MARTIN MARIETTA

APOLLO APPLICATIONS PROGRAM (AAP) PAYLOAD INTEGRATION

General Test Plan
Combined Mission, Flights AAP 1/2/3/4

Volume I
Test Program Summary

MARTIN COMPANY

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7 April 1967

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Volume I
Test Program Summary

Contract No. NAS8-21004

MARTIN MARIETTA CORPORATION
DENVER DIVISION

FOREWORD

This document is submitted under DRL Line Item 20 of Exhibit C of Contract NAS8-21004 for the use of MSFC. This document is the forty-ninth submitted under this contract.

This is Volume I of four volumes containing the General Test Plan.

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1. INTRODUCTION

This plan establishes the overall test program guidelines for the Apollo Applications Program (AAP) Combined Mission, Flights AAP 1/2/3/4. All aspects of the test program are described as they will occur during design, development, qualification and operations phases, from subsystem component level to complete integration of facility, GSE, and the vehicle for a launch operation.

This plan defines the criteria or ground rules adhered to in the preparation of the test plans for the activities of payload integration testing of the qualification and flight article hardware at all locations, and at all levels of equipment complexity. The principal locations affected by this plan are: The manufacturing source of flight equipment; the Payload Integration Facility (PIF), or equivalent space for Marshall Space Flight Center (MSFC) operations; the Manned Space Operations Building (MSOB) at Kennedy Space Center (KSC); and the launch complex at KSC.

1.1 Purpose - A logical flow of operations for AAP hardware testing, from design concept through launch and postflight checks and analysis, is established and delineated by this Test Plan.

The plan is designed to present a sequential flow of test functions from the point of initial design through manufacturing, checkout and launch. The detailed activities will be used as the basic framework for preparation of acceptance and checkout procedures, establishing GSE and tooling requirements, and determining the facilities necessary to support the test program. Testing and evaluation of interactions at the integrated levels of assembly shall be emphasized.

1.2 Scope - The AAP test program is a prime factor in assuring the successful accomplishment of the assigned missions. This program fully considers the desirability of using applicable existing Apollo hardware and of limiting the testing necessary by thorough evaluation of existing data and prudent planning. Through the implementation of this test plan, the integrating contractor shall direct a test program that will develop and demonstrate the adequate and timely performance of all systems designed for these missions, and will ensure that they meet the requirements of the mission specifications. Tests which are to be directed or performed by the integrating contractor, or tests of Contract End Item (CEI) components, subsystems, systems and modules are included.

For this mission, integrated module testing is the predominent task. Support subsystem and component testing are slightly subordinate in scope, the objective being to develop support subsystems in modular form to use across as many missions as possible. The extent of integrated module testing is, in some cases, limited by application of fail-safe design criteria in the experiment apparatus and its support subsystems. Each mission configuration will assemble unique combinations of modular subsystems, experiment carriers, and experiments and their support subsystems. The concept of integrated testing is based on the delivery of a mission module to KSC which has undergone sufficiently thorough testing to establish a high confidence level and to minimize the extent of KSC test requirements. This requires adequate development testing utilizing both prototype assemblies and simulators of experiment carriers such as the CSM, and spent S-IVB stage, as required.

Maximum use will be made of existing hardware. This hardware will be subjected, in some instances, to slightly divergent functions and environments; therefore, the test requirements for this hardware have been established after considering the substitution of analysis for test. Principal considerations that have influenced this substitution are: experience with similar equipment or missions, adaptability to positive analysis, design safety factors, applied protective measures, amount of configuration similarity to the qualified article, similar tests involving more rigorous hardware conditions than that under consideration, and critical analysis and failure mode effects. Performance, design, test specifications, applicable test data and results of the Apollo program will be the basis for modification of hardware used in this program. This background data will generally be proof of design development and qualification for unmodified hardware configurations. Where modifications are made, test data gained from prior NASA space programs will be used to the maximum extent possible for meeting the AAP test requirements. For hardware whose failure would be critical, analysis has not been substituted for adequate testing.

A broad spectrum of pre-installation test requirements are needed to give assurance that the AAP system components are ready for installation. To ensure successful achievement of mission objectives, flight hardware will be tested and checked out at the component, subsystem, system, carrier, and combined carrier levels. The test plan presents the mission test programs and establishes basic test program policies. The plan also describes the sequential flow of hardware through the total AAP test and checkout process, the organizations involved, their responsibilities in the program, the software required by the program, and the geographic location of the various test activities and functions.

2. APPLICABLE DOCUMENTS

The following documents form a part of this test plan to the extent specified herein.

Project Documents

Martin Marietta

ED-2002-69	Configuration Trade Study - Cluster Verification Test, dated 17 March 1967
ED-2002-68	Cluster Verification Test Justification and Feasibility, dated 17 March 1967
ED-2002-33	Orbital Workshop (OWS) General Test Plan, dated 25 January 1967
ED-2002-64	Cluster Electromagnetic Compatibility Report, dated 13 March 1967

Manuals

NASA

NPC 200-1	Quality Assurance Provisions for Inspection Agencies, dated April 1962
NPC 200-2	Quality Assurance Provisions for Space System Contractors, dated April 1962
NPC 200-3	Inspection System Provisions for Suppliers of Space Materials, Parts, Components and Services, dated April 1962
NPC 250-1	Space System Contractors Reliability Program Provisions, dated July 1963

NPC 500-1	Apollo Configuration Management Manual, dated 18 May 1967
NPC 500-10	Apollo Test Requirements, dated 20 May 1967

3. PROGRAM DESCRIPTION

3.1 General Description - Missions AAP 1/2 and AAP 3/4 are established and fully described in Volumes I through IV of this test plan. This volume of the plan establishes and delineates the general test requirements, policies and philosophies, which govern the preparation of, and are implemented by, the more detailed test plans. This volume also includes: A concise description of the test categories and types of tests that will be performed on AAP equipment; a comprehensive description of the responsibilities and functions of the various agencies and organizations as they affect the test activity; a detailed abstract of the test program documentation requirements and responsibilities; a definition of the test support requirements necessary to accomplish the test program; and the program test flow and basic test and checkout schedules.

The Subsystem Development and Qualification Plan, Volume II, is the test plan which will be utilized through the development and qualification phase of mission subsystems. The Payload Integration Development Plan, Volume III, outlines a comprehensive test program established for implementation during the payload integration development and qualification phase of the missions. The Integration and Prelaunch Checkout Plan, Volume IV, outlines a comprehensive test program designed to fully check out all AAP airborne equipment and ground installations during the integration phase through launch. These three volumes interface with each other, through Volume I to form a concise, continuous test flow from design concept through launch. Figure 1 illustrates this relationship and the hardware flow from development test, through integrated module development and prelaunch checkout to flight.

3.1.1 Subsystem Development and Qualification Plan - This plan has been prepared to document and specify the individual tests required to assure proper performance of the various subsystems involved. The plan is based on the ground rule that all experiment, carrier and GSE contractors will be

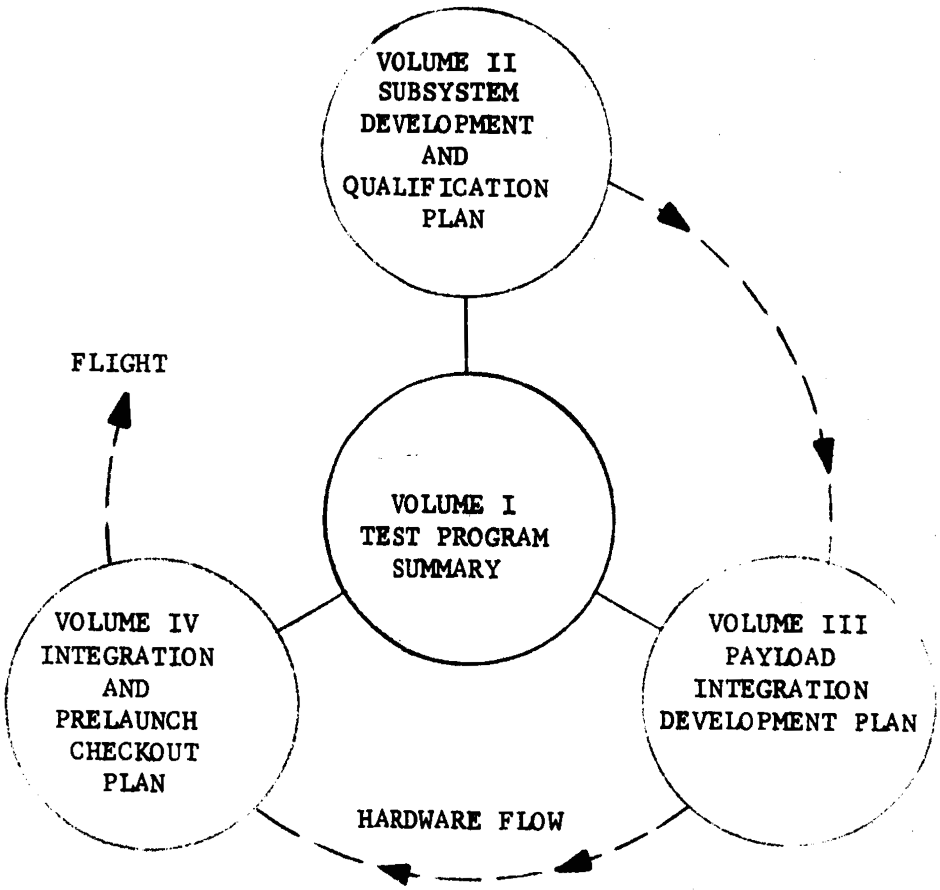


Figure 1. General Test Plan Interfaces and Hardware Flow

responsible for their development, qualification and acceptance testing at the component level and below; and, that all such hardware delivered to the Payload Integration Contractor (PIC) will be acceptance tested. These contractors are responsible for subsystem development, test planning and testing at the subsystem level. The plan defines the test interfaces to a level of detail suitable for interface negotiations.

3.1.2 Payload Integration Development Plan - This plan has been prepared to develop and quality the integrated experiment modules for this mission, and to verify the compatibility of the various configurations in which they will be placed. The test program is established in three phases: 1) Development; 2) Qualification; and 3) Intercarrier verification. The test hardware used in the program is at the integrated experiment module level.

Development testing is performed on mockup and prototype hardware, capable of performance in specific environments, to verify engineering design. The qualification test program will demonstrate performance requirements in selected environments on flight type hardware. Intercarrier verification tests will be accomplished on the various launch and orbit configurations to verify the compatibility of all interfaces utilizing flight type hardware.

3.1.3 Integration and Prelaunch Checkout Plan - This plan describes and defines the tasks and responsibilities for planning, scheduling, implementing and controlling the integration and prelaunch checkout functions on the integrated experiment carriers at the PIF and at KSC.

This plan establishes and delineates a comprehensive flow of test and checkout activities for all of the AAP missions. The criteria and operations cover the entire spectrum of test activities necessary to ensure that all of the AAP equipment conforms to the design specification requirements established for successful launch and on-orbit operations through re-entry and recovery. The plan is designed to present a step-by-step, sequential flow of test tasks from the point of assembly of the integrated carrier at the PIF to the final checkout and launch of the spacecraft at KSC.

These tasks are detailed and described to the extent that they will act as the basic foundation for the future preparation of acceptance and checkout procedures required to assure mission success.

3.2 Mission Description - Mission AAP 1/2 will be initiated with the launch of Flight AAP 1, which consists of a manned Command and Service Module (CSM) and a Lunar Module and Synoptic Survey (LM&SS) rack payload. This payload will be placed in a 120 nautical mile (n.mi.) circular orbit, inclined 28.9 degrees with respect to the equator. After CSM transposition and docking, experiments will be conducted in this orbit for five days.

Flight AAP 2 will be launched on the sixth day of this mission. The unmanned Flight 2 payload will consist of an Airlock Module (AM), a Multiple Docking Adapter (MDA), and the S-IVB stage. This payload will be placed into a 260 n.mi. circular orbit, coplaner with the Flight 1 payload. Once this orbit is established, the S-IVB propellants will be vented and dumped, and the payload attitude stabilized.

Flights 1 and 2 will remain in these orbits until proper phasing is achieved. At this time the CSM and LM&SS rack will transfer orbit to the 260 n.mi. orbit of the Flight 2 payload. The CSM will undock from the rack, transpose to the other end of the rack, and redock. The CSM will then proceed to dock the LM&SS to the MDA for possible reuse. After the LM&SS is docked, the CSM will undock from the LM&SS and also dock to the MDA.

Those activities necessary to passivate and activate the spent S-IVB stage, converting it into the Orbital Workshop (OWS) configuration, will be accomplished. Experiment operations will continue for the next 15 days. On mission day 28, the OWS, LM&SS, AM, and MDA will be prepared for in-orbit storage. On mission day 30 the CSM will undock and position for re-entry. When the proper position is achieved, the Command Module (CM) will be separated from the CSM and stabilized for re-entry. Mission 1/2 will terminate after re-entry and recovery operations are complete. A schematic profile of this mission is shown in Figure 2. Mission AAP 3/4 will commence with the ground initiation of repressurization of the OWS and the subsequent launch of Flight 3, three to six months after the Flight 1 CSM re-entry. The Flight 3 payload will consist of a manned CSM, a Resupply Module (RM) and experiments. After the payload is placed in an orbit slightly lower than the OWS cluster, the CSM will transpose and dock with the RM and then

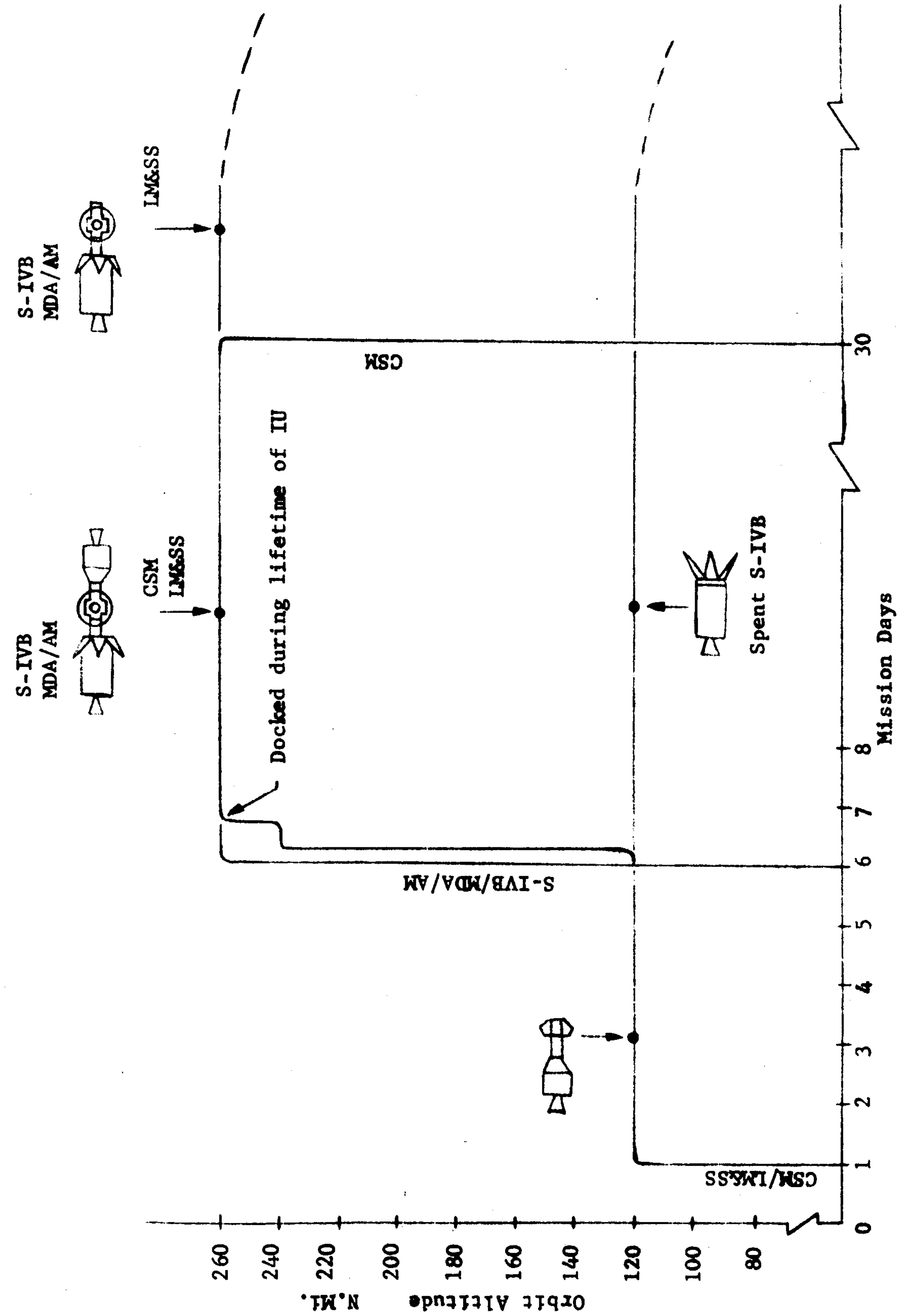


Figure 2. Schematic Profile of Mission AAP 1/2

will dock the RM to the center port of the MDA. Access to the OWS will be through the RM.

Flight AAP 4 will be launched on mission day 2 of this Flight 3 and 4 mission. The unmanned Flight 4 payload will consist of a Lunar Module (LM), Apollo Telescope Mount (ATM), and experiments. After being placed in an orbit slightly lower than the OWS cluster, the Flight 3 CSM will undock from the RM, rendezvous and dock with Flight 4 LM and detach the LM/ATM from the S-IVB. The CSM/LM/ATM will then rendezvous with the OWS, and crewmen will man and activate the LM. The CSM will then undock from the LM, dock to the RM, and stabilize the OWS for LM/ATM docking on a side port of the MDA. After LM/ATM docking, the LM will stabilize the cluster while the CSM/RM undocks and redocks on a side port. The CSM will then undock from the RM, and redock on the center port of the MDA.

Experiment activities and crew operations will continue in the OWS cluster until mission day 56. The OWS, LM and ATM will be prepared for in-orbit storage; and, on the 56th day, the CSM will separate from the cluster. When the proper position is achieved, the CM will be separated from the SM and stabilized for re-entry. Re-entry and recovery will follow, completing Mission 3/4. A schematic profile of Flights AAP 3 and 4 is shown in Figure 3.

The on-orbit configuration of Mission AAP 1/2 is shown in Figure 4. Figure 5 depicts the on-orbit configuration of Mission AAP 3/4.

4. GENERAL PROGRAM REQUIREMENTS

The Test Program requirements, as established in this volume, are applicable to the overall mission test program regardless of the geographic location of testing or the organization performing the test. By using a universal standard for all mission test functions, continuity is ensured, thus increasing the probability of successful accomplishment of the total mission. A continuum of flow must occur in the test plans and procedures from payload integration through launch.

4.1 Test Objectives - The AAP test program has the primary objective of providing the maximum amount of useful, correlated data for establishing the highest possible degree of confidence in the successful performance of the assigned missions. The program will develop and demonstrate the adequate and timely

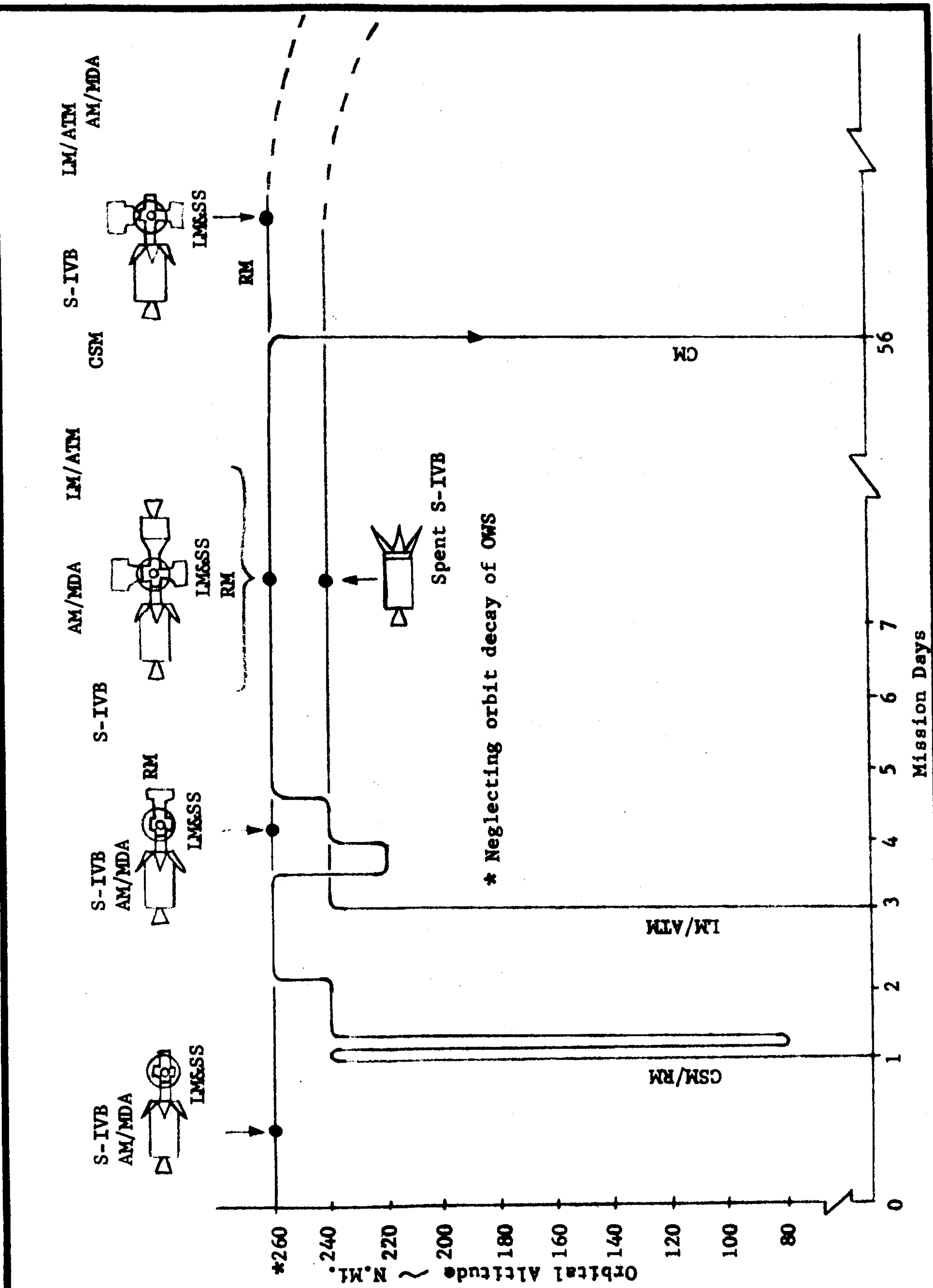


Figure 3. Schematic Profile of Mission AAP 3/4

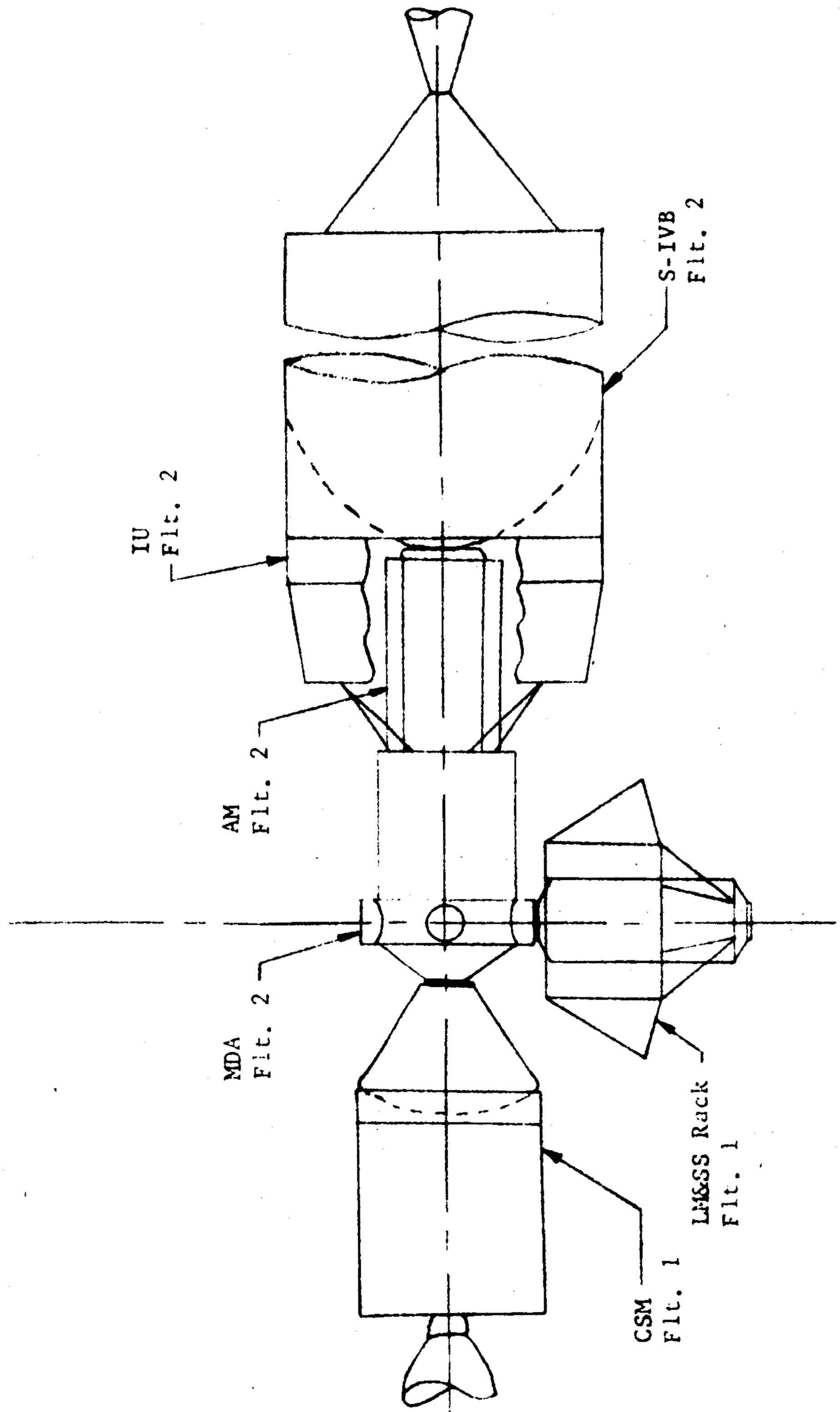
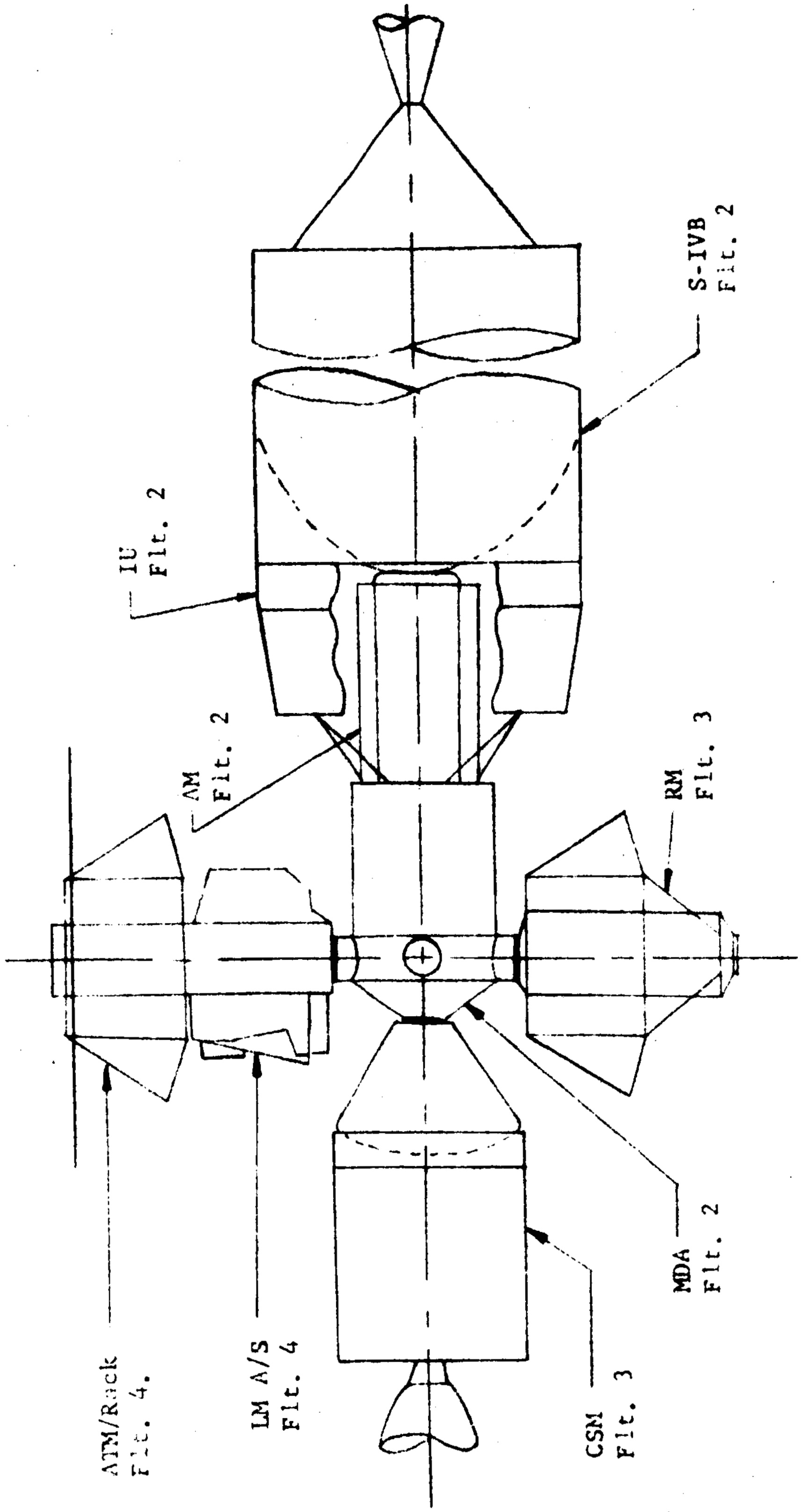


Figure 4. Mission AAP 1/2 Orbit Configuration



Note: LM&SS/Rack from Flight 1 is omitted for clarity

Figure 5. Combined Mission, **Flights** AAP 1/2/3/4 Orbit Configuration

performance of all systems for AAP missions and assure that they meet the requirements of the program specifications.

4.1.1 Major Objectives - The major objectives of this plan are:

a. To demonstrate that component, subsystem, module and system design, packaging, and functional requirements comply with applicable specifications

b. To demonstrate the performance and compatibility of the integrated experiment module when operated in a mission sequence under ambient and prescribed environmental conditions

4.1.2 Subordinate Objectives - To achieve these major objectives, the following subordinate objectives are established:

a. To establish methods for test data acquisition, handling, reduction and evaluation from all phases of the test program

b. To develop the criteria and method of analysis to be used to demonstrate that the modules, subsystems, systems and GSE are capable of meeting specification requirements

c. To design operational tests for preparing the systems for launch and ensuring performance reliability

d. To provide design verification tests for demonstrating the capability of the systems and GSE to meet operational requirements

e. To perform tests which will demonstrate compliance of modules and/or subsystems with design, packaging and functional requirements, and which will qualify subsystems and components for use in the system

f. To perform tests which will demonstrate compliance of the various airborne subsystems and integrated systems to specification requirements

g. To perform tests which will demonstrate compliance of GSE and Special Test Equipment (STE) with design and functional requirements, and which will qualify that GSE and STE for use with airborne hardware

h. To perform tests which will demonstrate the functional capability of GSE and STE following installation at the integration and launch facilities

i. To perform tests which will demonstrate the functional capability of the integrated facility-GSE-vehicle to successfully perform subsystem and system checkout and then launch

j. To establish test procedure requirements, configuration control and validation methods.

4.2 Test Philosophy - The philosophy adhered to in developing a test program for AAP was to provide the simplest set of tests possible for achieving the desired goal of a reliable system which would ensure complete mission accomplishment. The tests established in this plan achieve this goal, are comprehensive, yet contain the necessary constraint of performing no test unless it is required to demonstrate a level of confidence. There are no redundant tests specified. Although the mechanics of some tests are similar, each has a specific and different objective that makes its accomplishment mandatory. In addition, the most comprehensive testing is applied at the component level and becomes less detailed in scope at each subsequent test level, i.e., component, subsystem, system, etc.

Several specific philosophies are applicable to all development tests, qualification tests, ground tests, system checkouts, and flight simulation operations at any contractor facility, MSFC, KSC and other National Aeronautics and Space Administration (NASA) centers as they are affected by the Apollo Applications Program. These philosophies are:

a. Test and checkout operations will follow a buildup from the design level to the completed flight system. Proper functional performance of all components, subsystems or systems will be verified before mating them with an equal level of assembly or with the next higher assembly.

b. Each succeeding test or checkout operation shall be based on a progressive growth pattern that takes advantage of all previously accomplished tests and test results.

c. Generally, any test that is once performed successfully shall not be repeated, unless the degree of confidence established by that test is voided by subsequent events or data.

d. Throughout flight article testing and checkout no malfunction, however slight, shall remain unexplained. Testing will proceed beyond the test phase in which a malfunction occurred only when the cause is satisfactorily explained and corrected, and the unit/subsystem successfully demonstrates performance to test specifications.

e. Positive fault isolation will be accomplished on anomalies discovered during flight article checkout, prior to distubring system integrity for component or "black box" replacement.

f. All personnel directly involved in the AAP integrated test program will be trained and certified to perform or support the program.

g. No testing will be performed on flight hardware without a written procedure that has been prepared to valid specification requirements, verified by usage, and approved by cognizant personnel.

h. Actual flight hardware will be utilized during all prelaunch checkout operations. Where this is precluded due to schedule constraints, operating constraints, etc., properly certified simulators will be utilized in place of the mission flight element.

i. All mechanical and electrical acceptance tolerances will be verified at the component, subsystem and system level testing.

j. The test conductor method of operation will be used. This concept provides that one individual be responsible and have the authority for conducting a specific test, including coordination of efforts; enforcing adherence to procedures; providing for or obtaining test support; and, conducting a valid test using approved test techniques and controls.

k. GSE, STE, Test Procedures and other test software will be developed concurrently with the integrated carriers during the development test phase and, finalized and verified during Qualification and Design Verification tests prior to first usage on the actual flight hardware.

4.3 Test Policies - This section establishes and defines the test policies which are imposed throughout all AAP test planning and test programs at all NASA and manufacturing centers involved in this program. Included are test policies imposed on all activities from design concept through manufacturing, assembly, mating and launch. Adherence to these prescribed constraints will ensure the probability of total mission success.

The design, development and production of experiments and carriers is accomplished separately from the payload integration activity all of which are under the management of various NASA centers. All AAP mission experiments shall be delivered to the payload integration area in a flight qualified condition.

4.3.1 Environmental Control - Components, subsystems, systems and carriers requiring environmental testing for the purpose of assuring that the item subject to test will satisfactorily perform its designed functions within the natural and induced mission environments will be tested to the maximum extent practicable under simulated mission environments.

In this test plan, special consideration has been directed toward simulating the most strenuous environments that a specific item of flight or ground hardware might encounter. Besides those environments encountered in launch and flight, environments occurring during transportation, assembly and handling are considered. Environmental test levels employed may, in some cases, be lower than levels that will be encountered. Such levels will be used only when it has been definitely determined that such a test will completely reveal all quality defects that may be present.

Special methods, tooling, and/or fixtures shall be developed for the handling of solar panels and heat reflective areas during test operations and shipment. Methods of protecting the sensor and sensor assemblies of optical systems during test and shipment will be devised. Clean room requirements will be maintained during transportation when required. Methods and systems to control environments during special testing will be developed under the direction of the PIC and NASA.

