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R E O N

ROCKET ENGINE OPERATIONS - NUCLEAR

REPORT NO. RN-S-0194

TO

AEC - NASA SPACE NUCLEAR PROPULSION OFFICE

RADIATION EFFECTS PROGRAM PLANNING DETAILS

FOR

GENERAL DYNAMICS - FORT WORTH

FOR

CONTRACT YEAR 1965

NERVA PROGRAM - CONTRACT SNP-1 - DECEMBER 1964

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REPORT NO. RN-S-0194
TO
AEC - NASA SPACE NUCLEAR PROPULSION OFFICE

AEROJET - GENERAL CORPORATION
A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

ABSTRACT

Program planning details are presented for the Radiation Effects Program to be conducted at the Reactor Facilities operated by General Dynamics/Fort Worth at Fort Worth, Texas, for Contract Year 1965; as partial fulfillment of Sub-Task 1.9. Contract SNP-1, Modification 8.

Detailed descriptions of work to be performed will be furnished as applicable in individual test specifications for the various components.

This work will be conducted under the supervision of REON, and represents the combined efforts of REON and Westinghouse Astronuclear Laboratory.

W.E. Anderson for

R. E. Branstrom, Manager
Radiation Effects Department
Component Development Division-REON

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I. SUMMARY OF REON AND WANL SUPPLIED EQUIPMENT

- A. Wiancko Pressure Calibrator
- B. Pallets
- C. Dewar for Resistance Temperature Transducer Test
- D. LH₂ 750-Gal Dewar
- E. Test Items
- F. Data Acquisition Equipment for WANL Tests (as required)
- G. LH₂ Vacuum-Jacketed Line
- H. GH₂, GHe, and GN₂ Supply-Piping Systems
- I. Dewar Deluge System
- J. Structural Materials Dewar

II. GD/FW SUPPLIED SPECIAL TEST EQUIPMENT

- A. Tube Trailers
- B. Gas Detection System
- C. Fire Protection System
- D. Piping and Hookup for Deluge System
- E. Remote Handling Tools for Pallet
- F. Dosimetry
- G. TV Cameras
- H. Environmental Chambers
- I. Additional Data Acquisition Equipment as Follows:
 - 1. Macrograph photographic equipment
 - 2. Vacuum system (10⁻⁶ mm Hg)
 - 3. Multipoint strip-chart temperature recorder
 - 4. Dual-beam oscilloscope
 - 5. Oscillographic and analog magnetic-tape recorders (2 kc)
 - 6. Audio oscillator (10 cps to 3 kc)
 - 7. Power amplifier (200 watts)
 - 8. Strip-chart recorder (+100°F to -350°F)
 - 9. Ohmmeter and digital meter (0.1% accuracy)
 - 10. Cryostat vacuum gage
 - 11. 28-v,dc power supply (10 ma) regulated
 - 12. 5-conductor shielded wire (18 or 20 AWG) with irradiated polyolefin insulation
 - 13. Strip-chart temperature recorder (multipoint; +100°F to -350°F)
 - 14. Megohmmeter (1% accuracy)
 - 15. Strip-chart recorder (0-50 mv)
 - 16. Helium-gas regulators (0-50 and 0-200 psig)
 - 17. Tera ohmmeter
 - 18. Battery-type ohmmeter for insulation-resistance measurements
 - 19. Two-digital voltmeters (0.1% accuracy)
 - 20. Three Heise pressure gages (0-900 psig)
 - 21. Pressure transducer control panel

III. GD/FW SUPPLIED ENGINEERING

- A. Tie-Down Fixtures for Test Pallets with Drawings
- B. STE Location Drawings
- C. Design of Handling Equipment
- D. Procedures for Data Handling
- E. Personnel for Data Taking
- F. Personnel for Test-Item Installation on Test Stand
- G. Personnel for Test-Item Removal from Test Stand
- H. Reactor Operation Personnel
- I. Health Physics Personnel
- J. Data Reduction (Dosimetry and Experimental Test Data)
- K. Test Reports (Preliminary and Contributions to Final Report: 20 copies)
- L. Personnel for IML Area Operation (Hot Cell)
- M. Personnel for Assembly of Data Handling Equipment
- N. Personnel for Checkout of Data Handling Equipment
- O. Photographic Coverage (Movies, Stills)
- P. Consultation on Test Fixture Design
- Q. Consultation on ASTR and GTR Radiation Environment - Predicted Fluxes and Data from Mapping Run
- R. Decontamination
- S. Shipping, Storage
- T. Liaison
 - 1. Schedule
 - 2. Hazards
 - 3. Procedures
 - 4. Test specifications
 - 5. Reports
 - 6. Security
- U. Piping and Associated Hardware for Aerojet Dewars
- V. Perform Structural Materials Test (Formerly NP-5 Subcontract)
 - 1. Repair, modify, and check out pulling assembly
 - 2. Perform tensile, shear, and thermal conductivity tests as specified by AGC
 - 3. Prepare specimens for both optical and electronic micrograph examinations
 - 4. Present reduced data in both tabular and graphical form as specified for AGC
- W. Repair, Maintain, and Check Out Gas Distribution System for ASTR Tests

IV. SUMMARY OF POST-IRRADIATION REQUIREMENTS

Approximately 2 weeks in the IML area for mechanical component tests.

