LRP #30 DEC. 63

SNP-1SA3-CONTRACT

MONTHLY LETTER REPORT

DECEMBER 1963

DISCLAIMER

M E M O R A N D U M

TO: W. L. Wheeler (25) 6 January 1964
SAT:ck

FROM: J. J. Peterson

SUBJECT: SNP-1SA3 Contract Monthly Letter Report for the Period 27 November 1963 through 26 December 1963

DISTRIBUTION: Azusa: G L Ryland (5), D L Dewing (10 of Enclosure (2)

Sacto: R M Beattie, G Birdsell, G A Boeck (2), V R Boulton, W J Caress (2), V H Chang, J V Danek, O I Ford, M B Grossman, W H Hanse, L A Holcomb, G S Kaveney (2), I L Odgers, J E Ogden, P W Rowe, K F Royer, L R Shirley, L A Shurley, J L Smith (2), J J Sogorka, D L Spurling, R R Stewart, H R Todd, H A Yee, 8200 File

SNPO-C Rep: M M Carness

Enclosure: (1) NERVA LRP-30 Monthly Letter Report, December 1963
(2) NERVA Reliability and Quality Assurance Status Report, December 1963

1. Enclosure (1) is the monthly letter report describing LRP effort on AEC-NASA Contract SNP-1SA3 in December 1963. Work accomplished in this period and work planned for January 1964 are presented in this report.

2. Enclosure (2) is the NERVA Reliability and Quality Assurance Monthly Status Report for December 1963. This report is being submitted under separate cover.

for J. Sogorka

J. J. Peterson, Manager
NERVA Rocket Operations
Liquid Rocket Plant

ENCLOSURE (1)

NERVA LRP-30 MONTHLY LETTER REPORT

DECEMBER 1963

I. INTRODUCTION

This is the thirtieth monthly letter report describing LRP effort on the NERVA Engine Development Program. It is submitted in partial fulfillment of AEC-NASA Contract SNP-ISA3.

II. SUMMARY

This report describes the progress of work on the CY 1964 Program Plan.

NCS 400, CY 1964 Program Plan was prepared for a submittal to RECN in early December.

The CY 1964 Program Plan was reviewed by REON and LRP personnel in Sacramento on 5-7 December 1963. This review resulted in several substantial revisions of the CY 1964 Program Plan, submitted to REON on 16 December 1963.

Due to the program redirection as stated in SNPO-C TWX, R. W. Schroeder to W. C. House, dated 24 December 1963, the Cy 1964 Program Plan is currently undergoing a new revision. This revision will be indicated in NCS-400 A, to be submitted to REON in early January 1964.

The hardware demand and test schedules (as requested by TWX from J. J. Peterson to W. D. Stinnett, dated 20 April 1963) are omitted from the monthly report this month because they will be submitted as a portion of NCS-400A.

Accomplishments during December and plans for January as they are presently being formalized are described by subtask on the following pages.

ITEM 1.1 - ENGINE SYSTEMS

A. ITEM 1.1.0 - ENGINE SYSTEM INTEGRATION, DESIGN & DOCUMENTATION

1. Accomplished in December

a. Engineering

Test stand thrust structure and adapter design layouts were continued and associated design criteria and funding were provided for initiation of design and procurement of linear position transducers and remote actuators.

The revision of the NERVA development engine layout, P/N 701811, was initiated.

b. Fabrication

With the completion of proof loading of the sling for T-603330 (reflector master gage), all master gages and match plates fabricated in CY 1963 were made available for NRX-A use.

2. Planned for January

a. Engineering

Design studies of the test stand thrust structure and test stand adapter will continue.

Design revisions to the CY 1963 NRX-A master gages will be initiated following design agreement with REON and WANL.

b. Fabrication

There will be no fabrication.

B. ITEM 1.1.2 - COLD FLOW DEVELOPMENT TEST SYSTEM

1. Accomplished in December

a. Engineering

A response to the request from REON for a proposal for revision of the H-5 run tank propellant line assembly was made.

A visit was made to the Lewis Research Center, NASA, Cleveland, Ohio, to discuss the B-1 Test Facility and the Nuclear Rocket System Cold Flow Test.

b. Fabrication

Vendor drawings of the main nozzle ejector adapter and turbine exhaust manifold were compared with LRP specification control drawings and approved.

2. Planned for January

a. Engineering

Work on the test specification, operation support plan, and the H-5 run tank propellant line assembly will continue.

b. Fabrication

The fabrication of the CFDTS unique hardware will continue.

C. ITEM 1.1.7 - INTERFACE MOCKUP

1. Accomplished in December

a. Engineering

The design of phase I interface mockup details was started.

b. Fabrication

A setup assembly of the Azusa fabricated interface mockup was started.

2. Planned for January

a. Engineering

Drawings of the remote connector flange for the phase I interface mockup will be released. Design of the phase I interface mockup will continue.

b. Fabrication

There will be no fabrication.

D. ITEM 1.1.8 - NRX-A

1. Accomplished in December

a. Engineering

The first rough draft of the NRX-A2 test specification was completed.

Delivery of the pressure vessel, propellant feed line, and permanent instrumentation to NRDS was completed on 29 December 1963.

b. Fabrication

Planning and initial fabrication for the second phase NRX-A1 acceptance assembly was completed.

c. Testing

The phase one NRX-A1 acceptance tests on the pressure vessel and propellant feed line were completed.

2. Planned for January

a. Engineering

Liaison will be maintained with NRDS on a full time basis.

The 298650-29 nozzle assembly, 400 camera system, and remaining instrumentation will be delivered to NRDS for NRX-A1 testing.

b. Fabrication

The phase 2 NRX-A1 acceptance assembly will be completed and delivered to the test area.

c. Testing

The phase 2 NRX-A1 acceptance tests will be completed.

ITEM 1.2 - PROPELLANT FEED SYSTEM

A. Accomplished in December

The TSOV actuator piston galling problem was solved.

An effort is being made to decrease the rotation sensitivity and actuating torque requirement of the TPCV gate.

A TPCV needle bearing with Inconel X bearing races and titanium carbide needles was successfully tested at 1000°F for 10 minutes.

The Mark IV TPA installation drawing was released.

Assembly of Mark III Mod 3 TPA S/N 009 was completed on 12 December.

An impeller failure occurred during Mark III Mod 3 TPA test 1.2-09-NNP-014. A failure report is being prepared.

Assembly of bearing tester S/N 006 was completed on 6 December.

Ten bearing development tests were conducted. On 4 December over one hour endurance at speed and load was demonstrated with the bearings previously run for 10 minutes in a radiation environment on MIT #903. On 11 December tester S/N 005 was successfully acceptance tested; it was shipped to GD/FW on 18 December.

B. Planned for January

The program will be revised in accordance with direction from the customer in TWX NR 749 on 26 December; effort in January will be responsive to these revisions.

ITEM 1.4 - THRUST CHAMBER ASSEMBLY

1. Accomplished in December

a. Engineering

A second simulated U-tube nozzle test segment was brazed and tested with 1500 psig burst attained; subsequent repairs increased burst pressure to 2350 psig.

A test plan for the NRX-A propellant inlet assembly vibration test was issued.

A report "Reactor for Dynamic testing of the NERVA TCA" was issued.

An NRX-A2 pressure vessel ICDR from WANL was compiled with enlarging the ID of the forward flange of the pressure vessel cylinder.

b. Fabrication

Pressure vessel S/N 003 was delivered to Sub-subtask 1.1.8 for cold flow acceptance and development tests.

Propellant feed line was delivered to Sub-subtask 1.1.8.

Nozzle S/N 011 was delivered to Sub-subtask 1.1.8 for cold flow testing and delivery to NRDS.

Nozzle S/N 009 was completely grooved and deburring was started.

Nozzle S/N 008 was completely grooved and deburred.

c. Testing

Test 909N (PV S/N 003, one zone PV-nozzle simulator structural test) was started, as was Test 1050N (bolt thread insert evaluation test).

No LO_2-LH_2 firings were performed.

2. Planned for January

a. Engineering

A test report on the metallic seals test program will be issued.

A test plan for gimbal shock and vibration test will be issued.

b. Fabrication

Tubes will be installed in steel nozzle S/N 008 and brazing will be completed.

Tube installation in steel nozzle S/N 009 will be completed during the next report period pending the delivery of tubes from Marquardt.

Nozzle S/N 013 will be cast and nozzle S/N 014 will be ready for the first furnace braze cycle.

NERVA adapter S/N 003N will be completed.

c. Testing

The one-zone pressure vessel nozzle simulator structural test will be completed.

Test 904N, Series II will be started, testing ACFI metallic seals.

Two LO_2-LH_2 firings are scheduled for January to checkout test stand H-4.

ITEM 1.5 - ENGINE CONTROLS

A. ACCOMPLISHED IN DECEMBER

1. Engineering

Test planning for wire, cable, and connectors was completed.

Cost study work for the NCS-400 CY 64 proposal was prepared.

2. Fabrication

Wire orders for radiation effects testing were received.

3. Testing

Tests on harness components were initiated. High temperature testing on a flexible cable conduit and a woven ceramic insulated wire were performed.

A current derating test was performed on a typical cable assembly.

B. PLANNED FOR JANUARY

In compliance with customer direction, all subtask 1.5 work will be stopped immediately or brought to a logical conclusion during January.

A topical report will be prepared outlining development progress to date and summarizing status as of January 1964.

ITEM 1.7 - PNEUMATIC SYSTEM

A. ACCOMPLISHED IN DECEMBER

Contract year 1964 cost study information was prepared.

Radiation effects test plan, engine schematic preparation, and CFDTS liaison work continued.

Layouts of the pneumatic system for the E-engine was continued.

Vendor design and development effort continued on the valve and filter components.

Bellows specifications and TSPC test plans were completed.

Orifice design work for E-Block I was started and TSPC design studies were continued.

A design review was held on the vendor proposal for the TSPC and revisions to the design were submitted to the vendor. Fabrication orders for nine TSPC's were completed.

B. PLANNED FOR JANUARY

In compliance with customer direction of 24 December, the pneumatic system development effort for the balance of CY 1964 will be concluded. Work in process will be stopped immediately, or brought to a logical conclusion during January. Fabrication of control components will continue and should be completed in April 1964.

A topical report will be prepared and issued in January 1964 outlining subtask 1.7 development effort to date.

ITEM 1.8 - SYSTEM ANALYSIS

A. ACCOMPLISHED IN DECEMBER

The NRX-A1 pre-test analysis report was issued this month and the first series of in-house cold flow tests were completed. Data from the first series of tests were analyzed and the second series of tests, scheduled for January, will also receive full analysis support. Work was started on the -A2 pre-test analysis report.

B. PLANNED FOR JANUARY

Major effort in January will be given to the transient digital engine program. The program was completed in December and is being refined.

ITEM 1.9 - RADIATION EFFECTS

A. ACCOMPLISHED IN DECEMBER

1. Engineering

The designs of the pallet for MIT #905 and the control pallet were continued.

The final report for MIT #901 was continued.

The final test specifications and test procedures for MIT #904 were continued. Revisions to the test requirements were received from subtask 1.2.

The final test plan for MIT #904 (3/L 004) was revised and transmitted to REON.

Data reduction and evaluation of EIT #501 test results were continued.

All engineering work on the EIT #5xx series test pallets was stopped. All drawings and engineering data are being forwarded to REON.

The checkout of the bearing tester and bearings for MIT #904 was completed and the bearing tester, with bearings installed, was shipped to GD/FW.

The drawings and basic parts list for EIT # 501 were revised to reflect the final test configuration.

MIT #903 corrected test data was received from GD/FW and the data reduction and evaluation of test results was started.

MIT #902 data reduction and evaluation is awaiting corrected test data from GD/FW. Cost proposal NCS-400 information was completed.

A thermal analyses for the revised EIT #502 dewar was initiated on 12 December and terminated on 19 December 1963. The analyses was complete but a report had not been written.

2. Fabrication

Fabrication of pallets for MIT #905, 906 and 907, the control pallet, the control rack for control of MIT functional checkouts at LRP, and the shunt calibrator and regulator control panel for MIT #906 was continued.

All in-house work on the fabrication of the test pallet for EIT #502 was halted. Those parts being fabricated at Downey which were approximately 50% complete were continued. Fabrication of the dewar for EIT #502 was terminated.

B. PLANNED FOR JANUARY

1. Engineering

The design of the pallet for MIT #906 and the control pallet will be completed.

The final report for MIT #901 will be completed.

The final test specifications and procedures for MIT #904 will be completed.

Data reduction and evaluation of EIT #501 and MIT #902 test results will be continued.

Data reduction and evaluation of MIT #902 cannot be resumed until receipt of corrected test data from GD/FW.

2. Fabrication

The effects of program redirection upon the requirements for new pallets are being evaluated and fabrication will be phased out for pallets no longer needed to support the radiation effects program.

ITEM 2.1 - REMOTE HANDLING EQUIPMENT

A. ACCOMPLISHED IN DECEMBER

Engineering

NCS-400 proposal information was prepared.

Revision 4 of the NRX-A2 operational support plan was completed.

The preliminary equipment requirement sheets were completed and conceptual design work was started on the following items:

a. N-9 Tool kit, rocket engine disassembly - remote

b. N-137 Fixture, nozzle examination - remote

c. N-210 Fixture lifting, propellant line

d. N-218 Fixture, lifting, floor mounted support equipment - remote

B. PLANNED FOR JANUARY

Engineering

The item N-211 interface control drawing will be completed.

The NRX-A3 operational support plan will be started.

Detail designs of items N-9, N-137, N-210, and N-218 will be started.

The NRX-A2 operational support plan will be revised, based upon post mortem task force direction.

A study will be initiated to determine support equipment requirements for concurrent NRX operation in the E-MAD and R-MAD.

The final design review will be conducted on item N-135.

ITEM 2.2 - GSE CHECKOUT AND TEST

A. ACCOMPLISHED IN DECEMBER

Engineering

The interface control drawing for item N-450 was started.

NCS-400 information was prepared.

Preliminary equipment requirement sheets were completed and the conceptual design of item N-469 was started.

