TEST REPORT

WYLE LABORATORIES

SCIENTIFIC SERVICES & SYSTEMS GROUP
WESTERN OPERATIONS, NORCO FACILITY

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Menlo Park, California 92024

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DATE 18 November 1982

ENVIRONMENTAL QUALIFICATION TEST REPORT
OF
RAYCHEM WCSP-N IN-LINE BOLTED SPLICE ASSEMBLIES
FOR
RAYCHEM CORPORATION

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

STATE OF CALIFORNIA }
COUNTY OF RIVERSIDE } ss.

R. 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.

R. C. Myrick

SUBSCRIBED and sworn to before me this 18th day of November, 19 82

Catherine C. Kelty
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

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1.0 SUMMARY

Twelve specimens of Raychem WCSF-N In-Line Bolted Splice Assemblies were subjected to an environmental qualification type test to demonstrate their capability 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. 4 AWG insulated conductors and at full rated voltage (1000V a-c).

The effects of installed life were simulated by the accelerated aging of six test specimens to an equivalent service life in excess of 44 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. 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 six 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 WCSF-N In-Line Bolted Splice Assembly is 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.

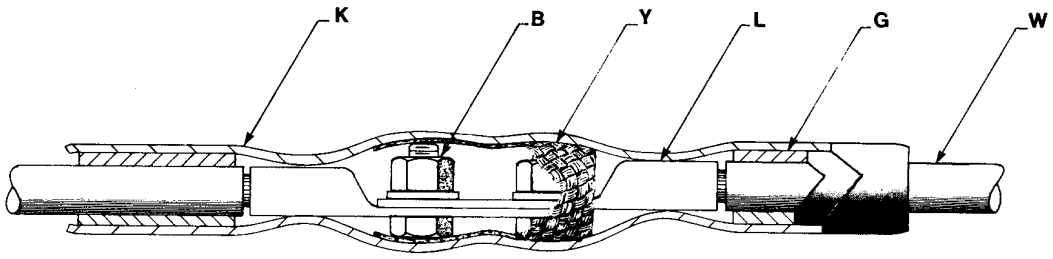
2.0 TEST SPECIMEN

2.1 Materials and Construction

2.1.1 Each test specimen was constructed of Raychem's nuclear grade extrusion materials and EPPA 109 sleeving taken from standard production. All components conformed to the applicable Raychem Specification Component Drawings referenced in Figures 1 and 2.

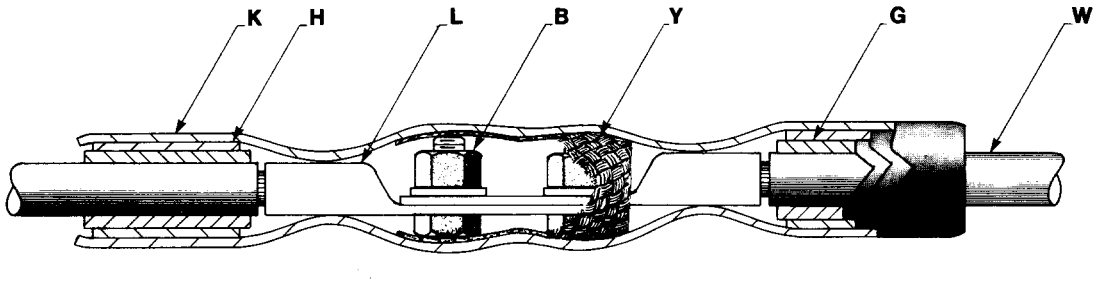
2.1.2 All test specimens were assembled by Raychem personnel in the configurations shown in Figures 1 and 2, using Raychem's standard cable preparation and splice assembly procedures. The cables were cleaned with 1,1,1 Trichloroethane prior to splice assembly and the components were installed using a Raychem FH-2609, LPG portable flame heater. Specimen Numbers 1 through 6 were the Single Shim Constructions assembled as shown in Figure 1. Specimen Numbers 7 through 12 were the Double Shim Constructions shown in Figure 2.

2.1.3 In addition to these twelve 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 twelve constructions reported herein are referenced as specimen numbers 1 through 12. These specimen numbers are cross-referenced with actual Raychem specimen identification numbers in Table 1.



