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ML 3200.035

OFFICE OF
MANNED SPACE
FLIGHT

SATURN APOLLO
APPLICATIONS PROGRAM

SATURN APOLLO APPLICATIONS PROGRAM SPECIFICATION

JUNE 17
~~July 15~~, 1966

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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Specification No. ML 3200.035
Dated July 15, 1966

SATURN APOLLO APPLICATIONS PROGRAM SPECIFICATION

Approved by: ______________________

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Acting Saturn/Apollo
Applications Director

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IN REPLY REFER TO:

July 15, 1966

TO: Distribution

FROM: Acting Director, Saturn/Apollo Applications

SUBJECT: Saturn Apollo Applications Program Specification

The document transmitted herewith is the first issue dated July 15, 1966, of the Saturn Apollo Applications Program Specification. This is the first level technical specification, and the requirements set forth shall be fully reflected in subsidiary specifications.

All proposed changes shall be submitted to the Saturn Apollo Applications Program Office Configuration Control Board using the procedure defined in exhibit VIII of NPC 500-1.

This first issue contains only some general provisions for the Program and the requirements for the Saturn IB launch vehicle. Additional elements of the Program will be specified in revisions issued concurrent with Program procurement decisions or Program initiation of Phase C (design) for such elements.

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Enclosure

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1.0 Scope This specification delineates performance, design and test requirements for the system elements to be procured for the Saturn Apollo Applications Program as defined by the current issue of the Saturn Apollo Applications Program Development Plan.

The body of the specification applies to the flight vehicles and ground systems associated with the several types of missions to be flown in the Program. These missions are described in the current issue of the Saturn Apollo Applications Flight Mission Assignment Directive.

The appendices to the specification delineate the special performance, design and test requirements of individual missions.

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2.0 Applicable Documents The following documents form a part of this specification and are applicable to the extent specified herein.

	SAA Program Development Plan
	SAA Flight Mission Assignments
M-DE 8020.008B April, 1965	Natural Environment and Physical Standards for the Apollo Program
MIM 7000.029 June 2, 1964	MSF Instruction to MSC: Biomedical Data Requirements
SE 008-001-1 June, 1965	Project Apollo Coordinate System Standards
NPC 500-1 May 18, 1964	Apollo Configuration Management Manual
M-DE 8000.006 (CM 018-001-1) June 1, 1963	OMSF Directive, Mass Properties Standards
MIL-D-70327 March 27, 1962	Drawings, Engineering and Associated Lists
MIL-E-6051C	Electrical-Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon Systems, Associated Subsystems, and Aircraft

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MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
MIL-I-6181D June 1, 1962	Interference Control Requirements, Aircraft Equipment

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3.0 Requirements

3.1 Performance

3.1.1 Missions The SAA Program shall include a variety of earth orbital and lunar operations, no single one of which is suitable for delineating the performance requirements of the entire program. The performance requirements for major elements of the program shall be established based on reference missions incorporated in Section 3.3.

3.1.2 Definition The program elements shall consist of the launch vehicles, spacecraft and ground systems identified in Figure 3.1.

3.1.3 Operability

3.1.3.1 Crew Safety The design of systems and missions shall be conducted to meet or exceed a crew safety probability of .99. Crew safety is defined as the safe return of all crew members whether or not a mission is completed.

3.2 Program Standards

3.2.1 Natural Environment and Physical Standards The natural environment data that shall be used in the SAA Program are contained in Natural Environment and Physical Standards for the Apollo Program, M-DE 8020.008B.