Approximately 2 weeks in the IML area for all electrical component tests.

NOTE: Activated material with a total activity greater than 0.1 micro-curie cannot be returned to REON, WANL, etc., unless an AEC biproduct material license (Isotopes 3-83) has been granted.

V. SUMMARY OF IRRADIATION TIME - GTR

<u>GTR Test Number</u>	<u>REON Scheduled Test Date</u>	<u>Test Plan Number</u>	<u>Test Item</u>	<u>Test Duration (hours)</u>	<u>Environment</u>
17 11	14 Dec 1964	23/R103	Resistance Temperature Transducers	100	LH ₂
		23/R303	Thermocouples	100	LH ₂
		23/R408	Strain Gages	100	LN ₂
		23/R508	Pressure Transducer Components	100	LN ₂
		23/R701	Cables and Connectors	100	AMB
		23/R702			
16	11 Jan 1965	37/R002	Tensile Materials	200	LH ₂
		37/R003	Shear Materials	200	LH ₂
		37/W003	Materials (WANL)	400	LN ₂
16	1 Feb 1965	37/R002	Tensile Materials	200	LH ₂
		37/R003	Shear Materials	200	LH ₂
		37/R004	Thermal Conductivity	200	LH ₂
		37/W003	Materials (WANL)	Cont. from GTR 15	LN ₂
17	17 Apr 1965	15/W901	Mechanical Components	100	LH ₂
		23/R304	High Temperature Thermocouples	100	4000°F
		23/R509	Pressure Transducer Components	100	LN ₂
		23/R704	Cables and Connectors	100	AMB
		23/R703			

VI. SUMMARY OF IRRADIATION TIME - ASTR

<u>ASTR Test</u> <u>Number</u>	<u>REON Scheduled</u> <u>Test Date</u>	<u>Test Plan</u> <u>Number</u>	<u>Test Item</u>	<u>Test Duration</u> <u>(minutes)</u>	<u>Environment</u>
4-A	5 Oct 1964	3/R004	TPA Bearing Set	60	LH ₂
5	14 Nov 1964	3/R005	TPA Bearing Set	60	LH ₂

VII. SUMMARY OF CABLE REQUIREMENTS - GTR

<u>GTR Test Number</u>	<u>Test Plan Number</u>	<u>Test Item</u>	<u>Cable Requirements</u>
17	23/R103	Resistance Temperature Transducers	60 cables
	23/R303	Thermocouples	20 cables
	23/R408	Strain Gages	80 cables
	23/R508	Pressure Transducer Components	10 cables
	23/R701	Cables and Connectors	30 cables
	23/R702		
15	37/R002	Tensile Materials	20 cables
	37/R003	Shear Materials	20 cables
	37/W003	Materials (WANL)	40 cables
16	37/R002	Tensile Materials	20 cables
	37/R003	Shear Materials	20 cables
	37/R004	Thermal Conductivity	40 cables
	37/W003	(Cont. from GTR 15) Materials (WANL)	40 cables
18	23/R304	High Temperature Thermocouples	20 cables
	23/R509	Pressure Transducer Components	20 cables
	23/R703	Cables and Connectors	30 cables
	23/R704		
	15/W901	Mechanical Components	30 cables

VIII. SUMMARY OF CABLE REQUIREMENTS - ASTR

<u>ASTR Test Number</u>	<u>Test Plan Number</u>	<u>Test Item</u>	<u>Cable Requirements</u>
4-A	3/RO04	TPA Bearing Set	50 cables
5	3/RO05	TPA Bearing Set	50 cables

IX. SUMMARY OF ESTIMATED FLUID REQUIREMENTS - GTR

<u>GTR Test Number</u>	<u>Test Plan Number</u>	<u>Fluid</u>	<u>Flow Rate</u>	<u>Total Required</u>
17	23/R103 } 23/R303 }	{ LH ₂ } { GHe }	{ 150 gal/hr } { Purging }	15,000 gal 13,000 C.F.
	23/R408 } 23/R508 }	{ LN ₂ } { GHe }	{ 175 gal/hr } { Purging }	17,500 gal 13,000 C.F.
	23/R701	None		
	23/R702	None		
16	37/R002 } 37/R003 }	{ LH ₂ } { GHe }	{ 350 gal/hr } { Purging }	35,000 gal 26,000 C.F.
	37/W003	{ LN ₂ } { GHe }	{ 175 gal/hr } { Purging }	17,500 gal 13,000 C.F.
16	37/R002 } 37/R003 }	{ LH ₂ } { GHe }	{ 150 gal/hr } { Purging }	15,000 gal 13,000 C.F.
	37/R004	{ LH ₂ } { GHe }	{ 150 gal/hr } { Purging }	15,000 gal 13,000 C.F.
	37/W003	LN ₂	175 gal/hr (during test) 60 gal/hr (between GTR 15 and GTR 16)	17,500 gal 21,000 gal
18	23/R304	GHe	Purging	40,000 C.F.
	23/509	{ LN ₂ } { GHe }	{ 175 gal/hr } { Purging }	17,500 gal 13,000 C.F.
	23/R704	None		
	23/R703	None		
	15/W901	{ LH ₂ } { GHe }	{ 175 gal/hr } { Purging }	17,500 gal 13,000 C.F.

