NARRATIVE END ITEM REPORT

SATURN S-IVB-504N

[redacted]

DOUGLAS MISSILE & SPACE SYSTEMS DIVISION

[redacted]

MCDONNELL DOUGLAS CORPORATION

NARRATIVE END ITEM REPORT
SATURN S-IVB-504N

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PREPARED BY W M REITZELL
BRANCH CHIEF, QUALITY DATA AND REPORTING
RELIABILITY ASSURANCE DEPARTMENT

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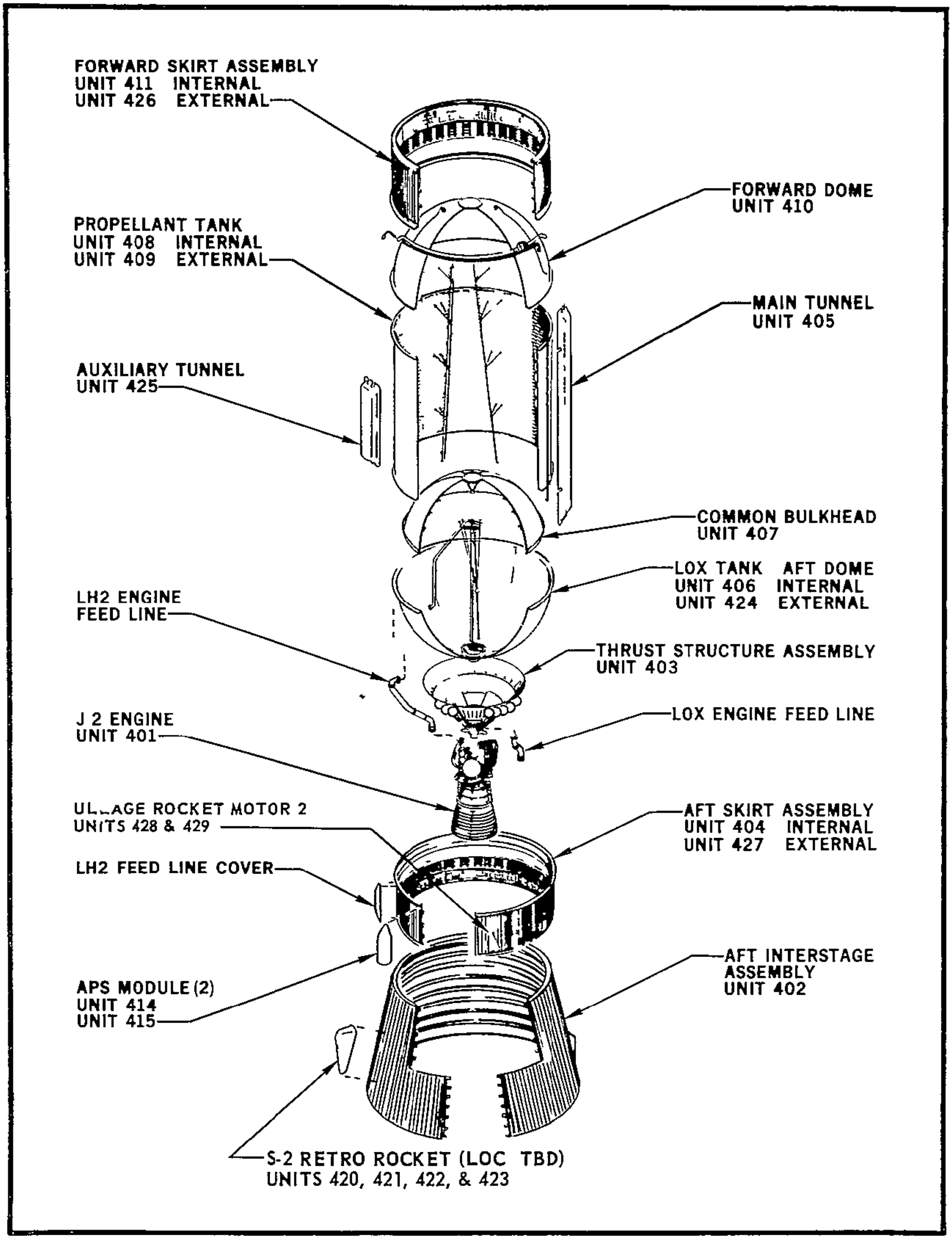
APPROVED BY K A FREDERIKSEN
CHIEF QUALITY ENGINEER
RELIABILITY ASSURANCE DEPARTMENT

APPROVED BY W W REASER
DIRECTOR, SATURN PROGRAM
PRODUCT ASSURANCE

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
WESTERN DIVISION



Exploded View of S-IVB Stage for Saturn V

ABSTRACT

The Narrative End Item Report (NEIR) contained herein is a narrative summary of the McDonnell Douglas Astronautics Company (MDAC) Sacramento Test Center test records relative to the Saturn S-IVB-504N Flight Stage (MDAC P/N 1A39300-507, S/N 1009).

Narrations are included on those conditions related to permanent nonconformances which were generated during the manufacturing cycle and existed at the time of Sacramento Test Center acceptance testing The report sets forth data pertinent to total time or cycle accumulation on time or cycle significant items Data relative to variations in flight critical components is also included There is no provision to update or revise the NEIR after initial release

Descriptors

NEIR

Documentation

Configuration

Significant Items

Stage Checkout

Prefire and Poststorage

PREFACE

This Narrative End Item Report is prepared by the Reliability Assurance Directorate of the McDonnell Douglas Astronautics Company (MDAC), Western Division, for the National Aeronautics and Space Administration under Contract NAS7-101 This report is presented in response to requirements of NPC 200-2, paragraph 14.2.4, and is issued in accordance with MSFC-DRL-021, Contract Data Requirements, which details the contract data required from MDAC The report summarizes the period from initial stage acceptance testing at the MDAC Sacramento Test Center, Rancho Cordova, California, through turnover to the MDAC Florida Test Center, Cape Kennedy, Florida.

The previous period of stage acceptance testing at the MDAC Space Systems Center, Huntington Beach, California, and transfer to the Sacramento Test Center, was covered by Narrative End Item Report, Saturn S-IVB-504N, Douglas Report DAC-56561, dated July 1967

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1 0 INTRODUCTION

1 1 Scope

The NEIR compiles quality evidence and assessments of a particular end item for use in evaluating program objectives and end item usage This report narrates upon the Saturn S-IVB-504N Stage, and discusses the following

a Configuration at turnover for shipment to the Florida Test Center, Cape Kennedy, Florida

b Replacements made during Sacramento Test Center (STC) test and acceptance checkout, including serial number of articles removed or substituted.

c Nature of problems and malfunctions encountered

d Corrective action taken or pending.

e Extent of retests or tests not completed

f Total operating hours or cycles for each time or cycle significant item

1 2 Format

This document is organized into sections, with each section fulfilling a specific purpose The title of each section, and a brief outline of its purpose follow

SECTION

1 INTRODUCTION. This section discusses the scope of the NEIR, the Stage Design Concept, Documentation, and Turnover Data

2. NARRATIVE SUMMARY A brief summary of principal test areas is presented to give management personnel a concise view of successful test achievement, and remaining areas of concern

3 STAGE CONFIGURATION Conformance to engineering design, and data on time/cycle significant items

4 NARRATIVE A presentation of checkout operations, presented in the chronological order of testing Failure and Rejection Reports (FARR's) are referenced as applicable for each paragraph

APPENDICES

I TESTING SEQUENCE Graphic presentation of the order and activity dates of the STC checkout procedures

II TABLES.

a TABLE I - A compilation of FARR's initiated during prefire checkout.

b TABLE II - A compilation of FARR's recorded during countdown initiation and postfire checkout.

1 2 (Continued)

c TABLE III - A compilation of FARR's recorded during poststorage checkout

III FLIGHT CRITICAL ITEMS INSTALLED AT TURNOVER A listing of those flight critical items installed on the stage at the time of turnover for shipment to the Florida Test Center

1 3 Stage Functional Description

A detailed system analysis is beyond the scope of this report The S-IVB-V Stage End Item Test Plan, 1B66684-503, contains a description of each operational system, and includes a listing of test procedures with the objective and prerequisites of each test Stage 504N is primarily a booster stage, consisting of propellant tanks, feed lines, electrical and pneumatic power for operation of stage systems, and such systems as are required for checkout purposes, fuel loading and unloading control, in-flight control and pressurization, and data measurement during these operations.

1 4 Documentation

Manufacturing and test records for this stage include Fabrication Orders (FO's), Assembly Outlines (AO's), Failure and Rejection Reports (FARR's), Serial Engineering Orders (SEO's), Radiographic Inspection Records, Sacramento Test Center (STC) test data and vendor data FO's and AO's record in sequence all manufacturing processes, and Quality Control inspection activities Any discrepancies from drawing requirements are recorded on FARR's by Inspection and Test personnel The FARR is also used to record the Material Review Board (MRB) disposition applicable to the discrepancy SEO's may be written to define the rework required by a FARR, to change the effectivity of a drawing, or to change other drawing requirements Radiographic Inspection Records and X-ray photographs are maintained on file by the contractor All original data is retained in the contractor's Reliability Assurance Department Central Files Vendor technical data is received on functional purchased parts and is also retained in Central Data Files Much of the documentation referenced within this report is included in the log book which accompanies each stage

1 5 Turnover

Turnover of the Saturn DSV-4B-1-1 (S-IVB-504N) stage, for transport to the Florida Test Center, was made on 10 September 1968 at the Sacramento Test Center Final acceptance was made by the Air Force Quality Assurance Division Representative on Form DD250. Two letters, A3-131-5.4.3 13-L-4013, dated 16 August 1968, and A45-870-L-039, dated 10 September 1968, from the MDAC management to the NASA Resident Manager at STC, submitted the documentation necessary to effect turnover. Copies of these letters and the accompanying documentation is included in the stage log book. Acceptance of the Auxiliary Propulsion Modules was effected on the same Form DD250 as the stage, although the modules were noted as shortage items on the Form DD250, and were shipped separately to FTC.

2 0 NARRATIVE SUMMARY

The following paragraphs present a narrative summary of stage checkout of the S-IVB-504N stage. Stage prefire tests and stage poststorage checkouts conducted at the Sacramento Test Center (STC) are summarized in paragraphs 2.1 and 2 2 respectively The Final Inspection, Weight and Balance, and Preshipment Preparations are summarized in paragraphs 2.3, 2 4, and 2.5 respectively More detailed narrations on these tests and operations are presented in section 4

Paragraph 2 6 summarizes any tests that were not completed prior to stage transfer, and any retesting that will be required Paragraph 2 7 summarizes the incomplete failure and rejection reports that were transferred open at the time of stage transfer from STC to MSFC/FTC

2 1 Stage Prefire Acceptance Tests

The S-IVB stage acceptance test program, conducted at the Sacramento Test Center (STC), verified the functional capabilities of the stage systems, at sea level conditions, during static acceptance firing The stage acceptance firing plan, 1B71775, delineated the general philosophies of the STC test programs Test request 1047 authorized the acceptance firing and delineated the test objectives and requirements The stage prefire checkouts were designed to ensure a condition of readiness for the stage, facility, and GSE to conduct a successful static acceptance firing program

The stage was received at the STC on 16 June 1967. The prefire checkouts began on 19 June 1967, and were concluded on 12 August 1967 Twenty-six procedures were exercised to ensure the functional capabilities of the stage. Detailed narrations on the prefire checkouts are presented in paragraph 4 1.

Prefire checkouts began with the prefire structural inspection, which was successfully completed without the generation of FARR's, however, there were six revisions to the procedure

2 1 (Continued)

The forward skirt thermoconditioning system checkout, the umbilical interface compatibility check, the APS interface compatibility check, the preliminary propulsion leak and functional checks, and the common bulkhead vacuum system checks were successfully conducted without generating any FARR's However, a total of 105 revisions were written against these procedures Two revisions were against the forward skirt thermoconditioning system Five revisions were against the umbilical interface compatibility checks One revision was against the APS interface compatibility check Ninety-three revisions were against the preliminary propulsion leak and functional checks Four revisions were against the common bulkhead vacuum system checks

The hydraulic system setup and operation procedure was successfully completed after the incorporation of nine revisions Two FARR's were generated as a result of this checkout

Power was applied to the stage for the first time on 14 July 1967, with the initiation of the stage power setup procedure Stage power setup and stage power turnoff were successfully demonstrated without the generation of FARR's No revisions were written against the stage power setup procedure One revision was written against the stage power turnoff procedure

The EBW system checkout, the APS checkout, and the stage and GSE manual controls check were successfully demonstrated without generating any FARR's One revision was written against the stage and GSE manual controls procedure, and one revision was written against the EBW system checkout No revisions were written against the APS procedure

The telemetry and range safety system checks were successfully concluded, with one revision to the procedure. No FARR's were generated

Verification of the cryogenic temperature sensors required the issuance of two procedures, because of a tank feedthrough connector pin verification per AO 1B58968-A45-2. Although there were three revisions to the first issue and four revisions to the second issue, there were no FARR's generated

2.1 (Continued)

Power distribution system checks were successfully conducted without generating any FARR's. There were nine revisions written against the procedure The range safety system was successfully demonstrated, after writing one revision. There were no FARR's generated as a result of this test

The DDAS calibration was successfully completed, after writing eleven revisions to the procedure. One FARR was written as a result of this test The propellant utilization system calibration was successfully completed, without the generation of FARR's. However, it was necessary to write four revisions against the procedure.

Hydraulic system checkouts were successfully completed, after writing one revision to the procedure. No FARR's were generated as a result of this test

The propellant utilization system was successfully demonstrated, after three revisions were incorporated There were no FARR's generated as a result of this test. The propulsion system automatic check was successfully demonstrated, after thirty-six revisions were incorporated in the test. No FARR's were written as a result of this test.

The digital data acquisition system checks were successfully completed, after the incorporation of twenty revisions to the procedure There were no FARR's written as a result of this test.

The integrated system test was successfully conducted without the generation of FARR's However, there were forty-four revisions to the procedure It was necessary to run the signal conditioning setup procedure to check out the manual decoder assembly, which had been replaced There were no FARR's written during the procedure. One revision was written against the procedure

The final prefire propulsion system leak check was successfully conducted without encountering any major problems that resulted in the generation of FARR's. It was necessary, however, to write ten revisions to the procedure

2 1 (Continued)

The stage was ready for the simulated static firing on 8 August 1967. The "Ready For Acceptance Firing" milestone was met on 11 August 1967.

The acceptance firing test required three runs on three different days in order to accomplish all required objectives of test request 1047, revision 2 and addendum 1 Run 1, designated countdown 614088, was initiated on 15 August 1967, and was terminated following completion of LH_2 loading Termination was due to problems experienced with the Beckman ground data acquisition system Countdown 614089 was initiated for Run 2 on 21 August 1967, and the countdown proceeded normally through the T-1 day The count was then terminated due to a burnwire touching the fuel turbine inlet duct, causing a fire indication.

On 25 August 1967, countdown 614090 was accomplished for Run 3 The firing was terminated after 438 seconds of successful mainstage operation. A detailed narrative of the acceptance firing is delineated in Douglas Report SM37551, dated September 1967

The normally scheduled postfiring checkouts were deferred, and the stage was placed into storage following the completion of the acceptance firing operations.

2.2 Stage Poststorage Acceptance Tests

The stage was removed from storage and installed in Test Stand Beta I on 8 January 1968, for the poststorage checkout One poststorage checkout had been accomplished on 7 January 1968, at the VCL prior to transfer of the stage to Beta I Cryogenic temperature sensor verification in accordance with H&CO 1B37622 was conducted in the VCL for the LH_2 tank sensors due to postfire internal work in the LH_2 tank This test is described in detail in paragraph 4 2.1 Checkout of the stage systems on Beta I started on 10 January 1968, and was completed on 11 March 1968 Twenty-five H&CO's involving the stage systems were performed during this period Detailed narrations on the poststorage checkouts are presented in paragraph 4 2

2.2 (Continued)

Prior to turning on the stage power at Beta I, checks were made of the stage wiring, the umbilical interface wiring, the forward skirt thermoconditioning system, and the manual controls No significant problems were encountered during this period and no FARR's were initiated as a result of these checkouts Procedure revisions were written to correct minor problems.

Power was first applied to the stage on 22 January 1968, with the initiation of the stage power setup and turnoff procedures. There were no major problems, although several procedure revisions were required to correct minor problems

Following successful checkout of the stage power distribution system, three tests of the DDAS automatic calibration were required, as FARR's against the first two tests resulted in replacement of the DDAS assembly and the DP1-BO multiplexer

The propulsion system leak checks were run concurrently with the electrical systems tests during January and February, 1968 A number of leaks were found, and those exceeding allowable limits were corrected. There were no significant problems and no FARR's were initiated.

The APS modules were installed and the APS electrical interface compatibility check was conducted satisfactorily prior to additional APS testing. Manual and automatic leak and functional checks of the APS modules were conducted with no discrepancies noted.

The electrical systems tests were accomplished with no major problems One FARR initiated during the range safety receiver checks replaced the range safety 1 antenna due to low sensitivity

The hydraulic system setup and operation, and the hydraulic system automatic checkout procedures, were conducted without significant problems No FARR's were initiated against the system, although a number of revisions were written to correct minor procedure problems.

2 2 (Continued)

The propulsion system automatic test was accomplished with minor problems that were corrected by procedure revisions. No FARR's were initiated as a result of the test.

Individual system tests were completed by 28 February 1968, and the all systems test (AST) was conducted on 29 February 1968 All problems encountered during the AST were of a minor nature and were handled by procedure revisions, with one exception The apparent malfunction of the control units for the LOX point level sensors 1 and 2, during a preliminary AST engineering run, resulted in FARR documentation and replacement of the control units The level sensor and control unit calibration procedure was then performed to calibrate the new control units for the LOX point level sensors 1 and 2, prior to successful demonstration of the AST

Final poststorage operations on Test Stand Beta I included final checkout and securing of the hydraulic system and the forward skirt thermoconditioning system. Only one problem of significance was noted A leak in the hydraulic accumulator was documented by a FARR as acceptable to Engineering

The stage was removed from Test Stand Beta I and transferred to the VCL on 11 March 1968, for preshipment preparation. Investigation of the hydraulic accumulator leakage was resumed, resulting in additional FARR documentation and eventual replacement of the accumulator The hydraulic system servicing procedure was then performed to accomplish the necessary filling, bleeding, air content checks, functional and leak checks, and fluid sampling required as a result of replacing the accumulator

In addition, miscellaneous work was performed on the stage in the VCL, including modifications to incorporate the LOX tank nonpropulsive vent system in accordance with ECP 2057-1, removal of the LH_2 tank mass probe for modification in accordance with SEO 1A48431-009, internal inspection of the LH_2 tank per QEC, and torque checks of the cold helium system connections and joints in accordance with WRO A45-S-IVB-327

2 2 (Continued)

Because the LH_2 tank was entered during this period, it was necessary to reverify the cryogenic temperature sensors located in this tank A cryogenic temperature sensor verification procedure was performed to accomplish this, with only the LH_2 tank sensors involved. No problems were encountered during this final VCL checkout

2 3 Final Inspection

Following the final manufacturing operations and modifications, the final inspection of Stage 504N was accomplished between 16 August 1968 and 9 September 1968, to locate and correct any remaining stage discrepancies A total of four hundred ninety-five mechanical and electrical area discrepancies were recorded during the inspection, mostly of a minor nature All except five of these discrepancies were cleared to an acceptable condition without requiring failure and rejection report action The remaining five problems were noted on FARR's 500-225-246, 500-373-024, and 500-373-156, and were acceptably corrected. A more detailed narration on the final inspection is presented in paragraph 4 3

2 4 Weight and Balance

The stage was rotated to a horizontal position in preparation for the weight and balance operation. On 3 September 1968 the stage was weighed by means of a three point electronic weighing system Three electronic load cells, one aft and two forward, measured the reaction forces of the otherwise unsupported stage The reaction force measurements were then used to determine that the stage shipping and handling weight was 26,905 4 pounds, the stage weight corrected for Standard Gravity in a vacuum was 26,957 4 pounds, and the stage longitudinal center of gravity was located at station 328.6. Paragraph 4 4 presents a more detailed narration on this operation

2 5 Preshipment Purge

The final operation before the stage was shipped to FTC was the preshipment purge Gaseous nitrogen was used to purge the stage systems to dewpoints of -31 5°F for the LH_2 system, and -62.5°F for the LOX system The proper desiccants were installed to maintain the proper stage environment during the air transport operations Paragraph 4 5 presents a more detailed narration on this operation

2.6 Incomplete Tests and Retesting Requirements

All required prefire and poststorage stage checkouts were accomplished during the stage testing period.

During the period following the stage testing, numerous modifications were made to the stage prior to shipment from STC, and additional modifications were scheduled at FTC. These modifications invalidated parts of the previously accomplished stage testing, including tests on the stage power system, the DDAS, the range safety receivers, the propulsion utilization system, the APS, the propulsion system and tanks, and the hydraulic and thermoconditioning systems. MDAC report DAC-61230, dated 10 September 1968, extensively covered these modifications and the retesting that would be required at FTC to reverify the affected stage systems. This report was prepared in accordance with contract change order CCO 1890.

2 7 Incomplete FARR's

Two FARR's were not closed at the time Stage 504N was shipped to FTC, and these FARR's were transferred open with the stage. FARR's 500-372-346 and 500-372-354 noted that curtain assemblies, P/N 1B69815-7, S/N 002, and P/N 1B65607-503, S/N 009, respectively, did not fit at the nonpropulsive vent duct. Both curtains were accepted for use at STC, but were to be resubmitted at FTC for final disposition.

3.0 STAGE CONFIGURATION

The paragraphs of this section define the configuration of the stage, and note the applicable variations Paragraph 3.1 discusses the means used to verify the stage configuration, paragraph 3 2 describes those flight critical items which deviate from the stage design, and paragraph 3.3 contains those variations in stage configuration which represent changes in the scope of the program

A listing, in tabular form, of all time/cycle significant items on the stage, along with the accumulated time/cycles for each item, is included in paragraph 3.4.

Existing contractual configuration control papers are referenced wherever possible.

3 1 Design Intent Verification

This configuration of the stage is defined in the Engineering Configuration List (ECL), Space Vehicle, Model DSV-4B-1-1, Manufacturing Serial Number 1009, revision D, dated 18 March 1968. This ECL document includes a listing of all parts, non-hardware drawings, and manufacturing and process specifications required for the manufacture and test of the stage, as defined by Engineering production drawings and EO releases. The ECL has been transmitted to NASA under a separate cover

Verification of design intent was accomplished by comparing the ECL with the Planning Configuration List (PCL), and the Reliability Assurance Department As-Built Configuration List (ABCL) Any discrepancies found were resolved by the contractor, and a listing of the resultant action is filed at the contractor's facility

3.2 Stage Variations - Flight Critical Items

Identification of components and assemblies which are variations to the stage design is accomplished by including the serial engineering order (SEO) dash number after the part number. Those flight critical items which are installed

3 2 (Continued)

in the stage with SEO variations are reviewed in this paragraph A description of the variation, along with part number and serial number, is presented for each part.

3.2.1 LOX and LH_2 Fill and Drain Valves

SEO 1A48240-007 authorized the removal of the existing bonded insert and O-ring from the electrical connectors, leak testing of the receptacles, and subsequent installation of an unbonded insert and O-ring for the LOX and LH_2 fill and drain valves, P/N 1A48240-505, S/N's 001 and 0118, respectively. The unbonded inserts were installed to minimize cracking of the inserts and glass insulation at cryogenic temperatures, in accordance with NASA change order 1602.

3.2.2 Fuel Tank Vent and Relief Valve

SEO 1A48257-006 authorized the same replacement of the bonded insert with an unbonded insert, as described in paragraph 3 2.1, for the fuel tank vent and relief valve, P/N 1A48257-511, S/N 0039.

3.2.3 LOX Tank Vent and Relief Valve

SEO 1A48312-008 authorized an insert and O-ring replacement, as described in paragraph 3 2.1, for the LOX tank vent and relief valve, P/N 1A48312-505, S/N 0023

3.2.4 Oxidizer Mass Probe

SEO 1A48430-011 was a salvage SEO for reworking and cleaning the oxidizer mass probe, P/N 1A48430-509, S/N C1. Due to improper probe assembly, silicone O-rings, which are not LOX compatible, were found in some LOX tanks

3 2.5 Fuel Mass Probe

SEO 1A48431-009 provided salvage instructions for the fuel mass probe, P/N 1A48431-505, S/N D3, due to defective spot welds discovered by the vendor, Honeywell, during assembly of other probes, P/N's 1A48431-501 and -505 Rework substituted a riveted attachment in place of the welded assembly

3.2.6 LH$_2$ Chilldown Shutoff Valve

SEO 1A49965-012 authorized unbonded insert replacement for the bonded insert, as previously described in paragraph 3.2.1, for the LH$_2$ chilldown shutoff valve, P/N 1A49965-523, S/N 0402

3 2.7 LOX Chilldown Shutoff Valve

SEO 1A49965-013 authorized the removal of the valve assembled with Drilube 822, which was no longer LOX compatible, and the installation of LOX chilldown shutoff valve, P/N 1A49965-529-013, S/N 0607, which was assembled with an acceptable lubricant.

3.2.8 LOX and LH$_2$ Tank Prevalves

SEO 1A49968-010 authorized reworking the LH$_2$ prevalve, P/N 1A49968-507, S/N 022, and the LOX prevalve, P/N 1A49968-509, S/N 142, to improve the valve response time, and to prevent cryopumping into the shaft seal port.

3.2.9 Directional Control Fuel Vent Valve

SEO 1A49988-003 accomplished the unbonded insert substitution, described in paragraph 3.2.1, for the directional control fuel vent valve, P/N 1A49988-509, S/N 0039, to minimize cracking at cryogenic temperatures

3.2.10 Helium Fill Module

SEO 1A57350-002C authorized the removal of the relief valve from the helium fill module, P/N 1A57350-507, S/N 0227. An on-board relief valve was no longer required, and its deletion from the module resulted in an improvement in reliability.

3.2.11 Hydraulic Pitch Actuator Assembly

SEO 1A66248-011A reworked the hydraulic pitch actuator assembly, P/N 1A66248-505, S/N 52, by cleaning per MSFC-SPEC-237A, priming per MIL-P-23377, and top coating per MIL-C-22750A. This was done because the aluminum parts on the actuator might have been subjected to stress corrosion.

3 2.12 Hydraulic Yaw Actuator Assembly

SEO 1A66248-012A authorized replacement of electrical connectors, P/N's 061-45703 and 061-45704, with connectors, P/N's 061-44051 and 061-44052, for hydraulic yaw actuator, P/N 1A66248-507, S/N 60. The bayonet studs on the electrical connectors, P/N's 061-45703 and 061-45704, were being sheared off under normal usage.

3 2.13 Chilldown Inverter Electronic Assembly

SEO 1A74039-011E authorized special rework and testing to verify the low temperature integrity of the chilldown inverters, P/N 1A74039-517, S/N's 053 and 00015.

3 2.14 O_2H_2 Burner Welded Assembly

SEO 1B62600-009C authorized rework of the O_2H_2 burner, P/N 1B62600-507, S/N 07, to plug the back pressure system connection port, P/N 1A21229-501, located on the nozzle and dome assembly, P/N 1B62609 This port was no longer required due to deletion of the back pressure system

SEO 1B62600-012 authorized reworking the O_2H_2 burner assembly to update it to provide restart capabilities.

SEO 1B62600-A45-55A authorized the manufacture of a stud, P/N A45-55-3, from a bolt, P/N NAS 1004-5A, and the installation of the stud through the O_2H_2 burner spool and injectors 1 and 2.

3 2.15 Actuation Control Modules

SEO 1B66692-A45-1 authorized correction of electrical designations stamped in error on the actuation control modules, P/N 1B66692-501, S/N's 60, 61, 68, 69, 70, 71, 72, 75 and 86.

3 3 Scope Change/Engineering Change Proposal Verification

Scope Changes (SC) and Engineering Change Proposals (ECP), with the applicable verification data, are listed in Form DD829-1, which is included in the Stage

3.3 (Continued)

Log Book. This paragraph lists those SC/ECP's which were verified at STC, or subsequent to stage turnover to NASA. Those SC/ECP's which were incorporated and verified prior to transfer of the stage to the STC were covered in the DAC-56561 NEIR.

The following SC/ECP's were incorporated subsequent to stage transfer from the SSC, and were substantiated as being incorporated by MDAC and AFQA personnel "buy off" of the AO paper. The SC/ECP's are listed as previously complied with (PCW) on Form DD829-1.

a. ECP X114, authorized by CCO 482 and letter S-IVB-65-182, provided for an independent excitation EDS power supply

b. ECP X126, authorized by CCO's 511, 551, 578, and 607, and letter S-IVB-5-293, provided for modification of the cryogenic repressurization system

c. ECP X132, authorized by CCO's 383, 422, 435, 508, and 516, and letter S-IVB-5-581, provided for an operational telemetry system

d. ECP X134, authorized by CCO's 526, 537, 573, and 636, and letters SD-L-747, SD-L-748, and SD-L-749, provided for the redesign of the J-2 engine electrical interface.

e. ECP X154, authorized by CCO's 543 and 612, provided for the design and procurement of the control relay packages

f. ECP X171, authorized by CCO's 79 and 582, provided for MC fittings and flared tubing

g. ECP X180, authorized by letters S-IVB-5-740 and S-IVB-5-972, and technical directives TD-65-79, TD-65-116, and TD-65-119, provided for changes to the operational and mission control measurements.

h. ECP X181, authorized by CCO's 642, 651, 659, and 743, and letters SD-L-864, S-IVB-5-858, S-IVB-5-9-55, S-IVB-6-221, and S-IVB-65-173, provided for implementation of the cryogenic repressurization system.

i. ECP X190, authorized by letters SD-L-762, S-IVB-5-762, and S-IVB-934, provided for the forward skirt environmental control system.

j. ECP X204, authorized by CCO's 650, 661, 670, and 708, and letter S-IVB-65-246, provided for the deletion of the pad safety and minimum liftoff pressure switches

3.3 (Continued)

k. ECP X222, authorized by letter SD-L-1470 and technical directive TD-66-1, provided for the modification of the LOX tank propellant utilization probe

l. ECP X224, authorized by CCO's 700 and 739, provided for the recirculation chilldown pump pressure measurements

m. ECP X226, authorized by CCO 690, provided for Apollo coordinate system standards

n. ECP X227, authorized by CCO 704, provided for the implementation of measurement changes on DSV-IVB stages

o. ECP X255, authorized by CCO 645 and letter S-IVB-6-518, provided for the thermal insulation of Model II switch selectors

p. ECP X259, authorized by technical directive TD-66-16, provided for the modification of the LH_2 tank probe

q ECP X262, authorized by CCO's 813 and 853, and letter S-IVB-6-198, provided for the modification of the emergency detection system cutoff circuits.

r. ECP X264, authorized by CCO 788 and technical directive TD-66-38, provided for the deletion of the rate gyro and the accelerometer provisions.

s ECP X267, authorized by letter L-131-66, provided for the identification of GFE test code plugs.

t. ECP 0271, authorized by CCO 798 and letter S-IVB-6-442, provided for range safety system measurements

u. ECP 0273, authorized by CCO's 837 and 861, and letters L-78-66, S-IVB-6-343, and S-IVB-6-427, provided for the deletion of the LH_2 translunar vent.

v. ECP 0277, authorized by CCO 801, provided for the deletion of the interstage propellant dispersion system pyrotechnics.

3 3 (Continued)

w ECP 0302, authorized by CCO 886 and 942, letters S-IVB-6-485 and S-IVB-6-870, and technical directive TD-66-80, provided for the design of the LH_2 slosh filter and guidance system computer

x. ECP 0304, authorized by CCO 977 and letters S-IVB-6-886 and S-IVB-6-1050, provided for the deletion of S-IVB vent termination pressure switches

y. ECP 0318, authorized by CCO 956 and letter S-IVB-6-519, provided for the modification of the range safety controller safing plug

z. ECP 0322, authorized by CCO 900 and technical directives TD-66-60 and TD-66-63, provided for the modification of the control relay package.

aa. ECP 0341-R1, a compatibility ECP, provided for the replacement of the low pressure cold gas check valve

ab ECP 0354, a compatibility ECP, provided for a thermal barrier for the ambient helium fill module

ac. ECP 0355-R1, a compatibility ECP, provided for the redesign of the fuel tank pressurization diffuser assembly

ad ECP 0441, authorized by CCO 934 and letter S-IVB-6-779, provided for the rework of the remote analog submultiplexer

ae. ECP 0444, a compatibility ECP, provided for the improvement of hardwire measurements M514 and M515.

af ECP 0449, a compatibility ECP, provided for the installation of studs in forward skirt thermoconditioning panel 16.

ag. ECP 0450, a compatibility ECP, provided for the rework of the auxiliary tunnel covers and forward fairings

ah. ECP 0466, authorized by letter S-IVB-6-805, provided for the modification of the PU static inverter-converter telemetry voltage supply

ai. ECP 0479, a compatibility ECP, changed the wiring of the PAM inputs to the PCM/DDAS

aj ECP 0486, authorized by letter S-IVB-6-1459, provided for replacement of the diodes in the inverter-converter

ak ECP 0488, a compatibility ECP, provided for the installation of an ullage pressure transducer in the forward dome

al. ECP 0490, a compatibility ECP, provided for the redesign of the checkout valve, P/N 1B53817.

am. ECP 0493-R2, a compatibility ECP, provided for the redesign of the chilldown shutoff valves.

an. ECP 0506, authorized by letter I-CO-6-984, provided for telemetry measurement D0225-403.

3.3 (Continued)

ao ECP 0510, a compatibility ECP, provided for the installation of the coaxial cable assembly at location 411W212.

ap. ECP 0522, authorized by CCO 1079 and letter L-6-955, provided for the redesign of the hydraulic actuator rod end bolt

aq. ECP 0533, a compatibility ECP, provided for the installation of temperature and pressure transducers on the hydraulic accumulator/reservoir

ar. ECP 0534, a compatibility ECP, provided for the redesign of the tank relief valves

as. ECP 0542, authorized by letter S-IVB-6-874, provided for changes to the Model II PCM RF assembly

at ECP 0547, authorized by CCO 1122, provided for the redesign of the bi-level summing network

au ECP 0565, a compatibility ECP, provided for the redesign of the fill and drain valve

av. ECP 0575, a compatibility ECP, provided for the rework of the auxiliary hydraulic pump assembly.

aw ECP 0581-R1, authorized by letter S-IVB-6-1341, provided for the redesign of the fuel injection temperature bypass command circuit

ax. ECP 0590, a compatibility ECP, provided for the substitution of the multiplexer and selector switch shrouds with aluminized mylar shrouds.

ay. ECP 0597-R1, authorized by letter S-IVB-6-1271, provided for the redesign of the propellant umbilical fill and drain valve disconnects

az ECP 0600, a compatibility ECP, provided for the rework of the engine drive high pressure check valve

ba. ECP 0601, authorized by CCO 993, changed the self locking bolts to bolts and nuts that could be lockwired

bb ECP 0605, a compatibility ECP, provided for the installation of EDS isolator vibration transducer brackets.

3.3 (Continued)

bc. ECP 0613-R1, authorized by letter S-IVB-6-1176, provided for the replacement of hydraulic hose support bracket bolts.

bd. ECP 0622, a compatibility ECP, provided for the replacement of 10 amp relay module, P/N 1A74218.

be. ECP 0630, a compatibility ECP, provided for the reconfiguration of the LOX inlet duct.

bf. ECP 0633, a compatibility ECP, provided for the rework of the LH_2 propellant duct resilient mount.

bg ECP 0634, authorized by letter S-IVB-6-1215, provided for the revision of the EDS circuit.

bh. ECP 0638-R1, authorized by letter S-IVB-6-1262, provided for the replacement of the APS quick-disconnect.

bi. ECP 0639, a compatibility ECP, provided for the relocation of the transducers for measurements D2, D3, D4, and D105.

bj. ECP 0648-R1, authorized by letter S-IVB-6-1327, provided for the deletion of the relief valve function from the ambient helium fill module.

bk ECP 0651, a compatibility ECP, provided for the core reset resistor for the chilldown inverter.

bl. ECP 0653, a compatibility ECP, revised the stage umbilical panel markings.

bm ECP 0663, a compatibility ECP, provided for the reconfiguration of the LH_2 -503 inlet duct.

bn. ECP 0672, a compatibility ECP, provided for the reconfiguration of the pneumatic power control module

bo ECP 0677, authorized by CCO 1104, provided for the redundant start relay for the 70 pound ullage engine

bp ECP 0678, a compatibility ECP, provided for the RF bond on the small No. 2 battery in the forward skirt.

bq ECP 0680, authorized by letter S-IVB-6-1380, provided for the inverter-converter 21 vdc measurement.

3 3 (Continued)

br ECP 0681, authorized by letter S-IVB-7-680, provided for the checkout of spare depletion sensors.

bs. ECP 0685, a compatibility ECP, provided for the replacement of the accumulator/reservoir support.

bt ECP 0686, a compatibility ECP, provided for the replacement of the LH_2 depletion sensor time delay module

bu ECP 0688, authorized by CCO 1031 and letters S-IVB-6-1337, S-IVB-6-1443, S-IVB-6-1490, and L-1356-66, provided for aft umbilical modifications

bv ECP 0689, a compatibility ECP, provided for the redesign of the vent and relief valves in the seal areas of the open position actuators and in the area of the boost close piston installation

bw. ECP 0690, a compatibility ECP, provided for the release of the O_2H_2 burner shutdown valve

bx ECP 0699, a compatibility ECP, provided for the LOX ullage sensing line purge.

by ECP 0808, a compatibility ECP, provided for the transducer mounting for measurement D055

bz ECP 0809, a compatibility ECP, modified the wire harness for the power input for measurement K169

ca. ECP 0814, a compatibility ECP, provided for the rework of the plenum environmental segment

cb ECP 1008, authorized by letter S-IVB-S-1406, provided for the redundant EDS J-2 engine cutoff modifications

cc ECP 2019, a compatibility ECP, provided for the redesign of the continuous vent system

cd ECP 2027, a compatibility ECP, provided for the replacement of the feedthrough coaxial socket contacts

ce ECP 2033, a compatibility ECP, provided for the redesign of the pneumatic power control module and the engine pump purge module pipe assemblies

cf. ECP 2037, a compatibility ECP, provided for the main hydraulic pump compensator attachment

cg ECP 2040, authorized by letter I-CO-S-IVB-7-100, provided for additional measurements in the S-IVB stage operational measurement program

ch ECP 2046, a compatibility ECP, provided for the relocation of the pressure transducers for measurements D16, D183, and D184

ci. ECP 2048-R1, authorized by CCO 1198, provided for the modification of the continuous vent module bypass valve hardwire talkback

cj ECP 2051, a management directive ECP, provided for the reconfiguration of the cold helium dump module

3 3 (Continued)

ck ECP 2053, a compatibility ECP, provided for the modification of the chilldown inverter assembly over-volt suppression circuitry.

cl. ECP 2054-R1, authorized by letter I-CO-S-IVB-7-100, provided for the redesign of the APS propellant tank recirculation system.

cm. ECP 2060-R1, a compatibility ECP, provided for a new configuration of the cold gas check valve seat seal installation

cn. ECP 2073, a compatibility ECP, provided for the painting of the hydraulic actuators to relieve stress corrosion

co. ECP 2079, authorized by CCO's 1231 and 1318 and letter S-IVB-7-1029, provided for the rain baffles for the environmental control system vents.

cp ECP 2080, authorized by CCO 1155 and letters S-IVB-7-668 and S-IVB-7-149, provided for the shot peening of the APS module

cq. ECP 2090, authorized by letter 2-403-67, provided for the redesign of the directional control valve.

cr ECP 2091, authorized by letter I-CO-S-IVB-7-2-244, provided for the reconfiguration of the auxiliary hydraulic pump.

cs. ECP 2092, a compatibility ECP, provided for the replacement of bus connectors

ct. ECP 2096, authorized by CCO 1198, provided for the modification of the continuous vent system

cu. ECP 2105-R2, authorized by CCO 1160, provided for the S-IVB stage propellant utilization modifications.

cv. ECP 2112, a compatibility ECP, provided for the reconfiguration of the pneumatic actuator used in the continuous vent module and the the O_2H_2 burner.

cw. ECP 2117-R1, a compatibility ECP, provided for the addition of a check valve in the actuation control module

cx. ECP 2124-R1, a compatibility ECP, provided for the reconfiguration of the LOX chilldown pump.

cy ECP 2130-R1, authorized by letter I-CO-S-IVB-7-346, provided for eddy current tests of the helium pressure vessels

cz. ECP 2123, authorized by letter I-CO-S-IVB-7-183, provided for the reconfiguration necessary to establish qualified RFI filters

da. ECP 2134, authorized by CCO 1170, provided for replacement of channel cards for the model 270 multiplexers.

db ECP 2160-R1, a compatibility ECP, provided for replacement of coaxial contacts in internal propellant tank connectors

dc ECP 2169, a compatibility ECP, provided for relocation of the telemetry common bulkhead pressure sensing port

3.3 (Continued)

dd. ECP 2174-R1, a compatibility ECP, provided for LOX and LH_2 chilldown return duct transducer installation.

de. ECP 2175, a compatibility ECP, provided for a LOX chilldown pump purge bypass line and orifice

df. ECP 2176-R1, a compatibility ECP, provided for the rerouting of coaxial cables

dg. ECP 2180-R2, a compatibility ECP, provided for the modification and installation of the LOX tank relief valve

dh. ECP 2183, a compatibility ECP, provided for the replacement of the fuel chilldown duct aluminum burst disc

di ECP 2184, a compatibility ECP, provided for the replacement of the fuel low pressure feed duct aluminum burst disc.

dj. ECP 2189, a compatibility ECP, provided for rework of the LH_2 PU probe spotwelds.

dk. ECP 2193, a compatibility ECP, provided for the replacement of the NAS 1351 passivated screws in the aft skirt

dl. ECP 2204-R2, a compatibility ECP, provided for the removal of a relief valve from the repressurization control module

dm ECP 2206-R1, authorized by CCO 1226, 1282, and 1297, provided for modification of the LH_2 chilldown pump bearings

dn ECP 2214, authorized by CCO 1278, provided for the addition of instrumentation for the new temperature measurement, C0016

do ECP 2226-R1, a compatibility ECP, provided for modification of the PU electronics circuitry to prevent erroneous LH_2 excess mass readings

dp ECP 2234-R2, a compatibility ECP, provided for reconfiguration of the fuel relief valve.

dq. ECP 2235, a compatibility ECP, provided for replacement of the 2 amp relays, P/N 1B50992-1, with relays, P/N 1B50992-505.

dr ECP 2242, a compatibility ECP, provided for modification of the PU component oven to incorporate high reliability transistors

ds ECP 2244, a compatibility ECP, provided for reconfiguration of the pneumatic power control module

dt ECP 2247, a compatibility ECP, provided for insulation of the static inverter heat sink.

du. ECP 2248, a compatibility ECP, provided for modification of the continuous vent module

dv ECP 2249, a compatibility ECP, provided for rework of the APS propellant control modules

dw ECP 2252, a compatibility ECP, provided for the replacement of a check valve in the cold helium dump module

3 3 (Continued)

dx. ECP 2261-R1, authorized by CCO 1384, provided talkback capability for the O_2H_2 burner LOX shutdown valve.

dy. ECP 2265, a compatibility ECP, provided for replacement of the flexible couplings, P/N 1B38430-1, with couplings, P/N 1B38430-501, in the forward skirt environmental control system.

dz. ECP 2269, a compatibility ECP, provided for reconfiguration of the fuel and LOX chilldown shutoff valves.

ea. ECP 2271, authorized by CCO 1280, provided for the lengthening of the IU electrical ground cable

eb. ECP 2273, authorized by CCO 1381, provided for a drag-in cable door in the forward skirt.

ec. ECP 2279, a compatibility ECP, provided for sealant at the forward skirt mating surfaces for the range safety and telemetry antennas.

ed. ECP 2292, a compatibility ECP, provided for diode module insulating washers.

ee. ECP 2293, a management directed ECP, provided for removal of the exterior position plane coordinate markings

ef ECP 2296-R2, authorized by CCO 1647, provided for control relay package modification.

eg. ECP 2304, authorized by CCO 1352 and 1383, provided for reconfiguration of the LH_2 chilldown system supply duct

eh. ECP 2305, authorized by CCO 1352 and 1383, provided for modification of the repressurization control module

ei ECP 2308, authorized by CCO's 1352 and 1383, provided for the design of a fuel duct vacuum valve locking device

ej ECP 2309, authorized by CCO's 1352 and 1383, provided for the reconfiguration of the LH_2 chill system supply duct.

ek. ECP 2311-R2, authorized by CCO 1522, provided for modification of the LH_2 pressurization system

el. ECP 2312, a compatibility ECP, provided for the replacement of the servo bridge transmission motor.

em. ECP 2325-R1, authorized by CCO 1426, provided for the redesign of the low pressure helium module.

en. ECP 2330-R2, authorized by CCO 1528, provided for the design of the PU oven monitor.

eo ECP 2360, authorized by letter S-IVB-7-1136, provided for the replacement of the 2 amp relay, P/N 1A93619, by relay, P/N 1B39033.

ep. ECP 2419-R1, a compatibility ECP, provided for the replacement of the solenoid on the continuous vent modules, P/N's 1B67193-503 and -505.

3 3 (Continued)

eq ECP 2434, authorized by CCO's 1410 and 1494, provided for the qualification certification of the J-2 engine to stage attach bolts

er ECP 2454, authorized by CCO 1430, provided for test and checkout requirements at KSC

es ECP 2483-R1, authorized by CCO 1556, provided for the S-IVB paint change

et. ECP 2485-R1, authorized by CCO 1562, provided for the modification of the RASM division module

eu ECP 2545-R1, authorized by CCO 1561, provided for the removal of the LOX tank repressurization check valve

ev ECP 2566, authorized by CCO 1492, provided for electrical design changes

ew ECP 2572, a compatibility ECP, provided for the rework of the tunnel disconnect connector

ex ECP 2630, a compatibility ECP, provided for the removal of the orifice from the inlet of the actuation control module

ey ECP 2706, a compatibility ECP, provided for the replacement of the LH_2 tank diffuser pipe assembly

ez ECP 2793, a compatibility ECP, provided for the Saturn V helium fill module thermal protection.

fa ECP 5015-R2, a compatibility ECP, provided for metal protective covers for the unmated stage receptacles

fb SC 1204, authorized by CCO 171, 220, and 371, provided for the telemetry system components

3 4 Time/Cycle Significant Items

Twenty-nine items installed on the stage are time/cycle significant as defined by design requirements drawings 1B55423, Government Furnished Property Time/Cycle Significant Items, and 1B55425, Reliability Time/Cycle Significant Items The following table lists these items, along with the time/cycles accrued on each at the time of stage transfer to FTC, and the maximum allowable limits prescribed by Engineering

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
Reliability Items (1B55425 P)			
1A48858-1	1063	4 cycles	50 cycles
Helium Storage Sphere	1069	5 cycles	50 cycles
	1093	4 cycles	50 cycles

3 4 (Continued)

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
1A48858-1 (Cont'd)	1112	4 cycles	50 cycles
	1113	4 cycles	50 cycles
	1120	4 cycles	50 cycles
	1125	4 cycles	50 cycles
	1135	4 cycles	50 cycles
	1140	4 cycles	50 cycles
1A49421-507 LH_2 Chilldown Pump	193	No Data Available **	100 hours
1A49423-507 LOX Chilldown Pump	1763	2 2 hours	20 hours
1A59562-509 PU Bridge Potentiometer	5019	358 cycles	5,000 cycles
	5024	339 cycles	5,000 cycles
1A66241-511 Auxiliary Hydraulic Pump	X454590	24 8 hours ***	120 hours
		117 cycles	300 cycles
1B57731-501 ' Control Relay Package	407	152 cycles	100,000 cycles
	409	78 cycles	100,000 cycles
G.F.P Items (1B55423 G)			
40M39515-113 EBW Firing Unit	238	48 firings	1,000 firings
	239	55 firings	1,000 firings
	240	47 firings	1,000 firings
	245	42 firings	1,000 firings
40M39515-119 EBW Firing Unit	463	53 firings	1,000 firings
	464	46 firings	1,000 firings
50M10697 Command Receiver	104	48 4 hours	2,000 hours
	167	50.0 hours	2,000 hours
50M10698 Range Safety Decoder	92	49 3 hours	2,000 hours
	133	53 4 hours	2,000 hours
50M67864-5 Switch Selector	159	71,320 cycles	250,000 cycles

**Recent addition to 1B55425, no data kept on this unit to date.
***Reflects correction of previous SSC data to delete erroneously charged time

3 4 (Continued)

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
103826	J-2094		
J-2 Engine (for gimbal cycles)*			
a Customer connect lines and inlet ducts		24 45%	250-10,000 cycles
b Gimbal bearing		21.74%	250-10,000 cycles
c Firing time		844 4 seconds	3,750 seconds
d Helium Regulator (P/N 558100-111)	4087095	29 cycles	Not established

*This data includes all engine gimbal cycles at STC, plus cycles brought forward from Rocketdyne records The cycle data is expressed as a percent of design limits based on the gimbal angle, and can vary from 250 to 10,000 + cycles as noted. The indicated percentages were computed from the Engine Log Records utilizing the graph per Rocketdyne Rocket Engine Data Manual R-3825-1

4.0 NARRATIVE

The paragraphs of this section narrate on the stage checkout in the chronological order of testing. The major paragraphs comprising the narrative are 4 1 Stage Prefire Checkout, 4 2 Stage Poststorage Checkout, 4 3 Final Inspection, 4.4 Weight and Balance, and 4.5 Preshipment Preparations Each major paragraph is subdivided to the degree required to present a complete historical record of stage checkout.

Permanent nonconformances and functional failures affecting the stage have been recorded on FARR's, and are referred to by serial number throughout this section (e.g FARR A255315) The referenced FARR's are presented in numerical order in Appendix II

4.1 Stage Prefire Checkout

The stage prefire checkout began on 19 June 1967 with the initiation of the prefire structural inspection, and ended on 14 August 1967 with the completion of the final prefire propulsion system leak check Paragraphs 4 1.1 through 4.1.26 cover the checkouts that were accomplished during this period All tests required by the End Item Test Plan, 1B66684-503, advance revision C, dated 11 June 1967, were activated and completed

4.1.1 Prefire Structural Inspection (1B40654 B)

Performed between 19 June 1967 and 24 July 1967, this inspection verified that transportation of the stage from SSC to STC had no detrimental effect on the structure, and also established the condition of the stage prior to static acceptance firing for comparison with the stage condition subsequent to a full duration static firing program.

Prior to rotating or moving the stage from the horizontal position in which it was shipped, the area between the forward skirt and the forward dome was visually inspected and determined to be free of debris

After completion of stage installation into the test stand, the forward access kit and the protective cover kit were installed. The thrust structure access doors, P/N 1A68531-3 and P/N 1A68531-4, were removed to facilitate inspection

4 1.1 (Continued)

of the thrust structure area. The main and auxiliary tunnel fairing covers, the LH_2 feed line fairing assembly, P/N 1B28109, the fill, drain, and chill system fairing assembly, P/N 1B28110, the LH_2 chilldown pump line fairing assembly, P/N 1B28111, and the chill system return fairing assembly, P/N 1B28112, were removed to facilitate inspection in the respective areas

A visual inspection was performed on all adhesive bonded parts for voids and unbonded or broken conditions, and all metal to metal bond continuity was verified by the coin tap test method as prescribed by DPS 32330.

A visual inspection of the ambient helium storage spheres was accomplished to determine if any out-of-tolerance ding, scratch or finish discrepancies existed

A radiographic inspection of the forward and aft "V" sections (the junction of the forward skirt and forward dome, and the junction of the thrust structure and aft dome), revealed three pieces of foreign material in the aft section Two steel blind nuts, 1/2 by 1/4 inch, and one aluminum rivet 1/2 inch long by 3/16 inch diameter All items were removed prior to the initial pressurization of the propellant tanks

Six revisions were made to facilitate inspection of the stage and were as follows

- a One revision added the environmental control plenum, P/N 1B64850, to the list of spheres to be inspected
- b One revision authorized installation of X-ray equipment for radiographic inspection of the stage
- c One revision corrected a procedure listing error
- d. One revision deleted the requirement for the APS fit check
- e Two revisions changed part number references

There were no other deviations or FARR's noted, and the procedure was certified as complete and acceptable on 24 July 1967

4.1 2 <u>Forward Skirt Thermoconditioning System Checkout Procedure (1B41955 B)</u>

Prior to initiating prefire automatic checkout of the stage at STC, the forward skirt thermoconditioning system (TCS) was functionally checked to prepare it for operation, and to verify that the system was capable of supporting stage

4.1 2 (Continued)

checkout operations. The procedure utilized the Model DSV-4B-359 TCS servicer, P/N 1A78829-1, which conditioned and supplied the water/methanol heat transfer fluid to the forward skirt TCS, P/N 1B38426-513

Checkout of the TCS was accomplished from 10 through 12 July 1967, and was certified as acceptable on 8 August 1967 Preliminary operations included setup and connection of the servicer to the TCS, and inspection of the TCS panels for open equipment mounting bolt holes and properly torqued bolts The TCS was pressurized to 32 ±1 psig with freon gas, and leak checked with the gaseous leak detector, P/N 1B37134-1. The areas checked for leakage included all TCS B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows No leakage was detected.

The TCS was purged with gaseous nitrogen, and water/methanol fluid was circulated through the system. Water/methanol samples were taken from both the fluid sample pressure valve (system inlet) and the fluid sample return valve (system outlet), and checked for cleanliness, specific gravity, and temperature. Particle counts for each micron range were well within the acceptable cleanliness limits specified. The specific gravity and temperature of the fluid were measured with a hydrometer and thermometer, respectively, determining that the water/methanol concentration was within the acceptable mixture range.

A differential pressure test was conducted to verify correct system geometry and proper flow distribution. The test was conducted by measuring the differential pressure between the TCS inlet and outlet ports, as well as the inlet and outlet temperatures, while maintaining a water/methanol flow rate of 7.8 ± 0 2 gpm. The differential pressure was recorded as 15 1 psid, while the inlet and outlet temperatures were 61°F and 64°F, respectively.

The final step consisted of operating the TCS with the servicer at the required temperatures, pressures, and flow rate, while visually checking for leakage at all water lines, internal piping, and the supply and return lines to the TCS. No leakage was detected. The TCS operation demonstrated that the system was prepared to support prefire checkout activities on the test stand

4.1.2 (Continued)

Two revisions to the procedure were recorded during checkout operations

a One revision authorized substitution of the flex hose assemblies, P/N 1B71989-501, that adapt the supply and return lines of the test setup to the TCS inlet and outlet ports

b. One revision repeated the water/methanol specific gravity test, because the initial samples gave indications of a low methanol concentration, as documented by IIS 364776 The servicer was operated for 30 minutes prior to taking the fluid samples, and the repeated test indicated that the fluid was within the acceptable water/methanol mixture range

No other discrepancies were recorded

4 1.3 Umbilical Interface Compatibility Check (1B64316 C)

Prior to connecting the forward and aft umbilical cables for automatic power on checks, this manual checkout provided the test sequences used to check the design specifications and the continuity of the stage umbilical wiring Accomplished by point-to-point resistance checks of all umbilical circuits, this test ensured that the proper loads were present on all power buses and that the control circuits for the propulsion valves and safety items on the stage were within prescribed tolerances

This procedure was initiated and completed on 12 July 1967 A series of resistance measurements were made at specified test points on the GSE Model DSV-4B-133 signal distribution unit, P/N 1A59949-1, using terminal 463A1A5J43-FF as the common test point for all measurements These measurements verified that all wires and connections in the umbilical cables and stage umbilical wiring were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits A Simpson Model 260 multimeter was used to make the resistance measurements Test Data Table 4 1 3 1 shows the particular test points, circuit functions, measured resistances, and resistance limits involved in this test.

Two assemblies, either not installed or disconnected at the start of this test, resulted in out-of-tolerance conditions which were acceptable to Engineering (Reference Revision b) This procedure was certified as complete and the stage was accepted for further testing on 15 July 1967

4.1.3 (Continued)

There were five revisions written to this procedure

a Three revisions changed the resistance value requirements

	Test Point	Value in Ohms Was	Value in Ohms Is	Reason
1	A2J29-h	50 max / 500K min	200-300 / 500K min	The hardwire emergency vent cables, P/N's 1B04913-595 and 1B04913-597, were installed with diodes in series with the circuits, thus increasing the resistance
2	A2J30-W	10-60 / 500K min	200-300 / 500K min	
	A2J29-c	10-60 / 500K min	10-60	Stage wiring modifications through design changes altered the resistance
	A2J30-Y	100 max / Inf	Inf / Inf	
3.	CB-11-12*	5-15	5-40	*A wiring modification to incorporate a relay increased the resistance
	A2J29-i	50 max / 500K min	40-100 / 500K min	
	A2J6-AA	60-100	80-130	The existing resistances were re-evaluated by Engineering to reflect realistic values

b. Two revisions accepted out-of-tolerance conditions caused by missing and disconnected assemblies as follows

1. The LOX tank cold helium sphere dump solenoid, P/N 1B57781-503, was removed for modification by Serialized Engineering Order, 1B57781-003A.

2. Close solenoid L-1 of the LOX and LH_2 childown actuation control module, P/N 1B66692-501, was not connected.

4.1 3.1 Test Data Table, Umbilical Interface Compatibility Check

Test Point	Function	Meas Ohms	Limit Ohms
Reference Designation 463A2			
A2J29-C	Cmd., Ambient Helium Sphere Dump	30	10-60
CB-8-2	Cmd., Engine Ignition Bus Power Off	Inf	Inf
CB-9-2	Cmd., Engine Ignition Bus Power On	11	5-15
CB-10-2	Cmd , Engine Control Bus Power Off	Inf	Inf
CB-11-12	Cmd., Engine Control Bus Power On	33	5-40
A2J29-N	Cmd., Engine He Emerg Vent Control On	55	10-60
A2J29-P	Cmd., Fuel Tank He Sphere Dump	40	10-60
A2J29-Y	Cmd., Start Tk Vent Pilot Valve Open	27	10-60

4.1.3.1 (Continued)

Test Point	Function	Meas Ohms	Limit Ohms
CB-4-2	Cmd., LOX Tank Cold He Sphere Dump	Inf	10-60
A2J29-c	Cmd , LOX Tank Repress He Sphere Dump	42	10-60
A2J29-h	Cmd., Fuel Tank Vent Pilot Vlv Open	300	200-300
	(Same, reverse polarity)	Inf	500k min
A2J29-i	Cmd., Fuel Tank Vent Vlv Boost Close	80	40-100
	(Same, reverse polarity)	Inf	500k min
A2J29-q	Cmd., Ambient He Supply Shutoff Vlv Close	25	10-60
A2J30-H	Cmd., Cold He Supply Shutoff Vlv Close	1 2k	1 5k max
	(Same, reverse polarity)	Inf	Inf
A2J30-W	Cmd , LOX Vent Valve Open	300	200-300
	(Same, reverse polarity)	Inf	Inf
A2J30-X	Cmd , LOX Vent Valve Close	Inf	Inf
A2J30-Y	Cmd , LOX & Fuel Emerg Close	49	100 max
A2J30-Z	Cmd , LOX & Fuel Chilldown Vlv Close	Inf.	Inf
A2J42-F	Meas , Bus +4D111 Regulation	200	6 min
A2J35-Y	Meas , Bus +4D141 Regulation	Inf	3 min
A2J6-AA	Sup , 28v Bus +4D119 Talkback Power	110	80-130

Reference Designation 463A1

A5J41-A	Meas., Bus +4D131 Regulation	160	20 min
A5J41-E	Meas., Bus +4D121 Regulation	2k	1.6k min
A5J53-AA	Sup , 28v +4D119 Fwd Talkback Power	76	60-100

4 1 4 APS Interface Compatibility Check (1B49558 B)

Initiated, accomplished, and accepted on 12 July 1967, this manual checkout specified and provided instructions for compatibility and continuity test requirements that were performed subsequent to installation of the Model DSV-4B-188C auxiliary propulsion system (APS) simulators, P/N 1B56715-1, and prior to the operational checkout of stage systems pertinent to APS circuitry

Under supervision of a Test Engineer, the check was started with a visual inspection of all plugs and connectors involved in this test for bent or broken pins and other physical defects Proper connection between the control relay package, the aft skirt components, and the APS simulators was verified by point-to-point resistance measurements (Reference Test Data Table 4 1 4 1)

One revision was written to delete sections of the test not applicable to this stage.

4.1 4 (Continued)

There were no shortages or interim use material items installed at the start of this test.

No test requirement changes were contemplated that would require a re-issue of this procedure.

4.1.4.1 Test Data Table, APS Interface Compatibility Check

Common Test Point Stage Ground

Test Point			Component Nomenclature	Meas Ohm	Limit Ohms
404A51A4	J4	A	414A8L1 Eng 1 Valve A	27	25 ±5
404A51A4	J4	B	414A8L5 Eng 1 Valve 1	27	25 ±5
404A51A4	J4	C	414A8L2 Eng 1 Valve C	27	25 ±5
404A51A4	J4	D	414A8L6 Eng 1 Valve 3	27	25 ±5
404A51A4	J4	E	414A8L3 Eng 1 Valve B	27	25 ±5
404A51A4	J4	F	414A8L7 Eng 1 Valve 2	27	25 ±5
404A51A4	J4	G	414A8L4 Eng 1 Valve D	27	25 ±5
404A51A4	J4	H	414A8L8 Eng 1 Valve 4	27	25 ±5
404A51A4	J4	J	414A10L1 Eng 3 Valve A	27	25 ±5
404A51A4	J4	K	414A10L5 Eng 3 Valve 1	27	25 ±5
404A51A4	J4	L	414A10L2 Eng 3 Valve C	27	25 ±5
404A51A4	J4	M	414A10L6 Eng 3 Valve 3	27	25 ±5
404A51A4	J4	N	414A10L3 Eng 3 Valve B	27	25 ±5
404A51A4	J4	P	414A10L7 Eng 3 Valve 2	27	25 ±5
404A51A4	J4	R	414A10L4 Eng 3 Valve D	27	25 ±5
404A51A4	J4	S	414A10L8 Eng 3 Valve 4	27	25 ±5
404A51A4	J4	T	414A9L1 Eng 2 Valve A	27	25 ±5
404A51A4	J4	U	414A9L5 Eng 2 Valve 1	27	25 ±5
404A51A4	J4	V	414A9L2 Eng 2 Valve C	27	25 ±5
404A51A4	J4	W	414A9L6 Eng 2 Valve 3	27	25 ±5
404A51A4	J4	X	414A9L3 Eng 2 Valve B	27	25 ±5
404A51A4	J4	Y	414A9L7 Eng 2 Valve 2	27	25 ±5
404A51A4	J4	Z	414A9L4 Eng 2 Valve D	27	25 ±5
404A51A4	J4	a	414A9L8 Eng 2 Valve 4	27	25 ±5
404A71A19	J4	A	415A8L1 Eng 1 Valve A	27	25 ±5
404A71A19	J4	B	415A8L5 Eng 1 Valve 1	27	25 ±5
404A71A19	J4	C	415A8L2 Eng 1 Valve C	27	25 ±5
404A71A19	J4	D	415A8L6 Eng 1 Valve 3	27	25 ±5
404A71A19	J4	E	415A8L3 Eng 1 Valve B	27	25 ±5
404A71A19	J4	F	415A8L7 Eng 1 Valve 2	27	25 ±5
404A71A19	J4	G	415A8L4 Eng 1 Valve D	27	25 ±5
404A71A19	J4	H	415A8L8 Eng 1 Valve 4	27	25 ±5
404A71A19	J4	J	415A10L1 Eng 3 Valve A	27	25 ±5
404A71A19	J4	K	415A10L5 Eng 3 Valve 1	27	25 ±5
404A71A19	J4	L	415A10L2 Eng 3 Valve C	27	25 ±5

4 1.4.1 (Continued)

Test Point			Component Nomenclature	Meas Ohm	Limit Ohms
404A71A19	J4	M	415A10L6 Eng 3 Valve 3	27	25 ±5
404A71A19	J4	N	415A10L3 Eng 3 Valve B	27	25 ±5
404A71A19	J4	P	415A10L7 Eng 3 Valve 2	27	25 ±5
404A71A19	J4	R	415A10L4 Eng 3 Valve D	27	25 ±5
404A71A19	J4	S	415A10L8 Eng 3 Valve 4	27	25 ±5
404A71A19	J4	T	415A9L1 Eng 2 Valve A	27	25 ±5
404A71A19	J4	U	415A9L5 Eng 2 Valve 1	27	25 ±5
404A71A19	J4	V	415A9L2 Eng 2 Valve C	27	25 ±5
404A71A19	J4	W	415A9L6 Eng 2 Valve 3	27	25 ±5
404A71A19	J4	X	415A9L3 Eng 3 Valve B	27	25 ±5
404A71A19	J4	Y	415A9L7 Eng 2 Valve 2	27	25 ±5
404A71A19	J4	Z	415A9L4 Eng 2 Valve D	27	25 ±5
404A71A19	J4	a	415A9L8 Eng 2 Valve 4	27	25 ±5
404A4	J7	r	414A5L1	600	550-650
404A4	J7	d	414A5L1	600	550-650
404A4	J7	p	414A6L1	610	550-650
404A4	J7	x	414A1L1	640	550-650
404A4	J7	f	414A1L1	600	550-650
404A4	J7	v	414A2L1	640	550-650
404A4	J7	m	414A6L2	600	550-650
404A4	J7	t	414A2L2	610	550-650
404A4	J7	z	Spare	Inf	10 meg (min)
404A4	J7	q	415A5L1	610	550-650
404A4	J7	c	415A5L1	600	550-650
404A4	J7	n	415A6L1	600	550-650
404A4	J7	w	415A1L1	640	550-650
404A4	J7	e	415A1L1	600	550-650
404A4	J7	u	415A2L1	600	550-650
404A4	J7	k	415A6L2	600	550-650
404A4	J7	s	415A2L2	610	550-650
404A4	J7	y	Spare	Inf	10 meg (min)
404A2A16	J2	B	414A7L1 Eng 4 Valve A	600	550-650
404A2A16	J2	C	414A7L2 Eng 4 Valve 1	600	550-650
404A2A16	J2	A	415A7L1 Eng 4 Valve A	625	550-650
404A2A16	J2	D	415A7L2 Eng 4 Valve 1	580	550-650

4 1 5 Preliminary Propulsion Leak and Functional Check (1B71877 New)

This checkout procedure defined the operations required to perform the leak and functional checks which certified the stage propulsion system preparatory to static firing The prefire test sequences performed during this checkout, initiated on 12 July 1967, and completed on 8 August 1967, consisted of the following systems checkout

4 1 5 (Continued)

The O_2H_2 burner spark igniter arcing check consisted of a visual observation of the spark gap for constant arcing across the plate while exciter power was on. The observation was accomplished by sighting through the 9/16 inch diameter hole in the gauge assembly, P/N 1B67184-1, which was installed into the O_2H_2 burner adapter flange. This checkout was repeated on the second spark igniter, satisfactorily completing the spark igniter arcing checks

The cold helium fill module relief and internal seat leakage test was accomplished by removal of the module from the stage for shipment to LOX service for leakage and relief tests. The checks were satisfactorily completed

The calip pressure switch system leak checks performed a decay check of the LOX and LH_2 pressure switch checkout circuits by pressurizing the system to 30 ±5 psia, and monitoring for 5 minutes A decay and leak check of the mainstage pressure switches was accomplished by pressurizing the systems through the J-2 customer connect panel to 400 ±10 psig, isolating the mainstage switches from the supply source, and monitoring decay for 15 minutes. All decay checks were satisfactorily completed.

The stage integrity checks performed pickup and dropout tests on the control helium regulator discharge pressure switch, P/N 1B52624-517, S/N 010, and cold helium regulator backup pressure switch, P/N 1B52624-519, S/N 22 Audible leak checks were conducted on the cold and ambient helium systems, the engine spheres, and the stage tanks by pressurizing the engine control bottle to 350 ±50 psig, the start tank to 250 ±50 psig, the LOX tank to 5 psig, and the LH_2 tank to 3 psig At the completion of the audible leak checks, the stage integrity tests were initiated by pressurizing the control helium bottle to 3100 ±100 psig, the start tank to 800 ±25 psig, the cold helium spheres to 2275 ±50 psia, and the engine control bottle to 2250 ±50 psig, and holding these pressures for 5 minutes. The LOX and LH_2 tanks were pressurized to relief pressure while the vent valves were allowed to perform three relief cycles. The stage integrity checks were satisfactorily completed

4 1.5 (Continued)

The ambient helium system leak and flow checks performed were

a. The stage purge system orifice flow and system leak check verification of the LOX ullage sense line, LOX vent pilot chamber, LH_2 and LOX fill and drain microswitch housing, LH_2 chilldown solenoid valve (SOV) microswitch, non-propulsive vent (NPV) duct, LH_2 propellant valve microswitch, continuous vent module duct, and orifice bypass valve bellows

b The purge system check valve reverse leakage check, accomplished by monitoring the reverse flow of the LOX and LH_2 fill and drain (F/D) purge check valves, and the LOX and LH_2 vent purge check valves.

c. The ambient helium fill module check, including internal and reverse leakage checks of the module backup check valve and the ambient LH_2 repressurization module backup check valve

d Ambient LOX and LH_2 repressurization module control valves functional checks and internal leakage test

e The pneumatic power control module internal leakage check, consisting of a control helium SOV seat leakage check, and regulator lockup test

f The control helium system leak and functional checks, consisting of an ambient helium system leak check, and an actuation control module internal leak check. Several leakage conditions were found in this system Two leaks were repaired by replacing seals and retorquing, one leak was corrected by replacing hardware, and two leaks were transferred to stage FARR A255315

g The ambient repressurization system leak checks Eight conditions of leakage were found Six leaks were corrected by replacing seals and subsequently retorquing, while two leaks required only retorquing

h The pneumatic control system lockup, which verified the control helium lockup with the valves in their normal position and with the prevalves closed, the chilldown (C/D) shutoff valves closed, the vent valves open, and the LOX C/D pump purge on

The ambient helium system leak and flow checks were satisfactorily completed The engine start system leak and functional section included a drying sequence for the start tank vent valve actuator, a seat leakage check of the start tank control solenoid valve, and a reverse leakage check of the start tank fill check valve Leakage checks were performed on the GH_2 start system, the start tank dump control solenoid seal, and the vent and relief valves and valve bellows

Start bottle retention tests were conducted to measure the start bottle decay by calculating the pound-mass/hour loss All tests of the engine start system were satisfactorily completed

4.1.5 (Continued)

LH_2 pressurization and repressurization system leak and functional checkouts included a functional check of the burner LH_2 repressurization control valves, a reverse leakage test of the burner LH_2 check valve, and leakage checks of the repressurization system and burner LH_2 repressurization control valve seat and pilot bleed. This section also performed a reverse leakage test of the fuel pressure module check valve, and the LH_2 repressurization check valve All tests were satisfactorily completed.

The thrust chamber leak checks performed a leak check of the ignition detector probe, the LOX dome purge line from the purge portion, the LOX dome to the GSE purge check valve, the main fuel valve (MFV), and the main oxidizer valve (MOV) idler and drive shaft seals. This section also covered reverse leakage of the LOX dome, thrust chamber (T/C) and purge check valves Two leakage conditions noted during this section were subsequently corrected by replacing a union and a seal. All tests were satisfactorily completed

The LOX pressurization and repressurization system leak and functional checks performed an internal leakage and functional check of the LOX tank pressure control module and the burner LOX repressurization module, and a leak check of the LOX pressurization system, the burner LOX repressurization coil, the burner, and the ambient repressurization system Reverse leakage checks were performed on the cold sphere fill check valve and the LOX repressurization system check valve. This section also performed a leak check of the cold helium system, which included a system leak check and reverse leakage check of the LOX tank prepressurization check valve Several leakage conditions noted during this section were subsequently corrected by replacement of seals and unions. All tests were satisfactorily completed

The LOX tank, O_2H_2 burner, and engine feed system leak checks performed internal leakage checks of the engine feed system, which included the LOX prevalves, the LOX chilldown shutoff valve, the LOX chilldown return check valve, the engine LOX bleed valve and MOV seal leakage checks, the LOX tank and engine feed system leak checks, the LOX turbopump torque checks, the purge flow checks of the LOX chilldown pump, and the LOX boiloff valve flow check LOX valves

4 1 5 (Continued)

leakage checks were performed and included a shaft seal leakage check of the LOX prevalve and a seat leakage check of the LOX fill and drain valve This section also covered a leak and flow check of the burner LOX system which included a leak check from the LOX tank to the burner LOX propellant valve, and seat leakage checks on the burner LOX propellant valve

The LH_2 tank, O_2H_2 burner, and engine feed system leak checks performed external and internal leakage checks of the engine feed system, including the LH_2 chilldown return check valve, and a seal leakage check of the LH_2 prevalve, the LH_2 chilldown shutoff valve, the engine LH_2 bleed valve, the engine MFV, and the LH_2 fill and drain valve Reverse flow leakage tests were performed on the LH_2 chilldown return check valve, the LH_2 pump drain and purge check valves, and the LOX and LH_2 turbine seal cavity purge check valves. A forward flow check was also performed on the LH_2 pump drain check valve Seal leakage checks were performed on the LH_2 prevalve shaft and turbopump primary seal with the turbopump running, which included a breakaway torque check This section also performed a leak and flow check of the O_2H_2 burner LH_2 system and chamber, and included seat leakage checks of the burner LH_2 propellant valve, and burner LOX shutdown valve Two leakage conditions noted during this section were corrected by replacing and retorquing seals All tests were satisfactorily completed

The engine gas generator (GG) and exhaust system leak and flow checks performed engine seal leakage checks, which included a reverse leakage test of the GG fuel purge check valve, and seal leakage tests of the LH_2 and LOX turbine seals and the start tank discharge valve (STDV) gate seal The GG exhaust system leak checks included a leakage test of the oxidizer turbine bypass valve (OTBV) shaft seal, and reverse leakage tests of the LOX GG poppet and purge check valve A leak check of the hydraulic pump shaft seal was also performed with satisfactory results, and this section was concluded with seat leakage tests of the GG LOX and LH_2 propellant valves One leakage condition was noted and was corrected by a seal replacement All sections were satisfactorily completed

4 1.5 (Continued)

The engine pump purge leak and flow checks performed a regulation check of the engine pump purge module discharge pressure, measured the seat leakage of the engine pump purge valve, checked the purge flows of the LOX and LH_2 turbine seal cavity bleed exits and LH_2 pump drain test port, and verified the GG fuel purge flow of the LH_2 turbopump access All engine pump purge leak checks were satisfactorily completed

The engine pneumatic leak and flow checks performed were

a. Engine solenoid energized leak checks, which included

  1. Leak checks of the helium control solenoid circuits from the normally open ports of the ignition phase and mainstage solenoids, the pressure actuated fast shutdown valves diaphragm, and the internal pneumatic components.
  2. The LOX pump intermediate seal leakage check in the pump direction and turbine direction, also, a flow check on the check valve overboard flow cracking pressure
  3. Leak checks of the ignition phase solenoid normally closed circuit, the STDV solenoid seat (closed position), the STDV piston seal (closed position), and the internal pneumatic components.
  4. Seat leakage checks on the STDV solenoid (open position), and piston seal (open position), also, a leak check of the STDV solenoid circuit.
  5. Leakage checks of the mainstage solenoid normally closed circuit, the pressure actuated fast shutdown valve seat, and the internal pneumatic components

b Pressure actuated purge system leak checks, which included a seat leakage check of the pressure actuated purge valve inlet and vent, and a pressure actuated purge circuit leak check

c. An engine control bottle fill system leak check of the engine control bottle and fill line to the pneumatic package high pressure relief valve

d. Engine control bottle retention tests, which were conducted to measure the control bottle decay by calculating the pound-mass/hour loss

One leakage condition was noted during this section and was corrected by a seal replacement. All sections were satisfactorily completed.

