NUCLEAR DIVISION

RELIABILITY AND QUALITY ASSURANCE
INFORMAL PROGRESS LETTER NO. 47A

FOR FOURTH QUARTER, CY 1968

COVERING

JULY, AUGUST, AND SEPTEMBER 1968

NERVA PROGRAM

CONTRACT SNP-1

OCTOBER 1968

MASTER

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

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FOREWORD

This report is submitted in partial fulfillment of Sub-Subtask-2.6.0 of Contract SNP-1. The discussion covers product assurance activities at NRO, NTO, and manufacturing quality control activities at the Sacramento Facility for July, August, and September of Contract Year 1968.

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I. WANL SURVEILLANCE

A. WANL/WNCO ACTIVITIES

The NERVA nuclear subsystem product assurance program plan (WANL-TNR-088, Revision G) is being revised in accordance with current guidelines. The related quality methods and procedures (QMP) and the reliability methods and procedures (RMP) are approximately 90% completed. The WNCO quality control manual was received by WANL product assurance. The manual is being revised to reflect the current reorganization resulting from manpower reductions.

Specification requirements, fabrication methods and procedures, and inspection planning for Pewee II fuel elements are being developed. SNPO-W, SNPO-C, Y-12, WNCO, WANL, and NRO are participating in the fuel-element development meetings.

SNPO-C, Y-12, WNCO, and WANL participated in a Pewee II fuel element nondestructive test standards meeting at WANL 12 September. The purpose of the meeting was to discuss plans (prepared by WANL fuel quality assurance and technology nuclear design) which are being proposed as the first steps to comply with the changes made to fuel-element specification PDS 30124 by ECO 16440 for the fuel elements. The requirements include:

1. All fuel suppliers will use a common set of standards to develop all gamma counting and beta backscatter calibration curves.
2. The assumptions and forms of the equations used by each supplier in his set of computations will be the same for similar computations.

The results of this meeting, together with further investigation by WANL, will be presented at the next meeting of the Nondestructive Testing Committee. WANL specification PDS 30124, pertaining to acceptance criteria for Pewee II fuel elements, will then be finalized and submitted to NRO for review.

II. RELIABILITY ASSURANCE

A. FAILURE MODE ANALYSIS

1. Prime Engine

All prime-engine failure modes analyses (FMA) have been published formally.

2. ETS-1

FMA's for the following systems have been distributed in preliminary form:

a. Gas and Liquid Storage and Distribution

- (1) Run Tank Topping System
- (2) Simulated Engine System
- (3) Valve Pneumatic System (Facility)
- (4) Process Water System

b. Nuclear Exhaust System

- (1) Primary Gas Seals and Bellows
- (2) Duct Cooling Water System
- (3) Steam Generators
 - (a) LOX Feed System
 - (b) Propane Feed System
 - (c) LOX Pressurization System
 - (d) Propane Pressurization System
 - (e) LOX Vent Relief System
 - (f) Propane Vent and Relief System
 - (g) Steam Line and Separator
 - (h) Cooling and Process Water System
- (4) Propane Flare System

- (5) Miscellaneous
 - (a) Flare Stack Heating
- (6) Disaster and Emergency Systems
 - (a) Fire Protection System
- (7) Electrical System
 - (a) Electrical Power Distribution System
- (8) I&C Systems
 - (a) Test Stand Control System
- (9) New Systems of the ETS-1
 - (a) Simulated Engine System
 - (b) Run Tank Topping System

3. ETS-1/XE-1 Thrust Ring Reliability Analysis

The structural reliability of the ETS-1/XE-1 thrust ring was analyzed by comparing the material yield strength with the calculated stress. Yield-strength values were used to represent the material capability resulting from the accidental chilling of the thrust ring by cryogenic fluids. The analysis showed the structural reliability of the thrust ring to be 0.9_{17}^{88} (i.e., 17 nines followed by 88).

