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ROCKET ENGINE OPERATIONS - NUCLEAR

REPORT NO. 2641

AGC--2641

PRELIMINARY TEST REPORTS

FOR

GROUND TEST REACTOR (GTR)

TESTS DURING 13-19 MAY 1963

MASTER

AEROJET-GENERAL CORPORATION

AZUSA, CALIFORNIA

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**AEROJET
GENERAL**

REPORT NO. 2641

PRELIMINARY TEST REPORTS
FOR
GROUND TEST REACTOR (GTR)

ROCKET ENGINE OPERATIONS - NUCLEAR

TESTS DURING 13-19 MAY 1963

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RADIATION EFFECTS TESTING

Section No:

System:

Component:

Test:

Date:

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R E O N

TEST 22/W006

FISSION COUNTER PULSE PREAMPLIFIER

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RADIATION EFFECTS TESTING

Section No:	1.5.2.7.0
System:	Controls
Component:	Fission Counter Pulse Preamp.
Test:	22/W006
Date:	May 1963
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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A.	TEST NUMBER	22/W006
B.	TEST DATES	13 through 19 May 1963
C.	TEST SPONSOR	WANL
D.	TEST FACILITY	GTR

II. SUMMARY

Four pulse preamplifiers were irradiated in the north position of the GTR reactor facility from 13 through 19 May 1963. The preamplifiers were tested for approximately 100 hours of full power (3 mw) reactor operation at ambient temperatures ($\sim 200^{\circ}\text{F}$ at 3 mw).

The preamplifiers operated throughout the test with no significant detrimental effects of irradiation.

III. PURPOSE OF TEST

The purpose of this test was to determine the sensitivity of a neutron detector pulse preamplifier as a function of radiation dose rate and integrated flux. Of particular interest was the change in noise level as a function of nuclear environment.

IV. TEST ITEM DESCRIPTION

The tested pulse preamplifiers were designed by WANL. A schematic of the preamplifiers is presented in Figure 1.

V. RADIATION TEST DESCRIPTION

The preamplifiers were attached to a perforated aluminum sheet which was mounted on the reactor side of the liquid nitrogen dewar located in the north irradiation position of the test reactor (Figure 2). The preamplifiers remained in the irradiation position for 100 hours of 3 mw reactor operation.

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RADIATION EFFECTS TESTING

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System: Controls

Component: Fission Counter
Pulse Preamp

Test: 22/W006

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Noise was monitored in an oscilloscope and photographs of the traces were taken periodically throughout the test. Test input signals were applied to two of the preamplifiers, and the input and output traces were photographed simultaneously. Also, filament voltage and current, plate current, and temperature (air and component) were measured and recorded for each of the preamplifiers.

VI. TEST RESULTS

All four preamplifiers operated satisfactorily throughout the test. None were adversely affected by the irradiation. Table I indicates the filament voltage and current, plate current, and preamplifier temperatures recorded during pre- and postirradiation data cycles and during the first (A) and last (Z) 3 mw data cycles.

Preliminary dosimetry data indicated an integrated fast neutron flux ($E > 2.9$ Mev) of 4.4×10^{16} nvt and an integrated gamma flux of 1.6×10^{11} ergs/gm(C).

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RADIATION EFFECTS TESTING

Section No: 1.5.2.7.0

System: Controls

Component: Fission Counter
Pulse Preamp.

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TABLE I

Fission Counter Pulse Preamplifiers

*Temperatures (Recorder No. 1)

Preamp Test Stage	Filament		Plate Current (ma)	(°F)				
	Voltage (volts)	Current (amps)		Point 1	Point 2	Point 3	Point 4	Point 5
A	Pre	7.5	.96	12.7	75			
	3 MW-(A)	7.5	.98	13.9	160			
	3 MW-(Z)	7.5	1.0	14.0	234			
	Post	7.5	1.0	13.9	214			
B	Pre	7.5	.95	13.1	75	92	70	
	3 MW-(A)	7.5	.97	14.3	160	157	122	
	3 MW-(Z)	7.5	.98	14.2	234	252	196	
	Post	7.5	.98	14.0	214	244	182	
C	Pre	7.5	.94	11.9	75			
	3 MW-(A)	7.5	.97	13.2	160			
	3 MW-(Z)	7.5	.98	13.3	234			
	Post	7.5	.98	13.1	214			
D	Pre	-	.95	11.7	75		60	51
	3 MW-(A)	7.5	.97	13.0	160		120	100
	3 MW-(Z)	7.5	.98	13.0	234		200	165
	Post	7.5	.98	12.9	214		180	152

- * Point 1: Thermocouple sensing air temperature
 Point 2: Thermocouple attached to a resistor on Amplifier B
 Point 3: Thermocouple attached to a capacitor on Amplifier B
 Point 4: Thermocouple attached to a resistor on Amplifier D
 Point 5: Thermocouple attached to a capacitor on Amplifier D

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RADIATION EFFECTS TESTING

Section No: 1.5.2.7.0

System: Controls

Component: Fission Counter
Pulse Preamp.

Test: 22/W006

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Figure 1. Schematic Diagram Alt #1 Pulse Preamplifier GTR Test

- 4 * INPUT CIRCUITRY FOR PREAMP A & C ONLY
 3 FILAMENT VOLTAGE TO BE 6.3 VDC
 2 ALL CAPACITORS CORNING TYPE CGW-FM
 1 ALL RESISTERS IRC METAL FILM TYPE CEM COAT

NOTES

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NERVA
PROGRAM

RADIATION EFFECTS TESTING

Section No: 1.5.2.7.0

System: Controls

Component: Fission Count
Pulse Preamp.

Test: 22/W006

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Figure 2. Pulse Preamplifiers (right) and Electronic Components

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TEST 23/W002

ACCELEROMETERS

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RADIATION EFFECTS TESTING

Section No: 1.7.2.5.0

System: Instrument

Component: Accelerometers

Test: 23/W002

Date: May 1963

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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A.	TEST NUMBER	23/W002
B.	TEST DATES	13 through 19 May 19 1963
C.	TEST SPONSOR	WANL
D.	TEST FACILITY	GTR

II. SUMMARY

Ten accelerometers (four piezoelectric and six electro-mechanical) were irradiated within a liquid nitrogen dewar in the north irradiation position of GTR. The accelerometers were tested for approximately 100 hours of full power (3 mw) reactor operation

Because detonations occurred in and around the dewars following a reactor shut down to repair a faulty control rod, both dewars were purged with helium gas and cooled with gaseous nitrogen throughout the remainder of the test. This action resulted in a total of 4 hours and 37 minutes of 3 mw testing at liquid nitrogen temperature. The remaining hours of 3 mw testing were accomplished with the dewars cooled by gaseous nitrogen.

