ACME-CLEVELAND DEVELOPMENT COMPANY
625 ALPHA DRIVE • HIGHLAND HEIGHTS, OHIO 44143 • (216) 473-0300

T.R. 3613-PP

TESTS OF LIMIT SWITCH #138-90

FEBRUARY 15, 1980

REVISION 0

TABLE OF CONTENTS

	Page
CERTIFICATION	
T.R. 3613-PP (BODY OF REPORT)	1-7
FIGURES 1-3	1-3
APPENDICES	
APPENDIX A Letter from M. Bruce of Georgia Institute of Technology to E. L. Solem Regarding Switch Irradiation	1-4
APPENDIX B Seismic Qualification Test of Limit Control Switches Dated June 1977 by Dr. E. J. Walter & Associates	1-14
APPENDIX C Cross Coupling	1-4
APPENDIX D Data Sheets	1-19
APPENDIX E Equipment Calibration Listings	1

CERTIFICATION

The undersigned certify that this report presents a true account of the tests conducted and the results obtained:

James J. Patsey — 2/19/80
J. J. Patsey — Date
R & D Technician

Edward L. Solem — 2/18/80
E. L. Solem — Date
Development Engineer

APPROVED BY: Thomas J. Skingle — Feb-18, 1980
T. J. Skingle, P. E. — Date
Corporate Manager
Materials R & D

Robert L. Nekola — Feb 19, 1980
R. L. Nekola, P. E. — Date
General Manager
Acme-Cleveland Development Company

TEST REPORT NO.:	T.R. 3613-PP
DATE:	2/15/80
TITLE OF TEST:	TESTS OF LIMIT SWITCH #138-90 AS PER TEST PLAN LP-10767-3, REVISION 1
SIZES AND KINDS OF SWITCHES:	One Namco Controls limit switch Model EZ-10683-90/EA-180-11302
PURPOSE OF TEST:	To establish the performance characteristics of the switch under normal and abnormal conditions.
TEST REQUESTED BY:	Namco Controls
PREVIOUS HISTORY AND REFERENCES:	E.R. 1418 All Series 3613 test reports Test Plan LP-10767-3, Rev. 1, dated 7/26/79

PROCEDURE FOLLOWED

The following tests were carried out at or under contract to Acme-Cleveland Development Company, the research center for the Acme-Cleveland Corporation.

The tests consisted of the following parts:

1. Thermal aging for 400 hours at 120°C (248°F).
2. Mechanical wear aging for 100,200 actuation cycles under electrical load of 0.5 amps at 100 volts DC.
3. Irradiation to a level of 204 megarads of gamma radiation.
4. Seismic testing to a maximum of 9.52 g's in the 1-35 Hz range.
5. DBE testing to a maximum 196°C (346°F) at 70 PSIG.

The test procedure will be presented in the order in which it was performed. Paragraph references are provided in parentheses for correlation with the test plan.

E L S

Throughout the testing the following equipment was used to determine the performance level of the units.[1] A megohm meter measured the resistance between contacts when open. A test circuit measured the load current between contacts when closed. This circuit consisted of a 100 volt DC power supply, appropriate voltage and current meters, and a load bank set to pass 86 milliamps.

Inspection and Preparation (6.1)

The switch identity was recorded and the switch wired and assembled as called for by the test plan.

Initial Test (6.2.1 and 6.2.2)

Open and closed circuit performance was measured and recorded for purposes of providing base-line data. Trip angle and torque tests (identified as Functional Test - 6.2.1.3 of the test plan) were deferred until after the Mechanical Wear Aging.

Thermal Aging (6.3)

The thermal aging test consisted of exposing the unit to a temperature of 120°C (248°F) for 400 hours. A thermometer was placed such that the switch was between it and the heat source. This thermometer was monitored during thermal aging. During the time of this test the conduit opening of the switch was sealed. A Performance Test (6.2.2) was performed at the conclusion of the thermal aging.

Mechanical Wear Aging (6.4)

The switch was subjected to 100,200 actuation cycles. The actuation was accomplished by a cam mechanism operating at 70 actuations per minute. The electrical loading during this part of the test was 0.5 amps at 100 volts DC. Per-

[1] Calibration dates are contained in Appendix E.

E J S

formance (6.2.2) and Base-line Functional (6.2.1.3) tests were performed after mechanical wear aging.

