TEST REPORT

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
WESTERN OPERATIONS, NORCO FACILITY

REPORT NO. 58722-6
OUR JOB NO. ND 58722
CONTRACT ---
YOUR P. O. NO. A02011-2

RAYCHEM CORPORATION
300 Constitution Drive
Menlo Park, California 92024

29 - Page Report

DATE 21 December 1982

ENVIRONMENTAL QUALIFICATION TEST REPORT

OF

RAYCHEM NUCLEAR PLANT KIT (NPK)

FOR

RAYCHEM CORPORATION

MENLO PARK, CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
GEORGE D. SHIPWAY
No. 12157
MECHANICAL
STATE OF CALIFORNIA

STATE OF CALIFORNIA
COUNTY OF RIVERSIDE } ss. Ray C. Myrick

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

SUBSCRIBED and sworn to before me this 20th day of December 19 82

Notary Public in and for the County of Riverside, State of California

My Commission expires 14 July, 19 83

OFFICIAL SEAL
CATHERINE C KELTY
NOTARY PUBLIC - CALIFORNIA
RIVERSIDE COUNTY
My comm. expires JUL 14, 1983

W-867A

DEPARTMENT DYNAMICS

DEPT. MGR. James J. Anderson

TEST ENGINEER Luther F. Goad

REGISTERED PROFESSIONAL ENGINEER

DCAS—QAR VERIFICATION

QUALITY ASSURANCE L. Housteau

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1.0 SUMMARY

Six specimens of Raychem Nuclear Plant Transition Splice Assemblies were subjected to an environmental qualification type test to demonstrate their ability to maintain functional operability under all service conditions postulated to occur within the containment of nuclear generating stations during the installed life of the product. The qualification program was based upon the methods, procedures and guidelines set forth in IEEE Standards 323-1974[1] and 383-1974[2] as endorsed by USNRC Regulatory Guides 1.89[3] and 1.131[4] respectively.

The test specimens were exposed to a single environmental profile encompassing temperatures up to 228°C (442°F) that enveloped the conditions produced by main steamline break and loss-of-coolant accidents (MSLB/LOCA), in accordance with the simulated environmental profile preferred by NUREG-0588[5] for qualifying equipment located inside containment. A caustic solution was sprayed on the test specimens throughout the environmental exposure to simulate conditions that would occur when containment spray systems actuate. Extremes in power supply voltage ranges were simulated by energizing the test specimens at the maximum allowable ampacity of the No.14 AWG insulated conductors and at full rated voltage (1000V a-c).

The effects of installed life were simulated by the accelerated aging of three test specimens to an equivalent service life in excess of 42 years at 90°C (194°F). Accelerated aging was accomplished via thermal exposure at a rate based upon the Arrhenius data documented in Raychem Report EDR-5046.[6] These specimens were then exposed to gamma radiation at a level to include both the postulated LOCA accident dose and a dose equivalent to an installed assembly containment exposure integrated over a 40-year period. The remaining three specimens received only the postulated accident radiation dose to simulate beginning of life LOCA/MSLB exposure. The thermally aged and the unaged

specimens received in excess of 2.15×10^8 rads gamma and 1.65×10^8 rads gamma respectively.

Acceptance criterion was established as the specimen's ability to maintain rated voltage and current during and after the environmental exposure. Margin was demonstrated by the specimen's ability to pass voltage withstand testing at 80 volts per mil based on the wire insulation thickness.

Based upon the satisfactory performance of the specimens during this test program, it was concluded that the Raychem Transition Splice is functional and suitable for use inside the containment of nuclear power generating stations.

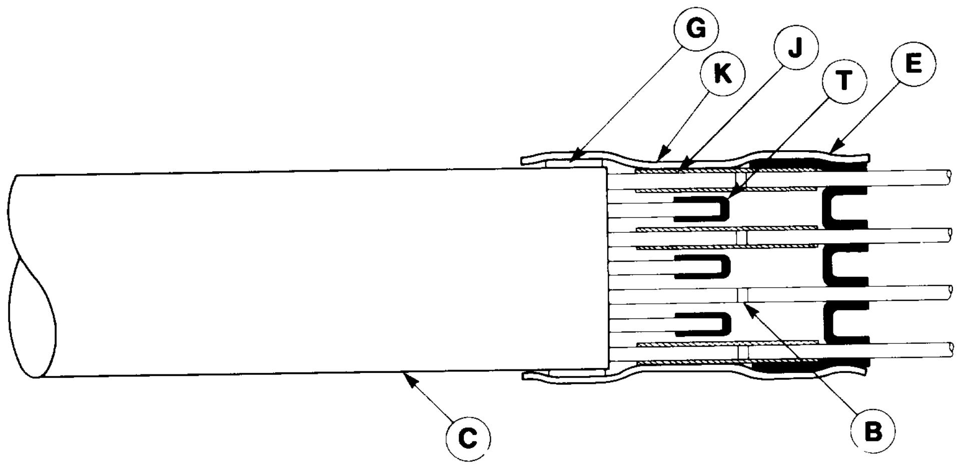
The LOCA/MSLB environmental exposure was performed by Wyle Laboratories, Norco, California. Thermal preconditioning of samples was performed at Raychem Corporation, Menlo Park, California. Radiation sample preconditioning was performed at Isomedix Inc., Parsippany, New Jersey.