Because the test data is being analyzed to determine the combined low temperature and radiation environment effects on accelerometer performance, no definitive results can be presented. However, several of the accelerometers failed as a direct result of the detonations, as described in Section VI.

III. PURPOSE OF TEST

This test was conducted to evaluate the effects of a combined cryogenic and radiation environment on the operational parameters of NERVA candidate accelerometers.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.5.0

System: Instrument

Component: Accelerometers

Test: 23/W002

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IV. TEST ITEM DESCRIPTION

The following accelerometers were tested.

GROUP I. PIEZOELECTRIC

Quan.	Manufacturer	Model	Frequency Range	G Level	Excitation Voltage	Output
2	Endevco	2242MSA	5 to 4,000 cps	0 to 500	-	10 mv/g
2	Gulton	SA32401-142	5 to 6,000 cps	0 to 500	-	7.5 mv/g

GROUP II. ELECTRO-MECHANICAL

2	Physical Science	XT1A	50 to 500 cps	2 to 200	12 vdc	0.2 mv/g
2	Statham	A515	0 to 300 cps	<u>+25</u>	5 vdc	0.8 mv/g
2	Wiancko	AX40	0 to 125 cps	<u>+25</u>	28 vdc	0.2 mv/g

V. RADIATION TEST DESCRIPTION

Each accelerometer under test was mounted on a separate vibration generator consisting of an electromagnet and voice coil suspended from a flat plate by four spring mounted rods (Figure 1). The accelerometers were vibrated by applying a sinusoidal input to the voice coil. This input was supplied by an audio oscillator through a 200 watt amplifier. Each accelerometer was vibrated at several frequencies during a data cycle. The oscillator frequency was monitored by an EPUT meter.

At each test frequency, the electromagnet and voice coil currents were adjusted to provide the desired displacement. The accelerometer output indicated by a peak-to-peak voltmeter was recorded. Oscilloscope photographs were made of the voice coil input and the accelerometer output traces displayed simultaneously on an oscilloscope.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.5.0

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VI. TEST RESULTS

After approximately 100 hours of irradiation at full power (3 mw) only five of the original ten accelerometers were operating. In the remaining five, either there was no output or noise was excessive. Table I presents data recorded before irradiation, the 3 mw cycle just before the detonation, the first 3 mw cycle after the detonations, and the first postirradiation cycle. The notations "N.R." and "Data not Recorded" indicate either that there was no output or that noise was excessive.

Over 800 photographs were taken of the oscilloscope trace, voice coil inputs, and accelerometer outputs. These photographs are still being analyzed, so no conclusions can be reached at this time. However, in many instances, noise and transients presented problems.

All of the accelerometers, except the Wiancko units were postirradiation tested on a standard vibration table. The test of the Wiancko units was delayed pending solution of difficulties encountered with the amplifiers. Results of the tests of the other accelerometers were as follows:

Statham:	Neither of the two units was operative.
Endevco:	Both units were operative with very little change in sensitivity; results were very close to factory calibration.
Physical Sciences:	One unit was inoperative; the sensitivity of the other unit was considerably reduced.
Gulton:	Gulton No. 1 was essentially inoperative (low output at high g levels); the sensitivity of Gulton No. 2 was reduced.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.5.0

System: Instrument

Component: Accelerometers

Test: 23/W002

Date: May 1963

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TABLE I

Accelerometer Data

		E _{out} Peak-to-Peak (mv)				
		Frequency (~)				
<u>Instrument Test Stage</u>	<u>Temp.</u>	<u>50</u>	<u>200</u>	<u>750</u>	<u>1.5 k</u>	<u>3.0 k</u>
Endevco No. 1						
Pre	LN ₂	N.R.	250	300	N.R.	N.R.
3 MW(1)	LN ₂	1550	1500	1300	800	400
3 MW(2)	GN ₂	160	480	300	250	120
Post	GN ₂	Data not Recorded				
Endevco No. 2						
Pre	LN ₂	N.R.	280	520	460	168
3 MW(1)	LN ₂	1200	700	N.R.	N.R.	N.R.
3 MW(2)	GN ₂	60	360	72	38	30
Post	GN ₂	28	55	40	36	38

		E _{out} Peak-to-Peak (mv)					
		Frequency (~)					
<u>Instrument Test Stage</u>	<u>Temp.</u>	<u>50</u>	<u>100</u>	<u>200</u>	<u>300</u>	<u>400</u>	<u>500</u>
Wiancko No. 1							
Pre	LN ₂	270	260	360	420	510	N.R.
100 kw *	LN ₂	150	40	24	24	24	N.R.
Shutdown **	-	22	22	23	N.R.	N.R.	N.R.
Post	-	-	-	-	-	-	-
* 3 MW data not recorded (N.R.)							

* 3 MW data not recorded (N.R.)

** Data taken at "0" power after dewar difficulties

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		E _{out} Peak-to-Peak (mv)						
		Frequency (~)						
Instrument	Test Stage	Temp.	50	100	200	300	400	500
Wiancko No. 2								
	Pre	LN ₂	N.R.	210	210	240	250	N.R.
	3 MW(1)	LN ₂	520	510	900	400	140	70
	3 MW(2)	GN ₂	580	560	670	760	430	200
	Post	GN ₂	80	70	33	17	12.7	14.1
Physical Science No. 1								
	Pre	LN ₂	660	72	29	22	N.R.	N.R.
	3 MW(1)	LN ₂	700	90	32	28	26	N.R.
	3 MW(2)	GN ₂	205	340	32	8.4	26	28
	Post	GN ₂	290	230	47	37	44	50
Physical Science No. 2								
	Pre	LN ₂	91	90	34	20	N.R.	N.R.
	3 MW(1)	LN ₂	135	170	28	14	N.R.	N.R.
	3 MW(2)	GN ₂	24	22	22	22	22	22
	Post	GN ₂	N.R.	40	43	45	46	46
Statham No. 1								
	Pre	LN ₂	76	92	90	96	110	190
	3 MW(1)	LN ₂	40	32	25	40	55	65
	3 MW(2)	GN ₂	110	120	140	155	180	220
	Post		Data Not Recorded					
Statham No. 2								
	Pre	LN ₂	70	120	125	100	120	150
	3 MW(1)	LN ₂	45	25	40	45	50	60
	3 MW(2)	GN ₂	N.R.	100*	190	200	220	230
	Post		Data Not Recorded					