Revision 4 of the NRX-A2 operational support plan was completed.

Acceptance test plans for items N-450 and N-451 were completed.

B. PLANNED FOR JANUARY

Engineering

Performance specifications of item N-469 were completed and the detail design was started.

Work on the NRX-A3 operational support plan will commence.

A conceptual design review of item N-469 will be conducted.

The NRX-A2 operational support plan will be revised, as required.

ITEM 2.3 - LOGISTICS (MAINTENANCE AND HANDLING EQUIPMENT)

A. ACCOMPLISHED IN DECEMBER

Engineering

NCS-400 information was prepared.

Preliminary interface control drawings were started on the following items:

1. N-724 Semitrailer, rocket engine
2. N-803 Fixture, lifting, rocket engine forward closure
3. N-809 Sling, beam type
4. N-817A Sling, multiple leg
5. N-914 Adapter, handling rocket engine
6. N-917 Stand, forward closure, rocket engine

Revision 4 of the NRX-A2 operational support plan was completed.

A study to determine extent of modification required for N-915 engine stand for R-MAD cold and hot useage was made.

Acceptance test plans for items N-724, N-914, and N-915 were completed.

B. PLANNED FOR JANUARY

Engineering

Interface control drawings on the following items will be completed:

1. N-724 Semitrailer, rocket engine
2. N-809 Sling, beam type
3. N-817A Sling, multiple leg - 12,000 pound capacity
4. N-914 Adapter, handling, rocket engine
5. N-915 Stand, rocket engine
6. N-916 Maintenance platform, rocket engine

Work on the NRX-A3 operational support plan will be started.

The NRX-A2 operational support plan will be revised as required.

ITEM 2.4 - INSTRUMENTATION

A. ITEM 2.4.1 - NON NUCLEAR DEVELOPMENT TEST SYSTEM

1. Accomplished in December

Procurement lists for all instrumentation ordered was prepared.

Input was supplied for the Instrumentation Data Book.

2. Planned for January

No special activities are planned other than a continuation of present activity.

B. ITEM 2.4.2 - NRX INSTRUMENTATION

1. Accomplished in December

NRX-A1

Data book inputs were completed. All components were non-nuclear qualified.

Standard controls differential pressure transducers were cancelled.

NRX-A2

Specification control drawings for a copper-constantan thermocouple were completed.

Final ordering of instrumentation kit components is now under way since non-nuclear tests have been completed.

2. Planned for January

Engineering support will be provided to aid installation of NRX-A1 components at NRDS.

C. ITEM 2.4.4 - MECHANICAL COMPONENTS IRRADIATION TEST INSTRUMENTATION

1. Accomplished in December

Piazoelectric type accelerometers will be used on MIT #903, #904, #906, and #908, procurement has begun.

Two RTT calibration sets were accepted and sent to substores.

2. Planned for January

Specification control drawings will be started for MIT #907, #909, #910, #911, and #912 test instrumentation.

D. ITEM 2.4.6 - NON-NUCLEAR INSTRUMENTATION DEVELOPMENT

1. Accomplished in December

A non-nuclear instrumentation component test program was completed. Final reports for non-nuclear environmental tests of NRX-A2 candidate transducers are in progress. Coordination with the manufacturers of bonded strain gages and pressure transducers continued.

Selection of NRX-A3 candidate transducers has started.

Work continued on the two wire and coaxial W/W 26% Re thrust chamber thermocouple.

The January quarterly revision of the NERVA Instrumentation Data Book was submitted.

2. Planned for January

Test plans will be written for the CY 64 EIT tests and will support NRX-A candidate transducer evaluation.

ITEM 4.1 - PROGRAM PLANNING AND CONTROLS

1. Accomplished in December

CY 1964 Program Plan PERT Networks were reviewed and interfaced with RIDN personnel.

CY 1964 PERT Networks were checked against the work statements and hardware demand and test schedules.

New PERT Networks were distributed to the subtask engineers and RIDN.

NRX computer runs were updated.

PERT biweekly reports were prepared and submitted to RIDN.

2. Planned for January

CY 1964 Program Plan PERT Networks will be modified to correspond with revisions in NCS-400A.

Milepost listing contained in RN 63005A will be modified to correspond with revisions in NCS-400A. Terminal events for which critical path is calculated will be selected. Weekly monitoring and biweekly reporting will be made against these mileposts.

NRX computer runs will be updated.

CY 1964 Development Program computer runs will be initiated.

PERT biweekly reports will be prepared and submitted to RIDN.

ITEM 4.2 - FISCAL CONTROL

A. Accomplished in December

NCS-400, Contract Year 1964, Revised, was submitted to REON on 16 December 1963. Subsequently, NCS-400A, prepared in response to SNPO TWX NR 749 from R. W. Schroeder to W. C. House, was submitted to REON on 30 December 1963.

B. Planned for January

A definitive cost study will be prepared to define a reduced level of LRP effort during contract year 1964.

ITEM 4.3 - TECHNICAL REPORTS

1. Accomplished in December

NCS-400 (CY 1964 Program Plan) was prepared and submitted to REON.

LRP weekly status reports, biweekly PERT reports, and the monthly letter report were prepared and submitted to REON.

2. Planned for January

NCS-400A, CY 1964 Program Plan Revised will be prepared and submitted to REON.

LRP weekly status reports, biweekly PERT reports, the monthly letter report, and the document listing report depicting documentation released during the SNP-1 contract period ending 30 September 1963 will be prepared and submitted to REON.

ITEM 4.4 - CENTRAL DATA SYSTEM

1. Accomplished in December

Engineering documentation including drawing lists, drawing number control reports, and WANL specifications received from REON were distributed.

2. Planned for January

Routine distribution of engineering documentation will be maintained.

ITEM 5.1 - LRP TEST ZONE C

A. ACCOMPLISHED IN DECEMBER

Activation of the NRX-A cold flow test system was accomplished while installation of STE for TPCV Testing continued.

B. PLANNED FOR JANUARY

Fabrication and installation of STE for TPCV Testing is scheduled for completion on 31 January.

ITEM 5.3 - LRP TEST ZONE H

A. ACCOMPLISHED IN DECEMBER

On 5 December a leak was detected in the inner vessel of vessel VH-10. Subsequent investigation showed that there were, in fact, two leaks. A leak was found in the fourteen inch vent piping nozzle and another leak was found on the twelve inch fill piping nozzle. Chicago Bridge and Iron Co. pressure vessel personnel inspected the vessel and proposed a course of action that, if effective, will complete the repairs by the middle of January.

Concurrent with the leak problems, a catch vessel flare stack malfunctioned (burning progressed into the stack during venting operations and caused some thermal damage to the upper portion of the stack). The flare stack is being repaired and with some modification to the design of the upper portion is under consideration.

Contractor work on test stand H-4 under specification 6740 was completed on 9 December. AGC activation of test stand H-4 was started on 6 December.

B. PLANNED FOR JANUARY

If no problems develop, repairs on vessel VH-10 should be completed by 15 January.

Activation of test stand H-4 without a diffuser should be accomplished by 27 January.

ITEM 5.8 - SACRAMENTO PLANTS MISCELLANEOUS LABS

A. ACCOMPLISHED IN DECEMBER

The fabrication of an exciter base plate for the SRP vibration laboratory (Event No. 5801166) was completed on 7 December. Also, the procurement of a low frequency drive unit for the SRP vibration laboratory (Event No. 5801168) was completed on 30 December as activation of laboratory support equipment continues.

B. PLANNED FOR JANUARY

The low frequency drive unit will be installed in the vibration laboratory.

ITEM 5.9 - LRP ENGINEERING LABS (STE)

A. ACCOMPLISHED IN DECEMBER

Procurement of the second LN_2 leak vessel (Event No. 5901103) was initiated on 4 December after the tests on the first vessel proved the acceptability of the design.

B. PLANNED FOR JANUARY

O.P. procurement and fabrication of the second LN_2 leak tank will be continued.

III DETAILED DISCUSSION

ITEM 1.1 - ENGINE SYSTEM

A. ITEM 1.1.0 - ENGINE SYSTEM INTEGRATION, DESIGN AND DOCUMENTATION

1. Accomplished in December

a. Engineering

Initiation of design revisions to the gage fabricated in CY 1963 was postponed until January (following a design review meeting with REON and WANL scheduled for 3 January 1964).

The test stand thrust structure and test stand adapter design layouts were continued. Design criteria and funding were made available for initiation of the design and procurement of the test stand adapter remoted actuators and linear position transducers.

The revision of the NERVA development engine layout (Drawing Number 701811) was initiated on 16 December. As directed by the customer, work will be completed by the end of the month to finalize the revision.

b. Fabrication

The sling for T-603330 (reflector master gage) was proof tested to 12,000 lbs. Following proof testing of the sling, the master gage was placed in tool storage and was available for use on 12 December.

The nozzle match plate (T-603007) was shipped to NTO on 23 December and was reshipped to Rocketdyne from NTO on 30 December for use with backup NRX-A Nozzle RN-6.

2. Planned for January

a. Engineering

Revisions to the CY 1963 NERVA development engine layout (No. 701811) will be transmitted to REON. This revision will include axial, radial, and rotational assembly tolerances of major components and subassemblies and callouts of mismatched components.

Design revisions to the CY 1963 gages will be initiated following a design review and coordination meeting with REON and WANL, scheduled for 3 January 1964.

Design studies of the test stand thrust structure and the test stand adapter will continue.

b. Fabrication

No fabrication is planned.

B. ITEM 1.1.2 - COLD FLOW DEVELOPMENT TEST SYSTEM

1. Accomplished in December

a. Engineering

Work continued on the CFDTS test specification.

A response to the request from REON for a proposal for revision of the H-5 run tank propellant line assembly was formulated. It included the Test Division input and discussed the feasibility of installing a ball valve, but recommended retention of the existing tank safety Y-valve.

WANL engineers visited LRP assembly and test area facilities to become acquainted with the handling and transportation problems (with the intention of verifying that the procedures to be followed will not result in damage to the reactor).

WANL and LRP representatives met at REON to discuss CFDTS instrumentation. The eleven thermocouples that were deleted from the NRX-A1 instrumentation were also deleted from CFDTS.

A visit was made to the Lewis Research Center, NASA, Cleveland, to discuss the B-1 test facility and the nuclear rocket system cold flow test. The facility and test equipment were viewed at Plumbrook.

b. Fabrication

Vendor drawings for the main nozzle ejector adapter and turbine exhaust manifold were compared with LRP specification control drawings and were approved.

2. Planned for January

a. Engineering

Work on the test specification and operational support plan will continue.

Work on the H-5 run tank propellant line assembly will depend upon agreement on design criteria by NERVA LRP Engine System Department, REON, and LRP Test Operations Division.

b. Fabrication

Fabrication of the CFDTS unique hardware will continue.

C. ITEM 1.1.7 - INTERFACE MOCKUP

1. Accomplished in December

a. Engineering

Design of the Phase I interface mockup details was initiated.

b. Fabrication

A setup assembly of the Azusa fabricated interface mockup was initiated.

2. Planned for January

a. Engineering

Drawings of the remote connector flange for the Phase I

interface mockup will be released.

Design of the Phase I interface mockup will continue.

b. Fabrication

There will be no fabrication.

D. ITEM 1.1.8 - NRX-A

1. Accomplished in December

a. Engineering

Preparation and review of NRX-A documentation continued during this report period. Effort was primarily in three areas:

(1) Preparation of LRP input to the NRX-A2 test specification.

(2) Preparation of in-house LRP procedures for disassembly and shipping of the NRX-A1 components.

(3) Review of NRDS procedures.

Detailed fabrication drawings for the 1200 ft camera system to be used on NRX-A1 were completed and are ready to be submitted for fabrication.

The major engineering effort was directed toward completion of the acceptance tests and disassembly and delivery of components to NRDS. This effort was accomplished with delivery to NRDS being completed on 29 December. Further details are presented in the fabrication and testing sections of this report.

b. Fabrication

The fabrication effort during this report period has been limited to the preparation for disassembly of the acceptance test system, disassembly, cleaning, and preparation for shipment to NRDS. In addition, work was started on the second acceptance test assembly with respect

to improving the seal between the liner and nozzle assembly. This problem is discussed further in the testing section.

c. Testing

The first phase of the NRX-A1 acceptance test was completed on 21 December. Gaseous nitrogen and hydrogen checkout tests were conducted satisfactorily. A fifty lb/sec maximum liquid hydrogen test at an average rate of 1.1 lb/sec/sec, and a 22.5 lb/sec gaseous hydrogen acceptance test were accomplished.

During this series of tests a problem developed due to a leak at the internal seal between the liner and nozzle assembly. This leak reduced the flow through the upper portion of the pressure vessel severely and resulted in vessel pressures of about 25% of anticipated pressures. Major diameter seal evaluation during the test indicated no leakage in this area during the liquid test and 30 cc leakage in approximately 30 seconds during the gas test.

Analysis of the test data has started. The final report on the acceptance test will be issued on 1 February 1964.

2. Planned for January

a. Engineering

Documentation and technical liaison will continue as required for the NRX-A program.

NRX-A2 acceptance test drawings will be started.

NRX-A2 final assembly drawings will be reviewed and updated.

The NRX-A1 nozzle (P/N 298650-29) will be delivered to NRDS for testing.

Liaison at NRDS will be maintained on a full time basis.

b. Fabrication

The second phase NRX-A1 acceptance test assembly will be assembled and delivered to the test area.

The 1200 ft camera system will be ordered.

c. Testing

The acceptance testing of the NRX-A1 nozzle and the 400 ft camera system will be completed.

ITEM 1.2 - PROPELLANT FEED SYSTEM

A. ITEM 1.2.0 - SYSTEM ASSEMBLY

1. Accomplished in December

a. Engineering

Installation of test hardware on test stand H-6 was started. The upper thrust structure, TSOV, lower thrust structure, and turbopump were installed. Final mating of the turbopump-to-test stand propellant lines is being delayed due to late fabrication completion of the turbine inlet line and pump discharge line.

The propellant feed system assembly interface drawing for the NARF installation was continued. The drawing will be released "for record only" by 15 January 1964.

