Raychem

Energy Division Report

Title: WBTF/NJRT Qualification Type Test		Pages: ~~20~~ 19 Enclosures: Revision 1
Report Number: EDR-5210	Date: December 10, 1991	
Tested by: Emil Pokojny	Signature: Emil Pokojny	Date: Jan. 9, 1992
Prepared by: Gary Will	Signature: Gary Will	Date: Jan. 9, 1992
Approved by: Ken Baker for Technical Operations	Signature: Kenneth Baker	Date: JAN. 9, 1992

Raychem Corporation
Energy Division
300 Constitution Drive
Menlo Park, California 94025-1164

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REVISION RECORD

Rev.	Page	Paragraph	Description	Date
1	Title Page		Changed number of pages from 20 to 19	4/16/92
1	3	3.2	Changed functional test to six	4/16/92
1	4	3.2.2	Corrected spelling of instrument	4/16/92
1	4	3.3.1	Added thermal aging time and temperature	4/16/92
1	-	Figure 1	Changed thickens to thickness	4/16/92
1	-	Table 1	Corrected Sample #2 gamma dose to 1.65E+08	4/16/92
1	-	Table 2	Corrected Note 1	4/16/92
1	9	Table 1	Deleted	4/16/92

APPROVALS (Type and sign name)

Rev.	Date	Tested By	Prepared By	Prod. Mgmt.	Tech. Oper.
1	4/16/92	N/A	G. Will	K. Baker	N/A

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1.0 SUMMARY

Eight Raychem NJRT specimens were subjected to an environmental qualification type test to demonstrate functionality during and after a temperature and pressure profile for the installed life of the product. The type test program was based upon the applicable methods, procedures and guidelines set in IEEE Standards 323-1974 and 383-1974.

The test specimens were exposed to a single environmental profile encompassing temperatures up to 202°C (396°F).

Power supply voltage ranges were simulated by energizing the test specimens to 600Vac and 25 amps.

The effects of installed life were simulated by the accelerated aging of six of the test specimens to an equivalent service life in excess of 40 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 and beta radiation at a level to include both postulated LOCA accident dose and a dose equivalent to an installed assembly containment exposure integrated over a 40 year period. The remaining two specimens received only the postulated accident radiation dose to simulate beginning of life accident exposure. The thermally aged and the unaged specimens received 2.15×10^8 rads gamma, 0.83×10^8 rads beta and 1.65×10^8 rads gamma respectively.

Acceptance criterion was established as the specimen's ability to maintain rated voltage 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 NJRT is functional in environments enveloped by this test.

2.0 TEST SPECIMEN

2.1 Materials and Construction

2.1. 1 Each test specimen was constructed of Raychem's WBTF and S1119 materials. The WBTF was selected at random from a prototype run using standard nuclear extrusion materials and manufacturing procedures. The S1119 was obtained from standard stock. All components conformed to the Raychem Material Specifications referenced in Figure 1.

2.1.2 All specimens were assembled in the configuration shown in Figure 1. All specimen assembly was accomplished by Raychem personnel and using Raychem's standard cable preparation and splice assembly procedure. The wire was cleaned with 1,1,1 Trichlorethane prior to assembly and the specimens were installed using a Raychem Thermogun Model 750.

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 following test sequence was utilized throughout the qualification type test.

Sequence	Test Description
1.	Water Immersion
2.	Functional Tests
3.	Thermal Aging
4.	Functional (IR only)
5.	Radiation Exposure
6.	Water Immersion
7.	Functional Tests
8.	Radiation Exposure
9.	Inspection
10.	Water Immersion
11.	Functional Tests
12.	Environmental Exposure
13.	Functional Tests
14.	Inspection
15.	LOCA Solution Immersion
16.	Functional Test (IR only)
17.	Inspection

3.2 Functional Test Procedure

Functional tests were repeated six 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. 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 Table 3.

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-c voltage withstand test were performed on each test specimen in accordance with IEEE-383 1974, 2.3.3.4. Using the water bath as ground, the voltage was applied to the conductor in each specimen. Because of the instrument used to measure voltage withstands, the volts per mil of insulation was 73. No bending was performed.

