REPORT OF APOLLO 204 REVIEW BOARD

TO

THE ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APPENDIX D

PANELS 6 thru 10

REPORT OF PANEL 6
HISTORICAL DATA
APPENDIX D-6
TO
FINAL REPORT OF
APOLLO 204 REVIEW BOARD

A. TASK ASSIGNMENT

The Apollo 204 Review Board established the Historical Data Panel 6. The task assigned for accomplished by Panel 6 was prescribed as follows:

Assemble, review, and summarize historical data on Spacecraft and associated systems as pertinent to the fire incident. Data to be analyzed shall include records such as included in Spacecraft log, failure reports, other quality engineering and inspection documents. Make interpretation on data as to applicability to subject problem.

B. PANEL ORGANIZATION

1. MEMBERSHIP:

The assigned task was accomplished by the following members of the Historical Data Panel:

Mr. T.J. Adams, Chairman, Manned Spacecraft Center (MSC), NASA
Mr. J.H. Dickinson, Kennedy Space Center (KSC), NASA
Mr. J.L. Hansel, North American Avis tion, Inc., (NAA), KSC
Mr. D. Buffington, North American Aviation, Inc., (NAA), KSC

2. COGNIZANT BOARD MEMBER:

Mr. G.C. White, Jr., NASA, Washington, D.C., Board Member, was assigned to monitor the Historical Data Panel.

C. PROCEEDINGS

1. GENERAL

a. Panel 6, Historical Data, was established to assemble and review records on Spacecraft (S/C) and associated systems in order to determine the applicability of these records to the Apollo 204 accident. In addition, historical narratives (Enclosures 6-6 and 6-7) were prepared to reflect the relationship and flow of significant review and acceptance points, highlight documentation pertinent thereto, and to present a brief history of the prelaunch operational performed on S/C 012 at Kennedy Space Center.

b. Enclosure 6-2 lists the records reviewed by Panel 6, with an explanation of these records, and the criteria used for judgement of applicability.

c. Throughout the Panel's activities, contact was maintained with MSC-Houston and NAA-Downey and several requests for records review were placed on both organizations.

2. IMPOUNDING AND INVENTORY

a. Impound Procedure - Action was begun within an hour of the Apollo 204 accident to impound all S/C 012 quality documents in accordance with the guidelines contained in the Apollo Mission Failure Contingency Plan dated May 15, 1966. (Reference 6-1.) The impounded records from Launch Complex 34, Flight Crew Systems Laboratory, and Acceptance Checkout Equipment Control Room No. 1 were collected and delivered to the Quality Records Center. A NASA Security guard was posted, with access permitted only to personnel approved in writing by the Board. NAA Downey Quality and Reliability Assurance was notified and immediately impounded all quality pertinent to S/C 012 concurrent with notification to applicable vendors to impound same.

b. Inventory Procedure - The impounded records were inventoried and all documents applicable to the Apollo 204 accident were segregated.

Approximately 42,500 pages of records were catalogued, representing 12,000 documents. Three documents were not accounted for adequately. These documents were Test Preparation Sheet (TPS) S/C 012-SLA-004. Temporary Installation and Removal Record (TIRR) S/C 012-CME-42 and Parts Installation and Removal Record (PIRR) S/C 012-PIRR-(010) No. 132. An evaluation of the type documents concerned discounted any relevance to the accident.

As the documents were catalogued, significant information was recorded on special review forms prepared to enhance accountability and evaluation.

3. REVIEW TEAMS

a. The review teams consisted of Quality and Reliability Engineering Personnel drawn from government, NAA, and the General Electric Company (Apollo Support Division). All review personnel had previously been associated with S/C 012 operations and were familiar with the test history. The review was conducted on a continuous basis in order to make pertinent information available to Panel 6 and other Panels for consideration as rapidly as possible.

4. REVIEW PROCEDURE

a. Data review consisted of determining which Command Module (C/M) records were considered significant (in consonance with criteria delineated in Enclosure 6-2) so as to warrant consideration by other Panels, e.g., the Materials Review Panel 8 was provided with all records pertaining to use of nonmetallic materials. Dissemination of significant records was conducted in accordance with the following criteria:

(1) Relevant Items and Their Disposition:

(a) Chemicals:

All records documenting the use of chemicals, such as cleaning solvents, paints, and other chemicals were forwarded to the Materials Review Panel 8. This category included any reports of leakage in fluid systems.

(b) Nonmetallics:

All records documenting the use of nonmetallic materials in the crew compartment were forwarded to the Materials Review Panel 8.

(c) Electrical:

All pertinent records documenting problems with electrical systems were forwarded to the Integration Analysis Panel 18.

b. Panel 7 activities continued in support of the other Panels. Mainly, this consisted of researching the records to provide data requested other Panels. One example of this is the use of the methyl-ethyl-ketone, (MEK), as a cleaning agent. Since this is a flammable material, and because a partially filled bottle of MEK was found in the White Room after the fire, there was concern over the use of this material. The records search, combined with the interrogation of personnel who were known to have used MEK in the S/C in the three days immediately preceding the accident, enabled Panel 6 to supply information to Panel 8 for their evaluation.

c. Panel 6 also conducted a review of Problem Action Records (PAR's) and Unsatisfactory Reports (UR's). These records are defined in Enclosure 6-2, and the results of the review are given below:

(1) Problem Action Records - Failure Category:

All problem reports in the failure category were reviewed by support personnel at MSC. The reports covered failure-type problems from inception of the Apollo Program through development, qualification tests, manufacturing-vendor tests, field tests, checkout, and flight testing of all Command Modules and Command Modules Systems, subsystems and components throughout the country. Any previous conditions that could be related in some manner to the Apollo 204 accident were reviewed and evaluated. Upon completion of the Panel 6 review of these reports, a total of 39 were identified as requiring further evaluation for applicability by Panel 18 (Enclosure 6-2). In cases where conclusions drawn by an original failure analysis seemed questionable, the results were re-examined. No new conclusions relevant to the Apollo 204 accident were found in the review.

(2) Problem Action Record - Unsatisfactory Condition (PAR-UC):

A review of PAR-UC's was conducted and yielded no new significant information.

(3) Unsatisfactory Reports (UR's):

All UR's written at KSC prior to the accident were reviewed, and only one was considered applicable, i.e., bent electrical connector pins. This problem was identified to Panel 18 as a result of the Discrepancy Record Review (Enclosure 6-4).

5. DISCUSSION

a. Ingress-Egress Log

(1) In reviewing the Ingress-Egress Log, pertinent discrepancies were noted. An Ingress-Egress Log is maintained in accordance with Apollo Preflight Operations Procedures (APOP) No. 0-201, "Access Control of Test and Work Areas" (Reference 6-2). Personnel entering the C/M are required to record on log sheets all tools and other items carried into the C/M. The log sheets for S/C 012 were reviewed and in several cases showed that tools were recorded as having been carried into the C/M, but no record of removal of these items was made. Considering that tools could come in contact with electrical equipment and cause an arc, Panel 6 initiated an investigation of the S/C to look for these specific tools.

b. Shakedown Inspection

(1) Shakedown inspection is defined as a pre-scheduled period when all other operations are discontinued while inspection personnel conduct a visual inspection. This is in accordance with established and approved criteria to detect and record hardware discrepancies.

(2) Panel 6 conducted an investigation to determine how shakedown inspections were scheduled and performed on the S/C. From this investigation, it was learned that there were shakedown inspections performed prior to major test and milestones. However, these inspections were performed without definitive inspection criteria, but were conducted using the inspector's knowledge of previous S/C practices. In addition, the S/C 012 Master Flow Plan was reviewed (Reference 6-5 and it was found that shakedown inspections while not shown in the S/C test flow plan at KSC, are scheduled in bi-weekly and in daily work schedules.

c. Inspection Procedures During Test Operations

At the request of Panel 18, inspection procedures just prior to C/M hatch installation were reviewed. This review disclosed that Inspection monitored this phase of the test operations over the communications network because the White Room space and weight loading limitations prevented having an Inspector witness these functions in the White Room. Procedure APOP-0-202, "Operational Checkout Procedure", (Reference 6-3), states that Inspection will stamp each line item in the procedure requiring Inspection verification. Spacecraft Operations Letter SCO-2-104-65 (Reference 6-11) defines the verification requirements and the functions being performed prior to hatch installation that would have normally required Inspection physical verification.

d. Constraints List

(1) As a result of investigation of open work items, questions arose regarding conduct of tests. The investigation revealed that prior to the start of any test, an open-item review meeting is held by NASA/NAA, in accordance with APOP-0-202, "Operational Checkout Procedure". From this meeting, a list of those items which must be worked prior to the start of test is prepared, and approved by NASA/NAA engineers. The constraints list for Operational Checkout Procedure (OCP) FO-K-0021-1 was examined for content (Reference 6-6) to see if previous tests were listed as constraints. Research disclosed that OCP FO-K-0034 and OCP FO-K-0005 summarysheets (Reference 6-7) had not been signed off as accepted prior to OCP FO-K-0021-1, but were not listed on the constraints list for OCP FO-K-0021-1. It should be noted that OCP numbers are not related to the sequence of test accomplishment. APOP-0-202 does not contain a requirement to list open tests as constraints to subsequent tests, although there is a requirement to review the open items. Individual open items from previous tests are listed on the constraint list for subsequent tests if they are constraints to that test.

Analysis revealed that constraints lists are signed only by NASA/NAA Operations and Engineering with no NASA or NAA Quality control signature indicating approval of the constraints lists.

e. Mandatory Inspection Points

(1) As a result of questions which arose regarding Inspection coverage, APOP-0-202, "Operational Checkout Procedure", was examined to determine if there were any requirements for Mandatory Inspection Points (MIP's). The requirement is not clearly defined in the APOP, although many OCPs do contain MIP's.

MIP's are defined as inspection of actual hardware status.

Normally, Inspection monitors the test to insure adherence to the procedure.

f. Review of Engineering Changes

(1) As a result of review of open work, it was found that a large number of engineering changes were incorporated into the S/C at KSC. Many of these changes resulted from non-fit or non-function problems.

Some of the changes were due to the fact that S/C 012 was the first manned Apollo Spacecraft. Some of the changes were requested by the crew members. The large number of changes made it difficult to establish the vehicle configuration. An example of a major change is shown in Reference 6-8.

g. Retest Requirements

(1) As a result of the review of Discrepancy Records to determine open work, it was discovered that the requirement for retest may in some cases be deferred to a later test, (Reference 6-10). The records covering the work were closed out prior to the retest.

(2) Panel 6 investigated the requirements for retesting of components or subsystems after rework. APOP-T-502, "Discrepancy Recording System", (Reference 6-9) covers the retest requirement, but there is no requirement to keep the discrepancy records open until the retest has been verified. The records are closed out with a statement that the retest will be done in a subsequent test. This can then be deleted by on-the-spot deviations to the subsequent test.

h. Subsystem History

(1) In an attempt to obtain a complete subsystem history from the records, considerable difficulty was experienced. This was due to the fact that the records are not maintained by subsystem. Records are presently filed by category of document (Discrepancy Record, Test Preparation Sheet, etc.). In the event of subsystem problems, it is often necessary to develop the history of the subsystem, including failures, reworks, test results, etc. The present system required a great deal of effort to retrieve the necessary records to provide this history.

D. FINDINGS AND DETERMINATIONS

1. FINDING:

The Ingress-Egress Log (Reference 6-4) discloses several instances where tools and equipment were carried into the S/C, but the log does not show these tools as removed.

DETERMINATION:

The maintenance of the Ingress-Egress Log is inadequate.

2. FINDING:

a. Shakedown inspection periods are not shown in the Master Flow Plan. (Reference 6-6).

b. There are no definitive inspection criteria to perform shakedown inspections for the Apollo Program.

DETERMINATION:

a. Hardware condition prior to major tests and milestones is difficult to establish.

b. Inspection personnel are not able to assess the condition of the S/C for compliance with definitive criteria, but rather assess it in accordance with their knowledge of standard practices.

3. FINDING:

Inspection personnel do not perform a pre-scheduled inspection with a checklist prior to hatch closing.

DETERMINATION:
Inspection personnel could not verify these functions during this period.

4. FINDING:
Formal approval by NASA or NAA Quality Control of the constraints list is not required (Reference 6-6).

DETERMINATION:
NASA/NAA Quality Control cannot discharge their responsibilities without approving the constraints list.

5. FINDING:
The requirements for Mandatory Inspection Points (MIP's) are not clearly defined in the Apollo Preflight Operations Procedures.

DETERMINATION:
Proper Inspection coverage is not assured without clearly defined MIP'S).

6. FINDING:
At the time of shipment of the S/C to KSC, the contractor submitted an incomplete list of open items. A revision of the said list significantly and substantially enlarged the list of open items.

DETERMINATION:
The true status of the S/C was not identified by the contractor.

7. FINDING:
There is no efficient system which readily identifies that results accomplished by rework are verified by retest.

DETERMINATION:
The present system of verification of rework by retest is cumbersome.

8. FINDING:
There is no requirement to maintain records by subsystem classification, nor does the system present status in this fashion.

DETERMINATION:
The recovery of pertinent historical information is extremely difficult.

E. SUPPORTING DATA

Enclosures

6-1	Not Used
6-2	List of documents reviewed by Panel 6, including criteria for determining applicability to the AS-204 accident.
6-3	List of Problem Action Records submitted to other Panels.
6-4	Unsatisfactory Report on Bent Pins
6-5	List of References
6-6	Historical Narrative
6-7	Historical Narrative of Prelaunch Operations at Kennedy Space Center

LIST OF DOCUMENTS REVIEWED

The following are the types of documents reviewed by Panel 6, including a description of each type of document, and the criteria used in judging the applicability of these documents to the Apollo 204 accident.

1. TEST PREPARATION SHEET (TPS):

A document which authorizes work, provides engineering instructions, establishes a method of work control, furnishes historical records, and facilitates inspection under the two categories defined below:

a. Type "A" TPS: Required to authorize work involving a change of configuration (design change).
b. Type "B" TPS: Required to authorize all other planned work and tests.

Criteria for review

a. Agreement between Engineering Order (EO) and TPS.
b. Unworked, or partially worked, EO/TPS's which are considered significant.
c. Any configuration changes by TPS without EO coverage.
d. All non-metallics.
e. Questionable design changes.
f. All electrical items.
g. All solvents or cleaning agents.

2. DISCREPANCY RECORD (DR):

A document utilized to record significant and/or test discrepancies. This document provides for engineering instructions and dispositions, authorizes work of disposition, authorizes facilities inspection, and furnishes historical records under the two categories listed below:

a. Significant Discrepancy: A discrepancy that (a) cannot be returned to specified configuration, or (b) requires engineering disposition, i.e., (1) functional failure, (2) defective component, (3) discrepancy affecting test schedule, (4) action which could invalidate previously accepted tests, or (5) a discrepancy which could have an adverse effect on mission objectives or be a safety hazard.
b. Test discrepancy: Any anomaly encountered during integrated testing (testing which unites two or more space systems, e.g., Acceptance Checkout Equipment, Spacecraft Systems or components, etc.) except an obvious deviation or human factor which is immediately recognized and corrected without disturbing the normal progress of the test.

3. DISCREPANCY RECORD SQUAWK SHEET (DRSS): A document used to record minor discrepancies, provide technician supervision instructions, authorize work of the disposition, authorize facilities inspection, and furnish historical records under the category of discrepancy listed below:

Minor Discrepancy: Any deficiency which can be returned to drawing configuration without engineering disposition, e.g., workmanship items, string ties, oversize clamps, unclean areas, past-due calibration, etc.

Criteria for review

a. All solvents or cleaning agents.
b. Unapproved non-metallics.
c. Questionable deviations to drawings.
d. Any dispositions and/or conclusions not clearly defined.
e. Dispositions without retest.

4. OPERATIONAL CHECKOUT PROCEDURE (OCP): An engineering document which provides

detailed instructions to personnel for operational checkout and verification of equipment performance. OCP's are based on NAA Process Specifications and those applicable are referenced in the OCP by document number. OCP's: (1) provide technical step by step delineation of required personnel activity for the operation, assembly, handling or test of the equipment and for system(s) involved, (2) provide for insertion of program requirement record data, (3) provide NASA/NAA Engineering and Inspection Acceptance, (4) provide for safety of personnel and equipment.

5. DEVIATIONS: A change to a published OCP, such as changes in equipment lists, test parameters, sequences added or deleted or modified by order of occurrence or content to permit accomplishment of the test. Obvious errors, such as typographical errors, wrong page numbers, etc., are not considered deviations.

Criteria for review

a. Open Interim Discrepancy Records (IDR's).
b. Unsatisfactory Closed IDR's (vague).
c. Parameter Deviations.
d. Unexplained Deviations.
e. Deviations not satisfactorily documented.
f. Other suspected deviations.

6. PARTS INSTALLATION AND REMOVAL RECORD (PIRR): A document utilized to record selected new installations and all removals and reinstallations of previously installed parts. Removals and installations are those components of the end item configuration which are removed or installed, connected or disconnected. This document by itself does not authorize any work.

Criteria for review

a. Open installations or removals.
b. Unsatisfactory closeouts.
c. Unsatisfactory transfers (recapped PIRR or TIR).
d. Unauthorized installations or removals.
e. Installations of non-metallics.
f. Installations without retest.
g. Part number/serial number changes.

7. TEMPORARY INSTALLATION AND REMOVAL RECORD (TIRR): A document utilized extensively to record Spacecraft installations. It must be removed prior to flight and serves as a historical record. Temporary installations are non-flight Command and Service Module hardware and temporarily installed flight hardware (e.g., fit-check installations), which must be removed prior to flight.

CRITERIA for review

a. Open installations or removals.
b. Unsatisfactory closeouts.
c. Unsatisfactory transfers (recapped PIRR or TIR).
d. Unauthorized installations or removals.
e. Installations of non-metallics.
f. Installations without retest.
g Part number serial number changes.

8. PROBLEM ACTION RECORDS (PAR's): The PAR is a NAA form on which hardware problems are reported for failure or cause analysis, and corrective action. There are two uses for the PAR, i.e.; (a) Failure Reporting, (PAR-F), and (b) Unsatisfactory Condition reporting, (PAR-UC).

Criteria for review

The PAR-F's were reviewed for failure analysis to determine what caused the malfunction and applicability to the Apollo 204 accident. PAR-UC's were reviewed to determine if significant items had been reported on this record that had not appeared in other records.

9. UNSATISFACTORY RECORDS (UR's): The UR is a NASA document, used by the government to report conditions which are repetitive, or involve safety of flight. The condition reported may or may not have been reported by the contractor in his paperwork system.

Criteria for review

UR's were reviewed to determine if any significant item was not reported through other mediums.

PROBLEM ACTION RECORDS SENT TO OTHER PANELS

PAR	TO PANEL	PROBLEM
27094 27049 27057 3958	8	ECS LEAKS
27017 27056	18	UNQUALIFIED PARTS IN GAS CHROMATOGRAPH
24201	18	LEAKS IN QUICK DISCONNECT
163286 171589 171612	18	INTERNAL SHORTS IN TEE-ADAPTER
27204 12460 13484 13485 12470 16605 23437 23500 23502 23686 23660 163740 163378	18	GSE ETHYLENE/GLYCOL FLUID - TRANSDUCER AND RELAY FAILURES
27235		CONTACT RESISTANCE OUT OF SPECIFICATION
23592 16726		GSE CIRCUIT BREAKER OPERATION ERRATIC
3951		ELECTROLUMINESCENT BAR FAILED TO LIGHT
28637		ECS WATER/GLYCOL PUMP FAILED TO OPERATE
171560		CLUTCH VOLTAGE OSCILLATES
171578		TRANSISTOR FAILURE IN CONTROLLER

ENCLOSURE 6-3

PROBLEM ACTION RECORDS SENT TO OTHER PANELS (CONTD)

PAR	TO PANEL	PROBLEM
12032 12040 14555 16696 23495 23526 23603	18	GSE - WATER/GLYCOL SERVICE SET
15833	18	BURNT SPOTS ON RELAY MODULE PINS
164203	18	CYCLIC ACCUMULATOR SOLENOID VALVE STICKS IN FULL OPEN POSITION

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UNSATISFACTORY REPORT - PART I

1. Category	2. System	3. U.R. No.
S/C	EPS	A-054

4. Contractor Part Name	5. Contractor Part No.	6. Serial No.	7. Date Reported
Cable Harness Assy. (Crew Compartment)	V16-420302	012	10/11/66

8. Supplier	9. Supplier Part No	10. Contr. Ref. Drawing No.	11. Time In Use	12. Cycles
NAA	V16-420302	V16-000002	hr. N/A min. sec.	N/A

13. Mission	14. Photos Enclosed	15. No. Previous Failures	16. Previous Failure References
Apollo	[X] Yes [ ] No	N/A	N/A

17. Unsatisfactory Condition

This Unsatisfactory Report documents a recurring problem concerning bent pins in S/C electrical connectors, which if not corrected, could seriously impair the checkout schedules and/or jepardize subsequent Apollo missions. The following is a summary of the failures encountered at KSC during checkout of S/C 012 which were a direct result of this unsatisfactory condition:

1. During Seq. 11-040A of Combined Systems Test (OCP-K-0035), the RCS transfer "B" light was not observed. Troubleshooting isolated the problem to a short circuit within C/M - S/M umbilical connector J3A3. Further investigation revealed that pins # 75 and # 51 were bent and shorting against pins # 50 and # 52 respectively. (Ref. IDR 028 vs OCP-K-0035; DR S/C 012 - S/C 0189; PAR#27056)

2. On September 16, 1966, a check of S/C 012 separation monitor circuits via PCM was made per TPS-099 during Seq. 04 of OCP-K-0035, Combined Systems Test. During this test an out-of-tolerance (O%) indication was obtained. Subsequent troubleshooting isolated the problem to a blown fuse which was later found to have been caused by open jumper wires between Matrix Terminal Boards. (Ref. DR S/C 012 - S/C 0191; PAR#27096) During the repair operation of this problem, connector P1116 was disconnected from J54 of the V16-764042, Event Conditioner to facilitate the connection of a spare fuse into the circuitry previously protected by the blown fuse. Visual inspection of the disconnected plugs P1116 and J54, revealed 8 bent pins. (Ref. DR S/C 012-S/C 0258 and S/C 0264)

3. Following power-up for the sea level run of the Altitude Chamber Test (OCP-K-0034), an indication of C/M - S/M separation was observed. Troubleshooting revealed a short circuit within the C/M - S/M umbilical connector, J3B3. Further investigation of the connector disclosed that pin # 32 was bent and shorting against pin # 33. It was further noted that pins # 1, # 18, and # 36 were also bent. (Ref. IDR 022 vs OCP-K-0034; DR S/C 012 - S/C 0431; PAR#27105)

Since many electrical connectors are practically inaccessible, mating is often a blind operation. As a result, the pins are often bent due to improper connector alignment. To preclude recurrences of this problem, we recommend the following:

18. Initiator (Signature & Date)	19. Systems Engineer (Signature & Date)
Charles E. Welly 10-14-66	M. Gundy 10-14-66
20. Approved by (Signature, Title & Date)	21. Approved by (Signature, Title & Date)
Joseph M. Dobik 10-14-66.	FM Bond 10-14-66

ENCLOSURE 6-4

NASA - Manned Spacecraft Center
UNSATISFACTORY REPORT - Continuation Sheet (PART I, II, III)

27. U.R. No. A-054

1. Only connectors/receptacles with sufficient alignment features should be utilized in inaccessible areas. eg. Use of connectors with pin guides would lessen mating difficulties.

2. Circuits which route through connectors and/or receptacles that have been interrupted subsequent to Integrated Testing at NAA Downey should be reverified prior to shipment of the CSM to KSC. Adherence to this policy would effectually eliminate the prelaunch problems resulting from bent or broken pins incurred during connector remating operations.

It should be further noted at this time that the NAA Standard Repair Manual repair No. 1 EL1.4, authorizes straightening of all pins, size twenty or smaller, for all bend angles up to 90 degrees. We feel that this is a very unreliable fix, as damage may be done to the pins internal to the connector which would not be detected through the prescribed visual inspection. In addition, there is no practical method of determining how many times a particular pin has previously been straightened. Due to these facts, we recommend that the following changes be made to the NAA Standard Repair Manual:

1. Pins with bend angles of less than 20 degrees may be straightened and accepted through visual inspection if it can be definitely determined that the pin has not been previously straightened.

2. Pins that are straightened after being bent at angles of more than 20 degrees should be accepted only after a satisfactory X-ray examination has been made.

3. Pins that are bent in excess of 20° and are inaccessible for X-ray should be replaced. If replacement is not practical, the bent pins should be broken-off and the associated circuit routed through undamaged spare pins if available.

Enclosures:
1. DR S/C 012 - S/C-0189, PAR#27056
2. DR S/C 012 - S/C-0191, PAR#27096
3. DR S/C 012 - S/C-0258
4. DR S/C 012 - S/C-0264
5. DR S/C 012 - S/C-0431, PAR#27105
6. Standard Repair Manual, Repair No. EL1.4
7. Photos (3 ea.)

ENCLOSURE 6-4

REFERENCES

6-1 Apollo Mission Failure Contingency Plan

6-2 Apollo Preflight Operations Procedure Number 0-201 "Access Control of Test and Work Areas"

6-3 Apollo Preflight Operations Procedure Number 0-202 "Operational Checkout Procedure"

6-4 Apollo Ingress-Egress Log Sheets

6-5 Spacecraft 012 Schedule, KSC

6-6 Constraint List, Spacecraft 012 Operational Checkout Procedure FO-K-0006 0021-1

6-7 OCP FO-K-005A 1 and OCP F-K-0034A, A-1

6-8 TPS-012-SC100, "Modification of Quad Heater"

6-9 Apollo Preflight Operations Procedure Number T 502, entitled, "Discrepancy Recording System"

6-10 DR-SC0838 and DR-SC012-0810

6-11 Spacecraft Operations Letter SCO-2-104-65

1. APOLLO DEVELOPMENT/REVIEW PROCESS

Apollo Program Directive (APD) No. 6A defines the sequence and flow of hardware development and key inspection, review and certification checkpoints for Apollo spacecraft and is included as reference 6-12. This directive is the basic document that controlled the evolution of milestones for Spacecraft 012.

These checkpoints insure that sufficient visibility is obtained of the status of design, manufacture and testing to adequately determine the integrity of the spacecraft prior to mission accomplishment.

The six key checkpoints defined by APD 6A are:

- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- First Article Configuration Inspection (FACI)
- Certification of Flight Worthiness (COFW)
- Design Certification Review (DCR)
- Flight Readiness Review (FRR)

The PDR, CDR, FACI and COFW are accomplished at selected booster and spacecraft levels of assembly (stages and modules). The DCR and FRR encompass the total mission complex. With the exception of the COFW, the requirements for these formal reviews were further defined by NASA, Houston, in the Apollo Spacecraft Program Office Configuration Management Plan (Reference 6-13), see Appendix E), however, only the PDR, CDR, FACI and the FRR were implemented by the North American Aviation (NAA) in the NAA CSM Configuration Management Plan, SID 65-100 (Reference 6-14) as approved by NASA, Houston, Paragraph 10.6 on page 10-16 was never approved by NASA, Houston, and therefore is not contractual. The Certification of Flight Worthiness (COFW) requirements were established by separate Apollo Program Office direction to NAA (Reference 6-15) and the DCR requirements were implemented by a letter from the Program Manager to NAA, Downey, as confirmed by a supplemental agreement to the contract (Reference 6-16).