4. ETS-1 Electrical Power Failure Mode Analysis

The FMA on the ETS-1 electrical power system was completed and coordinated at the Sacramento Facility and the test site. The analysis of the three main bus distribution systems starts with the 69,000 volt utility supply and ends with the 208/120 volt panel breakers. The FMA contains: (1) a narrative that describes the systems operation; (2) single-line diagrams that graphically related the system's components with each other; and (3) a series of coordination curves that quantitatively show the degree of current tripping (selectively) that exists between related circuit breakers and the analysis itself. The FMA is also divided between the system's current status and several recommended designs that are more reliable. The ultimate engine

effect of specific failures, however, is not always clear since the FMA does not include instrument and control system distribution. Numerous reliability improvements have been accomplished in the electrical power system since FMA activities began. More are in process as indicated by the many actions shown in the last column on the analysis sheets. Because of its size, the FMA will be published as an addendum to RN-S-0454.

5. XE-1 Reactor Controls and Safety System FMA Revisions

The reactor safety system FMA (WANL-TME-1647) was updated to reflect improvement in the reliability of scrambling. The power and temperature controller FMA now shows better reliability in commanding control drums "full-in". Also the actuator control power amplifier FMA reflects improved reliability in powering all drums "full-in" and "full-out".

A concept for the improved reliability of the power scram (by eliminating the possibility of having a drum "run-out" due to bias shift when in scram) is being reviewed by NRO.

6. XE-1 Control Drum System FMA Revisions

The actuator drive gas supply subsystem FMA (WANL-FMA-1523) was revised to show that failure modes containing unresolved problems have been corrected to a reliable test status.

7. LH₂ Open Valve Cooldown System FMA

The LH₂ open valve cooldown system FMA was prepared for the redesigned system. Its refinement is being paced by the release of FEP-V results. Its release for internal coordination is planned for the next quarter.

8. Exhaust Duct Cooling System FMA

The exhaust duct cooling system FMA was internally coordinated for technical accuracy and completeness. NRO safety comments emphasized concurrence with improvement actions to prevent accidental closing of valves 50RSV298, 50FCV32, and 50BFV666.

9. Steam Generator System FMA

The first draft of the steam generator system FMA was released for internal coordination. The system was divided into four major subsystems: LOX, propane, gas actuation/purge, and water/steam. Subsystem aspects that particularly require further evaluation are: (1) reconciliation of the normal run position of valves as compared to their bias position in the event of failure; and (2) marginal reliability of components whose success history is poor.

10. Fire Protection Water System FMA

The fire protection water system FMA was prepared. It shows that there are no major problems requiring reliability improvements.

B. ETS-1 LH₂ COOLDOWN SYSTEM CHECK VALVE RELIABILITY DATA

Vendors and users were contacted for reliability data on the three critical LH₂ cooldown system check valves: 50CHV2302, 50CHV3364, and 50CHV3365. Development, qualification, and use data were not obtainable in documentary form. Information indicated that the Flowmatics 6-in. in-line poppet (Model HE 402) procured for 50CHV2302 was the third unit built of this design. The first two valves were tested and modified several times before satisfactory tests were obtained. There are no users other than LASL and NERVA, and there were no development or qualification test data.

A Mission valve (Model No. 150CPR-374D) is used for 50CHV3364. The manufacturer stated that this was a standard valve, extensively used by Rocketdyne and Cosmodyne for cryogenic service. Further checking with Rocketdyne confirmed that organizations' experience of high-performance reliability. The valve was also demonstration tested under cryogenic conditions and endurance cycled 2.5 mission times at ambient temperature by Linde without reported failure. Mission's representative reports a single failure caused by excessive shock from a pulsating compressor.

An Anderson-Greenwood valve (Model AGCO-CV1-0690RSTO) is used for 50CHV3365. The manufacturer reports that there are several thousand of these valves in cryogenic service at Marshall Space Flight Center, Langley, and Cape Kennedy without reported failure. However, since the original design of four years ago, the valve has had its hinge assembly redesigned for more secure locking.

