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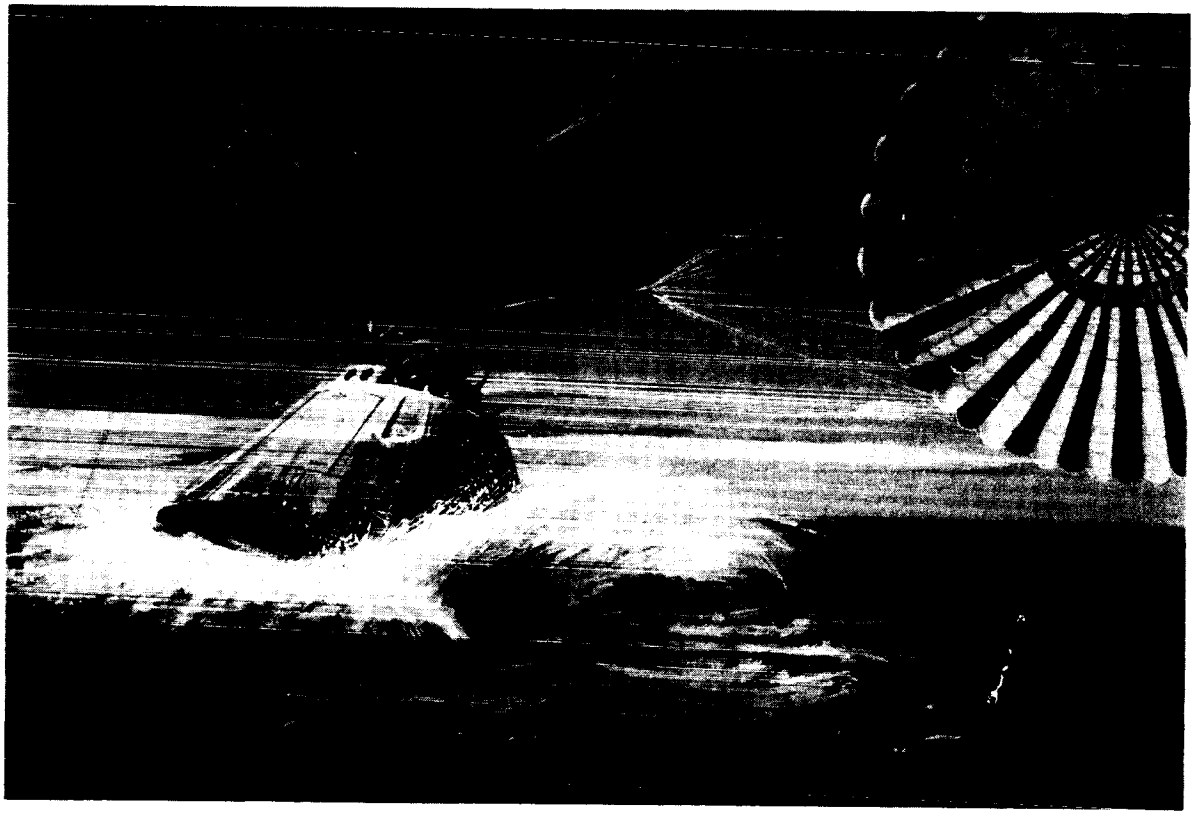
CUSTOMER ACCEPTANCE READINESS REVIEW
PROJECT APOLLO
CSM 012
PHASE I REPORT

JUNE, 1966



Space and Information Systems Division
North American Aviation Inc.
Downey, California

Coordinated By

Test Documentation
Apollo Test and Operations

(CSM-012) CUSTOMER ACCEPTANCE READINESS REVIEW PROJECT APOLLO CSM 012, PHASE 1 (North American Rockwell Corp.) Jun. 1966 609 p

N73-70018

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INTERNAL LETTER
North American Aviation, Inc.

Date · 13 June 1966

TO Address · CARR Participants

FROM Address · J. F. Parker
642-001
FA 02, B-6

Phone · 4333 (F. Mohr)

Subject · Customer Acceptance Readiness Review (CARR) Phase I Report, CSM 012

In accordance with the provisions of NAS9-150, Exhibit R, paragraph 1.0.6 the Phase I CARR Report has been prepared. This document represents the information required by the NASA to accurately assess the CSM for acceptance.

The Phase I CARR Report includes information available through the completion of individual systems test (13 June 1966). This document covers the systems associated with CSM 012, CM and SM (NAA), and the G&N (ACED/MIT-IL). Additional information resulting from the systems assessment meeting or CARR board meeting will be included in the Phase II CARR Report.

Refer questions concerning the CARR Report or other CARR activities to the CARR Project Administrator, J. F. Parker, D/642, Phone 213-923-8111, Ext. 5303, or F. Mohr, D/642, Phone 4333.

Note to contracts: Transmit this information to NASA; include CARR Administrators on distribution list.

J. F. Parker

J. F. Parker
Technical Assistant
Apollo Test & Operations

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0. GENERAL

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0.1 CARR SCOPE

0.1.1 PURPOSE:

The CARR is a final review conducted between NAA and NASA to formally evaluate CSM systems performance.

0.1.2 SUMMARY

The CARR project consists of:

(1) The Phase I CARR report - a comprehensive technical document summarizing events that occurred during test operations, functional problems, corrective actions taken, and reliability analysis to demonstrate ability of the CSM to perform its designated mission.

(2) The Systems Assessment - an informal NAA/NASA working meeting to assess in detail the CSM based on the published Phase I CARR report.

(3) The Pre-CARR - an internal NAA briefing to finalize the detail CARR agenda of open items remaining from Systems Assessment and additional unresolved new problems.

(4) The CARR - a formal meeting directed by a CARR board to evaluate the CSM based on the systems assessment findings and the Mission Simulation Run (MSR)/ integrated test results.

(5) The Phase II CARR Report - a compilation of the Systems Assessment and CARR meeting minutes and action responses.

For the inter-relationship between CARR activities, see the CARR functional flow chart, on following page.

0.1.3 GENERAL INFORMATION

Phase I CARR Report inputs, documenting all required information progressively, are completed at the end of

combined systems testing by all departmental CARR Administrators who are totally responsible for the completeness and quality of information submitted by them. These coordinated inputs are immediately collated and sent to Publications by the CARR coordinator as the Phase I CARR report. Approximately four days later, the finished printed report is distributed. This report is not updated.

Systems Assessment meeting is held based on the CARR report to identify and close most discussion items in support of the CARR board meeting. The Systems Assessment meeting will include working group meetings during a morning session and a summary session during the afternoon.

Minutes for the summary session and the systems working group meetings are prepared by the CARR coordinator. However, in order to ensure that information is not omitted, the working group chairmen prepare and initial the rough draft of each working group's meeting minutes.

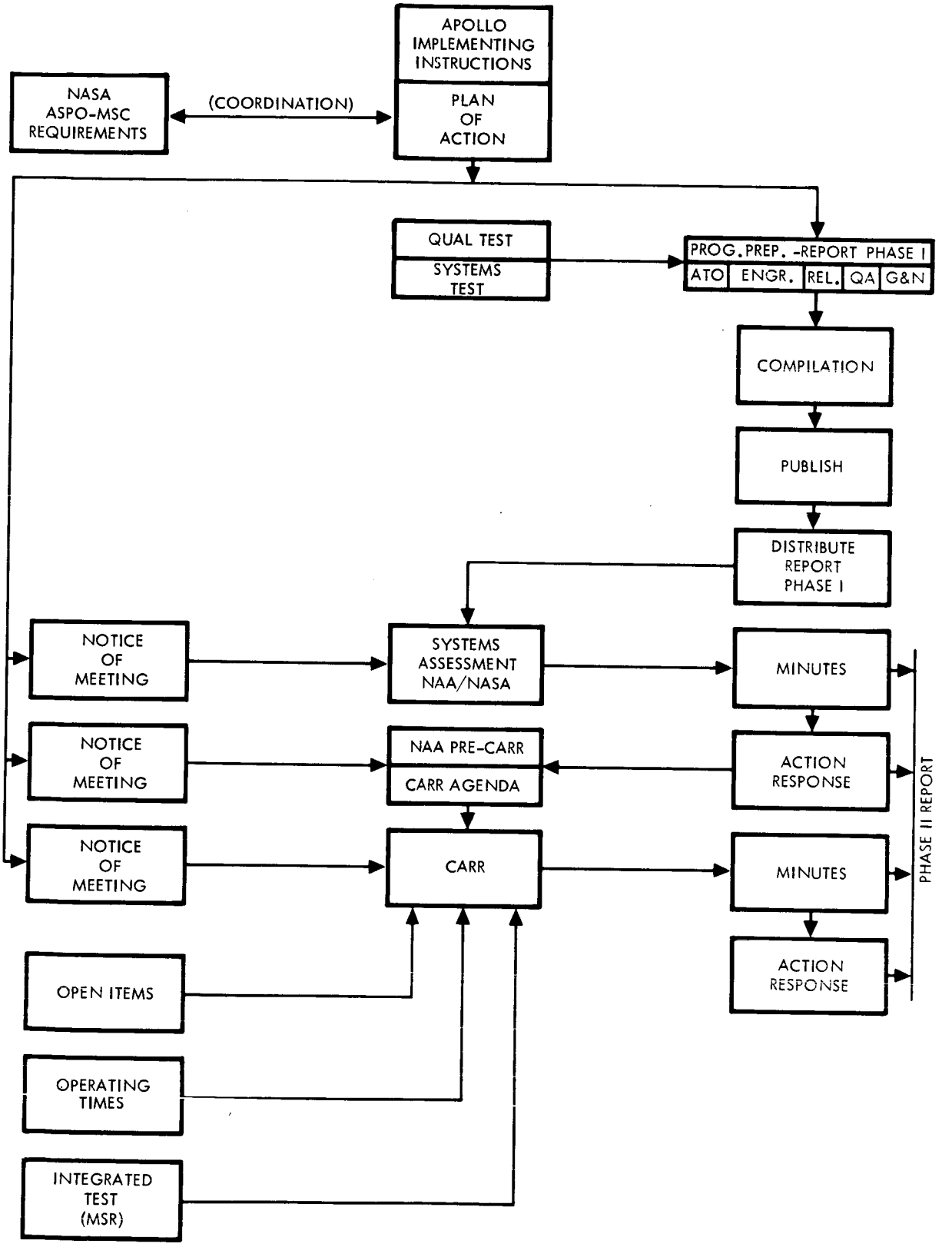
Action Assignments, as documented in the minutes, are complied with and documented in writing prior to the Pre-CARR meetings which are held internally and separately at both NAA and MSC to finalize the detail CARR Agenda of open items which require CARR board resolution.

Pre CARR is a series of short informal meetings to define the remaining open or controversial problems from the Systems Assessment and NASA PreCARR for inclusion into the detail CARR Agenda.

CARR meeting is held after a "quick-look" data review of the final accepted plugs-out mission sequence run (MSR). Spacecraft formal acceptance is granted at the CARR meeting by the customer.

Minutes of the CARR meeting are prepared jointly by the NASA and NAA CARR coordinators to formally document the CARR board resolutions and action assignments.

Action Assignments, as documented in the minutes, are complied with as soon as possible if identified as constraints



CARR Functional Flow Chart

to CSM shipment; or as scheduled at Downey or the field site if not constraining. Action responses are documented in writing.

Phase II CARR Report will include Systems Assessment and CARR minutes, integrated test results, and action responses, and is distributed in progressive increments as available. This report complements the phase one report and summarizes the conclusions reached at the meetings.

0.1.4 REQUIREMENTS AND RESPONSIBILITIES

CARR SCOPE - Section 0.1, Phase I Report

Summary of CARR purpose, methods used for data accumulation and meeting concepts.

(Responsibility, CARR Coordinator)

SPACECRAFT NARRATIVE - Section 0.2, Phase I Report

Summary of CSM history during Downey checkout activities documenting significant dates and test phases.

(Responsibility, ATO Advance Planning/TPE)

SYSTEMS ORGANIZATION - Section X.0, Phase I Report

Subsystem listing to identify the name of major equipments included within each system section of the report.

(Responsibility, CARR Coordinator)

SYSTEMS TEST RESULTS - Section X.1, Phase I Report

Brief summary of test accomplishments by OCP or significant problems/anomalies by subject, problem/cause, and corrective action taken.

(Responsibility, ATO)

ENGINEERING ANALYSIS - Section X.1, Phase I Report

Engineering analysis of problems which could possibly affect the spacecraft mission objectives.

(Responsiblity, Engineering)

PROBLEM SUMMARIES - Section X.2, Phase I Report

Provided on NAA format (Form 2958-G new 1-66). Only mutually selected significant APS's will be included.

(Responsibility, Reliability)

HARDWARE SUMMARY - Section X.3, Phase I Report

Certification test summary is provided on NAA format (Form TEMP-R&E 1056).

(Responsibility, Reliability)

CERTIFICATION/FLIGHT HARDWARE DIFFERENCES - Section X.4, Phase I Report

Special exceptions between the CTN and CSM hardware are identified on NAA format (Form TEMP TBD). Normally, CTN and CSM differences are indicated in the CTN.

(Responsibility, Reliability)

WAIVER/SCN/RFC INFORMATION - Section X.5, Phase I Report

Identification of pending and open waivers and SCN/s required from the end item specification. Includes exceptions required by each CSM from the AFETRM 127-1 Range Safety Manual not previously documented. Status of open RFC's assigned at the CDR for this CSM.

(Responsibility, Engineering)

OPEN ITEMS FOR DOWNEY - Presentation at CARR, Phase II Report

Summary of all significant tasks which remain to be accomplished between CARR and ship

(Responsibility, ATO)

OPEN ITEMS FOR THE FIELD - Presentation at CARR, Phase II Report

Summary of all MCR's (Mod Kits) and other significant tasks which will be transferred to field at CSM ship.

(Responsibility, Field Operations)

OPEN ITEM REPORT - Handout at Systems Assessment and CARR

Detail identification of open work - ATO daily recap.

(Responsibility, Spacecraft Operations Support)

CRITICAL LIFE COMPONENTS - Handout at S.A. and CARR, Phase II Report

Accumulation of operating times required by process spec MA0201-0077.

(Responsibility, Quality Control)

INTEGRATED TEST RESULTS - Presentation at CARR, Phase II Report

Summary of integrated test. Problems are included as discussions in CARR meeting minutes.

(Responsibility, ATO)

CSM COMPARISON - Handout at Systems Assessment

Summary of the differences between the as built and as designed configuration; as well as a CSM 012 to 008 comparison.

(Responsibility, CMO)

WAIVERS LIST - Handout at Systems Assessment

List of all waivers request against the CSM.

(Responsibility, Engineering)

RFC LIST - Handout at Systems Assessment

List of all RFC's from the ΔCDR for this CSM.

(Responsibility, Engineering)

SCN/MCR LIST - Handout at Systems Assessment

List of all SCN's and/or all MCR's since the ΔCDR for this CSM.

(Responsibility, Engineering)

SINGLE POINT FAILURE SUMMARY - Handout at Systems Assessment

List of all potential single point failures that would affect crew safety.

(Responsibility, Reliability)

CTN STATUS - Reference Copy Only

Copy of latest monthly CTN status report.

(Responsibility, Engineering)

PROBLEM SUMMARIES - Reference Copy Only

All problem summaries applicable to this CSM.

(Responsibility, Reliability)

SYSTEMS ASSESSMENT MINUTES - Phase II Report

Documentation of Systems Assessment (S.A.) meeting. Includes only problems discussed in meeting either open or closed. Distributed as the first section of the Phase II Report.

(Responsibility, Working Group Chairman)
(Coordinated by, CARR Coordinator)

S.A. ACTION RESPONSE - Phase II Report

Documentation of all open problem resolutions assigned in the S.A. minutes. Distributed as the second section of the Phase II Report.

(Responsibility, as assigned)
(Coordinated by, CARR Coordinator)

CARR MINUTES - Phase II Report

Documentation of CARR meeting. Includes only problems discussed in meeting and information inserted by board direction. Distributed as the third section of the Phase II Report.

(Responsibility, CARR Coordinator)

CARR ACTION RESPONSE - Phase II Report

Documentation of all open problem resolutions assigned in the CARR minutes. Distributed as the fourth and final section of the Phase II Report.

(Responsibility, as assigned)
(Coordinated by, CARR coordinator)

CARR MEETINGS

The Systems Assessment and CARR meetings are defined above. These require joint participation by NAA and NASA

(Coordinated by, CARR Coordinator)

CARR PARTICIPATION

All activities associated with CARR are administered through a central point within each department. The individuals assigned to this responsibility for CSM 012 are designated below.

CARR Responsibility/Designation	Name
Project Administrator	J.F. Parker
NAA Coordinator	F. Mohr
NASA Coordinator	C.H. Laubach
ATO Administrator	J.W. Cuzzupoli
Engineering Administrator	W.E. Day
Reliability Administrator	J.E. Moeller
Quality Control Administrator	J.L. Long
G&N Administrator	W.T. Gahan
Field Site Support	B.R. Haight
Configuration Support	J.P. Harrington
Contracts Support	R.F. Johnson
ATO Advance Planning Support	R.W. Johnson
NASA RASPO Support	J.M. Gerding
ATO SC Operations Support	B.S. Keyes

0.2 SPACECRAFT NARRATIVE

0.2.1 Mission Abstract

Mission AS-204A is designated as the primary mission for Launch Vehicle SA-204 and Spacecraft 012. It will be a manned configuration, open-ended flight of up to 14 days duration. This will be the first flight for an Apollo spacecraft in the manned configuration.

The Spacecraft is to be launched by a Saturn IB from Launch Complex 34, Kennedy Space Center (KSC). Subsequent to liftoff, vertical rise is maintained for 10 seconds, after which the launch vehicle performs a roll maneuver to achieve the programmed flight azimuth of 72 degrees from north. Simultaneously with the roll maneuver, an S-IB pitch program is initiated, followed by a gravity tilt program. S-IB/S-IVB separation will occur at 144 seconds after liftoff with S-IVB J-2 engine ignition occurring approximately 2 seconds later. The Launch Escape Tower is jettisoned 20 seconds after J-2 ignition. Manned Space Flight Networks (MSFN) close loop (RF) guidance will then steer in the launch vehicle to a desired 105 nautical mile circular earth orbit. The CSM will separate from the S-IVB after an inertially stabilized condition is achieved. The CSM will practice transposition and simulated docking using the stabilized S-IVB as a target.

During the mission, the following maneuvers in coordination between the astronauts and MSFN may be performed.

- S-IVB/CSM transposition
- CSM orbital (first orbit) plane change
- First-orbit transfer and circularization
- Second-orbit plane change
- Third-orbit plane change
- Second-orbit transfer and minimum impulse maneuver

- SPS deorbit maneuver
- Pre-entry sequence

Splash down will occur shortly after the deorbit maneuver, optimately 13.8 days after lift-off, in an area close to Hawaii.

0.2.2 Schedule Analysis

Schedule 1 of Figure 1 "Downey Test Schedule Spacecraft 012" was based upon MDS 9, SCA 8-30A issued on 24 November 1965. This schedule reflects a Manufacturing-ATO transfer date for both Command Module and Service Module of 31 December 1965, with a resultant completion of Downey Tests on 17 May 1966 and a completion of Preparation for Shipment on 31 May 1966.

The Service Module was actually transferred into ATO on 31 January 1966 and the command module on 3 March 1966.

Having anticipated the late turnover of the modules into ATO, the Spacecraft 012 Test Team issued a preliminary revised S/C 012 ATO Downey detailed checkout schedule in January 1966. This schedule defined the tests and work level required but did not define either the turnover date or the ship date since neither could be ascertainable prior to the transfer of the spacecraft or the update of MDS 9, SCA 8-30A.

Upon receipt of the Service Module on 31 January 1966, therefore, the ATO checkout schedule issued in January 1966 was the controlling document which was made official by the issuance of MDS 9, Rev 1, SCA 9-11A.

Schedule 2 of Figure 1 "Downey Test Schedule, Spacecraft 012" was based upon MDS 9, Revision 1, SCA 9-11A issued on 11 March 1966. This schedule took into consideration the late transfer of the spacecraft into ATO and the test and work level definition of the ATO checkout schedule of January 1966. The completion of Downey test operations was scheduled for 9 July 1966, with a shipment of the SM to KSC of 15 July 1966 and shipment of the CM to KSC on 1 August 1966.

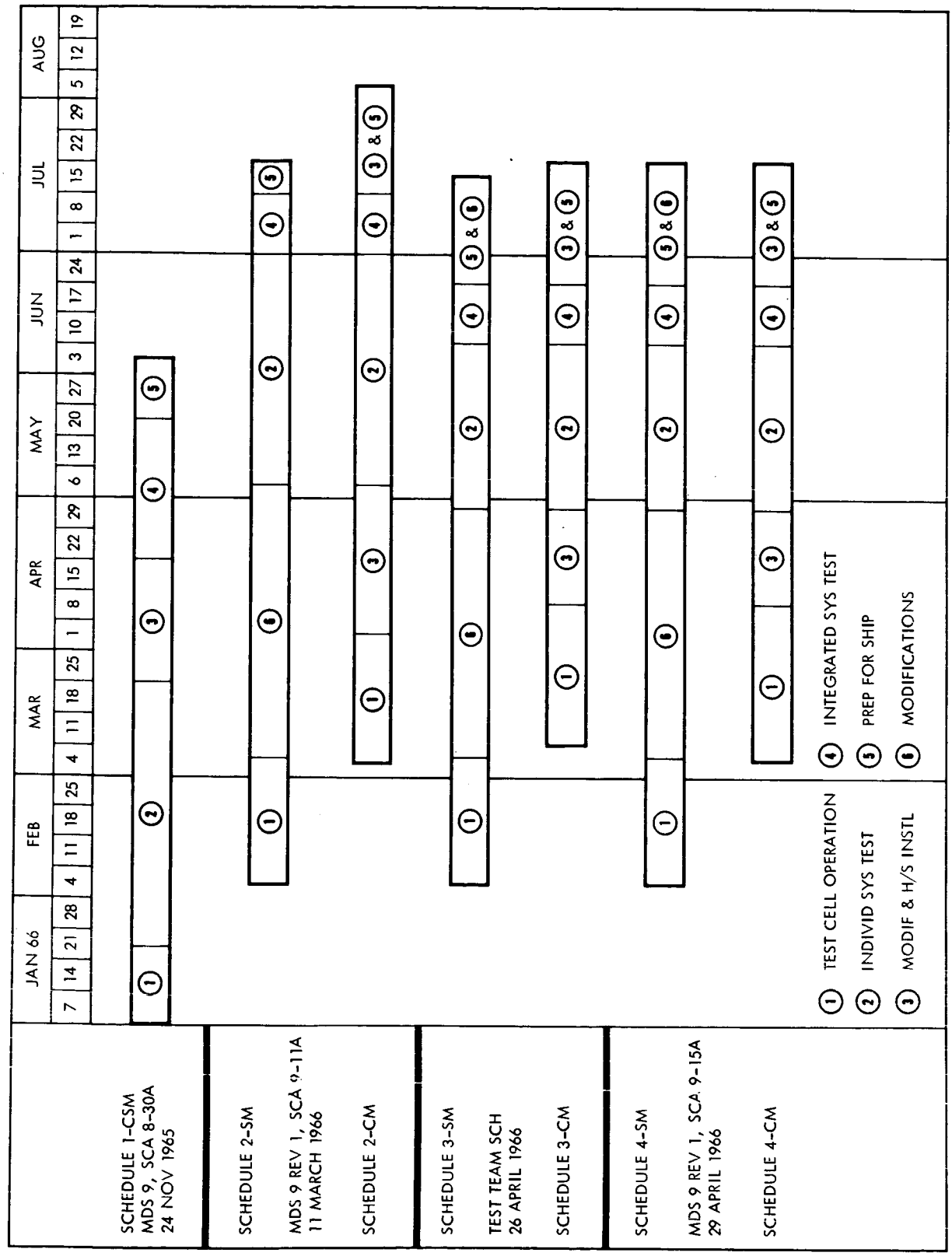


Figure 1. Downey Test Schedule - S/C 012

Schedule 3 of Figure 1 "Downey Test Schedule, Spacecraft 012" was based upon a revised S/C 012 ATO Downey detailed checkout schedule issued by the Test Team on 26 April 1966. As a result of careful reappraisal of the activities required to complete S/C 012 Downey operations, the new plan was developed to improve the scheduled ship date of the spacecraft.

The new plan reflects a final installation period after completion of test operations, during which a modified ECS System will be installed and tested. The aft heat shield and all applicable modification kits will also be installed during this period.

This Test Team schedule reflects the actual transfer dates into ATO of the modules. Shipment of the SM to KSC is scheduled for 12 July 1966 and shipment of the CM to KSC is scheduled for 15 July 1966.

Schedule 4 of Figure 1 "Downey Test Schedule, Spacecraft 012" was based upon MDS 9, Revision 1, SCA 9-15A issued on 29 April 1966. The reason for the SCA was to reflect the latest ATO test plan (Schedule 3) which revised the Command Module ship date from 8-1-66 to 7-15-66.

Figure 2 shows the actual detailed Downey checkout schedule history and the planned remaining work effort. It is expected that the CM ship date of 15 July and the SM ship date of 12 July will be met.

0.2.3 Significant Events

0.2.3.1 Test All Operations

0.2.3.1.1 Service Module

Transfer of responsibility for the SC 012 from Manufacturing to ATO (Apollo Test and Operations) was effected on 31 January 1966.

Tests on the SM were initiated in Building 290 where electrical power bus isolation verification and low pressure leak tests were performed. Subsequent to completion of the above tests, the SM was moved to the Building 260 pressure

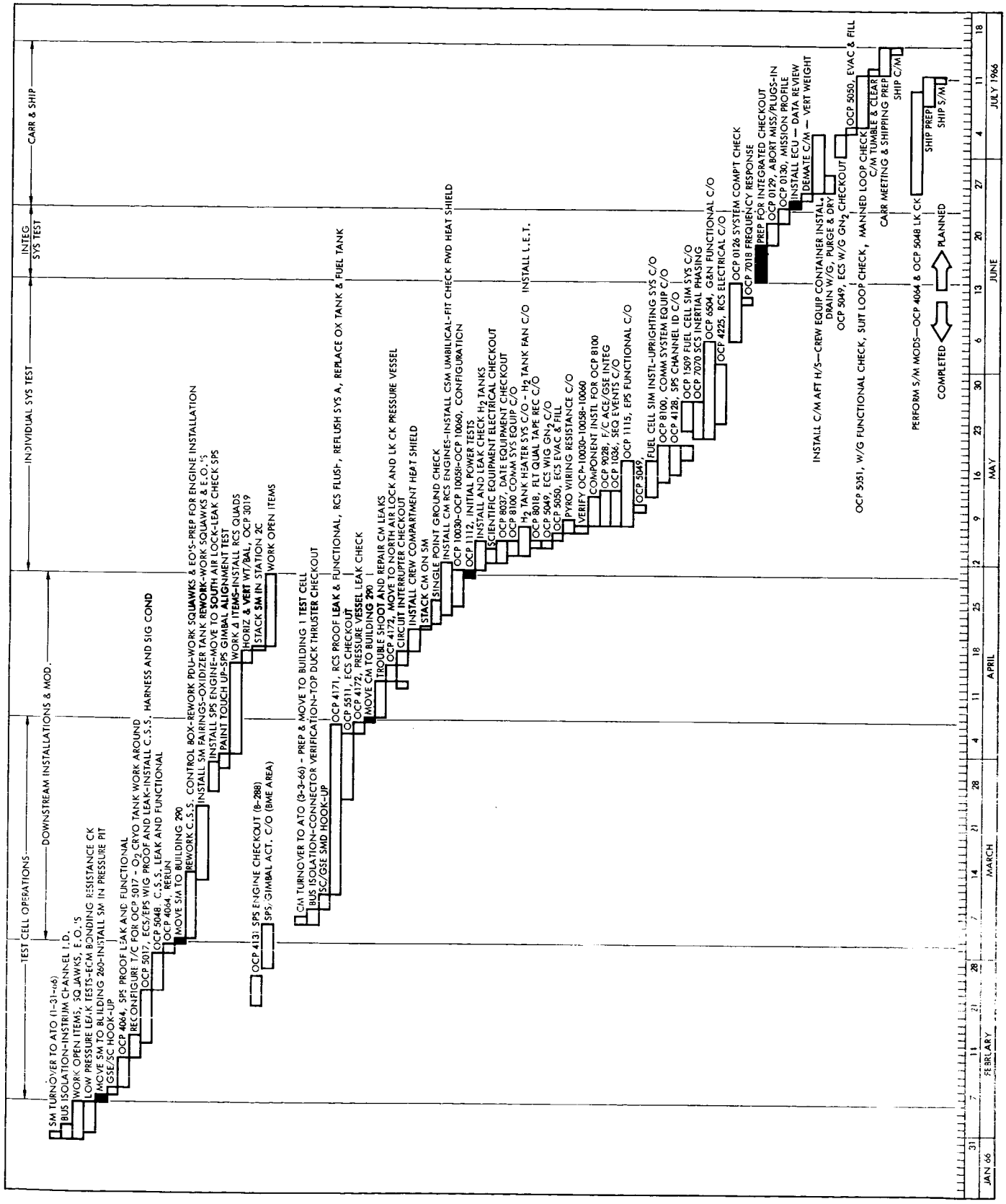


Figure 2 - S/C 012 ATO Downey Detailed Checkout Schedule

test cell. Proof pressure, leak, and functional tests on the Service Module's Service Propulsion System (OCP-4064), ECS and EPS Water-Glycol System (OCP-5017), and Cryogenic Storage System (OCP-5048) were performed. The major problem area was the identification and correction of leaks throughout all systems.

Simultaneously to the above SM pressure tests, the SM SPS Engine leak and functional checkout (OCP-4131) was performed in Building 288, followed by SPS Engine movement to the Building 290 BME area where the SPS Engine Actuator checkout was performed.

At the completion of OCP-5048, the SM was returned to Building 290 for modifications and pre-power preparation. The Building 290 Test Cell operations on the SM were completed in 22 working days.

0.2.3.1.2 Command Module

Transfer of SC 012 CM from Manufacturing to ATO was effected on 3 March 1966.

The CM was moved to the Building 1 pressure test cell where bus isolation verification, connector verification, and top deck thruster checkout tests were performed. Subsequent to completion of these tests, proof pressure, leak and functional checkout of the Command Module's RCS (OCP-4171), ECS (OCP-5511), and pressure vessel (OCP-4172) were accomplished.

Again, a major problem area was the identification and correction of leaks throughout all systems. Due to inner structure leaks that could not be located immediately, OCP-4172 was not completed in the test cell. The CM was moved to B-290, where inner structure leaks were found and repairs made. OCP-4172 was completed in the B-290 north air lock.

During OCP-4171 RCS flushing operations, the particle count test on System "A" indicated contamination. An investigation disclosed that a faulty drying cart (GSE) was the problem. A reflush of System "A" was accomplished,

at which time an RCS fuel tank leakage problem and potential contamination in the oxidizer tank necessitated the replacement of both RCS propellant tanks in the "A" Systems.

At the completion of OCP-5511, the CM was returned to B-290 for modifications and pre-power preparation. The Building 1 Test Cell Operations on the CM were completed in 30 working days.

0.2.3.2 Modification Period

Work that was deferred until completion of pressure tests and accomplished during this period was as follows:

SM

A. Rework CSS (Cryogenic Storage System) Control Box

B. Rework PDU (Power Distribution Unit) - MCR's 1208 & 1209

C. Circuit Interrupter Checkout - TPS

D. Prep. Engine Bay for Engine installation

E. Install SM Fairings

F. SPS Oxidizer Tank Seal change

G. Repair and recheck Signal Conditioners

H. Install SPS Engine

I. Leak check Service Propulsion System

J. Paint touch-up

K. SPS gimbal alignment test

L. Install RCS Quads

M. Horizontal and vertical weight and balance - OCP-3019

CM

A. Troubleshoot and repair CM leaks

B. Circuit Interrupter checkout

C. Move to B-290 north airlock and perform leak checks

D. Install Main Display Panels and Black Boxes

E. Install Crew Compartment Heat Shield

In parallel to the above work, effort was expended in clearing squawks open at transfer plus those accumulated during pressure tests and accomplishing EO's applicable to spacecraft systems. The modification phase, which lasted 12 working days for the CM and 42 working days for the SM, ended with the completion of the CM Crew Compartment Heat Shield installation and subsequent stacking of the spacecraft in Station 2C in preparation for Individual Systems Tests.

0.2.3.3 Individual Systems Tests

After the spacecraft was stacked in Station 2C, the CM RCS Engines and CSM Umbilical were installed. At the same time the Phase III G&N installation was accomplished per OCP-6500.

In preparation for spacecraft power-on tests, a single point ground check was made and the test configuration was verified utilizing OCP's 10030, 10058, and 10060. At the completion of the test configuration OCP's, Initial Power-On was accomplished utilizing OCP-1112.

Individual Systems Tests were conducted in parallel whenever possible in order to save time. The general order of tests performed were: Scientific Equipment C/O, Data Systems Equipment, Communication System Equipment, Flight Qualification Tape Recorder, ECS, Fuel Cell GSE/ACE-ACE Integration, Sequential Events Control System, EPS, SPS, Fuel Cell Simulated System, SCS, G&N, and RCS.

Individual Systems Tests was culminated with Frequency Response Tests (OCP-7018) and Systems Compatibility Checkout (OCP-0126).

0.2.3.4 Integrated System Test

In preparation for Integrated Systems Test, the test configuration will be verified utilizing OCP's 10030, 10058, and 10060. At this time, EO's and OCP squawks, required to be cleared prior to the start of Integrated Systems Test, will be cleared.

Subsequent to the above, Mission Ready and Abort (OCP-0129), Simulated Mission (Plugs in OCP-0129), and Mission Profile (Plugs Out OCP-0130) tests will be performed.

0.2.3.5 Final Installations

Following completion of Integrated Systems Test, a final installation period will be required during which a modified ECU System will be installed and tested utilizing OCP's 5049 (ECS Subsystem), 5050 (ECS Servicing), and 5051 (ECS Functional Checkout). The aft heat shield and all applicable modification kits will also be installed during this period. Final shipping preparations will complete Downey checkout operations.

0.2.4 Operations Review

The original Downey checkout program for Spacecraft 012 was defined in Section 6 of the Operational Test Plan, SID 65-304-3, "Section III of Vehicle Plan for Spacecraft 012 (SA-204) Downey Operational Test Plan" dated 20 January 1966.

This test plan delineates all the Operational Checkout Procedures (OCP's) to be accomplished through the test phase including component pressure test, systems pressure tests and spacecraft individual, combined and integrated systems tests. The checkout program was followed, with the following exceptions:

Pressure Test

	OCP	Exception	Documentation
4130	SPS Engine Leak and Functional Checkout - SM	Replaced by 4131	IL No. ATO-D-SGS-4-66-1709 Dated 1 February 1966 From C. J. Krilowicz
4174	RCS Quad Assemblies Proof, Leak, and Functional Checkout - SM	Replaced by 4175	IL No. ATO-D-SGS-4-66-1709 Dated 1 February 1966 From C. J. Krilowicz

Individual Systems Test

	OCP	Exception	Documentation
1013	Initial Power-Up	Deleted	IL No. ATO-D-SGS-4-66-1430 Dated 2 February 1966 From W. R. Hutchinson
1112	Power Distribution Test, CM-SM	Added	IL No. ATO-D-SGS-4-66-1430 Dated 2 February 1966 From W. R. Hutchinson
1509	Fuel Cell Simulated System Checkout	Added	IL No. ATO-D-SGS-4-66-1450 Dated 4 April 1966 From W. R. Hutchinson
4129	RCS Solenoid and Engine Flow Check - CM	Deleted	IL No. ATO-D-SGS-4-66-1709 Dated 1 February 1966 From C. J. Krilowicz

	OCP	Exception	Documentation
4640	RCS Quad Gas Flow And Valve Signature	Deleted	IL No. ATO-D-SGS-4-66-1719 Dated 7 March 1966 From C. J. Krilowicz
4641	Backup for 4640	Deleted	OCP started, but not completed - no IL in file.
4642	Backup for 4640	Deleted	IL No. ATO-D-SGS-4-66-1719 Dated 7 March 1966 From C. J. Krilowicz
8059	U. D. L. Tape Verification	Added	IL not numbered Dated 23 March 1966 From R. W. Brearey
10029	Test Configuration Checklist - Vehicle Pretest and Post-Test	Added	IL No. ATO-D-SGS-4-66-1430 Dated 2 February 1966 From W. R. Hutchinson
10060	Test Configuration Checklist - Crew Compartment Controls	Added	IL No. ATO-D-SGS-4-66-1430 Dated 2 February 1966 From W. R. Hutchinson
10062	Test Configuration Checklist - GSE Pretest (Fluid)	Deleted	Not in file

Spacecraft Systems Compatibility Tests

	OCP	Exception	Documentation
3502	Thruster Installation and Configuration for QVVT	Deleted	IL No. ATO-D-T012-66-55 Dated 9 March 1966 From N. H. Casson
3503	QVVT Vibration Station Readiness	Deleted	IL No. ATO-D-T012-66-55 Dated 9 March 1966 From N. H. Casson

1. ELECTRICAL POWER SYSTEM

1.0 System Organization

1.1 Systems Test Results

1.2 Problem Summaries

1.3 Hardware Summary

1.4 Cert/Flt Hdw Differences

1.5 Waiver/SCN/RFC Information

1.0 ELECTRICAL POWER SYSTEM

The Electrical Power System (EPS), for purposes of the CARR, consists of electrical subsystems, equipment and assemblies as listed herein. The EPS performs basic functions within the CSM which include provisions for power distribution, dc power source (except fuel cells—CARR Section 2), dc to ac power inversion, automatic voltage and current control, displays and manual control.

Electrical Wiring

Power Distribution Buses

Storage Batteries

Static Inverters

Battery Charger

Sensing and Automatic Control

Manual Controls

Circuit Breakers

Displays

GSE

1.1 SYSTEMS TEST RESULTS

1.1.1 OCP-P-1112-SC012 - Power Distribution Test CM/SM

SCOPE

This OCP verified the isolation of the AC busses, proper operation of fuel cell motor switches, ability to accurately and safely apply ground power to the spacecraft busses, and to accurately and safely remove ground power from the spacecraft busses.

RESULTS

Test completed satisfactorily. No spacecraft hardware or design problems. Problems that were encountered were due to spacecraft connector configuration and/or GSE cable configuration or GSE patching and defective diodes in the DC ground power unit.

1.1.1.1 PROBLEM

Seq. 02-004, Panel 18 Fuel Cell 1 Main Bus A. Flag indicated barber pole should be gray.

CORRECTIVE ACTION

CM/SM umbilical connector not mated to SM J11. Reconnected P11/J11, P12/J12, P13/J13 and P8/J8, which were disconnected on a TPS subsequent to OCP-P-10030 and not reconnected.

DOCUMENTATION

NAA Squawk #OCP-1112-002
TPS #OCP-1112-005

1.1.1.2 PROBLEM

Seq. 03-008, no voltage reading on CC0345 AC voltage main bus 2 phase C, should be 110 to 120 volts AC.

CORRECTIVE ACTION

Defective patch wire in C14-203 J-box. Corrected patch wire in C14-203.

DOCUMENTATION

NAA Squawk #OCP-1112-006
TPS-OCP-1112-007

1.1.1.3 PROBLEM

Seq. 03-015, CRT reading for AC Bus 2 Phase B became intermittent or zero should be 105 volts AC.

CORRECTIVE ACTION

Downlink program had been reloaded several times prior to this problem arising and ACE Cal Data inserted a lower limit for CC0344 that was too high. Reloaded downlink computer with proper Cal Data.

DOCUMENTATION

NAA Squawk #OCP-1112-007, TPS-OCP-1112-008

1.1.2 OCP-P-1115-SC012 - Electrical Power System Functional Checkout

SCOPE

This OCP demonstrated the functional integrity of the Electrical Power System by ACE/Spacecraft display control and operation of the Fuel Cell, Caution/Warning, D.C., A.C. and Gimbal Motor Circuitry with use of Fuel Cell Substitute Unit, facility DC power, facility and S/C inverter AC power.

RESULTS

OCP was successfully accomplished. Problems encountered:

Design wiring error in panel C14A7 C/B 9 and C/B 11 corrected by EO #483858. In proper caution and warning system indications due to two moisture seals in J511, J513 and J514 and J511. Outer plastic shell cracked when torqued with two moisture seals installed.

Miswiring of C22-2A67 (panel 18) S22 and S23 caused motor switch chatter when inverter 1 was switched OFF. Two incorrectly routed wires in J850 caused erroneous fuel cell 3 02 flow rate.

Miscellaneous problems with 200 OHM 5 watt bus load resistors until they were completely insulated and wrapped. Inverter 1 could not be turned off due to miswiring of motor switch C14S6.

1.1.2.1 PROBLEM

Seq. 04-054 Main Bus A read 0 VDC, should be 29 to 38 VDC.

CORRECTIVE ACTION

Wires connected to load side of panel C14A7 C/B 9 and C/B 11 were reversed. Wire No. 2P106A6 (to C14A7CB9-2) was interchanged with wire #1P106A6 (to C14A7 C/B11-2) per EO #483858

DOCUMENTATION

NAA Squawk #OCP-1115-007
TPS #OCP-1115-004
EO #483858
TPS #V16-EPS-102

1.1.2.2 PROBLEM

Seq. 06-114, AC Bus 1 fail and AC Bus 2 fail lamps did not light on panel 11.

CORRECTIVE ACTION

Found two moisture seals installed in caution and warning unit C28-2A77J511 connector. Removed one seal per EO #431470 and EO #431471.

NOTE: Examination of J511 disclosed crack in outer plastic sealing shell (Ref. Sqk #OCP-1115-015) connector was reinstalled finger tight. Sqks V16-EPS-157 & 166. Connectors will be torqued to 5 +/- 1 inch pounds per spec. MA0305-0005.

DOCUMENTATION

NAA Sqk-OCP-1115-013
TPS-OCP-1115-006
EO #431470
EO #431471
Spec. MA0305-0005
NAA Sqk V16-EPS-157 and 166

1.1.2.3 PROBLEM

Seq. 06-100 weak tone in CCR bump hat (J165 connector)

CORRECTIVE ACTION

Poor pin/socket contact due to double moisture seals in connectors C28-2A77J513, J511 and J514 (ref. NAA Sqks #OCP-1115-13 and 36). Removed the extra seal. TPS V17-EPS-081 verified equal tone volume in bump hat connected to J164, J165 and J166.

DOCUMENTATION

NAA Sqk #OCP-1115-13, 16, & 36
TPS V17-EPS-081
PAR 22784

1.1.2.4 PROBLEM

A. Seq. 06-197 200 OHM 5 watt resistor momentarily shorted to ground. B. Seq. 07 200 OHM 5 watt resistor lead from TB67-3 momentarily shorted to an ECS line.

CORRECTIVE ACTION

A. Replaced resistor and insulated leads. B. Properly insulated resistor and leads and reconnected.

DOCUMENTATION

NASA Sqk. V16-EPS-3
MR #91476

1.1.2.5 PROBLEM

Seq. 10-031, when panel 18 AC Inverter 1 switch (C22-2A67S22) was set to OFF Inverter 1 motor switch C14S6 chattered.

CORRECTIVE ACTION

Panel 18 AC Inverter 2 switch (C22-2A67S23) not wired per print and terminals 4 and 5 of (C22-2A67S22) shorted together. Rewired per V16-761865 wire list and cleared short by proper installation of wires.

DOCUMENTATION

NAA Sqk #OCP-1115-023, NAA Dwg. V16-761865, TPS #OCP-1115-010

1.1.2.6 PROBLEM

Seq. 17-068 floodlight S/N 05883 began smoking (not related to circuitry involved in Seq. 17)

CORRECTIVE ACTION

Removed and replaced floodlight

DOCUMENTATION

NAA Sqk #OCP-1115-030
TPS-V16-COM-115
PAR 22753

1.1.2.7 PROBLEM

Seq. 18-046 & 057, Panel 11 fuel cell 1 and fuel cell 2 lamps lighted - should not be lighted.

CORRECTIVE ACTION

Found two moisture seals installed in C22-2A77J513 and J514. Mated connectors with one seal installed.

DOCUMENTATION

NAA Sqk #OCP-1115-36 and 38
TPS #OCP-1115-012
NAA Sqk V16-EPS-166

1.1.2.8 PROBLEM

Seq. 18-047A, Fuel Cell 3 02 flow rate SC2144 reads 0.57 lb/hr on CRT, panel 18 meter indicates 0.76 lb/hr.

CORRECTIVE ACTION

Corrected improper routing of two wires on instrumentation connector J850.

DOCUMENTATION

NAA Sqk #OCP-1115-37
TPS #OCP-1115-012

1.1.2.9 PROBLEM

Seq. 12-101, Panel 18 AC Inverter 1 switch (C22-2A67S22) would not turn off Inverter 1 DC input.

CORRECTIVE ACTION

+DC wires to C14S6 X1 and Y1 were both connected to X1 terminal. Connected wires to X1 & Y1 per print.

DOCUMENTATION

NAA Sqk #OCP-1115-46
NAA Sqk #V16-EPS-165 and 167
TPS V16-EPS-108
TPS V16-EPS-120
PAR 22782

1.1.2.10 PROBLEM

Seq. 14-007, DC current battery charger out CC0215 reads 0.98 AMPS on CRT should read LLL, Panel 18 meter indicates 0 AMPS.

CORRECTIVE ACTION

Replaced SCE J11 module differential amplifier CRT now reads 0.01 AMPS and 39 volts DC.

DOCUMENTATION

NAA Sqk #OCP-1115-049
NAA Sqk V16-EPS-167
TPS-EPS-124
PAR 21038

NAA ATO Systems Supr

1.2 PROBLEM ANALYSIS - ELECTRICAL POWER SYSTEM

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

APOLLO PROBLEM SUMMARY

Ø1 S/C # 012, 014, 017, 020

Ø2 008, 101 & Subs

Date: 1-29-66

Revised: Ø1 4/30/66

Ø2 5/23/66

Ø3

Ø4

Subsystem/End Item Electrical Power System

Equipment Name, S&ID P/N Motor Switch, Power Transfer, ME452-0036-0002, S1

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

During acceptance testing of the Motor Switch Assembly, Inverter No. 3 Control, P/N V16-454352-101, the resistance reading from pin 13 of the motor switch S1, to chassis ground read 7 megohms. Should be greater than 100 megohms.

PARs MA 19442 and MA 19444

CTR 01222310 (Ref. APS-352-AM)

Ø1 (2) Problem Status ~~Unresolved~~ Resolved (Resolved, Unresolved, or Explained)

The motor switch has been removed and replaced and is being shipped to Kinetics Corp. for failure analysis. The effect of this failure happening on S/C 012 mission flight is to place a 4 microampere drain on the battery relay bus when the third inverter is on. This drainage is considered to be negligible.

Ø1 ~~Schedule: Estimated completion date March 30, 1966~~

Responsible Manager, N. H. Nelson, D/697-800

Ø1 Failure analyzed by supplier as having been caused by contaminants build-up on the terminal stud roots (under the header). Fabricating and Testing Departments are being alerted to problem and requested to exercise proper handling (cleaning) techniques.

1-18

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PAGE 1 OF 1

TEMP. FORM ENG-A-1185 EXP 1-24-66

30

APOLLO P[illegible]EM SUMMARY
S/C # [illegible]012/014/017/020
008/

Date: Jan. [illegible] 1966
Revised: Ø1 — 5/27/66
Ø2
Ø3
Ø4

Page 1 of 2

Subsystem/End Item E. P. S.

Equipment Name, S&ID P/N Connector Electrical Special Purpose Potted Version ME 414-0270

Spacecraft [X] GSE [ ]

Apollo Reliability Ø1 E. Johnson

Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

The potted version of Hughes connectors in Qual test exhibitted a lack of moisture resistance and corrosive contaminates that caused failures in insulation resistance and dielectric strength.

Original potted connectors did not use pin positioners while potting. Dry lube contained carbon which reduced dielectric strength.

FR MA 12721
CTR 01225326

1-19

Ø1 (2) Problem Status ~~Unresolved~~ Resolved (Resolved, Unresolved, or Explained)

A concentrated analysis is being made and recommendations include the following.

1. Use pin positioners during potting for improved mating.
2. Double the depth of potting to improve wire support and improved sealing effect.
3. Omit dry lube or replace gaskets when contaminated with carbon (Darkened).
4. Replacement of gaskets with improved dimensions , as well as, reduced moisture absorption characteristics.
5. Rerun test to insure corrective action where required.
6. Plans are being made to implement retest as soon as possible with completion to support S/C 012.

Ø1 Samples using the above recommendations and two gaskets on the 16 ga size connectors satisfactorily completed Qualification tests which included the revised corrosive contaminants test. Samples did not require Item 2.

T&QA 978 Void 2-14-66 (Revised 1-14-66)

APS-354-A1
PAGE 1 OF 2

Failure Effects:

Potential decrease in insulation resistance and dielectric strength breakdown due to moisture penetration and corrosive contaminants in the following systems (typical) some degradation of function could occur. Criticality of major functions are listed.

1. Attitude Gyroscopes - Part No. ME493-0005-0004 Crit II.

2. Premod Processer - Part No. ME478-0021-0024 Crit II.

3. Signal Conditioner - Part No. ME901-0081-0003 Crit III.

4. PMC Telemetry - Part No. ME901-0083-0003 Crit II.
   or - Part No. ME901-0081-0104 Crit II.

5. Pitch and/or Yaw Electronics Control Assembly

   RCS - Part No. ME901-0168-0314 or ME901-0168-0324

   During re-entry only Crit I.

KWM for E.E Clements
2-7-66

Schedule: Complete re-test 5-1-66

Responsible Manager, E. K. Mason D/697-900

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 008/011/012/014/017/020 & Subs Date: 5/23/66

Revised: Ø1 _____
Ø2 _____
Ø3 _____
Ø4 _____

Subsystem/End Item Electrical Power Subsystem

Equipment Name, S&ID P/N Circuit Breaker ME454-0011-0011

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

DSE/PCM indicates that between T + 1635.06 and T + 1636.06 (S/C 009 Flight), C15A5CB18 opened.

PAR #5201

CTR # N/A

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

Investigation and analysis revealed cause of premature open on CB18 due to an over-load fault resulting from a wire that was left wired to term board C23TB1-12 when the ECS/TCS was deleted by MCR in 1964. This wire was routed through the umbilical. TB1-12 was later utilized as a tie point from CB18. Guillotining of the umbilical and subsequent shorting during re-entry caused the overload on CB18. Impact of CB18 premature open is to remove the sequencer "B" logic capability to the RCS engines, and the ELS chute pyro initiaters. This condition does not exist on S/C 011 & subs since no extra wires are connected to CB18. This has been verified by visual inspection on S/C 011 and the TCS does not exist on S/C 012 & subs.

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FORM 2958-G NEW 1-66

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 008/011/012/014/017/020 & Subs Date: 5/23/66

Subsystem/End Item Electrical Power Dist. Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Wiring Harness V16-450949

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During S/C 009 Mission Flight CB33 (B-D Roll B), CB31 (Yaw B), CB39 (Pitch B), CB34 (B-D Roll A), CB32 (Yaw A), CB40 (Pitch A), CB15 (Prop Isolation "B"), and CB16 (Prop Isolation "A") on panel opened as a result of a DC Bus fault which appeared between T ± 1639 and T ± 2125.

PAR # MA5211 & MA5209

CTR N/A

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

Circuits to the above circuit breakers, with the exception of CB15 & CB16, are normally dead-faced when the RCS transfer switch is actuated to the C/M contacts just prior to CSM separation. CB15 & CB16 had 28 VDC for propulsion isolation valves, and these wires were routed through the CSM umbilical with no deadface provision. Routed also through the CSM umbilical were RCS switch reset wires used for pre-flight checkout. Re-entry heat melted the insulation on guillotined wires causing the RCS switch reset wire to short out to the live Iso. prop circuits. The subsequent transfer of the RCS motor switch back to the S/M position destroyed the deadface capability of above circuits. Failure impact was loss of RCS

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(2) Problem Status (Continued)

engines and lowered voltage on the DC Bus due to the electrical overload. On S/C 011 and subs, all wires with current carrying potential greater than one amp have been deadfaced. SCS diodes have also been rearranged to preclude tying the two DC Buses together in the event of a diode-to-ground short.

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012, 014, 017, 020 Date: 5-13-66

Subsystem/End Item Electrical Wiring Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Circuit Utilization EPS Box, V16-442127-301

Spacecraft [X] GSE [ ]

Apollo Reliability [illegible] Apollo Engineering RWG [illegible]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Resistance readings of the relay coils were out of tolerance during the high temperature exposure functional test. Readings obtained were as follows: K1-195 ohms, K2-196 ohms, K3-199 ohms, K4-199 ohms, K5-175 ohms, K6-195 ohms. Specification tolerances were 150 to 180 ohms for K1 through K4 and 125 to 160 ohms for K5 and K6.

PAR MA 24251

CTR 01225323

(2) Problem Status Explained (Resolved, Unresolved, or explained)

The out of tolerance resistance readings are relay coil measurements. The specification tolerances are for ambient conditions and do not allow for the normal increase in coil resistance as a result of high temperature exposure (180°F for 24 hours). A resistance reading of 199 ohms at 180°F is considered to be normal for these coils.

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(2) Problem Status (Cont.)

Occurrence of these coil resistance readings during flight would have no effect on spacecraft operation. The relays operated properly during high temperature exposure.

If any further tests are performed per this test procedure (EDL EE 2-66-104) it will be modified to compensate for temperature effect on coil resistance.

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012/014/017/020/ Date: 5/23/66

Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Subsystem/End Item Electrical Wiring

Equipment Name, S&ID P/N Electrical Control RCS V16-447596-201

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] C. E. Darner Apollo Engineering [signature] 5/25/66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During Y axis random vibration exposure, time delay relay K1 timed out in 46.93 seconds. Specification requirements were 42 ± 0.42 seconds. During the same vibration, exposure, time delay relay K13 gave no indication of timing out. Specification limits are 18 ± 1 second.

PAR #MA12701, MA18270

CTR # 01225321

(2) Problem Status Explained (Resolved, Unresolved, or explained)

The Y axis vibration exposure was repeated and both relays timed out within tolerance. Relay performance was also within tolerance during all subsequent checks during the qualification test and the above time-out problem could not be repeated.

The long time-outs are attributed to improper operation of test equipment. The Engineering Test Lab reports that the electronic timer used for these test readouts will sometimes, due to sensitivity, time-out long or not at all.

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(2) Problem Status (Continued)

The lab has been requested to use recording oscillographs for readouts of this type whenever test conditions permit. The RCS Electrical Control test specification tolerances for relay K1 were changed by EO M467917 to 42 + 2.1 seconds - 0.42 seconds so as to be compatible with the relay procurement specification.

Since this was a test set-up problem, there would be no effect on S/C operations.

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012/008/011/014/017/020, Block II Date: 6/2/66

Revised: Ø1 _____
Ø2 _____
Ø3 _____
Ø4 _____

Subsystem/End Item Electrical Power Distribution

Equipment Name, S&ID P/N Box Assembly - Power Factor Correction V16-452543

Spacecraft [X] GSE [ ]

Apollo Reliability D.B. Prince C.E. Varner Apollo Engineering [illegible] C.J. Nutkeyh
R.K. Goharing 6-3-66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During the functional test performed during the first axis of high temperature vibration, the following out-of-tolerance readings were obtained: J1-B to J1-C 0.96 MFD, J1-G to J1-J 0.98 MFD, J1-B to J1-C 0.290 amperes, J1-G to J1-J 0.295 amperes. Specification requirements are 1.41 MFD ± 10% and 0.425 ± 0.050 amperes. The test was continued and the same readings were obtained following high temperature vibration exposure.

A tear-down analysis revealed that fuse F-4 on terminal board 1 and fuse F-5 on terminal board 3 had opened as a result of broken fuse wires.

PAR #18351 and 18337 Datafax #3661

CTR #01222314

(2) Problem Status Explained (Resolved, Unresolved, or explained)

Occurrence of this failure mode during flight would essentially result in a slight increase in load on the AC bus, since the power factor of each fuel cell phase correction system would decrease by about 0.07.

This failure is attributed to the use of defective fuses and is not considered to be a failure of the phase correction box. Examination revealed the bonding agent at each end of the ceramic core of F-4 had failed allowing the core to move freely within the fuse case. The ceramic core of F-5 was broken approximately

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FORM 2958-G NEW 1-66

(2) Problem Status (Continued)

1/16 " from one end and the bonding agent at the other end had failed. Five fuses which had not failed were visually examined; each core was found to be intact and firmly bonded to the end cap. The two failed fuses were apparently damaged by mishandling prior to being installed in this box. When the damaged fuses were subjected to vibration, the fuse wires parted and caused the failure indication.

Another test unit was subjected to and passed the high temperature vibration exposure.

Manufacturing personnel have been cautioned not to use fuses which have been dropped or possibly damaged otherwise and to use extra caution when handling fuses and parts containing fuses.

1.3 HARDWARE SUMMARY - ELECTRICAL POWER SYSTEM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Operational Checkout Procedures
Acceptance Data Packages
Flight Test Data
Problem Action Records
Operating Time Data

CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 1.0 ELECT. PWR.

NO.	NOMENCLATURE BASIS PART NUMBER OUR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS						CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Battery, SC, Pyrotechnic ME461-0007 00922313	45	4	6	21	14	X	X	X	X	X	X	X	X		X							100%	8	0	0	120 C	-0002 (4)	0	0	0	
2	Battery Charger ME461-0002 01122305	15	3	5	5	2	X	X	X	X	X	X	X	X	X	X							100%	0	0	0	2350 H	-0001 (1)	0	0	0	8 H 15 C
3	Battery, Entry & Post Landing (40AH) ME461-0012 01222302	50	3	7	28	12	X	X	X	X	X	X	X	X		X							90%	1	0	0	78 C	-0002 (3)	0	0	0	
4	Box Assy, AC Power Control V16-451136 01222307	4	0	2	0	2	X	X		X	X		X			X							90%	0	0	0	190 H	(1)	0	0	0	
5	Box Assy, Fuse V16-451115 01222317	5	0	2	0	3	X	X	X	X	X	X	X	X		X							90%	0	0	0	1050 H	-0011 (1)	0	0	0	
6	Box Assy, Power Factor Correction V16-452543 01222314	9	0	5	1	3	X	X	X	X	X	X	X	X		X							80%	0	1	1	1070 H	-0006 (1)	0	0	0	1 H
7	Box Assy, S/M Power Distribution V17-451208 01222309	7	0	2	1	4				X	X		X			X							80%	0	0	0	220 H	(1)	0	0	0	
8	Box Assy, Uprighting V16-451240 01222316	3	0	2	0	1	X	X	X		X		X			X							90%	0	0	0	190 H	(1)	0	0	0	

Temp. Form R&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 1.0 ELECT. PWR.

No.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS						CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
9	Circuit Breaker Assy, Auxiliary Battery V16-451189 01122319	3	0	1	0	2	X	X		X	X					X							100%	0	0	0	30 H	.0101 (1)	0	0	0	
10	Circuit Breaker Assy, Battery V16-451167 01222311	4	0	2	0	2				X	X		X	X		X							80%	0	0	0	180 H	(1)	0	0	0	
11	Circuit Breaker, Types I, II, III and IV ME454-0010 01126304	2786		69			X	X	X	X	X	X	X	X		X							100%	46	1	4		-0005 (35)	1	0	0	
12	Circuit Utilization Elect. Power V16-442127 01225323	4	0	2	0	2	X		X	X	X		X		X	X							80%	0	1	1	375 H	(1)	0	0	0	
13	Control Box, Auxiliary Battery Power V16-451175	3	0	1	0	2	X	X		X	X					X							100%	1	0	0	30 H	BAS- (1)	0	0	0	
14	Control Elect, Cryo Sys. 441122 V17-441112 01125322	6	0	2	1	3	X	X	X	X	X		X	X	X	X							100%	0	0	0	30 H	BAS- (1)	0	0	0	
15	Control, Elect RCS V16-447596 01225321	4	0	2	0	2	X	X	X	X	X		X	X	X	X							80%	0	4	0	300H	(2)	0	0	0	
16	Current Limiters, Suit V16-443515 01225322	3	0	1	0	2				X	X												80%	0	0	0	2 H		0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 1.0 ELECT. PWR.

NO.	NOMENCLATURE BASIC PART NUMBER CUR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
17	Interrupter, Elect Circuit Type I ME453-0010 00925306	30	2	6	2	4	X	X	X	X	X	X	X			X		100%	0	0	0	43 C	0001 (1) 1001 (2)	0 0	0 0	0 1	5 C
	Type II	45	2	6	4	4	X	X	X	X	X	X	X			X		100%	0	0	0	43 C	0003 (5) 1003 (3)	0 0	0 0	0 0	13 C 5 C
18	Inverter, Static 3 Phase ME495-0001 01222302	35	3	6	18	8	X	X	X	X	X	X	X	X	X	X		80%	2	0	0	5003 H	-0004 (3)	0	0	0	
19	Panel Assy, DC Power, RH Equip. Bay V16-451168 01222308	4	0	2	0	2	X	X		X	X		X			X		80%	0	0	0	225 H		0	0	0	
20	Panel Assy, Main Circuit Breaker V16-451165 01222312	3	0	1	0	2	X	X		X	X					X		80%	0	0	0	180 H	(1)	0	0	0	
21	Potentiometer, Hermetically Sealed ME444-0033 01226310	70		12			X	X	X	X	X	X	X	X		X		100%	6	0	0		-1011 (1) -1012 (3)	0	0	0	
22	Relay, AC Over-Voltage ME455-0051 00925309	46	0	8	15	23	X	X			X				X	X		100%	0	0	0	100K C	0002 (24)	0	0	0	
23	Relay, Time Delay ME455-0080 01225702	36	0	30	0	6	X	X		X	X				X				1	0	0	200 CY	(2)	0	0	0	

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CERTIFICATION TEST DATA

CEM 012

SUBSYSTEM 1.0 ELECT. PWR.

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CEM GROUND TEST QUANTITY	CEM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC						CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CEM DATA: CONF. & QUANT.	CEM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONSIST TIME/ CYCLES
24	Rheostat ME444-0049 01226311	12		9			X	X		X	X	X	X	X		X							80%	1	0	0		-1002 (1) -1003 (2)	0	0	0	
25	Sensing Unit Assy, AC Over-Undervolts ME431-0062 01222313	24	2	4	1	5	X	X	X	X	X	X	X	X	X	X							80%	0	0	0	494 H	-0003 (1)	0	0	0	199 H
26	Sensing Unit Assy, DC Undervoltage ME431-0063 V16-452570 01222320	24	1	6	1	4	X	X	X	X	X	X	X	X	X	X							80%	0	0	0	E 400 H	0011 (1) 0003 (1)	1	0	0	200 H
27	Summing Logic Assy. V17-444124 01225320	3	0	2	0	1	X		X	X	X		X	X	X	X							80%	0	1	0	280 H	0004 (3) 0005 (2)	1	0	0	200 H
28	Switch Assy, Motor, Inverter V16-454352 01222310	7	0	2	1	4	X	X		X	X		X			X							80%	2	3	0	860 H	0101 (1)	0	0	0	
29	Switch, Motor Driven ME452-0045 00925311	15	0	2	6	7	X	X		X	X					X							100%	0	0	0	850 C	0004 0005	0	0	0	
30	Switch Panel Assy, FC Remote Cont. Elect. V17-451200 01222315	5	0	2	0	3				X	X		X			X							100%	0	1	0	120 H	(1)	0	0	0	
31	Switch, Power, Over Current Relay ME452-0055 01225313	51	4	5	26	16	X	X	X	X			X			X							75%	0	0	3	396 C	0004 (4)	0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 1.0 ELECT. PWR.

NO.	NOMENCLATURE BASIC PART NUMBER CUR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
32	Switch, Power Transfer ME452-0036 01222303	183	3	14	94	72	X	X	X	X	X		X		X	X		80%	1	0	0	2298 C	-0001 (12) -0002 (6)	0	0	0	200C
[illegible]																							-0003 (7)	0	0	0	
33	Switch, Power, S/M Overcurrent ME452-0038 01222304	59	0	10	31	18	X	X	X	X	X		X		X	X		80%	1	0	0	3000C	-0001 (6)	0	0	0	45 C
34	Switch, Pushbutton ME452-0060 01226313	27		6			X	X	X	X	X	X	X	X		X		100%	1	0	0		-1005 (2)	0	0	0	
35	ME452-0061 01226313	51		6			X	X	X	X	X	X	X	X		X		100%	2	0	0		-1020 (1)	0	0	0	
[illegible]																							-1021 (1)	0	0	0	
[illegible]																							-1022 (1) -1023 (1)				
35																							-1024 (1) -1025 (1)				

Temp. Form R&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 1.0 ELECT. PWR.

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NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER REQ'D	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM CONFIG TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS						CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONFIDENT TIME/ CYCLES
35	Cont'd.																											-1026 (1)				
36	Switch, Rotary ME452-0049 01226309	104		26			X	X	X	X	X	X	X	X		X							100%	4	0	0		-1001 (1) -1003 (4)	0	0	0	
																												-1004 (1) -1007 (2)				
																												-1008 (1) -1010 (1)				
																												-1011 (1) -1012 (1)				
																												-1013 (1)				
37	Switch, Toggle ME452-0050 01226308	2700		160			X	X	X	X	X	X	X	X		X							95%	25	7	0		-0001 (1) -1001 (28)	0	0	0	
																												-1003 (29) -1004 (6)				

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 1.0 ELECT PWR.