*I_{ac} = 0.5 for this entry only

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System: Instrument

Component: Accelerometer

Test: 23/W002

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Instrument Test Stage			E _{out} Peak-to-Peak (mv)				
			Frequency (~)				
			50	200	750	1.5 k	3.0 k
Gulton No. 1							
Pre	E ₁	LN ₂	N.R.	690	490	340	170
	E ₀			610	390	320	220
3 MW(1)	E ₁	LN ₂	N.R.	460	340	340	200
	E ₀			410	360	310	290
3 MW(2)	E ₁	GN ₂	5000	950	780	600	400
	E ₀		N.R.	N.R.	N.R.	N.R.	N.R.
Post	E ₁	Data Not Recorded (N.R.)					
	E ₀						
Gulton No. 2							
Pre	E ₁	LN ₂	N.R.	96	53	N.R.	N.R.
	E ₀			280	150	N.R.	N.R.
3 MW(1)	E ₁	LN ₂	N.R.	N.R.	N.R.	N.R.	N.R.
	E ₀			120	130	68	N.R.
3 MW(2)	E ₁	GN ₂	N.R.	5.4	12.8	4.56	13.2
	E ₀			27.3	84	26	47
Post	E ₁	GN ₂	66	100	260	115	110
	E ₀		50	400	380	190	240

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NERVA
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RADIATION EFFECTS TESTING

Section No: 1.7.2.5.0

System: Instrument

Component: Accelerometer

Test: 23/W002

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The Statham, Physical Sciences, and Gulton accelerometers were disassembled following the postirradiation vibration table test. In one of the two Statham units, the strain wire was broken in all four legs; in the other, the strain wire was broken in two of the four legs. The damage in these accelerometers is attributed to shock caused by the detonations.

The inoperative Physical Science unit had some foreign material in the dynamic mass area. This material caused the unit to "hang up." After being cleaned, the unit was operative. The other Physical Science unit, whose output decreased, contained a smaller amount of foreign matter. Cleaning this unit improved its operation.

Capacitance measurements of Gulton No. 1 were approximately the same as the preirradiation values. When disassembled, fracture of the conductor insulation and deterioration of the bond between the element and its armature were indicated. This accelerometer had operated satisfactorily until the detonations occurred, after which it became noisy and erratic.

Capacitance measurements of Gulton No. 2 showed a 20 percent reduction from the original values. The ceramic material used in this unit was a different type than that used in Gulton No. 1. This unit operated with reduced sensitivity after the detonations occurred.

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System: Instrument

Component: Accelerometer

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Figure 1. Accelerometer and LVDT Test Setup

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TEST 23/W102

RESISTANCE THERMOMETERS

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RADIATION EFFECTS TESTING

Section No: 1.7.2.2.0

System: Instrument

Component: Resistance Thermometers

Test: 23/W102

Date: May 1963

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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A.	TEST NUMBER	23/W102
B.	TEST DATES	13 through 19 May 1963
C.	TEST SPONSOR	WANL
D.	TEST FACILITY	GTR

II. SUMMARY

Two Winsco No. 2534 and three Engelhard No. 30707-A resistance thermometers were irradiated in a liquid nitrogen dewar in the east irradiation position of GTR. The resistance temperature thermometers (RTT) were tested for approximately 100 hours of full power (3 mw) reactor operation.

Because detonations occurred in and around the dewars following a reactor shut down to repair a faulty control rod, both dewars were purged with helium gas and cooled with gaseous nitrogen throughout the remainder of the test. This resulted in a total of 4 hours and 37 minutes of 3 mw testing at liquid nitrogen temperature. The remaining hours of 3 mw testing were accomplished with the dewar cooled by gaseous nitrogen.

Both Winsco thermometers failed, one showing evidence of failure immediately following the detonations, and the other failing later. Both failures were open circuits. The three Engelhard thermometers operated throughout the test.

III. PURPOSE OF TEST

This test was conducted to determine the operational parameters of NERVA candidate resistance thermometers under a combined cryogenic and radiation environment.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.2.0

System: Instrument

Component: Resistance
Thermometers

Test: 23/W102

Date: May 1963

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IV. TEST ITEM DESCRIPTION

Two Winsco No. 2534 and three Engelhard No. 30707-A (platinum) resistance thermometers were tested.

V. RADIATION TEST DESCRIPTION

The resistance thermometers were mounted on the WANL strain test fixture (Figure 1). The Winsco RTT's were attached to the outside of the cylindrical pan at the bottom of the fixture. The Engelhard RTT's were installed near the bottom of a tube which projected downward from the top part of the fixture. A thermocouple was attached with Fiberglas tape to the sensing element of each Winsco thermometer. Two thermocouples were attached to the tube in which the Engelhard thermometers were installed.

The electrical schematic of the resistance thermometer test setup is presented in Figure 2. Voltages were measured with a digital voltmeter and the resistance of each thermometer was calculated by:

$$(R_{RTT}) = \frac{E_{n2}}{E_{n1}} R_{n1}$$

(n = 1, 2, 3, 4, 5).

Leakage resistances were measured with an ohmmeter. Thermocouple readings were recorded with each data cycle.

VI. TEST RESULTS

Resistance thermometer data recorded during four of the data cycles are shown in Table I. The data includes a preirradiation cycle at liquid nitrogen temperatures, the last 3 mw cycle before the detonations (3 mw-1), the first 3 mw cycle following the detonations (3 mw-2), and a postirradiation cycle.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.2.0

System: Instrument

Component: Resistance
Thermometers

Test: 23/W102

Date: May 1963

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TABLE I

Resistance Thermometer Data

Component	Test Stage	Temp (°F)	Leakage Resistance (Megohms)	R.T.T Resistance (ohms)
R T T No. 1	Pre	-321	1	97.17
	3 MW-(1)	-330	1.6	96.99
	3 MW-(2)	-110	< 0.1	--*
	Post	-144	440	--*
* Component Failed				
R T T No. 2	Pre	-321	8000	92.25
	3 MW-(1)	-330	2.6	97.51
	3 MW-(2)	-107	1.9	341.74
	Post	-141	400	--*
R T T No. 3	Pre	-328	8000	19.95
	3 MW-(1)	-342	3.9	20.08
	3 MW-(2)	-116	2.4	71.54
	Post	-118	450	70.26
R T T No. 4	Pre	-329	6000	19.87
	3 MW-(1)	-342	4.5	20.38
	3 MW-(2)	-119	2.6	71.47
	Post	-119	380	70.47
R T T No. 5	Pre	-328	9000	19.79
	3 MW-(1)	-	3.8	20.29
	3 MW-(2)	-115	2.4	71.72
	Post	-119	350	70.16