C. RELIABILITY ANALYSIS REPORT

The initial reliability analysis of the NERVA 75K reference flight engine was completed. The report will be distributed early in October.

D. NERVA VALVE ASSESSMENT

Methods to assess the reliability of NERVA valves were developed and recommended to the valve engineering group. Typical valve data from other engine programs were presented to indicate the kind of data necessary and the assessment methodology to be considered for the NERVA program. Close coordination between the valve and reliability groups to develop a total reliability approach for NERVA valves is continuing.

E. PNEUMATIC SUPPLY SYSTEM (PSS)

A reliability review of the latest PSS design was conducted and recommended changes discussed with engineering. A detailed analysis of various tank-shutoff circuit configurations was completed and the configuration recommended by reliability was incorporated.

F. PROPELLANT FEED SYSTEM (PFS)

Reliability estimates were made of ten different, possible PFS configurations for NERVA. Reliability ranking of the systems was presented to engineering. Reliability support of this effort is continuing as system modifications evolve.

III. QUALITY ENGINEERING

During the fourth quarter, the quality engineering effort has been directed primarily to support of NRO sub-subtasks and of NTO during assembly of the XE prime engine and ETS-1 design modifications.

A. ASSEMBLY AND MODIFICATION OF TECHNOLOGY ENGINES XE-1, XE-2, XE PRIME, AND ETS-1

1. Readiness Review Actions

XE-prime engine end item reports, data books, and discrepancy reports were developed, assembled, and presented to the XE-2 readiness review team in accordance with SNPO requirements.

NRO quality engineering also provided support to the preparation of the support systems readiness review.

Quality engineering and quality evaluation is currently responding to SNPO requirements regarding action items resulting from preliminary XE-2 reviews by SNPO-C.

XE prime engine readiness review is scheduled for 22-25 October.

2. Turbine Power Control Valve (TPCV) Actuators

Concurrent with the program manager's decision that the XE prime UTSM be transferred from NTO to NRO cognizance, NRO quality engineering initiated a coordinated program with NTO inspection to provide a means for quality data retrieval on all work performed at NTO on hardware under NRO cognizance. This effort became necessary due to the program requirements related to upgrading the UTSM end item reports. A documentation center was established at NTO and procedures were established to assure adequate operation.

An NRO quality engineer has been assigned responsibility for effective interface coordination and has divided his time between NRO and NTO as the work schedule requires. Before the hardware is returned to NRO cognizance, the responsible NRO quality engineer will review all data for completeness and will supervise the preparation of the supplemental data book from which the supplemental end item report will be prepared.

NRO quality engineering and component valve engineering collaborated in establishing demonstration test requirements substantially in excess of technology engine test requirements. It has been concluded that these rigid requirements have demonstrated a functional capability that will prevent failures during the engine test. The TPCV, TBV, 5-in. butterfly valve, 5-in. check valves, 3/8-in. pilot valves, pressure relief valves, and the PSV have been included in this valve demonstration testing program.

Resolution of the TPCV actuator's sensitivity to vibration levels generated by the turbopump has resulted in a major modification of the Bendix design. The design, fabrication, assembly, qualification, and acceptance phases associated with this modification have required initiation of a configuration and quality program tailored to meet the limitations of the administration and facilities of the NRO Research Laboratory. Quality engineering has provided continual assistance to NRO engineering to assure that the requirements of RN2469 have been included in the modification workscope.

Since considerable engineering evaluation has been required to establish conformance of major components to the revised systems requirements, the quality engineering effort has been one of surveillance.

Approval of disassembly and assembly procedures prior to initiation of work has been an effective control by quality engineering so qualification and acceptance of deliverable material can be adequately controlled and documented.

During this reporting period, all control and diagnostic instrumentation has been evaluated by both NRO quality engineering and NRO component engineering, found to be satisfactory, and released for use on the technology engine. It has been concluded that a high confidence of functional capability exists for technology engine instrumentation.

