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S-IVB-503N STAGE TECHNICAL PERFORMANCE CRITERIA DOCUMENT

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S-IVB-503N STAGE
TECHNICAL PERFORMANCE
CRITERIA DOCUMENT

DOUGLAS REPORT DAC-56636A
23 FEBRUARY 1968
23 DECEMBER 1968

PREPARED BY:
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PREPARED FOR:
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UNDER NASA CONTRACT NAS7-101

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ABSTRACT

This document describes the AS-503 mission objectives and the S-IVB-503N stage technical performance criteria which will be used to determine the Contractor's cost plus incentive fee bonus or penalty pertaining to mission accomplishment, payload capabilities and telemetry performance. This report was prepared in accordance with MSFC-DRL-021 Line Item 181 and supporting Data Requirements Description SE-956.

DESCRIPTORS

AS-503 Mission

S-IVB-503N stage

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SECTION 1

INTRODUCTION

1. INTRODUCTION

This document was prepared in accordance with MSFC-DRL-021 Line Item 181 (reference 1)* and supporting Data Requirements Description SE-956 (reference 1, appendix 2). The document contains the AS-503 mission objectives and the S-IVB-503N stage technical performance criteria which will be used to determine the Contractor's incentive bonus or penalty pertaining to mission accomplishment, payload capability, and telemetry performance as defined in Contract NAS7-101, Supplemental Agreement 1700.

The technical performance criteria includes the required preconditions of flight, end conditions of flight, mission duration, payload capability, and telemetry performance. The telemetry performance will be evaluated for two phases: (1) liftoff until 10 sec after the first S-IVB ECC and (2) liftoff until planned LV/SC separation.

McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) considers the Saturn V, Mission Implementation Plan, Mission C Prime, AS-503/Apollo-8 (reference 2) as the official document for providing identification and control of the launch vehicle mission requirements except as modified by Reference 6 in Appendix 2. These requirements include principal and secondary detailed test objectives and are presented in section 2.

*References are given in appendix 2.

SECTION 2

MISSION OBJECTIVES

2. MISSION OBJECTIVES

McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) considers the MSFC Saturn V, Mission Implementation Plan, Mission C Prime, AS-503/Apollo-8 (reference 2, appendix 2) as the official document for providing necessary launch vehicle mission requirements.

The mission implementation plan gives the objectives as follows:

a. MSF Objectives

Specific primary objectives have not yet been published by OMSF. OMSF stated that: "The C Prime Mission is to have the general purpose of maturing the CSM and launch vehicle systems and operations to the maximum degree consistent with the state of space vehicle development and flight experience resulting from Apollo 7".

b. MSFC Detailed Test Objectives (DTOs) for the Mission C Prime

All MSFC DTOs are in support of the general mission purpose stated in paragraph a. above.

Priority

Principal DTOs

1	Verify launch vehicle capability for free return, translunar injection (TLI)
2	Demonstrate S-IVB restart capability
3	Verify J-2 engine modifications
3	Confirm J-2 engine environment in S-II and S-IVB stages
4	Confirm launch vehicle longitudinal oscillation environment during S-IC stage burn period.
4	Verify the modifications incorporated in the S-IC stage suppress low frequency longitudinal oscillations

Priority

Principal DTOs

5

Demonstrate helium heater repressurization system

The following two principal DTOs have been deleted from stage performance incentive evaluation considerations in accordance with Reference 6.

6

Verify capability to inject S-IVB/IU/LTA-B into a lunar "slingshot" trajectory

7

Demonstrate capability to safe S-IVB stage.

Secondary DTOs

8

Verify the onboard command and communications (CCS)/ground system interface and operation in the deep space environment.

SECTION 3

TECHNICAL PERFORMANCE CRITERIA

3. TECHNICAL PERFORMANCE CRITERIA

3.1 General

McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) will be awarded a bonus if the S-IVB-503N stage successfully accomplishes the assigned flight mission. Conversely, MDAC-WD will be assessed a penalty if the S-IVB-503N stage fails to accomplish the assigned flight mission because of inadequate stage performance.