Irradiation (6.5)

Irradiation was performed by the Frank H. Neely Nuclear Research Center of Georgia Institute of Technology. Their certification is contained in Appendix A. Irradiation was carried out to a level of 204 megarads. Gamma radiation from a cobalt 60 source at 1.173 Mev and 1.332 Mev. was used. The irradiation was carried out at a rate of 0.91 megarads per hour. The Performance Test (6.2.2) was performed after the irradiation.

Seismic Testing (6.6)

Single axis tests were performed in each of the three axes. This testing included Resonance Search (6.6.8), Fragility Test (6.6.9), and Plant Induced Vibration Simulation (6.6.10). The analysis of cross coupling in this model switch is presented in Appendix C.

The Seismic tests (see Appendix B) were performed on a different Model EA-180 switch. These tests cover the Resonance Search (6.6.8) and most of the Fragility Test (6.6.9) required by the referenced test plan. The testing of Appendix B was conducted at a reduced g level in the 10-20 Hz frequency range of the Fragility test. Therefore, full fragility testint was performed on the present switch in this frequency range.

The performance instrumentation for this test was the same as that for Appendix B. A Nicolet Explorer III oscil-

EJL

loscope was, however, substituted for the Tektronix. The Fragility Test was performed on a mechanical shaker. The input motion of the shaker was monitored by an accelerometer.

The test spectrum for the Fragility Test (6.6.9) is given in Table I. Note that either acceleration or displacement may be the independent variable.

TABLE I

SEISMIC TEST SPECTRUM (INPUT MOTION)
(See Also Figure 1)

Frequency	Peak Acceleration	Peak to Peak Displacement
1-4 Hz	0.6-9.52 g's	12"
4-35 Hz	9.52 g's	12"-.091"

The data acquisition portion of the tests covered in Appendix B were not repeated on the switch (#138-90) presently under test. However, this switch (#138-90) was subjected to all vibrations which are a part of the Fragility Test in order to simulate the post-seismic condition before subjecting the switch to DBE testing.[1]

The Plant Induced Vibration Test (6.6.10) was run on Switch #138-90 at 100 Hz using a B & K electrodynamic shaker. Table motion was monitored by a BBN accelerometer.

The Performance Test (6.2.2) was [illegible] Seismic testing.

DBE Test (6.7)

The temperature pressure profile for the test is given in Figure 3.[2]

---

[1] The switch circuits were energized and the switch exercised in this test as it would have been in full testing.

[2] The recorded pressure/temperature data are presented on Pages 9 of 19 (D) and 13-19 of 19 (D).

The first four days of DBE testing were performed in a chamber of 12" height and 8" diameter. The switch was mounted in the chamber in a horizontal position such that the lever shaft pointed upwards. The switch was attached by means of a threaded pipe. Teflon tape was used for sealing the pipe threads. This pipe ran through an O-ring type feed-through in the chamber. The electrical connections from the switch were run through this same pipe. Actuation of the switch was provided by a rotary feed-through in the top of the chamber.

The switch was subjected to a caustic spray during this portion of the DBE test. The flow rate of the spray was 230 cc's per minute providing the necessary coverage of 0.15 gallons per minute per square foot of cross-section. The pH of the spray was maintained between 10 and 11. The spray was composed of boric acid, water, sodium thiosulfate and sodium hydroxide and was recycled during the entire time. Spraying was initiated following each transient temperature rise. The switch was submerged in caustic spray at temperature during some portions of this test due to the instability of the recycling system.

The rate of temperature rise during the two transients of the DBE test was somewhat slower than shown in Figure 2. The data are summarized in Figure 3 and Page 9 of Appendix D.

The switch was transferred from the high pressure chamber to the low pressure chamber following the first four days of the DBE test. It remained in this low pressure chamber for the rest of the 30-day DBE period.

Two data acquisition methods were used during the DBE. The temperature was recorded on a strip chart recorder via a thermocouple. During the transient sections of the DBE the digital readout from the thermocouple as well as the reading of the pressure gauge were recorded on video tape. The data are recorded on Scene 138 of this tape which is on file in the library of the Acme-Cleveland Development Company.

The switch was actuated and data recorded during the peak level of the DBE and at other times as noted in Figure 3. Additional data were taken during the long-term portion and at the conclusion of the test.

RESULTS

During all phases of the test the open contact resistance of the switch remained above 5 megohms. The closed circuit current remained within 0.001 amps of the specified load.

At one point in the DBE test the switch failed to transfer when released after actuation. The switch did transfer after a second actuation provided a small additional lever arm rotation. The lever arm was not pushed back toward the unactuated position.