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
37	Cont'd.																										-1006 (1) -1008 (17)				
																											-1009 (10) -1011 (6)				
																											-1014 (11) -1024 (12)				
																											-1025 (8) -1030 (4)				
																											-1031 (1) -1034 (3)				
																											-1041 (2) -1042 (4)				
																											-1043 (19) -1045 (11)				
																											-1046 (13) -1047 (7)				

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CSM 012

SUBSYSTEM 1.0 ELECT. PWR.

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NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS						CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
37	Cont'd.																											-1048 (2)				
38	Switch, Transfer Motor Oper. ROS ME452-0044 00925310	10	0	4	0	6	X	X	X	X	X					X							100%	0	0	0	13063 C	0001 (3)	0	0	0	

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1.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

ELECTRICAL POWER SYSTEM

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

A. S. Kravitz 6/18/66
Certification Project Engineer

1.5 WAIVERS, SCN's AND RFC's - ELECTRICAL POWER SYSTEM

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
1.5.1	EDC/JCA 45-2464 5-5-66	Deletes Pyro battery voltage measurements	MCR & SCN in work
1.5.2	SCN 38 to SID 64-1080 4-11-66	Changes to non-essential bus configuration	Pending NASA Approval
1.5.3	SCN 228 to SID 64-1237 4-11-66	Block I load grouping on non-essential bus network	Pending NASA Approval
1.5.4	SCN 235 to SID 64-1237 4-28-66	Block I -0004 Inverter configuration for Phase Voltage Unbalance	Pending NASA Approval

Engineering Manager

Project Engineer

2. FUEL CELLS/CRYOGENIC SYSTEM

2.0 System Organization

2.1 Systems Test Results

2.2 Problem Summaries

2.3 Hardware Summary

2.4 Cert/Flt Hdw Differences

2.5 Waiver/SCN/RFC Information

2.0 FUEL CELL/CRYOGENIC SYSTEM

The Fuel Cell/Cryogenic System (F/C-CRYO), for purposes of the CARR, consists of fuel cells and cryogenic subsystems equipment and assemblies as listed herein. The fuel cells provide energy conversion to electrical power; the cryogenic subsystem provides storage and distribution of hydrogen and oxygen for the fuel cells, and oxygen for the ECS.

FUEL CELL SUBSYSTEM

- Fuel Cells
- Controls
- Displays
- Radiators
- GSE

CRYOGENIC STORAGE SUBSYSTEM

- Hydrogen Storage Tanks
- Hydrogen Distribution Equipment
- Oxygen Storage Tanks
- Oxygen Distribution Equipment
- Controls
- Displays
- GSE

2.1 SYSTEM TEST RESULTS

2.1.1 OCP-P-1509-SC-012 - Fuel Cell Start-up and Checkout.

SCOPE

This checkout was performed in mated configuration in Station 2C. The purpose of this procedure was to verify the ability of the spacecraft to operate fuel cell electrical power plants. The testing also proved ACE, GSE, and fuel cell compatibility except that the simulators were used instead of fuel cells.

RESULTS

The test was conducted in B/290, Downey from 5/19/66 thru 5/27/66. All spacecraft problems encountered during the test are listed in the problem section which follows.

2.1.1.1 PROBLEM - H_2 and O_2 Shutoff Valves Inoperative

FC#1 O_2 shutoff valve (ME284-0116-0002) S/N 065538431505 was burned out. FC#1 H_2 shutoff valve (ME284-0117-0002, S/N 10024A-630030) was stuck in the OPEN position.

CORRECTIVE ACTION

Both H_2 and O_2 reactant shutoff valves were removed and replaced with ME284-0289-0001 valves (O_2 S/N 06553J041002 and H_2 S/N 06553J041001).

DOCUMENTATION

SQK 5, 6, 9, and 15, T/S TPS OCP1509-004, TPS OCP-1509-007, 008, 009, and 010, E.O. 386900 PAR's 22768 & 22775

2.1.1.2 PROBLEM - Fuel Cell 1 and 3 Wiring Reversed on H_2 and O_2 Reactant Valves

During the vacuum cycle it was found the on the H_2 and the O_2 reactant shutoff valves, the FC1 and FC3 wiring was reversed.

2.1.1.1 Engineering Analysis

The valves were damaged due to a incompatibility between the ACE program and the DTCS latching relay module which in turn controls the S/C H_2 and O_2 reactant shutoff valves. Corrective actions taken by Engineering included a review of programming requirements and sub-programs for compatibility with relays, and replacement of three latching relays with conventional relays. F.E.O.339991 effecting the C14-268-1C1 in Station 2C was released 6-16-66.

CORRECTIVE ACTION

The wiring was corrected per "B" revision of V17-942107 which incorporates the wire change E. O.'s, 466923 & 466904.

DOCUMENTATION

SQK 18, TPS EPS 080, E. O. 466923, E. O. 466904 V17-942107 "B".

2.1.1.3 PROBLEM - Unable to verify Barber Pole on Fuel Cell #1 O_2 Reactant Valve. Closed Indicator

The Fuel Cell #1 O_2 reactant shutoff valve indicator circuit switch would not close, therefore, no event light or barber pole could be obtained.

CORRECTIVE ACTION

Remove & replace O_2 Reactant Shutoff Valve ME284-0289-001 S/N 6553J041002 with new ME284-0289-0001 S/N 6553J041003

DOCUMENTATION

SQK 22, 25, T/S TPS OCP 1509-013, TPS V17-EPS-082, EPS TAIR SQK #212 PAR 22916

2.1.1.4 PROBLEM - O_2 Flowmeter Readouts are Low on FC1, 2 & 3.

During purge operation, FC1, 2, & 3 O_2 flowmeters read low and did not correspond to ACE readouts.

CORRECTIVE ACTION

Open Problem

DOCUMENTATION

SQK 29 (Low Flowmeter Readout), T/S TPS OCP-016,

2.1.1.5 PROBLEM - S14-014 FDS PG-1 was low.

PG1 was reading 170 psig S/B 225±25 psig.

CORRECTIVE ACTION

Re-adjusted PR-1 per OCP-P-1509-SC 012

DOCUMENTATION

Sqk #2

2.1.1.6 PROBLEM - S14-014 FDS - Unable to pull vacuum

Unable to pull a vacuum in H_2 System

CORRECTIVE ACTION

HV-2 G.H.C. was loose and was re-installed - problem corrected

DOCUMENTATION

Sqk 3, T/S TPS OCP-1509-004

2.1.1.7 PROBLEM - S14-014 FDS - Unable to manually operate LV-4

Unable to manually operate G35LV4

CORRECTIVE ACTION

No problem - mechanic error - manual override was not being turned far enough.

DOCUMENTATION

Sqk 4

2.1.1.8 PROBLEM - S14-014 GHC leaks excessively

Ground Half Coupling HV-2 leaks excessively.

CORRECTIVE ACTION

Retorqued "B" nut on HV-2 GHC

DOCUMENTATION

Sqk 7, T/S TPS OCP-1509-004

2.1.1.9 PROBLEM - S14-014 B nut leaks

Small leak at HV-1 Q. H. C. "B" nut

CORRECTIVE ACTION

Retorqued "B" nut at HV-1 GHC

DOCUMENTATION

Sqk 8, T/S TPS OCP-1509-4

2.1.1.10 PROBLEM - S14-014, CB-1 pops

Circuit breaker on S14-014 J-Box pops

CORRECTIVE ACTION

Remove; replace CB-1 circuit breaker

DOCUMENTATION

Sqk 26, S14-014 TAIR Sqk 55, T/S TPS OCP-1509-014, PRR 119789

2.1.1.11 PROBLEM - Lost 28 VDC on S14-014

Lost 28 VDC power from S14-014 J-Box due to G35LV26 shorting out

CORRECTIVE ACTION

Remove; Replace G35LV26.

DOCUMENTATION

Sqk 20, T/S TPS OCP-1509-012, PRR 119788

2.1.1.12 PROBLEM - S14-014 - FC 5990 reads low

GN_2 purge pressure FC5990 reads 75 psig S/B 100±10 psig.

CORRECTIVE ACTION

ACE problem - corrected by ACE

DOCUMENTATION

Sqk 27, TPS S14-014-024

2.1.1.13 PROBLEM - Could not get FC1 on Bus A

Could not connect FC1 to Bus A using ACE.

CORRECTIVE ACTION

ACE problem - corrected

DOCUMENTATION

Sqk 30, TPS - OCP 1509-015

2.1.2 OCP-P-5048-SC-012 - Cryogenic Storage Systems Proof Pressure Leak Checkout

SCOPE

This test was performed to verify the Cryogenic Gas Storage System Electrical Sub-system, to proof pressure test and leak check the O_2, H_2 and N_2 subsystems and to functionally check the system components.

RESULTS

Test not completed. Test completion will be accomplished after O_2 tank installation and prior to ship.

2.1.3 TPS V17-EPS-069 and TPS V17-EPS-070 - H_2 Tank 1 & 2

SCOPE

The H_2 tanks have been replaced after completion of OCP-5048-S/C 012. TPS-EPS-069 checks out the heater resistance in H_2 tanks 1 & 2. TPS-EPS-070 checks out the H_2 tank 1 & 2 fan motor operation.

RESULTS

The H_2 tank heater checkout for tanks 1 & 2 indicated that all heater resistances are in tolerance. This indication was achieved after the heater thermocouples were closed. The H_2 tank #1 fan motor check indicated the tank #1 fan motors were operating proper. Checkout of the fan motors for the H_2 tank #2 indicated fan motors were inoperative. Trouble-shooting indicated that several pins were recessed on panel 13 connector. This problem was corrected and fan motors were operative.

2.1.3.1 PROBLEM - H_2 Tank #2 Fan Motor Inoperative

H_2 tank #2 fan motor was inoperative due to recessed pins in panel 13 connector.

CORRECTIVE ACTION

Recessed pins in connector CO3W15175 on panel 13 were repaired per Sqk 192 and 195.

DOCUMENTATION

SQK 192, SQK 195, TPS V17-EPS-070, TPS V17-EPS-071

2.1.4 TPS V17-EPS- - Leak Check O_2 Tanks

SCOPE

This TPS leak check is performed to verify the leakage rate at the tank interface "B" nut connections and the coupling poppets leak rate are within specification.

RESULTS

Test will be performed after O_2 tanks are installed and prior to ship.

2.1.5 TPS V17-EPS- and TPS V17-EPS- - O_2 Tank 1 & 2 Heater and Fan C/O

SCOPE

These TPS check out the heater resistance in the O_2 tank 1 & 2 and verifies operation of the fan motors of O_2 tank 1 & 2.

RESULTS

Test to be accomplished after O_2 tanks are installed and prior to ship.

J. E. Jolley

NAA ATO Systems Supr

2.2 PROBLEM ANALYSIS - FUEL CELL/CRYOGENICS

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 011/012/014/017/020 Date: 6/3/66

Revised: Ø1 6/17/66

Ø2

Ø3

Ø4

Subsystem/End Item Cryogenic Storage Subsystem

Equipment Name, S&ID P/N H_2 Fuel Cell Shut-Off Valve Module, ME284-0117-0002

Spacecraft [X] GSE [ ]

Apollo Reliability

Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During 180 degree S/M acoustic vibration tests per MCRA 1096 two out of three solenoids in the H_2 valve module mechanically closed. The problem was attributed to amplification of vibrational forces by the mounting configuration beyond the module's design limit, which caused the internal bellville spring to pass beyond its peak, latching the valve closed. This failure mode was repeated on at least 2 units utilizing several different methods of dampening induced vibrations. (During these attempts relocation to a preferred location was
Ø1 not considered due to its impact on S/C 011 schedules.) Other failures experienced during several attempts to eliminate this problem.
No CTR Assigned this test

Ø1 Datafax 3592 Failure Reports MA022826,-022822,-022820, 021024, 021023
First date of failure 5/10/66

Ø1 (2) Problem Status ~~011-Explained; 012 & Subs-Unresolved~~ Resolved (Resolved, Unresolved, or explained)

Failure Effects: Should any of the three valves close during launch for longer than a few seconds, on either the O_2 or H_2 valve module, the corresponding fuel cell would fail. Loss of two fuel cells would abort the mission. On a manned vehicle loss of 3 fuel cells could cause loss of crew.

The solenoids have passed the above test when the open coil of the solenoid valve is energized. The test was successfully accomplished utilizing a 50 ohm resistor in series with the 28 volt supply to the open solenoid

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PAGE 1 OF 2

FORM 2958-C NEW 1-66

(2) Problem Status (Continued)

coil. The effect of this fix is to add a magnetic force to support the mechanical force of the bellville springs which prevents transfer of the solenoid during exposure to acoustic vibration energy.

The current is limited by the resistor to restrict the normal temperature rise within safe limits.

Analysis for S/C 012 expected by 6/30/66
Action by C. P. Bouman 697-807
N. H. Nelson 697-800 Manager

Ø1 Corrective Action Reference MCR-A-1542, -1517, -1515

S/C 011: Mod Kit V17-880036, dated 6-13-66, initiated to add 6 resistors and change wiring to 3 motor switches in S/M (V17-451200). GSE transfer motor switch (S14A4S1, -S2, -S3) was rewired to perform function of completing circuit to resistors, 1 per solenoid for each fuel cell (previous function permanently connected). Reduced current, through resistors, will be applied to each of 6 open coils of valve modules during entire mission.

S/C 012 & 014: Same as above except provisions for pilot removal of power to resistor circuit thru panel switch.

S/C 017 & 020: Same as S/C 011 except power provided from main S/M busses to avoid excessive battery drain.

CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 2.0 FUEL CELL & CRYO. SYS.

2-26

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Disconnects ME273-0036 01224701	5	0	2	2	0	X	X	X								X	80%	0	0	0		-0001 (1) -0002 (3)	0	0	0	
	ME273-0052 01224701	15	0	0	6	0	X	X	X								X	80%	0	0	0		-0001 (3)	0	0	0	
2	Fuel Cell, Power Plant ME464-0007 01124301	26	10	2	0	0		X		X			X			X		100%	1	0	0	2100 H	-0001 (3)	0	0	6	65 H 13 C
3	Radiator Assy.,EPS ME362-0009 01224701	17	2	3	6	0	X	X	X								X	80%	6	0	0	14.5 H	-0004 (2) -0005 (1)	0	0	0	
																							-0006 (3)				
4	Coupling, H_2, Relief Disconnect ME273-0047 01123306	14	2	3	7	2	X	X				X						100%	1	0	0	650 C	-0001 (2)	0	0	0	
5	Coupling, O_2, Relief Disconnect ME273-0041 01123304	14	2	3	7	2	X	X		X		X						100%	1	0	0	650 C	-0001 (2)	0	0	0	
6	Signal Conditioner, H_2 ME901-0158 01223702 01123706	26	3	3	16	4	X	X	X	X			X					100%	2	0	0	1550 H	-0002 (2)	0	0	0	K 212 K 66

Temp. Form R&E - 1056 Exp. 6-10-66

2.3 HARDWARE SUMMARY - FUEL CELL/CRYOGENICS

Information from the following sources was used in the preparation of the Hardware Summary:

- Certification Test Network
- Certification Test Summary
- Configuration Data
- Supplier Data
- Receiving Inspection
- Personal Contact with Suppliers
- Configuration Control
- Operational Checkout Procedures
- Acceptance Data Packages
- Problem Action Records
- Operating Time Data

GEN 012

SUBSYSTEM 2.0 FUEL CELL & CRYO. SYS.

2-27

No.	NOMENCLATURE BASIC PART NUMBER SER NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	GEN GROUND TEST QUANTITY	GEN FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	HUMIDITY	ACCELERATION	PROOF PRESSURE	LEAKAGE	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CERTIFICATION TEST DATA / GEN DATA: CONF. & QUANT.	GEN FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
7	Signal Conditioner, O_2 ME901-0157 01123705 01223702	26	3	3	16	4	X	X	X	X			X			100%	3	0	0	1550 H	-0002 (6)	0	0	2	K 481 H K 22 C
8	Tank, H_2, Storage ME282-0027 01123702	25	3	3	15	4	X	X	X	X		X	X	X	X	100%	19	0	4	1780 H	-0070 (2)	0	0	0	212 H 66 C
9	Connector, Electrical H_2 ME414-0145 01123702	26	3	3	16	4	X	X	X	X		X	X			100%	1	0	0	1780 H	-0020 (2)	0	0	0	
10	Tank, O_2, Storage ME282-0026 01123701	25	3	3	16	4	X	X	X	X		X	X	X	X	95%	11	0	1	1680 H	-0060 (2)	0	0	0	481 H 22 C
11	Connector, Electrical ME414-0146 01123701	25	3	3	16	4	X	X	X	X		X	X			95%	1	0	0	1680 H	-0020 (2)	0	0	0	
12	Tank, Surge, Oxygen, ECS V16-613059 00923301	14		4	3	1				X	X		X			100%	0	0	0		BAS (1)	0	0	0	
13	Valve, O_2, Disconnect, Fill and Purge ME284-0115 01123709	47		7	32	8	X	X	X	X		X	X			100%	1	0	0	650 C	-0002 (4)	0	0	0	27 C
14	Valve, Module, H_1 ME284-0118 01123704	15	3	2	8	2	X	X	X	X		X	X			100%	6	0	4	7500 C	-0020 (1)	0	0	0	

Temp. Form R&E - 1056 Exp. 6-10-66

CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 2.0 FUEL CELL & CRYO SYS.

2-28

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	HUMIDITY	ACCELERATION	PROOF PRESSURE	LEAKAGE	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
15	Valve Module, O_2 ME284-0114 01123703	15	3	2	8	2	X	X	X	X		X	X			90%	6	0	1	7500 C	-0020 (1)	0	0	0	
16	Valve Module, H_2, Fuel Cell Shutoff ME284-0117 01123708	15	2	3	8	2	X	X	X	X		X	X			100%	2	0	0		-0002 (1)	0	0	0	6:12 H 53 C
17	Valve Module, O_2 Fuel Cell Shutoff ME284-0116 01123707	15	2	3	8	2	X	X	X	X		X	X			100%	3	0	0		-0002 (1)	0	0	0	
18	Valve, O_2, Vent ME284-0119 01123710	24	2	4	14	4	X	X	X	X		X	X			100%	5	0	0	650 C	-0002 (2)	0	0	0	6 C

Temp. Fr R&E - 1056 Exp. 6-10-66

2.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

FUEL CELL/CRYOGENICS

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

A. S. Meavitz 6/18/66
Certification Project Engineer

2.5 WAIVERS, SCN's AND RFC's - FUEL CELLS/CRYOGENICS

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
2.5.1	SCN 44 to SID 64-1080 5-17-66	EPS Radiator area reduced to 2/3 of previous	NAA to Submit ECP
2.5.2	SCN 238 to SID 64-1237 5-3-66	Eliminates 30 hour standby time for cryo tanks	NAA to Submit ECP

Engineering Manager

Project Engineer

3. ENVIRONMENTAL CONTROL SYSTEM

3.0 System Organization

3.1 Systems Test Results

3.2 Problem Summaries

3.3 Hardware Summary

3.4 Cert/Flt Hdw Differences

3.5 Waiver/SCN/RFC Information

3.0 ENVIRONMENTAL CONTROL SYSTEM

The Environmental Control System (ECS), for purposes of the CARR, consists of environmental control subsystems, equipment and assemblies as listed herein. The ECS performs basic functions on board the CSM which include provisions for heat transferring from the CSM, atmosphere for life support, potable and waste water, pressure suit loads and waste material disposal.

WATER GLYCOL SUBSYSTEM

- Environmental Control Unit
- Space Radiators
- Cold Plates
- Cabin Air Heat Exchanger
- Controls
- Displays
- GSE

OXYGEN SUBSYSTEM

- Environmental Control Unit
- Surge Tank
- Cabin Pressure Relief Valve
- Controls
- Displays
- GSE

WATER MANAGEMENT SUBSYSTEM

- Waste Water Storage
- Potable Water Storage
- Controls

PRESSURE SUIT SUBSYSTEM

- Environmental Control Unit
- CO_2 Absorber Canister Assembly
- Controls

WASTE MANAGEMENT SUBSYSTEM

- Waste Storage Compartment
- Urine Dump Nozzle
- Vacuum Cleaner
- Controls

3.1 SYSTEMS TEST RESULTS

3.1.1 OCP-P-5017A-SC-012 - ECS and EPS Water-Glycol Systems Proof Pressure, Leak, and Pressure Decay Check

SCOPE

This test was performed to:

1. Proof pressure and externally leak check the S/C 012 S/M ECS.

2. Make an external leak check and a pressure decay check of the SC 012 S/M Water Glycol lines interfacing with the fuel cells.

3. Proof pressure, functionally check, pressure decay and an external leak check of the SC 012 Supplemental Water System.

RESULTS

A total of 10 mechanical and five (5) metallurgical joints were determined to be leaking during performance of the OCP. Following repair of these leaks, the systems successfully passed allowable leakage rates.

3.1.1.1 PROBLEM - ECS Check Valve Leak

The check valve P/N ME284-0152-0001 was found to have an internal leak, nullifying its check functions.

CORRECTIVE ACTION

The valve was replaced with a duplicate item which subsequently performed normally.

DOCUMENTATION

Squawk No. 17 - OCP-P-5017A TAIR Book and PAR 10960.

3.1.1.2 PROBLEM - Pressure Regulator Flow

Flow was detected through the water system pressure regulator P/N ME284-0315-0001 while in the "OFF" position.

CORRECTIVE ACTION

The regulator was removed and replaced with a duplicate item which subsequently performed normally.

DOCUMENTATION

Squawk No. 26 - OCP-P-5017A TAIR Book and TPS-5017A 007. PAR 19147

3.1.1.3 PROBLEM - Fuel Cell Leak

While pressurizing Fuel Cell Loop 1 Water Glycol System, flow was detected from Fuel Cell Loop 3 Water Glycol System.

CORRECTIVE ACTION

New water glycol lines, V17-454555-77 and V17-454555-79 were mocked and installed to correct the system interconnection.

DOCUMENTATION

Squawk No. 18 OCP-P-5017A TAIR Book; Squawk No. 18 - EPS TAIR Book; TPS-5017A-006; TPS-5017A-008; TPS-EPS-16; and EO M485092. PAR 19148

3.1.1.4 PROBLEM - Leaks in ECS Water Glycol Joints

Leakage was detected in five mechanical joints of the system.

CORRECTIVE ACTION

Voi-shan seals were installed and the connections torqued and leak checked. Following repairs, the system leakage was 21 SCCH with 40 SCCH maximum allowable. (Helium)

DOCUMENTATION

Squawks Nos. 4, 8, 11, 12 and 16 - OCP-P-5017A TAIR Book and TPS-5017A-003, 004, and 005.

3.1.1.5 PROBLEM - Leaks in Supplemental Water System

System Leakage was noted at two mechanical joints and two soldered junctions. An additional soldered junction was thought to be cracked, however, this was erroneous as an X-Ray showed no crack and no leakage was detected.

CORRECTIVE ACTION

The leakage in the two mechanical connections was corrected by insertion of Voi-shan seals, torqued and leak checked. The two leaking soldered unions were removed and replaced. There was pre-stressing apparent in each line which required remocking before unions could be soldered. Final leakage rates of the system were:

Water System - 29 SCCH; 202 SCCH maximum allowable. (He)

Low Pressure N_2 System 6.55 SCCM; 10 SCCM maximum allowable. (Helium)

High Pressure N_2 System 0.5 psig Decay in one hour; 0.7 psig decay in one hour maximum allowable.

DOCUMENTATION

Squawk Nos. 19, 20, 21, 25 and 27 - OCP-P-5017A TAIR Book.

3.1.1.6 PROBLEM - Leaks in EPS Water Glycol Lines

Leaks were detected in three mechanical joints and one welded joint during performance of the OCP.

CORRECTIVE ACTION

Voi-shan seals were installed in the three mechanical connections, torqued and leak checked. The faulty weld joint was reworked but a subsequent leak check revealed continued leakage. MR action was generated and the weld reworked, correcting the leak.

DOCUMENTATION

Squawks Nos. 33, 34, 35, 36 and 37 OCP-P-5017A TAIR Book; and MR 107349.

3.1.2 OCP-P-5511A-SC-012 - CM ECS System Leak and Proof Pressure Checkout

SCOPE

This test was performed to proof pressure and externally leak check the SC 012 C/M Environmental Control System. Subsystem checks were performed on:

Water Glycol Subsystem
Water Management Subsystem and Oxygen Subsystem (100 psig, 20 psig, and 90 psig subsystems)

RESULTS

This test was run in Building 1, Pressure Test Cell, and prior to this time, gross leak checks were performed on the various subsystems on a non-interference basis with the CM RCS system checkout, OCP-P-4171A. The Water Management Subsystem checks were completed successfully and met the required allowable leakage rates. The water glycol subsystem proof pressure and external leak detection sequences were completed, however, due to leaks behind the ECU, the subsystem did not meet the allowable leakage rates.

The 100 and 20 psig oxygen subsystems proof pressure and external leak detection sequences were completed successfully, however, the high pressure (900 psig) subsystem proof pressure and leak detection were not completed due to leaks. Agreement was reached between NAA and NASA to complete the unaccomplished tests and objectives in Building 290 after repairs to the water glycol and high pressure oxygen subsystems were completed. OCP-P-5511-SC-012 was sold to NASA with the above exceptions and objectives to be performed at a later date in Building 290.

3.1.2.1 PROBLEM - Water Pressure Relief Valve Leak

In Sequence 04-007, water subsystem failed to maintain 18 to 22 psig on PG-207 due to excessive leakage. The valve (5.23) relief valve was not properly detented in the off position.

CORRECTIVE ACTION

Reverify relief valve operation in Sequence 08. Relief valve was properly positioned and performed satisfactorily upon recheck in Sequence 08.

DOCUMENTATION

Squawk No. 3 - V16-OCP-5511-TAIR Book.

3.1.2.2 PROBLEM - Leaks in Waterline Joints

Leakage in ECS System Mechanical (B-Nut) joints, solder joints, and welded joints.

CORRECTIVE ACTION

Mechanical (B-Nut) joints were repaired by installing Voi-shan seals, torquing and leak check. Soldered joints were repaired, by reheating in some cases, where allowed or by removing and replacing unions, resoldering, X-raying and leak checking. Welded joints were repaired by MR disposition and then rewelding, X-raying and leak check.

DOCUMENTATION

Squawks 4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 27, 28, 29, 30, 31, 33, 34, 35, and 38 - V16-OCP-5511 TAIR Book.

3.1.2.3 PROBLEM - Excessive Leak in Water Management System

The leak rate exceeded 24 SCCM allowable in Water Management Subsystem.

Excessive leakage in system distribution line joints and water pressure relief valve which was not fully in off position.

CORRECTIVE ACTION

Repaired system distribution line joints (Ref. Problem 3.1.2.2) and troubleshooting the over-board pressure relief valve operated satisfactorily when properly detented in off position.

DOCUMENTATION

Squawk No. 10, V16-OCP-5511 TAIR Book TPS-OCP-5511-003.

3.1.2.4 PROBLEM - Leaks in W/G Line Joints

Water Glycol Subsystem excessive leak rate due to many leak sources at "B" nuts, solder joints and welds.

CORRECTIVE ACTION

Troubleshooting TPS-004 was worked to isolate and correct leaks in system. TPS-OCP-5511-004 had to be closed out due to command module being moved from B/1 Test Cell to B/290. Troubleshooting was continued in B/290, and seq 01, gross leak check, was satisfactorily completed.

DOCUMENTATION

Squawk 26 - V16-OCP-5511 TAIR Book & TPS-OCP-5511-004 TPS-ECS 017 leak check ECS

3.1.2.5 PROBLEM - One Pound Bottle Seal Failure

Defective O-ring seal and plug in 1 lb. O_2 bottle. O-ring displaced when at proof pressure of 1,345 psig. Hex on plug did not adequately cover O-ring.

CORRECTIVE ACTION

EO M496494. V16-613001 removed and replaced with new type seals and plug.

DOCUMENTATION

Squawk No. 38, V16-OCP-5511 TAIR Book EO M496494. V16-613001

3.1.2.6 PROBLEM - Defective O_2 Line Union

Defective line/union on O_2 subsystem high pressure fill connection. Line/union separated when at proof pressure of 1,345 psig due to a defective joint.

CORRECTIVE ACTION

The line was removed and replaced and passed X-ray and leak checks.

DOCUMENTATION

Squawk No. 38, V16-OCP-5511 TAIR Book

3.1.3 OCP-P-5049-S/C-012 ECS Subsystem

SCOPE

This test was performed to:

1. Make an external leak check on the S/M ECS water glycol system and internal leak checks of various components of this system.

2. Make an external leak check on the C/M ECS water glycol system less the ECU package.

3. Verify component operations of the C/M water management system and an external leak check of the system.

4. Completion of this test will be done upon the complete installation of the ECU at which time re-verification of the W/G, water management and oxygen external leak checks will be made.

RESULTS

The C/M water glycol system had a gross leak rate of .75 SCCM vs an allowable of .91 SCCM. The C/M water glycol system components that were checked performed within allowable limits. The S/M water glycol system had a gross leak rate of .15 SCCM vs an allowable of .66 SCCM. The individual component checks of the S/M water glycol system were all within specified limits. The water management system had a gross leak rate of 1.95 cc/min vs an allowable of 24 cc/min.

3.1.3.1 PROBLEM - Leaks in S/M W/G System

Gross leak rate of S/M ECS water glycol was excessive

CORRECTIVE ACTION

Troubleshooting initiated to determine leaks, discovered leaks in installation of line for servicing S/M. Corrected leaks and re-ran OCP successfully.

DOCUMENTATION

SQK #11 TPS 5049-007

3.1.3.2 PROBLEM - Faulty Potable Tank Quantity Transducer

Potable Tank Quantity transducer did not give an accurate readout. The troubleshooting verified the transducer to be open thereby giving erroneous readouts.

CORRECTIVE ACTION

The potable tank assembly was replaced with another unit. Verification of new unit to be run pending new calibration curve.

DOCUMENTATION

SQK 23 TPS 5049-008
PAR 22927

3.1.4 OCP-P-5050-S/C-012 ECS Servicing

SCOPE

Sequence 04 of this procedure provided the operations necessary to evacuate and service the water glycol system of the command module.

RESULTS

The W/G system of the command module less the ECU was connected to the SK 1229 vacuum set-up and a vacuum of 200 microns was obtained prior to servicing. The system was charged with W/G and no major problems were encountered. Sufficient volume exchanges were made and W/G samples taken from the spacecraft were satisfactory.

PROBLEMS

No problems.

DOCUMENTATION

Not applicable.

3.1.5 OCP-P-5051-SC-012 ECS Functional Checkout

SCOPE

This test will provide the operations necessary to check the operation of the cabin fans, the water glycol pumps, and the various temperature control systems of the water glycol system. The operation of the suit compressors and the associated controls of the suit circuit will also be checked during this test.

RESULTS

The Environmental Control unit (ECU) is presently at the supplier (AiResearch) for updating and qualification testing. The complete testing specified above will be accomplished upon the installation of the ECU in S/C 012. The cabin fans and the cabin temperature control system performed satisfactorily per an information TPS.

An information TPS (TPS-ECS-037) was run to check cabin temperature control operation because this system is a completely isolated system and has proven to be troublesome in other spacecrafts.

A TPS-ECS-040 was run to check IMU flow and temperature adjustment to provide flow and temperature required by the G/N for their testing, the IMU simulator was installed and the GSE adjusted accordingly.

The Cabin Temperature Control functioned satisfactorily and the required temperature and flow of W/G to the IMU has been provided.

3.1.6 OCP-P-5136 S/C-012 Waste Management System

SCOPE

This test performs a gross leak check of the installed waste management system and verifies component internal leak rates are within allowable limits.

RESULTS

Data recorded will be the leak rates of the various loops of the waste management and internal leak rates through various components.

Test cannot be scheduled at this time but will be prior to accomplishing OCP-P-0129.

3.1.7 ENGINEERING ANALYSIS

The Block I Master End Item Spec., SID 64-1237, specifies that the repressurization control of the cabin absolute pressure regulator must supply a minimum oxygen flow rate of 5.9 lb/hr during repressurization. The oxygen flow restrictors must be capable of supplying a minimum flow of this rate plus the metabolic consumption of the crew of 0.23 lb/hr plus the allowable command module leakage of 0.2 lb/hr; or a total oxygen flow rate of 6.33 lb/hr. The two SC 012 oxygen flow restrictors supply a total flow of 6.24 lb/hr. This is only 1.5% below the required minimum and is acceptable since the cabin repressurization time will not be significantly increased.

3.1.7 TPS-ECS-039 Flowrate Check O_2 System

SCOPE

This test was performed to check the flow through the restrictors of the command module oxygen system.

RESULTS

Flow through one restrictor was determined to be 3.2 lbs/hour and flow through the other restrictor was 3.0 lb per hour.

3.1.7.1 PROBLEMS - None

CORRECTIVE ACTION

Flow through both restrictors are within limits specified by Engineering.

DOCUMENTATION

EO 447155
EO 420342

3.1.8 TPS- ECS 017 Leak Check ECS

SCOPE

This test was performed to check the external leakage of the command module water glycol and oxygen systems to insure these systems were ready for OCP checkout.

RESULTS

A pressure decay check on the water glycol system at 55 psig indicated zero decay in 48 minutes. Two leaks were found in the oxygen system, one in a 'B' nut and another in the 1# O_2 bottle plug. These were repaired and successfully rechecked. All joints in the 900, 100 and 20 psig portions of the oxygen system were checked and no leaks were found. A pressure decay on the 900 psig O_2 system was run at 150 psig with no decay noted in 20 minutes. Removal of the 1# O_2 bottle for X-ray inspection, and the O_2 panel for qualification testing limited further testing on TPS 017. Following reinstallation of all O_2 system components, sequence 03 of OCP-P-5049 will be run to leak check and functionally verify all O_2 system components.

Note: At time of going to press, tests documented in this section were not complete. Documentation of final test results will be provided in Phase II Report.

Jerry E. Jolley
NAA ATO Systems Supr

3.2 PROBLEM ANALYSIS - ENVIRONMENTAL CONTROL SYSTEM

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø2 S/C # 008, 011, 012, 014, 017, 020 Date: 4/18/66

Revised: Ø1 4/26/66
Ø2 5/24/66
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Cabin Pressure Regulator, ME 284-0144 Item 3.28

Spacecraft [x] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

3-36

During the ECS system shakedown prior to the mission boost simulation qualification test phase, which follows the simulated dynamic test phase, the cabin pressure regulator 810200-1-1 on the oxygen panel ME 284-0144 shifted regulation from the required 5 ± .2 psia to 5.8 psia.

(Ref. AR008808).
CTR 01111704

Ø2 (2) Problem Status S/C 008 and 011 - Explained; S/C 012, 014, 017, 020 - Resolved (Resolved, Unresolved, or explained)

This shift in cabin pressure would cause loss of O_2 supply overboard by continuing dumping of the cabin pressure relief valve which is set at 6^{+2}_{-4} psia. The shift in regulation was caused by both metering valve poppet assemblies (P/N 810206) being cut by the sharp edges of the seal housing (P/N 810205). The subcontractor recommends retrofit of all flight and spare valve with the redesigned valve which has modified seat edges. This failure mode may cause an early abort due to the loss of O_2 supply since there are no means to shut off the cabin
Ø2 pressure regulator valve. For S/C 008 this valve
does not receive flight vibration therefore the valve would not shift calibration.
Ø1 The poppet assemblies were cut during vibration testing.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 008, 011, 012, 014, 017, 020 Date: 4/18/66

Revised: Ø1 4/26/66
Ø2 5/24/66
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Cabin Pressure Regulator, ME 284-0144
Item 3.28

Spacecraft [x] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

3-37

Ø2 (2) Problem Status S/C 008 and 011 - Explained
S/C 012, 014, 017, 020 - Resolved (Resolved, Unresolved, or explained)

Ø2 For S/C 011 if this failure mode did occur there would be a sufficient O_2 supply in the cryogenic system to keep a continuous O_2 flow to space for the 16 hour mission.

Ø2 The O_2 panels for S/C 012, 014, 017, and 020 are being retrofit with the reworked valve, 810200-2-1, which has the modified seats.

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APOLLO PROBLEM SUMMARY-042-AL
Ø3 S/C # 012 & subs. (Block I)

Date: 1/21/66
Revised: Ø1 2/9/66
Ø2 3/23/66
Ø3 4/26/66
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Potable Water Tank, ME 192-0008
Item 5.10

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

Quantity transducer (820978-1-1) on the potable water tank, P/N 812300-5-1, failed to operate (Ref:AR006628). The same type of transducer is used on the Waste Water Tank, P/N 812200-5-1. The 820978 quantity transducer
Ø2 is used on S/C 012 and subs. The failure of the transducer was due to a broken cable at the bladder during
Ø1 the Group III, Phase I Vibration/Temperature Test.

CTR 01111302

3-38

(2) Problem Status Resolved (Resolved, Unresolved, or Explained)

~~For S/C 011, the quantity in the potable or waste water tanks is 10#. Not be knowing the amount of water in the tanks during flight would not affect the S/C flight or its flight objectives.~~

Ø1 For S/C 012, failure of the quantity transducer would give an erroneous water quantity in the potable and waste water tanks. If the crew got an erroneous indication that the tanks were empty then extra water would be forced up from the S/M supplemental water supply. At this time, if the tanks were full, then the extra water would be forced overboard. Both the waste and potable water tanks using the 820978-1-1 quantity transducer have successfully passed the vibration/temperature and acceleration tests of the Group III Phase I qualification
Ø2 program. The transducer ~~which failed is presently undergoing failure analysis which will be available 3/1/66.~~ failure was caused by the incorrect positioning of the transducer during assembly.

T&QA 978 Void 2-14-66 (Revised 1-14-66)

APS-042-AL

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012, 014, 017, 020 Date: 6/26/66

Subsystem/End Item ECS Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Waste Water Tank, ME192-0008-0021 Item 5.15

Spacecraft [x] GSE [ ]

Apollo Reliability [signature] Apollo Engineering J. E. Phillips

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During the EMI Qualification Test the output of the quantity transducer 820978 on the waste water tank, P/N 812200-5-1 was a constant 4.3 volts and did not change when water was removed. Voltage should vary from 5 volts for a full tank to 0 volts for an empty tank.

Ref. AR007654
CTR 01111302
No SPF.

(2) Problem Status Explained: 012, 014, 017, 020 (Resolved, Unresolved, or explained)

Failure analysis indicated that the freon cleaning process caused the potting compound to swell and lodge against the variable resistor pulley. The potting compound swelling process takes thirty days to take full effect. For S/C 012, 014, 017, and 020 if this failure mode has not occurred by thirty days after assembly of the quantity transducer then the potting compound has not been contaminated with freon and is operational for flight. This is the transducer also used in the potable water tank, P/N 812200-5-1 for S/C 012, 014, 017, and 020.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø2 S/C # 008, 012, 014, 017, 020 Date: 4/18/66

Revised: Ø1 4/26/66
Ø2 5/24/66
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Glycol Reservoir, ME 901-0216, P/N 812800-4-1 S/C 12 & SC35
Item 2.29 3-1 S/C 8

Spacecraft ☒ GSE ☐

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During system checkout on S/C 008 the water glycol system was over-pressurized causing the bladder (812815-1) in the water glycol reservoir (812800-3-1) to burst and pumped glycol into the oxygen system and suit circuit. MA008008 (secondary failures were MA8029, 8030, 8105, 19393, and 19406, due to glycol contamination). During the shakedown checkout for the mission simulation test, at AiResearch, the glycol reservoir was overpressurized during the fill operation, reference AR008809, which was also a human error.

Ø2 (2) Problem Status S/C 008 - Explained; S/C 012,014,017, & 020 - Resolved (Resolved, Unresolved, or explained)

Two 812815-1 bladders were proof pressure tested in a water glycol reservoir, P/N 812820, at AiResearch. Both bladders failed at 150 psi. The proof pressure for these bladders is 90 psi. The Revision E to the 812815-1 bladder does add material to prevent this human error due to overpressurization. S/C 008 will be used with the failed bladder by keeping the water glycol reservoir isolated from the system. For S/C 012 and 014, the failure mode could be isolated by the crew and as long as there is a 100 psi oxygen pressure in the O_2 circuit, glycol will not back up from a failed reservoir into the O_2 loop. For S/C 012, 014, 017, 020, the ECU's will be retrofit with the new 812800-4-1 reservoir using the modified bladder to prevent this failure mode.

Ø1

Ø2

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APOLLO PROBLEM SUMMARY

Ø1 S/C # 008, 012, 014

Date: 1/24/66
Revised: Ø1 6/6/66
Ø2
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Selector, Control, ME 901-0216

Ø1 Item 1.50 (820970-3-1)

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature] R. E. Seyton/M.E.S.

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

Ø1 After the high and low temperature test the selector control, P/N 820970-1-1, would not electrically open or close the diverter valve, P/N 828880-2-2. This control is used on S/C 008, 012, and 014.

AR006622, Ø1 AR009605
CTR 01211715

3-41

Ø1 (2) Problem Status Explained - S/C 008
Resolved - S/C 012, 014 (Resolved, Unresolved, or Explained)

Ø1 If this control failed during the flight, the crew could use the manual override, as a backup, on the glycol diverter valve to control the suit temperature, through water/glycol cooling. The problem with this control functioning was due to two radio interference capacitors left in the circuit by error. The new control 820970-3-1, without these capacitors, has passed qualification testing and will be installed in S/C 012, 014. S/C 008 has the older control and the glycol bypass function could be manually operated by the crew for suit water boiling operation if this problem occurred.

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APOLLO PROBLEM SUMMARY

Ø1 S/C # 008, 012, 014

Date: 1/21/66
Revised: Ø1 6/6/66
Ø2
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Glycol Diverter Valve, ME 901-0216
Item 1.46

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature] R. E. Dayton/m.c.d.

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

During qualification functional testing the glycol diverter valve, P/N 828880-2-2, had a low delta pressure of 2.65 in.H_2O. The required delta P is 2.9 to 3.5 inches of H_2O. This valve is used on S/C 008, 012, and 014.

AR006625
CTR 01211719

3-42

Ø1 (2) Problem Status Explained-S/C 008
Resolved-S/C 012, 014 (Resolved, Unresolved, or Explained)

Ø1 For S/C 008 the system uses the 828880-2-2 glycol diverter valve and a failure mode of low delta pressure across this valve would cause approximately 8% overshooting of the high and low temperature requirements of the C/M water/glycol cooling system. This would cause crewman discomform with no major impact on the mission. The diverter valve is being redesigned to the 828880-2-4 configuration using a new stop plate, 82888-2-3, and the teflon coating removed from the drive pin contact area to prevent chipping and to preclude the valve from over-driving for S/C 012, 014.

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APOLLO PROBL[illegible] SUMMARY

Ø1 S/C # 008, 012, 014

Date: 1/27/[illegible]

Revised: Ø1 6/6/66
Ø2
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Surge Tank Pressure Relief Valve, ME 284-0191-0001
Item 4.27

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature] R. E. Sexton/[illegible]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

During the 200° temperature portion of the qualification program the surge tank pressure relief valve (828650-1-1) operating at 1000 psig inlet had an external leakage of 4000 SCCM. Allowable reseat leakage is 0 to 5 SCCM.

AR008180, AR006144
CTR 01211312

3-43

Ø1 (2) Problem Status Explained (Resolved, Unresolved, or Explained)

Ø1 This failure would dump O_2 into the C/M eventually exhausting the O_2 supply. (This valve is used on S/C 008, 012, and 014). This valve has a manual shutoff backup which the crew could operate. For S/C operation, the 828650-1-1 relief valve is only used in the system when the surge tank is isolated from the 1000 psi O_2 subsystem, and the temperature in the C/M increases which would raise the pressure in the surge tank above 1020 psig. This failure mode does not affect the relief pressure, but the reseat leakage, which the crew could override closed, and once it relieved the pressure in the surge tank would be at a safe level. The surge tank is never isolated during flight, which is a valid assumption under normal operating conditions, since the relief valve in the Cryogenic Subsystem is set at a lower relief pressure of 983 to 1005 psig and the surge tank pressure relief valve would not be required to normally function during a mission since it relieves at 1020 to 1070 psig.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø2 S/C # 008, 011, 012, 014 Date: 4/8/66

Subsystem/End Item ECS Revised: Ø1 4/26/66

Equipment Name, S&ID P/N Suit Heat Exchanger, Item 1.29 ME 901-0215 Ø2 5/23/66

813000-10-1 S/C 008, 011 Ø3

-11-1 S/C 012, 014 Ø4

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During the ECS shakedown tests for the mission simulation qualification test phase the porous plate in the suit heat exchanger failed to remove H_2O from the suit gas. Maximum water flow to the accumulator from the porous plate is to be 1.4 #/hr. and the actual flow was 0.

AR008804

CTR 01211728

Ø2 (2) Problem Status Explained - S/C 008 and 011; Resolved - S/C 012 and 014 (Resolved, Unresolved, or explained)

Disassembly of the porous plate assembly revealed that the water removal failure was caused by plugging of the plate by corrosion. Heavy rust deposits were visible on the inner (manifold) side of the porous plate. Through an I&T investigation the porous plates material in S/C 008, 011, 012, 014 was found to have a high carbon content. This carbon content combined with the brazing process causes intergranule corrosion resulting in the above failure. There is no way to check how far the corrosion has progressed prior to flight. The two Group I

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APOLLO PROBLEM SUMMARY

Ø2 S/C # 008, 011, 012, 014 Date: 4/8/66

Revised: Ø1 4/26/66
Ø2 5/23/66
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Suit Heat Exchanger, Item 1.29 ME 901-0215 813000-10-1

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

3-45

Ø2 (2) Problem Status Explained - S/C 008 and 011 Resolved - S/C 012 and 014 (Resolved, Unresolved, or explained)

qualification tests units have degraded the water flow from about 44 #/hr. to about 5 #/hr. This water flow test cannot be accomplished on an assembled suit heat exchanger. AiResearch recommended retrofit the porous plates for all manned S/C (012 and 014). If the suit heat exchanger does not remove H_2O from the suit gas then an early abort would result due to water buildup in both the suit loop and cabin gases. Because S/C 011 is unmanned then there would be no H_2O in the cabin gas.

For S/C 008 this failure mode would cause very little effect on the crew because the porous material would have to degrade to less than .5 lb./hr. before chamber abort. This value is the estimated water production rate for the crew and suit circuit CO_2 removal system.

Ø2 For S/C 012 and 014 the ECU Retrofit Program will modify the suit heat exchanger to the 813000-11-1 configuration using the new low carbon material EMS 780 for the porous plate.

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APOLLO PROBLEM SUMMARY

Ø1 S/C # 008, 011, 012, 014 Date: 4/18/66

Revised: Ø1 6/6/66
Ø2
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Suit Demand Pressure Regulator, ME 901-0216 Item 4.16 P/N 828730-1-1

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During mission simulation vibration/temperature tests the calibration of the aneroid chamber relief valves changed from the allowable 4.1 to 4.5 psig. The valve relieved at 3.81 psig.

Ref AR006627
CTR 01111729

Ø1 (2) Problem Status S/C 008, 011 - Explained; S/C 012, 014 - Resolved (Resolved, Unresolved, or explained)

The analysis revealed that the long lok screws backed out during boost dynamics causing the calibration shift. AiResearch recommends retrofit or rework of all flight hardware to add new long lok screws, add lok-tite to the long lok screws and suit relief calibration nut. S/C 011 has the suit circuit operating, but this failure would not cause loss of any primary mission objectives. The 828550-1-1 valve used on S/C 008 and 011 has this same failure mode as the 828730-1-1 valve. For S/C 008 there would be no flight dynamics to cause shifting of the calibration of this valve.

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SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø1 S/C # 008, 011, 012, 014 Date: 4/18/66

Revised: Ø1 6/6/66
Ø2
Ø3
Ø4

Subsystem/End Item ECS

Equipment Name, S&ID P/N Suit Demand Pressure Regulator, ME 901-0216
Item 4.16 P/N 828730-1-1

Spacecraft [X] GSE [ ]

Apollo Reliability [signature] Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

3-47

(2) Problem Status _____ (Resolved, Unresolved, or explained)
(continued)

For S/C 012 and 014 this failure would have no effect on a pressurized cabin. If the cabin was depressurized then the absolute suit pressure may shift as a function of the aneroid chamber relief valve position. The aneroid calibration screws worked loose causing this failure which would limit the suit loop pressure only in a depressurized cabin to whatever the new calibration was. For this case, the suit pressure would be limited to 3.81 psia.

Ø1 S/C 012 and 014 suit demand pressure regulator was redesigned to the 828730-3-1 configuration to include long-lok screws and lok-tite on all screws and nuts.

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APOLLO PROBLEM SUMMARY

S/C # 011, 012, 014, 017, 020, and 101 Date: 6/10/66

Revised: Ø1 _____
Ø2 _____
Ø3 _____
Ø4 _____

Subsystem/End Item ECS

Equipment Name, S&ID P/N Union V17-610032 (V16-613001 Assy.)

Spacecraft [X] GSE [ ] C. O. Bahr

Apollo Reliability C. H. Rohrberg CWB Apollo Engineering RAB 636 R S Sexton

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Both V16-610032-17 unions leaked during Florida facility checkout (Ref. PAR MA 017736). The probable cause of both solder joint failures is not due to poor solder joints, but failure to hold V17-610032 unions to prevent it from turning when removing test port cap and attaching test hose. (Ref.MA 0201-3297). The union support bracket attaching checknut is not adequate to keep it from turning. The "Leak Control Program" (Ref. C. H. Feltz's instructions of January 21, 1966 "Action Items to Alleviate Block I Line Leak Problems") has not changed this installation per J. Soga (Mr. Plumbing).

(2) Problem Status Resolved - Block II / Unresolved - Block I (Resolved, Unresolved, or explained)

Design agrees that the two fittings should be welded to a plate (Ref. V36-613506 - Block II fix). They are awaiting approval from Project before writing E.O.

Responsible Design Manager, R. Sexton.

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3.3 HARDWARE SUMMARY - ENVIRONMENTAL CONTROL SYSTEM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Operational Checkout Procedures
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

NO.	NOMENCLATURE BASIC PART NUMBER CSM NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONSIDERT TIME/ CYCLES
1	Anticipator, Cabin Temperature ME901-0221-0001 01111323	14	2	2	4	1	X	X		X		X	X	X	X	X							100%	0	0	0		-0001	0	0	0	
2	Bag Assy, Vacuum Cleaner Refuse Storage ME901-0629 01111759	100	2	51	10	0	X	X	X			X						X	X				95%	2	0	0			0	0	0	
3	Bag Assy, Refuse, Vacuum Cleaner ME901-0039 01111759	200	10	150	14	0	X	X	X			X						X	X				95%	0	2	0			0	0	0	
4	Blower, Cabin Recirculating ME492-0004 01111322	35	4	5	6	1	X	X		X		X	X		X	X							100%	0	0	0	384:58H	-0001 (2)	0	0	0	2H
5	Blower, Post Landing Ventilation ME492-0010 01211705	20	6	2	1	0	X	X		X		X	X	X	X	X							80%	0	0	0		-0021 (1)	0	0	0	
6	Blower, Waste Management ME901-0030 01111339	20	1	5	6	0	X	X	X	X		X	X	X	X								100%	3	0	0		-0003 (1) -0004 (1)	0	0	2	
7	Chiller, Water 812400-3 01111731	16	1	4	2	1	X	X		X						X							100%	0	0	0			0	0	0	2:48H 10 C
8	Cleaner Assy, Vacuum ME901-0024 01111334	17	2	4	3	0	X	X	X			X						X	X					1	0	0			0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

NO.	NOMENCLATURE BASIS PART NUMBER OUR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/CYCLES	CSM DATA: COMP. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONSIDERATION TIME/CYCLES
9	Cold Plate V16-614006 01211725 V16-614007 01211725	12 12	3 3	1 1			X X	X X	X X		X X	X X		X X	X X								80% 80%	0 0	0 0	0 0			0 0	0 0	0 0	
	V16-614038 01211725 V16-614056 01211725	12 12	3 3	1 1			X X	X X	X X		X X	X X		X X	X X								80% 80%	0 0	0 0	0 0			0 0	0 0	0 0	
	V16-614137 01211725 V16-614148 01211725	12 12	3 3	1 1			X X	X X	X X		X X	X X		X X	X X								80% 80%	1 0	0 0	0 0			0 0	0 0	0 0	
10	Compressor, Suit 826000-2 011111713	28	4	5	2		X	X		X		X	X	X	X	X							100%	0	0	0			0	0	0	1.16 H 6C
11	Connector, Glycol Fill & Vent ME284-0145 01111346	25	3	6	12	2	X	X								X							100%	0	0	0		-0001 (4)	0	0	0	4:24 H 80C
12	Control, Backpressure 820908-4 01211715	12	2	3	3	1	X	X		X		X	X	X	X	X							90%	1	0	0			0	0	0	
13	Control, Cyclic Accumulator 820914-2 01111717	22	4	4	3	1	X	X		X					X	X							100%	2	0	0			0	0	0	50M 4 C
14	Control, Glycol Diverter Valve 820970-1 01211722	6	1	3	1	0	X	X		X		X	X	X	X	X							75%	0	0	1			0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

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No.	Nomenclature Basic Part Number CTR Number	Number Built	Development Test Quantity	Certification Test Quantity	Can Ground Test Quantity	Can Flight Test Quantity	Certification Test Environments: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR Status	CTR Failures: Resolved	Explained	Open	CTR Time/Cycles	CSM Data: Conf. & Quant.	CSM Failures: Resolved	Explained	Open	Accept. & Checkout Time/Cycles
15	Control, Glycol Evap. Temperature 820908-2 01111722	18	4	4	3	1	X	X		X		X	X	X	X	X							100%	3	0	0	9:30H		0	0	0	36M 10C
16	Control, Suit Evap. Temperature 828540-2 01111744	10	2	4	3	1	X	X		X						X								0	0	0			0	0	0	
17	Control, Temperature 820010-2 01111330	18	2	4	0	0	X	X		X		X	X	X	X	X							100%	1	0	0			0	0	0	5 H 5 C
18	Control, Wetness 820910-1 01111725	14	2	4	3	1	X	X		X		X	X	X	X	X							100%	1	0	0	57:14H		0	0	0	5 H 2 C
19	Element, CO_2 Absorber ME901-0218 01111328	20	12	12	0	4	X	X		X						X							100%	3	0	0		-0011 (28)	0	0	0	E 60H 10C
20	Evaporator, H_2O Glycol 812000-5 01111718	18	6	4	3	1	X	X		X						X							100%	1	0	0	23:21H		0	0	0	.21M 5C
21	Filter, Oxygen ME286-0034 01211702	12	2	4	3	1				X													80%	0	0	0		-0001 (2)	0	0	0	
22	Flex Hose, Fecal Cannister ME271-0015 01111739	12	2	1	3	0	X	X				X	X	X										0	0	1		-0003 (1)	0	0	0	

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GSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

No.	NOMENCLATURE / MAKER PART NUMBER / CTR SERIAL	EXPOSED HRS.	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CEM GROUND TEST QUANTITY	CEM FLIGHT TEST QUANTITY	HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES RESOLVED	CTR FAILURES EXPLAINED	CTR FAILURES OPEN	CTR TIME/ CYCLES	CONF. & DRAWT.	CEM FAILURES RESOLVED	CEM FAILURES EXPLAINED	CEM FAILURES OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
23	Heater, Steamduct ME363-0012 01211[illegible]	12	2	1	3	1	X	X		X	X	X	X	X		X							80%	0	0	0		-0002 (1)	0	0	1	
24	Heat Exchanger, Cabin Air 812100-4 01111737	15	2	4	3	1	X	X		X		X	X	X		X							100%	0	0	0			0	0	0	
25	Heat Exchanger, Suit 813000-6 01111716	13	3	4	3	1	X	X		X						X							100%	1	0	0	38:19H		0	0	0	1:15 H 5 C
26	Limiter, Suit Flow 810602-1 01111332	36	1	8	9	3	X	X		X		X	X	X		X							100%	2	0	0			0	0	0	
27	Power Supply, Temp. Transducer 836066-1 01111736	48	2	4	3	1	X	X		X		X	X	X	X	X							100%	3	1	0			0	0	0	
28	Pump, Water Glycol 850024-3 01111720	20	6	4	4	1	X	X		X		X	X	X	X	X							95%	2	0	0	597:06H		0	0	0	37M 20C
29	Regulator, Cabin Pressure 810200-1 01111704	16	2	3	3	1	X	X		X		X	X	X		X							100%	4	0	0				0	0	
30	Regulator, Cabin Pressure 828510-2 01111705	14	2	4	3	1	X	X		X		X											100%	2	0	0			0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: COMP. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
31	Regulator, Oxygen Demand Pressure 828550 01111729	10	2	4	3	1	X	X		X		X	X	X		X							95%	5	1	0			0	0	0	
32	Regulator, Oxygen Pressure 827330-1 01111707	16	2	4	3	1	X	X		X						X							100%	1	0	0	60:33H		0	0	0	6:54H 40C
33	Reservoir, Water Glycol 812800-2 01111719	12	2	4	4	1	X	X		X						X							100%	1	0	0			0	0	0	10:00H 4C
34	Sensor, Amplifier ME473-0031 01111317	26	3	8	9	3	X	X		X		X	X	X	X	X							100%	6	0	0			0	0	0	2H 12C
35	Sensor, Back Pressure Glycol Evap. 836108-1 01111723	18	2	4	4	1	X	X		X				X	X	X							100%	3	0	0	87:36H		0	0	0	
36	Sensor, Cabin Temp. ME449-0044 01111314	16	3	3	6	1	X	X		X		X	X	X	X	X							100%	4	0	0		0001 (1)	0	0	0	
37	Sensor, Cabin Temp. ME431-0029 01111315	18	1	4	6	1	X	X		X		X	X	X	X	X							100%	1	0	0		-0001 (1)	0	0	0	
38	Sensor, Cyclic Accum. O_2 Warning 820928-1 01111714	20	1	3	3	1	X	X		X		X	X	X	X	X							95%	2	0	0			0	0	0	

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CSS 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

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	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONFIDENCE TIME/ CYCLES
	Sensor, Glycol Temp. 820918-1 01111727	15	1	4	5	1	X	X		X		X	X	X	X	X							95%	1	0	0			0	0	0	10:00H 6C
40	Sensor, Glycol Temp. 820980-1 01211718	12	1	2	1	0	X	X		X		X	X	X	X	X							100%	0	0	1			0	0	0	
41	Sensor, Outlet Temp. Space Radiator ME449-0047 01111318	12	2	4	5	1	X	X		X		X	X	X	X	X							100%	2	0	0	50:43H		0	0	1	
42	Sensor, Outlet Temp. Glycol Evaporator ME449-0046 01111319	12	2	4	5	1	X	X		X		X	X	X	X	X							100%	0	0	0	43:21H	-0001 (1)	0	0	0	
43	Sensor, Suit Supply Temperature ME432-0128 01111311	12	2	4	3	0				X					X	X							100%	0	0	0		-0001 (1)	0	0	0	1:45 H 9C
44	Sensor, Temperature Suit Evaporator 820950-1 01211721	12	2	2	2	0	X	X		X		X	X	X	X	X							90%	0	0	0			0	0	0	1.15 H 20 C
45	Sensor, Temperature Suit Evap. Oxygen 820050-2 01111743	12	2	2	2	1	X	X		X		X	X	X	X	X								0	0	0			0	0	0	
46	Sensor, Wetness Glycol Evap. 820912-1 01111726	12	2	3	3	1	X	X		X		X	X	X	X	X							100%	1	0	0	390:36H		0	0	0	0:30M 4C

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CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

3-56

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
47	Signal Conditioner Cyclic Accumulator 820930-1 01211713	12	2	2	6	2	X	X		X		X	X	X	X	X							90%	1	0	0			0	0	0	
48	Space Radiator, Structural ME362-0006 01211726	12	2	2	1	0	X	X			X		X	X			X	X	X				80%	0	0	0			0	0	0	
49	Space Radiator, Thermal ME362-0006 01211727	5	1	1	1	0	X	X															85%	0	0	0			0	0	0	
50	Switch Assy., Toggle 820950-1 01211720	12	0	3	1	0	X	X		X		X	X	X	X	X							90%	0	0	0			0	0	0	
51	Tank, Pressure Gaseous Oxygen ME282-0048 01211704	11	4	4	5	0				X	X												60%	0	0	0			0	0	0	
52	Tank, Waste Water ME192-0008 01111302	35	3	7	4	1	X	X		X			X		X	X							80%	1	0	0			0	0	0	21:04 H
53	Transducer, Flow Oxygen 837028-1 01111709	30	10	4	4	1	X	X		X		X	X	X	X	X							85%	3	0	0		-1 (1)	0	0	0	
54	Transducer, Pressure Differential Suit Comp. 837054-1 01111733	25	2	4	10	3	X	X		X		X	X	X	X	X							100%	4	1	0			0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

3-57

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
55	Transducer, Pressure Glycol 837008-2 01111734	16	3	4	3	1	X	X		X		X	X	X	X	X							100%	0	0	0		-1 (2)	0	0	0	:45M 6C
56	Transducer, Pressure Glycol Evap. Outlet ME449-0059 01111321	16	2	2	5	1	X	X		X					X	X							100%	3	0	0		(1)	0	0	0	
57	Transducer, Pressure Oxygen 837016-1 01111710	22	8	4	3	1	X	X		X		X	X	X	X	X							100%	0	0	0		-1 (1)	0	0	0	
58	Transducer, Pressure Total Cabin ME449-0045 01111320	28	3	5	5	2	X	X		X		X	X	X	X	X							100%	0	0	0		0011 (1) -0003 (1)	0	0	0	
59	Transducer, Quantity Glycol Accum. 837026-3 01111735	16	2	4	3	1	X	X		X		X	X	X	X	X							100%	1	0	0		-1 (1)	0	0	0	45 M 5 C
60	Umbilical Assy., Glycol ME271-0045 01111342	58	8	4	42	6					X												100%	0	0	0			0	0	0	
61	Umbilical Assy, Oxygen ME271-0045 01111349	25	7	4	14	2					X												--	0	0	0		-0005 (1) -0007 (1)	0	0	0	
																												-0009 (1)				

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SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

No.	NOMENCLATURE DASH PART NUMBER SER NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONFIDENT TIME/ CYCLES
62	Umbilical Assy., Water ME271-0045 01111348	18	7	4	7	1					X												-	0	0	0		-0003 (1) -0008 (1)	0	0	0	
63																													-0004 (1)	0	0	0	
63	Valve, Back Pack Supply 828990-2	10	1	4	3	1	X	X		X						X							100%	0	0	0			0	0	0	
64	Valve, Back Pressure 828870-1 01211716	12	2	3	1	0	X	X		X		X	X	X	X	X							90%	0	1	0			0	0	0	
65	Valve, Back Pressure Control 828990-1 01111721	24	8	4	4	1	X	X		X		X	X	X	X	X							100%	2	1	1			0	0	0	
66	Valve, Backup Waste Management ME901-0068 01111340	6	1	5	3	0	X	X	X	X													100%	0	0	0		-0001 (1) -0004 (1)	0	0	0	
67	Valve, Cabin Relief ME284-0149- 01111309	22	3	4	8	2	X	X		X						X							100%	4	1	0		-0021 (1)	0	0	0	
68	Valve Check, Glycol 827990-1 01111343	45	5	5	10	2	X	X		X						X							100%	1	0	0			0	0	0	2:45 H 3C

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CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

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NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONCURRENT TIME/ CYCLES
69	Valve, Check Oxygen ME284-0187 01111310	44	2	8	12	2	X	X		X		X				X							100%	0	0	0		-0001 (2)	0	0	0	
70	Valve, Check Radiator ME284-0145 01111346	85	3	9	12	4	X	X		X						X							100%	0	0	0		-0001 (7)	0	0	0	
71	Valve, Check Suit Return 850026-1 01111711	15	1	4	3	1	X	X		X		X	X	X	X	X							100%	1	0	0			0	0	0	
72	Valve, Check Waste Management 3/8" ME285-0050 01111336	8	1	5	4	0	X	X	X	X		X											100%	0	0	0			0	0	0	
73	Valve, Check Waste Management 3/4" ME285-0050 01111337	8	1	5	4	0	X	X	X	X		X											100%	7	0	0			0	0	0	
74	Valve, Check Waste Management 1/4" ME285-0050 01111338	8	1	5	4	0	X	X	X	X		X											100%	0	0	0			0	0	0	
75	Valve, Check Water 837360-2 01111703	80	3	11	16	4	X	X		X						X							100%	0	0	0			0	0	0	
76	Valve, Control Cabin Temperature 850028-2 01111738	18	2	4	5	1	X	X		X		X	X	X	X	X							100%	2	0	0			0	0	0	

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

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No.	NOMENCLATURE BASIC PART NUMBER SER NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: COMP. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
77	Valve, Control Glycol 828540-2 01111724	18	1	4	3	1	X	X		X		X	X	X	X	X							100%	2	1	1			0	0	0	
78	Valve, Control Glycol Water Evap. 828470-2 01111732	18	2	4	3	1	X	X		X		X	X	X	X	X							100%	0	0	0			0	0	0	36M 10C
79	Valve, Control Radiator ME284-0148 01111344	72	6	6	16	4	X	X		X			X		X	X							100%	4	2	0	310:36H	-0021 (5)	0	0	0	72:30H 40C
80	Valve, Control Tank Pressure 810340-2 01111706	14	1	4	4	1	X	X		X		X	X	X		X							100%	0	0	0			0	0	0	
81	Valve, Diverter Glycol 828880-1 01211719	12	2	3	1	0	X	X		X		X	X	X	X	X							80%	2	0	0			0	0	0	
82	Valve, Gate Post Landing ME284-0287 01211706	12	3	2	2	0	X	X		X		X	X	X	X	X							40%	1	1	0		-0021 (2)	0	0	0	
83	Valve, Metering Oxygen ME284-0150 01111307	18	2	4	4	1	X	X		X		X	X	X		X							100%	2	0	0		-0011 (1)	0	0	0	1:30 H 10C
84	Valve, Oxygen Cyclic Accumulator 828020-2 01111742	30	3	6	4	2	X	X		X					X	X							100%	3	0	0		-2 (2)	0	0	0	3 H 40 C

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CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
85	Valve, Pressure Relief Surge Tank ME284-0192 01211312	12	2	4	3	1	X	X		X		X	X	X		X							95%	2	0	0		-0001 (1)	0	0	0	1 H 20 C
86	Valve, Pressure Relief Water 827830-1 01111701	27	1	6	8	2	X	X		X						X							100%	0	0	0			0	0	0	
87	Valve, Pressure Relief Water 827970-2 01111702	20	1	3	3	1	X	X		X						X							95%	6	0	0			0	0	0	
88	Valve, Relief Glycol ME284-0176 01111308	30	2	7	6	2	X	X		X						X							100%	6	2	0		-0011 (2)	0	0	0	
89	Valve, Selector 3 Way Oxygen Tank 828860-1 01211723	12	2	3	1	0	X	X		X						X							90%	1	1	0			0	0	0	
90	Valve, Selector Waste Management ME284-0076 01111341	6	1	5	3	0	X	X	X	X		X	X	X									100%	3	0	0		-0001 (1)	0	0	0	
91	Valve, Shutoff Elect. Glycol ME284-0146 01111345	22	2	3	5	2	X	X		X			X		X	X							100%	0	0	0	33:45H	-0011 (6)	0	0	0	9:30 H 60 C
92	Valve, Shutoff Glycol ME284-0147 01111301	80	5	15	26	6	X	X		X						X							100%	2	0	0	65:21H	-0011 (2) -0021 (4)	0	0	0	9 H 60 C

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CSM 012

SUBSYSTEM 3.0 ENVIRONMENTAL CONTROL

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTIC	PROOF PRESSURE	STRUCTURAL				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
93	Valve, Shutoff H_2O 827410-1 01111306	40	2	8	9	3	X	X		X						X							100%	1	0	0			0	0	0	
94	Valve, Shutoff Manual ME284-0191 01211306	20	0	6	9	2	X	X		X						X							90%	0	0	0		-0001 (4) -0011 (1)	0	0	0	3:46 H 20 C
95	Valve, Shut ByPass 810520-2 01111715	16	1	4	2	1	X	X		X		X	X	X	X	X							100%	4	1	0	20C		0	0	0	1:30 H 20 C
96	Waste Management System, Complete Sys. 01111759	3	1	1	4	0	X	X		X		X	X	X		X							95%	0	0	2			0	0	2	
97	Water Supply, Potable ME901-0223 01111327	12	2	3	3	1	X	X		X		X	X	X	X	X							85%	4	1	0		-0031 (1)	0	0	0	

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3.1.

