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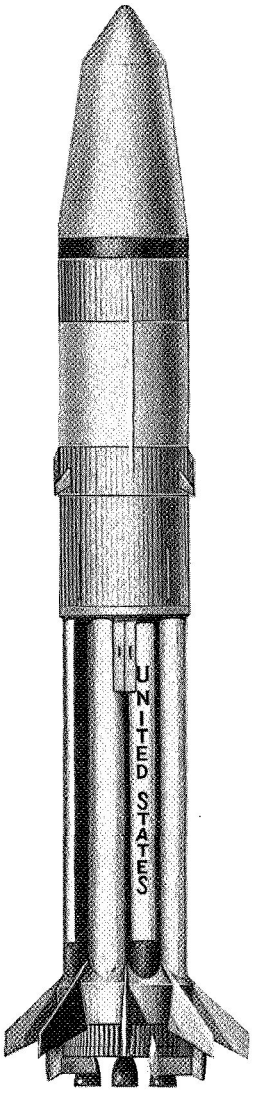
AS-204 Launch Vehicle



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ABSTRACT

Douglas Aircraft Company Report No. SM-46977B, *S-IVB-204 Stage Flight Test Plan* documents the Douglas requirements and responsibilities relative to the S-IVB-204 stage of the Saturn IB vehicle AS-204/LM-1 flight test that will be conducted by National Aeronautics and Space Administration (NASA) at the Kennedy Space Center. The test plan defines the Douglas support activities and reports required under NASA Contract NAS7-101.

DESCRIPTORS

AS-204/LM-1 mission

S-IVB-204 stage mission

configuration

CPIF (cost plus incentive fee)

sequence of events

mass characteristics

predicted flight performance

J-2 engine

16 December 1967

PREFACE

The purpose of this report is to provide a flight test plan for the Saturn S-IVB-204 stage. In general, it provides information and direction to Douglas personnel at Huntington Beach Missile and Space Systems Division, Florida Test Center, and Marshall Space Flight Center.

Included in this report are detailed descriptions of the following: AS-204/LM-1 mission and objectives, S-IVB-204 stage objectives and configuration, technical performance incentives, launch mission rules, flight sequence of events, mass characteristics, and propulsion system performance predictions.

This report is a second revision of the original issue of Douglas Report No. SM-46977, *S-IVB-204 Stage Flight Test Plan*, dated 9 August 1966. This revision was prepared because of change in mission.

This report was prepared under National Aeronautics and Space Administration Contract NAS7-101, and issued in accordance with the contractual requirements of NAS7-101 *Contract Data Requirements, Saturn S-IVB Stage and GSE, MSFC-DRL-021*, dated 15 September 1966.

PREFACE TO THIRD REVISION

Dated 17 January 1968

This revision consisted of updating the technical performance criteria and adding the telemetry power margins. These pages supersede those issued 16 December 1967.

PREFACE TO FOURTH REVISION

Dated 18 January 1968

This revision consisted of updating the technical performance criteria. These pages supersede those issued 17 January 1968.

18 January 1968

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SECTION 1

INTRODUCTION

1. INTRODUCTION

This document delineates the requirements and responsibilities of the Douglas Aircraft Company in support of the S-IVB-204 stage flight test. The flight test, as defined in this test plan, will be limited to the S-IVB stage contribution toward the accomplishment of the AS-204/LM-1 flight mission and S-IVB stage performance verification as the second stage of the AS-204/LM-1 space vehicle.

1.1 General

This document provides information and direction to Douglas personnel comprising the Saturn S-IVB Test Planning and Evaluation Committees at the Missile and Space Systems Division (MSSD) Huntington Beach, California, Florida Test Center (FTC), and the liaison team at Marshall Space Flight Center, Huntsville, Alabama.

Detailed descriptions of the following are included:

a. Launch vehicle objectives

b. S-IVB stage objectives

c. S-IVB stage configuration

d. S-IVB stage launch mission rules and redlines

e. S-IVB stage flight test management

f. Technical performance incentives.

1.2 Background

The S-IVB-204 stage was assembled at MSSD where production testing of components and systems was accomplished. The stage was then transported to the Sacramento Test Center (STC), where the acceptance firing was conducted. Preliminary tests consisted of manual and automatic subsystem checkouts, integrated system tests, a simulated acceptance firing, and an automatic propellant loading test. Following these preliminary tests, the stage underwent a full duration acceptance firing. Post-firing checkout included manual leak checks, functional tests, and an All Systems Test.

The stage was then shipped to Kennedy Space Center (KSC), installed in the low bay of the Vertical Assembly Building and subjected to post transportation receiving inspections. After installation of the aft interstage, the stage was transferred to launch complex 34 and mated to the AS-204 space vehicle. After a change in mission plans, the stage was transferred to launch complex 37B and mated to the AS-204/LM-1 space vehicle. Figure 1-1 presents a checkout and test history of the S-IVB-204 stage.

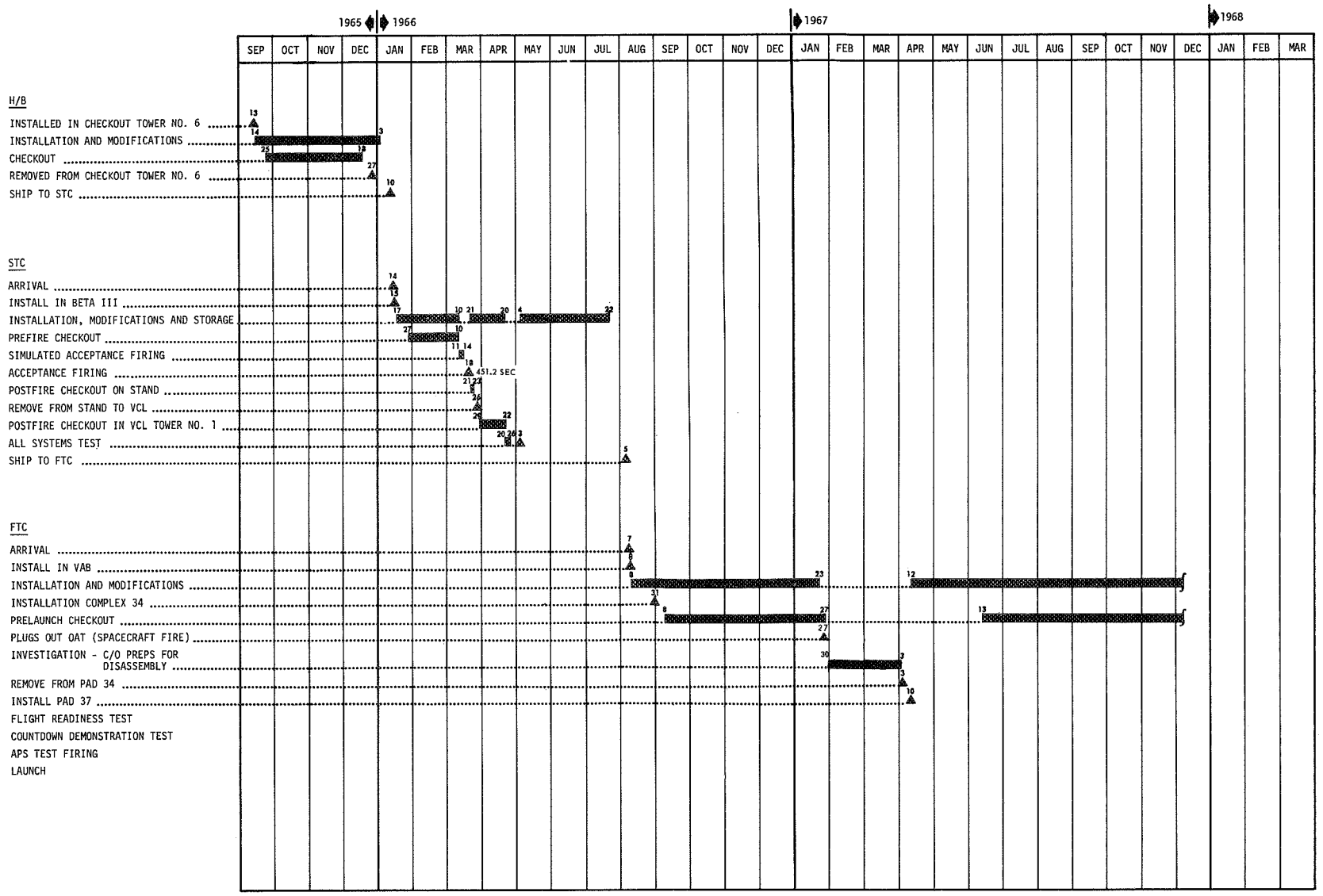


Figure 1-1. S-IVB-204 Stage Checkout and Test History

SECTION 2

MISSION

2. MISSION

The AS-204 is the fourth Saturn IB flight vehicle allocated for launch vehicle and spacecraft development and qualification. This section delineates the objectives of the vehicle as a whole. Section 3 describes the objectives of the S-IVB-204 stage. Figure 2-1 presents the launch configuration of the AS-204 space vehicle and Figure 2-2 presents the AS-204 ground trace.

2.1 Mission Objectives

Douglas Aircraft Company considers the *MSFC Flight Mission Directive Apollo-Saturn IB Missions* (reference 1) as the official document for providing identification and control of the launch vehicle mission requirements. The *Apollo Flight Mission Assignments* document (reference 2) and the *Program Support Requirements* document (reference 3) also define mission objectives and can be referred to for supplemental information.

The mission directive states that"general objectives are primary objectives listed in the *Flight Mission Assignments* document" (reference 2). According to the mission directive, the general objectives are:

a. "Verify operation of the following LM subsystems: APS, DPS, (including restart), and Structure.

b. "Evaluate LM staging.

c. "Evaluate S-IVB/IU orbital performance."

The mission directive states that "primary objectives are those which are mandatory. Malfunctions of spacecraft or launch vehicle systems, ground equipment, or instrumentation which would result in failure to achieve these objectives will be cause to hold or cancel the mission until the malfunction has been eliminated." According to the mission directive, the primary objectives are:

"Evaluate S-IVB/IU orbital performance.

Specifically:

a. "Evaluate the launch vehicle attitude control system operation and maneuvering capability.

*b. "Verify the S-IVB LH2 and LOX tank pressure rise rates.

c. "Demonstrate nosecone separation from the S-IVB/IU/SLA.

d. "Evaluate the operational adequacy of the launch vehicle systems: including guidance and control, electrical, mechanical and instrumentation."

Secondary objectives as defined in the mission directive "are those which are desirable but not mandatory. Malfunctions which would result in failure to attain these objectives may be cause to hold or cancel the mission as indicated in the mission rules." The secondary objectives which are listed in the mission directive are as follows:

a. "Evaluate S-IVB forward skirt in-flight panel flutter.

b. "Evaluate J-2 engine crossover duct temperature experiment.

c. "Evaluate S-IVB LH2 and LOX propellant dump experiment.

d. "Evaluate Launch Vehicle orbital coast lifetime capability."

2.2 Mission Description

2.2.1 Launch Phase

2.2.1.1 S-IB Flight

The S-IB flight of the launch vehicle trajectory is initiated at first motion which occurs nominally 4.8 sec after Guidance Reference Release (GRR). The time of umbilical disconnect establishes time base one (T_1) which is nominally 0.2 sec after first motion.

The AS-204/LM-1 vehicle will be launched from KSC Complex 37B on a 90 deg launch azimuth. A pitch and roll maneuver will then be initiated at 10.2 sec to achieve the proper vehicle orientation for a 72 deg flight azimuth.

---

*NOTE: This primary objective has been modified to reflect a change in mission requirements. This variation has been forwarded to NASA/MSFC by Douglas letter A3-131-KWAO-L-3246, dated October 5, 1967.

Table 2-1 is a summary of the flight mass summary presented in appendix 2. Maximum dynamic pressure (Max Q) is predicted to occur at 74.0 sec flight time and the predicted flight conditions at that time are presented in Table 2-2.

The S-IB propellant depletion level sensors are actuated at 136.0 sec flight time. This initiates time base two (T_2) in preparation for S-IB engines cutoff and separation.

The S-IVB tape recorder is turned on fast record at a flight time of 136.4 (T_2 +0.4 sec) sec to record data during the black-out period of S-IB engines cutoff, separation and S-IVB ignition.

The S-IB inboard engines will cutoff at a flight time of 139.1 sec and the outboard engines at 142.1 sec which initiates time base three (T_3).

The S-IB stage flight phase ends at S-IB/S-IVB physical separation which will be approximately 1.4 sec after Outboard Engine Cutoff Command. Table 2-3 presents the predicted conditions of flight at S-IB/S-IVB physical separation.

Figures 2-3 through 2-5 show the predicted time histories of earth fixed velocity, elevation flight path angle, dynamic pressure, axial acceleration, range, altitude, cross range position, and cross range velocity during the S-IB powered phase.

2.2.1.2 S-IVB Stage Flight

After S-IB cutoff the retrorockets force the S-IB stage away from the S-IVB/spacecraft and ullage rockets are fired to settle the S-IVB stage propellants. At 144.6 sec after liftoff the J-2 Engine Start Command is given which initiates a one sec fuel lead and subsequent thrust buildup.

From engine start until the initiation of the Iterative Guidance Mode (IGM), the S-IVB is commanded to a 30.54 deg pitch attitude. Active guidance of the vehicle begins at 158.9 sec after liftoff. In the IGM the S-IVB stage pitch and yaw attitude commands are issued to obtain an optimal path (that which requires the least propellant consumption) to achieve the desired end conditions of altitude and velocity. Guidance staging (change in guidance constants) is predicted to occur when the

shift in engine mixture ratio (EMR) from 5.5 to 4.7 is sensed by "onboard" accelerometers. The EMR cutback is predicted to occur at 449.8 sec after liftoff. The resulting change in thrust level will be sensed at 474.1 sec flight time. The IGM switches from a guidance interval of 1.75 to 1.25 sec at chi tilde which occurs at 584.2 sec after liftoff and the equations are changed such that only the final velocity magnitude and direction is considered in guidance. At 594.9 sec after liftoff (chi freeze) the guidance commands are held constant through the cutoff transients. The predicted time of J-2 Engine Cutoff Command is 598.2 sec after liftoff.

Appendix 3 shows a tabulation of the predicted S-IVB powered flight trajectory from which tables 2-4 and 2-5, and figures 2-6 through 2-17 were derived. Tables 2-4 and 2-5 present predicted trajectory conditions at Engine Cutoff Command and orbital insertion, respectively. Figures 2-6 through 2-17 show predicted time histories of selected trajectory and guidance parameters during S-IVB powered flight.

2.2.2 Orbital Phase

2.2.2.1 Lunar Module Pre-Separation

The lunar module pre-separation time period begins at orbital insertion which occurs 10 sec after Guidance Cutoff Command (GCC) and with the vehicle in a 85 by 120 nautical mile elliptical orbit. At GCC plus 60 sec a pitch maneuver is initiated to align the vehicle with the local horizontal and is maintained until 3,000 sec after liftoff with an orbital pitch rate. At 3,000 sec a small maneuver from the local horizontal is required to achieve the desired separation inertial attitude of 87.1, -0.9, and 0 deg in pitch, yaw and roll, respectively. During this pre-separation orbital phase the LOX tank will be vented for a 40 sec duration starting at a flight time of 598.4 sec and a 1,260 sec LH2 tank venting, starting at 598.6 sec. The PU will be deactivated at a flight time of 601.5 sec and the auxiliary hydraulic pump will be turned off at 601.9 sec. Separation between the S-IVB stage and the LM will take place at 3,235 sec after liftoff.

2.2.2.2 Lunar Module Post-Separation

At 3,415 sec the S-IVB will be maneuvered to the local horizontal (SLA forward, Position I down) and then pitched at the orbital rate.

At 6,355 sec the vehicle will be pitched to a retrograde attitude and the orbital rate resumed.

In preparation for dump experiment, the S-IVB will be maneuvered to a -90 deg pitch angle relative to the local horizontal (nose down), and rolled to inertial yaw and roll attitudes of 0 and 85 deg, respectively.

An investigation of the S-IVB trajectory resulting from dump thrust at various attitudes has been conducted. It was found that low thrust could place the S-IVB on a collision course with the LM at various attitudes in the first, second, and fourth quadrants (figure 2-18). Attitudes between 0 and -100 deg (positive measured counterclockwise from the local horizontal in the direction of motion) provide adequate communication. The proposed attitude, -90 deg, will therefore avoid the possibility of a collision and also provide adequate S-band communications. This attitude will be held until 8,158 sec after cutoff, when a -0.28 deg/sec roll rate will be initiated to provide for telemetry communications with the Carnarvon station and maintained through the experiment.

During the first 80 sec of the LOX main engine propellant dump period of the experiment, the thrust vector control (TVC) system will be used to maintain attitude control. Because of the C.G. offset a control system transient will occur when control is switched to the TVC system. Attitude error and rate transients during LOX dump are shown in figures 2-19 and 2-20. The S-IVB will be oriented in the local horizontal plane, in the retrograde direction, for the remainder of its orbital flight. The attitude timeline has been presented in figure 2-21.

Appendix 3 presents the predicted orbital trajectory. Predicted orbital conditions at start of first and second orbits, S-IVB/LM separation, and at the beginning and end of the dump experiment are shown in table 2-6. The predicted time of total axial impulse of the propellant vent and dump during orbit are presented in table 2-7.

2.2.3 Alternate Mission

The alternate inflight mission capability, in the event of a one S-IB engine shutdown, is that the desired orbit may be attained by using the remaining seven S-IB engines, S-IVB burn, and LM Descent Propulsion System (DPS) burn to orbit. This type of failure after 55 seconds results in a three sigma probability of achieving prescribed orbital conditions using only an S-IVB burn to depletion. In the event of S-IVB engine failure, an abort mission provides for a LM burn to accomplish certain spacecraft objectives.

TABLE 2-1
PREDICTED S-IVB-204 FLIGHT MASS SUMMARY

ITEM	S-IB LIFTOFF	S-IB/S-IVB SEPARATION COMPLETE	S-IVB ESC	S-IVB 90 PERCENT THRUST	EMR SHIFT	S-IVB ECC	S-IVB ETD	JETTISON NOSE CONE	DEPLOY SLA PANELS	S-IVB/LM SEPARATION	START LOX DUMP	END LOX DUMP	START LH2 DUMP	END LH2 DUMP	END PASSIVATION
Aft frame	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Detonation package	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frost	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ullage rocket grain	176	167	106	0	0	0	0	0	0	0	0	0	0	0	0
Ullage rocket case	214	214	214	214	0	0	0	0	0	0	0	0	0	0	0
Nose cone	1,067	1,067	1,067	1,067	1,067	1,067	1,067	0	0	0	0	0	0	0	0
SLA ring	91	91	91	91	91	91	91	0	0	0	0	0	0	0	0
Lunar module	31,325	31,325	31,325	31,325	31,325	31,325	31,325	31,325	31,325	0	0	0	0	0	0
Instrument unit	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600
Adapter (SLA)	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859	3,859
S-IVB-204 dry stage	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453	23,453
LOX ullage gas	37	37	37	39	278	368	363	223	235	279	400	400	400	400	-0
LOX in tank	192,906	192,906	192,906	192,533	47,127	2,915	2,795	2,795	2,783	2,739	2,618	-0	-0	-0	-0
LOX in ports	13	13	13	13	13	13	13	13	13	13	13	-0	0	0	0
LOX in lines	246	246	246	246	246	246	246	246	246	246	246	0	0	0	0
LOX in engine	108	108	108	138	138	108	108	108	108	108	108	0	0	0	0
LH2 ullage gas	163	163	163	165	396	482	483	470	306	484	488	493	493	377	-0
LH2 in tank	37,392	37,392	37,392	37,289	10,816	1,453	1,426	1,413	1,244	669	5	1	0	0	0
LH2 in lines	38	38	38	38	38	38	38	38	38	38	38	38	38	0	0
LH2 in engine	10	10	10	20	20	20	10	10	10	10	10	10	10	0	0
Cold helium quad 1	165	165	165	164	109	88	88	88	88	88	88	88	88	88	0
Cold helium quad 2	165	165	165	164	109	88	88	88	88	88	88	88	88	88	0
APS propellant fin plane I	66	66	66	65	64	63	63	63	62	58	48	48	48	48	35
APS propellant fin plane III	66	66	66	65	64	63	63	63	62	58	48	48	48	48	35
APS helium	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Service items	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
GH2 in start tank	5	5	5	1	7	7	7	7	7	7	7	7	7	7	0
Environmental control fluid	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Total mass (lbm)	296,376	296,231	296,170	295,627	123,895	70,423	70,262	68,937	68,602	36,873	36,193	33,208	33,208	33,043	32,058
Time from liftoff (sec)	0.000	143.523	144.840	148.140	475.500	598.210	599.610	643.210	1,198.210	3,235.000	8,779.010	8,899.210	8,909.010	9,089.210	16,200.000

TABLE 2-2
PREDICTED AS-204/LM-1 CONDITIONS AT MAXIMUM DYNAMIC PRESSURE

PARAMETER		UNITS	MSFC PREDICTED
Flight Time	t	sec	74.0
Dynamic Pressure	q	lbf/ft^2	68.3
Altitude	h	ft	40,494
Freestream Velocity	V_{RM}	ft/sec	1,485.9
Mach Number	M	--	1.535
Ambient Pressure	Pa	lbf/ft^2	413.93
Pitch Angle of Attack	α	deg	-0.5153
Yaw Angle of Attack	β	deg	0.0409

TABLE 2-3
PREDICTED AS-204/LM-1 CONDITIONS AT S-IB/S-IVB PHYSICAL SEPARATION

PARAMETER		UNITS	MSFC PREDICTED
Flight Time	t	sec	143.4
Downrange Distance	X_E	ft	207,792
Vertical Distance	Y_E	ft	207,571
Crossrange Distance	Z_E	ft	-159.8
Downrange Velocity	$\dot{X}_E$	ft/sec	5,648.94
Vertical Velocity	$\dot{Y}_E$	ft/sec	3,496.53
Crossrange Velocity	$\dot{Z}_E$	ft/sec	2.42
Relative Velocity	V_E	ft/sec	6,643.51
Inertial Velocity	V_I	ft/sec	7,774.20
Inertial Flight Path Elevation Angle	γ_{1_I}'	deg	27.146
Inertial Flight Path Azimuth Angle	γ_{2_I}'	deg	75.644
Altitude	h	ft	208,592
Range	S	ft	205,924
Dynamic Pressure		$16/ft^2$	9.05
Pitch Angle of Attack		deg	-0.9753
Yaw Angle of Attack		deg	0.0553

TABLE 2-4
PREDICTED AS-204/LM-1 CONDITIONS AT S-IVB CUTOFF

PARAMETER		UNITS	DAC	MSFC
Flight Time	t	sec	598.21	598.15
Downrange Distance	X_E	ft	5,949,935	5,956,577
Vertical Distance	Y_E	ft	-307,511	-309,432
Crossrange Distance	Z_E	ft	297,610	298,156
Downrange Velocity	$\dot{X}_E$	ft/sec	23,311.0	23,308.6
Vertical Velocity	$\dot{Y}_E$	ft/sec	-6,743.3	-6,751.0
Crossrange Velocity	$\dot{Z}_E$	ft/sec	1,749.8	1,751.9
Relative Velocity	V_E	ft/sec	24,329.8	24,329.7
Inertial Velocity	V_1	ft/sec	25,661.1	25,661.1
Inertial Flight Path Elevation Angle	γ_{1_I}'	deg	-0.003	-0.004
Inertial Flight Path Azimuth Angle	γ_{2_I}'	deg	85.691	85.707
Altitude	h	ft	535,406	535,411
Range	S	ft	5,886,281	5,893,027

TABLE 2-5
PREDICTED AS-204/LM-1 CONDITIONS AT INSERTION

PARAMETER		UNITS	DAC	MSFC
Flight Time	t	sec	608.21	608.15
Downrange Distance	X_E	ft	6,184,060	6,189,480
Vertical Distance	Y_E	ft	-376,647	-378,283
Crossrange Distance	Z_E	ft	315,294	315,765
Downrange Velocity	$\dot{X}_E$	ft/sec	23,253.5	23,252.8
Vertical Velocity	$\dot{Y}_E$	ft/sec	-7,010.6	-7,017.7
Crossrange Velocity	$\dot{Z}_E$	ft/sec	1,776.2	1,768.4
Relative Velocity	V_E	ft/sec	24,351.5	24,353.0
Inertial Velocity	V_I	ft/sec	25,682.8	25,684.4
Inertial Flight Path Elevation Angle	γ_{1_I}'	deg	0.009	0.008
Inertial Flight Path Azimuth Angle	γ_{2_I}'	deg	86.111	86.125
Altitude	h	ft	535,489	535,491
Range	S	ft	6,124,868	6,130,390
Inclination		deg	31.61	31.61
Eccentricity		deg	0.0048	0.0049
Period		min	88.26	88.28
Apogee Altitude*	h_{ap}	n. mi.	118.69	119.56
Perigee Altitude*	h_p	n. mi.	84.97	84.98

*Measured with respect to a mean earth radius of 3,443.94 n. mi.

TABLE 2-6
PREDICTED AS-204/LM-1 ORBIT CONDITIONS

PARAMETER	UNITS	START OF 1ST ORBIT	S-IVB-LM SEPARATION	DUMP EXPERIMENT	
				BEFORE	AFTER
Flight Time	sec	608.2	3,235	8,780	9,100
Inclination	deg	31.61	31.61	31.61	31.63
Eccentricity		0.0048	0.0038	0.0038	0.0047
Apogee Altitude*	n. mi.	118.1	116.5	117.6	122.9
Perigee Altitude*	n. mi.	84.96	89.3	90.4	89.4
Apogee Velocity	ft/sec	35,440	25,459	25,456	25,426
Perigee Velocity	ft/sec	25,683	25,655	25,652	25,667
Period	min	88.26	88.30	88.34	88.42

*Measured with respect to a mean earth radius of 3,443.9 n. mi.

TABLE 2-7
PREDICTED AS-204/LM-1 ORBITAL VENT IMPULSE

DESCRIPTION	TIME FROM S-IVB ECC (sec)		TOTAL AXIAL IMPULSE (lb-sec)
	FROM	TO	
LOX Vent	0.2	40.2	10,000
LOX Dump	8,180.8	8,300.8	51,000
LH2 Dump	8,310.8	8,490.8	7,200

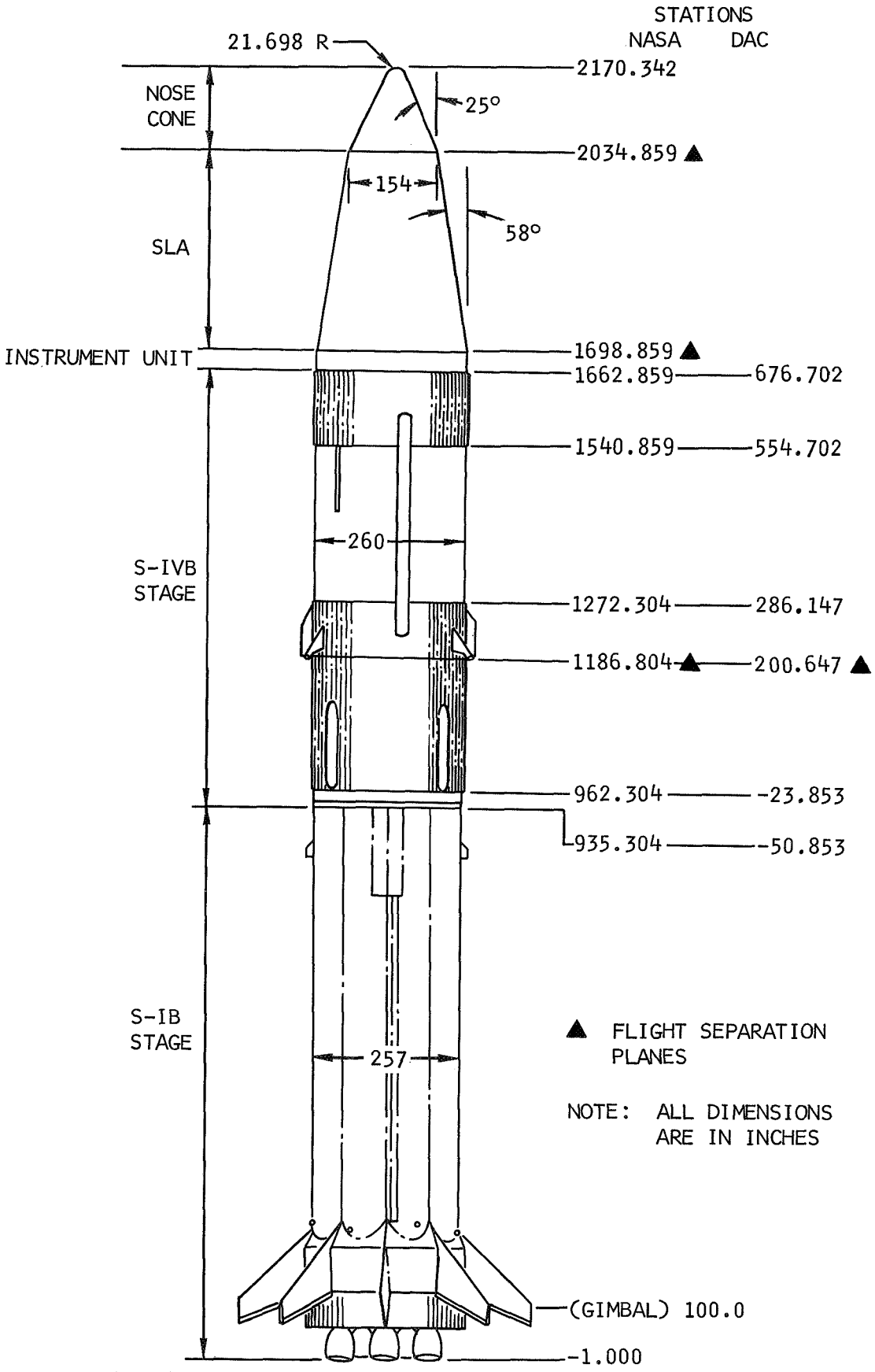


Figure 2-1. AS-204/LM-1 Launch Vehicle

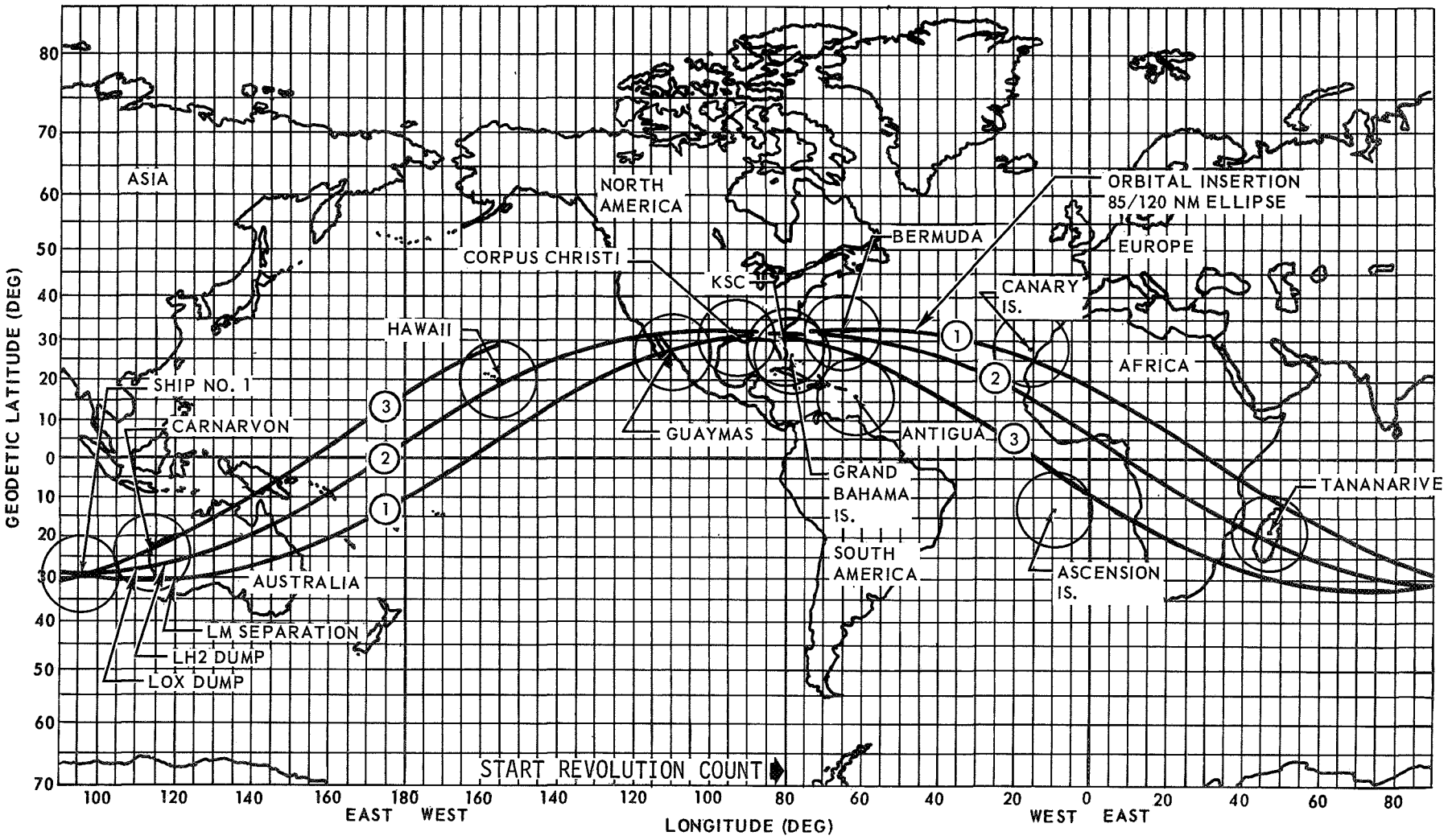


Figure 2-2. Ground Trace and Mission Events, 5 Deg Elevation Angle Coverage

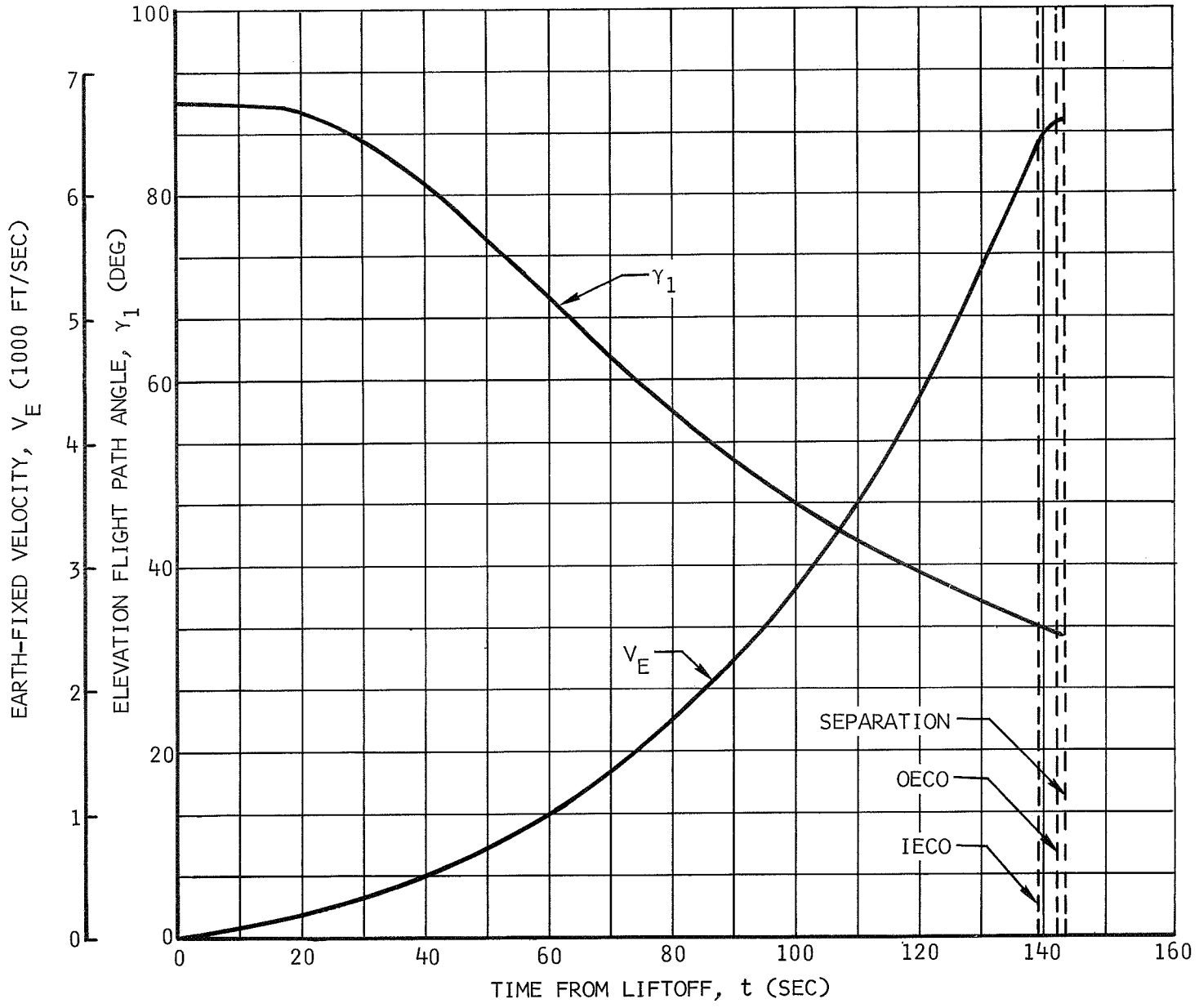


Figure 2-3. Predicted Trajectory, S-IB Powered Flight, Earth Fixed Velocity and Elevation Flight Path Angle

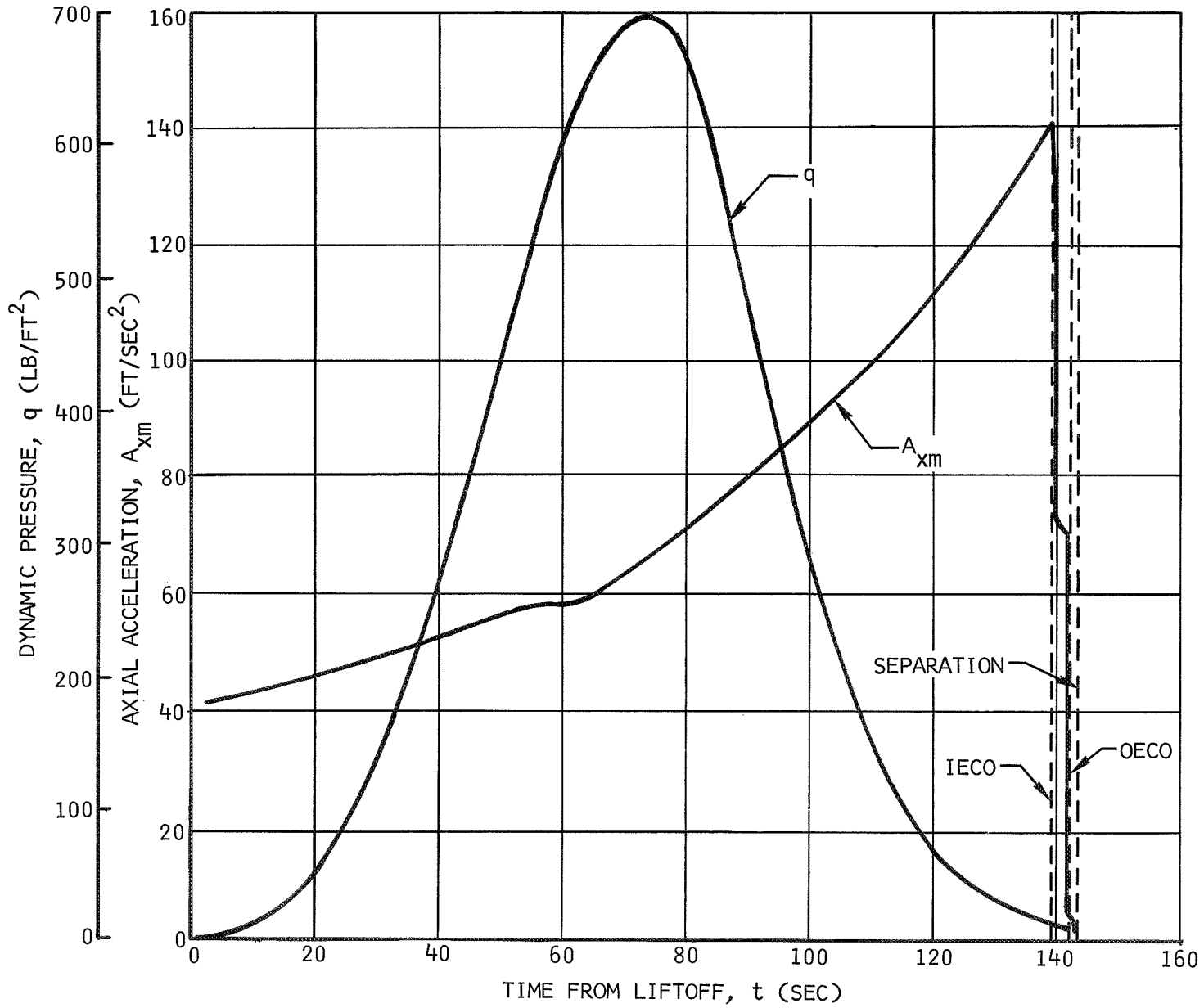


Figure 2-4. Predicted Trajectory, S-IB Powered Flight, Dynamic Pressure and Axial Acceleration

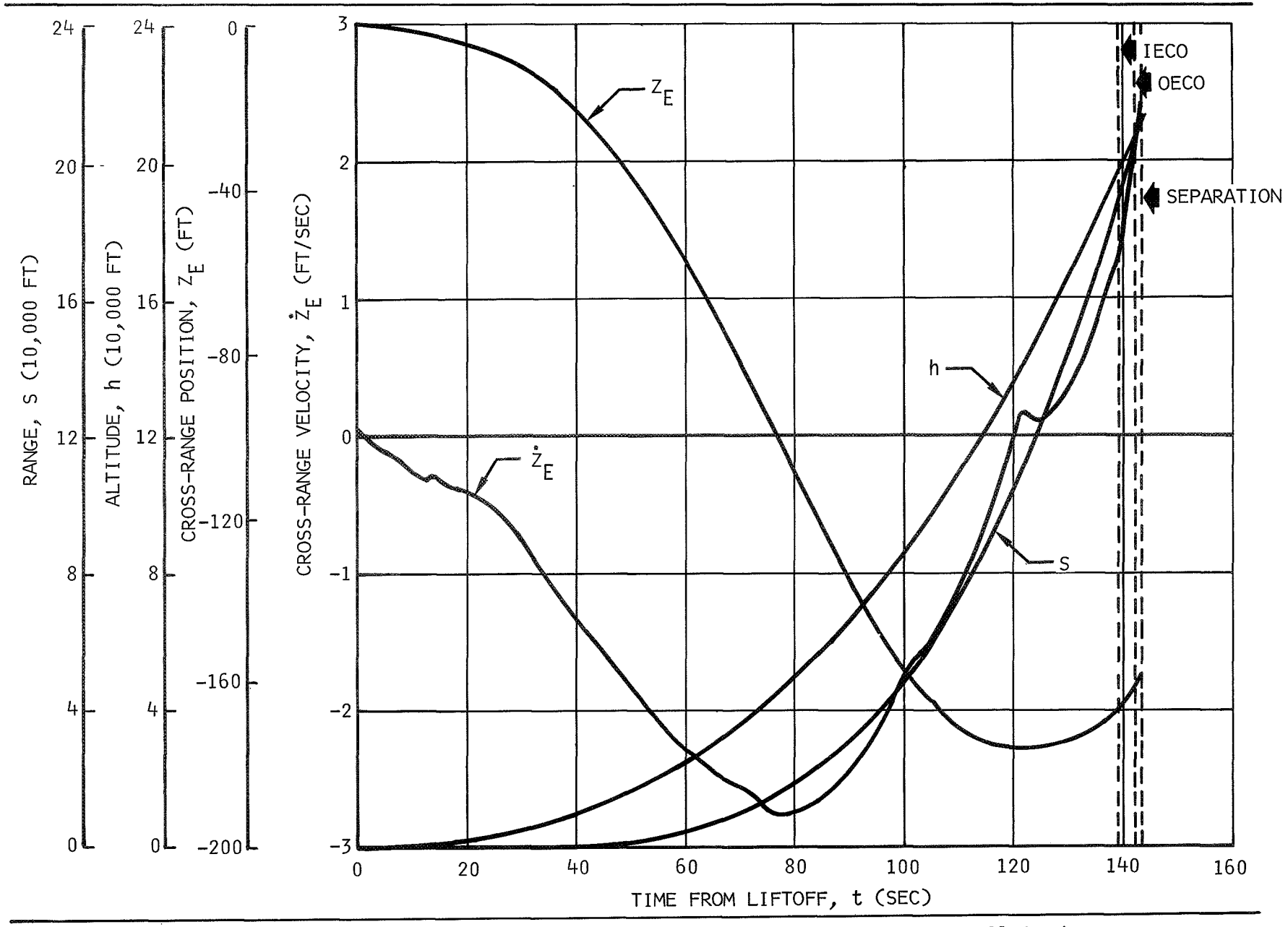


Figure 2-5. Predicted Trajectory, S-IB Powered Flight, Range, Altitude, Cross-Range Position, and Cross-Range Velocity.

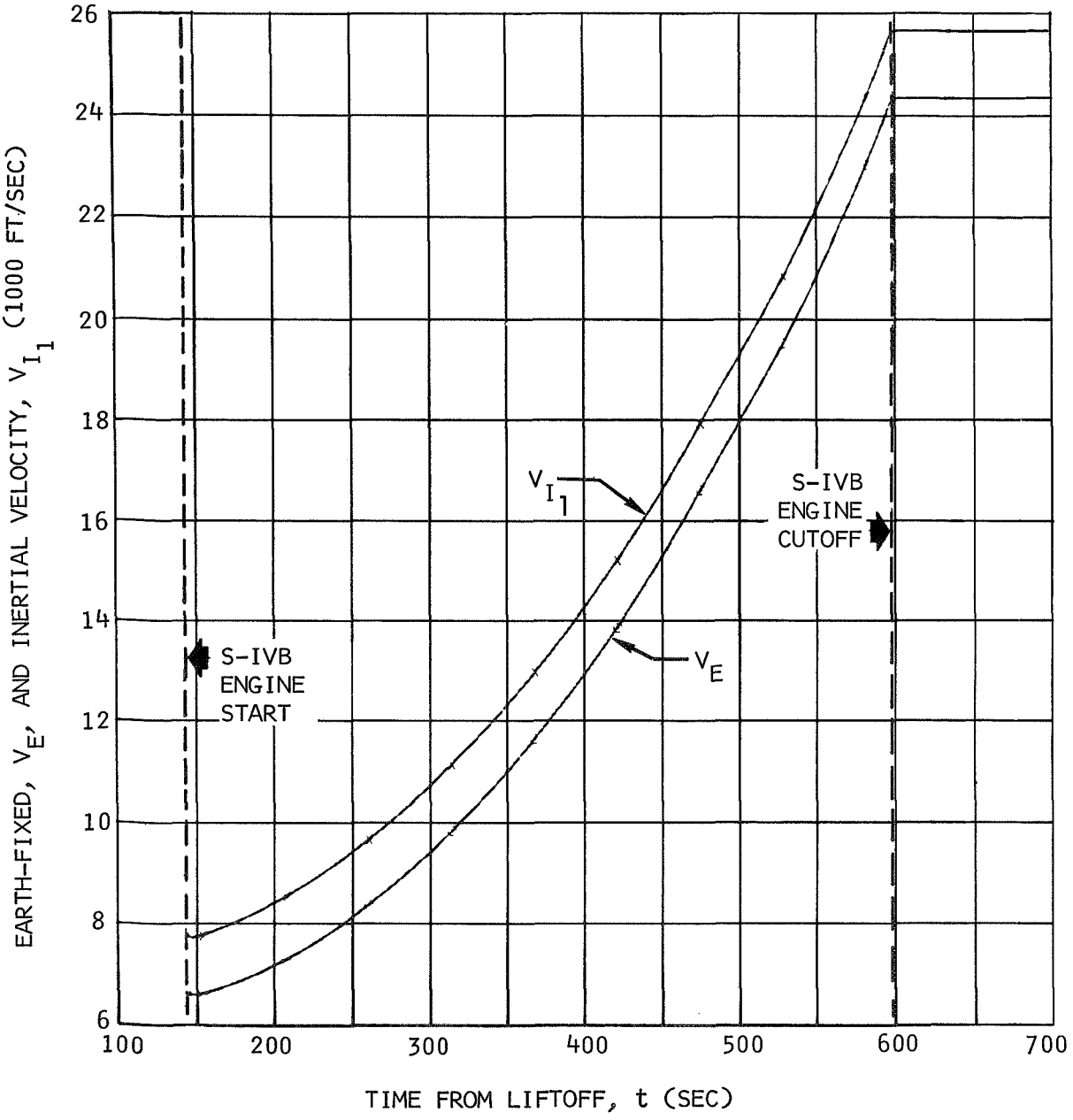


Figure 2-6. Predicted Trajectory, S-IVB Powered Flight, Earth Fixed Velocity and Inertial Velocity

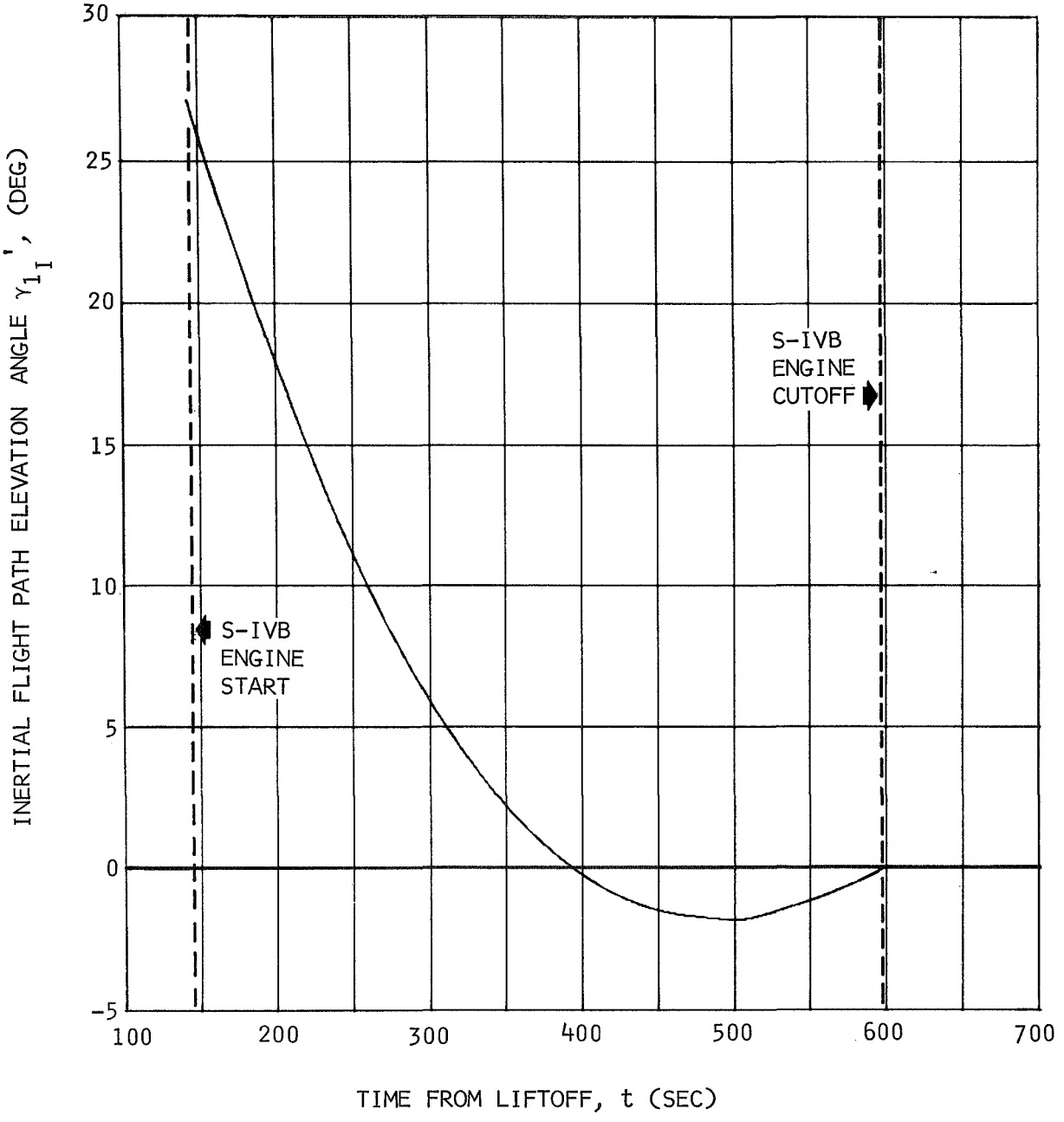


Figure 2-7. Predicted Trajectory, S-IVB Powered Flight, Inertial Elevation Angle

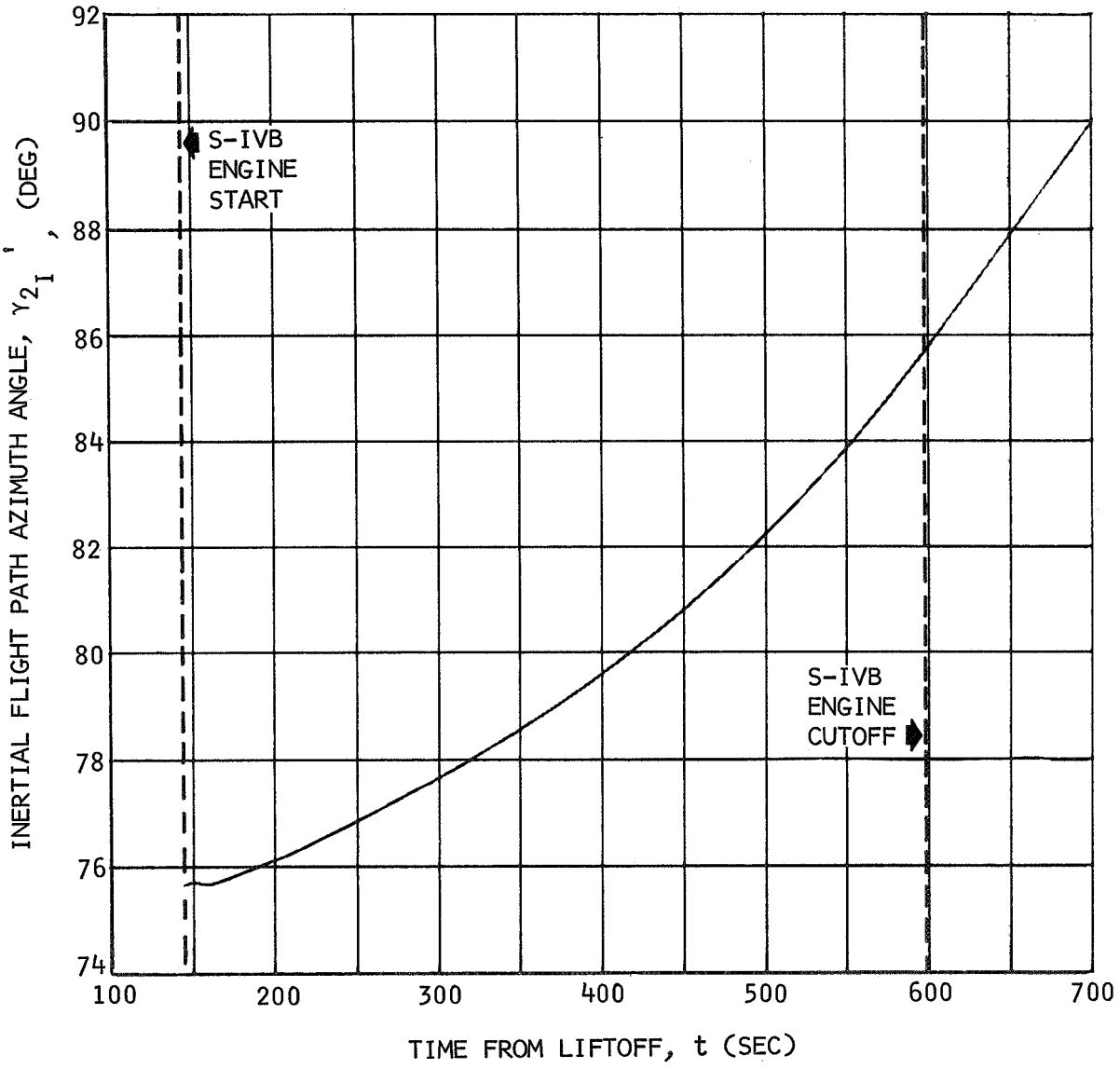


Figure 2-8. Predicted Trajectory, S-IVB Powered Flight, Inertial Azimuth Angle

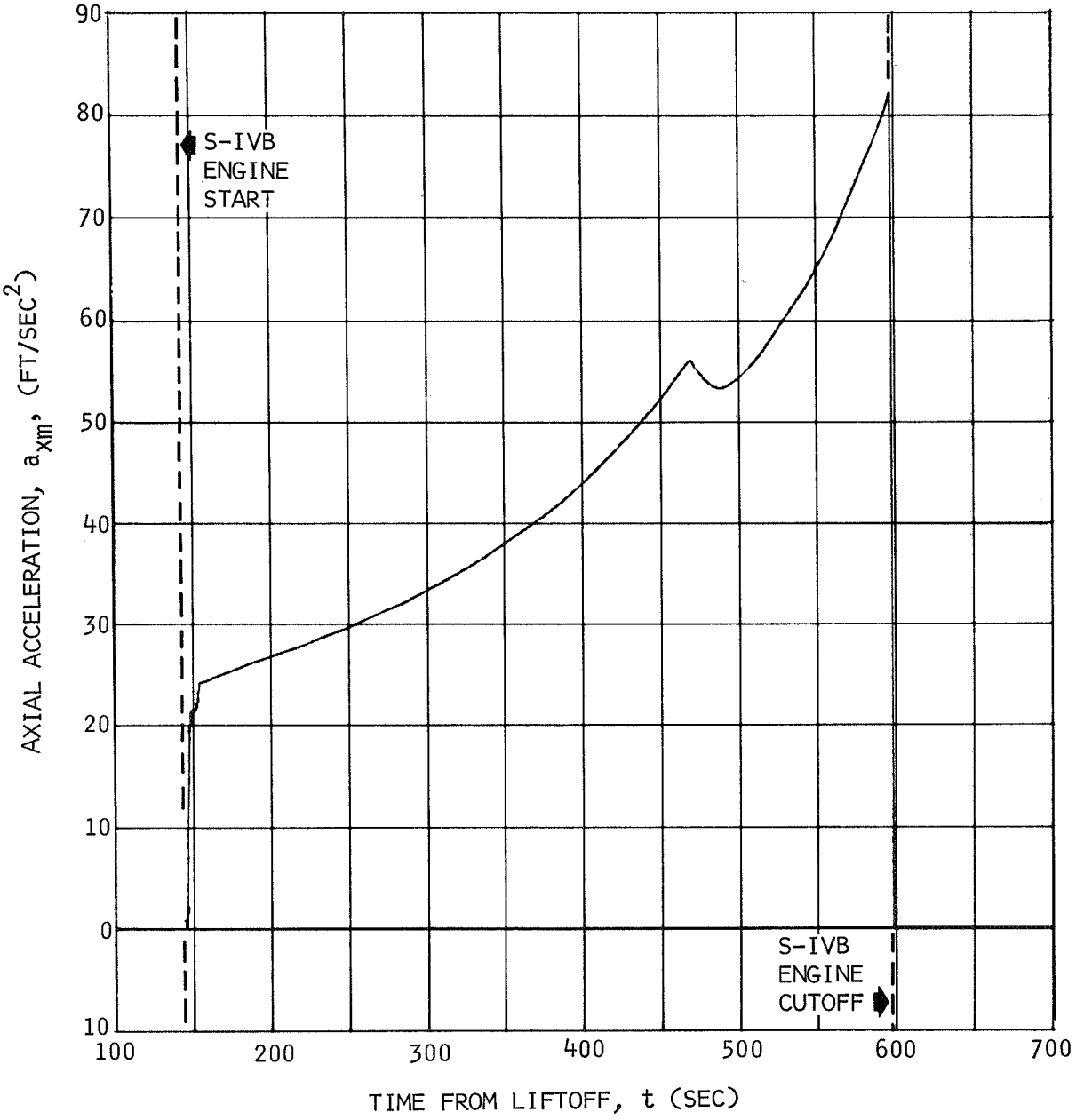


Figure 2-9. Predicted Trajectory, S-IVB Powered Flight, Axial Acceleration

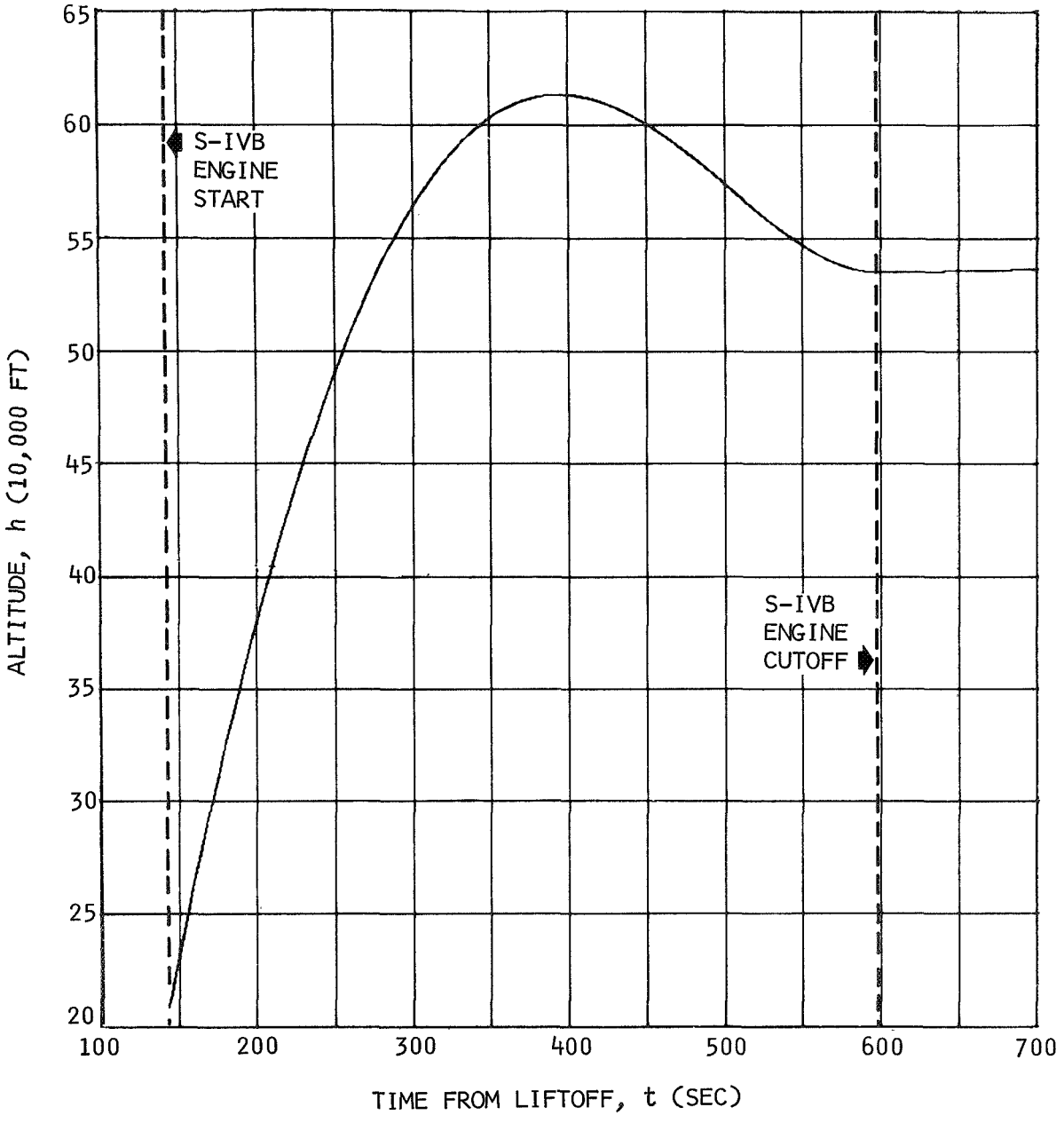


Figure 2-10. Predicted Trajectory, S-IVB Powered Flight, Altitude

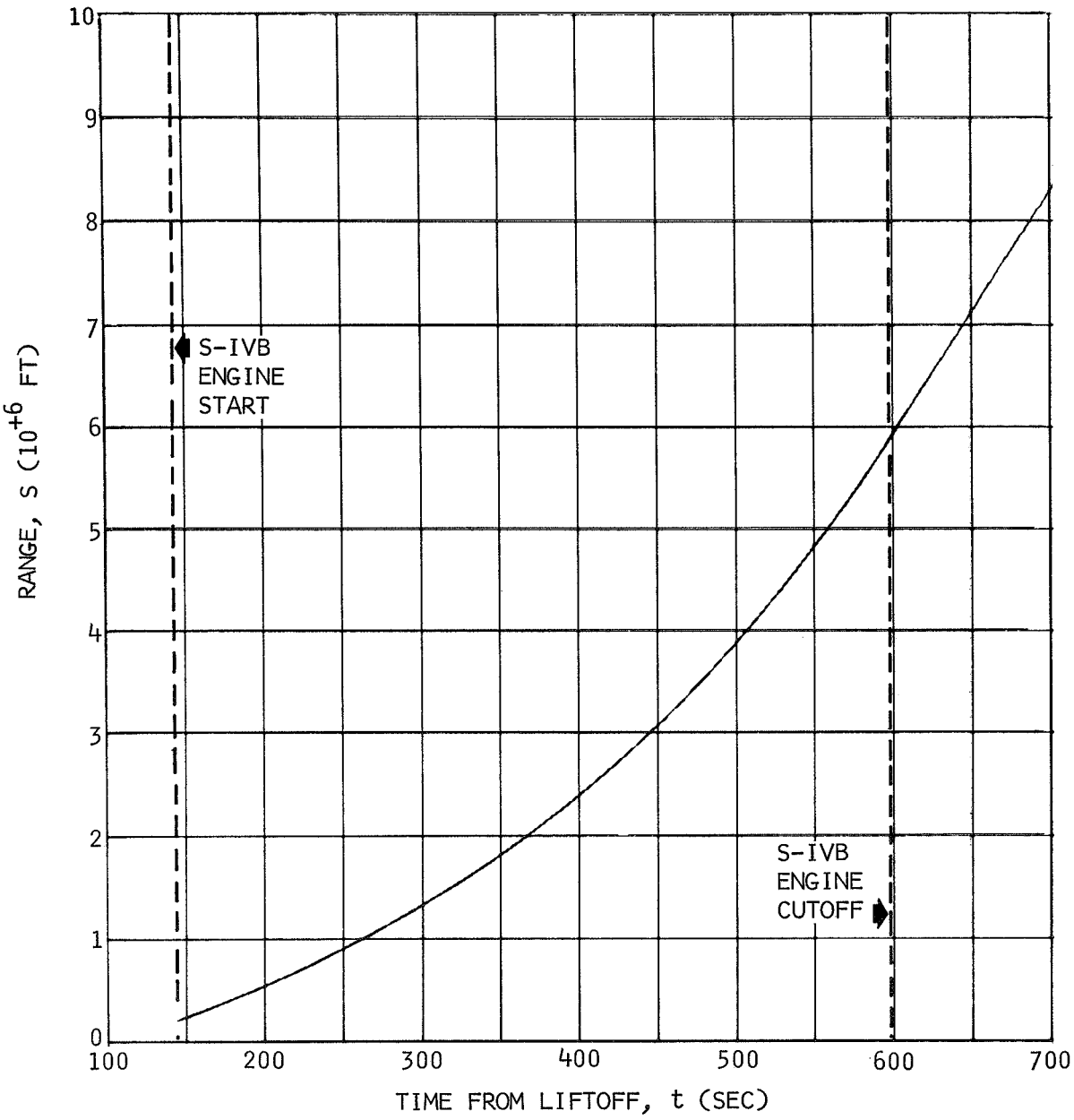


Figure 2-11. Predicted Trajectory, S-IVB Powered Flight, Range

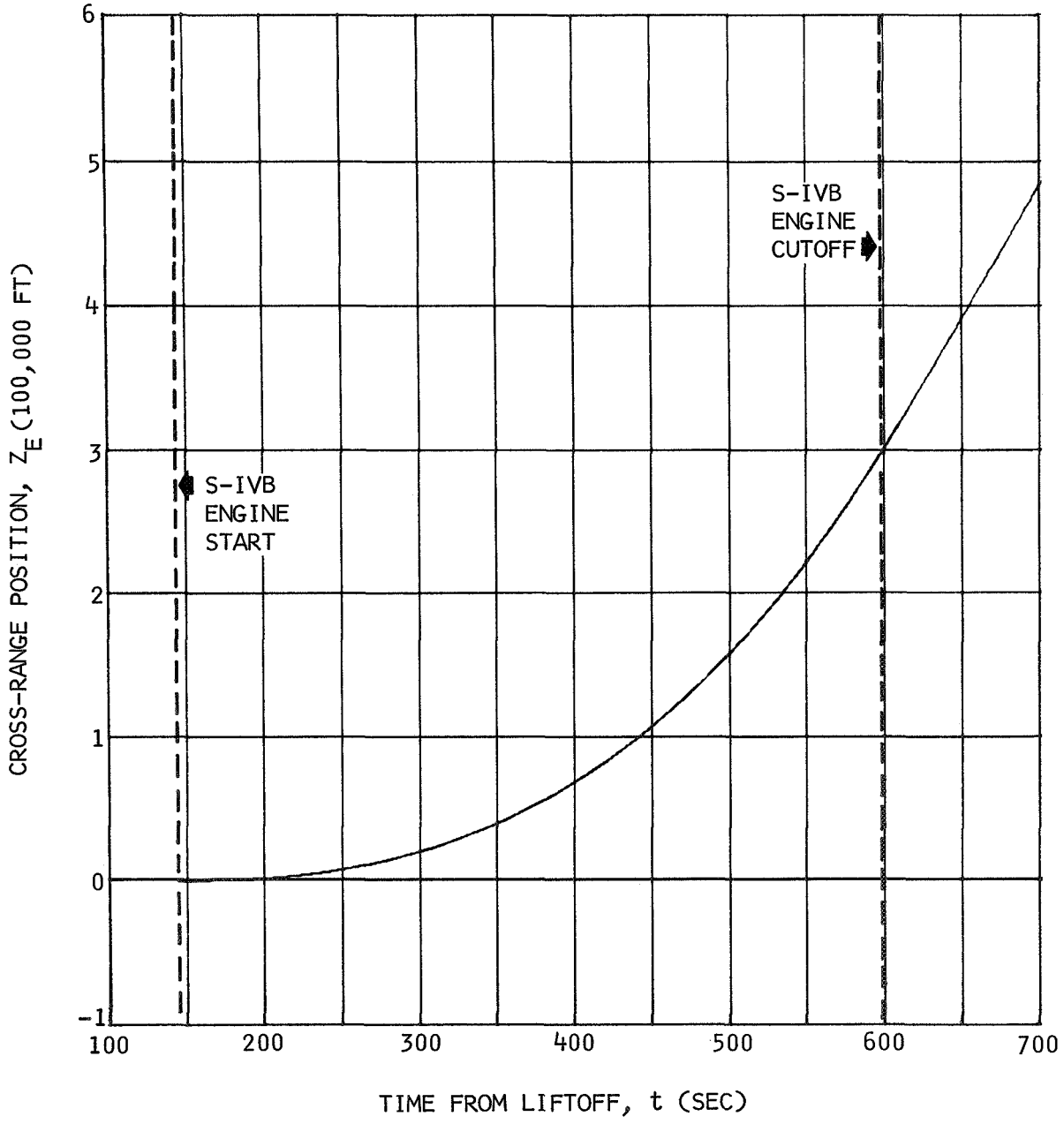


Figure 2-12. Predicted Trajectory, S-IVB Powered Flight, Cross-Range Position

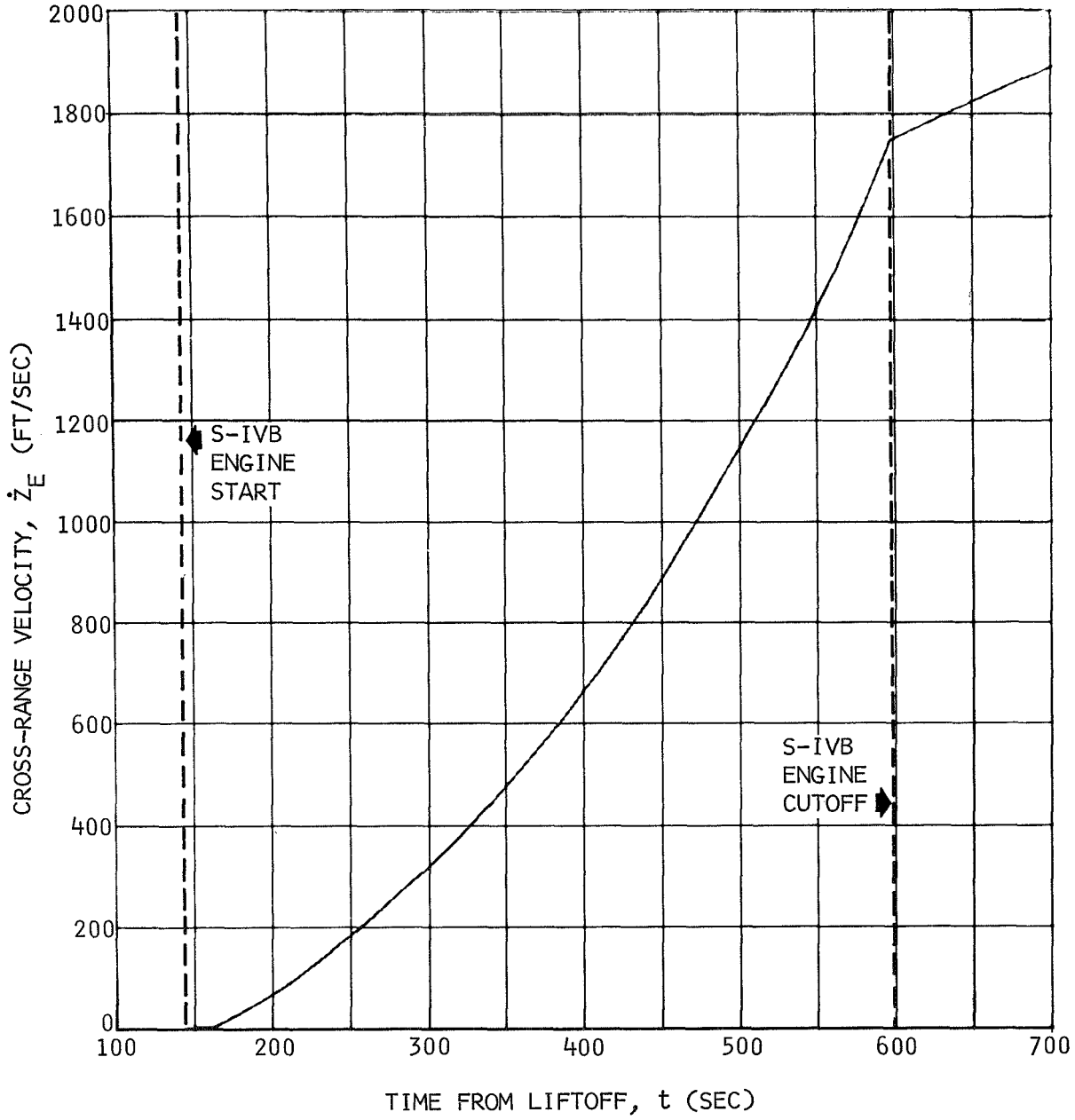


Figure 2-13. Predicted Trajectory, S-IVB Powered Flight, Cross-Range Velocity

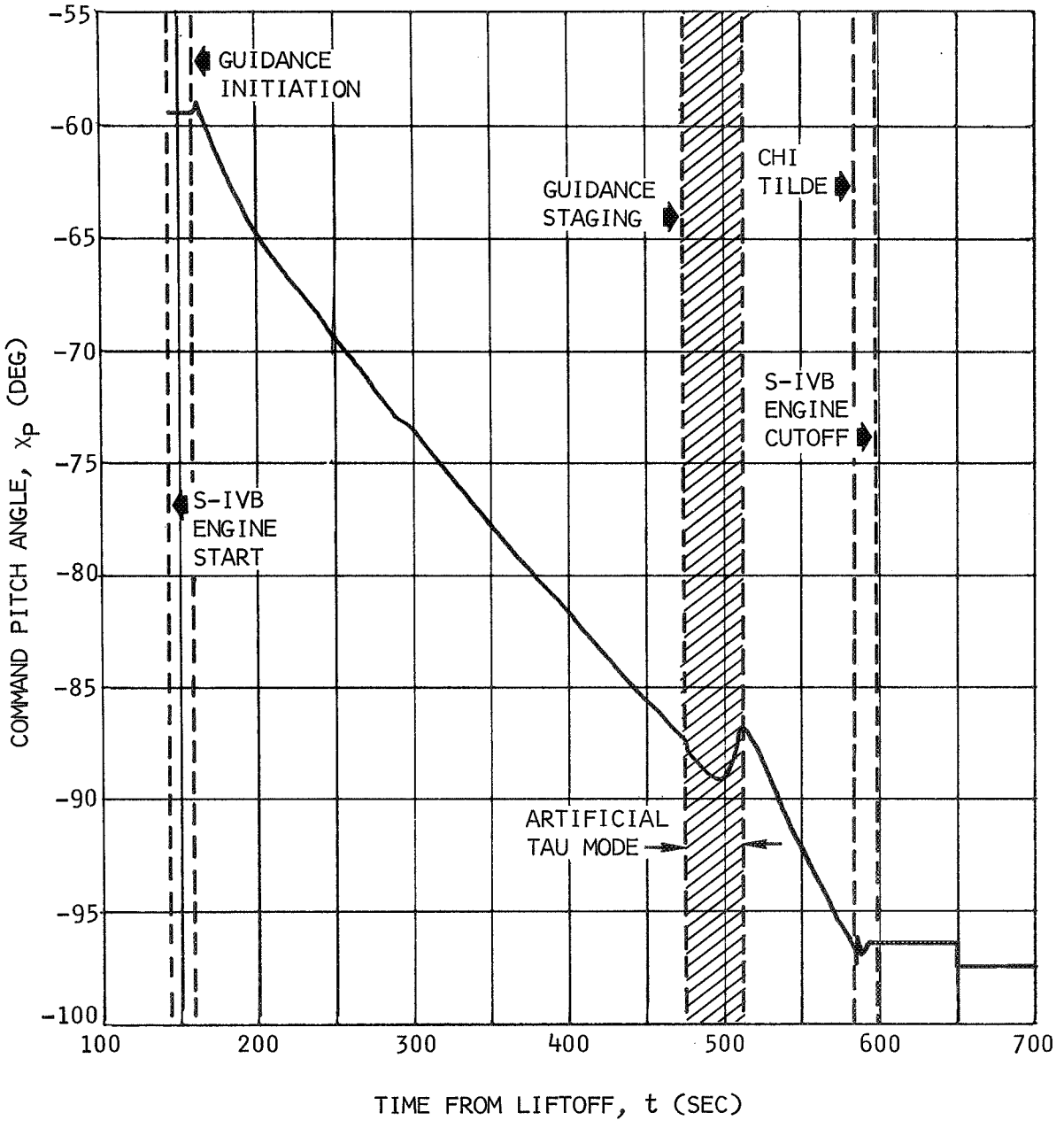


Figure 2-14. Predicted Trajectory, S-IVB Powered Flight, Commanded Pitch Angle

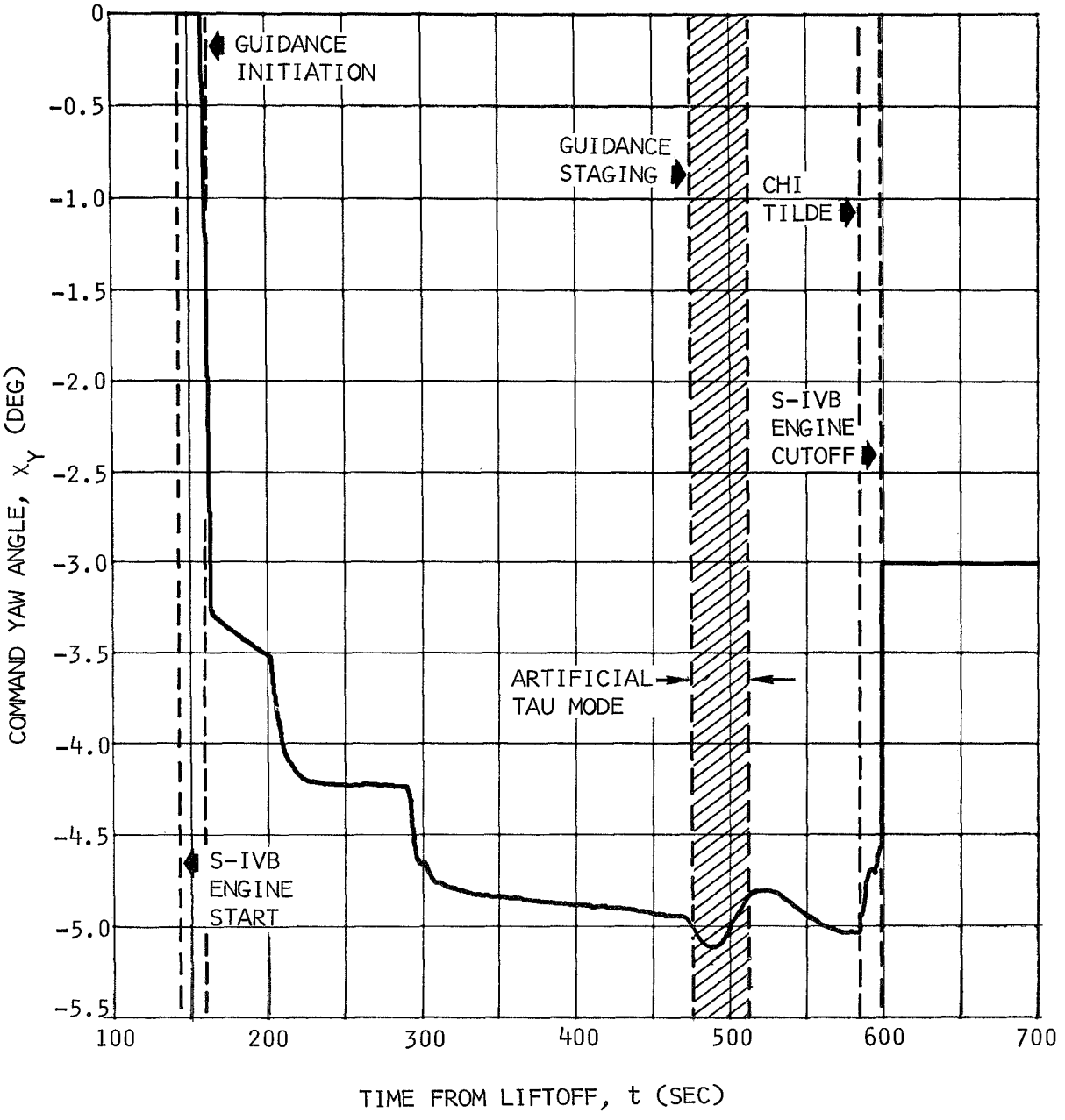


Figure 2-15. Predicted Trajectory, S-IVB Powered Flight, Commanded Yaw Angle

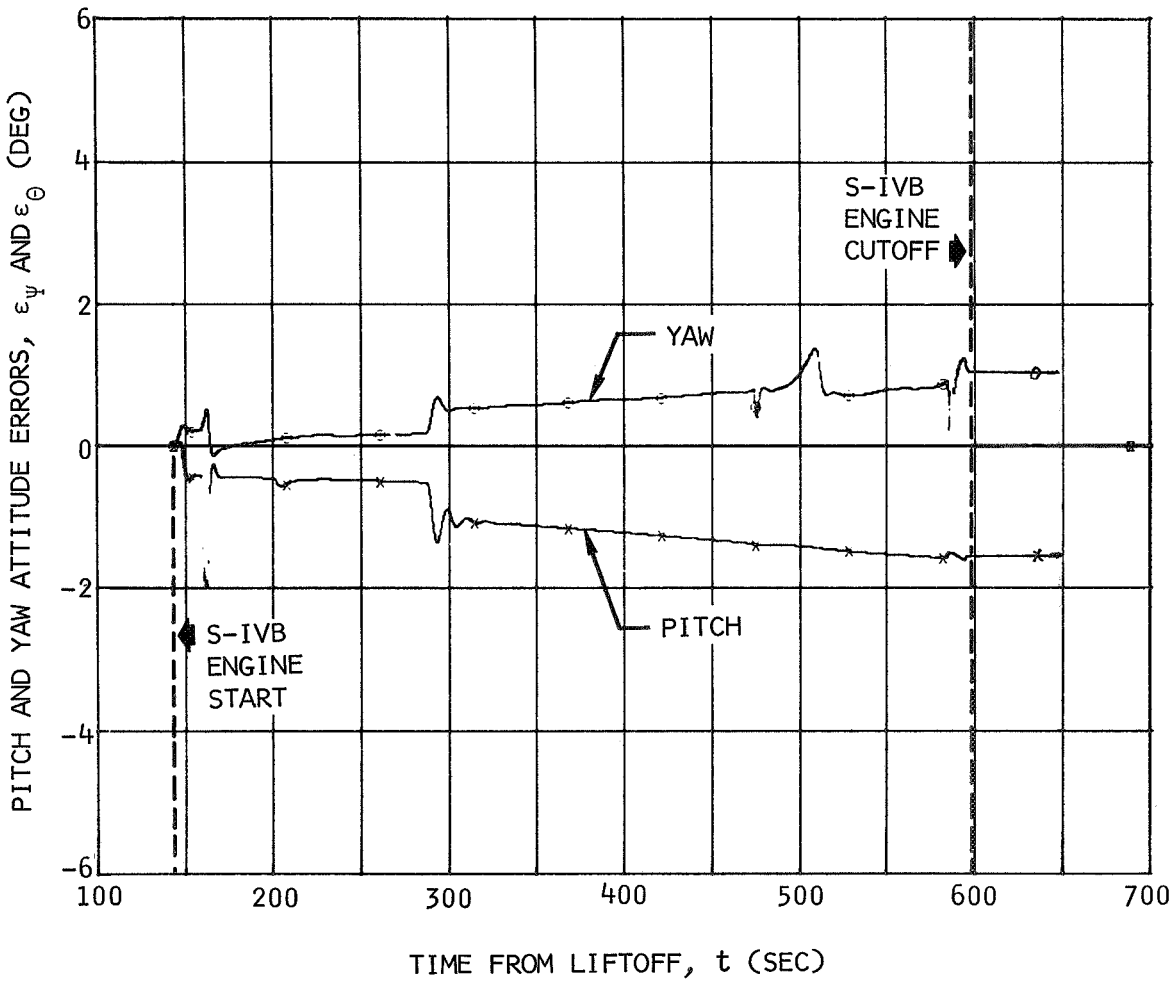


Figure 2-16. Predicted Trajectory, S-IVB Powered Flight, Pitch and Yaw Attitude Errors