In general, all AAP equipment must be able to meet the operating requirements of the applicable performance specifications after exposure to the following environments:

a. Temperature (air)

Air transportation	-45 to +140°F for 8 hours
Ground transportation	-20 to +145°F for 2 weeks
Storage	+25 to +105°F for 3 years

b. Pressure

Air transportation	Minimum of 3.47 psia for 8 hours (35,000 ft alt)
Ground transportation	Minimum of 11.78 psia for 3 years (6,000 ft alt)

c.	Humidity	0 to 100 percent relative humidity, including conditions wherein condensation takes place in the form of water or frost for at least 30 days
d.	Sunshine	Solar radiation of 360 Btu per square foot per hour for 6 hours per day for 2 weeks
e.	Rain	Up to 0.6 inch per hour for 12 hours, 2.5 inch per hour for 1 hour
f.	Sand and Dust	As encountered in desert and ocean beach areas, equivalent to 140-mesh silica flour with particle velocity up to 500 feet per minute and a particle density of 0.25 grams per cubic foot
g.	Fungus	As experienced in Florida climate, materials will not be used which will support or be damaged by fungi

h. Salt Spray	Salt atmosphere as encountered in coastal areas, the effect of which is simulated by exposure to a 5-percent salt solution by weight for 48 hours
i. Ozone	Up to 3 years exposure to 0.05 parts per million concentration or 3 months at 0.25 ppm or 72 hours at 0.5 ppm.

4.3.2 Criticality Categories - It is recognized that all CEI's will not have the same relative importance to NASA with respect to performance, cost, and schedule effectiveness; that any failure or malfunction of some could affect crew safety; that improper operation of others might prevent accomplishment of some experiments; and that malfunctions of others will not affect the mission or other experiments. Therefore, the degree to which the requirements must be imposed is not necessarily the same for all CEI's but should be variable based on the criticality of the function.

To satisfy this philosophy, all airborne and ground hardware will be classified into categories by Reliability showing the criticality of any component, subsystem, module and system. The criticality categories that will be utilized are listed in Tables 1 and 2. This criticality listing will be kept current throughout the program by the PIC, and the listing will be made available for use in test planning purposes at MSFC, MSC, and KSC. The placement of any item in a category will be predicated upon a Failure Mode, Effect and Criticality Analysis (FMECA) made during design development and qualification testing by cognizant PIC and NASA personnel.

Any modification to existing ground or airborne equipment will require the re-evaluation of the criticality category listing of that item. All new flight or airborne equipment designed will be evaluated within the parameters of the FMECA system and a criticality category established prior to initial test procedure preparation or commencement of flight article testing.

Table I.

Flight Hardware Criticality Categories

Category I	- (Failure) - Any failure which will result in loss of life of any crew member
Category IIA	- (Failure) - Any failure which will result in not achieving one or more primary mission objectives, but does not cause loss of life
Category IIB	- (Failure) - Any failure which will result in not achieving one or more secondary mission objectives but which does not cause loss of life or preclude the achievement of any primary mission objective
Category III	- (Failure) - Any failure which does not result in any of the above conditions

Table II.

Ground Support Equipment Criticality Categories

Category A	- Hardware, failure of which results in the loss of life or injury to any flight or ground crew member
Category B	- Hardware, failure of which would cause a mission abort but does not cause any loss of, or injury to human life
Category C	- Hardware, failure of which would result in neither mission abort nor loss of life

Test procedure preparation will be accomplished utilizing data supplied by this criticality listing of components. Components, subsystems and modules which are more critical will receive more rigorous and detailed testing. The resulting test data for these more critical items will be carefully screened for any trends, irregularities and/or anomalies by cognizant personnel.

It is obvious that it is difficult to categorize an experiment until sufficient information is received from the Experiment Developer. Each experimenter must therefore thoroughly analyze the experiment prior to submission of the experiment plan and make a preliminary determination of the criticality category of the experiment.

4.3.3 Certification of Flight Worthiness (COFW) - Each experiment, subsystem and system will be certified flight worthy prior to leaving the manufacturing or assembly site of that CEI. For a CEI to receive a Certification of Flight Worthiness, it must have met the following minimum requirements:

a. That the spacecraft, vehicle, system, subsystem, assembly, and component specifications and drawings have been developed in accordance with the Apollo Configuration Management Manual, NPC 500-1; Section 3, NASA Reliability Publication, NPC 250-1; and Section 4.2, NASA Quality Publication, 200-2. That each departure therefrom has been approved by the Material Review Board in accordance with Section 8.1, NASA Quality Publication, NPC 200-2.

b. That all tests through manufacturing checkout have been successfully completed meeting the requirements described in Sections 3.6, 3.7 and 3.8 of NASA Apollo Test Requirements, NPC 500-10.

c. That failures of flight hardware in criticality categories 1 and 2 have been analyzed and corrective action implemented in accordance with Section 3.7, NASA Reliability Publication, NPC 250-1.

d. Be a complete item in accordance with Section 14.2.4 of NASA Quality Publication, NPC 200-2.

e. Have been fabricated, assembled, inspected and tested within the requirements of the quality control program defined in Sections 7.3, 7.4, 12 and 14.2 of NASA Quality Publication, NPC 200-2.

f. Be accompanied, in shipment, by support manuals and data packages necessary for the checkout and the operation of the item and be shipped in accordance with Section 11.6 of NASA Quality Publication, NPC 200-2.

4.3.4 Astronaut Participation - The mission astronauts will participate in the test and checkout program, as required, to familiarize themselves with the particular mission hardware and to support the astronaut training program. Recommendations and suggestions of the astronauts will be carefully considered and evaluated throughout the test program. Qualified personnel will be utilized, as required, to complete the "man-in-the-loop" concept. All environmental test chambers must be currently man rated prior to astronaut or other personnel participation in a test within that chamber.

The mission astronauts may observe the overall system tests in the PIF area. They will participate in the Overall Test 1 and 2 at KSC. In addition, they will actively participate in the countdown demonstration and the flight simulation tests at KSC.

4.3.5 Safety Considerations - Flight safety is of paramount importance. Extreme measures must be taken to insure that the safety of the flight and ground crews and mission success are not jeopardized by the results of poor or inadequate testing and evaluation. It is imperative that high reliability, a high degree of quality control, proper test and operational procedures, and sufficient crew training be obtained since the basic costs of manned space experimentation are high; and, since all the data is important to scientific research and/or future space exploration.

The Safety Program will be organized to provide unified control over all safety matters by direct representation to management during the operation of the AAP. Safety will monitor all organizations associated with this Program to assure that established safety requirements are being fulfilled. The Safety Program shall be in accordance with the Safety Engineering Plan.

The program shall include:

a. Procedural reviews to ensure the introduction of safety requirements and criteria in the form of warnings and cautions to minimize the accident or incident potential.

b. Continuous operation to develop new safety requirements and criteria as the program progresses.

c. An auditing system to detect and identify potential hazards in operating procedures or operational systems.

General system safety requirements and precautions that will be adhered to during the AAP Program are:

1. All components and systems shall be returned to the safest mode possible (fail-safe) if a malfunction or failure occurs during any operation or test;

2. Toxic, flammable, or inert gasses shall not be vented into a confined area or an area occupied by personnel;

3. All new, repaired or modified systems, using gases or fluids as a controlling or operating medium, shall be proof-certified to design specifications before operational use;

4. Critical pressure, temperature, and voltage readouts or status indications shall be provided and monitored during all operational testing;

5. Shorting plugs will remain on all ordnance devices until final electrical connections are made. A stray voltage check will be conducted on all ordnance items before final electrical connection with all equipment energized and, if practicable, in operation;

6. All electrical harnesses and test cables shall be located and routed in such a manner that minimum interference is experienced by test personnel during test and checkout;

7. Before initial pressure testing of gas-pressurized systems, the following checks shall be accomplished to ensure proper system operations:

a) Operation, sequence, and reaction of remotely operated valves will be verified.

b) System relief valves, vent and supply valves, pressurization supply valves, temperature sensors and all associated test gauges and equipment will be properly calibrated.

c) All critical solenoids, microswitches and pressure switches will be functioning properly.

d) Previous leak checks of each system will be verified to be within specification tolerances.

e) Operation of remote emergency shutdown controls will be verified.

f) All critical pressurization services will be checked for conformance to design/performance parameters.

g) Applicable special test equipment will be functionally tested to verify proper operation.

8. Where static electricity in equipment presents a hazard, the equipment will be bonded to ground. Where static electricity on personnel is hazardous, arm stats and/or leg stats will be used to bleed the charge to ground.

9. Before any lift operation, the lifting device will be functionally operated and proof tested to a minimum of 125 percent of the expected load, or verified that it has been proof loaded to the desired safety factor within specified calibration dates.

4.3.6 <u>Training and Personnel Certification</u> - All Test Engineering and Operations personnel responsible for this program shall undergo specialized training and when applicable, employee certification. All technician and operations engineering personnel, who perform critical functions on or with AAP equipment, will be trained, tested and certified as capable of performing that specific function.

The training and certification program will be tailored to meet the specific needs of the Test Engineering and Operations activities as specified in the Personnel Training Requirements

Analysis (PTRA). The training courses are divided into the following categories:

1. Orientation training courses will be presented to acquaint the trainee with the subject material for purposes of establishing a background. The trainee will not be expected to perform any specific task as a result of attending these courses.

2. Technical task-based courses will present the subject matter for purposes of enabling the trainee to apply the knowledge obtained to actual job situations. These courses will provide instruction in methods and techniques to be used in the performance of job tasks, systems and equipment operation, and testing processes and results analysis.

Certification of trainees to perform critical tasks will be accomplished as specified in the PTRA. These tasks, because of their critical nature, or because they are covered by regulation, require certification of employee capability to perform such tasks. Certification will occur upon the successful testing and, when applicable, a performance demonstration of the task. Continual personnel performance and skill evaluation of these personnel shall be accomplished to assure adequacy of training and maximum employee proficiency.

4.3.7 <u>Quality Considerations</u> - NASA Quality Publication, NPC 200-2 is the basic guideline used during the testing of AAP hardware. NASA Quality Publication, NPC 200-3 provides the minimum inspection system requirements for all AAP hardware. The Quality Control Program Plan is based on these two documents and will be adhered to throughout the duration of the test program.

4.3.8 <u>Prelaunch Operations</u> - The PIC and NASA-MSFC, with support from MSC, will assist KSC in the development of a checkout operation and ground support plan for the AAP Program at KSC. The test plan will be supplied by MSFC to KSC. This plan will be of such detail as to specify each test procedure that will be required from receipt of the flight items through launch and post launch tests.

The plan will specify all procedures and documents necessary to support ground testing and checkout activities, at each test location, to assure a flight-prepared vehicle when all systems are mated. Final vehicle checkout operations will verify that the vehicle and systems are in the maximum state of readiness to assure mission success.

Throughout the duration of this program, some experiments may not be available for installation in the carrier prior to the carrier acceptance test. Installation of the late-arriving experiment would then occur at the Merritt Island Launch Area at the earliest possible point in the checkout sequence. Inasmuch as the carrier would have been accepted with a simulator, a detailed checkout verifying the experiment compatibility with the carrier must be performed at this time.

4.3.9 Minimization of Test Duplication - Test programs, for ground and airborne hardware utilized on this mission that are common to other programs, will be reviewed to determine adequacy and to eliminate any test duplication. Items which have been previously qualified for an equivalent application on other programs will be carefully screened by the PIC and NASA for acceptance as a qualified item for the AAP Program. In the case where the previous application and testing of an item was similar to AAP requirements, but not equal or more severe, the AAP CEI test plan for that item will concentrate on testing in the areas of new or increased requirements.

The evaluation of a component, subsystem, module or system for test redundancy shall consider such factors as fabrication and inspection procedures, criticality category, methods of prior tests, applicable performance history, environmental conditions encountered, and design safety factors for the item. Any rework required on any item will be cause for considering the retest of that item. The degree and extent of that retest will be determined upon review of the rework and the item with respect to the above listed parameters by cognizant PIC and NASA personnel.

4.3.10 Hardware - Software Development - The preparation of detailed integration test plans for flight hardware will identify the GSE, special test equipment (STE) and software that will be required to attain the test objectives established.

Figure 6 shows the development of GSE, STE and software being accomplished with the development of the integrated carrier. The support equipment development program will make extensive use of functional mockups, breadboards and brassboards to confirm initial design. The completed GSE, STE will then be used to

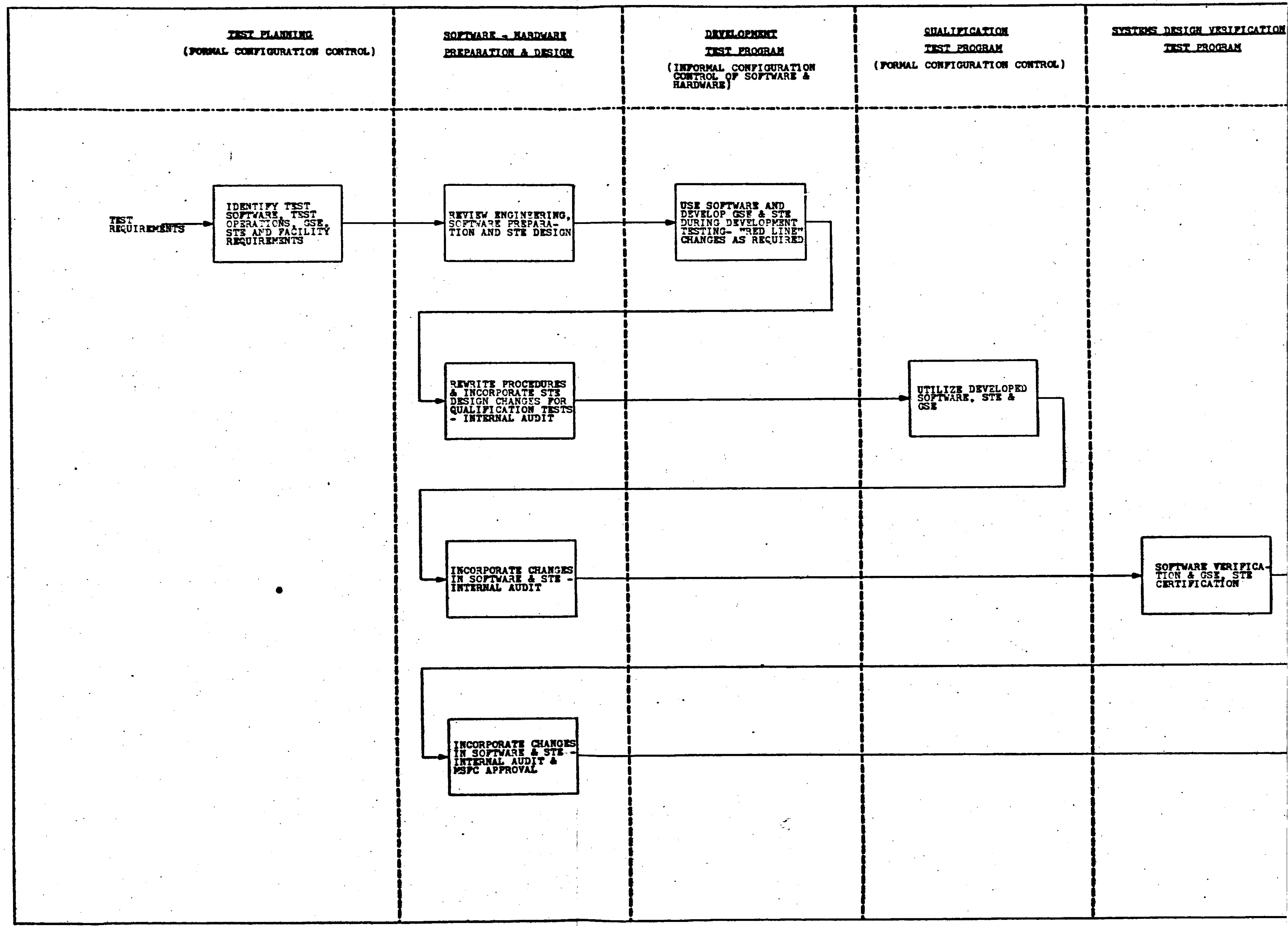


Figure 6. Hardware/Software Development & Verification

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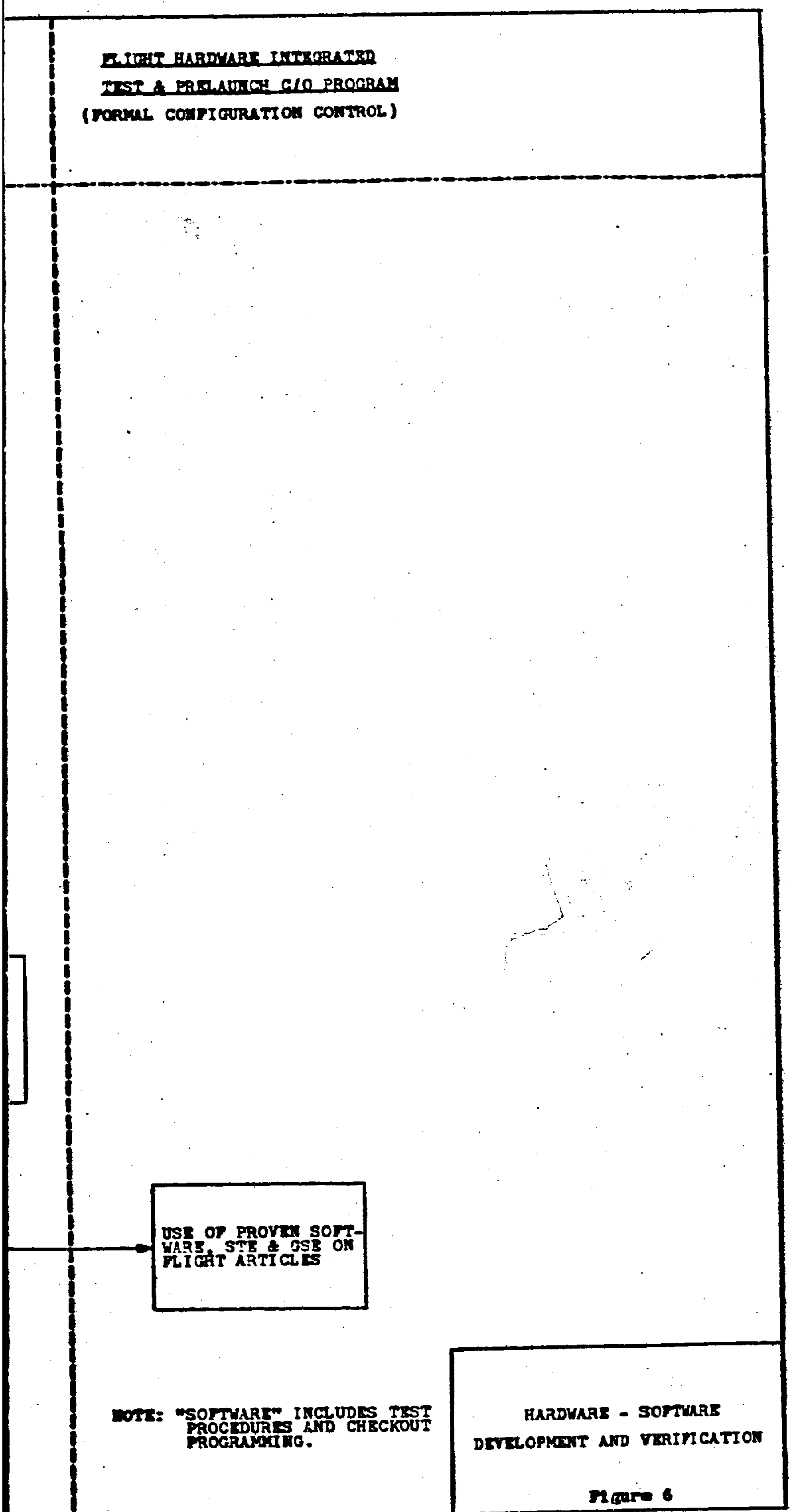

HARDWARE - SOFTWARE DEVELOPMENT AND VERIFICATION

Figure 6

perform certain checks in the development test phase. The equipment and associated software is qualified during the integrated carrier qualification test program. Final acceptance and verification of the equipment and software will be accomplished during design verification testing.

This system of developing, qualifying and accepting GSE, STE and associated software concurrently with the integrated carriers provides certified and verified hardware and software prior to its first usage on the flight articles.

4.4 Test Categories - Test categories in the present stage of the art are many and varied, each designed to check out a specific operation or function of components, subassemblies, systems and combinations of systems. For the AAP, test flow will follow a build-up from the component level to the complete space vehicle. The functional performance of every component, subsystem and system will be verified prior to mating it with an equal or next higher assembly. Receiving Inspection conducted on experiments, support subsystems, subsystems, systems, and carriers at the PIF area and at KSC will be limited to that necessary to verify that no shipping damage has occurred, i.e., limited or no detailed functional checkout with maximum emphasis on verification of documentation and inspection for physical damage. Figure 7 shows the AAP Test Program test categories and relationships.

This section will define and briefly describe the specific categories of testing that will be performed to assure AAP mission success. Since the requirements for certain test types may depend upon the criticality rating and type of hardware, some tests are much more complex and intense on some items than on others. Test time or cycles on any component shall not exceed its design life minus its flight life. Logs will be maintained on all items that have a definite shelf life or limited operational life span.

NASA personnel shall have the prerogative of witnessing all testing accomplished in any category at any locality or facility. All testing accomplished under the jurisdiction of the PIC may be conducted and/or monitored by the PIC Operations and Quality personnel.

NASA may provide Engineering personnel to review, analyze and evaluate the data collected throughout the test program.

Development Tests	Qualification Tests	System Verification	Acceptance Tests	Prelaunch Tests
Dynamic Environmental Static Structural	All Systems Dynamic Environmental Functional Reliability Off Limits Simulated Flight Static System Design Verification	Carrier Interface EMC/EMI	Vehicle Calibration Functional In Process Laboratory Calibration Manufacturing Simulated Flight	Calibration Flight Readiness Functional Simulated Flight Vehicle Calibration

Figure 7. AAP Test Categories

All integration testing shall be performed to procedures that have been subjected to PIC and NASA review and have been subsequently approved.

For experiment integration test purposes, the Experiment Developer will be required to supply the following equipment:

a. Flight hardware

b. Backup hardware

c. Qualification test hardware

d. Mockup hardware

e. Hardware simulators

f. Ground support equipment (GSE)

The flight hardware, backup hardware and qualification test hardware must be identical in configuration and production processing. The mockup hardware and hardware simulators must be exact models with correct external dimensional configuration and must duplicate weight, center-of-gravity, functional controls, electrical connections and mounting provisions of the flight hardware. The mockup hardware need not be a functional model, but the methods of operation and any critical axis-mounting direction must be indicated. Hardware simulators, used for thermal vacuum testing, must present thermal balance characteristics identical with the flight hardware. The GSE supplied is that support equipment which is peculiar to the requirements of the experiment and is not readily available as government furnished equipment.

4.4.1 Design Development Tests - Development testing is accomplished on non-functional and functional test articles to confirm subsystem and system design and to verify that the integrated system will satisfy compatibility and performance requirements. Development testing includes tests to evaluate hardware performance under simulated or actual environments, determination of hardware failure modes and establishment of safety factors. This type of testing will not be performed using the flight article; the development test article should, however, be representative of the flight article.

The development test program may be divided into two categories:

a. Nonfunctional Mockups - Extensive use of nonfunctional mockups will be made to verify space allocations, equipment and experiment locations, cable and tubing routing, accessibility, man-machine relationships, and interfaces between segments or modules which make up the AAP vehicle.

b. Functional Mockups - Breadboards, brassboards, and prototypes will be subjected to functional tests to confirm and/or verify engineering design. These developmental test articles will be subjected to specific functional and margin-of-safety requirements and the test results will be used for early evaluation of production hardware capabilities and compatibility. As required, environmental tests will be accomplished on some prototype hardware. During the accomplishment of these tests certain anomalies may occur which will necessitate additional special or specific testing. These tests are not discussed further at this time but will be detailed when the requirement for a test is known.

Development functional mockup testing may be further defined by division into three categories:

1. Tradeoff Tests - Testing performed to evaluate subsystem and integrated system design to arrive at an optimum overall configuration.

2. Ambient Functional Tests - Testing performed at ambient conditions to verify and confirm subsystem and integrated system design and performance compatibility under these conditions.

3. Environmental Functional Testing - Testing accomplished under environmental conditions such as vacuum, thermal vacuum, static, dynamic, etc., to demonstrate and prove subsystem performance and integrated system design compatibility under these induced conditions.

Development testing will be patterned to determine mechanical and physical properties and design values where data does not now exist. Such items may include properties such as: thermal conductivity, thermal expansion, strength, stiffness, flammability, absorptivity, emissivity, mass properties characteristics, electrical conductivity, etc. In general, such design parameters as flow rates,pressure drops, voltage drops, transient response, etc., will be verified and confirmed by these tests.

4.4.2 Qualification Tests - Qualification testing is performed to verify that piece parts, components, assemblies, subsystems, systems, primary and secondary structures of the carrier segments comprising the integrated experiment module, and associated ground equipment meet design specification requirements. Such tests are necessary to assure that the item is qualified to meet the life, environmental, parametric, and reliability standards which its particular application demands prior to the first article usage. The tests will include overall performance evaluation of the article within the full spectrum of the anticipated environment and, where applicable, life cycle testing of the specific component. All qualification testing will be performed on an identical sample of flight-type production hardware and, if practical, shall be conducted at the system level or above. Should size and complexity of the equipment preclude testing at the system level, testing shall be done at the next lower level of assembly. Testing shall be designed to:

a. Verify that the elements of the integrated experiment modules meet specification requirements necessary to assure operational success;

b. Determine the effects of combinations and sequences of environmental stress levels;

c. Locate significant failure modes and establish failure and anomaly trends;

d. Determine the effects of combinations of tolerances and drift of design parameters;

e. Determine the effects of varied stress levels.

Performance evaluation by Qualification Testing shall include such typical tests as flow rate, operating pressure, allowable leakage, mass properties characteristics, voltage drop, phase shift, gain, and heat transfer. The anticipated environment for the specific article may include shock, vibration (random and/or sinusoidal), random acoustics, temperature, humidity, etc.

Qualification testing may be separated into four broad categories:

a. Functional Testing, Ambient - Tests on both prototype and flight articles may be included in this category. The tests that may be accomplished on flight articles are such tests as compatibility checks of carriers in orbit configuration and EMC tests.

b. Functional Testing, Thermal Vacuum - Tests on prototype articles to verify effects of space environments on hardware performance.

c. Functional Testing, Other Environments - Tests performed on prototype hardware to verify and confirm effects of such environments as static loads, radiation, meteors, rain, dust, sunshine, etc.

d. Functional Testing, Dynamic - Dynamic tests will be accomplished on prototype articles only. These tests will confirm the effects of shock, bending, and vibration encountered during transportation, launch, orbit maneuvers, and re-entry.

A functional test to determine whether the hardware is performing within specification tolerances must be conducted before and after each environmental exposure. The same functional test must be performed during the exposure period if the equipment is required to operate in that environment during the mission. If the tests are run in series, with no significant time interval between tests, the functional test after an environmental exposure may serve as verification of proper performance before the succeeding environmental test. Performance outside of specification tolerances during and/or after any of these tests shall constitute failure to pass the test.

Items comprising the AAP mission may be placed in several categories in which the degree of qualification testing will vary. These categories are:

1. Previously qualified items, being utilized within this program for identical or similar purposes, requiring no greater or more stringent applications.

2. Previously qualified items now having more stringent requirements than the original qualification, either additional or new.

3. Previously qualified items that have been modified for AAP usage wherein qualification of the modification only is required, inasmuch as previous qualification was compatible with program objectives.

4. Previously qualified items wherein complete or nearly complete requalification is required due to modification of the item.

5. New components requiring a complete qualification test program.

Each item will be carefully evaluated, changed, added or new qualification requirements will be assigned to it as dictated by comparison between previous tests and the AAP requirements.

Complete requalification testing will be accomplished when:

1. Design or manufacturing processes are changed to the extent that the original tests are invalidated;

2. Inspection, test or other data indicate that a more severe environment or operational condition exists than that to which the equipment was originally qualified.

3. Manufacturing source is changed.

Qualification by similarity may be accepted providing all the following minimum requirements are met:

1. The item was qualified to the Apollo and Saturn IB/V environmental levels expected on an orbital mission.

2. The item was designed to equivalent specifications required of the Apollo and Saturn IB/V designs.

3. The item was fabricated by the same manufacturer with the same processes and quality control.

Additional testing, after qualification and beyond specified design limit conditions (off-limits tests), will not be planned for those components qualified by prior usage. For newly developed components, off-limits testing shall be planned for those suspected of contributing a high proportionate share of unreliability to a system, and for those components shown to be critical to astronaut safety and/or mission success in the Failure Mode, Effect and Criticality Analysis.

All experiments and support subsystems will be subjected to electromagnetic interference (EMI) tests. Tests will be performed at the Payload Integration Facility (PIF) on the integrated carrier level and on the on-orbit cluster level to verify electromagnetic compatibility (EMC) between support subsystems, basic carrier subsystems experiments and between integrated carriers in the on-orbit mission configuration. Tests will also be performed at KSC to verify the absence of RF interference between all spacecraft elements, the booster, and ground equipment in the launch configuration.

Ground qualification tests are planned to satisfy the following AAP general requirements:

1. Qualification testing shall include both natural and induced environments which simulate as closely as possible the anticipated environments including the operational cycles, levels, range and sequence. Combined environments shall be used when necessary and practical.

2. Where redundance in design exists, the qualification test program will assure that each redundant item will be included in the test program.

3. Functional operation is required. During qualification tests, interfaces shall be present or simulated. The usage of simulators during qualification testing will be held at a minimum; however, if simulators are used, they will adequately simulate the article in a manner that allows valid test results to be obtained.

4. Any failure shall be cause for positive corrective action. The degree of retest, in event of failure, shall be mutually agreed upon between the cognizant MSFC design group and the contractor or test agency after evaluation of the failure.

5. Certain special tests, such as burst tests to verify that hardware does not fail below proof limits, shall be performed as required to assure operational safety.

6. Particular emphasis shall be given to qualifying the man-machine compatibility and the adequacy of the man-machine combination to fulfill the mission requirements.

7. Acceptance tests, through manufacturing checkout, shall be performed on hardware prior to its being subjected to ground qualification tests.

8. Any failure of a test specimen shall disqualify the entire class of hardware (all items of hardware made to the same specifications and intended for the same application as the qualification hardware). Where a failure occurs, hardware or procedural changes shall be introduced into all test hardware and the qualification test shall be reinitiated. MSFC approval is a prerequisite to initiation of requalification testing. However, if the cause of failure is a quality defect which can be detected by a non-destructive inspection, then those units of the sample which have already been tested without failure need not be retested. Nevertheless, all units must perform without failure, including the retested units for which defects have been corrected. In the above cases, extreme caution shall be taken to assure that these changes and corrections are made to all units in the class and that such action will not degrade the units.

9. Qualification testing will be performed at the carrier level whenever possible. Integrated carrier and experiment checkout will be conducted utilizing on-orbit mission sequences.

10. Life-test qualification requirements will be satisfied at the component level. Subsystem and integrated experiment module qualification tests shall include more real time sequences than flight article tests, but will not be constrained to real time qualification for inactive mission segments.

11. Adjustments, or tuning is not permissible during the course of a test unless it is normal to the in-service operation. If such action becomes necessary, the test specimen shall be disqualified pending corrective action.

12. The requirement for utilization of production or flight-type hardware may be partially waived on complete carrier level qualification tests; e.g., thermal vacuum testing. Complete configuration control shall be required, however, such that each deviation from pure flight or orbit configuration is analyzed for its effect on qualification test validity. Such deviations will be approved by MSFC on an individual basis.

13. Structural-load qualification tests will be held to an absolute minimum by the general philosophy of utilizing conservative design margins of safety.

14. All carrier, experiment, and subsystem components shall be subjected to pre-delivery acceptance (PDA) tests at the completion of their manufacture at the manufacturer's location.

15. Thermal vacuum tests for large modules (i.e., AM, MDA) will be performed on qualification articles. Whenever carrier articles are available from past Apollo program activity, they will be modified to the proper configuration and utilized if practical. Thermal vacuum testing will not be performed onproduction articles unless the configuration of the production article differs from the qualification article to such an extent that the risk to mission success justifies the cost of such a test.

16. Checkout operations used during qualification will be as nearly identical to KSC operations as possible.

17. Qualification tests supporting Flights AAP 1 and 2 shall be completed prior to the launch of Flight 1. Orbital interface qualification tests involving spacecraft of Flights 1 and 2, and Flights 3 and 4 will be accomplished prior to launch of AAP 1. However, due to schedule constraints it may become impractical to accomplish orbital interface verification of Mission 3/4 prior to the launch of Mission 1/2. In the event of such constraints orbital interface verification of Mission 3/4 will be completed prior to the launch of Flight 3.

18. Equipment shall be mounted in a manner simulating the actual mounting in the spacecraft for all environmental tests wherein the equipment is expected to be affected by the spacecraft mounting.

The Qualification Test hardware will not be used as flight hardware unless a specific written waiver to do so is granted by NASA.

The sequence of tests normally shall follow the same order in which the environments will be encountered during the mission. However, scheduling of test equipment and other factors may work an undue hardship in attempting to adhere to this criterion. Consequently, the sequence of tests may be altered subsequent to approved changes to the test specifications.

A final environmental qualification test report must be submitted to NASA-MSFC for approval. Disapproval will be a constraint upon flight qualification. Consequently, the qualification test program should be scheduled allowing sufficient time for failures, rework during testing, preparation of the final test report, and review after submittal.

4.4.2.1 System Design Verification Test Program - The intercarrier verification test program is necessary to verify the systems operation of the various carriers in the launch and orbit configurations. This test program is based on the assumption that all experiments, subsystems and integrated experiment modules used in this test program have been qualified or at least undergone design verification testing. Some integrated experiment module qualification tests may be performed during this test program, however, this test program is mainly for the verification of interfaces between experiment carriers. Any test that involves two or more carriers has been included in this section.

This test program will be divided into three basic parts: Launch compatibility tests, Mission 1/2 orbit configuration compatibility tests and Mission 3/4 orbit configuration compatibility tests.

The launch configurations for Flights 1, 2, 3, and 4 will be tested to verify the mechanical and electrical interfaces between carriers. The EMC design verification test will be performed at the KSC launch pad with the flight hardware.

The test programs for Mission 1/2 and Mission 3/4 orbit configurations will verify all orbital configurations and operations to be accomplished during these missions. Verification of critical malfunction corrective actions and emergency procedures and performance of special tests (i.e., parametric voltage, contingency tests, etc.) will also comprise the test program.

The test requirements which will be satisfied by the Systems Design Verification Test Program are summarized in the following test flow, Figure 8.

4.4.3 Reliability Tests - Specific reliability testing to gather reliability data will not be accomplished by the PIC for the AAP. The determination of numeric reliability for a system, or portion thereof, will be determined from data generated in design, development, and qualification testing. These tests will serve in lieu of a specific reliability test program by virtue of the test conditions chosen. This data will be collected by a single organization (see Section 4.6.6), and will be available as required for reliability assessments.

Reliability Engineering will supply a list of all those items for which they will need data. When qualification tests are planned for any of these items, Reliability Engineering will be given an opportunity to request any extension of these tests (off-limits tests) for reliability predictions. The extended qualification tests requested may be a test to failure of the test sample or some preset maximum time or value to determine a margin of safety.

Where test-to-failure is required prime emphasis shall be placed on time and/or cycles. The elevating of environmental stresses beyond those predicted or measured should be kept to a minimum consistent with the uncertainty of the environment to be encountered in use. Any hardware that has been subjected to reliability demonstration testing will not be used on flight vehicles.

4.4.4 Acceptance Tests - The term Acceptance Tests covers a broad spectrum of specific kinds of tests. For this mission, Acceptance Tests are defined as tests performed to assure confirmation to design or specifications as a basis for "acceptance".