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

ENVIRONMENTAL CONTROL SYSTEM

The pages which follow indicate the significant differences between the Certification Test Hardware and Flight Hardware.

APPROVED BY:

A. S. Marty 6/12/66

Certification Project Engineer

CERTIFIED/FLIGHT HARDWARE DIFFERENCES

Flight Part No.	Test Part No.	Part Name	Test Ident.
828560-1	827310-2	VALVE-METERING, O_2	01111307

Differences

TEST PART HAS T HANDLE FOR ACTUATION

FLIGHT PART HAS INTERNAL WRENCHING PROVISIONS

Certification Basis

DIFFERENCES IN ACTUATION DO NOT AFFECT FUNCTION UNDER FLIGHT ENVIRONMENTS

3.5 WAIVERS, SCN's AND RFC's - ENVIRONMENTAL CONTROL SYSTEM

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
3.5.1	SCN in work	O_2 Restricter Flow Rate	NAA to Submit
3.5.2	Waiver in Process	Cabin Pressure Relief Valve	NAA to Submit
3.5.3	Waiver in Process	Water Tank Press. Relief Valve	NAA to Submit
3.5.4	SCN 213 to SID 64-1237	Add Relief Valve	NAA to Implement
3.5.5	SCN 185A to SID 64-1237	CO_2 Sensor Range	NAA to Implement
3.5.6	SCN 215A to SID 64-1237	Urine Disposal	NAA to Implement
3.5.7	RID 012-3A-15	Suit Configuration (Capability Study)	NAA to Take Action
3.5.8	RID 012-6A-1 (4-6-66)	Water Profile Analysis	Pending NASA Action
3.5.9	RID 012-6A-11 (4-13-66)	Thermal Control Data	Pending NASA Action

R. S. Sexton/m.s.

Engineering Manager

Project Engineer

4.0 COMMUNICATIONS SYSTEM

The Communications System (COMM), for purposes of the CARR, consists of communications equipment as listed herein. The Communications System transmits telemetry data, voice signals, ranging and tracking signals, television information, recovery voice and recovery beacon signals and receives digital up-date, ranging and tracking signals and voice transmissions.

C-Band Transponder

VHF/AM Transmitter-Receiver

VHF/FM Transmitter

VHF Recovery Beacon

HF Transceiver

Unified S-Band

S-Band Power Amplifier

VHF Multiplexer

Recovery Antennas

VHF and S-Band Omni Antennas

C-Band Beacon Antennas

Data Storage

Premodulation Processor

Up-data Link

Audio Center

Television

GSE

4. COMMUNICATIONS SYSTEM

4.0 System Organization

4.1 Systems Test Results

4.2 Problem Summaries

4.3 Hardware Summary

4.4 Cert/Flt Hdw Differences

4.5 Waiver/SCN/RFC Information

4.1 SYSTEM TEST RESULTS

4.1.1 OCP-P-8058-S/C 012 - UDL Tape Generation and Verification

SCOPE

(1) To generate an up data link tape

(2) To verify the data format on the punched tape

(3) To provide a time line for each data word during continuous data transmission

RESULTS

The UDL tape was generated and verified to meet the requirements of Spec. MA0201-5163 "Up-link RF tapes for plugs out S/C-012 and S/C 014 Downey integrated system test."

Punched IBM cards were used to program autonetics computer that generated the UDL tape also should be incorporated on future tapes due to the savings of time and money also the utilization of a TPS instead of a OCP.

4.1.1.1 PROBLEM - One hour after test minus 1 day review, tape punch on the C14-429 jammed.

CORRECTIVE ACTION

Deleted requirement of generation of tape, and punched IBM cards to program autonetics computer to generate tape

DOCUMENTATION

EDWA #M9418, Deviation 001P #1

4.1.1.2 PROBLEM - Tape Paper Printout Failed to Print

During verification of tape, paper printout failed to print all messages or print them correctly.

CORRECTIVE ACTION

Reran all questionable readouts unable to repeat error.

DOCUMENTATION

Squawks #1 through #7, Deviations 003 T #1 through #7

4.1.1.3 PROBLEM - Erroneous Message

OCP called out erroneous message.

CORRECTIVE ACTION

Deleted message from tape and OCP

DOCUMENTATION

Deviations 001 P #3 through #6

4.1.2 OCP-P-8251-A-SC-012 - RF Transmission Lines and Multiplexer

SCOPE

This test was performed to verify S/C multiplexer and RF transmission lines in regards to insertion loss and VSWR measurements; in accordance with Process Specification MA0205-0494.

RESULTS

The RF transmission lines were satisfactorily checked (VSWR and insertion loss). The following problem areas were corrected and rechecked.

4.1.2.1 PROBLEM - Plate Assy Not Floating

Plate Assy (V16-764216-2) did not float and will tend to damage mating connector (J97) at time of installation. This was due to insufficient slack on coax cable (V16-764464).

CORRECTIVE ACTION

Loosen clamps as required and installed larger clamp.

DOCUMENTATION

Coax Cable (V16-764464) was too rigid and plate assy (V16-764216-2) did not float; Squawk #29 - Comm TAIR Book - sold.

4.1.2.2 PROBLEM - Torquing Requirements

Torquing requirements could not be maintained on clamps for the following connectors:

C28W86P468,	C28W86P469,	C28W32P470,
C28W36P472,	C28W39P473,	C28W36P667

Restriction was due to inaccessible location of connectors which were on the VHF antenna switch (C281A85) and conn. assy. feed thru BHD (ME414-0140-0002) in crew compartment.

CORRECTIVE ACTION

Torquing requirements were waivered by E. O. and bonding material applied in lieu of safety wire on connectors.

DOCUMENTATION

Torque requirements on clamps not maintained - SQK #22 - Comm Tair Book. Transferred to EDB-SQK #12 - Sold E. O. #467199 waivered torque requirements. Superseded by E. O. #467193 which adds note to DWG. V16-764390 to apply bonding material between plate and coupling nut in lieu of safety wire.

4.1.2.3 PROBLEM - Attenuation Readings Through VHF Antenna Switch Unobtainable

Unable to obtain attenuation readings through VHF antenna switch. VHF antenna switch (C281A85) connectors were not identified properly; and therefore incorrectly connected.

CORRECTIVE ACTION

VHF antenna switch reidentified correctly by E. O. 's and connected correctly. Retest of sequence 03 was performed and proper attenuation readings obtained.

DOCUMENTATION

Could not obtain attenuation measurements through VHF antenna switch SQK #26 and #27 - Comm TAIR Book. Transferred to EDB SQK. 14, 151. E. O. 444594 superseded by E. O. 467191 reidentifies antenna switch correctly.

4.1.2.4 PROBLEM - Split Sleeving

Insulated sleeving on the following coax connectors were found split:

C28W32J93, C28W31J97, C28W28J114,
C28W14J174 C28W48J213

The cause was undetermined.

CORRECTIVE ACTION

Problem sent to MR Epoxy applied to discrepant area on sleeving and wrapped with mystic tape.

DOCUMENTATION

Split sleeving - SQK #28, 30, 31 and 34 - Comm TAIR Book

MR's 109721 and 109722 applied epoxy and mystic tape.

4.1.2.5 PROBLEM - Connector Not Floating

Coax connector (J82) on cable V16-764464 was not floating which restricted movement of associate hardware (UDL).

CORRECTIVE ACTION

Clamp (ME127-0012-1004) deleted. Ref EDB TAIR Book - SQK #19.

DOCUMENTATION

Coax connector not floating - SQK #19 - EDB TAIR Book

4.1.2.6 PROBLEM - Could not fit Check USBE Sep Adapter

USBE Sep adapter could not be installed in L. E. B. as plate assy. (V16-764212-21) was identified and mounted incorrectly

CORRECTIVE ACTION

Plate removed and installed to per print (V16-764390).

DOCUMENTATION

SQK #36 - Comm Tair Book - unable to fit the USBE sep adapter into L. E. B. rack.

4.1.3 OCP-P-8100-SC-012 - Communications Systems Equipment Checkout

SCOPE

This test was performed to functionally verify the communication systems as specified in Process Specification MA0205-0494.

RESULTS

All the sequences were satisfactorily performed except in the areas covering USBE AGC - Readings. Verifications are still open on troubleshooting TPS's. The following is a list of the significant problems encountered during the test run of 8100.

4.1.3.1 PROBLEM - No Communications Through CCR Position (Panel 23)

Unable to communicate with CCR Panel 23 (C22-2A71) in either the T/R or Rec positions.

CORRECTIVE ACTION

On Panel 23, connector P485 was replaced due to damage and mating connector J159 was also replaced as several pins were bent. Retest was performed satisfactorily.

DOCUMENTATION

CCR unable to establish communication from panel 23 (C22-2A71). SQK. #2-8100 TAIR Book, SQK #154, 155 Com-TAIR Book. Troubleshooting TPS #8100-003. - Sold. Connectors C22-2A71W4P485 (J159) replaced. PAR 8237

4.1.3.2 PROBLEM - No Output From HF Transceiver or Elapsed Time Meter Running When Turned on.

CORRECTIVE ACTION

The shells on connectors C28-1A13-P150 and P160 were found damaged when VHF/HF package was removed from S/C . The LES mating connectors were aligned to prevent connector damage. A new VHF/HF (C28-1A13) package was installed. Old S/N-02672001-0010. New S/N-02672001-0014.

DOCUMENTATION

HF XCVR (C28-1A13) had no output or ETM running when turned on. SQK - 8100 - #4. Troubleshooting TPS-8100-004. PAR 8235

4.1.3.3 PROBLEM - Up-Link Voice Transmission in the AM Mode to the HF Transceiver (C28-1A13) was Unintelligible at the Three Positions CCL, CCC and CCR.

CORRECTIVE ACTION

Checks on the GSE HF Transmitter showed it was being grossly overmodulated. The GSE HF Transmitter was readjusted to give a modulation level of approximately 75% and no over-modulation on voice peaks.

DOCUMENTATION

The HF transceiver (C28-1N13) up-link transmission unreadable at the 3 S/C positions CCL, CCC, and CCR. SQK #6 - 8100 TAIR Book

4.1.3.4 PROBLEM - Unable to Select PCM Low Bit Rate

During DSE Record Checks, PCM low bit rate could not be selected with Panel 20 PCM hiflow switch.

CORRECTIVE ACTION

Panel 20 (C22-2A68) connector P456 was mated correctly with S/C harness connector J176.

DOCUMENTATION

SQK #8, 9, 13 and 14. 8100 TAIR Book.

4.1.3.5 PROBLEM - C14-442 CTS Displayed 'CTE ERROR' on Indicator

CTE confirm light on C14-442 confidence test set did not light when CTE message was transmitted to UDL from C14-442. Displayed CTE error instead. The CTE was being up-dated correctly.

CORRECTIVE ACTION

Repaired open wire on GSE ACE carry-on cable (C14-574 - W6) P83-23 to P83A-D.

DOCUMENTATION

No CTE confirm light on CTS. SQK #15 - 8100 TAIR Book - Sold. Troubleshooting TPS-8100-013

4.1.3.6 PROBLEM - USBE Det. RF Output Read Zero

Measurement (CT0215) USBE Det. RF output read zero on CRT during S-Band checkout. RF power was being transmitted to C14-442.

CORRECTIVE ACTION

ACE program was updated to read correct prime frame and time slot.

DOCUMENTATION

Measurement CT 0215 USBE Det. RF output reads zero - SQK #17-8100 TAIR Book.

4.1.3.7 PROBLEM - C14-442 CTS Displayed Verify Error on Up-Data Check

When sending test message from C14-442 to USBE, a "Verify Error" was indicated at the C14-442. Also, no validity was received on ACE.

CORRECTIVE ACTION

The PSK modulation from the C14-429 (UDL BME) was used to modulate the 70 KC up-data VCO. The PSK modulation of the C14-442 CTS was analyzed and found to have unwanted delay.

DOCUMENTATION

Temporary deviation 026 Item 12 (OCP-8100) written to use C14-429 UDL BME instead of the C14-442 CTS.

A "Verify Error" was indicated on the C14-442 when test message was sent to the USBE - SQK #24 - 8100 TAIR Book. -

4.1.3.8 PROBLEM - No S-Band Up-Voice or Data Operation at -110 DBM Level.

The USBE did not process up-link messages with the C14-442 S-band generator output level set for a -110 DBM at the USBE receiver; with the PRN, voice and data applied.

CORRECTIVE ACTION

Since the -110 dbm level is below the equipment threshold, deviation was written to check operation at -100 dbm level. Operation was satisfactory at -100 dbm.

DOCUMENTATION

Process Specification MA0205-0494 was updated to specify new level by E.O. 418797. Could not process up-link messages for a -100 dbm level at USBE receiver - SQK #27 and 28 - 8100 TAIR Book

4.1.3.9 PROBLEM - RTC 00, Abort A Reset Inoperative

Real time command 00, abort "A" reset does not turn off the RTC01 - abort "A" set light in the C/M.

CORRECTIVE ACTION

Two wires, reversed at C01W1J59-41 and 77, were correctly wired to wire list V16-420316. Operation on retest ok.

DOCUMENTATION

RTC 00 could not turn off RTC 01 abort "A" set light. - SQK #11 - 8100 TAIR book

4.1.3.10 PROBLEM - USBE Receiver AGC Reads Zero

S-band receiver AGC (CT0147) measurement read zero on the ACE CRT. S-band antenna meter (S-band receiver AGC) also reads zero.

CORRECTIVE ACTION

Repaired open wire at J850-G80 operation ok on retest.

DOCUMENTATION

USBE AGC measurement CT0147 and S-band antenna meter read zero - SQK #19 and 22 - 8100 TAIR Book. Trouble-shooting TPS-8100-010.

4.1.3.11 PROBLEM - C14-442 CTS Displayed 'AGC ERROR'

Did not get "AGC confirm" on the C14-442 confidence test set when transmitting Apollo Guidance Computer message to UDL. Received "AGC Error" on CTS. Validity signal was received on ACE.

CORRECTIVE ACTION

Repaired open wires on GSE ACE Carry-on Cable (C14-574 W6). Operation ok on retest.

DOCUMENTATION

Did not get "AGC" confirm verification - SQK #16 - 8100 TAIR Book. Sold. Troubleshooting TPS-8100-013.

4.1.3.12 PROBLEM - Observed Word Dropouts on S-Band Data Dump

S-band DSE Playback fast dump, of low bit rate data at high speed, through the Telemetric unit 6103 in TGS had 13 dropouts.

CORRECTIVE ACTION

The DCS (Data Corp. Sys.) decom. unit verified spacecraft operation was satisfactory. Later magnetic tape playback was also ok on Telemetric 6103 unit.

DOCUMENTATION

S-band DSE playback fast dump had 13 bit drop-outs - SQK #30 - 8100 - TAIR Book.

4.1.3.13 PROBLEM - DSE Playback Operation Not Verified

DSE playback acceptance open until analysis of TGS telemetrics vamp strip chart (indicating playback dropouts) recording can be made.

CORRECTIVE ACTION

Recording analyzed and was satisfactory.

DOCUMENTATION

Squawk #21-8100-TAIR Book - Seq. 08-037-8100 to remain open until TGS telemetrics recording analyzed.

4.1.3.14 PROBLEM - Unqualified Hardware Used for System Checkout

All audio checks were run with unqualified bump hats (V16-601120)

CORRECTIVE ACTION

Flight type bump hats will not be available for Downey testing due to late delivery mikes, earphones, cables and adapters and also due to late engineering changes at the request of NASA and the astronauts (the change to soft hats instead of hard shell). The new hats will be provided by the NASA and are not expected to arrive until late June which is after integrated systems testing. The audio checks are scheduled to be performed at the field site using qualified headsets per a field procedure.

DOCUMENTATION

Tests run with unqualified bump hats - SQK #32 - 8100 - TAIR Book.

4.1.4 OCP-P-8077-A-SC-012 - Antenna Systems Functional Verification

SCOPE

This test was performed to functionally verify the spacecraft antennas with respect to VSWR measurements, as specified in Process Specification MA0205-0494, using fixed system frequencies.

RESULTS

Sequences 01 and 02 covering the VHF-UHF (SCIN and recovery) and S-band SCIN antennas were satisfactorily performed. Sequence 03 (C-band) was not completed. This sequence will be verified after AFT heat shield installation. C-band antennas #1, 2 and 3 are on the H/S; antenna #4 has been satisfactorily tested.

There were no problems encountered during this test.

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4.2 PROBLEM ANALYSIS - COMMUNICATIONS SYSTEM

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 009* 011, 012, 014, 017, 020 Date: 6-17-66

Subsystem/End Item Communications Revised: Ø1 _____

Ø2 _____

Equipment Name, S&ID P/N H. F. Recovery Antenna, ME481-0049-0003 Ø3 _____

Spacecraft [X] GSE [ ] Ø4 _____

Apollo Reliability J. Bowers Jas [illegible] Apollo Engineering G. C. Covington, III GVI

G. C. Covington III

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

CTR: N/A

No high frequency radio signal was received by any ground station during the recovery operations for S/C 009.

PAR No. MA 5207

(2) Problem Status *Explained Resolved (Resolved, Unresolved, or explained)

HF Antenna is not used during flight. Primary function is long range recovery in event S/C fails to impact in the target area. Subsequent post flight tests did not reveal any anomalies that could cause a complete loss of signal. However when salt water was allowed to stand in the base of the antenna and/or the bulkhead feedthrough connector, the transmitted signal was seriously attenuated. Redesign of the antenna and usage of a moisture sealed connector has been incorporated on S/C 011 and subs. New part numbers involved are ME481-0049-0004 HF Antenna and ME414-0140-000[illegible] Coaxial Bulkhead Connector.

*Explained for S/C 009; Resolved for S/C 011 and subs.

APS — 806 — [illegible]

PAGE 1 OF [illegible]

FORM 2[illegible]8-G NEW 1-66

4.3 HARDWARE SUMMARY - COMMUNICATIONS SYSTEM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CERTIFICATION TEST DATA

CEM 012

SUBSYSTEM 4.0 COMMUN. SYS.

4-30

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CEM GROUND TEST QUANTITY	CEM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CEM DATA: CONF. & QUANT.	CEM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONSIGNMENT TIME/ CYCLES
1	Antenna, C-Band, Beacon ME481-0005 00921314	32	2	2	8	4	X	X	X	X			X				X	100%	2	0	0		0002 (1) 0004 (2)	0	0	0	EST. 113 HRS
																							0005 (1)				
2	Antenna, HF Recovery ME481-0049 00921311	9	2	2	2	1	X	X	X	X	X		X	X				100%	5	0	1		0004 (1)	0	0	2	EST. 105 HRS
3	Antenna, Scin, VHF/2KMC +Z Axis V16-321377-91 01121308	19	2	2	1	2	X	X	X	X				X		X	X	100%	8	0	0		-91 (1)	5	0	0	EST. 107 HRS
4	Antenna, Scin, VHF/2KMC +Z Axis V16-321610-31 01121308	0	2	2	0	0	X	X	X	X				X		X	X	100%	6	0	0		-31 (1)	0	0	0	EST. 107 HRS.
5	Antenna, VHF Recovery, No. 1 and 2 V16-716120 00921313	9	2	2	6	2	X	X	X	X	X		X	X			X	100%	0	0	0		(2)	0	0	0	EST. 105 HRS.
6	Antenna Switch, 2 KMC ME452-0052 01221316	9	2	4	2	1	X	X	X	X	X	X	X	X	X	X		100%	0	0	0		0002 (1)	0	0	0	422 CY.
7	Antenna Switch, VHF ME452-0052 01221701	10	2	4	5	1	X	X	X	X	X	X	X	X	X			85%	0	0	0		0012 (1)	1	0	0	EST. 107 HRS.

Temp. Form R&E - 1056 Exp. 6-10-66

CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 4.0 COMMUN. SYS.

NO.	NOMENCLATURE / CONTR PART NUMBER / CTR NUMBER	MEMBER BUILD	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & CHANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
8	Audio Center ME473-0021 01221303	14	2	4	3	1	X	X	X	X	X	X	X	X	X	X						100%	7	0	0	3635 H	0003 (1)	0	0	0	176 H
9	C-Band Transponder ME478-0027 01221304	14	2	4	2	1	X	X	X	X	X			X	X	X						100%	20	5	0	5842 H	0003 (1)	1	0	0	113 H
10	Multiplexer, VHF ME456-0013 01221315	14	2	4	3	1	X	X	X	X	X	X	X	X	X	X							9	0	0	1494 H	0013 (1)	1	0	2	EST. 107 H
11	Premodulation Processor ME478-0021 01221309	16	2	4	2	1	X	X	X	X	X	X	X	X	X	X						100%	25	0	0	4578 H	0004 (1)	0	0	0	170 H 1379 H
12	Relay Assy., Magnetic Latching ME455-0106 01221702	0	0	2	0	0	X	X	X	X	X	X	X	X	X	X						100%	0	0	0	(1)	0001 (1)	0	0	0	EST. 25 C
13	S-Band Power Amplifier ME478-0020 01221305	15	2	4	2	0	X	X	X	X	X	X	X	X	X	X						100%	10	0	0	1701 H	0003 (1)	0	0	1	190 H 92 C
14	T. V. Command Module ME901-0090 01221310		0	2	2	0	X	X	X	X	X	X	X	X	X	X	X					100%	3	0	0	2495 H	0020 (1)	0	0	0	
15	Unified S-Band Equip. ME478-0026 01221306	14	2	4	2	0	X	X	X	X	X	X	X	X	X	X	X					100%	10	0	0	6395 H	0003 (1)	0	0	0	187 H 440 C

Temp. Form R&E - 1056 Exp. 6-10-66

CERTIFICATION TEST DATA

CERTIFICATION TEST ENVIRONMENTS

CTR FAILURES

CTR DATA

CERTIFICATION TEST DATA

CERTIFICATION TEST ENVIRONMENTS

CTR FAILURES

CTR DATA

CERTIFICATION TEST DATA

CERTIFICATION TEST ENVIRONMENTS

CTR FAILURES

CTR DATA

NO.	NOMENCLATURE DATE DAY NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CTR GROUND TEST QUANTITY	CTR FLIGHT TEST QUANTITY	HI TEMP.	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS						CTR STATUS	RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CONF. & QUANT.	RESOLVED	EXPLAINED	OPEN	ACCE & CONFIG TIME CYCL
16	Up-Data Link ME470-0014 01221313	15	2	4	2	0	X	X	X	X	X	X	X	X	X	X							100%	4	0	0	1716 HRS	0007 (1)	0	0	0	180
17	VHF/AM Xmtr-Rcvr & VHF Recovery Beacon ME478-0023 01221302	14	2	4	2	1	X	X	X	X	X		X		X	X							100%	26	0	0	6152 HRS	0003 (1)	0	0	0	105
18	VHF/FM Xmtr & HF Xcvr ME478-0022 01221301	14	2	4	2	1	X	X	X	X	X		X		X	X							100%	12	0	0	1733 HRS	0004 (1)	0	0	0	107

Temp. Form R&E - 1056 Exp. 6-10-66

4.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

COMMUNICATIONS SYSTEM

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

A. S. Kearney 6/15/66

Certification Project Engineer

4.5 WAIVERS, SCN's AND RFC's - COMMUNICATIONS

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
4.5.1	SCN 15 to SID 64-1866 (ECP 0292)	Delete S-Band Dump of Recorded Voice	Pending NASA Direction
4.5.2	RFC 12-5-22	Delete Deep Space Comm. & Tracking Requirements	Requires NAA/NASA Resolution
4.5.3	SCN 37 to SID 64-1080 (ECP 0292)	Delete VHF/AM Biomedical Requirements	Pending NASA Direction
4.5.4	SCN 39 to SID 64-1080 (ECP 0281)	Correct Instr. Interface Requirements	Pending NASA Direction
4.5.5	RFC 012-5-7	Time for UDL/CTE Update	Pending NASA Direction
4.5.6	RFC 012-5-51	Format and Symbology Improvements	NASA to Provide Definition

R L Kurtz/mer
Engineering Manager

Project Engineer

5. INSTRUMENTATION SYSTEM

5.0 System Organization

5.1 Systems Test Results

5.2 Problem Summaries

5.3 Hardware Summary

5.4 Cert/Flt Hdw Differences

5.5 Waiver/SCN/RFC Information

5.0 INSTRUMENTATION SYSTEM

The Instrumentation System (INST), for purposes of the CARR, consists of instrumentation equipment as listed herein. The Instrumentation System pulse code modulation for telemetry, signal conditioning, operational and flight qualification instrumentation (except instrumentation required to operate other CSM subsystems), flight qualification recording and timing.

Operational Instrumentation (464 measurements)

Flight Qualification Instrumentation (61 measurements)

Flight Qualification Recorder

Signal Conditioner Equipment

Central Timing Equipment

Digital Event Timer

PCM Equipment

Displays

GSE

5.1 SYSTEMS TEST RESULTS

5.1.1 OCP-P-8037A-SC-012 - Data Systems Equipment Checkout

SCOPE

This test was performed to verify the following:

1. Demonstrate the compatibility of the PCM, the CTE, and the SCE to the spacecraft wiring, circuit breakers, switches and S/C in general.

2. Demonstrate the compatibility of the PCM, the CTE, and the SCE to operate within the performance limits of the design specification.

3. Demonstrate the compatibility of the PCM, the CTE, and to the ACE-S/C system.

4. Demonstrate the operational status of those measurement systems which are not functionally verified as a part of other systems OCP's.

5. Partially verify the SCE measurement channels and the PCM channel assignments. The SCE measurement channels and the PCM channel assignments will be verified throughout individual and integrated systems tests.

RESULTS

During the system checkout seventeen measurements could not be verified. The SCE circuit breaker would not hold and two SCE cables were found switched. DC power was lost at one time and there was no DC at the biomedical simulators.

5.1.1.1 PROBLEM - No Output From Measurements

During sequence 06-008 SA 2364T and SA 2365T had no output. Connectors were not connected per OCP 10030.

CORRECTIVE ACTION

Connectors S28AR56P1 and S28AR57P1 were connected and part of sequence 06-008 rerun to verify measurements.

DOCUMENTATION

OCP 8037
Squawks 1 and 2
OCP 10030

5.1.1.2 PROBLEM - Measurement Not Verified

During sequence 06-009 measurement CA5481T, CA5484R, CA5491T, CA5492T, and CA5493T could not be verified. The heat shield simulator was wired incorrectly.

CORRECTIVE ACTION

The heat shield simulator wiring was corrected and part of sequence 06-009 repeated to verify measurements.

DOCUMENTATION

OCP 8037
Squawks 3, 4, 5, and 6
TPS 8037-008
TPS COM 104

5.1.1.3 PROBLEM - Lost DC Power

Personnel working on OCP 10030 for next OCP disconnected connector W2686P2 from SK5J2.

CORRECTIVE ACTION

Reconnected SK5P2 to J2 and verified DC power.

DOCUMENTATION

OCP 8037
Squawk #7
TPS 8037-003

5.1.1.4 PROBLEM - No DC Voltage at Bio-Med Simulator

Suit adapter cable SK1328 wired incorrectly.

CORRECTIVE ACTION

Corrected cable SK1328 and verified DC voltage at simulator.

DOCUMENTATION

OCP 8037
Squawk 8
TPS 8037-004

5.1.1.5 PROBLEM - Circuit Breaker Tripped

At sequence 07-001, on panel 22 circuit breaker SIG COND - S Band PA would not hold. S/C harness connectors to signal conditioner connectors J51 and J55 were crossed.

CORRECTIVE ACTION

Corrected cabling at J51 and J55. Checked all pins where 115 VAC was applied incorrectly (most were spares) and removed one module for bench checking. This module was not required for this OCP. Reverified power to SCE and completed OCP.

DOCUMENTATION

OCP 8037
Squawk 9
TPS 8037-004

5.1.1.6 PROBLEM - Measurement Incorrect

Bit configuration for measurements CJ0210X and CJ0212X incorrect. Jumper wire at J850 was missing.

CORRECTIVE ACTION

Replaced jumper wire and reverified measurement.

DOCUMENTATION

OCP 8037
Squawk 10 and 11
TPS COM 103

5.1.1.7 PROBLEM - Measurement CSO 100X Bit was 0 Should be 1

SCE was not installed which supplies 5VDC. Due to cable connectors being crossed resulting in removal of SCE for bench check.

CORRECTIVE ACTION

Installed SCE and verified measurement.

DOCUMENTATION

OCP 8037
Squawk 15

5.1.1.8 PROBLEM - CRT Display Measurement CT0010 Indicated Upper Limits

Patch cord was broken in C14-203.

CORRECTIVE ACTION

Replaced patch cord.

DOCUMENTATION

OCP 8037
Squawk 16
TPS 8037-006

5.1.1.9 PROBLEM - Crossed Wires

S/C Harness to J51 and J55 on SCE were crossed

CORRECTIVE ACTION

Reconnected S/C harness correctly. Removed affected module for bench check. (Checked out ok)

DOCUMENTATION

OCP 8037
Squawk 17
TPS COM 17

5.1.1.10 PROBLEM - Measurement LS 0090X Bit Configuration Incorrect

Bad fuse in C28A5.

CORRECTIVE ACTION

Used spare fuse and verified measurement.

DOCUMENTATION

OCP Squawk 18
TPS COM 110

5.1.1.11 PROBLEM - Measurement LS0001V could not be Verified

(Pin crimped over insulation instead of wire)

CORRECTIVE ACTION

Replaced crimp pin and verified LS0001V.

DOCUMENTATION

OCP 8037 Squawk 19
TPS COM 109

5.1.1.12 PROBLEM - Measurement CC0207V Out of Tolerance

A pin was found to be recessed

CORRECTIVE ACTION

Replaced pin verified CC0207V

DOCUMENTATION

OCP 8037 Squawk 20
TPS COM 113

5.1.2 OCP-P-8018A-SC-012 - Flight Qualification Tape Recorder Checkout

SCOPE

This test was performed to demonstrate the following:

1. The compatibility of the FQR with spacecraft wiring and interfacing systems configuration.

2. The operational status of instrumentation which is being recorded by the tape transport.

3. The capability of the FQR and its associated instrumentation to operate within the performance requirements of the design specification.

RESULTS

During the FQR checkout two problems were found and have been corrected. The system now operates properly.

5.1.2.1 PROBLEM - Cables too Short

Spacecraft harness C01W1 connectors P118 and P119 would not mate with FQR connectors.

CORRECTIVE ACTION

Took up slack in harness to mate P118 wires to P119 were spliced to give sufficient length.

DOCUMENTATION

OCP 8018 Squawk 1
TPS V16-COM-173
MR 91456

5.1.2.2 PROBLEM - Console Light Remains ON

Event light E24 on 18A2 remained on (tape motion monitor) plug to broken wire at J850A.

CORRECTIVE ACTION

Replaced pin on wire at J850A-37A

DOCUMENTATION

OCP 8018 Squawk 2
TPS V16-COM-112
TPS 8018-003

5.1.3 OCP-P-8056-SC-012 - Instrumentation, Heat Shield Subsystem Checkout

SCOPE

This test was performed to verify the following:

1. The functional integrity of the heat shield instrumentation

2. The proper polarity and identification of the heat shield instrumentation at spacecraft interfaces.

RESULTS

During this test, ten measurements had incorrect output and one had one step with no output.

5.1.3.1 PROBLEM - Eight Measurements Had Incorrect Output

Measurements CA5480T, CA5481T, CA5482T, CA5483T, CA5490T, CA5491T, CA5492T, and CA5493T, had incorrect output. Schematic and wire lists were incorrect.

CORRECTIVE ACTION

Corrected wiring.

DOCUMENTATION

EO M489150.

5.1.3.2 PROBLEM - Two measurements had incorrect output

Measurements CA5484R and CA5494R had incorrect output. OCP was incorrect.

CORRECTIVE ACTION

Corrected OCP

DOCUMENTATION

OCP 8056 DEV 001P-9

5.1.3.3 PROBLEM - One measurement had one bad step

Measurement CA5494R step three had no output. Thermocouple in step 3 was open.

CORRECTIVE ACTION

Waiver has been requested.

DOCUMENTATION

OCP 8056 Squawk 1 transferred to V16-COM Book Squawk 264.
TWX MA17840

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PROBLEM ANALYSIS - INSTRUMENTATION SYSTEM

There are no significant unresolved problems related to this equipment.

J. Adelstone

NAA Reliability Project Engineer

5.3 HARDWARE SUMMARY - INSTRUMENTATION SYSTEM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

5-24

NO.	NOMENCLATURE BASIC PART NUMBER CSM NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Accelerometer Linear ME449-0020 00920308 ME449-0091 01220319	65 65	0 0	4 4	0 0	7 7	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X		100% 100%	1 1	0 0	0 0	2080 H	-1023 (1) -1003 (2)	2	0	0	11 C
2	Acoustic Measurement System, Microphone ME901-0080 00920309	15	0	2	0	2	X	X		X	X	X					X		100%	1	0	0	1986 H	1001	1	0	0	
3	Central Timing Equip. ME456-0006 01221312	13	2	4	2	1	X	X	X	X	X	X	X	X	X	X			100%	13	0	0	4693 H	0031 (1)	1	0	0	487 H
4	Char Measurement Sensor ME431-0026 00920314	55	0	4	0	3	X	X	X	X	X				X	X	X		100%	0	0	0	468 H	2403 2908 (20)	0	0	0	
5	Char Measurement Signal Conditioner ME901-0332 00920314	60	0	4	0	3	X	X	X	X	X				X	X	X		100%	1	0	0	612 H	4001	0	0	0	
6	Current Limiters V14-750151 00920307	10	0	2	17	10	X	X	X	X	X	X	X	X		X			100%	1	0	0	E400 H	(1)	0	0	0	
	Current Limiters V14-750152 00920307	10	0	2	17	10	X	X	X	X	X	X	X	X		X			100%	1	0	0	E400 H	(2)	0	0	0	
	Current Limiters V14-750155 00920307	10	0	2	17	10	X	X	X	X	X	X	X	X		X			100%	1	0	0	E400 H	(2)	0	0	0	

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SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

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No.	NOMENCLATURE BOEING PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: DESIG. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
7	Data Storage Equip. ME435-0013 01221311	16	2	4	2	1	X	X	X	X	X	X	X	X	X	X							100%	19	19	14	3211 H	(1)	0	0	0	E224 H
8	Heat Shield Instr., Thermocouples ME265-0007 00920322		0	76	0	55	X			X	X					X	X						100%	1	0	0		-0081 (3) -0082 (3)	0	0	0	
9	Heat Shield Instr., Xducer., Thermal Flux., Surf ME449-0064 00920322		0	4	2	24	X			X	X					X	X						100%	0	0	0	E1050 H		0	0	0	
10	Heat Shield Instr., Sensor, Calorimeter ME432-0088 00920322		0	6	0	12	X			X	X					X	X						100%	0	0	0	E140 H	-0013 (1) -0014 (1)	0	0	0	
11	Meters ME432-0047 01226312	80		23			X	X	X	X	X			X	X	X							80%	1	2	0		-1103 (1) -1113 (1)	0	0	0	
																												-1114 (1) -1132 (1)				
																												-1133 (1) -1204 (1)				
																												-1206 (1) -1238 (1)				

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CERTIFICATION TEST DATA

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NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
11	CONT'D.																											-1240 (1) -1610 (1)				
																												-1612 (1) -6116 (1)				
																												-6218 (1) -6219 (1)				
																												-6220 (1) -6225 (1)				
																												-6226 (1) -6227 (1)				
																												-6228 (1) -6235 (1)				
																												-6236 (1) -6241 (1)				
																												-6534 (1) -6723 (1)				

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CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

No.	NOMENCLATURE BASIC PART NUMBER CSM NUMBER	NUMBER UNITS	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONFIDENT TIME/ CYCLES
12	Module Assy., Power Control Instr. V16-754024 00920306	2	0	1	2	1	X	X	X	X	X	X	X	X		X							100%	1	0	0	E1000 H	BAS. (1)	0	0	0	
13	Noise Filter, Modular Assy., Thermocouple Sys. V17-750589 00920703	5	0	1	1	1	X	X		X	X		X			X							100%	0	0	0	E1000 H		0	0	0	
14	Panel Assy., Data Distr., Flight Qualification V16-757132 00920313	5	0	1	1	1	X	X	X	X	X	X	X	X		X							100%	0	0	0	E1000 H		0	0	0	
15	Panel Operational Data Distribution V16-754000 00920304	10	0	1	1	1	X	X	X	X	X	X	X	X									100%	0	0	0	E1000 H	BAS. (1)	0	0	0	
16	Power Supply (5 Volt) ME464-0090 00920320	205	0	2	0	14	X	X	X	X	X	X	X		X								100%	3	0	0	E214 H	-0004 (2)	0	0	0	3 H 7 C
17	Power Supply (10 Volt) ME464-0090 00920711	205	0	2	0	2	X	X	X	X	X	X	X		X								100%	1	0	1	214 H	-0004 (2)	0	0	0	3 H 7 C
18	Recorder, Flight Qualification ME435-0026 01221314	13	2	4	1	1	X	X	X	X	X	X	X	X	X	X							100%	7	0	1	1274 H	0003 (1)	0	0	5	130 H
19	Reference Junction, Thermocouple ME476-0012 00920321	1470	0	4	0	108	X	X	X	X	X					X	X						100%	0	0	0	496 H	-0020 (9) -0048 (7)	0	0	0	15 C

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SUBSYSTEM 5.0 INSTRUMENTATION

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
20	Sensor Assy., Calorimeter ME432-0088 00920316	160	0	4	0	12	X	X	X	X	X					X	X		100%	0	0	0	510 H	-0013 (1) -0014 (1)	0	0	0	
21	Sensor, Temperature ME432-0082 00920303	65	0	1	9	4				X									100%	0	0	0	38 H	-1050 (4)	0	0	0	
22	Sequencer ME470-0100 00920317	110	0	8	0	0	X	X	X	X	X				X	X	X		100%	0	0	0		-0006 (2)	0	0	0	
23	Signal Conditioning Equip. ME901-0081 01221307	13	2	4	2	1	X	X	X	X	X		X		X	X			100%	22	4	0	4659 H	(1)	0	0	0	434 H
24	Signal Conditioner, Pressure Meas. ME901-0289 00920301	870	0	8	42	57	X	X	X	X	X				X			X	100%	0	0	0	208 H	-1002 (1) -1004 (2)	0	0	0	
																								-1005 (1) -1007 (1)				
																								-1009 (2) -1010 (9)				
																								-1012 (12) -1028 (9)				

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CERTIFICATION TEST DATA

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SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

No.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
25	Signal Conditioner, Temperature Meas. ME901-0291 00920302	950	0	4	12	56	X	X	X	X	X				X	X	X	X					100%	0	0	0	100 H	-0050 (2) -3043 (1)	0	0	0	
																												-3046 (2) -3048 (6)				
																												-3050 (5) -3091 (4)				
																												-3534 (7) -3549 (2)				
																												-3582 (2) -3583 (2)				
																												-3084 (1) -3589 (1)				
																												-6363 (2)				
26	Telemetry, PCM ME901-0083 01221308	16	2	4	2	1	X	X	X	X	X	X	X	X	X	X							100%	12	0	0	6104 H	0104 (1) 0002 (1)	0	0	0	478 H 481 H

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CERTIFICATION TEST DATA

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SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
27	Temperature Measurements, Zone Box ME161-0015 00920319	940	0	28	14	101	X	X	X	X					X		X						100%	1	0	0	E100 H	-0002 (2) -0004 (2)	0	0	0	
																												-0005 (1) -0010 (3)				
																												-0011 (1) -0013 (3)				
																												-0067 (1) -0068 (2)				
28	Temperature Measurements, Thermocouple ME265-0007 00920319	215	0	6	0	55	X	X	X	X					X		X						100%	1	0	0		-0081 (3) -0082 (3)	0	0	0	
	ME361-0004 00920319	420	0	4	0	29	X	X	X	X					X		X						100%	1	0	0		-0001 (4)	0	0	0	
	ME361-0008 00920319	70	0	7	8	13	X	X	X	X					X		X						100%	0	0	0		(15)				
29	Temperature Measurements Signal Conditioner ME901-0338 00920319	185	0	8	6	93	X	X	X	X					X		X						100%	1	0	0	E100 H	-0030 (1) -0040 (1)	3	0	0	

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CSM 012

SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	PROPELLANT COMP.						CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
29	CONT'D.																											-0050 (8) -0100 (1)				
	Transducer, Mass Flow																															
30	ME449-0015 01120303	75	0	4	18	0	X	X	X	X	X				X	X	X						100%	1	0	0	1850 H	-1003 (3) -1004 (4)	1	0	0	
	Transducer, Pressure																											-0050				
31	ME449-0050 00920301	0	0	0	12	6	X	X	X	X	X	X	X	X	X	X	X						100%	0	0	0	208 H	(2)	5	0	0	
	ME449-0051 00920301	40	0	4	0	0	X	X	X	X	X	X	X	X	X	X	X						100%	0	0	0	208 H	-1004 (1)	3	0	0	
	ME449-0052 00920301	930	0	4	48	21	X	X	X	X	X	X	X	X	X	X	X						100%	1	0	0	208 H	-1000 (2)	14	0	0	
																												-1002 (1) -1004 (2)				
																												-1005 (1) -1010 (9)				
																												-1012 (12) -1028 (7)				
	ME449-0053 00920301	160	0	4	4	36	X	X	X	X	X	X	X	X	X	X							100%	1	0	0	208 H		0	0	0	

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SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

NO.	NOMENCLATURE / BASIC PART NUMBER / CTR NUMBER	NUMBER BUILT	CERTIFICATION TEST DATA: DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	GEN GROUND TEST QUANTITY	GEN FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
31	CONT'D.																															
	ME449-0101 01220311	45	0	4	0	0	X	X	X	X	X	X	X	X	X	X	X						95 %	0	0	0	1928 H	-0002 (3) -0008 (1)	0	0	0	
																												-0011 (1) -0015 (1)				
	ME449-0070 01220312	15	0	4	0	0	X	X	X	X	X	X	X	X	X	X	X						95%	0	0	0		-1008 (1)	0	0	0	
32	Transducer, Separation Monitor ME449-0107 00920721	55	0	2	0	0	X	X		X	X						X						100%	1	0	0	E200 H	-0001 (4) -0004 (2)	1	0	0	
33	Transducer, Temperature ME449-0029 00920302				0	12	X	X	X	X	X				X	X	X	X					100%	0	0	0	100 H	-6363 (2)	1	0	0	
	ME449-0030 00920302	765	0	2	33	31	X	X	X	X	X				XX		X	X					100%	0	0	0	100 H	-3046 (2) -3048 (1)	30	0	0	
																												-3086 (1) -3091 (1)				

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SUBSYSTEM 5.0 INSTRUMENTATION SYSTEM

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
33	CONT'D.																											-3086 (1) -3091 (1)				
																												-3534 (7) -3543 (1)				
																												-3548 (1) -3549 (2)				
																												-3550 (5) -3582 (2)				
																												-3583 (2) -3584 (1)				
																												-3589 (5)				
	ME449-0034 00920302	50	0	2	9	3	X	X	X	X	X				X	X	X	X					100%	0	0	0	E100 H	-2044 (3)	0	0	0	
	ME449-0097 01220309	20	0	4	0	0	X	X	X	X	X	X	X		X	X	X	X					100%	0	0	0		-0198 (1) -0202 (1)	0	0	0	

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5.4 CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

INSTRUMENTATION

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

A. S. Kearsley 6/15/66

Certification Project Engineer

5.5 WAIVERS, SCN's AND RFC's - INSTRUMENTATION SYSTEM

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
5.5.1	Waiver	Measurement No. CA5494R	NAA to Submit
5.5.2	Waiver	Wiring Splice	NAA to Submit

Engineering Manager

Project Engineer

6. REACTION CONTROL SYSTEM

6.0 System Organization

6.1 Systems Test Results

6.2 Problem Summaries

6.3 Hardware Summary

6.4 Cert/Flt Hdw Differences

6.5 Waiver/SCN/RFC Information

6.0 REACTION CONTROL SYSTEM

The Reaction Control System (RCS), for purposes of the CARR, consists of RCS subsystems, equipment and assemblies as listed herein. The RCS consists of the command module and service module subsystems, both of which provide CSM control and translation using pulse modulated positive expulsion of earth storable liquid hypergolic propellants, with helium as a pressurant.

COMMAND MODULE RCS—SYSTEM A

- Engines
- Propellant Storage
- Pressurization Equipment
- Propellant Feed Equipment
- Displays

COMMAND MODULE RCS—SYSTEM B

- Engines
- Propellant Storage
- Pressurization Equipment
- Propellant Feed Equipment
- Displays

SERVICE MODULE RCS QUADS

- Engines
- Propellant Storage
- Pressurization Equipment
- Propellant Feed Equipment
- Displays
- Gaging Equipment

6.1 SYSTEMS TEST RESULTS

6.1.1 OCP-P-4171A-SC-012 - RCS System Leak, Proof Functional Checkout and System's Flush - CM

SCOPE

To proof pressure test and leak check the complete SC 012, CM, RCS, less engines. To verify instrumentation calibration, functionally check the system components, flush the completed system, less engines.

RESULTS

This test was run and the problems that were encountered during the OCP are summarized as follows: The Command Module RCS system components were functionally verified successfully, the instrumentation calibration was verified successfully and the system successfully met the required maximum allowable leakage rates. The systems were flushed and meet the requirements of Process Specification MA0210-0143.

6.1.1.1 PROBLEM - Metal Chips in Line

During Pre-Test set-up, metal chips were found in fuel side System A lines.

CORRECTIVE ACTION

System A was flushed. Later amended to remove fuel tank, back-flush lines, and replace tank.

DOCUMENTATION

Squawk 1 and 83, V16-OCP-4171 TAIR Book.
TPS-V16-RCS-015
TPS-V16-RCS-016
TPS-V16-RCS-017
TPS-V16-RCS-018
TPS-V16-RCS-025

TPS-OCP-4171-010
MR109730
PAR's 5144 & 19065

6.1.1.2 PROBLEM - (Identification on Wire Bundle)

During Pre-Test set-up, unable to verify P132 mated to C28AR31-J1 due to no identification on wire bundle

CORRECTIVE ACTION

DOCUMENTATION

6.1.1.3 PROBLEM - (Transducers CR0623P and CR0625P)

No voltage output from Flight Qual. Transducers CR0623P and CR0625P due to EO M445430 being worked on C03 TB74 instead of C03 TB56.

CORRECTIVE ACTION

Rework C03 TB56 and C03 TB74 correctly per EO M445430.

DOCUMENTATION

Squawk Numbers 9, 12, 13, 14, 15, 17, 19 and 33; V16-4171 TAIR Book.
TPS-OCP-4171-002
Ref. E.O. M445430

6.1.1.4 PROBLEM - (Transducer CR0623P)

No voltage output from Flight Qual. Transducer CR0623P.

CORRECTIVE ACTION

Removed and replaced Defective sensor - Signal conditioner set (S/N 10095080258A) with S/N 10095080247A.

DOCUMENTATION

Squawk 10, V16-OCP-4171-TAIR Book.
TPS-OCP-4171-002
PAR No. 19036, PRR No. M89037

6.1.1.7 ENGINEERING ANALYSIS

Changed to allow use of procurement specification maximum allowable ΔP (5 psi). System ΔP of 1 psi accounts for line length and flight half quick-disconnect. Total ΔP is 6 psi.

6.1.1.5 PROBLEM - (Cut Wire)

Wire from D1 to D2 on C03 TB74 cut without MR approval.

CORRECTIVE ACTION

Remove cut wires. No MR action required

DOCUMENTATION

Squawk 18 - V16-OCP-4171-TAIR Book.
Ref. E.O. M445430

6.1.1.6 PROBLEM - (Incorrect Wiring)

All System A operational instrumentation transducers shifted on C14-420 recorder due to C19VL1 Propellant Isolation Valve not being wired per print, causing a short to ground through System B. bus.

CORRECTIVE ACTION

Rewire C19VL1 Propellant Isolation Valve per print.

DOCUMENTATION

Squawk 22, 24, 25, 26, 27 and 30, V16-OCP-4171-TAIR Book.
TPS OCP-4171-004
TPS OCP-4171-005

6.1.1.7 PROBLEM - (Pressure Drop Fuel Check Valve)

Pressure drop across Fuel System A check valve was 6.0 psi; should be 4.5 psi maximum.

CORRECTIVE ACTION

Acceptable per EO M465750, MA0210-0142.

DOCUMENTATION

Squawk 28, V16-OCP-4171-TAIR Book.
E.O. M465750, MA0210-0142

6.1.1.8 PROBLEM - (Incorrect Dust Cap Installation)

Flight-half coupling ME273-0024-0001 has dust cover marked ME273-0021-0001 and red ink markings on cover, 0024.

CORRECTIVE ACTION

Wrong dust cap was installed.

Ground-half coupling ME273-0024-0002 was properly installed. Dust cover was removed and replaced with correctly identified cover. Dust covers are interchangeable, ground-half couplings are not.

DOCUMENTATION

Squawk 32, V16-OCP-4171-TAIR Book

6.1.1.9 PROBLEM - (Sensor Element Shorted to Ground)

CR0004T has output voltage of 4.7 VDC, should be 1.2 VDC. Sensor element shorted to ground.

CORRECTIVE ACTION

Remove and replace CR0004T

DOCUMENTATION

Squawk 36, V16-OCP-4171-TAIR Book.
TPS-OCP-4171-006
PRR 8904

6.1.1.10 PROBLEM - (Helium Tank Temperature)

Helium tank temperature exceeded 110°F maximum temperature by 2°F to 112°F.

CORRECTIVE ACTION

GSE console pressure regulator was not set to full decrease quite soon enough when coming up to 4,000 psi in helium tank.

2°F over maximum is acceptable to RCS Engineering.

DOCUMENTATION

Squawk 39, V16-OCP-4171-TAIR Book.

6.1.1.11 PROBLEM - (Bladder Differential Pressure)

Bladder differential pressure was momentarily 46 psi, maximum allowable is 40 psi in Sequence 07-043, regulator lock-up flow.

CORRECTIVE ACTION

GSE console regulator decrease adjustment was set slightly too slow. Bladder integrity was verified during Sequence 11.

DOCUMENTATION

Squawk 40, V16-OCP-4171-TAIR Book.

6.1.1.12 PROBLEM - (Jumper Wire Incorrectly Installed)

System B Propellant Isolation Valves would not close in Sequence 07-076.

CORRECTIVE ACTION

Jumper wire D1 to D2 and C1 to C2 were incorrectly installed on C03 TB56.

Rewire C03 TB56 to print.

DOCUMENTATION

Squawk 41, V16-OCP-4171-TAIR Book.
TPS-OCP-4171-007

6.1.1.13 PROBLEM - (Bent Pin in P3A3J)

P3A3J-41 pin bent at 30° angle.

CORRECTIVE ACTION

Straighten pin and inspect per MR109631,

6.1.1.15 ENGINEERING ANALYSIS

EOM 484972 was issued as a result of re-evaluation of system Δ P. Recalculation of Δ P for $-$ P engines, (because of the pressurehead difference) allowed the Δ P allowable to be increased by 4 psi. These were the only engine lines over the 14 psi Δ P allowed.

DOCUMENTATION

Squawk 42, V16-OCP-4171-TAIR Book.
MR 109631, CAR 1347

6.1.1.14 PROBLEM - (Pressure Gage Read Incorrectly)

Pressure drop across Propellant Isolation Valves was minus (-) 1.5 psi.

CORRECTIVE ACTION

Gages read incorrectly. Re-run sequence to verify pressure drop reading properly.

DOCUMENTATION

Squawk 47 and Squawk 70 - V16-OCP-4171-TAIR Book.

6.1.1.15 PROBLEM - (Pressure Drop Across Dummy Engine)

Pressure drop across RCS propellant distribution lines exceeds 14 psi maximum allowable.

CORRECTIVE ACTION

Pressure drop across dummy engines was not taken into account when specification requirements were calculated.

Ran TAIR across dummy engines to provide RCS Engineering data when test equipment is installed.

DOCUMENTATION

Squawk 50, 61, 69 and 72, V16-OCP-4171-TAIR Book.
TPS-V16-RCS-014
E.O. M484972 - MA0210-0143.

6.1.1.16 PROBLEM - (Isolation Valves Pressure Drop)

Pressure drop across Propellant Isolation Valves exceeds 3 psig maximum allowable.

6.1.1.16 EOM 484972 increased the ΔP by .5 psi to take into consideration the system line loss.

CORRECTIVE ACTION

EO 484972 change maximum allowable valve to 3.5 psig

DOCUMENTATION

Squawk 73, V16-OCP-4171-TAIR Book.
E.O. 484972, MA0210-0143

6.1.1.17 PROBLEM - (Fuel and Oxid System A Possible Contamination)

Fuel and Oxid. System A possibly contaminated

CORRECTIVE ACTION

Reflush System A per MR109300. MR109300 later was voided and superseded by MR109730 and MR109736 which removed and replaced System A fuel and oxid. tanks.

DOCUMENTATION

Squawk 68, 83 and 84, V16-OCP-4171-TAIR Book.
MR109300 - voided and superseded
MR109730 - Fuel tank replacement
MR109736 - Oxidizer tank replacement
PAR 19065

6.1.1.18 PROBLEM - (Skin Temperature on Tanks)

During drying of system after Freon flush, no provision was made to monitor skin temperature of tanks

CORRECTIVE ACTION

No capability of existing GSE/SMD to monitor tank skin temperatures.

While heat lamps were on Freon was in tank. The level of Freon in the tank was monitored and lamp position changed to prevent excessive temperature on bladder.

DOCUMENTATION

Squawk 77A, V16-OCP-4171-TAIR Book

6.1.1.19 PROBLEM - High NVR Count

High NVR count was found on the flushing cart, after Freon was introduced into System A

CORRECTIVE ACTION

4 to 8 hours delay in receiving NVR results from QAL caused STC to start test without NVR results.

After NVR result was obtained, Freon was changed and an acceptable NVR was obtained, system then reflushed.

DOCUMENTATION

Squawk 78, V16-OCP-4171-TAIR Book
TPS - V16-RCS-023

6.1.1.20 PROBLEM - Fuel Tank Leakage

System A Fuel tank bladder leaked excessively (305 cc/15 min. S/B NMT 130 cc/15 min).

CORRECTIVE ACTION

Defective fuel tank bladder.

Removed and replaced fuel tank, back-flushed system lines prior to new tank installation.

DOCUMENTATION

Squawk 83, V16-OCP-4171-TAIR Book.
MR 109730
TPS-RCS-018
TPS-RCS-022
TPS-OCP-4171-010
PAR 5144

6.1.1.21 PROBLEM -

Oxidizer Tank System A possibly contaminated.

CORRECTIVE ACTION

After inspection and engineering evaluation of System A fuel tank bladder, decision was made to replace System A oxidizer tank also.

Removed and replaced oxidizer tank, back-flushed system lines prior to new tank installation.

DOCUMENTATION

Squawk 84, V16-OCP-4171-TAIR Book
MR 109736
TPS-RCS-018
TPS-RCS-023
TPS-OCP-4171-010
PAR 19065

6.1.2 OCP-P-4175-SC-012 - RCS Quad Assemblies Proof, Leak, Quad "A" and Functional Checkout Bldg. 289.

SCOPE

This test was conducted to verify that the RCS quad meets the leak, proof pressure and functional requirements of Process Specification MA0210-0099.

RESULTS

During sequence 01, a pressure regulator failed to lock up. Test was discontinued and the quad was shipped to D/659 for replacement of this pressure regulator. PAR 19025

Quad was returned and retest started when a leak was detected at a braze joint in sequence 01 which was above the specified limit of the OCP. It was decided by RCS engineering to continue with the test thru sequence 08 and test was completed on 2 April 1966.

This Quad did not meet the requirements of Process Specification MA0210-0099 as open squawks are still pending. Following integrated tests the Quad will be shipped to D/659 for repair of leaks and MCR rework. It will then be returned to the Test Cell area for retest.

6.1.3 OCP-P-4175-SC-012 - RCS Quad Assembly Proof, Leak, and Functional Checkout
Quad "B"

SCOPE

This test was conducted on RCS quad assembly "B to verify proof, leak, and functional checkout requirements of Process Specification MA0210-0099.

RESULTS

Quad "B" was installed in Test Cell 289-5B and test progressed to sequence 01-015 at which time testing per OCP was discontinued in order to perform a troubleshooting TPS on the instrumentation problems encountered. Testing for TPS 003 and TPS 004 revealed the high and low pressure sensors were installed in reverse, and that the transducers intermittent readings were caused by a broken wire in the splice.

Testing for TPS 005, 006, 007 and 008 revealed a check valve was installed in the system instead of a filter, causing pressure lockup. **The facility check valve was replaced with a filter, and testing was completed with no major problems.**

6.1.4 OCP-P-4175-S/C-012 - RCS Quad "C" Leak, Proof Pressure and Functional Checkout
Quad "C"

SCOPE

This test was conducted to verify that the RCS quad "C" met the leak, proof pressure and functional requirements of Process Specification MA0210-0099.

RESULTS

Test was conducted on the RCS quad "C" and during leak check in Sequence 01 a leak was detected at one of the transducer fittings. Sequence 01 was completed and leak repaired. Test continued until Sequence 02 when a hold was called due to a shortage of high and low pressure orifices. Test continued after receiving orifices. Also during Sequence 02 pressure regulators failed to lockup at the correct pressure. A troubleshooting TPS was run to determine cause of regulator failure. During Sequence 03 test was stopped to replace a faulty facility supply valve. Test continued until Sequence 07 when a hold was called to determine the correct electrical schematic to use.

Sequence 06 was rerun to determine if bladders had been damaged. Due to delta "P" gauges having "0" pressure at two occasions during pressurization. Sequence 06 was performed satisfactorily. Sequence 07 was also performed to verify readings of previous checks. Quad was again returned for test of Sequence 02 and Sequence 03, for recheck of regulators. Test was stopped during Sequence 03 because quad was required at Bldg. 290 to support weight and balance tests on the S/M. The RCS quad "C" did not meet the requirements of Process Specification MA0210-0099, because open squawks are still pending and rerun of Seq. 03 has not been completed. After integrated tests, quad will be delivered to D/659 for MCR rework.

6.1.5 OCP-P-4175-SC-012 - RCS Quad Assemblies Leak, Proof Pressure and Functional Checkout. Quad "D"

SCOPE

This test was conducted to verify that the RCS quad meets the leak, proof pressure and functional requirements of Process Specification MA0210-0099.

RESULTS

During leak test in Sequence 01, a leak was detected at a brazed joint which was above the specified limits of the OCP. It was decided by RCS engineering that Sequences 02 and 03 would be omitted until after the leak was repaired, but to go on testing Sequence 04 thru 08. After Sequence 08 was completed the defective braze joint was repaired. Retest of Sequence 01 was accomplished to clear squawk against the leak and Sequence 02 and 03 were run successfully. RCS engineering requested that Sequence 04 be rerun at which time a leak was noted at the fuel secondary check valve. Sequence 04 was completed with an open squawk against the check valve leakage. The RCS "D" quad did not meet the requirements of Process Specification MA0210-0099 as open squawks are still pending. The quad will be retested at a later date following MCR rework and replacement of the secondary fuel check valve.

PAR 10822

6.1.6 OCP-P-4628-SC-012 - RCS Helium Panel Leak, Proof and Functional Checkout C/M "A" System

SCOPE

This test was conducted to verify leak, proof and functional checkout per Process Specification MA0210-0097.

1. To verify the pressure integrity of the C/M RCS helium pressurization sub-system.

2. To verify leakage rate do not exceed specification limits.

3. To functionally checkout the regulators, check valves and relief valves.

4. To verify integrity of the burst discs.

RESULTS

Testing was started on the RCS Helium Panel C/M "A" system and sequences 01 and 02 were successfully run. Sequences 03 and 04 had low out of tolerance readings. Sequence 05 was run with no apparent problems. Sequence 06 had excessive leakage at the fuel check valve. Sequence 07 and 010 thru 014 were run successfully. Sequences 08 and 09 revealed low out of tolerance readings.

The RCS Helium Panel was then sent to D/659 for flushing of fuel check valve to correct the indicated malfunctions. After flushing the fuel check valves the panel was returned to the test area for retest of the flushed components. It was determined that flushing had not cleared up the problem so the panel was again returned to Dept 659 for additional flushing as no spare parts were available. Panel was then returned to Bldg. 289 for retest but fuel valves were still malfunctioning. RCS engineering dispositioned to remove and replace the fuel check valve. After this had been accomplished the panel was once again returned to Bldg. 289 retest. This time sequences 01 thru final 014-001 were run with no problems experienced.

PAR's 10153 & 16009

6.1.7 OCP-P-4629-SC-012 - RCS Helium Panel Leak, Proof and Functional Checkout C/M "B" System

SCOPE

This test was conducted to verify leak, proof and functional checkout for Process Specification MA0210-0097

1. To verify pressure integrity of the C/M RCS Helium distribution sub-system.

2. To verify leakage rates do not exceed specification limits.

3. To functionally checkout the regulators, check valves and relief valves.

4. To verify integrity of the burst discs.

RESULTS

Testing was started on the RCS Helium Panel, C/M "B" system and during Sequence 01 a hold was called to correct an audible leak at the GSE connections to the helium panel. After resuming testing, at Sequence 01-010 a leak was detected at tube stems, another hold was initiated to repair these leaks. Conicle scales were installed on the tube stems and other facility lines and TPS-RCS-003 was written to rerun Sequence 01. NASA red tagged the new facility pressure supply lines and TPS-B-289-GEN-308 was generated to switch from facility to EDL pressure supply. This could not be accomplished at will due to the fact EDL supply was being used with concurrent test in progress at Sta. 5B.

Sequence 01-001 thru 01-012 was successfully rerun. Sequence 02 thru Sequence 03 were run successfully. Sequence 04 was run successfully with the exception of Squawk #9, pressure readings out of tolerance which were made acceptable by coverage by EO 432788 which resolved the problem. Sequence 05 revealed check valve leakages and A1 trouble shooting TPS 004 was initiated to isolate the trouble. Decision to by-pass further check valve tests was made and testing

proceeded to Sequence 07. Tube stem leakage occurred and repairs were made and testing proceeded to Sequence 08, where Squawk #13 revealed metal particles in the system which required a hold for a particle count blowdown was made and testing resumed after satisfactory reports were made. Sequences 09 thru 012 were successfully run. TPS 005 was written to identify difficulty encountered on check valve leakage during the first run of Sequence 05. Running of T/S TPS-005 proved indications on first run were in error and that no leakage existed through the check valves. During retesting on Sequence 01 a valve stem blew off when 620 psig was applied and necessitated an emergency shutdown. Rework of the valve stem was accomplished B T/S TPS 007 and the retest initiated per TPS 008 was successfully accomplished.