The S-IVB stage requirements are presented in the Contract End Item Detail Specification, No. CP 209000 A (reference 3, appendix 2).

3.2 Flight Mission Accomplishment

A mission is considered successful if the S-IVB-503N stage delivers to the payload acceptably valued end conditions of flight (ECF) or, if having received from the booster stages and instrument unit (IU) inadequate preconditions of flight (PCF), the S-IVB stage performance is such that the ECF would have been acceptably valued had the PCF been adequate.

Table 3-1 presents the MDAC-WD position on established trajectory PCF and associated tolerances for a December 21, 1968 launch on a flight azimuth of 72 deg east of north. The established trajectory PCF are shown in plot form, as a function of flight azimuth, across the launch window in MSFC Letter I-CO-S-IVB-8-1096, dated December 13, 1968. The PCF parameters will be calculated and evaluated based upon the time at which the IU issued the S-II/S-IVB separation command.

Table 3-2 presents the MDAC-WD position on established trajectory ECF and associated tolerances for a December 21, 1968 launch on a flight azimuth of 72 deg for both first and second S-IVB reignition opportunities. The ECF trajectory parameters will be calculated and evaluated based upon the time of injection of the S-IVB-503N stage into translunar orbit, which is defined as 10 sec after the IU command signal is issued for second S-IVB J-2 engine cutoff.

ECF attitude control parameters listed in table 3-3 will be evaluated from S-II/S-IVB separation signal until S-IVB/CSM separation signal. Tolerances have been established for S-IVB burn phase and parking orbit and transfer orbit phases; all tolerances are referenced to a zero nominal. Normal transient responses which temporarily exceed tolerance are excluded for the purpose of the incentive contract. All parameters are space-fixed unless otherwise noted.

Actual flight results will be compared with a new nominal trajectory generated after launch for the actual day and specific flight azimuth employed. All input data, except date of launch and flight azimuth, will be the same as used to generate the representative trajectory from which the nominal values shown in tables 3-1, 3-2, and 3-3 were obtained. Tolerances and evaluation inaccuracies to be applied for any launch azimuth and any day will be the same as those given in tables 3-1, 3-2, and 3-3.

Table 3-4 presents the definitions of the PCF and ECF parameters.

Table 3-5 presents the equations used for calculation of ECF parameters.

3.3 Payload Capability

The capability of the S-IVB-503N stage to meet a specification payload will be established by engineering analysis in accordance with the method set forth in Douglas Report No. SM-47263, Specification for the Calculation of Payload Capability under CPIF Exhibit to NAS7-101 (reference 4, appendix 2). The provisions of Exhibit "J" to the Supplemental Agreement 1700 will apply in the event of any conflict with the provisions of Douglas Report SM-47263. Within 60 days after launch a certificate of payload capability will be delivered to the contracting office stating specification payload capability and predicted payload capability for the S-IVB-503N stage.

3.4 Key Mission Accomplishment

The AS-503 mission is considered a key mission. If the S-IVB-503N stage delivers to the payload the acceptable valued end conditions of flight

(ECF) as defined in paragraph 3.2, MDAC-WD, under the provisions of Supplemental Agreement 1700, will be additionally awarded a key mission accomplishment bonus.

3.5 Telemetry Performance Evaluation

The measurements to be evaluated for technical performance incentives are those listed in the Instrumentation Program and Components List (IP&CL) (reference 5, appendix 2) that are wholly on the S-IVB-503N stage and which are operative at the time the automatic launch sequence is initiated.

Measurements which achieve their intended purpose are scored as successful. Measurements which do not obtain valid data due to noise from unknown sources will be removed from the total number of measurements upon which the telemetry performance evaluation is based.

The IP&CL lists a total of 453 measurements, of which 13 are not active during flight and 36 are not wholly on the S-IVB stage. This leaves a total of 404 measurements to be evaluated for technical performance incentives.