Quality engineering has continued to stress workmanship conformance to AGC-STD-9012 on all electrical assemblies and chassis fabricated at the Sacramento Facility for the ECS or TSCS for ETS-1. The effort has increased the assurance that the assemblies will not fail during use.

Quality engineering has stressed close surveillance of the fabrication of nonserialized components and assemblies of the XE UTS and LTS fabricated at the Sacramento Facility to released drawings.

3. Ground Support Equipment

The support system NES duct removal plan was reviewed by NRO quality engineering prior to issuance. Special handling equipment designs to effect duct removal were reviewed prior to their release for comment.

The acceptance testing of the forward closure bolt removal tool (PL 4148) was witnessed, and the tool accepted at the Fullerton Facility and shipped to NTO for use in remotely removing the bolts that attach the forward closure and nozzle assembly to the XE pressure vessel and reactor assembly. This tool can be handled either by overhead positioning system auxiliary manipulation or by a wall-mounted Class A manipulator.

The turbine exhaust nozzle closure modification kit (PL 4108) was inspected and shipped during this report period.

The manned control car (MCC) and engine installation vehicle (EIV) end item reports have been completed, reviewed, and accepted and will now be published and distributed.

At the site, the MCC/EIV umbilical transfer tests were continued. These tests were performed both with the EIV unloaded and loaded with the WEMU. Four of five loaded transfers were completed satisfactorily. The first attempt did not connect and was attributed to lack of usage. The next four were successful. Twenty-five unloaded transfers have been completed satisfactorily. It was also demonstrated that the actuator vent line closure (PL 4112) can be removed remotely. During testing, adjustments were made to the engine nozzle closure actuator. Remote cycles of the installation and removal of the engine nozzle closure were successfully demonstrated. All tests were witnessed by NTO product assurance personnel.

The three inspection reports (IR) written against the modification kit for the turbine exhaust nozzle closures (PL 4108) were dispositioned. The fabrication of this kit should be completed early in the next report period.

The post-operative cell material transfer system narrative end item report was completed, reviewed, approved, and submitted to contracts for transmittal to SNPO-C.

The detailed test plan for the remote UTS/TSA nut removal tool (PL 4112) was completed. This plan describes the detail test which must be conducted at NRDS utilizing the MCC/EIV, WEMU, and SETS-1. Tests were initiated in accordance with the plan and witnessed by NTO product assurance.

The program directive (RN-PD-MA-1714) authorizing the installation of a check valve in the pump discharge vent line has been prepared and is awaiting approval. NTO has located an "off-the-shelf" valve which is suitable for this installation, and will initiate procurement as soon as the program directive is officially reviewed, accepted, and issued.

Test specification 202D, Nuclear Exhaust System (NES) Steam Line Design Demonstration Tests, was completed. This specification, which authorizes and provides instructions to NTO for performance of tests required to demonstrate the safety and operating characteristics of the new steam line and to qualify it for use for the XE test program, was reviewed and approved by NRO quality engineering prior to its transmittal to SNPO-C 18 September.

During the checkout and inspection of the completed engine test compartment (ETC) shield latch modification, excessive leakage was encountered in the pneumatic actuators. Inspection of these cylinders revealed the need for modifications to the piston seal arrangement. This rework is in process and will be completed early in the next reporting period and in time for total ETC shield system checkout and inspection.

Based on the concept presented in RN-DR-0150, a detailed design was initiated for Phase I of the duct removal modifications. These modifications consist of jacks, slings, and appropriate attachments to the duct and jack mounting pads. All project and quality engineering effort on this modification was cancelled by SNPO-C at the time the final design was presented to SNPO for approval (22 August).

Steam generator problems experienced during NEP-He-1 and -2 testing and during operational checkout of the steam line illustrated the need for an adequate supply of spares for the SGS. During the last report period, SNPO-C approved a program for maintenance of spare components for the SGS including: (1) fabrication of three new ignitors; and (2) rework of three combustion chambers, two injectors, and two ignitors.