6.1.8 OCP-P-4634-SC-012 - RCS Oxidizer Panel Leak, Proof, and Functional Checkout C/M.

SCOPE

The test was conducted on the RCS oxidizer panel to verify leak, proof, and functional checkout per Process Specification MA0210-0055.

RESULTS

The oxidizer panel when received for testing had to be returned to D/659 to check TS-12 for 60° angle because the ground half coupling would not go on TS-12. After completing a constraints review and pre-test briefing the panel installed in the test cell. Sequences 01 thru 02 were completed successfully as were Sequences 04 thru 011. In Sequence 03 sequence line number-133 leaked at a rate to exceed leakage rate as specified in Process Specification MA0210-0055. After Sequence 011 was completed, the panel was prepared and shipped to D/659 for repair of braze joint on - 133 line.

6.1.9 OCP-P-4635-SC-012 - RCS Fuel Panel Leak, Proof, and Functional Checkout C/M

SCOPE

The purpose of this test was to determine if the command module reaction control fuel panel meets the functional, leak, and proof pressure requirements of MA0210-0061 - C/M fuel panel checkout.

RESULTS

Testing of the RCS Fuel Panel was successfully carried out Sequence 01, 003 thru 008 without any problems. Leakage occured during sequence 02 but was repaired and sequence 02 completed successfully with no further problems.

6.1.10 OCP-P-4225-SC 012 - RCS Electrical System Verification - CSM

SCOPE

This test is performed to provide an end-to-end system checkout for the propellant and helium isolation valves, for both flight and qual and operational instrumentation and for the SM RCS quantity gaging system.

RESULTS

In performance of the test, several problems of mechanical and of electrical nature were encountered, all of which were resolved. All RCS electrical tests were satisfactorily completed.

6.1.10.1 PROBLEM - No CLOSED Indication, Quad AH_e1 Switch

No closed indication when Quad A H_e #1 switch was closed. The SM-to-Quad connectors were found not engaged.

CORRECTIVE ACTION

The simulators were removed and Quad-to SM connectors hooked up. Sequence was repeated satisfactorily.

DOCUMENTATION

6.1.10.2 PROBLEM - Measurement CR0514P Not Functioning

A transducer measuring system A CCW Roll Engine pressure was found to be defective.

CORRECTIVE ACTION

The transducer was removed, replaced and retested.

DOCUMENTATION

Squawk 6, OCP-4225. T/S TPS-4225-007, T/S TPS-V16-COM-149. Dev. 009 T #97 reran measurement. PAR 22777

6.1.10.3 PROBLEM - Measurement CR0006 Not Functioning

Transducer measuring System B fuel tank pressure found defective.

CORRECTIVE ACTION

Transducer removed, replaced and retested.

DOCUMENTATION

Squawk 9, OCP-4225. T/S TPS 4225-010, T/S TPS-V16-COM-152. Dev 12T purged during replacement. Dev 015T reran measurement. PAR 22780

6.1.10.4 PROBLEM - Measurement C0520P Not Functioning

Transducer measuring System B CCW roll engine pressure found defective.

CORRECTIVE ACTION

Transducer removed, replaced and retested.

DOCUMENTATION

Squawk 10, OCP-4225. T/S TPS-4225-009, TPS-V16-COM-151. Dev 010T purged during replacement. Dev 011T reran measurement. PAR 22781

6.1.10.5 PROBLEM - Measurements CR2204 (System B-Pitch Eng. Oxid Valve Out Temp) and CR2205 (System A - Pitch Eng. Oxid Valve Out Temp) channels were crossed.

CORRECTIVE ACTION

Remove wire from J850D54A and place in J850D64A. Wire in J850D64A place in J850D54A.

DOCUMENTATION

Sqk 11, OCP-4225, T/S TPS-4225-012 EDB Squawk #132

6.1.10.6 PROBLEM - Measurement CR4582T Not Functioning

Transducer measuring CCW roll eng out wall temp. was found defective.

CORRECTIVE ACTION

Transducer and signal conditioner were found defective, removed, replaced, and retested

DOCUMENTATION

Squawk 12, OCP-4225. T/E TPS 4225-011, TPS - V26-COM-154 TPS 4225-011 reran measurement.

6.1.10.7 PROBLEM - Union Between Flex Line and Dynatube Fitting Leaking

Braze union on system B + pitch oxidizer side was leaking about 7×10^{-2} std cc/sec)

CORRECTION ACTION

A reheat was attempted but failed. The union was removed and replaced.

DOCUMENTATION

Squawk 14, OCP-4225. TPS-4225-013. Squawk 16, Dev 013T leak test joint.

6.1.10.8 PROBLEM - Measurement SR5006 not Reading Ambient

Cal data card for SR5006 in ACE was found to be incorrect.

CORRECTIVE ACTION

Correct cal data card was put into ACE.

DOCUMENTATION

Squawk #18, OCP-4225, T/S TPS-4225-041, TPS-ACE-073

6.1.10.9 PROBLEM - The CM Panel 12 RCS Helium Pressure Gage Out of Tolerance

Helium pressure indicated 200 psia at ambient conditions.

CORRECTIVE ACTION

This reading was found to be acceptable per MA0201-0782.

DOCUMENTATION

Squawk #19, OCP-4225, T/S TPS - 4225-017.

6.1.10.10 PROBLEM - The CM RCS Propellant Isolation Valves Were Found Hot

On panel 15 the controlling switches for the CM are not spring loaded to the center position when set to on.

CORRECTIVE ACTION

The test team and engineering were informed on this incident and the potential hazard. The valves were continuity, meggar and functionally checked for possible damage and found acceptable.

DOCUMENTATION

Squawk #21, OCP-4225, T/S TPS-4225-006, EDB Squawk 133. PAR 21037

6.1.10.11 PROBLEM - SM RCS Quantity Gaging Tank Counts Read High

The empty tank calibration counts test environment is different than the spacecraft empty tank conditions. The spacecraft readings are high due to scatter (reflection) from the SPS tanks and inter quad radiation

CORRECTION ACTION

The system will be calibrated on the spacecraft before launch at KSC. No further correction action is required.

DOCUMENTATION

Squawk #23, OCP-4225, T/S TPS-4225-016

6.1.10.12 PROBLEM - The Fuel Quantity Gaging Measurement on the ACE CRT did not always agree with the GCE input and CM Fuel Display

The ACE program is not compatible with the telemetered output.

CORRECTIVE ACTION

ACE programmers are developing a new program for SR 5055 and SR 5056.

DOCUMENTATION

Squawk #25, OCP-4225, T/S TPS-4225-016

Note: At time of going to press, tests documented in this section were not complete. Documentation of final test results will be provided in Phase II Report.

Jerry E. Jolley
NAA ATO Systems Supr

6.2 PROBLEM ANALYSIS - REACTION CONTROL SYSTEM/CM-SM

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012 Date: 6-10-66

Subsystem/End Item Command Module Reaction Control System Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Propellant Feed System for CM RCS V16-400101-501

Spacecraft [X] GSE [ ] CTR Not Applicable

Apollo Reliability C. E. Barner Apollo Engineering J. Wolff 6/10/66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Contamination was introduced into the propellant system during manufacturing preparation for brazing and from test equipment. Reference PAR's 5144 and 19065.

Subsequent to system cleanliness verification, the "A" system was exposed to decomposition products of heated Freon which was inadvertently drawn into the nitrogen heating cart prior to the drying operation. Halogen contamination was suspected. Subsequent leak check of fuel tank showed excessive bladder leakage.

The unit fuel tank was removed from the system and disassembled. The bladder was sent to the QAL for analysis. Metal chips and plasticizer were identified. Bladder leakage was caused by the metal chips during final cycling operation to expel the flushing fluid. Plasticiper was introduced by transfer of the Freon MF from the storage drum to the flushing cart. Tygon tubing was used for transfer.

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

The test equipment (SMD-9FS-5212) was changed to prevent drawing freon into the heating elements. Reference E. O. 325984. NVR count will be made and results given to test personnel before flushing with freon to prevent residue in system (called out in OCP 4171A). System was reflushed and verified clean after tank removal and prior to new tank installation. New oxidizer and fuel tanks were installed into system and all tests were successfully passed. X-ray diffraction and Electron Microprobe examination showed no evidence of tank or system damage due to contamination by halogens (chlorides or fluorides).

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RM 2958-G NEW 1-66

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012 & 014 Date: 6-17-66

Revised: Ø1 _____
Ø2 _____
Ø3 _____
Ø4 _____

Subsystem/End Item SM/RCS

Equipment Name, S&ID P/N Fuel Sensor ME431-0027-0002
Oxidizer Sensor ME431-0028-0002

Spacecraft [X] GSE [ ]

Apollo Reliability DLH C. E. Varner C.O. Behn Apollo Engineering [signature]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

(a) Requirement: The RMS value of a 3 x 4 matrix (3 readings per each of 4 tank positions) must be within ± 2.5% of full tank, minus 1/10 pound.

Observed: Fuel sensor RMS values of ± 5.43% minus 1/10 pound and oxidizer sensor RMS values of ± 2.73% minus 1/10 pound were observed.

CTR # 01214316
Failure Reports: GCC # 3718, 3720, 3721, 4278, 4723, 4726

(2) Problem Status Unresolved (Resolved, Unresolved, or explained)

(a) Effect on Flight: The failure would be unobservable. It could cause the astronauts to believe they have RCS propellants when the tanks are empty.

(b) Analysis being conducted by Giannini Controls Corporation to determine the cause of inaccuracies. Analysis to be completed by June 23, 1966.

(c) Responsible department, Vehicle Systems - Apollo, D/696-603; Manager J. W. Gibb

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012 & 014 Date: June 17, 1966

Subsystem/End Item SM/RCS Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Fuel Sensor ME431-0027-0002
Oxidizer Sensor ME431-0028-0002

Spacecraft [X] GSE [ ]

Apollo Reliability C. E. Daniel C.O. Baker Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

(a) Requirement: The output signal of any specific sensor, for any one reading at any given quantity and tank position, must represent that quantity within ± 4% of full tank, minus 1/10 pound.

Observed: Fuel sensor readings of 16% minus 1/10 pound and oxidizer readings of 5% minus 1/10 pound wer observed.

FR - Attached List
CTR #01214316

(2) Problem Status Unresolved (Resolved, Unresolved, or explained)

(a) Effect on flight: The failure would be unobservable. It could cause the astronaut to believe that he has RCS propellants when the tanks are empty.

(b) Analysis being conducted by Giannini Controls Corporation to determine why the system is sensitive to high temperature and vacuum. Analysis to be completed by 23 June 1966.

(c) Responsible department, Vehicle Systems - Apollo, D/696-603; Manager J. W. Gibb

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APOLLO PROBLEM SUMMARY

(1) Problem Description (Continued)

Failure Reports: GCC # 3401
3402
3403
3404
3405
3406
3407
3408
3409
3412
3413
3414
3415
3416
3417
3418
3721
4249
4270
4271
4272
4273
4274
4278
4296
4374
4375
4376
4377
4531
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4591
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4735
4736
4737

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012 & 014 Date: 6-17-66

Subsystem/End Item SM/RCS Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Fuel Sensor ME431-0027-0002
Oxidizer Sensor ME431-0028-0002

Spacecraft [X] GSE [ ]

Apollo Reliability C. E. Darnell Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

(a) Requirement: Sensor self test readings should be within ± 2% of a predetermined numeral or 77.5 to 80.5 pounds fuel and 154.9 to 161.1 pounds oxidizer.

(b) Observed: During self test fuel reading varied from 76.2 to 81.1 pounds and oxidizer readings down to 153.9 pounds.

CTR #01214316
Failure Report: GCC #3782, 4269, 4272, 4525, 4526, 4527, 4530, 4531, 4532, 4533, 4534, 4535, 4537, 4538, 4539, 4540, 4579, 4725, 4732, 4735, 4737

(2) Problem Status Unresolved (Resolved, Unresolved, or explained)

(a) Effect on Flight: Failure would be observable. Astronauts would know that their Gaging system was not accurate.

(b) Supplier is in process of conducting failure analysis. Analysis is due June 23, 1966.

Responsible department: Vehicle Systems-Apollo, D/696-603, Manager J. W. Gibb

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6.3 HARDWARE SUMMARY - REACTION CONTROL SYSTEM/CM-SM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSM 012

SUBSYSTEM 6.0 RCS CM/SM

6-56

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	PROPELLANT COMP.	PROOF PRESSURE	LEAKAGE	ACOUSTICS			CTR STATUS	CTR FAILURES RESOLVED	CTR FAILURES EXPLAINED	CTR FAILURES OPEN	CTR TIME/ CYCLES	CONF. & QUANT.	CSM FAILURES RESOLVED	CSM FAILURES EXPLAINED	CSM FAILURES OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Computer, Propellant Quantity ME470-0018 01214314		1	2	1	1	X	X	X	X			X	X									40%	0	0	8	800C	0002 (1)	0	0	0	
2	Coupling, Helium Tank, 1/4" Fill, Disconnect ME273-0010 00913303	30	2	4	24	24	X	X		X	X												100%	0	0	0	2167C	0001 (6)	0	0	0	
3	Coupling, Propellant, RCS Disconnect ME273-0011 00913304	81	4	6	80	96				X	X						X						100%	0	0	0	93C	0001 (5)	0	0	0	26C
	ME273-0019 00913304	81	4	6	80	96				X	X						X						100%	0	0	0	23C	0001 (12)	0	0	0	
	ME273-0021 00913304	81	4	6	80	96				X	X						X						100%	0	0	0	423C	0001 (12)	0	0	0	
4	Coupling, Test Point Disconnect ME144-0023 00913301	988	8	8	128	128	X	X		X							X						100%	4	0	0	1542C	0011 (28) 0031 (30)	0	0	0	
5	Disc Assy., Burst 5/8" Dia Ports ME251-0005 01213312		8	8	16	16	X	X		X							X						80%	2	0	0		0004 (2) 0014 (2)	0	0	0	2:20H 84C
6	Engine, Rocket, Bi-Prop C/M RCS ME901-0067 01113314	330	9	8	47	47	X	X	X	X	X		X	X		X	X						100%	13	0	0	23KC 2150S	0011 (4) 0012 (8)				
7	Engine, Rocket, S/M RCS ME901-0004 01114313	380	3	5	37	36	X	X	X	X	X		X	X	X		X						100%	0	0	0	111KC	0201 (16)	0	0	0	11M 2133C

Temp. Form R&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 6.0 RCS CM/SM

No.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER UNITS	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM CONFIRM TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	PROPELLANT COMP.	PROOF PRESSURE	LEAKAGE	ACOUSTICS			CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
8	Fitting, Dynatube, Spec. Jump Type ME273-0046 00913305	2226	7	7	48	48				X	X						X						100%	0	0	0		0003 (1) 0004 (2)	0	0	0	
																												0037 (1) 0038 (1)				
																												0041 (1) 0043 (2)				
																												0044 (2) 0047 (12)				
	ME273-0046 00913305	2226	7	7	48	48				X	X						X						100%	0	0	0		0049 (8) 0051 (12)	0	0	0	
9	Gaging System, Propellant Quantity ME289-0010 01214313		1	2	1	1		X		X	X				X								40%	0	0	4	400C	0002 (1)	0	0	0	
10	Hose Assy., Flexible Metal ME271-0019 00913302	594	9	6	24	24	X	X	X	X	X						X						100%	0	0	0	51KC	0014 (2) 0018 (1)	0	0	0	
																												0031 (1) 0032 (8)				

Temp. Form R&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 6.0 RCS CM/SM

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	PROPELLANT COMP.	PROOF PRESSURE	LEAKAGE	ACOUSTICS			CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
10	Continued																											0033 (1) 0034 (1)				
11	Panel, Display, Quantity ME470-0019 01214315		1	2	1	1	X	X	X	X		X	X	X									40%	0	0	11	800C	0002 (1)	0	0	0	
12	Pressure Vessel, He ME282-0002 00913306	170	2	4	24	24				X						X							100%	0	0	0	25,000C	0001 (2)	0	0	0	9C
13	Regulator Unit, Pressure Helium ME284-0021 00913307	135	2	4	61	64	X	X	X	X				X			X						100%	0	0	0	80K C	0002 (4)	0	0	0	
14	Regulator Unit, Pressure, Helium, S/M RCS ME284-0022 00914307	236	2	6	16	16	X	X	X	X							X						100%	0	0	0	121K C	0002 (8)	0	0	0	
15	Sensors, Fuel, Quantity ME431-0027 01214316		1	2	4	4	X	X	X	X	X		X	X	X	X	X						40%	4	0	44	750C	0002 (4)	0	0	0	
16	Sensors, Oxidizer, Quantity ME431-0028 01214316		1	2	4	4	X	X	X	X	X		X	X	X	X	X						40%	2	0	23	750C	0002 (4)	0	0	0	
17	Tank, N_2O_4 ME282-0004 01214701	110	2	2	13	16	X	X		X	X		X			X		X	X	X			90%	5	0	0	40C	0001 (4)	0	0	0	35C

Temp. Form R&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 6.0 RCS CM/SM

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	PROPELLANT COMP.	PROOF PRESSURE	LEAKAGE	ACOUSTICS			CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
18	Tank, N_2O_4 ME282-0006 01113313	55	2	2	7	8				X						X							95%	0	0	0	70C	0001 (2)	0	0	0	4C (D) 4C (W)
19	Tank, UDMH, Positive Expulsion ME282-0007 01113312	55	2	2	7	8				X						X	X						95%	1	0	0	24C	0001 (2)	0	0	0	10C (D) 2C (W)
20	Tank, UDMH, Positive Expulsion ME282-0008 00914306	110	2	2	13	16				X	X							X	X	X			100%	0	1	0	40C	0001 (4)	0	0	0	
21	Valve Assy., Check, He ME284-0024 01213701	360	6	4	8	8	X	X		X						X	X							0	1	0	43,300C	0022 (6) 0052 (6)	0	2	1	
22	Valve, Explosive Operated, Helium, 1/4 inch ME284-0019 01213314		4	4	0	42				X	X					X	X	X	X	X			90%	0	0	0	4C	0002 (8) 0004 (3)	0	0	0	
23	Valve, Propellant, N/C, Explosive Actuated ME284-0130 01213315	169	6	0	0	16				X	X					X	X	X	X	X			100%	0	0	0	65K C	0002 (2) 0012 (1)	0	0	0	
																												0014 (1)				
24	Valve, Relief, Pressure, Helium, S/M RCS ME284-0026 00914309	257	3	4	32	32	X	X		X							X	X					100%	4	0	0	26K C	0002 (4) 0012 (4)	14	0	1	

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CSM 012

SUBSYSTEM 6.0 RCS CM/SM

09-9

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER UNITS	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	PROPELLANT COMP.	PROOF PRESSURE	LEAKAGE	ACOUSTICS			CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
25	Valve, Relief, Pressure, Helium ME284-0062 00913309	103	3	4	16	16	X	X		X					X	X	X						100%	1	0	0	27.5K C	0002 (2) 0012 (2)	8	3	5	8H 20C
26	Valve, Solenoid, Latching ME284-0276 01113310	257	4	4	36	36			X	X				X	X	X	X						100%	0	0	0	86K C	0001 (6) 0002 (4)	0	0	0	
27	Valve, Solenoid, Latching, Helium, 1/4 inch ME284-0053 01114312	128	3	4	32	32	X	X	X	X			X	X	X	X	X							0	0	0	50C	0002 (8)	0	0	0	

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6.4 CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

REACTION CONTROL SYSTEM/CM-SM

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

J.A. for A.S. Krawetz 6/18/66
Certification Project Engineer

6.5 WAIVERS, SCN's AND RFC's - REACTION CONTROL SYSTEM

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
6.5.1	RFC 012-3-16 (PR 12-1-77)	Helium blow-down curves for SM RCS	NAA to complete by 6-20-66

Engineering Manager

Project Engineer

7. SERVICE PROPULSION SYSTEM

7.0 System Organization

7.1 Systems Test Results

7.2 Problem Summaries

7.3 Hardware Summary

7.4 Cert/Flt Hdw Differences

7.5 Waiver/SCN/RFC Information

7.0 SERVICE PROPULSION SYSTEM

The Service Propulsion System (SPS), for purposes of the CARR, consists of SPS subsystems, equipment and assemblies as listed herein. The SPS provides the propulsion increments required for all major velocity corrections subsequent to CSM separation from the launch vehicle and abort propulsion after jettison of the LES. The LES engines provide abort capability during initial phases of launch.

SERVICE PROPULSION SYSTEM

- Engine Assembly
- Propellant Storage
- Propellant Feed Equipment
- Propellant Utilization and Gaging Equipment
- Displays

LAUNCH ESCAPE MOTORS

- Launch Escape
- Pitch Control
- Tower Jettison

7.1 SYSTEMS TEST RESULTS

7.1.1 OCP-P-4064-SC-012 - SPS Propellant System Leak Proof and Functional Checkout - SM

SCOPE

The service propulsion helium pressurization and propellant distribution subsystems were proof, leak, and functional tested per Process Specification MA0201-0101 in Building 260.

The SPS pressurization and propellant distribution subsystems were pressurized to appropriate levels to test the quality of the final assembly joints, and during the pressurization the instrumentation pressure measurement systems calibrations were verified. Temperature measurement systems were verified by comparing readings with the true ambient temperature.

The relief valve poppets and burst discs, and the check valves were tested for internal leakage. Proper setting of the relief valve cracking and reseating pressures were verified and the regulators were tested for proper operating pressures.

RESULTS

A re-run was made to determine an accurate leakage rate of the airborne couplings at test points 13, 14, 15 and 16 (Ref. Squawk #10) and to obtain more data for the Regulator Flow functional checkout because of questionable data obtained on the first run. (Ref. Squawk #11). The rerun showed that the coupling leakage was within the revised allowable leak rate a and the regulator flow data obtained on the rerun showed that the Class 3 and 4 regulators were within specification. All of the sequences in OCP-P-4064-SC-012 were completed successfully.

7.1.1.1 PROBLEM - Leaky "B" Nut

During external leak check at 10 PSIG, the "B" nut on the oxidizer relief valve overboard line indicated leakage when soap solution was applied.

CORRECTIVE ACTION

"B" nut torque was increased within allowable tolerance (900-1100 inch pounds) and the joint was retested successfully.

DOCUMENTATION

Squawk No. 8 - OCP-P-4064 TAIR Book

7.1.1.2 PROBLEM - Leaky Swage Joint

During an external leak check at 183 PSIG, the mass spectrometer indicated leakage at the oxidizer storage tank (V17-470221-11) swage joint at leak rate of 2.82×10^{-4} cc/sec. requirement was 5×10^{-6} cc/sec.

CORRECTIVE ACTION

EO M464951 reduced the requirement to 5×10^{-3} cc/sec.

DOCUMENTATION

Squawk No. 9-OCP-P-4064 TAIR Book

7.1.1.3 PROBLEM - Leaky Flight - Half Couplings

During extenal leak check, the flight-half couplings at TP13 TP14, TP15 and TP16 were found to leak excessively (dust caps were removed). The Mass Spectrometer readings were nearly off-scale which indicated questionable data.

CORRECTIVE ACTION

EO M464951 was released to increase the allowable leak rate and a retest with a lower sensitivity Mass Spectrometer indicated satisfactory results.

DOCUMENTATION

Squawk No. 10 - OCP-P-4064, TAIR Book

7.1.1.4 PROBLEM - Invalid Data

Pressure reading at TP6 was low during regulator flow functional checkout. The data obtained was questionable since the pressure readings downstream of TP6 were higher than the TP6 reading.

CORRECTIVE ACTION

Recalibrated instrumentation and retested with satisfactory results.

DOCUMENTATION

Squawk No. 11 OCP-P-4064 TAIR Book and TPS 4064-008

7.1.2 OCP-P-4131-SC-012 - SPS Engine Leak and Functional Checkout - S/M

SCOPE

This procedure performs external leak checks of the pneumatic control and propellant distribution system of the SPS engine assembly, and internal leak checks and functional checks of all valves in the systems per requirements of process specification MA 0310-0023.

RESULTS

The SPS engine was installed for testing on 17 February. EO 484053, purge check valves and seal installation, was completed before the start of test. During the plumbing connections for test it was discovered that the high pressure quick disconnect airborne coupling on the "A" propellant sub-assembly was the wrong type (4200 series, should be 5200), and at a convenient time during the test the sub-assembly was replaced. The valve timing check revealed that two timing orifices were incorrectly installed in each others port (SP24 and SP25), and after re-installing the orfices correctly, the valve timing was within specification.

7.1.2.1 PROBLEM - Propellant Valve Timing

During the propellant valves functional check, the "A" propellant subassembly valve timing was not within specification limits.

CORRECTIVE ACTION

Test data indicated that the two timing orifices were switched. The orifices were installed in the correct ports and a retest showed that the valve timing was within specification.

DOCUMENTATION

Squawk #5 and #6, OCP-4131

7.1.3 TPS V17-SPS-036 - Leak Check After Oxidizer Tank Rework

SCOPE

This test was made to leak check the engine-to-spacecraft propellant system interfaces, the propellant tank door joints, and all rewelded joints after the replacement of the oxidizer sump and storage tanks with reworked tanks having the stand-pipe butyl seals replaced with teflon seals.

RESULTS

The tanks were pressurized to 120 psig to insure that no failures would occur at the reduced leak check pressure. Pressure was then reduced to 85 psig and the leak check was made. There were no leaks or any other significant problems.

7.1.4 OCP-P-4128-SC-012 - SPS Electrical System and Instrumentation Channel Verification

SCOPE

Instrumentation systems were tested for continuity and correct channel readout by applying stimuli to the circuit and verifying the readout. The electrical control circuits were checked by closing the various manual switches and verifying correct signal indications.

RESULTS

A major spacecraft wiring error was discovered during the injector valve control system test that nullified the SPS redundancy. The wiring change was corrected and the system performed per specification.

Two defective instrumentation channels were uncovered during the checkout and were corrected by replacing the defective components and retesting the channels. Testing of the Propellant Utilization Gaging System uncovered a spacecraft wiring error that caused the tank quantity data to read on incorrect channels. The spacecraft wiring was corrected and a retest of the system showed that the MDP readout correlated with the ACE telemetry readout per specification. At the start of the FCSM test there was no voltage supplied to the reset switch. After investigating the circuit the connector that had been demated was remated and the voltage appeared. The connector was carefully examined and appeared to be in good condition. A reasonable explanation was that the connector had been partially engaged but the technician failed to observe that the engagement jack screw had not been torqued for tight and proper engagement.

7.1.4.1 PROBLEM - SPS Electrical Control Wiring Error

When operating SPS control system using only one electrical power system (MN A or MN B) the respective helium isolation valve and injector valves would not open. Spacecraft wiring design incorrectly made the two "independent" SPS systems dependent on both electrical power systems (MN A and MN B).

CORRECTIVE ACTION

An EO was issued to make each SPS control system dependent only on its respective power system.

DOCUMENTATION

OCP 4128 squawks 11, 12, 13, 14 and 15; EO M462758, EO M466987, TPS V16-TPS-118.

7.1.4.2 PROBLEMS - Defective Temperature Zone Box

When measurement SP0050T sensor was stimulated by the application of heat, there was no response on the readout.

CORRECTIVE ACTION

Zone box was replaced (a component performing some degree of signal conditioning) and the measurement SP0050T responded properly to stimulus.

DOCUMENTATION

OCP 4128 Squawk 17, TPS V17-COM-027 PAR 22849

7.1.4.3 PROBLEM - Defective Signal Conditioner

Measurement SP0008T was reading zero percent for ambient reading and should have been reading a nominal value of 30% (signal conditioner had internal short).

CORRECTIVE ACTION

Replaced matched set of signal conditioner and sensor, and retest demonstrated that measurement system was functioning properly.

DOCUMENTATION

OCP 4128 squawk 18, TPS V16-COM-138, PAR 22918

7.1.4.4 PROBLEM - PUGS Wiring Error

During test of propellant utilization gaging system the tank quantity data did not show correlation of MDP readout with CRT displayed values. Measurement data read on the wrong channels due to incorrect SC wiring.

CORRECTIVE ACTION

SC wiring was corrected. Per EO M508370

DOCUMENTATION

OCP 4128 Squawks 19, 20, 21 and 22: EO M508370

7.1.4.5 PROBLEM - FCSM Improper Electrical Connector Engagement

Before the start of test the Caution and Warning SPS rough EO indicator was illuminated and could not be extinguished by placing the FCSM on/reset switch to the reset position. No voltage was at the FCSM ON/RESET switch.

CORRECTIVE ACTION

Investigated problem and could not find any electrical discrepancies. Reconnected Panel 2 connector and voltage became available to the switch. Examined connectors and could find no faults. Performed three operations of mating and unmating the connections to provide confidence that the trouble would not reoccur. After further analysis it was decided that the most logical explanation of the problem was that during the original mating of the connectors the engagement screw was not torqued for complete engagement.

DOCUMENTATION

OCP 4128 Squawk 25; TPS-OCP-4128-017, TPS-OCP-4128-022

7.1.5 TPS V17-SPS-033 - Install SPS Engine

SCOPE

The SPS engine was installed in the SC-012 service module in accordance with Installation Specification MA0201-0022. The engine and the service module were prepared for the installation. The engine was raised and fastened into place, actuators connected and fuel and oxidizer supply and vent lines connected.

RESULTS

Installation of the engine was performed without problem. Electrical connectors on the engine wiring harness were squawked, but this was of paper work nature requiring a vendor drawing to specify connector configuration. This squawk has been cleared.

No real problems encountered and no documentation required.

7.1.6 TPS V17-SPS-043 - Gimbal Actuator Replacement

SCOPE

These instructions show the method for replacing the SPS engine gimbal actuators and adjusting their lengths to give minimum position signal output with the engine in its design orientation (nulling the actuators).

RESULTS

Per EO M463424 the pitch and yaw actuators installed on the engine (S/N 31) were replaced by actuators, ME901-0615-0015 and ME901-0615-0016 respectively, modified by Aerojet to conform to specification. During installation the new actuators were nulled with the engine fixed in the design orientation of 3° 15 yaw and 0° 41' pitch. The work was completed satisfactorily with no significant problems.

7.1.7 OCP-P-4643 - SPS Helium Panel Leak, Proof, and Functional Checkout

SCOPE

The test of the SM S/C 012 SPS helium pressurization panel is to verify proof pressure external leakage, component leakage, system cleanliness, regulator flow characteristics and overall functional integrity.

RESULTS

Test was begun on 29 December 1965 after completion of facility line blowdown per TPS SPS 001 and SPS helium panel hookup. Sequence 01 (decontamination) S1 and S2 fuel side passed particle count on the first samples, S1 and S2 oxidizer side required total of 4 reruns of oxidizer blowdown per OCP. Sequences 02 thru 04 were completed successfully. Sequence 05 had a leakage rate at TP-9 of 90 cc per hour, should not have been more than 9 cc per hour. Sequence 05 was completed and leakage test at TP-9 was later rerun per TPS-SPS-007. Leakage rates at TP-9 were in tolerance. Sequences 06 thru 08 were completed successfully. Sequence 09 was rerun following replacement of flight transducer SP0003P. All squawks were cleared.

Jerry E. Jolley
NAA ATO Systems Supr

7.2 PROBLEM ANALYSIS - SERVICE PROPULSION SYSTEM

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012, checkout program may also be included.

Each Problem Summary is categorized as resolved, explained or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 008, 011, 012, 014, 017, 020 Date: 5-24-66

Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Subsystem/End Item Service Propulsion

Equipment Name, S&ID P/N Bipropellant Valve, P/N 1118931-136

Spacecraft [X] GSE [ ] CTR 00915301, 01115301, 01215301

Apollo Reliability J. C. Huber C. E. Farmer Apollo Engineering [illegible]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)
Electrical Connector- Dielectric Strength

Electrical connector pin C on pneumatic actuation system three-way valve B-2 showed a short to ground. Failure is attributed to residue from leak detecting solution inside the disconnected connector. The connector was not covered with a plastic cover, as required, during the leak checking operation. AGC FR Q-740.

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

The connector was flushed with freon. A subsequent electrical systems checkout was found to be satisfactory. Test personnel have been directed to follow procedures strictly and cover all such openings when applying leak detecting solutions.

Effectivity: S/C 008, 011, 012, 014, 017 and 020.

APS 856-BA

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 011, 012, 014, 017, 020, 001 Date: 4-25-66

Revised: Ø1 6-9-66

Ø2

Ø3

Ø4

Subsystem/End Item Service Propulsion System

Equipment Name, S&ID P/N Engine Assembly, V17-410101

Spacecraft [X] GSE [ ] CTR 00915301, 01115301 & 01215301

Apollo Reliability C. E. Garner Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Engine Thrust Decay (Helium Ingestion)

SPS engine thrust decayed during S/C 009 flight resulting in a reduced re-entry velocity. Post flight data analysis indicates a time phased development of a fuel rich propellant mixture-ratio. The suspect cause is helium ingestion by the oxidizer, attributed to a possible increase of a leakage observed during static-firing checkout at Pad 16, prior to S/C 009 stacking. Reference: PAR #MA5202, MA14292

Ø Helium ingestion by the N_2O_4 was verified as the failure mode by testing on S/C 001 at WSTF.

Ø (2) Problem Status Resolved (Resolved, Unresolved, or explained)

Ø The following configuration changes are made per MCR-A-1525 dated 5-26-66. Seals are eliminated from the standpipe transfer line within the propellant retention reservoir. A welded steel transfer line is extended up through the existing aluminum standpipe. These changes effective on S/C 011, 012, 014, 017, 020, and 001.

APS 870-BA

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7.3 HARDWARE SUMMARY - SERVICE PROPULSION SYSTEM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CERTIFICATION TEST DATA

CEM 012

SUBSYSTEM 7.0 SPS

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CEM GROUND TEST QUANTITY	CEM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	HUMIDITY	SALT	EMI	ACCEL.	STATIC LOAD	PROP. COMPAT	LEAKAGE	PROOF PRESSURE				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CEM DATA: CONF. & QUANT.	CEM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CONFIDENT TIME/ CYCLES
1	Connector, Flexible, Fuel ME273-0039 00915306	29	0	2	0	6				X													100%	0	0	0		0001 (1)	0	0	0	
2	Connector, Flexible Oxidizer ME273-0040 00915306	21	0	2	0	6				X													100%	0	0	0		0001 (1)	0	0	1	
3	Coupling, Engine Manifold Type I ME273-0011 00915303	128	0	3	4	3				X							X						100%	0	0	0	400 C	0001 (7)	0	0	0	26 CY
4	Coupling Engine Manifold Type III ME273-0024 00915303	123	0	3	4	3				X							X						100%	0	0	0	400 C	0001 (7)	0	0	0	
5	Coupling, Fill Disconnect HE, 5/8" ME273-0009 00915304	41	0	4	4	3					X												100%	0	0	0	400 C	0001 (1)	4	0	0	
6	Couplings, Fill & Vent Propellant, Disconnect ME273-0012 00915305	100	0	5	8	6					X	X					X						100%	0	0	0	100 C	0001 (1)	0	0	0	
	ME273-0018	100	0	5	8	6					X	X					X						100%	0	0	0	100 C	0001 (1)	0	0	0	
	ME273-0020	100	0	5	8	6					X	X					X						100%	0	0	0	100 C	0001 (1)	0	0	0	
	ME273-0022	100	0	5	8	6					X	X					X						100%	0	0	0	100 C	0001 (1)	0	0	0	

Temp. Form B&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 7.0 SPS

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	HUMIDITY	SALT	EMI	ACCELERATION	STATIC LOAD	PROP. COMP.	LEAKAGE	PROOF PRESSURE				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
7	Coupling, Test Point ME144-0023 00915302	1451	3	8	208	208																	100%	4	0	0	1542 C	0011 (4) 0031 (4)	0	0	0	
																												0041 (2) 0051 (4)				
																												0061 (2) 0071 (4)				
																												0081 (2)				
8	Eng. Assy., Rocket ME901-0484 01215301	12	0	3	48	36	X	X	X	X	X	X	X	X	X	X	X						95%	0	4	0	57 C 1500 S	0002 (1)	0	0	0	85 SEC 10 CY
9	Nozzle Assy. Rocket Engine ME901-0192 01215301	8	0	0	4	3	X	X	X	X	X	X	X	X	X	X	X						95%	4	0	0	40 C 1000 S		0	0	0	
10	Gaging System, Propellant Utilization ME901-0023 01115310	11	0	2	4	2		X	X	X				X			X						55%	0	8	35	160 H	0042 (2) 0052 (2)	0	2	0	125:40 12 C
11	Heat Exchanger, Fuel ME362-0008 00915309	18	0	1	4	4		X		X							X						100%	0	6	0	5200 C	0012 (4) 0001 (1)	0	0	0	

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CEM 012

SYSTEM 7.0 SPS

No.	Nomenclature Manufacturer's Part Number CEM Number	Number Units	Development Test Quantity	Certification Test Quantity	CEM Ground Test Quantity	CEM Flight Test Quantity	HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	HUMIDITY	SALT	EMI	ACCELERATION	STATIC LOAD	PROPELLANT COMP.	LEAKAGE	PROOF PRESSURE				CTR STATUS	CTR Failures Resolved	CTR Failures Explained	CTR Failures Open	CTR Time/ Cycles	CEM Conf. & Quant.	CEM Failures Resolved	CEM Failures Explained	CEM Failures Open	Accept. & Checkout Time/ Cycles
		Certification Test Data					Certification Test Environments																					CEM Data				
12	Heat Exchanger, Oxidizer ME362-0007 00915309	16	1	1	4	4		X		X							X						100%	0	4	0	5200 C	0001 (1)	0	0	0	
13	Monitor, Flight, Combustion Stability ME450-0009 01215702	13	0	2	4	4	X	X		X	X	X		X	X								100%	0	0	0	5500 C	0001 (1)	0	0	0	26:40 HR
14	Regulator, Helium, Pressure ME284-0020 01115314	42	1	2	8	8	X	X		X													100%	6	0	0	6.5 KC	0004 (1) 0014 (1)	0	0	1	1:30 HR
15	Valve, Check, Fuel ME284-0025 00915308	0	0	0	4	4	X	X		X					X		X						100%	3	0	0	12.3 KC	0012 (4)	0	0	0	89 C 8:05 HR
16	Valve, Check, Oxidizer ME284-0025 01215701	0	0	0	4	4	X	X		X					X		X	X	X					3	0	0		0026 (1)	0	0	0	
17	Valve, Pressure Relief, Helium ME284-0027 01115307	57	0	6	8	8	X	X		X													100%	0	0	0	14.1 KC	0004 (1) 0014 (1)	11	0	2	
18	Valve, Solenoid, Helium ME284-0018 01115311	45	0	3	8	8	X	X	X	X		X			X									0	0	1	4000 C	0005 (2)	0	0	1	46 C
19	Motor, Launch Escape ME467-0003 00912301	51	18	20	20	8	X	X		X	X												100%	2	0	0	48 C	1000 (1)	0	0	0	

Temp. Form R&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 7.0 SPS

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	HUMIDITY	SALT	EMI	ACCELERATION	STATIC LOAD	PROPELLANT COMP.	LEAKAGE	PROOF PRESSURE				CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
20	Ignitor Assy., Launch Escape Motor ME453-0014 00912801			6	6	0	S	S															100%	0	0	0		0081 (2)	0	0	0	
21	Motor, Pitch Control ME467-0005 00912303	63	28	22	22	8	X	X		X	X				X								100%	0	0	0	60 C	0081 (2)	0	0	0	
22	Igniter Assy., Pitch Control Motor ME453-0014 00912802			8	8	0	S	S															100%	0	0	0		0081 (2)	0	0	0	
23	Motor, Tower Jettison ME467-0004 01212701	64	28	22	22	11	X	X		X	X												90%	4	0	0	59 C	1005 (1)	0	0	0	
24	Igniter Assy., Tower Jettison Motor ME453-0014 00912803			25	25	0	S	S															100%	0	0	0		0082 (2)	0	0	0	

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7.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

SERVICE PROPULSION SYSTEM

The pages which follow indicate the significant differences between the Certification Test Hardware and Flight Hardware.

APPROVED BY:

A. S. Kravitz 6/14/66

Certification Project Engineer

Flight Part No.	Test Part No.	Part Name	Test Ident.
V17-480240-301	V17-480240-101	SPS STANDPIPE, FUEL	

Differences

S/C 012 IS BEING RETROFITTED WITH NEW REINFORCED STANDPIPES IN THE FUEL TANK.

Certification Basis

1. COMPONENT VIBRATION TESTING BY VENDOR.
2. S/C 001 HOT FIRING TESTS AT WSMR.

Flight Part No.	Test Part No.	Part Name	Test Ident.
V17-479240-601	V17-479240-301	SPS STANDPIPE, OX	

Differences

S/C 012 IS BEING RETROFITTED WITH NEW REINFORCED STANDPIPES IN THE OXIDIZER TANK.

Certification Basis

1. COMPONENT VIBRATION TESTS BY VENDOR
2. S/C 001 HOT FIRING TESTS AT WSMR

CERTIFIED/FLIGHT HARDWARE DIFFERENCES

Flight Part No.	Test Part No.	Part Name	Test Ident.
V17-342052	V17-342001	SPS OX. TANK	
V17-343052	V17-343051	SPS FUEL TANK	CTR 902701

Differences

TEST PARTS HAD 5 CIRCUMFERENTIAL WELDS, FLIGHT PART 3 CIRCUMFERENTIAL WELDS.

Certification Basis

FLIGHT PARTS ARE SUPERIOR

7.5 WAIVERS, SCN's AND RFC's - SERVICE PROPULSION SYSTEM

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
7.5.1	012-NAA-3-3	Study of Requirements for SPS Force Gain Test at KSC	Study MCR in prep. at NAA
7.5.2	Verbal NASA Request	Cold Flow Test at Downey	CCA to be Submitted by NASA
7.5.3	SCN 96	Isp Value	NASA reply pending (See CARR No. 7.5.6)
7.5.4	SCN 237 (ECP 317)	SPS Line Heaters	To Be Submitted by NAA
7.5.5	SCN 40	Engine Continuous Burn Time Limit	To Be Submitted by NAA
7.5.6	Deviation (NASA verbal request)	Engine Performance Requirements	NAA/NASA resolution needed (See CARR No. 7.5.3)
7.5.7	Deviation	LES Motor Thermal Protection	MCR A1439 in work

Engineering Manager

Project Engineer

8. STABILIZATION AND CONTROL SYSTEM

8.0 System Organization

8.1 Systems Test Results

8.2 Problem Summaries

8.3 Hardware Summary

8.4 Cert/Flt Hdw Differences

8.5 Waiver/SCN/RFC Information

8.0 STABILIZATION AND CONTROL SYSTEM

The Stabilization and Control System (SCS), for purposes of the CARR consists of SCS subsystems, equipment and assemblies as listed herein. The SCS is of the Block K configuration and provides angular rate and displacement signals in addition to those provided by the G&N for stabilization, control and display and provides attitude control for the SPS and RCS.

- Rate Gyro Assembly
- Attitude Gyro Accelerometer Package
- Flight Direction Attitude Indicator
- Attitude Set/Gimbal Position Indicator
- Velocity Change Indicator
- Rotational Controllers
- Translation Controllers
- Electronic Control Assemblies
  - Pitch
  - Roll
  - Yaw
  - Auxiliary
  - Display/Attitude

8.1 SYSTEM TEST RESULTS

8.1.1 OCP-P-7070-SC-012 - SCS Inertial Phasing Test

SCOPE

This test was made in Checkout Station 2C in Bldg. 290 to functionaly test the stabilization and control system. All components of the SCS were satisfactorily installed. Among the units checked were rate gyro activation, RCS depressurization, EPS-ECS-41 activation, SCS/SPS/RCS polarity and scaling, attitude stabilization (AGAA installed) to mention just a few of the items.

RESULTS

All components checked out satisfactorily with only one replacement, the display ECS which requires a replacement to obtain the latest configuration. All requirements of the procedure were complied with and have been accepted by NASA.

8.1.1.2 PROBLEM

CH-0045, CH-1045 and CH-2045 read lower limits.

CORRECTIVE ACTION

Replaced ACE signal conditioning module.

DOCUMENTATION

OCP-7070 Squawk No. 6

8.1.1.3 PROBLEM

CH-2015 and CH-2026 are interchanged on the CRT.

CORRECTIVE ACTION

Worded EO 466988 which corrected the reversal.

DOCUMENTATION

OCP-7070 Squawk No. 7 and EO 466988

8.1.1.4 PROBLEM - Rate Gyro Null Readings

Three rate gyro null readings were indicating high.

CORRECTIVE ACTION

Worked TPS GEN-048 and 049 which patched around an open shield in ACE C14-203.

DOCUMENTATION

OCP-7070 Squawk No. 8 and TPS-GEN-048 and 049.

8.1.1.5 PROBLEM - Yaw Rate Error

Yaw rate error (CH 1050) was reading high.

CORRECTIVE ACTION

Broken wire at J800 F63-A was spliced per MRD 98340.

DOCUMENTATION

OCP-7070 Squawk No. 9, TPS-7070-008 and MRD 88340.

8.1.1.6 PROBLEM

CH 0045 and CH 2045 indicated a reversal during torquing of the rate gyros.

CORRECTIVE ACTION

The location of displays were in accordance with Programming Requirements Specification which was corrected by EO

DOCUMENTATION

OCP-7070 Squawk No. 13 and 69.

DOCUMENTATION

OCP-7070 Squawk No. 18, 19, 20 and 21. EDB Squawk No. 120 and TPS 7070-010 and TPS-7070-011, PAR 22909

8.1.1.10 PROBLEM

Delta V counter slewing was too slow.

CORRECTIVE ACTION

D ac 8 had normalized. Test was rerun with D AC 8 operating normally.

DOCUMENTATION

OCP-7070 Squawk No. 53 and 54.

8.1.1.11 PROBLEM

No deflection on Channel seven of recorder for CH 1060 measurement.

CORRECTIVE ACTION

Missing patch on 5A3A2 was installed which corrected the problem.

DOCUMENTATION

OCP-7070 Squawk No. 100.

8.1.1.12 PROBLEM

Measurement CH 0660 decimal point is misplaced one place to the right.

CORRECTIVE ACTION

Transferred to ACE Integrated tape to be corrected by program change.

8.1.1.7 PROBLEM - Rate Gyros out of Tolerance

Rate gyros did not meet the tolerance of 59.4 to 80.6 MVDC during hysteresis check.

CORRECTIVE ACTION

The hysteresis test was deleted from the OCP because the ACE measurements did not have sufficient resolution to determine actual hysteresis.

DOCUMENTATION

OCP-7070 Squawk No. 15, 23, 25, 28, 31, 33, 35, 37 and 39.

8.1.1.8 PROBLEM

CH 0076, CH 1076 and CH 2076 measurements were out of tolerance.

CORRECTIVE ACTION

The out of tolerance condition was caused by the B mag and rotation control power deriving their power from different sources. OCP was corrected by deviation to prevent this.

DOCUMENTATION

OCP-7070 Squawk No. 17, 22, 24, 26, 29, 30, 32, 36 and 38.

8.1.1.9 PROBLEM

Master alarm light and main bus a under voltage light came on when ATT/MON/ENT switch was set to ATT on panel 8.

CORRECTIVE ACTION

The problem was caused by mechanical interference between CR10 on Panel 8 and a vehicle bolt. The diode was replaced and the protruding bolt was countersunk to prevent contact with CR-10.

DOCUMENTATION

OCP-7070 Squawk No.'s 62, 63, 74, 76, 80, 82, 83, 84, 86, 144, 145, 146, 147, 148, 151, 152, 158 and 160.

8.1.1.13 PROBLEM

The Genisco rate table used for OCP-7070 had a valid calibration sticker but during testing it was noted the actual table speed and the dial were not in agreement.

CORRECTIVE ACTION

A rate table corrective curve was calculated using a stop watch at the speeds the tests were to be conducted. The tests were rerun and the below listed squawks cleared.

DOCUMENTATION

OCP-7070 Squawks 64, 65, 67, 68, 70, 71, 72, 73, 75, 77, 78, 79, 81 and 159.

8.1.1.14 PROBLEM

Several tolerances in Specification MA0201-0699 were too stringent and were subsequently relaxed by SCS Design Engineering.

CORRECTIVE ACTION

Engineering recalculated tolerances.

DOCUMENTATION

OCP-7070 Squawks 61, 66, 85, 88, 91, 93, 94, 96, 97, 98, 101, 102, 103, 105, 109, 110, 137, 139, 143, 149, 150, 153, 154, 155, 156, 157, 163, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, and 184.

8.1.1.15 PROBLEM

Some portions of Specification MA0201-0699, had been performed in other sequences of OCP 7070 which resulted in certain sequences of OCP-7070 being redundant.

CORRECTIVE ACTION

Deleted from the OCP.

DOCUMENTATION

Deviation 013P (Deletes Sequence 9 entirely) and OCP-7070 Squawks 111, 113, 114, 115, 116, 117, 118, 119, 120, 121, 133, 134, 135 and 136 were cleared by D 020P Items 1, 3, 6, 7, 8, 14, 16, 17.

8.1.2 OCP-P-7018-SC 012 - SCS Frequency Response

SCOPE

This test was run to perform the Frequency Response Test of the SCS/SPS components installed in the mated Command Module and Service Module.

RESULTS

Operational verification of the SCS/SPS Frequency Response was conducted in Bldg. 290 Checkout Station 2C, Downey and covered the following operations: Sequence 01, SCS Activation, Sequence 02 Primary Gimbal Motors Activation, Sequence 03 Secondary Gimbal Motors Activation. Several problems were encountered and resolved as covered in the following paragraphs:

8.1.2.1 PROBLEM

Master caution alarm came on when the Pitch Gimbal Drive Motor was activated.

CORRECTIVE ACTION

Reset master caution system and continued with test. This problem was under investigation at the time due to similar squawks in OCP-P-D126.

DOCUMENTATION

8.1.2.2 PROBLEM

Received a non-verification on C172 at Seq. 02-013.

CORRECTIVE ACTION

C172 was inserted 3 seconds too soon. Recycled and ran this step again successfully.

DOCUMENTATION

Note: At time of going to press, tests documented in this section were not complete. Documentation of final test results will be provided in Phase II Report.

NAA ATO Systems Supr

8.2 PROBLEM ANALYSIS - STABILIZATION AND CONTROL SYSTEM

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

APOLLO PROBLEM SUMMARY
S/C # 012
Ø1 008/014/017/020

Date: 1-27-66
Revised: Ø1 3-30-66
Ø2
Ø3
Ø4

Subsystem/End Item SCS/(RGA) Rate Gyro Assembly

Equipment Name, S&ID P/N 493-0005-0304

Spacecraft [X] GSE [ ]

Apollo Reliability R R Oman C. E. Farber Apollo Engineering [signature]

APS- 024 AJ

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

During Post vibration visual inspection the connector disclosed a crack between the center screw and pin 19. No functional failure existed.

Ø1 FR# 20115, 020105 (AGAA connector), 20194

CTR# 01217709

8-18

Ø1 (2) Problem Status ~~Unresolved~~ Explained (Resolved, Unresolved, or Explained)

(a) Afailure of this type could cause shorts in the connector resulting in loss of rate gyro power which causes loss of SCS Automatic Thrust Vector Control.

(b) Action being taken. Failure being analyzed by the failure Analysis committee. Should be completed by February 15, 1966.

(c) Responsible Dept. Control Systems D/697-500, Manager J. Dyson

Ø1 The conclusion of the analysis is that actual cause cannot be determined. The possible causes of the crack are:

1. The connector was received this way from the vendor.
2. The connector was received into qualification in this condition.
3. A workmanship problem in installation at harness build or connecting for test.
4. A design problem in installation (cannot be installed without breakage).
5. A design problem due to vibration cracking the connector.

APS-024-AJ

TEMP. FORM ENG-A-1185 EXP 3-24-66

(2) Problem Status (Continued)

Ø1 The corrective action taken is as follows:

1. Source inspection at Hughes has been altered to check all Hughes connectors for cracks with 20 X minimum eye loops. Effective 11-20-65.

2. All future production units just prior to shipping shall have gaskets removed and connectors inspected under magnification to verify no cracked shells. A new gasket will be installed at this time.

3. Any installation breakage will be discovered by the inspection change noted above and the CQ-2 (Qual Tests) procedure change.

4. All connectors will be checked under magnification after vibration tests in CQ-2 to verify any cracks due to vibration.

5. The special program for CQ-2 units has been red-lined into all documents and approved by NAA, that after every environment the gaskets will be removed and the connectors checked for cracks and new gaskets installed. This program will determine if and/or where there is a problem of cracking Hughes connector bodies in any special environment.

The above corrective action should eliminate any cracked Hughes connectors from getting aboard S/C 012 and subs.

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APOLLO PROBLEM SUMMARY
S/C # 012

Date: 1-27-66
Revised: Ø1 3-24-66
Ø2
Ø3
Ø4

Subsystem/End Item SCS/Display Electronic Control Assembly Ø1 008/014/017/020

Equipment Name, S&ID P/N ME 901-0170-0304

Spacecraft [X] GSE [ ]

Apollo Reliability B.R. Oman C. E. Varner Apollo Engineering J. Dyson

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)
During post vibration inspection card clamp screws were found loose. They were not at their 4-in-lb torque; some were at zero torque and others from 0 to 4 in-lbs torque.

FR #20178

CTR #01217704

8-20

Ø1 Resolved (See APS-032-AJ for conclusion)

(2) Problem Status ~~Unresolved~~ (Resolved, Unresolved, or Explained)

(a) Effect on flight - this type of failure could allow the cards to pull loose and cause electrical disconnect of the circuits. This is not criticality I since there are G & N automatic modes.

(b) Action being taken. The failure analysis committee is analyzing the failure, and should be completed by February 15, 1966.

(c) Responsible Dept. - Control Systems D/697-500, Manager J. Dyson.

APS-025-AJ
PAGE OF

TEMP. FORM ENG-A-1185 EXP. 3-24-66

90

APOLLO PROBLEM SUMMARY
S/C # 012
Ø1 008/014/017/020

Date: 1-27-
Revised: Ø1 3-24-66
Ø2
Ø3
Ø4

Subsystem/End Item SCS/Yaw ECA

Equipment Name, S&ID P/N ME 901-0168-0324

Spacecraft [X] GSE [ ]

Apollo Reliability B.R. Oman C. E. Farner Apollo Engineering J. B. Dyson

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)
During Post Vibration visual inspection it was found that a number of the top screw and nut assemblies holding top card wedges were loose. Also one screw holding assembly for top card wedges was loose.

8-21

FR #20174
Ø1 FR # 021516, 021517, 020178

CTR #01217710

Ø1 (2) Problem Status ~~Unresolved~~ Resolved (Resolved, Unresolved, or Explained)

(a) Effect on Flight - This type of failure could allow the cards to become loose and disconnect causing electrical circuits to become inoperable. Also if the screws or nut assemblies come off they could cause electrical shorts. This can be a criticality I if an RCS ΔV cannot be performed to de-orbit. This applies to pitch ECA also. However, attitude control has a Direct Control Backup

(b) Responsible Dept. Control Systems D/697-500; Manager J. Dyson

(c) Failure being analyzed by failure analysis committee, analysis should be complete by 15 February 1966.

Ø1 The loose screws were caused by the following reasons: As the top clamp screw is tightened, the plate nut strikes the two wedges. When the plate nut strikes the wedge it rides up the inclined plane on the left wedge, this skews the plate nut and causes point contact between the plate nut and wedge. This fact plus the low axial force on the screw and the low friction level between the plate nut and wedges, allows the plate nut to slide off the inclined

TEMP. FORM ENG-A-1185 EXP. 3-24-66

(2) Problem Status (Continued)

Ø1 plane of the wedge. This results in a loose screw and plate nut assembly. (This condition does not result in unattached hardware.)

E.O. 66-12191 (Hw.) requires rework of left wedge and increasing torque on top clamp screws from 4 in.-lbs to 5 in.-lbs. This E.O. also requires verification of proper position of plate-nut.

This fix (E.O. 66-12191) is in S/C 008 & subs.

8.3 HARDWARE SUMMARY - STABILIZATION AND CONTROL SYSTEM

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSM 012

SUBSYSTEM 8.0 STAB. & CONTR. SYSTEM

NO.	NOMENCLATURE BASIS PART NUMBER CTR NUMBER	NUMBER UNITS	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Accelerometer Assy, Attitude Gyro ME493-0005 01217708	23	9	4	3	1	X	X	X	X	X	X	X	X		X	90%	6	0	0	2308H	0314 (1)	0	0	0	360H
2	Control, Rotation ME901-0172 01217703	25	14	4	2	0	X	X	X	X	X	X	X	X		X	90%	0	0	0	902H	0204 (2)	0	0	0	719H
3	Control, Translation ME901-0171 01217702	25	14	4	2	0	X	X	X	X	X	X	X	X		X	100%	3	0	0	819H	0204 (2)	0	0	0	972H
4	ECA, Display ME901-0170 01217704	23	9	4	3	1	X	X	X	X	X	X	X	X		X	90%	12	0	0	1913H	0324 (1)	0	0	0	317H
5	ECA, Auxiliary ME901-0169 01217711	23	9	4	3	1	X	X	X	X	X	X	X	X		X	90%	3	1	0	1656H	0314 (1)	0	0	0	355H
6	ECA, Pitch ME901-0166	22	9	1	3	1	X	X	X	X	X	X	X	X		X	90%	0	0	0	887H	0314 (1)	0	0	0	334H
7	ECA, Roll ME901-0167 01217712	23	9	4	3	1	X	X	X	X	X	X	X	X		X	100%	4	0	0	1586H	0334 (1)	0	0	0	310H
8	ECA, Yaw ME901-0168 01217710	23	9	4	3	1	X	X	X	X	X	X	X	X		X	100%	2	0	0	1738H	0334 (1)	0	0	0	154H

Temp. Form R&E - 1056 Exp. 6-10-66

CIN 012

SUBSYSTEM 8.0 STAB. & CONTR. SYSTEM

8-25

No.	Nomenclature Series Part Number CIN Number	Hours Hrs	Development Test Quantity	Qualification Test Quantity	CIN Ground Test Quantity	CIN Flight Test Quantity	Hi Temp	Lo Temp	Vacuum	Vibration	Shock	Oxygen	Humidity	Salt	EMI	Acceleration							CTR Status	CTR Failures Resolved	CTR Failures Explained	CTR Failures Open	CTR Time/ Cycles	Conf. & Quant.	CIN Failures Resolved	CIN Failures Explained	CIN Failures Open	Accept. & Current Time/ Cycles
							Qualification Test Environments																									
9	Gyro Assy, Rate & Mounting Base ME493-0006 01217708	23	9	4	3	1	X	X	X	X	X	X	X	X		X							90%	4	1	0	1909H	0314 (1)	0	0	0	346H
10	Indicator, ΔV ME432-0057 01217705	22	10	4	3	1	X	X	X	X	X	X	X	X		X							100%	0	0	0	1139H	0314 (1)	0	0	0	257H
11	Indicator, Flight Director, Attitude ME432-0055 01217707	24	12	4	2	0	X	X	X	X	X	X	X	X		X							90%	0	0	0	1099H	0304 (1)	0	0	0	302H
12	Indicator, Gimbol Pos., Attitude Set ME432-0056 01217706	24	10	4	3	1	X	X	X	X	X	X	X	X		X							90%	0	0	0	914H	Bas. (1)	0	0	0	558H
13	SCS Subsystem ME901-0012 01217701	26	12	4	3	1				X				X	X								90%	3	2	0	1123H		0	0	0	

Temp. Form R&E - 10%6 Exp. 6-10-66

8.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

STABILIZATION AND CONTROL SYSTEM

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

A. S. Kawitz 6/18/66
Certification Project Engineer

8.5 WAIVERS, SCN's AND RFC's - STABILIZATION & CONTROL SYSTEM

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
8.5.1	SCN 236 to SID 64-1237 (ECP 0320)	Adds tolerances to various parameters in para. 3.4.1.3.1.2.2 sections	ECP in work by NAA

Engineering Manager

Project Engineer

APOLLO

GUIDANCE AND NAVIGATION SYSTEM

CUSTOMER ACCEPTANCE READINESS REVIEW

AND

FLIGHT READINESS REVIEW REPORT

G & N SYSTEM 12 — MISSION 204

Prepared in Response to

NASA Contract NAS 9-497

Submitted by

AC Electronics Division
General Motors Corporation
Milwaukee, Wisconsin 53201

J. P. Kaiser, Site Manager
NAA/Downey

EP66-28

13 June 1966

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9.1 G & N SUBSYSTEM AND MISSION DESCRIPTION

The G & N System is divided into three major subsystems: Inertial, Optical, and Computer. These subsystems or combinations of subsystems will perform the following functions during Mission 204:

1. Maintain an inertial reference, which is used as a basis for measurements and computations,
2. Calculate the position and velocity of the spacecraft,
3. Generate attitude error signals and thrust commands necessary to maintain the required spacecraft trajectory.

G & N System 012 will be used for Mission 204. This is a Block I 50 Series system comprised of the following assemblies:

1. Inertial Subsystem (ISS) — Block I 50 Series
   - Inertial Measurement Unit (IMU)
   - Inertial System CDU's (electro-mechanical) (ICDU's)
   - Power Servo Assembly (PSA)
   - IMU Control Panel
2. G & N Harness — Block I 50 Series
3. Computer Subsystem — Block I 100 Series
   - APOLLO Guidance Computer (AGC)
   - Display and Keyboard (DSKY - Main Display Console)
   - Display and Keyboard (DSKY - Lower Equipment Bay)
   - Computer Harness
4. Optics Subsystem — Block I 50 Series
   - Scanning Telescope (SCT)
   - Sextant (SXT)
   - Optical System CDU's (OCDU's)
   - Power Servo Assembly (PSA)
5. Navigation Base — Block I 50 Series

9.1.1 INERTIAL SUBSYSTEM

The Inertial Subsystem (ISS) consists of the IMU, three CDU's portions of the PSA, and portions of the lower Display and Control Panel.

The Inertial Subsystem is used for spacecraft guidance and control, and performs three major functions:

1. Measures spacecraft attitude changes,
2. Assists in generating steering commands,
3. Measures spacecraft velocity changes.

To accomplish these functions, the IMU provides an inertial reference consisting of a stable member gimballed for three degrees of freedom and stabilized by three integrating gyros and associated servos. Each time the Inertial Subsystem is energized, the stable member must be aligned with respect to a predetermined reference. Prior to launch, the stable member is aligned by means of a gyrocompassing routine for azimuth, and local vertical is established through accelerometers sensing gravity.

Once the Inertial Subsystem is energized and aligned, any rotational motion of the spacecraft will be about the gimballed stable member, which remains rotationally fixed in inertial space. Resolvers, mounted on the gimbal axes, act as angular sensing devices and measure the attitude of the spacecraft with respect to the stable member. These angular measurements and angular changes are available to the AGC.

Gimbal angles required to produce a desired spacecraft attitude are calculated in the AGC. The AGC then commands the CDU's to the desired attitude angles. Any difference between the gimbal angles and the CDU angles causes an attitude error signal to be generated in the Inertial Subsystem CDU resolvers. The error signal is sent to the stabilization control system which drives the spacecraft reaction control system to correct the spacecraft attitude.

Acceleration of the spacecraft is sensed by three pendulous accelerometers mounted orthogonally on the stable member. The resultant signals from the accelerometer loops are supplied to the AGC, which then calculates the present velocity.

9.1.2 OPTICAL SUBSYSTEM

The Optical Subsystem (OSS) consists of the OUA, two CDU's, and portions of the PSA and D & C Panel.

The Optical Subsystem, used to determine the position of the spacecraft and orientation of the IMU in space, contains a sextant and scanning telescope. The sextant is a high-magnification, dual line-of-sight device used for precision angular measurements. The telescope has a wide field of view single line-of-sight and can be used for coarse acquisition of stars and landmarks and orbital tracking of landmarks.

9.1.3 COMPUTER SUBSYSTEM

The Computer Subsystem, consisting of the AGC and portions of the D & C Panel used to perform space flight data handling and computations, is a general purpose digital

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computer employing a core memory, parallel operation, and a built-in self-check capability.

Programs are stored in the AGC until selected to control and solve flight equations. The selection of programs can be controlled by automatic sequencing or manually by the astronaut.

The computer subsystem performs five major functions:

1. Calculates steering signals and engine discretes necessary to keep the spacecraft on the required trajectory,
2. Positions the stable member in the IMU to a coordinate system defined by precise optical measurements,
3. Positions the optical unit to celestial objects,
4. Conducts limited malfunction isolation of the G & N System by monitoring the level and rate of system signals,
5. Supplies pertinent spacecraft condition information to the D & C Panel.

Using information from navigation measurements, the AGC computes deviations from the required trajectory and calculates the necessary corrective thrust magnitude and direction commands. The velocity corrections are controlled by the Computer Subsystem by processing incremental velocity from the Inertial Subsystem. Velocity corrections are not made continuously, but rather are initiated at predetermined check points in the flight. The technique of check point velocity corrections reduces fuel consumption, since the engines are used only when a significant correction in velocity is required.