4.1 5 (Continued)

The LOX and LH_2 vent system leak and flow checks performed leak checks of the nonpropulsive vent ducting, the nonpropulsive vent and ground system vent, the LOX and LH_2 vent systems, the LOX vent and relief and relief valve internal leakage, the LH_2 vent and relief, relief, and directional vent valve internal leakage, and actuator piston leakage of the LH_2 directional vent All tests of the LOX and LH_2 vent system were satisfactorily completed with five leakage conditions noted Three leaks were corrected by replacing and retorquing seals, while two leaks noted on the LH_2 nonpropulsive vent adapter, P/N 1B60060-501, at the quadrant II and IV connections, were acceptable to Engineering

Thirty-three leakage conditions were described in the leak check log Twenty-eight of these were corrected by retorquing, or by replacing seals and components with subsequent retorquing Two leaks noted at the facility interface adapter, P/N 1B60060-501, of the nonpropulsive vent system were acceptable to Engineering Two leakage conditions were noted at the LOX and LH_2 prevalve actuation port flange, and one leak was noted at the leak port of the injector to thrust chamber manifold.

There were ninety-seven revisions written against this test procedure, of which four were subsequently deleted. The revisions incorporated were

a. Thirty-nine revisions corrected and added requirements that were in error or missing
b. Thirty revisions added steps to acquire Engineering data and temporary hardware installations
c. Seven revisions deleted previous revisions or portions thereof
d. Six revisions repeated leak checks and requirements previously accomplished
e. Four revisions were incorporated to leak check hardware which was replaced subsequent to system leak checks.
f Four revisions deleted sections that were performed by installation requirements and other procedures.
g. Three revisions added steps to troubleshoot leakage conditions

There were no missing parts or modifications pending that would void any portion of this test. The propulsion systems leak and functional checks were acceptable to Engineering and this test procedure was signed off on 10 August 1967

4.1.5.1 Test Data Table, Propulsion Leak and Functional Check

Cold Helium Fill Module Relief & Internal Leak Checks

Function	Measurement			Limits
Relief Valve	Cycle 1	Cycle 2	Cycle 3	
Crack Pressure (psig)	3350	3200	3225	*
Reseat Pressure (psig)	3150	3150	3150	*
Relief Valve Seat Leakage (scim)		0		*
Dump Solenoid Seat Leakage (scim)		250		*

Calip Pressure Switch Leak Checks

Function	Measurement	Limits
LOX Press Sw C/O Circuit Decay (psi)	0.05	0.5 max
LH_2 Press Sw C/O Circuit Decay (psi)	0.0	0 5 max
Eng Mnstg Press Sw Diaph Decay		
Initial (psig)	401	*
Final (psig)	401	*
Decay (psi)	0	10 in 15 min

Stage Integrity Checks

Function	Measurement			Limits
Control He Reg Disch P/S	Run 1	Run 2	Run 3	
Pickup Press (psia)	612.68	612.68	612.68	600 ±21
Dropout Press (psia)	494 68	493.68	492.68	490 ±31
Cold He Reg Backup P/S				
Pickup Press (psia)	451	451	451	444 to 491
Dropout Press (psia)	337	337	337	329 to 376
LOX Tank Relief Cycle (psia)	43.8	43.8	43.8	41 to 44
LH_2 Tank Relief Cycle (psia)	36.2	36 2	36.2	34 to 37

Ambient Helium System Flow Checks

Function	Measurement	Limits
LOX Tnk Ullage Sense Line Purge (scim)	300	432 ±245
LOX F&D Vlv Microsw Housing Purge (scim)	2.3	3.5 ±2
LH_2 F&D Vlv Microsw Housing Purge (scim)	2 5	3.5 ±2
LH_2 C/D Shutoff Vlv Microsw Purge (scim)	4500	6500 ±2450
Contin Vent Mod Purge (scim)	40	70 ±30
LH_2 Prop Vlv Microsw Purge (scim)	1.5	4 ±2
Orifice Bypass Vlv Microsw Purge (scim)	1.8	3 5 ±2
Nonpropulsive Vent Duct Purge (scim)	320	432 ±245
Contin Vent Duct Purge (scim)	300	432 ±245

* Limits Not Specified

4.1 5.1 (Continued)

Purge System Check Valve Reverse Leak Check
(P/N 1B51361-1)

Check Valve Function	S/N	Reverse Leakage (scim) Measurement	Limits
LOX Vent Purge	280	0	10 max
LOX Fill & Drain Purge	247	0	10 max
LH_2 Fill & Drain Purge	259	0	10 max
LH_2 Vent Purge	226	0	10 max

Ambient He Fill Module Internal Leak Checks
(P/N 1A57350-507-002, S/N 0227)

Function	Measurement	Limits
Check Valve Reverse Leakage (scim)	0	0
Dump Valve Seal Leakage (scim)	0	0

Ambient He Spheres Fill System Check Vlvs Reverse Leak Checks
(P/N 1B51361-1)

Function	S/N	Measurement	Limits
LOX Repress Mod Check Valve	-	0	10 max
LH_2 Repress Mod Backup Check Valve	224	0	10 max
LH_2 Repress Mod Check Valve	-	0	10 max
He Fill Mod Backup Check Valve	103	0	10 max

Ambient Repress Module Control Valve Functional Checks

LOX Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0	*
Cont Vlv (L2) Seat Leakage (scim)	0	*
Module Dump Vlv Seat Leakage (scim)	0	*
Mod Dump Vlv Pilot Bleed (scim)	0	*
Mod Dump Vlv Seat & Pilot Bleed Leakage (scim)	0	9 max
Cont Vlv (L2) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L2) Seat & Pilot Bleed Leakage (scim)	0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0	9 max

* Limits Not Specified

4.1 5.1 (Continued)

LH_2 Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0	*
Cont Vlv (L2) Seat Leakage (scim)	0	*
Module Dump Vlv Seat Leakage (scim)	0	*
Module Dump Vlv Pilot Bleed Leakage (scim)	0	*
Mod Dump Vlv & Pilot Bleed Seat Lkg (scim)	0	9 max
Cont Vlv (L2) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L2) Seat & Pilot Bleed Lkg (scim)	0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0	9 max

Pneumatic Power Control Module Internal Leak Check
(P/N 1A58345-519, S/N 1057)

Function	Measurement	Limits
Control He Shutoff Seat Leakage (scim)	0	10 max
Control Module Reg Lockup Press (psig)	518	550 max

Actuation Control Module Checks
(P/N 1B66692-501)

Module Function	S/N	Vent Port Leakage (scim) Normal	Open	Closed	Limits
O_2H_2 Burner LOX Valve Control	68	0	0	0	6 max
O_2H_2 Burner LH_2 Valve Control	70	0	0	0	6 max
Orifice Bypass Valve Control	86	0	0	0	6 max
		Normal	Open	Boost	
LOX Vent Valve Control	71	0	0	0	6 max
LH_2 Fill & Drain Valve Control	72	0	0	0	6 max
LOX Fill & Drain Valve Control	60	0	0	0	6 max
LH_2 Vent Valve Control	75	0	0	0	6 max
		Normal	Flight	Ground	
Directional Vent Valve Control	69	0	0	0	6 max
		Normal		Closed	
Prevalve/Chilldown Valve Control	61	0		-	6 max
Prevalve Control	-	-		0	6 max
Chilldown Valve Control	-	-		0	6 max

* Limits Not Specified

4.1.5.1 (Continued)

Pneumatic Control System Decay Checks

Function	Measurement Initial	Measurement Final	Limits
Reg Disch Press - Valve Pos, Normal (psig)	518 5	512.0	*
Reg Disch Press - Valve Pos, Activated (psig)	499 0	499 0	*

Engine Start Tank Leak Checks

Function	Measurement	Limits
Vent Control Solenoid Seat Leakage (scim)	0	10 max
Initial Fill, Check Valve Reverse Leakage (scim)	0	2 max
Vent & Relief Valve Seat Leakage (scim)	0	2 max
Dump Valve Bellows Leakage (scim)	0	0
Bottle Decay (Delta M) (lb-mass/hr)	0 0099†	0.0066 max

LH_2 Repressurization System Leak Checks

Function	Measurement	Limits
O_2H_2 Burner Control Valve Seat Leakage (scim)	0	*
O_2H_2 Burner Control Valve Pilot Bleed Lkg (scim)	0	*
O_2H_2 Burner Module Cont Vlv Int Leakage (scim)	0	12 max
O_2H_2 Burner Cont Vlv & Check Vlv Rev Lkg (scim)	0	*
O_2H_2 Burner Check Vlv Reverse Leakage (scim)	0	5 max
O_2H_2 Burner Coil Leakage (scim)	0	0

LH_2 Pressurization System Leak Checks

Function	Measurement	Limits
LH_2 Press Module Check Valve Rev Leakage (scim)	0	10 max
LH_2 Prepress Check Vlv Rev Leakage (scim)	0	0

Thrust Chamber Checks

Function	Measurement	Limits
LOX Dome		
Purge Check Valve Reverse Leakage (scim)	1 5	4 max
Main Oxidizer Valve		
Idler Shaft Seal Leakage (scim)	0	10 max
Drive Shaft Seal Leakage (scim)	0	10 max

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* Limits Not Specified

† Error in computation accepted by Engineering and AFQA because the Bottle Decay will be computed again prior to static firing.

4 1 5 1 (Continued)

Function	Measurement	Limits
Main Fuel Valve		
Idler Shaft Seal Leakage (scim)	0	10 max
Drive Shaft Seal Leakage (scim)	0.9	10 max
Thrust Chamber		
Pressure (psig)	30	20 min
Jacket Purge Check Vlv Reverse Leakage (scim)	2 5	25 max

LOX Pressurization & Repressurization System Leak Checks

Function	Measurement	Limits
Cold Helium Sphere		
Fill Check Valve Reverse Leakage (scim)	0	0
Shutoff Valve Seat & Pilot Bleed Lkg (scim)	270	375 max
LOX Press Module Internal		
Hot Gas Bypass Vlv Seat & Pilot Bleed Lkg (scim)	0	1000 max
O_2H_2 Burner LOX Repress System		
Burner Control Valves Seal Leakage (scim)	0	*
Burner Control Valve Pilot Bleed Leakage (scim)	0	*
Burner Module Control Vlv Internal Lkg (scim)	0	12 max
System Check Valve Reverse Leakage (scim)	0	5 max
Combined Burner Check Vlv & Cont Vlv Seat Leakage (scim)	0	0
Burner Check Vlv Rev Leakage (scim)	0	0
Burner Coil Leakage (scim)	0	0
Cold Helium System		
LOX Tank Prepress Check Vlv Rev Leakage (scim)	0	0

LOX Tank, O_2H_2 Burner, & Engine Feed System Leak Checks

Function	Measurement	Limits
LOX Tank Helium Content (%)	99.37	75 min
Engine Feed Sys Internal Leak Checks		
LOX Prevlv & Chilldown Shutoff Vlv Seat & Chilldown Return Check Vlv Lkg (scim)	86	*
LOX Chilldown Ret Check Vlv Rev Lkg (scim)	10	350 max
LOX Prevlv & Chilldown Shutoff Vlv Combined Seat Leakage (scim)	76	150 max
LOX Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	7.5	*
LOX Bleed Valve Seat Leakage (scim)	2.5	300 max
Main Oxidizer Vlv Seat Leakage (scim)	0	10 max

*Limits Not Specified

4 1.5.1 (Continued)

LOX Tank, O_2H_2 Burner, & Engine Feed System Leak Checks (Cont'd)

Function	Measurement	Limits
LOX Tank & Engine Feed System Leak Checks		
LOX Low Pressure Duct Pressure (psig)	25	30 max
Oxidizer Pump Speed Pickup Seat Bleed (scim)	0	0
LOX Turbopump Torque Checks		
Pump Primary Seal Leakage		
Max (scim)	16	350 max
Min (scim)	15	350 max
Turbine Torque		
Breakaway (in/lbs)	117	1000 max
Running (in/lbs)	37	200 max
LOX Chilldown Pump Purge Flow Checks		
Pump Purge Shutoff Sol Vlv Leakage (scim)	0	1 max
Pump Purge Flow (scim)	40	33 to 49
Pump Purge Dump Solenoid Seat Leakage (scim)	0	0
Pump Shaft Seal Leakage (scim) (Tank Pressurized & Purge On)	0	50 max
Pump Shaft Seal Leakage - Pump Direction (scim)	0	*
Pump Shaft Seal Leakage - Tank Direction (scim)	0	*
LOX Boiloff Valve Flow Check		
Valve Seat Leakage (scim)	0	10 max
LOX Turbopump Torque Checks		
Prevalve Shaft Seal Leakage		
Open Position (scim)	0	10 max
Closed Position (scim)	0	10 max
Fill and Drain Valve Seat Leakage (scim)	0	18 max
O_2H_2 Burner LOX System Leak Check		
Burner LOX Prop Valve Seat Leakage (scim)	0	0.7 max
Burner LOX Shutdown Valve Seat Leakage (scim)	0	*

LH_2 Tank, O_2H_2 Burner, & Engine Feed System Leak Checks

Function	Measurement	Limits
LH_2 Tank Helium Content (%)	99.84	75 min
Engine Feed System Internal Leak Checks		
LH_2 Prevlv & Chilldown Shutoff Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	0	*
LH_2 Chilldown Ret Check Vlv Rev Lkg (scim)	0	350 max
LH_2 Prevlv & Chilldown Shutoff Vlv Combined Seal Leakage (scim)	0	150 max
LH_2 Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	0	*
LH_2 Bleed Vlv Seat Leakage (scim)	0	300 max
MOV & MFV Combined Seat Leakage (scim)	0	*
Main Fuel Vlv Seat Leakage (scim)	0	10 max

*Limits Not Specified

4 1.5.1 (Continued)

LH2 Tank, O2H2 Burner, & Engine Feed System Leak Checks (Cont'd)

Function	Measurement	Limits
Engine Purge System Leak Checks		
LH_2 Pump Drain Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Pump Drain Check Vlv Fwd Flow 30 psi (scim)	0	30 max
LH_2 Pump Drain Check Vlv Fwd Flow 60 psi (scim)	7250	2420 min
LH_2 Pump Purge Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Pump Intermediate Seal Leakage (scim)	4.3	500 max
LH_2 Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Tank & Engine Feed System Leak Checks		
LH_2 Low Pressure Duct Pressure (psig)	30	30 max
LH_2 Pump Speed Monitor Seal Bleed (scim)	0	0
LH_2 Turbopump Torque Checks		
LH_2 Pump Primary Seal Leakage:		
Max (scim)	3.5	350 max
Min (scim)	3.5	350 max
Turbine Torque		
Breakaway (in/lbs)	25	1000 max
Running (in/lbs)	25	300 max
LH_2 Valves Leak Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0	10 max
Closed Position (scim)	0	10 max
Fill & Drain Valve Seat Leakage (scim)	0	18 max
O_2H_2 Burner LH_2 System Leak Check		
Combined Burner LH_2 Prop Vlv & LOX Shutdown Valve Seat Leakage (scim)	0	*
Burner LH_2 Prop Valve Seat Leakage (scim)	0	0.7 max
LOX Prop Line Relief Valve Seat Leakage (scim)	0	0

Engine GG & Exhaust System Leak Checks

Function	Measurement	Limits
Engine Seal Leak Checks		
GG Fuel Purge Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Turbine Seal Leakage (scim)	870	3680 max
2nd E&M Value from J-2 Eng Log Book (scim)	680	*
LOX Turbine Seal Leakage (scim)	5.1	350 max
Start Tnk Disch Vlv Gate Seal Leakage (scim)	1.5	20 max
GG & Exhaust System Leak Checks		
Oxid Turb Bypass Vlv Shaft Seal Leakage (scim)	0	15 max
Oxid Manifold Carr Flng Bleed (scim)	2.55	20 max
GG LOX Poppet Rev Leakage (scim)	740	*
GG LOX Purge Check Vlv Rev Leakage (scim)	0	15 max
Hydraulic Pump Shaft Seal Leakage (scim)	2.4	228 max

*Limits Not Specified

4.1.5.1 (Continued)

Engine GG & Exhaust System Leak Checks (Cont'd)

Function	Measurement	Limits
GG LOX & LH_2 Propellant Valve Seat Leak Checks		
GG LOX Prop Vlv Seat Leakage (scim)	0	1 max
Combined GG LOX & LH_2 Prop Vlv Seat Lkg (scim)	0	*
GG LH_2 Prop Vlv Seat Leakage (scim)	0	1 max

Engine Pump Purge Leak Checks

Function	Measurement	Limits
Pump Purge Module Internal Leak Checks		
Purge Valve Seat Leakage (scim)	0	12 max
Purge Discharge Pressure (psig)	96	67 to 110
Pump Purge Flow Checks		
GG Fuel Purge Flow (scim)	3900	2400 min
LOX Turbine Seal Purge Flow (scim)	3900	2400 min
LH_2 Turbine Seal Purge Flow (scim)	4100	2400 min
Fuel Pump Seal Cavity Purge Flow (scim)	940	200 min

Engine Pneumatics Leak Checks

Function	Measurement	Limits
Helium Control Solenoid Energized Leak Checks		
Low Press Relief Vlv Seal Leakage (scim)	0	5 max
Low Press Relief Vlv Pilot Bleed Lkg (scim)	0	10 max
Fast Shutdown Vent Port Diaph Leakage (scim)	0	5 max
Press Act Purge Vlv Diaph Leakage (scim)	0	3 max
Int Pneu Sys Leakage (He Cont Sol On) (scim)	1 25	20 max
LOX Pump Intermediate Seal Purge Leak Checks		
Seal Leakage Pump Direction (scim)	11.5	*
Seal Leakage Turbine Direction (scim)	47	*
Seal Leakage Total (scim)	58.5	850 max
Seal Purge Check Vlv Overboard Flow (scim)	2500	*
Seal Purge Flow (scim)	2558 5	2558 5 min
Ignition Phase Solenoid Energized Leak Checks		
Start Tnk Disch Vlv 4-Way Sol Seat Lkg (scim)	5 2	15 max
Start Tnk Disch Vlv Piston Seal Lkg (Closed Pos) (scim)	1.1	40 max
Internal Pneu Sys Lkg (Ign Phase Sol On) (scim)	6	20 max

*Limits Not Specified

4.1.5.1 (Continued)

Engine Pneumatics Leak Checks (Cont'd)

Function	Measurement	Limits
Start Tank Discharge Valve Solenoid Energized Leak Checks		
STDV 4-Way Sol Seat Lkg (Energized) (scim)	2	15 max
STDV Piston Seal Lkg (Open Pos) (scim)	0	40 max
Mainstage Control Solenoid Energized Leak Check		
Press Act Fact Shutdown Vlv Seat Lkg (scim)	0	10 max
Int Pneu Sys Lkg (Mnstg Sol On) (scim)	6	20 max
Pressure Actuated Purge System Leak Check		
Press Act Purge Vlv Vent Seat Lkg (scim)	0.5	10 max
Press Act Purge Vlv Inlet Seat Lkg (scim)	0	10 max
Engine Control Bottle Fill System Leak Check		
Eng Cont Bot Fill Check Vlv Rev Lkg (scim)	0	3 max
Eng Cont Bot Decay Check (Delta M) (lb-mas/hr)	0.00848	0.036 max
GG LOX & LH_2 Propellant Valve Seat Leak Checks		
GG LOX Prop Vlv Seat Leakage (scim)	0	1 max
Combined GG LOX & LH_2 Prop Vlv Seat Lkg (scim)	0	*
GG LH_2 Prop Vlv Seat Leakage (scim)	0	1 max

Engine Pump Purge Leak Checks

Function	Measurement	Limits
Pump Purge Module Internal Leak Checks		
Purge Valve Seat Leakage (scim)	0	12 max
Purge Discharge Pressure (psig)	96	67 to 110
Pump Purge Flow Checks		
GG Fuel Purge Flow (scim)	3900	2400 min
LOX Turbine Seal Purge Flow (scim)	3900	2400 min
LH_2 Turbine Seal Purge Flow (scim)	4100	2400 min
Fuel Pump Seal Cavity Purge Flow (scim)	940	200 min

Engine Pneumatics Leak Checks

Function	Measurement	Limits
Helium Control Solenoid Energized Leak Checks		
Low Press Relief Vlv Seal Leakage (scim)	0	5 max

*Limits Not Specified

4 1.5 1 (Continued)

Engine Pneumatics Leak Checks (Cont'd)

Function	Measurement	Limits
Low Press Relief Vlv Pilot Bleed Lkg (scim)	0	10 max
Fast Shutdown Vent Port Diaph Leakage (scim)	0	5 max
Press Act Purge Vlv Diaph Leakage (scim)	0	3 max
Int Pneu Sys Leakage (He Cont Sol On) (scim)	1.25	20 max

LOX & LH_2 Vent System Leak Checks

Function	Measurement	Limits
LOX Vent System Leak Checks		
Combined LOX Vent & Relief Vlv & Relief Vlv Seat & Pilot Bleed Lkg (scim)	0	100 max
Combined LOX V&R Vlv & Relief Vlv Seat, Pilot Bleed Lkg (scim)	87.5	*
LOX Vent Boost Piston Seal Lkg (scim)	87.5	2420 max
Propulsive Vent System Leak Checks		
Continuous Vent & Orifice Bypass Vlv Seat Lkg (scim)	0	16 max
Nonpropulsive Vent System Leak Checks		
Bi-Direct Vent Vlv Seat Lkg (Flt Pos) (scim)	0	50 max
Ground Vent System Leak Checks		
Combined LH_2 V&R Vlv, Relief Vlv Seat, & Pilot Bleed Lkg (scim)	0	150 max
Combined LH_2 V&R Vlv & Relief Vlv Seat, Pilot Bleed, & Boost Piston Seal Lkg (scim)	4.8	*
LH_2 V&R Vlv Boost Piston Seal Lkg (scim)	4.8	1728 max
Bi-Direct Vent Vlv Seat Lkg (Gnd Pos) (scim)	0	50 max
Bi-Direct Vent Vlv Act Piston Lkg (Flt Pos)(scim)	0	3 max
Bi-Direct Vent Vlv Act Piston Lkg (Gnd Pos)(scim)	0	3 max

*Limits Not Specified

4 1 6 <u>Common Bulkhead Vacuum System (1B49286 G)</u>

The purpose of this manual checkout, initiated on 13 July 1967, was to ensure that the common bulkhead, P/N 1A39309-501, was free of leakage conditions and acceptable for propellant loading and static acceptance firing The checkout included the following activities

The test stand vacuum system was isolated from the stage system, and the test stand system was set up for checkout. The vacuum pump was operated for 10 minutes, shut off, and, after a 15 minute delay, the vacuum system pressure was recorded Periodically, at intervals of 1 hour, the pressure was monitored for a pressure rise No increase in pressure was noted over an 8 hour span

The test stand system was reconnected to the stage, and preparations for a 96-hour pumpdown of the common bulkhead were made The evacuation supply was set to evacuate the bulkhead, the vacuum supply and vacuum pump were turned off, and the purge supply and sample supply were verified to be closed Verification was made that measurement D545, the bulkhead pressure transducer, P/N 1B40242-501, was installed and electrically connected to the monitoring strip charts in the test control center

It was verified that the common bulkhead quick-disconnect assembly, P/N 1B41065, was properly installed and engaged Two sample bottles, P/N 1B71532-1, were installed at positions 1 and 2 on the sample bottle rack and sealed into place The vacuum supply switch was turned on After a time lapse of 10 minutes, the evacuation supply switch was set to evacuate the bottles, and the sample supply switch number 1 was opened After 5 minutes, sample supply switch number 1 was closed, the evacuation supply switch was set to sample the bulkhead, and sample supply switch number 1 was reopened After 1 minute, sample supply switch number 1 was closed, and the evacuation supply switch was set to evacuate the bulkhead Bulkhead pressure was monitored every hour for 6 hours, with no pressure rise noted Upon completion of the 6-hour check, the evacuation supply switch was set to evacuate the bottles, and sample supply switch number 2 was opened After a lapse of 5 minutes, sample supply switch number 2 was momentarily closed while setting the evacuation supply switch to sample the bulkhead. Sample supply switch number 2 was then closed 1 minute later, and the evacuation supply switch was set to evacuate the bulkhead The sample bottles, number 1 and 2, were removed from the sample bottle rack

4 1.6 (Continued)

and shipped to Material Research and Production Methods (MR&PM) Engineering for analysis

After 96 hours of vacuum pumpdown, the vacuum supply switch was turned off, and the evacuation supply switch was set to evacuate the bottles Then the 48-hour bulkhead decay check was started The indicated bulkhead pressure at the start was recorded as 1 0 psia No decay in bulkhead pressure was noted During the decay check, a setup was made for the argon purge test A bottle of 99 percent pure argon was connected to the bulkhead GN_2 supply line The bulkhead GN_2 purge hand valve was opened, the evacuation supply switch was set to evacuate the bulkhead, and the purge supply regulator was set to 2 5 psig The argon purge was run for 24 hours to obtain ambient bulkhead pressure. After purge completion the argon bottle was removed, and the bulkhead vacuum system was secured

The bulkhead leak check was accomplished next Bulkhead pressure was determined to be 14 7 psia The LOX tank was pressurized to 30 ± 1 psia, and the fuel tank to 25 ± 1 psia These pressures were maintained for 12 hours, while the bulkhead pressure was monitored No increase in bulkhead pressure was noted, indicating that the bulkhead was free from leakage The propellant tanks were vented to ambient and this checkout was certified as acceptable on 15 August 1967

Engineering comments revealed no part shortages and no interim use material items installed at the start of this test There were no FARR's written as a result of this checkout

There were four revisions written to the procedure

a One revision added the requirement for customer approval on all revisions prior to completion of the test.

b One revision authorized the procedure for temporarily securing bulkhead pumpdown for the weekend of 4 July 1967

c One revision re-initiated the 96-hour pumpdown The test stand system was not connected to the stage for the first pumpdown attempt

4 1 6 (Continued)

d One revision deleted requirements for the test stand vacuum system leak check The test stand vacuum system checkout proved that no leaks existed in the system

4 1 7 Hydraulic System Setup and Operation (1B41005 B)

The purpose of this manual procedure was to ensure that the hydraulic system was correctly filled, flushed, bled, and maintained free of contaminants during hydraulic system operation The hydraulic system pressures and temperatures were checked for proper operational levels, the hydraulic system transducers were tested for correct operations, and the J-2 engine operational clearance in the aft skirt was established

This test was initiated on 13 July 1967, and certified as complete on 10 August 1967 Proper operation of the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454590, the hydraulic actuator assemblies, P/N 1A66248-505-011, S/N's 52 and 60; the main hydraulic pump, P/N 1A66240-503, S/N X457806, and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00032, was verified during checkout activity There were no part shortages affecting this test.

Prior to initiation of the test, the Model DSV-4B-358 hydraulic pumping unit (HPU), P/N 1A67443-1, was checked to ensure hydraulic fluid cleanliness The HPU was connected to the stage by pressure and return hoses, and hydraulic fluid was circulated through the stage hydraulic system to ensure that the system was properly filled Hydraulic fluid samples were taken and were certified to be free of contamination

The accumulator/reservoir was charged with GN_2, and the stage air bottles were charged to a pressure of 475 ± 50 psig The HPU was turned on and the system pressure was increased until the system pressure high gauge indicated no further increase in pressure but was less than 4400 psig The stage hydraulic system was checked for leaks and determined to be within design requirements On completion of the leak check, the stage hydraulic system pressure was reduced to 1000 ± 50 psig The auxiliary hydraulic pump was turned on and verified to be operating properly.

With the midstroke locks installed in the hydraulic actuators, the vernier scales were adjusted to read zero The pitch and yaw command relays were disabled, the midstroke locks were removed. and the system hydraulic pressure

4 1 7 (Continued)

was increased to 3650 ± 50 psig The vernier scales were read and recorded, and the midstroke locks were reinstalled subsequent to reduction of the HPU pressure regulator and system pressure

The engine deflection clearance check was accomplished next The gimbal control unit (GCU) was installed, the protective covers were removed from the J-2 engine bellows, and the platform extension, P/N 1B70620, was removed from the engine area The engine restrainer and the midstroke locks were removed from the engine The stage hydraulic system pressure was established at 1000 psig The pitch and yaw manual controls on the GCU were turned in the retract and extend directions As the controls were moved it was verified that the pitch and yaw actuators moved in relation to the direction and amplitude of the controls After the J-2 engine was certified cleared for gimbal tests, the HPU was secured, and the actuator midstroke locks and J-2 engine bellows were reinstalled

Verification and setup of the stage and test control center hydraulic system instrumentation was started by turning on the HPU and adjusting the pressure compensator until the system hydraulic pressure high gauge indicated the desired pressure readings These readings were used to support verification of the measurement D549 system pressure The reservoir oil level was checked at zero and one hundred percent by measurement L504

Preparations for the engine gimbal test were started by setting the pitch and yaw manual controls on the GCU to the center position and turning the GCU off The HPU was turned off, the GCU was disconnected from the actuators, and the stage electrical cables were connected to the actuators The midstroke locks were removed, and it was verified that the engine area was clear for engine gimbaling tests The HPU was turned on, and the system pressure was increased to 3650 ± 50 psig Various signals were applied to the pitch and yaw actuators, and the resultant voltages were noted and recorded Upon completion of this series of tests, the HPU was turned off, and the midstroke locks and J-2 engine bellows protective covers were reinstalled

4 1.7 (Continued)

A check to determine the pressure decay of the stage air supply was next The stage air bottles were charged to 469 psig After a 24-hour period, the pressure was remeasured and found to be 465 psig

An instrumentation setup was made to provide telemetry parameters for computer interrogation during the hydraulic system automatic checkout Telemetry connections were made to the reservoir oil pressure transducer, the reservoir oil level transducer, and the pump inlet temperature transducer After completion of the hydraulic system automatic checkout, these parameters were disconnected and the hardwire cables were reconnected

The final engine deflection clearance check was accomplished next This test provided for gimbaling the engine to its travel extremities and checking the clearance between engine, stage, and test stand structure, with particular emphasis on clearance of the electrical cables This section was not performed until the final cable installations and wrapping had been completed. The GCU was re-installed, the engine bellows protective covers were removed, and the test stand platform extension was removed from the engine area. The restrainer links and midstroke locks were removed. The auxiliary hydraulic pump was turned on and verified to be operating normally. The pitch manual control and the yaw manual control on the GCU were varied and the engine deflection test was repeated After completion of the test, the auxiliary hydraulic pump was turned off, and the midstroke locks and bellows protective covers were re-installed. The GCU was disconnected and removed, and the stage electrical connectors were reconnected to the actuators

The simulated static firing support test was accomplished next This checkout was required to simulate the engine-driven hydraulic pump flow capabilities during simulated static firing. The HPU was turned on approximately 20 seconds prior to simulated engine start, and the hydraulic system pressure was set at 3700 psig. After simulated engine cutoff the HPU was turned off.

4 1 7 (Continued)

The following FARR's were written against this procedure

a FARR A255356 stated that the accumulator GN_2 pressure decayed from 2350 psig to approximately 1000 psig during the weekend A leak check revealed a fast bubble leak at the low pressure vent relief valve The accumulator, P/N 1B29319-519, S/N 00026, was removed and replaced by S/N 00032

b FARR A255225 documented that the lower ends of the pitch and yaw actuators were scratched The discrepancy was corrected by smoothing the damaged areas with a hand oil-stone The mating surface of the midstroke locks were inspected and smoothed to match the actuator shafts

Nine revisions were written to this procedure

a One revision deleted the requirements to check out measurements D510 and D511 These measurements were not required on this configuration

b One revision added the statement "turn off the IU five volt power supply Disable pitch and yaw command relays. Secure computer from OLSTOL status " This was to secure the computer after the completion of actuator command response measurements

c One revision changed connector part numbers The original connectors specified were in error

d One revision authorized the repeat of the accumulator GN_2 charging section of the checkout The accumulator was not fully charged.

e One revision reran the accumulator GN_2 charging, to troubleshoot for a possible leak in the accumulator

f One revision reran the accumulator GN_2 charging, the engine deflection clearance check, and the instrumentation support setup, due to replacement of the accumulator/reservoir assembly

g One revision changed the reference designation number for a connector The original callout was in error

h One revision reran the accumulator GN_2 charging and the stage air bottle charging to verify the proper charge in the accumulator to meet requirements of the DDAS automatic procedure, H&CO 1B55817 E

i The last revision added "On the HPU, perform the following

1 Depress the high pressure pump ON button
2 Close the bypass valve
3 Turn the pressure compensator in the INCR direction until the system hydraulic pressure high-pressure gauge indicates 2000 ± 50 psig

4 1.7 (Continued)

4. After 2 minutes minimum, turn the pressure compensator to full DECR
5 Open the bypass valve.
6 Depress the high pressure pump OFF button "

These test sequences were necessary to refill the stage hydraulic system reservoir for the integrated systems test

4 1 7 1 Test Data Table, Hydraulic System Setup and Operation

Test Description	Instrumentation Name	Instrumentation Location	Actual (in)	Requirement (in)
Actuator	Pitch Vernier	Pitch Actuator	0	0
	Yaw Vernier	Yaw Actuator	0	0
			Position	Voltage
Instrumentation Support	Pitch Actuator Position	TCC	0	2.5125 vdc
			+1	2.1626 vdc
			+2	1.816 vdc
			+1	2.1716 vdc
			0	2.517 vdc
	Pitch Actuator Position	TCC	0	2.517 vdc
			-1	2.863 vdc
			-2	3.208 vdc
			-1	2.858 vdc
			0	2.513 vdc
	Yaw Actuator Position	TCC	0	2.506 vdc
			+1	2.857 vdc
			+2	3.201 vdc
			+1	2.851 vdc
			0	2.504 vdc
	Yaw Actuator Position	TCC	0	2.504 vdc
			-1	2.161 vdc
			-2	1.812 vdc
			-1	2.169 vdc
			0	2.513 vdc

4 1.8 Stage Power Setup (1B55813 D)

Prior to initiating any other automatic prefire checkout, the stage power setup procedure verified the capability of the GSE automatic checkout systems (ACS) to control power switching to and within the stage, and ensured that the forward and aft power distribution systems were not subjected to excessive static loads during initial setup sequences Subsequent to satisfactory compliance with design specifications and requirements, this procedure was utilized to establish initial conditions preparatory to performing automatic stage checkouts

Testing sequences, initiated on 14 July 1968, verified the operation of the procedure and equipment The test was started by resetting all matrix magnetic latching relays, and verifying that the corresponding command relays were in the proper state. The umbilical connectors were verified to be mated, and plugs 404W26P1 and 404W27P1 were disconnected from the LOX and LH_2 static inverter connectors The bus 4D119 talkback power was turned on, and the prelaunch checkout group was turned off The forward and aft power buses were transferred to external power The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propellant level sensor power were all verified to be off The range safety system 1 and 2 receiver power and EBW firing unit power were transferred to external and verified to be off The switch selector checkout indication enable and the flight measurement indication enable were both turned on. The bus 4D131 28 vdc power was turned on, and the forward bus 1 initial current and voltage were measured

The range safety safe and arm device was verified to be in the SAFE condition The 70 pound ullage pilot relay was verified to be reset The propellant utilization system power and inverter and electronics power, the PCM system group power, the environmental control group power, the propellant utilization system boiloff bias, and the PCM RF group power, were all verified to be off The EBW ullage rocket relay was verified to be reset The switch selector functions were turned off, and the engine cutoff was verified to be off The forward bus 1 quiescent current was measured The cold helium shutoff valve was closed The bus 4D111 28 vdc power was turned on, and the aft bus 1 current and voltage were measured The sequencer power was turned on, the

4.1.8 (Continued)

PCM system group power was turned on, and the PCM system group current was measured The bus 4D121 28 vdc power was turned on, the forward bus 2 current was verified to be less than 2 amperes, and the forward bus 2 voltage was measured The prelaunch checkout group power was turned on, and the checkout group current was measured The RACS run mode was turned on, and the forward and aft battery load test was turned off. The DDAS ground station was verified to be in synchronization, and the EBW pulse sensor power was turned off.

A series of checks verified that sixty stage functions were in the proper state of off or on, forty functions were verified to be off and twenty functions were verified to be on The LOX and LH_2 tank valves were also verified to be in the proper open or closed position

There were no shortages at the start of this test, and no failure and rejection reports were written.

4 1.8 1 Test Data Table, Stage Power Setup

Function	Measured Value	Limit
Fwd Bus 1 Voltage (vdc)	28 68	28 ±2
Fwd Bus 1 Current (amps)	8 00	20 max
Fwd Bus 1 Quiescent Current (amps)	2 40	5 max
Aft Bus 1 Voltage (vdc)	28 40	28 ±2
Aft Bus 1 Current (amps)	0 30	10 max
Fwd Bus 2 Voltage (vdc)	28.28	28 ±2
Prelaunch Checkout Grp Current (amps)	0 00	12 max
Aft 5V Excitation Module Voltage (vdc)	5 00	5 0 ±0 03
Fwd 5V Excitation Module 1 Voltage (vdc)	5 00	5 0 ±0 03
Fwd 5V Excitation Module 2 Voltage (vdc)	5 00	5 0 ±0 03

4 1 9 Stage Power Turnoff (1B55814 C)

The stage power turnoff procedure was used for automatic shutdown of the stage power distribution system, returning the stage to the de-energized condition after completion of the various system checkout procedures during prefire testing of the stage The procedure deactivated stage relays so that no current flowed from the battery simulators through the stage wiring All internal/external transfer relays were set to the external condition

Satisfactory demonstration of this procedure was accomplished and accepted on 14 July 1967 Stage power turnoff measurement values for this demonstration issue are tabulated in Test Data Table 4 1 9 1 Following this, the stage power turnoff procedure was used to shut down the stage at the conclusion of the various automatic checkouts conducted during prefire operations

The automatic stage power turnoff started with a verification that the umbilical connectors were mated and that the flight measurement indication enable was turned on The bus 4D119 talkback power, the forward bus 1 and aft bus 1 28 vdc power supplies, and the sequencer power were all verified to be on The forward bus 1 and aft bus 1 voltages were then measured

Switch selector functions were then turned off and a series of checks verified that the stage electrical functions were in the proper state of off or reset The forward and aft bus power supplies were verified as off, and the forward and aft bus battery simulator voltages were measured Stage buses were then transferred to external power, and the forward and aft stage bus voltages were measured The EBW pulse sensor power was turned off, and the range safety receivers and EBW firing units were transferred to external power The range safety system safe and arm device was verified to be on safe, and the bus 4D119 talkback power was turned off. The matrix magnetic latching relays were then reset, completing this demonstration run for stage power turnoff

There were no discrepancies recorded by FARR's against this test One revision was made to the procedure, to correct a program error

4.1.9 1 <u>Test Data Table, Stage Power Turnoff</u>

Function	Measurement	Limit
Forward Bus 1 Voltage, Power On (vdc)	28 64	28 ±2
Aft Bus 1 Voltage, Power On (vdc)	27 08	28 ±2
O_2H_2 Burner Spark Sys 1 (vdc)	0 00	0 ±0 5
O_2H_2 Burner Spark Sys 2 (vdc)	0 00	0 ±0 5
Forward Bus 1 Battery Simulator Voltage (vdc)	-0 08	0 ±2
Forward Bus 2 Battery Simulator Voltage (vdc)	0 00	0 ±2
Aft Bus 1 Battery Simulator Voltage (vdc)	-0 04	0 ±2
Aft Bus 2 Battery Simulator Voltage (vdc)	-0 16	0 ±2
Forward Bus 1 Voltage, Power Off (vdc)	0 04	0 ±1 0
Forward Bus 2 Voltage, Power Off (vdc)	-0.04	0 ±1 0
Aft Bus 1 Voltage, Power Off (vdc)	-0 04	0 ±1 0
Aft Bus 2 Voltage, Power Off (vdc)	-0 24	0 ±1 0

4 1 10 <u>Exploding Bridgewire System (1B55822 D)</u>

This automatic procedure verified the design integrity of the exploding bridgewire (EBW) system, and demonstrated the operational capability of the EBW system to initiate ullage rocket ignition and jettison when commanded by the instrument unit during flight. The particular items involved in this test were

Part Name	Ref. Location	P/N	S/N
Ullage Rocket Ignition System			
EBW Firing Unit	404A47A1	40M39515-113	245
EBW Firing Unit	404A47A2	40M39515-113	240
Pulse Sensor *	404A47A4A1	40M02852	-
Pulse Sensor *	404A47A4A2	40M02852	-
* On Pulse Sensor Bracket Assy	404A47A4	1B52640-1	00002
Ullage Rocket Jettison System			
EBW Firing Unit	404A75A1	40M39515-113	238
EBW Firing Unit	404A75A2	40M39515-113	239
Pulse Sensor **	404A75A10A1	40M02852	375
Pulse Sensor **	404A75A10A2	40M02852	376
** On Pulse Sensor Bracket Assy	404A75A10	1A97791-501 1	00001

This procedure was accomplished on 14 July 1967, and was accepted on 27 July 1967 Throughout this procedure, the charged condition of each EBW firing unit was determined by verifying that the firing unit voltage indication measured 4 2 ± 0 3 vdc, while the uncharged or discharged condition

4 1 10 (Continued)

was determined by verifying that the voltage indication measured 0 0 ± 0 3 vdc or, during the firing unit disable test, 0 2 ± 0 3 vdc

The stage power setup, H&CO 1B55813, was accomplished and initial conditions were established An EBW pulse sensor self test was conducted first, by verifying that the self test command properly turned on the four EBW pulse sensors, and that the reset command properly turned off the pulse sensors

The ullage ignition EBW firing units were tested next The charge ullage ignition command was verified to properly charge both ullage ignition EBW firing units, while both ullage jettison EBW firing units remained uncharged To verify that the fire ullage ignition command properly fired the ullage ignition EBW firing units, it was determined that both ignition pulse sensors were turned on while both jettison pulse sensors remained off, and that both ullage ignition EBW firing units were discharged

The ullage jettison EBW firing units were tested in the same way, by verifying that the charge ullage jettison command charged the ullage jettison EBW firing units, and that the fire ullage jettison command fired the jettison firing units and turned on the jettison pulse sensors

A series of checks then verified that the EBW ullage rocket firing unit disable command prevented the firing units from charging when the charge ullage ignition and charge ullage jettison commands were turned on, and discharged the firing units, while preventing them from firing, when the fire ullage ignition and fire ullage jettison commands were turned on

A final series of checks verified the operation of the EBW pilot relay by determining that the pilot relay reset indication was off after each of the charge ullage ignition and jettison, and fire ullage ignition and jettison commands were turned on, and that the pilot relay reset indication was on after each command was reset. The switch selector was used 22 times during this procedure, and each of the ignition and jettison firing units were discharged 3 times

4 1 10 (Continued)

Engineering comments noted that all parts were installed at the start of this checkout No problems were encountered during this test, and no FARR's were written One revision was made to the procedure to correct a program error that caused the computer to repeat the initial condition scan, and prevented the calling up of sequence 1

4 1 11 Auxiliary Propulsion System (1B55825 C)

The auxiliary propulsion system test verified the integrity of the stage wiring associated with APS functions, and verified receipt of command signals routed from the GSE automatic checkout system, through the attitude control relay packages, to the APS electrical interfaces The APS simulators, used in place of the APS flight modules for this test, did not functionally simulate the APS modules, but provided suitable loads at the electrical interface to determine that the stage mounted components of the APS functioned properly

All stage mounted components of the APS were tested, in particular the attitude control relay packages, P/N 1B57731-501, S/N 409, at reference location 404A51A4 and S/N 407, at reference location 404A71A19

The procedure was satisfactorily accomplished and accepted on 14 July 1967 After initial conditions were established, the GSE IU substitute -28 vdc power supply was turned on The APS firing enable command and the APS bus power were turned on A series of tests were then conducted to verify the proper operation of the APS engine valve solenoids The attitude control nozzle commands were turned on and the appropriate APS engine valve open indication was verified

The attitude control nozzle command was then turned off and the valve open indication was again verified The 70 pound ullage engine commands 1 and 2 were then individually turned on and off, while the ullage engine relay reset was verified to operate properly At the conclusion of these tests, the stage was returned to the pre-test configuration, thereby completing the test procedure

4 1 11 (Continued)

Engineering comments indicated that there were no part shortages that would affect this test No problems were encountered during the test, no FARR's were written, nor were any revisions made to the procedure

4 1 11 1 Test Data Table, Auxiliary Propulsion System

Attitude Control Nozzle Command		APS Engine	Valve Open Indication Voltage (vdc) AO Multiplexer	BO Multiplexer	Limits
Nozzle I IV	On	1-1 or 1-3	3 99	4 02	4 2 ± 0 3
	Off	1-1 or 1-3	0 00	0 00	0 0 ± 0 25
Nozzle I II	On	1-1 or 1-3	3 96	3 97	4.2 ± 0 3
	Off	1-1 or 1-3	0 00	0 00	0 0 ± 0 25
Nozzle I P	On	1-2	4 01	4 03	4 2 ± 0 3
	Off	1-2	0 00	0 00	0 0 ± 0 25
Nozzle III II	On	2-1 or 2-3	3 91	3.91	4 1 ± 0 25
	Off	2-1 or 2-3	0 00	0 00	0 0 ± 0 25
Nozzle III IV	On	2-1 or 2-3	3.86	3 87	4 1 ± 0 25
	Off	2-1 or 2-3	0 00	0 01	0 0 ± 0 25
Nozzle III P	On	2-2	3 93	3 94	4.1 ± 0 25
	Off	2-2	0 00	0 00	0 0 ± 0 25

4 1.12 Stage and GSE Manual Controls Check (1B70177 E)

This document defined the checkout sequences required to verify manual mode control of the components in the propulsion GSE and stage systems The manually functioned components included the pneumatic regulators in consoles "A" and "B" and on the stage, as well as the separate solenoid and pneumatic valves in consoles "A" and "B", on the LH_2 and LOX control skids, and on the stage Manual control verification consisted of supplying electrical and pneumatic signals to the system components and checking for the proper response

The stage and GSE manual controls checkout was initiated on 17 July 1967, and was satisfactorily completed on 21 July 1967 Preliminary GSE equipment setup operations were initiated to verify that the switches and valves on the test consoles were positioned properly for the functional check The GSE manual controls were operated to ensure their functional capability

4 1 12 (Continued)

The stage control helium system check began by verifying that the LOX repressurization spheres were isolated per H&CO 1B70422, and that the stage purge hand valves were closed The control helium spheres were pressurized to 100 $\pm$ 25 psig and the control sphere dump valves were functioned The spheres were then pressurized to 500 $\pm$ 50 psig for the stage valves control check

On the mainstage panel, the LOX and LH_2 chilldown valves and the LOX and LH_2 prevalves were cycled At the LH_2 control panel, the tank vent and the fill and drain valves were opened and closed The tank vent boost and the fill and drain boost valves were cycled The directional vent valve was placed in the flight position, then returned to the ground position

At the LOX panel, the tank vent valve, the cold helium shutoff valve, and the fill and drain valve were cycled and verified to be open, then closed The fill and drain boost valve and the tank vent boost valve were then cycled

The engine control bottle dump valve, the cold helium dump valve, the start tank dump valve, the LOX and LH_2 repressurization dump valves, and the control helium bottle fill valve on the vehicle supply panel were cycled On the pressurization control panel, the O_2H_2 propellant valve and LOX shutdown valve were cycled

The LH_2 and LOX umbilical purge interlock checks were accomplished next At the LH_2 control panel, the LH_2 fill and drain valve and the LH_2 umbilical drain valve were verified to be closed The LH_2 umbilical purge valve was positioned open, and talkback indication was verified The LH_2 fill and drain valve was cycled, and it was verified that the LH_2 umbilical purge valve also opened and closed Verification was made that operating the LH_2 umbilical drain valve also operated the LH_2 umbilical purge valve

On the LOX control panel, the LOX emergency drain was opened, the LOX fill and drain and the LOX umbilical drain valves were closed The LOX umbilical purge valve was opened, and talkback was verified The LOX fill and drain and the LOX umbilical drain valves were cycled to verify that the LOX umbilical purge valve opened and closed as the drain valves were functioned

4 1 12 (Continued)

The helium supply hand valve in console "A" was closed. The stage 1 bleed valve was opened, and the stage 1 line pressure was verified to be ambient All systems were vented to ambient and secured

No FARR's were written as a result of this test, and the manual control systems were accepted by Engineering for use.

Four revisions were written during this checkout

a One revision deleted a previous revision The test of the LH_2 continuous vent was not required

b One revision changed the dome regulator and vent open indications from on to off, and the ground prevalve from open to closed, to correct the procedure

c One revision added requirements for testing the operation of the control helium pressure switch

d One revision deleted the cold helium emergency dump test, as it was not required

4 1 13 <u>Cryogenic Temperature Sensor Verification (1B44471 C)</u>

The calibration and functional capabilities of the cryogenic temperature sensors, for which the normal operating range did not include room ambient temperatures, were verified by this manual procedure The cryogenic temperature sensors, basically platinum resistance elements, changed resistance according to the Callendar-Van Dusen equation

The first issue was conducted on 19 July and 20 July 1967, and was accepted on 20 July 1967 A second issue of the procedure, released due to a tank feedthrough connector pin verification check per AO 1B58968-A45-2, was accomplished on 24 and 25 July 1967 Only those sensors affected by the feedthrough rework were checked during the second test, as shown in Test Data Table 4 1 13 1

As each cryogenic temperature sensor was checked, the ambient temperature at that time was measured and recorded The temperature during the test ranged between $79^{\circ}F$ and $88^{\circ}F$ The procedure specified a resistance value at $32^{\circ}F$ and a sensitivity value (change in resistance for each degree between

4.1 13 (Continued)

32^{o}F and 100^{o}F) With these values and the measured ambient temperature, the expected ambient resistance was calculated for each sensor The actual ambient resistance was then compared to the calculated resistance The measured resistance was verified to be within ± 5 percent of the calculated resistance, except for sensor, P/N 1A68589-519, at reference location 403MT784 After the resistance of each sensor was measured, the sensor wiring was verified to be per blueprint by connecting a jumper wire on the adapter cable, P/N 1B64095-1, and shorting out the sensor element to a resistance measurement of 5 ohms or less

Three revisions were written to the first issue and four to the second

a Two revisions changed a test cable callout from P/N 1B40895-1 to P/N 1B64095-1 The P/N 1B40895-1 cable does not have a shorting wire

b One revision changed the reference location of the fuel pump discharge temperature bridge from 404A64A200 to 404A64A220

c. One revision accepted an out-of-tolerance resistance reading of the helium heater support No 2 temperature sensor Nichrome-5 wire was used in the sensor element, causing an increase of 2 8 ohms in the resistance

d One revision deleted portions of the procedure that were not affected by the feedthrough rework

e One revision added a checkout requirement for measurement C229-406 This parameter was affected by the feedthrough rework but was not normally checked out in this procedure

No FARR's were written as a result of this checkout

4 1 13 1 Test Data Table, Cryogenic Temperature Sensor Verification

Measurement Number	Sensor Reference P/N	S/N	Ref Loc	Resistance (ohms) Meas	Limits
CO 003	1B34473-1	307	403MT686	5280	5192 - 5974
CO 004	1B34473-501	296	403MT687	1548	1458 8 - 1624 7
CO 005	1A67863-503	850	405MT612	550	530 - 586
CO 009	1A67863-535	1104	403MT653	222	209 - 231
CO 015	1A67863-509	1075	410MT603	1550	1485 - 1641
CO 040	1A67862-505	449	406MT613	1540	1464 - 1618

4 1 13.1 (Continued)

Measurement Number	Sensor Reference P/N	S/N	Ref Loc	Resistance (ohms) Meas	Limits
CO 052*	1A67862-513	565	408MT612	5150	4967 - 5715
CO 057	1A67862-501	51293	406MT606	545 1	518 9 - 573 5
CO 059	1A67862-517	51425	406MT611	548	518 9 - 573 5
CO 133	NA5-27215T5	-	401(3MTT17)	1390	1298 4 - 1446 4
CO 134	NA5-27215T5	-	401(3MTT16)	1409	1348 - 1490
CO 159	1A67863-519	1115	424MT610	224	209 - 231
CO 161	1A67863-537	1097	404MT733	5280	5101 - 5867
CO 208	1A67863-503	859	405MT605	552	530 - 586
CO 229*	1A67862-509	429	406MT646	542	510 - 564
CO 230	1A67863-509	1089	403MT706	1557	1485 - 1641
CO 231	1A67863-529	626	403MT707	555	530 - 586
CO 256	1B37878-501	1055	409MT646	1550	1485 - 1641
CO 257	1B37878-501	1250	409MT647	1550	1485 - 1641
CO 368	1A67862-505	51380	406MT660	1514	1429 - 1579
CO 369	1A67862-505	242	406MT661	1513	1433 5 - 1584 5
CO 370*	1B51648-507	59789	408MT735	5200	5064 - 5596
CO 371*	1B51648-507	59803	408MT736	5201	5074 - 5608
CO 384	1B37878-511	1381	403MT779	551	518 - 572
CO 391	1A68589-519	5700	403MT784	14 6†	10 61- 11 73

* Second Issue Measurements

† See revision c for out-of-tolerance explanation

4 1 14 Telemetry and Range Safety Antenna System Check (1B44472 B)

This test procedure verified the operational capabilities of the telemetry and range safety antenna system by determining that the continuities, voltage standing wave ratios (VSWR's), insertion losses, phasing, and power levels of the systems were all within the required limits In addition, the center frequency and carrier deviation of the PCM transmitter were determined to be correct, and the operation of the PCM RF assembly and FM/FM group power functions were checked. The particular items involved in this test included:

Part Name	Reference Location	P/N	S/N
PCM RF Assembly	411A64A200	1B52721-509	036
Bi-Directional Coupler	411A64A204	1A69214-503	20012
Coaxial Switch	411A64A202	1A69213-1	0072
Power Divider	411A64A201	1A69215-501	046
Telemetry Antennas	411E200 & E201	1A69206-501	69 & 72
Reflected Power Det	411MT744	1A74776-501	2-0178

4 1 14 (Continued)

Part Name	Reference Location	P/N	S/N
Forward Power Det	411MT728	1A74776-503	0275
Dummy Load	411A64A203	1A84057-1	386
Directional Power Divider	411A97A56	1B38999-1	00020
Hybrid Power Divider	411A97A34	1A74778-501	047
Range Safety Antennas	411E56 & E57	1A69207-501	39 & 40

Initiated on 19 July 1967, the procedure was completed on 27 July 1967 The tests in this procedure were generally performed by disconnecting various transmission lines in the telemetry and range safety RF systems, and determining the insertion losses and VSWR's for those segments of the system Before the tests were started, a test cable, P/N 1B50922-1, was calibrated for use during the tests

Insertion loss measurements were made of the telemetry system transmission lines from the transmitter output of the PCM RF assembly to the input of each of the telemetry antennas, while the other antenna was replaced by a 50 ohm load The phasing difference of the transmission lines from the outputs of the power divider to the telemetry antenna inputs was measured with the antennas replaced by short circuit terminations The VSWR's of the transmission lines from the power divider to the antennas were then measured with the antennas reconnected

The coaxial switch was energized and the telemetry system closed loop VSWR was measured from the transmitter output of the PCM RF assembly to the dummy loads. The coaxial switch was then de-energized and the telemetry system open loop VSWR was measured from the PCM RF assembly output to the antennas

On the range safety system transmission lines, the center conductor continuity resistances were measured from the input of each range safety receiver to the output of each range safety antenna The transmission line insulation resistances were measured between the center conductor and shield at both receiver inputs and both antenna outputs A series of insertion loss checks were then conducted to find the isolation between the two receiver inputs, the insertion loss between each receiver and each antenna, and between each receiver and the directional power divider closed loop checkout connector, and

4 1 14 (Continued)

the insertion loss in the closed loop checkout cable between the directional power divider and the forward umbilical VSWR measurements were then made on the transmission lines from the outputs of the hybrid power divider to each antenna, and on the complete range safety system from the inputs of each receiver to the antennas.

The stage power was turned on for the PCM transmitter tests A dummy load was connected to the output of the transmitter and power was turned on to the PCM RF assembly Measurements were made of the transmitter center frequency, and the carrier deviation for a plus and minus 5 vdc input signal The transmitter RF output power into the dummy load was measured and the dummy load was removed The output of the forward power detector was measured and verified to be within ±3 percent of the detector calibration requirement for the transmitter RF power output

Engineering comments noted that there were no parts shortages affecting this test No FARR's were written as a result of this test

One revision was made to this procedure to delete all tests except the sections dealing with the PCM RF assembly, the transmitter center frequency and carrier deviation checks, the forward power calibration, and the PCM RF power detector calibration The PCM RF assembly had been replaced after the original checkout at Huntington Beach All other items in the range safety system were not disturbed

4 1 14 1 Test Data Table, Telemetry and Range Safety Antenna System

Function	Measurement	Limit
PCM Transmitter Center Frequency (MHz)	258.502	258 5 ± 0 026
PCM Transmitter Carrier Deviation (kHz)	37 7	36 0 ± 3 0
Forward Power Detector Power (watts)	24 0	15 0 min

4 1 15 Level Sensor and Control Unit Calibration (1B44473 D)

This manual procedure determined that the control units associated with the LOX and LH_2 liquid level, point level, fast fill, and overfill sensors, were adjusted for operating points within the design calibration limits The particular items involved in this test are noted in Test Data Table 4.1.15.1.

This procedure was initially accomplished on 19 July 1967 Reverification by a second issue was required on 25 July 1967, due to rework of the LOX and LH_2 tank feed through connectors

The point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, General Radio Type 1422 CD, were used during the test to provide capacitance changes to the control units as required to simulate wet conditions, and to determine the control unit operating points

The manual checkout assembly was connected between each control unit and its associated sensor, and the precision capacitor was connected to the checkout assembly to parallel the sensor capacitance A voltmeter, connected to the appropriate checkout assembly test points, measured the control unit output signal. The precision capacitor, set to an appropriate capacitance for the sensor under test, simulated a wet condition for the appropriate level sensor The required settings for the precision capacitor were 0 7 ± 0 01 picofarads for all LH_2 sensors with the exception of the LH_2 overfill sensor, which required 1 10 ± 0 02 picrofarads, and 1 50 ± 0 02 picofarads for all LOX sensors, except the LOX overfill sensor, which required 2 10 ± 0 02 picrofarads The control unit power was turned on, and the control point adjustment, R1, on the unit under test was adjusted until the control unit output signal increases from 0 0 ± 1 1 vdc to 28 0 ± 2 0 vdc,

4 1 15 (Continued)

indicating activation of the control unit output relay The capacitance value of the precision capacitor was reduced until the control unit output relay deactivated The deactivation capacitance value was recorded The capacitance value of the precision capacitor was increased until the control unit output relay reactivated The reactivation capacitance was also recorded, as shown in Test Data Table 4 1.15.1.

The capacitance checks were followed by a series of tests to verify operation of the output relay With the sensor reconnected, the output relay for each control unit was reverified to be deactivated under normal conditions, and activated under test conditions

There were no part shortages that affected this test No problems were encountered and no FARR's were written The first issue had no revisions, however, two revisions were made to the second issue

a One revision deleted the tests for those sensors not affected by the feedthrough connector rework

b One revision deleted the requirements for calibrating the sensors, and performed an operational test only, as the calibration was accomplished by the first issue

4 1 15 1 Test Data Table, Level Sensor and Control Unit Calibration

Function	Sensor P/N 1A68710 Ref. Loc.	Dash No.	S/N	Control Unit, P/N 1A68710 Ref. Loc.	Dash No.	S/N	Deact. Cap. pf Meas.	Min.	React. Cap. pf Meas.	Max.
LH2 Tank	408			411						
Liq. Lev. L17	MT732	-507	D-68	A61A217	-509	D-68	0.6523	0.5	0.6525	0.9
Liq. Lev. L18	MT733	-507	D-69	A61A219	-509	D-73	0.677	0.5	0.678	0.9
Liq. Lev. L19	MT734	-507	D-70	A61A221	-509	D-74	0.668	0.5	0.670	0.9
Pt. Lev. 1	A2C1	-507	D-38	A92A25	-509	D101	0.6801	0.5	0.6813	0.9
Pt. Lev. 2	A2C2	-507	D-57	A92A26	-509	D-90	0.6769	0.5	0.6779	0.9
Pt. Lev. 3	A2C3	-507	D-62	A92A27	-509	D-87	0.6741	0.5	0.6754	0.9
Pt. Lev. 4	A2C4	-507	D-66	A61A201	-509	100	0.681	0.5	0.684	0.9
Fastfill	A2C5	-1	E149	A92A43	-509	C-1	0.6864	0.5	0.6892	0.9
Overfill	*	*	*	A92A24	-509	D-92	1.087	0.9	1.089	1.3
LOX Tank	406			404						
Liq. Lev. L14	MT657	-1	E143	A63A221	-511	D-77	1.472	1.3	1.496	1.7
Liq. Lev. L15	MT658	-1	E135	A63A206	-511	D-84	1.492	1.3	1.497	1.7
Liq. Lev. L18	MT659	-1	D86	A63A223	-511	D-79	1.465	1.3	1.468	1.7
Pt. Lev. 1	A2C1	-1	D-18	A72A1	-511.1	B-101	1.496	1.3	1.498	1.7
Pt. Lev. 2	A2C2	-1	E-67	A72A2	-511.1	D-80	1.482	1.3	1.485	1.7
Pt. Lev. 3	A2C3	-1	D-88	A72A3	-511.1	D-100	1.476	1.3	1.486	1.7
Pt. Lev. 4	A2C4	-1	E-99	A63A227	-511	D-111	1.476	1.3	1.478	1.7
Fastfill	A2C5	-1	D-97	A72A5	-511.1	E12	1.489	1.3	1.494	1.7
Overfill	**	**	**	A72A4	-511.1	D-50	2.093	1.9	2.094	2.3

* Part of LH_2 Mass Probe 408A1, P/N 1A48431-505, S/N D3

** Part of LOX Mass Probe 406A1, P/N 1A48430-509-010, S/N C1

4 1 16 Power Distribution System (1B55815 E)

The automatic checkout of the stage power distribution system verified the capability of the GSE to control power switching to and within the stage, and determined that static loads within the stage were not excessive The procedure verified that particular stage relays were energized or de-energized as required, and that bi-level talkback indications were received at the GSE Static loading of the various stage systems or assemblies was determined by measuring the GSE supply current before and after turn-on of the system All electrical components on the stage were involved in this test, including the point level sensors, the propellant utilization system, the auxiliary propulsion system, the J-2 engine ignition bus, the stage telemetry system, the stage power buses, the LOX and LH_2 chilldown inverters, and the external to internal power transfer system

The procedure was accomplished between 24 and 27 July 1967, and was accepted by Engineering on 27 July 1967

The stage power setup procedure was accomplished, establishing initial conditions for the test To verify that the power supply and stage buses were operating properly, measurements were made of the engine control bus current and voltage, the APS bus current, the engine ignition bus current and voltage with the bus on, and voltage with the bus off, and the component test power current and voltage with the power on, and with the component test power turned off For a check of the emergency detection systems (EDS), it was verified that the EDS 2 engine cutoff signal turned off the engine control bus power and prevented it from being turned back on, and also turned on the instrument unit range safety 1 EBW firing unit arm and engine cutoff signal The engine control bus voltage was measured during this check, and again with the bus turned back on Verification was then made that the EDS 1 engine cutoff signal turned on the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indication (K13), and that with the EDS 1 signal turned off, the engine bypass turned off both cutoff indications

For the point level sensor test, the propellant level sensor power current was measured, and each of the LH_2 tank and LOX tank point level sensors were verified to respond properly within 300 milliseconds to the simulated wet conditions A series of checks then verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition off commands, resulted in the required engine cutoff signal For the dry condition of LOX tank sensors 1 and 2, the engine cutoff LOX depletion timer value was measured to determine the cutoff signal delay time Each of the point level sensors was then verified to respond properly within 300 milliseconds to simulated wet condition off commands

Verification was then made that the engine cutoff command turned on the AO multiplexer engine cutoff signal indication (K13), the engine cutoff command indication (K140), and the engine cutoff, but did not turn on the nonprogrammed engine cutoff indication. With the engine cutoff command turned off, it was verified that the engine cutoff command indication was off while the multiplexer engine cutoff indication and the engine cutoff remained on, until turned off by the engine ready bypass

The propellant utilization inverter and electrical power current was measured while the power was momentarily turned on. The PCM RF assembly power current was then measured, and the PCM/FM transmitter output power was measured through the AO and BO multiplexers With the telemetry RF silence command turned on, the RF group was verified to be off, the PCM/FM transmitter output power was measured through the AO multiplexer, and the switch selector output monitor voltage (K128), was measured with the PCM RF assembly power and read commands 1 and 2 turned on With the telemetry RF silence command turned off, the RF group was verified to be on, and the PCM/FM transmitter power was again measured through the AO multiplexer

The rate gyro voltages were manually verified to be 28 $\pm$2 0 vdc with the gyro turned on, and 0 0 $\pm$2 0 vdc with the gyro turned off The environmental control group current was measured while the group was momentarily turned on The aft bus 2 current and voltage were then measured, and the aft bus 2 power supply local sense indication was verified to be off

For the chilldown inverter tests, the chilldown pump simulator was connected to the LOX and LH_2 chilldown inverters, and for each inverter, measurements

4 1 16 (Continued)

were made of the input current, the output voltages through both hardwire and telemetry, and the operating frequency, through telemetry

A series of checks then verified the operation of the external/internal transfer system for forward bus 1 and 2, and aft bus 1 and 2 The battery simulator voltages and the electrical support equipment load bank voltages were measured first The power bus voltages were then measured with the buses transferred to internal, and the bus local sense indications were verified to be off The bus voltages were measured again with the buses transferred back to external, and the battery simulator voltages were measured with the simulators turned off The aft bus 2 voltage was then measured with the bus power supply turned off

Verification was made that the switch selector register was operating properly and that the instrument unit 28 vdc power supplies were on The range safety receiver currents were measured with the receivers transferred to external power and momentarily turned on The range safety system EBW firing units were verified to be on, when they were transferred to external power and momentarily turned on This completed the power distribution system test

Engineering comments noted that no part shortages existed and that no interim use material parts were installed at the start of this test

Nine revisions were made to the procedure

a. One revision resumed the automatic program, after a halt occurred because the aft bus 2 voltage was not turned off prior to the start of the initial condition scan, as required

b One revision changed the part number callout for the breakout box from P/N 1A66381 to P/N 1B63887 The original part number was for an SSC drawing

c One revision allowed for an initial turn-on voltage surge on aft bus 2 by disabling SIM channel 17, and then re-enabling it 1 second after the PU inverter turn-on

d One revision deleted the LOX chilldown inverter hardwire instrumentation check This test was not required on this stage

4 1.16 (Continued)

e Two revisions accepted an out-of-tolerance reading of the LOX chilldown inverter voltage AB output, which was caused by a maladjustment of the T/M instrumentation module, and a reading for the LOX chilldown inverter voltage A1B1, which was caused by a program error that was corrected

f One revision provided instructions to accomplish readjustment of the LOX chilldown inverter T/M instrumentation module

g One revision reran the LOX chilldown section of the procedure using the proper DDT curves for all LOX hardwire phase voltage checks

h. One revision was written to notify Engineering at Huntington Beach that a variation from the procedure may exist due to improper setup of the T/M module A4

No other discrepancies were noted and the power distribution system was accepted for use

4 1 16 1 Test Data Table, Power Distribution System

Function	Measured Value	Limits
Engine Control Bus Voltage (vdc)	27 783	28 0 ± 2 0
Engine Cutoff LOX Depletion Timer (seconds)	0 551	0 56 ± 0 025
PU Inverter & Electrical Pwr Current (amps)	3 800	5 0 max
Engine Ignition Bus Voltage (vdc)	27 814	28 0 ± 2.0
PCM RF Assembly Current (amps)	6 399	4.5 ± 3.0
Aft Bus 2 Voltage (vdc)	54 96	56 0 ± 4 0
Chilldown Inverter No Load Test		
LH_2 Inverter Frequency (Hz)	401.8	400 ± 4.0
LH_2 Inverter Phase AB Voltage (vac)	53.063	55 0 ± 5.0
LH_2 Inverter Phase AC Voltage (vac)	53.063	55.0 ± 5.0
LOX Inverter Frequency (Hz)	399.4	400 ± 4.0
LOX Inverter Phase AB Voltage (vac)	52 086	55 0 ± 5 0
LOX Inverter Phase AC Voltage (vac)	53 127	55 0 ± 5 0
Chilldown Inverter Load Test		
LH_2 Inverter Frequency (Hz)	401 4	400 ± 4 0
LH_2 Inverter Phase AB Voltage (vac)	55 998	55 0 ± 5 0
LH_2 Inverter Phase AC Voltage (vac)	56 065	55.0 ± 5 0
LOX Inverter Frequency (Hz)	398 7	400 ± 4 0
LOX Inverter Phase AB Voltage (vac)	53 779	55 0 ± 5 0
LOX Inverter Phase AC Voltage (vac)	54 625	55.0 ± 5 0

4 1.16 1 (Contınued)

Functıon	Measured Value	Lımıts
Fwd Bus 1 Battery Sımulator Voltage (vdc)	29 12	28 0 ± 2 0
Fwd Bus 2 Battery Sımulator Voltage (vdc)	27 60	28 0 ± 2 0
Aft Bus 1 Battery Sımulator Voltage (vdc)	27 92	28 0 ± 2 0
Aft Bus 2 Battery Sımulator Voltage (vdc)	54.96	56 0 ± 4 0
ESE Load Bank Bus 4D20 Voltage (vdc)	0 04	0 0 ± 1 0
ESE Load Bank Bus 4D40 Voltage (vdc)	0 00	0 0 ± 1 0
ESE Load Bank Bus 4D30 Voltage (vdc)	0 00	0 0 ± 1 0
ESE Load Bank Bus 4D10 Voltage (vdc)	0 00	0 0 ± 1 0
Fwd Bus 1 Internal Voltage (vdc)	29 00	28 0 ± 2 0
Fwd Bus 2 Internal Voltage (vdc)	27 24	28 0 ± 2 0
Aft Bus 1 Internal Voltage (vdc)	28 00	28 0 ± 2 0
Aft Bus 1 External Voltage (vdc)	27 76	28 0 ± 2 0
Aft Bus 1 Battery Sımulator Voltage (vdc)	-0 04	0 0 ± 1 0
Aft Bus 2 Internal Voltage (vdc)	55 12	56 0 ± 4 0
Aft Bus 2 External Voltage (vdc)	54.96	56.0 ± 4 0
Aft Bus 2 Battery Sımulator Voltage (vdc)	-0 16	0 0 ± 1 0
Fwd Bus 1 External Voltage (vdc)	29 08	28 0 ± 2 0
Fwd Bus 1 Battery Sımulator Voltage (vdc)	0 00	0 0 ± 1 0
Fwd Bus 2 External Voltage (vdc)	27.68	28 0 ± 2 0
Fwd Bus 2 Battery Sımulator Voltage (vdc)	-0 04	0 0 ± 1 0
Aft Bus 2 Voltage (vdc)	0 00	0 0 ± 1.0

4 1 17 Range Safety System (1B55821 E)

The automatıc checkout of the range safety system verıfıed the system external/ınternal power transfer capabılıty, and the capabılıty of the system to respond to the propellant dıspersıon ınhıbıt and trıgger commands, the engıne cutoff command, and the system off command The ıtems ınvolved ın thıs test ıncluded the followıng

Part Name	Ref Locatıon	P/N	S/N
Range Safety Receıver 1	411A97A14	50M10697	104
Range Safety Receıver 2	411A97A18	50M10697	167
Secure Command Decoder 1	411A99A1	50M10698	0133
Secure Command Decoder 2	411A99A2	50M10698	0092
Secure Command Controller 1	411A97A13	1B33084-503	012
Secure Command Controller 2	411A97A19	1B33084-503	011
RS System 1 EBW Fırıng Unıt	411A99A12	40M39515-119	463
RS System 2 EBW Fırıng Unıt	411A99A20	40M39515-119	464
RS System 1 EBW Pulse Sensor	411A99A31	40M02852	*
RS System 2 EBW Pulse Sensor	411A99A32	40M02852	*
Hybrıd Power Dıvıder	411A97A34	1A74778-501	047
Dırectıonal Power Dıvıder	411A97A56	1B38999-1	00020
* Installed ın Pulse Sensor Assembly	411A99A31/A32	1B29054-501	00004

4.1.17 (Continued)

Initial conditions were established for the start of this checkout on 24 July 1967 The forward bus 1 and bus 2 battery simulators were turned on and both voltages were measured The two range safety receivers were verified to be off The internal/external transfer test was conducted next The EBW firing units were verified to be off, and the external power for the receiver and firing unit of both range safety systems was turned on The charge voltage indications and firing unit voltage indications were measured for both firing units The cutoff inhibit command was turned on for both receivers. Both firing units were transferred to internal power, the external power for these units was turned off, and both units were verified to be on. The charging voltage indications were measured for both firing units. The firing units were transferred back to external power and verified to be off, and the charging voltage indications were again measured. The external power for the receivers was then turned off and both receivers were verified to be off. The receivers were then transferred to internal power and verified to be on, then transferred back to external power and verified to be off Finally, both receivers were transferred back to internal power and again verified to be on

The EBW firing unit arm and engine cutoff test was conducted next. The engine control bus power was turned on and the voltage was measured, then the low level signal strength indications were measured for both receivers The EBW firing unit arm and engine cutoff command was turned on and verified to be received by range safety system 1. The charging voltage indication for system 1 was measured The engine cutoff indication was verified to be off at the umbilical and at the AO and BO telemetry multiplexers Verification was made that the nonprogrammed engine cutoff indication was off, and that the instrument unit receiver 1 arm and engine cutoff indication was off The cutoff inhibit command for receiver 1 was turned off and the instrument unit receiver 2 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was off, that the engine cutoff indications were still off at the umbilical and through both multiplexers, that the nonprogrammed engine cutoff indication was still off, and that the instrument unit receiver 1 arm and engine cutoff indication was then on The receiver 1 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff

4 1 17 (Continued)

indication was verified to again be off The EBW firing unit arm and engine cutoff command was turned off The engine control bus power was turned back on and verified to be 28 0 ± 2 0 vdc. Both firing units were transferred to external power and verified to be off, and the charging voltage indications were measured. The same EBW firing unit arm and engine cutoff test procedure was repeated for range safety system 2

The EBW pulse sensor power and pulse sensor self-test were turned on, and both range safety system pulse sensors were verified to be on The pulse sensor power was cycled from on to off, then back on, and the pulse sensors were verified to be off The propellant dispersion command was turned on and verified to be received by the system 1 receiver The system 1 firing unit charging voltage was measured, and the system 1 pulse sensor was verified to be off The propellant dispersion command was turned off, the receiver 1 cutoff command inhibit was turned off, and the propellant dispersion command was turned back on The system 1 firing unit charging voltage was measured and the system 1 pulse sensor was verified to be on The engine cutoff inhibit command was turned back on, and the propellant dispersion command was turned off The propellant dispersion command was turned back on and verified to be received by the system 2 receiver The above test was repeated on the system 2 firing unit and pulse sensors After the test of system 2, the cutoff command inhibits were turned off for both receivers

The range safety system off command was turned on, and the power for the system 1 receiver and EBW firing unit was verified to be off The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system off command was cycled back to on, and the power for system 2 receiver and the EBW firing units was verified to be off The range safety system off command was then turned back off

The safe and arm device test was the final test of this series The propellant dispersion safe-arm safe command was turned on Verification was made that the safe indication was on and the arm indication was off The safe-arm arm

4.1.17 (Continued)

command was turned on, and it was verified that the safe indication was off, and the arm indication was on. The safe-arm safe command was turned on again, and it was verified that the safe indication was again on, and the arm indication was again off

One revision was written during this procedure, to allow the use of 10 dbm in place of a calculated value for RF cable attenuation The average attenuation for past stages had been 10 dbm.