These six formal reviews are scheduled jointly by NASA and North American Aviation.

a. Preliminary Design Review (PDR)

The purpose of the PDR is to formally review the design approach of a spacecraft prior to, or very early in, the detail design phase. (See paragraph b. below for a further discussion.)

b. Critical Design Review (CDR)

The purpose of a CDR is to formally review the design of a spacecraft when the design is essentially complete and is intended to precede the release of engineering drawings for manufacture. This review for S/C 012 was in reality a PDR as well as a CDR. It was accomplished after the spacecraft had been released for manufacturing and was a review of both the design and the requirements. The negotiation of the Block I Spacecraft Technical Specification, the Block I Spacecraft Master End Item Specification accomplished the PDR for each spacecraft. This approach was taken because S/C 012 was the first major Block I vehicle with the second manned Spacecraft (S/C 014) being identical. All other Block I spacecraft were to be unmanned and, therefore, were not to be fully configured. The S/C 012 PDR was appropriately used to represent all Block I spacecraft. A Delta CDR was also conducted for S/C 012 prior to testing. The Delta CDR is discussed in detail later.

c. First Article Configuration Inspection (FACI)

The purpose of the FACI is to establish the Configuration Baseline for the spacecraft. It is accomplished by establishing the relationship of the spacecraft as described by released engineering documentation (drawings, specifications) to the spacecraft as manufactured, assembled, and tested. The FACI checkpoint has been implemented for Block II spacecraft only. It was not implemented for S/C 012 or Block I because of the differences between each spacecraft. A baseline configuration is not established until Block II where each spacecraft is to be of the same configuration. Two integrated reviews known as the Systems Assesment Review (SAR) and the Customer Acceptance

Readiness Review (CARR) were conducted to support the acceptance and delivery from the Contractor (NAA). These reviews are discussed later.

d. Certification of Flight Worthiness (COFW)

The Certificate of Flight Worthiness (COFW) is a requirement of NASA-Apollo Program Directive No. 6 dated 15 August 1965. NAA was directed to implement this requirement in accordance with the MSC-Houston procedure, "Procedure for the Certification of Flight Worthiness (COFW)" dated 20 June 1966 (Reference 6-15). The COFW is used to certify that each flight stage and module is a complete and qualified item prior to shipment, and is supported by adequate supporting documentation, i.e., the Acceptance Data Package (ADP) and the Material Inspection and Receiving document (DD Form 250). The COFW informs the Apollo Program Director of any deficiencies prior to shipment from the manufacturing sites and from the static firing site. The COFW has requirements for the following documents for the following endorsements: Endorsement one is executed and signed at the completion of checkout at the Contractor's plant by the Contractor, MSC quality representative, and the MSC Program Manager's designee. Endorsement one reflects the final action taken at the CARR and information contained on the DD Form 250. Endorsement number two is executed and signed at the completion of receiving inspection at KSC and is signed by the KSC representative, the MSC quality representative, and the MSC Program Manager's designee. Endorsement number three is executed and signed at the time the Launch Vehicle and Spacecraft are mated, by the same people that signed endorsement number two. Endorsement number four is executed and signed at the completion of the Flight Readiness Review (FRR) by the KSC representative and the MSC Program Manager's designee. The final certification is executed at the time the Spacecraft is declared flight worthy and requires the signature of the Apollo Spacecraft Program Manager (Reference 6-15 and 6-17).

e. Design Certification Review (DCR)

The purpose of the DCR is delineated in Apollo Program Directive No. 7 (Reference 61-8) is to examine the design of the total mission complex (spacecraft, booster, GSE, launch complex, communications network, etc.) for proof of development maturity and assess and certify the design of the Space Vehicle, Launch Complex, Mission Control Center and Manned Space Flight Network for manned flight safety.

f. Flight Readiness Review (FRR)

The FRR as delineated in Apollo Program Directive No. 8 (Reference 6-19) is a two part review consisting of a Program Director's FRR and a Mission Director's FRR. The purpose of the Program Director's FRR is to determine that the space vehicle hardware and Launch complex are ready to commence the mission period. The purpose of the Mission Director's FRR is to make a judgement for initiating the mission period and committing the deployment of world wide forces to support the mission.

g. Review Schedule

The following bar-chart illustrates the Apollo development review process (See figure 1).

2. DISCUSSION OF SPACECRAFT 012 CHECKPOINTS

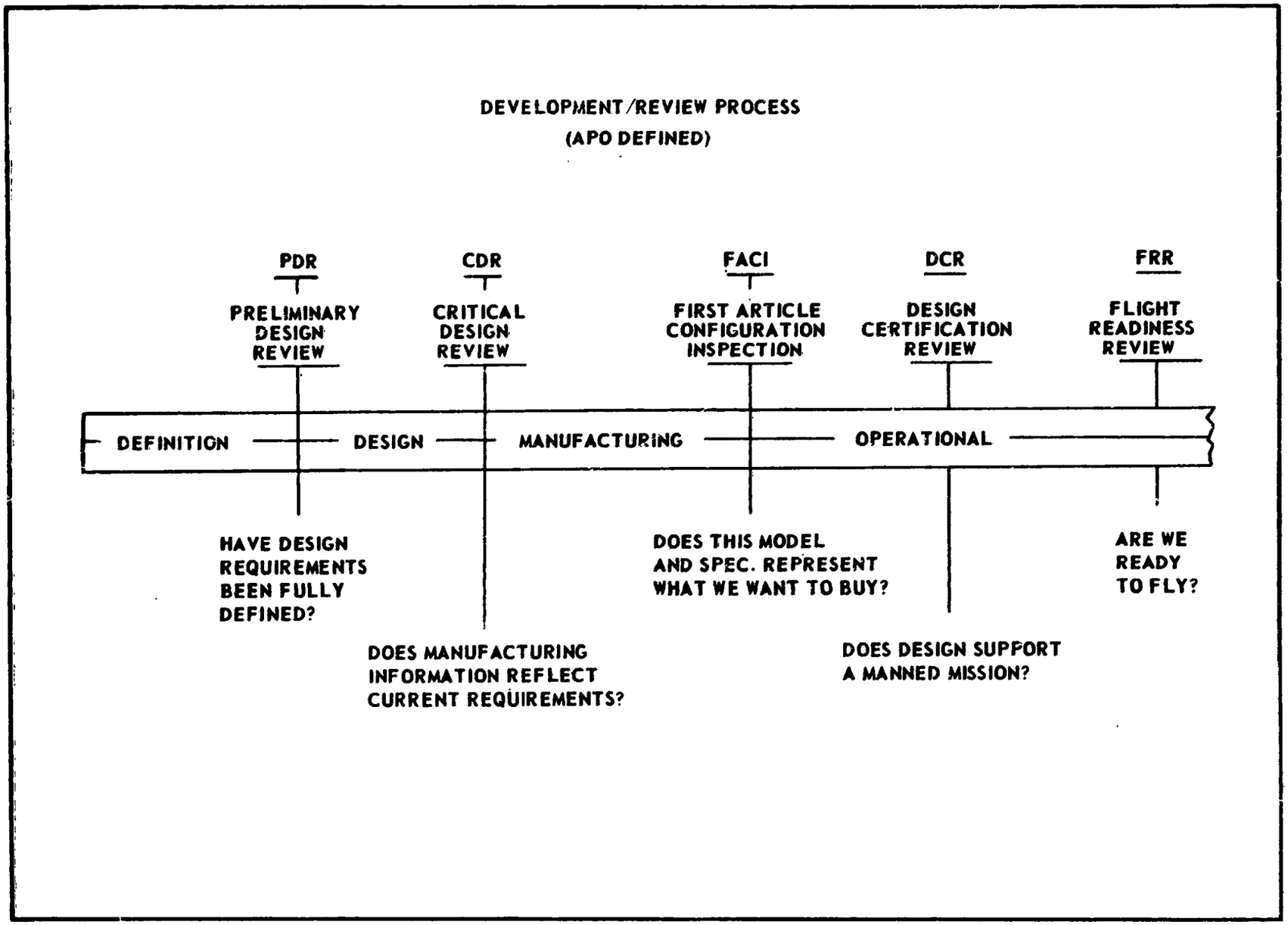
This section describes the specific Spacecraft 012 checkpoints in detail. The checkpoint activities, locations, dates, personnel involved, and significant results are included. The checkpoints are discussed in chronological order and present a complete historical summary of the flow of hardware development and key inspection, review and certification checkpoints.

a. Preliminary Design Review (PDR)

The PDR checkpoint was conducted during the period from November 1964 through January 1965 for all Block I spacecraft including Spacecraft 012. As mentioned previously this was a review of both the requirements and the design since Spacecraft 012 had been released for manufacturing In reality it was both a PDR and a CDR

b. Delta Critical Design Review (DCDR)

The intent of the Delta CDR for Spacecraft 012 was to insure that each level of spacecraft flight hardware and ground support equipment (GSE) end item was designed and built to meet all the requirements and was compatible with the planned mission. The review was also intended to determine the adequacy of the spacecraft checkout flow plans. It was held just prior to commencing



ENCLOSURE 6-6

systems testing on S/C 012. The Delta CDR utilized the CSM 012 End Item Specification, Part I, Performance Design Requirements Apollo dated 22 February 1965, classified Confidential (Reference 6-20).
6-20).

For S/C 012 the Delta CDR was held in two phases as discussed in the following paragraphs and is documented in S/C 012 Delta CDR Minutes, Part I, (Reference 6-21) and Part II (Reference 6-22).

(1) The scope of the first phase was limited to the nominal mission (Block I Design Reference Trajectory) and the "as built" configuration of the spacecraft ground support equipment (GSE). In addition, Spacecraft 008, (the thermal/vacuum test article) was reviewed concurrently with Spacecraft 012 primarily to determine the "as built" configuration differences between the two spacecrafts and to arrive at a final determination of the acceptable differences in the S/C 008 configuration. The testing of S/C 008 in the thermal-vacuum chamber at Houston was a constraint to the first Apollo manned mission S/C 012). This Delta CDR commenced on February 11, 1966, with the delivery of the NAA Data Package to NASA-Houston and was concluded with the publication of the Minutes on March 3, 1966. The data package contained 1) documents related to the Flight Mission such as AS-204A Mission Requirements and Design Analysis Report, S/C 012 End Item Specification, Measurement Requirements, Weight Report, Functional Integrated Schematics, Failure Mode and Effect Analysis and Reliability Problem Summaries for S/C 012, and 2) Ground Operations documents such as the Apollo Ground Operations Requirements Plan, Test and Checkout plans and Integrated Checkout Process Specifications. Additional documentation was available at NAA-Downey to support the Downey review. (For details see Reference 6-23, Appendix I)

After the receipt of the NAA Data Package and a technical briefing by NAA, NASA reviews were conducted at Houston, Texas, by five working groups, made up of NASA-MSC representatives. The purpose of these reviews was to identify existing and potential deficiencies, with respect to specific mission requirements, of the spacecraft design or the checkout philosophy and specifications. The Preliminary Requests for Changes (Pre-RFC's) resulting from these reviews were then submitted to a NASA-Houston Review Panel consisting of key management representatives from NASA-Houston.

As a result of the total NASA-MSC review, 137 Pre-RFC's were submitted to North American Aviation (NAA) for their consideration and then for further reviews by the same five working groups, with the addition of NAA representation on each group, at the NAA plant, Downey, California. During these reviews, many Pre-RFC's were resolved or deemed inappropriate primarily because NAA documentation showed that either design changes were in progress or, through additional information, the Pre-RFC was not valid and no change was required.

From the above five working group meetings, 37 Requests for Changes (RFC's) were submitted to the CDR Board for review. The disposition of each of these RFC's is documented in the Apollo Spacecraft 012 Delta CDR Minutes (Part I), dated March 3, 1966 (Reference 6-21). In summary 3 RFC's were rejected, 3 were not applicable, 19 were assigned for studies (10 NAA, 5 NASA, 4 joint) and the remaining 12 required immediate NAA action.

Concurrently with the working group reviews and prior to the CDR Board Review, a crew compartment review was conducted by crew members utilizing a mockup of the crew compartment. All of the Request for Changes (RFC's) resulting from this mockup review were satisfactorily resolved prior to the CDR Board Review on March 3, 1966.

(2) The Part II Delta CDR objectives were to verify compatibility of the S/C 012 design with the requirements of Mission AS-204A (Reference Trajectory) and to assure compatibility of the ground support equipment (GSE) for Launch Complex 34, at KSC, Cape Kennedy.

This activity began on March 22, 1966, and was completed on April 5, 1966, with the publicwtion of the Minutes of the NASA/NAA Management Review, Spacecraft 012 Delta Critical Design Review (Phase II) Mission Review (Reference 6-22). During the period from March 22 through March 25, 1966, a review was made at MSC by essentially the same five working groups but with primary interest by members from the APOLLO Program Office, the Flight Operations Directorate, and the Flight Crew Operations Directorate. On completion of the NASA Review on March 25, 1966, a total of 53 Review Item Dispositions (RID's) were transmitted to NAA by NASA letter PD2/L1501/66-319. (The Review Item Disposition forms are new NAA forms that have essentially updated and replaced the NAA Request for Change (RFC) forms. They accomplish the same purpose.) Thirteen of these RID's were identified as having significant program or mission impact. A NASA/NAA management review was held at NAA, Downey, on March 29, 1966, where agreements were reached and action items identified for each RID (Reference 6-22).

A second NASA/NAA Management Review was held at NAA Downey on April 5, 1966, where agreements were reached and action items assigned for the remaining 40 RID's, which consisted of requirements for data or revisions to documentation (Reference 6-22).

All of these action items were not closed out by July 19, 1966, for the Phase I of the CARR (SAR Meeting) as evidenced by the Phase I CARR report (Reference 6-24 for example, see page 3-65). They were, however, closed out by the CARR which was held on August 19, 1966, since no RFC's or RID's are reflected as open items. (In this regard, the CARR report is by exception and, therefore, reflects only open items.) The fact that they were closed out prior to the CARR has been confirmed by the NASA-Houston CSM Project Officer in his letter to Chairman of Panel 6, Historical Data. (Reference 6-25)

c. Customer Acceptance Readiness Review (CARR)

The CARR was a two phase review. Phase I was a System Assessment Review (SAR) held at NAA-Downey on July 19, 1966. The SAR was a working level, informal meeting held to assess spacecraft systems testing (all systems functioning for checking interfaces) and enabled the participants to evaluate the system performance and problems. The SAR is a constraint to performing integrated systems testing (mission simulation tests). The systems testing was documented by NAA-Downey in the Phase I CARR report (Reference 6-24) which was submitted by NAA-Downey to NASA-Houston on June 13, 1966.

The SAR meeting minutes and action assignments are documented in the Phase II CARR Report (Reference 6-26). As a result of the SAR meeting, one-hundred ninety-three (193)a action items were assigned. One-hundred twenty-seven (127) action items had program or mission impact while sixty-six (66) of the action items were requirements for data or documentation.

The Phase II of the CARR is a formal board meeting to review the results of spacecraft integrated systems testing, the open action items from the SAR, and the action items from the Crew Compartment Fit and Functions (CCFF) review. The CCFF is a review where the spacecraft crew enters the spacecraft and physically verifies the stowage and proper use of crew equipment. The CCFF was initiated prior to the CARR, but was incomplete at the time of the CARR and was completed after the CARR Board Review. The CARR Board Review. The CARR Board determines if the spacecraft is ready for shipment to the launch facility (KSC-Cape Kennedy).

The CSM 012 CARR Board was held in Downey on August 19, 1966. There were 66 items brought before the Board for discussion, 33 of which originated at the Phase I SAR. Sixteen (16) items were determined to have been adequately dispositioned and were closed for future action. Thirty-three (33) items were deferred for resolution at a later date and were not constraints to the shipment of the vehicle. These items fell into the general categories of: work or tests to be accomplished at KSC; resolutions to be made pending results of studies; investigations or qualifications tests; and furnishing NASA with data requested at the CARR meeting. The remaining 17 discussion items were required to be dispositioned at Downey prior to shipment to KSC. The CARR

action items are documented in "CARR Minutes and Action Assignments" and "CARR Action Response" (Reference 6-26).

The following summarizes the Downey ACTIONS AND DISPOSITIONS OF THE ABOVE REFERENCED ITEMS] Each item is identified by its respective item number in the Phase II CARR report minutes.

1.7.1 POWER LOSS ON CSM - INVERTER
Problem: During spacecraft testing, power loss occurred.

Resolution: Inverter 1 was determined to be faulty and was removed and replaced. The replacement inverter was installed, checked and determined to be acceptable prior to shipment.

3.6.14 FLIGHT QUAL INSTRUMENTATION STATUS
Problem: Four transducers were determined to not be operating properly.

Resolution: The transducers were replaced and the new transducers functionally verified prior to spacecraft shipment.

3.7.1 SUIT LOOP LEAKAGE
Problem: Leakage noted during Operational Checkout Procedure (OCP) 5051 was greater than the specification allows.

Resolution: It was concluded from evaluations that misinterpretation of data caused the out-of-specification statement. Re-evaluations were made of test data and it was concluded that leakage of the suit loop circuit at time of shipment was within acceptable limits. It was also noted that normal test flow at KSC would verify this conclusion.

3.7.2 DEMAND REGULATOR FAILURE (OXYGEN)
Problem: The demand regulator was determined during spacecraft testing to be inoperative.

Resolution: The regulator was replaced and the new regulator functionally verified prior to shipment.

3.7.3 WATER CYCLIC ACCUMULATOR FAILURE
Problem: During spacecraft testing, the water cyclic accumulator was determined to be inoperative.
inoperative.

Resolution: Two (2) new units were installed before the water cyclic accumulator would pass checkout. The units were installed and checked out and the final unit was determined to be acceptable prior to shipment.

3.7.10 OPERATIONAL CHECKOUT PROCEDURE (OCP) 5051, SUIT LOOP CHECKS
Problem: Checkout per OCP 5051 was not complete at the time of the CARR.

Resolution: OCP was completed prior to shipment. The following problems were transferred to KSC for final resolution. Squawks 54, 58, 59, 60, 61, 62, 63, and 908. (See Reference 6-27, Material Inspection and Receiving, DD Form 250, CF66-51922 numbers, 1,. 2, and 3.)

4.6.8 TV CAMERA CHECKOUT - PICTURE DISTORTION
Problem: The TV image was distorted during Crew Compartment Fit and Function Tests (CCFF).

Resolution: A reverification of the TV image was performed prior to shipment and found to be within acceptable limits.

5.6.17 CALIBRATION CURVES

Problem: The Flight Crew required the Spacecraft panel meter calibration curves.

Resolution: The calibration curves were transmitted to the crew prior to shipment.

5.7.1 FAILURE OF ECS MEASUREMENTS

Problem: The water-glycol pump package pressure measurements CF0025P was found defective. Measurements CF0484T and CF0135R were also faulty.

Resolution: The cause was found to be defective transducers. The transducers for measurements CF0484T and CF0135R were replaced and the new transducers reverified prior to shipment. The transducer for water-glycol pump inlet pressure measurement CF0025P was not replaced and NAA's request for waiver was granted (Reference 6-28).

12.6.3 HATCH DECALS

Problem: Installation of torque limit decals had not been completed.

Resolution: The decals were installed prior to vehicle shipment.

13.6.10 CO2 PARTIAL PRESSURE GAGE

Problem: When power was turned on, the gage went to full scale deflection and triggered the caution and warning system.

Resolution: Additional testing was accomplished prior to shipment and gage operation was determined to be satisfactory although Automatic Checkout Equipment (ACE) readouts did not correspond. Per CARR Board direction, calibration was to be validated at KSC.

13.7.1 RHEOSTAT FAILURE - FLOODLIGHTS

Problem: The rheostat failed to provide a smooth linear resistance change with shaft rotation.

Resolution: The rheostat was removed and replaced. The new rheostat was installed and operation verified prior to shipment.

13.7.2 EVAPORATOR STEAM BACKPRESSURE C&W INDICATION

Problem: The master caution and warning light triggered with no visible indication on the individual display when the glycol evaporator steam backpressure was operated.

Resolution: The problem was found to be a defective switch which was removed and replaced. A retest with the new switch was not performed and was transferred as open work to KSC. (Reference 6-27, Material Inspection and Receiving Document, DD Form 250, Squawk 62, CM Number 1, 2 and 3.)

14.7.1 PARTIAL CREW COMPARTMENT FIT AND FUNCTION CHECK (CCFF) SUMMARY

Problem: CCFF was not completed at the time of the CARR and numerous items were open for evaluation.

Resolution: The CCFF was completed prior to shipment. The following problems were transferred to KSC for final resolution: Squawks 12, 15, 20, 22, 23, 30, 33, 35, 38, 56, 925,

and 929 (Reference 6-27, Materials Inspection and Receiving Document, DD Form 250, CF66-51922, CM numbers 1, 2, and 3).

14.7.2 FLAMMABLE MATERIALS IN CM

Problem: Use of Velcro and other materials in the Command Module (CM) was not considered desirable and was unsatisfactory for flight.

Resolution: Investigation of the CM crew compartment was performed with identification of undesirable materials listed prior to shipment of the spacecraft. NASA participated in the investigation and the results of the investigation are documented in NAA IL 633-300-040-66-1009, dated 22 August 1966 (Reference 6-29). Further documentation is in the Materials Review, Panel 8 Final Report, Section C.8.b.

15.7.1 MDAS CHECKOUT

Problem: The Medical Data Acquisition System (MDAS) was not checked out during the Crew Compartment Fit and Function (CCFF) review.

Resolution: The checkout of the MDAS was performed satisfactorily during the Operational Checkout Procedure (OCP) 5051, prior to shipment.

15.7.2 16 MM CAMERA OPERATION

Problem: The camera was not operable at time of CARR.

Resolution: Camera operation was satisfcatorily demonstrated during the second run of OCP-P-5051 and CCFF, prior to shipment.

(1) Description of Material Inspection and Receiving Document, DD Form 250.

In conjunction with the CARR procedures and as a part of the CARR Board aActions, it is necessary to officially document the spacecraft configuration at the time of shipment as well as any items of open work to be transferred to KSC-Cape Kennedy for accomplishment. The DD Form 250 is utilized for this purpose and is the formal acceptance of the spacecraft by the government from the contractor.

The status is defined by listing those additions to, and those unaccomplished items from the major module configuration definition of record at the time of shipment (i.e., top level engineering drawings for the spacecraft). The DD Form 250 will normally contain the following information:

- Government Furnished Equipment (GFE) installed
- Field site installations that were installed at Downey
- Removals (normally to support shipment)
- Loose equipment with shipment (to support open work and removals for shipment)
- Actual part shortages
- Open work items (squawks, Engineering Orders, drawings)

On Spacecraft 012, there were four (4) DD Form 250's used (Reference 4-16) since four (4) separate shipments were made as follows:

- Spacecraft complete V14-000002-21 (DD Form 250 CF66-51968, 9 September 66). This form confirms shipment of the total spacecraft and the spacecraft data package.
- LES - V15-000002-221 (DD Form 250 CF66-51886, 22 July 1966).
- CM - V16-000002-191 (DD Form 250, CF66-51922, 1, 19 August 66; 2, 25 August 66; 3, 27 September 66).
- SM - V17-000002-131 (DD Form 250, CF66-51898, 8 August 66).

Two revisions were made to the original Command Module (CM) DD Form 250 (Ref-

erence 6-27). The first (original) DD 250 did not reflect the true status of the Command Module in that it did not include all of the actual part shortages nor did it list the equipment removed to facilitate shipment. To correct the status of the Command Module, the second CM DD Form 250 was written.

After shipment, additional discrepancies were discovered in the "as shipped" hardware configuration status. Additional shortages, Field Installation Items (FOI), equipment removals, Government Furnished Equipment installed on the CM or accompanying the shipment, and additional items of loose equipment were discovered. The third CM DD 250 was written to correct the status of the Command Module. In addition, the contents of third DD 250 were rearranged to provide a document which was easier to read and understand.

Those CARR items requiring Downey action which were not completed at NAA-Downey, were transferred to KSC, Cape Kennedy, on the DD Form 250 (Reference 6-27).

(2) Certificate of Flight Worthiness (COFW)

A COFW was initiated in accordance with Apollo Program Directive No. 6 for S/C 012 on August 24, 1966, at NAA-Downey. This was endorsement one and is included as Reference 6-17.

d. Design Certification Review (DCR)

The initial phase of the DCR was conducted for the Apollo 204 mission in accordance with the requirements of Apollo Program Directive (APD) No. 7 (Reference 6-18) during the period September 21-28, 1966, and concluded on October 7, 1966. The results of this phase of the DCR are documented in the attachment to an Apollo Program Director's letter dated October 12, 1966 (Reference 6-30). The Apollo Design Certification Board was chaired by the Associate Administrator for Manned Space Flight and the Board Members were as follows:

Director, NASA Manned Spacecraft Center
Director, NASA Marshall Space Flight Center
Director, NASA Kennedy Space Center

Presentations on the spacecraft were made to the Board jointly by NASA-Houston and NAA-Downey personnel. In addition, a memorandum for Design Certification Board (Reference 6-31 -sample) was submitted for the Board's consideration, certifying with contingencies the spacecraft for a manned mission. These memorandums were signed by the NASA-Houston Subsystem Managers and NAA-Downey Design Engineers.

There were a total of 89 action items resulting from the Board's review. In addition, each of the three Apollo Program Managers developed a Certification Contingency List and they are also included as Minutes. These Contingency Lists contain a total of 20 action items.

Action items resulting from all aspects of the review are as follows:

Launch Vehicle	- 29 (No. 11 combined with No. 19)
Launch Complex	- 10 (41 through 49 have no action)
Spacecraft	- 38
Other	- 12
Launch Vehicle Program Manager's Contingency List	- 5
Spacecraft Program Manager's Contingency List	- 8
Launch Complex Program Manager's Contingency List	- 7
TOTAL	- 109

On October 7, 1966, the Design Certification Board issued the AS-204 Design Certification Document (Reference 6-30, Attachment) which certified the design of the Space Vehicle for flight worthiness and manned safety and the capability of the Mission Support to support a manned mission contingent upon satisfactory resolution of the qualifications, tests, investigations and action items listed in attachments to the Design Certification Document.

The action close out processes continued from October 7 through December 20, 1966, however, during this period the Apollo Program Director made a decision to conduct a Recertification Review to be conducted during the month of December 1966. This action was deemed necessary in view of the large number of action items resulting from the initial review, with many remaining open. The selected date of December 21, 1966, for this second review was influenced by a slippage in the launch schedule caused by the delay in completion of the Environmental Control Sub-system water boiler test at the AiResearch Corporation to correct a previously identified deficiency wherein the water boiler became contaminated and blocked fluid flow (Reference 6-30, Attachment II, item 5.d.).

The status of action items as of December 20, 1966, is contained in the Apollo Program Director's report (Reference 6-32) on that date to the DCR Board Chairman. There were 14 items with incomplete responses and 9 to be closed prior to the FRR. The status as of January 27, 1967, as reported to the Apollo 204 Review Board on March 17, 1967 (Reference 6-33, shows 66 items closed, 4 not required for certification, 2 to be closed out at the AS-204 FRR, 4 with incomplete response and 13 with closure pending the Apollo Program Director's concurrence. There were no new action items as a result of the December 21, 1966 meeting. The updated Action Item Synopsis sheets are included in the Apollo Program Director's status report (Reference 6-32) and appropriately marked to indicate the status as of January 27, 1967.

e. Flight Readiness Review (FRR)

The Office of Manned Space Flight, Washington, D.C., had planned to conduct a two-part Flight Readiness Review for S/C 012 with the purpose as:

Part I - To determine that the space vehicle hardware and launch complex are ready to commence the mission period.

Part II - To determine the readiness of the operational elements for a manned space flight.

Part I would have been conducted by the Apollo Program Director; Part II by the Mission Director. The FRR is defined in Apollo Program Directive No. 8 OReference 6-19). The FRR would have been held approximately two weeks prior to launch.

MSC, Houston, in conjunction with KSC - Cape Kennedy, would have conducted a Pre-Flight Readiness Review (Pre-FRR) at KSC - Cape Kennedy approximately 3 days prior to Part I of the FRR. Upon completion of the Pre-FRR, a NAA prepared report would have been submitted to the Program and Mission Directors along with the Apollo Spacecraft Program Manager's report. The Apollo Spacecraft Program Manager would have orally summarized these reports at the FRR and provided an update of the spacecraft checkout, failure analysis and qualification status, implementation of Pre-FRR action items and DCR action items.

The basic objective othe Pre-FRR is to evaluate the readiness of the spacecraft, GSE hardware and ACE hardware to achieve the specified mission as documented in the MSC, Houston FRR Procedure (Reference 6-34). Specifically the objectives are to:

- Evaluate all work accomplished subsequent to the delivery of the spacecraft to KSC.
- Determine the status of the hardware with respect to all waivers, deviations, discrepancies, shortages, unresolved checkout problems, generic and spacecraft failures, limited life components, configuration changes, uncontrolled parts, and open work.
- Determine qualification/certification status of spacecraft hardware, including evaluation of test versus flight hardware differences.
- Determine the flight readiness and degree of engineering confidence in the reliability of the

hardware at the point in time of the review.

- Specify action to be accomplished as a result of the review.
- Release the hardware for final launch preparations.

The Pre-FRR review board consists of:

Chairman - Apollo Spacecraft Program Manager, or his designated appointee.

Members - Representative from Engineering and Development Directorate, MSC-Houston.

- Representative from the Flight Operations Directorate, MSC - Houston.
- Representative from the Flight Crew Operations Directorate, MSC - Houston.
- Representative from the Flight Safety Office, MSC - Houston
- Representative from the Medical Research and Operations Directorate, MSC-Houston.
- Representative from the Office of the Director, Plans, Programs, and Resources, KSC - Cape Kennedy.
- Representative from the Office of Assistant Director for Spacecraft Operations, KSC-Cape Kennedy.