Malfunctions in the G & N System are detected by the AGC, which monitors critical signals and rates. Lamps on the D & C Panel illuminate to indicate malfunctions.

Lamps on the DSKY indicate the program being used by the AGC or the results of calculations. Selection of a computer program or insertion of data into the AGC can be done by the astronaut with a keyboard on the DSKY or by uplink data through the Communication and Instrumentation System from the ground station.

9.1.4 G & N SYSTEM FUNCTIONS AND RELATION TO MISSION 204 PHASES

9.1.4.1 General

The G & N System is designed to perform the CSM guidance and navigation functions required on the lunar landing mission in a self-contained mode and within specified accuracy and maneuver propellant constraints. The system is also designed to accept navigation data from earth-based facilities whenever required to improve accuracy,

reduce maneuver propellant requirements, or to gain some other operational advantage. It is essential on Mission 204 to demonstrate, to the maximum extent possible, both the self-contained and earth-cooperative modes of operation since either mode may be required on the lunar mission.

9.1.4.2 G & N System Test Objectives

The prime G & N System test objectives of Mission 204 are as follows.

1. Demonstrate satisfactory performance of the following modes of operation:
   - Orbit determination from data obtained by navigator visual tracking of known landmarks using the Scanning Telescope and unidentified ground features using the Sextant,
   - Insertion of orbit parameters from earth facilities via digital uplink,
   - Navigator plotting of present orbit, determination of required maneuvers, and insertion of target data into the G & N System,
   - Insertion of target data into the G & N System via digital uplink,
   - Inflight IMU alignment using navigator visual tracking of known stars,
   - Automatic thrust vector control initiated and monitored by the flight crew,
   - Automatic entry lift vector control initiated and monitored by the flight crew,
   - Automatic orbit attitude control,
   - Application of minimum SPS ΔV,
   - Boost monitor,
   - Measure the angle between a known star and a lunar landmark, and the angle between a known star and the illuminated lunar horizon by the Manual-Visual mode using the Sextant.
2. Demonstrate satisfactory operation and performance of the G & N System in the spacecraft — (long duration earth orbit mission environment):
   - IMU and Optics accuracy,
   - Thermal control of the Inertial, Optics, and Computer Subsystems.

9.1.4.3 Mission Operations

9.1.4.3.1 Prelaunch

During prelaunch, the IMU stable member is held at a fixed orientation with respect to earth. The Z PIPA input axis is held to the local vertical (down) by torquing the stable member about X and Y in response to Y and X PIPA outputs. Azimuth orientation about the Z axis is held by a gyrocompassing loop such that the X PIPA input axis points downrange at an azimuth of 71.9901 degrees east of true north. Azimuth is verified by tracking a ground target with Sextant at Liftoff minus 13.5 hours. Upon receipt of the guidance reference release signal from the Saturn IU, the stable member is released to maintain a fixed orientation in inertial space until the IMU is turned off or realigned in flight. In this manner, the Saturn and APOLLO IMU stable members retain a fixed relative orientation. Also, at the time of guidance reference release, the G & N System starts its computation of position and velocity, which continues until Saturn cutoff. The guidance reference release signal is backed up by the liftoff signal.

9.1.4.3.2 Pre-LET Jettison Boost Monitor

Upon receipt of the liftoff signal from the Saturn IV, the AGC will display Program 11, initiate DSKY boost monitor displays, and drive the IMU CDU's to the stored polynomial histor associated with the Saturn attitude program. The attitude error needles on the FDAI will then indicate, in CSM axes, the difference between actual CSM attitude and the programmed Saturn attitude. The FDAI ball is slaved to the IMU and indicates total attitude. The DSKY will display altitude (h), inertial velocity magnitude (V_i), and the angle of the inertial velocity vector above the local horizontal (γ_i).

So long as the above information looks normal to the crew, they may be confident that boost is proceeding satisfactorily. An abnormal display, however, can result from either a spacecraft or Saturn malfunction. Consequently, an abort decision should be derived using additional information including EDS displays, G & N failure displays, and communications from the ground.

9.1.4.3.3 Post-LET Jettison Boost Monitor

The G & N System will not have the capability to control the SIVB. At Liftoff plus 171 seconds, the AGC will terminate Program 11 functions, display Program 12, and initiate the Post-LET Jettison Boost Monitor functions. The ISS will be switched to Fine Align mode, thereby nulling the FDAI attitude error indication. The FDAI ball will continue to indicate total attitude. The AGC will compute, for DSKY display, the

following quantities associated with instantaneous Saturn shutdown: altitude of perigee above equatorial radius (h_{per}), maximum g predicted for free-fall and entry at 1/2 full lift (g_{max}), and free-fall time to 300,000-foot altitude (T_{ff}). Also, at the initiation of Program 12, the AGC will start monitoring vehicle thrust and the SIVB/CSM separation (abort) signal to detect Saturn shutdown and CSM abort, respectively.

Again, as in the Pre-LET Jettison phase, normal displays indicate a satisfactory boost. Furthermore, a suspected Saturn trajectory error need not be cause for an immediate abort so long as the maximum g and free-fall time displays indicate a safe margin. Also, as in the Pre-LET Jettison phase, an abort decision should be derived using additional information.

When the G & N System detects Saturn shutdown, the maximum g display will be terminated and, in its place will be displayed the miss-distance from the discrete boost abort recovery area, ΔR.

9.1.4.3.4 Abort From Boost

In the event of LET abort, the G & N System has no control function. The system will display Program 17, drive the FDAI ball, and will continue the Pre-LET Jettison Boost Monitor DSKY displays. Upon receipt of the CM/SM separation signal, the ISS will be switched to the Fine Align mode, thereby, nulling the FDAI attitude error needles.

The AGC will be notified of a Post-LET Jettison abort by the CSM/SIVB separation (abort) signal and will enter Program 71, First Abort Burn. Separation, and a short duration SPS burn to increase CSM/SIVB separation distance and arrest tumbling will be accomplished manually. Upon termination of the first abort burn, the system will start Program 72. The AGC will display ΔR, ΔV_{ins}, and T_{ff}. ΔV_{ins} is the ΔV required for contingency orbit insertion. The ΔR display will be turned on and off if the AGC calculates that the recovery area can be reached using SPS thrust. If ΔV_{ins} is less than the available ΔV, leaving a reserve for subsequent deorbit, the ΔV_{ins} display will be turned on and off.

The crew must decide on the ultimate abort mode and, if G & N control is desired, select one of the following programs via the DSKY keyboard:

- Program 74 — Contingency Orbit Insertion,
- Program 73 — Thrust to Discrete Recovery Area,
- Program 61 — CM/SM Separation Maneuver.

9.1.4.3.5 Coast — SIVB Attached

While attached to the SIVB, two G & N System functions must be performed: IMU alignment and orbit navigation by landmark tracking. Since the Block I System has no control of SIVB attitude, an attitude history requirement that permits these G & N functions is required for satisfaction by the Saturn Guidance and Control System. It is assumed that CSM/SIVB separation will take place during the third orbit.

IMU alignments are shceduled for the first and second passes in darkness. During the remaining time, the stack is oriented for landmark tracking to maximize the number of tracking opportunities. The specific landmarks used will depend on the time of launch; however, for the anticipated 0800 to 1400 launch window, North American landmarks in daylight will be available during the first and second passes. In the event the primary landmarks cannot be identified, the navigator will track alternate known landmarks or unidentified ground features.

9.1.4.3.6 IMU Alignment in Flight

IMU alignment to a known spatial orientation is required prior to landmark tracking, powered flight and entry guidance, and attitude maneuvers. A preferred orientation is defined by the program in process at the time IMU alignment is initiated. Alignment to this preferred orientation may be bypassed if the AGC is explicitly so instructed by the crew to expedite a maneuver. It is always essential, however, that the existing IMU orientation be stored in the AGC from a previous alignment process that has been followed by continuous operation of the IMU. It must also be remembered that the AGC's memory of IMU orientation contains a drift error roughly proportional to the time since the last alignment. It is also essential whenever alignment is bypassed that the crew ascertain from the AGC whether the present IMU orientation is such that subsequent usage will result in an excessive middle gimbal angle (approximately 15 degrees for powered flight guidance and 60 degrees for other functions).

There are three distinct IMU alignment modes to provide for three basically different situations. Each mode has a unique program display that serves as a graphic reminder of the operation in process.

- Program 51, IMU Orientation Determination, is used whenever the IMU spatial orientation is unknown. (For example, just after IMU turn-on, after a very long period or drift, or after the IMU has lost stabilization due to gimbal lock or a severe power transient.) In this mode the navigator tracks and marks two known stars using the SCT. The directions of the star lines of sight are found in IMU axes and, since the two star lines establish a fixed frame of reference, the IMU orientation can be derived.

- Program 53, CSM/IMU Align, is a fine alignment process in which the IMU orientation is precisely determined by SXT tracking, and trimmed to the preferred orientation by torquing the gyros. In this process the stars are automatically selected and acquired. Also, spacecraft maneuvers to permit star acquisition and to obtain the CSM attitude called for in the governing program are automatically performed and integrated with the star tracking tasks.
- Program 52, SIVB/IMU Align, performs the same functions as Program 53 but is specifically designed for the period when the CSM is attached to the SIVB.

9.1.4.3.7 CSM Orbit Navigation

It is a general rule, with four exceptions,* that no flight program may be completed without prior knowledge of position and velocity. During thrust and entry phases, position and velocity are updated frequently (every one or two seconds) using acceleration data from the IMU. During coast phases the position and velocity state vector is updated infrequently using landmark tracking data or a complete new state vector received via the uplink from the ground. Useful life of the state vector in AGC memory is limited only by its error propagation because the extrapolation equations include a drag model and all significant gravitational forces.

In the Selfcontained mode, CSM orbit navigation requires periodic use of Program 26, Landmark Tracking (tracking known landmarks using the SCT or unknown terrrain features using the SXT). When the flight plan does not permit optics tracking when required to suppress error propagation, the state vector may be updated via the uplink in Program 27, AGC Update.

Navigation data will be displayed automatically as required during the computational process and, upon navigator request via the DSKY keyboard when needed, to plot the ground track, ascertain orbit characteristics, or develop thrust maneuver requirements.

9.1.4.3.8 CSM Attitude Control

The G & N System will provide CSM attitude control in the following ways.

9.1.4.3.8.1 Local Vertical. In Program 21, CSM Local Vertical, the G & N System will hold the spacecraft attitude fixed with respect to the local vertical axes. The spacecraft -Y axis will be held in the direction of the orbital angular momentum vector $\underline{r} \times \underline{v}$, and the pitch attitude will be held to the value inserted by the pilot via the DSKY keyboard.

*Programs 00 (AGC Idling), 27 (AGC Update), 51 (IMU Orientation Determination), and 71 (First Abort Burn).

9.1.4.3.8.2 Program Derived. Whenever a program in process requires a particular attitude, the desired attitude will be displayed to the crew. They may:

- Allow the AGC to do the complete maneuver automatically,
- Do all or part of the maneuver manually with an automatic AGC controlled trim of the final attitude,
- Do the complete maneuver manually without any further AGC controlled trim,
- Allow the AGC to start the automatic maneuver then interrupt it and finish the maneuver manually. This procedure may also be followed by an optional automatic trim maneuver.

Examples are attitude maneuvers to initial thrust, CM/SM separation, preentry, and star sighting orientations. Automatic maneuver rates will be 4 degrees per second for abort or entry maneuvers only. Otherwise all AGC controlled maneuvers will be done at 1/2 degree per second.

9.1.4.3.8.3 Optics Tracking. During the sighting mark routine used for star and landmark tracking, the G & N will relinquish attitude control to switch the ISS to Fine Align mode. When this occurs during IMU alignment, it will be normal procedure for the navigator to minimize rates using the minimum impulse control. During landmark tracking it will be normal procedure for the pilot to hold local vertical manually, however, the navigator, who is tracking with the optics, may also exercise manual attitude control using the rotational hand control or the minimum impulse control.

9.1.4.3.9 SPS Orbit Change Maneuvers

Maneuvers in earth orbit are set up in Program 31 Prethrust by inserting the following target data into the AGC: SPS ignition time, desired orbit period, latitude and longitude of a point over which it is desired to fly on the first orbit after cutoff, the desired altitude over this point, SPS engine trim angles, and tailoff ΔV. The AGC will extrapolate the navigation state vector forward to ignition time, compute the desired trajectory, and display the following derived data: required ΔV, perigee altitude, and apogee altitude. This data load process may be repeated as often as desired to obtain a satisfactory set of derived data. The crew may load the data by using carry-on data or maneuver requirements developed from a groundtrack plot and present-orbit characteristics. Alternatively, the ground may load the data via the uplink in Program 27 or via the voice link for insertion by the crew.

After completion of the target data load, the AGC will display time-to-ignition and the crew will proceed when ready with the requisite IMU Alignment mode(s). At ignition -15 minutes the crew will initiate Program 41, which includes the countdown and thrust vector control.

Sufficient flexibility exists in the logic and procedures associated with orbit change maneuvers to coordinate essential activities with the MCC. The critical target data load procedure may be performed considerably in advance of SPS ignition, the lead time being limited solely by the quality of the state vector in AGC memory. Critical data in the AGC will be transmitted continuously on downlink during Program 31 to maximize the opportunities for data transmission to the MCC.

Thrust maneuvers under SCS or manual control will be monitored by the G & N System to preserve the accuracy of its navigation data. This monitor function is performed in Program 46, G & N Standby SPS Monitor, or in Program 47, G & N Standby RCS Monitor.

9.1.4.3.10 SPS Return-to-Earth Maneuver

The return-to-earth or de-orbit maneuver is set up in a manner similar to the orbit change maneuver described in Paragraph 9.1.4.3.9. In Program 32, the following target data must be inserted into the AGC: the earliest permissible ignition time, latitude and longitude of the desired splash point, de-orbit ΔV, SPS engine trim angles, and tailoff ΔV. The AGC will compute and display the following derived data: SPS ignition time, miss distance from the desired splash point (no out-of-plane thrust is used), and entry path angle. This data load process may be repeated as often as desired to obtain a satisfactory set of derived data. The alternative methods of developing and loading the target data available in Program 31 are available here also.

After completion of the target data load, the crew will proceed when ready with IMU alignment and initiate Program 42, Return-to-Earth Thrust, at ignition -15 minutes. De-orbit thrust control equations will hold the X axis a fixed angle below the visual horizon. Program 32, like Program 31, permits coordination of all essential activities with the MCC.

9.1.4.3.11 SPS Minimum Impulse

Program 33 is similar to Program 31, except that the SPS burn time is specified during the data load.

9.1.4.3.12 Entry

After the completion of de-orbit thrust or during a coast to entry following boost abort, the crew will monitor T_{ff} and initiate Program 61, CM/SM Separation Maneuver. The G & N will command a maneuver to the separation attitude at 4 degrees per second and hold this attitude (X axis 60 degrees above the velocity vector and tipped forward in the direction of motion, -Y axis along the orbital angular momentum $\underline{r} \times \underline{v}$).

The G & N System will proceed automatically to Program 62, CM/SM Separation and Preentry Maneuver. The crew will monitor T_{ff} and command separation manually. The CM will be commanded to the entry trim attitude for lift vector up. The system will then automatically sequence through the entry initialization and steering phases, informing the crew of its status by means of the program and other displays. These phases are: initialization (Program 63), post 0.05 g (Program 64), and final (Program 67).

9.1.4.3.13 Sextant Midcourse Angle Measurements

On several occasions the Optical Subsystem and AGC will be energized to perform the midcourse star-landmark angle measurement program. The angles between known stars and the illuminated lunar horizon and lunar landmarks will be measured by each of the three astronauts. In this way both equipment and human errors can be measured and a reliable evaluation of the overall mode of operation can be obtained. No difficulty is anticipated in scheduling these measurements in the flight plan so as not to interfere with time-critical operations such as SPS maneuvers. However, the following constraints must be met:

- At the time of measurement the ground's uncertainty in CSM position must be less than 5 miles,
- For the duration of the task, estimated to be 5 to 20 minutes, the optics shaft drive axis must be directed at the moon.

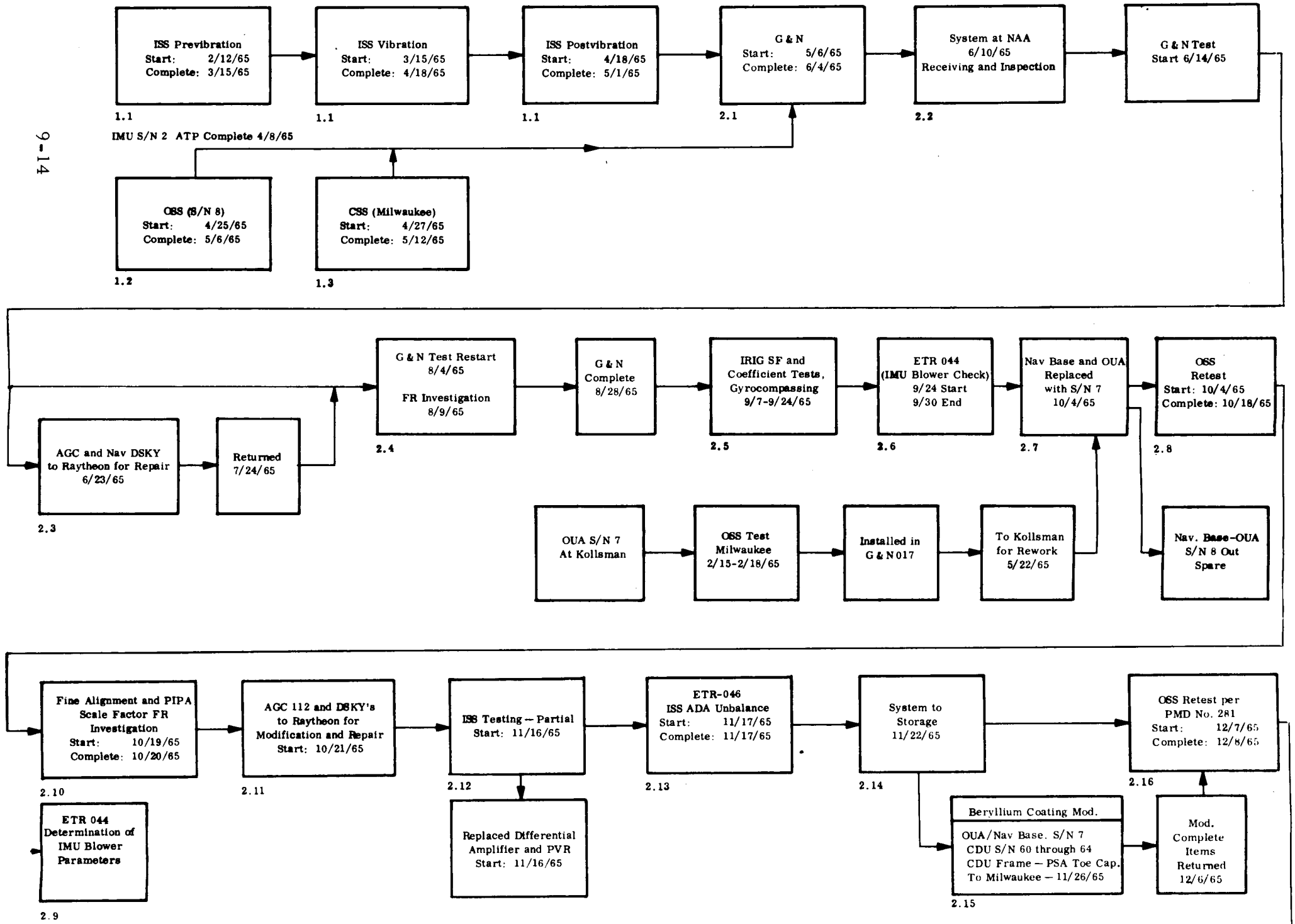
Upon receipt of the mark signal, the AGC will display the time of mark and the measured SXT trunnion angle. The data will be recorded by the navigator and, for the duration of the display, will be transmitted to the ground on the digital downlink.

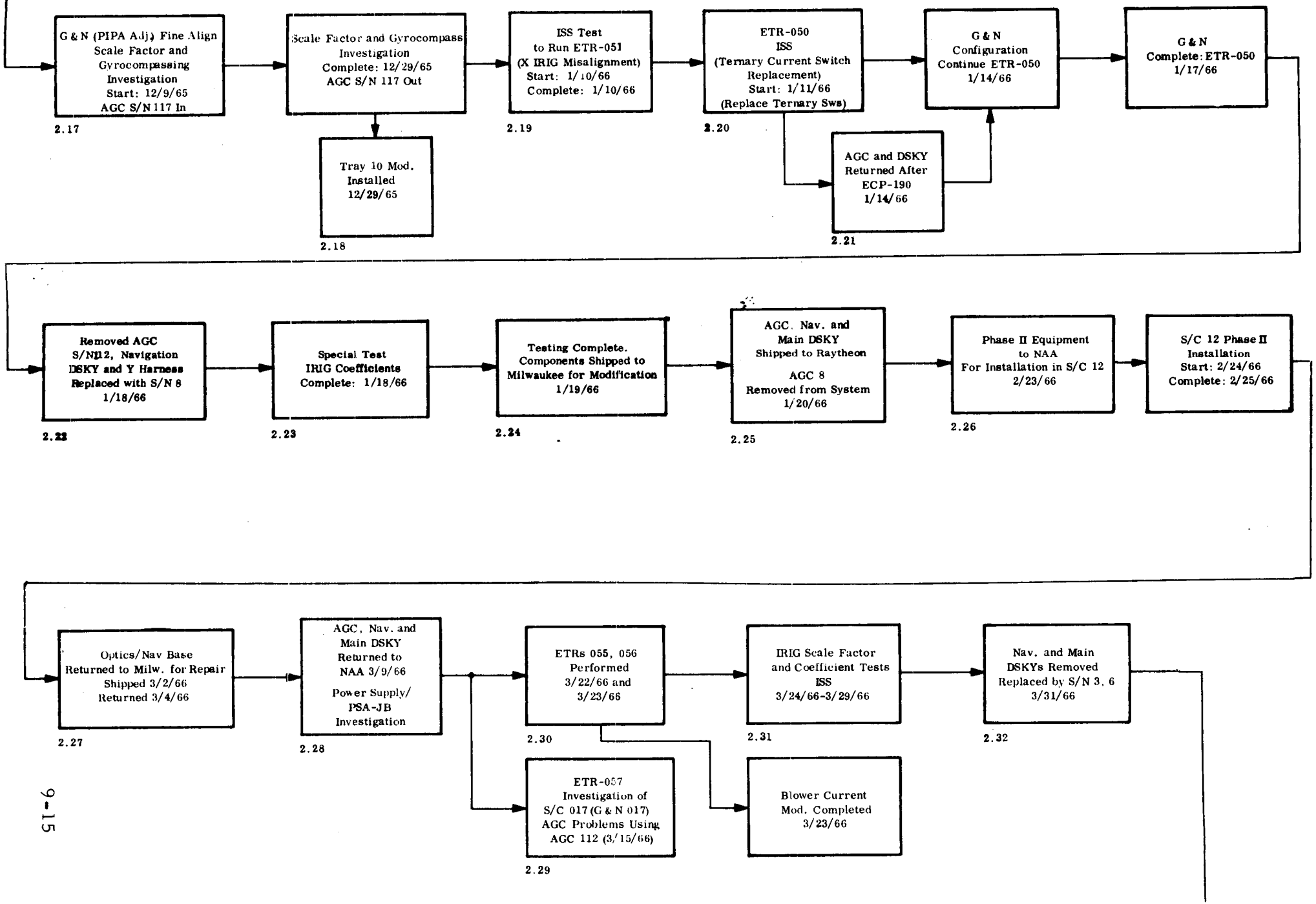
A number of trunnion angle bias calibration measurements may also be required. These measurements are functionally similar to the midcourse angle measurements.

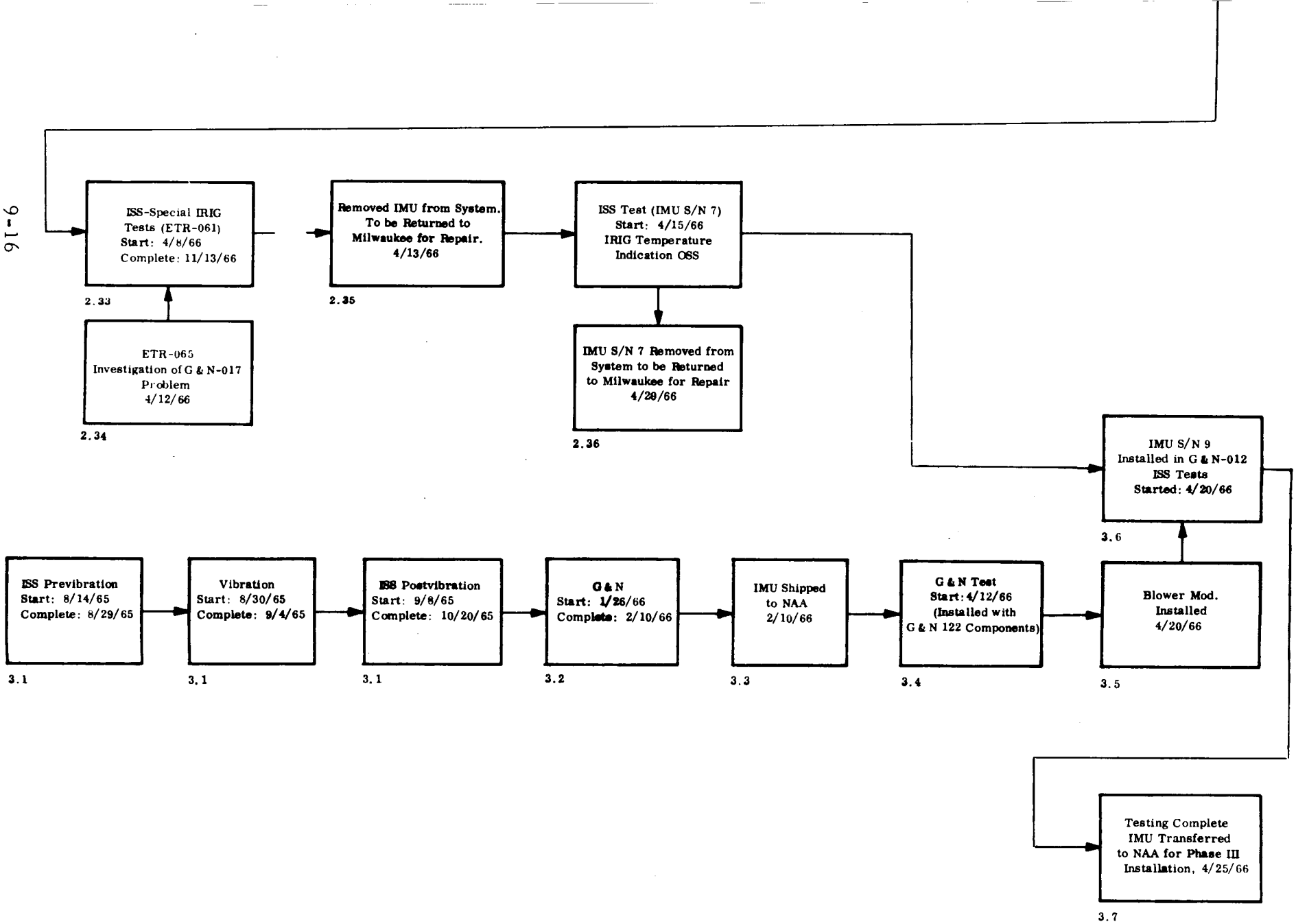
9.2 SCOPE AND RESULTS OF TESTS

9.2.1 GENERAL

A chronological summary of tests performed on G & N 012 is presented in the following paragraph. A flow chart and narrative are used to delineate test sequence, date, purpose of test and pertinent results and/or data accumulated during the test. The test period includes factory subsystem and acceptance testing at Milwaukee through Phase III equipment installation in Spacecraft 12 at NAA.


ISS Previbration
Start: 2/12/65
Complete: 3/15/65
1.1
ISS Vibration
Start: 3/15/65
Complete: 4/18/65
1.1
ISS Postvibration
Start: 4/18/65
Complete: 5/1/65
1.1
G & N
Start: 5/6/65
Complete: 6/4/65
2.1
System at NAA
6/10/65
Receiving and Inspection
2.2
G & N Test
Start 6/14/65
IMU S/N 2 ATP Complete 4/8/65
OSS (S/N 8)
Start: 4/25/65
Complete: 5/6/65
1.2
CSS (Milwaukee)
Start: 4/27/65
Complete: 5/12/65
1.3
AGC and Nav DSKY
to Raytheon for Repair
6/23/65
2.3
Returned
7/24/65
G & N Test Restart
8/4/65
FR Investigation
8/9/65
2.4
G & N
Complete
8/28/65
IRIG SF and
Coefficient Tests,
Gyrocompassing
9/7-9/24/65
2.5
ETR 044
(IMU Blower Check)
9/24 Start
9/30 End
2.6
Nav Base and OUA
Replaced
with S/N 7
10/4/65
2.7
OSS
Retest
Start: 10/4/65
Complete: 10/18/65
2.8
OUA S/N 7
At Kollsman
OSS Test
Milwaukee
2/15-2/18/65
Installed in
G & N017
To Kollsman
for Rework
5/22/65
Nav. Base-OUA
S/N 8 Out
Spare
Fine Alignment and PIPA
Scale Factor FR
Investigation
Start: 10/19/65
Complete: 10/20/65
2.10
AGC 112 and DSKY's
to Raytheon for
Modification and Repair
Start: 10/21/65
2.11
ISS Testing — Partial
Start: 11/16/65
2.12
Replaced Differential
Amplifier and PVR
Start: 11/16/65
ETR-046
ISS ADA Unbalance
Start: 11/17/65
Complete: 11/17/65
2.13
System to
Storage
11/22/65
2.14
OSS Retest per
PMD No. 281
Start: 12/7/65
Complete: 12/8/65
2.16
ETR 044
Determination of
IMU Blower
Parameters
2.9
Beryllium Coating Mod.
OUA/Nav Base. S/N 7
CDU S/N 60 through 64
CDU Frame — PSA Toe Cap.
To Milwaukee — 11/26/65
2.15
Mod.
Complete
Items
Returned
12/6/65


G & N (PIPA Adj) Fine Align Scale Factor and Gyrocompassing Investigation Start: 12/9/65 AGC S/N 117 In
2.17
Scale Factor and Gyrocompass Investigation Complete: 12/29/65 AGC S/N 117 Out
Tray 10 Mod. Installed 12/29/65
2.18
ISS Test to Run ETR-051 (X IRIG Misalignment) Start: 1/10/66 Complete: 1/10/66
2.19
ETR-050 ISS (Ternary Current Switch Replacement) Start: 1/11/66 (Replace Ternary Sws)
2.20
AGC and DSKY Returned After ECP-190 1/14/66
2.21
G & N Configuration Continue ETR-050 1/14/66
G & N Complete: ETR-050 1/17/66
Removed AGC S/N112, Navigation DSKY and Y Harness Replaced with S/N 8 1/18/66
2.22
Special Test IRIG Coefficients Complete: 1/18/66
2.23
Testing Complete. Components Shipped to Milwaukee for Modification 1/19/66
2.24
AGC, Nav. and Main DSKY Shipped to Raytheon
AGC 8 Removed from System 1/20/66
2.25
Phase II Equipment to NAA For Installation in S/C 12 2/23/66
2.26
S/C 12 Phase II Installation Start: 2/24/66 Complete: 2/25/66
Optics/Nav Base Returned to Milw. for Repair Shipped 3/2/66 Returned 3/4/66
2.27
AGC, Nav. and Main DSKY Returned to NAA 3/9/66
Power Supply/ PSA-JB Investigation
2.28
ETRs 055, 056 Performed 3/22/66 and 3/23/66
2.30
ETR-057 Investigation of S/C 017 (G & N 017) AGC Problems Using AGC 112 (3/15/66)
2.29
IRIG Scale Factor and Coefficient Tests ISS 3/24/66-3/29/66
2.31
Blower Current Mod. Completed 3/23/66
Nav. and Main DSKYs Removed Replaced by S/N 3, 6 3/31/66
2.32


ISS-Special IRIG Tests (ETR-061) Start: 4/8/66 Complete: 11/13/66
2.33
ETR-065 Investigation of G & N-017 Problem 4/12/66
2.34
Removed IMU from System. To be Returned to Milwaukee for Repair. 4/13/66
2.35
ISS Test (IMU S/N 7) Start: 4/15/66 IRIG Temperature Indication OSS
IMU S/N 7 Removed from System to be Returned to Milwaukee for Repair 4/28/66
2.36
IMU S/N 9 Installed in G & N-012 ISS Tests Started: 4/20/66
3.6
ISS Previbration Start: 8/14/65 Complete: 8/29/65
3.1
Vibration Start: 8/30/65 Complete: 9/4/65
3.1
ISS Postvibration Start: 9/8/65 Complete: 10/20/65
3.1
G & N Start: 1/26/66 Complete: 2/10/66
3.2
IMU Shipped to NAA 2/10/66
3.3
G & N Test Start: 4/12/66 (Installed with G & N 122 Components)
3.4
Blower Mod. Installed 4/20/66
3.5
Testing Complete IMU Transferred to NAA for Phase III Installation, 4/25/66
3.7

9.2.2 SCOPE OF G & N SYSTEM 12/50 TEST OPERATIONS

This section contains an explanation of the significant test operations represented in the following flow chart.

9.2.2.1 Factory Subsystem Testing – Milwaukee

9.2.2.1.1 Previbration, Vibration and Postvibration Testing

Previbration, vibration, and postvibration testing was performed from 12 February 1965 through 1 May 1965. No problems occurred that were directly attributable to the vibration environment; however, some inertial instrument performance parameters did exceed specification.

9.2.2.1.2 OSS Testing

OSS testing was performed at AC Electronics, Milwaukee from 25 April 1965 through 6 May 1965. One significant problem occurred, which necessitated replacing the shaft CDU.

9.2.2.1.3 CSS Testing

CSS testing was performed at AC Electronics, Milwaukee from 27 April 1965 to 12 May 1965.

9.2.2.2 Acceptance Testing

9.2.2.2.1 Assembly of Equipment – Milwaukee

Equipment assembly started on 6 May 1965 for G & N testing. Functional testing began on 15 May 1965 and was completed on 4 June 1965. Problems were encountered with inertial instrument parameters and AGC GO JAMS.

9.2.2.2.2 G & N System 12/50 Receiving and Inspection Testing – NAA

G & N 12/50 was shipped to NAA, arriving on 10 June 1965. Receiving and inspection tests were performed and G & N level tests initiated on 14 June 1965.

9.2.2.2.3 AGC and NAV DSKY to Raytheon for Repair

During G & N testing a Program Alarm occurred at frequent intervals. Also a parity fail indication was obtained and the G & N error light operation became intermittent. An additional problem occurred on the NAV DSKY (Noun 10's digit intermittent). Following a period of troubleshooting, the AGC and DSKY were sent to Raytheon for repair. The first problem was traced to a faulty ground connection in the AGC harnessing and the latter to a defective EL panel.

9.2.2.2.4 G & N Test Restart

Following return of the AGC and DSKY, G & N testing was resumed. A discrepant value of the IMU 2.5 Vac, 25.6 kc supply occurred on 6 August 1965 and further investigation of the problem was started on 9 August 1965. The ensuing investigation resulted in replacement of the Power Supply module on 24 August 1965. However, in the interim a change in the JDC tolerance value had been made from a 5 percent value to 10 percent. The original module output satisfied the 10 percent tolerance value and was therefore reinstalled. G & N testing was completed on 28 August 1965 (see next item).

9.2.2.2.5 IRIG Scale Factor, Coefficient Determination, PIPA Bias, Fine Alignment and Gyrocompassing Retest

IRIG Scale Factor and Coefficients, PIPA Bias, Fine Alignment, and Gyrocompassing tests were rerun during this period to obtain more data on erratic and out-of-specification conditions noted during G & N testing. (Reference FR's 6712, 6717, 6714, 6718, and 6719 respectively.)

9.2.2.2.6 ETR - 044 (Date: 24 September 1965)

A special test (ETR - 044) was run to determine IMU blower parameters during a maximum heater current on cycle. Data obtained was used to determine if ECP 232 (Blower resistor change) should be incorporated. An additional gyrocompassing run was also performed for further investigation of the problem mentioned in the previous paragraph.

9.2.2.2.7 OUA and NAV Base Removal and Replacement

The OUA and NAV Base were removed and replaced by the original OSS components of System 17/50 (the replacement unit had ECP 83, OUA update, incorporated). This information is included to indicate replacement unit history and disposition of the removed OSS.

9.2.2.2.8 OSS Retest (Date: 4 October 1965)

OSS retest took place to verify functional operation of the replacement unit.

9.2.2.2.9 ETR - 044 Partial Retest (Date: 12 October 1965)

A partial rerun of ETR - 044 was performed to reverify IMU blower motor parameters.

9.2.2.2.10 Fine Alignment and PIPA Scale Factor FR Investigation (Date: 19 October 1965)

Additional Fine Alignment and PIPA Scale Factor tests were run to obtain more data on the problems noted in Paragraph 11.2.2.2.5 above. The Z PIPA PVR was found to be high (FR 6776). (See Paragraph 11.2.2.2.12 below).

9.2.2.2.11 AGC 112 and DSKY's to Raytheon for Modification and Repair (Date: 21 October 1965)

The AGC and DSKY's were removed and shipped to Raytheon for incorporation of ECP 190 (Nightwatchman).

9.2.2.2.12 ISS — Partial Test (Date: 16 November 1965)

Replacement of the Z (PIP) DC Differential Amplifier and PVR was made to resolve FR 6776. A partial ISS test was run to verify functional operation of the replacement items.

9.2.2.2.13 ETR - 046 (Date: 17 November 1965)

Special test ETR - 046 was performed to determine ADA mass unbalances and to reverify that G & N System 12/50 parameters were within tolerance for flight.

9.2.2.2.14 System Storage

On 22 November 1965 the system was removed from the test station and placed in storage.

9.2.2.2.15 Beryllium Coating Modification

OUA/NAV Base S/N 7, CDU's S/N 60 through 64, CDU Frame, and PSA Toe Cap were returned to Milwaukee for incorporation of the beryllium coating modification (ECP 219).

9.2.2.2.16 OSS Retest per PMD 281 (Date: 7 December 1965)

OSS retest was successfully performed following return of the OSS and CDU components.

9.2.2.2.17 G & N PIPA, Fine Align, Scale Factor and Gyrocompassing Investigation (Date: 9 December 1965)

G & N PIPA, Scale Factor, and Bias terms were adjusted as requested by MIT/IL (Y and Z only). This period was also utilized to continue the investigation of G & N test out-of-specification conditions. AGC S/N 117 was used on a temporary basis pending return of AGC S/N 112. Data obtained during testing indicated a change in ternary current switch pulse output characteristics at high bus during gyrocompassing. Unstable and variable IRIG coefficients were again noted at this time. MIT/IL recommended replacement of the ternary current switches as a result of this testing phase. (See Paragraph 9.2.2.2.20.)

9.2.2.2.18 Installation of Modified PSA Tray 10

ECP 25 (replacement of Signal Conditioning Power Supply in PSA Tray 10) was incorporated 29 December 1965.

9.2.2.2.19 ISS Test to Run ETR - 051 (Date: 10 January 1966)

The G & N System was established in an ISS configuration for performance of special test ETR - 051. The test verified IRIG misalignment values were within tolerance limits established by the ETR.

9.2.2.2.20 ETR - 050 (Date: 11 January 1966)

Special test ETR - 050 provided for temporary replacement of the ternary current switches (Series 50) with Series 100 switches in pursuit of the gyrocompassing problem.

This temporary substitution of Series 100 switches became a permanent change per NASA direction.

9.2.2.2.21 AGC and DSKY's Returned and ETR - 050 Completed

The AGC and DSKY's were returned after incorporation of ECP 190 and installed in the system on 14 January 1966. The entire system was then placed in a G & N configuration and ETR - 050 completed.

9.2.2.2.22 Removal and Replacement of AGC, NAV DSKY, and Y Harness

During G & N checkout,AGC torquing of the CDU's in Coarse Align became erratic and in error (Reference FR 6891). The AGC, NAV DSKY, and Y harness were removed and temporarily replaced by S/N 8 to allow testing to continue.

9.2.2.2.23 Special Test — IRIG Coefficients

An additional test (for FR investigation) was performed to provide data to aid in the continuing investigation of the IRIG coefficient problem. IRIG coefficient and Scale Factor tests were run with all values obtained being in specification but with large variations noted between repeated runs in NBD_X.

9.2.2.2.24 Termination of Tests and Return of Components.

Testing was terminated at this time and required components (CDU's, PSA's. and so on) were returned to Milwaukee for incorporation of the flight qualification fixes (ECP 250).

9.2.2.2.25 AGC, NAV, and Main DSKY's to Raytheon for Repair

AGC S/N 8 was removed from the system.

The AGC, NAV, and Main DSKY's were shipped to Raytheon for repair as a result of discrepancies noted on 18 January 1966 (CDU torquing problem). Investigation of the problem at Raytheon revealed a malfunction in the register which controls the CDU torquing. Repair was affected by replacement of a logic module.

9.2.2.2.26 Phase II Equipment to NAA for Installation

The Phase II required components were provided to NAA on 23 February 1966 and installation completed in S/C 012 on 25 February 1966.

9.2.2.2.27 Optics/NAV Base to Milwaukee for Repair

The OUA-NAV/Base was returned to Milwaukee for rework and retest following discovery of a dent in the bellows.

9.2.2.2.28 AGC, NAV and Main DSKY's Returned to NAA

All computer components sent to Raytheon for repair were returned to NAA.

During initial turn-on of the system (ISS configuration) the IMU 3.2 kc 1 percent power supply output had 28 Vdc inadvertently applied to its output terminals (Reference FR 10280). Subsequent troubleshooting and investigation resulted in replacement of the Power Supply and Fail Detect modules to preclude the possibility of future problems arising due to the "overstress" conditions.

9.2.2.2.29 Investigation of G & N System 17/50 AGC Problems Using AGC 112

AGC S/N 112 was utilized to verify program alarm and restart problems which occurred during testing of G & N System 17/50 in S/C 011 (ETR 057).

9.2.2.2.30 ETR - 055 and ETR -056 (Date: 22 March 1966)

Special tests, ETR - 055 and - 056, were performed on the dates indicated. ETR - 055 verified the IRIG float freedom and ETR - 056 provided a check on the PIPA sensing linearity. Both tests indicated these aspects of inertial instrument performance were good.

9.2.2.2.31 IRIG Scale Factor and Coefficients Tests

The IRIG Scale Factor and Coefficient tests were performed partly to provide verification of these terms following the Power Supply PSA-JB problem of 9 March 1966 and to obtain more data at an ISS level for comparison with previous values. Results obtained compared favorably to Previbration ISS tests in Milwaukee on 26 April 1965 with the exception of NBD_Z and $ADIA_Z$.

9.2.2.2.32 Removal and Replacement of NAV and Main DSKY's

The NAV and Main DSKY's were replaced because of a cracked EL panel in the NAV. This DSKY replacement resolved problems that had been waivered during the original acceptance tests at Raytheon and during ECP 190 retest, also at Raytheon.

9.2.2.2.33 ETR - 061 (Date: 8 April 1966)

A special test (ETR - 061) was run on the Z IRIG to determine the stability of the ADIA coefficient, since results of previous tests displayed shifts of this coefficient. This test utilized a wave form analysis of the IRIG error signal to determine coefficient stability. Results of the test indicated that the Z IRIG was subject to frequent short term ADIA shifts and indicated a very unstable gyro wheel package.

9.2.2.2.34 ETR - 065 (Date: 12 April 1966)

ETR - 065 was performed to verify operation of G & N System 17/50's Outer Gimbal CDU as part of an investigation of a problem occurring during S/C 011 testing. This test was not related to the performance of G & N System 12/50 and no data was obtained for this system.

9.2.2.2.35 Return IMU to Milwaukee for Repair

Due to the $ADIA_Z$ instability observed during ETR-061, IMU S/N 2 was removed from G & N System 12/50 on 13 April 1966 for return to Milwaukee for repair (replacement of Z IRIG).

9.2.2.2.36 ISS Test (IMU) Start and Return of IMU to Milwaukee for Repair

ISS testing was started utilizing IMU Spare II (S/N 7). During initial performance of the temperature control tests the IRIG temperature-indicating circuit indicated out-of-specification values. Special tests were run on the temperature control circuits; the problem was isolated to the IMU. The decision was made on 15 April 1966 to return the unit to Milwaukee for repair. A shift in the padding resistor for one of the IRIG indicating sensors was found during troubleshooting and repair at Milwaukee.

9.2.2.3 ISS Testing of IMU S/N 9

The following items describe the chronological history of IMU G & N 122 (S/N 9). It should be noted that G & N 122 had already been undergoing G & N level tests (Paragraph 9.2.2.3.4) with System 122 components prior to its use as a replacement for the Spare II IMU.

9.2.2.3.1 ISS Previbration, Vibration and Postvibration Testing

ISS Previbration, Vibration, and ISS Postvibration tests were performed during the period 14 August 1965 to 20 October 1965. No significant problems occurred during the vibration testing that were attributable to the vibration environment.

9.2.2.3.2 Completion of G & N Testing

G & N testing was completed on 10 February 1966 with the following out-of-specification conditions waived:

1. $ADIA_X$ out of specification
2. X PIPA Scale Factor out of specification
3. Y PIPA Bias out of specification

9.2.2.3.3 Shipment of IMU to NAA

Shipment of the system (G & N 122) to NAA was accomplished on 10 February 1966.

9.2.2.3.4 G & N Test Start at NAA

G & N testing at NAA started on 12 April 1966 and was terminated on 20 April 1966 following the decision to replace IMU Spare II with G & N 122's, IMU (S/N 9).

9.2.2.3.5 Installation of Blower Modification

The blower modification (ECP 232) was incorporated on 20 April 1966 prior to start of ISS testing in G & N System 12/50.

9.2.2.3.6 Replaced IMU S/N 9 and Started ISS Testing

IMU S/N 9 replaced IMU S/N 7 for use in G & N System 12/50. ISS testing was initiated on 20 April 1966.

9.2.2.3.7 Completion of ISS Testing and Transfer of IMU to NAA

ISS testing was completed and the IMU transferred to NAA for S/C installation, Phase III. Significant out-of-tolerance values were obtained during ISS and previous G & N (in G & N 122) tests as follows:

1. Several X and Z IRIG coefficients out of specification.
2. X PIPA Scale Factor out of specification.
3. Gyrocompassing values were out of specification from 180 to 300 minutes of the test.

In addition an out-of-tolerance Fine Alignment test value was obtained during G & N testing with G & N 122 components (Paragraph 9.2.2.3.4). The X PIPA about Z misalignment value was 478 arc-seconds out of specification. This problem remains an open item pending further investigation during S/C 012 testing.

9.3 PROBLEM SUMMARY

9.3.1 PROBLEM STATUS

The problem status is summarized by checking the appropriate block indicating: Unresolved, Resolved, or Explained, based upon the following guidelines.

9.3.1.1 Resolved

This block indicates that problem has been satisfactorily resolved and documented for both mission and program.

9.3.1.2 Explained

This block indicates that problem has been explained and is acceptable for application on this mission.

9.3.1.3 Unresolved

This block indicates that the problem described has not been satisfactorily resolved for mission or program.

9.3.2 PROBLEM SUMMARY NUMBER

The problem summary number is coded as follows, and numbered sequentially without particular significance:

I — Inertial Subsystem

P — Power Servo Assembly

O — Optical Subsystem

D — Display and Controls including the Signal Conditioner

C — Computer Subsystem

Q — Qualification Test

G — Generic

W — Waiver

9.3.3 FAILURE SUMMARIES

The failure summaries directly resulting from a failure on G&N System 12/50, including other failures related to G&N System 12/50 by use of assemblies, operations, and so on. are separated by type as follows:

- G&N 12/50 Problems are summarized in Paragraph 9.3.4.1,
- Generic problems involving the entire series of equipment of which G&N System 12/50 is involved are summarized in Paragraph 9.3.4.2,
- System Qualification failures are summarized in Paragraph 9.3.4.3,
- Part Qualification irregularities are summarized in Paragraph 9.3.4.4.

9.3.4 APOLLO PROBLEM SUMMARIES

9.3.4.1 G&N 12/50 PROBLEM SUMMARIES

The following problem summaries represent the significant G&N System 12/50 acceptance and preinstallation test problems. Many other reports were reviewed; however, they were of the type including specification or JDC change, corrected physical defects, personnel error, and conditions that were removed and verified.

APS NUMBER	SUBJECT	STATUS
G&N I-001	IRIG Performance	Explained
G&N I-002	PIPA Misalignment	Unresolved
G&N I-003	PIPA Performance	Explained
G&N I-004	Outer Gimbal Angle Deviation	Unresolved
G&N O-001	G&N optics slew rate	Explained
G&N P-001	PSA J-box switch	Resolved
G&N P-002	OG CDU resolver errors	Explained
G&N P-003/G002	Julie resistors	Unresolved

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 7 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N IMU S/N 9

Spacecraft [X] GSE [ ]

APS G & N-I-001

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Affect on Mission — Objectives — Influence on Interfaces

1.1 The X IRIG bias drift and ADIA drift have deviated beyond the deviation specification limits.

1.2 The referenced performance data has been evaluated and appraised to provide the required performance for Mission 204A.

1.2 Failure Report Number(s) FR: 10362, 11256

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

2.0 G & N 12/50 will be removed from the S/C as required to perform ISS tests after cessation of integrated testing at NAA. (The X IRIG ADIA drift will be monitored to confirm stability about the present ADIA drift level.)

R 66-23-23

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 7 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N IMU S/N 9

Spacecraft [X] GSE [ ]

APS G & N-I-002

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION

1.1 Technical Narrative — Failure Mode
1.2 Affect on Mission — Objectives — Influence on Interfaces

1.11 The X PIPA misalignment about the Z axis with respect to the SXT line of sight is +628 arc-seconds as measured in the G & N Lab at NAA and +1,007 arc-seconds as measured in the S/C.

1.12 The X PIPA scale factor has shifted from a value of +492 PPM as tested in the G & N Lab to a value of -997 PPM as tested in the S/C.

1.2 The referenced performance data has been evaluated and appraised to provide degraded but acceptable Mission 204A performance.

9-28

1.2 Failure Report Number(s) 10368

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

2.0 G & N 12/50 will be removed from the S/C as required to perform ISS PIPA alignment and performance tests after cessation of integrated testing at NAA.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 7 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N IMU S/N 9

Spacecraft [X] GSE [ ]

APS G & N-I-003

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Affect on Mission — Objectives — Influence on Interfaces

1.1 PIPA scale factor and bias deviate beyond specification limits during ISS and G & N system testing.

1.2 The referenced performance data has been evaluated and appraised to provide the required performance for Mission 204A.

1.2 **Failure Report Number(s)** FR: 7755, 7756, 7757, 10351, and 11255

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

2.0 PIPA scale factor and bias deviation are under investigation by MIT/IL. The stability of the PIPA scale factor exceeds that of the average or nominal Block I system while the bias stability is below average for the X and Y PIPA's. The greatest amount of bias deviation was experienced during HI and LO bus voltage tests, utilizing Series 100 binary current switches. Bias deviation with bus voltage is expected to decrease during operation with the Series 50 current switches currently installed in G & N 12/50. The X PIPA scale factor has exhibited a drifting condition which yields scale factor readings that are normally predictable and compensatable.

R 6 -28-24A

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 7 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N IMU S/N 9

Spacecraft [X] GSE [ ]

APS G & N-I-004

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Affect on Mission — Objectives — Influence and Interfaces

1.1 The Outer Gimbal Angle deviation during the period of from 120 minutes to 300 minutes during the gyrocompassing test in the G & N Laboratory at NAA was a maximum of +0.20 degree. This condition is indicative of a change in NBD-Z or ADIA-X drift during the period of test.

1.2 The referenced performance data has been evaluated and appraised to provide degraded but acceptable Mission 204A performance.

9-30

1.2 **Failure Report Number(s)** 10363

2.0 **PROBLEM STATUS** Unresolved [X] Resolved [ ] Explained [ ]

2.0 G & N 12/50 will be removed from the S/C as required to perform ISS tests after cessation of integrated testing at NAA.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N N/A

Spacecraft [X] GSE [ ]

APS G & N 0-001

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During the performance of the G & N Optics Slew rate test (JDC 10071) the shaft and trunnion CDU's failed to achieve acceptable slew rates with the speed controller in the MED and LO positions.

1.2 A low slew rate in the MED and LO positions will not affect mission performance since the Hand Controller can still be successfully used with the speed controller in the HI position.

Shift Medium	Slew Rate	0.1 V	(0.85 — 1.25 V)
Trunnion Medium	Slew Rate	0.65 V	(0.85 — 1.25 V)
Short High	Slew Rate	0.1 V	(0.85 — 0.125)
Trunnion Medium	Slew Rate	0.15 V	(0.85 — 0.125)

1.3 Failure Report Number(s) 5472

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

All subsequent investigations have failed to show any out-of-tolerance condition as specified. The Optics Hand Controller outputs to the shaft and Trunnion Motor Drive Amplifier were within specification for the three different slew rates. Data obtained from engineering investigation did not correlate with the recorded values when operator error possibilities were simulated. Subsequent operation has been monitored, with no recurrence to date.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1007257, PSA

Spacecraft [X] GSE [ ]

APS G & N P-001

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During functional testing at NAA Downey, PSA Junction Box P/N 1901933-011 was inadvertently used in place of PSA Junction Box P/N 1901933-021. As a result, pins e and f of connector J-12 of the junction box were switched by Test Control Panel moding causing contact with 28 Vdc from the relay and lamp power supply.

1.2 An overstress study determined that a transformer in two modules in the PSA received the application of 28 Vdc. The modules were subsequently replaced with a result that this condition will have no affect on the mission.

1.3 **Failure Report Number(s)** 10280

2.0 **PROBLEM STATUS** Unresolved [ ] Resolved [X] Explained [ ]

Analysis indicated a probable electrical overstress of the 3.2 kHz 1% Amplifier Module, P/N 1007402-021, S/N 2, and the Failure Indicator Module P/N 1007551-021, S/N 2. Although the modules were functional, they were replaced by serial numbers 3 and 11, respectively. Due to GSE fuse protection, the overstress to the modules was of short duration. However, the degree of overstress was sufficient to establish a reliability risk, and replacement was accomplished. All field sites have received cautionary information concerning PSA junction box configuration and use.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N

Spacecraft [X] GSE [ ]

APS G & N P-002

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION

1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During a special test on G & N 12/50, the Outer Gimbal CDU 1x and 16x resolver errors are found to be excessively large. The system was subsequently down moded to standby and the problem could not be repeated after the system was returned to operate.

1.2 This failure during in-flight alignment could result in up to 7 arc-minutes error in the alignments.

1.3 Failure Report Number(s) 5898

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

Analysis of the circuit and error signals observed, indicate the most probable cause was an intermittent hang-up of the relay in the OG-CDU motor drive amplifier module. The module was tested extensively on the module test stand, but the failure could not be verified and the module was replaced.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1007257, PSA

Spacecraft [X] GSE [ ]

APS G & N P-003/G002

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Julie resistors P/N 1010254-022, P/N 1010450-012, and P/N 1010923-029 have experienced increases in resistance due to internal weld failures. Failures have occurred in the PIPA Calibration Module, IMU Temperature Indicator Alarm and Backup Module, DC Differential Amplifier, and PVR Module.

1.2 a) Failures in PIPA Calibration Modules, and DC Differential Amplifier, and PVR Modules will result in changes in PIPA scale factor and degrade guidance accuracy.

b) Failures in the IMU Temperature Indicator Alarm and Backup Module would have no significant affect on G & N functions.

1.3 Failure Report Number(s)

Module acceptance test:
5608, 8281, 11650, 13311, 16507
5609

System Acceptance Test:
6776 (G & N 12/50 at NAA)
5177 (G & N 17/50 at AC)
6856 (G & N 20 at NAA)

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

The vendor has altered the welding processes and the internal design to protect the welds within resistors fabricated after 24 October 1965. Julie resistors of the older configuration exist within modules in G & N 12/50 and present an element of risk for this flight. No parts qualification failures occurred during testing of P/N 1010450. All three parts are very similar in construction. There have been no G & N Subsystem 110 or G & N System 111 qualification test failures attributed to these parts.

9.3.4.2 APOLLO Problem Summaries-Generic

The following APOLLO Problem Summaries represent significant conditions observed in the G & N System 12/50. These were derived from a review of all APOLLO problem data to determine the parts and assemblies for which; (1) a high quantity of reports have been received, (2) a high report rate has been established and, (3) a large factor exists between the observed and predicted performance.

APS NUMBER	SUBJECT	STATUS
G & N G-001	PIP Preamplifier Capacitor, P/N 1010317-1	Explained
G & N G-003	PSA Sigma Relays, P/N 1010353	Explained
G & N G-004	Two-speed switch Utrad transformer, P/N 1010329	Explained
G & N G-009	OUA Loctite	Explained
G & N G-010	AGC relay module	Explained
G & N G-013	AGC GO-JAM	Resolved
G & N G-014	AGC Lock	Explained
G & N G-015	AGC Tray insulation "cold flow"	Unresolved
G & N G-017	IRIG Daven resistor, P/N 8595547	Explained
G & N G-018	PIPA bias versus bus voltage	Explained
G & N G-019/Q-75	OUA sextant SDA and TDA shifts	Explained
G & N G-020	E/L panel	Unresolved
G& N G-021/Q-41	OUA Exudate and haze	Explained
G & N G-022	DSKY Double entry	Unresolved

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1001500, IMU

Spacecraft [X] GSE [ ]

APS G & N G-001

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 A number of PIP Preamplifier Modules P/N 1008285 and P/N 2007060 have failed due to either an open or a shorted Sprague capacitor P/N 1010317-1. This capacitor is used only in the PIP preamplifier of which there are three per G & N System.

1.2 A shorted capacitor will result in loss of module output and loss of the guidance function. An open capacitor will cause severe degradation of guidance accuracy.

1.3 Failure Report Number(s) 8338, 11812, *12298, *12603, 37981 (* open) 7448, 7418, 7437, 7490, 7482 (Parts Qualification Test)

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

It was concluded from vendor analysis that the inability to control the thickness of extremely thin polystyrene dielectric is the cause of the short circuit failure mode. Poor solder joints between the lead and the connecting ribbon are responsible for the open circuit failure mode. Parts qualification test failures occurred in life tests with dc voltages applied, or during dielectric withstanding voltage checks. However, no field failures have occurred. Class II TDRR 26610 incorporates a new mylar dielectric capacitor, 1008848. Evaluation tests have determined that the capacitor is suitable for this application. Polystyrene capacitors exist within the PIP preamplifiers in G & N System 12/50 and present minor risk for this mission. There were no failures of this capacitor during G & N Subsystem 110 or G & N System 111 qualification tests.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1007257, PSA

Spacecraft [X] GSE [ ]

APS G & N G-003

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION
1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Sigma relays, P/N 1010353, within PSA Modules have failed during the workmanship vibration portion of module level acceptance tests and during module qualification tests in a vibration environment.

1.2 Various serious G & N System malfunctions will result from the observed relay malfunctions and cause loss of the guidance.

1.3 Failure Report Number(s) 7017, 5762, 7218, 12433,
(Module qualification test 4231, 4234)

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

During vibration the relays have exhibited contact chatter, failure to energize and failure to deenergize. Failure analyses have determined that the failures are caused by degraded spring forces within the relay during vibration. This relay exists in PSA modules in G & N System 12/50 and presents a risk for the mission. However, the relay has successfully passed part qualification tests at 20g vibration and 50g shock. No failures have occurred during PSA acceptance workmanship vibration or during G & N Subsystem 110 and G & N System 111 vibration and shock qualification tests.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1007257, PSA

Spacecraft [X] GSE [ ]

APS G & N G-004

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Failures of Utrad transformers, P/N 1010329-1, have been observed in Block I-100 Two-Speed Switch Modules, P/N 1007522-011, due to open windings.

2.2 Transformer failures in two-speed switch modules would result in inability to zero the optics.

1.3 Failure Report Number(s) 5932, 5933, 5937, 7205, 7225, 8190
5127 (G & N Subsystem 110 qualification test)

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

All failures have occurred on Block I-100 modules. A shield and cover surrounding the transformer in earlier configuration two-speed modules was removed in Block I-100 modules. Removal of the shield resulted in a temperature shock due to exotherm during module encapsulation. The vendor improved the transformer winding termination design for units produced after August 1964. ECP 348 is being processed to replace Block I-100 two-speed switch modules containing transformers with the prior termination design. Modules in G & N 17/50 and 12/50 are of the design which utilized a shielded transformer. There have been no failures in this design, thus no risk is presented to this mission.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1011000, OUA

Spacecraft [X] GSE [ ]

APS G & N G-009

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION

1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During design evaluation tests on OUA 101, the scanning telescope objective lens, P/N 1011709, was found to be loose after the oxygen overpressure and temperature tests. Scanning telescope shaft drive axis accuracy and reticle eccentricity variations were noted. The application of "Locktite" appeared to be inadequate on the objective lens locking ring, P/N 1011659.

1.2 The condition could result in inaccuracies of star and landmark angular data inputs.

1.3 Failure Report Number(s) 7346, 7351, 7353, 8514, 8516

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

Extensive locktite application investigations resulted in process improvements that included a change of the "Locquic" primer from type N to Q, a change of the Locktite cure to 2 hours at 140°F, and an increase in the amount of Locktite used. Evaluation tests of the new processes were successful. Additional tests have confirmed that a loose objective lens will not affect the spacecraft pressure seal, which is maintained by the eyepiece window. The condition may exist in the OUA and G & N 12/50. However, there has been no indication that it does exist through acceptance vibration tests. No loosening of retaining rings was detected in subsystem qualification test of OUA 124 nor in G & N 111 qualification tests.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003770-071, AGC

Spacecraft [X] GSE [ ]

APS G & N G-010

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 The Computer Subsystem has experienced numerous relay module failures during functional testing. The module failures have been caused by intermittent or inoperative relays, P/N 1006772.

1.2 Relay module failures result in the inability to communicate with the computer via uplink/downlink and/or DSKY entries.

1.3 Failure Report Number(s) 6267, 6402, 6403, 6271, 6414, 6413, 5247, 6477, 11335, 9092, 11405, 4414, 8981, 8982, 6437, 11405, 11406, 9088, 9803, 11348, 6428

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

The major cause of the relay failures has been determined to be low pull-in voltage. GSE cables have been modified to minimize line drop. Investigation of worst case thermal conditions and cabling within the spacecraft indicate that 12V will be available at the relay. This voltage is at the low specification limit and provides no safety margin but is sufficient to operate the relays.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003770, AGC

Spacecraft [X] GSE [ ]

APS G & N G-013

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Noise transients occurring at varying and random intervals cause the AGC to restart and abort any program it may be performing (GO-JAM). "GO-JAM" and "PARITY FAIL" type of failures have occurred in most systems to some degree with the GO-JAM being prevalent.

1.2 Computer restarts result in loss of computing time. Lost data and/or program jumps are possible during the mission.

1.3 Failure Report Number(s) 5791, 5792 (G & N 12/50)
4774, 8637, 8821, 8825, 8823, 9221, 7694, 7785, 13596, 11199,
5525, 4363, 8113, 4190

2.0 PROBLEM STATUS Unresolved [ ] Resolved [X] Explained [ ]

Noise transient investigation has resulted in two fixes. ECP-189 incorporated a change to AGC Tray B grounding the zero volts dc line in the tray to reduce noise susceptability. ECP-180 resulted in the modification of the Y harness bringing a reduction of noise transient problems through changes in wire shielding and an EMI tape over wrap. Both ECP's have been incorporated in G & N 12/50 and G & N 17/50 without this problem reoccurring. No GP-JAM's were reported during EMI qualification tests conducted on AGC Subsystem 110 and G & N System 111.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 23 May 1966
Rev 7 June 1966

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003770, AGC

Spacecraft [X] GSE [ ]

APS G&N G-014

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Computer "locks have been experienced such that the AGC will not function normally and may lock such that no address may be made to the AGC via the DSKY or uplink.

Computer Lock has been experienced under two basic conditions:

(a) When a 28 Vdc bus fluctuation outside ICD limits occurs while data is being transferred to and from the erasable memory.
(b) When a DSKY entry of improper data is made in certain memory locations.

1.2 A computer lock condition results in the inability to communicate with the computer via uplink/downlink and/or the DSKY.

1.3 Failure Report Number(s) 6894, 10204 (G&N System 8 at NAA)
5499 (G&N 12/50 at NAA)

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

(a) No known corrective action exists to preclude lock due to low bus voltage. The computer FTM has been changed to stop computer operations prior to power shutdown, thereby precluding the possibility of computer lock during the tests. The stop capability is limited to runs with the GSE connected.

(b) The flight rope design has been changed and will provide a means for the astronaut to break out of the lock condition. These flight ropes will be installed in the AGC in G&N 12/50.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003770, AGC

Spacecraft [X] GSE [ ]

APS G & N G-015

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Several Block I-100 AGC trays have experienced Surflene B wire insulation "cold flow" where the wire is pressed or passes around the Malco wrap-posts resulting in short circuits.