There were no FARR's written during this procedure. The computer printout showed the range safety command receivers 1 and 2 were operated for 1 minute 2.528 seconds, and the EBW firing units were each cycled 1 time. At this time, there were no planned modifications that would require a rerun of this procedure, and on 24 July 1967, the range safety system was accepted for use.

4.1.17.1 Test Data Table, Range Safety System

Function	Measured Value (vdc)	Limits (vdc)
Forward Bus 1 Battery Simulator	29 079	28.0 ±2 0
Forward Bus 2 Battery Simulator	27 479	28.0 ±2 0
External/Internal Power Transfer Test		
External Power On		
System 1 Charging Voltage Indication	4.239	4 2 ±0 3
System 1 Firing Unit Indication	4.245	4.2 ±0.3
System 2 Charging Voltage Indication	4.265	4 2 ±0 3
System 2 Firing Unit Indication	4.266	4 2 ±0 3
Internal Power		
System 1 Charging Voltage Indication	4.244	4 2 ±0 3
System 2 Charging Voltage Indication	4.265	4.2 ±0.3
External Power Off		
System 1 Charging Voltage Indication	0 039	0 3 max
System 2 Charging Voltage Indication	0.039	0 3 max

4.1.17.1 (Continued)

Function	Measured Value (vdc)	Limits (vdc)
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage	27 783	28.0 ±2 0
Receiver 1 Signal Strength Indication	3.502	3 75 ±1 25
Receiver 2 Signal Strength Indication	3.410	3 75 ±1 25
System 1 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.244	4.2 ±0 3
Engine Control Bus Voltage	27 78	28 0 ±2 0
External Power Off		
System 1 Charging Voltage Indication	0.050	0 3 max
System 2 Charging Voltage Indication	0.034	0 3 max
System 2 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.274	4 2 ±0 3
Propellant Dispersion Test		
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4 260	4.2 ±0 3
Charging Voltage Indication (Pulse Sensor On)	1.564	3.0 max
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4 284	4.2 ±0.3
Charging Voltage Indication (Pulse Sensor On)	1 619	3 0 max

4 1 18 Digital Data Acquisition System Calibration (1B55816 D)

This procedure provided the manual and automatic operations for the checkout and calibration of the digital data acquisition system (DDAS), and prepared the system for use The integrity of the DDAS was verified from data inputs through the various multiplexers and the PCM/DDAS assembly, to the DDAS ground station The particular components of the DDAS involved in this test were the PCM/DDAS assembly 411A97A200, P/N 1A74049-511, S/N 014, the model 270 time division multiplexers 404A61A200 (CP1-BO), P/N 1B62513-529, S/N 019, and 404A61A201 (DP1-BO), P/N 1B62513-513, S/N 026, the remote digital submultiplexer (RDSM) 404A60A200, P/N 1B52894-1, S/N 09, and the low level remote analog submultiplexer (RASM) 404A60A201, P/N 1B54062-503, S/N 021

The checkout was initiated on 25 July 1967, and was completed on 27 July 1967 After verifying that initial conditions were established, the manual 72 kHz bit rate test was conducted The DDAS ground station was verified to be in synchronization with the stage DDAS, and the DDAS 72 kHz clock bit rate was measured as 72,005 bits per second, which was within the 71,975 to 72,025 bits per second requirements Test connections were then made to the PCM/DDAS assembly to manually measure the output frequency and voltage of the 600 kHz VCO used to transmit data from the stage DDAS to the DDAS ground station over hardwire circuits The upper bandedge of the 600 kHz VCO was measured as 630 705 kHz at 2 95 vrms, meeting the requirement of 623 2 to 642 2 kHz at greater than 2 2 vrms The lower bandedge was measured as 567 313 kHz at 3 00 vrms, meeting the requirements of 556 8 to 576 8 kHz at greater than 2 2 vrms The VCO deviation, found as the difference between the bandedge frequencies, was 63 392 khz, within the 70 ± 10 kHz deviation limits.

An automatic flight calibration test was conducted on both the CP1-BO and DP1-BO multiplexers The outputs of data channels DP1-BO-11-01 through -11-10 and CP1-BO-11-01 through -11-10 were recorded at each of the calibration input levels of 0 000, 1 250, 2 500, 3.750, and 5 000 vdc The output of each of these channels was within the ± 0 030 vdc tolerance limit of the input for each calibration level Initially, power supply number 2 was not turned on, causing malfunctions to occur The power supply was turned on, and the test was rerun satisfactorily

4 1 18 (Continued)

The CP1-BO and DP1-BO multiplexers were then checked individually For testing of the CP1-BO multiplexer, the required manual test cable connections were made, and, when called for by the computer typeout, the multiplexer input signal power supply was adjusted to voltage levels of 0 000, 1 250, 2 500, 3 750, and 5 000 vdc, ± 0 001 vdc each, for the five test runs on this multiplexer During the 0 000 vdc input level test run only, input voltages of 4 5 ± 0 100 vdc and 20 0 ± 1 0 vdc were supplied to the PCM/DDAS assembly These inputs were 0 0 ± 0 100 vdc and 0 0 ± 1.0 vdc, respectively, during the other four test runs For testing of the DP1-BO multiplexer, the required test cable connections were made, and, when called for by the computer typeout, the multiplexer input signal power supply adjustments were repeated for the five test runs on this multiplexer All channel outputs for both multiplexers were verified to be within the applicable tolerance of the applied inputs, generally ± 0 025 vdc or ± 0 03 vdc

For testing of the remote digital submultiplexer, the required manual test cable connections were made, all RDSM test switches on the RDSM/RASM checkout kit, P/N 1B64402-1, were placed in the OFF position, and the RDSM input signal power supply was adjusted to 20 ± 1 vdc When required by the computer typeout for each of the ten test runs on this multiplexer, nine of the ten RDSM test switches were placed in the OFF position, while one of the switches was placed in the ON position Only switch SW1 was on for run 1, only switch SW2 was on for run 2, etc The RDSM outputs were in the proper state for each of the ten test runs for this unit

For testing of the remote analog submultiplexer, the required manual test cable connections were made, and, as required by the computer typeout, the RASM input signal power supply was adjusted to voltage levels of 0 00, 10 00, 20 00 and 30 00 millivolts dc, ± 0 015 millivolts dc each, for the four test runs on this submultiplexer All channels of the RASM were within the required ± 0 035 vdc tolerance A malfunction occurred during the test, and investigation revealed that the wrong size capacitor had been installed The correct size was installed, and the test was rerun

4 1 18 (Continued)

Engineering comments noted that all parts were installed at the start of this test, with the exception of the LH_2 continuous vent bypass valve This affected the initial conditions only

FARR A255370 reported that the inflight calibration on channel CP1-BO-11 at the 5 00 vdc level read consistently 21 mv low The disposition stated that the condition was acceptable for static firing and would be resolved during postfire DDAS automatic checkout

Eleven revisions were written to this procedure

a One revision authorized the use of a battery and decade resistors as a voltage source to replace the power supply for the remote analog submultiplexer test The 15 microvolt tolerance required was very difficult to maintain on the power supply

b One revision authorized an HP425L counter in place of the HP523C counter as callout in the procedure

c One revision explained that a malfunction on channel CP1-BO-11-06 had occurred due to a system error produced by the 5-volt module ground loop error and ambient noise The tolerance of 30 millivolts was changed to 35 millivolts This malfunction was reported on failure and rejection report A255370

d One revision explained that a malfunction during the CP1-BO test occurred because the number 2 power supply was not turned on When the test was rerun with the power supply turned on, the malfunction did not reoccur

e One revision stated that the malfunction that occurred on the CP1-BO test, 1 25 volt portion, was caused by the test cable, P/N 1B55536-1, not being connected to the number 2 power supply This portion of the test was rerun satisfactorily, when all the test equipment was properly connected

f One revision enabled the test operator to enter OLSTOL to turn on the common bulkhead pressure transducer to support the argon purge of the common bulkhead

g One revision explained that a channel 6 lockout occurred because a function number which had a PAM ground station address was dialed up on the numeric readout The PAM ground station was not selected, causing a channel 6 lockout The locked-up word was cleared, and the test was resumed

4 1 18 (Continued)

h One revision instructed the test operator to enter OLSTOL to set the LH_2 and LOX repressurization burner mode, and to set and then reset the LH_2 repressurization control valve, to support the propulsion leak check procedure, H&CO 1B71877

i One revision explained that several malfunctions in the RASM test were caused by the use of a capacitor of the wrong size in the test setup. The test was rerun without problems after a capacitor of the correct value was installed

j One revision deleted a step that was no longer required

k One revision stated that initial conditions could not be completed due to the LH_2 continuous vent orifice bypass valve not being installed. The valve was removed per FARR A255352. The absence of this valve did not affect the results of this test.

4 1 19 Propellant Utilization System Calibration (1B64368 C)

Calibration and operation instructions for the propellant utilization (PU) system, prior to automatic checkout, were provided by this manual test For calibration purposes, the propellant utilization test set (PUT/S), P/N 1A68014-2, was used to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA) to simulate the LOX and LH_2 mass probe outputs under varying propellant load conditions The items involved in this test included the following

Part Name	Ref Location	P/N	S/N
Propellant Utilization Electronics Assy	411A92A6	1A59358-525	00004
Static Inverter-Converter	411A92A7	1A66212-507	020
LOX Mass Probe	406A1	1A48430-509	C1
LH_2 Mass Probe	408A1	1A48431-501	D3
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511 1	D50
LOX Fastfill Sensor	406A2C5	1A68710-1	D97
LOX Fastfill Control Unit	404A72A5	1A68710-511 1	E12
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D92
LH_2 Fastfill Sensor	408A2C5	1A68710-1	E149
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	C1

Prior to the initiation of this test, the inverter-converter was removed and reconfigurated from 1B66212-505 to -507 Also, FARR A255390 rejected the PUEA, P/N 1A59358-525, S/N 00013, which was replaced by S/N 00004.

4 1 19 (Continued)

Initiated on 26 July 1967, this calibration was certified acceptable by Engineering on 28 July 1967 Megohm resistance measurements were made of the LH_2 and LOX mass probes using a 50 vdc megohmeter All resistance measurements were greater than the 1000 megohm minimum requirement The output voltage and operating frequency of the static inverter-converter were measured The resulting values, as shown in Test Data Table 4 1 19 1, were within the specified limits

The PUEA LH_2 bridge was calibrated for the empty condition by nulling the PUT/S ratiometer at a reading of 0 02006, and then nulling the PUEA R2 potentiometer The PUEA LOX bridge was calibrated for the empty condition by nulling the PUT/S ratiometer at a reading of 0 02012, and then nulling the PUEA R1 potentiometer The PUEA LH_2 and LOX bridges were then calibrated for the full condition by setting the PUT/S ratiometer to 0.82303 and nulling the LH_2 and LOX bridge potentiometers

Data acquisition was then verified by establishing simulated empty and full conditions and determining the PUT/S ratiometer settings required to null the PUEA LH_2 and LOX bridges. The values obtained were within the required limits The bridge slew checks were conducted next by simulating 1/3 and 2/3 slew conditions, and determining the PUT/S ratiometer settings required to null the PUEA LH_2 and LOX bridges for each case

The reference mixture ratio (RMR) calibration was then accomplished The first step consisted of determining the difference between the LOX and LH_2 empty ratiometer readings and multiplying this difference by 98 4 vdc The resultant product was designated as V1 Simulated empty conditions were set-up, and the PUEA residual empty bias potentiometer R6 was nulled Simulated full conditions were then established with the PUT/S C1 capacitor (LH_2) set up to 182 4 picofarads, and the C2 capacitor (LOX) set to 122 42 picofarads The residual full bias potentiometer R5 on the PUEA was set to the null position The LH_2 bridge linearity check was then accomplished by adjusting the PUT/S capacitors C1 (LH_2) and C2 (LOX) to specific values, and determining the PUT/S ratiometer settings required to null the PUEA bridges The hardwire loading voltages of the LH_2 and LOX bridges were checked and found to be within the tolerance of 23 52 $\pm$ 2 vdc

4 1 19 (Continued)

All required parts were installed at the start of this test, and there were no interim use material (IUM) parts installed

There were four revisions written to this procedure

a One revision changed a callout from "Disconnect stage connector 410W200P16 from J4 of the static inverter-converter" to "Disconnect stage connector 410W200P16 from J4 and 411W6P37 from J2 of the static inverter-converter " The reasons for the change was that cable 411W6P37 was added to the stage but was not added to the procedure

b One revision deleted paragraphs for the "fuel boiloff bias adjust " This function is not on this stage

c One revision deleted requirements for the 200 pf ratiometer readings on the LH_2 bridge linearity checks The full capacitance of the LH_2 bridge was 182 04 pf.

d One revision changed the acceptable limits in H&CO paragraph 4 2 3 9.1 1c from "0 21996 to 0 22316," to "0 21987 to 0 22019," and for paragraph 4 2 3 9 1 2b from "0 44764 to 0 45094," to "0 45390 to 0 45719 "

4.1.19.1 Test Data Table, Propellant Utilization System

Static Inverter-Converter Output Checks

Function		Measured Value	Limits
5 vdc	(vdc)	4 93	4 50 - 5 10
21 0 vdc	(vdc)	21 4	20 0 - 22 5
29 0 vdc	(vdc)	27 2	26.0 - 30 0
V/P excitation	(vdc)	48.68	47 26 - 50 31
115 vrms monitor	(vdc)	2.72	2.28 - 3 18
117 vdc	(vdc)	120 5	115.0 - 122 5
TP 2 reading	(vdc)	21 57	20 0 - 22 5
Frequency output	(Hz)	400	400 ± 6

Data Acquisition (Ratio)

LH_2 empty	0 01398	*
LOX empty	0 03989	*
LH_2 full	0.82310	*
LOX full	0 82303	*

*Limits Not Specified

4 1 19 1 (Continued)

Function	Measured Value	Limits
Bridge Slew Checks (Ratio)		
LH_2 1/3 slew	0 30986	*
LH_2 2/3 slew	0 63986	*
LOX 1/3 slew	0 28376	*
LOX 2/3 slew	0 57146	*
LH_2 Bridge Linearity Check (Ratio)		
50 pf	0.22174	0 21996 - 0 22316
100 pf	0.44899	0 44764 - 0.45094
150 pf	0 67656	0 67542 - 0 67871
LOX Bridge Linearity Check (Ratio)		
20 pf	0 15106	0 14958 - 0 15287
50 pf	0 34785	0 34616 - 0 34945
70 pf	0 47868	0 47722 - 0 48051
100 pf	0 67510	0 67381 - 0 67710

*Limits Not Specified

4 1 20 Hydraulic System Checkout (1B55824 D)

This automatic procedure verified the integrity of the stage hydraulic system and demonstrated the capability of the system to provide engine centering and control during powered flight The test involved all components of the stage hydraulic system, including the hydraulic pump, P/N 1A66240-503, S/N X457806, the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454590, the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00032, the hydraulic pitch actuator, P/N 1A66248-507-012, S/N 52, and the hydraulic yaw actuator, P/N 1A66248-505-011, S/N 60

Initiated on 27 July 1967, and satisfactorily completed on 28 July 1967, this checkout was accepted on 3 August 1967

After completion of the stage power setup, H&CO 1B55813 B, initial conditions were established for the test The instrument unit (IU) substitute 5 volt power supply was turned on, its voltage was measured, and the aft 5 volt excitation module voltage was measured Various functions of the hydraulic system were measured with the system unpressurized The accumulator/reservoir gaseous nitrogen mass and the corrected oil level were also measured

The coast mode operation of the hydraulic system was checked next After application of dry ice to the coast mode thermal switch, it was verified that the low temperature caused the thermal switch to turn on the auxiliary pump, when the auxiliary hydraulic pump coast command was turned on. Turning off the coast command turned off the auxiliary pump. The flight mode operation was checked by verifying that turning the auxiliary hydraulic pump flight command on and off, properly turned the auxiliary pump on and off. Manual operation was checked by verifying that the auxiliary pump could be properly operated from the GSE mechanical systems panel when the GSE was in the manual mode

The operation of the sine wave generators was verified, and the J-2 engine centering test was accomplished The first section of the check was conducted with the actuator position locks engaged and the hydraulic system unpressurized By measuring the actuator positions, the voltage of the IU substitute 5 volt power supply, and the aft 5 volt excitation module voltage, the

4 1 20 (Continued)

corrected actuator positions were determined The pitch and yaw actuator locks were removed, the aft bus 2 power was turned on, and the voltage was measured The auxiliary pump was turned on in the automatic mode, and the aft bus 2 current was measured The hydraulic system pressure was measured, and various hydraulic system functions were verified to be within their proper operating limits

The second J-2 engine centering test was conducted with the hydraulic system pressurized, the actuator locks disengaged, and with no excitation signal applied to the actuators Repeating the test measurements, the corrected actuator positions were again determined A zero excitation signal was then applied to the actuators, and the system functions were measured

A polarity, linearity, and clearance check was accomplished next The actuators were individually extended to their stops and retracted, causing the J-2 engine to gimbal to its travel extremity, 0 degrees to 7-1/2 degrees, in a square pattern A clearance check verified that there was no interference to engine motion within the gimbal envelope A comparison of the hydraulic servo engine positioning system command and response signals verified that the response movement was of the correct polarity and magnitude to agree with the command signal, and had met the requirements for movement linearity

An engine slew rate test was conducted next Step commands were applied to the pitch and yaw actuators, causing each actuator to individually move the engine from 0 degrees to -3 degrees, from -3 degrees to 0 degrees, from 0 degrees to +3 degrees, and from +3 degrees to 0 degrees The engine response was observed visually and audibly for unwanted oscillations, and the actuator responses were recorded during the engine movement

With the hydraulic system pressurized, the actuator locks removed, and no pitch or yaw excitation signals applied to the hydraulic actuators, final measurements were made of the hydraulic system and the J-2 engine centering functions

4 1 20 (Continued)

The procedure was completed by a systematic turnoff of the hydraulic system The computer printout noted that during this checkout, the switch selector was used four times, and the auxiliary hydraulic pump was cycled on and off one time with a total running time of 17 minutes 37 048 seconds The engine accumulated one cycle of 7 5 degrees amplitude and one cycle of 3 degrees amplitude in the pitch plane, and one cycle at each amplitude in the yaw plane

There were no part shortages at the start of this test No FARR's were written against the procedure or the hydraulic system as a result of this test

One revision was written to change the program to interrogate the hydraulic pump inlet oil temperature rather than the hydraulic reservoir oil temperature The original program was in error

There were no other deviations and the hydraulic system was accepted for use

4 1 20 1 Test Data Table, Hydraulic System

Function	Measurement	Limits
IU Substitute 5 volt Power Supply (vdc)	5 00	5 00 ± 0 05
Aft 5 volt Excitation Module (vdc)	5 00	5 00 ± 0 05
Hydraulic System Unpressurized		
Reservoir Oil Pressure (psia)	69 83	*
Accumulator GN_2 Pressure (psia)	2211 88	*
Accumulator GN_2 Temperature (°F)	76 06	*
Reservoir Oil Level (%)	91 94	*
Pump Inlet Oil Temperature (°F)	76 06	*
Reservoir Oil Temperature (°F)	76 88	*
Aft Bus 2 Current (amp)	0 00	*
Gaseous Nitrogen Mass (lb)	1.784	1 925 ± 0 2
Corrected Reservoir Oil Level (%)	99 2	95 0 min
Engine Centering Test, Locks On, System Unpressurized		
T/M Pitch Actuator Position (deg)	-0 08	*
IU Pitch Actuator Position (deg)	-0 03	*
T/M Yaw Actuator Position (deg)	0 05	*
IU Yaw Actuator Position (deg)	-0 01	*
IU Substitute 5 Volt Pwr Supply (vdc)	5 00	*
Aft 5 Volt Excitation Module (vdc)	5 00	*
Corrected T/M Pitch Actuator Position (deg)	-0 080	-0 236 to 0 236
Corrected T/M Yaw Actuator Position (deg)	0 049	-0 236 to 0 236
Corrected IU Pitch Actuator Position (deg)	-0 29	-0 236 to 0 236
Corrected IU Yaw Actuator Position (deg)	-0 015	-0 236 to 0.236

* Limits Not Specified

4 1 20 1 (Continued)

Function	Measurement	Limits
Aft Bus 2 Voltage (vdc)	56 88	56 0 ± 4 0
Aft Bus 2 Current (amp)	51.0	*
Hydraulic System Pressure (psia)	235 6	200.0 min.
Engine Centering Test, Locks Off, System Pressurized, No Excitation Signal		
T/M Pitch Actuator Position (deg)	-0.03	*
IU Pitch Actuator Position (deg)	0.01	*
T/M Yaw Actuator Position (deg)	0.08	*
IU Yaw Actuator Position (deg)	0 03	*
IU Substitute 5 volt Power Supply (vdc)	4 99	*
Aft 5 volt Excitation Module (vdc)	5.00	*
Corrected T/M Pitch Actuator Position (deg)	-0.033	-0 517 to 0 517
Corrected IU Pitch Actuator Position (deg)	0 008	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	0 080	-0 517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.036	0 517 to 0 517
Hydraulic System Pressurized, Locks Off, Zero Excitation Signal Applied to Actuators		
Hydraulic System Pressure (psia)	3604.63	*
Reservoir Oil Pressure (psia)	165 84	*
Accumulator GN_2 Pressure (psia)	3581 19	*
Accumulator GN_2 Temperature (°F)	101 18	*
Reservoir Oil Level (%)	36 03	*
Pump Inlet Oil Temperature (°F)	79 20	*
Reservoir Oil Temperature (°F)	77.63	*
Aft Bus 2 Current (amp)	47 00	*

Pitch 0 to -3 Degree Step Response - Engine Slew Rate 12 2 deg /sec

Time from Start (Seconds)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	0.000	-0.103	4 990
0 090	-19 824	-1 472	5 000
0 180	-19 775	-2 784	5 000
0 271	-19 824	-3 188	5 005
0 362	-19 824	-3 087	5 000
0 453	-19 775	-2 986	5 000
0 544	-19 775	-3 116	5 005
0 635	-19 775	-3 116	5 000
0 726	-19 824	-3 044	5 000

* Limits Not Specified

4.1 20 1 (Contınued)

Pıtch 0 to -3 Degree Step Response (Contınued)

Tıme from Start (Seconds)	Pıtch Excıtatıon Sıgnal (ma)	IU Pıtch Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 907	-19 824	-3 116	4 990
1 089	-19 824	-3 087	4 990
1 271	-19 775	-3 102	4 990
1 453	-19 824	-3 102	5 000
1 634	-19 824	-3 102	5 000
1 815	-19 775	-3.116	5 005

Pıtch -3 to 0 Degree Step Response - Engıne Slew Rate 12 2 deg /sec

Tıme from Start (Seconds)	Pıtch Excıtatıon Sıgnal (ma)	IU Pıtch Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	-19 649	-3.117	5 005
0 090	0 000	-1 702	5 000
0 181	0 049	0 403	5.000
0 271	0 000	0 087	5.000
0 362	0 000	-0 115	5 000
0 453	0 000	-0 129	5 000
0 544	0 049	-0 071	5 000
0 635	-0 098	-0 014	5 000
0 726	0 000	-0 058	5 000
0 907	0 000	-0 058	5 000
1 090	-0 049	-0 043	5 000
1 271	-0 049	-0 058	5 005
1 452	0 000	-0 058	5 000
1 635	0 000	-0 058	5 000
1 816	-0 049	-0 058	4 990

Pıtch 0 to +3 Degree Step Response - Engıne Slew Rate 12 2 deg /sec

Tıme from Start (Seconds)	Pıtch Excıtatıon Sıgnal (ma)	IU Pıtch Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	0 000	-0 059	4 999
0 091	19 824	1 356	4 990
0 183	19 874	2 655	4 990
0 273	19.873	3 160	4 990
0 364	19 873	2.973	5 000
0 455	19 824	2 973	5 000
0 546	19 824	3 030	5 000
0 638	19 775	3 045	5 000
0 729	19 824	3.045	4.990
0 909	19 824	3 030	5 000
1 091	19 824	3 045	4 990
1 273	19 824	3 030	5 000
1 455	19 824	3 045	4 990
1 638	19.824	3 030	5 000
1 818	19.824	3 045	5 000

4 1 20 1 (Contınued)

Pıtch +3 to 0 Degree Step Response - Engıne Slew Rate 12 2 deg /sec

Tıme From Start (Seconds)	Pıtch Excıtatıon Sıgnal (ma)	IU Pıtch Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	19 850	3 028	4 999
0 090	-0 098	1 588	5 005
0 182	0 000	0 260	4 985
0 272	0 000	0 129	5 000
0 363	0 000	0 000	5.000
0 453	-0 049	0 029	5 000
0.544	-0.049	-0 058	5.000
0.636	-0.049	-0.058	5 000
0 727	0 049	-0.058	5 000
0 908	-0 049	-0 058	5.005
1 090	-0 049	-0 043	5 000
1 271	-0 049	-0 058	4 990
1 453	-0 098	-0 043	5 000
1 636	0 000	-0.043	5 000
1 817	0 000	-0 058	5 000

Yaw 0 to -3 Degree Step Response - Engıne Slew Rate 12 2 deg /sec

Tıme from Start (Seconds)	Yaw Excıtatıon Sıgnal (ma)	IU Yaw Actuator Pot. Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	0 000	-0 029	5 005
0 081	-19 971	-1 343	5 000
0 172	-20 020	-2 598	5 000
0 263	-19 971	-3.117	5 000
0 354	-20 020	-3 017	5 000
0 453	-19 971	-3 017	4 990
0 544	-19 971	-3 045	4 990
0 635	-20 020	-3 060	5 000
0 726	-20 020	-3 045	5 000
0 906	-20 020	-3 017	4 990
1 089	-20 020	-3 060	5 000
1 271	-19 971	-3 060	5 000
1 453	-20 020	-3 074	4 990
1 634	-20 020	-3 060	5 000
1 815	-19 971	-3 074	5 000

Yaw -3 to 0 Degree Step Response - Engıne Slew Rate 12 2 deg /sec

Tıme from Start (Seconds)	Yaw Excitatıon Sıgnal (ma)	IU Yaw Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	-20 000	-3 088	5 005
0 089	-0 146	-1 732	5 000
0 180	-0 098	-0 448	5 000
0.271	-0 146	0 028	4 990
0 362	-0 049	-0 044	5 000
0 452	0 000	-0 072	4 985
0 543	0 049	0 014	4 990

4 1 20 1 (Continued)

Yaw -3 to 0 Degree Step Response (Continued)

Time from Start (Seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 634	0 000	0 014	5 000
0 725	-0 146	0.014	5 010
0 907	-0 049	0 043	4 990
1 089	0 000	0 014	4 990
1 271	-0 146	0 014	5 000
1 452	0 000	0 014	5 005
1 634	-0 146	0 014	4 990
1 815	-0 098	0 014	5 000

Yaw 0 to +3 Degree Step Response - Engine Slew Rate 12 2 deg /sec

Time from Start (Seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	0 000	0 014	4 999
0 090	19 824	1 284	5 000
0 181	19 727	2 611	5 000
0 271	19 775	3 029	4 990
0 361	19 775	3 016	5 005
0 453	19 727	2 972	4 990
0 544	19 775	3 016	4 990
0 635	19 727	3 059	5 000
0 726	19 775	3 016	5 000
0 906	19 824	3 044	5 000
1 089	19 775	3 059	5 000
1 271	19 775	3 059	4 990
1 451	19 727	3 059	4 990
1 634	19 727	3 059	4 990
1 814	19 775	3 044	5 010

Yaw +3 to 0 Degree Step Response - Engine Slew Rate 12 2 deg /sec

Time from Start (Seconds)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot Pos (deg)	IU 5 volt Power Supply (vdc)
0 000	19 800	3 058	4 999
0 089	0 146	1 702	5 000
0 180	0 000	0 418	5 000
0 271	-0 049	-0 130	5 000
0.361	0 000	0 014	4 990
0 452	-0 146	-0 029	4 990
0 634	-0 098	-0 029	5 000
0 725	-0 049	-0 059	5 000
0 906	0 000	0.000	4 990
1 088	-0 098	-0 044	5 000
1 270	-0 049	-0 044	5 005
1 451	0 000	0 000	5 000
1 633	0 000	-0 044	4 990
1 814	-0 049	-0 029	5 000

4 1.20 1 (Continued)

Final Hydraulic System and Engine Centering Test - System Pressurized, Locks Off, No Excitation Signal

Function	Measurement	Limits
Hydraulic System Pressure (psia)	3604 63	*
Reservoir Oil Pressure (psia)	171 08	*
Accumulator GN_2 Pressure (psia)	3592 13	*
Accumulator GN_2 Temperature (°F)	86 64	*
Reservoir Oil Level (%)	36 41	*
Pump Inlet Oil Temperature (°F)	133.92	*
Reservoir Oil Temperature (°F)	116 94	*
Aft Bus 2 Current (amps)	44.80	*
T/M Pitch Actuator Position (deg)	-0 13	*
IU Pitch Actuator Position (deg)	-0.06	*
T/M Yaw Actuator Position (deg)	0.02	*
IU Yaw Actuator Position (deg)	-0 03	*
IU Substitute 5 volt Power Supply (vdc)	4 99	*
Aft 5 volt Excitation Module (vdc)	5.00	*
Corrected T/M Pitch Actuator Pos (deg)	-0.127	-0.517 to 0.517
Corrected IU Pitch Actuator Pos (deg)	-0.065	-0.517 to 0.517
Corrected T/M Yaw Actuator Pos (deg)	0.018	-0 517 to 0 517
Corrected IU Yaw Actuator Pos (deg)	-0 022	-0.517 to 0 517

*Limits Not Specified

4 1 21 Propellant Utilization System (1B55823 E)

This automatic checkout verified the ability of the propellant utilization (PU) system to determine and control the engine propellant flow mixture ratio in a manner that ensured simultaneous propellant depletion, and provided propellant level information to control the fill and topping valves during LOX and LH_2 loading This test involved all components of the stage PU system, including the following

Part Name	Ref Location	P/N	S/N
Propellant Utilization Electronics Assy	411A92A6	1A59358-525	00004
Static Inverter-Converter	411A92A7	1A66212-507	020
LOX Mass Probe	406A1	1A48430-509	C1
LH_2 Mass Probe	408A1	1A48431-501	D3
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511 1	D50
LOX Fastfill Sensor	406A2C5	1A68710-1	D97
LOX Fastfill Control Unit	404A72A5	1A68710-511 1	E12
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D92
LH_2 Fastfill Sensor	408A2C5	1A68710-1	E149
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	C1

4 1 21 (Continued)

Initiated on 1 August 1967, and completed on 4 August 1967, after 3 days of activity, this procedure was certified and accepted on 4 August 1967

After initial conditions were established, ratio values were obtained from the manual propellant utilization system calibration procedure, H&CO 1B64368, and were loaded into the computer From these ratio values, nominal test values were computed for LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages After an evaluation of the computer printout, a test of the PU system power was made Power was applied to the PU inverter-converter and electronics, and the forward bus 2 voltage was measured After a delay of 15 minutes to allow the inverter-converter to stabilize, the output voltages and frequency were measured and found to be within specified limits An additional delay of 30 minutes was required for the PU oven temperature to stabilize, and verification was then made that the oven temperature was within the tolerance range

The servo bridge and ratio valve null test was conducted next. The error voltage, as well as the LOX and LH_2 coarse and fine mass voltages, were found to be within required limits

The PU loading test was accomplished next. The boiloff bias on indication was verified to be off, and the LH_2 boiloff bias voltage was measured as 0.29 vdc. With the boiloff bias on indication on, the bias voltage measured 12.69 vdc. The boiloff bias was turned off and the voltage was measured as 0.32 vdc.

The GSE power supply voltage, the PU LOX and LH_2 loading potentiometer sense voltages, and the PU LOX and LH_2 loading potentiometer signal voltages were measured The LOX and LH_2 1/3 checkout relay commands were turned on and the LOX and LH_2 loading potentiometer voltages were measured. The LOX and LH_2 checkout relay commands were turned off and the loading potentiometer voltages were again measured.

The servo balance bridge gain test was conducted next, starting with a measurement of the error signal voltage and the ratio valve position in degrees The LOX and LH_2 coarse and fine mass voltages were measured initially, and were remeasured with the LOX and LH_2 bridge 1/3 and 2/3 checkout relay commands turned on, with the 2/3 checkout relay commands turned off, and with the

4.1.21 (Continued)

1/3 checkout relay commands turned off All of these measurements were within the required limits as determined by the computer.

The next test checked operation of the overfill and fast fill sensors in the LOX and LH_2 tanks. This test was accomplished by verifying that the proper indications were registered under ambient (dry) conditions and under simulated wet conditions of the sensors. All four sensors reacted satisfactorily.

The PU activate test was accomplished next. All measurements were made through the AO and BO multiplexers during the test. The ratio valve position was measured, the LOX bridge 1/3 checkout relay command was turned on, and the LOX coarse mass voltage was measured. The ratio valve position was remeasured with the PU activate switch turned on, and with the PU activate switch turned off. The LOX bridge 1/3 checkout relay command was turned off, and the LOX coarse mass voltage and the ratio valve position were remeasured The test was then repeated using the LH_2 bridge 1/3 checkout relay command, and measuring the LH_2 coarse mass voltage. All of these measurements were within the required limits.

Engineering comments indicated that no interim use material items were installed, nor were there any part shortages at the start of this test No FARR's were written as a result of this checkout. There were three revisions written for the following

a. One revision stated that the LH_2 and LOX repressurization continuous vent valves were "not on" during initial condition scan Leak checks per 1B71877 were active at that time, and the valves could not be operated. This condition did not affect running the test

b One revision changed the PU valve movements test measurements from plus 1 volt and minus 1 volt to plus degrees and minus degrees, respectively The original callout was in error

c One revision explained a malfunction printout for the PU ratio valve not returning to a null position within 2 seconds The valve servo system had dynamic overshoot The ratio valve did return to a null position from a minus position, and continued to travel and was in a plus 5 degree position at the end of 2 seconds.

4.1.21.1 Test Data Table, Propellant Utilization System

Loaded Ratio Values (from H&CO 1B64368)

LOX Empty Ratio	0.020	LH_2 Empty Ratio	0.000
LOX 1/3 Bridge Slew Ratio	0 284	LH_2 1/3 Bridge Slew Ratio	0.310
LOX 2/3 Bridge Slew Ratio	0 572	LH_2 2/3 Bridge Slew Ratio	0.640
LOX Wiper Ratio	0 040	LH_2 Wiper Ratio	0 014
LH_2 Boiloff Bias Voltage (vdc)	12.320		

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.098	LH_2 Empty	0 000
LOX 1/3 Mass	1.421	LH_2 1/3 Mass	1 548
LOX 2/3 Mass	2.861	LH_2 2/3 Mass	3.198

Computed Fine Mass Voltages (vdc)

LOX Empty	3.911	LH_2 Empty	1.367
LOX 1/3 Mass	0.151	LH_2 1/3 Mass	2.339
LOX 2/3 Mass	1.919	LH_2 2/3 Mass	4 683

Computed Loading Voltages (vdc)

LOX Empty	0.547	LH_2 Empty	0 000
LOX 1/3 Coarse Mass	7.957	LH_2 1/3 Coarse Mass	8 668

PU System Power Test

Function	Measured Value	Limits
Forward Bus 2 Voltage (vdc)	28 76	28 0 ±2.0
Inv-Conv 115 vrms Output (vac)	114 783	115 0 ±3 4
Inv-Conv 21 vdc Output (vdc)	21.604	21.25 ±1.25
Inv-Conv 5 vdc Output (vdc)	4.952	4.8 ±0.3
Inv-Conv Frequency (Hz)	400.109	400.0 ±6.0

Bridge Balance and Ratio Valve Null Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.265			0.0 ±1.5
LOX Coarse Mass Voltage (vdc)		0 093	0.093	0 098 ±0 1
LOX Fine Mass Voltage (vdc)		3 931	3 926	3 911 ±0 4
LH_2 Coarse Mass Voltage (vdc)		0.005	0 000	0.000 ±0.1
LH_2 Fine Mass Voltage (vdc)		1.343	1.333	1.367 ±0 4

PU Loading Test

Function	Measured Value	Limits
LH_2 Boiloff Bias Signal Voltage (vdc)	12.69	12.320 ±1
GSE Power Supply Voltage (vdc)	29.438	28 0 ±2.0

4.1.21.1 (Continued)

Loading Potentiometer Function	LOX Value	LH_2 Value	Limits
Sense Voltage, GSE Power On (vdc)	29.318	29.358	GSE Pwr ±0.4
Signal Voltage, 1/3 Relay Commands	0.520	-	0 560 ±0.5
Off (vdc)	-	0.055	0 000 ±0.5
Signal Voltage, 1/3 Relay Commands	7.738	-	7 957 ±0 6
On (vdc)	-	8 449	8 668 ±0 6
Signal Voltage, 1/3 Relay Commands	0.520	-	0.560 ±0 5
Off (vdc)	-	0.027	0.000 ±0.5
Sense Voltage, GSE Power Off (vdc)	0.079	0 079	0 0 ±0.75

Servo Balance Bridge Gain Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.265			1.265 ±1.5
LOX Coarse Mass Voltage (vdc)		0.093	0.088	0 098 ±0.1
LOX Fine Mass Voltage (vdc)		3.926	3.926	3.911 ±0.4
LH_2 Coarse Mass Voltage (vdc)		0 000	0.000	0.000 ±0 1
LH_2 Fine Mass Voltage (vdc)		1.343	1.343	1.367 ±0.4
1/3 Checkout Relay Commands On				
Ratio Valve Position (deg)	1.792			1.265 ±1.5
LOX Coarse Mass Voltage (vdc)		1.416	1.416	1.421 ±0.1
LOX Fine Mass Voltage (vdc)		0.122	0.117	0.151 ±0 4
LH_2 Coarse Mass Voltage (vdc)		1.548	1.553	1.548 ±0 1
LH_2 Fine Mass Voltage (vdc)		2 456	2 451	2.339 ±0.4
2/3 Checkout Relay Commands On				
Ratio Valve Position (deg)	2.252			1.265 ±1 5
LOX Coarse Mass Voltage (vdc)		2 866	2.866	2 861 ±0 1
LOX Fine Mass Voltage (vdc)		1.724	1.729	1 919 ±0.4
LH_2 Coarse Mass Voltage (vdc)		3.203	3 208	3.198 ±0.1
LH_2 Fine Mass Voltage (vdc)		5.000	4.976	4 683 ±0 4
2/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	1.792			1 265 ±1.5
LOX Coarse Mass Voltage (vdc)		1.416	1.416	1 421 ±0.1
LOX Fine Mass Voltage (vdc)		0 137	0.127	0 151 ±0 4
LH_2 Coarse Mass Voltage (vdc)		1.553	1.548	1.548 ±0 1
LH_2 Fine Mass Voltage (vdc)		2 441	2 446	2 339 ±0 4

4.1.21.1 (Continued)

Function	Measured Value	AO Multi	BO Multi	Limits
1/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	1.199			1.265 ±1.5
LOX Coarse Mass Voltage (vdc)		0.098	0.103	0.098 ±0.1
LOX Fine Mass Voltage (vdc)		3.926	3.921	3.911 ±0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	0.000	0 000 ±0 1
LH_2 Fine Mass Voltage (vdc)		1.338	1.343	1.367 ±0.4

PU Valve Movement Test

Function	Measured Value	Limits
Ratio Valve Position, AO (deg)	1 199	1.265 ±1.50
Ratio Valve Position, BO (deg)	1.199	1.265 ±1.50

50 Second Plus Valve Slew, AO Multiplexer	Measured Value	Limits
+1 vdc System Test Valve Position Signal (vdc)	0 984	1 00 ±0.36
V1, Position at T+3 Seconds (deg)	4 343	1 92 to 6.00
V2, Position at T+5 Seconds (deg)	5.396	2.51 to 6.99
V3, Position at T+8 Seconds (deg)	5 987	2.81 to 6.99
V4, Position at T+20 Seconds (deg)	6.185	4.94 to 6.99
V5, Position at T+50 Seconds (deg)	6.315	4.94 to 6.99
50 Second Minus Valve Slew, AO Multiplexer		
Ratio Valve Position, AO (deg)	1.26	1.265 ±0 150
-1 vdc System Test Valve Error Signal (vdc)	1.005	-1.00 ±0.02
V1, Position at T+3 Seconds (deg)	-3.749	-1.92 to -6 00
V2, Position at T+5 Seconds (deg)	-4.867	-2.51 to -6.99
V3, Position at T+8 Seconds (deg)	-5.395	-2.81 to -6.99
V4, Position at T+20 Seconds (deg)	-5.255	-4 94 to -6 99
V5, Position at T+50 Seconds (deg)	-5.460	-4.94 to -6.99

4.1.21.1 (Continued)

PU Activation Test

Function	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.265	1.199	1.265 ±1.50
LOX 1/3 Command Relay On			
LOX Coarse Mass Voltage (vdc)	1.416	1.421	1.421 ±0 1
PU System On			
Ratio Valve Position (deg)	32.979	33.044	20.0 min
PU System Off			
Ratio Valve Position (deg)	1.594	1.660	15 0 max
LOX 1/3 Command Relay Off			
LOX Coarse Mass Voltage (vdc)	0.088	0.093	0.098 ±0.1
Ratio Valve Position (deg)	1.330	1 330	1 265 ±1.5
LH_2 1/3 Command Relay On			
LH_2 Coarse Mass Voltage (vdc)	1.553	1.548	1.548 ±0.1
PU System On			
Ratio Valve Position (deg)	-25.250	-25.315	-20 0 max
PU System Off			
Ratio Valve Position (deg)	1.53	1.59	-15 0 min
LH_2 1/3 Command Relay Off			
LH_2 Coarse Mass Voltage (vdc)	0.000	0 000	0 098 ±0 1
Ratio Valve Position (deg)	1.199	1 265	1.265 ±1.5
PU Valve Hardover Test			
Ratio Valve Position (deg)	-25.4	-	-20 max

4 1 22 Propulsion System Check (1B62753 C)

This automatic procedure performed the integrated electromechanical functional tests required to verify the operational capability of the stage propulsion system For convenience of performance, the test sequences were divided into three sections The first section checked the pump purge pressure switches for activation, deactivation, and proper control function, and also ensured the functional capability and valve operation of the pneumatic control system and the propellant tanks repressurization systems. The second section verified the operation of the propellant tanks pressurization systems The third section was a four part check of the J-2 engine spark ignition system, cutoff logic and delay timers, engine control helium bottle and valves, and engine operating sequence Initiated on 1 August 1967, the procedure was completed on 2 August 1967, with acceptance occurring on 4 August 1967. The sections of the procedure are presented in the order of occurrence and the test results are given in Test Data Table 4.1.22 1

Subsequent to establishing initial conditions, testing of the ambient helium system commenced by pressurizing the ambient helium pneumatic control sphere and repressurization spheres to 700 $\pm$ 50 psia, and setting the stage control helium regulator discharge pressure at 515 $\pm$ 50 psia A series of checks verified the proper operation of the control helium dump valve and the pneumatic power control module shutoff valve. After verification of proper operation of the LOX chilldown pump purge control and dump valves, the LOX chilldown pump purge pressure switch checkout was conducted

The LH_2 and LOX repressurization control module dump valves and control valves were verified to operate properly A series of checks verified proper functioning of the O_2H_2 burner spark system and propellant valves. The repressurization control and voter circuit interlock checks malfunctioned due to a test requirements drawing error omitting two required commands. Necessary entries were made to correct the program and the interlock checks were satisfactorily demonstrated A three-cycle test of the engine pump purge pressure switch preceded functional checkout of the engine pump purge valve The control helium regulator backup pressure switch and control helium shutoff valve were similarly tested

4 1 22 (Continued)

A series of checks verified the operation of the pneumatically controlled valves, including the LH_2 and LOX vent valves, fill and drain valves, prevalves, and chilldown shutoff valves, the LH_2 directional vent valve, the LH_2 continuous vent and relief override valve and orificed bypass valve, and the O_2H_2 burner propellant valves and LOX shutdown valve The LH_2 tank pressurization and continuous vent valve blowdown check completed the ambient helium system test

Section two, the propellant tanks pressurization systems test, was started with functional checks of the cold helium dump and shutoff valves The operation of the cold helium regulator backup pressure switch was verified by the three-cycle pressure switch test, as well as by verifying that the switch properly controlled the cold helium shutoff valve

The LOX and LH_2 repressurization control valves were verified to operate properly, and the operation of the LOX and LH_2 tank repressurization backup pressure switch interlocks was verified by the three-cycle test, and by demonstrating that the switches properly controlled the LOX and LH_2 repressurization control valves

The proper operation of the O_2H_2 burner spark ignition system was verified The LOX tank pressure switches, the cold helium shutoff valve, and the cold helium heat exchanger bypass valve were verified to operate properly Proper control of the LOX main fill valve, the LOX auxiliary tank pressurization valve, the LOX replenish valve, and the LOX repressurization valve by the pressure switch was demonstrated

The LH_2 repressurization and ground fill over-pressurization pressure switches were verified to operate properly Control of the LH_2 main fill valve, the LH_2 replenish valve, the LH_2 auxiliary tank pressure valve, the step pressure valve, and the repressurization control valve by the pressure switches was demonstrated After satisfactory completion of the LH_2 pressure switch checks, the cold helium system was pressurized to 885 psia, and the cold helium sphere blowdown and cold helium regulator low flows tests were conducted.

4 1 22 (Continued)

The cold helium spheres were vented and a series of checks verified proper operation of the O_2H_2 burner voting circuit and burner malfunction temperature sensors This completed testing of the propellant tanks pressurization systems

Section 3, the J-2 engine functional tests, was conducted next The LH_2 and LOX tanks were vented to ambient, and the O_2H_2 burner spark systems 1 and 2, the emergency detection systems 1 and 2 engine cutoffs, the repressurization control valves, and the O_2H_2 burner propellant valves were verified to operate properly.

The engine spark test verified proper operation of the thrust chamber augmented spark igniter (ASI) and gas generator spark systems. The engine start tank was pressurized, the proper operation of the start tank vent valve was verified, and the start tank was vented to ambient pressure prior to the engine cutoff test. The engine ready signal was verified to be on, and the simulated main stage OK signal opened the prevalves Verification of proper prevalve response to the switch selector engine cutoff signals was made with the prevalves closing to the cutoff signal and opening at signal removal The engine ignition cutoff test and the LH_2 injector temperature detector bypass test were satisfactorily conducted.

The next series of tests verified that the simulated aft separation signals 1 and 2 individually inhibited engine start, and demonstrated the proper operation of the LH_2 injector temperature detector bypass and start tank discharge control During these tests, measurements were made of the helium delay timer, the sparks de-energized timer, and the start tank discharge timer

Three-cycle tests of mainstage OK pressure switches 1 and 2 were conducted, and it was verified that the pickup of either switch turned off the engine thrust OK 1 and 2 indications, and that after a dry engine start sequence, pickup of either switch would maintain the engine in mainstage It was also demonstrated that dropout of both pressure switches was required to turn on engine thrust OK indications and cause engine cutoff

4 1 22 (Continued)

The engine helium control sphere was pressurized to 1402 13 psia to conduct the engine valve sequence tests which demonstrated that actuation and deactuation of the helium control solenoid valve caused the LH_2 and LOX bleed valves to close and open, that opening and closing the ignition phase control solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close, that the start tank discharge solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close, that the start tank discharge solenoid valve opened and closed, and that opening and closing the mainstage control solenoid valve caused the gas generator valve and main LOX valve to open and close, and the LOX turbine bypass valve to close and open

The final test was the combined automatic functional demonstration of the entire J-2 engine system. The necessary commands were given to initiate engine start and cutoff, and throughout the automatic sequence the engine system responses were verified to be within the predetermined limits

There were no parts shortages affecting this test, and no test discrepancies resulting in the initiation of FARR's.

There were thirty-six revisions written to this procedure for the following

a One revision deleted several items of test equipment, as the items were not required for this test.

b One revision provided instructions to readjust the forward bus 2 power supply voltage. The original setting was too low and caused a malfunction typeout

c. Two revisions changed the program to switch the aft bus 1 power supply from remote to local sense, so that the O_2H_2 burner spark noise would not cause the power supply to over-regulate

d. One revision provided for corrective action to clear a malfunction typeout caused by a miswired stage cable After correction of the miswiring, the affected sections of the test were repeated.

e One revision changed the program to set and post safety item monitor, channel 41, and set the aft 1 power supply back to remote sense This returned the program to the original configuration after the O_2H_2 burner spark test

4.1 22 (Continued)

f. One revision accepted and explained a malfunction typeout of the forward 5 volt excitation module The output was 10 mvdc out-of-tolerance from the expected 5.00 $\pm$0.03 vdc output The malfunction occurred because forward buses 1 and 2 were set to greater than 27.5 vdc.

g One revision changed SIM channel 41 to channel 19, to prevent the aft bus 1 power supply from over-regulating due to noise during the O_2H_2 burner spark test.

h One revision explained that a SIM interrupt on channel 19 occurred because the aft bus 1 power supply was not placed in the local sense mode.

i One revision reran the program to ensure that the proper settings had been made for SIM interrupt routines, SIM channels, and backups. A SIM interrupt was received on channel 24 because the aft bus 1 power supply was not on. A SIM interrupt on channel 19 had turned the power supply off, and the power supply had not been manually turned back on.

j. One revision reinitiated the program with the aft bus 1 power supply manually turned on

k Three revisions corrected program and test requirement drawing errors.

l One revision reinitiated the program with SIM channel 41 effective

m Two revisions added a 100 millisecond delay after turning on the EDS 2 engine cutoff, and provided rerun instructions for the EDS 2 burner spark test

n. Three revisions provided instructions for manually turning the secondary batteries on, and for turning the aft bus to internal.

o One revision stated that a malfunction typeout, "engine pump purge pressure switch no PU in 3 minutes", occurred because the checkout pressure supply hose was not connected to the aft umbilical, thus, no pressure could reach the pressure switch The proper connection was made and the test was rerun successfully

p One revision explained that the LH_2 auxiliary tank pressure valve not open indication occurred because the LH_2 auxiliary pressure panel switch was not in the AUTO ENABLE position The switch was placed in the AUTO ENABLE position and the function was rerun and verified

q One revision stated that the facility helium low supply pressure resulted in the malfunction statement "LH_2 tank not pressurized in 3 minutes" The supply pressure was brought up to 2000 psi, and the test was rerun satisfactorily

r One revision accepted the "control helium bottle supply, NO CLOSED indication" The valve was allowed a nominal closing time by the procedure and the valve was slow in closing, therefore, when the computer interrogated a closed talkback, it was not available The valve function was verified by panel light indications and a manual check

4 1 22 (Continued)

s One revision accounted for a "cold helium supply shutoff valve NOT OPEN indication" The stage 4 helium system was pressurized after the final control regulator backup pressure switch test. This pressure held the cold helium regulator backup pressure switch closed, thus maintained a closed command The stage 4 system was depressurized and the test was rerun and performed per program

t One revision stated that the heat exchanger supply valve was slow in closing, causing a NO CLOSED malfunction typeout. The operation of the valve was verified by panel light indications

u. One revision noted that the LH_2 vent valve had been left open after the section 2 checkouts, causing a typeout, "LH_2 vent NOT CLOSED" The valve was closed manually and the test was resumed

v One revision accounted for the malfunction typeout, "start bottle pressure not decreased in 30 seconds" The start tank vent valve pneumatic supply line was disconnected during the propulsion leak checks and was not reconnected for this checkout.

w One revision stated that the reason for the malfunction statement, "mainstage OK pressure switch 2 - no PU indication in 3 minutes", was a leak in the test pressure line The leak was fixed and the test was resumed without a malfunction

x. One revision explained that the O_2H_2 burner voting circuit confirmation printouts were not malfunction statements

y One revision explained that the malfunction statement, "LOX chilldown pump purge valve NO CLOSED indication", was due to the loss of the READY light on the line printer and not to a malfunction of the purge valve

z One revision accepted an out-of-tolerance condition for the STDV close delay time of 0 184 seconds Oscillograph data indicated an actual delay of 0.087 seconds, within the tolerance limits of 0 075 to 0.115 seconds

aa One revision stated that the STDV close travel time was out-of-tolerance at 0 114 seconds This condition was acceptable to Engineering, as oscillograph data indicated that the travel time was 0 251 seconds, within the tolerance limits of 0.210 to 0 290 seconds

ab One revision accepted the out-of-tolerance condition "main LOX valve did not lose open indication by 80 msec from ECO", based on oscillograph data which indicated the start of closing travel at 53 msec from ECO The computer looked at open talkback data on a T/M channel which was sampled every 83 milliseconds, thus creating a potential error

ac One revision explained that the SIM interrupts on channels 71 and 72 were created by opening the chilldown shutoff valve, which caused the prevalves to bounce off the open position and then return to the open position

ad One revision explained that the type and print statements, "LH_2 tank not vented to 18 0 psia in 6 minutes", was not a malfunction As the program was written for an estimated 6 minute vent to 18 0 psia, a loop was provided to return the test to the mainflow at 21 0 psia, with the expectation that 18 0 psia would be attained by the time the computer interrogation was made

4.1.22.1 Test Data Table, Propulsion System Test

Section 1, Ambient Helium Test

Pressure Switch Checks

Function	Measured Value Test 1	Test 2	Test 3	Limits
LOX Chilldown Pump Purge Pressure Switch				
Pickup Pressure (psia)	40.33	40.17	40.27	41.5 max
Dropout Pressure (psia)	38.76	38.81	38.71	37.5 min
Deadband (psi)	1.56	1.36	1.57	0.3 min
Repress System Interlocks				
LOX Repress Helium Sphere Press (psia)	663.72			
Burner Spark No. 1 On OK (vdc)	3.63			2.7 min
Burner Spark No. 2 On OK (vdc)	3.52			2.7 min
Engine Pump Purge Pressure Switch				
Pickup Pressure (psia)	113.71	112.92	115.30	136.0 max
Dropout Pressure (psia)	102.62	102.62	102.60	99.0 min
Deadband (psi)	11.09	10.30	12.68	3.0 min
Control Helium Regulator Backup Pressure Switch				
Pressurization Time (sec)	102.202	44.795	44.053	180.0 max
Pickup Pressure (psia)	606.00	602.05	601.27	600.0 ± 21.0
Depressurization Time (sec)	11.582	11.297	11.386	180.0 max
Dropout Pressure (psia)	495.59	494.80	495.59	490.0 ± 31.0

Pneumatically Controlled Valve Checks

	Measured Value	Limits
Control Helium Sphere Pressure (psia)	723.53	700 ± 50
Control Helium Reg Disch Press (psia)	528.36	515 ± 50

Operating Times (sec)

Valve	Open	Total Open	Close	Total Close	Boost Close	Total Boost
LH_2 Vent Valve	0.015	0.075	0.227	0.457	0.091	0.226
LOX Vent Valve	0.019	0.079	0.099	0.314	0.059	0.179
LOX Fill and Drain Valve	0.104	0.205	0.669	1.866	0.350	0.817
LH_2 Fill and Drain Valve	0.153	0.274	0.783	2.275	0.451	0.947
LOX Prevalve	1.928	2.603	0.281	0.423	-	-
LH_2 Prevalve	1.652	2.388	0.279	0.427	-	-
LOX C/D Shutoff Valve	1.196	0.975	0.025	0.128	-	-
LH_2 C/D Shutoff Valve	0.151	0.901	0.007	0.126	-	-

4.1.22.1 (Continued)

Valve	Open	Total Open	Close	Total Close	Boost Close	Total Boost
	Operating Times (sec)					
LH_2 Cont. Vent Orifice Bypass Valve	0.007	0.040	0.007	0.066	-	-
Burner LH_2 Propellant Valve	0.042	0.116	0.071	0.229	-	-
Burner LOX Propellant Valve	0.028	0.107	0.022	0.103	-	-
Burner LOX Shutdown Valve	0.007	0.081	0.008	0.142	-	-

	Flight Pos.	Total Flight Pos.	Gnd Pos.	Total Gnd Pos.
LH_2 Directional Vent Valve	0.080	0.198	0.814	1.331

Section 2, Pressurization System Check

Pressure Switch Checks

Function	Test 1	Test 2	Test 3	Limits
	Measured Value			
Cold Helium Regulator Backup Pressure Switch				
Pressurization Time (sec)	43.098	27.385	26.675	180.0 max
Pickup Pressure (psia)	464.82	465.61	464.03	467.5 ± 23.5
Depressurization Time (sec)	15.444	15.252	15.307	180.0 max
Dropout Pressure (psia)	374.00	372.41	373.21	362.5 ± 33.5
LOX Tank Repressurization Backup Pressure Switch				
Pressurization Time (sec)	27.125	54.551	54.067	180.0 max
Pickup Pressure (psia)	466.40	466.40	464.82	467.5 ± 23.5
Depressurization Time (sec)	16.153	16.135	16.112	180.0 max
Dropout Pressure (psia)	370.84	370.84	371.63	362.5 ± 33.5
LH_2 Tank Repressurization Backup Pressure Switch				
Pressurization Time (sec)	16.937	54.512	53.996	180.0 max
Pickup Pressure (psia)	464.82	463.23	463.23	467.5 ± 23.5
Depressurization Time (sec)	16.933	17.021	17.003	180.0 max
Dropout Pressure (psia)	367.68	366.10	365.31	362.5 ± 33.5
LOX Tank Ground Fill Pressure Switch				
Manifold Press Time (sec)	28.422	23.711	14.189	180.0 max
Pickup Pressure (psia)	40.27	40.17	40.22	41.0 max
Manifold Depress Time (sec)	4.272	3.731	3.636	180.0 max
Dropout Pressure (psia)	38.71	38.61	38.61	37.5 min
Deadband (psi)	1.57	1.57	1.62	0.5 min

4.1.22.1 (Continued)

Function	Test 1	Test 2	Test 3	Limits
LH_2 Flight Control and Ground Fill Pressure Switches				
Manifold Press Time (sec)	145.284	108.936	96.707	180.0 max
Manifold Depress Time (sec)	175.592	170.149	168.859	180.0 max
Flight Control Pickup (psia)	30.44	30.33	30.18	31.5 max
Flight Control Dropout (psia)	28.03	27.93	27.88	27.8 min
Flight Control Deadband (psi)	2.41	2.41	2.30	0.5 min
Ground Fill Pickup (psia)	33.79	33.68	33.58	34.0 max
Ground Fill Dropout (psia)	31.59	31.64	31.69	30.8 min
Ground Fill Deadband (psi)	3.20	2.04	1.88	0.5 min

Pressure Switch Checks

Function	Measured Value	Limits (sec)
Burner Spark System Checks		
Exciter No. 1 Off (Umb) (vdc)	1.55	2.0 max
Exciter No. 2 Off (Umb) (vdc)	1.44	2.0 max
Exciter No. 1 On OK (Umb) (vdc)	3.59	2.7 min
Exciter No. 2 On OK (Umb) (vdc)	3.55	2.7 min
Exciter No 1 Ind On (T/M M0074) (vdc)	3.32	2.7 min
Exciter No 2 Ind On (T/M M0073) (vdc)	3.30	2.7 min
Exciter No 1 Ind Off (T/M M0074) (vdc)	0.10	0.0 ± 0.2
Exciter No 2 Ind Off (T/M M0073) (vdc)	0.09	0.0 ± 0.2

Section 3, J-2 Engine Checks

Engine Timer Checks

Function	Delay Time (sec)	Limits (sec)
Engine Ignition Timer	0.432	0.450 ± 0.030
Helium Delay Timer	0.995	1.000 ± 0.110
Sparks De-Energized Time	3.295	3.300 ± 0.200
Start Tank Discharge Timer	0.999	1.000 ± 0.040

Pressure Switch Checks

Function	Measured Value Test 1	Test 2	Test 3	Limits
Mainstage OK Pressure Switch 1				
Pickup Pressure (psia)	499.22	488.76	488.76	515.0 ± 36.0
Dropout Pressure (psia)	420.89	422.45	421.66	PU-62.5±43.5
Deadband Pressure (psi)	73.33	66.30	67.09	*

*Limits Not Specified

4.1.22.1 (Continued)

Function	Measured Value Test 1	Test 2	Test 3	Limits
Mainstage OK Pressure Switch 2				
Pickup Pressure (psia)	515.31	509.02	508.21	515.0 ± 36.0
Dropout Pressure (psia)	440.34	441.13	439.55	PU-62.5±43.5
Deadband Pressure (psi)	74.97	67.88	68.66	*

Engine Sequence Check

Function	Start Time (sec)	Oper. Time (sec)	Total Time (sec)
Engine Start			
Ignition Phase Solenoid Command Talkback	-	0.006	-
Control Helium Solenoid Command Talkback	-	0.012	-
ASI LOX Valve Open	-	0.043	-
Main LH_2 Valve Open	0.078	0.063	0.142
LOX Bleed Valve Closed	-	0.057	-
LH_2 Bleed Valve Closed	-	0.064	-
Start Tank Discharge Timer	-	0.998	-
Start Tank Discharge Valve Open	0.106	0.120	0.227
Mainstage Control Solenoid Energize	-	1.453	-
Ignition Phase Timer	-	0.455	-
Start Tank Discharge Control Solenoid Off	-	0.006	-
Gas Generator Valve LOX Poppet Open	**	0.128	0 207
Start Tank Discharge Valve Closed	0.087	0.251	0 298
LOX Turbine Bypass Valve Closed	0.278	0.167	0 445
Main LOX Valve 2nd Stage Open	0.451	1.650	2 102
Spark System Off Timer	-	3.302	-
Engine Cutoff			
Ignition Phase Control Solenoid Off	-	0.007	-
Mainstage Control Solenoid Off	-	0.017	-
ASI LOX Valve Closed	0.039	-	-
Main LOX Valve Closed	0.053	0.111	0.164
Main LH_2 Valve Closed	0.132	0.136	0.268
Gas Generator Valve Closed	0.141	0.094	0.234
LOX Turbine Bypass Valve Open	0.322	0.585	0.907
Helium Control Solenoid De-energize Timer	-	1.010	-
LOX Bleed Valve Open	4.966	-	-
LH_2 Bleed Valve Open	4.866	-	-

* Limits Not Specified

** No Value Given

4.1.23 Digital Data Acquisition System (1B55817 E)

The digital data acquisition system (DDAS) test verified the operation of all data channels on the stage, except certain data channels that were tested during specific system tests The GSE D924A computer verified that the output of each channel tested was within the required tolerances. Proper operation was verified for the DDAS signal conditioning equipment and associated amplifiers, the remote automatic calibration system (RACS) and the associated command calibration channel decoder assemblies, and the telemetry transmitter and antenna system. The specific items involved in this test were

Part Name	Ref. Location	P/N	S/N
PCM/DDAS Assembly	411A97A200	1A74049-511	014
CP1-BO Time Division Multiplexer	404A61A200	1B62513-547	019
DP1-BO Time Division Multiplexer	404A61A201	1B62513-543	026
Remote Digital Submultiplexer (RDSM)	404A60A200	1B52894-1	09
Remote Analog Submultiplexer (RASM)	404A60A201	1B54062-503	021
PCM RF Assembly	411A64A200	1B52721-521	036

This automatic procedure was accomplished by the first attempt on 2 August 1967, and was accepted on 4 August 1967. All channels were checked at ambient conditions, and those channels having a calibration capability were also checked under a RACS high or low mode calibration command. Ambient conditions were defined as 70°F at 14 7 psia, or, for bi-level parameters, the normal state of valves or switches during the performance of this test. All channel outputs were measured and printed out.

The PCM RF test was conducted first The forward and reflected RF output powers of the PCM/DDAS assembly were measured through the CP1-BO and the DP1-BO multiplexer telemetry outputs, and the voltage standing wave ratios (VSWR's) were determined. The same measurements were also made through the ground monitor outputs for both multiplexers. The CP1-BO multiplexer telemetry readings were forward power, 27.601 watts, reflected power, 0.537 watts, VSWR, 1.323 The DP1-BO multiplexer telemetry readings were forward power, 27.214 watts; reflected power, 0.750 watts, VSWR, 1 397 The CP1-BO multiplexer ground monitor readings were forward power, 25.697 watts, reflected power, 0.349 watts, VSWR, 1.264. The DP1-BO multiplexer ground monitor readings were forward power, 25 786 watts, reflected power, 0 353 watts, VSWR, 1.265.

4.1.23 (Continued)

All measurements were within the acceptable tolerances High and low RACS tests were then conducted for the aft 5 volt excitation module voltage, while both the ground monitor and telemetry outputs were measured. High and low RACS for both telemetry and ground monitor outputs were 4.010 vdc and 0.010 vdc, respectively, within the expected tolerances.

The CP1-BO multiplexer was tested next, except for special channels. This test made measurements of high and low RACS voltages of each channel having calibration capability, and measurements of the ambient outputs in units of temperature, pressure, voltage, current, frequency, event indication, liquid level indication, and position indication, as applicable for the various channels. Output values for each of the CP1-BO multiplexer channels tested were within the required limits

The DP1-BO multiplexer was then tested, except for special channels, in the same manner as described for the CP1-BO multiplexer, with no malfunctions. All channel outputs were within tolerance

Special channel tests were conducted next. These special channels measured 400 Hz, 100 Hz, and 1500 Hz signals. The 400 Hz test checked the static inverter-converter frequency, the LOX and LH_2 chilldown inverter frequencies, and the LOX and LH_2 circulation pump flow rates. The LOX and LH_2 flowmeter tests at 100 Hz followed the 400 Hz test, and the LOX and LH_2 pump speeds were checked using the 1500 Hz signal. All of these special channels were within the required tolerance of the expected values.

An APS multiplexer test was then run to check the special channels on both multiplexers that measured the APS functions. Measurements were made of the high and low RACS voltages for each of the APS channels having calibration capabilities, and the ambient outputs were measured in degrees Fahrenheit or psia, as appropriate for the channel tested. All special channels were within the required tolerances.

4.1 23 (Continued)

The common bulkhead pressure and the LOX and LH_2 ullage pressures were verified to be within tolerances.

One interim use material (IUM) item was installed at the time of this test This was pressure transducer, P/N 1A72913-539, S/N 39-26, at reference location 410MT601. This IUM part was replaced by flight hardware after the static acceptance firing, when a pressure transducer, P/N 1B42042-509, was installed and tested by assembly outline 1A81848-503-A45-4J.

Measurement C387 (channel DP1-BO-10-09) malfunctioned during this test. FARR A255374 rejected the defective transducer, P/N 1A68589-509, S/N E849, and a new transducer, S/N 0238, was installed on 4 August 1967. This replacement transducer was tested during the integrated system test (IST), H&CO 1B55831.

There were twenty revisions made to this procedure for the following

a. One revision changed the -296 cable connection from stage connector 411A95A207J1 to 411A201J1. The original stage connector specified was in error

b. One revision changed the setting for the Boonton counter vernier control from 00850 ±0.5 to 08500 ±5 The first setting callout was in error.

c. One revision reworded a step to read, "Place XTAL-OFF-VFO control to VFO position", to correct a procedure misstatement which specified the XTAL position

d One revision added, "Place source selector switch to position 1", after the PCM RF test The switch was manually placed in position 1 to prevent the DDAS ground station from randomly dropping out of synchronization.

e. One revision added a change to the computer program to correct an error.

f One revision explained and accepted a channel malfunction printout for CP1-BO-09-04N04 and CP1-BO-09-04N05 These measurements were for the oxidizer turbine bypass valve (OTBV) open and closed This test was accomplished while three test plates were installed in the valve, preventing the microswitch talkbacks from operating properly The talkback indications were verified in the propulsion automatic procedure, H&CO 1B62752.

4.1.23 (Continued)

g. One revision explained a malfunction printout for channel CP1-BO-10. This Rocketdyne transducer oscillated on high-calibration, and was rejected and replaced during the post-fire checkout

h. One revision accounted for the malfunctions on channels CP1-BO-13-03 and DP1-BO-13-03. The high and low calibration and ambient test values were shown as malfunctions because the GN_2 start bottle was pressurized to 510 psig when this test was accomplished The high and low calibration and ambient values were subsequently verified to be within the specified tolerance

i. One revision stated that the malfunction on channel DP1-BO-05-04 occurred because the heat flux explosive nozzle -2 was not installed for this test. (This measurement was verified during the postfire DDAS checkout)

j. One revision established a test to verify the operation of channels DP1-BO-10-09 and DP1-BO-16-06, which had malfunctioned during the original test. A thermocouple meter was placed as close as possible to the transducer, and the ambient test value was verified. Measurement C394 (channel DP1-BO-16-06) was verified to be within the procedure tolerance of 90 ±12°F Measurement C387, P/N 1B68589-509, S/N E849, failed and was rejected on FARR A255374

k. One revision concerned a malfunction on channel DP1-BO-19-01 The transducer was incorrectly wired when this test was run The wiring was corrected per AO 1B49398 "AF" and the transducer was verified to operate properly

l One revision added ambient values to the program for the R/NAA transducers.

m One revision added measurement C016, the oxidizer tank helium inlet temperature, to the program on channel DP1-BO-19-03. This measurement was erroneously omitted from the program

n One revision changed the RACS values for the simulated battery temperature measurements from 3 5 ±0 5 vdc to 3 0 ±0 5 vdc The original values were in error

o One revision corrected the RACS tabulation number 45, in order to receive a high and low RACS value instead of high RACS only, to correct a program error.

p. One revision corrected a program error by changing a bit pattern

4.1 23 (Continued)

q One revision removed the requirements for measurement K95, the thrust chamber LH_2 injector temperature This parameter was deleted from the original program

r One revision deleted the requirement for the LH_2 ullage pressure transducer supply command to be set or reset. The command test was not required for this program.

s. One revision changed the procedure to enable the program to compute the common bulkhead ambient pressure value instead of the function number

t. One revision noted that channels CP1-BO-14-05 and DP1-BO-14-05, for measurement D088, malfunctioned during an engineering run of the integrated systems test, H&CO 1B55831 The transducer for this measurement was rejected by FARR A255375, written during the integrated system test

4 1.24 Integrated System Test (1B55831 D)

This automatic checkout verified the design integrity and operational capability of the S-IVB stage and facility systems which were functional during propellant loading and static acceptance firing

The automatic and manual test sequences performed during this checkout, initiated on 4 August 1967, consisted of the following sections

Stage power setup established a known condition by a matrix reset, and systematically applied power to those stage buses and systems required for the operation of the test This section was satisfactorily completed with two error messages and a channel 6 lockout, which were attributed to an improperly reset PAM ground station receiver register The register was reset and the test proceeded without interruption.

The GSE valve functional checkout established an ambient condition in the pneumatic console by bleeding down all regulators and resetting them to predetermined values. All console and sled valves used in propellant loading and static acceptance firing were cycled, and the heat exchanger was functioned There was one malfunction, indicating that the LOX umbilical purge supply did not open, however, this was attributed to a test requirements drawing error, since this valve was no longer used in the countdown and was capped. All portions of this section were satisfactorily completed and the checkout was resumed.

4.1.24 (Continued)

The DDAS section of the test was accomplished next, with the PCM transmitter operated open loop The telemetry 5 step calibration, high and low RACS, and special calibrations of flows, speed, and frequencies were commanded to provide verification of all calibration techniques The parameters on the CP1-BO and DP1-BO multiplexers and remote analog and digital submultiplexers, which were required for loading or firing, were verified by receipt of proper response through open loop PCM transmissions At the conclusion of DDAS, the output was again received by the 600 Hz VCO. There were eleven channel malfunctions associated with this section. Three were attributed to program errors, and eight were attributed to the pressure transducers for parameters D014, D088, D103, and D236. During the CP1-BO section of the test, twenty functions were verified to be on while thirty-eight were off. The DP1-BO section indicated that thirteen functions were on while seven were off.

The torch and water test was performed satisfactorily Following setup of the console GH_2 supply, the GH_2 igniters, the diffuser water, the deflection plate water, and the aspirator water were functioned in acceptance test sequence. This series of events verified that proper water pressures and torch ignition signals were received

The stage valves and O_2H_2 burner functional checkouts were performed next The LH_2 and LOX vent valves and fill and drain valves were opened and closed while the valve operating times were measured, and then were opened and boosted closed with the boost close times measured. The LOX and LH_2 prevalves and chilldown shutoff valves were closed and opened, while the operating times were measured. The LH_2 directional vent valve was set to the flight and ground positions while the operating times were measured. A simulated O_2H_2 burner firing sequence was conducted in the flight sequence, and two malfunctions were recorded. One malfunction indicated that the LOX shutdown valve did not open Investigation revealed that the valve was defective and required replacement. The other malfunction resulted because the cold helium shutoff valve did not open, due to the special test fixture installed on the LOX pressurization line for propellant automatic and leak check procedures

4.1.24 (Continued)

The auxiliary hydraulic system was operated while proper pressures and levels were verified prior to restrainer link disengagement The J-2 engine received a step gimbal signal, as well as 1/4 and 1/2 degree sinusoidal inputs at 0.6, 5, and 7 Hz. The checkout proceeded without interruption.