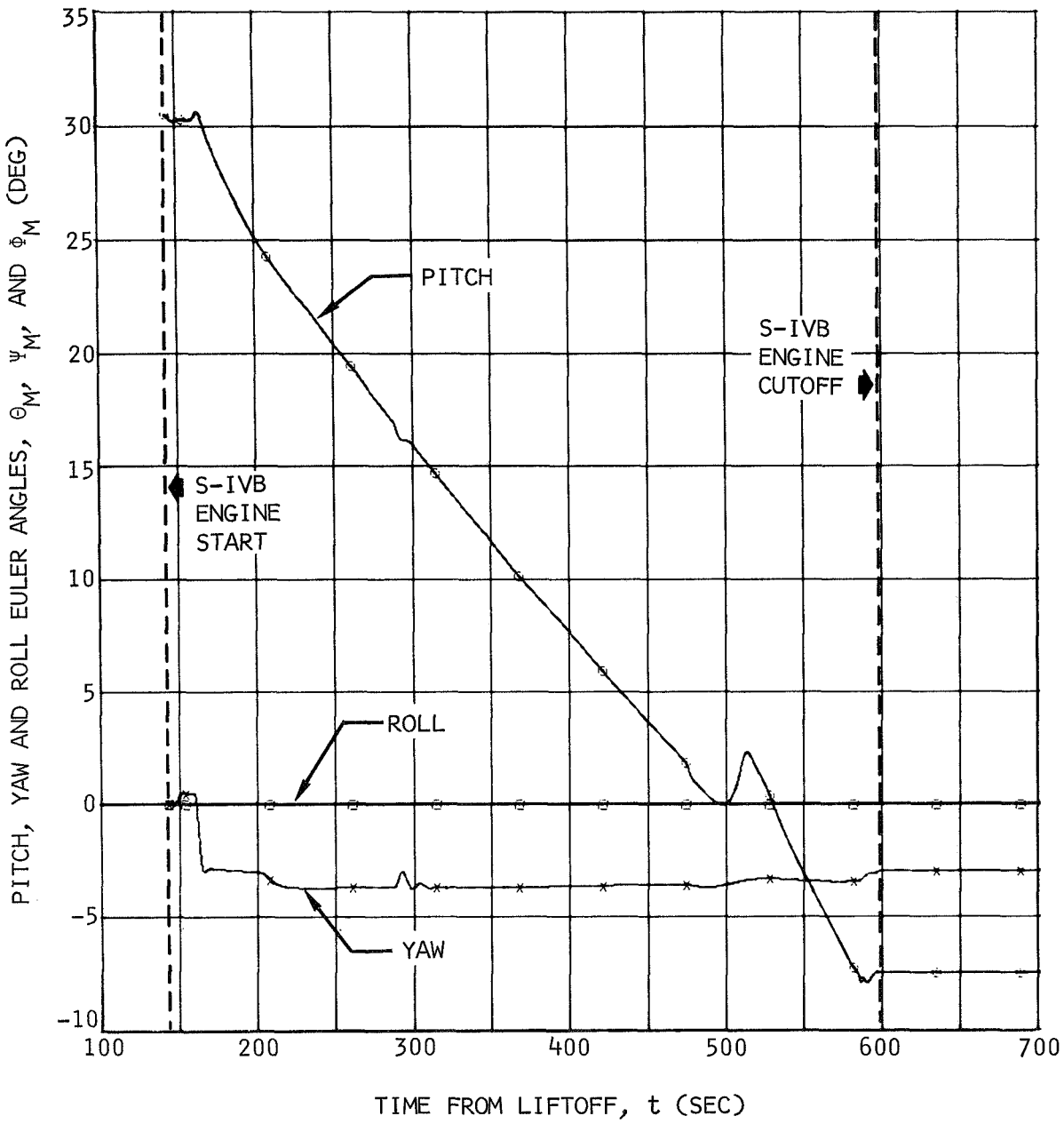


Figure 2-17. Predicted Trajectory, S-IVB Powered Flight, Pitch, Yaw, and Roll Euler Angles

16 December 1967

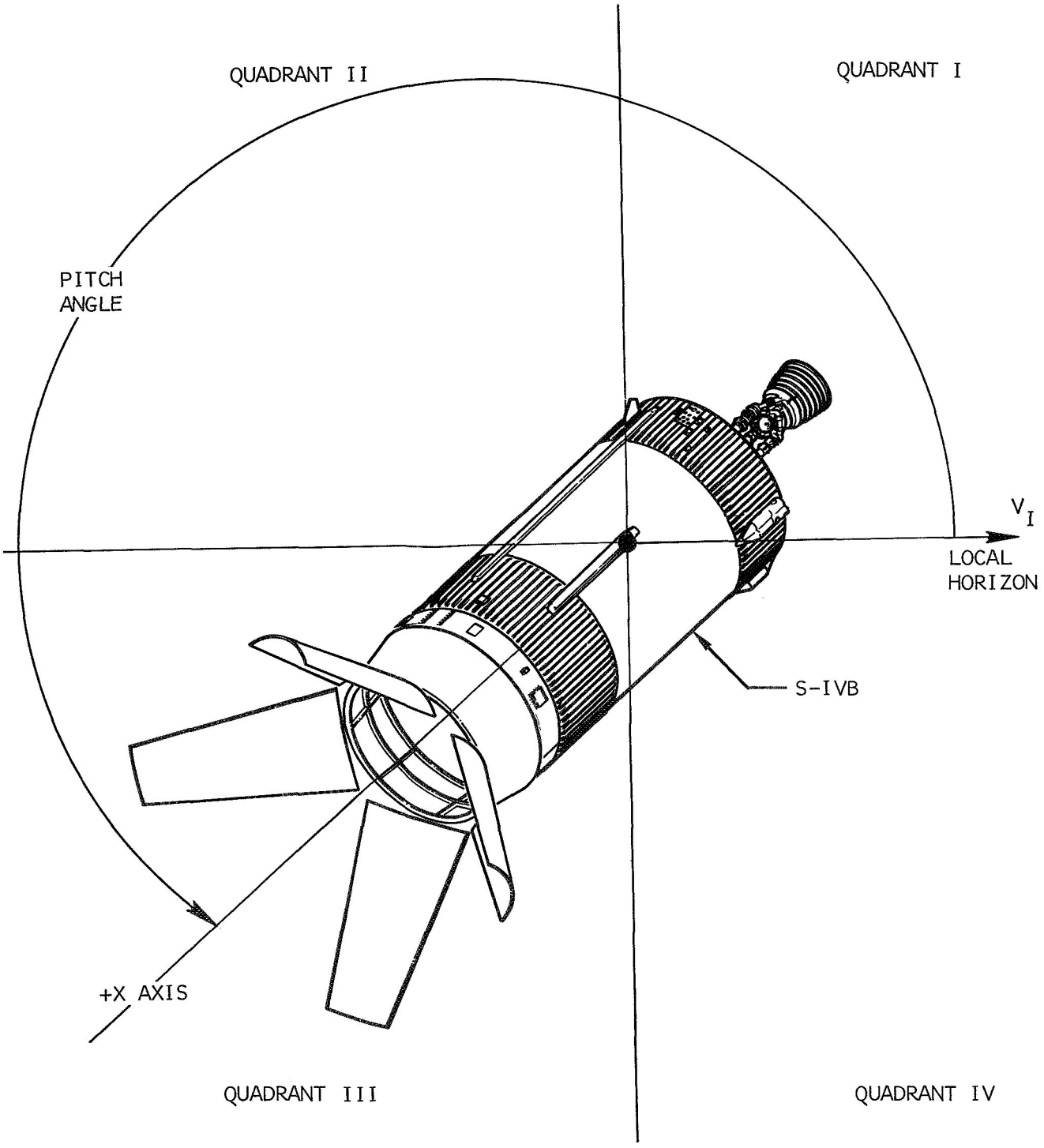


Figure 2-18. S-IVB Attitude Quadrants

16 December 1967

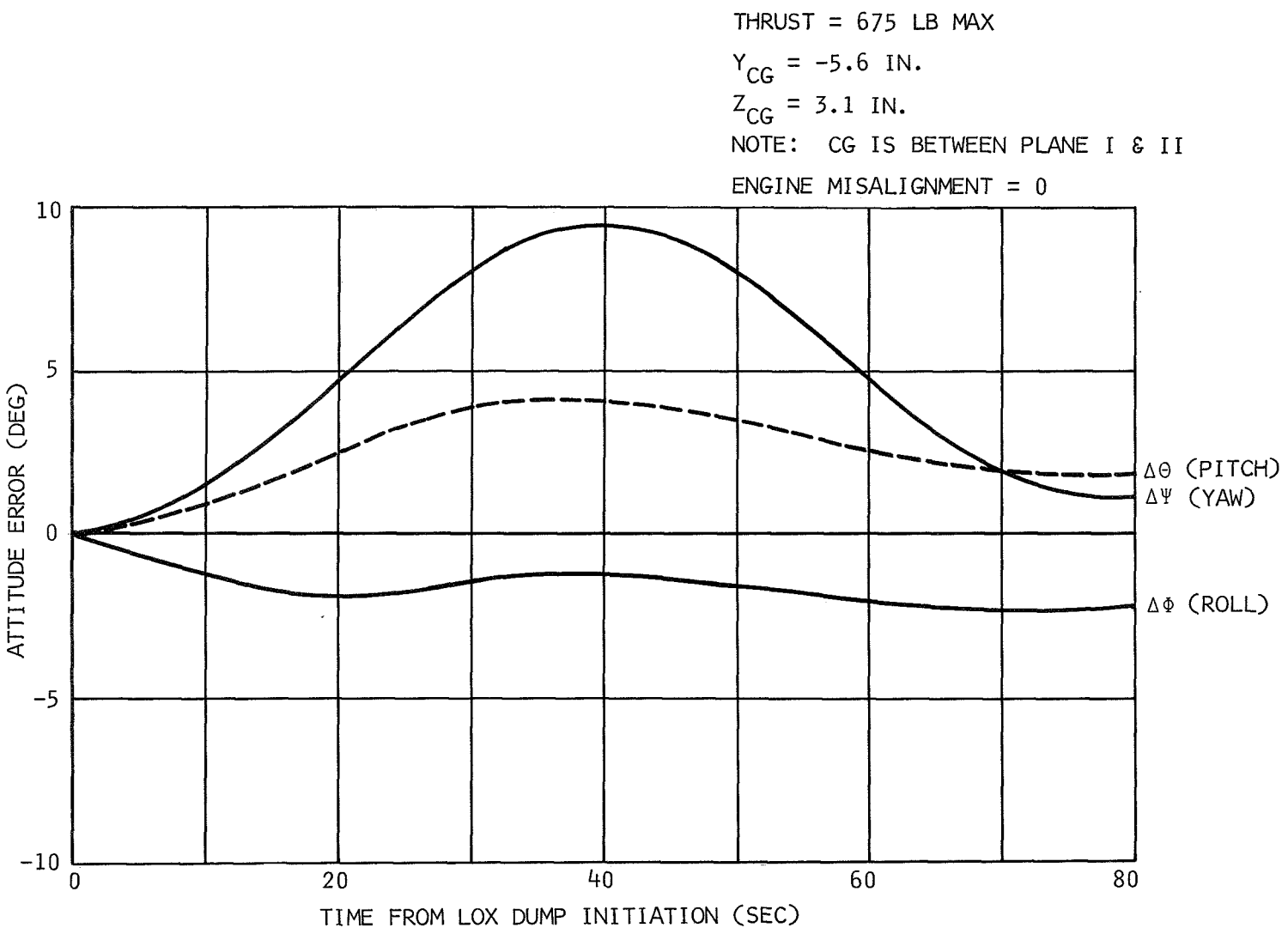
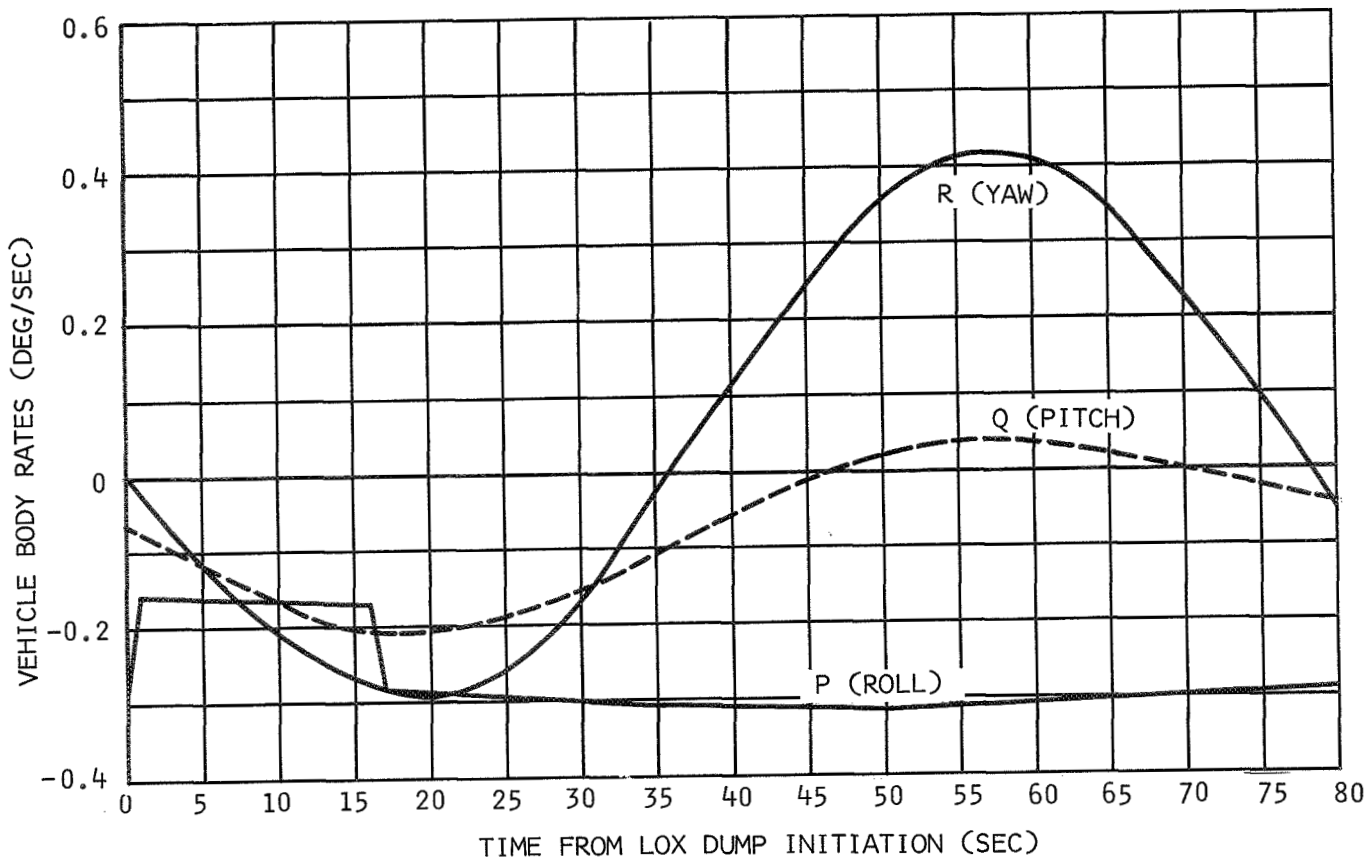


Figure 2-19. Predicted Pitch, Roll, and Yaw Attitude Errors during LOX Dump



THRUST = 675 LB. MAX.

ENGINE MISALIGN. = 0

Y_{CG} = -5.6 IN.

Z_{CG} = 3.1 IN.

Figure 2-20. Predicted Vehicle Body Rates During LOX Dump

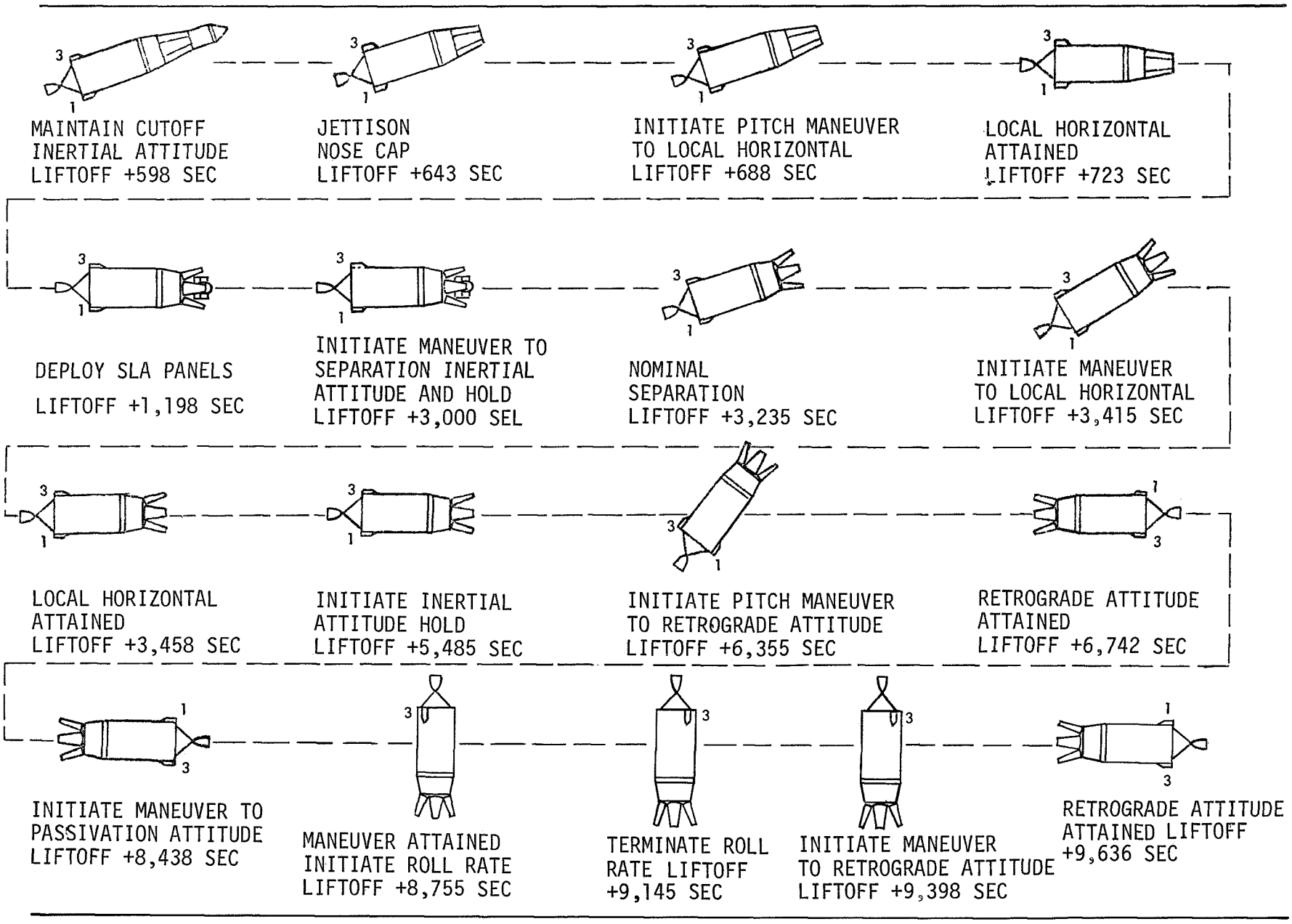


Figure 2-21. Orbital Attitude Timeline

SECTION 3

STAGE OBJECTIVES

3. STAGE OBJECTIVES

This section defines the S-IVB stage flight objectives for the AS-204 mission.

The purpose of the S-IVB stage objectives is to verify the performance of the S-IVB stage airframe and stage systems, to confirm the compatibility of the S-IB/S-IVB vehicle interfaces, and to determine and evaluate the internal and external stage environments. It should be noted that the stage objectives describe the evaluation efforts to be accomplished exclusively by Douglas Aircraft Company and do not completely satisfy the mission objectives. Mission objectives, described in section 2 of this document, are satisfied by the cumulative evaluation efforts of MSFC, Douglas, and the other Saturn program contractors and the results reported in the MSFC vehicle report.

3.1 Airframe Structural Integrity

Verify the structural integrity of the S-IVB stage during launch, boost, and powered flight. This objective will be achieved by the evaluation of the structural integrity of the following airframe components:

a. Forward skirt assembly

b. LH2 tank assembly

c. LOX tank assembly

d. Engine thrust structure

e. Aft skirt assembly

f. Aft interstage assembly

g. Common bulkhead.

3.2 Main Propulsion System

Verify the propulsion system operations during launch, boost and powered flight.

This objective will be achieved by evaluation of the performance of the following systems: the J-2 engine, LH2, LOX, and the stage pneumatic

control and purge system. Predicted propulsion system performance curves are presented in figures AP 5-1 through AP 5-32. Average predicted propulsion system performance parameters are presented in table AP 5-1.

3.2.1 J-2 Engine Performance and Conditioning

Determine the J-2 engine chilldown, start, steady-state, and cutoff performance characteristics. Evaluation of the following will verify this objective:

a. Thrust buildup characteristics during engine start transient

b. Thrust characteristics during steady-state operation

c. Thrust decay characteristics during engine cutoff

d. Total impulse

e. Start impulse

f. Cutoff impulse

g. J-2 engine thrust chamber chilldown time; thermal gradients; response of the structure to chilldown, S-IB/S-IVB interstage environment, and retro and ullage rocket plume impingement during the S-IB stage boost phase

h. J-2 engine start sphere chilldown and loading, conditions in the sphere at liftoff and Engine Start Command (ESC); mass used for engine start; and sphere warmup rate from pressurization to liftoff and during S-IB boost

i. J-2 engine control helium sphere prepressurization and loading; sphere conditions at liftoff and at ESC; and sphere warm-up rate from loading to liftoff and during S-IB boost

j. J-2 engine sequencing

k. Propellant consumption using flow integration and thrust profile for flight performance reconstruction.

3.2.2 LH2 System

Satisfactory operation of the LH2 system will be verified by the following:

3.2.2.1 LH2 Propellant Feed System

Demonstrate the capability of the LH2 system to provide sufficient fuel and net positive suction head (NPSH) to the J-2 engine for satisfactory operation. Evaluation of the following will verify this objective:

a. Loading rates and tank ullage pressure to satisfy prelaunch loading operation requirements

b. Prepressurization of the LH2 tank prior to launch

c. Transition from ground prepressurization to onboard flight pressurization system to provide tank ullage pressure during engine operation

d. Conditions of propellant NPSH supplied to the J-2 engine LH2 interface during prestart and steady-state operation

e. LH2 recirculation chilldown

f. NPSH delivered to the J-2 engine interface.

3.2.2.2 LH2 Vent System

Demonstrate the capability of the vent system to provide required tank pressures after J-2 engine cutoff. Evaluation of the following will verify this objective:

a. Nonpropulsive vent system flowrate

b. Nonpropulsive vent system thrust and thrust imbalance

c. Tank depressurization rate

d. Tank self-pressurization rate

e. Heat input rates.

3.2.3 LOX System

Demonstrate the capability of the oxidizer system to provide sufficient oxidizer and net positive suction head (NPSH) to the J-2 engine for

satisfactory operation. Evaluation of the following will verify this objective:

a. Loading rates and tank ullage pressure to satisfy prelaunch loading operation requirements

b. Prepressurization of the LOX tank prior to launch

c. Transition from ground prepressurization to onboard flight prepressurization and operation of the onboard LOX tank pressurization to provide tank ullage pressure during engine operation

d. Pressurization control module operation

e. Cold helium supply

f. J-2 heat exchanger performance

g. LOX pump chilldown and recirculation

h. Conditions of propellant NPSH supplied to the J-2 engine LOX interface during prestart and steady-state operation

i. Tank depressurization rate following J-2 engine shutdown and vent valve actuation.

3.2.4 Pneumatic Control and Purge System

Demonstrate the capability of the pneumatic control and purge system to provide pneumatic power and purge gas throughout the mission.

Performance evaluation will include:

a. Ambient helium supply

b. Regulation of control pressure

c. Actuation of pneumatic valves

d. Helium purge pressure and flow for the LH2 and LOX turbopump purges during prelaunch operations

e. LOX recirculation chilldown pump motor container purge pressure.

3.2.5 LH2 and LOX Tank Orbital Dump

Demonstrate the capability of the S-IVB stage to dump the residual propellants for the orbital workshop concept. Evaluation of the following will verify this objective:

a. Propellant residual dump through the J-2 engine

b. "Blow-down" of the cold helium spheres

c. "Blow-down" of the pneumatic control sphere.

3.3 Auxiliary Propulsion System

Demonstrate the capability of the auxiliary propulsion system (APS) to provide propulsion on demand for roll control during S-IB boost, and to provide pitch, yaw, and roll control for the remainder of the mission.

Performance evaluation will include the following:

a. Propellant loading rates and the ullage and propellant tank pressures during loading operations

b. Loading rate for the helium supply sphere

c. Pressurization of the propellant tanks to flight pressure

d. Response of the engines to stage commands during preflight checkouts and powered flight

e. Value of the minimum impulse bit

f. APS system performance in space environment.

3.4 Ullage Rockets

Demonstrate the capability of the ullage rockets to provide sufficient thrust for propellant stabilization during separation and the J-2 engine start transient.

Performance evaluation will include:

a. Response of ullage rockets to ignition signal

b. Chamber pressure versus time

c. Proper jettisoning.

3.5 Retrorockets

Demonstrate the capability of the retrorockets to provide sufficient thrust for S-IVB/booster separation.

Performance evaluation will include:

a. Response of retrorockets to ignition signal

b. Chamber pressure versus time.

3.6 Hydraulic System

Verify the operation of the hydraulic system during launch, boost, powered flight and orbit. Performance evaluation will include:

a. Powered Flight

(1) Verification that adequate pressurized fluid flow is available to the servo-actuator and that hydraulic system pressures are maintained within expected limits (figure AP 8-1)

(2) Verification that fluid temperature is maintained within operable limits during system operation (figure AP 8-1).

b. Orbital Coast

(1) Observe hydraulic system temperatures, auxiliary pump air bottle pressure, and reservoir oil level.

3.6.1 Servo System

Verify the operation of the servo system during powered flight and orbital coast. Performance evaluation will include:

a. Powered Flight

(1) Verification of the adequacy of actuator artificial damping mechanism performance

(2) Verification of the magnitude of IU command errors just prior to switching guidance to S-IVB burn mode

(3) Verification of the adequacy of present compensation for thrust vector deflection errors caused by manufacturing tolerances in the gimbal joint and thrust structural compression effects

(4) Evaluation of thrust misalignment and thrust eccentricity errors

(5) Evaluation of actuator start transient loads during engine start

(6) Evaluation of gimbal friction during powered flight

(7) Compare critical actuator component temperatures with predicted values

(8) Verify proper pitch and yaw actuator responses to commands.

b. Orbital Coast

(1) Verification of the magnitude of IU command errors in the non - S-IVB burn modes

(2) Compare critical actuator component temperatures with predicted values

(3) Evaluate actuator deflections during coast.

3.7 Flight Control System

Verify the proper operation of the flight control systems during powered flight and orbital coast. This objective will be achieved by: verification of the proper operation of the thrust vector control system and the auxiliary attitude control system; comparison of inflight body bending frequencies and propellant sloshing frequencies with those predicted (figures AP 7-1 through AP 7-4).

3.7.1 Thrust Vector Control System

Demonstrate proper performance of the main engine control system during S-IVB powered flight. This objective will be achieved by evaluation of the following:

a. Response of the thrust vector control loop to commands from the guidance control computer

b. Proper response of the shaping networks and servo-amplifier to commands from the data adapter

c. Demonstrate overall control stability during S-IVB flight, including controllability immediately after separation

d. Simulation of transient regions of flight (e.g., separation, guidance initiation).

3.7.2 Auxiliary Attitude Control System (AACS)

Verification of control system stability and evaluation of performance during S-IVB powered flight and orbital coast. This objective will be achieved by consideration of the following:

a. Simulation of actual APS firings and roll attitude error

b. Comparison between theoretical and actual control system phase planes

c. Comparison between actual and allocated impulse usage for vehicle maneuvers and disturbances

3.8 Stage Separation

Verify clearance distance between stages during separation. Predicted stage clearance is presented in figures AP 7-5 and AP 7-6.

This objective will be achieved by determining the following:

a. Lateral clearance between stages

b. Separation distance between stages at J-2 Engine Start Command

c. Simulation of stage attitude error and rate.

3.9 Data Acquisition System

Verify that the data acquisition system is within design tolerances.

The achievement of this objective will be verified by evaluation of data and of the performance of the following: radio frequency (RF) system, telemetry system, instrumentation system, and inflight tape recorder.

3.9.1 RF System

Verify the proper operation of the RF system.

The achievement of this objective will be verified by evaluation of the following:

a. RF signal strength at ground stations, horizontal and vertical polarization energy of each of the RF frequencies to determine radiated power

b. RF power output of all transmitter power amplifiers measured by means of directional couplers and RF power detectors

c. RF insertion loss during flight between RF amplifiers and the applicable antenna inputs

d. Voltage standing wave ratio (VSWR) computed from forward and reflected power data for each antenna obtained from the bi-directional coupler and RF power detectors

e. Effect of flame attenuation by measuring transmitted power out the antenna arrays during separation, measuring signal strength at ground stations and computing the signal attenuation.

3.9.2 Telemetry System

Verify the telemetry subsystem performance. The achievement of this objective will be verified by consideration of the following:

a. Verification of the compatibility of the data format, signal synchronization, and system calibrations with the data reduction equipment utilizing prelaunch data. During flight, checks are made to determine synchronization between data reduction systems and incoming data.

b. Examination of output of the data reduction system for proper reference channel levels, synchronization pulses, etc.

c. Examination of PAM wave-train stripouts for proper format

d. Examination of PCM data channels and synchronization words to verify consistency and proper operation of ground equipment

e. Evaluation of FM/FM telemetry system accuracy from inflight calibration data

f. Evaluation of PAM/FM and PCM/FM data accuracy by flight data comparison.

3.9.3 Instrumentation System

Verify the performance of the instrumentation system. The achievement of this objective will be verified by evaluating the following:

a. FM system data for expected ranges and frequencies. Examination of inflight calibration of sub-carrier oscillator (SCO) assemblies to determine proper operation and linearity

b. PAM system data for proper format, proper reference channels and consistency of data channels from frame to frame

c. PCM data for proper format (correlation with redundant PAM link for accuracy)

d. Single sideband (SSB) data, calibration signals and format of vibration multiplexer and marker pulses present on the service channel.

3.9.4 Inflight Tape Recorder

Verify proper performance of the inflight tape recorder. Verification of this objective will be achieved by evaluation of the following:

a. Tape recorder stabilization time determined from the time for data stabilization observed from oscillograph recordings

b. Wow and flutter during fast record and playback determined by discrimination of the 120 kc tape speed compensation signal

c. Data received from tape recorder compared to real time data

d. Indication of ready-to-record event.

3.9.5 Data Validity

Verify the validity of data from Digital Data Acquisition System (DDAS). The achievement of this objective will be established by determination of data validity on a channel-by-channel basis from the following systems:

a. FM/FM systems No. 1, 2, and 3

b. PAM/FM/FM systems (prime and subchannels of the model 270 time-division multiplexers)

c. PCM/DDAS system

d. SSB system.

3.10 Electrical Control System

Verify proper performance of the electrical control system. The achievement of this objective will be verified by evaluation of the operation of the following:

a. Switch selector

b. Sequencer

c. Control distributors

d. Power distributors

e. Pressure switches

f. EBW and range safety equipment

g. Interconnecting cables.

3.11 Propellant Utilization

The objective will be verified by evaluating the performance of the PU system as utilized in a propellant loading mode and for inflight propellant management as defined by the criteria listed herein (S-IVB-204 propellant loading data is given in appendix 6).

a. Demonstrate that the PU system indicated propellant load is within 1.12 percent of the actual propellant load in each tank

as determined by the statistical weighted average propellant mass history.

b. Demonstrate the ability of the PU system to provide propellant management, such that usable propellant residuals at depletion, as extrapolated from the conditions existing at guidance cutoff, are within 575 lbm or less.

c. Demonstrate closed-loop PU operation in the programmed mixture ratio (PMR) mode with high engine mixture ratio (EMR) for 306 ($\pm$45) sec from Engine Start Command followed by a cutback to a nominal reference mixture ratio of 4.70:1 for the duration of the powered flight.

3.12 Range Safety System

The achievement of this objective will be verified by proper operations of the range safety system (during powered flight) for normal flight, or for the termination of an erratic flight.

a. Normal Flight

(1) An RF carrier should be received by the stage at all times

(2) Indication of signal strengths from each range safety receiver should be a nominal 1.3 v.

b. Abnormal Flight

The operation of the range safety system during an abnormal flight should include those operations described for normal flight (paragraph 3.12a) plus the following:

(1) Indication of receipt of the propellant dispersion (PD) EBW Firing Unit Arm and Engine Cutoff Command, from the range safety decoder. Tri-level signals should show a step increase from 1.27 ($\pm$0.3) v to 2.43 ($\pm$0.15) v

(2) The EBW firing units should show a charge of 2,300 ($\pm$100) v within one sec after the receipt of the EBW arm and engine cutoff signal

(3) After a predetermined time from the arm and engine cutoff signal, a propellant dispersion command will be given to the vehicle. At this time the range safety decoder tri-level signal should show a step increase to 4.16 ($\pm$0.45) volts.

3.13 Stage Aero/Thermodynamics

Determine stage aero/thermodynamics during launch, boost, powered flight, and orbital coast. This objective will include:

Powered Flight

a. Stage thermal environment and the response of structure and components subjected to cryogenics, aerodynamic heating, and J-2 engine plume impingement. Comparisons will be made between flight data and postflight simulations based on the actual trajectory, atmospheric parameters, stage operations, and ground test data. Areas to be investigated are:

(1) Forward skirt

(2) LH2 tank

(3) Aft skirt

(4) Aft interstage (J-2 engine plume heating only)

(5) APS fairing

b. The propellant heat input during ground hold, boost, powered flight, and orbital coast.

c. The external static pressure distributions on the stage, the LH2 feed line fairing, and the APS fairing as well as the internal pressure histories in the forward skirt, aft skirt, and interstage compartments. Comparisons will be made between

the flight data, preflight predictions, and postflight simulations.

Orbital Coast

a. Determine the propellant heat input during orbital coast.

3.14 Vibration and Acoustic Environment

This objective will be achieved by evaluation of the vibration environment of the stage basic structure, engine, and components, and the acoustic environment of the aft skirt during powered portions of flight.

The evaluation will include:

a. Vibration

(1) The basic structure vibration will be measured on the LH2 tank cylinder and on the field splice ring frame.

(2) The engine vibration will be measured at the LH2 and LOX turbopumps and on the combustion chamber dome.

(3) The component vibration will be measured at the retrorocket, APS, LOX and LH2 feedlines, auxiliary hydraulic pump, LOX and LH2 vent valves, cold helium sphere, and telemetry antenna.

b. Acoustics

Internal and external sound pressure levels will be measured on the aft skirt during S-IB powered flight.

Predicted envelopes of the composite vibration and acoustic levels are presented in figure AP 8-6.

3.14.1 Forward Skirt Panel Dynamic Response

This objective will be achieved by evaluation of the dynamic response of the forward skirt skin panels. Sixteen strain gage measurements, located circumferentially on the forward skirt, will provide the data.

A predicted envelope of the dynamic peak strain time-history and wave shapes are presented in figure AP 8-7.

The maximum response will have a wave shape characteristic of narrow band random vibration and will be the result of random pressure fluctuations in the boundary layer. If panel flutter occurs, the dynamic peak strain levels will be the same as shown or lower, but the wave shape will be primarily periodic and of constant amplitude.

3.15 Ordnance System

Verify proper operation of the ordnance system during powered flight. The objective will be achieved by verification of the following:

a. Operation of the stage separation systems

b. Operation of the ullage rocket ignition and jettison systems

c. Operation of the retrorocket ignition system.

3.16 Environmental Control System

Verify proper environmental control system performance during launch, boost, powered flight, and orbital coast. Performance evaluation will include:

Powered Flight

a. Verification that the proper S-IVB thermo-conditioning fluid flowrate supply pressure and temperature were maintained by the IU thermo-conditioning system.

b. Verification that the S-IVB thermo-conditioning system fluid return pressure and temperature were within normal operating ranges.

Orbital Coast

a. Verification that the proper S-IVB thermo-conditioning fluid flowrate, supply pressure and temperature were maintained by the IU thermo-conditioning system.

b. Verification that the S-IVB thermo-conditioning system fluid return pressure and temperature were within normal operating ranges.

3.17 Stage Sequence of Events

Determination of the proper S-IVB acknowledgment of sequence commands issued from the IU will be verified by comparing IU command times to stage monitored command times.

3.18 Countdown Demonstration Test

The objectives of the countdown demonstration test relevant to flight, are to:

a. Verify propellant utilization system calibration presented in appendix 6 (Propellant Loading).

b. Maintain a 15 min fuel boiloff period with the fuel level near maximum load in order to more fully define the stage's insulation thermal conductivity.

c. Determine propellant loading and temperature effects on strain gauge measurements to be utilized in subsequent flight test evaluation.

SECTION 4

STAGE CONFIGURATION

4. STAGE CONFIGURATION

This section presents the general configuration of the S-IVB-204 stage and significant S-IVB-204 stage configuration differences from the S-IVB-202 stage.

4.1 S-IVB-204 Stage

The S-IVB-204 stage (figure 4-1) consists of the following assemblies:

a. Forward skirt

b. Propellant tanks

c. Aft skirt

d. Engine thrust structure

e. Aft interstage

f. Supporting subsystems.

Complete S-IVB system descriptions are presented in Douglas Report No. SM-46974, *S-IVB-201 Stage Flight Test Plan*, (reference 4) and Douglas Drawing No. 1B59668: *S-IVB 204 End Item Test Plan*, (reference 5).

4.2 Stage Configuration Differences

The following paragraphs delineate significant configuration differences between the S-IVB-202 and S-IVB-204 stages.

4.2.1 LH2 Vent System

An orbital vent initiation pressure switch has been added to the S-IVB-204 stage LH2 vent system. This pressure switch (normally open), which operates in conjunction with an LH2 vent system timer, opens the LH2 orbital vent when pressure builds up within the LH2 tank. As pressure decays to a predetermined value, the pressure switch will open, but the timer continues to the end of its cycle at which time it closes the LH2 orbital vent. Figure 4-2 presents a schematic arrangement of the propulsion system and its associated instrumentation.

4.2.2. LOX Vent

The LOX vent angle will be fixed at 31 deg 33 min for the S-IVB-204 stage. This angle may vary between the S-IVB-204 and subsequent stages. An investigation will be conducted to determine an optimum angle applicable to each stage.

4.2.3 Auxiliary Propulsion System

The helium regulator has been changed from a Douglas design to the Apollo design. This change deletes the crossover pressure switch, resulting in a reduction of the electrical wiring harness requirements.

4.2.4 Retrorockets

The nozzle size has been revised to increase the expansion ratio from 4.26:1 to 7.03:1, and the motor centerline was moved 6-1/2 in. outboard and parallel to the interstage for purposes of reducing plume impingement on the interstage. Internal insulation between the propellant and pressure vessel was added to reduce the possibility of burn thru.

4.2.5 J-2 Engine

The J-2 engine has been modified for start tank repressurization by using tap-offs at the injector manifold and main fuel manifold.

4.2.6 LH2 Stratification

Temperature probes will be located within the LH2 tank at certain strategic locations for the purpose of defining LH2 stratification during powered flight.

4.2.7 LH2 Tank

A reduction in available net positive suction head (NPSH) requirement resulted in lowering the LH2 tank pressurization limit from 42 psia to 39 psia. Consequently; the skin thickness of the LH2 tank, with the exception of the common bulkhead, was reduced to conform to this revised requirement.

4.2.8 Forward Skirt

The S-IVB-204 stage has a 150-sq in. vent area for skirt cavity pressure control, as opposed to 100-sq in. for the S-IVB-202.

4.2.9 Propellant Utilization System

The S-IVB-204 PU system forward and feedback shaping networks were changed as the result of a study to optimize PU performance. The feedback gain depends upon the reference mixture ratio (RMR) and has been adjusted for a 4.70:1 RMR in order to obtain optimum stage performance.

4.2.10 Ambient Helium Bottle

The size of the ambient helium bottle has been changed from 905 cu in. to 4.5 cu ft in order to perform the additional exercises scheduled for this mission.

4.2.11 Strain Instrumentation

Sixteen external forward skirt measurement systems, installed to determine axial and body bending strains, were removed. Sixteen additional measurements were installed and located to measure dynamic strain for evaluation of flutter of the forward skirt panels. This necessitated changes in wiring, signal conditioning hardware and telemetry channel assignments.

4.2.12 Engine Cutoff

It has been determined that fuel depletion will not occur. Therefore, the fuel point level depletion sensors will not be activated unless velocity cutoff does not occur.

4.2.13 Dump Experiment

The S-IVB-204 dump experiment required the following stage configuration changes:

a. Ten additional switch selector commands were added which enable the dumping.

b. Rewire helium dump valve (located in the ambient helium fill module) to provide passivation of the pneumatic control sphere.

c. Rewire mainstage control solenoid so the LOX main engine valve can be opened independently.

d. Rewire the ignition phase control solenoid so the LH2 main engine valve can be opened independently.

e. Realign the LOX tank vent to optimize APS propellant usage during the dump experiment.

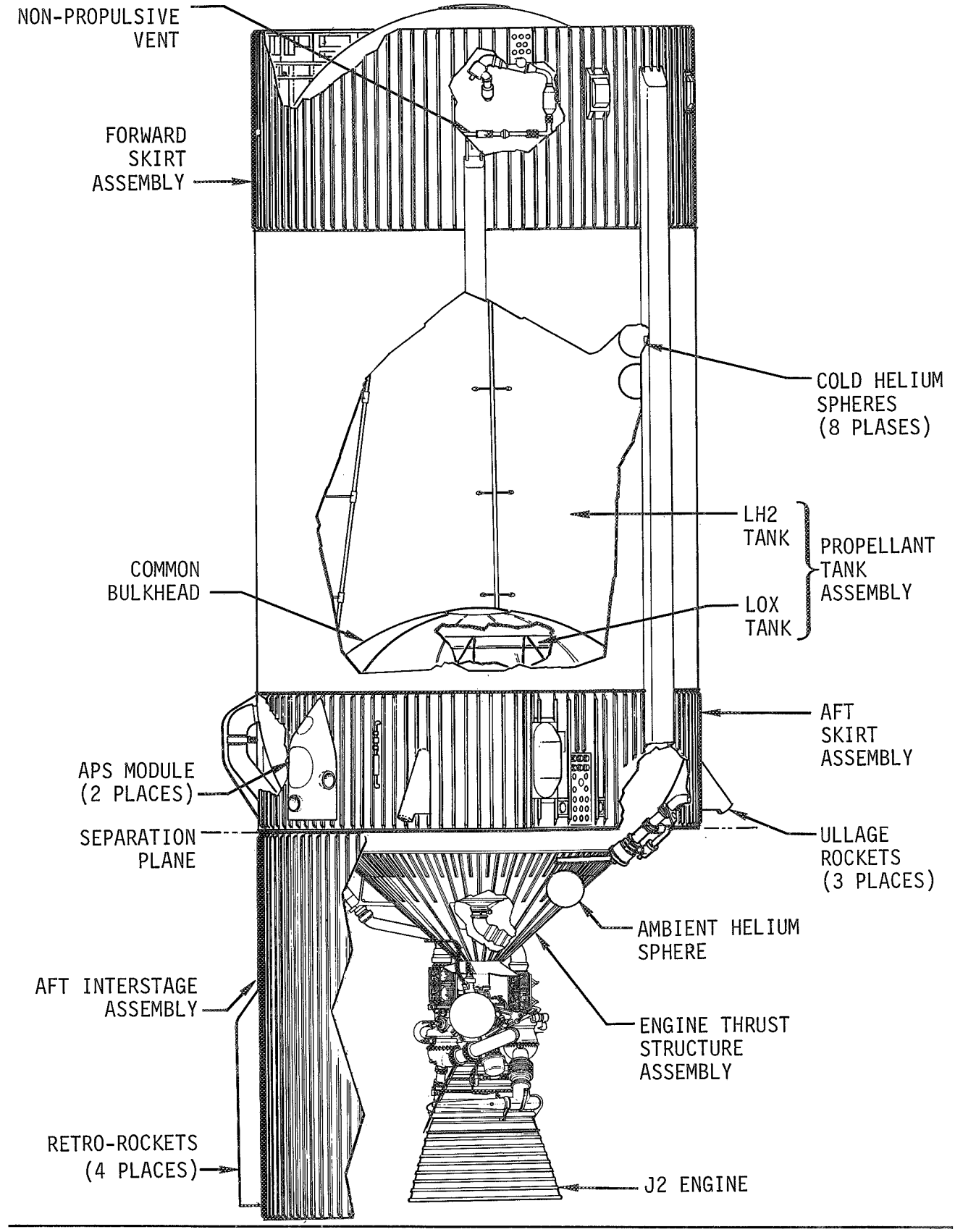


Figure 4-1. S-IVB-204 Stage Cutaway

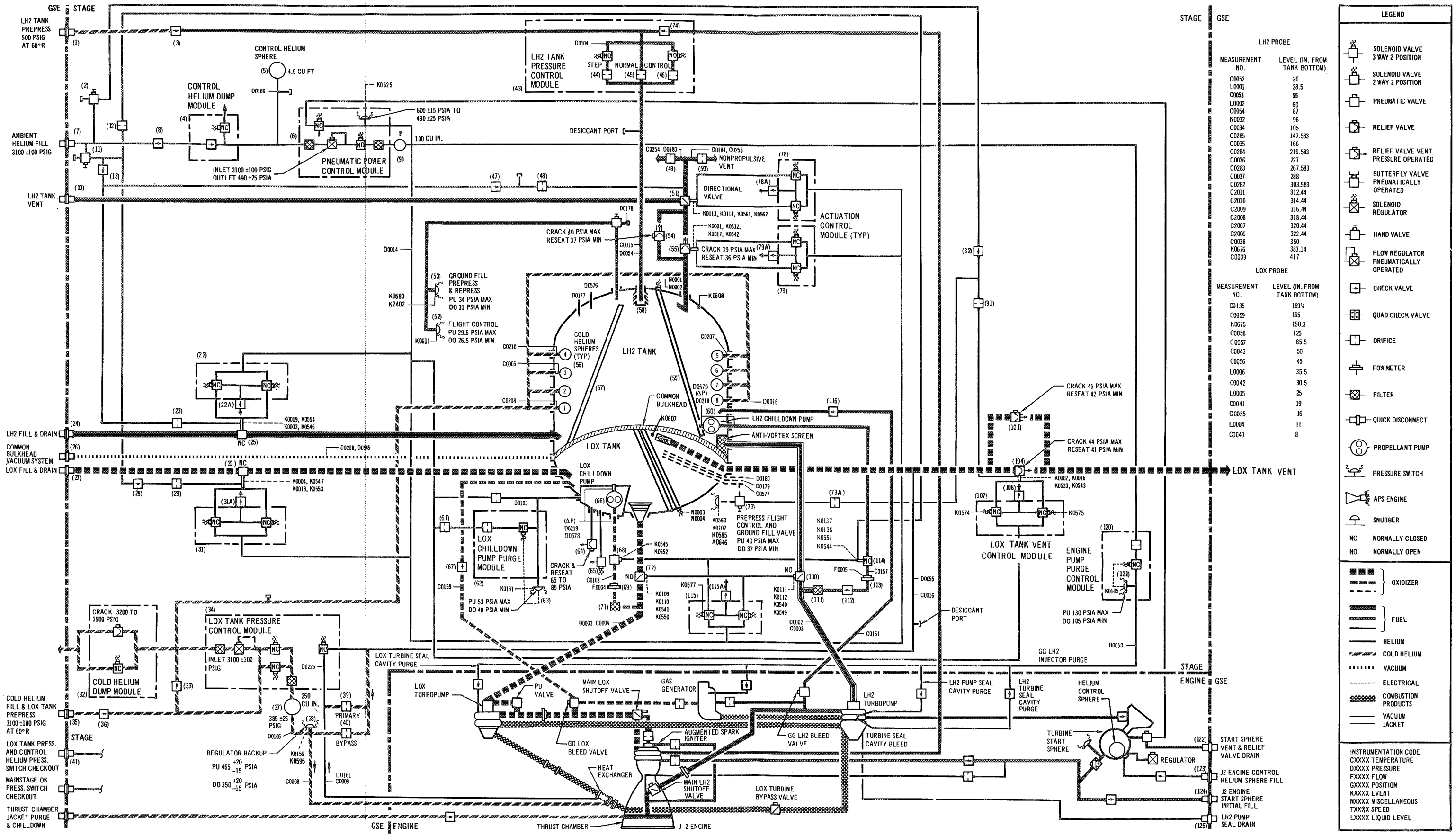


Figure 4-2. Propulsion System Configuration and Instrumentation

SECTION 5

LAUNCH MISSION RULES AND REDLINES

5. LAUNCH MISSION RULES AND REDLINES

This section defines the launch mission rules pertaining to the S-IVB stage, redlines (which are a part of the launch mission rules), backup redlines, and bluelines. The information regarding launch mission rules and backup redlines has been submitted to NASA/MSFC prior to incorporation into this report.

5.1 Launch Mission Rules

Launch mission rules are launch vehicle, space vehicle, and spacecraft launch constraining requirements. These launch constraints are to be incorporated into the NASA/KSC *Launch Mission Rules* document (reference 6) prior to the AS-204/LM-1 flight.

The Launch Mission Rules document is divided into five major areas as follows:

a. Mission Rules and Definitions

b. Launch Vehicle Requirements

c. Space Vehicle Requirements

d. Spacecraft Requirements

e. Technical Support

The S-IVB stage is not affected by the spacecraft or technical support requirements.

The launch mission rules are effective during the prelaunch operations period. For the AS-204/LM-1 flight, this period commences with the spacecraft cabin close out at T -14 hr and ends at T -5 sec (2 sec prior to ignition command).

5.1.1 Mission Rules and Definitions

The following mission rules and definitions extracted from the Launch Mission Rules document pertain directly to the S-IVB stage.

a. A mandatory item is a space vehicle element or operational support element that is essential for accomplishment of the

primary mission, which includes prelaunch, flight, and recovery operations that assure crew safety and effective operational control as well as the attainment of the primary mission objectives.

b. A highly desirable item is a space vehicle element or operational support element that supports and enhances the accomplishment of the primary mission or is essential for the accomplishment of the secondary mission objectives.

c. Redlines are minimum and/or maximum acceptable values of pressures, temperatures, etc., essential for accomplishing the primary mission. All redlines are mandatory items by definition.

d. A hold is an interruption of the countdown for unfavorable weather, repair of hardware, or correction of conditions unsatisfactory for launch or flight.

e. Cutoff is the automatic or manual command to stop the launch sequence after initiation of the "automatic launch sequence start."

f. Liftoff is the event determined by the instrument unit umbilical disconnect signal and is the point in time when plus time commences.

g. The command pilot (manned missions), spacecraft test conductor, launch vehicle test conductor, space vehicle test supervisor, launch operations manager, launch director, flight director, DOD manager for manned space flight support operations, or the mission director may call a hold for conditions within their respective areas of responsibility. Only the mission director may scrub a mission.

h. When time permits, the failure of a mandatory or highly desirable item will be reported to the mission director by the

launch director or the flight director. The initial report will include the position or facility that detected the malfunction. Subsequently, the mission director will be informed of estimated time to repair and recommended proceed, hold recycle or scrub action as it develops.

i. Whenever possible, the launch site and Mission Control Center-Houston (MCC-H) will verify telemetry readout discrepancies occurring prior to liftoff. If the MCC-H loses a parameter but the launch site has a valid readout, the MCC-H will continue on the launch site readout. This is true except for those mandatory parameters (listed in the Flight Mission Rules) upon which mission rules action is taken. In this case, a hold will be called to evaluate the problem.

j. If a mandatory item fails during the countdown, it will be corrected prior to launch, holding or recycling the countdown as necessary. If the item cannot be corrected to permit liftoff within the launch window, the mission director may proceed with the launch after appropriate coordination with the launch and flight directors and the DOD manager for MSF support operations.

k. Consideration will be given to the repair of any highly desirable item, but in no case will the launch be scrubbed for any single highly desirable item. If two or more highly desirable items fail and if other aggravating circumstances occur, the mission director may scrub the mission after appropriate coordination with the launch and flight directors and the DOD manager for MSF support operations.

l. The launch may be held, but will not be scrubbed for a secondary mission objective.

m. The countdown will continue where possible concurrently with correction of an existing problem.

n. A verbal request for cutoff will not be given by individuals monitoring items listed in this document after T -5 sec. Panel

operators C1NP and C1FR will not initiate cutoff after T -5 sec except for failure of the space vehicle to liftoff.

o. Any function that is interlocked on an automatic sequencing and will effect an automatic shutdown or will prevent liftoff is defined herein as mandatory and is not reiterated within this document.

p. All redlines (minimum and/or maximum values or conditions) are defined herein as mandatory. Verification that the values or conditions remain within the limits of acceptable operation specified is also mandatory.

5.1.2 Space Vehicle Requirements

The S-IVB stage launch constraints, as defined by the Launch Mission Rules document and applied to the space vehicle, are listed in the following paragraphs:

a. Launch Window Restrictions - No mandatory or highly desirable launch window restrictions exist for SA-204/LM-1.

b. Surface Wind Restrictions - Surface wind restrictions referenced to 60 feet and based on Cape Kennedy 95.0 percentile wind profile with a gust factor will be included in a later revision.

c. Range Safety Restrictions - Both S-IVB stage range safety command receivers are mandatory for launch.

d. Space Vehicle Functional Sequence - During the time period specified, and in the event problems are encountered in the countdown, the following actions are to be followed:

TIME PERIOD	CONDITION	ACTION/COMMENT
T -4 hr 20 min (service structure removal) to T -3 hr 20 min (start L/V dual LOX loading).	Malfunction of any repairable space vehicle element or operational support element.	Correct malfunction in parallel with other operations. Hold at T -4 hr 20 min for mandatory or highly desirable items if

TIME PERIOD	CONDITION	ACTION/COMMENT
		repair cannot be completed in parallel with or after cryogenic loading.
T -15 min (S-IVB thrust chamber chilldown) to T -2 min 43 sec (automatic sequence start).	Malfunction of any one of the following: 1. Malfunction of the L/V guidance and control system. 2. Loss of any complete L/V telemetry link. 3. Malfunction of the vehicle fire detection system (2 of 4 M; 2 of 4 HD). 4. Loss of or exceeding any S/V redline condition applicable to this time period. 5. Malfunction of L/V tape recorder. 6. Malfunction of the L/V propellant dispersion system (all 4 DRSCR's are mandatory). 7. Malfunction of the LM environmental control system. 8. Malfunction of the LM electrical power system.	Hold. A hold of 5 min maximum can be tolerated without recycling to T -15 min provided S-IVB chilldown operations continue. This limitation is dictated by S-IVB thrust chamber chilldown. If the hold exceeds 5 min recycle to T -15 min. A warmup period of 10 min is required prior to initiating chilldown sequence after recycling to T -15 min. A hold in excess of one hour at T -15 min will require a recycle to T -30 min. NOTE 1: The number of recycles to T -15 min is limited by the capability of the gaseous hydrogen storage facility. This capability will allow a maximum of 4 complete charges of the S-IVB start bottle before depletion. 6 to 8 hr are required to recharge the storage facility.
T -2 min 43 sec (automatic sequence start) to T -5 sec (2 sec prior to ignition).	Malfunction of any one of the following: 1. Malfunction of the L/V guidance and control system.	Cutoff. Recycle to T -15 min. Make the decision to hold and repair or to scrub. A warmup period of 10 min is required

TIME PERIOD	CONDITION	ACTION/COMMENT
	2. Loss of the S-IVB stage telemetry link CP-1.	before initiating S-IVB chilldown sequence after recycling to T -15 min.
	3. Malfunction of the vehicle fire detection system (2 of 4 M; 3 of 4 HD).	NOTE 1: The number of recycles to T -15 min is limited by the capability of the gaseous hydrogen storage facility. This capability will allow a maximum of 4 complete charges of the S-IVB start bottle before depletion. 6 to 8 hr are required to recharge the storage facility.
	4. Loss of or exceeding any S/V redline condition applicable to this time period.	
	5. Malfunction of the L/V propellant dispersion system (all 4 DRSCR's are mandatory).	

5.1.3 Launch Vehicle Requirements

The launch vehicle requirements are comprised of the following:

a. Redlines

b. Critical Flight Control Measurements

c. Critical Telemetry Systems.

These requirements are described in the following paragraphs.

5.1.3.1 Redlines

Redlines are the limits of a critical prelaunch parameter, which singularly or in combination with other parameters, describe acceptable performance requirements of a component or system. The prelaunch operations period or countdown cannot be completed if the conditions specified are not met. The launch mission rules define all redlines as mandatory. The measurements monitoring the parameters with redline limits are listed in table 5-1 with their limits, expected values and applicable time period. Each redline measurement must be monitored on a strip chart in the blockhouse.

5.1.3.2 Critical Flight Control Measurements

Critical flight control measurements (table 5-2) are implemented for realtime flight control of the mission. It is required that these elements be operational during the final part of the countdown, in compliance with the assigned category, or successful completion of the primary mission will be jeopardized.

5.1.3.3 Critical Telemetry Systems

The propulsion system performance analysis is considered a primary flight objective for the AS-204/LM-1 mission, which emphasizes the importance of the postflight engine analysis. The S-IVB-204 stage instrumentation is configured such that certain key data, required for engine analysis, may be obtained only from the FM/FM portions of links CF-1 or CF-2. To be consistent with the requirement for engine analysis, Douglas requires that telemetry links CF-1 and CF-2 be mandatory for the S-IVB-204 stage, and link CF-3 be highly desirable.

The A1 and A2 multiplexers provide the majority of the data used for flight evaluation and therefore are mandatory. The BO multiplexer, via the IU, provides the flight control measurement data and is considered as mandatory. The A3 multiplexer is used primarily for ground checkout and therefore is not considered mandatory by the launch mission rules.

Douglas recommends that the tape recorder be categorized as highly desirable, based upon data requirements during flame attenuation effects at engine start, and the importance of continuous vent, maneuvering, APS, and boiloff data during orbital flight.

Total Douglas telemetry requirements for the S-IVB-204 stage are as follows:

a. The PCM/FM link CP-1 is mandatory

b. The PAM/FM links CF-1, CF-2 are mandatory

c. The PAM/FM link CF-3 is highly desirable

d. The SSB/FM link CS-1 is highly desirable

e. The BO multiplexer (via IU) is mandatory

f. The A1 and A2 multiplexers are mandatory

g. The A3 multiplexer is highly desirable

h. The tape recorder is highly desirable.

These requirements will continually be reviewed and coordinated with the cognizant MSFC laboratories. In the event that S-IVB stage or mission requirements should change, these requirements will be revised and updated as required.

5.2 Backup Redlines

Backup redlines are substitutions for redline measurements in the event the redline becomes faulty. These measurements are to be used only after a careful investigation and assessment of data has established the primary measurement to be unacceptable. The backup measurement applicable time corresponds with its redline. The backup redline measurements are listed in table 5-3.

For redlines that have backups, at least one backup for each of these redlines should be monitored in the blockhouse at KSC or at the Central Instrumentation Facility (CIF).

If a redline value is exceeded during automatic sequence, a hold is imposed, the countdown is reverted to T -15 min and the decision to implement the backup redline is made.

5.3 Bluelines

Bluelines are maximum and/or minimum values of a parameter which, if exceeded, shall result in an engineering judgment as to whether the countdown will be completed without corrective action. The measurements monitoring bluelines are listed in table 5-4.

Bluelines have not been included in the Launch Mission Rules document in the past.

The blueline philosophy and limits are implemented by instructions from the design technologies to the instrumentation observers. Under no condition should exceeding a blueline, hold or scrub a launch without the consent of the Launch Director.

It is planned to monitor all bluelines in the blockhouse at KSC or at the CIF by strip chart or "page format."

TABLE 5-1 (Sheet 1 of 6)
S-IVB-204 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	APPLICABLE TIME PERIOD FROM LIFTOFF (T) AND REMARKS*
			MINIMUM	MAXIMUM		
C0003-403	Temperature, Fuel Pump Inlet	deg R	Fig.5-1	Fig.5-1	Fig.5-1	Check from T-15 sec to T-5 sec. No check required prior to automatic sequence.
C0006-401	Temperature, GH2 Start Bottle	deg R	Fig.5-2	Fig.5-2	280	Check from immediately prior to initiation of automatic sequence to T-5 sec.
C0050-401	Temperature, Hydraulic Pump Inlet Oil	deg F	--	165	30 to 110	From auxiliary hydraulic pump flight mode ON to initiation of automatic sequence.
C0168-414	Temperature, Oxidizer Tank Outlet Module 1	deg R	535	560	550	Check at T-15 min (no check required after T-15 min).
C0169-415	Temperature, Oxidizer Tank Outlet Module 2	deg R	535	560	550	Check at T-15 min (no check required after T-15 min).
C0199-401	Temperature, Thrust Chamber Jacket	deg R	None	265	220	Check from immediately prior to initiation of automatic sequence to T-5 sec.
D0014-403	Pressure, Control He Regulator	psia	465 (Note 1)	585	540	Check from time of sphere pressurization to T-5 sec.
D0016-425	Pressure, Cold He Sphere	psia	2,800 (Note 2)	3,200	3,000	Check from time of sphere pressurization to T-5 sec.
D0017-401	Pressure, GH2 Start Bottle	psia	Fig.5-2	Fig.5-2	1,250	Check from immediately prior to initiation of automatic sequence to T-5 sec.
D0019-401	Pressure, Engine Control He Sphere	psia	2,800	3,300	3,100	Check from time of sphere pressurization to initiation of automatic sequence.

*See General Notes

TABLE 5-1 (Sheet 2 of 6)
S-IVB-204 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	APPLICABLE TIME PERIOD FROM LIFTOFF (T) AND REMARKS*
			MINIMUM	MAXIMUM		
D0019-401 (Cont'd)		psia	2,800	3,375	3,150	Check from initiation of automatic sequence to T-5 sec.
D0021-408	Pressure, Fuel Tank Ullage	psia	None	16.7	16.5	Check from T-30 min to initiation of fuel tank pressurization.
		psia	None	39	--	Check from initiation of LH2 tank pressurization to T-15 sec.
		psia	Fig.5-1	Fig.5-1	Fig.5-1	Check from T-15 sec to T-5 sec.
D0022-406	Pressure, Oxidizer Tank Ullage	psia	37	44	40	Check from T-15 sec to T-5 sec.
		psia	None	44	--	Check from initiation of LOX tank pressurization to T-15 sec.
D0041-403	Pressure, Hyd System (Aux Pump ON)	psia	3,400	4,100	3,550 to 3,650	Check from application of S-IVB Stage power to T-5 sec. Aux hyd pump ON.
D0042-403	Pressure, Reservoir Oil (Aux Pump OFF)	psia	45	--	67 to 89	Check from application of S-IVB Stage power to aux hyd pump flight mode ON. Aux hyd pump OFF.
D0064-414	Pressure, Helium Regulator Inlet Module 1	psia	2,800	3,200	3,000	Check from T-15 min to T-5 sec.

*See General Notes

TABLE 5-1 (Sheet 3 of 6)
S-IVB-204 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	APPLICABLE TIME PERIOD FROM LIFTOFF (T) AND REMARKS*
			MINIMUM	MAXIMUM		
D0068-415	Pressure, Helium Regulator Inlet Module 2	psia	2,800	3,200	3,000	Check from T-15 min to T-5 sec.
D0094-414	Pressure, Oxidizer Tank Outlet Module 1	psia	203	222	211	Check from T-15 min to T-5 sec.
D0095-415	Pressure, Oxidizer Tank Outlet Module 2	psia	203	222	211	Check from T-15 min to T-5 sec.
D0160-403	Pressure, Helium (Ambient) Sphere	psia	2,800	3,200	3,000	Check from time of sphere pressurization to T-5 sec.
F0004-424	Flowrate, Oxidizer Recirculation Pump	gpm	30	50	42	Check from start of recirculation to T-5 sec.
F0005-404	Flowrate, Fuel Recirculation Pump	gpm	130	160	142 (Note 4)	Check from T-97 sec to T-5 sec.
G0001-403 (S-IVB measurement)	Position, Pitch Actuator	deg	None	±1.5	±.5	Check from application of S-IVB Stage power to initiation of automatic sequence. NOTE: Redline does not apply when actuators are being commanded to move.
G0002-403 (S-IVB measurement)	Position, Pitch Actuator	deg	None	±1.5	±.5	Check from application of S-IVB power to initiation of automatic sequence. NOTE: Redline does not apply when actuators are being commanded to move.

*See General Notes

TABLE 5-1 (Sheet 4 of 6)
S-IVB-204 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	APPLICABLE TIME PERIOD FROM LIFTOFF (T) AND REMARKS*
			MINIMUM	MAXIMUM		
G0010-401	PU Valve Position	deg	Null -2°	Null +2°	Null	Check from T-5 min to T-5 sec.
K0013-411	Event, Cutoff Signal		Off	Off	Off	Observe drop from ON indication at engine ignition power ON and monitor that indication remains OFF.
K0151-411	Event, PU Oven ON Ind.		On	On	On	From prior to initiation of propellant loading until T-5 sec.
L0007-403 C51-403**	Level, Reservoir Oil (Aux Pump ON)	per-cent	6	--	25 to 45	From application of stage power to T-5 sec.
	(Aux Pump OFF)	per-cent	Fig.5-3	--	84 to 99	From application of stage power aux hyd pump flight mode ON.
M0036-307	Voltage, Aft Bus No. 1 (+4D11)	vdc	26	31 (Note 3)	28	While busses are energized either from ground or internal power.
M0040-307	Voltage, Fwd Bus No. 2 (+4D21)	vdc	24.5	30.5	28	
M0050-307	Voltage, Fwd Bus No. 1 (+4D31)	vdc	26	32	28	
M0083-307	Voltage, Aft Bus No. 2 (+4D41)	vdc	51	61	56	

*See General Notes
**Measurement C51-403 is required to determine oil level as indicated in Figure 5-3.

TABLE 5-1 (Sheet 5 of 6)
S-IVB-204 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	APPLICABLE TIME PERIOD FROM LIFTOFF (T) AND REMARKS*
			MINIMUM	MAXIMUM		
M0123-303	***Voltage - Aft Battery No. 2	vdc	TBD (Loaded)	TBD (Loaded)	TBD	From battery installation to ignition command. Values for each battery will be determined by tests conducted during battery actuation and will be furnished to KSC by the Program Manager or his representative.
		vdc	TBD (Open Circuit)	TBD (Open Circuit)	TBD	
M0120-303	***Voltage - Aft Battery No. 1	vdc	TBD (Loaded)	TBD (Loaded)	TBD	
		vdc	TBD (Open Circuit)	TBD (Open Circuit)	TBD	
M0121-303	***Voltage - Fwd Battery No. 2	vdc	TBD (Loaded)	TBD (Loaded)	TBD	
		vdc	TBD (Open Circuit)	TBD (Open Circuit)	TBD	
M0122-303	***Voltage - Fwd Battery No. 1	vdc	TBD (Loaded)	TBD (Loaded)	TBD	
		vdc	TBD (Open Circuit)	TBD (Open Circuit)	TBD	

*See General Notes
***NASA Recommended Redlines

TABLE 5-1 (Sheet 6 of 6)
S-IVB-204 REDLINE REQUIREMENTS

General Notes: All parameters are to be within the noted values immediately prior to initiation of the automatic sequence (T - 2:43) unless otherwise noted.

These redlines are also generally applicable any time their limits could be exceeded with resultant hazard to vehicle personnel and/or mission.

NOTES:

1. Violation of the minimum redline for a period not greater than two seconds is expected and allowable at times of valve actuation.

2. 2,500 psia is acceptable from mission requirements standpoint as long as it is verified that no system leaks exist.

3. During the initial application of voltage to the engine busses, the maximum allowable voltage may be 32 vdc for a period not to exceed 60 sec.

4. While in the unpressurized condition and with the recirculation system operating the flowrate of the fuel will be in a band between 80 and 110 gpm. It should be noted that when prepressurization is initiated, sharp fluctuations in the flowrate may result. These fluctuations have lasted from 15 to 16 sec. on previous countdowns. This is a normal condition and monitoring of this parameter should not be started until the flowrate has attained a steady-state value.

TABLE 5-2 (Sheet 1 of 2)
S-IVB-204 CRITICAL FLIGHT CONTROL MEASUREMENTS

MEASUREMENT NUMBER	TITLE	CATEGORY
C0003-403	Temp - Fuel Pump Inlet	Highly Desirable
C0004-403	Temp - Oxidizer Pump Inlet	Highly Desirable
D0001-401	Pressure - Thrust Chamber	Highly Desirable
D0002-403	Pressure - Fuel Pump Inlet	Highly Desirable
D0003-403	Pressure - Oxidizer Pump Inlet	Highly Desirable
D0014-403	Pressure - Control He Regulator Discharge	Highly Desirable
D0016-425	Pressure - Cold Helium Sphere	Highly Desirable
D0017-401	Pressure - GH2 Start Bottle	Highly Desirable
D0019-401	Pressure - Engine Control He Sphere	Highly Desirable
D0021-408	Pressure - Fuel Tank Ullage	1 of 2 Mandatory
D0178-410	Pressure - Fuel Tank Ullage EDS 2	
D0041-403	Pressure - Hydraulic System	Highly Desirable
D0042-403	Pressure - Reservoir Oil	Highly Desirable
D0064-414	Pressure - He Regulator Inlet Mod 1 (APS)	Highly Desirable
D0068-415	Pressure - He Regulator Inlet Mod 2 (APS)	Highly Desirable
D0160-403	Pressure - Helium (Ambient) Sphere	Highly Desirable
D0179-424	Pressure - Oxidizer Tank Ullage EDS 1	1 of 2 Mandatory
D0180-424	Pressure - Oxidizer Tank Ullage EDS 2	
G0001-403	Posit - Actuator Piston Pot Pitch	Highly Desirable
G0002-403	Posit - Actuator Piston Pot Pitch	Highly Desirable
G0003-401	Posit - Main Oxidizer Valve	Highly Desirable
G0004-401	Posit - Main Fuel Valve	Highly Desirable
G0010-401	Posit - PU System Ratio Valve	Highly Desirable

TABLE 5-2 (Sheet 2 of 2)
S-IVB-204 CRITICAL FLIGHT CONTROL MEASUREMENTS

MEASUREMENT NUMBER	TITLE	CATEGORY
K0001-410	Event - Fuel Tank Vent Valve - Closed	Highly Desirable
K0002-424	Event - Oxidizer Tank Vent Valve - Closed	Highly Desirable
K0014-401	Event - Mainstage OK Press Switch 1	Highly Desirable
K0157-401	Event - Mainstage OK Press Switch 2	Highly Desirable
L0007-403	Level - Reservoir Oil	Highly Desirable
N0037-414	Misc - Qty - Oxidizer Tank Mod 1 (APS)	Highly Desirable
N0038-415	Misc - Qty - Oxidizer Tank Mod 2 (APS)	Highly Desirable
N0039-414	Misc - Qty - Fuel Tank Mod 1 (APS)	Highly Desirable
N0040-415	Misc - Qty - Fuel Tank Mod 2 (APS)	Highly Desirable

TABLE 5-3 (Sheet 1 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
C0003-403	Temperature, Fuel Pump Inlet	a. Recirculation System Failure b. Excessive Facility Back Pressure	Temperature - GG Fuel Bleed Valve C0012-401 See figure 5-4	1. Measures LH2 temperature flowing through the bleed valve during chilldown. 2. Bleed valve is located downstream of LH2 pump. 3. If satisfactory chilldown has been accomplished, the LH2 bleed valve temperature will be approximately 1.0°R higher than the LH2 inlet temperature (C0003-403). 4. Must satisfy requirements defined in figure 5-4, at T-15 sec (in conjunction with fuel ullage pressure D0021-408).
C0004-403	Temperature, Oxidizer Pump Inlet	a. Recirculation System Failure	Temperature - GG LOX Bleed Valve C0013-401 Minimum: None Maximum: 168°R Nominal: 166°R	1. Measures LOX temperature flowing through the bleed valve during chilldown. 2. Bleed valve is located downstream of LOX pump. 3. If satisfactory chilldown has been accomplished, the LOX bleed valve temperature will be approximately 1.0°R higher than LOX pump inlet temperature (C0004-403) at T-2 min 43 sec. Therefore, the LOX GG bleed valve temperature must be less than 169°R at the start of automatic sequence.

TABLE 5-3 (Sheet 2 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION
C0006-401	Temperature, GH2 Start Bottle	a. Improper Chill-down b. Excessive Hold Time	Temperature-Engine Control Helium C0007-401 See figure 5-5	1. Start bottle chilldown is reflected by the temperature of the control Helium sphere which is located within the GH2 start bottle. 2. The two sphere temperatures will converge and stabilize after start bottle pressurization. 3. If the two sphere temperatures are stabilized by T-2 min 43 sec, the control Helium sphere temperature may be used as a backup from this point on (see figure 5-5 for requirements).
C0199-401	Temperature, Thrust Chamber Jacket	a. Insufficient GSE Performance	Temperature - LH2 Injection-C0200-401 Minimum: None Maximum: 275°R Nominal: 240°R	1. In the event of C0199 failure, C0200 can be used. The expected injection temp will be higher than the T/C jacket temperature. The temperature (C0200) shall be below 275°R at Liftoff to prevent excess back-pressure on the injector at J-2 ignition.

TABLE 5-3 (Sheet 3 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
D0014-403	Pressure, Control He Regulator Discharge	a. Regulator Failure b. Excessive Leakage	No Backup	Although there is no backup measurement for this parameter, a system pressure switch interlock is provided to inhibit the countdown at initiation of auto sequence start or S-IVB ignition command, if the regulator operates out of spec in the high direction (which is the regulator design failsafe mode).
D0016-425	Pressure, Cold Helium Sphere	a. Ground Regulator Failure b. Improper Regulator Setting c. Check Valve Failed Closed d. Vent and/or Dump Relief Valve Failure e. Excessive Leakage	No Backup	Although there is no backup measurement for this parameter, it appears possible to determine if adequate bottle conditions exist by a controlled venting and refilling sequence of events. It should be noted that a sequence such as that mentioned above has not been established nor verified at this time. NOTE: 2800 to 3200 psia are limits. However, 2500 psia is acceptable from Mission Requirements standpoint, as long as it is verified that no system leaks exist.

TABLE 5-3 (Sheet 4 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
D0017-401	Pressure, GH2 Start Bottle	a. Check Valve Between Start Bottle and LH2 Injector Fails Open b. Vent and Relief Valve Failed to Close c. Excessive Ground Pressure d. Excessive Hold Time e. Excessive Heating Rate f. Excessive Leakage	Pressure, GH2 Start Bottle Backup Measurement See figure 5-5 D0241-401	1. The backup requirements are same as for primary redline. 2. This backup pressure should be used in conjunction with temperature GH2 start bottle (C0006-401).
D0019-401	Pressure, Engine Control He Sphere	a. Improper Ground Supply Pressure b. Relief Valve Failure c. Excessive Hold Time d. Excessive Start Bottle Temperature e. Excessive Leakage	Pressure, Engine Control He Sphere Backup Measurement D0242-401 Minimum: 2800 psia Maximum: 3300 psia Nominal: 3100 psia	1. The backup requirements are the same as for the primary redline. 2. Check from time of sphere pressurization to initiation of auto sequence (IAS). (See Note) NOTE: 2800 to 3200 psia are limits. However, 2500 psia is acceptable from Mission Requirements standpoint, as long as it is verified that no system leaks exist.
			Minimum: 2800 psia Maximum: 3375 psia Nominal: 3150 psia	1. Same comment as above. 2. Check from IAS to T-5 sec. (See Note)

TABLE 5-3 (Sheet 5 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
D0160-403	Pressure, Helium Ambient Sphere	a. Ground Regulator Failure b. Improper Regulator Setting c. Check Valves Closed Failed d. Vent and/or Relief Valve Failed Open (Min) e. Excessive Leakage	No Backup	Although there is no backup measurement for this parameter, it appears possible to determine if adequate bottle conditions exist by a controlled venting and refilling sequence of events. It should be noted that a sequence such as that mentioned above has not been established nor verified at this time.
C0168-414	Temperature, Oxidizer Tank Outlet Mod 1 APS	Failure of Stage Environmental Control Purge System	Temperature, Fuel Tank Outlet Mod 1 S-IVB APS C0170-414 Minimum: 535°R Maximum: 560°R Nominal: 550°R	Fuel and oxidizer temperature will be stable and equal after approximately 3 hrs of ECS operation. Consequently, the fuel temperature may be monitored as a redline backup and must be between 535 and 560°R at T-15 min.
C0169-415	Temperature, Oxidizer Tank Outlet Mod 2 APS	Failure of Stage Environmental Control Purge System	Temperature, Fuel Tank Outlet Mod 2 S-IVB APS C0169-415 Minimum: 535°R Maximum: 560°R Nominal: 550°R	Fuel and oxidizer temperature will be stable and equal after approximately 3 hrs of ECS operation. Consequently, the fuel temperature may be monitored as a redline backup and must be between 535 and 560°R at T-15 min.