Acceptance tests will consist of functions pertinent to operating requirements of the specific components, subsystem, or system. The tests may or may not include environmental conditions. Typical of these tests are flow rate, vibration, operating pressure, leakage, heat transfer, voltage regulation,

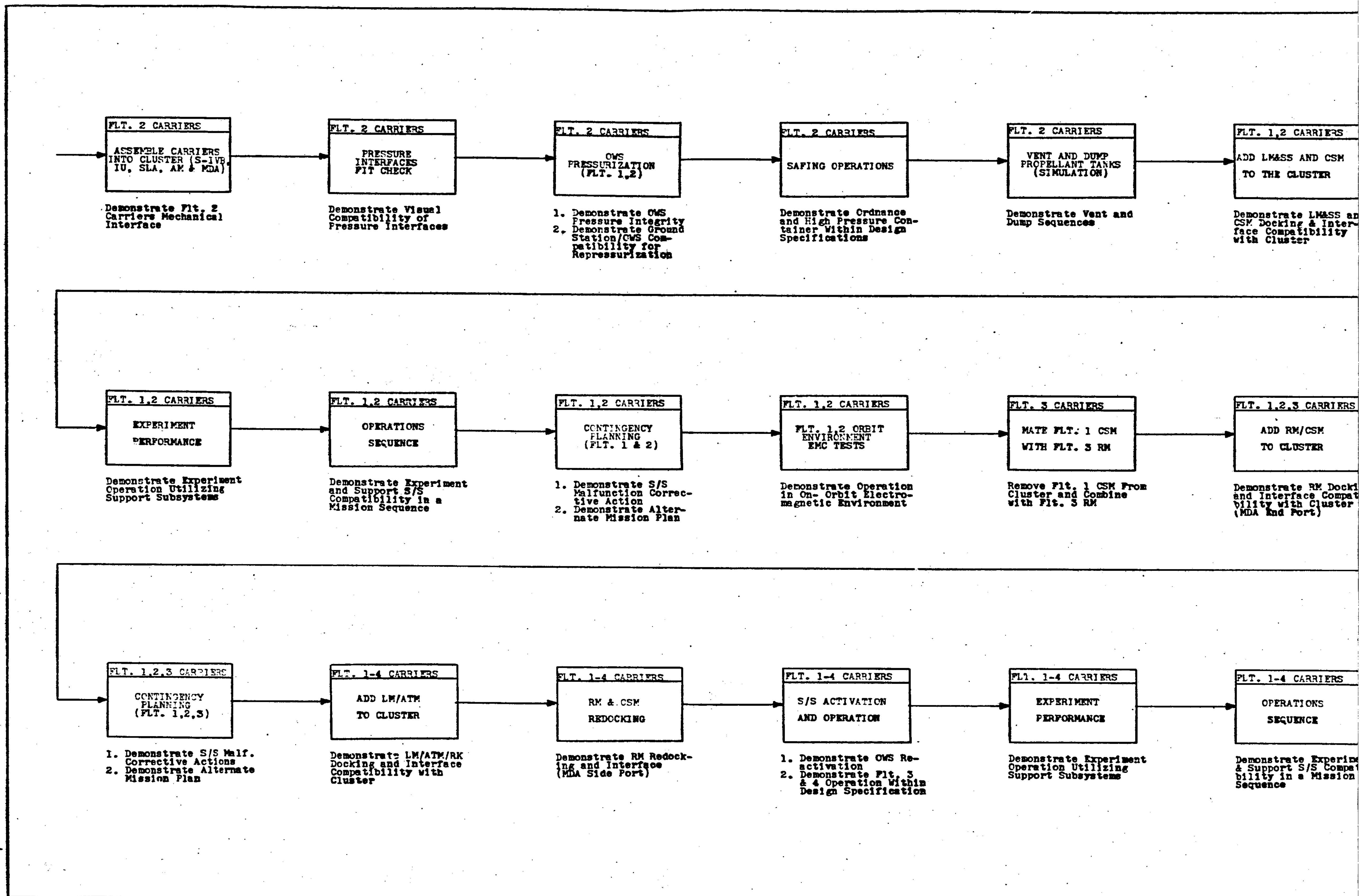

Figure 8. AAP 1/2 & 3/4 Systems Design Verification Test Requirements

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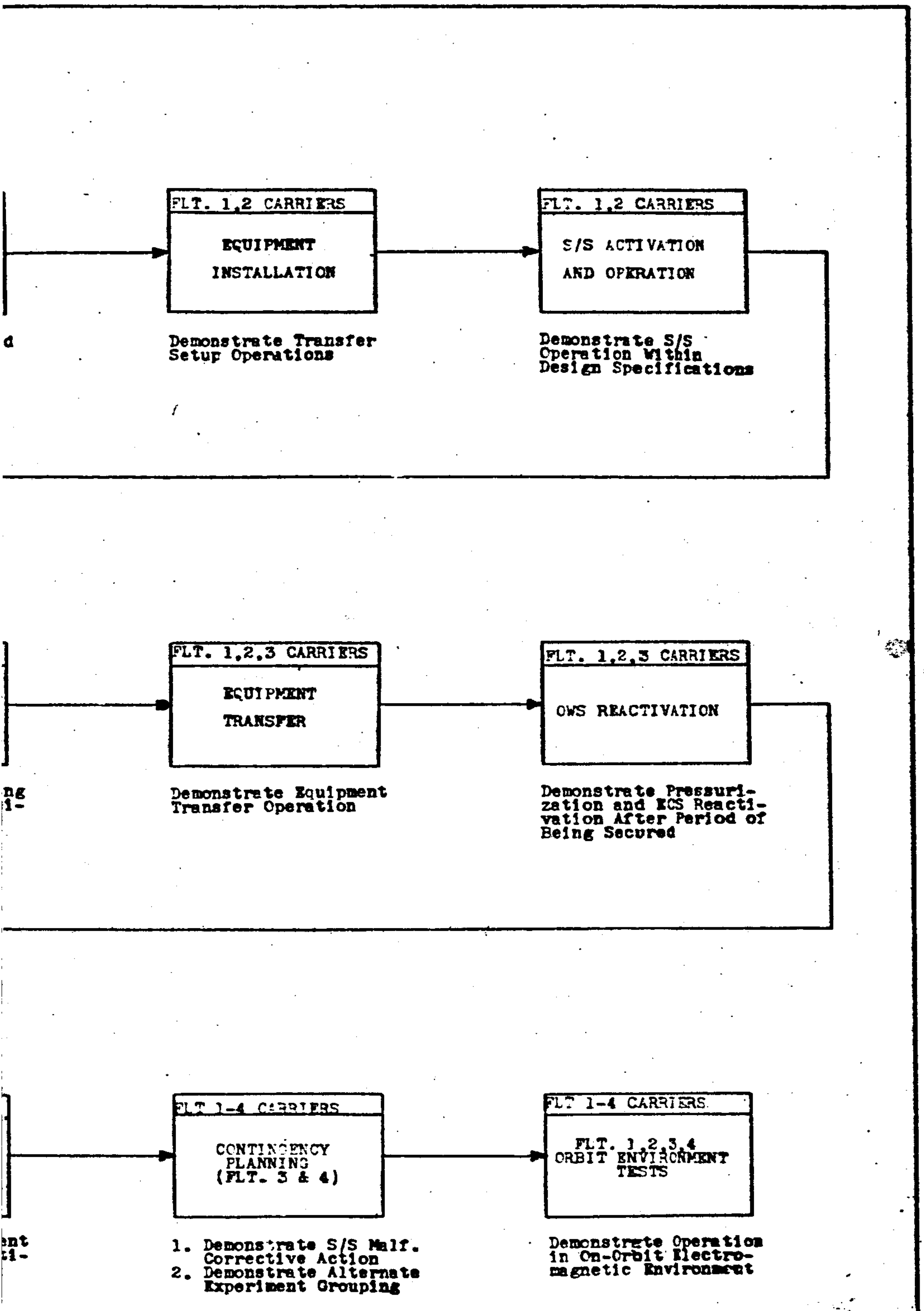

Figure 8

AAP 1/2 &3/4

SYSTEMS DESIGN VERIFICATION TEST REQUIREMENTS

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phase lag, gain and pressure drop. An acceptance test represents a level of confidence milestone in the overall test program. All CEI received by the PIC shall show evidence of successful completion of pre-delivery acceptance (PDA) test programs. These tests shall include complete operational and functional checks to insure that the equipment is flight worthy.

At intermediate points during the manufacturing process and prior to the start of the final manufacturing checkout, "In Process" testing may be performed. The necessity for these tests shall be based on the complexity of the component and the fabrication and packaging techniques utilized. Typical tests performed in this category are pressure and leak checks, and electrical tests to identify a random anomalous item. In process tests will be accomplished on all new build or modified components and will be specified for all off-the-shelf hardware that will be utilized.

All components, subsystems, systems or carriers shipped from remote fabrication sites to MSFC or other assembly locations shall be subjected to a Receiving Inspection (R&I) test prior to incorporating them into a higher level assembly. This receiving inspection will be only that necessary to verify that no shipping damage has occurred, i.e., limited or no detailed functional checkout with maximum emphasis on verification of documentation and inspection for physical damage. After R&I, certain CEI's may be selected for Pre-Installation Acceptance (PIA) tests. These tests are performed on flight and backup hardware following delivery to the integration facility, but prior to integration. These tests further insure the equipment has not been damaged in handling and shipping and is still in a flight worthy condition.

4.4.5 Pre-Use Checkout of GSE and STE - GSE and STE checkout prior to first usage is accomplished to verify the condition of the equipment for use and to demonstrate its operability and compatibility with flight hardware. Generally, this verification shall be achieved through the utilization of ground support equipment previously utilized in the basic Apollo program and through utilization of the ground support equipment in conjunction with the ground qualification of the spacecraft equipment.

Apollo Applications GSE and STE will be classified into two categories relative to the testing required: 1) Mission Essential Equipment is that whose failure could endanger the flight crew or ground personnel, or could abort or significantly delay the launch; 2) Mission Support Equipment consists of handling and servicing equipment, the failure of which would not result in unsafe conditions, lengthly repair times, or launch delay.

Design and performance parameters for modified or new Mission Essential Equipment will be more stringent than those for modified or new Mission Support Equipment.

The purpose of GSE and STE pre-use checkout is to prove that all ground equipment is capable of performing its assigned task. The tests will ensure that a minimum of delay is experienced during vehicle checkout and launch by discovering and correcting all equipment anomalies prior to first usage with the flight article. Ground support equipment, at the installation site, shall be checked out initially through self-verification or other appropriate means prior to connection with each item of spacecraft hardware. After connection of ground support equipment to spacecraft items, a systems compatibility check shall be made prior to beginning the checkout of the spacecraft.

GSE and STE will not be utilized with flight hardware prior to the completion of acceptance tests.

Final acceptance tests of GSE and STE will not be considered complete until that equipment has been properly mated and operated with the applicable spacecraft element; and, compatibility tests have been performed to ensure that all functional and physical interfaces are perfect, and that the GSE/STE can sucesssfully demonstrate its designed function(s).

4.4.6 <u>Prelaunch Checkouts</u> - The prelaunch checkout of a vehicle and its systems assures that the vehicle is ready to launch and that the ground equipment is ready to support the launch. This checkout may include a countdown, flight readiness tests, combined functional tests, all systems tests, a simulated firing with all launch equipment operating and a flight simulation program. The primary goal of the prelaunch checkout is to ascertain, on the ground, that all systems can achieve their intended missions.

A continuum of flow shall occur in the test plans and procedures from payload integration through launch. The prelaunch checkout of carrier experiment modules at KSC will be integrated into the normal Apollo test flow. The manner of integration shall present the least disturbance of this Apollo flow while giving maximum mission assurance to the integrated experiment carrier. All systems, which are shipped to the launch site from a remote location, shall be subjected to a complete and thorough Receiving Inspection prior to mounting the system on a carrier or launch vehicle.

The KSC checkout activities can be regarded as an extension of the payload integration function. The normal prelaunch preparation of the spacecraft, prior to mating it with the launch vehicle, shall be conducted in the Merritt Island Launch Area (MILA), Manned Space Operations Building (MSOB). At the conclusion of the MSOB activities, launch activities will commence on the combined booster and spacecraft.

During this final phase of ground test activity, all flight electrical and mechanical connectors, once mated in the spacecraft, will not be disconnected for checkout purposes. In the event that "trouble shooting" is required, a procedure approved by those agencies affected shall be utilized and all steps taken shall be documented in detail. Should it become necessary to utilize spares or to modify a spacecraft system during the course of a test, those minimum tests, which are necessary to re-establish confidence in the unit or system that has been affected, must be repeated. The installation of late-arriving experiments will necessitate a complete functional test of the new item, as installed, and a demonstration of its capability to function properly with interfacing equipment.

Wherever practical, the preferred method of installed-experiment repair shall consist of removal and replacement of the faulty element at the major functional component level. In place repair of a component at the PIF or launch site location, without removal from the major assembly, shall be accomplished only when the following conditions are satisfied.

a. The failed component cannot be replaced within the program time constraints;

b. Adequate testing and calibration equipment are readily available to ensure reliability of component repaired;

c. Qualified personnel are available for repair and checkout;

d. Concurrence of all affected management and/or contractor personnel is obtained.

All reparable components, which are removed from carrier-installed experiment systems or GSE, shall be repaired by the principal investigator or his experiment contractor. In general, this repair concept will require component repair at the PIF or within an area at the launch site designated for this purpose.

4.4.7 Flight Support Tests - The purpose of flight support testing, as applicable to the integration activity, is to be able to duplicate and resolve, on the ground, any anomaly occurring in flight. All AAP equipment and parameters will be closely monitored during flight in order to establish an early identification of any module, system or subsystem which demonstrates abnormal performance or unusual characteristics of appearance, and to measure and evaluate the extent and effects of the deviation. These tests require that the ground test hardware be in the orbit configuration during the flight.

4.4.8 Postflight Tests - The purpose of postflight testing is to accurately evaluate the effects of a rigorous space flight operation on the flight hardware using a prototype testbed. Anomalies occuring in flight will be cause for extensive retest of prototype models of the discrepant hardware to determine, isolate and identify the cause of the anomaly. The postflight tests performed, and the subsequent data evaluation, shall be accomplished to procedures and methods that have been approved by NASA.

4.5 Test Responsibilities - A test program of the magnitude of the Apollo Applications Program involves many contractors, several NASA centers and an Integrating Contractor. Each of these organizations or agencies has specific test responsibilities. This section covers the responsibilities for each organization, defines interfaces between them and provides for a smooth test flow from design testing through launch and postflight testing. Figure 9 shows, in matrix form, the basic broad responsibilities of the various organizations interfacing with the overall AAP Test Program. Detailed descriptions of the responsibilities and functions of each organization will be further defined in subsidiary detailed test plans which will be generated prior to the actual commencement of testing.

The Interface Control Documents (ICDs) shall delegate responsibilities relating to the integration and test of all AAP hardware. This document will also specify those interfaces between the carrier, experiments and launch vehicle which require coordination between the various contractors.

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TEST FUNCTION / ORGANIZATION	PRINCIPAL INVESTIGATOR	EXPERIMENT CONTRACTOR	SUPPORT SUBSYSTEM CONTRACTOR	CARRIER CONTRACTOR	INTEGRATION CONTRACTOR	MSFC	KSC	MSC	OTHER NASA
ENGINEERING									
EVALUATE INTERFACE REQUIREMENTS					X	X		X	
PREPARE INTERFACE TEST SPECIFICATIONS					X			X	
APPROVE INTERFACE TEST SPECIFICATIONS		X	X	X	X	X	X	X	X
FURNISH TEST CRITERIA AND DATA TO PIC	X	X	X	X		X	X	X	X
PREPARE INTEGRATED TEST PLAN					X			X	
APPROVE TEST PLAN	X	X	X	X	X	X	X	X	
EVALUATE CONTRACTOR QUAL TEST PROGRAM	X				X	X			
PREPARE INTEGRATED MODULE DEVEL TEST PROCEDURES					X				
PREPARE INTEGRATED MODULE QUAL TEST PROCEDURES					X				
PREPARE INTEGRATED FLIGHT MODULE TEST PROCEDURES					X				
APPROVE INTEGRATED MODULE TEST PROCEDURES	X	X	X	X	X	X	X	X	
PREPARE AND MAINTAIN PIF TEST PROCEDURES					X				
PREPARE QUALIFICATION TEST REPORT		X	X	X	X			X	
PREPARE PRELAUNCH TEST PROCEDURES							X		
ASSIST IN PREPARATION OF PRELAUNCH TEST PROCEDURES					X				
PROVIDE AAP INTEGRATED TEST MANAGEMENT					X				
PROVIDE TEST CONDUCTOR AND CREWS FOR INTEGRATED TESTS					X				
ACQUIRE AND CENTRALIZE TEST DATA COLLECTION					X				
PROVIDE TEST ENGINEERING ANALYSIS OF INT TEST DATA	X			X	X				
PERFORM CARRIER QUALIFICATION TESTS				X					
PERFORM CARRIER PDA TESTS				X					
PERFORM EXPERIMENT QUALIFICATION TESTS		X							
PERFORM EXPERIMENT PDA TESTS		X							
PERFORM SUPPORT S/S QUALIFICATION TESTS			X						
PERFORM SUPPORT S/S PDA TESTS			X						
MONITOR AND EVALUATE					X				

Figure 9. AAP Test Responsibilities

FOLDOUT FRAME 1

FOLDOUT FRAME 2

OPERATIONS

PDA TESTS	DELIVER FLIGHT QUALIFIED HARDWARE	CONDUCT INTEGRATED PAYLOAD DEVELOPMENT TESTS	CONDUCT INTEGRATED PAYLOAD QUALIFICATION TESTS	PERFORM RECEIVING INSPECTION	PERFORM EXPERIMENT PRE-INSTALLATION FUNCTIONAL C/O	PERFORM PAYLOAD INTEGRATION TESTS	SUPPORT INTEGRATED MODULE TESTING	PERFORM INTEGRATED PRELAUNCH C/O AT KSC	ASSIST IN INTEGRATED PRE-LAUNCH C/O AT KSC	SUPPORT TRAINING PROGRAM	PROVIDE FIELD MAINTAINANCE	PROVIDE LIAISON
					X							
	X				X		X		X		X	
	X						X		X		X	
	X						X		X		X	
X		X	X	X	X	X			X	X	X	X
								X				
	X											
	X											

4.5.1 Experiment Developer - The role of the Experiment Developer consists of two main functions; that of a Principal Investigator and that of an Experiment Contractor. For some experiments, one agency may assume both functions.

a. Principal Investigator - The Principal Investigator (PI) is responsible for the scientific integrity of the individual experiment. He has the primary responsibility and authority for the performance requirements of the experiment. He is also responsible for the following specific items:

1) Provide an experiment plan. The plan will describe each experiment's flight objective, mission profile and operating procedures, data and support requirements, experiment configuration, test requirements, and expected results.

2) Provide experiment checkout and monitor programs, supported by test sequence plans, for use at the PIF and KSC prelaunch checkout and in-flight operations.

3) Technical surveillance and assistance during experiment integration operations, ground test and field maintenance at the PIF and at KSC.

4) Analysis of the test data after each PIC test, the flight and preparation of the required reports.

5) Assurance that the test programs on the equipment meet the objectives of the investigation, and reflect the AAP environmental and interface constraints.

b. Experiment Contractor - The experiment contractor is responsible for the design, development qualification and support of the experiment. Specifically, he is responsible for:

1) Delivery of the flight qualified experiments, supporting GSE, and experiment peculiar test equipment to the PIF in a timely manner prior to payload integration and testing.

2) The development/verification tests, and necessary qualification tests on a qualification model, to insure the flight readiness of the experiment equipment. As a system contractor, the Experiment Contractor has full responsibility to prepare the qualification test plan,

conduct the test, and prepare a qualification test report. Both the plan and the final report will be reviewed by NASA, the PI, and the Integration Contractor.

3) Predelivery testing, through acceptance testing, of the experiment at the Experiment Developer's facility.

4) Furnishing test criteria, specifications, operating instructions and procedures to the Integrating Contractor in sufficient time for procedure integration and approval prior to payload integration and test.

5) Providing experiment familiarization, programming, operations and maintenance training for PIC and NASA AAP personnel.

6) Provisioning spares for experiment components and assuring their ready availability should anomalies or malfunctions occur during Integration and Prelaunch Tests.

7) Providing field maintenance for experiments at the PIF and at KSC.

8) Furnishing experiment test performance data to the PIC as a basis for performance comparison during integrated test and checkout.

Prior to delivery of the flight qualified experiment, the experiment developer will furnish technical data to the PIC. He will also monitor the Payload Integrating Contractor during any experiment testing at the PIF and KSC and assist in the preparation, operation and maintenance of the experiment when requested.

Following receiving and inspection at the PIF, the experiments will be moved to the experiment accommodation area where the experiment developer can perform any necessary experiment calibration, modification or functional checkout. The PIF will contain the required space and common type test equipment, e.g., meters, gauges, strip charts, recorders, etc. The experiment developer will be required to provision any special experiment GSE and STE necessary to verify the functional integrity of the experiment.

The Experiment Developer will not be permitted to install or remove experiment hardware from the integrated carrier, nor will he be permitted to make connections or disconnections, conduct GSE operations, conduct servicing or stowage operations, or alter any structure. He shall assist in the preparation of test procedures but will not be responsible for technical integration nor the accomplishment of integrated tests.

4.5.2 Support Subsystems Contractor - The Support Subsystems Contractor will be responsible for the fabrication and delivery of the support subsystems components to the interface specifications imposed by the specific mission. The performance tests will be conducted by the subsystems component contractor at his facility prior to shipment of the components to the payload integrating facility. The test requirements will concern the subsystem components electrical and mechanical interfaces and the particular mission environments. The support subsystems contractor is charged with delivering to the PIC at the PIF a fully flight qualified CEI.

4.5.3 Carrier Contractor - The AAP Carrier Contractor shall be responsible for:

a. Completion of all testing, through acceptance testing of the carrier, to interface specifications at the carrier contractor's facility.

b. Supporting the PIC as required, in performing integrated module testing by assigning personnel directly to the Payload Integration Test Conductor. The assigned personnel will operate the associated carrier checkout equipment at the direction of the PIC Test Conductor.

c. Supplying test specifications, criteria, procedures and operating instructions to the Integrating Contractor in sufficient time so that procedures may be integrated and approved before delivery of the hardware for experiment installation and integrated testing.

d. Provisioning spares for components having a high proportionate share of failure.

4.5.4 The Payload Integration Contractor (PIC) - The Payload Integration test function is that effort of demonstrating that the integrated payload will perform to the required specifications and assure mission success. The PIC is charged, under MSFC direction, with the responsibility for integrating experiments into the Experiment Carriers and for the delivery of flight-qualified integrated experiment carriers. Test tasks that will be accomplished by the PIC include:

a. Integration of the experiments and carriers into an integrated experiment carrier qualified for flight.

b. Monitoring and evaluating, in conjunction with NASA personnel, the adequacy of the qualification and acceptance programs for the individual experiments and the carriers. Where the PIC considers these programs inadequate, he shall recommend the appropriate corrective action to NASA-MSFC.

c. Providing recommendations to NASA regarding compatibility problems and control of experiment to carrier and carrier to carrier interfaces. When test operation constraints impose specific interface requirements between carrier contractors (e.g., between AM and S-IVB contractors), the PIC shall recommend to MSFC that such interface requirements be included in the interface specifications between those contractors.

d. Conducting and performing all integrated payload development compatibility tests.

e. Performance of experiment testing after installation in the integrated carrier.

f. Conducting an integrated checkout and overall systems test of the integrated experiment carriers.

g. The development of specifications which establish the test requirements for experiment-unique support equipment and the development of test procedures for demonstrating performance of such equipment.

h. Preparing and providing to NASA detailed performance specifications for each integrated experiment carrier.

i. Participating in the preparation of test interface control documents.

j. Participating as a consultant to NASA-KSC in the checkout of the experiment modules.

k. Providing liaison with experiment developers, spacecraft manufacturers and various NASA mission experiment support centers relative to test functions.

l. Preparing and releasing test directives, coordinating test changes, preparing test schedules, scheduling and chairing the test review board meetings, obtaining NASA concurrence on test completion, and releasing periodic test program and status reports.

m. Providing a qualified test conductor and test crews, manning the experiment and support subsystem consoles.

n. Scheduling, controlling, coordinating, and directing all test activities including those of the carrier contractors at the PIF.

o. Acquiring all test data and providing test engineering evaluation of all data acquired during integration testing.

p. Maintaining a central test documentation and test data collection center for the program.

q. Preparing, validating and maintaining test procedures for:

1) Performing integrated experiment module test and checkout.

2) Setup and operation of test equipment.

3) Performing integration development and qualification tests.

4) Controlling integration test operations at the PIF.

r. Preparing test plans for KSC AAP Test Operations.

s. Provide technical assistance in the preparation of pre-launch checkout procedures utilizing test requirements provided by MSFC.

4.5.4.1 Support Subsystems - The PIC shall be responsible for the following support subsystems test requirements:

a. Approving the predelivery acceptance tests at the support subsystems contractor's facility.

b. Performing a support subsystem receiving inspection to verify that no shipping damages have occurred. A part of the receiving inspection will consist of an evaluation of the data to assure compliance with the interface specifications.

c. Performing pre-installation functional checkout of those subsystem components which cannot be functionally evaluated after installation into the carrier.

d. Development and qualification testing of all new-build support subsystems at the PIF by the PIC.

e. Acquiring all prelaunch data on the experiment support subsystems which are an MSFC responsibility.

4.5.4.2 Experiments - The PIC shall be responsible for the following experiment test activities:

a. Approving experiment acceptance test procedures.

b. Performing experiment receiving inspection to verify that no shipping damages have occurred and evaluating accompanying data for compliance with interface specifications.

c. Providing a test engineering analysis of all experiment and experiment support subsystem data acquired during the integration and prelaunch checkout cycle for MSFC carriers.

4.5.4.3 Carrier - The Payload Integration Contractor shall be responsible for the following activities in the area of carrier testing:

a. Recommending to NASA-MSFC certain applicable specific interface requirements to be incorporated into the interface agreements between carrier contractors as required by test operation constraints.

b. Performing a carrier receiving inspection consisting of a visual check for damage and an evaluation of the accompanying paperwork for compliance with the interface specifications.

c. Assisting in combined system and overall tests at MSC, as required, to support MSFC integrated carriers.

4.5.4.4 Integrated Carriers - Integrated carrier testing is covered in detail in Volumes III and IV.

4.5.5 NASA - The responsibility of the NASA are defined in Exhibit B, Program and Technical Guidelines of the Phase C Contract.

4.6 Test Documentation and Control - The Integrating Contractor is responsible for the establishment and control of all test documentation required to reflect the fulfillment of the integration test program. There are many supporting documents which are essential to the overall control and management of an effective test program as specified within this test plan. This section provides identification of the minimum test documents required; a description of their purpose, objectives and control; assignment of responsibilities; and, details of implementation to achieve an effective test program. Responsibilities for preparation of the various types of test documentation are depicted in Figure 10.

This section establishes the duties and responsibilities of a data analysis team which will actively participated in all test evaluations, data reviews and will be cognizant of any overall test problems or problem areas. This team shall also perform trend analysis on all critical items undergoing tests.

4.6.1 Test Plans

4.6.1.1 General Test Plan - The General Test Plan, prepared by the PIC, describes the overall test activities for the AAP integration function. This plan presents the program level test organization, management, test policies and requirements. Within this general test plan are overall descriptions of the following subordinate test plans:

a. Development Testing

b. Qualification Testing

c. System Design Verification

d. Integration Checkout

e. Prelaunch Checkout

4.6.1.2 Mission Test Plans - The Mission Test Plans will be prepared by the PIC and shall, as a minimum, identify the test requirements and test activities which will lead to a

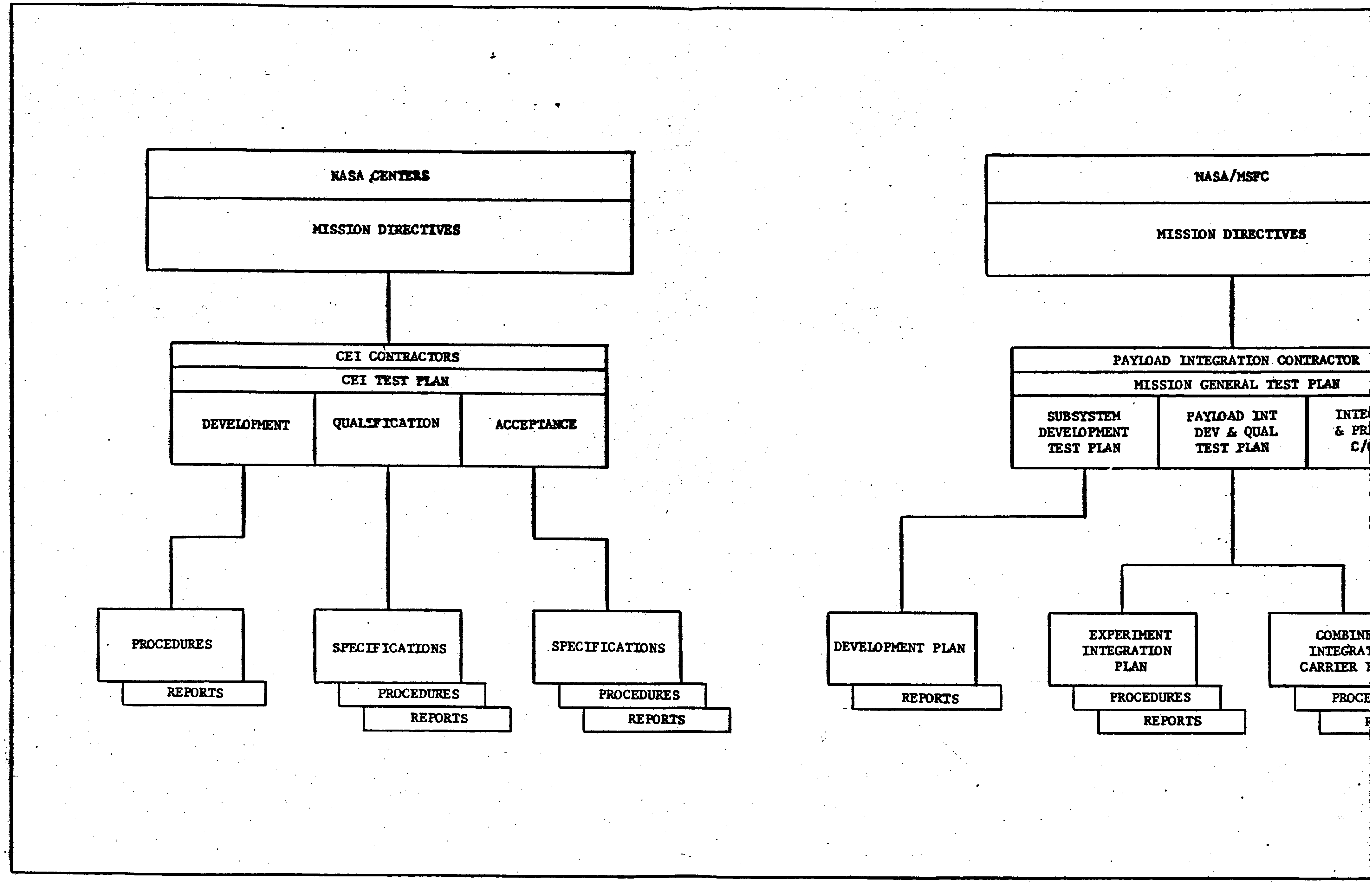
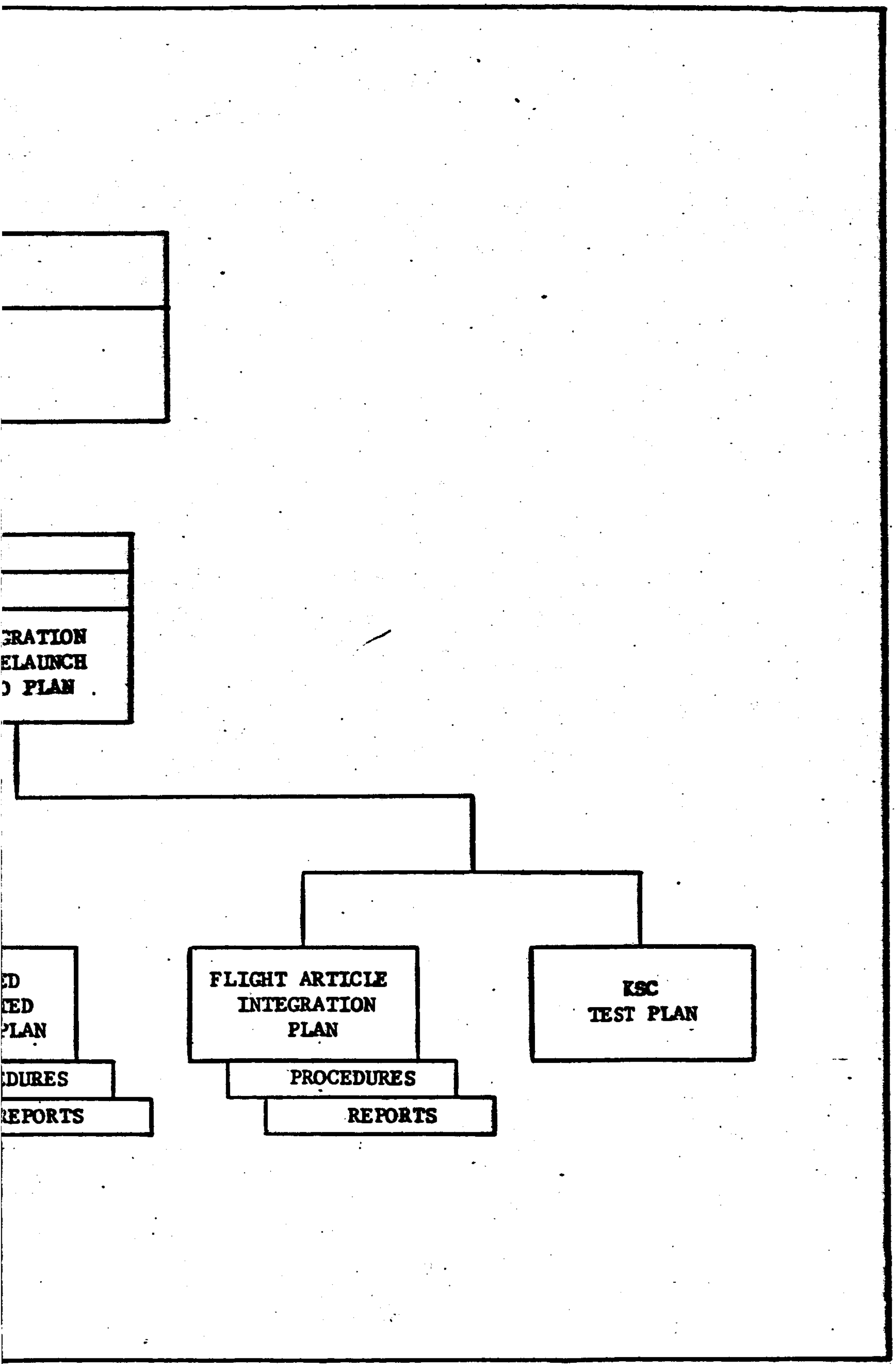


Figure 10. AAP Test Documentation Tree

FOLDOUT FRAME 1

FOLDOUT FRAME 2


GRATION
ELAUNCH
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TED
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DURES
REPORTS
FLIGHT ARTICLE
INTEGRATION
PLAN
PROCEDURES
REPORTS
KSC
TEST PLAN

successful mission integration. The Mission Test Plan contains other plans which outline specific and detailed test requirements for components, subsystems and systems. Each of these item or article test plans will be subordinate to the Mission Test Plan and will comply with all the requirements established within this plan.