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3.0 Requirements

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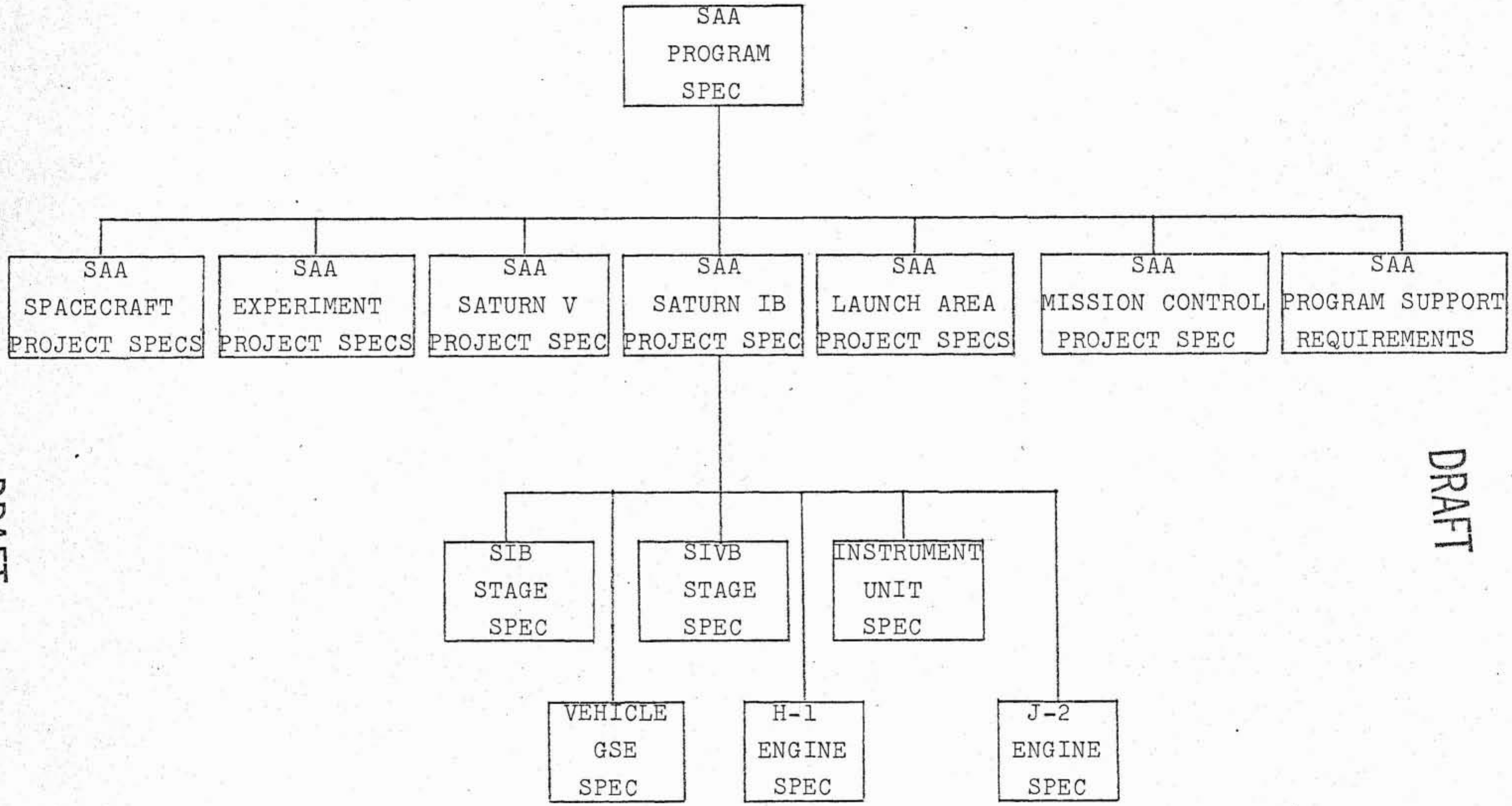

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FIGURE 3.1

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3.2.2 Electromagnetic Interference Control All flight systems and subsystems of the SAA Program shall be designed in accordance with the requirements of MIL-E-6051C. Equipment in the systems and subsystems shall be designed in accordance with the requirements of MIL-I-26600 or MIL-I-6181D, as applicable. Adaptation of these specifications for use in the SAA Program shall be approved by the cognizant NASA Centers.