The "fired" steam generator components that were shipped from NTO to the Sacramento Facility for inspection (and repair as required to restore them to usable condition) have been processed through inspection.

Repair, rework, and inspection on the SGS combustion chamber (S/N 00101) were completed and the unit shipped to NRDS 19 September. Repair, rework, and inspection of two injectors were completed and one of the injectors (S/N 880003) was sent to NRDS 17 September. The second injector (S/N 880001) was shipped to the site 18 September.

The three new ignitors which had been found to be leaking during checkout were repaired and returned to the Sacramento Facility for additional hydrotesting 19 September. These units were ready for shipment to NRDS during the latter part of this report period after successful completion of the testing and accomplishment of the required flushing, cleaning, and inspection operations.

In addition, fabrication of SGS gaskets (24, 36, and 12; each of P/N 901726-1, -2, and -3, respectively) was completed, and the gaskets shipped to NRDS.

Quality engineering support was provided to NTO for the preparation of preventative maintenance instructions, applicable checkout procedures, quality control instructions, and maintenance periods for the SGS.

Fabrication, inspection, and acceptance of the second poison wire retention adapter (PL 4143) was completed at the Fullerton Facility.

A minor modification to the engine reassembly stand was initiated at NTO. The change is required because of differences between the RADA XECF and XE-1 external shield outside diameters. New centering and radial indexing guides were required but the change did not delay the planned remote demonstrations. This modification was coordinated with NTO product assurance and its acceptance was accomplished at NRDS.

The duct vault inerting wall ETS-1 acoustic modification specification (RN-DR-0163) has been reviewed, approved, and distributed. The preliminary drawings have been reviewed by quality engineering in conjunction with the specification, and requested changes have been recommended. Surveillance of this modification by NRO product assurance will be continued until completion.

After NEP-He-2, examination of the steam line indicated that it had moved to the point of bottoming the gimbal in the vertical run against its restrainer, causing some deformation in that area. In addition, the line was damaged at the point in the horizontal run where the ceiling-mounted saddle hanger is located. Repairs and readjustment of the line were accomplished to support XECF test requirements.

The design of a new steam line, scheduled for installation prior to XE testing, was completed and a conceptual design of a new system incorporating a water separator was approved by SNPO-C. All drawings were reviewed and released during this report period. Procurement action was undertaken for the delivery of the various steam-line components to NRDS, and quality engineering assistance was provided to NTO for development of required installation design and checkout procedures. The NRO design drawings for the new steam line were revised to incorporate all changes which were made. NTO installation drawings were reviewed and signed by all NRO disciplines. Late in July, major fabrication problems were experienced by the gimbal supplier. The basic problem associated with these gimbals were extensive stiffness (i.e., resistance to rotational motion). Gimbal modification and repair were accomplished at the Sacramento Facility and flexibility testing was successfully completed following proof-pressure checks.

The gimbals were then shipped to the ETS-1 steam line component fabricator in Los Angeles and incorporated into their respective assemblies. All line components were inspected visually, and welds were X-rayed, stress relieved, and found to be acceptable for shipment to NRDS.

The steam separator, fabricated at Capitol Westward, Inc., Los Angeles, was also inspected, tested, and found acceptable for shipment to NRDS.

NRO quality engineering assisted design engineering in the preparation of the assembly and test procedures for the PDKV and CKV valves, directly participated in their fabrication and assembly at NTO facilities, and provided supplementary documentation review.

Five suppliers were contacted by NRO project engineering and quality engineering to facilitate shipment to curtail anticipated problems on the newly designed bellows assembly. After reviewing supplier special processes, testing procedures, cleanliness control, drawings, material listings, and non-destructive testing (NDT) methods, Ametek/Straza (El Cajon, California) and Avica Corporation (Newport, Rhode Island) were selected for supplying the new design of the convolutions/flexible coupling (1135394-1).

