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NUCLEAR DIVISION

RELIABILITY AND QUALITY ASSURANCE
INFORMAL PROGRESS LETTER NO. 45A

FOR SECOND QUARTER, CY 1968
COVERING
JANUARY, FEBRUARY, AND MARCH 1968

NERVA PROGRAM

CONTRACT SNP-1

APRIL 1968

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NUCLEAR ROCKET OPERATIONS

NRO

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CLASSIFICATION CATEGORY

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AEROJET - GENERAL CORPORATION
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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 the quality-control organization at Aerojet's Sacramento Facility for January, February, and March of Contract Year 1968.

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I. SUBCONTRACTOR AND NTO SURVEILLANCE

A. WANL-WNCO ACTIVITIES

The WANL Product Assurance Program Plan, WANL, TNR-088, Revision F, has been processed through a series of reviews with SNPO, SNPO-C, and NRO product-assurance personnel. The rather extensive coordinated reviews should assure a single-purpose reliability approach to the NERVA program.

Implementation of the computerized release of fuel elements at WNCO has been delayed. Acquisition of an additional computer is being evaluated by Westinghouse for use at WNCO to upgrade the total computer capability for fuel-element processing and release.

The testing and installation of the WANL XE-1 pneumatic actuators at NRDS has been delayed pending resolution of nonconforming XE-1 actuators SN 58597 and SN 58605, which are being evaluated and tested at WANL.

Acceptance performance of the WANL control-drum spring assembly, 978D559 H01D, for the XE-2 reactor, has not been achieved by the supplier.

B. NTO COORDINATION

The NTO Product Assurance Program Plan (NTO-A-001, Revision 2) is being completed and will be submitted to NRO product-assurance personnel after SNPO and SNPO-C approval of the NRO Reliability and Quality Assurance Program Plan, 2469 Revision D.

Paragraph V, "NTO Product Assurance" covers NTO product-assurance activities.

II. RELIABILITY ASSURANCE

A. NTO RELIABILITY COORDINATION

Coordination meetings between NTO and NRO reliability personnel were held in January and March. Failure-data acquisition and utilization were the major topics in these meetings. Discrepancy Log NTO-04-014, submitted at the second meeting, has proved useful for the development and checking of the ETS-1 FMAs.

The NRO QRDR document file has been expanded to include all QRDRs issued by NTO to date.

B. RELIABILITY PRESENTATION

NRO reliability-engineering personnel participated in a presentation at SNPO-C in January 1968 at which the results of a preliminary TPA reliability evaluation were discussed. The objective of this evaluation was to determine the following:

1. Whether the inherent reliability of the TPA design is compatible with an apportioned reliability goal of 0.99967.
2. Whether the design can be translated into hardware with the process capability, quality, and controls required to achieve the reliability goal.

Among topics discussed were:

1. Summary of TPA historical reliability.
2. Review of original NERVA TPA reliability predictions.
3. Summary of the technical approach that will be used to provide definitive answers to the above questions.

NRO was requested to complete the reliability evaluation of the TPA design, with several alternatives to be considered.

C. XE-1 FAILURE-MODE ANALYSIS

Completion of the computerized malfunction-analysis runs (Reports RN-S-0447 and RN-S-0452) on the common analog model produced quantitative data pertinent to the existing failure-mode analysis (FMA). Incorporation of these data into the FMA, either as confirmation of the adequacy of the existing design or as delineation of problem areas, was initiated. The revision of Report RN-DR-0141, planned for April 1968, will reflect data from these studies as well as investigations similar to the XECF vibration resonant search conducted in December 1967 and January 1968. The FMA is being coordinated with Safety Reports RN-S-0378 and NJD-8. Anomalies and failures occurring during facility and XECF engine checkout and tests are being reflected in the revisions.

Readiness review meetings utilized the XE-1 FMAs for assessing design readiness. The following XE-1 FMAs were updated on the basis of extensive analytical and test data prepared for these reviews:

- a. 5-in. engine butterfly valves
- b. Turbine block valve
- c. Turbine power-control valve
- d. Turbopump
- e. Engine instrumentation
- f. Engine external shield
- g. Pressure vessel
- h. Nozzle
- i. Thrust structures
- j. Propellant shutoff valve

In addition to the revised FMAs, the following new FMAs were prepared:

- a. Test-stand adapter (TSA)
- b. Propellant inlet line in TSA
- c. Common vent line (engine)
- d. Cooldown line in TSA

NRO controls engineering, test engineering, and reliability personnel are evaluating WANL review comments on the XE-1 and the ETS-1 FMAs for incorporation into these documents.