A final dry sequence of the J-2 engine, through the use of simulation commands for ASI ignition and mainstage, was conducted to verify the proper engine operation as well as the ESCS spark monitoring circuitry The second and third J-2 engine sequences were required because of a test plate that was installed on the engine for leak checks, and an improper setup of the Beckman DDAS system This section was satisfactorily completed

The ullage rocket ignition and jettison EBW firing units were functionally certified by charging the units and firing them into pulse sensors

The overfill point level sensors and depletion point level sensors were proven to operate satisfactorily by cycling the sled main fill and replenish valves, with 2-out-of-3 depletion sensors verifying that the cutoff logic was operational. In addition, the individual ability to create a cutoff was proven for the engine lockout component test power and the engine lockout GSE power - EDS1 - EDS2 systems.

A check of the inverter-converter outputs was followed by cycling the PU mass bridge while creating positive and negative error signals for verification of the engine PU valve position. There were two operator errors and two program errors encountered during this section. These were subsequently corrected and a rerun of this section was satisfactorily completed.

The stage bus internal power was set up by the use of secondary battery power The forward internal/external cycle was completed while switching normal telemetry current on forward bus 1, and PU current on forward bus 2. Following the APS and range safety functional check, aft bus 1 was cycled internal/external while the stage ambient and APS currents were measured. The LOX and LH_2 chilldown inverters were operated for current and frequency tests, and then switched internal/external on aft bus 2

4 1 24 (Continued)

Engineering status review indicated that one nonflight transducer, P/N 1A72913-539, S/N 39-26, was installed on the stage during the integrated system test This transducer was for measurement D576, the LH_2 tank pressure

There were three FARR's generated, as a result of this checkout, for the following

a. FARR A255310 noted that the measurement D014 pressure transducer, P/N 1A72913-557, S/N 343-1, indicated an out-of-tolerance pressure at 31 psia The actual pressure was 14 7 psia. This condition was accepted by Engineering

b. FARR A255375 noted that the measurement D088 pressure transducer, P/N 1B39293-1, S/N 36, indicated an out-of-tolerance high calibration at 3.896 vdc. For the ambient condition of 16.826 psia, the calibration should have indicated 4.00 $\pm$0 1 vdc The defective transducer, S/N 36, was removed, and a new transducer, S/N 20, was installed.

c FARR A255402 noted that the LOX burner shutdown valve, P/N 1B66639-503, S/N 04, indicated an open talkback The defective valve, S/N 04, was removed and a new unit, S/N 022, was installed

There were forty-four revisions made to the procedure

a Fourteen revisions concerned correction of procedure, test requirements drawing, and program errors

b. One revision explained a temporary inability to perform the executive setup routine

c One revision, during setup, placed the DDAS ground station initially in manual mode for closed loop operation, to simplify the procedure It was later switched to automatic for open loop operation, and was automatically controlled

d One revision deleted setup operations for the LN_2 vaporizer, which was required only for IST runs performed in conjunction with static firing, as this run was for prefire checkout.

e One revision added RACS values to the program, based on calibration data for the J-2 engine pressure transducers

f One revision added a new requirement to the program to prevent pulling contaminants out of the ejector system into the O_2H_2 burner

g One revision explained that SIM interrupts received during the matrix reset resulted from the talkback power turnoff, which gave an indication of prevalve closure

h One revision concerned the two error messages and the channel 6 lockout received during power setup These were attributed to an improper initial reset of the PAM ground station receiving register The register was reset prior to resuming

4.1.24 (Continued)

i. One revision explained that the malfunction indication for the LOX umbilical purge supply valve failure to open, occurred because the valve was capped off It is no longer used in the countdown, but has not yet been deleted from the test requirements drawing

j. One revision explained that a malfunction indication of low console helium supply pressure was caused by low facility helium supply pressure The facility supply pressure was corrected by connecting another helium trailer

k. Four revisions concerned channel malfunctions received due to out-of-tolerance measurements recorded during DDAS automatic checkout Measurement numbers D014, D013, and D236 were out-of-tolerance because the system was pressurized during this portion of the test, and the procedure was written for ambient pressure values. These measurement values had been verified to be within acceptable tolerances during the DDAS automatic checkout A rerun at ambient pressure resulted in the rejection of D014 for exceeding the ambient pressure tolerance, reference FARR A255310. Channel malfunctions against measurement number D088 were attributed to transducer malfunction, reference FARR A255375. Channel malfunctions for measurements number M28, M29, and M60, were attributed to program errors.

l. Three revisions explained malfunction indications during the stage valve functional checkout The LOX shutdown valve failed to transmit open talkback, reference FARR A255402. An indication of failure to open by the cold helium shutoff valve was caused by a special test fixture installed on the LOX pressurization line for leak checks ,which had not been completed. A malfunction, indicating that the ambient helium dump valve had failed to open, was in reality a program error, because the program had allowed insufficient time for venting the ambient helium pressure below the 160 psia level.

m. Two revisions listed OLSTOL program changes to prevent SIM interrupts expected to result from O_2H_2 burner spark noise, and listed OLSTOL inputs to void these changes after completion of the O_2H_2 burner test, in order to resume the program

n. Seven revisions were concerned with the need for the second and third J-2 engine sequence runs. Included were backups to restart the J-2 engine sequence runs, an explanation of SIM cutoffs resulting from operator errors, and an explanation of operator errors resulting in malfunction indications due to running the program out of sequence.

o. Five revisions were initiated due to malfunction indications during the propellant utilization system checkout. These explained out-of-tolerance PU valve indications that resulted from improper entry of PU system constants into the program, corrected the PU system constants entry, and initiated backups to rerun this checkout.

4.1.24.1 Test Data Table, Integrated System Test

CP1-BO Multiplexer Ambient Measurements and High and Low RACS Voltages

Meas No	Function	Measurement	Limits
D043	Amb Output (psia)	2351.000	2350.000 ± 125.000
M025	Hi RACS Test (vdc)	3.999	4.000 ± 0.050
M025	Lo RACS Test (vdc)	0.005	0.000 ± 0.050
M025	Amb Output (vdc)	4.997	5.000 ± 0.030
D236	Hi RACS Test (vdc)	4.046	4.000 ± 0.100
D236	Lo RACS Test (vdc)	1.030	1.000 ± 0.100
D236	Amb Output (psia)	151.438 †	14.700 ± 70.000
D225	Hi RACS Test (vdc)	3.994	4.000 ± 0.100
D225	Lo RACS Test (vdc)	1.025	1.000 ± 0.100
D225	Amb Output (psia)	18.957	14.700 ± 10.000
D016	Hi RACS Test (vdc)	4.056	4.000 ± 0.100
D016	Lo RACS Test (vdc)	1.082	1.000 ± 0.100
D016	Amb Output (psia)	83.055	14.700 ± 70.000
D019	Hi RACS Test (vdc)	4.010	4.015 ± 0.100
D019	Lo RACS Test (vdc)	1.010	1.015 ± 0.100
D019	Amb Output (psia)	11.163	14.700 ± 70.000
D018	Hi RACS Test (vdc)	4.163	4.180 ± 0.100
D018	Lo RACS Test (vdc)	1.169	1.174 ± 0.100
D018	Amb Output (psia)	11.530	14.700 ± 15.000
M024	Hi RACS Test (vdc)	4.015	4.000 ± 0.050
M024	Lo RACS Test (vdc)	0.005	0.000 ± 0.050
M024	Amb Output (vdc)	4.992	5.000 ± 0.030
M068	Hi RACS Test (vdc)	4.010	4.000 ± 0.050
M068	Lo RACS Test (vdc)	0.005	0.000 ± 0.050
M068	Amb Output (vdc)	4.990	5.000 ± 0.030
D017	Hi RACS Test (vdc)	4.035	4.015 ± 0.100
D017	Lo RACS Test (vdc)	1.035	1.020 ± 0.100
D017	Amb Output (psia)	12.308	14.700 ± 30.000
G001	Amb Output (deg)	-0.520	-0.300 ± 0.400
G002	Amb Output (deg)	0.457	0.300 ± 0.400
M028	Lo RACS Test (vdc)	-0.123 †	2.500 ± 0.075
M028	Amb Output (Hz)	389.508	390.000 ± 1.000
D020	Hi RACS Test (vdc)	4.005	4.000 ± 0.100
D020	Lo RACS Test (vdc)	1.040	1.000 ± 0.100
D020	Amb Output (psia)	9.348	14.700 ± 70.000
D177	Amb Output (psia)	14.402	14.700 ± 1.000
D178	Amb Output (psia)	14.238	14.700 ± 1.000
M029	Hi RACS Test (vdc)	-0.123 †	2.500 ± 0.075
M029	Amb Output (Hz)	389.508	390.000 ± 1.000
D088	Hi RACS Test (vdc)	3.851 †	4.000 ± 0.100
D088	Lo RACS Test (vdc)	0.882 †	1.000 ± 0.100

† See revision k.

4.1.24.1 (Continued)

Meas No	Function	Measurement	Limits
D088	Amb Output (psia)	-28.045	14.700 ∓ 70.000
D179	Amb Output (psia)	14.282	14.700 ∓ 1.000
D180	Amb Output (psia)	14.479	14.700 ∓ 1.000
L007	Amb Output (%)	47.490	50.000 ∓ 10.000

DP1-BO Multiplexer Ambient Measurements and High and Low RACS Voltages.

D236	Hi RACS Test (vdc)	4.046	4.000 ∓ 0.100
D236	Lo RACS Test (vdc)	1.030	1.000 ∓ 0.100
D236	Amb Output (psia)	147.699 †	14.700 ∓ 70.000
D043	Amb Output (psia)	2353.750	2350.000 ∓ 120.000
C138	Hi RACS Test (vdc)	3.979	4.000 ∓ 0.075
C138	Lo RACS Test (vdc)	-0.010	0.000 ∓ 0.075
C138	Amb Output (°F)	68.225	65.000 ∓ 16.000
M025	Amb Output (vdc)	5.005	5.000 ∓ 0.030
D209	Amb Output (psia)	14.402	14.700 ∓ 1.200
D230	Hi RACS Test (vdc)	4.020	4.000 ∓ 0.075
D230	Lo RACS Test (vdc)	1.030	1.000 ∓ 0.075
D230	Amb Output (psia)	14.721	14.700 ∓ 1.000
C383	Hi RACS Test (vdc)	3.999	4.000 ∓ 0.075
C383	Lo RACS Test (vdc)	0.005	0.000 ∓ 0.075
C383	Amb Output (°F)	75.377	65.000 ∓ 32.000
D229	Hi RACS Test (vdc)	3.948	4.000 ∓ 0.075
D229	Lo RACS Test (vdc)	1.051	1.000 ∓ 0.075
D229	Amb Output (psia)	14.758	14.700 ∓ 1.000
C377	Hi RACS Test (vdc)	3.994	4.000 ∓ 0.075
C377	Lo RACS Test (vdc)	0.000	0.000 ∓ 0.075
C377	Amb Output (°F)	71.727	65.000 ∓ 32.000
M074	Amb Output (vdc)	0.000	0.000 ∓ 0.075
M073	Amb Output (vdc)	-0.005	0.000 ∓ 0.075
D016	Hi RACS Test (vdc)	4.056	4.000 ∓ 0.100
D016	Lo RACS Test (vdc)	1.076	1.000 ∓ 0.100
D016	Amb Output (psia)	79.236	14.700 ∓ 70.000
D014	Amb Output (psia)	120.563 †	14.700 ∓ 13.000
D019	Hi RACS Test (vdc)	4.010	4.015 ∓ 0.100
D019	Lo RACS Test (vdc)	1.010	1.015 ∓ 0.100
D019	Amb Output (psia)	11.163	14.700 ∓ 70.000
M006	Amb Output (vdc)	26.707	28.000 ∓ 2.000
M007	Amb Output (vdc)	0.030	0.000 ∓ 1.000
D050	Amb Output (psia)	15.057	14.700 ∓ 3.000
D018	Hi RACS Test (vdc)	4.163	4.180 ∓ 0.100
D018	Lo RACS Test (vdc)	1.169	1.174 ∓ 0.100
D018	Amb Output (psia)	13.071	14.700 ∓ 15.000
M024	Hi RACS Test (vdc)	4.015	4.000 ∓ 0.050

† See revision k.

4.1.24.1 (Continued)

Meas No	Function	Measurement	Limits
M024	Lo RACS Test (vdc)	0.010	0.000 + 0.050
M024	Amb Output (vdc)	4.993	5.000 ∓ 0.030
M068	Hi RACS Test (vdc)	4.005	4.000 ∓ 0.050
M068	Lo RACS Test (vdc)	0.000	0.000 ∓ 0.050
M068	Amb Output (vdc)	4.989	5.000 ∓ 0.030
D017	Hi RACS Test (vdc)	4.040	4.015 ∓ 0.100
D017	Lo RACS Test (vdc)	1.046	1.020 ∓ 0.100
D017	Amb Output (psia)	21.308	14.700 ∓ 30.000
C006	Hi RACS Test (vdc)	4.010	4.000 ∓ 0.075
C006	Lo RACS Test (vdc)	-0.041	0.000 ∓ 0.075
C006	Amb Output (°F)	72.523	65.000 ∓ 18.000
D103	Amb Output (psia)	30.932	14.700 ∓ 30 000
G001	Amb Output (deg)	-0.535	-0.300 ∓ 0.400
G002	Amb Output (deg)	0.473	0.300 ∓ 0.400
M010	Hi RACS Test (vdc)	3.989	4.000 ∓ 0.060
M010	Lo RACS Test (vdc)	1.010	1.000 ∓ 0.060
M010	Amb Output (vdc)	0.445	0.000 ∓ 1.000
D020	Hi RACS Test (vdc)	3.994	4.000 ∓ 0.100
D020	Lo RACS Test (vdc)	1.030	1.000 ∓ 0.100
D020	Amb Output (psia)	16.824	14.700 ∓ 70.000
D054	Hi RACS Test (vdc)	4.035	4.000 ∓ 0.100
D054	Lo RACS Test (vdc)	1.046	1.000 ∓ 0.100
D054	Amb Output (psia)	15.438	14.700 ∓ 2.000
C231	Hi RACS Test (vdc)	3.969	4.000 ∓ 0.075
C231	Lo RACS Test (vdc)	-0.021	0.000 ∓ 0.075
C231	Amb Output (°F)	-155.555	-155.000 ∓ 8.000
C001	Hi RACS Test (vdc)	3.984	4.000 ∓ 0.075
C001	Lo RACS Test (vdc)	-0.021	0.000 ∓ 0.075
C001	Amb Output (°F)	73.444	65.000 ∓ 72.000
D177	Amb Output (psia)	14.402	14.700 ∓ 1.000
D178	Amb Output (psia)	14.418	14.700 ∓ 1.000
D105	Hi RACS Test (vdc)	3 958	4.000 ∓ 0.100
D105	Lo RACS Test (vdc)	0.994	1.000 ∓ 0.100
D105	Amb Output (psia)	18.957	14.700 ∓ 10.000
C230	Hi RACS Test (vdc)	3.979	4.000 ∓ 0.075
C230	Lo RACS Test (vdc)	-0.010	0.000 ∓ 0.075
C230	Amb Output (°F)	-378.438	-379.000 ∓ 4.000
D088	Hi RACS Test (vdc)	3.882 †	4.000 ∓ 0.100
D088	Lo RACS Test (vdc)	0.887 †	1.000 ∓ 0.100
D088	Amb Output (psia)	-24.306	14.700 ∓ 70.000
C002	Hi RACS Test (vdc)	3.999	4.000 ∓ 0.075
C002	Lo RACS Test (vdc)	-0.021	0.000 ∓ 0.075
C002	Amb Output (°F)	63.798	65.000 ∓ 48.000
D179	Amb Output (psia)	14.282	14.700 ∓ 1.000

† See revision k

4.1.24.1 (Continued)

Meas No	Function	Measurement	Limits
D180	Amb Output (psia)	14.479	14.700 + 1.000
M026	Amb Output (vac)	0.000	0.000 ∓ 1.500
M027	Amb Output (vac)	0.000	0.000 ∓ 1.500
M041	Amb Output (vac)	-0.066	0.000 ∓ 1.500
M040	Amb Output (vac)	-0.066	0.000 ∓ 1.500
M060	Hi RACS Test (vdc)	4.056	4.000 ∓ 0.100
M060	Lo RACS Test (vdc)	1.015	1.000 ∓ 0.100
M060	Amb Output (vac)	1.395 †	2.500 ∓ 1.000
M061	Hi RACS Test (vdc)	3.974	4.000 ∓ 0.100
M061	Lo RACS Test (vdc)	0.999	1.000 ∓ 0.100
M061	Amb Output (vdc)	-0.554	0.000 ∓ 1.000
L007	Amb Output (%)	47.490	50.000 ∓ 10.000
C199	Hi RACS Test (vdc)	4.051	4.000 ∓ 0.075
C199	Lo RACS Test (vdc)	0.010	0.000 ∓ 0.075
C199	Amb Output (°F)	71.172	65.000 ∓ 21.000

Valve Functional Checks

Function	Measurement	Limits
LH_2 & LOX Prevalves		
Close Time (sec)	0.626	4.000 max
Open Time (sec)	2.346	4 000 max
LH_2 Vent Valve		
Open Time (sec)	0.138	4.000 max
Close Time (sec)	0 426	4.000 max
LOX Vent Valve		
Open Time (sec)	0.132	4.000 max
Close Time (sec)	0 314	4.000 max
LH_2 & LOX C/D SOV		
Close Time (sec)	0.188	4 000 max
Open Time (sec)	0.925	4 000 max
LH_2 Vent Valve		
Open Time (sec)	0.095	4.000 max
Close Time (sec)	0.404	4.000 max
Open Time (sec)	0 101	4.000 max
Close Time (sec)	0 230	4.000 max
LOX Vent Valve		
Open Time (sec)	0.090	4.000 max
Close Time (sec)	0.291	4.000 max
Open Time (sec)	0.097	4.000 max
Close Time (sec)	0.192	4.000 max

†See revision k.

4.1.24.1 (Continued)

Function	Measurement	Limits
LH_2 Fill & Drain Valve		
Open Time (sec)	0.248	4.000 max
Close Time (sec)	1.714	4.000 max
Open Time (sec)	0.235	4.000 max
Close Time (sec)	0.820	4.000 max
LOX Fill & Drain Valve		
Open Time (sec)	0.315	4.000 max
Close Time (sec)	2.135	4.000 max
Open Time (sec)	0.298	4.000 max
Close Time (sec)	0.945	4.000 max
LH_2 & LOX Prevalves		
Close Time (sec)	0.508	4.000 max
Open Time (sec)	2.481	4.000 max
LH_2 & LOX C/D SOV		
Close Time (sec)	0.147	4.000 max
Open Time (sec)	0.943	4.000 max
DIR Vent to Flt Pos (sec)	0.241	4 000 max
DIR Vent to Grd Pos (sec)	0.241	4.000 max

Engine Gimbal Step Commands with Engine Restrainer Links

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	T/M Pitch Pos (deg)	T/M Yaw Pos(deg)	IU Pitch Pos(deg)	IU Yaw Pos(deg)
0 Pitch	0.00	0.00	-0.13	0.10	-0.07	0.04
0 Yaw	-0.10	0.05	-0.13	0.10	-0.07	0.04
1 Pitch	6.60	0.05	0.78	0.06	0.81	0.04
0 Pitch	0.05	0.05	-0.13	0.10	-0.07	0.03
1 Pitch	-0.60	0.00	-1.10	0.10	-1.08	0.01
0 Pitch	0.00	0.00	-0.10	0.10	-0.06	0.04
1 Yaw	0.00	-6.80	-0.13	-0.78	-0.06	-0.87
0 Yaw	0.00	-0.05	-0.10	0.10	-0.06	0.06
1 Yaw	0.00	6.65	-0.10	1.15	-0.07	1.06
0 Yaw	0.00	0.00	-0.10	0.10	-0.04	0.06

Engine Gimbal Step Commands - Restrainer Links Dropped

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	T/M Pitch Pos (deg)	T/M Yaw Pos(deg)	IU Pitch Pos(deg)	IU Pitch Pos(deg)
0 Pitch	0.05	-0.05	-0.10	0.10	-0.06	0.06
0 Yaw	0.00	0.00	-0.08	0.06	-0.03	0.04
1 Pitch	6.60	0.05	0.97	0.10	1.00	0.04
0 Pitch	0.00	0.00	-0.10	0.10	-0.04	0.04
1 Pitch	-6.65	0.05	-1.13	0.13	-1.09	0.06
0 Pitch	0.00	0.00	-0.10	0.10	-0.03	0.04

4.1 24.1 (Continued)

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	T/M Pitch Pos (deg)	T/M Yaw Pos (deg)	IU Pitch Pos (deg)	IU Yaw Pos (deg)
1 Yaw	0.00	-6 60	-0.10	-0.91	-0 03	-0 97
0 Yaw	0 00	0.10	-0.10	0.10	-0 01	0 04
1 Yaw	0 00	6 60	-0 10	1.16	-0 04	1.08
0 Yaw	0 00	0 00	-0 06	0.10	-0 03	0 06

Engine Gimbal Frequency Response

Axis (deg)	Desired Freq (Hz)	Actual Freq (Hz)	Time Lag (sec)	Phase Lag (deg)	Cycles Gimb'd	Sample Time
0 25 Pitch	0.60	0 57	0.011	0.018	3 14	1 912
	5.00	4 95	2 030	0 083	39 01	1 911
	7.00	6 97	4094 024	0 095	70 79	1.941
0 25 Yaw	0 60	0.58	15 999	0 009	3 14	1 917
	5 00	5.02	48 000	0 023	40 16	1.941
	7 00	6 97	66.000	0 052	71 46	1.940
0.50 Pitch	0 60	0 57	4092.021	0 015	3 13	1.922
	5.00	4 95	0 065	0.069	39 08	1 928
	7 00	6 92	2 050	0.092	70 54	1 963
0.50 Yaw	0 60	0 57	32 000	0 011	3 12	1 925
	5.00	4 95	128 000	0 049	38 77	1.913
	7 00	6 78	125.999	0 071	68.47	1 932

4.1.25 Signal Conditioning Setup (1B44474 C)

This manual procedure provided the method to calibrate the signal conditioning equipment that had been found out-of-tolerance during automatic checkout or when a removed and replaced component was out-of-tolerance.

After initial conditions had been established on 4 August 1967, the manual checkout decoder assembly, P/N 1B50927-1, was connected into the test setup On the aft signal conditioning rack, at location 404A66, the stage connector was removed from J1 of the heat flux expansion nozzle -2 dc amplifier, P/N 1A82395-501, at location 403A22, for measurement C396, and the test cable assembly, P/N 1B50938-1, was then connected to J1 of the amplifier The jack leads of the test cable were connected to a Fluke voltmeter with a 100k ohm ±1 percent resistor in parallel with the voltmeter The zero control of the dc

4.1.25 (Continued)

amplifier was adjusted until the output, as read on the voltmeter, was 0.000 ±0.005 vdc The gain control was then adjusted for an output of 3.600 ±0.005 vdc. The zero output was checked and found to have changed from its original setting, and the zero and gain controls were adjusted until no further improvement in the readings were made. After the test was repeated for heat flux expansion nozzle -1, P/N 1A82395-501, 403A223, measurement C397, the test setup was removed, the stage wiring was returned to the original configuration, and the procedure was accepted by Engineering

All parts were installed at the start of this test. There were no FARR's written as the result of this checkout.

One revision was written to change the gain output voltage from 4.000 ±0.005 vdc to 3.600 ±0.005 vdc.

4.1.26 Final Prefire Propulsion System Leak Check (1B70175 E)

Final leak checks for the stage propulsion system were conducted prior to acceptance firing after all other stage checkouts had been completed. The primary purpose of the final prefire leak checks was to test for any external leakage that could occur as a result of system disturbance during checkouts conducted after the prefire propulsion system leak check procedure had been completed. Examples of system disturbances that required a repeat of the external leak checks included removal and replacement of instrumentation, replacement of malfunctioning components, and plumbing connections required to facilitate prefire checkouts.

Checkout was initiated on 9 August 1967, was completed on 12 August 1967, and was certified as acceptable on 14 August 1967. Recorded measurements are listed in Test Data Table 4.1.26 1.

After the preliminary test equipment was set up, the checkout was started by taking vacuum readings of the stage vacuum jacketed ducts. All vacuum levels measured were acceptable, as listed in the Test Data Table.

4.1.26 (Continued)

The stage ambient helium system leak checks were conducted next, with the pneumatic control sphere and the LOX and LH_2 ambient helium repressurization spheres pressurized with helium to 1450 ± 50 psig, and the control regulator discharge pressure set at 515 ± 50 psig. All portions of the system were checked for external helium leakage with a helium leak detector and LOX compatible bubble solution AMS3159. In addition, the pneumatic actuation control modules were checked for internal leakage by monitoring each module vent port for the 6.0 scim maximum allowable leakage. One pipe assembly leak was detected while checking the LH_2 repressurization control module and sphere plumbing for external leakage. This leak was corrected by replacing a union in the pipe assembly

After the satisfactory completion of the ambient helium systems leak check, the cold helium system was leak checked with helium by pressurizing the cold helium spheres to 950 ± 50 psig, and using the helium leak detector to check all plumbing, including the O_2H_2 burner portion of the system, for external leakage. No leaks were detected.

After completing the setup operations for pressurizing the LOX and LH_2 tank assembly, the O_2H_2 burner nozzle plug was installed in preparation for the burner propellant system leak checks. Pressurizing the LOX and LH_2 tank assembly with helium to 5 + 0, -1 psig, the O_2H_2 burner propellant valves and LOX shutdown valve were individually checked for internal leakage at the burner nozzle plug monitoring ports No leakage was detected. Next, the burner nozzle plug monitoring ports were capped, and the burner propellant valves were opened to lock up pressure between the tank assembly and the nozzle plug. The entire O_2H_2 burner propellant system was then checked externally for leakage from the tank assembly to the burner nozzle plug No leaks were detected.

The burner propellant valves were then closed, the downstream systems were vented, and the burner nozzle plug was removed in preparation for the LOX and LH_2 tank assembly pressure decay checks. These were accomplished by closing all engine and burner propellant supply valves, to maintain static helium pressure in the tank assembly, and monitoring any loss in tank pressures over

4.1.26 (Continued)

a 30 minute period. The pressure requirements were 15 ± 0, -1 psig for the LOX tank and 9 + 1, -0 psig for the LH_2 tank. Prior to the pressurization, gas samples were taken from both tanks and analyzed for helium content. The results of the helium concentration check and the pressure decay check for the LOX and LH_2 tank assembly are listed in the Test Data Table.

Next, the control helium bottle fill valve was closed and a 30 minute control sphere pressure decay check was made (refer to the Test Data Table).

While maintaining the LOX tank helium pressure at 15 + 0, -1 psig, the LOX propellant supply line (low pressure duct) to the J-2 engine was pressurized with helium at 15 to 30 psig. The entire LOX propellant supply system, the recirculation system, and the LOX tank fill and drain line were checked for external leakage from the LOX tank downstream to the J-2 engine, including the LOX turbopump and all related pump discharge plumbing. This included the PU valve, the main LOX shutoff valve (MOV), the ASI valve, and the gas generator oxidizer circuitry terminating at the gas generator oxidizer valve. No external leakage was recorded for the LOX system.

After venting the LOX low pressure duct, the LH_2 low pressure duct (propellant supply to the J-2 engine), was pressurized with helium at 10 to 30 psig while the LOX tank and LH_2 tank pressures were maintained at 10 to 15 psig and 10 + 0, -1 psig, respectively. The LH_2 system from the LH_2 tank through the J-2 engine was then checked for external helium leakage, similarly to the LOX system previously described. No external leaks were detected.

The J-2 engine thrust chamber throat plug was then installed and helium pressure at 9 + 1, -0 psig was stabilized between the throat plug and the main oxidizer and fuel thrust chamber valves (MOV and MFV) to conduct the thrust chamber leak checks. The entire J-2 engine thrust chamber system was then checked for external helium leakage. No leakage was detected. In addition to external leak checks of the thrust chamber system, the actuator drive and idler shaft seal leak checks were conducted for the thrust chamber valves (MOV and MFV) The results are listed in the Test Data Table.

4.1.26 (Continued)

The J-2 engine start system leak check was started by drying the start tank vent valve actuator. A vacuum pump was attached and the actuator was pumped down to a vacuum of 10 millimeters of Mercury maximum. A heat lamp was applied to the actuator to obtain a surface temperature between 100°F and 150°F. The actuator temperature and vacuum were maintained for a minimum of 2 hours. The start tank system was leak checked by pressurizing the tank with helium to 500 ± 10 psig and checking all connections for external leakage. No leakage was detected. After allowing the start tank pressure to stabilize for 2 hours, the start tank temperature and pressure were measured and recorded. After 1 hour these measurements were repeated to calculate the helium mass decay rate for the start tank. The calculated decay rate was 0.00465 pound-mass/hour, which was acceptable based on an allowable mass decay rate of 0.0066 pound-mass/hour.

The J-2 engine control sphere was then pressurized with helium to between 225 and 250 psig in preparation for the engine pneumatic leak checks. The low pressure side leak check was then conducted to determine internal leakage within the engine pneumatic control package. Leakage rates as measured at the pneumatic control module common vent port were within the acceptable tolerances, as listed in the Test Data Table. The engine control sphere pressure was then increased to 300 ± 10 psig and the helium control solenoid was turned on to pressurize the pressure actuated purge system for external leak checks. No leaks were detected. The engine control sphere pressure was then increased to 1450 ± 50 psia for the pneumatic control high pressure side retention test. After allowing the control sphere pressure to stabilize for 1 hour, the control sphere temperature and pressure were measured and recorded to calculate sphere helium mass. This was repeated 1 hour later to obtain a calculated engine control sphere helium mass decay rate of 0.0003 pound-mass/hour, which was acceptable based on an allowable decay rate of 0.036 pound-mass/hour.

The LH_2 and LOX tanks and the engine systems were then purged, after which gas samples from the tanks were taken to establish the final acceptable prefire helium concentration for the propellant tank assembly. The results are listed

4.1.26 (Continued)

in the Test Data Table. Tank blanket pressures were then maintained with helium, at 5 + 0, -1 psig for the LOX tank and 3 + 0, -1 psig for the LH_2 tank. All systems, except the LOX and LH_2 tanks, were vented to ambient and secured.

Final checks were then made to verify that the umbilical hoses required for static firing were installed, and that the unrequired stage umbilical ports were capped off The checkout was completed by verifying that the required electrical cables were connected to the proper solenoid valves in the LOX and LH_2 tank pressurization modules. There were no areas of unacceptable leakage detected, no FARR'S were initiated, and the stage was designated acceptable for static firing countdown operations.

Ten revisions were recorded in the procedure as follows

a. Five revisions corrected procedure errors

b. One revision authorized temporary removal of the 1/4 inch vent port check valves prior to monitoring actuation control module internal leakage at the vent ports.

c. One revision authorized a flex hose installation at the aft umbilical panel.

d One revision deleted the external leak check of the fill line from the engine start tank GH_2 fill valve to the facility interface panel, as this line had been leak checked previously per H&CO 1B70099

e. Two revisions authorized temporary electrical disconnection at the engine start tank vent actuator solenoid valve at two places in the procedure This was a convenience change, to avoid start tank vent valve actuation when the engine control package power was turned on.

4.1.26.1 Test Data Table, Final Prefire Propulsion System Leak Check

Stage Vacuum Duct Readings

	Reading (Microns)	Limits (Microns)
LH_2 LPD Upper	34	Less than 250
LH_2 LPD Lower	98	Less than 250
LH_2 Recirculation	65	Less than 250
O_2H_2 Burner Propellant Upper	8	Less than 250
O_2H_2 Burner Propellant Lower	9	Less than 250
O_2H_2 Burner Propellant	4	Less than 250

4.1.26.1 (Continued)

LOX and LH_2 Tank Helium Concentration

		Reading (%)	Limits (%)
LOX Tank:	Top	100	75 min
	Bottom	99	75 min
LH_2 Tank	Top	100	75 min
	Bottom	99	75 min

LOX and LH_2 Tank Pressure Decay Test

	Initial (psig)	Final (psig)	Limits
LOX Tank	14.2	14.0	*
LH_2 Tank	9.5	9.2	*

Stage Control Helium Sphere Pressure Decay Test

	Initial (psig)	Final (psig)	Limits
Control Sphere Pressure	760	760	*

Thrust Chamber Valve Actuator Shaft Seal Leak Checks

	Measured (scim)	Limits (scim)
MOV Idler	0	3.3 max
MFV Idler	0	3.3 max
MOV 2nd Stage Actuator	0	3.3 max
MFV Actuator	0	3.3 max

Engine Pneumatic Control Package (Low Pressure Side) Leak Check

	Vent Port Flow (scim)	Limits (scim)
Helium Control Solenoid On	5.6	20 max
Ignition Phase Solenoid On	7.4	20 max
Mainstage Solenoid On	8.0	20 max

Final Helium Concentration Check

		Reading (%)	Limits (%)
LOX tank	Top	100	99 min
	Bottom	100	99 min
LH_2 Tank	Top	100	99 min
	Bottom	100	99 min

* Limits Not Specified

4 2 Stage Poststorage Checkout

The stage poststorage checkout began on 7 January 1968 with the initiation of the cryogenic temperature sensor verification, and ended on 26 August 1968 with the completion of another cryogenic temperature sensor verification. Paragraphs 4 2 1 through 4.2 28 cover the checkouts that were accomplished during this period All tests required by the End Item Test Plan, 1B66684-503, advance revision G, dated 20 October 1967, were activated and completed.

4 2 1 Cryogenic Temperature Sensor Verification (1B37622 NC)

The calibration and functional capabilities of the cryogenic temperature sensors, for which the normal operating range did not include ambient temperatures, were verified by this manual procedure. The cryogenic temperature sensors, basically platinum resistance elements, changed resistance according to the Callendar-Van Dusen equation Resistance and continuity checks of the internal fuel tank temperature transducers were conducted as the result of rework activity within the fuel tank subsequent to static acceptance firing This checkout was initiated and accepted on 7 January 1968

The test sequences consisted of sensor element resistance checks and sensor wiring continuity checks. The sensor element resistance was measured for each of the transducers at the ambient room temperature, with a General Radio, Model 1652A, resistance limit bridge The ambient temperature was measured and recorded as $68^{\circ}F$ The checkout sensor parameter table specified the resistance value at $32^{\circ}F$ for each sensor, and its change in resistance for each degree between $32^{\circ}F$ and $100^{\circ}F$ Using these values, the required resistance at the ambient temperature of $68^{\circ}F$ was calculated and compared with the actual resistance measured to determine acceptability for each sensor A tolerance of ± 5 percent or ± 7 percent of the calculated resistance (depending on sensor part number), was allowed for acceptance of the actual resistance measurements

The check for correct sensor wiring (continuity) was accomplished by connecting a jumper wire on the adapter cable, P/N 1B64095-1, and verifying that the sensor element for each transducer was shorted out to a resistance measurement of 5 ohms or less

Three revisions to the procedure were noted on the documentation log sheet Two of the revisions deleted all portions of the procedure applying to

4.2.1 (Continued)

cryogenic temperature sensors other than those located in the stage fuel tank, as only these sensors required recalibration after the fuel tank was entered. The third revision corrected typographical errors in the procedure.

No discrepancies were documented as a result of this checkout

4 2 1.1 Test Data Table, Cryogenic Temperature Sensor Verification

Meas	Sensor			Temp	Resistance (ohms)			
Number	P/N	S/N	Ref Desig	(°F)	Meas	Calc	±Tol	Cont
CO 052	1A67862-513	565	408MT612	68	5130	5396	7%	1.5
CO 370	1B51648-507	59789	408MT735	68	5230	5396	5%	1 5
CO 371	1B51648-507	59803	408MT736	68	5200	5396	5%	1 5

4 2 2 Postfire Structural Inspection (1B70756 B)

This manual procedure outlined the postfire and poststorage inspection requirements for the stage. The purpose of the checkout was to verify that static firing and storage were not detrimental to the stage structure, and that the stage was structurally ready for flight

The procedure was initiated on 10 January 1968, with the inspection of the LOX and LH_2 tank assemblies, the thrust structure, the tunnel areas, and the forward and aft skirt assemblies for cracked or debonded brackets, cracks or deformation in skin panels, or chipped or peeled paint The external ducts, tubes, and spheres were checked for scratches, dings, and corrosion Inspection Item Sheet 338793 reported a small hole and a scrape in the aft dome mylar covering These discrepancies were repaired per DPS 22301.

All bonded supports were verified to be acceptable by performing a "coin tap" test under the direction of MR&PM Engineering After inspection of the environmental control plenum, P/N 1B64850, for rips and debonded areas, the forward and aft domes, the main and auxiliary tunnels, and the thrust structure area were inspected and determined to be acceptable

The auxiliary propulsion system (APS) modules were installed at positions I and III to check the alignment of the APS support structural installation This was followed by an inspection of the control helium, helium storage, compressed gas, and cold helium spheres

4 2 2 (Continued)

The hardware mounted on the forward dome was checked to verify that all components, with the exception of the temperature transducer, P/N 1B67863, were not extended more than 8 inches outward from the outer surface of the dome. Verification was also made that stage hardware was not extended inward more than 17-1/2 inches from the forward skirt

The thrust structure area, the main tunnel, and the auxiliary tunnel areas were verified to be clean, with all hardware secured The thrust structure doors, the main tunnel fairings, and the auxiliary tunnel fairings were installed subsequent to inspection

The APS modules were removed upon completion of the poststorage APS automatic checkout, H&CO 1B70430, and this checkout was certified as complete on 11 March 1968

No FARR's were written as a result of this inspection, and the stage was certified to be ready for flight

Two revisions were made for the following

a One revision gave instructions to sweep the area between the aft dome and the thrust structure with a thin strip of fiberglass to dislodge any debris

b One revision deleted the internal inspection of the LH_2 tank, and the engine position verification, as these checks had been accomplished prefire and were not required for postfire checks

4 2 3 Umbilical Interface Compatibility Check (1B64316 E)

Prior to connecting the forward and aft umbilical cables for automatic power on checks, this manual checkout provided the test sequences which were used to check the design specifications and the continuity of the stage umbilical wiring Accomplished by point-to-point resistance checks of all umbilical circuits, this test ensured that the proper loads were present on all power buses, and that the control circuits for the propulsion valves and safety items were within the prescribed tolerances

This checkout was initiated on 17 January 1968, and was accepted as complete on 18 January 1968 A series of resistance measurements were made at

4 2 3 (Continued)

specified test points on the GSE Model DSV-4B-463 signal distribution unit, P/N 1A59949-1, using 463A1A5J43-FF as the common test point for all measurements. These measurements verified that all wires and connections in the umbilical system were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits. A Simpson, Model 260, multimeter and a Triplett, Model 630, multimeter were utilized to make the resistance measurements See Test Data Table 4 2.3 1 for the particular test points, circuit functions, measured resistances, and resistance limits

No FARR's were written against this test

One revision was written to change the allowable resistance tolerance for test point A2J30-W from 10 to 80 ohms to 10 to 300 ohms, as an additional diode in the LOX emergency vent cable circuitry increased the resistance.

This procedure was re-issued on three additional occasions during the stage poststorage test operations (22 February, 27 February, and 29 February 1968) The purpose for the re-issues was to reverify umbilical wiring integrity after umbilical ejection during automatic testing (all systems test, 1B55833) There were no problems encountered during the repeat checks and no FARR's were initiated

4 2 3 1 Test Data Table, Umbilical Interface Compatibility Check

Reference Designation 463A2

Test Point		Function	Meas Ohms	Limit Ohms
A2J29-C	Cmd ,	Ambient Helium Sphere Dump	29	10-60
CB-8-2	Cmd ,	Engine Ignition Bus Power Off	Inf	Inf
CB-9-2	Cmd.,	Engine Ignition Bus Power On	12	5-100
CB-10-2	Cmd ,	Engine Control Bus Power Off	Inf	Inf
CB-11-12	Cmd ,	Engine Control Bus Power On	80	5-100
A2J29-N	Cmd ,	Engine Helium Emerg Vent Control On	50	10-60
A2J29-P	Cmd ,	Fuel Tank Helium Sphere Dump	37	10-60
A2J29-Y	Cmd ,	Start Tank Vent Pilot Valve Open	20	10-60
CB-4-2	Cmd ,	LOX Tank Cold Helium Sphere Dump	33	10-60
A2J29-c	Cmd ,	LOX Tank Repress Helium Sphere Dump	35	10-60
A2J29-h	Cmd ,	Fuel Tank Vent Pilot Valve Open	250	10-300
		(Same, reverse polarity)	Inf	500K min

4 2 3 1 (Continued)

Test Point	Function	Meas Ohms	Limit Ohms
A2J29-i	Cmd , Fuel Tank Vent Valve Boost Close	65	10-80
	(Same, reverse polarity)	Inf	500K min
A2J29-q	Cmd , Ambient He Supply Shutoff Vlv Close	22	10-60
A2J30-H	Cmd , Cold He Supply Shutoff Vlv Close	, 1K	1 5K max
	(Same, reverse polarity)	Inf	Inf
A2J30-W	Cmd , LOX Vent Valve Open	225	10-300
	(Same, reverse polarity)	Inf.	500K min
A2J30-X	Cmd., LOX Vent Valve Close	60	10-80
	(Same, reverse polarity)	Inf	500K min
A2J30-Y	Cmd., LOX and Fuel Prevalve Emergency Close	67	10-80
	(Same, reverse polarity)	Inf	Inf
A2J30-Z	Cmd , LOX and Fuel Chilldown Valve Close	68	10-80
	(Same, reverse polarity)	Inf	500K min
A2J30-b	Cmd , LOX Fill & Drain Valve Boost Close	30	10-40
A2J30-c	Cmd , LOX Fill & Drain Valve Open	31	10-40
A2J30-d	Cmd , Fuel Fill & Drain Valve Boost Close	30	10-40
A2J30-e	Cmd , Fuel Fill & Drain Valve Open	30	10-40
A2J42-F	Meas , Bus +4D111 Regulation	170	100 min
A2J35-y	Meas , Bus +4D141 Regulation	Inf	50 min
A2J6-AA	Sup , 28v Bus +4D119 Talkback Power	90	60-120

Reference Designation 463A1

Test Point	Function	Meas Ohms	Limit Ohms
A5J41-A	Meas , Bus +4D131 Regulation	200	20 min
A5J41-E	Meas , Bus +4D121 Regulation	2 5K	1 6K min
A5J53-AA	Sup , 28v +4D119 Fwd Talkback Power	70	60-100

4 2.4 Forward Skirt Thermoconditioning System Checkout Procedure (1B41955 B)

The forward skirt thermoconditioning system (TCS) was functionally checked per this manual procedure to prepare it for operation, and to verify that the system was capable of supporting the stage poststorage checkout operations The checkout utilized the Model DSV-4B-359 TCS servicer, P/N 1A78829-1, which conditioned and supplied the water/methanol heat transfer fluid to the forward skirt thermoconditioning system, P/N 1B38426-513

Checkout of the TCS was accomplished from 18 January through 20 January 1968, and was certified as acceptable on 24 January 1968 Preliminary operations included setup and connection of the servicer to the TCS, and inspection of the TCS panels for open equipment mounting bolt holes and properly torqued

4.2.4 (Continued)

bolts The TCS was pressurized to 32 ±1 psig with freon gas, and was then leak checked with the gaseous leak detector, P/N 1B37134-1 The areas checked for leakage included all TCS B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows No leakage was detected.

The TCS was purged with gaseous nitrogen, then water/methanol fluid was circulated through the system. Water/methanol samples were taken from the fluid sample pressure valve (system inlet) and the fluid sample return valve (system outlet), and checked for cleanliness, specific gravity, and temperature Particle counts for each micron range were well within the acceptable cleanliness limits specified The system inlet sample had eight particles in the 175-700 micron range (25 allowed) and no particles in either the 700-2500 micron range or above 2500 microns (none allowed) The system return sample had one particle in the 175-700 micron range and none in the other micron ranges. The specific gravity and temperature of the fluid were measured with a hydrometer and thermometer, respectively, determining that the water/methanol concentration was within the acceptable mixture range

A differential pressure test was conducted to verify correct system geometry and proper flow distribution The test was conducted by measuring the differential pressure between the thermoconditioning system inlet and outlet, as well as the inlet and outlet temperatures, while maintaining a water/methanol flow rate of 7 8 ±0 2 gpm The differential pressure was recorded as 11 5 psid, while inlet and outlet temperatures were both 58°F

There were no FARR's initiated against the TCS, and the checkout demonstrated that the system was prepared to support additional poststorage stage checkout activities

Twelve revisions to the procedure were recorded during checkout operations

a One revision changed the identification of the test stand GN_2 supply valve

b. Two revisions authorized substitutions for the specified water/methanol return hoses for the thermoconditioning servicer, P/N 1A78829-1, based on current configuration requirements for this plumbing

4.2 4 (Continued)

c Two revisions authorized substitutions for the specified Thermador DRA-161 portable electric heater used to warm the servicer R12 freon gas bottle, because a Thermador heater was not available

d Six revisions corrected errors in the procedure that referred to other water/methanol hose part numbers for the thermoconditioning servicer installation, rather than those specified in the schematic layout of the test setup

e One revision corrected typographical errors, which referred to the wrong paragraph numbers in the procedure

There were no other discrepancies and the thermoconditioning system was accepted for use

4 2 5 <u>Propulsion Leak and Functional Check (1B71877 B)</u>

This checkout procedure defined the operations required to perform the leak and functional checks which certified the stage propulsion system poststorage condition Initiated on 20 January 1968, the checkout was completed and certified as acceptable on 27 February 1968

The O_2H_2 burner was insepcted for external signs of damage or loose equipment, and verification was made that the burner exciter cable connectors, 403W8P8 and 403W8P10, were connected to the spark exciter simulator, P/N 1B71782-1

Visual observation of the spark gap for constant arcing was accomplished by sighting through the 9/16 inch diameter hole in the gauge assembly, P/N 1B67184-1, which was installed on the O_2H_2 burner adapter flange This checkout was repeated for the second spark igniter, which satisfactorily completed the spark igniter arcing checks

The umbilical quick-disconnect check valve leak test was accomplished by disconnecting the tube assembly on the stage side of the umbilical, applying regulated helium to the stage side of the quick-disconnect, and measuring the leakage with a flow tester, P/N G-3104 The quick-disconnect check valves involved in this check were for the thrust chamber, the purge engine start bottle, the engine control sphere, the LOX tank repressurization supply, the LH_2 tank repressurization supply, the ambient helium fill, and the APS helium supply

4.2 5 (Continued)

The calip pressure switch system leak checks performed a decay check of the LOX and LH_2 pressure switch checkout circuits by pressurizing the system to 30 ±5 psia, and monitoring the pressure for 5 minutes A decay and leak check of the mainstage pressure switches was accomplished by pressurizing the system to 400 ±10 psig through the J-2 customer connect panel, isolating the mainstage switches from the supply source, and monitoring decay for 15 minutes All decay checks were satisfactorily completed.

The LOX chilldown pump purge integrity test was accomplished by setting the stage 1 helium regulator at 950 ±25 psig, and pressurizing the control helium sphere The LOX chilldown pump purge control valve was opened, and the chilldown pump motor container was monitored for pressure increase and pressure switch pickup Pressurizing of the motor container progressed until the relief valve activated, and the container pressure stabilized The motor container was monitored for 2 hours and the pressure decay was noted and recorded The test was concluded by venting the pump purge system to ambient

The ambient helium system leak and flow check was accomplished next This section performed a reverse leak check of the LOX and LH_2 fill and drain purge check valves, and the LOX and LH_2 vent purge check valves The internal and reverse leakage of the ambient helium fill module was checked during this test. Included in this section were the reverse leakage tests of the check valves for the ambient helium sphere fill system, and the ambient LOX and LH_2 repressurization module Internal leakage of the LOX and LH_2 repressurization module and the pneumatic power control module was also checked

The control helium system leak and functional checks consisted of an ambient helium system leak check and an actuation control module internal leakage check A leak was discovered between the actuation control module and the LOX prevalve This leak was corrected by installing Voi-Shan seals and retorquing the B-nut fittings. A small leak found on the LOX shutdown valve was determined to be of a magnitude insufficient to measure and was accepted (the maximum leakage allowable was established at 20 scim). The leak check log indicated that a leak on the actuation control module continuous vent valve microswitch housing was accepted, as it was below the maximum allowable leakage One other leak was noted at the ambient helium sphere, position 7, at the leak check port Retorquing of the flange bolts stopped this leak

The engine start system leak and functional test included a drying sequence for the start tank vent valve actuator, a seat leakage check of the start tank control solenoid valve, and a reverse leakage check of the start tank fill check valve Leakage checks were performed on the GH_2 start system, the start tank dump control solenoid seal, and the vent and relief valves and valve bellows Start bottle retention tests were conducted to measure the start bottle decay by calculating the pound-mass/hour loss With the exception of a leak at the manifold block outlet on the LOX pressure plenum, which was repaired by replacing the seal and retorquing, all tests were satisfactorily completed

LH_2 pressurization and repressurization system leak and functional checkouts included functional checks of the burner LH_2 repressurization control valves, reverse leakage tests of the burner LH_2 check valves, and leakage tests of the burner LH_2 repressurization control valve seat and pilot bleed repressurization system This section also performed reverse leakage tests of the fuel pressure module check valve, the LH_2 pressurization redundant check valve, and the LH_2 prepressurization check valve One leak on the LH_2 burner repressurization plenum was repaired by replacing the seals and retorquing the connections

Thrust chamber leak checks included the ignition probe, the LOX dome purge line from the purge port on the LOX dome to the GSE purge check valve, and the main fuel valve (MFV) and main oxidizer valve (MOV) idler and drive shaft seals This section also covered reverse leakage tests of the LOX dome and thrust chamber purge check valves. No leakage conditions were found during this section of the test

LOX pressurization and repressurization system leak and functional checkouts included internal leakage and functional checks of the LOX tank pressure control module, the burner LOX repressurization module, the LOX pressurization system burner LOX repressurization coil, and the burner and ambient repressurization system Reverse leakage checks were performed on the cold sphere

4 2.5 (Continued)

fill check valve, the LOX repressurization check valve, and the burner LOX repressurization check valve This section also performed a leak check of the cold helium system, which included a system leak check and a reverse leakage check of the LOX tank prepressurization check valve One leakage condition was found to exist at the LOX pressurization module adapter flange This was corrected by retorquing the flange bolts All tests were completed and accepted.

The LOX tank, O_2H_2 burner, and engine feed system leak checks were accomplished next This section performed internal leakage checks of the engine feed system, which included the LOX prevalve, the LOX chilldown shutoff valve, and the LOX chilldown return check valve The engine LOX bleed valve and MOV seat leakage checks, the LOX tank and engine feed system leak checks, the LOX turbopump torque checks, and the LOX chilldown pump purge flow checks were also accomplished The LOX valve leakage checks were performed, including a shaft seal leakage check of the LOX prevalve, and a seat leakage check of the LOX fill and drain valve. This section also covered a leak and flow check of the O_2H_2 burner LOX system, which included a leak check from the LOX tank to the burner LOX propulsion valve, and seat leakage checks on the burner LOX propellant and shutdown valves One leakage condition, a bubble leak on the lower shaft seal of the LOX prevalve, was accepted, as the leak was less than the maximum allowable leakage rate

The LH_2 tank O_2H_2 burner and engine feed system leak checks performed external and internal leakage checks of the engine feed system, which included the LH_2 chilldown return check valve, the LH_2 prevalve, the LH_2 chilldown shutoff valve, the engine LH_2 bleed valve, the engine MFV, and the LH_2 fill and drain valve Reverse flow leakage tests were performed on the LH_2 chilldown return check valve, the LH_2 pump drain and purge check valves, and the LOX and LH_2 turbine seal cavity purge check valves A forward check was performed on the LH_2 pump drain check valve Seal leakage checks were performed on the LH_2 prevalve shaft and turbopump primary seal with the turbopump running This leakage test included a breakaway torque check

4 2 5 (Continued)

This section also performed a leak and a flow check of the O_2H_2 burner LH_2 system and chamber, and included seat leakage checks of the burner LH_2 propellant valve shutdown valve. No leakage conditions were found, and this section was satisfactorily completed

The engine gas generator and exhaust system leak and flow test checked the gas generator purge check valve reverse leakage, and the LH_2 and LOX turbine seal cavity bleed flow The start tank discharge valve gate seal leakage was checked. The gas generator and exhaust system were checked for leaks, and the gas generator LOX purge check valve and LOX poppet valves were checked for reverse leakage Seal leakage checks were made for the hydraulic pump seal, and the gas generator LOX and LH_2 propellant valve seats The purge system leak checks were accomplished during this section of the test

The next series of tests included engine pump purge module internal leakage and regulation checks, engine pump purge system leak checks, and flow rate checks of the gas generator fuel purge, LOX and LH_2 turbine seal cavity bleed, and fuel seal cavity purge systems

The engine pneumatics leak and flow check executed leak checks of the helium control solenoid circuit, the pneumatic package, the circuits from the normally open ports of the ignition phase and mainstage solenoids, the pressure actuated purge system, the pressure actuated fast shutdown valves diaphragm, and the internal pneumatic components The LOX pump intermediate seal was checked for leaks, and a flow check was accomplished on the cracking check valve overboard flow Seat leakage tests were made on the ignition phase solenoid normally closed circuit, the start tank discharge valve solenoid (closed position), the start tank discharge valve piston seal (closed position), and the internal pneumatic components The open positions of the start tank discharge valve solenoid and piston seal were accomplished, followed by a leak check of the start tank discharge valve solenoid circuit The mainstage solenoid normally closed circuit and the pressure actuated fast shutdown valve were then leak checked The engine control bottle and the fill line to the pneumatic package high pressure relief valve were leak checked The engine control bottle fill check valve was tested for reverse leakage

4 2.5 (Continued)

The LOX and LH_2 vent system leak and flow checks included the LOX vent system leak check, and the LH_2 ground and flight vent system leak checks. Also, the LOX vent and relief valve, the LH_2 vent and relief valve, and the LH_2 continuous vent valve were tested for internal leakage The LH_2 propellant vent ducting was checked for leaks, and the LH_2 continuous vent module was checked for internal leakage. The LH_2 nonpropulsive vent and ground systems vents were leak checked The LH_2 vent and relief valve and the directional vent valve were checked for internal leakage The LH_2 directional vent actuator was checked for piston leakage

Eleven leakage conditions were reported in the leak check log Five leaks were corrected by retorquing, two required rewelding of the stub-outs, one required installation of Voi-Shan seals, and three were acceptable, as the leakage was not in excess of the maximum allowance

Sixty-five revisions were written to this procedure, two of which were subsequently voided The revisions incorporated were

a Twenty-nine revisions corrected and added requirements that were in error or missing

b Eleven revisions added steps to acquire engineering data or to make temporary hardware installations

c Six revisions repeated previously performed leak checks.

d Six revisions deleted steps or sections that were not required for poststorage checkout

e Five revisions changed steps to allow the use of substitute parts, or to change the sequence of operations

f Three revisions reran sections of the test to set up conditions for other procedures

g One revision deleted a previous revision

h One revision authorized a troubleshooting sequence

i One revision deleted a step performed by an installation procedure

4 2 5 (Continued)

There were no missing or IUM parts, and no modifications pending that would void any portion of this test. The propulsion systems leak and functional checks were acceptable to Engineering, and this checkout was signed on 27 February 1968.

4.2.5.1 Test Data Table, Propulsion Leak and Functional Check

Calip Pressure Switch Leak Checks

Function	Measurement	Limits
LOX Press Switch C/O Circuit Decay (psi)	0	0 5
LH_2 Press Switch C/O Circuit Decay (psi)	0	0.5
Low Press Switch C/O Circuit Decay (psi)	2 0	5 0
Engine Mainstage Press Switch Diaphragm Press Decay Check		
Initial Press (psig)	400	*
Final Press (psig)	400	*
Decay (psi)	0	10 in 15 min

Purge System Check Valve Reverse Leak Check (P/N 1B51361-1

Check Valve Function	S/N	Reverse Leakage (scim) Measurement	Limits
LOX Vent Purge	280	0	10 max
LOX Fill & Drain Purge	247	0	10 max
LH_2 Fill & Drain Purge	259	0	10 max
LH_2 Vent Purge	226	0	10 max

Ambient He Fill Module Internal Leak Checks (P/N 1A57350-507-002, S/N 0227)

Function	Measurement	Limits
Check Valve Reverse Leakage (scim)	0	0
Dump Valve Seal Leakage (scim)	0	0

Ambient He Spheres Fill System Check Vlvs Reverse Leak Checks (P/N 1B51361-1)

Function	S/N	Measurement	Limits
LOX Repress Mod Check Valve (scim)	-	0	10 max
LH_2 Repress Mod Backup Check Valve (scim)	224	0	10 max
LH_2 Repress Mod Check Valve (scim)	-	0	10 max
He Fill Mod Backup Check Valve (scim)	103	0	10 max

*Limits Not Specified

4.2.5.1 (Continued)

Ambient Repress Module Control Valve Functional Checks

LOX Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0	*
Cont Vlv (L2) Seat Leakage (scim)	0	*
Module Dump Vlv Seat Leakage (scim)	0	*
Mod Dump Vlv Pilot Bleed (scim)	0	*
Mod Dump Vlv Seat & Pilot Bleed Leakage (scim)	0	9 max
Cont Vlv (L2) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L2) Seat & Pilot Bleed Leakage (scim)	0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0	9 max

LH_2 Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0	*
Cont Vlv (L2) Seat Leakage (scim)	0	*
Module Dump Vlv Seat Leakage (scim)	0	*
Module Dump Vlv Pilot Bleed Leakage (scim)	0	*
Mod Dump Vlv & Pilot Bleed Seat Lkg (scim)	0	9 max
Cont Vlv (L2) Pilot Bleed Lkg (scim)	0	*
Cont Vlv (L2) Seat & Pilot Bleed Lkg (scim)	0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L3) Seat & Pilot Bleed Lkg (scim)	0	9 max

Pneumatic Power Control Module Internal Leak Check
(P/N 1A58345-519, S/N 1057)

Function	Measurement	Limits
Control He Shutoff Seat Leakage (scim)	0	10 max
Control Module Reg Lockup Press (psig)	512	550 max

Actuation Control Module Checks
(P/N 1B66692-501)

Module Function	S/N	Normal	Open	Closed	Limits
O_2H_2 Burner LOX Valve Control (scim)	68	2.3	0	0	6 max
O_2H_2 Burner LH_2 Valve Control (scim)	70	0	0	0	6 max
Orifice Bypass Valve Control (scim)	86	1.5	1.5	0	6 max

*Limits Not Specified

4.2.5.1 (Continued)

Function	S/N	Normal	Open	Boost	Limits
LOX Vent Valve Control (scim)	71	0	0	0	6 max
LH_2 Fill & Drain Valve Control (scim)	60	0	0	-	6 max
LOX Fill & Drain Valve Control (scim)	72	0	0	-	6 max
LH_2 Vent Valve Control (scim)	75	0	0	0	6 max

	Open	Closed	
LH_2 F&D Act Seal Lkg (scim)	0.1	0.0	2 max
LOX F&D Act Seal Lkg (scim)	0.0	0.0	2 max
LH_2 Cont Vent Act Piston & Shaft Seal Lkg (scim)	0.0	0 0	20 max

		Normal	Flight	Ground	
Directional Vent Valve Control (scim)	69	0	0	0	6 max

		Normal	Closed	
Prevalve/Chilldown Valve Control (scim)	61	0	-	6 max
Prevalve Control (scim)	-	-	0	6 max
Chilldown Valve Control (scim)	-	-	0	6 max

	Measurement	Limits
LOX Prevlv Microsw Housing Flng Lkg (scim)	0	20 max
LOX Shutdown Vlv Act Piston & Shaft Seal Lkg (scim)	0	20 max

Pneumatic Control System Decay Checks

Function	Measurement Initial	Measurement Final	Limits
Reg Disch Press - Valve Pos, Normal (psig)	512 5	490 0	*
Reg Disch Press - Valve Pos, Activated (psig)	513.0	483 0	*

Engine Start Tank Leak Checks

Function	Measurement	Limits
Vent Control Solenoid Seat Leakage (scim)	0	10 max
Initial Fill, Check Vlv Rev Leakage (scim)	0	2 max
Vent & Relief Valve Seat Leakage (scim)	0	2 max
Dump Valve Bellows Leakage (scim)	0	0
Bottle Decay (Delta M) (lb-mass/hr) (scim)	0 0028	0 0066 max

*Limits Not Specified

4.2 5 1 (Continued)

LH2 Repressurization System Leak Checks

Function	Measurement	Limits
O_2H_2 Burner Control Valve Seat Leakage (scim)	0	*
O_2H_2 Burner Control Valve Pilot Bleed Lkg (scim)	0	*
O_2H_2 Burner Module Cont Vlv Int Lkg (scim)	0	12 max
O_2H_2 Burner Cont Vlv & Check Vlv Rev Lkg (scim)	0	*
O_2H_2 Burner Check Vlv Reverse Leakage (scim)	0	5 max
O_2H_2 Burner Coil Leakage (scim)	0	0

LH_2 Pressurization System Leak Check

Function	Measurement	Limits
LH_2 Press Module Check Vlv Rev Lkg (scim)	0	10 max
LH_2 Prepress Check Vlv Rev Leakage (scim)	0	0

Thrust Chamber Checks

Function	Measurement	Limits
LOX Dome		
Purge Check Valve Reverse Leakage (scim)	0	4 max
Main Oxidizer Valve		
Idler Shaft Seal Leakage (scim)	0	10 max
Drive Shaft Seal Leakage (scim	0	10 max
Main Fuel Valve		
Idler Shaft Seal Leakage (scim)	0	10 max
Drive Shaft Seal Leakage (scim)	0	10 max
Thrust Chamber		
Pressure (psig)	27	20 min
Jack Purge Check Vlv Rev Leakage (scim)	1.82	25 max

LOX Pressurization & Repressurization Leak Checks

Function	Measurement	Limits
Cold Helium Sphere		
Fill Check Valve Reverse Leakage (scim)	0	0
Shutoff Vlv Seat & Pilot Bleed Lkg (scim)	270	375 max
LOX Press Module Internal		
Hot Gas Bypass Vlv Seat & Pilot Bleed Lkg (scim)	0	1000 max
O_2H_2 Burner LOX Repress System		
Burner Control Valves Seal Leakage (scim)	2.85	*
Burner Control Valve Pilot Bleed Leakage (scim)	0	*
Burner Module Control Vlv Internal Lkg (scim)	2.85	12 max
System Check Valve Reverse Leakage (scim)	0	5 max
Combined Burner Check Vlv & Cont Vlv Seat Leakage (scim)	0	0
Burner Check Vlv Rev Leakage (scim)	0	0
Burner Coil Leakage (scim)	0	0

*Limits Not Specified

4 2.5 1 (Continued

Cold Helium System

Function	Measurement	Limits
LOX Tank Prepares Check Vlv Rev Leakage (scim)	0	0

LOX Tank, O_2H_2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LOX Tank Helium Content (%)	99	75 min
Engine Feed Sys Internal Leak Checks		
LOX Prevlv & Chilldown Shutoff Vlv Seat & Chilldown Return Check Vlv Lkg (scim)	87	*
LOX Chilldown Ret Check Vlv Rev Lkg (scim)	5.6	250 max
LOX Prevlv & Chilldown Shutoff Vlv Combined Seat Leakage (scim)	81.4	150 max
LOX Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	5.6	*
LOX Bleed Valve Seat Leakage (scim)	0	300 max
Main Oxidizer Vlv Seat Leakage (scim)	0	10 max
LOX Tank & Engine Feed System Leak Checks		
Oxidizer Pump Speed Pickup Seat Bleed (scim)	0	0
LOX Turbopump Torque Checks		
Pump Primary Seal Leakage		
Max (scim)	25	350 max
Min (scim)	0	350 max
Turbine Torque		
Breakaway (in/lbs)	60	1000 max
Running (in/lbs)	30	200 max
LOX Chilldown Pump Purge Flow Checks		
Pump Purge Shutoff Sol Vlv Leakage (scim)	0	1 max
Pump Purge Bypass Flow (scim)	8.2	10 ± 2
Pump Purge Flow (scim)	42	33 to 49
Pump Purge Dump Solenoid Seat Leakage (scim)	0	0
Pump Shaft Seal Leakage (scim) (Tank Pressurized & Purge On)	2.4	50 max
Pump Shaft Seal Lkg - Pump Direction (scim)	0	75 max
Pump Shaft Seal Lkg - Tank Direction (scim)	2.4	25 max
LOX Turbopump Torque Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0	10 max
Closed Position (scim)	1.6	10 max
Prevalve Act Internal Lkg - Closed (scim)	0.5	75 max
Fill and Drain Valve Seat Leakage (scim)	0	18 max
Fill and Drain Vlv Primary Shaft Seal Lkg (scim)	0	6.1 max
O_2H_2 Burner LOX System Leak Check		
Burner LOX Prop Valve Seat Leakage (scim)	0	0.7 max
Burner LOX Shutdown Valve Seat Leakage (scim)	0	*

*Limits Not Specified

4 2 5 1 (Continued)

LH2 Tank, O2H2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LH_2 Tank Helium Content (%)	99	75 min
Engine Feed System Internal Leak Checks		
LH_2 Prevlv & Chilldown Shutoff Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	7.6	*
LH_2 Chilldown Ret Check Vlv Rev Lkg (scim)	1.3	350 max
LH_2 Prevlv & Chilldown Shutoff Vlv Combined Seal Leakage (scim)	6.3	150 max
LH_2 Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	1.1	*
LH_2 Bleed Vlv Seat Leakage (scim)	0.2	300 max
MOV & MFV Combined Seat Leakage (scim)	0	*
Main Fuel Vlv Seat Leakage (scim)	0	10 max
Engine Purge System Leak Checks		
LH_2 Pump Drain Check Vlv Rev Leakage (scim)	1.8	25 max
LH_2 Pump Drain Check Vlv Fwd Flow 30 psi (scim)	0	30 max
LH_2 Pump Drain Check Vlv Fwd Flow 60 psi (scim)	7500	2420 min
LH_2 Pump Purge Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Pump Intermediate Seal Leakage (scim)	0	500 max
LH_2 Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Tank & Engine Feed System Leak Checks		
LH_2 Low Pressure Duct Pressure (psig)	30	30 max
LH_2 Pump Speed Monitor Seal Bleed (scim)	0	0
LH_2 Turbopump Torque Checks		
LH_2 Pump Primary Seal Leakage:		
Max (scim)	8.1	350 max
Min (scim)	6.8	350 max
Turbine Torque:		
Breakaway (in/lbs)	40	1000 max
Running (in/lbs)	20	300 max
LH_2 Valves Leak Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0	10 max
Closed Position (scim)	0	10 max
Fill & Drain Valve Seat Leakage (scim)	0	18 max
Fill & Drain Valve Primary Shaft Seal Lkg (scim)	0	6.1 max
O_2H_2 Burner LH_2 System Leak Check		
Combined Burner LH_2 Prop Vlv & LOX Shutdown Valve Seat Leakage (scim)	0	*
Burner LH_2 Prop Valve Seat Leakage (scim)	0	0.7 max

*Limits Not Specified

4.2 5 1 (Continued)

Engine GG & Exhaust System Leak Checks

Function	Measurement	Limits
Engine Seal Leak Checks		
GG Fuel Purge Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Turbine Seal Leakage (scim)	2250	3680 max
2nd E&M Value from J-2 Eng Log Book (scim)	680	*
LOX Turbine Seal Leakage (scim)	3.8	350 max
Start Tnk Disch Vlv Gate Seal Leakage (scim)	0.5	20 max
GG & Exhaust System Leak Checks		
Oxid Turb Bypass Vlv Shaft Seal Leakage(scim)	0	15 max
Oxid Manifold Carr Flng Bleed (scim)	2.1	20 max
GG LOX Poppet Rev Leakage (scim)	1000	*
GG LOX Purge Check Vlv Rev Leakage (scim)	0	15 max
Hydraulic Pump Shaft Seal Leakage (scim)	0	228 max
GG LOX Prop Vlv Seat Leakage (scim)	0	20 max
Combined GG LOX & LH_2 Prop Vlv Seat Lkg (scim)	0	*
GG LH_2 Prop Vlv Seat Leakage (scim)	0	15 max

Engine Pump Purge Leak Checks

Function	Measurement	Limits
Pump Purge Module Internal Leak Checks		
Purge Valve Seat Leakage (scim)	0	12 max
Purge Discharge Pressure (psig)	94	67 to 110
Purge Cont Vlv Backup P/S Diaph (scim)	0	0
Pump Purge Flow Checks		
GG Fuel Purge Flow (scim)	3000	2400 min
LOX Turbine Seal Purge Flow (scim)	3450	2400 min
LH_2 Turbine Seal Purge Flow (scim)	3875	2400 min
Fuel Pump Seal Cavity Purge Flow (scim)	975	200 min

Engine Pneumatics Leak Checks

Function	Measurement	Limits
Helium Control Solenoid Energized Leak Checks		
Low Press Relief Vlv Seal Leakage (scim)	0	5 max
Low Press Relief Vlv Pilot Bleed Lkg (scim)	0	10 max
Fast Shutdown Vent Port Diaph Leakage (scim)	0	3 max
Press Act Purge Vlv Diaph Leakage (scim)	0	3 max
Int Pneu Sys Leakage (He Cont Sol On) (scim)	4.8	20 max

*Limits Not Specified

4.2.5 1 (Continued)

LOX Pump Intermediate Seal Purge Leak Checks

Function	Measurement	Limits
Seal Leakage Pump Direction (scim)	17.5	*
Seal Leakage Turbine Direction (scim)	0	*
Seal Leakage Total (scim)	17.5	850 max
Seal Purge Check Vlv Overboard Flow (scim)	2250	*
Seal Purge Flow (scim)	2267.5	1300 to 3500
Ignition Phase Solenoid Energized Leak Checks		
Start Tnk Disch Vlv 4-Way Sol Seat Lkg (scim)	4.5	15 max
Start Tnk Disch Vlv Piston Seal Lkg (Closed Pos) (scim)	0	40 max
Internal Pneu Sys Lkg (Ign Phase Sol On) (scim)	0	20 max
Start Tank Discharge Valve Solenoid Energized Leak Checks		
STDV 4-Way Sol Seat Lkg (Energized) (scim)	2.0	15 max
STDV Piston Seal Lkg (Open Pos) (scim)	0	40 max
Mainstage Control Solenoid Energized Leak Check		
Press Act Fact Shutdown Vlv Seat Lkg (scim)	0	10 max
Int Pneu Sys Lkg (Mnstg Sol On) (scim)	0	20 max
Pressure Actuated Purge System Leak Check		
Press Act Purge Vlv Vent Seat Lkg (scim	0	10 max
Press Act Purge Vlv Inlet Seat Lkg (scim)	0	10 max
Engine Control Bottle Fill System Leak Check		
Eng Cont Bot Fill Check Vlv Rev Lkg (scim)	0	3 max
Eng Cont Bot Decay Check (Delta M) (lb-mass/hr)	-0.002	0.036 max

LOX & LH_2 Vent System Leak Checks

Function	Measurement	Limits
LOX Vent System Leak Checks		
Combined LOX Vent & Relief Vlv & Relief Vlv Seat & Pilot Bleed Lkg (scim)	100	100 max
Combined LOX V&R Vlv & Relief Vlv Seat, Pilot Bleed Lkg (scim)	269	*
LOX Vent Boost Piston Seal Lkg (scim	169	2420 max
Propulsive Vent System Leak Checks		
Continuous Vent & Orifice Bypass Vlv Seat Lkg (scim)	0	16 max
Nonpropulsive Vent System Leak Checks		
Bi-Director Vent Vlv Seat Lkg (Flt Pos) (scim)	0	50 max
Ground Vent System Leak Checks		
Combined LH_2 V&R Vlv, Relief Vlv Seat, & Pilot Bleed Lkg (scim)	0	150 max
Combined LH_2 V&R Vlv & Relief Vlv Seat, Pilot Bleed, & Boost Piston Seal Lkg (scim)	270	*
LH_2 V&R Vlv Boost Piston Seal Lkg (scim)	270	1725 max
Bi-Direct Vent Vlv Seat Lkg (Gnd Pos) (scim)	0	50 max
Bi-Direct Vent Vlv Act Piston Lkg (Flt Pos) (scim)	0	3 max
Bi-Direct Vent Vlv Act Piston Lkg (Gnd Pos) (scim)	0	3 max

*Limits Not Specified

4.2.6 Stage and GSE Manual Controls Check (1B70177 F)

This poststorage procedure verified manual control capability for the pneumatic regulators and valves in the propulsion GSE and stage systems The test consisted of supplying electrical and pneumatic signals to the system components and checking for the proper response utilizing the Beta I Test Control Center (TCC) panels

The manual controls checkout was satisfactorily conducted on 20 January 1968, and was certified as acceptable on 2 February 1968. Preliminary GSE setup operations were initiated to verify that the switches and valves on the test consoles were positioned properly for the functional check The GSE manual controls were then operated to ensure their functional capability

The stage control helium system check began by verifying that the LOX repressurization spheres were isolated per H&CO 1B70422, and that the stage purge hand valves were closed The control helium spheres were pressurized to 100 $\pm$25 psig and the control sphere dump valves were functioned The spheres were then pressurized to 500 $\pm$50 psig for the stage valves control check

The stage valves control check was accomplished by supplying signals manually from the Beta I TCC control panels to the stage valve controls in a specified sequence, and then verifying correct talkback In addition, test stand personnel verified stage valve actuation audibly or by touch Starting at the TCC mainstage propulsion manual control panel, the LH_2 and LOX chilldown shutoff valves and the LH_2 and LOX prevalves were individually cycled and verified. At the TCC LH_2 control panel, the LH_2 tank vent and the fill and drain valves were cycled open and closed The LH_2 tank vent boost close valve and the LH_2 fill and drain boost close valve were cycled. The LH_2 directional vent valve was cycled from the flight to the ground position. Using the TCC LOX control panel, the LOX tank vent and fill and drain valves were cycled open and closed. The LOX tank vent boost close valve and the LOX fill and drain boost close valve were cycled The cold helium shutoff valve was cycled open and closed. The valves cycled from the TCC stage supply panel included the engine control bottle dump valve, the cold helium bottle dump valve, the start tank dump valve, and the LOX and LH_2 repressurization dump valves The control helium bottle fill valve was then closed.