The inactive measurements that will not be evaluated are listed in the following table:

<u>Measurement No.</u>	<u>Measurement Title</u>	<u>Reason</u>
K0141-411	Event - R/S 1 Pulse Sensor	These measurements are for checkout only and are not transmitted during flight by the S-IVB-503N stage TM system.
K0142-411	Event - R/S 2 Pulse Sensor	
K0149-404	Event - U/R Jettison 1 Pulse Sensor	
K0150-404	Event - U/R Jettison 2 Pulse Sensor	
K0169-404	Event - EEW Pulse Sensor OFF Indication	
K0168-404	Event - Switch Selector Register Test	
K0176-404	Event - Ullage Rocket Ignition Pulse Sensor 1 Indication	
K0177-404	Event - Ullage Rocket Ignition Pulse Sensor 2 Indication	

Measurement No.	Measurement Title	Reason
DO545-407	Press - Common Bulkhead Int-H/W	These measurements are landline for prelaunch requirements and are not transmitted during flight by the S-IVB-503N stage TM system.
DO576-408	Press - Fuel Tank Ullage Umb-H/W	
DO577-406	Press - Oxid Tank Ullage Umb-H/W	
KO152-404	Event - Rate Gyro Wheel Speed OK Indications	Rate Gyro is not installed.
KO95-401	Event-Thr Chamber IM2 Inj Temperature OK	Shorting Plug installed.

The measurements not wholly on the S-IVB are the following:

DO153-423	Press - Chamb Retro Rkt Pos IV-I	Transmitted by S-II stage TM.
DO154-421	Press - Chamb Retro Rkt Pos II-III	
DO155-420	Press - Chamb Retro Rkt Pos I-II	
DO156-422	Press - Chamb Retro Rkt Pos III-IV	
S0054-426	Strain - Axial, Fwd Skirt Loc. 10A	Multiplexed and transmitted by IU Stage TM.
S0055-426	Strain - Axial, Fwd Skirt Loc. 10B	
S0056-426	Strain - Fwd Skirt Loc. 11A	
S0057-426	Strain - Fwd Skirt Loc. 11B	
S0058-426	Strain - Axial Fwd Skirt Loc. 12A	
S0059-426	Strain - Axial Fwd Skirt Loc. 12B	
S0060-426	Strain - Axial Fwd Skirt Loc. 13A	
S0061-426	Strain - Axial Fwd Skirt Loc. 13B	
S0062-426	Strain - Axial Fwd Skirt Loc. 14A	
S0063-426	Strain - Axial Fwd Skirt Loc. 14B	
S0064-426	Strain - Axial Fwd Skirt Loc. 15A	
S0065-426	Strain - Axial Fwd Skirt Loc. 15B	
S0066-426	Strain - Axial Fwd Skirt Loc. 16A	
S0067-426	Strain - Axial Fwd Skirt Loc. 16B	
S0068-426	Strain - Axial Fwd Skirt Loc. 17A	
S0069-426	Strain - Axial Fwd Skirt Loc. 17B	

Measurement No.	Measurement Title	Reason
S0070-427	Strain - Axial Aft Skirt Loc. 10A	Multiplexed and transmitted by IU stage TM
S0071-427	Strain - Axial Aft Skirt Loc. 10B	
S0072-427	Strain - Axial Aft Skirt Loc. 11A	
S0073-427	Strain - Axial Aft Skirt Loc. 11B	
S0074-427	Strain - Axial Aft Skirt Loc. 12A	
S0075-427	Strain - Axial Aft Skirt Loc. 12B	
S0076-427	Strain - Axial Aft Skirt Loc. 13A	
S0077-427	Strain - Axial Aft Skirt Loc. 13B	
S0078-427	Strain - Axial Aft Skirt Loc. 14A	
S0079-427	Strain - Axial Aft Skirt Loc. 14B	
S0080-427	Strain - Axial Aft Skirt Loc. 15A	
S0081-427	Strain - Axial Aft Skirt Loc. 15B	
S0082-427	Strain - Axial Aft Skirt Loc. 16A	
S0083-427	Strain - Axial Aft Skirt Loc. 16B	
S0084-427	Strain - Axial Aft Skirt Loc. 17A	
S0085-427	Strain - Axial Aft Skirt Loc. 17B	