The fluid dynamics analysis of the complete C-7 test stand propellant feed system was halted due to higher priority work. However, dynamic analysis of the pump suction line (between the TSOV inlet and the pump inlet) was continued.

The preliminary selection report for seal and remote joint assemblies for the NERVA propellant feed system is 90% complete. This report will be published in January.

b. Testing

The Marman six-inch stainless-steel remotely-operable test cell assembly, which simulates the NERVA engine turbine exhaust joint, was subjected to a gaseous helium leak test at liquid nitrogen temperature. Leakage past the seal was 1.43×10^{-4} cc/sec at 220 psig. At 375 psig the leakage was between 1×10^{-2} and 1.4×10^{-4} cc/sec. A gaseous helium leakage rate of 3.70×10^{-5} cc/sec was detected during a 375-psig ambient-temperature leak test.

An ambient temperature gaseous helium leak test was conducted on the Nuco seven-inch stainless-steel remotely-operable test cell. A leakage rate of $3.35.10^{-5}$ cc/sec was detected at 150 psig inlet pressure. This seal design is being evaluated as a back up to the conoseal design.

Gaseous helium leak tests were conducted on the five-inch stainless steel conoseal test cell at ambient and liquid nitrogen temperatures. This assembly simulates the NERVA engine pump discharge duct. With 1125 psig leak pressure, leakage was less than 1×10^{-2} cc/sec at both ambient and liquid nitrogen temperatures. The test cell was disassembled and a new conoseal installed. The 1125 psig ambient temperature leak test was repeated. The leakage rate was again less than 1×10^{-2} cc/sec.

The six-inch conoseal test cell formerly used for RET #901 was subjected to a liquid hydrogen temperature shock test at the Cryogenics Laboratory. The test cell had previously been modified by installing two-inch inlet and outlet lines. This modification allowed a much quicker cooldown time. Five hundred gallons of liquid hydrogen were flowed through the test cell in 33 seconds, at which time a minimum flange temperature of -330°F was obtained. The gasious helium leak rates achieved for each joint before and after the liquid hydrogen flow are as follows:

Ambient Temperature Leak Test Results

Joint	GHe Pressure	Leak Rate
CRES to CRES	500 psig	1.79×10^{-7} cc/sec
CRES to Aluminum	500 psig	1.79×10^{-7} cc/sec
Aluminum to Aluminum	500 psig	1.86×10^{-7} cc/sec

Cryogenic Temperature Leak Test Results

Joint	GHe Pressure	Leak Rate
CRES to CRES	500 psig	3.22×10^{-6} cc/sec
CRES to Aluminum	500 psig	3.22×10^{-6} cc/sec
Aluminum to Aluminum	500 psig	3.10×10^{-6} cc/sec

2. Planned for the month of January

The seals and remote joint assembly selection report will be published.

Installation of propellant feed system components on H-6 test stand will be completed and system checkout will be started.

The NARF propellant feed system interface control drawing will be released and a preliminary test plan will be completed. The NARF-PFS effort will then be concluded.

The analysis of pump suction inlet conditions will be concluded.

The E-1 engine layout effort will be concluded.

B. ITEM 1.2.1 - LINES AND DISCONNECTS

1. Accomplished in December

a. Engineering

Detail drawings of the propellant line supports were completed and are being checked.

A layout drawing of the emergency cooldown line was started. Line movement resulting from engine gimballing is being incorporated into the layout drawing.

b. Fabrication

The turbine inlet and pump discharge lines for H-6 tests were delayed during fabrication. Completion is expected by 31 December 1963.

Fabrication of CFDTS pump discharge line and turbine exhaust line was continued. A vendor was selected to manufacture the jacketed portion of the turbine inlet line. The remaining sections of the turbine inlet line will be fabricated in LRP shops.

2. Planned for January

a. Engineering

E-1 engine line layout effort will be concluded.

b. Fabrication

Fabrication of CFDTS and nozzle bleed port test propellant lines will continue.

C. ITEM 1.2.2 - VALVES

1. Accomplished in December

a. Engineering

(1) Tank Shutoff Valve

The Conf. II TSOV actuator piston galling discovered last month was the outcome of the poor wear characteristics of the aluminum piston against the CRES poppet sleeve. This problem was alleviated in the existing hardware by reducing the outside diameter of the piston to prevent contact with the sleeve bore and by installing spacers in the bottom of the top and bottom piston ring grooves, thereby causing the two top and two bottom bronze rings to act as guides as well as seals. The middle four rings were allowed to float for maximum sealing ability. A visual inspection of the actuator after 20 actuations at -320°F showed no further galling or damage.

Two approaches to a more permanent solution to the actuator piston galling problem are being taken. One is simply the application of "Microseal" dry lubricant to the contact surfaces of new pistons and poppets, with no other design changes; the alternate solution is the installation of bronze guide rings on the piston in addition to the existing piston rings.

The eccentricity between the poppet and the seal ring detected last month was found to exist in the conical seal joint between the poppet and the seal ring. All other related diameters were found to be within blueprint specifications. The seal ring eccentricity was measured

as 0.020 inch T.I.R, and was due to the poor centering characteristics of the two aluminum conical seals used in the joint. A satisfactory installation was made by installing shims between mating diameters on the poppet and the ring prior to gasket installation. The poppet and seal ring designs are being changed to make the ring self-guiding.

(2) Turbine Power Control Valve

An effort is being made to decrease the rotation sensitivity of the TPCV gate to ± 3 degrees from the full-closed position by grinding a spherical diameter in the TPCV bore. This diameter will cut into the bore surface by .0020-.0025 inches.

The test data from the compressible flow and torque tests of the Conf. II TPCV are being analyzed.

(3) Reactor Cooldown Valve

During a checkout of the RCDV test cart, the weld holding the outlet pipe of the RCDV tank to the tank bottom failed. The failure was due to poor penetration of the weld material into the pipe and to lack of adequate consideration for thermal stresses in the original design.

The test results of the pre-radiation evaluation tests of the Astro, Beckman, Maurey, and Ciannini RCDV potentiometers were tabulated.

b. Fabrication

(1) Tank Shutoff Valve

The G.W. Lisk TSOVPV solenoid with the thermistor network installed was received and is being inspected.

(2) Turbine Power Control Valve

The holding fixture is being fabricated to hold the TPCV piston rings while the sealing surfaces are being ground to new configurations. One configuration scheduled for evaluation is a half-round edge design, the purpose of which is to decrease gate position sensitivity and reduce the valve opening torque requirement.

A testing device is being fabricated to determine the sensitivity of gate rotation vs. leakage. The test fixture is designed to measure gate rotation to within 5 minutes accuracy.

An order for ten 0.165-in.-diameter x 72-in.-long pieces of heating element rod was placed. This will be capable of supplying a 1400°F temperature for the TPCV bearing tester.

(3) Reactor Cooldown Valve

Ten thermal circuit breakers were ordered to protect the RCDV motor from overheating during development testing.

The RCDV test cart is being repaired.

c. Testing

(1) Tank Shutoff Valve

The Conf. II TSOV was reassembled with the reworked piston, poppet, and seal ring. The valve leak tested at ambient temperature with gaseous nitrogen. Leakage past the primary seal was several hundred cc/min. However, leakage past the secondary seal was less than 1.0 cc/min after one valve actuation, and was 10 cc/min after ten valve actuations. This valve was then shipped to the Cryogenics Laboratory for liquid hydrogen testing.

Pre-radiation evaluation tests were started on two Beckman TSOV potentiometers.

(2) Turbine Power Control Valve

A TPCV needle bearing with inconel-X bearing races and titanium carbide needles was tested. The bearing was subjected to a simulated load of 30 psi differential pressure across the gate and ± 1° to 3° of rotation at a frequency of 5 cps. The bearing was held at 1000°F during the ten minute cycling program. Disassembly of the bearing revealed some evidence of race brinelling, but no evidence of galling was found. This

bearing configuration has the advantage of closer shaft-to-bearing tolerances, together with a lower cost than the all-titanium carbide bearing.

The TPCV step-gap piston rings were subjected to preliminary gaseous nitrogen and gaseous helium 25-psig leak tests. The nitrogen and helium leakage rates correspond to a maximum equivalent gaseous hydrogen leakage of 1.3 cfm at ambient temperature. The allowable leakage is 4 cfm gaseous hydrogen at operating temperature (1800°R). The step-gap piston ring appears to be less affected by ring position than the square gap configuration.

The fabrication of the TPCV hot gas test facility at test area C-7 was completed. The instrumentation is being installed.

(3) Reactor Cooldown Valve

RCDV gaseous helium leak tests with the valve body at liquid nitrogen temperature were conducted. After five valve actuations a leakage rate of 11 cc/min was detected past the primary seal, with 50 psig applied to the valve inlet; a secondary seal leak test was not conducted. After three more actuations a leakage rate of 80 cc/min was detected past the primary seal with 50 psig inlet pressure; the secondary seal leakage was less than 1×10^{-2} cc/sec with 3 psi pressure differential across the seal.

(4) Propellant Feed System Check Valves

Evaluation testing of three 2-inch purge check valves continued. Ambient temperature leak tests were satisfactorily conducted. Internal icing tests were begun.

2. Planned for the Month of January

Effort on all valves will be replanned and redirected in accordance with TWX #NR749, H. Finger to W. House, dated 26 December 1963.

Testing

Conf. II TPCV hot gas tests will be initiated.

D. ITEM 1.2.3 - TURBOPUMP ASSEMBLY

1. Accomplished in December

a. Engineering

The Mark IV turbopump assembly specification was initiated.

New pump volute drawings were released. These drawings included the benefit of additional stress analysis and engineering checking.

The eight degree diffuser layout was completed and detail fabrication drawings were initiated.

A preliminary test plan for the piston thrust balancer component development was issued.

The Mark IV turbopump installation drawing was completed.

Analyses were continued to establish the cause of failure of Mark III Mod 3 TPA S/N 0000005, impeller P/N 263043-1, S/N 0000033. The design analysis of the Mark IV Mod 2 impeller No. 2 for improved stress was continued. The determination of the existing Mark IV impeller center of gravity from the released prints for use in the final calculation of critical speed was completed. Detail drawings for the tester for the Mark IV pump water program were initiated and are nearing completion.

Plans were prepared for machining specimens from the Mark IV Mod 2 pump impeller forging, P/N 701034, for tensile tests at room temperatures, -320°F, and -423°F, and thermal contraction measurement between room and cryogenic temperatures. The impeller material is 7075-T73 aluminum alloy.

Sheet material of 1/8-in.-thick D-979 alloy was heat-treated in accordance with AGC spec. 44135 to obtain mechanical properties of

notched and unnotched welded sheet specimens at both room and elevated temperatures.

Preparation of the final Mark IV design report was initiated.

Publications during the past period included the following:

Memo/RMR No	Title	Date Published	Remarks
RMR # 0140	NERVA TPA Shaft Thrust Analysis	11-25-63	Summaries of Mk III Mod 3 rotor thrust test results Mk IV Mod 2 rotor thrust analyses, and results of an investigation of the possibility of redundancy in the Mk IV between the balance piston and bearings.
RMR # 0141	NERVA Cold Gas Drive Turbopump Test Results Mk III Mod 3	11-27-63	Tests 1.2-09-NNP-009 thru 014 on Mark III Mod 3 TPA S/N 0000005
Memo 9685:0246	Request for Material Failure Analysis on NERVA Mk III Mod 3 Impeller P/N 263043, S/N 0000033	12-04-63	Post test 1.2-09-NNP-014
Memo 9685:0248	Monthly Status Report on H_2O Test Program for Mark IV	12-06-63	
Memo 9685-0252	Mk IV Pump Performance Improvement Program	12-10-63	Order of priority for present and future planning LH_2 and H_2O testing
Memo 9685:0254	Stress Analysis on Mk III Mod 3 Impeller Failure	12-11-63	Post test 1.2-09-NNP-014 Impeller P/N 263043, S/N 0000033
Memo 9685:0258	Investigation Program for NERVA TPA	12-17-63	Assignment of specific tasks to expert personnel - Subj: Failure of Impeller P/N 263043, S/N 0000033
Memo 9685:0261	NERVA Mk IV Piston Thrust Balancer Test Plans	12-19-63	Preliminary Plan
N-79	Structures Report 290479 Pump Housing		
N-80	Structures Report 290432 Thrust Piston		

Memo/RMR No	Title	Date Published	Remarks
N-81	Structures Report 290404 Impeller		
N-82	Structures Report 290446 Deflector		
N-96A	Structures Report 290481 Turbine Support		
N-113	Structures Report 290400 Impeller Bolt		
N-117	Structures Report 290410 & 290441 Seal Ring		
N-128	Structures Report 290403 Impeller Coupler		
TR 8771:2197	Instrumentation for Cryogenic Temperature Measurements of the NERVA Turbopump Assembly Bearings	11-19-63	

b. Fabrication

Completed fabrication during the past period included the following:

Quantity	Part No.	Nomenclature	Date
1	265811-9 D/O	Retainer Nozzle	11-26-63
1	268647-9 A/-	Sleeve	11-26-63
1	268647-9 A/-	Speed Pickup	11-26-63
1	265811-9 D/O	Nozzle Retainer	12-02-63
1	263079-5	Sleeve	12-04-63
8	269368-19 B/O	Tube Assembly	12-09-63
14	700977-9 A/-	Seal	12-09-63
1	268646-1 Nc/-	Sleeve	12-09-63
1	268646-1	Inner Spacer	12-11-63
2	269368-19	Tube	12-11-63
1	278000-139	TPA S/N 0000009 BU 2	12-12-63

Quantity	Part No.	Nomenclature	Date
1	259961-5	Flange	12-16-63
20	290304-1 Nc/-	Cover	12-17-63
3	285284-1 Nc/-	Seal	12-18-63
350	AN-814-5	Plug	12-10-63
200	AS-1026-428-20	Bolt	12-10-63
300	AS-4013-04-004	Screw	12-05-63
151	NAS 1005-30H	Bolt	12-02-63
12	Com'l Prod 406019	Plug	12-10-63
2	PA-1	Coil Pickoff	12-13-63
5	284044	Coupling	12-03-63
38	283418-9 A/-	Gasket	12-05-63

Assembly of Mark III, Mod 3 TPA, S/N 0000009 was completed (BU 2) on 12 December 1963.