TABLE 5-3 (Sheet 6 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
D0064-414	Pressure, Helium Regulator Inlet Mod 2 (APS)	a. Ground Reg Failure b. Check Valves Failed Closed c. System Leakage	No Backup	Although there is no backup measurement for this parameter, it appears possible to determine if adequate bottle conditions exist by a controlled venting and refilling sequence of events. It should be noted that a sequence such as that mentioned above has not been established nor verified at this time.
D0068-415	Pressure, Helium Regulator Inlet Mod 2 (APS)	a. Ground Reg Failure b. Check Valves Failed Closed c. System Leakage	No Backup	Although there is no backup measurement for this parameter, it appears possible to determine if adequate bottle conditions exist by a controlled venting and refilling sequence of events. It should be noted that a sequence such as that mentioned above has not been established nor verified at this time.
D0094-414	Pressure, Oxidizer Tank Mod 1 (APS)	a. He Control Module Failure b. System Leakage c. Quad Check Valves Sticking	Pressure - Oxidizer Tank Ullage Mod 1 APS D0090-414 Minimum: 203 psia Maximum: 222 psia Nominal: 211 psia	1. Outlet pressure and ullage pressure will be equal with the system pressurized and in a static condition. 2. Ullage pressure must be between the limits of 203 and 222 psia at T-15 min.

TABLE 5-3 (Sheet 7 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
D0094-414 (Cont'd)			Pressure - Fuel Tank Ullage Volume Mod 1 APS D0089-414 Minimum: 203 psia Maximum: 222 psia Nominal: 211 psia Pressure - Fuel Tank Supply Manifold Mod 1 APS D0063-414 Minimum: 203 psia Maximum: 222 psia Nominal: 211 psia	
D0095-415	Pressure, Oxidizer Tank Outlet Mod 2 (APS)	a. He Control Module Failure b. System Leakage c. Quad Check Valves Sticking	Pressure - Oxidizer Tank Ullage Mod 2 APS D0092-415 Minimum: 203 psia Maximum: 222 psia Nominal: 211 psia Pressure - Fuel Tank Ullage Volume Mod 2 APS D0091-415 Minimum: 203 psia Maximum: 222 psia Nominal: 211 psia Pressure - Fuel Tank Supply Manifold Mod 2 APS D0067-415 Minimum: 203 psia Maximum: 222 psia Nominal: 211 psia	1. Outlet pressure and ullage pressure will be equal with the system pressurized and in a static condition. 2. Ullage pressure must be between the limits of 203 and 222 psia at T-15 min.

TABLE 5-3 (Sheet 8 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
VXC0050-401	Temperature-Hydraulic Pump Inlet Oil	a. Auxiliary Pump Overheating. b. High Pressure Relief Valve Failed Open.	a. Temperature Reservoir Oil VC0051-403 Nominal: 70°F	1. Reservoir oil temp usually lags pump inlet oil temp by approximately 20°F. 2. Auxiliary pump overheating may be due to excessive heat rejection of the electric motor which may be accompanied by higher than normal aft bus No. 2 current. 3. High pressure relief valve failing open is accompanied by lower than normal hydraulic system pressure.
VXD0041-403	Pressure-Hydraulic System	a. Aux Hyd Pump Motor or Pressure Compensator Failure. b. Leak or Break in Hydraulic System. c. High Pressure Relief Valve Setting Drops to Lower Pressure	a. GN2 Accumulator Pressure D0043-403 Nominal: 3600 psia b. Pressure-Reservoir Oil D0042-403 Nominal: 170 psia	Loss of excessive fluid from Hydraulic lines or reservoir will cause aux hyd pump to cavitate and fluctuate in pressure level. High pressure relief valve is set to relieve at 4000 psid. If pressure setting of valve decays below setting of pump pressure compensator, the system pressure will decay proportionately.

TABLE 5-3 (Sheet 9 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
K0013-401	Event-Cutoff Signal	Loss of Engine Ready Signal when Engine Cutoff is on.	None	The signal should drop from ON to OFF following Engine Ignition Power ON and remain OFF. The following test can be conducted to verify if the cutoff circuit is operative and in the proper state. Verify that K0140 (Switch Selector Cutoff) is on; cutoff indication on the C4EN panel is on; non-programmed cutoff is off; engine control and ignition power are on, and Engine Ready (K0012) is on. A. Send RACS and verify strip chart operation to check instrumentation. B. Remove Ignition Power (verify Engine Ready goes off). C. Remove K0140 (Switch Selector Cutoff off). (Verify cutoff indication on C43N remains on.) NOTE: If C4EN cutoff indication goes off with the removal of K0140, immediately turn off engine control power.

TABLE 5-3 (Sheet 10 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
K0013-401 (Con'd)				D. Send Engine Ready Bypass. (Verify cutoff indication on C4EN goes off). E. Send K0140 (Switch Selector Cutoff) to Safe Engine. A negative finding will require additional electronics analysis and disposition.
K0151-411	Event-PU Oven On Indication	Temperature in PU Oven Drops Below 80°C due to Heater Power Failure.	None	1. Measurement picks up and drops out at 80°C. Oven operating temperature is 100 ±0.30°C. A 6.7 min. temperature decay time constant exists from oven heater power failure to K0151 OFF indication. 2. A K151 OFF indication at liftoff would indicate a propellant loading error and the possibility of a depletion cutoff in flight.

TABLE 5-3 (Sheet 11 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
D0021-408	Pressure, Fuel Tank Ullage	a. Vent Valve Open or Excessive Leakage b. Ground Regulator Malfunction c. Pressurization Switch Malfunction d. GSE Pressurization Valve Malfunction	Pressure - Fuel Tank Ullage EDS 1 D0177-410 or Pressure Fuel Tank Ullage EDS 2 D0178-410 (See figure 5-4)	1. This measurement must be requested via the IU Digital Select. 2. GG fuel bleed valve temperature (C0012-401) must be used in conjunction with the backups even if C0003-403 has not failed.
D0022-406	Pressure, Oxidizer Tank Ullage	a. Backup Relief Vent Valve Open or Excessive Leakage b. Ground Regulator Malfunction c. Pressurization Switch Malfunction d. GSE Pressurization Malfunction	Pressure - Oxidizer Tank Ullage EDS 1 D0179-424 or Pressure Oxidizer Tank Ullage EDS 2 D0180-424 Minimum: 37 psia Maximum: 44 psia Nominal: 40 psia	1. This measurement must be requested via the IU Digital Select. 2. This parameter may be used directly as a backup for the ullage pressure. 3. Ullage pressure must be between the limits of 37 to 44 psia at T-15 sec.
G0010-401	Position, PU Valve	a. PU Activate OFF Failure b. Mechanical Failure in PU Valve Motor Gear Assembly	None	PU Activate is interlocked for start of automatic sequence.

TABLE 5-3 (Sheet 12 of 18)

S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
VXD0042-403	Pressure-Reservoir Oil (Aux Pump Off)	a. Accumulator Gas Leakage. b. External Oil Leakage.	a. Pressure-GN2 Accumulator D0043-403 Nominal: 2350 psia	1. Required to insure adequate aux pump inlet pressure at pump start. 2. Reservoir Oil Pressure is developed through a piston powered by GN2 accumulator pressure.
VXL0007-403	Level-Reservoir Oil (Aux Pump Off)	a. System Leakage. b. System Under-filled.	Pressure-Reservoir Oil D0042-403 Nominal: 170 psia (Aux Pump On)	1. If aux pump is OFF, turn ON and check alternative pressure measurement. 2. If aux pump is OFF, turn ON and observe low level light. Light indicates below 9.54% to 11.02%.
VXC0051-403	Temperature-Reservoir Oil	See other information.	Temperature-Hydraulic Pump Inlet Oil C0050-403 Nominal: 70°F.	This measurement is to be used to determine whether adequate reservoir oil level (L0007-403) exists at the indicated oil temperature. (Ref: Chart of acceptable reservoir oil level vs. oil temperature)
VXL0007-403	Level-Reservoir Oil (Aux Pump On)	a. External Leakage. b. System Under-filled.	a. Pressure-Hydraulic System D0041-403 Nominal: 3600 psia.	If reservoir oil level is too low, the pump will cavitate after start and hydraulic system pressure will not rise to minimum level.

TABLE 5-3 (Sheet 13 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
VXL0007-403 (Cont'd)			b. Pressure-Reservoir Oil D0042-403 Nominal: 170 psia	Observe low level light. Light indicates when oil level drops below 9.54% to 11.02%.
M0543-411 *VXM050-307	Voltage, Fwd Bus No. 1	Ground Power Malfunction when on external power or battery malfunction when on internal power.	M0048-307 4D310 ESE Bus Volt/28vdc M0016-411 Volt, Output Fwd Batt 1/28 vdc M0024-411 5 Volt Excit Mod Fwd/5vdc M0025-404 5 Volt Excit Mod Aft/5vdc	1. With proper allowances for the potential difference between GSE and vehicle voltage buses, Measurement M0048-307 is a redline alternate when on external power and Measurement M0016-411 is a redline alternate when on internal power. 2. During the time that the Fwd and Aft 5 Volt excitation modules are energized, they will give a gross indication of whether Fwd Bus No. 1 is ON or OFF. 3. The design limits of the Switch Selector (NASA Spec. 50M71765) established the redline limit. 4. S-IVB ready for launch interlock. "+4D31 supervision Network No. 1 OK" is provided.

* This measurement of the +4D31 Bus is the NASA KSC equivalent of Redline Measurement M0542-411.

TABLE 5-3 (Sheet 14 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
M0542-411 **VXM040-307	Voltage, Fwd Bus No. 2	Ground Power Malfunction when on external power or battery malfunction when on internal power.	M047-307 4D210 ESE Bus Volt/28 vdc M0018-401 Volt, Output Fwd Batt. No. 2/28 vdc M0001-411 Volt-Static Inv-Conv/115 vac M0004-411 Volt-Static Inv-Conv/5 vdc M0023-411 Volt-Static Inv-Conv/21 vdc M0068-411 Volt-5V Excit Mod Fwd No. 2/5 vdc	1. With proper allowances for the potential difference between GSE and vehicle voltage buses, Measurement M047-307 is a redline alternate when on external power and Measurement M0018-401 is a redline alternate when on internal power. 2. During the time that the Inv-Conv and Fwd 5V Excit Mod No. 2 are energized, they will give a gross indication of whether Fwd Bus No. 2 is On or OFF. 3. The design limits of the PU Inv-Conv and PU Elect. Assy established the redline limits of the bus. 4. S-IVB ready for launch interlock, "+4D21 supervision Network No. 2 OK" is provided.

** This measurement of the +4D21 Bus is the NASA KSC equivalent of Redline Measurement M0542-411.

TABLE 5-3 (Sheet 15 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
M0541-404 ***VXM036-307	Voltage, Aft Bus No. 1	Ground Power Malfunction when on external power or battery malfunction when on internal power.	M0038-307 4D110 ESE Bus Volt/28 vdc M0014-404 Volt, Output Aft Batt No. 1/28 vdc M0006-401 Volt-Eng Control Bus/28 vdc M0007-401 Volt-Eng Ignition Bus/28 vdc	1. With proper allowances for the potential difference between GSE and vehicle voltage buses, Measurement M0038-307 is a redline alternate when on external power and Measurement M0014-404 is a redline alternate when on internal power. 2. Within the limitations of T/M monitoring, the engine control and ignition bus measurements give an indication of Aft Bus No. 1 during engine power ON. 3. The design limits of the engine control bus (Rocketdyne Specification R-3925-1) established the redline limits of the bus. 4. S-IVB ready for launch interlock, "+4D11 supervision Network No. 3 OK" is provided.

*** This measurement of the +4D11 Bus is the KSC equivalent of Redline Measurement M0541-404.

TABLE 5-3 (Sheet 16 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
M0540-404 ****VXM083-307	Voltage, Aft Bus No. 2	Ground Power Malfunction when on external power or battery malfunction when on internal power.	M0015-404 Volt, Output, Aft Battery No. 2/56 vdc M0026-404 Volt-Phase A-B, Fuel Chilldown Inv/56 vac M0027-404 Volt-Phase A-B, LOX Chilldown Inv/56 vac M0040-404 Volt-Phase A-C, LOX Chilldown Inv/56 vac M0041-404 Volt-Phase A-C, Fuel Chilldown Inv/56 vac M0044-404 Volt-Phase A1-B1, LOX Chilldown Inv/56 vac M0045-404 Volt-Phase A1-C1, LOX Chilldown Inv/56 vac	1. With proper allowances for the potential difference between GSE and vehicle voltage buses, Measurement M0085-307 is a redline alternate when on external power and Measurement M0015-404 is a redline alternate when on internal power. 2. During the time that the chilldown inverters are energized, the inverter phase voltages will give a gross indication of whether Aft Bus No. 2 is ON or OFF. 3. The design limits of the chilldown inverters established the redline limits of the bus. 4. S-IVB ready for launch interlock, "+4D41 supervision Network No. 4 OK" is provided.

**** This measurement of the +4D41 Bus is the NASA KSC equivalent of Redline Measurement M0540-404.

TABLE 5-3 (Sheet 17 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
M0540-404 (Cont'd)			M0046-404 Volt-Phase A1-B1, LH2 Chilldown Inv/56 vac M0047-404 Volt-Phase A1-C1, LH2 Chilldown Inv/56 vac M0085-307 4D410 ESE Bux Volt/56 vdc	
M0014-404	Voltage, Output Aft Battery #1	Battery Malfunction	M120-303 Voltage Output, Aft Battery #1 (Open Circuit Voltage)*	This measurement is only good when power is switched to external.
M0015-404	Voltage, Output Aft Battery #2	Battery Malfunction	M123-303 Voltage Output, Aft Battery #2 (Open Circuit Voltage)*	This measurement is only good when power is switched to external.
M0016-411	Voltage, Output Fwd Battery #1	Battery Malfunction	M122-303 Voltage Output, Fwd Battery #1 (Open Circuit Voltage)*	This measurement is only good when power is switched to external.
M0018-411	Voltage, Output Fwd Battery #2	Battery Malfunction	M121-303 Voltage Output, Fwd Battery #2 (Open Circuit Voltage)*	This measurement is only good when power is switched to external.

* If strip charts become available for M120 through M123, then these measurements become prime and M0014, M0015, M0016 and M0018 become backup.

TABLE 5-3 (Sheet 18 of 18)
S-IVB-204/LM-1 REDLINE BACKUP INFORMATION

MEASUREMENT NO.	TITLE	PROBABLE CAUSES OF EXCEEDING REDLINE LIMITS	ALTERNATIVE MEASUREMENTS AND NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC)
F0004-424	Flowrate, Oxidizer Recirculation Pump	Recirculation System Failure	Pressure, Oxid Pump Inlet minus Oxid Tank Ullage D0003-403 minus D0577-408 Minimum: 13 psid Maximum: 18 psid Nominal: 16 psid	In order to detect recirculation system failure flowrate and pump inlet pressure were selected as new redline and backup redline
F0005-424	Flowrate, Fuel Recirculation Pump	Recirculation System Failure	Pressure, Fuel Pump Inlet minus Fuel Tank Ullage D0002-403 minus D0516-406 Minimum: 6 psid Maximum: 10 psid Nominal: 8 psid	In order to detect recirculation system failure flowrate and pump inlet pressure were selected as new redline and backup redline

TABLE 5-4 (Sheet 1 of 2)
S-IVB-204 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	TIME PERIOD OF BLUELINE APPLICABILITY
			MINIMUM	MAXIMUM		
C0102-411	Temp - Fwd Battery No. 1	deg F	70	140	90	After battery is stabilized.
C0103-411	Temp - Fwd Battery No. 2	deg F	70	140	90	
C0104-404	Temp - Aft Battery No. 1	deg F	70	140	90	
C0105-404	Temp - Aft Battery No. 2	deg F	70	140	90	
C0211-411	Temp - Fwd Battery No. 1 - Unit 2	deg F	70	140	90	
D0545-407	Press - Common Bulkhead Internal	psia	--	5.5	<5.5	Anytime prior to liftoff.
M0001-411	Volt - Static Inverter-Converter	vac	110.5	119.5	115	From turn-on to T-3 sec.
M0012-411	Freq - Static Inverter-Converter	cps	396	404	400	During inverter operation.
M0014-404	Volt - Output Aft Battery No. 1	vdc	29	36	29.5	These open circuit voltages should be monitored from battery installation to transfer to internal power.
M0015-404	Volt - Output Aft Battery No. 2	vdc	64	75	72	
M0016-411	Volt - Output Fwd Battery No. 1	vdc	29	36	29.5	These open circuit voltages should be monitored from battery installation to transfer to internal power.
M0018-411	Volt - Output Fwd Battery No. 2	vdc	29	36	29.5	
M0019-411	Current - Load Fwd Battery No. 1	amps	--	50 (58)	40	From transfer to internal power until liftoff (during battery heater operation).
M0020-411	Current - Load Fwd Battery No. 2	amps	--	5	3.5	From transfer to internal power until liftoff.

TABLE 5-4 (Sheet 2 of 2)
S-IVB-204 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	TIME PERIOD OF BLUELINE APPLICABILITY
			MINIMUM	MAXIMUM		
M0021-404	Current - Load Aft Battery No. 1	amps	--	15 (30)	7	From transfer to internal power until liftoff (during battery heater operation).
M0022-404	Current - Load Aft Battery No. 2	amps	--	95	90	From transfer to internal power until liftoff
M0026-404	Volt - Phase A-B Fuel C/D Inv	vac	54	60	56	During inverter operation.
M0027-404	Volt - Phase A-B LOX C/D Inv	vac	54	60	56	During inverter operation.
M0540-404	Volt - 4D41 Bus	vdc	54	60	56	Anytime power is applied.
M0541-404	Volt - 4D11 Bus (X035)	vdc	26	30	28	
M0542-411	Volt - 4D21 Bus (X040)	vdc	26	30	28	
M0543-411	Volt - 4D31 Bus (X065)	vdc	26	30	28	
M0038-307	Volt - 4D110 Bus	vdc	26	30	28	
M0043-307	Current - 4D110 Bus	amps	--	20	10	
M0044-307	Current - 4D111 Bus	amps	--	15	7	
M0047-307	Volt - 4D210 Bus	vdc	26	30	28	
M0048-307	Volt - 4D310 Bus	vdc	26	30	28	
M0053-307	Current - 4D210 Bus	amps	-- (Note 1)	15	10	
M0054-307	Current - 4D121 Bus	amps	--	5	3.5	
M0057-307	Current - 4D131 Bus	amps	--	50	40	
M0085-307	Volt - 4D410 Bus	vdc	54	60	56	
M0087-307	Current - 4D141 Bus	amps	--	110	0 to 90	

NOTE 1: 40 amps during Remote Analog Calibration System (RACS)

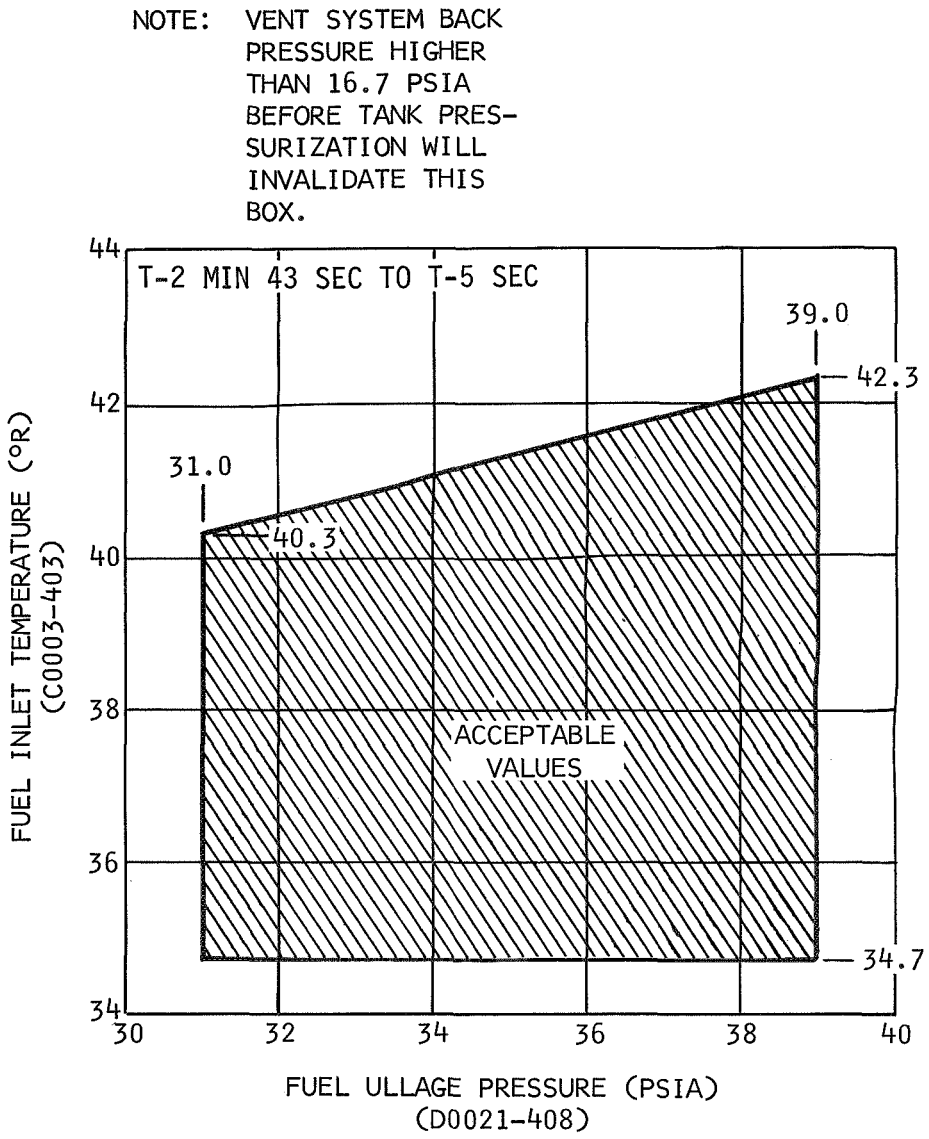


Figure 5-1. LH2 Critical Limits at Liftoff

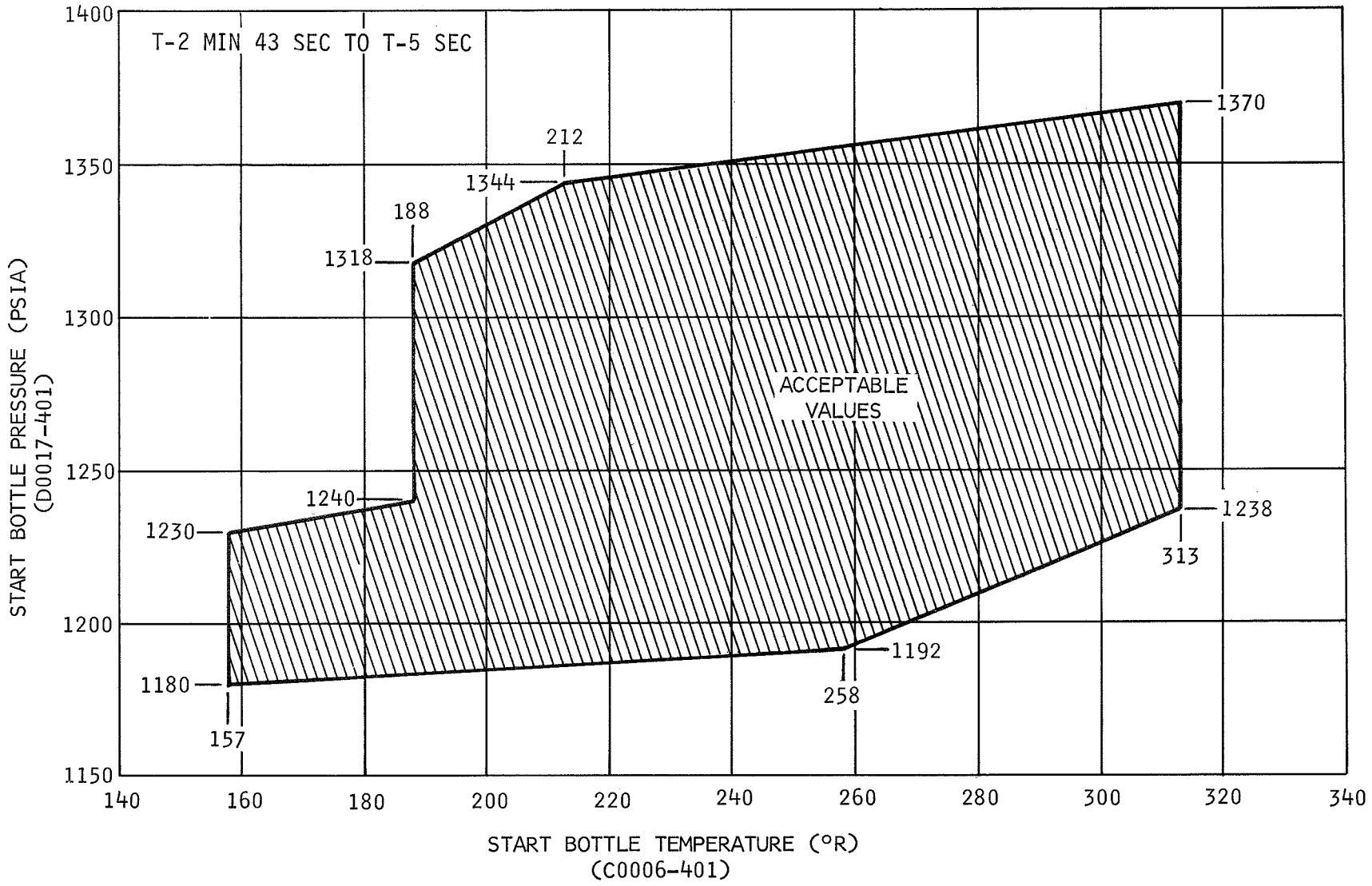


Figure 5-2. GH2 Start Bottle Critical Limits at Liftoff

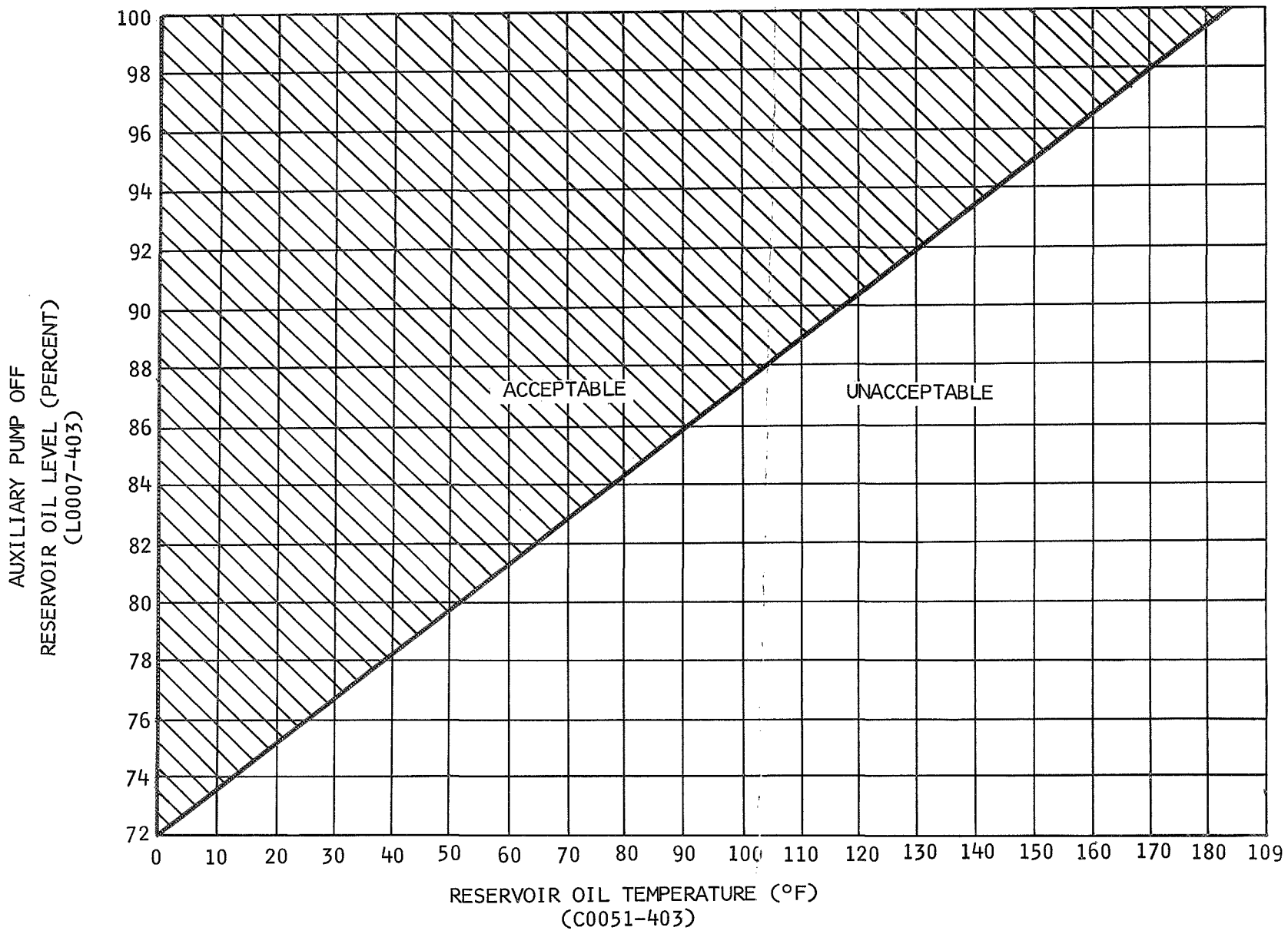


Figure 5-3. Hydraulic Reservoir Level Critical Limits (Auxiliary Pump Off)

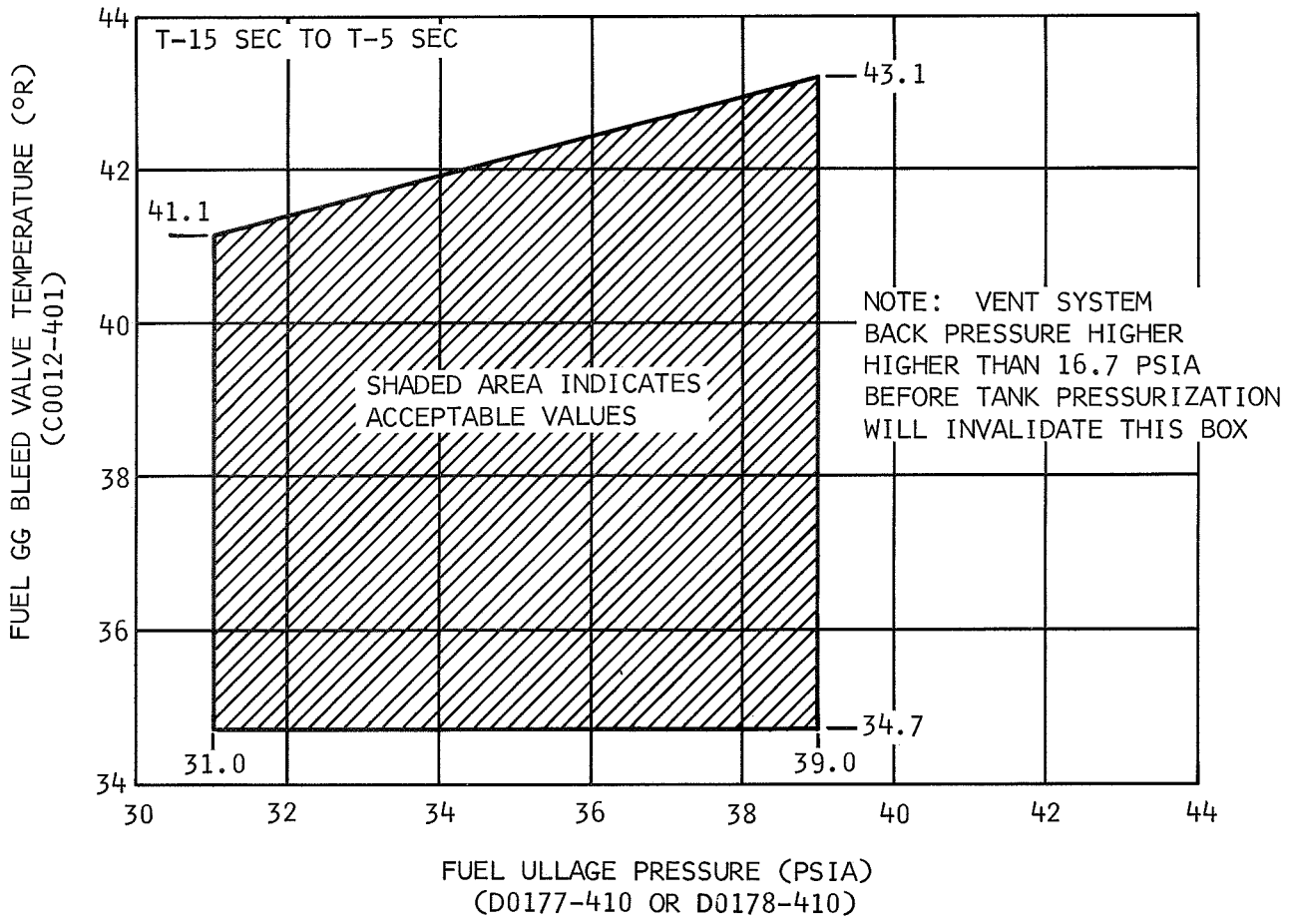


Figure 5-4. LH2 Critical Limits at Liftoff (Backup)

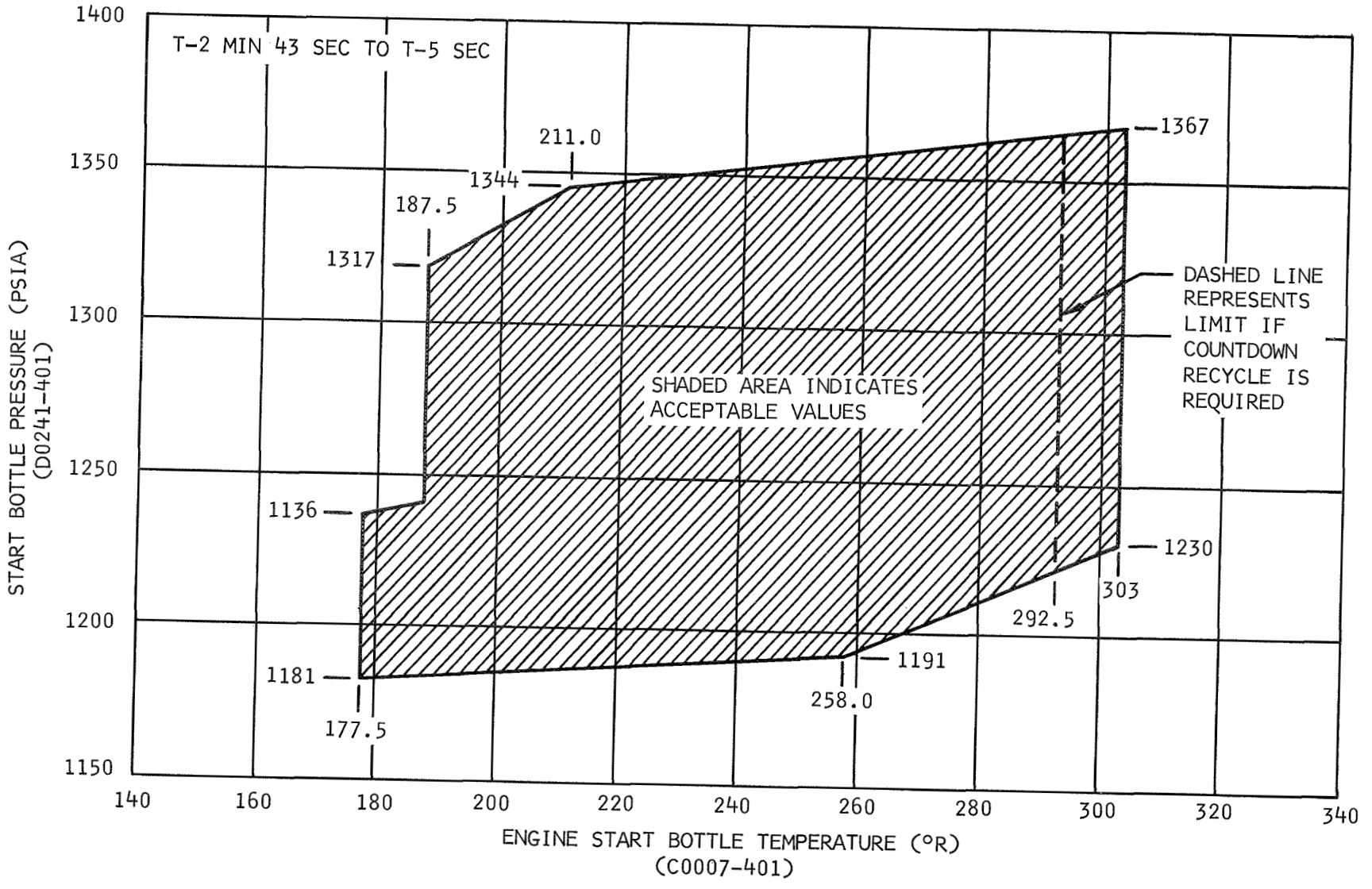


Figure 5-5. GH2 Start Bottle Critical Limits at Liftoff (Backup)

SECTION 6

FLIGHT TEST MANAGEMENT

6. FLIGHT TEST MANAGEMENT

This section defines the responsibilities of the Douglas Aircraft Company relative to the data flow, flight test evaluation, and documentation of the S-IVB-204 stage flight test.

6.1 Flight Test Responsibilities

Douglas Aircraft Company personnel will perform postflight evaluations of the S-IVB-204 stage at the following locations:

a. Kennedy Space Center (KSC), Cape Kennedy, Florida

b. Marshall Space Flight Center (MSFC), Huntsville, Alabama

c. Douglas Missile & Space Systems Division (MSSD), Huntington Beach, California.

At KSC, Douglas is represented by the Florida Test Center (FTC) Test Planning and Evaluation (TP&E) Committee; at Huntington Beach, Douglas is represented by the DAC/HB TP&E Committee; and at MSFC, by the DAC/MSFC liaison team.

The DAC/HB and DAC/FTC TP&E Committees consist of personnel assigned from Saturn Engineering sections and branches. Their functions are to:

a. Coordinate postflight evaluation

b. Provide information for all contractual documentation

c. Coordinate test planning for future flights.

The onsite quick-look postflight evaluation, consisting primarily of analog data evaluation, is performed by the DAC/FTC TP&E Committee, and the results are transmitted to:

a. National Aeronautics and Space Administration (NASA), Kennedy Space Center

b. DAC/HB TP&E Committee

c. DAC/MSFC liaison team.

The major postflight evaluation is conducted at DAC/HB and consists primarily of analyses from digital data.

All analyses conducted at DAC/FTC and DAC/HB are transmitted to the DAC/MSFC liaison team. This liaison team transmits information between Douglas and MSFC, provides the MSFC Flight Evaluation Working Group (FEWG) with required information, and performs rapid analyses in response to FEWG requests. In addition, the liaison team participates in many of the MSFC postflight evaluations which contribute to, or parallel, Douglas postflight evaluation efforts.

6.2 Postflight Communication

The following means of communication (figure 6-1) have been established to expedite transmittal of evaluation information:

a. TWX communications between DAC/MSSD, DAC/MSFC, and DAC/FTC

b. Facsimile communications between DAC/MSSD, DAC/MSFC, and DAC/FTC

c. Data phone link between DAC/MSFC and DAC/MSSD.

Transmittal of classified material between Douglas facilities by any of the above means is not authorized. A standard format is used for transmission of unclassified data by TWX or facsimile.

To insure rapid and controlled data transmission between locations, it is highly desirable that all information be channeled through one coordinator of flight information at each location.

6.3 Documentation

Douglas prepares and publishes certain documents for each S-IVB stage flight. The documents, listed in the approximate order in which they will be published, are as follows:

Preflight

a. Douglas Drawing 1B43557, *Saturn S-IVB-204 Instrumentation Program and Components List* (reference 7)

b. Douglas Report No. SM-46538, *Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights* (reference 8)

c. Douglas Report No. SM-46977, *S-IVB-204 Stage Flight Test Plan*, (reference 9).

Postflight

a. Quick-Look Assessment Report (second morning following launch)

b. FTC Ground Systems Evaluation Report (10 days)

c. FTC Preliminary Flight Evaluation Summary (2 wk)

d. Written Informal Evaluation Inputs to MSFC/FEWG (21 days)

e. Douglas Report No. SM-46989, *S-IVB-204 Stage Flight Evaluation Report*. (60 days) (reference 10).

Descriptions of the contents are presented in the following paragraphs.

6.3.1 *Saturn S-IVB-204 Instrumentation Program and Components List - 1B43557* (reference 7)

This drawing contains all the telemetry measurements of the S-IVB-204 stage. A partial list of its contents is as follows:

a. Measurement numbers

b. Component part numbers

c. Reference designation numbers

d. Telemetry channel coding definitions

e. Measurement list

f. Measurement matrix by area and function

g. Measurement locations, illustrations, and index.

All sections of the Instrumentation Program and Components List are revised as necessary to reflect current instrumentation information. Revisions are controlled by the Saturn Project Office - Test at DAC/MSSD.

6.3.2 *Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights* - SM-46538 (reference 8)

This document describes the detailed data requested by DAC/MSSD for evaluation of the S-IVB stage of the Saturn IB flights. The requested data will be provided by KSC, Goddard Space Flight Center (GSFC), and MSFC.

6.3.3 *S-IVB-204 Stage Flight Test Plan*, SM-46977B (reference 9)

The contents of the *S-IVB-204 Stage Flight Test Plan* are described in section 1, Introduction, of this document. This document is prepared by the DAC/MSSD TP&E Committee.

6.3.4 Quick-Look Assessment Report (Second Morning Following Launch)

Approximately forty-eight hours after launch or as soon as sufficient data are available, the DAC/FTC TP&E Committee will TWX to DAC/MSSD, DAC/MSFC, and DAC/Manned Spacecraft Center, Houston, a quick-look evaluation which will include a brief description of system performance, mission objective accomplishments, and any malfunction which may have occurred. This will be for internal use only.

6.3.5 FTC Ground Systems Evaluation Report (10 days)

The DAC/FTC TP&E Committee will prepare an evaluation report of the performance of DAC/NASA-supplied GSE used in handling propellants for the S-IVB auxiliary propulsion system. This report will be transmitted to KSC.

6.3.6 FTC Preliminary Flight Evaluation Summary (2 wk)

The DAC/FTC TP&E Committee will compile, publish, and distribute the Preliminary Flight Evaluation Summary for internal use only approximately 2 weeks after launch. It will be the final FTC effort and will summarize test objectives, discuss possible causes of malfunctions, and recommend any corrective action required.

6.3.7 Douglas Inputs to MSFC/FEWG

The DAC/MSFC liaison team will summarize the results of the DAC/FTC flight evaluations as they are completed during the 3 weeks subsequent to launch. These summaries, as they become available, will be input to the FEWG and will constitute the Douglas input to the MSFC Saturn Vehicle Flight Evaluation Report.

In addition, Douglas will review its portion of the FEWG report to ensure the technical accuracy and adequacy of evaluation.

6.3.8 *S-IVB-204 Stage Flight Evaluation Report* (60 days) (reference 10)

Sixty days after launch the DAC/MSSD TP&E Committee will write, publish and distribute Douglas Report No. SM-46989, *S-IVB-204 Stage Flight Evaluation Report*. The data for evaluation will be required at DAC/MSSD 15 days after launch, thereby allowing 45 days for preparation of the report. Tentative evaluation meetings and documentation schedules are shown in tables 6-1 and 6-2. A flight evaluation report outline delineating the responsible design technologies is presented in table 6-3.

TABLE 6-1
TENTATIVE AS-204 FLIGHT EVALUATION MEETING SCHEDULE

DAYS AFTER LAUNCH	EVENT SCHEDULED	MEETING LOCATION
1	Flight Review Meeting	MSFC
5	First "How-Goes-It" Meeting	DAC/HB
6	Second Evaluation Meeting	MSFC
13	Second "How-Goes-It" Meeting	DAC/HB
14	Third Evaluation Meeting	MSFC
15	Third "How-Goes-It" Meeting	DAC/HB
16	Fourth Evaluation Meeting	MSFC
20	Fourth "How-Goes-It" Meeting	DAC/HB
21	Summary Meeting	MSFC

TABLE 6-2
EVALUATION AND DOCUMENTATION SCHEDULE FOR S-IVB-204
STAGE FLIGHT EVALUATION REPORT

DAYS AFTER LAUNCH	EVENT
0	Launch
1	Support FEWG Flight Review Meeting
6	Support FEWG Second Evaluation Meeting
14	Support FEWG Third Evaluation Meeting
15	All Final Data Due at A3
16	Support FEWG Fourth Evaluation Meeting
21	Written Informal Evaluation Inputs to MSFC/FEWG Report Due; Support FEWG Meeting
26	*First Inputs Due from Design Sections
40	*All Final Evaluation Inputs Due for 60-Day Report
45	Management Review Copy to Reproduction
47	Management Review Copy Distributed
50	Management Review Comments Due
53	Final Report to Reproduction
60	Final 60-Day Evaluation Report Distributed

*A detailed outline will be published immediately after launch, indicating when inputs are due during the 26-to-40 day period.

TABLE 6-3 (Sheet 1 of 5)
S-IVB-204 STAGE FLIGHT EVALUATION REPORT OUTLINE

Section	Engineering Section
1. INTRODUCTION	S-IVB Project
2. SUMMARY	S-IVB Project*
3. TEST CONFIGURATION	DAC/FTC TP&E Committee** and Propulsion
3.1 Stage Configuration	
3.2 Stage Modifications	
3.3 Ground Support Equipment Modifications	
4. SEQUENCE OF EVENTS	Electronics and FD&C
5. COUNTDOWN OPERATIONS	
5.1 Checkouts	Propulsion
5.2 Purges	Propulsion
5.3 Propellant and Pneumatic Loading	Propulsion
5.4 Holds	Propulsion
5.5 Environmental Control Systems	Structural/Mechanical
5.6 Terminal Count	Propulsion and Electronics
5.7 Launch Environment	S-IVB Project
6. CPIF	FD&C and S-IVB Project
7. TRAJECTORY	FD&C
7.1 Comparison Between Actual and Preflight Predicted Trajectories	
7.2 Trajectory Simulation Analysis	
8. MASS CHARACTERISTICS	Weight Control

*Each Design Technology will summarize its individual areas. The S-IVB TP&E Section will insure compatibility between the various analyses. A separate anomaly summary will be developed by the TP&E Committee.

**Includes serial numbers of significant stage end items, orifice sizes, nominal pressure switch settings, and nominal regulator settings. Significant modifications to the stage since acceptance firing are listed, if any.

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TABLE 6-3 (Sheet 2 of 5)
S-IVB-204 STAGE FLIGHT EVALUATION REPORT OUTLINE

Section	Engineering Section
9. ENGINE ANALYSES	
9.1 Engine Chilldown and Conditioning	Propulsion
9.2 Engine Performance	Propulsion and FD&C
10. SOLID ROCKET PERFORMANCE	Propulsion
10.1 Ullage Rockets	
10.2 Retrorockets	
11. OXIDIZER SYSTEM	Propulsion
11.1 LOX Tank Pressurization	
11.2 LOX Chilldown	
11.3 LOX Supply	
12. FUEL SYSTEM	Propulsion
12.1 Fuel Tank Pressurization	
12.2 LH2 Chilldown	
12.3 LH2 Supply	
13. AUXILIARY PROPULSION SYSTEM	Propulsion
13.1 Sequence and Control	
13.2 Operation	
13.2.1 Oxidizer System	
13.2.2 Fuel System	
13.2.3 Helium System	
13.3 Module No. 1 Performance	
13.4 Module No. 2 Performance	
14. PNEUMATIC CONTROL AND PURGE SYSTEMS . .	Propulsion
14.1 Ambient Helium Supply	
14.2 Pneumatic Control	
14.3 Stage Helium Purge System	

TABLE 6-3 (Sheet 3 of 5)
S-IVB-204 STAGE FLIGHT EVALUATION REPORT OUTLINE

Section	Engineering Section
15. PROPELLANT UTILIZATION	PU Analysis Panel
15.1 Propellant Mass History	
15.2 Closed Loop System Performance	
15.3 Subsystem Performance	
16. S-IB/S-IVB STAGE SEPARATION	FD&C
16.1 Stage Separation and Clearance Analysis	
16.2 Control System Response to Separation Transient	
17. DATA ACQUISITION SYSTEM PERFORMANCE . .	Electronics
17.1 Instrumentation System Performance	
17.2 Telemetry System Performance	
18. ELECTRICAL SYSTEM PERFORMANCE	Electronics
18.1 Control System	
18.2 Electrical Power System	
19. RANGE SAFETY SYSTEM PERFORMANCE	Electronics
19.1 Controllers	
19.2 Firing Unit Monitors	
19.3 CDR Signal Strength	
20. FLIGHT CONTROL	FD&C
20.1 General	
20.2 Critical Parameters During Transient Periods	
20.3 Sloshing	
20.4 Body Bending	
20.5 Flight Control System	
20.6 APS System Simulation	
21. HYDRAULIC SYSTEM PERFORMANCE	Structural/Mechanical
21.1 Hydraulic Systems Operation	
21.2 Servo Systems Operation	

TABLE 6-3 (Sheet 4 of 5)
S-IVB-204 STAGE FLIGHT EVALUATION REPORT OUTLINE

Section	Engineering Section
22. STAGE STRUCTURE AND ENVIRONMENT	
22.1 Explosive Ordnance Equipment . . .	Structural/Mechanical
22.2 Flight Loads (Strain Analysis)	Strength
23. FORWARD SKIRT THERMOCONDITIONING	Structural/Mechanical
24. ACOUSTIC AND VIBRATION ENVIRONMENT . . .	Acoustics
24.1 Data Acquisition and Reduction	
24.2 Vibration Environment	
24.3 Acoustic Environment	
25. AERO/THERMODYNAMIC ENVIRONMENT	Aero-Thermodynamics
25.1 Aerodynamic Environments	
25.2 Thermodynamic Environments	
26. ORBITAL FLIGHT ANALYSES	
26.1 Summary	S-IVB Project
26.2 Sequence of Events	Electronics, FD&C, Propulsion
26.3 Vent Systems	Propulsion
26.4 Auxiliary Propulsion System . . .	Propulsion
26.5 Vehicle Motion and Forces	FD&C
26.6 Flight Control	FD&C
26.7 Thermodynamic Environment	Aero/Thermodynamics
26.8 Data Acquisition and Electrical Systems	Electronics
26.9 Hydraulic System	Structural/Mechanical
26.10 Stage Pneumatic Control System	Propulsion
26.11 Forward Skirt Thermoconditioning	Structural/Mechanical
26.12 S-IVB/LM Separation	FD&C
26.13 Dump Experiment	Electronics and Propulsion

TABLE 6-3 (Sheet 5 of 5)
S-IVB-204 STAGE FLIGHT EVALUATION REPORT OUTLINE

Appendix	Engineering Section
1. Mass Characteristics (WS11)	Weight Control
2. Flight Test Reconstruction (PA49)	Propulsion
3. Observed Trajectory (AA83).	FD&C
4. Flight Simulated Data (AC77).	FD&C
5. Meteorological Data	DAC/FTC TP&E Committee
6. Glossary and Abbreviations.	S-IVB Project

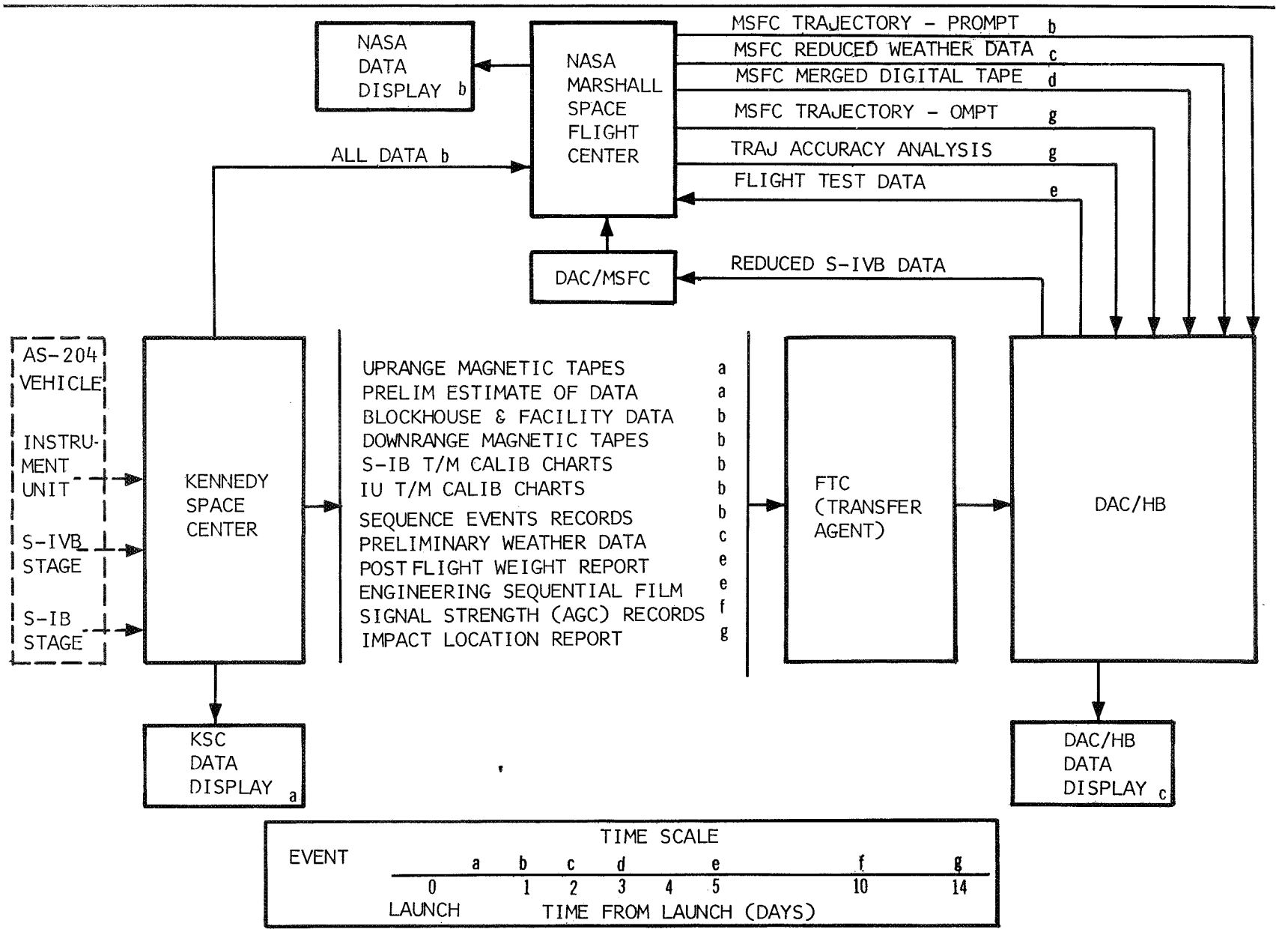

Figure 6-1. Data Flow Chart

SECTION 7

TECHNICAL PERFORMANCE CRITERIA

7. TECHNICAL PERFORMANCE CRITERIA

7.1 General

Douglas Aircraft Company will be awarded a bonus if the S-IVB-204 stage successfully accomplishes the assigned flight mission. Conversely, Douglas will be assessed a penalty if the S-IVB-204 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. CP208004A (reference 11).

7.2 Flight Mission Accomplishment

A mission is considered to be successfully accomplished if the S-IVB-204 stage delivers acceptable valued End Conditions of Flight (ECF) or, if having received from the lower stages and/or IU inadequate Preconditions of Flight (PCF), the S-IVB stage performance is such that the ECF would have been accomplished had the PCF been adequate.

Tables 7-1 and 7-2 present the Contractor's position on PCF, ECF, and their respective allowable tolerances applicable to its S-IVB-204 flight mission.

The flight time which will be used in calculating and evaluating the PCF parameters will be the time when the instrument unit will have issued the command signal for the S-IB to separate from the S-IVB-204 stage. The flight time which will be used in calculating and evaluating ECF trajectory parameters will be the time when the S-IVB-204 stage will have been injected into orbit, which is defined as ten seconds after the instrument unit command signal (Guidance Cutoff Signal) is issued for S-IVB J-2 engine cutoff.

The ECF attitude control parameters will be evaluated until issuance of the Flight Control Computer S-IVB Burn Mode on "A" command which is programmed to occur at Time Base 4 plus 8180.1 sec (refer to appendix 1).

The tolerances on attitude control ECF parameters presented in table 7-2 are not large enough to include expected transients during both S-IVB powered flight and orbit. The Contractor is relying on the Language in paragraph 3.3.6 (h) of Exhibit "J" to Supplemental Agreement 1100 of Contract NAS7-101 to assist both parties in reaching a reasonable post flight incentive evaluation.

7.3 Payload Capability

The capability of the S-IVB-204 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 the CPIF Exhibit to NAS7-101* (reference 12). The provisions of Exhibit J to Supplemental Agreement 1100 will apply in the event of any conflict with the provisions of 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-204 stage.

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7.4 Telemetry Performance Evaluation

The measurements to be evaluated for technical performance incentives are those listed in the Instrumentation Program and Components List (IP&CL) that are wholly on the S-IVB-204 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 515 measurements of which 13 are not active during flight and 5 are not wholly on the S-IVB stage, leaving a total of 497 measurements to be evaluated for technical performance incentives.

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

Measurement No.	Measurement Title	Reason
K0141-411	Event - R/S 1 Pulse Sensor	These measurements are for checkout only and are not transmitted during flight by the S-IVB-204 stage T/M system.
K0142-411	Event - R/S 2 Pulse Sensor	
K0143-404	Event - U/R 1 Ignition Pulse Sensor 1	
K0144-404	Event - U/R 1 Ignition Pulse Sensor 2	
K0145-404	Event - U/R 2 Ignition Pulse Sensor 1	
K0146-404	Event - U/R 2 Ignition Pulse Sensor 2	
K0147-404	Event - U/R 3 Ignition Pulse Sensor 1	
K0148-404	Event - U/R 3 Ignition Pulse Sensor 2	
K0149-404	Event - U/R Jettison 1 Pulse Sensor	
K0150-404	Event - U/R Jettison 2 Pulse Sensor	
K0169-404	Event - EBW Pulse Sensor OFF Indication	
K0152-404	Event - Rate Gyro Wheel Speed OK Indications	Rate Gyro is not installed
D0545-407	Press - Common Bulkhead Int-H/W	This measurement is landline for prelaunch requirements and is not transmitted during flight by the S-IVB-204 stage T/M system.

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

Measurement No.	Measurement Title	Reason
C0375-402	Temp - Heat Flux Aft Interstage-3	Transmitted by S-IB stage T/M
D0153-423	Press - Chamb Retro Rkt Pos IV-I	
D0154-421	Press - Chamb Retro Rkt Pos II-III	
D0155-420	Press - Chamb Retro Rkt Pos I-II	
D0156-422	Press - Chamb Retro Rkt Pos III-IV	

7.4.1 Performance Baseline Determination

Douglas Aircraft Company 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 DAC/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 DAC/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. 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.

DAC/MSFC and NASA/MSFC will have a cognizant representative in the HOSC, and these two representatives will sign the Memo of Agreement after liftoff.

7.4.2 Performance Evaluation Period

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

a. Phase I

From AS-204/LM-1 launch vehicle liftoff until S-IVB stage ECC +10 sec.

b. Phase II

From AS-204/LM-1 launch vehicle liftoff until issuance of the Flight Control Computer S-IVB Burn Mode on "A" command which is programmed to occur at Time Base 4 plus 8180.1 sec.

7.4.3 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:

Special calibration relays ON	PCM transmitter ON
Special calibration relays OFF	PCM transmitter OFF
Regular calibration relays ON	Slow record ON
Regular calibration relays OFF	Slow record OFF
FM transmitters ON	Fast record ON
FM transmitters OFF	Fast record OFF
FM SCO assemblies ON	Recorder playback ON
FM SCO assemblies OFF	Recorder playback OFF
SSB/FM transmitter ON	Emergency playback ON
SSB/FM transmitter OFF	Emergency playback OFF

TABLE 7-1
S-IVB-204 PCF AND ASSOCIATED TOLERANCES

(S-IB/S-IVB Separation Signal)

PARAMETER	UNITS	NOMINAL	TOLERANCES	EVALUATION INACCURACY**	TOTAL ENVELOPE
*Range	km	62.63	+10.17 -5.17	±0.15	+10.32 -5.32
*Crossrange (see note 1)	km	-0.05	±5.57	±0.15	±5.72
*Altitude	km	63.49	+2.91 -4.01	±0.15	+3.06 -4.16
Velocity	m/sec	2,369.8	+56.6 -68.6	±1.5	+58.1 -70.1
Velocity Vector Direction (Path Angle from local horizontal)	deg	27.16	+2.47 -3.90	±0.04	+2.51 -3.94
Pitch Rate	deg/sec	0	±1	±0.5	±1.5
Pitch Attitude (see note 2)	deg	-59.46	±2	±1	±3
Yaw Rate	deg/sec	0	±1	±0.5	±1.5
Yaw Attitude (see note 3)	deg	-0.08	±2	±1	±3
Roll Rate	deg/sec	0	±1	±0.5	±1.5
Roll Attitude	deg	0	±5.8	±1	±6.8

* Earth Fixed

** Assuming radar only tracking available for trajectory parameters

NOTES:
1. Crossrange 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.
2. Pitch attitude is measured negatively nose downrange from the launch vertical in the pitch plane.
3. Yaw attitude is measured positive nose to the right in the yaw plane as seen looking forward with position one down.

TABLE 7-2
S-IVB-204 ECF AND ASSOCIATED TOLERANCES
(GUIDANCE CUTOFF COMMAND +10 SEC)

A. S-IVB Trajectory Parameters

PARAMETER	UNITS	NOMINAL	TOLERANCES	EVALUATION INACCURACY**	TOTAL ENVELOPE
*Range	km	1,868.55	+82.99 -87.48	±0.75	+83.74 -88.23
Crossrange (Space Fixed)	km	146.12	+4.89 -5.04	±0.75	+5.64 -5.79
*Altitude	km	163.22	±0.60	±0.75	±1.35
Velocity Vector Magnitude	m/sec	7,828.6	+3.2 -3.1	±3.0	+6.2 -6.1
Velocity Vector Direction (Path angle from local horizontal)	deg	0.008	+0.027 -0.034	±0.05	+0.077 -0.084

B. S-IVB Attitude Control Parameters

PARAMETER	UNITS	TOLERANCES	EVALUATION INACCURACY	TOTAL ENVELOPE
S-IVB Burn Phase				
Attitude Errors	deg	±8.0	±1.0	±9.0
Pitch and Yaw Rates	deg/sec	±2.5	±0.5	±3.0
Roll Rate	deg/sec	±1.0	±0.5	±1.5
Orbital Phase (To Time Base 4 +8,180.1 sec)				
Pitch or Yaw Rates	deg/sec	±0.5	±0.5	±1.0
Roll Rate	deg/sec	±1.0	±0.5	±1.5

*Earth fixed

**Assuming radar only tracking

APPENDIX 1

SEQUENCE OF EVENTS

1. SEQUENCE OF EVENTS

This appendix presents the predicted AS-204/LM-1 flight sequence of events (table AP 1-1). Four time bases are programmed to achieve an optimum vehicle mission with suitable sequential operation and timing of flight events. Definitions of the time bases and symbols used are listed in table AP 10-1.

The sequence of events is based on the Marshall Space Flight Center sequence requirements as indicated in the Interface Control Document (reference 13), *Definition of Saturn SA-204 Flight Sequence Program.*

TABLE AP 1-1 (Sheet 1 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGIN START (sec)	SSS	REMARKS
POWERED					
Guidance Reference Release	-5.0	N/A	-149.8	-	
S-IB Engine Start	-3.1	N/A	-147.9	-	
First Vertical Motion	0.0	N/A	-144.8	-	
IU Umbilical Disconnect (Liftoff)	0.2	$(0.0)_1$	-144.6	-	Time Base #1 (T_1) is initiated by a liftoff signal provided by the deactuation of the liftoff relay in the IU at umbilical disconnect. However, as a safety measure, the Launch Vehicle Digital Computer (LVDC) will not recognize the liftoff signal and start T_1 prior to receiving Guidance Reference Release which is initiated and verified 5 sec prior to schedule liftoff. A backup method for starting T_1 is provided should the LVDC fail to receive or recognize the liftoff signal. If T_1 is not initiated within 5.5 sec after Guidance Reference Release, the LVDC will monitor the vertical accelerometer. If a significant positive acceleration (in excess of 1 g) exists, the LVDC assumes liftoff has occurred and begins T_1. A time adjustment is made by the computer. No "Negative Backup" (i.e., provisions for the LVDC to return to prelaunch conditions) is provided because the

TABLE AP 1-1 (Sheet 2 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
IU Umbilical Disconnect (Continued)					Saturn IB vehicle could safely complete T_1 on the pad without catastrophic results, in the event T_1 began by error.
Multiple S-IB Engine Cutoff Enable	10.2	$(10.0)_1$	-134.6	S-IB	This signal enables cutoff of any engine due to rough combustion or low thrust.
Pitch Program Start	10.2	N/A	-134.6	-	
Roll Program Start	10.2	N/A	-134.6	-	
Telemeter Calibration ON	20.2	$(20.0)_1$	-124.6	S-IB	
Telemeter Calibration OFF	25.2	$(25.0)_1$	-119.6	S-IB	
Telemetry Calibrator In-Flight Calibrate ON	27.2	$(27.0)_1$	-117.6	IU	
LOX Tank Relief Control Valve Enable	30.0	$(29.8)_1$	-114.8	S-IB	
Telemetry Calibrator In-Flight Calibrate OFF	32.2	$(32.0)_1$	-112.6	IU	
Tape Recorder Record ON	39.2	$(39.0)_1$	-105.6	S-IB	
Flight Control Computer - Switch Point No. 1	40.2	$(40.0)_1$	-104.6	IU	
Launch Vehicle Engines EDS Cutoff Enable	60.2	$(60.0)_1$	-84.6	IU	
Maximum Dynamic Pressure	74.0	N/A	-70.8	-	
Telemetry Calibrator In-Flight Calibrate ON	90.4	$(90.2)_1$	-54.4	IU	

TABLE AP 1-1 (Sheet 3 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Telemetry Calibrator In-Flight Calibrate OFF	95.4	$(95.2)_1$	-49.4	IU	
Flight Control Computer - Switch Point No. 2	100.2	$(100.0)_1$	-44.6	IU	
Telemeter Calibration ON	120.0	$(119.8)_1$	-24.8	S-IB	
Flight Control Computer - Switch Point No. 3	120.2	$(120.0)_1$	-24.6	IU	
Control Accelerometer OFF	120.4	$(120.2)_1$	-24.4	IU	
Telemeter Calibration OFF	125.1	$(124.9)_1$	-19.7	S-IB	
Special TM Calibration On	125.3	$(125.1)_1$	-19.5	S-IVB	
Regular TM Calibration On	125.5	$(125.3)_1$	-19.3	S-IVB	
Regular TM Calibration Off	130.5	$(130.3)_1$	-14.3	S-IVB	
Special TM Calibration Off	130.7	$(130.5)_1$	-14.1	S-IVB	
Excessive Rate (P, Y, R) Auto-Abort Inhibit Enable	131.7	$(131.5)_1$	-13.1	IU	
Excessive Rate (P, Y, R) Auto-Abort Inhibit	131.9	$(131.7)_1$	-12.9	IU	
S-IB Two Engines Out Auto-Abort Inhibit Enable	132.1	$(131.9)_1$	-12.7	IU	
S-IB Two Engines Out Auto-Abort Inhibit	132.3	$(132.1)_1$	-12.5	IU	
Propellant Level Sensors Enable	132.5	$(132.3)_1$	-12.3	S-IB	Four level sensors are armed at this time.
Tilt Arrest	133.4	N/A	-11.4	-	

TABLE AP 1-1 (Sheet 4 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IB Propellant Level Sensor Actuation	136.0	$(0.0)_2$	-8.8	S-IB	Time Base #2 (T_2) is initiated by the LVDC upon receiving the S-IB low level sensor dry signal. However, the propellant low level sensors are armed prior to calculated actuation time. If a failure occurs which would prevent the LVDC from receiving or recognizing the sensors actuation signal, a backup method of starting T_2 is available. The LVDC will monitor the downrange accelerometer after arming the S-IB propellant level sensors. If T_2 is not started within 0.55 sec after calculated actuation of the level sensors and a significant downrange velocity reading appears, the LVDC will start T_2. However, because of the one engine out capability of the Saturn IB, a time adjustment to the time backup will be made if an S-IB engine out condition occurs. When the LVDC receives an S-IB engine out signal, it will adjust the backup time remaining to 8/7 of the remaining nominal level sensors actuation time plus 0.55 sec. This will allow initiation of T_2 by propellant level sensors actuation at a later time with one S-IB engine out.

TABLE AP 1-1 (Sheet 5 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IB Propellant Level Sensor Actuation (Continued)					Use of the downrange velocity reading as a backup provides a safeguard against starting T_2 inadvertently. If a significant downrange velocity value does not appear, the time backup for starting T_2 will not be issued. Furthermore, if T_2 is not established, no subsequent time bases can be started. This insures a safe vehicle, even if T_1 is started without liftoff, requiring at least one additional failure to render the vehicle unsafe on the pad.
IU Tape Recorder Record On	136.2	$(0.2)_2$	-8.6	IU	
Fast Record On	136.4	$(0.4)_2$	-8.4	S-IVB	
S-IB Inboard Engines Cutoff (IECO)	139.1	$(3.1)_2$	-5.7	S-IB	
Reset Auto-Abort Enable Relays	139.3	$(3.3)_2$	-5.5	IU	
Ullage Ignition Charge On	140.0	$(4.0)_2$	-4.8	S-IVB	
Prevalves Open	140.4	$(4.4)_2$	-4.4	S-IVB	
LOX Depletion Cutoff Enable	140.6	$(4.6)_2$	-4.2	S-IB	
Fuel Depletion Cutoff Enable	141.6	$(5.6)_2$	-3.2	S-IB	
S-IB Outboard Engines Cutoff (OECO)	142.1	$(0.0)_3$	-2.7	S-IB	Time Base #3 (T_3) is initiated by the S-IB outboard engines cutoff signal from the S-IB Stage at propellant depletion cutoff. However, the start of Time Base #3 is inhibited

TABLE AP 1-1 (Sheet 6 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IB Outboard Engines Cutoff (Continued)					until the command "LOX Depletion Cutoff Enable" is issued by the LVDC. As a safeguard against trying to separate the S-IB Stage with the thrust of the outboard engines present, a redundant S-IB outboard engines cutoff command is issued at the start of T_3 (T_3 +0.0). If a failure should prevent the LVDC from receiving or recognizing the S-IB outboard engines cutoff signal, a time backup for starting T_3 is available. If T_3 is not initiated within 4 sec after calculated S-IB outboard engine cutoff the LVDC will issue an S-IB outboard engines cutoff command and start T_3.
Engine Cutoff Signal Off	142.5	$(0.4)_3$	-2.3	S-IVB	The S-IVB engine cutoff "ON" is turned on prior to liftoff and remains on until this time to prevent an erroneous J-2 engine start.
Ullage Rockets Ignition	143.2	$(1.1)_3$	-1.6	S-IVB	The effective burning time of the S-IVB ullage rockets is approximately 3.6 sec. The ullage rocket burn sequence is scheduled so that the S-IVB propellants are properly seated prior to J-2 engine mainstage operation.

TABLE AP 1-1 (Sheet 7 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IB/S-IVB Separation	143.4	$(1.3)_3$	-1.4	S-IB	The separation devices are fired at this time. The signal is also given to fire the retrorocket motors, but circuit delays are built into the separation circuitry so that retro-rocket ignition occurs after separa-tion device detonation, thereby, preventing possible unseating of the S-IVB propellants.
Flight Control Computer S-IVB Burn Mode on "B"	143.5	$(1.4)_3$	-1.3	IU	This signal activates the AACS roll control and enables J-2 engine gimbaling.
Flight Control Computer S-IVB Burn Mode on "A"	143.6	$(1.5)_3$	-1.2	IU	
Engine Ready Bypass On	143.8	$(1.7)_3$	-1.0	S-IVB	This signal prevents engine cutoff by any of the malfunction cutoff modes.
LH2 Chilldown Pump Off	144.2	$(2.1)_3$	-0.6	S-IVB	Chilldown initiated on the ground.
LOX Chilldown Pump Off	144.4	$(2.3)_3$	-0.4	S-IVB	Chilldown initiated on the ground.
S-IVB Engine Ignition Sequence Start	144.8	$(2.7)_3$	0.0	S-IVB	A one second J-2 engine fuel lead is initiated at this time. The J-2 engine sequence of events is controlled by internal engine logic.
Engine Ignition Sequence Start Relay Reset	145.3	$(3.2)_3$	0.5	S-IVB	
LOX Tank Flight Pressurization Switch Enable	145.6	$(3.5)_3$	0.8	S-IVB	The control function of the LOX tank flight pressure switch is switched from the main pressurization shutoff valves to the heat exchanger bypass valves.

TABLE AP 1-1 (Sheet 8 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Fuel Injection Temperature OK Bypass	145.8	$(3.7)_3$	1.0	S-IVB	Fuel lead is terminated at this time by opening the start tank discharge valve.
S-IVB Engine Out Indication "A" Enable	146.0	$(3.9)_3$	1.2	IU	
LH2 Tank Pressurization Control Switch Enable	147.4	$(5.3)_3$	2.5	S-IVB	Enables the LH2 tank pressure switch to control LH2 pressurization.
PU System Activate	150.8	$(8.7)_3$	6.0	S-IVB	Initiates PU system propellant management.
Emergency Playback Enable	151.8	$(9.7)_3$	7.0	S-IVB	
Fast Record Off	151.9	$(9.8)_3$	7.1	S-IVB	
Charge Ullage Jettison EBW Firing Units	152.3	$(10.2)_3$	7.5	S-IVB	
Ullage Rockets Jettison	155.4	$(13.3)_3$	10.6	S-IVB	
Fuel Injection Temperature OK Bypass Reset	155.8	$(13.7)_3$	11.0	S-IVB	
Active Guidance Initiation	159.1	N/A	11.1	-	
Tape Recorder Record Off	161.1	$(19.0)_3$	16.3	IU	
Ullage EBW Firing Units Charge Relays Reset	161.4	$(19.3)_3$	16.6	S-IVB	
Ullage Rockets Ignition and Jettison Relays Reset	161.6	$(19.5)_3$	16.8	S-IVB	
Telemetry Calibrator In-Flight Calibrate On	170.9	$(28.8)_3$	26.1	IU	

TABLE AP 1-1 (Sheet 9 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Telemetry Calibrator In-Flight Calibrate Off	175.9	$(33.8)_3$	31.1	IU	
Water Coolant Valve Open	179.8	$(37.7)_3$	35.0	IU	
Flight Control Computer-Switch Point No. 4	285.8	$(143.7)_3$	141.0	IU	
Telemetry Calibrator In-Flight Calibrate On	349.8	$(207.7)_3$	205.0	IU	
Regular TM Calibration On	350.8	$(208.7)_3$	206.0	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	354.8	$(212.7)_3$	210.0	IU	
Regular TM Calibration Off	355.8	$(213.7)_3$	211.0	S-IVB	
LH2 Tank Pressurization Control Switch Disable	445.0	$(302.9)_3$	300.2	S-IVB	LH2 tank pressure buildup.
Introduction of Artificial Tau Mode	474.1	N/A	327.1		Artificial Tau mode begins when the IGM detects EMR cutback.
Guidance Staging	474.1	N/A	327.1		Guidance staging occurs at nominal EMR cutback or at the time of forced artificial Tau mode introduction.
Telemetry Calibrator In-Flight Calibrate On	500.9	$(358.8)_3$	356.1	IU	
Telemetry Calibrator In-Flight Calibrate Off	505.9	$(363.8)_3$	361.1	IU	
Chilldown Shutoff Valves Close	567.5	$(425.4)_3$	422.7	S-IVB	This signal isolates the S-IVB tanks at engine cutoff.
Emergency Playback Inhibit	582.5	$(440.4)_3$	437.7	S-IVB	

TABLE AP 1-1 (Sheet 10 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Introduction of $\tilde{\chi}$ Guidance Mode	584.4	N/A	439.3		This guidance mode begins approximately 15 sec before guidance cutoff.
Freeze Body Attitude	595.1	N/A	442.4		This guidance mode begins approximately 3 sec before guidance cutoff.
Arm S-IVB Propellant Depletion Sensor	599.2	$(457.1)_3$	454.4	S-IVB	Three LOX depletion sensors and three LH2 depletion sensors are armed. Actuation of any two of three depletion sensors in either tank will initiate engine cutoff. The propellant depletion level sensors are armed to provide a back-up for the predicted velocity cutoff.

