 0	1.5 x 10^4
	7		X		X	
	8		X		X	
	9		1.8 x 10^9		500 Vdc = 0 100 Vdc = 0	1.4 x 10^5
	10		1.6 x 10^9		500 Vdc = 0 100 Vdc = 0	1.5 x 10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti, L. Wilkens

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1[illegible]

I.R. @ 500 Vdc for 1 minute

Remarks

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB327)		(ZB327)	(ML57A
	1		X		X	
	2		X		X	
	3		X		X	
	4		2.0x10^9		500 Vdc = 0 100 Vdc = 0	3.5x10^3
	5		X		X	
	6		1.7x10^9		500 Vdc = 0 100 Vdc = 0	3.7x10^4
	7		X		X	
	8		X		X	
	9		1.8x10^9		500 Vdc = 0 100 Vdc = 0	1.3x10^5
	10		1.8x10^9		500 Vdc = 0 100 Vdc = 0	1.3x10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti, L. Wilkens

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10

Remarks I.R. @ 500 Vdc for 1 minute

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB327)		(ZB327)	(ML574
		1		X	X	X	
		2		X	X	X	
		3		X	X	X	
		4		2.0×10^9		500 Vdc = 0 100 Vdc = 0	3.2×10^3
		5		X	X	X	
		6		1.6×10^9		500 Vdc = 0 100 Vdc = 0	3.4×10^4
		7		X	X	X	
		8		X	X	X	
		9		1.6×10^9		500 Vdc = 0 100 Vdc = 0	1.2×10^5
		10		1.7×10^9		500 Vdc = 0 100 Vdc = 0	1.3×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1

I.R. @ 500 Vdc for 1 minute

Remarks

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(28327)		(28327)	
		1		X		X	
		2		X		X	
		3		X		X	
		4		1.3×10^9		500 Vdc = 0 100 Vdc = 0	2.7×10^4
		5		X		X	
		6		1.1×10^9		500 Vdc = 0 100 Vdc = 0	5.8×10^4
		7		X		X	
		8		X		X	
		9		1.2×10^9		500 Vdc = 0 100 Vdc = 0	1.5×10^5
		10		1.1×10^9		500 Vdc = 0 100 Vdc = 0	1.6×10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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DATA SHEET

Job Number 24843-89N

Date 7.13.88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10)

Remarks I.R. @ 500 Vdc for 1 minute

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB327)		(ZB327)	(ML574)
	1		X		X	
	2		X		X	
	3		X		X	
	4		1.5 x 10^9		500 Vdc = 0 100 Vdc = 0	2.8 x 10^4
	5		X		X	
	6		1.3 x 10^9		500 Vdc = 0 100 Vdc = 0	6.0 x 10^4
	7		X		X	
	8		X		X	
	9		1.6 x 10^9		500 Vdc = 0 100 Vdc = 0	1.5 x 10^5
	10		1.4 x 10^9		500 Vdc = 0 100 Vdc = 0	1.6 x 10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10

I.R. @ 500 Vdc for 1 minute

Remarks

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB327)		(ZB327)	(ML574)
		1					
		2					
		3					
		4		1.4×10^9		500 Vdc = 0 100 Vdc = 0	2.7×10^4
		5					
		6		1.3×10^9		500 Vdc = 0 100 Vdc = 0	7.2×10^4
		7					
		8					
		9		1.3×10^9		500 Vdc = 0 100 Vdc = 0	9.1×10^4
		10		1.4×10^9		500 Vdc = 0 100 Vdc = 0	9.1×10^4

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Job Number 24843-89N
Date 7.15.88 Page ____ of ____
Customer Public Service of New Hampshire
Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N
Test Sample Coaxial Instrument Cables
Model/Serial Number RG 58
Test Insulation Resistance
Mode of Operation Mandrel (4,6,9,10)
I.R. @ 500 Vdc for 1 minute
Remarks

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB 327)		(ZB327)	(ML574)
		1		X		X	
		2		X		X	
		3		X		X	
		4		1.4×10^9		500 Vdc = 0 100 Vdc = 0	2.5×10^4
		5		X		X	
		6		1.4×10^9		500 Vdc = 0 100 Vdc = 0	6.8×10^4
		7		X		X	
		8		X		X	
		9		1.2×10^9		500 Vdc = 0 100 Vdc = 0	8.7×10^4
		10		1.4×10^9		500 Vdc = 0 100 Vdc = 0	9.0×10^4

* C-S: center conductor to shield
S-M: shield to mandrel

Test Technician T. J. Rotti
Test Engineer K. G. Whittles

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Date 7.15.88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance (@ REMOTE SET UP)

Mode of Operation Mandrel (4,6,9,

I.R. @ 500 Vdc for 1 minute

Remarks FINAL I.R. @ END OF 30 DAYS
CHAMBER T=241°F, P=10 PSIG

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB327)		(ZB327)	(ML 504
		1		X		X	
		2		X		X	
		3		X		X	
		4		1.9x10^9		500 Vdc = 0 100 Vdc = 0	2.6x10^4
		5		X		X	
		6		1.4x10^9		500 Vdc = 0 100 Vdc = 0	4.2x10^4
		7		X		X	
		8		X		X	
		9		1.7x10^9		500 Vdc = 0 100 Vdc = 0	1.6x10^5
		10		1.2x10^9		500 Vdc = 0 100 Vdc = 0	1.6x10^5

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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DATA SHEET

Job Number 24843-89N

Date 7.16.88 Page ____ of ____

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,10)

I.R. @ 500 Vdc for 1 minute

Remarks POST 30 DAY LOCA, @ CHAMBER (SAMPLES NOT IMMERSED)

	CABLE NO.		I.R. C-S *		I.R. S-M *	
			(ZB 327)		(ZB327)	(ML574)
	1		X		X	
	2		X		X	
	3		X		X	
	4		2.8x10^9		500 Vdc = 0 100 Vdc = 0	3.1 x10^4
	5		X		X	
	6		2.5x10^9		500 Vdc = 0 100 Vdc = 0	4.9 x10^4
	7		X		X	
	8		X		X	
	9		2.5x10^9		500 Vdc = 0 100 Vdc = 0	1.3 x10^7
	10		2.5x10^9		500 Vdc = 0 100 Vdc = 0	1.0 x10^7

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Job Number 24843-89N

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1[illegible]

I.R. @ 500 Vdc for 1 minute

Remarks POST 30 DAY LOCA, REMOTE (SAMPLES NOT IMMERSED)

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB327)		(ZB327)	(ML504[illegible]
		1					
		2					
		3					
		4		2.5×10^9		500 Vdc = 0 100 Vdc = 0	3.3×10^6
		5					
		6		2.5×10^9		500 Vdc = 0 100 Vdc = 0	6.1×10^4
		7					
		8					
		9		2.5×10^9		500 Vdc = 0 100 Vdc = 3×10^6	1.4×10^7
		10		2.2×10^9		500 Vdc = 0 100 Vdc = 1.1×10^6	1.1×10^7

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Roiti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1

I.R. @ 500 Vdc for 1 minute

Remarks POST 30 DAY LOCA, @ CHAMBER (AFTER 1 HOUR SOAK)

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB 327)		(ZB327)	(ML547
		1					
		2					
		3					
		4		1.8×10^9		500 Vdc = 0 100 Vdc = 0	1.1×10^5
		5					
		6		1.4×10^9		500 Vdc = 0 100 Vdc = 0	8.2×10^3
		7					
		8					
		9		1.6×10^9		500 Vdc = 0 100 Vdc = 9.5×10^4	1.6×10^7
		10		1.6×10^9		500 Vdc = 0 100 Vdc = 1.9×10^6	1.5×10^7

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Insulation Resistance

Mode of Operation Mandrel (4,6,9,1

I.R. @ 500 Vdc for 1 minute

Remarks POST 30 DAY LOCA, REMOTE (AFTER 1 HOUR SOAK)

		CABLE NO.		I.R. C-S *		I.R. S-M *	
				(ZB327)		(ZB327)	(ML547)
		1					
		2					
		3					
		4		1.5×10^9		500 Vdc = 0 100 Vdc = 0	1.2×10^4
		5					
		6		1.3×10^9		500 Vdc = 0 100 Vdc = 0	1.0×10^4
		7					
		8					
		9		1.5×10^9		500 Vdc: 8×10^5 100 Vdc = 4.5×10^6	1.0×10^7
		10		1.4×10^9		500 Vdc = 6×10^5 100 Vdc = 1.6×10^6	1.1×10^7

* C-S: center conductor to shield

S-M: shield to mandrel

Test Technician T. J. Rotti

Test Engineer K. G. Whittles

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Job Number 24843-89N

Date 7.16.88 Page ___ of ___

Customer Public Service of New Hampshire

Specification IEEE 323, IEEE 383, NTS/Acton Test Procedure 24843-89N

Test Sample Coaxial Instrument Cables

Model/Serial Number RG 58

Test Continuity

Mode of Operation Non- operating, unpowered

Remarks POST 30 DAY LOCA, @ CHAMBER, AFTER 1 HOUR SOAK

	CABLE NO.		CONTINUITY			
			CENTER CONDUCTOR	SHIELD		
	1		X	X		
	2		X	X		
	3		X	X		
	4		0.630	0.296		
	5		X	X		
	6		0.608	0.297		
	7		X	X		
	8		X	X		
	9		0.610	0.264		
	10		0.605	0.243		

Test Technician T. J. Rossi

Test Engineer K. G. Whittles

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DATA SHEET

Job Number 24843-89N

Date 7·16·88 Page ____ of ____

Customer N.H. YANKEE (PSNH)

Specification NTS T.P 24843

Test Sample COAXIAL CABLES

Model/Serial Number RG 58 COAX CABL

Test VOLTAGE WITHSTAND @ 3200 Vac

Mode of Operation MANDREL, 40 DIAMETER

Remarks IMMERSED IN WATER FOR 5 MINUTES

	SAMPLE NO.	TEST VOLTAGE	LEAKAGE CURRENT				
			CENTER COND TO SHIELD				
	4	3200 Vac	2.2 mAac				
	6	3200 Vac	2.5 mAac				
	9	3200 Vac	3.1 mAac				
	10	3200 Vac	2.9 mAac				

Test Technician T.J. Potti

Test Engineer [signature]

EMC F01

Reference 3

EGFILE No 113-19-02
REFERENCE 3

VU 030131

AUG 24 '82 G.M. Aggarwal

International Telephone and Telegraph Corporation

RECEIVED BY U.E.&C INC.
AUG 27 1982

PSNH CONTROLLED CORRESPONDENCE 8/82			
RESPONSE REQ'D YES			
SUBJ FILE			
RESPONSE BY SWW		JR SLOTTERBACK	11UO
AM EBNER	06U8	WP MC KENNA	15MM
RB CHEYNE	12U8	HH KATZ	[illegible]
JL CASOLARI	06U1	RA MABRY	06U8

August 23, 1982

OCT 1982

172 Sterling Street
Clinton, MA 01518
(617)365-6331 Telex 920451
TWX 710-347-1736

RESPONSE YES

PR DCC	06U1	✓	RF PERRY	07U8
KM KALAWADIA	06U4		RH TOLAND	12U1
RP NEUSTADTER	06U3		RJ MAZZA	05U1
WE HAUG	05U0		TE POLQUIN	12U5
DC BOYLE	06U4	✓	RA REBEL	FIELD
JJ PARISANO	06U5		RH BRYANS	FIELD
RJ AGNER	05U5		RE KEANE	12U8
JJ GRANSAMMER	05U4		DE MC GARRIGAN	14U8
WITH ENCLOSURE			ADVANCED COPY	
PO EGNR 113-19			GW VICKERS SVZ	

Mr. Girish M. Aggarwal
United Engineers and Constructors, Inc.
30 South 17th Street
Philadelphia, PA 19101

RECEIVED BY ESRC AUG 31 1982

Dear Mr. Aggarwal:

As a follow-up to our pre-award meeting of August 12th, I have investigated several of your questions and provided the necessary answers below.

F-A5550-2 262-01 1179-01 33263-01

1. Provide extrapolation of RG11 triax, to RG11 coax LOCA data provided by ITT. ITT Surprenant chose to LOCA test RG11 coax and RG59 coax since they are the two constructions we considered most commonly used by nuclear facilities. Since LOCA testing is very expensive to the manufacturer, only the best representative sample of similar constructions can be feasibly tested. Testing all constructions would be economically unfeasible.

Specifically addressing RG11 triax, we feel that our coaxial LOCA data is more than adequate. The dimensions of the 11 coax and 11 triax are identical through the first shield. Couple this with the fact that the triax has an additional shield and jacket of identical material as the shield and jacket of the LOCA approved coax, and our conclusion is LOCA approval for RG11 triax. As additional information, I have enclosed a copy of our 1979 LOCA data when we did have the RG11 triax approved. Please note that the only reason we were not able to use this data, was that we did not have a main stream line break at 390°F. Both RG59U and RG11U coax are covered by our new data enclosed.

We feel similar concerning RG58C/U LOCA approval. Since we have chosen RG59 for our LOCA program and have that approval, and RG58 has similar construction details, we are confident that, had it been submitted, it also would have been approved.

The 2/C #2 AWG 1000 volt crosslinked polyolefin with a hypalon jacket cable, which we propose to supply for items 11 & 12 of your inquiry will be covered under a separate LOCA approval, which we expect to receive from Franklin Institute within 2 weeks.

2. Certify thermal aging of LOCA samples.
   ITT Surprenant, hereby, certifies that we did thermal age, as specified, samples of all necessary cables submitted to Franklin Institute for SLB/LOCA simulation during 1982.

3. Basis for pre-aging 150°C for 168 hours.
   I have attached a copy of our Arrhenius data showing that using a very conservative end of life value of 50% insulation elongation and testing at 158°C, 136°C, and 121°C, the cables have a projected 40 year life of 83°C. Our pre-aging 150°C at 168 hours gives us a 40 year life at 75°C.

4. Aged and Unaged cable samples must pass the flame test requirements Para. 2.5.6 (single conductors).
   This is to certify that all cables RG11 triax, RG11 coax, RG59 coax, RG58 coax, and our proposed 2C #2 AWG cross-lined polyolefin insulated cable pass the single conductor flame tests referenced in Para. 2.5.6 for both aged and unaged samples.

5. IEEE 383 vertical flame tests.
   Per IEEE 383 Table I vertical flame test refers to Para. 2.5.6. Para. 2.5.6 is the single conductor wire test in accordance with ASTM-D2220-68 referenced above.

6. All LOCA test simulation is done with Gamma radiation, address Beta requirement per Para 2.4.1.2 "Radiation Beta" 1.4×10^8 RADS over 12 months at a maximum rate of 5.2×10^6 R/HR.

   It is our opinion that Gamma radiation is more severe (penetrating) than Beta. We, therefore (worst case) have considered the total dosage to be cumulative Gamma, considering the total Gamma plus Beta during design basis event to be 1.5×10^8 RADS. We feel very confident that our referenced coaxial cables can more then withstand both the Gamma rates of exposure and the total exposure.

7. Chemical flow rate 0.42 gpm.
   Since our material was tested using a chemical flow rate of 2.5 gpm, we feel 0.42 gpm would present no problems.

8. Extrapolate 1 year post LOCA.
   Our LOCA data previously submitted is only 30 days in length. Although we have not received final printed reports from Franklin Institute, we have received verbal confirmation that we have successfully passed our 100 day LOCA submittal. We will continue this testing until 1 year is reached. Until time allows the ...ance of the test, we submit our IR values as extrapolated proof o. 1 year acceptability.

The insulation resistance at the start of test was 1120 meg-ohms. The insulation resistance after 100 days was 1010 meg-ohms. Extrapolating this data, our I.R. after 1 year would be approximately 700 meg-ohms.

9. Long-term water absorption data.
   Attached are long-term water absorption data for Exane 20 mil wall.

I believe this should answer most of the outstanding questions. If either yourself or George Morris have additional questions, please do not hesitate to call.