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RADIATION EFFECTS TESTING

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System: Instrument

Component: Resistance
Thermometers

Test: 23/W102

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The two Winsco resistance thermometers failed during the test. Winsco No. 1 showed an open circuit immediately after the detonations, and failure is attributed to this cause. Winsco No. 2 failed later. Postirradiation investigation showed that Winsco No. 1 was broken at the point where it was mounted on the test fixture. Postirradiation resistance of Winsco No. 2 was 560 ohms, however, very light pressure at the point where the thermometer attached to its mount produced an intermittent open. Winsco No. 2 may have been damaged during the detonations. Both of the reference thermocouples which had been attached to the Winsco RIT's were loose and dangling when the dewar was opened following the test.

The three Engelhard resistance thermometers operated satisfactorily throughout the test and apparently were not affected. However, before definite conclusions can be drawn, the data must be analyzed to evaluate the change in test conditions resulting from the switch from liquid nitrogen to gaseous nitrogen following the dewar detonations.

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Section No: 1.7.2.2.0

System: Instrument

RADIATION EFFECTS TESTING

Component: Resistance
Thermometers

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Figure 2. Resistance Temperature Detectors Wiring Diagram

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RADIATION EFFECTS TESTING

Section No: 1.7.2.2.0

System: Instrument

Component: Resistance Thermometer

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Figure 1. Strain Gage Fixture
with Resistance Thermometer Attached

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TEST 23/W201

LINEAR VELOCITY DISPLACEMENT TRANSDUCER

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RADIATION EFFECTS TESTING

Section No: 1.7.2.5.0

System: Instrument

Component: Linear velocity Displacement Transducers

Test: 23/W201

Date: May 1963

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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A. TEST NUMBER	23/W201
B. TEST DATES	13 through 19 May 1963
C. TEST SPONSOR	WANL
D. TEST FACILITY	GTR

II. SUMMARY

Two Physical Sciences Corp. linear velocity displacement transducers (LVDT) and the accelerometers (test 23/W002) were irradiated within a liquid nitrogen dewar in the north irradiation position of GTR. The LVDT's were tested for approximately 100 hours of full power (3 mw) reactor operation.

Because the detonations occurred in and around the dewars following a reactor shut down to repair a faulty control rod, both dewars were purged with helium gas and cooled with gaseous nitrogen throughout the remainder of the test. This action resulted in a total of 4 hours and 37 minutes of 3 mw testing at liquid nitrogen temperatures. The remaining hours of 3 mw testing were accomplished with the dewars cooled by gaseous nitrogen.

The test data is still being analyzed, therefore, no definite results can be presented at this time. One of the transducers failed completely following the detonations. The other failed after the detonations, but recovered later.

III. PURPOSE OF TEST

This test was performed to determine the operational parameters of NERVA candidate LVDT's under a combined cryogenic, vibration, and radiation environment. This test was conducted in conjunction with accelerometer test 23/W002 to measure displacement of the accelerometer vibration "shaker table."

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RADIATION EFFECTS TESTING

Section No:	1.7.2.5.0
System:	Instrument
Component:	Linear Velocity Displacement Transducer
Test:	23/W201
Date:	May 1963
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IV. TEST ITEM DESCRIPTION

Two Physical Sciences Corp. model TIA. 100 HTR LVDT's were tested.

V. RADIATION TEST DESCRIPTION

Each LVDT was mounted on a separate shaker table. The shaker table consisted of an electromagnet and voice coil suspended from a flat plate by four spring mounted rods (Figure 1). The LVDT's were vibrated by applying a sinusoidal input to the voice coil. This input was supplied by a 200 watt amplifier; the signal frequency was obtained from an audio oscillator. Each LVDT was vibrated at several frequencies during a data cycle. The frequency of the oscillator was monitored by an EPUT meter.

At each test frequency, the electromagnet and voice coil currents were adjusted for the desired displacement. The LVDT output indicated on a peak-to-peak voltmeter was recorded. Oscilloscope photographs were made of the voice coil input, and the LVDT output traces were displayed simultaneously on an oscilloscope.

VI. TEST RESULTS

Table I presents data recorded before irradiation, the 3 mw cycle just before the detonations, the first 3 mw cycle after the detonations, and the first post-irradiation cycle.

The input-output photographs are being studied, and no definite conclusions can be presented at this time. One LVDT failed following the detonations.

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System: Instrument

Component: Linear Velocity Displacement Transducers

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TABLE I

Sample LVDT Outputs

Instrument	Test Stage	Temp	E _{out} Peak-to-Peak (mv)				
			Frequency				
			50	200	750	1.5K	3.GK
LVDT No. 1	Preirrad.	LN ₂	N.R.	70	N.R.	N.R.	N.R.
	3 mw (1)	LN ₂	N.R.	50	25	26	N.R.
	3 mw (2)	GN ₂	N.R.	N.R.	N.R.	N.R.	N.R.
	Postirrad.	GN ₂	N.R.	N.R.	N.R.	N.R.	N.R.
LVDT No. 2	Preirrad.	LN ₂	N.R.	24	7.8	N.R.	N.R.
	3 mw (1)	LN ₂	450	25	N.R.	N.R.	N.R.
	3 mw (2)	GN ₂	N.R.	N.R.	N.R.	N.R.	N.R.
	Postirrad.	GN ₂	700	260	26	N.R.	N.R.

N.R. indicates data that is not recorded.

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Test: 23/W201

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Figure 1. Accelerometer and LVDT Test Setup

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TEST 23/W402

STRAIN GAUGES

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RADIATION EFFECTS TESTING

Section No: 1.7.2.4.0

System: Instrument

Component: Strain Gauges

Test: 23/W402

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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A.	TEST NUMBER	23/W402
B.	TEST DATES	13 through 19 May 1963
C.	TEST SPONSOR	WANL
D.	TEST FACILITY	GTR

II. SUMMARY

Twelve Microdot SS-E-6A strain gauges were irradiated in a liquid nitrogen dewar in the east irradiation position of GTR. The strain gauges were tested for approximately 100 hours of full power (3 mw) reactor operation.

