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APOLLO APPLICATIONS PROGRAM (AAP)
PAYLOAD INTEGRATION

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

Volume II
Subsystem Development and
Qualification Plan

Contract No. NAS8-21004

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 II of four volumes containing the General Test Plan.

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1. INTRODUCTION

1.1 Purpose - The purpose of this plan is to establish test requirements and recommend certain tests for the development, qualification and acceptance of new and modified components and subsystems of Apollo Applications Program (AAP) spacecraft modules which are a Marshall Space Flight Center (MSFC) responsibility. The plan shall be used as a guide in subsequent detailed test planning.

1.2 Scope - Test requirements will be established and recommendations made for qualification and acceptance tests of those new or modified components and subsystems of the following Combined Mission, Flights AAP 1/2/3/4, spacecraft modules:

Flight AAP 1	Lunar Mapping and Synoptic Survey Rack (LM&SS)*
Flight AAP 2	S-IVB Stage Instrument Unit (IU)
Flight AAP 3	Resupply Module (RM)
Flight AAP 4	Lunar Module - Ascent Stage LM A/S Apollo Telescope Mount Rack ATM/Rack

Spacecraft modules for which MSC or other NASA centers have responsibility are not considered herein with the exception of the LM&SS Rack.

Where tests have been recommended, the following supplemental information has been provided:

- a. Gross descriptions of the tests
- b. Major test equipment identification
- c. Recommend number of test articles

GSE test requirements will be treated in a general manner in a subsequent section herein.

*Although the LM&SS Rack is an MSC responsibility, certain components and subsystems will be developed by MSFC.

1.3 Test Objectives - The primary objectives to be achieved during the phase of the component and subsystem test program are as follows:

1.3.1 Development Test Phase

- a. Provide that data necessary to finalize the design of new or modified subsystems.
- b. Verify that new or modified component and/or subsystem design is adequately developed to permit starting the qualification tests.

1.3.2 Qualification Test Phase

- a. Verify that each critical component performs as required by the applicable CEI specification in the environment for which it has been designed to operate.
- b. Provide that data necessary to establish an adequate confidence of the hardware being able to meet the life requirement of one year.

1.3.3 Acceptance Test Phase

- a. Verify that each component meets the performance requirements of the applicable CEI specification.

2. GENERAL CONSIDERATIONS

The success achieved in the implementation of this and subordinate test plans will depend upon the management of the test program and the philosophies, ground rules and constraints which guide its progress. These aspects of the subsystem development and qualification test phase are explained in detail in Section 4, Volume 1, Test Program Summary. Typical topics covered in that section include documentation requirements, personnel organizations, application of configuration control practices, training and certification of operating test personnel, safety and security policies and prime responsibilities of NASA agencies and contractors.

3. TEST PROGRAM

3.1 Test Planning Approach - The approach taken in establishing the tests required on the subsystems and components is depicted in figure 1. The general approach has been to identify those environments within which the specified hardware must perform. A judgment has been made in doing this task as to the applicability of each environment and if it is found to have little or no influence on the performance of the particular piece of hardware, no requirement has been indicated. Further discussion on test requirement selection is provided in a subsequent paragraph. For each environment that has been indicated to have an effect on the hardware, a determination of the tests which could possibly satisfy those requirements was made. Once the test was selected, it was possible to indicate the major pieces of test equipment that would be required and to briefly describe the test operations. After completing the test selection process, an estimate of the probable number of test articles was made.

The tests identified in subsequent sections will have to be re-evaluated, once specific hardware information is available. This is necessary in order to incorporate detailed information on existing qualification status, criticality ratings and design requirements of the individual components, assemblies and subsystems.

3.2 Test Requirements - The requirement to perform a specific test is derived from the test article's performance characteristics, the environments in which it must perform and period of time that it must properly function. Analysis of these factors yields the basic test requirements for each article evaluated. They are then modified to reflect criticality ratings, prior test history, testing state of the art, cost effectiveness and design safety margins. This set of requirements then becomes the baseline upon which the test program is developed.

AAP subsystem test requirements for Flights AAP 1, 2, 3 and 4 are presented in brief preliminary form below. Once sufficient information becomes available on the individual components listed in the test matrix, the requirements can be expanded.

Figure 2, AAP Preliminary Subsystem Test Requirements, indicates the general test requirements for AAP hardware. The hardware has been classified as either internally or externally mounted and each further broken down into mechanical, electrical