TABLE AP 1-1 (Sheet 11 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
ORBITAL					
S-IVB Engine Cutoff	598.2	$(0.0)_4$	BDA (1)	S-IVB	After a predetermined time, sufficient to allow the engine to establish Thrust OK, the LVDC will start T_4 after receiving any two of four functions monitored by the LVDC. The functions are (1) S-IVB Engine Out "A" (2) S-IVB Engine Out "B" (3) S-IVB Velocity Cutoff which is issued by the LVDC (4) Loss of Thrust determined by the LVDC using accelerometer readings. A redundant S-IVB engine cutoff command is issued at the start of T_4 (T_4 +0.0), as a safeguard against having started T_4 with the thrust of the S-IVB engine present.
LOX Tank Vent Valve Open	598.4	$(0.2)_4$	BDA (1)	S-IVB	A 40 sec LOX tank blowdown is initiated at this time.
LH2 Tank Vent Valve Open	598.6	$(0.4)_4$	BDA (1)	S-IVB	A 1,260 sec LH2 tank blowdown is initiated at this time.
LOX Tank Pressurization Shut-off Valves Close	599.0	$(0.8)_4$	BDA (1)	S-IVB	
Prevalves Close	599.2	$(1.0)_4$	BDA (1)	S-IVB	
LOX Tank Flight Pressurization Switch Disable	599.4	$(1.2)_4$	BDA (1)	S-IVB	
LOX Chilldown Pump Purge Off	599.8	$(1.6)_4$	BDA (1)	S-IVB	
Propellant Depletion Cutoff Disarm	600.0	$(1.8)_4$	BDA (1)	S-IVB	

TABLE AP 1-1 (Sheet 12 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
PU System Deactivate	601.3	$(3.1)_4$	BDA (1)	S-IVB	
PU Inverter and DC Power Off	601.5	$(3.3)_4$	BDA (1)	S-IVB	
Flight Control Computer S-IVB Burn Mode Off "B"	601.6	$(3.4)_4$	BDA (1)	IU	This signal disables J-2 engine gimbaling and enables the APS to control pitch and yaw.
Flight Control Computer S-IVB Burn Mode Off "A"	601.7	$(3.5)_4$	BDA (1)	IU	
Aux Hydraulic Pump Flight Mode Off	601.9	$(3.7)_4$	BDA (1)	S-IVB	
Tape Recorder Playback Reverse On	602.1	$(3.9)_4$	BDA (1)	IU	
Emergency Playback Enable	602.3	$(4.1)_4$	BDA (1)	S-IVB	
Emergency Playback Inhibit	628.1	$(29.9)_4$	BDA (1)	S-IVB	
Tape Recorder Playback Reverse Off	630.2	$(32.0)_4$	BDA (1)	IU	
LOX Tank Vent Valve Close	638.4	$(40.2)_4$	BDA (1)	S-IVB	
LOX Tank Vent Valve Boost Close On	641.4	$(43.2)_4$	BDA (1)	S-IVB	
Nose Cone/SLA Separation Sequence Start "A"	643.2	$(45.0)_4$	BDA (1)	IU	
Nose Cone/SLA Separation Sequence Start "B"	643.4	$(45.2)_4$	BDA (1)	IU	
LOX Tank Vent Valve Boost Close Off	643.6	$(45.4)_4$	BDA (1)	S-IVB	
Telemetry Calibrator In-Flight Calibrate On	648.5	$(50.3)_4$	BDA (1)	IU	
Telemetry Calibrator In-Flight Calibrate Off	653.5	$(55.3)_4$	BDA (1)	IU	

TABLE AP 1-1 (Sheet 13 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Nose Cone/SLA Separation Sequence Start Reset	653.7	$(55.5)_4$	BDA (1)	IU	
Chilldown Shutoff Valves Open	658.5	$(60.3)_4$	BDA (1)	S-IVB	
Prevalves Open	658.7	$(60.5)_4$	BDA (1)	S-IVB	
Start Pitch Maneuver (to local horizontal)	688.2	$(90.0)_4$	BDA (1)	-	
Slow Record On	697.9	$(99.7)_4$	BDA (1)	S-IVB	
Slow Record On	707.9	$(109.7)_4$	BDA (1)	S-IVB	
Azusa Transponder Power Off	898.2	$(300.0)_4$		IU	
SLA Panel Deployment "A"	1,198.2	$(600.0)_4$		IU	
SLA Panel Deployment "B"	1,198.4	$(600.2)_4$		IU	
LH2 Tank Vent Valve Close	1,858.6	$(1,260.4)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close On	1,861.6	$(1,263.4)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close Off	1,863.6	$(1,265.4)_4$		S-IVB	
Slow Record On	2,297.9	$(1,699.7)_4$	TAN (1)	S-IVB	
Slow Record Off	2,329.9	$(1,731.7)_4$	TAN (1)	S-IVB	
Recorder Playback On	2,330.1	$(1,731.9)_4$	TAN (1)	S-IVB	
Recorder Playback Off	2,542.1	$(1,943.9)_4$	TAN (1)	S-IVB	
Slow Record On	2,542.3	$(1,944.1)_4$	TAN (1)	S-IVB	
Slow Record On	2,552.3	$(1,954.1)_4$	TAN (1)	S-IVB	
Start Maneuver to Separation Attitude	2,999.8	N/A	TAN (1)	-	

TABLE AP 1-1 (Sheet 14 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Telemetry Calibrator In-Flight Calibrate On	3,222.9	$(2,624.7)_4$	CRO (1)	IU	
Special TM Calibration On	3,223.1	$(2,624.9)_4$	CRO (1)	S-IVB	
Regular TM Calibration On	3,223.3	$(2,625.1)_4$	CRO (1)	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	3,227.9	$(2,629.7)_4$	CRO (1)	IU	
Regular TM Calibration Off	3,228.3	$(2,630.1)_4$	CRO (1)	S-IVB	
Special TM Calibration Off	3,228.5	$(2,630.3)_4$	CRO (1)	S-IVB	
LM Separation Sequence Initiated	3,234.8	N/A	CRO (1)	-	
Slow Record On	3,317.9	$(2,719.7)_4$	CRO (1)	-	
LH2 Tank Vent Valve Open	3,403.2	$(2,805.0)_4$	CRO (1)	S-IVB	A 1,200 sec LH2 tank blowdown is initiated at this time.
Pitch to Local Horizontal	3,414.8	N/A	CRO (1)	-	
Temperature Control Sensor Bias On	4,320.4	$(3,722.2)_4$		IU	
Cooling System Electronic Assembly Power Off	4,420.4	$(3,822.2)_4$		IU	
LH2 Tank Vent Valve Close	4,603.2	$(4,005.0)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close On	4,606.2	$(4,008.0)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close Off	4,608.2	$(4,010.0)_4$		S-IVB	
Telemetry Calibrator In-Flight Calibrate On	5,352.9	$(4,754.7)_4$	GYM (1)	IU	
Special TM Calibration On	5,353.1	$(4,754.9)_4$	GYM (1)	S-IVB	

TABLE AP 1-1 (Sheet 15 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Regular TM Calibration On	5,353.3	$(4,755.1)_4$	GYM (1)	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	5,357.9	$(4,759.7)_4$	GYM (1)	IU	
Regular TM Calibration Off	5,358.3	$(4,760.1)_4$	GYM (1)	S-IVB	
Special TM Calibration Off	5,358.5	$(4,760.3)_4$	GYM (1)	S-IVB	
Slow Record On	5,358.9	$(4,760.7)_4$	GYM (1)	S-IVB	
Slow Record Off	5,388.9	$(4,790.7)_4$	GYM (1)	S-IVB	
Recorder Playback On	5,389.1	$(4,790.9)_4$	GYM (1)	S-IVB	
Start Inertial Attitude Hold	5,484.8	N/A	GYM (1)		
Recorder Playback Off	5,744.9	$(5,146.7)_4$	GYM (1)	S-IVB	
Slow Record On	5,745.1	$(5,146.9)_4$	GYM (1)	S-IVB	
Slow Record On	5,755.1	$(5,156.9)_4$	GYM (1)	S-IVB	
Passivation Enable	5,819.4	$(5,221.2)_4$	KSC (2)	S-IVB	The purpose of this command is to provide power to three mag-latch-controlled circuits used to control opening and closing of the engine helium control solenoids for propellant dump.
LH2 Tank Vent Valve Open	6,148.2	$(5,550.0)_4$	KSC (2)	S-IVB	A 600 sec LH2 tank blowdown is initiated at this time. This vent will assure that bulkhead pressure differential limits are not exceeded when LOX is dumped and ullage gas is vented through the engine.
Telemetry Calibrator In-Flight Calibrate On	6,293.9	$(5,695.7)_4$	BDA (2)	IU	
Special TM Calibration On	6,294.1	$(5,695.9)_4$	BDA (2)	S-IVB	

TABLE AP 1-1 (Sheet 16 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Regular TM Calibration On	6,294.3	$(5,696.1)_4$	BDA (2)	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	6,298.9	$(5,700.7)_4$	BDA (2)	IU	
Regular TM Calibration Off	6,299.3	$(5,701.1)_4$	BDA (2)	S-IVB	
Special TM Calibration Off	6,299.5	$(5,701.3)_4$	BDA (2)	S-IVB	
Start Pitch to Retrograde Attitude	6,354.8	N/A			
Auxiliary Hydraulic Pump Coast Mode On	6,378.2	$(5,780.0)_4$		S-IVB	A thermal switch is enabled to control the auxiliary hydraulic pump at this time. The thermal switch controls the running time of the hydraulic pump so that a predetermined maximum and minimum temperature of the hydraulic fluid is maintained.
LH2 Tank Vent Valve Close	6,748.2	$(6,150.0)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close On	6,751.2	$(6,153.0)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close Off	6,753.2	$(6,155.0)_4$		S-IVB	
Slow Record On	7,839.9	$(7,241.7)_4$	TAN (2)	S-IVB	
Slow Record Off	7,871.9	$(7,273.7)_4$	TAN (2)	S-IVB	
Recorder Playback On	7,872.1	$(7,273.9)_4$	TAN (2)	S-IVB	
Recorder Playback Off	8,140.1	$(7,541.9)_4$	TAN (2)	S-IVB	
Slow Record On	8,140.3	$(7,542.1)_4$	TAN (2)	S-IVB	
Slow Record On	8,150.3	$(7,552.1)_4$	TAN (2)	S-IVB	

TABLE AP 1-1 (Sheet 17 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Start Pitch to Passivation Attitude	8,438.2	$(7,840.0)_4$			
Initiate Constant Roll	8,755.2	N/A			
Auxiliary Hydraulic Pump Flight Mode On	8,773.0	$(8,174.8)_4$		S-IVB	
Flight Control Computer S-IVB Burn Mode On "A"	8,778.3	$(8,180.1)_4$		IU	This command allows J-2 engine gimbaling for pitch and yaw control. Because of the expected resultant force due to the LOX dump, it is preferable to maintain attitude control by positioning the J-2 engine bell through the use of the engine gimbaling hydraulic actuators, thus conserving APS propellant.
Flight Control Computer S-IVB Burn Mode On "B"	8,778.5	$(8,180.3)_4$		IU	
Engine Mainstage Control Valve Open On	8,779.0	$(8,180.8)_4$		S-IVB	A 120 sec LOX tank dump is initiated at this time.
Engine He Control Valve Open On	8,779.2	$(8,181.0)_4$		S-IVB	Helium pneumatic pressure is supplied to open the main LOX valve.
Telemetry Calibrator In-Flight Calibrate On	8,807.9	$(8,209.7)_4$	CRO (2)	IU	
Special TM Calibration On	8,808.1	$(8,209.9)_4$	CRO (2)	S-IVB	
Regular TM Calibration On	8,808.3	$(8,210.1)_4$	CRO (2)	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	8,812.9	$(8,214.7)_4$	CRO (2)	IU	

TABLE AP 1-1 (Sheet 18 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Regular TM Calibration Off	8,813.3	$(8,215.1)_4$	CRO (2)	S-IVB	
Special TM Calibration Off	8,813.5	$(8,215.3)_4$	CRO (2)	S-IVB	
Slow Record On	8,815.9	$(8,217.7)_4$	CRO (2)	S-IVB	
Flight Control Computer Burn Mode Off "A"	8,860.2	$(8,262.0)_4$	CRO (2)	IU	This signal disables J-2 engine gimbaling and enables the APS to control pitch and yaw steering.
Flight Control Computer Burn Mode Off "B"	8,860.4	$(8,262.2)_4$	CRO (2)	IU	
Engine Mainstage Control Valve Open Off	8,899.2	$(8,301.0)_4$	CRO (2)	S-IVB	
Engine He Control Valve Open Off	8,900.2	$(8,302.0)_4$	CRO (2)	S-IVB	
Engine Ignition Phase Control Valve Open	8,909.0	$(8,310.8)_4$	CRO (2)	S-IVB	A 180 sec LH2 tank dump is initiated by this command.
Engine He Control Valve Open On	8,909.2	$(8,311.0)_4$	CRO (2)	S-IVB	
Engine Ignition Phase Control Valve Closed	9,089.2	$(8,491.0)_4$	CRO (2)	S-IVB	
Engine He Control Valve Open Off	9,090.2	$(8,492.0)_4$	CRO (2)	S-IVB	
Auxiliary Hydraulic Pump Coast Mode On	9,092.7	$(8,494.5)_4$	CRO (2)	S-IVB	A thermal switch is enabled to control the auxiliary hydraulic pump at this time. The thermal switch controls the running time of the hydraulic pump so that a predetermined maximum and minimum temperature of the hydraulic fluid is maintained.

TABLE AP 1-1 (Sheet 19 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Auxiliary Hydraulic Pump Flight Mode Off	9,092.9	$(8,494.7)_4$	CRO (2)	S-IVB	
LH2 Tank Vent Valve Open	9,099.0	$(8,500.8)_4$		S-IVB	A 2,557 sec LH2 tank vent is initiated at this time to vent any residual boiloff not removed during the dump.
LOX Tank Vent Valve Open	9,099.2	$(8,501.0)_4$		S-IVB	A 2,557 sec LOX tank vent is initiated at this time to vent any residual boiloff not removed during the dump.
Terminate Constant Roll	9,145.2	$(8,547.0)_4$		-	
Pitch Nose Up to Local Horizontal	9,398.2	$(8,800.0)_4$		-	
LOX Tank Pressurization Shutoff Valves Open	10,354.2	$(9,756.0)_4$	HAW (2)	S-IVB	This command initiates a 1,302 sec cold helium sphere dump through the LOX tank.
Slow Record On	10,356.9	$(9,758.7)_4$	HAW (2)	S-IVB	
Slow Record Off	10,388.9	$(9,790.7)_4$	HAW (2)	S-IVB	
Recorder Playback On	10,389.1	$(9,790.9)_4$	HAW (2)	S-IVB	
Recorder Playback Off	10,671.1	$(10,072.9)_4$	HAW (2)	S-IVB	
Slow Record On	10,671.3	$(10,073.1)_4$		S-IVB	
Slow Record On	10,681.3	$(10,083.1)_4$		S-IVB	
Telemetry Calibrator In-Flight Calibrate On	11,005.9	$(10,407.7)_4$	GYM (2)	IU	
Special TM Calibration On	11,006.1	$(10,407.9)_4$	GYM (2)	S-IVB	

TABLE AP 1-1 (Sheet 20 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Regular TM Calibration On	11,006.3	(10,408.1)$_4$	GYM (2)	S-IVB	
Telemetry Calibrator In-Flight Calibrate OFF	11,010.9	(10,412.7)$_4$	GYM (2)	IU	
Regular TM Calibration Off	11,011.3	(10,413.1)$_4$	GYM (2)	S-IVB	
Special TM Calibration Off	11,011.5	(10,413.3)$_4$	GYM (2)	S-IVB	
LOX Tank Pressurization Shutoff Valves Close	11,655.8	(11,057.6)$_4$	KSC (3)	S-IVB	
LOX Tank Vent Valve Close	11,656.0	(11,057.8)$_4$	KSC (3)	S-IVB	
LH2 Tank Vent Valve Close	11,656.2	(11,058.0)$_4$	KSC (3)	S-IVB	
LOX Tank Vent Valve Boost Close On	11,659.0	(11,060.8)$_4$	KSC (3)	S-IVB	
LH2 Tank Vent Valve Boost Close On	11,659.2	(11,061.0)$_4$	KSC (3)	S-IVB	
LOX Tank Vent Valve Boost Close Off	11,661.0	(11,062.8)$_4$	KSC (3)	S-IVB	
LH2 Tank Vent Valve Boost Close Off	11,661.2	(11,063.0)$_4$	KSC (3)	S-IVB	
Telemetry Calibrator In-Flight Calibrate On	11,777.9	(11,179.7)$_4$	ANT (3)	IU	
Special TM Calibration On	11,778.1	(11,179.9)$_4$	ANT (3)	S-IVB	
Regular TM Calibraton On	11,778.3	(11,180.1)$_4$	ANT (3)	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	11,782.9	(11,184.7)$_4$	ANT (3)	IU	
Regular TM Calibration Off	11,783.3	(11,185.1)$_4$	ANT (3)	S-IVB	

TABLE AP 1-1 (Sheet 21 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Special Calibration Off	11,783.5	(11,185.3)$_4$	ANT (3)	S-IVB	
Slow Record On	12,519.9	(11,921.7)$_4$	ASC (3)	S-IVB	
Slow Record Off	12,551.9	(11,953.7)$_4$	ASC (3)	S-IVB	
Record Playback On	12,552.1	(11,953.9)$_4$	ASC (3)	S-IVB	
Recorder Playback Off	12,789.1	(12,190.9)$_4$	ASC (3)	S-IVB	
Slow Record On	12,826.9	(12,228.7)$_4$	ASC (3)	S-IVB	
Slow Record On	12,836.9	(12,238.7)$_4$	ASC (3)	S-IVB	
LH2 Tank Vent Valve Open	14,221.2	(13,623.0)$_4$		S-IVB	This command initiates a 2,764 sec LH2 tank vent.
LOX Tank Vent Valve Open	14,221.4	(13,623.2)$_4$		S-IVB	This command initiates a 2,764 sec LOX tank vent.
Telemetry Calibrator In-Flight Calibrate On	14,383.9	(13,785.7)$_4$	CRO (3)	IU	
Special TM Calibration On	14,384.1	(13,785.9)$_4$	CRO (3)	S-IVB	
Regular TM Calibration On	14,384.4	(13,786.2)$_4$	CRO (3)	S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	14,388.9	(13,790.7)$_4$	CRO (3)	IU	
Regular TM Calibration Off	14,389.4	(13,791.2)$_4$	CRO (3)	S-IVB	
Special TM Calibration Off	14,389.6	(13,791.4)$_4$	CRO (3)	S-IVB	
Slow Record On	14,395.9	(13,797.7)$_4$	CRO (3)	S-IVB	
Slow Record On	15,904.9	(15,306.7)$_4$	HAW (3)	S-IVB	
Slow Record Off	15,936.9	(15,338.7)$_4$	HAW (3)	S-IVB	
Recorder Playback On	15,937.1	(15,338.9)$_4$	HAW (3)	S-IVB	

TABLE AP 1-1 (Sheet 22 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
Recorder Playback Off	16,349.1	$(15,750.9)_4$	HAW (3)	S-IVB	
Slow Record On	16,349.3	$(15,751.1)_4$	HAW (3)	S-IVB	
LH2 Tank Vent Valve Close	16,985.2	$(16,387.0)_4$		S-IVB	
LOX Tank Vent Valve Close	16,985.4	$(16,387.2)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close On	16,988.2	$(16,390.0)_4$		S-IVB	
LOX Tank Vent Valve Boost Close On	16,988.4	$(16,390.2)_4$		S-IVB	
LH2 Tank Vent Valve Boost Close Off	16,990.2	$(16,392.0)_4$		S-IVB	
LOX Tank Vent Valve Boost Close Off	16,990.4	$(16,392.2)_4$		S-IVB	
Open He Control Vent	16,990.6	$(16,392.4)_4$		S-IVB	This command initiates a 300 sec Pneumatic Control Helium Sphere vent.
Close He Control Vent	17,290.6	$(16,692.4)_4$		S-IVB	
Passivation Disable	N/A	N/A		S-IVB	This command will be in the Generalized Switch Selector Program for Ground Control use through the DCS Command System.
<u>LM ABORT SEQUENCE</u>					A DCS "LM ABORT" command will be required for initiation of this alternate time base. When this DCS command is received in the IU, an S-IVB engine cutoff command will be issued to the S-IVB stage. However, T_{3a} will be inhibited until T_4 +5.0 sec.

TABLE AP 1-1 (Sheet 23 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
LOX Tank Vent Valve Close	V	$(0.2)_{3a}$		S-IVB	
LH2 Tank Vent Valve Close	V	$(0.4)_{3a}$		S-IVB	
LOX Tank Vent Valve Boost Close On	V	$(2.6)_{3a}$		S-IVB	
LH2 Tank Vent Valve Boost Close On	V	$(2.8)_{3a}$		S-IVB	
Nosecone/SLA Separation Sequence Start "A"	V	$(3.0)_{3a}$		IU	
Nosecone/SLA Separation Sequence Start "B"	V	$(3.2)_{3a}$		IU	
LOX Tank Vent Valve Boost Close Off	V	$(4.6)_{3a}$		S-IVB	
LH2 Tank Vent Valve Boost Close Off	V	$(4.8)_{3a}$		S-IVB	
SLA Panel Deployment "A"	V	$(8.0)_{3a}$		IU	
SLA Panel Deployment "B"	V	$(8.2)_{3a}$		IU	
WATER COOLANT VALVE SWITCHING					After the IU 204 primary mission is completed, the water coolant valve will be cycled open or closed by the LVDC via the IU switch selector. The LVDC will be programmed to open the coolant valve when either of two thermal switches, mounted in the water/methanol system, closes and to close the valve when both of the

TABLE AP 1-1 (Sheet 24 of 24)
PREDICTED AS-204/LM-1 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (sec)	TIME FROM BASE (sec)	TRACKING STATION AND ORBIT NO.	SSS	REMARKS
WATER COOLANT VALVE SWITCHING (continued)					switches open. This will not interfere with other events in the Flight Sequence Program.
Water Coolant Valve Open	V	V		IU	
Water Coolant Valve Closed	V	V		IU	

APPENDIX 2

MASS CHARACTERISTICS DATA (WS11)

2. MASS CHARACTERISTICS DATA (WS11)

This appendix presents two types of digital printouts as computed by the WS11 Computer Program as follows:

a. The mass breakdown (table AP 2-1) is an itemized listing of major components (including all propellants, gases, etc.) listing mass, centers of gravity, and moments of inertia, and includes a summation for the indicated time. A summary of items jettisoned is also presented where applicable.

b. The mass characteristics summary (table AP 2-2) is a chronological listing of the S-IVB-204 flight stage mass characteristics. These data were generated using a flight sequence of events which is presented in appendix 1 of this document.

c. Figures AP 2-2 and AP 2-3 present graphs of S-IVB-204 flight stage mass characteristics. Supplementary information is contained in table AP 2-3 (definitions of terms and abbreviations) and figure AP 2-1, S-IVB-204 stage station numbers.

All mass characteristics parameters are time referenced from AS-204/LM-1 vehicle liftoff and progress chronologically from liftoff to 4.5 hours (16,200 sec) of flight time. Data is also presented at predicted guidance cutoff time (598.21 sec).

The sources of the mass characteristics data presented in the WS11 computer program are as follows:

a. S-IVB-204 stage dry mass is based on the stage weight measured at DAC/STC on July 8, 1966.

b. The S-IVB-204 payload (IU, adapter, lunar module, and nose cone) data are as presented in *AS-204 Final Predicted Mass Characteristics, Guidance Cutoff,* (reference 14).

c. S-IVB-204 propellant loading is as presented in appendix 6 of this document

d. Propellant mass flows are based on those found in appendix 5 of this document.

e. The vehicle coordinate system used conforms to standard coordinate system 9, mass properties, as presented in document SE008-001-1, *Project Apollo Coordinate System Standards*, (reference 15).

Figures AP 2-4 thru AP 2-7 present the final predicted three sigma mass characteristics dispersions for the Saturn IB AS-204/LM-1 second flight stage during S-IVB powered flight.

The dispersions are referenced relative to time from Saturn IB liftoff, rather than event. It is assumed that the lower stage performs nominally.

TABLE AP 2-1 (Sheet 1 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

S-IB LIFTOFF — TIME 0.000 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
1.	AFT FRAME	30.95	200.70	0.0	0.0	.52064367 06	.36812188 06	.36812188 06
2.	DETONATION PKG	4.74	201.00	0.0	0.0	.80105998 05	.56636723 05	.56636723 05
3.	FROST	100.00	420.40	0.0	0.0	.16926009 07	.14472090 07	.14472090 07
6.	ULLAGE RKT GRN	176.00	225.80	0.0	0.0	.35433678 07	.17861443 07	.17861443 07
7.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39317294 07	.19653613 07	.19653613 07
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	37.00	318.33	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	192906.00	241.81	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	163.00	618.52	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	37392.00	435.77	0.0	0.0	.00000000 00	.12292853 09	.12292853 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	165.00	494.30	86.3	-75.6	.00000000 00	.15168489 06	.15168489 06
85.	COLD HE QUAD 2	165.00	494.30	113.8	20.0	.00000000 00	.15168489 06	.15168489 06
86.	APS PROP FP 1	65.50	248.00	-3.6	-140.0	.28885500 05	.23645500 05	.23645500 05
87.	APS PROP FP 3	65.50	248.00	3.6	140.0	.28885500 05	.23645500 05	.23645500 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	5.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	296375.76	350.73	0.8	-0.4	.48300301 09	.12358364 11	.12353943 11
						SLF .10425140 06	SLF .26674301 07	SLF .26664758 07

S-IB/S-IVB SEPARATION COMPLETED — TIME 143.523 — ITEMS JETTISONED

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
1.	AFT FRAME	30.95	200.70	0.0	0.0	.52064367 06	.36812188 06	.36812188 06
2.	DETONATION PKG	4.74	201.00	0.0	0.0	.80105998 05	.56636723 05	.56636723 05
3.	FROST	-0.00	420.40	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
	TOTAL JETTISONED	35.69	200.74	-0.0	-0.0	.60074966 06	.42475902 06	.42475902 06
						SLF .12966585 03	SLF .91680017 02	SLF .91680017 02

S-IB/S-IVB SEPARATION COMPLETED — TIME 143.523 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
6.	ULLAGE RKT GRN	166.74	225.80	0.0	0.0	.33568758 07	.16921373 07	.16921373 07
7.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39317294 07	.19653613 07	.19653613 07
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	37.00	318.33	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	192906.00	241.81	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	163.00	618.52	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	37392.00	435.77	0.0	0.0	.00000000 00	.12292853 09	.12292853 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	165.00	494.30	86.3	-75.6	.00000000 00	.15168489 06	.15168489 06
85.	COLD HE QUAD 2	165.00	494.30	113.8	20.0	.00000000 00	.15168489 06	.15168489 06
86.	APS PROP FP 1	65.50	248.00	-3.6	-140.0	.28885500 05	.23645500 05	.23645500 05
87.	APS PROP FP 3	65.50	248.00	3.6	140.0	.28885500 05	.23645500 05	.23645500 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	5.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	296230.80	350.73	0.8	-0.4	.48052304 09	.12354965 11	.12350544 11
						SLF .10371613 06	SLF .26666966 07	SLF .26657423 07

TABLE AP 2-1 (Sheet 2 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

S-IVB ENGINE START COMMAND — TIME 144.840 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
6.	ULLAGE RKT GRN	105.74	225.80	0.0	0.0	.21288197 07	.10730975 07	.10730975 07
7.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39317294 07	.19653613 07	.19653613 07
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	37.00	318.33	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	192906.00	241.81	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	163.00	618.52	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	37392.00	435.77	0.0	0.0	.00000000 00	.12292853 09	.12292853 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	165.00	494.30	86.3	-75.6	.00000000 00	.15168489 06	.15168489 06
85.	COLD HE QUAD 2	165.00	494.30	113.8	20.0	.00000000 00	.15168489 06	.15168489 06
86.	APS PROP FP 1	65.50	248.00	-3.6	-140.0	.28885500 05	.23645500 05	.23645500 05
87.	APS PROP FP 3	65.50	248.00	3.6	140.0	.28885500 05	.23645500 05	.23645500 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	5.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	296169.81	350.76	0.8	-0.4	.47929494 09	.12353394 11	.12348973 11
						SLF .10345105 06	SLF .26663574 07	SLF .26654031 07

S-IVB 90% THRUST — TIME 148.140 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
6.	ULLAGE RKT GRN	0.00	225.80	0.0	0.0	.76800429 00	.38713636-00	.38713636-00
7.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39317294 07	.19653613 07	.19653613 07
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	39.41	318.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	192532.79	241.68	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673955 06	.76990810 05	.76990810 05
80.	LH2 TNK ULLAGE	165.32	618.01	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	37288.89	435.37	0.0	0.0	.00000000 00	.12132327 09	.12132327 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165155 05	.11158090 05	.11158090 05
84.	COLD HE QUAD 1	164.44	494.30	86.3	-75.6	.00000000 00	.15117124 06	.15117124 06
85.	COLD HE QUAD 2	164.44	494.30	113.8	20.0	.00000000 00	.15117124 06	.15117124 06
86.	APS PROP FP 1	65.48	248.00	-3.6	-140.0	.28877500 05	.23638951 05	.23638951 05
87.	APS PROP FP 3	65.48	248.00	3.6	140.0	.28877500 05	.23638951 05	.23638951 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	1.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	295627.31	350.74	0.8	-0.4	.47719562 09	.12349982 11	.12345552 11
						SLF .10299794 06	SLF .26656211 07	SLF .26646649 07

TABLE AP 2-1 (Sheet 3 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

SUMMARY PRINTOUT — TIME 155.440 — ITEMS JETTISONED

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
6.	ULLAGE RKT GRN	0.00	225.80	0.0	0.0	.76800429 00	.38713636-00	.38713636-00
7.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39317294 07	.19653613 07	.19653613 07
	TOTAL JETTISONED	214.46	222.00	0.4	-0.7	.39317302 07	.19653620 07	.19653620 07
						SLF .84862492 03	SLF .42420386 03	SLF .42420386 03

SUMMARY PRINTOUT — TIME 155.440 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	44.74	315.62	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	189642.19	240.65	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673954 06	.76990805 05	.76990805 05
80.	LH2 TNK ULLAGE	170.46	615.30	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	36730.72	433.24	0.0	0.0	.00000000 00	.11279800 09	.11279800 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	163.21	494.30	86.3	-75.6	.00000000 00	.15003497 06	.15003497 06
85.	COLD HE QUAD 2	163.21	494.30	113.8	20.0	.00000000 00	.15003497 06	.15003497 06
86.	APS PROP FP 1	65.44	248.00	-3.6	-140.0	.28859803 05	.23624465 05	.23624465 05
87.	APS PROP FP 3	65.44	248.00	3.6	140.0	.28859803 05	.23624465 05	.23624465 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	1.88	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	291972.88	350.82	0.8	-0.4	.47322768 09	.12327214 11	.12322766 11
						SLF .10214150 06	SLF .26607068 07	SLF .26597468 07

SUMMARY PRINTOUT — TIME 200.00 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	77.27	302.88	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	169780.70	234.06	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673954 06	.76990805 05	.76990805 05
80.	LH2 TNK ULLAGE	201.81	599.15	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	33134.32	419.44	0.0	0.0	.00000000 00	.14249722 09	.14249722 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	155.66	494.30	86.3	-75.6	.00000000 00	.14309910 06	.14309910 06
85.	COLD HE QUAD 2	155.66	494.30	113.8	20.0	.00000000 00	.14309910 06	.14309910 06
86.	APS PROP FP 1	65.20	248.00	-3.6	-140.0	.28751782 05	.23536039 05	.23536039 05
87.	APS PROP FP 3	65.20	248.00	3.6	140.0	.28751782 05	.23536039 05	.23536039 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	268568.42	351.99	0.9	-0.4	.47300324 09	.12276552 11	.12271995 11
						SLF .10209305 06	SLF .26497718 07	SLF .26487882 07

TABLE AP 2-1 (Sheet 4 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

SUMMARY PRINTOUT — TIME 300.000 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	150.28	284.37	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	125107.45	220.66	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673954 06	.76990805 05	.76990805 05
80.	LH2 TNK ULLAGE	272.18	567.05	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	25014.40	388.11	0.0	0.0	.00000000 00	.10625833 09	.10625833 09
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	138.73	494.30	86.3	-75.6	.00000000 00	.12753383 06	.12753383 06
85.	COLD HE QUAD 2	138.73	494.30	113.8	20.0	.00000000 00	.12753383 06	.12753383 06
86.	APS PROP FP 1	64.65	248.00	-3.6	-140.0	.28509364 05	.23337598 05	.23337598 05
87.	APS PROP FP 3	64.65	248.00	3.6	140.0	.28509364 05	.23337598 05	.23337598 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	215883.67	362.45	1.1	-0.5	.47247589 09	.11895023 11	.11890208 11
						SLF .10197923 06	SLF .25674226 07	SLF .25663833 07

SUMMARY PRINTOUT — TIME 400.000 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	223.29	270.06	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	80599.03	206.60	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673954 06	.76990805 05	.76990805 05
80.	LH2 TNK ULLAGE	342.54	535.57	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	16902.46	356.60	0.0	0.0	.00000000 00	.82908189 08	.82908189 08
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	121.80	494.30	86.3	-75.6	.00000000 00	.11196858 06	.11196858 06
85.	COLD HE QUAD 2	121.80	494.30	113.8	20.0	.00000000 00	.11196858 06	.11196858 06
86.	APS PROP FP 1	64.10	248.00	-3.6	-140.0	.28266947 05	.23139156 05	.23139156 05
87.	APS PROP FP 3	64.10	248.00	3.6	140.0	.28266947 05	.23139156 05	.23139156 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	163371.72	389.55	1.5	-0.6	.47191241 09	.11177485 11	.11172387 11
						SLF .10185761 06	SLF .24125492 07	SLF .24114488 07

TABLE AP 2-1 (Sheet 5 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

ENGINE MIXTURE RATIO SHIFT — TIME 475.500 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	278.41	260.11	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	47126.79	193.96	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673954 06	.76990805 05	.76990805 05
80.	LH2 TNK ULLAGE	395.67	511.35	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	10816.49	332.06	0.0	0.0	.00000000 00	.59225935 08	.59225935 08
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	109.01	494.30	86.3	-75.6	.00000000 00	.10021680 06	.10021680 06
85.	COLD HE QUAD 2	109.01	494.30	113.8	20.0	.00000000 00	.10021680 06	.10021680 06
86.	APS PROP FP 1	63.68	248.00	-3.6	-140.0	.28083921 05	.22989332 05	.22989332 05
87.	APS PROP FP 3	63.68	248.00	3.6	140.0	.28083921 05	.22989332 05	.22989332 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	123895.35	433.53	1.9	-0.8	.47143556 09	.10036244 11	.10030897 11
						SLF .10175468 06	SLF .21662236 07	SLF .21650694 07

SUMMARY PRINTOUT — TIME 500.000 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	296.30	257.25	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	37709.62	189.76	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	138.00	71.00	0.0	0.0	.16673954 06	.76990805 05	.76990805 05
80.	LH2 TNK ULLAGE	412.90	503.87	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	8906.90	323.88	0.0	0.0	.00000000 00	.50249907 08	.50249907 08
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	104.87	494.30	86.3	-75.6	.00000000 00	.96403315 05	.96403315 05
85.	COLD HE QUAD 2	104.87	494.30	113.8	20.0	.00000000 00	.96403315 05	.96403315 05
86.	APS PROP FP 1	63.55	248.00	-3.6	-140.0	.28024529 05	.22940714 05	.22940714 05
87.	APS PROP FP 3	63.55	248.00	3.6	140.0	.28024529 05	.22940714 05	.22940714 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	112595.15	453.18	2.1	-0.9	.47127025 09	.95160391 10	.95106040 10
						SLF .10171900 06	SLF .20539426 07	SLF .20527694 07

TABLE AP 2-1 (Sheet 6 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

S-IVB ENGINE CUTOFF COMMAND — TIME 598.210 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	368.00	245.66	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	2914.97	165.41	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	482.01	475.51	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	1453.12	278.97	0.0	0.0	.00000000 00	.11134821 08	.11134821 08
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	20.00	72.00	0.0	0.0	.24165151 05	.11158088 05	.11158088 05
84.	COLD HE QUAD 1	88.24	494.30	86.3	-75.6	.00000000 00	.81116674 05	.81116674 05
85.	COLD HE QUAD 2	88.24	494.30	113.8	20.0	.00000000 00	.81116674 05	.81116674 05
86.	APS PROP FP 1	63.01	248.00	-3.6	-140.0	.27786451 05	.22745824 05	.22745824 05
87.	APS PROP FP 3	63.01	248.00	3.6	140.0	.27786451 05	.22745824 05	.22745824 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	70423.20	594.82	3.3	-1.4	.47044513 09	.55828852 10	.55770124 10
						SLF .10154091 06	SLF .12050103 07	SLF .12037428 07

S-IVB END OF THRUST DECAY — TIME 599.610 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	362.92	245.62	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	2794.97	165.18	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	483.00	475.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	1426.12	278.70	0.0	0.0	.00000000 00	.10925357 08	.10925357 08
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898761 05	.80898761 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898761 05	.80898761 05
86.	APS PROP FP 1	63.00	248.00	-3.6	-140.0	.27783057 05	.22743046 05	.22743046 05
87.	APS PROP FP 3	63.00	248.00	3.6	140.0	.27783057 05	.22743046 05	.22743046 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	70261.62	595.76	3.3	-1.4	.47042471 09	.55552560 10	.55493789 10
						SLF .10153650 06	SLF .11990468 07	SLF .11977783 07

TABLE AP 2-1 (Sheet 7 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

JETTISON NOSE CONE — TIME 649.210 — ITEMS JETTISONED

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
57.	NOSE CONE	1067.00	1094.70	0.0	0.0	.35881503 07	.29174384 07	.28840584 07
58.	SLA RING	91.00	1047.80	0.0	0.0	.53660006 06	.26831258 06	.26831258 06
	TOTAL JETTISONED	1158.00	1091.01	0.0	0.0	.41247504 07	.33702150 07	.33368349 07
						SLF .89028641 03	SLF .72742743 03	SLF .72022268 03

JETTISON NOSE CONE — TIME 649.210 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	848.00	3.8	-1.9	.44366708 08	.62224799 08	.61766059 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	223.10	245.62	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	2794.86	165.18	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	470.08	475.35	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	1412.86	278.56	0.0	0.0	.00000000 00	.10822511 08	.10822511 08
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	62.92	248.00	-3.6	-140.0	.27748486 05	.22714747 05	.22714747 05
87.	APS PROP FP 3	62.92	248.00	3.6	140.0	.27748486 05	.22714747 05	.22714747 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	68937.36	588.23	3.4	-1.5	.46627925 09	.52452681 10	.52394155 10
						SLF .10064175 06	SLF .11321390 07	SLF .11308758 07

DEPLOY PANELS — TIME 1198.210 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	235.17	245.61	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	2782.79	165.16	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	305.65	474.66	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	1244.02	276.79	0.0	0.0	.00000000 00	.95162005 07	.95162005 07
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	61.93	248.00	-3.6	-140.0	.27309151 05	.22355110 05	.22355110 05
87.	APS PROP FP 3	61.93	248.00	3.6	140.0	.27309151 05	.22355110 05	.22355110 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	68602.10	588.65	3.5	-1.5	.53129722 09	.52203340 10	.52120815 10
						SLF .11467523 06	SLF .11267573 07	SLF .11249760 07

TABLE AP 2-1 (Sheet 8 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

LM/S-IVB SEPARATION — TIME 3235.000 — ITEMS JETTISONED

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
61.	LUNAR MODULE	31325.00	797.10	1.2	0.2	.92770126 08	.10400102 09	.10617823 09
	TOTAL JETTISONED	31325.00	797.10	1.2	0.2	.92770126 08	.10400127 09	.10617848 09
						SLF .20023510 05	SLF .22447642 05	SLF .22917572 05

LM/S-IVB SEPARATION — TIME 3235.000 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	279.46	245.60	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	2738.51	165.08	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	484.26	472.29	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	668.86	269.61	0.0	0.0	.00000000 00	.50991644 07	.50991644 07
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	58.27	248.00	-3.6	-140.0	.25696838 05	.21035280 05	.21035280 05
87.	APS PROP FP 3	58.27	248.00	3.6	140.0	.25696838 05	.21035280 05	.21035280 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	36873.23	415.87	5.5	-2.9	.43790041 09	.25959644 10	.25855196 10
						SLF .94516456 05	SLF .56031314 06	SLF .55805872 06

START LOX DUMP — TIME 8779.010 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	399.99	245.55	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	2617.97	164.84	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
77.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
78.	LOX IN LINES	246.00	136.80	6.4	9.9	.22718616 05	.22718616 05	.22718616 05
79.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
80.	LH2 TNK ULLAGE	488.00	469.51	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	5.12	251.99	0.0	0.0	.00000000 00	.38964071 05	.38964071 05
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	48.32	248.00	-3.6	-140.0	.21308228 05	.17442790 05	.17442790 05
87.	APS PROP FP 3	48.32	248.00	3.6	140.0	.21308228 05	.17442790 05	.17442790 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	36193.33	418.86	5.6	-2.9	.43747456 09	.25715394 10	.25614692 10
						SLF .94424539 05	SLF .55504125 06	SLF .55286768 06

TABLE AP 2-1 (Sheet 9 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

END LOX DUMP — TIME 8899.210 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	399.99	244.59	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	-0.03	157.52	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
77.	LOX IN PORTS	-0.00	155.00	-25.0	10.0	-.99563598-03	-.15556812-02	-.17285347-03
78.	LOX IN LINES	0.00	136.80	6.4	9.9	.19200093-01	.19200093-01	.19200093-01
79.	LOX IN ENGINE	0.00	71.00	0.0	0.0	.10831472-00	.50013554-01	.50013554-01
80.	LH2 TNK ULLAGE	492.62	469.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	0.50	251.79	0.0	0.0	.00000000 00	.38081793 04	.38081793 04
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	48.10	248.00	-3.6	-140.0	.21213078 05	.17364901 05	.17364901 05
87.	APS PROP FP 3	48.10	248.00	3.6	140.0	.21213078 05	.17364901 05	.17364901 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	33207.89	442.23	6.1	-3.3	.43713556 09	.23507358 10	.23406411 10
						SLF .94351370 05	SLF .50738298 06	SLF .50520413 06

START LH2 DUMP — TIME 8909.010 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	399.99	244.59	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	-0.03	157.52	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
77.	LOX IN PORTS	0.00	155.00	-25.0	10.0	.00000000 00	.00000000 00	.00000000 00
78.	LOX IN LINES	0.00	136.80	6.4	9.9	.00000000 00	.00000000 00	.00000000 00
79.	LOX IN ENGINE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
80.	LH2 TNK ULLAGE	493.00	469.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	0.12	251.78	0.0	0.0	.00000000 00	.94190804 03	.94190804 03
82.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
83.	LH2 IN ENGINE	10.00	72.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	48.08	248.00	-3.6	-140.0	.21205320 05	.17358550 05	.17358550 05
87.	APS PROP FP 3	48.08	248.00	3.6	140.0	.21205320 05	.17358550 05	.17358550 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	33207.86	442.23	6.1	-3.3	.43713486 09	.23507174 10	.23406233 10
						SLF .94351217 05	SLF .50737900 06	SLF .50520030 06

TABLE AP 2-1 (Sheet 10 of 10)
S-IVB-204 PREDICTED MASS BREAKDOWN SUMMARY

END LH2 DUMP — TIME 9089.210 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	399.99	244.59	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
76.	LOX IN TANK	-0.03	157.52	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
77.	LOX IN PORTS	0.00	155.00	-25.0	10.0	.00000000 00	.00000000 00	.00000000 00
78.	LOX IN LINES	0.00	136.80	6.4	9.9	.00000000 00	.00000000 00	.00000000 00
79.	LOX IN ENGINE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
80.	LH2 TNK ULLAGE	377.00	469.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
81.	LH2 IN TANK	0.12	251.78	0.0	0.0	.00000000 00	.94190804 03	.94190804 03
82.	LH2 IN LINES	0.00	187.91	-59.9	-64.8	.15357069-00	.16400704-00	.16400704-00
83.	LH2 IN ENGINE	0.00	72.00	0.0	0.0	.19012689-00	.87789748-01	.87789748-01
84.	COLD HE QUAD 1	88.00	494.30	86.3	-75.6	.00000000 00	.80898609 05	.80898609 05
85.	COLD HE QUAD 2	88.00	494.30	113.8	20.0	.00000000 00	.80898609 05	.80898609 05
86.	APS PROP FP 1	47.76	248.00	-3.6	-140.0	.21062675 05	.17241781 05	.17241781 05
87.	APS PROP FP 3	47.76	248.00	3.6	140.0	.21062675 05	.17241781 05	.17241781 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	7.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	33043.21	442.54	6.2	-3.2	.43674906 09	.23465629 10	.23364564 10
						SLF .94267947 05	SLF .50648230 06	SLF .50430091 06

SUMMARY PRINTOUT — TIME 16,200.000 — ITEMS REMAINING

SEQ	DESCRIPTION	MASS (POUNDS)	STATION(INCHES) H. ARM	L.ARM	V.ARM	MOI (POUND INCHES SQUARE) ROLL	PITCH	YAW
72.	INSTRUMNT UNIT	4600.00	699.00	2.9	-8.5	.69627351 08	.37633531 08	.33000814 08
73.	SLA-ADAPTER	3859.00	837.20	5.9	-1.6	.10940715 09	.77644865 08	.74726892 08
74.	S4B DRY STAGE	23452.61	330.78	6.4	-2.4	.25273742 09	.10055035 10	.10038531 10
75.	LOX TNK ULLAGE	-0.01	244.59	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
76.	LOX IN TANK	-0.03	157.52	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
77.	LOX IN PORTS	0.00	155.00	-25.0	10.0	.00000000 00	.00000000 00	.00000000 00
78.	LOX IN LINES	0.00	136.80	6.4	9.9	.00000000 00	.00000000 00	.00000000 00
79.	LOX IN ENGINE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
80.	LH2 TNK ULLAGE	-0.00	469.49	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
81.	LH2 IN TANK	0.12	251.78	0.0	0.0	.00000000 00	.94190804 03	.94190804 03
82.	LH2 IN LINES	0.00	187.91	-59.9	-64.8	.00000000 00	.00000000 00	.00000000 00
83.	LH2 IN ENGINE	0.00	72.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
84.	COLD HE QUAD 1	0.00	494.30	86.3	-75.6	.00000000 00	.25179257 01	.25179257 01
85.	COLD HE QUAD 2	0.00	494.30	113.8	20.0	.00000000 00	.25179257 01	.25179257 01
86.	APS PROP FP 1	35.00	248.00	-3.6	-140.0	.15433809 05	.12634025 05	.12634025 05
87.	APS PROP FP 3	35.00	248.00	3.6	140.0	.15433809 05	.12634025 05	.12634025 05
88.	APS HELIUM	3.00	246.20	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
89.	SERVICE ITEMS	30.00	127.20	14.2	9.3	.43548299 05	.59060906 05	.25966092 05
90.	GH2 IN STRT TK	0.00	88.40	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
91.	ENV CONT FLUID	43.00	662.70	0.0	0.0	.66116800 06	.33193332 06	.33193332 06
	TOTAL REMAINING	32057.69	444.64	5.8	-3.2	.43409347 09	.23269677 10	.23162558 10
						SLF .93694764 05	SLF .50225287 06	SLF .49994081 06

TABLE AP 2-2 (Sheet 1 of 3)
S-IVB-204 PREDICTED MASS CHARACTERISTICS SUMMARY

TIME (SECONDS)	MASS (POUNDS)	H.ARM (INCHES)	L.ARM (INCHES)	V.ARM (INCHES)	ROLL MOI (SLUG FT.SQ.)	PITCH MOI (SLUG FT.SQ.)	YAW MOI (SLUG FT.SQ.)
0.000	296375.76	350.73	0.8	-0.4	104251.49	2667432.44	2666478.13
60.000	296375.76	350.73	0.8	-0.4	104251.49	2667432.44	2666478.13
80.000	296275.76	350.71	0.8	-0.4	103886.15	2667015.19	2666060.91
100.000	296275.76	350.71	0.8	-0.4	103886.15	2667015.19	2666060.91
143.323	296275.76	350.71	0.8	-0.4	103886.15	2667015.19	2666060.91
143.523	296266.50	350.71	0.8	-0.4	103845.89	2666963.84	2666009.56
143.523	296230.80	350.73	0.8	-0.4	103716.22	2666698.88	2665744.56
144.840	296169.81	350.76	0.8	-0.4	103451.14	2666359.72	2665405.41
147.123	295908.81	350.76	0.8	-0.4	102996.08	2665791.31	2664835.72
148.140	295627.31	350.74	0.8	-0.4	102998.02	2665623.38	2664667.19
150.000	294806.30	350.73	0.8	-0.4	102996.05	2664764.31	2663807.19
155.440	292187.34	350.72	0.8	-0.4	102990.22	2661900.88	2660940.91
155.440	291972.88	350.82	0.8	-0.4	102141.58	2660709.06	2659749.09
160.000	289612.10	350.85	0.9	-0.4	102136.67	2658246.06	2657283.72
170.000	284385.65	350.98	0.9	-0.4	102125.85	2652475.34	2651507.75
180.000	279128.02	351.22	0.9	-0.4	102115.00	2646250.25	2645277.38
190.000	273851.82	351.54	0.9	-0.4	102104.11	2655736.69	2654758.50
198.140	269551.73	351.90	0.9	-0.4	102095.22	2650915.22	2649932.78
200.000	268568.42	351.99	0.9	-0.4	102093.14	2649774.06	2648790.53
210.000	263278.75	352.53	0.9	-0.4	102081.98	2643401.19	2642412.28
220.000	258002.27	353.17	1.0	-0.4	102070.77	2636653.19	2635658.75
230.000	252728.75	353.92	1.0	-0.4	102059.52	2629523.16	2628523.28
240.000	247450.79	354.77	1.0	-0.4	102048.23	2621994.06	2620988.69
250.000	242187.15	355.73	1.0	-0.4	102036.88	2614072.91	2613061.94
260.000	236922.16	356.82	1.0	-0.4	102025.49	2605722.19	2604705.63
270.000	231653.39	358.02	1.1	-0.4	102014.04	2596909.44	2595887.25
280.000	226395.51	359.36	1.1	-0.5	102002.53	2587623.34	2586595.53
290.000	221144.22	360.83	1.1	-0.5	101990.96	2577821.75	2576788.25
300.000	215883.67	362.45	1.1	-0.5	101979.32	2567424.78	2566385.47
310.000	210624.72	364.22	1.2	-0.5	101967.60	2556400.56	2555355.44
320.000	205369.65	366.16	1.2	-0.5	101955.81	2544697.75	2543646.78
330.000	200118.35	368.27	1.2	-0.5	101943.93	2532250.81	2531193.88
340.000	194869.15	370.56	1.2	-0.5	101931.96	2518979.59	2517916.72
350.000	189610.42	373.07	1.3	-0.5	101919.89	2504761.28	2503692.31
360.000	184349.91	375.85	1.3	-0.6	101907.70	2488832.66	2487757.59
370.000	179098.92	378.85	1.3	-0.6	101895.40	2471997.34	2470916.09
380.000	173853.28	382.11	1.4	-0.6	101882.98	2453794.28	2452706.72
390.000	168611.77	385.67	1.4	-0.6	101870.41	2434046.41	2432952.44

TABLE AP 2-2 (Sheet 2 of 3)
S-IVB-204 PREDICTED MASS CHARACTERISTICS SUMMARY

TIME (SECONDS)	MASS (POUNDS)	H.ARM (INCHES)	L.ARM (INCHES)	V.ARM (INCHES)	ROLL MOI (SLUG FT.SQ.)	PITCH MOI (SLUG FT.SQ.)	YAW MOI (SLUG FT.SQ.)
3235.000	68198.23	590.98	3.5	-1.5	114642.42	1114103.52	1112352.30
3235.000	36873.23	415.87	5.5	-2.9	94516.54	560313.63	558059.20
3403.210	36872.63	416.11	5.5	-2.9	94513.92	560053.96	557802.09
3403.211	36872.63	416.11	5.5	-2.9	94513.92	560053.96	557802.09
3500.000	36833.57	416.13	5.5	-2.9	94512.09	559936.57	557685.98
4000.000	36631.77	416.25	5.5	-2.9	94502.63	559326.79	557082.82
4500.000	36429.98	416.38	5.6	-2.9	94493.14	558710.47	556473.12
4603.210	36388.32	416.41	5.6	-2.9	94491.19	558582.28	556346.28
5000.000	36386.90	416.60	5.6	-2.9	94485.01	558344.00	556114.02
5500.000	36385.10	416.84	5.6	-2.9	94477.22	558039.92	555817.52
6000.000	36383.31	417.08	5.6	-2.9	94469.44	557731.42	555516.60
6148.210	36382.77	417.15	5.6	-2.9	94467.13	557639.02	555426.45
6500.000	36275.98	417.80	5.6	-2.9	94460.75	556680.52	554472.77
6748.210	36200.62	418.27	5.6	-2.9	94456.24	555957.15	553752.79
7000.000	36199.72	418.34	5.6	-2.9	94452.32	555845.84	553645.30
7500.000	36197.92	418.49	5.6	-2.9	94444.54	555622.97	553430.00
8000.000	36196.13	418.63	5.6	-2.9	94436.75	555397.66	553212.28
8500.000	36194.33	418.78	5.6	-2.9	94428.96	555169.89	552992.09
8779.010	36193.33	418.86	5.6	-2.9	94424.62	555041.73	552868.16
8848.000	33575.08	438.67	6.0	-3.2	94399.15	515737.80	513551.32
8899.210	33207.89	442.23	6.1	-3.3	94351.45	507383.42	505204.57
8909.010	33207.86	442.23	6.1	-3.3	94351.30	507379.45	505200.74
9000.000	33124.72	442.39	6.1	-3.2	94309.28	506926.86	504746.82
9089.210	33043.21	442.54	6.2	-3.2	94268.03	506482.74	504301.35
9500.000	32921.71	442.77	6.1	-3.2	94188.09	505981.14	503768.13
10000.000	32773.82	443.06	6.0	-3.2	94090.71	505369.63	503118.05
10500.000	32625.93	443.34	6.0	-3.2	93993.25	504756.92	502466.71
11000.000	32478.04	443.63	5.9	-3.2	93895.70	504143.07	501814.14
11500.000	32330.15	443.92	5.8	-3.1	93798.07	503528.00	501160.25
11656.000	32284.00	444.01	5.8	-3.1	93767.58	503335.89	500956.02
12000.000	32282.77	444.02	5.8	-3.1	93762.23	503320.33	500945.68
12500.000	32280.97	444.03	5.8	-3.1	93754.44	503297.71	500930.64
13000.000	32279.18	444.04	5.8	-3.1	93746.65	503275.13	500915.64
13500.000	32277.39	444.05	5.8	-3.1	93738.87	503252.45	500900.54
14000.000	32275.59	444.06	5.8	-3.1	93731.08	503229.86	500885.53
14400.000	32274.15	444.07	5.8	-3.1	93724.85	503211.77	500873.50
14500.000	32262.13	444.10	5.8	-3.1	93723.19	503158.62	500821.81
15000.000	32202.00	444.26	5.8	-3.1	93714.85	502892.75	500563.21
15500.000	32141.87	444.42	5.8	-3.2	93706.52	502626.53	500304.29
16000.000	32081.74	444.58	5.8	-3.2	93698.18	502360.02	500045.05
16200.000	32057.69	444.64	5.8	-3.2	93694.85	502253.30	499941.25

TABLE AP 2-2 (Sheet 3 of 3)
S-IVB-204 PREDICTED MASS CHARACTERISTICS SUMMARY

TIME (SECONDS)	MASS (POUNDS)	H.ARM (INCHES)	L.ARM (INCHES)	V.ARM (INCHES)	ROLL MOI (SLUG FT.SQ.)	PITCH MOI (SLUG FT.SQ.)	YAW MOI (SLUG FT.SQ.)
400.000	163371.72	389.55	1.5	-0.6	101857.70	2412551.31	2411450.88
410.000	158122.22	393.79	1.5	-0.6	101844.80	2389037.31	2387930.25
420.000	152870.82	398.44	1.6	-0.7	101831.72	2363288.94	2362175.16
430.000	147624.88	403.51	1.6	-0.7	101818.44	2335086.97	2333966.31
440.000	142380.30	409.07	1.7	-0.7	101804.92	2304081.13	2302953.41
450.000	137142.05	415.18	1.7	-0.7	101791.16	2269898.09	2268763.22
460.000	131909.13	421.89	1.8	-0.8	101777.11	2232127.50	2230985.22
470.000	126683.81	429.29	1.9	-0.8	101762.75	2190316.13	2189166.22
475.500	123895.35	433.53	1.9	-0.8	101754.77	2166225.47	2165071.31
480.000	121705.38	437.01	1.9	-0.8	101748.26	2146404.59	2145247.00
490.000	117066.85	444.88	2.0	-0.9	101733.76	2101522.16	2100356.91
500.000	112595.15	453.18	2.1	-0.9	101719.09	2053944.34	2052771.23
510.000	108200.20	462.13	2.2	-0.9	101704.14	2002368.08	2001186.97
520.000	103839.76	471.82	2.3	-1.0	101688.83	1946657.91	1945468.55
530.000	99496.47	482.58	2.4	-1.0	101673.10	1883591.09	1882393.19
540.000	95179.87	494.43	2.5	-1.1	101656.89	1813550.17	1812343.42
550.000	90896.02	507.40	2.6	-1.1	101640.17	1739098.09	1737882.14
560.000	86632.88	521.68	2.7	-1.2	101622.84	1653851.30	1652625.72
570.000	82375.48	537.68	2.8	-1.2	101604.77	1557397.66	1556161.98
580.000	78121.92	555.74	3.0	-1.3	101585.86	1447156.31	1445909.95
590.000	73899.79	576.01	3.2	-1.4	101566.01	1322300.33	1321042.63
598.210	70423.20	594.82	3.3	-1.4	101541.00	1205011.38	1203743.80
598.410	70400.11	594.96	3.3	-1.4	101540.37	1204161.48	1202893.75
598.610	70377.03	595.09	3.3	-1.4	101539.74	1203311.30	1202043.44
599.610	70261.62	595.76	3.3	-1.4	101536.59	1199047.89	1197779.38
638.210	70098.38	596.53	3.3	-1.4	101535.53	1195046.66	1193778.41
638.410	70098.26	596.53	3.3	-1.4	101535.53	1195045.17	1193776.94
643.210	70095.36	596.54	3.3	-1.4	101535.44	1195007.23	1193739.06
643.210	68937.36	588.23	3.4	-1.5	100641.83	1132140.02	1130876.78
1000.000	68721.83	588.89	3.4	-1.5	100635.66	1129487.20	1128228.95
1198.209	68602.10	589.25	3.4	-1.5	100632.23	1127993.58	1126738.09
1198.210	68602.10	588.65	3.5	-1.5	114675.33	1126758.23	1124977.00
1500.000	68419.80	589.21	3.5	-1.5	114670.07	1124468.33	1122691.25
1858.610	68203.17	589.88	3.5	-1.5	114663.82	1121705.53	1119933.44
1858.611	68203.17	589.88	3.5	-1.5	114663.82	1121705.53	1119933.44
2000.000	68202.66	590.00	3.5	-1.5	114661.62	1120937.70	1119167.75
2500.000	68200.87	590.39	3.5	-1.5	114653.84	1118199.08	1116436.70
3000.000	68199.07	590.79	3.5	-1.5	114646.07	1115422.50	1113667.70

TABLE AP 2-3 (Sheet 1 of 3)
DEFINITIONS FOR MASS CHARACTERISTICS
COMPUTER PROGRAM WS11 PRINTOUTS

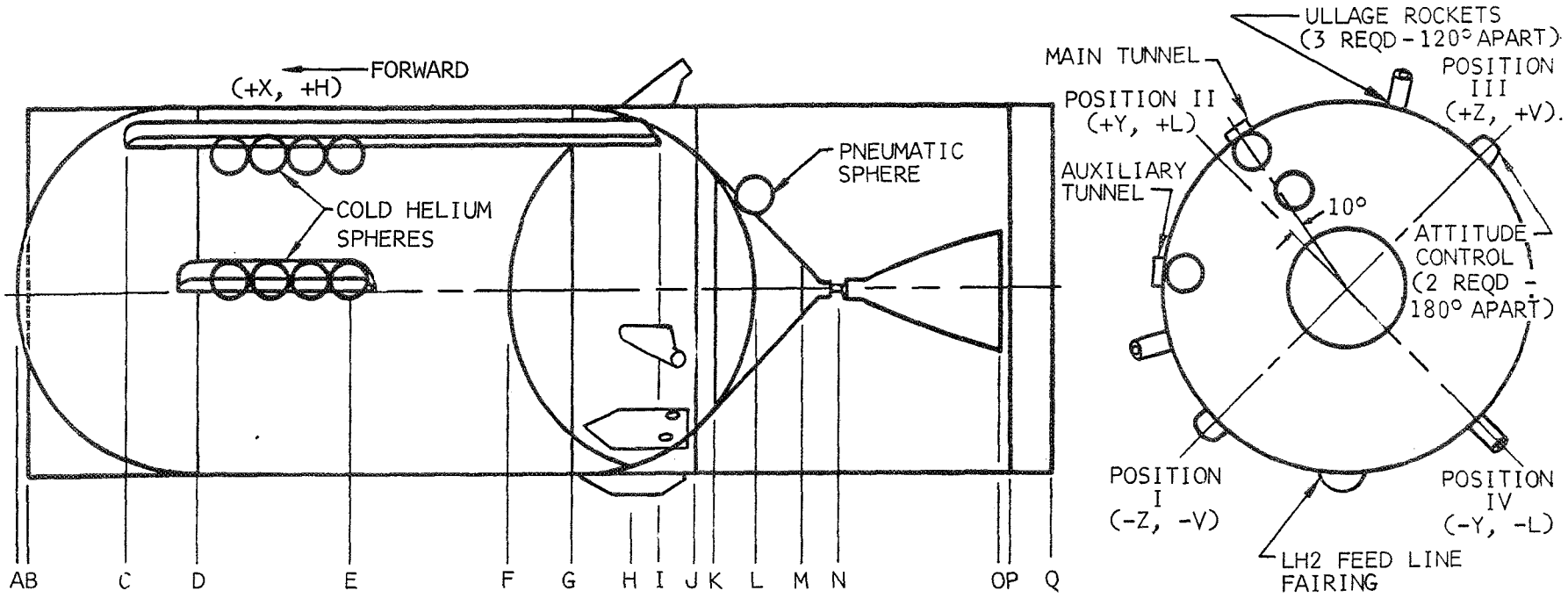
TERM	DEFINITIONS	UNITS
DAC Station	Distance along the H axis from an arbitrary S-IVB-204 stage reference zero. The ZERO station is located so that the S-IVB-204 stage engine gimbal point is station 100.0. Positive values increase in the forward direction and negative values are aft of station zero.	Inches
H Arm	Distance along the centerline of the S-IVB-204 stage from the center of gravity of the item under consideration to S-IVB-204 stage DAC station zero.	Inches
Items Jettisoned	A listing of all items being considered at the current computing time that will not be considered at the next computing time.	None
Items Remaining	A listing of all items being considered at the current computing time that will be considered at the next computing time.	None
L Arm	Distance from the center of gravity of the item under consideration to the centerline of the S-IVB-204 stage along an axis perpendicular to the centerline and coinciding with positions II and IV. Position II is positive and position IV is negative.	Inches

TABLE AP 2-3 (Sheet 2 of 3)
DEFINITIONS FOR MASS CHARACTERISTICS
COMPUTER PROGRAM WS11 PRINTOUTS

TERM	DEFINITIONS	UNITS
Pitch MOI	Moment of inertia of any item or total about an axis through its own center of gravity and parallel to the V axis.	$Lbm\text{-}In^2$
Pound Inches Square	Moment of inertia about the center of gravity of each item or total of items.	$Lbm\text{-}In^2$
SLF	Slug feet squared	
SLG	Slugs	
SS	Center of gravity expressed in terms of stage coordinates when individual items are in another coordinate system.	Inches
Time	Time is referenced to range time. All computing was done in the pounds, inches, and pound inches squared system of units. (Items below the TOTAL REMAINING line were converted to other unit systems.) Pound mass is defined as 1/32.174 slugs.	Seconds
Total Jettisoned	A summation of the items being jettisoned at the current computing time.	None
Total Remaining	A summation of the items remaining	None
V Arm	Distance from the center of gravity of item under consideration to the centerline of the stage along an axis perpendicular to the H and L axes and coinciding with positions I and III. Position I is negative and position III is positive.	Inches

TABLE AP 2-3 (Sheet 3 of 3)
DEFINITIONS FOR MASS CHARACTERISTICS
COMPUTER PROGRAM WS11 PRINTOUTS

TERM	DEFINITIONS	UNITS
VS	Vehicle station (when center of gravity is expressed in coordinates other than S-IVB-204 stage).	Inches
Yaw MOI	Moment of inertia of any item or total, about an axis through its own center of gravity and parallel to the L axis.	$Lbm\text{-}In^2$



INSTALLATION	STATION
A. FWD BULKHEAD (FWD END)	684.6
B. FWD SKIRT (FWD END)	676.7
C. MAIN TUNNEL (FWD END)	607.7
D. FWD SKIRT (AFT END)	554.7
FWD BULKHEAD (AFT END)	553.0
E. COLD HELIUM SPHERES (8 REQD -26.9" ℄ TO ℄)	454.0
F. COMMON BULKHEAD (FWD END)	335.2
AFT BULKHEAD (FWD END)	287.8
G. AFT SKIRT (FWD END)	286.1
LH2 FEED LINE FAIRING (FWD END)	286.1
AUXILIARY PROPULSION MODULE (FWD END)	285.5
ULLAGE ROCKET (FWD END)	245.3
H. COMMON BULKHEAD (AFT END)	244.4
I. MAIN TUNNEL (AFT END)	224.1

INSTALLATION	STATION
AUXILIARY PROPULSION MODULE (AFT END)	205.1
ULLAGE ROCKET FAIRING (AFT END)	204.6
LH2 FEED LINE FAIRING (AFT END)	202.7
J. AFT SKIRT (AFT END)	200.6
INTERSTAGE (FWD END)	200.6
K. THRUST STRUCTURE/AFT BULKHEAD TANGENT POINT	186.9
AMBIENT HELIUM SPHERES	158.6
L. AFT BULKHEAD (AFT END)	156.3
M. THRUST STRUCTURE SKIN (AFT END)	121.3
N. GIMBAL STATION	100.0
O. ENGINE NOZZLE (AFT END)	-16.0
P. INTERSTAGE (AFT END	-23.9
AERODYNAMIC FAIRING (FWD END)	-23.5
Q. AERODYNAMIC FAIRING (AFT END)	-50.9

Figure AP 2-1. S-IVB-204 Stage Station Numbers

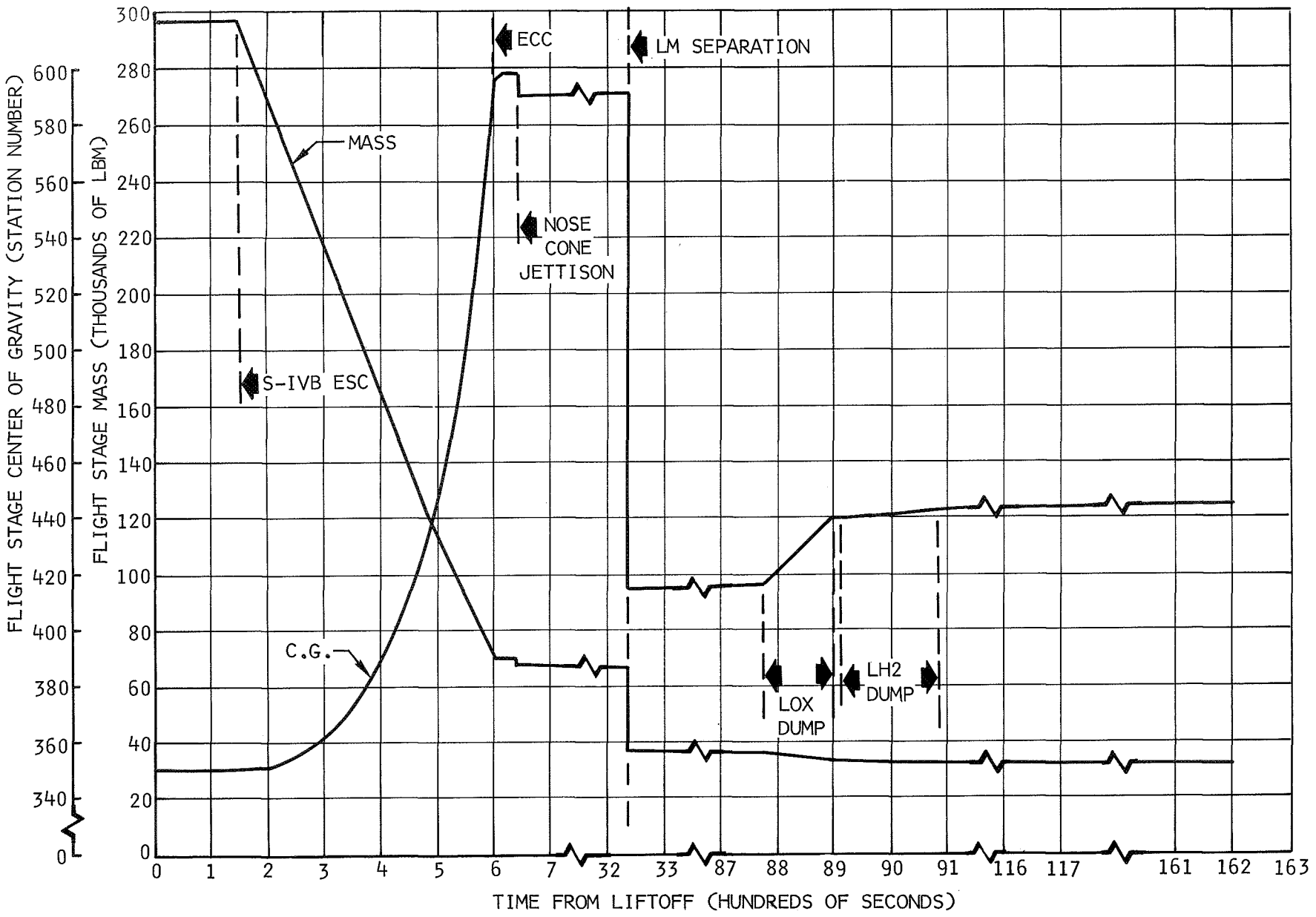


Figure AP 2-2. S-IVB-204 Stage Mass and Center of Gravity

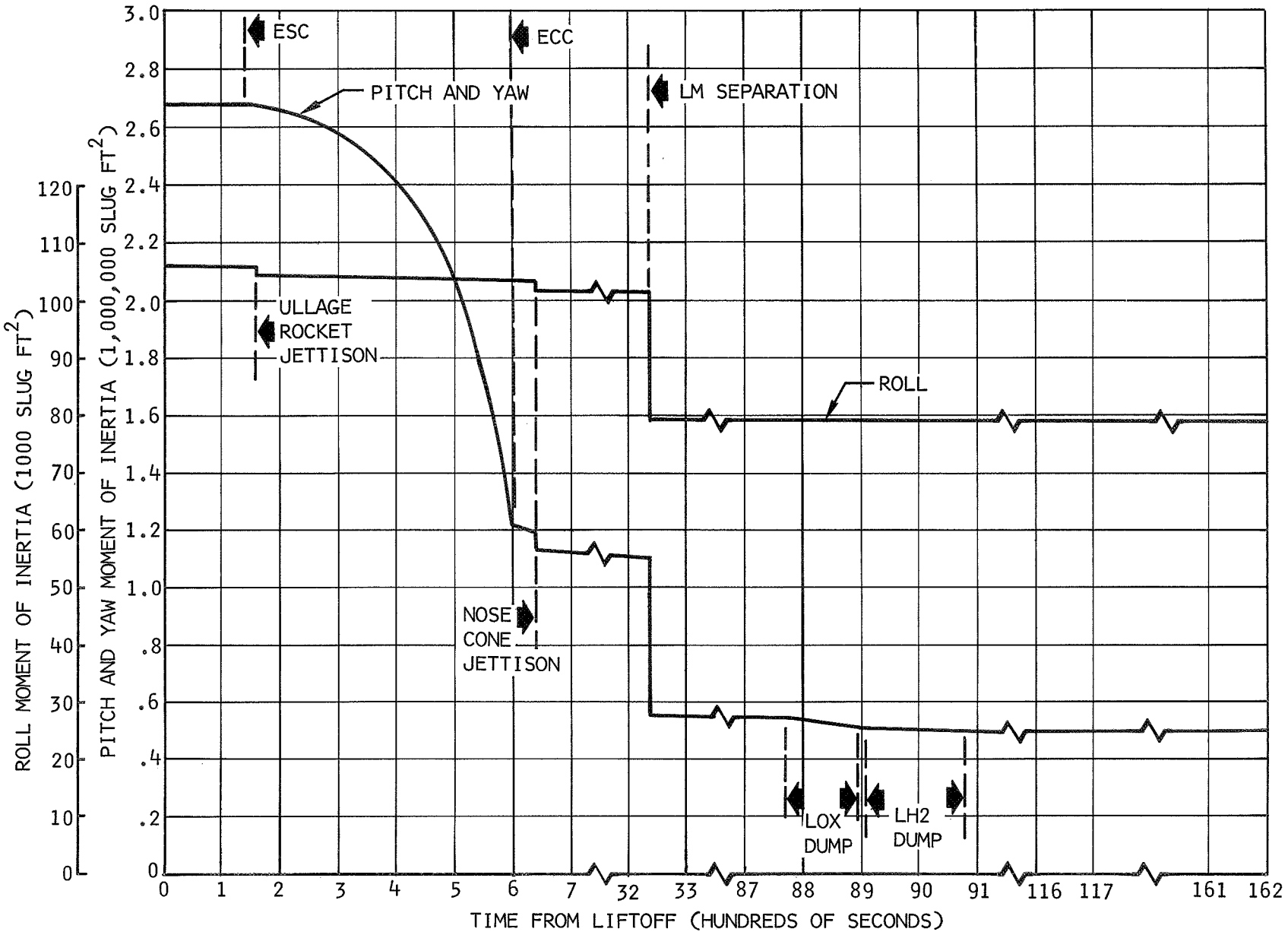


Figure AP 2-3. S-IVB-204 Stage Mass Moment of Inertia

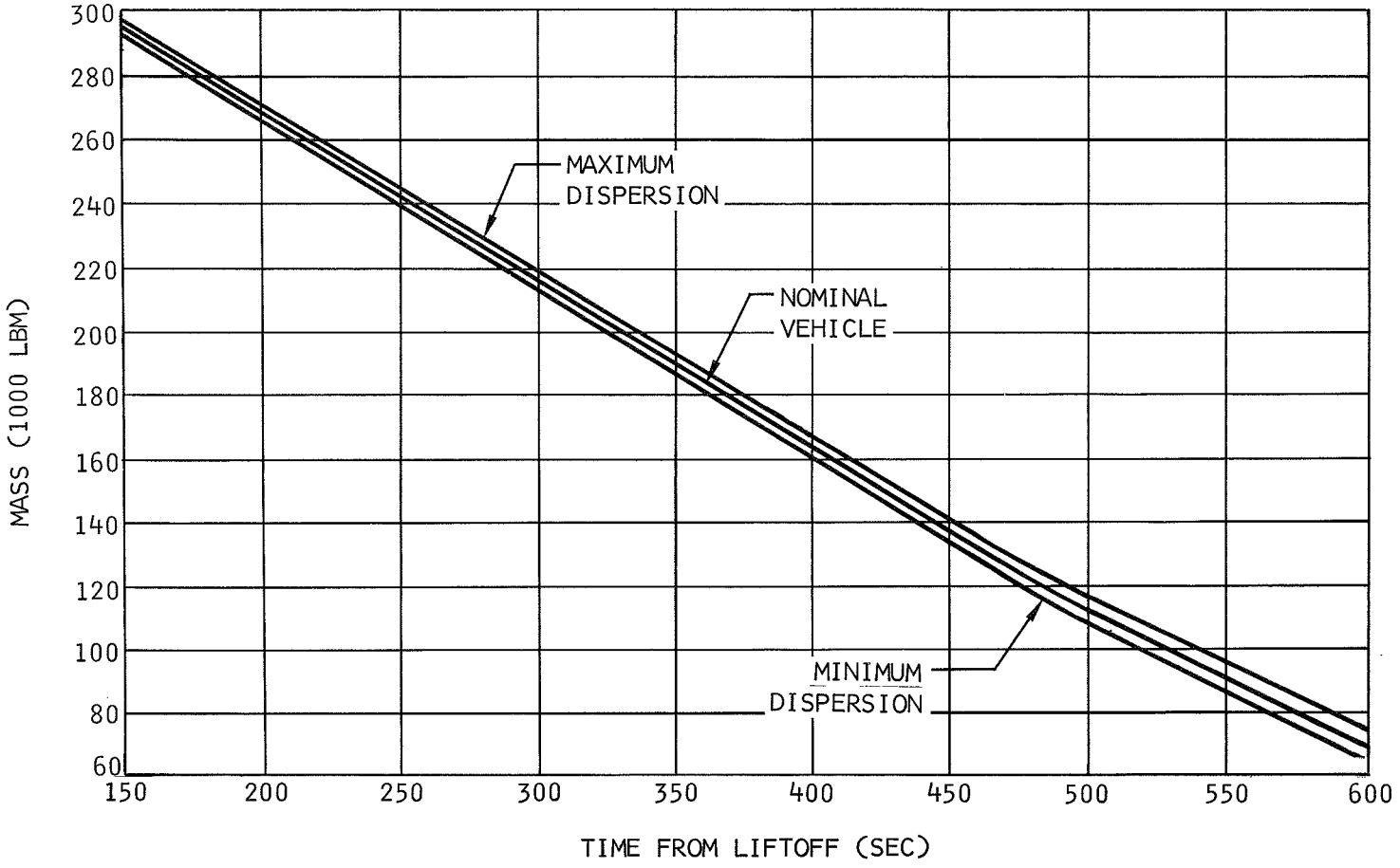


Figure AP 2-4. Predicted Three Sigma Mass Dispersions for AS-204/LM-1 Second Flight Stage During S-IVB Burn

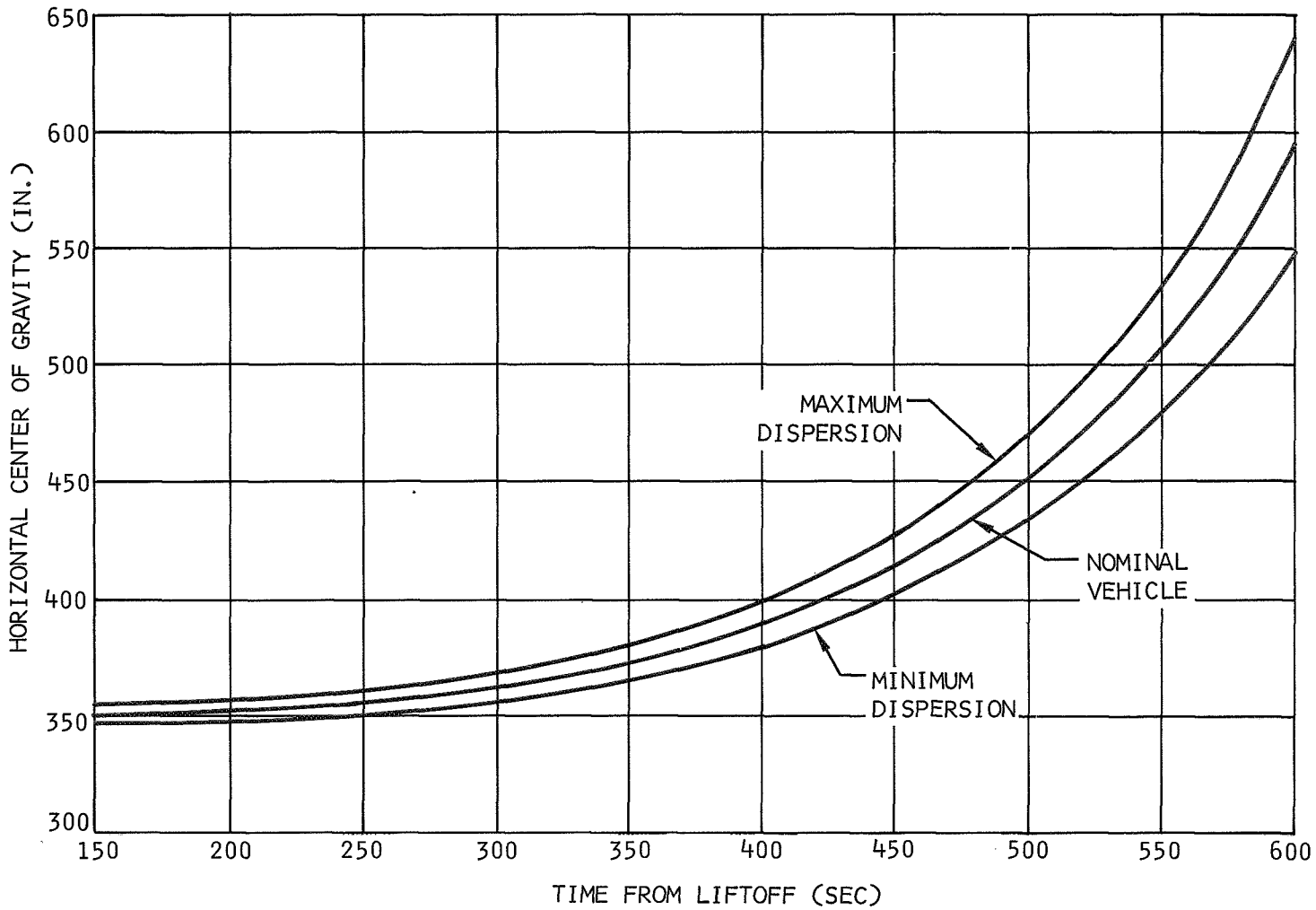


Figure AP 2-5. Predicted Three Sigma Horizontal Center of Gravity Dispersions for AS-204/LM-1 Second Flight Stage During S-IVB Burn

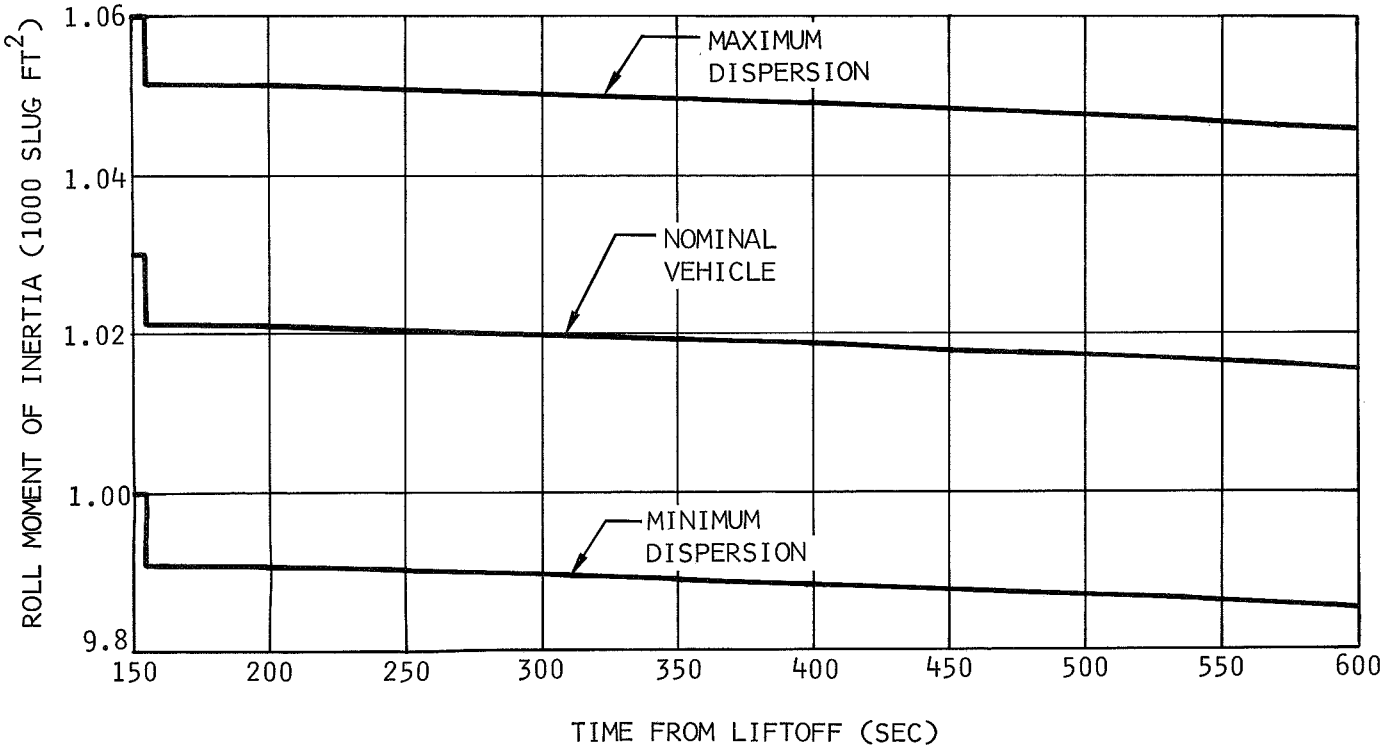


Figure AP 2-6. Predicted Three Sigma Roll Moment of Inertia Dispersions for AS-204/LM-1 Second Flight Stage During S-IVB Burn

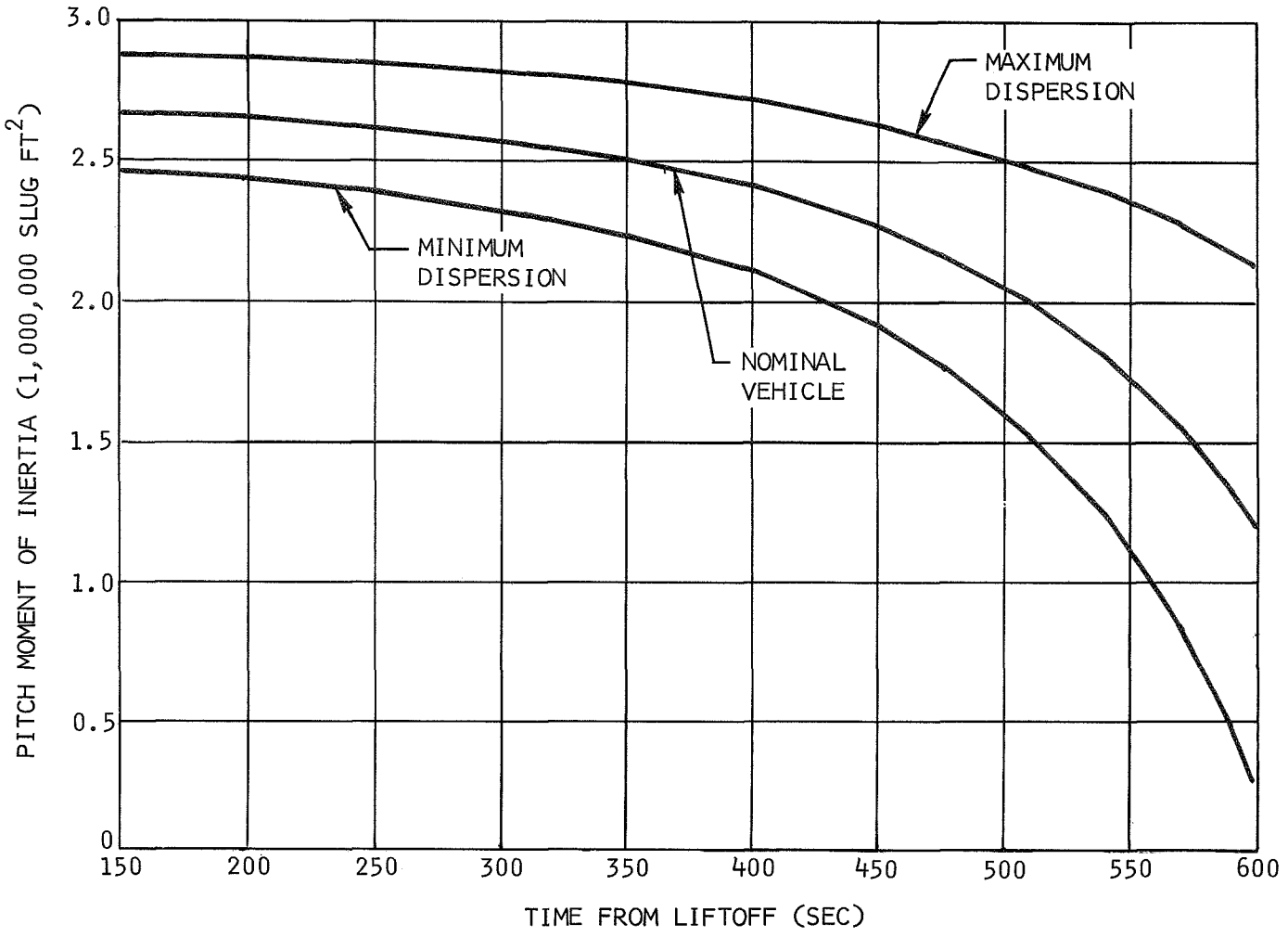


Figure AP 2-7. Predicted Three Sigma Pitch Moment of Inertia Dispersions AS-204/LM-1 Second Flight Stage During S-IVB Burn

APPENDIX 3

PREDICTED FLIGHT TRAJECTORY

3. PREDICTED FLIGHT TRAJECTORY

This appendix presents the S-IVB stage predicted flight trajectory. The trajectory simulation was derived using the S-IVB stage predicted performance characteristics documented in this report. These predictions are based on the MSFC predicted AS-204/LM-1 vehicle flight trajectory (section 2), sequence of events (appendix 1), mass characteristics data (appendix 2), and predicted propulsion system performance (appendix 5).