Secretary - Representative from the Reliability, Quality and Test Division, MSC - Houston.

The Pre-FRR report (Reference 6-35) was completed by NAA on January 27, 1967, however fifteen (15) preliminary copies were delivered to MSC - Houston on January 25, 1967. The original masters were impounded on January 27, 1967, after the S/C 012 accident. With the Apollo 204 Review Board's approval, copies of the original masters of the Pre-FRR report were made and one copy delivered to the Apollo 204 Review Board Legal Counsel.

All hardware problems in the Pre-FRR report (Reference 6-35) were reviewed to determine which problems may have been related to the accident. These problems are listed in below along with the action taken:

- During Downey and KSC checkout of S/C 012, two inverters experienced "moly-Block" transistor failures. These failures cast suspicion on the conclusiveness of the "Moly-Block" transistor fix for a prior overheating problem. Analysis of the problem revealed no design inadequacies but did show the need for improved screening techniques of the transistors. Such techniques were developed and imposed on the transistors installed in S/C 012.

Action - Inverters to be removed from S/C 012 and analyzed per Review Board Action Items 0041, 0123, 0153, and 0182.

- The Environmental Control System, in particular the Environmental Control Unit (ECU), has experienced several significant problems that had impact on S/C 012. The majority of these problems occurred in qualification testing. The most serious problem was that the water evaporator (water boiler) blocked and would not accept water for evaporation to cool the water/glycol. This problem was eliminated by redesign of the distribution plates and making a filter change. With these and other changes incorporated, the ECU has successfully completed qualification testing. All of these changes were implemented on S/C 012.

Action - ECU to be analyzed per Review Board Action Items 0097, 0102, 0168.

- During the Combined Systems Test at Downey, several caution and warning light indications could not be verified. Troubleshooting isolated the problem to an open circuit within terminal block assembly No. 1 behind the Main Display Console (MDC) C&W Panel No. 11. An x-ray examination of the matrix terminal block assembly (TB-1) revealed seven pins not proerly inserted. The pin insertions in the remaining 31 similar TB assemblies installed in the S/C were examined. This examination revealed nine additional discrepant terminal block assemblies.

Action - Terminal Blocks to be analyzed per Review Board Action Items 0160, 0161, 0153.

- Several spacecraft electrical wire harness assemblies were saturated with water-glycol during KSC Checkout Operations. Subsequent investigations have proven that this solution in spacecraft wiring and connectors will support electrolytic corrosion particularly in the presence of a polarizing electric potential.

Action - Wire harness assemblies to be analyzed per Review Board Action Items 0160, 0161.

- Analysis of shielded and unshielded Environmental Control Unit (ECU) electrical harnesses

indicated that numerous connectors were improperly potted. S/C 012 was retrofitted with cables using ML wire and larger backshells. All of these cables have had dielectric testing. These cables have been tested under a corrosive contaminant oxygen and humidity environment and have satisfactorily passed the minimum acceptable insulation resistance requirement. The ECU with these new cable assemblies was installed in S/C 012.

Action - ECU electrical harnesses to be analyzed per Review Board Action Items 0161, 0168.

- Floodlights: Problems which occurred in S/C checkout, characterized by abrupt loss of light output and blowing of internal fuses, were traced to susceptibility to line transients within the floodlight power converter circuit. Circuit design and component changes were made to improve transient susceptibility margin, and units have since been subjected to a more rigorous acceptance test.

Action - Floodlights were analyzed per Review Board Action Item 0169 and it was determined the floodlights were not an initiator or propagator of the fire.

- Bio-Med parameter CJ0002 (Respiration) decreased in level when either crew member pressed Push to Talk (PTT) switch. Modulation was also present when crewman spoke.

Action - Bio-Med harness and Medical Data Acquisition System to be analyzer per Review Board Action Items 0155, 0156, 0165.

- Flexible Polyurethane Foam (FPF). The FPF has failed in the flammability test per MA0115-008 whch requires no flame at 400°F in 02. This foam is used in Crew Systems Design and Support, ECU, ECS, and Telecommunications.

Action - The FPF is discussed and future corrective action is outlined in the final report of Panel 8 - section C.8.b. Corrective action is to use a substitute, nonflammable material in future spacecraft.

The Apollo Spacecraft Program Manager's FRR report was approximately 60 percent complete at the time of the S/C 012 accident, but had not been reviewed by the Manager. The existing sections of the report were reviewed to determine if any problems discussed could be related to the accident. The following problems were a result of this review and are in addition to the problems discussed from the Pre-FRR report.

- Polyurethane foam is used as potting in the Electronic Control Assembly (ECA). This potting includes and surrounds printed circuit boards and electronic components. Polyurethane foam gives off a flammable gas at elevated temperatures. These units are installed in the crew compartment and are therefore exposed to an oxygen environment.

Action - The polyurethane foam is discussed in the final report of Panel 8 - Section C.8.b. Corrective action is to use a substitute, nonflammable material in future spacecraft.

- As the result of recent flammability tests, the Uralane Foam 577-1 was found to fail the flammability tests below 400°F. If this foam were used in close proximity to components whose normal or overload condition could reach excessive temperature, a fire could be started. Typical components falling into this category are electrical resistors, capacitors, or malfunctioning diodes.

Action - Corrective action is to use a substitute nonflammable material in future spacecraft as discussed in the final report of Panel 8 - Section C.8.b.

- Of the approximately 1300 nonmetallic materials identified as used in the Command Module, NAA has supplied the following status information:

300 Materials do not meet the criteria established by MC999-0058.

350 Materials are acceptable by these same criteria.

650 Materials have no status as to acceptability.

Due to the type of information, i.e., material lists, bill of materials, etc. used by NAA to compile the material usage list, exact location and amount used is not available in the majority of the cases. Such information is obtainable only by drawing review. This activity is not planned by NAA. In addition, subcontractor compliance has not been either imposed or obtained in all cases. Due to this lack of information, an engineering decision cannot be made on whether a serious problem does or does not exist nor can an assessment be made on the effect on the reliability from a toxicity and flammability standpoint. It is estimated at this time that the identification of the nonmetallic materials is approximately 85-90 percent complete.

Action - Corrective action is outlined in the final report of Panel 8 - Section C.8.b.

REFERENCES

6-12 Apollo Program Directive No. 6A MA009-006-1A, dated August 30, 1966, titled "Sequence and Flow of Hardware Development and Key Inspection, Review and Certification Checkpoints".

6-13 Apollo Spacecraft Program Office Configuration Management Plan, Revision B, dated March 15, 1966.

6-14 NAA-CSM Configuration Management Plan, SID 65-100. Section 10.0, Formal Reviews.

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6-17 Certificate of Flight Worthiness for Spacecraft 012, Endorsement No. 1, dated August 24, 1966.

6-18 Apollo Program Directive No. 7, dated April 21, 1966, titled, "Apollo Design Certification Review".

6-19 Apollo Program Directive No. 8, dated November 8, 1965, titled, "Apollo Flight Readiness Reviews".

6-20 CSM-012 End Item Specification SID 64-1080, dated 22 February 1965. Classified CONFIDENTIAL.

6-21 Apollo S/C 012 Delta CDR Minutes of the Meeting. Part I NAA-Downey, California, dated March 3, 1966.

6-22 Apollo S/C 012 Delta CDR Minutes of the Meeting. Part II NAA-Downey, California, dated March 29, 1966 and April 5, 1966.

6-23 Manned Spacecraft Center, Project Apollo, Plan for Phase I, Delta Critical Design Review, Spacecraft 012. dated January 28, 1966.

6-24 Customer Acceptance Readiness Review, Project Apollo, CSM 012, Phase I Report, dated June 1966.

6-25 United States Government Memorandum PF2/G-116-67, Subject: Disposition of S/C 012 Delta CDR Action Items, dated March 23, 1967.

6-26 Customer Acceptance Readiness Review, Project Apollo, CSM 012, Phase III Report from NNAA-Downey, California, dated 21 July 1966.

6-27 CSM Major Module Material Inspection and Receiving, DD Form 250's.

6-28 Apollo NAA/NASA Waiver Approval Request. CSM S0001 dated 3-24-66.

6-29 NAA Internal Letter dated August 22, 1966, Subject: Flammability Investigation S/C 012 CARR.

6-30 Apollo Program Director's Letter, dated 12 October 1966, Subject: AS-204 Design Certication Review.

6-31 Memorandum for Design Certification Board dated September 23, 1966, Subject: Service Propulsion Subsystem.

6-32 United States Government Memorandum dated 20 December 1966, Subject: AS-204 DCR Action Items

6-33 Datafax transmission from Apollo Program Office Action Center, dated 17 March 1967 supplemented by Letter from APO Action Center, dated 24 March 1967, Subject: AS-204 DCR Record Supplement.

6-34 Apollo Spacecraft Program Office Flight Readiness Review Procedure MSC-A-D-66-6, dated October 12, 1966.

6-35 Project Apollo, Flight Readiness Review Spacecraft Readiness Review, Spacecraft 012 Report, dated February 1967.

APOLLO REVIEW BOARD

APOLLO SPACECRAFT 012

HISTORICAL NARRATIVE

OF

PRELAUNCH OPERATIONS

AT

KENNEDY SPACE CENTER

Enclosure 6-7

INTRODUCTION

This report presents a brief historical narrative of the prelaunch operations performed on Apollo Spacecraft 012 at Kennedy Space Center. Each major test that was accomplished is briefly described in addition to significant problems and spacecraft rework required.

For additional clarification, an "as run" bar chart is included. Charts are also included to portray the relationship of spacecraft testing to scheduled and non-scheduled work as a result of design modifications and discrepancies during the prelaunch operations.

Apollo Spacecraft 012 prelaunch checkout at Kennedy Space Center was initiated on August 10, 1967, with arrival of the Service Module portion of the Spacecraft. After arrival at the Cape Kennedy Skid Strip, the Service Module was transported to the Kennedy Space Center industrial area warehouse for painting. Service Module painting is normally delayed until arrival at Kennedy Space Center to preclude abrasions during shipment. The condition of the Service Module paint is of concern since it is a thermal paint and performs a mission function in the environmental control of the Service Module.

With completion of painting, the Service Module was moved to the Operations & Checkout Building and installed in a workstand for installation of the Service Propulsion System engine nozzle plug. The nozzle plug was installed in preparation for accomplishing leak and functional testing of the Service Propulsion System.

After installation of the nozzle plug, the Service Module was moved into the adjacent altitude chamber on August 13. On August 15, the parallel tasks of

receiving inspection and preparations for Operations Checkout Procedure number 4074 were initiated. Receiving inspection is delayed until this point is reached since the required removal of various panels for testing provides better visibility to perform the inspection. Receiving inspection consists of a visual inspection to check the "as received" condition of the vehicle for possible damage incurred during shipment. Operations Checkout Procedure 4074 is a leak and functional test of the Service Module Propulsion System to verify the pressure integrity and functional operation prior to mating with the Launch Vehicle on the launch complex. The actual performance of Operations Checkout Procedure 4074 was started on August 17 and continued through August 27.

In parallel with Operations Checkout Procedure 4074, a Service Module radiator reflectivity test was accomplished per Operations Checkout Procedure 5116. This test confirms the capability of the radiators in the Service Module to remove the heat generated by the Spacecraft systems. In addition to

the accomplishment of these two parallel tasks, two design modifications were incorporated and five discrepant conditions were repaired on the Service Module during this time period.

The Command Module portion of Spacecraft 012 arrived at Kennedy Space Center on the 26th of August, three weeks after arrival of the Service Module. The Command Module was transported directly to the Pyrotechnic Installation Building for weight and balance and Launch Escape System thrust vector alignment checks. Command Module weight and balance checks are performed to determine the weight and center of gravity of the spacecraft. Launch Escape System thrust vector alignment consists of optically ascertaining the proper alignment of the Launch Escape System rocket engine nozzles with respect to the centerline of the CM after mating the Launch Escape System tower to the Command Module. With the completion of these two tasks, the Launch Escape System tower was removed from the Command Module and returned to storage to await reinstallation during final preparations for launch at the launch complex.

The Command Module was removed from the Pyrotechnic Installation Building and transported to the Operations & Checkout Building altitude chamber on August 29 for mating with the Service Module. The Command and Service Module mating operation was started on the 30th of August and required 64 hours to complete. Command and Service Module mating normally requires 16 hours. In this instance, the mechanical hardware utilized to attach the Command Module to the Service Module was of a new design and proved to be difficult to adjust with relation to the Command Module aft heat shield interface. Previous experience was not available since factory checkout plans did not require final installation of the aft heat shield prior to factory Command and Service Module mating. In addition, information (strain guage calibration curves) required to ascertain when the proper tension adjustment between the Command Module and Service Module was achieved, had inadvertantly not been shipped from the factory with the spacecraft, and was subsequently lost. Completion of mating was delayed until calibration curves could be generated locally.

After completion of Command and Service Module mating,

a receiving inspection was performed on the Command Module. With completion of receiving inspection, the accumulation of required design changes, and repair of discrepant conditions was such that a fifteen-day, "no test" work period was initiated. The spacecraft had arrived with 113 approved, but unincorporated design changes (EO's). During this period, thirteen major system design changes (MCR's, Master Change Record) were incorporated, the majority of which were wiring modifications. In addition, various removal and repair and rework activities were conducted. The incorporation of known modifications and repairs at this point in time was required prior to proceeding into Operations Checkout Procedure 0035, Combined Systems Testing, since rework of this nature and scope could invalidate the test. The objective of the combined systems test is to determine that all spacecraft systems perform properly and that no incompatibilities or interferences exist between systems.

On September 15, the Combined Systems Test was commenced and continued until September 17 when testing was stopped in order to determine the cause of two major malfunctions in the spacecraft Caution and

Warning System and Reaction Control System respectively. Investigation revealed that several pins within a Matrix electrical connector (TBI) on the caution and warning main display panel in the Command Module cabin had not been completely inserted during manufacturing. This resulted in a lack of electrical continuity. As a precautionary measure, seven cabin display panels were removed from the spacecraft and x-rayed to determine if a similar discrepancy existed on other Matrix electrical connectors. This activity required two days to accomplish. The Reaction Control System malfunction was determined to be two badly bent pins in an electrical connector resulting in a short circuit to ground. On September 19, Operations Checkout Procedure 0035 was again started and was completed on September 23; however, some additional unresolved malfunctions had been detected. At this point, spacecraft testing was discontinued for an eight-day period to resolve and repair the known malfunctions. In addition, this time period was utilized for various mechanical work and incorporation of two design changes.

With relation to the detected malfunctions, improper

operation of the fuel cell water-glycol coolant system was determined to be blockage of fluid flow due to installation of a blind (no hole) Voishan seal in a system line. After seal replacement, the system was purged, dried, and reserviced. Other malfunctions repaired during this period included replacement of an oxygen supply valve and resolution of problems in the Telemetry and Guidance and Navigation systems. Also during this work period, a leak developed in the Environmental Control System water-glycol loop due to a faulty soldered joint behind the Display Electronic Control Unit. This was subsequently repaired.

One area of considerable trouble during this time period was the crew couches which had been removed from the spacecraft for extensive mechanical rework. Some twelve separate major discrepancies had been detected and required factory design engineering personnel to travel to Kennedy Space Center to assist in the resolution of design deficiencies.

On October 1, spacecraft testing was reinitiated for a one-day period to demonstrate that the previous electrical malfunctions had been properly resolved

and repaired. At completion of this one-day period of testing, the Combined Systems Test was considered satisfactorily completed and was accepted.

On October 2, a work period was started for the purpose of preparing the Spacecraft for Operations Checkout Procedure 0034, Altitude Chamber Testing. This test involves testing the spacecraft under simulated altitude conditions with the flight crew onboard. Preparation for the altitude test included a leak test to verify pressure integrity of the spacecraft cabin, various crew equipment installations, flushing and servicing the environmental control water system, and the continued reservicing of the fuel cell water-glycol system. During reservicing of the fuel cell water-glycol system, additional leaks were detected and repaired. During the cabin leak test, improper operation of a cabin relief valve was detected. This unit was removed and replaced and the test satisfactorily completed. Also during this work period, a design modification was incorporated, which provided the flight crew with additional mechanical leverage to open the spacecraft hatch. With completion of a crew equipment stowage exercise by the flight crew, the spacecraft was considered ready

for the Altitude Chamber Test.

On October 10, the Altitude Chamber Test was started. This test consists of a sea level run, an unmanned run "at altitude", and two manned tests, or runs, "at altitude". The sea level run consists of testing all systems in a mission sequence to ascertain that systems perform properly and events occur at the correct point in time with relation to the planned flight. The flight crew participates as an integral part of the test. The unmanned run "at altitude" is accomplished to assure the capability of the spacecraft life support systems to sustain the flight crew "at altitude" prior to attempting the manned runs. Finally, the manned altitude runs (one for the prime crew and one for the backup crew) are for the purpose of evaluating the spacecraft systems operation at altitude; compatibility of spacecraft and crew under altitude conditions; and capability of the crew to perform various tasks with the crew stowed equipment.

During the sea level portion of the Altitude Chamber Test, a malfunction was detected in the spacecraft abort system. Investigation revealed three bent pins in the electrical umbilical connector between the Command

Module and Service Module. This problem was corrected and the sea level run was successfully completed on October 13. During the following two days, the unmanned run at altitude was satisfactorily completed.

With completion of the unmanned run, preparation for the initial manned run was initiated. This preparation consisted of servicing the spacecraft environmental control system with potable water; liquid oxygen loading, and fuel cell activation. These tasks were completed on October 17. On the following day the manned run was initiated and continued until a spacecraft electrical power system inverter failed during pump down of the altitude chamber. After replacement of the inverter, testing was again resumed and the run completed on the following day, October 19, with one equipment malfunction, failure of a spacecraft primary oxygen regulator.

Determination of the cause of the regulator failure proceeded with removal of the regulator from the spacecraft and subsequent disassembly of the unit. Disassembly of the unit and further investigation revealed a design deficiency existed in the regulator.

While awaiting a redesign decision on the spacecraft oxygen regulator, various miscellaneous spacecraft work items were accomplished such as replacement of all spacecraft circuit interrupters (improved design), additional x-rays of Matrix connectors, etc. On October 27 a decision was made to remove the Environmental Control Unit from the spacecraft and return to the factory for incorporation of a design change to the water boiler.

Meanwhile, a Spacecraft 017 Service Module propellant tank had ruptured during factory checkout at Downey, California. In view of the tank failure at the factory, it was decided to conduct some special testing on the Spacecraft 012 tanks at the Kennedy Space Center. In order to proceed with the Service Module special tank test and continue work on the Command Module in parallel, the Command and Service Modules were demated on October 29. The Command Module was moved out of the Altitude Chamber and installed in the adjacent integrated work stand and removal of the Environmental Control Unit was started. The Service Module remained in the altitude Chamber and preparation for removal of the Service Propulsion System propellant tanks was initiated. The rationale behind removal of the tanks prior to testing

was to prevent destruction of the Service Module in the event a tank rupture occurred similar to the Spacecraft 017 failure during factory checkout.

On November 2, removal of the Service Module propellant tanks was completed and the tanks were transported to Launch Complex 16 at Cape Kennedy for special pressure testing. During pressure testing, the tanks were serviced with liquid Freon to reduce the hazardous aspect of the test. Complex 16 is a remote area approved for hazardous testing. Tank testing was successfully completed on November 7 and on the following day the tanks were returned to the Operations & Checkout Building. By November 11, tank installation in the Service Module was complete. The following two days were utilized to incorporate an engineering modification on the Service Module propulsion fuel tank plumbing.

On November 13, the Service Module was transported to Launch Complex 16 at Cape Kennedy for Service Propulsion System pressure testing. This was necessary to reestablish overall system confidence at operational pressure after the tanks had been reinstalled in the Service Module

Pressure testing on the Service Module was completed on November 16 and the Service Module was returned and reinstalled in the Operations & Checkout Building altitude chamber. Two days of preparation and work followed and on November 18, the Service Module was ready for mating with the Command Module.

In parallel with the previously described Service Module activity, work had been progressing on the Command Module in the Operations & Checkout Building integrated workstand. The Environmental Control Unit had been removed and returned to the factory for modification. On November 8, a new configuration Environmental Control Unit was received and installation into the Spacecraft was started. Installation was complete on November 12 and a leak and functional test on the system was initiated. This was completed on November 18.

In additional to the Environmental Control Unit activity described above, other testing had proceeded on the Command Module. A reaction Control System leak and functional test had been performed per Operations Checkout Procedure 4070. This test would normally have been performed at the launch complex as a portion of Operations Checkout Procedure 0005. However,

since the capability to perform the test existed in the Operations & Checkout Building and time was available, the test was performed to alleviate testing and provide additional contingency time on the launch complex. It is noted that the Reaction Control System Test performed is only a small portion of the Operations Checkout Procedure 0005 that was utilized, and only the Reaction Control System portion was performed. In addition to the Reaction Control System Test, a calibration test on the Guidance and Navigation System was performed at this time as a normal periodic requirement.

Concurrent with preparation of the Service Module for mating, the Command Module was moved from the Operations & Checkout integrated workstand into the adjacent altitude chamber and mated to the Service Module on November 19. With completion of Command and Service Module mating, preparation for continuation of the manned altitude chamber test (second manned run for backup crew) was started. On November 25, a new configuration spacecraft oxygen regulator was installed.

On November 29, servicing of the Environmental

Control System water and water-glycol systems had been completed and power was applied to the spacecraft in preparation for the manned altitude run. During powerup of the spacecraft, evidence (a few drops) of water-glycol was observed on the spacecraft cabin floor under the aft right hand corner of the newly installed Environmental Control Unit. Three days of investigation failed to positively locate the source of the leakage. On December 3, a decision was made to remove the Environmental Control Unit and return it to the factory for further investigation and location of the source of leakage.

While awaiting return of the Environmental Control Unit from the factory, a reverification test was performed on two components (check valves) of the Reaction Control System. These units had failed during the previously described Reaction Control System leak and functional test and had been replaced. Also during this time period an additional leak was detected at a supply line solder joint (lower equipment bay) in the Environmental Control System water-glycol system.

On December 14, the Environmental Control Unit was returned to Kennedy Space Center from the factory.

Extensive testing on the unit at the factory had not confirmed any leakage associated with the unit. After Environmental Control Unit installation was completed, the Environmental Control System was serviced, and again an indication (a few drops) of water-glycol leakage was observed on the cabin floor under the aft right hand corner of the Environmental Control Unit. At this time extensive efforts were made to locate the source of the leak, but were unsuccessful. No leakage was ever noted or observed at this same location apart from the servicing operation. It was assumed that the leakage condition was due to a dynamic action by "O" ring seals and/or other seals as a result of prolonged vacuum during servicing operations and thus would not occur except during servicing. A decision was made to proceed with testing and continue to observe this condition.

Reverification testing of the Environmental Control System was successfully completed on December 20. The crew couches were installed on December 21 and the environmental control water system serviced the following day. The crew couches had been removed for access to remove and reinstall the Environmental Control Unit. Preparations for continuing the altitude chamber test

were continued until December 24 when work was discontinued for the Christmas holiday.

On December 27 and 28, the sea level and unmanned portions of the altitude chamber test were successfully completed. Although these tests had been previously completed, they were repeated to establish confidence for the manned run since a significant amount of spacecraft rework had been accomplished. On December 29 and 30, the second manned altitude run with the backup crew participating was performed and all test objectives were met. It is noted that the final manned run was very successful with all spacecraft systems functioning normally. At the post test debriefing, the backup flight crew expressed their complete satisfaction with the condition and performance of the spacecraft.

After completion of the altitude chamber test, the environmental control water and liquid oxygen systems were deserviced and the spacecraft was removed from the altitude chamber and placed in an adjacent workstand on January 3. The Service Propulsion System nozzle extension was installed and leak checked on the following day. On January 4, the spacecraft was mated to the spacecraft adapter and installation of ordnance devices was started.

On January 6, the spacecraft was moved to the launch complex and mechanically mated to the launch vehicle.

After mechanical mate with the launch vehicle, ground support equipment was connected in preparation for the spacecraft Integrated Systems Test, Operations Checkout Procedure 0005.

The basic objectives of this test are to verify that spacecraft electrical systems are compatible with the launch complex and ground support equipment prior to electrically mating the spacecraft to the launch vehicle and performing overall space vehicle testing.

Test preparations were completed on January 11 and the spacecraft was powered up for the integrated systems test on the following day. This test was completed on January 14. The Launch Escape System tower was mated to the spacecraft on the following day and preparation for the cryogenic loading test, Operations Checkout Procedure 4736 was started.

The cryogenic loading test involves servicing the spacecraft liquid oxygen and liquid hydrogen systems. The basic objective is to assure that servicing can be

performed and that no incompatibilities exist between the spacecraft and ground support equipment. This test also provides early verification of the test procedure and provides practice for the servicing exercise to be repeated later during critical portions of the launch countdown. The cryogenic loading test was completed successfully on January 17 and the spacecraft was deserviced.

With completion of the cryogenic loading test, the spacecraft was electrically mated to the launch vehicle. Verification that proper electrical connection had been made was verified by performing Operations Checkout Procedure 0004. This test was completed on January 18.

At this point the spacecraft was powered down for a one-day work period. Power had been applied to the spacecraft since the initial launch complex test was started (except during launch escape tower installation); as a result, various minor work items had accumulated, the majority of which were configuring the interior of the cabin for flight. In addition, detailed study of test results (data) from the spacecraft Integrated

System Test had indicated possible malfunctioning equipment in the guidance and navigation inertial measurement unit and the stabilization and control system. Further investigation of these two possible problems were continued during this period. The Inertial Measuring Unit (platform) was determined to be acceptable. The Yaw Electronic Control Assembly of the Stabilization and Control System was found to be unsatisfactory and was replaced at a later date.

On January 20, a decision was made to proceed with a practice run of the Space Vehicle Overall Test number 1, Operations Checkout Procedure 0006. The run was a practice run in that it would have to be repeated since the required participation of the Mission Control Center in Houston, Texas, was not available to support the test until some four days later. The prime objective of making a practice run was to identify at the earliest possible time any procedural or hardware compatibility problems. It is noted that up to this point testing had involved the spacecraft and launch vehicle individually except for the Electrical Mate Test. The opportunity to detect overall spacecraft launch vehicle hardware and procedural problems had not occurred.

It is noted that since initiation of the final manned altitude chamber test, operations had proceeded so well that testing was five days ahead of schedule even after completion of the overall test No. 1 practice run.

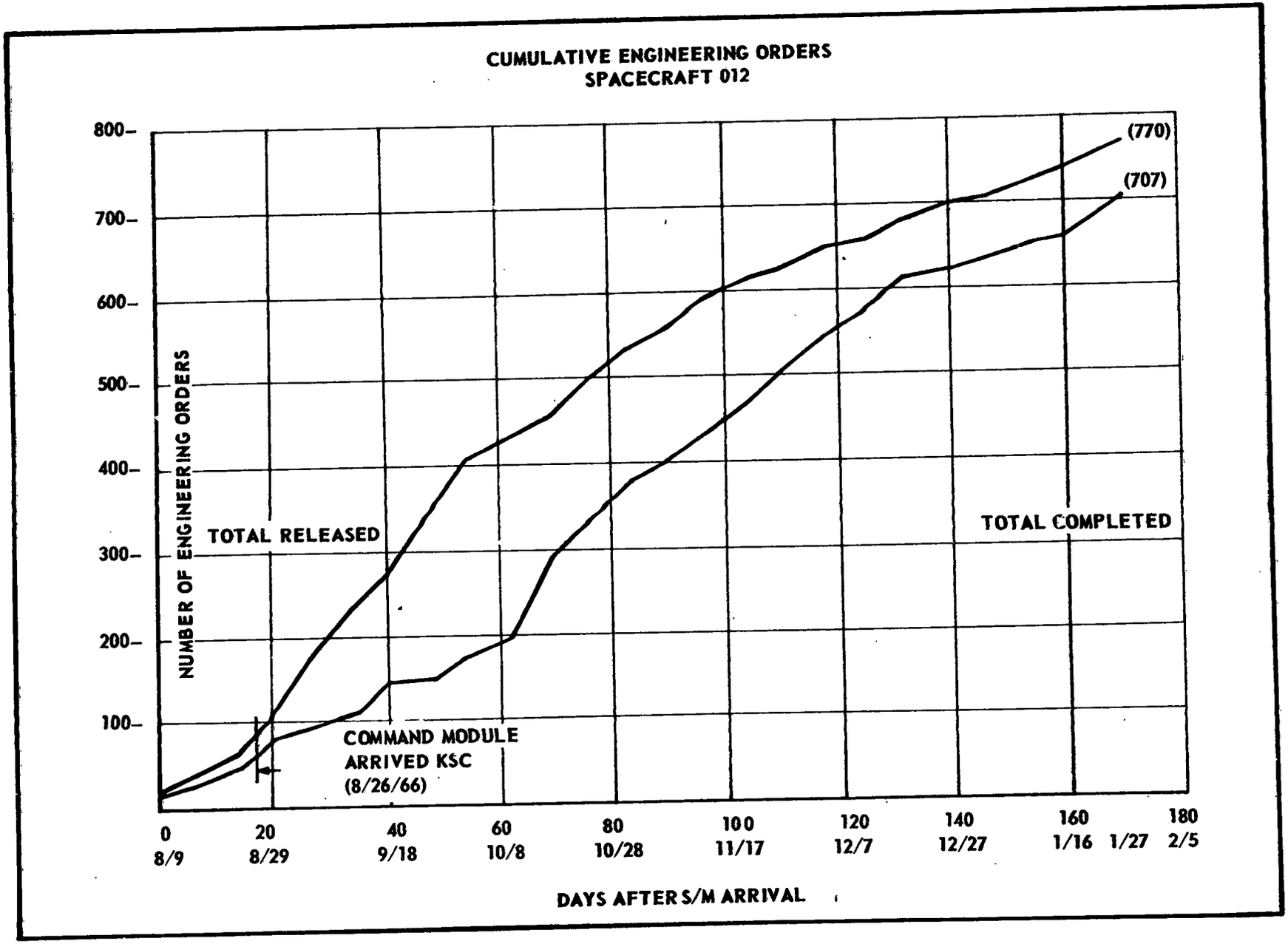
The objective of the Space Vehicle Overall Test Number 1 (plugs in) is to ascertain proper operation of the total Space Vehicle (launch vehicle and spacecraft) during a simulated mission sequence from liftoff to completion of the spacecraft reentry and recovery phase. The practice run was completed successfully on January 20. On the following day minor work items and repairs were accomplished with no work scheduled for January 22 (Sunday). On January 23 minor spacecraft work items and repairs continued in addition to preparation for the Houston Mission Control Center Software Integration Test.