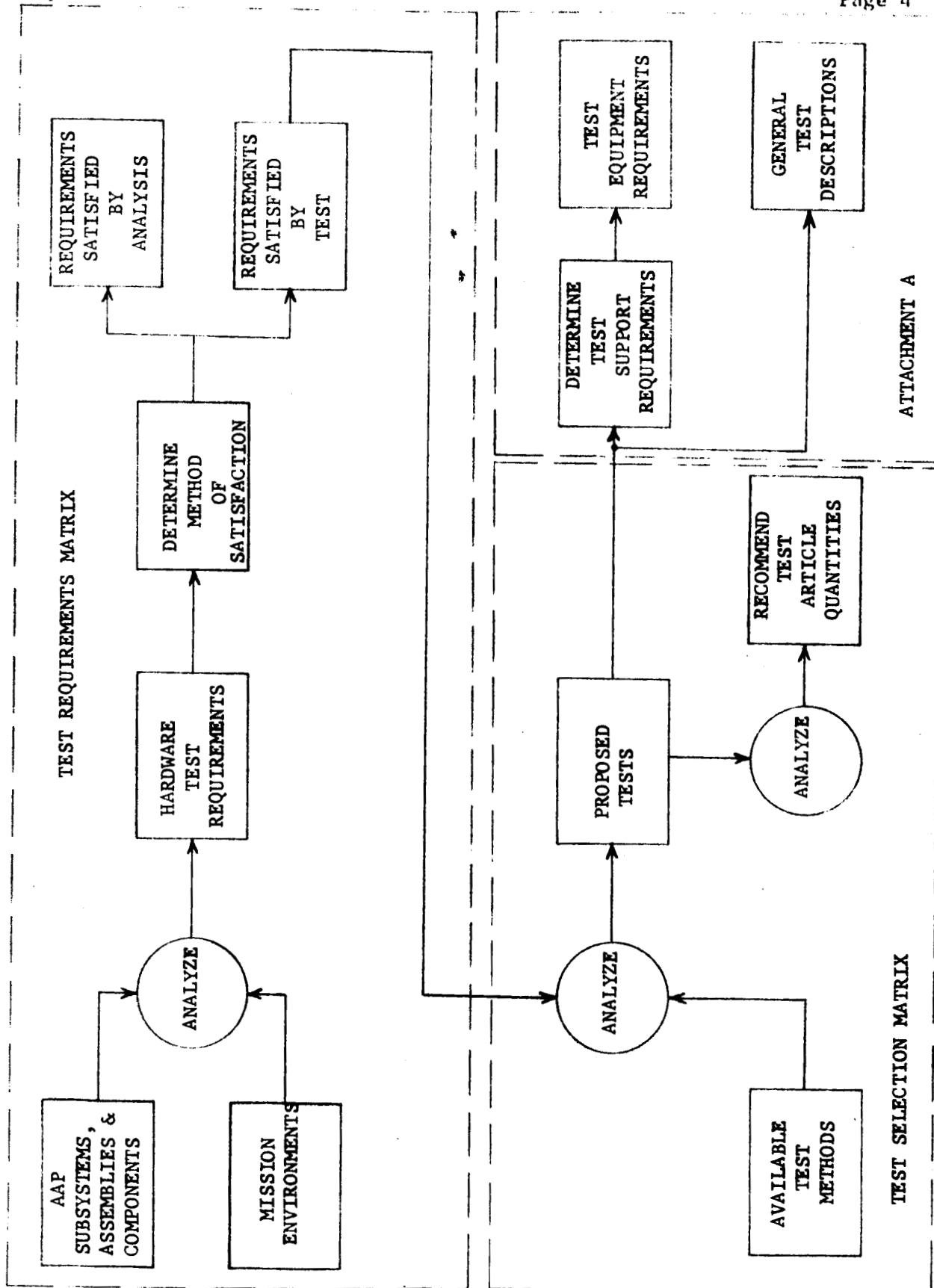


Figure 1. Test Planning Approach

ENVIRONMENTS	SUBSYSTEMS ASSEMBLIES COMPONENTS			INTERNAL			EXTERNAL		
				MECH	ELECT	STRUCT	MECH	ELECT	STRUCT
Vibration				X	X	X	X	X	X
Shock				X	X	X	X	X	X
Temperature				X	X	X	X	X	X
Vacuum				X	X	A	X	X	A
Acceleration				X	X	X	X	X	X
Acoustic				A	A	A	X	X	X
Thermal Shock				A	A	A	X	X	X
Humidity				X	X	A	X	X	A
Solar Radiation							X	X	A
Atomic Radiation				A	A	A	A	A	A
Meteoroid							A	A	A
Altitude				X	X		X	X	
Zero G				A	A	A	A	A	A
O ₂ Atmosphere				X	X	X	A	A	A
H ₂ Atmosphere				X	X	X	A	A	A
Ozone				X	X	X			
RF Radiation					X			X	
Fungus				A	A	A	A	A	A
Sand/Dust				A	A	A	A	A	A
Saltspray				A	A	A	A	A	A
LEGEND X Test Required A Requirement Satisfied by Analysis No Requirement									

Figure 2. AAP Preliminary Subsystem Test Requirements

or structural categories. The environments are those associated with storage, transportation, launch and orbit. As the legend indicates, an X indicates that a test is to be performed to demonstrate proper hardware operation. For those blocks checked with an A, the requirement will be satisfied by analysis. This could include use of past test data on existing components, analysis of the hardware design or performing tests on materials or piece parts comprising the hardware article to provide sufficient data for analytically satisfying the requirement on the component, assembly or subsystem.

3.3 Test Selection - A test selection matrix has been used to identify those tests required to be performed on individual components, assemblies, and subsystems. No attempt has been made to identify those tests which might be necessary to supplement analysis. (i.e., those blocks in the test requirements matrix marked with an A.)

Provisions have also been made on the test selection matrix to indicate the number of individual test articles that will be required during the qualification test program as well as columns to provide size and weight categories for each item of test hardware. The latter information is needed in determining test equipment requirements.