Best Regards,

Joel Sibley

Joel Sibley
Industry Manager
Engineered Products

JS/dw

Attachment

page 3 of 6

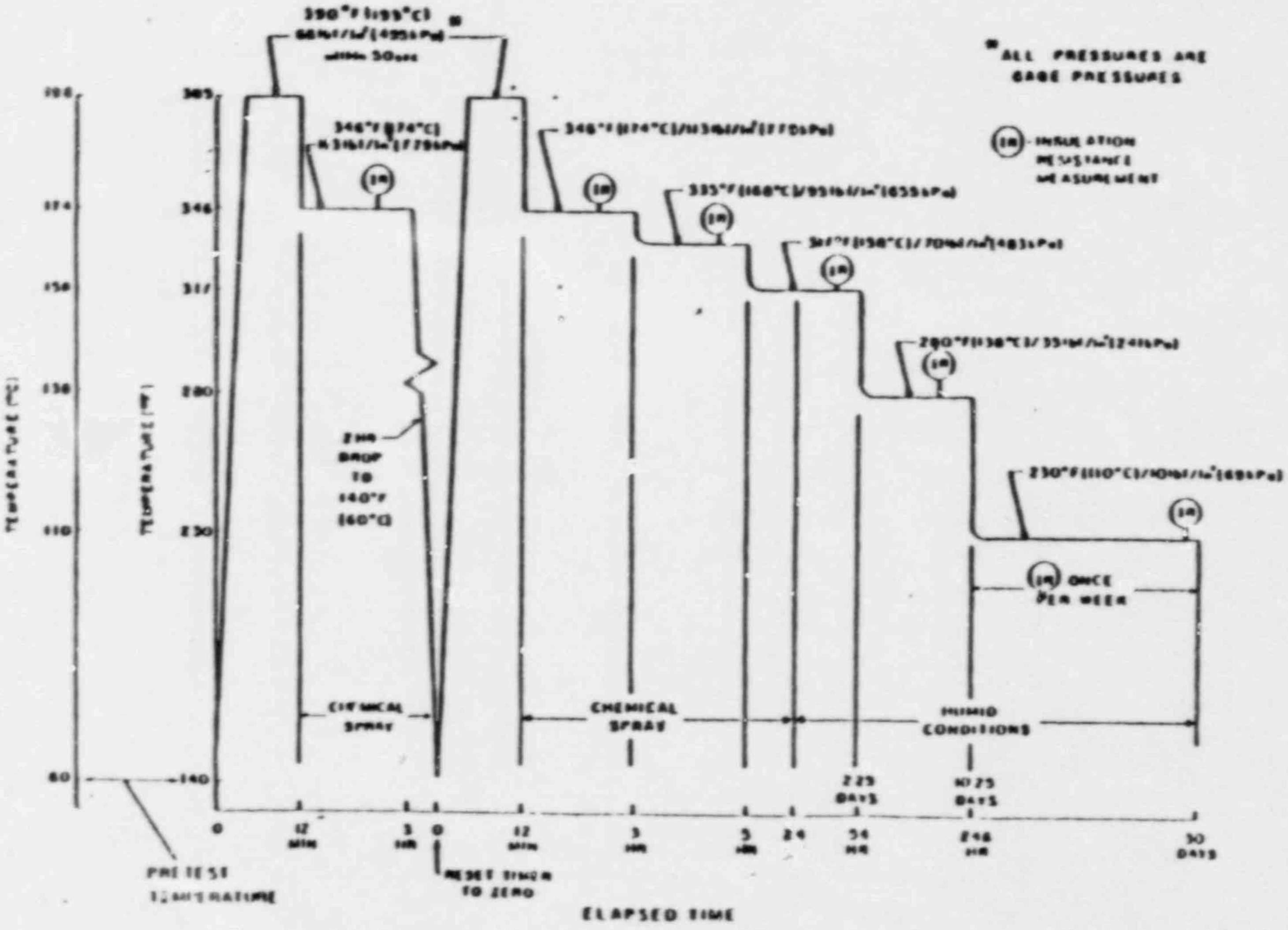
ALL PRESSURES ARE GAGE PRESSURES
IR - INSULATION RESISTANCE MEASUREMENT
IR ONCE PER WEEK
CHEMICAL SPRAY
HUMID CONDITIONS
ELAPSED TIME
PRETEST TEMPERATURE
RESET TIMER TO ZERO
DROP TO 140°F (60°C)
225 DAYS
10.25 DAYS
30 DAYS

Figure 4

ITT

International Telephone and Telegraph Corporation

Surprenant Division

172 Sterling Street
Clinton, MA 01510
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TWX 710-347-1736

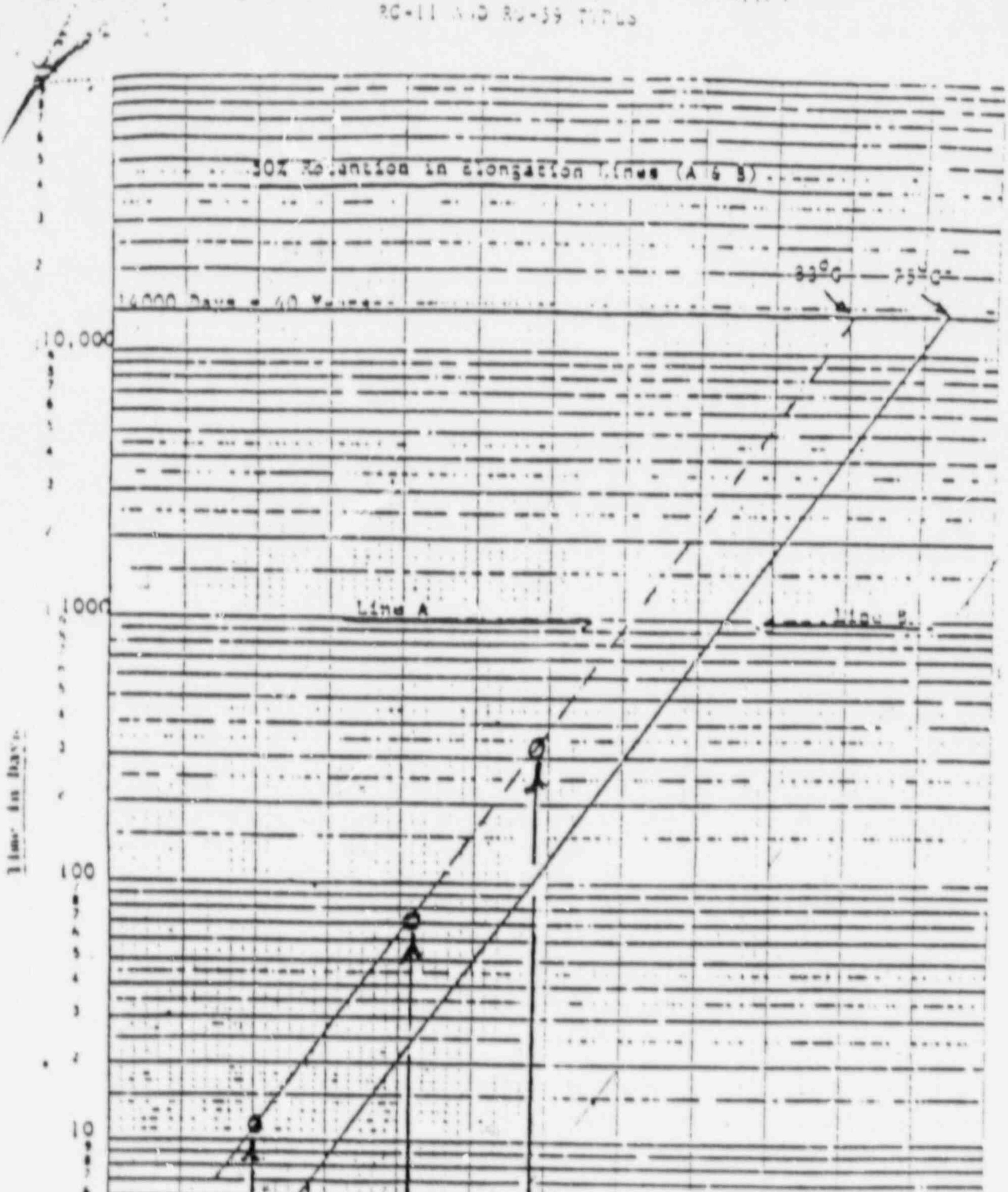
THERMAL AGING CHARACTERISTICS OF IRRADIATED CROSS-LINKED POLYETHYLENE INSULATION, FOR COAXIAL CABLES, USING THE ARRHENIUS TECHNIQUE

The thermal aging properties of irradiated cross-linked polyethylene insulation, for RG-11 AND RG-59 type coaxial and triaxial cables, were determined using the Arrhenius technique of accelerated aging for these materials.

Samples of insulated conductor were aged in a circulating air oven, set at 158°C, 136°C and 121°C. At intervals depending on aging temperature, samples of insulated conductor, cut from the coil of insulated conductor, were removed from the oven and cooled to room temperature for several hours. The copper was removed and the tube of insulation tested for tensile strength and percent elongation on an Instron machine. These results were tabulated versus time of aging at the respective oven temperatures. Testing of insulation was continued periodically, depending on the aging rate observed from previous data. The "end of life" was recorded when the percent elongation was reduced to 50% of the original value at each of the aging temperatures. These data points were used to draw line A, which represents the rate of aging for the irradiated cross-linked polyethylene insulation.

Line B was then drawn parallel to line A so that it would intercept the 40 year point at 75°C, which is the design life and temperature rating. Seven (7) days at 150°C was selected from line B for pre-aging purposes as noted in LOCA report 1179-C1 (November 1979).

RC-11 AND RU-39 TITLE



page 6 of 6

Reference 4

E.Q. File No. 113-19-02
Reference 4

Environmental Qualification of ITT Surprenant RG-58 Coaxial Instrument Cable

Determination of Post Accident Operating Time

By

Newell K. Woodward - TENERA L.P.

September 6, 1988

Engineering Evaluation Number 88 - 026

Prepared by Newell K. Woodward 9/8/88 (Date)
9/8/88

Reviewed by 9/8/88 (Date)

Approved by 9/8/88 (Date)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ATTACHMENTS

1.0 Purpose

To extrapolate the data from the 30 day LOCA test to show that the RG-58 coaxial instrument cable is capable of performing its function for one year from the time of accident initiation.

2.0 Scope

The evaluation applies only to the RG-58 cable tested in Reference 1 and used in Seabrook Station, Unit No. 1.

3.0 References

1. NTS/Action Report No. 24843-89N-2, "Environmental Qualification Testing of Coaxial Instrument Cables (RG-58) for NHYD/PSNH, 7/22/88 (Attachment 1).

2. UE&C Drawing No. 9763-F-300219, Service Environment Chart, Revision 19, 9/25/86.

3. Impell Calculation No. 0570-032-002, "Profile Extrapolation for ITT Surprenant Instrument Cable," Revision 1, 11/5/86 (Attachment 2).

4. UE&C Specification No. 9763-006-113-19, "Specification for Specialty Cable," 9/20/82 (Attachment 3).

5. NP-1558, "A Review of Equipment Aging Theory and Technology," Franklin Research Center for EPRI, 9/80.

4.0 Method of Analysis

The LOCA temperature test profile (Reference 1) and the Seabrook Containment Accident Design Temperature Envelope (Reference 2, Figure 2) are plotted in Figure 1. The Arrhenius methodology is then used to determine the amount of time required for the cable when exposed to plant temperature conditions to experience the equivalent amount of aging which occurred during exposure to the tested temperature conditions.

5.0 Basic Data and Assumptions

1. The Activation Energy is 1.26eV as established for cables of the same insulation system in Reference 3 (p. 4).

2. The cable service temperature is conservatively assumed to be 167°F (75°C) instead of the post accident ambient temperature of 120°F shown in Reference 2 (Figure 2). The RG-58 cable is only used in low current instrument applications and, therefore, will not experience any significant conductor internal heating. Therefore, evaluation at its design maximum continuous conductor temperature (75°C) is conservative (Reference 4, p. B1). The 167°F temperature is shown in Figure 1 of this evaluation.

6.0 Summary Results

The ITT Surprenant RG-58 coaxial instrument cable is capable of withstanding the postulated Seabrook worst case accident temperature environment for one year plus a large margin.

7.0 Body of Evaluation

1. The amount of degradation experienced by a device due to exposure to elevated temperature can be determined by the Arrhenius equation:

$$t_1 = t_2 e^{A/K[(1/T_1) - (1/T_2)]}$$ (Reference 5, Sect. 4)

Where:

	t_1	=	Service Time (Operating Time) (Hours)
	t_2	=	Test Time (Hours)
	A	=	Activation Energy (eV)
	K	=	Boltzmann's Constant = 8.617×10^{-5} eV/K
	T_1	=	Service Temperature (°K)
	T_2	=	Test Temperature (°K)

2. An examination of Figure 1 shows that both test and plant postulated temperature profiles are stabilized at a time of approximately 1.4×10^6 seconds (388.8 hrs.). The amount of test time at 260°F to be extrapolated in comparison with an equivalent aging time at 167°F is

from the elapsed test time of 500 hrs. to the end of the 30 day test (t_{end} = 720 hrs.). This time duration of 220 hrs. is shown as A in Figure 1.

3. The desired cable post-accident operating time is one year (8760 hours). If the test time extrapolated begins at 500 hrs. of elapsed test time, then a review of Figure 1 shows that the test envelopes the postulated profile for the first 500 hrs. and the 220 hour period from 500 hours to the end of the test at 720 hours must be at least equivalent to 8260 hours (8760 hrs. - 500 hrs.) in order for the one year operating time to be met. Therefore:

If: $t_1 = t_2 e^{A/K[(1/T_1)-(1/T_2)]}$

Where: t_1 = Operating time to be found (>8540 hrs. for one year)

t_2 = Test time = 220 hours

A = Activation Energy = 1.26 eV

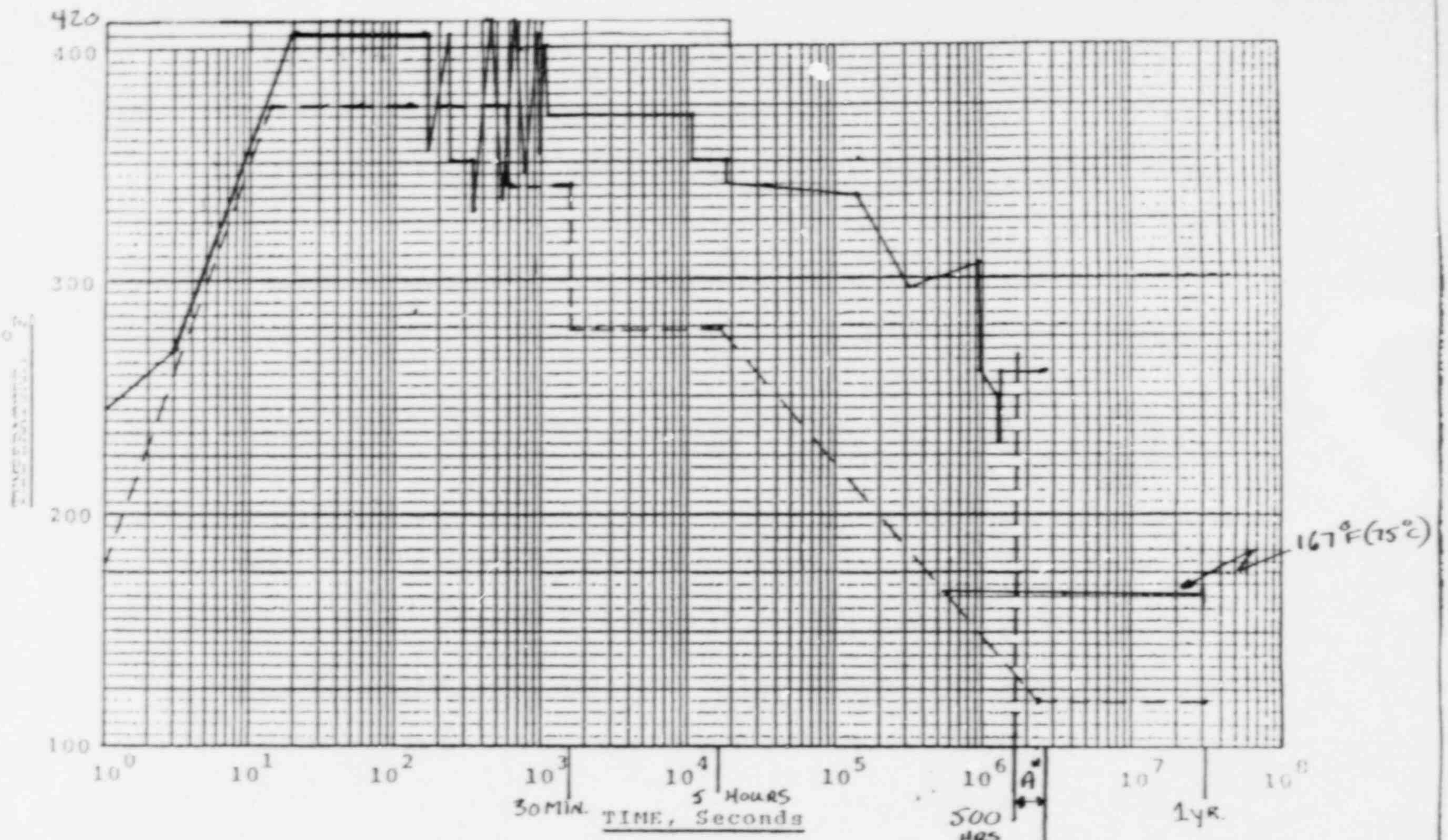
K = 8.617×10^{-5} eV/K

T_1 = Service Temperature = 167°F = 75°C = 348°K

T_2 = Test temperature from 500 to 720 hrs. of test time = 260°F = 126.7°C = 399.7°K

Then: t_1 = 50,439 hours

4. In conclusion, if t_1 = 50,439 hours, then the cable test shows that the cable will withstand the accident temperature environment for one year with an additional margin of 42,179 hours (50,439 - 8260hours).



KEY

——— Qualification Test (REF 1, p.10-9)**

– – – – Postulated Accident (REF. 2 p.1, FIGURE 2)

** TEST PROFILE PLOTTED IS LOCA (2ND TRANSIENT) ONLY. TIME SCALE IS PLOTTED WITH A 40 SECOND SHIFT TO LEFT (e.g. 1ST PEAK TO 410°F IS PLOTTED AT t = 20SEC. INSTEAD OF ACTUAL TEST TIME ≈ 60SEC.)