1.2 Failures of this type could render the computer inoperable and/or induce a failure of other G & N hardware.

1.3 Failure Report Number(s) 5236, 6417, 6416, 6418

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

The occurrances have been observed in the high density wiring areas of the trays and only during the elevated temperature tests conducted on AGC's returned to Raytheon for modification. All Block I-100 AGC trays scheduled for flight use have been recycled through acceptance temperature tests. There have been no tray short circuits of this nature detected during AGC Subsystem 110 and G & N System 111 qualification tests.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1001500, IMU

Spacecraft [X] GSE [ ]

APS G & N G-017

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION
1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Resistors, P/N 8595547, supplied by Daven were found to be intermittent and open in a 25 IRIG during acceptance vibration of IMU S/N 6 in G & N System 109, during acceptance testing of IMU S/N 9 in G & N System 122, and acceptance testing of spare IMU S/N 7.

1.2 The resistors are used only in the temperature control indicating circuits within the Block I-100 Series APOLLO I IRIG. An intermittent or open condition would result in inertial instrument temperature control anomalies. Automatic backup heater control is available minimizing the failure effect on G & N System performance.

1.3 Failure Report Number(s) 3216, 3424, 7677

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

Failure analysis revealed that the resistor failures were due to the use of low temperature solder (50/50) for internal termination of the resistive element and also due to inadequate tinning that was disturbed during installation soldering of the resistor in the IRIG. Similar IRIG's in G & N Subsystem 110 have undergone design limit tests without failure.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1001500-IMU

Spacecraft [X] GSE [ ]

APS G & N G-018

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 PIPA bias variations with bus voltage is a problem on all Block I systems. These variations are due to differences between the plus and minus torquing envelopes generated within the binary current switch when used with an unregulated pulse torque power supply.

1.2 Bias variations, which could be caused by bus voltage variations, will cause position and velocity errors during flight.

1.3 Failure Report Number(s) 9242, 6049

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

The magnitude of error resulting from this problem during the mission will not prevent the successful accomplishment of all mission objectives.

Reference Waivers:

C-806 (G & N 109)	C-764 (G & N 122)
C-752 (G & N 110)	C-821 (G & N 123)
C-755 (G & N 111)	C-809 (G & N SP II)
C-751 (G & N 121)	C-722 (G & N 12/50)

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 7 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1011000, OUA

Spacecraft [X] GSE [ ]

APS G&N G-019/Q-75

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 a) 15 arc-sec shift in zero alignment about the SXT shaft and trunnion axes.
b) 52 arc-sec error in SXT trunnion angles during thermal vacuum testing.
c) 32 arc-sec SXT 16 × shaft resolver realignment error following vibration.

1.2 The one sigma degradation in optical accuracy are:

a) 1.4 arc-sec, b) 1.7 arc-sec, c) 3.4 arc-sec, respectively, and would not compromise the mission objectives.

1.3 **Failure Report Number(s)** 7346, 7351, 7353, 8514, 8516,
(9545, 9550, 9626, 9638, 9644, 9689 OUA 124 (201A) Qualification)

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

Analyses indicate that shifts have occurred in the resolver, sextant head assembly, index mirror, and resolver trim module. The condition has been observed during OUA acceptance and during OUA Subsystem 124 qualification tests. Torque requirements for screws used in the sextant index head assembly and resolver have been increased. Inspection and cleaning processes have been initiated for the sextant index mirror mount. Trim module voltages are being monitored before and after module encapsulation. The OUA in G&N 12/50 was fabricated before these controls were instituted.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 7 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N MAIN & NAV DSKY

Spacecraft [X] GSE [ ]

APS G & N G-020

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 The electroluminescent (E/L) panels which are used in the NAV & MAIN DSKY's have been a continuing problem. Failure modes have been as follows.

a. Leaking displays
b. Case to ground shorts
c. Voids in glass seals around feedthroughs
d. Black spot in displays
e. Degradation of display areas due to dielectric break-down
f. Misaligned connections.

1.2 Astronaut to computer interface will be adversely affected. Case to ground shorts could render the guidance nonoperative.

1.3 Failure Report Number(s) 8606, 11427, 11428, 6374, 11403, 10259, 12258, 12304, 6287, 6288, 5403, 5404, 5422, 6296, 12258, 9183, 6408, 5422

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

There have been improvements and changes made on the hermetically sealed units that include improved evacuation equipment, and design improvements on the register panels (1006739), and an alternate design has been employed (1003575) to replace the alarm panel (1006754). The improved register panel, (1006739) and the new 1003575 assembly (consisting of 4 each a 1 × 4 1006386 panels) which will replace the present alarm panel, have been installed in G & N 12/50 and have been submitted to qualification tests. The tests were started on 2 February 1966, and are expected to be completed approximately 1 August 1966.

APOLLO PROBLEM SUMMARY
AFRM NO. 014

DATE 7 June 1966
Rev

Subsystem/End Item G & N 121

Equipment Name, P/N 1011000, OUA

Spacecraft [X] GSE [ ]

APS G&N G-021/Q-41

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During acceptance testing at Kollsman, and during G&N 111 qualification tests in a thermal vacuum exposure, two conditions have been noted. One manifests itself by the appearance of fluid, known as exudate, between the optical base and the silicone rubber gasket in the panel cover. The second is the desposition of an oily appearing "haze" on the lens or window surfaces.

1.2 Exudate has no affect on guidance performance. Haze reduces luminous transmittance and may result in slight diffusion of viewed elements.

1.3 **Failure Report Number(s)** (9216 G&N 111 qualification) (7316, 7317 OUA 110) (2946 G&N 12/50) 2865, 4497, 7873, 8513, 9506, 2886, 12036, 9630, 9631, 7894

2.0 **PROBLEM STATUS** Unresolved [ ] Resolved [ ] Explained [X]

The condition reported at Kollsman on the OUA in G&N 12/50 was corrected by removal and cleaning of the SXT window. No additional haze has been reported. The oily appearance reported on the SXT and SCT eyepiece windows during G&N 111 qualification is scheduled for investigation to determine the amount of diffusion and affect on accuracies by Kollsman upon completion of qualification testing.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50 & 122

Equipment Name, P/N Computer Subsystem

Spacecraft [X] GSE [ ]

APS G & N 3-022

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Two or more entries into the computer occur for a single depression of the DSKY keys.

1.2 Delays in entering data into the AGC are inherent in this type of problem. Erroneous results could be caused by double entries on the ENTER pushbutton.

1.3 Failure Report Number(s) 10436

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

It was determined that noise caused the problem. Placing a capacitor in the key reset line or changing the Keyrupt program has eliminated the problem. Final resolution and implementation of corrective action have not been accomplished.

9.3.4.3 APOLLO Problem Summaries— System and Subsystem Qualification

Block I-100 Series, or equivalent, qualification test hardware was subjected to design limit level testing in accordance with ND 1002037. Humidity exposure was the most critical environment for the G & N System. Failures encountered were due to water penetration and corrosion. Engineering changes to correct all noted discrepancies have been evaluated and were incorporated in all Block I-100 Series flight hardware, with the exception of DSKY changes (New EL panels). Requalification of G & N System 111 was recently completed, which further validates the effectiveness of the incorporated changes. Qualification testing of the new EL panel is scheduled for completion by 1 August 1966. All changes, including the new EL panels, have been incorporated in G & N System 12/50.

The following APOLLO Problem Summaries represent significant items noted during qualification tests of G & N Subsystems 110 and 111, which are applicable to G & N 12/50.

APS NUMBER	SUBJECT	STATUS
G & N Q-016	E/L panel humidity failures	Unresolved
G & N Q-026	NAV DSKY gaskets	Unresolved
G & N Q-030	E/L failures in oxygen overpressure	Unresolved
G & N Q-053	DSKY pushbutton switches	Explained
G & N Q-072	Erroneous E/L display	Unresolved
G & N Q-073	SCT SDA starting voltage	Unresolved
G & N Q-074	AGC response improper	Explained
G & N Q-076	AGC rope diode cracked	Resolved
All Humidity	Potting separation and corrosion	Resolved

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003706-011 NAV-DSKY

Spacecraft [X] GSE [ ]

APS G & N Q-016

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 The following problems were experienced during and after system level humidity exposure.

(a) Verb and Noun displays on NAV DSKY, 1003706-011, Raytheon-5 remain on instead of flashing on and off as required.

(b) Communications to AGC via DSKY's were unattainable. Continuous GO-JAM's, Error Rupts and complete lock-up was experienced. Failure was caused by inability of this configuration E/L panel to withstand system level humidity requirements.

1.2 Failure mode outlined in item (b) would result in loss of G & N guidance control.

1.3 Failure Report Number(s) 6182, 9289, 6347

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

E/L panels of a new and improved configuration have been installed in System 12/50 but qualification has not been completed. Qualification is scheduled to be performed by Raytheon on AGC 110 DSKY's. This problem will be considered resolved when the new DSKY's have passed qualification test which is expected to be completed by 1 July 1966.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003570-021 NAV DSKY

Spacecraft [X] GSE [ ]

APS G & N Q-026

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Following the humidity exposure, corrosion was observed in the pin contact area of NAV DSKY Power Supply Module, P/N 1003811-011, RAY-9, and on the connector of harness (P/N 1005727).

1.2 Insulation resistance degradation in this location due to moisture could result in degradation of system performance.

1.3 Failure Report Number(s) 6197

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

The NAV DSKY Module gaskets were replaced following humidity. No other gaskets were replaced in the MAIN DSKY or the AGC. No evidence of this problem occurred during the requalification of G & N 111 in humidity. There is evidence through the qualification of AGC 110 that if a module is replaced a number of times, the gasket may not give full protection. An investigation is underway by Raytheon to determine the recommended replacement cycle.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003706-011 NAV DSKY

Spacecraft [X] GSE [ ]

APS G & N Q-030

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Following oxygen exposure, the computer activity lamp on the NAV DSKY P/N 1003706-011, Raytheon-5 displayed only a small spot of light. Subsequently, the light extinguished.

1.2 This failure will have no affect on system performance but is the indication of arcing.

1.3 Failure Report Number(s) 8599, 9275

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

E/L panels of a new and improved configuration have been installed in System 12/50 but qualification has not been completed. Qualification is scheduled to be performed by Raytheon on AGC 110 DSKY's as soon as they are retrofitted. This problem will be considered resolved when the new DSKY's have passed qualification test which is expected to be completed by 1 July 1966.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1002707-011

Spacecraft [X] GSE [ ]

APS G & N Q-053

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During thermal vacuum conditions of 100° F and 10^{-4} mm Hg, eight Main DSKY pushbutton switches (P/N 1006738) would not energize, even when fully depressed to the mechanical stops. Investigation indicates that proper switch operation is dependent on individual switch leak rate when exposed to pressures below 3 PSIA.

1.2 The capability for the astronaut to supply data to the computer would be compromised.

1.3 Failure Report Number(s) 6371

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

The mechanical stops have been adjusted on switches with low individual leak rate. This adjustment solves the problem of activation under the environmental combination. Thermal Vacuum Evaluation Tests have been accomplished on adjusted units and the fix has been verified. G & N System 12/50 DSKY's have been reworked for ECP 327F and CCN 497-0188.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003706

Spacecraft [X] GSE [ ]

APS G & N Q-072

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During the Z_{cm} Axis Vibration Test (3.85g rms input) of the NAV DSKY an erroneous E/L Display was present.

1.2 Occurrence of this phenomena during flight would give incorrect readings to the astronaut.

1.3 Failure Report Number(s) 4189

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

Based on the E/L display, Raytheon Engineering determined that the only possible cause of the failure would be a short between the EV 250 line and the 800 LO line. During investigation the fault disappeared and could not be made to reappear by further vibration. Further investigation will be performed during overstress vibration.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 2011000, OUA

Spacecraft [X] GSE [ ]

APS G & N Q-073

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION

1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During thermal vacuum testing and in baseline checks following ground temperature tests, the SCT SDA starting voltage exceeded the tolerance in both directions, maximum reading 10 volts, tolerance 5.3 volts.

1.2 The out-of-specification condition can be indicative of a deteriorating condition resulting in a loss of optical and mission objectives.

1.3 Failure Report Number(s) 9690, 9693, 9607

2.0 PROBLEM STATUS Unresolved [X] Resolved [ ] Explained [ ]

The problem is under investigation. Kollsman has not as yet isolated the cause. Crew safety will not be jeopardized by the failure of the OUA, however, optical mission objectives may be compromised.

APOLLO PROBLEM SUMMARY
AFRM NO. 011
QUALIFICATION TEST G & N 111

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003770-131 AGC

Spacecraft [X] GSE [ ]

APS G & N-Q-74

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Occasionally during testing, when Verb 41 is requested there is a variable time delay before the correct response is displayed. This is about 5 seconds if no other action is taken. If a second "ENTER" is pressed, and the response displayed immediately, the first request will cause a display (Verb 21, Noun 22) or "KEY RELEASE" some minutes later.

1.2 This condition has not caused any problem in ground operation nor would it cause a problem in this mode (COARSE ALIGN) during flight.

1.3 Failure Report Number(s) 9217

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

An investigation of this problem on G & N 111 after completion of Qualification is scheduled.
Verb-41 is not used during flight; coarse align is accomplished within automatic major mission programs in flight.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1003400, AGC RAY-180

Spacecraft [X] GSE [ ]

APS G & N Q-076

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 During ground temperature exposure (107° F) a computer failure occurred. Addresses 2000_8 through 2377_8 show Bit 13 set continuously. Failure was caused by defective Rope Memory Module, P/N 1003733-051, RAY 41.

1.2 This failure in a flight rope would lock the computer in an error loop, and would result in a complete loss of the guidance and navigation functions.

1.3 **Failure Report Number(s)** 9219, 6364

2.0 **PROBLEM STATUS** Unresolved [ ] Resolved [X] Explained [ ]

Analysis of the defective module determined that a diode had cracked due to potting material pressure. The original GSE test ropes (Ares) were utilized in an unpotted condition. Several of these were subsequently potted and also experienced cracked diodes. The remainder of the test ropes and all flight ropes now utilize a silastic coating over all diodes to preclude breakage due to potting pressures. The current rope modules in G & N System 12/50 will be replaced by flight ropes prior to the mission. The failure mechanism observed on the qualification program will not exist on G & N System 12/50. Raytheon has verified that diodes which are silastic coated do not demonstrate this failure mode. All ropes are cycled through a 0° to 65° C temperature cycle.

APOLLO PROBLEM SUMMARY
AFRM NO. 012
QUALIFICATION TEST ISS 110 AND G & N 111

DATE 1 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N N/A

Spacecraft [X] GSE [ ]

APS All Humidity

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION
1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Module potting separation, metallic corrosion and multiple functional failures resulting from inadequate moisture protection have occurred during humidity exposure.

1.2 These failures could have a catastrophic affect on the mission.

1.3 Failure Report Number(s) 6021, 6022, 6023, 6042, 6053, 6175, 6176, 6178, 6179, 6180, 6183, 6184, 6185, 6186, 6191, 6192, 6193, 6194, 6195, 6198, 6199, 6200, 8584, 8586, 8589, 8597, 8609, 8610, 8614, 8618, 8625.

2.0 PROBLEM STATUS Unresolved [ ] Resolved [x] Explained [ ]

The following ECP's have been installed into G & N 12/50: 219, 250F, 267F, 269F, 270F.

These changes have been incorporated in G & N System 111 and have passed requalification testing satisfactorily.

9.3.4.4 Part Qualification Irregularities

The presence of parts in G & N 12/50 that have been classified as "unqualified" because of failures experienced through completed part level qualification testing was determined. These parts are identified as subject items in the following group of APOLLO Part Qualification Irregularity sheets. Subject items were also derived on the basis of higher level (subassembly, subsystem, and system) qualification test failures directly associated with a part, or on the basis of currently undetermined part level qualification status created by part failures in incomplete testing.

Each identified part, because of the incidence of failure in its history, presents some magnitude of reliability risk. The recommendations for the acceptance of the risks have been determined individually through the analysis of information available for the part and relative to the mission requirements.

APOLLO G & N SYSTEM 12/50 PART QUALIFICATION IRREGULARITIES

ITEM NO.	PART NO.	PART NAME AND MANUFACTURER	QUALIFICATION STATUS					DISPOSITION FOR FLIGHT
			110 QUAL	111 QUAL	SUB-ASSY	PART QUAL	OTHER	
1	1010317	Capcitor Supplier: Sprague Quantity: 3 Application: 100B285-011 PIP Preamp		Q		F		Part failure mechanism is dielectric breakdown caused by variations in polystyrene film. An application analysis, supported by data from additional qualification testing, revealed part is not used at a voltage greater than 2 volts, which is a safe energization level. Part is, therefore, acceptable for use in its application.
2	1006755	Capacitor Suppliers: Sprague and Kemet Quantity: Over 300 Applications: Multiple	F	Q	Q	Q		Cause of part-oriented failure in qualification system 110 was determined as a manufacturing defect. Failures experienced in part level qualification testing conducted by Raytheon have been determined as caused by testing beyond the SCD limits. One production failure (part shorted) was recorded; cause could not be established as part-oriented. The absence of additional failures against this high usage part is considered as the basis for its acceptability for flight.
3	1010779	Connector Supplier: Cannon Quantity: 12 Applications: Signal Conditioner Assemblies 1007663-011 Signal Conditioner IRIG and PIGA 1007663-011 Scaler Assembly 1007664-011 Signal Conditioner Gimbal Resolver 1007665-011 Resolver CDU 1007666-011 Signal Conditioner Torque Motor 1007667-011 Optics 1007670-021 Frame Assembly				F		Failures experienced in part qualification test occurred in the humidity environment. This environment was unrealistic with respect to the parts application that will not allow moisture penetration through the rear of the connector. However, limitations of the part are created by dimensional tolerances with mating connectors and can allow moisture penetration at the mating interfaces. This part is considered acceptable for flight use with the application of DC-4 grease to the connector interfaces.
4	1010286 1010462 1010830	Diode Supplier: Motorola Quantities: 40 — 1010286 6 — 1010462 6 — 1010830	Q	Q		F		1010286 and 1010462 are qualified by similarity to 1010830. 1010286, 1010462, and majority of 1010830's in-flight hardware are nonmetal-over-oxide construction and are susceptible to failure from vibration, shock, or acceleration. No failures of this type have occurred in system qualification testing or production workmanship vibration. Only three failure reports, other than those generated in part qualification testing, exist against all three part numbers. None can be associated with nonmetal-over-oxide construction. These parts are considered acceptable for flight use.

F = Failed
Q = Qualified

APOLLO G & N SYSTEM 12/50 PART QUALIFICATION IRREGULARITIES

ITEM NO.	PART NO.	PART NAME AND MANUFACTURER	QUALIFICATION STATUS					DISPOSITION FOR FLIGHT
			110 QUAL	111 QUAL	SUB-ASSY	PART QUAL	OTHER	
5	1010290 1010831	Diode Supplier: Motorola Quantity: 9-1010290 Application: 1007517-021 AC Differential Amplifier	Q	Q		F	F*	1010290 is qualified by similarity to 1010831. No failures were experienced in environmental phases of part qualification testing; all failures occurred in life test. Three failure analyses determined similar conditions: degradation of cathode/anode junction caused by contamination trapped in voids in solder preform. Conclusion is that part has time-dependent failure mechanism. *Two production failures of the ac differential amplifier were associated with part failure. One against the 1010831, was analyzed for intermittency but was unconfirmed. The other, against the 1010290, states action has been taken through circuit modification to reduce part electrical stress. A review of 12 systems containing 108 of the subject parts have accumulated 156,834 part-hours of life without failure of these parts. The two qualified systems along have accrued over 5,000 hours of operation as compared to 2,000 hours life required in part qualification testing. Part qualification was conducted at 90% device rating. System application is at 30% with possible transients of 75%. Based on the available information, the part is acceptable as a risk for flight application.
6	1006751	Diode Suppliers: Texas Instrument, Fairchild, and Unitrode Quantity: 1,562 in AGC	Q	Q		F		Part qualification testing was conducted by Raytheon. All recorded failures have occurred in part qualification testing, none in system level qualification or production hardware. Suppliers are not distinguished in computer ADP. Per 17/50 CARR, primary concern of risk was for Fairchild-supplied devices. Absence of part-oriented failures other than in part qualification test of this extremely high usage part is considered as the basis for its acceptability for use in 12/50.
7	1006712	Resistor Supplier: Gulton Quantities: 3/ISS 1/AGC Application: 1007532-041 1007533-041 1007534-041 Frame Trays 2, 3, 4	Q	Q		F		Identical lot numbers found in G & N 110 and G & N 111 All reported failures are isolated to part qualification testing at Raytheon. A review of discrepancies experienced in part qualification testing and the complete absence of failures during qualification of G & N 110/111 and production is the basis for considering the part acceptable for use in 12/50.
8	1006736	Resistor Supplier: Waters Quantity: 2/AGC	Q	Q		F		Two failures, other than those reported in part qualification testing, are recorded: one is not part-oriented, the other was caused by the absence of keeper for the potentiometer shaft. Part qualification test requirements were, in some cases, unrealistic with respect to part application, for example, 10 r/min rotary life. The part is used to control brightness of electroluminescent panels in the DSKY. An open potentiometer would result in maximum brightness. Shorting is not considered a potential failure mode

APOLLO G & N SYSTEM 12/50 PART QUALIFICATION IRREGULARITIES								
ITEM NO.	PART NO.	PART NAME AND MANUFACTURER	QUALIFICATION STATUS					DISPOSITION FOR FLIGHT
			110 QUAL	111 QUAL	SUB-ASSY	PART QUAL	OTHER	
								because travel is limited. Furthermore, redundancy in the form of two DSKY's, is available. The part is acceptable for use in G & N 12/50.
9	1006715	Resistor Supplier: Fenwal Quantity: 4/AGC Application: Oscillator and Power Switch	Q	Q		F		The primary discrepancy experienced in part level qualification testing at Raytheon was resistance changes over the range of environments. The range of resistance change was 1.09% to 3.07% compared to a maximum allowable limit of ±1%. The part level environments, particularly temperature cycling and high and low temperature exposures, are considered severe compared to the expected application conditions. No catastrophic failures were experienced in part level qualification testing. No failure have been reported in higher level qualification testing or in operational hardware. The part is considered acceptable as a risk for G & N 12/50.
10	1010453	Resistor Supplier: Conelco Quantity: 1 Application: 1007426-011 IMU Temperature Control	Q	Q		F		Poor setting stability and noise were experienced during mechanical environments of shock, vibration, and in life testing. The part level testing, particularly rotary life testing, were considered unrealistic relative to the unit's application as a trim potentiometer. One catastrophic failure occurred in life testing resulting in complete loss of part function. No failures are identified to this part at higher assembly levels of qualification testing or in operational hardware. The part is considered acceptable in its application.
11	1010430 1010610	Servomotor Tachometer Generator Supplier: Kearfott Quantity: 5 — 1010430/ISS 4 — 1010610/OUA	Q	F		F		1010610 is qualified by similarity to 1010430. Failure of the 1010430 G & N 110 occurred in the humidity environment, which in its severity causes heavy moisture condensation on the CDU's and moisture penetration into the CDU's. The CDU's in G & N 12/50 have been sealed to prevent moisture penetration to the internal components. The motor tachometers in the OUA application will be subject to ground humidity. The severity is not expected to reach the conditions of the qualification test where condensation formed directly on the components. The failures experienced in part qualification test were related to endurance and thermal-vac environments. The thermal-vac conditions at the part level are considered excessive with respect to the 1010430 application. The operation of the 1010610 in hard space vacuum, however, is considered a high risk. Failure of the 1010610 will negate mission success in terms of OUA operation. An application analysis has determined that the part's demonstrated endurance satisfies the system life requirement. This condition is limited by the elapsed time between date of part manufacture (bearing lubrication) and the completion of a specific mission operation. (Reference Time Significant and Critical Life Operating Time, Paragraph 9.6.)

APOLLO G & N SYSTEM 12/50 PART QUALIFICATION IRREGULARITIES

ITEM NO.	PART NO.	PART NAME AND MANUFACTURER	QUALIFICATION STATUS					DISPOSITION FOR FLIGHT
			110 QUAL	111 QUAL	SUB-ASSY	PART QUAL	OTHER	
12	1010341	Resolver Supplier: Clifton Quantity: 5/ISS 3/OUA	Q	F		F		The failure in Qualification Section III was an open stator winding, the cause of which was determined as the severity of the humidity environment. The resolvers in the CDU application in 12/50 will be protected against moisture in a sealed CDU. The resolvers in the OUA application will be subject to ground humidity. The severity is not expected to reach the conditions of the qualification test where condensation formed directly on the components. Discrepancies experienced in part level qualification testing at KIC will not have a significant effect on system performance. The primary discrepancies were angular deviations and null voltage variations during high and low temperature environments. These temperature extremes are not expected in the CDU application. Should the discrepancies occur in the OUA resolvers, a reduction in the optical unit's accuracy can be expected. No failures of this part have been reported in any other area except qualification testing. The part is acceptable for use in G & N 12/50.
13	1000160	Resolver Supplier: Bendix Quantity: 2/OUA				F		All failures recorded for this part occurred in part qualification testing. This part is used exclusively in G & N 12/50 and 17/50. During part qualification testing, out-of-limits accuracy measurements were noted after high temperature exposure and after all subsequent environments and endurance cycles. The accuracy limitations of the resolver will reduce the accuracy of OUA operation, thus reducing the degree of mission success.
14	1010335	Transformer Supplier: UTC Qualified by Similarity 1010315 — 10/ISS 1010323 23 1010324 32 1010326 3 1010328 3 1010407 3 1010433 0 1010466 4 1010467 2 1010880 0 80	Q	Q		F		Only failures recorded against part occurred in part level qualification test. No failures are recorded against any of the associated parts. Part qualification failures occurred in temperature cycling cause was determined as inability of magnetic wire to sustain mechanical stresses resulting from temperature extremes. Part is not exposed directly to temperature extremes in its applications. Part level testing is considered severe. Complete absence of failures at all other qualification levels is considered basis for parts acceptability for flight application.

APOLLO G & N SYSTEM 12/50 PART QUALIFICATION IRREGULARITIES

ITEM NO.	PART NO.	PART NAME AND MANUFACTURER	QUALIFICATION STATUS					DISPOSITION FOR FLIGHT
			110 QUAL	111 QUAL	SUB-ASSY	PART QUAL	OTHER	
15	1010252 1010397	Transistor Supplier: Texas Instrument Quantity: 12 — 1010252 134 — 1010397	Q	Q	Q	F		Two catastrophic bonding failures out of 30-1010252 samples used in part qualification testing occurred during shock and acceleration. All productive parts have been screened using 20 kg impact test. Successful qualification testing of this part at higher assembly levels is considered the basis for the acceptability of these parts for 12/50 use.
16	1010271 1010437	Transistor Supplier: STC Quantity: 3 — 1010271 3 — 1010437 Application: 1007540-011 OG-MG-1G Servo Amplifier	Q	Q	Q	F		All reported failures have occurred at part level qualification testing. Failures occurred in thermal shock, vibration, acceleration, shock, hermetic seal, and in life. Although these parts were tested near rated limits and are used in the system at 1/10 rating, the causes of failure were considered primarily workmanship and quality oriented. Acceptability for G & N 12/50 is based on successful qualification of the part at higher assembly levels and absence of operational failures.
17	1010398 1010343 1010270	Transistor Supplier: GE Quantity: 26 — 1010398 30 — 1010343 9 — 1010270 Applications: 1010398 1007412 Pulse Torque Power Supply 1007482 Motor Drive Amplifier 1007523 Resolver Drive Amplifier 1007525 Signal Conditioner Power Supply 1007542 28 Vdc Power Supply 1007545 Temperature Control Power Supply 1007548 5% 800 c/s Amplifier 1007549 Encoder Excitation Power Supply 1007567 Signal Conditioner Optics Module 1010343 1007555 Converter 1010270 1007540 Servo Amplifier 1007541 Amplifier Module	Q	Q		F		1010343 and 1010270 are qualified by similarity to 1010398. The identified problems are channeling, noted in part level qualification testing, and internal contamination, noted in the analysis of production failures. APOLLO Engineering has determined that the degree of channeling encountered is not detrimental to system performance. Part qualification life tests indicated that the amount of channeling demonstrated over a period of 2,000 hours does not propagate to a catastrophic failure condition. EPT and production failures have not demonstrated any channeling problem. The parts in G & N 12/50, except 1010270, represent lots which did not have EPT requirements or were not subjected to X-ray examination by the vendor. The latter screen has been implemented to identify parts with internal contamination. EPT testing of subsequent lots has not resulted in an unusual number of failures of the 1010270 and 1010343. EPT testing of the 1010398 has revealed the presence of contamination. Internal contamination does present the greater risk of the two problems. However, this problem has not, either through EPT results or production failures, been classified of sufficient magnitude to consider replacement or retorfit action.

APOLLO G & N SYSTEM 12/50 PART QUALIFICATION IRREGULARITIES

ITEM NO.	PART NO.	PART NAME AND MANUFACTURER	QUALIFICATION STATUS					DISPOSITION FOR FLIGHT
			110 QUAL	111 QUAL	SUB-ASSY	PART QUAL	OTHER	
18	1010715	Transistor Supplier: Fairchild Quantity: 3 Application: 1007516 Ternary Current Switch	Q	Q		F		Channeling failures were experienced during life testing. Parts in G & N 12/50 were not affected by screening process recently implemented to segregate potential failures. Fallout from screening is reported at 25 percent. However, the part as used in the ternary current switch is not considered a high risk if excessive leakage current should occur. In addition, successful completion of higher level qualification testing with this part and absence of part-oriented system failures are the basis for considering its acceptability for G & N 12/50.

9.4 ECP STATUS AND HARDWARE SUMMARY

9.4.1 ECP STATUS

The ECP Status and Retrofit Plan for G & N System 12/50 is shown in the following table.

ECP No.	ECP Title	Equipment Affected Name	Equipment Affected P/N	Equipment Affected Qty.	Kit P/N	Est. Kit Delivery Date	Date Kit On-Site	Est. Kit Install. Date	Est. Time to Install. & Retest	Kit to be Installed at Lab.	Kit to be Installed at S/C	Kit to be Installed at Mfg.	Equip. P/N After Kit Installed	Date Kit Installed	S/C Interface	Remarks
25	Signal Conditioning Power Supply	PSA	1007400-011	1	8102600	10/27/65	Del. Comp.		N/A	Y			1007257-041	See Remarks	No	Replaced by modified spare
83	Update OUA for G&N 12	OUA	1011000-003	1	8106012			1/21/66	N/A			X	1011000-005	4-1-66	No	Includes ECP 1[illegible] Changes
85	AGC Front Close-out Panel Mod	AGC	1003700-011	1		N/A	N/A		N/A	N/A	N/A	N/A		N/A	N/A	Retrofit Portion cancelled Per CCA 43R-1 (11-2-65) See ECP 167
90	Add Diode to IMU Blower Circuit	IMU	1001500-011	1										See Remarks		ECP 90 cancelled, superseded by ECP 232.
111	Redesign Trap Circuit	AGC Nav DSKY Main DSKY	1003700-011 1003551 1003484-011	1 1 1	8104119 8104121 8104118	10/19/65 10/19/65 10/19/65	N/A N/A N/A	11/4/65 11/4/65 11/4/65	See ECP 190	NAA		X X X	1003565-011 1003570-011 1003[illegible]-011 *1003564-021	11/24/65 11/24/65 11/24/65 3/31/66	No	Retrofit Plan Per ECP 190 *After NAA Retrofit
114	Vibration Damping	AGC	1003700-011	1	8104119	10/19/65	N/A	11/4/65	See ECP 190			X	1003565-011	11/24/65	No	Retrofit Plan Per ECP 190
130 R	Nameplate Change	Nav. Base & Optics	1899950-031	1	8102622	11/15/65	2/1[illegible]/66	*	N/A	X			1899950-051	2/23/66	No	*To be Installed on a Non-Interference Basis
137	Time Delay Assy. Change	D&C Group D&C Elec. Assy.	1015023-011 1015065-011	1 1	N/A 8102620	N/A 2/4/66	N/A 2/12/66	N/A	N/A 1 Day	N/A	N/A N/A	N/A	1015023-011 1015065-011	2/23/66	No	
147	Stand-by Power Switch Replacement	AGC	1003700-011	1	8104119	10/19/65	N/A	11/4/65	See ECP 190			X	1003565-011	11/24/65	No	Retrofit Plan per ECP 190
160	Reduction of Stray Light & Heat	OUA	1011000-003	1	8106012			1/21/66					1011000-005	4-1-66	No	Retrofit Authorized per CCA 497-0067
169	Eyepiece Storage Component Assembly	Eyepiece Stowage Unit G&N Ind.Cont.Pnl.	1021255 1015053-011	1 1	8102623 8102643	4/15/66 4/15/66	4/16/66 4/16/66						1021255-011 1015053-021	4/28/66 4/28/66	No No	
175	Night Watchman	Main DSKY	1003484-011	1	8104118 *8104088	10/19/65 12/10/65	N/A	11/4/65	See ECP 190	X		X	1003569-011 *1003564-021	11/24/65 3-31-66	No	ECP 190 Retrofit. Authorized per CCA No. 497-0007. *Kit for module (Install at NAA)
165	Replacement of IMU CDU Difference Meter	D&C Group IMU Control Panel	1015023-011 1015095-011	1 1	N/A 8102[illegible]	N/A	N/A	N/A	N/A 2.5 Days	N/A	N/A	N/A AC	1014628-011	[illegible]/21/66	No	Authorization of ECP will result in new P/N's.
177	Harness & End Conn. Assy. Mod for S/C Installation	Harness & End Conn. Assy. CDU Frame & Pnl	1015056-011 1016903-021	1 1	---					NAA			1015056-021 1016903-041	9/24/65	Yes	Change Installed per NACA direction. Accomplished by Engrg. task team.
180 R	Replace AGC/PSA Harness EMI Fixture	G&N Harness	1005772-011	1	8104096	2/18/66	2/23/66				NAA		1005785-011	4-1-66	No	90 Series
182	DSKY Rework to ICD Requirements	Main DSKY Nav DSKY	1003484-011 1003551	1 1	8104118 8104121	10/19/65 10/19/65	N/A N/A	11/4/65 11/4/65	See ECP 190		NAA	X X	1003569-011 *1003564-021 1003570-011	11/24/65 3/31/66 11/24/65	No	*After NAA retrofit, retrofit plan per ECP 190
183	Replace DSKY Guide Pins	Nav DSKY	1003551	1	8104121	10/19/65	N/A	11/4/65	See ECP 190			X	1003570-011	11/24/65	No	Retrofit Plan per ECP 190

ECP Status and Retrofit Plan (Sheet 1 of 4)

ECP No.	ECP Title	Equipment Affected Name	Equipment Affected P/N	Qty.	Kit P/N	Est. Kit Delivery Date	Date Kit On-Site	Est. Kit Install. Date	Est. Time to Install & Retest	Kit to be Installed at Lab.	S/C	Mfg.	Equip. P/N After Kit Installed	Date Kit Installed	S/C Interface	Remarks
184	Vibration Dampening of DSKY Keyboards	Main DSKY Nav DSKY	1003484-011 1003551	1 1	8104118 8104121	10/19/65 10/19/65	N/A N/A	11/4/65 11/4/65	See ECP 190		NAA	X X	1003569-011 *1003564-021 1003570-011	11/24/65 3/31/66 11/24/65	No	*After NAA Retrofit, retrofit plan per ECP 190 (Will result in reidentification of the affected assy)
185	Add Moisture Sealing Gaskets to all Modules	AGC	1003700-011	1	8104119	10/19/65	N/A	11/4/65	See ECP 190			X	1003565-011	11/24/65	No	Retrofit Plan per ECP 190
186	Replace Decode Modules	Nav DSKY Main DSKY	1003551 1003484-011	1 1	8104121 8104118	10/19/65 10/19/65	N/A N/A	11/4/65 11/4/65	See ECP 190		NAA	X X	1003570-011 *1003569-011 *1003564-021	11/24/65 11/24/65 3/31/66	No	Retrofit Plan per ECP 190 Authorized per CCA No. 497-0051. *After NAA Retrofit
187	Rework of Front Close-out Panel	AGC Front Close-out Panel	1003700-011 1004783	1 1	8104119	10/19/65	N/A	11/4/65	See ECP 190			X X	1003565-011 1004783	11/24/65	No	Retrofit Plan per ECP 190.
188	MARK Button Problem	AGC Tray A	1003700-011 1003703-000	1 1	8104119	10/9/65	N/A	11/4/65	See ECP 190			X	1003565-011	11/24/65	No	Retrofit Plan Per ECP 190.
189	0 VDC Ground in Tray B	AGC Tray B	1003700-011 1003701	1 1	8104119	10/9/65	N/A	11/4/65	See ECP 190			X	1003565-011	11/24/65	No	Retrofit Plan Per ECP 190.
190	Factory Retrofit of AGCG 117 & 112	AGCG	1003770-011	1	8104120	N/A	N/A	N/A	6 weeks		NAA	X	1003770-071 *1003770-131	11/24/65 3/31/66	No	Call-out of all ECPs to be incorporated during recycle. *After NAA retrofit.
195	DSKY Key Button Travel Interference	Main DSKY Nav DSKY	1003484-011 1003551	1 -	8104118 8104121	10/9/65 10/9/65	N/A N/A	11/4/65 11/4/65	See ECP 190		NAA	X X	1003569-011 *1003564-021 1003570-011	11/24/65 3/31/66 11/24/65	No	*After NAA retrofit. Retrofit Plan per ECP 190.
208	Add Jumper Wires for Night Watchman	G&N Harness	1005707-021	1	8104122	10/9/65	N/A	11/4/65	See ECP 190			X	1003572-011	11/24/65	No	Retrofit Plan per ECP 190.
212	Potting of Power Switch Modules	AGC Power Switch Mod.	1003700-011 1003113	1 1	8104119	10/9/65	N/A	11/4/65	See ECP 190			X	1003565-011 1003113-011	11/24/65	No	Retrofit Plan per ECP 190.
174	Eyepiece Polarizer and Eyeguard Reinstatement	OPA	2011000			6/15/66									No	
211	ECP of Record for Screw Replacement, Optics to Nav Base Blk I, 50 & 100 Series	Nav. Base and Optical Unit Assy	1899950-051	1	8102624		2/12/66		8 hours	X			1899950-091	2/23/66	No	
74	Replace 800 cps 57 amplifier in G&N 1[illegible] and 17	PSA	1007257-041	1	8102631	2-4-66	2-7-66			NAA			1007257-061	2/26/66	No	
206	Addition of Jackets and Covers	PSA	1007257-061	1	8102650 8102651	4/10/66	4/11/66	4/1/66	1 hour	NAA			1007257-061		No	ECP of record - No S/C change. Used when PSAA not installed. Rel'd as end item - installed per manual.

ECP Status and Retrofit Plan (Sheet 2 of 4)

ECP		Equipment Affected			Kit P/N	Est. Kit Delivery Date	Date Kit On-Site	Est. Kit Install. Date	Est. Time to Install & Retest	Kit to be Installed at			Equip. P/N After Kit Installed	Date Kit Installed	S/C Interface	Remarks
No.	Title	Name	P/N	Qty.						Lab.	S/C	Mfg.				
219	Coat all Exposed Beryllium Parts on Manned Flight, Blk. I G&N Systems	G&N System	1015000-041	1	N/A	N/A	N/A	N/A	60 days			AC	N/A	Complete	No	All units recycled to AC
232	Resistor Change to IMU Blower Circuit	IMU	1001500-011	1	8102621	3-4-66	3-4-66		3 days	NAA			1001500-041	4-1-66	No	
240	Attitude Impulse Switch Pin and Knob Modification	G&N Panel	1015053-011	1	8102629				See ECP 250			AC	1015053-011	2-21-66	No	Incorp. of this change in G&N 12 will be accomplished under ECP 250.
246 F	Replacement of Relay & Diode Module in Block I, 50 and 100 Series	D&C Group D&C Elect.Assy.	1015023-021 1015065-011	1 1	8102626	2-1-66	2-7-66			NAA			1015065-051	2-23-66	No	
250 F	Retrofit of G&N 12 for Qual. Test Failures	D&C Elect.Assy. G&N Ind.Cont.Panel G&N Harness & PSA End. Conn. PSA CDU Frame & Panel IMU	1015065-011 1015053-011 1015056-021 1007257-041 1016903-041 1001500-011	1 1 1 1 1 1	8102626 8102629 8102628 8102634 8102636 8102634				2 weeks	NAA		AC AC AC AC	1015065-051 1015053-021 1015056-031 1007257-061 1021304-021 1001500-041	2-23-66 2-21-66 2-12-66 2-26-66 2-12-66	No No No No No No	Replacement of Nameplate
253	ECP of Record for Replacement of the Ternary Current Switch in G&N 12	PSA	1007257	1	See Remarks	N/A	N/A	N/A	8 Days	NAA				2-26-66	No	Switch modules (1/100 spares) Shipped to NAA 1-7-66 for test & installation in G&N 12
266 F	Replacement of G&N Subsystem Filter Module	PSA	1007257-041	1	8102634							AC	1007257-061	2-26-66	No	
267 F	Redesign of CDU Frame & Panel Assy.	CDU	1016903-021	1	8102637		3-10-66					AC	1021304-011	4-1-66	No	
268	Removal of Temp. Monitor Output (A47) from Tray 7	PSA	1007257-041	1	8102634								1007257-061	2-26-66		
269 F	PSA & TOE Cap Qual Fixes	PSA	1007257-041										1007257-061	2-26-66		Incorporation of this change will be accomplished under ECP 250.
270 F	G&N Harness & PSA End Conn.Qual.Fixes	G&N Harness & PSA End Conn.	1015056-021	1	8102628							AC	1015056-031	2-12-66	No	
277	Horizontal Hand Holds for G&N Panel - Sys. 12	G&N Ind.Cont. Panel	1015053-011	1	8102643							AC	1015053-011	2-21-66	No	Incorporation of this change will be accomplished along ECP 250.
290 F	Quick Disconnect OUA Eyepiece	OUA	2011000	1		6-15-66			1/2 day	*See Remarks						*Planned as a field replacement on a "one for one" basis

ECP Status and Retrofit Plan (Sheet 3 of 4)

ECP No.	ECP Title	Equipment Affected: Name	Equipment Affected: P/N	Equipment Affected: Qty.	Kit P/N	Est. Kit Delivery Date	Date Kit On-Site	Est. Kit Install. Date	Est. Time to Install & Retest	Kit to be Installed at: Lab.	Kit to be Installed at: S/C	Kit to be Installed at: Mfg.	Equip. P/N After Kit Installed	Date Kit Installed	S/C Interface	Remarks
265 F	Replacement of Captive Screw	D&C Group	1015023	1	8102644									4-1-66	Yes	
		D&C Ind. Control Panel	1015053-011	1	8102643							AC	1015053-021	2/21/66		50 Series Change Only
		DSKY Cont. Panel	1014628-011	1	8102637					NAA			1014628-021	4-1-66		
		Optical Group	1014502-011	1	8102642	2-[illegible]-66				NAA			1014502-021	4-1-66		
		D&C Electronics	1015065-051	1	8102640					NAA			1015065-061	4-1-66		
234	ECP of Record for Removal of Rear Lockout Assembly Blk I	Nav. Base and Optical Unit Assembly	1899950	1						NAA				4-1-66	No	
327 F	DSKY Push Switch Adjustment	Main DSKY	1003564-011	1	*	N/A	N/A	N/A	1 Week (Test & Adj)			Ray.	N/A	N/A	No	No Kit required readjustment of DSKY switches to be made at the factory. Prior to shipping.
		Nav. DSKY	1003570-011	1	*	N/A	N/A	N/A				Ray.	N/A	N/A		
202	Modify SCT Eye-pieces to a Focus-able Configuration	OUA		1		6-15-66			4 hours						No	

ECP Status and Retrofit Plan (Sheet 4 of 4)

9.4.2 HARDWARE SUMMARY

The APOLLO Guidance and Navigation System hardware summary has been prepared to identify the G & N hardware designated for APOLLO Mission 204 and to compare flight hardware to qualification hardware to graphically demonstrate the validity of qualification for flight.

The information included in the hardware summary is defined as follows:

1. Item entries are at the replaceable unit level.
2. Numbers Built are limited to the series 50 and 100 configurations. Series 0 and Block II configurations are not included because of dissimilarity to the subject flight hardware.
3. Environments to which qualification articles have been exposed are identified.
4. Differences between flight hardware and qualification hardware configuration which are identified (D) have been individually evaluated with respect to qualification test validity. The results of these evaluations follow the hardware summary.
5. Failures specifically identified to the airborne hardware, both flight hardware and qualification hardware, are included and categorized as resolved, explained, or unresolved.
6. Estimated Operational Time is entered as cumulative time on all qualification hardware as compared to accrued time on the subject flight hardware, at major subassembly levels.

The difference identified in the Hardware Summary are not adverse in determining the qualification validity of System 12/50 for Mission 204. Four modules used in the optical circuitry of System 12/50 have no direct counterpart in the qualification test systems, however, are considered low risk due to similar manufacturing techniques and the use of qualified parts.

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS													QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
2	1	Coupling and Display Frame and Panel Assembly — 1021304-011	9		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	2	0	0		1725	5091
60, 61, 62, 72, 64	2	CDU Assembly-1015500-041	57		6	5	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	2	0	0			
1	3	CDU Case and Panel Assembly — 1021302-011	9		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	4	Power and Servo Assembly — 1007257-061	9		2	1	0	X	X	X	X	X	X	X		X	X				0	D	2	1	0	5	0	0		1764	5091
2	5	Gimbal Servo Electronics Assembly, Tray 1-1007571-041	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	6	Power Supply Electronics Assembly, Tray 2-1007572-051	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
3	7	Gyro Accelerometer Electronics Assembly, Tray 3-1007573-041	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	8	Gyro Accelerometer Electronics Assembly, Tray 4-1007574-041	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	9	CDU and Gyro Accelerometer Electronics Assembly, Tray 5 — 1007575-041	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	10	CDU and Power Supply Electronics Assembly, Tray 6 — 1007456-031	12		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	11	Miscellaneous Electronics Assembly, Tray 7— 1007577-041	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
3	12	Optical Electronics Assembly, Tray 8 — 1007458-021	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
3	13	Optical Electronics Assembly, Tray 9 — 1007459-021	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
3	14	Power Diodes and Signal Conditioner Electronics Assembly, Tray 10 — 1007256-041	12		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
4	15	Frame Assembly — 1007531-041	16		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	16	3.2 kc/s AAC Filter and Multivibrator — 1007543-041	18		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	17	20 V 3.2 kc/s Temperature Controller Power Supply — 1007545-041	18		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	18	-28 Vdc Power Supply — 1007542-021	18		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
9, 11, 8	19	Coarse Align Amplifier — 107541-041	46		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	20	3.2 kc/s 1 percent, Power Amplifier — 1007402-021	6		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS													QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
9, 8, 10	21	Servo Amplifier — 1007540-041	48		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4	22	Frame Assembly — 1007532-041	13		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
13	23	IRIG Pulse Torquing Power Supply — 1007412-021	4		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
7, 4	24	25.6 kc/s ISS Encoder Excitation Power Supply — 1007549-041	26		4	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	25	Failure Indicator — 1007551-021	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4, 3	26	800 c/s 1 percent, Power Amplifier — 1007437-021	32		4	2	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
503, 504, 26	27	800 c/s 5 percent, Power Amplifier — 1007548-021	27		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4	28	Frame Assembly — 1007533-041	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
8, 12, 39, 13, 10, 11	29	DC Difference Amplifier and PVR— 1007507-041	90		12	6	0	X	X	X	X	X	X	X		X	X				0	I	0	1	0	0	0	0			
13, 6, 4	30	PIPA Binary Current Switch — 1007427-021	37		6	3	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
5, 4, 6	31	PIPA Interrogator — 1007419	31		6	3	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
5, 4, 6	32	PIPA AC Difference Amplifier — 1007517-021	32		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
18, 20, 6	33	IRIG Calibration — 1007521-041	42		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
7, 9, 8	34	PIPA Calibration Assembly — 1007509-021	42		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4	35	Frame Assembly — 1007534-041	16		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
	36	Deleted																													
24, 19, 23	37	IRIG Ternary Current Switch — 1007516-021	34		6	3	0	X	X	X	X	X	X	X		X	X				0	I	1	0	0	0	0	0			
4	38	Frame Assembly — 1007535-041	16		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
7, 8, 10, 6, 9	39	CDU Encoder — 1007414-021	65		10	5	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	40	CDU Zero and Lock Relay — 1007561-021	19		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	41	Forward-Backward Counter— 1007558-021	18		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS														QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																								G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
10, 11, 12, 13, 14	42	CDU V — 1007555-021 Digital-to-Analog Converter	72		10	5	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
3	43	Frame Assembly -- 1007446-041	5		2	1	0	X	X	X	X	X	X	X		X	X				0	D									
9, 5, 7	44	Motor Drive Amplifier — 1007560-021	46		6	3	0	X	X	X	X	X	X	X		X	X				0	D	1	0	0	1	0	0			
2	45	CDU Resolver Loads — 1007462-021	18		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	1	0	0			
4, 3	46	800 c/s AAC Filter and Multivibrator -- 1007546-021	29		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	47	CDU Zero Transformer and Entry Relay — 1007564-021	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4	48	Frame Assembly -- 1007537-041	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	49	CDU Fixed Resolution Transformation and Entry — 1007563-021	21		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
3	50	IMU Temperature Controller -- 1007426-021	18		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
	51	Deleted																													
7	52	PIPA Pulse Torquing Power Supply — 1007412-021	14		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
14	53	IMU Temperature Indicating Alarm Backup Controller — 1007518-041	18		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
5	54	Frame Assembly -- 1007448-021	14		2	1	0	X	X	X	X	X	X	X		X	X				0	D									
3, 4	55	Buffer Circuit — 1007484-021	34		4	2	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
3, 4	56	SXT Shaft and Trunnion 2X Switch — 1007480-021	34		4	2	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	1	0	0			
5, 3	57	Relay Module — 1007485-021	34		4	2	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	58	Zero Optics — 1007487-021	6		0	1	0														0	D									
2	59	Integrator Motor Drive Preamplifier -- 1007481-021	6		0	1	0														0	D									
7, 8, 10, 11, 12, 14	60	Motor Drive Amplifier — 1007482-021	95	0	12	6	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	61	Resolver Drive Amplifier -- 1007523-021	21	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	62	Cosecant Generator — 1007483-021	19	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
4	63	Frame Assembly -- 1007449-021	16	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D									
2	64	Isolation Transformer — 1007401-021	6	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS													QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
2	65	Servo Motor Drive Preamplifier — 1007486-031	16		0	1	0														0	D									
2	66	Resistor and Capacitor — 1007488-021	6		0	1	0														0	D									
3	67	Frame Assembly — 1007258-031	13		2	1	0	X	X	X	X	X	X	X		X	X				0	D									
39	68	OSS Supply Filter — 1007590-031	32		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
45, 48	69	ISS Supply Filter — 1007590-031	38		4	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	70	800 c/s Optics Compensation — 1007591-021	17		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4	71	Signal Conditioner Power Supply — 1007525-021	16		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
9	72	IMU — 1001500-031	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	1	1	0	3	0	0		975	5091
19	73	Case Center Machined Assembly — 1000085	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	74	Connector Mount Assembly 1 X OA — 1001558	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	75	Case Cover Movable Assembly — 1000082	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	76	Case Covered Fixed Assembly — 1000241	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	77	Connector Mount Assembly 16 X OA — 1001559	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
13	78	Pressure Valve Assembly — 1000234	14		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	79	Intergimbal Subassembly 1 X — 1001506-1	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
502	80	IMU-CDU Load Compensation Module Assembly — 1007550-011	19		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
15	81	Intergimbal Subassembly 16 X — 1000205	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	82	IMU Outer Axis Assembly — 1001501-011	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
18	83	Outer Gimbal Housing Assembly — 1000103	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
15	84	Regulator, 28 Vdc Assembly — 1007013	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	85	Wiring Harness "C" Outer Axis — 1000124	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
1	86	Wiring Harness "B" Outer Axis — 1000034	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS													QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
32, 31	87	SAT Reactor Blower Speed Control — 1000288	24		4	2	0	X	X	X	X	X	X	X		X	X				0	I									
965622 965613	88	Blower Variable Speed — 1000219	27		4	2	0	X	X	X	X	X	X	X		X	X				0	I									
—	89	IMU Middle Axis Assembly — 1001502-011	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	90	Intergimbal Subassembly 1 X — 1001508-1	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
15	91	Intergimbal 16 X — 1000206	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
17	92	Middle Gimbal Housing Assembly — 1000074	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
13, 20	93	ADA Preamplifier Middle Gimbal Axis — 1007255	25		4	2	0	X	X	X	X	X	X	X		X	X				0	I									
—	94	ADA-1000097 (01-5-12, 01-4-02, 01-5-09)	34		6	3	0	X	X	X	X	X	X	X		X	X				0	I	1	0	0	0	0	0			
—	95	Inner Axis Assembly — 1001503-011	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	96	Intergimbal Subassembly 1X — 1001510-1	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
15	97	Intergimbal Subassembly 16 X — 1000207	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	98	Intergimbal Subassembly 1 X MA — 1001508-1	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	99	IMU Stable Member Assembly — 1000005-011	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
11	100	Wiring Harness "A" Stable Member — 1001474	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	101	ADA Preamplifier Assembly — 1007263-011	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
—	102	PIP Assembly, Prealigned — 1000013 (2AP103, 96, 117)	33		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	2	0	0			
	103	(Deleted)																													
28, 31, 32	104	PIP Preamplifier Assembly — 1008285-011	35		6	3	0	X	X	X	X	X	X	X		X	X				0	I									
2328, 2322, 2315	105	Heater and Taper Mount — 1000126	36		6	3	0	X	X	X	X	X	X	X		X	X				0	I									
15	106	Emergency Heater Control — 1007012	13		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
5	107	IRIG Preamplifier Assembly — 1008284-011	13		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
5A8, 5A7, 5A9	108	25 IRIG Assembly — 1000012	33		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	1	0	1	0	0			
	109	(Deleted)																													

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS													QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
9	110	IMU Intergimbal Subassembly 1 X IA — 1001510-1	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
15	111	IMU Intergimbal Subassembly 16 X IA — 1000207	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I									
9	112	Intergimbal Subassembly 1X OA — 1001506-1	11	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
15	113	IMU Intergimbal Subassembly 16X OA — 1000205	11	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
5	114	Prec. Resolver Align Assembly — 10008283-011	13	0	2	1•	0	X	X	X	X	X	X	X		X	X				0	I									
2	115	Display and Control Group — 1015023-011	9	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	1	0	2	0	0		1698	5091
6	116	Optics Cover Assembly — 1014532	10	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
10	117	IMU Control Panel Assembly — 1014628-021	8	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	118	G & N IC Panel Assembly — 1015053-021	12	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D									
2	119	Control Electronics Assembly — 1015064-011	12	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	120	D & C Electronics Assembly — 1015065-081	11	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
12	121	Optics Shroud Assembly — 1014502-021	10	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
2	122	SXT Hant Controller 1021700-011	10	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
2	123	Attitude Impulse Switch — 1015048-031	10	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
1	124	Relay and Diode Module — 1015039-011	15	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	125	Base Assembly — 1015076-011	12	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I									
45, 46, 47	126	Attitude Error Module — 1007034-011	37	0	2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	127	Relay and Diode Module — 1023036-011	10	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
501	128	40-Second Time Delay — 1015038-021	13	0	2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
11	129	APOLLO Guidance Computer — 1003700-051	11		2	1	0	X	X	X	X	X	X	X		X	X				0	D	1	0	0	4	0	0		247	2011
10	130	Tray A Wired Assembly — 1003703	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			

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																								G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP				RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
30, 28	131	Interface Module — 1003709	28		4	2	0	X	X	X	X	X	X	X		X	X				0	I	1	0	0	1	0	0			
25, 26	132	Interface Module — 1003708	28		4	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
	133	Deleted																														
*	134	Logic Module — 1003812	275		40	0	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
	135	Deleted																														
*	136	Logic Module — 1003815	201		32	16		X	X	X	X	X	X	X		X	X				[illegible]	I	0	0	0	1	0	0			
11	137	Tray B Wired Assembly — 1003701-011	11		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
15	138	Filter Module — 1003704-011	13		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
14, 20, 21	139	Power Switch Module — 1003113	40		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
21	140	Driver Service Module — 1003165	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
29	141	Oscillator Module — 1003527	18		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
25	142	Current Switch Module — 1003153	16		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
36	143	Eraseable Memory Module — 1003069	20		1	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
43, 44	144	Eraseable Drive Module — 1003139	30		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
24	145	AGC Power Supply Control — 1003150	15		4	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
33, 34	146	Eraseable Sense Amplifier — 1003463	30		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
43, 44	147	Rope Sense Amplifier — 1003154	30		6	3	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
—	148	Rope Memory Module — 1003133-021	44		6	0	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
—	149	Rope Memory Module — 1003733-011	36		6	6		X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
—	150	Rope Jumper Module — 1003763-021	18		2	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
21	151	Rope Strand Select Module — 1003132	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
15	152	Strand Gate Module — 1003485	15		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
46, 47	153	Rope Drive Module — 1003178	30		4	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			

* See following page.