Key	Component	Description	Applicable Raychem Specification Component Drawing
K	WCSF-500-12-N	Outer Sealing Sleeve	SCD-37001
Y	EPPA-109-1	Bolt Pad	SCD-10017
G	WCSF-300-3-N	Cable Jacket Shim	SCD-37001
B	Bolt	1/2" L x 1/2" Dia.`	N/A
L	2-hole terminal	4 inches long	N/A
W	1/C-#4 AWG Wire	Rockbestos XLPE 0.045" Insulation thickness	N/A

Figure 1. Single Shim Specimen Construction



Key	Component	Description	Applicable Raychem Specification Component Drawing
Y	EPPA-109	Bolt Pad	SCD- 10017
K	WCSF-650-12-N	Outer Sealing Sleeve	SCD-37001
H	WCSF-300-3-N	Cable Jacket Shim	SCD-37001
G	WCSF-500-2.3-N	Cable Jacket Shim	SCD-37001
B	Bolt	1/2" L x 1/2" Dia.	N/A
L	2-hole terminal	4 inches long	N/A
W	1/C-#Y4 AWG Wire	Rockbestos XLPE 0.045" Insulation thickness	N/A

Figure 2. Double Shim Specimen Construction

3.0 TEST PROGRAM

3.1 Test Sequence

In conformance with section 6.3.2 of IEEE Standard 323-1974 , test specimens were neither modified nor altered after assembly and 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 3600 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

Six specimens 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 44.2 years installed life at 90°C (194°F). The remaining six specimens were not thermally aged, simulating the product at the beginning of installed life. All thermal aging was accomplished at Raychem Corporation. Specimens were placed horizontally in a Blue M circulating air oven throughout the aging period. Table 1 presents the aging time and the temperature used during specimen conditioning.

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/FISLB 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. Figure 3 shows the installation of test specimens in the pressure vessel.

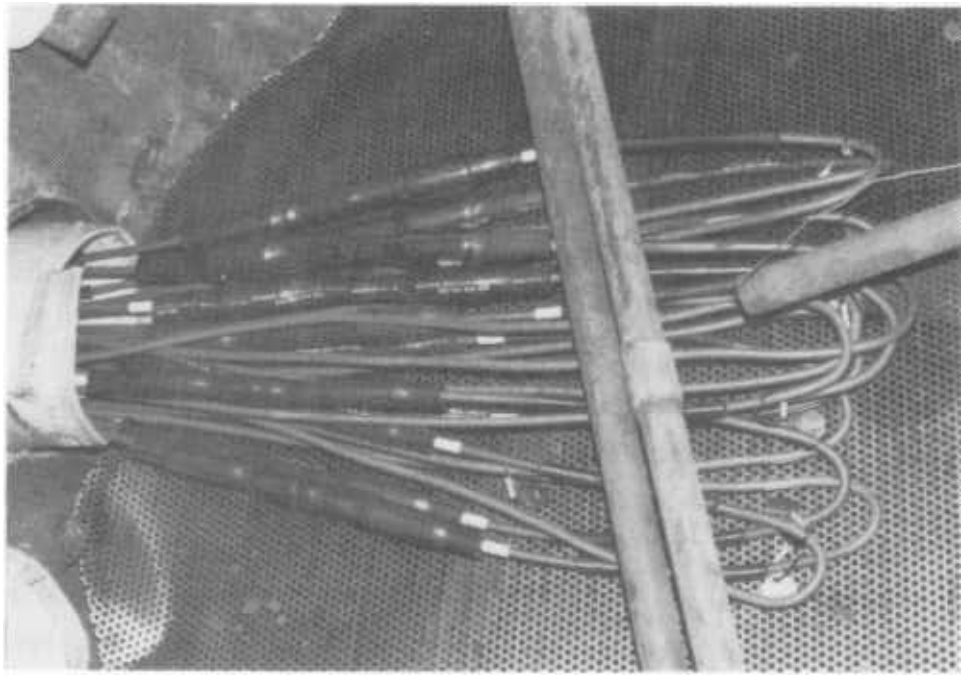


Figure 3. Specimen Installation

The specimens were energized at 1.0 kV a-c to ground and carried a current of 90 amperes. Current values were sampled 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 4.