Detailed performance data are presented in Appendix D.

CONCLUSIONS

The switch failed to Transfer (7.4) one time during DBE testing. No other Performance Limits (7) as specified by the test plan were encountered during the tests.

The tests were carried out from October of 1979 to January of 1980.

ELS/JJP:cr

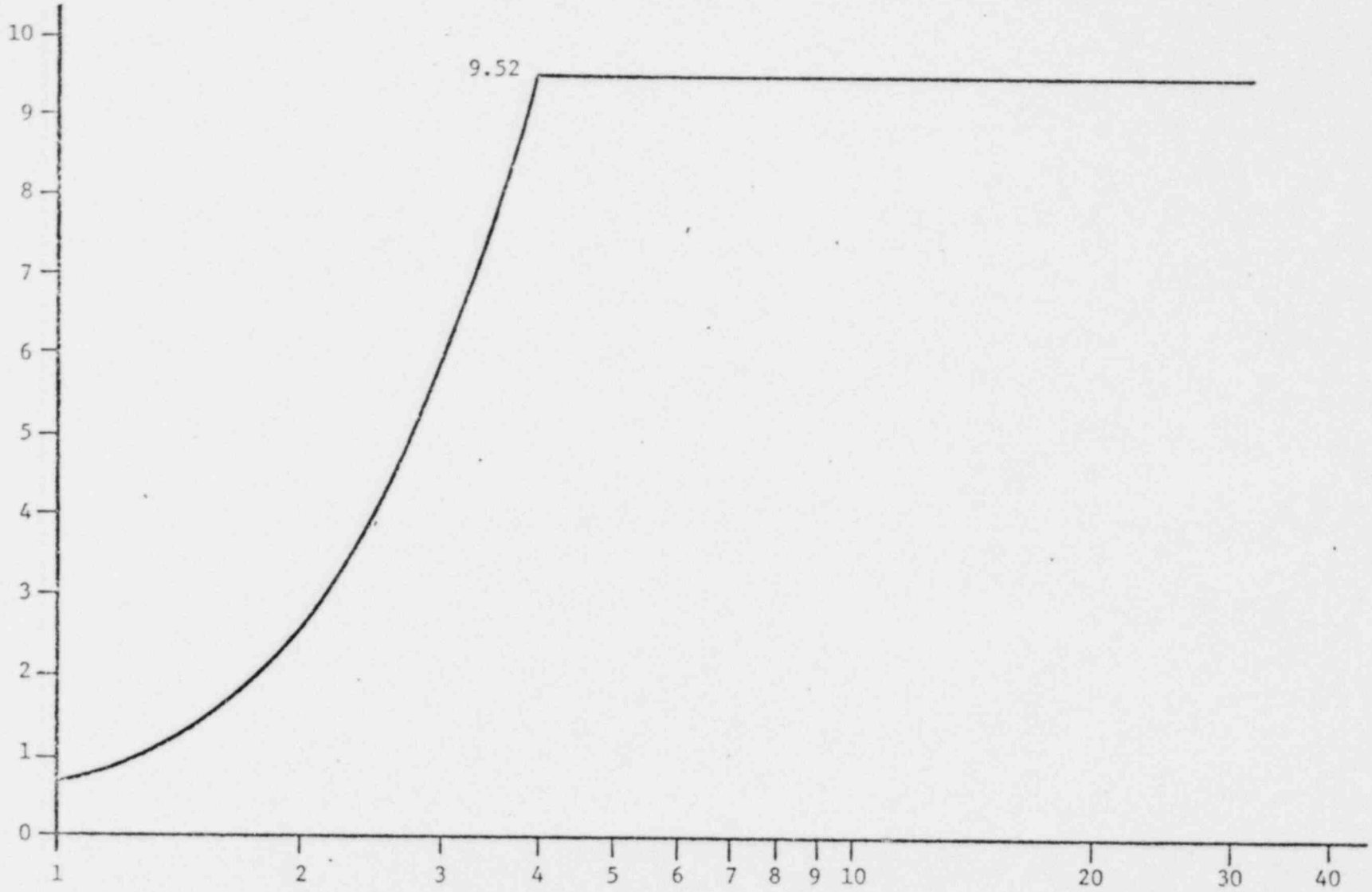
Enclosures

E L. S

FIGURES

FIGURE 1

SEISMIC INPUT MOTION



MAX. G
(g's)

FIGURE 2

TEST CHAMBER PROFILE FOR ACCIDENT ENVIRONMENT SIMULATION
(TAKEN FROM IEEE STD 382-1972)