3.2.3 Coordinate System Standards The Project Apollo Coordinate System Standards, SE 008-001-1, contains the approved coordinate system standards for the SAA Program.

3.3 Requirements for Program Areas

3.3.1 Saturn IB Launch Vehicle The requirements which follow shall apply to the launch vehicle SA-213 and subsequent.

3.3.1.1 Performance

3.3.1.1.1 Mission

3.3.1.1.1.1 Prelaunch The Saturn IB shall be capable of meeting the following functional requirements during the period from the beginning of operations to lift-off.

3.3.1.1.1.1.1 Environment During the prelaunch period the space vehicle (including Apollo spacecraft configurations) shall be capable of withstanding the natural ground environment given in Section 2.2 of M-DE 8020.008B.

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3.3.1.1.1.1.2 Standby Time The launch vehicle shall have the capability to stand by in a cryogenic environment after propellant loading for 12 hours and still perform the mission.

3.3.1.1.1.2 Launch From lift-off through insertion into orbital or suborbital trajectories the launch vehicle shall have the following capabilities.

3.3.1.1.1.2.1 Ascent Trajectory The launch vehicle shall be capable of injecting payloads into elliptic or circular orbits with altitudes up to 250 miles and into sub-orbital trajectories consistent with the stack limits specified in Section 3.3.1.3.1.1.

3.3.1.1.1.2.2 Azimuth It shall have a capability of launching on any flight azimuth between 44° and 120° from Launch Complexes 34 and 37B of the Kennedy Space Center.

3.3.1.1.1.2.3 In-Flight Performance Evaluation The S-IVB/IU shall be designed to facilitate in-flight system performance and status evaluation by the Mission Control Center.

3.3.1.1.1.2.4 Emergency Detection Subsystem (EDS) The launch vehicle shall contain an EDS which shall be capable of sensing incipient launch vehicle failures which might result in crew loss. EDS information shall be provided for display to the crew and to ground personnel. The EDS shall have the capability to initiate automatically the crew escape sequence if the failure is such that the crew would not have time to escape safely by manual initiation.

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3.3.1.1.1.3 Orbit

3.3.1.1.1.3.1 Attitude Control The S-IVB and IU shall be capable of maintaining attitude control for 7.0 hours in earth orbit.

3.3.1.1.1.3.2 Deactivation The S-IVB and IU shall be capable of being deactivated to permit safe crew operations both internal and external to the spent stages.

3.3.1.1.1.4 Payload Performance The reference mission for performance calculations shall include a launch from complex 34 or 37B on a flight azimuth of 90° with a manned spacecraft payload (Apollo configuration) carrying an 8200 pound Launch Escape System until 25 seconds after the S-IB/S-IVB separation command. The spacecraft payload inserted into a circular orbit at 100 nautical miles altitude shall be 39,300 pounds.

3.3.1.1.2 Definition The Saturn IB shall include the S-IB stage, S-IVB stage, Instrument Unit, H-1 Engines, J-2 Engines and Ground Support Equipment as indicated in Figure 3.1.

3.3.1.1.3 Operability

3.3.1.1.3.1 Reliability Based on the reference mission of Section 3.3.1.1.1.4 the launch vehicle shall have a numerical reliability of .90 or greater from lift-off through insertion. This reliability will be achieved independent of ground system and spacecraft inputs but will include the successful performance of all onboard mission essential communication systems.

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3.3.1.2 Standards Refer to Section 3.2.

3.3.1.3 Requirements for Saturn IB Areas

3.3.1.3.1 Structure

3.3.1.3.1.1 Prelaunch The launch vehicle structure shall be self-supporting with the propellant containers pressurized or unpressurized and shall be capable of supporting a payload of 66,000 pounds when pressurized.

3.3.1.3.1.2 Launch The space vehicle (including the Apollo spacecraft configuration) shall be capable of being launched in the 95 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The space vehicle shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the vehicle shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.3.1.3.1.3 Orbit The S-IVB and IU shall be configured to permit the entrance of a suited astronaut to the interior of the spent and deactivated S-IVB fuel tank.

