NUCLEAR ROCKET OPERATIONS
SACRAMENTO PLANT

RELIABILITY AND QUALITY ASSURANCE
INFORMAL PROGRESS LETTER NO. 44A

FOR FIRST QUARTER, CY 1968
COVERING
OCTOBER, NOVEMBER, AND DECEMBER 1967
NERVA PROGRAM CONTRACT SNP-1
JANUARY 1968

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CONTRACT SNP-1

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JANUARY 1968

CLASSIFICATION CATEGORY

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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 Subtask 2.6 of Contract SNP-1. The discussion covers product-assurance activities of NRO, NTO, and the quality-control organization at Aerojet's Sacramento Plant for October, November, and December of Contract Year 1968.

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I. SUBCONTRACTOR AND NTO SURVEILLANCE

A. WANL/WNCO ACTIVITIES

Calibration practices at WANL and WNCO were reviewed relative to the applicable WANL/WNCO implementing QMP's. Calibration of fuel element processing and testing equipment is being improved at WNCO.

Studies of the XE-1 fuel element hydrolysis problem are continuing. Several methods are being proposed by WANL to control the XE-2 fuel element environment. The XE-1 reactor is under continuous purge at NRDS to minimize the hydrolysis.

Failure analysis studies are being conducted to establish the cause and determine corrective action for the nonconforming XE-1 pneumatic actuators. Documentation associated with the testing of XE-1 pneumatic actuators at NRDS is being assembled and evaluated.

A joint WANL/SNPO-C/NRO product assurance review of the WANL/WNCO WP-J-038 work statements was made at SNPO-C. The work statements are being revised by WANL and WNCO.

The WANL Product Assurance Program Plan, WANL-TNR-088, Rev. F, was reviewed and comments were submitted to WANL.

A program for computer certification of fuel elements is being developed by WANL/WNCO. The fuel element computer certification program will include (1) inspection data input; (2) processing of data to determine its conformance to established accept/reject criteria; and (3) printout of fuel element status (accepted or rejected).

The current schedule calls for the system to be defined and debugged ready for use during the second quarter of CY '68.

B. NTO COORDINATION

The NTO Product Assurance Program Plan was reviewed and approved subject to the inclusion of several revisions, and implementing procedures are being revised in accordance with review comments from WANL, SNPO-C, and NRO.

The NTO product assurance work statements were reviewed. Comments were submitted to program management.

NRO/NT0 interfaces were clarified and monthly coordination meetings have been started.

II. RELIABILITY ASSURANCE

A. RELIABILITY ASSESSMENT STUDIES

Reliability assessment studies have increased the need for complete test data acquisition. A review of this problem with Nevada Test Operations (NTO) personnel led to the examination of the logs maintained for quality reliability disposition reports (QRDR's). Comparison with the latest Sacramento tab run showed that a number of documents had not been received at Sacramento.

NTO has been requested to forward copies of the missing reports to AGC-Sacramento.

NTO reliability personnel are reviewing the adequacy of QRDR's as they are initiated. There is a need for a total compilation of all anomalies and failures and for definitive detail relative to the causes and preventative action.

B. RELIABILITY PRESENTATION

Reliability engineering personnel participated in a presentation at SNPO-C in December 1967. The following subjects were discussed: African-window probability and Reliability assessment.

Re-evaluation of the African-window problem resulted in reducing the probability of sudden loss of coolant flow from the original failure estimate of 25.2 per 10^6 to 2.71 per 10^6 . This revised estimate used a TPA reliability value of 0.9975, the same value used in the flight safety presentation. With a TPA reliability goal in excess of 0.999, the African-window failure-probability estimate was reduced to approximately 1 per 10^7 .

The reliability assessment portion included preliminary data and concepts for demonstrating the reliability of the pressure vessel, TPA, and TPA bearings. Statistical demonstration of system/component reliability is considered unfeasible. However, by securing system/component data regarding the physical and functional variables, as these are influenced by environments and time, a reliability assessment can be made. If the test program is planned so that adequate data are obtained, confidence levels can be assigned to these assessments.