3.3 Specimen Preconditioning

3.3.1 Thermal Aging

Six specimens (numbers 4, 5, 10, 11, 22 and 23) were thermally aged to simulate a service condition of 40 years based on Arrhenius data for Raychem's nuclear grade materials as documented in Raychem Report EDR-5046. These samples were aged for 302 hours at 163°C (324°F) which represents 40 years installed life at 90°C (194°F). Specimen numbers 1 and 2 were not thermally aged, simulating the condition of product at the beginning of installed life. All thermal conditioning was accomplished at Raychem Corporation. Test specimen matrix is 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 X 10^7 rads. The postulated accident gamma radiation dose was 1.5 X 10^8 rads and 8.3 X 10^7 rads beta.

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 X 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 X 10^8 rads gamma. Four of eight samples received the 8.3 X 10^7 rads beta.

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. Beta radiation was applied using Raychem's electron beam.

After preconditioning and functional testing, the test specimens were spliced together in a series loop and placed in the test vessel.

3.4 Environmental Exposure

The temperatures and pressures throughout the test period are given in Figures 2 through 6. The thermocouple used to measure the temperature was located approximately at the center of the test specimen loop. The test specimen loop was energized to 600Vac and 25 amps of current during the exposure. The current was applied at room temperature and was not adjusted for temperature affects.

4.0 TEST RESULTS

4.1 Functional Test Results

The results of all voltage withstand test, and insulation resistance measurements are listed on Table 2. All specimens passed the functional tests after the environmental exposure while installed in the flooded vessel.

4.2 Post Environmental Exposure Tests and Inspection

At the conclusion of the environmental exposure, the test vessel was filled with tap water. The test specimens were then given a voltage withstand test and insulation resistance measured. The values are given in Table 2. Visual examination of the test specimens showed no cracking or splitting.

4.2.1 The specimen loop remained in the flooded vessel at room temperature for 30 days. Insulation resistance measurements were made daily. These results are given in Table 2 (daily results are not given).

4.2.2 After the 30 day water immersion, the test specimen loop was immersed in a borated solution with a pH of 10. and heated to 130°C (266°F). At this temperature the pressure was 42 PSIG. Time at this temperature and pressure was 7 days. The solution was that given in IEEE 323, 1974, Table A1. Insulation resistance measurements were made after the 7 day immersion and the results are given in Table 2.

5.0 CONCLUSION

The results of this comprehensive test program provide reasonable assurance, by type test, that the Raychem NJRT can perform its' intended function of insulating and sealing when used in these tested configurations

TABLES AND FIGURES

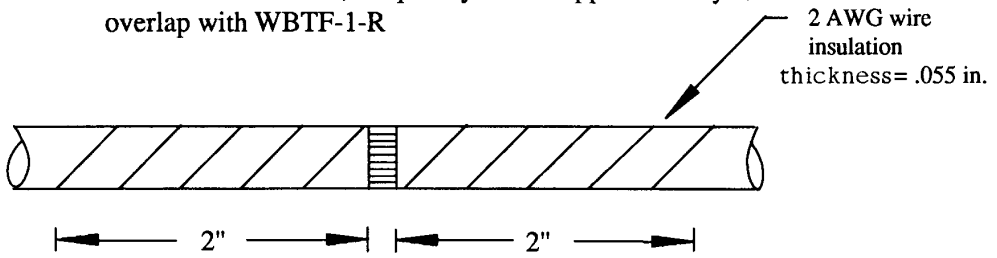
Figure 1
Sample Construction

A. 1 Wrap Construction

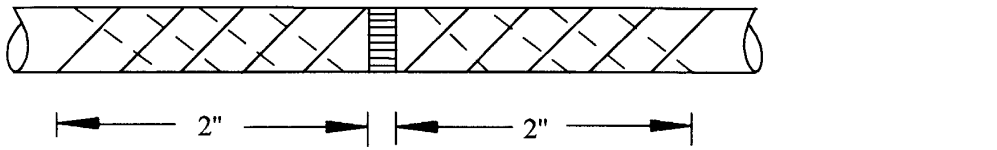
1. Expose conductor by removing approximately 1/4 inch of insulation. (Same for 2 wrap construction)

2. Wrap 1 layer with 1/2 overlap of S1119 Ribbon Adhesive

3. Over S1119 adhesive, wrap 1 layer with approximately 2/3 overlap with WBTF-1-R



B. 2 Wrap Construction



Materials of Construction	Material Specification
1. S1119-6-1500 - 1/2 lapped layer.	PPS-3012/19
2. WBTF-1-R First Layer WBTF 1/2 lapped over and inthe opposite direction of S1119 Ribbon Adhesive Second Layer WBTF wrapped in opposite direction to first layer of WBTF.	PPS-3010/7