[*A = TIME DURATION USED TO EVALUATE OPERATING TIME]

Seabrook Station: EQ Assessment Report

Figure 1: Temperature Profile Comparison

	JOB NO EVALUATION NO. 88-	1 of 1

NTS

ENGINEERING EVALUATION 88-
ATTACHMENT 1

Test Report No. 24843-89N-2 Page Nos. ____

TEST REPORT

FOR

ENVIRONMENTAL QUALIFICATION TESTING OF
COAXIAL INSTRUMENT CABLES (RG 58)

FOR

NEW HAMPSHIRE YANKEE
A DIVISION OF PUBLIC SERVICE
P.O. BOX 300
SEABROOK, NH 03874

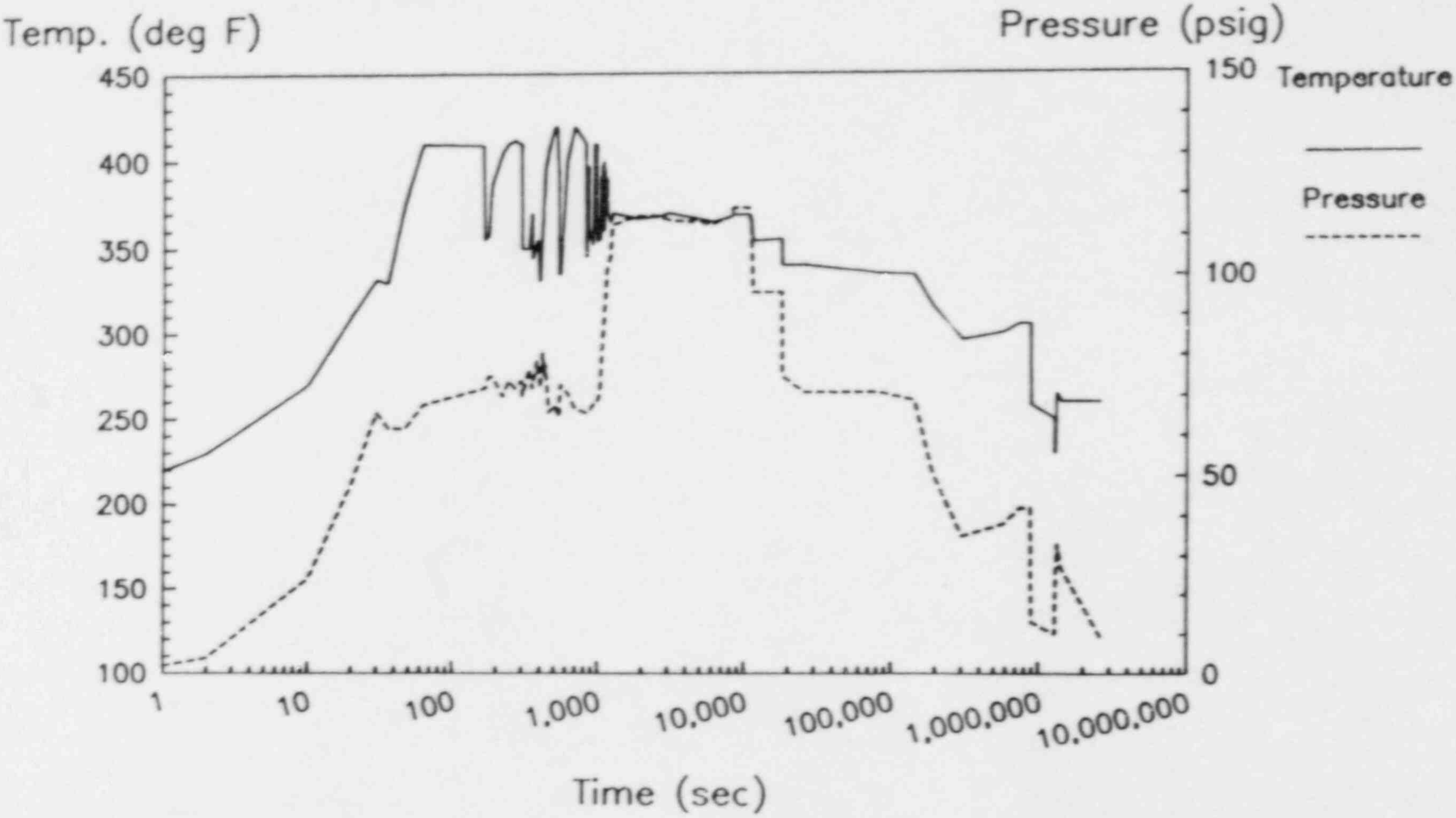
Purchase Order No. 61917

Prepared by: [signature] Date 22 JULY 88
Timothy J. Rotti, Associate Engineer
NTS/Acton
533 Main Street, Acton, MA 01720

Reviewed and
Approved by: [signature] Date 22 July '88
Keith G. Whittles, Engineering Manager
NTS/Acton

KT/RPT/2484389N.NH2

New Hampshire Yankee
LOCA Test



Page 2 of 2

Starting Conditions:
Temp @ t0= 130
Pres @ t0= 0

Report No. 24843-89N-2
Page No. 10-9

EVALUATION NO. 88 - ATTACHMENT 2

CALCULATION/PROBLEM COVER SHEET

Calculation/Problem No: 0570-032-002

Title: Profile Extrapolation for ITT Surprenant Instrument Cable

Client: PSC of New Hampshire Project: Seabrook Station

Job No: 0570-032-1661

Design Input/References:

Refer to Table of Contents on page 2 of 6

Assumptions:

Refer to Table of Contents on page 2 of 6

Method:

Refer to Table of Contents on page 2 of 6

Remarks:

The purpose of this calculation is to determine the ability of ITT Surprenant Coaxial and Triaxial Instrument Cables to withstand the postulated 1 year accident conditions based on its ability to function under a previous 30 day LOCA test.

REV. NO.	REVISION	PERFORMED BY	CHECKED	APPROVED	DATE
0	Original Issue	Ali Ayaah	[signature]	N K Woodward	11/7/85
1	pp. 1, 3, 5, 6 & FIGURE 1	Patrick J Cistt	Jim Buckley	[signature]	11/5/86

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ATTACHMENTS

1. VU-30454, ITT letter to UE&C, dated 8/23/84.
2. EPRI 1556, prepared by Franklin Research Center, September 1980 (Excerpts)

					Profile Extrapolation ITT Suprenant Instrument Cables		
0	GA	4/15/85	DCP	11/19/85	IMPELL	JOB NO 0570-032-1661 / CALC NO 0570-032-002	PAGE 2 OF 6
REV	BY	DATE	CHECKED	DATE			

1.0 Purpose

To extrapolate the data from the 30 day LOCA test to show that the coaxial and triaxial cables are capable of operating for 1 year under accident conditions.

2.0 Scope

This calculation applies to Equipment Qualification File No. 113-19-01 for Seabrook Station Unit 1 only. The cables are ITT Surprenant with cross linked polyethylene insulation and exane jacket.

3.0 References

1. WU-30454, ITT's letter to UE&C, dated 8/23/82 (Attachment 1).
2. EPRI 1556, prepared by Franklin Research Center, September 1980 (Attachment 2)
3. UE&C Drawing No. 9763-F-300219, Service Environment Chart, Rev. 19, 9/25/86.

4.0 Method of Analysis

The Activation Energy is calculated, using the Arrhenius Equation, from data contained in Reference 1. The Arrhenius Methodology is then used to determine the amount of time required for a device exposed to plant temperature conditions to experience the equivalent amount of aging which occurred during exposure to the test temperature conditions.

5.0 Basic Data and Assumptions

1. The endpoint temperature and time are per temperature profiles in Figure 1.

6.0 Summary Results

The ITT Surprenant Cables are capable of withstanding the accident environment for 1 year plus a large margin.

REV	BY	DATE	CHECKED	DATE	
					Profile Extrapolation for ITT Surprenant Instrument Cables
1	PJP	11/4/86	JJB	11/5/86	JOB NO 0570-032-1621
0	[illegible]	12/15/85	[illegible]	[illegible]	CALC NO 0570-032-002

IMPELL

PAGE 3 OF 6

7.[illegible] Body of Calculation.

[illegible] Calculation of Activation Energy.

```
THE ACTIVATION ENERGY WILL BE DETERMINED USING THE
THE ARRHENIUS EQUATION AS SHOWN BELOW:

THE NORMAL FORM OF THE ARRHENIUS EQUATION IS AS FOLLOWS

   LN(X1/X2)=(A/K)*((1/T1)-(1/T2))
      WHERE   X1=SERVICE TIME(HOURS)
              X2=TEST TIME(HOURS)
              T1=SERVICE TEMPERATURE(K)
              T2=TEST TEMPERATURE(K)
               A=ACTIVATION ENERGY(EV)
               K=BOLTZMANS CONSTANT=8.617E-5

      AND     X1 IS GREATER THAN X2
              T1 IS LESS THAN T2

SOLVING FOR A RESULTS IN THE FOLLOWING EQUATION:

    A=[LN(X1/X2)*K]/[(1/T1)-(1/T2)]

SUBSTITUTE THE FOLLOWING INTO THE ABOVE EQUATION

          X1=           72 HOURS
          X2=           12 HOURS
          T1=          277 [illegible]
          T2=          314 [illegible]
[illegible]  THE ACTIVATION ENERGY IS [illegible](EV)
```

REF. 1.

					Profile Extrapolation For ITT Instrument Cables (Coaxial and triaxial)		
0	AA	10/15/85	DEP	11/6/85	IMPELL CORPORATION	JOB NO 0570-032-1461 / CALC NO 0570-032-002	PAGE 4 OF 6
REV	BY	DATE	CHECKED	DATE			

7.2 Profile Extrapolation

The amount of degradation experienced by a device due to exposure to elevated temperatures can be determined by the Arrhenius equation.

L=B*EXP[A/(K*T)]; (Ref. 2, Section 4)

Where L= Time to Reach a Specified Endpoint
B= Constant
A= Activation Energy
K= Boltzmans Constant=8.617E-5
T= Temperature

Solving for B Yields;

B=L*EXP[-A/(K*T)]

For equivalent degradation, B will be the same for exposure to both plant and test temperature conditions.

Test Aging = Plant Aging

However, the plant aging is equal to the aging which results from exposure to the accident environment plus the aging which result from exposure to the normal ambient temperature for some length of time called the thermal life, which we are trying to determine. Therefore;

Test Aging = Accident Aging + Normal Aging (Unknown)
and;
Sum of L*EXP[-A/(K*T(Test))] = Sum of L*EXP[-A/(K*T(Accident))]
+ X*EXP[-A/(K*T(Normal))]

which can easily be solved for the thermal life X.

In order to use the above equation, both the test and accident profile have been enveloped by straight lines, each line a region of the profile (See Figure 1) and the endpoints of these lines input to the program. |

Each region is then divided into N intervals, the duration of the interval and the average temperature over the interval are then input into the Arrhenius equation and summed over all intervals.

					Profile Extrapolation For ITT Surprenant Instrument Cable		
1			JJB	11/5/86	IMPELL	JOB NO 0570-032-1661	PAGE 5 OF 6
0		10/4/85				CALC NO 0570-032-002	
REV	BY	DATE	CHECKED	DATE			

BODY OF CALCULATION

THE ACTIVATION ENERGY OF THIS DEVICE IS 1.26(EV)

TEST PROFILE DEFINITION

THIS PROFILE WAS DIVIDED INTO 1 REGIONS.

REGION NUMBER ******	ENDPOINT TEMP.(F) ********	ENDPOINT TIME(HRS) *********	NUMBER OF INTERVALS *********
INITIAL	230.0	0.00	.....
1	230.0	442.00	1

THIS DATA IS TAKEN FROM REF. 1, p4 & 6 FOR THE TEST DURATION BETWEEN 278 HRS. AND 720 HRS ONLY AT STABILIZED TEMPERATURES

PLANT PROFILE DEFINITION

THE NORMAL AMBIENT TEMPERATURE IS 167.0(F)
THE ACCIDENT PROFILE WAS DIVIDED INTO 1 REGIONS.

REGION NUMBER ******	ENDPOINT TEMP.(F) ********	ENDPOINT TIME(HRS) *********	NUMBER OF INTERVALS *********
INITIAL	167.0	0.00	.....
1	167.0	8442.00	1

THIS DATA IS TAKEN FROM REF 3 FOR THE POSTULATED ACCIDENT DURATION FROM 278 HRS. TO 8760 HRS.

SOLUTION: THIS DEVICE IS CAPABLE OF WITHSTANDING THE ACCIDENT ENVIRONMENT FOR 8442.00 HOURS

PLUS AN ADDITIONAL MARGIN OF 12077 HRS. AT 167 °F. SINCE THE TEST PROFILE ENVELOPES THE POSTULATED ACCIDENT PROFILE - TOTALLY - UPTO 278 HRS., - THE DEVICE IS CONSIDERED CAPABLE OF OPERATING UNDER ACCIDENT CONDITIONS FOR ONE YEAR WITH THE ABOVE MARGIN.

REV	BY	DATE	CHECKED	DATE
1	PJC	11/4/86	SSB	11/5/86

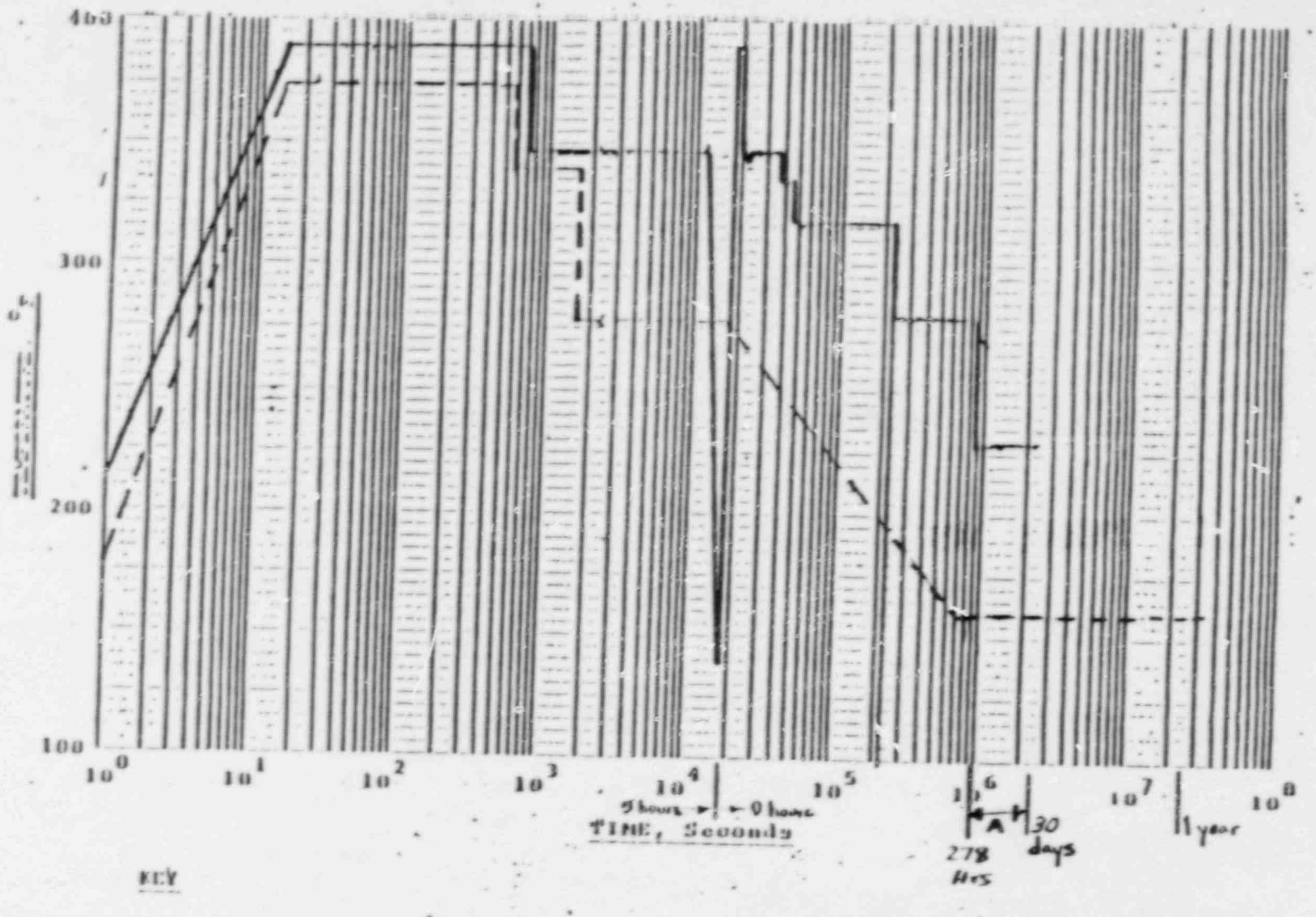
PROFILE EXTRAPOLATION FOR ITT SURPRENANT INSTRUMENT CABLE

IMPELL CORPORATION

JOB NO 0570-032-1661

CALC NO 0570-032-002

PAGE 6 OF 6



KEY

——— Qualification Test (REF. 1, p. 4-66)

– – – – Postulated Accident (REF. 3, p. 1, Fig. 2)

A = Duration used for evaluating operating time

Seabrook Station	
Figure 1: Temperature Profile Comparison	
IMPELL	[illegible] 10-033-16.6 / CALC. NO. 0570-032-002 — PAGE 1 of 1

VU 030131

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TWX 710-347-1736

RECEIVED BY U E & C INC.
AUG 27 1982
RESPONSE YES

ATTACHMENT 1
CALC.# 0570-032-00
P 1 of 6.