The pump kit for TPA S/N 0000010 was also completed during the past period.

Mark III, Mod 3 TPA, S/N 0000005 was disassembled on 26 November 1963 (Teardown No. 4).

c. Testing

Test Conducted	This Period	CY 1964 to Date
Turbopump Development Tests	0	8

Following test 1.2-09-NNP-014, Mark III, Mod 3 TPA, S/N 0000005 was torn down and inspected. The post test inspection revealed evidence of pump rub and turbine tip rub. Pump impeller vanes were broken, the housing was gouged at the suction area, and some housing diffuser vanes were damaged. The power transmission was found to be in excellent condition. All hardware except the pump housing and impeller appeared to be refurbishable.

Investigation of the cause of failure is proceeding in accordance with memorandums 9685:0246, 0254, and 0258. Effort was scheduled for a separate report concerning the failure, to be compiled and published in January 1964.

The compatibility of the TPA with the H-6 test facility was being assured by means of mockup Mark III Mod 3 TPA, S/N 0000008.

2. Planned for January

All effort will be replanned and redirected per TWX #NR749, H. Finger to W. House, dated 26 December 1963.

E. ITEM 1.2.4 - TURBOPUMP ASSEMBLY BEARING DEVELOPMENT

1. Accomplished in December

a. Engineering

The design changes and detailed fabrication drawings for modification of electric motor driven bearing testers to incorporate Mark IV bearings neared completion. This tester assembly is identified by P/N 287710.

A new spring loaded thermocouple was designed in order to obtain temperature data from the ball thrust bearing outer races. A preliminary draft of a new bearing test plan was completed in order to update the test program in keeping with the latest Mark IV program requirements. A test plan contribution was issued to define the procedure for radiation test MIT #904, (Memo 9685:0257 - MIT #904).

Data were analyzed for test series 640-032, 640-033, and 640-034, conducted utilizing tester S/N 0000006 to evaluate BMC roller bearings.

New requirements were established for radiation effects testing of Mark IV bearings.

Publications during the past period included the following:

Memo No.	Title	Date Published
9685:0257	NERVA Test Plan Bearings Radiation Effects	12-17-63

b. Fabrication

Completed fabrication during the past period included the following:

Quantity	Part No.	Nomenclature	Date
1	290159-19	Bearing, Roller	12-02-63
2	290157-49	Bearing, Roller	12-02-63
2	290159-69	Bearing, Roller	12-20-63
2	290159-99	Bearing, Roller	12-20-63

Assemblies completed during the past period were:

Tester	S/N	Date
290300-9	0000006 BU 1	12-06-63

Disassemblies completed were:

290300-9 0000006 TD1

c. Testing

Test Conducted	This Period	CY 1964 to Date
Bearing Development Test		
Non-Nuclear	10	17
Radiation Effects	0	2

On 4 December 1963, a series of six bearing tests were conducted at the AGC Cryogenic Laboratory to demonstrate endurance after operation in a nuclear environment (MIT #903). The roller bearings consisted of two Bower bearings, P/N 290156-109, which have previously demonstrated (on another bearing of the same part number) 91 minutes of non-nuclear operation. The ball bearings were a pair of MRC bearings P/N 287812-19, which have demonstrated (on another bearing of the same part

number) 75 minutes of non-nuclear operation. All bearings utilized Armalon as a cage material and 440 C race and rolling element material. This set of bearings accumulated 81.5 minutes of operation at full loads and speed, which includes 10 minutes of operation in a nuclear environment. The total duration of the six-post radiation non-nuclear tests was 66 minutes and 28 seconds. Bearing inspection is pending; however, no indication of bearing failure was observed during the test series.

On 11 December one test was performed at the IRP Cryogenic Laboratory to document acceptance of bearing tester P/N 290300-19 (S/N 0000005) in preparation for MIT #904. Test duration was 368 seconds, of which 317 seconds were at 2,000 lb radial and axial loads with a shaft speed of 24,000 rpm. The motor current subsided to the normal 30-45 amps in approximately two seconds and remained at the value for the remainder of the test. Bearing temperatures were normal and steady at -400°F. No indication of abnormal operation was evidenced during the test. Shipment of tester S/N 0000005 to GD/FW was accomplished on 18 December.

On 16 December 1963 a series of three non-nuclear bearing development tests was conducted to evaluate the BMC (alternate source) roller bearing, P/N 290159-49 and 290159-19. The duration of the test series was 61 minutes and 40 seconds at 2100 lbs radial and axial load. Teardown of bearing tester S/N 0000006 indicated bearing and cage failure of the new source (BMC) roller bearing P/N 290159-49. Investigation of the failure is currently being accomplished and will be the subject of a bearing failure report.

2. Planned for January

All effort will be replanned and redirected in accordance with TWX #NR749, H. Finger to W. House, dated 26 December 1963.

number) 75 minutes of non-nuclear operation. All bearings utilized Armalon as a cage material and 440 C race and rolling element material. This set of bearings accumulated 81.5 minutes of operation at full loads and speed, which includes 10 minutes of operation in a nuclear environment. The total duration of the six-post radiation non-nuclear tests was 66 minutes and 28 seconds. Bearing inspection is pending; however, no indication of bearing failure was observed during the test series.

On 11 December one test was performed at the LRP Cryogenic Laboratory to document acceptance of bearing tester P/N 290300-19 (S/N 0000005) in preparation for MIT #904. Test duration was 368 seconds, of which 317 seconds were at 2,000 lb radial and axial loads with a shaft speed of 24,000 rpm. The motor current subsided to the normal 30-45 amps in approximately two seconds and remained at the value for the remainder of the test. Bearing temperatures were normal and steady at -400°F. No indication of abnormal operation was evidenced during the test. Shipment of tester S/N 0000005 to GD/FW was accomplished on 18 December.

On 16 December 1963 a series of three non-nuclear bearing development tests was conducted to evaluate the BMC (alternate source) roller bearing, P/N 290159-49 and 290159-19. The duration of the test series was 61 minutes and 40 seconds at 2100 lbs radial and axial load. Investigation of the failure is currently being accomplished and will be the subject of a bearing failure report. Teardown of bearing tester S/N 0000006 indicated bearing and cage failure of the new source (BMC) roller bearing P/N 290159-49.

2. Planned for January

All effort will be replanned and redirected in accordance with TWX #NR749, H. Finger to W. House, dated 26 December 1963.

ITEM 1.4 - THRUST CHAMBER ASSEMBLY

A. ITEM 1.4.0 - ASSEMBLY

1. Accomplished in December

a. Engineering

Project effort was directed toward sub-subtask input for NCS-400. Directions was given to the test area in preparation for the experimental determination of stiffness values for the dummy gimbal actuators employed in TCA dynamic testing. A study entitled "A Reactor for Dynamic Testing of the NERVA Thrust Chamber Assembly" was issued as enclosure (1) to memorandum 8207:505.

b. Fabrication

No hardware fabrication was scheduled for December.

c. Testing

No testing was scheduled for December.

d. Support

All the deflection data from the Series I, Phase I, TCA Dynamics Test have been presented graphically. These deflection plots were studied to evaluate and separate the principal modes. Effort on the final test data report for the Series I, Phase I, TCA Dynamics Test continued.

A test arrangement for the calibration of the dummy gimbal actuators was formulated.

2. Planned for January

a. Engineering

Direction will be given the test area in writing the final test data report for the Series I, Phase I, TCA Dynamics Test. Direction will again be given for the determination of stiffness values for the dummy gimbal actuators.

b. Fabrication

No hardware fabrication is planned for January.

c. Testing

Stiffness values for the dummy gimbal actuators, employed in TCA dynamic testing, will be determined.

d. Support

The dummy gimbal actuators will be calibrated.

Data evaluation of the Series I, Phase I, TCA Dynamics Test will continue with the probable completion of the final test data report.

B. ITEM 1.4.1 - NOZZLE AND EXTENSION DEVELOPMENT

1. Accomplished in December

a. Engineering

Engineering efforts involved surveillance of the U-tube nozzle fabrication activities at LRP and the Marquardt Co. Revisions to the fabrication drawings were accomplished as conditions requiring them were disclosed.

Evaluation of the tube-to-nozzle braze joint proceeded with full length specimens simulating the nozzle contour upon receipt of 16 U-tubes from Marquardt. These tubes were development pieces with local deviations in contour from print, and were supplied to LRP (at no cost) to permit acquisition of handling, preparation, and tube loading experience prior to receipt of acceptable tubes. Tube loading exercises were conducted with braze foil attached to the tubes as described in AGC process specification #46601 "Nozzles, U-tube, NERVA, Fabrication and Brazing Procedure for". It was learned that this method is impractical because excessive force is required to insert the tubes in the grooves with resultant tube damage highly probable.

The tube loading procedure was revised as follows:

1. Braze alloy in the form of 0.020 diameter wire was preplaced on the jacket at each side of the groove (no alloy was attached to the tube).

2. The tubes were inserted in the grooves.

3. Shims wrapped with braze foil were inserted between the tubes (and bottomed in grooves) to reduce the tube-to-jacket clearance for good braze joint integrity.

This specimen was brazed and subsequently hydrotested. Failure occurred at 1080 psig at a place predicted to fail due to insufficient depth of the tube leg into the groove.

The specimen is being repaired using methods under investigation for repair of the nozzle. Hydrostatic testing will be resumed after repair is complete.

The second simulated nozzle test segment was brazed at Marquardt. A successful repair of numerous leaks was made utilizing Nioro wire. During hydrostatic testing burst occurred at 1500 psig. Subsequent repair was successfully made three times by removing sections of failed tubes and manually welding and brazing tube sections back in place with a 2350 psig burst pressure being reached.

Surveillance and evaluation of fabrication efforts continued. Tube manufacturing techniques and problems were given special consideration because delivery of the parts from the vendor is two months behind schedule. However, the first shipment of J-tubes is being inspected.

Evaluation of optimum joint configuration between tube and jacket was continued. Four configurations are being fabricated for testing early in January 1964.

The design of the J-tube nozzle assembly has been completed and drawings are being released for fabrication. Advance copies of the drawings were submitted in mid-December to Fabrication Engineering for evaluation and to serve as an aid in planning the fabrication sequences required to build the part.

Hot bleed nozzle drawings were modified to preclude any possible leakage between the aluminum jacket and tube bundle. These changes will be incorporated into all hot bleed nozzles.

Detail fabrication drawings (704969) for the jacketed turbine inlet line are being released.

b. Fabrication

Brazing of tubes to the test segment was completed; the braze was then x-rayed and hydrotested. X-ray revealed the feasibility of checking tubes for blockage after brazing. The hydrotest failure occurred at the cylindrical portion of nozzle, approximately three inches from the radius into the convergent section of the nozzle. Investigation of the sample will continue.

An explosion occurred at the Marquardt plant on 2 December when the retort was being cut open after a furnace annealing cycle of approximately 40 preformed tubes. Approximately 16 tubes were salvaged. An improved furnace pruging cycle has been incorporated. In addition, another method of sealing incorporating a tear seal has been developed; the new procedures are expected to eliminate any further explosions.

Rework of tube forming and trimming tooling has been completed; an initial shipment of 16 tubes to LRP is expected by 1 January 1964.

S/N 009 nozzle was completely grooved and the deburring operation has been started. All component parts except the tubes are available for assembly.

S/N 008 nozzle was grooved and deburred. The torus and associated fittings were installed. Currently, bridges over the grooves in the aft end of the nozzle are being installed.

Machining of the J-tube jacket continued. The jacket I.D. was contoured to accept the tubes, and fuel outlet passages were machined. During machining of the fuel inlet slots, a descrepancy developed requiring rework.

An approximate slip of two weeks in completion of this operation resulted.

The old configuration hot bleed nozzle port manifold of nozzle S/N 013 was machined off during this report period. The new port manifold is being installed. As a result of the decision to install the new torus and flange assembly on hot bleed nozzle S/N 014, no fabrication was pending arrival of the new designed torus from the vendor. At present the new torus and flange are being mated together prior to installation on the nozzle.

The aluminum manifold was installed and final machined on adapter S/N 003N. 75% of the dump system components were welded into place.

Adapter S/N 004N has undergone heat treatment and preliminary machining.

The quantity of adapters on order has been reduced from 3 to 2. Fabrication is pending receipt of the tube assemblies which are on order for CY 1964.

The face of injector S/N 0260 was machined to contour. Approximately 50% of the injection orifice pattern was drilled.

The fuel feed slots and bolt holes in the injector main flange were drilled, along with pressure and temperature boss inlets for injector S/N 0242. The seventeenth channel face plate was also welded into place during this report period.

Action has been taken to rework injector S/N 0112 to copper face plates and baffles.

The quantity of new injectors on order for this contract year has been reduced from 2 to 1. All component hardware has been procured to start fabrication of one unit.

Fabrication of skirt S/N 001 was initiated on December 17 and is 30% complete on weld mandrel. (Approximately 15% complete overall) No problems have been encountered thus far.

The start of water cooled adapter fabrication has been delayed due to lack of shop planning. All parts and tooling are available.

Fabrication of the pump discharge line (299090) for CFDTS continued.

Material for the jacketed portion of the turbine inlet line is in-house and the unit will be placed O.P. early in January. Material for the other two portions of the line is not completely available in LRP as of this report period.

c. Testing

No testing was accomplished during December.

d. Support

Analysis for redesign of the hot bleed port structural reinforcement is 10% complete.

The thermal and pressure stress analyses for chemical firing and with a prechill and 1.3 second propellant flow ramp and profile times of 5, 10, 15, and 25 seconds are 85% complete. These analyses incorporate the new 6061-T6 aluminum injector-to-nozzle adapter.

The steel nozzle jacket is presently being stress analyzed for the nuclear firing environment as defined by the new heat-up rates. The analysis is 70% complete.