3.3.1.3.2 Propulsion The main propulsion, retrorocket and auxiliary propulsion system shall be compatible with other components of the space vehicle and the Ground Support Equipment.

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3.3.1.3.2.1 Main Propulsion

3.3.1.3.2.1.1 S-IB Stage The S-IB stage propulsion system shall consist of eight H-1 rocket engines utilizing liquid oxygen and RP-1 as propellants. Each engine shall provide a nominal sea level thrust of 205,000 ± 3000 lbs. and a nominal sea level specific impulse of 263 seconds.

3.3.1.3.2.1.2 S-IVB Stage The S-IVB stage propulsion system shall consist of one J-2 engine utilizing liquid oxygen and liquid hydrogen propellants. The J-2 engine shall provide a nominal vacuum thrust of 205,000 ± 6150 lbs. and a nominal specific impulse of 427 seconds at a mixture ratio of 5:1.

3.3.1.3.2.2 Solid Rockets Solid rocket systems shall be used on the S-IB/S-IVB interstage for stage separation and on the S-IVB stage for the initial ullage maneuver.

3.3.1.3.2.3 Auxiliary Propulsion The auxiliary propulsion system of the S-IVB stage shall provide thrust for roll control during powered flight and attitude control about three axes during unpowered flight.

3.3.1.3.3 Navigation, Guidance and Control The navigation, guidance and control systems shall include the inertial platform, digital computers, data adapters and rate gyros.

3.3.1.3.3.1 Prelaunch This system shall be capable of being checked out on the launch pad and shall be capable of receiving launch guidance parameters for the purpose of earth orbital rendezvous.

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3.3.1.3.3.1.1 Rendezvous The system shall be capable of variable launch azimuth and plane change in order to rendezvous with target spacecraft at altitudes up to 250 miles and inclinations up to 30° by launching into the target plane on two successive orbits.

3.3.1.3.3.1.2 Response The system shall be capable of accepting revised target parameters between successive target orbits.

3.3.1.3.3.2 Launch The system shall be capable of guiding the space vehicle into orbit with small plane change independent of external commands and shall be capable of utilizing spacecraft commands for backup guidance and control during S-IVB thrusting.

3.3.1.3.3.3 Orbit The system shall be capable of maintaining a programmed space vehicle attitude for 7 hours without realignment of its inertial reference and shall be capable of receiving ground commands for updating onboard information.

3.3.1.3.4 Electrical Each stage shall have an independent electrical power system.

3.3.1.3.4.1 Orbit Electrical power shall be provided for the S-IVB and IU operations during a 7 hour orbital coast period.

3.3.1.3.4.2 Interference The systems shall be designed to minimize electrical interferences.

3.3.1.3.5 Instrumentation and Range Safety These systems which include Measurement, Telemetry, Command, Tracking and Range Safety Systems shall be designed to minimize radio frequency interference.

3.3.1.3.5.1 Measurement These systems in each of the flight stages shall be used to supply flight control information, to supply prelaunch checkout information and to supply engineering information for flight evaluation.

3.3.1.3.5.2 Telemetry This system shall include signal conditioning in each stage and VHF PCM/FM transmission from the S-IB and IU only.

3.3.1.3.5.2.1 Orbit The IU transmitter shall operate continuously through launch and the 7 hour coast period.

3.3.1.3.5.3 Command The IU shall have a VHF command receiving system for the purpose of updating and controlling launch vehicle functions.

3.3.1.3.5.4 Tracking The IU shall have a C-Band and an AZUSA tracking system.

3.3.1.3.5.4.1 Orbit The C-Band system shall operate continuously for at least 7 hours after launch and permit angle and range tracking when in line of sight of suitably equipped Manned Space Flight Network stations.

3.3.1.3.5.5 Range Safety The range safety systems shall include two sets of identical and independent command receivers and decoders on each propulsive stage, compatible with Eastern Test Range range safety command transmitters and permitting continuous reception irrespective of vehicle attitude from liftoff until predicted impact points are outside of the areas specified by range safety.