4.6.1.3 Detailed Test Plans - Copies of each detailed test plan prepared by CEI manufacturers or other agencies shall be submitted to the Integrating Contractor prior to the scheduled commencement of testing. The format of each detailed test plan will be left to the discretion of the responsible manufacturer and/or the testing agency as long as the following subjects/sections are included, as a minimum:

a. Introduction, consisting of the purpose and scope of plan, overall program description and philosophy, applicable documents, definitions and abbreviations.

b. Test program requirements including test categories and descriptions, test policies, test responsibilities of parties and agencies involved and test objectives.

c. Test documentation and data handling including test procedures, specifications, reports, monitoring and control, test data and analysis, procedure change processes, and unsatisfactory condition reports.

d. Test program support requirements and flow consisting of flow diagrams, schedules, facility and manpower requirements and necessary equipment.

4.6.1.4 Test Plan Control - NASA-MSFC has the responsibility of control of test plans and subsequent tests. All test plans will be reviewed by the Integrating Contractor to determine if the requirements of the overall mission test program are being fulfilled and all program constraints are being followed.

4.6.1.5 Test Plan Updating - Test plans undoubtedly will require some changes and updating during the life of the applicable mission. Any changes that are required to an existing test plan must be submitted, and justified in detail, to NASA. The PIC will review such proposed changes to determine their adequacy and compliance with the test program objectives. Changes recommended by the PIC will then be presented to NASA for concurrence. After approval by the PIC and NASA, a copy of the approved changes will be returned to the submitting organization. The PIC will maintain a file of current test plans at all times.

4.6.2 Test Directives - A test directive, bearing authorization signatures of NASA and the PIC will be required before any integration tests are started. The fully signed test directive will constitute the authority for a test to commence. It also serves as notification to the NASA and AAP contractors of immediately pending tests and provides a media for scheduling surveillance of specific test activities.

An authorized test directive will indicate that all pretest requirements have been satisfied. It will also state the name of the test planned, the procedure names and numbers that will be utilized, the place, the date and the planned test start and completion time. The test directive will be submitted for approval a minimum of 10 days prior to planned commencement of testing.

4.6.3 Test Specifications - The specifications established for a test shall specify the test objectives and performance criteria, test item, number and disposition of test specimens, environmental and performance conditions, allowable maintenance, logging requirements, manner of analysis and utilization of test results, retest requirements, test limitations, test equipment, test methods, reliability goals, allowable failures per test and definition of failure, and the commodities and facilities used. These test specifications will fully encompass design requirements, criteria and specifications.

A component environmental qualification test specification shall be prepared for all components used in AAP systems. It shall contain the mandatory, minimum allowable qualification test requirements for all components in a system. For all flight components used in AAP systems, a component environmental flight acceptance test specification will also be prepared. All flight components and flight spare components shall be subjected to environmental flight acceptance tests as required by this specification.

Test specifications, criteria and operating instructions shall be furnished to the PIC by the experiment contractor of each experiment and by each AAP carrier contractor. These documents shall be delivered in sufficient time to allow preparation and approval of integration procedures before experiment delivery for pre-installation tests and subsequent installation on the carrier.

4.6.4 Test Procedures - All tests shall be conducted in accordance with detailed test procedures prepared, processed and maintained by the cognizant agencies. These procedures shall implement and conform to the required test methods as defined within this test plan.

Close adherence to the following philosophies is required of the PIC and other agencies involved throughout the preparation of procedures for the AAP. These philosophies are applicable to all ground-oriented tests, system checks, and mission simulation operations:

a. Test operations will be standardized at all areas where AAP testing is accomplished.

b. Procedures will be designed to demonstrate performance to test specifications.

c. Procedures will be written to insure that all critical operations receive incremental acceptance.

d. Procedures will include adequate safety precautions for the protection of personnel and equipment.

e. Procedures will provide for positive identification, removal, and/or prevention of use of equipment that is defective, obsolete, or for which the calibration date has expired.

f. Each procedure will be subjected to a comprehensive review and approval cycle before usage.

g. Verification of each acceptance procedure shall be performed on the qualification article. Additional verification during acceptance tests may be performed at the request of the NASA.

h. Malfunctions will be recorded, indicating the exact paragraph of the procedure where the malfunction occurred, the prevailing conditions, the indications displayed, the corrective action taken, and the retest performed.

All test operations performed on the AAP systems from manufacture through launch will be controlled and documented by Test Procedures (TP), Operational Checkout Procedures (OCP), or Ground Article Test Procedures (GATP). Test Procedures will govern and control all operations and tests performed at facilities other than KSC and MSC. All operations and tests performed at KSC and MSC will be governed and controlled by Operational Checkout Procedures.

All procedures will be written in accordance with the following ground rules:

1. Quantitative Testing will predominate.

2. Procedures must assure that the sum total of the test sequences, performed on a given system, will exercise the system through its design modes of operation.

3. Procedural provisions will be made for time and cycle recording logs for time sensitive equipment.

4. The criteria for success for all tests, with the exception of development tests, is generally established to be that the items tested shall incur no failure, malfunction, out of tolerance condition or system degradation during and/or following each specific test. Specific limits of acceptable performance and failure criteria for each item tested shall be defined in detail within each applicable procedure.

5. A formal verification will be performed during the first use of the completed procedure.

4.6.4.1 Test Procedure Content - A separate Test Procedure shall be prepared for each category of testing on an article which shall define in detail all testing to be conducted and the sequence and parameters for any given test or test series. The Procedure shall also prescribe test equipment to be used and calibration requirements, layout and interconnection of equipment, safety practices (for equipment and personnel) to be observed, and the facility and commodity requirements.

Test Procedures shall contain, but not be limited to, the following minimum requirements.

a. Procedure Title Page - The Title Page shall include:

   1) Procedure Number

   2) Procedure Title (Title must identify the type of test and equipment to be tested)

   3) Preparing Organization

   4) Originator Signature and Date

   5) Approval Signatures and Dates

   6) Change Incorporation Record

b. Revision Record Page - This page will provide a record of procedural changes by page for the entire procedure.

c. Table of Contents - The Table of Contents will list the contents of the procedure by paragraph number and title, and indicate the page on which they may be found.

d. Procedure Text - The text of the procedure shall be sectionalized as specified herein; and, the sections shall be numbered, titled and constructed as shown.

   1. PURPOSE

   This section shall contain a brief statement of the purpose of the procedure, including the reason for the document and its intended goal in terms of performing a specific operation.

   2. SCOPE

   This section shall briefly define the tests to be performed with the procedure. The definition shall include all work to be performed and shall be consistent with the requirements of the governing test plan(s).

   3. SUPPORT REQUIREMENTS

   This section shall specify the equipment, documents, commodities and personnel required in the performance of the procedure.

3.1 Equipment

This subsection shall include a listing of commercial test equipment (capital equipment), special test equipment, GSE and expendable or consumable items required in the performance of the procedure. Commercial equipment shall be listed by nomenclature and identification number. When pertinent, such additional information as make, model, identification number, and acceptable substitute equipment (specified by make and model number) shall be listed.

3.2 Power and Commodities

This subsection shall specify the requirements for electrical power and other commodities such as nitrogen, air, oxygen, water, etc. Power that is permanently connected or self-contained in permanently installed equipment shall not be listed.

3.3 Documents and References

This subsection shall list all documentation, by identifying number and title, that was used in developing the procedure (source documents) or which may be helpful in using the procedure (reference documents).

3.4 Personnel

This subsection shall list the types of personnel required to accomplish and support the test, such as test, safety, transportation, etc.

4. SPECIAL CONSIDERATIONS

This section shall identify all considerations which may be unique to the test.

4.1 General Notes and Responsibilities

This subsection will provide general information and safety requirements applicable to the procedure and identify the responsibilities of supporting groups in the performance of the procedure.

4.2 Definitions and Abbreviations

Wherever applicable, all key terms used in this procedure will be defined in this subsection. All abbreviations used shall also be defined.

5. OPERATIONS

This section shall be divided into four subsections entitled prerequisites, preparations, detailed operations, and securing.

5.1 Prerequisites

This subsection shall specify those tests, inspections and/or other functions that must have been accomplished prior to starting this procedure. Each prerequisite entry shall include a space for recording acceptance of the satisfactory completion of the event by the cognizant quality organization.

5.2 Preparations

This subsection shall describe the operations required to prepare the test area or unit for test. Included are special setup operations and the performance of standard operating procedures or other functions which must be performed before the test can begin. It will be verified that special test equipment and GSE used in the test are within calibration dates, and that seals are intact.

5.3 Detailed Operations

This subsection shall contain step-by-step instructions for performing the test.

5.4 Securing

This subsection shall contain step-by-step instructions for securing the equipment or for placing the equipment in a safe condition for the next operation.

6. GRAPHIC PRESENTATION AND SCHEMATIC DIAGRAMS

Where applicable, this section shall contain schematic diagrams, photographs, illustration or graphs to clarify the text of the procedure.

7. REPORT REQUIREMENTS, REMARKS AND DATA SHEETS

Whenever the accomplishment of a procedure requires the submittal of a report, this section will specify that action as being required and to where and whom the reports must be sent. The type of information desired will also be specified. This section also includes remarks and data sheets for use in report preparation and forwarding of data.

8. PROCEDURE COMPLETION BUY-OFF - APPROVAL PAGE

This page will provide spaces for the signatures required for the certification of completion of the procedure and the official buy-off and approval. Procedure buy-off will occur when the cognizant quality organization certifies that all test parameters obtained were within the engineering specification tolerances.

To facilitate the capability to change Test Procedures, a Procedure Change Notice (PCN) will be used. Once the requirement for a change to a procedure is recognized, the procedure writer will prepare a PCN, affix the proper change identification and secure review and approval in accordance with 4.6.4.3 of this plan. After approval the PCN shall be attached to the front of the procedure for which it is written. Attached PCNs shall be incorporated into the body of the procedure on a routine basis. Procedures may be amplified, prior to the test period, by Systems Engineering Test Orders. These Test Orders will provide additional, detailed tests, not contained in the design and test specifications, but required for backup data and failure analysis.

4.6.4.2 Operational Checkout and Ground Article Test Procedures - Operational Checkout Procedures (OCP) will be prepared for use at KSC. These OCPs will be used for pre-installation, installation, prelaunch, launch and post launch activities. All OCPs will be prepared in accordance with Apollo Documentation Procedure No. 2.

Ground Article Test Procedures will also be prepared for use at KSC. These GATPs will be designed to checkout the experiment unique GSE, special test equipment and all mission GSE required at the MSOB, VAB and the Saturn pads. GATPs will also be prepared in accordance with Apollo Documentation Procedure No. 2.

4.6.4.3 Procedure Approval - Each procedure will be subjected to a comprehensive review and approval cycle prior to first usage with flight hardware. The participating organizations and their functions follow:

a. Manufacturer and/or Test Agency Test Engineering - Determines test requirement, prepares the test procedure using applicable specifications and drawings.

b. Technical Evaluation - Performs initial technical review to assure conformance with source data.

c. Responsible Design Engineer - Performs a comprehensive review to verify that the methods of checkout are adequate and sufficient.

d. Quality - Reviews the procedure to verify that sufficient quality check points and controls are present. Development procedures excepted.

e. Safety - Reviews the procedure for safe operating techniques. Assures that potential hazards to personnel or equipment have been identified and flagged with caution or warning notations. Development procedures excepted.

f. NASA - Provides final review and approval to assure compliance with overall program requirements.

g. Contractor - Any procedure that interfaces mechanically or electrically with a system of another contractor will require that contractor's review and approval. The PIC will provide recommendations to NASA regarding interface control and compatibility.

All procedures will be verified during their first use by operational personnel to ensure their accomplishment of the activity intended. A verification team, comprised of representatives from cognizant NASA engineering and contractor procedure writing, test operations, quality, and safety organizations, shall perform and/or witness the performance of the procedure. Alternate methods or words to clear discrepancies will be redlined into the procedure at the point they occur. The test will then be conducted in accordance with the redlined procedure.

Acceptance of the test will be contingent upon subsequent incorporation of the redlines into the procedure master copy. All redline verification changes will be incorporated before the procedure is used again. Reverification shall be required when procedures subsequently require a significant amount of change in technical content or sequencing. Minor changes, that do not adversely affect the performance of the activity, shall not be reverified.

4.6.4.4 Procedure Control - A system shall be established to compare test procedure configuration level against design engineering changes. This system will identify those engineering changes which have been released that may affect a test procedure. The specific changes will then be reviewed for their effect on the procedure and the procedure changed accordingly.

Procedures prepared for the development test program will provide positive control and safe operating methods but will not adhere to the procedure change control systems outlined above, i.e., formal PCNs will not be issued as each design engineering change is released, rather the procedure will be redlined after close liaison between Design and Test. As the number of redlines becomes too extensive for clarity, the procedure will then be periodically reissued incorporating the redlined changes.

Configuration of development test procedures will be maintained as these procedures will form the baseline for preparing succeeding qualification and acceptance test procedures as well as checkout procedures.

Procedures written for the qualification test program will adhere to the procedure change control system as stated. These procedures will maintain configuration for the equipment being tested. The applicable qualification test procedures will be used to prepare the acceptance test procedures upon incorporating the latest configuration changes between the qualification and flight article.

Procedures used for the integration checkout effort will also comply with the procedure change control system. These procedures will be verified during the qualification test program. Constant, close configuration control of Checkout Procedures will be maintained to assure that these procedures are updated to conform with the latest design configuration for the item being tested.

4.6.4.5 Procedure Monitoring and Buy-Off - Both NASA and the PIC shall have the prerogative of witnessing any or all testing conducted within this program, to assure that proper test disciplines are being exercised.

Upon completion of the test efforts necessary to fulfill the requirements of a procedure, the completed procedure, signed by the Testing Agency and Test Conductor, and a test report indicating that the test was completed satisfactorily, will be presented to NASA for final buy-off. Criteria for buy-off is that the test data received be within the allowable tolerances established by engineering.

4.6.5 Test Reports

4.6.5.1 Status Reports - Upon the completion of each major test phase or series, a report shall be prepared by the testing agency which shall describe in detail all aspects of the test activity conducted.

Examples of these reports are: Development Test Report at the completion of the development test program on a CEI, Qualification Test Report at the completion of the qualification test program, Acceptance Test Report at the end of the Acceptance Test Program on a CEI, the Flight Performance Report at the completion of each flight, and the Monthly Progress Report. Each qualification test report must contain the certifying signature of the cognizant design engineer before any item will be considered qualified. A Qualification Status List shall be prepared and maintained showing the planned and completed environmental qualification tests. The qualification status will be updated in the Monthly Progress Report commencing at the time of qualification test specification approval. Other reports, which are more completely described in subsequent sections of this plan, are Unsatisfactory Condition Reports and Failure Analysis Reports.

Copies of each test report shall be submitted to NASA for review and approval following the completion of a specific test category. A copy, bearing the appropriate NASA approval signatures, will be returned to the Testing Agency.

4.6.5.2 Unsatisfactory Condition Reports (UCR) - As defined by applicable Test Procedures, all failures and malfunctions occurring during the life of AAP program hardware (beginning with pre-delivery acceptance testing of qualification test hardware) shall be reported immediately. A detailed failure analysis must be conducted for each failure; and, the corrective action taken must be reported to NASA.

4.6.6 Test Data - Data provides the basis for determining whether any part or all of the components for a mission are adequate to carry out their assignment. It will be generated by the PIC, experiment developers, subsystem developers, carrier contractors and material suppliers. Results of both successful and unsuccessful tests are considered data.

The performance and completion of properly designed test procedures will supply sufficient information about a test article to analyze its performance. Successive test runs on an individual item will be numbered and the reason(s) for failure of any run will be documented. If a re-run results from some reason other than failure of the previous test, the reason for the re-run will be documented. All data must be collected, evaluated and a determination made that the unit under test met, failed to meet, or exceeded design requirements and specifications.

4.6.6.1 Handling and Centralization - To facilitate integration of data, a central collection agency, within the Integrating Contractor's organization, will be charged with receiving and integrating all data. Files will be maintained on an individual component, subsystem, system and carrier basis. One copy of all hardware Design/Procurement Specifications, Test Plans, Test Specifications, Test Procedures, Test Reports, Inspection Plans, Test Failure and Unsatisfactory Condition reports and Failure Analysis Reports will be retained in this file. Data from qualification testing will be organized and filed separately. It shall be indexed and filed so that qualification data for a component, experiment subsystem, system or carrier may be easily recovered for review as necessary. Data will be collected from all tests performed on piece parts, subassemblies, assemblies, components, subsystems, systems and carriers. The Experiment Developer must provide sufficient information to assure that data resulting from his experiment is interpreted properly. Therefore, data he submits must include calibration data.

All completed test procedures and data gathered shall be furnished to the central collection agency at the PIF area. Such procedures and data will be retained by the central collection agency and furnished to the launch area upon shipment of the integrated carriers to that facility. Data will be accumulated by test procedure, entered on test data sheets, and categorized, reviewed and stored by the central collection agency. This collection agency will be the same organization that reviews and approves procedures, allowing both the monitoring of procedures and data to reduce redundancy while ensuring adequate testing. Such an arrangement will also facilitate data collection and review for trend analysis.

Receiving Inspection will be responsible for ensuring that the proper data is received with all experiments, subsystems, systems, carriers and modules. All data will then be forwarded to the central collection agency.

As components are incorporated into subassemblies, assemblies, subsystems, systems and carriers, the central collection agency shall be notified of serial numbers utilized. This information shall then be used to start the data integration process. As the experiments are integrated by the PIC, the applicable serial numbers utilized will likewise be forwarded to this central collection agency.

At any point in time, data may be assembled by carrier and carrier subsystems to show results of tests starting with tests of components, subassemblies, etc., and continuing through acceptance, prelaunch, flight and post flight tests. Such integrated data will be used for functions such as reliability evaluation, flight readiness evaluation and improvement evaluation.

A system review board will be established to meet and perform incremental review of the results of major tests performed on subsystems, systems and carriers. The review board shall consist of representatives of the manufacturer, test agency, PIC, other applicable contractors, and NASA. All pertinent data from a particular test will be reviewed as well as applicable data from previous tests which may be useful in establishing trends. Out-of-tolerance conditions will be evaluated to determine if engineering changes, interface changes, or merely retests are required. Data and information will be supplied for reliability determination and studies as required.

4.6.6.2 Analysis - Representatives of the PIC will form a mission data analysis team which will participate in the test evaluation, attend major test review meetings, and be cognizant of the problems and results of the test program. Using this team concept, a firm base will be developed for subsequent mission analysis, trend analysis, corrective action, decisions, etc. This data analysis team will evaluate data in conjunction with the NASA representatives on the system review board. Analysis of data gathered at subassembly and component level will be given only a cursory review, unless anomalies encountered at the subsystem or system levels indicate the need for a comprehensive review. Analysis of data gathered at the subsystem and system levels for acceptance, prelaunch, and flight must be carefully reviewed by Engineering personnel in order to identify minute degradation or trouble which might jeopardize a flight mission. All test data will be analyzed to verify compliance with test objectives. All discrepancies discovered during data analysis will be resolved to the mutual satisfaction of the PIC, the manufacturer, and NASA. If necessary, special tests will be performed to support theoretical conclusions presented in the explanation of a given problem.

4.6.7 Change/Deviation Procedures - During the implementation of this test program, there may be interferences with other programs currently in work. Though most of the requirements established herein can be readily followed, the accomplishment of some may become impractical or impossible because of such program interferences. For these reasons, methods must be established whereby deviations from this test plan can be permitted or changes and alterations made.

When the need for deviation is identified, the PIC will immediately notify all NASA agencies involved of the requirement, and request that a deviation be granted by the applicable agency. This request will state the nature of the deviation, the justification for the change and will contain the following minimum information:

a. Detail program limitations which are currently preventing compliance with the requirements

b. Specify any additional resources or time required to permit compliance with the requirements

c. List and/or recommend any alternate courses of action possible that would permit compliance with requirements

d. Discuss any possibilities of the deviation having an effect on crew safety and mission success

When the need for a test plan change is identified, the PIC will immediately submit a request for this change to NASA-MSFC with copies of the request being sent to all NASA agencies involved in this program. This request for change will set forth all justification in support of the request and will contain the following minimum information:

a. Detail program limitations and requirements which are requiring updating or change

b. Specify and recommend the change required and describe how this change would affect the overall test plan

c. Discuss any possibility of the change having an effect on crew safety and mission success

Upon written approval of the deviation/change, the PIC will notify all agencies involved of the test plan deviation/change. The PIC will periodically update the test plan and send copies of changes to all NASA Centers and other agencies involved. Such revisions will also include any approved deviations of a permanent nature.

Should the situation arise wherein waiting for NASA approval of a deviation would cause increased costs and unnecessary program delays, the PIC will direct the effort to proceed in line with the alternate recommended course and carefully monitor the effort. When the requirement for achieving Certification of Flight Worthiness will cause unnecessary delay in shipment of an item, the PIC will consult the NASA AAP Program Manager to reach a decision. This decision will be fully documented and used in lieu of a deviation approval.

4.6.8 <u>Test Configuration Control</u> - In the AAP Program, coordination with many organizations must occur to accomplish an assigned mission. The program involves the efforts of principal investigators, experiment developers, carrier contractors, NASA Centers, and the PIC. A change initiated by any one of these organizations could affect the work effort of one or more of the other organizations. Therefore, a control system for maintaining configuration status through the test program shall be established by the PIC. This system will become a part of the overall configuration management system, and will supply configuration data into that system as required.

Test procedures, operational checkout procedures and ground article test procedures will be the means used to assure configuration control of all ground and airborne hardware. The applicable procedure will specify the configuration of the article undergoing test. Each procedure shall contain a complete list of engineering that affects the equipment covered by the document. Procedures will be updated by PCNs as required, to maintain compatibility with all approved changes to source data documentation.

Special test equipment (STE) designs are prepared and maintained for configuration compatibility between test hardware, procedures, and checkout programming, for all test activities through the release of Test Equipment Change Notices (TECNs). Checkout programming will be prepared using engineering documents as source data. Configuration compatibility between engineering, test hardware, procedures and checkout programming will be maintained through the release of checkout programming change notices (CPCNs). Programming is subject to an internal audit and approval prior to submittal to MSFC for approval.

We will establish test liaison support with AAP experiment developers, carrier manufacturers, and the various NASA Centers relative to test activities. Test liaison personnel will assist experiment developers, as required, in preparation of their test plans to assure an integrated test approach. They will also monitor the experiment developers' Qualification and Acceptance Program for adequacy.

The test liaison group will assist MSFC in the acquisition, review and evaluation of CEI test plans, procedures, specifications, data and reports to assure their compatibility with the AAP requirements. Recommendations will be made to MSFC on changes required to these documents by payload integration constraints. This test liaison group will also perform liaison operations internal to the PIC organization and between MSFC laboratories to assure proper test coordination, test plan and software configuration.

4.6.9 Test Operations Control - All testing operations will be controlled through the use of Work Authorizations (WAs). No test may start before a WA is obtained which describes the activities to be performed and is approved by the Operations Test Conductor. A status of all open WAs will be maintained to show current test status and progress.

Test Directives (TDs) will be used to authorize and schedule test activities. The TDs will be prepared by the PIC and submitted to MSFC for approval prior to release. The PIC will coordinate the PIF integration activities by using TDs to notify AAP contractors and agencies of pending tests, involving their hardware and requiring their assistance. All integration test and support activities will be scheduled, and monitored for schedule compliance. Daily status and schedule meetings will be held to discuss problem areas. Comparison of actual progress with a realistic schedule will point out potential problem areas for corrective action.

The integration test and checkout of experiment carriers and combined integrated carriers will be accomplished by trained and qualified test conductors and crews. Paragraph 4.3.6 discusses personnel training. These personnel will man the experiment and experiment support subsystem consoles and perform troubleshooting to resolve problems. The test conductor will be responsible for, and have the authority to, coordinate contractor test efforts, enforce adherence to procedures and arrange for the test support required to conduct tests. The test conductor and critical test crew members will be available to follow the flight hardware, for which they were responsible at the PIF, to KSC to assist in the prelaunch test and checkout program.

The PIC will define workable test operations, and interfaces between all contractors involved in the integrated test and checkout. The PIC will establish control over all AAP contractors and enforce interface constraints throughout all testing activities.

When a malfunction occurs during the testing process, that test will be stopped and the malfunction and its cause identified. Before disturbing systems integrity, the fault will be isolated and an Unsatisfactory Conditions Report (UCR) will be prepared. A WA containing a troubleshooting plan will be prepared before troubleshooting commences. During troubleshooting, and subsequent repair, all operations performed will be documented in procedural form on the WA. Retest procedures will be prepared by test engineering to verify performance of the required repairs.

4.7 Flight Support and Postflight Test Operations

4.7.1 Flight Support Testing - All AAP inflight testing will be accomplished at the direction of the PIC and NASA. Flight support testing is that testing performed on flight hardware for which MSFC has responsibility, and within which some anomaly or problem has occurred during flight. During the flight period, a mockup or prototype of the on-orbit hardware will be maintained in the on-orbit configuration so that any anomalies arising in flight may be duplicated and resolved. To accomplish this activity in a timely manner, the results of real-time data must be provided to the data analysis team continuously during the flight in order to analyze and establish trends, to prevent anomalies and to analyze and resolve problems as they occur.

During flight operations, members of the data analysis team will be present to constantly observe flight test or experiment operations, monitor and evaluate applicable data received and review astronaut communications. Thus, any anomaly occurring will be brought to the immediate attention of NASA and the PIC allowing possible inflight remedies or solutions to be recommended.

4.7.2 Postflight Testing - Postflight testing will be accomplished, under the direction of the PIC, to determine the effects of space flight operations on flight hardware. Early analysis of flight data will enable the early identification of areas of possible failure.

Determination of the nature, type and extent of postflight tests will be dependent upon the results of examination of flight data, recovered hardware and the degree of abnormality. All postflight tests will be performed to the mutual satisfaction of NASA-MSFC and the PIC, and will be agreed upon prior to the commencement of testing.

4.7.2.1 Flight Anomaly Resolution - The data analysis team, which participated in prelaunch test and checkout evaluation, will also evaluate flight data and postflight test results. All anomalies peculiar to a subassembly, assembly or component will be resolved prior to a subsequent flight of that item.

5. TEST SUPPORT REQUIREMENTS

5.1 Manpower Requirements - The Denver Division of the Martin Marietta Corporation, and the Bendix Corporation, have formed a team for the purpose of performing this program. These two organizations maintain a highly competent group of test specialists who are fully capable of assuming the test functions of this program. The Test Engineering and Operations Group is responsible for establishing the requirements and equipment for, and conducting the AAP test program assigned to the PIC by MSFC.

The Test Engineering and Operations group will develop the test requirements and the test planning for all phases of test activity including development, qualification, reliability, design verification, acceptance, integration and prelaunch. Test plans will be prepared to describe the methods, test procedures, facilities and special test and support equipment required to implement the test requirements.

5.1.1 Organization - Within the overall AAP program structure, departmental operations and duties are delegated to a Department Manager. The Manager, Test Engineering and Operations, reports directly to the Director of Quality, as the test function falls within the Quality organization. The Manager is responsible for all AAP PIC test functions. Figure 11 shows a detailed breakdown of the Test Engineering and Operations structure, and the associated functions.

5.1.2 Personnel - The test group will provide, for the implementation of the test program, personnel whose functions will include such items as preparation of test procedures, design of special test equipment, preparation of checkout programs, installation and checkout of support equipment, training and certification of test personnel and crews, test performance, data analysis and preparation of final test reports. Personnel in all of these categories will be located at the PIF and at KSC as required. Specialized personnel will be located in other areas as required.

5.2 Facility Requirements - The total test plan identifies the major test facilities and their location. Facilities at MSFC and KSC will be kept as nearly identical as possible for similar operations. All existing NASA and other government facilities and equipment will be used to the maximum extent, on a non-interference basis, whenever feasible. Facilities required are discussed in detail in the Facility Plan.

5.3 GSE and Special Test Equipment (STE)

5.3.1 General - The PIC shall maintain GSE and STE design personnel during the performance of this program. These groups will be responsible for the design of all new and modified GSE and STE utilized by the PIC both at the PIF and KSC. All GSE and STE utilized will be qualified and certified to insure that any output from those items will not cause damage or introduce contaminants into other ground test hardware, or the flight article, during testing.

5.3.2 Equipment Summary - Figure 12 lists all of the major GSE and STE required to support the test program. These matrices present the Combined Mission AAP 1/2/3/4 Development/Qualification GSE/Tools defined in Volume III, and the Flights AAP 1,2,3 and 4 GSE/tools defined in Volume IV. The matrices use block numbers and titles taken from the test flows of Volumes III and IV, to summarize the GSE/tools needed for test operations support as identified by the Requirements Allocation Sheets.

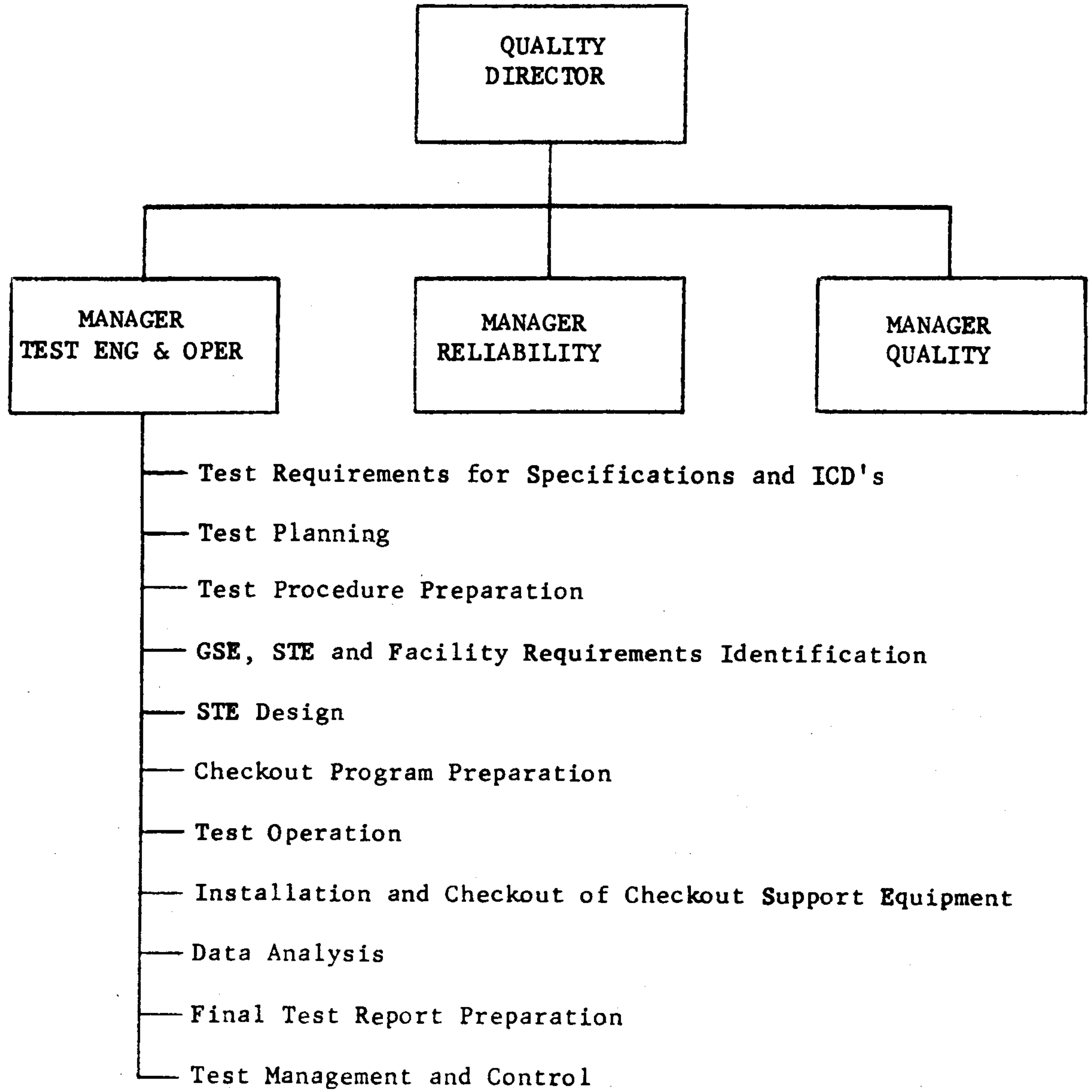

Figure 11. Test Organization and Function

AAP 1 - 4 DEVELOPMENT/ QUALIFICATION GSE/TOOLS

TEST / GSE / TOOLS

DEVELOPMENT

GSE/TOOLS	3.0 Mock-Up Development Tests	4.1 LM&SS Rack Static Load	5.1 SIVB Passivation & Activation	5.2 SIVB Pressure Test	6.1.1 MDA Vibration	6.1.2 MDA Shock	6.1.3 MDA Acoustic	6.2.1 AM/MDA Equipment Transfer	6.2.2 MDA S/S Activation & Operation	6.4.1 MDA Static Load	7.1.1 RM Thermal Vacuum	7.2.1 RM Vibration Test	7.2.2 RM Shock	7.2.3 RM Acoustic	7.3.1 RM S/S Operations (Cryo)	8.1.1 ATM Package Static Load	8.2.1 ATM Package Thermal Vacuum	8.2.2 RK/ATM Thermal Vacuum	8.3.1 ATM Package Vibration	8.3.2 ATM Package Shock	8.3.3 RK/ATM Vibration	8.3.4 RK/ATM Shock
MECHANICAL/STRUCTURAL/FLUID																						
Mockup Handling GSE	X																					
Rack Handling, GSE, LM&SS		X																				
Stress Monitoring GSE		X								X						X						
X-Ray Equipment		X								X						X						
Static Loading GSE		X								X						X						
S-IVB Handling GSE			X																			
Mass Spectrometer				X																		
Pressure Console				X																		
Gnd Press Umbilical				X																		
AM Pressure Sim				X																		
MDA Handling GSE					X	X	X	X	X	X												
MDA Shaker Fixture					X																	
MDA Shock Fixtures						X																
AM Sim (Acoustic)							X															
SLA Sim (Acoustic)							X							X								
AM Handling GSE								X	X													
Exp & S/S Mockups								X														
RM Handling GSE											X	X	X	X	X							
Solar Panel Shadow Sim, RK											X							X				
VIB Fixtures, RM & RK/ATM												X									X	
CSM I/F Sim												X	X									
Shock Fixtures, RM & RK/ATM													X									X
MDA Docking I/F Sim													X									

GSE/TOOLS	8.3.5 RK/ATM Acoustic	8.4.1 ATM Package S/S Operations	8.4.2 ATM Package Exp Performance	8.4.3 RK/ATM S/S Operations	8.4.4 RK/ATM Exp Performance	8.7.1 ATM Rack S/S Operation (AMB)	8.7.2 ATM Rack S/S Operation (Cryo)	9.1 Cluster Scale Mod Antenna Test	9.2 Cluster Scale Mod Therm Vac	10.6 OWS Thermal Vacuum
MECHANICAL/STRUCTURAL/FLUID										
Mockup Handling GSE										
Rack Handling, GSE, LM&SS										
Stress Monitoring GSE										
X-Ray Equipment										
Static Loading GSE										
S-IVB Handling GSE										
Mass Spectrometer							X			
Pressure Console										
Gnd Press Umbilical										
AM Pressure Sim										
MDA Handling GSE										
MDA Shaker Fixture										
MDA Shock Fixtures										
AM Sim (Acoustic)										
SLA Sim (Acoustic)	X									
AM Handling GSE										
Exp & S/S Mockups										
RM Handling GSE										
Solar Panel Shadow Sim, RK										
VIB Fixtures, RM & RK/ATM										
CSM I/F Sim										
Shock Fixtures, RM & RK/ATM										
MDA Docking I/F Sim										

