Test Procedure No. 24843-89N

Page Nos. ____

TEST PROCEDURE

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: Brian J. Drain
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NTS/Acton
533 Main Street, Acton, MA 01720

Date May 25, 1988

Reviewed and
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NTS/Acton

Date 5.25.88

KT/PRO/2484389N.NHY

NTS

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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 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 will not be conducted 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.

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 (1973).

2.5 10CFR21 - Reporting of Defects and Noncompliances (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.

3.0 TEST ITEM DESCRIPTION

Four (4) Coaxial Implementation 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. If the condition is determined to be acceptable, each item shall be tagged with a unique identification number. This number will remain unchanged throughout the test program.

The test specimens sh ll consist of:

Cable Type:	Coaxial
Manufacturer:	ITT Surprenant
Cable Code:	TA6Y
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 ..vided 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	Limited DBE 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
6) Cable Preparation and LOCA Setup
7) LOCA Simulation
8) Post-LOCA Functional

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 forwarded to New Hampshire Yankee for their evaluation and approval.

5.2 Insulation Resistance

The cables shall be wrapped around mandrels having a diameter of approximately twenty times the cable diameter. A minimum cable length of ten feet shall contact the mandrel surface. Insulation resistance measurements shall be made between the center conductor and the shield, and between the shield and the mandrel. The insulation resistance test

5.0 **BASELINE FUNCTIONAL** (continued)

5.2 Insulation Resistance (continued)

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 transmitted to New Hampshire Yankee for evaluation.

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:

Service Temperature =	130°F (54.4°C)
Weak-Link Material =	Cross-linked Polyethylene
Activation Energy =	≈1.29eV (150°C)
Aging Temperature =	302°F (specified by NHY)
Aging Time =	168 hours (specified by NHY)
Qualified Life =	40 years

The previously listed aging time and temperature was specified by New Hampshire Yankee, based on existing qualification data provided by the manufacturer for the identical cable insulation and jacketing materials. The 1.29eV activation energy was derived by use of the Arrhenius equation and the previously listed times and temperatures.

7.0 POST THERMAL AGING FUNCTIONAL

A New Hampshire Yankee representative may be present at NTS/Acton to witness the post-thermal aging functional and packaging prior to radiation exposure. 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.

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

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.

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 capabiiity. The calibration run will be performed to the transient conditions. New Hampshire Yankee representative may be present to witness the calibration run, if desired.

10.2 Test Fixturing

The four cable test specimens, each approximately ten feet in length, will be wrapped around a steel mandrel whose outside diameter is approximately twenty (20) times that of each test item. Each test item will be secured to its mandrel via Sager TY25M Tyraps.

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.

10.0 LOCA SIMULATION (continued)

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.

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/changing current exceeds approximately 1.0A.

10.0 LOCA SIMULATION (continued)

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:

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

2) At the peak temperature test temperature (390°F), as time permits.

3) 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 fixtured in the autoclave.

Due to the duration required for I.R. measurements, they will be initiated at the peak temperature but will continue for the next thirty (30) minutes of the test profile.

Circuit voltage and current will be monitored continuously during the 30-day LOCA 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