C. RELIABILITY APPORTIONMENT

Preliminary reliability apportionments have been made for engine reliability goals of 0.990 and 0.995 and will be presented to SNPO-C for review and comment at a meeting in Cleveland in January 1968. The apportionments include non-nuclear subsystem reliability goals and subsystem component reliability goals where sufficient detail exists.

D. XE-1 PRELIMINARY FAILURE-MODE ANALYSIS (FMA)

The coordination of the XE-1 FMA, which was completed during this report period, significantly improved the analysis. Comments were evaluated and reconciled with opposing recommendations. Comments providing technical improvements were incorporated into the revised draft.

Discussions at NRDS with NTO provided information regarding recent changes in hardware and revisions to test plans. A number of technical errors in the FMA were discovered and eliminated.

Control system review of the XE-1 FMA resulted in the expansion of the original four engine control subsystem analyses into 16 subsystems to include the inhibit and override subsystem developed for the XE engine. The new subsystems analyses were internally reviewed, revised, and condensed.

The preliminary draft of the XE-1 FMA, RN-DR-0141 was issued in November. The preliminary XE-1 FMA will be updated as systems are modified and test plans are changed.

E. FMA PROCEDURES

FMA Procedure, RN-PD-S-10743 was revised to emphasize a total-system failure approach. Together with this change in emphasis from component to system orientation, additional attention was directed to reliability efforts. Design engineering is responsible for analyzing the causes and effects of failure modes and for the initiation of design changes and controls that will prevent failures or reduce their effects. The NRO coordination and approval cycle for the B revision was initiated during November 1967.

An improved format was proposed for use during the review of the NTO facility failure-mode analysis. Facility systems were re-analyzed using the failure mode of the system rather than the failure modes of the components

within the system. The system failure (inability to vent, inability to retain pressure, etc.) was emphasized as the failure mode and the component responsible for the system failure was identified.

F. ETS-1 ELECTRICAL POWER SYSTEM FMA

The ETS-1 electrical power system FMA is being coordinated by reliability engineering personnel. ETS-1 circuit-breaker cascading is being corrected.

G. ETS-1 FLUID-FLOW SYSTEMS FMA

The preliminary ETS-1 fluid-flow systems FMA was issued in December 1967 and is being reviewed.

H. ETS I&C SYSTEM FMA

The ETS I&C system FMA was issued in December 1967. This FMA included the following system elements: rack 01 L, signal conditioning, engine safety system, ATE console, CTE console, switching units A1 and A2, TSE console, ASE console, and PSC rack 66.

Failure-mode analyses for the remainder of the I&C system elements not included above or in the XE engine FMA, RN-DR-0141, are being prepared.

I. PNEUMATIC SUPPLY SYSTEM RELIABILITY REVIEW

A reliability review of the preliminary design for the pneumatic supply system has been initiated. The objective of the initial review is to provide an estimate of pneumatic supply system reliability and a comparison of the estimate with the preliminary reliability goals established for the system.

III. QUALITY ENGINEERING

A. NERVA QUALITY ENGINEERING

1. XE-2 Upper Thrust Structure Module (UTSM)

During the first quarter of CY '68, NRO quality engineering activities related to the technology engine were primarily in support of the XE-2 engine assembly. The shop planning and assembly procedures for the XE-2 UTSM were prepared by manufacturing engineering and quality engineering personnel in accordance with the program plan requirements and improvements were incorporated based on the experience gained during the assembly of XECF and XE-1 modules. Detailed instructions were provided to eliminate previous problems and inspection points were incorporated to verify conformance to acceptance criteria. Instructions for environmental control of the engine assembly area were revised, and changes were incorporated to control cleanliness consistent with the engine assembly requirements. The revised instructions (RN-DR-0139) were incorporated into the assembly procedure.

Quality engineering surveillance has been maintained in the assembly area to assure that controls are being maintained and that inspections are being performed in accordance with manufacturing, assembly, and inspection planning.