3.3.1.3.6 Ordnance These systems shall include stage and interstage separation systems and propellant dispersion systems.

3.3.1.3.6.1 Orbit The propellant dispersion system shall be capable of being made passive during the 7 hour coast period.

3.3.1.3.7 Environmental Control

3.3.1.3.7.1 Launch Each stage shall provide environmental control suitable for stage systems during the launch phase.

3.3.1.3.7.2 Orbit The S-IVB and IU shall continue to provide this environmental control during the 7 hour coast period.

3.3.2 Saturn V Launch Vehicle (To be supplied)

3.3.3 Spacecraft (To be supplied)

3.3.4 Launch Area (To be supplied)

3.3.5 Experiment Equipment (To be supplied)

3.3.6 Mission Control Center (To be supplied)

3.3.7 Program Support (To be supplied)

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4.0 Quality Assurance

4.1 General Performance, design and reliability requirements shall be achieved, maintained and verified by a rigorous application of an integrated quality assurance and test program. The guidelines, definitions and responsibilities are defined in the current issue of the SAA Program Development Plan.

4.2 Tests The general requirements for testing in the Saturn Apollo Applications Program are contained in the Program Development Plan and the Test Requirements documents. For the purpose of defining tests to be applied to the specific performance and design requirements of Section 3 of this specification, the following structure has been used.

A. There are three program phases: development, production and operations.

B. Under development there are two types of tests:

1. Design Verification Tests simulate the natural and induced environments at design levels.
2. Reliability tests simulate the natural and induced environment at higher than design levels in order to verify adequate design margins.

C. Under production there are two types of tests:

1. Qualification of first production items to insure product control within the design margins.

2. Acceptance of production items on the basis of limited tests and inspection.

D. Under operations there are two types of tests:

1. Ground tests conducted in connection with the integration of space vehicle and ground system elements.

2. Flight test

E. In the following tables the tests are classified as analysis (A), simulation (S), or inspection (I) to indicate the predominant testing requirements in each area.

F. Flight tests are classified manned (M) or unmanned (U) depending on the need for unmanned flight tests.

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5.0 Preparation for Delivery (To be supplied)

Test Requirements		Development		Production		Operations		Notes
Section 3	Title	Design	Reliab.	Qualif.	Accept.	Ground	Flight	
3.0	Requirements							
3.1	Performance							
3.1.1	Missions							
3.1.2	Definition							
3.1.3	Operability	A						
3.2	Program Standards							
3.2.1	Natural Env.&Physical Stds	A						
3.2.2	Electromag. Interf. Cont.	A				S		
3.2.3	Coordinate System Stds.	A						
3.3	Req. for Program Areas							

A-Analysis I-Inspection M-Manned S-Simulation U-Unmanned

4.3.0 Requirements for Program Areas — Table 4.3

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Test Requirements		Development		Production		Operations		Notes
Section 3	Title	Design	Reliab.	Qualif.	Accept.	Ground	Flight	
3.3.1	Saturn IB Launch Vehicle				I	S	M	(1)
3.3.1.1	Performance							
3.3.1.1.1	Mission							
3.3.1.1.1.1	Prelaunch							
3.3.1.1.1.1.1	Environment				I	I	M	
3.3.1.1.1.1.2	Standby Time				I	I	M	
3.3.1.1.1.2	Launch							
3.3.1.1.1.2.1	Ascent Trajectory				I	S	M	
3.3.1.1.1.2.2	Azimuth				I	S	M	
3.3.1.1.1.2.3	In-Flight Perf. Evaluation				I	S	M	
3.3.1.1.1.2.4	Emergency Detection System				I	S	M	
3.3.1.1.1.3	Orbit							
3.3.1.1.1.3.1	Attitude Control	A			I	A	M	
3.3.1.1.1.3.2	Deactivation	S	S	S	I	S	M	(2)
3.3.1.1.1.4	Payload Performance				I	A	M	
3.3.1.1.2	Definition				I			
3.3.1.1.3	Operability							
3.3.1.1.3.1	Reliability				A	A	M	
3.3.1.2	Standards				I			
3.3.1.3	Requirements for S-IB Areas							
3.3.1.3.1	Structure							