D. ETS-1 ELECTRICAL-POWER-SYSTEM FMA

Coordination of the ETS-1 electrical-power-system FMA was completed in March. The final phase of the NRO-NTO coordination involved determining action of the reliability facility changes that were to be implemented. As a result, a two-fold improvement program was established. The essential and urgent changes will be accomplished before XE-1 testing to provide the minimum reliability improvements. The second group of changes will provide additional system redundancy commensurate with the value of the test article and state-of-the-art risks involved in future testing. These changes require additional time for implementation.

The electrical-power FMA segments include a narrative, power-coordination curves, and the FMA sheets on the power networks down to and including the essential and instrument buses providing power for the individual control circuits and components. The electrical-power FMA will be issued with the balance of the ETS-1 FMAs.

E. ETS-1 FLUID-FLOW-SYSTEMS FMA

Review comments on the preliminary fluid-flow-system FMAs were incorporated into a revised issue. The revision emphasizes identification of those failure modes for which no adequate system failure exists to nullify the effects of their occurrence. The analysis for each such mode designated the changes necessary to maintain the function despite the failure. The revised FMAs included 41 subsystems. Eleven of the subsystem FMAs remained in their preliminary form. The revised FMAs were released for NRO and NTO coordination in March.

The removal and redesign of the LH₂ run line PC-5 strainer is an example of reliability improvement resulting from failure-mode analysis. The fragile nature of the upstream turbine flowmeter required a reliability safeguard for the TPA in the event of failure of the flowmeter. The constraint on pressure drop in the run line dictated the use of a screen of maximum grid opening. However, the repetitive appearance of sand in the LH₂ run tank system could not be controlled by a coarse screen. Furthermore, experience with filters used for LH₂ flow in other programs has shown them to be prone to failure.

Despite the successful performance of the PC-5 strainer in earlier facility testing, the adequacy of the strainer was evaluated by comparing its design against selected reliability criteria. The evaluation showed the structure of the strainer to be of doubtful reliability, and the strainer was redesigned. In the redesign, accumulated flow data made it possible to diminish the screen openings, thereby providing protection for the engine against instrument fragments and other types of debris.

F. ETS-1 INSTRUMENTATION-AND-CONTROL (I&C) FMA

Updating of the preliminary issue of the I&C FMA continues.

G. FACILITY-VALVE FAILURE-BIAS STUDY

The failure-mode analyses of ETS-1 systems are based on the behavior of remotely operated critical valves when they lose actuation power. Such losses can be either electrical or pneumatic-, or hydraulic-pressure failures. The effect of such failures depends on how the valve is mechanically biased and whether the upstream pressure is above or under the valve plug. Reliability personnel initiated a study to establish an accurate and current listing of such valve characteristics. The first issue of this listing was made in March.

III. QUALITY ENGINEERING

A. NERVA QUALITY ENGINEERING

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

NRO quality-engineering activities related to the technology engine were primarily in support of the XE-2 upper-thrust-structure-module (UTSM) assembly and components required for the XE-2 engine assembly at NTO. The use of integrated shop planning prepared by manufacturing-engineering and quality-engineering personnel for the XE-2 UTSM has limited the number of problems during fabrication and assembly operations and has provided improved data regarding inspection and test status, as-built configuration, and materials traceability.

Contamination in the fuel lines has been the most significant problem. As reported previously, all lines in which contaminants could become entrapped were reinspected after metal chips were discovered in the gas vent line (prior to installation). Repeated cleaning in accordance with specification AGC-90082C, Lines, Propellant, Cleaning of, did not provide conformance to the requirements of AGC-STD-9007C (NRO), Cleanliness Levels, Components and Assemblies. It was concluded that the continued detection of contaminants resulted from the inability to completely remove all contaminants entrapped in the bellows assemblies. A cleaning-and-inspection procedure was therefore developed and included in the shop planning. Implementation of the procedure provided satisfactory results through (1) use of a pneumatic vibrator during flow with the line in a horizontal attitude and (2) use of a plastic mallet for tapping the line while held in a vertical position. All lines were subjected to two cleaning and inspection cycles.