Table 1
Test Speciman Matrix

Sample #	Sample Construction		Aging	Radiation	
	1 Wrap	2 Wraps		Gamma	Beta
1	X		------	1.65E+08	------
2	X		------	1.65E+08	------
4	X		X	2.15E+08	------
5	X		X	2.15E+08	------
10	X		X	2.15E+08	8.3E+07
11	X		X	2.15E+08	8.3E+07
22		X	X	2.15E+08	8.3E+08
23		X	X	2.15E+08	8.3E+07

Table 2
Test Values

Sample #	1		2		4		5		10		11		22		23		Speciman Loop	
Test	IR (OHMS)	Current Leakage (Micro Amps)	IR	Current Leakage	IR	Current Leakage	IR	Current Leakage	IR	Current Leakage	IR	Current Leakage	IR	Current Leakage	IR	Current Leakage	IR	Current Leakage
Test Condition																		
Before Precond.(1)	1.5 E13	165	2.0 E13	170	1.4 E13	180	2.0 E13	175	1.9 E13	175	1.4 E13	180	2.1 E13	175	2.0 E13	178	---	------
After Thermal Aging (1)	-----	-----	----	----	4.0 E13	-----	5.0 E13	----	3.5 E13	----	5.0 E13	----	5.0 E13	----	5.0 E13			
After Irradiation (1)	8.5 E11	260	9.5 E11	255	5.9 E11	275	5.6 E11	250	4.0 E11	270	4.0 E11	265	4.0 E11	265	4.0 E11	260	1.25 E11	1720

During Test Profile (2) SPECIMAN LOOP
(See Figures 3-6)

	IR (OHMS)	Current Leakage (Micro Amps)
At Start of 200°C RAMP	2.8 E8	110
At End of 200°C RAMP	1.35 E8	110
At End of 150°C RAMP	2.8 E8	110
At 135°C RAMP		
1 Day	8.0 E7	105
2 Day	4.0 E7	140
3 Day	4.0 E7	115
4 Day	1.0 E8	110
5 Day	4.5 E7	110
6 Day	5.0 E7	110
7 Day	8.0 E7	115
30 Day Submergenge		
At Ambient Temp.		
After 1 Day	4.5 E9	---
7 Day	4.5 E9	---
14 Day	3.0 E9	----
21 Day	3.0 E9	---
28 Day	3.5 E9	---
30 Day (1)	3.0 E9	---
After 7 Day	2.0 E9	

Submergence in LOCA Solution at 130°C and 42 PSIG

NOTES:

1. Voltage withstand were conducted at 4kVac for 5 min. all passed.
2. Current leakage measured at 600Vac
3. The instrument to measure voltage withstand had a maximum voltage of 4kVac

Table 3
List of Data Acquistion Instruments

Instrument	Manufacture	Model	Calibration Cycle	Due Date
Megohmeter	General Radio	1864	6 Mos.	07/07/91
Pyrometer	Omega	HH82	6 Mos.	03/26/92
Hi Pot	Associated Research	4030	6 Mos.	01/25/92
Pressure Transducer	Omega	236 PC, 100GW	Before use	------
Molytek Dataloger	Molytek	2702-5H-R-T/C	Before use	------

Calibration was performed in accordance with the requirements of MIL-STD-45662 and against standards traceable to the National Institute of Standards and Technology using industry accepted methods.