3.5.1 Performance Baseline Determination

McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) will utilize the following procedure to establish the operative and non-operative telemetry measurements at the initiation of the last automatic sequence prior to liftoff. This information will be used as the baseline for subsequent calculation of the telemetry performance incentive.

Prior to resuming the count for T -0 day, the MDAC-WD/FTC Project Engineer will contact MSFC/S-IVB Project Office to review the inoperative measurements, their failure mode, and their effect on launch and/or mission.

Continual surveillance for inoperative measurements will be made by Contractor personnel in the blockhouse and the Central Instrumentation Facility (CIF) during T -0 day. MSFC will be periodically contacted by the MDAC-WD/FTC Project Engineer up until approximately T -15 min to report any additional inoperative measurements detected either by the Launch Control Center or CIF personnel. Measurement scans will be made

periodically by dialing up measurements in the CIF and the Saturn V Measuring Station. MSFC will in most instances be able to verify inoperative measurements by viewing the same data as it is being transmitted to the Huntsville Operations Support Center (HOSC) from the CIF.

The Douglas S-IVB Project Engineer will dictate a Memo of Agreement to document those measurements which the Contractor declares inoperative prior to initiation of the automatic launch sequence.

3.5.2 Performance Evaluation Period

The expected duration of the telemetry performance evaluation will be as follows:

a. Phase I

From AS-503 launch vehicle liftoff until first S-IVB stage ECC +10 sec.

b. Phase II

From AS-503 launch vehicle liftoff until planned LV/SC separation (TB7 +1500 sec).

3.5.3 Command Requirements

In order to ensure the required transmission of data from the S-IVB stage telemetry system, the following commands must be received from the IU as scheduled in the sequence of events.

TM Calibrate ON

TM Calibrate OFF

Measurement Transfer Mode Position "B"

In-Flight Calibration Mode ON

In-Flight Calibration Mode OFF

SSB FM Transmitter ON

SSB FM Transmitter OFF

TABLE 3-1

S-IVB-503 C' PCF AND ASSOCIATED TOLERANCES (LAUNCH AZIMUTH = 72 DEG)
(S-II/S-IVB Separation Signal)

<u>Parameter</u>	<u>Units</u>	<u>Nominal</u>	<u>Tolerances</u>	<u>Evaluation Inaccuracy**</u>	<u>Total Envelope</u>
*Range	km	1495.4	+ 28.7 - 36.1	+ 0.8	+ 29.5 - 36.9
*Cross Range (See Note 1)	km	23.1	+ 2.6 - 2.8	+ 0.8	+ 3.4 - 3.6
*Altitude	km	193.0	+ 4.0 - 4.1	+ 0.8	+ 4.8 - 4.9
Velocity Vector Magnitude	m/sec	6814.6	+ 47.9 - 61.8	+ 3.0	+ 50.9 - 64.8
Velocity Vector Direction (Path Angle) local Horizontal)	deg	0.41	+ 0.40 - 0.39	+ 0.05	+ 0.45 - 0.44
Velocity Vector Direction (Heading Azimuth from True North)	deg	81.64	+ 0.24 - 0.31	+ 0.05	+ 0.29 - 0.36
Pitch Attitude (See Note 2)	deg	- 94.5	+ 5.0	+ 1.0	+ 6.0
Pitch Rate	deg/sec	0.0	+ 1.0	+ 0.5	+ 1.5
Yaw Attitude (See Note 3)	deg	0.2	+ 4.0	+ 1.0	+ 5.0
Yaw Rate	deg/sec	0.0	+ 1.0	+ 0.5	+ 1.5
Roll Attitude	deg	0.0	+ 4.0	+ 1.0	+ 5.0
Roll Rate	deg/sec	0.0	+ 1.0	+ 0.5	+ 1.5

* Earth-fixed

** Assuming radar only
tracking for tra-
jectory parameters

NOTE 1: Cross range is measured laterally, along a line normal to the plane containing the flight azimuth vector, the launch pad plumbline, and the pad center. Positive is to the right, looking along the azimuth direction.