Lines were adjusted to fit the UTSM, and all interface dimensions of the lower interface were satisfactory. The lines were subsequently removed for hydrostatic testing and cleaning. With the lines out of the structure, the electrical cables were installed without incident.

Metal chips were found in the bellows section (prior to installation) of the gas vent line. The metal chips were traced to the failure of the gas vent line fabricator to exercise in-process controls.

To increase confidence in the cleanliness of internal flow passages, all lines, adapters, connectors and socket assemblies were reinspected using dental mirrors with a light source, a nylon probe, and subsequent wipe and flow tests. A quality engineer visited the supplier to establish procedures and process controls for preventing the recurrence of contamination problems. Corrective action by the supplier included:

- a. Revision of processing procedure to include the placing of line assembly in various attitudes during ultrasonic cleaning and final flushing cycle;
- b. Compliance with nonvolatile residue test per NASA Cleaning Specification, MSFC-SPEC-164;
- c. Provision for deliberate flexing of bellows (within allowable limits) during cleaning and flushing cycles to eliminate the possibility of chips being trapped within a bellows convolution.

2. AFPRO Surveillance

AFPRO surveillance, in accordance with the SNPO-C direction, was initiated concurrently with XE-2 assembly operations. Biweekly coordination meetings between AFQA representatives, the SNPO-C product assurance representative, and NRO quality engineering representatives have been held to enable coordination within the operating interfaces.

3. Revision of Assembly and Test Procedures for XE-2 Valves

The assembly and testing procedures for XE-2 valves were revised to reflect end-use requirements for the XE-2 engine, in accordance with quality engineering direction. These revisions were, in part, responsible

for the satisfactory assembling and testing of four 5-in. butterfly valves and two 5-in. check valves that met or exceeded the acceptance test requirements.

4. Failure Analysis - XE-1 TPCV Actuator

Quality engineering personnel conducted a failure analysis of the XE-1 TPCV actuator (Bendix Model NT-D1) that failed at NTO due to inadvertent shorting of an internal thermocouple to a 28-volt source.

Refurbishing and reacceptance testing of the actuator was accomplished. The tests demonstrated that the functional reliability of the XE-1 TPCV actuator had been increased since the unit was received from Bendix. Information obtained during the refurbishing of this actuator will be used during surveillance of fabrication and acceptance of the Bendix NT-D actuator intended for the XE-2 TPCV assembly.

5. Instrumentation - XE-2 Engine System

During the report period, quality engineering personnel have accomplished the source acceptance and calibration of all purchased instrumentation for the XE-2 engine system. Manufacturing and inspection instructions for the assembly of instrumentation into the XE-2 UTSM have been written. Basically the XE-1 UTSM assembly procedure has been modified to include specific inspection direction and stop-point requirements to eliminate problems encountered in the assembly of the XE-1 unit. Installation of instrumentation will begin in the early part of the second quarter of CY '68. Inspection stop points in the assembly procedures for the XE-2 LTS transducer assemblies have been provided.

6. Use of Freon for Cleaning Butyl Materials

Information related to the deterioration of butyl materials due to use of Freon for cleaning, as described in SNPO-C quality assurance brief (QAB 67-4), was used to reevaluate and determine damage to instrumentation components. As a result, it was discovered that O-rings in Fisher Gage Savers were significantly damaged by the cleaning fluid. Stored units have been disassembled, cleaned, and reassembled with new O-rings. The units on XECF and XE-1 will be replaced with these refurbished Gage Savers.

7. NRO Acceptance of Hard Canning Shrouds

Final acceptance by NRO quality engineering personnel of the hard canning-type shrouds to be used on ETS-1 hydrogen line flanges was accomplished at AGN, San Ramon, prior to shipment to NRDS. The shrouds will be mounted on the hydrogen line flanges at NRDS and will be pressure leak tested to assure proper function prior to facility (ETS-1) testing.