Figure 2

Environmental Profile

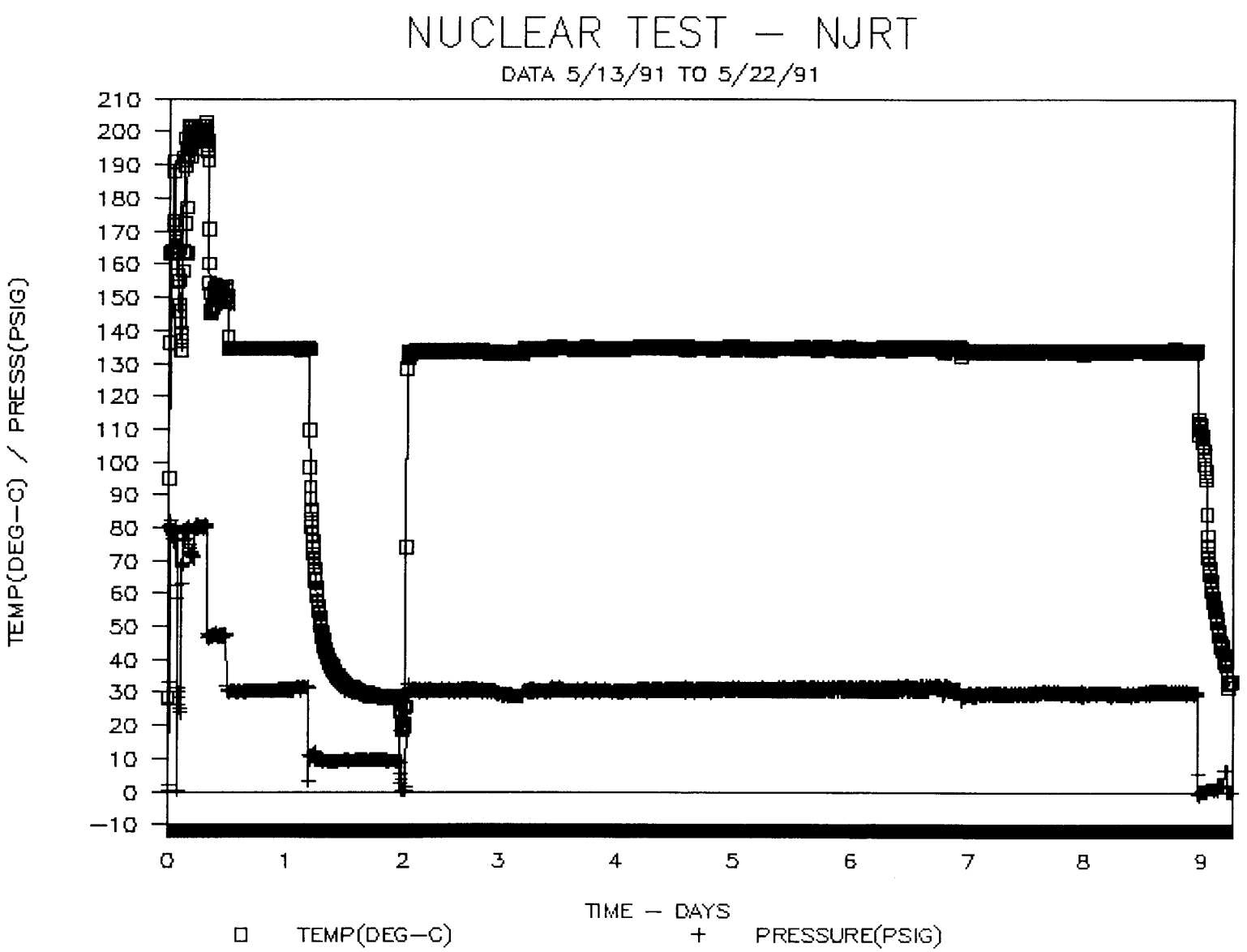


Figure 3