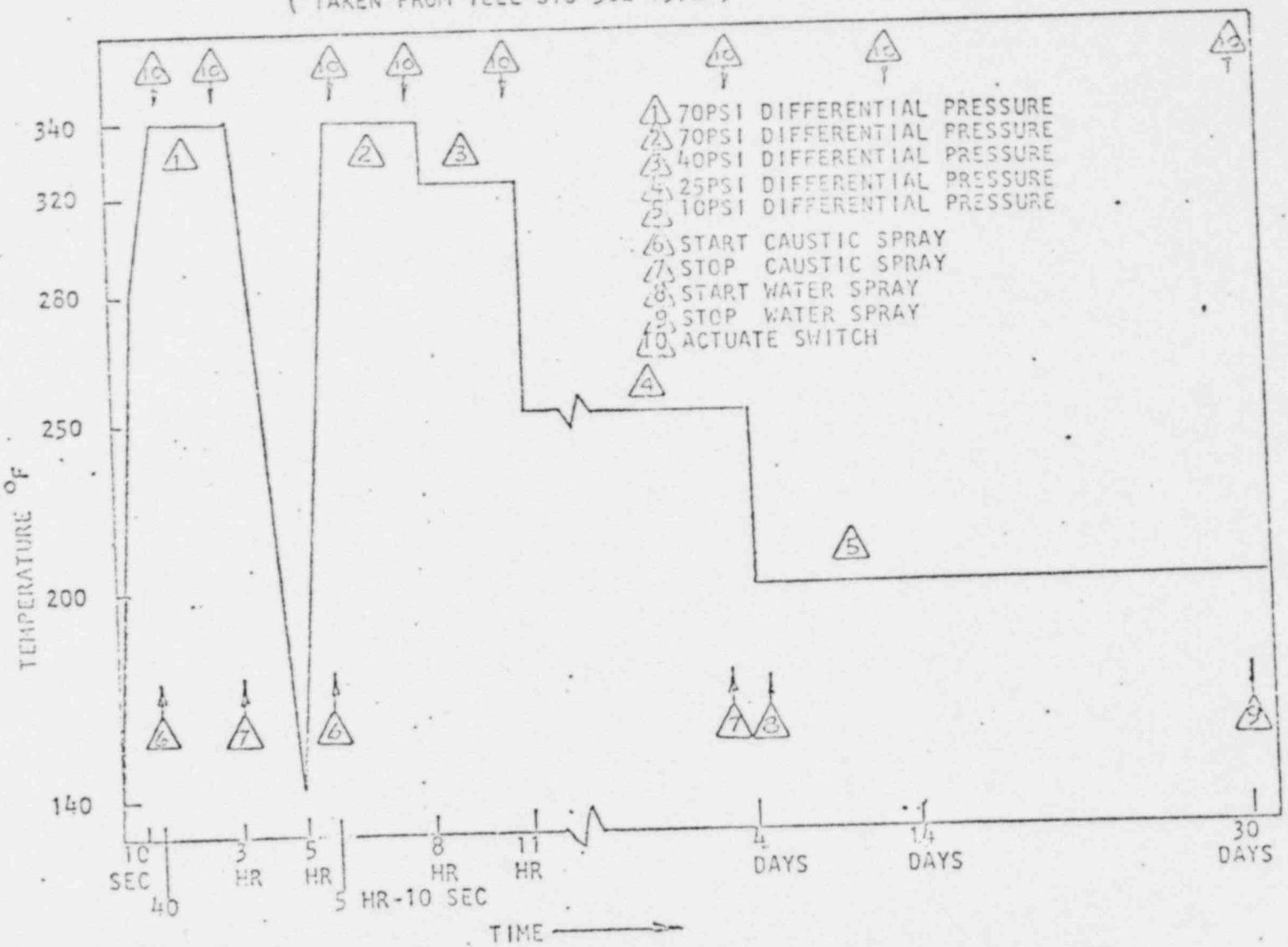