On January 24, the Houston Mission Control Center Software Integration Test was performed per Operations Checkout Procedure 0045. This test verifies that the Houston Mission Control computer programs and equipment performs properly with relation to the spacecraft. This test was successfully completed and the following day the "repeat" run of the Space Vehicle Overall Test Number 1 was made with the Houston Mission

Control Center participating. The test was completed and all test objectives met.

At the conclusion of the Space Vehicle Overall Test Number 1 (plugs in), spacecraft power was left on in order to perform a detailed system test on the yaw Electronic Control Assembly and the Guidance and Navigation System. These systems were suspected of malfunctioning due to a detailed data review of the Operations Checkout Procedure 0005, Integrated Systems Test. It was determined that the yaw Electronic Control Assembly was defective. The unit was replaced and retested satisfactorily. The Guidance and Navigation System was found to be functioning properly. Spacecraft power was removed and preparation for Space Vehicle Overall Test Number 2, Operations Checkout Procedure 0021, was started.

The prime objective of the Space Vehicle Overall Test Number 2 is to verify performance of the total space vehicle during a simulated mission sequence with the space vehicle as near launch and flight configuration as possible. This test was initiated on January 27, 1967.



ENCLOSURE 6-7
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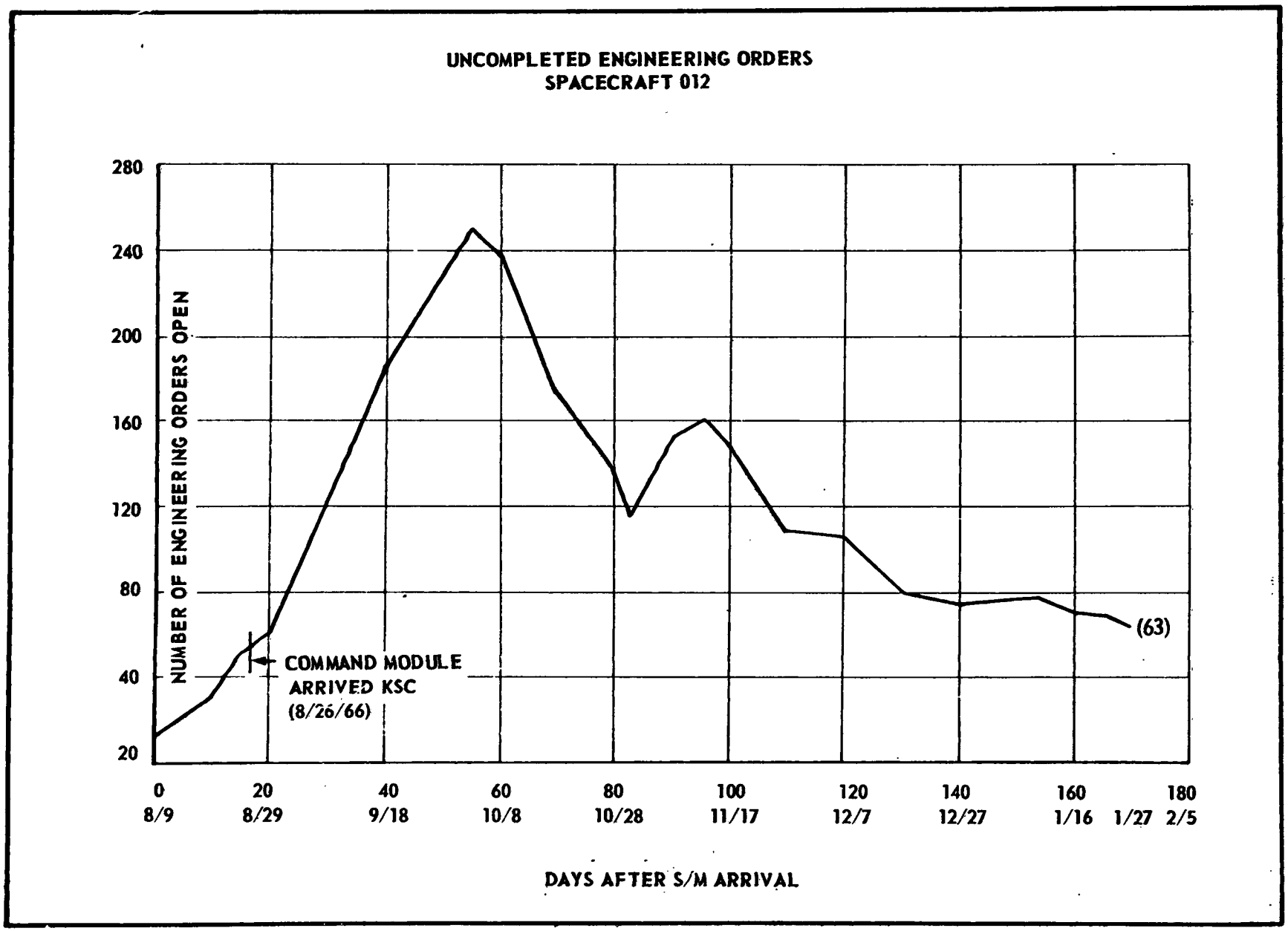
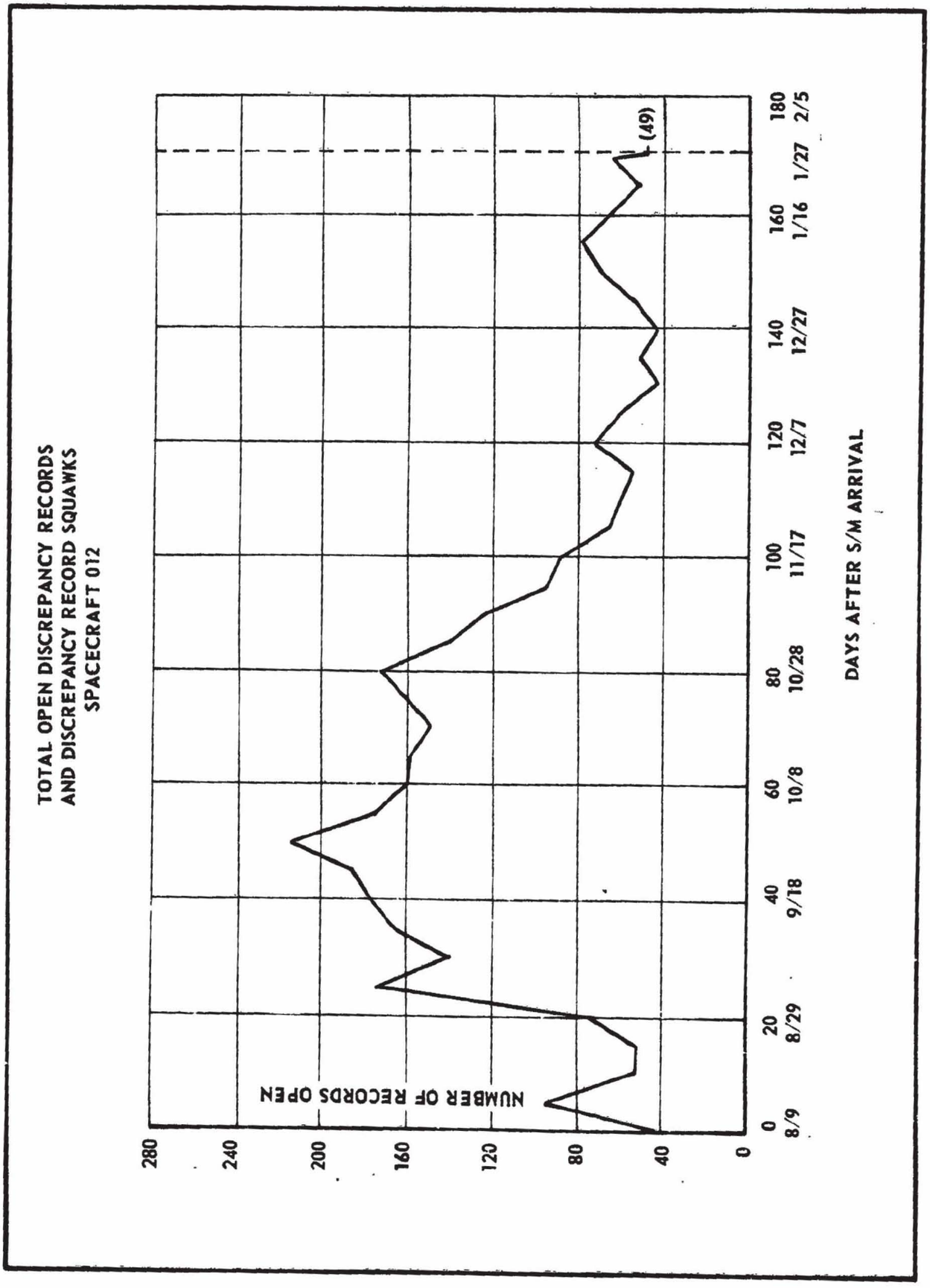
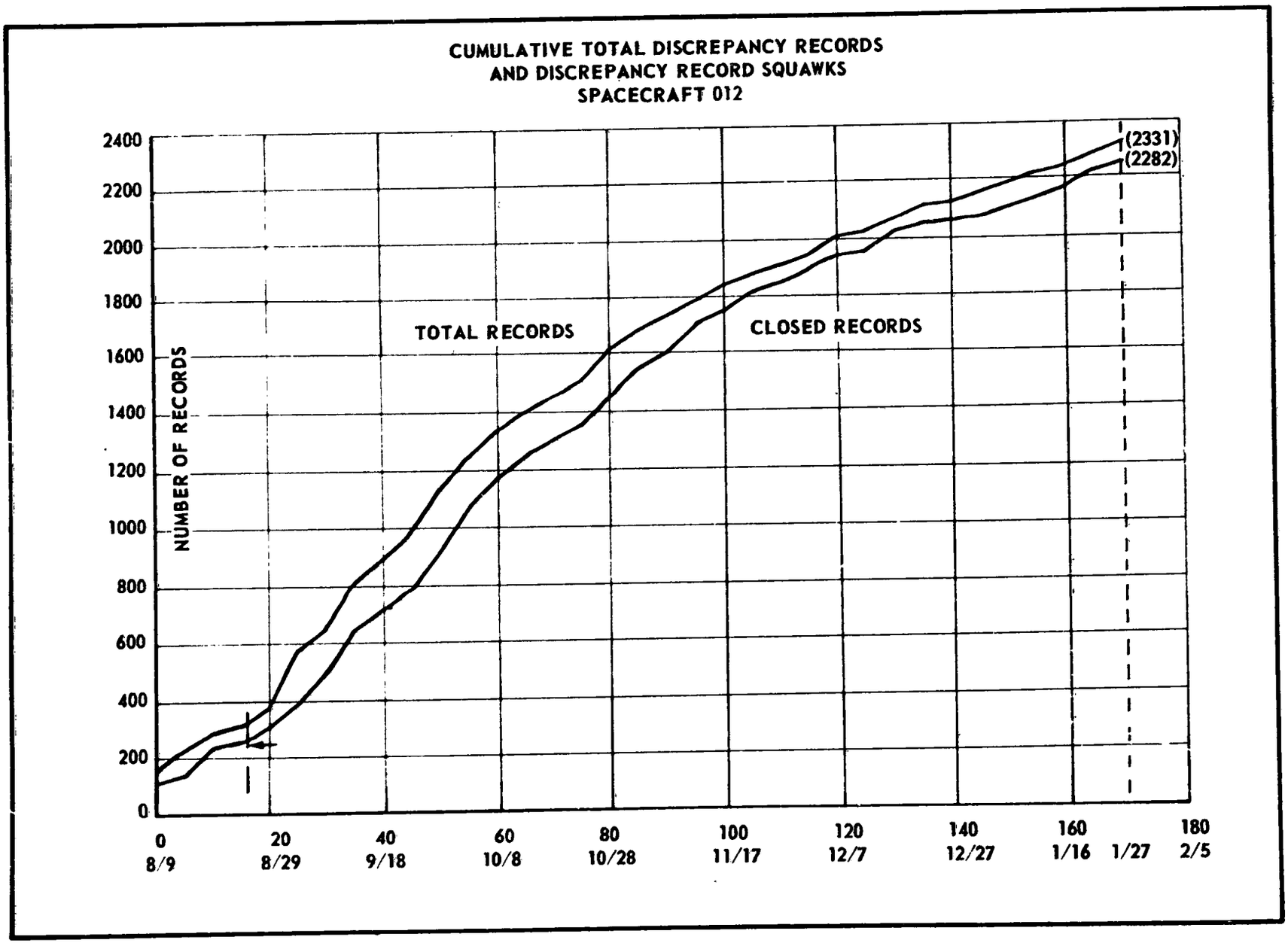
ENCLOSURE 6-7

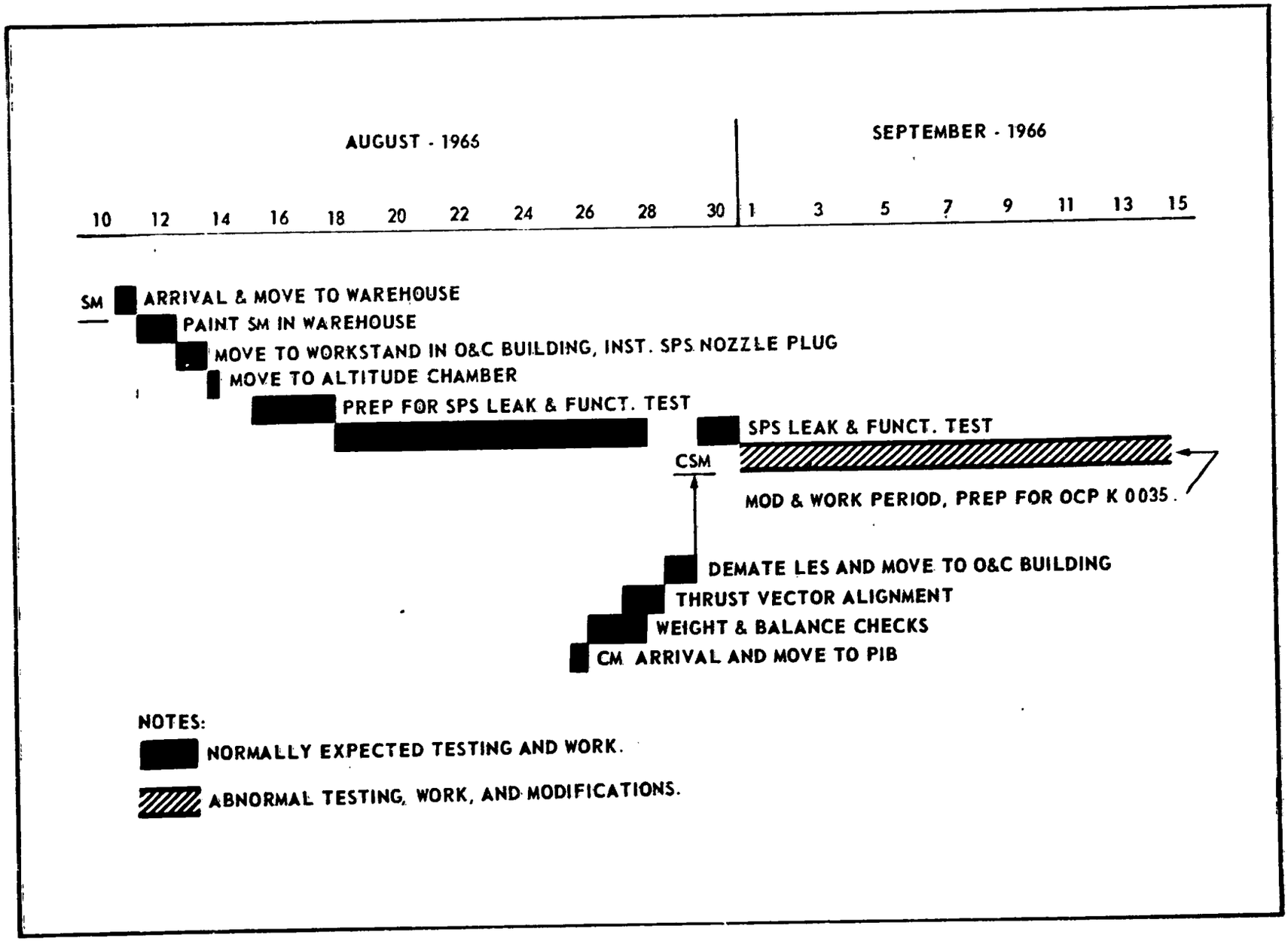




ENCLOSURE 6-7

ENCLOSURE 6-7
D-6-60





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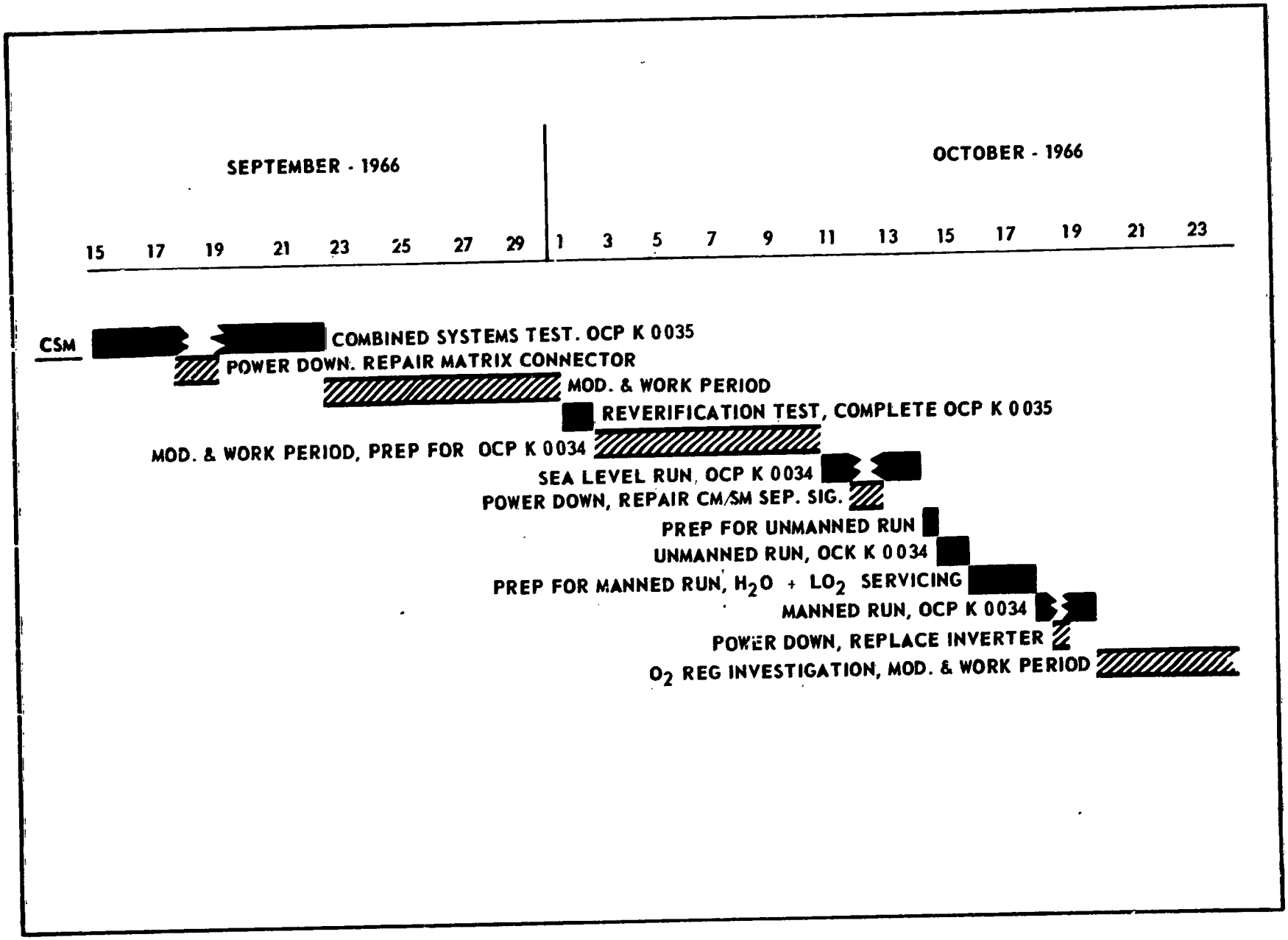

ENCLOSURE 6-7

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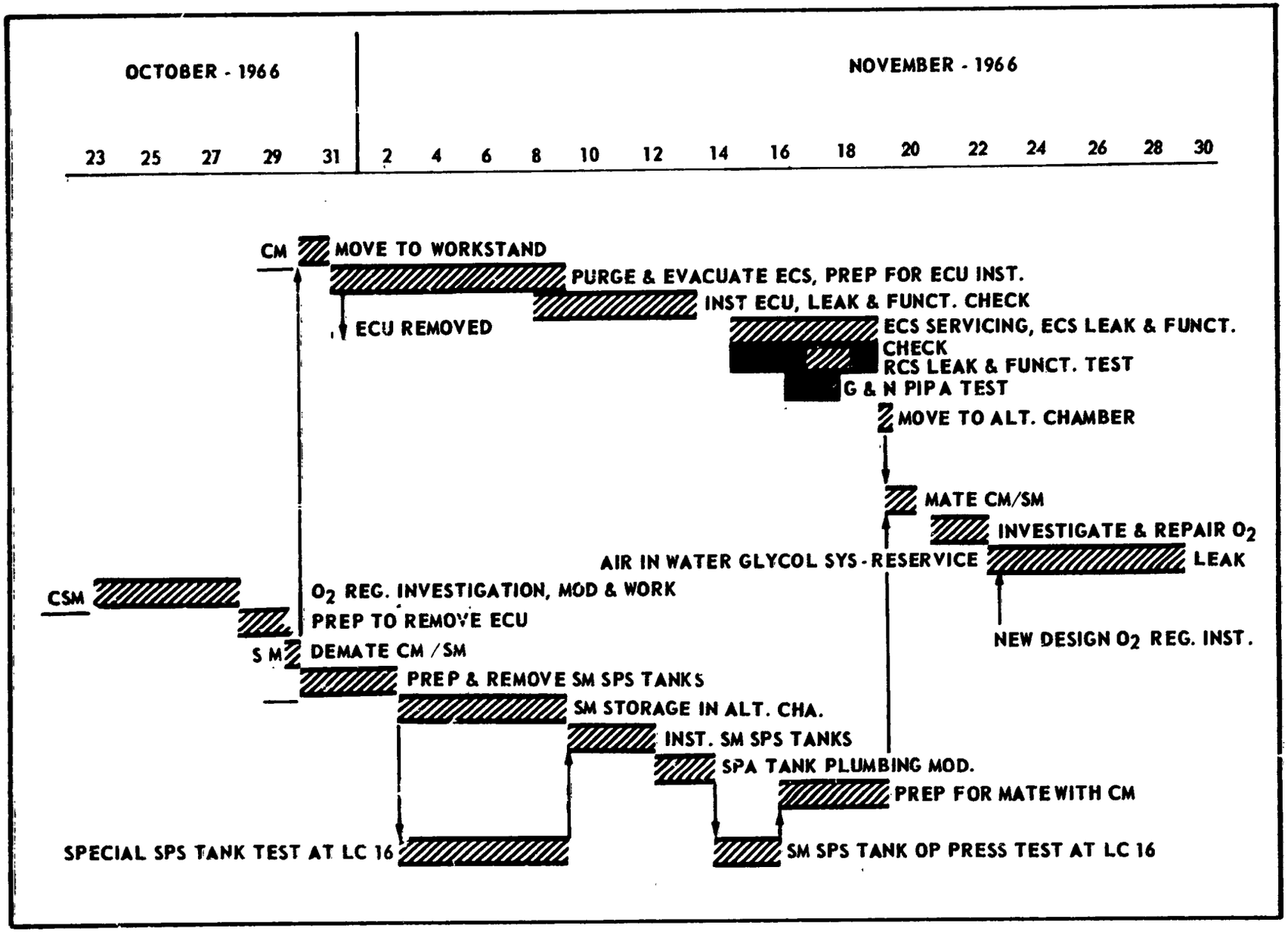

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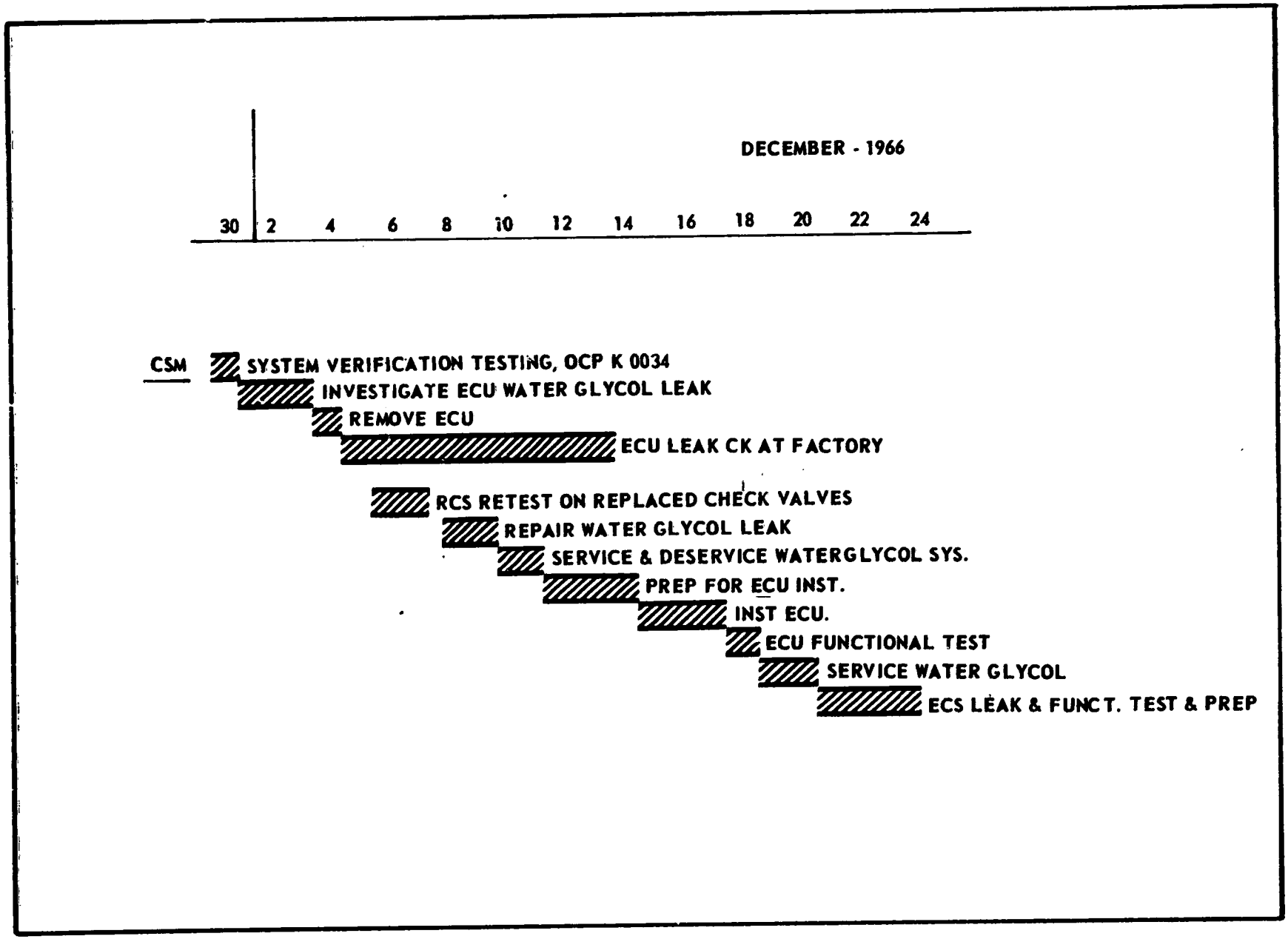