Environmental Profile

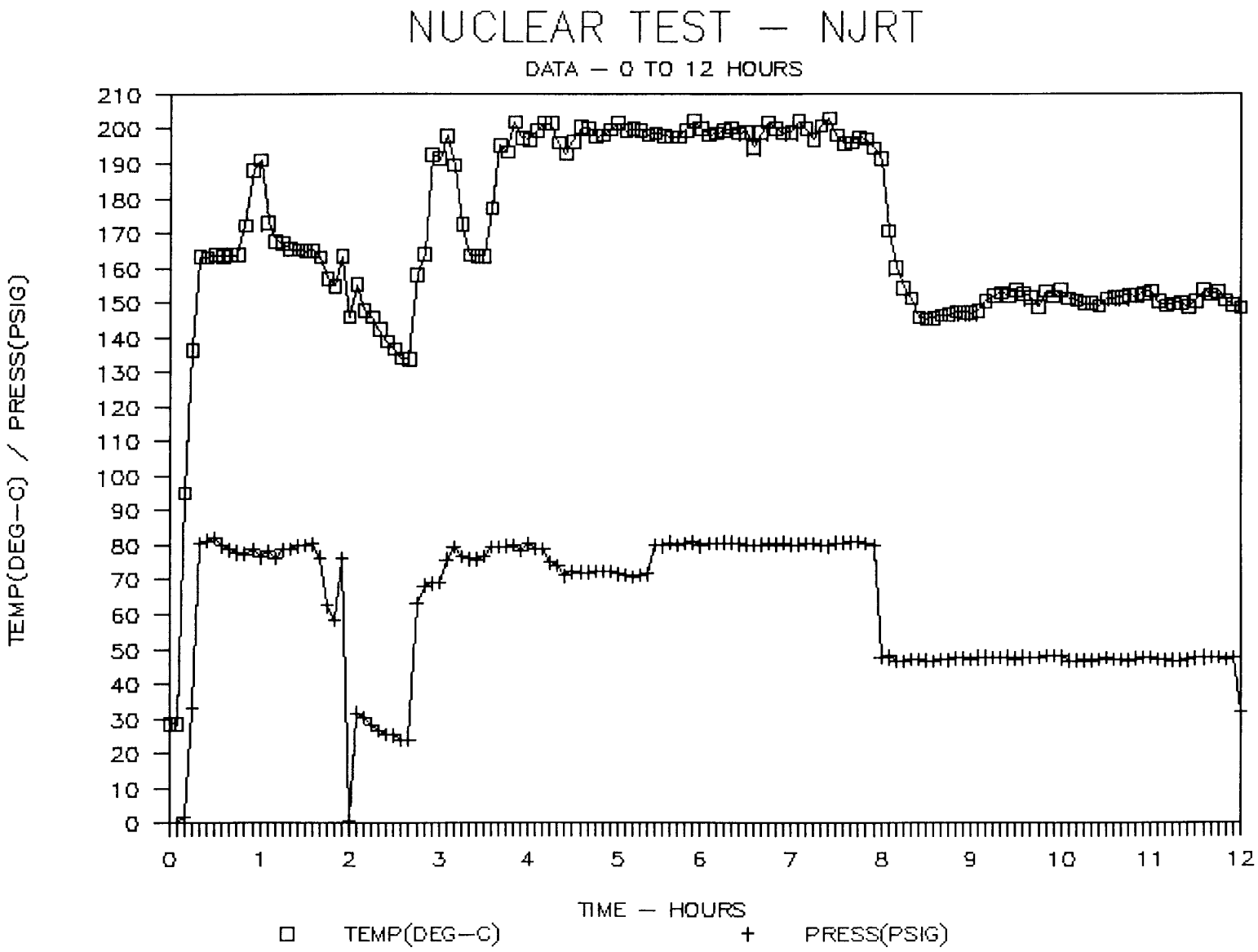


Figure 4