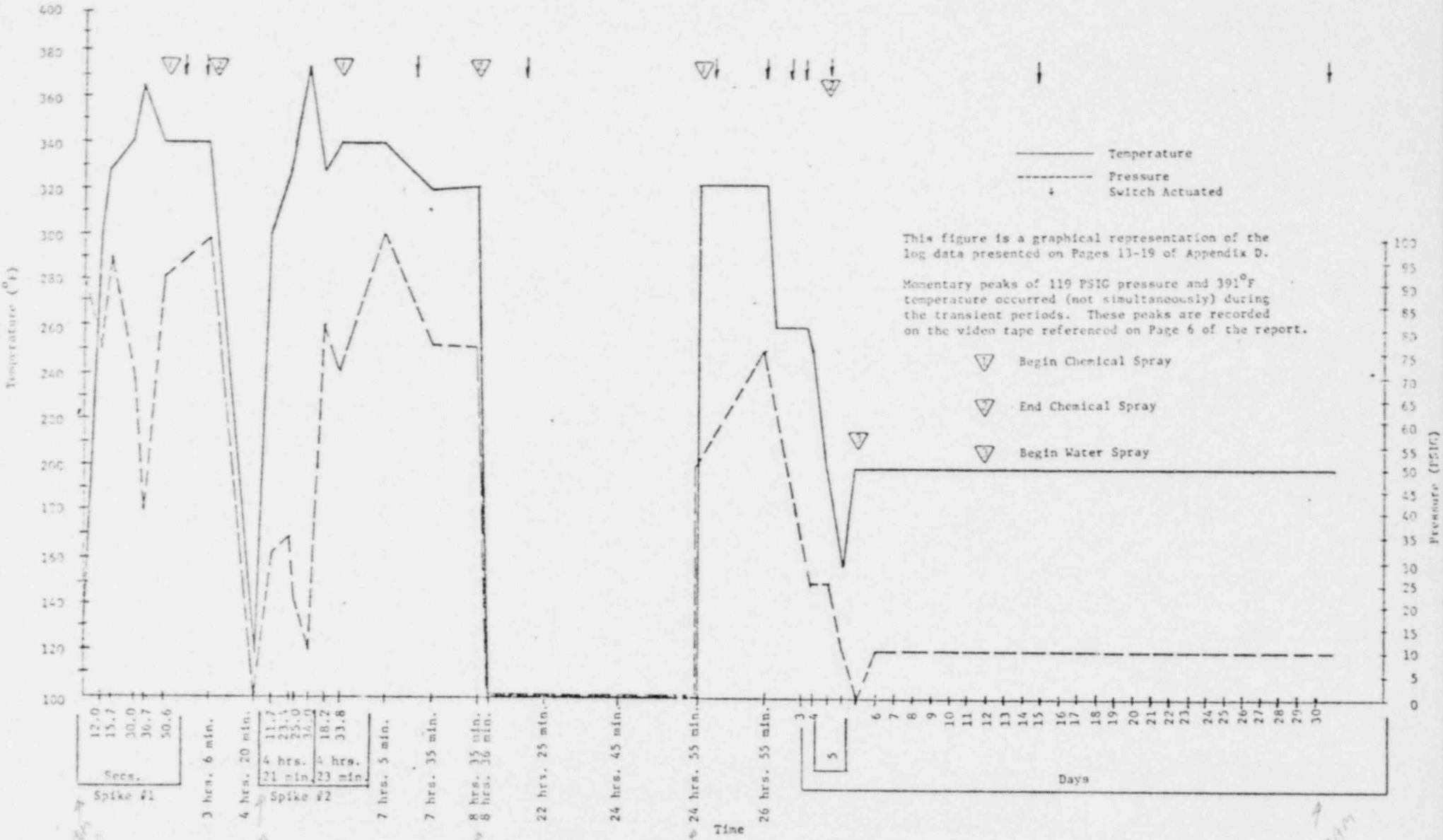