PSNH CONTROLLED CORRESPONDENCE 8/82

RESPONSE REQ'D YES			
SUBJ FILE			
RESPONSE BY		JR SLOTTERBACK	
WW EBNER		WP MC KENNA	
RB CHEYNE		HH KATZ	
JL CASOLARI		RA MABRY	

WDCG		RF PERRY	
RM KALAWADIA		RW TOLAND	
RF RELSTATTER			
WE HAUG			
DC BOYLE		RA REBEL	
JJ PARISANO		RM BRYANS	
FJ EGNER		RE KEANE	
WITH ENCLOSURE		ADVANCED COPY	
PO ECN# 113-14		SW HARRIS	

August 23, 1982

Mr. Girish M. Aggarwal
United Engineers and Constructors, Inc.
30 South 17th Street
Philadelphia, PA 19103

RECEIVED BY
AUG 31 1982

Dear Mr. Aggarwal:

As a follow-up to our pre-award meeting of August 12th, I have investigated several of your questions and provided the necessary answers below.

-A5550-2
02-01
1179-01
33263-01

1. Provide extrapolation of RG11 triax, to RG11 coax LOCA data provided by ITT. ITT Surprenant chose to LOCA test RG11 coax and RG59 coax since they are the two constructions we considered most commonly used by nuclear facilities. Since LOCA testing is very expensive to the manufacturer, only the best representative sample of similar constructions can be feasibly tested. Testing all constructions would be economically unfeasible.

Specifically addressing RG11 triax, we feel that our coaxial LOCA data is more than adequate. The dimensions of the 11 coax and 11 triax are identical through the first shield. Couple this with the fact that the triax has an additional shield and jacket of identical material as the shield and jacket of the LOCA approved coax, and our conclusion is LOCA approval for RG11 triax. As additional information, I have enclosed a copy of our 1979 LOCA data when we did have the RG11 triax approved. Please note that the only reason we were not able to use this data, was that we did not have a main stream line break at 390°F. Both RG59U and RG11U coax are covered by our new data enclosed.

We feel similar concerning RG58C/U LOCA approval. Since we have chosen RG59 for our LOCA program and have that approval, and RG58 has similar construction details, we are confident that, had it been submitted, it also would have been approved.

The 2/C #2 AWG 1000 Volt crosslinked polyolefin with a hypalon jacket cable, which we propose to supply for items 11 & 12 of your inquiry will be covered under a separate LOCA approval which we expect to receive from Franklin Institute within 2 weeks.

2. Certify thermal aging of LOCA samples.
ITT Surprenant, hereby, certifies that we did thermal age, as specified, samples of all necessary cables submitted to Franklin Institute for SLB/LOCA simulation during 1982.

3. Basis for pre-aging 150°C for 168 hours.
I have attached a copy of our Arrhenius data showing that using a very conservative end of life value of 50% insulation elongation and testing at 158°C, 136°C, and 121°C, the cables have a projected 40 year life of 83°C. Our pre-aging 150°C at 168 hours gives us a 40 year life at 75°C.

4. Aged and Unaged cable samples must pass the flame test requirements Para. 2.5.6 (single conductors).
This is to certify that all cables RG11 triax, RG11 coax, RG59 coax, RG58 coax, and our proposed 2C #2 AWG cross-lined polyolefin insulated cable pass the single conductor flame tests referenced in Para. 2.5.6 for both aged and unaged samples.

5. IEEE 383 vertical flame tests.
Per IEEE 383 Table I vertical flame test refers to Para. 2.5.6. Para. 2.5.6 is the single conductor wire test in accordance with ASTM-D2220-68 referenced above.

6. All LOCA test simulation is done with Gamma radiation, address Beta requirement per Para 2.4.1.2 "Radiation Beta" 1.4 X 10^8 RADS over 12 months at a maximum rate of 5.2X10^6 R/HR.

It is our opinion that Gamma radiation is more severe (penetrating) than Beta. We, therefore (worst case) have considered the total dosage to be cumulative Gamma, considering the total Gamma plus Beta during design basis event to be 1.5X10^8 RADS. We feel very confident that our referenced coaxial cables can more than withstand both the Gamma rates of exposure and the total exposure.

7. Chemical flow rate 0.42 gpm.
Since our material was tested using a chemical flow rate of 2.5 gpm, we feel 0.42 gpm would present no problems.

8. Extrapolate 1 year post LOCA.
Our LOCA data previously submitted is only 30 days in length. Although we have not received final printed reports from Franklin Institute, we have received verbal confirmation that we have successfully passed our 100 day LOCA submittal. We will continue this testing until 1 year is reached. Until time allows the balance of the test, we submit our IR values as extrapolated proof of 1 year acceptability.

The insulation resistance at the start of test was 1120 meg-ohms. The insulation resistance after 100 days was 1010 meg-ohms. Extrapolating this data, our I.R. after 1 year would be approximately 700 meg-ohms.

9. Long-term water absorption data.
   Attached are long-term water absorption data for Exane 20 mil wall.

I believe this should answer most of the outstanding questions. If either yourself or George Morris have additional questions, please do not hesitate to call.

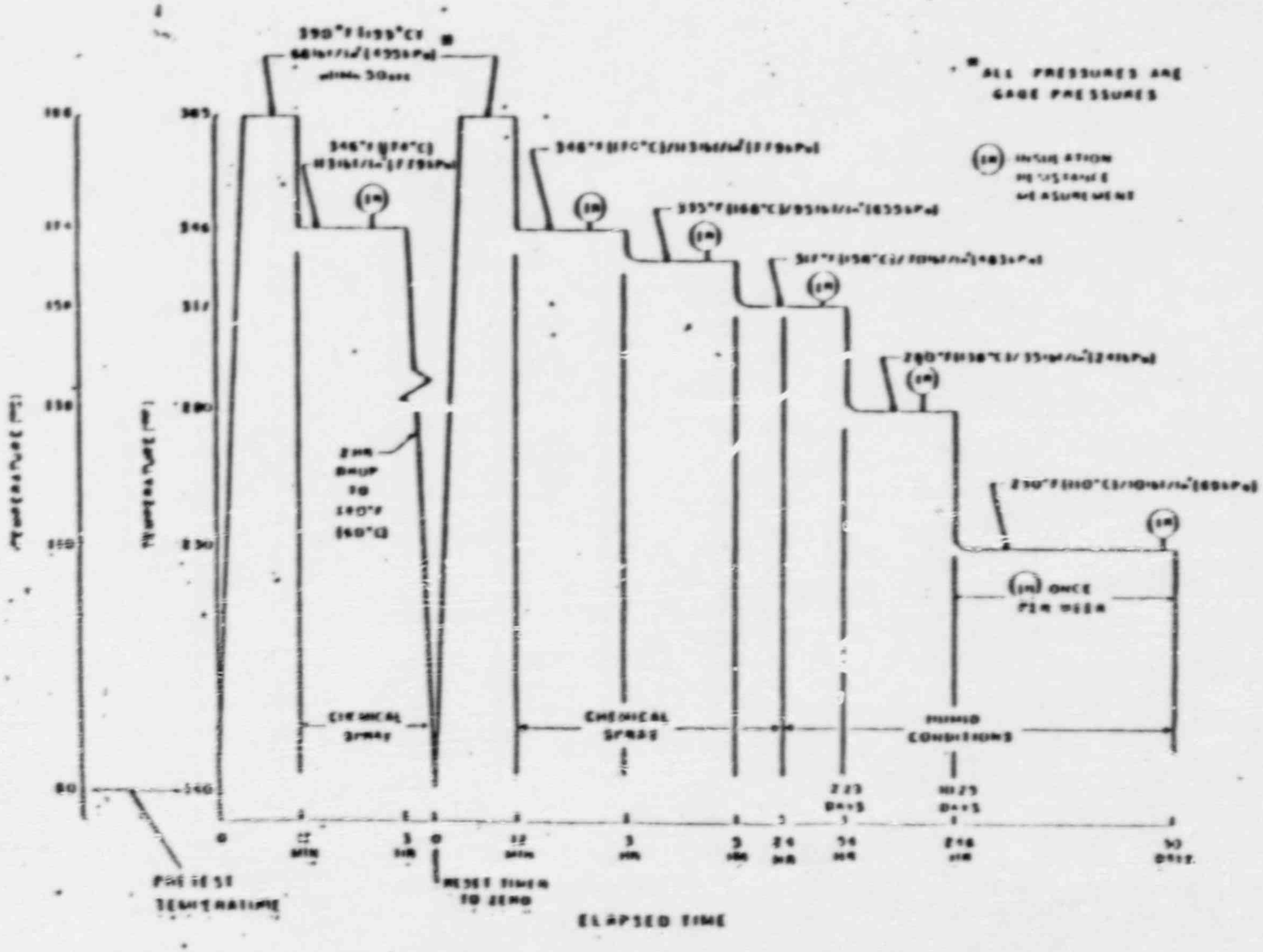
Best Regards,

Joel Sibley

Joel Sibley
Industry Manager
Engineered Products

JS/dw

Attachment


ALL PRESSURES ARE GAGE PRESSURES
INSULATION RESISTANCE MEASUREMENT
CHEMICAL SPRAY
CHEMICAL SPRAY
HUMID CONDITIONS
ONCE PER WEEK
RESET TIMER TO ZERO
PRETEST TEMPERATURE
ELAPSED TIME

International Telephone and Telegraph Corporation

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THERMAL AGING CHARACTERISTICS OF IRRADIATED CROSS-LINKED POLYETHYLENE INSULATION, FOR COAXIAL CABLES, USING THE ARRHENIUS TECHNIQUE

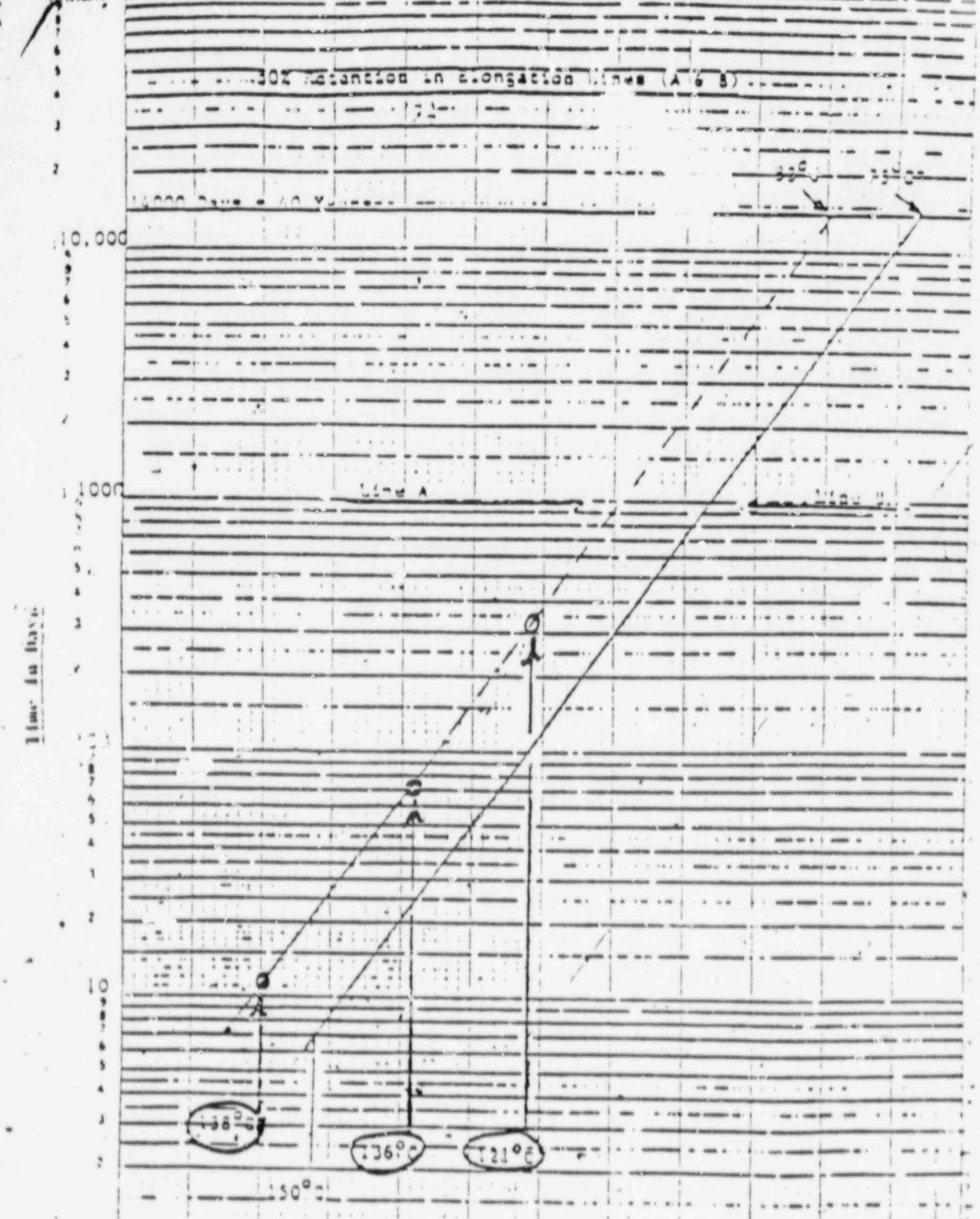
The thermal aging properties of irradiated cross-linked polyethylene insulation, for RG-11 AND RG-59 type coaxial and triaxial cables, were determined using the Arrhenius technique of accelerated aging for these materials.

Samples of insulated conductor were aged in a circulating air oven, set at 158°C, 136°C and 121°C. At intervals depending on aging temperature, samples of insulated conductor, cut from the coil of insulated conductor, were removed from the oven cooled to room temperature for several hours. The copper was removed and tube of insulation tested for tensile strength and percent elongation on an Instron machine. These results were tabulated versus time of aging at the respective oven temperatures. Testing of insulation was continued periodically, depending on the aging rate observed from previous data. The "end of life" was recorded when the percent elongation was reduced to 50% of the original value at each of the aging temperatures. These data points were used to draw line A, which represents the rate of aging for the irradiated cross-linked polyethylene insulation.

Line B was then drawn parallel to line A so that it would intercept the 40 year point at 75°C, which is the design life and temperature rating. Seven (7) days at 150°C was selected from line B for pre-aging purposes as noted in LOCA report 1179-01 (November 1979).

RC-11 AND RU-39 TYPES

P 6 of 6



STAR-Q II Ref. 2
ATTACHMENT 2
CALC # 0520.032-c
P. 1 of 4

A Review of Equipment Aging Theory and Technology

NP-1558
Research Project 890-1

Final Report, September 1980
Work Completed, October 1979

Prepared by

FRANKLIN RESEARCH CENTER
The Parkway at Twentieth Street
Philadelphia, Pennsylvania 19103

Principal Investigators
S. P. Carfagno
R. J. Gibson

Prepared for

Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

EPRI Project Manager
D. G. Cain

Water Reactor System Technology Program
Nuclear Power Division

Section 4
Theories of Aging

In the context of equipment qualification, aging of components and materials refers to the variation of their properties with time, the properties of interest being those related to the safety function of the component or material. Although aging sometimes improves functional capability, the type of aging of greatest interest is that associated with deterioration of functional capability. Aging may cause changes in many properties of a material or a device; for practical purposes, however, the aging of an item is measured by considering only the few properties most directly related to the safety function. For example, the aging of insulating materials is often measured by the time variation of the dielectric strength, since this is the most important parameter for high voltage insulation; however, the time variation of several parameters such as dc gain and base leakage must be considered when studying the aging of transistors.

Many physical stresses, both internal and external, can lead to aging. Internal, or operational, stresses—such as current, voltage, and ohmic heating in electrical devices—are inherent in the operation of the device; external stresses—such as ambient temperature, radiation (visible, gamma, beta, neutron, ultraviolet, etc.), vibration or shock, or other mechanical and chemical stresses (humidity, oxidation, etc.)—originate in the environment.

Theoretical relationships between a stress over a limited range and a deterioration or failure, based on the physical or chemical processes taking place, are known for some types of materials and components. More commonly, especially for complex devices, the relation of degradation to stress rests on empirical knowledge, or the observation of aging as a function of time and stress magnitude. In such cases, the relation can be considered valid only if statistically significant data have been gathered over the range of interest.

Well-established models relating aging to stress are the Arrhenius, Eyring and Inverse Power formulations. The classic use of the first and third models is discussed by Nelson (198, 459, 497, 498) in great detail, and his papers provide references to other papers on the subject. Further detail is also provided in Section 8.

4.1 THE ARRHENIUS MODEL

The Arrhenius Model is usually applied to thermal aging in the form

$$L = Be^{\phi/kT} \qquad (4-1)$$

where

L = time to reach a specified endpoint or lifetime

B = constant (usually determined experimentally)

ϕ = activation energy (eV)

k = Boltzmann's constant (0.8617×10^{-4} eV/K)
T = absolute temperature (K)

4.2 THE EYRING MODEL

The Eyring model provides a thermodynamically more nearly correct (600) formulation and may include additional stress terms.

$$K = K_0 e^{nS} = aT^w \exp\left(-\frac{b}{kT}\right)\exp\left(S\left(c + \frac{d}{kT}\right)\right) \qquad (4\text{-}2)$$

where

K_0 = reaction rate in the absence of applied stress

K = reaction rate in the presence of applied stress

k = Boltzmann's constant

T = absolute temperature

a, b, c, d and w = experimentally determined constants independent of time, temperature, and stress

S = a function of the applied stress

$n = c + \frac{d}{kT}$

4.3 THE INVERSE POWER MODEL

The inverse power model can be applied to problems such as the fatigue testing of metals, the dielectric breakdown of capacitors, and the aging of multicomponent systems.

$$L = 1/kV^n \qquad (4\text{-}3)$$

where

L = time to reach a specified endpoint

k,n = positive parameters characteristic of the material and test method

V = stress (e.g., current, voltage, temperature)

4.4 SPECIAL FORMS OF THE ARRHENIUS EQUATION

A general derivation of the Arrhenius equation is provided in Section 8.3.2. In this section, a discussion of chemical kinetics is provided as an introduction to the Arrhenius model; also included are special forms of the Arrhenius equation and examples of their use in accelerated aging applications.