Two full length "U" tube specimens were assembled during December. The tubes and simulated jacket sections used for these specimens were re-worked from scrapped components which did not meet blueprint dimensionel requirements, but did permit obtaining assembly and processing data. Specimen number one was assembled by Department 9670 and 9660 personnel. Groove widths were 0.037 to 0.038 inch and alloy preplaced on both sides of the tube legs. The third tube could not be forced into position and specimen

fabrication was abandoned. Specimen number two was assembled by Department 9670 personnel at Pyromet Incorporated, San Carlos. Nioro braze alloy wire 0.020 inch in diameter was preplaced on the grooves adjacent to the shim areas. Nioro braze alloy foil 0.001 inch in thickness was resistnce welded to precut stainless steel shims of predetermined thicknesses. These shims were forced between the tubes. Tube contours were such that tube legs did not bottom the grooves between the cylindrical and the convergent sections and hydrotest failure occurred in this area at 1080 psi.

2. Planned for January

a. Engineering

Evaluation of the U-tube nozzle tube-to-jacket braze joint will have been completed. Three specimens, in addition to the current one, will have been brazed, hydrotested, and sectioned for detailed analysis. Concurrently, the braze joint repair procedure will have been established, based on test experience. The results of these investigations will have been incorporated into the U-tube nozzle design.

Complete redesign of the U-tube nozzle concept will have been accomplished. This effort will include all the experience gained on fabrication of the two U-tube nozzles currently being built. This design will be incorporated in future U-tube nozzles.

Final J-tube nozzle assembly drawings will be available early in the report period.

Evaluation of the joint configuration, tube-to-jacket, will have been completed, and the design will be incorporated into the nozzle.

Drawings will be released showing the installation of copper baffles into the stainless steel injector S/N 0242. Also, an injector development test plan will be written and published.

b. Fabrication

Installation of the tubes into the nozzle 008 jacket, including brazing, will be completed. Fabrication completion of the nozzle is scheduled for the second week of February 1964.

The jacket will be ready for nozzle 009 tube installation during the first week of January 1964, however, tube delivery from Marquardt is not expected until the middle of the month. Based upon this, tube installation will be nearing completion by the end of the report period. Nozzle fabrication will be complete in the first week of March 1964.

The J-tube nozzle jacket will be machined to the level of assembly for tube installation early in the report period. However, the actual tube installation operation may be delayed if tube rework is required to incorporate the optimum joint configuration.

Hot bleed nozzle S/N 013 will be cast during the third week of January. Radiographic inspection and interpretation of the x-rays will be complete by the end of the report period.

Nozzle S/N 014 will be ready for the first furnace braze cycle by the end of January. The new port manifold, flange, and torus assembly and thermocouple pass thrus will have been installed.

NERVA adapter S/N 003N will be completed and delivered to sub-store #11 during the third week of January.

The tapped and drilled holes which mate the thrust support structure, injector, and aluminum manifold will be completed. The ring seal between the adapter casting and aluminum manifold will also be welded into place for adapter S/N 004N.

Long lead components for adapters S/N 005N and S/N 006N necessary for initial tube layup will be started during the report period.

The orifice pattern for injector S/N 0260 will be completed during the report period. In addition, the copper baffles will be brazed into the injector.

Injector S/N 0242 will be completed to the point of pattern installation.

The stainless steel face plates of injector S/N 0112 will be removed and replaced with copper face plates during the report period.

Fabrication of the new injector will be started during the second week of the report period.

The skirt S/N 001 will be complete on weld mandrel. Furnace brazing will be accomplished by end of January. The skirt will be 70% complete at this time.

The water cooled adapter will begin layup in first week of January. The component will be removed from weld mandrel by the end of January.

Pump discharge line fabrication will continue. Turbine inlet line fabrication will be initiated.

c. Testing

No testing is scheduled during January.

d. Support

The following full length U-tube contoured specimens are scheduled for assembly and brazing during January:

(a) Specimen No. 3

(1) Groove width 0.037 to 0.038

(2) Shim size 0.006 to 0.008

(3) 0.001 "U" foil around shim

(4) 0.020 wire on each side of groove

(5) Six each standard size tubes, and one split tube

The above is to be brazed, with closures welded.

(b) Specimen No. 4

(1) Groove width 0.041 to 0.042

(2) Shim size 0.008 to 0.010

(3) 0.001 "U" foil around shim

(4) 0.001 foil preplaced in shear areas

(5) Six each standard size tubes, and one split tube

The above specimen is to be brazed, with closures welded.

(c) Specimen No. 5

(1) Groove width 0.051 to 0.052

(2) Shim size 0.018 to 0.020

(3) 0.001 "U" foil around shim

(4) 0.001 foil preplaced in shear area

(5) Six each redesigned tubes (to accommodate shims) and one split tube .

The above specimen is to be brazed, with closures welded.

Specimens 3 and 4 will be fabricated upon receipt of the present designed tubes scheduled for delivery during the first week of January. After brazing, these specimens will be subjected to x-ray examination and hydrostatic test.

C. ITEM 1.4.2 - THRUST STRUCTURE AND GIMBAL

1. Accomplished in December

a. Engineering

The design study of E-engine prototype thrust structures has been stopped pending the receipt of revised Saturn boost loads from REON.

Evaluation of test data from the upper and lower thrust structure static tests, 748N and 749N, continued. Work on the final test evaluation report for static test 748N was continued. This report is presently being delayed due to the unavailability of manpower for the stress analysis support.

Design of the tubular supports and end fittings for the pneumatic supply system tanks has been initiated. This structure will initially be designed as a unit to be bolted on the upper thrust structure. The bolt-on concept will permit the pneumatic supply system tanks and support structure to be dynamic and static tested in CY 64 with existing thrust structure hardware.

Gimbal assembly engineering effort responsibility was transferred from the LRP Thrust Chamber Department (9663) to the NERVA Thrust Systems Department (8207).

Gimbal drawings, documentation, and status were reviewed by Department 8207 personnel for familiarization.

The updating of gimbal drawings continued. The release of updated drawings is being delayed due to a lack of manpower for stress analysis support.

The gimbal cryogenic structural test fixture design was reviewed and approved by Department 8207 personnel.

Preparation of the gimbal schock and vibration test plan continued.

A preliminary thermal analysis was made on a proposed external gimbal ring design.

A thermal analysis was initiated on the Rift flange. Boundary conditions were determined and preliminary hand calculations were made. A computer is being used to calculate the thermal gradients in areas of interaction of the flange, the clamp, and the actuator supports.

b. Fabrication

Fabrication of three each upper (S/N 006, 007, and 008) and lower (S/N 002, 003, and 008) thrust structure assemblies continued.

Completion of gimbal assembly S/N 001, scheduled for completion in December, was delayed pending receipt of bearings. These bearings were rescheduled for delivery in January.

c. Testing

No testing was scheduled for December.

d. Support

All the deflection data from the thrust structure resonance survey (Test NV-DL-015-SV) were converted to graph form. Evaluation of test data continued. Effort on the final test data report for the resonance survey (Test NV-DL-015-SV) continued.

The final test data report (TR 749N) for UTS S/N 001 was published. The final test data report (TR 748N) for LTS S/N 001 is being published.

Materials report MRR 63-618, recommending Inconnel 718 alloy as a higher strength-to-weight ratio material for thrust structure application, was issued.

2. Planned for January

a. Engineering

Design of the pneumatic supply system tank supports will be completed.

The design study of E-engine prototype hardware will be continued pending receipt of design loads from REON.

Evaluation of test data from the upper and lower thrust structure static tests, 749N and 748N, will continue.

The gimbal shcok and vibration test plan will be issued.

Thermal analysis of the RIFT flange will be completed.

b. Fabrication

One upper (S/N 006) and one lower (S/N 008) thrust structure, presently being fabricated at Arde-Portland Inc., will be completed.

The four gimbal housing assemblies presently being fabricated will be completed.

The third gimbal assembly (S/N 001) will be completed.

Two upper (S/N 007 and 008) and two lower (S/N 002 and 003) thrust structure assemblies, presently being fabricated at AGC Downey, will continue.

c. Testing

No tests are programmed for January.

d. Support

Evaluation of data from the resonance survey (Test NV-DL-015-SV) will be completed, and the final test data report will be issued.

The final test data report (TR 748N) for LTS S/N 001 will be published.

D. ITEM 1.4.3 - PRESSURE VESSEL

1. Accomplished in December

a. Engineering

Work was initiated on the preliminary drawings for the location and fabrication of the attachment pads needed for the cold flow development test. The interface requirements for the instrumentation holes, pneumatic systems tube support brackets, the pump discharge line brackets, and turbine inlet line brackets have been established.

Advanced drawing change notices were written and released to revise the pressure vessel fabrication drawings to reflect the interface change order requested by WANL. The changes increased the inside diameter of the forward end of the cylinder and established a chamber on the inside diameter of the closure.

The steady state thermal analysis of the nozzle pressure vessel flange was initiated and completed. The analysis was based on a profile taken through the bolt section with both the keensert and helicoil inserts.

Evaluation of metallic seals, test series I, has been completed with the assembly and publication of the document remaining. Cryogenic pressure vessel seal testing studies continued.

Data evaluation of the titanium pressure vessel test (Test 280N) was not accomplished during the report period due to manpower priorities.

Plans for thread inserts (helicoil and Keensert) evaluation have been completed and testing will soon commence.

b. Fabrication

Pressure vessel S/N 005 was machined for the NRX-A series of instrumentation holes and was then turned over to Sub-subtask 1.1.8 for fit-up with S/N 011 nozzle.

Pressure vessel S/N 002 was returned to the vendor to have the helicoils replaced and is presently scheduled for delivery to sub-subtask 1.1.8 in January.

Pressure vessel S/N 007 is approximately 95% complete. The pressure vessel will be hydrotested prior to delivery to AGC.

Pressure vessel S/N 006 underwent hydrotest at the vendor's facility and upon disassembly some of the helicoils backed out of the flanges with the bolts. An investigation of this problem is underway and appropriate action will be taken.

The fabrication of the new pressure actuated seal design was not initiated because the SNPO-C purchase order approval was not received at LRP until 27 December. Futhermore, LRP has not received authorization to use the government owned vendor facilities.

c. Testing

See Item d, Support.

d. Support

Aluminum pressure vessel S/N 003, was received in the structural test laboratory on 12 December. Instrumentation was installed and the test setup was begun.

Helicoil bench tests were initiated (Test 1050N).

Preparations were made for beginning the second series of seals tests in January 1964.

A new wooden spacer, T-417212-2, for use in reducing free gas volume inside the pressure vessel during gas pressure seals tests was completed.

Stress analyses were completed for two component test conditions, the titanium pressure vessel test (280N), and the one zone aluminum pressure vessel now being run (909N). Results are presented in stress reports N-83 and N-139, respectively.

2. Planned for January

a. Engineering

Design support of the pressure vessel program will be continued. No major design changes are anticipated. The investigation of the helicoil problem will be continued and every effort will be made to determine the cause and corrective action. Results of the helicoil bench tests will be analyzed.

Project direction will be provided supporting test 909N and the ambient temperature series 2 seal test (904N-2).

The test report for metallic seals, test series 1, will be issued. Cryogenic seal test planning will continue.

b. Fabrication

Pressure vessel S/N 002 will have the helicoils in the aft end replaced. The I.D. of the forward end will be remachined and the vessel will be hydrotested for requalification.

Closures S/N 003, 004, and 007 will be machined by the vendors, prior to delivery to AGC, to incorporate the interface change order requested by WANL.

Fabrication of the pressure actuated seals will be started in January.

c. Testing

See Item d, Support.

d. Support

Test 909N, a hydrostatic proof pressure test of aluminum pressure vessel S/N 003, will be completed.

Series 2 of test 904N, the metallic seals gas pressure leakage test, will begin in January.

Work will be preformed on the transient thermal stress analysis of the pressure vessel for the NRX-A2 power transient conditions.

E. ITEM 1.4.5 - REACTOR NOZZLES

1. Accomplished in December

a. Engineering

Studies were continued on evaluation of tube-jacket contact conductance. Cast samples are presently under fabrication for correlated heat transfer and ultrasonic testing.

Heat transfer work was continued on the evaluation of thermal conditions in the NRX-A jacket. The transient jacket temperature profile was established under NRX-A2 flow and power conditions. Stress analysis was initiated on the above. The NRX engine conditions, as outlined in model specifications, are being similarly analyzed for jacket temperature transients.

Design changes were adopted which seal the jacket from external leakage under the jacket. These apply to the area under the aft retaining band, the thermocouple pass throughs, and the three bolt coolant nipples. Techniques are being evaluated for similar application at the core support flange.

The cast jacket from S/N 007 was evaluated for casting defects. Repairs were recommended for two discrepant areas.

The new torus-flange assembly design was completed for NRX-A nozzles. It has been incorporated on S/N 015.

Engineering surveillance was provided to follow fabrication efforts.

Engineering effort on hybrid nozzles will be directed towards locating and repairing the leak sources in these nozzles.

Transient and steady state thermal analyses were completed for the NRX-A2 nozzle-pressure vessel flange with external bolt coolant manifold. The analyses were performed both with and without a gap leakage between the nozzle jacket and tubes.

A steady state thermal analysis of the NRX-A2 nozzle-pressure vessel flange, with a profile taken through the bolt section with "Keenserts" and "Helicoil" inserts, was completed.

New drawings of the NRX-Propellant Feed Line to facilitate fabrication were released.

Effort was initiated on a vibration test of the NRX-PFL.

b. Fabrication

The test samples from nozzle S/N 006 and 007 flanges were heat treated and are being machined into R-3 test specimens. The defects found in the jackets were weld repaired. X-ray inspection verified soundness of repair. The nozzles were preliminary machined and bolt coolant feed holes in flanges were drilled. Welding of exterior bolt cooland manifolds will be complete before January.

The casting of nozzle S/N 007 was grit blasted after two casting descrepancies were weld repaired.

A tube leak test after casting revealed leakage under the jacket on nozzle S/N 007. Location of the leak was found to be at the core support flange where the tubes are brazed in. Final disposition of the problem has been held up pending studies of possible repair methods. To date, the repair procedure has been partially established at the aft retaining band at the bolt coolant nipples and at the thermocouple pass-through location and will be incorporated in fabrication. These techniques keep the leakage internal.