The tests identified in the matrix could fall into any of the three categories of development, qualification or acceptance. The following paragraphs set forth the guide lines which, in general, will determine into which category the tests fall.

3.3.1 Development Tests - Any one of the tests in the test selection matrix could be classified as a development test. Essentially, if the tests are run to accomplish the objective of paragraph 1.3.1, they will be termed development tests.

3.3.2 Qualification Tests - There are two aspects to qualification testing. If an individual component is classified as a critical component, defined in NPC 500-1 Exhibit II, it shall be subjected to a series of tests which must satisfy the requirements of its own CEI specification.

Other tests run on components, assemblies, or subsystems are qualification tests if the data resulting from such tests shall be used to satisfy formal qualification requirements of the contract end item that they are a part of.

3.3.3 Acceptance Tests - Tests satisfying acceptance specification requirements verify that no change in design operating characteristics has occurred due to the manufacturing processes, tolerances, or inferior workmanship.

Upon completing the test selection matrix, an analysis was made to determine those tests which best demonstrate that each hardware item performs as designed. The tests that were selected have been marked with an asterisk to show the recommended acceptance tests that should be performed.

3.4 Test Description - A general description of the tests identified in the top horizontal row of the test selection matrix is contained in Attachment A. The descriptions indicate the test methods, the typical requirements this type of test usually verifies, the normal instrumentation requirements and guidelines in their application.

3.5 Test Equipment - The major items of test equipment that are required for each test described in 3.4 above will also be included in the Test Description. When it is appropriate to do so, each test equipment item will be classified according to size. The choice of equipment will depend upon the weight and size of the test specimen. Therefore, for each item listed in the test selection matrix, an entry has been made in the columns labeled size category, and weight category in accordance with their own characteristics. The specific categories are shown in Table I. Where new or unique equipment is identified, it will be included in the special test equipment section of each Spacecraft Module writeup.

Table I. Test Hardware Weight and Size Categories

TEST HARDWARE CATEGORIES			
WEIGHT		SIZE	
CODE	DIMENSIONS (Pounds)	CODE	DIMENSIONS (Cubic Feet)
1	0 - 20	A	0 - 1
2	21 - 50	B	1 - 4
3	51 - 100	C	4 - 10
4	101 - 150	D	10 - 50
5	151 - 200	E	50 - 100
6	201 - 500	F	100 and above
7	501 - 1000		
8	1000 and above		

3.6 Test Location - The majority, if not all, the tests identified herein can be performed in an environmental test laboratory. The geographical location will, of course, depend upon contractual commitments, and thus no attempt has been made to assign definite test locations for any of the component or subsystem tests.

4. COMBINED MISSION, FLIGHTS AAP 1/2/3/4

4.1 Flight AAP 1

4.1.1 LM&SS Rack - Integration of the LM&SS rack is the responsibility of MSC; however, the primary rack structure is the concern of MSFC and the required testing is presented in the Payload Integration Development Plan.

The docking collars for the LM&SS rack are covered by this test program. The test selection matrix appears in figure 3.

a. Special considerations: The collars will be functionally checked under simultaneous conditions of temperature and vacuum.

b. Special test equipment: Collar docking and holding fixtures are required for the thermal vacuum test.

4.2 Flight AAP 2

4.2.1 Instrument Unit - The test selection matrix appears in figure 3.

4.2.2 S-IVB - The test selection matrix appears in figure 4.

a. Special considerations: The S-IVB Skin Structure Section Tests will be performed on a segment of the S-IVB. Fans, thermal curtains, insulation sealant, insulation, external paint and meteoroid bumper shall be included in the segment. The main objective of these tests is to evaluate the thermal control capabilities of the S-IVB. S-IVB Skin Structure Thermal Tests shall be performed in a thermal vacuum chamber.

[illegible]

Figure 3. LMSS/IU Test Matrix

TESTS SUBSYSTEM	VIBRATION	SHOCK	TEMPERATURE	VACUUM	ACCELERATION	ACOUSTIC	THERMAL SHOCK	HUMIDITY	EMC/RF	DYNAMIC PRESSURE	LEAK	ALTITUDE	FLOW RATE	O ₂ ATMOSPHERE	PRESSURE BURST PROOF	PHYSICAL FIT	EXPLOSIVE ATMOS.	POWER CONSUMPTION	NOISE & RIPPLE	LIFE TEST	RESPONSE TIME	ELECTRICAL INTEGRITY	THERMAL CHARACTER.	STATIC LOAD	ANTENNA PATTERN	SLOSH	FUNCTIONAL	THERMAL VACUUM	SIZE CATEGORY	WEIGHT CATEGORY	TEST HARDWARE REQ.
Tk Attach Fittings																													A 1 2		
Protective Padding																													B 1 1		
Insulation Sealant (1)																													A 1 1		
External Paint (1)																													A 1 1		
AM Flexible Boot																													B 2 2		
Mobility Aids																													A 1 1		
Meteoroid Bumper (1)																													A 1 1		
Fire Detectors																													A 1 1		
Crew Quarters (3tr)																													B 1 1		
3" Vent Line & Valve Assy																															
1 1/2" Press Line Ext Valve																													D 2 2		
Passivation Cable Assy																													B 1 2		
Manhole Cover Assy																													B 2 1		
Tk Sealing Devices																													B 3 1		
Tk Floor & Ceiling Assy																															
Lighting Assy																															
Fans																													A 1 1		
Thermal Curtains																													B 1 1		
Control Panels (4)																													B 1 1		
VHF Antenna Assy																													C 2 1		
Solar Panel Assy																													C 2 2		
AC & DC Cont & Dist Sys																													D 2 2		
Hygiene Area Exh Vent																													B 1 1		
Temp Sensors																													A 1 1		
Atmosphere Diffusers																													A 1 1		