2.0 TEST SPECIMEN

2.1 Materials and Construction

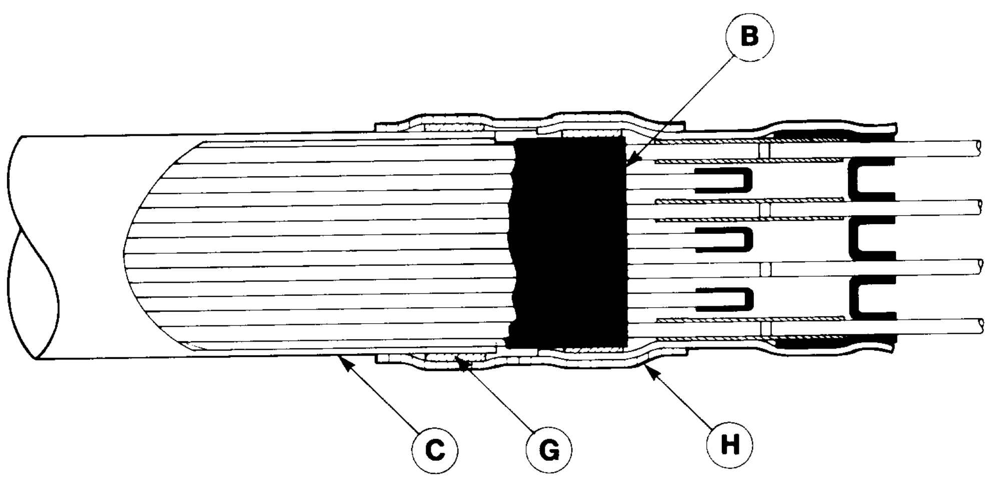
Each test specimen was constructed of Raychem's nuclear grade extrusion and molding materials. All components conformed to the applicable Raychem Specification Component Drawings referenced in Figures 1 and 2.

Figure 1 depicts the sample construction specified in Raychem Test Plan NPE-TP-81-03.[8] Figure 2 shows the deviation from that construction required



KEY COMPONENT		DESCRIPTION	APPLICABLE RAYCHEM SPEC. COMPONENT DRAWING
G	WCSF-300-3-N	Cable Jacket Shim	SCD-37001
K	WCSF-500-13-N	Outer Sealing Sleeve	SCD-37001
J	WCSF-115-6-N	Primary Sealing Sleeve	SCD-37001
T	101A021-52/144	End Cap	SCD-48015
E	502A812-52/144	Conductor Sealing Breakout	SCD-48023
B	Butt Splice	3/4 inch long	N/A
C	7/C – #14 AWG Cable	7S – #14 AWG, 0.03″ XLPE Insulation	N/A
		Outer Jacket-WCSF-200-U	SCD-37001

Figure 1. Specimen Construction



KEY COMPONENT		DESCRIPTION	APPLICABLE RAYCHEM SPEC. COMPONENT DRAWING
B	0.06″ Hypalon Insulation	Original Cable Outer Jacket	N/A
C	WCSF-200-U	Outer Jacket	SCD-37001
G	WCSF-300-3-N	Cable Jacket Shim	SCD-37001
H	WCSF-500-9-N	Sealing Sleeve	SCD-37001

Figure 2. Specimen Construction

for thermally aged specimens. This deviation was required because the outer jacket of the multiconductor cable did not withstand the thermal aging profile required of the Raychem materials. Figures 3 and 4 show the condition of the outer cable jackets and single conductors after thermal aging.

2.1.2 Specimen numbers 4, 5 and 6 were assembled in the configuration shown in Figure 1. Specimens 1, 2, and 3 differ in that components C, G, and H, as shown in Figure 2, were added after the outer jacket was removed to the extent possible and all specimen conditioning was completed. These three components were added to restore the multiconductor outer jackets which did not withstand thermal conditioning. This was considered acceptable since the seal at the transition end was considered to be the significant portion of this configuration under test. This portion was not modified. The modified portion was not considered to be a significant loss as the identical geometry was tested in other constructions included in this same test program.

All sample assembly was accomplished by Raychem personnel using Raychem's standard cable preparation and splice assembly procedures. The cables were cleaned with 1,1,1 Trichloroethane prior to splice assembly. The components were installed using a Raychem FH-2609, LPG portable flame heater.

2.1.3 In addition to these six specimens, several other types of products were tested in this program. The other constructions are the subject of separate reports. For clarity of data presentation, the six constructions reported herein are referenced as Specimen numbers 1 through 6. Each conductor of a single construction has been identified by the addition of -1, -2, -3, or -4 to the specimen number. Specimen numbers are cross-referenced with actual Raychem specimen identification numbers in Table 1.