NOTE 2: Pitch attitude is measured negatively nose downrange from the launch vertical, in the pitch plane.

NOTE 3: Yaw attitude is measured positive nose to the right in the yaw plane, as seen looking forward with position one down.

TABLE 3-2
S-IVB 503 C' ECF AND ASSOCIATED TOLERANCES*
(Translunar Injection - First Opportunity S-IVB Reignition)

<u>Parameters</u>	<u>Units</u>	<u>Nominal</u>	<u>Tolerances++</u>	<u>Evaluation Inaccuracy**</u>	<u>Total Envelope</u>
Inclination	deg	30.655	+ 0.130 - 0.123	+ 0.053	+ 0.183 - 0.176
Node	deg	119.727	+ 0.138 - 0.130	+ 0.130	+ 0.268 - 0.260
C ₃	m ² /sec ²	- 1,429,364.	+ 62,087. - 72,456.	+ 193,400.	+ 255,487. - 265,856.
Eccentricity		0.97636	+ 0.00102 - 0.00119	+ 0.00320	+ 0.00422 - 0.00439

S-IVB 503 C' ECF AND ASSOCIATED TOLERANCES*
(Translunar Injection - Second Opportunity S-IVB Reignition)

<u>Parameters</u>	<u>Units</u>	<u>Nominal</u>	<u>Tolerances++</u>	<u>Evaluation Inaccuracy**</u>	<u>Total Envelope</u>
Inclination	deg	34.190	+ 0.130 - 0.123	+ 0.053	+ 0.183 - 0.176
Node	deg	123.853	+ 0.138 - 0.130	+ 0.130	+ 0.268 - 0.260
C ₃	m ² /sec ²	- 1,438,860.	+ 62,087 - 72,456.	+ 193,400.	+ 255,487. - 265,856.
Eccentricity		0.97618	+ 0.00102 - 0.00119	+ 0.00320	+ 0.00422 - 0.00439

* December 21, 1968 launch on a 72 degree azimuth

** Assuming only radar tracking available for trajectory parameters

++ Tolerances are those of a second opportunity S-IVB restart

TABLE 3-3
S-IVB ECF ATTITUDE CONTROL PARAMETERS***

<u>Parameters</u>	<u>Units</u>	<u>Tolerances</u>	<u>Evaluation Inaccuracy</u>	<u>Total Envelope</u>
S-IVB First Burn Phase:				
Pitch or Yaw Attitude Error	deg	± 6.0	± 1.0	± 7.0
Roll Attitude Error	deg	± 1.0	± 1.0	± 5.0
Pitch or Yaw Attitude Rate	deg/sec	± 2.5	± 0.5	± 3.0
Roll Attitude Rate	deg/sec	± 1.0	± 0.5	± 1.5
Parking Orbit:				
Pitch or Yaw Attitude Error	deg	± 3.0	± 1.0	± 4.0
Roll Attitude Error	deg	± 4.0	± 1.0	± 5.0
Pitch or Yaw Attitude Rate	deg/sec	± 1.0	± 0.5	± 1.5
Roll Attitude Rate	deg/sec	± 1.0	± 0.5	± 1.5
Transfer Orbit (Until CSM Separation):				
Pitch or Yaw Attitude Error	deg	± 6.0	± 1.0	± 7.0
Roll Attitude Error	deg	± 4.0	± 1.0	± 5.0
Pitch or Yaw Attitude Rate	deg/sec	± 1.0	± 0.5	± 2.1
Roll Attitude Rate	deg/sec	± 1.0	± 0.5	± 1.5

*** Attitude errors during parking and transfer orbit exclude normal transients and maneuvers; all rates apply to rigid body response (exclude structural dynamics).