Because detonation occurred in and around the dewars following a reactor shutdown to repair a faulty control rod, both dewars were purged with helium gas and cooled with gaseous nitrogen throughout the remainder of the test. This action resulted in a total of 4 hours and 37 minutes of 3 mw testing at liquid nitrogen temperatures. The remaining hours of 3 mw testing were accomplished with the dewar cooled by gaseous nitrogen.

Before the detonations occurred, all of the gauges indicated strains within 4 percent of the preirradiation run. Following the detonations, one of the circuits (two gauges per circuit) showed no strain output, and several other circuits intermittently read incorrectly. The latter symptom was attributed to freezing of moisture on the gauges and bellows, because the affected gauges indicated within 4 percent of a postirradiation run when the dewar was warmed to ambient temperature. Both gauges in the circuit that failed completely were broken.

III. PURPOSE OF TEST

This test was performed to determine operational parameters of NERVA candidate strain gauges under a combined cryogenic and radiation environment.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.4.0

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Component: Strain Gauges

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IV. TEST ITEM DESCRIPTION

Twelve Microdot SS-E-6A strain gauges were mounted in pairs on the six tapered beams of a WANL designed strain gauge tester. (See Figure 1, a post-irradiation photograph.)

V. RADIATION TEST DESCRIPTION

The Microdot strain gauges were mounted on the tapered beams of the WANL strain gauge tester. The beams were deflected against fixed stops by applying helium gas pressure to the six bellows of the test fixture (Figure 1).

The strain data were recorded automatically on a strip chart recorder and manually from a strain indicator. The gauge resistances were measured with a digital ohmmeter. Insulation resistances to the test fixture were measured with an ohmmeter.

VI. TEST RESULTS

Before the dewar detonations, all gauges indicated strains within 4 percent of the preirradiation run. Following the detonations, no output was present on circuit 3. A resistance check indicated an open across the top gauge on the beam, and five ohms across the bottom gauge of the beam. No further data were obtained from this gauge during the run. Postirradiation examination revealed that both gauges were broken.

Strain gauge circuit 2 indicated zero resistance to ground immediately following the detonations, but later recovered insulation resistance and operated properly. Circuits 1, 4, 5, and 6 checked out electrically and showed no indications of detrimental effects resulting from the detonations.

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RADIATION EFFECTS TESTING

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System: Instrument

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Test: 23/W402

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Further operation with gaseous nitrogen presented problems with circuits 6 and 4, both of which showed intermittent drops in output. Freezing moisture on the bellows or on the gauges was probably the cause. When the dewar was warmed up for the postirradiation data cycle at ambient temperature, all strain measurements except beam 3 were within 4 percent of those recorded in the preirradiation run.

Table I presents sample data recorded throughout the test. Cycle 3M (1) was recorded before the detonations, 3M (2) was recorded after.

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Section No: 1.7.2.4.0

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RADIATION EFFECTS TESTING

System: Instrument

Component: Strain Gauge

Test: 23/W402

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TABLE I

WANL Strain Gauge Data

Test Stage	Strain Output μ inches/inch			Temp. Thermocouple Readings ($^{\circ}$ F)				
	Avg.	Range	N+	No. 11	No. 12	No. 13	No. 14	
Pre	1342	1191 - 1501	6	LN ₂				
3 MW - (1)	1348	1193 - 1493	6	LN ₂				
3 MW - (2)	1386	1276 - 1580	5	-55	-63	-50	-45	
Post	779	59 - 1447	5	-122	-124	-114	-105	

Insulation Resistances
WANL Strain Gauge

Test Stage	Resistance (ohms)			N+
	Avg.	Range		
Pre	932	460 - 1250		6
3 MW - (1)	2.5	0.1 - 3.4		6
3 MW - (2)	2.4	1.6 - 4.0		5
Post	129	88 - 160		6

Resistance Measurements
WANL Strain Gauge

Test Stage	Resistance (ohms)			N+
	Avg.	Range		
Pre T*	121.6	119.9 - 123.4		6
B	121.4	119.5 - 124.2		6
3 MW (A)				
(1) T	122.4	120.3 - 124.0		6
B	122.2	120.9 - 125.0		6
3 MW T	122.4	120.5 - 124.0		5
(2) B	122.6	120.4 - 125.4		5
Post T	122.7	120.8 - 124.4		5
B	123.1	120.4 - 127.5		5

* T = Beam Top
B = Beam Bottom

(A) Slight trouble with
No. 4 beam values

+ N indicates the number of
gage circuits utilized
in determining the average
values, i.e., number of
operative gage circuits.

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RADIATION EFFECTS TESTING

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System: Instrument

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Figure 1. Strain Gage Fixture
with Resistance Thermometer Attached

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TEST 23/W502

PRESSURE TRANSDUCERS

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RADIATION EFFECTS TESTING

Section No: 1.7.2.1.0

System: Instrument

Component: Pressure
Transducers

Test: 23/W502

Date: May 1963

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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A. TEST NUMBER	23/W502
B. TEST DATES	13 through 19 May 1963
C. TEST SPONSOR	WANL
D. TEST FACILITY	GTR

II. SUMMARY

Seven pressure transducers were irradiated in a liquid nitrogen dewar in the east irradiation position of the GTR. The transducers were tested for approximately 100 hours of full power (3 mw) reactor operation.

Figure 1 shows the pressure transducers mounted to the left of the bearing and strain gauge testers.

Because detonations occurred in and around the dewars following a reactor shutdown to repair a faulty control rod, both dewars were purged with helium gas and cooled with gaseous nitrogen throughout the remainder of the test. This action resulted in a total of 4 hours and 37 minutes of 3 mw testing at liquid nitrogen temperature. The remaining hours of 3 mw testing were accomplished with the dewar cooled by gaseous nitrogen.

Only three of the transducers were operative at the end of the test (0 to 100 psid CEC, 0 - 3 psid CCC, and 0 - 125 psid Wiancko). The pressure lines received rough handling when the dewars were withdrawn from the irradiation position for examination following the detonations. The extent of detonation and rough handling of pressure lines as causes of transducer failures has not been determined.

III. PURPOSE OF TEST

This test was conducted to determine operational parameters of NERVA candidate pressure transducers.

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IV. TEST ITEM DESCRIPTION

The types and ranges of pressure transducers tested are listed below

CEC	0 to 350 psia (DC)
CEC	0 to 100 psid (DC)*
Statham	0 to 25 psia (DC)
Statham	0 to 50 psid (DC)*
CCC	0 to 3 psid (AC)*
Wiancko	0 to 750 psia (AC)
Wiancko	0 to 125 psid (AC)*

*Differential transducer

V. RADIATION TEST DESCRIPTION

The pressure transducers were irradiated in the east reactor position, and were mounted to the dewar lid as indicated in Figure 1. Controlled helium pressure was supplied individually to each of the transducers. During a data cycle, pressure was applied in ten increments covering the range of the transducer, then was decreased in ten increments. At each point, the transducer output was observed on a digital voltmeter.