8. Pulse Cooldown System Valves

The pilot-operated relief valve for the pulse cooldown system, fabricated by a supplier, was rejected by NRO quality engineering personnel during the visual examination of components after preliminary hydrostatic testing. Due to a thin-wall area, the threaded section of the valve body became distorted during preliminary hydrostatic testing. The supplier has submitted a repair procedure for NRO review and approval. NRO stress engineering personnel will participate in the review. Valve components will be inspected prior to final acceptance testing.

The 3-in. pressure control valve for the pulse cooldown system was returned to the supplier for minor repair. During acceptance testing at cryogenic temperature, the valve continued to leak. Dye check and radiographic inspection of the valve seat area indicated a crack at right angles to, and running through the seat area.

The supplier has been requested to submit repair, radiographic, dye penetrant, and welding procedures for NRO approval prior to making the repairs. The repair and acceptance testing operation will be witnessed by NRO/QE prior to final acceptance of the valve at the supplier's plant.

The installation and acceptance procedure for the side-shield locking-mechanism modification has been reviewed by NRO facilities and quality engineering, revised, and released to NTO.

9. Nondestructive Testing

NDT engineering personnel have provided technical support for the maintenance program of the GH_2 heater, located in Test Area H. A procedure was prepared for the ultrasonic shear wave inspection of new replacement tubes and existing tubes in the radiant section of the heater. The inspection was performed by a subcontractor on-site. Seventy-five new replacement tube arches were inspected and accepted. The original 200 tube arches in the heater were inspected and accepted with the exception of tube numbers 70 and 73, located in the south arch of the heater. The ultrasonic indications for these tubes exceeded those from the 0.004-in.-deep reference slot in the test standard. Tube numbers 70 and 73 will be replaced with tubes that have been subjected to ultrasonic inspection.

A review by NDT engineering personnel of the materials data sheets for aluminum alloy 7039 disclosed that unless rigid controls are used in welding, interpass lack of fusion may occur. Materials engineering personnel have been requested to include (in addition to X-ray and penetrant inspection) longitudinal ultrasonic inspection to detect interpass lack of fusion. X-ray inspection will not detect defects of this type unless they are extensive. Longitudinal ultrasonic inspection will be used until the welding process demonstrates that interpass lack of fusion is not a problem.

Eddy-current inspection correlated with Brinell hardness related to yield strength may be used to verify the uniformity of heat-treat condition.

A plan is being coordinated with materials engineering personnel to determine the most effective surface preparation for penetrant inspection of aluminum alloy 7039. Information available for other aluminum alloys indicates that controlled machining tends to produce surfaces with discontinuities that are open to penetrant penetration, and that abrasive processes tend to close surface flaws. There is concern regarding the use of etchants because of potential corrosion. The plan includes preparation of artificial cracks and a study of the effects of various surface-finishing processes relative to detectability of cracks by penetrant inspection.

NDT engineering personnel have performed successful experiments with liquid crystal as a means of locating tube blockage. On a subscale test piece with five Hastelloy-X tubes, gross blockage was readily located due to delay of color change at the point of blockage. Study of methods for determining the effect of blockage size is in progress. During the report period, a test was conducted with immersion ultrasonics for location of tube blockage. However, in this application the method does not have sufficient sensitivity. Five NDT methods for establishing that tubes are clear of obstructions have been investigated to provide back-up information for tube flow tests. In order of determined value and efficiency, these are: (a) X-ray, (b) negative radiography, (c) neutron radiography, (d) liquid crystal, and (e) immersion ultrasonics.

A by-product of the NDT experiments with liquid-crystal is the possibility of studying heat-transfer patterns and efficiency in coolant tube assemblies.

NDT of molybdenum-disulfide ring inserts for ball bearing spacers was accomplished and indicated that the inserts were not damaged by the cryogenic tests. X-ray and red penetrant inspection methods were used. Because the material is slightly porous, the units will be baked to evaporate the penetrant oil.