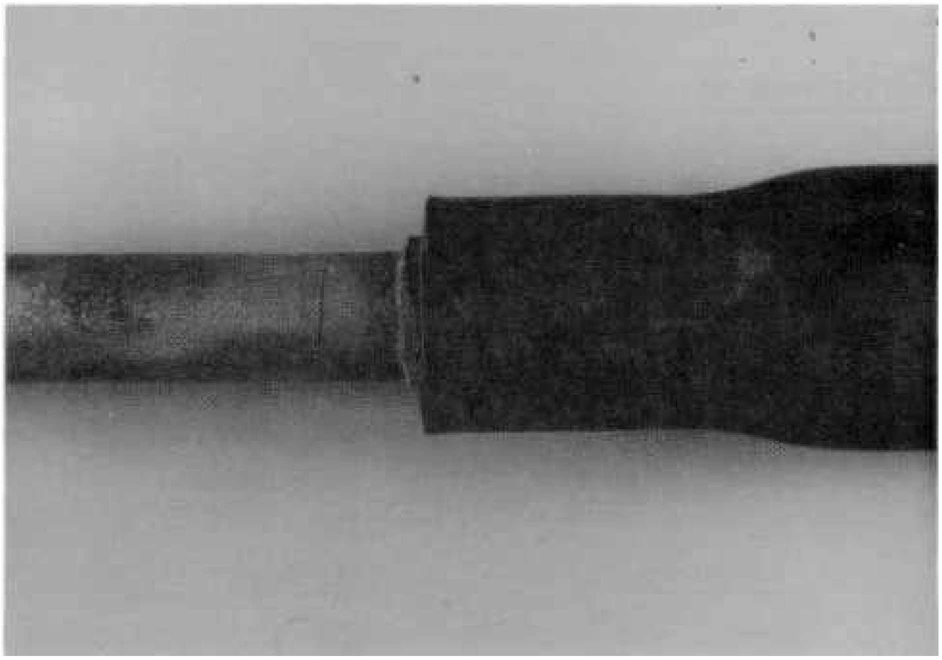


Figure 3. Thermally Aged Cable

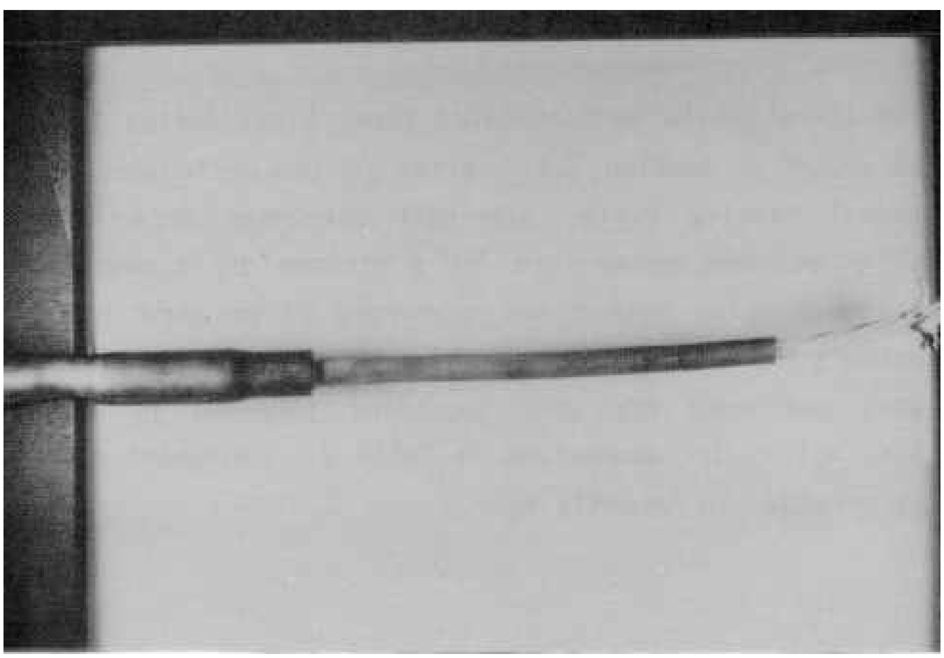


Figure 4. Thermally Aged Assembly

3.0 TEST PROGRAM

3.1 Test Sequence

In conformance with Section 6.3.2 of IEEE Standard 323-1974[1] , test specimens were neither modified nor altered after the assembly described in Section 2.1.2 of this report. Each specimen was used throughout the entire test sequence. The test sequence comprising this qualification type test is listed below:

Sequence	Test Description
1.	Functional Tests
2.	Specimen Preconditioning
3.	Functional Tests
4.	LOCA/MSLB Environmental Exposure
5.	Functional Tests

3.2 Functional Test Procedures

Functional tests were repeated three times during the test program as shown in Section 3.1. Prior to the performance of each functional testing cycle, all test specimens were immersed in tap water at room temperature for a minimum of 16 hours. Each splice assembly being tested was submerged 12 or more inches below the water's surface during the 16 hour soak. All functional tests were performed with the specimens immersed in the water bath. Test values are summarized in Table 2. Equipment calibration data is provided in Appendix B.

3.2.1 Insulation Resistance (I.R.)

After the 16 hour immersion, while still in the water bath, the I.R. of each specimen was measured. Measurements were made at 500 volts d-c after one minute of electrification. The water bath was used as the ground plane during this test.

3.2.2 Voltage Withstand

After the I.R. of each specimen was measured and while still in the water bath, a 2400 volt a-c voltage withstand test was performed on each test specimen in accordance with ICEA S-61-402, 6.11.2.[7] Using the water bath as ground, the voltage was applied to the conductor in each specimen.

3.3 Specimen Preconditioning

3.3.1 Thermal Aging

Three specimens (numbers 1, 2, and 3) were thermally aged to simulate a service condition of over 40 years based on Arrhenius data for Raychem's nuclear grade materials as documented in Raychem Report EDR-5046.[6] These samples were aged to an equivalent of 44.8 years installed life at 90°C (194°F). The remaining three specimens (numbers 4, 5, and 6) were not thermally aged, simulating the condition of product at the beginning of installed life. All thermal conditioning was accomplished at Raychem Corporation. Specimens were placed horizontally in a circulating air oven throughout the aging period. Aging times and temperatures used are presented in Table 1.

3.3.2 Radiation Aging

The radiation dose determined to represent the gamma exposure to installed assemblies within containment over a 40 year period was 5.0×10^7 rads. The postulated accident gamma radiation dose was 1.5×10^8 rads.

Thermally aged specimens were exposed both to the postulated accident dose, plus 10 percent margin, and the dose representing 40 years of installed life totaling 2.15×10^8 rads gamma. The samples simulating the beginning of installed life received only the postulated accident dose plus 10 percent margin for a total dose of 1.65×10^8 rads gamma.

The actual gamma radiation exposures exceeded the required 2.15×10^8 rad and 1.65×10^8 rad levels. Table 1 depicts the actual air equivalent radiation doses and associated dose rates by specimen number. The radiation source utilized was Co^{60} and the Certificate of Radiation is shown in Appendix A.

3.3.3 Functional Tests

The functional tests were again performed after specimen preconditioning as described in Section 3.2. Test values are listed in Table 2.

3.4 LOCA/MSLB Environmental Exposure

The test specimens were placed horizontally on perforated metal trays inside a pressure vessel. Extension leads were spliced to the test specimens inside the pressure vessel and insulated with Raychem WCSF-N tubing. The extension leads were brought out of the test vessel through penetrations installed in the pressure vessel wall to allow for electrical connection and monitoring.

The specimens were energized to 1.0 kV a-c to ground and carried a current of 25 amperes. Current values were samples throughout the test and are presented in Table 3. The voltage energization circuit for each test specimen was separately fused at 1/4 amp. A schematic of the energizing circuit is given in Figure 5.