For a first-order reaction of a material, the rate of the reaction can be written for constant temperature as.

$$-\frac{dc}{dt} = Kc \qquad (4\text{-}4)$$

The 10-degree rule requires two generally unwarranted assumptions concerning activation energy and temperature range. The effort required to determine whether the 10-degree or n-degree rule is a sufficiently good approximation is about the same as the effort required to use the Arrhenius model. In addition, the Arrhenius model has a theoretical basis, whereas the 10-degree rule does not. It is better to use the Arrhenius equation with an assumed, albeit conservative, activation energy.

4.6 CONSIDERATION OF VARIABLE SERVICE CONDITIONS

Service conditions are rarely constant with respect to a given stress. Although a passive device, i.e., one which generates no self-heating, may be maintained in a control room environment at a constant temperature throughout its life, this is the exception rather than the rule. In general, a device will be exposed to a range of temperatures for different times at any one temperature. This variation may be regular (cyclic) or irregular. To a first approximation, the total time at any given temperature governs the amount of degradation. Therefore, we may sum the times at the various temperature levels; however, this still leaves us the problem of combining the aging at various temperature levels. After combining the times at each temperature, we can define

t_i = total time spent at temperature T_i $\quad i = 1,2,3,\ldots,n$

For some fixed degree of degradation, we can write the Arrhenius equation as:

$$ln\,(t_{oi}/t_i) = \frac{\phi}{k}\left(\frac{1}{T_o} - \frac{1}{T_i}\right)$$

where:

T_o = some arbitrary reference temperature
t_{oi} = the time associated with this temperature

We solve this equation for the t_i associated with the T_i. Since all the ages are now associated with the same temperature T_o, they may be added.

$$t_o = \sum_i t_{oi}$$

This time (or age) may be larger or smaller than the total time of service, which is equal to:

$$t_s = \sum_i t_i$$

If we wish to determine a single temperature for which the degree of degradation is the same as that of the combined temperatures T_i, we again use the Arrhenius equation:

$$ln\,(t_o/t_s) = \frac{\phi}{k}\;\frac{1}{T_o} - \frac{1}{T_e}$$

THIS DOCUMENT IS NUCLEAR SAFETY RELATED

UNITED ENGINEERS & CONSTRUCTORS INC.

30 SOUTH 17TH STREET

PHILADELPHIA, PENNSYLVANIA 19101

ENGINEERING EVALUATION No. 88-

ATTACHMENT 3

SPECIFICATION

FOR

SPECIALTY CABLE

FOR

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

SEABROOK STATION

UNITS 1 & 2

REVISIONS						
No.	Date	Prep.	Checked	Q/A	SDE	PEM

Specification No. 9763-006-113-19

Date: 9/20/82

Prepared: G.W. Morris

Checked: D. W. Knox

Q/A Review: S. E. Rubenstein

Approved: G. M. Aggarwal

Approved: D. H. Rhoads

page 1 of 2

APPENDIX B

SELLER'S DATA

		TRIAXIAL COAXIAL
1)	Minimum allowable temperature during installation	-30 °C
2)	Maximum continuous conductor temperature	75 °C
3)	Maximum emergency overload conductor temperature	130 °C
4)	Maximum short circuit conductor temperature	250 °C
5)	Percent copper conductivity at 20°C	96 %
6)	State if copper conductors are coated or uncoated	Coated
7)	State the type insulation: a) by Seller's trade name	None
	and b) by generic name	Polyethy-lene
8)	State the insulation curing process	Irradiation Cross-linked
9)	Does the stated insulation contain fillers? Give the generic chemical names and purposes of major fillers	YES
		______
		______
		______
10)	State the type of cover: a) by Seller's trade name	Exane
	b) by generic name	Polyolefin
11)	State the cover curing process	Irradiation Cross-linked
12)	Does the stated cover contain fillers? Give the generic chemical names and purposes of major fillers	Yes
		— %
13)	Give the percentage halogen content of insulation by weight	8 %

Reference 5

EG FILE NO. 113-19-02 REFERENCE 5

Seabrook Station's commitment to perform this testing is also described in Subsection 14.2.6, which describes Seabrook Station's interpretation of Regulatory Guide 1.68, Appendix A, Section 1.g.

d. Environmental Effects on Electric Equipment

All equipment that must operate in a hostile environment during and/or subsequent to a design basis event are identified with their ambient environmental conditions, and their qualifications are discussed in Section 3.11. 52

e. Effects of Submergence on Electrical Equipment

The response to RAI 430.62 presents an analysis of the effects of submergence as a result of a LOCA on electrical equipment. The results of this study indicate no detrimental effect upon the Class 1E electrical power sources as a result of submergence of electrical equipment following a LOCA. 52

8.3.1.3 Physical Identification of Safety-Related Equipment

All cables, raceways and safety-related equipment are assigned to a particular channel or train. There are two redundant trains of power and controls, and four redundant channels of instrumentation. Each channel or train is assigned a particular color, as shown below:

Separation Group	Equipment Nameplate	Raceway Tag	Cable Color
A. Channel I and Train A	Red	Red	Red
Train A Associated	Black		Black w/Red Tracer 47
B. Channel II and Train B	White	White	White
Train B Associated	Black		Black w/White Tracer 47
C. Channel III	Blue	Blue	Blue
D. Channel IV	Yellow	Yellow	Yellow 52

Each piece of electrical equipment is marked with the node number indicated on the design drawings, in the particular color corresponding to the channel or train to which that equipment is assigned. Similarly, trays and exposed conduits are marked with color-coded markers. The cable jacket color code serves as its identification. The operator or maintenance craftsman needs only to observe the color of the nameplate of any piece of equipment or the cable jacket color to determine which channel or train it serves. For exceptions to the above cable and raceway identification criteria, see Subsection 8.3.1.4.k. 55

8.3.1.4 Independence of Redundant Systems

a. General

The Seabrook Station complies with the requirements of FSAR Appendix 8A, IEEE 384-1974 and Regulatory Guide 1.75, Rev. 2. These documents describe acceptable methods of complying with IEEE 279-1971 and Criteria 3, 17 and 21 of Appendix A to 10 CFR Part 50 with respect to the physical independence of the circuits and electrical equipment comprising or associated with the Class 1E power system, the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems that must be operable for the protection system and the systems it actuates to perform their safety-related functions. Preservation of independence of redundant systems within the control boards and all other field mounted racks is discussed in Subsection 7.1.2.2.

In accordance with the provisions of Section 4.5a and 4.6.2 of FSAR Appendix 8A, Sections 4.5(1) and 4.6.1 of IEEE 384-1974, and Position C4 of Regulatory Guide 1.75, Revision 2, we have elected to associate all of the Non-Class 1E circuits with Class 1E circuits. This application of associated circuits allows the plant to be designed with one less separation group; that is, instead of having five separation groups consisting of four safety-related separation groups and one non-safety-related separation group, Seabrook has only four separation groups. The major advantages of this approach are the ability to provide greater separation distances between the groups, as well as to reduce the raceway system's exposure to fire.

As a result of this design, all plant circuits are specifically assigned to one of the following four separation groups as noted in Figure 8.3-57:

Group A - Train A, Channel I and Train A Associated Circuits
Group B - Train B, Channel II and Train B Associated Circuits
Group C - Channel III
Group D - Channel IV

The great majority of associated circuits are with Group A, a very limited number are with Group B, and none are with Groups C and D.

The circuits that are associated with Train A consist of:

1) Non-Class 1E power, control, instrument circuits contained within the Nuclear Island.

2) Non-Class 1E power, control, and instrumentation circuits that traverse the Nuclear Island boundary.

3) Non-Class 1E power, control, and instrument circuits outside the Nuclear Island.

The following analysis examines the design features and modes of failure of associated circuits of each separation group to determine any interaction and challenges with other separation groups. The overall objective is to assure that the ability to achieve a safe plant shutdown under design basis event (DBE) conditions is not compromised.

* b. Train A Associated Circuit Analysis

1. Associated Circuits Contained within the Nuclear Island

Non-Class 1E circuits that remain within the Nuclear Island are permitted to share the same raceway as Train A Class 1E circuits. These circuits are classified as Train A Associated Circuits and are designed and installed to meet all the requirements placed on associated circuits as required by the compliance documents listed earlier.

Challenges to Class 1E circuits, because of failure in an associated circuit, have been examined and determined to have no detrimental effect because:

(a) When Class 1E power supplies are utilized, failure of a Non-Class 1E motor, load, or device connected to this power supply will be promptly isolated by operation of Class 1E protective devices.

Non-Class 1E loads connected to Class 1E buses are in all cases protected by Class 1E devices. The breakers protecting Non-Class 1E loads are coordinated such that failure of all Non-Class 1E loads, with proper operation of their own breakers, will not result in tripping of the incoming breaker to the bus.

Further, in the few cases where credit is taken for the incoming bus feeder breaker to provide backup protection to meet Regulatory Guide 1.63, the associated bus is dedicated to Non-Class 1E loads only and, therefore, will not degrade a Class 1E bus.

(b) In cases where Non-Class 1E power supplies, such as switchgear, motor control centers, and distribution panels are utilized, these are of identical design of the Class 1E counterparts and have been purchased to the same specification requirements inclusive of quality control. Mounting of the Non-Class 1E power supplies within the Nuclear Island is identical to the mounting of their Class 1E counterparts; therefore, credit can be taken for this equipment to function under DBE conditions.

(c) All Non-Class 1E protective circuit breakers will be periodically inspected approximately once every five years according to a program developed for the inspection of Non-Class 1E equipment. This program will be in accordance with manufacturer's recommendations for maintenance and inspections.

Since Class 1E and Non-Class 1E protective devices are identical, any generic degradation such as setpoint drift, manufacturing deficiencies, and material defects will be detected and corrected as a result of the rigorous program performed on the Class 1E protective devices to satisfy the requirements of ANSI N-18.7-1976 and Regulatory Guide 1.63; therefore, credit can be taken for this equipment to function under DBE conditions.

(d) The probability of an ensuing fire is minimized because all cables utilized for these associated circuits are specified, designed, manufactured, and installed to the same criteria as Class 1E cables. Factors that have been taken into consideration include flame retardancy, non-propagating and self-extinguishing properties, splicing restrictions, appropriate limitations on raceway fill, cable pulling and termination requirements, appropriate cable derating, and environmental qualifications. The above provisions and considerations used for the associated circuits during the construction phase of the plant will also be used during the operations phase. 55

(e) Degradation of an associated circuit because of a raceway failure during a DBE, has been eliminated because all electrical raceway systems within the Nuclear Island are seismically analyzed.

(f) Other design considerations that contribute to the integrity of these associated circuits are:

1) Cables associated with one train are never routed in raceways containing Class 1E or associated cable of another train or channel.

2) All cables for instrumentation circuits utilize shielded construction which minimizes any unacceptable interaction between Class 1E and associated circuits.

3) All circuits entering the reactor containment are provided with protective devices complying with Regulatory Guide 1.63. For exceptions see Subsection 8.3.1.1.C.7(a). 53

Based on the above design features and analysis, we do not consider these associated circuits to pose any challenges to any Class 1E circuits. Therefore, the ability for safe plant shutdown under DBE conditions has not been jeopardized.

2. Train A Associated Circuits that Traverse the Nuclear Island Boundary

For analysis purposes, the associated circuits that traverse the Nuclear Island boundary can be further subdivided into two basic types: (a) those that have their protective device located in the Nuclear Island, and (b) those that have their protective device outside the Nuclear Island. It should be noted that there are a limited number of power cables in these categories.

(a) Associated Circuits that have Protective Devices Located in the Nuclear Island

These circuits are also designed and installed to meet all the requirements as outlined above in Subsections 8.3.1.4.b.1(a), (b), (c), (d) and (f). Though the raceway system outside the Nuclear Island is not seismically analyzed, this is of no concern because the circuit protective devices inside the Nuclear Island are assumed to perform their protective function. Concerns that design basis events such as a seismic event may cause high voltage cables that are not in seismically analyzed raceways and not located in Category I buildings to interact with lower voltage cables are analyzed below:

Recent seismic tests, performed on raceways representing typical installations on SEP plants, proved that the raceways can withstand seismic events with no significant failures. Since the typical non-seismic installation at Seabrook is superior to the tested SEP installations, it can be assumed that they will survive a seismic event. Failures of raceways resulting from collapse of the non-seismically designed buildings can be dismissed because the conservative criteria and UBC seismic loading used in the construction of the building will ensure little likelihood of collapse.

Not withstanding the preceding, any event involving the raceway system that can cause a higher voltage cable to come in contact with another lower voltage cable will first cause the higher voltage cable to be grounded. Contributing factors to this are: 1) the cables are in grounded metallic trays or enclosures, 2) the 13.8 kV and 4.16 kV power cables are of armored construction, and 3) as indicated in Fig. 8.3-57, separate raceways are designated for the different voltage levels.

51

IMPELL CORPORATION

EQ FILE NO 113-19-02

REFERENCE 6

Record of Conversation

File 0570-032-1661

Copy GRahner
ABiswas
GMoore
DGhosh
RBergeron (PSNH)
~~WCloutier (YAEC)~~

X Telephone ☐ Meeting ☐ Other

To C.D. Greiman From N.K. Woodward NKW

Company United Engineers & Contractors Phone No 215-422-3292 Date 10/8/85

Subject Seabrook EQ: P.O. 113-18

Summary of Conversation

Chuck and I discussed how Impell can identify which of the different cables in P.O. 113-18 and the other cable specifications are connected to equipment which must perform a safety functon subsequent to accident events.

The color coding of the outer jacket as defined in UE&C separation documents enables this determination. Specifically, outer jackets with the single solid color of red, white, blue, or yellow designates cables for which performance requirements such as I.R. and accuracy must be met during environmental qualificaton. Cable of other colors or color schemes must only remain intact (e.g. no shorting to ground). However, all Class 1E cables as defined by the Specification must be environmentally qualified.

Chuck will forward a copy of the UE&C separation document which defines these color schemes so that it may be included in the EQFs.

NKW/jm

Reference 7

EQ FILE No 113-19-02
REFERENCE 7

Form 4433

ACCT NO

PURCHASE ORDER

united engineers & constructors inc

DATE October 7, 1982

THE ORDER NUMBER MUST APPEAR ON INVOICES, CORRESPONDENCE, SHIPPING PAPERS AND PACKAGES.

P. O. NO. SNH-744 9763.006-113-19

Mail 5 copies of invoices, the original shipping papers and packing list to UNITED ENGINEERS & CONSTRUCTORS INC
Post Office Box 700
Seabrook, New Hampshire 03874

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE et al
c/o United Engineers & Constructors Inc. Agents
Post Office Box 700
Seabrook, New Hampshire 03874 PURCHASER

REQ NO 13819

REQ BY G.W.Morris

ITT-Suprenant Division
172 Sterling Street
Clinton, Massachusetts 01510 SELLER

ALL CORRESPONDENCE AND A COPY OF SHIPPING PAPERS AND PACKING LISTS MUST BE SENT TO UNITED ENGINEERS & CONSTRUCTORS INC
P.O. BOX 8223 PHILA. PA 19101
ATTN: E. H. CASE, MANAGER PROCUREMENT

SHIP VIA Motor Freight

CONSIGN TO Public Service Company of New Hampshire
c/o United Engineers & Constructors Inc.
Seabrook Station
Seabrook, New Hampshire 03874

TERMS 1% ten (10)/ net thirty (30) days.

DATED 9/21/82

TYPED BY ew

BUYER T.M.O'L.

Items furnished hereunder shall be made in a workmanlike manner and fit for the purpose set forth. All items are subject to Purchaser's inspection at destination. Rejected items will be held at Seller's risk and expense. On demand Seller shall replace without delay.
Seller shall pay all royalties and license fees and shall defend all suits or claims whatsoever for infringement of any patent rights and shall save the Purchaser harmless from loss on account thereof.

ITEM NO	DESCRIPTION	PRICE

FURNISH F.O.B. Job Site.

SPECIALTY CABLE

Design, furnish, fabricate, test and deliver 1 Lot of Special Cable in accordance with the following documents:

A. Specification No. 9763.006-113-19, dated September 20, 1982 consisting of Cover Page, Table of Contents, nineteen (19) reproduced typewritten pages, Figure 1, three (3) pages of Appendix A, and three (3) pages of Appendix B, attached hereto and made a part hereof.

B. Specification No. 9763-QAS-3, Quality Assurance Administrative and System Requirements, For Safety Related Electrical Equipment, Revision 7, dated April 11, 1979, consisting of Cover, Table of Contents, Current Page Listing, Identification of Changes, and thirty-nine (39) reproduced typewritten pages, already in your possession and made a part hereof.

C. Specification No. 9763-EQ-1, Class IE Equipment Qualification Requirements, Revision 7, dated February 19, 1976, consisting of Cover, Table of Contents, ten (10) reproduced typewritten pages and Data to be submitted with Proposal, consisting of two (2) reproduced typewritten pages, numbered D1 and D2, already in your possession and made a part hereof.