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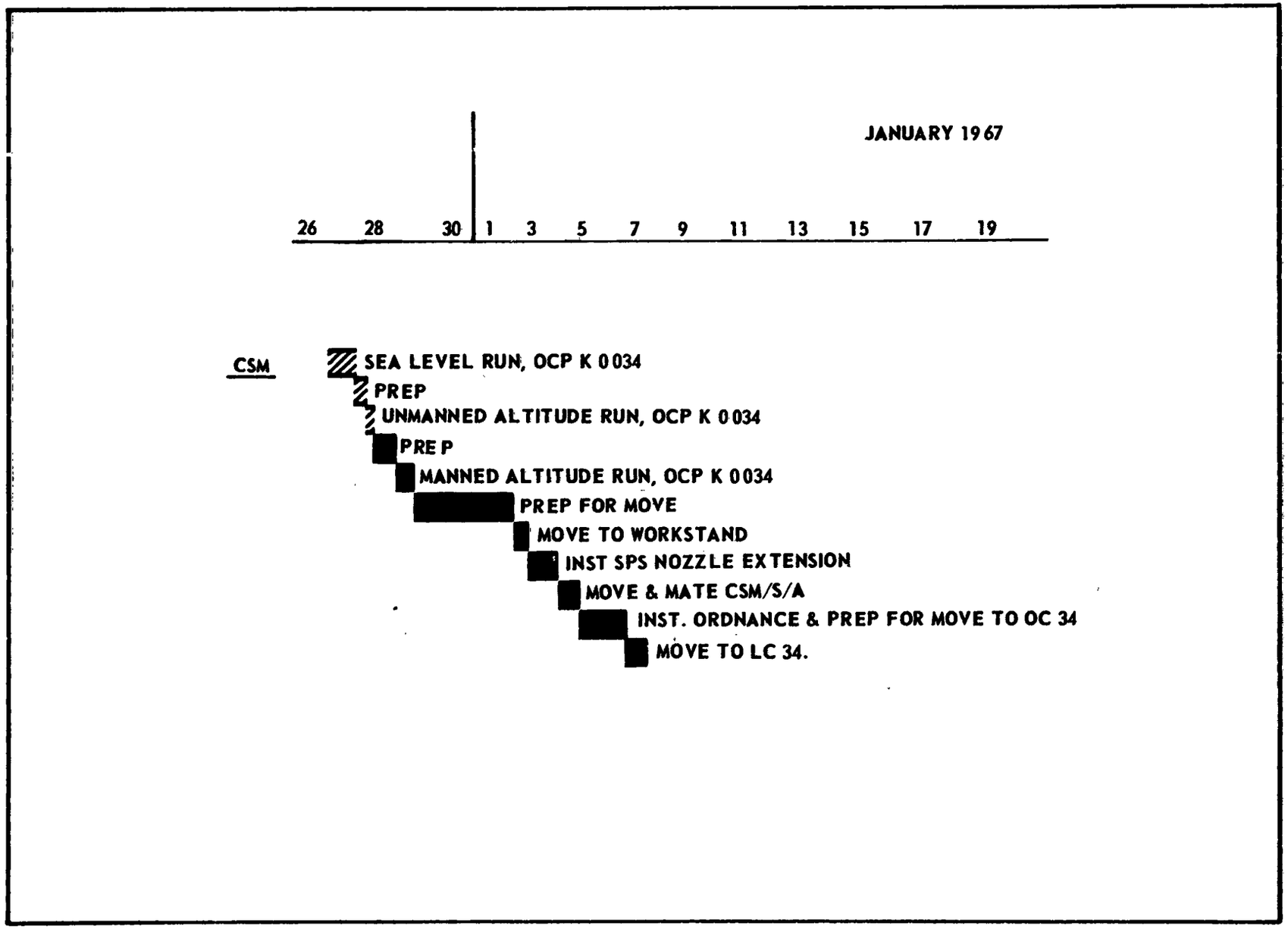

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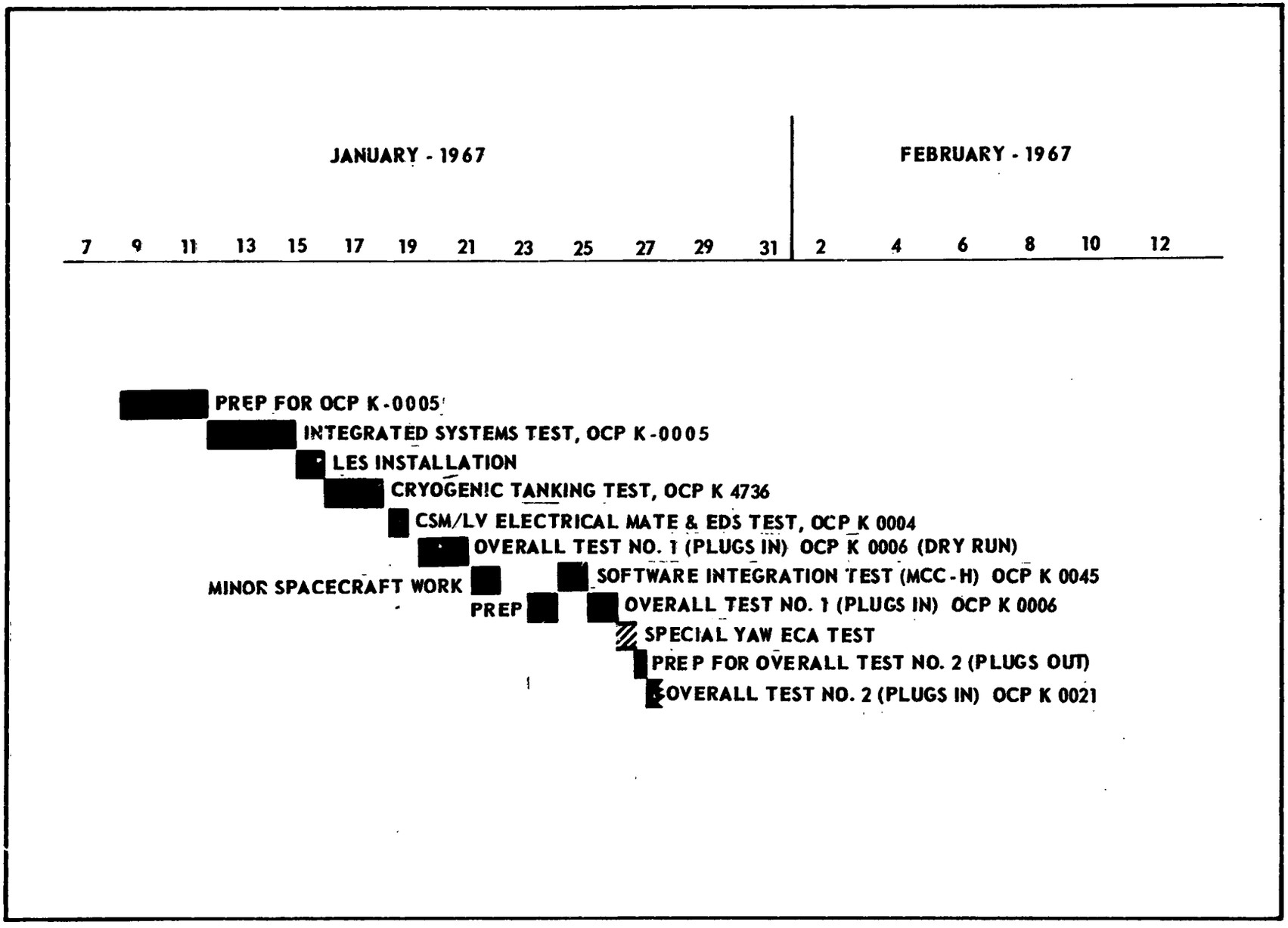

ENCLOSURE 6-7

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APOLLO SPACECRAFT 012

HISTORICAL NARRATIVE FOR PERIOD

OF

SPACE VEHICLE OVERALL TEST NO. 2 PREPARATION

ENCLOSURE 6-7

D-6-67

INTRODUCTION

This report presents a brief historical narrative of the period encompassing final preparation for the Space Vehicle Overall Test No. 2 (plugs out), Operations Checkout Procedure 0021.

The initial portion of the report describes the various types of operational meetings and procedural methods used during the period of checkout described. The final portion of the report includes a cronological listing of pertinent events that occurred in preparation for the plugs out test.

DESCRIPTION OF MEETINGS

Open Items Review

The purpose of an Open Item Review is to examine all paperwork that exists at that point in time depicting work that must be accomplsihed to the Spacecraft and Ground Support Equipment. The basic documents utilized in an Open Item Review are the NAA Spacecraft and Ground Support Equipment Status Reports. At an Open Item Review a constraints list is developed which indicates the work that must be accomplished prior to proceeding into the next spacecraft test. A test constraint is defined as that open work item which if not accomplished would interfere with, or prohibit, the successful completion of a spacecraft test.

Test constraints are normally broken up into two basic categories: constraints to powering up, and constraints to powering down. A constraint to applying power to the spacecraft busses normally indicates work which must be performed that would require modifications (removal and replacement) of spacecraft and/or Ground Support Equipment. Judgement is utilized to recognize hardware availability and work and retest time available in subsequent operations. A constraint to removing

power from the spacecraft busses normally indicates investigation and retest that should be accomplished at that point in the test operation but which would not prohibit the conduct of that test procedure.

Open Item Review Meetings are co-chaired by the NASA Spacecraft Test Conductor and the NAA Test Project Engineer. Functional groups represented at an Open Items Review are as follows:

NAA	NASA
Test Project Engineering	Spacecraft Test Conductor
Engineering (S/C & GSE)	Engineering (S/C & GSE)
Operations	Project Engineering (S/C & GSE)
Inspection	Operations
Shop	Inspection
Service Engineering	Flight Crew Representative
Operations Integration	

Open Item Reviews are normally conducted several days prior to a test in order that appropriate time will be available to work off the identified constraining items.

At the Open Item Review Meeting, the Spacecraft and Ground Support Equipment Status Reports are reviewed and those open items considered to be constraints for the forthcoming test are identified. The identified

constraints are compiled into a single "constraints list" and published shortly after the open item review meeting, usually within three hours. The constraints list identifies the tasks to be worked by system and indicates the responsible person to accomplish close-out of the item.

The constraints list cover sheet identifies the applicable spacecraft test constrained by the list and provides for NAA and NASA approval signatures. Two types of approvals are required. The initial approval signatures indicate that the list is official and are obtained prior to distribution of the list. The final approval signatures indicate that all constraints listed have been worked and closed out. This approval is obtained just prior to going "on station" to start the test. Constraints list approvals are provided by the NAA Test Project Engineer and the NASA Spacecraft Test Conductor.

After completion of the Open Item Review Meeting and subsequent distribution of the constraints list, new items of work are continuously assessed by the NAA and NASA operations engineers. As each new item of work is released, the operations engineer contacts the applicable system engineer to discuss disposition

of the item. The system engineer may or may not proceed to the spacecraft area at this time and actually write the disposition. The main object of the discussion is to maintain the operations engineer's knowledge of new constraints.

Regardless of the previously described discussion relative to the disposition all new items are added to the Spacecraft and Ground Support Equipment Status Reports. New spacecraft work items are reflected daily in the form of an addendum to the basic Spacecraft Status Report utilized at the Open Item Review Meeting. New ground support equipment work items are also reflected in addendums to the Ground Support Equipment Status Report. These addendums are issued weekly or more frequently as required by the amount of new items. Utilization of these status report addendums occurs in real time and at the daily 0800 Status Meeting and 1430 Scheduling Meeting described below.

It is noted that after initial generation of the official constraints list, newly identified constraints become a part of the list in two different manners. If time permits, a revised constraints list is generated. In the absence of appropriate time for revision, the appropriate sheets of the Spacecraft and Ground Support

Equipment Status Report addendums are attached to the original constraints list. The attached addendum sheets are marked to indicate the constraining additional items.

Daily Status Review Meeting

The daily 0800 Status Review Meeting is a general coordination meeting to review the work accomplished during the past 24 hours and to discuss new work items that any have been generated during that same period of time. The following personnel attend the 0800 meetings.

NAA	NASA
Sr. Test Project Engineer	Chief Test Conductor
Asst. Sr. Test Project Engr.	Spacecraft Project Engr.
Engineering Representative	Operations
GSE Representative	GSE Project Engr.
Inspection	Inspection
Shop	RASPO Representative
Service Engineers	Support Contractor Representative
Quality Engineering	
Downey Project Engineering	
Logistics	
Safety Engineering	

Following the 0800 meeting, new work items are scheduled on the Working Schedule Planning Sheet by NAA and NASA Operations personnel. This Planning Sheet is used to schedule all work that must be accomplished on the space

craft and projects three weeks into the future. The Planning Sheet is updated daily if required and is used in supplement to the overall spacecraft schedule. The Planning Sheet is not an official document (not signed by either NAA or NASA) but is given wide distribution throughout the NAA/NASA Test organizations.

In preparation for the 0800 Status Meeting, a complete review of the updated Spacecraft Status Report is conducted by the NASA and NAA operations engineers. This review is usually conducted at the spacecraft where all inspection logs are available to verify the status report.

Daily Scheduling Meeting

At 1430 each day a scheduling meeting is conducted at which the spacecraft work schedule for the next 24 hours is generated. Planning Sheets are utilized at this meeting for reference. At the 1430 meeting, the Spacecraft and Ground Support Equipment Status Report addendums are reviewed to determine if additional constraining work items exist which should be scheduled.

for work. The 1430 schedule meeting is attended by the following personnel:

NAA	NASA
Representatives from each system	Representatives from each system
GSE Representatives	GSE Representatives
Operations	Operations
Quality Engineering	NASA MSC Representative
Safety Representatives	Flight Crew Representative
Inspection	Inspection
Downey Project Engineering	NASA Headquarters Representative

Support Contractor Representatives and other personnel as required also attend this meeting to support the operation.

Note that the individual spacecraft systems are represented individually at the 1430 Daily Scheduling Meeting whereas at the 0800 meeting an engineering coordinator is the only engineering representative.

Pretest Briefing

A Pretest Briefing is a meeting conducted by the NAA Test Project Engineer and the NASA Spacecraft Test Conductor prior to each test to review various aspects of test with other members of the test team. Each

systems engineer presents a summary of his particular system status with relation to state of readiness for the test. Any open items (constraints) existing at that time are identified and anticipated problems associated with the closeout of same prior to the test are discussed. If the test is eminent, a "Go" is requested from each system engineer indicating his complete state of preparedness for the test.

All pertinent operational ground rules for the test are reviewed and past problems of an operational nature are discussed. Specific attention is directed to any hazardous aspects of the test and test discipline. The method of handling certain paperwork during the test, such as procedure deviations, is reviewed and the integration engineer responsible for writing deviations is identified.

A Bar Chart of the test is also reviewed on a system by system basis to briefly review the intent of the test and the manner of accomplishment. The meeting is normally concluded with an announcement of the "on station" time and time for initiation of GSE setup and spacecraft switch list accomplishment.

Personnel normally attending Pretest Briefing are as follows:

NAA	NASA
Sr. Test Project Engineer	Spacecraft Test Conductor
Test Project Engineer	Project Engineer
System Engineers	Operations Engineer
Operations Engineers	System Engineers
Shop Supervision	GSE Engineering
Quality Control	Quality Control
Safety	RASPO
Service Engineers	Flight Crew Systems
Downey Project Engineer	ACE Engineering
GSE Engineers	Flight Crew Representative
ACE Engineering	

It is noted that separate pretest briefings are held for the test team technicians. In this instance only those operational aspects of the test involving the technicians are discussed.

Post Test Debriefing

A Post Test Debriefing is a test team meeting held subsequent to a test for the purpose of determining if the test objectives were met. The Interim Discrepancy Record (IDR) log is reviewed on a system by system basis. Each system engineer explains any problems encountered during the test, the implication of same, and establishes

the post test status of his system.

At the completion of a test, spacecraft power is normally left on for troubleshooting if problems have been encountered during the test. In this event, the post test debriefing is not held until spacecraft power is removed. It is also noted that a complete review of test data is not available at the time of the post test debriefing and it is not uncommon for IDRs to be generated at a later date when a complete data review is available.

A post test debriefing concludes with the decision to perform additional troubleshooting, await further detail data review for analysis, or consider the test complete and proceed into the next test, as the situation warrants. Personnel normally attending post test debriefings are as follows:

NAA	NASA
Sr. Test Project Engineer	Spacecraft Test Conductor
Test Project Engineer	Project Engineer
Systems Engineers	Systems Engineers
Operations Engineer	ACE Engineering
Quality Control	Quality Control
GSE Engineers	Operations Engineering
Downey Project Engineer	Flight Crew Systems
ACE Engineering	RASPO
	Flight Crew Representative
	Flight Crew (if applicable)

CHRONOLOGICAL LISTING

1. January 23, 1967, 1030. Open Item Review Meeting for Operations Checkout Procedures 0006 (Plugs In) and 0021 (Plugs Out). A constraints list was developed with the following open items:

   Operations Checkout Procedure 0006 (Plugs In)

   Constraints to power up - 11 open items.

   Constraints to power down - 16 open items.

   Operations Checkout Procedure 0021 (Plugs Out)

   Constraints to power up - 26 open items.

   Constraints to power down - 2 open items.

   The power up constraints that were developed for Operations Checkout Procedure 0006 were also to apply to Operations Checkout Procedure 0045 (MCCH Software Integration Test) scheduled to be run prior to Operations Checkout Procedure 0006.

2. January 23, 1967, 1230. Pre-test Briefing for Operations Checkout Procedure 0045 and 0006. This meeting excluded the test team technicians.

3. January 23, 1967, 1430. Daily scheduling meeting.

4. January 23, 1967, 1530. Pre-test Briefing, Operations Checkout Procedures 0045 and 0006 for first shift test team technicians.

5. January 23, 1967, 2400. Pre-test Briefing, Operations

5. Checkout Procedures 0045 and 0006 for second and third shift test team technicians.
6. January 24, 1967, 0400. Power on for Operations Checkout Procedure 0045. The constraints list for Operations Checkout Procedure 0006 had been signed off prior to start of the test.
7. January 24, 1967, 0800. Daily status meeting.
8. January 24, 1967, 1430. Daily scheduling meeting.
9. January 24, 1967, 2030. Operations Checkout Procedure 0045 completed. Spacecraft power remained on to close out Operations Checkout Procedure 0006 (Plugs In) constraints. Those spacecraft systems which had no constraints were powered down. A post test debriefing was conducted "on station" on an individual system basis through review of real time recordings and all new Interim Discrepancy Reports (IDR).
10. January 25, 1967, 0400. Operations Checkout Procedure 0006 was started.
11. January 25, 1967, 0800. Daily status meeting.
12. January 25, 1967, 1430. Daily scheduling meeting.
13. January 26, 1967, 0300. Operations Checkout Procedure 0006 (Plugs In) completed. A post test debriefing was conducted on station on an individual systems basis through review of all new IDR's and real time records.

13. Spacecraft power was left on for troubleshooting associated with the Guidance and Navigation System and the Yaw Electronic Control Assembly. IDR's had been written on these systems as a result of detailed data review of the Integrated Systems Test, Operations Checkout Procedure 0005. IDR's were constraints to power up for Operations Checkout Procedure 0021 (Plugs Out).

14. January 26, 1967, 0800. Daily status meeting.

15. January 26, 1967, 0900. A meeting was held at Complex 34 to review the spacecraft readiness status for the Plugs Out Test with the following personnel in attendance:

NAA	NASA
Senior Test Project Engr	Chief Spacecraft Test Conductor
Asst Senior Test Proj. Engr	Spacecraft Test Conductor
	Senior Operations Engr

This meeting was held in order to verify that the spacecraft would be ready to proceed into the Plugs Out Test on the following day and that the NASA Spacecraft Test Conductor could commit the spacecraft for that test to the Test Supervisor. At that time, it was determined that the remaining constraints to the Plugs Out Test (accomplishment of which were required) was the retest of the Yaw Electronic Control Assembly, a spacecraft removals review, and completion of the test checklist.

Based on discussions with engineering personnel, it was agreed that several items that appeared on the constraints list could be waived for the Plugs Out Test, but that they must be accomplished prior to the Flight Readiness Test (Operations Checkout Procedure 0028). The results of this meeting were submitted to the NASA Spacecraft Project Engineer for evaluation. It is noted that a waiver is obtained when it is determined that a work item cannot be accomplished to meet a specific test schedule and that the particular work item is not an absolute test prerequisite, but rather preferential to that test. This procedure has been followed on each of the Apollo spacecraft operations at Kennedy Space Center.

16. January 26, 1967, 1000. Space vehicle post test debriefing. The NASA Chief Spacecraft Test Conductor, NASA Spacecraft Test Conductor, and the NAA Test Project Engineer attended the Plugs In Debriefing held by the NASA Space Vehicle Test Supervisor at Complex 34. At the conclusion of that meeting, the spacecraft status for the Plugs Out Test was summarized. A portion of this summary included the fact that all of the spacecraft data from the Plugs In Test had not been completely reviewed and that there were still final preparations and work items to complete before being ready to meet the scheduled power on time.

17. January 26, 1967, 1430. Daily scheduling meeting.

18. January 26, 1967, 1800. Spacecraft power removed. Power was removed from the spacecraft busses at 1800 on January 26 following replacement and successful retest of the Yaw Electronic Control Assembly. Additional Guidance & Navigation System testing had indicated that the system was operating satisfactorily. IDR constraint to these two systems were closed out.

19. January 26, 1967, 1900. Meeting to discuss revision to Operations Checkout Procedure 0021 (Plugs Out). On January 26 at 1900 a meeting was held to discuss the Operations Checkout Procedure 0021 to be utilized for the Plugs Out Test. A revision to the Plugs Out procedure had been issued earlier in the day at 1730. There was some concern with the timeliness of the revision and its possible affect on the time critical sequences of the test. It was concluded, however, that the revision had been properly reviewed and approved by the test team and a decision was made to proceed with the procedure and test as scheduled.

20. January 27, 1967, 0600. Operations Checkout Procedure 0021 (Plugs In) pre-test briefing.

21. January 27, 1967, 0635. Test Team on station for Operations Checkout Procedure 0021 (Plugs Out).

22. January 27, 0735. Spacecraft power on for Operations Checkout Procedure 0021 (Plugs Out). The test team went on station immediately after the pre-test briefing and the NASA Test Conductor and NAA Test Project Engineer received a "Go" from each Systems Engineer and the Pad Leader verifying readiness to proceed with the test. The Environmental Control Systems Engineer and the Pad Leader stated that they were running late with their preparations but that the remaining work could be completed in parallel with the power up operation. These preparations were required in order to establish the Environmental Control Systems Ground Support Equipment Test configuration required for gaseous oxygen servicing. These preparations were completed satisfactorily at 0900 at which time the Environmental Control System Test was initiated. The Stabilization and Control Systems Engineer gave a qualified "Go" based on incomplete data review. At the start of the test, the NASA Test Conductor and the NAA Test Project Engineer requested that an Interim Discrepancy Record (IDR) be written to document the fact that there was no signed off constraints list for

the Plugs Out Test. The status of each item not signed off on the operations engineers' master constraints list, in addition to those open items accumulated since the generation of the constraints list, were to be provided in the disposition of the IDR at the completion of the test. The Test Conductors chose to request an IDR rather than to sign the constraints list since it was not complete and "up-to-date". The disposition was never documented on the IDR since all documentation was impounded at the time of the incident. It is noted that the constraint list and all open items that were generated between the time of the constraints list generation and the incident had been reviewed (and determined satisfactory to proceed) by NAA/NASA Operations and Systems Engineering personnel.

23. January 27, 1967, 0800. Daily status meeting

Summary of Operations Checkout Procedure 0021
Unsigned Constraints List Situation

A. A constraints list was developed for Operations Checkout Procedure 0021, but was not signed prior to proceeding into the Plugs Out Test since it did not represent an accurate picture of all open paper work due to the additional work generated from January 23 to January 27, 1967. The constraints list had not been formally updated due to the limited time available between tests.

B. The constraints and additional open work items generated after development of the constraints list were under constant review by the test team.

C. Two meetings were held daily between systems personnel (or their representatives) and operations personnel at which time the status of spacecraft open items was discussed.

D. A number of items on the constraints list were evaluated and deferred for accomplishment until after the Plugs Out Test, but prior to the Flight Readiness Test (Operations Checkout Procedure 0028).

E. The status of the spacecraft was known at the time of the test by systems engineering and operations personnel. Readiness reports were received from all operations and systems engineering personnel prior to power up and there were no open work items to constrain the running of the Plugs Out Test.

REPORT OF PANEL 7
TEST PROCEDURES REVIEW
APPENDIX D
TO
FINAL REPORT OF
APOLLO 204 REVIEW BOARD

TEST PROCFDURES REVIEW

A. TASK ASSIGNMENT

The Apollo 204 Review Board established the Test Procedures Review Panel, 7. The task assigned for accomplishment by Panel 7 was prescribed as follows:

Document test procedures actually employed during day of incident. Indicate deviations between planned procedures and those actually used. Determine from review potential changes that might alleviate fire hazard conditions or that might provide for improved reaction or corrective conditions. Review these changes with respect to applicability to other test sites or test conditions.

B. Panel organization

1. MEMBERSHIP:

The assigned task was accomplished by the following members of the Test Procedures Review Panel:

Mr. D. L. Nichols, Chairman Kennedy Space Center (KSC), NASA,
Mr. F. G. Bryan, Kennedy Space Center (KSC), NASA
Mr. J. M. Twigg, Kennedy Space Center (KSC), NASA
Mr. C. O. Brooks, Marshall Space Flight Center (MSFC), NASA
Mr. W. Petynia, Manned Spacecraft Center (MSC), NASA
Mr. W. F. Cahill, North American Aviation (NAA), KSC
Mr. R. H. Jones, North American Aviation (NAA), KSC
Mr. J. C. Wright, North American Aviation (NAA), KSC, Technical Assistant
Mr. J. W. Cuzzupoli, North American Aviation (NAA), Downey
Mr. E. E. Dale, North American Aviation (NAA), Downey
Mr. C. C. Harshberger, North American Aviation (NAA), Downey (Alternate)
Mr. R. L. Swanson, North American Aviation (NAA), Downey (Alternate)
Mr. H. H. Luetjen, Mc Donnell Company KSC

2. COGNIZANT BOARD MEMBER:

Mr. John J. Williams, Kennedy Space Center, NASA, Board Member, was assigned to monitor the Test Procedures Review Panel.

C. PROCEEDINGS

1. In response to the Apollo 204 Review Board, the Panel derived detailed objectives as follows:

a. Document test procedures actually employed during day of accident. Verify and cross-correlate following sources of information.

(1) Offical Operational Checkout Procedure (OCP) FO-K-0021-1, :Plugs Out Test, With Deviations, and associated procedures.
(2) Voice Tape of Test
(3) Cabin configuration as found vs. OCP
(4) GSE configuration as found vs. OCP
(5) Test Conductor's log
(6) Test Project Engineer's log
(7) Test Supervisor's log
(8) Pad Leader's Report
(9) North American Aviation (NAA) Test Monitor report

b. Research the relationship between hardware changes and retest thereof in the period between Altitude Chamber Test and Plugs Out Test.

c. Compare procedural difference between the Altitude Chamber Test as run and Plugs Out Test as run.

d. Document the development of the as run procedure used for the Plugs Out Test.

(1) Chronological development of test philosophy and of the actual OCP.