Tables AP 3-1 through AP 3-3 present the S-IB stage powered trajectory, S-IVB stage powered trajectory, and S-IVB orbital flight trajectory simulations; symbol definitions and coordinate subscript definitions are presented in tables AP 3-4 and AP 3-5. Figures AP 3-1 and AP 3-2 show the coordinate system applicable to the trajectory simulation.

Trajectory parameters are graphically presented in section 2; lower stage flight parameters were obtained from references stated therein.

TABLE AP 3-1 (Sheet 1 of 14)

PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	TIME (SEC)	WEIGHT (LB)	F SB T (LB)	ALTITUDE (FT)	RANGE (FT)
2	V SB I (FT/SEC)	V SB E (FT/SEC)	R SB C (FT)	R SB E (FT)	RANGE ANGLE (RAD)
3	X SB E (FT)	X SB P (M) (M)	X SB S (FT)	X SB SFE (FT)	MU (DEG)
4	Y SB E (FT)	Y SB P (M) (M)	Y SB S (FT)	Y SB SFE (FT)	RHO (DEG)
5	Z SB E (FT)	Z SB P (M) (M)	Z SB S (FT)	Z SB SFE (FT)	RHO PRIME (DEG)
6	D-X SB E (FT/SEC)	D-X SB P (M) (M/SEC)	D-X SB S (FT/SEC)	D-X SB SFE (FT/SEC)	A SB XM (FT/SEC/SEC)
7	D-Y SB E (FT/SEC)	D-Y SB P (M) (M/SEC)	D-Y SB S (FT/SEC)	D-Y SB SFE (FT/SEC)	A SB YM (FT/SEC/SEC)
8	D-Z SB E (FT/SEC)	D-Z SB P (M) (M/SEC)	D-Z SB S (FT/SEC)	D-Z SB SFE (FT/SEC)	A SB ZM (FT/SEC/SEC)
9	F SB X (LB)	F SB TX (LB)	F SB AX (LB)	M SB X (LB-FT)	M SB AX (LB-FT)
10	F SB Y (LB)	F SB TY (LB)	F SB AY (LB)	M SB Y (LB-FT)	M SB AY (LB-FT)
11	F SB Z (LB)	F SB TZ (LB)	F SB AZ (LB)	M SB Z (LB-FT)	M SB AZ (LB-FT)
12	THETA M QRP (DEG)	D-THET M QPP (DEG)	V SB RM (FT/SEC)	I SB XX (SLUG/FT/FT)	EPS (THETA) (DEG)
13	PSI M QRP (DEG)	D-PSI M QRP (DEG/SEC)	V SB W (FT/SEC)	I SB YY (SLUG/FT/FT)	EPS (PSI) (DEG)
14	PHI M QRP (DEG)	D-PHI M QRP (DEG/SEC)	E SB W (DEG)	I SB ZZ (SLUG/FT/FT)	EPS (PHI) (DEG)
15	CHI SB P (DEG)	D-CHI SB P (DEG/SEC)	ALPHA * (DEG)	P SB M (DEG/SEC)	X SB CG (IN)
16	CHI SB Y (DEG)	D-CHI SB Y (DEG/SEC)	ALPHA (DEG)	Q SB M (DEG/SEC)	Y SB CG (IN)
17	CHI SB R (DEG)	D-CHI SB R (DEG/SEC)	BETA (DEG)	R SB M (DEG/SEC)	Z SB CG (IN)
18	GAMMA SB 1 (DEG)	GAMMA SB 1I (DEG)	GAMMA 1I PR (DEG)	DELTA SB YE (DEG)	V SB S (FT/SEC)
19	GAMMA SB 2 (DEG)	GAMMA SB 2I (DEG)	GAMMA 2I PR (DEG)	DELTA SB ZE (DEG)	F/M (FT/SEC/SEC)
20	I SB SP (SEC)	WEIGHT FLOW (LB/SEC)	V SB WX (FT/SEC)	V SB WY (FT/SEC)	V SB WZ (FT/SEC)
21	G (RHO) (FT/SEC/SEC)	G (PSI) (FT/SEC/SEC)	DENSITY SLUG/FT3	CHORD FORCE (LB)	NORMAL FORCE (LB)
22	DYN PRESS (LB/SQ FT)	MACH NO.	PRESSURE (LB/FT/FT)	ALPHA Q PROD (LB/DEG/F/F)	X SB CP (IN)
23	K SB 1 (DEG)	K SB 2 (DEG/SEC)	K SB 3 (DEG)	K SB 4 (DEG/SEC)	SEMILATREC FT
24	R (PER) FT	V (PER) (FT/SEC)	ECCENTRICITY	TRUE ANOMALY (DEG)	PERIOD SEC
25	R(AP) (FT)	V (AP) (FT/SEC)	INCLINATION DEG	ECC ANOMALY DEG	SEMIMAJ AXIS FT
26	DELTA D-X(V)	DELTA D-Y(V)	DELTA D-Z(V)	N SB 1	N SB 2

GUIDANCE REFERENCE RELEASE

1	-4.9999	.0	.0	112.0	.1
2	1341.64	.00	20909949.0	20909838.0	.0000
3	.0	-5540.3	.0	3022659.6	80.5650
4	113.1	6373327.4	113.1	-18148495.0	28.5319
5	.0	17051.2	.0	9935878.4	28.3707
6	.00	388.92	127.60	132.34	.00
7	.00	.00	-.00	22.04	-.00
8	.00	126.37	41.46	-.00	.00
9	-1322.8	.0	-1322.8	.0	-.0
10	.0	-.0	-.0	.0	-.0
11	.0	.0	.0	.0	.0
12	90.000	-.003	.00	1564330.50	.0000
13	-.000	-.001	.00	44473603.00	.0000
14	18.000	-.002	4125.296	44473603.00	-18.0000
15	-.000	.000	.0000	.000	100.0
16	-.000	-.000	.0000	.000	-.0
17	.000	.000	.0000	-.000	.0
18	6.2656	.0000	.0000	.000	1137.49
19	266.6008	90.0000	90.0000	.000	.0
20	.00	-.000	.00	.00	.00
21	-32.21	-.044	.0023	1322.77	.00
22	.00	.000	2115.81	.000	863.39
23	.000	.000	.000	.000	55909.8
24	27992.4	1002193.76	.9973	180.0000	1793.86
25	20909949.0	1341.65	28.3707	180.0000	10468970.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	2.6907	9203.1	80.5650	28.5319	

TABLE AP 3-1 (Sheet 2 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	5.0000	1254262.4	1608531.0	218.4	.8
2	1342.36	43.80	20910055.0	20909838.0	.0000
3	.2	-1650.8	1276.2	3023998.5	80.5649
4	219.5	6373358.4	219.5	-18148367.0	28.5319
5	-.2	18314.2	414.4	9935929.5	28.3707
6	.03	388.98	127.63	138.65	41.54
7	43.80	13.09	43.79	-15.86	-.01
8	-.10	126.20	41.35	21.01	-.00
9	1621758.6	1608531.2	8084.3	10.1	-2.1
10	-483.5	-599.9	116.4	39203.3	-375.4
11	-44.5	-90.2	46.7	-43124.5	1306.1
12	89.987	-.007	43.81	1523781.70	.0130
13	.015	.004	-1.16	44303975.00	-.0149
14	18.004	-.003	72.000	44303975.00	-36.0044
15	.000	.000	1.5847	.003	720.8
16	.000	.000	1.4709	-.005	-.1
17	-18.000	.000	.5896	.006	-.3
18	89.7021	1.8697	1.8697	-.033	1137.02
19	331.8158	89.9554	89.9903	-.032	41.5
20	262.12	-6156.484	-1.16	-.00	.00
21	-32.21	-.044	.0023	2944.92	125.43
22	2.23	.039	2107.97	3.223	862.32
23	.000	.000	.000	.000	55910.7
24	27992.8	1002186.30	.9973	179.9950	1793.88
25	20910084.0	1341.65	28.3707	179.8630	10469038.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	3.8050	9203.1	80.5650	28.5319	
1	10.0000	1223353.1	1615699.8	559.6	2.3
2	1344.69	93.61	20910396.0	20909838.0	.0000
3	.0	294.1	1914.0	3024708.9	80.5650
4	560.6	6373460.8	560.6	-18148552.0	28.5319
5	-1.0	18944.9	620.9	9936093.0	28.3707
6	-.18	388.96	127.43	145.61	42.69
7	93.61	28.14	93.59	-59.02	.02
8	-.25	126.10	41.21	44.86	.01
9	1625760.3	1615700.1	4837.3	-15.2	-19.8
10	771.4	-247.8	1019.2	37802.8	-4371.0
11	264.2	-110.8	375.1	-14128.6	12133.2
12	89.997	-.000	93.74	1479456.00	.0034
13	.019	.000	-5.02	44165492.00	-.0185
14	18.001	.000	72.000	44165492.00	-36.0006
15	.000	.000	3.0162	-.000	717.8
16	.000	.000	2.8306	-.000	-.1
17	-18.000	.000	1.0417	.000	-.3
18	89.6912	3.9917	3.9917	-.033	1135.53
19	331.1609	89.9236	89.9811	-.007	42.7
20	262.21	-6181.844	-5.02	.00	.00
21	-32.21	-.044	.0023	6238.14	1085.99
22	10.13	.083	2083.01	28.127	861.11
23	.000	.000	.000	.000	55894.5
24	27984.6	1002332.40	.9973	179.9893	1793.94
25	20910533.0	1341.43	28.3707	179.7071	10469258.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	9.8877	9203.1	80.5650	28.5319	
1	15.0000	1192303.9	1630742.9	1164.9	-5.6
2	1350.11	149.87	20911002.0	20909838.0	.0000
3	-1.1	2239.0	2551.0	3025456.4	80.5650
4	1166.2	6373643.1	1166.0	-18148966.0	28.5319
5	-2.5	19575.2	826.6	9936383.2	28.3707
6	.16	389.13	127.78	154.03	44.13
7	149.87	45.16	149.85	-107.64	.05
8	-.30	126.03	41.16	71.87	-.00
9	1638417.6	1630743.0	2290.4	-39.8	-29.3
10	1656.7	241.3	1415.4	62485.0	-5350.2
11	-142.5	-585.8	450.6	16668.4	16953.7
12	89.433	-.117	149.97	1434903.60	-.1087
13	.001	.013	-5.40	44054568.00	-.0008
14	14.384	-1.087	72.000	44054568.00	-27.5839
15	-.676	.159	1.6314	1.087	715.2
16	.000	.000	1.5545	-.110	-.1
17	-13.200	.000	.4949	.042	-.3
18	89.7094	6.3731	6.3731	-.065	1132.98
19	4.4396	89.8565	89.9676	.032	44.1
20	263.47	-6209.859	-5.40	.00	.00
21	-32.21	-.044	.0022	8775.17	1485.44
22	25.51	.132	2039.29	38.885	859.10
23	.000	.000	.000	.000	55925.9
24	28000.4	1002049.58	.9973	179.9828	1794.04
25	20911352.0	1341.76	28.3707	179.5310	10469675.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	14.5458	9203.1	80.5650	28.5319	

TABLE AP 3-1 (Sheet 3 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	20.0000	1161063.2	1645569.2	2071.0	12.4
2	1361.72	213.81	20911908.0	20909838.0	.0000
3	6.1	4186.8	3196.4	3026255.0	80.5649
4	2072.2	6373916.3	2071.7	-18149637.0	28.5319
5	-4.3	20205.2	1032.0	9936819.4	28.3707
6	3.35	390.18	131.00	166.15	45.67
7	213.78	64.50	213.76	-162.03	.06
8	-.39	125.95	41.07	103.35	.01
9	1651182.7	1645569.4	20.2	-46.2	-40.3
10	2111.7	192.5	1919.2	40067.8	-5711.4
11	330.1	-146.7	485.5	19278.6	22579.0
12	88.500	-.229	213.99	1390660.10	-.1953
13	-.012	.001	-5.97	43967382.00	.0120
14	9.387	-1.002	72.000	43967382.00	-17.5866
15	-1.696	.248	1.0875	1.002	713.0
16	.000	.000	1.0543	-.226	-.1
17	-8.200	.000	.2667	.039	-.3
18	89.0171	9.0324	9.0322	-.035	1129.33
19	56.7431	89.4114	89.9143	.025	45.7
20	264.26	-6248.156	-5.97	.00	.01
21	-32.21	-.044	.0022	11042.24	1979.66
22	50.62	.189	1975.24	52.344	854.23
23	.000	.000	.000	.000	56186.7
24	28131.2	999715.20	.9973	179.9755	1794.22
25	20912620.0	1344.80	28.3708	179.3310	10470375.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	19.7264	9203.1	80.5648	28.5320	
1	25.0000	1129704.4	1659136.0	3315.1	45.4
2	1362.03	285.36	20913152.0	20909838.0	.0000
3	40.0	6143.2	3868.6	3027126.8	80.5648
4	3316.4	6374291.9	3315.9	-18150595.0	28.5319
5	-6.5	20834.7	1237.2	9937424.7	28.3708
6	11.15	392.66	138.82	183.56	47.18
7	265.14	86.12	285.11	-221.45	.09
8	-.52	125.87	40.95	139.65	.01
9	1660223.6	1659136.2	-4769.6	-67.0	-57.8
10	2671.4	316.1	2555.3	43451.0	-5121.2
11	260.3	-168.3	433.4	33154.8	29557.7
12	87.137	-.313	285.70	1346444.90	-.2670
13	-.002	.004	-6.69	43899933.00	.0019
14	4.385	-1.000	72.000	43899933.00	-7.5850
15	-3.130	.333	.8250	1.000	711.4
16	.000	.000	.8134	-.312	-.1
17	-3.200	.000	.1380	.027	-.3
18	87.6966	11.9066	11.9063	-.036	1124.61
19	65.5944	88.4410	89.7992	.032	47.2
20	265.46	-6271.750	-6.69	.01	.01
21	-32.20	-.044	.0021	15832.15	2591.77
22	87.07	.254	1689.99	69.453	849.98
23	.000	.000	.000	.000	56818.6
24	28448.0	994125.90	.9973	179.9671	1794.49
25	20914418.0	1352.22	28.3714	179.1077	10471433.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	25.7400	8465.6	80.5640	28.5322	
1	30.0000	1098255.9	1673670.6	4935.0	134.9
2	1413.87	365.00	20914772.0	20909838.0	.0000
3	128.8	8116.9	4595.9	3028102.7	80.5646
4	4936.3	6374781.3	4935.5	-18151860.0	28.5320
5	-9.6	21463.8	1441.4	9938225.2	28.3708
6	25.70	397.23	153.41	208.20	48.82
7	364.10	110.04	364.06	-265.38	.05
8	-.74	125.76	40.73	181.50	.00
9	1670564.6	1673670.9	-9314.8	-36.5	-32.8
10	1465.2	44.0	1421.2	53251.7	-3595.7
11	8.4	-292.8	301.9	6232.9	15916.7
12	85.362	-.394	365.39	1302060.80	-.3228
13	.022	.004	-4.91	43848523.00	-.0215
14	-.007	-.169	72.000	43848523.00	.0073
15	-4.961	.402	.2952	.169	710.2
16	.000	.000	.2888	-.394	-.1
17	.000	.000	.0613	.004	-.3
18	85.9045	14.9226	14.9218	-.045	1118.83
19	68.2242	86.8763	89.5944	.014	48.8
20	267.08	-6289.703	-4.91	.01	.01
21	-32.20	-.044	.0020	20348.91	1452.95
22	135.78	.327	1783.54	38.456	843.92
23	.000	.000	.000	.000	58001.0
24	29040.9	983911.64	.9972	179.9575	1794.88
25	20916837.0	1366.06	28.3735	178.8605	10472938.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	32.1073	8465.6	80.5622	28.5328	

TABLE AP 3-1 (Sheet 4 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	35.0000	1066743.4	1688298.1	6968.7	319.8
2	1460.13	453.39	20916805.0	20909838.0	.0000
3	312.3	10120.2	5418.0	3029224.6	80.5640
4	6970.1	6375396.2	6969.3	-18153455.0	28.5322
5	-14.1	22092.3	1644.4	9939250.1	28.3710
6	49.41	404.61	177.17	242.30	50.52
7	450.69	136.28	450.64	-353.13	-.01
8	-1.04	125.63	40.44	229.55	.01
9	1679667.4	1688298.3	-15297.1	25.7	16.9
10	-884.4	-431.2	-453.1	49989.2	-6046.2
11	281.2	-241.1	522.4	-39472.0	-4749.3
12	83.200	-.469	453.70	1257321.50	-.3653
13	.023	.000	-2.71	43805142.00	-.0227
14	.000	-.001	72.000	43805142.00	-.0004
15	-7.165	.479	.0965	.001	709.7
16	.000	.000	-.0632	-.469	-.1
17	.000	.000	.0729	.000	-.3
18	63.6879	17.9782	17.9769	-.041	1111.95
19	69.4167	84.8658	89.2771	-.019	50.5
20	268.93	-6302.500	-2.71	.00	.00
21	-32.19	-.044	.0019	26325.07	691.52
22	196.92	.408	1657.02	-12.206	839.53
23	.000	.000	.000	.000	59952.9
24	30019.5	967717.67	.9971	179.9466	1795.41
25	20919970.0	1388.65	28.3795	178.5893	10474995.1
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	39.2639	9203.1	80.5583	28.5340	
1	40.0000	1035188.3	1703903.5	9454.4	651.5
2	1523.29	551.25	20919291.0	20909836.0	.0000
3	642.1	12168.9	6386.7	3030545.0	80.5631
4	9455.6	6376147.9	9454.4	-18155396.0	28.5325
5	-20.0	22720.2	1845.9	9940531.8	28.3713
6	84.64	415.54	212.45	286.02	52.29
7	544.71	164.76	544.64	-423.83	-.11
8	-1.32	125.51	40.17	264.25	.02
9	1687943.0	1703903.5	-23242.3	109.4	86.6
10	-3904.1	-940.7	-2963.4	48918.5	-8372.2
11	529.8	-229.5	759.3	-90204.0	-30022.7
12	80.688	-.536	551.28	1212472.20	-.4104
13	.024	.000	-.22	43765844.00	-.0236
14	-.002	-.000	72.000	43765844.00	.0017
15	-9.722	.551	.3090	.001	709.8
16	.000	.000	-.2994	-.536	-.1
17	.000	.000	.0767	.000	-.3
18	81.1144	20.9510	20.9488	-.039	1103.74
19	70.1351	82.7156	88.8346	-.054	52.3
20	271.14	-6311.031	-.22	.00	.00
21	-32.18	-.044	.0017	34265.17	3059.11
22	269.37	.499	1512.67	-79.084	832.33
23	.000	.000	.000	.000	62917.4
24	31506.1	944578.27	.9970	179.9338	1796.11
25	20923916.0	1422.30	28.3933	178.2948	10477711.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	46.5441	9550.5	80.5515	28.5361	
1	45.0000	1003609.2	1719474.5	12428.0	1193.4
2	1605.35	659.52	20922264.0	20909838.0	.0001
3	1181.8	14282.7	7565.6	3032127.5	80.5615
4	12429.0	6377047.4	12427.4	-18157696.0	28.5330
5	-27.2	23347.4	2046.1	9942104.5	28.3718
6	133.74	430.73	261.62	347.44	54.21
7	645.82	195.39	645.73	-496.49	-.21
8	-1.57	125.39	39.92	346.09	.02
9	1697579.5	1719474.1	-29828.3	204.5	168.3
10	-7169.7	-1402.6	-5767.0	49803.6	-9806.2
11	729.7	-238.1	967.9	-136604.9	-53241.2
12	77.861	-.595	659.10	1167633.70	-.4762
13	.027	.001	2.10	43722853.00	-.0269
14	-.005	-.001	72.000	43722853.00	.0054
15	-12.615	.609	.4502	.001	710.6
16	.000	.000	-.4440	-.595	-.1
17	.000	.000	.0745	.001	-.3
18	78.2499	23.7201	23.7169	-.040	1093.72
19	70.5938	80.6847	88.2601	-.084	54.2
20	273.51	-6315.828	2.10	-.00	-.00
21	-32.17	-.044	.0016	40899.80	5847.68
22	351.00	.603	1353.98	-152.839	821.99
23	.000	.000	.000	.000	67177.8
24	33643.0	914042.06	.9968	179.9189	1797.01
25	20928769.0	1469.33	28.4207	177.9779	10481205.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	54.4846	12241.2	80.5400	28.5395	

TABLE AP 3-1 (Sheet 5 of 14)

PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	50.0000	972014.2	1735506.7	15924.0	2020.4
2	1707.82	779.51	20925759.0	20909838.0	.0001
3	2006.7	16484.5	9030.1	3034045.9	80.5590
4	15925.0	6378105.1	15922.8	-18160363.0	28.5338
5	-35.7	23974.1	2245.1	9944005.4	28.3726
6	198.94	450.85	326.89	422.57	56.24
7	753.69	228.04	753.56	-570.15	-.24
8	-1.82	125.27	39.68	415.52	.03
9	1706422.0	1735506.9	-37610.4	233.4	214.4
10	-7899.3	-764.6	-7134.6	51161.4	-10977.0
11	883.4	-249.6	1133.2	-114869.5	-61993.8
12	74.943	-.563	778.24	1122807.20	-.5291
13	.032	.001	5.01	43667466.00	-.0320
14	-.008	.001	72.000	43667466.00	.0084
15	-15.586	.613	.4409	-.001	712.1
16	.000	.000	-.4355	-.563	-.1
17	.000	.000	.0692	.001	-.3
18	75.1667	26.1863	26.1818	-.040	1081.09
19	70.9022	78.9304	87.5583	-.042	56.2
20	276.00	-6319.016	5.01	-.01	-.01
21	-32.16	-.044	.0014	48691.41	7224.00
22	438.49	.720	1185.36	-187.252	817.10
23	.000	.000	.000	.000	73068.0
24	36597.9	876303.56	.9965	179.9013	1798.14
25	20934625.0	1531.96	28.4688	177.6395	10485611.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	62.9581	17311.7	80.5221	28.5447	
1	55.0000	940417.0	1751527.3	19974.6	3213.7
2	1829.77	911.31	20929809.0	20909838.0	.0002
3	3197.9	18799.4	10861.3	3036379.0	80.5555
4	19975.5	6379330.7	19972.6	-18163398.0	28.5348
5	-45.4	24600.1	2442.9	9946271.5	28.3737
6	280.42	475.98	408.46	513.39	57.80
7	867.09	262.34	866.92	-643.67	-.35
8	-2.07	125.14	39.44	492.01	.03
9	1697470.5	1751526.7	-63191.0	330.5	281.3
10	-10987.2	-1796.6	-9190.5	55955.4	-10577.4
11	930.0	-296.7	1226.9	-170351.1	-64745.3
12	71.912	-.609	908.73	1078098.40	-.5989
13	.039	.001	8.48	43592972.00	-.0393
14	-.010	-.000	72.000	43592972.00	.0097
15	-18.686	.627	.4695	.001	714.5
16	.000	.000	-.4653	-.609	-.1
17	.000	.000	.0621	.001	-.4
18	72.0354	28.2650	28.2790	-.043	1064.88
19	71.1114	77.5254	86.7629	-.108	57.8
20	278.62	-6319.437	8.48	-.02	-.02
21	-32.15	-.044	.0012	74291.37	9272.07
22	526.02	.853	1011.90	-240.049	799.97
23	.000	.000	.000	.000	80804.9
24	40480.6	833142.45	.9961	179.8805	1799.53
25	20941553.0	1610.49	28.5425	177.2833	10491016.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	71.6555	25009.0	80.4963	28.5523	
1	60.0000	908843.8	1765018.2	24593.6	4854.7
2	1966.88	1049.52	20934426.0	20909838.0	.0002
3	4837.5	21252.5	13141.4	3039203.9	80.5507
4	24594.0	6380727.9	24590.1	-18166789.0	28.5363
5	-56.3	25225.5	2639.5	9948931.7	28.3751
6	377.90	506.02	506.04	618.64	57.57
7	979.13	296.19	978.89	-711.17	-.52
8	-2.28	125.01	39.22	572.17	.04
9	1635201.9	1765014.7	-139536.9	479.6	371.8
10	-15496.1	-3633.4	-11862.6	36481.3	-21902.8
11	1262.9	-99.8	1362.8	-354702.9	-152592.2
12	68.811	-.625	1044.87	1033463.21	-.6506
13	.041	.000	13.11	43489821.00	-.0410
14	-.013	-.001	72.000	43489821.00	.0127
15	-21.839	.633	.5318	.002	717.9
16	.000	.000	-.5283	-.625	-.1
17	.000	.000	.0607	-.000	-.4
18	68.8573	29.8542	29.8467	-.029	1044.28
19	71.2656	76.4441	85.9131	-.230	57.6
20	281.05	-6314.633	13.11	-.04	-.03
21	-32.14	-.044	.0011	150668.11	11940.65
22	599.98	1.001	839.57	-310.863	873.89
23	.000	.000	.000	.000	90611.5
24	45404.0	786583.73	.9957	179.8571	1801.18
25	20949417.0	1704.78	28.6437	176.9309	10497410.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	80.4351	36187.5	80.4611	28.5625	

TABLE AP 3-1 (Sheet 6 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	65.0000	877221.5	1779785.2	29760.5	7021.3
2	2117.79	1194.16	20939591.0	20909838.0	.0003
3	7004.0	23867.9	15948.8	3042589.4	80.5443
4	29760.6	6382290.6	29755.4	-18170496.0	28.5382
5	-68.1	25850.2	2835.3	9951997.5	28.3770
6	491.90	541.11	620.16	738.59	59.69
7	1088.13	329.06	1087.82	-771.06	-.68
8	-2.43	124.87	39.06	655.30	.04
9	1637269.8	1779776.8	-152816.7	625.1	450.7
10	-19315.6	-5533.2	-13782.3	32665.9	-27676.1
11	1149.2	-70.6	1219.9	-558347.3	-256217.1
12	65.720	-.617	1185.96	988806.18	-.7281
13	.047	.001	20.21	43345375.00	-.0473
14	-.016	-.001	72.000	43345375.00	.0164
15	-25.008	.633	.6018	.001	722.3
16	.000	.000	-.5995	-.617	-.1
17	.000	.000	.0531	.001	-.4
18	65.6420	30.9181	30.9090	-.027	1019.32
19	71.3895	75.6199	85.0376	-.350	59.7
20	283.04	-6324.477	20.21	-.08	-.05
21	-32.12	-.044	.0009	163979.82	13836.16
22	652.33	1.163	675.08	-383.500	946.94
23	.000	.000	.000	.000	102841.4
24	51547.2	738118.43	.9951	179.8307	1803.09
25	20958129.0	1815.43	28.7721	176.5872	10504838.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	89.0962	51304.0	80.4151	28.5757	
1	70.0000	845473.3	1794215.4	35486.2	9807.3
2	2290.31	1356.67	20945314.0	20909838.0	.0005
3	9791.7	26674.4	19378.1	3046623.3	80.5361
4	35485.3	6384021.3	35478.2	-18174498.0	28.5406
5	-80.6	26474.2	3030.1	9955499.0	28.3794
6	626.98	582.67	755.35	878.67	63.06
7	1203.10	363.68	1202.69	-829.74	-.90
8	-2.55	124.72	38.92	746.99	.05
9	1667633.1	1794202.8	-137424.9	807.2	587.2
10	-24382.8	-6806.0	-17576.8	35845.2	-27825.8
11	1184.0	-95.9	1280.1	-692117.8	-319016.7
12	62.868	-.595	1343.17	944130.24	-.8237
13	.051	.001	29.75	43144812.00	-.0507
14	-.021	-.001	72.000	43144812.00	.0212
15	-28.156	.624	.6720	.002	728.0
16	.000	.000	-.6702	-.595	-.2
17	.000	.000	.0488	.001	-.4
18	62.4501	31.6914	31.6807	-.029	991.20
19	71.4878	74.9696	84.1329	-.428	63.1
20	284.28	-6349.617	29.75	-.12	-.08
21	-32.10	-.043	.0007	148648.24	17623.33
22	686.11	1.355	523.40	-450.928	946.93
23	.000	.000	.000	.000	118390.5
24	59362.8	687687.00	.9944	179.7990	1805.37
25	20968013.0	1946.92	28.9301	176.2237	10513687.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	98.1922	71605.8	80.3546	28.5930	
		MAXIMUM DYNAMIC PRESSURE			
1	74.0000	820071.7	1804983.5	40494.8	12556.4
2	2445.99	1503.02	20950320.0	20909838.0	.0006
3	12544.0	29080.3	22644.1	3050389.5	80.5280
4	40492.4	6385534.7	40483.4	-18177912.0	28.5430
5	-91.0	26972.8	3165.6	9958646.5	28.3818
6	751.48	620.96	879.96	1006.72	66.31
7	1301.67	393.34	1301.16	-877.42	-.62
8	-2.67	124.58	38.79	827.96	.03
9	1701175.9	1804981.3	-115058.5	558.8	463.7
10	-16278.3	-2963.0	-13315.2	66762.9	-16539.8
11	642.3	-414.0	1056.3	-331420.9	-157977.5
12	60.373	-.592	1485.91	908423.97	-1.0072
13	.060	.000	34.83	42933296.00	-.0596
14	-.018	.003	72.000	42933296.00	.0182
15	-30.634	.613	.5169	-.002	733.5
16	.000	.000	-.5153	-.592	-.2
17	.000	.000	.0409	.000	-.4
18	59.9848	32.1579	32.1459	-.049	968.12
19	71.5301	74.5480	83.4026	-.179	66.3
20	286.00	-6350.422	34.83	-.16	-.11
21	-32.09	-.043	.0006	126200.68	13357.07
22	696.27	1.535	413.93	-351.846	877.17
23	.000	.000	.000	.000	133737.7
24	67082.7	646790.14	.9936	179.7687	1807.51
25	20976930.0	2068.40	29.0763	175.9112	10522006.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	105.8425	92030.7	80.2935	28.6104	

TABLE AP 3-1 (Sheet 7 of 14)

PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	75.0000	813721.2	1807208.6	41809.8	13323.3
2	2487.44	1542.12	20951635.0	20909838.0	.0006
3	13312.0	29706.3	23540.6	3051413.2	80.5257
4	41806.9	6385931.8	41797.5	-18178795.0	28.5437
5	-93.7	27097.4	3224.4	9959485.1	28.3825
6	784.84	631.22	913.34	1040.93	67.16
7	1327.46	401.09	1326.93	-889.65	-.59
8	-2.70	124.54	38.75	849.37	.03
9	1709583.3	1807206.0	-108966.9	539.3	434.0
10	-15527.0	-3218.6	-12308.3	64697.5	-17281.6
11	702.4	-374.7	1076.7	-340614.1	-153634.6
12	59.762	-.627	1524.74	899497.38	-1.0074
13	.059	-.002	34.70	42880416.00	-.0586
14	-.016	.002	72.000	42880416.00	.0158
15	-31.245	.610	.4900	-.001	734.9
16	.000	.000	-.4882	-.627	-.2
17	.000	.000	.0427	-.002	-.4
18	59.3928	32.2605	32.2482	-.046	962.83
19	71.5632	74.4542	83.2213	-.198	67.2
20	286.37	-6350.422	34.70	-.16	-.11
21	-32.08	-.043	.0006	120095.07	12355.31
22	695.73	1.584	388.56	-333.066	886.01
23	.000	.000	.000	.000	138015.6
24	69235.6	636622.42	.9934	179.7603	1808.10
25	20979321.0	2100.98	29.1152	175.8293	10524278.1
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	107.8512	97896.6	80.2762	28.6153	
1	80.0000	781976.8	1817766.8	48782.2	17683.6
2	2710.41	1752.35	20958603.0	20909838.0	.0008
3	17680.9	32999.2	23552.4	3057072.4	80.5128
4	48775.8	6388037.1	48763.5	-18183396.0	28.5475
5	-107.4	27719.6	3417.9	9964011.2	28.3863
6	966.88	687.19	1095.54	1226.73	71.20
7	1461.46	441.36	1460.78	-950.63	-.25
8	-2.74	124.35	38.68	962.82	.05
9	1742105.4	1817764.9	-87417.2	253.0	155.3
10	-6634.3	-2737.2	-3897.0	30777.1	-36711.6
11	1141.7	-36.0	1177.7	-275117.8	-109947.6
12	56.626	-.602	1740.59	854910.53	-.8660
13	.047	.000	21.48	42537686.00	-.0473
14	-.008	.003	72.000	42537686.00	.0083
15	-34.240	.586	.1874	-.003	743.3
16	.000	.000	-.1794	-.602	-.2
17	.000	.000	.0542	.000	-.4
18	56.5099	32.6426	32.6286	-.025	942.10
19	71.6319	74.0536	82.3290	-.160	71.2
20	288.16	-6348.883	21.48	-.11	-.07
21	-32.06	-.043	.0004	98456.85	4071.11
22	670.29	1.848	275.19	-117.896	1085.44
23	.000	.000	.000	.000	162597.7
24	81615.0	586184.69	.9923	179.7132	1811.36
25	20992241.0	2279.01	29.3210	175.4027	10536927.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	118.1234	131545.6	80.1762	28.6436	
1	85.0000	750242.3	1825922.0	56448.5	23011.3
2	2959.81	1988.23	20966265.0	20909838.0	.0011
3	23022.8	36591.1	34538.0	3063721.1	80.4971
4	56436.8	6390350.0	56420.6	-18188302.0	28.5521
5	-120.9	28340.9	3611.4	9969131.9	28.3909
6	1174.40	750.98	1303.23	1437.15	75.63
7	1604.33	484.24	1603.46	-1011.61	.09
8	-2.64	124.17	38.72	1087.31	.04
9	1775476.9	1825922.3	-62531.7	-47.9	-38.1
10	1666.6	254.7	1411.9	29161.3	-39938.3
11	931.4	-31.3	962.6	50114.0	56103.3
12	53.576	-.606	1987.83	810361.84	-.6792
13	.047	-.000	.68	42099468.00	-.0467
14	.002	.001	72.000	42099468.00	-.0015
15	-37.103	.554	.0955	-.000	753.3
16	.000	.000	.0789	-.606	-.2
17	.000	.000	.0538	-.000	-.4
18	53.8077	32.8439	32.8284	-.024	937.12
19	71.6948	73.7416	81.4738	.027	75.6
20	289.68	-6346.906	.68	-.00	-.00
21	-32.04	-.043	.0003	73561.26	1708.87
22	598.01	2.121	186.14	46.259	1222.63
23	.000	.000	.000	.000	193171.8
24	97032.1	537407.41	.9908	179.6563	1815.24
25	21006918.0	2482.32	29.5411	174.9456	10551974.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	129.0357	173700.7	80.0505	28.6789	

TABLE AP 3-1 (Sheet 8 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	90.0000	718686.9	1831122.2	64850.3	29438.9
2	3236.94	2250.75	20974661.0	20909838.0	.0014
3	29472.3	40523.5	41632.1	3071488.7	80.4780
4	64830.5	6392882.8	64809.4	-18193508.0	28.5576
5	-133.7	28961.3	3805.2	9974902.5	28.3964
6	1410.25	823.45	1539.27	1674.50	80.12
7	1754.16	529.13	1753.09	-1070.08	.08
8	-2.47	123.97	38.84	1222.76	.03
9	1801987.7	1831122.5	-41454.1	-51.3	-41.0
10	1526.5	197.7	1330.9	45527.4	-36602.1
11	604.0	-178.9	782.7	50655.8	60060.9
12	50.675	-.547	2259.95	765962.75	-.4725
13	.045	-.001	-14.64	41554410.00	-.0445
14	.002	-.000	72.000	41554410.00	-.0021
15	-39.797	.521	.1082	.001	765.1
16	.000	.000	.0933	-.547	-.2
17	.000	.000	.0549	-.001	-.5
18	51.2330	32.8471	32.8301	-.034	952.54
19	71.7513	73.4947	80.6623	.022	80.1
20	292.10	-6311.094	-14.64	.09	.06
21	-32.01	-.043	.0002	52483.83	1543.98
22	490.37	2.373	122.15	44.857	1301.40
23	.000	.000	.000	.000	231215.3
24	116246.9	490765.44	.9890	179.5880	1819.85
25	21023435.0	2713.64	29.7704	174.4631	10569840.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	140.4988	226152.8	79.6944	28.7223	
1	95.0000	687200.3	1834075.9	74020.1	37108.2
2	3541.84	2540.39	20983824.0	20909838.0	.0018
3	37173.7	44840.5	49979.1	3080511.9	80.4553
4	73986.2	6395644.1	73961.3	-18198997.0	28.5642
5	-145.4	29580.6	3999.9	9981377.1	28.4029
6	1675.11	904.82	1804.33	1939.26	84.65
7	1909.87	575.69	1908.54	-1124.87	.05
8	-2.18	123.75	39.04	1368.79	.01
9	1820615.4	1834076.1	-25942.5	-37.0	-31.8
10	1016.1	1.4	1014.8	65074.5	-29978.7
11	297.0	-347.3	644.3	23660.3	45940.2
12	48.093	-.488	2555.89	721606.63	-.3790
13	.040	-.000	-23.43	40874536.00	-.0404
14	.002	-.000	72.000	40874536.00	-.0017
15	-42.286	.474	.1072	.000	779.0
16	.000	.000	.0905	-.488	-.2
17	.000	.000	.0575	-.000	-.5
18	48.7980	32.6785	32.6602	-.044	968.18
19	71.8036	73.3006	79.9069	.009	84.7
20	293.21	-6297.273	-23.43	.16	.10
21	-31.99	-.043	.0001	36971.50	1202.00
22	389.30	2.640	78.19	34.563	1317.65
23	.000	.000	.000	.000	278125.7
24	139988.0	446968.32	.9868	179.5067	1825.30
25	21041889.0	2973.60	30.0016	173.9574	10590938.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	152.4869	290311.1	79.7032	28.7750	
1	100.0000	655741.2	1834755.6	83987.7	46160.1
2	3874.00	2857.24	20993783.0	20909838.0	.0022
3	46271.0	49586.3	59723.1	3090926.3	80.4286
4	83937.9	6398642.1	83903.5	-18204750.0	28.5720
5	-155.4	30198.7	4195.8	9988607.4	28.4107
6	1968.70	995.00	2098.15	2231.06	89.29
7	2070.76	623.70	2069.13	-1175.47	-.04
8	-1.80	123.51	39.33	1525.02	-.00
9	1832349.2	1834755.8	-14990.6	40.8	10.8
10	-976.0	-912.7	-65.3	89925.4	-20531.8
11	-47.1	-551.4	504.2	-79291.3	-2338.7
12	45.697	-.451	2875.21	677260.32	-.3250
13	.039	-.000	-26.02	40030595.00	-.0389
14	-.000	-.000	72.000	40030595.00	.0000
15	-44.628	.435	.0584	.001	795.2
16	.000	.000	-.0075	-.451	-.2
17	.000	.000	.0579	-.000	-.5
18	46.5235	32.3773	32.3577	-.057	981.68
19	71.8521	73.1484	79.2154	-.048	89.3
20	293.61	-6291.828	-26.02	.20	.12
21	-31.95	-.043	.0001	26017.95	508.38
22	299.75	2.929	48.91	-2.204	1268.74
23	.000	.000	.000	.000	335302.2
24	168996.3	406525.75	.9841	179.4108	1831.71
25	21062397.0	3261.80	30.2285	173.4296	10615696.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	165.0092	367700.4	79.4724	28.8381	

TABLE AP 3-1 (Sheet 9 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	105.0000	624323.9	1833849.2	94780.8	56735.7
2	4233.79	3202.14	21004567.0	20909838.0	.0027
3	56908.9	54805.3	71008.8	3102867.8	80.3972
4	94704.6	6401883.5	94661.2	-18210745.0	28.5811
5	-163.5	30815.5	4393.0	9996644.6	28.4197
6	2291.19	1094.04	2420.88	2550.01	94.15
7	2236.99	673.19	2235.01	-1221.90	-.02
8	-1.50	123.17	39.51	1691.71	-.03
9	1839676.1	1833849.1	-6816.1	13.2	-5.1
10	-491.4	-700.4	209.1	121267.7	-8906.5
11	-534.3	-790.7	256.1	-60557.9	7135.1
12	43.643	-.395	3220.47	632964.42	-.3334
13	.062	-.002	-25.59	38991027.00	-.0615
14	.001	-.000	72.000	38991027.00	-.0008
15	-46.691	.392	.0489	.001	814.2
16	.000	.000	.0309	-.395	-.2
17	.000	.000	.0379	-.002	-.5
18	44.4196	31.9830	31.9623	-.072	993.89
19	71.8934	73.0252	78.5867	-.034	94.2
20	293.72	-6283.461	-25.59	.22	.13
21	-31.92	-.043	.0000	17843.23	330.60
22	223.89	3.240	29.87	6.790	1217.16
23	.000	.000	.000	.000	404381.1
24	204148.3	369570.15	.9808	179.2983	1839.20
25	21085133.0	3578.22	30.4476	172.8775	10644640.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	178.1022	459998.3	79.1967	28.9126	
1	110.0000	592957.2	1832053.1	106431.3	68974.5
2	4622.06	3576.29	21016207.0	20909838.0	.0033
3	69231.4	60541.6	83980.4	3116472.3	80.3610
4	106318.0	6405376.9	106263.7	-18216963.0	28.5915
5	-170.1	31430.4	4591.1	10005542.3	28.4301
6	2642.84	1202.03	2772.78	2896.54	99.39
7	2409.41	724.42	2407.04	-1264.85	-.09
8	-1.12	122.79	39.74	1869.21	-.04
9	1844446.1	1832053.0	-281.7	63.4	34.5
10	-1601.7	-945.3	-656.3	138228.6	-5320.4
11	-722.2	-911.7	189.8	-103740.6	-18351.3
12	41.715	-.382	3583.67	588729.95	-.3090
13	.063	.001	-10.00	37717170.00	-.0634
14	-.001	-.001	72.000	37717170.00	.0005
15	-48.594	.375	.1363	.001	836.3
16	.000	.000	-.1309	-.382	-.2
17	.000	.000	.0379	.001	-.6
18	42.4936	31.5332	31.5115	-.080	1011.11
19	71.9337	72.9297	78.0222	-.051	99.4
20	294.06	-6273.344	-10.00	.09	.06
21	-31.89	-.043	.0000	11310.15	683.20
22	159.84	3.544	17.83	-20.526	1171.90
23	.000	.000	.000	.000	487204.9
24	246446.3	336031.93	.9769	179.1664	1847.96
25	21110356.0	3922.90	30.6551	172.2965	10678400.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	191.8991	569287.5	78.8696	28.9999	
1	115.0000	561653.3	1828744.0	118973.9	83022.1
2	5040.90	3981.72	21028738.0	20909838.0	.0040
3	83389.5	66841.6	98788.9	3131882.5	80.3194
4	118809.3	6409130.7	118742.1	-18223386.0	28.6035
5	-174.6	32043.3	4790.6	10015355.8	28.4420
6	3025.75	1319.61	3155.98	3272.60	105.10
7	2588.24	777.43	2585.41	-1303.90	-.11
8	-.64	122.36	40.06	2058.17	-.05
9	1847354.7	1828743.7	5929.0	81.5	49.5
10	-1950.4	-1003.7	-946.6	152696.4	-2607.5
11	-876.6	-995.9	119.5	-115276.4	-23115.9
12	39.815	-.390	3984.71	544541.18	-.3127
13	.070	.001	-3.95	36164813.00	-.0695
14	-.002	-.001	72.000	36164813.00	.0016
15	-50.498	.394	.2752	.001	862.1
16	.000	.000	-.2730	-.390	-.2
17	.000	.000	.0345	.001	-.6
18	40.7213	31.0404	31.0178	-.085	1030.95
19	71.9744	72.8565	77.5167	-.054	105.1
20	293.92	-6260.813	-3.95	.04	.02
21	-31.85	-.043	.0000	5102.42	954.13
22	111.28	3.865	10.44	-29.793	1153.71
23	.000	.000	.000	.000	586296.6
24	297270.9	305600.02	.9723	179.0120	1858.19
25	21138322.0	4297.69	30.8501	171.6833	10717796.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	206.4694	698165.7	78.4832	29.1015	

TABLE AP 3-1 (Sheet 10 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	120.0000	530426.8	1824025.6	132444.6	99034.8
2	5492.39	4420.35	21042194.0	20909838.0	.0047
3	99545.3	73754.9	115596.6	3149251.3	80.2719
4	132210.0	6413153.7	132127.5	-18229993.0	28.6171
5	-176.3	32653.9	4991.9	10026143.6	28.4556
6	3442.52	1447.57	3573.05	3680.50	111.19
7	2772.83	832.00	2769.49	-1337.70	-.18
8	-.03	121.88	40.48	2258.97	-.06
9	1845749.8	1824025.1	9053.9	142.3	101.1
10	-3042.6	-1173.0	-1869.5	167813.6	-893.3
11	-1000.6	-1072.0	71.6	-143891.6	-36092.3
12	37.781	-.431	4403.78	500431.31	-.3423
13	.074	.001	21.37	34279601.00	-.0743
14	-.005	-.001	72.000	34279601.00	.0046
15	-52.561	.438	.8086	.002	892.1
16	.000	.000	-.8080	-.431	-.2
17	.000	.000	.0310	.001	-.6
18	39.0716	30.5054	30.4820	-.090	1052.83
19	72.0163	72.8020	77.0647	-.065	111.2
20	294.09	-6245.297	21.37	-.25	-.15
21	-31.81	-.043	.0000	1999.14	1870.91
22	75.05	4.183	6.01	-59.472	1122.60
23	.000	.000	.000	.000	704713.5
24	358321.0	277959.27	.9667	178.8315	1870.17
25	21169256.0	4704.87	31.0324	171.0369	10763788.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	221.8646	849549.7	78.0281	29.2190	
1	125.0000	499293.6	1818653.8	146872.3	117184.1
2	5979.06	4894.36	21056607.0	20909838.0	.0056
3	117677.7	81336.6	134582.5	3168745.5	80.2181
4	146543.3	6417452.1	146442.5	-18236749.0	28.6325
5	-175.6	33261.7	5194.4	10037965.9	28.4709
6	3897.19	1587.14	4028.04	4123.33	117.88
7	2960.85	887.42	2956.94	-1362.79	-.21
8	.12	121.17	40.40	2472.07	-.08
9	1841965.4	1818653.4	10660.9	160.3	128.5
10	-3260.3	-967.2	-2292.9	181560.7	1487.0
11	-1173.4	-1105.0	-70.2	-125960.1	-29061.4
12	35.466	-.494	4672.34	456470.00	-.4086
13	.161	-.008	27.76	31994957.00	-.1614
14	-.005	-.000	72.000	31994957.00	.0053
15	-54.943	.521	1.5059	.002	927.2
16	.000	.000	-1.5052	-.494	-.3
17	.000	.000	-.0461	-.008	-.7
18	37.4966	29.9106	29.3865	-.092	1073.44
19	72.0513	72.7543	76.6536	-.051	117.9
20	294.11	-6226.633	27.78	-.35	-.21
21	-31.76	-.043	.0000	426.16	2294.01
22	50.19	4.539	3.41	-74.078	1078.08
23	.000	.000	.000	.000	846448.8
24	431844.2	252767.00	.9601	178.6211	1884.19
25	21203241.0	5148.08	31.2052	170.3606	10817543.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	236.0887	1026927.7	77.4936	29.3546	
1	130.0000	468269.1	1812015.2	162274.0	137664.1
2	6604.50	5406.91	21071990.0	20909838.0	.0066
3	138589.2	89648.3	155949.0	3190550.7	80.1574
4	161819.2	6422027.7	161697.2	-18243600.0	28.6498
5	-174.6	33865.5	5396.2	10050883.9	28.4882
6	4395.19	1739.96	4526.38	4605.81	125.32
7	3149.13	942.68	3144.55	-1374.94	-.24
8	.32	120.34	40.33	2697.03	-.08
9	1836585.8	1812014.9	11950.5	182.7	162.9
10	-3493.5	-765.2	-2728.2	194354.8	924.8
11	-1196.3	-1160.4	-35.9	-101894.8	-16077.3
12	32.733	-.601	5365.15	412677.58	-.5352
13	.161	.000	51.70	29228795.00	-.1606
14	-.007	-.000	72.000	29228795.00	.0066
15	-57.802	.640	2.7417	.002	968.2
16	.000	.000	-2.7415	-.601	-.3
17	.000	.000	-.0360	.000	-.7
18	35.9487	29.2336	29.2091	-.097	1083.37
19	72.0892	72.7202	76.2845	-.039	125.3
20	294.06	-6204.910	51.69	-.72	-.42
21	-31.72	-.043	.0000	-792.09	2728.40
22	33.29	4.952	1.90	-89.492	1037.73
23	.000	.000	.000	.000	1016763.6
24	520848.2	229692.00	.9521	178.3764	1900.68
25	21240255.0	5632.45	31.3668	169.6593	10880551.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	255.0912	1234313.2	76.8668	29.5100	

TABLE AP 3-1 (Sheet 11 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

TILT ARREST

1	133.2000	448499.7	1806791.3	172641.7	152096.5
2	6863.07	5756.86	21082345.0	20909838.0	.0073
3	153199.6	95383.7	170979.6	3205815.7	80.1145
4	172086.0	6425099.7	171948.6	-18247999.0	28.6620
5	-173.2	34249.7	5525.3	10059752.8	28.5004
6	4740.00	1845.75	4871.41	4938.12	130.54
7	3267.08	977.12	3262.04	-1372.64	-.44
8	.58	119.79	40.39	2846.75	-.09
9	1832247.7	1806788.1	12865.6	356.2	176.0
10	-6136.8	-3319.5	-2817.2	203357.6	889.2
11	-1205.5	-1180.8	-24.5	-291934.8	-9851.5
12	30.726	-.505	5713.10	384753.91	-.1550
13	.163	.001	53.46	27083411.00	-.1628
14	-.009	-.005	72.000	27083411.00	.0086
15	-59.429	.000	3.6765	.006	999.1
16	.000	.000	-3.6763	-.505	-.3
17	.000	.000	-.0319	.001	-.8
18	34.9437	28.7399	28.7148	-.098	1072.87
19	72.1167	72.7060	76.0690	-.200	130.5
20	294.49	-6177.914	53.47	-.79	-.46
21	-31.69	-.042	.0000	-1654.33	2817.30
22	25.96	5.325	1.28	-93.582	1039.73
23	.000	.000	.000	.000	1143936.9
24	587777.8	215891.20	.9462	178.1998	1912.75
25	21265375.0	5967.26	31.4643	169.2029	10926576.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	266.3129	1384838.7	76.4105	29.6205	
1	135.0000	437379.4	1803357.8	178646.2	160698.7
2	7072.85	5961.77	21088342.0	20909838.0	.0077
3	161913.5	98761.8	179930.2	3214879.3	80.0890
4	178025.7	6426875.7	177879.2	-18250465.0	28.6693
5	-172.0	34465.1	5598.2	10064954.5	28.5076
6	4943.04	1908.03	5074.58	5133.30	133.63
7	3333.04	996.33	3327.71	-1368.26	-.25
8	.78	119.46	40.47	2933.20	-.09
9	1829201.5	1803357.2	13268.2	189.8	142.4
10	-3414.0	-1187.2	-2226.8	208270.1	902.3
11	-1210.0	-1189.8	-20.0	-141667.9	-5976.7
12	30.431	.059	5913.17	369046.87	.1396
13	.164	.001	59.01	25876635.00	-.1642
14	-.012	.005	72.000	25876635.00	.0118
15	-59.429	.000	3.3950	-.005	1016.4
16	.000	.000	-3.3948	.059	-.3
17	.000	.000	-.0305	.001	-.8
18	34.3818	28.4495	28.4241	-.099	1064.76
19	72.1331	72.7005	75.9549	-.060	133.6
20	293.94	-6177.950	59.00	-.90	-.52
21	-31.67	-.042	.0000	-2105.54	2226.92
22	22.37	5.554	1.02	-74.490	1046.89
23	.000	.000	.000	.000	1222364.8
24	629255.2	208459.02	.9426	178.0926	1920.13
25	21280075.0	6164.17	31.5172	168.9412	10954665.1
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	272.7917	1476303.2	76.1327	29.6867	

S-IB PROPELLANT SENSOR ACTIVATION (TIME BASE 2)

1	136.0400	430990.3	1801382.9	182174.1	165834.9
2	7196.76	6083.07	21091866.0	20909838.0	.0079
3	167118.5	100765.9	185272.0	3220279.7	80.0738
4	181513.3	6427918.1	181361.0	-18251887.0	28.6736
5	-171.1	34589.2	5640.3	10068032.3	28.5119
6	5062.50	1944.67	5194.12	5248.26	135.49
7	3372.65	1007.87	3367.16	-1366.38	-.17
8	.90	119.27	40.53	2984.45	-.09
9	1827481.8	1801382.7	13533.3	118.6	117.1
10	-2266.9	-469.8	-1797.1	212370.7	928.2
11	-1218.3	-1199.8	-18.1	-85994.0	-4579.5
12	30.493	.043	6034.59	359958.92	.0771
13	.165	.001	58.64	25043500.00	-.1652
14	-.007	.004	72.000	25043500.00	.0069
15	-59.429	.000	2.9985	-.004	1028.1
16	.000	.000	-2.9983	.043	-.3
17	.000	.000	-.0302	.001	-.8
18	34.0764	28.2930	28.2676	-.100	1059.42
19	72.1428	72.6981	75.8917	-.020	135.5
20	295.27	-6143.371	58.63	-.92	-.53
21	-31.66	-.042	.0000	-2408.91	1797.20
22	20.50	5.696	.89	-60.295	1056.44
23	.000	.000	.000	.000	1269748.1
24	654390.2	204304.75	.9404	178.0273	1924.61
25	21288954.0	6279.84	31.5468	168.7829	10971672.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	276.6918	1531743.9	75.9642	29.7265	

TABLE AP 3-1 (Sheet 12 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	139.1440	411921.3	1792962.5	192967.7	181887.2
2	7578.44	6457.66	21102646.0	20909838.0	.0087
3	183394.5	106974.5	201956.9	3237111.6	80.0261
4	192172.4	6431102.0	192002.1	-18256123.0	28.6871
5	-167.7	34958.5	5766.2	10077539.2	28.5254
6	5428.57	2056.98	5560.43	5601.03	141.14
7	3497.43	1044.24	3491.42	-1363.57	-.13
8	1.28	118.67	40.69	3143.11	-.10
9	1819565.3	1792962.2	14081.5	83.6	64.3
10	-1662.0	-727.8	-934.2	225430.7	1005.7
11	-1255.0	-1241.0	-13.7	-106062.5	-2520.1
12	30.509	.000	6406.78	332834.97	.0619
13	.170	.001	60.94	22556917.00	-.1697
14	-.003	.001	72.000	22556917.00	.0035
15	-59.429	.000	2.0795	-.001	1062.9
16	.000	.000	-2.0793	.000	-.3
17	.000	.000	-.0304	.001	-.8
18	33.2407	27.8713	27.8456	-.103	1041.06
19	72.1723	72.6938	75.7138	-.037	141.1
20	293.89	-6143.355	60.93	-1.01	-.58
21	-31.63	-.042	.0000	-3018.75	934.34
22	15.52	6.154	.57	-31.651	1090.72
23	.000	.000	.000	.000	1420528.1
24	734745.0	192457.74	.9334	177.8166	1938.92
25	21317236.0	6633.48	31.6319	168.2789	11025990.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	289.0278	1709063.6	75.4241	29.8522	
1	140.0000	408724.1	923934.8	196012.5	186501.8
2	7648.25	6525.57	21105687.0	20909838.0	.0089
3	188076.1	108746.0	206751.4	3241939.3	80.0124
4	195175.8	6431998.6	195000.5	-18257288.0	28.6910
5	-166.6	35060.0	5801.2	10080243.6	28.5293
6	5498.92	2078.57	5630.82	5667.71	73.86
7	3513.54	1048.77	3507.41	-1356.21	-.09
8	1.42	118.54	40.77	3169.79	-.05
9	944738.5	923934.6	14290.6	67.0	50.9
10	-1203.2	-473.4	-729.8	121115.3	1008.7
11	-667.6	-672.8	-3.9	-64245.4	-2255.1
12	30.516	.020	6486.38	328246.56	.0545
13	.151	-.055	46.81	22056272.00	-.1506
14	-.003	.001	72.000	22056272.00	.0028
15	-59.429	.000	1.7801	-.001	1069.6
16	.000	.000	-1.7801	.020	-.3
17	.000	.000	-.0095	-.055	-.8
18	33.0378	27.7466	27.7208	-.061	1035.45
19	72.1809	72.6961	75.6848	-.022	73.9
20	249.11	-6143.403	46.80	-.79	-.45
21	-31.62	-.042	.0000	-3239.51	729.79
22	14.20	6.264	.51	-24.782	1100.71
23	.000	.000	.000	.000	1450561.3
24	750819.2	190317.94	.9320	177.7792	1941.78
25	21322864.0	6701.46	31.6474	168.2052	11036841.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	291.1986	1744549.1	75.3158	29.8770	
1	141.0000	404988.9	900508.2	199579.4	191951.4
2	7706.87	6581.95	21109249.0	20909838.0	.0092
3	193606.2	110834.2	212413.5	3247636.1	79.9962
4	198692.9	6433048.2	198511.3	-18258638.0	28.6956
5	-165.0	35178.5	5842.0	10083423.6	28.5338
6	5561.28	2097.73	5693.23	5725.81	72.67
7	3520.55	1050.50	3514.29	-1343.42	-.07
8	1.68	118.44	40.98	3189.84	-.03
9	921133.8	900508.2	14271.4	56.4	40.0
10	-915.0	-354.3	-560.7	93103.4	971.6
11	-319.0	-338.5	14.2	-54002.7	-1850.1
12	30.533	.012	6537.63	322886.29	.0371
13	.102	-.032	52.80	21471407.00	-.1017
14	-.003	.000	72.000	21471407.00	.0026
15	-59.429	.000	1.5441	-.000	1077.4
16	.000	.000	-1.5436	.012	-.3
17	.000	.000	.0391	-.032	-.8
18	32.8118	27.5929	27.5671	-.041	1028.69
19	72.1921	72.7017	75.6627	-.015	72.7
20	242.79	-3735.138	52.79	-.91	-.52
21	-31.61	-.042	.0000	-3228.21	560.90
22	12.60	6.355	.44	-19.078	1109.16
23	.000	.000	.000	.000	1477527.0
24	765271.3	188451.40	.9307	177.7499	1944.35
25	21327904.0	6761.87	31.6605	168.1623	11046587.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	292.8989	1776415.6	75.2185	29.8992	

TABLE AP 3-1 (Sheet 13 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

1	142.0000	401253.6	876505.7	203155.1	197460.2
2	7763.69	6636.57	21112819.0	20909838.0	.0094
3	199198.0	112941.2	218137.2	3253390.3	79.9799
4	202216.5	6434099.5	202028.7	-18259975.0	28.7002
5	-163.2	35296.9	5883.1	10086623.0	28.5384
6	5622.00	2116.39	5754.01	5782.32	71.42
7	3526.63	1051.95	3520.25	-1330.35	-.06
8	2.00	118.36	41.25	3208.97	-.03
9	896858.5	876505.6	14159.3	46.3	30.6
10	-796.9	-375.4	-421.6	99667.6	965.0
11	-413.9	-432.2	17.6	-55132.7	-1517.9
12	30.540	.002	6588.92	317526.06	.0309
13	.085	-.005	56.64	20886549.00	-.0854
14	-.002	.001	72.000	20886549.00	.0023
15	-59.429	.000	1.3135	-.001	1085.2
16	.000	.000	-1.3124	.002	-.3
17	.000	.000	.0547	-.005	-.9
18	32.5908	27.4412	27.4154	-.048	1021.76
19	72.2039	72.7081	75.6425	-.017	71.4
20	236.31	-3734.988	56.63	-.99	-.57
21	-31.59	-.042	.0000	-3121.92	421.92
22	11.17	6.449	.38	-14.372	1117.98
23	.000	.000	.000	.000	1504039.2
24	779498.2	186664.40	.9295	177.7217	1946.88
25	21332844.0	6820.68	31.6729	168.1225	11056171.2
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	294.5419	1807756.3	75.1227	29.9208	

S-IB OUTBOARD ENGINE CUTOFF

1	142.1440	400716.0	801889.0	203670.4	198258.2
2	7771.43	6644.00	21113334.0	20909838.0	.0095
3	200008.1	113246.2	218966.4	3254223.5	79.9775
4	202724.4	6434251.0	202535.7	-18260166.0	28.7009
5	-162.9	35314.0	5889.1	10087085.2	28.5391
6	5630.37	2118.96	5762.38	5790.07	64.63
7	3527.28	1052.09	3520.88	-1328.39	-.06
8	2.05	118.35	41.28	3211.51	-.03
9	810684.8	801889.0	3114.0	45.5	29.4
10	-776.4	-372.9	-403.5	91642.3	175.4
11	-390.4	-408.2	17.4	-52719.8	-1188.5
12	30.540	.002	6596.09	316754.19	.0306
13	.085	-.003	56.93	20802329.00	-.0849
14	-.002	.001	72.000	20802329.00	.0022
15	-59.429	.000	1.2800	-.001	1086.3
16	.000	.000	-1.2788	.002	-.3
17	.000	.000	.0552	-.003	-.9
18	32.5595	27.4194	27.3935	-.049	1020.75
19	72.2056	72.7090	75.6399	-.017	64.6
20	216.21	-3735.271	56.91	-1.00	-.57
21	-31.59	-.042	.0000	-3104.21	403.86
22	10.97	6.462	.37	-13.760	1119.24
23	.000	.000	.000	.000	1507711.9
24	781470.6	186420.48	.9293	177.7179	1947.23
25	21333528.0	6828.79	31.6746	168.1176	11057498.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	294.7607	1812091.7	75.1095	29.9238	

1	143.0000	399647.2	61122.6	206731.1	203015.4
2	7779.37	6649.93	21116391.0	20909838.0	.0097
3	204836.6	115063.4	223909.8	3259189.0	79.9634
4	205739.1	6435150.1	205544.7	-18261296.0	28.7049
5	-161.1	35415.2	5924.5	10089834.9	28.5431
6	5647.26	2124.18	5779.29	5803.31	5.15
7	3511.41	1047.01	3504.94	-1309.55	-.03
8	2.29	118.30	41.49	3208.32	-.00
9	64414.2	61122.6	2861.6	22.9	22.3
10	-326.7	-21.4	-305.3	7503.2	159.9
11	-20.0	-35.6	15.6	-4307.7	-957.6
12	30.540	-.001	6600.49	314875.47	.0302
13	.084	-.000	58.63	20620982.00	-.0841
14	-.003	-.002	72.000	20620982.00	.0025
15	-59.429	.000	1.0902	.002	1088.6
16	.000	.000	-1.0888	-.001	-.3
17	.000	.000	.0556	-.000	-.9
18	32.3794	27.2694	27.2435	-.050	1014.71
19	72.2154	72.7169	75.6401	-.018	5.2
20	49.30	-3735.049	58.62	-1.04	-.60
21	-31.58	-.042	.0000	-2855.27	305.67
22	9.76	6.505	.32	-10.420	1123.38
23	.000	.000	.000	.000	1515320.1
24	785557.3	185917.98	.9290	177.7205	1947.96
25	21334938.0	6845.54	31.6781	168.1614	11060247.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	294.6597	1821082.4	75.0820	29.9300	

TABLE AP 3-1 (Sheet 14 of 14)
PREDICTED S-IB-204 STAGE POWERED FLIGHT TRAJECTORY

S-IB/S-IVB SEPARATION SIGNAL

1	143.4440	399092.9	48375.2	208312.0	205484.7
2	7775.03	6644.52	21117970.0	20909638.0	.0098
3	207346.3	116006.6	226476.2	3261765.6	79.9560
4	207295.4	6435614.1	207098.2	-18261875.0	28.7070
5	-160.0	35467.8	5942.9	10091258.1	28.5452
6	5648.72	2124.65	5780.77	5802.87	4.12
7	3498.80	1043.05	3492.30	-1298.18	-.02
8	2.40	118.28	41.59	3202.59	-.00
9	51401.6	48375.2	2685.4	19.8	19.1
10	-280.6	-19.5	-261.0	5916.3	149.7
11	-13.0	-27.6	14.6	-3696.4	-833.2
12	30.540	-.002	6594.29	313901.02	.0308
13	.084	.000	59.51	20526921.00	-.0841
14	-.004	-.003	72.000	20526921.00	.0036
15	-59.429	.000	.9939	.003	1089.9
16	.000	.000	-.9924	-.002	-.3
17	.000	.000	.0556	.000	-.9
18	32.2871	27.1870	27.1611	-.050	1011.57
19	72.2205	72.7214	75.6438	-.019	4.1
20	39.02	-1248.557	59.50	-1.07	-.61
21	-31.58	-.042	.0000	-2680.42	261.44
22	9.16	6.519	.30	-8.913	1124.98
23	.000	.000	.000	.000	1516097.4
24	765974.9	185866.85	.9289	177.7275	1948.03
25	21335079.0	6847.25	31.6784	168.2005	11060527.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	294.2904	1821986.4	75.0793	29.9306	
1	144.0000	296186.4	8703.8	210283.4	208576.9
2	7767.75	6635.91	21119938.0	20909838.0	.0100
3	210487.0	117187.9	229690.3	3264991.4	79.9468
4	209236.1	6436192.5	209035.3	-18262593.0	28.7096
5	-158.6	35533.5	5966.1	10093036.6	28.5477
6	5648.95	2124.74	5781.00	5800.70	.88
7	3462.05	1037.82	3475.51	-1283.61	-.01
8	2.55	118.26	41.71	3194.53	.00
9	8070.9	8703.8	-632.9	7.4	7.4
10	-102.1	-.0	-102.1	338.9	-277.6
11	6.3	.0	6.3	-4000.2	-3739.6
12	30.528	-.046	6584.68	102815.28	.0426
13	.085	.003	60.61	2686014.70	-.0849
14	-.006	-.005	72.000	2686014.70	.0059
15	-59.429	.000	.8846	.005	350.6
16	.000	.000	-.8829	-.046	-.4
17	.000	.000	.0547	.003	-.9
18	42.1716	27.0826	27.0567	-.036	1007.62
19	72.2268	72.7272	75.6492	-.045	.9
20	155.36	-.000	60.59	-1.10	-.63
21	-31.57	-.042	.0000	634.38	102.28
22	8.45	6.535	.28	-7.317	792.37
23	.000	.000	.000	.000	1516369.5
24	786121.1	185848.97	.9289	177.7375	1948.06
25	21335126.0	6847.85	31.6784	168.2529	11060624.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	293.7614	1922310.7	75.0783	29.9308	

S-IVB START COMMAND

1	144.8440	296139.1	8624.6	213259.5	213269.8
2	7756.39	6622.51	21122910.0	20909838.0	.0102
3	215254.7	118981.2	234569.5	3269885.6	79.9329
4	212164.1	6437065.1	211957.7	-18263666.0	28.7135
5	-156.4	35633.3	6001.3	10095727.4	28.5517
6	5648.96	2124.79	5781.02	5797.09	.88
7	3456.43	1029.81	3449.83	-1261.43	-.01
8	2.77	118.23	41.90	3182.11	.00
9	8065.7	8624.6	-558.9	5.7	5.7
10	-78.1	-.0	-78.1	387.0	-223.8
11	5.0	.0	5.0	-3117.6	-2860.3
12	30.461	-.109	6569.79	102815.28	.1093
13	.090	.010	62.27	2686014.70	-.0904
14	-.012	-.008	72.000	2686014.70	.0117
15	-59.429	.000	.7664	.008	350.6
16	.000	.000	-.7648	-.109	-.4
17	.000	.000	.0490	.010	-.9
18	31.9958	26.9235	26.8977	-.042	1001.64
19	72.2364	72.7360	75.6575	-.109	.9
20	153.97	-56.022	62.25	-1.15	-.66
21	-31.56	-.042	.0000	559.94	78.26
22	7.48	6.559	.24	-5.608	792.65
23	.000	.000	.000	.000	1516643.5
24	786268.3	185830.95	.9289	177.7528	1948.09
25	21335176.0	6848.46	31.6784	168.3333	11060722.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	292.9448	1822629.6	75.0773	29.9310	

TABLE AP 3-2 (Sheet 1 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

CONSTANT VALUE FOR THE ENTIRE ANALYSIS

.805611 02	.285319 02	.720000 02	.100000 01	.321740 02
.140765 17	.209257 08	.208356 08	.729211-04	
.162345-02	.230000-05	.787300-05	.000000 00	
.000000 00	.000000 00	.590500 02	.000000 00	.000000 00
.000000 00	.000000 00	.133171 03	.000000 00	.000000 00
.000000 00	.000000 00	.000000 00	.114829 03	.000000 00

1	TIME	WEIGHT	F SB T	ALTITUDE	RANGE
2	V SB I	V SB E	R SB C	R SB L	RANGE ANGLE
3	X SB E	X SB P (M)	X SB S	XI	D* SB 1
4	Y SB E	Y SB P (M)	Y SB S	ETA	A* SB 1
5	Z SB E	Z SB P (M)	Z SB S	ZETA	E* SB 1
6	D-X SB E	D-X SB P (M)	D-X SB S	D-XI	A SB XM
7	D-Y SB E	D-Y SB P (M)	D-Y SB S	D-ETA	A SB YM
8	D-Z SB E	D-Z SB P (M)	D-Z SB S	D-ZETA	A SB ZM
9	F SB X	F SB TX	F SB AX	M SB X	M SB AX
10	F SB Y	F SB TY	F SB AY	M SB Y	M SB AY
11	F SB Z	F SB TZ	F SB AZ	M SB Z	M SB AZ
12	THETA(M) QRP	DTHETA(M)QRP	F AUX SB X	I SB XX	EPS(THETA)
13	PSI(M) QRP	D-PSI(M)QRP	F AUX SB Y	I SB YY	EPS(PSI)
14	PHI(M) QRP	D-PHI(M)QRP	F AUX SB Z	I SB ZZ	EPS(PHI)
15	CHI SB P	D-CHI SB P	THETA(P)	P SB M	D-EPS(THETA)
16	CHI SB Y	D-CHI SB Y	THETA(Y)	Q SB M	D-EPS(PSI)
17	CHI SB R	D-CHI SB R	THETA(R)	R SB M	D-EPS(PHI)
18	GAMMA SB 1	GAMMA SB 1I	GAMMA(1I)PR.	DELTA(A)	D-DELTA(A)
19	GAMMA SB 2	GAMMA SB 2I	GAMMA(2I)PR.	DELTA(B)	D-DELTA(B)
20	I SB SP	AVG I SB SP	WEIGHT FLOW	AVG D-W	AVG F SB L
21	Q	MACH NO.	PRESSURE	TEMPERATURE	X SB CP
22	MU	RHO	RHO PRIME	G(RHO)	G(PSI)
23	ALPHA*	ALPHA	BETA	CHORD FORCE	V SB RM
24	T(1)	TAU(1G)	PHI(T)	X(V)	D-X(V)
25	T(3)	TAU(3G)	SHCP	Y(V)	D-Y(V)
26	D-T(CO)	DELTA-T(3)	SHCY	Z(V)	D-Z(V)
27	SAF(1)			V SB W	E SB W
28	THETA SB C	D-THETA SB C	X SB CG	W(LOX)RES	W(LH2)RES
29	PSI SB C	D-PSI SB C	Y SB CG		GAMMA SB 1F
30	PHI SB C	D-PHI SB C	Z SB CG		GAMMA SB 2F
31	R(PER)	V(PER)	ECCENTRICITY	PERIOD	BETA
32	R(AP)	V(AP)	INCLINATION	E/M	BETA(F)
33	T SB F	S SB F	V(F)	MU SB F	RHO SB F

1	148.1400	295663.332	179997.889	224688.197	231594.514
2	7729.8822	6588.1816	21134324.25	20909636.25	0.6346
3	233882.047	125987.805	431520.832	4.832	323429.504
4	223396.771	6440443.500	220198.301	2.808	71.9842
5	-146.025	36022.486	62242.286	0.010	43.6863
6	5663.6058	2129.4825	6986.4777	3.5082	19.7017
7	3365.3271	1001.2178	3284.8289	3.2012	-0.0469
8	3.7047	118.0949	387.4496	0.0060	-0.0224
9	181049.195	179397.227	-348.028	17.878	-0.003
10	-430.948	-436.352	5.204	5926.438	-255.559
11	-206.137	-215.063	8.195	2561.242	162.167
12	30.2638	-0.0446	2000.0000	105430.743	0.2762
13	0.0170	0.1622	0.0000	2668653.063	-0.0170
14	-0.0000	-0.0000	0.0000	2670308.594	0.0000
15	-59.4600	0.0000	0.0000	0.0000	0.0446
16	0.0000	0.0000	0.0000	-0.0446	-0.1622
17	0.0000	0.0000	0.0000	0.1622	0.0000
18	31.3514	26.3235	26.2840	-0.0687	-0.1732
19	72.3675	75.7600	75.6833	0.1394	-0.0084
20	456.6517	456.6517	-397.2332	-397.2332	181397.223
21	4.6253	6.7324	0.1458	398.4952	694.448
22	79.8746	28.7271	28.3670	-31.5307	-0.0422
23	0.1494	0.0802	-0.1262	-348.0282	6588.182
24	0.0000	0.0000	0.0000	0.000	0.0000
25	0.0000	0.0000	0.0000	0.000	0.0000
26	0.0000	0.0000	0.0000	0.000	0.0000
27	110.1956			0.0000	0.0000
28	30.5400	0.0000	350.7181	192364.7852	36148.1831
29	0.0000	0.0000	-0.4491		
30	0.0000	0.0000	-0.7131		
31					
32					
33					