TABLE 3-4 (Sheet 1 of 2)
PCF AND ECF PARAMETER DEFINITION

PARAMETER	DEFINITION
Range	Spherical earth ground range. Based on the spherical earth range angle and the average earth radius.
Cross-range	Component of vehicle position as measured laterally, along a line normal to the plane containing the flight azimuth, the launch pad plumbline, and the earth center. Positive is to the right, looking along the azimuth direction.
Altitude	Distance between the spheroid's surface and vehicle measured along the normal to the earth's surface, positive up.
Velocity vector	Measured with respect to non-rotating space fixed reference system.
Velocity vector direction (path angle from local horizontal)	Angle between inertial velocity vector and a plane perpendicular to the instantaneous earth radius vector.
Velocity vector direction (heading azimuth from true north)	Angle between true north and the projection of the inertial velocity vector upon a plane perpendicular to the instantaneous subvehicle earth radius vector.
Pitch attitude	Inertial Euler angle measured between the platform "P" coordinate system and the vehicle fixed "M" system. The rotation order is pitch, yaw, roll. Pitch attitude is measured negatively nose downrange from the launch vertical, in the pitch plane.
Pitch rate	Angular velocity about vehicle pitch axis, positive nose up.
Pitch attitude error	Commanded pitch attitude minus the vehicle pitch attitude measured in vehicle coordinates.
Yaw attitude	Inertial Euler angle measured between the platform "P" coordinate system, and the vehicle fixed "M" system. The rotation order is pitch, yaw, roll. Yaw attitude is measured positive nose to the right in the yaw plane, as seen looking forward with position one down.
Yaw rate	Angular velocity about vehicle yaw axis, positive nose right.

TABLE 3-4 (Sheet 2 of 2)
PCF AND ECF PARAMETER DEFINITION

PARAMETER	DEFINITION
Yaw attitude error	Commanded yaw attitude minus the vehicle yaw attitude measured in vehicle coordinates.
Roll attitude	Inertial Euler angle measured between the platform "P" coordinate system and the vehicle fixed "M" system. The rotation order is pitch, yaw, roll. Roll attitude is measured positive in the roll plane in a clockwise direction as seen looking forward.
Roll rate	Angular velocity about vehicle roll axis, positive clockwise looking forward.
Roll attitude error	Commanded roll attitude minus the vehicle roll attitude measured in vehicle coordinates.
Inclination (i)	Elements of waiting orbit. Longitude of descending node is measured in the earth's equatorial plane relative to the longitude of the launch site at Guidance Reference Release, positive east. Calculated as shown in table 3-4.
Eccentricity (e)	
Longitude of Descending Node (θ_N)	
Energy (C_3)	
	Energy of waiting orbit. Equals twice the total waiting orbit vis-viva energy. Calculated as shown in table 3-4.

TABLE 3-5
EQUATIONS FOR C_3 , INCLINATION, NODE PARAMETER AND ECCENTRICITY

The equations used to calculate eccentricity, C_3 , node, and inclination for the AS-503 S-1VB ECF's are listed below. Position and velocity data used to calculate the sub-equations of P and γ are in the Apollo Coordinate System Standard 13.

$$\text{Eccentricity} = \sqrt{1 - \frac{(2\mu - RV^2)(1 - \sin^2 \gamma) RV^2}{\mu^2}}$$

$$C_3 = V^2 - \frac{2\mu}{R}$$

$$\text{Node} = \cos^{-1} \left(\frac{P_u}{P_{uv}} \right) = 90^\circ + \sin^{-1} \left(\frac{P_u}{P_{uv}} \right)$$