Figure 4. S-IVB Test Matrix (Sheet 1 of 2)

TESTS SUBSYSTEM	VIBRATION	SHOCK	TEMPERATURE	VACUUM	ACCELERATION	ACOUSTIC	THERMAL SHOCK	HUMIDITY	EMC/RF	DYNAMIC PRESSURE	LEAK	ALTITUDE	FLOW RATE	O ₂ ATMOSPHERE	PRESSURE BURST PROOF	PHYSICAL FIT	EXPLOSIVE ATMOS.	POWER CONSUMPTION	NOISE & RIPPLE	LIFE TEST	RESPONSE TIME	ELECTRICAL INTEGRITY	THERMAL CHARACTER.	STATIC LOAD	ANTENNA PATTERN	SLOSH	FUNCTIONAL	THERMAL VACUUM	SIZE CATEGORY	WEIGHT CATEGORY	TEST HARDWARE REQ.
Wiring Harness																															
Hazard Warning																															
Audio Housekeeping Sys																															
Coax Switch																															
Structural Supports																															
(1) S-IVB Skin Structure Tests																															

Figure 4. S-IVB Test Matrix (Sheet 2 of 2)

- b. Special Test Equipment: Holding fixtures for the S-IVB segment are required.

4.2.3 MDA - The test selection matrix appears in figure 5. The MDA structure and MDA-carrier Interface Tests will be presented in the Payload Integration Development Plan.

- a. Special Considerations - None
- b. Special Test Equipment - None

4.3 Flight AAP 3

4.3.1 Resupply Module - The test selection matrix appears in figure 6. The primary rack structure with pressure module is covered in Volume III, Payload Integration Development Plan.

- a. Special Considerations - None
- b. Special Test Equipment - None

4.4 Flight AAP 4

4.4.1 ATM Rack - The test selection matrix appears in figure 7. The primary rack structure tests are covered in the Payload Integration Development Plan.

- a. Special Considerations - the solar array deployment test will be conducted in a thermal vacuum chamber.
- b. Special Test Equipment - Mounting fixture for the solar array operational thermal vacuum test.

4.4.2 LM - The test selection matrix appears in figure 8.

- a. Special Considerations - None
- b. Special Test Equipment - None

Figure 5. MDA Test Matrix

Figure 6. RM Test Matrix

TESTS SUBSYSTEM	VIBRATION	SHOCK	TEMPERATURE	VACUUM	ACCELERATION	ACOUSTIC	THERMAL SHOCK	HUMIDITY	EMC/RF	DYNAMIC PRESSURE	LEAK	ALTITUDE	FLOW RATE	O ₂ ATMOSPHERE	PRESSURE BURST PROOF	PHYSICAL FIT	EXPLOSIVE ATMOS.	POWER CONSUMPTION	NOISE & RIPPLE	LIFE TEST	RESPONSE TIME	ELECTRICAL INTEGRITY	THERMAL CHARACTER.	STATIC LOAD	ANTENNA PATTERN	SLOSH	FUNCTIONAL	THERMAL VACUUM	SIZE CATEGORY	WEIGHT CATEGORY	TEST HARDWARE REQ.
ASAP Recorder																															
VHF/UHF Omni Antenna																															
S Band Omni Antenna																															
Mod 410 Multiplexer																															
Video Switch																															
CMG & Electronics																															
LO ₂ Tank & Plumbing																															
O ₂ Tank & Plumbing																															
H ₂ O Tank & Plumbing																															
ECS H ₂ O Tank & Plumbing																															
Batteries																															
Solar Array																															
Battery Charger & Reg																															
Dist & Cont Subsystem																															
Passive Thermal Cont Sys																															
Exp & Ops Cont Cabl & Com																															
VHF/UHF Multiplexer																															
UHF Receiver																															
Command Decoder																															
VHF/FM Transmitter																															
Mod 301 PCM																															
Mod 270 Multiplexer																															
Xmitter Contingency Selec																															
Coax Switch																															