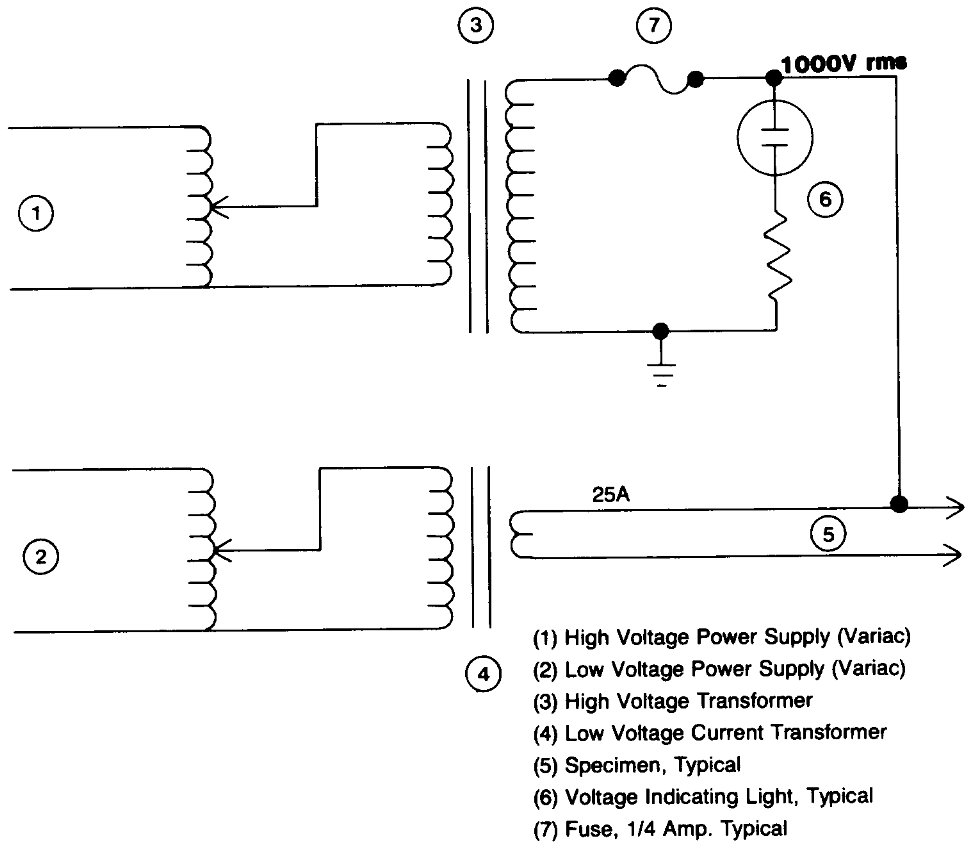
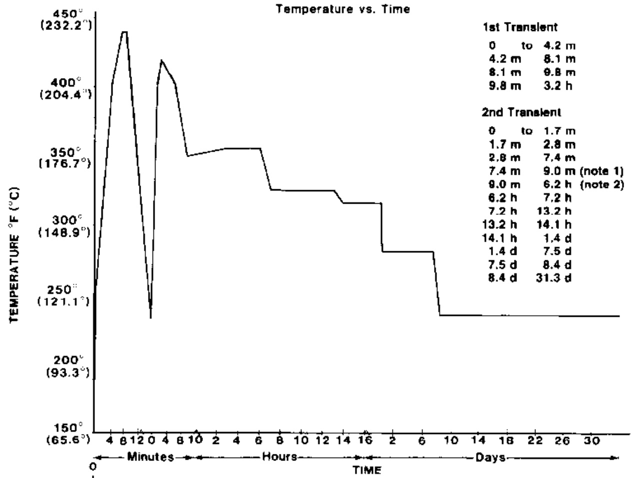
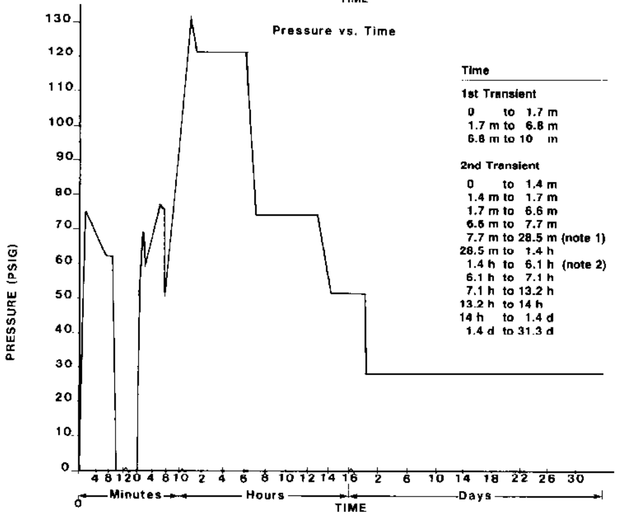


Figure 5. Energizing Circuit Schematic

A chemical spray solution consisting of 0.28 molar H_3B0_3 (3000 ppm boron), 0.064 molar $Na_2S_20_3$, buffered with NaOH to a pH of 10.5 at 25°C (77°F) was provided in a separate reservoir. This solution was sprayed through two nozzles from the top of the vessel at a rate in excess of 0.15 gpm/ft^2 beginning immediately after the second temperature transient and ending upon completion of the 30-day environmental exposure (actual flow was 34 gpm). The temperatures, pressures, and spray duration throughout the test period are given in Figure 6. Figure 7 depicts a diagram of the pressure vessel used for the environmental exposure.



Time		Temperature (°F)	Temperature (°C)
1st Transient			
0 to	4.2 m	191 to 400	88 to 204
4.2 m	8.1 m	442	228
8.1 m	9.8 m	400	204
9.8 m	3.2 h	255	124
2nd Transient			
0 to	1.7 m	230 to 400	110 to 204
1.7 m	2.8 m	420	216
2.8 m	7.4 m	400	204
7.4 m	9.0 m (note 1)	350	177
9.0 m	6.2 h (note 2)	356	179
6.2 h	7.2 h	325	163
7.2 h	13.2 h	325	163
13.2 h	14.1 h	307	153
14.1 h	1.4 d	307	153
1.4 d	7.5 d	280	138
7.5 d	8.4 d	232	111
8.4 d	31.3 d	232	111