QUALIFICATION

GSE/TOOLS	12.1 SIVB Passivation (Vent & Dump)	12.2 SIVB Passivation (Safing)	12.3 SIVB Equip Instal & Activation	12.4 SIVB S/S Operation	12.5 SIVB Exp Performance	12.6 SIVB Ops Seq Flts 1 & 2	12.7 SIVB Equip Trans Flts 3 & 4	12.8 SIVB Ops Seq Flts 1 & 2	12.9 SIVB Tank Entry & Sealing	12.10 SIVB Pressure Test	12.11 SIVB Static Firing	12.12 SIVB Mass Properties	12.13 SIVB Passivation (Vent & Dump)	13.1 IU Exp Performance	13.2 IU Passivation (Vent & Dump)	13.3 IU Passivation (Safing)	13.4 IU Launch EMC Tests
MECHANICAL/STRUCTURAL/FLUID																	
Mockup Handling GSE																	
Rack Handling, GSE, LM&SS																	
Stress Monitoring GSE																	
X-Ray Equipment																	
Static Loading GSE																	
S-IVB Handling GSE	X	X	X					X		X		X					
Mass Spectrometer										X							
Pressure Console										X							
Gnd Press Umbilical										X							
AM Pressure Sim										X							
MDA Handling GSE																	
MDA Shaker Fixture																	
MDA Shock Fixtures																	
AM Sim (Acoustic)																	
SLA Sim (Acoustic)																	
AM Handling GSE																	
Exp & S/S Mockups																	
RM Handling GSE																	
Solar Panel Shadow Sim, RK																	
VIB Fixtures, RM & RK/ATM																	
CSM I/F Sim																	
Shock Fixtures, RM & RK/ATM																	
MDA Docking I/F Sim																	

GSE/TOOLS	14.1 MDA S/S Act & Operation	14.2 MDA Experiment Perf	14.3 MDA Oper Sequence	14.4 MDA Vibration	14.5 MDA Shock	14.6 MDA Acoustic	14.7 MDA Mass Properties	14.8 MDA Pressure Test	14.9 MDA Equip Stor (Launch)	15.1 RM S/S Act & Operation	15.2 RM S/S Act & Oper (Cryo)	15.3 RM Oper Sequence	15.4 RM Vibration	15.5 RM Shock	15.6 RM Acoustic	15.7 RM Therm Vac (Off Site)
MECHANICAL/STRUCTURAL/FLUID																
Mockup Handling GSE																
Rack Handling, GSE, LM&SS																
Stress Monitoring GSE																
X-Ray Equipment																
Static Loading GSE																
S-IVB Handling GSE																
Mass Spectrometer								X								
Pressure Console								X								
Gnd Press Umbilical								X								
AM Pressure Sim																
MDA Handling GSE	X			X	X	X	X	X								
MDA Shaker Fixture				X												
MDA Shock Fixtures					X											
AM Sim (Acoustic)						X										
SLA Sim (Acoustic)						X									X	
AM Handling GSE																
Exp & S/S Mockups									X							
RM Handling GSE													X	X	X	X
Solar Panel Shadow Sim, RK																
VIB Fixtures, RM & RK/ATM													X			
CSM I/F Sim													X			
Shock Fixtures, RM & RK/ATM														X		
MDA Docking I/F Sim																

Figure 12. COMBINED MISSION AAP 1/2/3/4 GSE/TOOLS (Sheet 1 of 18)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

					X																			15.8	RM EMC Test
					X																			15.9	RM Mass Properties
																								16.1	ATM S/S Act & Oper
																								16.2	ATM Exp Performance
																								16.3	ATM Oper Sequence
																								16.4	ATM Vibration
																								16.5	ATM Shock
								X																16.6	ATM Acoustic
																								16.7	ATM Thermal Vacuum
																								16.8	ATM EMC Test
																								16.9	ATM Mass Properties
																								17.1	ATM Rack S/S Act & Oper (Amb)
																								17.2	ATM Rack S/S Act & Oper (Cryo)
																								17.3	ATM Rack Oper Sequence
																								18.1	RK/ATM S/S Act & Oper
																								18.2	RK/ATM Exp Perf
																								18.3	RK/ATM Oper Sequence
																								18.4	RK/ATM Vibration
																								18.5	RK/ATM Shock
																								18.6	RK/ATM Acoustic
																								18.7	RK/ATM Thermal Vacuum
																								18.8	RK/ATM EMC
																								18.9	RK/ATM Mass Properties
																								34.1	Flt 1 Pre-Launch Fit Check
																								34.2	Flt 1 Pre-Launch Access Cap
																								34.3	Flt 1 Launch EMC (KSC)
							X					X												35.1	Flt 2 Pre-Launch Fit Check
							X					X												35.2	Flt 2 Pre-Launch Access Cap
																								35.3	Flt 2 Launch EMC
					X																			36.1	Flt 3 Pre-Launch Fit Check
					X																			36.2	Flt 3 Pre-Launch Access Cap
																								36.3	Flt 3 Launch EMC
																								37.1	Flt 4 Pre-Launch Fit Check
																								37.2	Flt 4 Pre-Launch Access Cap
																								37.3	Flt 4 Launch EMC

FOLDOUT FRAME 3

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AAP 1 - 4 DEVELOPMENT/QUALIFICATION GSE/TOOLS

GSE/TOOLS \ TEST	3.0 Mock-Up Development Tests	4.1 LM&SS Rack Static Load	5.1 SIVB Passivation & Activation	5.2 SIVB Pressure Test	6.1.1 MDA Vibration	6.1.2 MDA Shock	6.1.3 MDA Acoustic	6.2.1 AM/MDA Equipment Transfer	6.2.2 MDA S/S Activation & Operation	6.4.1 MDA Static Load	7.1.1 RM Thermal Vacuum	7.2.1 RM Vibration Test	7.2.2 RM Shock	7.2.3 RM Acoustic	7.3.1 RM S/S Operations (Cryo)	8.1.1 ATM Package Static Load	8.2.1 ATM Package Thermal Vacuum	8.2.2 RK/ATM Thermal Vacuum	8.3.1 ATM Package Vibration	8.3.2 ATM Package Shock	8.3.3 RK/ATM Vibration	8.3.4 RK/ATM Shock
	DEVELOPMENT																					
MECHANICAL/STRUCTURAL/FLUID (CONT'D)																						
Propellant Servicing GSE															X							
AM/MDA I/F Sim (Func)															X							
ATM Handling GSE																X	X	X	X	X		
Solar Panel Shadow Sim, ATM																	X					
Rack Thermal Sim																	X					
ATM Vibration Fixtures																			X			
ATM Shock Fixtures																				X		
RK/ATM Handling GSE																					X	X
LM I/F Sim (VIB)																					X	
LM I/F Sim (Func)																						
Scale Mod Cluster TV Fixture																						
Exp Thermal Sim																						
OWS Air Purifier Sys																						
Mass Properties GSE																						
Exp Mass Sim																						
ATM Acoustic Fixture, RK																						
AM I/F Sim																						
SLA Handling GSE																						
IU Handling GSE																						
Flt Type AM/MDA Service GSE																						
Flt Type RM Servicing GSE																						
LM Handling GSE																						
Flt Type LM/RK/ATM Serv GSE																						

GSE/TOOLS \ TEST	8.3.5 RK/ATM Acoustic	8.4.1 ATM Package S/S Operations	8.4.2 ATM Package Exp. Performance	8.4.3 RK/ATM S/S Operations	8.4.4 RK/ATM Exp. Performance	8.7.1 ATM Rack S/S Operation (AMB)	8.7.2 ATM Rack S/S Operation (Cryo)	9.1 Cluster Scale Mod. Antenna Test	9.2 Cluster Scale Mod. Therm. Vac.	10.6 OWS-Thermal Vacuum	12.1 SIVB Passivation (Vent & Dump)	12.2 SIVB Passivation (Safing)	12.3 SIVB Equip. Instal. & Activation	12.4 SIVB S/S Operation	12.5 SIVB Exp. Performance	12.6 SIVB Ops. Seq. Flts 1 and 2	12.7 SIVB Equip. Trans. Flts 3 and 4	12.8 SIVB Ops. Seq. Flts 1 and 2	12.9 SIVB Tank Entry and Sealing	12.10 SIVB Pressure Test	12.11 SIVB Static Firing	12.12 SIVB Mass Properties
	DEVELOPMENT										QUALIFICATION											
MECHANICAL/STRUCTURAL/FLUID (CONT'D)																						
Propellant Servicing GSE							X															
AM/MDA I/F Sim (Func)																						
ATM Handling GSE		X	X																			
Solar Panel Shadow Sim, ATM																						
Rack Thermal Sim																						
ATM Vibration Fixtures																						
ATM Shock Fixtures																						
RK/ATM Handling GSE	X			X	X	X	X															
LM I/F Sim (VIB)																						
LM I/F Sim (Func)							X															
Scale Mod Cluster TV Fixture									X													
Exp Thermal Sim										X												
OWS Air Purifier Sys										X												
Mass Properties GSE																						X
Exp Mass Sim																						
ATM Acoustic Fixture, RK																						
AM I/F Sim													X									
SLA Handling GSE																						
IU Handling GSE																						
Flt Type AM/MDA Service GSE																						
Flt Type RM Servicing GSE																						
LM Handling GSE																						
Flt Type LM/RK/ATM Serv GSE																						

GSE/TOOLS \ TEST	12.13 SIVB Passivation (Vent and Dump)	13.1 IU Exp. Performance	13.2 IU Passivation (Vent & Dump)	13.3 IU Passivation (Safing)	13.4 IU Launch EMC Tests	14.1 MDA S/S Act. & Operation	14.2 MDA Experiment Perf.	14.3 MDA Oper. Sequence	14.4 MDA Vibration	14.5 MDA Shock	14.6 MDA Acoustic	14.7 MDA Mass Properties	14.8 MDA Pressure Test	14.9 MDA Equip. Stor. (Launch)	15.1 RM S/S Act. & Operation	15.2 RM S/S Act. & Oper. (Cryo)	15.3 RM Oper. Sequence	15.4 RM Vibration	15.5 RM Shock	15.6 RM Acoustic	15.7 RM Therm. Vac. (Off Site)
	QUALIFICATION																				
MECHANICAL/STRUCTURAL/FLUID (CONT'D)																					
Propellant Servicing GSE																					
AM/MDA I/F Sim (Func)																					
ATM Handling GSE																					
Solar Panel Shadow Sim, ATM																					
Rack Thermal Sim																					
ATM Vibration Fixtures																					
ATM Shock Fixtures																					
RK/ATM Handling GSE																					
LM I/F Sim (VIB)																					
LM I/F Sim (Func)																					
Scale Mod Cluster TV Fixture																					
Exp Thermal Sim																					
OWS Air Purifier Sys																					
Mass Properties GSE												X									
Exp Mass Sim									X		X	X									
ATM Acoustic Fixture, RK																					
AM I/F Sim																					
SLA Handling GSE																					
IU Handling GSE																					
Flt Type AM/MDA Service GSE																					
Flt Type RM Servicing GSE																					
LM Handling GSE																					
Flt Type LM/RK/ATM Serv GSE																					

Figure 12 COMBINED MISSION AAP 1/2/3/4 GSE/TOOLS (Sheet 2 of 18)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

																								15.8	RM EMC Test
									X															15.9	RM Mass Properties
																				X				16.1	ATM S/S Act. and Oper.
																				X				16.2	ATM Exp. Performance
																				X				16.3	ATM Oper. Sequence
																	X			X				16.4	ATM Vibration
																X				X				16.5	ATM Shock
							X													X				16.6	ATM Acoustic
																			X	X				16.7	ATM Thermal Vacuum
																				X				16.8	ATM EMC Test
									X											X				16.9	ATM Mass Properties
																								17.1	ATM Rack S/S Act. & Oper(AMB)
																								17.2	ATM Rack S/S Act. & Oper (Cryo)
																								17.3	ATM Rack Oper. Sequence
																								18.1	RK/ATM S/S Act. & Oper.
																								18.2	RK/ATM Exp. Perf.
																								18.3	RK/ATM Oper. Sequence
																								18.4	RK/ATM Vibration
																								18.5	RK/ATM Shock
																								18.6	RK/ATM Acoustic
																								18.7	RK/ATM Thermal Vacuum
																								18.8	RK/ATM EMC
																								18.9	RK/ATM Mass Properties
																								34.1	Flt.1 Pre-Launch Fit Check
																								34.2	Flt. 1 Pre-Launch Access Cap.
																								34.3	Flt. 1 Launch EMC (KSC)
				X	X																			35.1	Flt. 2 Pre-Launch Fit Check
			X	X	X																			35.2	Flt. 2 Pre-Launch Access Cap.
																								35.3	Flt. 2 Launch EMC
				X	X																			36.1	Flt. 3 Pre-Launch Fit Check
		X		X	X																			36.2	Flt. 3 Pre-Launch Access Cap.
																								36.3	Flt. 3 Launch EMC
	X			X	X										X									37.1	Flt. 4 Pre-Launch Fit Check
X	X			X	X										X									37.2	Flt. 4 Pre-Launch Access Cap.
																								37.3	Flt. 4 Launch EMC

FOLDOUT FRAME 3

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AAP 1 - 4 DEVELOPMENT/QUALIFICATION GSE/TOOLS

DEVELOPMENT

GSE/TOOLS \ TEST	3.0 Mock-Up Development Tests	4.1 LM&SS Rack Static Load	5.1 SIVB Passivation & Activation	5.2 SIVB Pressure Test	6.1.1 MDA Vibration	6.1.2 MDA Shock	6.1.3 MDA Acoustic	6.2.1 AM/MDA Equipment Transfer	6.2.2 MDA S/S Activation & Operation	6.4.1 MDA Static Load	7.1.1 AM Thermal Vacuum	7.2.1 AM Vibration Test	7.2.2 AM Shock	7.2.3 AM Acoustic	7.3.1 AM S/S Operations (Cryo)
ELECTRICAL/ELECTRONIC															
IU Sim			X												
Ordnance Sim			X												
VIB Monitor Instr					X		X					X		X	
Shock Monitor Instr						X							X		
MDA C/O Set									X						
I/F Sim, CSM, AM, LM&SS									X						
Thermal Instr											X				
AM C/O Set															X
RK/ATM C/O Set															
Exp Peculiar GSE															
LM I/F Sim (Elect)									X						
ATM Rack I/F Sim															
Solar Array Sim															
ATM I/F Sim															
Antenna Op & Monitor GSE															
OWS TV Monitor Sys															
RCA 110 A															
DDAS															
DEE-3															
AM I/F Sim															
S/S Support GSE															
Exp Landline Instr															
S/S Load Sim															

GSE/TOOLS \ TEST	8.1.1 ATM Package Static Load	8.2.1 ATM Package Thermal Vacuum	8.2.2 RK/ATM Thermal Vacuum	8.3.1 ATM Package Vibration	8.3.2 ATM Package Shock	8.3.3 RK/ATM Vibration	8.3.4 RK/ATM Shock	8.3.5 RK/ATM Acoustic	8.4.1 ATM Package S/S Operations	8.4.2 ATM Package Exp. Performance	8.4.3 RK/ATM S/S Operations	8.4.4 RK/ATM Exp. Performance	8.7.1 ATM Rack S/S Operation (AMB)	8.7.2 ATM Rack S/S Operation (Cryo)	9.1 Cluster Scale Mod. Antenna Test	9.2 Cluster Scale Mod. Therm. Vac.	10.6 OWS Thermal Vacuum
ELECTRICAL/ELECTRONIC																	
IU Sim																	
Ordnance Sim																	
VIB Monitor Instr				X		X		X									
Shock Monitor Instr					X		X										
MDA C/O Set																	
I/F Sim, CSM, AM, LM&SS																	
Thermal Instr		X	X													X	X
AM C/O Set																	
RK/ATM C/O Set			X						X	X	X		X				
Exp Peculiar GSE										X		X					X
LM I/F Sim (Elect)									X	X	X	X					
ATM Rack I/F Sim									X	X			X				
Solar Array Sim											X	X					
ATM I/F Sim											X		X				
Antenna Op & Monitor GSE															X		
OWS TV Monitor Sys																	X
RCA 110 A																	
DDAS																	
DEE-3																	
AM I/F Sim																	
S/S Support GSE																	
Exp Landline Instr																	
S/S Load Sim																	

QUALIFICATION

GSE/TOOLS \ TEST	12.1 SIVB Passivation (Vent & Dump)	12.2 SIVB Passivation (Safing)	12.3 SIVB Equip. Instal. & Activation	12.4 SIVB S/S Operation	12.5 SIVB Exp. Performance	12.6 SIVB Ops. Seq. Flts 1 and 2	12.7 SIVB Equip. Trans. Flts 3 and 4	12.8 SIVB Ops. Seq. Flts 1 and 2	12.9 SIVB Tank Entry and Sealing	12.10 SIVB Pressure Test	12.11 SIVB Static Firing	12.12 SIVB Mass Properties	12.13 SIVB Passivation (Vent and Dump)	13.1 IU Exp. Performance	13.2 IU Passivation (Vent & Dump)	13.3 IU Passivation (Safing)	13.4 IU Launch EMC Tests
ELECTRICAL/ELECTRONIC																	
IU Sim	X	X															
Ordnance Sim		X															
VIB Monitor Instr																	
Shock Monitor Instr																	
MDA C/O Set																	
I/F Sim, CSM, AM, LM&SS																	
Thermal Instr																	
AM C/O Set																	
RK/ATM C/O Set																	
Exp Peculiar GSE					X	X								X			
LM I/F Sim (Elect)																	
ATM Rack I/F Sim																	
Solar Array Sim																	
ATM I/F Sim																	
Antenna Op & Monitor GSE																	
OWS TV Monitor Sys																	
RCA 110 A	X	X		X	X	X		X						X	X	X	X
DDAS	X	X		X	X	X		X						X	X	X	X
DEE-3	X	X		X	X	X		X						X	X	X	X
AM I/F Sim		X		X	X	X		X						X		X	
S/S Support GSE	X	X		X	X	X								X			
Exp Landline Instr					X	X								X			
S/S Load Sim				X											X		

GSE/TOOLS \ TEST	14.1 MDA S/S Act. & Operation	14.2 MDA Experiment Perf.	14.3 MDA Oper. Sequence	14.4 MDA Vibration	14.5 MDA Shock	14.6 MDA Acoustic	14.7 MDA Mass Properties	14.8 MDA Pressure Test	14.9 MDA Equip. Stor. (Launch)	15.1 AM S/S Act. & Operation	15.2 AM S/S Act. & Oper. (Cryo)	15.3 AM Oper. Sequence	15.4 AM Vibration	15.5 AM Shock	15.6 AM Acoustic	15.7 AM Therm. Vac. (Off Site)	15.8 AM EMC Test
ELECTRICAL/ELECTRONIC																	
IU Sim																	
Ordnance Sim																	
VIB Monitor Instr				X		X							X		X		
Shock Monitor Instr					X									X			
MDA C/O Set	X	X	X	X	X	X		X									
I/F Sim, CSM, AM, LM&SS	X	X	X														
Thermal Instr																X	
AM C/O Set													X	X	X	X	X
RK/ATM C/O Set																	
Exp Peculiar GSE		X	X														
LM I/F Sim (Elect)	X	X	X														
ATM Rack I/F Sim																	
Solar Array Sim																	
ATM I/F Sim																	
Antenna Op & Monitor GSE																	
OWS TV Monitor Sys																	
RCA 110 A																	
DDAS																	
DEE-3																	
AM I/F Sim	X	X	X														
S/S Support GSE		X	X														
Exp Landline Instr		X	X														
S/S Load Sim																	

Figure 12 COMBINED MISSION AAP 1/2/3/4 GSE/TOOLS (Sheet 3 of 18)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

15.9	RM Mass Properties																								
16.1	ATM S/S Act. & Oper.												X			X									
16.2	ATM Exp. Performance			X									X		X	X									
16.3	ATM Oper. Sequence												X		X	X									
16.4	ATM Vibration												X		X	X						X			
16.5	ATM Shock												X			X					X				
16.6	ATM Acoustic														X	X						X			
16.7	ATM Thermal Vacuum															X		X							
16.8	ATM EMC Test														X	X									
16.9	ATM Mass Properties																								
17.1	ATM Rack S/S Act. & Oper. (AMS)																								
17.2	ATM Rack S/S Act. & Oper. (Cryo)																								
17.3	ATM Rack Oper. Sequence																								
18.1	RK/ATM S/S Act. & Oper.																								
18.2	RK/ATM Exp. Perf.																								
18.3	RK/ATM Oper. Sequence																								
18.4	RK/ATM Vibration																								
18.5	RK/ATM Shock																								
18.6	RK/ATM Acoustic																								
18.7	RK/ATM Thermal Vacuum																								
18.8	RK/ATM EMC																								
18.9	RK/ATM Mass Properties																								
34.1	Flt. 1 Pre-Launch Fit Check																								
34.2	Flt. 1 Pre-Launch Access Cap.																								
34.3	Flt. 1 Launch EMC (KSC)																								
35.1	Flt. 2 Pre-Launch Fit Check																								
35.2	Flt. 2 Pre-Launch Access Cap.																								
35.3	Flt. 2 Launch EMC																								
36.1	Flt. 3 Pre-Launch Fit Check																								
36.2	Flt. 3 Pre-Launch Access Cap.																								
36.3	Flt. 3 Launch EMC																								
37.1	Flt. 4 Pre-Launch Fit Check																								
37.2	Flt. 4 Pre-Launch Access Cap.																								
37.3	Flt. 4 Launch EMC																								

FOLDOUT FRAME 3

AAP 1 - 4 DEVELOPMENT/QUALIFICATION GSE/TOOLS

TEST / GSE/TOOLS	DEVELOPMENT																																QUALIFICATION																																	
	3.0 Mock-Up Development Tests	4.1 LMSS Rack Static Load	5.1 SIVB Passivation & Activation	5.2 SIVB Pressure Test	6.1.1 MDA Vibration	6.1.2 MDA Shock	6.1.3 MDA Acoustic	6.2.1 AM/MDA Equipment Transfer	6.2.2 MDA S/S Activation & Operation	6.4.1 MDA Static Load	7.1.1 RM Thermal Vacuum	7.2.1 RM Vibration Test	7.2.2 RM Shock	7.2.3 RM Acoustic	7.3.1 RM S/S Operations (Cryo)	8.1.1 ATM Package Static Load	8.2.1 ATM Package Thermal Vacuum	8.2.2 RK/ATM Thermal Vacuum	8.3.1 ATM Package Vibration	8.3.2 ATM Package Shock	8.3.3 RK/ATM Vibration	8.3.4 RK/ATM Shock	8.3.5 RK/ATM Acoustic	8.4.1 ATM Package S/S Operations	8.4.2 ATM Package Exp Performance	8.4.3 RK/ATM S/S Operations	8.4.4 RK/ATM Exp Performance	8.7.1 ATM Rack S/S Operation (Amb)	8.7.2 ATM Rack S/S Operation (Cryo)	9.1 Cluster Scale Mod Antenna Test	9.2 Cluster Scale Mod Therm Vac	10.6 OWS Thermal Vacuum	12.1 SIVB Passivation (Vent & Dump)	12.2 SIVB Passivation (Safing)	12.3 SIVB Equip Instal & Activation	12.4 SIVB S/S Operation	12.5 SIVB Exp Performance	12.6 SIVB Ops Seq Flts 1 & 2	12.7 SIVB Equip Trans Flts 3 & 4	12.8 SIVB Ops Seq Flts 1 & 2	12.9 SIVB Tank Entry & Sealing	12.10 SIVB Pressure Test	12.11 SIVB Static Firing	12.12 SIVB Mass Properties	12.13 SIVB Passivation (Vent & Dump)	13.1 IU Exp Performance	13.2 IU Passivation (Vent & Dump)	13.3 IU Passivation (Safing)	13.4 IU Launch EMC Tests	14.1 MDA S/S Act & Operation	14.2 MDA Experiment Perf	14.3 MDA Oper Sequence	14.4 MDA Vibration	14.5 MDA Shock	14.6 MDA Acoustic	14.7 MDA Mass Properties	14.8 MDA Pressure Test	14.9 MDA Equip Stor (Launch)	15.1 RM S/S Act & Operation	15.2 RM S/S Act & Oper (Cryo)	15.3 RM Oper Sequence	15.4 RM Vibration	15.5 RM Shock	15.6 RM Acoustic	15.7 RM Therm Vac (Off Site)	15.8 RM EMC Test
ELECTRICAL/ELECTRONIC (Contd)																																																																		
EMC Monitoring GSE																																																	X																	X
Gnd Station																																													X																					
SIVB I/F Sim																																														X																				
EMI Inducing GSE																																																	X																	X
Launch Seq Sys																																																																		
FIXTURES/PLATFORMS/DOLLIES																																																																		
Cluster Fixture, Mockup	X																																																																	
Mockup Work Platforms	X																																																																	
Static Load Fix, Rack		X																																																																
Static Load Fix, ATM																X																																																		
Static Load Fix, MDA										X																																																								
Held Fixture, Horiz. SIVB			X	X																													X	X								X	X																							
Work Platforms, Int, SIVB			X																													X			X							X																								
Work Platforms, Ext SIVB			X	X																													X	X								X	X																							

Figure 12 COMBINED MISSION AAP 1/2/3/4 GSE/TOOLS (Sheet 4 of 18)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

																								15.9	RM Mass Properties
																								16.1	ATM S/S Act & Oper
																								16.2	ATM Exp Performance
																								16.3	ATM Oper Sequence
																								16.4	ATM Vibration
																								16.5	ATM Shock
																								16.6	ATM Acoustic
																								16.7	ATM Thermal Vacuum
																			X			X		16.8	ATM EMC Test
																								16.9	ATM Mass Properties
																								17.1	ATM Rack S/S Act & Oper (Amb)
																								17.2	ATM Rack S/S Act & Oper (Cryo)
																								17.3	ATM Rack Oper Sequence
																								18.1	RK/ATM S/S Act & Oper
																								18.2	RK/ATM Exp Perf
																								18.3	RK/ATM Oper Sequence
																								18.4	RK/ATM Vibration
																								18.5	RK/ATM Shock
																								18.6	RK/ATM Acoustic
																								18.7	RK/ATM Thermal Vacuum
																								18.8	RK/ATM EMC
																								18.9	RK/ATM Mass Properties
																								34.1	Flt 1 Pre-Launch Fit Check
																								34.2	Flt 1 Pre-Launch Access Cap
																		X				X		34.3	Flt 1 Launch EMC (KSC)
																								35.1	Flt 2 Pre-Launch Fit Check
																								35.2	Flt 2 Pre-Launch Access Cap
																		X				X		35.3	Flt 2 Launch EMC
																								36.1	Flt 3 Pre-Launch Fit Check
																								36.2	Flt 3 Pre-Launch Access Cap
																		X				X		36.3	Flt 3 Launch EMC
																								37.1	Flt 4 Pre-Launch Fit Check
																								37.2	Flt 4 Pre-Launch Access Cap
																		X				X		37.3	Flt 4 Launch EMC

FOLDOUT FRAME 3

AAP 1 - 4 DEVELOPMENT/QUALIFICATION GSE/TOOLS

DEVELOPMENT (3.0 – 10.6) / QUALIFICATION (12.1 – 15.8)

GSE/TOOLS \ TEST	3.0 Mock-Up Development Tests	4.1 LM&SS Rack Static Load	5.1 SIVB Passivation & Activation	5.2 SIVB Pressure Test	6.1.1 MDA Vibration	6.1.2 MDA Shock	6.1.3 MDA Acoustic	6.2.1 AM/MDA Equipment Transfer	6.2.2 MDA S/S Activation & Operation	6.4.1 MDA Static Load	7.1.1 RM Thermal Vacuum	7.2.1 RM Vibration Test	7.2.2 RM Shock	7.2.3 RM Acoustic	7.3.1 RM S/S Operations (Cryo)	8.1.1 ATM Package Static Load	8.2.1 ATM Package Thermal Vacuum	8.2.2 RK/ATM Thermal Vacuum	8.3.1 ATM Package Vibration	8.3.2 ATM Package Shock	8.3.3 RK/ATM Vibration	8.3.4 RK/ATM Shock
FIXTURES/PLATFORMS/DOLLIES (Cont)																						
Shaker					X							X							X		X	
Shock Table						X							X							X		
Hold Fixture, Horiz, MDA								X	X													
Work Platforms, Int, AM								X	X													
Work Platforms, Int, MDA								X	X													
Work Platforms, Ext, AM									X													
Work Platforms, Ext, MDA									X													
Sup & Rot Fix, RM, RK/ATM											X							X				
Rack Test Stand															X							
Sup & Rot Fix, ATM																	X					
Work Platforms, ATM Rack																						
OWS Vert Hold Fix																						
Ext Platforms, SIVB Vert																						
Int Platforms, SIVB Vert																						
Hold Fixture, IU Vert																						
Hold Fixture, MDA Vert																						
Int/Ext Platf MDA Vert																						
RF Transp Sup Fix, ATM																						
RF Transp Sup Fix, RM																						
Launch Type Serv Platf																						
Int Platforms, RM Vert																						
Int Platforms, SLA, Vert																						
Hold Fixture Horiz, AM								X	X													

GSE/TOOLS \ TEST	8.3.5 RK/ATM Acoustic	8.4.1 ATM Package S/S Operations	8.4.2 ATM Package Exp Performance	8.4.3 RK/ATM S/S Operations	8.4.4 RK/ATM Exp Performance	8.7.1 ATM Rack S/S Operation (AMB)	8.7.2 ATM Rack S/S Operation (Cryo)	9.1 Cluster Scale Mod Antenna Test	9.2 Cluster Scale Mod Therm Vac	10.6 OWS Thermal Vacuum	12.1 SIVB Passivation (Vent & Dump)	12.2 SIVB Passivation (Safing)	12.3 SIVB Equip Instal & Activation	12.4 SIVB S/S Operation	12.5 SIVB Exp Performance	12.6 SIVB Ops Seq Flts 1 & 2	12.7 SIVB Equip Trans Flts 3 & 4	12.8 SIVB Ops Seq Flts 1 & 2	12.9 SIVB Tank Entry & Sealing	12.10 SIVB Pressure Test	12.11 SIVB Static Firing	12.12 SIVB Mass Properties
FIXTURES/PLATFORMS/DOLLIES (Cont)																						
Shaker																						
Shock Table																						
Hold Fixture, Horiz, MDA																						
Work Platforms, Int, AM																						
Work Platforms, Int, MDA																						
Work Platforms, Ext, AM																						
Work Platforms, Ext, MDA																						
Sup & Rot Fix, RM, RK/ATM																						
Rack Test Stand							X															
Sup & Rot Fix, ATM																						
Work Platforms, ATM Rack						X																
OWS Vert Hold Fix										X			X	X	X	X	X	X				
Ext Platforms, SIVB Vert										X			X	X	X	X	X	X				
Int Platforms, SIVB Vert																X	X	X				
Hold Fixture, IU Vert																						
Hold Fixture, MDA Vert																						
Int/Ext Platf MDA Vert																						
RF Transp Sup Fix, ATM																						
RF Transp Sup Fix, RM																						
Launch Type Serv Platf																						
Int Platforms, RM Vert																						
Int Platforms, SLA, Vert																						
Hold Fixture Horiz, AM																						

GSE/TOOLS \ TEST	12.13 SIVB Passivation (Vent & Dump)	13.1 IU Exp Performance	13.2 IU Passivation (Vent & Dump)	13.3 IU Passivation (Safing)	13.4 IU Launch EMC Tests	14.1 MDA S/S Act & Operation	14.2 MDA Experiment Perf	14.3 MDA Oper Sequence	14.4 MDA Vibration	14.5 MDA Shock	14.6 MDA Acoustic	14.7 MDA Mass Properties	14.8 MDA Pressure Test	14.9 MDA Equip Stor (Launch)	15.1 RM S/S Act & Operation	15.2 RM S/S Act & Oper (Cryo)	15.3 RM Oper Sequence	15.4 RM Vibration	15.5 RM Shock	15.6 RM Acoustic	15.7 RM Therm Vac (Off Site)	15.8 RM EMC Test
FIXTURES/PLATFORMS/DOLLIES (Cont)																						
Shaker									X													
Shock Table										X								X	X			
Hold Fixture, Horiz, MDA						X	X	X														
Work Platforms, Int, AM																						
Work Platforms, Int, MDA							X	X														
Work Platforms, Ext, AM																						
Work Platforms, Ext, MDA						X	X	X														
Sup & Rot Fix, RM, RK/ATM																					X	
Rack Test Stand																						
Sup & Rot Fix, ATM																						
Work Platforms, ATM Rack																						
OWS Vert Hold Fix																						
Ext Platforms, SIVB Vert																						
Int Platforms, SIVB Vert																						
Hold Fixture, IU Vert		X																				
Hold Fixture, MDA Vert														X								
Int/Ext Platf MDA Vert														X								
RF Transp Sup Fix, ATM					X																	
RF Transp Sup Fix, RM																						X
Launch Type Serv Platf																						
Int Platforms, RM Vert																						
Int Platforms, SLA, Vert																						
Hold Fixture Horiz, AM																						

Figure 12 COMBINED MISSION AAP 1/2/3/4 GSE/TOOLS (Sheet 5 of 18)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

																								15.9	RM Mass Properties
																								16.1	ATM S/S Act & Oper
																								16.2	ATM Exp Performance
																								16.3	ATM Oper Sequence
																						X		16.4	ATM Vibration
																					X			16.5	ATM Shock
																								16.6	ATM Acoustic
													X											16.7	ATM Thermal Vacuum
					X																			16.8	ATM EMC Test
																								16.9	ATM Mass Properties
																								17.1	ATM Rack S/S Act & Oper (Amb)
																								17.2	ATM Rack S/S Act & Oper (Cryo)
																								17.3	ATM Rack Oper Sequence
																								18.1	RK/ATM S/S Act & Oper
																								18.2	RK/ATM Exp Perf
																								18.3	RK/ATM Oper Sequence
																								18.4	RK/ATM Vibration
																								18.5	RK/ATM Shock
																								18.6	RK/ATM Acoustic
																								18.7	RK/ATM Thermal Vacuum
																								18.8	RK/ATM EMC
																								18.9	RK/ATM Mass Properties
																								34.1	Flt 1 Pre-Launch Fit Check
																								34.2	Flt 1 Pre-Launch Access Cap
																								34.3	Flt 1 Launch EMC (KSC)
			X			X		X																35.1	Flt 2 Pre-Launch Fit Check
			X			X																		35.2	Flt 2 Pre-Launch Access Cap
																								35.3	Flt 2 Launch EMC
			X					X																36.1	Flt 3 Pre-Launch Fit Check
	X	X																						36.2	Flt 3 Pre-Launch Access Cap
																								36.3	Flt 3 Launch EMC
	X		X																					37.1	Flt 4 Pre-Launch Fit Check
	X																							37.2	Flt 4 Pre-Launch Access Cap
																								37.3	Flt 4 Launch EMC

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TEST / GSE / TOOLS	KSC - INDUSTRIAL AREA															
	R&I Experiments	Install Exps in CSM	R&I LM&SS	Plumbing Leak Cks, LM&SS	Func C/O of Pwr Dist Sys	Stab & Control Sys C/O	Install & C/O Exps, LM&SS	LM&SS/SLA Fit Check	LM&SS Wgt & Balance	Manned Altitude Test, CSM	CSM/LM&SS Docking & I/F Test	Orbit Config C/O	Camera Align Verification	Mate LM&SS/Lower SLA	Mate SLA	Docking Collar Fit & Leak Check
	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	4.12	4.13	4.14	4.15	4.16
MECHANICAL/STRUCTURAL/FLUIDS																
Expt Handling GSE	X	X					X									
LM&SS Handling GSE			X					X	X		X			X		
LM&SS Press Console/GSE				X												
LM&SS Gnd Press Umb				X												
Leak Rate Tester				X												
Optical Alignment Kit							X						X			
Weight & Bal GSE, LM&SS									X							
Exp Mass Sim									X							
Thermal Control GSE, AM												X				
AM/MDA Press GSE												X				
Upper SLA Handling GSE															X	
AM/MDA Handling GSE																X
Fluid Servicing GSE, LM&SS																

KSC-LP

RFI Test	CDDT	Install & C/O Time Sens Exp	Fluid Servicing, LM&SS	Launch Monitor
3.1	3.2	3.3	3.4	3.5
			X	
			X	
			X	