VI. TEST RESULTS

Only three of the pressure transducers were operative at the end of the test. These were CEC No. 2 (0-100 psid), CCC (0-3 psid), and Wiancko No. 2 (0-125 psid). Transducer outputs recorded during four data cycles are listed in Table I. The four data cycles include the last preirradiation cycle (at LN₂ temperature), the last 3 Mw cycle that was recorded before the detonation occurred in the east dewar, the first cycle recorded after operation was resumed at 3 Mw, and the first postirradiation cycle. Internal resistances of the transducers measured before and after the test are presented in Table II.

It is not known to what extent the pressure transducer failures can be attributed to the detonations in the dewar - either directly, or as a result of possible damage to pressure lines and signal leads when the dewar was withdrawn from the irradiation cell for examination. Since the dewar was highly

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radioactive, special care could not be given to the handling of the lines and leads during movement of the system out of, and back into, the irradiation cell. Before the detonations occurred, all of the transducers were operative, although Statham No. 2 was becoming erratic. After the detonations, only three of the transducers operated satisfactorily.

Postirradiation resistance measurements made at the pins on the Statham transducers indicated that all pins were open. There were no shorts to the case. The units were disassembled for inspection. It was found that the strain wire was broken in all four legs of both units. Shock resulting from the detonation is considered to be the cause of these failures.

CEC No. 1 (0-350 psia) operated satisfactorily until the detonations occurred, then it failed to respond. After being returned to the irradiated materials lab, instrumentation and pressure lines were connected to this unit and it was pressure cycled in the same manner as during the test. The data obtained were identical to preirradiation values. Lack of response of this unit during the test is attributed to failure of the cable assembly attached to the transducer. Disassembly of the transducer revealed no internal radiation damage.

CEC No. 2, which had operated throughout the test, was also pressure cycled in the IML with satisfactory results. This unit was not disassembled. It is being retained for further testing, if desired.

The CCC transducer operated successfully throughout the test. On the last day of the test a slight leak was noted. It is believed that this leak was in the pressure system. After the test, the transducer was pressurized to 3 psi and checked for leaks with leak detector fluid. None were detected - either externally or through the diaphragm from the pressure port. The unit was disassembled for inspection. All internal parts appeared normal except that the stainless-steel core showed some signs of oxidation. This core is on the reference pressure side which was open to the atmosphere throughout the test. Postirradiation pin-to-pin resistance measurements indicated no significant change from the "as-built" values.

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RADIATION EFFECTS TESTING

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The Wiancko pressure transducers are to be pressure cycled and disassembled for inspection. These efforts will be completed as soon as the necessary carrier amplifiers are received.

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RADIATION EFFECTS TESTING

Component: Pressure
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TABLE I

Pressure Transducer Data

(CEC No. 1 (0-350 psia))

Desired Pressure (psi)	Pre Output (volts)	3 Mw-(1) Output (volts)	3 Mw-(2) Output (volts)	Post Output (volts)
0 INC	-.001	.000	.009	Unstable at 1.06 Will not follow pressure changes
DEC			.020	
35 INC	-.000	.001	.016	
DEC	+.000	.002	.022	
70 INC	.002	.003	.018	
DEC	.002	.004	.025	
105 INC	.004	.005	.020	
DEC	.004	.006	.025	
140 INC	.006	.007	.020	
DEC	.008	.008	.023	
175 INC	.009	.009	.017	
DEC	.010	.011	.025	
210 INC	.011	.011	.023	
DEC	.012	.011	.028	
245 INC	.013	.013	.025	
DEC	.014	.015	.028	
280 INC	.015	.015	.028	
DEC	.016	.017	.028	
315 INC	.017	.018	.031	
DEC	.018	.019	.033	
335	.018	.019	.033	

CEC No. 2 (0-100 psid)

600 INC	.002	.002	-.262	.001
DEC			-.284	.000
610 INC	.004	.003	-.263	.003
DEC	.003	.004	-.280	.003
620 INC	.006	.005	-.283	.005
DEC	.005	.006	-.280	.005
630 INC	.008	.007	-.276	.007
DEC	.007	.008	-.275	.005
640 INC	.010	.009	-.275	.008
DEC	.010	.010	-.290	.007
650 INC	.012	.011	-.266	.010
DEC	.011	.011	-.265	.010
660 INC	.014	.013	-.267	.012
DEC	.013	.013	-.266	.010 (1)
670 INC	.016	.016	-.265	.014 (1)
	.015	.015	-.265	.013
680 INC	.019	.018	-.273	.016
DEC	.017	.017	-.269	.016
690 INC	.021	.020	-.270	.018
DEC	.020	.020	-.260	.019
700	.023	.022	-.264	.019
Temp. (P _T 16, R ₂)	326°F	-328°F	-100°F	-148°F

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System: Instrument

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TABLE 1 (cont.)

Desired*		CCC (0-3 PSID)			
Pressure		Pre	3 MW-(1)	3 MW-(2)	Post
(psi)		Output	Output	Output	Output
		(volts)	(volts)	(volts)	(volts)
0	INC	.183	0.190	0.223	.030
	DEC				.024
.5	INC	.200	.202	.240	.050
	DEC	.199	.203	.240	.047
1.0	INC	.217	.220	.258	.080
	DEC	.217	.220	.257	.073
1.5	INC	.234	.238	.277	.097
	DEC	.235	.239	.276	.096
2.0	INC	.252	.256	.294	.119
	DEC	.251	.256	.294	.117
2.5	INC	.268	.273	.312	.143
	DEC	.270	.273	.313	.142
3.0	INC	.287	.292	.331	.167

Statham No. 1 (0-25 PSIA)

2.5	INC	-.003	.003	Erratic	No data recorded.
	DEC	-.003	.003	readings.	
5.0	INC	-.001	.001	Voltmeter	
	DEC	-.001	.001	won't	
7.5	INC	-.001	.000	settle	
	DEC	.000	.000	down.	
10.0	INC	+.001	.001	Low	
	DEC	.002	.002	resistance	
12.5	INC	.003	.003	on	
	DEC	.004	.004	connector.	
15.0	INC	.004	.005		
	DEC	.004	.004		
17.5	INC (1)	.006 (1)	.007		
	DEC	.006	.006		
20.0	INC	.008	.008		
	DEC	.008	.008		
22.5	INC	.009	.010		
	DEC	.011	.010		
25.0		.011 (2)	.011		

(1) 18.0
(2) 24

*Actual pressures are same as desired pressures except when noted.