PRICING:

TOTAL FIRM DELIVERED PRICE $130,365.00

ITEM	QUANTITY	DESCRIPTION	PRICE/MFT	EXTENSION
1.	25,000 ft.	UA1T Triax RG-11 Red	$810.00	$ 20,250.00
2.	25,000 ft.	UA2T Triax RG-11 White	$810.00	$ 20,250.00
3.	7,000 ft.	UA3T Triax RG-11 Blue	$810.00	$ 5,670.00
4.	7,000 ft.	UA4T Triax RG-11 Yellow	$810.00	$ 5,670.00
5.	60,000 ft.	UA6T Triax RG-11 Black/Red	$810.00	$ 48,600.00

Continued

NO CHANGE WILL BE PERMITTED IN THIS ORDER UNLESS BY WRITTEN AGREEMENT

Form 4438

ACCT NO

PURCHASE ORDER

united engineers & constructors inc

DATE October 7, 1982

THE ORDER NUMBER MUST APPEAR ON INVOICES, CORRESPONDENCE, SHIPPING PAPERS AND PACKAGES.

P. O. NO. SNH-744 9763.006-113-19

Mail copies of invoices, the original shipping papers and packing list to UNITED ENGINEERS & CONSTRUCTORS INC

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE et al
c/o United Engineers & Constructors Inc. Agents

PURCHASER

REQ NO

REQ BY

ITT-Suprenant Division

SELLER

ALL CORRESPONDENCE AND A COPY OF SHIPPING PAPERS AND PACKING LISTS MUST BE SENT TO UNITED ENGINEERS & CONSTRUCTORS INC P.O. BOX 8223 PHILA. PA. 19101 ATTN E. H. CASE MANAGER PROCUREMENT

SHIP VIA

CONSIGN TO

TERMS

DATED

TYPED BY

BUYER

Items furnished hereunder shall be made in a workmanlike manner and fit for the purpose set forth. All items are subject to Purchaser's inspection at destination. Rejected items will be held at Seller's risk and expense. On demand Seller shall replace without delay. Seller shall pay all royalties and license fees and shall defend all suits or claims whatsoever for infringement of any patent rights and shall save the Purchaser harmless from loss on account thereof.

ITEM NO. | DESCRIPTION | PRICE

[redacted]

ITEM	QUANTITY		DESCRIPTION		PRICE/MFT	EXTENSION
6.	10,000 ft.	TA6T	Coax	RG-11 Black/Red	$755.00	$ 7,550.00
7.	60,000 ft.	TA6Y	Coax	RG-58 Black/Red	$250.00	$ 15,000.00
8.	5,000 ft.	TA1Y	Coax	RG-59 Red	$225.00	$ 1,125.00
9.	5,000 ft.	TA2Y	Coax	RG-59 White	$225.00	$ 1,125.00
10.	5,000 ft.	TA6U	Coax	RG-59 Black/Red	$225.00	$ 1,125.00

Premium Price - Vendor to expedite delivery to October 8, 1982.

ITEM	QUANTITY		DESCRIPTION		PREMIUM
5.	25,000 ft.	UA6T	Triax	RG-11 Black/Red	$ 4,000.00

Prices are firm for delivery through January 14, 1983.

TERMS OF PAYMENT:
1% ten (10)/ net thirty (30) days.

SPECIAL CONDITIONS - Form No. 9763-4224, Revised May 20, 1981 consisting of Cover Page, Table of Contents and twenty (20) reproduced typewritten pages is attached hereto and made a part hereof.

GAURANTEE:
In accordance with Article 9 of Special Conditions Form 9763-4224 for a period of one (1) year from date of commercial operation.

Two (2) unpriced copies of outside Purchase Orders are to be submitted to the attention of Mr. D. E. McCaig, Manager - Expediting.

Monthly progress charts outlining engineering, purchasing, production and delivery status will be submitted starting August 23, 1982.

Continued

NO CHANGE WILL BE PERMITTED IN THIS ORDER UNLESS BY WRITTEN AGREEMENT

Form 4438

ACCT NO

PURCHASE ORDER

united engineers & constructors inc

DATE October 7, 1982

THE ORDER NUMBER MUST APPEAR ON INVOICES, CORRESPONDENCE, SHIPPING PAPERS AND PACKAGES

P. O. NO. SNH-744 9763.006-113-19

Mail copies of invoices, the original shipping papers and packing list to UNITED ENGINEERS & CONSTRUCTORS INC

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE et al
c/o United Engineers & Constructors Inc. Agents

PURCHASER

ITT-Suprenant Division

SELLER

ALL CORRESPONDENCE AND A COPY OF SHIPPING PAPERS AND PACKING LISTS MUST BE SENT TO UNITED ENGINEERS & CONSTRUCTORS INC
P. O. BOX 8223 PHILA PA 19101
ATTN E. H. CASE MANAGER PROCUREMENT

REQ NO

REQ BY

SHIP VIA

CONSIGN TO

TERMS

DATED

TYPED BY

BUYER

Items furnished hereunder shall be made in a workmanlike manner and fit for the purpose set forth. All items are subject to Purchaser's inspection at destination. Rejected items will be held at Seller's risk and expense. On demand Seller shall replace without delay.
Seller shall pay all royalties and license fees and shall defend all suits or claims whatsoever for infringement of any patent rights and shall save the Purchaser harmless from loss on account thereof.

ITEM NO	DESCRIPTION	PRICE

[redacted]

SHIPPING POINT: Leominster, Massachusetts

TIME REQUIRED TO MANUFACTURE: 12-14 WEEKS ARO

DELIVERY:
Item 5 - 25,000 ft. (partial) will start delivery October 8, 1982
Item 7 - 15,000 ft. (partial) will start delivery October 15, 1982
Balance of Items 1 through 5, will start delivery November 19, 1982
Balance of Order will start delivery January 14, 1983 (based on release for fabrication October 8, 1982).

Minimum reel length produced will be 1,000 ft.

Deliveries accepted 7:30 a.m. to 3:00 p.m., Monday through Friday only, except local holidays.

Seller will provide two (2) weeks written notification for inspection or witnessing of tests and a subsequent 72 hour verbal confirmation, attention Mr. D. E. McCaig.

Invoices shall be submitted in accordance with instructions shown in Section 12 of Special Conditions Form 9763-4224. Failure to comply with these instructions may result in return of invoice for correction, thus delaying payment.

On all correspondence which is a reply to a UE&C letter, the Seller shall reference in his letter heading the SBU number of Purchaser's transmittal. The SBU number shall always be found below the letter date on the Cover Page.

Continued

Form 4452

ACCT NO

PURCHASE ORDER

united engineers & constructors inc

DATE October 7, 1982

THE ORDER NUMBER MUST APPEAR ON INVOICES, CORRESPONDENCE, SHIPPING PAPERS AND PACKAGES.

P. O. NO. SNH-744 9763.006-113-19

Mail copies of invoices, the original shipping papers and packing list to UNITED ENGINEERS & CONSTRUCTORS INC

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE et al
c/o United Engineers & Constructors Inc. Agents

PURCHASER

ALL CORRESPONDENCE AND A COPY OF SHIPPING PAPERS AND PACKING LISTS MUST BE SENT TO UNITED ENGINEERS & CONSTRUCTORS INC
P.O. BOX 8223 PHILA. PA 19101
ATTN: E. H. CASE, MANAGER PROCUREMENT

Page 4 of 4

REQ NO

REQ BY

ITT-Suprenant Division

SELLER

SHIP VIA

CONSIGN TO

TERMS

DATED

TYPED BY

BUYER

Items furnished hereunder shall be made in a workmanlike manner and fit for the purpose set forth. All items are subject to Purchaser's inspection at destination. Rejected items will be held at Seller's risk and expense. On demand Seller shall replace without delay. Seller shall pay all royalties and license fees and shall defend all suits or claims whatsoever for infringement of any patent rights and shall save the Purchaser harmless from loss on account thereof.

ITEM NO	DESCRIPTION	PRICE

TAGGING:
Tagging shall be in accordance with instructions in Section 7 of Special Conditions Form 9763-4224.

Seller must show the amount included for transportation as a separate item on all invoices.

Supplement Equal Employment Opportunity Form 4079 (Rev. 1/80), consisting of one (1) page printed both sides, is attached hereto and made a part hereof.

CONFIRMING VERBAL ORDER AWARDED TO AND ACCEPTED BY MR. JOEL SIBLEY, AN AUTHORITATIVE REPRESENTATIVE OF SELLER, AUGUST 12, 1982.

NO CHANGE WILL BE PERMITTED IN THIS ORDER UNLESS BY WRITTEN AGREEMENT

TOTAL $130,363.00

...k Copy of this Order must be ...by Seller and returned to ...Engineers & Constructors Inc

No invoice will be passed for payment unless Acceptance Copy has been executed and returned

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE et al
united engineers & constructors inc
Agents

E.H. Case /TMA

BY E. H. CASE, MANAGER - PROCUREMENT

ORDER NO. 9763.006-113-19

SERIAL NO. SNH-744

DATE October 7, 1982

page 4 of 4

EXTRA COPY

Reference 8

EQ FILE No. 113-19-02
REFERENCE 8

United Engineers & Constructors Inc.
30 South 17th Street
Post Office Box 8223
Philadelphia, PA 19101

BOSTON
DALLAS
DENVER
KNOXVILLE
PHILADELPHIA
VALLEY FORGE

February 13, 1985
SBU - 92605
File: 49-7
1.0.5.7.1
Cat: TECH

Impell Corporation
225 Broad Hollow Road
Melville, New York 11747

No Response Required
3/13/85

Attention: Mr. N. Woodward

Public Service Company of New Hampshire et al.
New Hampshire Yankee Division
Seabrook Station
Environmental Zones

As requested in the EQTT project meeting of February 11, 1985, we have reviewed the location of Class 1E equipment in the plant to determine if any equipment is located in areas containing radiation levels above 2 x 10^8 Rads TID.

Other than the in-line instrumentation in the reactor coolant piping inside containment, the only areas which contain radiation levels above 2 x 10^8 Rads TID are the demineralizer cubicles at Elevation 2'-0" of the PAB (Radiation Zone 27 - Environmental zone PB-19) and the Chemical and Volume Control Tank Cubicle at Elevation 53'-0" of the PAB (Radiation Zone 16 - Environmemtal Zone PB-4). Review of the Class 1E Equipment List (Drawing No. 9763-M-505300, Rev. 13) and the electrical conduit drawings 9763-F-310764, Rev. 18 and 9763-F-310768, Rev. 19 has determined that these PAB areas contain no Class 1E or Reg. Guide 1.97 equipment or cables.

If you have any further questions on this matter, please call me.

Very truly yours,

C. D. Greiman

C. D. Greiman
Supervising EQTF Engineer

CDG/frb

cc: Messrs.
R. J. DeLoach - YNSD 5L
J. DeVincentis - PSN940 2L
W. Cloutier - YNSD 1L
B. B. Beckley - PSNH 2L
G. Thomas - PSNH 2L
D. G. McLain - YNSD Start-Up 1L
C. M. Wiley - PSNH/YNSD Field Office 1L
N. K. Woodward - Impell 3L
R. Bergeron - 01/04 Site

Reference 9

EQ FILE No 113-14-02
REFERENCE 9

IMPELL CORPORATION

February 2, 1986
0570-032-NY-156

Yankee Atomic Electic Company
1671 Worcester Road
Framingham, Massachusetts 01701

ATTENTION: Mr. William J. Cloutier

SUBJECT: Public Service Company of New Hampshire
Seabrook Station
Environmental Qualification of Electrical Equipment
Summary of Class 1E Equipment
Submerged as a Result of Design Bases Events

Gentlemen:

In order to determine if any Class 1E equipment is submerged subsequent to Design Bases Events, Impell engineers specifically identified in the plant all equipment located below postulated flood levels. Upon identifying this equipment, further evaluations where performed to determine if this equipment should be qualified for submergence.

The results of this evaluation and a list of reference documents upon which it was based are provided in the enclosed.

Should there be any questions regarding the enclosed please contact me at your earliest convenience.

Very truly yours,

Newell K. Woodward

Newell K. Woodward
Project Engineer

NKW/jm

cc: R. Bergeron (PSNH)
J. Salvo (YAEC)

SUMMARY OF CLASS 1E EQUIPMENT SUBMERGED AS A RESULT OF DESIGN BASES EVENTS

Equipment Vaults:

Flooding in the Equipment Vaults results from a Moderate Energy Line Break (MELB). The flood elevation is (-)55'-11" (Reference 1, Table 3-2). Class 1E equipment located below the flood elevation in these areas is discussed below.

Pumps CBS-P-9A and CBS-P-9B and pressure transmitter CBS-PT-2314 are located below the flood elevation, but are not required for mitigation of the MELB (Reference 2, p. 12), and are designated in Reference 3 as Operability Code C for the MELB. Therefore, submergence qualification need not be addressed.

The cable to instruments RH-FIS-610 and RH-FIS-611 has been supplied under P.O. 9753-006-113-17 and is located below the flood elevation. These instruments will not be submerged, but are required to mitigate the MELB (Reference 3). Therefore, submergence qualification will be addressed for this cable.

The cable codes are AD1P and AD2P for instruments RH-FIS-610 and 611, respectively.

Containment Building:

The flood elevation in Containment is (-)20'-8" (Reference 1). Flooding does not occur in environmental zones CS-3, CS-11, CS-12 and CS-13 (Reference 4). Class 1E equipment located below the flood elevation in those areas of the Containment Building where flooding is postulated to occur is discussed below.

Transmitter RC-FT-446 performs no safety function subsequent to a LOCA or MSLB and is Operability Code C for these events (Reference 3).

The equipment listed below is installed below flood level but justifications for not addressing submergence qualification is provided in RAI 430.62 (Reference 5).

CS-V-168
RH-FY-2426
RH-FY-2464
SI-FY-2416
SI-FY-2428
SI-ZS-2413
SI-ZS-134
SI-ZS-160
SI-FY-2409

SI-FY-2427
RH-ZS-28
SI-ZS-2433
RH-ZS-27
SI-ZS-2403
SI-ZS-131
RH-ZS-49
SI-ZS-2423
RM-RM-6535B

Gems containment building level transmitters CBS-LE-2384-1 and CBS-LE-2385-1 are installed below the flood level, but will be qualified for submergence. Equipment I.D. Nos. RC-TE-1318 and RC-TE-1328 are also installed below flood level. However, this equipment and its cable is encapsulated in a stainless steel sheath and will not be affected by submergence.

Instrument racks MM-IR-1 an, MM-IR-4 contain the Class 1E and non 1E equipment shown below (Reference 6).

MM-IR-1

```
SI-FY-2404-----|                 RH-FY-2426-----|
NG-FY-4605     |                 SI-FY-2428     |
SI-FY-2401     |---Non 1E        RH-FY-2463     |---1E
CS-FY-7400     |                 SI-FY-2427-----|
RH-FY-2407-----|
```

MM-IR-4

```
CS-FY-7417-----|                 SI-FY-2416-----|---1E
RH-FY-2408     |                 RH-FY-2464-----|
RMW-LY-178     |
CS-FY-7418     |
CS-FY-7419     |
CS-FY-7403     |
CS-FY-7447     |---Non 1E
NG-FY-4608     |
SI-FY-2406     |
CS-FY-7413     |
SI-FY-2431     |
CS-FY-7412     |
SI-FY-2434     |
RC-LY-459-B    |
CS-FY-7414-----|
```

Per RAI 430.62 (Reference 5), all the above listed Class 1E equipment located on racks MM-IR-1 and MM-IR-4 need not be addressed for submergence qualification.

For the equipment listed below, the electrical cable to the equipment is the only item submerged. Reference 3 shows that these transmitters are Operability Code C for the Design basis events which cause flooding inside containment. Therefore, the cable to these instruments need not be qualified for submergence.

RC-FT-415
RC-FT-416
RC-FT-444
RC-FT-434
RC-FT-435
RC-FT-436
RC-FT-446

The cable to CC-FT-2175A is below flood level. However, this Thermal Barrier Cooling System transmitter is expected to be designated as Operability Code C and therefore, this cable need not be qualified for submergence.

The cables to valves SI-V-17, SI-V-32 and CS-V-149 are below the flood level. A review of the UE&C CASP sorting system shows that the following cable codes and purchase orders are associated with these valves.

Valve	Node	Cable No.	Cable Code	P.O.
SI-V-17	V40	H15-V40	BC2J	113-03
		H41-V40	AG2P	113-17
		H41-V40/1	AD2P	113-17
		H41-V40/2	AD2P	113-17
		H41-V40/3	AB2P	113-17
		H55-V40	MA7R	113-18
SI-V-32	V41	H18-V41	BC1J	113-03
		H35-V41	AG1P	113-17
		H35-V41/1	AD1P	113-17
		H35-V41/2	AD1P	113-17
		H35-V41/3	AB1P	113-17
		H45-V41	MA6R	113-20
CS-V-149	V21	H19-V21	BC1N	113-03
		H36-V21	AG1P	113-17
		H36-V21/1	AD1P	113-17
		H36-V21/2	AB1P	113-17
		H43-V21	MA6R	113-20

Submergence qualification will be addressed for these cables.

Mechanical Penetration Area:

Flooding in the Mechanical Penetration Area results from a MELB. The flood elevation is (-)25'-11" (Reference 1, Table 3-2).