Figure 7. ATM Test Matrix

TESTS SUBSYSTEM	VIBRATION		SHOCK	TEMPERATURE	VACUUM	ACCELERATION	ACOUSTIC	THERMAL SHOCK	HUMIDITY	EMC/RF	DYNAMIC PRESSURE	LEAK	ALTITUDE	FLOW RATE	O ₂ ATMOSPHERE	PRESSURE BURST PROOF	PHYSICAL FIT	EXPLOSIVE ATMOS.	POWER CONSUMPTION	NOISE & RIPPLE	LIFE TEST	RESPONSE TIME	ELECTRICAL INTEGRITY	THERMAL CHARACTER.	STATIC LOAD	ANTENNA PATTERN	SLOSH	FUNCTIONAL	THERMAL VACUUM	SIZE CATEGORY	WEIGHT CATEGORY	TEST HARDWARE REQ.
Control Panels (Exp)	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	A 2	1	
Cryo O ₂ Heat Exch	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	A 1	2	
Δ P Gage & Valve	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	A 1	2	
Comm Switch	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	A 1	2	
Intercon LM/ATM LM/MDA	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			
Exp Cont Cabling & Comm	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			
Pri Guid & Nav Sys Mod	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			
Abort Guid Sys Mod	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			
Stab & Cont Sys Mod	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			
D&C for Life Support	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	B 2	1	
D&C for Guid & Cont	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	B 2	1	

Figure 8. LM Test Matrix

5. GSE TEST REQUIREMENTS

GSE for Combined Mission, Flights AAP 1, 2, 3 and 4 that will be new or modified is classified into the following categories:

- a. Ground Handling Equipment
- b. Fluid GSE
- c. Handling and Transportation Equipment
- d. Electrical Ground Equipment

All of this GSE will require acceptance testing and some of the more complicated or critical items will be required to undergo qualification tests. Development testing (if required) can be accomplished in conjunction with the flight hardware development for which the GSE is to support. Primary emphasis in any of the test phases shall be placed on functional performance. Only where analysis shows environmental testing to be necessary shall it be performed. A preliminary list of basic test requirements are shown below for the above types of GSE. Phase D definition of detail GSE design requirements will permit expansion of these general test requirements into a detail GSE test plan.

GSE EQUIPMENT TYPES	TESTS										
	Vibration	Shock	Temperature	Humidity	Fluid Compat.	Road Tests	Leak Check	Flow Tests	Static Load	Elect. Integrity	Performance
Ground Handling GSE									X		X
Fluid GSE					X		X	X		X	X
Handling and Transportation GSE						X			X		X
Electrical GSE	X	X	X	X						X	X

Figure 9. GSE Test Requirements

ATTACHMENT A
TEST DESCRIPTIONS

STANDARD PROCEDURE

Many tests follow the same general procedure, and for simplicity, a standard procedure has been outlined for reference.

- 1) Mating of test hardware with test equipment including mounting fixtures and cabling used for control and monitoring purposes.
- 2) Functional check of test hardware and verification of control and monitoring capability.
- 3) Verification of instrumentation calibration.
- 4) Activate test function.
- 5) Operate test hardware in the required manner.
- 6) Monitor and record the parameters associated with the test hardware and test equipment.
- 7) De-activate test function.
- 8) Functional check of test hardware.
- 9) Verification of instrumentation calibration.

STANDARD TEST EQUIPMENT

The tests identified in section 4 will require the normal types of standard equipment such as voltmeters, oscilloscopes, pressure transducers, gages, regulators, etc. The test procedures prepared to perform the tests should detail the standard equipment required.

VIBRATION TEST

Reason for Test

The vibration test is performed to evaluate equipment effects when subjected to the following vibration environments:

- 1) Transportation
- 2) Launch

Vibration causes a stress reversal cycle which can result in mechanical failure.

General Procedure

- 1) Utilize the standard procedure with the following exceptions and additions.
 - a) The test hardware will be monitored for transmissibility and resonant points.
 - b) The test hardware will be non-operational during the vibration cycle.
 - c) Where possible, vibration accelerometer mountings should be specified based on vibration responses and performance noted during the vibration development test cycle. If a development test has not been performed previously, the accelerometer mountings should be installed based on calculated locations and anticipated vibration patterns.
 - d) The test hardware will be subjected to vibration levels approximately 1.5 times the "g" levels expected during launch.

Test Equipment

The vibration shakers and tables needed for these tests must be of a capacity to accept the following test hardware size and weight categories:

<u>SIZE</u>	<u>WEIGHT</u>
A	1
A	2
A	3
B	4
C	2
C	3
D	4
D	7

Facilities & Commodities

- 1) Vibration lab

SHOCK TEST

Reason for Test

The shock test is performed to determine the effect on the equipment of the sudden applied forces during:

- 1) Transportation
- 2) Launch release
- 3) Engine ignition and cutoff
- 4) Staging
- 5) Pyrotechnics
- 6) Docking

General Procedure

- 1) For unpackaged equipment a free drop test will be performed in all probable orientations from a height of 1 inch.
- 2) The test hardware will be non-operational during the test cycle.
- 3) Packaged shipping shock tests will be performed by dropping the package from the following heights onto a hard surface.

<u>WEIGHT CATEGORY</u>	<u>DROP HEIGHT</u>
1	30 in.
2	30 in.
3	21 in.
4	18 in.
5	16 in.

- 4) Functional tests will be performed before and after the drop tests.

Test Equipment

- 1) Shock Tester

Facilities and Commodities

- 1) Shock-test lab drop-test area
- 2) Overhead crane

TEMPERATURE TEST

Reason for Test

The temperature test is performed to determine equipment effects when subjected to the following:

- 1) Aerodynamic heating
- 2) Temperature extremes of the space environment

The test will evaluate the following characteristics:

- 1) Equipment operation under high temperature conditions.
- 2) Equipment operation under low temperature conditions.