FOLDOUT FRAME

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GSE/TOOLS \ TEST	4.1 R&I Experiments	4.2 Install Exps in CSM	4.3 R&I LM&SS	4.4 Plumbing Leak Cks, LM&SS	4.5 Func C/O of Pwr Dist Sys	4.6 Stab & Control Sys C/O	4.7 Install & C/O Exps, LM&SS	4.8 LM&SS/SLA Fit Check	4.9 LM&SS Wgt & Balance	4.10 Manned Altitude Test, CSM	4.11 CSM/LM&SS Docking & I/F Test	4.12 Orbit Config C/O	4.13 Camera Align Verification	4.14 Mate LM&SS/Lower SLA	4.15 Mate SLA	4.16 Docking Collar Fit & Leak Check
	KSC - INDUSTRIAL AREA															
ELECTRICAL/ELECTRONIC																
Gnd Power Console, LM&SS				X	X	X					X					
Gnd Power Dist & Seq, LM&SS				X		X										
Control Signal Sim					X											
Carry Near LM&SS GSE					X						X					
Weight and Bal Instr Kit									X							
ACE-ACE S/C										X	X	X				
DDAS										X	X	X				
Exp Peculiar GSE										X	X					
CSM/LM&SS I/F Cables & Boxes											X					
PCM Gnd Station											X	X				
Pwr Seq Sys Cont & Mon, AM/MDA												X				
Test Set AM/MDA S/C Instr												X				
DEE-6 System												X				
Control Console, TM C/O												X				
I/F Sim (S-IVB, RM, RK/ATM)												X				
Parasitic Antenna Complex																

FOLDOUT FRAME 1

Figure 12 (

KSC-LP

	3.1 RFI Test	3.2 CDDT	3.3 Install & C/O Time Sens Exp	3.4 Fluid Servicing, LM&SS	3.5 Launch Monitor
	X	X	X		X
	X	X	X		X
			X		
	X	X	X	X	X
	X	X	X		
	X	X	X	X	
	X	X	X	X	

FOLDOUT FRAME

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TEST / GSE / TOOLS	4.1 R&I Experiments	4.2 Install Exps in CSM	4.3 R&I LM&SS	4.4 Plumbing Leak Cks, LM&SS	4.5 Func C/O of Pwr Dist Sys	4.6 Stab & Control Sys C/O	4.7 Install & C/O Exps, LM&SS	4.8 LM&SS/SLA Fit Check	4.9 LM&SS Wgt & Balance	4.10 Manned Altitude Test, CSM	4.11 CSM/LM&SS Docking & I/F Test	4.12 Orbit Config C/O	4.13 Camera Align Verification	4.14 Mate LM&SS/Lower SLA	4.15 Mate SLA	4.16 Docking Collar Fit & Leak Check
KSC - INDUSTRIAL AREA																
FIXTURES/PLATFORMS/DOLLIES																
LM&SS Holding Fixture			X	X	X	X	X				X		X			
LM&SS Access Platforms			X	X	X	X	X				X		X			
LM&SS Access Ladders			X	X	X	X	X				X		X			
East Integration Stand								X						X	X	
Adapter Access Platforms								X						X		
Wgt & CB Adapter Fixtures									X							
CSM Altitude Chamber										X	X	X				X
LM&SS Inverting Fixture											X					
AM/MDA Work & Transport Dolly												X				
AM Work & Access Platform												X				
AM/MDA Inverting Fixture																X

FOLDOUT FRAME

KSC-LP

			RFI Test	CDDT	Install & C/O Time Sens Exp	Fluid Servicing, LM&SS	Launch Monitor
			3.1	3.2	3.3	3.4	3.5

FOLDOUT FRAME

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AAP 2

MECH/STRUCT/FLUIDS

No.	TEST \ GSE/TOOLS	MDA Pressure Console	MDA Gnd Press Umb	X-Ray Equip	Dye Penetrant Kit	Water Gage Radiator Pl	Docking Collar & Press Sim	Exp Handling GSE	Shaker (Vib. Exciter)	Wt & Balance GSE	Exp Sim (Wt., Size, Shape)	MDA Handling GSE	Leak Rate Tester	Mass Quant Ind Kit	Mass Quant C/O Console	Thermal Control GSE, AM	AM/MDA Press GSE	AM/MDA Handling GSE	Apollo Handling GSE	Cryo Servicing GSE, AM
	MSFC - FTF (MDA)																			
5.1	In Process Testing	X	X																	
5.2	Visual Insp Docking Collar																			
5.3	MDA Center Sec Visual Insp																			
5.4	Mate Upper & Center Sec MDA											X								
5.5	Conn Interf Plumbing & Elec																			
5.6	Low Level Vibration								X			X								
5.7	Verify Weld Integrity			X	X															
5.8	Elec Continuity																			
5.9	Display & Control Checks																			
5.10	Plumbing Leak Checks	X	X										X							
5.11	MDA Press & Leak Checks	X	X			X							X							
5.12	Docking Collar Fit & Leak	X	X				X						X							
5.13	Install & Fit Check Exp or Sim							X			X									
5.14	Mass Properties									X	X	X								
5.15	Critical Spares C/O																			
	KSC - INDUSTRIAL AREA																			
4.1	R.I. AM Sections																			
4.2	R.I. AM Sections																			
4.3	R.I. AM Sections																			
4.4	R.I. MDA																			
4.5	R.I. Experiments							X												
4.6	Assemble AM/MDA/SLA/NC																	X	X	
4.7	Perf. AM/MDA Align & Clear C/O																			
4.8	Exp Pre-Instal C/O							X												
4.9	Press & Leak Check AM/MDA												X				X			
4.10	Dock. Collar Leak Check						X										X			
4.11	Interface Cable C/O																			
4.12	Single Pt Gnd																			
4.13	Mass Quantity													X	X		X			
4.14	Plumbing Leak Checks												X				X			
4.15	Elec Func LSS																X			
4.16	Elec Func C/O O_2 & N_2																X			
4.17	Leak & Func C/O TC Sys															X	X			
4.18	Perf D&C Funct C/O															X	X			
4.19	Instr Convert Volt C/O																			
4.20	TM Calibration																			
4.21	C/O Spare Encoder Chan																			
4.22	Amb Closed Loop C/O Sys Xducer																			
4.23	Funt C/O TV Sys																			
4.24	Conn all Cluster Umb															X				
4.25	Power Dist & Volt Checks															X				
4.26	D&C Interface Tests															X				
4.27	Voice Intercom C/O															X				
4.28	SIVB Exp Interf Tests															X				
4.29	Comp Time Mission Sim															X	X			
4.30	MDA/CSM Docking Check																	X		
4.31	MDA/CSM Alignment																	X		
4.32	CSM/MDA Collar Leak Ck												X				X	X		
4.33	Instal AM/MDA Exp							X												
4.34	R.I. Solar Panels																			
4.35	Solar Panel Pre-Inst C/O																			
4.36	Post Instal Solar Panel C/O																			
4.37	AM/MDA Wt & C.G.									X								X		
4.38	Mate AM/MDA and Lower SLA																	X	X	
4.39	Mate Upper SLA and N.C.																		X	

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS (Sheet 9 of 18)

FOLDOUT FRAME

FOLDOUT FRAME

FOLDOUT FRAME

FOLDOUT FRAME 2

KSC-LP

	Sys C/O Pass Med	AM/MDA LP C/O	AM Boot Leak Ck	RFI Test	CDDT	Fluid Servicing	Launch Monitor
	3.1	3.2	3.3	3.4	3.5	3.6	3.7
			X			X	
		X				X	

FOLDOUT FRAME

FOLDOUT FRAME 3

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AAP 2

MSFC - FIT (MDA)

GSE / TOOLS \ TEST	5.1 In Process Testing	5.2 Visual Insp Docking Collar	5.3 MDA Center Sec Visual Insp	5.4 Mate Upper & Center Sec MDA	5.5 Conn Interf Plumbing & Elec	5.6 Low Level Vibration	5.7 Verify Weld Integrity	5.8 Elec Continuity	5.9 Display & Control Checks	5.10 Plumbing Leak Checks	5.11 MDA Press & Leak Checks	5.12 Docking Collar Fit & Leak	5.13 Install & Fit Check Exp or Sim	5.14 Mass Properties	5.15 Critical Spares C/O
ELECTRICAL/ELECTRONIC															
MDA C/O Set	X							X	X	X					X
Mobile Analog Recorders						X									
Gnd Power Console, MDA									X	X					X
Gnd Power Dist & Seq, MDA									X	X					X
Interface Sim, CM, AM, RM									X	X					X
PCM Gnd Station									X		X	X			X
Landline Inst Test Set, MDA									X	X	X	X			X
Cable & Ntwk C/O Unit, AM/MDA									X						
Pwr Seq Sys Con & Mon, AM/MDA															
Test Set AM/MDA S/C Inst															
DEE-6 Sys															
Control Console, TM C/O															
ACE & ACE-S/C															
DDAS															
RCA-110A															
I/F Sim SIVB, RM, RK/ATM															
Pyrotechnic C/O Kit															
Light Source															
Para Antenna Complex															
Exp Peculiar GSE															
Commercial Equip															
Vibration Inst Kit						X									
Wt & Bal Inst Kit														X	

KSC - INDUSTRIAL AREA

GSE / TOOLS \ TEST	4.1 R.I. AM Sections	4.2 R.I. AM Sections	4.3 R.I. AM Sections	4.4 R.I. MDA	4.5 R. I. Experiments	4.6 Assemble AM/MDA/SLA/NC	4.7 Perf AM/MDA Align & Clear C/O	4.8 Exp Pre-Instal C/O	4.9 Press & Leak Check AM/MDA	4.10 Dock Collar Leak Check	4.11 Interface Cable C/O	4.12 Single Pt Gnd	4.13 Mass Quantity	4.14 Plumbing Leak Checks	4.15 Elec Func LSS	4.16 Elec Func C/O O_2 & H_2	4.17 Leak & Func C/O TC Sys	4.18 Perf D&C Funct C/O	4.19 Instr Convert Volt C/O	4.20 TM Calibration
ELECTRICAL/ELECTRONIC																				
MDA C/O Set											X									
Mobile Analog Recorders																				
Gnd Power Console, MDA																				
Gnd Power Dist & Seq, MDA																				
Interface Sim, CM, AM, RM																				
PCM Gnd Station															X	X	X	X	X	X
Landline Inst Test Set, MDA																				
Cable & Ntwk C/O Unit, AM/MDA											X	X								
Pwr Seq Sys Con & Mon, AM/MDA											X		X	X	X	X	X	X	X	X
Test Set AM/MDA S/C Inst													X	X	X	X	X	X	X	X
DEE-6 Sys																				
Control Console, TM C/O																				X
ACE & ACE-S/C																				
DDAS																				
RCA-110A																				
I/F Sim SIVB, RM, RK/ATM																		X		
Pyrotechnic C/O Kit																				
Light Source																				
Para Antenna Complex																				
Exp Peculiar GSE								X												
Commercial Equip																				
Vibration Inst Kit																				
Wt & Bal Inst Kit																				

GSE / TOOLS \ TEST	4.21 C/O Spare Encoder Chan	4.22 Amb Closed Loop C/O Sys Xducer	4.23 Funt C/O TV Sys	4.24 Comm all Cluster Umb	4.25 Power Dist & Volt Checks	4.26 D&C Interface Tests	4.27 Voice Intercom C/O	4.28 SIVB Exp Interf Tests	4.29 Comp Time Mission Sim	4.30 MDA/CSM Docking Check	4.31 MDA/CSM Alignment	4.32 CSM/MDA Collar Leak Ck	4.33 Instal AM/MDA Exp	4.34 R.I. Solar Panels	4.35 Solar Panel Pre-Inst C/O	4.36 Post Instal Solar Panel C/O	4.37 AM/MDA Wt & C.G.	4.38 Mate AM/MDA and Lower SLA	4.39 Mate Upper SLA and N.C.
ELECTRICAL/ELECTRONIC																			
MDA C/O Set					X	X	X	X	X										
Mobile Analog Recorders																			
Gnd Power Console, MDA																			
Gnd Power Dist & Seq, MDA																			
Interface Sim, CM, AM, RM																			
PCM Gnd Station	X	X		X	X	X	X	X	X										
Landline Inst Test Set, MDA																			
Cable & Ntwk C/O Unit, AM/MDA																			
Pwr Seq Sys Con & Mon, AM/MDA	X	X		X	X	X	X	X	X										
Test Set AM/MDA S/C Inst	X	X		X	X	X	X	X	X										
DEE-6 Sys				X	X	X	X	X	X										
Control Console, TM C/O	X	X		X	X				X										
ACE & ACE-S/C				X	X	X	X	X	X										
DDAS				X	X	X	X	X	X										
RCA-110A																			
I/F Sim SIVB, RM, RK/ATM				X	X	X	X	X	X										
Pyrotechnic C/O Kit																		X	X
Light Source															X				
Para Antenna Complex																			
Exp Peculiar GSE								X											
Commercial Equip															X	X			
Vibration Inst Kit																			
Wt & Bal Inst Kit																			

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS (Sheet 10 of 18)

FOLDOUT FRAME

FOLDOUT FRAME 1

FOLDOUT FRAME

FOLDOUT FRAME 2

KSC-LP

3.1 Sys C/O Pass Mod	3.2 AM/MDA LP C/O	3.3 AM Boot Leak Ck	3.4 RFI Test	3.5 CDDT	3.6 Fluid Servicing	3.7 Launch Monitor																										
X	X	X	X	X	X	X																										
	X	X	X	X	X																											
	X	X	X	X	X																											
X	X	X	X	X																												
	X	X	X	X	X																											
			X	X		X																										
X	X	X	X	X		X																										
X																																
	X	X	X	X	X																											

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AAP 2

TEST / GSE/TOOLS

MSFC - FIF (MDA)

GSE/TOOLS	5.1 In Process Testing	5.2 Visual Insp Docking Collar	5.3 MDA Center Sec Visual Insp	5.4 Mate Upper & Center Sec MDA	5.5 Conn Interf Plumbing & Elec	5.6 Low Level Vibration	5.7 Verify Weld Integrity	5.8 Elec Continuity	5.9 Display & Control Checks	5.10 Plumbing Leak Checks	5.11 MDA Press & Leak Checks	5.12 Docking Collar Fit & Leak	5.13 Install & Fit Check Exp or Sim	5.14 Mass Properties	5.15 Critical Spares C/O
FIXTURES/PLATFORMS/DOLLIES															
MDA Holding Fixture				X	X		X	X	X	X	X	X	X		X
MDA Work/Access Platforms	X	X	X	X	X		X	X	X	X	X	X	X		X
MDA Access Ladders	X	X	X	X	X		X	X	X	X	X	X	X		X
Wt & C.G. Adapt Fix														X	
Upper MDA Handling Fix	X	X													
Center MDA Handling Fix			X												
Docking Port Access Plat							X	X	X	X		X	X		X
Docking Collar Sim Dolly												X			
MDA Transport															
AM/MDA Work & Trans Dolly															
AM Work & Access Plat															
East Stokes Stand															
CSM Altitude Chamber															
AM/MDA Inverting Fixture															
Shaker Adapter Fix						X									
PIB Wt & Bal Assy															

KSC-INDUSTRIAL AREA

GSE/TOOLS	4.1 R.I. AM Sections	4.2 R.I. AM Sections	4.3 R.I. AM Sections	4.4 R.I. MDA	4.5 R.I. Experiments	4.6 Assemble AM/MDA/SLA/NC	4.7 Perf AM/MDA Align & Clear C/O	4.8 Exp Pre-Instal C/O	4.9 Press & Leak Check AM/MDA	4.10 Dock Collar Leak Check	4.11 Interface Cable C/O	4.12 Single Pt Gnd	4.13 Mass Quantity
FIXTURES/PLATFORMS/DOLLIES													
MDA Holding Fixture													
MDA Work/Access Platforms				X									
MDA Access Ladders				X									
Wt & C.G. Adapt Fix													
Upper MDA Handling Fix													
Center MDA Handling Fix													
Docking Port Access Plat													
Docking Collar Sim Dolly													
MDA Transport				X									
AM/MDA Work & Trans Dolly	X	X	X			X			X	X	X	X	X
AM Work & Access Plat	X	X	X						X	X	X	X	X
East Stokes Stand						X	X						
CSM Altitude Chamber													
AM/MDA Inverting Fixture													
Shaker Adapter Fix													
PIB Wt & Bal Assy													

GSE/TOOLS	4.14 Plumbing Leak Checks	4.15 Elec Func L&S	4.16 Elec Func C/O O_2 & N_2	4.17 Leak & Func C/O TC Sys	4.18 Perf D&C Funct C/O	4.19 Instr Convert Volt C/O	4.20 TM Calibration	4.21 C/O Spare Encoder Chan	4.22 Amb Closed Loop C/O Sys Xducer	4.23 Funct C/O TV Sys	4.24 Conn all Cluster Umb	4.25 Power Dist & Volt Checks	4.26 D&C Interface Tests
FIXTURES/PLATFORMS/DOLLIES													
MDA Holding Fixture													
MDA Work/Access Platforms													
MDA Access Ladders													
Wt & C.G. Adapt Fix													
Upper MDA Handling Fix													
Center MDA Handling Fix													
Docking Port Access Plat													
Docking Collar Sim Dolly													
MDA Transport													
AM/MDA Work & Trans Dolly	X	X	X	X	X	X	X	X	X	X	X	X	X
AM Work & Access Plat	X	X	X	X	X	X	X	X	X	X	X	X	X
East Stokes Stand													
CSM Altitude Chamber											X	X	X
AM/MDA Inverting Fixture													
Shaker Adapter Fix													
PIB Wt & Bal Assy													

GSE/TOOLS	4.27 Voice Intercom C/O	4.28 SIVB Exp Interf Tests	4.29 Comp Time Mission Sim	4.30 MDA/CSM Docking Check	4.31 MDA/CSM Alignment	4.32 CSM/MDA Collar Leak Ck	4.33 Instal AM/MDA Exp	4.34 R.I. Solar Panels	4.35 Solar Panel Pre-Inst C/O	4.36 Post Instal Solar Panel C/O	4.37 AM/MDA Wt & C.G.	4.38 Mate AM/MDA and Lower SLA	4.39 Mate Upper SLA and N.C.
FIXTURES/PLATFORMS/DOLLIES													
MDA Holding Fixture													
MDA Work/Access Platforms													
MDA Access Ladders													
Wt & C.G. Adapt Fix													
Upper MDA Handling Fix													
Center MDA Handling Fix													
Docking Port Access Plat													
Docking Collar Sim Dolly													
MDA Transport													
AM/MDA Work & Trans Dolly	X	X	X				X			X			
AM Work & Access Plat	X	X	X				X			X			
East Stokes Stand												X	X
CSM Altitude Chamber	X	X	X	X	X	X							
AM/MDA Inverting Fixture				X		X		X	X				
Shaker Adapter Fix													
PIB Wt & Bal Assy											X		

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS (Sheet 11 of 18)

FOLDOUT FRAME

FOLDOUT FRAME 1

FOLDOUT FRAME

FOLDOUT FRAME 2

KSC-LP

Sys C/O Pass Mod	AM/MDA LP C/O	AM Boot Leak Ck	RFI Test	CDDT	Fluid Servicing	Launch Monitor
3.1	3.2	3.3	3.4	3.5	3.6	3.7

FOLDOUT FRAME

FOLDOUT FRAME 3

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TEST / GSE/TOOLS	MSFC-PIF (RM)												
	In Process Testing	RM Visual Inspection	RM Low Level Vibration Test	Weld Integrity Test	Antenna System Test	Elect I/F Test RM/AM/MDA	Press Ck of Center Cannister	Press Ck of Fluid Systems	Verify Fluid Transfer Sys	Verify Docking Collars	RM/Lower SLA Fit Check	Critical Spares Checkout	Clean and Determine Mass Props
	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	5.12	5.13
MECHANICAL/STRUCTURAL/FLUID													
RM Pressure Console	X						X	X	X	X		X	
RM Gnd Press Umbilical	X						X	X	X	X		X	
Shaker			X										
RM Handling GSE			X							X	X		X
X-Ray Equipment				X									
Dye Penetrant Check Kit				X									
Mass Spectrometer							X	X		X			
Cryogenic Umbilical									X				
Docking Collar & Press Sim										X			
Weight and Balance GSE													X
Mass Property Sims													X
Exp Handling GSE													
LM A/S Inverting Fixture													
CM Pressure Console													
CM Gnd Pressure Umb													
Upper SLA Handling GSE													
RM Inverting Fixture													
Cryogenic Servicing GSE, LP													

FOLDOUT FRAME

FOLDOUT FRAME

Figure 12 C

AAP 3 GSE/TOOLS

KSC - INDUSTRIAL AREA | KSC-LP

	4.1 R&I Experiments	4.2 Install Exps in CM	4.3 CSM/LM Dock & Leak Check	4.4 R&I RM	4.5 RM Load Check	4.6 RM/SLA Fit Check	4.7 CSM/RM Docking Test	4.8 CSM/RM D&C I/F C/O	4.9 CSM Manned Altitude Test	4.10 CSM/LM I/F Test	4.11 RM Leak Tests	4.12 RM Regulator Flow Checks	4.13 RM Docking & Collar Leak Check	4.14 Install Exps in RM	4.15 RM Weight & Balance Test	4.16 Connect Cluster Umbilicals & GSE	4.17 Cluster I/F C/O	4.18 Install & C/O Exps, IU					3.1 Spacecraft RFI Test	3.2 Countdown Demonstration Tests	3.3 Install & C/O Time Sens Exps	3.4 Final Fluid Servicing, RM	3.5 Launch Monitor						
											X	X	X																				
											X	X	X																				
						X									X																		
			X								X		X																				
													X																				
															X																		
	X	X												X				X							X								
			X																														
			X																														
			X																														
						X																											
							X					X																					
																									X		X						

FOLDOUT FRAME

FOLDOUT FRAME 2

GSE / TOOLS \ TEST	5.1 In Process Testing	5.2 RM Visual Inspection	5.3 RM Low Level Vibration Test	5.4 Weld Integrity Test	5.5 Antenna System Test	5.6 Elect I/F Test RM/AM/MDA	5.7 Press Ck of Center Cannister	5.8 Press Ck of Fluid Systems	5.9 Verify Fluid Transfer Sys	5.10 Verify Docking Collars	5.11 RM/Lower SLA Fit Check	5.12 Critical Spares Checkout	5.13 Clean and Determine Mass Props			
	MSFC-PIF (RM)															
ELECTRICAL/ELECTRONIC																
Mobile Analog Recorders			X			X										
RM Vibration Instr Kit			X													
Antenna C/O Kit					X											
Gnd Pwr Console, RM						X	X	X	X	X		X				
AM/MDA Electrical Sim						X			/							
PCM Gnd Station							X	X	X	X		X				
Landline Instr Test Set, CSM																
Gnd Pwr Sonsole, CSM																
RM Cable C/O Boxes																
ACE & ACE-S/C GSE																
CSM/RM Marriage Cables																
Experiment GSE																
DDAS																
CSM/LM Marriage Cables																
DEE-6 System																
I/F Sim, LM&SS, AM/MDA, S-IVB																
Cluster Marriage Cables																
Parasitic Antenna Complex																

KSC - INDUSTRIAL AREA | KSC-LP

4.1 R&I Experiments	4.2 Install Exps in CM	4.3 CSM/LM Dock & Leak Check	4.4 R&I RM	4.5 RM Load Check	4.6 RM/SLA Fit Check	4.7 CSM/RM Docking Test	4.8 CSM/RM D&C I/F C/O	4.9 CSM Manned Altitude Test	4.10 CSM/LM I/F Test	4.11 RM Leak Tests	4.12 RM Regulator Flow Checks	4.13 RM Docking & Collar Leak Check	4.14 Install Exps in RM	4.15 RM Weight & Balance Test	4.16 Connect Cluster Umbilicals & GSE	4.17 Cluster I/F C/O	4.18 Install & C/O Exps, IU					3.1 Spacecraft RFI Test	3.2 Countdown Demonstration Tests	3.3 Install & C/O Time Sens Exps	3.4 Final Fluid Servicing, RM	3.5 Launch Monitor						
		X														X						X	X	X	X	X						
		X																														
		X							X																							
				X																												
							X		X						X	X																
							X																									
								X								X																
									X																							
									X																							
									X																							
															X	X																
															X	X																
																						X	X			X						

FOLDOUT FRAME

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GSE / TOOLS \ TEST	In Process Testing 5.1	RM Visual Inspection 5.2	RM Low Level Vibration Test 5.3	Weld Integrity Test 5.4	Antenna System Test 5.5	Elect I/F Test RM/AM/MDA 5.6	Press Ck of Center Cannister 5.7	Press Ck of Fluid Systems 5.8	Verify Fluid Transfer Sys 5.9	Verify Docking Collars 5.10	RM/Lower SLA Fit Check 5.11	Critical Spares Checkout 5.12	Clean and Determine Mass Props 5.13
	MSFC-PIF (RM)												
FIXTURES/PLATFORMS/DOLLIES													
RM Holding Fixture	X	X		X	X	X	X	X	X	X		X	
RM Access Platforms	X	X		X	X	X	X	X	X	X		X	X
RM Access Ladders	X	X		X	X	X	X	X	X	X		X	X
RM Shaker Fixture			X										
SLA Access Platform											X		
SLA Holding Fixture											X		
Alt Chamber Plat Adapter													
RM Transporter													
RM Wgt & Bal Fixture													X
CSM Altitude Chamber													
LM Altitude Chamber													
CM Holding Fixture													

FOLDOUT FRAME 1

Figure 12 CO

KSC - INDUSTRIAL AREA																		KSC-LP				
4.1 R&I Experiments	4.2 Install Exps in CM	4.3 CSM/LM Dock & Leak Check	4.4 R&I rm	4.5 RM Load Check	4.6 RM/SLA Fit Check	4.7 CSM/RM Docking Test	4.8 CSM/RM D&C I/F C/O	4.9 CSM Manned Altitude Test	4.10 CSM/LM I/F Test	4.11 RM Leak Tests	4.12 RM Regulator Flow Checks	4.13 RM Docking & Collar Leak Check	4.14 Install Exps in RM	4.15 RM Weight & Balance Test	4.16 Connect Cluster Umbilicals & GSE	4.17 Cluster I/F C/O	4.18 Install & C/O Exps, IU	3.1 Spacecraft RFI Test	3.2 Countdown Demonstration Tests	3.3 Install & C/O Time Sens Exps	3.4 Final Fluid Servicing, RM	3.5 Launch Monitor
			X	X						X	X	X	X									
			X	X			X			X	X	X	X	X								
			X	X			X			X	X	X	X	X								
					X																	
		X				X																
					X		X															
														X								
	X				X	X	X	X	X					X	X	X						
									X					X	X	X						
	X																					

FOLDOUT FRAME

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AAP 4 GSE/TOOLS

Test		MECHANICAL/STRUCTURAL/FLUID	Solar Disc Sim	X-Ray Equipment	Dye Penetrant C/O Kit	ATM Handling GSE	RK/ATM Handling GSE	Exp Handling GSE	CMG Handling GSE	Pressure Control Console	Pressure Lines & Umbilicals	Mass Spectrometer	Solar Panel Sim	Weight & Bal GSE	Mass Properties Sim	Optical Alignment Kit	Thermal Control GSE	LM A/S Handling GSE	Solar Array Handling GSE	RK/ATM/LM Handling GSE
MSFC - FIP (RK/ATM)																				
5.1	Receiving Test, PCS S/S		X						X											
5.2	Weld Integrity			X	X															
5.3	Mate ATM & Rack					X														
5.4	RK/ATM - SLA Fit Check						X													
5.5	RK/ATM - LM A/S Fit Check						X													
5.6	Receiving Tests, Comps & Exps							X												
5.7	ATM Ditmco Checks																			
5.8	PCS Checkout								X											
5.9	RK/ATM Ditmco Checks																			
5.10	RK/ATM Pressure & Leak Tests									X	X	X								
5.11	Communications Checkout																			
5.12	Power System Checkout																			
5.13	Instrumentation System C/O																			
5.14	Telemetry System C/O																			
5.15	Experiment C/O																			
5.16	Solar Panel Deployment C/O												X							
5.17	Interface Compatibility Tests																X			
5.18	All Systems Test																X			
5.19	Critical Spares C/O																			
5.20	Mass Properties Checks						X							X	X					
5.21	Optical Alignments						X									X				
5.22	Location Change C/O						X													
5.23	Thermal Vacuum Test																X			
5.24	Post Thermal Vacuum Test																X			
KSC - INDUSTRIAL AREA																				
4.1	R&I Experiments							X												
4.2	R&I LM A/S																	X		
4.3	R&I Rack & ATM Package					X	X													
4.4	LM A/S Load Checks																			
4.5	LM A/S - CSM Docking Test																			
4.6	Docking Collar Press & Leak Ck									X	X	X								
4.7	RK/ATM - Lower SLA Fit Check						X													
4.8	CMG Mounting Pad Alignment						X									X				
4.9	Install CMGs								X											
4.10	Install Exps, RK/ATM/LM							X												
4.11	Exp Alignment, RK/ATM							X								X				
4.12	Plumbing Leak Test, RK/ATM/LM									X	X	X								
4.13	Thermal Control S/S C/O LM									X	X						X			
4.14	Comm Sys C/O, LM																X			
4.15	Data Management Sys C/O, LM																X			
4.16	LSS C/O, LM									X	X	X					X			
4.17	Stab & Control Sys C/O, LM																			
4.18	D&C, C/O, LM																X			
4.19	Pwr Dist C/O, RK/ATM																			
4.20	Data Management Sys C/O, RK/ATM																X			
4.21	Comm Sys C/O, RK/ATM																X			
4.22	Elect I/F Test, RK/ATM/LM																			
4.23	Pwr Dist C/O, RK/ATM/LM																			
4.24	Thermal Con S/S C/O, RK/ATM/LM																X			
4.25	PCS C/O, RK/ATM/LM																X			
4.26	Data Manage Sys C/O, RK/ATM/LM																X			
4.27	Comm Sys C/O, RK/ATM/LM																X			
4.28	Exp Sys C/O, RK/ATM/LM																X			
4.29	D&C C/O, RK/ATM/LM																X			
4.30	Waste Manage Sys C/O, RK/ATM/LM									X	X	X								
4.31	Elect I/F Test, CSM/LM																			
4.32	Pwr Dist C/O, CSM/LM																			
4.33	Comm Sys C/O, CSM/LM																X			
4.34	D&C C/O CSM/LM																X			

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS (Sheet 15 of 18)

FOLDOUT FRAME

FOLDOUT FRAME 1

FOLDOUT FRAME

FOLDOUT FRAME 2

4.35 Orbit Config I/F C/O	4.36 R&I Solar Panels	4.37 Pre-Int C/O, Solar Panels	4.38 Functional C/O, Solar Array	4.39 Final Exp Align, RK/ATM	4.40 Mass Prop Test, RK/ATM/LM	4.41 Install & C/O Exps, IU	KSC-LP 5.1 S/S Func C/O, RK/ATM/LM	5.2 RFI Test	5.3 CDDT	5.4 Install Time Sens Exps
		X								
				X		X				X
					X					
				X						
X										
	X	X	X							
					X					

FOLDOUT FRAME

FOLDOUT FRAME 3

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AAP 4

MSFC-FIF (RK/ATM)

GSE/TOOLS \ TEST	5.1 Receiving Test, PCS S/S	5.2 Weld Integrity	5.3 Mate ATM & Rack	5.4 RK/ATM - SLA Fit Check	5.5 RK/ATM - LM A/S Fit Check	5.6 Receiving Tests, Comps & Exps	5.7 ATM Ditmco Checks	5.8 PCS Checkout	5.9 RK/ATM Ditmco Checks	5.10 RK/ATM Pressure & Leak Tests	5.11 Communications Checkout	5.12 Power System Checkout	5.13 Instrumentation System C/O	5.14 Telemetry System C/O	5.15 Experiment C/O	5.16 Solar Panel Deployment C/O	5.17 Interface Compatibility Tests	5.18 All Systems Test	5.19 Critical Spares C/O	5.20 Mass Properties Checks	5.21 Optical Alignments	5.22 Location Change C/O	5.23 Thermal Vacuum Test	5.24 Post Thermal Vacuum Test
ELECTRICAL/ELECTRONIC																								
Cable C/O Box, Solar Array																								
I/F Sim, LM&SS, AM/MDA-SIVB																								
Cluster Marriage Cables																								
CMG Test Console	X																							
Commercial Test Equip	X					X					X			X										
Exp Peculiar GSE						X									X			X	X			X	X	X
Ditmco Circuit Analyzer							X		X															
PCS Servo Complex								X																
PCS Test Cable Harness								X																
ACE-ACE S/C																								
UHF/VHF Antenna Dummy											X													
PCM Gnd Station											X			X				X	X			X	X	X
Landline Instr Link											X			X				X	X			X	X	X
Parasitic Antenna Complex											X			X										
Antenna Coupler/Suppressors											X			X										
Cable C/O Boxes, RK/ATM/LM																								
LM A/S Sim								X				X	X	X			X	X	X			X	X	X
Gnd Pwr Console, RK/ATM												X	X	X	X	X	X	X	X					
Cable C/O Boxes, CSM																								
Mobile Analog Recorders												X												
TV C/O Equip													X											
Camera C/O Equip													X											

KSC - INDUSTRIAL AREA

GSE/TOOLS \ TEST	4.1 R&I Experiments	4.2 R&I LM A/S	4.3 R&I Rack & ATM Package	4.4 LM A/S Load Checks	4.5 LM A/S - CSM Docking Test	4.6 Docking Collar Press & Leak Ck	4.7 RK/ATM - Lower SLA Fit Check	4.8 CMG Mounting Pad Alignment	4.9 Install CMGs	4.10 Install Exps, RK/ATM/LM	4.11 Exp Alignment, RK/ATM	4.12 Plumbing Leak Test, RK/ATM/LM	4.13 Thermal Control S/S C/O LM	4.14 Comm Sys C/O, LM	4.15 Data Management Sys C/O, LM	4.16 LSS C/O, LM	4.17 Stab & Control Sys C/O, LM	4.18 D&C, C/O, LM
ELECTRICAL/ELECTRONIC																		
Cable C/O Box, Solar Array																		
I/F Sim, LM&SS, AM/MDA-SIVB																		
Cluster Marriage Cables																		
CMG Test Console																		
Commercial Test Equip																		
Exp Peculiar GSE										X								
Ditmco Circuit Analyzer																		
PCS Servo Complex																		
PCS Test Cable Harness																		
ACE-ACE S/C				X								X	X	X	X	X	X	X
UHF/VHF Antenna Dummy																		
PCM Gnd Station				X									X	X	X	X	X	X
Landline Instr Link				X									X	X	X	X	X	X
Parasitic Antenna Complex																		
Antenna Coupler/Suppressors																		
Cable C/O Boxes, RK/ATM/LM				X														X
LM A/S Sim																		
Gnd Pwr Console, RK/ATM																		
Cable C/O Boxes, CSM																		
Mobile Analog Recorders																		
TV C/O Equip																		
Camera C/O Equip																		