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RADIATION EFFECTS TESTING

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System: Instrument

Component: Pressure
Transducer

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TABLE I (cont.)

Statham No. 2 (0-50 psid)

Desired Pressure (psi)	Pre Output (volts)	3 Mw-(1) Output (volts)	3 Mw-(2) Output (volts)	Post Output (volts)
605 INC	.000	.823	-1.090	Disconnected. Affecting other transducers.
DEC	.000	.861 (3)	-1.043	
610 INC	.004	N.R.	-1.089	
DEC	.004	.864	-1.043	
615 INC	.007	N.R.	-1.088	
DEC	.006	.862 (4)	-1.075	
620 INC	.011	.833	-1.087	
DEC	.010	N.R.	-1.065	
625 INC	.015	N.R.	-1.082	
DEC	.013	.873	-1.036	
630 INC	.018	.838	-1.080	
DEC	.019	.869	-1.037	
635 INC	.022	.842 (5)	-1.077	
DEC	.022(1)	.873	-1.039	
640 INC	.026(2)	.848	-1.069	
DEC	.025	.876	-1.038	
645 INC	.029	.850 (6)	-1.063	
DEC	.030	.874 (7)	N.R.	
650	.033	.853	-1.061	
Temp.	-325°F	-337°F	-80°F	
		(1) 634	(5) 636	
		(2) 641	(6) 644	
		(3) 602	(7) 644	
		(4) 616		

Wiancko No. 1 (0-750 psia)

75 INC	0.712	0.684	0.033	Stable at 0.017. Will not follow pressure changes.
DEC	0.705	0.683	0.011	
150 INC	1.194	1.171	0.033	
DEC	1.194	1.173	0.015	
225 INC	1.680	1.660	0.033	
DEC	1.682	1.629 (1)	0.015	
300 INC	2.162	2.157 (2)	0.033	
DEC	2.160	2.143	0.015	
375 INC	2.633	2.617	0.033	
DEC	2.637	2.616	0.015	
450 INC	3.111	3.095	0.021	
DEC	3.114	3.096	0.015	

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RADIATION EFFECTS TESTING

Section No: 1.7.2.1.0
 System: Instrument
 Component: Pressure Transducer
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TABLE I (cont.)

Wiancko No. 1 (cont.)

Desired Pressure (psi)	Pre Output (volts)	3 Mw-(1) Output (volts)	3 Mw-(2) Output (volts)	Post Output (volts)
525 INC	3.575	3.564	0.020	
DEC	3.577	3.561	0.015	
600 INC	4.041	4.033	0.020	
DEC	4.046	4.031	0.015	
675 INC	4.510	4.498	0.015	
DEC	4.512	4.438 (3)	0.015	
735	4.881	4.872	0.015	
0	0.220	0.190	0.011	
Temp.	-325°F	-342°F	-100°F	-84°F _L
(1) 220		(2) 303	(3) 665	

Wiancko No. 2 (0-125 psid)

600 INC	0.180	0.092	0.055	0.048
DEC		0.097		0.350
612.5 INC	0.602	0.857(3)	0.585	0.702(7)
DEC	0.686	0.865	0.880	0.806
625 INC	1.094	1.338	1.222	1.201
DEC	1.048(1)	1.550	1.113(6)	1.282
637.5 INC	1.424	1.909	1.748	1.853(8)
DEC	1.635	2.019	1.823	1.891
650 INC	2.100	2.468	2.270	2.253
DEC	2.052	2.501	2.862	2.301
662.5 INC	2.627	2.926	2.821	2.689
DEC	2.623	2.987	2.835	2.806
675 INC	3.049	3.426	3.294	3.101
DEC	3.007(2)	3.453	3.320	3.310
687.5 INC	3.530	3.907	3.791	3.589
DEC	3.565	3.922	3.822	3.6
700 INC	3.974	4.395(4)	4.240	4.218
DEC	3.994	4.390	4.170	4.209
712.5 INC	4.482	4.828	4.839	4.690
DEC	4.503	4.812(5)	4.730	4.651
725	4.922	5.316	5.370	5.170
(1) 623		(5) 712		
(2) 674		(6) 620		
(3) 614		(7) 614		
(4) 701		(8) 640		

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**NERVA
PROGRAM**
RADIATION EFFECTS TESTING**Section No:** 1.7.2.1.0**System:** Instrument**Component:** Pressure
Transducer**Test:** 23/W502**Date:** May 1963**Page** 9 **of** 10TABLE II

Pressure Transducer Resistance Readings

		<u>Reading</u>		<u>Resistance (ohms)</u>	
		<u>Points</u>		<u>Pre</u>	<u>Post</u>
CEC No. 1	Typical circuit for CEC No. 1 and CEC No. 2	A - B		268.2	278
		A - E		272.2	280
		A - D		356.9	360
		B - E		357.2	355
		B - D		263.9	262
		E - D		267.7	262
CEC No. 2 (psid)		A - B		266.3	270
		A - E		268.3	270
		A - D		355.5	356
		B - E		355.8	358
		B - D		265.6	270
		E - D		267.4	270
Statham No. 1 (0-25 psia)	Typical circuit for Statham No. 1 and No. 2	A - B		250.2	45,000
		A - C		249.2	35,000
		A - D		335.7	40,000
		B - C		314.4	50,000
		B - D		345.7	45,000
		C - D		237.2	155
Statham No. 2 (psid)		A - B		272.0	5,500
		A - C		270.3	6,200
		A - D		256.8	13,000
		B - C		344.3	12,000
		B - D		262.3	12,000
		C - D		259.7	342
Wiancko No. 1 (psia)	Typical circuit for Wiancko No. 1 and No. 2	A - B		7.1	7.3
		A - C		14.0	14.3
		B - C		7.0	7.3
Wiancko No. 2 (psid)		A - B		7.2	7.3
		A - C		13.8	14.1
		B - C		7.0	7.3

Note: On CCC only Post Resistance was recorded.