There are three items of Class 1E equipment located below flood level that are required to function when submerged. They are MM-IR-12, RH-FT-618 and RH-FT-619 (reference 3). Rack MM-IR-12, [illegible] tories, and the transmitters are not qualified for submergence [illegible] e, it is recommended that they be relocated above flood level u[illegible] an be shown that operability for the MELB is not required.

The Class 1E equipment listed below is also installed below flood level but is designated Operability Code C for the MELB and need not be qualified for submergence conditions (Reference 3).

SI-FY-2419
CBS-ZS-2307-1
CBS-ZS-2306-2
CBS-TK-101A
CBS-TK-101B
CBS-V-8
CBS-V-14

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Terminal boxes EDE-TBX-Y31, Y32, Y33, Y34, Y35, and Y36 are installed below flood level, but service only the CBS equipment shown above. Since the above equipment need not function when submerged, the argument can be made that these boxes also need not function when submerged. However, Reference 3 designates this equipment as Op. Code A for all events. It is recommended that the operability code for these boxes be evaluated for change to Op. Code C for the MELB.

The following conduits are located below flood level: HVJ/RA, 4UC/RA, 4UA/RA, 4TZ/RA, HTK/VA, 4TY/RA and 4VM/RA. A review of the UE&C CASP sorting system shows that they carry cables to RH-V-70, CS-V-142, CS-V-162, CS-V-166 and MM-IR-12. A review of the Reference 3 Harsh Environment Equipment List, shows that only MM-IR-12 must function during the MELB which causes submergence. The cables associated with this equipment and their purchase orders and cable codes are shown below:

Cable No.	Cable Code	Reel No.	P.O.
F26-GK8	AG1P	C5-11	113-17
GK8-LB7	AG1P	C5-20	113-17
FA5-GK8	MA6R	EU-118	113-06
FA5-GK8/1	MA6R	EU-32	113-06
FA6-GK8	MA6R	EU-30	113-06
FA8-GK8	MA6R	EU-30	113-06
GK8-GK9	MD6R	EW140	113-20

As instrument rack MM-IR-12 is also submerged (see 1st paragraph of this section), the resolution for the attached cable should be consistent with that provided for the rack.

Main Steam and Feedwater Pipe Chases:

The only Class 1E equipment installed below the HELB flood level (5'-5") (Reference 1, Table 3-2) is FW-PT-514, 515, 544 and 545. Per Reference 3, they must function during a HELB. They are not qualified for submerged conditions. These instruments are located on racks MM-IR-52A and MM-IR-52B, whose junction boxes are above flood level. If relocated, care should be taken that their associated rack wiring is also relocated above the flood level. RM-RM-6481 is also located below flood level, but it is not required to function when submerged (Reference 3).

The cables to valves MSD-V-44, MSD-V-45, MSD-V-46, and MSD-V-47 are below the flood level. This equipment must function for HELB events (Reference 3). From a review of the UE&C CASP sorting system, the following cable codes and purchase orders are associated with the various valves.

Valve	Node	Cable No.	Cable Code	P.O.
MSD-V-46	VE2	DCO-VE2/4	AG1P	113-17
		F27-VE2	AB1P	113-17
		VE2-ZK4/1	AB1P	113-17
		DCO-VE2/3	BC1N	113-03

Valve	Node	Cable No.	Cable Code	P.O.
MSD-V-V45	VE1	DC9-VE1/4	AG1P	113-17
		F27-VE1	AB1P	113-17
		G1U-VE1	AB6P	113-17
		VE1-ZK4/1	AB1P	113-17
		DC9-VE1/3	BC1N	113-03
MSD-V-44	VDO	DC8-DVO/4	AG1P	113-17
		F27-VDO	AB1P	113-17
		VDO-ZK2/1	AB1P	113-17
		GY3-VDO	MA6R	113-20
		DC8-VDO/3	BC1N	113-03
MSD-V-47	VE3	GY3-VE3	MA6R	113-20
		DD1-VE3/3	BC1N	113-03
		DD1-VE3/4	AG1P	113-17
		F27-VE3	AB1P	113-17
		VE3-ZK2	AB1P	113-17

These cables will be analyzed for submergence.

Three additional conduits are located below flood level. They are FUD/VA, FJG/VA and FJF/VA. A search of the UE&C CASP sorting systems shows that these conduits carry cables JW4-UM6 and JW7-UM7. The cable code is MA6R and the purchase order is 113-20 for both cables. This cable code is already being evaluated for submergence as it is attached to the MSD valves listed above.

One cable tray runs north to south at elevation 4'-6" in the east pipe chase. The tray, marked 86J1VA thru 86R1VA, contains cables which operate both Class 1E and non 1E equipment, some of which must operate during the event which causes flooding. For example, by using the UE&C CASP Sorting System, cable FS7/QV7 supplies power to instrument VB-YT-6822. From Reference 3 it can be determined that this equipment must function during the HELB which causes the flooding. Therefore, this cable must function during the event also. Since these cables are in an open tray and there is no separation, all cables in this tray are assumed to have to remain intact u[illegible] submergence conditions. Therefore, submergence qualification w[illegible] be addressed. A review of the UE&C CASP sorting system shows the following purchase order numbers and cable codes for all the cable contained in this tray.

Cable No.	Cable Code	Reel No.	P.O.
FA1/GL5	MB1P	EU-06	11[illegible]
FA6/GL5	MA6R	EU-40	113-06
FA6/S3C	MA6R	EU-34	113-06
FA7/GL5	MA6R	EU-34	113-06
FA[illegible]	MA6R	EU-40	113-06
FB7/GX6	MB1R	ED-06	113-06
FB7/GX7	MB1R	ED-02	113-06
FC1/GX6	MD1R	EE-02	113-06
FC1/GX[illegible]	MA1R	EC-02	113-06

Cable No.	Cable Code	Reel No.	P.O.
FC1/GX7/1	MA1R	EC-07	113-06
FC5/GX6	MA6R	EU255	113-20
FJ0/GL5	MB6R	EV-17	113-06
FJ7/GL5	MA6R	EU-32	113-06
FR5/H33	VC6R	EX249	113-20
FR5/H49	VC6R	EX250	113-20
FR5/H49/A	VC6R	EX249	113-20
FR5/H49/B	VC6R	EX136	113-20
FR5/H49/C	VC6R	EX-25	113-20
FR5/H49/D	VC6R	EX251	113-20
FR5/H49/E	VC6R	EX250	113-20
FR5/H49/1	VC6R	EX249	113-20
FR5/H49/2	VC6R	EX250	113-20
FR5/H49/3	VC6R	EX-25	113-20
FR5/H49/4	VC6R	EX249	113-20
FR5/H49/5	VC6R	EX249	113-20
FR5/H49/6	VC6R	EX249	113-20
FR5/H49/7	VC6R	EX250	113-20
FR5/H49/8	VC6R	EX-25	113-20
FR5/H49/9	VC6R	EX249	113-20
FR5/JW4	MD6R	EW164	113-20
FR5/JW4/1	MD6R	EW169	113-20
FR5/JW6	MD6R	EW162	113-20
FR5/JW6/1	MD6R	EW162	113-20
FS7/QV7	MA6R	EU224	113-20
FS7/QV8	MA6R	EU224	113-20
F20/GX6	MA1R	EC-02	113-06
F20/GX6/1	MA1R	EC-07	113-06
F20/GX7	MA1R	EC-02	113-06
F20/GX7/1	MA1R	EC-02	113-06
F36/S5E	MA6R	EU315	113-20
F60/GX6/1	MD1R	EE-02	113-06
F60/GX7/1	MD1R	EE-01	113-06
F77-GX6	NR1R	FJ167	113-20
F77-GX7	NR1R	FJ167	113-20
F77-HM4/4	MD1R	EE-01	113-06
GL4/XF7	MD6R	EW241	113-20
GX6/SW7	MB6R	EV-25	113-18
GX6/SW7/1	MD6R	EW371	113-20
GX6/SW7/2	MD6R	EW371	113-20
GX6/ZV0/1	MA1R	EC-08	113-06
GX6/ZV1/1	MA1R	EC-08	113-06
GX6/ZX3/1	MA1R	EC-08	113-06
GX6/Z18/1	MA1R	EC-02	113-06
GX7/GY3	MD6R	EW229	113-20
GX7/JW7	MD6R	EW229	113-20
GX7/JW7/1	MB6R	EV-25	113-18
GY3/H2U	MB6R	EV349	113-20
G2G/GL5	MA6R	EU311	113-20
G2G/GX6/5	MD1R	EE-02	113-06
G2G/GL7/5	MD1R	EE-01	113-06
G2H/GL5/1	MA6R	EU223	113-20

Cable No.	Cable Code	Reel No.	P.O.
G3T/G3U	PN6Q	JJ-01	113-06
G3U/G3V	PH6Q	JD-04	113-06
HM4/JW4	MB6R	EV-25	113-18
H2M/Q9B	VC6R	EX318	113-20
I29/ZG6	MA6R	EU224	113-20
I29/ZG6/1	MJ6T	FH395	113-20
I30/I63	MA6R	EU227	113-20
I30/ZG6	MA6R	EU-29	113-06
JW4/PP1	MA6R	EU261	113-20
JW4/T6R	MA6R	EU255	113-20
JW4/VR8	MA6R	EU-67	113-18
JW4/VU7	MA6R	EU-97	113-06
GX7/ZW0/1	MA1R	EC-06	113-06
GX7/ZW3/1	MA1R	EC404	113-20
GX7/ZW5/1	MA1R	EC404	113-20
GX7/ZW8/1	MA1R	EC-06	113-06
JW7/P91	NR6R	FN205	113-20
JW7/RC8	MA6R	EU316	113-20
JW7/VR9	MA6R	EU223	113-20
JW7/VU8	MA6R	EU-28	113-06
JW7/V2Q	MA6R	EU255	113-20
JW7/ZW7	MD6R	EW241	113-20
JW7/ZX2	MD6R	EW-24	113-06
JZ6/TOA	ZA6R		Not pulled as of 1/30/86
JZ6/TOB	ZA6R		
JZ6/T92/1	VC6R	EX-25	113-20
JZ6/T93/1	VC6R	EX250	113-20
JZ7/T92/1	VC6R	EX200	113-20
JZ7/T93/1	VC6R	EX212	113-20
Q20/Q25	MB6R	EV-30	113-13
Q20/Q25/1	MA6R	EU-62	113-18
Q24/Q25	MB6R	EV-29	113-18
Q24/Q25/1	MA6R	EU-28	113-06

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REFERENCES

1. "Environmental Qualification of Electrical Equipment Important to Safety", Seabrook Station, Revision 2, October 31, 1985.

2. "Moderate Energy Line Break Study", Seabrook Station, TP7, Revision 4, March, 1985.

3. "Harsh Environment Equipment List", UE&C Drawing 9763-M-300218, Revision 002, January 20, 1986.

4. "Service Environment Chart", UE&C Drawing 9763-F-300219, Revision 17, July 22, 1985.

5. Seabrook Station FSAR, Amendment 56, RAI 430.62.

6. "Class 1E Equipment List", UE&C Drawing 9763-M-505300, Revision 017, January 20, 1986.

Reference 10

EQ FILE No. 113-19-02
REFERENCE 1C

NTS

Test Procedure No. 24843-89N

Page Nos. 24

Revision 1, dated 22 June 1988

TEST PROCEDURE

FOR

ENVIRONMENTAL QUALIFICATION TESTING OF COAXIAL INSTRUMENT CABLES (RG 58)

FOR

NEW HAMPSHIRE YANKEE
A DIVISION OF PUBLIC SERVICE CO. OF N.H.
P.O. BOX 300
SEABROOK, NH 03874

Purchase Order No. 61917

Prepared by: [signature] for Date 22 June 88
Brian J. Drain, NEQ Project Engineer
NTS/Acton
533 Main Street, Acton, MA 01720

Reviewed and Approved by: [signature] for Date 22 June 88
Keith G. Whittles, Engineering Manager
NTS/Acton

KT/PRO/2484389N.NHY

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REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARA. NUMBER	CHANGES OR ADDITIONS	APPROVED BY
	0	-------------FIRST ISSUE------------			
06/21/88		cover sheet		add: Co. of NH	
		1-1	1.0	chng: degradation performance to degration of performance	
				chng:will not be conducted to is not required	
				chng: 50,40 to 50.49	
		2-2	2.0	chng: 1973 to 1988 and 1977 to 1988 del: 1st clause, 2nd sentence, 2nd para.	
		3-1	3.0	chng:Implementation to Instrumentation add: Seabrook cable code. chng:limited DBE to Test Spares	
		4-1	4.0	add: Functional to step 5	
		5-1	5.1	chng: Forwarded to, to provided to del: for their evaluation and approval	

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REVISION RECORD					
DATE	REVISION NUMBER	PAGE NUMBER	PARA. NUMBER	CHANGES OR ADDITIONS	APPROVED BY
	0	---------------FIRST ISSUE---------------------			
06/21/88		5-1	5.2	add:each test item will be secured.... chng:transmitted to provided del: for evaluation	[signature] 22 June 88
		6-1	6.0	chng: service temp to design conductor temp. add: Irradiated add:specified by NHY chng: 1.29 to 1.26 add: design conductor temp activation energy chng: was to were del: the 1.29 ev activation energy...	[signature] 22 June 88
		9-1	9.0	add:A N.H. Yankee representative...	
		10-1	10.0	add: A	
			10.2	chng: The four to eight chng:will be to were previously add:see section 5.1 del: each test item will be... add: 4 aged specimens and four unaged...	

REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARA. NUMBER	CHANGES OR ADDITIONS	APPROVED BY
	0	---------------FIRST ISSUE---------------------			
06/21/88		10-3	10.4	chng: changing to charging	
		10-3	10.4	add: as shown in fig 10-5. add: at approximately...	[signature] 22 June 88
		10-4	10.4	del: due to the duration... del: circu... add: drop across the monitoring circuit load del: 30-day LOCA	
		10-5	figure	chng: to reflect 30 day test not 100 day test	[signature] 22 June 88
		10-7	10.7	add: shown in the fig. on page 10-5	
		11-1	11.0	del: subsequent to LOCA testing... add: Post LOCA functional testing shall consist of...	
		A-1		del: a del: , and as chng: all to ALL add: will	
		A-1 to A-		add: T.E. List	

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TABLE OF CONTENTS

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1.0 PURPOSE

The purpose of this document is to describe the procedures which shall be followed during environmental qualification testing of ten (10) ITT Surprenant RG 58 Coaxial Cables supplied by New Hampshire Yankee. Section 3.0 of this procedure provides specific identification of the subject test specimens.

The intent of the test program is to evaluate the performance and durability of the coaxial cables during and following exposure to postulated in-service and end-of-life accident environment simulations. Qualification acceptability of the cables will be dependent on their ability to withstand the specified environmental simulations without loss of physical integrity or degradation of performance capability.

As detailed herein, the cable qualification program shall be conducted in accordance with the guidelines of IEEE Std. Nos. 323-1974 and 383-1974. Per the stipulation of New Hampshire Yankee, the vertical flame test described within Section 2.5 of IEEE 383-1974 is not required for any test specimen.

The subject program shall be conducted in accordance with the provisions of NTS/Acton's Quality Assurance Manual. This fact shall ensure compliance with all pertinent provisions of 10CFR, Part 21, 10CFR, Part 50.49 and 10CFR, Part 50, Appendix B.

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2.0 REFERENCE REGULATIONS AND DOCUMENTS

2.1 New Hampshire Yankee Purchase Order No. 61917.

2.2 IEEE383-1974 Institute of Electrical and Electronics Engineers, Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

2.3 IEEE323-1974 Institute of Electrical and Electronics Engineers, Standard for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations.

2.4 10CFR50 Appendix B - Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants (1988).

2.5 10CFR21 - Reporting of Defects and Noncompliance (1988).

2.6 10CFR50.49 - Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants.

2.7 NEP 160 - Environmental Qualification (EQ) Program.

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3.0 TEST ITEM DESCRIPTION

Four (4) Coaxial Instrumentation Cables shall be subjected to the environmental and performance tests described in this procedure.

Each cable shall be inspected upon its receipt at NTS/Acton to document the pre-test condition of each test item. Each item shall be tagged with a unique identification number. This number will remain unchanged throughout the test program.

The test specimens shall consist of:

Cable Type:	Coaxial
Manufacturer:	ITT Surprenant
Cable Code:	TA6Y (Seabrook Cable Code)
Cable Color:	Black w/ Red Tracer
Sample Length:	Fifty (50) feet
No. of Samples:	Ten (10)

The test samples will be numbered one through ten and will be divided into test groups as follows:

Group No.	Aged	Unaged	DBE Exposure
1	1, 2	7, 8	30-day LOCA Simulation
2	3, 4	9, 10	Limited DBE Test (Optional)
3	5, 6	N/A	Test Spares

Initially, only the Group 1 test specimens will be subjected to the test sequence described in Section 4.0 of this document. The remaining test items will be reserved for any additional testing which might be deemed to be required by New Hampshire Yankee.

4.0 TEST ITEM SEQUENCE

Following receipt and inspection, the cables shall be subjected to environmental and performance testing in the following sequence:

1) Baseline Functional
2) Thermal Aging
3) Post Thermal Aging Functional
4) Irradiation
5) Post-Irradiation Functional
6) Cable Preparation and LOCA Setup
7) LOCA Simulation
8) Post-LOCA Functional

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5.0 BASELINE FUNCTIONAL

Subsequent to receipt and inspection at NTS/Acton, the cables shall be subjected to Baseline Functional Testing. The results of these tests shall be used as a benchmark for comparison to the results of similar tests at critical points in the test program. This process shall provide a means of monitoring cable performance characteristics in order to identify and qualify any test item deficiency or verify qualification acceptability.