FIGURE 3

TEST CHAMBER PROFILE FOR ACCIDENT ENVIRONMENT SIMULATION
(As Recorded)



APPENDIX A

RADIATION EXPOSURE

GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF NUCLEAR ENGINEERING
ATLANTA, GEORGIA 30332

FRANK H. NEELY
CLEAR RESEARCH CENTER
ELEPHONE: (404) 894-3600

November 20, 1979

Mr. E.L. Solem
Development Engineer
Acme-Cleveland Development Co.
625 Alpha Drive
Highland Heights, Ohio 44143

Dear Mr. Solem:

Pursuant to your instructions seven limit switches and nine small items were irradiated in our hot cell facility using Cobalt 60 (gamma energies 1.173 Mev; 1.332 MeV) to a total dose of 2.04 X 10^8 rads (air) or 2.3 X 10^8 rads (air) as indicated below.

We certify the specific parameters of this irradiation to be:

Test I - 204 Megarads

Irradiation Period:	Total of 9 days, 8 hours and 15 minutes P-1 November 5-November 12, 6 days 15 hours and 15 minutes P-2 November 16 - November 19, 2 days 17 hours and 0 minutes
Dose Rate:	9.1 X 10^5 rad/hour
Total Dose:	2.04 X 10^8 rads (air)
Specimen Id:	(Switch) 134-63 (Switch) 136-90 (Switch) 131-2 (Switch) 138-90 (Switch) 137-67 (Switch) 97 (Switch) 96

Hexseal APM
346
0
308
100
400
NPC-80
2 unlabeled items

Test II - 230 Megarads

Irradiation Period:	Total of 10 days 12 hours and 45 minutes P-1 and P-2 of Test I and P-3, November 19 - November 20, 1 day 4 hours and 30 minutes
Dose Rate:	9.1×10^5 rad/hour
Total Dose:	2.3×10^8 rads (air)
Specimen Id:	(Switch) 134-63 (Switch) 136-90 2 unlables items Hexseal APM 346 308 100 400 0
Dosimetry:	Thermoluminescent dosimeters of lithium borate. (Harshaw TL-800) calibrated with a Farmer Dosimeter model 2502/3. Farmer unit calibrated using NBS cobalt 60 at M.D. Anderson Hospital, Houston, Texas.

The last date of TLD calibration was March 12, 1979; the last date of Farmer unit calibration was July 27, 1979. If you require additional information please contact me at (404) 894-3608.

GEORGIA INSTITUTE OF TECHNOLOGY

Margaret Bruce

Margaret Bruce
Research Scientist

MB:lrm

IRR. REF. Number 79629

Irr. Ref. Number G 29

Account Number

Sponsor/Address Nuclear Consultants / Acme - Cleveland

Job Description: (7) Limit canister (9) small quivers
204 M Rods 131-2, 138-90, 137-67,
97, 96 and NPC-80

Scheduled Start:

Budget:

P.S. _____ hr. @ _____ = _____

M&S _____ = _____

Hot Cell _____ @ _____ = _____

Gamma Pool _____ @ _____ = _____

Other _____ = _____

Total Contract _____

6 days 11 hours 1st Series
Actual Start 11-5-79 1655 (4:55 pm) Stop 8:10 am 11/12/79

Completion 2nd start 11-16-79 (1730 - 5:30 pm) 2nd Stop 11-19-79 10:30 AM

4 Repair 2 days 17 hrs
Removed 2.04 x 10^8 equiv min
1 day 9 hrs 30 min Restart 11-19-79 at 1225 (12:25 PM) — Stop 11-20-79 1655 pm

Smearable contamination on specimn after test < 100 d/m / 100 cm²

Jim Boyd
Radiological Safety Officer

Irradiation of specimen(s) performed by Dwight E. Taylor

Page 3 of 4 (A)

Dosimeter Readings

A 1610 rad → 1690 × 99.6 rad(H₂O)/rad(C) × .9017 rad(air)/rad(H₂O) × 60 min/hr × 1/20 min =

B 1770 " /

etc.

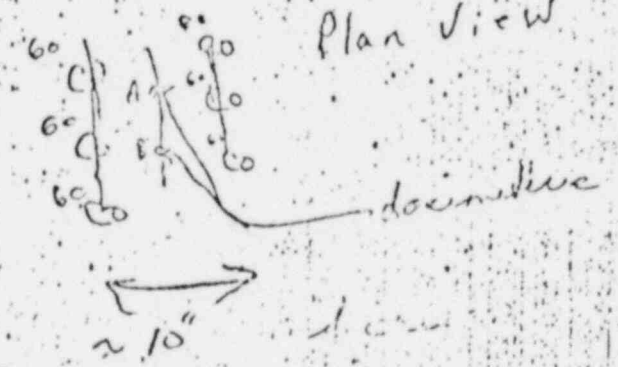
9.1×10^5 rad (air)/hr

Irradiation Geometry

"Sketch showing source positions, dosimeter position, and position of test specimen during irradiation"

Photo attached to original

Dosimeter 2 – horizontal center ~ 5" above bottom



Calculations

$\frac{2.04 \times 10^8}{9.1 \times 10^5}$ = 224 hours 11 min (9 days 8 hr 11 min)

actual — 9 days 8 hrs 15 min

$\frac{2.3 \times 10^8}{9.1 \times 10^5}$ = 252 hr 45 min = 10 days 12 hr 45 min

actual — 10 days – 12 hrs 45 min

APPENDIX B

SEISMIC QUALIFICATION TEST