10.0 LOCA SIMULATION (continued)

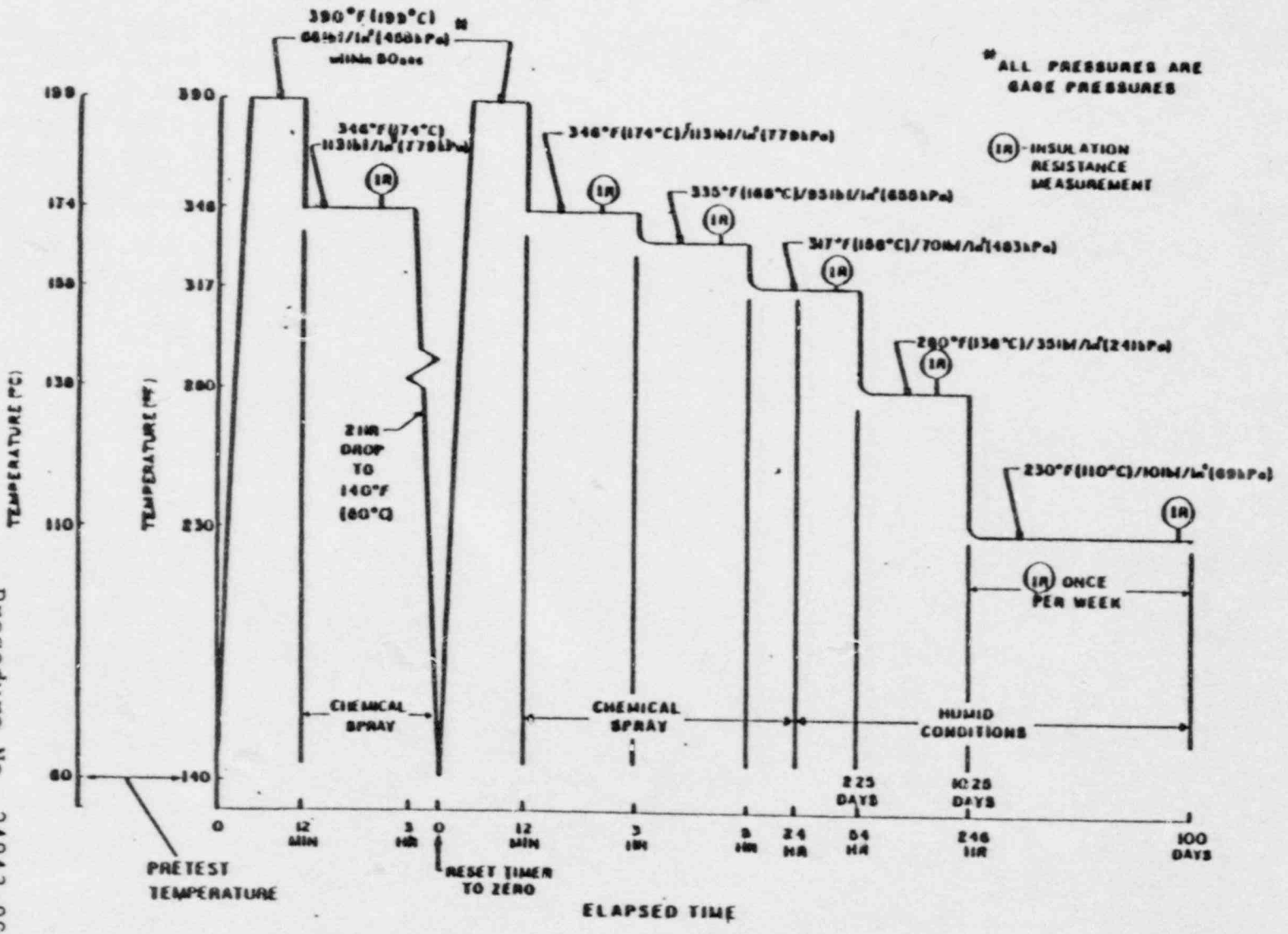
10.5 Test Item Monitoring (continued)

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 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.



Specified Temperature and Pressure Profile for Simulated SLB/LOCA Exposure

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. 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.

11.0 POST LOCA FUNCTIONALS

Subsequent to LOCA testing, the test specimens will be visually inspected for signs of damage. Next, the samples will be subjected to the baseline functional tests.

Acceptance Criteria

The results of the post-LOCA functional tests will be forwarded to New Hampshire Yankee for their review and evaluation.

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 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 a 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, and as all calibrated test monitoring equipment used in this project have certification traceable to the NBS.