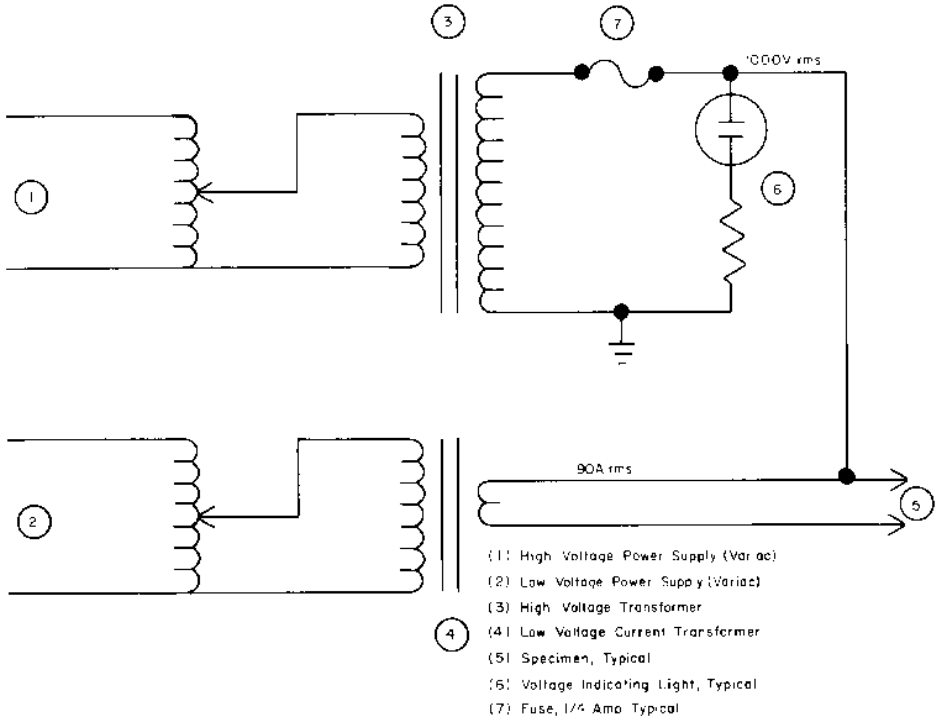
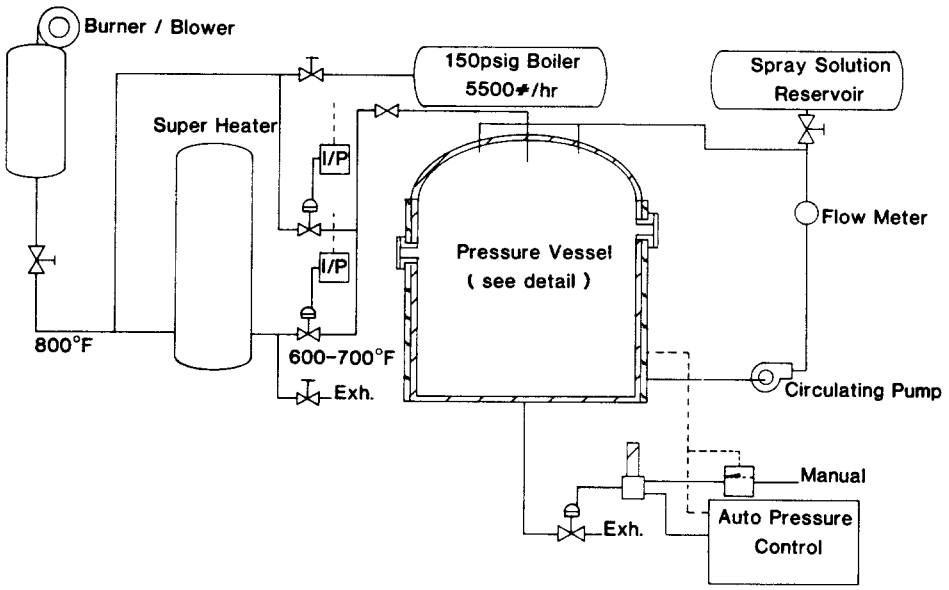
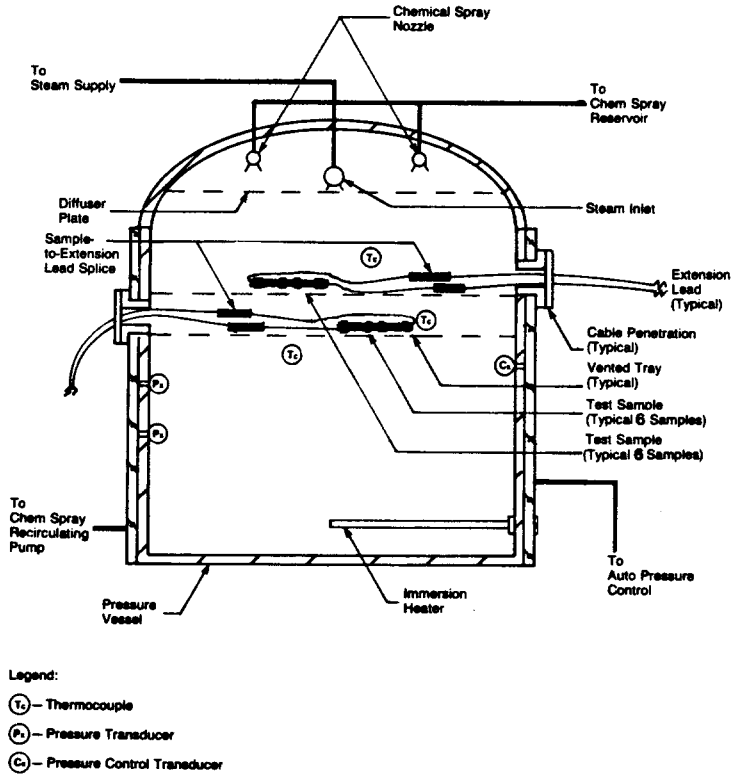