It is proposed to continue the development of ultrasonic techniques for automated inspection of NERVA nozzles that will provide a quantitative, computerized data-evaluation capability. This plan will make use of the experience gained from laboratory experiments conducted on the SNP-35, Phoebus-2 nozzles, as part of the SNP-1 technology engine program. The objective of the continued development is to provide a complete ultrasonic testing system for computerized, quantitative analysis. This includes final development of reference standards, tooling, electronic equipment, data recording and data processing equipment, and operating procedures.

The development of the system will involve three phases: Phases I and II will be accomplished at Aerojet-General, and Phase III will be accomplished by Automation Industries.

Phase I - Reference Standard Evaluation: A Phoebus-2 nozzle and the existing reference samples will be used for destructive examination. The results of ultrasonic inspection utilizing a reference standard will be compared with actual measurements.

Phase II - Reference Standard Fabrication: Reference standards will be fabricated from the material selected for the NERVA nozzles.

Phase III - Procurement of Ultrasonic Tooling and Equipment:
Procurement of tooling and equipment required for application of ultrasonic inspection and recording of the information so that data can be analyzed and a quantitative digital computerized readout can be obtained.

B. PROCUREMENT AND FABRICATION CONTROL

1. Procurement and Manufacturing Documents Reviewed
by NRO Quality Engineering

The following NRO procurement requisitions (PR's), interplant work authorizations (IWA's), advance quotation requests (AQR's), purchase orders (PO's), and changes were reviewed by quality engineering personnel to ensure adequate reliability and quality requirements:

<u>Month</u>	<u>PR's</u>	<u>Change PR's</u>	<u>IWA'S</u>	<u>Change IWA's</u>	<u>AQR's</u>	<u>Total</u>	<u>P.O's and P.O. Changes</u>
Oct	84	45	19	2	8	158	40
Nov	84	24	2	2	9	121	23
Dec	<u>76</u>	<u>21</u>	<u>0</u>	<u>3</u>	<u>5</u>	<u>105</u>	<u>65</u>
TOTAL	244	90	21	7	22	384	128

NRO quality engineering personnel reviewed and approved planning and inspection requirements for 83 shop orders for Aerojet-Sacramento plant fabrication and assembly.

Quality engineering is continuing to analyze nonconformance reports to identify significant causes and ensure against the recurrence of similar discrepancies.

2. NRO Quality-Engineering Coordination with Design Engineering

The NRO Quality Engineering organization is working with project engineering personnel in the design effort for the new NERVA engine and is making significant contributions by defining the most effective quality and nondestructive-testing controls. On the basis of experience gained during development of the technology engine, quality-engineering personnel have initiated and participated in the preparation and specification revisions incorporating or changing the quality and reliability requirements to improve the understanding of the design intent, clarify the acceptance criteria, and improve the implementation. Improvements are also being made in the quality-engineering operations and disciplines. Stringent requirements have been established for engineering-drawing and specification review by quality-engineering personnel, who will coordinate the product-assurance review with reliability-engineering and nondestructive-engineering personnel, the cognizant task quality engineer, and other specialized quality-engineering personnel. This degree of review and study will require more time than in the past, but the benefit is apparent from accomplishments that have been achieved in improved definition of quality and control requirements.

3. Revision of Specification Acceptance Criteria

Revision of instrumentation specifications to provide for realistic acceptance criteria and controls is continuing. This effort by quality-engineering and instrumentation-components-engineering personnel has resulted in seven such revisions to specifications for sheathed MgO-insulated cable, pressure transducers, thermocouples, and accelerometers. These revisions have been based on waiver and deviation requests granted, nonconformances approved, and test data on the instrumentation procured for NRX and XE engines. The revisions will provide for effective demonstration of the functional performance and reliability of instrumentation for proposed NERVA engines.

4. Quality Requirements for EPIC Microelectronic Systems

At the request of controls-engineering personnel, quality-engineering personnel have initiated a plan to establish specific quality requirements for EPIC micro-electronic systems. This plan is necessary to provide the basis for evaluation and orientation of potential fabricators of this circuitry when future needs develop. As this is a current technology, quality requirements must be carefully selected and thoroughly evaluated for optimum value to the end use of the product. Engineering at SNPO-C is collaborating in this effort.