SAMPLE

TEST EQUIPMENT LIST

Report No. 24843-89N

NAME	MFR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL DUE
High Temperature Chamber	Blue M Electric	Pom 336C-1	P14-2351	Ambient to +325°C	±5°C	CH366	
Stopwatch	Micronta	63-5010	None	0 to 10 hrs. 1/100 sec. resolution	.5 sec./day	FM325	
Stopwatch	Micronta	63-5009A	None	0 to 59 min. 59 sec. 1/100 sec. resolution	.5 sec./day	FM326	
Digital Multimeter	Fluke	8050A	2646172	10 mV to 750 VAC True rms 0 to 20 MΩ Res., dB Voltage	DC±.03%R +2 digits	ML503	
Digital Multimeter	Fluke	8050A	2876259	10 microvolts to 1000 VDC 10 millivolts to 750 VAC 0 to 20 MΩ resistance	DC ±0.03% +2 digits	ML546	
Current Shunt	G.E.	0-50 Amp	N/A	50 amps - 50 millivolts	±1%	ML550	
AC/DC Hi Pot	Hipotronics	HD125	9870-01	AC to 10 kV DC to 25 kV	Meters 2%	PA517	
Variac	Superior Electric	1256-2D-B	2870	Priority Voltage: 240/120 3φ 50/60 Hz input 0 to 280 volts, 28 amp output	N/A	PA519	
DC Amplifier	Honeywell	117	0100135-G68	4 Channel Gain: .01 to 10	±2%	PE405	
Digital Pressure Indicator	Jay	3502-08	10306	0 to 150 psi	±1.0 psi	PI402	
Digital Pressure Indicator	Jay	3502-08	10307	0 to 350 psi	±1.0 psi	PI403	
Digital Pressure Indicator	Jay	3502-08	10308	0 to 150 psi		PI404	

SAMPLE

TEST EQUIPMENT LIST

Test Report # 24843-89N
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NAME	MFR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL DUE
Pressure Gauge	U.S. Gauge	0-160	N/A	0 to 160 psi	±1.0 psi	PI406	
Flow Gauge	Fisher & Porter	10A1755	8103A100 4A1	0.2 to 1.9 gpm	±3%	PI416	
Pressure Transducer	C.J. Enter-prises	CJDL-4010	1917	0 to 150 psi	±2%	PI443	
Pressure Transducer	Viatran	218-28	172475	0 to 200 psig	Static Error Band <±.4% span	PI449	
Visicorder	Honey-well	906C	9-9334	DC to 2 KHz 12 channel 6" paper	±1 dB	RE311	
Data Logger	Solar-tron	3530D	100378	DC 0 to 100V, 0 to 100mA AC 0 to 20V, 0 to 200mA Resistance 0 to 10K	See Mfr. Manual	RE388	
Digital Temper-ature Indicator	Omega	199	19843	-245 to +1999°F	±1°F	TI326	
Digital Temper-ature Indicator	Omega	199	19862	-245 to +1999°F	±1°F	TI334	
Digital Temper-ature Indicator	Omega	199	43242	-178°F to 1400°F Type "J"	±1.5°F	TI352	
Mercury Thermometer	ERTCO	ASTMIIC	6796	0 to 400°C	±2°C	TI362	

SAMPLE

TEST EQUIPMENT LIST

NAME	MFR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL DUE
Dual Thermocouple Probe (LOCA)	Omega	Type J	N/A	-300 to 1600°F	±2.2°C or ±0.75%	TP319	
Thermocouple Probe (L)	Omega	Type J	None	-300 to 1600°F	±2.2°F or ±0.75% whichever is greater	TP338	
Thermocouple Probe (L)	Omega	Type J	None	-300°F to +1600°F	±2.2°F or ±0.75% whichever is greater	TP339	
Dual Thermocouple Probe (L)	Omega	Type J	None	-300 to 1600°F	±2.2°F or ±0.75% whichever is greater	TP340	
Thermocouple Probe	Omega	Type J	None	-300 to 1600°F	±2.2°F or ±0.75% whichever is greater	TP341	
Megohmeter	General Radio	1862C	2477	0.5 megohms to 2M megohms 100/500 volts	±3% to ±12%	ZB327	
Megohm Bridge	General Radio	1644A	1041	1K ohm to 1000 tera ohm	±1% to ±10%	ZB332	