(2) Relationship between test as developed and MSC/NAA Downey tese requirements.
(3) Effect of philosophy changes on the test.
(4) Assess adequacy of the technical review of the OCP prior to its use.
(5) Assess adequacy of the safety review of the OCP prior to its use.
(6) Review late-change control.
(7) Review deviation control during test.
(8) Evaluate test discipline from voice tape.

e. Evaluate total procedural interface with respect to adequacy and complexity.

(1) OCP FO-K-0021-1
(2) GSE checklist
(3) Crew countdown
(4) What procedures did crew carry on board and use?
(5) What TPS's if any were used to supplement OCP's?
(6) Space Vehicle Plugs Out procedure
(7) Support documentation

f. Evaluate potential effect of automation upon safety of operation.

g. Review overall control of testing requirements with regard to timeless, level of control, and technical integration.

(1) Ground Operations Checkout Plan (GORP)
(2) Process Specifications and Test Specifications
(3) Vehicle Test Planning
(a) Downey
(b) KSC
(c) MSC
(d) Other test sites

h. Evaluate potential changes to vehicle hardware and test procedures to indlude experience gained from Apollo and other related Programs.

(1) Investigation areas in which minor design changes may allow significantly improved checkout capability and alleviate hazardous conditions.
(a) Solicit recommendations from contractor and NASA checkout personnel.
(b) Solicit recommendations from procedure writers.
(2) Review testing philosophy and specific procedures utilized.
(a) Other Apollo test sites
(b) Other Manned S/C programs
(c) Manned Launch Vehicles

2. TEST PROCEDURE EMPLOYED DURING DAY OF ACCIDENT

A master copy of the Space Veicle Plugs Out Integrated Test FO-K-0021-1 S/C 012/014 was developed documenting the procedure as run on the day of the accident. This master procedure used the Quality Control Record copy of the test as a starting point. Information obtained from the test engineers' copies of the Operational Checkout Procedure (OCP) was added.

Voice recordings of communication channels used during time of test were reviewed. Procedural functions performed were checked in the master procedure as they were verified by audio reply. Deviations from published procedures were noted and investigated.

Two (2) intercom channels, designated Black 3 and Black 4, were recorded throughout the test. These two channels were superimposed upon one track of recording tape. The recording was adequate to reconstruct the events immediately prior to the accident. During earlier periods of the Plugs Out Test, Spacecraft test activity took place on approximately half of the fifteen channels assigned to Spacecraft operations. Complete reconstruction of the activity during this period was not possible due to the lack of recording.

The Quality Control (QC) copy of the OCP, which Panel used as a baseline, was incomplete. Operating method did not require continuous QC monitoring of each communications channel in use during test.

Spacecraft switch positions specified in the OCP were compared with the as-found post accident positions. There were no functionally significant differences except for the main bus tie switches (2). Telemetry data indicates the bus tie switches were positioned by the crew subsequent to the detection

of the fire. The pocedural sequence in which each switch was last positioned was also identified. One significant circuit breaker (CB-116) position was noted. The closed circuit breake.r, as specified by the OCP, applied power to gas chromotograph cable although the instrument had been removed and documented by approved procedures.

3. RELATIONSHIP BETWEEN HARDWARE CHANGES AND RETEST THEREOF

A. Records were researched to determine relationships between hardware changes and retest verification made during the period between the Altitude Chamber Test (OCP FO-K-0034-A) and the OCP run on the day of the accident. Appropriate modifications, rework, and discrepancy items were defined for more detailed review. The review included Interim Discrepancy Records (IDR), Discrepancy Records (DR), Test Preparation Sheets (TPS), and Engineering Orders (EO), which were worked between the Altitude Chamber Test (OCP-K-0034-A) and the Plugs Out Test (OCP FO-K-0021-1). Both of these tests were run with the spacecraft hatch closed and an oxygen (O_2) cabin environment. Emphasis was placed on review of electrical changes, such as modifications to spacecraft wiring, replacement of electronic boxes, and Ground Support Equipment (GSE). The required retest was performed for all spacecraft changes except for those noted in Enclosure 7-2.

Definition of retest required and the point at which it constrains subsequent testing, is determined by the responsible NASA and NAA System Engineers. Documentation of these requirements is defined by Apollo Pre-Flight Operations Procedure (APOP) Manual No. T-501, 5.1.

b. An open item review prior to starting any test is required by Apollo Pre-Flight Operations Procedure (APOP) No. 0-202. This was accomplished and a constraints list complied on January 23, 1967, four days prior to the implementation of the test. The review allowed lead time for accomplishment of the open items prior to the test. However, additional open items were accumulated on the daily Spacecraft status Report in the form of released Test Preparation Sheets (TPS), Discrepancy Records (DR's), Discrepancy Record Squawks Sheets (DRSS's), and Interim Discrepancy Records (IDR's). This accumulation of open items was not added to the constraints list. Systems engineers were expected to be aware of these items which were published in the Daily Status Report. The Panel requested clarification from the NASA Chief Spacecraft Test Conductor (CSTC). The response statement is included as Enclosure 7-2. According to referenced enclosure, the accumulation of open items was "under constant review by the test team." The enclosure indicates that certain items were evaluated and deferred until after Plugs Out OCP FO-K-0021-1 and prior to Flight Readiness Test (FRT).

The NASA Spacecraft Test Conductor (Organization Chart; Enclosure 7-1) normally gets a sign-off by each systems engineer verifying that no constraints to the test exists in his system. The Test Conductor can, therefore, affix his signature to the Constraints List verifying that all constraints have been resolved. The Test Conductor is required by APOP 0-202, paragraph 6.3.6, to sign the Constraints List prior to beginning the test.

The Test Conductor and NAA Test Project Engineer agreed to proceed with the test based upon the reasons listed in Enclosure 7-2. The available Constraints List was not signed off since it was not complete list of all open items due to the additional work generated from January 23 to January 27, 1967. Interim Discrepancy Record No. 001 was issued noting that the Spacecraft was powered up without the Constraints List formally signed off.

This Panel did not evaluate whether the open items, as discussed in the referenced enclosure, contributed to the indident. This item was referred to Panel No. 18 of the Review Board for analysis.

4. COMPARISON OF ALTITUDE CHAMBER TEST AND PLUGS OUT TEST

The differences between the OCP s were evaluated in an attempt to identify functions which may have been improperly performed in the Plugs Out Test. The procedural differences were attributable to required configuration differences with one exception.

During the Altitude Chamber Test only those functions required prior to altitude simulation were performed with cabin pressures greather than sea level, and an O_2 environment. During Plugs Out, all testing after hatch closeout was to be accomplished with the cabin at greater than sea level pressures and an O_2 environment. In th e Altitude Chamber, the cabin was pressurized with O_2 four times (varying from 1 hour to 2 hours 30 minutes) for a total of 6 hours 15 minutes at pressures greater than sea level. This length of time is two and a half times as long as the cabin was pressurized with O_2 prior to the accident during Plugs Out Test.

The analysis of differences, and methods of implementation between the Altitude Chamber Test and Plugs Out Test, has not provided any discrepant conditions that could contribute to the cause of the accident. The Test Configuration differences are covered in the report of Panel No. 1.

5. DEVELOPMENT OF THE PLUGS OUT TEST

The Plugs Out Test procedure was reviewed to determine the adequacy of the system used in developing the OCP.

a. The chronological development of the Plugs Out Test philosophy and OCP was documented (Enclosure 7-3).

The Plugs Out Test was defined in preliminary form on July 12, 1966. In September, the crew emergency egress practice was added to the test procedure, to be performed at the conclusions of the Plugs Out Test. The preliminary OCP was released and reviewed in October. In November the OCP was modified to provide closed hatch operation during the test. The approved OCP was released on December 13, 1966. The revisions designated as dash one (-1), was released on January 26.

b. The relationship between the test as developed and MSC/Downey test requirements was reviewed.

The MSC test requirements document is the Ground Operations Requirement Plan (GORP). It is primarily a flow plan through the various test locations used to prepare the vehicle for flight. The definition of testing to be performed varies in detail from test to test While some specific testing requirements are defined, emphasis is more on sequence than on specific technical requirements. The NAA, Downey prepared test specification for the Plugs Out Test (Process Specification MAO-0201-3214, Revision B, dated August 19, 1966) is written in test procedure format. This document contained outdated pretest switch lists, and a GSE listing not compatible with GSE available at KSC. It lacked the detail of engineering specifications to which systems should be tested, and was not directly relatable to overall vehicle test planning at KSC. The process specification is an internal contractor document used to prepare test procedures for NASA approval.

NAA personnel at KSC (NAA, Fla) prepared an overall test plan for KSC covering operations from receipt of the vehicle to launch. SP 64, S/C 012 Test Outline, was published and presented to MSC for review containing the outline of the Plugs Out Test. Specific procedures for system operation were based on the Test Outline and NAA Downey Test Procedures. They were also extracted from previously run procedures at KSC. The Plugs Out Test Procedure meets the intent of both the MSC GORP and the NAA Downey Test Specification.

c. Effect of philosophy changes on the test was evaluated.

Major changes such as closed hatch, O_2 cabin environment, and crew emergency egress practice were generated and implemented subsequent to the preliminary Plugs Out OCP preparation. These changes were made with sufficient lead time to allow timely incorporation into the procedure.

d. The adequacy of the technical review of the OCP was assessed.

The technical review of the OCP was as adequate for initial release of the procedure. NASA and NAA engineering representatives for each system, participated in the review prior to approval of the Plugs Out Procedure. A detailed review of the subsequent revision showed that the percentage of changes attributable to technical error in the original procedure was approximately one percent.

e. The adequacy of the safety review of the OCP prior to its use was assessed.

The KSC Safety Office did not receive or review the procedure since it was not submitted as a hazardous test. (Enclosure 7-5.) All participants in the test failed to realize the extent to which hazard potential existed. This is evidenced by the following: (a) a Safety Office review of the procedure was not made, (b) Pad Emergency Procedures were not prepared, and (c) Fire fighting and ambulance equipment were not on the pad during the test. This procedure was handled in accordance with normal operating methods as shown in Enclosure 7-4.

f. OCP revision control was reviewed.

The basic procedure, OCP FO-K-0021-1, was released and distributed on December 13, 1966 and consisted of 275 pages. Following the release, there were many changes in the OCP. These changes were collected and incorporated into "flimsies" (preliminary copies), six (6) of which were circulated for systems engineering review two days prior to the test. The resulting revision, consisting of 209 replacement pages, was distributed at 5:30 p.m., January 26, 1967, 14½ hours before start of the test.

The technical changes to the OCP were not as great as the number of changed pages would indicate. The actual changed lines represented less than 25 percent of the revision with the remaining 75 percent being required to allow full page replacement. (If one side of a page is changed, both sides must be reprinted.) The reasons for these changes were researched. The basic causes for change were defined:

(1) To make the OCP compatible with the updated Flight Crew Checklist.

(2) To make the OCP sequences similar to the Spacecraft Launch Countdown which was first published on January 23.

(3) To perform the Emergency Detection System Test at a different time due to new Launch Vehicle requirements.

(4) To incorporate the experience gained from running the Plugs In Test (OCP-K-0006).

(5) To incorporate items existing in the Space Vehicle procedure.

(6) To delete the Guidance Computer erasable memory update since the Mission Control Center Houston (MCCH) was unable to support the test.

(7) To incorporate general operational improvement.

(8) To correct the OCP technical and typographical errors.

(9) To perform certain crew stowage operations transferred from the Altitude Chamber Test to the Plugs Out Test.

A copy of the entire revision has been annotated, with the reasons for the change, and submitted as reference material.

A number of the changes were not avoidable, considering the first-of-a-kind mission. However, the changes were not integrated into OCP revisions and released early enough to allow test personnel to become completely familiar with the test as it was to be run.

g. Review deviation control and documentation during test.

A review of the 106 OCP deviations written during the test showed that they were handled in accordance with requirements of APOP No. 0-202. This procedure permits performing deviations during the test with the documentation of the deviation to be coordinated subsequent to the test. The forms were not completed during the test in many cases and the impodunding of documents prevented their normal post-test completion. As a result, the Panel had to work from incomplete records.

h. Evaluate test discipline from voice tape

The overall test discipline displayed by the voice tape recordings was generally adequate, but was hindered by communications difficulties. There was considerable evidence of uncoordinated switching during the period of communications troubleshooting which left the Spacecraft Test Conductor in doubt as to on-board system configuration.

A contributing factor to this undesirable condition was the chronic difficulty which had been experienced with communications during previous tests.

During the period of difficult communications between the Flight Crew and Spacecraft Test Conductor, the procedures to isolate the problem appeared haphazard and uncoordinated. The troubleshooting did not isolate the cause of the poor communications, even though several hours were spent in trying various links and communications configurations. Troubleshooting at times was being run independently from three locations; the Spacecraft, Launch Complex 34, and the Manned Spacecraft Operations Building (MSOB). This occurred due to lack of a single controlling station to coordinate and direct the total troubleshooting effort.

6. REVIEW OF PLUGS OUT TEST SUPPORT DOCUMENTATION

A list of documents required in direct support of the Plugs Out Test was compiled (Enclosure 7-18). The purpose, scope and operational interfaces of these documents were evaluated to determine their overall technical and or operational adequacy and complexity.

a. Crew Checklist and OCP

One potential source of confusion was the overlap between the pre-launch switch configuration contained in the OCP (prepared at KSC) and that in the Apollo Crew Abbreviated Checklist (prepared at MSC). It was determined that no copies of the Apollo Crew Abbreviated Checklist were taken into the spacecraft. The crew had copies of the OCP Switch Checklist but no copies of the entire OCP.

b. The Ground Support Equipment (GSE) Checklist

The GSE Checklist adequately defines required pre-test setups. The procedure refers to other documents for the step-by-step installation of equipment but effectively retains control of overall test setup operation.

c. The Space Vehicle Plugs Out Procedure

The Space Vehicle Plugs Out Procedure was written as the overall control document for the Plugs Out Test. The intent of the space vehicle procedure was to provide the Test Supervisor with the interface points required to maintain overall control in the test. The space vehicle procedure also covers both launch vehicle and spacecraft interfaces with external organizations such as the Eastern Test Range, Mission Control Center, Houston, etc. The space vehicle procedure accomplished this function. Actual launch vehicle operations were performed from a launch vehicle procedure under the direction of Launch Vehicle Test Conductor. Similarly, the spacecraft team under the direction of The Spacecraft Test Conductor operated from the spacecraft OCP.

Each of the procedures provides specific data for performing independent operations usually by different groups of personnel. To combine or modify any of these documents would possibly increase the confusion and complexity of the end objectives. The documentation as defined fulfills its intent and no significant requirements for changes are noted by the Panel.

7. POTENTIAL EFFECT OF AUTOMATION UPON THE SAFETY OF THE OPERATION

Acceptance Checkout Equipment (ACE) system capability and the ACE to spacecraft interface was reviewed. While some computer program changes were proposed to aid checkout and improve safety (Reference 7-7), no significant area was found where additional automation could substantially increase safety without a significant enlargement of the ACE to spacecraft interface. ACE computer programs neither contributed to the accident, nor could they have been used in the existing ACE configuration to reduce or extinguish the fire.

Computer program and hardware design precludes the ground computer from operating the existing GSE and facility systems pertinent to extinguishing a fire. In addition, existing fire retardant or extinguishing systems are inadequate to cope with such an emergency. If active fire retardant or extinguishing systems are added in the future, a careful analysis should be made before automating these systems. Activating emergency systems such as nitrogen purge or pressure relief may present additional hazards to personnel.

In reviewing the existing method of activating safety systems on both the Spacecraft and GSE, it is evident that additional remote control capability should be considered for systems such as:

a. Service Structure Water Deluge
b. ECS Control
c. Electrical Power
d. GN_2 Deluge
e. Pressure Supply and Control
f. Cryogenic and Hypergolic Supply

8. CONTROL OF TEST REQUIREMENTS

A review of overall control of testing requirements with regard to timeless, level of control, and technical integration was accomplished. This task was treated in two basic parts. Part a. dealt with the review of Apollo S/C 012 pre-launch test and checkout documentation. Part b. of the task encompassed the review of pre-launch test and checkout documentation, planning and control as applied to other similar programs as related to Apollo Spacecraft.

a. S/C 012 Pre-launch Test and Checkout Documentation.

Documentation can be categorized into four major types:

(1) Pre-launch Checkout Requirements
(2) Test Specifications and Criteria
(3) Checkout Plan
(4) Checkout Procedures

The first two categories represent the requirements imposed upon the pre-launch operations and the last two, methods for implementing these requirements.

(1) Pre-launch Checkout Requirements

Pre-launch checkout requirements are established in the Ground Operations Requirements Plan (GORP). This document, as currently approved, establishes the contractual baseline for the sequential flow of the Spacecraft and for the tests to be conducted at each test station in the flow. The GORP is prepared by NAA, Downey as a contractual document for MSC-Houston, requiring joint NAA MSC approval (Class I). The GORP effectiveness as a test requirements document is

hampered by its original intent as a GSE provisionin document. The GORP also contains considerable detail not directly applicable as requirements. Because of this level of detail it is difficult to maintain the GORP current through formal contractual channels.

The GORP is a Class I document between MSC and NAA but in the case of CSM 012 it was not formally submitted to KSC by MSC. NAA releases the requirements through its internal document distribution system which constitutes formal direction to its field organization. Implementation of the GORP by NAA, Florida results in a situation whereby the contractor may, in fact, provide direction to KSC.

(2) Test Specifications and Criteria

The Test Specifications and Criteria for Apollo are contained in the NAA generated process specifications MAO-201-XXXX. For CSM 012 the document was written in a procedural sequence format, rather than by system, makeing determination of the actual engineering hardware performance values and tolerances difficult. The specifications were not updated to provide the latest configuration and tolerances. However, NAA, Downey personnel were assigned to Florida on a temporary basis to assist in interpreting the requirements. This information is made available to NASA-KSC by the NAA, Florida at KSC. The Process Specification documents do not require NASA, MSC approval and are not sent to MSC for information unless specifically requested (Class III). The requirements contained therein are not necessarily screened by MSC or KSC. These specifications are generated within NAA, Downey and forwarded to NAA, Florida to be implemented in the Operational Checkout Procedure.

(3) Checkout Plan

The Checkout Plan for Apollo is contained in the Florida Facility Test Flow Plan. This document is prepared by NAA, Florida for NSA-KSC approval. The Test Flow Plan establishes the flow of the vehicle through KSC, the sequence of tests to be performed, and the activities to be accomplished in each OCP at each test location. The plan implements the intent of the GORP but may not implement the operational requirements in the precise manner stated in the GORP. There is no formal requirement for the plan to be submitted to either MSC or to NAA, Downey for review or approval. It is used extensively by pre-launch and launch operations personnel of both NASA, KSC and NAA, Florida.

(4) Checkout Procedures

The pre-launch OCP's are written locally at KSC by NAA-Florida and approved by NASA-KSC. These procedures are forwarded to both MSC and NAA, Downey for review. However, because of the late release of the OCP's an acceptable before-the-fact technical review of the procedures, other than by local KSC personnel, has not been feasible. The OCP's provide a detailed step-by-step procedure for the accomplishment of an activity or task during the pre-launch and launch operations at KSC. The OCP's are related to a particular task or functional activity and are based on the GORP, the Florida Facility Test Flow Plan and the Process Specifications (Enclosure 7-4).

b. Control of pre-launch test requirements

A detailed review of the overall control and implementation of the pre-launch operational requirements and the test specifications and criteria was accomplished. This review was centered primarily around the type of documentation used on programs similar to Apollo and the type that was used specifically for S/C 012 The review also encompassed the adequacy of content and timeliness of the documents to support its intended use. The Panel interviewed representatives from the following:

Marshall Space Flight Center, Kennedy Space Center, for the Saturn 1B and Saturn V Launch Vehicles

North American Aviation, Manned Spacecraft Denter and Kennedy Space Center, for the Apollo CSM Spacecraft

McDonnell Company Manned Spacecraft Center Resident Gemini Program Office at KSC, and Kennedy Space Center for the Gemini Spacecraft

The types of documentation used by the above programs were obtained and reviewed by the Panel for definition of requirements and the implementation of these requirements in pre-launch checkout operations at KSC (Enclosures 7-6 and 7-7).

(1) Saturn

Delegation of pre-launch checkout and launch implementation responsibility from MSFC to KSC was the significant feature of the Saturn Launch Vehicle Program. This relationship was complemented by the existence of detailed inter-Center agreements and by KSC controlled supplemental contracts with stage prime contractors to implement the delegation. The engineering pre-launch checkout requirements, specifications, and criteria are formally controlled by MSFC, Enclosure 7-7. This control is

accomplished by having the necessary documentation prepared by the respective stage contractors for MSFC. The documents, upon MSFC aaproval, are then levied upon KSC and its stage contractors for implementation. A formal response is required from the KSC stage contractor to MSFC via KSC. This response is in the form of checkout plans and procedures. A significant characteristic of this method of control is that formal contractor direction is accomplished only through MSFC/KSC channels. The stage prime contractor home/field relationship is one of informal technical coordination and communication.

(2) Gemini

The MSC Resident Gemini Program Office (RGPO) at KSC provided for rapid response to operational changes. This was primarily accomplished by after-the-fact contractual closure of open items, and changes on a quarterly basis.

Pre-launch checkout requirements were prepared by the contractor's field organization at the launch site with parallel feedback to the home plant, MSC-RGPO, and MSC-Houston.

(3) Apollo

The Apollo Spacecraft pre-launch operational requirements flow is characterized by a highly centralized control exercised by the MSC-Apollo Program Office at Houston. Since MSC approval is required prior to implementing detailed operational changes in pre-launch planning, there is an inherent slow response loop which constrains normal pre-launch activity. The lack of detailed inter-Center agreements relating to the delegation and control of spacecraft pre-launch operations at KSC is another factor. This lack of detailed agreement clouds the definition of MSC and KSC roles and missions and the interface involved, leading to misunderstandings.

The S/C Contractor at Florida is subject to technical direction from both KSC and its home plant. This direction may be conflicting. Clarification of S/C Contractor pre-launch direction at the field site would materially improve the implementation and control of pre-launch operations.

c. Improvements Currently in Progress

During the course of the investigation, it was determined that several significant changes are presently being made in the system of pre-launch checkout documentation and management control.

It was determined that the s/c Contractor (NAA) is in process of preparing a specification covering spacecraft checkout requirements applicable to factory acceptance (Contract End Item Specification, Part II). This document is Class I and requires approval sign-off by MSC-Houston. The S/C Contractor (NAA) has, since early January 1967, initiated action to develop a new type of checkout requirements and specification document to cover field operations. This document will represent a logical extension of the Contract End Item Specification, Part II, in that it will provide requirements and specifications tailored to field pre-launch checkout operations. The new specification will replace a multitude of existing subsystem, interface, and integrated system level specifications. It will be system-oriented and will take precedence over the existing specifications.

This type of document will satisfy the intent of the test specification and criteria document as required for testing at KSC. The authority for, and description of, the new format of specifications is stated in Enclosures 7-9 and 7-10.

Several major changes intended to improve the control of Apollo Spacecraft pre-launch operations requirements are also underway in response to the direction received from the Apollo Program Director in the NASA-OMSF memorandum of January 31, 1967, subject: Minutes of Meeting at KSC, January 26, 1967 (Enclosure 7-11).

9. POTENTIAL IMPROVEMENT IN CHECKOUT CAPABILITY

The panel investigated areas in which minor design changes may be made which will permit a significant improvement in checkout capability in the areas of safety and alleviation of hazardous conditions.

This task was treated in two basic parts. Part a. covered recommendations from contractor and NASA test and checkout personnel in the area of hardware changes. Part b. covered recommendations for improvements in the areas of operations and procedures.

a. Recommendations for Design Changes to Hardware

The Panel interviewed NASA, KSC and NAA, Florida system engineers with regard to recommendations for design changes affecting either spacecraft or GSE hardware. Their comments and recommendations were categorized by spacecraft subsystem with an explanation of the reason for the change and the advantages that will be gained if the change is incorporated. Panel 7 screened and evaluated the proposed changes on the basis that the change would provide increased margins of safety or that the improvement in the checkout operations will contribute to safer operations. The review included a comparison of the master measurement lists for Block I and Block II spacecraft. The system engineers submitted 110 recommendations for design changes. Of these changes 92 effect the Apollo, 1 the LM and 17 the GSE.

Results of this review were forwarded to Panels 9 and 18 for final review, disposition and closeout.

b. Recommednations for Changes to Procedures

The Panel evaluated potential changes to test procedures as a result of investigating areas in which such changes may allow significantly improved checkout capability to alleviate hazardous conditions. Interviews and briefings were conducted with procedure oriented engineers and management personnel from Apollo and other related programs. The methods and procedures are sound in concept for both administrative and technical direction and control of the preparation, publication, release, and revision of OCP. However, in post test evaluation, the content (and scope) of test deviations should be evaluated by test management to ascertain that test objectives have been met and that procedure preparation was adequate.

e. Review of Philosophy and Procedures

Review testing philosophy and specific procedures utilized on other manned programs and launch vehicles.

(1) This item was investigated by addressing a number of questions to the various programs and sites in order to understand the different test policies, operating standards, and test management structures.

Programs and sites considered were:

(a) Apollo - KSC
(b) Apollo - Houston (Space Environmental Simulation Laboratory)
(c) Apollo - Downey
(d) Gemini - KSC
(e) Saturn - KSC
(f) Titan - (Titan I, Gemini Launch Vehicle, and Titan III)
(g) LM - KSC (Planned Approach)

The questions asked were:

(a) Does Safety review all test procedures?
(b) Is there a formal work item review prior to each test?
(c) Does Q C monitor the operation and in what capacity?
(d) How are test deviations written and approved?
(e) How and to what extent does the Government monitor and control tests?
(f) Are tests run by engineers or technicians or by both?
(g) Who (Q C, Safety, Design Engineering, Operations Engineering) may stop or scrub a test?
(h) How thoroughly are procedure changes documented?
(i) Who determines if a procedure is hazardous?
(j) Does the local operations group have design change authority?

(2) By studying the answers to the questions provided by representatives of the sites, the Panel was able to compare those operations with Apollo-KSC operations to illustrate areas of possible improvement. These areas are listed below:

(a) Safety Review of Procedures - Martin Titan uses the policy of having Safety review all all procedures for possible hazardous operations, rather than giving the operations engineers the responsibility for deciding which operations are hazardous. This item is also discussed in Paragraph 5e of this Report. It was found that for Apollo operations Safety does not review all procedures.

(b) Formal Review of Work Items Prior to Tests - The three Apollo sites were all found to have similar procedures for reviewing open work prior to beginning major tests.

(c) Q C Monitoring of Test Operations - At all Apollo spacecraft sites the policy pro-

vides for Q C to monitor tests and provide an as run copy. The policy is not fully implemented since not all operations are monitored full time. This item is also discussed in Paragraph 2 of this Panel Report.

(d) Test Deviations - In the case of the Apollo operations at KSC and Downey, and the LEM operations at KSC, engineering supervision (one level above the operations systems engineer) does not approve procedure deviations. In the case of the two launch vehicles and the MSC Apollo operation the supervision approval is by signature during the test.

(e) Government Monitoring of Tests - The only significant difference noted is that the Saturn operation does not use NASA Q C to formally monitor test operations. The KSC Launch Vehicle Operations (LVO) systems engineers are required to monitor tests, and thus provide the required NASA surveillance.

(f) Procedures Not Run by Engineers - Tests are run by engineers inall cases except that of Martin Titan where technicians are used on a regular basis to run tests.

(g) Authority to Stop a Test - It was noted that Safety can stop a test in progress at all sites, either directly or through the Test Conductor depending on the type of test in process.

(h) Real Time Procedure Deviation Documentation - All sites had policies requiring that this be done.

(i) Determination of Hazardous Procedures - In four of the seven cases it was found that both Safety and Operations personnel made determinations as to whether a particular procedure was hazardous. In the remaining three cases only Operations personnel determined such. In all cases Safety personnel reviewed in detail those procedures declared hazardous regardless of who made the declaration.