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RADIATION EFFECTS TESTING

Section No: 1.7.2.1.0

System: Instrument

Component: Pressure Transducer

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Figure 1. WANL Strain Gages,
RTT's Bearing Tester and Pressure Transducers

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TEST 31/W011

ELECTRICAL COMPONENTS

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RADIATION EFFECTS TESTING

Section No: 1.5.2.7.0

System: Controls

Component: Electronic
Components

Test: 31/W011

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PRELIMINARY TEST REPORTI. TEST IDENTIFICATION

A. TEST NUMBER 31/W011

B. TEST DATES 13 through 19 May 1963

C. TEST SPONSOR WANL

D. TEST FACILITY GTR

II. SUMMARY

A total of 144 precision metal film resistors, 84 capacitors, 3 Raychem tricoaxial cables, and two Raychem coaxial cables were mounted on an aluminum frame on the reactor side of the north dewar (outside the dewar). The components were irradiated for approximately 100 hours of full power (3 mw) reactor operation.

A comparison of pre- to postirradiation average values for the resistors indicated resistance deviations from -5 percent to +9 percent. The average change in capacitance values of the capacitors ranged from -14.5 percent to +1.3 percent from pre- to postirradiation measurements. The cables indicated no detrimental effects resulting from irradiation. A more thorough analysis of the changes incurred by each component is being performed.

III. PURPOSE OF TEST

This test was conducted to determine the change in the characteristics of resistors and capacitors, which are to be used in the flight-type neutron detector pulse preamplifier, as a function of dose rate and integrated dose. Also, several cables were tested to determine the magnitude of radiation-induced currents.

IV. TEST ITEM DESCRIPTION

The following items were tested:

Component	Mfg.	Type	100 ohm	1K	10K	100K	1 Meg.
Resistors	IRC	CEC (M-Coat)	10	10	10	10	10
Resistors	Weston	9855-4	9	10	10	8	10
Resistors	Daven	DA-2C	10	10	10	7	10

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Component	Mfg.	Type	Dielectric	100 μ f	1000 μ f	10,000 μ f
Capacitors	Corning	CYFM	10 (500 vdc)	10 (300 vdc)	10 (300 vdc)	10 (300 vdc)
Capacitors	Elmenco	DM	10 (500 vdc)	10 (500 vdc)	10 (500 vdc)	10 (500 vdc)
Capacitors	Vitramon	VK	4 (200 vdc)	4 (200 vdc)	4 (200 vdc)	4 (200 vdc)
Triax Cables	Raychem	42-179				
Triax Cables	Raychem	42-195				
Coax Cables	Raychem	32-195				

Figure 1 shows the components mounted on a pallet in front of the liquid nitrogen dewar.

V. RADIATION TEST DESCRIPTION

The components were mounted on an aluminum frame that was placed on the reactor side of the dewar in the north irradiation position. They were irradiated for approximately 100 hours of 3 mw reactor operation.

Test data on the resistors were recorded automatically using a General Dynamics (GD/FW) programmed test controller and a digital voltmeter and printer. Measurements were made while the resistors (except the one-megohm resistors) were dissipating their full-rated wattage (1/2 watt). The one-megohm resistors were measured with their full rated voltage (350 v) applied.

The capacitances of the 100 μ f and 1000 μ f capacitors were measured by a capacitance tester. The 10,000 μ f capacitors were measured with an automatic capacitance bridge. Leakage current, with full rated voltage applied, was measured with an amplifier and dectrameter. Leakage resistances were calculated from the leakage current values.

Tests of the coaxial and triaxial cables consisted of measuring the leakage current between the center conductor and the shield. The voltage on the cables was increased in increments up to 80 volts, then the polarity was reversed and the voltage was stepped down.

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VI. TEST RESULTS

Comparison of the pre- and postirradiation average values for the resistors and capacitors indicate the overall percentage changes shown in Table I. The cables showed no significant change throughout the test.

A more precise analysis of the performance of each component throughout the test is being performed.

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TABLE I

31/W011

Resistors:

	<u>100 ohm</u>	<u>1 k ohm</u>	<u>10 k ohm</u>	<u>100 k ohm</u>	<u>1 Megohm</u>
Daven	+3.8%	-2.6%	-4.7%	-5.1%	-8.7%
IRC	+4.6%	+2.7%	+0.6%	+0.1%	-4.6%
Weston	+5.0%	+1.7%	+6.0%	+1.4%	-4.5%

Capacitors:

	<u>100 μf</u>	<u>1000 μf</u>	<u>10,000 μf</u>
Corning			
Coax	+1.3	+0.3	
Shielded wire		-3.5	+0.4
Elmenco			
Coax	-9.2	-8.7	
Shielded wire		-13.8	-0.8
Vitramon (molded)			
Coax	-1.0	-5.4	-3.6
Shielded Wire			
Vitramon (epoxy)			
Coax	-2.2	-1.6	
Shielded wire			-14.5

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**NERVA
PROGRAM**

RADIATION EFFECTS TESTING

Section No: 1.5.2.7.0

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Component: Electronic
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Test: 31/W011

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Figure 1. Electronic Components and Preamplifiers
Mounted on Aluminum Frame in Front of LN₂ Dewar

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TEST 40/W001/2

CONTROL DRUM BEARING

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RADIATION EFFECTS TESTING

Section No: 1.2.2.1.0

System: Reactor

Component: Control Drum
Bearing

Test: 40/WOOL/2

Date: May 1963

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PRELIMINARY TEST REPORT

I. TEST IDENTIFICATION

A. TEST NUMBER	40/WOOL/2
B. TEST DATES	13 through 19 May 1963
C. TEST SPONSOR	WANL
D. TEST FACILITY	GTR

II. SUMMARY

A NERVA control drum bearing was impact tested in a liquid nitrogen dewar in the east irradiation position of the GTR. The bearing was irradiated for approximately 100 hours of full power (3 mw) reactor operation.

The impact plunger of the bearing tester was actuated 6,085 times during the test. The bearing suffered no apparent damage.

III. PURPOSE OF TEST

This test was conducted to determine the ability of the control drum bearing to withstand high axial forces in a combined cryogenic and radiation environment.

IV. TEST ITEM DESCRIPTION

One NERVA control drum bearing (No. 206 ball bearing) was tested.

V. RADIATION TEST DESCRIPTION

The test fixture consisted of a solenoid actuated plunger designed to impact the inner race of the bearing with a shock of more than 30,000 g. The control circuit was designed such that, when turned on, the solenoid would strike the plunger once each minute. The control circuit would also terminate the test if the bearing failed. The solenoid plunger was turned on when reactor power reached 3 mw.

VI. TEST RESULTS

The impact plunger was actuated 6,085 times during the test. Postirradiation examination of the bearing indicated no visible damage.

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