Calibration Abbreviation

U.W.C.E. - Use With Calibrated Equipment

National
Technical
Systems

Acton Division
533 Main Street
Acton, MA 01720
617/263-2933

July 5, 1988

New Hamsphire Yankee
A Division of Public Service of New Hampshire
Route 1, Lafayette Road
General Office Building
Seabrook Station
Seabrook, NH 03874

Attention: Richard Bergeron
Joseph Vargas

Reference: Environmental Qualification Testing of RG58 Coaxial Instrument Cables, NTS/Acton Job No. 24843-89N

Gentlemen:

The purpose of this letter is to provide a summary of the Qualification Test Program for RG58 Cable samples for New Hampshire Yankee. A comprehensive report shall be submitted in addition to this letter. The agreed submittal due date is July 8, 1988.

Ten cable samples were submitted to NTS/Acton for qualification testing in accordance with IEEE 383-1974, and a previously conducted test program documented in Franklin Research Test Report No. F-A5550-8. The ten samples were designated as follows:

Group One: Two aged samples and two unaged samples
Group Two: Two aged samples and two unaged samples
Group Three: Two aged spares

One group of two aged and two unaged samples was subjected to the following tests:

Receiving Inspection & Baseline Functional Test
Thermal Aging
Post-thermal Functional Test
Irradiation
Post-Irradiation Functional Test
15-Day LOCA Test
Post-LOCA Functional Test

The other group of two aged and two unaged samples was subjected to a 30-day LOCA test instead of the 15-Day LOCA test. Testing on this group is not discussed in this letter as testing is still in progress.

Receiving/Inspection and Baseline Functional Test:

Each cable sample was logged in and labeled with a unique identification number. The identification numbers for this sample group are:

1, 2	Aged Samples
7, 8	Unaged Samples

The samples were then subjected to continuity checks and insulation resistance measurements. The results are on the attached data sheets.

Thermal Aging:

Two of the samples (1, 2) were placed in a temperature chamber at 302°F for 168 hours, simulating a 40-year service life.

Post-Thermal Aging Functional Test:

The samples were again subjected to continuity checks and insulation resistance measurements.

Irradiation:

Two of the smaples (1, 2) were subjected to gamma radiation exposure at Isomedix, New Jersey. The radiation dose was specified as 220 megarads at a rate not to exceed one magarad per hour.

Post-Irradiation Functional Test:

The samples were subjected to continuity checks and insulation resistance measurements.

15-Day LOCA Test:

The samples were placed in the NTS/Acton System One LOCA chamber and subjected to a margin transient (with chemical spray) followed by a 15-day LOCA exposure as required by NTS/Acton Test Procedure No. 24843-89N and the Franklin Reasearch Report previously noted. During LOCA testing, daily insulation resistance measurements were recorded. The sample carried one amp continuously throughout the LOCA test.

Post-LOCA Functional Test:

Following the 15-day LOCA exposure, each sample was subjected to insulation resistance measurements and a voltage withstand test at 3200 VAC.

Results:

All results were acceptable. Some embrittlement of the outer jacket material was observed during the test program, however, the cable samples carried a continuous one amp load during LOCA and withstood the 3200 VAC Hipot Test. All results are included in the attached data sheets.

Conclusions:

The RG58 cable is acceptable for use under environmental and accident conditions specified in NTS/Acton Test Procedure No. 24843-89N.

If you should have any questions concerning the test program, please do not hesitate to contact me.

Sincerely,

NTS/Acton

Keith G. Whittles

Keith G. Whittles
Engineering Manager