Environmental Profile

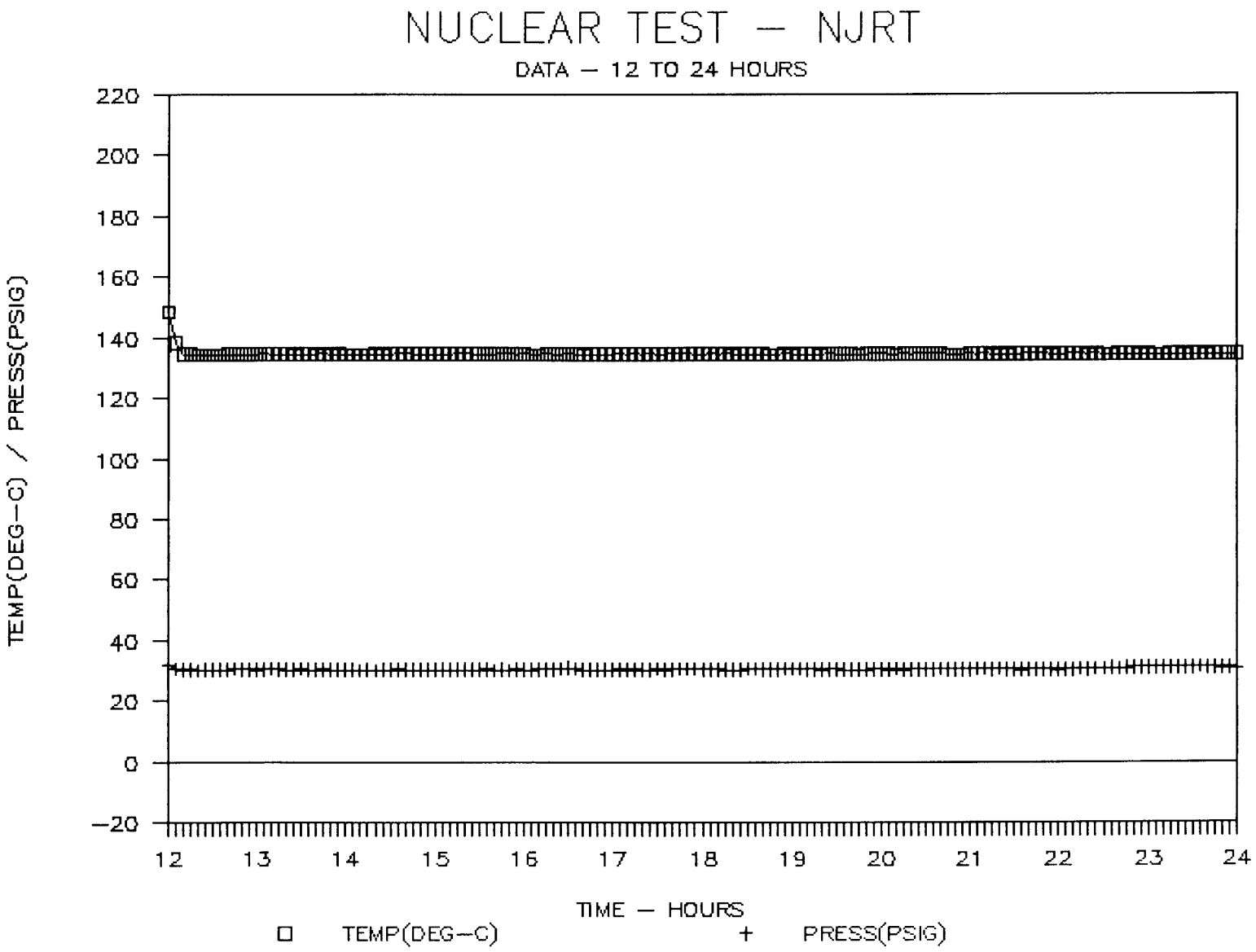


Figure 5

Environmental Profile