Figure 4. Energizing Circuit Schematic

A chemical spray solution consisting of 0.28 molar H_3BO_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). A diagram of the pressure vessel is given in Figure 5. The temperatures, pressures, and spray duration throughout the test period are given in Figure 6.

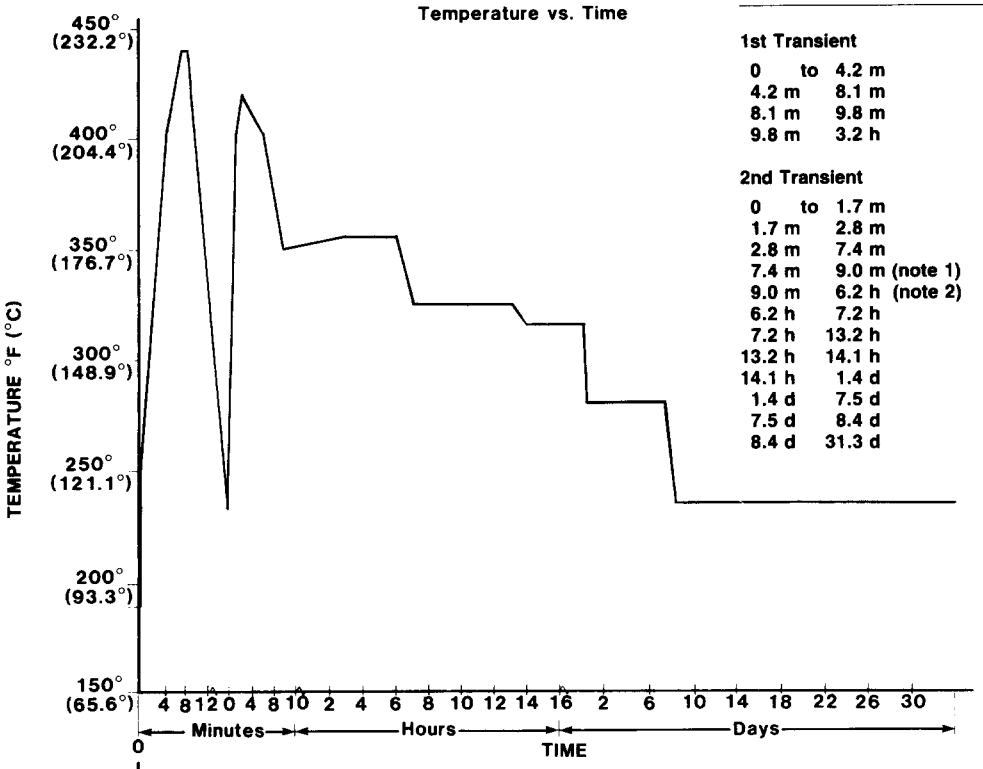


Auxiliary Equipment

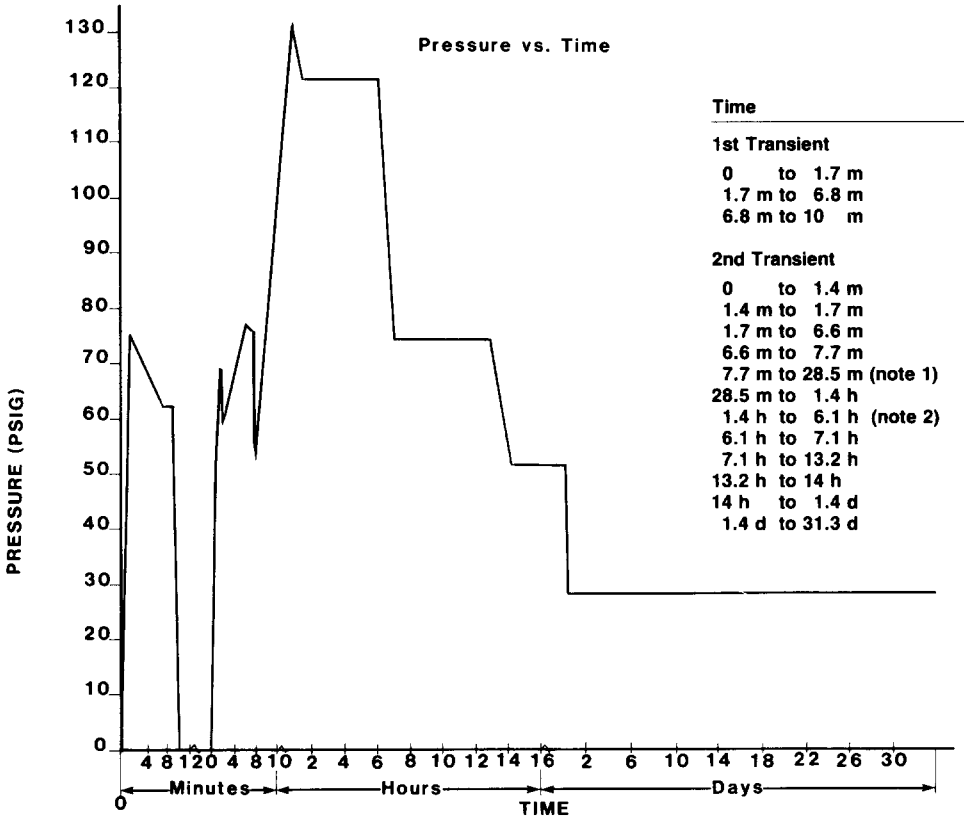


Pressure Vessel Detail

Figure 5. LOCA/MSLB Pressure Vessel and Auxiliary Equipment



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)	355	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

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. Test specimen current loading values during the environmental exposure are presented in Table 3. All specimens passed voltage withstand tests and measured good insulation resistance throughout the test sequence specified in Section 3.1. Two test specimens (Nos. 2 and 7) were unable to pass post-environmental exposure functional tests while installed in the test vessel. These specimens passed functional tests after removal from the test vessel and exclusion of faulty extension leads from test.

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.

b. 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. Replacement of the vessel penetration seals was required at this point which necessitated replacement of test specimen extension leads. 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 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 the two test circuits 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.