5. Material Development for Pressure Vessels

Subscale pressure-vessel forgings for use in material development have been ordered from Wyman-Gordon Company. Quality requirements consistent with the material development requirements were incorporated into the purchase order. Controls for material quality are incorporated into the development specification, AGC 90181, Forgings, Pressure Vessel, Aluminum Alloy 7039.

6. Quality-Engineering Review of AGC Specifications

AGC Specification 90082-C, Lines, Propellant, Cleaning of, was reviewed to evaluate the request of SNPO-C to (1) delete Type-I trichloroethylene and (2) provide for periodic testing of solvents for purity. It was determined that a flushing operation would require the use of Type I and that tests for acidity and alkalinity can be accomplished. A memorandum that was coordinated with NRO materials personnel has been issued that reflects the need for revision of AGC Specification 90082-C.

AGC Specification 46357, Fusion Welding, is being studied for revisions prior to presentation to the AGC Corporate Specification Committee. Quality-engineering personnel have made recommendations regarding establishment

of controls through the use of welding procedures and control of rework and repairs. The committee intends to establish a welding specification that will be acceptable to all projects, with the recognition that, for special requirements, the specification would be supplemented by engineering-drawing notes or special product-control specifications. An example of the supplementary requirements would be those for controlling the flushness of welds. Problems have arisen with suppliers relative to the interpretation of "flush" welding. The use of the flush-contour welding symbol (with or without the mechanical finishing symbol) without a dimensional limit leads to various interpretations. Field interpretations of "approximately flush" vary from 0.010 in. to 100% of parent-metal thickness. To ensure compliance with the actual functional-design intent, requirements for flush welds must be dimensioned on the engineering drawing.

7. Nozzle-Skirt Inspection Tooling and NDT Equipment

The requirements for nozzle-skirt inspection tooling have been coordinated with engineering and manufacturing-engineering personnel and will be incorporated with the manufacturing tooling requirements. In most cases, the manufacturing tooling can be controlled and used as an inspection means in conjunction with standard measuring equipment. For the NDT X-ray inspection, a rotatable carrying cart will be needed to achieve access to the inside of the skirt tubes. This same cart may be used for tube repairs and penetrant inspection. Ultrasonic inspection for braze integrity of the nozzle skirt does not appear to be feasible or practical.

IV. NRO QUALITY ASSURANCE

A. STATISTICAL DATA

1. Introduction

A discrepancy index factor was discussed in the last two quarterly reports, where it was stated that this factor, by itself, was not

meaningful but was used as a guide for corrective action. The factor indicated the major types of discrepancies, causes, and responsibilities. Each of these categories would assist the quality engineer in taking preventive measures to curb problem areas. Percentage values of the same three categories were found to be even more beneficial. Consequently, the concept was changed to include this improvement.

Biweekly computer tab runs indicating the discrepancies and the category breakdown percentages are distributed to quality-engineering personnel and the Air Force Plant Representative Office. These tab runs are used as guides to investigate major sources of trouble and to determine corrective actions required.

2. Technology Hardware

a. General Data

<u>Data Item</u>	<u>Quantity</u>			<u>Quarter Total</u>
	<u>October</u>	<u>November</u>	<u>December</u>	
SDARs	12	5	3	20
IRs	17	7	9	33
SIRs	4	3	1	8
Discrepant pieces	45	27	14	86
Discrepant characteristics	81	35	22	138

b. Statistical Analysis

The percentage of total discrepancies for the report period, by category, were:

<u>Types</u>		<u>Causes</u>		<u>Responsibility</u>	
Functional	26.3	Dwgs-specs	28.1	Supplier	56.1
Dimensional	17.5	Planning	22.8	Engineer	29.8
Other	17.5	Inspection	17.5	To be determined	12.3
Docum-procedure	12.3	Oper. error	14.1	Other	1.8
Weld-braze	8.8	Other	10.5		
Special process	5.2	To be determined	7.0		
Assembly errors	3.5				
Damage	3.5				
Identification	1.8				
Contamination	1.8				
Material	1.8				

c. Discussion and Summary of Data

The statistical data for the first quarter of CY '68 reveal that the number of discrepant pieces and the number of discrepant characteristics dropped 80% from the previous quarterly totals.