As a result of these problems, cleanliness specifications and controls are being subjected to a critical evaluation, and engineering personnel will consider designs for the NERVA engine that minimize areas where contaminants can be entrapped.

Installation of instrumentation on the UTSM has been initiated. This work is proceeding without incident in accordance with the integrated planning. Damage to transducers, experienced during previous assembly operations, has been eliminated by cleaning all components separately and inspecting for damage prior to assembly of the units in the clean room.

2. Valves

All flow-control and vent valves for the XE-2 UTSM were successfully tested for use in the engine system, except for two 4-in. butterfly valves (TPCV and TBV) located on the turbine inlet line. Re-evaluation of the 4-in. butterfly demonstration valve disclosed that, although it conformed to all functional acceptance criteria, the ends of the high-temperature carbide bearing rollers had been chipped. It was determined that this mechanical failure resulted from high stresses placed on the bearing rollers (located at either end of the butterfly shaft) by distortion of the shaft due to high differential pressure across the valve during closing. Disposition of previously accepted valves is under review, and design modifications are being evaluated.

The 8-in. tank-shutoff demonstration valve was subjected to a life-cycle test at ambient temperatures under the surveillance of quality-engineering personnel. This test requirement was not included in the engine design criteria but was performed because the valve located in the ETS-1 test-stand adapter had been cycled dry at ambient temperatures during the training program for ETS-1 control-room personnel. The life-cycle tests demonstrated that the leakage between the valve seat and poppet sealing surface was within specification limits after 600 cycles. However, during

the life-cycle tests, the lower-actuator-shaft Gits seal was pulled out of position. Quality-engineering and inspection personnel carefully examined each part of the disassembled valve for other defects. The only other unanticipated wear condition detected was galling of the actuator piston shaft. A design modification will be initiated to eliminate both anomalies.

3. AFPRO Surveillance

AFPRO surveillance, in accordance with SNPO-C delegation, has not reported any deficiencies in product-assurance operations or inspection operations related to XE-2 hardware. Mutual understanding of requirements and controls has been accomplished through biweekly meetings between AFPRO, SNPO-C, and NRO quality-engineering representatives.

4. TPCV Actuators - XE-2 TPCV Assembly

Quality-engineering personnel performed on-site surveillance of the assembly and testing of the Model NT-D2 TPCV actuators. Because not all units presented for acceptance met the test criteria, quality-engineering personnel recommended that the subcontractor revise component and subassembly acceptance tests, that check lists be prepared to ensure test facilities are adequately set up and operative, and that the subcontractor complete a successful acceptance-test run before requesting source acceptance.

Because of failure history, emphasis was placed on having the subcontractor provide an adequate acceptance test for the dynamic-seal-and-bellows assembly. Because of this failure history, quality-engineering, NDT-engineering, and materials-engineering personnel have initiated an investigation to determine adequate controls for the microwelding and NDT to be incorporated into the requirements for welded bellows used in dynamic seals. Quality-engineering personnel provided the quality-assurance provisions for a new specification for a nuclear-environment, gaseous-hydrogen,

dynamic seal to be considered for use in the NT-D2 actuator. The specification includes qualification and testing criteria and procedures to ensure conformance to design requirements.

Specification AGC-90201 was reviewed by product-assurance personnel. This specification establishes the performance, test, and design-verification requirements for a rotary electropneumatic servo actuator. Because this actuator will be used in conjunction with the NERVA-engine turbine power-control valve (TPCV), the specification will be continually updated prior to release.

5. NERVA Engine Design

NRO quality-engineering personnel are actively working with engineering personnel in the design effort for the NERVA engine. Significant recommendations have been made to improve quality-assurance provisions in specifications to ensure demonstration and conformance of components to the preliminary engine design criteria.

Analysis of the NERVA subscale-pressure-vessel forging test coupons has been received from Wyman-Gordon. The coupons for testing were taken from the mid-radius section of 4-in. test slices of material. Acceptance testing indicated that the material was free of segregation and inclusions. Compliance with requirements for zinc and magnesium content was established.