5.1 Continuity Check

Using an ohmmeter, each conductor and shield of each cable shall be checked for continuity. Results shall be recorded on test data sheets.

Acceptance Criteria

The measured values (a total of twenty) shall be recorded on a test data sheet and subsequently provided to New Hampshire Yankee.

5.2 Insulation Resistance

The cables shall be wrapped around mandrels having a diameter of approximately twenty times the cable diameter. Each test item will be secured to its mandrel via Sager TY25M Tyraps. A minimum cable length of ten feet shall contact the mandrel surface. Insulation resistance measurements shall be made between the center conductor and

5.0 **BASELINE FUNCTIONAL** (continued)

5.2 **Insulation Resistance** (continued)

the shield, and between the shield and the mandrel. The insulation resistance test shall be performed by applying a 500 Vdc potential to one conductor for a minimum of one minute. After the one minute energization, the insulation resistance shall be measured using an I.R. Bridge and the results shall be recorded on data sheets.

Acceptance Criteria

The measured insulation resistance shall be acceptable if it is greater than one megohm. The data shall be provided to New Hampshire Yankee.

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6.0 THERMAL AGING

Subsequent to the Baseline Functional Test, the cables shall be subjected to thermal aging. The cables shall be placed in a forced hot air aging chamber as attached to the mandrels. Only the test cables and spares (six cables total) shall be in the aging oven during the aging process.

Aging temperature shall be monitored and recorded a minimum of twice daily.

Thermal aging duration is based on the following information:

Design Conductor Temp. =	167°F (75°C) (specified by NHY)
Weak-Link Material =	Irradiated Crosslinked Polyethylene
Activation Energy =	1.26eV (150°C) (specified by NHY)
Aging Temperature =	302°F (specified by NHY)
Aging Time =	168 hours (specified by NHY)
Qualified Life =	40 years

The previously listed design conductor temperature, activation energy, aging time and temperature were specified by New Hampshire Yankee, based on existing qualification data provided by the manufacturer for the identical cable insulation and jacketing materials.

7.0 POST THERMAL AGING FUNCTIONAL

A New Hampshire Yankee representative may be present at NTS/Acton to witness the post-thermal aging functional test. Following completion of thermal aging testing, the test cables shall be subjected to identical functional tests as those specified for baseline functional testing, except that the cables and mandrels shall be submerged in tap water for a minimum of one hour prior to the insulation resistance test.

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8.0 RADIATION

Subsequent to the post-thermal aging functionals, the test samples will be packaged in two cardboard boxes. They will be placed carefully in paper insulation to protect the samples during shipping and handling. The box containing the test samples will be shipped to Isomedix's radiation facility in Whippany, New Jersey and tested in the sealed box.

At Isomedix, the specimens will be exposed to a Cobalt-60 gamma field at a dose rate not to exceed 1.0×10^6 rads per hour providing a T.I.D. of 2×10^8 rads +10% (2.2×10^8 rads). Halfway through the exposure, the specimens will be rotated 180 degrees to insure a more uniform dose.

Dosimetry will be performed using Harwell Red Perspex dosimeters, utilizing a Bausch and Lomb Model 70 Spectrophotometer as the readout instrument, or an equivalent dosimetry system. This system which is calibrated directly with Atomic Energy of Canada, Limited (AECL) is traceable to NBS. A copy of the correlation report will be available upon request. Irradiation will be conducted at ambient temperature and pressure for the Isomedix facility.

9.0 POST-IRRADIATION FUNCTIONAL

A New Hampshire Yankee representative may be present at NTS/Acton to witness the Post-Irradiation funtional and unpacking prior to LOCA simulation.

Subsequent to completion of the gamma irradiation exposure, the test specimens will be subjected to the identical functional tests as those specified for baseline functional testing, except that the cables and mandrels shall be submerged in tap water for a minimum of one hour prior to the insulation resistance test.

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10.0 LOCA SIMULATION

The following test will be performed to simulate the postulated LOCA at the end of the cable service life.

10.1 Calibration Run

Prior to performing the LOCA test, a calibration run will be performed to demonstrate system capability. The calibration run will be performed to the transient conditions. A New Hampshire Yankee representative may be present to witness the calibration run, if desired.

10.2 Test Fixturing

Eight cable test specimens, each approximately ten feet in length, were previously wrapped around a steel mandrel whose outside diameter is approximately twenty (20) times that of each test item (see Section 5.1).

Four aged specimens and four unaged specimens shall be placed in the LOCA Chamber. The eight specimens shall be divided into two groups, each group having 2 aged and 2 unaged specimens. Both groups shall be subjected to the margin transient and 15 days of the 30 day LOCA test. At the 15 day mark, at New Hampshire Yankee's option, the LOCA test shall be interrupted and both groups of specimens shall be subjected to continuity and an immersed Insulation resistance test. One group shall then be removed and subjected to a voltage withstand test, as described in

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10.0 LOCA SIMULATION (continued)

10.2 Test Fixturing

section 11.0. The remaining four samples shall then be subjected to the remainder of the 30 day LOCA test.

The fixtured test units will then be placed onto a horizontal metal base inside NTS/Acton Test Autoclave No. 1.

The cable ends will be trimmed to permit electrical measurements from outside the test autoclave. The cable specimens will be of sufficient length to allow each specimen to be brought through a sealed autoclave penetration without need for any special connection within the autoclave. The minimum test specimen length physically located in the autoclave shall be 30 feet.

10.3 Test Condition Monitoring

NTS/Acton will use three (3) Type "J" thermocouples to monitor the LOCA simulation test. One thermocouple (T_1) will be placed approximately 2" from the steam outlet, one thermocouple (T_2) will be placed one inch off the test fixture on the left hand side near the steam outlet, and one thermocouple (T_3) will be placed on the right hand side furthest from the steam outlet approximately one inch off the test fixture.

Autoclave pressure will be monitored using a calibrated pressure transducer.

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10.0 LOCA SIMULATION (continued)

10.3 Test Condition Monitoring

The environmental test conditions will be monitored during the LOCA simulation using a Gould Strip Chart Recording System (or equivalent instrument).

10.4 Test Item Loading

Each test cable conductor will be energized with an AC potential of 600V at a test current of 1.0 amperes per conductor. The cable shields, mandrel and test vessel will be at ground potential. The test circuit will be designed such that the applied potential will be interrupted if the leaking/charging current exceeds approximately 1.0A.

10.5 Test Item Monitoring

The test items will be energized as detailed in Section 10.4 during the LOCA simulation with the following exception:

The circuit will be de-energized to perform I.R. measurements as detailed in Section 5.0 of this procedure at the following test intervals, as shown in the figure on page 10-5:

1) After interconnection c the test specimens and placement of the sampl s s ts on the base fixture, test specimens submerged.
2) At the test temperature of 346°F, as time permits, at approximately the 1.5 hour mark.

10.0 LOCA SIMULATION (continued)

10.5 Test Item Monitoring (continued)

3) At a minimum of once per day during LOCA. If the IR reading monitored drops below 1 megohm, the recovery of the IR reading to megohm will be determined as a function of temperature by more frequent monitoring of readings within this period.

4) After LOCA, at ambient conditions, while still fixture in the autoclave, with the specimens covered with water.

Voltage drop across the monitoring circuit load will be monitored continuously during the test.

If failure occurs during the LOCA test, the failed test sample(s) will be identified utilizing the insulation resistance measurements described in this section of this procedure. Subsequent to isolating the failed sample(s), it will be jumpered out and the test circuit reenergized. This action would be a contingency plan allowing NTS/Acton to address failure if failure occurs. New Hampshire Yankee will be notified as soon as possible if failure occurs.

10.6 Chemical Spray

The test cables will be subjected to a chemical-spray exposure based on the profile specified.

Fresh chemical spray will be used for a minimum of one (1) hour at each dwell at 346°F(174°C); thereafter, the spray solution will be recirculated from the pool of solution collected in the bottom of the vessel. The

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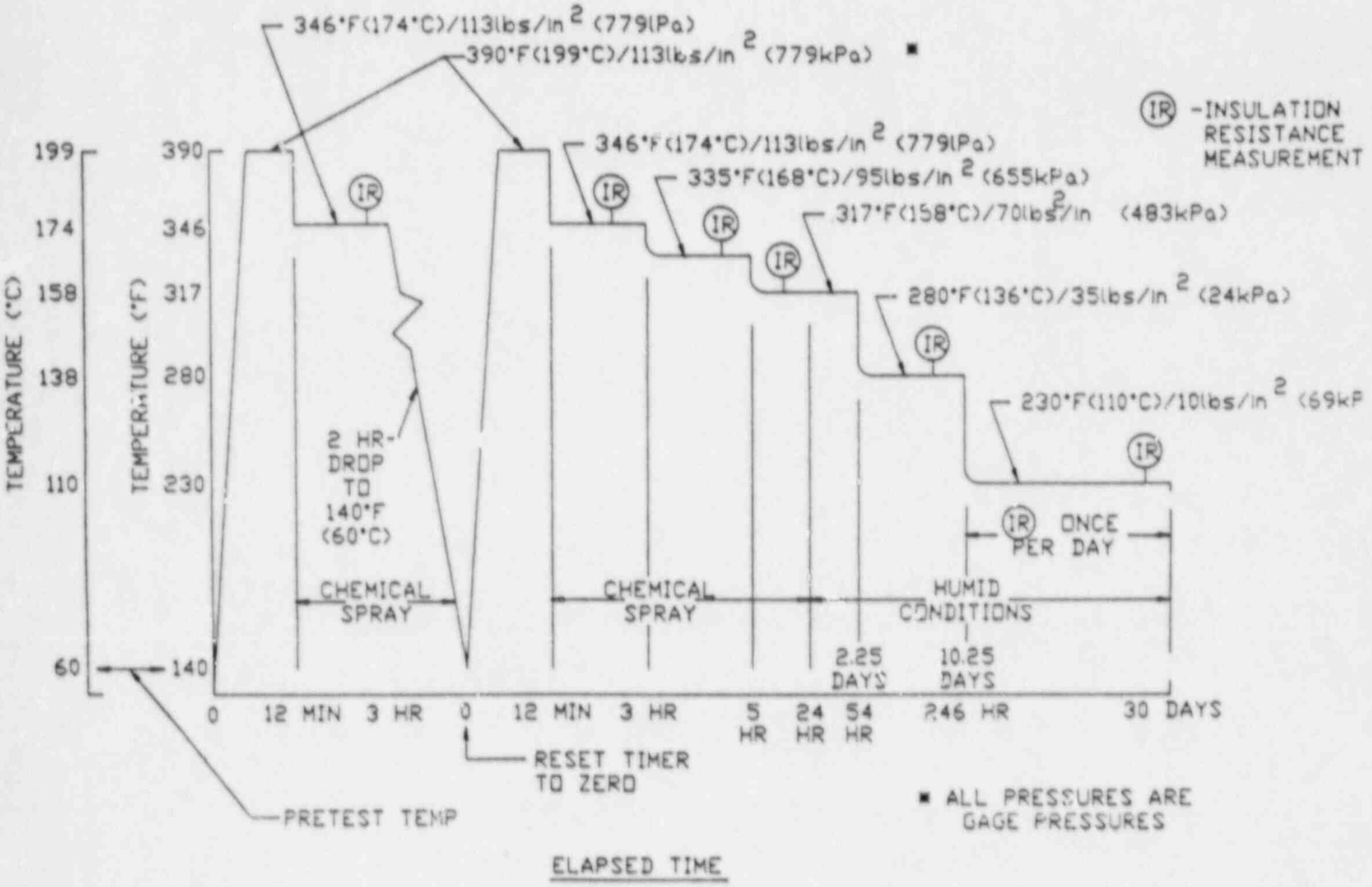

346°F(174°C)/113lbs/in 2 (779lPa)
390°F(199°C)/113lbs/in 2 (779kPa) *
IR -INSULATION RESISTANCE MEASUREMENT
346°F(174°C)/113lbs/in 2 (779lPa)
335°F(168°C)/95lbs/in 2 (655kPa)
317°F(158°C)/70lbs/in 2 (483kPa)
280°F(136°C)/35lbs/in 2 (24kPa)
230°F(110°C)/10lbs/in 2 (69kP
TEMPERATURE (°C)
TEMPERATURE (°F)
199
174
158
138
110
60
390
346
317
280
230
140
IR
2 HR-DROP TO 140°F (60°C)
CHEMICAL SPRAY
CHEMICAL SPRAY
HUMID CONDITIONS
IR ONCE PER DAY
2.25 DAYS
10.25 DAYS
0
12 MIN
3 HR
0
12 MIN
3 HR
5 HR
24 HR
54 HR
246 HR
30 DAYS
RESET TIMER TO ZERO
PRETEST TEMP
* ALL PRESSURES ARE GAGE PRESSURES
ELAPSED TIME

10.0 LOCA SIMULATION (continued)

10.6 Chemical Spray (continued)

chemical spray will consist of 3000 ppm boron as boric acid, 0.064 molar sodium thiosulfate, and sufficient sodium hydroxide to obtain a pH of 10.5 at room temperature. The spray shall be applied at a total flow rate of 0.63 gal/min, which is calculated to provide a spray intensity of approximately 0.15 (gal/min)/ft^2 over the cylindrical area of the mandrels.

10.0 **LOCA SIMULATION** (continued)

10.7 LOCA Simulation

The LOCA Simulation will consist of injecting saturated steam into the autoclave to achieve the temperature/pressure profile shown in the figure on page 10-5. Due to the length of the fixture, and autoclave volume, Acton anticipates varying temperatures internal to the autoclave during transient conditions Therefore, thermocouple placement has been designed to demonstrate a general test condition envelope. Subsequent to achieving the transient condition the chemical condensate will submerge NTS/Acton's immersion heater and saturated conditions will be maintained by the immersion heater. At the conclusion of the LOCA test, at ambient conditions, photographs will be taken of the test samples.

NTS

11.0 POST-LOCA FUNCTIONALS

Post-LOCA functional testing shall consist of continuity checks, and immersed insulation resistance testing and voltage withstand testing. These post-LOCA functional tests shall be conducted on one group of four specimens at the end of the first fifteen days of the LOCA test. The continuity checks and immersed insulation resistance test shall also be conducted for the second group of four specimens at the end of the first 15 days of the LOCA test. The second group of four specimens shall not be subjected to the voltage withstand test at this time.

At the conclusion of the complete 30-day LOCA test the second group of four specimens shall be subjected to continuity checks and immersed insulation resistance test while still fixture in the sealed chamber. Following these two tests, the chamber shall be drained and opened and the specimens shall be visually inspected for damage or deterioration. The specimens shall then be subjected to the voltage withstand test.

A New Hampshire Yankee representative may be present to witness all Post-LOCA activities and specimen handling.

Acceptance Criteria

The results of the post-LOCA functional tests will be forwarded to New Hampshire Yankee for their review and evaluation.

NTS

11.0 POST-LOCA FUNCTIONALS

Voltage Withstand Test

The cables will be straightened and then re-wrapped around mandrels having a diameter of approximately forty times the cable diameter. The cables and mandrels will be immersed in tap water for a minimum of one hour and subjected to a voltage withstand test for five (5) minutes at a potential of 80 Vac/mil. The leakage current shall be measured after five (5) minutes of energization.

APPENDIX A - REPRESENTATIVE TEST EQUIPMENT LIST

The following equipment is representative of the test equipment to be used during this test program. Acton may use substitutions for test equipment, but the replacement equipment will have accuracies equal to or better than those listed in this Appendix. All calibrated test monitoring equipment used in this project will have certification traceable to the NBS.

TEST EQUIPMENT LIST

Test Report # ____________
Page _____

NAME	MFR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL DATE
LCD Digital Timer	NTS/ Acton	CAL-5	DKP01	To 9hr/59min/59sec	1sec/day	FM322	
Digital Multimeter	Fluke	8502-03	2215048	100 MV to 1000 VDC 100 Micro ohms to 1 A DC	.003%	ML545	
Digital Multimeter	Fluke	8050A	2876259	10 U to 1000 VDC 10mV to 750 VAC, true rms 0 to 20 megohm, res dB volt.	±.03% DC + 2 digits	ML546	
Precision Calibrator	Omega	CL-505	85014-0740	Type J,K,T,E,R,S,B, THRMO CPLE SMLTR 100 RTD MEAS)± 10V output: 0.5 ma OUTPUT, 0-130 ma input 0 to ± 10V input	see Mfr specs	ML564	
Voltage Reference Source	Heathsen	EU16	6742265	0 - 100 VDC 4 ranges	± 3%	PD504	
Power Supply	Sorensen	QRS30-1	1549	0-30 VDC, 0-1 amp	.03%	PD320	
Digital PH Meter	Orion Research	701A	A52810	6 to 8 pH	± .002 ph ± .1 mv	PD391	
Digital Pressure Indicator	Jay	3502-8	10307	0 to 350 psi	±1.0 psi	PI403	
Flow Gauge	Fisher & Porter	10A1755	8103A1-OG4A1	0.2 to 1.9 GPM	± 3%	PI416	
Pressure Transducer	Wiancko	PP2-3239-1		0 to 350 psi	± 2%	PI417	
Heavy Duty Solution Balance	OHAUS	20KG-45 lb		1 Gm to 20 KGms	± 1 gram	PP395	