S-IVB ENGINE IGNITION SEQUENCE

1	144.8400	296151.987	0.000	213245.471	213247.951
2	7756.3994	6622.5311	21122896.50	20909652.00	0.5843
3	215232.586	118973.334	408507.520	0.198	302212.910
4	212150.414	6437095.188	209213.061	-0.114	71.9583
5	-156.075	35632.560	60963.005	0.001	44.5867
6	5648.9077	2124.7743	6971.0308	0.3008	0.8728
7	3456.5524	1029.8481	3378.7601	0.1740	-0.0050
8	2.7655	118.2257	387.8790	0.0008	0.0018
9	8034.086	0.000	-565.914	3.354	3.354
10	-46.213	-0.000	-46.241	-495.676	-495.514
11	16.220	0.000	16.228	-1295.572	-1294.992
12	30.5014	-0.0529	8599.9999	105826.092	0.0386
13	-0.0100	-0.0148	0.0000	2669257.938	0.0100
14	-0.0000	0.0000	0.0000	2670913.406	0.0000
15	-59.4600	0.0000	0.0000	-0.0000	0.0529
16	0.0000	0.0000	0.0000	-0.0529	0.0148
17	0.0000	0.0000	0.0000	-0.0148	0.0000
18	32.0456	26.9382	26.8986	0.0100	0.0134
19	72.3318	75.7363	75.6575	0.0380	0.0442
20	0.0000	0.0000	-46.3160	0.0000	0.000
21	7.4563	6.6116	0.2437	417.5063	692.233
22	79.9292	28.7119	28.5517	-31.5649	-0.0423
23	0.4643	-0.4381	-0.1538	-565.9143	6622.531
24	0.0000	0.0000	0.0000	0.000	0.0000
25	0.0000	0.0000	0.0000	0.000	0.0000
26	0.0000	0.0000	0.0000	0.000	0.0000
27	109.6063			0.0000	0.0000
28	30.5400	0.0000	350.6743	192638.0000	36245.0000
29	0.0000	0.0000	-0.4489		
30	0.0000	0.0000	-0.7128		
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1	150.0000	294841.914	196774.059	231032.293	241979.846
2	7742.9057	6597.0027	21140658.75	20909627.50	0.6831
3	244446.238	129957.784	444545.570	24.521	355379.762
4	229621.320	6442294.625	226271.553	14.242	71.9874
5	-138.779	36242.015	62962.525	-0.032	43.2087
6	5695.9907	2139.4197	7019.0800	13.7956	21.4435
7	3328.0802	989.3298	3245.8263	9.1726	-0.0352
8	4.0673	117.9408	386.9441	-0.0702	-0.0861
9	196507.434	196772.207	-264.772	-10.384	-1.884
10	-322.909	-347.651	24.878	-4263.627	295.567
11	-788.982	-778.913	-10.801	624.015	726.962
12	30.2600	0.0262	0.0000	105059.615	0.2800
13	0.3632	0.1469	0.0000	2668187.219	-0.3632
14	0.0000	0.0000	0.0000	2669843.625	0.0000
15	-59.4600	0.0000	0.0000	-0.0002	-0.0262
16	0.0000	0.0000	0.0000	0.0262	-0.1409
17	0.0000	0.0000	0.0000	0.1409	0.0000
18	30.9589	25.9949	25.9554	-0.2268	-0.0184
19	72.3858	75.7604	75.6848	0.1012	-0.0210
20	429.4556	437.4596	-458.1898	-441.6049	193076.553
21	3.5436	6.8299	0.1085	388.2377	696.398
22	79.8438	28.7388	28.5756	-31.5118	-0.0422
23	0.5491	0.5037	0.2187	-264.7725	6397.003
24	0.0000	0.0000	0.0000	0.000	0.0000
25	0.0000	0.0000	0.0000	0.000	0.0000
26	0.0000	0.0000	0.0000	0.000	0.0000
27	110.5107			0.0000	0.0000
28	30.5400	0.0000	350.7222	191674.0156	36017.5464
29	0.0000	0.0000	-0.4494		
30	0.0000	0.0000	-0.7135		
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1	145.0000	296144.543	0.000	213806.814	214137.479
2	7754.2534	6619.9996	21123457.75	20909651.25	0.5868
3	216136.402	119313.298	409622.883	0.249	303244.750
4	212703.084	6437259.813	209753.262	0.144	71.9586
5	-156.222	35651.476	61023.064	0.001	44.5412
6	5648.9089	2124.7820	6971.0562	0.3376	0.8743
7	3451.6977	1028.3305	3373.7810	0.1954	-0.0046
8	2.8077	118.2193	387.8578	0.0009	0.0017
9	8047.242	0.000	-532.757	3.117	3.117
10	-42.291	-0.000	-42.321	-491.843	-491.462
11	16.100	0.000	16.108	-1184.887	-1184.260
12	30.4926	-0.0572	8599.9999	105826.092	0.0474
13	-0.0125	-0.0165	0.0000	2669257.938	0.0125
14	0.0000	0.0000	0.0000	2670913.406	0.0000
15	-59.4600	0.0000	0.0000	-0.0000	0.0372
16	0.0000	0.0000	0.0000	-0.0372	0.0165
17	0.0000	0.0000	0.0000	-0.0165	0.0000
18	32.0122	26.9080	26.8684	0.0120	0.0114
19	72.3335	75.7378	75.6591	0.0444	0.0370
20	0.0000	0.0000	-46.3160	0.0000	0.000
21	7.2853	6.6166	0.2377	416.3841	692.332
22	79.9263	28.7126	28.5524	-31.5632	-0.0423
23	0.4392	-0.4165	-0.1563	-532.7375	6620.000
24	0.0000	0.0000	0.0000	0.000	0.0000
25	0.0000	0.0000	0.0000	0.000	0.0000
26	0.0000	0.0000	0.0000	0.000	0.0000
27	109.6359			0.0000	0.0000
28	30.5400	0.0000	350.6743	192638.0000	36245.0000
29	0.0000	0.0000	-0.4489		
30	0.0000	0.0000	-0.7128		
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1	155.0000	292449.734	220520.322	247778.066	270173.277
2	7786.2944	6629.5082	21157380.50	20909603.50	0.7403
3	273150.934	140724.188	479868.449	175.368	367608.160
4	246017.479	6447163.188	242244.457	101.973	71.9756
5	-117.315	36830.245	64892.411	-1.328	42.0082
6	5788.3431	2167.9021	7112.5258	45.2865	24.2469
7	3231.9413	958.5565	3144.8578	26.3613	-0.0331
8	4.5440	117.3529	385.0133	-0.4473	-0.0681
9	220395.160	220519.205	-124.043	-5.288	-2.586
10	-301.237	-340.760	39.475	550.032	169.679
11	-618.598	-612.488	-6.048	-25.007	1160.599
12	30.3240	-0.0048	0.0000	104935.925	0.2160
13	0.4140	-0.0094	0.0000	2666288.156	-0.4140
14	0.0000	-0.0000	0.0000	2667946.363	0.0000
15	-59.4600	0.0000	0.0000	0.0000	0.0048
16	0.0000	0.0000	0.0000	-0.0048	0.0094
17	0.0000	0.0000	0.0000	-0.0094	0.0000
18	29.9159	25.1275	25.0880	-0.1591	-0.0024
19	72.4302	75.7555	75.6828	0.0885	0.0030
20	425.7375	430.5852	-517.9696	-468.4375	201582.402
21	1.6937	7.1042	0.0479	362.3810	702.084
22	79.7800	28.7592	28.5991	-31.4619	-0.0420
23	1.7252	1.7053	0.2613	-124.0433	6629.508
24	0.0000	0.0000	0.0000	0.000	0.0000
25	0.0000	0.0000	0.0000	0.000	0.0000
26	0.0000	0.0000	0.0000	0.000	0.0000
27	111.3077			0.0000	0.0000
28	30.5400	0.0000	350.6889	189669.4844	33629.9800
29	0.0000	0.0000	-0.4518		
30	0.0000	0.0000	-0.7170		
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TABLE AP 3-2 (Sheet 2 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	160.0000	289646.129	220780.168	264105.168	298810.270
2	7841.4950	6674.3854	21173683.50	20909579.00	0.8188
3	302343.809	151641.066	515684.910	481.925	400036.395
4	261949.848	6451882.875	257728.971	280.481	71.9823
5	-93.190	37415.535	66812.649	-4.499	40.9053
6	5889.0020	2198.9053	7214.2422	77.3926	24.5176
7	3141.1861	929.3685	3049.1034	45.0720	-0.0449
8	5.0987	116.7556	383.0557	-0.8285	-0.1516
9	220719.365	220775.549	-56.182	-27.366	-1.869
10	-403.961	-433.411	29.502	-15074.502	69.334
11	-1363.190	-1360.141	-2.442	1564.710	880.624
12	30.3125	0.0087	0.0000	104082.004	0.3181
13	0.3935	-0.1033	0.0000	2662504.875	-1.2535
14	0.0000	0.0000	0.0000	2664165.719	0.0000
15	-59.3694	0.1034	0.0000	-0.0001	-0.0087
16	-0.8600	-1.0000	0.0000	0.0087	0.1033
17	0.0000	0.0000	0.0000	-0.1033	0.0000
18	28.8927	24.2838	24.2443	-0.3530	-0.3207
19	72.4759	75.7490	75.6790	0.1125	0.0349
20	426.1271	428.6433	-518.0979	-489.2907	209606.338
21	0.7866	7.4058	0.0204	337.9988	708.115
22	79.6748	28.7829	28.6229	-31.4134	-0.0419
23	2.8224	2.8128	0.2330	-56.1822	6674.385
24	315.0500	556.6272	4.5947	-1904539.297	1786.3215
25	118.9791	271.0000	0.0000	6165467.625	1583.4469
26	0.0000	7.2791	0.0000	1776.461	-11.6460
27	112.0420			0.0000	0.0000
28	30.6306	0.0000	350.7807	187475.7891	35234.1709
29	-0.8600	0.0000	-0.4552		
30	0.0000	0.0000	-0.7226		
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1	175.0000	281790.422	223142.193	310696.672	387516.813
2	8028.7938	6832.6219	21220200.00	20909504.00	1.0619
3	392982.070	185333.385	626223.805	2379.086	498720.234
4	307062.348	6465176.625	301343.723	1385.021	72.0165
5	113.439	39188.420	72629.190	9.574	38.0028
6	6198.9072	2294.2271	7526.9770	176.4933	25.4771
7	2873.6071	843.0226	2765.8168	101.9705	-0.0475
8	25.5910	120.5450	395.4881	3.6259	-0.0747
9	223136.482	223140.828	-4.344	0.270	-0.131
10	-416.194	-420.866	3.637	-39.293	-71.799
11	-654.507	-656.878	2.398	201.994	108.646
12	28.7242	-0.1736	0.0000	104066.008	0.0107
13	-2.9357	-0.0045	0.0000	2653869.313	-0.4291
14	0.0000	-0.0000	0.0000	2655537.563	0.0000
15	-61.2650	-0.1633	0.0000	-0.0089	0.1733
16	-3.3648	-0.0065	0.0000	-0.1733	0.0049
17	0.0000	0.0000	0.0000	-0.0045	0.0000
18	25.9307	21.8473	21.8082	-0.1687	-0.0008
19	72.7917	75.8806	75.8185	0.1081	-0.0012
20	424.2794	426.2298	-525.9290	-508.5086	216649.150
21	0.0608	7.4444	0.0016	350.5529	708.887
22	79.4105	28.8558	28.6958	-31.2756	-0.0416
23	5.3715	4.4883	-2.9630	-4.3443	6832.622
24	299.3000	532.3379	4.5953	-1879358.031	1908.9821
25	115.9695	271.0000	0.0000	6188788.625	1530.3856
26	0.0000	-0.2419	0.0000	1571.189	-13.2984
27	113.9571			0.0000	0.0000
28	28.7350	0.0000	350.9797	180820.6465	34033.7583
29	-3.3648	0.0000	-0.4672		
30	0.0000	0.0000	-0.7406		
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1	165.0000	287040.461	222079.889	280030.035	327908.629
2	7900.2629	6723.1849	21189583.25	20909554.25	0.8985
3	332042.383	162713.652	552012.227	949.901	432689.410
4	277431.691	6456457.500	272737.594	553.228	71.9894
5	-61.439	37999.239	68727.685	-8.169	39.8797
6	5990.5518	2230.1653	7316.8011	109.8320	24.8899
7	3051.9532	900.6118	2954.7574	64.1349	0.0004
8	9.3365	117.2563	384.6984	-0.1125	0.0327
9	222055.578	222079.711	-24.131	11.060	-0.629
10	3.257	-16.738	19.378	18855.498	-432.103
11	292.070	278.955	14.304	-7575.550	584.321
12	30.7018	-0.1042	0.0000	104076.679	-0.1005
13	-3.0429	-0.2000	0.0000	2659713.906	-0.2523
14	0.0000	0.0019	0.0000	2661377.219	0.0000
15	-59.3989	-0.1999	0.0000	-0.0055	0.1040
16	-3.2952	-0.0110	0.0000	-0.1040	0.2000
17	0.0000	0.0000	0.0000	-0.2000	0.0000
18	27.8940	23.4615	23.4221	0.0720	-0.1266
19	72.5576	75.7728	75.7055	0.0043	0.0391
20	423.8048	427.5395	-524.0141	-498.7314	213114.518
21	0.3421	7.6056	0.0084	325.1700	712.113
22	79.5882	28.8070	28.6469	-31.3662	-0.0418
23	5.3448	4.3046	-3.1802	-24.1313	6723.185
24	309.8000	548.1197	4.5978	-1914501.750	1822.0524
25	117.9782	271.0000	0.0000	6167729.250	1570.8678
26	0.0000	-0.4378	0.0000	1709.940	-13.2087
27	112.7235			0.0000	0.0000
28	30.6011	0.0000	350.8293	185268.8633	34835.4722
29	-3.2952	0.0000	-0.4591		
30	0.0000	0.0000	-0.7285		
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1	180.0000	279158.105	223721.793	325437.848	418048.734
2	8098.4608	6893.2747	21234915.50	20909478.50	1.1453
3	424244.066	196886.641	664128.109	3347.221	532123.484
4	321204.863	6469318.875	314933.738	1941.070	72.0354
5	262.094	39795.288	74620.222	32.423	37.1301
6	6306.2599	2327.1852	7635.1073	210.8730	25.7844
7	2783.3740	813.8492	2670.1038	120.4040	-0.0486
8	33.9320	122.2095	400.9491	5.5203	-0.0764
9	223718.400	223720.404	-2.004	0.298	-0.067
10	-422.033	-424.733	1.773	3.730	-32.457
11	-662.632	-663.695	1.095	132.659	52.398
12	27.9060	-0.1583	0.0000	104060.661	0.0393
13	-2.9630	-0.0035	0.0000	2650791.094	-0.4338
14	0.0000	-0.0000	0.0000	2652461.781	0.0000
15	-62.0546	-0.1528	0.0000	-0.0080	0.1551
16	-3.3968	-0.0063	0.0000	-0.1551	0.0055
17	0.0000	0.0000	0.0000	-0.0055	0.0000
18	24.9583	21.0489	21.0099	-0.1700	-0.0004
19	72.9080	75.9350	75.8753	0.1088	-0.0003
20	424.5318	425.9436	-526.9815	-511.3246	217713.303
21	0.0277	7.2633	0.0007	374.8158	705.266
22	79.3194	28.8805	28.7206	-31.2322	-0.0415
23	5.5718	4.7439	-2.9358	-2.0037	6893.273
24	295.8000	527.7712	4.5946	-1868145.688	1938.4008
25	115.5660	271.0000	0.0000	6195477.000	1516.9711
26	0.0000	-0.1901	0.0000	1524.538	-13.3587
27	114.5202			0.0000	0.0000
28	27.9454	0.0000	351.0882	178588.9219	33633.2222
29	-3.3968	0.0000	-0.4713		
30	0.0000	0.0000	-0.7469		
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1	170.0000	284417.703	222610.896	295560.887	357473.875
2	7962.7254	6775.9292	21205088.50	20909529.25	0.9795
3	362251.723	173943.420	588855.227	1581.144	465579.934
4	292469.996	6460889.063	287276.930	921.861	72.0009
5	5.889	38589.790	70665.185	-3.898	38.9162
6	6093.6247	2261.8733	7420.8296	142.7992	25.1810
7	2963.2162	871.9685	2860.7834	83.2399	-0.0461
8	17.4650	118.9160	390.1437	1.7709	-0.0739
9	222599.313	222609.529	-10.215	-0.229	-0.286
10	-407.112	-416.503	8.244	-328.474	-171.350
11	-653.528	-659.081	5.655	342.514	249.310
12	29.6415	-0.1928	0.0000	104071.349	-0.0221
13	-2.8882	-0.0170	0.0000	2656866.688	-0.4420
14	-0.0000	-0.0061	0.0000	2658532.469	0.0000
15	-60.3806	-0.1857	0.0000	-0.0097	0.1926
16	-3.3302	-0.0073	0.0000	-0.1926	0.0170
17	0.0000	0.0000	0.0000	-0.0170	0.0000
18	26.9105	22.6525	22.6132	-0.1696	0.0105
19	72.6756	75.8272	75.7625	0.1072	-0.0036
20	424.0137	426.7059	-525.0054	-504.6345	215226.924
21	0.1454	7.6598	0.0035	325.6406	713.195
22	79.5001	28.8313	28.6713	-31.3203	-0.0417
23	5.2406	4.3256	-2.9698	-10.2150	6775.929
24	304.5500	539.7697	4.5965	-1896720.516	1865.2311
25	116.8020	271.0000	0.0000	6178424.438	1550.6279
26	0.0000	-0.3580	0.0000	1640.772	-13.2051
27	113.3599			0.0000	0.0000
28	29.6194	0.0000	350.8885	183047.1367	34434.5010
29	-3.3302	0.0000	-0.4631		
30	0.0000	0.0000	-0.7345		
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1	185.0000	276520.504	224283.357	339784.234	449080.441
2	8171.7214	6957.8975	21249235.00	20909452.75	1.2306
3	456047.828	208606.154	702377.883	4488.927	565803.961
4	334895.082	6473314.813	328043.633	2588.640	72.0569
5	453.051	40410.568	76638.854	64.845	36.2913
6	6415.6160	2360.7276	7743.1544	245.9194	26.0958
7	2692.6576	784.4906	2573.7831	138.5847	-0.0496
8	42.4922	123.9106	406.5302	7.4554	-0.0781
9	224280.965	224281.941	-0.976	0.196	-0.037
10	-426.010	-427.798	0.921	1.201	-15.417
11	-671.181	-671.678	0.528	75.445	26.812
12	27.1581	-0.1448	0.0000	104055.304	0.0567
13	-2.9898	-0.0053	0.0000	2652754.000	-0.4375
14	0.0000	-0.0000	0.0000	2654427.188	0.0000
15	-62.7851	-0.1428	0.0000	-0.0076	0.1446
16	-3.4273	-0.0060	0.0000	-0.1446	0.0053
17	0.0000	0.0000	0.0000	-0.0053	0.0000
18	23.9960	20.2591	20.2203	-0.1716	-0.0003
19	73.0245	75.9903	75.9331	0.1093	0.0001
20	424.7678	425.7688	-528.0107	-513.5200	218567.385
21	0.0132	6.9989	0.0004	411.2681	699.979
22	79.2267	28.9035	28.7456	-31.1900	-0.0415
23	5.8296	5.0612	-2.9078	-0.9763	6957.898
24	290.5500	521.2539	4.5936	-1851708.438	1982.9219
25	115.0910	271.0000	0.0000	6205231.625	1496.9624
26	0.0000	-0.1462	0.0000	1454.173	-13.4454
27	115.0533			0.0000	0.0000
28	27.2149	0.0000	351.2245	176351.6875	33232.9102
29	-3.4273	0.0000	-0.4756		
30	0.0000	0.0000	-0.7533		
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TABLE AP 3-2 (Sheet 3 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	190.0000	273879.918	224318.064	353733.355	480622.320
2	8248.3976	7026.3184	21263159.00	20909426.75	1.3170
3	488403.051	220494.732	741582.328	5807.432	599776.922
4	348130.500	6477163.438	340670.426	3326.493	72.0806
5	687.337	41034.442	78685.681	107.041	35.4809
6	6526.7889	2394.7972	7856.9310	281.5772	26.3515
7	2601.4513	734.9449	2476.8484	156.5124	-0.0505
8	51.2644	125.6461	412.2238	9.4288	-0.0796
9	224316.109	224316.625	-0.515	0.178	-0.022
10	-429.782	-431.131	0.519	1.413	-7.936
11	-677.299	-677.543	0.276	57.164	14.900
12	26.4508	-0.1385	0.0000	104049.941	0.0683
13	-3.0160	-0.0052	0.0000	2657431.375	-0.4410
14	0.0000	-0.0000	0.0000	2659107.063	0.0000
15	-63.4806	-0.1365	0.0000	-0.0073	0.1383
16	-3.4570	-0.0059	0.0000	-0.1383	0.0052
17	0.0000	0.0000	0.0000	-0.0052	0.0000
18	23.0454	19.4790	19.4404	-0.1731	-0.0003
19	73.1411	76.0446	75.9918	0.1101	0.0003
20	424.6622	425.6430	-528.2236	-515.2621	219251.447
21	0.0069	6.7603	0.0002	449.5334	695.205
22	79.1324	28.9307	28.7708	-31.1491	-0.0414
23	6.1192	5.4087	-2.8790	-0.5152	7026.319
24	285.3000	514.9515	4.5927	-1835526.594	2027.9255
25	114.6993	271.0000	0.0000	6214716.813	1477.0321
26	0.0000	-0.1234	0.0000	1383.366	-13.5268
27	115.5598			0.0000	0.0000
28	26.5194	0.0000	351.3758	174111.5645	32832.5103
29	-3.4570	0.0000	-0.4799		
30	0.0000	0.0000	-0.7598		
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1	205.0000	265950.035	224323.506	393213.797	578401.891
2	8498.0194	7253.4756	21302559.75	20909347.00	1.5849
3	588862.406	257199.461	862004.430	10852.547	703598.133
4	385083.457	6487816.500	375621.234	6069.082	72.1616
5	1660.646	42959.277	85000.743	294.126	33.1823
6	6870.2932	2499.8890	8201.7196	391.9446	27.1621
7	2325.0286	665.2223	2182.4837	208.8312	-0.0538
8	78.8867	131.0663	430.0068	15.5882	-0.0845
9	224521.869	224521.979	-0.108	0.238	-0.006
10	-444.453	-445.216	0.133	-55.439	-1.603
11	-698.317	-697.909	0.058	97.188	3.634
12	24.5951	-0.1047	0.0000	104032.247	0.1279
13	-3.2343	-0.0775	0.0000	2650982.875	-0.5546
14	0.0000	0.0000	0.0000	2652666.656	0.0000
15	-65.2767	-0.1007	0.0000	-0.0059	0.1045
16	-3.7889	-0.0590	0.0000	-0.1045	0.0775
17	0.0000	0.0000	0.0000	-0.0775	0.0000
18	20.2778	17.2065	17.1684	-0.1781	0.0069
19	73.4922	76.2220	76.1740	0.1136	-0.0002
20	424.3669	425.3438	-529.0751	-518.7932	220613.824
21	0.0013	5.8194	0.0001	646.5027	680.000
22	78.8396	29.0079	28.8480	-31.0338	-0.0411
23	7.2507	6.6429	-2.9321	-0.1083	7253.476
24	269.5500	498.2488	4.5904	-1788465.813	2165.4713
25	114.3963	271.0000	0.0003	6241599.438	1417.6365
26	0.0000	0.0316	0.0057	1168.621	-13.7199
27	116.9465			0.0000	0.0000
28	24.7233	0.0000	352.0340	167385.6699	31628.6990
29	-3.7889	0.0000	-0.4941		
30	0.0000	0.0000	-0.7811		
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1	195.0000	271238.051	224382.865	367288.781	512683.723
2	8328.3467	7098.3956	21276687.75	20909400.50	1.4048
3	521318.316	232554.873	781149.641	7305.649	634057.055
4	360908.691	6480863.875	352810.930	4153.330	72.1062
5	966.053	41667.075	80761.242	159.195	34.6948
6	6639.6420	2429.3521	7970.2996	317.8047	26.6159
7	2509.7304	725.2042	2379.2742	174.1809	-0.0518
8	60.2435	127.4141	418.0244	11.4390	-0.0810
9	224381.109	224381.395	-0.285	0.370	-0.014
10	-436.735	-437.825	0.307	2.387	-4.262
11	-683.203	-683.324	0.151	113.337	8.637
12	25.7761	-0.1365	0.0000	104044.568	0.0850
13	-3.0414	-0.0050	0.0000	2657152.281	-0.4443
14	0.0000	-0.0000	0.0000	2658830.469	0.0000
15	-64.1388	-0.1262	0.0000	-0.0069	0.1303
16	-3.4857	-0.0056	0.0000	-0.1303	0.0050
17	0.0000	0.0000	0.0000	-0.0050	0.0000
18	22.1078	18.7095	18.6711	-0.1745	-0.0003
19	73.2579	76.1039	76.0514	0.1118	0.0009
20	424.5594	425.5327	-528.5041	-516.6598	219795.246
21	0.0037	6.4483	0.0001	504.2674	688.966
22	79.0365	28.9562	28.7963	-31.1095	-0.0413
23	6.4332	5.7772	-2.8495	-0.2850	7098.396
24	280.0500	508.9449	4.5918	-1819473.594	2073.3861
25	114.4237	271.0000	0.0000	6223972.625	1457.1099
26	0.0000	-0.0714	0.0000	1312.147	-13.6019
27	116.0426			0.0000	0.0000
28	25.8612	0.0000	351.5669	171870.5645	32431.7021
29	-3.4857	0.0000	-0.4844		
30	0.0000	0.0000	-0.7665		
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1	210.0000	263304.332	224567.742	405587.566	612076.477
2	8587.6979	7336.4037	21314906.00	20909319.75	1.6772
3	623507.359	269788.566	903307.195	12906.756	738890.469
4	396476.727	6491067.188	386286.203	7155.920	72.1912
5	2080.534	43619.720	87167.548	377.819	32.4513
6	6987.9825	2535.8399	8319.6687	429.8278	27.4405
7	2232.2549	635.0427	2083.4694	225.8777	-0.0544
8	89.2070	133.1503	436.8440	17.9270	-0.0844
9	224566.164	224566.236	-0.071	0.609	-0.004
10	-445.498	-446.179	0.092	231.532	-1.108
11	-690.465	-690.294	0.040	36.489	2.512
12	24.0918	-0.0978	0.0000	104026.753	0.1386
13	-3.5171	-0.0350	0.0000	2647827.344	-0.4942
14	0.0000	0.0000	0.0000	2649513.719	0.0000
15	-65.7693	-0.0958	0.0000	-0.0060	0.0976
16	-4.0113	-0.0265	0.0000	-0.0976	0.0350
17	0.0000	0.0000	0.0000	-0.0350	0.0000
18	19.3887	16.4754	16.4374	-0.1761	-0.0035
19	73.6151	76.2874	76.2415	0.1138	-0.0001
20	424.4935	425.2687	-529.0216	-519.6287	220933.695
21	0.0008	5.3599	0.0000	779.6106	680.000
22	78.7386	29.0341	28.8742	-30.9978	-0.0411
23	7.7933	7.1406	-3.1545	-0.0712	7336.404
24	264.3000	493.2940	4.5899	-1773405.172	2212.0874
25	114.5348	271.0000	0.0007	6250008.688	1398.1328
26	0.0000	0.0514	0.0086	1096.921	-13.5547
27	117.3716			0.0000	0.0000
28	24.2307	0.0000	352.2964	165142.1523	31226.5627
29	-4.0113	0.0000	-0.4988		
30	0.0000	0.0000	-0.7882		
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1	200.0000	268594.762	224431.264	380448.617	545273.883
2	8411.5614	7174.1227	21289821.25	20909373.75	1.4941
3	554802.039	244788.996	821287.758	8986.420	668659.039
4	373226.977	6484415.188	364462.090	5067.900	72.1332
5	1290.113	42308.629	82866.075	221.492	33.9294
6	6754.1570	2464.3867	8085.2424	354.5976	26.8860
7	2417.5566	695.2868	2281.1203	191.6101	-0.0527
8	69.4311	129.2149	423.9324	13.4861	-0.0825
9	224449.600	224449.770	-0.168	0.346	-0.009
10	-440.284	-441.189	0.194	1.917	-2.430
11	-689.056	-689.115	0.088	102.788	5.331
12	25.1543	-0.1184	0.0000	104039.189	0.1052
13	-3.0658	-0.0048	0.0000	2654204.281	-0.4475
14	-0.0000	-0.0000	0.0000	2655884.969	0.0000
15	-64.7403	-0.1140	0.0000	-0.0063	0.1182
16	-3.5133	-0.0054	0.0000	-0.1182	0.0048
17	0.0000	0.0000	0.0000	-0.0048	0.0000
18	21.1848	17.9516	17.9133	-0.1759	-0.0002
19	73.3747	76.1622	76.1120	0.1126	0.0007
20	424.4590	425.4339	-528.7902	-517.8155	220240.627
21	0.0021	6.0953	0.0001	576.4677	681.907
22	78.9389	28.9819	28.8220	-31.0710	-0.0412
23	6.7887	6.1857	-2.8189	-0.1680	7174.123
24	274.8000	503.4129	4.5911	-1803774.906	2119.2429
25	114.3372	271.0000	0.0000	6232935.563	1437.2941
26	0.0000	-0.0093	0.0000	1240.552	-13.6702
27	116.5041			0.0000	0.0000
28	25.2597	0.0000	351.7796	169628.5977	32030.4387
29	-3.5133	0.0000	-0.4889		
30	0.0000	0.0000	-0.7733		
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1	215.0000	260663.760	224243.330	417570.844	646306.055
2	8680.3920	7422.7076	21326861.25	20909292.50	1.7710
3	658744.297	282558.445	945203.039	15151.624	774551.164
4	407405.512	6494166.688	396455.172	8327.561	72.2221
5	2553.691	44291.018	89369.964	473.652	31.7348
6	7107.0580	2572.1880	8438.9207	468.1973	27.6784
7	2139.2265	604.7435	1984.0693	242.7491	-0.0553
8	100.1348	135.3884	444.1868	20.4244	-0.0865
9	224241.732	224241.783	-0.050	0.346	-0.003
10	-448.212	-448.850	0.069	114.974	-0.787
11	-700.700	-700.622	0.029	26.185	1.872
12	23.6108	-0.0948	0.0000	104021.246	0.1453
13	-3.6437	-0.0177	0.0000	2644548.500	-0.4753
14	0.0000	-0.0000	0.0000	2646237.406	0.0000
15	-66.2436	-0.0939	0.0000	-0.0060	0.0946
16	-4.1190	-0.0169	0.0000	-0.0946	0.0177
17	0.0000	0.0000	0.0000	-0.0177	0.0000
18	18.5183	15.7589	15.7211	-0.1790	-0.0008
19	73.7413	76.3565	76.3127	0.1147	0.0001
20	425.0283	425.2369	-527.5926	-520.2629	221190.236
21	0.0006	5.0164	0.0000	911.1010	680.000
22	78.6358	29.0666	28.9007	-30.9630	-0.0410
23	8.2777	7.6425	-3.2179	-0.0504	7422.708
24	260.8000	490.0451	4.5895	-1763426.094	2243.3699
25	114.6467	271.0000	0.0010	6255496.625	1385.1842
26	0.0000	0.0576	0.0097	1049.813	-13.3550
27	117.7810			0.0000	0.0000
28	23.7564	0.0000	352.5906	162903.7969	30824.3718
29	-4.1190	0.0000	-0.5037		
30	0.0000	0.0000	-0.7955		
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TABLE AP 3-2 (Sheet 4 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	220.0000	258027.164	224107.336	429163.641	681098.422
2	8776.0880	7512.3745	21338426.75	20909265.00	1.8663
3	694580.063	295511.039	987698.398	17589.554	810595.203
4	417868.523	6497114.438	406126.203	9583.134	72.2543
5	3082.490	44973.736	91609.848	582.211	31.0314
6	7227.5414	2608.9395	8559.4963	507.0599	27.9443
7	2045.9709	574.3388	1884.3100	259.4548	-0.0567
8	111.4443	137.7115	451.8084	23.0112	-0.0883
9	224105.713	224105.752	-0.038	0.445	-0.003
10	-454.687	-455.277	0.034	67.491	-0.582
11	-708.241	-708.210	0.021	87.433	1.476
12	23.1479	-0.0892	0.0000	104015.733	0.1578
13	-3.7076	-0.0086	0.0000	2641203.250	-0.4664
14	0.0000	-0.0000	0.0000	2642894.688	0.0000
15	-66.6939	-0.0869	0.0000	-0.0058	0.0890
16	-4.1740	-0.0082	0.0000	-0.0890	0.0086
17	0.0000	0.0000	0.0000	-0.0086	0.0000
18	17.6672	15.0574	15.0198	-0.1811	-0.0004
19	73.8687	76.4277	76.3860	0.1164	0.0002
20	425.1987	425.2283	-527.0612	-520.7543	221397.770
21	0.0004	4.7559	0.0000	1038.3067	680.000
22	78.5312	29.0872	28.9273	-30.9293	-0.0409
23	8.7411	8.1443	-3.2177	-0.0377	7512.375
24	255.5500	485.3431	4.5890	-1748492.828	2290.6059
25	114.8769	271.0000	0.0013	6263568.500	1365.8262
26	0.0000	0.0889	0.0106	980.629	-12.9900
27	118.1761			0.0000	0.0000
28	23.3061	0.0000	352.9020	160669.4141	30422.1279
29	-4.1740	0.0000	-0.5086		
30	0.0000	0.0000	-0.8029		
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1	225.0000	255392.145	224277.600	440370.371	716461.898
2	8874.8235	7605.4378	21349605.25	20909237.00	1.9632
3	731021.906	308648.469	1030800.055	20223.061	847038.516
4	427864.793	6499909.875	415297.652	10921.863	72.2875
5	3668.546	45668.210	93888.302	703.858	30.3400
6	7349.4930	2646.1128	8681.4556	546.4345	28.2540
7	1952.5625	543.8446	1784.2636	276.0180	-0.0575
8	123.0325	140.0877	459.6044	25.6556	-0.0902
9	224275.959	224275.990	-0.029	0.229	-0.002
10	-456.596	-457.137	0.045	37.217	-0.445
11	-715.991	-715.985	0.016	38.782	1.216
12	22.7209	-0.0825	0.0000	104010.210	0.1690
13	-3.7374	-0.0038	0.0000	2637735.938	-0.4636
14	0.0000	-0.0000	0.0000	2639429.906	0.0000
15	-67.1097	-0.0812	0.0000	-0.0054	0.0823
16	-4.2010	-0.0037	0.0000	-0.0823	0.0038
17	0.0000	0.0000	0.0000	-0.0038	0.0000
18	16.8362	14.3716	14.3342	-0.1829	-0.0003
19	73.9965	76.5002	76.4604	0.1168	0.0001
20	424.9375	425.2281	-527.7858	-521.1596	221372.750
21	0.0003	4.5527	0.0000	1161.2762	680.000
22	78.4248	29.1141	28.9542	-30.8969	-0.0409
23	9.2129	8.6631	-3.1834	-0.0295	7605.438
24	250.3000	480.8832	4.5886	-1733753.969	2338.1976
25	115.1922	271.0000	0.0017	6271407.875	1346.6326
26	0.0000	0.1104	0.0111	913.481	-12.5843
27	118.5581			0.0000	0.0000
28	22.8903	0.0000	353.2463	158436.8574	30019.7598
29	-4.2010	0.0000	-0.5136		
30	0.0000	0.0000	-0.8105		
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1	230.0000	252752.848	224401.619	451192.195	752405.148
2	8976.7772	7702.0700	21360399.75	20909208.75	2.0617
3	768077.539	321972.914	1074515.359	23054.868	883897.508
4	437394.078	6502552.750	423968.484	12343.156	72.3217
5	4313.205	46374.670	96206.079	838.841	29.6596
6	7473.1042	2683.7666	8804.9916	586.3817	28.5648
7	1859.1427	513.3047	1684.0672	292.4825	-0.0582
8	134.8554	142.5031	467.5290	28.3438	-0.0920
9	224399.959	224399.984	-0.024	-0.042	-0.002
10	-457.317	-457.850	0.038	18.044	-0.351
11	-723.094	-723.103	0.013	-33.469	1.034
12	22.3128	-0.0819	0.0000	104004.681	0.1700
13	-3.7478	-0.0007	0.0000	2634202.906	-0.4632
14	0.0000	0.0000	0.0000	2635899.438	0.0000
15	-67.5168	-0.0830	0.0000	-0.0054	0.0817
16	-4.2110	-0.0010	0.0000	-0.0817	0.0007
17	0.0000	0.0000	0.0000	-0.0007	0.0000
18	16.0264	13.7023	13.6651	-0.1846	-0.0003
19	74.1242	76.5737	76.5358	0.1169	-0.0003
20	425.0622	425.2140	-527.9227	-521.5684	221741.613
21	0.0002	4.3915	0.0000	1280.0221	680.000
22	78.3166	29.1413	28.9814	-30.8656	-0.0408
23	9.6829	9.1810	-3.1301	-0.0238	7702.070
24	245.0500	476.4705	4.5883	-1719118.578	2386.2126
25	115.5148	271.0000	0.0020	6279042.375	1327.6449
26	0.0000	0.1005	0.0113	848.517	-12.1621
27	118.9280			0.0000	0.0000
28	22.4832	0.0000	353.6083	156200.3730	29616.9807
29	-4.2110	0.0000	-0.5187		
30	0.0000	0.0000	-0.8182		
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1	235.0000	250112.865	224525.867	461634.957	788937.531
2	9081.8583	7802.1676	21370813.50	20909180.50	2.1618
3	805755.211	335486.777	1118852.094	26087.806	921189.008
4	446456.023	6505042.813	432137.887	13846.503	72.3568
5	5017.400	47093.278	98563.711	987.348	28.9896
6	7598.3323	2721.8877	8930.0605	626.8896	28.8823
7	1765.6710	482.7063	1583.6791	308.8370	-0.0591
8	146.8741	144.9456	475.5422	31.0638	-0.0939
9	224524.186	224524.207	-0.020	-0.205	-0.002
10	-459.501	-460.075	0.033	4.934	-0.284
11	-729.988	-730.001	0.010	-76.142	0.898
12	21.8871	-0.0893	0.0000	103999.139	0.1601
13	-3.7480	0.0004	0.0000	2630540.469	-0.4657
14	0.0000	0.0000	0.0000	2632239.531	0.0000
15	-67.9524	-0.0917	0.0000	-0.0058	0.0892
16	-4.2137	-0.0002	0.0000	-0.0892	-0.0004
17	0.0000	0.0000	0.0000	0.0004	0.0000
18	15.2378	13.0495	13.0125	-0.1863	-0.0003
19	74.2516	76.6478	76.6118	0.1174	-0.0001
20	425.1875	425.2088	-528.0592	-521.9380	221898.166
21	0.0002	4.2619	0.0000	1394.6087	680.000
22	78.2065	29.1687	29.0087	-30.8354	-0.0408
23	10.1194	9.6615	-3.0673	-0.0198	7802.168
24	239.8000	471.7967	4.5879	-1704320.797	2434.7051
25	115.7338	271.0000	0.0021	6286346.750	1308.7626
26	0.0000	0.0600	0.0113	785.782	-11.7373
27	119.2870			0.0000	0.0000
28	22.0476	0.0000	354.0058	153963.4492	29213.9361
29	-4.2137	0.0000	-0.5240		
30	0.0000	0.0000	-0.8261		
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1	240.0000	247474.141	224349.584	471698.953	826068.328
2	9190.0171	7905.6640	21380849.75	20909151.75	2.2636
3	844063.141	349192.441	1163818.094	29324.714	958929.820
4	455050.375	6507379.625	439804.660	15431.288	72.3925
5	5782.210	47824.156	100961.601	1149.525	28.3294
6	7725.1875	2760.4787	9036.6710	667.9625	29.1674
7	1672.0342	452.0144	1482.9839	325.0481	-0.0605
8	159.0741	147.4100	483.6278	33.8106	-0.0956
9	224347.873	224347.891	-0.017	-0.064	-0.002
10	-465.283	-465.891	0.029	-1.214	-0.235
11	-735.603	-735.616	0.009	-29.916	0.793
12	21.4222	-0.0957	0.0000	103993.589	0.1548
13	-3.7452	0.0006	0.0000	2626808.344	-0.4694
14	0.0000	0.0000	0.0000	2628509.938	0.0000
15	-68.4227	-0.0963	0.0000	-0.0063	0.0955
16	-4.2146	-0.0005	0.0000	-0.0955	-0.0006
17	0.0000	0.0000	0.0000	0.0006	0.0000
18	14.4699	12.4127	12.3759	-0.1879	-0.0003
19	74.3787	76.7226	76.6884	0.1190	0.0003
20	425.7583	425.2190	-526.9372	-522.2537	222039.713
21	0.0002	4.1570	0.0000	1505.0391	680.000
22	78.0945	29.1962	29.0363	-30.8064	-0.0407
23	10.5038	10.0837	-3.0027	-0.0168	7905.664
24	234.5500	466.8733	4.5876	-1689198.109	2483.7240
25	115.8557	271.0000	0.0020	6293964.938	1289.8916
26	0.0000	0.0326	0.0114	725.269	-11.3166
27	119.6357			0.0000	0.0000
28	21.5773	0.0000	354.4223	151727.8926	28810.8218
29	-4.2146	0.0000	-0.5293		
30	0.0000	0.0000	-0.8342		
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1	245.0000	244840.734	224224.703	481389.172	863806.547
2	9301.0997	8012.3882	21390510.50	20909122.75	2.3670
3	883009.164	363092.152	1209420.734	32768.312	997135.969
4	463175.766	6509562.688	446966.840	17096.660	72.4288
5	6608.430	48567.401	103400.063	1325.493	27.6782
6	7853.5745	2799.5095	9184.7247	709.5709	29.4647
7	1578.0808	421.1825	1381.8298	341.0705	-0.0620
8	171.4456	149.8932	491.7746	36.5810	-0.0974
9	224222.965	224222.980	-0.015	0.105	-0.002
10	-471.448	-472.060	0.026	-1.615	-0.198
11	-741.171	-741.178	0.007	21.504	0.710
12	20.9386	-0.0967	0.0000	103988.026	0.1576
13	-3.7437	0.0001	0.0000	2622949.500	-0.4739
14	-0.0000	-0.0000	0.0000	2624633.656	0.0000
15	-68.9034	-0.0939	0.0000	-0.0063	0.0965
16	-4.2177	-0.0007	0.0000	-0.0965	-0.0001
17	0.0000	0.0000	0.0000	0.0001	0.0000
18	13.7220	11.7911	11.7545	-0.1894	-0.0004
19	74.5054	76.7981	76.7656	0.1206	0.0002
20	425.9414	425.2516	-526.4174	-522.4820	222155.609
21	0.0001	4.0717	0.0000	1611.3682	680.000
22	77.9805	29.2241	29.0641	-30.7785	-0.0406
23	10.8565	10.4688	-2.9405	-0.0146	8012.388
24	229.3000	461.8773	4.5872	-1673817.953	2533.2377
25	115.9460	271.0000	0.0020	6301277.500	1270.9938
26	0.0000	0.0339	0.0115	666.946	-10.9023
27	119.9751			0.0000	0.0000
28	21.0966	0.0000	354.8740	149497.5273	28407.8142
29	-4.2177	0.0000	-0.5348		
30	0.0000	0.0000	-0.8424		
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1	250.0000	242209.773	224100.508	490705.914	902161.258
2	9415.1527	8122.3735	21399798.25	20909093.75	2.4721
3	922601.117	377188.172	1255667.422	36421.349	1035823.273
4	470830.551	6511591.188	453622.066	18841.668	72.4656
5	7496.950	49323.116	105879.438	1515.380	27.0358
6	7983.5718	2839.0042	9314.3002	751.7400	29.7682
7	1483.8051	390.2081	1280.2078	356.9032	-0.0634
8	184.0003	152.3981	499.9927	39.3781	-0.0992
9	224098.740	224098.754	-0.013	0.235	-0.001
10	-476.942	-477.516	0.024	1.768	-0.170
11	-746.578	-746.586	0.006	58.546	0.646
12	20.4683	-0.0909	0.0000	103982.457	0.1695
13	-3.7431	0.0002	0.0000	2619022.438	-0.4775
14	0.0000	-0.0000	0.0000	2620729.188	0.0000
15	-69.3618	-0.0895	0.0000	-0.0059	0.0907
16	-4.2207	-0.0005	0.0000	-0.0907	-0.0002
17	0.0000	0.0000	0.0000	0.0002	0.0000
18	12.9939	11.1848	11.1484	-0.1909	-0.0003
19	74.6318	76.8742	76.8434	0.1221	-0.0000
20	426.0778	425.2887	-525.9574	-522.6637	222253.994
21	0.0001	4.0026	0.0000	1713.5991	680.000
22	77.8646	29.2521	29.0921	-30.7518	-0.0406
23	11.2074	10.8490	-2.8801	-0.0128	8122.374
24	225.8000	458.6224	4.5870	-1663534.109	2566.5138
25	116.0309	271.0000	0.0020	6306063.938	1258.4279
26	0.0000	0.0491	0.0115	629.269	-10.6286
27	120.3057			0.0000	0.0000
28	20.6382	0.0000	355.3446	147269.5293	28004.8845
29	-4.2207	0.0000	-0.5404		
30	0.0000	0.0000	-0.8508		
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1	265.0000	234308.962	224535.936	516448.293	1021021.883
2	9775.7717	8472.4213	21425450.75	20909004.75	2.7978
3	1045337.531	420678.605	1398352.297	48666.497	1154937.844
4	490958.633	6516743.438	470525.836	24546.042	72.5780
5	10545.893	51666.239	113566.836	2169.962	25.1567
6	8384.0952	2960.5380	9713.0322	881.8915	30.8318
7	1199.6756	296.6113	973.1323	403.4575	-0.0666
8	222.8235	160.0559	525.1167	47.9432	-0.1052
9	224534.090	224534.100	-0.010	-0.129	-0.001
10	-485.171	-485.758	0.020	-0.945	-0.120
11	-766.487	-766.498	0.004	-48.423	0.536
12	19.1436	-0.0928	0.0000	103965.677	0.1715
13	-3.7319	0.0010	0.0000	2606536.625	-0.4881
14	0.0000	0.0000	0.0000	2608251.094	0.0000
15	-70.6844	-0.0937	0.0000	-0.0060	0.0926
16	-4.2200	0.0002	0.0000	-0.0926	-0.0010
17	0.0000	0.0000	0.0000	0.0010	0.0000
18	10.9334	9.4612	9.4255	-0.1956	-0.0003
19	75.0099	77.1068	77.0808	0.1240	0.0001
20	425.9673	425.3660	-527.1158	-523.1841	222519.824
21	0.0001	3.9348	0.0000	1929.3418	680.489
22	77.5047	29.3377	29.1776	-30.6779	-0.0405
23	12.2453	11.9622	-2.6955	-0.0097	8472.422
24	210.0300	443.9952	4.5862	-1616939.016	2719.0890
25	116.3958	271.0000	0.0024	6326735.750	1202.4810
26	0.0000	0.0144	0.0117	471.424	-9.4236
27	121.2512			0.0000	0.0000
28	19.3156	0.0000	356.9512	140577.8496	26795.8022
29	-4.2200	0.0000	-0.5579		
30	0.0000	0.0000	-0.8771		
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1	255.0000	239578.234	224280.043	499652.992	941141.906
2	9532.2303	8235.6711	21408715.25	20909064.25	2.5789
3	962847.203	391482.859	1302565.906	40286.668	1075007.969
4	478013.238	6513464.500	459768.121	20665.403	72.5027
5	8448.706	50091.412	108400.089	1719.321	26.4016
6	8115.2617	2878.9879	9445.4801	794.4963	30.1193
7	1389.2807	359.1126	1178.1885	372.5687	-0.0644
8	196.7459	154.9265	508.2881	42.2038	-0.1011
9	224278.252	224278.264	-0.012	0.129	-0.001
10	-479.647	-480.197	0.022	10.576	-0.150
11	-752.820	-752.829	0.006	21.482	0.602
12	20.0258	-0.0867	0.0000	103976.874	0.1773
13	-3.7417	0.0005	0.0000	2614959.156	-0.4807
14	-0.0000	-0.0000	0.0000	2616668.469	0.0000
15	-69.7965	-0.0839	0.0000	-0.0057	0.0866
16	-4.2223	0.0000	0.0000	-0.0866	-0.0005
17	0.0000	0.0000	0.0000	0.0005	0.0000
18	12.2863	10.3942	10.5580	-0.1923	-0.0003
19	74.7580	76.9510	76.9219	0.1227	0.0001
20	425.7838	425.3183	-526.7421	-522.8339	222343.332
21	0.0001	3.9697	0.0000	1791.1229	680.228
22	77.7467	29.2804	29.1204	-30.7261	-0.0406
23	11.5693	11.2382	-2.8198	-0.0116	8235.671
24	220.5500	453.8282	4.5867	-1648118.844	2616.8255
25	116.1857	271.0000	0.0022	6313096.125	1239.6711
26	0.0000	0.0536	0.0116	574.538	-10.2215
27	120.6282			0.0000	0.0000
28	20.2035	0.0000	355.8530	145040.9668	27601.9485
29	-4.2223	0.0000	-0.5461		
30	0.0000	0.0000	-0.8594		
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1	270.0000	231674.521	224352.434	524302.914	1061941.984
2	9902.1353	8595.7611	21433275.25	20908974.50	2.9099
3	1087599.938	435584.941	1447257.500	53187.309	1195717.156
4	496719.004	6518147.938	475133.734	26601.370	72.6160
5	11693.190	52473.001	116213.688	2416.945	24.5454
6	8521.2395	3002.1035	9849.4019	926.5331	31.1569
7	1104.4548	265.1616	869.9511	418.6397	-0.0681
8	236.1504	162.6542	533.6412	50.8545	-0.1073
9	224350.557	224350.566	-0.009	-0.030	-0.001
10	-490.407	-491.015	0.019	-5.302	-0.108
11	-772.275	-772.284	0.004	-17.140	0.509
12	18.6692	-0.0964	0.0000	103960.063	0.1698
13	-3.7273	0.0008	0.0000	2602170.344	-0.4926
14	0.0000	0.0000	0.0000	2603887.344	0.0000
15	-71.1606	-0.0964	0.0000	-0.0063	0.0962
16	-4.2199	-0.0005	0.0000	-0.0962	-0.0008
17	0.0000	0.0000	0.0000	0.0008	0.0000
18	10.2873	8.9181	8.8826	-0.1972	-0.0004
19	75.1356	77.1858	77.1614	0.1254	0.0002
20	426.3892	425.3963	-526.1637	-523.3353	222001.100
21	0.0001	3.9268	0.0000	1993.9823	680.549
22	77.3806	29.3667	29.2065	-30.6555	-0.0404
23	12.5267	12.2633	-2.6355	-0.0090	8595.761
24	204.8000	438.8010	4.5860	-1600914.609	2771.1102
25	116.4018	271.0000	0.0023	6333410.000	1183.9082
26	0.0000	-0.0031	0.0117	422.971	-9.0360
27	121.5526			0.0000	0.0000
28	18.8394	0.0000	357.5425	138346.5527	26392.7571
29	-4.2199	0.0000	-0.5639		
30	0.0000	0.0000	-0.8862		
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1	260.0000	236944.031	224408.326	508232.711	980758.641
2	9652.4557	8352.3695	21417265.25	20909034.75	2.6875
3	1003756.320	405978.793	1350124.656	44367.341	1114707.156
4	484722.879	6515182.125	465403.285	22567.107	72.5402
5	9464.673	50872.414	110962.426	1937.467	25.7753
6	8248.7673	2919.4986	9578.3890	837.8791	30.4716
7	1294.5830	327.9175	1075.8428	388.0903	-0.0653
8	209.6886	157.4798	516.6649	45.0595	-0.1032
9	224406.310	224406.521	-0.011	-0.106	-0.001
10	-481.020	-481.573	0.021	0.977	-0.139
11	-759.789	-759.801	0.005	-42.407	0.566
12	19.5934	-0.0872	0.0000	103971.283	0.1773
13	-3.7372	0.0011	0.0000	2610822.531	-0.4840
14	0.0000	0.0000	0.0000	2612534.438	0.0000
15	-70.2288	-0.0880	0.0000	-0.0057	0.0871
16	-4.2212	0.0003	0.0000	-0.0871	-0.0011
17	0.0000	0.0000	0.0000	0.0011	0.0000
18	11.5995	10.0197	9.9838	-0.1940	-0.0003
19	74.8840	77.0285	77.0010	0.1230	-0.0000
20	425.8771	425.3412	-526.9279	-523.0127	222432.656
21	0.0001	3.9488	0.0000	1861.7307	680.384
22	77.6267	29.3090	29.1489	-30.7015	-0.0405
23	11.9241	11.6185	-2.7575	-0.0106	8352.370
24	215.3000	449.0146	4.5865	-1632652.859	2667.6699
25	116.3279	271.0000	0.0024	6319969.563	1221.0507
26	0.0000	0.0403	0.0116	521.933	-9.8190
27	120.9432			0.0000	0.0000
28	19.7712	0.0000	356.3818	142809.8535	27198.8950
29	-4.2212	0.0000	-0.5519		
30	0.0000	0.0000	-0.8681		
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1	275.0000	229044.441	224238.943	531798.930	1103529.219
2	10031.3961	8722.2235	21440741.25	20908944.25	3.0239
3	1130552.313	450700.320	1496848.531	57932.804	1237061.297
4	502002.281	6519394.750	479224.246	28732.060	72.6541
5	12907.649	53292.807	118903.333	2678.549	23.9414
6	8660.0908	3044.1611	9987.3859	971.7706	31.4987
7	1008.8001	233.5316	766.1784	433.6011	-0.0697
8	249.6662	165.2734	542.2346	53.7922	-0.1093
9	224237.031	224237.041	-0.009	0.130	-0.001
10	-496.412	-497.019	0.018	-1.333	-0.100
11	-777.964	-777.968	0.004	26.525	0.489
12	18.1855	-0.0962	0.0000	103954.432	0.1746
13	-3.7257	0.0001	0.0000	2597652.625	-0.4975
14	0.0000	-0.0000	0.0000	2599372.219	0.0000
15	-71.6395	-0.0934	0.0000	-0.0062	0.0959
16	-4.2231	-0.0007	0.0000	-0.0959	-0.0001
17	0.0000	0.0000	0.0000	0.0001	0.0000
18	9.6604	8.3898	8.3545	-0.1988	-0.0003
19	75.2612	77.2636	77.2426	0.1270	0.0004
20	426.4214	425.4360	-525.8578	-523.4407	222667.783
21	0.0001	3.9424	0.0000	2036.8377	680.432
22	77.2544	29.3939	29.2357	-30.6341	-0.0404
23	12.7840	12.5376	-2.5796	-0.0085	8722.224
24	199.5500	433.5665	4.5857	-1584623.313	2823.6963
25	116.3936	271.0000	0.0023	6339980.000	1165.2935
26	0.0000	0.0016	0.0118	376.534	-8.6555
27	121.8478			0.0000	0.0000
28	18.3605	0.0000	358.1746	136119.3262	25989.9382
29	-4.2231	0.0000	-0.5702		
30	0.0000	0.0000	-0.8956		
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TABLE AP 3-2 (Sheet 6 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	280.0000	226415.902	224099.504	538939.555	1145793.781
2	10163.6168	8851.8599	21447851.00	20908913.25	3.1397
3	1174203.375	466027.273	1547133.719	62906.044	1278986.547
4	506806.199	6520482.936	482794.430	30937.008	72.6924
5	14190.177	54125.769	121636.145	2954.918	23.3443
6	8800.7383	3086.7380	10127.0735	1017.6326	31.8446
7	912.7205	201.7230	661.8195	448.3444	-0.0713
8	263.3866	167.9178	550.9102	56.7605	-0.1114
9	224097.561	224097.570	-0.008	0.216	-0.001
10	-501.469	-502.039	0.018	-0.553	-0.092
11	-783.739	-783.743	0.003	50.903	0.473
12	17.7190	-0.0900	0.0000	103948.793	0.1866
13	-3.7253	0.0001	0.0000	2593053.344	-0.5014
14	-0.0000	-0.0000	0.0000	2594775.563	0.0000
15	-72.0940	-0.0872	0.0000	-0.0058	0.0898
16	-4.2267	-0.0006	0.0000	-0.0898	-0.0001
17	0.0000	0.0000	0.0000	0.0001	0.0000
18	9.0527	7.8763	7.8412	-0.2004	-0.0004
19	75.3869	77.3462	77.3247	0.1284	-0.0002
20	426.4345	425.4741	-525.5146	-523.5264	222725.174
21	0.0001	3.9631	0.0000	2076.0141	680.277
22	77.1259	29.4253	29.2651	-30.6137	-0.0404
23	13.0425	12.8117	-2.5261	-0.0081	8851.860
24	194.3000	428.4839	4.5855	-1568250.953	2876.8429
25	116.4334	271.0000	0.0023	6346399.188	1146.7314
26	0.0000	0.0182	0.0119	332.081	-8.2791
27	122.1373			0.0000	0.0000
28	17.9060	0.0000	358.8286	133893.5273	25587.2288
29	-4.2267	0.0000	-0.5765		
30	0.0000	0.0000	-0.9052		
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1	285.0000	223790.043	223817.721	545727.945	1188746.000
2	10298.6478	8984.3099	21454608.00	20908882.50	3.2574
3	1218561.906	481568.332	1598121.344	68110.066	1321509.141
4	511128.637	6521411.625	485841.348	33215.131	72.7307
5	15541.799	54972.012	124412.526	3246.200	22.7540
6	8943.0588	3129.7965	10268.3413	1064.0830	32.1777
7	816.2235	169.7379	556.8819	462.8734	-0.0723
8	277.3653	170.5852	559.6617	59.7576	-0.1134
9	223815.750	223815.758	-0.008	0.162	-0.001
10	-504.385	-504.927	0.017	0.387	-0.086
11	-789.066	-789.069	0.003	34.948	0.460
12	17.2812	-0.0834	0.0000	103943.137	0.1937
13	-3.7249	-0.0001	0.0000	2588290.281	-0.5057
14	0.0000	-0.0000	0.0000	2590015.094	0.0000
15	-72.5226	-0.0844	0.0000	-0.0055	0.0852
16	-4.2306	-0.0008	0.0000	-0.0852	0.0001
17	0.0000	0.0000	0.0000	-0.0001	0.0000
18	8.4643	7.3777	7.3428	-0.2020	-0.0003
19	75.5126	77.4278	77.4076	0.1293	0.0001
20	426.3111	425.5041	-525.0057	-523.5862	222767.211
21	0.0001	3.9869	0.0000	2113.2581	680.098
22	76.9953	29.4550	29.2947	-30.5943	-0.0404
23	13.3132	13.0973	-2.4735	-0.0077	8984.310
24	190.8000	425.1652	4.5854	-1557306.469	2912.5596
25	116.4813	271.0000	0.0026	6350591.313	1134.3875
26	0.0000	0.0238	0.0120	303.539	-8.0305
27	122.4214			0.0000	0.0000
28	17.4774	0.0000	359.5266	131668.9590	25185.9744
29	-4.2306	0.0000	-0.5830		
30	0.0000	0.0000	-0.9150		
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1	290.0000	221163.839	224007.660	532165.563	1232396.141
2	10436.6859	9120.3624	21461014.75	20908851.25	3.3770
3	1263636.609	497325.996	1649819.609	73547.929	1364643.188
4	514967.758	6522180.063	488362.348	35565.425	72.7691
5	16963.544	55831.663	127232.896	3552.550	22.1705
6	9087.2789	3173.4054	10411.4149	1111.1911	32.5874
7	719.3648	137.3918	451.4156	477.2041	-0.0765
8	291.3555	173.2544	568.4188	62.7620	-0.1141
9	224005.650	224005.658	-0.007	2.027	-0.001
10	-526.038	-527.419	0.017	251.338	-0.069
11	-784.570	-786.077	0.003	401.935	0.442
12	16.6531	-0.2209	0.0000	103937.473	0.4155
13	-3.3792	0.2432	0.0000	2383439.000	-0.8511
14	0.0000	-0.0002	0.0000	2385166.406	0.0000
15	-72.9306	-0.0806	0.0000	-0.0130	0.2205
16	-4.2303	0.0019	0.0000	-0.2205	-0.2432
17	0.0000	0.0000	0.0000	0.2432	0.0000
18	7.8952	6.8942	6.8595	-0.2011	-0.0559
19	75.6379	77.5098	77.4909	0.1349	0.0328
20	425.9442	425.3286	-525.9038	-523.6441	222805.302
21	0.0001	4.0138	0.0000	2148.5775	680.000
22	76.8625	29.4849	29.3246	-30.5760	-0.0403
23	13.3238	13.1719	-2.0782	-0.0073	9120.363
24	185.5500	420.3222	4.5852	-1540834.094	2966.5939
25	116.5936	271.0000	0.0029	6356752.000	1115.9597
26	0.0000	0.0421	0.0121	262.358	-7.6500
27	122.7004			0.0000	0.0000
28	17.0694	0.0000	360.2483	129444.0732	24784.7151
29	-4.2303	0.0000	-0.5897		
30	0.0000	0.0000	-0.9250		
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1	295.0000	218533.752	224116.764	558255.406	1276757.094
2	10578.1311	9259.8477	21467072.25	20908819.75	3.4986
3	1309438.719	513303.539	1702239.266	79223.414	1408412.109
4	518319.605	6522786.625	490352.520	37986.219	72.8073
5	18451.548	56703.320	130092.660	3872.603	21.5933
6	9233.9829	3217.7327	10556.8452	1159.1274	32.9956
7	621.3104	105.0294	344.5841	491.0831	-0.0776
8	303.8337	175.4023	575.4657	65.2512	-0.1261
9	224114.504	224114.512	-0.007	-1.397	-0.001
10	-527.349	-527.264	0.016	-1136.179	-0.063
11	-856.195	-854.797	0.002	331.021	0.433
12	16.1852	0.0164	0.0000	103931.788	0.6709
13	-3.3046	-0.2237	0.0000	2578398.250	-1.2532
14	-0.0000	-0.0001	0.0000	2580128.250	0.0000
15	-73.1423	-0.0365	0.0000	0.0009	-0.0164
16	-4.5578	-0.0801	0.0000	0.0164	0.2257
17	0.0000	0.0000	0.0000	-0.2257	0.0000
18	7.3399	6.4211	6.3866	-0.2185	0.0363
19	75.7521	77.5828	77.5652	0.1348	-0.0148
20	425.9696	425.5431	-526.1280	-523.7247	222848.160
21	0.0001	4.0466	0.0000	2181.1432	680.000
22	76.7273	29.5151	29.3547	-30.5587	-0.0403
23	13.5310	13.3977	-1.9659	-0.0071	9259.848
24	180.3000	415.5045	4.5851	-1524295.688	3021.4232
25	116.7054	271.0000	0.0066	6362760.000	1097.4527
26	0.0000	0.0306	0.0182	222.171	-7.7904
27	122.9746			0.0000	0.0000
28	16.8577	0.0000	361.0178	127215.5479	24383.1702
29	-4.5578	0.0000	-0.5965		
30	0.0000	0.0000	-0.9353		
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1	300.0000	215902.529	224226.010	563998.320	1321840.813
2	10722.4667	9402.3481	21472784.25	20908788.00	3.6221
3	1355978.563	529503.953	1755390.125	85140.118	1452827.656
4	521182.180	6523230.625	491809.102	40476.493	72.8453
5	20006.532	57587.026	132991.951	4206.424	21.0226
6	9382.3440	3262.5474	10703.8748	1207.6625	33.4141
7	523.7945	72.5765	238.1115	505.0368	-0.0722
8	318.4567	178.1669	584.5359	68.3625	-0.1077
9	224224.309	224224.316	-0.007	1.879	-0.001
10	-484.699	-485.311	0.016	1905.779	-0.074
11	-722.614	-723.190	0.003	-700.047	0.435
12	16.0249	-0.0958	0.0000	103926.093	0.4955
13	-3.7772	0.0919	0.0000	2573255.469	-0.8703
14	0.0000	0.0002	0.0000	2574988.094	0.0000
15	-73.4783	-0.0862	0.0000	-0.0063	0.0956
16	-4.6476	0.0142	0.0000	-0.0956	-0.0919
17	0.0000	0.0000	0.0000	0.0919	0.0000
18	6.8095	5.9679	5.9336	-0.1848	-0.0226
19	75.8788	77.6675	77.6512	0.1240	0.0058
20	425.9965	425.5576	-526.3525	-523.8074	222891.648
21	0.0001	4.0863	0.0000	2203.1988	680.000
22	76.5899	29.5454	29.3850	-30.5424	-0.0403
23	14.1007	13.9127	-2.3875	-0.0069	9402.348
24	175.0500	410.4586	4.5849	-1507424.813	3076.8306
25	116.7454	271.0000	0.0077	6368678.750	1079.1001
26	0.0000	0.0097	0.0186	181.521	-7.5477
27	123.2443			0.0000	0.0000
28	16.5217	0.0000	361.8132	124986.0645	23981.4670
29	-4.6476	0.0000	-0.6035		
30	0.0000	0.0000	-0.9458		
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1	305.0000	213270.811	224141.859	569403.781	1367658.031
2	10869.8903	9548.1139	21478157.75	20908756.00	3.7477
3	1403265.344	545929.922	1809281.016	91301.252	1497909.406
4	523556.797	6523512.125	492732.645	43036.246	72.8833
5	21634.910	58484.564	135936.625	4555.830	20.4582
6	9532.7977	3307.9703	10852.8998	1256.9188	33.8136
7	426.0141	39.9895	131.1989	518.8231	-0.0805
8	332.8092	180.8089	593.2038	71.3579	-0.1343
9	224139.445	224139.453	-0.007	-2.732	-0.001
10	-533.391	-533.920	0.016	-1623.156	-0.063
11	-890.439	-890.037	0.002	269.919	0.428
12	15.5351	-0.0823	0.0000	103920.377	0.5628
13	-3.5356	-0.0649	0.0000	2567910.906	-1.1762
14	-0.0000	-0.0001	0.0000	2569646.156	0.0000
15	-73.9007	-0.0829	0.0000	-0.0051	0.0822
16	-4.7118	-0.0308	0.0000	-0.0822	0.0649
17	0.0000	0.0000	0.0000	-0.0649	0.0000
18	6.2985	5.5301	5.4960	-0.2275	0.0116
19	76.0028	77.7506	77.7354	0.1365	-0.0015
20	425.4319	425.5736	-525.6160	-523.8880	222934.994
21	0.0001	4.1302	0.0000	2223.9584	680.000
22	76.4501	29.5760	29.4155	-30.5270	-0.0403
23	14.2182	14.0744	-2.1010	-0.0067	9548.114
24	169.8000	405.2275	4.5848	-1490166.516	3132.8852
25	116.7282	271.0000	0.0083	6374321.438	1060.8109
26	0.0000	-0.0105	0.0205	142.766	-7.2894
27	123.5097			0.0000	0.0000
28	16.0993	0.0000	362.6582	122756.2207	23579.6353
29	-4.7118	0.0000	-0.6106		
30	0.0000	0.0000	-0.9566		
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TABLE AP 3-2 (Sheet 7 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	310.0000	210642.803	224143.527	574474.375	1414220.781
2	11020.2856	9696.9865	21483196.25	20908723.75	3.8753
3	1451309.313	562584.445	1863921.734	97710.392	1543674.563
4	525441.438	6523630.188	493120.004	45664.354	72.9212
5	23336.072	59395.504	138925.268	4920.417	19.9002
6	9685.1986	3353.9591	11003.7816	1306.8357	34.2358
7	327.8097	7.2180	23.6812	532.3924	-0.0791
8	347.8726	183.6270	602.4496	74.5349	-0.1163
9	224141.625	224141.633	-0.007	2.620	-0.001
10	-518.129	-518.760	0.016	1357.222	-0.068
11	-761.141	-761.262	0.003	-163.078	0.425
12	15.1286	-0.0889	0.0000	103914.651	0.5385
13	-3.8050	0.0189	0.0000	2362457.656	-0.9633
14	0.0000	0.0000	0.0000	2364195.531	0.0000
15	-74.3314	-0.0893	0.0000	-0.0059	0.0887
16	-4.7683	0.0080	0.0000	-0.0887	-0.0189
17	0.0000	0.0000	0.0000	0.0189	0.0000
18	5.8059	5.1068	5.0729	-0.1946	-0.0057
19	76.1300	77.8373	77.8233	0.1326	0.0007
20	426.4819	425.6002	-525.5596	-523.9407	222972.002
21	0.0001	4.1763	0.0000	2243.4319	680.000
22	76.3078	29.6049	29.4463	-30.5126	-0.0403
23	14.4801	14.3078	-2.3230	-0.0065	9696.987
24	164.5500	399.9133	4.5846	-1472575.922	3189.6127
25	116.6867	271.0000	0.0086	6380273.500	1042.4809
26	0.0000	-0.0130	0.0207	105.185	-6.9614
27	123.7711			0.0000	0.0000
28	15.6686	0.0000	363.5299	120530.0049	23177.8801
29	-4.7683	0.0000	-0.6180		
30	0.0000	0.0000	-0.9676		
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1	325.0000	202760.418	224085.443	587717.297	1558505.406
2	11490.2015	10163.1393	21496340.75	20908625.25	4.2706
3	1600089.500	613949.906	2032443.234	118462.189	1685243.859
4	528134.406	6522994.730	491035.195	53948.169	73.0348
5	28901.141	62214.351	148173.436	6111.198	18.2635
6	10155.4319	3495.7212	11468.8792	1461.1645	35.5575
7	30.5397	-92.2480	-302.6503	571.7641	-0.0858
8	394.5538	192.2831	630.8490	84.3064	-0.1369
9	224083.119	224083.127	-0.006	-0.849	-0.001
10	-540.906	-541.479	0.016	-429.411	-0.058
11	-862.475	-862.507	0.002	37.817	0.417
12	13.7902	-0.0884	0.0000	103897.363	0.5677
13	-3.7068	0.0048	0.0000	2344981.344	-1.0948
14	-0.0000	-0.0000	0.0000	2346727.136	0.0000
15	-75.6406	-0.0859	0.0000	-0.0057	0.0882
16	-4.8015	-0.0032	0.0000	-0.0882	-0.0048
17	0.0000	0.0000	0.0000	0.0048	0.0000
18	4.4355	3.9224	3.8892	-0.2205	-0.0006
19	76.5142	78.1040	78.0933	0.1384	0.0004
20	426.6606	425.6897	-525.2023	-524.0716	223076.313
21	0.0001	4.3283	0.0000	2294.2912	680.000
22	75.8664	29.7007	29.5399	-30.4751	-0.0403
23	14.9203	14.7859	-2.0896	-0.0062	10163.140
24	150.5500	385.8737	4.5843	-1424594.906	3344.3458
25	116.6107	271.0000	0.0093	6395037.750	993.8063
26	0.0000	-0.0069	0.0217	14.385	-6.0000
27	124.5333			0.0000	0.0000
28	14.3594	0.0000	366.4099	113857.0938	21968.5344
29	-4.8015	0.0000	-0.6411		
30	0.0000	0.0000	-1.0024		
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1	315.0000	208014.434	224252.578	579214.430	1461341.078
2	11173.8655	9849.1831	21487903.50	20908691.00	4.0049
3	1500120.734	579470.500	1919322.063	104371.090	1590140.391
4	526834.242	6523583.938	492968.387	48359.811	72.9591
5	25113.813	60320.799	141961.006	5301.171	19.3483
6	9839.8187	3400.5984	11136.7874	1357.5536	34.6852
7	229.2099	-25.7306	-84.4178	545.7530	-0.0827
8	363.1496	186.4684	611.7717	77.7419	-0.1351
9	224250.230	224250.238	-0.006	-1.876	-0.001
10	-534.395	-534.972	0.016	-951.485	-0.061
11	-873.271	-873.222	0.002	88.701	0.421
12	14.6694	-0.0894	0.0000	103908.903	0.5369
13	-3.6549	-0.0083	0.0000	2356788.781	-1.1159
14	0.0000	-0.0000	0.0000	2358529.281	0.0000
15	-74.7722	-0.0863	0.0000	-0.0057	0.0893
16	-4.7708	-0.0121	0.0000	-0.0893	0.0083
17	0.0000	0.0000	0.0000	-0.0083	0.0000
18	5.3316	4.6980	4.6644	-0.2231	0.0040
19	76.2574	77.9249	77.9120	0.1367	0.0001
20	426.6637	425.6316	-525.5901	-523.9924	223011.043
21	0.0001	4.2248	0.0000	2261.6361	680.000
22	76.1632	29.6379	29.4773	-30.4992	-0.0403
23	14.6112	14.4684	-2.1271	-0.0064	9849.185
24	159.3000	394.6548	4.5845	-1454777.938	3247.0506
25	116.6596	271.0000	0.0089	6385905.375	1024.2151
26	0.0000	-0.0086	0.0214	69.660	-6.6063
27	124.0287			0.0000	0.0000
28	15.2278	0.0000	364.4529	118304.8428	22774.7158
29	-4.7708	0.0000	-0.6255		
30	0.0000	0.0000	-0.9789		
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1	330.0000	200134.861	224002.146	591489.063	1608174.594
2	11652.9847	10324.9075	21500078.50	20908592.00	4.4067
3	1651268.234	631549.469	2090184.469	125900.021	1733916.016
4	528037.070	6522449.625	489246.766	56838.693	73.0725
5	30913.857	63183.094	151351.721	6541.023	17.7301
6	10316.5054	3544.2345	11628.0435	1514.1006	36.0106
7	-69.5522	-125.8232	-412.8116	584.4078	-0.0876
8	410.6047	195.2319	640.5233	87.6398	-0.1347
9	223999.906	223999.914	-0.006	0.781	-0.001
10	-544.722	-545.273	0.016	266.909	-0.057
11	-837.746	-837.714	0.002	23.467	0.416
12	13.3592	-0.0844	0.0000	103891.569	0.5780
13	-3.7465	-0.0054	0.0000	2538831.094	-1.0736
14	-0.0000	-0.0000	0.0000	2540579.563	0.0000
15	-76.0612	-0.0830	0.0000	-0.0055	0.0842
16	-4.8201	-0.0011	0.0000	-0.0842	0.0054
17	0.0000	0.0000	0.0000	-0.0054	0.0000
18	4.0132	3.5552	3.5223	-0.2143	0.0003
19	76.6432	78.1952	78.1854	0.1395	0.0002
20	426.6591	425.7163	-525.0091	-524.1000	223102.801
21	0.0001	4.3834	0.0000	2308.7766	680.000
22	75.7142	29.7324	29.5715	-30.4644	-0.0403
23	15.0633	14.9309	-2.0863	-0.0062	10324.908
24	145.3000	380.6898	4.5842	-1406199.859	3403.6774
25	116.6045	271.0000	0.0095	6400358.250	975.5982
26	0.0000	0.0002	0.0221	-16.234	-5.6583
27	124.7806			0.0000	0.0000
28	13.9388	0.0000	367.4463	111634.4854	21565.6287
29	-4.8201	0.0000	-0.6492		
30	0.0000	0.0000	-1.0145		
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1	320.0000	205386.943	224168.920	583627.680	1509631.813
2	11330.5039	10004.3724	21492283.75	20908658.25	4.1367
3	1549710.641	596591.305	1975492.563	111287.135	1637324.453
4	527732.664	6523372.500	492274.570	51121.474	72.9970
5	26968.072	61260.239	145043.219	5697.931	18.8029
6	9996.5362	3447.8472	11311.8126	1408.9891	35.1159
7	130.1187	-58.8860	-193.1950	558.8766	-0.0833
8	378.6904	189.3480	621.2192	80.9930	-0.1262
9	224166.828	224166.836	-0.006	1.523	-0.001
10	-532.901	-533.467	0.016	684.047	-0.062
11	-805.638	-805.622	0.002	-40.976	0.419
12	14.2340	-0.0875	0.0000	103903.145	0.5583
13	-3.7715	-0.0030	0.0000	2551003.781	-1.0328
14	0.0000	0.0000	0.0000	2552746.938	0.0000
15	-75.2061	-0.0874	0.0000	-0.0058	0.0873
16	-4.8043	-0.0003	0.0000	-0.0873	0.0030
17	0.0000	0.0000	0.0000	-0.0030	0.0000
18	4.8749	4.3032	4.2698	-0.2059	-0.0012
19	76.3853	78.0137	78.0019	0.1364	0.0002
20	426.6626	425.6615	-525.3960	-524.0360	223049.846
21	0.0001	4.2735	0.0000	2278.5851	680.000
22	76.0161	29.6692	29.5085	-30.4867	-0.0403
23	14.7903	14.6399	-2.1987	-0.0063	10004.573
24	155.8000	391.1338	4.5844	-1442791.359	3285.7327
25	116.6376	271.0000	0.0091	6389594.563	1012.0492
26	0.0000	-0.0115	0.0216	46.892	-6.3898
27	124.2827			0.0000	0.0000
28	14.7939	0.0000	365.4035	116080.5439	22371.5635
29	-4.8043	0.0000	-0.6332		
30	0.0000	0.0000	-0.9905		
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1	335.0000	197510.271	223919.041	594945.242	1658652.234
2	11818.8655	10489.8781	21503501.25	20908558.50	4.5451
3	1703257.594	649393.125	2148726.563	133604.445	1783358.063
4	527437.914	6521736.063	486905.828	59791.842	73.1102
5	33007.654	64166.748	154578.924	6987.701	17.2028
6	10479.8041	3593.3962	11789.3347	1567.8078	36.4755
7	-170.1285	-159.6103	-523.6548	596.8161	-0.0894
8	426.9752	198.2339	650.3724	91.0332	-0.1406
9	223916.695	223916.703	-0.006	-0.267	-0.001
10	-548.782	-549.325	0.016	-145.846	-0.055
11	-862.926	-862.962	0.002	12.918	0.417
12	12.9413	-0.0829	0.0000	103885.750	0.5857
13	-3.7238	0.0052	0.0000	2532419.875	-1.0971
14	0.0000	-0.0000	0.0000	2534170.969	0.0000
15	-76.4713	-0.0813	0.0000	-0.0054	0.0827
16	-4.8208	-0.0015	0.0000	-0.0827	-0.0052
17	0.0000	0.0000	0.0000	0.0052	0.0000
18	3.6080	3.2018	3.1691	-0.2208	-0.0011
19	76.7730	78.2879	78.2791	0.1406	0.0003
20	426.6572	425.7414	-524.8164	-524.1217	223125.650
21	0.0001	4.4407	0.0000	2322.0501	680.000
22	75.5594	29.7643	29.6034	-30.4547	-0.0403
23	15.1966	15.0737	-2.0210	-0.0061	10489.879
24	140.0500	375.5729	4.5841	-1387607.391	3463.7381
25	116.6157	271.0000	0.0097	6405555.813	957.4403
26	0.0000	0.0092	0.0222	-44.959	-5.2869
27	125.0248			0.0000	0.0000
28	13.5287	0.0000	368.5425	109412.7197	21162.8459
29	-4.8208	0.0000	-0.6575		
30	0.0000	0.0000	-1.0271		
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TABLE AP 3-2 (Sheet 8 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	340.0000	194884.863	224095.031	598091.328	1709951.875
2	11987.9286	10658.1318	21506613.75	20908524.75	4.6856
3	1756069.203	667484.266	2208080.594	141579.383	1833587.906
4	526334.797	6520853.125	484008.996	62806.452	73.1478
5	35183.817	65165.439	157855.463	7451.388	16.6815
6	10645.4452	3643.2413	11952.8680	1622.3227	36.9960
7	-271.1673	-193.5978	-635.1621	608.9949	-0.0914
8	443.5568	201.2552	660.2848	94.4525	-0.1421
9	224092.684	224092.691	-0.006	0.284	-0.001
10	-553.841	-554.379	0.016	81.765	-0.054
11	-860.478	-860.461	0.002	9.980	0.418
12	12.5301	-0.0816	0.0000	103879.917	0.5933
13	-3.7315	-0.0030	0.0000	2525868.094	-1.0994
14	-0.0000	-0.0000	0.0000	2527621.875	0.0000
15	-76.8750	-0.0804	0.0000	-0.0053	0.0815
16	-4.8308	-0.0007	0.0000	-0.0815	0.0030
17	0.0000	0.0000	0.0000	-0.0030	0.0000
18	3.2197	2.8622	2.8298	-0.2200	0.0003
19	76.9032	78.3815	78.3737	0.1417	0.0002
20	426.2307	425.7615	-525.7544	-524.1465	223147.197
21	0.0001	4.5002	0.0000	2334.1326	680.000
22	75.4019	29.7964	29.6354	-30.4458	-0.0403
23	15.3263	15.2087	-1.9874	-0.0061	10658.132
24	134.8000	370.4998	4.5840	-1368790.734	3524.5563
25	116.6368	271.0000	0.0100	6410636.563	939.3370
26	0.0000	0.0075	0.0225	-71.806	-4.9393
27	125.2660			0.0000	0.0000
28	13.1250	0.0000	369.6709	107190.0977	20760.1033
29	-4.8308	0.0000	-0.6660		
30	0.0000	0.0000	-1.0399		
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1	345.0000	192255.568	224163.645	600932.508	1762088.047
2	12160.3475	10829.8330	21509421.25	20908490.75	4.8283
3	1809715.469	685826.516	2268258.469	149829.074	1884624.156
4	524725.398	6519799.750	480553.035	65881.408	73.1853
5	37443.691	66179.368	161181.996	7932.322	16.1662
6	10813.6217	3693.8290	12118.8381	1677.7075	37.5134
7	-372.6368	-227.7804	-747.3095	620.9527	-0.0933
8	460.4474	204.3244	670.3544	97.9267	-0.1461
9	224161.238	224161.246	-0.006	-0.124	-0.001
10	-557.368	-558.113	0.016	-36.974	-0.052
11	-873.175	-873.204	0.002	-19.031	0.420
12	12.1220	-0.0822	0.0000	103874.036	0.5967
13	-3.7215	0.0041	0.0000	2519014.969	-1.1098
14	-0.0000	0.0000	0.0000	2520771.406	0.0000
15	-77.2796	-0.0826	0.0000	-0.0053	0.0820
16	-4.8313	-0.0006	0.0000	-0.0820	-0.0041
17	0.0000	0.0000	0.0000	0.0041	0.0000
18	2.8484	2.5365	2.5043	-0.2232	-0.0007
19	77.0342	78.4765	78.4696	0.1427	0.0001
20	426.2008	425.7730	-525.9522	-524.1898	223172.055
21	0.0001	4.5621	0.0000	2345.0441	680.000
22	75.2417	29.8288	29.6676	-30.4378	-0.0403
23	15.4427	15.3320	-1.9370	-0.0061	10829.833
24	129.5500	365.4009	4.5839	-1349712.281	3586.2089
25	116.6479	271.0000	0.0101	6415608.313	921.3060
26	0.0000	-0.0002	0.0226	-96.801	-4.5836
27	125.5045			0.0000	0.0000
28	12.7204	0.0000	370.8663	104963.6924	20357.2529
29	-4.8313	0.0000	-0.6748		
30	0.0000	0.0000	-1.0531		
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1	350.0000	189625.344	224208.643	603474.563	1815075.234
2	12336.0742	11004.9276	21511928.75	20908456.50	4.9737
3	1864208.859	704423.547	2329272.219	158357.842	1936485.406
4	522607.566	6518574.938	476334.621	69015.561	73.2227
5	39788.650	67208.703	164559.072	8430.703	15.6568
6	10984.3124	3745.1522	12287.2209	1733.9561	38.0414
7	-474.5926	-262.1757	-860.1549	632.6725	-0.0954
8	477.5753	207.4191	680.5074	101.4333	-0.1490
9	224206.207	224206.215	-0.006	-0.030	-0.001
10	-562.189	-562.763	0.016	12.037	-0.051
11	-878.370	-878.367	0.002	-27.280	0.423
12	11.7011	-0.0863	0.0000	103868.180	0.5973
13	-3.7165	-0.0008	0.0000	2511999.563	-1.1199
14	0.0000	0.0000	0.0000	2513758.719	0.0000
15	-77.6999	-0.0858	0.0000	-0.0056	0.0861
16	-4.8364	-0.0008	0.0000	-0.0861	0.0008
17	0.0000	0.0000	0.0000	-0.0008	0.0000
18	2.4935	2.2243	2.1923	-0.2245	-0.0001
19	77.1657	78.5727	78.5666	0.1438	0.0005
20	426.1456	425.7829	-526.1258	-524.2355	223197.076
21	0.0001	4.6262	0.0000	2354.8068	680.000
22	75.0787	29.8613	29.7001	-30.4306	-0.0403
23	15.5334	15.4283	-1.8928	-0.0061	11004.928
24	124.3000	360.1683	4.5839	-1330257.781	3648.7085
25	116.6245	271.0000	0.0102	6420494.500	903.2657
26	0.0000	-0.0106	0.0228	-119.976	-4.2445
27	125.7403			0.0000	0.0000
28	12.3001	0.0000	372.0977	102736.3311	19934.4395
29	-4.8364	0.0000	-0.6838		
30	0.0000	0.0000	-1.0666		
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1	355.0000	186994.252	224253.838	605722.086	1868928.188
2	12515.1578	11183.4575	21514141.50	20908422.00	5.1213
3	1919561.984	723279.023	2391133.906	167170.053	1989190.172
4	519978.430	6517177.563	471950.059	72207.664	73.2600
5	42219.896	68253.611	167987.244	8946.735	15.1532
6	11157.5823	3797.2302	12458.0800	1791.0897	38.5846
7	-577.1165	-296.8102	-973.7848	644.1285	-0.0979
8	494.9931	210.5541	690.7929	104.9875	-0.1525
9	224251.354	224251.361	-0.006	0.069	-0.001
10	-568.753	-569.337	0.017	-2.834	-0.050
11	-886.463	-886.479	0.002	7.411	0.426
12	11.2649	-0.0875	0.0000	103862.273	0.6038
13	-3.7117	0.0022	0.0000	2504460.156	-1.1278
14	0.0000	-0.0000	0.0000	2506222.031	0.0000
15	-78.1296	-0.0860	0.0000	-0.0057	0.0873
16	-4.8395	-0.0006	0.0000	-0.0873	-0.0022
17	0.0000	0.0000	0.0000	0.0022	0.0000
18	2.1544	1.9231	1.8934	-0.2265	-0.0006
19	77.2979	78.6701	78.6649	0.1455	0.0003
20	426.0904	425.7909	-526.3000	-524.2832	223221.979
21	0.0001	4.6927	0.0000	2363.4384	680.000
22	74.9129	29.8940	29.7327	-30.4243	-0.0403
23	15.5959	15.4962	-1.8499	-0.0061	11183.458
24	120.8000	356.6390	4.5838	-1317080.719	3690.8598
25	116.5987	271.0000	0.0103	6423703.438	891.2242
26	0.0000	-0.0135	0.0229	-134.438	-4.0188
27	125.9735			0.0000	0.0000
28	11.8704	0.0000	373.4153	100508.0498	19551.6738
29	-4.8395	0.0000	-0.6931		
30	0.0000	0.0000	-1.0807		
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1	360.0000	184364.055	224045.520	607680.258	1923662.219
2	12697.5876	11365.4063	21516065.25	20908387.25	5.2713
3	1975787.969	742396.805	2453856.156	176270.184	2042757.375
4	516835.242	6515606.375	466795.266	75456.350	73.2972
5	44738.951	69314.278	171467.113	9480.639	14.6556
6	11333.4398	3850.0645	12631.4207	1849.1133	39.0985
7	-680.2693	-331.7033	-1088.2632	655.3021	-0.1000
8	512.6761	213.7213	701.1839	108.5810	-0.1558
9	224042.996	224043.004	-0.006	0.069	-0.001
10	-573.222	-573.803	0.017	-6.136	-0.049
11	-893.037	-893.040	0.002	9.210	0.429
12	10.8295	-0.0867	0.0000	103856.351	0.6112
13	-3.7060	0.0001	0.0000	2496638.625	-1.1389
14	0.0000	-0.0000	0.0000	2498403.188	0.0000
15	-78.5575	-0.0852	0.0000	-0.0056	0.0865
16	-4.8448	-0.0014	0.0000	-0.0865	-0.0001
17	0.0000	0.0000	0.0000	0.0001	0.0000
18	1.8307	1.6386	1.6071	-0.2284	-0.0003
19	77.4308	78.7688	78.7644	0.1467	0.0003
20	426.4579	425.8005	-525.3578	-524.3245	223244.951
21	0.0001	4.7615	0.0000	2370.9587	680.000
22	74.7443	29.9269	29.7655	-30.4187	-0.0403
23	15.6466	15.5519	-1.8071	-0.0062	11365.407
24	115.5500	351.3232	4.5837	-1297040.781	3754.8282
25	116.5553	271.0000	0.0104	6428435.625	873.1511
26	0.0000	-0.0146	0.0231	-154.662	-3.6890
27	126.2043			0.0000	0.0000
28	11.4425	0.0000	374.7795	98280.5283	19149.0376
29	-4.8448	0.0000	-0.7026		
30	0.0000	0.0000	-1.0949		
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1	365.0000	181737.695	223950.844	609354.555	1979292.406
2	12883.2638	11550.6676	21517704.50	20908352.50	5.4237
3	2032899.563	761780.578	2517451.094	185662.564	2097205.188
4	513174.453	6513860.063	461065.832	78760.165	73.3342
5	47347.040	70390.869	174999.230	10032.617	14.1638
6	11511.7999	3903.6290	12807.1567	1908.0009	39.6468
7	-784.0954	-366.8689	-1203.6357	666.1799	-0.1025
8	530.6412	216.9253	711.6959	112.2189	-0.1592
9	223948.277	223948.285	-0.006	0.200	-0.001
10	-579.042	-579.615	0.017	6.574	-0.049
11	-899.479	-899.486	0.002	33.641	0.434
12	10.3998	-0.0848	0.0000	103850.397	0.6217
13	-3.7043	0.0008	0.0000	2488509.906	-1.1471
14	0.0000	-0.0000	0.0000	2490277.188	0.0000
15	-78.9768	-0.0823	0.0000	-0.0055	0.0847
16	-4.8514	-0.0012	0.0000	-0.0847	-0.0008
17	0.0000	0.0000	0.0000	0.0008	0.0000
18	1.5219	1.3645	1.3333	-0.2301	-0.0004
19	77.5644	78.8689	78.8652	0.1483	0.0004
20	426.4277	425.8153	-525.1729	-524.3461	223262.230
21	0.0001	4.8325	0.0000	2377.3889	680.000
22	74.5728	29.9601	29.7986	-30.4140	-0.0403
23	15.6912	15.6007	-1.7693	-0.0062	11550.668
24	110.3000	346.0361	4.5837	-1276692.984	3819.6395
25	116.5202	271.0000	0.0105	6433065.250	855.0453
26	0.0000	-0.0087	0.0233	-173.179	-3.3651
27	126.4328			0.0000	0.0000
28	11.0232	0.0000	376.2146	96056.5840	18746.6711
29	-4.8514	0.0000	-0.7124		
30	0.0000	0.0000	-1.1098		
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TABLE AP 3-2 (Sheet 9 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	370.0000	179112.271	223856.441	610749.609	2035833.875
2	13072.3143	11739.3646	21519064.75	20908317.25	5.5787
3	2090909.516	781434.117	2581931.063	195351.658	2152552.063
4	508993.004	6511937.188	454757.340	82117.642	73.3711
5	50045.741	71483.578	178584.227	10602.900	13.6777
6	11692.8119	3957.9691	12985.4375	1967.8006	40.2109
7	-888.5663	-402.3004	-1319.8805	676.7691	-0.1049
8	548.8969	220.1677	722.3335	115.9025	-0.1629
9	223853.830	223853.838	-0.006	0.200	-0.002
10	-584.052	-584.596	0.017	-1.842	-0.048
11	-906.860	-906.865	0.002	39.222	0.439
12	9.9873	-0.0800	0.0000	103844.427	0.6348
13	-3.7005	0.0005	0.0000	2480215.813	-1.1572
14	0.0000	-0.0000	0.0000	2481985.781	0.0000
15	-79.3761	-0.0780	0.0000	-0.0052	0.0798
16	-4.8576	-0.0012	0.0000	-0.0798	-0.0005
17	0.0000	0.0000	0.0000	0.0005	0.0000
18	1.2280	1.1028	1.0719	-0.2321	-0.0003
19	77.6989	78.9704	78.9674	0.1496	0.0002
20	426.3974	425.8287	-524.9887	-524.3626	223276.590
21	0.0001	4.9039	0.0000	2382.7466	680.000
22	74.3983	29.9934	29.8318	-30.4101	-0.0403
23	15.7407	15.6545	-1.7301	-0.0063	11739.365
24	105.0300	340.8811	4.5836	-1256117.750	3885.3343
25	116.5153	271.0000	0.0108	6437575.688	836.9809
26	0.0000	0.0011	0.0236	-190.005	-3.0456
27	126.6591			0.0000	0.0000
28	10.6239	0.0000	377.6880	93833.4268	18344.4407
29	-4.8576	0.0000	-0.7225		
30	0.0000	0.0000	-1.1249		
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1	385.0000	171244.291	223388.863	613323.820	2211082.688
2	13659.6802	12325.9884	21521532.00	20908210.50	6.0589
3	2270462.844	842052.133	2780808.688	226245.031	2324173.969
4	493293.305	6505096.813	432315.172	92498.028	73.4810
5	58699.790	74860.320	189662.756	12425.873	12.2539
6	12251.9379	4125.6965	13535.7233	2152.7470	41.9706
7	-1205.5931	-510.1237	-1673.6308	706.8768	-0.1121
8	605.4404	230.1280	755.0117	127.2329	-0.1742
9	223386.131	223386.139	-0.007	0.087	-0.002
10	-596.868	-597.383	0.019	2.494	-0.047
11	-927.376	-927.387	0.002	8.730	0.462
12	8.8291	-0.0743	0.0000	103826.337	0.6605
13	-3.6890	0.0014	0.0000	2453079.188	-1.1850
14	0.0000	-0.0000	0.0000	2454857.375	0.0000
15	-80.5086	-0.0734	0.0000	-0.0048	0.0742
16	-4.8740	-0.0007	0.0000	-0.0742	-0.0014
17	0.0000	0.0000	0.0000	0.0014	0.0000
18	0.4353	0.3928	0.3627	-0.2379	-0.0006
19	78.1078	79.2835	79.2825	0.1532	0.0002
20	426.1277	425.8519	-524.2234	-524.3728	223293.939
21	0.0001	5.1404	0.0000	2392.6328	680.000
22	73.8566	30.0944	29.9325	-30.4029	-0.0404
23	15.8958	15.8214	-1.6172	-0.0066	12325.989
24	89.3000	325.8814	4.5835	-1192830.172	4087.8023
25	116.5947	271.0000	0.0115	6450430.375	783.0726
26	0.0000	0.0133	0.0242	-230.609	-2.1180
27	127.3254			0.0000	0.0000
28	9.4914	0.0000	382.5483	87168.1533	17141.8677
29	-4.8740	0.0000	-0.7545		
30	0.0000	0.0000	-1.1731		
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1	375.0000	176488.193	223540.688	611872.625	2093302.344
2	13264.7087	11931.4617	21520151.50	20908282.00	5.7361
3	2149831.219	801361.297	2647308.844	205342.061	2208816.719
4	504287.656	6309836.563	447865.523	85527.369	73.4079
5	52836.440	72592.596	182222.727	11191.718	13.1974
6	11876.4664	4013.0818	13166.2534	2028.5122	40.7512
7	-993.6459	-437.9877	-1436.9646	687.0804	-0.1070
8	567.4456	223.4486	733.0976	119.6323	-0.1664
9	223538.043	223538.051	-0.006	0.075	-0.002
10	-586.834	-587.368	0.018	3.850	-0.047
11	-912.827	-912.835	0.002	4.870	0.446
12	9.5939	-0.0781	0.0000	103838.422	0.6422
13	-3.6971	0.0010	0.0000	2471488.938	-1.1662
14	0.0000	-0.0000	0.0000	2473261.656	0.0000
15	-79.7621	-0.0765	0.0000	-0.0050	0.0780
16	-4.8633	-0.0013	0.0000	-0.0780	-0.0010
17	0.0000	0.0000	0.0000	0.0010	0.0000
18	0.9491	0.8537	0.8230	-0.2340	-0.0004
19	77.8343	79.0733	79.0710	0.1505	0.0003
20	426.1548	425.8393	-524.5465	-524.3724	223286.600
21	0.0001	4.9817	0.0000	2387.0595	680.000
22	74.2208	30.0269	29.8652	-30.4070	-0.0403
23	15.7970	15.7149	-1.6921	-0.0064	11931.462
24	99.8000	335.8056	4.5836	-1235300.578	3951.9182
25	116.5274	271.0000	0.0110	6441969.875	818.9683
26	0.0000	0.0053	0.0238	-205.167	-2.7310
27	126.8832			0.0000	0.0000
28	10.2379	0.0000	379.2465	91610.9766	17942.8572
29	-4.8633	0.0000	-0.7329		
30	0.0000	0.0000	-1.1405		
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1	390.0000	168623.549	223327.236	613666.180	2271427.938
2	13862.5098	12528.6616	21521838.25	20908174.50	6.2243
3	2332201.156	862824.094	2848958.031	237167.359	2383305.469
4	486998.379	6502455.188	423648.418	96056.245	73.5173
5	61775.449	76019.439	193665.631	13071.700	11.7907
6	12444.0515	4183.2888	13724.6741	2216.3654	42.6111
7	-1312.4179	-546.5636	-1793.1842	716.3716	-0.1146
8	624.9041	233.5295	766.1713	131.1069	-0.1784
9	223324.461	223324.469	-0.007	-0.024	-0.002
10	-600.828	-601.355	0.019	-0.671	-0.046
11	-934.872	-934.882	0.002	-16.264	0.471
12	8.4554	-0.0756	0.0000	103820.255	0.6644
13	-3.6823	0.0012	0.0000	2443365.469	-1.1951
14	0.0000	0.0000	0.0000	2445146.406	0.0000
15	-80.8784	-0.0746	0.0000	-0.0049	0.0755
16	-4.8774	-0.0007	0.0000	-0.0755	-0.0012
17	0.0000	0.0000	0.0000	0.0012	0.0000
18	0.2004	0.1811	0.1513	-0.2398	-0.0004
19	78.2461	79.3909	79.3904	0.1543	0.0003
20	426.1399	425.8577	-524.0638	-524.3680	223295.189
21	0.0001	5.2235	0.0000	2393.9476	680.000
22	73.6697	30.1284	29.9663	-30.4020	-0.0404
23	15.9360	15.8654	-1.5784	-0.0067	12528.662
24	85.8000	322.5928	4.5835	-1178396.906	4133.9616
25	116.6180	271.0000	0.0117	6453158.563	771.1583
26	0.0000	0.0110	0.0244	-237.676	-1.9197
27	127.5436			0.0000	0.0000
28	9.1216	0.0000	384.2961	84947.9180	16741.4043
29	-4.8774	0.0000	-0.7658		
30	0.0000	0.0000	-1.1901		
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1	380.0000	173865.838	223464.406	612728.492	2151713.094
2	13460.4343	12126.9413	21520971.75	20908246.25	5.8962
3	2209677.688	821565.945	2713396.906	215638.260	2266017.563
4	499055.367	6507556.875	440386.180	88987.954	73.4445
5	55720.592	73718.108	185915.348	11799.294	12.7228
6	12062.7712	4068.9695	13349.8115	2090.1386	41.3318
7	-1099.3316	-473.9310	-1554.8886	697.1140	-0.1096
8	586.2866	226.7671	743.9850	123.4074	-0.1703
9	223461.715	223461.723	-0.006	0.140	-0.002
10	-592.462	-592.990	0.018	1.379	-0.047
11	-920.125	-920.130	0.002	21.994	0.436
12	9.2059	-0.0767	0.0000	103832.397	0.6517
13	-3.6935	0.0005	0.0000	2462529.063	-1.1761
14	0.0000	-0.0000	0.0000	2464304.500	0.0000
15	-80.1406	-0.0762	0.0000	-0.0049	0.0766
16	-4.8696	-0.0011	0.0000	-0.0766	-0.0005
17	0.0000	0.0000	0.0000	0.0005	0.0000
18	0.6848	0.6170	0.5866	-0.2359	-0.0003
19	77.9706	79.1777	79.1760	0.1520	0.0002
20	426.1409	425.8439	-524.3846	-524.3744	223291.172
21	0.0001	5.0598	0.0000	2390.3464	680.000
22	74.0403	30.0665	29.8987	-30.4046	-0.0404
23	15.8468	15.7686	-1.6548	-0.0065	12126.942
24	94.5500	330.8024	4.5835	-1214199.375	4019.3838
25	116.5544	271.0000	0.0113	6446255.813	800.9832
26	0.0000	0.0115	0.0240	-218.693	-2.4222
27	127.1053			0.0000	0.0000
28	9.8594	0.0000	380.8507	89389.1670	17542.3562
29	-4.8696	0.0000	-0.7435		
30	0.0000	0.0000	-1.1565		
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1	395.0000	166003.600	223265.828	613764.500	2332766.156
2	14069.0045	12735.0382	21521900.00	20908138.50	6.3924
3	2394907.563	883886.242	2918059.438	248410.369	2443432.188
4	480167.957	6499630.730	414381.797	99661.242	73.5535
5	64949.283	77195.671	197324.650	13737.022	11.3331
6	12639.2096	4241.7754	13916.5590	2281.0255	43.2717
7	-1419.8455	-583.2647	-1913.5943	725.5845	-0.1175
8	644.6870	236.9731	777.4692	135.0311	-0.1826
9	223263.006	223263.014	-0.007	0.014	-0.002
10	-606.181	-606.723	0.020	3.324	-0.046
11	-942.176	-942.188	0.002	-10.231	0.481
12	8.0727	-0.0773	0.0000	103814.132	0.6690
13	-3.6758	0.0015	0.0000	2433100.188	-1.2046
14	0.0000	0.0000	0.0000	2434883.938	0.0000
15	-81.2564	-0.0762	0.0000	-0.0050	0.0772
16	-4.8804	-0.0006	0.0000	-0.0772	-0.0015
17	0.0000	0.0000	0.0000	0.0015	0.0000
18	-0.0201	-0.0182	-0.0478	-0.2418	-0.0004
19	78.3853	79.4998	79.4999	0.1557	0.0003
20	426.1519	425.8635	-523.9047	-524.3602	223295.133
21	0.0001	5.3091	0.0000	2394.3252	680.000
22	73.4797	30.1625	30.0004	-30.4018	-0.0404
23	15.9361	15.8889	-1.5408	-0.0068	12735.038
24	80.5500	317.6194	4.5835	-1156427.141	4204.0521
25	116.6425	271.0000	0.0118	6457175.313	753.3018
26	0.0000	0.0067	0.0246	-246.988	-1.6294
27	127.7600			0.0000	0.0000
28	8.7436	0.0000	386.1463	82728.4404	16340.9775
29	-4.8804	0.0000	-0.7775		
30	0.0000	0.0000	-1.2077		
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TABLE AP 3-2 (Sheet 10 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	400.0000	163382.701	223451.771	613624.836	2395115.531
2	14279.3191	12945.2697	21521723.75	20908102.00	6.5632
3	2458597.750	905243.164	2988127.938	259979.369	2504574.844
4	472798.762	6496622.063	404510.848	103311.563	73.5895
5	68222.832	78389.227	201240.508	14422.093	10.8812
6	12837.5818	4301.2076	14111.5463	2346.7800	44.0025
7	-1527.9213	-620.2432	-2034.9145	734.4998	-0.1205
8	664.7996	240.4604	788.9106	139.0074	-0.1872
9	223448.898	223448.906	-0.007	0.028	-0.002
10	-612.102	-612.657	0.020	2.728	-0.046
11	-950.730	-950.741	0.002	-6.864	0.491
12	7.6833	-0.0784	0.0000	103807.986	0.6744
13	-3.6686	0.0013	0.0000	2422537.938	-1.2145
14	0.0000	0.0000	0.0000	2424324.469	0.0000
15	-81.6404	-0.0773	0.0000	-0.0050	0.0782
16	-4.8832	-0.0003	0.0000	-0.0782	-0.0013
17	0.0000	0.0000	0.0000	0.0013	0.0000
18	-0.2267	-0.2055	-0.2348	-0.2438	-0.0003
19	78.5257	79.6102	79.6109	0.1571	0.0002
20	425.7406	425.8665	-524.8475	-524.3564	223295.350
21	0.0001	5.3974	0.0000	2393.7888	680.000
22	73.2863	30.1968	30.0346	-30.4022	-0.0405
23	15.9583	15.8943	-1.5034	-0.0070	12945.270
24	75.3000	312.5965	4.5835	-1134062.250	4275.2059
25	116.6549	271.0000	0.0119	6461102.250	735.4516
26	0.0000	0.0028	0.0247	-254.800	-1.3483
27	127.9747			0.0000	0.0000
28	8.3596	0.0000	388.0515	80508.0566	15940.5103
29	-4.8832	0.0000	-0.7895		
30	0.0000	0.0000	-1.2258		
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1	405.0000	160757.998	223519.936	613254.727	2458495.281
2	14493.7043	13159.6018	21521317.75	20908065.50	6.7369
3	2523288.406	926899.789	3059179.719	271880.063	2566754.844
4	464887.508	6493427.813	394030.973	107005.701	73.6253
5	71597.813	79600.341	205213.973	15127.188	10.4349
6	13039.4347	4361.6662	14309.9008	2413.7127	44.7345
7	-1636.6685	-657.5094	-2157.1787	743.1070	-0.1235
8	685.2629	243.9960	800.5102	143.0403	-0.1919
9	223517.016	223517.023	-0.007	-0.045	-0.002
10	-617.008	-617.580	0.021	-0.386	-0.046
11	-959.022	-959.037	0.002	-22.524	0.501
12	7.2876	-0.0802	0.0000	103801.793	0.6778
13	-3.6602	0.0020	0.0000	2411334.719	-1.2243
14	0.0000	0.0000	0.0000	2413124.031	0.0000
15	-82.0327	-0.0798	0.0000	-0.0051	0.0801
16	-4.8845	-0.0003	0.0000	-0.0801	-0.0020
17	0.0000	0.0000	0.0000	0.0020	0.0000
18	-0.4194	-0.3808	-0.4097	-0.2458	-0.0005
19	78.6672	79.7223	79.7234	0.1583	0.0002
20	425.7283	425.8639	-525.0227	-524.3676	223298.973
21	0.0001	5.4884	0.0000	2392.3674	680.000
22	73.0895	30.2313	30.0689	-30.4033	-0.0405
23	15.9433	15.8825	-1.4657	-0.0072	13159.602
24	70.0500	307.5037	4.5835	-1111291.047	4347.5330
25	116.6504	271.0000	0.0120	6464940.313	717.6281
26	0.0000	-0.0044	0.0249	-261.161	-1.0768
27	128.1877			0.0000	0.0000
28	7.9673	0.0000	390.0735	78284.0391	15539.8691
29	-4.8845	0.0000	-0.8020		
30	0.0000	0.0000	-1.2446		
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1	410.0000	158132.416	223588.451	612664.328	2522925.281
2	14712.1643	13378.0366	21520690.25	20908028.75	6.9135
3	2588997.000	948861.273	3131231.688	284118.367	2629994.344
4	456430.785	6490046.375	382937.242	110742.048	73.6610
5	75076.023	80829.246	209245.805	15852.583	9.9942
6	13244.7806	4423.1541	14511.6321	2481.8287	45.4912
7	-1746.1708	-695.0902	-2280.4753	751.3797	-0.1267
8	706.0727	247.5773	812.2599	147.1276	-0.1968
9	223585.480	223585.488	-0.007	-0.024	-0.002
10	-622.798	-623.396	0.021	-2.136	-0.046
11	-967.273	-967.284	0.002	-17.204	0.512
12	6.8784	-0.0834	0.0000	103795.574	0.6808
13	-3.6520	0.0013	0.0000	2399786.375	-1.2350
14	0.0000	0.0000	0.0000	2401578.500	0.0000
15	-82.4389	-0.0824	0.0000	-0.0053	0.0832
16	-4.8871	-0.0006	0.0000	-0.0832	-0.0013
17	0.0000	0.0000	0.0000	0.0013	0.0000
18	-0.5987	-0.5444	-0.5730	-0.2479	-0.0003
19	78.8098	79.8360	79.8376	0.1597	0.0003
20	425.7160	425.8611	-525.1987	-524.3816	223303.764
21	0.0001	5.5821	0.0000	2390.1000	680.000
22	72.8893	30.2659	30.1034	-30.4050	-0.0405
23	15.9047	15.8467	-1.4293	-0.0074	13378.036
24	64.8000	302.2686	4.5834	-1088061.406	4421.0472
25	116.6213	271.0000	0.0121	6468697.125	699.7710
26	0.0000	-0.0117	0.0251	-266.130	-0.8176
27	128.3991			0.0000	0.0000
28	7.5611	0.0000	392.1583	76059.1846	15139.1887
29	-4.8871	0.0000	-0.8148		
30	0.0000	0.0000	-1.2638		
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1	415.0000	155505.949	223657.008	611859.094	2588426.125
2	14934.8156	13600.6874	21519848.75	20907992.00	7.0930
3	2655741.281	971132.813	3204300.906	296700.281	2694315.625
4	447424.316	6486476.250	371224.234	114518.860	73.6965
5	78659.107	82076.181	213336.789	16598.558	9.5589
6	13453.7415	4485.7074	14716.8593	2551.1668	46.2737
7	-1856.5156	-733.0147	-2404.8993	759.2887	-0.1302
8	727.2484	251.2088	824.1742	151.2737	-0.2018
9	223653.982	223653.990	-0.008	0.088	-0.002
10	-629.449	-630.058	0.022	-0.095	-0.046
11	-975.496	-975.508	0.002	7.087	0.523
12	6.4584	-0.0841	0.0000	103789.305	0.6880
13	-3.6454	0.0014	0.0000	2387526.406	-1.2451
14	0.0000	-0.0000	0.0000	2389321.406	0.0000
15	-82.8517	-0.0825	0.0000	-0.0053	0.0840
16	-4.8905	-0.0008	0.0000	-0.0840	-0.0014
17	0.0000	0.0000	0.0000	0.0014	0.0000
18	-0.7650	-0.6967	-0.7250	-0.2499	-0.0004
19	78.9537	79.9514	79.9534	0.1614	0.0002
20	425.7036	425.8582	-525.0749	-524.3985	223309.658
21	0.0001	5.6787	0.0000	2387.0075	680.000
22	72.6856	30.3006	30.1381	-30.4073	-0.0406
23	15.8456	15.7901	-1.3958	-0.0076	13600.088
24	59.5500	296.9543	4.5834	-1064390.828	4495.7952
25	116.5797	271.0000	0.0122	6472367.875	681.8752
26	0.0000	-0.0146	0.0253	-269.765	-0.5686
27	128.6090			0.0000	0.0000
28	7.1483	0.0000	394.3705	73833.4883	14738.4690
29	-4.8905	0.0000	-0.8281		
30	0.0000	0.0000	-1.2839		
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1	420.0000	152880.213	223522.189	610850.438	2655018.500
2	15161.7058	13827.5983	21518802.75	20907954.75	7.2754
3	2723539.656	993719.875	3278405.281	309632.008	2759741.563
4	437863.883	6482715.625	358886.152	118334.268	73.7319
5	82349.002	83341.402	217487.775	17365.414	9.1292
6	13666.3704	4549.3416	14925.6324	2624.7451	47.0401
7	-1967.7654	-771.3036	-2530.5186	766.8135	-0.1336
8	748.7968	254.8911	836.2554	155.4795	-0.2069
9	223519.115	223519.123	-0.008	0.089	-0.002
10	-634.681	-635.290	0.023	-5.959	-0.046
11	-983.154	-983.163	0.002	10.744	0.534
12	6.0392	-0.0835	0.0000	103783.007	0.6959
13	-3.6391	0.0010	0.0000	2374883.281	-1.2559
14	-0.0000	-0.0000	0.0000	2376681.125	0.0000
15	-83.2629	-0.0814	0.0000	-0.0053	0.0833
16	-4.8950	-0.0013	0.0000	-0.0833	-0.0010
17	0.0000	0.0000	0.0000	0.0010	0.0000
18	-0.9188	-0.8379	-0.8660	-0.2520	-0.0005
19	79.0989	80.0685	80.0709	0.1628	0.0004
20	426.0972	425.8577	-524.5731	-524.4121	223315.396
21	0.0001	5.7782	0.0000	2383.1338	680.000
22	72.4784	30.3355	30.1728	-30.4101	-0.0406
23	15.7780	15.7247	-1.3625	-0.0078	13827.598
24	54.3000	291.6070	4.5834	-1040310.469	4571.8021
25	116.5347	271.0000	0.0123	6475945.875	663.9487
26	0.0000	-0.0147	0.0255	-272.117	-0.3294
27	128.8174			0.0000	0.0000
28	6.7371	0.0000	396.6512	71608.4697	14337.7930
29	-4.8950	0.0000	-0.8418		
30	0.0000	0.0000	-1.3045		
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1	425.0000	150256.736	223680.814	609644.641	2722723.813
2	15392.9672	14058.8994	21517560.25	20907917.75	7.4610
3	2792410.438	1016627.836	3353562.500	322919.781	2826294.813
4	427744.961	6478762.563	345916.902	122186.313	73.7670
5	86147.656	84625.169	221699.598	18153.455	8.7049
6	13882.8118	4614.1003	15138.0948	2693.6079	47.8954
7	-2079.9410	-809.9658	-2657.3628	773.9448	-0.1372
8	770.7381	258.6289	848.5184	159.7497	-0.2123
9	223677.686	223677.695	-0.008	0.153	-0.002
10	-640.873	-641.477	0.023	8.698	-0.046
11	-991.393	-991.403	0.002	15.520	0.547
12	5.6251	-0.0820	0.0000	103776.652	0.7053
13	-3.6349	0.0011	0.0000	2361462.781	-1.2657
14	0.0000	-0.0000	0.0000	2363263.469	0.0000
15	-83.6676	-0.0804	0.0000	-0.0052	0.0819
16	-4.9005	-0.0010	0.0000	-0.0819	-0.0011
17	0.0000	0.0000	0.0000	0.0011	0.0000
18	-1.0601	-0.9682	-0.9959	-0.2539	-0.0004
19	79.2454	80.1874	80.1902	0.1643	0.0003
20	426.3090	425.8648	-524.6844	-524.4170	223321.441
21	0.0001	5.8805	0.0000	2378.5029	680.000
22	72.2675	30.3705	30.2077	-30.4136	-0.0406
23	15.7063	15.6551	-1.3323	-0.0080	14058.900
24	50.8000	288.0495	4.5833	-1024040.742	4623.1904
25	116.5066	271.0000	0.0124	6478277.188	651.9906
26	0.0000	-0.0138	0.0256	-272.997	-0.1744
27	129.0243			0.0000	0.0000
28	6.3324	0.0000	399.0689	69386.6211	13936.2075
29	-4.9005	0.0000	-0.8561		
30	0.0000	0.0000	-1.3260		
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TABLE AP 3-2 (Sheet 11 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	430.0000	147633.477	223607.895	608252.273	2791564.313
2	15628.6711	14294.6592	21516129.75	20907880.25	7.6496
3	2862373.375	1039862.516	3429791.594	336570.164	2893999.346
4	417062.820	6476615.313	332310.340	126073.020	73.8021
5	90057.010	85927.769	225973.209	18963.014	8.2859
6	14103.1488	4680.0082	15354.3278	2766.7849	48.7305
7	-2193.0568	-849.0078	-2785.4532	780.6760	-0.1408
8	793.0805	262.4232	860.9670	164.0857	-0.2179
9	223604.711	223604.721	-0.008	0.093	-0.003
10	-646.052	-646.651	0.024	-6.153	-0.046
11	-999.787	-999.795	0.002	11.383	0.360
12	5.2190	-0.0865	0.0000	103770.269	0.7143
13	-3.6291	0.0009	0.0000	2347623.688	-1.2769
14	0.0000	-0.0000	0.0000	2349427.250	0.0000
15	-84.0647	-0.0790	0.0000	-0.0051	0.0803
16	-4.9060	-0.0012	0.0000	-0.0803	-0.0009
17	0.0000	0.0000	0.0000	0.0009	0.0000
18	-1.1890	-1.0875	-1.1149	-0.2362	-0.0004
19	79.3934	80.3082	80.3113	0.1657	0.0003
20	426.2314	425.8720	-524.6687	-524.4210	223327.086
21	0.0001	5.9859	0.0000	2373.1556	680.000
22	72.0529	30.4056	30.2426	-30.4176	-0.0407
23	15.6332	15.5841	-1.3013	-0.0083	14294.659
24	45.5500	282.7420	4.5833	-999320.289	4701.3887
25	116.4686	271.0000	0.0126	6481691.125	634.0617
26	0.0000	-0.0126	0.0259	-273.315	0.0521
27	129.2300			0.0000	0.0000
28	5.9353	0.0000	401.5603	67165.2891	13534.3245
29	-4.9060	0.0000	-0.8707		
30	0.0000	0.0000	-1.3480		
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1	445.0000	139767.184	222763.582	603047.727	3005120.938
2	16363.0221	15029.2520	21510812.75	20907767.50	8.2348
3	3079011.938	1111585.031	3665101.250	379763.801	3104259.000
4	381589.188	6460988.500	287603.176	137920.697	73.9061
5	102469.875	89951.460	239174.270	21524.162	7.0609
6	14788.2303	4884.8354	16026.3319	2994.4300	51.2788
7	-2538.2204	-968.4868	-3177.4438	798.3936	-0.1521
8	862.6109	274.1619	899.4794	177.5057	-0.2349
9	222760.252	222760.242	-0.009	0.121	-0.003
10	-660.619	-661.207	0.027	-1.303	-0.049
11	-1020.549	-1020.559	0.002	14.095	0.621
12	4.0393	-0.0767	0.0000	103750.797	0.7418
13	-3.6162	0.0011	0.0000	2301479.594	-1.3085
14	-0.0000	-0.0000	0.0000	2303291.938	0.0000
15	-85.2168	-0.0740	0.0000	-0.0048	0.0765
16	-4.9247	-0.0020	0.0000	-0.0765	-0.0011
17	0.0000	0.0000	0.0000	0.0011	0.0000
18	-1.5028	-1.3803	-1.4067	-0.2625	-0.0006
19	79.8464	80.6823	80.6862	0.1701	0.0005
20	425.3981	425.8807	-523.6512	-524.4203	223331.998
21	0.0001	6.3201	0.0000	2353.1676	686.403
22	71.3859	30.5114	30.3480	-30.4324	-0.0408
23	15.4001	15.3565	-1.2163	-0.0094	15029.252
24	29.8000	267.0299	4.5832	-922795.969	4944.1880
25	116.3875	271.0000	0.0132	6491340.500	580.2915
26	0.0000	-0.0032	0.0266	-267.409	0.6880
27	129.8392			0.0000	0.0000
28	4.7832	0.0000	409.8387	60502.7398	12330.7021
29	-4.9247	0.0000	-0.9182		
30	0.0000	0.0000	-1.4194		
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1	435.0000	145010.594	223535.018	606681.930	2861561.813
2	15868.8685	14534.9261	21514522.25	20907842.75	7.8414
3	2933447.625	1063429.578	3507111.250	350589.738	2962878.500
4	405812.680	6470271.813	318060.152	129992.366	73.8369
5	94079.078	87249.481	230309.529	19794.419	7.8723
6	14327.4438	4747.0840	15574.3923	2841.2961	49.5958
7	-2307.1301	-888.4369	-2914.8135	786.9999	-0.1446
8	815.8337	266.2759	873.6068	168.4893	-0.2235
9	223531.783	223531.793	-0.009	0.155	-0.003
10	-651.714	-652.313	0.025	5.228	-0.047
11	-1007.251	-1007.260	0.002	17.702	0.578
12	4.8182	-0.0797	0.0000	103763.822	0.7231
13	-3.6254	0.0009	0.0000	2332896.438	-1.2869
14	0.0000	-0.0000	0.0000	2334702.906	0.0000
15	-84.4567	-0.0776	0.0000	-0.0050	0.0795
16	-4.9123	-0.0012	0.0000	-0.0795	-0.0009
17	0.0000	0.0000	0.0000	0.0009	0.0000
18	-1.3057	-1.1939	-1.2230	-0.2582	-0.0004
19	79.5428	80.4369	80.4343	0.1672	0.0004
20	426.1539	425.8775	-524.5330	-524.4235	223331.262
21	0.0001	6.0942	0.0000	2367.1247	681.885
22	71.8344	30.4467	30.2777	-30.4220	-0.0407
23	15.5568	15.5096	-1.2730	-0.0086	14534.927
24	40.3000	277.4496	4.5833	-974203.531	4780.9299
25	116.4345	271.0000	0.0128	6485007.375	616.1275
26	0.0000	-0.0106	0.0261	-272.466	0.2708
27	129.4343			0.0000	0.0000
28	5.5433	0.0000	404.2065	64944.2354	13132.5396
29	-4.9123	0.0000	-0.8860		
30	0.0000	0.0000	-1.3711		
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1	450.0000	137149.021	222715.383	601004.492	3078727.750
2	16616.7871	15283.1161	21508732.25	20907729.75	8.4366
3	3153541.594	1136185.063	3745809.875	394931.695	3176808.031
4	368605.695	6456044.625	271383.141	141925.438	73.9404
5	106842.703	91332.307	243704.600	22423.179	6.6630
6	15024.5453	4955.4561	16258.0264	3073.0011	52.2463
7	-2655.2909	-1009.1253	-3310.7722	803.4447	-0.1564
8	886.6303	278.1926	912.7037	182.1162	-0.2412
9	222711.996	222712.008	-0.010	0.242	-0.003
10	-666.822	-667.390	0.028	12.275	-0.050
11	-1028.098	-1028.100	0.002	31.618	0.644
12	3.6641	-0.0730	0.0000	103744.213	0.7547
13	-3.6150	-0.0001	0.0000	2284726.656	-1.3191
14	0.0000	-0.0000	0.0000	2286541.938	0.0000
15	-85.5791	-0.0764	0.0000	-0.0046	0.0729
16	-4.9341	-0.0013	0.0000	-0.0729	0.0001
17	0.0000	0.0000	0.0000	-0.0001	0.0000
18	-1.5838	-1.4567	-1.4828	-0.2645	-0.0003
19	80.0006	80.8110	80.8151	0.1717	0.0002
20	425.3457	425.8723	-523.6024	-524.4071	223322.096
21	0.0001	6.4376	0.0000	2345.3206	688.753
22	71.1557	30.5468	30.3833	-30.4382	-0.0408
23	15.3239	15.2817	-1.1923	-0.0098	15283.116
24	24.5500	261.9710	4.5832	-896516.492	5027.8342
25	116.3825	271.0000	0.0135	6494354.438	562.3659
26	0.0000	0.0001	0.0269	-263.274	0.8865
27	130.0398			0.0000	0.0000
28	4.4209	0.0000	412.8345	58281.9375	11933.4180
29	-4.9341	0.0000	-0.9350		
30	0.0000	0.0000	-1.4448		
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1	440.0000	142388.090	223462.420	604944.195	2932739.625
2	16113.6868	14779.8256	21512746.25	20907805.25	8.0365
3	3005653.688	1087335.078	3585541.188	364985.301	3032956.875
4	393989.727	6465730.250	303139.934	133942.285	73.8716
5	98215.969	88590.611	234709.553	20648.016	7.4640
6	14555.8362	4815.3696	15798.4260	2917.1859	50.4928
7	-2422.1763	-928.2604	-3045.4680	792.9086	-0.1485
8	839.0119	270.1894	886.4463	172.9631	-0.2294
9	223459.133	223459.143	-0.009	0.129	-0.003
10	-657.052	-657.642	0.026	-0.980	-0.048
11	-1015.398	-1015.406	0.002	15.810	0.599
12	4.4249	-0.0777	0.0000	103757.344	0.7328
13	-3.6206	0.0008	0.0000	2317690.938	-1.2977
14	0.0000	-0.0000	0.0000	2319500.313	0.0000
15	-84.8402	-0.0759	0.0000	-0.0049	0.0776
16	-4.9184	-0.0012	0.0000	-0.0776	-0.0008
17	0.0000	0.0000	0.0000	0.0008	0.0000
18	-1.4102	-1.2934	-1.3202	-0.2604	-0.0004
19	79.6938	80.5556	80.5593	0.1686	0.0003
20	426.0763	425.8815	-524.4581	-524.4246	223334.047
21	0.0001	6.2057	0.0000	2360.4509	684.113
22	71.6122	30.4760	30.3128	-30.4270	-0.0408
23	15.4788	15.4334	-1.2442	-0.0090	14779.826
24	35.0500	272.2139	4.5832	-948698.992	4861.8609
25	116.4076	271.0000	0.0130	6488223.500	598.2066
26	0.0000	-0.0082	0.0264	-270.483	0.4829
27	129.6373			0.0000	0.0000
28	5.1598	0.0000	406.9360	62723.4629	12730.8530
29	-4.9184	0.0000	-0.9017		
30	0.0000	0.0000	-1.3947		
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1	455.0000	134532.070	222604.438	598826.461	3153584.094
2	16875.5166	15541.9498	21506516.50	20907691.75	8.6417
3	3229263.969	1161141.531	3827687.844	410496.180	3250629.219
4	355034.547	6450896.563	254493.203	145954.389	73.9746
5	111336.885	92733.489	248301.645	23345.453	6.2704
6	15265.3458	5027.4041	16494.0759	3153.0772	53.2361
7	-2773.3149	-1050.1664	-3445.4016	808.0771	-0.1605
8	911.1260	282.2951	926.1631	186.8083	-0.2479
9	222600.996	222601.008	-0.010	0.065	-0.003
10	-671.146	-671.705	0.029	-2.148	-0.051
11	-1036.534	-1036.548	0.002	2.949	0.669
12	3.3056	-0.0711	0.0000	103737.553	0.7632
13	-3.6102	0.0016	0.0000	2266837.313	-1.3291
14	0.0000	0.0000	0.0000	2268655.563	0.0000
15	-85.9290	-0.0764	0.0000	-0.0045	0.0709
16	-4.9393	-0.0007	0.0000	-0.0709	-0.0016
17	0.0000	0.0000	0.0000	0.0016	0.0000
18	-1.6527	-1.5221	-1.5478	-0.2668	-0.0007
19	80.1366	80.9419	80.9462	0.1729	0.0003
20	425.3237	425.8637	-523.3684	-524.3903	223310.652
21	0.0001	6.5584	0.0000	2336.9558	691.168
22	70.9213	30.3823	30.4187	-30.4444	-0.0409
23	15.2554	15.2149	-1.1650	-0.0103	15541.950
24	19.3000	257.0992	4.5832	-869832.672	5113.0029
25	116.3853	271.0000	0.0138	6497266.063	544.5163
26	0.0000	0.0005	0.0272	-258.104	1.0828
27	130.2393			0.0000	0.0000
28	4.0710	0.0000	416.0236	56062.3281	11536.1343
29	-4.9393	0.0000	-0.9527		
30	0.0000	0.0000	-1.4714		
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TABLE AP 3-2 (Sheet 12 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	460.0000	131915.287	222567.861	596526.156	3229715.396
2	17139.4490	15805.9904	21504178.25	20907654.00	8.8503
3	3306202.125	1186461.203	3910757.469	426464.996	3325749.594
4	340870.938	6445542.375	236926.893	150005.461	74.0086
5	115934.701	94155.352	252966.539	24291.384	5.8828
6	15310.8915	5100.7582	16734.7385	3234.7384	34.2832
7	-2892.2844	-1091.5935	-3581.3365	812.2888	-0.1649
8	936.0930	286.4634	939.8451	191.5783	-0.2547
9	222564.367	222564.379	-0.011	-0.008	-0.004
10	-675.982	-676.564	0.030	5.081	-0.052
11	-1044.456	-1044.470	0.002	-18.078	0.693
12	2.9459	-0.0732	0.0000	103730.851	0.7669
13	-3.6027	0.0016	0.0000	2248336.063	-1.3396
14	-0.0000	0.0000	0.0000	2250157.313	0.0000
15	-86.2851	-0.0721	0.0000	-0.0046	0.0731
16	-4.9422	-0.0005	0.0000	-0.0731	-0.0016
17	0.0000	0.0000	0.0000	0.0016	0.0000
18	-1.7093	-1.5763	-1.6017	-0.2689	-0.0004
19	80.3143	81.0749	81.0794	0.1742	0.0003
20	425.2789	425.8546	-523.3374	-524.3736	223298.893
21	0.0001	6.6824	0.0000	2328.1215	693.649
22	70.6828	30.6178	30.4540	-30.4509	-0.0409
23	15.1768	15.1381	-1.1356	-0.0108	15805.990
24	15.8000	253.8534	4.5832	-851821.688	3170.6713
25	116.3828	271.0000	0.0139	6499135.625	532.6440
26	0.0000	-0.0019	0.0273	-254.097	1.2076
27	130.4378			0.0000	0.0000
28	3.7149	0.0000	419.3166	53842.9961	11138.7449
29	-4.9422	0.0000	-0.9709		
30	0.0000	0.0000	-1.4988		
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1	474.1400	124578.113	213512.805	589470.094	3452143.250
2	17909.6421	16576.5037	21497014.75	20907546.50	9.4599
3	3530566.688	1260091.313	4152325.625	473881.324	3545457.344
4	297563.730	6429266.000	183526.832	161561.873	74.1039
5	129703.361	98291.134	266535.352	27097.777	4.8144
6	16226.4364	5314.4153	17435.7119	3472.9213	55.1417
7	-3235.0156	-1211.2502	-3973.9104	821.5872	-0.1737
8	1008.9191	298.5351	979.4439	205.4020	-0.2660
9	213509.244	213509.258	-0.012	0.675	-0.004
10	-672.612	-673.150	0.034	-131.140	-0.056
11	-1029.829	-1029.790	0.002	212.651	0.771
12	1.8851	-0.0676	0.0000	103711.535	0.8064
13	-3.5895	-0.0056	0.0000	2190476.188	-1.3835
14	0.0000	-0.0000	0.0000	2192306.125	0.0000
15	-87.3062	-0.3357	0.0000	-0.0042	0.0675
16	-4.9730	-0.0141	0.0000	-0.0675	0.0056
17	0.0000	0.0000	0.0000	-0.0056	0.0000
18	-1.8110	-1.6762	-1.7005	-0.2763	-0.0004
19	80.7698	81.4629	81.4677	0.1806	0.0003
20	425.6208	0.0000	-501.0578	0.0000	0.000
21	0.0002	7.0493	0.0000	2301.0228	700.987
22	69.9847	30.7183	30.5542	-30.4710	-0.0411
23	14.8736	14.8387	-1.0648	-0.0123	16576.504
24	0.0000	240.5733	4.5815	-757698.688	5438.5930
25	115.3577	270.1101	0.0133	6508366.875	470.0653
26	0.0000	0.9479	0.0287	-231.086	1.6957
27	130.9934			0.0000	0.0000
28	2.6938	0.0000	429.3578	47629.1777	10015.5144
29	-4.9730	0.0000	-1.0263		
30	0.0000	0.0000	-1.5822		
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1	465.0000	129299.025	222458.881	594116.180	3307148.873
2	17408.7605	16075.4127	21501730.50	20907616.00	9.0629
3	3384380.219	1212151.266	3995042.313	442846.219	3402197.000
4	326109.910	6439979.938	218677.443	154076.473	74.0429
5	120698.553	95598.240	257700.416	25261.363	5.5004
6	15761.3600	5175.5715	16980.1885	3318.0421	55.3543
7	-3012.2857	-1133.4542	-3718.6746	816.0493	-0.1696
8	961.5435	290.7049	953.7544	196.4278	-0.2619
9	222455.330	222455.342	-0.011	0.008	-0.004
10	-681.716	-682.326	0.032	-0.608	-0.053
11	-1052.634	-1052.652	0.002	-11.671	0.721
12	2.5730	-0.0798	0.0000	103724.063	0.7711
13	-3.5936	0.0020	0.0000	2228546.406	-1.3504
14	0.0000	0.0000	0.0000	2230370.719	0.0000
15	-86.6538	-0.0746	0.0000	-0.0048	0.0757
16	-4.9440	-0.0004	0.0000	-0.0757	-0.0020
17	0.0000	0.0000	0.0000	0.0020	0.0000
18	-1.7539	-1.6195	-1.6446	-0.2711	-0.0005
19	80.4738	81.2101	81.2147	0.1757	0.0003
20	425.2841	425.8433	-523.0746	-524.3558	223286.623
21	0.0002	6.8099	0.0000	2318.8661	696.198
22	70.4399	30.6533	30.4895	-30.4578	-0.0410
23	15.0766	15.0397	-1.1054	-0.0113	16075.413
24	10.5500	248.9174	4.5832	-824357.852	5258.5663
25	116.3694	271.0000	0.0140	6501916.625	514.8476
26	0.0000	-0.0037	0.0275	-247.287	1.3843
27	130.6352			0.0000	0.0000
28	3.3462	0.0000	422.8262	51624.3496	10741.1738
29	-4.9440	0.0000	-0.9900		
30	0.0000	0.0000	-1.5276		
31					
32					
33					