The purchase order for pressure-vessel subscale weld development was released to the Marquardt Corporation. The welder, welding equipment, and related facilities were approved; and weld plates were submitted to Aerojet for evaluation. Evaluation of the weld plates indicated sufficient weld dilution, good response to reheat treatment to the T-61 condition, good mechanical properties, and no evidence of macro- or microcracks. The weld plates contained scattered and linear porosity. A process-development effort is planned to solve these porosity defects.

Test planning for lines and components has been initiated. Documentation requirements will be planned in advance to ensure that adequate data are obtained. This planning will identify required preproduction control procedures, product control, verification points, and documentation required to verify conformance of the product to component and engine design criteria.

6. ETS-1, GSE and Facility Test Equipment

a. Steam Lines

After the NEP-He-2 test, examination of the steam line revealed that it had moved to the point of bottoming the two gimbals in the vertical run against their restrainers, thereby causing some deformation in these areas. The line was also dented in the horizontal run, by the ceiling-mounted hanger. The line was repaired for XECF testing, and the soundness of the gimbals and bellows sections within the gimbals was verified. The steam-generator and steam-line will be checked before XECF testing to ensure an adequate test operation.

Because of deformation of the steam line, a new steam-line design concept has been initiated by NRO. The material requisitions are being processed through quality-engineering personnel for inclusion of appropriate quality-control requirements. All steam-line coordination meetings are being attended by an NRO quality-engineering representative.

b. Valve and Pressure-Switch Refurbishment

A valve and pressure-switch refurbishment program has been initiated at NRO for ETS-1 steam-generator components. This work is being coordinated through the valve shop at the Sacramento Facility. Quality-engineering personnel have followed the progress of component refurbishment and are witnessing the acceptance test prior to shipment of components to NTO.

c. Helium Cooldown Supply Valve

The helium cooldown supply valve encountered fabrication difficulties at the supplier's plant. An assessment of the condition of the valve resulted in a decision by project and quality-engineering personnel to cancel the procurement activity and obtain a replacement valve. A survey of the equipment at Test Cell A revealed that relief valve SV-90 would satisfy the requirements for the helium cooldown line at ETS-1. The SV-90 valve had previously been satisfactorily used at Test Cell A and has been disassembled, inspected, reassembled, and tested prior to installation at ETS-1.

d. Installation and Testing of Shrouding

Fabrication, installation, and testing of shrouding for flange-joint seals and the vent system was completed to enclose all potential H_2 leaks above the top shield and to vent the enclosures on ETS-1. Final checkout and inspection were accomplished after the affected lines had been subjected to cryogenic-temperature shock.

e. Latching Cylinders

During the mating up of side shields CS-1 and S-2 in preparation for the NEP-He₁ test at NRDS, excessive leakage was noted in the latching cylinders. An investigation of one of the cylinders revealed that the piston seals had rolled out of place during hand-actuation checkout. NRO has requested that cylinder kits be sent to NTO after the supplier's recommended fix was reviewed and accepted by NRO facility-engineering personnel. As a temporary measure for the NEP-He₂ test, the cylinders were blocked mechanically, and the required tension was applied to the latches by tightening the cables against the block. Resolution of this problem has been coordinated by facility-engineering personnel with all other cognizant personnel.

f. Analysis of Screen in Main Propellant Line

As a result of a screen failure at the Sacramento Facility, the main-propellant-line screen at ETS-1 was analyzed. The analysis indicated that the screen was structurally marginal for a ΔP of greater than 5 psi. The decision by project and quality-engineering personnel was to design and fabricate a new screen and ship it to NRDS prior to XECF testing. The screen was installed, and a leak check of the propellant line was witnessed by an NTO product-assurance representative.

g. Control of ETC Purge Temperature

A heater and its associated controls for maintaining the ETC purge temperature above 40°F were purchased. Preliminary system checkouts were conducted and witnessed by NTO product-assurance personnel. Final checkout is scheduled to take place during XECF testing.

h. Shield-Drain-Line Support

During the preceding report period, the shield drain line support on ETS-1 was analyzed by facility-engineering personnel. There were positive indications that overheating of the line support would occur during engine operations. A new support design was initiated and completed at NRO that reduced the exposed area and increased the percentage of positive contact with the drain line. The fabrication, installation, and inspection of the new support were completed at NTO.

i. Repair of Side Shield

NRO quality-engineering personnel assisted facility-engineering personnel in determining the proper repair to the side-shield top

trough. RTV-type compound was recommended to seal all leaking areas. The top trough was satisfactorily sealed and leak-checked, and the test was witnessed by NTO product-assurance personnel.