Specimens Nos. 2 and 7 did not hold rated voltage throughout the environmental exposure nor did they pass the voltage withstand test while immersed inside the test.

vessel. With the extension leads excluded from test, these specimens passed 3600 volt a-c withstand testing in the water bath and also measured good insulation resistance. Visual inspection of all specimens showed no cracking or splitting of the sleeving material. A summary of these findings is presented in Table 4.

5.0 CONCLUSIONS

Twelve specimens of Raychem WCSF-N In-Line Bolted Splice Assemblies were subjected to an environmental qualification 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 cable maximum rated 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.

This Raychem splice configuration demonstrated the ability to insulate and seal bolted connections when subjected to LOCA/MSLB environmental conditions. All specimens had the ability to maintain rated voltage and current throughout the environmental exposure and demonstrated satisfactory electrical performance at the conclusion of the test program. Although specimens Nos. 2 and 7 did not hold voltage throughout the

environmental exposure, retest at the conclusion of the exposure demonstrated the electrical integrity of the specimens. Visual examination substantiated the physical integrity of all specimens. It was concluded that all specimens demonstrated the ability to maintain electrical integrity throughout the test program. The two samples did not maintain rated voltage during the exposure due to damaged extension leads. All specimens demonstrated performance margin at the conclusion of the test by passing voltage withstand testing.

The results of this comprehensive test program provide reasonable assurance, by type test, that the Raychem bolted splice configuration can perform its intended function of insulating and sealing in the most limiting environment in which it is expected to function. Therefore, it is concluded that the WCSF-N In-Line Bolted Splice Assembly is 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[1]	Raychem I.D. Number[2]	Thermal Aging[5]			Radiation Aging[4]	
		Temperature	Duration	Installed Life Equivalent[3]	Dose (rads)	Rate (rads/hr)
1.	1	150°C (302°F)	916.75 hrs.	44.2 yrs	2.2×10^8	5.7×10^5
2.	3	150°C (302°F)	916.75 hrs.	44.2 yrs	2.2×10^8	5.7×10^5
3.	4	150°C (302°F)	916.75 hrs.	44.2 yrs	2.2×10^8	5.7×10^5
4.	101	Unaged	-	Day 1	1.7×10^8	4.7×10^5
5.	102	Unaged	-	Day 1	1.7×10^8	4.7×10^5
6.	100	Unaged	-	Day 1	1.7×10^8	4.7×10^5
7.	9a	150°C (302°F)	916.75 hrs.	44.2 yrs	2.2×10^8	5.7×10^5
8.	9b	150°C (302°F)	916.75 hrs.	44.2 yrs	2.2×10^8	5.7×10^5
9.	50	150°C (302°F)	916.75 hrs.	44.2 yrs	2.2×10^8	5.7×10^5
10.	104	Unaged	-	Day 1	1.7×10^8	4.7×10^5
11.	105	Unaged	-	Day 1	1.7×10^8	4.7×10^5
12.	106	Unaged	-	Day 1	1.7×10^8	4.7×10^5

Notes: (1) Specimen Numbers 1 through 6 consist of the Single Shim Constructions depicted in Figure 1 of this report. Specimen Numbers 7 through 12 consist of the Double Shim Constructions depicted in Figure 2 of this report.
(2) Raychem Specimen Identification Numbers are referred to by adjacent Sample Numbers throughout this report for clarity and ease of comprehension.
(3) Installed Life Equivalents are based upon Arrhenius data documented in Raychem Report EDR-5046 for continuous conductor temperature of 90°C (194°F).
(4) All Radiation Aging values listed are air equivalents of gamma radiation from a Co^{60} source.
(5) The 916.75 hour Thermal Aging exceeded the required aging time to simulate 40-year life for the cable.