4.2.6 (Continued)

The stage valves control check was completed at the TCC repressurization control panel by cycling the O_2H_2 burner LOX and LH_2 propulsion valves, and the LOX shutdown valve

The final portion of the procedure consisted of the LH_2 and LOX umbilical purge interlock check, using the TCC LH_2 and LOX control panels

The test was terminated by securing the test stand pneumatic systems using the Beta I TCC control panels and the test stand pneumatics consoles

There were no FARR's resulting from this checkout.

Three revisions were recorded in the procedure during checkout, as follows

a. One revision deleted the GH_2 lead igniter controls check, a GSE checkout that was not required as a poststorage procedure
b One revision permitted verifying the control helium sphere pressure and the regulator discharge pressure at the test stand vehicle monitor panel (VMP), because the pressure transducers required for the deleted panel meter readouts were not installed for poststorage checkout.
c. One revision deleted the control helium regulator backup pressure switch checkout, based on performing a poststorage checkout of this switch during the performance of H&CO 1B62753.

4 2 7 Stage Power Setup (1B55813 E)

Prior to the initiation of poststorage checkouts for the stage on Test Stand Beta I, the automatic stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage, and ensured that the stage power distribution system was not subjected to excessive static loads during initial setup sequences. After successful demonstration, this procedure was used to establish initial conditions during the subsequent poststorage automatic checkouts

This checkout, successfully demonstrated in two issues, on 22 January and 31 January 1968, was accepted on 5 February 1968.

4.2.7 (Continued)

The test was started by resetting all matrix magnetic latching relays and verifying that the corresponding command relays were in the proper state The umbilical connectors were verified to be mated, and plugs 404W26P1 and 404W27P1 were verified to be disconnected from the LOX and LH_2 inverters The bus 4D119 talkback power was turned on, and the prelaunch checkout group was turned off The forward and aft power buses were transferred to external power The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propellant level sensor power were all verified to be off The power to the range safety receivers and EBW firing units was transferred to external and verified to be off The switch selector checkout indication enable and the flight measurement indication enable were both turned on The bus 4D131 28 vdc power supply was turned on and the forward bus 1 initial current and voltage were measured.

The range safety system safe and arm device was verified to be in the SAFE condition. The 70 pound ullage engine relay, the LH_2 and LOX repressurization mode and control valve relays, the LH_2 continuous vent valve relays, and the O_2H_2 burner propellant valve relay were all verified to be reset The LH_2 continuous vent and relief overboard valve closed indication was verified Power was verified to be off for the propellant utilization boiloff bias The O_2H_2 burner spark system 1 and 2 voltages were measured and recorded The O_2H_2 burner LOX and LH_2 valves, and LOX shutdown valve, were verified as closed The LH_2 continuous vent orificed bypass valve was then verified as closed

The forward bus 1 quiescent current was measured. The PCM system group power was turned on and the current was measured and recorded. The forward bus 2 28 vdc power supply was turned on and the forward bus 2 current and voltage were measured The prelaunch checkout power was turned on and the current was measured.

The DDAS ground station source select switch was manually set to position 1 and the ground station was verified to be in synchronization The cold helium supply shutoff valve was closed The aft bus 1 28 vdc power supply was turned on and the aft bus 1 power supply current and voltage were measured. The sequencer power was turned on and the current was measured The forward and aft battery load test off commands were set

4.2.7 (Continued)

A series of checks verified that the stage functions were in the proper state. Forty functions were verified to be off and twenty were verified to be on The LOX and LH_2 prevalves and chilldown shutoff valves were verified as open, and the LOX and LH_2 vent valves and fill and drain valves were verified as closed

The final operations of this automatic procedure measured the forward and aft 5 volt excitation modules, the range safety EBW firing unit charging voltages, the aft bus 2 voltage, the forward and aft battery simulator voltages, and the component test power voltage

Four revisions were written and recorded

a. One revision postponed the program requirement for checking the EBW pulse sensor indications until after the aft bus 1 power supply was turned on, in order to obtain talkback power for the sensor indications

b One revision authorized a change of the 28 ±0 5 vdc program tolerance for stage bus voltages to the previous 28 ±2 0 vdc tolerance, in order to complete issue 1 of the procedure. Because the rework of the external stage bus power supply sense line filters had not been accomplished, it was not possible to operate within the tighter tolerance of the second issue

c One revision explained that an OLSTOL entry for issue 1 was required to reset a function to complete the matrix reset at the start of the test.

d One revision authorized issue 2 for the procedure, and included the initial conditions scan routine as part of the checkout. Issue 2 was run to demonstrate the new program tolerance of 28 ±0.5 vdc for stage bus voltages after the rework of the external stage bus power supply sense line filters had been accomplished

There were no discrepancies recorded by FARR's during this test

4 2.7 1 Test Data Table, Stage Power Setup

Function	Measured Value	Limit
Forward Bus 1 Power Supply Current (amps)	6 70	20 max
Forward Bus 1 Voltage (vdc)	28.24	28 ±0 5
O_2H_2 Burner Spark System 1 Voltage (vdc)	0.01	0 ±0 5
O_2H_2 Burner Spark System 2 Voltage (vdc)	0.00	0 ±0 5
Forward Bus 1 Quiescent Current (amps)	1.10	5 max
PCM System Group Current (amps)	4 70	5 ±3

4.2.7.1 (Continued)

Function	Measured Value	Limit
Forward Bus 2 Power Supply Current (amps)	0.30	2 max
Forward Bus 2 Voltage (vdc)	28.04	28 ±0 5
Prelaunch Checkout Group Current (amps)	1.50	1 ±3
Aft Bus 1 Power Supply Current (amps)	0.10	2 max
Aft Bus 1 Voltage (vdc)	28.20	28 ±0.5
Sequencer Power (amps)	0.20	0 ±3
Aft 5v Excitation Module Voltage (vdc)	4.99	5 ±0 030
Fwd 1 5v Excitation Module Voltage (vdc)	5 01	5 ±0.030
Fwd 2 5v Excitation Module Voltage (vdc)	5.01	5 ±0.030
RS 1 EBW Firing Unit Chg Voltage (vdc)	0.00	0 ±1
RS 2 EBW Firing Unit Chg Voltage (vdc)	0.00	0 ±1
Aft Bus 2 Voltage (vdc)	0 00	0 ±1
Fwd Battery 1 Voltage (vdc)	- 0.04	0 ±1
Fwd Battery 2 Voltage (vdc)	- 0.08	0 ±1
Aft Battery 1 Voltage (vdc)	- 0.04	0 ±1
Aft Battery 2 Voltage (vdc)	0.00	0 ±1
Component Test Power Voltage (vdc)	0.52	0 ±1

4.2.8 Stage Power Turnoff (1B55814 D)

The stage power turnoff procedure was used for automatic shutdown of the stage power distribution system, returning the stage to the de-energized condition after completion of the various system checkout procedures during poststorage testing of the stage on Test Stand Beta I The procedure deactivated the stage relays so that no current flowed from the battery simulators through the stage wiring. All internal/external transfer relays were set to the external condition.

Satisfactory demonstration of this procedure was accomplished on 22 January 1968, and the procedure was accepted on 5 February 1968. Stage power turnoff measurement values for this demonstration issue are tabulated in Test Data Table 4 2 8.1. Following this acceptance, the stage power turnoff procedure was used to shut down the stage at the conclusion of the various automatic checkouts conducted during poststorage operations.

The automatic stage power turnoff started with verification that the umbilical connectors were mated and that the flight measurement indication enable was turned on The bus 4D119 talkback power, the forward bus 1 and aft bus 1 28 vdc power supplies, and the sequencer power were all verified to be on. The forward bus 1 and aft bus 1 voltages were then measured.

4 2.8 (Continued)

The switch selector functions were then turned off, and a series of checks verified that the stage electrical functions were in the proper state of off or reset. The O_2H_2 burner spark systems 1 and 2 voltages were measured. The forward and aft bus power supplies were verified to be off, and the forward and aft bus battery simulator voltages were measured. The stage buses were then transferred to external power, and the forward and aft stage bus voltages were measured. The EBW pulse sensor power was turned off, and the range safety receivers and EBW firing units were transferred to external power. The range safety system safe and arm device was verified to be on safe, and the bus 4D119 talkback power was turned off The matrix magnetic latching relays were then reset, completing this demonstration run for stage power turnoff.

There were no discrepancies recorded by FARR's against this test.

Three revisions were written and recorded in the procedure as follows

a One revision deleted the STOL statement "Reset SIM CHAN 26", occurring at the end of stage power turnoff The statement disables the GSE power supply low voltage SIM interrupt, which must remain active until GSE power is terminated

b. Two revisions involved resetting function number 1172, which was not reset at the beginning of the test by matrix reset Function number 1172 is the aft purge blower, which was in use at the time of the matrix reset, thus giving an on indication. The stage power turnoff was rerun, verifying that the matrix reset would turn off the aft purge blower (Function number 1172).

4 2.8.1 Test Data Table, Stage Power Turnoff

Function	Measured Value	Limit
Forward Bus 1 Voltage, Power on (vdc)	27 84	28 ±2
Aft Bus 1 Voltage, Power On (vdc)	29 08	28 ±2
O_2H_2 Burner Spark System 1 Voltage (vdc)	- 0 04	0 ±0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	- 0 04	0 ±0.5
Forward Bus 1 Battery Simulator Voltage (vdc)	- 0.04	0 ±2
Forward Bus 2 Battery Simulator Voltage (vdc)	0.00	0 ±2
Aft Bus 1 Battery Simulator Voltage (vdc)	0.00	0 ±2
Aft Bus 2 Battery Simulator Voltage (vdc)	0 00	0 ±2
Forward Bus 1 Voltage, Power Off (vdc)	0.00	0 ±1.0
Forward Bus 2 Voltage, Power Off (vdc)	0.00	0 ±1.0
Aft Bus 1 Voltage, Power Off (vdc)	0.00	0 ±1.0
Aft Bus 2 Voltage, Power Off (vdc)	- 0 16	0 ±1.0

4 2.9 Power Distribution System (1B55815 F)

The automatic checkout of the stage power distribution system during poststorage operation verified the capability of the GSE to control power switching to and within the stage, and determined that initial static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized, as required, and that bi-level talkback indications were received at the GSE Static loading of the various stage systems was determined by measuring the GSE supply current before and after turn-on of each system.

Accepted on 16 February 1968, this automatic checkout was initiated on three separate attempts Attempt 1, on 25 January 1968, was terminated due to a computer malfunction, attempt 2, on 25 January 1968, was terminated due to interference resulting from concurrent testing, and attempt 3, on 26 January 1968, was a successful demonstration of power distribution. The LOX and LH_2 chilldown inverter frequencies were remeasured per a revision to attempt 3, on 31 January 1968. (Reference Test Data Table 4 2 9 1.)

Attempt 3 was initiated by a performance of the automatic stage power setup to establish initial conditions To verify that the power supply and stage buses were operating properly, measurements were made of the stage component bus voltages, and of the forward and aft power supply current differentials with the power turned on and turned off to each individual stage component bus.

Starting with the engine control bus power turn-on, the current differential for the aft 1 power supply was measured The engine control bus voltage M6 was measured and determined to be within tolerance The APS bus power was turned on, and again the current differential for the aft 1 power supply was measured. This operation was repeated for the engine ignition bus, measuring the aft 1 power supply current differential and the engine control bus voltage M7 The engine ignition bus power and the APS bus power were then turned off and verified

4.2.9 (Continued)

The engine safety cutoff system (ESCS) power was turned on and the aft 1 power supply current was measured. The component test power was turned on and the aft 1 power supply current differential and the component test power voltage were measured. The component test power was turned off and verified The ESCS power was then turned off.

To check the emergency detection systems (EDS), verification was made that the EDS 2 engine cutoff signal turned off the engine control bus power and prevented it from being turned back on, and also turned on the instrument unit (IU) range safety 1 EBW firing unit arm and engine cutoff signal. The engine control bus voltage was measured during this check, and again after the check with the bus turned back on. Verification was made that the EDS 1 engine cutoff signal turned on the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indication (K13). With the EDS 1 engine cutoff system turned off, the engine ready bypass on turned off both the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indications.

The propellant point level sensor test was started by turning on the propellant level sensor power and measuring the resulting current differential for the forward 1 power supply. Next, each of the four LH_2 tank and four LOX tank point level sensors was verified to respond to simulated wet condition on commands within the allowable 300 milliseconds tolerance A series of checks verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition off commands, resulted in the required engine cutoff signal. For the dry condition of LOX tank point level sensors 1 and 2, the LOX depletion engine cutoff timer value was measured to determine engine cutoff signal delay time. Each of the point level sensors was verified to respond to simulated wet condition off commands within the allowable 300 milliseconds tolerance. This completed the point level sensor testing.

Verification was made that the engine cutoff command turned on the AO multiplexer engine cutoff signal indication (K13), the engine cutoff command indication (K140), and the engine cutoff. The nonprogrammed engine cutoff indication was not turned on as the result of the engine cutoff command. With the engine cutoff command turned off, K140 was verified as off while K13 and the engine cutoff remained on until turned off by the engine ready bypass

The propellant utilizatation (PU) inverter and electronics power supply current differentials were measured while power was momentarily turned on. The PCM RF assembly power was turned on, the RF group was verified to be on, the power supply differential current was measured, and the PCM RF transmitter output wattage was measured through the AO and BO multiplexers. With the telemetry RF silence command turned on, the RF group was verified to be off, the PCM RF transmitter output wattage was measured through the AO multiplexer, and the switch selector output monitor voltage (K128) was measured with the PCM RF assembly power and the switch selector read commands 1 and 2 turned on. With the telemetry RF silence command turned off, the RF group was verified to be on, and the PCM RF transmitter output wattage was again measured through the AO multiplexer.

The rate gyro voltages were manually verified to be 28 0 $\pm$2 0 vdc with gyro power turned on and 0 0 $\pm$2 0 vdc with gyro power turned off. The aft 2 power supply was verified to be within the 56.0 $\pm$4 0 vdc tolerance. The bus 4D141 56 volt supply was turned on, the voltage was measured, and the aft 2 power supply current was measured. The aft 2 power supply local sense indication was verified to be off, the LH_2 and LOX chilldown pump simulators were turned on and the resultant aft 2 power supply current differentials were measured.

For the chilldown inverter tests, the chilldown pump simulators were connected to the LOX and LH_2 chilldown inverters, and for each inverter, measurements were made of the input current, the output voltages through hardwire and telemetry, and the operating frequency through telemetry Attempt 3 conducted the frequency checks manually, and a revision to the attempt subsequently demonstrated the automatic measurement of the chilldown inverter frequencies by hardwire and telemetry. The LOX and LH_2 inverter current draw measurements were verified to be within the 20 0 $\pm$5.0 amps tolerance

4.2.9 (Continued)

A series of automatic checks verified the operation of the external/internal transfer system for forward buses 1 and 2 and aft buses 1 and 2 The battery simulator voltages and the electrical support equipment load bank voltages were measured initially, then the power bus voltages were measured with the buses transferred to internal, and the bus local sense indications were verified to be off. The bus voltages were measured again with the buses transferred back to external, and the battery simulator voltages were measured with the simulators turned off The aft bus 2 voltage was then measured with the bus power supply turned off

A series of checks verified that the switch selector register was operating properly, and that the instrument unit 28 vdc power supplies were on Power was turned on to the range safety receivers after they were transferred to external power, and the resulting GSE power supply current differentials were measured. The range safety EBW firing units were verified to be on when they were transferred to external power and momentarily turned on. This completed the power distribution test.

There were no parts shortages affecting the test, and no problems resulted in FARR's against the checkout. Fifteen revisions were made to the procedure, with one of these deleted. The remaining revisions were

a. One revision added the "Vehicle Safety Brochure, Beta-STC" as the basic authorizing document for the procedure safety instructions

b. One revision repeated the on-line changes for stage power setup required prior to power distribution testing. These were the same as those discussed in the stage power setup, paragraph, 4 2 7.

c. One revision corrected a program error which erroneously called for stage power setup or initial conditions scan prior to loading the executive program tape and data description tape.

d. One revision deleted the program check for the environmental control group. This was no longer required, based on WRO S-IVB 3863, the LH_2 Pressurization System Modification, which eliminated the environmental control group command lines

e One revision authorized the momentary manual reduction of the 28 vdc forward bus 2 voltage to 26 5 vdc, to avoid possible damage to the propellant utilization electronics assembly from a high power turn on voltage spike.

4.2.9 (Continued)

f. One revision added instructions for connecting and disconnecting the chilldown inverter input cables Except where requirements existed to exercise the chilldown inverters, they were disconnected to ensure that they remained in a safe configuration during checkout.

g. Two revisions deleted the automatic frequency checks for the LH_2 and LOX chilldown inverters, and authorized manual frequency measurements, due to lack of monitoring capability through the response conditioner.

h. One revision explained the deletion of another revision, based on the decision to measure the chilldown inverter frequencies manually rather than to incorporate the program changes necessary to permit automatic frequency measurement.

i. One revision provided an electrical installation instruction needed to permit automatic measurement of the LH_2 chilldown inverter frequency during a partial repeat of test run 3.

j Four revisions explained the termination of checkout attempts 1 and 2, and authorized test run 3, as previously described

4.2.9.1 Test Data Table, Power Distribution System

Function	Measurement	Limits
Engine Control Bus Current (amps)	0 299	2 ±2
Engine Control Bus Voltage (vdc)	27 876	28 ±2
APS Bus Current (amps)	0.500	1.5 ±3
Engine Ignition Bus Current (amps)	- 1 999	0 ±2
Engine Ignition Bus Voltage, On (vdc)	28 122	28 ±2
Engine Ignition Bus Voltage, Off (vdc)	0 000	0 ±2
Component Test Power Current (amps)	0.301	0 ±2
Component Test Power Voltage (vdc)	28 039	28 ±2
Engine Control Bus Voltage, EDS 2 On (vdc)	0 000	0 ±2
Engine Control Bus Voltage, EDS 2 Off (vdc)	27 814	28 ±2
Propellant Level Sensor Power Current (amps)	- 0 300	1 ±2
LOX Depletion Engine Cutoff Timer (sec)	0 558	0.560 ±0.025
PU Inverter & Electronics Power Current (amps)	3.400	3 ±2
PCM RF Assembly Power Current (amps)	4 600	4.5 ±3 0
PCM RF Transmitter Output Power, AO (watts)	24 537	10 min.
PCM RF Transmitter Output Power, BO (watts)	24 508	10 min.
PCM RF Transmitter Output Power, AO, T/M RF Silence On (watts)	- 0 118	0 ±2
Switch Selector Output Monitor, K128 (vdc)	2 133	2 ±1
PCM RF Transmitter Output Power, AO, T/M RF Silence Off (watts)	24.180	10 min.
Aft Bus 2 Current (amps)	- 0 199	5 max
Aft Bus 2 Voltage (vdc)	55 917	56 ±4
Forward Battery 1 Simulator Voltage (vdc)	28.24	28 ±2
Forward Battery 2 Simulator Voltage (vdc)	27.96	28 ±2

4.2.9.1 (Continued)

Function	Measurement	Limits
Aft Battery 1 Simulator Voltage (vdc)	27 96	28 ±2
Aft Battery 2 Simulator Voltage (vdc)	55 92	56 ±4
Bus 4D20 ESE Load Bank (vdc)	0 00	0 ±1
Bus 4D40 ESE Load Bank (vdc)	0.00	0 ±1
Bus 4D30 ESE Load Bank (vdc)	0.00	0 ±1
Bus 4D10 ESE Load Bank (vdc)	0 00	0 ±1
Forward Bus 1 Voltage, Internal (vdc)	28.16	28 ±2
Forward Bus 2 Voltage, Internal (vdc)	28 20	28 ±2
Aft Bus 1 Voltage, Internal (vdc)	28.00	28 ±2
Aft Bus 1 Voltage, External (vdc)	28 00	28 ±2
Aft Battery 1 Voltage (vdc)	0 00	0 ±1
Aft Bus 2 Voltage, Internal (vdc)	56.16	56 ±4
Aft Bus 2 Voltage, External (vdc)	55.76	56 ±4
Aft Battery 2 Voltage (vdc)	0 00	0 ±1
Forward Bus 1 Voltage, External (vdc)	28 08	28 ±2
Forward Battery 1 Voltage (vdc)	0 00	0 ±1
Forward Bus 2 Voltage, External (vdc)	28 28	28 ±2
Forward Battery 2 Voltage (vdc)	0.08	0 ±1
RS Receiver 1 External Power Current (amps)	0 250	0 ±2
RS Receiver 2 External Power Current (amps)	0 000	0 ±2

(Data per partial repeat of Attempt 3)

Function	Measurements		Limits
	LOX Inv.	LH_2 Inv	
Phase AB Voltage, Hardwire (vac)	56.904	56.123	* In Tolerance
Phase AB Voltage, Telemetry (vac)	57 332	57.466	* In Tolerance
Phase AC Voltage, Hardwire (vac)	56.970	56.253	* In Tolerance
Phase AC Voltage, Telemetry (vac)	57.199	57.531	* In Tolerance
Phase A_1B_1 Voltage, Hardwire (vac)	56 839	56.059	* In Tolerance
Phase A_1C_1 Voltage, Hardwire (vac)	56.970	56 059	* In Tolerance
Frequency, Hardwire (Hz)	400 0	403 0	400 ± 4
Frequency, Telemetry (Hz)	400.2	402 9	400 ± 4

* Bus 4D41 ± 3 vdc

4.2.10 Digital Data Acquisition System Calibration (1B55816 F)

This procedure provided the manual and automatic operations for the checkout and calibration of the digital data acquisition system (DDAS), and prepared the system for use. The integrity of the DDAS was verified from data inputs through the various multiplexers and the PCM/DDAS assembly to the DDAS ground station The items involved in this test were PCM/DDAS assembly, P/N 1A74049-511,

4 2 10 (Continued)

S/N 017, CP1-BO time division multiplexer, P/N 1B62513-547, S/N 019, DP1-BO time division multiplexer, P/N 1B62513-543, S/N 021, remote digital submultiplexer (RDSM), P/N 1B52894-1, S/N 09, and low level remote analog submultiplexer (RASM), P/N 1B54062-505, S/N 021

This test, initiated on 26 January 1968, required three attempts before successful completion and acceptance occurred on 26 February 1968. The first attempt was completed, but, with the exception of the RASM test, the attempt was invalidated by a malfunction of the DDAS assembly (reference FARR 500-025-611) After the DDAS assembly was replaced, the second attempt was completed with only minor problems (reference FARR 500-025-654) Subsequently, the DP1-BO multiplexer malfunctioned during an Engineering run of the all systems test, H&CO 1B55833 (reference FARR 500-025-751, paragraph 4 2.24) The multiplexer was replaced, and the third attempt of this procedure accomplished only those parts of the test required to check out the new DP1-BO multiplexer.

The stage power was turned on per H&CO 1B55813, and initial conditions were established for the stage and DDAS The 72 kHz bit rate check was made on the PCM data train to ensure that the frequency was within tolerance The 72 kHz bit rate was measured as 72,006 bits per second, well within the 71,975 to 72,025 bits per second limits. The 600 kHz VCO test was accomplished by measuring the band edge frequencies and voltages of the PCM/DDAS VCO output The upper band edge frequency was measured at 632.82 kHz at 4.00 vrms, within the acceptable limits of 623.2 kHz to 643.2 kHz, at greater than 2.2 vrms. The lower band edge frequency was measured at 567.84 kHz at 3.65 vrms, within the acceptable limits of 556.8 kHz to 576.8 kHz, at greater than 2 2 vrms. The frequency differential was calculated as 65.01 kHz, within the acceptable limits of 60 to 80 kHz

The next tests performed were the flight calibration and individual checks of the CP1-BO and DP1-BO multiplexers The outputs of the multiplexer data channels were recorded for each of the calibration and input levels of 0 000, 1 250, 2.500, 3.750, and 5 000 vdc All measured channels were within the required tolerances

4.2.10 (Continued)

The RDSM was verified by inserting signal levels equivalent to ones (20 vdc) and zeros (0 vdc) into the RDSM input circuits, and checking the output at the computer for a digital word of corresponding ones and zeros. The RASM was verified by inserting signal voltages, 0 to 30 millivolts, which were amplified to an output range of 0 to 5 volts dc in correspondence with the 0 to 30 millivolt range input. All measured outputs for the RDSM and the RASM were within the required tolerances.

A final test measured the PCM/FM transmitter current as 5.5 amps.

There were six revisions written to attempt one, six revisions to the second attempt, and three revisions to attempt three.

The attempt one revisions were

a One revision changed a test setup, using a battery and variable resistors as a voltage divider to replace the power supply called out in the procedure.

b. One revision explained that a safety item monitor interrupt during the initial condition scan was due to a program error

c. One revision accepted a malfunction statement "Forward bus 1, forward bus 2, and aft bus 1 not 0.0 ±1 0 vdc", during the initial condition scan The battery simulator was turned on at the time to support other checkouts

d. One revision explained that the typeout statement "noise input on channel 5" was caused by turning the Model 131 power off during a hold condition.

e One revision called for the use of a test cable, P/N 1B66556-1, for SV stages. The original part called out was cable, P/N 1B58151-1, for S-IB stages.

f One revision stated that the malfunctions on run 1 of the RASM test occurred because a capacitor was installed with the polarity reversed. The connection was corrected and no further malfunctions occurred.

The second attempt revisions were

a One revision deleted the RASM section of the test. This section of the test was not affected by the removal and replacement of the PCM/DDAS assembly per FARR 500-025-611.

b One revision deleted the Model DSV-4B-232 telemetry console from the end item requirement list, as it no longer exists

4.2.10 (Continued)

c. One revision stated that the items reported out of certification by inspection item sheet 363077 did not affect the results of this test.

d. One revision inserted the stage power turn on procedure into the program

e. One revision explained the safety item monitor interrupt on channel 22 as a program error

f. One revision stated that the malfunction printouts indicating out-of-tolerance conditions for channels CP1-BO-28-10, DP1-BO-29-08, and DP1-BO-29-10 were due to cross-coupling and noise induced by an inadequate grounding configuration in the telemetry ground station, and were not considered as component failures. This problem is documented on FARR 500-025-654.

The three revisions for attempt three were

a. One revision deleted the requirement for the Model DSV-4B-232 telemetry console as an end item requirement, as it no longer exists.

b One revision deleted the initial condition scan for safety item monitor channel 22 This step set SIM channel 22, which would result in a SIM interrupt since aft bus 2 was not on at that time.

c. One revision deleted all portions of the checkout except the sections necessary to verify the correct operation of the DP1-BO multiplexer after replacement per FARR 500-025-751.

Two FARR's were written during this procedure

a. FARR 500-025-611 noted that the DDAS assembly, P/N 1A74049-511, S/N 014, dropped out data seven times during this test. The assembly was removed, and a new DDAS assembly, S/N 017, was installed and accepted.

b. FARR 500-025-654 noted low output voltages on one channel of the CP1-BO multiplexer and two channels of the DP1-BO multiplexer. These conditions were accepted by Engineering.

4.2.11 Auxiliary Propulsion System Interface Checkout (1B49558 B)

Contained in this manual checkout were the test sequences necessary to verify a suitable electrical interface between the stage and the auxiliary propulsion system (APS) modules, P/N 1A83918-519, S/N's 1009-1 and 1009-2, after installation of the modules on the stage.

This checkout was satisfactorily performed and certified as acceptable on 26 January 1968. A preliminary inspection of plugs and sockets was accomplished

4.2.11 (Continued)

prior to mating, to ensure against damaged electrical connectors. Resistance checks verified the proper connections between the stage control relay packages and the APS engine valves, and also between the stage aft skirt and the APS control system components.

There were no discrepancies recorded by FARR's as a result of this checkout.

Two revisions were written to the procedure during checkout operations for the following:

a. One revision corrected a procedure error that had omitted a notation requiring the removal of a patch board before the test, and the reinstallation of the board after the procedure was completed.

b. One revision changed the resistance tolerance range for the connections between the aft skirt and the APS control components, based on the requirements of H&CO 1B70108, Electrical Module Checkout Controls and Instrument Interface SV APS Modules.

4.2.11.1 Test Data Table, APS Interface Compatibility

		Common Test Point	Stage Ground	
Stage Comp.	Test Point	APS Component	Meas Ohms	Limit Ohms
404A51A4	J4 A	414A8L1 Eng. 1, Valve A	25	25 ±5
404A51A4	J4 B	414A8L5 Eng. 1, Valve 1	25	25 ±5
404A51A4	J4 C	414A8L2 Eng. 1, Valve C	26	25 ±5
404A51A4	J4 D	414A8L6 Eng. 1, Valve 3	25	25 ±5
404A51A4	J4 E	414A8L3 Eng. 1, Valve B	25	25 ±5
404A51A4	J4 F	414A8L7 Eng. 1, Valve 2	24	25 ±5
404A51A4	J4 G	414A8L4 Eng 1, Valve D	24	25 ±5
404A51A4	J4 H	414A8L8 Eng 1, Valve 4	25	25 ±5
404A51A4	J4 J	414A10L1 Eng 3, Valve A	25	25 ±5
404A51A4	J4 K	414A10L5 Eng 3, Valve 1	25	25 ±5
404A51A4	J4 L	414A10L2 Eng 3, Valve C	25	25 ±5
404A51A4	J4 M	414A10L6 Eng. 3, Valve 3	25	25 ±5
404A51A4	J4 N	414A10L3 Eng. 3, Valve B	25	25 ±5
404A51A4	J4 P	414A10L7 Eng 3, Valve 2	25	25 ±5
404A51A4	J4 R	414A10L4 Eng. 3, Valve D	25	25 ±5
404A51A4	J4 S	414A10L8 Eng. 3, Valve 4	25	25 ±5
404A51A4	J4 T	414A9L1 Eng. 2, Valve A	25	25 ±5
404A51A4	J4 U	414A9L5 Eng. 2, Valve 1	25	25 ±5
404A51A4	J4 V	414A9L2 Eng 2, Valve C	25	25 ±5
404A51A4	J4 W	414A9L6 Eng. 2, Valve 3	25	25 ±5

4.2.11.1 (Continued)

Stage Comp	Test Point	APS Component	Meas. Ohms	Limit Ohms
		Common Test Point — Stage Ground		
404A51A4	J4 X	414A9L3 Eng. 2, Valve B	25	25 ±5
404A51A4	J4 Y	414A9L7 Eng 2, Valve 2	25	25 ±5
404A51A4	J4 Z	414A9L4 Eng. 2, Valve D	25	25 ±5
404A51A4	J4 a	414A9L8 Eng 2, Valve 4	25	25 ±5
404A71A19	J4 A	415A8L1 Eng. 1, Valve A	25	25 ±5
404A71A19	J4 B	415A8L5 Eng. 1, Valve 1	24	25 ±5
404A71A19	J4 C	415A8L2 Eng. 1, Valve C	25	25 ±5
404A71A19	J4 D	415A8L6 Eng. 1, Valve 3	25	25 ±5
404A71A19	J4 E	415A8L3 Eng. 1, Valve B	25	25 ±5
404A71A19	J4 F	415A8L7 Eng. 1, Valve 2	25	25 ±5
404A71A19	J4 G	415A8L4 Eng. 1, Valve D	25	25 ±5
404A71A19	J4 H	415A8L8 Eng. 1, Valve 4	25	25 ±5
404A71A19	J4 J	415A10L1 Eng. 3, Valve A	25	25 ±5
404A71A19	J4 K	415A10L5 Eng 3, Valve 1	25	25 ±5
404A71A19	J4 L	415A10L2 Eng. 3, Valve C	25	25 ±5
404A71A19	J4 M	415A10L6 Eng 3, Valve 3	25	25 ±5
404A71A19	J4 N	415A10L3 Eng. 3, Valve B	25	25 ±5
404A71A19	J4 P	415A10L7 Eng. 3, Valve 2	25	25 ±5
404A71A19	J4 R	415A10L4 Eng. 3, Valve D	25	25 ±5
404A71A19	J4 S	415A10L8 Eng. 3, Valve 4	25	25 ±5
404A71A19	J4 T	415A9L1 Eng. 2, Valve A	25	25 ±5
404A71A19	J4 U	415A9L5 Eng. 2, Valve 1	25	25 ±5
404A71A19	J4 V	415A9L2 Eng. 2, Valve C	25	25 ±5
404A71A19	J4 W	415A9L6 Eng. 2, Valve 3	25	25 ±5
404A71A19	J4 X	415A9L3 Eng 2, Valve B	25	25 ±5
404A71A19	J4 Y	415A9L7 Eng 2, Valve 2	25	25 ±5
404A71A19	J4 Z	415A9L4 Eng. 2, Valve D	25	25 ±5
404A71A19	J4 a	415A9L8 Eng. 2, Valve 4	25	25 ±5
404A4	J7 r	414A5L1	21	13-25
404A4	J7 d	414A5L1	20	13-25
404A4	J7 p	414A6L1	13.5	13-25
404A4	J7 x	414A1L1	22	13-25
404A4	J7 f	414A1L1	19	13-25
404A4	J7 v	414A2L1	14	13-25
404A4	J7 m	414A6L2	17.5	13-25
404A4	J7 t	414A2L2	17	13-25
404A4	J7 z	SPARE	Inf	Inf
404A4	J7 q	415A5L1	24	13-25
404A4	J7 c	415A5L1	20	13-25
404A4	J7 n	415A6L1	13.5	13-25
404A4	J7 w	415A1L1	22	13-25
404A4	J7 e	415A1L1	20	13-25

4.2.11.1 (Continued)

		Common Test Point	Stage Ground	
Stage Comp.	Test Point	APS Component	Meas. Ohms	Limit Ohms
404A4	J7 u	415A2L1	14	13-25
404A4	J7 k	415A6L2	17 5	13-25
404A4	J7 s	415A2L2	17	13-25
404A4	J7 y	SPARE	Inf	Inf
404A2A16	J2 B	414A7L1 Eng 4, Valve A	39	40 ±5
404A2A16	J2 C	414A7L2 Eng 4, Valve 1	39	40 ±5
404A2A16	J2 A	415A7L1 Eng 4, Valve A	39	40 ±5
404A2A16	J2 D	415A7L2 Eng 4, Valve 1	39	40 ±5

4.2.12 Hydraulic System Setup and Operation (1B41005 B)

The purpose of this manual procedure was to ensure that the hydraulic system was correctly flushed, filled, bled, and maintained free of contamination during hydraulic system operation The hydraulic system pressures and temperatures were checked for proper operational levels, the hydraulic system transducer circuits were tested for correct operation and response characteristics; and the J-2 engine operational clearance in the aft skirt was established

The test was initiated on 29 January 1968, and was completed on 2 February 1968. A second issue was released on 12 February 1968, to verify the operation of the hydraulic system after the replacement of the hydraulic system pressure transducer for measurement D041. This transducer malfunctioned during an Engineering run of the hydraulic system test, H&CO 1B55824 (reference FARR 500-025-697, paragraph 4.2.19).

Proper operation of the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454590, the main hydraulic actuator assemblies, P/N 1A66248-505-011, S/N 52, and P/N 1A66248-507-012, S/N 60, the main hydraulic pump, P/N 1A66240-503, S/N X457806, and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00032, were verified during the course of this checkout.

Prior to operation of the stage hydraulic system, the GSE Model DSV-4B-358 hydraulic pumping unit (HPU), P/N 1A67443-1, was checked to ensure that the hydraulic fluid met the cleanliness requirements. The HPU was connected to

4.2.12 (Continued)

the stage via the pressure and return hoses. Hydraulic fluid was circulated through the stage system to ensure that the system was properly filled, and hydraulic fluid samples were taken and were certified to be free of contamination.

The accumulator/reservoir was charged with gaseous nitrogen, and the stage air bottles were charged to a pressure of 475 ±50 psig The HPU was turned on and the pressure compensator turned in the INCR direction until the system hydraulic pressure gauge indicated no further increase in pressure, but was less than 4400 psig. The stage hydraulic system was then checked for leaks.

On completion of the leak check, the pressure compensator on the HPU was turned in the DECR direction until the stage hydraulic system pressure reached 1500 ±5 psig. The HPU bypass valve was opened and the stage system pressure was further reduced to 1000 ±50 psig. The auxiliary hydraulic pump was turned on and verified to be operating properly

With the midstroke locks installed on the hydraulic actuators, the vernier scales were adjusted to read zero The midstroke locks were then removed The HPU was turned on and the hydraulic system pressure was brought up to 3650 ±50 psig. The pitch and yaw vernier scales were read and the values were recorded in the Test Data Table. The HPU was turned off and the midstroke locks were reinstalled.

The engine deflection clearance check was accomplished next The gimbal control unit (GCU), P/N 1B50915, was installed and set up per H&CO 1B53382. The J-2 engine bellows protective covers were removed, and the platform extension, P/N 1B70620, was removed from the engine area. The J-2 engine restrainer and the hydraulic actuator midstroke locks were removed. After an inspection of the engine area for possible interference points, the HPU was turned on and the stage system pressure was brought up to 1000 psig The pitch and yaw controls on the GCU were turned in the retract and extend directions. As the controls were moved it was verified that the pitch and yaw actuators moved in relation to the direction and amplitude of the controls. By returning the pitch and yaw controls to center, the actuators were positioned to center and HPU was turned off. The midstroke locks and the J-2 engine bellows protective covers were reinstalled.

4.2.12 (Continued)

Verification and setup of the stage and test control center hydraulic system instrumentation was started by turning on the HPU and adjusting the pressure compensator until the system hydraulic pressure gauge indicated the desired pressure readings.

Preparations for the engine gimbal test were initiated by disconnecting the GCU from the actuators and connecting the stage electrical cables to the actuators, and removing the midstroke locks and the J-2 engine bellows protective covers. The engine area was verified to be clear for gimbaling. The HPU was turned on and the system pressure was established at 3650 psig. Various signals of predetermined input values were applied to the pitch and yaw actuators by the computer, and the resultant voltages were noted and recorded in the Test Data Table. Upon completion of the gimbal test, the HPU was turned off, and the midstroke locks and the engine protective covers were reinstalled.

The shutdown sequence of this checkout included a final air content test which provided the information necessary for system analysis by discharging a portion of the internal system fluid volume overboard. The volume discharged was determined to be a function of the fluid temperature measurement, to provide space in the reservoir for fluid thermal expansion under ground operating conditions (0-160°F). The HPU was turned on and the system pressure was increased to 3650 ±50 psig, the bypass valve was opened and the HPU was then turned off. Verification was made that the return pressure gauge indicated a minimum of 200 psig. The shutoff valve was cycled open and closed until the return pressure was reduced to 180 ±5 psig. An empty 100 ml graduate was placed under the drain port, and, by cycling the reservoir drain valve open and closed, the return pressure was decreased to 80 ±5 psig. The volume of fluid bled was less than the 16 milliliters maximum as specified per design requirements.

A check to determine the pressure decay of the stage air bottles was conducted next. The air bottles were verified to be charged to 453 psia, well within the 475 ±50 psia limits, and the pressure and range time were recorded. After a lapse of 24 hours, the bottle pressure was remeasured and recorded as 449 psia, well within the allowable limits.

4.2.12 (Continued)

All data was reviewed and this checkout was acceptable to Engineering.

There were neither part shortages nor retest requirements pending that affected this test. One GSE FARR reported a leak at a quick disconnect on the HPU. After replacement of the quick-disconnect, no further leakage was noted and no other problems occurred.

There were fifteen revisions written to the two issues, six to the first issue and nine to the second issue.

The revisions to issue one were

a. Two revisions deleted sections of the procedure that were normally prefire checks, and were not applicable to poststorage conditions.
b. One revision added the requirement to visually verify the proper functioning of the main system filter by depressing the differential pressure indicator of the accumulator/reservoir and verifying that it remained depressed.
c. One revision changed the data callouts from volts to psia, and from volts to percent, because the prefire performance of the procedure recorded voltages to check the hardwire system, but for poststorage checkout the telemetry is operating and the actual values are required
d. One revision repeated the system cleanliness test for the final air content check.
e. One revision changed the reservoir fluid bleed curve to permit higher operating temperatures, and to lessen the chances of dumping fluid overboard during system operation.

The revisions to the second issue were

a. Three revisions pertained to the requirement to record readings of the HPU system hydraulic pressure high gauge and the numerical readout of measurements D041 and D043, to allow a comparison of the measurements and the HPU gauge indications at various pressure levels (Reference Test Data Table)
b. One revision authorized the bleeding of the stage air bottles and the accumulator/reservoir to ambient, to ensure system depressurization prior to the removal and replacement of the hydraulic system pressure transducer (Ref FARR 500-025-697, paragraph 4.2.19).

4.2.12 (Continued)

c One revision deleted all sections of the procedure that were not required for the support of the transducer D041 change.

d. One revision added a retest of the hydraulic system cleanliness after the replacement of transducer D041.

e. One revision altered the slope of the fluid bleed curve to incorporate new curve data, which allowed higher operating temperatures and lessened the possibility of fluid loss as the result of thermal expansion.

f. One revision authorized the repressurizing of the hydraulic accumulator subsequent to GN_2 pressure stabilization after the initial fill.

g One revision recharged the stage air bottles to ensure the proper charge pressure prior to performing the DDAS automatic checkout.

4.2.12.1 Test Data Table, Hydraulic System Setup and Operation

Test Description	Instrumentation Name	Instrumentation Location	Actual	Requirement
Actuator Position System Unpressurized	Pitch Vernier	Pitch Actuator	0 inches	0 inches
	Yaw Vernier	Yaw Actuator	0 inches	0 inches
Actuator Position System Pressurized	Pitch Vernier	Pitch Actuator	0 inches	Ref. Only
	Yaw Vernier	Yaw Actuator	0 inches	Ref. Only

4.2.12.1 (Continued)

	Instrumentation			
Test Description	Name	Location	Position	Voltage
Instrumentation Support	Pitch Position	Actuator TCC	0°	2.525 volts
			+1°	2.168 volts
			+2°	1.818 volts
			+1°	2.181 volts
			0°	2.531 volts
	Pitch Position	Actuator TCC	0°	2.531 volts
			-1°	2 884 volts
			-2°	3.232 volts
			-1°	2 875 volts
			0°	2 529 volts
	Yaw Position	Actuator TCC	0°	2.524 volts
			+1°	2.871 volts
			+2°	3.215 volts
			+1°	2.866 volts
			0°	2.518 volts
	Yaw Position	Actuator TCC	0°	2.518 volts
			-1°	2.176 volts
			-2°	1.836 volts
			-1°	2.180 volts
			0°	2.518 volts

D041 Pressure Comparison Test

HPU (psig)	System Press. D041 (psia)	Resv. Press. D042 (psia)	Accum. GN_2 Press. D043 (psia)
2600	2561	265.8	2526
2900	2845	265.8	2807
3200	3140	265.8	3101
3300	3232	265.8	3199
3400	3333	265.8	3300
3500	3434	265.8	3401
3600	3526	265 8	3499
3700	3628	265.8	3609
3800	3726	265.8	3709
3900	3831	265.8	3810
4000	3932	265.8	3884

4 2.13 Propellant Utilization System Calibration (1B64368 E)

Calibration and operation instructions for the propellant utilization (PU) system were provided by this manual checkout. For calibration purposes, the propellant utilization test set (PUT/S), P/N 1A68014-2, was utilized to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA) to simulate the LOX and LH_2 mass probe outputs under varying propellant load conditions

The items involved in this test included

Part Name	Ref Location	P/N	S/N
Propellant Utilization Electronics Assy	411A92A6	1A59358-525	00004
Static Inverter-Converter	411A92A7	1A66212-505	020
LOX Mass Probe	406A1	1A48430-509	C1
LH_2 Mass Probe	408A1	1A48431-501	D3
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D50
LOX Fastfill Sensor	406A2C5	1A68710-1	D97
LOX Fastfill Control Unit	404A72A5	1A68710-511.1	E12
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D92
LH_2 Fastfill Sensor	408A2C5	1A68710-1	E149
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	C1

Initiated on 31 January 1968, the PU system calibration was completed and accepted on 5 February 1968. Megohm resistance measurements of the LOX and LH_2 mass probes were verified to be greater than the 1000 megohm minimum requirement The output voltage and operating frequency of the static inverter/converter were measured, and the resulting values were within the specified limits. The PUEA LH_2 bridge was calibrated for the empty condition by nulling the PUT/S ratiometer at a reading of 0 00613, then nulling the PUEA R2 potentiometer. The PUEA LOX bridge was calibrated for the empty condition by nulling the PUT/S ratiometer to a reading of 0.01977, then nulling the PUEA R1 potentiometer. The PUEA LH_2 and LOX bridges were calibrated for full conditions by setting the PUT/S ratiometer to 0.82303 and nulling the LH_2 and LOX bridge potentiometers

Data acquisition was verified by establishing simulated empty and full conditions and determining the PUT/S ratiometer settings required to null the PUEA LH_2 and LOX bridges. All values obtained were within the required

4.2.13 (Continued)

limits The bridge slew checks were conducted by simulating 1/3 and 2/3 slew conditions and determining the PUT/S ratiometer settings required to null the PUEA LH_2 and LOX bridges for each case.

The reference mixture ratio (RMR) calibration was then accomplished. The first step consisted of determining the difference between the LOX and LH_2 empty ratiometer readings, and multiplying this difference by 98.4 vdc. The resultant product was designated as VI. Simulated empty conditions were set up and the PUEA residual empty bias potentiometer R6 was nulled. Simulated full conditions were then established with the PUT/S C1 (LH_2) capacitor set to 182 04 picofarads and the C2 (LOX) capacitor set to 122.52 picofarads. The residual full bias potentiometer R5 on the PUEA was set to the null position The bridge linearity checks were then accomplished by adjusting the PUT/S capacitors C1 (LH_2) and C2 (LOX) to specific values and determining the PUT/S ratiometer settings required to null the PUEA bridges The hardwire loading voltages of the LH_2 and LOX bridges were checked and found to be within the specified tolerance of 23.52 ± 2.0 vdc.

All required parts were installed at the start of this checkout There were three revisions written to correct errors in the procedure. No other discrepancies were documented.

4.2 13.1 Test Data Table, Propellant Utilization System Calibration

Function		Measured Value	Limits
Static Inverter Output			
5 vdc	(vdc)	4 92	4.5 to 5.10
21 vdc	(vdc)	21 46	20 to 22 5
28 vdc	(vdc)	27 39	26 to 30
V/P Excitation	(vdc)	50 96	48.6 to 51 7
115 VRMS Monitor	(vdc)	2 82	2.28 to 3.18
117 vdc	(vdc)	120 4	115 to 122.5
TP_2 Reading	(vdc)	21 5	20 to 22.5
Frequency Output	(Hz)	396 1	396.1 to 406

4.2.13 1 (Continued)

Function	Measured Value	Limits
Data Acquisition (Ratios)		
LH_2 Empty	0.01388	*
LOX Empty	0.03989	*
LH_2 Full	0.82308	*
LOX Full	0.82296	*
Bridge Slew Checks (Ratios)		
LH_2 1/3 Slew	0.30985	*
LH_2 2/3 Slew	0.63990	*
LOX 1/3 Slew	0.28367	*
LOX 2/3 Slew	0.57163	*
LH_2 Bridge Linearity Check (Ratios)		
36.41 pf	0 15974	0.15795 to 0.16125
72.82 pf	0 32543	0.32381 to 0.32710
109.22 pf	0.49091	0.48967 to 0.49296
145 63 pf	0.65675	0.65552 to 0.65882
182.04 pf	0.82301	0.82138 to 0.82467
LOX Bridge Linearity Check (Ratios)		
24.5 pf	0.18047	0.17910 to 0.18232
49.01 pf	0 34054	0.33967 to 0.34296
73.51 pf	0.50178	0.50024 to 0.50353
98.02 pf	0.66217	0.66081 to 0.66410
122 52 pf	0.82302	0.82138 to 0.82467

* Limits not specified

4.2.14 Range Safety Receiver Checks (1B55819 F)

This combined manual and automatic checkout verified the functional capabilities of the range safety receivers and decoders, prior to their use in the range safety system. The receivers were checked for automatic gain control (AGC) calibration and drift, minimum acceptable deviation sensitivity, minimum acceptable RF sensitivity, and open loop RF operation. The items involved in this test were

Item	Ref Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	104
Range Safety Receiver 2	411A97A18	50M10697	167
Secure Command Decoder 1	411A99A1	50M10698	0133
Secure Command Decoder 2	411A99A2	50M10698	0092

4.2.14 (Continued)

Initiated on 5 February 1968, this checkout was completed and accepted on 16 February 1968.

Several manual operations were accomplished before the automatic phase of the checkout was started. The total cable insertion loss values at the 450 MHz range safety frequency were determined to be 29.90 db for range safety system 1, and 29.90 db for range safety system 2 The GSE Model DSV-4B-136 destruct system test set, P/N 1A59952-1, was set up at 450 ± 0.045 MHz with a -17 dbm output level and a 60 ± 0.60 kHz deviation. The stage range safety antennas were disconnected from the directional power divider, and 50 ohm loads were connected to the power divider in their place for testing, until the open loop RF checks.

The cable insertion loss values were loaded into the computer, initial test conditions were established, the range safety receivers were transferred to external power and turned on, and the propellant dispersion cutoff command inhibit was turned on

The receiver AGC calibration checks were conducted next For each input signal level used in the calibration check, the computer determined the GSE test set output level required to compensate for the cable insertion loss. Per the computer typeout, the GSE test set was manually adjusted to the appropriate output levels. The computer determined the input signal levels and measured the low level signal strength (AGC telemetry) of each receiver. These AGC measurements, in the 0.0 to 5.0 vdc range, were multiplied by a conversion factor of twenty and presented as percent of full scale values. As the result of a loose connector, the AGC calibration check was conducted twice. The difference in AGC values at each step was determined and utilized for the AGC drift check. As shown in Test Data Table 4.2.14.1, the AGC values were all acceptable, and the drift deviations were well below the 3 percent of full scale maximum limit.

Manual -3 db and -60 db RF bandwidth checks were individually conducted on each receiver With a GSE test set output frequency of 450.000 ± 0.005 MHz, the output level was adjusted to obtain a 2.0 ± 0 1 vdc AGC voltage from the receiver under test. The corresponding receiver RF output level was determined, and +20 dbm was added to obtain the RF reference level. The GSE test set output level was increased by 3 db, and the test set frequency was increased to greater than 450 MHz, and decreased to less than 450 MHz, until the receiver AGC voltage was again 2 0 ± 0.1 vdc. The frequencies at which this occurred were measured as the upper and lower -3 db band edge frequencies The -3 db bandwidth was found as the difference between these frequencies, and the bandwidth centering was found as the difference between the midpoint of these frequencies and 450 MHz. For the -60 db bandwidth check, this checkout was repeated, except that the test set output level was increased by 60 db in lieu of 3 db.

For the deviation threshold check, the GSE test set was adjusted to an output of 450 ± 0.045 MHz at a level that provided receiver input levels of -63 dbm for receivers 1 and 2. A series of checks determined the minimum input deviation frequency at which each receiver responded to the respective range safety command For each command, the GSE test set was manually adjusted to a sequence of deviation frequencies increasing from 5 kHz, per the computer typeout. At each deviation frequency, the range safety secure command decoders were checked for the presence of the command signal from the appropriate receiver. As shown in the Test Data Table, the receivers responded to all commands at minimum deviation frequencies less than the 50 kHz maximum limit

For the radio frequency sensitivity checks, the GSE test set was adjusted for an output of 450 ± 0 045 MHz with a fixed deviation of 60 ± 0.5 kHz A series of checks determined the minimum input signal level at which each receiver responded to the respective range safety commands For each command, the GSE test set output was manually adjusted to a sequence of levels increasing from -85 5 dbm, as requested by the computer This gave input levels increasing from -115.0 dbm for receiver 1 and increasing from -115.0 dbm for receiver 2. At each input level, the range safety secure command decoders were checked for receipt of the command signal from the appropriate receiver. Both receivers responded to minimum input levels less than the -93 dbm maximum limit.

The 50 ohm loads were disconnected from the stage power divider, and the range safety antennas were reconnected. For the manual open loop check, the GSE

4.2.14 (Continued)

test set was adjusted for open loop operation, and the test set antenna coaxial switch was set to test position 1. The test set output level was set at -100 dbm and increased in 1 dbm increments until the AGC voltage of the least sensitive receiver no longer increased. This occurred at an output level of -73 dbm. The AGC voltage of the other receiver was verified to be at least 3 vdc at this level. The check was repeated with the test set antenna coaxial switch set to test position 2, with the output level measured as -73.5 dbm. The test set antenna coaxial switch was returned to the first test position, and the test set output level was set at -88.0 dbm for the automatic open loop RF checks.

Under open loop conditions, the low level signal strength (AGC telemetry voltage) of receiver 1 was 3.50 vdc, while that of receiver 2 was 3.12 vdc. The range safety commands were transmitted from the GSE test set, and checks of the secure command decoders indicated the receivers responded properly to the open loop transmission The PCM RF assembly power was turned on, the open loop PCM signal was verified to be received at the DDAS ground station, and the range safety commands were again transmitted. Checks of the decoders indicated that the receivers responded and were not adversely affected by the PCM RF transmission The PCM RF assembly power was turned off, and the range safety EBW firing units were transferred to external power. The propellant dispersion cutoff command inhibits were turned off for each receiver, and the range safety receivers were turned off, thus completing the range safety receiver checks

Engineering comments noted that there were no part shortages affecting the test. FARR 500-025-662 documented the replacement of range safety antenna 1 as the result of low sensitivity. Antenna, P/N 1A69207-501, S/N 40, was removed, and another antenna, S/N 21, was installed.

Sixteen revisions were documented against the checkout

a. One revision deleted the special calibration requirements for the attenuator, P/N TAC-50-X1, as the attenuator had been certified previously

4.2.14 (Continued)

b. One revision changed the HP608C signal generator setup instructions to correct a procedure error.

c One revision changed the counter readout indication for the signal generator from 60.000 ± 000.600 to 60.00 ± 000.60 kHz The procedure callout was in error.

d. One revision corrected a typographical error.

e. One revision authorized the performance of an attenuation measurement on a test cable to be used for a special open loop test. The insertion test data was required to verify the other antenna systems.

f. One revision repeated the open loop test with the range safety checkout antenna moved 180 degrees in respect to the original location, to comply with a NASA request

g. One revision added the requirement for the stage power setup procedure to be accomplished prior to entering the range safety automatic procedure. The test data was to be a part of this checkout

h. One revision provided instructions for a special test to isolate the signal attenuation of the range safety antenna circuit.

i. One revision reran the open loop RF check to verify the operation of range safety antenna 1. This antenna was removed and replaced per FARR 500-025-662.

j. One other revision repeated the rerun test for the replacement antenna, reference FARR 500-025-662.

k. One revision noted that the FILADD program changes on the stage power setup procedure printout sheets referred to the stage power setup procedure, H&CO 1B55813, not to the range safety receiver checkout.

l. One revision enabled the program to perform the open loop section of the checkout for two revisions of the procedure, will all other tests bypassed by the computer.

m. One revision gave instructions to disregard the flagged portions of the test printout. The printout was due to an operator error.

n. One revision authorized a rerun of the AGC calibration checks, due to a loose connector on the range safety antenna.

o Two revisions explained changes to the stage power setup procedure.

4.2.14.1 Test Data Table, Range Safety Receiver Checks

AGC Calibration and Drift Checks (% = Percent of Full Scale)

Test Set Output (dbm)	Receiver 1 Input (dbm)	AGC 1 (%) Run 1	AGC 1 (%) Run 2	AGC 1 (%) Drift	Receiver 2 Input (dbm)	AGC 2 (%) Run 1	AGC 2 (%) Run 2	AGC 2 (%) Drift
-97 1	-127.0	11.78	11.89	0.12	-127.0	7.48	7.79	0.31
-90.1	-120 0	12.09	11.89	0.20	-120.0	7.68	7.58	0.10
-85 1	-115.0	12.19	12.09	0.10	-115.0	8 09	7.89	0.20
-80 1	-110.0	13.73	14.04	0.31	-110.0	8.91	8.91	0.00
-75.1	-105.0	17.73	17.64	0.10	-105.0	11.51	11.17	0 10
-70.1	-100.0	27.79	27.89	0.10	-100 0	17 83	17.73	0.10
-65.1	- 95.0	48.20	47.99	0.21	- 95 0	31 89	32.09	0.20
-60.1	- 90.0	66.04	65 43	0.61	- 90.0	58.46	56.29	2.17
-55.1	- 85 0	69.53	69.53	0.00	- 85 0	70.25	70.14	0.12
-50.1	- 80.0	70.25	70.35	0.10	- 80 0	71.68	71.68	0.00
-45.0	- 75.0	70.55	70 55	0.00	- 75 0	72.19	72.30	0.12
-40.0	- 70 0	70 96	70.96	0.00	- 70.0	72.40	72.40	0 00

-3 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2 07	2.04	2.0 ± 0 1
Reference RF Power Level (dbm)	-67.0	-63 0	-
Upper Band Edge Freq. (MHz)	450.151	450.150	-
Lower Band Edge Freq. (MHz)	449.838	449 816	-
-3 db Bandwidth (kHz)	313.0	334.0	340.0 ± 30 0
Bandwidth Centering (kHz)	6.0	17.0	33.8 max

-60 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2 07	2.04	2.0 ± 0.1
Reference RF Power Level (dbm)	-67.0	-65 0	-
Upper Band Edge Freq (MHz)	450 467	450 747	-
Lower Band Edge Freq (MHz)	449 504	449.533	-
-60 db Bandwidth (MHz)	0 963	0.941	1.2 max

4.2.14 1 (Continued)

Deviation Sensitivity Check

Range Safety Command	Minimum Deviation (kHz) Receiver 1	Receiver 2
Arm and Engine Cutoff	12.5	12.5
Propellant Dispersion	12.5	12.5
Range Safety System Off	12.5	12.5

RF Sensitivity Check

Range Safety Command	Minimum Input Level (dbm) Receiver 1	Receiver 2
Arm and Engine Cutoff	-110 0	-105.0
Propellant Dispersion	-105.0	-110.0
Range Safety System Off	-105.0	-105 0

4.2.15 Propellant Utilization System (1B55823 G)

This automatic checkout verified the capability of the propellant utilization (PU) system to determine and control the engine propellant flow mixture ratio in a manner that ensured simultaneous propellant depletion. The test also verified the capability of the PU system to provide propellant level information for controlling the fill and topping valves during LOX and LH_2 loading operations The automatic checkout system (ACS) was utilized during testing to function PU system components and to monitor responses This test involved all components of the stage PU system including

Part Name	Ref Location	P/N	S/N
Propellant Utilization Electronics Assy	411A92A6	1A59358-525	00004
Static Inverter-Converter	411A92A7	1A66212-505	020
LOX Mass Probe	406A1	1A48430-509	C1
LH_2 Mass Probe	408A1	1A48431-501	D3
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D50
LOX Fastfill Sensor	406A2C5	1A68710-1	D97
LOX Fastfill Control Unit	404A72A5	1A68710-511.1	F12
LH_2 Overfill Sensor	(Part of LH2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D92
LH2 Fastfill Sensor	408A2C5	1A68710-1	E149
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	C1

4 2.15 (Continued)

Initial conditions for the test were established on 5 February 1968, and the ratio values, obtained from the manual PU system calibration procedure, H&CO 1B64368, were loaded into the computer. From these ratio values, nominal test values were computed for the LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages After an evaluation of the computer printout, a test of the PU system power was made. Power was applied to the PU inverter-converter, and the forward bus 2 voltage was measured After a programmed delay of 15 minutes, to allow the inverter-converter to stabilize, the output voltage and frequency were measured and determined to be within specified limits. An additional delay of 30 minutes was required for the PU oven temperature to stabilize. Verification was made that the oven temperature was within the tolerance range

The servo bridge balance and ratio valve null tests were conducted next. The error voltages, as well as the LOX and LH_2 coarse and fine voltages, were measured and determined to be within design specifications and tolerance limits

The PU loading test was accomplished next The PU boiloff bias on indication was verified to be off, and the LH_2 boiloff bias voltage was measured as 0.40 vdc With the PU boiloff bias on indication on, the PU boiloff bias was measured as 6.71 vdc. The PU boiloff bias was then turned off, and the bias voltage was determined to be 0.29 vdc.

The GSE power supply voltage was measured as 28.079 vdc. The LOX and LH_2 loading potentiometer sense voltages were measured, and the LOX and LH_2 loading potentiometer signal voltages were measured. The LOX and LH_2 1/3 checkout relay commands were turned on, and the LOX and LH_2 loading potentiometer signal voltages were again measured. The checkout relay commands were turned off and the LOX and LH_2 loading potentiometer sense voltages were again measured.

The servo balance bridge gain test was conducted next, starting with a measurement of the error signal voltage and the ratio valve position in degrees. The LOX and LH_2 coarse and fine mass voltages were measured initially, and

4.2.15 (Continued)

were remeasured with the 1/3 and 2/3 checkout relay commands turned on. In reverse order, the voltages were measured as the 2/3 and 1/3 checkout relay commands were turned off. All measurements were within the required limits as determined by the ACS.

The next test checked operation of the overfill and fastfill sensors in the LOX and LH_2 tanks. This test was accomplished by verification that the proper indications were registered under ambient (dry) and under simulated wet conditions of the sensors.

For a PU valve movement test, 50 second plus valve slew checks and 50 second minus valve slew checks were conducted. The preslew ratio valve position and the system test valve position signal were measured before each of the slew checks was started. During each slew, the ratio valve position was measured through the AO telemetry multiplexer at 3, 5, 8, 20, and 50 seconds after the slew started, to determine the change in the position from the preslew measurement. As shown in the Test Data Table, all of the measurements were within the required limits.

The PU activate test was conducted next, with the measurements made through the AO and BO multiplexer circuits. The ratio valve position was measured, the LOX bridge 1/3 checkout relay command was turned on, and the LOX coarse mass voltage was measured. The ratio valve position was remeasured with the PU activate switch turned on, then turned off The LOX bridge 1/3 checkout relay command was turned off and all voltages were remeasured The test was then repeated using the LH_2 bridge 1/3 checkout relay command, and measuring the LH_2 coarse mass voltage

For a final test, the PU valve hardover position command was turned on, and the PU system ratio valve position was measured as -27 3 degrees with the LOX bridge 1/3 checkout relay command and the PU activate switch both on, meeting the requirement of -20 degrees maximum.

Engineering comments indicated that no interim use material items were installed, and there were no part shortages at the start of this test No FARR's were written as a result of this test, and the PU system was accepted for use on 5 February 1968.

4.2.15 (Continued)

Seven revisions were written to the procedure

a. One revision changed the tolerance of the PU loading potentiometer from ± 2.0 vdc to + 0.2, -0.6 vdc. The previous tolerance was in error

b One revision changed the tolerance of the system test valve error command from 1 00 ± 0.03 vdc to 1.00 ± 0.02 vdc, per a NASA request.

c. One revision added a 30 minute delay after the PU turn-on, to allow the PU oven to reach operating temperature.

d. One revision added the requirement for the PU oven temperature indication to be measured four times at 1 minute intervals The measured values were to agree within ± 0 3 vdc

e. One revision set the high calibration value for the PU oven temperature transducer at 4 00 ± 0.075 vdc, and the low calibration value at 0.00 ± 0.075 vdc.

f. One revision added a requirement to run an initial condition scan prior to performing the PU automatic test, and to make the printout result a part of the PU system procedure.

g One revision explained a malfunction in the initial condition scan. The PU oven should have been off during the scan.

4.2.15.1 Test Data Table, Propellant Utilization System

Loaded Ratio Values (from H&CO 1B64368)

LOX Empty Ratio	0.020	LH_2 Empty Ratio	0 000
LOX 1/3 Bridge Slew Ratio	0.284	LH_2 1/3 Bridge Slew Ratio	0.310
LOX 2/3 Bridge Slew Ratio	0.571	LH_2 2/3 Bridge Slew Ratio	0.640
LOX Wiper Ratio	0.040	LH_2 Wiper Ratio	0.014
LH_2 Boiloff Bias Voltage (vdc)		7.000	

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.098	LH_2 Empty	0.000
LOX 1/3 Mass	1.421	LH_2 1/3 Mass	1.548
LOX 2/3 Mass	2.856	LH_2 2/3 Mass	3 198

Computed Fine Mass Voltages (vdc)

LOX Empty	3.911	LH_2 Empty	1 367
LOX 1/3 Mass	0.151	LH_2 1/3 Mass	2.339
LOX 2/3 Mass	2.017	LH_2 2/3 Mass	4.683

4 2.15.1 (Continued)

Computed Loading Voltages (vdc)

LOX Empty	0.547	LH_2 Empty	0 000
LOX 1/3 Coarse Mass	7.957	LH_2 1/3 Coarse Mass	8 668

PU System Power Test

Function	Measured Value	Limits
Forward Bus 2 Voltage (vdc)	27.92	28 0 ± 2
Inv-Conv 115 vrms Output (vac)	115 660	115.0 ± 3.4
Inv-Conv 21 vdc Output (vdc)	21 626	21 25 ± 1.25
Inv-Conv 5 vdc Output (vdc)	4.965	4.8 ± 0.3
Inv-Conv Frequency (Hz)	400.070	400.0 ± 6

Bridge Balance and Ratio Valve Null Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0 419			0.0 ± 1 5
LOX Coarse Mass Voltage (vdc)		0 093	0.103	0 098 ± 0.1
LOX Fine Mass Voltage (vdc)		3.979	3 979	3.911 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0 005	0.000	0 000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.387	1 387	1.367 ± 0 4

PU Loading Test

Function	Measured Value	Limits
LH_2 Boiloff Bias Signal Volt (vdc)	6 71	7 0 ± 1 0
GSE Power Supply Voltage (vdc)	28 079	28 0 ± 2.0

Loading Potentiometer Function	LOX Value	LH_2 Value	Limits
Sense Voltage, GSE Power On (vdc)	28.079	28 039	GSE Pwr ± 0.4
Signal Voltage, Relay Commands	0.492		0.560 ± 0.5
Off (vdc)		0.000	0 0 ± 0.5
Signal Voltage, Relay Commands	7.684		7.957 ± 0 6
On (vdc)		8 449	8 668 ± 0.6
Signal Voltage, Relay Commands	0.520		0 560 ± 0 5
Off (vdc)		0.000	0 0 ± 0.5
Sense Voltage, GSE Power OFF (vdc)	0.000	-0 039	0 0 ± 0.75

4.2 15 1 (Continued)

Servo Balance Bridge Gain Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.487			0.419 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.107	0.103	0.098 ± 0.1
LOX Fine Mass Voltage (vdc)		3.970	3.965	3.911 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.005	-0.010	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.396	1.392	1.367 ± 0.4

1/3 Checkout Relay Commands On

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0 965			0.419 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.416	1.416	1.421 ± 0.1
LOX Fine Mass Voltage (vdc)		0.073	0.068	0.151 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.553	1 543	1.548 ± 0 1
LH_2 Fine Mass Voltage (vdc)		2 505	2.500	2.339 ± 0.4

2/3 Checkout Relay Commands On

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.715			0.419 ± 1 5
LOX Coarse Mass Voltage (vdc)		2.856	2.852	2.856 ± 0.1
LOX Fine Mass Voltage (vdc)		1.699	1.699	2 017 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		3 193	3.198	3.198 ± 0.1
LH_2 Fine Mass Voltage (vdc)		5.005	4.985	4.683 ± 0.4

2/3 Checkout Relay Commands Off

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1 033			0.419 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.416	1.421	1 421 ± 0.1
LOX Fine Mass Voltage (vdc)		0.083	0 078	0.151 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.553	1.548	1 548 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.490	2.500	2.339 ± 0.4

1/3 Checkout Relay Commands Off

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.282			0.419 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.107	0.103	0.098 ± 0.1
LOX Fine Mass Voltage (vdc)		3 979	3.965	3.911 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		-0.005	-0.005	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1 396	1.401	1.367 ± 0.4

4.2.15.1 (Continued)

PU Valve Movement Test

Function	Measured Value	Limits
Ratio Valve Position, AO (deg)	0.351	0 419 ± 1.50
Ratio Valve Position, BO (deg)	0.419	0.419 ± 1.50

50 Second Plus Valve Slew, AO Multiplexer

+1 vdc System Test Valve Position Signal (vdc)	0.999	1.00 ± 0.36
V1, Position at T+3 Seconds (deg)	4.500	2 037 to 6 351
V2, Position at T+5 Seconds (deg)	5 592	2.659 to 7.396
V3, Position at T+8 Seconds (deg)	6 137	2.977 to 7.396
V4, Position at T+20 Seconds (deg)	6.409	5.226 to 7 396
V5, Position at T+50 Seconds (deg)	6.409	5.226 to 7.396

50 Second Minus Valve Slew, AO Multiplexer

Ratio Valve Position, AO (deg)	0.35	0 419 ± 0 150
-1 vdc System Test Valve Error Signal (vdc)	-1 010	-1 00 ± 0 036
V1, Position at T+3 Seconds (deg)	-3 953	-2 037 to -6.351
V2, Position at T+5 Seconds (deg)	-4.976	-2.659 to -7.396
V3, Position at T+8 Seconds (deg)	-5.453	-2 977 to -7.396
V4, Position at T+20 Seconds (deg)	-5 726	-5 226 to -7 396
V5, Position at T+50 Seconds (deg)	-5.726	-5.226 to -7.396

PU Activation Test

Function	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.215	0 282	0.419 ± 1 50
LOX 1/3 Command Relay On			
LOX Coarse Mass Voltage (vdc)	1.421	1.411	1.421 ± 0.1
PU System On			
Ratio Valve Position (deg)	33.213	33.485	20 0 min
PU System Off			
Ratio Valve Position (deg)	0.624	0.828	15.0 max
LOX 1/3 Command Relay Off			
LOX Coarse Mass Voltage (vdc)	0.107	0.103	0.098 ± 0.1
Ratio Valve Position (deg)	0.351	0.419	0 419 ± 1.5
LH_2 1/3 Command Relay On			
LH_2 Coarse Mass Voltage (vdc)	1 553	1.548	1.548 ± 0 1

4.2.15.1 (Continued)

Function	AO Multi	BO Multi	Limits
PU System On			
Ratio Valve Position (deg)	-27.056	-25.056	-20.0 max
PU System Off			
Ratio Valve Position (deg)	0 49	-	-15.0 min
LH_2 1/3 Command Relay Off			
LH_2 Coarse Mass Voltage (vdc)	0.000	0.005	0.000 ± 0.1
Ratio Valve Position (deg)	0.351	0.419	0.419 ± 1.5

4.2.16 Auxiliary Propulsion System Test (1B66774 A)

Contained in this automatic checkout were the procedures which verified the design integrity and operational capability of the auxiliary propulsion system (APS) electrical system for the flight stage.

Initial conditons for the test were established with the performance of the stage power setup procedure H&CO 1B55813, on 6 February 1968. The instrument unit (IU) substitute power supply was turned on and measured The APS 1 test was started by measuring the helium sphere and helium regulator outlet pressure through the AO and BO multiplexers. The helium sphere, oxidizer tank, and fuel tank temperatures were measured. The fuel and oxidizer ullage pressure were then measured

The APS 1 engine propellant transfer valve test was accomplished next. The APS firing command was turned on and the 1-2 engine valve open indication was verified to be 0 00 vdc (closed position) The aft bus 1 voltage was then measured With the APS firing command turned off, the 1-2 engine valve was commanded open then closed. During valve movement, the following functions were monitored and recorded time, valve voltage, thrust chamber pressure, and oxidizer and fuel manifold pressures. The 1-2 engine propellant transfer valve full open indication was measured by the BO multiplexer. The APS firing enable command was turned off, the aft bus 1 voltage was measured, and the 1-3 engine propellant transfer valve open indication was verified to be -0.0005 vdc (closed position)

With the APS 1 firing command turned off, the propellant transfer valve for the 1-3 engine was operated and the operating elapsed time, valve voltage, thrust chamber pressure, and oxidizer and fuel manifold pressures were

4.2.16 (Continued)

recorded. The propellant transfer valve full open indication was measured and the firing command was turned on. The transfer valve was closed, the open indication was recorded at 0.000 vdc, and the aft bus 1 voltage was measured

The APS 1 firing command was again turned off and the test repeated for the 1-1 engine propellant transfer valve.

Upon completion of the APS 1 engine propellant transfer valve test, the entire test was repeated for APS 2.

The APS 1 and 2 ullage engine propellant transfer valves, engines 1-4 and 2-4, were then tested using the same method as that used for the attitude control engines.

All measured values are listed in Test Data Table 4.2 16.1 The checkout was completed on 7 February 1968, and was accepted on 8 February 1968.

There were nine revisions written during the course of this procedure

a. One revision added the requirement for the Test Requirement APS Subsystem Auto, SIV/SV, 1B62711, to this procedure per NASA request.

b. One revision added a reference to the Sacramento Test Center Safety Brochure.

c. One revision changed the APS 1 pre-test setup to 1B70430 in lieu of Paragraph 4.1 2.

d. One revision changed the APS 2 pre-test setup to 1B70430 in lieu of Paragraph 4.3.1.

e. One revision accepted, for this test, an out-of-tolerance reading of 60.23 psia for the APS 1 helium regulator outlet pressure. The pressure should have been 50 ± 10 psia.

f. One revision deleted the securing of APS 1 and 2 per Paragraph 4 2 5 Securing was accomplished per 1B70430

g. One revision changed the sequence of a test from before to after aft bus 1 turn on.

h. One revision changed the tolerance for the bus 1 voltage from 28 ± 0.5 vdc to 28 ± 2 vdc.

i. One revision clarified two lines of printout that were overlapped due to a line printer hangup.