7. Nondestructive Testing

Radiographic standard MIL-STD-453 was reviewed with the SNPO-C representative for use as the primary NERVA radiographic-control document. It was agreed that this standard is adequate when supplemented by procurement provisions requiring submittal and approval of the supplier's radiographic procedures. A form containing the elements for the procedure was developed. It is planned to implement this form for procedural submittal for NERVA engine hardware.

Application of the new Drawing Requirements Manual directive for NDT callouts has reduced the need for changes at the time of drawing review. The reduced number of NDT specifications has resulted in greater familiarity and understanding, especially by suppliers, of those now in use.

Review of X-rays of the welding of GH_2 heater tubes at the Sacramento test area indicates continued high-quality film, all showing the 0.010-in. 1T penetrameter hole, with the penetrameter placed on the side of the tube opposite of the film. Consistent use of low kilovoltage, small focal spot, and 60-in. distance has accounted for this radiographic quality. Interpretation of the film has been rigid. No cracking problems have been encountered.

A study of the effectiveness of penetrant inspection on 7039 aluminum is in progress. The present objective is to determine the machining parameters that can prevent penetrants from locating cracks on machined surfaces. It has been found that some degree of crack closure occurs with small cracks when a dull cutting tool, high feed, high speed, and negative rake

angle are combined. These conditions will be reduced in degree until limits are determined. Specimens 1 by 4 by 3/8 in. are being used with cracks that were induced by repeated quench cycling from incipient-melting temperature to liquid-nitrogen temperature. Photographs are being made of the penetrant inspection results after machining, and each specimen is studied microscopically.

Neutron radiography of a NERVA nozzle section with foreign materials in the coolant tubes was performed on the 250-kw reactor at Aerojet-General Nucleonics, San Ramon. Results of the test demonstrated this method of inspection can be used to locate low-density tube blockage. A 0.009-in. strand of dental floss in a coolant tube was clearly visible on film made through the 1/2-in. Hastelloy X wall. A valve was also radiographed to show that the presence and position of rubber O-rings can be determined.

B. PROCUREMENT AND FABRICATION CONTROL

1. Procurement and Manufacturing Documents Reviewed by Quality Engineering

The following NRO procurement requisitions (PRs), inter-facility work authorizations (IWAs), advance quotation requests (AQRs), purchase orders (POs), and changes were reviewed by quality-engineering personnel to ensure adequate reliability and quality requirements.

<u>Month</u>	<u>PRs</u>	<u>Change PRs</u>	<u>IWAs</u>	<u>Change IWAs</u>	<u>AQRs</u>	<u>Total</u>	<u>POs and PO Changes</u>
Jan	123	28	28	1	6	162	64
Feb	110	34	6	-	3	153	52
Mar	<u>155</u>	<u>46</u>	<u>3</u>	<u>1</u>	<u>5</u>	<u>210</u>	<u>69</u>
Totals	338	108	37	2	14		186

Quality-engineering personnel reviewed and approved the planning and inspection requirements for 98 shop orders for fabrication and assembly at the Sacramento Facility.

Acceptance-at-source actions involving 56 purchase orders and 20 subcontractors and suppliers were completed. Eighteen purchase orders involving sixteen suppliers and subcontractors are currently under surveillance.

Quality-engineering personnel are continuing to analyze non-conformance reports to identify significant causes and ensure nonrecurrence of similar discrepancies.

2. Quality-Engineering Review of AGC Specifications

The proposed Dalic gold-plating specification, AGC-90199, was reviewed by quality-engineering personnel to provide a document for gold plating of seals used in valve assemblies. The tasks included training instructions for plating operators; requirements for certification of operators; upgrading of the plating specification for Dalic plating on aluminum, Inconel 718, and 300-series stainless; and methods for measuring plating thickness.

AGC-STD-1194B, Fusion Welding Specification, which will replace the present weld specification, AGC-46351, has been reviewed. The document provides for improvements in weld procedures, permissive weld repairs, welding qualification, and quality-assurance provisions.