Nondestructive testing surveillance was maintained at plants manufacturing the steam line separator and gimballed expansion joints. In each case, X-ray procedures were upgraded. In addition to review of NDT results to assure welding soundness, weld procedures were additionally controlled as a result of "fit-up" problems evidenced in initial X-rays. Upon their completion, all welds were found to be in accordance with the NDT requirements of Section VIII of the ASME code. NDT surveillance also resulted in the detection and acceptable repair of minor parent-metal defects.

X-ray inspection of longitudinal welds on bellows cylindrical sections (P/N 1135394) was reviewed at Avica Corporation. It was found that problems common to many X-ray laboratories existed: i.e., failure to allow for the almost microscopic requirements for radiography of such welds and also film interpretation. Refinement of procedural factors resulted in clear interpretation of minute lines of porosity along weld edges. This resulted in detection of oxides mixed into the weld. Weld procedures were subsequently revised.

Further work on neutron radiography, as applicable to inspection of the nozzle coolant tube system, was accomplished using the Aerojet-General industrial reactor at the San Ramon Facility. A high degree of resolution through nozzle-wall samples (e.g., clear images of 0.009-in. nylon dental floss are obtained) was achieved using a 6-in. diameter tube as a collimator. To accommodate nozzles with an exposure area of two 14x17-in. films, a funnel-shaped tube was installed. However, this resulted in less resolution and recent efforts have been directed toward development of a tube-bundle collimator to achieve both a large exposure field and high resolution.

Technical papers were presented on the following subjects:

a. To the AEC-NASA Space Nuclear Propulsion Office, "Correlation Study of Ultrasonic Shear-Wave Inspection of Nozzle Coolant - Channel Braze Shear Joints - Phoebus-2 Nozzle," R. M. Peterson.

b. To the AEC NDT Symposium, Savannah River Plant, "Locating Tube Blockage that X-ray Cannot Detect," J. A. Hendron.

c. To the seventh Annual Meeting, American Society for Testing and Materials, "Application of Alcohol Penetrant for Evaluation of Surface Porosity of Graphite Inserts for Rocket Nozzles," J. A. Hendron.

4. NERVA Engine Development

TG heat-treatment of 7039 aluminum alloy was deleted from the materials evaluation portion of the pressure vessel material development program due to inadequate stress corrosion resistance. The program is continuing with the TG3 heat-treatment material.

Electroform tube tensile testing for the hot bleed port design was cancelled due to insufficient material from which meaningful test data could be obtained. Test tensile coupons will be ordered with the first electroform liner to obtain the needed material property data.

Fabrication of six full-scale nozzle low-pressure-drop coolant channel end caps for evaluation of assembly and installation techniques has been initiated and is near completion. The low-aluminium forged plates for the braze samples have been received at Pyromet. The coolant channels also have been completed and shipped to Pyromet. The replacement 0.25% aluminum-content Hastelloy X forged plate has been shipped from the Union Carbide Company. A quality control program plan is in preparation for these components to meet NERVA reliability requirements.

IV. NRO QUALITY ASSURANCE

A. GENERAL

The NRO product assurance program plan (AGC Report 2469, Revision E, Data Identification Number P017-SS090205-F1) has been completed and is currently under review. This plan covers the functions of both quality engineering and quality evaluation. NRO product assurance has issued a mechanized monthly Quality Reliability Discrepancy Report (QRDR) status report. This report lists all QRDR's requiring corrective action in the "open" category and shows all processed corrective-action items in the "closed" category. The August report was issued to SNPO-C, AGC, WANL, and NTO.

B. STATISTICAL DATA

1. Monthly Quality Reliability Disposition Reports (QRDR)

The newly established mechanized report reveals that the number of QRDR's currently requiring corrective action is: NRO, 13; NTO, 4; and WANL, 3. The number of QRDR's requiring corrective action which were "closed" during August was: NRO, 26; NTO, 32; and WANL, 14.