TABLE 2

SUMMARY OF INSULATION RESISTANCE MEASUREMENTS

Test Conditions	Temperature (°C)	Temperature (°F)	Vessel Pressure (psig)	Test Sample Insulation Resistance (ohms) 1.	2.	3.	4.	5.	6.
Baseline (Note 1)	Ambient		-	1.7×10^{12}	6.0×10^{12}	3.0×10^{12}	1.2×10^{12}	1.2×10^{12}	1.0×10^{12}
After conditioning	Ambient		-	5.0×10^{11}	5.2×10^{11}	5.0×10^{11}	4.5×10^{11}	4.5×10^{11}	4.5×10^{11}
During LOCA/MSLB Exposure									
After 3 hours (Note 2)	177	350	120	-	Note 3	-	-	-	-
After 9 hours	163	325	74	6.8×10^{6}	-	6.4×10^{6}	3.5×10^{6}	3.8×10^{6}	4.0×10^{6}
After 23 hours	153	307	51	1.3×10^{7}	-	1.3×10^{7}	8.6×10^{6}	7.8×10^{6}	8.2×10^{6}
After 82 hours	138	280	28	3.3×10^{7}	-	3.2×10^{7}	1.7×10^{7}	1.9×10^{7}	2.0×10^{7}
After 132 hours	138	280	28	3.0×10^{7}	-	3.0×10^{7}	2.2×10^{7}	1.9×10^{7}	2.0×10^{7}
After 272 hours	111	232	28 (Note 4)	9.0×10^{7}	-	1.2×10^{8}	1.0×10^{8}	8.4×10^{7}	1.1×10^{8}
After 363 hours	111	232	28	8.0×10^{7}	-	9.6×10^{7}	7.8×10^{8}	6.4×10^{7}	8.3×10^{7}
After 454 hours	111	232	28	1.0×10^{8}	-	1.1×10^{8}	9.0×10^{7}	8.0×10^{7}	9.7×10^{7}
After 546 hours	111	232	28	8.2×10^{7}	-	1.1×10^{8}	8.2×10^{7}	7.8×10^{7}	9.7×10^{7}
After 637 hours	111	232	28	9.4×10^{7}	-	1.2×10^{8}	1.0×10^{8}	1.0×10^{8}	1.0×10^{8}
Test vessel filled with water (Note 1)	Ambient		-	1.6×10^{6}	-	1.8×10^{10}	1.9×10^{10}	1.8×10^{10}	3.5×10^{7}
Samples 2 and 7 removed from vessel and retested (Note 1)	Ambient		-	NA	1.0×10^{7}	NA	NA	NA	NA

TABLE 2 (continued)

Test Conditions	Temperature (°C)	(°F)	Vessel Pressure (psig)	Test Sample Insulation Resistance (ohms) 7.	8.	9.	10.	11.	12.
Baseline (Note 1)	Ambient		-	3.5×10^{12}	3.5×10^{12}	6.2×10^{12}	1.5×10^{12}	1.0×10^{12}	1.1×10^{12}
After conditioning	Ambient		-	5.0×10^{11}	5.0×10^{11}	5.2×10^{11}	5.0×10^{11}	4.0×10^{11}	5.0×10^{11}
During LOCA/MSLB Exposure									
After 3 hours (Note 2)	177	350	120	-	-	-	-	-	-
After 9 hours	163	325	74	6.4×10^{6}	6.1×10^{6}	5.5×10^{6}	3.5×10^{6}	3.4×10^{6}	3.4×10^{6}
After 23 hours	153	307	51	Note 3	1.3×10^{7}	1.1×10^{7}	6.8×10^{6}	7.0×10^{6}	6.8×10^{6}
After 82 hours	138	280	28	-	3.0×10^{7}	2.8×10^{7}	1.7×10^{7}	1.7×10^{7}	1.7×10^{7}
After 132 hours	138	280	28	-	2.8×10^{7}	2.7×10^{7}	1.7×10^{7}	1.7×10^{7}	1.7×10^{7}
After 272 hours	111	232	28 (Note 4)	-	1.1×10^{7}	5.0×10^{6}	7.8×10^{7}	8.2×10^{7}	8.4×10^{7}
After 363 hours	111	232	28	-	8.6×10^{7}	3.2×10^{6}	5.9×10^{7}	6.7×10^{7}	6.2×10^{7}
After 454 hours	111	232	28	-	1.0×10^{8}	2.4×10^{6}	7.6×10^{7}	8.8×10^{7}	7.4×10^{7}
After 546 hours	111	232	28	-	1.1×10^{8}	6.0×10^{6}	6.5×10^{7}	7.8×10^{7}	6.6×10^{7}
After 637 hours	111	232	28	-	1.4×10^{8}	1.5×10^{7}	7.7×10^{7}	9.5×10^{7}	7.7×10^{7}
Test vessel filled with water (Note 1)	Ambient		-	-	1.2×10^{9}	1.4×10^{6}	2.4×10^{8}	1.6×10^{10}	1.4×10^{10}
Samples 2 and 7 removed from vessel and retested (Note 1)	Ambient		-	2.5×10^{9}	NA	NA	NA	NA	NA