In equipment where thermal gradients are critical, this test will be combined with the vacuum test.

General Procedure

- 1) Utilize the standard procedure.

Test Equipment

- 1) Temperature chambers for the following size categories:
A, C, D

Facilities and Commodities

- 1) Environmental test lab

VACUUM TEST

Reason for Test

The vacuum test is utilized to simulate the orbital vacuum and evaluate the following test hardware characteristics:

- 1) Proper functional performance
- 2) Verify the absence of corona arcing
- 3) Determine thermal characteristics
- 4) Determine leakage characteristics

General Procedure

- 1) Utilize the standard procedure
- 2) The parameters to be measured in a vacuum test are chamber pressure, chamber wall temperature and test hardware temperature.
- 3) Special precautions should be taken to avoid any contamination of the vacuum chamber by outgassing of the test hardware or support equipment housed in the chamber. The test specimen should also be protected against oil deposition from vacuum pump backstreaming.

Test Equipment

- 1) Vacuum chambers capable of achieving at least a vacuum of 10^{-6} torr and accepting the following size category test hardware.

Size: A, C, D

Facilities and Commodities

- 1) Environmental test area

ACCELERATION TEST

Reason for Test

The acceleration test is performed to evaluate equipment performance when subjected to acceleration forces during the following environments:

- 1) Transportation
- 2) Launch

Acceleration produces mechanical stresses which may result in a mechanical failure.

General Procedure

- 1) Utilize the standard procedure with the following exception:
 - a) Test hardware to be non-operational during the test cycle.
- 2) Test hardware is to be inspected for damage or malfunction after test.

Test Equipment

- 1) Centrifuge for accepting test hardware of the following size and weight categories:

<u>SIZE</u>	<u>WEIGHT</u>
A	1
A	2
A	3
B	2
D	4
D	7

Facilities and Commodities

- 1) Centrifuge test facility

THERMAL VACUUM TEST

Reason for Test

The thermal vacuum test is performed to simulate the orbital environment and evaluate the following test hardware characteristics:

- 1) Temperature stability under temperature and vacuum conditions.

General Procedure

- 1) Utilize the standard procedure
- 2) This test differs from the temperature test and the vacuum test in that it combines the two with the addition of solar simulation and a cold wall to simulate space conditions.

Test Equipment

- 1) Thermal vacuum chamber to accept the following size category hardware: C, D, E

Facilities and Commodities

- 1) Environmental test lab

HUMIDITY TEST

Reason for Test

The humidity test is utilized to determine any detrimental effects on the test hardware due to high humidity conditions which may exist in the following environments:

- 1) Storage
- 2) Transportation

Humidity may cause corrosion and electrical short circuits.

General Procedure

- 1) Utilize the standard procedure with the following exception:
 - a) The equipment is non-operational during the test cycle.
- 2) At the conclusion of the test, the equipment is inspected for damage and given a functional test.

Test Equipment

- 1) Humidity chamber to accept the following size hardware categories: A, B, D

Facilities and Commodities

- 1) Environmental test lab

ALTITUDE TEST

Reason for Test

The altitude test is performed to determine what effect pressure changes have on the equipment during the following environments:

- 1) Air transportation
- 2) Launch

This test is similar to the vacuum test, with the only difference being the rate of change of pressure. In the altitude test, the rate of change is faster than in a normal vacuum test resulting in higher test hardware stresses.

General Procedure

- 1) Utilize the standard procedure with the following change:
 - a) Test hardware to be non-operational during the test cycle.

Test Equipment

- 1) Altitude chamber

Facilities and Commodities

- 1) Environmental test lab

DYNAMIC PRESSURE TEST

Reason for Test

The dynamic pressure or wind tunnel test is performed to simulate the launch condition. External equipment such as antennas will be exposed to high velocity air impact during the launch phase; and therefore, must be tested for mechanical integrity.

General Procedure

- 1) Utilize the standard procedure with the following exception:
 - a) Test hardware to be non-operational during the test cycle.

Test Equipment

- 1) Wind tunnel to accept the following size category hardware: B

Facilities and Commodities

- 1) Environmental test lab.

EMC TEST

Reason for Test

Electronic equipment generates RF radiation which may affect adjacent equipment, therefore, an electromagnetic compatibility test is performed. The EMC test consists of two basic checkout sequences:

- 1) Determine the effect of external sources of interference on the equipment operation.
- 2) Determine the transmission of interference waves from the equipment to the surrounding area.

General Procedure

- 1) Utilize the standard procedure with the following exception:
 - a) Omit the after test functional check of test hardware

Test Equipment

- 1) EMC screen room for hardware size categories: A, D, E
- 2) Field intensity meters, antennas, etc.

Facilities and Commodities

- 1) EMC test area

THERMAL SHOCK TEST

Reason for Test

This test is utilized to demonstrate equipment integrity when subjected to sudden intense temperature changes. Thermal shock results in high temperature gradients and depending upon the resultant stresses due to equipment geometry, the effects can vary from little or no damage to complete rupture.

General Procedure

- 1) Utilize the standard procedure with the following exception:
 - a) Equipment to be non-operational during the test cycle.
- 2) Thermal shock is accomplished by sudden transfer of the equipment from an oven to a cold chamber and vice-versa. Where test hardware is exposed to cryogenic fluids, the thermal shock test will consist of immersion in an LN₂ bath.