1	475.0000	124148.639	212188.078	389019.188	3466016.156
2	17956.2588	16623.1411	21496556.50	20907539.75	9.4979
3	3544539.906	1264667.219	4167338.406	476874.223	3559171.563
4	294772.395	6428221.125	180098.809	162268.613	74.1097
5	130572.881	98548.183	267378.688	27274.781	4.7507
6	16269.5643	5327.2783	17477.9133	3487.3277	54.9892
7	-3256.2564	-1218.6633	-3998.2312	822.0105	-0.1477
8	1013.3609	299.2605	981.8239	206.2370	-0.2657
9	212184.818	212184.832	-0.012	-12.492	-0.004
10	-570.041	-570.710	0.034	-143.963	-0.056
11	-1025.302	-1025.240	0.002	-2522.065	0.776
12	1.8241	-0.0887	0.0000	103710.346	0.5793
13	-3.5956	-0.0086	0.0000	2186727.563	-1.3896
14	-0.0000	0.0007	0.0000	2188558.031	0.0000
15	-87.5950	-0.3357	0.0000	-0.0054	0.0855
16	-4.9851	-0.0141	0.0000	-0.0855	0.0086
17	0.0000	0.0000	0.0000	-0.0086	0.0000
18	-1.8157	-1.6809	-1.7052	-0.2768	-0.0007
19	80.7980	81.4871	81.4919	0.1541	-0.0471
20	425.6208	0.0000	-497.7027	0.0000	0.000
21	0.0002	7.0718	0.0000	2299.2911	701.437
22	69.9411	30.7244	30.3603	-30.4723	-0.0411
23	14.8586	14.8235	-1.0675	-0.0124	16623.142
24	0.0000	240.5733	4.5815	-757698.688	5438.5930
25	115.3577	270.1101	0.0133	6508366.875	470.0653
26	0.0000	0.9479	0.0287	-231.086	1.6957
27	131.0270			0.0000	0.0000
28	2.4050	0.0000	430.2184	47267.6738	9947.5530
29	-4.9851	0.0000	-1.0299		
30	0.0000	0.0000	-1.5875		
31					
32					
33					

1	470.0000	126689.171	220898.416	591611.430	3383911.250
2	17683.1880	16349.9327	21499186.25	20907578.00	9.2784
3	3463822.656	1238218.933	4080566.063	459647.969	3479999.656
4	310746.016	6434207.000	199737.523	158165.076	74.0762
5	125570.822	97062.488	262504.371	26255.778	5.1230
6	16016.4504	5251.7505	17230.1191	3402.9023	56.0985
7	-3133.4580	-1175.7841	-3857.5518	819.3170	-0.1736
8	987.4523	295.0060	967.8655	201.3496	-0.2677
9	220894.824	220894.838	-0.012	0.112	-0.006
10	-683.725	-684.341	0.033	-10.880	-0.056
11	-1054.013	-1054.023	0.002	16.340	0.748
12	2.1912	-0.0763	0.0000	103717.230	0.7792
13	-3.5855	0.0011	0.0000	2208063.031	-1.3626
14	-0.0000	-0.0000	0.0000	2209890.438	0.0000
15	-87.0275	-0.0743	0.0000	-0.0048	0.0762
16	-4.9481	-0.0013	0.0000	-0.0762	-0.0011
17	0.0000	0.0000	0.0000	0.0011	0.0000
18	-1.7874	-1.6526	-1.6772	-0.2734	-0.0006
19	80.6351	81.3474	81.3521	0.1775	0.0006
20	425.6208	425.8391	-518.9945	-524.3186	223267.684
21	0.0002	6.9406	0.0000	2309.2466	698.812
22	70.1927	30.6888	30.5249	-30.4649	-0.0410
23	14.9603	14.9249	-1.0770	-0.0118	16349.933
24	5.3000	243.9000	4.5831	-796395.602	5348.1242
25	116.3496	271.0000	0.0142	6504587.750	497.0278
26	0.0000	-0.0064	0.0277	-239.589	1.3458
27	130.8316			0.0000	0.0000
28	2.9725	0.0000	426.4525	49411.8398	10343.8760
29	-4.9481	0.0000	-1.0097		
30	0.0000	0.0000	-1.5571		
31					
32					
33					

1	480.0000	121709.948	204549.713	586342.656	3547445.938
2	18225.0750	16892.0825	21493841.75	20907501.75	9.7210
3	3626508.531	1291488.641	4255335.063	494518.734	3639692.625
4	278178.443	6422018.813	159750.107	166383.537	74.1430
5	135704.291	100054.999	272322.301	28318.096	4.3833
6	16517.3628	5401.1234	17720.1868	3570.2596	54.0717
7	-3382.1845	-1262.5186	-4142.1135	823.7020	-0.1829
8	1039.2426	303.4737	995.6468	211.0936	-0.2612
9	204546.141	204546.154	-0.013	6.870	-0.004
10	-691.790	-692.268	0.035	77.580	-0.062
11	-988.145	-988.060	0.003	1355.543	0.778
12	0.9460	-0.0616	0.0000	103703.436	0.8591
13	-3.6624	-0.0121	0.0000	2164906.781	-1.3924
14	0.0000	-0.0005	0.0000	2166740.313	0.0000
15	-88.1925	-0.0737	0.0000	-0.0039	0.0614
16	-5.0347	-0.0123	0.0000	-0.0614	0.0121
17	0.0000	0.0000	0.0000	-0.0121	0.0000
18	-1.8465	-1.7114	-1.7353	-0.2768	-0.0003
19	80.9631	81.6296	81.6345	0.1939	-0.0126
20	425.6208	0.0000	-478.3205	0.0000	0.000
21	0.0002	7.2024	0.0000	2289.0119	704.047
22	69.6851	30.7599	30.3956	-30.4799	-0.0411
23	14.2584	14.2178	-1.1209	-0.0130	16892.083
24	0.0000	240.5733	4.5820	-731803.055	5526.5717
25	109.9430	264.8206	0.0132	6510459.250	452.6185
26	0.0000	-0.0582	0.0302	-221.716	1.8928
27	131.2213			0.0000	0.0000
28	1.8075	0.0000	434.0626	45221.4844	9555.0967
29	-5.0347	0.0000	-1.0504		-12.8296
30	0.0000	0.0000	-1.6184		88.9564
31	1200.1439	33693.9912	0.49353	48.2212	-178.2175
32	3539.1064	18208.1313	31.6114	184985988.0	-166.0906
33	724.6427	1259.6675	19207.9409	56.5836	31.7680

TABLE AP 3-2 (Sheet 13 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	485.0000	119359.048	198299.322	583576.555	3630182.623
2	18490.4497	17157.5869	21491037.75	20907463.75	9.9478
3	3709704.563	1318675.609	4344531.000	512574.730	3721541.623
4	260947.180	6415594.875	138674.109	170504.447	74.1761
5	140965.420	101582.890	277335.055	29385.730	4.0208
6	16760.8000	5473.5827	17957.9138	3651.9961	53.4520
7	-3510.5046	-1307.1326	-4288.4846	824.6066	-0.1681
8	1065.2403	307.6871	1009.4701	215.9611	-0.2606
9	198295.967	198295.980	-0.014	-0.491	-0.005
10	-623.630	-624.269	0.036	24.645	-0.066
11	-966.852	-966.809	0.003	-132.730	0.810
12	0.6427	-0.0855	0.0000	103696.527	0.7856
13	-3.7052	-0.0065	0.0000	2142784.438	-1.3992
14	0.0000	0.0001	0.0000	2144621.000	0.0000
15	-88.5694	-0.0740	0.0000	-0.0055	0.0853
16	-5.1044	-0.0061	0.0000	-0.0853	0.0065
17	0.0000	0.0000	0.0000	-0.0065	0.0000
18	-1.8765	-1.7412	-1.7647	-0.2793	-0.0002
19	81.1308	81.7754	81.7803	0.1804	0.0027
20	425.6208	0.0000	-462.8480	0.0000	0.000
21	0.0002	7.3326	0.0000	2278.3888	706.652
22	69.4248	30.7953	30.6309	-30.4878	-0.0412
23	14.2315	14.1891	-1.1436	-0.0136	17157.587
24	0.0000	240.5733	4.5819	-701738.609	5613.6076
25	104.5243	259.3238	0.0138	6512868.500	430.6572
26	0.0000	-0.0569	0.0315	-211.044	2.1842
27	131.4145			0.0000	0.0000
28	1.4306	0.0000	437.9471	43259.2109	9166.5125
29	-5.1044	0.0000	-1.0710		-12.4456
30	0.0000	0.0000	-1.6493		89.2672
31	1247.3049	52408.4189	0.47878	48.9382	-178.0769
32	3538.8069	18472.1230	31.6108	189772222.0	-165.6936
33	731.2032	1288.3442	19455.5364	56.0229	31.7752

1	500.0000	112598.143	190033.352	574808.773	3886173.938
2	19286.1812	17953.7217	21482156.75	20907350.50	10.6493
3	3966549.063	1402394.391	4619198.375	569185.414	3974984.125
4	205356.443	6394968.188	71001.368	182876.977	74.2743
5	157533.018	106292.625	292786.914	32734.688	2.9613
6	17487.0330	5689.4330	18666.0828	3896.8356	54.2995
7	-3902.7292	-1443.5591	-4736.0770	824.5616	-0.1832
8	1143.9043	320.2276	1050.6135	230.5289	-0.2704
9	190029.895	190029.912	-0.016	3.710	-0.006
10	-641.188	-641.004	0.042	17.559	-0.065
11	-946.251	-946.372	0.003	744.116	0.931
12	-0.0247	0.0323	0.0000	103675.702	1.0074
13	-3.6056	0.0169	0.0000	2074144.636	-1.4065
14	-0.0000	-0.0003	0.0000	2075990.516	0.0000
15	-89.0145	0.0531	0.0000	0.0020	-0.0323
16	-5.0120	0.0147	0.0000	0.0323	-0.0169
17	0.0000	0.0000	0.0000	0.0169	0.0000
18	-1.9251	-1.7920	-1.8143	-0.2853	-0.0005
19	81.6447	82.2262	82.2314	0.1933	0.0006
20	425.6208	0.0000	-442.3194	0.0000	0.000
21	0.0002	7.7302	0.0000	2244.7162	714.604
22	68.6180	30.9007	30.7359	-30.5128	-0.0413
23	14.3554	14.3244	-0.9845	-0.0158	17953.722
24	0.0000	240.5733	4.5823	-624491.383	5844.2938
25	91.2158	246.6790	0.0172	6518200.563	373.7435
26	0.0000	0.3778	0.0317	-174.341	3.0056
27	131.9867			0.0000	0.0000
28	0.9855	0.0000	449.9587	37649.0645	8015.8823
29	-5.0120	0.0000	-1.1340		-11.3163
30	0.0000	0.0000	-1.7437		90.2632
31	1398.7971	48722.1538	0.43330	51.2649	-177.6241
32	3537.8393	19263.8506	31.6091	204531468.0	-164.3888
33	752.1987	1380.3315	20199.9128	54.2237	31.7802

1	490.0000	117070.623	194285.869	580725.820	3714214.844
2	18754.4172	17421.6870	21488149.25	20907426.00	10.1780
3	3794111.219	1346222.766	4434908.625	531037.742	3804705.344
4	243070.521	6408946.563	116862.239	174628.590	74.2091
5	146356.768	103131.841	282416.906	30477.720	3.6629
6	17002.1160	5545.3489	18193.3569	3733.2259	53.3938
7	-3640.3487	-1352.2599	-4436.5396	824.9697	-0.1721
8	1091.3786	311.8994	1023.2899	220.8381	-0.2616
9	194282.508	194282.523	-0.014	1.128	-0.005
10	-626.092	-626.554	0.038	84.272	-0.068
11	-951.933	-951.938	0.003	164.865	0.839
12	0.2629	-0.0608	0.0000	103689.619	0.8359
13	-3.7180	0.0031	0.0000	2120556.750	-1.3972
14	-0.0000	-0.0000	0.0000	2122396.375	0.0000
15	-88.8987	-0.0521	0.0000	-0.0039	0.0807
16	-5.1151	0.0045	0.0000	-0.0607	-0.0031
17	0.0000	0.0000	0.0000	0.0031	0.0000
18	-1.9015	-1.7663	-1.7894	-0.2807	-0.0010
19	81.3007	81.9237	81.9288	0.1848	-0.0012
20	425.6208	0.0000	-453.0545	0.0000	0.000
21	0.0002	7.4634	0.0000	2267.4405	709.269
22	69.1601	30.8306	30.6661	-30.4959	-0.0412
23	14.1248	14.0825	-1.1373	-0.0143	17421.688
24	0.0000	240.5733	4.5817	-671166.945	5700.0140
25	99.1387	253.6777	0.0146	6515161.875	407.8501
26	0.0000	-0.0303	0.0322	-198.697	2.5231
27	131.6064			0.0000	0.0000
28	1.1013	0.0000	441.8466	41356.4434	8780.8992
29	-5.1151	0.0000	-1.0916		-12.0679
30	0.0000	0.0000	-1.6802		89.5861
31	1295.8282	51158.5415	0.46391	49.6795	-177.9298
32	3538.4990	18734.6904	31.6101	194599900.0	-165.2809
33	737.9153	1317.7482	19702.1189	55.4478	31.7797

1	505.0000	110394.063	188825.404	571775.867	3974122.781
2	19555.8035	18223.4761	21479086.50	20907313.25	10.8903
3	4054597.031	1431023.578	4713126.000	588876.891	4062123.250
4	185516.297	6387636.438	46947.134	186999.316	74.3066
5	163318.035	107903.934	298073.348	33899.252	2.6176
6	17733.0698	5762.5201	18905.8694	3979.9878	55.0315
7	-4032.8782	-1489.0270	-4885.2496	824.4918	-0.1901
8	1170.1354	324.2892	1063.9389	235.2888	-0.2761
9	188821.885	188821.902	-0.017	5.139	-0.007
10	-652.227	-651.198	0.046	-6.242	-0.060
11	-947.352	-947.474	0.003	1064.891	1.018
12	0.4200	0.1531	0.0000	103668.661	1.1983
13	-3.5201	0.0169	0.0000	2049503.625	-1.4170
14	-0.0000	-0.0004	0.0000	2051352.625	0.0000
15	-88.3783	0.1878	0.0000	0.0094	-0.1528
16	-4.9371	0.0148	0.0000	0.1528	-0.0169
17	0.0000	0.0000	0.0000	0.0169	0.0000
18	-1.9149	-1.7844	-1.8063	-0.2875	-0.0004
19	81.8180	82.3794	82.3846	0.1976	0.0019
20	425.6208	0.0000	-439.4069	0.0000	0.000
21	0.0002	7.8668	0.0000	2233.0684	717.335
22	68.3403	30.9335	30.7706	-30.5215	-0.0414
23	15.0398	15.0166	-0.8741	-0.0165	18223.477
24	0.0000	240.5733	4.5842	-605909.625	5931.2200
25	88.1743	247.1056	0.0209	6518969.875	362.8016
26	0.0000	0.9429	0.0310	-158.137	3.1435
27	132.1751			0.0000	0.0000
28	1.6217	0.0000	454.2472	35825.4922	7635.4204
29	-4.9371	0.0000	-1.1561		-10.9382
30	0.0000	0.0000	-1.7769		90.6316
31	1453.8658	47525.4399	0.41744	52.1193	-177.4758
32	3537.4678	19532.5056	31.6090	209674132.0	-163.9020
33	760.0581	1414.5231	20432.9065	53.5551	31.7754

1	495.0000	114821.964	191819.203	577798.336	3799542.250
2	19019.1545	17686.5593	21485184.50	20907388.25	10.4119
3	3879724.125	1374128.516	4526462.750	549907.117	3889183.063
4	224541.619	6402071.563	94306.431	178753.354	74.2418
5	151879.184	104701.816	287567.734	31594.084	3.3098
6	17243.6174	5617.1186	18428.8311	3814.6593	53.7483
7	-3771.3338	-1397.8042	-4585.9630	824.8862	-0.1759
8	1117.6256	316.0898	1037.0381	225.7042	-0.2656
9	191815.818	191815.834	-0.015	1.699	-0.005
10	-627.705	-628.000	0.040	46.774	-0.068
11	-947.701	-947.786	0.003	308.960	0.877
12	0.0103	-0.0366	0.0000	103682.671	0.8838
13	-3.6783	0.0116	0.0000	2097558.219	-1.4006
14	0.0000	-0.0001	0.0000	2099400.969	0.0000
15	-89.1033	-0.0279	0.0000	-0.0023	0.0365
16	-5.0789	0.0100	0.0000	-0.0365	-0.0116
17	0.0000	0.0000	0.0000	0.0116	0.0000
18	-1.9188	-1.7843	-1.8070	-0.2831	-0.0005
19	81.4721	82.0742	82.0793	0.1876	0.0003
20	425.6208	0.0000	-447.0997	0.0000	0.000
21	0.0002	7.5938	0.0000	2256.1976	711.915
22	68.8912	30.8657	30.7011	-30.5043	-0.0413
23	14.1364	14.0985	-1.0780	-0.0150	17686.360
24	0.0000	240.5733	4.5817	-651207.203	5757.6060
25	95.7040	250.2124	0.0153	6516554.000	392.9541
26	0.0000	0.0603	0.0322	-189.473	2.7427
27	131.7972			0.0000	0.0000
28	0.8967	0.0000	445.8694	39491.1367	8397.5896
29	-5.0789	0.0000	-1.1126		-11.6923
30	0.0000	0.0000	-1.7118		89.9167
31	1346.1893	49932.4604	0.44878	50.4329	-177.7778
32	3538.1786	18998.0649	31.6095	199509544.0	-164.8476
33	744.8739	1348.2617	19949.7573	54.8510	31.7815

1	510.0000	108202.402	187987.857	568732.727	4063403.906
2	19827.9758	18495.7681	21476006.00	20907276.00	11.1350
3	4143883.438	1460020.703	4808260.688	608987.078	4150619.969
4	165034.518	6380079.813	22155.232	191123.723	74.3386
5	169234.172	109535.371	303425.824	35087.464	2.2788
6	17982.3872	5836.6093	19148.9436	4064.3490	55.8972
7	-4138.8461	-1533.3211	-5030.5714	823.5619	-0.1859
8	1196.3262	328.2817	1077.0374	239.9912	-0.2827
9	187984.398	187984.416	-0.017	0.645	-0.008
10	-625.316	-623.311	0.053	-49.777	-0.055
11	-950.799	-950.908	0.002	226.482	1.158
12	1.5464	0.2907	0.0000	103661.580	1.3333
13	-3.4388	0.0131	0.0000	2024201.656	-1.4312
14	-0.0000	-0.0001	0.0000	2026053.813	0.0000
15	-87.1166	0.2531	0.0000	0.0174	-0.2902
16	-4.8700	0.0100	0.0000	0.2902	-0.0151
17	0.0000	0.0000	0.0000	0.0151	0.0000
18	-1.8796	-1.7532	-1.7747	-0.2898	-0.0009
19	81.9921	82.3339	82.3389	0.1900	-0.0113
20	425.6208	0.0000	-437.3847	0.0000	0.000
21	0.0003	8.0053	0.0000	2221.3812	720.079
22	68.0583	30.9700	30.8050	-30.3301	-0.0414
23	16.3841	16.3683	-0.7597	-0.0174	18495.769
24	0.0000	240.5733	4.5878	-597885.477	6018.2813
25	86.1206	250.6265	0.0260	6518720.250	363.6810
26	0.0000	0.5615	0.0303	-141.585	3.1381
27	132.3623			0.0000	0.0000
28	2.8834	0.0000	458.6431	34013.5254	7255.7727
29	-4.8700	0.0000	-1.1787		-10.5566
30	0.0000	0.0000	-1.8108		91.0311
31	1511.5681	46341.5615	0.40119	53.0189	-177.3474
32	3537.0404	19804.2480	31.6092	214939724.0	-163.3852
33	768.7305	1451.7487	20708.7368	52.8272	31.7661

TABLE AP 3-2 (Sheet 14 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	515.0000	106019.074	187429.438	565727.008	4194030.031
2	20102.3642	18770.4573	21472964.00	20907239.00	11.3833
3	4234423.188	1489391.047	4904619.938	629522.422	4240493.000
4	143939.426	6372306.563	-3347.475	195258.205	74.3704
5	175281.178	111186.646	308843.379	36299.095	1.9452
6	18235.4282	5911.8592	19393.8259	4130.0804	56.8789
7	-4278.3879	-1575.7634	-5169.8173	828.4482	-0.1669
8	1222.5547	332.2329	1090.0008	244.6643	-0.2891
9	187426.186	187426.205	-0.018	-10.735	-0.009
10	-549.983	-550.770	0.039	-3.547	-0.052
11	-952.689	-952.767	0.002	-2126.644	1.279
12	2.2464	-0.1018	0.0000	103654.403	0.7212
13	-3.3860	0.0077	0.0000	1997323.234	-1.4448
14	0.0000	0.0008	0.0000	1999178.363	0.0000
15	-87.0306	-0.1138	0.0000	-0.0060	0.1019
16	-4.8308	0.0058	0.0000	-0.1016	-0.0077
17	0.0000	0.0000	0.0000	0.0077	0.0000
18	-1.8127	-1.6926	-1.7136	-0.2912	-0.0003
19	82.1674	82.6898	82.6947	0.1684	0.0132
20	425.6208	0.0000	-436.0384	0.0000	0.000
21	0.0003	8.1454	0.0000	2209.8378	722.181
22	67.7717	31.0044	30.8392	-30.5387	-0.0415
23	17.2781	17.2682	-0.6798	-0.0183	18770.458
24	0.0000	240.3733	4.3893	-575692.344	6106.7100
25	82.1170	249.0764	0.0228	6519737.563	354.6814
26	0.0000	0.3515	0.0298	-125.426	2.9998
27	132.5483			0.0000	0.0000
28	2.9694	0.0000	463.2942	32209.3203	6876.6914
29	-4.8308	0.0000	-1.2024		-10.1702
30	0.0000	0.0000	-1.8463		91.4729
31	1572.0684	43170.2598	0.38434	53.9669	-177.2535
32	3536.5388	20079.1633	31.6096	220329096.0	-162.8361
33	778.4978	1492.9784	20967.3389	32.0212	31.7507

1	530.0000	99497.052	186327.887	557227.719	4434200.000
2	20958.4888	19626.6494	21464355.25	20907129.75	12.1511
3	4513809.875	1579809.234	5201266.938	693757.677	4518642.938
4	77034.184	6347699.063	-84080.709	207732.377	74.4838
5	194220.883	116259.667	325487.117	40075.254	0.9768
6	19024.0393	6146.2977	20164.9795	4417.2345	60.2310
7	-4646.7491	-1706.7823	-5599.6686	833.1860	-0.2031
8	1303.4675	344.2542	1129.4406	258.9234	-0.3123
9	186324.297	186324.318	-0.021	-0.124	-0.010
10	-627.973	-629.276	0.063	-20.878	-0.054
11	-963.918	-963.908	0.002	-46.521	1.324
12	0.0923	-0.1675	0.0000	103632.428	0.7322
13	-3.3374	-0.0016	0.0000	1909882.063	-1.4828
14	-0.0000	0.0000	0.0000	1911747.078	0.0000
15	-89.1736	-0.1672	0.0000	-0.0098	0.1673
16	-4.8202	-0.0036	0.0000	-0.1673	0.0016
17	0.0000	0.0000	0.0000	-0.0016	0.0000
18	-1.3663	-1.4667	-1.4864	-0.2970	-0.0003
19	82.7040	83.1702	83.1743	0.1935	0.0009
20	429.9263	429.8978	-433.3866	-434.4077	186750.920
21	0.0003	8.3822	0.0000	2176.3505	728.733
22	66.8845	31.1058	30.9402	-30.5630	-0.0416
23	15.6989	15.6880	-0.6144	-0.0212	19626.650
24	0.0000	240.3733	4.5908	-498598.453	6331.4917
25	69.2644	239.3425	0.0149	6523611.250	317.1176
26	0.0000	0.0214	0.0293	-87.857	2.3198
27	133.1002			0.0000	0.0000
28	0.8264	0.0000	478.3899	26822.7422	5741.3792
29	-4.8202	0.0000	-1.2785		-8.9783
30	0.0000	0.0000	-1.9603		93.0225
31	1776.3471	41663.6978	0.33111	57.2110	-176.9932
32	3534.9931	20937.1677	31.6111	237638752.0	-160.8376
33	812.8042	1638.1161	21777.0796	49.1873	31.6528

1	520.0000	103841.158	187077.238	562800.448	4246020.000
2	20381.9507	19049.9375	21470000.25	20907202.25	11.6354
3	4326243.625	1319141.047	5002224.688	630490.297	4331772.813
4	122248.843	6364321.500	-29345.240	199407.387	74.4018
5	181460.031	112857.684	314325.777	37334.129	1.6172
6	18493.0972	5988.4818	19647.2119	4237.3974	57.9627
7	-4398.3301	-1618.4444	-5309.8466	831.0395	-0.1945
8	1249.0696	336.1934	1102.9914	249.3576	-0.2968
9	187073.707	187073.727	-0.019	0.699	-0.009
10	-627.789	-628.735	0.061	-35.579	-0.051
11	-957.983	-958.022	0.002	136.455	1.300
12	1.5630	-0.1224	0.0000	103647.175	0.7850
13	-3.3514	0.0091	0.0000	1969595.922	-1.4584
14	0.0000	-0.0001	0.0000	1971454.453	0.0000
15	-87.6480	-0.1306	0.0000	-0.0072	0.1222
16	-4.8098	0.0018	0.0000	-0.1222	-0.0051
17	0.0000	0.0000	0.0000	0.0051	0.0000
18	-1.7349	-1.6215	-1.6421	-0.2934	-0.0003
19	82.3442	82.8476	82.8523	0.1926	-0.0019
20	429.8703	429.8703	-433.1864	-433.1864	187073.725
21	0.0003	8.2878	0.0000	2198.5984	724.316
22	67.4806	31.0383	30.8732	-30.5471	-0.0413
23	16.7880	16.7772	-0.6387	-0.0192	19049.938
24	0.0000	240.3733	4.3902	-549383.102	6196.7542
25	77.5927	246.2315	0.0190	6521052.500	343.0097
26	0.0000	0.1920	0.0295	-110.223	2.7810
27	132.7333			0.0000	0.0000
28	2.3520	0.0000	468.0827	30410.1563	6497.9827
29	-4.8098	0.0000	-1.2267		-9.7790
30	0.0000	0.0000	-1.8826		91.9503
31	1636.0549	44002.4004	0.36735	54.9737	-177.1681
32	3536.0204	20339.1433	31.6100	225894018.0	-162.2393
33	789.0815	1537.6115	21231.0479	31.1491	31.7279

1	535.0000	97334.063	185632.154	554600.516	4550449.375
2	21255.8984	19924.1396	21461692.25	20907094.00	12.4149
3	4609610.188	1610742.766	5302754.688	716074.242	4614291.750
4	53477.908	6339050.688	-112454.646	211896.727	74.4946
5	200808.018	117991.261	331168.188	61382.125	0.6640
6	19297.2617	6227.4626	20431.2681	4509.7739	61.3599
7	-4776.4056	-1752.8024	-5730.6528	832.3340	-0.2091
8	1331.5361	348.4065	1143.0638	263.8464	-0.3200
9	183628.523	183628.547	-0.022	0.369	-0.010
10	-632.591	-633.930	0.064	-11.789	-0.057
11	-968.031	-968.004	0.003	40.355	1.323
12	-0.7584	-0.1765	0.0000	103624.896	0.7386
13	-3.3517	-0.0039	0.0000	1876978.625	-1.4939
14	0.0000	-0.0000	0.0000	1878846.933	0.0000
15	-90.0181	-0.1685	0.0000	-0.0100	0.1702
16	-4.8456	-0.0039	0.0000	-0.1702	0.0039
17	0.0000	0.0000	0.0000	-0.0039	0.0000
18	-1.4784	-1.3897	-1.4049	-0.2988	-0.0004
19	82.8876	83.3356	83.3396	0.1937	0.0003
20	429.9642	429.9133	-431.7302	-433.8036	186497.943
21	0.0003	8.7413	0.0000	2161.9366	731.119
22	66.5793	31.1390	30.9733	-30.5705	-0.0417
23	15.0434	15.0316	-0.6250	-0.0223	19924.140
24	0.0000	240.3733	4.5909	-465269.339	6447.0636
25	63.9569	234.3867	0.0134	6525208.000	298.5323
26	0.0000	-0.0248	0.0294	-76.434	2.0355
27	133.2821			0.0000	0.0000
28	-0.0181	0.0000	483.9969	25037.3594	5363.8137
29	-4.8456	0.0000	-1.3062		-8.5679
30	0.0000	0.0000	-2.0017		93.6287
31	1853.3824	40496.9819	0.31202	58.4521	-176.8980
32	3534.4945	21235.3967	31.6116	243834862.0	-160.0473
33	826.1917	1695.1019	22039.6729	48.0767	31.5956

1	525.0000	101666.966	186780.039	559963.136	4339400.063
2	20667.1702	19335.2463	21467127.25	20907166.00	11.8913
3	4419363.000	1349277.844	5101098.500	671899.063	4424479.250
4	99951.915	6356120.625	-56630.885	203367.166	74.4330
5	187772.318	114348.604	319873.402	38792.738	1.2945
6	18755.9269	6066.6174	19903.5620	4326.4438	59.1082
7	-4520.9283	-1662.0387	-5452.9378	832.6979	-0.1966
8	1276.0040	340.1897	1116.1057	254.1007	-0.3044
9	186776.302	186776.323	-0.020	-0.777	-0.010
10	-621.165	-622.355	0.062	-16.243	-0.052
11	-961.997	-962.009	0.002	-171.439	1.319
12	0.8977	-0.1514	0.0000	103639.832	0.7422
13	-3.3371	0.0014	0.0000	1940190.734	-1.4703
14	0.0000	0.0000	0.0000	1942052.484	0.0000
15	-88.3382	-0.1586	0.0000	-0.0088	0.1511
16	-4.8074	-0.0015	0.0000	-0.1511	-0.0014
17	0.0000	0.0000	0.0000	0.0014	0.0000
18	-1.6523	-1.5438	-1.5659	-0.2971	-0.0004
19	82.5230	83.0077	83.0121	0.1909	0.0021
20	429.8978	429.8842	-434.4673	-434.8338	186929.057
21	0.0003	8.4328	0.0000	2187.7018	726.492
22	67.1849	31.0723	30.9069	-30.5352	-0.0416
23	16.3118	16.3013	-0.6182	-0.0202	19335.247
24	0.0000	240.3733	4.5907	-519775.359	6288.8685
25	72.6768	242.3599	0.0163	6522535.313	328.3228
26	0.0000	0.0757	0.0293	-96.312	2.5111
27	132.9172			0.0000	0.0000
28	1.6418	0.0000	473.1588	28614.4688	6119.5217
29	-4.8074	0.0000	-1.2322		-9.3820
30	0.0000	0.0000	-1.9209		92.4630
31	1704.0219	42834.3813	0.34953	56.0546	-177.0821
32	3535.5035	20645.0669	31.6106	231660276.0	-161.5838
33	800.4784	1585.8166	21500.8718	30.2078	31.6960

1	540.0000	93179.636	184913.451	552089.125	4628177.563
2	21559.4031	20227.7195	21459143.50	20907038.50	12.6827
3	4706789.375	1642085.813	5405586.000	738857.820	4711653.375
4	29263.323	6330168.750	-141394.691	216053.297	74.5247
5	207537.211	119743.875	336918.223	42713.904	0.3559
6	19375.3193	6310.0836	20702.3408	4603.9764	62.3059
7	-4910.1262	-1800.1900	-5906.1237	830.0668	-0.2152
8	1360.2780	352.6658	1157.0377	268.8889	-0.3278
9	184909.783	184909.807	-0.023	0.796	-0.011
10	-636.587	-637.873	0.065	-1.973	-0.062
11	-969.836	-969.800	0.003	115.937	1.319
12	-1.5932	-0.1615	0.0000	103617.296	0.7608
13	-3.3749	-0.0091	0.0000	1842678.000	-1.5037
14	0.0000	-0.0000	0.0000	1844569.672	0.0000
15	-90.8306	-0.1568	0.0000	-0.0095	0.1612
16	-4.8786	-0.0069	0.0000	-0.1612	0.0051
17	0.0000	0.0000	0.0000	-0.0051	0.0000
18	-1.3889	-1.3031	-1.3219	-0.3003	-0.0003
19	83.0741	83.3040	83.3078	0.1976	0.0006
20	430.0075	429.9313	-430.0153	-433.0723	186191.338
21	0.0004	8.9029	0.0000	2148.1361	733.543
22	66.2691	31.1718	31.0060	-30.5777	-0.0417
23	14.4068	14.3935	-0.6439	-0.0234	20227.720
24	0.0000	240.3733	4.5908	-430778.281	6544.7012
25	58.6065	229.2069	0.0127	6526749.438	278.3824
26	0.0000	-0.0346	0.0296	-66.441	1.7789
27	133.4631			0.0000	0.0000
28	-0.8304	0.0000	489.8064	23259.9063	6986.9043
29	-4.8786	0.0000	-1.3367		-8.1490
30	0.0000	0.0000	-2.0444		94.2923
31	1935.5247	39328.7100	0.29223	59.7839	-176.7944
32	3534.0101	21539.7483	31.6121	250254344.0	-159.1355
33	840.8907	1737.6528	22348.6594	46.8395	31.5205

TABLE AP 3-2 (Sheet 15 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	545.0000	93033.681	184240.107	549700.219	4727413.938
2	21869.1765	20537.5630	21456721.25	20907023.50	12.9546
3	4805372.563	1673845.672	5509784.813	762116.711	4810155.438
4	4370.078	6321046.563	-171523.199	220195.035	74.5548
5	214411.914	121518.086	342739.113	44071.228	0.0520
6	19858.9917	6394.2216	20978.3767	4699.9194	63.7148
7	-5047.8259	-1848.9231	-6066.0089	826.4097	-0.2208
8	1389.7502	357.0469	1171.4114	274.0660	-0.3362
9	184236.406	184236.432	-0.025	0.815	-0.011
10	-638.427	-639.615	0.066	4.698	-0.066
11	-972.010	-971.975	0.003	116.933	1.315
12	-2.3637	-0.1466	0.0000	103609.556	0.7879
13	-3.4004	-0.0069	0.0000	1807080.125	-1.5124
14	0.0000	-0.0000	0.0000	1808955.188	0.0000
15	-91.5737	-0.1413	0.0000	-0.0087	0.1466
16	-4.9128	-0.0067	0.0000	-0.1466	0.0049
17	0.0000	0.0000	0.0000	-0.0049	0.0000
18	-1.2973	-1.2183	-1.2365	-0.3023	-0.0004
19	83.2635	83.6756	83.6791	0.1989	0.0003
20	430.0471	429.9506	-428.4098	-432.2962	185865.986
21	0.0004	9.0669	0.0000	2135.0516	736.004
22	65.9539	31.2043	31.0384	-30.5846	-0.0417
23	13.8364	13.8216	-0.6639	-0.0245	20537.563
24	0.0000	240.5733	4.5907	-395710.633	6644.3799
25	53.2654	224.0339	0.0127	6528184.188	257.2612
26	0.0000	-0.0276	0.0298	-57.688	1.5661
27	133.6432			0.0000	0.0000
28	-1.5737	0.0000	493.9645	21490.3105	4610.5708
29	-4.9128	0.0000	-1.3647		-7.7201
30	0.0000	0.0000	-2.0894		95.0268
31	2023.2702	38160.6348	0.27179	61.2226	-176.6823
32	3533.5381	21850.4133	31.6124	256906748.0	-158.0991
33	857.0996	1827.0712	22644.2073	45.5112	31.4221