There were no other discrepancies, and the APS system was accepted for use

4.2.16.1 Test Data Table, Auxiliary Propulsion System

APS 1 Test

Function	Meas.	AO Multi	BO Multi	Limit
IU Substitute Power (vdc)	-29.08			-28.5 ± 2.5
Helium Sphere Pressure (psia)		45.8	49.6	100 0 max
Helium Regulator Outlet (psia)		59 8	60.23**	50.0 ± 10 0
Helium Sphere Temperature (°F)		69.7	-	*
Oxidizer Tank Temperature (°F)		62 7	62 9	*
Fuel Tank Temperature (°F)		60.3	60.2	*
Fuel Tank Ullage Pressure (psia)		54.1	-	50.0 ± 10.0
Oxidizer Tank Ullage Pressure (psia)		54.1	-	50.0 ± 10.0
Fuel Manifold Pressure (psia)		31.4	-	40.0 ± 20.0
Oxidizer Manifold Pressure (psia)		38.4	-	40.0 ± 20.0
Engine 1-2 Valve Test				
Valve Open Ind (Closed) (vdc)	0.00			*
Aft Bus 1 Voltage (vdc)	28.438			*
Valve Open Ind (Open) (vdc)	4 092			*
Engine 1-3 Valve Test				
Valve Open Ind (Closed) (vdc)	-0.0005			*
Aft Bus 1 Voltage (vdc)	28.438			*
Valve Open Ind (Open) (vdc)	4.081			*
Engine 1-1 Valve Test				
Valve Open Ind (Closed) (vdc)	0.000			*
Aft Bus 1 Voltage (vdc)	28 278			*
Valve Open Ind (Open) (vdc)	4.087			*

APS 1 - Engine Propellant Transfer Valve Tests

	Time	Valve Open	Measured Pressures (psia)		
Valve Movement	(sec)	Ind (vdc)	Thrust Chamb	Oxid Manif	Fuel Manif
Engine 1-2					
Open	0.000	0 000	14 979	38.406	32.295
	0.021	0.000	14.979	38 406	32.295
	0 057	3.969	24.612	35 787	32 295
	0.093	4.087	27.823	35 787	32.295
	0.130	4.102	27 181	31 858	29 676
Close	0 022	4.066	26.539	31.858	29.676
	0 056	0.000	22 258	31.423	28.804
	0 090	-0.005	18 618	31.423	28 804
	0 123	0.005	16.264	31 423	28.804
	0.157	-0 005	15.407	31 423	28 804
Engine 1-3					
Open	0 000	-0.005	14 927	35.787	30 550
	0.022	0.041	14.140	34 914	30.550
	0.056	4 071	24 282	34.914	30.113
	0.090	4.112	26 834	33.168	30.113
	0.124	4.056	27.046	33.168	28.804

* Limits Not Specified
** See revision e

4.2 16.1 (Continued)

Valve Movement	Time (sec)	Valve Open Ind (vdc)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
Engine 1-3					
Close	0.021	3 820	26.195	31.423	28.804
	0.057	0 000	21.730	31.423	27.494
	0.094	0.000	18 329	31.423	27.494
	0 129	-0.005	16.628	31 423	27.494
	0.163	0.000	14.715	31 423	27.931
Engine 1-1					
Open	0 000	-0.005	15.458	34 914	29 676
	0.022	-0.005	14.618	34.914	27.931
	0.057	4.005	23.063	32.295	29.676
	0 090	4.061	25.598	32.295	29 676
	0.124	4.056	26.231	32.295	29.676
Close	0.021	4.081	25.598	31.423	29.676
	0.058	-0.005	21.162	31.423	27.931
	0.095	0.000	17.147	29.676	27.931
	0 130	-0.005	15.458	29 676	27.931
	0.164	0.000	14 825	30 550	27.494

APS 2 Test

Function	Meas.	AO Multi	BO Multi	Limit
IU Substitute Power (vdc)	-29.16			-28.5 ± 2.5
Helium Sphere Pressure (psia)		57.3	49 6	100.0 max
Helium Regulator Outlet (psia)		54.1	54.6	50.0 ± 10.0
Helium Sphere Temperature (°F)		69.0	-	*
Oxidizer Tank Temperature (°F)		58.5	58 3	*
Fuel Tank Temperature (°F)		60.6	60 6	*
Fuel Tank Ullage Pressure (psia)		56.3	-	50.0 ± 10.0
Oxidizer Tank Ullage Pressure (psia)		55.0	-	50.0 ± 10.0
Fuel Manifold Pressure (psia)		36.2	-	40.0 ± 20 0
Oxidizer Manifold Pressure (psia)		33 2	-	40.0 ± 20.0
Engine 2-2 Valve Test				
Valve Open Ind (Closed) (vdc)	0.00			*
Aft Bus 1 Voltage (vdc)	28.479			*
Valve Open Ind (Open) (vdc)	4.040			*
Engine 2-3 Valve Test				
Valve Open Ind (Closed) (vdc)	-0.0005			*
Aft Bus 1 Voltage (vdc)	28.278			*
Valve Open Ind (Open) (vdc)	3 969			*
Engine 2-1 Valve Test				
Valve Open Ind (Closed) (vdc)	0.000			*
Aft Bus 1 Voltage (vdc)	28.118			*
Valve Open Ind (Open) (vdc)	4 010			*

* Limits Not Specified

4.2.16.1 (Continued)

APS 2 - Engine Propellant Transfer Valve Tests

Valve Movement	Time (sec)	Valve Open Ind (vdc)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
Engine 2-2					
Open	0.000	-0.005	14.607	33.168	36.659
	0.022	0.000	14.607	33.168	37.096
	0.057	3.953	22 711	33.168	37.096
	0.091	3.994	23 564	29.676	33.604
	0.128	4.015	23.138	29.676	33.604
Close	0.022	4.030	20.792	27.931	32.295
	0.056	-0.005	15.247	27.931	32.295
	0.090	-0.005	14 607	27.059	31.423
	0 124	-0.010	14.607	27.059	31.423
	0.158	0.000	14.820	27.931	31.423
Engine 2-3					
Open	0.000	-0.005	15.203	33.168	37.532
	0.022	0.000	15.203	32.731	36.659
	0.056	3.855	25.106	33.168	37 532
	0.090	3.953	28 478	33.168	37.532
	0.124	3.964	29 109	27.931	37.532
Close	0.022	1.805	28.056	27.931	33.168
	0.059	0.010	22.156	28.804	32.295
	0.094	0.000	18.152	28.804	32.295
	0.128	0.000	16.467	28.804	32.295
	0.162	-0 005	15.624	28 804	32.295
Engine 2-1					
Open	0.000	-0 005	14.244	33.168	36.659
	0.021	0.000	14.032	33 168	37.096
	0.055	3.928	24.208	31.413	34.914
	0.089	3.999	27 388	31.423	34.914
	0.123	4.015	27.600	29.676	34 914
Close	0.022	4.010	26.751	29.676	33.168
	0.058	0.000	26.664	28 804	33.168
	0 094	0.010	18 061	28.804	31.423
	0 131	0.000	15.305	28.804	31.423
	0 164	-0.005	14 244	28.804	32.295

Ullage Engine Tests

Function	Measurement	Limit
IU Substitute Power (vdc)	-29.20	-28 5 ± 2.5
APS 1 Fuel Supply Manifold Pressure (psia)	33.2	40.0 ± 20.0
APS 1 Oxidizer Supply Manifold Pressure (psia)	38.0	40.0 ± 20.0
APS 2 Fuel Supply Manifold Pressure (psia)	36.7	40.0 ± 20.0
APS 2 Oxidizer Supply Manifold Pressure (psia)	33.2	40.0 ± 20.0

4.2.16.1 (Continued)

Ullage Engine Propellant Transfer Valve Test

Valve Movement	Time (sec)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
APS 1 - Engine 1-4				
Open	0 000	14 979	38 406	33 168
	0.030	15.191	37.532	32.731
	0.074	25.847	35.787	33 168
	0.117	25.847	35.787	33.168
	0 162	20 732	34.042	31.423
	0.210	19.454	34.042	31 423
Close	0.031	18.814	29.676	27.059
	0.074	18.814	29.676	27 059
	0.117	15.405	29.676	26.186
	0.165	14.979	29.676	26.186
	0.211	14 979	30.113	26.186
APS 2 - Engine 2-4				
Open	0.000	15 449	33.168	36.659
	0.030	15.237	34.042	37.532
	0.074	15 449	33.168	37.096
	0.117	15.449	33.168	37.096
	0.162	15 237	33 168	36 659
	0.210	15.237	33.168	36.659
Close	0.031	15.237	32.731	36.659
	0.074	15 237	32.731	36.659
	0.117	15.237	33.168	37.532
	0 165	15 237	33 168	37.532
	0.211	15.237	32.731	37.532

4 2 17 Auxiliary Propulsion System Checkout (1B70430 NC)

Contained in this manual and automatic checkout were the procedures required to verify the functional capabilities of the auxiliary propulsion system (APS), when mated to the stage This procedure defined the preliminary preparation, safety requirements, and detailed manual operations necessary for checkout

The checkout was initiated on 6 February 1968, after verification of satisfactory completion of the APS and stage interface compatibility checkout, H&CO 1B49558

After the initial setup, which included measuring and recording fuel and oxidizer tank pressures, and fuel and oxidizer manifold pressures on APS module 1, a fuel valve functional and system leak check was performed The blanket pressure line was connected to port "J" on APS 1 and the fuel tank transfer valve open command was executed The APS panel blanket pressure supply valve was opened and the hand loader regulator was set at 20 ± 5 psig The APS blanket pressure valve was opened and the fuel manifold pressure was measured and recorded Cycling of the fuel tank recirculation valve was accomplished and it was verified that helium flowed from port "L" as the recirculation valve was opened, and ceased when the valve was closed The recirculation valve was again commanded open, and helium flow was again noted at port "L" The flow ceased when the fuel tank transfer valve was closed The fuel tank recirculation valve and the fuel tank transfer valve were opened After verification that the fuel manifold pressure had stabilized, both valves were closed The APS blanket pressure panel was secured The APS fuel manifold pressure was recorded, and after 5 minutes, a final pressure reading was taken The same test procedure was repeated for the oxidizer section of APS 1

A helium valve functional test was accomplished next The APS blanket pressure line was connected to port "P" of APS 1 The blanket pressure handloader regulator was set to 40 ± 5 psig, and bleed valve V-3315 was closed The APS 1 fuel and oxidizer ullage pressures were reported and entered in Test Data Table 4 2 17 1

The APS fuel tank ullage vent valve was opened for 1 second, then closed The fuel tank emergency ullage vent was also cycled similarly Operation of the oxidizer ullage vent valve and the oxidizer ullage emergency vent valve was

4 2 17 (Continued)

accomplished using the same method used for the fuel valves The APS blanket pressure panel was again secured and the fuel and oxidizer ullage pressures were monitored for 5 minutes The initial and final pressures were noted and recorded

The pressure scan and engine valve function test for APS 1 was the next section completed The blanket pressure hand loader regulator was set to 25 ± 5 psig, and the bleed valve was closed The APS 1 blanket pressure valve was opened and the fuel tank and oxidizer tank transfer valves were opened The APS automatic checkout was called up on the automatic checkout system and the manual automatic control switch was placed in the automatic mode During this section of the test, the computer verified several APS functions Upon completion of the automatic test, manual control was resumed The magnetic amplifier output voltage required to cycle the engine valves was noted and recorded

The APS 1 blanket pressures were re-established and recorded The fuel tank transfer valve and the oxidizer tank transfer valve were closed The blanket pressure panel bleed valve was opened, the hand loader regulator was secured, then the bleed valve was closed Final securing from the APS 1 test was accomplished by closing the APS 1 blanket pressure valve and the blanket pressure supply valve

The test as performed on APS 1 was repeated for APS 2 All data for APS 1 and APS 2 are found in the Test Data Table

All parts were installed at the start of this test, and no interim use material items were installed

No FARR's were written as a result of this test, and the procedure was accepted on 7 February 1968

Seven revisions were written to the procedure

a One revision provided instructions for re-establishing the APS blanket pressures after completion of the test

b One revision authorized the substitution of a 0 to 100 psia Heise gauge in place of the D1-3313 gauge in the panel, P/N 1B73321-1 The panel meter was not in service at time of the test

4 2 17 (Continued)

c One revision authorized and provided instructions for leak checking the installation of the Heise gauge into the panel, P/N 1B73321-1

d One revision repeated a previous revision to re-establish the blanket pressure on the fuel and oxidizer manifolds

e One revision extended the authority of the previous revision concerning the Heise gauge

f One revision deleted the requirement for removing the throat plugs from APS engine 1, 2, 3, and 4

g One revision corrected a typographical error in the original procedure

4 2 17 1 Test Data Table, Auxiliary Propulsion System Checkout

Module Setup	APS 1	APS 2	Limits
Fuel Tank Pressure (psig)	5 0	6 0	0 5 min
Fuel Ullage Pressure (psia)	57 2	59 4	*
Fuel Manifold Pressure (psia)	16 1	25 3	*
Oxidizer Tank Pressure (psig)	4 5	4 5	0 5 min
Oxidizer Ullage Pressure (psia)	57 2	56 3	*
Oxidizer Manifold Pressure (psia)	26 2	22 3	*
Fuel Valve Functional Check			
Fuel Manifold Pressure			
Initial (psia)	29 7	31 9	35 ± 15
Final (psia)	29 7	32 3	35 ± 15
Oxidizer Valve Functional Check			
Oxidizer Manifold Pressure			
Initial (psia)	34 5	27 5	35 ± 15
Final (psia)	34 5	27 5	35 ± 15
Helium Valve Functional Check			
Fuel Ullage Pressure (psia)	57 2	59 8	50 ± 15
Oxidizer Ullage Pressure (psia)	56 7	56 7	50 ± 15
Engine Valve Functional Test			
Voltage Required for Valve Cycle			
Engine 1 (vdc)	4 056	4 015	*
Engine 2 (vdc)	4 102	4 015	*
Engine 3 (vdc)	4 112	3 964	*

* Limits Not Specified

4 2 17 1 (Continued)

Module Setup	APS 1	APS 2	Limits
Blanket Pressures (psia)			
Oxidizer Ullage	54 1	55 1	*
Fuel Ullage	55 0	56 0	*
Fuel Manifold	33 6	36 7	*
Oxidizer Manifold	37 5	32 7	*

* Limits Not Specified

4 2 18 Range Safety System (1B55821 G)

The automatic checkout of the range safety system verified the system external/internal power transfer capabilities, and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command, and system off command The items involved in this test included the following

Part Name	Reference Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	104
Range Safety Receiver 2	411A79A18	50M10697	167
Secure Command Decoder 1	411A99A1	50M10698	0133
Secure Command Decoder 2	411A99A2	50M10698	0092
Secure Command Controller 1	411A97A13	1B33084-503	012
Secure Command Controller 2	411A97A19	1B33084-503	011
RS System 1 EBW Firing Unit	411A99A12	40M39515-119	463
RS System 2 EBW Firing Unit	411A99A20	40M39515-119	464
RS System 1 EBW Pulse Sensor	411A99A31	40M02852	*
RS System 2 EBW Pulse Sensor	411A99A32	40M02852	*
Safe and Arm Device	411A99A22	1A02446-503	*
Directional Power Divider	411A97A56	1B38999-1	00020
Hybrid Power Divider	411A97A34	1A74778-501	047
*Installed in Pulse Sensor Assembly	411A99A31/32	1B29054-501	0004

Initiated on 9 February 1968, the procedure was accepted as complete on 12 February 1968, after the second attempt The first attempt was completed on 9 February 1968, but was not acceptable due to many errors in the first revision to the program

4 2 18 (Continued)

Initial conditions for the second attempt were established on 12 February 1968, and the GSE Model DSV-4B-136 destruct system test set, P/N 1A59952-1, was set up for closed loop operation at 450 MHz with a -50 dbm output level and a 60 kHz deviation The forward bus 1 and bus 2 battery simulators were turned on, both receivers were verified to be off, and the battery simulator voltages were measured

The external/internal power transfer test was then started. Both EBW firing units were verified to be off, and external power was turned on for both receivers and both firing units. The firing unit charging voltage indications and the firing unit indications were measured for both range safety systems The propellant dispersion cutoff command inhibit was then turned on for both receivers Both firing units were transferred to internal power, and the external power for the units was turned off. Both units were verified to be on, and the charging voltage indications were measured Both firing units were transferred back to external power and verified to be off, and the firing unit charging voltage indications were again measured. The external power for both receivers was turned off, and the receivers were verified to be off The receivers were transferred to internal power and verified to be on, then transferred back to external power and verified to be off Finally, both receivers were transferred back to internal power and again verified to be on

The EBW firing unit arm and engine cutoff command was turned on and verified to be received by range safety system 1. The system 1 firing unit charging voltage indication was measured Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers, that the non-programmed engine cutoff indication was off, and that the instrument unit receiver 1 arm and engine cutoff indication was off The receiver 1 propellant dispersion cutoff command inhibit was then turned off, and the instrument unit receiver 2 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was then off, that the engine cutoff indications were still off at the umbilical and through both multiplexers, that the non-programmed engine cutoff indication was still off, and that the instrument unit receiver 1 arm and engine cutoff

4 2.18 (Continued)

indication was then on The receiver 1 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff indication was verified to again be off. The EBW firing unit arm and engine cutoff command was turned off. The engine control bus power was turned back on and the bus voltage was measured. Both firing units were transferred to external power and verified to be off, and the charging voltage indications were measured

The EBW firing unit arm and engine cutoff command was turned back on and verified to be received by range safety system 2 The system 2 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers, that the non-programmed engine cutoff indication was off, and that the instrument unit receiver 2 arm and engine cutoff indication was off. The receiver 2 propellant dispersion cutoff command inhibit was turned off, and the instrument unit receiver 1 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was still on, that the engine cutoff indication was then on at the umbilical and through both multiplexers, that the non-programmed engine cutoff indication was then on, and that the instrument unit receiver 2 arm and engine cutoff indication was on The receiver 2 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 2 arm and engine cutoff indication was verified again to be off The EBW firing unit arm and engine cutoff command was turned off The engine ready bypass was turned on, and the engine cutoff indication was verified to be off at the umbilical.

The EBW pulse sensor power and pulse sensor self test were turned on and both range safety pulse sensors were verified to be set. The pulse sensor reset was turned on, and both pulse sensors were verified to be reset. Each of the range safety systems was individually tested by the following steps, starting with system 1 The propellant dispersion command was turned on and verified to be received by the receiver under test The appropriate firing unit charging voltage indication was measured, and the appropriate pulse sensor was verified to be off. The propellant dispersion command was turned off, the

4.2 18 (Continued)

propellant dispersion cutoff command inhibit for the receiver under test was turned off, and the propellant dispersion command was turned back on. For the system under test, the firing unit charging voltage indication was measured, and the pulse sensor was verified to be on. The propellant dispersion cutoff command inhibit was then turned back on and the propellant dispersion command was turned off. The above steps were then repeated to test system 2. After the test of system 2, the propellant dispersion cutoff command inhibit was turned off for both receivers, and the engine control bus power was verified to be off.

The range safety system off test was conducted next. The range safety system off command was turned on, and power for receiver 1 and the system 1 EBW firing unit was verified to be off The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system off command was turned back on, and the power for receiver 2 and the system 2 EBW firing unit was verified to be off. The range safety system off command was then turned back off

The safe and arm device was tested next The safe-arm safe command was turned on, the safe indication was verified to be on, and the arm indication was verified to be off The safe-arm arm command was turned on, the safe indication was verified to be off, and the arm indication was verified to be on. The safe-arm safe command was turned back on, and again the safe indication was verified to be on, and the arm indication was verified to be off.

This completed the range safety system tests, and the shutdown operations were accomplished The computer printout indicated that each of the two range safety receivers and two secure decoders had accumulated 1 minute 12.194 seconds of running time during the procedure, each of the range safety EBW firing units had been cycled one time, and the switch selector had been used one time

Engineering comments noted that there were no part shortages affecting this test There were a total of seven revisions written to the procedure

a One revision retained the data from the first attempt for reference

b Two revisions outlined a special test for the range safety controller

4 2 18 (Continued)

c Three revisions corrected program errors

d One revision changed the automatic tests entered for initial conditions scan and stage power setup, to allow performance of the initial condition scan or stage power setup immediately prior to the range safety system test, per NASA request.

4.2 18 1 Test Data Table, Range Safety System

Function	Measured Value (vdc)	Limits (vdc)
Forward Bus 1 Battery Simulator	28 239	28 0 ± 2 0
Forward Bus 2 Battery Simulator	28 158	28 0 ± 2 0
External Internal Power Transfer Test		
External Power On		
System 1 Charging Voltage Indication	4 234	4 2 ± 0 3
System 1 Firing Unit Indication	4 235	4 2 ± 0 3
System 2 Firing Unit Indication	4 266	4 2 ± 0 3
Internal Power		
System 1 Charging Voltage Indication	4 249	4 2 ± 0 3
System 2 Charging Voltage Indication	4 270	4 2 ± 0 3
External Power Off		
System 1 Charging Voltage Indication	0 039	0 3 max
System 2 Charging Voltage Indication	0 045	0 3 max
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage	27 783	28 0 ± 2 0
Receiver 1 Signal Strength Indication	3 497	3 75 ± 1 25
Receiver 2 Signal Strength Indication	3 481	3 75 ± 1 25
System 1 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4 244	4 2 ± 0 3
Engine Control Bus Voltage	27 66	28 0 ± 2 0
External Power Off		
System 1 Charging Voltage Indication	0 050	0 3 max
System 2 Charging Voltage Indication	0 050	0 3 max
System 2 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4 279	4 2 ± 0 3

4 2 18 1 (Continued)

Function	Measured Value (vdc)	Limits (vdc)
Propellant Dispersion Test		
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4 260	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1 270	3 0 max
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.300	4 2 ± 0 3
Charging Voltage Indication (Pulse Sensor On)	1 369	3 0 max

4 2 19 Hydraulic System (1B55824 F)

This automatic procedure verified the integrity of the stage hydraulic system and demonstrated the capability of the system to provide engine centering and control during powered flight. The test involved all components of the stage hydraulic system, including the hydraulic pump, P/N 1A66240-503, S/N X457806, the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454590, the accumulator/ reservoir assembly, P/N 1B29319-519, S/N 32, the hydraulic pitch actuator 403A71A1, P/N 1A66248-507, S/N 52, and the hydraulic yaw actuator 403A72L1, P/N 1A66248-507, S/N 60

The procedure was satisfactorily accomplished by the first attempt on 13 February 1968, and was accepted on 16 February 1968 Those function values measured during the test are presented in Test Data Table 4.2.19.1. All of these values were acceptable and were within general design requirements, although specific limit requirements were not defined in the procedure for most of the measurements.

The stage power setup, H&CO 1B55813, was accomplished, and initial conditions were established for the test. The instrument unit (IU) substitute 5 volt power supply was turned on and its voltage was measured, and the aft 5 volt excitation module voltage was measured. Measurements were made of various

4 2 19 (Continued)

hydraulic system functions with the hydraulic system unpressurized Measurements were also made to determine the accumulator/reservoir gaseous nitrogen mass and corrected oil level.

The methods of controlling the auxiliary hydraulic pump were checked next. After verification that a power cable was connected to the auxiliary hydraulic pump motor, the aft bus 2 power supply was turned on and the bus voltage was verified to be 56 0 $\pm$ 4.0 vdc. The coast mode operation was checked by applying dry ice to the coast mode thermal switch and verifying that the low temperature caused the thermal switch to turn the auxiliary pump on when the auxiliary hydraulic pump coast command was turned on The dry ice was removed, and it was verified that the increased temperature caused the thermal switch to turn the pump back off The coast command and the aft bus 2 power supply were turned off, and the bus voltage was verified to be 0 0 $\pm$ 1 0 vdc. During the remaining pump control checks, only the auxiliary hydraulic pump motor on indication was checked, as the pump did not run while the aft bus 2 power was off The flight mode operation was checked by verifying that turning the auxiliary hydraulic pump flight command on and off properly turned the auxiliary pump on and off. The manual mode operation was checked by verifying that the auxiliary pump could be properly turned on and off at the GSE mechanical systems panel when the GSE was in the manual mode

The engine centering tests were then conducted. The first test was conducted with the actuator position locks on and with the hydraulic system unpressurized The actuator positions and the voltage of the IU substitute 5 volt power supply and the aft 5 volt excitation module were measured, and the corrected actuator positions were determined The pitch and yaw actuator locks were then removed, and the aft bus 2 power was turned on and the voltage was measured. The auxiliary hydraulic pump was turned on in the automatic mode, and the aft bus 2 current was measured The increase in hydraulic system pressure over a 4 second period was measured, and the various hydraulic system functions were verified to be within their proper operating limits.

With the hydraulic system pressurized, the second engine centering test was conducted with the actuator locks off and with no excitation signal applied to the actuators The test measurements were repeated as before, and the

4.2 19 (Continued)

corrected actuator positions were again determined. A zero excitation signal was then applied to the actuators, the hydraulic system functions were measured, the actuator position measurements were repeated, and the corrected actuator positions were again determined.

A clearance, linearity, and polarity check was accomplished next The actuators were individually extended to their stops, then retracted, causing the engine to move out to its extremes of travel, 0 degrees to $\pm$ 7 1/2 degrees, in a square pattern, counterclockwise as viewed from the engine bell. The engine was then returned to its 0 degree centered position As the engine was sequenced through the square pattern, a clearance check verified that there was no interference to engine motion within the gimbal envelope A comparison of the hydraulic servo engine positioning system command and response signals verified that the response movement was of the correct polarity and magnitude to agree with the command signal, and met the requirements for movement linearity Checks of the hydraulic system pressure and reservoir oil pressure when the actuators were at their extremes and when they were returned to neutral, verified that these pressures remained acceptable.

Transient response tests were conducted next. Step commands were separately applied to the pitch and yaw actuators, causing each actuator to individually move the engine from 0 degrees to -3 degrees, from -3 degrees to 0 degrees; from 0 degrees to +3 degrees, and from +3 degrees to 0 degrees. The engine response was observed visually and audibly for unwanted oscillations, and the actuator responses were recorded during the engine movement. The engine slew rates were computed for each of the step movements The Test Data Table shows the computed slew rates and representative actuator response values for the initial period of each check. The values measured were all acceptable and within general design requirements, although specific limits were not discernible from the procedure.

After the transient response test was completed, final measurements were made of the hydraulic system functions and the engine centering functions with the hydraulic system pressurized, the actuator locks off, and no excitation signals applied to the actuators

4 2 19 (Continued)

The procedure was completed by turning off the auxiliary hydraulic pump, aft bus 2, and the IU substitute 5 volt power supply. The pitch and yaw actuator locks were then replaced The computer printout noted that during this procedure, the switch selector was cycled 4 times, the auxiliary hydraulic pump accumulated 2 cycles and 21 minutes, 32.780 seconds running time, and the engine accumulated 1 5 cycles of 7 5 degrees amplitude and 1 cycle of 3 degrees amplitude in the pitch plane, and 1 cycle at each amplitude in the yaw plane

Engineering comments noted that all parts were installed during this test No major problems were encountered during the test One minor malfunction occurred when the LH_2 fill and drain valve and the LOX fill and drain valve were not closed during the initial condition scan This was due to leak checks being performed, and did not affect the test One FARR was written during an Engineering run of this procedure FARR 500-025-697 rejected transducer, P/N 1B31356-515, S/N 184-7, for incorrect pressure readings and a below tolerance resistance The transducer was removed and another transducer, S/N 245-2, was installed, tested, and accepted

Nine revisions were made to the procedure for the following

a One revision added a requirement to record the data outputs of measurements D209 and D223 prior to, during, and after operation of the auxiliary hydraulic pump

b One revision gave instructions to accomplish the stage power setup immediately prior to performing this procedure The test results (printout) of the stage power setup were retained as part of this test

c One revision changed computer statements from "If reservoir oil pressure is less than 160 psia," to "If reservoir oil pressure is less than 150 psia," and from "If reservoir oil pressure is not equal to 180 ± 20 psia," to "If reservoir oil pressure is not equal to 170 ± 20 psia," per NASA request, and new hydraulic systems tolerances

d One revision changed a computer statement "If reservoir oil pressure is not equal to 180 ± 20 psia," to "If reservoir oil pressure is not equal to 170 ± 20 psia

e One revision disabled the output of the function generators to the hydraulic actuators, so the engine would not gimbal at this step The original program was in error

f One revision disabled safety item monitor (SIM) channel 41 until after the hydraulic pump turn on, as this caused a noise spike on aft bus 1 This noise spike would trigger the SIM interrupt and cause a shutdown of the program

4 2 19 (Continued)

g One revision explained that a malfunction statement that the LOX and LH_2 fill and drain valves were not closed during the initial condition scan affected the scan, and did not interfere with the hydraulic system

h One revision deleted a step that set SIM channel 22 during the initial conditions scan This SIM channel was set after turn on of aft bus 2 The original program was in error

i One revision removed the telemetry system console from the list of end item equipment The telemetry system console had been deleted from the TCC support equipment

4 2 19 1 Test Data Table, Hydraulic System

Function	Measurement	Limits
IU Substitute 5 volt Power Supply (vdc)	5 00	5 00 ± 0 05
Aft 5 volt Excitation Module (vdc)	4 98	5 00 ± 0 05
Hydraulic System Unpressurized		
Reservoir Oil Pressure (psia)	71 57	*
Accumulator GN_2 Pressure (psia)	2351 00	*
Accumulator GN_2 Temperature (°F)	66 27	*
Reservoir Oil Level (%)	88 33	*
Pump Inlet Oil Temperature (°F)	69 01	*
Reservoir Oil Temperature (°F)	83 12	*
Aft Bus 2 Current (amp)	-0 40	*
Gaseous Nitrogen Mass (lb)	1 933	1 925 ± 0 2
Corrected Reservoir Oil Level (%)	97 2	95 0 min
Engine Centering Test, Locks On, System Unpressurized		
T/M Pitch Actuator Position (deg)	-0 05	*
IU Pitch Actuator Position (deg)	-0 01	*
T/M Yaw Actuator Position (deg)	0 05	*
IU Yaw Actuator Position (deg)	0 00	*
IU Substitute 5 volt Power Supply (vdc)	5 00	*
Aft 5 Volt Excitation Module (vdc)	4 98	*
Pitch Actuator Signal (ma)	0 05	*
Yaw Actuator Signal (ma)	0 00	*
Corrected T/M Pitch Actuator Position (deg)	-0 070	-0 236 to 0 236
Corrected IU Pitch Actuator Position (deg)	-0 007	-0 236 to 0 236
Corrected T/M Yaw Actuator Position (deg)	0 070	-0 236 to 0 236
Corrected IU Yaw Actuator Position (deg)	0.008	-0 236 to 0 236
Aft Bus 2 Voltage (vdc)	55 92	56 0 ± 4 0
Aft Bus 2 Current (amp)	35 00	55 0 ± 30 0
Hyd System 4 Second Press Change (psia)	245 5	200 0 min

* Limits Not Specified

4 2 19 1 (Continued)

Function	Measurement	Limits
Engine Centering Test, Locks Off, System Pressurized No Excitation Signal		
T/M Pitch Actuator Position (deg)	-0 05	*
IU Pitch Actuator Position (deg)	-0 04	*
T/M Yaw Actuator Position (deg)	0 06	*
IU Yaw Actuator Position (deg)	0 01	*
IU Substitute 5 volt Power Supply (vdc)	5 00	*
Aft 5 volt Excitation Module (vdc)	4 98	*
Pitch Actuator Signal (ma)	0 00	*
Yaw Actuator Signal (ma)	0 00	*
Hydraulic System Pressurized, Locks Off, Zero Excitation Signal Applied to Actuators		
Hydraulic System Pressure (psia)	3513 00	*
Reservoir Oil Pressure (psia)	166 28	*
Accumulator GN_2 Pressure (psia)	3573 00	*
Accumulator GN_2 Temperature (°F)	75 67	*
Reservoir Oil Level (%)	35 04	*
Pump Inlet Oil Temperature (°F)	96.46	*
Reservoir Oil Temperature (°F)	88 21	*
Aft Bus 2 Current (amp)	41 60	*
T/M Pitch Actuator Position (deg)	-0 05	*
IU Pitch Actuator Position (deg)	-0 03	*
T/M Yaw Actuator Position (deg)	0 06	*
IU Yaw Actuator Position (deg)	0 01	*
IU Substitute 5 volt Power Supply (vdc)	4 99	*
Aft 5 volt Excitation Module (vdc)	4 98	*
Pitch Actuator Signal (ma)	0.00	*
Yaw Actuator Signal (ma)	0 10	*
Corrected T/M Pitch Actuator Position (deg)	-0 070	-0 517 to 0 517
Corrected IU Pitch Actuator Position (deg)	-0.036	-0 517 to 0 517
Corrected T/M Yaw Actuator Position (deg)	0 085	-0 517 to 0 517
Corrected IU Yaw Actuator Position (deg)	0 021	-0 517 to 0 517

Transient Response Tests, Pitch Axis

Time From Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot Pos (deg)	IU 5 Volt Power Supply (vdc)
Pitch 0 to -3 Degree Step Response - Engine Slew Rate 16.6 deg/sec			
0 000	-0 100	-0 088	5 005
0 142	-20 068	-2 510	5 010
0 279	-19 971	-3 016	5 000
0 416	-20 020	-3 116	4 990

* Limits Not Specified

4 2 19 1 (Contınued)

Tıme From Start (sec)	Pıtch Excıtatıon Sıgnal (ma)	IU Pıtch Actuator Pot Pos (deg)	IU 5 Volt Power Supply (vdc)
0 553	-19.971	-3.131	4.980
0.689	-19 971	-3.131	4 990
0 918	-19 971	-3.131	4.990
1 192	-19 971	-3.131	5.005
1 466	-20.020	-3.146	5.000
1 740	-19.971	-3.131	5 005

Pıtch -3 to 0 Degree Step Response - Engine Slew Rate 15 1 deg/sec

0.000	-20.000	-3.132	5.005
0.136	0.000	-0.865	5.005
0 273	0 000	-0 101	5.000
0.409	0.000	-0.043	5.000
0.546	0.000	-0 043	5.000
0.684	0.000	-0.043	5.005
0.911	0.049	-0.043	5.000
1.186	0 000	-0.043	5.000
1.459	0.000	-0.043	5.005
1.733	0.098	-0.043	5.005

Pitch 0 to +3 Degree Step Response - Engine Slew Rate 16.1 deg/sec

0.000	0.000	-0.044	4.999
0 163	19 873	2 150	5.000
0.272	20.668	3 017	5.000
0.410	19.971	3.030	4.990
0.547	19.922	3.045	5.005
0.684	20.020	3.030	5.000
0.912	19.971	3.060	4.990
1.186	19.971	3.060	5.000
1.369	19.971	3.045	5.005
1.643	19.971	3.074	4.990

Pıtch +3 to 0 Degree Step Response - Engine Slew Rate 16.7 deg/sec

0.000	20 000	3 059	5 005
0.139	0.000	0.779	5.005
0.275	0.000	0.029	5.005
0.413	0.000	0.029	5.005
0.550	0.000	0.028	5.000
0.687	0.000	0.043	4.990
0.915	-0.049	-0.058	4.990
1 188	0.000	-0.043	5.000
1.463	0 000	-0.043	5.000
1.736	0 000	-0.058	5.005

4 2 19 1 (Contınued)

Transıent Response Tests, Yaw Axıs

Time From Start (sec)	Yaw Excıtatıon Sıgnal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Yaw 0 to -3 Degree Step Response - Engıne Slew Rate. 14.3 deg/sec			
0.000	0.100	-0.029	5.005
0.136	-19.873	-2.165	5.005
0.410	-19.824	-3.017	5.005
0.547	-19.922	-3 045	5.010
0 685	-19 873	-3.045	4.990
0.913	-19.873	-3.045	5.005
1.188	-19 873	-3.030	4.990
1 401	-19.873	-3 030	5.000
1.736	-19.824	-3.060	5.000
Yaw -3 to 0 Degree Step Response - Engine Slew Rate 15.2 deg/sec			
0.000	-19 850	-3.014	4.999
0.137	0.000	-0.967	5.005
0 273	0.000	-0.116	5.005
0 410	-0.098	-0.029	5.000
0 548	-0.098	-0.000	5.000
0.686	0.098	-0.029	5.005
0.913	0.000	-0.014	5.000
1.188	0 000	-0.029	5.000
1.463	0.049	-0.043	4.990
1.736	0.146	-0 000	5.000
Yaw 0 to +3 Degree Step Response - Engine Slew Rate 14.8 deg/sec			
0.000	0.050	-0.015	5.005
0.136	19.922	2.049	5 005
0.273	19.922	2.972	4.990
0.410	19.873	3.087	5.005
0.547	19.922	3.059	5.000
0.685	19.922	3.087	4.990
0.913	19.873	3.044	4.990
1.188	19.922	3.087	5.005
1.462	19 922	3.087	4.990
1 736	19.873	3 102	5.005
Yaw +3 to 0 Degree Step Response - Engine Slew Rate 14.7 deg/sec			
0.000	19.949	3.103	4.999
0.138	0 146	0.865	5.000
0.274	0.000	0.071	5.005
0.412	0.000	-0.044	4.990
0 549	0.049	-0.029	5.000

4.2.19.1 (Continued

Time From Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
0.686	0.000	-0.059	5.000
0.915	-0.049	-0.044	5.000
1.188	0.049	-0.029	5.000
1.463	0.000	-0.072	4.990
1.737	0.000	-0.044	5.000

Final Hydraulic System and Engine Centering Test
System Pressurized, Locks Off, No Excitation Signal

Function	Measurement	Limits
Hydraulic System Pressure (psia)	3590.69	*
Reservoir Oil Pressure (psia)	172.39	*
Accumulator GN_2 Pressure (psia)	3578.44	*
Accumulator GN_2 Temperature (°F)	74.88	*
Reservoir Oil Level (%)	39.27	*
Pump Inlet Oil Temperature (°F)	142.63	*
Reservoir Oil Temperature (°F)	124.83	*
Aft Bus 2 Current (amps)	51.00	*
T/M Pitch Actuator Position (deg)	-0 08	*
IU Pitch Actuator Position (deg)	-0.04	*
T/M Yaw Actuator Position (deg)	0.00	*
IU Yaw Actuator Position (deg)	-0.04	*
IU Substitute 5 Volt Power Supply (vdc)	5.00	*
Aft 5 Volt Excitation Module (vdc)	4.98	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	-0.05	*
Corrected T/M Pitch Actuator Position (deg)	-0.102	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0 044	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	0.023	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.044	-0.517 to 0.517

* Limits Not Specified

4 2 20 Propulsion System Test (1B62753 G)

This automatic procedure performed the poststorage integrated electromechanical functional tests required to verify the operational capability of the stage propulsion system For convenience of performance, the test sequences were divided into three sections The first section checked the ambient helium system, and included functional checks of the pneumatic control system and the

4 2 20 (Continued)

propellant tanks repressurization system, the second test section checked the propellant tanks pressurization system, and the third section was a four part functional check of the J-2 engine system. The first segment of the J-2 engine checkout tested the spark ignition systems for the J-2 engine thrust chamber and gas generator, the second segment functionally checked the engine cutoff logic and delay timers, the third segment checked the J-2 engine valve sequencing with control helium pressurization, and the final segment was a combined automatic check of J-2 engine system operation

Poststorage propulsion system testing was initiated on 14 February 1968, with the ambient helium system test. This was completed satisfactorily with the exception of the repressurization control and voter circuit interlock checks, which were retested satisfactorily on 16 February 1968. The propellant tanks pressurization system test was also conducted satisfactorily on 16 February 1968 The third test section, which functionally checked the J-2 engine systems, was satisfactorily demonstrated on 19 February 1968, and the entire propulsion system test checkout was accepted on 26 February 1968

Subsequent to establishing initial conditions, testing of the ambient helium system commenced by pressurizing the ambient helium pneumatic control sphere and repressurization spheres to 700 ± 50 psia and setting the stage control helium regulator discharge pressure at 515 ± 50 psia A series of checks verified the proper operation of the control helium dump valve and the pneumatic power control module shutoff valve After verifying the proper operation of the LOX chilldown pump purge control and dump valves, the LOX chilldown pump purge pressure switch checkout was conducted.

The LH_2 and LOX repressurization control module dump valves and control valves were verified to operate properly A series of checks verified the proper functioning of the O_2H_2 burner spark system and propellant valves The repressurization control and voter circuit interlock checks malfunctioned due to a test requirements drawing error that omitted two required commands The necessary entries were made to correct the program, and the interlock checks were satisfactorily demonstrated

4 2 20 (Continued)

A three-cycle test of the engine pump purge pressure switch preceded the functional checkout of the engine pump purge valve The control helium regulator backup pressure switch and the control helium shutoff valve were similarly tested The control helium sphere was pressurized to 731 02 psia and the control helium regulator discharge pressure was measured at 534 03 psia, both within acceptable limits A series of checks verified the operation of the pneumatically controlled valves, including the LH_2 and LOX vent valves, fill and drain valves, prevalves, and chilldown shutoff valves, the LH_2 directional vent valve, the LH_2 continuous vent and relief override valve and orificed bypass valve, and the O_2H_2 burner propellant valves and LOX shutdown valve The LH_2 tank pressurization and continuous vent valve blowdown check completed the ambient helium system test

Section two, the propellant tanks pressurization systems test, was started with functional checks of the cold helium dump and shutoff valves The operation of the cold helium regulator backup pressure switch was verified by the three-cycle pressure switch test, as well as by verifying that the switch properly controlled the cold helium shutoff valve

The LOX and LH_2 repressurization control valves were verified to operate properly, and the operation of the LOX and LH_2 tank repressurization backup pressure switch interlocks was verified by the three-cycle test, and by demonstrating that the switches properly controlled the LOX and LH_2 repressurization control valves

The proper operation of the O_2H_2 burner spark ignition system was verified The LOX tank pressure switches, the cold helium shutoff valve, and the cold helium heat exchanger bypass valve were verified to operate properly Proper control of the LOX main fill valve, the LOX auxiliary tank pressurization valve, the LOX replenish valve, and the LOX repressurization valve by the pressure switches was demonstrated

The LH_2 repressurization and ground fill over-pressurization pressure switches were verified to operate properly Control of the LH_2 main fill valve, the LH_2

4 2 20 (Continued)

replenish valve, the LH_2 auxiliary tank pressure valve, the step pressure valve, and the repressurization control valve by the pressure switches was also demonstrated After satisfactory completion of the LH_2 pressure switch checks, the cold helium system was pressurized to 888 81 psia, and the cold helium sphere blowdown and cold helium regulator low flow test were conducted The cold helium spheres were vented, and a series of checks verified proper operation for the O_2H_2 burner voting circuit and burner malfunction temperature sensors This completed testing of the propellant tanks pressurization systems.

Section three, the J-2 engine functional tests, was conducted next. The LH_2 and LOX tanks were vented to ambient, the O_2H_2 burner spark systems 1 and 2, the emergency detection systems 1 and 2 engine cutoffs, the repressurization control valves, and the O_2H_2 burner propellant valves were verified to operate properly

The engine spark test verified proper operation of the thrust chamber augmented spark igniter (ASI) and gas generator spark systems. The engine start tank was pressurized, the proper operation of the start tank vent valve was verified, and the start tank was vented to ambient pressure prior to the engine cutoff test. The engine ready signal was verified to be on, and the simulated mainstage OK signal opened the prevalves. Verification of proper prevalve response to the switch selector engine cutoff signals was made with the prevalves closing to the cutoff signal and opening at signal removal. The engine ignition cutoff test and the LH_2 injector temperature detector bypass test were satisfactorily conducted

The next series of tests verified that the simulated aft separation signals, 1 and 2, individually inhibited engine start, and demonstrated proper operation of the LH_2 injector temperature detector bypass and start tank discharge control. During these tests, measurements were made of the helium delay timer, the sparks de-energized timer, and the start tank discharge timer.

Three-cycle tests of mainstage OK pressure switches 1 and 2 were conducted, and it was verified that the pickup of either switch turned off the engine thrust OK 1 and 2 indications, and that after a dry engine start sequence, pickup of either switch would maintain the engine in mainstage. It was also demonstrated that dropout of both pressure switches was required to turn on engine thrust OK indications and cause engine cutoff.

The engine helium control sphere was pressurized to 1460.34 psia to conduct the engine valve sequence tests which demonstrated that actuation and deactuation of the helium control solenoid valve caused the LH_2 and LOX bleed valves to close and open, that opening and closing the ignition phase control solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close, that the start tank discharge solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close, that the start tank discharge solenoid valve opened and closed, and that opening and closing the mainstage control solenoid valve caused the gas generator valve and main LOX valve to open and close and the LOX turbine bypass valve to close and open

The final test was the combined automatic functional demonstration of the entire J-2 engine system The necessary commands were given to initiate engine start and cutoff, and throughout the automatic sequence the engine system responses were verified to be within the predetermined limits.

There were no parts shortages affecting propulsion automatic testing, and no test discrepancies resulting in the initiation of FARR's

Forty-two revisions were made to the procedure as follows

- a One revision authorized removal of the desiccant cover from the LH_2 continuous vent exit port, to permit continuous vent blowdown during the ambient helium system test
- b Six revisions listed additions or modifications needed for miscellaneous test setup instructions
- c One revision described an addition to the STOL, requiring the Test Control Center to announce pressurization of the stage LOX tank for test stand personnel notification
- d Sixteen revisions authorized changes needed to correct procedure, test requirement drawing, and program errors
- e Two revisions corrected typographical errors

4 2 20 (Continued)

f Two revisions dealt with minor items not related to the propulsion auto testing

g Two revisions authorized the program changes required to repeat the repressurization control interlock and voting circuit interlock checks of section 1 (ambient helium system test) The interlock checks had malfunctioned during the initial attempt due to a test requirements drawing error omitting two required commands

h One revision deleted the program requirement for opening the emergency engine helium vent control, as it was not required for proper venting of the helium control bottle prior to initiating the helium control solenoid closed test for opening the engine bleed valves

i Two revisions authorized switching of aft bus 1 power supply, as required, to avoid high voltage spikes on aft bus 1, and to prevent O_2H_2 burner spark noise from exceeding the SIM interrupt levels

j One revision authorized a retest to recover lost data for the O_2H_2 burner sparks test portion of section 2 of the procedure The failure of the A-1 oscillograph to roll the oscillograph paper properly resulted in loss of data

k One revision explained the failure to obtain LH_2 tank flight pressurization indication (K184) on the first attempt This resulted from the improper installation of the jumper wiring at the LH_2 ground fill pressure switch cable The jumper wire was changed to the proper pins, K184 indication was then obtained, and the test was resumed

l One revision explained that the LH_2 repressurization control pressure switch deadband measured value of 1 98 psi for the third test cycle was printed as "out-of-tolerance" due to a program error, and was acceptable based on the 0 5 psi deadband minimum limit

m One revision indicated that a SIM interrupt was generated by prevalve bounce during the opening of the chilldown shutoff valves This condition was considered a system peculiarity that required test requirements drawing modification

n Two revisions explained malfunction indications that occurred due to insufficient time allowed for the LH_2 tank venting and the heat exchanger 3 helium supply valve closing

o One revision indicated that an apparent out-of-tolerance cold helium regulator discharge pressure, measured during the cold helium regulator flow test, resulted from a marginal program condition based on an instrumentation error that was within the acceptable calibration limits

p One revision attributed a malfunction indication of the J-2 engine start bottle vent failing to open to operator error The test control

4 2 20 (Continued)

center (TCC) panel switch was not repositioned from "manual close" to "auto" The panel switch was set to auto and the test was resumed with satisfactory start bottle vent open indications

q One revision deleted securing the purge valves after test completion because they were to be secured per H&CO's 1B70422 and 1B70425

4 2 20 1 Test Data Table, Propulsion Test

Section 1 - Ambient Helium Test

LOX Childown Pump Purge Pressure Switch Checkout

Function		Measured Values Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	40.33	40.18	40.23	41.5 max
Dropout Pressure	(psia)	38.67	38.77	38.67	37.5 min
Deadband	(psid)	1.67	1.41	1 56	0.3 min

Engine Pump Purge Pressure Switch Checkout

Pickup Pressure	(psia)	118.62	115.52	117.07	136.0 max
Dropout Pressure	(psia)	110.09	110.86	110.09	99.0 min
Deadband	(psid)	8.54	4.66	6.99	3.0 min

Control Helium Regulator Backup Pressure Switch Checkout

Pressurization Time	(sec)	66.203	31.310	30.553	180.0 max
Pickup Pressure	(psia)	608.34	605.25	606.03	600 ± 21
Depressurization Time	(sec)	8.967	8.911	8.958	180.0 max
Dropout Pressure	(psia)	498.15	498.92	498.15	490 ± 31

Pneumatically Controlled Valve Timing Checkout

Valve	Operating Times (sec) Open	Total Open	Close	Total Close	Boost Close	Total Boost Close
LH_2 Vent Valve	0.020	0.086	0.218	0 450	0.094	0.226
LOX Vent Valve	0 017	0.078	0.103	0.323	0.068	0.188
LOX F&D Valve	0.156	0.276	0.788	2.308	0.456	0.962
LH_2 F&D Valve	0.108	0.212	0.703	1.896	0.362	0.827
LOX Prevalve	1.480	2.159	0.258	0.394	*	*
LH_2 Prevalve	1.618	2.384	0.281	0.433	*	*

* Not applicable to these valves

4 2 20 1 (Continued)

Section 1 - Ambient Helium Test (Continued)

Valve	Operating Times (sec) Open	Total Open	Closed	Total Close	Boost Close	Total Boost Close
LOX C/D SOV	0 233	1.056	0 022	0 126	*	*
LH_2 C/D SOV	0 196	0.990	0 020	0.128	*	*
LH_2 Cont Vent Orif'd Bypass Valve	0 007	0 041	0.007	0 068	*	*
O_2H_2 Burner LH_2 Prop	0 030	0 106	0.027	0.117	*	*
O_2H_2 Burner LOX Prop	0 032	0 107	0 021	0.098	*	*
O_2H_2 LOX S/D Valve	0 008	0 088	0 009	0 089	*	*

Valve	Flight Position	Total Flt. Position	Ground Position	Total Ground Position
LH_2 Directional Vent Valve	0.081	0 200	0.836	1.411

Section 2 - Propellant Tanks Pressurization System Test

Cold Helium Regulator Backup Pressure Switch Checkout

Function		Measured Values Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	60.666	20.484	20.325	180 max
Pickup Pressure	(psia)	472.54	471.76	470.21	467.5 ± 23.5
Depress. Time	(sec)	12.360	12.146	12.142	180 max
Dropout Pressure	(psia)	380.17	379.40	380.17	362.5 ± 33.5

LOX Tank Repressurization Backup Pressure Switch Checkout

Pressurization Time	(sec)	20.680	43.074	42.560	180 max
Pickup Pressure	(psia)	471.76	472.54	470 98	467.5 ± 23.5
Depress. Time	(sec)	12.688	12.644	12.709	180 max
Dropout Pressure	(psia)	376.30	378.63	377.08	362.5 ± 33.5

LH_2 Tank Repressurization Backup Pressure Switch Checkout

Pressurization Time	(sec)	41.920	42.363	41.988	180 max
Pickup Pressure	(psia)	471.76	470.21	470.21	467.5 ± 23.5
Depress. Time	(sec)	13.502	13.378	13.455	180 max
Dropout Pressure	(psia)	370.09	372.41	371.64	362.5 ± 33 5

* Not applicable to these valves

4.2.20.1 (Continued)

Section 2 - Propellant Tanks Pressurization System Test (Continued)

LOX Tank Ground Fill Over-Pressure Pressure Switch Checkout

Function		Measured Values Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	21.510	15 128	11.818	180 max
Pickup Pressure	(psia)	40 23	40 18	40 13	41 max
Depress Time	(sec)	4 975	4.769	4 673	180 max
Dropout Pressure	(psia)	38 46	38 61	38 56	37.5 min
Deadband	(psid)	1.77	1.56	1.56	0.5 min

LH_2 Repressurization Control Pressure Switch Checkout

Function		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	94 998	22.967	23 319	180 max
Pickup Pressure	(psia)	33 19	33 09	33 09	34 max
Depress Time	(sec)	39 321	37 943	38 318	180 max
Dropout Pressure	(psia)	31 00	31 00	31 10	30 8 min
Deadband	(psid)	2 19	2.09	1.98	0 5 min

LH_2 Tank Ground Fill Over-Pressure Pressure Switch Checkout

Function		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	85 761	40.244	24 386	180 max
Grd Fill Over-Press Pickup Press	(psia)	33 45	33 50	33.50	34 max
Depress Time	(sec)	53 641	40 520	39 976	180 max
Grd Fill Over-Press Dropout Pressure	(psia)	31 47	31 57	31 57	30.8 min
Deadband	(psid)	1 99	1 93	1 93	0.5 min

Section 3 - J-2 Engine Functional Test (Engine S/N J-2094)

Engine Delay Timer Checkout

Function	Delay Time (sec)	Limits (sec)
Ignition Phase Timer	0.432	0.450 ± 0.030
Helium Delay Timer	0.992	1.000 ± 0.110
Sparks De-Energized Timer	3.293	3.300 ± 0 200
Start Tank Discharge Timer	1.000	1.000 ± 0.040

4.2.20.1 (Continued)

Section 3 - J-2 Engine Functional Test (Continued)

Mainstage OK Pressure Switch 1 Checkout

Function		Measured Values Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	490.70	489.91	489.13	515 ± 36
Dropout Pressure	(psia)	420.70	420.70	420.70	*
Deadband	(psid)	69.99	69.20	68.42	62.5 ± 48.5

Mainstage OK Pressure Switch 2 Checkout

Function		Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	515.98	513.67	513.67	515 ± 36
Dropout Pressure	(psia)	446.15	445.38	447.70	*
Deadband	(psid)	69.84	68.30	65.97	62.5 ± 48.5

Engine Sequence Check

Function	Start or Delay Time (sec)	Oper. or Travel Time (sec)	Total Time (sec)
Engine Start			
Cont He Solenoid Command Talkback	**	0.014	**
Ign Phase Cont Solenoid Command Talkback	**	0.007	**
ASI Valve Open	**	0 045	**
Engine LOX Bleed Valve Close	**	0.059	**
Engine LH_2 Bleed Valve Close	**	0.066	**
Main Fuel Valve Open	0 083	0.044	0.127
Start Tank Disch Timer	**	0.998	**
Start Tnk Disch Valve Open	0.098	0.115	0.213
Mainstage Cont Solenoid Energized	**	1.449	**
Ignition Phase Timer	**	0.451	**
Start Tnk Disch Cont Solenoid De-Energized	**	0.007	**
Main LOX Valve Open	0.440	1.654	2.095
Start Tnk Disch Valve Close	0 171	0.162	0.333
Gas Generator Valve Open	**	0.098	0.196
LOX Turbine Bypass Valve Close	0 029	0.405	0.435
Spark System Off Timer	**	3.315	**

* Limits not specified
** Not applicable or not available

4 2 20 1 (Continued)

Section 3 - J-2 Engine Functional Test (Continued)

Engine Sequence Check (Continued)

Function	Start or Delay Time (sec)	Oper. or Travel Time (sec)	Total Time (sec)
Engine Cutoff			
Ign Phase Cont Solenoid De-Energized from Cutoff	**	0 007	**
Mainstage Cont Solenoid De-Energized from Cutoff	**	0 015	**
ASI Valve Close	0 037	**	**
Main LOX Valve Close	0 118	0 042	0.160
Main Fuel Valve Close	0 126	0 152	0 278
Gas Generator Valve Close	0 133	0.111	0 244
He Cont De-Engergized Timer	**	1 009	**
Engine LOX Bleed Valve Open	**	**	11.040
Engine LH_2 Bleed Valve Open	**	**	10 793
LOX Turbine Bypass Valve Open	0 379	0 509	0.888

Engine Sequence Data (Oscillograph Records)

Function	Measurements		Limits	
	Delay	Valve Motion	Delay	Valve Motion
Ignition (sec)				
Main Fuel Valve Open	'0 036	0 074	0 030-0 090	0 030-0 130
Start Tank Disch Valve Open	0 089	0 088	0 080-0 120	0 085-0 120
Mainstage (sec)				
GG Valve Fuel Open	0 067	0 044	*	*
GG Valve LOX Open	0 132	0 055	0 130-0 150	0 020-0 80
Start Tank Disch Valve Close	0 122	0 244	0 130±0 020	0 215±0.040
MOV 1st Stage Open	0 044	0 054	0 030-0 070	0 025-0 075
MOV 2nd Stage Open	0 610	1 817	0 054-0.680	1.750-1 900
Oxidizer Turbine Bypass Vlv Close	0 190	0 274	*	5 0 max

* Limits not specified
** Not applicable or not available

4.2 20 1 (Continued)

Engine Sequence Data (Oscillograph Records) (Continued)

Function	Measurements		Limits	
	Delay	Valve Motion	Delay	Valve Motion
Cutoff (sec)				
Oxidizer Turbine Bypass Valve Open	0 223	0 708	*	10 0 max
GG Valve Lox Close	0 056	0 023	0 040-0 100	0 010-0 055
Main Oxid Vlv Closed	0 052	0 128	0 045-0 075	0 105-0 135
Main Fuel Vlv Closed	0 077	0 222	0 065-0 115	0 200-0 250
Bleeds (sec)				
ASI Open	**	0 035	**	0 010-0 070
ASI Close	**	0 028	**	0.010-0 070
GG Valve LOX Open	**	11.0	**	30 0 max
GG Valve LOX Close	**	0 050	**	*
GG Valve Fuel Open	**	10 8	**	30 0 max
GG Valve Fuel Close	**	0 046	**	0 120 max
Timers (sec)				
Start Tank Disch Vlv Decay	0.987	**	0 960-1 040	**
Ignition Phase	0 450	**	0 420-0 480	**
Sparks De-Energize	3 276	**	3 10 -3 50	**
Helium Control De-Energize	0 997	**	0.890-1 110	**
Trace Deflections				
Oxid Turbine Bypass Valve 80% (sec)	0 418	**	0 350-0 550	**
Main Oxid Valve (deg)	15	**	10-16	**
GG Valve (%)	52	**	35-65	**

* Limits not specified

** Not applicable or not available

4.2 21 Signal Conditioning Setup (1B44474 C)

This procedure calibrated the stage 5 volt and 20 volt excitation modules, and calibrated any items of the stage signal conditioning equipment that were found to be out-of-tolerance during testing. The signal conditioning equipment consisted of those items required to convert transducer low level or ac signals to the 0 to 5 vdc form used by the telemetry system, and included dc amplifiers, temperature bridges, frequency to dc converters, and expanded scale voltage monitors. Only the particular items calibrated during this procedure are noted below and in Test Data Table 4.2.21 1.

The procedure was initiated on 15 February 1968, and was certified as completed on 28 February 1968. The stage power setup, H&CO 1B55813, was performed prior to any calibration activity, to provide electrical power to the equipment

Three 5 volt excitation modules were calibrated The input voltage to each module was verified to be 28 $\pm$0.1 vdc, and each module was adjusted to obtain a 5 vdc output of 5 0 $\pm$0.005 vdc, a -20 vdc output of -20.00 $\pm$0 005 vdc, and an ac output of 10 $\pm$1 volt peak-to-peak at 2000 $\pm$200 Hz The final values measured, as shown in the Test Data Table, were all within the above limits. The ac output measurements were made with the test switch set to four different positions, sequentially, and were found to be the same for each position

Seven 20 volt excitation modules were calibrated by adjusting the coarse control and fine control on each module to obtain an output of 20 000 $\pm$0.005 vdc As shown in the Test Data Table, the final measured value for each module was within the above limits

One temperature bridge required calibration This was the PU oven stability monitor, measurement N63, temperature bridge 411A61A214, P/N 1B68861-1, S/N 0157 With a low level calibration input, the temperature bridge was adjusted to obtain a bridge output of 0 000 vdc, within the 0 000 $\pm$0 005 vdc limits With a high level calibration input, the bridge output was verified to be 4 000 vdc, within the 4 000 $\pm$0 005 vdc limits

4 2 21 (Continued)

One expanded scale voltage monitor module was calibrated by calibrating the associated dc amplifier This was the forward 5 vdc excitation module monitor, measurement M24, expanded scale voltage module 411A61A210, P/N 1A95181-1, S/N 0119, and dc amplifier 411A61A209, P/N 1A82395-1, S/N 2314. With a low RACS command on, the dc amplifier zero control was adjusted to obtain a zero output of 0.001 vdc, within the 0.000 ±0.005 vdc limits With a high RACS command on, the amplifier gain control was adjusted to obtain a gain output of 4 001 vdc, within the 4.000 ±0.005 vdc limits.

No part shortages were recorded that affected this test No particular problems were encountered during the test, and no FARR's were written Four revisions were made to this procedure for the following

a One revision added the requirement for calibration of temperature bridge N063 This parameter was added to the stage after release of this procedure

b One revision deleted the 10 vac and 2000 Hz measurement for the 411A98A2 module as this function is not part of the stage wiring

c One revision added a 20 volt excitation module erroneously omitted from the procedure.

d. One revision deleted all sections of the test that were not required, as the procedure was used for only those components that had been removed and replaced or were found to be out-of-tolerance during automatic checkouts

4 2 21 1 <u>Test Data Table, Signal Conditioning Setup</u>

<u>5 Volt Excitation Module - P/N 1A77310-503.1</u>

Reference Location	S/N	5 vdc Output (vdc)	-20 vdc Output (vdc)	ac Output (vpp)	Hz
411A99A33	0132	5 005	-20 002	9 5	2004
404A52A7	0136	4 997	-20 002	10 5	1985
411A98A2	0131	5.002	-19 996	*	*

<u>20 Volt Excitation Module - P/N 1A74036-1.1</u>

Reference Location	S/N	20 vdc Output (vdc)
411A61A242	0264	20 000
404A62A241	0284	19.999

*Reference revision b

4 2 21 1 (Continued)

Reference Location	S/N	20 vdc Output (vdc)
404A63A241	0289	20 001
404A64A241	0283	19 999
404A65A241	0278	19 999
404A63A233	0258	20 002
404A66A241	0263	20 000

4 2.22 Digital Data Acquisition System (1B55817 G)

The digital data acquisition system (DDAS) test provided operational status verification of data channels on the stage, except certain data channels that were tested during specific system tests The outputs of the tested channels were checked by the GSE D924A computer and found to be within the specified tolerances The proper operation of all DDAS signal conditioning units and associated amplifiers, the remote automatic calibration system (RACS) and the command calibration channel decoder assemblies, and the telemetry transmitter and antenna system were also checked by the computer

The particular items involved in this test were

Part Name	Reference Location	Part Name	Serial Number
PCM/DDAS Assembly	411A97A200	1A74049-511	017
CP1-BO Time Division Multiplexer	404A61A200	1B62513-547	019
DP1-BO Time Division Multiplexer	404A61A201	1B62513-543	021
Remote Digital Submultiplexer	404A60A200	1B52894-1	09
Remote Analog Submultiplexer	404A60A201	1B54062-505	021
PCM RF Assembly	411A64A200	1B52721-521	036

All channels having a calibration capability were checked under a RACS high mode or low mode calibration command, as well as under ambient conditions. Channels without RACS capability, and spare channels, were tested at ambient conditions

4 2.22 (Continued)

Ambient conditions were defined as 70°F at 14.7 psia or, for bi-level parameters, the normal state of valves or switches during the performance of this test All channel outputs were measured and printed out

Poststorage DDAS automatic testing was successfully demonstrated on 21 February 1968, and was accepted on 26 February 1968 After establishing initial conditions, a DDAS ground station calibration was performed to verify that the DDAS ground station and peripheral equipment were properly setup and ready for test

The PCM RF test was conducted first. The forward and reflected RF output powers of the PCM/DDAS assembly were measured through the CP1-BO and the DP1-BO multiplexer telemetry outputs, and the voltage standing wave ratios (VSWR) were determined The same measurements were also made through the ground monitor outputs for both multiplexers The CP1-BO multiplexer telemetry readings were forward power, 24.418 watts, reflected power, 0 418 watts, VSWR, 1 301 The DP1-BO multiplexer telemetry readings were forward power, 24 418 watts, reflected power, 0.431 watts, VSWR, 1 306. The CP1-BO multiplexer ground monitor readings were forward power, 24 508 watts, reflected power, 0 390 watts, VSWR, 1 288 The DP1-BO multiplexer ground monitor readings were forward power, 24 537 watts, reflected power, 0 394 watts, VSWR, 1 289 All measurements were within the acceptable tolerances High and low RACS tests were then conducted on measurement channel CP1-BO-05-10, for the aft 5 volt excitation module voltage, while both the ground monitor and telemetry outputs were measured High and low RACS for both telemetry and ground monitor outputs were 3 999 vdc and 0.005 vdc, respectively, within the expected tolerances.

The CP1-BO multiplexer was tested next, except for special channels This test made measurements of the high and low RACS voltages of each channel having calibration capability, and measurements of the ambient outputs in units of temperature, pressure, voltage, current, frequency, event indication, liquid level indication, and position indication, as applicable for the various channels

4.2.22 (Continued)

Output values for each of the CP1-BO multiplexer channels tested were within the required limits except for channels CP1-BO-09-03N01, CP1-BO-09-09N06, and CP1-BO-09-10N08 (events K013, K140, and K195), which malfunctioned. These malfunctions were caused by engine cutoff being on as a result of ESCS power off due to a procedure error The program was backed up, corrections were made, and the CP1-BO multiplexer test was repeated with no malfunctions.

The DP1-BO multiplexer was then tested, except for special channels, in the same manner as described for the CP1-BO multiplexer, with no malfunctions. All channel outputs were within tolerance.

Special channel tests were conducted next These special channels measured 400 Hz, 100 Hz, and 1500 Hz signals The 400 Hz test checked the static inverter-converter frequency, the LOX and LH_2 chilldown inverter frequencies, and the LOX and LH_2 circulation pump flow rates. The LOX and LH_2 flowmeter tests at 100 Hz followed the 400 Hz test, and the LOX and LH_2 pump speeds were checked using the 1500 Hz signal All of these special channels were within the required tolerance of the expected values.

An APS multiplexer test was then run to check those special channels on both multiplexers that measured the APS functions APS units, S/N 1009-1, and S/N 1009-2, had previously been installed on the stage for poststorage test operations. Measurements were made of the high and low RACS voltages for each of the APS channels having calibration capability, and the ambient outputs were measured in degrees Fahrenheit or psia, as appropriate for the channel tested All special channels were within the required tolerances

Engineering status review noted that an interim use pressure transducer, P/N 1A72913-539, S/N 341-1, was installed as a substitute for the transducer, P/N 1B40242-509, required for measurement D0576, the fuel tank ullage umbilical pressure The interim use transducer was installed for poststorage checkout only, per 1A81838-A45-7A, and will be replaced by the flight configuration transducer prior to shipment of the stage to KSC

4 2 22 (Continued)

Ten revisions were made to the procedure

a One revision authorized the substitution of the Model DSV-4B-128 frequency calibration unit, P/N 1A78186-1, for the specified Model DSV-4B-232 telemetry system control console, P/N 1A65726-1 The Model 128 is installed at STC Beta I, while the Model 232 no longer exists

b One revision authorized the substitution of a jumber plug in place of the specified jumper wire, as a more convenient installation during the preliminary equipment setup operations

c One revision authorized the setups required for the special channel tests at 400 Hz, 100 Hz, and 1500 Hz to be made prior to the setup for automatic DDAS testing, rather than during the test, as a more convenient method

d One revision listed the FILADD entries required to add calibration (RACSTAB) values for the Rocketdyne pressure transducers to the program

e One revision listed the FILADD entries to correct the program so that the NASA measurement number would print out for C050 (channel CP1-BO-11-03).

f One revision provided the OLSTOL and ALCO entries required to correct the program to accomodate the APS modules during the unbilical measurements test, since they were installed rather than the APS simulators

g One revision explained the cause of the malfunctions on channels CP1-BO-09-03N01, CP1-BO-09-09N06, and CP1-BO-09-10N08 during the initial CP1-BO multiplexer test, as described previously

h. Three revisions were corrections of program and procedure typographical errors

The subsequent replacement of the DP1-BO time division multiplexer and a channel decoder during Engineering runs of the all systems test (reference paragraph 4 2 24), resulted in re-issues of the procedure Retesting per issue 2, run 1, was accomplished on 26 February 1968, after the replacement of the DP1-BO time division multiplexer, P/N 1B62513-543, S/N 026, with S/N 021 Additional re-testing per issue 2, run 2, was conducted on 28 February 1968, after the replacement of the channel decoder, P/N 1A74053-503, S/N 273, with S/N 164

4 2 22 (Continued)

All measurements recorded during these retests were within the acceptable tolerances, with the exception of those resulting in malfunction of the channels measuring the battery simulator temperatures However, these occurred due to improper COAL entries into the program for battery simulator ambient temperatures A check of the actual ambient temperatures at the battery simulators during these tests indicated the voltage measurements recorded for the malfunctioned channels were well within the tolerances for the corrected expected values and were therefore acceptable

Revisions for the two re-issues of the procedure were substantially the same as those previously discussed for the initial issue, with the exception of two problems. One was an explanation of the channel malfunctions previously discussed for the battery simulator temperatures The other concerned the last issue only (issue 2, run 2), in which the program was modified to permit the use of the flight configuration transducer, P/N 1B40242-509, S/N 509-16, which had previously been installed in place of the interim use pressure transducer, P/N 1A72913-539, S/N 341-1, for measurement D0576, the fuel tank ullage umbilical pressure

There were no discrepancies documented by FARR's as a result of poststorage DDAS automatic testing

4 2 23 <u>Level Sensor and Control Unit Calibration (1B44473 D)</u>

Replacement of the control units for the LOX tank point level sensors 1 and 2 during poststorage operations necessitated calibration of these units per this procedure All other LOX and LH_2 level sensor units had been previously calibrated by this same procedure during the prefire operations This manual procedure adjusted the new control units for an operating point well within the limits of the capacitance change caused by a simulated wet condition of the LOX tank point level sensors 1 and 2.

Calibration of the new control units was successfully accomplished and accepted on 28 February 1968. Results are listed in Test Data Table 4 2 23 1 During the calibration test, the point level sensor manual checkout assembly, P/N 1B50928-1, was connected between each control unit and its associated point level sensor

4 2 23 (Continued)

A precision capacitor, General Radio, type 1422CD, was connected in parallel with the sensor to provide capacitance changes to each control unit to simulate wet conditions for calibration and to determine the control unit operating point A voltmeter was connected to the appropriate checkout assembly test points to measure the control unit output voltage

To establish the operating point for each of the LOX sensor control units under test, the precision capacitor was set for 1 5 ±0 02 picofarads to simulate a wet condition for the associated sensor After turning on power to the individual control unit, the control unit potentiometer (R1) was adjusted until activation of the control unit was indicated by a change in output voltage from 0 ±1 vdc to 28 ±2 vdc The capacitance of the precision capacitor was then decreased to obtain a 0 ±1 vdc output voltage, indicating relay deactivation, and again increased to obtain a 28 ±2 vdc output voltage, indicating relay reactivation The deactivation and reactivation capacitance values were recorded as noted in the Test Data Table

A series of checks then verified the operation of the control unit output relay test function With the associated sensor disconnected, each control unit output relay was verified to be deactivated under both normal and test conditions. With the sensors reconnected, the output relay for each control unit was reverified to be deactivated under normal conditions and activated under test conditions

No problems were encountered during this test and no FARR's were initiated One revision was made to delete all portions of the procedure except those applicable to the replaced control units for LOX tank point level sensors 1 and 2

4.2.23 1 <u>Test Data Table, Level Sensor and Control Unit Calibration</u>

	Sensor P/N 1A68710			Control Unit P/N 1A68710			Deactivation Cap (pf)		Reactivation Cap (pf)	
Function	Ref Loc	Dash P/N	S/N	Ref Loc	Dash P/N	S/N	Meas	Min	Meas	Max.
LOX Tank	406			404						
Pt Lev 1	A2C1	-1	D-18	A72A1	-511	C89	1 479	1.3	1 485	1 7
Pt Lev 2	A2C2	-1	E-67	A72A2	-511	E58	1 459	1 3	1 462	1 7

4.2.24 All Systems Test (1B55833 F)

After the completion of individual system checkouts for the stage during post-storage operations, the all systems test (AST) was conducted to demonstrate the combined operation of the stage electrical, hydraulic, propulsion, instrumentation, and telemetry systems under simulated flight conditions. The test procedure followed, as closely as possible, the actual flight sequence of prelaunch operations, simulated liftoff, ullage firing, engine start, hydraulic gimballing, engine cutoff, coast period, engine restart and cutoff, attitude control, and stage shutdown.

The AST was conducted twice, first with the umbilicals in, then with the umbilicals out During the umbilicals-in test, the umbilical cables were connected to permit monitoring of talkback during test and to provide complete stage control for troubleshooting and safing operations. During the umbilicals-out test, the umbilicals were ejected at simulated liftoff to verify the proper operation of all on-board systems with the umbilicals disconnected. After completion of the AST, the umbilicals were reconnected and the stage power turn-off was executed to return the stage to the pretest configuration

The AST was satisfactorily demonstrated on 29 February 1968, and was designated as acceptable on 12 March 1968

After accomplishing the various manual electrical and propulsion system setups, automatic testing started with a performance of the stage power setup to establish initial conditions During the power setup, power was turned on to the propellant utilization (PU) inverter and electronics assembly, the EBW pulse sensors, the engine control and ignition buses, the APS buses, and aft bus 2. The various currents and voltages were measured as presented in the power setup portion of Test Data Table 4 2 24 1. The EBW ullage rocket firing unit disable command and the propellant dispersion cutoff command inhibit for the range safety receivers were turned on. The proper operation of the switch selector was verified during the umbilicals-in test The power turn-on to the PCM RF group and a transmitter warm-up completed the stage power setup for the AST

The manual setup of the propulsion system was verified, the propulsion system initial conditions were established, and the various helium supply pressures were measured. The LOX chilldown pump purge and engine pump purge sequences were then accomplished.

4.2.24 (Continued)

The next series of prelaunch checks verified that the LOX and LH_2 tank vent valves and fill and drain valves opened properly on command, and that the LOX and LH_2 point level sensors, fastfill sensors, and overfill sensors all responded properly to simulated wet conditions The simulated wet conditions were left on for all except the overfill sensors, to simulate loaded propellant tanks. The proper operation of the LOX and LH_2 chilldown shutoff valves, prevalves, and vent valves was verified, and the LOX and LH_2 tank prepressurization sequences were accomplished. The LH_2 pressure control module pressure (D104) was measured during the last sequence The LOX and LH_2 fill and drain valves were then closed, the proper operation of the LH_2 directional vent valve was verified, and the valve was set to the ground position

The EBW and telemetry prelaunch checks were conducted next A pulse sensor self test verified the proper operation of the ullage rocket and range safety EBW firing unit pulse sensors During the umbilicals-in test only, a check verified that the telemetry RF silence command properly turned off the PCM RF assembly. During both tests, a telemetry calibration and a RACS calibration were then accomplished The PCM/FM transmitter RF power was measured as was the telemetry antenna 1 forward power. The telemetry RF system reflected power was measured, and the telemetry system closed loop VSWR was determined Measurements were also made of the static inverter-converter output voltages and operating frequency. During the umbilicals-in test only, the engine cutoff and the nonprogrammed engine cutoff indications were both verified to be off, while during the umbilicals-out test only, the engine cutoff command was turned on and only the nonprogrammed engine cutoff indication was verified to be off

The hydraulic system prelaunch checks were conducted next The pitch and yaw actuator locks were removed, the hydraulic reservoir gaseous nitrogen mass and corrected oil level were measured, and the hydraulic system functions were measured with the hydraulic system unpressurized. The auxiliary hydraulic pump was then turned on to pressurize the system The system pressure increase over a 4 second period was measured, and the hydraulic system functions were remeasured with the system pressurized. During the umbilicals-in test only, the 7.5 degree square gimbal pattern check was then satisfactorily accomplished, after which the hydraulic system was depressurized by the auxiliary hydraulic pump shutdown.