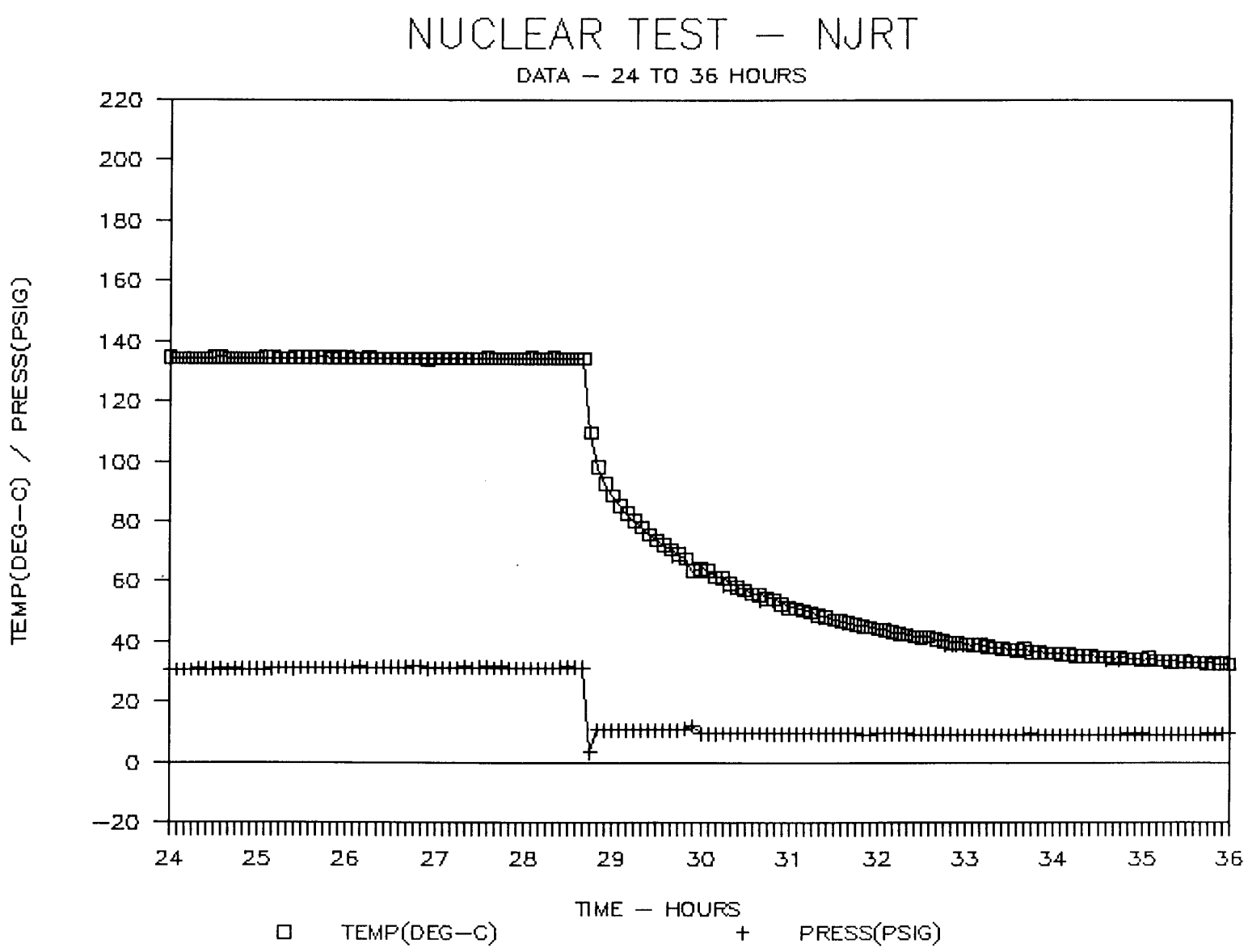
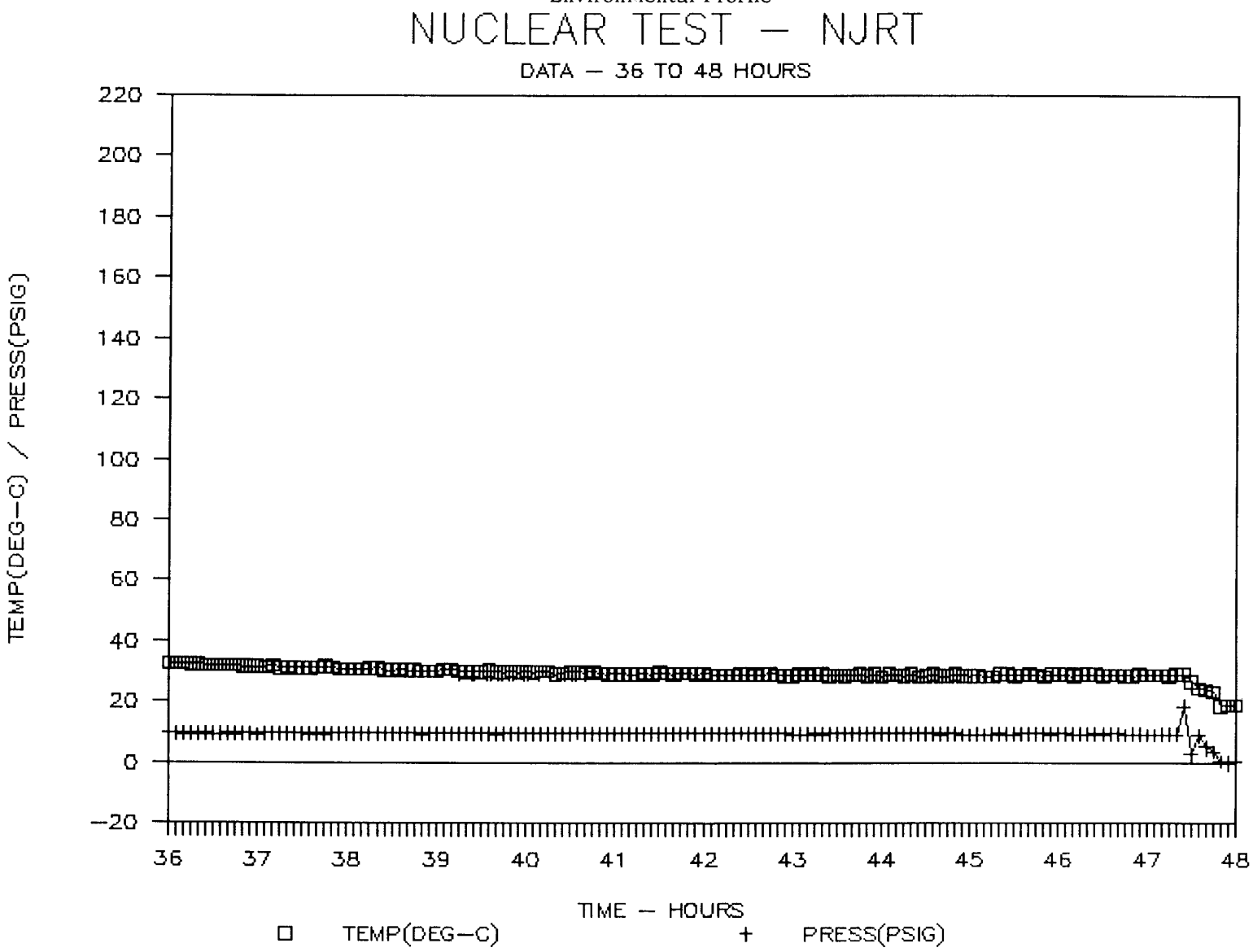