Test Equipment

- 1) Cold chamber to accept test hardware size categories:
A, B, C, D
- 2) Oven to accept test hardware size categories: A, B,
C, D
- 3) LN₂ bath

Facilities and Commodities

- 1) Environmental test area
- 2) Cryogenic lab
- 3) LN₂ supply

LEAK TEST

Reason for Test

Leak tests are performed to determine the presence of leakage and in gaseous systems to determine whether it is within allowable limits. No leakage is permissible in fluid systems.

General Procedure

- 1) The equipment under test is pressurized to operating pressure and the leakage around joints and interfaces checked by the soap bubble method, helium leak detection monitor, time-delay techniques or visible inspection. This test should be performed before and after the proof pressure test.

Test Equipment

- 1) Helium leak detection equipment
- 2) Pressure monitor equipment
- 3) Pumps
- 4) Valves

Facilities and Commodities

- 1) Leak test area
- 2) Pressurized helium
- 3) Cryogenic lab
- 4) LN₂ supply
- 5) Air supply
- 6) H₂O supply

FLOW RATE TEST

Reason for Test

This test is performed to determine the rate of flow of a liquid or gas and confirm conformity to design requirements.

Test Equipment

- 1) Flowmeters
- 2) Valves
- 3) Pressure gages
- 4) Pumps

Facilities and Commodities

- 1) Fluids and cryogenic test lab
- 2) Air supply
- 3) LN₂ supply
- 4) H₂O supply

PROOF PRESSURE TEST

Reason for Test

Following the leak test, the equipment under test is pressurized to proof pressure levels to provide added assurance that a catastrophic failure will not occur at operating pressures.

General Procedure

The equipment under test is pressurized to 1.5 times the normal operating pressure and maintained for a short period of approximately 5 minutes. The pressure is brought back to operating pressure and the leak test is repeated. The leak test is repeated since the proof pressure levels may have caused valves or connections to reseal. Pressure cycle tests to operating pressures will be applicable on some components.

Test Equipment

- 1) Pressure monitoring equipment, valves
- 2) Pumps

Facilities and Commodities

- 1) Fluids and cryogenic test lab
- 2) LN₂ supply
- 3) Air supply
- 4) H₂O supply

BURST PRESSURE TEST

Reason for Test

The burst pressure test is performed to determine the ultimate strength of a pressure vessel. This test is utilized to verify structural design margin of safety.

General Procedure

The test specimen is connected to a source of high pressure fluid and monitored for pressure buildup until rupture is achieved or until the required burst pressure is attained.

Test Equipment

- 1) Test chamber or shielded area
- 2) Pumps

Facilities and Commodities

- 1) Fluid supply
- 2) Air supply

EXPLOSIVE ATMOSPHERE TEST

Reason for Test

This test is conducted on equipment which must operate in an atmosphere that will support combustion, such as oxygen, or in cases where it is suspected that combustible gases may be present, such as hydrogen.

General Procedure

- 1) Utilize the standard procedure.
- 2) The test is performed in a special explosion test chamber in which the equipment is operated in an explosive atmosphere.

Test Equipment

- 1) Explosion chamber to accept the following test hardware size categories: A, B, D

Facilities and Commodities

- 1) Explosive atmosphere test area

POWER CONSUMPTION TEST

Reason for Test

This test is performed to insure that the equipment is compatible with the following:

- 1) Design requirements
- 2) Available power
- 3) Thermal analysis

General Procedure

- 1) The equipment is operated and the appropriate measurements of line current and voltage recorded under full load conditions.

Test Equipment

- 1) Voltmeter
- 2) Ammeter
- 3) Power supply

Facilities and Commodities

- 1) Electrical lab

NOISE AND RIPPLE TEST

Reason for Test

This test is utilized for determining signal quality and verifying that any disturbance is within tolerable limits.

General Procedure

- 1) The equipment is operated and an oscilloscope is connected across the output and input. The patterns noted on the scope will display the wave shapes and amplitudes.

Test Equipment

- 1) Oscilloscopes

Facilities and Commodities

- 1) Electrical lab

LIFE TEST

Reason for Test

The life test is performed to insure the required life of equipment which is in continuous operation, such as batteries, lights, etc.

General Procedure

The equipment under test is operated and monitored for performance for a specified period of time. The time factor may be accelerated by operating under conditions of high temperature or overload conditions.

Test Equipment

- 1) Temperature chamber for test hardware size category B
- 2) Resistive load
- 3) Voltmeters, ammeters

Facilities and Commodities

- 1) Electrical lab

RESPONSE TIME TEST

Reason for Test

This test is performed to measure the equipment time lag to determine whether it is within tolerable limits. Inertia exists in both mechanical and electrical systems and a finite time is required between command and performance.

General Procedure

The equipment is set up in its operational configuration and its performance monitored on a dual oscilloscope which is connected across the input command signal and output. The two patterns are compared on the time scale.

Test Equipment

- 1) Oscilloscope

Facilities and Commodities

- 1) Electrical lab

PHYSICAL FIT TEST

Reason for Test

This test is performed to insure that the equipment configuration and mounting provisions are compatible with the next higher assembly.