Nozzle S/N 012 was prepared for casting and is in the foundry. Leak prevention techniques were incorporated under the aft retaining band using steel wool stuffing and Easy-Flo 45 braze alloy. The thermocouple pass throughs were sealed with Premabraze 250 to prevent gas holes in the casting. (Gas holes could be caused by contamination escaping under pass throughs from action of molten aluminum).

The new torus-flange assembly was installed on nozzle S/N 015. Tubes were swaged and the nozzle was delivered to Pyromet for furnace braze of tube bundle.

Viewport nozzle S/N 010 had Armstrong C-2 and lithumn silicate applied to the leakage area. However, leakage continued because of misapplication and because the leakage area could not be well defined when applying the sealant. The nozzle was then turned over to Department 8200 for vibration testing.

Fabrication of viewport nozzle S/N 011 was completed during the month and was turned over to Department 8200 for NRX-A1 cold flow testing. The new drawings of nozzle S/N 011 will be released next month.

Tests to locate the leak source on Hybrid nozzle S/N 001H were not conducted due to a lack of special tooling. This special tooling was designed and put into fabrication for the nozzle.

Due to delay in completion of hybrid nozzle S/N 002H, the test assembly builup was halted. A mockup test assembly was sent to test zone "H" for stand activation. A special shrink ring was designed and fabricated for this nozzle, to ensure a seal at cryogenic temperatures.

No fabrication work was done on nozzle S/N 001L in December, due to other higher priority work in the shop and AGC foundry.

The cast jacket of nozzle S/N 002L was chemically removed to prepare this nozzle for recasting.

Nozzle S/N 001N was received from Howard Foundry. It was visually and dimensionally inspected. A large number of voids were noted in the cast aluminum around the throat. It was decided to examine the nozzle thoroughly prior to making any decision to machine or scrap the nozzle.

Fabrication of NRX-PFL S/N 003 continued.

c. Testing

No testing was performed during December.

d. Support

The steady state nuclear environment analysis for the NRX-aluminum nozzle jacket, drawing 284800, was 75% completed.

Twelve test fixtures simulating the leak area conditions on the S/N 005 nozzle were submitted for repair and leak testing. Four of the fixtures were repaired with four candidate materials, including three epoxy resins (one metal filled, one alumina filled and an unfilled flexible compound) and a metal filled lithium silicate compound with one epoxy topcoat. Leak testing

will be performed.

Testing will be performed at room temperature and -320F with pressures to 533 psi. Both slow and rapid pressure application will be used.

Pressure testing of S/N 010 nozzle has shown that only two of the six tube crack repairs were successful. Notwithstanding these results, it is possible that this repair procedure and material may be effective in situations where the leak areas are more readily identified and more accessible. Additional repairs will not be necessary since NRXA-10 is no longer intended for flow test.

Voids between support webs on the aft end of the S/N 9 nozzle were filled with a water soluble trisodium phosphate sodium pyrophosphate salt mixture to serve as a machining aid during groove cutting on the nozzle I.D. The material can be removed with hot water or steam, following machining.

Work was begun to develop methods of sealing the interface gap between the chamber tubes and cast jacket. Three specific methods were considered:

(1) Sealing the interface gap off at the core support flange and bottom end of the jacket.

(2) Using organic (metal filled) materials to fill the gap.

(3) Developing a metallurgical bond between the steel tubes and the aluminum jacket material to eliminate the possibility of a gap forming.

Fabrication was begun on special test samples and tube bundles to support the sealing program.

The gating for the cast jackets has tenetatively been fixed to the configuration used in castings NRX-A-006 and 007.

2. Planned for January

a. Engineering

Studies will continued on the contact conductance problem.

Cryogenic heat transfer tests will be conducted on thirteen different samples of cast jackets. Results from the recent cold flow test of S/N 004 (skin temperature data) will be utilized. In addition, ultrasonic evaluation of the test samples and possibly a nozzle will be compared with heat transfer data analysis.

Heat transfer and associated stress analysis on the NRX-A jacket will be continued. By the end of January the jacket will have been completely analyzed for conditions of cold flow, NRX-A2, engine, and chemical firing. Relative stress levels will be used to establish acceptance tests.

A final decision will be made on repair and prevention of leakage under the NRX-A jackets. This will be incorporated on the drawings for all NRX-A nozzles in process.

Evaluation of the tensile properties of S/N 006 and 007 nozzle jackets will be made from the specimens taken from the flange area.

Evaluation of the nozzle S/N 012 casting will be made on the basis of cast bars, samples taken from the flange, and x-rays.

Engineering surveillance will be provided for all fabrication efforts.

Engineering effort on hybrid nozzle S/N 002H will be directed toward fabrication liaison and the conductance of test stand H-4 checkout firing.

The vibration test of the NRX-propellant feed line will continue and completion should be near by the end of January.

b. Fabrication

Nozzle S/N 006 will have all the welding on the jacket and the heat treatment completed. Final machining and drilling of the flange should also be completed.

The casting of nozzle S/N 012 jacket will be accomplished late in December. Following engineering evaluation, repairs will be made, if required. The jacket will be cleaned up, grit blasted, and preliminary machined. By the end of January, heat treatment should be accomplished and final machining begun.

Nozzle S/N 015 will be furnace brazed for the first cycle. Following hydrotest, the interlocks will be tacked in place and brazed. The jacket repair procedure will be incorporated at the aft retaining band, bolt coolant nipples, and thermocouple pass-throughs. Following a tube leak check, the tube bundle assembly will be mounted on the casting fixture and cast late in January.

The leak sources in nozzle S/N 001H will be located and, if repairable, will be repaired and the nozzle put into storage.

The new shrink ring for nozzle S/N 002H will be installed and checked for leaks. If any leaks are found, these will be repaired and the nozzle will be made available for TCA buildup.

Nozzle S/N 001L will be made available to the AGC foundry for casting during the last week of December. After casting, the nozzle will be hydrotested and x-rayed. (If found acceptable) the machining operation will be started.

Nozzle S/N 002L will be made available to the AGC foundry during the first week of January. After casting, the nozzle will be hydrotested and x-rayed. If acceptable the machining operations will be started.

Nozzle S/N 001N will be x-rayed. The physical properties of the jacket will be evaluated from the cast-on bars parted from the pressure vessel support flange. The tube bundle will be checked for leaks. If the

x-ray results and physical properties of the cast jacket are acceptable, the jacket and tube bundle will be repaired, and the nozzle will be machined.

Fabrication of NRX-PFL S/N 003 will be completed and fabrication of line S/N 004 will begin in accordance with the new drawings.

c. Testing

Two LO_2/LH_2 firings are planned for the fourth week of January to check out test stand H-4. The test plan for this series will be released the first week of January.

d. Support

The steady state nuclear environment analysis will be completed.

Room temperature and cryogenic pressure testing will be performed on the repaired S/N 005 test fixtures. Four of the remaining fixtures will be repaired using the most promising material(s) if the schedule permits.

The S/N 005 nozzle will be repaired using the most promising material.

F. ITEM 1.4.6 - APPLIED RESEARCH PROGRAM

1. Accomplished in December

Engineering

a. Pressure Vessel Assembly

A report covering the results of laboratory tests to simulate the corrosion problem arising from the hydrotesting of the PVA when the metal ring seals (lead-plated 6061-T4 Al. alloy) contact the 6061-T6 alloy cylinder and closure, is being written.

The investigation of the 6061-T6 forging from Marquardt which showed mottling on radiographs made by the vendor is being continued. Tensile specimens machined from a section which showed mottling have been tested and

the results show tensile properties equal to or better than those from 6061 Al forgings - not exhibitring mottling.

The tensile specimens machined from the forgings used in P.V. S/N 004 were tested. Standard V-notched Charpy specimens were machined from these forgings and delivered to project engineering for further disposition.

b. TCA Materials Development

Quotations were requested for chemical analysis of the A-286 material purchased from Camcar Screw and Manufacturing Company. Vendor certifications of chemical composition have been received from Camcar covering the A-286 material purchased from them. An appearent error in one of the certifications is being checked. The report on the testing of this material has been held up pending resolution of this discrepancy.

DVR 63-606 covering tensile testing of 18% Ni maraging steel bolt material was issued.

c. Gimbal Materials Development

Re-evaluation of the Gimbal Materials Development Program was continued with principal effort being on a literature review. An investigation into the feasibility of hard coating 18% Ni maraging steel for gimbal application was started.

d. Cast Aluminum Jacket Development

Effort for the report period was in direct support of sub-subtasks 1.4.1 and 1.4.5.

e. Brase Alloy Development

Effort was in direct support of sub-subtask 1.4.1.

2. Planned for January

Engineering

a. Pressure Vessel Materials Development

The evaluation of mottled 6061 aluminum forging will be completed. A report on the tensile properties of forgings used in pressure vessel S/N 004 will be completed.

A report detailing the corrosion simulation laboratory tests will be issued.

b. TCA Materials Development

The report on testing of Camcar A-286 bolt material will be published.

The testing of Inconel 718 bolt material from Vol-Shan will be started when the material arrives.

Cryogenic testing (-423°F) will be started on both the 18% Ni maraging steel and the A-286 bolt materials when the AGC cryogenic lab is activated.

c. Gimbal Material Development

The materials re-evaluation and hardcoating investigation will continue.

d. Cast Jacket Program

Engineering support will be given sub-subtasks 1.4.1 and 1.4.5.

e. Braze Alloy Development

Engineering support will be given to sub-subtask 1.4.1.

ITEM 1.5 - ENGINE CONTROLS

A. ITEM 1.5.0 - CONTROL SYSTEM INTEGRATION

1. Accomplished in December

Engineering

Preparation of the contract year 1964 cost study was continued as was the technical management and coordination of the Subtask 1.5 effort.

2. Planned for January

Engineering

All work will be concluded and a topical report describing accomplishments and status at the end of January 1964 will be issued.

B. ITEM 1.5.4 - HARNESS AND CONNECTORS

1. Accomplished in December

a. Engineering

The test plan for evaluating wire, cable, and harness insulations was completed as was the test plan for evaluating remote assembly/disassembly electrical connectors.

b. Fabrication

The wire from Physical Science Corp. for the simulated harness for EIT #504 was received.

c. Testing

Two conduit designs were tested to determine performance at 1500°F. Both the Servi-Flex and Anaconda tubing withstood 10 minutes at 1500°F without damage. The tubing was discolored, but remained flexible.

A nickel clad copper wire with special woven ceramic sleeving insulation was successfully tested for five minutes at 1500°F. A 1000 vac dielectic strength test conducted at 1500°F resulted in a leakage current of 80 microamperes.

A test to determine the maximum current derating of a particular wire size in a space vacuum was completed. The test was conducted on a typical cable bundle consisting of 60 size No. 20 Nickel clad copper conductor stranded wire. The center wires were subjected to the maximum current carrying capacity in accordance with MIL-W-8160B; the wire temperature rise was monitored by a thermocouple at sea level and 150,000 feet simulated altitude. The maximum steady state current carrying capacity derating at simulated altitude was 30% with a temperature rise of 30°F.

2. Planned for January

a. Engineering

In complisnce with customer direction of 26 December 1963, the engine control system development effort for the balance of CY 1964 will be concluded. Engineering, test planning, and fabrication work in process will be stopped immediately or brought to a conclusion during January. A report of the Subtask 1.5 development efforts and program status at the end of January 1963 will be issued.

b. Fabrication

Wire and cable components on order will be received in January. This material will be stored for future development work on the Subtask 1.5 effort.

ITEM 1.7 - PNEUMATIC POWER SUPPLY

A. ITEM 1.7.0 - PNEUMATIC POWER SYSTEM ASSEMBLY

1. Accomplished in December

Engineering

Revisions to the NCS-400 program cost study (to reduce the scope of the Subtask 1.7 pneumatic system effort during contract year 1964) were prepared.

The preliminary radiation effects test plan for radiation effect testing of the E-block I pneumatic system components on pallet #931 was approved and issued.

Schematic diagrams for E-blocks I, II, and III and for the FX engine were reviewed.

Some work was done on the FX engine layout and development layouts; however, due to recent instructions all work has been discontinued.

Vendors continued detail design and fabrication development of the various pneumatic system control components.

Coordination and liaison effort related to the pneumatic system components of the CFDTS program was performed.

2. Planned for January

Engineering

Engine schematics for the E-blocks I, II, III, and the FX engine will be approved and distributed as part of the status report for the subtask effort.

The preliminary test plan for pneumatic system component testing on radiation effects test pallet #931 will be approved and included in the subtask status report.

Engineering development work on the pneumatic system will be concluded during January 1964, per customer direction. A report will be prepared defining the program accomplishments to date on systems and analysis work of the pneumatic system and outlining status of work at the end of January 1964.

B. ITEM 1.7.1 - PNEUMATIC POWER SYSTEM COMPONENTS

1. Accomplished in December

a. Engineering

Bellows and line component specification AGC 40187 was released.

A preliminary test plan for non-radiation development testing of the test stand pneumatic connector was completed.

Preliminary design of orifices for the E-block I engine was started.

Design studies on the various test stand pneumatic connectors were continued. These designs represent a backup design effort to vendor design proposals.

A design review of the Aeroquip (marman) test stand pneumatic connector design proposals was held and minor changes to the designs were discussed with Aeroquip personnel. These revisions will be incorporated in the revised proposal to be submitted prior to completion of contract negotiation.

b. Fabrication

A fabrication order was issued for three 3/4" test stand pneumatic connectors (TSPC), three 2½" TSPC, and three 5" TSPC. These will be procured from the Aeroquip (marman) Corporation. A memo outlining the justification for sole source procurement of TSPC was prepared and submitted for outside procurement.

DACO Metal Products Company submitted the lowest bid on fabrication of four 38" diameter 410 CRES spherical (non-prototype) storage tanks. Specification control drawings were prepared and approval signatures are now being obtained. The tanks will be fabricated to Qcal III.

The two vendors supplying 1¼-inch check valves, H. W. Loud Machine Works, Inc. and W. O. Leonard, Inc., have both finished fabrication of detail parts and have started development testing. Both vendors are approximately two weeks behind schedule.