GSE/TOOLS \ TEST	4.19 Pwr Dist C/O, RK/ATM	4.20 Data Management Sys C/O, RK/ATM	4.21 Comm Sys, C/O, RK/ATM	4.22 Elect I/F Test, RK/ATM/LM	4.23 Pwr Dist C/O, RK/ATM/LM	4.24 Thermal Con S/S C/O, RK/ATM/LM	4.25 PCS C/O, RK/ATM/LM	4.26 Data Manage Sys C/O, RK/ATM/LM	4.27 Comm Sys C/O, RK/ATM/LM	4.28 Exp Sys C/O, RK/ATM/LM	4.29 D&C C/O, RK/ATM/LM	4.30 Waste Manage Sys C/O, RK/ATM/LM	4.31 Elect I/F Test, CSM/LM	4.32 Pwr Dist C/O, CSM/LM	4.33 Comm Sys C/O, CSM/LM	4.34 D&C C/O, CSM/LM	4.35 Orbit Config I/F C/O	4.36 R&I Solar Panels	4.37 Pre-Int C/O, Solar Panels
ELECTRICAL/ELECTRONIC																			
Cable C/O Box, Solar Array																			
I/F Sim, LM&SS, AM/MDA-SIVB																	X		
Cluster Marriage Cables																	X		
CMG Test Console																			
Commercial Test Equip	X																		
Exp Peculiar GSE										X							X		
Ditmco Circuit Analyzer																			
PCS Servo Complex																			
PCS Test Cable Harness																			
ACE-ACE S/C					X	X	X	X	X	X	X		X	X	X	X	X		
UHF/VHF Antenna Dummy			X																
PCM Gnd Station		X	X		X	X	X	X	X	X	X		X	X			X		
Landline Instr Link		X	X		X	X	X	X	X	X	X		X	X			X		
Parasitic Antenna Complex									X										
Antenna Coupler/Suppressors									X										
Cable C/O Boxes, RK/ATM/LM	X			X															
LM A/S Sim																			
Gnd Pwr Console, RK/ATM	X			X	X	X	X	X	X	X	X	X							
Cable C/O Boxes, CSM													X						
Mobile Analog Recorders																			
TV C/O Equip																			
Camera C/O Equip																			

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS (Sheet 16 of 18)

FOLDOUT FRAME

FOLDOUT FRAME 1

FOLDOUT FRAME

FOLDOUT FRAME 2

KSC-LP

4.38 Functional C/O, Solar Array	4.39 Final Exp Align, RK/ATM	4.40 Mass Prop Test, RK/ATM/LM	4.41 Install & C/O Exps, IU						3.1 S/S Func C/O, RK/ATM/LM	3.2 EMI Test	3.3 CDDT	3.4 Install Time Sens Exps																					
X																																	
												X																					
									X	X	X	X																					
									X	X	X	X																					
										X	X	X																					

FOLDOUT FRAME 3

FOLDOUT FRAME

AAP-4

MSFC-PTF (RK/ATM)

GSE/TOOLS \ TEST	5.1 Receiving Test, PCS S/S	5.2 Weld Integrity	5.3 Mate ATM & Rack	5.4 RK/ATM - SLA Fit Check	5.5 RK/ATM - LM A/S Fit Check	5.6 Receiving Tests, Comps & Exps	5.7 ATM Ditmco Checks	5.8 PCS Checkout	5.9 RK/ATM Ditmco Checks	5.10 RK/ATM Pressure & Leak Tests	5.11 Communications Checkout	5.12 Power System Checkout	5.13 Instrumentation System C/O	5.14 Telemetry System C/O	5.15 Experiment C/O	5.16 Solar Panel Deployment C/O	5.17 Interface Compatibility Tests	5.18 All Systems Test	5.19 Critical Spares C/O	5.20 Mass Properties Checks	5.21 Optical Alignments	5.22 Location Change C/O	5.23 Thermal Vacuum Test	5.24 Post Thermal Vacuum Test
ELECTRICAL/ELECTRONIC (Contd)																								
Instr Calibrate & C/O Equip													X											
DDAS																								
I/F Cabling, RK/ATM/LM												X	X	X			X	X	X			X	X	X
EMC Test Set																		X	X					
Gnd Power Supply																								
DEE-6																								
CSM/LM Marriage Cables																								

KSC - INDUSTRIAL AREA

GSE/TOOLS \ TEST	4.1 R&I Experiments	4.2 R&I LM A/S	4.3 R&I Rack & ATM Package	4.4 LM A/S Load Checks	4.5 LM A/S - CSM Docking Test	4.6 Docking Collar Press & Leak Ck	4.7 RK/ATM - Lower SLA Fit Check	4.8 CMG Mounting Pad Alignment	4.9 Install CMGs	4.10 Install Exps, RK/ATM/LM	4.11 Exp Alignment, RK/ATM	4.12 Plumbing Leak Test, RK/ATM/LM	4.13 Thermal Control S/S C/O LM	4.14 Comm Sys C/O, LM	4.15 Data Management Sys C/O, LM	4.16 LSS C/O, LM	4.17 Stab & Control Sys C/O, LM	4.18 D&C, C/O, LM
ELECTRICAL/ELECTRONIC (Contd)																		
Instr Calibrate & C/O Equip																		
DDAS				X									X	X	X	X	X	X
I/F Cabling, RK/ATM/LM																		
EMC Test Set																		
Gnd Power Supply												X	X	X	X	X	X	X
DEE-6				X									X	X	X	X	X	X
CSM/LM Marriage Cables																		

GSE/TOOLS \ TEST	4.19 Pwr Dist C/O, RK/ATM	4.20 Data Management Sys C/O, RK/ATM	4.21 Comm Sys, C/O, RK/ATM	4.22 Elect I/F Test, RK/ATM/LM	4.23 Pwr Dist C/O, RK/ATM/LM	4.24 Thermal Con S/S C/O, RK/ATM/LM	4.25 PCS C/O, RK/ATM/LM	4.26 Data Manage Sys C/O, RK/ATM/LM	4.27 Comm Sys C/O, RK/ATM/LM	4.28 Exp Sys C/O, RK/ATM/LM	4.29 D&C C/O, RK/ATM/LM	4.30 Waste Manage Sys C/O, RK/ATM/LM	4.31 Elect I/F Test, CSM/LM	4.32 Pwr Dist C/O, CSM/LM	4.33 Comm Sys C/O, CSM/LM	4.34 D&C C/O, CSM/LM	4.35 Orbit Config I/F C/O	4.36 R&I Solar Panels	4.37 Pre-Int C/O, Solar Panels
ELECTRICAL/ELECTRONIC (Contd)																			
Instr Calibrate & C/O Equip																			
DDAS		X			X	X	X	X	X	X	X			X			X		
I/F Cabling, RK/ATM/LM																			
EMC Test Set																			
Gnd Power Supply													X	X	X	X			
DEE-6					X	X	X	X	X	X	X						X		
CSM/LM Marriage Cables													X	X	X	X			

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS (Sheet 17 of 18)

FOLDOUT FRAME

FOLDOUT FRAME 1

FOLDOUT FRAME

FOLDOUT FRAME 2

KSC-LP

4.38 Functional C/O, Solar Array	4.39 Final Exp Align, RK/ATM	4.40 Mass Prop Test, RK/ATM/LM	4.41 Install & C/O Exps, IU	3.1 S/B Func C/O, RK/ATM/LM	3.2 RFI Test	3.3 CDDT	3.4 Install Time Sens Exps
				X	X	X	X
					X	X	X
				X	X	X	X

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AAP 4

MSFC - FIF (RK/ATM)

TESTS / GSE/TOOLS	5.1 Receiving Test, PCS S/S	5.2 Weld Integrity	5.3 Mate ATM & Rack	5.4 RK/ATM - SLA Fit Check	5.5 RK/ATM - LM A/S Fit Check	5.6 Receiving Tests, Comps & Exps	5.7 ATM Ditmco Checks	5.8 PCS Checkout	5.9 RK/ATM Ditmco Checks	5.10 RK/ATM Pressure & Leak Tests	5.11 Communications Checkout	5.12 Power System Checkout	5.13 Instrumentation System C/O	5.14 Telemetry System C/O	5.15 Experiment C/O	5.16 Solar Panel Deployment C/O	5.17 Interface Compatibility Tests	5.18 All Systems Test	5.19 Critical Spares C/O	5.20 Mass Properties Checks	5.21 Optical Alignments	5.22 Location Change C/O	5.23 Thermal Vacuum Test	5.24 Post Thermal Vacuum Test
FIXTURES/PLATFORMS/DOLLIES																								
Star Tracker Test Fixture	X																							
Rate Gyro Test Fixture	X																							
Rack Holding Fixture		X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
Rack Work/Access Platforms		X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
ATM Holding Fixture							X																	
Wgt & Bal Test Fixture																				X				
Align Stand Work Platform																					X			
RK/ATM Rotate & Clean Fixture																								X
LM A/S Transporter																								
LM A/S Access Platforms																								
CSM Alt Chamber																								
LM A/S Inverting Fixture																								
CSM Alt Chamber Work Plat Adap																								
East Integration Stand																								
RK/ATM/LM Holding Fixture																								
RK/ATM/LM Access Platforms																								
LM Alt Chamber																								
LM Alt Chamber Work Plat Adptr																								
Solar Panel Holding Fixture																								
Solar Panel Access Stand																								
PIB Wgt & Bal Assy																								

KSC - INDUSTRIAL AREA

TESTS / GSE/TOOLS	4.1 R&I Experiments	4.2 R&I LM A/S	4.3 R&I Rack & ATM Package	4.4 LM A/S Load Checks	4.5 LM A/S - CSM Docking Test	4.6 Docking Collar Press & Leak Ck	4.7 RK/ATM - Lower SLA Fit Check	4.8 CMG Mounting Pad Alignment	4.9 Install CMGs	4.10 Install Exps, RK/ATM/LM	4.11 Exp Alignment, RK/ATM	4.12 Plumbing Leak Test, RK/ATM/LM	4.13 Thermal Control S/S C/O LM	4.14 Comm Sys C/O, LM	4.15 Data Management Sys C/O, LM	4.16 LSS C/O, LM	4.17 Stab & Control Sys C/O, LM	4.18 D&C, C/O, LM	4.19 Pwr Dist C/O, RK/ATM	4.20 Data Management Sys C/O, RK/ATM	4.21 Comm Sys, C/O, RK/ATM	4.22 Elect I/F Test, RK/ATM/LM	4.23 Pwr Dist C/O, RK/ATM/LM	4.24 Thermal Con S/S C/O, RK/ATM/LM	4.25 PCS C/O, RK/ATM/LM	4.26 Data Manage Sys C/O, RK/ATM/LM	4.27 Comm Sys C/O, RK/ATM/LM	4.28 Exp Sys C/O, RK/ATM/LM	4.29 D&C C/O, RK/ATM/LM	4.30 Waste Manage Sys C/O, RK/ATM/LM	4.31 Elect I/F Test, CSM/LM	4.32 Pwr Dist C/O, CSM/LM	4.33 Comm Sys C/O, CSM/LM	4.34 D&C C/O, CSM/LM	4.35 Orbit Config I/F C/O	4.36 R&I Solar Panels	C/O Solar Panels
FIXTURES/PLATFORMS/DOLLIES																																					
Star Tracker Test Fixture																																					
Rate Gyro Test Fixture																																					
Rack Holding Fixture			X						X																												
Rack Work/Access Platforms			X						X																												
ATM Holding Fixture			X																																		
Wgt & Bal Test Fixture																																					
Align Stand Work Platform								X																													
RK/ATM Rotate & Clean Fixture																																					
LM A/S Transporter		X		X																																	
LM A/S Access Platforms		X		X																																	
CSM Alt Chamber					X	X																									X	X	X	X	X		
LM A/S Inverting Fixture					X	X																															
CSM Alt Chamber Work Plat Adap					X	X																															
East Integration Stand							X																														
RK/ATM/LM Holding Fixture										X	X	X																									
RK/ATM/LM Access Platforms										X	X	X																									
LM Alt Chamber													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LM Alt Chamber Work Plat Adptr																			X	X	X	X	X	X	X	X	X	X	X	X							
Solar Panel Holding Fixture																																					X
Solar Panel Access Stand																																					X
PIB Wgt & Bal Assy																																					

Figure 12 COMBINED MISSION 1/2/3/4 GSE/TOOLS .(Sheet 18 of 18)

FOLDOUT FRAME

FOLDOUT FRAME 1

FOLDOUT FRAME

FOLDOUT FRAME 2

KSC-LP

4.38	4.39	4.40	4.41	3.1	3.2	3.3	3.4
Functional C/O, Solar Array	Final Exp Align, RK/ATM	Mass Prop Test, RK/ATM/LM	Install & C/O Exps, IU	S/S Func C/O, RK/ATM/LM	RFI Test	CDDT	Install Time Sens Exps

FOLDOUT FRAME 3

FOLDOUT FRAME

6. TEST SEQUENCE AND SCHEDULE

6.1 Integrated Test Flows - The test flow for Flights AAP 1/2/3/4 is shown as Figure 13. This is a high level flow which summarizes the individual development, qualification and flight article test flows contained in Volumes II and III. Each block of the integrated test flow references the volume and section of that volume which presents the detailed discussion of the tests included in the block.

This flow presents the development, qualification and integration tests for those carriers for which MSFC has prime responsibility, and the intercarrier systems design verification tests which verify the integrated experiment carrier interfaces and systems level operation in the launch and orbit configurations.

This test flow is based on the ground rule that all experiments shall have been qualified and accepted prior to delivery to the integration facility. Upon receipt by the integration contractor, the experiment and associated support equipment will be subjected to a detailed receiving inspection for damage checks. All physical and electrical interfaces from carrier to carrier, experiments to carrier, and experiments to experiments, will be checked before experiment checkout begins.

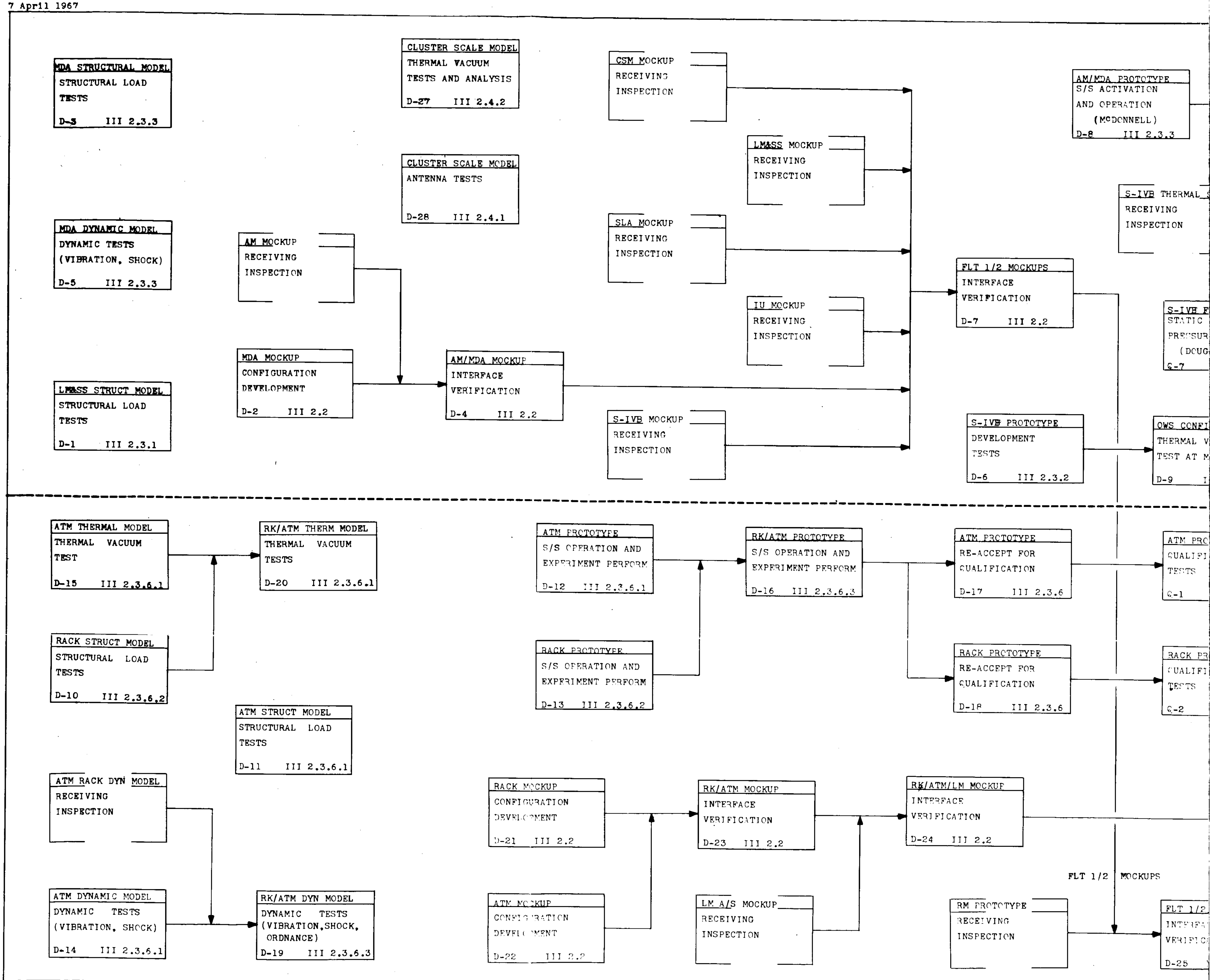
Upon completion of the actual integration effort, tests will be performed to verify proper operation of, and compatibility between, experiments as well as compatibility between carrier subsystems and the experiments.

The final phases of the test flow plan are the operations at the launch site. The following functions will be performed at KSC:

a. Final checks to assure that the experiments, installed in the carrier at the integration site, are operating correctly after shipment to KSC, and that the carrier is ready for the necessary operations to be conducted at KSC.

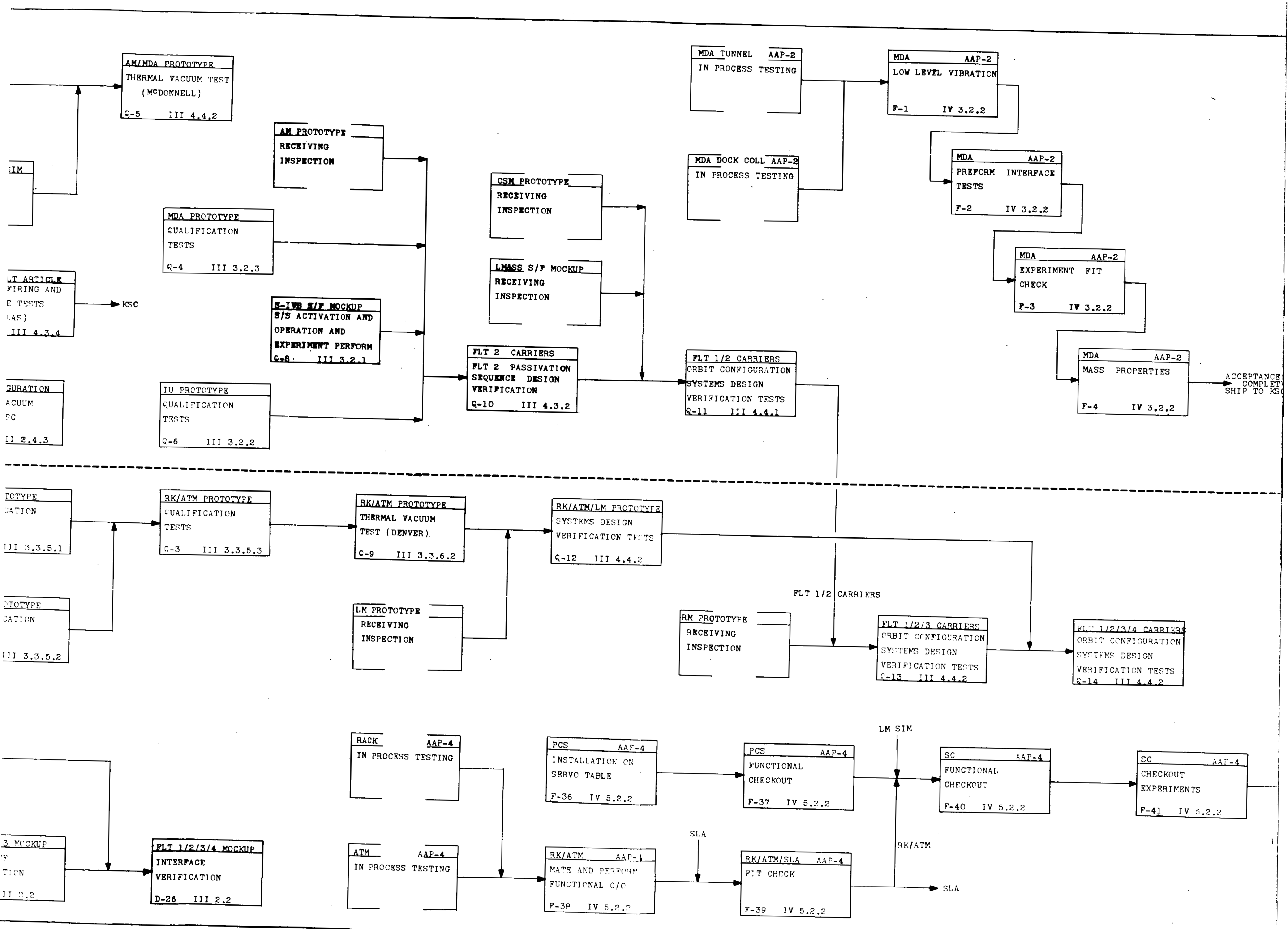
b. Experiment recalibration to within operational limits, as required, using standard equipment or unique contractor supplied equipment. The experiment hardware contractor personnel will participate in this function as required.

c. Installation of those experiments delivered at the launch site, after the functional tests of the individual experiment are conducted.



FOLDOUT FRAME 1

FOLDOUT FRAME 2



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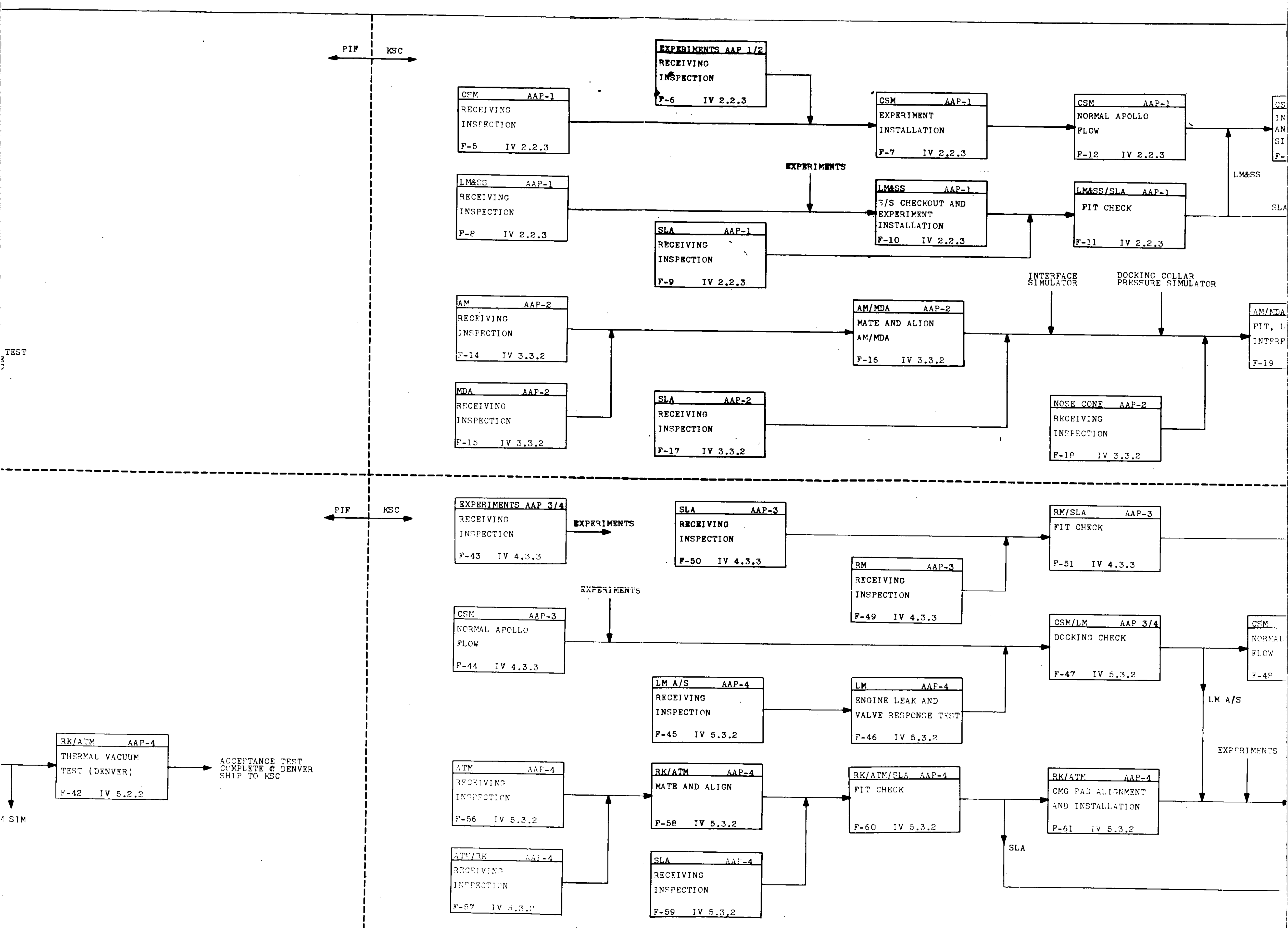

Figure 13. AAP 1/2 & 3/4 Mission Test Flow

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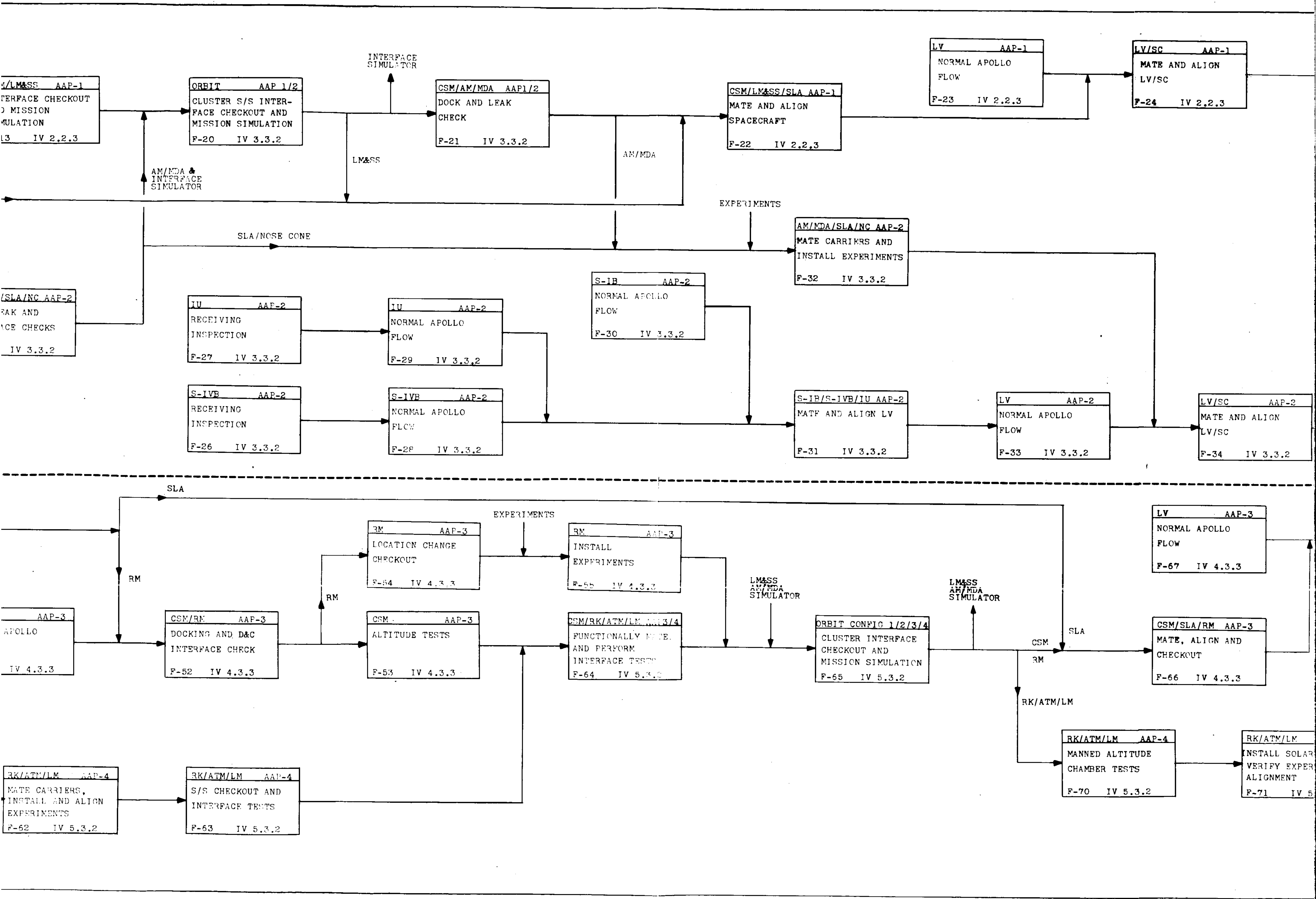

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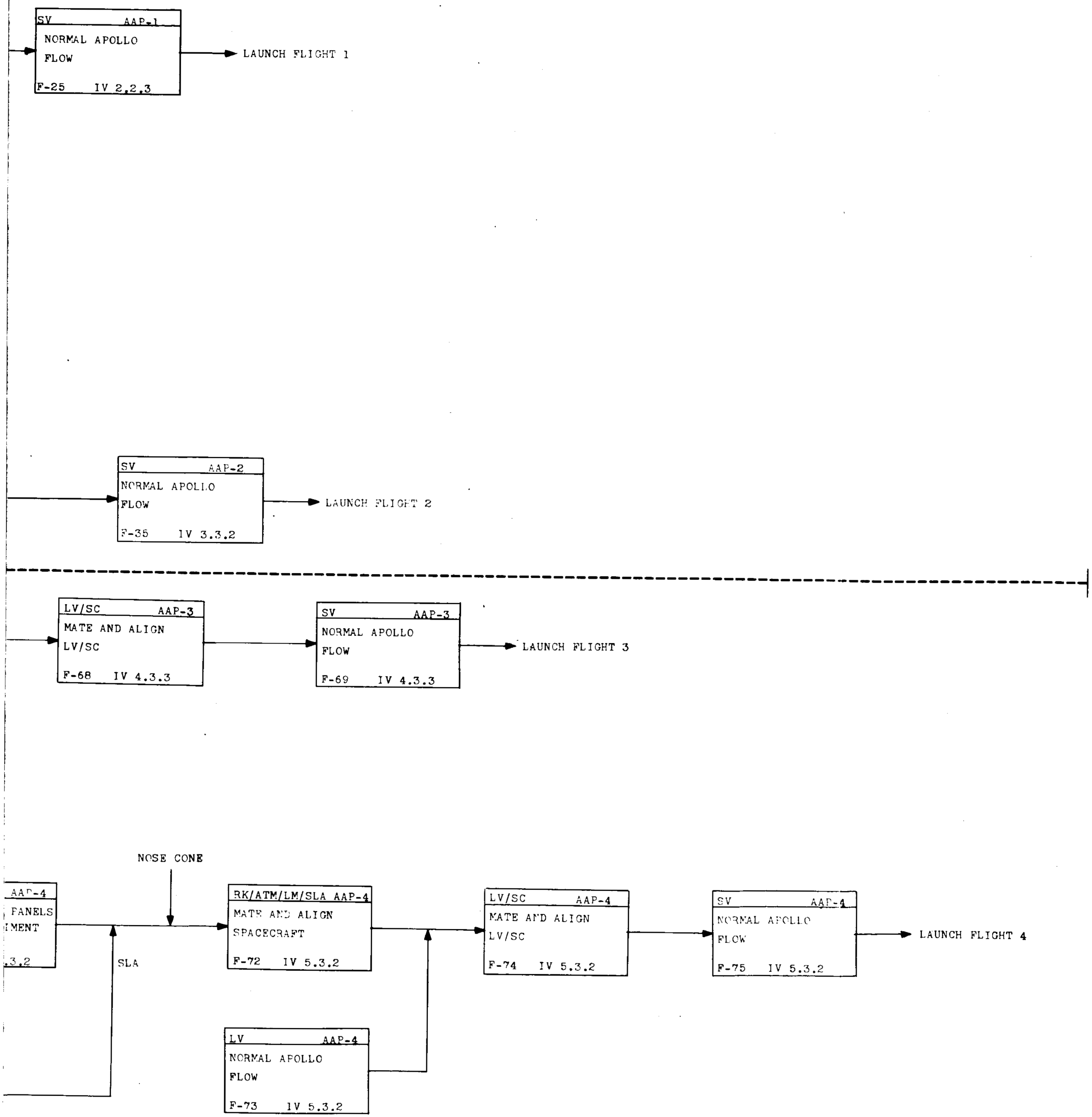

Figure 13

AAP 1/2 & 3/4
MISSION TEST PLAN

DATE: 7 APRIL 1967

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d. Conducting of carrier/experiment system tests to check the operation of the complete carrier system. This systems check will, primarily, verify that the carrier experiments and subsystem are operating within specification limits.

e. Conducting the integrated launch operations including checkout and malfunction detection.

f. Installation and checkout of the time-sensitive experiments after the carrier and launch vehicle are mated and checkout is performed.

All basic carriers shall have been qualified, and passed acceptance tests approved by NASA, prior to delivery to the integration facility. The Airlock Module (AM), the ascent stage of the Lunar Module (LM A/S), and the Command and Service Modules are the responsibility of NASA-MSC, and as such will be qualified under the direction of that center. The Lunar Mapping and Synoptic Survey Systems (LM&SS) rack will be developed and built at NASA-MSFC and fitted with subsystems and experiments, and qualified at NASA-KSC.

The Multiple Docking Adapter (MDA) is a new carrier which will be developed and qualified by NASA-MSFC. Specific tests required on the MDA will include static and dynamic structural tests, systems compatibility, and all-systems test. During the dynamic structural tests, designed to provide necessary data for the analysis of the dynamic structural characteristics of all potential docked configurations, docking loads will be introduced.

Requalification of the Spacecraft LM Adapter (SLA) will be required for any interface changes made. A major requalification program will be required if significant structural cutouts or modifications become necessary.

Requalification of the Instrument Unit (IU) will be required to demonstrate its ability to meet the additional output power requirements.

Qualification of the S-IVB, as an element of the integrated experiment module, shall consist of those activities necessary to qualify the stage as an element of the launch vehicle, and as an element of the Orbital Workshop (OWS) in the on-orbit configuration.

For Flights AAP 1 and 2, there is no specific Payload Integration Facility, as such, either at MSFC or KSC. All efforts shall be made to utilize selected MSFC and KSC facilities in the same manner anticipated for subsequent AAP activities in which full PIF capability is utilized.

It is assumed that, since no separate payload integrating contractor exists for Flight AAP 2, many of the functions of the PIC, as called out in this document, will be fulfilled by NASA-MSFC. For Flight AAP 2, experiment integration into the AM can be conducted either at KSC, or at the McDonnell manufacturing facility. Integration activity for the S-IVB will be split between Douglas Aircraft Corporation facilities, and KSC facilities. The PIC shall become more involved in the integrator function for Flights AAP 3 and 4, than for Flights AAP 1 and 2. The principal advantage of this approach lies in enabling a more gradual buildup of the Payload Integration Facility (PIF) capability while affording adequate program control by the integrating NASA center.

6.2 Test Schedules - As an integral part of this test program schedules, and schedule controls shall be developed. Effective schedule controls are essential due to the interdependence of components produced concurrently, and the relatively long interval between specification establishment and the time when integrated testing is accomplished. It is realized that the ability to accommodate necessary change is an important function of scheduling. Perturbations may take the form of hardware changes, or they may be changes in program direction. Inevitable test program revisions must be incorporated without degrading the sequenced test activity.

The following schedules (Figures 14 thru 17) show test activity timelines for this mission. The test number is that test I.D. number referred to in the lower left part of each block in the test flow of Figure 13.