Logic Module 1003812	Serial No,
-001	5
-002	6
-003	5
-004	7
-005	7
-006	6
-007	7
-008	7
-009	6
-010	6
-011	6
-012	21, 13
-013	6
-014	11, 12
-015	6
-016	7
-017	13
-018	6

Logic Module 1003815	Serial No.
	83
	84
	77
	86
	74
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	89
	90
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	98

SERIAL NO.	ITEM NO.	ITEM	NO. BUILT	NO. IN DEV TEST	NO. IN QUAL TEST	NO. IN GND SC TEST	NO. IN FLT SC TEST	QUALIFICATION TEST ENVIRONMENTS													QUAL STATUS	FLT HARDWARE DIFF	FAILURES						OPERATING HOURS		
																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
15	154	Cable Assembly (Inter Tray A-B) — 1003702	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
3	155	Navigation DSKY -- 1003706	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	1	0	0	0	0	2		143	2011
4	156	Keyboard Module -- 1003806	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
24, 21, 46, 69, 47, 79, 49, 60	157	Relay Module — 1003824	102		16	8	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
18, 26, 27, 31,	158	Decoding Module -- 1003817	85		12	6	0	X	X	X	X	X	X	X		X	X				0	I	1	0	0	0	0	0			
32, 33	159	Power Supply Module -- 1003811	24		4	2	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
11, 4																															
2	160	E/L Frame and Harness Assembly — 1003758	9		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	2			
6	161	Main DSKY — 1003707	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0		413	2011
6	162	Keyboard Module — 1003554	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	1	0	0			
9	163	E/L Frame and Harness Assembly — 1003809	9		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
12	164	G & N Failure Detect Assembly -- 1003220-011	13		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
	165	(Deleted)																													
1	166	AGE Harness and End Connector — 1015056-031	9		2	1	0	X	X	X	X	X	X	X		X	X				0	D									
	167	Deleted																													
4	167	Signal Conditioner — 1007700-021	9			1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0		307	2849
4	168	Signal Conditioner Gimbal Resolver — 1007664-011	10		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
1	169	Signal Conditioner CDU Resolver — 1007665-011	11		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
4	170	Signal Conditioner Scaler — 1007663-011	10		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
4	171	Signal Conditioner IRIG and PIPA — 1007662-011	10		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
2	172	Signal Conditioner Torque Motor — 1007666-011	10		2	1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			

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																							G&N 12/50			QUAL TEST					
								HI TEMP	LOW TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT (IMMERSION)	EMI	ACCELERATION	ACOUSTIC	STATIC LOAD	PROPELLANT COMP			RESOLVED	EXPLAINED	UNRESOLVED	RESOLVED	EXPLAINED	UNRESOLVED	CRITICALITY	SYSTEM 12/50	QUAL SYSTEMS
1	173	Signal Conditioner Optics — 1007667-011	11			1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
4	174	Signal Conditioner Frame Assembly — 1007670-021	9			1	0	X	X	X	X	X	X	X		X	X				0	D	0	0	0	0	0	0			
10	175	Optical Unit Assembly — 101100-004	Unit Qualified by Similarity to MIT Evaluation Tested Units. Refer to NASA Document EG44-462-65, Dated October 8, 1965.																											671	
4	177	Navigation Base Frame Assembly — 1899982	11		2	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			
4	178	Wiring Harness, AGC to PSA and G & N to Spacecraft — 1005785-011	3		1	1	0	X	X	X	X	X	X	X		X	X				0	I	0	0	0	0	0	0			

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
4	Power and Servo Assembly	1007257-061	1007570	The following modules in the PSA have different part numbers in the qualification system: 1007437-021 1007482-021 1007427-021 1007523-021 1007419 1007483-021 1007414-021 1007449-021 1007560-021 1007486-031 1007462-021 1007258-031 1007426-021 1007401-021 1007412-021 1007487-021 1007448-021 1007481-021 1007484-021 1007486-031 1007480-021 1007488-021 1007485-021	The PSA part number was changed to reflect the various module changes. See the individual module difference study for the possible effect on G & N 12.
20	3.2 KC 1% Power Amplifier	1007402-021	1007544-011	1. Addition of open loop gain adjust (R19) on G & N 110/111 improved amplifier stability. 2. Heatsink configuration changed slightly to accommodate additional resistor. 3. Redesign initiated to improve stability.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. . . . circuit and functional equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary
23	IRIG Pulse Torquing Power Supply	1007412-021	1007552	1. A summing network, which fed a test point was removed from G & N 110 module. 2. Resistance values of basic part types changed in converter of G & N 110. 3. Redesign initiated to remove nonessential summary network.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module . . . circuit and functional equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
26	800 CPS 1% Power Amplifier	1007437-021	1007547-011	1. Three new resistors added to G & N 110/111. 2. Heatsink configuration changed to accommodate added resistors. 3. Redesign initiated to improve stability.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module . . . circuit and functional equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
30	PIPA Binary Current Switch	1007427-021	1007527-011	1. A 43 V clamping circuit on the circuit drive source appears in G & N module. Redesign initiated to add an anti-saturation flip-flop; a bias adjust capability and improvement of input threshold control.	Similarity status: Qualification data from G & N 110/111 and the parts qualification program will provide qualification status for G & N 12. 1. Circuit and functional equivalency of all circuits except the 43 V clamping circuit are not effected by the redesign. 2. The clamping circuit is composed of a diode P/N 1010286. The diode is used elsewhere in the system and its application in this module is not in excess of its other applications. The status of the part for use in G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
31	PIPA Interrogator	1007419	1007519	1. G & N has 2 mono-stable circuits, replaced by RS flip flop in G & N 110/111. 2. Reset pulse input and associated DTL nan-gate switching circuit in G & N 12. Redesign initiated to solve the problem of threshold uncertainty which allows either no pulses to appear or a pulse simultaneously on each output line during a sampling period. Ref: RFC 1010	Similarity status: Qualification data from G & N 110/111 will provide qualification status for G & N 12. . . . circuit and functional equivalency not affected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary
36	PIPA Interrogator	1007419-021	1007519	1. G & N 12 has 2 mono-stable circuits, replaced by RS flip flop in G & N 110/111. 2. Reset pulse input and associated DTL nan-gate switching circuit is in G & N 12. Redesign initiated to solve the problem of threshold uncertainty which allows either no pulses to appear or a pulse simultaneously on each output line during a sampling period. Ref: RFC 1010	Similarity status: Qualification data from G & N 110/111 will provide qualification status for G & N 12. . . . circuit and functional equivalency not affected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
39	CDU Encoder Module	1007414-021	1007554	Parts (diodes) changed to accomodate different lead material.	Similarity status: Qualification test data will provide qualification status of G & N 12 module. . . . circuit and functional equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary
43	Frame Assembly	1007446-041	1007536-011	1. G & N 12 wire: use PVC (polyvinyl-chloride) G & N 110 wire: used kynar. 2. Circuit changes in tray accomplished to accomodate model changes. 3. Mounting configuration of tray to cold plate and secondary structure was improved on G & N 110.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. 1. Mounting configuration of trays to cold plate was modified on G & N 12 to conform to G & N 110. 2. Circuit and design equivalency not effected by redesign.
44	Motor Drive Amplifier	1007560-021	1007557-011	1. G & N 110/111 has seven dash number changes on basic parts, that is, diodes and resistors, to accomplish redesign goal. Redesign initiated to reduce the loading effect of chopper on the preamplifier section resulting in increased quadrature rejection efficiency.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. . . . circuit equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
45	CDU Resolver Load Module	1007462-021	1007510	1. G & N 110/111 module contains an ambiguity detect circuit. Redesign initiated to obviate the possibility of a 180 degrees ambiguity between CDU and IMU.	Similarity status: Qualification test data will provide qualification status of G & N 12 module. . . . circuit and functional equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
50	IMU Temperature Control Module	1007426-021	1007556	1. One capacitor added to G & N 110/111. 2. Redesign initiated to isolate the rest of the system from spikes generated by module.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not effected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
52	PIPA Pulse Torquing	1007412-021	1007552	1. A summing network, which fed a test point was removed from G & N 110 module. 2. Resistance values of basic part types changed in circuit of G & N 110. 3. Redesign initiated to remove nonessential summing network.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not effected by redesign The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary
54	Frame Assembly	1007448-021	1007538-011	1. G & N 12 wire: used PVC (polyvinyl-cloride) G & N 110 wire: used kynar. 2. Circuit changes in trays accomplished to accomodate module changes. 3. Mounting configuration of trays to cold plate and secondary structure was improved on G & N 110.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. 1. Mounting configuration of trays to cold plate was modified on G & N 12 to conform to G & N 110. 2. Circuit and design equivalency not effected by redesign.
55	Buffer Circuit Module	1007484-021	1007526-011	1. Removed attenuator network from G & N 12. 2. XFMR 1010329-1 is G & N 12 only. Part qualified 15 September 1965. 3. Resistor 1010375-54 resistor in G & N 12 only. Part qualified 18 August 1965. 4. Redesign initiated when 28 V monitoring no longer was a requirement.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not affected by redesign. ...P/N 1010329 qualified 15 September 1965 ...P/N 1010374 qualified 18 August 1966 ...1010265 QBST 1010829 interm weld schedule AP-75 has no history of field failure.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
56	SXT Shaft and Trunnion Two Speed Switch	1007480-021	1007522-011	1. One fine channel clipping levels in G & N 12 versus three fine channel clipping levels in G & N 110/111. 2. Transformer 1010291 in G & N 12. 3. Additional capacitors added for phase shift correction in G & N 110/111. 4. Redesign initiated to eliminate transformer, and add fine channel clipping level.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit functional equivalency not affected by redesign G & N 12 is a simplified version of G & N 110. ...P/N 1010291 is qualified.
57	Relay Module	1007485-021	1007567-011	1. G & N 110/111 contains additional diodes. 2. Minor heat sink changes to accommodate diodes. Redesign initiated to provide logic control of relays.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not affected by redesign. G & N 110 contains more parts The more complex article was qualification tested.
58	Zero Optics	1007487-021	None	A completely similar or equivalent module does not exist in G & N 110 or 111. Systems functions of the module have been redesign into other PSA modules.	A. This module is used as a part of the optics subsystem. B. Qualification test data from G & N 110/111 and the parts qualification program provide qualification status in the areas of parts, function, and construction. 1. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary. 2. Functional equivalency was not compromised as a result of the placement of the functions into other modules. 3. Wafer board construction techniques are utilized in building module 1007487. This configuration has been qualified on 1007581 and 1007524. C. Conclusion: As a result of the lack of directly applicable qualification test data there is a slight risk in the use of this module in flight.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
59	Integrator Motor Drive Preamplifier	1007481-021	None	A completely similar or equivalent module does not exist in G & N 110 or 111. System functions of the module have been redesigned into other PSA modules.	A. This module is used as a part of the optics subsystem. B. Qualification test data from G & N 110/111 and the parts qualification program provide qualification status in the areas of parts, function, and construction. 1. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary. 2. Functional equivalency was not compromised as a result of the placement of the functions into other modules. 3. Wafer board construction techniques are utilized in building module 1007481. This configuration has been qualified on 1007581 and 1007524. C. Conclusion: As a result of the lack of directly applicable qualification test data there is a slight risk in the use of this module in flight.
60	Motor Drive Amplifier	1007482-021	1007581-011	1. Forty-four part differences of which eleven are unique to G & N 110. 2. The function of the integrator and servo preamplifier of G & N 12 (PN 1007481-011) has been added to the G & N 110 modules. 3. One capacitor from the registor and capacitor module of G & N 12 (PN 1007488-011) is in G & N 110 module. 4. The redesign was initiated to: A. Accommodate a servo type and specification change. B. Provide an amplifier capable of driving either a Block I or Block II motor.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 modules. ...the design and functional equivalency of G & N 12 functions was not effected by the redesign. The additional functions in 1007581-011 serve to make it more complete, thus the more complex article was qualification tested The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
61	Resolver Drive Amplifier	1007523-021	1007651-011	1. A B+ decoupling network consisting of a resistor and a capacitor was added to G & N 110/111. 2. Redesign initiated to decouple B+ noise.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not affected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
62	Cosecant Generator Assembly	1007483-021	1007524-011	1. Decouple circuit added to G & N 110/111. Redesign initiated to decouple B+ noise.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not affected by redesign. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
63	Frame Assembly	1007449-021	1007539-011	1. G & N wire: used PVC (polyvinyl-cloride) G & N 110 wire: used kynar. 2. Circuit changes in trays accomplished to accomodate module changes. 3. Mounting configuration of trays to cold plate and secondary structure was improved on G & N 110.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. 1. Mounting configuration of trays to cold plate was modified on G & N 12 to conform to G & N 110. 2. Circuit and design equivalency not effected by redesign.
64	Isolation Transformer Assembly	1007041-011	1007528-011 (SCT Moding Assembly)	G & N 110/111 contains a SCT moding assembly which is not in G & N 12. This assembly contains the isolation transformer.	Similarity status: Qualification data from G & N 110/111 will provide qualification status for G & N 12. Circuit and functional equivalency was not affected by redesign.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
65	Servo Motor Drive Preamplifier	1007486-031	None	A completely similar or equivalent module does not exist in G & N 110/111. System functions of the module have been redesigned into other PSA modules.	A. This module is used as a part of the optics subsystem. B. Qualification test data from G & N 110/111 and the parts qualification program provide qualification status in the areas of parts, function, and construction. 1. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary 2. Functional equivalency was not compromised as a result of the placement of the functions into other modules. 3. Wafer board construction techniques are utilized in building module 1007486. This configuration has been qualified on 1007581 and 1007524. C. Conclusion: As a result of the lack of directly applicable qualification test data there is a slight risk in the use of this module in flight
66	Resistor and Capacitor	1007488-021	None	A completely similar or equivalent module does not exist in G & N 110/111. System functions of the module have been redesigned into other PSA modules.	A. This module is used as a part of the optics subsystem. B. Qualification test data from G & N 110/111 and the parts qualification program provide qualification status in the areas of parts, function, and construction. 1. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary. 2. Functional equivalency was not compromised as a result of the placement of the functions into other modules. 3. Wafer board construction techniques are utilized in building module 1007488. This configuration has been qualified on 1007581 and 1007524. C. Conclusion: As a result of the lack of directly applicable qualification test data there is a slight risk in the use of this module in flight.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
67	Frame Assembly	1007258-03	1007530-011	1. G & N 12 wire: used PVC (polyvinyl-cloride) G & N 110 wire: used kynar. 2. Circuit changes in trays accomplished to accomodate module changes. 3. Mounting configuration of trays to cold plate and secondary structure was improved on G & N 110.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. 1. Mounting configuration of trays to cold plate was modified on G & N 12 to conform to G & N 110. 2. Circuit and design equivalency not effected by re-design.
118	G & N Indicator Control Panel	1015053	1014664-011	1. Aluminum handle for support of astronauts hand was incorporated in G & N 110/111. 2. Toggle and pushbutton switching changed. 3. Rear panel wiring circuitry is different. 4. Panels are not interchangeable in either direction. 5. Redesign initiated because a "mark reject" switch was needed. Optics switching required rework.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of the G & N 12 panel. ...G & N 110/111 panel has more switching and is generally more complex than G & N 12. The more complex article was qualification tested. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
124	Relay and Diode Module	1015039-011	1015097-011	1. The G & N 110 module has been shortened dimensionally by using half size relays. 2. G & N 110 wiring includes logic diodes in the circuits.	Similarity status: Qualification data from G & N 110/111 and the parts qualification program will provide qualification status for G & N 12. 1. Qualification test data on P/N 1014638-011 in G & N 110/111 will provide mechanical equivalency to 1015039-011. 2. Qualification test data on P/N 1015097-011 in G & N 110/111 will provide junctional and circuit equivalency to 1015039-011. 3. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
126	Attitude Error Module	1007034-011	1014638-011	1. G & N 12 housing is lexon. G & N 110 housing is aluminum. 2. G & N 12 potting is stycast. G & N 110 potting is foam. 3. Redesign initiated to improve a manufacturing problem.	Similarity status: Qualification test data from G & N 110/111 will provide qualification status of G & N 12 module. ...circuit and functional equivalency not effected by design change.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
129	AGC Computer	1003565-011	1003700-031 1002700-021	The following modules in the AGC computer have different part numbers in the qualification systems. 1003701-011 1003133-021 In addition several logic modules are used in a different quantity mix and positions in G & N 12 compared to G & N 110/111.	The AGC computer part number was changed to reflect the module changes. See the individual module difference study for the possible effect on G & N 12. The change in the quantity mix and position of the logic modules does not effect the qualification status of the computers.
137	Tray B Wired Assembly	1003701-011	1003701	1003701-011: 0 volts dc grounded to tray. 1003701-011: retrofitted in G & N 110.	Similarity status: Qualification test data from AGC 110 will provide qualification status for G & N 12 for EMI
148	Rope Memory Module	1003133-021	1003733	1003133-021 is the "covered" configuration of the rope memory module. It is not for flight use.	1003133-021 will be replaced prior to flight with 1003733 per print 1021107. There is no need to qualify P/N 1003133-021. 1003733 has been qualification tested in G & N 111.
166	AGE Harness and End Connector	1015056-031	1015086	Wiring harness P/N 1023057 is in G & N 12 and P/N 1023059 is in G & N 110/111. PSA end connector P/N 1007461-021 is in G & N 12 and P/N 1007599-011 is in G & N 110/111. There are miscellaneous hardware changes between G & N 12 and G & N 110/111.	Similarity status: Qualification data from G & N 110/111 will provide qualification status for G & N 12. 1. The mechanical equivalency has not been compromised by the redesign of the end connector. 2. The electrical and mechanical equivalency has not been compromised by the redesign of the harness. 3. The G & N 12 connectors were encapsulated on a retorfit basis.
167	Signal Conditioner	1007700-021	1007121	The following modules in the signal conditioner have different part numbers in the qualification system. 1007664-011 1007665-011 1007663-011 1007662-011 1007666-011 1007667-011 1007670-021	The signal conditioner part number was changed to reflect the various module changes. See the individual module difference study for the possible effect on G & N 12.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
168	Signal Conditioner Gimbal Resolver	1007664	1007123	Transformer P/N change only.	Similarity status: Qualification data of series 0 will provide qualification status for G & N 12. . . . circuit and functional equivalency was not effected by redesign.
169	Signal Conditioner CDU Resolver	1007665-011	1007128	G & N has a -28 Vdc telemetry conditioning circuit. G & N 12 has a trunnion CDU 16x error input stage which is not frequency sensitive.	Similarity status: Qualification data of series 0 will provide qualification status for G & N 12. . . . circuit and functional equivalency was not adversely effected by redesign. . . . -28 Vdc telemetry circuit uses design elements similar to other circuits. . . . input to 16x error circuit is minor. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
170	Signal Conditioner Scalar	1007663	1007126	Thermistor circuit was added to G & N 12. No equivalent circuit exists in any series 0 modules.	Similarity status: Qualification data from G & N 110/111, stress analysis and the parts qualification program provide qualification status for G & N 12. 1. Qualification data from G & N 110/111 will provide qualification status on all circuits except the thermistor circuit. Circuit and functional equivalency of all scalar circuits was not compromised by redesign. 2. A stress analysis and design review reveals a well designed thermistor circuit with all parts properly derated. 3. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity report.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
171	Signal Conditioner IRIG and PIPA	1007662	1007131	Series 0 IRIG module is a two wafer construction unit. G & N IRIG and PIPA module is a four wafer construction unit. A bias network has been added to the output stage of G & N 12.	Similarity status: Qualification data from series 0 will provide qualification status for G & N 12. . . . circuit and functional equivalency was not adversely effected with the addition of the simple bias network. . . . four wafer construction was tested on series 0 by P/N 1007123, gimbal resolver. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary.
172	Signal Conditioner Torque Motor	1007666	1007124	The G & N 12 module contains a few additional pieces of fastener hardware. No redesign of circuits or function involved.	Similarity status: Qualification data from series 0 will provide qualification status for G & N 12. . . . circuit and functional equivalency was not effected by redesign.
173	Signal Conditioner Optics Module	1007667-011	None	A completely similar or equivalent module does not exist in G & N 110. System functions of the module have been redesigned into other PSA modules.	A. This module is used as a part of the optics subsystem. B. Qualification test data from G & N 110/111 and the parts qualification program provide qualification status in the areas of parts, function, and construction. 1. The status of the parts for G & N 12 is reviewed and recommendations made in the parts qualification irregularity summary. 2. Functional equivalency was not compromised as a result of the placement of the functions into other modules. 3. Wafer board construction techniques are utilized in building module 1007667. This configuration has been qualified on 1007581 and 1007524. C. Conclusion: As a result of the lack of directly applicable qualification test data there is a slight risk in the use of this module in flight.

ITEM NO.	ITEM DESCRIPTION	DRAWING NUMBER		DIFFERENCES BETWEEN G & N 12 AND G & N110/111	REMARKS
		G & N 12	G & N 110/111		
174	Signal Conditioner Frame Assembly	1007670-021	1007130	Series 0 has bracket No. 1008351 glued to the frame. G & N 12 bracket is screwed and bolted per manufacturing specifications. Series 0 signal conditioner contained five modules, one being four wafer construction and four modules being two wafer construction. G & N 12 signal conditioner will contain six modules, three modules being two wafer construction and three modules being four wafer construction. G & N 12 SC modules weight 30 percent more than series 0. Internal wiring configuration is different. G & N has additional connector and harness for additional signals not requiring conditioning.	Similarity status: Qualification data from series 0 test will provide qualification status for G & N 12 in all environmental exposures except vibration. ...overstress vibration levels on the series 0 are sufficient to provide justification for considering the heavier G & N 12 acceptable for flight.

9.5 WAIVERS AND VARIANCES

Flight System Variances include Material Review Board Reports, Contractual and Engineering Waivers, and Field Notifications of nonconformances. All variances associated with APOLLO G & N 12/50 have been reviewed by both the Reliability and Engineering functions for the purpose of identifying conditions of potential effect on mission objectives.

All MRBR's were determined to have no effect on system performance or reliability. APOLLO Problem Summaries have been prepared to identify waivered conditions that are significant in their content. However, the waivered conditions have in each case been determined as acceptable relative to the mission requirements.

SUBJECT	WAIVERED CONDITION	REFERENCE
Fairchild Micrologic P/N 1006771	Lot Qualification Requirements	APS-W001
Wheeler Transformer P/N 1010388	Supplier Deleted from QSL	APS-W002

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 9 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1006771 Micrologic (Fairchild)

Spacecraft [X] GSE [ ]

APS W-001

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Micrologics do not meet lot qualification requirements. Screening was performed to the ND 1002257 specification. However, the lot rejection criteria was not utilized. Functional discrepancies experienced included internal conductive contamination, corrosion, damaged bonding wires, and potentially weak bonds.

1.2 Part population per AGC is 4,099. Part failure could result in loss of G&N System function.

1.3 Failure Report Number(s) Raytheon Waivers 00395, 00401, 00586, 00587, 00588

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

Additional tests of each of the three lots of micrologics were conducted to eliminate, from each lot, those units with failure mechanisms found during initial inspection. Lots have been screened and burned-in and are considered acceptable for flight use.

Five failure reports have been written against P/N 1006771 (or 1004300 which the -6771 becomes after acceptance). This number is small compared to the high usage (4,099 per AGC), and suggests the effectiveness of lot sorting and screening techniques.

APOLLO PROBLEM SUMMARY
AFRM NO. 012

DATE 9 June 1966
Rev

Subsystem/End Item G & N 12/50

Equipment Name, P/N 1010338 Transformer (Wheeler)

Spacecraft [X] GSE [ ]

APS W-002

Apollo Reliability

Apollo Engineering

1.0 PROBLEM DESCRIPTION 1.1 Technical Narrative — Failure Mode
1.2 Effect on Mission — Objectives — Influence on Interfaces

1.1 Vendor was unable to meet the performance specification requirements for the following:

1) DC resistance at 25°C -R(406) = 0.40 Ω maximum	Actual:	0.50 Ω maximum
2) Leakage inductange -L = 50 μH maximum (Term 1-2) (Term 4-6 short)		100 μH maximum
3) Leakage inductance -L = 3 μH maximum (Term 1-2) Term 2-3 short)		6 μH maximum

1.2 None

1.3 Failure Report Number(s) AC Electronics Contractual Waiver ACSK-C-184

2.0 PROBLEM STATUS Unresolved [ ] Resolved [ ] Explained [X]

The waivered condition does not affect the functional performance of the guidance equipment measured at any level. However, the supplier, Wheeler, was subsequently removed from the QSL and the part is not considered qualified. However, this part and Wheeler-supplied parts 1010339, 1010473, and 1010492, are contained in Qualification Test Subsystem 110 and System 111. Lot numbers are identified between qualification hardware and flight hardware in several cases.

One reported failure exists against Wheeler transformer P/N 1010473: REF AFR 4738, FAR 4230. Cause of this failure was determined as improper orientation of leads, insulation, and magnet wire terminations that created an internal short in the primary leads.

The low incidence of failure and the presence, without failure, in the Qualification test subsystem and system are considered the basis for the acceptability of the part.

9.6 TIME SIGNIFICANT AND CRITICAL LIFE ITEM OPERATING TIME

Parts considered to have a significant time/cycle failure mode are listed on page 117.

All other parts were considered for time/cycle significance and were considered not critical. The following paragraphs show the analysis used in determining that these parts did not have a critical time/cycle failure mode.

1. All parts which satisfied these four ground rules were considered to have no critical time/cycle failure modes.
   - Two thousand hours of actual test on any part with no wear-out failures.
   - Twenty-five thousand cycles of actual test on any switch with no wear-out failures.
   - Five hundred cycles of actual mating and unmating of connectors with no wear-out failures.
   - Ten thousand shaft revolutions of actual test on variable resistors with no wear-out failures.
2. Parts not meeting the above criteria were further investigated on an individual basis. The following summarizes the results of these individual investigations.

1000037 and 1000038 Slipring. APOLLO Engineering estimated 100 hours of continuous operation would occur in 2,000 hours of system operation on G & N 12. Evaluation tests indicate 1,000 hours of successful operation on series 1,000 sliprings. EPT and qualification testing indicate 1.400 hours of successful operation on series 2,000 sliprings.

1010353 Relay. All applications of this relay (including those in equipment manufactured by Raytheon, Hughes, and AC Electronics) were reviewed, with respect to the results of qualification testing (TR-039-1), for the following areas:

1. Maximum contact current and voltage
2. Type of load being switched
3. Maximum allowable contact resistance
4. Minimum acceptable relay life — actuations
5. Maximum ambient temperature expected
6. Coil Drive Voltage

During the review it was determined that the relay was capable of meeting or exceeding all requirements demanded in existing applications.

PART NUMBER	DESCRIPTION	WHERE USED IN SYSTEM	LOWEST REPLACEMENT ASSEMBLY	REPLACEMENT TIME/ CYCLES	TOTAL TEST TIME/CYCLES AS OF (DATE)	SERIAL NUMBER OF ASSEMBLY
1000012	Gyro Assembly	IMU	IMU	Performance indicators are evaluated (See prealignment gyro assembly.)	1. 1,320 hours 2. 1,431 hours 3. 1,548 hours (As of 5-1-66)	1. 5A9 2. 5A8 3. 5A7
1010430	Motor Tachometer Generator	CDU's	CDU	Performance indicators are evaluated (See servomotor tach generator)	1. 20 months 2. 18 months 3. 27 months 4. 15 months 5. 20 months	1. 61 2. 101 3. 72 4. 69 5. 93
1010610	Motor Tachometer Generator	OUA	OUA		1. 24 months 2. 23 months 3. 25 months 4. 23 months	1. 62 2. 125 3. 69 4. 110

Time/Cycle Significant List

1010341 Resolver. APOLLO Engineering estimated the resolver operation at 10 percent of the system operation. For 2,000 hours of system operation, this is 200 hours of resolver operation. Test data exists of successful operation for a minimum of 1,000 equivalent hours of resolver operation.

1010428 and 1010429 Resolver. APOLLO Engineering estimated the resolver operation at 2 percent of the system operation. For 2,000 hours of system operation, this is 40 hours of resolver operation. Test data exists of successful operation for a minimum of 1,000 equivalent hours of resolver operation.

1010351 Resolver. APOLLO Engineering estimated the resolver operation at 10 percent of the system operation. For 2,000 hours of system operation, this is 200 hours of resolver operation. Test data exists of successful operation for a minimum of 500 hours of resolver operation.

1010904, 1010480, 1010902, 1010478, 1010905, 1010484 Switch. Diaphragm failures (part leakage) were detected upon test completion of 25,000 cycles. Failure occurred prior to this point but cycle number is undeterminable. It has been determined through test data from supplier that this failure mode has no detrimental effect on part or system operation.

1010906 and 1010494 Rotary Switch. APOLLO Engineering estimated 7,700 maximum detent operations (1,925 test cycles). High actuating force (on first sample) decreased to in-limits values during manual operation after removal from automatic drive T/F. Maximum values encountered during automatic drive operation would not impair mission accomplishment. The reduced operating force (on second sample) occurred after 20,000 detent operations (5,000 test cycles).

1001485 Thermostat, Safety. Since this is used as an alarm, APOLLO Engineering estimated that it will be operated less than 10 times in G & N 12. Successful test data to 5,000 cycles exists.

2021500 Prealignment Gyro Assembly. Gyro reliability is one of the critical items in each guidance system. The Gyro reliability program evolved from the test data, a gyro reliability prediction method. The criteria for performance prediction are that if a change occurs in ADIA of greater than 25 meru/g, and if the change is repeatable and in the same location, there is a cause for critical examination and, most certainly, rejection of the gyro. Data obtained in all units to date have shown that these criteria applied have yielded adequate performance margin for a period of 300 hours subsequent to the ADIA change.

9.7 GUIDANCE AND NAVIGATION SYSTEM TEST RESULTS

9.7.1 OCP-P-6500-012 - Mechanical Installation of G&N System

SCOPE

Install a Block I, Series 50 G&N system with a Series "100" computer into the SC 012 Apollo Command Module, using the sequential procedures outlined in OCP-P-6500-SC012 as a guide.

RESULTS

The G&N system was satisfactorily installed in SC 012. This was accomplished in Building 290 Checkout Station 2C. The problems encountered during the installation and the methods by which these were resolved are documented in the problem section of this report. The requirements of this procedure were satisfactorily complied with and have been accepted by NASA.

9.7.1.1 PROBLEM

Reference Sequence 918 Tape had been caught between the G&N harness connector block (PSA End Connector) and the cold plate.

CORRECTIVE ACTION

Removed tape per troubleshooting TPS OCP-6500-004.

DOCUMENTATION

Squawk 1 TPS OCP-6500-004.

9.7.1.2 PROBLEM

Reference Sequence 01-004 No. 918K no tag with Electronic Control Assembly (Ref. 1015064-011) at time of installation (Note ACSK #2).

CORRECTIVE ACTION

The original copy of 918K is available at A.C. Lab. NAA's copy was traced.

DOCUMENTATION

OCP-6500 Squawk 2, and M352349 918K.

9.7.1.3 PROBLEM

Reference Sequence 01-006 connector 50A4J1 is identified as J1 only. (Ref. to lines 0065 and 0070).

CORRECTIVE ACTION

Since there is only one connector on this unit and it is identified as J1 this is sufficient identification.

DOCUMENTATION

OCP-6500 Squawk 3.

9.7.1.4 PROBLEM

Reference OCP-6500 Sequence 02-003 and Figure 2-2 unable to install PSA toe cap due to structural interference.

CORRECTIVE ACTION

Trim as required, per drawing. Reference drawing V16-334002 Zone 17 and applied aladine 1200 per Specification MA0109003.

DOCUMENTATION

OCP-6500 Squawks 4 and 7.

9.7.1.5 PROBLEM

Reference OCP-6500 Sequence 02-006 unable to install one of the four (4) NO2162302 screws on left hand side of G&N due to coldplate interference. Reference Figure 2-2.

CORRECTIVE ACTION

MR 104290 states acceptable for unrestricted usage. Margin of safety is positive.

DOCUMENTATION

OCP-6500 Squawk 5, MR 104290.

9.7.1.6 PROBLEM

Reference Nav. DSKY Connector bracket is misaligned (Connector P/N 56J10).

CORRECTIVE ACTION

Reinstalled bracket and torqued it to structure.

DOCUMENTATION

OCP-6500 Squawk 6, TPS OCP-6500-005.

9.7.1.7 PROBLEM

In checking area for G&N installation bracket assembly V16-764832 was found to be riding a clip assembly Reference V16-764422 Zone 7.

CORRECTIVE ACTION

MR 104289 states - Acceptable for unrestricted usage. Will not effect design or structural intent.

DOCUMENTATION

OCP-6500 Squawk 8, MR 104289.

9.7.1.8 PROBLEM

Reference Sequence 03-003 the fire alarm By Pass/Normal switch was not switched to By Pass.

CORRECTIVE ACTION

Verified alarm working Reference OCP-6500 Deviation Sheet 010T.

DOCUMENTATION

OCP-6500 Deviation Sheet 010T Squawk 9.

9.7.1.9 PROBLEM

Reference Sequence 07 and Deviation Sheet 013P on observed Eyepiece Stowage Unit interference with a sheet metal angle above its mounting area. (Formerly occupied by Map and Data Viewer of smaller outline and mounted by guide pins).

9.7.1.9 (Continued)

CORRECTIVE ACTION

Removed excess metal above mounting area (applied Aldine 1200 per MA0109-003) and added nutplates at former guide pin location per drawing MH01-01316-116.

DOCUMENTATION

OCP-6500 Squawks 10, 11, 16, MH01-01316-116, E.O. M-478456, TPS-V16-SCM-056, TPS-V16-SCM-060.

9.7.1.10 PROBLEM

Reference OCP-6500 Sequence P1 of Deviation 013P cable harness of P1 connector is approximately 3/4 inch too short to mate with 56J8 receptacle on P/N 102127 Annonciator Panel.

CORRECTIVE ACTION

Remove center clamp from harness to give length to harness.

DOCUMENTATION

OCP-6500 Squawk 15.

9.7.1.11 PROBLEM

Reference Sequence 13-001 PSA tray P/N 1007571-041 ACSK #2. Approximately 1-1/2 inch from toe plate has two holes approximately 1/16 dia leading to wiring on wire potting.

CORRECTIVE ACTION

Inspected and verified that the moisture proofing was still valid since there was no break in the potting to the wiring.

DOCUMENTATION

OCP-6500 Squawk 13.

9.7.1.12 PROBLEM

Reference Sequence 13-001 PSA Tray #2 P/N 1007572-051 ACSK 13 has no potting on Pins 21 and 23.

CORRECTIVE ACTION

Reference Pins 21 and 23 are not connected internally nor externally to any wire per 100745 (MIT Drawing). This is therefore not detrimental to Mission Operation (i.e. this is per print).

9.7.1.12 (Continued)

DOCUMENTATION

OCP-6500 Squawk 14, 100745 (MIT Drawing)

9.7.1.13 PROBLEM

Reference Sequence 19-007 no voltage obtained on "Viewer AC 1" of Table 2-3 should be 115V +1 -10 VDC.

CORRECTIVE ACTION

Per Deviation 020P written to specify condition of 1. Circuit Breaker Viewer AC1 to "ON" and 2. Switch 7 Viewer AC 1/AC 2 to AC 1 on next to last line of Table 2-3. (Last line of test also clarified).

DOCUMENTATION

OCP-6500 Deviation 020P, OCP-6500 Squawk 17, TPS OCP-6500-008.

9.7.1.14 PROBLEM

Reference OCP-6500 Deviation 023T AGC Front Close Out Panel with 8 P/N 1010630-40 screws had 7 screws with burned heads.

CORRECTIVE ACTION

Replaced burned screws P/N 1010630-40.

DOCUMENTATION

OCP-6500 Squawk 18.

CONCLUSION

All test objectives for the mechanical installation of the guidance and navigation system listed in OCP-P-6500 was satisfactorily complied with, per Process Specification MA0205-046.

9.8 G & N System Functional Checkout -- OCP-P-6504, S/C 012

OCP 6504, S/C 012, was begun on 23 May 1966 and completed approximately 6 June 1966. Some troubleshooting was done after this to verify squawk disposition. Following is a discussion of the tests performed and the pertinent G&N problems that were encountered:

9.8.1 G&N Activation - Sequence 02

No G&N problems were encountered.

9.8.2 IMU Temperature Control Test - Sequence 03

A change to the lower limit of heater current was needed. This was precipitated because of the ambient in which the IMU was operating (approximately 65° WG.)

9.8.3 Panel Lights & Display Test - Sequence 04

No problems were encountered during the initial run. A later re-run discovered a burned-out light to check IMU coolant. To be replaced when IMU is removed.

9.8.4 AGC Operational Test - Sequence 05

During the performance of this test, the original AGC evidenced the first of several double entry problems. The AGC was replaced and a successful re-run was accomplished with the new computer.

9.8.5 Operate Power ON Test - Sequence 06

No G&N problems were encountered.

9.8.6 G&N Operational Test - Sequence 07

No G&N problems were encountered.

9.8.7 Failure Indicating Test - Sequence 08

No G&N problems were encountered. The initial installation damaged the moisture-proofing gasket. This will be repaired when the PSA is removed for IMU replacement.

9.8.8 G&N Reactivation - Sequence 08

No G&N problems.

9.8.9 AGC Clock Frequency Test - Sequence 10

No G&N problems. An ACE problem with R144 was encountered but was circumvented by manually switching the PSAAM.

9.8.10 Stabilization Loop Step Response Test - Sequence 11

No G&N problems.

9.8.11 AGC Mode Control Test - Sequence 12

OCP was changed to reflect a 100 sec delay after tape entry and before recording CG 2271 (Roll Offset Error). Squawks 135 and 136 are still open pending review by astronauts.

9.8.12 IRIG Scale Factor Test - Sequence 13

No G&N problems.

9.8.13 Zero Optics Test - Sequence 14

No G&N problems.

9.8.14 Optics Slew Rate Test - Sequence 15

Shaft Slew Rate out-of-spec. The test was re-written for system compatibality and the Shaft Slew Rate spec was changed from 17°/Sec to 19°/Sec.

9.8.15 Optics Coordinate Transformation - Sequence 16

No G&N problems.

9.8.16 Optics Positional Accuracy Test - Sequence 17

No G&N problems.

9.8.17 PIPA Scale Factor Test - Sequence 18

AGC displayed V33 instead of V06. The AGC was replaced and three successful runs were completed. The X PIPA Scale Factor was out-of-spec and will be cleared by replacement of the IMU.

9.8.18 IRIG Coefficient Determination Test - Sequence 19

No G&N problems.

9.8.19 Fine Alignment Test - Sequence 20

Double entries were encountered which were cleared by the replacement of the AGC. The "X About Z" term was out-of-spec and will be cleared by replacement of the IMU.

9.8.20 Gyro Compassing Test - Sequence 21

Several double entries were encountered which were cleared by replacement of the AGC. An OGA out-of-spec condition was covered by FNN-NAA-053 as being similar to Lab test results.

9.8.21 G&N System Deactivation - Sequence 22

No G&N problems.

9.9 Spacecraft Systems Compatibility Checkout

Spacecraft Systems Compatibility Checkout, OCP-P-0126, SC 012, was begun on 6 June 1966. Some troubleshooting was done during and after this test, to verify squawk disposition. Following is a discussion of the tests performed and the pertinent G&N problems that were encountered:

9.9.1 G&N Activation - Sequence 05

No G&N problems were encountered.

9.9.2 SPS Engine Ignition - Sequence 13

No G&N problems were encountered.

9.9.3 SPS Abort - Sequence 15

No G&N problems were encountered.

9.9.4 Attitude Impulse Test - Sequence 22

No G&N problems were encountered.

9.9.5 AGC/UDL Updating Test - Sequence 25

No G&N problems were encountered.

9.9.6 G&N SCS Interface Test - Sequence 26

Two Parity Fail Indications were encountered and attributed to incorrect procedures.

9.9.7 G&N SCS Polarity Test - Sequence 27

First run unsuccessful due to operator error. Re-run was successful.

9.9.8 G&N Manual Entry - Sequence 28

First run unsuccessful in generating a 6° Roll Offset Error. Successful run completed using experimental data to generate the 6° Roll Offset Error. Subsequent testing and troubleshooting showed the G&N system to be operating properly.

9.9.9 G&N Deactivation - Sequence 29

No G&N problems were encountered.

10. SEQUENTIAL SYSTEMS

10.0 System Organization

10.1 Systems Test Results

10.2 Problem Summaries

10.3 Hardware Summary

10.4 Cert/Flt Hdw Differences

10.5 Waiver/SCN/RFC Information

10.0 SEQUENTIAL SYSTEMS

The Sequential Systems (SEQ), for purposes of the CARR, consists of Sequential Subsystems equipment and assemblies as listed herein. The sequential subsystems provide the means of initiating descrete sequential control and synchronization of time critical events during any mission abort and/or normal mission separation and reentry functions.

SEQUENTIAL EVENTS CONTROL SUBSYSTEM (SECS)

- Master Events Sequence Controller
- CM RCS Sequence Controller
- SM Sequence Controller
- Earth Landing Sequence Controller
- Pyro Continuity Verification Box
- Post Landing Vent Controller

LAUNCH VEHICLE EMERGENCY DETECTION SYSTEM (LV-EDS)

10.1 SYSTEMS TEST RESULTS

10.1.1 OCP-P-1036-SC-012 - Operational test and checkout of Sequential Events Control System.

SCOPE

Operational test and checkout of the sequential events control system was conducted in Building 290 Checkout Station 2C, Downey during 10 May 1966 and 13 May 1966. The test was performed to checkout the sequential events control system.

RESULTS

All sequential events control system equipment has been satisfactorily installed. Several problems were encountered, all of which were resolved and documented in the problem section of this report. The requirements of this procedure were satisfactorily complied with and have been accepted by NASA.

10.1.1.1 PROBLEM

CD 0085, MESC Pyro Firing Relay Indicator Safe, "System B" did not occur.

CORRECTIVE ACTION

MESC C18A2 removed and returned to vendor for replacement of defective diodes, CR5 and CR6.

DOCUMENTATION

OCP-P-1030 Squawks Nos. 25, 30, 32, 43, 51 and 57. TPS-OCP-1036-023. PAR #22992.

10.1.1.2 PROBLEM

CD 1008 and 1009 Pitch Control Motor Fire Relay A and B respectively were cross connected.

10.1.1.1 ENGINEERING ANALYSIS

The circuit containing the diodes was operable early in the tests. Later it was determined the circuit was inoperative and the diodes were defective. A failure analysis performed on the MESC module containing the diodes which were open indicated the cause was not within the MESC. A check of the GSE associated with this circuit has been determined to be good. The extensive troubleshooting being performed prior to, and in the area of the failure, is considered to be the cause.

10.1.1.2 ENGINEERING ANALYSIS

NOT APPLICABLE TO THIS PROBLEM

10.1.1.3 ENGINEERING ANALYSIS

NOT APPLICABLE TO THIS PROBLEM

10.1.1.4 ENGINEERING ANALYSIS

NOT APPLICABLE TO THIS PROBLEM

CORRECTIVE ACTION

Worked EO 471555.

DOCUMENTATION

OCP-P-1036 Squawks 52 and 54, TPS-OCP-1036-023.

10.1.1.3 PROBLEM

CR 0270 and CR 0271, 61 second time delay relay. C19A1K1 System A and B respectively did not indicate ON.

CORRECTIVE ACTION

Ran troubleshooting TPS-OCP-1036-019, both timers functioned normally (4) four times. A loose GSE connector at C19A1J3 could have been the cause of this problem.

DOCUMENTATION

OCP-1036 Squawks 26, 28 and 31 TPS-OCP-1036-019, TPS-OCP-1036-023.

10.1.1.4 PROBLEM

GC5100, Service Module Deadface System 1 Initiate "A" GO did not indicate ON.

CORRECTIVE ACTION

GSE cable not connected. Connected cable.

DOCUMENTATION

OCP-1036 Squawk #21, TPS-OCP-1036-023.

10.1.1.5 PROBLEM

GC 5102 Service Module Deadface System 1 Initiate "B" GO did not indicate ON.

CORRECTIVE ACTION

GSE cables cross connected with GC 5104. Reconnected cables.

DOCUMENTATION

OCP-1036 Squawks 28 and 53, TPS-OCP-1036-023.

10.1.1.6 PROBLEM

GC 5104 Service Module Deadface System 2 Initiate "A" GO did not indicate ON.

CORRECTIVE ACTION

GSE cables cross connected with GC 5102. Reconnected cables.

DOCUMENTATION

OCP-1036 Squawks 21 and 46. TPS-OCP-1036-023.

10.1.1.7 PROBLEM

GC 5106, Service Module Deadface System 2 Initiate "B" GO did not indicate ON.

CORRECTIVE ACTION

Connected to wrong type of adapter cable (using paired C & D in place of "A and B") replaced with correct adapter cable.

DOCUMENTATION

OCP-1036 Squawks 28, 36, 53, 58. TPS-OCP-1036-032, TPS-OCP-1036-018.

10.1.1.8 PROBLEM

GE 5082, CM/SM Umbilical Deadface 4B GO did not indicate ON.

CORRECTIVE ACTION

Due to a defective GSE cable. Cable W2034 replaced by Cable W2054.

DOCUMENTATION

OCP-1036 Squawks 28, 35, 53, 58. TPS-OCP-1036-023 TPS-C14-308-059.

10.1.1.9 PROBLEM

GR8001, Oxidizer overboard initiate A GO
GR8003, Oxidizer overboard initiate B GO
GR8005, Oxidizer overboard initiate A GO
CR8007, Oxidizer overboard initiate B GO
were all cross or interconnected.

CORRECTIVE ACTION

Channel identification disclosed that EO 490427 covered by TPS-EPS-096 had been improperly worked. TPS-V16-EPS-111 corrected the problem and EO 490424 will be worked in Florida.

DOCUMENTATION

OCP-1036 Squawks 47, 54, 24, 50 and 62. TPS-OCP-1036-018, 020, 022, and 023.

10.1.1.10 PROBLEM

GR8034, Helium Pressure Dump Initiate A GO did not indicate ON.

CORRECTIVE ACTION

Incorrect wiring placing GR8034 squib on Pyro Battery B corrected by working EO 508353.

DOCUMENTATION

OCP-1036 Squawk 50 and 60, TPS-V16-EPS-110, 032.

10.1.1.11 PROBLEM

CR0266, 18 sec to relay System A K12 did not indicate ON.

CORRECTIVE ACTION

The GSE connector to C19A1J3 was found not fully connected. The connector was connected and the measurement functioned properly.

DOCUMENTATION

Reference TPS-1036-032, Squawk #7A.

10.1.1.12 PROBLEM

GT5006, HF Ant "B" GO did not indicate ON.

CORRECTIVE ACTION

During troubleshooting several connectors were demated and mated. During running of OCP-P-0126 the measurement functioned properly. This will be checked during integrated.

DOCUMENTATION

TPS-1036-032, Squawk #71, TPS-1036-027.

10.1.1.13 PROBLEM

CD0130, hand controller input "A" did not indicate ON.

CORRECTIVE ACTION

The J11 fuse module in C18A1 was found to be loose.

DOCUMENTATION

TPS-1036-032, Squawks 72 and 73.

10.1.1.16 PROBLEM - Three fuses blown in EDS UNSAFE circuit of MESC system A.

10.1.1.16 ENGINEERING ANALYSIS

The failure of three fuses in the EDS UNSAFE circuit of MESC system A, was caused during a troubleshooting mode. The three fuses, electrically in parallel during this mode were blown by inadvertantly shorting an MESC system B connector pin to ground.

10.1.1.14 PROBLEM

CD0038, ELS activate "B" did not indicate ON.

CORRECTIVE ACTION

GE removed patch panel on 3A5 console and replaced driver amplifier P/N 3A5A22L18.

DOCUMENTATION

TPS-1036-032, Squawk 70, GE F.R. No. 25418.

10.1.1.15 PROBLEM

GS5018 Gas Chromatograph initiate GO failed to light. The transient indication was received in its place.

CORRECTIVE ACTION

EO 4666985 was worked to reverse negative and positive leads (2QR94A20 WH and BLK).

DOCUMENTATION

TPS-1036-032, Squawks 29, 41, 62.

10.1.2 OCP-P-0126-S/C 012 - Spacecraft Systems Compatibility Checkout

SCOPE

To establish the functional compatibility of the Stabilization and Control System, Reaction Control System, Service Propulsion System and the Guidance and Navigation System.

RESULTS

This test was run in Building 290, Checkout Station 2C and ACE Control Room #1. The test sequences were run primarily with astronaut crew participation. The test sequences were not run in the order of the OCP sequences due to test configuration changes required or problem areas encountered in a sequence and test continued while troubleshooting on another communications channel. Numerous problems were encountered during the test. At this time, all of the problems have not been completely resolved, partly due to data reduction required and partly due to engineering evaluation of data and tolerances. The test was completed satisfactorily and final NASA buy-off is pending resolution of problems, data reduction and evaluation, and formal post-test briefing.

10.1.2.1 PROBLEM

Sequence 10, SPS Engine locked and SMT could not move it. Diff clutch current was 759 MA yaw and 743 MA roll position making engine impossible to move.

CORRECTIVE ACTION

Procedure error, clutch current cannot be applied during manual gimbal movement.

DOCUMENTATION

Squawk No. 3 - OCP-0126 TAIR Book TPS-0126-006

10.1.2.2 PROBLEM

Seq. 10, SPS Gimbal position is out of tolerance (Meas. CH 1034 - yaw) CRT readings out of tolerance due to miswiring in J95.

CORRECTIVE ACTION

J95 was rewired per print. Wire in Pin 42 was removed and installed in pin 80. On rerun, measurement was in tolerance.

DOCUMENTATION

Squawk No. 7 - OCP-0126 TAIR book TPS-0126-007

10.1.2.3 PROBLEM

When working TPS-0126-008, RCS patching for valve signatures, pins were shorted between SK-TC-083 and TGS, due to patching error between SK-TC-083 and TGS.

CORRECTIVE ACTION

Repatching was accomplished to eliminate shorts and verified proper, Dev. D1001P - Item 17 was written to show revised patching.

DOCUMENTATION

Squawk No. 13 - OCP-0126-TAIR book TPS-0126-009

10.1.2.4 PROBLEM

Sequence 07-006, event light, 15A1-A2-E19, was on and should have been off for this seq/stp (Meas. CH0100-2) due to a broken wire at J850J-53B.

CORRECTIVE ACTION

Wire was repaired and Meas. CH0100X Channel ID verified proper.

DOCUMENTATION

Squawk No. 12 - OCP-0126-TAIR Book TPS-0126-010

10.1.2.5 PROBLEM

Sequence 11, LES Abort event light was lighted and event timer was running and could not be reset indicating a constant abort. Abort system locked up when abort signal inadvertently was given from translation controller.

CORRECTIVE ACTION

Lock up was released by removing Bat A & B Logic Power. There was no malfunction as an abort signal was given through pilot error.

DOCUMENTATION

Squawk No. 18 - OCP-0126 TAIR Book TPS-0126-011

10.1.2.6 PROBLEM

DAC 5 & 6 drops out upon engine ignition cause - defective DACS - susceptible to noise pulses causing the drop out.

CORRECTIVE ACTION

DACS were replaced with new DACS from spares and verified operating properly.

DOCUMENTATION

Squawk Nos. 24, 27, 28, 29, 36 and 40 - OCP-0126 TAIR Book TPS-0126-012

10.1.2.7 PROBLEM

During T/S TPS-0126-012, event light for Meas. CH2093 was lighted on console 5A2-A3-E4 when it should not have been lighted due to a broken wire at J850A-29.

CORRECTIVE ACTION

Broken wire repaired and meas. stimulated with 4.5 volts and functions satisfactorily.

DOCUMENTATION

Squawk No. 39 OCP-0126-TAIR Book
TPS-0126-013
Squawk V16-COM #277

10.1.2.8 PROBLEM

Sequence 17, relief valve on PG100, SK-TC-007, relieved after completing sequence 17, due to improper setting on relief valve.

CORRECTIVE ACTION

Relief valve was reset and checked out properly.

DOCUMENTATION

Squawk No. 44 OCP-0126-TAIR Book
TPS-0126-014

10.1.2.9 PROBLEM

Sequence 17-030, Neg (-) Yaw, Sys. B, fuel side injector valve did not open, due to measuring on TB#19.

CORRECTIVE ACTION

Rewire per print - return wire to TB19-17 instead of TB19-7 (Ref. V16-942111), rerun showed proper operation.

DOCUMENTATION

Squawk No. 51 - OCP-0126 TAIR Book
TPS-0126-015
Squawk V16-EPS #185

10.1.2.10 PROBLEM

Sequence 14-059, Meas. No. CH2045 reads UUU and S/B between +0.217 to +0.335 due to improper calibration of DAC modules.

CORRECTIVE ACTION

DAC module was recalibrated and reinstalled and meas. verified properly.

DOCUMENTATION

Squawk No. 54 OCP-0126 TAIR Book
TPS-0126-016
EO M507601
TPS C14-212-038 TAIR Book

10.1.2.11 PROBLEM

Seq. 13-007, Meas. No. CH3178 was reading upper limit (UUU) instead of 1.5 vdc nominal. Patch lead was improperly patched at TB1-1H on the C14-203 patch box on ACE carry-on.

CORRECTIVE ACTION

Patch leak was correctly inserted and output on CRT verified proper.

DOCUMENTATION

Squawk No. 61 - OCP-0126 TAIR Book
TPS-0126-017

10.1.2.12 PROBLEM

Seq. 12-019, Meas. SC2118V on recorder 3A3-A2 channel 6 indicates F/C #3 connected to Bus A or Bus B instead of 0 vdc due to a bad ACE signal conditioner in C14-484.

CORRECTIVE ACTION

Replaced ACE signal conditioner in C14-484 and meas. verified properly.

DOCUMENTATION

Squawk No. 23 - OCP-0126 TAIR Book
TPS-0126-020
TPS-C14-484-030, 031

10.1.2.13 PROBLEM

Seq. 24-009, unable to verify steps A, B, C, and D were performed properly, due to a procedure error - valve desired recorded from data from OCP-P-4128-SC012 - 0.34 vrms (loaded condition).

CORRECTIVE ACTION

TPS-0126-021 showed that 0.34 vrms loaded would be equal to 0.58 vrms unloaded. Valves changed and rerun per D2024T-3 - Item 12 verified properly.

DOCUMENTATION

Squawk No. 117 - OCP-0126 TAIR Book
TPS-0126-021

10.1.2.14 PROBLEM

Seq. 24-012, "Thrust on" lamp did not go out due to incorrect wiring.

CORRECTIVE ACTION

The wire C65E22 was replaced properly to TB17-C1 from TB20-D8. This miswiring caused bypassing FCSM thereby not shutting "Thrust on" lamp off. Rerun verified properly after rework.

DOCUMENTATION

Squawk No. 121 - OCP-0126 TAIR Book
TPS-0126-022
Squawk V16-EPS #176

10.1.2.15 PROBLEM

Events CH0214, CH0217, CH1217 indicate on when they should be off. (Squawk requested by NTD) due to procedure in error.

CORRECTIVE ACTION

On Panel 25, SCS direct control MNA & MNB were on and on Panel 7 normal/direct on switch was in normal position. With this switch configuration events CH0214, CH0217, CH1217 should be on.

DOCUMENTATION

Squawk No. 130 - OCP-0126 TAIR Book
TPS-0126-023

10.1.2.16 PROBLEM

Seq. 28-020, Meas. CG2271, SCS roll body axis in phase, is out of tolerance, reading UUU, S/B+6.0±0.56 due to a procedure error.

CORRECTIVE ACTION

Special test run on TPS-0126-024 proves that the G&N is functioning as designed and that new procedure can achieve more accurate error signals than the manual procedure as written in the OCP. All data is repeatable in the new procedure.

DOCUMENTATION

Squawk No. 113 - OCP 0126 TAIR Book
TPS-0126-024

10.1.2.17 PROBLEM

Seq. 24-023, "Thrust on" did not go off in G&N mode, due to a wiring error in C01W1 Harness.

CORRECTIVE ACTION

Wire C76B22 was wired properly to TB17-C2 from TB19-C9. Rerun verified proper operation.

DOCUMENTATION

Squawk No. 134 - OCP-0126 TAIR Book
TPS-0126-025
Squawk V16-EPS #189
V16-420316

10.1.2.18 PROBLEM

Seq. 15-001, diff. clutch current readings max. and unable to null with thumbwheels. Procedure error and incorrect switch configuration for this seq.

CORRECTIVE ACTION

Proper switch configuration was made by D2015T-2-#6 and rerun verified properly, SCS CBS AC1 and AC2 were in the off position depriving SCS of AC power.

DOCUMENTATION

Squawk No. 140, OCP-0126 TAIR Book
TPS-0126-026

10.1.2.19 PROBLEM

Verify impulse enable system working properly assurance of system working properly for NASA.

CORRECTIVE ACTION

TPS-0126-028 ran through impulse enable system and verified system was working properly.

DOCUMENTATION

TPS-0126-028

10.1.2.20 PROBLEM

Seq. 15-058, GR8500-3 event light was not lighted for this seq. properly. T/S TPS-0126-029 in work.

CORRECTIVE ACTION

Unresolved at this time.

DOCUMENTATION

Squawk No. 148 - OCP-0126 TAIR Book
TPS-0126-029

10.1.2.21 PROBLEM

SCS measurements out of tolerance. SCS engineering tolerances too close for the SCS system.

CORRECTIVE ACTION

SCS engineering investigation upon data review and analysis revealed tolerances too close and the run was acceptable to SCS engineering.

DOCUMENTATION

Squawks Nos. 21, 26, 30, 34, 35, 54, 55, 56, 57, 58, 59, 60, 62, 63, 72, 73, 76, 77, 78, 82, 85, 88, 89, 90, 95, 96, 98, 99, 100, 102, 105, 154, 157, 158, 159, 160, 161, and 168 - OCP-0126 TAIR Book

10.1.2.22 PROBLEM

During running of OCP-0126, the caution and warning and master alarm lights came on in C/M. Pitch 1 and yaw 1 gimbal motor switch undercurrent inhibit circuitry during initial start-up is inoperative.

CORRECTIVE ACTION

Engineering investigation is still in process. T/S TPS-0126-027 was run finding above cause, however, additional investigation is required.

DOCUMENTATION

Squawks Nos. 20, 25, 32, 41, 45, 81, 112, 150, and 162 - OCP-0126 TAIR Book
TPS-0126-027

10.1.3 TPS V14-GEN-003 Pyro Resistance Measurements
TPS V14-GEN-005 Pyro-CKT Verification

SCOPE

The SE TPS' were performed to check and record, for future reference, the resistance of all the pyro circuits.

RESULTS

The resistance was measured and recorded for all the pyro circuits.

10.1.3.1 PROBLEM

GR8001, Oxidizer overboard initiate A GO
GR8003, Oxidizer overboard initiate B GO
GR8005, Oxidizer overboard initiate A GO
GR8007, Oxidizer overboard initiate B GO
were all crossed or interconnected.

CORRECTIVE ACTION

Channel identification disclosed that EO 490427 covered by TPS-EPS-096 had been improperly worked. TPS-V16-EPS-111 corrected the problem and EO 490424 will be worked in Florida.

DOCUMENTATION

OCP-1036 Squawks 47, 54, 24, 50 and 62. TPS-OCP-1036-018, 020, 022, and 023.

10.1.3.2 PROBLEM

GR8034, Helium Pressure Dump Initiate a GO did not indicate ON.

CORRECTIVE ACTION

Incorrect wiring placing GR8034 squib on Pyro Battery B corrected by working EO 508353.

DOCUMENTATION

OCP-1036 Squawk 50 and 60, TPS-V16-EPS-110, 032.

10.1.3.3 PROBLEM

GS5018 Gas Chromatograph initiate GO failed to light. The transient indication was received in its place.

CORRECTIVE ACTION

EO 4666985 was worked to reverse negative and positive leads (2QR94A20 WH and BLK).

DOCUMENTATION

TPS-1036-032, Squawks 29, 41, 62.

NAA ATO Systems Supr

10.2 PROBLEM ANALYSIS - SEQUENTIAL SYSTEMS

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø1 S/C # 008, 009, 011, 012, 014, 017, 020, 101 thru 112 Date: 12/15/65

Revised: Ø1 4/26/66

Ø2

Ø3

Ø4

Subsystem/End Item Sequential Events Control

Equipment Name, S&ID P/N MESC, ME901-0567 and SMJC, ME901-0569

Spacecraft [X] GSE [ ]

Apollo Reliability E. C. Dempsey Apollo Engineering [illegible] 6/9/66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Some of the stud mounted diodes of the type being used in the MESC, SMJC and Control Programmer were intermittently shorting during special SMJC high vibration ($2g^2$/cps) engineering tests. X-ray and teardown investigation of the diodes disclosed silver slivers introduced during final manufacturing steps were the cause of the internal shorting. The subject diodes are Westinghouse, P/N 540.

Ø1 (2) Problem Status Resolved (Resolved, Unresolved, or explained)

Ø1 All stud mounted diodes of the type used in the MESC and SMJC will be X-rayed in two planes, thus minimizing the possibility of contaminated diode usage on S/C 011, S/C 012, and subs. (Reference documentation IDTA35).

Ø1 The stud mounted diodes used in the S/C 008 MESC and SMJC have not been x-rayed because a failure of this type will not jeopardize crew safety, test personnel safety, or cause loss of spacecraft.

APS — 007 — AMS
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10.3 HARDWARE SUMMARY - SEQUENTIAL SYSTEMS

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CERTIFICATION TEST DATA

CSM 012

SUBSYSTEM 10.0 SEQUENTIAL SYS.

10-42

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Box, Pyro, Continuity Verification V16-540130 01209305	10	0	3	4	1	X	X	X	X	X	X	X	X		X	X						70%	1	0	0	** 6C * 44C	Bas. (1)	0	0	0	K 80C
2	Controller, Jettison Service Module ME901-0569 01209303	29	2	5	6	2	X	X	X	X	X		X	X		X	X						80%	11	0	0	** 9C * 77C	0008 (2)	0	0	0	K 80C
3	Controller, Sequence, Earth Landing ME901-0001 01209301	41	7	4	10	6	X	X	X	X	X	X	X	X		X	X						80%	1	0	0	** 84C * 212C	0019 (2)	0	0	0	K 80C
4	Controller, Sequence, Master Events ME901-0567 01209302	29	2	5	6	2				X	X	X	X	X		X							65%	17	0	0	** 27C * 333C	0008 (2)	2	0	0	80C
5	Controller, Vent, Post Landing V16-540170 01209702	10	2	3	3	0	X	X	X	X	X	X	X			X							80%	1	0	0		101 (1)	0	0	0	K 80C

* Fully Loaded with Squib. Sim.
** Not Loaded

Temp. Form R&E - 1056 Exp. 6-10-66

10.1

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

SEQUENTIAL SYSTEMS

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

Certification Project Engineer

10.5 WAIVERS, SCN's AND RFC's - SEQUENTIAL SYSTEMS

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
10.5.1	SCN 207 to SID 64-1237	SECS Helium Depressurization	Pending NAA System Engr. Rework - Est. Complete by 6/17/66
10.5.2	SCN 219 to SID 64-1237	Delete Apex Cover Jettison Light	Pending NASA Approval

Engineering Manager

Project Engineer

11. EARTH RECOVERY SYSTEMS-ORDNANCE

11.0 System Organization

11.1 Systems Test Results

11.2 Problem Summaries

11.3 Hardware Summary

11.4 Cert/Flt Hdw Differences

11.5 Waiver/SCN/RFC Information

11.0 EARTH RECOVERY SYSTEMS/ORDNANCE

The Earth Recovery Systems/Ordnance (ERS), for purposes of the CARR, consists of ERS and Ordnance subsystems, equipment and assemblies as listed herein. The ERS operates to stabilize and decelerate the CM using parachutes and to float and upright the CM on water impact and include various recovery aids. Ordnance devices are used for separation functions.

EARTH RECOVERY SUBSYSTEM

- Drogue Parachutes
- Pilot Parachutes
- Main Parachutes

UPRIGHTING SYSTEM

- Air Bags
- Compressor
- Bag Stowage Canisters

LOCATION AIDS

- Sea Dye Marker
- Flashing Light

ORDNANCE

- Tower Separation
- Adapter Separation
- CM/SM Separation
- Forward Heat Shield Separation
- Parachute Deployment
- Parachute Disconnect
- RCS Isolation Valves

11.1.1 TPS V16-VMS-027 - Command Module Uprighting System Checkout

SCOPE

This test was performed to verify operation of the uprighting system compressors and float bag fill/vent valves in accordance with Process Specification MA0201-5152. The compressors were operated to measure discharge pressure and flow and operation of the fill side of the fill/vent valves was verified. Operation of the vent side of the valves was verified using an external pressure source.

RESULTS

During the test, the compressors operated with normal starting and operating current draw. Discharge pressure of the compressors was higher than that required to mechanically open the fill portion of the float bag valves and air flow was noted at both fill and vent outlets of the valves not set in the fill position. During the vent position test of float bag valve operation, the valve controlling the -Y float bag was found to be inoperative due to a broken ground lug on the ground return lead from the valve solenoid. This was repaired and proper operation of the valve in both vent and fill positions verified. Test still incomplete.

11.1.1.1 PROBLEM - Valve Leakage

During compressor operation, flow was noted from the valves not set in fill position. This was found to be due to compressor discharge pressure mechanically opening the fill portion of the valves.

CORRECTIVE ACTION

The problem has been referred to Engineering for disposition. It is still an open item.

DOCUMENTATION

Valve leakage, Squawk 28, TAIR book. Open item.
PAR 21059

11.1.1.2 PROBLEM - Inoperative Valve

During test, the -Y float bag valve was found to be inoperative.

CORRECTIVE ACTION

A trouble shoot TPS was initiated and an open circuit caused by a broken ground lug found. Repair was made. The valve was rechecked for correct operation.

DOCUMENTATION

Inoperative valve, squawks 29 and 30, TAIR book. TPS V16-VMS-030, TPS V16-VMS-031 and TPS V16-VMS-032 troubleshoot TPS's located broken ground lug. Repaired working squawk 29. TPS-V16-VMS-035 verified operation of valve.

Jerry E. Jolley

NAA ATO Systems Supr

11.2 PROBLEM ANALYSIS - EARTH RECOVERY SYSTEMS/ORDNANCE

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Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 011, 012, 014, 017, 020 Date: 6/13/66

Subsystem/End Item Uprighting Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Equipment Name, S&ID P/N Uprighting Bag, ME 901-0572

Spacecraft [X] GSE [ ]

Apollo Reliability Donald F. Hopps CWB/DM 6-13-6 Apollo Engineering [signature] 6-13-66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

During inflation of +y and -y bags on B/P 1101 the bag fill hoses carried tensile load which may cause hose to kink or break. Load should be carried by attach cables.

Reference IL 696-700-042-66-67, dated 2/24/66 to J. Dodds from J. Underwood.

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

1. Hoses have been lengthened to four feet (were three feet).
2. Attachment point for hoses has been relocated from base of canister to a point on structure closer to the cable attach point.
3. Hose type has been changed to one less susceptible to kinking.
4. Subsequent test on B/P 1101 with above changes incorporated indicate problem resolved.

E.O. 428765 accomplished this change.

APS— 062 —BDU
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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 011, 012, 014, 017, 020 Date: 6/14/66

Revised: Ø 1 _____
Ø2 _____
Ø3 _____
Ø4 _____

Subsystem/End Item Uprighting

Equipment Name, S&ID P/N Uprighting Bag, P/N ME901-0572-0031 (y) -0033 (z) } S/C 011

Spacecraft [x] GSE [ ]

Apollo Reliability D. F. Hopps 6-14-66 CWB/DM Apollo Engineering 6-14-66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Tests at MSC on B/P 1101 disclosed that uprighting bags burst at from 5 to 6 psig. Bag pressure can reach 6 psig when the bags are submerged before the relief valve relieves the pressure. This is due to the pressure of the water acting on the outside of the valve.

(Verbal report from D. R. Dochen, G.E.Reliability, Houston).

Ref.: IL 696-700-042-66-67, J. C. Underwood to J. I. Dodds, dated 2/24/66.

(2) Problem Status Explained (Resolved, Unresolved, or explained)

Bags failed on B/P 1101 due to repeated usage far beyond S/C requirements. In addition, bag construction was of inferior quality. Goodyear Aerospace, the vendor, revised construction procedures in the areas of seam bonding and method of application of the final elastomer coating. All S/C bags reflect this change. Bags made prior to these changes were either scrapped or marked, "Non-Flight Article". New P/N's are ME901-0572-0035 (y) -0037 (z) for S/C 012 and subs.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012, 014, 017, 020 Date: 6/14/66

Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Subsystem/End Item Uprighting

Equipment Name, S&ID P/N Uprighting Bag Canisters, P/N V16-586502-101 -111

Spacecraft [x] GSE [ ]

Apollo Reliability [signature] 6 14 66 CWB/DM Apollo Engineering [signature] 6-14-66

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

1. Static pull tests (for main chute deployment) on B/P 12A disclosed that the main chute deployment bag damages the -y canister when line pull is at an extreme angle.

2. The outer edge of the -y canister is a possible source of interference for main chute deployment.

(Verbal report from D. R. Dochen, G.E.Reliability, Houston).

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

1. Canisters have been structurally strengthened.
2. Outermost corners of the canisters have been rounded off.
3. Corner of outer edge of the -y canister faired in to prevent interference.
4. Canisters were qualified for S/C 012 and subs.

MCR 1272 accomplished these changes.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012, 014 Date: 6/6/66

Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Subsystem/End Item Ordnance - Forward Heat Shield Separation

Equipment Name, S&ID P/N Umbilical Disconnect Shock Attenuator, V16-596141-31

Spacecraft [x] GSE [ ]

Apollo Reliability D.M. Mayne Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Bungee cylinder leaked oil in vacuum-thermal cycling qualification test.

CTR 01205705
PAR's 19935, 19936

(2) Problem Status Resolved (Resolved, Unresolved, or explained)

The probable cause of oil leakage was that the Viton O-rings were unsatisfactory at low temperature, permitting leakage to occur. Corrective action was to change the O-ring material to Buna-N, and to coat the bungee unit with white epoxy to reduce loss of heat from the unit, (E.O. M451496). The low temperature requirement for qualification test was changed from -65°F. to -5°F. (E.O. M493659-2) and qualification was successfully completed.

Associated APS: -046-PH

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø1 S/C # 012, 014, 017, 020, 101, 103 Date: 3/24/66

Revised: Ø1 6/8/66
Ø2
Ø3
Ø4

Subsystem/End Item Ordnance: SM-SLA Umbilical Disconnect

Equipment Name, S&ID P/N Explosive Train Charge Type IV, ME 901-0612-3001

Spacecraft [X] GSE [ ]

Apollo Reliability D.M. Mayne CWB/DM Apollo Engineering [illegible]

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

In a qualification test at low temperature (-205°F.), the 15 grains per foot detonating cord failed to fire, although the end booster fired. One similar failure in flight would have no effect because of redundancy, but two similar failures would result in loss of crew.

CTR 01205714
FR 3922

Ø1 (2) Problem Status Explained (Resolved, Unresolved, or explained)

Qualification low temperature firing tests will be performed at -150°F. instead of -205°F. This change is authorized by IL 66-995-520-T168, dated February 14, 1966.

Ø1 The failure is attributed to a faulty test setup which allowed the end booster to be displaced when the detonator fired, such that physical separation of the booster from the detonating cord occurred. The explosive train charge in the spacecraft installation is supported to preclude this type of failure. The test setup was changed to provide adequate support for the explosive train charge and seven firing tests were performed successfully, three at -150°F. and four at -205°F.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 011, 012, 014, 017, 020, 101 Date: 1/28/66

Subsystem/End Item Ordnance - Forward Heat Shield Separation System Revised: Ø1 3/22/66

Equipment Name, S&ID P/N Type VI Pressure Cartridge, ME453-0005-0066,-0076 Ø2 6/9/66

Spacecraft [x] GSE [ ] Ø3 Ø4

Apollo Reliability D.M. Mayne Apollo Engineering C.H. Lowry Jr.

Ø2 (1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

11-13

One cartridge from each of two lot samples took excessive time to reach peak pressure, and two cartridges in system firing tests failed to jettison the forward heat shield at the required minimum velocity of 24 feet per second. A similar failure in flight would increase the probability of collision between the jettisoned heat shield and partially deployed drogue parachute.

CTR 01105309, 01205704
FR's 2344, 3716, 3911, 3912

Ø2 (2) Problem Status Resolved CWB (Resolved, Unresolved, or explained)

The internal configuration of the cartridge has been changed to incorporate a debris deflector which prevents the initiator end closure from penetrating the cartridge end closure. Cartridge and system qualification tests with the ME453-0005-0076 cartridge, incorporating the debris deflector, have been successfully completed.

Notes: 1. The failures occurred only with the ME453-0005-0066 configuration.
2. This APS incorporates APS-244-PH.

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APOLLO PROBLEM SUMMARY

Ø2 S/C # 009, 011, 012, 014, 017, 020, 101, 103

Date: 12-8-65
Revised: Ø1 12-28-65
Ø2 6-17-66
Ø3
Ø4

Subsystem/End Item Ordnance - Electrical Wiring and CSM Separation

Equipment Name, S&ID P/N Circuit Interrupter, Type II, ME453-0010-0003, -1003

Spacecraft [X] GSE [ ]

Apollo Reliability D. M. Mayne Apollo Engineering

Ø1 (1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Two units failed to open at 260 psi static pressure in system checkout test (i.e. contacts failed to open).

CTR 009.25.3.06
PAR's 8508, 8510

Ø2 Single Point Failure

11-14

Ø1 (2) Problem Status Resolved (Resolved, Unresolved, or Rationalized)

Units operated successfully at less than 260 psi static pressure after sealing washers were installed in harness connectors.