$$\text{Inclination} = \cos^{-1} \left(\frac{P_w}{P} \right)$$

$$\text{Using } \bar{P} = \bar{V} \times \bar{R}$$

$$P_u = P_3 \sin A_z + P_2 \cos A_z$$

$$P_v = -P_3 \sin \phi_L \cos A_z + P_1 \cos \phi_L + P_2 \sin \phi_L \sin A_z$$

$$P_w = -P_3 \cos \phi_L \cos A_z - P_1 \sin \phi_L + P_2 \cos \phi_L \sin A_z$$

$$P_{uv} = \sqrt{P_u^2 + P_v^2}$$

$$\gamma = \sin^{-1} \left(\frac{X\dot{X} + Y\dot{Y} + Z\dot{Z}}{RV} \right)$$

$$\mu = 3.986032E14 \text{ m}^3/\text{sec}^2$$

$$A_z = 72 \text{ deg}$$

$$\phi_L = 28.60842 \text{ deg}$$

APPENDIX 1

GLOSSARY AND ABBREVIATIONS

TABLE AP 1-1 (Sheet 1 of 2)
GLOSSARY AND ABBREVIATIONS

<u>ABBREVIATION</u>	<u>TERM</u>	<u>DEFINITION</u>
ASI	--	Augumented Spark Igniter
AS	--	Apollo Saturn
CEI	--	Contract end item
CIF	--	Central Instrumentation Facility
CPIF	--	Cost plus incentive fee
CSM	--	Command Service Module
CVS	--	Continuous Vent System
EBW	--	Exploding bridgewire
ECC	--	Engine Cutoff Command
ECF	--	End conditions of flight
EDS	--	Emergency Detection System
GCS	--	Guidance Cutoff Signal
HOSC	--	Huntsville Operations Support Center
H/W	--	Hardwire
IP&CL	--	Instrument Program and Components List
IU	--	Instrument Unit
LV/SC	--	Launch vehicle/spacecraft
MDAC-WD	--	McDonnell Douglas Astronautics Company - Western Division
MSFC	--	Marshall Space Flight Center
NASA	--	National Aeronautics and Space Administration
PCF	--	Preconditions of flight
PCM	--	Pulse code modulation
R/F	--	Radio Frequency
R/S	--	Range Safety

TABLE AP 1-1 (Sheet 2 of 2)
GLOSSARY AND ABBREVIATIONS

<u>ABBREVIATION</u>	<u>TERM</u>	<u>DEFINITION</u>
SA	-	Saturn
SC	Spacecraft	Includes Apollo command and service module and the LM adapter
SLA	--	Spacecraft Lunar Module Adapter
S-IB	--	Saturn IB-First stage of the Saturn IB (200) series of vehicles
S-IVB	--	Second stage of the Saturn IB (200) series of vehicles and third stage of the Saturn V (500) series of vehicles
T/M	--	Telemetry
U/R	--	Ullage rocket

APPENDIX 2

REFERENCES

2. REFERENCES

The following listed documents are referenced in the text:

1. NAS7-101 Contract Data Requirements Saturn S-IVB Stage and GSE, (MSFC-DRL-021) Line Item 181, dated February 1, 1968
2. Saturn V, Mission Implementation Plan, Mission C Prime, AS-503/Apollo-8, (Prepared by Saturn V Systems Engineering Management Office [I-V-E]) dated September 18, 1968.
3. Contract End Item Detail Specification (Prime Equipment), Performance/Design and Qualification Requirements and Product Configuration and Acceptance Test Requirements for S-IVB Stages 501 through 506 McDonnell Douglas Astronautics Company - Western Division, Huntington Beach, dated March 13, 1967.
4. Specification for the Calculation of Payload Capability under CPIF Exhibit to NAS7-101, Douglas Report No. SM-47263, dated January 12, 1966.
5. Instrumentation Program and Components List S-IVB-503N, IB43569AL, McDonnell Douglas Astronautics Company, Huntington Beach, California, dated December 11, 1968.
6. MSFC Letter I-CO-SIVB-8-1074, Contract NAS7-101, Change Order 1979, AS-503 "C" Prime Mission Implementation Plan, dated December 10, 1968.

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