D. FINDINGS AND DETERMINATIONS

1. FINDING:
The Panel documented the Plugs Out Test Procedure (FO-K-0021-1) as it had been performed.
DETERMINATION:
The Test Prodecure did not contribute to the accident. There was a defect in the procedure in that power was applied to the uncapped gas chromatograph power cable after the gas chromatograph had been removed from the spacecraft.
2. FINDING:
209 pages of the 275 page OCP were revised and released on the day before the test. Less than 25 percent of the line items, however, were changed. Approximately 1 percent of the change was due to errors in technical content in the original issue of the procedure. In addition, 106 deviations were written during the test.
DETERMINATION:
Neither the revision nor the deviations are known to have contributed specifically to the incident. The late timing of the change release, however, prevented test personnel from becoming adequately familiar with the test procedure prior to its use.
3. FINDING:
During the Altitude Chamber Tests the cabin was pressurized at pressures greater than sea level with an oxygen environment 2-½ times as long as the cabin was pressurized with oxygen prior to the accident during Plugs Out Test.
DETERMINATION:
The spacecraft had successfully operated at the same cabin conditions in the Chamber for a greater period of time than on the pad up to the time of the accident.
4. FINDING:
The Plugs Out OCP was not classified as hazardous.
DETERMINATION:
The hazard level was not recognized and consequently the procedure was processed through the review cycle as a non-hazardous procedure.
5. FINDING:
Only local control is provided for certain systems which may require remote control for safety reasons, such as service structure water and hypergolic supplysources.

DETERMINATION:
The full potential of the safety systems is not utilized due to the lack of remote control capability.

6. FINDING:
The open item constraint list was not formalized as required by APOP No. 0-202.

DETERMINATION:
Pretest constraints were evaluated informally on a system-by-system basis by the test team. (Enclosure 7-2)

7. Finding:
Troubleshooting of the communication problem was not controlled by any one person, and was at times independently run from the Spacecraft, Launch Complex 34 Blockhouse, and the Manned Spacecraft Operations Building. Communications switching, some of which was not called out in the OCP, was prformed without the control of the Test Conductor.

DETERMINATION:
The uncontrolled troubleshooting and switching contributed to the difficulty experienced in attempting to assess the communication problem.

8. FINDING:
KSC was not able to insure that the spacecraft launch operations plans and procedures adequately satisfied, on a timely basis, the intent of MSC. Changes to S/C testing by KSC could not be kept in phase with the latest requirements of MSC. Pre-launch checkout requirements (GORP) were not formally transmitted to KSC from MSC.

DETERMINATION:
Pre-launch test requirements control for the Apollo Spacecraft Program is constrained by slow response to changes, lack of detailed KSC-MSC inter-Center agreements, and by the lack of official NASA approved Test Specifications applicable to pre-launch checkout.

9. FINDING:
The Test Specifications for Spacecraft 012 were not written in a convenient to use format, did not contain field tolerances, were not NASA approved, were not maintained up-to-date, and were not transmitted to NASA/KSC.

DETERMINATION:
The lack of usefulness of the Test Specifications has been recognized by NAA, Downey and measures intended to correct the situation have been initiated (Enclosures 7-9 and 7-10).

10. FINDING:
The decision to perform the Plugs Out Test with the flight crew, closed hatch, and pure O2 cabin environment made on October 31, 1966, was a significant change in test philosophy.

DETERMINATION:
There is no evidence that this change in test philosophy was made so late as to preclude timely incorporation into the test procedure.

E. SUPPORTING DATA

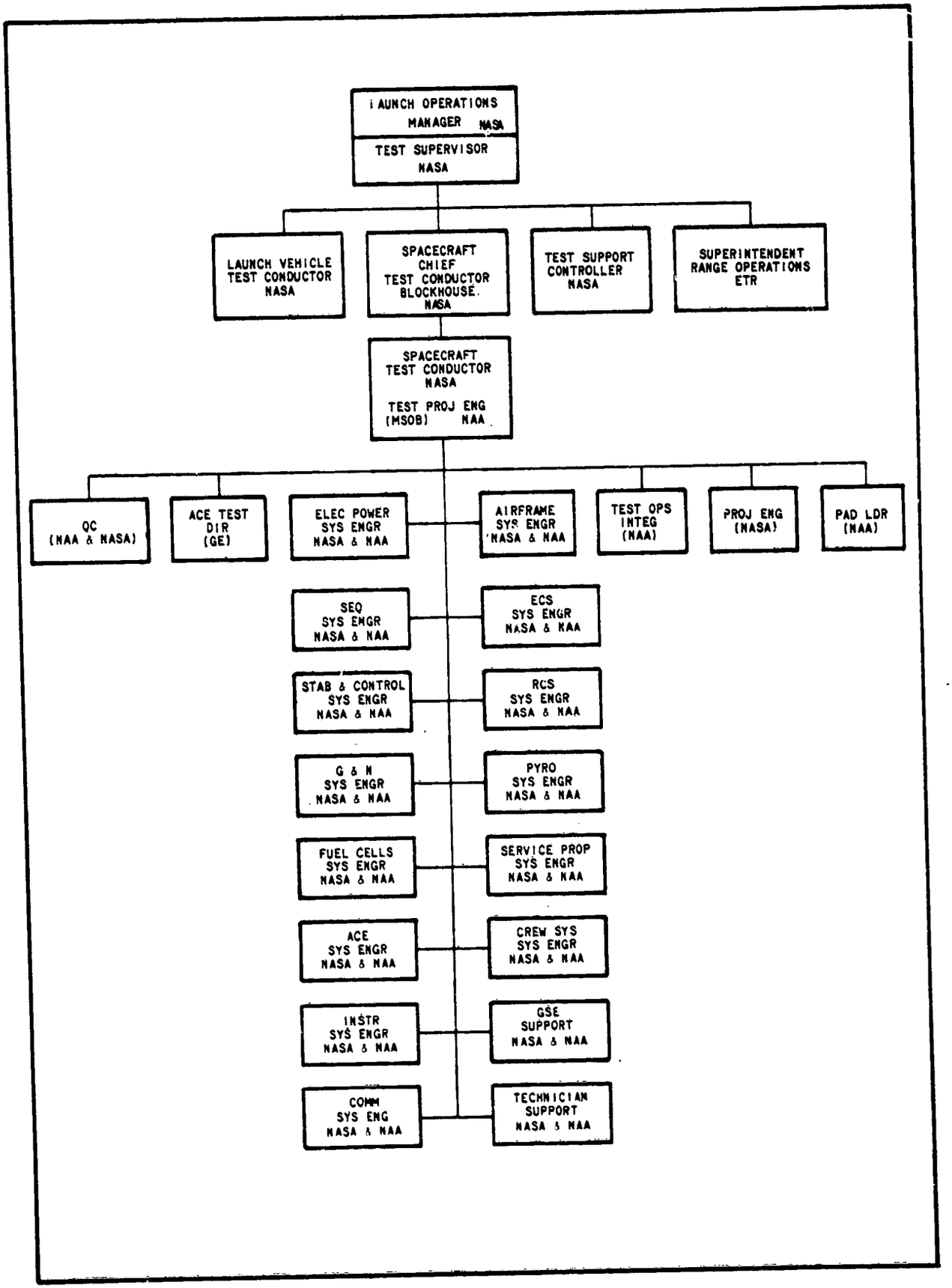
Enclosures

7-1	Test Team Organization
7-2	Memo for Record, Open Item Review
7-3	Plugs Out Test Development History
7-4	Procedure Development Flow Plan
7-5	Safety Office Memo, Procedure Review
7-6	Program Control of Prelaunch Test Requirements
7-7	Flight Vehicle Test Documentation
7-8	Plugs Out Test Support Documentation
7-9	NAA Memo, Test Specs & Outlines
7-10	NAA Memo, Process Specifications
7-11	Minutes of NASA Inter-Center Meeting
7-12	Spacecraft Configuration Comparison
7-13	List of References

GLOSSARY

AC	Alternate Current
ACE	Acceptance Checkout Equipment
AFETR	Air Force Eastern Test Range
AGC	Apollo Guidance Computer
APOP	Apollo Preflight Operations Procedure
BMAG	Body Mounted Attitude Gyro
B/P	Boilerplate
BPC	Booster Protective Cover
CCA	Contract Change Authorization
CDDT	Count Down Demonstration Test
C/M	Command Module
CMD	Command
C/O	Change Order
COMM	Communications
CRT	Cathode Ray Tube
CSM	Command Service Module
CSTC	Chief Spacecraft Test Conductor
CX	Complex
DC	Direct Current
DR	Discrepancy Record
DRS	Discrepancy Report Squawks
DSE	Data Storage Electronics
DSE	Data Storage Equipment
DSEA	Data Storage Equipment Assembly
DSKY	Data Storage Key Board
ECA	Electronic Control Assembly
ECS	Environmental Control System
EDS	Emergency Detection System
ELS	Earth Landing System
EO	Engineering Orders
EPS	Electrical Power System
FCS	Flight Control System
FCSD	Flight Crew Support Division
FCSM	Flight Combustion Stability Monitor
FEO	Field Engineering Order
FEO/FCA	Field Engineering Order/Field Change Analysis
FRT	Flight Readiness Test
FS	Full Scale
G&N	Guidance and Navigation
GAEC	Grumman Aircraft Engineering Corporation
GFE	Government Furnished Equipment
GMIL	Goddard Merritt Island
GN	Gaseous Nitrogen
GORP	Ground Operations Requirements Plan
GSE	Ground Support Equipment
IDR	Interim Discrepancy Record
IMU	Inertial Measurement Unit
INSTR	Instrumentation
KSC	Kennedy Space Center
L/C	Launch Complex

LEB	Lower Equipment Bay
LEM	Lunar Excursion Module
LM	Lunar Module
LO_2	Liquid Oxygen
LOS	Loss of Signal
LV	Launch Vehicle
LVO	Launch Vehicle Operations
MCC-H	Mission Control Center, Houston
MCR	Master Change Record
MDAS	Medical Data Acquisition System
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
MSOB	Manned Spacecraft Operations Building
NAA	North American Aviation
NAA-FF	North American Aviation, Florida Facility
OCP	Operational Checkout Procedure
OMSF	Office of Manned Space Flight
PCM	Pulse Code Modulated Data
PGNS	Primary Guidance Navigation System
PIRR	Permanent Installations and Removal Records
PLSS	Portable Life Support System
P/N	Part Number
PP	Peak to Peak
PSIG	Pounds per square inch - gage
PTT	Push To Talk
QC	Quality Control
RCS	Reaction Control System
RCS/SPS	Reaction Control System/Service Propulsion System
RGPO	Resident Gemini Program Office
S/C	Spacecraft
S/C AGC	Spacecraft Automatic Ground Control
SCS	Stabilization and Control System
SEDR	Specification
SEQ	Sequencers
SLA	Service-LM-Adapter
S/M	Service Module
SMJC	Service Module Jettison Controller
SPS PU	Service Propulsion System - Propellant Utilization
STC	Spacecraft Test Conductor
TAIR	Test and Inspection Record
TB	Terminal Board
TIRR	Temporary Installations and Removal Records
TPE	Test Project Engineer
TPS	Test Preparation Sheets
TVC	Thrust Vector Control
UDL/UHF	Up Data Link/Ultra High Frequency
W/G	Water-glycol
WMS	Waste Management System



ENCLOSURE 7-1

C-2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 204 REVIEW BOARD

IN REPLY REFER TO

TO: Chairman, Panel 1 & Panel 7

FROM: Deputy Manager, Operations Management, KE-2

SUBJECT: Memorandum for the Record

1. To clarify the records and provide an explanation of procedures followed to insure spacecraft readiness for OCP-K-0021-1, Plugs Out Test, the following information is submitted.

2. On 1/23/67 at 1030 an open item review was conducted with the S/C 012 NAA/NASA Test Team. Outstanding (open) items against the spacecraft were reviewed and a listing of 55 items was generated that were considered constraints in one of four categories. These four categories were:

a. Constraint to power up for OCP-K-0006 (Plugs In Test), 11 items.

b. Constraint to power down for OCP-K-0006, 16 items.

c. Constraint to power up for OCP-K-0021, 26 items.

d. Constraint to power down for OCP-K-0021, 2 items.

Names of the responsible NAA system engineers were assigned to each item and the cover sheet was signed by the NAA TPE and the NASA STC.

3. On 1/24/67 power was applied to the spacecraft at 0400 and OCP-K-0045, MCC-H Interface Test, was conducted. The test was completed at 2030 and power was maintained on the spacecraft.

4. On 1/25/67 at 0400 the Plugs In Test was started and was completed at 0300 on 1/26/67. Power was not removed from the spacecraft. The portion of the constraints list applicable to this test was signed off prior to the start of testing.

5. A review of the new work items (i.e., the delta accumulated since the creation of the constraints list) was conducted in the daily recap/review meeting held at Complex 34 on both 1/24/67 and 1/25/67 at 0800.

NOTE: Following this meeting the items are scheduled on the planning sheet by NAA and NASA operations personnel. These updated planning sheets are passed out at the 1430 daily scheduling meeting where the schedule for the next 24 hours is created. This meeting is attended by NAA/NASA S/C and GSE Engineering, NAA/NASA Operations, NAA/NASA Quality Control, plus support personnel safety representative, NASA-MSC and NASA-Headquarters personnel and others as required. The depth of engineering coverage is far greater at the daily scheduling meeting than it is at the 0800 meeting since the 0800 meeting is attended by the NAA Engineering Coordinator and the NASA S/C and GSE Project Engineers who represent their respective organizations in lieu of having all engineering disciplines present. At the daily 1430 meeting the S/C open items status report is once again reviewed for additional items that can be scheduled for work.

6. On 1/26/67 the S/C open items were reviewed at the 0800 meeting but there were so few changes since 1/25/67 that no new planning sheet was created.

7. On 1/26/67, at 0900, a meeting was held at Complex 34 to review the general S/C readiness for the Plugs Out Test. Participants in this meeting were:

C. Gay, Chief Spacecraft Test Conductor, NASA
C. Chauvin, Spacecraft Test Conductor, NASA
E. Reyes, Senior Operations Engineer, NASA
B. Haight, Senior Test Project Engineer, NAA
C. Hannon, Assistant Senior Test Project Engineer, NAA

It was the opinion of this group that the remaining open items from the constraints list could be accomplished prior to the scheduled power up time for the Flight Readiness Test. The remaining constraints for Plugs Out were retest of the Yaw ECA, review of the removals and completion of the checklist. The results of this meeting were passed on to Engineering for evaluation.

8. At 1000 on 1/26/67, Messrs. Gay, Chauvin, and Edson (NAA TPE) attended the Plugs In Debrieting held by DLO-1 at Complex 34 and at the conclusion of that meeting summarized the S/C status for the Plugs Out Test. A portion of this summary included the facts that all of the S/C data from Plugs In had not been completely reviewed and that there were still final preparations and work items to complete before being ready to meet the scheduled power on time.

10. Constraining test items, which were originally listed as open constraints to the test, were released by the NAA responsible systems engineer for each respective system by contacting the NAA Operations Engineer on duty at LC-34, who then signed off the respective item on the constraint list. In addition, those items which were completed and sold off were signed by the NAA Operations Engineer on duty.

11. Following replacement and retest of the Yaw ECA, the S C was powered down at approximately 1800 on 1 26 67. This was the first power down period since 0400 on 1 24 and power was off until approximately 0730 on 1 27.

12. On 1 27 67 at 0600, Pre-test Briefing was held with systems engineers, operational personnel, technicians and inspectors in the MSOB.

13. The test team then went on station and the STC and TPE received a "Go" from each Systems Engineer and from the Pad Leader verifying readiness to proceed with the test. ECS stated in their status report that they were running late with their preparations. SCS gave a qualified "Go" based on incomplete data review. The Pad Leader indicated he had additional ECS set-ups to complete and that they could be accomplished in parallel with power up.

14. An IDR requested by the STC and TPE was written at the start of the test documenting the fact that there was no signed off constraints list for the Plugs Out Test. Status of each item not signed on the Operations Engineer's constraint list plus the delta was to have been provided in the disposition of the IDR upon completion of the test. This was not accomplished as all documentation was impounded at the time of the incident.

15. On 1 27 67, the 0800 meeting was held at Complex 34 and the planning sheet for 1 25 67 was updated accordingly. Reference Enclosure #3.

16. The constraints list and the additional S C open items have been reviewed since the incident and their status reverified. The results of this review are included as a part of this report as Enclosures #1 and #2.

17. The constraints list that was being signed off by Operations Engineers upon work completion and or waiver was at the complex on level A8 of the service structure. A copy of this list is included as Enclosure #4

18. Summary

a. A constraints list was created for OCP-K-0021 but was not signed off since it did not represent a true picture of all open paper due to the additional work generated from 1/23 to 1/27.

b. The constraints and additional open items generated after development of the constraints list were under constant review by the test team.

c. Two meetings are held daily between systems (or their representatives) and operations personnel where the status of S/C open items is discussed.

d. Certain items were evaluated and deferred until after Plugs Out and prior to FRT.

e. The status of the S/C was known at the time of the test by systems and operations personnel. Readiness reports were received from all factions prior to power up and there were no open work items to constrain the running of the Plugs Out Test.

C.Gay, Deputy Opns Mgmt, NASA

Concurrence:

NASA		NAA	
STC		SR TPE	
SR OPS		ASST SR TPE	
S/C Proj Engr		TPE	
		Elect Sys Chief	
		Mech Sys Chief	
		Telecomm Sys Chief	

EVALUATION OF CONSTRAINTS LIST

DR RECAP FROM CONSTRAINTS LIST

DR#	SYSTEM	DESCRIPTION
923	RCS	No readout on panel 12 for S/M RCS He temp. Originated as IDR-035, OCP-0005, upgraded 1/19/67. EO 477825 - Ref - TPS S/C 012 C/M 008. Panel 12 temp installed on temp installation for 0006, 1/23/67. Was left installed to support OCP-0021. Step 5 of DR-S/C 923 specified to remove panel 12 for potting check. Item was left open because potting was not completely cured at installation. Measurement was replaced and retest was accomplished per OCP-0006.
858	ECS	a. Crew reported eyes smarting during first hour at altitude and discomfort (due to heat) periodically during remainder of test at altitude. b. Originated as IDR 079, OCP-0034A-1. Transferred to DR-S/C 858 1/4/67. c. Suit hose umbilical was removed from S/C and sent to malfunction lab for analysis of interior for LiOH and other eye irritants. Sample analysis report was attached to hose and sent to FCS lab. d. 2.5 micrograms of LiOH found in -71 suit hose. e. DR-S/C 858 - conclusions were left open for retest and evaluation during OPC-0021.
864		Communication problem that was corrected by working TPS S/C 493 (sold) and DR was open for retest in OCP-0021. VHF/AM communication was unintelligible when the crew was in pressure suits. Modified cables were evaluated during OCP-0006. Required further evaluation during OCP-0021 with suited crew.
916		a. When either crewman pushes PTT parameter CJ0002J(resp.rate) is modulated in negative direction approximately 20% full scale. b. Originated IDR-029 OCP-K-0034A-1. c. Was to be retested per OCP-K-0021. d. Problem could not be duplicated, therefore, was held open for evaluation during OCP-K-0021.
932		a. Seq. 04-048 measurement SS-01-20X (SLA Sep. Monitor) reads 0% at de-com. b. Originated as IDR-0008, during OCP-0006 (dry run). c. Troubleshooting per continuation sheet directed to remove defective separation monitors upon engineering direction. d. Defective separation monitor was not replaced prior to going into OCP-K-0021.

932 (Cont'd)		e. Portion of DR which was a constraint, i.e., CSM umbilical reinstallation, was accomplished. f. Replacement of separation monitor scheduled for 1/28 - required installation of SLA platforms.
684	EPS	a. Wire routing to LEB XX Strut lights is unacceptable. Wire much too loose--should be routed so as to lie flush on upper bulkhead. b. Originated as P/A SQK #9. c. EO release was pending and in meantime TPS S/C 469 was partially worked to correct discrepancy. d. DR-S/C 684 was left open due to pending EO release.
714	EPS	Floodlight connectors left and right couches are not adequately protected or supported to preclude damage by crew when changing couch position. b. Originated as P/A SQK #11. c. DR-S/C 714 was partially corrected per TPS S/C 469 - Ref EO 586488. d. DR-S/C 714 was left open due to shortage of parts.
865	EPS	Sold 1/26/67.
878	EPS	Sold 1/27/67.
922	EPS	Sold 1/24/67.
884	G&N	Sold 1/24/67.
905	G&N	Results of fine alignment test were unsatisfactory. Was IDR-038 of OCP-0005, Fine Alignment Test. Was rerun prior to OCP-K-0021. Rerun reverified original discrepancy. Out of spec condition required waiver. Waiver had not been requested at this time. No constraint.
915	G&N	Sold 1/26/67.
908	F/C	Sold 1/25/67.
344		Was IDR-072 - OCP-0035-1. When AC inverter #2 to AC Bus 1 On, a master alarm occurred. A successful attempt to duplicate the problem was performed prior to power down from OCP-K-0006. The data was returned to Downey for engineering evaluation.
909	F/C	Electrical noise was evident on 0_2 tank #1 temp measurement SF0041. Ref IDR-018 - OCP-4736 and IDR-0008 - OCP-0005. a. Noise was 8% FS of PP superimposed on normal reading - Ref IDR 018. Correction of problem (harness replacement) scheduled for 1/28. b. 0_2 tank #1 (SF0032) measurement cycling between 23-48. Closed by OCP deviation (without cryos measurement was not meaningful). Part a. required additional input.

918	F/C	Was IDR 009 in OCP-4736. No pressure indication on panel 13 of H_2 tank pressure. Troubleshooting accomplished. (EO 467267 scheduled for 1/28) Scientific matrix block was intermittent. EO changed pin location. Not accomplished.
831	FCS	Was IDR-001 from OCP-8240B. Nepheolometer could not be removed from stowage compartment without excessive pull. Foam cusion was removed and returned to bond room. A new nepheolometer foam cushion was installed in spacecraft on evening of 1/26/67 per TPS S/C 547 and EO 565265. A portion of this task required a piece of foam to be bonded onto the door on the nepheolometer storage compartment. This was not accomplished and was considered no constraint to OCP-K-0021 since nepheolometer was not installed.
899	Biomed	Was IDR 027 of OCP 0005. Simulator voltage was 6.8VDC, should be 16 ± 4 VDC. Troubleshooting revealed improper designed "T" adapter. Disposition was that Downey was aware of the problem and a redesign was required. Relay in all but two "T" adapters draws more current that voltage divider is designed for. This causes low voltage because source is not regulated. Part No.V16-601396, S/N 06362 AAF 8453 of defective adapter sent to Downey. S/N 3603. Part No.V16-601396 was installed in SSRP position on 1/24/67. (not same design S/N 06362 above)
126	FCS	TV camera mount assembly spring could not be installed, spring broke while installing during OCP-K-0034A. Disposition was to redesign spring. The spring was to be replaced per an EO from Downey. As soon as new spring was received DR could be closed.
165	FCS	T-adapter, pin #2 of P3 is protruding apporx 1/4" above other pins. Disposition was to remove pin as it was a spare and not required and was suitable for 0034A. DR held open until replacement adapter arrival. Above T-adapter sent back to Downey. The one in the S/C was S/N 3603 and the S/N of DR'd one is 8453.

(Sold Items on OCP-0021 Constraint List)

0865 Closed 1/26/67.

Problem: 12/27/67 OCP-0034A-1 IDR #034
Primary floodlight control rheostat causes lights to blink in the full on position.

Action: Floodlights were replaced per TPS S/C 485. Recheck completed per S/C DR 0865 during OCP-0006-1. New floodlights did not flicker. Floodlights emitted a low buzzing noise.

0878 Closed 1/27/67

Problem: PAS #92 LM DSEA splice cable makes 90° bend as it comes out of recorder.

Action: Remove straight backshell and install 90° backshell. Work complete 1/27/67. Cable stowed in S/C for OCP-0021.

0884 Closed 1/26/67

Problem: 10/21/66 OCP 0034-7 IDR #116 trans to OCP 0034-A IDR #012
Recorder 15 shows IMU temp CG 5006 IMU delay CG 5008, comp power fail CG 5030; CRT PG11 L14 shows mark error 1.

Action: Troubleshooting disclosed problem was caused by depression of check condition lamps push button on G&N GNIC panel with IMU operate power on and G&N in course align mode. No constraint to further testing.

0908 Closed 1/25/67

Problem: OCP 4736 IDR #0008 0_2 flow FC #1 will not shut off when 0_2 purge valve is cycled.

Action: Valve was found to leak. Valve was replaced and retested per section B on continuation sheets this DR. Retest was acceptable.

0915 Closed 1/26/67

Problem: 1/17/67, dust on lens and mirror on G&N telescope and sextant optics.

Action: Remove dust covers and clean lenses.

0922 Closed 1/27/67

Problem: 1/18/67
1. Unable to verify I/D on pyro connectors E18SQ9 (P9) and E18SQ7 (P7) per TPS S/C 012 - 534.
2. Connectors A18SQ1 (P3) in SLA is IDed as A15SQ1 (P3) and A18SQ2 (P1) in SLA is IDed as A15SQ1 (P1).
3. The following connectors are not connected per TPS-534: S1551 SQ2, S1552 SQ1, C19SQ14 (P480) and C19SQ12 (P77).

0922 (Cont'd)		Action: 1. ID the connectors. 2. Connector ID's as called out per the TPS in error. TPS corrected per mod. 3. TPS modified to disconnect only those connectors connected.
869	AF	Problem: Panel 312 is not identified as such and panel 313 has paint on the ID decal. Action: Identify panel 312 as panel 312 and remove paint from ID decal on panel 313. Sold.
891	RCS/ EPS	Problem: Connector C05WBP495 in RCS roll access has been disconnected without a PIRR being written and had been connected to GSE cabling. Action: Reverify connector and record on proper NAA documentation. Sold.
GSE-572-1-0026		Was IDR 070 (0005A) - could not establish two way communications over GSE intercomm, 1/18/67. Action: Repatch 572-J-box and return to original configuration after launch. 572-J-box was repatched and a satisfactory comm check was completed..

TPS RECAP FROM CONSTRAINTS LIST

TPS S/C	SYSTEM	DESCRIPTION
534	EPS	Inspection of pyro connector for correct P/N and correct keying and insert. Sold 1/23/67. Ref DR S/C 922 (sold).
537	SEQ	Support "Q" ball installation. TPS written to support activity required by IBM. Re-evaluated prior to test as no constraint..
555		Hand control removal and inspection and was cancelled by TPS 561.
561		TPS cancellation of TPS 555. Sold 1/24/67.

545	ECS	a. Waste management system and S/C H_2O system cleanliness level verification. b. Perform EO 548578. c. Flushed waste management system urine dump line. d. Originated IDR #1 - no sample analysis available for step 11 of EO 548578. A verbal report of a satisfactory sample was received by R. MacDonald of NAA from Pan Am Lab. e. Purge and dry urine dump. f. Step 2 TPS/545 was not performed because it wasn't scheduled to be done until OCP-0021 was completed. Step 2 is to perform an H_2O flush of potable, waste and supplemental subsystem to kill the bacteria present and should be done as close to launch as the schedule permits.
493	COMM	a. Reduce noise in mike to audio center. b. Sold 1/26/67. c. Installed noise limiters in aduio center.
225	EPS	a. Disable SPS PU sensor fail lights. b. EO 466789. c. Sold 1/23/67. d. Removed wire #K-348C20 from P3 and cap.
469	EPS	a. Wire protection in crew compartment. b. Ref EO 586488, MCR-1831. c. Installs protective covering over S/C interior TB's wire harnesses and connectors. d. Steps 5,6,7,9,10 (pending cure short stamp) (11,13,14,16) are sold. e. Not complete due to part shortage (17,15 12,8,4,3,2,1). f. Configuration considered acceptable for test.
543	EPS	Installation of SMJC batteries in S/M and pyro batts in C/M for 0006 and remove after test. Installation portion completed.
510	EPS	a. Circuit interrupter test. b. Mod #2 - retested all circuit interrupters because could not verify that travel limiters were not left installed on initial testing. c. Mod #1 - EO 602525, EO 566969-1&2, added connectors. d. Sold 1/26/67.
536	G&N	a. Sextant mirror housing plug. b. Applied Loctite primer and finish coat to mirror housing plug (14 hr cure). c. Sold 1/27/67.

400	FCS	a. Install temp plugs on G&N optics. b. Steps 1,2,3 bought off. c. Step 4 removes after flight items are installed. d. No sold until item "c." is complete.
511	FCS	Perform EO 582263, portable floodlight stowage bag installation. Sold 1/27/67.
021	FCS	a. Installation of cushion and container crew and scientific "G". b. Work EO 501694 - Install Scientific "G". c. Step #1 & #2 hex stamped because flag note 4 of V16-880168 not complied with. d. Intent of EO not complied with. e. Scheduled to be accomplished during stowage exercise 2/3 & 2/4. NOTE: Step #1 and #2 were hex stamped because intent of EO 501694 had not been fully accomplished as the GFE equipment called out in V16-880168 had not been installed and stowed.
079	FCS	a. Work EO 582206 b. Adds 2 spare -51 cobra cables. c. Cobra cables were on temp install. d. Per OPC-K-10011 deviation. This EO would be accomplished for launch.
505		Perform OCP-K-0006. Accomplished 1/26. No constraint.
506		Perform OCP-K-0021.