X. SUMMARY OF ESTIMATED FLUID REQUIREMENTS - ASTR

<u>ASTR Test Number</u>	<u>Test Plan Number</u>	<u>Fluid</u>	<u>Flow Rate</u>	<u>Total Required</u>
4-A	3/R004	GN ₂ LH ₂	0.05 lb/sec 30 gal/min	150 lb 1800 gal
5	3/R005	GN ₂ LH ₂	0.05 lb/sec 30 gal/min	150 lb 1800 gal

TEST FACILITY GTR

TEST DATE 14-Dec-64

TEST NO. 15
17

TEST ITEM DESCRIPTION

TEST NO.

LOCATION

RESPON. AGENCY

Resistance Temp. Transducers
Thermocouples
Strain Gages
Pressure Transducer Comp.
Cables and Connectors

23/R103
23/R303
23/R408
23/R508
23/R701
23/R702

N
N
E
E
W
W

REON
REON
REON
REON
REON
REON

23/R701
23/R702

23/R103
23/R303

23/R408
23/R508

SPECIAL SERVICES

1. LH₂ Dewar
2. NASA Dewar

TEST SCHEDULE (WEEKS)

	11-12	11-19	11-26	12-3	12-10	12-17	12-24	12-31	1-7	1-14	1-21	1-28	2-4	2-11
TEST SPECIFICATION	△													
SHIP	△													
INSTALLATION			△											
PRE-IRRADIATION TEST				△										
TEST					△									
PREL. REPORT												△		

TEST FACILITY GTR

TEST DATE 11-Jan-65 TEST NO. 164
25

W	37/R003 JL
N	37/W003 11A
E	37/R002 Ten

TEST ITEM DESCRIPTION

Tensile Materials
Shear Materials
Materials (WANL)

TEST NO.

37/R002
37/R003
37/W003

LOCATION

E
W
N

RESPON. AGENCY

REON
REON
WANL

SPECIAL SERVICES

1. Structural Materials Dewars (3)

TEST SCHEDULE (WEEKS)

	12-14	12-21	12-28	1-4	1-11	1-18	1-25	2-1	2-8	2-15	2-22	2-29	3-7	3-14
TEST SPECIFICATION	△													
SHIP	△													
INSTALLATION			△											
PRE-IRRADIATION TEST				△										
TEST					△									
PREL. REPORT												△		

TEST FACILITY GTR

TEST DATE 1-Feb-65 TEST NO. 16

TEST ITEM DESCRIPTION

TEST NO.

LOCATION

RESPON. AGENCY

Tensile Materials
Shear Materials
Thermal Conductivity
Materials (WANL)

37/R002
37/R003
37/R004
37/W003

E
E
W
N

REON
REON
REON
REON

<div data-bbox="193 409 445 657"> <div data-bbox="409 414 441 438">W</div> <div data-bbox="277 511 361 539">37/R004</div> </div>	<div data-bbox="172 669 445 945"> </div>	<div data-bbox="457 669 730 945"> <div data-bbox="697 673 728 698">N</div> <div data-bbox="556 779 640 807">37/W003</div> </div>
<div data-bbox="193 954 445 1201"> <div data-bbox="199 1169 231 1193">E</div> <div data-bbox="277 1026 361 1083">37/R002 37/R003</div> <div data-bbox="298 1096 367 1153">Ten sh.</div> </div>		

SPECIAL SERVICES

1. Structural Materials Dewars (3)

TEST SCHEDULE (WEEKS)

	1-4	1-11	1-18	1-25	2-1	2-8	2-15	2-22	3-1	3-8	3-15	3-22	3-29	4-5
TEST SPECIFICATION	△													
SHIP	△													
INSTALLATION			△											
PRE-IRRADIATION TEST				△										
TEST					△									
PREL. REPORT												△		

TEST FACILITY GTR

TEST DATE 17-April-65 TEST NO. 118

<div>W</div> <div>23/R703 23/R704 23/R509</div>	
<div>N</div> <div>23/R304</div>	
<div>E</div> <div>15/W901</div>	

SPECIAL SERVICES

1. NASA Dewar (1)

TEST ITEM DESCRIPTION	TEST NO.	LOCATION	RESPON. AGENCY
High Temperature Thermocouples	23/R304	N	REON
Pressure Transducer Comp.	23/R509	W	REON
Cables and Connectors	23/R703 23/R704	W	REON
Mechanical Comp.	15/W901	E	WANTL

	TEST SCHEDULE (WEEKS)													
	3-20	3-27	4-3	4-10	4-17	4-24	5-1	5-8	5-15	5-22	5-29	6-5	6-12	6-19
TEST SPECIFICATION	△													
SHIP	△													
INSTALLATION			△											
PRE-IRRADIATION TEST				△										
TEST					△									
PREL. REPORT												△		