Figure 6

Environmental Profile



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IRRADIATION CERTIFICATE

Facility: Raychem Beam 20, Building C

Location: Menlo Park, Main Site

Customer: Energy Nuclear Products; Gary Will - #7756

Sample Description: NPE-TP-91-01

Dose Rate: 0.80 Megarads/Pass (Rotated 1/5th = every 42 Passes during irradiation = 210 passes.

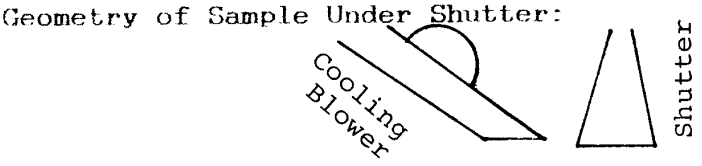
Cumulative Dose: #'s 7,8,9,10,11,12 & 19,20,21,22,23,24; 8.30e+07

Total Hours Exposed: 6 Hours Beam Time

Date Samples Rec: 12 March 1991

Date Samples Shipped: 09 April 1991

Geometry of Sample Under Shutter:



Calibration Certification:

* FWT-60 Radiochromis Dye Film, Far West Technology Calibrated, NBS, Washington, D.C. #Test 536/240189-87 NBS-DB 864/160 XRG-581
* Calibrated Polyethlene Dosimeter Sheet J-90 Stock Calibrated against NBS Film and G Stock 87

Certified By: Bradley D. Johnston 4/16/91
Radiation Technology
Ext. 4141

Raychem Raychem Corporation

IRRADIATION CERTIFICATE

Facility: Raychem Cobalt 60 / R & D

Location: Menlo Park, Main Site

Customer: Energy Nuclear Products; Gary Will - #7756

Sample Description: NPE-TP-91-01 (#'s 1-26)

Dose Rate: 0.66 Megarads/Hour

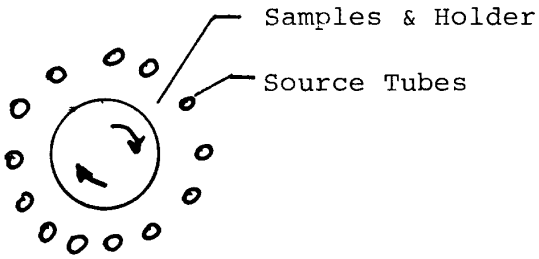
Cumulative Dose: 1.65E+08 & 2.15E+08 Megarads

Total Hours Exposed: 249.2 & 324.2 Hours

Date Sample/s Rec: 12 March 91

Date Sample/s Shipped: 09 April 1991

Geometry of Sample/s to Source:



Calibration Certification:

* FWT-60 Radiochromis Dye Film, Far West Technology Calibrated, NBS, Washington, D.C. #Test 536/240189-87 NBS-DB 864/160 XRG-581
* Perkin-Elmer/Lambda 4A/UV/VIS Spectrophotometer Model:C688-000/87 Dated:06 October 1987
** Recalibrated Instruments 2/90 w/NBS Film
** Dial Indicator Calibrated 1/91 w/Raychem Insp.

Certified By:

4/16/91

Bradley D. Johnston
Radiation Technology
Ext 4141