Notes: (1) All specimens listing an insulation resistance value also passed 3600 Vrms voltage withstand testing per Section 3.2.2.
(2) Due to the necessity of interrupting the test during this temperature plateau [ref. Section 4.2(b)], meaningful Insulation Resistance could not be measured.
(3) Subsequent test demonstrated specimen's ability to pass voltage withstand at 3600 Vrms and exhibit good Insulation Resistance.
(4) Test vessel was externally pressurized with air to maintain a minimum pressure of 28 psi.

TABLE 3

CURRENT MONITORING OF TEST SAMPLES
DURING LOCA/MSLB ENVIRONMENTAL EXPOSURE

Test Conditions	Temperature (°C)	Temperature (°F)	Vessel Pressure (psig)	Sample Numbers 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Pre-LOCA/MSLB(1)	84	183	-	88	79	86	83	86	90	91	80	88	88	87	85
After 3 hours	177	350	120	67	(2)	70	72	82	76	(2)	76	79	83	80	82
After 26 hours	153	307	51	65		68	70	78	74		74	76	80	77	79
After 2 days	138	280	28	69		68	70	80	74		78	77	82	80	81
After 3 days	138	280	28	73		73	72	82	76		77	80	84	82	84
After 6 days	138	280	28	71		71	71	80	76		77	80	83	80	83
After 8 days	111	232	28(3)	70		72	70	79	75		76	81	84	81	82
After 9 days	111	232	28	66		69	71	80	75		82	78	88	82	82
After 13 days	111	232	28	68		67	72	82	75		77	78	80	81	82
After 15 days	111	232	28	72		72	77	85	80		81	79	83	84	83
After 17 days	111	232	28	72		72	75	84	79		80	79	83	82	81
After 20 days	111	232	28	69		69	71	80	75		82	78	84	82	81
After 22 days	111	232	28	70		67	71	80	76		80	79	80	81	81
After 24 days	111	232	28	72		66	76	78	74		80	81	76	80	81
After 27 days	111	232	28	73		67	77	85	75		81	78	81	81	84
After 28 days	111	232	28	75		69	77	87	77		82	80	82	79	86
After 29 days	111	232	28	74		69	78	86	76		82	79	81	79	85
After 30 days	111	232	28	75		68	78	86	76		82	80	82	79	86
After 31 days	111	232	28	73		70	77	80	74		83	77	81	75	84

Notes: (1) Pre-LOCA/MSLB current measurement was made during vessel preheat.
(2) Current supply was terminated when the 1/4 amp fuse in the voltage circuit opened.
(3) Test vessel was externally pressurized with air to maintain a minimum pressure of 28 psig.

TABLE 4

POST LOCA/MSLB INSPECTION SUMMARY

Specimen Number	Duration of Sample Energization	Results of Inspection
1.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
2.	<9 hours	No visible damage to test sample. Passed VWT* in water bath and measured good insulation resistance.
3.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
4.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
5.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
6.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
7.	<9 hours	No visible damage to test sample. Passed VWT* in water bath and measured good insulation resistance.
8.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
9.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
10.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
11.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample or wire insulation.
12.	31 days	Maintained voltage and current throughout environmental exposure. No visible damage to test sample 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.

Mr. Joe Connolly -2- February 18, 1982

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

APPENDIX B

LIST OF DATA ACQUISITION INSTRUMENTS

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:

WYLE LABORATORIES

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 0-5 x 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 MCK

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.

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

WYLE LABORATORIES

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

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.