AGC-STD-2156, which provides the requirements and procedures for certification of personnel performing soldering, inspection, welding and assembly electrical equipment, and certification of personnel instructing others in these operations, has been prepared and released by Aerojet.

Specification AGC-90056, E revision, for forgings of nickel-base-alloy Hastelloy X, provides for improved metallurgical and quality-engineering controls and is ready for release. Specification AGC-90057, D revision, for nickel-base-alloy Hastelloy X sheets and strips, has been reviewed to incorporate the experience gained in the Phoebus 2 nozzle program.

Because of the cleaning problems with lines for the technology engine, considerable emphasis has been placed on preventing contamination in the designs being developed for NERVA lines. The conceptual design effort is to reduce areas where contaminants could be entrapped. The specification for flexible bellows includes product-assurance recommendations for preventing contamination, such as: (a) fabrication and assembly operations shall be performed in an area that will be controlled to prevent contamination; (b) equipment and facilities, including tooling, inspection, and testing devices, shall be controlled for cleanliness; (c) fittings and adapters shall be stainless steel; and (d) the testing media shall be controlled to eliminate contamination through the use of filters consistent with the product-cleanliness requirements.

The cleaning procedures and specifications are subject to review by both NRO engineering and quality engineering personnel. The current techniques used to clean NERVA lines are being evaluated to determine improvements that can be made to applicable specifications.

In addition to recommendations for improving Specification AGC-90082, Lines, Propellant, Cleaning of, other cleanliness controls will be subjected to critical evaluation. Issue of revision to AGC-90082 is not intended at present. Prior to fabrication of NERVA components, the specification will be revised; or a new specification will be written that incorporates all improvements.

IV. NRO QUALITY ASSURANCE

A. STATISTICAL DATA

1. Introduction

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 in investigating major sources of trouble and in determining the corrective actions required.

2. Technology Hardware

a. General Data

Analysis of data reveals that 266 discrepant pieces, containing 338 discrepant characteristics and involving 88 different line items and 47 different part numbers, were processed during the report period.

<u>Data Item</u>	<u>Quantity</u>			<u>Quarter Total</u>
	<u>January</u>	<u>February</u>	<u>March</u>	
SDARs	1	13	1	15
IRs	5	15	14	34
SIRs	1	5	5	11
Discrepant pieces	8	169	89	266
Discrepant characteristics	17	176	145	338

b. Statistical Analysis

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

<u>Type and %</u>		<u>Cause and %</u>		<u>Responsibility and %</u>	
Dimensional	38.8	Drawings, specs	32.8	Engineering	66.0
Material	34.6	Planning	32.0	Supplier	21.0
Weld-braze	5.9	Operator error	20.4	Manufacturing	10.7
Functional	5.6	Tool, machine	4.4	Other	2.3
Damage	2.7	Inspection	0.6		
Documentation	1.5	To be determined	2.4		
Assembly error	1.5	Other	7.4		
Contamination	1.2				
Other	8.2				

Analysis of discrepancies by major type, cause,
and responsibility categories:

<u>Category</u>	<u>No. of Line Items</u>	<u>No. of Part No's.</u>	<u>No. of Documents</u>	<u>No. of Pieces</u>	<u>No. of Discrep. Char.</u>
<u>Types of Discrepancies:</u>					
Dimensional Discrepancies	26	16	16	79	129
Material Discrepancies	8	6	8	117	117
Subtotal, type	34	22	24	196	246
Percent of total	38.6	46.8	40.0	73.7	72.8
<u>Causes of Discrepancies:</u>					
Drawings and specifications	7	6	7	111	113
Planning	19	10	10	58	108
Operator error	41	25	25	51	65
Subtotal, cause	67	41	42	220	286
Percent of total	76.1	87.2	70.0	82.7	84.6
<u>Responsibility for Discrepancy:</u>					
Engineering	15	10	9	168	249
Supplier	44	26	28	53	67
Subtotal, responsibility	59	36	37	221	316
Percent of total	67.0	76.6	61.7	83.1	93.5

c. Discussion and Summary of Data

Two items (Bracket, Part Number 1116936, and Seal Assembly, Part Number 1134533-11) accounted for a major portion of the discrepancies found. Two threaded holes in each of forty brackets were counterbored. The brackets were accepted by NRO Review Board action, and the manufacturing planning was revised to prevent recurrence. A supplier's information request was processed that indicated 100 seal assemblies developed cracks during cooldown after brazing. The material alloy used for this development component has been changed.