Ø2 Associated APS: 262-PH

T&QA 978 Void 12-30-65

APS-261-PH

APOLLO PROBLEM SUMMARY

Ø2 S/C # 009, 011, 012, 014, 017, 020

Date: 12/8/65
Revised: Ø1 12/23/65
Ø2 6/17/66
Ø3
Ø4

Subsystem/End Item Ordnance - Electrical Wiring

Equipment Name, S&ID P/N Circuit Interrupter, Type I, ME 453-0010-0001, -1001

Spacecraft [x] GSE [ ]

Apollo Reliability D.M. Mayne CWB Apollo Engineering [illegible]

Ø1 (1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Some units have failed to open at 260 psi static pressure in minimum operating pressure acceptance test and system checkout test.

CTR 009.25.3.06

PAR's 8193, 14328, 14334
Wallace O. Leonard QTR #1182

Ø2 Single Point Failure

11-15

Ø1 (2) Problem Status Explained (Resolved, Unresolved, or ~~Rationalized~~ Explained)

Units which failed to open at 260 psi static pressure did open at less than 300 psi except where sealing washers were omitted. Omission of sealing washers does not allow for sufficient piston travel to disconnect circuits. Failures occurring with washers installed were attributed to high friction force caused by set of O-rings.

Analysis of interrupter pressure-time histories, pin friction data and O-ring drag data shows the following results: 1) If the interrupter will operate at a static pressure of 260 psi or less it will operate full travel (.18 ins) with the output from a single initiator of minimum allowable peak pressure (525 psi in 10 cc). 2) If the interrupter will operate at a static pressure of 300 psi or less, a single initiator of minimum allowable output is capable of moving the piston far enough to disconnect the electrical circuits (.09 ins).

Two initiators are fired simultaneously in normal operation of the interrupter to overcome any possible marginal operation.

Ø2 Associated APS: 261-PH

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

S/C # 012, 014, 017, 020, 101, 103 Date: 6/14/66

Revised: Ø1 ____ Ø2 ____ Ø3 ____ Ø4 ____

Subsystem/End Item Ordnance - Electrical Wiring and CSM Separation

Equipment Name, S&ID P/N Electrical Circuit Interrupter, ME453-0010-0001, 1001, 0003, 1003.

Spacecraft [x] GSE [ ]

Apollo Reliability CWB/DM Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Guide pins on interrupters have frequently been bent during installation of mating connectors. A bent guide pin could prevent an interrupter from opening circuits when fired, resulting in possible loss of crew.

PAR's 14341, 14342, 14362, 19130, 19132, 24518, 24519, 24520, 24529.
CTR 00925306

(2) Problem Status Explained (Resolved, Unresolved, or explained)

Guide lines will be painted on both mating connector back-shells in line with their inside keyways. The pin connector will be installed first and then it will be used as a guide to align the socket connector. E.O. 431414 will add this requirement to MA0303-0021, E.O. 466391 to MA0303-0078, and E.O. 466392 to MA0303-0317.

S/C 101, 103 will have a stiffer guide pin. (Ref. PDC-1A against ME453-0010 "K" revision).

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø1 S/C # 011,012,014,017,020,B/P 30,101 Date: 3/22/66

Revised: Ø1 5/18/66
Ø2
Ø3
Ø4

Subsystem/End Item Ordnance - SLA Separation

Equipment Name, S&ID P/N Charge Holder Assembly, V24-590144

Spacecraft [X] GSE [ ]

Apollo Reliability P.M. Mayne CWB Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Explosive train charge, ME901-0612 Type III, fired prematurely in boost temperature shock test, at 290°F. during cooling down from 300°F. A similar failure occurring in flight would cause loss of mission and probable loss of crew.

CTR 01105321
Failure Report 3751, PAR 12704

Ø1 (2) Problem Status Explained (Resolved, Unresolved, or explained)

Ø1 Six charge holders of the same configuration as the failed specimen were subjected to the same test conditions in an attempt to reproduce the failures. In one of these six tests, one of the Type III explosive train charges was inadvertently not completely covered with the aluminum tape used to hold the thermocouples to the charges, and this unit fired when the thermocouples on the covered charges indicated a temperature of 290°F. No other charge holders fired. The thermocouple on the partially exposed charge indicated a temperature of 500°F. and it is therefore concluded that a similar partially exposed charge was the cause of the qualification test failure. Further tests by the supplier, Link Ordnance Division, to determine the auto-ignition temperature of the Type III explosive train charge, are scheduled for completion by May 26, 1966.

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø1 S/C # 011, 012, 014, 017, 020, B/P 30, 101 Date: 3/24/66

Revised: Ø1 5/24/66
Ø2
Ø3
Ø4

Subsystem/End Item Ordnance - SLA Separation

Equipment Name, S&ID P/N Charge Holder Assembly, V24-959110-41

Spacecraft [X] GSE [ ]

Apollo Reliability D.M. Mayne Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Both end boosters of a Type II explosive train charge broke off after $2\frac{1}{2}$ minutes of random vibration ($.65g^2/cps$) at low temperature (0°F.) in qualification testing. A similar failure occurring in flight would prevent separation of the service module from the SIVB with resultant loss of crew, except for an LES abort.

CTR 01105320
FR 3755, PAR 18338

Ø1 (2) Problem Status Resolved (Resolved, Unresolved, or explained)

Ø1 The charge holder design was changed to provide bonding around 180° segment of the end booster, instead of the previous 90° segment. The bonding technique was changed to eliminate voids in the bonding film between the booster and charge holder. No retest will be performed, with NASA (E. Weeks) concurrence, because one charge holder of the original configuration successfully completed an off-limit vibration test at 175% of the level at which the failure occurred.

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FORM 2958-G NEW 1-66

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

APOLLO PROBLEM SUMMARY

Ø1 S/C # 011, 012, 014, 017, 020 Date: 6/1/66

Revised: Ø1 6/9/66
Ø2 6/16/66
Ø3
Ø4

Subsystem/End Item Ordnance - CM to SM Tension Tie Cutter

Equipment Name, S&ID P/N Boostered Linear Shaped Charge, ME453-0028

Spacecraft [X] GSE [ ]

Apollo Reliability D.M. Mayne CWB/DM Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report Nos. applicable)

Linear shaped charge failed to sever simulated tension tie in qualification firing test, subsequent to fourteen-day vacuum exposure and temperature cycling between -65°F. and +160°F. Failure cause was gaseous decomposition of RDX explosive resulting in internal pressure and distortion of the shaped charge vee groove. Two similar failures in flight could result in failure to separate the CM from the SM.

CTR 01205716
RFNS 2357

Ø2 (2) Problem Status Resolved (Resolved, Unresolved, or explained)

Ø2 Rerun of vacuum-temperature cycling qualification tests on twenty specimens was successfully completed on 6/10/66; all simulated tension ties were severed in the subsequent firing tests. In this test rerun, the boostered linear shaped charges were potted in RTV with foam in the vee grooves, as in the spacecraft installation, and the high temperature requirement was reduced to 140°F. from the original 160°F. The time at maximum temperature was reduced from 140 hours to 60 hours, with 192 hours at 110°F.

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11.3 HARDWARE SUMMARY - EARTH RECOVERY SYSTEMS/ORDNANCE

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSM 012

SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

11-22

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Bag Assy., Inflatable, Flotation ME901-0572 01108304	72	3	7	6	6	X	X	X				X	X									100%	8	0	0	162C	0031 (2) 0033 (1)	0	0	0	
2	Bag, Uprighting, Canister (Single) V16-586520 01208305	14	2	2	4	6	X	X	X	X	X			X	X								60%	0	0	0		211 (1)	0	0	0	
3	Bag, Uprighting, Canister (Double) V16-586519 01208305	14	2	2	4	6	X	X	X	X	X			X	X								60%	1	0	0	120C	201 (1)	0	0	0	
4	Bladder Assy., Inflatable ME901-0728 01208307	32	4	4	8	12	X	X	X	X	X				X								90%	0	0	0	1410C	0004 0005 0006	0	0	0	
5	Cartridge Assy., Canard V15-590220 01105304	247	18	76	0	8	X	X		X	X		X	X									100%	0	0	0	164C	0051 (2)	0	0	0	
6	Compressor, Motor Driven ME281-0020 01208301	14	1	3	2	12	X	X	X	X	X			X		X	X						70%	7	0	1	31H	0001 (2)	0	0	0	1:52H 14C
7	Detonators ME453-0021 00905302	3000	500	102	0	50	X	X	X	X			X	X									100%	1	0	0	122C	0006 (18)	0	0	0	
8	Detonating Cord Assy., Confined ME320-0001 01105311	200	15	66	0	2	X	X	X	X			X	X									100%	4	12	0	181C		0	0	0	

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CSM 012

SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

11-23

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
9	Disconnect, Dual Drogue V16-576187 01105311	85	20	23	0	19	X	X	X	X			X										100%	0	2	0		0401 (1)	0	0	0	
10	Disconnect, Main Para Chute Cutter Assy. ME901-0001 01205328	80	20	20	0	20	X	X	X	X			X	X									100%	0	0	0	493C	0021 (2) 0026 (3)	0	0	0	
																												0027 (3) 0028 (1)				
																												0029 (1) 0030 (1)				
																												0031 (1) 0032 (2)				
11	Disconnect, Umbilical Guillotine, CM to SM V17-590090 01105314	45	4	19	2	2	X	X	X	X			X										95%	8	1	0	49C		0	0	0	
12	Explosive Joints & Interfaces V24-959103,5 01105320	45	25	20	NA	NA	X	X	X	X			X	X										0	47	0			0	0	0	
13	Explosive Train Charges ME901-0612 01105321	4000	300	275	0	75	X	X	X	X	X		X	X										3	2	0	1359C	0002 (4) 0004 (4)	0	0	0	

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CSM 012

SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

11-24

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
13	Continued																											0006 (4) 0007 (4)				
																												0015 (4) 0016 (4)				
																												1001 (4) 2002 (8)				
																												2003 (16) 3001 (1)				
																												4001 (4)				
14	Harness Assy., Main Chute ME901-0001 01206307,8,10	40	28	10	0	0												X					100%	0	0	0		0031 (1)	0	0	0	
15	Igniter Cartridge ME453-0014 01105303	800	410	94	0	54	X	X		X			X										100%	0	0	0		0081 (4) 0082 (2)	0	0	0	
16	Initiator, Hot Wire ME453-0009 00905301	15K	6K	611	0	1K	X	X	X	X	X		X	X									100%	0	4	0	611C	0001 (2) 0008 (17)	0	0	0	

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CSM 012

SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

11-25

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
17	Line Cutter, Mech Initiated ME901-0001 01205326	500	200	76	0	220	X	X	X		X		X			X		X					100%	1	0	0	12C		0	0	0	
18	Mortar Assy., Drogue Parachute Sys. ME901-0001 01205327	50	10	8	0	20	X	X	X	X			X					X					100%	3	0	0			0	0	0	
19	Mortar Assy., Pilot Parachute Sys. ME901-0001 01205327	75	10	8	0	30	X	X	X	X			X					X					100%	0	2	0			0	0	0	
20	Nut Frangible Explosive ME114-0013	185	60	58	0	0																	100%	0	0	0	270C	0001 (4)	0	0	0	
21	Pack Assy., Main Chute ME901-0001 01206307,8,10	120	84	30	0	0												X					100%	4	1	0		0035 (3)	0	0	0	
22	Panel Attenuator V24-590150 01105322	50	2	18	4	8	X	X	X	X			X	X									95%	0	2	0		Bas. (8)	0	0	0	
23	Pressure Cartridge Type IV ME453-0005 00905305	200	50	76	0	10	X	X	X	X			X	X									100%	0	0	0		0001 (4) 0002 (6)	0	0	0	
																												0004 (3) 0006 (2)				

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CSM 012

SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

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NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES RESOLVED	CTR FAILURES EXPLAINED	CTR FAILURES OPEN	CTR TIME/ CYCLES	CONF. & QUANT.	CSM FAILURES RESOLVED	CSM FAILURES EXPLAINED	CSM FAILURES OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
	CERTIFICATION TEST DATA						CERTIFICATION TEST ENVIRONMENTS																					CSM DATA				
24	Pressure Cartridge Type VI ME453-0005 01105309	400	300	24	0	0	X	X	X	X		X	X										100%	3	0	0	43C	0101 (9) 0202 (2)	0	0	0	
25	Pressure Cartridge Exp. Train Initiated ME901-0595 01105319	300	25	114	0	8	X	X	X	X			X	X									100%	1	1	0		0001 (8)	0	0	0	
	ME901-0689 01105319	300	25	114	0	8	X	X	X	X			X	X									100%	0	0	0		0001 (4) 0002 (4)	0	0	0	
26	Pressure Cartridge Drogue Mortar ME453-0005 01205325	200	50	76	0	40	X	X	X	X			X	X									100%	9	0	0	209C	0001 (4)	0	0	0	
27	Pressure Cartridge Main Para Disconnect ME453-0005 01205325	100	20	76	0	4	X	X	X	X			X	X									100%	0	0	0	247C	0202 (2)	0	0	0	
28	Pressure Cartridge Pilot Mortar Type II ME453-0005 01205324	250	50	76	0	60	X	X	X	X			X	X									100%	2	0	0	227C	0002 (6)	0	0	0	
29	Retention Flap Assy. -Y ME901-0001 01206307,8,10	40	28	10	0	0												X					100%	0	1	0		0028 (1)	0	0	0	
30	Retention Flap Assy. +Z ME901-0001 01206307,8,10	40	28	10	0	0												X					100%	0	1	0		0029 (1)	0	0	0	

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SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

11-27

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
31	Retention Flap Assy. +Y ME901-0001 01206307,8,10	40	28	10	0	0												X					100%	1	0	0		0030 (1)	0	0	0	
32	Seamarker V16-576137 01206304			6			X	X	X		X		X						X				100%	1	0	0		Bas. (1)	0	0	0	
33	Separation & Retention Sys. Fwd Comp HS V16-596100 01105310	20	4	3	2	10	X	X	X	X													95%	5	0	0		0021 (1)	0	0	0	
34	Shaped Charge, Boosterd ME453-0028 01105705	100	20	44	0	0	X	X	X	X			X										95%	0	0	1		5301 (6)	0	0	0	
35	Shaped Charge, Flexible Linear ME453-0006 01105306	600	100	70	0	50	X	X	X	X			X	X										2	0	0	660C	4016 (2)	0	0	0	
36	Spring Reel V24-590060 01105323	15	1	2	1	4	X	X	X	X			X	X									100%	2	0	0	191C	Bas. (4)	0	0	0	5C
37	Thruster Assy. (SIA) V24-590050,3 01105318	25	1	12	3	4	X	X	X	X			X	X									100%	0	1	0	38C	Bas. (4)	0	0	0	
38	Thruster Assy. Canard V15-590201 01105305	17	2	2	0	4	X	X		X			X	X	X								100%	0	0	0		31 (1)	0	0	0	

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CSM 012

SUBSYSTEM 11.0 RECOVERY/ PYROTECHNICS

11-28

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	STATIC LOAD	ACCELERATION	EMI	BP DROP TEST					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
39	Tie Cutter, Tension, Separation, CM to SM F01-100407 01105315	200	100	23	0	15	X	X		X		X											100%	0	0	0		Bas. (3)	0	0	0	
40	Tower to CM Separation Sys. F01-100402,3 01105703	7	0	7	0	0									X								100%	0	0	0		(1)	0	0	0	
41	Umbilical, SM to SLA V24-590230 01105316	40	13	25	0	1	X	X	X	X			X	X									100%	0	0	0	40C	(1)	0	0	0	
42	Valve, Check, Spring Loaded ME284-0283 01108309	18	1	2	2	12	X	X	X	X	X		X	X	X								90%	1	0	0		0001 (2)	0	0	0	6C
43	Valve, Pressure Relief, Air ME284-0314 01108303	40	1	2	5	30	X	X	X	X	X		X	X	X								100%	1	0	0	5H	0001 (3) 0002 (2)	0	0	0	
44	Valve, Solenoid, Latching ME284-0285 00908302	27	1	4	3	18	X	X	X	X	X			X	X								100%	1	0	0	7432C	0001 (3)	0	0	0	15C

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11.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

EARTH RECOVERY/ORDNANCE

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

A. S. Kravitz 6/18/66
Certification Project Engineer

11.5 WAIVERS, SCN's AND RFC's - RECOVERY SYSTEMS/ORDNANCE

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
11.5.1	SCN 59A to SID 63-313	SLA Panel Deployment	Pending NASA Direction
11.5.2	SCN 120 to SID 64-1237	Separation Devices	Pending NASA Direction
11.5.3	SCN 200 to SID 64-1237	Explosive Material Press. Cartridge	Pending NASA Direction
11.5.4	SCN 177 to SID 64-1237	Sea Dye Marker	Cancelled
11.5.5	RID 012-1A-5 to SID 65-1010	Revision to V_T vs θ Envelope	Requires NASA/NAA Resolution

Engineering Manager

Project Engineer

12. MECHANICAL SYSTEMS•STRUCTURES

12.0 System Organization

12.1 Systems Test Results

12.2 Problem Summaries

12.3 Hardware Summary

12.4 Cert/Flt Hdw Differences

12.5 Waiver/SCN/RFC Information

12.0 MECHANICAL SYSTEMS/STRUCTURES

The Mechanical Systems/Structures (MECH), for purposes of the CARR, consists of mechanical systems and the CSM structure as listed herein. The mechanical systems include miscellaneous mechanisms and the crew couches and structures includes the design stress analysis and CSM structural configuration requirements.

LAUNCH ESCAPE SYSTEM

- Tower Structure
- Canards
- Structural Skirt

COMMAND MODULE

- Heat Shields
- Hatches & Mechanisms
- Inner Structure
- Couch Assembly
- Attenuation System
- Aft Compartment
- Insulation
- Equipment Support
- Deployment Mechanisms
- Boost Protective Cover
- Outer Structure

SERVICE MODULE

- Radial Beams
- Bulkheads
- Outer Shell

12.1 SYSTEMS TEST RESULTS

12.1.1 OCP-P-4172-SC-012 - Pressure Vessel Leak Check - CM

SCOPE

(1) To verify that the leak rate of the Command Module Inner Structure does not exceed 1,060 SCCM (maximum allowable leak rate). The inner structure is complete to the extent that all openings and equipment penetrations through the structure are installed.

(2) To verify the positive pressure relief setting of the cabin pressure relief valve.

RESULTS

This test was started in Building 1, Pressure Test Cell. Due to inner structure leaks, Sequence 02 was not completed in Building 1 Test Cell as the leaks could not be located immediately. Sequence 04 was completed successfully while troubleshooting for the inner structure leak. The CM was moved to B290 and Sequence 02 was to be completed as soon as the inner structure leaks were found and repairs completed. The inner structure leak was found to be a hole back of the ECU (Environmental Control Unit). Repairs were made per MR109796. Testing resumed on Sequence 02 and was completed successfully on Run No. 4. All of the sequences were completed successfully.

12.1.1.1 PROBLEM - Inner Structure Leak

A leak rate in excess of 2,000 SCCM was determined during first run. (1,060 maximum allowable). Leaks were detected on the Outer Structure indicating the leak was someplace in the Inner Structure. After further T/S, the ECU was removed and a hole was found in the Inner Structure. Repairs were made per MR109796. PAR 19919

CORRECTIVE ACTION

A patch repair was accomplished per MR109796

DOCUMENTATION

TPS-V16-4172-002.
Squawks Nos. 2, 3, 4, 5, 6, 7, 8 and 9 -
V16-OCP-4172-TAIR Book
MR 109796

12.1.1.2 PROBLEM - Post Landing Vent Valve Leaks

Structure leaks were experienced in excess of 3,000 SCCM. (1,060 maximum allowable). (Run No. 2)

CORRECTIVE ACTION

Determine where leaks are, work corrective actions. and rerun Sequence 02. Leak was determined to be around Post Landing Vent Valves in egress hatch. RTV-102 was used to seal around Vent Valves per drawing Gen. Note No. 7.

DOCUMENTATION

Squawks Nos. 10 and 11 - V16-OCP-4172-TAIR Book.
TPS-V16-ECS-021
TPS-V16-ECS-022

12.1.1.3 PROBLEM - Leaks Around Bolts

Structure leaks were experienced in excess of 2,000 SCCM. (1,060 maximum allowable). (Run No. 3)

CORRECTIVE ACTION

Bolts were resealed with RTV-102 per E.O.'s 454635 and 454636. Rerun of Sequence 02 to meet allowable leak rate was performed as Run No. 4. The run was successful and leak rate determined to be 620 SCCM. Leak located at bolt holes where HCB mortar beef-up mod. had been made.

DOCUMENTATION

Squawks Nos. 11 and 13 V16-OCP-4172-TAIR Book (Ref. E.O.'s Nos. 454635 and 454636).

12.1.2 TPS V16-VMS-001 - Forward Heat Shield Thruster Checkout

SCOPE

This test was performed to verify thruster piston movement and thruster system leakage rate in accordance with Process Specification MA0302-0032. Thruster piston movement was measured for manual movement and for movement by test pressure. System leakage rate was determined by pressure decay from test pressure measured during a 30 second interval.

RESULTS

During the test, piston movement under test pressure operation was recorded as out of tolerance for thrusters at longeron 1 and longeron 4. Leakage rate met specification requirements but was not recorded as a rate. The thruster checkout was rerun on TPS-V16-VMS-002. During this run all piston movement measurements were within specification limits. System leakage was measured again and found to be out of tolerance on the system supplying pressure to thrusters 1 and 3. The leakage was corrected and operation of the system verified.

12.1.2.1 PROBLEM - Out of Tolerance Piston Movement

The retest on TPS V16-VMS-002 proved that the out of tolerance readings for piston movement were not due to malfunction but due to error in reading the number of revolutions of the needle on the dial gage.

CORRECTIVE ACTION

None required.

DOCUMENTATION

Out of tolerance readings at longerons 1 and 4, squawks 1 and 2, TAIR book, retest per TPS V16-VMS-002.

12.1.2.2 PROBLEM - Excessive Pressure Decay

During the retest, the pressure decay rate for the system supplying longerons 1 and 3 was measured to be out of tolerance.

CORRECTIVE ACTION

The areas of leakage were determined by a trouble shoot TPS (TPS V16-VMS-008). A leaking "B" nut at longeron 1 was loosened and retorqued. An audible leak at longeron 3 thruster cylinder was corrected by rework on the cylinder.

DOCUMENTATION

System leakage, squawk 7, TAIR book, performed TPS V16-VMS-008 trouble shoot TPS. Cylinder leakage, squawks 8 and 17, TAIR book. Cylinder removed and replaced after rework by TPS V16-VMS-014. "B" nut leakage, squawks 14 and 15, TAIR book. "B" nut at longeron #1 (squawk 14) retorqued. "B" nuts at breech assembly at longeron #4 (squawk 15), leakage too small to warrant retorquing. PAR 21929

12.1.3 OCP-P-3019-SC012) - Horizontal Weight and Balance - SM

SCOPE

This test was performed to determine the actual weight and to determine the radial and vertical centers of gravity of the Service Module. The Service Module was oriented in the vertical mode on three load reaction points with loading measured at each point for weight and radial center of gravity. The module was suspended in the horizontal mode measureing weight at each end for vertical center of gravity.

RESULTS

During installation in the vertical mode fixture, a deviation to the OCP was required for method of restraint of the Service Module. The module was installed and aligned after exchanging the Brunson transits with K&E transits. The load measurements were taken without problems. The balance of the test was completed with no problems.

12.1.3.1 PROBLEM - Restraint of S/M

Only one restraint line could be attached to the Service Module in the vertical mode.

CORRECTIVE ACTION

A temporary deviation to the OCP was written to permit restraint by physical handhold on the SM in lifting and positioning of the module.

DOCUMENTATION

Restraint, squawk 2, OCP-P-3019-SC012. Temporary Deviation 001T, Item 1, written.

12.1.3.2 PROBLEM - Leveling of Transits

The Brunson transits could not be leveled with sufficient accuracy to perform a satisfactory test.

CORRECTIVE ACTION

K&E transits were used in place of the Brunsons.

DOCUMENTATION

Transit leveling, squawk 3, OCP-P-3019-SC012.

12.1.4 ENGINEERING ANALYSIS

The pressure test was performed per MA0208-0012 using lead tape to close gap noted with the knowledge that greater pull down capability of the crew access pressure hatch cover latch mechanism had been released and would be available for SC 012 prior to the leak test per MA0406-0002. The lead tape was removed and the leak test was performed with this revised latch mechanism. The Crew Access Pressure Hatch Cover Mechanism Specification MA0308-0095 was revised, increasing allowable torque on mechanism to 200 inch pounds from 100 inch pounds. A new mechanism striker, V16-550320-5, was installed providing for greater adjustment of mechanism.

12.1.4 OCP-P-3239-SC-012 - Spacecraft 012
Command Module
Inner Structure
Proof Pressure Test.

SCOPE

The proof pressure test was conducted on the CM inner structure to verify external leakage of the assembly per MA028-0012.

RESULTS

All covers were installed and sold per TPS (200). Pressurization was attempted but failed due to a gap of approximately .015 inch at the bottom of the main hatch. Several attempts were made to correct this condition. The project office and the structural engineer for spacecraft 012 were consulted for disposition.

Project engineering decided to use lead tape for sealing. Spacecraft 012 CM was holding 3 PSIG steady. The OCP was completed successfully.

12.1.4.1 PROBLEM - Leakage at Main Hatch

A gap of approximately 0.015 inch at the bottom of the main hatch prevented pressure integrity.

CORRECTIVE ACTION

Lead tape was installed to provide a seal

DOCUMENTATION

No documentation available
PAR 1102

Jerry E. Jolley
NAA ATO Systems Supr

12.2 PROBLEM ANALYSIS - MECHANICAL SYSTEMS/STRUCTURE

There are no significant unresolved problems related to this equipment.

J. Adelstone

NAA Reliability Project Engineer

12.3 HARDWARE SUMMARY - MECHANICAL SYSTEMS/STRUCTURES

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSM 012

SUBSYSTEM 12.0 STRUCTURAL/ MECH. SYS.

12-20

CERTIFICATION TEST DATA																											CSM DATA				
							CERTIFICATION TEST ENVIRONMENTS																	CTR FAILURES				CSM FAILURES			
NO.	NOMENCLATURE BASED PART NUMBER OR NUMBER	NUMBER UNITS	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	ACCELERATION	EMI	STATIC LOAD	IMMERSION	LIFE	BP DROP TEST			CTR STATUS	RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CONF. & QUANT.	RESOLVED	EXPLAINED	OPEN	ACCEPT. & CURRENT TIME/ CYCLES
1	Canard Sys. Mech. & Structure V15-300800 00901301	23	2	1	7	5	X	X		X							X						100%	0	0	0		0051 (1)	0	0	0	
2	Deployment Mech., Swimmer Umbilical & Sea Dye Marker V16-550766 01202304	10	0	2	2	2	X	X	X	X	X			X									80%	0	0	0		Bas. (1)	0	0	0	
3	Deployment Mech., VHF Antenna V16-550700 01202301	21	0	2	9	6	X	X	X	X	X												80%	0	0	0		(1)	0	0	0	
4	Latching Mech., Boost Cover V15-550801 01202303	8	0	2	1	1	X	X	X	X		X	X										80%	0	0	0		(1)	0	0	0	
5	Pressure Vessel, Fuel V17-343052 00903701	23	1	4	2	0				X	X						X						100%	0	0	0		(2)	0	0	0	E18 C
6	Pressure Vessel, SPS, H_e V17-347102 00903301	21	1	4	6	0				X	X												100%	0	0	0		0003 0005 (2)	0	0	0	E12 C
7	Pressure Vessel, Oxidizer V17-342052 00903701	23	1	4	2	0				X	X						X						100%	0	0	0		0021 (2)	0	0	0	E20 C

Temp. Form M&E - 1056 Exp. 6-10-66

12.4

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

MECHANICAL SYSTEMS/STRUCTURE

The pages which follow indicate the significant differences between the Certification Test Hardware and Flight Hardware.

APPROVED BY:

[signature] 6/18/66

Certification Project Engineer

Flight Part No.	Test Part No.	Part Name	Test Ident.
V15-300102-271	V15-300102-191	LES TOWER	

Differences

TRUSS REDESIGN PER MCR A-519 (ADDED THE BOOST PROTECTIVE COVER) WAS NOT RETESTED

Certification Basis

ANALYTICAL EXTRAPOLATION OF TEST DATA IS SUFFICIENT FOR CERTIFICATION IN CONJUNCTION WITH THE NUMEROUS FLIGHT TESTS OF THE ABORT SYSTEM

Flight Part No.	Test Part No.	Part Name	Test Ident.
V15-300800-71	V15-300800-11	CANARD ASSY	

Differences

FLIGHT PART IS AS MODIFIED BY MOD. KIT, V15-880008 TO BE RETROFITTED TO S/C 012

Certification Basis

CHANGES MADE PER MCR A-1439 DO NOT ALTER THE BASIC STRUCTURE. THE CHANGES PROTECT THE STRUCTURE AGAINST THE MORE SEVERE THERMAL ENVIRONMENTS ASSOCIATED WITH A HIGH ALTITUDE ABORT

Flight Part No.	Test Part No.	Part Name	Test Ident.
V15-300680-71	V15-300680-61	BOOST COVER	

Differences

THERMAL MODIFICATION PER MCR A-1439

Certification Basis

THESE CHANGES WERE MADE FOR HIGH ALTITUDE ABORT AND THEY DO NOT ALTER THE BASIC STRUCTURE. THE CHANGES PROTECT THE STRUCTURE AGAINST THE MORE SEVERE THERMAL ENVIRONMENT.

Flight Part No.	Test Part No.	Part Name	Test Ident.
V11-[illegible]	NONE	SEXTANT TELESCOPE WINDOW	NONE

Differences

NEW PASSIVE DESIGN

Certification Basis

1. PARTIAL CERTIFICATION IS OBTAINED BY SIMILARITY OF MOLDED ABLATIVE PARTS TO THOSE PORTIONS OF ABLATIVE HEAT SHIELD HAVING SIMILAR MATERIALS.

2. FURTHER CERTIFICATION WILL BE OBTAINED BY MISSION AS-202 (C/C 011) WHOSE ENTRY ENVIRONMENT IS MORE SEVERE THAN THAT OF MISSION AS-204A (C/C 012)

12.5 WAIVERS, SCN's AND RFC's - STRUCTURES/MECHANICAL SYSTEMS

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
12.5.1	SCN TBD (MCR A1491)	Sextant, Telescope Thermal Protection	SCN to be submitted
12.5.2	SCN 231A to SID 64-1237	LES Thermal Protection during Hi-Alt Abort	NAA to Implement
12.5.3	RFC 012-NAA-1-1 (RID 012-1A-6)	Outer Hatch Removal Under Vacuum	NAA to Prepare ECP for special tool
12.5.4	RFC 012-6-29	TV Camera Window Mount	NAA to implement MCR A1344
12.5.5	Deviation	Reduced Factor of Safety for SM aft bulkhead	NAA Action Required

P. J. Hamfin
Engineering Manager

Project Engineer

13. DISPLAYS & CONTROLS

13.0 System Organization

13.1 Systems Test Results

13.2 Problem Summaries

13.3 Hardware Summary

13.4 Cert/Flt Hdw Differences

13.5 Waiver/SCN/RFC Information

13.0 DISPLAYS AND CONTROLS

The Displays and Controls (D&C), for purposes of the CARR, consists only of those displays and controls which are not a part of any other system. The following items may be included herein depending on test and other data accumulation requirements.

Timing System (Clock)

Lighting System

Caution and Warning System

Entry Monitoring System

13.1 TEST RESULTS

ATO test and operations activities affecting the displays and controls are reported within each appropriate system section.

13.2 PROBLEM ANALYSIS - DISPLAYS AND CONTROLS

Apollo Problem Summaries are generated by NAA/S&ID, Apollo Reliability and Design Engineering departments.

Those Problem Summaries which were "Unresolved" on May 19, 1966 were jointly selected by NAA Apollo Reliability Project Engineering and NASA/GE ASD project reliability for inclusion in this report. However, their status as of June 15, 1966, as presented in this report, reflects additional data and information permitting changes in classification to "Explained" or "Resolved", as applicable on an individual basis.

Problem Summaries of S/C 009 flight anomalies applicable to S/C 012 and recent significant problems occurring in the Certification Test Programs and S/C 011 and S/C 012 checkout programs may also be included.

Each Problem Summary is categorized as resolved, explained, or unresolved. These are defined as follows:

Resolved Problem:	Corrective action has been taken on S/C 012.
Explained Problem:	Corrective action has not been taken for S/C 012, but rationale exists to permit the hardware to be used for S/C 012.
Unresolved Problem:	Problem is neither resolved nor explained.

J. Adelstone

NAA Reliability Project Engineer

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APOLLO PROBLEM SUMMARY

Ø1 S/C # 012, 014, 017, 020

Date: 1-22-66
Revised: Ø1 4-21-66
Ø2
Ø3
Ø4

Subsystem/End Item Displays and Controls

Ø1 Equipment Name, S&ID P/N Toggle Switch, ME 452-0050-1045 (AT type) -1024

Spacecraft [X] GSE [ ]

Apollo Reliability Melvin CL Hove Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)
The switch experienced contact openings exceeding 10 micro-seconds during the Y and Z axes of vibration.

The failure indication could not be repeated, even when the "g" level was increased from 10.8g to 12g.

Ø1 Supplier Failure Report #15; NAA/S&ID Datafax #1367
SN - 0001 and 0003

13-6

CTR 01226308

Ø1 #20 -1024 SN170 and SN219 - NAA/S&ID Datafax #247

Ø1 (2) Problem Status ~~Unresolved~~ Explained (Resolved, Unresolved, or Explained)
The supplier concluded that the indication was a test equipment or set-up error. However, two additional switches of this configuration will be evaluated in a separate vibration test.

There will be no effect to the spacecraft because of this failure mode. There are presently six such switches on S/C 012, two used in the Electrical Power Subsystem and four in the Secondary Propulsion Subsystem. The two in the EPS are criticality III while the four in the SPS are criticality II (a) if the switches failed to reclose.
~~The results of the additional vibration test should be available by February 21, 1966.~~

Displays and Controls 41-697-806

Manager - N. Nelson

APS- 922 - PLD
PAGE 1 OF 2

TEMP. FORM ENG-A-1185 EXP. 3-24-

(2) Problem Status (Cont.)

ϕ_1

The separations noted on -1024 have the same indications as the -1045 in the Z axis. The failure could not be duplicated when mounted in the center of the vibration table.

Evaluation has shown that perimeter mounting of switches on the table permits uneven loading of the test specimen.

The supplier has taken procedural corrective action to assure the mounting on the vibration surface is smooth and clean with a single specimen positioned in the center of the table. The number of removals from the test surface will be reduced with the part rotated in its fixture rather than the fixture remounted.

The sensitivity to the short level indicates that panel position will be significant and that panel assembly to the spacecraft will require careful specification of mounting torque. Minimum torque levels must be specified for mounting of the switches and the panels to the structure.

There will be no effect at the spacecraft level since intermittent opens are not significant in the circuits using these components.

Additional test data from panel 22 (five parts) indicated no vibration failures.

APOLLO PROBLEM SUMMARY

Ø1 S/C # 008, 012, 014

Date: 2-17-66

Revised: Ø1 4-22-66

Ø2

Ø3

Ø4

Subsystem/End Item Displays and Controls

Equipment Name, S&ID P/N Toggle Switches, ME452-0050-1024 (AT Type)

Spacecraft [X] GSE [ ]

Apollo Reliability Melvin C. Hors

Apollo Engineering

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

Two such switches failed to meet the minimum insulation resistance of 10 megohms at 500 vdc following the O_2 - H_2O test. The first switch(from group II of the Qual test sequence) passed the insulation resistance test immediately after the O_2 - H_2O test, however, three days later the insulation resistance measurements were below 1 megohm. The second switch (from group III of the Qual test sequence) failed the insulation resistance test immediately following the O_2 - H_2O test with resistance measurements of approximately 90 K ohms. Subsequent measurements on the second switch disclosed short conditions, these shorts occurred between the two end terminals, each to case of the basic switch #1 and gross current leakages occurred between terminals to case of basic switch #5.

Initial analysis has disclosed a current leakage path between the basic switch's glass header and the potting material.

Ø1 Supplier Failure Report #19 (#24); NAA/S&ID Datafax #238 and 239 (#250) - CTR 01226308

Ø1 (2) Problem Status ~~Unresolved~~ Resolved (Resolved, Unresolved, or Explained)

There are twelve of the -1024 switches on S/C 012 of which five are between the S/C Power Busses and the load isolating circuit breaker. These switches are:

S_1, S_2, and S_3 - PNL 22; Fuel Cell Pumps #1, 2 & 3
S_{12}, - PNL 22; T/C Ess Bus
S_{13}, - PN 22; T/C Non Ess Bus

The -1024 switch each contain six of the basic switch modules. These are bonded to the switch structure which in turn is bonded to the panel and the panel is bonded to the spacecraft (electrically). Therefore, potentially a single terminal to case short can provide an electrical path from an A.C. bus phase to S/C structure and result in loss of an A. C. Bus. A second terminal to case short conceivably can cause loss of the second A. C. Bus. This can occur wither at one or more of the five switches and would result in complete loss of A.C. Power and thus loss of the spacecraft.

TEMP. FORM ENG-A-1185 TEMP. 3-24-66

A terminal to terminal short of one basic switch can couple a phase of one Bus to the same phase of the second Bus, providing the switch is in the appropriate position. A phase to phase short will cause loss of both A.C. Busses because an over voltage or under voltage condition would result. The procedure would then be to place all such switches into the center toggle position (off position) and re-energize the Busses. Then try the switches individually to determine which one has the fault.

~~The supplier has determined the cause of this failure to be a potting problem and believes that it is restricted to a lot of six switches (serial numbers 05885A3C 0093, 0098, 0102, 0115, 0116 and 0118). The potting material did not bond to the glass seal header of the basic switch or to the potting skirt, this then provided a low resistance path to the case and/or other terminals when moisture or some other contaminant entered this area. A breakdown then generated corrosion products continuously thus reducing the resistance which in turn allows an increase in the current. The supplier is analyzing the failure and should provide the analysis and corrective action by 2-21-66.~~

~~One of the six switches is in-house (S/N #0118) and is presently being used on panel 13 of S/C 012. This switch is controlling Environmental Control Subsystem functions and has a 4 out of 5 chance of being in a Criticality II application. Micro Switch has determined that in addition to the two qual test samples which failed, a third one (S/N 0102) also has failed for the same reason. The remaining two switches are qual samples ready to enter the electrical endurance test.~~

~~NAA/S&ID will either remove the switch (S/N 0118) from panel #13 or derive a fix that will prevent moisture or other contaminants from entering into the switch.~~

Displays and Controls, D/697-806 Manager - N. Nelson

Ø1 (2) Problem Status (Cont.)

Failure analysis has shown that moisture alone will permit the insulation breakdown. The recent change in duration of the test and reduction in pressure cycles will not prevent the lower insulation resistance if the potting process defect is present. Specific steps in the potting process causing the defect are still undetermined. The mechanism of failure has been verified and photographs of moisture paths obtained. The path is from the case of the basic module; down the side of the potting dam; across the header of the basic module to the round terminal post. The supplier has not supplied a process that can consistently satisfy the specification requirement.

NAA has eliminated the possibility of a Criticality 1 failure by replacing the units in S/C 012 for AC applications. EO 442880 requires the same action for S/C 014. DC applications do not require rework because of insensitivity to leakage. Unmanned spacecraft do not require rework because there is no moisture requirement on these missions.

A review of the two remaining spacecraft applications revealed that an insulation resistance as low as 1 K ohms would be permissable. The SCD has been revised to reflect the 1 K ohm insulation resistance for the -1024 only. Reference ME452-0050 Rev. J.

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APOLLO PROBLEM SUMMARY
Ø1 S/C # 008, 012 & Subs.

Date: 1-24-66
Revised: Ø1 4-22-66
Ø2
Ø3
Ø4

Subsystem/End Item Displays and Controls

Equipment Name, S&ID P/N Toggle Switches, ME 452-0050-1003, 1009, and 1043 (formerly-1006)TL type

Spacecraft [X] GSE [ ]

Apollo Reliability Melvin C L Hove 2-7-6 C. E. Farner Apollo Engineering [signature] 2/4/6

(1) Problem Description (Narrative Description, CTR # if applicable, Failure Report #'s applicable)

The switches experienced an inability to transfer during the thermal vacuum test. The switches failed during initial cycling in the low temperature portion (0°F) which follows the high temperature portion (150°F) and a 3 hour soak at 0°F. Tear down has disclosed a deformed plunger in each switch, along with discoloration and evidence of a lubricant breakdown.
Supplier Failure report #16, 17, 18; NAA/S&ID Datafax #1370

CTR 01226308

13-11

Ø1 (2) Problem Status ~~Unresolved~~ Resolved (Resolved, Unresolved, or Explained)

There are criticality I effects (loss of crew) if this failure mode occurs during the flight of S/C 012. Steps have been initiated to eliminate these single point failures that would result in crew loss. These steps will be to add other switches as backups to the present switches, whose criticality I failure mode is the inability to transfer.

~~Supplier analysis to date has included a thorough investigation of the lubricant used internal to the switch and the cycling test fixtures. Lubricant was ruled out as the cause for the failures, however, it may be a contributing factor. The test fixture is currently not considered to be the cause. The present approach of investigation is the possibility of a leakage problem. Analyses and tests are being performed, with written analysis available in February.~~

Displays and Control Design 41-697-806
Manager-N. Nelson

APS-931 - PLD
PAGE 1 OF 2

TEMP. FORM ENG-A-1185 EXP. 3-24-66

Ø1 (2) Problem Status (Continued)

Criticality I applications identified by Block I FMEA analysis have been eliminated by the rework of the five applications on panels 26, 16 and 25. Reference EO M454848 for part numbers. Reference assembly drawings V16-771426, V16-771416 and V16-771425. Redundancy was used to eliminate potential failure modes that would result in crew loss. Criticality II applications retain the same part numbers. The problem is unresolved at this criticality level since the causes of failure are not completely understood. Resolution is not necessary since the procurement specification has been changed to reduce the temperature extremes, and new units have qualified. The qualification test report LTR 21016-2a satisfies the requirements of the F revision and PDC-1 of the specification. (MC 452-0050)

Thermal analysis of command module interior shows original temperature extremes were excessive.

13.3 HARDWARE SUMMARY - DISPLAYS AND CONTROLS

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSN 012

SUBSYSTEM 13.0 DISPLAYS & CONTROLS SYSTEM

13-14

No.	NOMENCLATURE BOEING PART NUMBER OTR NUMBER	BOEING BUILD	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	GSE GROUND TEST QUANTITY	GSE FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSN DATA: COMP. & QUANT.	CSN FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHANGEOUT TIME/ CYCLES
1	Annunciator, Abort Light ME434-0021 01226318	6		3			X	X	X	X	X	X	X	X		X							95%	0	0	0		1002 (1)	0	0	0	
2	Annunciator, C & W Matrix ME434-0020 01226319	6		2			X	X	X	X	X	X	X	X		X							95%	0	0	0		1009 (1) 1008 (1)	0	0	0	
3	Annunciator, Engine Warning ME434-0022 01226317	6		3			X	X	X	X	X	X	X	X		X							95%	0	0	0		1004 (1)	0	0	0	
4	Clock, Mechanical ME432-0048 01226303	6		2			X	X	X	X	X	X	X	X		X							95%	3	0	0		1003 (1)	0	0	0	
5	Detection Unit, Caution ME430-0003 01226301	8	1	1	3	3	X	X	X	X	X	X	X	X	X								95%	3	1	0		1101 (1)	0	0	0	
6	Indicator, Barometric Pressure ME432-0052 01226307	4		4						X	X	X	X	X		X							80%	0	0	1		0005 (1)	0	0	0	
7	Indicator, Event ME432-0054 01226314	150		4			X	X	X	X	X	X	X	X		X							100%	1	0	0		1004 (6) 1005 (24)	0	0	0	
8	Indicator Event ME432-0058 01226315	20		4			X	X	X	X	X	X	X	X		X							80%	0	2	0		1001 (4)	0	0	0	

Temp. Form B&E - 1056 Exp. 6-10-66

CSM 012

SUBSYSTEM 13.0 DISPLAYS & CONTROLS SYSTEM

13-15

No.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP	LO TEMP	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	ACCELERATION	ACOUSTICS	PROPELLANT COMP.					CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
9	Timer, Event, Digital Readout ME456-0020 01226306	4		2			X	X	X	X	X	X	X	X		X							80%	2	0	0		1003 (1)	0	0	0	
10	Timer, Mechanical "From Event" ME432-0051 01226304	8		2			X	X	X	X	X	X	X	X		X							95%	2	0	0		2001 (1) 2002 (1)	0	0	0	
11	Timer, Stop ME456-0043 01226305	4		1			X	X		X						X							80%	1	0	0		1001 (1)	0	0	0	

Temp. Form R&E - 1056 Exp. 6-10-66

13.4 CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

DISPLAYS AND CONTROLS

There are no significant differences between Certification Hardware and Flight Hardware.

APPROVED BY:

Certification Project Engineer

13.5 WAIVERS, SCN's AND RFC's - DISPLAYS AND CONTROLS

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 8 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
13.5.1	SCN 223 to SID 64-1237 5-5-66	Update MEI Spec; Add C&W Tabulation	Awaiting NASA Approval (See CARR No. 13.5.6)
13.5.2	SCN 225 to SID 64-1237 (MCR A1348)	Adds (9) GFE Penlites	NAA to Submit ECP
13.5.3	SCN 232 to SID 64-1237 5-12-66	Add Additional Digital Event Timer	Awaiting NASA Approval
13.5.4	SCN 240 to SID 64-1237 (MCR A1461)	Add ECS Radiator Outlet Temp.	NAA to Submit ECP
13.5.5	SCN 237 to SID 64-1237 (MCR A1451)	Add GFE Line Heater Control	NAA to Submit ECP
13.5.6	SCN Pending to SID 64-1237	Revise C&W CO_2PP High Limit	Held by NAA Pending NASA OK of SCN 223 (See CARR No. 13.5.1)
13.5.7	SCN 241 to SID 64-1237	Update Fig. 117 Control & Displays Layout	NAA to Submit ECP
13.5.8	SCN Pending to SID 64-1237	Revise Floodlights	NAA to Submit ECP

Engineering Manager

Project Engineer

14. CREW EQUIPMENT

14.0 System Organization

14.1 Systems Test Results

14.2 Problem Summaries

14.3 Hardware Summary

14.4 Cert/Flt Hdw Differences

14.5 Waiver/SCN/RFC Information

14.0 CREW EQUIPMENT

The Crew Equipment (CREW), for purposes of the CARR, consists of the components provided in the crew compartment for effective operation of the spacecraft, sustenance of the crew, protection and safety of the crew.

Inflight Tool Set

Optical Equipment

Crewman Restraint Equipment

Personal Communications Assembly

Crewman Umbilical Assemblies

Crew Couch Pads

Water Dispenser

Work Shelf & Drawer Assembly

Fecal Canister & Bag

Relief Tube Receptacle Assembly

Storage Compartments

Storage Containers and Boxes

14.1 SYSTEMS TEST RESULTS

14.1.1 TPS_____ Crew Compartment Fit and Function

SCOPE

TPS_____ is performed to familiarize the prime flight crew with the crew compartment equipment and to verify operational suitability of the crew station provisions to satisfy mission objectives.

RESULTS

This test to be performed following integrated.

NAA ATO Systems Supr

14.2 PROBLEM ANALYSIS - CREW EQUIPMENT

There are no significant unresolved problems related to this equipment.

J. Adelstone

NAA Reliability Project Engineer

14.3 HARDWARE SUMMARY - CREW EQUIPMENT

Information from the following sources was used in the preparation of the Hardware Summary:

Certification Test Network
Certification Test Summary
Configuration Data
Supplier Data
Receiving Inspection
Personal Contact with Suppliers
Configuration Control
Acceptance Data Packages
Problem Action Records
Operating Time Data

CSM 012

SUBSYSTEM 14.0 CREW EQUIP.

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	STATIC LOAD	LIFE	PRESSURE LEAK	ULT. LOAD	FLEX END	TENSILE LOAD	PRESSURE DROP	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
1	Actuator, Electro Mech. ME287-0011 01207304	120	4	4	0	0	X	X	X	X		X	X										100%	1	0	0			0	0	0	
2	Adapter, Cable Assy. V16-601356,7 01216706	102	4	0	6	0	X	X	X	X					X									0	0	0		BAS. (3)	0	0	0	
3	Bag, Fecal Emesis, Inner V16-601378 01216304	1054	270	15	124	0	X	X	X			X											90%	0	2	0		BAS. (62)	0	0	0	
4	Bag, Fecal Emesis, Outer ME901-0736 01216303	1054	200	18	124	0	X	X	X			X											80%	0	7	0		0001 (62)	0	0	0	
5	Cannister, Fecal V16-601418 01216305	15	5	2	3	0			X	X	X												80%	1	0	0		BAS. (1)	0	0	0	
6	Communication Assy., Constant Wear, Personal V16-601176 01216301	12	12	3	6	0			X	X	X	X	X	X									80%	0	0	0		BAS. (2)	0	0	0	
7	Communication Assy. Elect. Pers. Crewman ME478-0072 01216705	208	12	3	0	0	X	X	X	X	X				X								60%	0	0	0		0001 (2) 0002 (2)	0	0	0	
8	Communication Assy. Elect. Pers. Crewman ME478-0073 01216705	208	12	3	0	0	X	X	X	X	X				X								60%	0	0	0		0001 (2) 0002 (2)	0	0	0	

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CSM 012

SUBSYSTEM 14.0 CREW EQUIP.

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER REQ'D	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	STATIC LOAD	LIFE	PRESSURE LEAK	ULT. LOAD	FLEX END	TENSILE LOAD	PRESSURE DROP	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
9	Compartment & Container Assy., Food 01216309 V16-601430,31,514,518	14	21	14	7	0				X	X												80%	0	0	0		30-(1) 36-(1) 40-(1)	0	0	0	
10	Compartment Installation Medical IEB. V16-601103 0126308 V16-601477	5	2	4	2	0				X	X												95%	3	0	0		103 (1)	0	0	0	
11	Container Assy., Survival Provisions V16-601371,2,3 01216307	6	3	3	3	0				X	X												100%	0	0	0		71(1) 72(1) 73(1)	0	0	0	
12	Courch Pad, Zero G V16-601472 01216704	54	2	3	3	0	X	X	X			X	X	X										0	0	0		BAS. (3)	0	0	0	
13	Dispenser Assy., Crew, Water V16-601521 01216320	20	1	2	0	0				X	X						X	X						0	0	0		BAS. (1)	0	0	0	
14	Harness Assy., Restraint, Crew ME901-0257 01216319	34	4	10	6	0	X	X	X			X	X	X		X			X				80%	1	3	2		0007 (1) 0009 (1)	0	0	0	
																												0011 (1)				
15	Hose Assy., Umbilical Oxygen ME271-0029 01216322			6	0	0														X	X	X	100%	4	0	0		0001 (1) 0002 (1)	0	0	0	

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CSM 012

SUBSYSTEM 14.0 CREW EQUIP.

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	STATIC LOAD	LIFE	PRESSURE LEAK	ULT LOAD	ACCELERATION	TENSILE LOAD	PRESSURE DROP	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
15	CONT'D.																											0003 (1)				
16	Receptacle Assy., Relief Tube V16-601421 01216302	15	5	3	6	0																X	80%	0	6	0		31 (1)	0	0	0	
17	Restraint Assy., Rest Station, Crew V16-601211 01216313	17	1	2	2	0	X	X	X			X	X	X									90%	1	0	0		BAS. (1)	0	0	0	
18	Sanitation Boxes V16-601112 01216306	11	6	3	6	0				X						X							90%	0	0	0		51(1) 101(1) 201(1)	0	0	0	
19	Strap, Main Display Console, Handhold, L. H. V16-601082,3,4 01216314	110	6	4	12	0										X							95%	2	0	0		82(1) 83(1) 84(4)	0	0	0	
20	Strap, Tie Down, Oxygen and Electrical V16-601335 01216702	14	4	2	6	0				X	X												90%	0	0	0		BAS. (6)	0	0	0	
21	Strut. Assy. (X-X Foot) V16-571411 V16-571311 01207301	14	1	2	0	0	X	X	X	X	X	X	X							X			65%	0	0	0		101 111 BAS.	0	0	0	
22	Strut. Assy. (X-X Head) V16-571412 V16-571312 01207302	15	0	2	0	0	X	X	X	X	X	X	X							X			65%	0	1	0		-81 -91 BAS.	0	0	0	

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CSM 012

SUBSYSTEM 14.0 CREW EQUIP.

NO.	NOMENCLATURE BASIC PART NUMBER CTR NUMBER	NUMBER BUILT	DEVELOPMENT TEST QUANTITY	CERTIFICATION TEST QUANTITY	CSM GROUND TEST QUANTITY	CSM FLIGHT TEST QUANTITY	CERTIFICATION TEST ENVIRONMENTS: HI TEMP.	LO TEMP.	VACUUM	VIBRATION	SHOCK	OXYGEN	HUMIDITY	SALT	EMI	STATIC LOAD	LIFE	PRESSURE LEAK	ULT. LOAD	ACCELERATION	TENSILE LOAD	PRESSURE DROP	CTR STATUS	CTR FAILURES: RESOLVED	EXPLAINED	OPEN	CTR TIME/ CYCLES	CSM DATA: CONF. & QUANT.	CSM FAILURES: RESOLVED	EXPLAINED	OPEN	ACCEPT. & CHECKOUT TIME/ CYCLES
23	Strut. Assy. (Z-Z Axis) V16-571314 01207303	15	0	2	0	0	X	X	X	X	X	X	X							X			80%	0	1	0		-41 (2)	0	0	0	
24	Umbilical Assy., Crewman, Electrical V16-601263 01216310	14	3	4	6	0	X	X	X	X	X				X								25%	0	0	2		11(1) 21(1) 31(1)	0	0	0	
25	Umbilical Assy., Crewman, Oxygen V16-601201 01216312	14	6	4	6	0	X	X	X	X	X	X											70%	3	0	0		BAS. (3)	0	0	0	

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14.1

CERTIFICATION TEST

HARDWARE DIFFERENCES VS FLIGHT HARDWARE

CREW EQUIPMENT

The pages which follow indicate the significant differences between the Certification Test Hardware and Flight Hardware.

APPROVED BY:

6/18/66

Certification Project Engineer

Flight Part No.	Test Part No.	Part Name	Test Ident.
MF478-0073-0001	ME901-0280-0001	MICROPHONE, AMP. ASSY. PERSONAL COMM.	1216705

Differences

FLIGHT PART IS A SIX TRANSISTOR DEVICE OPERATING AT 16.8 VOLTS.

TEST PART IS A FOUR TRANSISTOR DEVICE OPERATING AT 28 VOLTS

Certification Basis

TEST PART REC'D DESIGN PROOF TESTS CONSISTING OF: FUNCTION, HI-LO TEMPERATURE, VACUUM, VIBRATION, SHOCK, OXYGEN, HUMIDITY, SALT AND LIFE.

FLIGHT PART CERTIFIED BY SIMILARITY TO TEST PART PLUS DPT OF TEMPERATURE.

14.5 WAIVERS, SCN's AND RFC's - CREW EQUIPMENT

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 10 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
14.5.1	RFC 012-6-29	TV Camera Mount	Pending NASA OK of mockup
14.5.2	RFC 014-6-OP-25	Mirror Adjustments	NAA to Implement
14.5.3	RFC 014-6-OP-38	Bump Hat Electronics	Pending NASA Action
14.5.4	RFC 014-6-EX-2	Tee-adapter	NAA to Implement
14.5.5	RFC 014-6-EX-6	M-12A Ergometer	NAA to Implement
14.5.6	RFC 012-6-28	Water Dispenser Tubing Stowage	NAA to Implement
14.5.7	RFC 012-6-42	Increase Ergometer Lap Belt Length	NAA to Implement
14.5.8	RFC 012-6-46	Color Code Restraint Equip.	NAA to Implement
14.5.9	RFC 014-06-OP-1	Improve Sandals	NAA to Implement
14.5.10	RFC's 014-06-OP-9 014-06-OP-10	Make restraint Straps Adjustable	NAA to Implement
14.5.11	RFC 014-06-OP-11	Identify Equipment by Astronaut Name	NASA to take Action
14.5.12	RFC 014-06-OP-15	Add Velcro at Sides of LEB	NAA to Implement
14.5.13	RFC 014-06-OP-19	Urine Receptacle & Hose Assembly	NAA to Implement
14.5.14	RFC 014-06-OP-23	Tool Changes	NAA to Implement
14.5.15	RFC 014-06-OP-24	Change Stowage of "D" Ring Ext. Handle	NAA to Implement
14.5.16	RFC 014-06-OP-27	COAS - Add Spare Light Bulb	NAA to Implement

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
14.5.17	RFC 014-06-OP-33	Velcro Changes	NAA to Implement
14.5.18	RFC 014-06-OP-35	Improve Workshelf	NAA to Implement

P. J. Hanifin
Engineering Manager

Project Engineer

15. EXPERIMENTS

15.0 System Organization

15.1 Systems Test Results

15.2 Problem Summaries

15.3 Hardware Summary

15.4 Cert/Flt Hdw Differences

15.5 Waiver/SCN/RFC Information

15.0 EXPERIMENTS

Ten experiments are planned in connection with Spacecraft 012 operations. They fall into three categories - Medical, Scientific, and Technical - as listed below. Additionally, a medical data acquisition system (MDAS) is installed in the C/M to record outputs from Experiments M-4A and M-12A.

EXPERIMENT NO.	TITLE
Medical	
M-1A	Cardiovascular Conditioning
M-4A	Inflight Phonocardiogram
M-5A	Bioassays Body Fluids
M-6A	Bone Demineralization
M-9A	Human Otolith Function
M-11	Cytogenetic Blood Studies
M-12A	Exercise Ergometer
Scientific	
S-5A	Synoptic Terrain Photography
S-6A	Synoptic Weather Photography
Technical	
T-3	Inflight Nephelometer
Data	
MDAS	Medical Data Acquisition System

15.1 SYSTEM TEST RESULTS

15.1.1 OCP-8037

DATA SYSTEMS EQUIPMENT CHECKOUT - GFE Scientific Experiments

SCOPE

This test is performed to demonstrate the operational status of the Medical Data Acquisition System with a simulated experiment M4A. The test is performed in OCP-P-8037A-SC012 sequences 06-041 through 06-048.

RESULTS

During the test three squawks were written. One for the MDAS not being installed at the start of the OCP, one for no tape test light indication, and one for noisy measurements. It should be noted that the GFE Octopus cable and the NAA adapter cable used for this test were not flight hardware.

15.1.1.1 PROBLEM - Medical Data Acquisition System Not Installed.

MDAS was not installed until start of test so it would not be damaged.

CORRECTIVE ACTION

Installed MDAS temporarily for test

DOCUMENTATION

OCP 8037 Squawk 12.

15.1.1.2 PROBLEM - No Tape Test Light Indication on MDAS.

Circuit breaker SEB1 not closed.

CORRECTIVE ACTION

Closed circuit breaker

DOCUMENTATION

OCP 8037 Squawk 13

15.1.1.3 PROBLEM - Noisy Measurements

Measurements CJ0002J, CJ0066J, and CJ0067J were noisy. EO had not been worked to supply B10 MED instrumentation signal return wire.

CORRECTIVE ACTION

Added wires to pins 27 and 28 on J164, J165, and J166 per E.O. 454701

DOCUMENTATION

OCP 8037 Squawk 14
TPS 8037-007
EO 454701.

15.1.1.4 PROBLEM - Pins Recessed 1, 4, 8, and 9 of J101 of MDAS.

Noticed after OCP 8037 while in BME removing tape.

CORRECTIVE ACTION

Squawk in data pack and notified NASA. Repair or replacement required before reinstallation in CSM.

DOCUMENTATION

Squawk one in data pack.

15.1.2 TPS ( ) - Experiment M-1A (Cardiovascular Conditioning) Stowage Fit Checkout

SCOPE

This test is to verify the spacecraft stowage fit of the experiment M-1A lower body vascular support, GFE part number EC30155.

RESULTS

The stowage fit checkout of experiment M-1A has not been performed due to nonavailability of the spacecraft flight stowage foam. The stowage fit is scheduled to be accomplished during the crew compartment Fit & Function Checkout.

15.1.3 TPS ( ) - Experiment M-4A (Inflight Phonocardiogram) Functional Checkout

SCOPE

This test is to verify the functional operation and to demonstrate the spacecraft compatibility of the experiment M-4A phonocardiogram transducer (GFE part number 104119) and signal conditioner (GFE part number 103070) with the medical data acquisition system.

RESULTS

The functional checkout of experiment M-4A has not been performed due to misplacement of the GFE phonocardiogram transducer at NAA-Downey. The functional checkout is scheduled to be accomplished during OCP-0130 (Mission Profile)

15.1.4 TPS ( ) - Experiment M-5A (Bioassays Body Fluids) Stowage Fit and Functional Checkout

SCOPE

These tests are to verify the spacecraft stowage fit of the experiment M-5A equipment and to demonstrate the compatibility of the experiment quick-disconnects with the spacecraft operational urine system.

RESULTS

The stowage fit and the functional quick-disconnect compatibility checkout of experiment M-5A has not been performed due to an uncompleted spacecraft stowage configuration. The stowage and quick-disconnect compatibility checkout is scheduled to be performed during the crew compartment Fit & Function Checkout.

15.1.5 TPS ( ) - Experiment M-9A (Human Otolith Function) Stowage Fit and Functional Checkout

SCOPE

These tests are to verify the spacecraft stowage fit of the experiment M-9A equipment and to demonstrate the compatibility of the experiment operation with the spacecraft lighting conditions and the operational 16 mm sequence camera.

RESULTS

The stowage fit and functional checkout of experiment M-9A has not been performed due to nonavailability of the CFE experiment bracket, spacecraft lighting, spacecraft couches and stowage foam. The functional checkout and experiment alinement will be conducted after these items are available. The stowage fit is scheduled to be accomplished during the crew compartment Fit & Function Checkout.

15.1.6 TPS ( ) - Experiment M-12 (Exercise Ergometer) Stowage Fit and Functional Checkout.

SCOPE

These tests are to verify the spacecraft stowage fit of the experiment M-12 equipment and to demonstrate the functional operation of the ergometer assembly (GFE part number EC30154) with the medical data acquisition system.

RESULTS

The stowage fit and functional checkout of experiment M-12 has not been performed due to nonavailability of the spacecraft CFE flight stowage and operational bracket. This bracket will not be available until late August 1966 at KSC.

15.1.7 TPS ( ) - Experiment S-5A (Synoptic Terrain Photography) Stowage Fit Checkout

SCOPE

This test is to verify the spacecraft stowage fit of the two experiment S-5A film magazines, GFE part number SEB33100030.

RESULTS

The stowage fit checkout of experiment S-5A has not been performed due to nonavailability of the spacecraft flight stowage foam. The stowage fit checkout is scheduled to be accomplished during the crew compartment Fit & Function Checkout.

15.1.8 TPS ( ) - Experiment S-6A (Synoptic Weather Photography) Stowage Fit Checkout

SCOPE

This test is to verify the spacecraft stowage fit of the two experiment S-6A film magazines, GFE part number SEB33100030.

RESULTS

The stowage fit checkout of experiment S-6A has not been performed due to nonavailability of the spacecraft flight stowage foam. The stowage fit checkout is scheduled to be accomplished during the crew compartment Fit & Function checkout.

15.1.9 TPS ( ) - Experiment T-3 (Inflight Nephelometer) Stowage Fit Checkout

SCOPE

This test is to verify the spacecraft stowage fit of the experiment T-3 aerosol particle analyzer, GFE part number EA35068-6.

RESULTS

The stowage fit checkout of experiment T-3 has not been performed due to nonavailability of the spacecraft flight stowage foam. The stowage fit checkout is scheduled to be accomplished during the crew compartment Fit & Functional Checkout.

ATO Systems Engineer

Gordon C. Hrabal
AS-204 Experiments Spacecraft Mgr.

15.2
15.3
15.4

There are no reliability inputs applicable to the Experiments section of the CARR report.

J. Adelstone

NAA Reliability Project Engineer

15.5 WAIVERS, SCN'S AND RFC'S - EXPERIMENTS

The following waivers, SCN's and RFC's for CSM 012 are pending or open as of 10 June 1966:

CARR NO.	WAIVER/SCN/RFC NO.	SUBJECT	STATUS/REMARKS
15.5.1	SCN 4 (SID 62-1002)	Scientific Real Time Data Transmission	Delete Requirement Pending NASA Approval
15.5.2	SCN 42 (SID 64-1080)	Experiment M-1A	New Configuration Pending NASA Approval
15.5.3	SCN 43 (SID 64-1080)	Experiment M-12A	Revise Installation; NAA to Submit ECP
15.5.4	SCN 45 (SID 64-1080)	Experiment M-5A	Add Additional USVMS units; NAA to Submit ECP
15.5.5	RID 012-2A-5 RID 012-5A-3 (SID 66-142)	Experiment Implementation Plan	Pending NASA Direction
15.5.6	RID 014-6-EX-2	Experiment M-4A	Add 2 "Tee" Adapters Awaiting MCR Release
15.5.7	RID 014-06-EX-7	Scientific Compartments	Add Lables - Awaiting MCR Release
15.5.8	ECP TBD	Experiment M-5A	NAA & NASA Resolving Inflight Stowage of USVMS Units

Engineering Manager

Project Engineer