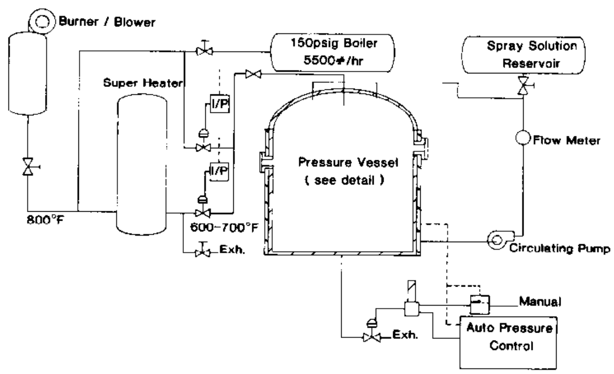


Time	Pressure (psig)
1st Transient	
0 to 1.7 m	75
1.7 m to 6.8 m	62
6.8 m to 10 m	0
2nd Transient	
0 to 1.4 m	69
1.4 m to 1.7 m	59
1.7 m to 6.6 m	77
6.6 m to 7.7 m	50
7.7 m to 28.5 m (note 1)	132
28.5 m to 1.4 h	120
1.4 h to 6.1 h (note 2)	120
6.1 h to 7.1 h	74
7.1 h to 13.2 h	74
13.2 h to 14 h	51
14 h to 1.4 d	51
1.4 d to 31.3 d	28

NOTES: (1) **Problems encountered with test vessel pressure seals necessitated interrupting the test after 9.0 minutes. Test was resumed at the 177°C *(350°F)* temperature plateau and the chemical spray was initiated.**

(2) **Problems encountered with the test specimen extension leads and the test vessel pressure seals necessitated interrupting the test after 5 hours. The test was resumed at the 177°C *(350°F)* temperature plateau to complete the required exposure at this temperature level.**

Figure 6. Temperature and Pressure Profiles for Simulation of LOCA/MSLB Environment



Auxiliary Equipment

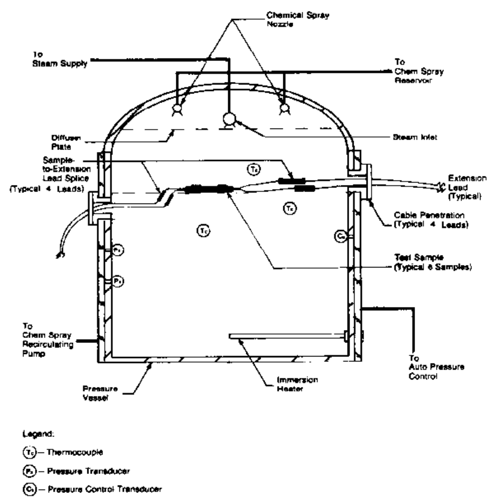


Figure 7. LOCA/MSLB Pressure Vessel and Auxiliary Equipment

4.0 TEST RESULTS

4.1 Functional Test Results

The results of all voltage withstand tests and insulation resistance measurements are listed in Table 2. The current loading values measured during the environmental exposure of the energized specimens are presented in Table 3. All specimens passed voltage withstand testing and measured good insulation resistance before and after conditioning and after the LOCA/HELB environmental exposure. Specimen numbers 1, 2, and 3 could not be energized during the environmental exposure due to failures in the non-specimen wire leads.

4.2 LOCA/MSLB Environment Exposure

The following details of the profile depicted in Figure 6 are noted:

a. The temperature of 204°C (400°F) was not reached in 10 seconds as proposed in Raychem Test Plan No. NPE-TP-81-03.[8] Attainable rise times were governed by the apparatus selected to encompass the entire scope of the Raychem test plan and precluded meeting the proposed temperature rise time.

However, during the temperature transients, both the peak temperatures and temperature durations exceeded those proposed.

Problems encountered with test vessel pressure seals and the test specimen extension leads necessitated interrupting the test after the second temperature transient and again after five hours of specimen exposure at the 177°C (350°F) temperature plateau. During the interruption at the 177°C (350°F) plateau, the specimens were visually inspected. All specimens appeared to be in good condition, however, tracking was visible on many of the thermally aged lead wires. Replacement of the vessel penetration seals was required at this point which necessitated replacement of test specimen extension leads.

During this replacement, the lead wires were repaired. The specimens themselves were not modified or changed in any way. The test was resumed at the 177°C (350°F) temperature plateau to complete the required specimen exposure at this level.

c. The test specimens were exposed to the LOCA/MSLB environment for 31.3 days rather than the 30 days proposed in Raychem Test 8 Plan No. NPE-TP-81-03.[8]

4.3 Post LOCA/MSLB Inspection

At the conclusion of the environmental exposure, the test vessel was flooded with tap water. The test specimens were then given a voltage withstand test and the insulation resistances were measured. Test values are listed in Table 2. The vessel was then opened and the cause for Specimen numbers 1, 2, and 3 being unable to hold rated voltage throughout the environmental exposure investigated.

At this point, specimen extension wires were severed inside the vessel and the specimens were removed for examination. The specimens unable to pass voltage withstand testing were retested in a water bath and again insulation resistance measurements were made.

Specimen numbers 1, 2, and 3 did not hold rated voltage and current throughout the exposure nor did they pass functional tests while immersed inside the test vessel. These specimens were retested in a water bath. With the faulty extension leads excluded from test, all specimens passed voltage withstand testing and measured satisfactory insulation resistance.

Visual inspection of all specimens showed no cracking or splitting of the Raychem materials.

A summary of these findings is presented in Table 4.

5.0 CONCLUSIONS

Six specimens of Raychem Nuclear Plant Transition Splice Assemblies were subjected to an environmental type test program designed to simulate the service conditions produced by main steamline break and loss-of-coolant accidents (MSLB/LOCA). The test specimens were exposed to the LOCA/MSLB environmental extremes of temperature, humidity, pressure and chemical spray while energized at maximum current and voltage. These test specimens were conditioned to simulate both the beginning of installed life and over 40 years of installed life. They were exposed to LOCA/MSLB levels of radiation to include both accident dose margin and the postulated containment radiation dose integrated over 40 years of installed life.

All specimens demonstrated the ability to insulate and seal multiconductor cable to single wire transition splices throughout the qualification test program by passing all voltage withstand testing and measuring satisfactory insulation resistance values.