B. DOCUMENTATION

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

1. Data Books

a. Lines (8) - supplements to previously presented data books.

b. Data books for valves, lines, TPAs, upper and lower modules and structures, shields, test-stand adapters, instrumentation and nozzles. These were presented to (SNPO-C and SNPO) representatives for the XE engine documentation readiness review.

2. End-Item Reports

- a. Valves (7)
- b. Lower thrust structure (1)
- c. Control instructions (3)
- d. Shields (1)
- e. Lines (1)

V. NTO PRODUCT ASSURANCE

A. GENERAL

A new NTO administrative procedure was completed and released that defines product-assurance activities at E-MAD.

A proposed format for the experimental-engine (XE) logs was prepared and is currently being coordinated. The following quality reliability instructions (QRIs) have been initiated and approved for NTO use:

1. 3.3B, "Quality Reliability Instructions"
2. 5.1D, "Receiving Inspection"
3. 5.8, "Supplier Source Control"
4. 6.1, "Control of Government-Furnished Property"
5. 7.13, "Product-Assurance Audit of Preventive Maintenance"
6. 9.2B, "Calibration of Inspection Measuring Equipment"
7. 9.5A, "Control of Electronic Instrumentation at ETS-1"

The NTO procedures governing control of nonconforming material at NRDS have been revised and transmitted to NRO, WANL, and SNPO-C for review and comment.

The proposed revision to the QRDR form has been completed and is currently being coordinated.

B. ETS-1 OPERATIONS

During a checkout of the fire-protection system, a substantial leak was discovered in that portion of the line that services valve pits No. 1 and 2. An examination revealed that a Victaulic coupling had failed, with the resulting leakage. The entire line was examined, and suspected couplings were replaced with welded steel bands. To more clearly define this problem, NTO product-assurance personnel sent the failed coupling to NRO for a detailed failure analysis.

NTO product-assurance personnel witnessed the final checkouts and adjustments of all modifications to the shield latch system. NTO product-assurance personnel also monitored all steam-generator-system checkouts in preparation for the NEP-He-1 test. Discrepancies discovered in the steam-generator pressure switches were documented on QRDRs. These switches were sent to the Pan Am valve shop for disassembly, cleaning, reassembly, and test. The problems were resolved and the generator tests were successfully completed.

A dye-penetrant inspection revealed cracks in the S-1 trough. Product-assurance personnel monitored all work required to correct this problem.

All hydraulic tests for V-3901 through -3905 were satisfactorily completed.

C. E-MAD OPERATIONS

The actuator-checker high-pressure system was inspected by NTO product-assurance personnel, and all discrepancies discovered were resolved.

All lifting equipment at E-MAD was inspected, and those items not meeting specification requirements were identified and are currently awaiting disposition.

Calibration of equipment at E-MAD has been progressing at a satisfactory rate.

Product-assurance personnel provided inspection services during XE-1 cable routing, instrumentation, installation, and checkout in accordance with XE-1-P4 and data-log-sheet requirements.

The XE-1 pneumatic actuators were inspected in accordance with the requirements of XE-1-P3. The discrepancies recorded are being satisfactorily resolved.

D. RELIABILITY

To prevent the degradation of reliability within critical facility systems, a procedure governing the age control of elastomeric or synthetic rubber parts has been approved for NTO use.

Reliability personnel have been participating in the establishment of a preventive-maintenance program for the ETS-1 facility. The responsibility for this task has been delegated to NTO engineering personnel; however, quality-control and reliability personnel have been requested to contribute to this program in the areas of discrepancy-failure history, operating time-cycle data, storage-life data, and component-evaluation data.

A reliability procedure governing the review or initiation of a failure-mode analysis by NTO personnel was prepared and has been approved for NTO use.

E. DOCUMENTATION SUPPORT AND SPECIAL PROJECTS

Product-assurance personnel took part in the compilation of all TS&PRB activities conducted during the report period. Surveys have been made of two major facility problems detected during the steam-generator tests: (a) cleanliness control of ETS-1 filters and (b) recurrent problems associated with the steam generator. Results of these surveys are presently being compiled and will be ready for distribution during the next period.