4.2 24 (Continued)

The stage and GSE were then set for open loop telemetry operation by turning on the RF distribution system 2 and setting the PCM ground station for open loop reception. A flow rate and turbine speed (FRATS) calibration then measured the reference indication voltages for the LOX and LH_2 circulation pump flow rates, the static inverter-converter frequency, the LH_2 and LOX chilldown inverter frequencies, the LOX and LH_2 flowmeter, and the LOX and LH_2 pump speeds. A 400 Hz GSE calibration frequency was used for the pump flow rates, and the static inverter-converter and chilldown inverter frequencies, a 100 Hz GSE calibration frequency was used for the flowmeters, and a 1500 Hz calibration frequency was used for the pump speeds. The telemetry system forward and reflected RF powers were then measured and the telemetry system open loop VSWR was determined. The LOX and LH_2 chilldown pumps were turned on, and the chilldown inverter frequencies and phase voltages were measured by hardwire and telemetry

A series of measurements were then made of the common bulkhead pressure, the LH_2 ullage pressure, and their 20 and 80 percent calibration voltages, the LOX ullage pressure, and the LH_2 and LOX emergency detection system pressures After the 20 and 80 percent calibration tests, the common bulkhead pressure and the ambient LH_2 ullage pressure were remeasured Common bulkhead pressures reflected the vacuum drawn on the bulkhead. The rate gyro was then turned on, and the RACS and telemetry calibrations were performed

The final prelaunch checks were then started. During the umbilicals-in test, the battery simulators were turned on, and measurements were made of the battery simulator voltages and the electrical support equipment load bank voltages During the umbilicals-out test, the checkout batteries were turned on, and the checkout battery voltages were measured The transducers for the common bulkhead pressure and the LH_2 and LOX ullage pressures were all turned off, and the transducer output voltages were measured. The LH_2 and LOX fast-fill sensor simulated wet conditions were then turned off.

The forward and aft power buses were transferred to internal, and the bus voltages were measured. Both range safety receivers were transferred to internal power, and their low level signal strength indications were measured

4.2.24 (Continued)

The EBW ullage rocket firing unit disable command was turned off, the range safety system safe and arm device was set to the ARM condition, the DDAS antenna input was turned on, and the propellant dispersion cutoff command inhibit was turned off for both range safety receivers It was verified that the open loop PCM RF signal was being received at the PCM and DDAS ground stations The cold helium supply shutoff valve was opened. For the umbilicals-out test only, the external power was turned off for the talkback bus, the forward and aft power buses, and the range safety receivers and EBW firing units, the aft and forward umbilicals were ejected and visually verified to be disconnected, and the local sense indications were verified to be on For the umbilicals-in test only, the external powers were on, it was verified that the umbilicals remained connected, and the local sense indications were verified to be off. The emergency detection system ullage pressures were then measured for both tests. The prelaunch checks were completed with simulated liftoff

Following the simulated liftoff, a telemetry calibration was accomplished, and the preseparation checks were conducted. The two ullage rocket ignition EBW firing units were charged The LH_2 and LOX prevalves were cycled, and the LH_2 chilldown pump was turned off. The fire ullage ignition command was turned on, and it was verified that the two ullage ignition EBW firing units responded properly and that the ullage ignition pulse sensors were on. The aft separate simulation 1 and 2 signals were then turned on to simulate stage separation. During the above part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the ignition EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

APS roll and engine start checks were conducted following the simulated stage separation The instrument unit (IU) substitute -28 volt power was turned on and the voltage was measured For the APS roll checks, attitude control nozzles I-IV and III-II were turned on and off and the corresponding APS engine valves were measured for open and closed indication voltages In addition, the APS engine thrust chamber pressures were measured with the engine valves in the open and closed positions, the thrust chamber throat plugs installed, and pressure upstream of the valves. This procedure was then repeated for attitude control nozzles I-II and III-IV and their corresponding APS engines, to satisfactorily complete the roll checks.

The LOX chilldown pump was then turned off, and the LH_2 and LOX chilldown shut-off valves were cycled open and closed. The engine start sequence was then accomplished, with the simulated ignition detected indication and the simulated mainstage OK indication turned on to simulate a satisfactory engine start The two ullage rocket jettison EBW firing units were charged, the fire ullage jettison command was turned on, and it was verified that both ullage jettison firing units responded properly and that the ullage jettison pulse sensors were on. During this part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the jettison EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing

Following the engine start sequence, the hydraulic gimbal and propellant utilization valve slew checks were conducted, starting with the step response gimbal and LOX valve slew checks The propellant utilization system ratio valve position and the hydraulic system pressure were both measured, and the LOX bridge 1/3 checkout relay was turned on A series of step response gimbal checks was conducted for 0 to -3 degrees, -3 to 0 degrees, 0 to +3 degrees, and +3 to 0 degrees, in the pitch and yaw planes As the results of these checks were compatible with the results of the same checks during the hydraulic system automatic checkout, H&CO 1B55824 (reference paragraph 4 2.19), the measured data was not repeated Following the gimbal sequence, the propellant utilization system ratio valve position was again measured, and the LOX bridge 1/3 checkout relay was turned off The 0 6 Hz gimbal and LH_2 propellant utilization valve slew checks were conducted next The propellant utilization system ratio valve position and the hydraulic pressure were measured, and the LH_2 bridge 1/3 checkout relay was turned on A 0.5 degree gimbal signal, at 0.6 Hz, was applied in the pitch and yaw planes The engine position command currents and resulting instrument unit actuator piston positions were found to be within the required limits throughout the cycling in both planes, for the umbilicals-in and umbilicals-out tests At the completion of the gimbal sequences, the hydraulic actuator piston positions and the instrument unit engine pitch and yaw positions were measured, and the hydraulic system functions were measured with the hydraulic system pressurized

4 2 24 (Continued)

The propellant utilization system ratio valve position was measured, and the LH_2 bridge 1/3 checkout relay was turned off.

The first burn and coast period sequences were conducted next During the first burn pressurization, the helium pressures of the LOX and LH_2 pressurization control modules were measured while the helium supply valves were temporarily open, and again after the pressure switch supplies were closed and the flight control pressure switches were verified to be off The engine cutoff was then accomplished, the auxiliary hydraulic pump was set for coast mode operation, the LH_2 first burn relay was turned off, and the LH_2 pressurization control module helium pressure was again measured. The LOX chilldown pump purge was started, and the LOX pump motor container helium pressure was measured The coast period command was turned on, the LOX flight pressurization system was turned off, and the engine pump purge was started The simulated mainstage OK indication was turned off to complete the first burn sequence

The engine restart preparations were conducted next. The 70 pound ullage engine command 1 was turned on and off, the LH_2 continuous vent valves were opened, and the ullage engine command 2 was turned on and off. The engine pump purge was completed. The LH_2 boiloff bias signal voltage was measured, then remeasured with the propellant utilization boiloff bias cutoff turned on The LH_2 continuous vent valves were then closed, and the LOX repressurization spheres and cold helium spheres pressures were measured.

The O_2H_2 burner spark excitation systems were verified to operate properly The proper operation of the LOX and LH_2 repressurization control valves was verified, and the LOX and LH_2 tank cryogenic repressurization sequences were accomplished The cold helium sphere pressure and the LOX repressurization spheres pressure were measured, and the LOX tank ambient repressurization sequence was accomplished. The LOX and LH_2 chilldown pumps were turned on, and the chilldown inverter voltages were measured The LH_2 tank ambient repressurization sequence was then accomplished With the propellant utilization valve hardover position command on, the ratio valve position was verified to be less than -20 degrees. The LH_2 and LOX chilldown pumps were turned off, and the inverter operating frequencies and

4.2 24 (Continued)

voltages were measured The cold helium supply shutoff valve was then opened, completing the restart preparations.

The engine restart sequence was accomplished with the simulated ignition detected indication and the simulated mainstage OK indication turned on to simulate a satisfactory engine restart The cold helium supply shutoff valve was closed to complete the restart sequence The LH_2 second burn repressurization sequence was accomplished, with the LH_2 pressurization control module helium pressure measured with the prepressurization supply open, and again after the pressure switch supply was closed. The engine cutoff was then accomplished, the simulated ignition detected indication was turned off, and the coast period command was turned on

A series of checks verified that a dry condition of any one LOX or LH_2 point level sensor would not cause engine cutoff, but that a dry condition of any two LOX sensors or any two LH_2 sensors would cause engine cutoff The sensors were checked by turning off the simulated wet conditions for the combinations of LOX and LH_2 sensors During the umbilicals-in test only, the operating time of the LOX depletion engine cutoff timer was measured for each combination of LOX sensors

The emergency detection system and range safety system tests were accomplished next Verification was made that each of the emergency detection system 1 and 2 engine cutoff commands properly caused engine cutoff A series of checks then verified that the range safety EBW firing unit arm and engine cutoff command properly charged the range safety firing units and caused engine cutoff, and that the range safety propellant dispersion command properly fired the range safety EBW firing units During the umbilicals-in test only, additional checks verified that the range safety 1 and 2 receiver propellant dispersion cutoff command inhibits properly prevented engine cutoff and EBW firing unit operation As a final range safety system test, it was verified that the range safety system off command properly turned off both range safety receivers

A series of APS yaw and pitch attitude control checks were conducted next The yaw attitude control nozzles I-IV and III-IV, plus pitch control nozzle I-P, were turned on and off and the corresponding APS engine valves were measured for open

4 2 24 (Continued)

and closed indication voltages. In addition, the APS engine thrust chamber pressures were measured with the valves open and closed, pressure upstream of the valves, and the thrust chamber throat plugs installed This procedure was then repeated for yaw attitude control nozzles I-II and III-II and pitch control nozzle III-P, satisfactorily completing the yaw and pitch checks. After a final telemetry calibration, the stage shutdown was accomplished, completing the all systems test

Several problems, encountered during Engineering runs of the all systems test, were resolved by FARR action prior to the acceptable test attempt

a FARR 500-025-751 noted faulty inflight calibrations on the DP1-BO multiplexer, P/N 1B62513-543, S/N 026. The multiplexer was removed and another multiplexer, S/N 021, was installed, tested, and accepted for use

b FARR 500-026-022 noted that cutoff indications were not received when the LOX point level sensors 1 and 2 were turned off The two control units, P/N 1A68710-511 1, S/N's D80 and B101, were removed, and new control units, S/N's E58 and C89, were installed, tested, and accepted for use

c. FARR 500-026-031 rejected time delay module, P/N 1B59020-1, S/N 028, for the same LOX point level sensor problem noted above A new module, S/N 048, was installed and accepted for use

d FARR 500-026-049 rejected decoder assembly, P/N 1A74053-503, S/N 273, for cycling from high calibration to low calibration without command Another decoder, S/N 164, was installed and accepted for use

Thirty-eight revisions were made to the procedure as follows

a. Thirteen revisions were modifications and additions required as supplementary setup instructions

b Five revisions were corrections of program and procedure errors

c. One revision incorporated tasks No 1 through No. 7 of the AST countdown manual into the procedure to supplement setup instructions

d Two revisions incorporated the OLSTOL changes for stage power setup and turnoff previously used in the accepted poststorage demonstration tests for these procedures (1B55813 E and 1B55814 D)

e One revision provided for calibration of the aft 5 volt excitation module, as the output voltage was out-of-tolerance during a preliminary engineering run of stage power setup

4.2 24 (Continued)

f. One revision explained that the SIM 141 interrupt during the stage power setup matrix reset resulted from inadvertently turning on the ESCS power prior to stage power setup

g. One revision authorized the momentary manual reduction of the 28 vdc forward bus 2 voltage to 26.3 vdc to avoid possible damage to the propellant utilization electronics assembly from the high power turn-on voltage spike

h One revision modified the program to accommodate a lower sensitivity of 3.25 mv/watt for the PCM transmitter reflected power detector The program called for a higher sensitivity of 5.0 mv/watt which was not required for the stage until after delivery to KSC

i One revision modified the program to substitute the aft 1 secondary battery for the aft 1 battery simulator, in order to maintain the aft 1 bus voltage below the 30 5 vdc redline during the engine sequence

j. One revision provided for measuring and recording the auxiliary hydraulic pump motor gas pressure and pump air tank pressure before and after gimballing.

k One revision attributed the malfunction indications for venting the stage 1 helium regulator to insufficient time allowed by the program for venting the large helium volume in the stage 1 and the precooler coils.

l Two revisions attributed out-of-tolerance malfunctions for cold helium sphere pressures and LH_2 ullage pressures to transducer sensitivity to radio frequency interference The pressures were verified on the VMP gauge to be within tolerance

m Two revisions explained that the malfunction indication, "burner spark No. 1 not off", had occurred due to the use of the flight configuration O_2H_2 burner spark exciters, which require a longer charge decay time than the program allows, and initiated a paper tape change increasing the allowable charge decay time from 1 second to the required 2 seconds for these exciters Subsequent retest resulted in a satisfactory burner spark check

n One revision attributed out-of-tolerance LH_2 chilldown inverter simulator phase voltages to a lack of filters for the simulator voltage monitoring circuits WRO S-IVB-3850 was issued to add the filters needed to preclude these measurement malfunctions during subsequent testing of the power distribution and all systems tests Telemetry output measurements during the AST verified the correct operation of the chilldown inverter

4.2.24 (Continued)

o One revision noted that stopping and restarting the 3 degree step response gimbal routine was necessitated by unintentional tearing of the line printer paper

p. One revision explained the malfunction indication, "DDAS antenna input not reset", at the start of umbilicals-out testing. The DDAS switch was inadvertently left in position 1 rather than AUTO after the stage power setup, due to an operator error Switching the DDAS to AUTO accomplished a satisfactory restart of the AST

q. One revision indicated that the out-of-tolerance initial measurement (umbilicals-out test) of the PU inverter and electronics assembly current draw, 5 50 amperes, occurred due to the inherent forward bus 2 noise induced by the propellant utilization electronics assembly power turn on The remeasurement after resumption of the program was within the 5 0 amps maximum allowable current draw

r One revision explained that the umbilicals-out test malfunction of low LH_2 pressure switch supply pressure, resulted from low stage 6 helium regulator pressure at 32 psia The stage 6 regulator was manually pressurized to the required 50 ±5 psia, and the LH_2 tank prepressurization sequence was then satisfactorily completed

s One revision noted that the indication of relays not reset for repressurization and O_2H_2 burner propellant valves occurred during the stage power turn off following the AST as a result of the engine cutoff cycling these valves prior to running the stage power turn off

4 2 24 1 Test Data Table, All Systems Test

Function	Umbil -In	Umbil -Out	Limits
Power Setup			
PU Inv and Elect. Current (amps)	3.8	3.5	5 0 max
Aft Bus 1 Current with Eng Cont Bus Pwr On (amps)	1 10	1 20	2 7 ±3.0
Aft Bus 1 Voltage with Eng Cont Bus Pwr On (X) (vdc)	27 96	27 92	28 0 ±2.0
Engine Control Bus Voltage (vdc)	27 78	27.78	Meas (X) ±1.0
Component Test Pwr Voltage (vdc)	27 56	27 48	Meas (X) ±1 0
Aft Bus 1 Current with Eng Ing Bus Pwr On (amps)	1.50	1.50	2.7 ±3 0
Aft Bus 1 Voltage with Eng Ign Bus Pwr On (Y) (vdc)	27 92	28 00	28 0 ±2 0
Engine Ignition Bus Voltage (vdc)	27 94	27 88	Meas (Y) ±1 0

4.2.24.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Power Setup (Continued)			
Aft Bus 1 Current with APS Bus Pwr On (amps)	2.80	1.50	2.7 ± 3.0
Aft Bus 2 Current (amps)	-0 60	-0.80	5.0 max
Aft Bus 2 Voltage (vdc)	56 24	56 24	56.0 ± 4 0
Propulsion System Setup			
Amb He Pneu Sphere Press D236 (psia)	686.1	697.4	700.0 ± 50.0
Cold Helium Sphere Press D016 (psia)	613 8†	606.2†	900 0 ± 50.0
Eng Cont He Supply Press D019 (psia)	1574.1	1567 3	1450.0 min
Cont He Reg Discharge Press. D014 (psia)	522.7	525.5	515.0 ± 50.0
LH_2 Repress. He Sphere Press. D020 (psia)	405.7	372.1	*
LOX Repress. He Sphere Press. D088 (psia)	738.5	731.0	*
APS 1 Fuel Sup Manf Press (psia)	32.29	33.17	38 ± 15
APS 1 Oxid Sup Manf Press (psia)	38.41	38.84	38 ± 15
APS 2 Fuel Sup Manf Press (psia)	37.10	36.66	38 ± 15
APS 2 Oxid Sup Manf Press (psia)	31.42	33.60	38 ± 15
APS 1 Fuel Ull Vol Press (psia)	51.9	51.9	50 ± 15
APS 1 Oxid Ull Vol Press (psia)	50.6	50.6	50 ± 15
APS 2 Fuel Ull Vol Press (psia)	54.1	54.6	50 ± 15
APS 2 Oxid Ull Vol Press (psia)	51.9	53.7	50 ± 15
LH_2 Prepressurization Sequence			
LH_2 Press. Control Module GH_2 Press. D104 (psia)	225.58	224.49	50.0 min
EBW and Telemetry Checks			
PCM/FM Transmitter Output with PCM RF Assy Off (watts)	-0.09	**	2.0 max
PCM/FM Transmitter Output with PCM RF Assy On (watts)	25.43	**	10.0 min
T/M Antenna 1 Forward Power (watts)	25.995	26.202	21.75 ± 6.75

†See revision 1

*Limits not specified

**Measurements not applicable

4.2.24.1 (Continued)

Function	Umbil -In	Umbil -Out	Limits
EBW and Telemetry Checks (Continued)			
T/M RF System Reflected Power (watts)	0.344	0.344	3.08 max
Telemetry System Closed Loop VSWR	1.259	1.258	2.0 max
Inv-Conv 115 vac Output (vac)	116.21	116.12	115 ± 3.45
Inv-Conv 5 vdc Output (vdc)	4.98	4.98	4.9 ± 0.2
Inv-Conv 21 vdc Output (vdc)	21.69	21.69	21.25 ± 1.25
Inv-Conv Operating Frequency (Hz)	400.15	400.21	400.0 ± 6.0
Hydraulic System Checks			
Reservoir GN_2 Mass (lbs)	1.917	1.968	1.925 ± 0.2
Corrected Reservoir Oil Level (%)	99.5	99.1	95.0 min
Hydraulic System Unpressurized			
Hydraulic System Pressure (psia)	1378.84	1375.56	*
Accumulator GN_2 Pressure (psia)	2323.69	2465.56	*
Accumulator GN_2 Temperature (°F)	64.31	81.94	*
Reservoir Oil Temperature (°F)	61.98	85.86	*
Reservoir Oil Level (%)	88.33	90.57	*
Reservoir Oil Pressure (psia)	73.76	75.06	*
Pump Inlet Oil Temperature (°F)	63.15	77.63	*
T/M Yaw Actuator Position (deg)	1.16	1.05	*
Corrected T/M Yaw Act. Pos (deg)	1.212	1.102	*
IU Yaw Actuator Position (deg)	1.17	1.00	*
Corrected IU Yaw Act. Pos (deg)	1.158	0.995	*
T/M Pitch Actuator Position (deg)	-0.13	-0.24	*
Corrected T/M Pitch Act. Pos (deg)	-0.171	-0.281	*
IU Pitch Actuator Position (deg)	-0.09	-0.22	*
Corrected IU Pitch Act. Pos (deg)	-0.080	-0.213	*
IU Substitute 5v Power Supply (vdc)	5.00	5.00	*
Aft 5v Excitation Module (vdc)	4.97	4.97	*
Aft Bus 2 Current (amps)	-0.80	0.00	*

*Limits not specified

4.2.24.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Hydraulic System Pressurized			
Hyd System 4 Second Press. Change (psia)	242.3	248.8	200.0 min
Hydraulic System Pressure (psia)	2598.06	3601.38	*
Accumulator GN_2 Pressure (psia)	3559.38	3564.88	*
Accumulator GN_2 Temperature (°F)	87.03	103.15	*
Reservoir Oil Temperature (°F)	63.54	86.25	*
Reservoir Oil Level (%)	38.28	45.25	*
Reservoir Oil Pressure (psia)	164.53	165.84	*
Pump Inlet Oil Temperature (°F)	65.10	84.68	*
T/M Yaw Actuator Position (deg)	0.06	0.05	*
Corrected T/M Yaw Act. Pos (deg)	0.107	0.085	*
IU Yaw Actuator Position (deg)	-0.01	0.01	*
Corrected IU Yaw Act. Pos (deg)	-0.022	0.006	*
T/M Pitch Actuator Position (deg)	-0.06	-0.05	*
Corrected T/M Pitch Act. Pos (deg)	-0.107	-0.085	*
IU Pitch Actuator Position (deg)	-0.07	-0.03	*
Corrected IU Pitch Act. Pos (deg)	-0.065	-0.021	*
IU Substitute 5v Power Supply (vdc)	5.00	5.00	*
Aft 5v Excitation Module (vdc)	4.97	4.97	*
Aft Bus 2 Current (amps)	45.40	44.60	*
FRATS Calibration			
LOX Circ Pump Flowrate Ind (vdc)	3.866	3.866	3.866 ± 0.100
LH_2 Circ Pump Flowrate Ind (vdc)	3.871	3.871	3.866 ∓ 0.100
Static Inv-Conv Freq Ind (vdc)	2.666	2.677	2.600 ∓ 0.100
LH_2 C/D Inv Freq Ind (vdc)	2.620	2.625	2.600 ∓ 0.100
LOX C/D Inv Freq Ind (vdc)	2.641	2.625	2.600 ∓ 0.100
LOX Flowmeter Indication (vdc)	1.682	1.682	1.667 ∓ 0.100
LH_2 Flowmeter Indication (vdc)	1.702	1.723	1.667 ∓ 0.100
LOX Pump Speed Indication (vdc)	3.169	3.164	3.125 ∓ 0.100
LH_2 Pump Speed Indication (vdc)	1.281	1.271	1.250 ∓ 0.100

* Limits not specified

4.2.24.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Telemetry RF Checks			
T/M Antenna 1 Forward Power (watts)	26.024	26.411	21.75 ± 6.75
T/M RF System Reflected Power (watts)	0.308	3.415	3.08 max
Telemetry System Open Loop VSWR	1.243	2.122	3.0 max
Chilldown Inverter Telemetry Checks			
LH_2 C/D Inv Frequency (Hz)	401.3	401.3	400.0 ± 4.0
LH_2 C/D Inv Phase AB Volt. (vac)	54.9	52.9	*
LH_2 C/D Inv Phase AC Volt. (vac)	55.1	53.1	*
LOX C/D Inv Frequency (Hz)	399.0	398.9	400.0 ± 4.0
LOX C/D Inv Phase AB Volt. (vac)	54.5	52.7	*
LOX C/D Inv Phase AC Volt. (vac)	54.7	52.7	*
Pressure Measurements			
Common Bulkhead Pressure (psia)	0.903	0.903	0.784 ± 0.5
Common Bulkhead Internal Press. (psia)	0.784	0.811	0.784 ± 0.5
Common Bulkhead 20% Calib (vdc)	1.060	1.039	1.0 ± 0.1
Common Bulkhead Press. (psia)	0.798	0.877	0.784 ± 0.5
Common Bulkhead 80% Calib (vdc)	3.989	4.015	4.0 ± 0.1
Common Bulkhead Press. (psia)	0.877	0.798	0.784 ± 0.5
LH_2 Ullage Pressure (psia)	18.658 †	16.907 †	14.7 ± 1.0
LH_2 Ullage 20% Calib (vdc)	1.354	1.204	1.0 ± 0.1
LH_2 Ullage Amb Press. (psia)	18.712 †	16.907 †	14.7 ± 1.0
LH_2 Ullage 80% Calib (vdc)	4.404	4.220	4.0 ± 0.1
LH_2 Ullage Amb Press. (psia)	18.605 †	16.907 †	14.7 ± 1.0
LOX Ullage Pressure (psia)	14.634	15.006	14.7 ± 1.0
LH_2 EDS Transducer 1 Press. (psia)	14.3	14.4	14.7 ± 1.0
LH_2 EDS Transducer 2 Press. (psia)	14.3	14.4	14.7 ± 1.0
LOX EDS Transducer 1 Press. (psia)	14.5	14.3	14.7 ± 1.0
LOX EDS Transducer 2 Press. (psia)	14.5	14.4	14.7 ± 1.0
Final Prelaunch Checks			
Fwd Bus 1 Batt. Sim. (Bus 4D30) (vdc)	28.76	**	28.0 ± 2.0
Fwd Bus 2 Batt. Sim. (Bus 4D20) (vdc)	28.52	**	28.0 ± 2.0
Aft Bus 1 Batt. Sim. (Bus 4D10) (vdc)	30.04	**	28.0 ± 2.0
Aft Bus 2 Batt. Sim. (Bus 4D40) (vdc)	55.60	**	56.0 ± 4.0
Bus 4D20 ESE Load Bank (vdc)	0.00	**	0.0 ± 1.0
Bus 4D40 ESE Load Bank (vdc)	-0.16	**	0.0 ± 1.0
Bus 4D30 ESE Load Bank (vdc)	0.00	**	0.0 ± 1.0
Bus 4D10 ESE Load Bank (vdc)	-0.24	**	0.0 ± 1.0
Fwd Bus 1 C/O Batt. (Bus 4D30) (vdc)	**	30.20	29.5 ± 1.5
Fwd Bus 2 C/O Batt. (Bus 4D20) (vdc)	**	30.16	29.5 ± 1.5
Aft Bus 1 C/O Batt. (Bus 4D10) (vdc)	**	29.72	29.5 ± 1.5
Aft Bus 2 C/O Batt. (Bus 4D40) (vdc)	**	60.08	60.5 ± 1.5
Common Bulkhead Press. Transducer (vdc)	0.000	0.000	0.0 ± 0.353

* Limits not specified

** Measurements not applicable

† See revision 1.

4.2 24.1 (Continued)

Function	Umbil -In	Umbil -Out	Limits
LH_2 Ullage Press. Transducer (vdc)	0.000	0.000	0.0 ∓ 0.353
LOX Ullage Press. Transducer (vdc)	0.119	0.114	0.0 ∓ 0.353
Fwd Bus 1 Internal (Bus 4D31) (vdc)	28.44	29.80	28.0 ∓ 2.0
Fwd Bus 2 Internal (Bus 4D21) (vdc)	27.88	28.84	28.0 ∓ 2.0
Aft Bus 1 Internal (Bus 4D11) (vdc)	29.92	29.36	28.0 ∓ 2.0
Aft Bus 2 Internal (Bus 4D41) (vdc)	54.96	54.96	56.0 ∓ 4.0
Receiver 1 Low Level Signal (vdc)	3.42	3.49	2.5 min
Receiver 2 Low Level Signal (vdc)	3.47	3.51	2.5 min
LH_2 EDS 1 Ullage Pressure (psia)	14.34	14.34	14.7 ± 1.0
LH_2 EDS 2 Ullage Pressure (psia)	14.30	14.42	14.7 ∓ 1.0
LOX EDS 1 Ullage Pressure (psia)	14.40	14.40	14.7 ∓ 1.0
LOX EDS 2 Ullage Pressure (psia)	14.60	14.60	14.7 ∓ 1.0
APS Roll Checks			
IU Substitute -28 volt Power (vdc)	-28.759	-29.039	-28.5 ± 2.5
Attitude Control Nozzles I-IV and III-II On			
APS Engine 1-1 Valves Open Ind (vdc)	4.07	3.94	3.9 ± 0.4
APS Engine 2-1 Valves Open Ind (vdc)	3.99	3.89	3.9 ∓ 0.4
APS Engine 1-1 Chamber Pressure with Valves Open (psia)	26.65	26.02	*
APS Engine 2-1 Chamber Pressure with Valves Open (psia)	26.33	25.27	*
Attitude Control Nozzles I-IV and III-II Off			
APS Engine 1-1 Valves Open Ind (vdc)	0 00	0 00	0 00 ± 0.25
APS Engine 2-1 Valves Open Ind (vdc)	0.00	0.00	0.00 ∓ 0 25
APS Engine 1-1 Chamber Pressure with Valves Closed (psia)	14.83	14 19	*
APS Engine 2-1 Chamber Pressure with Valves Closed (psia)	14.46	13.40	*
Attitude Control Nozzles I-II and III-IV On			
APS Engine 1-3 Valves Open Ind (vdc)	4.09	3.98	3.9 ± 0.4
APS Engine 2-3 Valves Open Ind (vdc)	3.94	3.83	3.9 ∓ 0.4
APS Engine 1-3 Chamber Pressure with Valves Open (psia)	28.11	27.05	*
APS Engine 2-3 Chamber Pressure with Valves Open (psia)	26.58	25.74	*

* Limits not specified

4.2.24.1 (Continued)

Function	Umbil.-In	Umbil -Out	Limits
Attitude Control Nozzles I-II and III-IV Off			
APS Engine 1-3 Valves Open Ind (vdc)	0.00	0.00	0 00 ±0 25
APS Engine 2-3 Valves Open Ind (vdc)	0.00	0 00	0 00 ±0.25
APS Engine 1-3 Chamber Pressure with Valves Closed (psia)	14 71	14.50	*
APS Engine 2-3 Chamber Pressure with Valves Closed (psia)	14.78	14 15	*
Hydraulic Gimbal Step Response Check			
Ratio Valve Pos (Relay Off)(P)(deg)	0.21	0.01	0 0 ±1.5
Hydraulic System Pressure (psia)	3592.0	3605 0	3575 ±75
Ratio Valve Pos. (Relay On) (deg)	33.28	33 35	20.0 min
Ratio Valve Pos. (Relay Off) (deg)	1.71	1.51	Meas.(P) + 1.5
Hydraulic System Pressure (psia)	3605.0	3605.0	3575 + 75
Pitch Act. Piston Pos., AO (deg)	-0.080	-0.064	0.0 + 0.517
Pitch Act. Piston Pos., BO (deg)	-0.033	-0.002	0.0 ∓ 0.517
Yaw Act. Piston Position, AO (deg)	-0.002	-0.002	0.0 ∓ 0.517
Yaw Act. Piston Position, BO (deg)	-0.250	-0.250	0.0 ∓ 0.517
Engine Pitch Position, IU (deg)	-0.088	-0.073	0.0 ∓ 0.517
Engine Yaw Position, IU (deg)	-0.015	-0.029	0.0 ∓ 0.517
Hydraulic System Pressurized			
Hydraulic System Pressure (psia)	3601.38	3594.81	*
Accumulator GN_2 Pressure (psia)	3575.75	3575.75	*
Accumulator GN_2 Temperature (^{o}F)	71.75	85.07	*
Reservoir Oil Temperature (^{o}F)	121.28	138.67	*
Reservoir Oil Level (%)	43.26	48.36	*
Reservoir Oil Pressure (psia)	170.21	169.77	*
Pump Inlet Oil Temperature (^{o}F)	138.27	151.34	*
T/M Yaw Actuator Position (deg)	0.02	0.00	*
Corrected T/M Yaw Act. Pos. (deg)	0.061	0.045	*
IU Yaw Actuator Position (deg)	-0.03	-0.04	*
Corrected IU Yaw Act. Pos. (deg)	-0.022	-0.009	*
T/M Pitch Actuator Position (deg)	-0.08	-0.06	*
Corrected T/M Pitch Act. Pos. (deg)	-0.123	-0.107	*
IU Pitch Actuator Position (deg)	-0.07	-0.06	*
Corrected IU Pitch Act. Pos. (deg)	-0.080	-0.095	*
IU Substitute 5v Power Supply (vdc)	4.99	4.97	*

* Limits not specified

4.2.24.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Aft 5v Excitation Module (vdc)	4.97	4 97	*
Aft Bus 2 Current (amps)	46.20	**	*
Aft Checkout Battery 2 Current (amp)	**	49.60	*
Ratio Valve Pos. (Relay On) (deg)	-27.260	-27.192	-20.0 max
First Burn and Coast Period			
LOX Press. Module Helium Pressure D105			
Cold Helium Supply Open (psia)	187.527	178.254	*
LOX Press. Sw. Supply Closed (psia)	171.703	160.797	*
LH_2 Press. Module Helium Pressure D104			
LH_2 Prepress. Supply Open (psia)	401.242	400.156	*
LH_2 Press. Sw. Supply Closed (psia)	296.50	294.32	*
LH_2 First Burn Relay Off (psia)	232.13	231.04	*
LOX Motor Container He Press. D103 (psia)	40.59	40.59	*
Engine Restart Preparations			
LH_2 Boiloff Bias Signal M010:			
Bias Cutoff Off (vdc)	0.28	0.32	0.0 ± 2.5
Bias Cutoff On (vdc)	6.368	6.153	4.0 min
LOX Repress. Spheres, D088 (psia)	723.53	719.78	*
Cold Helium Spheres, D016 (psia)	369.45	403.83	*
Cold Helium Spheres, D016 (psia)	193.80	235.80	*
LOX Repress. Spheres, D088 (psia)	719.78	719 78	*
Chilldown Pumps On			
LOX C/D Inv Phase AB Volt. (vac)	53 2	54 9	50 0 min
LOX C/D Inv Phase AC Volt. (vac)	53 1	55.3	50.0 min
LOX C/D Inv Phase A1B1 Volt. (vac)	53.5	55.1	50 0 min
LOX C/D Inv Phase A1C1 Volt. (vac)	53.8	55.5	50 0 min
LH_2 C/D Inv Phase AB Volt (vac)	52.2	52 9	50 0 min
LH_2 C/D Inv Phase AC Volt. (vac)	51 0	52.8	50 0 min
LH_2 C/D Inv Phase A1B1 Volt. (vac)	52.1	53 1	50.0 min
LH_2 C/D Inv Phase A1C1 Volt. (vac)	51.9	52 7	50 0 min
Chilldown Pumps Off			
LH_2 C/D Inv Frequency (Hz)	389.5	389.5	390 0 ± 1.0
LH_2 C/D Inv Phase AB Volt (vac)	0 00	-0.07	0 0 ± 1 5
LH_2 C/D Inv Phase AC Volt. (vac)	0.00	0.00	0.0 ± 1.5
LOX C/D Inv Frequency (Hz)	389.5	389.5	390.0 ± 1.0
LOX C/D Inv Phase AB Volt. (vac)	0.00	0.00	0.0 ± 1.5
LOX C/D Inv Phase AC Volt. (vac)	0.07	0.00	0.0 ± 1.5

* Limits not specified
**Measurement not applicable

4.2.24 1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
LH$_2$ Second Burn Repressurization			
LH$_2$ Press. Module Helium Pressure D104			
LH$_2$ Prepress. Supply Open (psia)	401.242	404.516	*
LH$_2$ Press. Sw. Supply Closed (psia)	289 953	285.586	*
LH$_2$ Second Burn Off	237.582	236.488	*
LOX Depletion Timer Check			
LOX Sensors 1 and 2 Dry (sec)	0.564	**	0.560 ±0.025
LOX Sensors 1 and 3 Dry (sec)	0 555	**	0 560 ±0 025
LOX Sensors 2 and 3 Dry (sec)	0.552	**	0.560 ±0.025
APS Yaw Checks			
Attitude Control Nozzles I-IV and III-IV On			
APS Engine 1-1 Valves Open Ind (vdc)	3.93	3.91	3 9 ±0 4
APS Engine 2-3 Valves Open Ind (vdc)	3.79	3 83	3 9 ±0 4
APS Engine 1-1 Chamber Pressure with Valves Open (psia)	24 75	25.39	*
APS Engine 2-3 Chamber Pressure with Valves Open (psia)	24 47	24.90	*
Attitude Control Nozzles I-IV and III-IV Off			
APS Engine 1-1 Valves Open Ind (vdc)	-0 00	0.00	0.0 ±0 25
APS Engine 2-3 Valves Open Ind (vdc)	0.00	0.00	0.0 ±0 25
APS Engine 1-1 Chamber Pressure with Valves Closed (psia)	14.61	13 98	*
APS Engine 2-3 Chamber Pressure with Valves Closed (psia)	14 15	14 78	*
Attitude Control Nozzles I-II and III-II On			
APS Engine 1-3 Valves Open Ind (vdc)	3 96	3 93	3 9 ±0 4
APS Engine 2-1 Valves Open Ind (vdc)	3.85	3 86	3 9 ±0 4
APS Engine 1-3 Chamber Pressure with Valves Open (psia)	26.20	26 20	*
APS Engine 2-1 Chamber Pressure with Valves Open (psia)	24.42	24 63	*

* Limits not specified
** Measurement not applicable

4 2.24.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Attitude Control Nozzles I-II and III-II Off			
APS Engine 1-3 Valves Open Ind (vdc)	-0 00	-0 00	0 0 ±0 25
APS Engine 2-1 Valves Open Ind (vdc)	0 00	0 00	0 0 ±0 25
APS Engine 1-3 Chamber Pressure with Valves Closed (psia)	14 93	14.50	*
APS Engine 2-1 Chamber Pressure with Valves Closed (psia)	13 40	12 97	*
Attitude Control Nozzle I-P On			
APS Engine 1-2 Valves Open Ind (vdc)	4.03	4.00	3 9 ±0 4
APS Engine 1-2 Chamber Pressure with Valves Open (psia)	27 82	27 61	*
Attitude Control Nozzle I-P Off			
APS Engine 1-2 Valves Open Ind (vdc)	-0 00	0.00	0 0 ±0 25
APS Engine 1-2 Chamber Pressure with Valves Closed (psia)	16 05	15 62	*
Attitude Control Nozzle III-P On			
APS Engine 2-2 Valves Open Ind (vdc)	3 89	3 92	3 9 ±0 4
APS Engine 2-2 Chamber Pressure with Valves Open (psia)	22.07	21 43	*
Attitude Control Nozzle III-P Off			
APS Engine 2-2 Valves Open Ind (vdc)	0 00	0 01	0 0 ±0 25
APS Engine 2-2 Chamber Pressure with Valves Closed (psia)	14 18	14 18	*

* Limits not specified

4.2.25 Hydraulic System Poststorage Operating and Securing (1B41006 A)

Contained in this procedure were the instructions necessary to obtain postfire and poststorage closed loop fluid samples, and to prepare the hydraulic system for removal of the stage from the test stand and for shipment to the VCL

This procedure was initiated on 6 March 1968, and was completed on 11 March 1968 Prior to the start of the checkout, the GSE Model DSV-IVB-358 hydraulic pumping unit (HPU), P/N 1A67443-1, was flushed and checked for hydraulic fluid cleanliness, then connected to the stage hydraulic system by pressure and return hoses

After the stage air tank was initially pressurized, the accumulator/reservoir was pressurized to 2350 psig with nitrogen gas Verification was made that all components of the stage hydraulic system were securely installed and that each hydraulic connection was properly torqued All bleed valves were verified to be closed, and all signs of hydraulic fluid were rinsed from the external system

A closed loop system fluid sample was obtained and found to be within the cleanliness requirements (Less than 1340 particles in the 10-25 micron range, 530 particles in the 25-50 micron range, 60 particles in the 50-100 micron range, and 10 particles over 100 microns).

For the hydraulic system air content test, the system was pressurized to 3650 $\pm$ 50 psig, using the HPU After 3 minutes, the HPU was turned off and the system pressure was allowed to decay to 180 psig Sufficient hydraulic fluid was then drained from the system to reduce the system pressure to 80 psig. The amount of fluid drained was verified to be less than 30 milliliters, indicating that filling and bleeding of the stage hydraulic system had been accomplished satisfactorily

The stage air supply bottle and the auxiliary pump case were depressurized. After complete depressurization of the pump case, the bleed plug was retorqued and safetied

The GN_2 accumulator was depressurized and all auxiliary equipment was removed from the hydraulic system, and all sample ports were capped The actuator midstroke locks were installed, the accumulator/reservoir drain hose was

4.2.25 (Continued)

removed, and a plastic dust cover was installed over the reservoir low pressure relief valve

Inspection Item Sheet 338458 and FARR 500-026-103 documented a leak in the hydraulic accumulator, P/N 1B29319-519, S/N 00032. A complete cycling and leak check was performed on the accumulator The leakage rate was determined to be within the acceptable range of 2 drops per 10 minutes, and the accumulator was accepted for use (Reference paragraph 4 2.27)

Engineering comments indicate that all parts were installed at the start of the test No further problems were encountered and the procedure was accepted by Engineering on 11 March 1968.

Four revisions were made to the procedure for the following

a Two revisions ran a leak check of the hydraulic accumulator to determine the amount of fluid leakage

b One revision established the allowable leakage rate for the hydraulic accumulator at 2 drops per 10 minutes

c. One revision changed the accumulator/reservoir bleed curve to allow for a higher operating temperature, to ensure that no fluid would be dumped overboard due to thermal expansion

4 2 26 Forward Skirt Thermoconditioning System Poststorage Checkout (1B41883 B)

This procedure tested the forward skirt thermoconditioning system (TCS) in preparation for shipment at the completion of the stage poststorage checkout operations The procedure utilized the Model DSV-4B-359 thermoconditioning servicer, P/N 1A78829-1, which had conditioned and supplied the water/methanol heat transfer fluid to the forward skirt TCS, P/N 1B38426-513, during poststorage operations

Checkout included the water/methanol cleanliness test and specific gravity test, the TCS differential pressure test, the TCS drying and leak check procedure, and preparation for shipment The purpose of the cleanliness test was to ensure against contamination of the water/methanol solution that could cause TCS system failure by such conditions as restriction of flow or pump abrasion

4 2 26 (Continued)

The specific gravity test checked for proper water/methanol concentration to obtain valid measurements during the TCS differential pressure test, which in turn was conducted to check for correct TCS system geometry and flow distribution. A drying procedure utilized gaseous nitrogen to purge the TCS system of water/methanol vapor prior to the system leak check. A final GN_2 purge was conducted to dry the TCS after completion of the freon leak check of the TCS.

The final poststorage TCS checkout was initiated on 7 March 1968, and was successfully completed and accepted on 8 March 1968. The water/methanol cleanliness test was conducted first Water/methanol fluid was circulated through the TCS, then water/methanol samples were obtained and taken to the laboratory for a particle count The samples were found acceptable for each micron range. The results for the supply and return samples were identical, one particle in the 175-700 micron range (25 particles allowable), no particles in the 700-2500 micron range (5 particles allowable), and no particles over 2500 microns (none allowable)

Next, the specific gravity and temperature of the water/methanol solution was measured with a hydrometer and thermometer, respectively, determining that the solution was within the acceptable mixture range for the required differential pressure testing band. The differential pressure test was then conducted by measuring the differential pressure between the TCS supply and return lines from the servicer, plus the supply and return temperatures, with a water/methanol flow rate of 7.8 ±0 1 gpm at a supply pressure of 42 0 ±0 psig The differential pressure was recorded at 18 7 psi with fluid supply temperature and return temperature both at 79°F.

Prior to leak checking the TCS, the system was purged of water/methanol with GN_2 until a system dryness of 25°F dewpoint was obtained, as verified by an Alnor dewpoint meter Next, an inspection of the TCS panels for open equipment mounting bolt holes and properly torqued bolts was accomplished satisfactorily, indicating readiness for the system leak checks The thermoconditioning system was then pressurized to 32 ±1 psig with freon gas and leak checked with the gaseous leak detector, P/N 1B37134-1 The areas checked for leakage included

4 2 26 (Continued)

all TCS B-nuts, fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows No leakage was detected and the TCS was then purged of freon with GN_2 pressurized to 32 ±1 psig

The final operation consisted of disconnecting and securing the servicer, and preparing the TCS for the stage shipment

There were no FARR's initiated as a result of this checkout, and no discrepancies were noted. No revisions to the procedure were recorded

4.2.27 Hydraulic System Servicing (1B41004 B)

During the stage modification period that followed the completion of the post-storage checkout operations, a final disposition of FARR 500-026-103 (reference paragraph 4 2.25) resulted in the rejection of the hydraulic accumulator/reservoir assembly, P/N 1B29319-519, S/N 32, for leakage A new accumulator/reservoir, S/N 31, was installed on the stage, and this servicing procedure was used in the VCL to ensure that the hydraulic system was properly filled, bled, and maintained free of contamination after the replacement

The servicing procedure was initiated on 25 April 1968, and was completed satisfactorily on 3 May 1968 Prior to the operation of the stage hydraulic system, the GSE and stage preliminary setups were accomplished The GSE Model DSV-4B-358 hydraulic pumping unit (HPU), P/N 1A67443-1, was flushed and checked for hydraulic fluid cleanliness The HPU was connected to the stage by the pressure and return hoses, hydraulic fluid was circulated through the stage system to ensure that it was properly filled, and hydraulic fluid samples were taken and certified to be free of contamination

The accumulator/reservoir was charged with GN_2 to 2340 psia at 68°F Using the HPU, the system pressure was gradually increased in 500 psi increments to 4400 psig maximum, while a continuous check was made for external leakage No unacceptable external leakage was detected in the stage hydraulic system

The HPU was then used to circulate hydraulic fluid through the stage hydraulic system at 1800 ±50 psig, to flush the accumulator/reservoir After 30 minutes

4 2.27 (Continued)

of circulation at this pressure, the system was bled free of excessive air by draining hydraulic fluid from the bleed valves at the accumulator inlet and outlet, the reservoir inlet, the engine driven hydraulic pump outlet, and the auxiliary hydraulic pump outlet. Checks were then made of the accumulator/ reservoir low pressure and high pressure relief valve functions, as shown in Test Data Table 4.2.27.1.

With the hydraulic system pressurized to 3650 ±50 psig with the HPU, the accumulator high pressure relief valve checks were conducted as shown in the Test Data Table, and the hydraulic system was checked for internal leakage All results were acceptable

An air content check was made to determine the amount of air trapped in the hydraulic system. Using the HPU, the system was pressurized to 3650 ±50 psig After 3 minutes, the HPU was turned off and the system pressure was allowed to decay to 180 psig Sufficient hydraulic fluid was then drained from the system to reduce the system pressure to 80 psig. The amount of fluid drained was verified to be less than 16 milliliters, indicating that the hydraulic system was satisfactorily filled and bled

No discrepancies were noted during this hydraulic servicing procedure and no FARR's were initiated

Eleven revisions were recorded in the procedure as follows

a Two revisions corrected procedure errors

b. Two revisions deleted all setup operations, leak checks, flushing, and fluid sampling for the gimbal actuators and the auxiliary hydraulic pump The hydraulic system servicing procedure was being conducted because of the replacement of the accumulator/reservoir

c Two revisions deleted all portions of the procedure requiring running of the auxiliary hydraulic pump. Stage power for the pump was not made available and retest of the hydraulic system involving running of the auxiliary hydraulic pump was scheduled to be accomplished at the KSC per Assembly Outline 1A39300, Job 16, Operation 3

d One revision deleted pressurizing the auxiliary hydraulic pump air supply bottle, since the power system flush procedure utilizing the auxiliary hydraulic pump was not to be conducted

4 2 27 (Continued)

e. One revision deleted an allowable leakage rate of 2 drops per 10 minutes under static conditions for the accumulator vent relief valve based on disapproval by the Customer (NASA)

f One revision noted that the differential pressure across the hydraulic system high pressure relief valve was for Engineering information only

g Two revisions provided instructions for securing the hydraulic system after completing the servicing procedure

4.2 27.1 Test Data Table, Hydraulic System Servicing

Function	Measurement	Limits
Accumulator/Reservoir Relief Valve Checks		
Low Pressure Relief Valve		
Relief Pressure, Ground Return (psig)	265.0	275 0 ±25.0
Reseat Pressure, Ground Return (psig)	245.0	220.0 min
Relief Pressure, Overboard (psig)	275 0	275.0 ±25.0
Reseat Pressure, Overboard (psig)	245.0	220.0 min
High Pressure Relief Valve		
System Hydraulic Pressure (psig)	4360.0	4400.0 max
Return Pressure (psig)	280 0	*
Differential Pressure (psid)	4080.0	*
Accumulator High Pressure Relief Valve Checks		
System Internal Leakage (gpm)	0 78	0 8 max
Relief Valve Cracking Pressure (psig)	3900 0	*
Reservoir Pressure (psig)	11 8	*
Differential Cracking Pressure (psid)	3888 2	4100 0 max
Relief Valve Reseating Pressure (psig)	3750.0	*
Reservoir Pressure (psig)	12.0	*
Differential Reseating Pressure (psid)	3738.0	3620 0 min

*Limits not specified

4.2.28 Cryogenic Temperature Sensor Verification (1B64678 E)

During the stage modification period that followed the completion of the poststorage checkout operations, the LH_2 tank was entered to accomplish rework per WRO 4183. This invalidated the previous verification of the cryogenic temperature sensors located in the LH_2 tank, and this procedure was used in the VCL to reverify the calibration and functional capabilities of these cryogenic temperature sensors These sensors, whose normal operating range did not include ambient temperature, were basically platinum resistance elements whose resistance changed with temperature according to the Callendar-Van Dusen equation.

This procedure was accomplished on 26 August 1968, and was accepted on 30 August 1968

For each sensor tested, the prevalent ambient temperature was measured, as was the sensor ambient resistance at that temperature. Using the value for resistance at 32°F and the sensor resistance sensitivity, which were given for each sensor, the expected resistance was calculated at the measured ambient temperature. The actual measured resistance was then verified to be within 7 percent of the calculated resistance The sensor wiring was then verified to be correct by shorting out the sensor element, measuring the continuity resistance, and verifying that this was 5 0 ohms or less Test Data Table 4.2.28 1 shows the measured and calculated values for each sensor involved in this test.

Engineering comments indicated that there were no parts shortages affecting this test No problems were encountered during the test, and no FARR's were written One revision was made to the procedure, to delete all measurements except those in the LH_2 tank

4 2.28.1 Test Data Table, Cryogenic Temperature Sensor Verification

Meas Number	Sensor P/N	Sensor S/N	Sensor Ref. Loc.	Temp (°F)	Resistance (ohms) Meas.	Resistance (ohms) Calc	Resistance (ohms) ± Tol.	Resistance (ohms) Cont
CO 052	1A67862-513	565	408MT612	72	5220	5440	381	1 6
CO 370	1B51648-507	59789	408MT735	72	5310	5440	381	1 6
CO 371	1B51648-507	57803	408MT736	72	5260	5440	381	1 6

4.3 Final Inspection

A final inspection was accomplished by MDAC and AFQC personnel on all stage mechanical and electrical areas, to locate and correct any remaining discrepancies. The inspection was initiated on 16 August 1968, and was completed on 9 September 1968, to verify that the stage was in satisfactory condition for shipment to FTC

A total of 495 defects were noted during this inspection, 389 by MDAC personnel and 106 by AFQC personnel. Of the 389 discrepancies noted by MDAC personnel, 179 were concerned with electrical components and 210 were concerned with mechanical components. Of the 106 discrepancies noted by AFQC personnel, 36 were concerned with electrical components and 70 were concerned with mechanical components.

Most of these discrepancies were corrected without requiring FARR action, but five items were transferred to FARR's for disposition:

a. FARR 500-225-246 noted damage to the insulation of the cable assembly, P/N 1B53524-501, for the LH_2 chilldown pump differential pressure sensor, reference location 403MT750. The cable was acceptably repaired per Material, Methods and Research Engineering instructions.

b. FARR 500-373-024 noted an 0.500 inch diameter by 0 020 inch deep dent in duct, P/N 1A87152-1, S/N 114, an 0.500 inch long by 0 010 inch deep ding in duct, P/N 1A87152-1, S/N 111, and a damaged shield on cable, P/N 1B40242-67, S/N 523-1. The two ducts were acceptable to Engineering without rework, while the cable was acceptably repaired per DPS 54010.

c FARR 500-373-156 noted that pipe assembly, P/N 1B75267-1, had a sharp kink 5 inches from the B-nut at stringer 18. The pipe assembly was removed, and a new pipe assembly was installed.

4 4 Weight and Balance Procedure (1B55602 E)

This procedure measured the stage weight with an accuracy of ±0 1 percent, using a three point electronic weighing system, and determined the longitudinal center of gravity of the stage. The measured stage weight was corrected for gravity and air buoyancy forces to determine the weight at Standard Gravity in a vacuum The procedure was satisfactorily accomplished on 3 September 1968, after the stage was rotated to a horizontal position and placed on the weighing cradles, P/N 1A68719-1 The procedure was accepted on 5 September 1968

Before starting the weighing operation, the electronic weighing system, P/N 1A57907-1, was set up and calibrated Three load cell assemblies, P/N CMU-1204 or 1B38965-1 and -501, were connected to the load cell readout indicator, P/N CMU-1204, checked for linearity and stability by the use of the indicator standardizer, and adjusted for a zero setting The stage was verified to be level within 0.250 inches over the axial distance between stations 554 702 and 286.147. The dry bulb temperature, barometric pressure, and relative humidity were measured in the weighing area, for use in determining the air density These measurements were repeated every half hour throughout the weighing operation

Using the hand pumps on the aft jack, P/N 1A93232-1, and the two forward glide-aire jacks, P/N 1A83320-1, the stage was raised to just clear the cradles, and leveled to the previous limit. Regulator air pressure was applied to the forward glide-aire jacks to permit self-adjustment of the stage, and the stage levelness was reverified After allowing 10 minutes for load cell creep stabilization, load cell readings were taken as shown in Test Data Table 4.4 1 The stage was then lowered back onto the cradles, the load cells were allowed to creep stabilize again, and the load cell zero was rechecked and adjusted if necessary. The weighing procedure was repeated three times, and the average reading for each load cell was determined and corrected for calibration From the capacity of each load cell, and the load cell reading, the reaction force on each load cell was determined. These reaction forces were then used to determine the stage shipping and handling weight, the stage weight at Standard Gravity in a vacuum, and the longitudinal center of gravity As shown in the Test Data Table, the stage shipping and handling weight was 26,905 4 pounds, the weight at Standard Gravity in a vacuum was 26,957 4 pounds, and the longitudinal center of gravity was at station 328.6.

4 4 (Continued)

No parts were short during this procedure, no revisions were written, and no problems were encountered

4.4 1 Test Data Table, Weight and Balance Procedure

Air Density Data

Time	Barometric Press. (in. Hg)	Relative Humidity (%)	Dry Bulb Temp (°F)
11 05	29 61	59.0	67.0
11.35	29 61	60.0	67.0
12 05	29.62	61 0	66 0
12 35	29 63	62 0	66 0

Calculated Air Density. 0.0742 pounds per cubic foot

Load Cell Collected Data

Reaction Load Cell	Aft (R1)	Forward (R2)	Forward (R3)
Serial Number	36246	34180	34251
Capacity (pounds)	25,000	10,000	10,000
Run 1 Reading (%)	79.866	37 702	39 297
Run 2 Reading (%)	79 883	37.762	39 326
Run 3 Reading (%)	79 901	37 762	39.246
Average Reading (%)	79 883	37 730	39.289
Calibration Correction	0.796	0 241	0 235
Corrected Reading (%)	80.679	37.971	39 524
Reaction (pounds)	20,169 7	3,797 1	3,952 4

Weight Determination (pounds)

Aft Reaction R1	20,169 7
Forward Reaction R2	3,797.1
Forward Reaction R3	3,952 4
Total Reactions as recorded	27,919.2
Minus Weighing Equipment "Tare"	-1,013.8
Shipping and Handling Weight	26,905.4
Plus Gravitational Correction	+18 9
Plus Buoyancy Correction	+31 1
Weight at Standard Gravity in a vacuum	26,957.4

4.4.1 (Continued)

Longitudinal Center of Gravity

Reaction R1 Moment at Sta 189 3	3,818,124 20
Reaction R2 Moment at Sta. 684 0	2,597,216.40
Reaction R3 Moment at Sta 684.0	2,703,441 60
Moment Sum	9,118,782.20
Tare Moment	- 278,870.75
Moment Sum Less Tare	8,839,911.45

As weighed Center of Gravity = Station 328 6
(Moment Sum Less Tare divided by Total Reactions Less Tare)

4 5 GN_2 - Electrical Air Carry Preshipment Purge (1B65454 G)

Just prior to stage shipment, this procedure purged the stage to a dewpoint of -30°F (235 ppm by volume) or less, using gaseous nitrogen, and installed the necessary desiccants for stage air carry shipment The desiccants maintained a clean, dry environment and a safe differential pressure during air transportation

The procedure was satisfactorily performed between 4 and 9 September 1968, and was accepted on 12 September 1968. The purge preparations started with the installation of the LOX and LH_2 desiccant support assemblies, P/N's 1B61272-1 and 1B61270-1. The LOX bellows, P/N 1A49971-501, and the LOX and LH_2 disconnects, P/N's 1A49970-503 and 1B66932-501, were removed for separate shipment with the stage Covers and desiccators were installed at the LOX and LH_2 fill and drain vents, the LH_2 propulsive, non-propulsive, and ground vents, the LOX propulsive and non-propulsive vents, and the O_2H_2 burner nozzle

The purge unit, P/N 1B51117-1, was prepared for operation, and the electrical and pneumatic purge connections were made on the stage and between the purge unit and the stage The engine LOX chilldown line and LH_2 feed duct, the LH_2 pressurization line, the LH_2 propulsive vent, non-propulsive vent, and ground vent, the LOX propulsive vent and non-propulsive vent, the O_2H_2 burner LOX and LH_2 ducts, and the LOX and LH_2 propellant tanks were all purged with gaseous nitrogen The final dewpoints attained were -62 5°F for the LOX system, and -31 5°F for the LH_2 system The LOX tank desiccant breather, P/N 1A79691-1, and the four LH_2 tank desiccant breathers, P/N 1A79691-501, were prepared, filled with desiccant material, and installed.

4.5 (Continued)

After the satisfactory completion of the purge operation, the purge unit was disconnected from the stage and secured. The aft skirt dust cover, P/N 1B61077-1, and the forward skirt dust cover, P/N 1B61099-1, were then installed to complete the procedure.

There were no parts shortages affecting this test. No particular problems were encountered, and no FARR's were written. Ten revisions were made to the procedure with one of these subsequently voided

a One revision deleted the requirement to remove the LH_2 tank dome door and install the manifold, P/N 1B61027-1, as this had been previously accomplished during the LH_2 tank horizontal access procedure, H&CO 1B70900.

b One revision deleted the requirements for purging the LH_2 continuous vent regulator module, as it was not installed

c One revision added steps to provide a method of purging the LH_2 tank with hot GN_2.

d One revision changed the hardware used to purge the LOX pressurization line, as the tee, P/N S0089 J8-8-16M, was not available for use

e. One revision installed a 0 to 1000 psia Heise gauge in place of the valve accuating pressure regulator on the stage valve actuating control panel, as the regulator was at the vendor for repair

f. One revision added instructions for hooking up the stage valve pneumatic system pressurization line purge, as the cross normally used had a redundant transducer installed in it

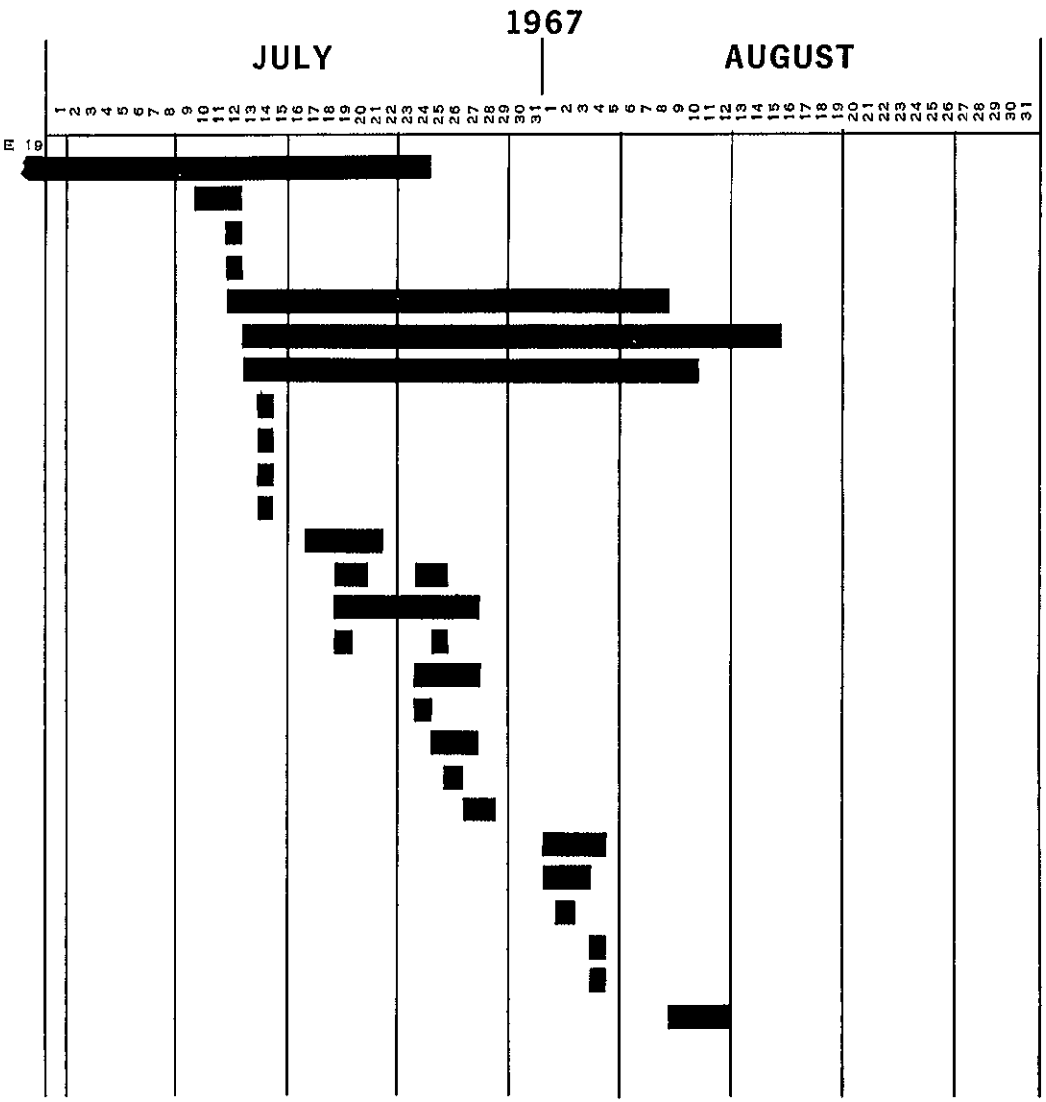
g One revision changed a procedure setup figure to agree with the non-propulsive vent modification

h. One revision changed an O-ring requirement to use an available O-ring

i. One revision deleted a requirement to tie a nylon rope behind the aft handling ring, as there was no rope on the dust cover

504N STC PREFIRE TESTING SEQUENCE

PARA	PROCEDURE	
4 1 1	1B40654	STRUCTURAL INSPECTION
4 1 2	1B41955	FWD SKIRT T/C C/O & OPER
4 1 3	1B64316	UMBILICAL I/F COMPATIBILITY
4 1 4	1B49558	APS I/F COMPATIBILITY
4 1 5	1B71877	PROP SYST LEAK CHK
4 1 6	1B49286	COMMON BULKHEAD VACUUM C/O
4 1 7	1B41005	HYD SYST SETUP & OPER
4 1 8	1B55813	STG POWER SETUP
4 1 9	1B55814	STG POWER TURNOFF
4 1 10	1B55822	EBW SYST AUTO C/O
4 1 11	1B55825	APS AUTO C/O
4 1 12	1B70177	MANUAL CONTROLS CHK
4 1 13	1B44471	CRYO TEMP SENSOR VERIF
4 1 14	1B44472	TM AND RS ANTENNA SYST C/O
4 1 15	1B44473	LEVEL SENS & CONT UNIT CALIB
4 1 16	1B55815	STG POWER DISTRIBUTION
4 1 17	1B55821	RANGE SAFETY AUTO C/O
4 1 18	1B55816	DDAS CALIBRATION
4 1 19	1B64368	PU SYSTEM CALIB
4 1 20	1B55824	HYDRAULICS AUTO C/O
4 1 21	1B55823	PU AUTO C/P
4 1 22	1B62753	PROPULSION SYST AUTO C/O
4 1 23	1B55817	DDAS AUTO C/O
4 1 24	1B55831	INTEGRATED SYSTEMS TEST
4 1 25	1B44474	SIGNAL CONDITIONING SETUP
4 1 26	1B70175	FINAL PROP SYST LEAK CHK



504N STC POSTSTORAGE TESTING SEQUENCE

PARA	PROCEDURE	
4 2 1	1B37622	CRYO TEMP SENSOR VERIF
4 2 2	1B70756	STRUCTURAL INSPECTION
4 2 3	1B64316	UMBILICAL I/F COMPATIBILITY
4 2 4	1B41955	FWD SKIRT T/C C/O & OPER
4 2 5	1B71877	PROP SYST LEAK CHK
4 2 6	1B70177	MANUAL CONTROLS CHK
4 2 7	1B55813	STG POWER SETUP
4 2 8	1B55814	STG POWER TURNOFF
4 2 9	1B55815	STG POWER DISTRIBUTION
4 2 10	1B55816	DDAS CALIBRATION
4 2 11	1B49558	APS I/F COMPATIBILITY
4 2 12	1B41005	HYD SYST SETUP & OPER
4 2 13	1B64368	PU SYSTEM CALIB
4 2 14	1B55819	RANGE SAFETY RECEIVER
4 2 15	1B55823	PU AUTO C/O
4 2 16	1B66774	APS AUTO C/O
4 2 17	1B70430	APS C/O
4 2 18	1B55821	RANGE SAFETY AUTO C/O
4 2 19	1B55824	HYDRAULICS AUTO C/O
4 2 20	1B62753	PROPULSION SYST AUTO C/O
4 2 21	1B44474	SIGNAL CONDITIONING SETUP
4 2 22	1B55817	DDAS AUTO C/O
4 2 23	1B44473	LEVEL SENS & CONT UNIT CALIB
4 2 24	1B55833	ALL SYSTEMS TEST
4 2 25	1B41006	HYD SYST OPER & SECURING
4 2 26	1B41883	FWD SKIRT T/C POSTFIRE C/O
4 2 27	1B41004	HYD SYST SERVICING
4 2 28	1B64678	CRYO TEMP SENSOR VERIF