Although none of the thermally aged specimens were energized during the environmental exposure, the cause of the inability to energize these specimens was directly attributable to the overaged wires and not the specimens themselves. This conclusion was reinforced by the ability of each specimen to pass both voltage withstand testing and insulation resistance measurements when tested in a water bath with the faulty leads excluded from test. Visual inspection showed that all specimens maintained their physical integrity with no signs of splitting or cracking of the Raychem materials.

The results of this comprehensive test program provide reasonable assurance, by type test, that the Raychem Transition Seal can perform its intended function of insulating and sealing when used in these tested configurations within the most limiting environment in which it is expected to function. Therefore, it is concluded that the tested configurations are suitable for use on Class IE systems within the containment of nuclear power generating stations.

REFERENCES

1. IEEE Standard 323-1974, "IEEE Standard for Qualifying IE Equipment for Nuclear Power Generating Stations."

2. IEEE Standard 383-1974, "IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations."

3. USNRC Regulatory Guide 1.89, "Qualification of Class IE Equipment for Nuclear Power Plants."

4. USNRC Regulatory Guide 1.131, "Qualification Tests of Electric Cables and Field Splices for Light-Water-Cooled Nuclear Power Plants."

5. NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment."

6. EDR-5046, Raychem Report "Analysis of Heat Aging Data on WCSF Material to Determine Pre-Aging Conditions for Nuclear Qualification Testing."

7. ICEA S-61-402, "ICEA/NEMA Standards Publication Thermoplastic-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy."

8. NPE-TP-81-03, "Environmental Qualification Test Plan of Raychem Nuclear Cable Splice Assemblies."

TABLE 1

TEST SPECIMEN CONDITIONING SUMMARY

Specimen Number	Raychem I.D.[1] Number	Thermal Aging[4] Temperature	Thermal Aging[4] Duration	Installed[2] Life Equivalent	Radiation Aging[3] Dose (rads)	Radiation Aging[3] Rate (rads/hr)
1.	18	150°C (302°F)	929 hrs.	44.8 yrs	2.2×10^8	5.7×10^5
2.	19	150°C (302°F)	929 hrs.	44.8 yrs	2.2×10^8	5.7×10^5
3.	20	150°C (302°F)	929 hrs.	44.8 yrs	2.2×10^8	5.7×10^5
4.	30	Unaged	-	Day 1	1.7×10^8	4.7×10^5
5.	31	Unaged	-	Day 1	1.7×10^8	4.7×10^5
6.	32	Unaged	-	Day 1	1.7×10^8	4.7×10^5

Notes: (1) Raychem Specimen Identification are referred to by adjacent Specimen Numbers throughout this report for clarity and ease of understanding. Each Specimen consisted of four conductors labeled as -1, -2, -3, and -4 for each Specimen Number.

(2) Installed Life Equivalents are based upon Arrhenius data documented in Raychem Report EDR-5046[6] for continucus conductor temperature of 90°C (194°F).

(3) All values listed are air equivalents of gamma radiation from a Co^{60} source.

(4) The thermal aging utilized exceeded the required aging time to simulate 40-year life for the cable.

TABLE 2

SUMMARY OF INSULATION RESISTANCE[1] MEASUREMENTS

Specimen Number	Insulation Resistance[2] Before Conditioning (ohms)	Insulation Resistance[2] After Conditioning (ohms)	Insulation Resistance[2] Post LOCA/HELB (ohms)
1-1	7.5×10^{12}	2.2×10^{11}	1.5×10^{8}
1-2	7.0×10^{11}	8.0×10^{10}	5.2×10^{9}
1-3	1.2×10^{13}	4.5×10^{11}	5.2×10^{8}
1-4	1.5×10^{13}	5.7×10^{11}	5.4×10^{8}
2-1	4.5×10^{12}	4.5×10^{11}	3.5×10^{8}
2-2	7.8×10^{11}	3.0×10^{11}	3.5×10^{8}
2-3	8.8×10^{12}	6.8×10^{11}	2.0×10^{8}
2-4	5.0×10^{12}	9.0×10^{10}	2.8×10^{7}
3-1	1.3×10^{13}	2.4×10^{11}	2.0×10^{8}
3-2	2.8×10^{12}	3.0×10^{11}	1.5×10^{8}
3-3	1.2×10^{13}	5.0×10^{11}	1.4×10^{8}
3-4	1.4×10^{13}	3.7×10^{11}	1.1×10^{8}
4-1	1.0×10^{14}	3.2×10^{11}	7.8×10^{9}
4-2	1.0×10^{14}	2.2×10^{10}	1.3×10^{10}
4-3	5.0×10^{12}	3.0×10^{11}	5.0×10^{9}
4-4	4.0×10^{11}	1.4×10^{12}	9.5×10^{9}
5-1	2.5×10^{12}	4.0×10^{11}	7.3×10^{9}
5-2	3.0×10^{13}	5.3×10^{10}	7.4×10^{9}
5-3	4.0×10^{12}	2.6×10^{10}	7.6×10^{9}
5-4	5.0×10^{12}	1.6×10^{11}	8.3×10^{9}
6-1	2.0×10^{12}	1.4×10^{12}	5.8×10^{9}
6-2	1.5×10^{12}	2.0×10^{12}	8.3×10^{9}
6-3	1.8×10^{12}	1.0×10^{12}	6.8×10^{9}
6-4	8.0×10^{11}	1.7×10^{12}	8.6×10^{9}

TABLE 2 (C   ued)