2. NRO Technology Hardware

a. Nonconformance Quality Data

<u>Data Item</u>	<u>Quantity</u>			<u>Quarter Total</u>
	<u>July</u>	<u>Aug</u>	<u>Sept</u>	
SDAR's	0	0	0	0
IR's	28	21	18	67
SIR's	0	0	0	0
Discrepant Pieces	98	70	50	218
Discrepant Characteristics	125	120	84	329

b. Statistical Analysis

These tabulations show the percentages of total discrepancies for the report period by category.

<u>Type and %</u>		<u>Cause and %</u>		<u>Responsibility and %</u>	
Dimensional	- 47.4%	Inspection	- 34.7%	Vendor	- 59.6
Damage	- 13.4	Operational Error	- 21.9	Manufacturing	- 11.6
Identification	- 12.2	Plan/Prep	- 13.4	To be Determined	- 10.6
Weld/Braze	- 5.5	To be Determined	- 10.3	Engineering	- 10.2
Special Process	- 4.6	Dwg/Spec	- 9.1	Other	- 8.0
Assy Error	- 4.3	Other	- 7.0		

C. DOCUMENTATION

The following documents, in the form of data books and end item reports, were prepared during the fourth quarter.

1. Data Books

- a. Upper Thrust Structure Module (1 with 2 supplements)
(XE-2)
- b. Port, Hot Gas Nozzle (1) - (XE-2)
- c. Valves - 5-in. Butterfly (4) - (XE-2)
Valves - 5-in. Check (2) - (XE-2)
Valves - 3/8-in. Check (4) - (XE-2)
Valves - 3/8-in. Solenoid (8) - (XE-2)
- d. Instrumentation - Transducers (3) - (XE-2)
Instrumentation - Transmitter (2) - (Prime)
Instrumentation - Thermocouple (8) - (Prime)

- e. Lines (3) - (XE-1)
Lines (1) - (Prime)

2. End Item Reports

- a. Upper Thrust Structure Module (1) - (XE-2)
- b. Valves - 5-in. Butterfly (4) - (XE-2)
Valves - 5-in. Check (2) - (XE-2)
Valves - 3/8-in. Solenoid (8) - (XE-2)
Valves - 3/8-in. Check (4) - (XE-2)
- c. Instrumentation - Thermocouple (8) - (Prime)
- d. Lines (3) - (XE-1)
Lines (2) - (Prime)

V. NTO PRODUCT ASSURANCE

A. GENERAL

A draft of a revision to the NTO product assurance program plan was completed and submitted to NRO and WANL for comment. Management coordination between NTO, NRO, WANL, and SNPO-C continued. Administrative procedures were initiated and completed to define product assurance interfaces with E-MAD, ETS-1, XE log activity, and the Test Specification and Procedures Review Board. All scheduled quality reliability instructions were written and approved.

Periodic management audits were conducted on support service subcontractor facilities and activities. Discrepancies were reported to higher management and all required correction actions were taken. In addition, vendor surveillance visits were made to two western and midwest suppliers to investigate the causes of the high rejection-rates being experienced on their electronic components at receiving inspections.

Inspection and surveillance activities associated with the final assembly checkout and testing of the NRX-A6 test article contributed to the successful full-power test.

All activities associated with the XE-1 and the XE-2 engine buildup (including the purge system for the XE-2 PVARA and delegated work on NRO hardware modifications) were inspected and/or monitored by product assurance personnel. Routine quality engineering reviews of all purchase orders, field changes, operational procedures and the initiation and dispositioning of all discrepancy reports continued.

Surveillance, inspection, and facility audits were conducted to detect or prevent system problems associated with the engine test facilities. Quality engineering review of operating procedures and facility modification

design packages continued. NTO product assurance participated in the various experimental plans conducted as part of the engine test stand facility and XECF programs.

Reliability activities were directed toward the completion of procedures related to the failure mode analyses, age control over synthetic rubber parts, and preventative maintenance programs for test facilities. In addition, failure mode analyses were completed on various systems associated with the test facility, the EIV, and the MCC, and then coordinated with NRO.