IDR RECAP FROM CONSTRAINTS LIST

OCP-0005

IDR-15 - Observed momentary LOS at time when cabin air fan, suit compressors (2) and glycol pump were switched on (individually) and off.

Results - AC buses were monitored and voltage transients were confirmed. Transients were within spec for inverter operation with full load on bus. IDR condition written with minimum load on bus. Additional testing to be accomplished prior to power down from OCP-K-0021.

IDR-48 - Problem with TV hardline from CX-34 to MSOB.

Results - Troubleshooting disclosed patching problem at MSOB. Not retested prior to OCP-K-0021. Retested during OCP-K-0021.

IDR-61 - GMIL reported poor quality of DSE reverse dump.

Results - Hardware design dictates that we should not dump in reverse direction. Evaluated as no constraint to OCP-K-0021. Test was performed in OCP-K-0006 and resulted in a forward dump mode only that was acceptable to FCS.

IDR-12 - While manually loading K-start tape, word error 1, sync error 3, and momentary PGNS were displayed at 01736E (just before tape listing stop).

Results - Results are normal. Close per OCP deviation.

IDR-13 - CH0413 reads - 0.1 and CH0613 reads - 2.199 and blinking, both should be zero.

Results - Troubleshooting indicated that problem is in ACE carry-on equipment. No GSE DR number available. ACE carry-on not utilized in OCP-K-0021.

IDR-66 - Non-verify received on K-start and TL fail indication observed in S/C.

Results - Troubleshooting disclosed that the S/C AGC had operated properly with erroneous information on uplink to the AGC. The failure indication was attributed to external noise, generated within the ACE uplink system, and responded to by the guidance computer as the first "one" bit into the computer. This spurious bit then caused a failure in the computer verification of the next legitimate data transmitted via the K-start. (The same problem was observed and verified on S/C 017 and the noise was found to originate in a R-start execution.)

IDR-72 - SCS executed C180, 184 and 172 and did not receive a confirm indication.

Results - This was transferred to GE software DR 322. The problem only occurred when using ACE uplink load 3. No change was made to software and a workaround was utilized by initiating and terminating from the same start. IDR was sold 1/25/67.

IDR-77 - When R-187 was executed, noise peaks appeared on recorder 26, GC1022, 1032, 1502, 1512, 1522 and 1532.

Results - Problem appears to be crosstalk between SCS and G&N systems. IDR still open for SCS and G&N further evaluation. Was considered no constraint to OCP-K-0021.

IDR-80 - Measurement CH1038 noisy when TVC power applied.

Results - Troubleshooting indicated bad Yaw ECA. IDR transferred to S/C DR 940. ECA was removed, replaced and retested successfully prior to OCP-K-0021 (with exception of frequency response test). Frequency response was scheduled for 2/1/67.

OCP 0006

IDR-2 - AC bus 2 phase C reads 112.4VAC on CRT and 117VAC in S/C. (within tolerance)

Results - No conclusion at this time. Signal conditioner appears to be drifting. Considered a S/C problem but requires further investigation to verify. Considered no constraint.

IDR-9 - Sold.

OCP 0034A-1

IDR-5 & IDR-37 - Did not receive He isolation #2 opening indication when thrust on was initiated.

Results - Troubleshooting (KSC & Downey) disclosed present GSE instrumentation is marginal with respect to providing positive readout of SPS He and pilot valve signals. IDR's were transferred to GSE DR GC484-7 -0041 & -0042. No constraint to OCP-K-0021.

MISCELLANEOUS ITEMS

1. SP113 is a test in which the meter readings in the S/C are compared against the PCM data. All system engineers were to compare their measurements and write an IDR against any reading out of tolerances established. Partially accomplished in OCP-K-0006 and further data was being obtained in OCP-K-0021.

2. This item was generated by DR 932 (Instr) in which measurement No.SS0120X read incorrectly. All engineers were advised as to what functions go through this connector and to write an IDR on any anomaly noted. Was monitored during OCP-K-0006 and no anomalies were noted.

EVALUATION OF ADDITIONAL OPEN ITEMS

The following items represent new work tasks that were entered into the S/C TAIR books between the completion of open items review and the start of OCP-K-0021. A status and/or explanation for each item is provided.

1. TPS 547 - Install nepheolometer cushion MCR 1875 logged 1/24/67. Item was partially worked third shift 1/27 but was not completed. It was not considered a constraint to the test.
2. TPS 548 - Markings on panel #23 MCR 1863 logged 1/24/67. Not considered a constraint.
3. TPS 553 - Remove ablator plugs; add pore seals, logged 1/23/67. Continuing exterior task which is accomplished NIB. No constraint.
4. TPS 556 - Assemble soft BPC in warehouse, logged 1/23/67. Completed for OCP-K-0021.
5. TPS 562 - Cover rough edges on crew couch, MCR 3563, logged 1/24/67. Scheduled for 1/31/67. No constraint.
6. TPS 563 - Change from 1 man rafts to 3 men raft, logged 1/24/67. Scheduled for 2/1/67. No constraint.
7. TPS 568 - Install BPC parts, logged 1/25/67. Accomplished 1/27 to support OCP-K-0021.
8. TPS 581 - Determine reflectivity of S/M coating, logged 1/27/67. Received after planning sheet dated 1/27 was originated. Planned for completion after OCP-K-0021. No constraint.

9. DR 0933 - Ding in CM floor, logged 1/23/67. Completed 1/26 - in cure - not sold. No constraint.
10. DR 934 - Valve markings on CM panel 307, 311 and 314 do not line up, logged 1/23/67. Scheduled for 1/31. No constraint.
11. DR 938 - Rain water in tower leg area, logged 1/24/67. Water dried out 1/24. No constraint.
12. DR 939 - Three dents in SM sector 6, logged 1/24. Sold 1/27.
13. DR 0944 - Washer dropped in F/C #1 sector 4, logged 1/25/67. Sold.
14. DR 949 - Scratches on SLA, logged 1/26/67. Under evaluation. No constraint.
15. TPS 554 Ball valve #3 position potentiometer change, logged 1/24/67. Work accomplished. Required EO verification. No constraint.
16. TPS 570 - Monitor CM isolation valve temp, logged 1/26/67. Monitoring was being accomplished during OCP-K-0021.
17. DR 0947 - WMS blower on more than 24 hours, logged 1/26/67. ECS blower - not to be run during test. To be replaced after test. No constraint.
18. TPS 580 - Event timer checkout, logged 1/26/67. No constraint. Check on 8 day wind up clock.
19. DR 0936 - Panel 206 wind and set control stuck in the in position, logged 1/24/67. Completed 1/26. No constraint.
20. DR 0940 - Measurement Ch1038 noisy when TVC power applied, logged 1/24/67. Yaw ECA replaced 1/26. Retest accomplished, less frequency response, 1/26. No constraint.

21. TPS 552 - Wiring change EO-467267, logged 1/23/67. Ref DR 0918 on constraints list, changed position of wire in matrix block. Task deferred until after Plugs Out. Scheduled for 1/28.

22. TPS 565 - Transport 2 pyro batteries per OCP-K-0006, logged 1/24/67. Accomplished less post test removal.

23. TPS 569 - Install S.C ordnance, logged 1/25/67. Scheduled for 1 31 67. No constraint.

24. TPS 577 and 579 - Transport and install battery for OCP-K-0021, logged 1 26 67. Accomplished less post test removal.

25. DR 0937 - Bonding material used not acceptable inside CM, logged 1 24/67. Work done per B P. Used MA0106-70 - waiver letter #192-20-66 309 permits material usage. Area involved approximately.1 square inch. No constraint.

26. DR 0948 - Connector J-54 broken,.logged 1/26. DR voided. Problem already covered on MR #250. Signal conditioner ACE carry-on connector.

27. DR 943 - Circuit breakers on panel 150 not in proper configuration per procedure, logged 1 24 67. Procedural problem circuit breakers closed in error caused draining of pyro batteries during OCP-K-0006 dry run. Batteries replaced prior to OCP-K-0006 sell run. DR sold 1/27/67.

28 DR 0945 - Panel 200 reads out H_2 regulator pressure. Should by O_2 regulator pressure, logged 1 25/67 System not involved in test. No constraint.

29. TPS 566 - Removal of hand controller, logged 1/24.67. Completed less post test removal of spare hand controllers. One spare rotational and one spare translation controller installed for test

30. TPS 573 - Install decals of computer codes, logged 1/26/67. No constraint.

31. DR 941 - Locking ball retainer ring for telescope flight cover missing, logged 1/24/67. GSE covers installed - no constraint.

32. DR 946 - LO_2 tank #2 exceeded replacement point by operating 90 hours, logged 1/25/67. No constraint - awaiting waiver.

33. TPS 528 - Determine stowage location for additional food, logged 1/26/67. Scheduled 2/3/67. No constraint.

34. TPS 538 - Installation of container V16-332131, logged 1/26/67. Sold 1/27. No constraint.

35. TPS 549 - Perform OCP-K-8240C section 2 part 2 of Crew System Stowage procedure, logged 1/23/67. Scheduled 2/3 and 2/4. No constraint.

36. TPS 564 - Fit check of octopus cable, logged 1/24/67. Accomplished 1/25 and 1/26.

37. TPS 570 - Install and checkout of crewman optical alignment sight, logged 1/26/67. Scheduled 2/3 and 2/4 - no constraint.

38. TPS 583 - Installation of stowage items to support OCP-K-0021, logged 1/27/67. Accomplished prior to crew ingress.

39. DR 0912 - Grommet damaged tee adapter, logged 1/24/67. Sent to lab - no constraint. This tee adapter was the second of two good ones. Had unused pins missing. Not used in S/C for OCP-K-0021.

40. DR 0950 - Cushion assembly for scientific "T" compartment has damage one edge of assembly, logged 1/26/67. No constraint.

41. DRS 878 - Fiberglass covers for gears (2) on docking mechanism were missing. Had not yet been scheduled. No constraint.
42. DRS 880 - Fiberglass covers P/N V16-531826-1 and -2 were not installed per print. Had not yet been scheduled. No constraint.
43. DRS 884 - Thermal shrink sleeving was not properly shrunk. No constraint.
44. DRS 886 - Transferred to DR 0945.
45. DRS 892 - Door #9, -Y axis on the SLA had a loose washer and there was dirt and other foreign material inside. Scheduled to work on a non-interference basis. No constraint.
46. DRS 894 - CMD position had two loose cobra cable clamp screws. Had been dispositioned to tighten the screws and had not been scheduled. No constraint.
47. DRS 895 & 896 - Written against the BPC during test preps. No constraint to test.

23 January 1967

CONSTRAINTS LIST - OCP-K-0006/0021 (Reference 23 January Status Report)

All power-up constraints to OCP-K-0006 have been satisfied.

NAA _____ NASA _____

All power-up constraints to OCP-K-0021 have been satisfied.

NAA _____ NASA _____

This listing identifies all constraints to OCP's 0006 and 0021 S/C 012 tests per constraints meeting held 10:30 AM on 23 January 1967.

NAA 1-23-67 NASA

CATEGORY	TPS/DR	TASK DESCRIPTION	RESP. ENGR.	CONSTRAINT 0003 PWR UP	0003 PWR DN	0021 PWR UP	0021 PWR DN
Misc. (1)	TPS 505	PIPR's/TIPR's 10011 Checklist 10010 Placards	All	X			
	TPS 506	PIPR's/TIPR's 10011 Checklist 10010 Placards	All			X	
AFRM/PYRO (2)	TPS 534	Pyro connector keying SOLD	Patterson	X OK			
	TPS 537	Support S-Cell Installation	Patterson				
ECS/EPS(3)	DR 0??3	No readout on Panel 12 for S/M ECS temp.	Tribe	X OK as is			
	0031-?-1 IDR 036 & 037	Monitor helium isolation valve oper.	Tribe	TRANSFER TO OSE			
ECS (4)	TPS 545	Verify waste management system cleanliness level - Part I of TPS only	Griffith	X			
	DR 0058	Eyes smarting	Griffith			X	
	0305A IDR 015	Momentary LOS	Griffith/ Warner		X*		
COMM (5)	TPS 485	Incorporate Mod Kit (ECR 1844) SOLD	Ostiguy			X	
	DR 0864	VHF/FM comm. unintelligible with pressure garments on	Ostiguy				
	DR 0916	C?6602 is modulated when PTT is pushed	Ostiguy				

*Indicates Engineering resolution required.

CATEGORY	TPS/DR	TASK DESCRIPTION	RESP. ENGR.	CONSTRAINT 0006 PWR UP	[illegible] DN	0021 PWR UP	[illegible]
[illegible] (5)	0005A-1 IDR 043	TV system retest	Ostiguy		X		
	GSE DR 572-1-002[illegible]	Communication system retest	Ostiguy		X		
		Houston Communications Check			During 0045		
	TPS	C14-348 reinstallation		Signed off per LMPE 25 Jan 0300			
INSTR. (8)	DR 0532	Availability of light weight headsets [illegible] and [illegible] should be [illegible] – No constraint to ultra test BP Hansen	Ostiguy/ Corley Sargent	OK for test BP Hansen			
	0005A-1 IDR 061	[illegible]	Sargent		X		
EPS (7)	TPS 225	[illegible] fail light	Vallin	Sold BP Hansen [illegible]			
	TPS 439	Wiring protection OK for test BP Hansen	Vallin			X	
	TPS 510 [illegible] 2	Circuit interrupter test	Vallin	No Constraint A. Wagner Per Telec.			
	TPS 543	Battery installation ok for test BP Hansen	Vallin	Installation OK BP Hansen [illegible]			
	DR 0682	Wiring routing to LEB OK for test BP Hansen	Vallin			X	
	DR 0714	Floodlight support OK for test BP Hansen	Vallin			X	
	DR 0655	Primary floodlight operation OK for test BP Hansen	[illegible]		X		
	DR 0378	LEM DSEA splice cable	Vallin			X	

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CATEGORY	TPS/DR	TASK DESCRIPTION	RESP. ENGR.	CONSTRAINT 0006 PWR UP	0006 PWR DN	0021 PWR UP	0021 PWR DN
[illegible] (7)	DR 0002	Pyro connections (reference TPS 534)	Vallin	X 50? E.P. [illegible]			
	0006-1 IDR 002		Vallin			X	
[illegible] (8)	TPS 536	Sextant mirror housing plug	Bennett *OK for Test E.P. [illegible]*			X	
	DR 0004	Shows 1 PV temp. 1 PV delay comp. pwr. fail & ckt. shows a mark error #1	Ferris		X		
	DR 0005	Fine align anomalies	Ferris		X		
	DR 0015	Sextant optics cleanliness *No Constraint to Test E.P. [illegible]*	[illegible]			X	
	0006-1 IDR 012	[illegible]	Ferris			X	
	DR 003	[illegible]-verify on [illegible]-Start, TL fail in S/C	Ferris			X	
ECS (8)	0006-1 IDR 013	DR 013 reads improperly → *now OK S/C [illegible]*	Schultz/Buzz		X		
	DR 072	[illegible]-Start execution anomaly	Schultz/HACS			X	
	DR 070		Schultz		X		
	[illegible]	Hand Controller installation/inspec.	Schultz	X *not reqd E.P. [illegible]*		*R.J. [illegible] NASA*	
	0006-1 IDR 009		Schultz/Buzz		Prior to Mission Run		
FUEL CELL (9)	DR 0008	O_2 Purge valve monitor - fuel cell #1 pressurization	Dvorak		X		
	DR 0009	[illegible] 0041-? is noisy	Dvorak				
	DR 0013	Panel 13 H2 Tank #2 pressure indication *Not required for OCP-K-0021 E.P. [illegible]*	Dvorak	X Panel Instl Comp.	*Not req'd E.P. [illegible] [illegible] NASA*		

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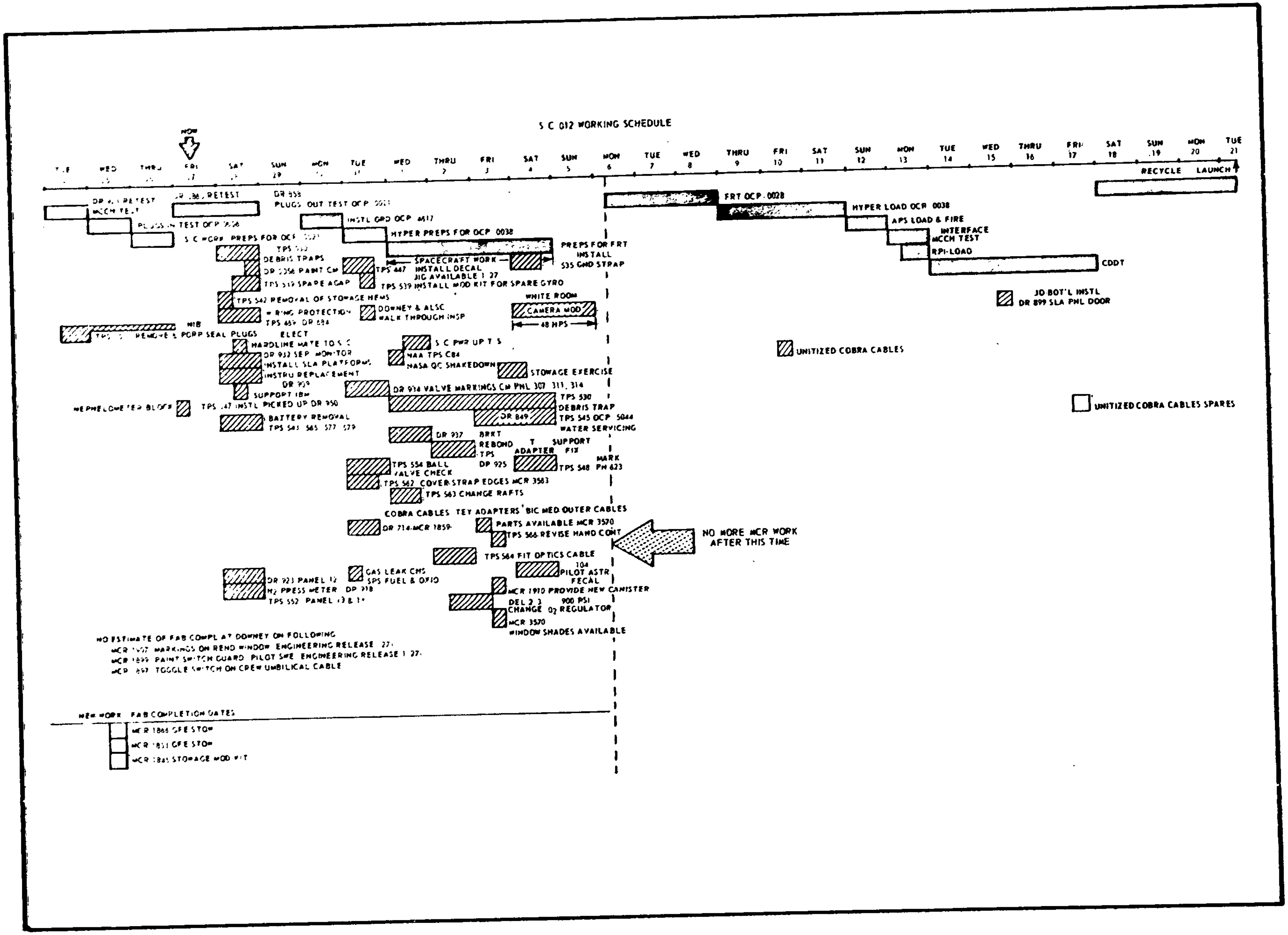
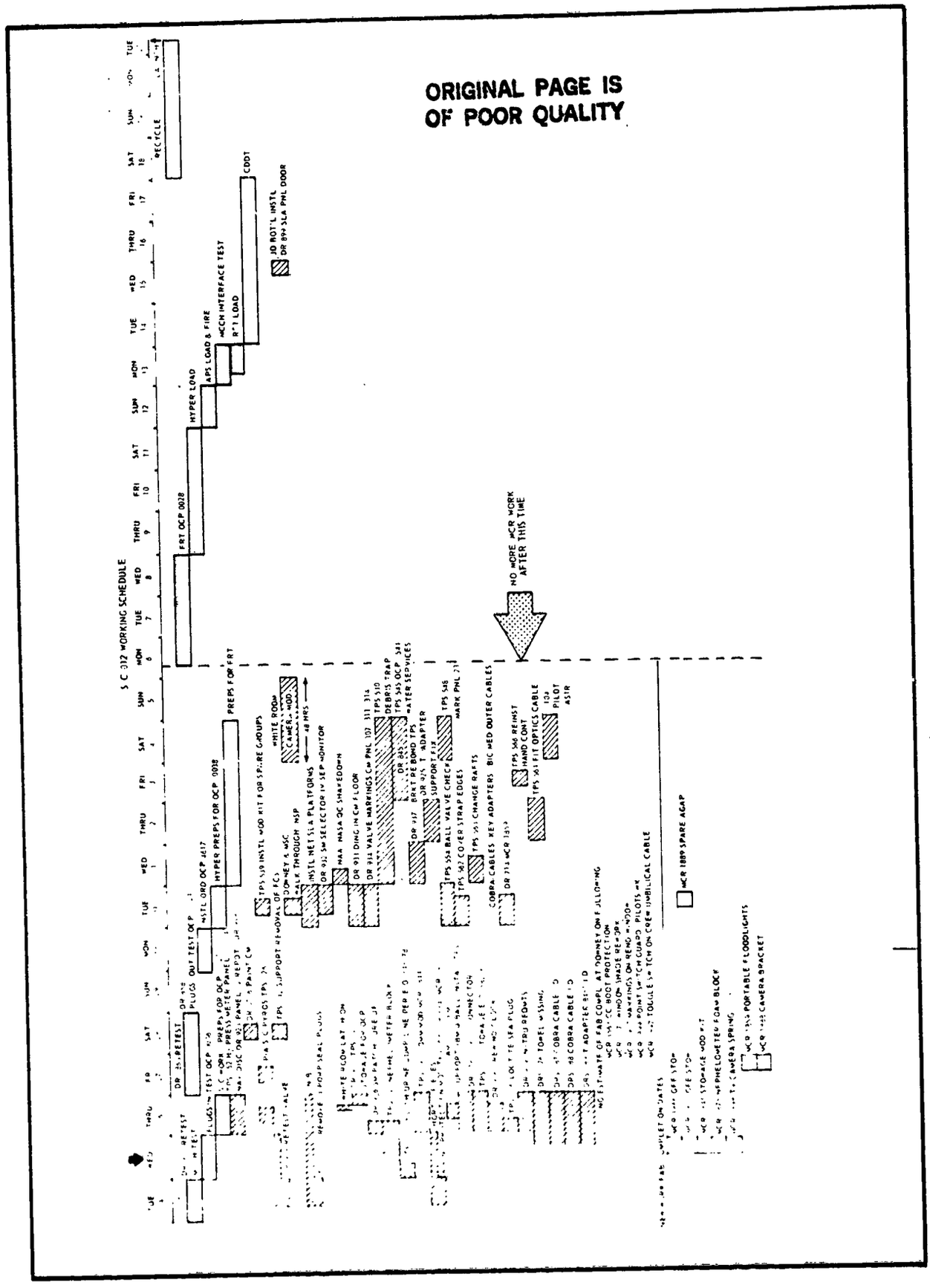
CATEGORY	TPS/DR	TASK DESCRIPTION	RESP. MGR.	CONFIG. 0006 PWR UP	CONFIG. 0006 PWR DN	CONFIG. 0021 PWR UP	CONFIG. 0021 PWR DN
SIM (10)	DR 0344	When A/C inverter #2 was connected to A/C Bus #1 the master alarm came on.	Brandon		X		
	00054-1 IDI 077	R187 execution anomaly	Brandon		X		
FCS (11)	TPS 400	C&W option plugs installation	Corley Not required G.P. Hanson			X	
	DR 0331	Napholometer installation/removal	Corley Not required G.P. Hanson			X Stowage	
	TPS 511	Work PD 582263	Corley Not required G.P. Hanson			X Stowage	
	DR 0339	Sim. voltage is 6.8, should be 16	Corley			X Head T-Adapter	
	TPS 521 (Lab)	Installation of scientific "G"	Corley Not required G.P. Hanson			X Stowage	
	TPS 520 (Lab)	Work PD 582263	Corley			X Stowage	
	DR C1265 (Lab)	TV camera mount spring broken	Corley Not required G.P. Hanson			X	
	DR C1265 (Lab)	Pin #2 of P3 protruding	Corley			X T-Adapter	
ECS (12)	DR 339	Panel 312 and 313 ID	Griffith Griffith Not required G.P. Hanson			X	
	DR 381	Panel 307, 311 & 312 valve markings				X	
MISC. (1)		SP113 to be filled out and evaluated	All		X		
		Retest due to pulling of C3H umb. connector P15 and circuit interrupter actuation	All		X		



S C 012 WORKING SCHEDULE
NOW
RECYCLE
LAUNCH
FRT OCP 0028
HYPER LOAD OCP 0038
APS LOAD & FIRE
INTERFACE
MCCH TEST
RPI-LOAD
CDDT
HYPER PREPS FOR OCP 0038
PREPS FOR FRT
INSTALL
S35 GND STRAP
SPACECRAFT WORK
INSTALL DECAL
WHITE ROOM
CAMERA MOD
48 HRS
UNITIZED COBRA CABLES
UNITIZED COBRA CABLES SPARES
DEBRIS TRAPS
BATTERY REMOVAL
STOWAGE EXERCISE
DEBRIS TRAP
WATER SERVICING
TPS 563 CHANGE RAFTS
TPS 564 FIT OPTICS CABLE
MCR 1910 PROVIDE NEW CANISTER
WINDOW SHADES AVAILABLE
NO MORE MCR WORK
AFTER THIS TIME
NEW WORK
FAB COMPLETION DATES



DEVELOPMENT HISTORY

PLUGS OUT TEST

OCP-K-0021

12 July 1966 - SP-64,, "S/C 012 Test Outlines". published for a preliminary review to be completed by 20 July 1966.

- PURPOSE OF OCP-K-0021

A. To verify overall S/C L/V compatibility and demonstrate proper function of S/C systems with all umbilicals and GSE disconnected.

B. To verify no electrical interference at time of umbilical disconnect.

10 August 1966 - SP-64, retitled "S/C 012 - S/C 014 Florida Facility Test Flow Plan" was published.

- PURPOSE OF OCP-K-0021 - No changes

- Presented to Checkout Management Panel #24, (MSC/KSC/NAA).
- No significant changes to L/C 34 testing were requested by the Checkout Management Panel.
- TEST CONFIGURATION

A. S/C and L/V were mechanically mated, and were electrically mated through fuse boxes.

B. S/C Internal Power Sources:

1) Pyro batteries (test) installed.

2) Entry and Postlanding batteries installed.

3) SM jettison controller (SMJC) batteries (test) installed.

4) GSE test batteries used to replace fuel cells.

5) GSE power to Spacecraft busses.

C. Installed Pyros disconnected and shorted.

D. Forward Heat Shield installed.

E. CM and SM RCS Simulators connected.

F. G and N Flight Ropes.

G. ECS CM W/G circulation.

H. Operational TV camera mounted.

I. LES installed and electrically and mechanically mated to CM.

J. Flight Qual and DSE Recorders loaded with Degaussed Tapes.

K. ACE Carry-on disconnected.

L. Physiological Simulators installed (MDAS connected).

6 September 1966 - Reviewed and redefined plus-time operation, specifically regarding the scope of G&N programs to be conducted during the altitude chamber runs and plugs out tests. This was done to adequately divide all the G&N checkout among the separate OCP's which have plus-time mission sequences.

19 September 1966 - Flight crew requested emergency egress practice prior to Countdown Demonstration Test due to hazardous conditions in the CDDT resulting from fully fueled Launch Vehicle.

20 September 1966	- Rough draft sent to keypunch for preliminary flimsy printout, delivered 21 September.
26 September 1966	- Flimsy copy of OCP to NAA Safety for electrical hazard review.
27 September 1966	- Decision made in NASA/NAA OCP Control Board Meeting this date to run emergency egress test after completion of the mission runs in OCP-K-0021. The following was then coordinated with the back-up crew Command Pilot: A. Back-up crew to participate in the test, then the prime crew would perform a normal ingress and the emergency egress test during L/V reset period. (See sequence 07-310, Page 7 - 56 of OCP-K-0021-1.) B. GSE air and open hatch for simulated mission by back-up crew. Full hatch close out (including Boost Protective Cover) for prime crew emergency egress test. C. Prime Crew wanted normal pre-T-0 ingress and closed hatch during simulated flight missions, but