The Roylyn Co., supplier of the ½-inch relief valve, has completed fabrication of a prototype valve and is conducting development tests. Testing to date indicates that they will be able to meet the required leakage rates with further development of their metal-to-metal seal. They have completed fabrication of the parts for three valve assemblies with the exception of the valve bodies. The valve bodies will undergo final machining after the metal-to-metal seal configuration has been established.

The Vacco Valve Co. completed assembly and all testing of the 1¼-inch filters. All four units successfully completed the acceptance tests. One filter was subjected to and successfully completed a vibration test.

2. Planned for January

a. Engineering

Engineering design and development effort on the pneumatic system components will be concluded during January 1964, as directed by the customer. A report will be prepared defining accomplishments to date and the status of component development as of 31 January 1964.

Some fabrication liaison on control components at vendors will be required.

b. Fabrication

Fabrication orders for test stand pneumatic connectors and non-prototype storage tanks will be cancelled.

Fabrication of pneumatic system control components (check, shut-off, relief, regulator valves; filter) will continue until these items are complete. Procurement of these components was started during contract year 1963. The components will be acceptance tested and inspected at the vendor plants by AGC source inspectors and after delivery to AGC, will be stored in the original shipping container.

Four filters will be received from the Vacco Valve Company.

ITEM 1.8 - SYSTEM ANALYSIS

A. ITEM 1.8.1 - NON-NUCLEAR DEVELOPMENT TEST SYSTEM

1. Accomplished in December

Engineering

A complete report of the data analysis program was compiled.

Engine start up transients were investigated for several different tank pressures.

Refinements of the CFDTS data reduction program (No. 18080), to take into account two phase flow, were started.

2. Planned for January

Engineering

Work will continue on CFDTS data reduction program, No. 18080, to include two phase flow.

Flow problems and heat transfer analysis will be solved as needed.

B. ITEM 1.8.2 - NRX REACTORS

1. Accomplished in December

Engineering

The NRX-A1 in-house pre-test analysis report was released.

Data from the NRX-A1 in-house tests were analyzed and presented.

The NRX error analysis program was completed; conclusions are being prepared.

The NRX-A2 pre-test analysis is in process.

2. Planned for January

Engineering

Work will be continued on the NRX-A2 pre-test analysis report.

Final results will be obtained from the NRX error analysis program.

The next series of A1 tests will be analyzed.

C. ITEM 1.8.3 - ENGINE ANALYSIS

1. Accomplished in December

Engineering

The modified nozzle tube program is in operation.

The transient engine digital computer program was compiled and is in the checkout phase of development.

Parametric studies of the four-inch hot bleed port were started.

Calculations are in process to obtain a computer program to predict test results on the hot bleed port program.

A preliminary thermal analysis of a proposed external gimbal ring was completed.

A thermal analysis of the RIFT flange is in process. Hand calculations are complete and computer runs are being made.

2. Planned for January

Engineering

Maximum effort will be given to the completion of the transient engine computer model; parametric studies of the hot bleed port will be continued.

An analysis of the NARF propellant feed system will be initiated.

The thermal analysis of the RIFT flange will be completed.

A study will be started on the four-inch hot bleed port test configuration.

Engine capacitance effects will be added to all major computer programs.

ITEM 1.9 - RADIATION EFFECTS

A. ACCOMPLISHED IN DECEMBER

1. Engineering

The design of the control pallet is essentially complete. All drawings have been submitted for final LRP approval.

All drawings for MIT 905, except the top assembly drawings, are complete.

Rework of the final report for MIT 901 to the revised format requested by REON was continued.

The final test specifications and test procedures for MIT 904 were continued. Revisions to the test requirements, received from Subtask 1.2 on 19 December, increase the test duration to 60 minutes irradiation time with a total running time on the bearings of 75 minutes. This will require temporary shutdown during the test while the liquid hydrogen dewar is refilled.

The final test plan for MIT 904 was revised in accordance with the above requirements and transmitted to REON on 20 December.

Data reduction and evaluation of EIT 501 test results was continued.

The checkout of the bearing tester with bearings for MIT 904 was completed and the bearing tester with bearings installed was shipped to GD/FW on 18 December.

The drawings and basic parts list for EIT 501 were revised to reflect the final test configuration with the revised shaker motor mounting.

MIT 903 corrected test data were received from GD/FW on 10 December and the data reduction and evaluation of test results was started.

MIT 902 data reduction and evaluation was discontinued at LRP until corrected test data are provided by GD/FW.

All engineering design tasks for the EIT tests were discontinued on 20 December. All drawings and engineering data are being forwarded to REON.

Cost Proposal NCS-400 was completed and forwarded to REON.

A revised thermal analysis for the EIT 502 dewar was initiated on 12 December. The boundry conditions were essentially the same as those used in the previous analysis (Report No. 8207-63-18, dated 6 November 1963) with the outer hydrogen both replaced with a helium purge. The analysis was terminated on 19 December; at this time the analysis was complete, but a report had not been written.

2. Fabrication

Fabrication of pallets for MIT 905 and 906 and the control pallet was continued.

Fabrication of a control rack for control of MIT functional checkouts at LRP was continued.

Fabrication of the shunt calibrator and regulator control panel for MIT 906 was continued.

The fabrication of the EIT 502, 503 and 504 "breadboard" prototype liquid level control systems were completed.

B. PLANNED FOR JANUARY

1. Engineering

The design of the pallet for MIT 906 and the control pallet will be completed.

The final report for MIT 901 will be completed.

The final test specifications and test procedures for MIT 904 will be completed and will reflect an irradiation time of 60 minutes and a total test time of 75 minutes. Due to the extended run time and the limitations

of the dewar tank, it will be necessary to revise the procedures that were used on MIT 902 and 903.

Data reduction and evaluation of EIT 501 and MIT 903 test results will be continued.

Data reduction and evaluation of MIT 902 will be resumed upon receipt of corrected test data from GD/FW.

2. Fabrication

The fabrication of new pallets will be reviewed with regard to program redirections received the end of December. Pallets not needed in the new program will be phased out.

3. Testing

Informal information received by telecon from GD/FW is that MIT 904 will be conducted in the ASTR facility at GD/FW the week of 17 February.

The tests of the "breadboard" prototype of the EIT 502, 503, and 504 liquid level sensor will be completed.

ITEM 2.1 - REMOTE HANDLING EQUIPMENT

Work on this subtask consisted of sub-subtask 2.1.3 activity, as follows:

A. Accomplished in December

1. Engineering

Preliminary interface control drawings were initiated on item N-211 (fixture, lifting, rocket engine forward closure - remote).

The NRX-A2 operational support plan as revised by REON was received and reviewed to determine the changes which had been made. These changes were incorporated into revision 4 of the operational support plan and submitted to the LRP Program Office, along with revised provisioning data sheets, for transmittal to REON.

Preliminary equipment requirement sheets were completed, permitting conceptual design of the following items to start:

1. N-9 - tool kit, rocket engine disassembly - remote
2. N-137 - fixture, nozzle examination - remote
3. N-210 - fixture, lifting, propellant line
4. N-218 - fixture, lifting, floor mounted support equipment - remote

Input for NCS-400 was submitted, including item identification, description, costs, schedules, and backup.

Detail drawings on item N-135 were completed.

2. Fabrication

Item N-211 unit awaits painting.

B. Planned for January

Engineering

The interface control drawing will be completed for item N-211

(fixture, lifting, rocket engine forward closure - remote).

Work on the NRX-A3 operational support plan will be started.

Performance specifications will be completed and detail design of the following items will be initiated:

1. N-9 - tool kit, rocket engine disassembly - remote
2. N-137 - Fixture, nozzle examination - remote
3. N-210 - fixture, lifting, propellant inlet line - remote
4. N-218 - fixture, lifting, floor mounted support equipment

Equipment performance specifications and designs on the following items will be initiated for NRX-A2 support:

1. N-265 - kit, polisher and grinder - remote
2. N-266 - ultrasonic cleaner - remote
3. N-267 - saw, specimen, metal cutting - remote
4. N-268 - radiation material shipping container

The NRX-A2 operational support plan will be revised, based upon the results of the post mortem task force.

The final design review of item N-135 is scheduled for 8 January 1964.

ITEM 2.2 - GSE CHECKOUT AND TEST

Work on this subtask consisted of sub-subtask 2.2.3 activity, as follows:

A. Accomplished in December

1. Engineering

Preliminary interface control drawings were initiated on item N-450 (closure kit, pressure testing, rocket engine).

Input for NCS-400 was submitted, including item identification, description, costs, schedules, and backup.

Preliminary equipment specifications were initiated, permitting conceptual design of item N-469 (kit, dimensional checking, rocket engine).

The NRX-A2 operational support plan, as revised by REON, was received and reviewed to determine the changes which had been made. These changes were incorporated into revision 4 of the operational support plan and submitted to the LRP Program Office, along with revised provisioning data sheets, for transmittal to REON.

Final acceptance test plans for items N-450 and N-451 were completed.

2. Fabrication

A fabrication order supplement for item N-450 was issued to incorporate proof and leak test requirements in the top assembly. Configuration changes to engine hardware require additional coverplates and clamps.

B. Planned for January

Engineering

The performance specification will be completed and detail design will be initiated on item 469 (kit, dimensional checking, rocket engine).

The NRX-A3 operational support plan will be initiated.

A conceptual design review of item 469 will be conducted.

Design work will be started to modify item N-451 for use with the RN-6 nozzle.

The NRX-A2 operational support plan will be revised as required.

ITEM 2.3 - GSE LOGISTICS AND TRANSPORTATION AND MAINTENANCE

Work on this subtask consisted of activity in sub-subtask 2.3.3, as follows:

A. Accomplished in December

1. Engineering

Preliminary interface control drawings were initiated on the following NRX logistics, maintenance, and handling items:

1. N-724 - semitrailer, rocket engine
2. N-803 - fixture, lifting, rocket engine forward closure
3. N-809 - sling, beam type
4. N-817A - sling, multiple leg - 12,000 pound capacity
5. N-914 - adapter, handling, rocket engine
6. N-917 - stand, forward closure, rocket engine

The NRX-A2 operational support plan, as revised by REON, was received and reviewed to determine the changes which had been made. These changes were incorporated into revision 4 of the operational support plan and submitted to the LRP Program Office, along with revised provisioning data sheets, for transmittal to REON.

An analysis of item N-915 (stand, rocket engine) was made to determine the modifications required to adapt the stand for usage at the R-MAD Cold and Hot Bay.

Input for NCS-400 was submitted, including item identification, description, costs, schedules, and backup.

Final acceptance test plans for items N-724, N-914, and N-915 were completed.

2. Fabrication

1. Item N-704

LRP is in the process of re-evaluating the rejected legs, which were incorrectly fabricated from angle stock.

2. Item N-809

A fabrication order supplement was issued to fabrication control on 17 December to incorporate a "C" change DCN in the top assembly (part number 278570-9). This change adds a 1-3/8-inch diameter pear-shaped lifting ring to the assembly. The links were pre-ordered on 5 December and arrangements are being made for installation of the added part on all units.

3. Item N-914

The pacing item for first unit is the coupling (P/N 279040-29).

4. Item N-915

Modification of S/N 01 is still being delayed awaiting assembly and shipment of NRX-A1. The status of S/N 02 and S/N 03 remains the same.

5. Item N-916

Shop orders were released to incorporate weld-on guard rails, required by the LRP safety engineer. Material to accomplish this work is available in sub-stores #11.

B. Planned for January

Engineering

Interface control drawings will be completed on the following items:

1. N-724 - semitrailer, rocket engine

2. N-809 - sling, beam type

3. N-817A - sling, multiple leg - 12,000 pound capacity

4. N-914 - adapter, handling, rocket engine

5. N-915 - stand, rocket engine

6. N-916 - maintenance platform, rocket engine

Design work will be started to modify the following items for use with the RN-6 nozzle:

1. N-813 - beam, hoisting, nozzle - rocket engine

2. N-918 - stand, nozzle, rocket engine

Work on the NRX-A3 operational support plan will be started.

The NRX-A2 operational support plan will be revised, as required.

ITEM 2.4 - INSTRUMENTATION

A. ITEM 2.4.1 - NON-NUCLEAR DEVELOPMENT TEST SYSTEM

1. Accomplished in December

A CFDTS instrumentation procurement list, stating the type, range, part number, quantity ordered, and purchase order number, was prepared for all instrumentation ordered by Department 8771.

CFDTS "NRX Type" instrumentation selection were listed for the Instrumentation Data Book.

2. Planned for January

No special activities are planned other than a continuation of present activity.

B. ITEM 2.4.2 - NRX INSTRUMENTATION

1. Accomplished in December

a. Engineering

Data book inputs for all NRX-A1 cold flow instruments that will be used have been completed. The Physical Sciences Test report, as noted in the November,report, was received and data book input was prepared from this report. The report reflected no dielectric break down when the single layer "H" film cable was subjected to a wet 150 PSI pressure bomb test for 24 hours.

The Statham redesigned units were not received during this report period.

The cost proposal on the NRX-A2 kit, as noted in the November report, was completed and released. Final selection of the instrumentation kit components based on the non-nuclear test as described in this report is now under way. The NRX-A2 kit parts planning list will be completed by 1 January 1964.

There has been no activity on NRX-A3 hot flow instrumentation since the previous report.

b. Fabrication

Coordination with procurement activities was continued to assure delivery of a complete NRX-A1 cold flow instrumentation kit by the end of December, since the November delivery date was slipped.

Procurement followup on the selected components for NRX-A2 hot flow instrumentation was continued.

2. Planned for January

a. Engineering

Engineering support on NRX-A1 cold flow instrumentation will be provided for any problems that may occur in delivery of the NRX-A1 instrumentation kit and subsequent installation at NRDS.

Engineering followup and review of proposed and selected NRX-A2 hot flow instruments will be continued.

C. ITEM 2.4.4 - MECHANICAL IRRADIATION TEST INSTRUMENTATION

1. Accomplished in December

a. Engineering

An additional requirement for a 750 psia radiation resistant pressure transducer on MIT #904 has been received. Advance quotes and fabrication orders are being processed.