INSULATION RESISTANCE MEASUREMENTS
OF ENERGIZED SPECIMENS
MADE DURING LOCA/HELB EXPOSURE

	Ellapsed Time After Start of LOCA/MSLB Environmental Profile								
	9 hours	23 hours	82 hours	132 hours	272 hours	363 hours	454 hours	546 hours	637 hours
Temperature ($\frac{°C}{°F}$)	160 325	149 307	138 280	138 280	111 232	111 232	111 232	111 232	111 232
Vessel Pressure (psig)	74	51	28	28	28[3]	28	28	28	28
	Insulation Resistance Measurement (ohms)								
Specimen Number[4]									
4-1	1.3×10^7	2.6×10^7	8.3×10^7	5.0×10^7	3.0×10^8	2.3×10^8	3.0×10^8	2.8×10^8	3.4×10^8
4-2	7.4×10^6	9.0×10^6	3.0×10^7	3.4×10^7	2.1×10^8	1.8×10^8	2.4×10^8	2.3×10^8	2.6×10^8
4-3	6.4×10^6	1.1×10^7	2.8×10^7	2.5×10^7	2.2×10^8	1.6×10^8	2.0×10^8	1.9×10^8	2.1×10^8
4-4	1.3×10^7	2.2×10^7	3.5×10^7	3.7×10^7	2.2×10^8	2.0×10^8	2.5×10^8	2.4×10^8	2.8×10^8
5-1	1.4×10^7	3.0×10^6	3.3×10^7	3.0×10^7	2.6×10^8	2.0×10^8	2.4×10^8	2.2×10^8	2.6×10^8
5-2	2.5×10^7	2.2×10^7	4.5×10^7	3.5×10^7	4.0×10^8	3.0×10^8	3.5×10^8	3.0×10^8	3.5×10^8
5-3	1.4×10^7	2.8×10^7	6.0×10^7	5.0×10^7	4.4×10^8	3.0×10^8	3.5×10^8	3.4×10^8	4.0×10^8
5-4	1.2×10^7	2.0×10^7	2.6×10^7	1.8×10^7	4.0×10^8	2.8×10^8	3.4×10^8	2.9×10^8	3.3×10^8
6-1	2.0×10^7	2.0×10^7	4.0×10^7	3.0×10^7	3.5×10^7	2.6×10^8	3.0×10^8	3.0×10^8	3.5×10^8
6-2	2.8×10^7	3.0×10^7	6.2×10^7	5.0×10^7	4.0×10^8	3.0×10^8	3.5×10^8	3.0×10^8	3.7×10^8
6-3	1.3×10^7	1.4×10^7	3.5×10^7	3.0×10^7	3.4×10^8	2.4×10^8	2.8×10^8	2.6×10^8	3.0×10^8
6-4	1.8×10^7	1.8×10^7	3.0×10^7	2.2×10^7	4.5×10^8	3.2×10^8	4.0×10^8	3.0×10^8	3.5×10^8

Notes:
1. All insulation resistance measurements were made after 5 minutes of energization at 500 volts d-c.
2. All specimens listing an insulation resistance value also passed voltage withstand testing per section 3.2.2.
3. Test vessel was externally pressurized with air to maintain a minimum pressure of 28 psig.
4. Specimen Numbers 1-1 through 3-4 were unable to maintain voltage during the environmental exposure; therefore, insulation resistance measurements could not be made. This was due to failures in the non-specimen wire leads. Reference Section 4.3.

TABLE 3

CURRENT MONITORING OF TEST SAMPLES
ENERGIZED THROUGHOUT LOCA/MSLB ENVIRONMENTAL EXPOSURE

Period of Measurement During LOCA/MSLB Profile	Temperature (°C)	Temperature (°F)	Vessel Pressure (psig)	Current Measurement ecimen Number (Amperes) 4-1	4-2	4-3	4-4	5-1	5-2	5-3	5-4	6-1	6-2	6-3	6-4
Pre-LOCA/MSLB	85	185	-	28	25	25	25	26	26	25	25	27	26	26	26
After 3 hours	177	350	120	24	20	22	23	24	24	24	23	24	23	22	24
After 26 hours	149	307	51	25	23	22	24	25	25	24	24	24	25	25	25
After 2 days	138	280	28	25	23	22	23	24	24	24	24	24	25	23	23
After 3 days	138	280	28	25	22	21	22	24	24	22	23	24	24	23	22
After 6 days	138	280	28	23	22	22	23	24	25	24	23	25	25	25	25
After 8 days	111	232	28	23	22	22	23	24	24	24	23	24	25	24	23
After 9 days	111	232	28	26	26	22	26	27	27	23	27	24	27	23	24
After 13 days	111	232	28	26	25	24	25	25	25	25	25	24	24	24	23
After 15 days	111	232	28	26	23	25	23	25	25	25	25	25	25	25	26
After 17 days	111	232	28	26	24	23	24	24	25	24	24	23	26	23	26
After 20 days	111	232	28	26	26	22	23	27	27	26	23	24	27	23	24
After 22 days	111	232	28	24	23	23	23	25	25	25	24	24	25	24	24
After 24 days	111	232	28	23	24	25	23	23	25	24	25	24	26	25	25
After 27 days	111	232	28	24	21	25	22	22	25	25	25	21	23	23	23
After 28 days	111	232	28	27	23	22	22	26	26	26	24	24	24	27	24
After 29 days	111	232	28	27	24	23	23	24	24	23	24	22	23	23	22
After 30 days	111	232	28	27	24	22	24	22	24	22	25	21	23	23	24
After 31 days	111	232	28	24	25	24	25	26	25	25	25	25	25	27	25

Notes: (1) Pre-LOCA/MSLB current measurements were made during test vessel preheat.
(2) Current was terminated on specimens when the 1/4 amp fuse opened. Therefore, specimen numbers 1-1 through 3-4 are not listed. Reference Section 4.1.
(3) Test vessel was externally pressurized with air to maintain a minimum pressure of 28 psig.

58722-6

Table 4

Post LOCA/MSLB Inspection Summary

Specimen Number	Results of Inspection
1.	All conductors unable to maintain voltage throughout environmental exposure. Specimen passed VWT* while immersed in water bath with high insulation resistance. Failures due to failed wire insulation. Specimen exhibited no signs of cracking or splitting.
2.	All conductors unable to maintain voltage throughout environmental exposure. Specimen passed VWT* while immersed in water bath with high insulation resistance. Failures due to failed wire insulation. Specimen exhibited no signs of cracking or splitting.
3.	All conductors unable to maintain voltage throughout environmental exposure. Specimen passed VWT* while immersed in water bath with high insulation resistance. Failures due to failed wire insulation. Specimen exhibited no signs of cracking or splitting.
4.	Maintained voltage and current throughout the environmental exposure. No evidence of damage to test specimen or wire insulation.
5.	Maintained voltage and current throughout the environmental exposure. No evidence of damage to test specimen or wire insulation.
6.	Maintained voltage and current throughout the environmental exposure. No evidence of damage to test specimen or wire insulation.