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MISSIONS 1/2 & 3/4 INTEGRATION TEST SCHEDULE

No.	Test Description
D-1	LM&SS Structural Load Tests
D-2	MDA Configuration Development
D-3	MDA Structural Load Test
D-4	AM/MDA Interface Verification
D-5	MDA Dynamic Tests
D-6	S-IVB Development Tests
D-7	Flights 1 & 2 Interface Verification
D-8	AM/MDA S/S Activation & Operation
D-9	OWS Thermal Vacuum Test
D-10	ATM Rack Structural Load Tests
D-11	ATM Structural Load Tests
D-12	ATM S/S Ops & Expt Performance
D-13	ATM Rack S S Activation & Operation
D-14	ATM Dynamic Tests
D-15	ATM Thermal Vacuum Tests
D-16	RK/ATM S S Ops & Expt Perform
D-17	ATM Re-Accept for Qualification
D-18	ATM Rack Re-Accept for Qualification
D-19	RK/ATM Dynamic Tests
D-20	RK ATM Thermal Vacuum Tests
D-21	Rack Configuration Development
D-22	ATM Configuration Development
D-23	RK/ATM Interface Verification
D-24	RK/ATM/LM Interface Verification
D-25	Flts 1, 2 & 3 Interface Verification
D-26	Flts 1, 2, 3 & 4 Interface Verification
D-27	Cluster Scale Model Thermal Vacuum
D-28	Cluster Scale Model Antenna Test

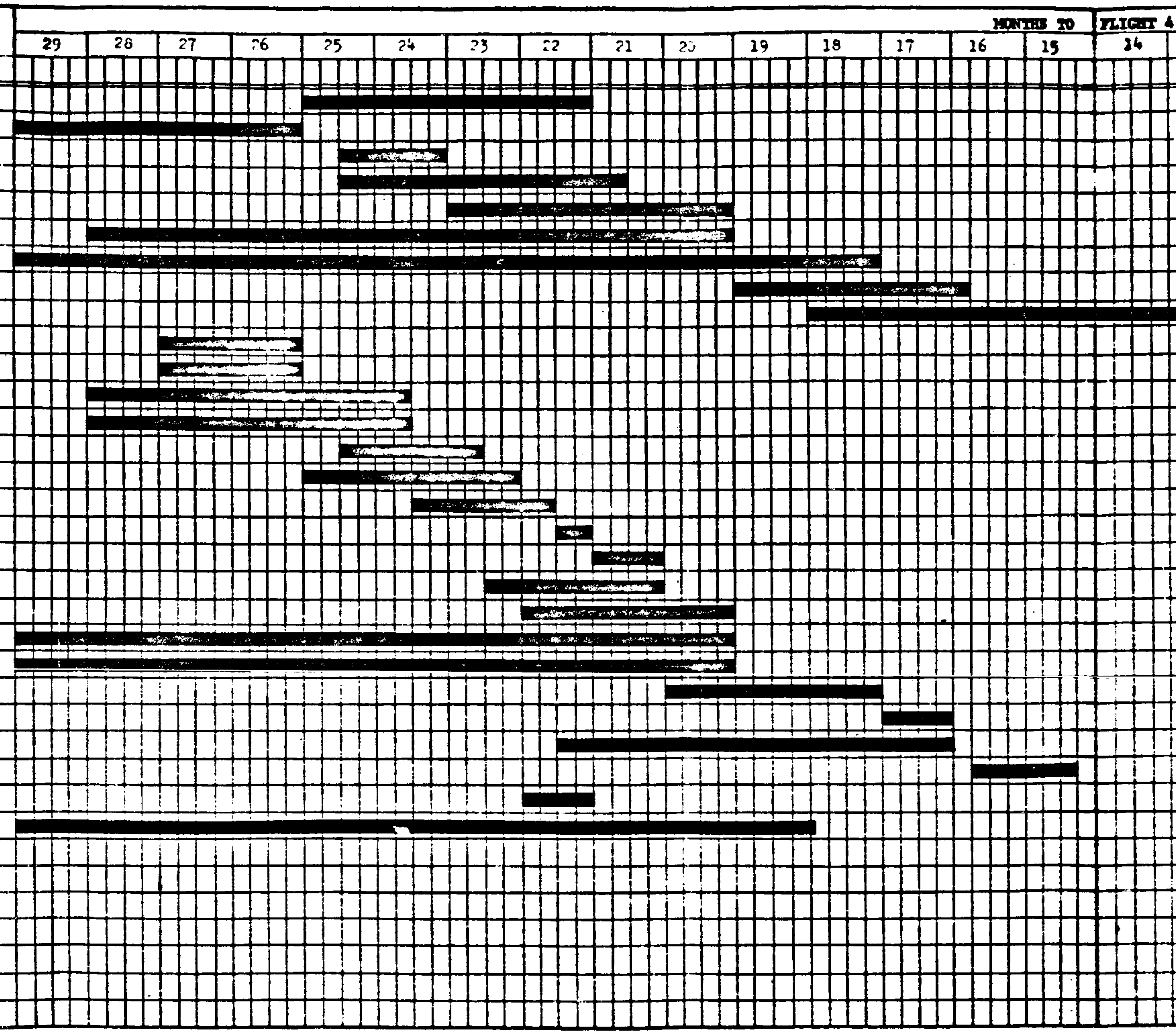

Figure 14. Missions 1/2 & 3/4 Development Test Schedul

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MISSIONS 1,2 & 3,4 INTEGRATION TEST SCHEDULE

Test No.	TEST DESCRIPTION
Q-1	ATM Qualification Tests
Q-2	ATM Rack Qualification Tests
Q-3	RK/ATM Qualification Tests
Q-4	MDA Qualification Tests
Q-5	AM/MDA Thermal Vacuum Tests
Q-6	IU Qualification Tests
Q-7	S-IVB Static Firing
Q-8	S-IVB S S Activation & Operation
Q-9	RK/ATM Thermal Vacuum Test
Q-10	Flt 2 Passivation Sequence Verif
Q-11	Flts 1 & 2 Orbit Configuration Verif
Q-12	LM RK ATM Systems Design Verif
Q-13	Flts 1, 2 & 3 Systems Design Verif
Q-14	Flts 1, 2, 3 & 4 Systems Design Verif

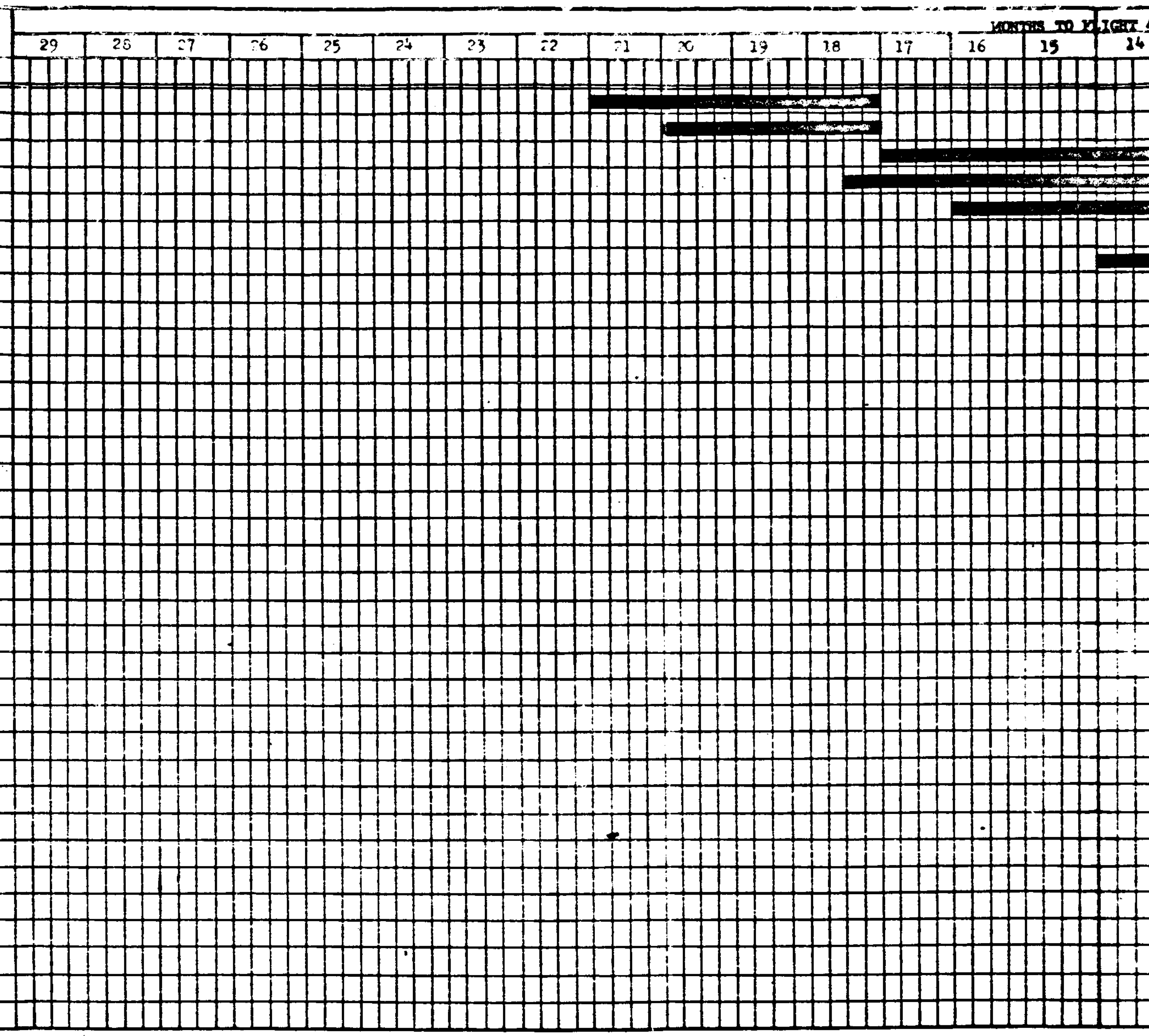

Figure 15. Missions 1/2 & 3/4 Qualification Test Sch

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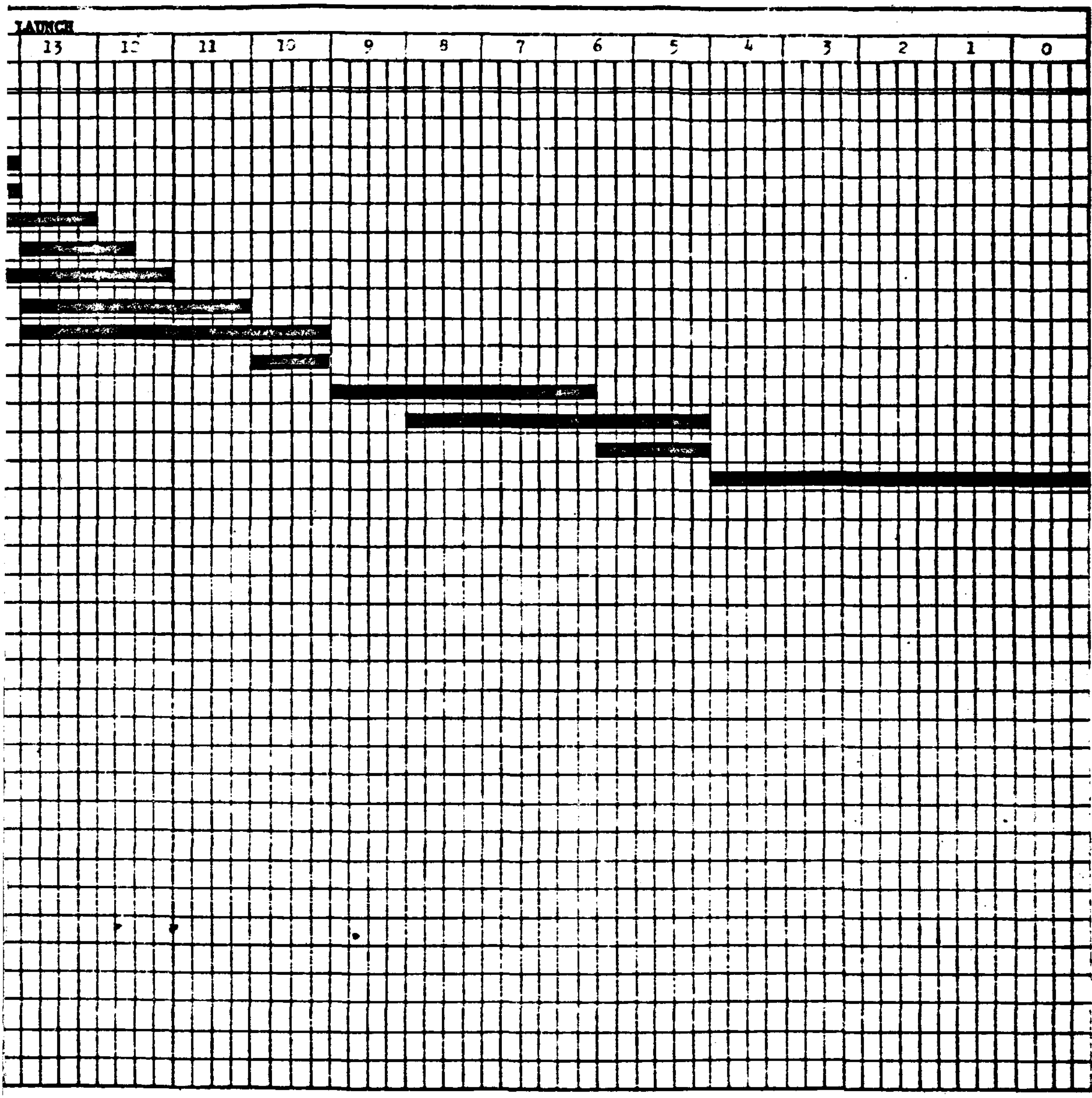

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MISSIONS 1/2 & 3/4 INTEGRATION TEST SCHEDULE		MONTHS TO FLIGHT 4															
NO.	TEST DESCRIPTION	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14
F-1	MDA Low Level Vibration																
F-2	MDA Mate & Interface Tests																
F-3	MDA Experiment Fit Checks																
F-4	MDA Mass Properties																
F-5	R&I CSM																
F-6	R&I Flts 1&2 Experiments																
F-7	Install Experiments in CM																
F-8	R&I LM&SS																
F-9	R&I SLA Flt 1																
F-10	LM&SS Subsystems Checkout																
F-11	LM&SS/SLA Fit Check																
F-12	CSM Normal Apollo Flow																
F-13	CSM/LM&SS Interface C/O & Miss Sim																
F-14	R&I AM																
F-15	R&I MDA																
F-16	AM/MDA Mate & Align																
F-17	R&I SLA Flt 2																
F-18	R&I Nose Cone																
F-19	AM/MDA/SLA/NC Fit Leak & Interface																
F-20	Cluster S/S Interface C/O & Miss Sim																
F-21	CSM/AM/MDA Dock & Leak Check																
F-22	CSM/LM&SS/SLA Mate & Align																
F-23	S-IB/S-IVB/IU AAP 1 Normal Apollo Flow																
F-24	LV/SC AAP Mate & Align																
F-25	SV AAP 1 Normal Apollo Flow																
F-26	R&I S-IVB Flt 2																
F-27	R&I IU Flt 2																
F-28	S-IVB Normal Apollo Flow																
F-29	IU Normal Apollo Flow																
F-30	S-IB Normal Apollo Flow																
F-31	S-IB/S-IVB/IU Mate & Align																
F-32	AM/MDA/SLA/NC Mate & Install Expts																
F-33	LV Normal Apollo Flow																
F-34	LV/SC Mate & Align																
F-35	SV AAP 2 Normal Apollo Flow																

Figure 16. Mission 1/2 Flight Hardware Test Schedule

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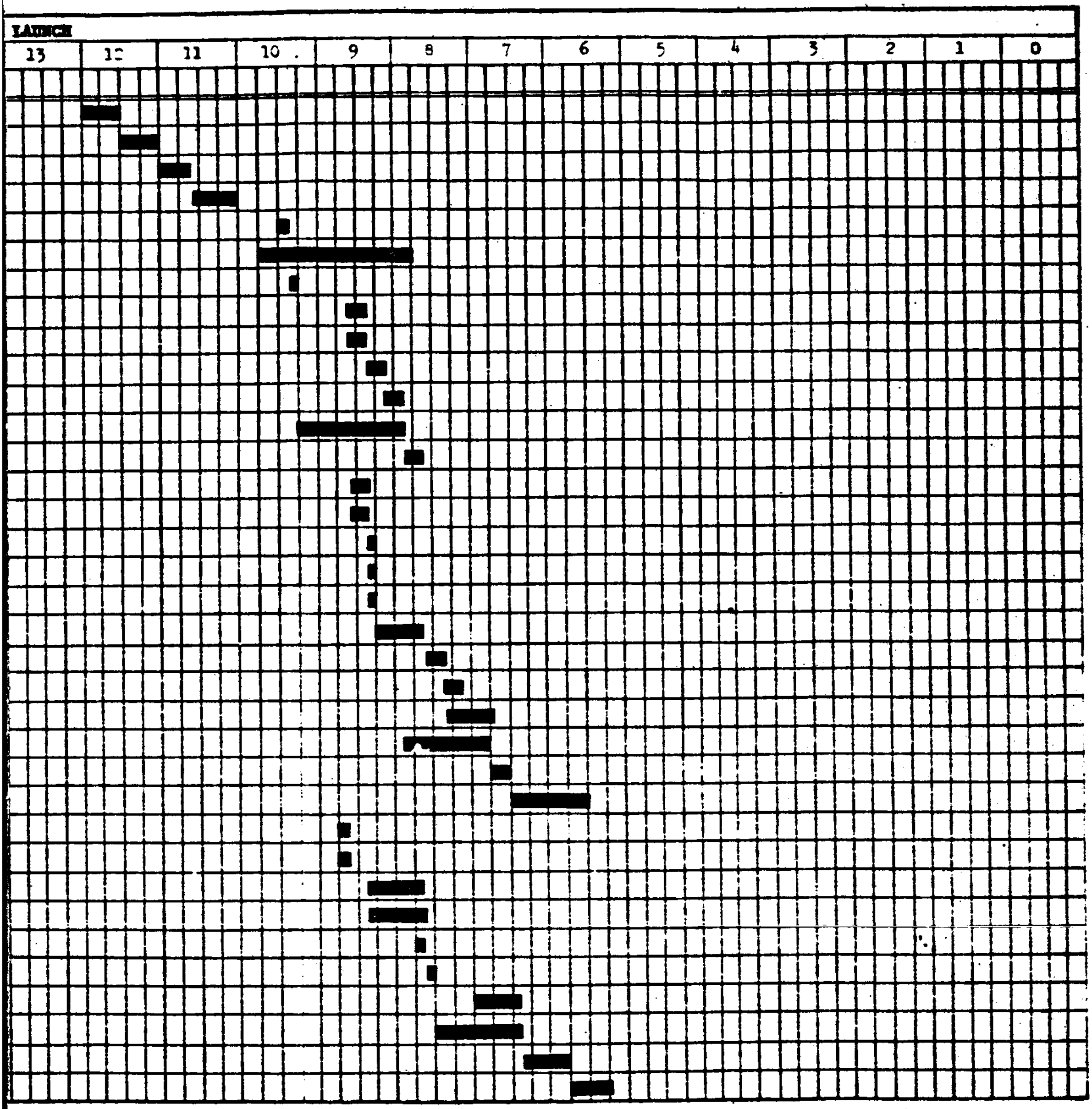

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MISSIONS 1/2 & 3/4 INTEGRATION TEST SCHEDULE		MONTHS TO FLIGHT 4 LA																
NO.	TEST DESCRIPTION	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	1
F-36	PCS Installation on Servo Table																	
F-37	PCS Functional Checkout																	
F-38	RK/ATM Mate & Functional C/O																	
F-39	RK/ATM/SLA Fit Check																	
F-40	SC Functional Checkout																	
F-41	SC-Install & C/O Experiments																	
F-42	RK/ATM Thermal Vacuum Test																	
F-43	R&I Experiments																	
F-44	CSM Normal Apollo Flow																	
F-45	R&I LM Ascent Stage																	
F-46	LM A/S Engine Leak & Valve Response																	
F-47	CSM/LM A/S Docking Check																	
F-48	CSM Normal Apollo Flow																	
F-49	R&I RM																	
F-50	R&I SLA																	
F-51	RM/SLA Fit Check																	
F-52	CSM RM Docking & D&C Interface Check																	
F-53	CSM Altitude Chamber Tests																	
F-54	RM Location Change Checkout																	
F-55	Install Experiments in RM																	
F-56	R&I ATM																	
F-57	R&I Rack																	
F-58	RK/ATM Mate & Align																	
F-59	R&I SLA																	
F-60	RK/ATM/SLA Fit Check																	
F-61	RK/ATM CMG Pad Align & Installation																	
F-62	Flt 4 SC Mate Carriers & Install & Align Exp																	
F-63	Flt 4 SC S/S C/O & Interface Tests																	
F-64	CSM/Flt 4 SC Func Mate & Perform I/F C/O																	
F-65	Cluster Interface C/O & Mission Sim AAP 3/4																	
F-66	CSM/SLA/RM Mate, Align & C/O																	
F-67	AAP 3 LV Normal Apollo Flow																	
F-68	AAP 3 LV/SC Mate & Align																	
F-69	AAP 3 SV Normal Apollo Flow																	
F-70	RK/ATM/LM Manned Altitude Chamber Tests																	

Figure 17. Mission 3/4 Flight Hardware Test Schedule (Sheet

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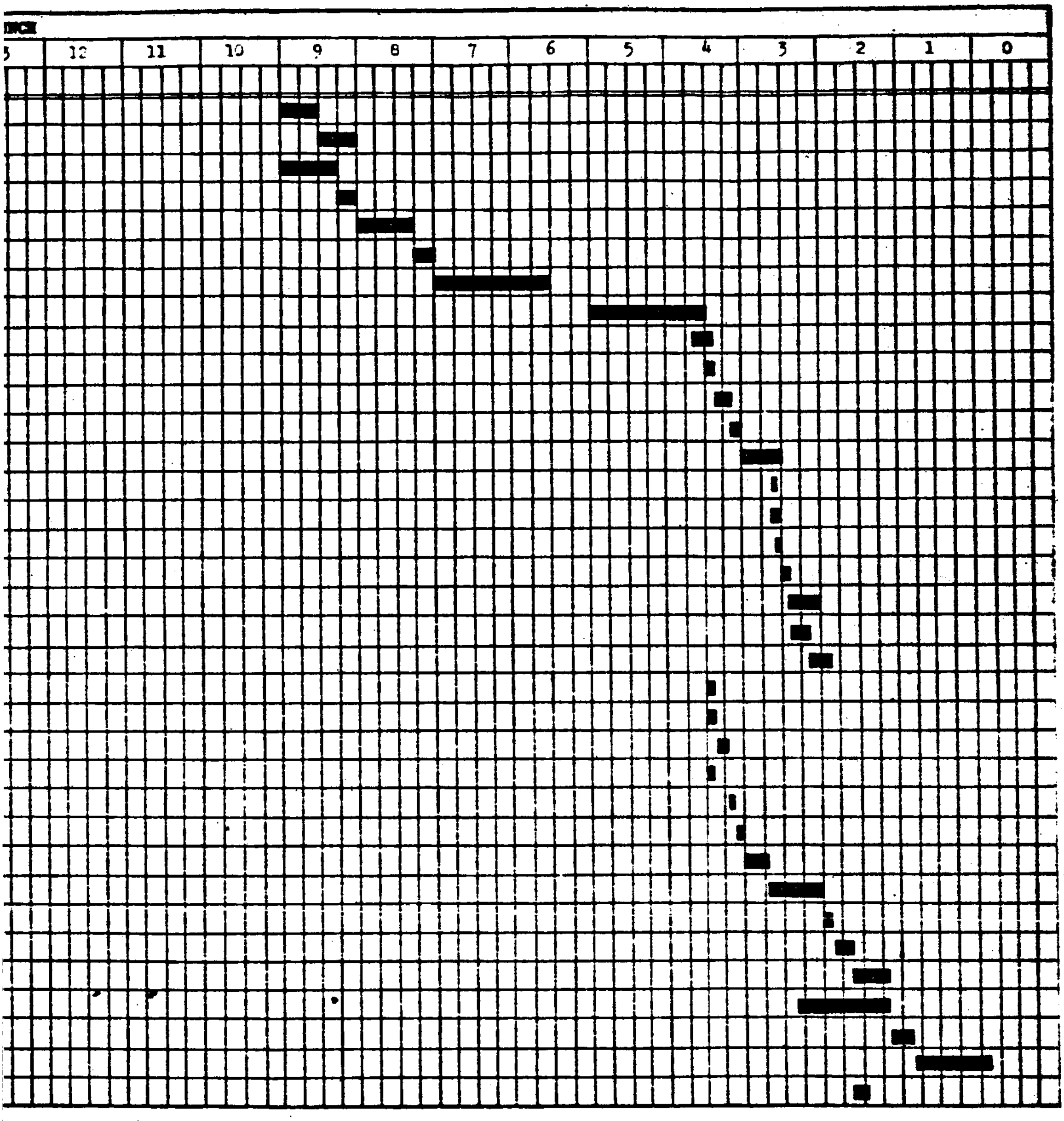

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MISSIONS 1/2 & 3/4 INTEGRATION TEST SCHEDULE		MONTHS TO FLIGHT 4 LAUN																
		29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13
No.	Test Description																	
F-71	AAP 4 Install Solar Panels & Verify Exp Align																	
F-72	AAP 4 SC Mate & Align																	
F-73	AAP 4 LV Normal Apollo Flow																	
F-74	AAP 4 Mate & Align SC/LV																	
F-75	AAP 4 SV Normal Apollo Flow																	

Figure 17. Mission 3/4 Flight Hardware Test Schedule (She

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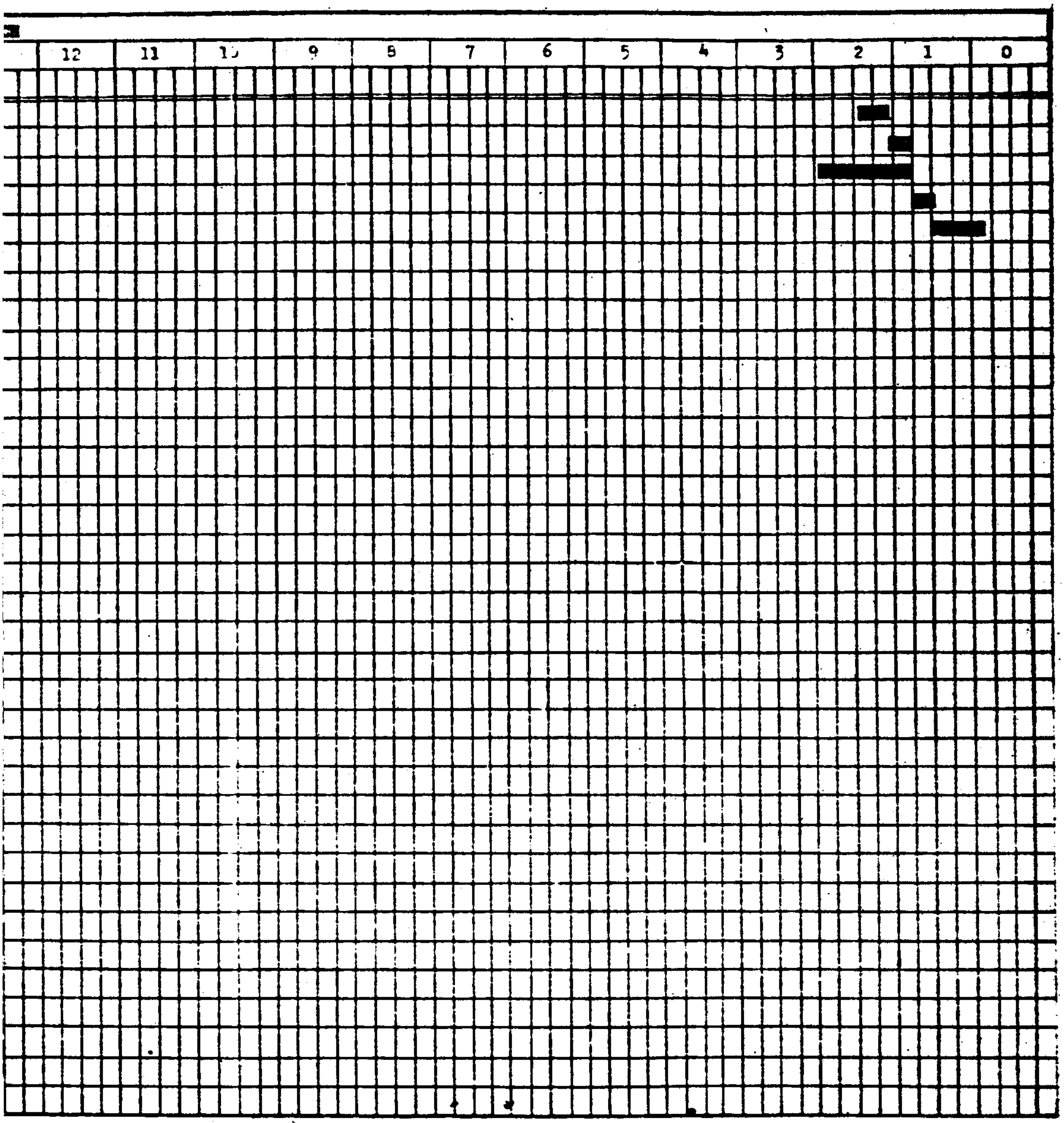

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7. NOTES

7.1 Abbreviations and Acronyms

AM - Airlock Module
CEI - Contract End Item
CM - Command Module
COFW - Certification of Flight Worthiness
CSM - Command Service Module
EMC - Electromagnetic Compatibility
EMI - Electromagnetic Interference
FMECA - Failure Mode Effect and Criticality Analysis
GATP - Ground Article Test Procedure
GFE - Government Furnished Equipment
GSE - Ground Support Equipment
IU - Instrumentation Unit
KSC - Kennedy Space Center
LM - Lunar Module
LM&SS - Lunar Mapping and Synoptic Survey
MDA - Multiple Docking Adapter
MSC - Manned Spacecraft Center
MSFC - Marshall Space Flight Center
NASA - National Aeronautics and Space Administration
OCP - Operational Checkout Procedures
OWS - Orbital Workshop
PI - Principal Investigator
PIC - Payload Integration Contractor
PIF - Payload Integration Facility
SLA - Spacecraft LM Adapter
TP - Test Procedure

7.2 Glossary of Terms

a. Acceptance Test - Test to determine conformance to design or specifications as a basis for acceptance. When specially designed they may apply to parts, equipments or systems, and may include functional tests.

b. All-Systems Test - A test performed on stages and modules to demonstrate the capability of each subsystem to perform its function when exposed to the full rigors of mission environments, and to demonstrate that the subsystems are physically and functionally compatible. This test may be a combination of development test and qualification test.

c. Ambient Functional Tests - Testing to demonstrate operation as specified under ambient environmental conditions.

d. Atomic Radiation - Particle radiation as encountered in space.

e. Calibration Test - Tests to determine that the output characteristics of a measuring device, component or assembly compare favorably to a known or certified standard, and to see if the characteristics are within specification.

f. Carrier Interference Checks - Checks for intercarrier mechanical alignment, electrical connection and interference checks and interface verification.

g. Checkout - A test or procedure for determining whether a device is capable of performing a required operation or function. A checkout usually consists of the application of a series of operational and calibrational tests in a certain sequence, with the requirement that the response of the device to each of these tests be within a predetermined tolerance.

h. Components - Group of parts, black boxes, and complete experiment packages that may be installed on a carrier.

i. Component Acceptance Test - Acceptance test of an individual component (consisting of a number of parts) to determine if these components will meet specifications prior to assembly in a subsystem.

j. Design Verification Test - Test employed to generate engineering knowledge concerning a design or piece of equipment. Development testing will be used to determine and verify safety margins and explore modes of failure.

k. Development Tests - The phase during which the proper function of the components of the system, in relation to one another, is assured. It includes the development engineering test of the prototype, necessary redesign and testing, modification of drawings and specifications.

l. Development Testing and Evaluation - Conducted to determine if theories, techniques, and materials are practicable, or if equipment and component items are technically sound, reliable, safe and meet established specifications or requirements.

m. Dynamic Testing - Ground test designed to determine the structural dynamic characteristics of stages or space vehicles (bending modes, structural feedback constants, damping constants, natural resonances, etc.) under simulated flight conditions. This test may be a combination development test and qualification test.

n. Environmental Tests - Any production acceptance test (in-process test, manufacturing checkout, etc.) performed under environmental rigors other than ambient for the prime purpose of verifying the quality of flight hardware or ground equipment.

o. Flow Rate - Mass flow rate of a fluid or gas.

p. Functional Test - A test performed to demonstrate that the item operates as specified (required).

q. Ground Station Compatibility - Compatibility of the support ground stations with the various orbital configurations of the spacecraft.

r. GSE Compatibility Tests - Tests accomplished to insure that the flight equipment is capable of being tested and will be electrically and mechanically compatible with its associated GSE.

s. In-Process Tests - All production line tests performed at intermediate points between receiving tests and start of final manufacturing checkout. These may be acceptance tests.

t. Integrated Carrier - Several carriers mated in an orbital or launch configuration.

u. Laboratory Calibration Test - Tests to determine if the measuring devices or components compare favorably with known or certified standards, and are within specifications.

v. Life Test - Those tests conducted to verify and qualify hardware from an endurance or life standpoint. Life test shall be conducted at design levels for the required operational cycles.

w. Man-Machine Compatibility - Compatibility between flight and ground crews with flight and ground equipments for accessibility, safety, etc.

x. Manufacturing Checkout - The final acceptance test or series of tests performed after final assembly at a manufacturer's plant. Successful completion of manufacturing checkout is a prerequisite to assembly into the next higher hardware generation level at another contractor's plant or NASA installation and for shipment to a static firing or installation site.

y. Mass Properties Tests - Tests performed to determine weight, center of gravity, and mass moment of inertia.

z. Offlimit Test - Test at stress levels higher than design level, conducted for the purpose of determining a safety factor or margin.

aa. Power Characteristics Tests - Testing performed to determine parametric voltage, cable IR drop, equipment power dissipation, etc.

ab. Prelaunch Test - Test of missile and ground equipment to determine readiness to launch. May include a countdown and a flight readiness firing with all launch complex equipment operating, but not including actual launching of the vehicle.

ac. Qualification Test - A test of parts, components, subassemblies, and higher levels of assembly which is performed to demonstrate that the design is inherently capable of meeting the established requirements. Tests are designed to locate significant failure modes and to determine the effects of varied stress levels, combinations of tolerances, drift of design parameters, and combinations and sequences of environments. Destructive tests and inspection of disassembled articles are included.

ad. Reliability Test - A statistically designed test, with specified confidence level, to demonstrate that an item meets the established reliability requirements.

ae. Shake-Table Test - A laboratory test in which an instrument or component is placed in or on a vibrator that simulates one of the conditions during the launch of a missile or other vehicle. This is an environmental test.

af: Simulated Flight Test - A test in which all vehicle subsystems are operated, insofar as possible, through a typical sequence simulating the entire flight of the vehicle. This test also provides a compatibility test of the vehicle system.

ag. Solar Radiation Tests - Tests that are performed primarily to identify any deterioration effects on materials, piece parts and components.

ah. Static Testing - The testing of a device in a stationary or held-down position as a means of testing and measuring its dynamic reactions.

ai. Structural Test - A development test and/or qualification test to determine the ability of structures to withstand predicted or measured static and dynamic forces to be encountered in assembly, storage, transportation, handling and flight.

aj. Systems Compatibility - The operation of a group of systems without inducing mutual interference and a corresponding sacrifice in performance of any system.

ak. Thermal Characteristics Tests - Testing to determine thermal conductivity, emissivity and absorption, etc.

al. Thermal Shock - Sudden extreme temperature change induced by natural environment or sudden contact with a cryogenic fluid.

am. Thermal Vacuum Tests - Tests to determine temperature stability in a temperature extreme and vacuum environment.

an. Vacuum Tests - Tests accomplished to determine functional performance in an orbital vacuum.

ao. Vehicle Acceptance Test - System and subsystem test to insure vehicle specification compliance before vehicle is accepted for flight use.

ap. Vehicle Calibration Test - Tests to determine if the onboard vehicle measuring device or component compares favorably with known or certified standards and is within specifications.

aq. Vibration Tests - Tests to determine the effect of a forced vibration as induced by transportation or launch and free resonant vibration as induced by docking.

ar. Wind Tunnel Tests - Testing accomplished to determine aerodynamic characteristics.