A-Analysis I-Inspection M-Manned S-Simulation U-Unmanned

4.3.1 Saturn IB Launch Vehicle Table 4.3-1

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Test Requirements		Development		Production		Operations		Notes
Section 3	Title	Design	Reliab.	Qualif.	Accept.	Ground	Flight	
3.3.1.3.1.1	Prelaunch				I	A	M	
3.3.1.3.1.2	Launch				I	A	M	
3.3.1.3.1.3	Orbit	S	S	S	I	A	M	(2)
3.3.1.3.2	Propulsion				I	A	M	(3)
3.3.1.3.2.1	Main Propulsion							
3.3.1.3.2.1.1	S-IB Stage				S	A	M	(4)
3.3.1.3.2.1.2	S-IVB Stage				S	A	M	
3.3.1.3.2.2	Solid Rockets				I	I	M	
3.3.1.3.2.3	Auxiliary Propulsion				S	I	M	
3.3.1.3.3	Navigation, Guid. & Cont.				I	I	M	
3.3.1.3.3.1	Prelaunch				I	S	M	
3.3.1.3.3.1.1	Rendezvous				S	S	M	
3.3.1.3.3.1.2	Response				I	S	M	
3.3.1.3.3.2	Launch				I	S	M	
3.3.1.3.3.3	Orbit	S	S	S	I	A	M	(2)
3.3.1.3.4	Electrical				I	I	M	
3.3.1.3.4.1	Orbit	S	S	S	I	A	M	(2)
3.3.1.3.4.2	Interference				I	S	M	
3.3.1.3.5	Instrument. & Range Safety							
3.3.1.3.5.1	Measurement				I	S	M	
3.3.1.3.5.2	Telemetry			S	I	S	M	

A-Analysis I-Inspection M-Manned S-Simulation U-Unmanned

4.3.1 Saturn IB Launch Vehicle Table 4.3-1(cont'd)

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Test Requirements		Development		Production		Operations		Notes
Section 3	Title	Design	Reliab.	Qualif.	Accept.	Ground	Flight	
3.3.1.3.5.3	Command				I	S	M	
3.3.1.3.5.4	Tracking				I	S	M	
3.3.1.3.5.5	Range Safety				I	S	M	
3.3.1.3.6	Ordnance				I	A	M	
3.3.1.3.6.1	Orbit	S	S	S	I	A	M	(2)
3.3.1.3.7	Environmental Control							
3.3.1.3.7.1	Launch				I	S	M	
3.3.1.3.7.2	Orbit	S	S	S	I	A	M	(2)

A-Analysis I-Inspection M-Manned S-Simulation U-Unmanned

4.3.1 Saturn IB Launch Vehicle

Table 4.3-1(cont'd)

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NOTES

For Table 4.3-1
Saturn IB Launch Vehicle

(1) The Saturn IB Launch Vehicle has been qualified by the Apollo Program and, with the exception of those areas indicated in subsequent paragraphs, will be accepted from production by inspection, tested in launch area by integrated simulation and manned.

(2) This and subsequent sections dealing with extended orbital duration and spent stage operations may be qualified by the Apollo Program and in that event will not need requalification.

(3) Static firing of assembled stages will not be required.

(4) Engines will continue to be accepted on the basis of static firing.

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6.0 Acronyms and Abbreviations

EDS	Emergency Detection Subsystem
FM	Frequency Modulation
IU	Instrument Unit
MSF	Manned Space Flight
OMSF	Office of Manned Space Flight
PCM	Pulse Code Modulation
SAA	Saturn Apollo Applications
UHF	Ultra High Frequency
VHF	Very High Frequency