* VWT - Voltage Withstand Test

APPENDIX A

CERTIFICATION OF RADIATION DOSE

ISOMEDIX

February 18, 1982

Mr. Joe Connolly
Ray Chem Corporation
300 Constitution Drive
Menlo Park, California 94025

Dear Mr. Connolly:

This will summarize parameters pertinent to the irradiation of two (2) containers of cable splice samples, as per your Purchase Order #A07349. Specimens were identified as follows:

Group I - R-24593- 165 megarad box

Group II - R-24591 - 215 megarad box

The specimens in Group I were exposed to a Cobalt 60 gamma source for a period of 362 hours at a nominal dose rate of 0.47 megarads per hour. The calculated dose based on dosimetry is 170 megarads. Halfway through the exposure, the specimens were rotated 180 degrees to give a more uniform dose distribution.

The specimens in Group II were exposed to a Cobalt 60 gamma source for a period of 386 hours at a nominal dose rate of 0.57 megarads per hour. The calculated dose based on dosimetry is 220 megarads. Halfway through the exposure, the specimens were rotated 180 degrees to give a more uniform dose distribution.

Dosimetry was performed using Harwell Red 4034 Perspex dosimeters, utilizing a Bausch and Lomb Model 710 spectrophotometer as the readout instrument. This system is calibrated directly with NBS, with the last readout calibration being September 08, 1981. A copy of the dosimetry correlation report is available upon request.

Irradiation was conducted in air at ambient temperature and pressure. Radiant heat from the source heated the specimens somewhat, but the temperature did not exceed 130 degrees F, as indicated by previous measurements on an oil solution in the same relative position.

Isomedix Inc. • 25 Eastmans Road, Parsippany, New Jersey 07054 • (201) 887-2666

Irradiation for Group I was initiated on December 31, 1981, and was completed on January 20, 1982.

Irradiation for Group II was initiated on December 31, 1981 and was completed on January 22, 1982.

Very truly yours,

ISOMEDIX, INC.

David P. Constantine

David P. Constantine
Production Manager

DC/mjb

Isomedix Inc. • 25 Eastmans Road, Parsippany, New Jersey 07054 • (201) 887-2666

APPENDIX B

LIST OF DATA ACQUISITION INSTRUMENTS

WYLE LABORATORIES

SPECIMEN: CABLE SPLICE ASSEMBLIES
CUSTOMER: RAYCHEM
PART NO.: SEE REC. INSP.
S/N: SEE REC. INSP.
TEST: LOCA

JOB NO.: 58722
DATE: 1-25-82
TEST BY: G. ADAIR
WITNESS:

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
VOM	BECKMAN	330	VARIOUS	8892	5-4-81	5-2-82	DATA
RECORDER	KAYE	DR-2B	VARIOUS	8750	1-28-82	8-1-82	± 0.05%
DIGITAL THERMOMETER	FLUKE	2160A	-350°F to +752°F	8401	12-7-81	6-13-82	± 2.0°F
DIGITAL THERMOMETER	FLUKE	2160A	-350°F to +752°F	8290	1-26-82	5-30-82	± 2.0°F
DIGITAL THERMOMETER	FLUKE	2160A	-350°F to +752°F	8032	12-29-81	5-2-82	± 2.0°F
A/C D/C HYPOT	ASSOCIATED RESEARCH	4045	0-5K VOLTS	9092	12-11-81	6-13-82	± 2%
RECORDER	HEWLETT PACKARD	7132A	1-500 mV	8674	SYSTEM CALIBRATION		
RECORDER	HEWLETT PACKARD	7132A	1-500 mV	8672	SYSTEM CALIBRATION		
VOM	BECKMAN	330	VARIOUS	8893	7-1-81	7-4-82	DATA
GAUGE	ASHCROFT	7320	0-100 psi	4435	1-22-82	4-25-82	-
X-DUCER	VALIDYNE	DP-15	0-100 psi	19937	2-2-82	8-1-82	± 1%
X-DUCER	VALIDYNE	DP-15	0-100 psi	32738	2-2-82	8-1-82	± 1%
MEGOHMMETER	GENERAL RADIO	1864	100-500V $0\text{-}5 \times 10^{13}$ Ω	L99838	12-16-81	6-16-82	± 5%
FLOW GAUGE	BARTON	D4-49053-1	0-80" H_2O	7784	1-11-82	7-18-82	± 0.5%
DIGITAL T/C METER	THERMO ELECT	DIGIMITE	0-400°F	7890	2-2-82	6-6-82	LABEL
DMM	BECKMAN	330	0-50 VDC 0-150 ACA	8892	5-4-81	5-2-82	DATA
CURRENT CLAMP	BECKMAN	CT-231	0-150 ACA	9065	10-7-81	7-4-82	LABEL

W614D Q.A. Approval [signature]

Where applicable, the listed test equipment has been calibrated using standards which are traceable to the National Bureau of Standards. Certificates and reports of all calibrations are retained in the Wyle Laboratories QA files and are available for inspection upon request.

SHEET 1 OF 2

WYLE LABORATORIES

SPECIMEN: CABLE SPLICE ASSEMBLIES
CUSTOMER: RAYCHEM
PART NO.: SEE REC. INSP.
S/N: SEE REC. INSP.
TEST: LOCA

JOB NO.: 58722
DATE: 1-25-82
TEST BY: G. ADAIR
WITNESS:

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
GAUGE	ASHCROFT	7322	0-200 PSI	30190	2-24-82	5-30-82	0.5% FULL SCALE
A. C. HIGHPOT	ASSOCIATED RESEARCH	4030	0-5kV A.C.	L30106	12-31-81	6-31-82	± 0.1%
CHART RECORDER	HONEYWELL	154201212 6927	0-500 mV	L30107	10-15-81	4-15-82	± 1%

W614D Q.A. Approval [signature]

Where applicable, the listed test equipment has been calibrated using standards which are traceable to the National Bureau of Standards. Certificates and reports of all calibrations are retained in the Wyle Laboratories QA Files and are available for inspection upon request.

SHEET 2 OF 2