Fab orders have been cancelled for the Statham A517 accelerometers planned for use on MIT 903, 904, 906, and 908. These instruments will be superseded by piezoelectric type accelerometers. AGC specification control drawing 701565 in conjunction with AGC specification 42285 for Clevite Model 25D21 satisfies the requirements, and will therefore be used. A fabrication order is being processed to procure these instruments.

Rough drafts of the technical memorandums concerning operating instructions for the 24 channel calibration sets (STE for 2.4.4 and 1.9.5)

are completed. They are currently undergoing review by departmental supervisors.

b. Fabrication

Two each RTT calibration sets (STE for Sub-Subtasks 2.4.4 and 1.9.5) have been acceptance tested, accepted, and dispositioned to sub-stores 11.

c. Testing

Followup on MIT instrumentation acceptance testing is continuing.

2. Planned for January

a. Engineering

Technical memorandums for the calibration sets are to be completed. Specification control drawings will be started for MIT #907, #909, #910, #911, and #912 test instrumentation.

b. Fabrication

Procurement followup and liaison will continue for MIT #903, #904, #905, #906, #908 and two each 900 control pallet instrumentation.

c. Testing

Followup on MIT instrumentation acceptance testing will continue.

D. ITEM 2.4.6 - NON-NUCLEAR INSTRUMENTATION DEVELOPMENT

1. Accomplished in December

a. Engineering

All NRX-A1 components presently intended for utilization have been non-nuclear qualified.

Final reports are in progress for the laboratory environmental tests of the NRX-A2 candidate transducers.

Coordination with manufacturers of bonded strain gauge pressure transducers for NRX-A2 continued through December. BLH has indicated that the production of prototype FDA-R type pressure transducers is still on schedule and will be delivered in January. These units are being considered for NRX-A3 selection, and as possible backup to a modified NRX-A2 kit. Preliminary work was started for the NRX-A3 candidate transducer selections. Development efforts were continued on the two wire and coaxial W/W 26% re-thrust chamber thermocouple.

Two all-aluminum model No. 400 Taber units were received on 19 November. One unit is rated at 0-750 psia and the other at 0-1000 psia. Both units have foil gauges which are bonded with epoxy. They are presently undergoing acceptance testing in the LRP transducer laboratory.

As noted under cable development in the November report, du Pont provided one quart of the new adhesive, code number PI-2200. This material was forwarded to Physical Sciences Corp. to be utilized in the fabrication of a sixty foot test cable.

A specification control drawing and formal specifications were completed for the copper constantan thermocouple (for use on the nozzle torus). Six each prototype units are presently being fabricated at LRP. These units will be utilized for non-nuclear and nuclear testing.

A non-nuclear test program was completed on 16 December. The test was conducted on the following instruments: Microdot strain patches, AGC-LRP tungsten/tungsten-rhenium thermocouples, Physical Sciences Corp. and Consolidated Controls Corp. differential and absolute linear variable differential transformer pressure transducers, a Servonic potentiometer type pressure transducer, and Clevite model 25D21-X accelerometers. A report will be issued by 1 January 1964.

The cold flow environmental test involving a Taber Model 185 pressure transducer as noted in the November report was completed. The Taber unit maintained an ambient air temperature of +65°F even though the six-inch long transducer impulse line at the pressure tap of the pump discharge line read a -425°F. Based upon the above test, all NRX instrument component specifications will establish the total error band between +30°F and +130°F.

b. Fabrication

There was no fabrication activity.

c. Testing

All non-nuclear laboratory testing has been completed for the NRX-A2 candidate transducer selections.

All environmental testing of the NRX-A1CF backup instrumentation has been completed except for vibration tests.

The January quarterly revision of the NERVA Instrumentation Data Book was submitted.

2. Planned for January

a. Engineering

Test plans will be written for the EIT tests in CY 64.

b. Fabrication

Upon completion the all aluminum No. 400 Taber foil gauges will be removed and the sensing elements plus new gauges will be forwarded to REON to have the gauges bonded to the sending element utilizing Rockide. The sensing elements will then be returned to LRP where they will be reassembled and retested. The second test will be compared to the acceptance test to determine the effect of Rockide bonding.

Taber will deliver one each 0-750 psia and 0-1000 psia units,

Model 401, by 1 January 1964. The difference between these two models is that the model 401 employs welded Microdot strain gauges.

Standard Controls has indicated that two evaluation units will be delivered in the first week of January (Reference the November report).

c. Testing

Environmental testing will begin on candidate transducers for NRX-A3. Non-nuclear and nuclear testing of proposed and selected instruments will be continued.

Physical Sciences will deliver the 60 foot cable test sample by the first week of January 1964.

Non-nuclear tests of the copper constantan thermocouples are to be completed by 15 January 1964.

ITEM 4.1 - PROGRAM PLANNING AND CONTROLS

1. Accomplished in December

CY 1964 Program Plan PERT Networks were reviewed and interfaced with REON personnel.

CY 1964 PERT Networks were checked against the work statements and hardware demand and test schedules.

New PERT Networks were distributed to the subtask engineers and REON.

NRX computer runs were updated.

PERT biweekly reports were prepared and submitted to REON.

2. Planned for January

CY 1964 Program Plan PERT Networks will be modified to correspond with revisions in NCS-400A.

Milepost listing contained in RN 63005A will be modified to correspond with revisions in NCS-400A. Terminal events for which critical path is calculated will be selected. Weekly monitoring and biweekly reporting will be made against these mileposts.

NRX computer runs will be updated.

CY 1964 Development Program computer runs will be initiated.

PERT biweekly reports will be prepared and submitted to REON.

ITEM 4.2 - FISCAL CONTROL

A. Accomplished in December

NCS-400, Contract Year 1964, Revised, was submitted to REON on 16 December 1963. Subsequently, NCS-400A, prepared in response to SNPO TWX NR 749 from R. W. Schroeder to W. C. House, was submitted to REON on 30 December 1963.

B. Planned for January

A definitive cost study will be prepared to define a reduced level of LRP effort during contract year 1964.

ITEM 4.3 - TECHNICAL REPORTS

1. Accomplished in December

NCS-400 (CY 1964 Program Plan) was prepared and submitted to REON.

LRP weekly status reports, biweekly PERT reports, and the monthly letter report were prepared and submitted to REON.

2. Planned for January

NCS-400A, CY 1964 Program Plan Revised will be prepared and submitted to REON.

LRP weekly status reports, biweekly PERT reports, the monthly letter report, and the document listing report depicting documentation released during the SNP-1 contract period ending 30 September 1963 will be prepared and submitted to REON.

ITEM 4.4 - CENTRAL DATA SYSTEM

1. Accomplished in December

Engineering documentation including drawing lists, drawing number control reports, and WANL specifications received from REON were distributed.

2. Planned for January

Routine distribution of engineering documentation will be maintained.

ITEM TASK 5 - SPECIAL TEST EQUIPMENT

A. ITEM 5.1 - LRP TEST ZONE C (Test Stands C-6 and C-7)

1. Accomplished in December

The NRX-A cold flow test system was activated, a GN_2 and an LN_2 test being conducted on 22 December.

The transducer simulator system was completed (5191470) on 31 December.

2. Planned for January

The fabrication and installation of conduit and cabling for a control system for TPA testing on test stand C-7 (5191430) and the fabrication and installation of instrumentation and control equipment for test stands C-6 and C-7 (5191450), which were due for completion on 31 December, will be delayed. The systems are complete except for work that must be done while the test stands are shut down. The heavy test firing schedule will not permit the shutting down of the test stands at this time but completion will be accomplished by 31 January.

B. ITEM 5.2 - LRP CRYOGINICS LAB. TEST ZONE "A"

1. Accomplished in December

Preliminary approval of the specification bid package on the hydraulic system of the gimbal tester was received from the project division on 9 December. The bid package is being prepared for the various processing steps leading to reviewal and bidding by outside vendors (5200100).

The design of the spin test drive adapters was initiated (5201124) on 12 December with the receipt of criteria for the adapters.

Design efforts on the turbine speed probe tester (5201142) have been shelved until the goals of the current program have been more clearly defined.

2. Planned for January

The bid package for the gimbal tester will be submitted for bidding. Evaluation of the bids should be accomplished in January with award of the contract in February.

Design of the spin test drive adapters (5201148) will be completed during the month and pre-procurement activities will begin at that time.

C. ITEM 5.3 - LRP TEST ZONE H

1. Accomplished in December

On 5 December 1963, on checking the operation of the repaired vacuum pump on vessel VH 10, a Chicago Bridge & Iron Company employee found that the inner vessel had developed a leak. Subsequent tests verified this fact. CB&I was immediately notified by wire.

CB&I pressure vessel personnel inspected the vessel on 6 December.

On 18 December, Pearlite insulation was removed from the top section of the annular space to enable CB&I people to inspect the top nozzle connections for leakage.

On 20 December, the vessel was pressurized and the interior connections were checked for leakage with "leak-tek" solution. A leak was found on the fourteen-inch vent piping nozzle and another leak on the twelve-inch fill piping nozzle.

Both leaks were in the shop fabricated transition sections. On the fourteen-inch nozzle, the defect was in the form of a minute tear where the fillet weld joined the silver band. It is presumed that the separation of metal was a result of poor fusion and the application of severe stresses from either (a) shifting of the inner vessel, or (b) reversal of stresses in the aluminum, silver, stainless connection by the reduction of temperatures accompanying the introduction of the cryogenic media. The leak in the twelve-inch nozzle was in the form of a pinhole. The transition sections were made and welded by Linde Co.

On inquiry, AETRON was advised by CB&I that they intend to have the repair welding done by a welder from their Chicago shop who is qualified for the material and welding process used on the transition nozzles.

Time involved in vessel repair is directly associated with the degree of success obtained in the welding operation. The Chicago office has informed the local CB&I supervisor that the most difficult connection to weld is the silver to stainless steel. While this defect is only a pinhole and is in a favorable welding position, they stated that in this material connection, the defect could propagate under the arc to the extent of resisting closure by welding in position. If this were to occur, it would be necessary to replace the nozzle. AETRON has requested CB&I to provide a welding engineer for on-the-job surveillance of the welding operation.

Contractor work on test stand H-4 under specification 6740 was completed on 9 December, including the punch-list clean-up that was necessary. AGC activation of test stand H-4 without a diffuser (5301037) was started on 6 December, with this phase of the activation (5301037) to be completed by 27 January.

The design of electrical controls for ejectors on test stand H-5 was completed on 6 December and sent to NASA for review (5300449) on 9 December. Other design work was completed on 11 December toward the activation of test stand H-5 for CFDTS testing. These designs include special work platforms for the CFDTS and ejector test system (5301648), the ejector for the GN_2 piping system, (5301650), and special ducting to adapt the simulator interface to the injector inlet (5301652). The completed designs were sent out for bid and NASA approval on 11 December. (5300421, 5300429, and 5300434).

The activation of test stand H-6 (5301510) was initiated on 8 December, with completion slated for 10 February 1964.

The design of the TVCV test fixture and related piping was completed (5301025) on 10 December and sent out for bidding in specification 6618 on 10 December.

Concurrent with the leak problems encountered on vessel VH-10, a catch vessel flare stack malfunctioned to the extent of progressive burning into the stack during venting operations. Some thermal damage occurred at the upper portion of the stack. The flare stack is under repair and certain modifications to the design of the upper portion are under consideration.

2. Planned for January

If no problem develops, repairs should be completed on vessel VH-10 by January 1964. In the event of reversals in the welding repair operation, the replacement of defective nozzles will result in removal of associated connecting piping. CB&I was reluctant to discuss the amount of time required for this operation.

The activation of test stand H-4 without a diffuser (5301039) will be accomplished by 27 January.

The procurement of a acryogenic reference junction sheduled for completion (5391488) on 19 December has been delayed by the inability of vendors to meet the requested delivery dates. The procurement completion can be expected by 6 January.

The response to bid requests for specification 6618 should be completed by 7 January. Award of the contract will be made on 31 January.

D. ITEM 5.8 - SACRAMENTO PLANTS MISC. LABS. (STE)

1. Accomplished in December

The fabrication of an exciter base plate for the SRP vibration laboratory (5801166) was completed on 7 December. Also, the procurement of a low frequency drive unit for the SRP vibration laboratory (5801168) was completed on 30 December as activation of laboratory support equipment continues.

2. Planned for January

Installation of The low-frequency drive unit will be made in the vibration laboratory (5801168).

ITEM 5.9 - LRP ENGINEERING LABS (STE)

1. Accomplished in December

Procurement of the second LN_2 leak vessel (5901103) was initiated on 4 December after the tests on the first vessel proved the acceptability of the design.

2. Planned for January

O.P. procurement and fabrication of the second LN_2 leak tank will be continued.

ITEM 6.2 - LRP TEST ZONE A (GP)

1. Accomplished in December

The designs of the GN_2 heating system (6201036) and the LH_2 piping extensions (6201210) have been halted until the scope of work that can be accomplished under the new budget can be determined.

The necessary requisition for procuring the spin test drive motors is in preparation. Upon completion, the requisition will be sent to purchasing for contract bidding (6200103).

Design of the bearing seal assembly equipment was completed (6201046) on 6 December.

A fifty ton hydraulic press was received at the cryogenic laboratory on 18 December and is being prepared for installation.

The quotes received from vendors on the bid request for a power tube bender were evaluated and the purchase order was placed (6201088) on 17 December. Delivery is expected during the next report period.

The balance of the task is in process of being re-evaluated for adjustment due to a revised budget.

2. Planned for January

The re-evaluation of subtask 6.2 will be accomplished and the scope of effort was defined to meet the new budget requirements.

IV. WEIGHT AND BALANCE CHANGE REPORT

There have been no weight and balance changes during the month of December. If any changes occur, they will be reported in separate documents.

ENCLOSURE (2) TO THE

SNP-1 SA3 CONTRACT MONTHLY LETTER

REPORT

NERVA RELIABILITY & QUALITY ASSURANCE

STATUS REPORT

6 January 1964

This Enclosure will be submitted under separate cover.