3. Cataloging and Retention of Reliability and Quality Data

The various elements of the quality-assurance program for cataloging, coding, and storage of reliability and quality data have been expanded to include all NERVA discrepancy documents.

Data books, end-item reports, failure-mode analyses, design-review reports, and reliability technical reports are currently being filmed on microfiche and retained as historical files.

Discrepancy and failure data such as inspection reports (IR), supplier discrepancy action requests (SDAR), supplier information requests (SIR), and quality-reliability disposition reports (QRDR) are being microfilmed and

processed for computer sort and readout. The objective of the system is the availability and on-time retrieval of reliability and quality data for use by product-assurance personnel in establishing effective corrective action to prevent recurrence.

B. DOCUMENTATION

The following documents, in the form of data books and end-item reports, were processed during the first quarter of CY '68.

1. Data Books

a. Nozzles (6)

Data books for the Phoebus nozzles for SN 605, 604, 602, and 600.

Technology Nozzle 028, 023

b. Instrumentation (8)

Threshold detectors and solenoid driver cards, transducers, transmitters, thermocouples, and switch assemblies.

c. Lines (6)

Inlet, cooldown-vent assemblies, actuation vent, helium supply, and adapter discharge.

d. Upper Thrust Structure (1)

2. End-Item Reports

- a. Turbopump Assemblies (2)
- b. Nozzle (1)
- c. Lines (13)

Assemblies, turbine exhaust, discharge adapter, inlet, actuation vent, and helium.

- d. Instrumentation (1)

Transmitters.

- e. Pressure Vessel (1)

- f. Actuators (1)

TPCV actuators.

- g. Valves (2)

Check valves.

V. NTO PRODUCT ASSURANCE

A. GENERAL

An administrative procedure redefining the interface between product-assurance and E-MAD personnel has been initiated and distributed for review and approval.

An interim quality reliability instruction (QRI) governing the handling of nonconforming material was issued for temporary use during this period.

A new quality-reliability disposition report (QRDR) form, together with a form instruction, has been initiated and is currently being reviewed by NRDS.

B. E-MAD OPERATIONS

Inspection and checkout of the NRX-A6 actuators were accomplished during the report period. Problems encountered during tests were resolved as evidenced by the successful conclusion of the NRX-A6 full-power test.

Product-assurance personnel witnessed and accepted final checks on the mechanical and electrical systems and reviewed and accepted all assembly log books of NRX-A6.

Product-assurance personnel performed inspection and checkout activities during transfer and mating of NRX-A6 to Test Cell C.

Product-assurance personnel verified all XE-1 disassembly operations and are currently witnessing the assembly operations.

C. ETS-1 OPERATIONS

Product-assurance inspection and measurements were conducted on the test-stand adapter during this period. Problems encountered during the inspection have been resolved.

Product-assurance personnel provided engineering surveillance during the duct-vault-purging installation.

Engineering surveillance was provided by product-assurance personnel during accomplishment of all XECF "P" procedures.

D. TEST CELL C

Product-assurance personnel participated in all prerun activities at Test Cell C for the NRX-A6 test series. The prerun included all end-to-end checks and all subsystem checks.

During NRX-A6 experimental plans I, II, and III, product assurance personnel recorded and evaluated all discrepancy occurrences.

Product-assurance personnel participated in the prerun status board and run-day activities for the NRX-A6 full-power test.

E. RELIABILITY

Review of the final draft of the XE-1 failure-mode analysis by NTO was completed and comments and recommendations were transmitted to NRO.

A preliminary draft of the failure-mode analysis for the engine installation vehicle and the manned control car has been completed and is currently in the final stages of assembly and reproduction.

The QRDR initiation and processing functions were reviewed, and action has been initiated to improve the quality and timeliness of this document.