General Procedure

The test hardware is checked for mechanical and electrical compatibility by mounting it on a mockup or prototype of the next higher assembly.

Test Equipment

- 1) Simulators, mockups or prototypes are required of all carriers involved in this test program.

Facilities and Commodities

- 1) Mockup area

ELECTRICAL INTEGRITY TEST

Reason for Test

This test is performed to verify electrical continuity, connection integrity, and check for open circuits, shorts, and dielectric strength.

General Procedure

This test is performed using an ohmmeter or a visual-audio continuity checker in the following sequence:

- 1) Point to point continuity check
- 2) Adjacent connection short check

A hi-pot tester is used to measure the dielectric strength of each circuit.

Test Equipment

- 1) Ohmmeter
- 2) Visual-audio continuity tester
- 3) Hi-pot tester

Facilities and Commodities

- 1) Electrical lab

THERMAL CHARACTERISTICS TEST

Reason for Test

This test is conducted to determine the thermal characteristics such as radiation, conduction and operating temperature in order to confirm spacecraft thermal balance.

General Procedure

- 1) Utilize the standard procedure.
- 2) The test is conducted in a thermal vacuum chamber.

Test Equipment

- 1) Thermal vacuum chamber
- 2) Thermocouples and readout equipment

Facilities and Commodities

- 1) Environmental Test Lab

STATIC LOAD TEST

Reason for Test

The static load test is performed to determine the effects of mechanical force on a structure and the corresponding amount of deflection or strain. In some cases this test is used in place of an acceleration test by simulating acceleration forces with mechanical loads.

General Procedure

- 1) Utilize the standard procedure.
- 2) The test specimen is installed in the supporting fixture and strain gages and dial indicators are attached.
- 3) The specimen is then loaded either by hanging weights from various sections or from forces applied by hydraulic rams and jacks.
- 4) The gages and indicators are monitored at various stages of loading.

Test Equipment

- 1) Strain gages
- 2) Dial indicators
- 3) Jacks and hydraulic rams
- 4) Weights

Facilities and Commodities

- 1) Structural test lab

ANTENNA PATTERN TEST

Reason for Test

This test is conducted to verify that the antenna radio frequency pattern is within the specified limits.

General Procedure

- 1) Utilize the standard procedure.

Test Equipment

- 1) EMC screen room
- 2) Field intensity meters
- 3) Anechoic chamber

Facilities and Commodities

- 1) EMC test area

FUNCTIONAL TEST

Reason for Test

The functional test is performed to insure that the equipment performs its design function in an ambient laboratory environment. This test is performed a number of times during the test phase usually before and after each test cycle.

General Procedure

- 1) The equipment is activated and monitored for performance.

Test Equipment

- 1) Peculiar to test specimen.

Facilities and Commodities

- 1) Peculiar to test specimen.

ACOUSTIC TEST

Reason for Test

This test is performed on equipment exposed to high frequency sound waves during launch. The sound waves are of high intensity and may cause material damage to equipment.

General Procedure

- 1) Utilize the standard procedure except for the following changes:
 - a) Equipment to be non-operational during test

Test Equipment

- 1) Acoustic chamber to accept size category D
- 2) Sonic analyzer
- 3) Vibration meter

Facilities and Commodities

- 1) Acoustic test area

SLOSH TEST

Reason for Test

The slosh test is utilized to simulate the fluid dynamics inside the S-IVB tank during launch. Crew partitions, thermal curtains and the tank floor are installed into the SIVB prior to launch and are exposed to the LH₂ fuel, thus necessitating the slosh test.

General Procedure

Data from previous S-IVB flights will be used in obtaining sloshing characteristics. Ground testing will be provided to support the S-IVB data. The SIVB will be retained in a test stand and movement will be initiated. Sloshing characteristics will then be monitored.

Test Equipment

- 1) Test stand
- 2) Activation devices
- 3) Monitor displays
- 4) Maneuvering control and displays
- 5) TV camera for flight test
- 6) Telemetry systems

Facilities and Commodities

- 1) Sloss test facility similar to MSFC's facility

O₂ ATMOSPHERE TEST

Reason for Test

This test is required to demonstrate the compatibility of the equipment with an oxygen atmosphere. Special attention will be given to those subsystems which are susceptible to arcing.

General Procedure

- 1) Utilize the standard procedure

Test Equipment

- 1) Oxygen chamber

Facilities and Chambers

- 1) Oxygen test area

FUNGUS, SAND-DUST, SALTSpray-RAIN TEST

Fungus, sand-dust, and saltspray-rain test requirements are imposed on some subsystems in this reference document; however, these test requirements can be satisfied by material testing of the subsystem components. These tests have therefore been excluded from the test selection matrices of this document.

HYDROGEN COMPATIBILITY TEST

Most subsystems exposed to the S-IVB hydrogen environment will be qualified by material testing of the subsystem, therefore the hydrogen compatibility test has been excluded from the test

selection matrices. An exception to the preceding rule is the 3" vent line subsystem. Qualification of this subsystem will include a hydrogen compatibility test. As subsystem identification and analysis becomes more explicit, additional subsystem hydrogen compatibility tests might be required.