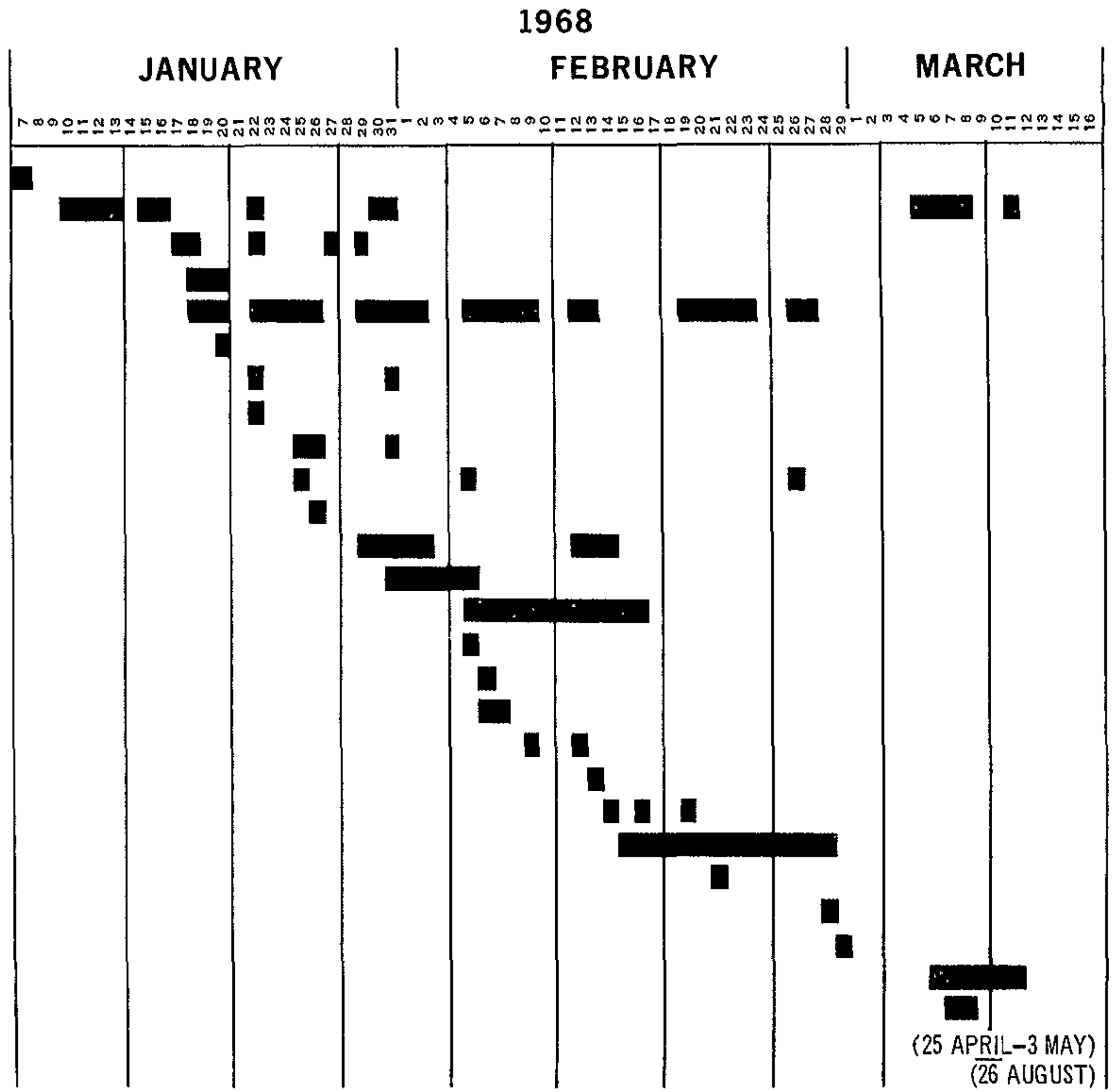


TABLE I. FAILURE AND REJECTION REPORTS
STAGE RECEIPT TO FORMAL COUNTDOWN INITIATION

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A234820 7-19-67	The helicoil insert, P/N 3591-4CN0325, for the center bolt hole of the continuous vent module regulator, P/N 1B67193-503, would not accept the attachment bolt required for mounting purposes.	The helicoil was removed and replaced.
A251569 6-21-67	Contamination of the compressed gas system for the O_2H_2 burner resulted due to an open port on P/N 1B66908-1, S/N 618.	Flush samples and particle count analysis of pipe assemblies, P/N 1B66843-1 and P/N 1B66924-1, attached to P/N 1B66908-1, S/N 618, were acceptable to Engineering for use.
A251573 6-26-67	Discrepancies noted during receiving inspection per H&CO 1B40654, Structural Inspection:	
	a. Blind nut missing for attaching the LH_2 chilldown return fairing line, P/N 1B28112-1, to the stage.	a. Installed blind nut per B/P - Acceptable for use.
	b. Wire bundle, P/N 1B64950-1, ref. loc. 404W6, lacked sufficient length (slack) to entry receptacle in forward skirt from main tunnel.	b. Pulled additional slack from the wire bundle. Acceptable for use.
	c. Flathead screws were missing from the forward and center sections of the panel, P/N 1B32915, on the aft skirt in the main tunnel area.	c. Installed the flathead screws per B/P. Acceptable for use.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A251573 (Cont.)	d. Dog bone missing from receptacle for wire bundle, P/N 1B56373-1, ref loc 404W32A1, low end of main tunnel.	d. Installed dog bone per B/P. Acceptable for use.
	e. Clamps missing from nyafil standoff for cable assemblies, P/N 1B40442, to forward dome transducers. Mount numbers, 410MT600A and 410MT610A.	e. Installed per B/P. Acceptable for use.
	f. Welds on LOX duct, P/N 1B59009, and LH_2 ducts, P/N's 1B59005 and 1B65206, to the O_2H_2 burner, were not passivated.	f. Weld passivation not required. Acceptable to Engineering.
	g. Mounting screws for panels, P/N's 1B62906-5, -7, and -9, ref loc 411 area between stringers 18 and 30, were excessively torqued; thus exerting sufficient force to imbed the respective washers in the panel face.	g. Acceptable to Engineering.
	h. Paint touchup required for unused hole in stringer 25 approximately 4 in. above panel, P/N 1B62906.	h. Repainted per B/P. Acceptable for use.
	i. Helium repressurization sphere, P/N 1A49990-505M, S/N 100, position 2, displayed: a series of shallow surface marks, adjacent to the neck at 270 degrees rotation; one scratch 6 in. long by 0.002 in. deep, near the harness boss at 350 degrees rotation; and one gouge 1/8 in. long by 1/32 in. wide by 0.002 in deep, near the harness boss at 135 degrees rotation.	i. Acceptable to Engineering.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A251573 (Cont.)	j. Helium repressurization sphere, P/N 1A49990-505M, S/N 104, position 10, reflected a low spot, 3/16 in. long by 1/8 in. wide by 0.020 in. deep, in the center weld area between planes A and B at 315 degrees rotation.	j. Acceptable to Engineering.
A255217 7-7-67	During installation of the stage into the test stand, it was noted that cable assembly, P/N 1B40242-73, had a cut in the insulation approximately 14 inches from the P3 end. The cut was 1/4 in. by 3/8 in.; no shield stands were damaged.	The cable assembly was repaired per DPS 54010.
A255219 7-12-67	The insulation on wire Q9058A22 of cable assembly type 7867674B/1SJ, 411W11, was cracked, knicked, or cut, exposing the shielding in the area at the end of the shrink tubing for the Deutsch connector P3, pin 5, for the LH_2 propellant utilization probe instrumentation feed-through in the forward dome. During repair additional damage was noted on wire Q9058A22. This damage consisted of a cut 2 in. above the previous damage.	The contact was removed from the damaged wire, the damaged portions were removed, the wire was reterminated per specifications, and was retested and found to be acceptable for use.
A255220 7-13-67	The LH_2 feed duct, P/N 1A49320-511, S/N 42R, did not maintain vacuum per specifications. The duct was pumped down to 180 microns Hg at 2:00 p.m. on 12 July 1967. At 1200 hrs. on 13 July, the reading was over 1000 microns Hg. Allowable vacuum loss "not to exceed" 100 microns in 10 days.	Acceptable to Engineering for use.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255222 7-19-67	Pin D of connector J1 on the LH_2 continuous vent module, P/N 1B67193-501, S/N 04, was bent approximately 15 degrees. The pin had been straightened for temporary use. This module was removed from the stage by FARR A257907.	The module was acceptable to Engineering for further use, but was not reinstalled on the stage.
A255224 7-20-67	During installation of the environmental control plenum, the following discrepancies were discovered:	
	a. The edge of the curtain, P/N 1B54849-501, just to the left of the purge gas inlet door near thrust structure stringer No. 26, was debonded	a. The faying surfaces were cleaned with Rymple cloth dampened with MEK; then, when dry, a thin layer of Polyurethane resin (DPM 3346) was applied. The mating surfaces were then clamped together and cured for 48 hours.
	b. The boot around the bulkhead vacuum lines had not been secured as shown in 1B64850, View S-S, Zone 17.	b. An 18 inch length of number 18 natural nylon cord was installed per 1B64850.
A255225 7-20-67	Abrasions were noted in the piston rods for the yaw and pitch hydraulic actuators (P/N 1A66248-507-013A, S/N 60, and P/N 1A66248-505-011, S/N 52, respectively) in the area of the grooves for the *mid-stroke* locks. The indentations measured 1/16 in. long by 0.020 in. deep for the yaw rod, and 1/16 in. long by 0.015 in. deep for the pitch rod. Noted during H&CO 1B41005, Hydraulic System Setup and Operation.	The respective piston rods were deburred and smoothed, utilizing a hand oilstone, and wiped visibly clean with oil moistened clean cloths. The mating and mid-stroke locks were also smoothed and cleaned and the damaged surfaces were restored, as closely as possible, to the original contour.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255301 7-10-67	During stage installation, it was noted that paint was scraped down to the primer, in an area 1/4 in. wide by 2-3/4 in. long, on the exterior of the fuel tank at fin line 4, 59 inches from the forward skirt.	A radiographic inspection of the damaged area revealed no further discrepancies, and the scraped area was repainted per FS 289.
A255303 7-14-67	The mainstage pressure switch adapter on the J-2 engine was found to be bent from the original shape, causing excessive preloading.	The mainstage pressure switch adapter was removed and replaced.
A255305 7-19-67	Two posts, P/N 1B37889-533, were mislocated approximately 1.75 in. forward of the respective location points per reference drawings 1A96771, Zone 8, View C-C; and 1B58305, Zone 7, View C.	Acceptable to Engineering.
A255307 7-28-67	A tube assembly, P/N 1B64606-1, on the LH_2 tank vent system, was 3/8 in. in excess of installation requirements; thus preventing proper mating with the next assembly.	The tube assembly was removed from the stage and replaced.
A255308 8-1-67	The LH_2 tank pneumatic system solenoid valve, P/N 1B66692-501, S/N 62, leaked through the L1 vent port at the rate of 235 scim. No leakage was permitted.	The solenoid valve was removed, dispatched for further testing, and replaced with P/N 1B66692-501, S/N 86.
A255309 8-7-67	The exterior insulation on the LH_2 tank vent duct, P/N 1A86711-505, was gouged and cracked during rework and checkout activities.	The damaged duct insulation was removed and replaced.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255310 8-8-67	The ambient output of the pressure transducer, P/N 1A72913-557, S/N 343-1, NASA measurement number D014, was out of tolerance. The output indicated 31 psia. The actual pressure was 14.7 psia.	This condition was acceptable to Engineering. Investigation showed that the system was pressurized at the time the 31 psia measurement was made. Retesting of the transducer was acceptable.
A255314 8-23-67	During test stand securing, it was noted that the cold helium fill module, P/N 1B557781-503-003B, S/N 0029, would not stop the flow of gas from the dump port.	The cold helium module was removed and replaced by S/N 0037.
A255352 7-21-67	During propulsion leak checks, the bellows purge outlet pipe assembly of the continuous vent module, P/N 1B67193-503, S/N 016, was broken at the valve body.	The module assembly was removed and replaced with S/N 029.
A255353 7-22-67	During the prefire instrumentation inspection, the following coaxial connector pins did not meet the DPS 54002-10 depth requirements. All pin depths should have been 0.065 ± 0.015 in. a. On cable assembly 404W30, P/N 1B67152-1, pin 8 of P1 (wire Q9787A22) was 0.050 in. deep (the Go-No Go shop aid rode the center pin); pin 9 of P7 (wire Q9788A22) was 0.047 in. deep; pin 11 of P7 (wire Q9783A22) was 0.047 in. deep, and the crimp was loose on the shield barrel; and pin 13 on P7 (wire Q9054A22) was 0.046 in. deep. b. On cable assembly 411W11, P/N 1B58983, pin 8 of P5 (wire Q9267A22) was 0.039 in. deep, and pin 12 of P13 (wire Q9046A22) was 0.040 in. deep. c. On cable assembly 408W200, P/N 1B58247-1, pin 10 of P4 was 0.045 in. deep.	All of the noted discrepancies were acceptable to Engineering except pin 11 of P7 on cable 404W30. This pin was removed and replaced.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255354 7-24-67	The LOX vent purge hand valve, P/N 1B53817-505, S/N 050, failed to reseat during propulsion leak checks.	The discrepant valve was removed and replaced.
A255355 7-24-67	The engine control helium pressure transducer, P/N NA5-27412T35-T, S/N 6156A, high calibration read 4.122 vdc and low calibration read 1.138 vdc. Tolerance limits are: high calibration 4.00 $\pm$ 0.100 vdc, and low calibration 0.997 $\pm$ 0.100 vdc.	The discrepant transducer was removed and replaced by S/N 3650A.
A255356 7-24-67	During the hydraulic system servicing procedure, 1B41005, it was noted that the pressure in the hydraulic accumulator/reservoir, P/N 1B29319-519, S/N 00026, had decayed, over a week end, from 235 psig to 0 psig. A leak check revealed a fast leak at the low pressure vent relief valve.	The accumulator/reservoir was removed and replaced with S/N 00032.
A255357 7-24-67	The repressurization sphere, P/N 1A49990-505, S/N 104, was found to have a low spot in the weld 3/16 in. long by 1/8 in. wide by 0.020 in. maximum depth. The low spot was located in the center of the weld between plane A and B at 315 degrees rotation. Radiographic inspection revealed that the low spot did not meet the requirements of DPS 14121; however, no subsurface defects were noted.	The repressurization sphere was accepted by Engineering.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255358 7-21-67	It was discovered, during an engineering run of the hydraulic system procedure, H&CO 1B55824, that the temperature transducer, P/N 1B34472-1, S/N 63212, acted erratic and periodically went to full scale of 325°F. The temperature at that time was approximately 125°F.	The temperature transducer was removed from the stage and replaced by S/N 53382.
A255360 7-27-67	The following discrepancies were found during the prefire instrumentation inspection: a. On connector 411W11J1, pin A (wire Q9055A22) was bent approximately 10 degrees. b. On connector 403W2P18, pin B (wire Q28A22) had a short cut on the edge of the cup and was scraped on the side of the pin. c. On connector 403W2P17, pin B (wire Q36A22) had a short cut on the edge of the cup at the crimped end of the pin. d. On connector 411W6P17, pin E (wire 3P13A22) and pin D (wire 3Q1BA22) had sharp cuts on the edge of the cups at the insulation end of the pins.	All damaged pins were removed and replaced. The rework was acceptable.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255361 7-27-67	Wire Q9265A22 of cable assembly 404W30, P/N 1B67152-1, S/N 7366, to the LOX propellant utilization probe, 406A200J3, was found to have a 360 degree cut in the outer insulation, exposing the shield at the end of the shrink tubing on connector P9, pin 8.	The wire was cut off at the damaged area and reterminated.
A255362 7-30-67	The thrust chamber pressure transducer, P/N NA5-27423T10T, S/N 4918A, high calibration read 4.205 vdc. The maximum tolerances were: High calibration 4.079 $\pm$ 0.100 vdc; low calibration 1.089 $\pm$ 0.100 vdc.	The discrepant transducer was removed and replaced with S/N 4788A.
A255363 7-30-67	The main fuel injector pressure transducer, P/N NA5-27412T15T, S/N 5215A, read out-of-tolerance, during the DDAS checkout, H&CO 1B55817. The high calibration read 4.179 vdc, but should have been 4.078 $\pm$ 0.100 vdc. The low calibration read 1.179 vdc, but should have been 1.074 vdc.	The transducer was removed from the stage and sent to R/NAA Government stores for rework, and S/N 7941A was installed.
A255364 7-30-67	The fuel tank ullage pressure hardwire transducer, P/N 1A72913-539, S/N 39-26, read out-of-tolerance. At ambient conditions the transducer indicated 17.611 psia, but should have been 14.7 $\pm$ 1.00 psia. Discovered during the DDAS checkout, H&CO 1B55817.	The transducer was removed and replaced with S/N 341-1.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255365 7-29-67	During an Engineering run of the DDAS procedure, it was noted that the temperature patch, P/N 1A68589-509, S/N E-363, NASA measurement C388, gave indications of being open.	The temperature patch was removed and replaced with S/N E401.
A255366 7-29-67	The injector ports and the entire circumference of the thrust chamber interior throat area of the J-2 engine was found to be contaminated with a greasy substance.	The contaminated areas were cleaned by Rocketdyne per R/NAA procedure R-3825-3 Vol. II.
A255368 7-31-67	During Engineering power checks, it was noted that several talk-back indications were missing. Investigation revealed that the wire harness, P/N 1B66968-1, S/N 4782, had four wires and two jumpers missing from J1 of 411A9W1.	The missing wires and jumpers were installed and the wire harness was tested per 1B66968, and found to be acceptable.
A255369 7-31-67	During prefire checkout, the following discrepancies were discovered: a. The insert in plug 404W208P55 was punctured at pin B. This plug connects to transducer P/N 1B31356-515, S/N 184-7, measurement D0041. b. Transducer, P/N 1B34472-1, S/N 53382, measurement C0051, had hydraulic oil inside the plug.	The following rework was accomplished: a. The damaged plug was removed and replaced. b. The contaminated plug was cleaned. Retest was performed per the DDAS auto procedure, H&CO 1B55817.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255370 8-1-67	During the DDAS calibration procedure, H&CO 1B55816, the inflight calibrations on channel CP1-BO-11, at the 5.00 vdc level, consistently read 21 mvdc low. This was within the $\pm$ 31 mvdc tolerance, but Engineering requested a FARR for subsequent investigation, as any deviation should be plus or minus from the nominal 5.00 vdc value. The CP1-BO time division multiplexer was P/N 1B62513-547, S/N 019.	The first partial disposition allowed the use of the multiplexer for static firing. Subsequently, the condition was accepted by Engineering for use.
A255371 8-2-67	The O_2H_2 burner spark exciters, P/N 1B59986-503T, S/N's 025 and 024, had been excited for 2 minutes of continuous operation, exceeding their duty cycle. One duty cycle is 5 seconds on, 5 minutes off, per 1B59986.	The burner spark exciters were removed and replaced by S/N's 027 and 036.
A255372 8-2-67	Postfiring checkout per 1B55817 determined that for pressure transducer, P/N NA5-27412T10T, S/N 4788A, measurement number D001, the high calibration value drifts from 4.025 to 4.30 vdc, with voltage spikes up to 4.40 vdc. The high calibration value should have been within the $\pm$ 0.100 vdc tolerance.	The transducer was removed from the J2 engine and replaced by S/N 6702A.
A255374 8-3-67	During the DDAS procedure, H&CO 1B55817, the hydraulic line temperature transducer 403MT780, P/N 1A68589-509, S/N E849, for NASA measurement C387, read 106.246°F. The indication should have been ambient temperature $\pm$ 16°F.	The transducer was removed from the stage and replaced with S/N 0238.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255375 8-3-67	During the integrated system test, H&CO 1B55831, the LOX tank repressurization sphere transducer, P/N 1B39293-1, S/N 36, measurement D088, had a high calibration reading of 3.896 vdc. The output for the ambient condition of 16.826 psia should have been 4.00 $\pm$ 0.1 vdc.	The transducer was removed and replaced with S/N 20.
A255401 8-3-67	The LH_2 fast fill sensor, P/N 1A68710-509, S/N D84, cycled on and off for approximately 3 to 4 minutes during debugging operations for the integrated systems test procedure.	The control unit was removed and replaced with S/N C1.
A255402 8-5-67	While performing the integrated systems test for simulated firing, it was noted that the LOX burner shutdown valve, P/N 1B66639-503L, S/N 04, did not transmit an open talkback.	The LOX burner shutdown valve was removed and replaced by S/N 022.
A255403 8-7-67	The following discrepancies were noted on the externally located spheres, P/N 1A49990-505, during the T-9 day checks: a. S/N 100, at position 2, had a series of surface marks approximately 1/4 in. long by 1/6 wide by 0.001 in. deep, located in plane "A" starting 2 inches below the weld seam and running approximately 4 inches down at 245 degrees rotation. b. S/N 103, at position 5, had many surface marks in plane "B", running from the neck edge downward 6 inches between 345 degrees and 15 degrees rotation. The maximum depth was 0.001 inches.	All items were acceptable to Engineering for use.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255403 (Cont.)	c. S/N 98, at position 7, had approximately 15 surface marks 1/2 in. long by 1/8 in. wide, maximum, in plane "A" 4 inches from the neck edge at 270 degrees rotation. The marks were too shallow to measure.	
	d. S/N 92, at position 8, had 4 scratches 3 in. long by 0.002 deep, maximum, located in plane "B", 12 inches down from the neck edge at 285 degrees rotation.	
A255414 8-12-67	During the propulsion leak check, H&CO 1B70175, the following discrepancies were found:	a. The debonded area was resealed per 1P00094 and general note 3 of 1B39505.
	a. The pro-seal 501 adhesive between the seal, P/N 1B39506-1, and the LH_2 chilldown pump line, was debonded from the line flange.	b. The torn areas were repaired per 1B39505.
	b. The black coating on the seal, P/N 1B39506-1, was torn in two places.	
A257907 6-12-67	During the preshipment purge at the Space Systems Center, the 10 ampere fuse in the purge unit dc power control circuit blew when the fuel propulsion vent switch was momentarily closed. A continuity check at STC located a short circuit in the wiring of the continuous vent module, P/N 1B67193-501, S/N 04, caused by a bent pin in the module plug. The mating plug, P30 on cable assembly, P/N 1B58138-1, S/N 02, had a damaged insert.	The continuous vent module was removed and replaced with another module, P/N 1B67193-503, S/N 016. Plug P30 was also removed and replaced. The removed module, P/N 1B67193-501, S/N 04, was dispositioned by FARR A255222.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A266204 8-2-67	Three hand valves, P/N 15600S, S/N's 975, 186, and 961, had the valve stems broken off.	The hand valves were not acceptable for use and were removed and replaced.

TABLE II. FAILURE AND REJECTION REPORTS COUNTDOWN INITIATION AND POSTFIRE CHECKOUT

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255315 8-30-67	The following discrepancies were noted:	
	a. Tube assembly, P/N 1B58838-1, had a bubbling leak at the flange of the LOX tank pressure module.	a. The tube assembly was retorqued. No further leakage was found.
	b. The isolation hand valve, P/N 15600S, on the LH_2 pressure line to the transducer, had a bubbling leak on the H/W side of the valve.	b. The hand valve system was removed from the stage. After reinstallation, the system was acceptable to Engineering.
	c. Aft umbilical quick-disconnect 4 had a bubbling leak.	c. After retorque, the quick-disconnect had no leakage.
	d. The LOX pressure module hot gas solenoid outlet had a bubbling leak.	d. The flange bolts were retorqued. No leakage was noted on a retest.
	e. Pipe assembly, P/N 1B63355-1, had a bubbling leak at the flex line connection to the forward dome LH_2 pressure line.	e. The tube assembly was removed and replaced.
	f. A fuzz leak existed at the B-nut and adapter flange on the LOX prevalve pneumatic port.	f. Tube assembly, P/N 1B59285-1, was removed and replaced.
	g. The LH_2 tank pressure line to the J-2 engine injector flange had been reinstalled using old seals.	g. The old seals were removed and replaced.
	h. The fuel pump primary seal cavity drain test port plug was reinstalled using old seals.	h. The old seals were removed and replaced.
	i. The helium heater injectors had been removed and reinstalled without a leak check.	i. The helium heater was leak checked per 1B71477; no discrepancy was noted.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255315 (Cont.)	j. The LOX prevalve was leaking at the actuation port flange.	j. A recheck per H&CO 1B71877 indicated a nonmeasurable leak. The allowable leakage was 1.3 scim. The condition was acceptable to Engineering.
	k. The LH_2 prevalve had leakage at the actuation port flange.	k. A releak check indicated no discrepancy.
	l. The F-25 injector was leaking at the thrust chamber manifold.	l. A recheck per H&CO 1B71877 indicated no leakage.
A255316 8-31-67	During the postfire structural inspection, the following discrepancies were found:	
	a. The upper angle, P/N 1B28112-11, on the O_2H_2 burner LH_2 propellant valve fairing, was cutting into the insulation blocks, P/N's 1B62676-7 and -33.	a. The insulation blocks, P/N 1B62676-7 and -33, were trimmed to clear the angle P/N 1B28112-11.
	b. The lower angle, P/N 1B28112-11, on the O_2H_2 burner LH_2 propellant valve fairing, was riding on the propellant valve actuation control line, P/N 1B67796-1.	b. The angle, P/N 1B28112-11, was trimmed to clear the LH_2 propellant valve.
A255416 8-17-67	During Countdown TR-1047, Run 1A propellant off-loading, the LOX prevalve, P/N 1A49968-509, S/N 124, had no closed talkback.	The prevalve, S/N 124, was removed and S/N 102 was installed.
A255417 8-18-67	After installation of the LOX prevalve, P/N 1A49968-509, S/N 102, a leak of 1800 scim was found across the valve seat. The maximum allowable leakage per H&CO 1B71877 was 150 scim.	The LOX prevalve, S/N 102, was replaced with S/N 125.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255418 8-17-67	During the performance of Task 39 of Countdown TR-1047, it was observed that at 5 percent LH_2, depletion sensors 1 and 2, P/N 1A68710-507, S/N's D38 and D57, indicated a steady dry condition. The sensors were immersed in LH_2.	The connectors on cable assembly 408W200 going to plugs 410A1J6 and 410A1J7 were disconnected, and the point level sensors were tested per 1B44473.
	During the testing of the depletion sensors, it was noted that pin 8 of 408W200P4 had a depth of 0.044 inches. The depth should have been 0.065 $\pm$ 0.015 inches.	The depth of pin 8 was acceptable to Engineering.
	Resubmit: During Run 2A, no sensor discrepancies were noted.	Resubmit: The sensors were accepted for use.
A255419 8-18-67	In the prefire checkout, it was noted that the manifold, P/N 1B66808-1, in the thrust structure area, had a ding 0.25 inch long by 0.005 inches deep, approximately 6 inches upstream from the bottle No. 7 tap off.	The manifold was removed and replaced. A leak check was performed per H&CO 1B70175 to verify the new installation. The defective manifold was rejected on FARR A255425 and routed to Santa Monica for further evaluation and disposition.
A255423 8-19-67	Following the installation of the LOX low pressure duct, P/N 1A49969-503, S/N 32R, to the LOX prevalve, P/N 1A49968-509, S/N 125, preliminary leak checks per 1A39321 revealed leakage past the secondary seal so great that the leak check port could not be effectively utilized to leak check the conoseal.	The LOX prevalve, P/N 1A49969-509, S/N 125, was accepted by Engineering for use during the TR-1047 static firing. After the static firing, the prevalve was removed and replaced with S/N 142, per FARR A255439.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255425 8-21-67	The repressurization system manifold, P/N 1B66808 -1, had a ding 1/4 inch long by 0.005 inch deep, located 6 inches from the No. 7 tap off.	The damaged manifold was removed and routed to Santa Monica for disposition. A new manifold was installed by FARR A255419.
A255427 8-23-67	The LH_2 chilldown duct, P/N 1A49966-503-003, S/N 019, would not hold vacuum per specification control drawing 1A49966. The chilldown duct was pumped down to 5 microns Hg on 8-19-67. The vacuum reading taken on 8-23-67 was 175 microns Hg, but should have been no more than 50 microns.	The chilldown duct was evacuated twice. After the second pump down, the vacuum held, and the duct was accepted by Engineering for use. The discrepancy was caused by outgassing of the vacuum annuals.
A255429 8-24-67	The following condition was observed from the uprange pillbox during TR-1047, Run 2A. The uprange side of the LH_2 tank had an area of frost or ice approximately 10 tiles high by 5 tiles wide in the shape of the interior tiles, with an additional round spot of ice or frost in the center of most of the tiles. The area of ice was located to the right of the weld seam above the eighth aft interstage stringer, and to the left of the chilldown pump fairing.	An ultrasonic inspection was performed with no unbonded areas discovered. The frost or ice conditions did not re-occur during Runs 1A and 3A, and the LH_2 tank was accepted for use.
A255430 8-24-67	Per information from the data review for TR-1047 Run 2A, the LOX chilldown pump differential pressure transducer, P/N 1B53573-507, S/N 507-9, measurement D219, read -2.5 psid. The actual value should have been indicated as 0.0 ± 1.2 psid.	The transducer was removed and replaced by S/N 507-5.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255431 8-24-67	The ambient output of the LH_2 chilldown pump differential pressure transducer, P/N 1B53574-501, S/N 501-9, measurement D218, reference location 403MT750, was out-of-tolerance. The reading was -3.5 psid, but the limits were 0.0 $\pm$ 1.3 psid. The defect was noted during data review for TR-1047, Run 2A.	Transducer, P/N 1B53574-501, S/N 501-14, replaced the discrepant part.
A255435 8-29-67	The repressurization bottle, P/N 1A49990-505, S/N 104, had two spots of foreign material or discoloration located approximately half way between the boss and the weld seam in plane A at 160 degrees rotation. The spots were 1/8 inch to 3/16 inch long.	The discoloration was polished out with 400 grit carborundum paper.
A255438 8-29-67	The following discrepancies were noted on the LOX tank propellant shutoff valve (prevalve), P/N 1A49968-509, S/N 142: a. The prevalve was not identified as to cure date. b. The prevalve was not identified with a change letter.	a and b. The prevalve was identified with a cure date and a change letter, as obtained from inspection records.
	c. Instrumentation housing attachment bolts were not safetied. There was no indication of torque on the unsafetied bolts.	c. All attachment bolts were retightened to the proper torque value and safetied per 1A49968-509.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255439 8-29-67	Postfire data indicated the following discrepancies for the LOX prevalve, P/N 1A49968-509, S/N 125: a. No closed talkback was received during the critical components check (talkback was received during manual cycles.) b. The cycle time was slow. The actual cycle time was not available at the time this FARR was written.	The prevalve was removed and sent to Santa Monica for evaluation, and S/N 142 was installed.
A255441 8-30-67	During postfire IST 1B55831, the LOX shutdown valve, P/N 1B66639-503, S/N 022, did not indicate closed when commanded closed. The pneumatically parallel LH_2 propellant valve did indicate closed.	The valve was removed and sent to Santa Monica for further disposition. S/N 021 was installed as the replacement part.

TABLE III. POSTSTORAGE FAILURE AND REJECTION REPORTS

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255323 1-29-68	During postfire checkout, it was noted that a blind nut assembly sleeve, P/N BN-330-428-1, and expander, P/N BB-341-12, had rotated, preventing attachment of the LOX low pressure duct support mount, P/N 1A49977-509.	The blind nut assembly was tightened and the LOX low pressure duct support mount was installed.
A255324 2-2-68	During a welding operation on the stub out section of tube TG5 at the auxiliary instrumentation package, a pinhole was burned in tube TG4 approximately 3/8 inch aft of the stub out plugged end.	The damaged area was trimmed off and a sleeve was welded over the damaged area. The tube was leak checked per 1B71877.
A255388 9-13-67	Pins A, M, and L, in plug 403W7P2, on cable assembly 1B58310-1, S/N 7090-2, showed evidence of contamination.	The contacts and plug face were cleaned with isopropyl alcohol, and the connector was functionally checked per the DDAS automatic H&CO 1B55817.
A261670 1-17-68	The sealing grommets of connectors 410MT600P3, 403MT770P3, 403MT738P3, 403MT708P3, 403MT709P3, 409MT650P3, 409MT648P3, 409MT649P3, 409MT651P3, 403MT751P3, 403MT640P3, and 403MT628P3, were found to have small splits around the pinholes.	The discrepant connectors were removed and replaced.
A261671 1-17-68	The pinholes of the sealing grommet were found to be split at the small diameter pin entry area on connector 403MT754P3.	The defective connector was removed and replaced.
A261675 1-16-68	During the postfire data review the following discrepancies were noted:	
	a. The connector on transducer 403MT603, measurement C051, had intermittent contacts.	a. The connector was removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261675 (Cont)	b. The rate gyro measurement, K152, cycled three times during the static firing engine start, due to vibration.	b. The rate gyro plug was cleaned with isopropyl alcohol (Ref. FARR A255388). Retest per the DDAS automatic, H&CO 1B55817, indicated no further discrepancies.
A261757 11-3-67	During the acceptance firing, the RFI noise level due to the operation of the oxidizer pump chilldown inverter was measured as 3 percent. This exceeded the maximum allowable noise level specified in SM47376.	The noise condition was eliminated in accordance with WRO 4188.
A261765 11-20-67	The power control module, P/N 1A58345-519, S/N 1057, was suspected of being contaminated.	The part was returned to the vendor for disassembly and cleaning per MSFC-164. After cleaning the part was reinstalled on the stage.
A261787 3-22-68	During poststorage leak checks of the LOX tank pressurization module, P/N 1B42290-505, S/N 0039, it was noted that with an ambient helium inlet pressure of 400 psig, the valve leak rate was 2565 scim (cycling improved this to 2250 scim). The maximum allowable leakage was 1000 scim.	The module was removed from the stage and sent to the Santa Monica plant for evaluation. See FARR 500-025-638 for further disposition of the module.
A261789 4-8-68	This FARR was generated per a customer request, to note that at the normal pre-charge pressure of 2930 psig, the leak rate of the hydraulic accumulator, P/N 1B29319-519, S/N 00032, was 0.971 scim for a 24.25 hour elapsed time.	The hydraulic accumulator, P/N 1B29319-519, S/N 00032, was removed from the stage and sent to Santa Monica for testing, failure analysis, and final disposition. The replacement part was S/N 00031.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261790 4-17-68	During modifications per AO 1B69013, it was noted that the LOX vent valve support, P/N 1B69608-3, was mislocated 3/16 inch too far to the right to allow the Marman flange on the vent valve to align with the Marman flange on the LOX tank.	The LOX vent valve support was removed, and a new support was installed using the vent valve as the locating media.
A261793 5-8-68	During installation of the doubler plates, P/N 1A98308-91, on the auxiliary tunnel cover, P/N 1A98308-501.1, the minimum edge distance was not maintained.	The auxiliary tunnel cover was accepted for use.
A261794 5-8-68	During installation of the doubler plates, P/N 1A98308-91, on the auxiliary tunnel cover, P/N 1A98308-509, the minimum edge distance was not maintained.	The auxiliary tunnel cover was accepted for use.
A261795 5-14-68	During inspection surveillance, it was noted that a nut plate on the forward attach ring frame segment, P/N 1A58328-1, at station 676.702, was damaged, preventing installation of the bolt and washer used to attach the forward support ring to the stage.	The damaged nut plate was removed. No replacement was installed as the nutplate was only used for attaching a hoist ring, and is not required for flight use. The lack of a nutplate was acceptable to Engineering for all hoisting operations.
A261796 5-15-68	Data review of the all systems test revealed that the LOX chilldown inverter, P/N 1A74039-517, S/N 053, exhibited a greater than 2 percent peak-to-peak noise level during the auxiliary hydraulic pump operation.	This condition was acceptably reworked by ECP 2763.
A261797 5-17-68	The static firing data review noted that the cold helium sphere pressure transducer, P/N 1B40242-565, S/N 565-12, for measurement D016, exhibited signal fluctuations of approximately 15 percent peak-to-peak.	The discrepant transducer was removed, and another transducer, S/N 565-1, was installed.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261799 6-14-68	The following discrepancies were noted during the LOX tank entry:	Items e, f, h, j, and l were acceptable for use.
	a. The debris found upon tank entry included two small pieces of dynatherm, one piece of lint, and one No. 10 washer.	a and d. The debris and foreign material was removed.
	b. One bolt on the LOX duct turnbuckle was loose.	b. The loose bolt was retorqued.
	c. Transducer, P/N 1A68710-1, S/N 88, had a nick in the element coating.	c. The transducer was removed and replaced.
	d. Transducer, P/N 1A68710-1, S/N 67, had several spots of foreign material on it.	
	e. Several connectors on the feedthrough had foreign material on the threads.	
	f. Numerous red and brown stains were found on the tank interior.	
	g. A clear wet foreign material was found inside the feedthrough, P/N 1B37873-503.	g. The feedthrough was cleaned per DPS 43000.
	h. The gray coating was found to be chipping off of the baffle lock bolts.	
	j. Superficial scratches existed in the area between seams 9 and 1.	
	k. Two scratches, 1/4 by 0.004 inches and 1/4 by 0.002 inches, were found on the aft dome.	k. The scratches were smoothed out with 400 grit paper, then dye checked. No cracks were found.
	l. A white flaky material was found around the huck bolts installed in the aft dome.	

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261799 (Cont.)	m. A wire harness clamp cushion was torn.	m. The damaged clamp was removed and replaced.
A261814 1-11-68	During tile rework in the LH_2 tank, it was noted that there were superficial scratches running in an erratic pattern across the common bulkhead. The scratches averaged from 0.0002 to 0.0005 inches deep.	The scratches were blended out with 400 grit paper, and the reworked areas were alodined per DPS 41410 and A45-PEO "A".
A261823 1-22-68	During the tile inspection in the LH_2 tank, superficial scratches were found on the common bulkhead. Dye penetrant inspection of the scratches showed no indications of cracks. The average depth of the scratches was 0.0002 to 0.0005 inches.	All scratches were dye checked for the presence of cracks. Only those scratches that were on weld beads were blended out with 400 grit paper. All other scratches were alodined per DPS 41410 and A45-PEO "A".
A262296 7-5-68	During modification per A.O. 1B58003 BF, it was noted that pipe assembly, P/N 1B75031-1, was 9/16 of an inch too long, preventing installation on the stage.	The pipe assembly was routed to the machine shop where a 9/16 inch piece was trimmed off. After reflaring, the pipe assembly was proof and leak checked per 1B75031, cleaned per 43000, and installed on the stage.
A270604 6-14-68	During checkout per H&CO 1B41017, indications of discoloration, foreign material, and pits were found on the individual screen and ring halves of the screen assembly, P/N 1B55445-1, S/N's 00020 and 00011.	The screen and rings were cleaned per PDS 43000, then reinstalled.
A270609 6-20-68	The following discrepancies were noted against the LOX instrumentation probe, P/N 1A69275-509-002A, S/N 03:	
	a. The probe was subjected to contamination from the exhaust of an air powered shop tool.	a. The probe was cleaned per drawing requirements.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECT	DISPOSITION
A270609 (Cont)	b. The J-6 connector was not safety wired.	b. The J-6 connector was torqued and lockwired.
	c. The removable cover had been removed.	c. The covers were reinstalled.
	d. It was suspected that loose items were inside the probe.	d. Re-inspection showed that the area was free of loose items.
A270616 8-20-68	During precleaning inspection of the LH_2 tank door, P/N 1A59710-510, S/N 20, corrosion was noted at the sealing surface and at the inner circumference of the bolt hole flange, and small scratches were found in the sealing surface.	The corrosion was removed by mechanical means, and the door was cleaned per the drawing requirements. The scratches were acceptable to Engineering for use.
A270627 7-24-68	During the rework of wire harness, P/N 1B66641-1, the insulation and shield braid of wires D9453A22 and D9455A22 were damaged. The damaged areas were located approximately 18 inches above the impingement curtain at stringers 109 and 110 in the aft skirt area.	The damaged insulation was removed by cutting above and below the break. All broken wire strands were removed from the shields. The areas were then wrapped with seven layers of DPM 2766 tape. After fusing the tape with a 100 watt soldering iron, per DPS 54010, the wire harness was reclamped into place.
A270633 1-8-68	The following discrepancies were noted during surveillance of an isolator pull test. a. The insulation of wire P31XD16, reference location 411A99A10P40, was damaged approximately three inches from plug P40. b. There were four cuts in the external insulation of cable assembly, P/N 1B40242-73. The cuts were located near 403MT754. One of the cuts extended through the braided shield.	The damaged insulation was removed by cutting above and below the damaged area. The broken strands of shield were removed. The bare areas of the cables were then wrapped with seven layers of DPM 2766 tape, with an overlap of one inch on both sides of the repaired area. After wrapping the tape, it was fused in accordance with the drawing requirements.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270634 8-2-68	During the rework of wire harness 403W200, P/N 1B66644-1, the outer insulation was found to have a 3/8 inch cut which damaged the shield braid at a location 2 1/2 inches from stringer number 87.	The damaged insulation was removed by cutting above and below the damaged area. The broken strands were withdrawn and the area was wrapped with three layers of DPM 2766 tape. The loose shield strands were placed over the wrap and four additional layers of DPM 2766 tape were applied and fused per DPS 54010.
A270635 8-20-68	A bolt, P/N NAS 1004-5A, would not fit between the O_2H_2 burner body and the injector 1 flange. Also, the clearance between the flange and the boss on the injector body was not enough to install a bolt. This condition was conforming but unsatisfactory.	The bolt was replaced by a stud per 1B62600-A45-55A.
A270636 3-8-68	During rework of the helium heater system, a pipe assembly, P/N 1B62600-9K, S/N 07, was found to have been crushed in one place and indented in another place. The crushed area, 0.30 inches long by 0.250 inches wide by approximately 0.035 inches deep, was located 1.0 inch aft of the B-nut coupling the pipe assembly to the igniter. The indentation, 0.020 inches long by 0.20 inches wide by 0.010 deep, was located approximately 1.0 inch aft of the crushed area.	The tube assembly was removed and replaced.
A270637 4-8-68	During rework per AO 1B74464 NC, the insulation on wire harness, P/N 1B74464, was found to be cut, exposing the shield braid in two places, approximately 36 inches from plug P8 on stringer number 30. There was no apparent damage to the shield.	The damaged insulation was repaired per DPS 54010, using DPM 2766 tape.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270638 8-4-68	During kit installation per AO 1B75175, the width of the bracket, P/N 1B75175-5, after the four mounting holes were drilled, was found to be 1.973 inches and should have been 2.000 $\pm$ 0.010 inches.	The condition was acceptable to the Material Review Board.
A270639 8-5-68	The 0.260/0.266 inch diameter mounting holes in bracket, P/N 1B75175, would not align with the channel assemblies. The holes were mismatched approximately 0.050 inches. It was noted that zone 5 of drawing 1B75175 did not show a center dimension for the mounting holes.	The mounting holes were elongated per Material Review Board instructions to a maximum of 0.03 inch. A drawing correction added the required dimension.
A270644 8-8-68	Identification plates, P/N's 1B63463-9 and 1A39300-11, were mislocated 6 inches to the left of position 1, and should have been 6 inches to the right.	The condition was acceptable to the Material Review Board.
A270647 8-11-68	The pipe assembly, P/N 1B58838-1, showed evidence of a green stain at the inside diameter of the pipe assembly.	The pipe assembly was removed from the stage and routed to the clean room for cleaning per DPS 43000. The pipe assembly was reinstalled after cleaning.
A270648 8-6-68	On sequencer panel, P/N 1B39550-511, wire harness 404A3W1, above and between modules A8 and A3, had cut and gouged insulation on wires M652A20, F272A20, F668A20, F120B20, P26XA20, F716A20, F683A20, and F178A20. Also, the rubber grommets were punctured in connectors P28, P29, and P32.	The damaged wires and the noted connectors were removed and replaced per 1B69018. Retest was to be accomplished at FTC per AO 1A39300, job 16, operation 3.
A270649 8-15-68	One bolt that attaches the blank flange to the D0225 instrumentation port on the LOX tank pressure control module, P/N 1B42290-507, S/N 0048, could not be removed.	The bolt was drilled out and the female threads were chased and cleaned to return the thread condition to drawing requirements. The module was reinstalled.

TABLE III (Contineud)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-025-565 1-24-68	During an Engineering run of H&CO 1B55817, the fuel pump inlet pressure transducer, P/N 1B40242-517, S/N 517-17, measurement D002, read 21.456 psia. It should have indicated a pressure of 14.7 ± 2 psia.	The discrepant transducer was removed from the stage and replaced by S/N 517-4.
500-025-611 2-2-68	During the DDAS automatic procedure, the DDAS assembly, P/N 1A74049-511, S/N 014, dropped out data seven times.	The DDAS assembly was removed from the stage and replaced by S/N 017.
500-025-620 2-6-68	The pipe assembly, P/N 1B64313-1, showed evidence of oxidation near the four bolt hole flange. Reference 1B58006, Zone 50, View K.	The pipe assembly was removed from the stage and routed to LOX service. The wrapping tape was removed and the pipe assembly was cleaned per DPS 41003 to remove the corrosion. After installing teflon tape, per 1B64131, the pipe assembly was reinstalled on the stage.
500-025-638 2-5-68	During poststorage leak checks the following discrepancies were noted against the LOX tank pressurization module, P/N 1B42290-505, S/N 0039. a. With a helium inlet pressure of 400 psig the hot gas control valve leak rate was 2568 scim. Cycling improved this leakage to 2250 scim. The maximum allowable leakage was 1000 scim. b. The leakage decay rate exhibited a 1980 scim variation between prefire and postfire leak checks. The prefire leakage was 270 scim, the postfire leakage was 2250 scim.	The module, P/N 1B42290-505, S/N 0039, was acceptable for use until a replacement module, P/N 1B42290-507, was available. On 22 March 1968, the module was removed from the stage and replaced with P/N 1B42290-507, S/N 0048.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-025-646 2-6-68	The flow meter assembly, P/N 1A89104-509, S/N 29927, was operated for approximately 13 minutes. The NASA identification sticker on the meter was damaged.	The flow meter was removed and replaced with S/N 28115.
500-025-654 2-7-68	During DDAS calibration procedure, H&CO 1B55816, the following discrepancies were noted: a. CP1-BO-28-10 was 4.969 vdc, but should have been 5.00 $\pm$ .03 vdc. b. DP1-BO-29-08 was 4.958 vdc, but should have been 5.00 $\pm$ .03 vdc. c. DP1-BO-29-10 was 4.969 vdc, but should have been 5.00 $\pm$ .03 vdc.	The discrepancies were corrected by reworking the transducers per WRO 4188.
500-025-662 2-7-68	During the range safety system checkout, H&CO 1B55819, it was noted that range safety antenna system 1 was less sensitive than antenna system 2. The sensitivity was -69.2 dbm, but should have been -98.8 dbm.	The range safety antenna, P/N 1A69207-501, S/N 040, was removed from the stage and replaced by S/N 00021.
500-025-671 2-7-68	The outer circumference of the LH_2 chilldown strainer, P/N 1B52985-501, showed evidence of suspected rust contamination. The top of the screen and the inner circumference also showed evidence of suspected rust contamination and corrosion.	The strainer was removed from the stage and routed to LOX service for cleaning. The discoloration was removed, the screen was cleaned per DPS 43000, and was then reinstalled in the stage.
500-025-697 2-13-68	During an Engineering run of the hydraulic system automatic checkout, two malfunctions were noted against a transducer, P/N 1B31356-515, S/N 184-7: a. The transducer readings ranged from +42 to -132 psi different than the reading taken from HPU gauge.	The transducer was removed from the stage and replaced by S/N 245-2.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-025-697 (Cont.)	b. The resistance readings of the transducer were 4380 ohm, but should have been 5000 ± 250 ohms.	
500-025-701 2-14-68	The following areas were inaccessible for vidigage inspection:	The stringers under the APS modules were inspected per WRO S-IVB-3818 after removal of the modules.
	a. Forward skirt, quadrant I, stringers 15, 16, 17, 19, 24 and 25.	All other stringers were acceptable to Engineering.
	b. Forward skirt, quadrant II, stringers 30, 31, and 32.	
	c. Forward skirt, quadrant III, stringers 69, 70, 77, 78, 79, and 80.	
	d. Aft skirt, quadrant I, stringers 1, 2, 6 and 9.	
	e. Aft skirt, quadrant II, stringers 38, 39, 40 41, 42, 54, 57, 70, 71, and 72.	
	f. Aft skirt, quadrant III, stringers 73, and 74.	
	g. Aft skirt, quadrant IV, stringers 142, 143, and 144.	
500-025-719 2-14-68	Pin C of solenoid 403A3L1J1 on the fuel tank pressure control module, P/N 1B66230-505, S/N 1037, was bent 10 degrees toward pin A.	Under the direction of MM&RE, the noted pin was straightened. Retest of the control module was accomplished per 1B62753.
500-025-727 2-14-67	Pin cup B of Deutsch connector 403W8P36 of cable assembly, P/N 1B63297-1, was gouged at the side of the connector.	The connector was accepted by Engineering for use.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-025-743 2-21-68	Black light and normal light inspection showed evidence of contamination in and around the injector face of the J-2 engine.	Further investigation indicated that the discolorations were surface stains and the J-2 engine was accepted, without rework, by Engineering.
500-025-751 2-23-68	Data assimilated during an Engineering run of AST procedure 1B55833 indicated faulty inflight calibrations on the DP1-BO multiplexer, P/N 1B62513-543, S/N 026. The multiplexer went to 5 vdc (100 percent) with the calibration command and remained for the calibration duration of 400 milliseconds. The output should have stepped through 0, 25, 50, 75, and 100 percent levels, remaining at each level for 80 milliseconds.	The defective multiplexer was removed and replaced by S/N 021.
500-026-022 2-28-68	During AST H&CO 1B55833, a cutoff indication was not received at the test control center when LOX point level sensors 1 and 2 were turned off. Control units, P/N 1A68710-511.1, S/N's D80 and B101, reference locations 404A72A2 and 404A72A1, respectively, were suspected of having malfunctioned.	The suspected control units were removed and replaced by S/N E58 and C89 respectively.
500-026-031 2-28-68	During an Engineering run of AST H&CO 1B55833, it was noted that a cutoff indication was not received at the test control center when LOX point level sensors 1 and 2 were turned off. Time delay module, P/N 1B59020-1, S/N 028, was suspected of having malfunctioned.	The suspected time delay module was removed and replaced by S/N 048.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-049 2-28-68	During an Engineering run of AST H&CO 1B55833, it was noted that the decoder assembly, P/N 1A74053-503, S/N 0273, cycled from high calibration to low calibration without command.	The discrepant unit was replaced with S/N 164.
500-026-081 3-5-68	Data review, subsequent to the all systems test, indicated that transducer, P/N 1A72913-557, S/N 343-1, measurement D014, exhibited a 40 per cent variation in the negative direction. The transducer then held steady at 400 psia for three sample times.	The transducer was removed and replaced by S/N 74-13.
500-026-090 3-8-68	The cold helium bottle fill manifold in the main tunnel area was found to be rusted.	The teflon tape was removed from the affected area and the area was passivated per DPS 41003 section 6.3.4.2. After passivation, the manifold was rewrapped with teflon tape per blueprint.
500-026-103 3-11-68	During hydraulic system operation and securing procedure 1B41006, Revision 2, a 1.5 ml sample of hydraulic fluid was taken from the accumulator/reservoir, P/N 1B29319-519, S/N 00032, to determine if any leakage existed in the accumulator high pressure system. (This FARR was a customer request rejection).	The hydraulic accumulator/reservoir was removed and replaced with S/N 00031.
500-026-600 3-29-68	During poststorage modifications, it was noted in wire harness, P/N 1B34884-1, that the insulation and shield of wire number D1670A22BK to J1 was damaged.	The shield was trimmed at the damaged area and reterminated per DPS 54001.
500-026-685 4-5-68	Two rivets in stringer number 17, reference location 403 area, were drilled out in error.	The rivets were replaced per DPS 13056.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-715 4-10-68	It was noted during modification per AO 1B69896 C, that seven of the eight 0.255 inch diameter holes in the support bracket, P/N 1B69896-1, were elongated and egg shaped to sizes ranging from 0.312 to 0.375 inches in diameter.	The discrepant part was removed and replaced.
500-026-731 4-17-68	During routine inspection surveillance, it was discovered that a wire, Q9101A22, in cable 404W30P10 at the depletion sensor feedthrough on the exterior of the LOX tank, had the outside insulation broken, exposing the shield braid.	The broken insulation was repaired per DPS 54010.
500-026-740 4-18-68	The following discrepancies were noted during testing per A659-1941-PATP1-T5: a. The plug of the pneumatic propellant control valve, P/N 1B59010-503, S/N 120, appeared to have cracks between the pins. b. The plug of the pneumatic propellant control valve, P/N 1B59010-503, S/N 122, had excessive crazing and a piece of glass missing. c. The talkback plug J1 on the LOX tank vent and relief valve, P/N 1A48312-505, S/N 0023, showed excessive crazing of the glass insert.	a, c, d, e. Acceptable to Engineering for use. b. Transferred to FARR A270641 per customer request 6 August 1968.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-740 (Cont)	d. The talkback plug J2 on the LOX tank vent and relief valve, P/N 1A498312-505, S/N 0023, showed excessive crazing of the glass insert.	
	e. The plug J2 in the LH_2 fill and drain valve, P/N 1A48240-505, S/N 0118, showed excessive crazing of the glass insert.	
500-026-758 4-19-68	The angle assemblies, P/N 1A81820-7 and -11, on stringers 6A and 6-3/4, were found to be mislocated. The angle assemblies were 6-15/16 inches from the forward edge of the angle bracket. The distance should have been 16 inches.	The angle assemblies were relocated per blueprint requirements.
500-162-902 2-23-68	During installation of the retro-rocket impingement curtain, P/N 1B69815-7, S/N 002, the following discrepancies were noted:	The curtain was removed from the stage and returned to the vendor for repair or replacement.
	a. A flap was missing below the duct cover end.	
	b. The -11 segment was not sewn per general note 2 of 1B69815-7.	
	c. The duct cutout had not been held to the center line.	
500-163-453 3-27-68	During installation of the purge system duct, P/N 1A67978-515, it was noted that the pilot hole was drilled through the weld. There was insufficient clearance to allow installation of the duct.	The duct assembly was removed from the stage and replaced. The discrepant duct was routed to Santa Monica plant for evaluation.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-225-017 6-4-68	During modification per 1B74463-NC, it was noted that wire 20-P33-A22 was cut in wire harness, P/N 1B66971-15, about 5 inches from J11.	The cut wire was removed and replaced.
500-225-025 6-5-68	A wire support, P/N 1B32740-1, was found to be missing from stringer 19-3/4.	The missing support was installed.
500-225-050 6-13-68	After removal of the sump assembly, P/N 1A39146 -501, S/N 25, it was noted that there was discoloration and buildup of foreign material on the outer mating surface of the sump cover, located in the vicinity of the bolt holes.	The sump assembly was cleaned per DPS 43000 and reinstalled in the stage.
500-225-068 6-18-68	During modification to the stage per 1A59098CZ, a heavy concentration of white substance was found at the inlet of the LH_2 chilldown pump.	The pump was removed from the stage and sent to LOX service for investigation.
500-225-076 6-18-68	During modification per 1A59098CZ, suspected contamination or corrosion was found on the outside surface at four bolt holes of the LH_2 chilldown pump motor attach points.	At the time the chilldown pump was reinstalled, both sealing surfaces were wiped down with freon, removing as much contamination as possible. Any remaining residue was acceptable.
500-225-165 7-3-68	The thickness of the silicone dispersion coating on the forward and aft skirt areas measured between 8.5 and 15.0 mils. The maximum thickness, per DPS 42210, para 6.1.5.2, should be 4 to 8 mils.	The stage was acceptable to Engineering.
500-225-181 7-11-68	Two plates, P/N 1A39295-025-15, located between stringers 62 and 63, and between stringers 134 and 135, were out-of-flat by 0.025 in. They should have been flat within 0.006 in. One plate, P/N 1A39295-025-15, located between stingers 134 and 135, had a 1/4 in. wide by 1 in. long gouge, approximately 0.002 in. deep.	The out-of-flat and gouge conditions were corrected by smoothing and polishing the surface, using a flat bar and 400 grit aluminum oxide paper.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-225-246 8-19-68	At the sensor end of cable, P/N 1B53574-7, on transducer assembly, P/N 1B53574-501, S/N 501-14, the teflon insulation was damaged, and one strand was broken.	The damaged insulation was removed by cutting above and below the damaged area. The broken strand was removed, and the bare areas were wrapped with 3 layers of DPM 2766 tape. After wrapping, the tape was fused per drawing requirements.
500-225-254 8-27-68	The flex hose, P/N FT167-4-96, had a one inch break through the material, caused by excessive bend radius.	The hose was removed and replaced.
500-225-281 7-11-68	During surveillance of modifications to the stage, the following discrepancies were noted: a. Two backup plates, P/N 1A39295-025-15, were found to be out-of-flat approximately 0.025 inches. The maximum allowable deviation from flat was 0.006 inches. The plates were located at station 220.750 between stringers 62 and 63, and stringers 134 and 135. b. One backup plate, P/N 1A39295-025-15, located at station 220.750 between stringers 134 and 135, was gouged approximate 1/4 inch wide by 1 inch long in the 32 rms finish area.	The out-of-flat condition was corrected, and the gauge was removed by polishing the backup plates with a flat bar and 400 grit aluminum oxide paper.
500-225-769 6-25-68	During a pull test per 1B70756, isolators, P/N 1B32255-1, S/N's 353 and 359, were found to be debonded approximately 0.50 inches from the forward end of the isolators.	The isolators were removed from the stage and replaced with S/N's 621 and 622.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-225-777 6-25-68	During a pull test per 1B70756, it was noted that an isolator, P/N 1B32256-1, was debonded at reference location 411A99, between stringers 25 and 31.	The isolator was removed and replaced.
500-225-858 8-2-68	An inspection of the stage, per line inspection check number 84, revealed that plate assembly, P/N 1B59265-1, and adapter assembly, P/N 1B59264-1, and were not installed as required per 1A39322.	The condition was found to be acceptable to the Material Review Board.
500-225-882 8-3-68	During inspection surveillance, it was noted that a pipe assembly, P/N 1B75268-1, had been bent from the original configuration by over 90 degrees.	The pipe assembly was removed and replaced.
500-225-891 8-3-68	During surveillance inspection, the bellows assembly, P/N 1A49986-1, S/N 3892-1, was found to have three indentations 0.010 inches deep and 0.080, 0.100, and 0.400 inches long, respectively.	The condition was accepted by the Material Review Board.
500-225-904 9-6-68	As noted by FARR 500-372-273, the rework of the gaps between the tunnel cover, P/N 1B39628-1, and the fairing, P/N 1A98365-501, was not acceptable. The tunnel cover was not flush with the mating surface as required.	The cover was acceptably reworked per SEO 1B39628-A45-1.
500-226-021 4-19-68	The following discrepancies were noted when removing the LH_2 vent and relief valve, P/N 1B69030-1, S/N 0007, from the stage for rework:	The valve was removed from the stage and was purged with GN_2 to remove the metal particles. All bare areas were touched up with alodine.
	a. Both Marman seal ports had nicks, dings and roughed up areas adjacent to sealing surfaces.	After rework, the valve was acceptable to Engineering for use.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-021 (Cont.)	b. Metal particles were found in the sealing area of the large port.	
500-226-030 4-25-68	The pressure switch, P/N 1B52624-517, S/N 010, had rust on the switch body. The suspected cause was poor or no passivation of the part. The switch was used as the control helium regulator over-pressure switch.	The pressure switch was removed from the stage and routed to LOX service for cleaning and passivation.
500-226-056 5-7-68	During modification work, it was noted that the attaching holes for the doubler plates, P/N 1B28411-43, were misaligned in relation with the bolt slots in the tunnel cover.	The mislocated rivet holes were plugged with AD4 rivet material. The doubler plates were then relocated to match the bolt slots and riveted in place.
500-226-064 5-7-68	It was noted in the main tunnel cover, P/N 1B28411-501, that the rivet holes used for attaching the doubler plates, P/N 1B28411-43, were misaligned in relation to the 0.320 by 0.750 inch bolt slots in the tunnel cover.	The existing rivet holes were plugged with AD4 rivet material and the doubler plates were reriveted to match the bolt slots.
500-226-072 5-7-68	During inspection surveillance, it was noted that drain holes in the forward skirt were not per the 0.310 to 0.319 inch diameter requirement of the blueprint. The diameter of the drain holes ranged from 0.184 to 0.314.	The condition was acceptable to Engineering for use.
500-226-081 5-8-68	During modification work, it was noted that cable assembly, P/N 1B40242-55, location 410MT601, was damaged approximately 6 inches from plug P2.	The damage was repaired per DPS 54010.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-099 5-8-68	During modification work, it was noted that the insulation was damaged on cable assembly P/N 1B40242-67, near stringer 29, reference location 425MT601C. Several wire strands were broken.	The cable assembly was removed from the stage and replaced.
500-226-111 5-9-68	During installation of an attach angle, P/N 1B37207-115, in the thrust structure, it was noted that the pipe assembly support bracket, P/N 1B37207-103, was mislocated. The top edge of the bracket was 58-17/32 inches from the heel line of the attach angle. The distance per blueprint should be 57-17/32 inches.	The pipe assembly support bracket was relocated per requirements of the blueprint. The rework resulted in two open holes in the attach angle, which were acceptable to Engineering.
500-226-129 5-9-68	During modification, it was found that the rivet holes in the auxiliary tunnel cover, P/N 1A98308-503, used for attaching the doubler plates, P/N 1A98308-91, were mislocated with respect to the bolt slots.	The auxiliary tunnel cover was accepted for use.
500-226-137 5-9-68	The following discrepancies were noted in the auxiliary tunnel cover, P/N 1A98308-1.1: a. The rivet hole for attaching the doubler plates, P/N 1A98308-91, were misaligned in relation to the bolt slots. b. The bolt slot of the left side tunnel cover was 7 degrees off parallel with the cover sealing edge.	Both items were accepted for use by Engineering.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-145 5-10-68	During modification per 1B57452BC, it was noted that the cable assembly, P/N 1B40242-63, had the following insulation damage; a. A cut, approximately 1/4 inch long, between stringers 17 and 19 below the fuel vent. b. A scuffed area 1 by 3/16 inches, with approximately 5 broken strands of braid, at location 409MT648.	The cable assembly was removed from the stage and replaced.
500-226-161 5-15-68	During inspection surveillance, it was discovered that cable assembly, P/N 1B67089-1, had a cut in the exterior insulation, approximately 0.30 inches long, near P1 on the 404A60 panel.	The damage was repaired per DPS 54010.
500-226-170 5-22-68	A hydraulic fluid leak was noted at the bleed valve, P/N 1A92754-501, on the engine driven hydraulic pump, P/N 1A66240-503, S/N X457806. The leak rate was determined to be 2.5 ml for a 74 hour period.	The bleed valve was retorqued, and the area was wiped clean with freon. A plastic bag was attached to the bleed valve, and the bleed valve was checked for leakage for 72 hours. After this check, the bleed valve was acceptable to Engineering for use.
500-226-196 5-28-68	During inspection surveillance, the following discrepancies were noted. a. Threads were stripped on the standoff, P/N 1B31249-1, located on the panel assembly, P/N 1B37276-423. b. Threads were stripped on the standoff, P/N 1B37286-503, located at stiffener 7-1/4, reference location 403W8.	The damaged standoffs were repaired per 1B53312.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-226 6-3-68	The isolator, P/N 1B32267-1, at reference location 404A64, debonded approximately 0.500 inches on stringer 109 during a pull test per 1B70756.	The isolator was removed and replaced.
500-226-234 6-3-68	The isolator, P/N 1B32258-1, at reference location 404A45, stringer 140, became debonded approximately 0.50 inches during a pull test per 1B70756.	The isolator was removed and replaced.
500-226-242 6-3-68	During a pull test per 1B70756, isolator, P/N 1B54125-1, debonded approximately 0.438 inches on stringer 10 at reference location 404A47A2.	The isolator was removed and replaced.
500-226-251 6-3-68	It was noted during a pull test per 1B70756, revision 5, that the isolator, P/N 1B54123-1, debonded approximately 0.75 inches on stringer 141, reference location 404A51A4.	The isolator was removed and replaced.
500-372-265 8-29-68	The first convolution of the duct assembly, P/N 1B59009-503, S/N 17, was pushed in 0.050 inches toward the second convolution on the upper bellows.	The condition was accepted by the Material Review Board.
500-372-273 8-29-68	During the final shakedown inspection, two gaps were noted between the tunnel cover, P/N 1B39628-1, and fairing, P/N 1A98365-501. The tunnel cover should have been flush with the mating surface.	The bolt holes in the tunnel cover were slotted to permit better alignment with the fairing. This did not sufficiently correct the gaps, and the condition was resubmitted on FARR 500-225-904.
500-372-311 9-3-68	The O_2H_2 burner fairing cover, P/N 1B28112-401, could not be bolted in place due to interference with pipe assembly, P/N 1B65056-1.	The stiffener on the inner surface of the cover was trimmed to clear the pipe assembly.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-346 9-4-68	Curtain assembly, P/N 1B69815-7, S/N 002, did not fit at the nonpropulsive vent duct.	Acceptable for use at STC only. The condition was to be resubmitted at FTC for final disposition. This FARR was transferred open to FTC.
500-372-354 9-4-68	Curtain assembly, P/N 1B65607-503, S/N 009, did not fit properly at the nonpropulsive vent duct.	Acceptable for use at STC only. The condition was to be resubmitted at FTC for final disposition. This FARR was transferred open to FTC.
500-373-016 8-16-68	During rework of the sequencer panel, P/N 1B39550-511, per 1B44389AK, the mounting holes for the A57 module were mislocated 0.125 inch.	The holes were relocated, and nutplates, P/N NAS686A3, were substituted for nutplates, P/N NAS 696A3.
500-373-024 8-18-68	During the final inspection, it was noted that duct, P/N 1A87152-1, S/N 111, had one ding, 0.050 in. long by 0.010 in. deep; duct, P/N 1A87152-1, S/N 114, had one dent 0.500 in. in diameter by 0.020 in. deep; and cable, P/N 1B40242-67, S/N 523-1, had a cut in the outer jacket.	The duct conditions were both acceptable to the Material Review Board. The cable was repaired per DPS 54010.
500-373-032 8-10-68	The insulation was debonded around the ends of the LH_2 feedline elbow, P/N 1A39308-21, and the elbow strut brackets. The fiberglass cloth and resin indicated some deterioration.	The conditions were acceptable to the Material Review Board.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-373-041 8-19-68	During interference damage inspection per WRO 4495, the following conditions were noted:	a. and b. The tube assemblies were polished with 400 grit aluminum oxide to remove piled up material.
	a. Tube assembly, P/N 1B52445-1, had a gouge, 0.100 inch long by 0.010 inch deep.	
	b. Tube assembly, P/N 1B64153-1, had two gouges 0.100 inch long by 0.010 inch deep.	
	c. Tube assembly, P/N 1B64599-1, was riding against tube assembly, P/N 1B59311-1.	c., d., and e. The tube assemblies were loosened and positioned to eliminate the interference condition.
	d. Tube assembly, P/N 1B65051-1, was riding against tube assembly, P/N 1B52460-1.	
	e. Tube assembly, P/N 1B66501-1, was riding against tube assembly, P/N 1B75035-1.	
	f. Flex hose, P/N 1A77111-507, had a strain condition at the weld joint.	f. The condition was accepted by the Material Review Board.
	g. Flex hose, P/N 1A48712-1, was buckled, indicating excessive strain.	g. The attachment hardware and hose assembly was repositioned to relieve the strain condition.
500-373-059 8-20-68	During the LH_2 Probe installation, the outer wall of the counterbore of bracket assembly, P/N 1B38793-1, was cracked 0.100 inch long.	The damaged portion was trimmed and touched up with alodine.
500-373-067 8-21-68	During the tank closure operations, corrosion was found adjacent to the sealing surface of the LH_2 tank access port.	The corrosion was removed by mechanical means per DPS 41004, and the cleaned area was passivated with a 5 percent solution of chromic acid.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-373-091 8-21-68	Three scratches were located on pipe assembly, P/N 1B52441-1, 0.125 inch long by 0.001 to 0.002, inch deep. The scratches were located behind the B-nut sleeve.	The noted scratches were polished with 400 grit aluminum oxide to remove the pileup of material.
500-373-113 8-21-68	The O_2H_2 burner LOX duct cradle, P/N 1B67479-1, and bracket, P/N 1B67478-1, were misaligned.	The cradle was removed, trimmed to fit, and realigned with the bracket, in accordance with MM&RE instructions.
500-373-121 8-23-68	The pipe assembly, P/N 1B62600-5, S/N 07, did not align with the fittings on valve P/N 1B66639-515, and had a flat portion in the 0.291 inch bend radius. The radius should have been 0.375 inch.	The pipe assembly was removed and replaced.
500-373-130 8-26-68	Duct assembly, P/N 1B59009-503, S/N 23, had a dent 1 in. long by 1/16 in. deep, 8 in. from bracket, P/N 1A49967-533.	The duct was removed and replaced.
500-373-148 8-26-68	During the cable rework to transducer assembly, P/N 1B53574-501, S/N 501-14, by FARR 500-225-246, the cable insulation was cut in three areas, and several areas were bruised and wrinkled.	The cut areas were repaired with teflon tape. The bruised and wrinkled areas were acceptable to the Material Review Board.
500-373-156 8-27-68	Pipe assembly, P/N 1B75267-1, had a sharp kink at the bend, 5 in. from the B-nut at stringer 18. Defect noted during final inspection.	The pipe assembly was removed and replaced.

APPENDIX III

FLIGHT CRITICAL ITEMS INSTALLED AT TURNOVER

The flight critical items (FCI) installed on the stage at the time of turnover to NASA/STC for shipment to KSC are listed in the following tabulation

P/N	S/N	Ref Location	Name
1A48240-505-007	0001	404A7S1, S2	Fill and drain valve
1A48240-505-007	0118	427A8S1, S2	Fill and drain valve
1A48257-511-006	0039	411A1S1, S2	LH_2 vent and relief valve
1A48312-505-008	0023	424A9	LOX vent and relief valve
1A48430-509-011	C1	406A1	LOX mass probe
1A48431-513-009	D3	408A1	LH_2 mass probe
1A48857-503	36	403A73	Control helium tank
1A48858-1	1063	Bnk 2 Pos 8	Helium sphere
1A48858-1	1069	Bnk 2 Pos 10	Helium sphere
1A48858-1	1093	Bnk 1 Pos 3	Helium sphere
1A48858-1	1112	Bnk 1 Pos 4	Helium sphere
1A48858-1	1113	Bnk 1 Pos 1	Helium sphere
1A48858-1	1120	Bnk 1 Pos 5	Helium sphere
1A48858-1	1125	Bnk 1 Pos 2	Helium sphere
1A48858-1	1135	Bnk 2 Pos 7	Helium sphere
1A48858-1	1140	Bnk 2 Pos 9	Helium sphere
1A49421-507	193	427A41	LH_2 aux chilldown pump
1A49423-509	1763	424A4, A2	LOX aux chilldown pump
1A49964-501	255	424 (LOX)	Chill system check valve
1A49964-501	256	427 (LH_2)	Chill system check valve
1A49965-523-012	0402	424A3	Chill system shutoff valve
1A49965-529-013A	0607	404A4S1, S2	Chill system shutoff valve
1A49968-507-010A	022	427A6	Prop tank shutoff valve
1A49968-509-010A	142	424A6	Prop tank shutoff valve
1A49988-509-003	0039	411A29	LH_2 directional vent valve
1A49991-1	27	403A74	Cold helium tank
1A49991-1	62	403A6	Cold helium tank
1A49991-1	82	403A7	Cold helium tank
1A57350-507-002	0227	403A73	Amb helium fill module
1A58347-513	4	403A73A3	Engine pump purge cont mod
1A59358-525	022	411A92A6	PU electronics assembly
1A66212-507	020	411A92A7	Inv-conv elect assy
1A66240-503	X457806	401A11S1, S2	Engine driven pump
1A66241-511	X454590	403B1	Aux hydraulic pump
1A66248-505-011A	52	403A71L1	Hydraulic actuator assy
1A66248-507-012A	60	403A72L1	Hydraulic actuator assy
1A68085-505	0056	411A99A10A1	300 amp pwr transfer switch
1A68085-505	0095	404A45A1	300 amp pwr transfer switch
1A68085-505	0100	404A2A1	300 amp pwr transfer switch

Appendix III (Continued)

P/N	S/N	Ref Location	Name
1A74039-517-011E	015	404A74A2	Chilldown inverter elect. assy
1A74039-517-011E	053	404A74A1	Chilldown inverter elect. assy
1A74211-509	0611	404A3A41	2 amp relay module
1A74211-509	0613	411A99A10A12	2 amp relay module
1A74211-509	0614	404A45A8	2 amp relay module
1A74211-509	0615	404A3A17	2 amp relay module
1A74211-509	0616	404A2A6	2 amp relay module
1A74211-509	0617	404A3A19	2 amp relay module
1A74211-509	0634	404A3A48	2 amp relay module
1A74211-509	0657	404A2A8	2 amp relay module
1A74211-509	0658	404A45A9	2 amp relay module
1A74211-509	0659	404A45A10	2 amp relay module
1A74211-509	0660	404A45A7	2 amp relay module
1A74211-509	0665	411A99A10A11	2 amp relay module
1A74216-503	0434	411A99A10A6	Mag latch relay module
1A74216-503	0460	404A3A23	Mag latch relay module
1A74216-503	0461	404A3A13	Mag latch relay module
1A74216-503	0462	404A3A21	Mag latch relay module
1A74216-503	0476	404A45A5	Mag latch relay module
1A74218-509	0612	404A3A20	10 amp relay module
1A74218-509	0613	404A2A2	10 amp relay module
1A74218-509	0614	404A3A44	10 amp relay module
1A74218-509	0615	404A45A11	10 amp relay module
1A74218-509	0616	404A3A12	10 amp relay module
1A74218-509	0617	411A99A10	10 amp relay module
1A74218-509	0618	404A3A49	10 amp relay module
1A74218-509	0619	404A3A14	10 amp relay module
1A74765-507	209	401A11S1	Hyd syst thermal switch
1A74890-501	0105	404A2A7	50 amp relay module
1A74890-501	0109	404A45A2	50 amp relay module
1A74890-501	0110	404A2A10	50 amp relay module
1A74890-501	0111	411A99A10A2	50 amp relay module
1A74890-501	0114	404A2A9	50 amp relay module
1A77310-503.1	0131	411A98A2	5 volt excitation module
1A77310-503.1	0132	411A99A33	5 volt excitation module
1A77310-503 1	0136	404A52A7	5 volt excitation module
1A86847-509	050	401A11S1, S2	Hyd pump thermal isol assy
1B29319-519	031	403A46S1	Accum/reservoir assy
1B32647-505	058	404A45A3	Hyd pwr unit start switch
1B33084-503	011	411A97A19	RS controller assy
1B33084-503	012	411A97A13	RS controller assy
1B39037-501	014	J-2 attach	Eng installation bolts
1B39037-501	027	J-2 attach	Eng installation bolts
1B39037-501	029	J-2 attach	Eng installation bolts
1B39037-501	047	J-2 attach	Eng installation bolts

Appendix III (Continued)

P/N	S/N	Ref Location	Name
1B39037-501	052	J-2 attach	Eng installation bolts
1B39037-501	070	J-2 attach	Eng installation bolts
1B39550-529	007	404A3	Sequencer mounting assy
1B39975-501	240	404A3A37	Diode module
1B39975-501	241	404A3A5	Diode module
1B39975-501	242	404A3A1	Diode module
1B39975-501	243	404A3A39	Diode module
1B39975-501	245	404A3A3	Diode module
1B39975-501	250	404A3A43	Diode module
1B39975-501	254	404A2A16	Diode module
1B39975-501	255	404A2A17	Diode module
1B40604-1.2	074	404A2A34	Diode assy module
1B40604-1 2	079	404A3A42	Diode assy module
1B40604-1 2	084	404A3A7	Diode assy module
1B40604-1 2	111	404A3A51	Diode assy module
1B40604-1 2	112	404A3A50	Diode assy module
1B40824-507 1	101	403 Str 9	Check valve
1B40824-507 1	102	403 Str 9-3/4	Check valve
1B40824-507 1	103	403 Str 5A	Check valve
1B40824-507 1	105	403 Str 9-3/4	Check valve
1B40887-501	229	404A3A46	10 amp mag latch relay mod
1B40887-501	250	404A2A15	10 amp mag latch relay mod
1B40887-501	268	404A45A6	10 amp mag latch relay mod
1B40887-501	282	411A99A10A4	10 amp mag latch relay mod
1B40887-501	295	404A3A2	10 amp mag latch relay mod
1B40887-501	296	404A3A18	10 amp mag latch relay mod
1B40887-501	297	404A3A6	10 amp mag latch relay mod
1B40887-501	298	404A3A10	10 amp mag latch relay mod
1B40887-501	299	411A99A10A5	10 amp mag latch relay mod
1B40887-501	300	404A3A8	10 amp mag latch relay mod
1B40887-501	301	404A3A16	10 amp mag latch relay mod
1B40887-501	302	404A3A4	10 amp mag latch relay mod
1B40887-501	418	404A3A57	10 amp mag latch relay mod
1B42290-507	48	403A74A1	LOX press. control module
1B51211-505	09	404A45	Aft 56 volt pwr dist assy
1B51354-523	07	404A2	Aft 28 volt pwr dist assy
1B51361-1	224	403A73A4	H_2 vent purge check valve
1B51361-1	229	404A44	H_2 vent purge check valve
1B51361-1	247	404A9	H_2 vent purge check valve
1B51361-1	256	403A73A5	H_2 vent purge check valve
1B51361-1	259	404	H_2 vent purge check valve
1B51361-1	280	404	H_2 vent purge check valve
1B51361-501	219	403A73A4	H_2 vent purge check valve
1B51361-501	279	403A74A3	H_2 vent purge check valve
1B51379-515	17	411A99A10	Fwd pwr dist mount assy

Appendix III (Continued)

P/N	S/N	Ref Location	Name
1B52624-511	23	411S2	Pressure switch
1B52624-511	28	411S4	Pressure switch
1B52624-515	29	403S8	Pressure switch
1B52624-519	22	403S1	Pressure switch
1B52624-519	41	403S5	Pressure switch
1B52624-519	43	403S6	Pressure switch
1B53920-503	41	424 (LOX)	Chill feed duct check valve
1B55200-505	1039	403A73A3	LH_2 press control module
1B55408-503	019	-	Compressed air tank
1B57731-501	407	404A71A19	Control relay package
1B57731-501	409	404A51A4	Control relay package
1B57781-507	42	403A74A2	Cold helium fill module
1B58006-401	27	403A74	1A49991, teflon wrapped
1B59010-509	108	427A7	Pneu prop. control valve
1B62600-527-009C-012-A45-55A	07	403	O_2H_2 welded burner assy
1B62778-503	62	403A6	Helium plenum and valve assy
1B62778-503	82	403A7	Helium plenum and valve assy
1B65319-503	12	404A70A1	Sw sel emissivity cont assy
1B65673-1	05	-	Cold helium check valve
1B66230-505	1039	403A73A3	Calibrated LH_2 press cont mod
1B66639-503	38	403	Pneu latching actuator assy
1B66692-501-A45-1	60	404A44	Actuation control module
1B66692-501-A45-1	61	404A43	Actuation control module
1B66692-501-A45-1	68	403A15	Actuation control module
1B66692-501-A45-1	69	411A30-17	Actuation control module
1B66692-501-A45-1	70	404A17	Actuation control module
1B66692-501-A45-1	71	403A75A1	Actuation control module
1B66692-501-A45-1	72	404A9	Actuation control module
1B66692-501-A45-1	75	411A2-13	Actuation control module
1B66692-501-A45-1	86	411A3-17	Actuation control module
1B67193-507	029	411A32L1	Continuous vent control mod
1B67481-1	708308	411A14L2	Check valve assembly
1B67481-1	7062111	403A15L1	Check valve assembly
1B67481-1	7062114	403A15L2	Check valve assembly
1B67481-1	7062119	404A17L2	Check valve assembly
1B67481-1	7062142	403A75A1L2	Check valve assembly
1B67481-1	8011510	403A74A2	Check valve assembly
1B67481-1	8011869	411A14L1	Check valve assembly
1B67481-1	60710185	403A74A1	Check valve assembly
1B67481-1	70621118	411A2L2	Check valve assembly
1B67481-1	70621119	411A3L2	Check valve assembly
1B67481-1	70621122	411A30L2	Check valve assembly
1B67481-1	70621148	411A30L1	Check valve assembly
1B67481-1	70621154	411A3L1	Check valve assembly

Appendix III (Continued)

P/N	S/N	Ref Location	Name
1B67481-1	70621158	411A2L1	Check valve assembly
1B67481-1	70621160	404A17L1	Check valve assembly
1B67481-1	70621165	404A44L1	Check valve assembly
1B67481-1	70621166	404A44L2	Check valve assembly
1B67481-1	70621171	404A9L2	Check valve assembly
1B67481-1	70621179	404A3L1	Check valve assembly
1B67481-1	70621184	404A43L2	Check valve assembly
1B67481-1	70621199	404A9L1	Check valve assembly
1B67481-1	70621201	403A75A1L1	Check valve assembly
1B67481-1	70621238	403 Str 20	Check valve assembly
1B67481-1	70621288	403A8L2	Check valve assembly
1B67481-1	70622162	403A8L1	Check valve assembly
1B67598-501	48	404 Str 30	Pneumatic check valve
1B67598-501	56	403 Str 7	Pneumatic check valve
1B67598-501	57	403 Str 10	Pneumatic check valve
1B67598-501	58	404A44	Pneumatic check valve
1B67598-503	49	403A73A5	Pneumatic check valve
1B67598-503	53	404A9	Pneumatic check valve
1B69030-1	7	424A9	LOX NPV control valve
1B69514-501	8	404A3A56	Isolation diode module
1B69550-501	010	403A73A4	Repress. control module
1B69550-501	011	403A74A3	Repress. control module
1B74535-1	2	-	LOX tank relief valve
7851823-503	1070	APS He inlet	Helium control disconnect
7851823-503	1086	APS He inlet	Helium control disconnect
7851844-501	67	427	Cold helium disconnect
7851861-1	14	427	LH_2 tank press. disconnect
40M39515-113	238	404A75A1	EBW firing unit
40M39515-113	239	404A75A2	EBW firing unit
40M39515-113	240	404A47A2	EBW firing unit
40M39515-113	245	404A47A1	EBW firing unit
40M39515-119	463	411A99A12	EBW firing unit
40M39515-119	464	411A99A20	EBW firing unit
103826	J-2094	401	J-2 engine

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MISSILE & SPACE SYSTEMS DIVISION/SPACE SYSTEMS CENTER
5301 BOLSA AVENUE, HUNTINGTON BEACH, CALIFORNIA
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