1	560.0000	86631.048	183166.820	543372.461	5034492.688
2	22839.9097	21508.4661	21450291.00	20906921.00	13.7962
3	5109827.750	1771708.109	5830855.188	834838.578	5115815.750
4	-74569.351	6292173.750	-266250.074	232464.533	74.6438
5	235947.197	126976.729	360448.016	48303.529	-0.8352
6	20744.9946	6657.0244	21840.5886	4999.5352	68.0251
7	-5482.7333	-2002.6314	-6570.3002	807.6078	-0.2390
8	1482.8579	370.9865	1217.1254	290.4650	-0.3654
9	183163.012	183163.041	-0.028	0.190	-0.012
10	-643.537	-644.634	0.069	3.472	-0.077
11	-983.825	-983.813	0.004	0.562	1.305
12	-4.3511	-0.1286	0.0000	103585.695	0.8264
13	-3.4541	-0.0020	0.0000	1689153.047	-1.5366
14	0.0000	0.0000	0.0000	1691038.516	0.0000
15	-93.5225	-0.1288	0.0000	-0.0078	0.1284
16	-4.9907	-0.0034	0.0000	-0.1284	0.0020
17	0.0000	0.0000	0.0000	-0.0020	0.0000
18	-0.9974	-0.9393	-0.9561	-0.3077	-0.0003
19	83.8497	84.2096	84.2123	0.2016	0.0004
20	430.0783	429.9971	-425.8830	-430.2497	185005.998
21	0.0004	9.5737	0.0000	2100.3349	749.606
22	64.9772	31.2990	31.1328	-30.6027	-0.0419
23	12.4488	12.4306	-0.6955	-0.0280	21508.464
24	0.0000	240.5733	4.5906	-287793.531	6956.7778
25	37.3184	208.8206	0.0136	6531757.688	190.0100
26	0.0000	-0.0266	0.0305	-36.461	1.1858
27	134.1783			0.0000	0.0000
28	-3.3225	0.0000	516.0840	16214.1250	3484.2524
29	-4.9907	0.0000	-1.4621		-6.3451
30	0.0000	0.0000	-2.2352		97.8680
31	2326.8325	34647.8931	0.20572	66.2841	-176.3037
32	3532.1730	22824.4319	31.6130	278410372.0	-153.8512
33	921.0390	2099.4803	23573.8928	40.2553	30.8862

1	550.0000	90894.997	183704.623	547443.133	4828189.563
2	22185.5122	20853.9619	21454429.25	20906988.75	13.2308
3	4905386.625	1706030.172	5615376.813	785839.867	4910427.688
4	-21221.244	6311677.438	-202261.701	224315.133	74.5847
5	221435.803	123314.528	348432.941	45454.787	-0.2476
6	20148.0264	6479.9777	21259.7283	4797.7127	65.0244
7	-5189.2393	-1898.9326	-6230.0815	821.4235	-0.2263
8	1419.9852	361.5569	1186.2080	279.3848	-0.3451
9	183700.889	183700.916	-0.026	0.569	-0.011
10	-639.266	-640.369	0.067	6.976	-0.070
11	-974.953	-974.923	0.003	70.621	1.314
12	-3.0617	-0.1336	0.0000	103601.740	0.8101
13	-3.4236	-0.0043	0.0000	1770783.750	-1.5207
14	-0.0000	-0.0000	0.0000	1772662.234	0.0000
15	-92.2495	-0.1298	0.0000	-0.0080	0.1334
16	-4.9443	-0.0058	0.0000	-0.1334	0.0043
17	0.0000	0.0000	0.0000	-0.0043	0.0000
18	-1.2022	-1.1300	-1.1478	-0.3041	-0.0003
19	83.4559	83.8504	83.8336	0.1997	0.0003
20	430.0739	429.9690	-427.1380	-431.5358	185346.926
21	0.0004	9.2334	0.0000	2122.6683	738.502
22	65.6336	31.2363	31.0703	-30.5910	-0.0418
23	13.3391	13.3230	-0.6804	-0.0257	20853.963
24	0.0000	240.5733	4.5907	-360253.469	6746.1742
25	47.9483	218.9433	0.0130	6529495.625	235.4756
26	0.0000	-0.0203	0.0301	-49.917	1.4001
27	133.8224			0.0000	0.0000
28	-2.2495	0.0000	502.3104	19727.4844	4234.7595
29	-4.9443	0.0000	-1.3956		-7.2788
30	0.0000	0.0000	-2.1356		95.8486
31	2117.2181	36992.0596	0.25058	62.7740	-176.5626
32	3533.0760	22167.7258	31.6127	263804690.0	-156.9066
33	875.4011	1905.2294	22946.6023	43.9970	31.2927

1	565.0000	84502.001	183119.027	541588.680	5140093.250
2	23179.1548	21847.7500	21448475.00	20906887.75	14.0855
3	5214321.500	1805221.172	5940805.938	860096.078	5221004.688
4	-102362.017	6282026.750	-299540.668	236480.859	74.6730
5	243442.738	128843.849	366773.723	49770.196	-1.1234
6	21054.0837	6748.6628	22141.2393	5103.9177	69.7208
7	-5634.9687	-2056.3973	-6746.6972	798.6963	-0.2466
8	1515.5424	375.8971	1233.2557	296.2297	-0.3767
9	183115.174	183115.203	-0.029	0.235	-0.013
10	-647.616	-648.771	0.069	4.771	-0.079
11	-989.321	-989.317	0.004	5.460	1.289
12	-5.0053	-0.1334	0.0000	103577.434	0.8269
13	-3.4613	-0.0009	0.0000	1644074.672	-1.5447
14	0.0000	0.0000	0.0000	1645963.734	0.0000
15	-94.1762	-0.1320	0.0000	-0.0081	0.1331
16	-5.0061	-0.0028	0.0000	-0.1331	0.0009
17	0.0000	0.0000	0.0000	-0.0009	0.0000
18	-0.8870	-0.8361	-0.8523	-0.3095	-0.0004
19	84.0511	84.3940	84.3965	0.2030	0.0004
20	430.0650	430.0083	-423.7849	-429.7560	184797.268
21	0.0005	9.7475	0.0000	2090.5483	746.212
22	64.6408	31.3296	31.1633	-30.6078	-0.0419
23	11.9925	11.9735	-0.6949	-0.0292	21847.751
24	0.0000	240.5733	4.5906	-263008.914	7029.2806
25	33.7555	205.3780	0.0137	6532408.063	174.1575
26	0.0000	-0.0332	0.0307	-32.399	1.1389
27	134.3551			0.0000	0.0000
28	-4.1762	0.0000	523.6040	14460.0176	3109.3633
29	-5.0061	0.0000	-1.4980		-5.8430
30	0.0000	0.0000	-2.2889		99.1506
31	2444.4101	33469.3081	0.18194	68.2818	-176.1627
32	3531.7321	23165.0396	31.6131	286160684.0	-151.8198
33	930.7123	2225.0976	23899.9075	37.8553	30.5802

1	555.0000	88761.467	183363.924	545329.211	4930337.563
2	22508.9023	21177.4080	21452281.00	20906954.50	13.5113
3	5006861.188	1738647.891	5722390.125	810096.984	5012302.938
4	-47528.527	6302055.188	-233830.643	228407.092	74.6143
5	228612.879	125133.849	354601.828	46865.308	-0.5433
6	20443.1689	6567.5206	21546.9417	4897.5257	66.4639
7	-5334.2303	-1950.1664	-6398.1713	815.1594	-0.2325
8	1451.0145	366.2012	1201.4452	284.8508	-0.3549
9	183360.134	183360.182	-0.027	0.433	-0.012
10	-641.461	-642.532	0.068	6.474	-0.074
11	-979.019	-978.999	0.004	45.633	1.311
12	-3.7128	-0.1275	0.0000	103593.762	0.8232
13	-3.4419	-0.0029	0.0000	1730926.969	-1.5285
14	0.0000	-0.0000	0.0000	1732808.922	0.0000
15	-92.8874	-0.1266	0.0000	-0.0077	0.1272
16	-4.9704	-0.0045	0.0000	-0.1272	0.0029
17	0.0000	0.0000	0.0000	-0.0029	0.0000
18	-1.1025	-1.0372	-1.0545	-0.3059	-0.0003
19	83.6513	84.0284	84.0314	0.2008	0.0000
20	430.0839	429.9850	-426.3358	-430.8454	185256.965
21	0.0004	9.4024	0.0000	2111.0704	741.036
22	65.3081	31.2679	31.1018	-30.5971	-0.0418
23	12.8882	12.8709	-0.6911	-0.0269	21177.408
24	0.0000	240.5733	4.5906	-324338.422	6850.2408
25	42.6403	213.9001	0.0133	6530685.188	213.0931
26	0.0000	-0.0198	0.0304	-42.913	1.2767
27	134.0007			0.0000	0.0000
28	-2.8874	0.0000	509.0823	17969.4063	3859.3472
29	-4.9704	0.0000	-1.4284		-6.8219
30	0.0000	0.0000	-2.1847		96.7842
31	2218.1129	35821.6362	0.22858	64.4553	-176.4363
32	3532.6213	22492.2029	31.6129	270983832.0	-155.3128
33	896.4025	1994.7623	23236.3179	42.2683	31.1202

1	570.0000	82372.827	183156.670	539995.766	5247379.563
2	23527.2976	22195.9298	21446848.50	20906855.25	14.3796
3	5320379.938	1839198.047	6052278.438	885881.797	5327911.125
4	-130925.785	6271607.438	-333724.656	240448.984	74.7022
5	251103.916	130735.897	372981.219	51266.067	-1.4081
6	21371.0225	6842.6092	22449.4617	5210.8504	71.5376
7	-5791.2715	-2111.3752	-6927.7266	788.3106	-0.2545
8	1549.0976	380.9531	1249.8438	302.1473	-0.3887
9	183152.770	183152.801	-0.030	0.213	-0.013
10	-651.601	-652.815	0.070	4.656	-0.081
11	-995.224	-995.226	0.004	-1.465	1.265
12	-5.6837	-0.1381	0.0000	103569.068	0.8263
13	-3.4645	-0.0063	0.0000	1397217.000	-1.5530
14	0.0000	0.0000	0.0000	1399109.703	0.0000
15	-94.8351	-0.1374	0.0000	-0.0083	0.1378
16	-5.0174	-0.0020	0.0000	-0.1378	0.0003
17	0.0000	0.0000	0.0000	-0.0003	0.0000
18	-0.7713	-0.7277	-0.7434	-0.3113	-0.0004
19	84.2555	84.5816	84.5838	0.2042	0.0003
20	430.0356	430.0098	-425.9015	-429.3634	184630.408
21	0.0005	9.9236	0.0000	2081.8089	748.854
22	64.2988	31.3597	31.1932	-30.6124	-0.0419
23	11.5113	11.4917	-0.6903	-0.0304	22195.926
24	0.0000	240.5733	4.5905	-225148.797	7140.4254
25	28.3857	200.1001	0.0138	6533283.125	149.5917
26	0.0000	-0.0432	0.0308	-26.574	1.0827
27	134.5311			0.0000	0.0000
28	-4.8351	0.0000	531.4030	12705.6445	2734.6099
29	-5.0174	0.0000	-1.5351		-5.3075
30	0.0000	0.0000	-2.3445		100.7094
31	2572.0612	32284.3845	0.15717	70.4737	-176.0077
32	3531.3013	23514.6788	31.6132	294241172.0	-149.2528
33	987.6688	2380.7574	24234.9524	34.9065	30.0890

TABLE AP 3-2 (Sheet 16 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

1	575.0000	80243.586	183031.107	538605.609	5336396.000
2	23884.7930	22553.4465	21443427.25	20906823.25	14.6783
3	5428043.500	1873650.688	6165311.813	912208.828	5436579.125
4	-160282.010	6260908.438	-368826.184	244361.248	74.7311
5	258935.098	132653.580	379272.820	52791.915	-1.6895
6	21696.1787	6938.9705	22765.6072	5320.4445	73.3855
7	-5951.9889	-2168.2778	-7113.7584	776.3346	-0.2631
8	1583.5465	386.1500	1266.8938	308.2194	-0.4010
9	183027.158	183027.191	-0.032	0.443	-0.013
10	-656.297	-657.520	0.070	3.559	-0.081
11	-1000.188	-1000.195	0.004	40.220	1.228
12	-6.3741	-0.1365	0.0000	103560.472	0.8361
13	-3.4644	0.0003	0.0000	1545984.781	-1.5611
14	0.0000	-0.0000	0.0000	1547881.219	0.0000
15	-95.5356	-0.1351	0.0000	-0.0083	0.1363
16	-5.0256	-0.0014	0.0000	-0.1363	-0.0003
17	0.0000	0.0000	0.0000	0.0003	0.0000
18	-0.6507	-0.6144	-0.6296	-0.3131	-0.0004
19	84.4630	84.7725	84.7743	0.2058	0.0001
20	430.0127	430.0109	-423.6320	-429.0436	184493.387
21	0.0005	10.1020	0.0000	2074.1820	750.510
22	63.9511	31.3891	31.2226	-30.6164	-0.0420
23	11.0178	10.9977	-0.6830	-0.0316	22553.447
24	0.0000	240.3733	4.5903	-186466.984	7254.6033
25	22.9912	194.6746	0.0138	6534029.813	124.0106
26	0.0000	-0.0500	0.0310	-21.012	1.0387
27	134.7065			0.0000	0.0000
28	-5.5356	0.0000	539.8561	10951.0313	2360.0327
29	-5.0256	0.0000	-1.5748		-4.7270
30	0.0000	0.0000	-2.4039		102.6709
31	2711.1287	31092.4302	0.13133	72.8887	-175.8296
32	3530.8833	23873.7937	31.6133	302672472.0	-145.8610
33	1035.8582	2582.4513	24579.3596	31.1330	29.3711

1	585.0000	76002.250	181553.500	536511.672	5579793.250
2	24626.5850	23295.2644	21443270.25	20906761.50	15.2905
3	5648346.813	1944030.328	6396215.688	966538.730	5659378.000
4	-221461.398	6238640.625	-441883.164	231985.922	74.7886
5	275124.875	136568.518	392117.074	55936.477	-2.2427
6	22369.8123	7138.5251	23420.3125	5547.2201	76.8362
7	-6286.6448	-2286.2472	-7500.7964	747.6074	-0.2656
8	1654.9777	396.9206	1302.2305	320.7825	-0.4208
9	181551.654	181551.689	-0.034	-5.037	-0.014
10	-627.297	-628.111	0.071	340.292	-0.080
11	-994.085	-994.148	0.004	-1158.157	1.151
12	-7.5383	-0.0851	0.0000	103542.780	0.8112
13	-3.4506	0.0066	0.0000	1434145.359	-1.5437
14	0.0000	0.0004	0.0000	1436049.422	0.0000
15	-96.7249	-0.2799	0.0000	-0.0051	0.0849
16	-4.9943	0.0526	0.0000	-0.0849	-0.0066
17	0.0000	0.0000	0.0000	0.0066	0.0000
18	-0.3942	-0.3729	-0.3869	-0.3137	0.0079
19	84.8870	85.1661	85.1652	0.1982	-0.0354
20	429.9756	430.0077	-422.2372	-428.2876	184166.986
21	0.0006	10.4632	0.0000	2062.6938	752.316
22	63.2379	31.4461	31.2794	-30.6224	-0.0420
23	10.2452	10.2253	-0.6524	-0.0342	23293.265
24	0.0000	240.3733	4.5900	-107181.516	7491.7777
25	12.2325	183.6916	0.0144	6535094.438	70.2282
26	13.9823	-0.0322	0.0312	-10.492	0.9643
27	135.0554			0.0000	0.0000
28	-6.7249	0.0000	558.1677	7436.8281	1612.9946
29	-4.9943	0.0000	-1.6599		-3.3423
30	0.0000	0.0000	-2.5312		108.8923
31	3028.7165	28694.6899	0.07644	78.5074	-175.3181
32	3530.0901	24619.2236	31.6134	320599116.0	-133.6409
33	1206.7129	3288.0086	25293.6670	18.4344	25.9809

1	580.0000	78118.452	182420.877	537439.078	5467187.063
2	24251.3877	22920.0581	21444229.25	20906792.00	14.9819
3	5537353.250	1908591.109	6279945.500	939090.328	5547054.063
4	-190453.201	6249922.063	-404870.711	248209.345	74.7599
5	266940.693	134597.582	385650.766	54348.488	-1.9676
6	22029.2466	7037.6505	23089.3596	5432.6082	75.1305
7	-6117.2437	-2226.5421	-7304.9139	762.7278	-0.2722
8	1618.8580	391.4774	1284.3723	314.4361	-0.4128
9	182416.887	182416.920	-0.033	1.067	-0.014
10	-660.993	-662.114	0.070	8.883	-0.081
11	-1002.157	-1002.169	0.004	152.795	1.186
12	-7.0303	-0.1225	0.0000	103551.732	0.8673
13	-3.4618	0.0009	0.0000	1492397.063	-1.5688
14	0.0000	-0.0001	0.0000	1494297.266	0.0000
15	-96.1606	-0.1139	0.0000	-0.0074	0.1222
16	-5.0306	-0.0064	0.0000	-0.1222	-0.0009
17	0.0000	0.0000	0.0000	0.0009	0.0000
18	-0.5253	-0.4965	-0.5111	-0.3148	-0.0003
19	84.6735	84.9667	84.9681	0.2080	0.0011
20	429.9884	430.0099	-424.2368	-428.7085	184348.891
21	0.0005	10.2820	0.0000	2067.7819	751.410
22	63.5975	31.4180	31.2513	-30.6197	-0.0420
23	10.5583	10.5378	-0.6725	-0.0329	22920.059
24	0.0000	240.3733	4.5902	-147065.117	7371.7850
25	17.5949	189.1467	0.0142	6534637.250	97.4492
26	0.0000	-0.0467	0.0312	-15.656	1.0018
27	134.8812			0.0000	0.0000
28	-6.1606	0.0000	548.6614	9199.9570	1986.0186
29	-5.0306	0.0000	-1.6159		-4.0835
30	0.0000	0.0000	-2.4654		105.2543
31	2862.8885	29895.1104	0.10442	75.5558	-175.6098
32	3530.4807	24242.1292	31.6133	311459044.0	-141.0865
33	1102.9128	2860.9453	24932.6357	26.0221	28.1895

1	590.0000	73895.498	180831.074	535843.242	5694255.688
2	25010.5349	23679.2175	21442573.00	20906731.75	15.6042
3	5761062.563	1979979.625	6514159.313	994566.547	5773593.438
4	-253326.008	6227057.375	-479885.898	255683.199	74.8171
5	283490.574	138566.619	398672.516	57556.187	-2.5148
6	22718.3169	7241.7318	23758.9163	5664.4185	78.7316
7	-6459.3743	-2347.1487	-7700.6041	731.2155	-0.3331
8	1691.1304	402.2413	1319.6867	327.0207	-0.4423
9	180826.553	180826.590	-0.035	21.614	-0.015
10	-765.147	-766.638	0.073	-455.985	-0.049
11	-1015.877	-1016.302	0.003	4150.615	1.126
12	-7.8835	-0.1597	0.0000	103533.674	0.9987
13	-3.1815	0.0474	0.0000	1373382.266	-1.5584
14	0.0000	-0.0018	0.0000	1375290.234	0.0000
15	-96.8823	0.0239	0.0000	-0.0089	0.1594
16	-4.7399	0.0315	0.0000	-0.1594	-0.0474
17	0.0000	0.0000	0.0000	0.0474	0.0000
18	-0.2549	-0.2413	-0.2548	-0.3220	-0.0010
19	85.1018	85.3631	85.3638	0.2429	0.0287
20	429.9317	430.0046	-420.5742	-427.7918	183952.488
21	0.0006	10.6432	0.0000	2059.0265	753.226
22	62.8721	31.4736	31.3068	-30.6244	-0.0421
23	10.0786	10.0719	-0.3751	-0.0354	23679.218
24	0.0000	240.5733	4.3898	-68220.648	7608.6777
25	7.5746	176.9086	0.0170	6535394.625	43.3549
26	8.8246	-0.0245	0.0310	-5.988	0.7434
27	135.2289			0.0000	0.0000
28	-6.8823	0.0000	568.0516	5722.0898	1241.0313
29	-4.7399	0.0000	-1.7033		-2.4183
30	0.0000	0.0000	-2.5992		114.5403
31	3210.5306	27491.1948	0.04735	81.7873	-174.8641
32	3529.7030	25005.2971	31.6137	330106856.0	-119.4124
33	1404.5661	4092.9796	25660.6956	5.0011	20.7096

CHI TILDE (χ) INITIATION

1	584.3900	76259.890	181658.580	536611.180	5565956.750
2	24580.3542	23249.0334	21443373.50	20906765.25	15.2526
3	5634714.125	1939679.672	6381941.875	963159.266	5645574.000
4	-217632.984	6240033.000	-437315.043	231529.301	74.7851
5	274116.660	136326.604	391323.395	55741.038	-2.2093
6	22327.8550	7126.0985	23379.5430	5533.1041	76.6399
7	-6265.7964	-2278.8983	-7476.6857	749.5212	-0.2807
8	1630.5298	396.2509	1300.0334	320.0019	-0.4228
9	181654.559	181654.594	-0.034	1.835	-0.014
10	-665.223	-665.988	0.071	26.878	-0.080
11	-1002.209	-1002.245	0.004	292.741	1.154
12	-7.4900	-0.0797	0.0000	103343.892	0.9332
13	-3.4533	0.0036	0.0000	1441558.469	-1.5730
14	0.0000	-0.0001	0.0000	1443462.047	0.0000
15	-96.5542	-0.2799	0.0000	-0.0048	0.0796
16	-5.0264	0.0526	0.0000	-0.0796	-0.0036
17	0.0000	0.0000	0.0000	0.0036	0.0000
18	-0.4106	-0.3884	-0.4025	-0.3161	-0.0004
19	84.8608	85.1399	85.1410	0.2101	-0.0015
20	429.9770	430.0080	-422.4751	-428.3438	184191.277
21	0.0006	10.4411	0.0000	2063.2397	752.206
22	63.2821	31.4427	31.2760	-30.6221	-0.0420
23	10.2701	10.2499	-0.6563	-0.0340	23249.036
24	0.0000	240.3733	4.5900	-107181.516	7491.7777
25	12.2325	183.6916	0.0144	6535094.438	70.2282
26	13.9823	-0.0322	0.0312	-10.492	0.9643
27	135.0342			0.0000	0.0000
28	-6.5542	0.0000	556.9619	7669.0117	1658.4458
29	-5.0264	0.0000	-1.6543		-3.4400
30	0.0000	0.0000	-2.5229		108.3673
31	3007.6746	28841.2803	0.07991	78.1308	-175.3585
32	3530.1377	24572.7480	31.6134	319464848.0	-134.7765
33	1190.8955	3223.2018	25249.2515	19.5654	26.3450

1	595.0000	71795.382	180381.066	535468.258	5810616.563
2	25403.7798	24072.4626	21442169.25	20906702.75	15.9231
3	5875543.375	2016451.609	6633817.813	1023187.617	5889747.250
4	-286058.441	6215167.875	-518893.414	259296.372	74.8455
5	292034.832	140590.320	405311.941	59206.122	-2.7839
6	23076.0234	7347.6744	24106.4966	5784.6093	80.8332
7	-6633.1870	-2408.5774	-7902.1412	714.2150	-0.2871
8	1726.6857	407.2430	1336.1029	332.9560	-0.4501
9	180377.098	180377.135	-0.037	-4.412	-0.017
10	-640.627	-639.500	0.079	94.759	-0.040
11	-1004.412	-1004.297	0.002	-803.365	1.162
12	-7.5689	0.1330	0.0000	103524.276	1.1573
13	-3.1075	-0.0129	0.0000	1307190.891	-1.5841
14	0.0000	0.0002	0.0000	1309102.891	0.0000
15	-96.4089	0.0004	0.0000	0.0072	-0.1328
16	-4.6916	0.0384	0.0000	0.1328	0.0129
17	0.0000	0.0000	0.0000	-0.0129	0.0000
18	-0.1013	-0.0960	-0.1089	-0.3190	0.0108
19	85.3162	85.5621	85.5624	0.2031	-0.0252
20	429.9224	430.0060	-419.5574	-427.2737	183727.791
21	0.0006	10.8274	0.0000	2056.9692	754.137
22	62.5000	31.5003	31.3334	-30.6254	-0.0421
23	10.5724	10.5686	-0.2909	-0.0365	24072.464
24	0.0000	240.5733	4.3898	-29530.641	7728.2943
25	2.5516	171.1577	0.0199	6535549.125	17.6530
26	3.8309	0.0023	0.0317	-3.990	0.0143
27	135.4019			0.0000	0.0000
28	-6.4089	0.0000	578.7539	3993.1191	869.9380
29	-4.6916	0.0000	-1.7541		-0.8753
30	0.0000	0.0000	-2.6722		121.0436
31	3410.8341	26283.3381	0.01707	85.4527	-173.7059
32	3529.3036	25401.0747	31.6144	340007080.0	-64.3725
33	2174.0234	7183.2848	26036.0425	-39.7289	-6.3458

TABLE AP 3-2 (Sheet 17 of 17)
PREDICTED S-IVB-204 STAGE POWERED FLIGHT TRAJECTORY

S-IVB ENGINE CUTOFF

1	598.2075	70450.258	180231.162	535405.797	5886281.563
2	25661.0908	24329.7681	21442088.25	20906684.50	16.1304
3	5949934.688	2040130.375	6711503.938	1041867.852	5965304.375
4	-307510.840	6207379.750	-544445.094	261570.365	74.8635
5	297610.297	141901.764	409614.566	60280.260	-2.9549
6	23311.0269	7417.3130	24334.9692	5863.5247	82.3081
7	-6743.2800	-2447.6704	-8030.3992	703.5789	-0.3040
8	1749.8089	410.4811	1346.7202	336.7976	-0.4639
9	180227.027	180227.066	-0.037	-0.331	-0.019
10	-665.759	-665.887	0.083	-266.786	-0.028
11	-1015.731	-1016.208	0.001	131.296	1.167
12	-7.4583	-0.0048	0.0000	103518.146	1.0485
13	-3.0075	0.0517	0.0000	1262854.125	-1.5609
14	0.0000	-0.0060	0.0000	1264768.750	0.0000
15	-96.4075	0.0004	0.0000	-0.0003	0.0048
16	-4.5684	0.0384	0.0000	-0.0048	-0.0517
17	0.0000	0.0060	0.0000	0.0517	0.0000
18	0.0096	0.0091	-0.0034	-0.3231	-0.0028
19	85.4550	85.6912	85.6912	0.2117	0.0001
20	429.9387	429.9971	-419.1925	-426.9493	183587.123
21	0.0006	10.9440	0.0000	2056.6265	754.720
22	62.2579	31.5170	31.3501	-30.6256	-0.0421
23	10.7881	10.7866	-0.1855	-0.0372	24329.769
24	0.0000	240.5733	4.5898	-493.539	7819.8516
25	-1.1723	167.4160	0.0199	6535581.500	-0.1938
26	0.0675	0.0145	0.0317	-5.086	-0.6256
27	135.5126			0.0000	0.0000
28	-6.4075	0.0000	585.9021	2885.8203	632.1479
29	-4.5684	0.0000	-1.7865		
30	0.0000	0.0000	-2.7207		
31	3528.9011	25661.2346	0.00305	88.0379	-3.4897
32	3550.5143	25505.0256	31.6149	346574380.0	
33					

1	605.0000	70246.948	0.000	535460.977	6047505.563
2	25681.8145	24350.4636	21442106.50	20906647.50	16.5723
3	6108231.688	2040130.375	6876713.875	1041867.852	6126302.188
4	-353936.719	6207379.750	-599679.969	261570.365	74.9010
5	309540.176	141901.764	418754.891	60280.260	-3.3120
6	23278.5942	7417.3130	24290.1282	5863.5247	-0.0000
7	-6924.5692	-2447.6704	-8230.4489	703.5789	0.0000
8	1761.3883	410.4811	1343.5435	336.7976	0.0000
9	-0.037	0.000	-0.037	-0.331	-0.019
10	0.086	0.000	0.086	-266.786	-0.028
11	0.001	0.000	0.001	131.296	1.167
12	-7.4584	0.0000	0.0000	103497.340	0.0000
13	-3.0066	0.0000	0.0000	1192594.500	0.0000
14	0.0000	0.0000	0.0000	1194513.563	0.0000
15	-97.4584	0.0000	0.0000	0.0000	0.0000
16	-3.0066	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0202	0.0192	0.0074	0.0000	0.0000
19	85.7547	85.9751	85.9751	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0006	10.9525	0.0000	2056.9292	754.763
22	61.7418	31.5510	31.3840	-30.6255	-0.0421
23	11.2426	11.2413	-0.1738	-0.0372	24350.464
24	0.0000	240.5733	4.5898	-493.539	7819.8516
25	-1.1723	167.4160	0.0199	6535581.500	-0.1938
26	0.0675	0.0145	0.0317	-5.086	-0.6256
27	135.7440			0.0000	0.0000
28	-7.4584	0.0000	597.1277	2885.8203	632.1479
29	-3.0066	0.0000	-1.8368		
30	0.0000	0.0000	-2.7958		
31	3528.9065	25681.9409	0.00467	88.2532	2.6460
32	3562.0487	25442.9897	31.6149	347106932.0	
33					

1	600.0000	70246.948	0.000	535419.750	5928824.875
2	25681.8511	24350.5205	21442091.75	20906674.50	16.2470
3	5991740.500	2040130.375	6755142.188	1041867.852	6007793.000
4	-319643.770	6207379.750	-558890.648	261570.365	74.8735
5	300751.664	141901.764	412029.305	60280.260	-3.0499
6	23318.0571	7417.3130	24338.7034	5863.5247	-0.0000
7	-6792.6033	-2447.6704	-8085.2645	703.5789	0.0000
8	1754.0286	410.4811	1346.7007	336.7976	0.0000
9	-0.037	0.000	-0.037	-0.331	-0.019
10	0.084	0.000	0.084	-266.786	-0.028
11	0.001	0.000	0.001	131.296	1.167
12	-7.4584	0.0000	0.0000	103514.721	0.0000
13	-3.0066	0.0000	0.0000	1238076.609	0.0000
14	0.0000	0.0000	0.0000	1239992.703	0.0000
15	-97.4584	0.0000	0.0000	0.0000	0.0000
16	-3.0066	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0193	0.0183	0.0059	0.0000	0.0000
19	85.5341	85.7660	85.7660	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0006	10.9531	0.0000	2056.7031	754.766
22	62.1218	31.5262	31.3593	-30.6256	-0.0421
23	10.9011	10.8997	-0.1816	-0.0372	24350.521
24	0.0000	240.5733	4.5898	-493.539	7819.8516
25	-1.1723	167.4160	0.0199	6535581.500	-0.1938
26	0.0675	0.0145	0.0317	-5.086	-0.6256
27	135.5743			0.0000	0.0000
28	-7.4584	0.0000	589.8969	2885.8203	632.1479
29	-3.0066	0.0000	-1.8046		
30	0.0000	0.0000	-2.7478		
31	3528.9090	25681.9417	0.00467	88.2534	2.2408
32	3562.0569	25442.9500	31.6149	347107428.0	
33					

INSERTION

1	608.2057	70202.433	250.000	535488.734	6124868.563
2	25682.8528	24351.4883	21442117.00	20906630.75	16.7843
3	6184059.813	2040492.734	6955762.063	1042278.578	6203536.688
4	-376646.711	6207259.875	-626637.031	261533.160	74.9187
5	315293.613	141921.842	423126.734	60302.134	-3.4809
6	23253.5271	7417.1665	24259.0767	5863.6154	0.1146
7	-7010.6404	-2448.1120	-8325.0577	703.4510	0.0000
8	1766.1805	410.4701	1341.5106	336.7961	0.0000
9	249.963	250.000	-0.037	-0.319	-0.018
10	0.087	0.000	0.087	-266.774	-0.028
11	0.001	0.000	0.001	133.445	1.154
12	-7.5756	0.0000	0.0000	103497.267	0.0000
13	-3.0019	0.0000	0.0000	1192345.281	0.0000
14	0.0000	0.0000	0.0000	1194264.313	0.0000
15	-97.5756	0.0000	0.0000	0.0000	0.0000
16	-3.0019	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0212	0.0201	0.0087	0.0000	0.0000
19	85.8985	86.1115	86.1114	0.0000	0.0000
20	429.9387	0.0000	-4.8000	0.0000	0.000
21	0.0006	10.9526	0.0000	2057.0815	754.763
22	61.4941	31.5665	31.3994	-30.6254	-0.0421
23	11.3476	11.3464	-0.1652	-0.0372	24351.489
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	135.8528			0.0000	0.0000
28	-7.5756	0.0000	597.1761	2886.4414	632.2813
29	-3.0019	0.0000	-1.8371		
30	0.0000	0.0000	-2.7962		
31	3528.9068	25682.9893	0.00476	88.2642	2.7282
32	3562.6344	25439.8479	31.6148	347133932.0	
33					

TABLE AP 3-3 (Sheet 1 of 3)
PREDICTED S-IVB-204 STAGE ORBITAL TRAJECTORY

CONSTANT VALUE FOR THE ENTIRE ANALYSIS

.805611 02	.285319 02	.720000 02	.100000 01	.321740 02
.140765 17	.209257 08	.208556 08	.729211-04	
.162345-02	.230000-05	.787500-05	.000000 00	
.910000 02	.000000 00	.114830 03	.000000 00	.590500 02
.000000 00	.590500 02	.983550 03	.209970 03	.328100 02
.000000 00	.000000 00	.000000 00	.360900 02	.374667 04

1	TIME	WEIGHT	F SB T	ALTITUDE	RANGE
2	V SB I	V SB E	R SB C	R SB L	RANGE ANGLE
3	X SB E	X SB P (M)	X SB S	XI	D* SB 1
4	Y SB E	Y SB P (M)	Y SB S	ETA	A* SB 1
5	Z SB E	Z SB P (M)	Z SB S	ZETA	E* SB 1
6	D-X SB E	D-X SB P (M)	D-X SB S	D-XI	A SB XM
7	D-Y SB E	D-Y SB P (M)	D-Y SB S	D-ETA	A SB YM
8	D-Z SB E	D-Z SB P (M)	D-Z SB S	D-ZETA	A SB ZM
9	F SB X	F SB TX	F SB AX	M SB X	M SB AX
10	F SB Y	F SB TY	F SB AY	M SB Y	M SB AY
11	F SB Z	F SB TZ	F SB AZ	M SB Z	M SB AZ
12	THETA(M) QRP	DTHETA(M)QRP	F AUX SB X	I SB XX	EPS(THETA)
13	PSI(M) QRP	D-PSI(M)QRP	F AUX SB Y	I SB YY	EPS(PSI)
14	PHI(M) QRP	D-PHI(M)QRP	F AUX SB Z	I SB ZZ	EPS(PHI)
15	CHI SB P	D-CHI SB P	THETA(P)	P SB M	D-EPS(THETA)
16	CHI SB Y	D-CHI SB Y	THETA(Y)	Q SB M	D-EPS(PSI)
17	CHI SB R	D-CHI SB R	THETA(R)	R SB M	D-EPS(PHI)
18	GAMMA SB 1	GAMMA SB 1I	GAMMA(1I)PR.	DELTA(A)	D-DELTA(A)
19	GAMMA SB 2	GAMMA SB 2I	GAMMA(2I)PR.	DELTA(B)	D-DELTA(B)
20	I SB SP	AVG I SB SP	WEIGHT FLOW	AVG D-W	AVG F SB L
21	Q	MACH NO.	PRESSURE	TEMPERATURE	X SB CP
22	MU	RHO	RHO PRIME	G(RHO)	G(PSI)
23	ALPHA*	ALPHA	BETA	CHORD FORCE	V SB RM
24	T(1)	TAU(1G)	PHI(T)	X(V)	D-X(V)
25	T(3)	TAU(3G)	SMCP	Y(V)	D-Y(V)
26	D-T(CO)	DELTA-T(3)	SMCY	Z(V)	D-Z(V)
27	SAF(1)			V SB W	E SB W
28	THETA SB C	D-THETA SB C	X SB CG	W(LOX)RES	W(LH2)RES
29	PSI SB C	D-PSI SB C	Y SB CG		GAMMA SB 1F
30	PHI SB C	D-PHI SB C	Z SB CG		GAMMA SB 2F
31	R(PER)	V(PER)	ECCENTRICITY	PERIOD	BETA
32	R(AP)	V(AP)	INCLINATION	E/M	BETA(F)
33	T SB F	S SB F	V(F)	MU SB F	RHO SB F

START PITCH MANEUVER

1	688.2057	68951.372	0.000	536531.813	8023996.063
2	25685.0623	24353.4761	21442929.00	20906399.75	21.9886
3	8016204.438	2040492.734	8862041.000	1042278.578	8094105.000
4	-1020976.844	6207259.875	-1384282.609	261533.160	75.2921
5	461097.754	141921.842	528241.289	60302.134	-7.2465
6	22516.8689	7417.1665	23359.8770	5863.6154	-0.0000
7	-9086.3289	-2448.1120	-10601.3857	703.4510	0.0001
8	1876.4459	410.4701	1284.2665	336.7961	0.0000
9	-0.037	0.000	-0.037	-0.319	-0.018
10	0.127	0.000	0.127	-266.774	-0.028
11	0.000	0.000	0.000	133.445	1.154
12	-7.5756	0.0000	0.0000	102506.800	0.0000
13	-3.0019	0.0000	0.0000	1122946.766	0.0000
14	0.0000	0.0000	0.0000	1124859.156	0.0000
15	-97.5756	0.0000	0.0000	0.0000	0.0000
16	-3.0019	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0394	0.0374	0.0359	0.0000	0.0000
19	89.4567	89.4849	89.4848	0.0000	0.0000
20	429.9387	0.0000	-0.8000	0.0000	0.000
21	0.0006	10.9383	0.0000	2062.8043	754.691
22	55.3923	31.7783	31.6106	-30.6227	-0.0423
23	16.8103	16.8103	-0.0372	-0.0368	24353.477
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	138.1634			0.0000	0.0000
28	-7.5756	0.0000	588.8174	2886.4414	632.2813
29	-3.0019	0.0000	-1.8545		
30	0.0000	0.0000	-2.9664		
31	3528.9112	25686.1348	0.00500	88.2972	7.4456
32	3564.4018	25430.3787	31.6144	347215544.0	
33					

INSERTION

1	608.2057	70202.433	250.000	535488.734	6124868.563
2	25682.8528	24351.4883	21442117.00	20906630.75	16.7843
3	6184059.813	2040492.734	6955762.063	1042278.578	6203536.688
4	-376646.711	6207259.875	-626637.031	261533.160	74.9187
5	315293.613	141921.842	423126.734	60302.134	-3.4809
6	23253.5271	7417.1665	24259.0767	5863.6154	0.1146
7	-7010.6404	-2448.1120	-8325.0577	703.4510	0.0000
8	1766.1805	410.4701	1341.5106	336.7961	0.0000
9	249.963	250.000	-0.037	-0.319	-0.018
10	0.087	0.000	0.087	-266.774	-0.028
11	0.001	0.000	0.001	133.445	1.154
12	-7.5756	0.0000	0.0000	103497.267	0.0000
13	-3.0019	0.0000	0.0000	1192345.281	0.0000
14	0.0000	0.0000	0.0000	1194264.313	0.0000
15	-97.5756	0.0000	0.0000	0.0000	0.0000
16	-3.0019	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0212	0.0201	0.0087	0.0000	0.0000
19	85.8985	86.1115	86.1114	0.0000	0.0000
20	429.9387	0.0000	-4.8000	0.0000	0.000
21	0.0006	10.9526	0.0000	2057.0815	754.763
22	61.4941	31.5665	31.3994	-30.6254	-0.0421
23	11.3476	11.3464	-0.1652	-0.0372	24351.489
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	135.8528			0.0000	0.0000
28	-7.5756	0.0000	597.1761	2886.4414	632.2813
29	-3.0019	0.0000	-1.8371		
30	0.0000	0.0000	-2.7962		
31	3528.9068	25682.9893	0.00476	88.2642	2.7282
32	3562.6344	25439.8479	31.6148	347133932.0	
33					

1	716.5057	68928.729	0.000	537039.586	8695784.250
2	25684.4446	24352.8289	21443440.00	20906403.00	23.8296
3	8649144.375	2040492.734	9517937.125	1042278.578	8759697.875
4	-1288288.563	6207259.875	-1695408.906	261533.160	75.4056
5	514706.109	141921.842	564261.695	60302.134	-8.4572
6	22210.3408	7417.1665	22989.0923	5863.6154	-0.0000
7	-9803.3636	-2448.1120	-11384.2887	703.4510	-0.0000
8	1911.8329	410.4701	1261.1214	336.7961	-0.0000
9	-0.037	0.000	-0.037	-0.319	-0.018
10	-0.002	0.000	-0.002	-266.774	-0.028
11	-0.000	0.000	-0.000	133.445	1.154
12	-26.5599	-0.6684	0.0000	102506.320	0.0000
13	-2.8389	0.0114	0.0000	1122658.406	0.0000
14	0.9762	0.0331	0.0000	1124570.406	0.0000
15	-116.5599	0.0000	0.0000	0.0000	0.0000
16	-2.8389	0.0000	0.0000	-0.6677	0.0000
17	0.9762	0.0000	0.0000	0.0000	0.0000
18	0.0452	0.0429	0.0449	0.0000	0.0000
19	90.7204	90.6830	90.6829	0.0000	0.0000
20	429.9387	0.0000	-0.8000	0.0000	0.000
21	0.0006	10.9306	0.0000	2065.5901	754.653
22	53.2300	31.7754	31.6078	-30.6212	-0.0423
23	0.2164	-0.2164	0.0092	-0.0366	24352.830
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	138.8498			0.0000	0.0000
28	-26.5599	0.0000	588.8861	2886.4414	632.2813
29	-2.8389	0.0000	-1.8551		
30	0.9762	0.0000	-2.9673		
31	3528.9141	25686.1052	0.00500	88.2971	9.2682
32	3564.3941	25430.4255	31.6144	347215316.0	
33					

1	650.0000	68981.945	0.000	535957.570	7117023.563
2	25685.7329	24354.2271	21442421.75	20906466.00	19.5032
3	7148602.750	2040492.734	7960659.500	1042278.578	7192672.125
4	-692550.648	6207259.875	-999739.023	261533.160	75.1257
5	390366.797	141921.842	478614.391	60302.134	-5.5253
6	22893.8428	7417.1665	23818.0676	5863.6154	-0.0000
7	-8103.5355	-2448.1120	-9525.3431	703.4510	0.0001
8	1825.6681	410.4701	1313.1841	336.7961	0.0000
9	-0.037	0.000	-0.037	-0.319	-0.018
10	0.108	0.000	0.108	-266.774	-0.028
11	0.001	0.000	0.001	133.445	1.154
12	-7.5756	0.0000	0.0000	102507.447	0.0000
13	-3.0019	0.0000	0.0000	1123336.047	0.0000
14	0.0000	0.0000	0.0000	1125248.969	0.0000
15	-97.5756	0.0000	0.0000	0.0000	0.0000
16	-3.0019	0.0000	0.0000	0.0000	0.0000
17	0.0000	0.0000	0.0000	0.0000	0.0000
18	0.0315	0.0298	0.0236	0.0000	0.0000
19	87.7529	87.8695	87.8694	0.0000	0.0000
20	429.9387	0.0000	-0.8000	0.0000	0.000
21	0.0006	10.9470	0.0000	2059.6537	754.735
22	58.3099	31.7176	31.5500	-30.6242	-0.0422
23	14.2005	14.2002	-0.0991	-0.0370	24354.227
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	137.1378			0.0000	0.0000
28	-7.5756	0.0000	588.7245	2886.4414	632.2813
29	-3.0019	0.0000	-1.8538		
30	0.0000	0.0000	-2.9652		
31	3528.9059	25686.2397	0.00501	88.2979	5.1142
32	3564.4441	25430.1426	31.6145	347217236.0	
33					

START MANEUVER TO SEPARATION ATTITUDE

1	3000.0000	68015.012	0.000	721702.391	3389703.813
2	25463.2236	24122.2688	21631125.25	20909426.00	9.2883
3	3250165.969	2040492.734	-636429.500	1042278.578	42401328.500
4	-42258039.000	6207259.875	-42530690.000	261533.160	93.0664
5	1251947.156	141921.842	-166745.754	60302.134	-85.2883
6	-23563.6030	7417.1665	-25409.1399	5863.6154	0.0000
7	-3807.1993	-2448.1120	750.8963	703.4510	0.0000
8	-3485.0701	410.4701	-1479.0649	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	-0.000	-266.774	-0.028
11	0.000	0.000	-0.000	133.445	1.154
12	178.1942	-0.0681	0.0000	102469.949	0.0000
13	2.9868	0.0004	0.0000	1109447.719	0.0000
14	0.3017	-0.0035	0.0000	1111327.203	0.0000
15	88.1942	0.0000	0.0000	0.0000	0.0000
16	2.9868	0.0000	0.0000	-0.0680	0.0000
17	0.3017	0.0000	0.0000	0.0000	0.0000
18	0.1010	0.0957	0.0584	0.0000	0.0000
19	104.4922	103.7136	103.7139	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0001	9.4684	0.0000	2700.9481	742.026
22	-88.8690	-28.9313	-28.7741	-30.0981	0.0387
23	0.4515	-0.1224	0.4347	-0.0000	24122.269
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	152.5476			0.0000	0.0000
28	178.1942	0.0000	591.8459	2886.4414	632.2813
29	2.9868	0.0000	-1.8773		
30	0.3017	0.0000	-3.0028		
31	3533.6090	25653.6174	0.00379	88.3127	164.4138
32	3560.5311	25459.6438	31.6209	347253624.0	
33					

TABLE AP 3-3 (Sheet 2 of 3)
PREDICTED S-IVB-204 STAGE ORBITAL TRAJECTORY

1	3010.6057	68015.012	0.000	722144.555	3150777.000
2	25463.1152	24122.0115	21631394.50	20909252.50	8.6337
3	3000048.938	2040492.734	-905856.313	1042278.578	42420576.500
4	-42296921.000	6207259.875	-42521035.000	261533.160	94.0443
5	1214795.734	141921.842	-182425.082	60302.134	-85.6241
6	-23601.9111	7417.1665	-25397.6863	5863.6154	0.0000
7	-3524.9608	-2448.1120	1069.7259	703.4510	0.0000
8	-3520.7809	410.4701	-1477.6898	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	-0.000	-266.774	-0.028
11	0.000	0.000	0.000	133.445	1.154
12	177.0632	0.0010	0.0000	102469.791	0.0000
13	-0.7250	-0.5000	0.0000	1109435.906	0.0000
14	-0.1173	-0.0000	0.0000	1111315.219	0.0000
15	87.0632	0.0000	0.0000	0.0000	0.0000
16	-0.7250	0.0000	0.0000	0.0000	0.0000
17	-0.1173	0.0000	0.0000	-0.5000	0.0000
18	0.0974	0.0922	0.0559	0.0000	0.0000
19	104.0855	103.3296	103.3298	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0001	9.4662	0.0000	2702.1611	741.993
22	-89.6187	-29.0992	-28.9414	-30.0970	0.0388
23	3.3386	-0.5395	-3.2949	-0.0000	24122.012
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	152.5515			0.0000	0.0000
28	177.0632	0.0000	591.8471	2886.4414	632.2813
29	-0.7250	0.0000	-1.8773		
30	-0.1173	0.0000	-3.0028		
31	3533.7157	25653.0549	0.00378	88.3148	164.9445
32	3560.5406	25459.7864	31.6206	347258968.0	
33					

PITCH TO LOCAL HORIZONTAL

1	3415.0000	38022.104	0.000	724790.133	6422842.313
2	25462.1863	24119.0029	21631313.25	20906526.00	17.6009
3	-6496756.375	2040492.734	-10688073.875	1042278.578	42040466.500
4	-41533149.500	6207259.875	-39693070.000	261533.160	255.8454
5	-436683.969	141921.842	-746634.930	60302.134	-81.0899
6	-22560.1904	7417.1665	-22061.6072	5863.6154	0.0000
7	7236.3737	-2448.1120	12649.9539	703.4510	0.0000
8	-4516.5273	410.4701	-1259.8298	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	0.000	-266.774	-0.028
11	0.000	0.000	0.000	133.445	1.154
12	177.0640	-0.0000	0.0000	79814.972	0.0000
13	-1.0911	0.0000	0.0000	554775.781	0.0000
14	-0.1173	0.0000	0.0000	556737.570	0.0000
15	87.0640	0.0000	0.0000	0.0000	0.0000
16	-1.0911	0.0000	0.0000	0.0000	0.0000
17	-0.1173	0.0000	0.0000	0.0000	0.0000
18	-0.0682	-0.0646	-0.0563	0.0000	0.0000
19	86.9554	87.1162	87.1160	0.0000	0.0000
20	429.9387	0.0000	-0.2500	0.0000	0.000
21	0.0001	9.4523	0.0000	2709.4185	741.785
22	-119.4567	-31.6627	-31.4968	-30.0919	0.0408
23	27.2013	26.9247	-4.5099	-0.0000	24119.003
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	152.4733			0.0000	0.0000
28	177.0640	0.0000	415.9990	2886.4414	632.2813
29	-1.0911	0.0000	-2.8862		
30	-0.1173	0.0000	-5.4908		
31	3533.1703	25655.9819	0.00386	88.3043	-165.2239
32	3560.5190	25458.9155	31.6150	347232860.0	
33					

START INERTIAL ATTITUDE HOLD

1	5485.0000	37724.879	0.000	548085.984	10806017.875
2	25669.8313	24341.7603	21460669.50	20912584.75	29.6080
3	-9928728.625	2040492.734	-3549134.125	1042278.578	10839321.875
4	-2250059.906	6207259.875	251727.186	261533.160	272.5463
5	-3721354.688	141921.842	-218340.607	60302.134	-11.9808
6	20771.0366	7417.1665	25274.3413	5863.6154	0.0000
7	11887.4401	-2448.1120	4220.8070	703.4510	0.0000
8	4446.8105	410.4701	1527.3565	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	-0.000	-266.774	-0.028
11	0.000	0.000	-0.000	133.445	1.154
12	9.2176	-0.0680	0.0000	79781.439	0.0000
13	1.0420	0.0004	0.0000	553463.008	0.0000
14	0.3444	-0.0012	0.0000	555395.922	0.0000
15	-80.7824	0.0000	0.0000	0.0000	0.0000
16	1.0420	0.0000	0.0000	-0.0680	0.0000
17	0.3444	0.0000	0.0000	0.0000	0.0000
18	-0.0688	-0.0652	-0.1135	0.0000	0.0000
19	69.6777	70.7718	70.7720	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0005	10.7688	0.0000	2126.1952	753.844
22	113.7463	25.7526	25.6062	-30.5845	-0.0369
23	3.3684	-0.2694	3.3576	-0.0000	24341.761
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	140.7000			0.0000	0.0000
28	9.2176	0.0000	416.5952	2886.4414	632.2813
29	1.0420	0.0000	-2.9103		
30	0.3444	0.0000	-5.5367		
31	3530.5208	25680.3835	0.00501	88.3587	-23.4798
32	3566.0859	25424.2686	31.6270	347367116.0	
33					

START PITCH TO RETROGRADE ATTITUDE

1	6355.0000	37693.898	0.000	556496.008	9913783.375
2	25661.4822	24331.0649	21466404.75	20909911.50	27.1651
3	9633195.500	2040492.734	16447238.000	1042278.578	9966577.000
4	-1807753.859	6207259.875	-7132080.813	261533.160	82.6257
5	1807272.906	141921.842	977613.656	60302.134	-10.4502
6	20488.0581	7417.1665	16490.0117	5863.6154	0.0000
7	-10947.7906	-2448.1120	-19637.9333	703.4510	0.0000
8	7237.8237	410.4701	971.0199	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	0.000	-266.774	-0.028
11	0.000	0.000	-0.000	133.445	1.154
12	9.1606	0.0000	0.0000	79768.058	0.0000
13	1.0423	0.0000	0.0000	553109.242	0.0000
14	0.3434	0.0000	0.0000	555029.609	0.0000
15	-80.8394	0.0000	0.0000	0.0000	0.0000
16	1.0423	0.0000	0.0000	0.0000	0.0000
17	0.3434	0.0000	0.0000	0.0000	0.0000
18	0.1065	0.1010	0.1408	0.0000	0.0000
19	105.5545	104.7293	104.7289	0.0000	0.0000
20	429.9387	0.0000	-0.1500	0.0000	0.000
21	0.0005	10.6491	0.0000	2172.3361	753.246
22	49.6114	28.4585	28.3018	-30.5628	-0.0394
23	59.2879	59.2120	7.4358	-0.0000	24331.066
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	139.9709			0.0000	0.0000
28	9.1606	0.0000	416.8260	2886.4414	632.2813
29	1.0423	0.0000	-2.9137		
30	0.3434	0.0000	-5.5430		
31	3530.5608	25678.5732	0.00488	88.3429	30.4180
32	3565.1972	25429.1023	31.6215	347328076.0	
33					

1	6518.8000	37669.323	0.000	564959.938	13765500.875
2	25650.5156	24321.8511	21478183.75	20913226.00	37.7163
3	12798821.500	2040492.734	18818653.250	1042278.578	13711471.875
4	-3916378.781	6207259.875	-10590843.500	261533.160	85.0899
5	2976007.250	141921.842	1116480.828	60302.134	-16.5964
6	18054.4580	7417.1665	12373.1412	5863.6154	0.0000
7	-14723.5004	-2448.1120	-22457.4561	703.4510	0.0000
8	6986.2388	410.4701	719.1160	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	0.000	-266.774	-0.028
11	0.000	0.000	-0.000	133.445	1.154
12	118.2784	-0.0680	0.0000	79765.149	0.0000
13	-0.6659	0.0010	0.0000	552916.859	0.0000
14	0.8724	0.0008	0.0000	554835.086	0.0000
15	28.2784	0.0000	0.0000	0.0000	0.0000
16	-0.6659	0.0000	0.0000	-0.0680	0.0000
17	0.8724	0.0000	0.0000	0.0000	0.0000
18	0.1374	0.1303	0.1797	0.0000	0.0000
19	111.2743	110.1232	110.1228	0.0000	0.0000
20	429.9387	0.0000	-0.1500	0.0000	0.000
21	0.0005	10.5614	0.0000	2206.8918	752.807
22	38.3254	25.0735	24.9300	-30.5359	-0.0360
23	176.5382	-0.4697	-3.4300	-0.0000	24321.852
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	142.7417			0.0000	0.0000
28	118.2784	0.0000	416.8978	2886.4414	632.2813
29	-0.6659	0.0000	-2.9180		
30	0.8724	0.0000	-5.5513		
31	3530.9396	25678.8796	0.00501	88.3747	38.9613
32	3566.5197	25422.7039	31.6282	347406332.0	
33					

1	8438.2000	37634.860	0.000	729419.703	7104857.125
2	25459.0593	24116.1992	21636813.50	20907396.25	19.4694
3	6262571.125	2040492.734	-4291950.625	1042278.578	41934209.000
4	-41313605.500	6207259.875	-42110784.000	261533.160	101.3921
5	3527645.875	141921.842	-357436.277	60302.134	-80.1304
6	-21383.2908	7417.1665	-24900.1597	5863.6154	0.0000
7	-7930.7431	-2448.1120	5074.6996	703.4510	0.0000
8	-7838.9586	410.4701	-1547.0374	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	0.000	-266.774	-0.028
11	0.000	0.000	0.000	133.445	1.154
12	-12.2363	-0.0680	0.0000	79735.792	0.0000
13	1.0958	-0.0001	0.0000	552071.859	0.0000
14	-0.0606	-0.0013	0.0000	553962.336	0.0000
15	-102.2363	0.0000	0.0000	0.0000	0.0000
16	1.0958	0.0000	0.0000	-0.0680	0.0000
17	-0.0606	0.0000	0.0000	0.0000	0.0000
18	0.0460	0.0435	0.0208	0.0000	0.0000
19	98.4262	97.9788	97.9789	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0001	9.4291	0.0000	2722.1183	741.437
22	-77.1848	-30.8583	-30.6948	-30.0783	0.0402
23	175.8049	-0.7210	4.1332	-0.0000	24116.201
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	152.4514			0.0000	0.0000
28	-12.2363	0.0000	417.5020	2886.4414	632.2813
29	1.0958	0.0000	-2.9239		
30	-0.0606	0.0000	-5.5624		
31	3534.5096	25649.6421	0.00374	88.3391	173.9053
32	3561.0442	25458.5171	31.6167	347318672.0	
33					

TABLE AP 3-3 (Sheet 3 of 3)
PREDICTED S-IVB-204 STAGE ORBITAL TRAJECTORY

1	8756.2000	37634.860	0.000	726818.086	1147022.516
2	25462.8494	24119.7341	21633615.25	20906800.75	3.1432
3	-749524.883	2040492.734	-11726388.750	1042278.578	42527451.500
4	-42513798.000	6207259.875	-39061788.000	261533.160	206.0696
5	774271.914	141921.842	-818969.844	60302.134	-88.5480
6	-22251.3237	7417.1665	-21308.3464	5863.6154	0.0000
7	462.3912	-2448.1120	13876.7438	703.4510	0.0000
8	-9296.5787	410.4701	-1321.8105	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	-0.000	-266.774	-0.028
11	0.000	0.000	0.000	133.445	1.154
12	55.6445	-0.0678	0.0000	79731.033	0.0000
13	0.8537	-0.0047	0.0000	551961.563	0.0000
14	85.9962	-0.0010	0.0000	553847.375	0.0000
15	-34.3555	0.0000	0.0000	0.0000	0.0000
16	0.8537	0.0000	0.0000	0.0000	0.0000
17	85.9962	0.0000	0.0000	-0.0680	0.0000
18	-0.0841	-0.0797	-0.0650	0.0000	0.0000
19	84.6224	84.9068	84.9066	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0001	9.4429	0.0000	2714.9815	741.643
22	-100.9060	-31.4098	-31.2447	-30.0861	0.0406
23	91.2175	30.7617	88.7824	-0.0000	24119.735
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	152.5734			0.0000	0.0000
28	55.6445	0.0000	417.5968	2886.4414	632.2813
29	0.8537	0.0000	-2.9238		
30	85.9962	0.0000	-5.5623		
31	3534.4848	25649.8335	0.00375	88.3392	-162.3061
32	3561.0758	25458.3030	31.6156	347318988.0	
33					

PITCH NOSE UP TO LOCAL HORIZON

1	9398.2000	34390.734	0.000	650798.039	15392328.750
2	25551.0740	24220.7266	21569128.25	20918331.50	42.1685
3	-13511866.625	2040492.734	-20901722.750	1042278.578	39635809.000
4	-36894234.000	6207259.875	-25990369.500	261533.160	273.1208
5	-5219432.938	141921.842	-1387298.453	60302.134	-68.5647
6	-15796.9806	7417.1665	-5884.7374	5863.6154	0.0000
7	16282.4934	-2448.1120	24861.5845	703.4510	0.0000
8	-8484.0687	410.4701	-359.1091	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	-0.000	-266.774	-0.028
11	0.000	0.000	-0.000	133.445	1.154
12	55.6015	-0.0000	0.0000	79512.873	0.0000
13	0.8507	0.0000	0.0000	501022.293	0.0000
14	-22.9711	0.0000	0.0000	502940.340	0.0000
15	-34.3985	0.0000	0.0000	0.0000	0.0000
16	0.8507	0.0000	0.0000	0.0000	0.0000
17	-22.9711	0.0000	0.0000	0.0000	0.0000
18	-0.3517	-0.3334	-0.2834	0.0000	0.0000
19	62.6217	64.1562	64.1556	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0002	9.8690	0.0000	2506.4429	748.035
22	-144.5812	-19.0350	-18.9202	-30.2891	0.0284
23	47.6070	-45.7205	21.0636	-0.0000	24220.727
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	151.9618			0.0000	0.0000
28	55.6015	0.0000	442.8505	2886.4414	632.2813
29	0.8507	0.0000	-3.2088		
30	-22.9711	0.0000	-6.0988		
31	3533.4782	25668.9949	0.00496	88.4631	-86.1568
32	3568.7159	25415.5378	31.6405	347623940.0	
33					

TERMINATE CONSTANT ROLL

1	9145.2000	34390.734	0.000	687353.688	9497377.000
2	25511.2166	24174.6626	21599986.50	20912634.75	26.0224
3	-9010124.500	2040492.734	-18503390.250	1042278.578	41418722.000
4	-40320221.500	6207259.875	-31960114.250	261533.160	270.0368
5	-2933959.125	141921.842	-1239413.984	60302.134	-76.7747
6	-19553.4878	7417.1665	-12926.8223	5863.6154	0.0000
7	10624.2061	-2448.1120	21979.0535	703.4510	0.0000
8	-9444.6643	410.4701	-800.4797	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	-0.000	-266.774	-0.028
11	0.000	0.000	-0.000	133.445	1.154
12	55.6015	-0.0000	0.0000	79561.973	0.0000
13	0.8507	0.0000	0.0000	501374.391	0.0000
14	-22.7471	-0.2800	0.0000	503272.813	0.0000
15	-34.3985	0.0000	0.0000	-0.2800	0.0000
16	0.8507	0.0000	0.0000	0.0000	0.0000
17	-22.7471	0.0000	0.0000	0.0000	0.0000
18	-0.3254	-0.3084	-0.2604	0.0000	0.0000
19	69.5855	70.6988	70.6981	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0002	9.6589	0.0000	2606.7226	744.884
22	-128.5342	-25.7001	-25.5548	-30.1913	0.0359
23	64.7744	-63.3832	35.8906	-0.0000	24174.664
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	152.3439			0.0000	0.0000
28	55.6015	0.0000	442.6874	2886.4414	632.2813
29	0.8507	0.0000	-3.2160		
30	-22.7471	0.0000	-6.1375		
31	3533.3430	25666.6511	0.00474	88.4284	-106.6168
32	3566.9955	25424.5020	31.6290	347538696.0	
33					

1	9711.2000	34390.734	0.000	605267.531	42981182.000
2	25601.6294	24278.0374	21529368.25	20924100.75	117.7341
3	-17506008.500	2040492.734	-21276182.750	1042278.578	36328100.000
4	-30924095.250	6207259.875	-18039669.750	261533.160	275.3238
5	-7547912.625	141921.842	-1407475.234	60302.134	-58.3473
6	-9466.5289	7417.1665	3529.0528	5863.6154	0.0000
7	21477.5344	-2448.1120	25356.1638	703.4510	0.0000
8	-6206.7267	410.4701	233.0295	336.7961	0.0000
9	0.000	0.000	-0.000	-0.319	-0.018
10	0.000	0.000	0.000	-266.774	-0.028
11	0.000	0.000	0.000	133.445	1.154
12	259.6889	-0.6698	0.0000	79452.097	0.0000
13	-0.3570	-0.0150	0.0000	500586.105	0.0000
14	-1.2866	0.0042	0.0000	502528.457	0.0000
15	169.6889	0.0000	0.0000	0.0000	0.0000
16	-0.3570	0.0000	0.0000	-0.6700	0.0000
17	-1.2866	0.0000	0.0000	0.0000	0.0000
18	-0.3251	-0.3083	-0.2796	0.0000	0.0000
19	57.6032	59.4641	59.4638	0.0000	0.0000
20	429.9387	0.0000	0.0000	0.0000	0.000
21	0.0003	10.1910	0.0000	2361.6927	750.955
22	-162.5750	-8.8223	-8.7658	-30.4127	0.0140
23	177.5420	-2.2327	1.0291	-0.0000	24278.038
24	0.0000	240.5732	4.5899	-479.828	7819.8941
25	-1.1737	167.4157	0.0199	6535581.125	-0.2066
26	0.0657	0.0149	0.0317	-5.090	-0.6267
27	151.2049			0.0000	0.0000
28	259.6889	0.0000	443.0533	2886.4414	632.2813
29	-0.3570	0.0000	-3.1999		
30	-1.2866	0.0000	-6.0507		
31	3532.6229	25678.5964	0.00547	88.4988	-63.4575
32	3571.4827	25399.1985	31.6523	347711716.0	
33					

TABLE AP 3-4 (Sheet 1 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
A*	A*	Azimuth angle measured in the plane tangent to the earth's surface at radar station; positive clockwise from north to the perpendicular projection of the vector drawn between the vehicle and the radar in the tangent plane (deg)
A SB XM A SB YM A SB ZM	a_{xm}, a_{ym}, a_{zm}	Vehicle accelerations in the vehicle coordinate system (ft/sec^2)
CHORD FORCE	C	Aerodynamic chord force (lbf)
D*	D*	Slant range distance between the vehicle and radar station (ft)
ECCENTRICITY	e	Eccentricity of a conic section (dimensionless)
E*	E*	Elevation angle measured positively up from a plane tangent to the earth's surface at the radar site. Angle between the plane and the vector drawn between the missile and radar station (ft)
E/M	E/m	Total energy (ft^2/sec^2)
F SB AX F SB AY F SB AZ	F_{A_x}, F_{A_y}, F_{A_z}	Aerodynamic forces in the vehicle coordinate system (lb)
AVG F SB L	$\bar{F}_L$	Average longitudinal thrust (lbf)
F SB T	F_T	Total effective engine thrust (lbf)

TABLE AP 3-4 (Sheet 2 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
F SB TX F SB TY F SB TZ	F_{T_x}, F_{T_y}, F_{T_z}	Propulsive forces in the vehicle system (lbf)
F SB X F SB Y F SB Z	F_x, F_y, F_z	Total forces in the vehicle coordinate system (lbf)
G (RHO)	g_ρ	Component of gravity due to the attractive force of the earth measured along r_c positive down (ft/sec^2)
G (PSI)	g_ψ	Component of gravity due to attractive force of the earth measured along the perpendicular to r_c positive down (ft/sec^2)
ALTITUDE	h	Vehicle altitude. Distance between the spheroid's surface and vehicle measured along the normal to the earth's surface positive up (ft)
INCLINATION	i	Equatorial orbital inclination (deg)
I SB SP	I_{sp}	Specific impulse (sec)
AVG I SB SP	$\bar{I}_{sp}$	Average specific impulse (sec)
I SB XX I SB YY I SB ZZ	I_{xx}, I_{yy}, I_{zz}	Principal vehicle moments of inertia (slug-ft^2)
MACH NO.	M	Vehicle mach number

TABLE AP 3-4 (Sheet 3 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
M SB X M SB Y M SB Z	M_x, M_y, M_z	Total moments about the axis of the vehicle coordinate system (ft-lbf)
M SB AX M SB AY M SB AZ	M_{A_x}, M_{A_y}, M_{A_z}	Aerodynamic moments in the vehicle coordinate system (ft-lbf)
NORMAL FORCE	N	Aerodynamic normal force (lbf)
PERIOD	P	Period of elliptical orbit (min)
P SB M	P_M	Total vehicle roll rate; positive roll clockwise looking forward along the X_m axis (deg/sec)
PRESSURE	P_a	Atmospheric pressure at the vehicle (lb/ft^2)
Q	q	Vehicle dynamic pressure (lbf/ft^2)
Q SB M	Q_M	Total vehicle pitch rate, positive nose up (deg/sec)
R (AP)	r_a	Radius of apogee (nautical miles)
R (PER)	r_{PER}	Radius of perigee (nautical miles)
R SB C	r_c	Instantaneous distance between the center of the earth and the vehicle (ft)
R SB L	r_L	Earth radius at the launcher (ft)
R SB M	R_M	Total vehicle yaw rate; positive yaw-nose left (deg/sec)
S (BAR*)	$\bar{S}$*	Product of the average earth radius and the central angle traversed during glide (nautical miles)

TABLE AP 3-4 (Sheet 4 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
S SB F	S_F	Downrange distance at terminal altitude (nautical miles)
RANGE	s	Spherical earth ground range (ft). Based on the spherical earth range angle and the average earth radius
SAF	SAF	Space attenuation factor measured from radar station i
TIME	t	Current simulation time, measured from vehicle liftoff (sec)
T SB F	t_f	Time since launch at the terminal altitude (sec)
T (1)	T_1	First stage time to go (sec)
T (3)	T_3	Second stage time to go (sec)
DELTA-T (3)	ΔT_3	Correction to T_3 (sec)
D-T (CO)	Δt_{co}	Time-to-go until engine cutoff command (sec)
TEMPERATURE	T_R	The temperature specified at a certain altitude (deg R)
V (AP)	V_{ap}	Apogee velocity of the glide phase orbit (ft/sec)
V SB E	V_e	Magnitude of the vehicle's earth fixed velocity (ft/sec)
V (F)	V_f	Magnitude of inertial velocity at terminal altitude (ft/sec)

TABLE AP 3-4 (Sheet 5 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
V SB I	V_I	Magnitude of the vehicle's inertial velocity (ft/sec)
V (PER)	V_{per}	Perigee velocity of the glide phase orbit (ft/sec)
V SB RM	V_{RM}	Magnitude of the vehicle's velocity relative to the earth's atmosphere (ft/sec)
V SB W	V_W	Wind velocity relative to the earth (ft/sec)
WEIGHT	W	Total vehicle weight (lbm)
WEIGHT FLOW	$\dot{W}$	Time rate of change of total vehicle weight (lbm/sec)
AVG D-W	$\bar{\dot{W}}$	Average time rate of change of total vehicle weight (lbm/sec)
X, Y, Z D-X, D-Y, D-Z DD-X, DD-Y, DD-Z	X, Y, Z	Components of vehicle position, velocity and accelerations. A subscript on these quantities indicates the coordinate system in which these quantities are measured. (ft, ft/sec, ft/sec^2, respectively)
X SB CG Y SB CG Z SB CG	X_{CG}, Y_{CG}, Z_{CG}	Components of vehicle center of gravity, with X_{CG} measured positive forward from the vehicle reference plane, Y_{CG} measured positive right from the missile centerline, and Z_{CG} measured positive down from the vehicle centerline (in.)

TABLE AP 3-4 (Sheet 6 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
X SB CP Y SB CP Z SB CP	X_{CP}, Y_{CP}, Z_{CP}	Components of vehicle center of pressure, with X_{CP} measured positive forward from the vehicle reference plane. Y_{CP} measured positive right from the missile centerline, and Z_{CP} measured positive down from the vehicle centerline (in.)
X (V) Y (V) Z (V)	X^V, Y^V, Z^V	Position coordinates in the terminal radius coordinate system. Origin is at the earth's center, Y^V along the desired terminal radius, X^V in the orbit plane in the direction of orbital motion, Z^V forming a right handed coordinate system (m)
D-X (V) D-Y (V) D-Z (V)	X^V, Y^V, Z^V	Velocity coordinates in terminal radius
ALPHA* (S-IVB) ALPHA (S-IB)	α' α	Total angle of attack. Angle between the centerline of the vehicle and the vehicle air velocity vector (deg)
ALPHA (S-IVB) ALPHA SB P (S-IB)	α α_p	Pitch angle of attack. Angle between the projection of the vehicle's air velocity vector onto the pitch plane and the centerline of the vehicle (deg)

TABLE AP 3-4 (Sheet 7 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
BETA (S-IVB) ALPHA SB Y (S-IB)	β α_y	Yaw angle of attack. Angle between the projection of the vehicle's air velocity vector onto the yaw plane and the center-line of the vehicle (deg)
BETA	β	True anomaly at start of glide (deg)
BETA (F)	β_f	True anomaly at terminal altitude (deg)
GAMMA (1)	γ_1	Elevation flight path angle. Angle between the earth fixed vehicle velocity and the local tangent plane positive for an ascending vehicle (deg)
GAMMA (2)	γ_2	Azimuthal flight path angle. Angle between the local north clockwise to the projection of the earth fixed vehicle velocity on the local tangent plane (deg)
GAMMA (1I)	γ_{1_I}	Inertial elevation flight path angle. Same as γ_2 except measured to inertial vehicle velocity (deg)
GAMMA (1I) PR	γ_{1_I}'	Inertial elevation flight path angle. Angle between the inertial velocity vector and the X_{L_I}' Z_{L_I}' plane. Angle is positive for an ascending vehicle (deg)
GAMMA (2I) PR	γ_{2_I}'	Inertial azimuthal flight path angle measured in the X_{L_I}', Z_{L_I}' plane. Angle between Z_{LI}, clockwise to the projection of the inertial velocity vector (deg)

TABLE AP 3-4 (Sheet 8 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
GAMMA SB 1F	γ_{1_f}	Inertial flight path elevation angle at the terminal altitude (deg)
GAMMA SB 2F	γ_{2_f}	Inertial flight path azimuth angle, at the terminal altitude (deg)
DELTA (A)	δ_A, δ_B	Vehicle actuator A (yaw) and actuator B (pitch)
D-DELTA (A) D-DELTA (B)	$\dot{\delta}_A$ $\dot{\delta}_B$	Vehicle actuator A (yaw) and actuator B (pitch) gimbal angle rates, respectively (deg/sec)
SMCP	δMCP	Pitch thrust misalignment correction (radians)
SMCY	δMCY	Yaw thrust misalignment correction (radians)
E SB W	ε_W	Tabular wind azimuth angle, positive clockwise from north, as a function of altitude (at ε_W = zero wind is coming from the north) (deg)
EPS (THETA) EPS (PSI) EPS (PHI)	ε_θ, ε_ψ, ε_ϕ	Autopilot error signal (deg)
RANGE ANGLE	η'	Spherical earth range angle. The angle is measured between lines connecting the following three points: the vehicle, the center of the earth, and the launcher with the earth's center as the vertex (radians)

TABLE AP 3-4 (Sheet 9 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
D-THETA (M) QRP D-PSI (M) QRP D-PHI (M) QRP	$\dot{\theta}_M$, $\dot{\psi}_M$, $\dot{\Phi}_M$	Vehicle pitch, yaw, and roll attitude Euler angle rates (deg/sec)
THETA SB C	θ_C	Commanded vehicle pitch Euler angle (deg)
THETA (M) QRP PSI (M) QRP PHI (M) QRP	θ_M, ψ_M, Φ_M	Vehicle pitch, yaw, and roll attitude Euler angle (deg)
THETA (P) THETA (Y) THETA (R)	θ_P, θ_Y, θ_R	For the three-gimbal stable platform, pitch, yaw and roll angles, respectively (deg)
MU	μ	Instantaneous vehicle longitude where Greenwich, England, is longitude zero. West of Greenwich is positive (deg)
MU SB F	μ	Longitude of r_f (deg)
XI ETA ZETA	ξ, η, ζ	Vehicle position obtained by integrating $\dot{\xi}$, $\dot{\eta}$, $\dot{\zeta}$. The ξ,η,ζ system coincides with the P system at t = 0, and is falling with an acceleration equal to gravity at the vehicle position. Position and velocity in this system correspond to the position and velocity the vehicle would have if gravity were zero. (m)
D-XI D-ETA D-ZETA	$\dot{\xi}$, $\dot{\eta}$, $\dot{\zeta}$,	Vehicle velocity obtained by integrating $\ddot{\xi}$, $\ddot{\eta}$, $\ddot{\zeta}$ (m/sec)

TABLE AP 3-4 (Sheet 10 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
RHO	ρ	Instantaneous geodetic latitude, positive in the northern hemisphere (deg)
RHO PRIME	ρ'	Instantaneous geocentric latitude, positive in the northern hemisphere (deg)
RHO SB F	ρ_f	Longitude of r_f (deg)
TAU-P	T	Radar polarization look angle for the ith radar station: angle between the projection of the vehicle centerline on a plane perpendicular to the radar line of sight and the line of intersection of the plane containing the radar line of sight, perpendicular to the earth's surface, and the plane perpendicular to the radar line of sight, measured positive counterclockwise from this line of intersection as viewed looking along the radar line of sight toward the vehicle (deg).
TAU SB PHI	T_ϕ	Roll look angle measured from the positive yaw axis (Y_m) clockwise looking forward (fin plane III to IV) to the telemetry line of sight in the roll plane (deg).
TAU SB THETA	T_θ	Total telemetry look angle measured from the positive (nose) vehicle centerline to the telemetry line of sight (deg).

TABLE AP 3-4 (Sheet 11 of 11)
SYMBOL DEFINITION FOR S-IB/S-IVB
STAGE TRAJECTORY AND RADAR PARAMETERS
COMPUTER PROGRAMS AB77, AC77, AND AB79

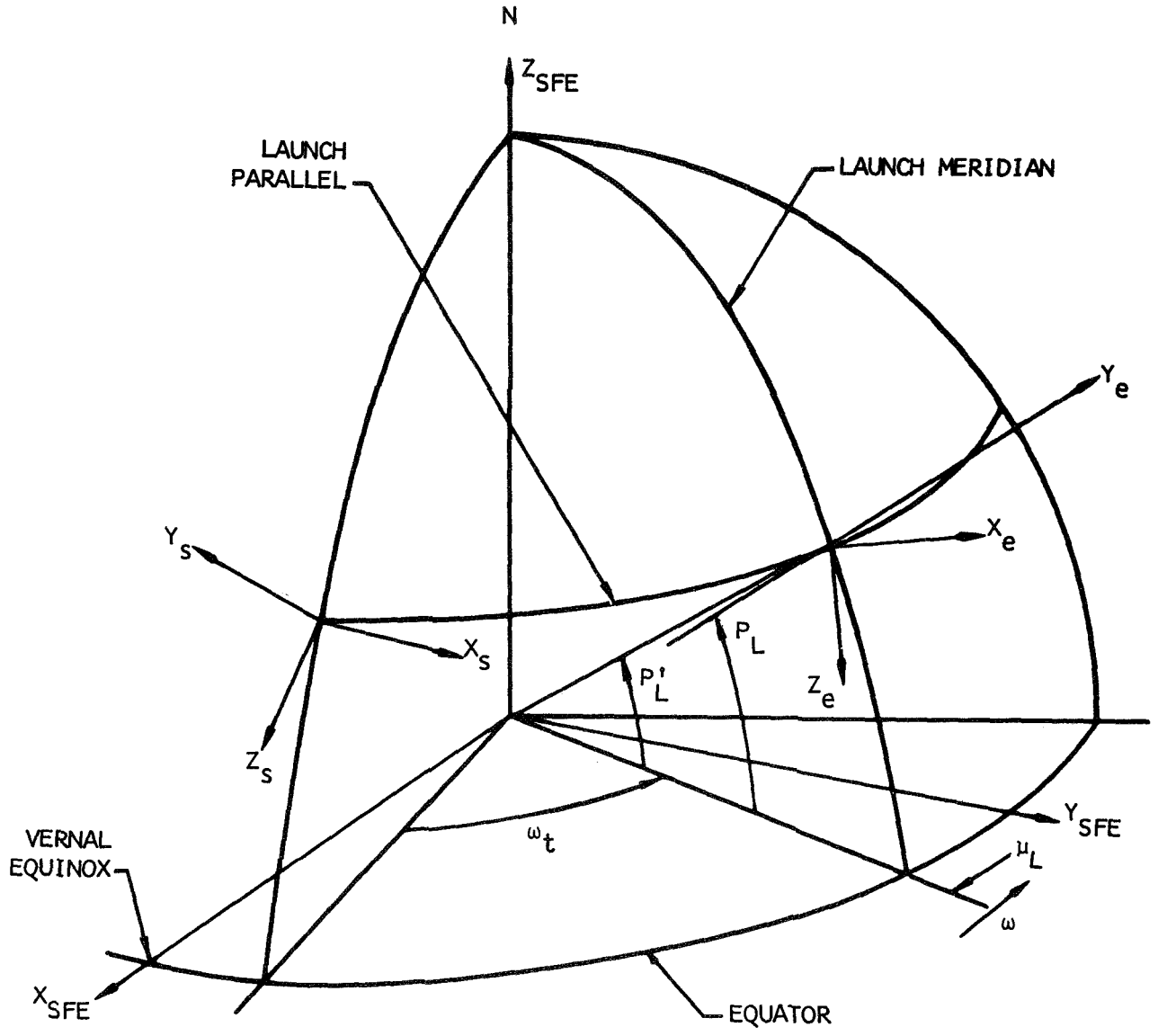
PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
TAU (1G)	τ_{1G}	Ratio of $W/\dot{W}$ during third stage operation (sec)
TAU (3G)	τ_{3G}	Ratio of $W/\dot{W}$ during third stage operation (sec)
TAU SB F	τ_f	Time since/to perigee at terminal altitude (sec)
PHI SB C	ϕ_C	Command vehicle roll Euler angle (deg)
PHI (T)	ϕ_T	Estimate of terminal range angle measured in the orbit plane from the descending node to the terminal radius vector, positive in the flight direction (radians)
PSI SB C	ϕ_C	Command vehicle yaw Euler angle (deg)
CHI SB P CHI SB R CHI SB Y	χ_P χ_R χ_Y	Guidance-commanded body attitude angle in the vehicle pitch, roll, and yaw plane (deg)
D-CHI SB P D-CHI SB R D-CHI SB Y	$\dot{\chi}_P$ $\dot{\chi}_R$ $\dot{\chi}_Y$	Guidance - commanded body attitude rates in the vehicle pitch, roll, and yaw plane (deg/sec)

TABLE AP 3-5 (Sheet 1 of 2)
LIST OF COORDINATE SUBSCRIPT DEFINITIONS

ee	Coordinate system on the surface of the spheroid representing the earth and whose origin is at the same latitude and longitude as the launcher. X_{ee} positive downrange, Y_{ee} perpendicular to the surface of the spheroid, positive up, and Z_{ee} crossrange positive in the right handed coordinate system. (English)
LL	Instantaneous coordinate system located on the earth's surface under the vehicle with the X_{LL}, Z_{LL} plane tangent to the earth's surface. Positive directions are X_{LL} west, Y_{LL} up, and Z_{LL} north. (English)
L_I	Instantaneous inertial coordinate system coincidental with the L system. Velocities in this system are inertial. (English)
L'_I	Instantaneous inertial coordinate system located on the earth's surface under the vehicle where Z_L' points north, X_L' points west and Y_L' is along a line connecting the earth center and the vehicle. Velocities in this system are inertial. (English)
m	Vehicle coordinates fixed at the center of gravity of the vehicle. X_m parallel to the longitudinal axis of the vehicle positive forward, Y_m at the zero deg bank angle position, and A_m at the 90 deg bank angle position. (English)
P'	Inertial coordinate system with its origin at the center of the earth and with its X_P axis along the line parallel to the local gravity vector at launch through the earth's center, positive up. The X_P axis is parallel to the plane defined by the X_x and Y_x axes at launch and Z_P' forms a right-handed coordinate system. (Metric)
s	Coordinates initially coincident with the e system, but remaining fixed in space. (English)

TABLE AP 3-5 (Sheet 2 of 2)
LIST OF COORDINATE SUBSCRIPT DEFINITIONS

SFE	Space Fixed Ephemeris System. The origin of the system is at the center of the earth, Z_{SFE} is positive north, X_{SFE} passes through the vernal equinox and Y_{SFE} completes the right handed system with the X_{SFE} -Y_{SFE} plane coincident with the equatorial plane. The directions of the axes remain fixed in space and the origin moves with the center of the earth. The reference equinox and equator are the true vernal equinox and equator for the epoch of midnight of the day of the launch. (English)



NOTE: THE Y AXES ARE PERPENDICULAR TO THE EARTH'S SURFACE AT THE LAUNCH SITE

Figure AP 3-1. Coordinate System, AB77 and AC77 Computer Programs

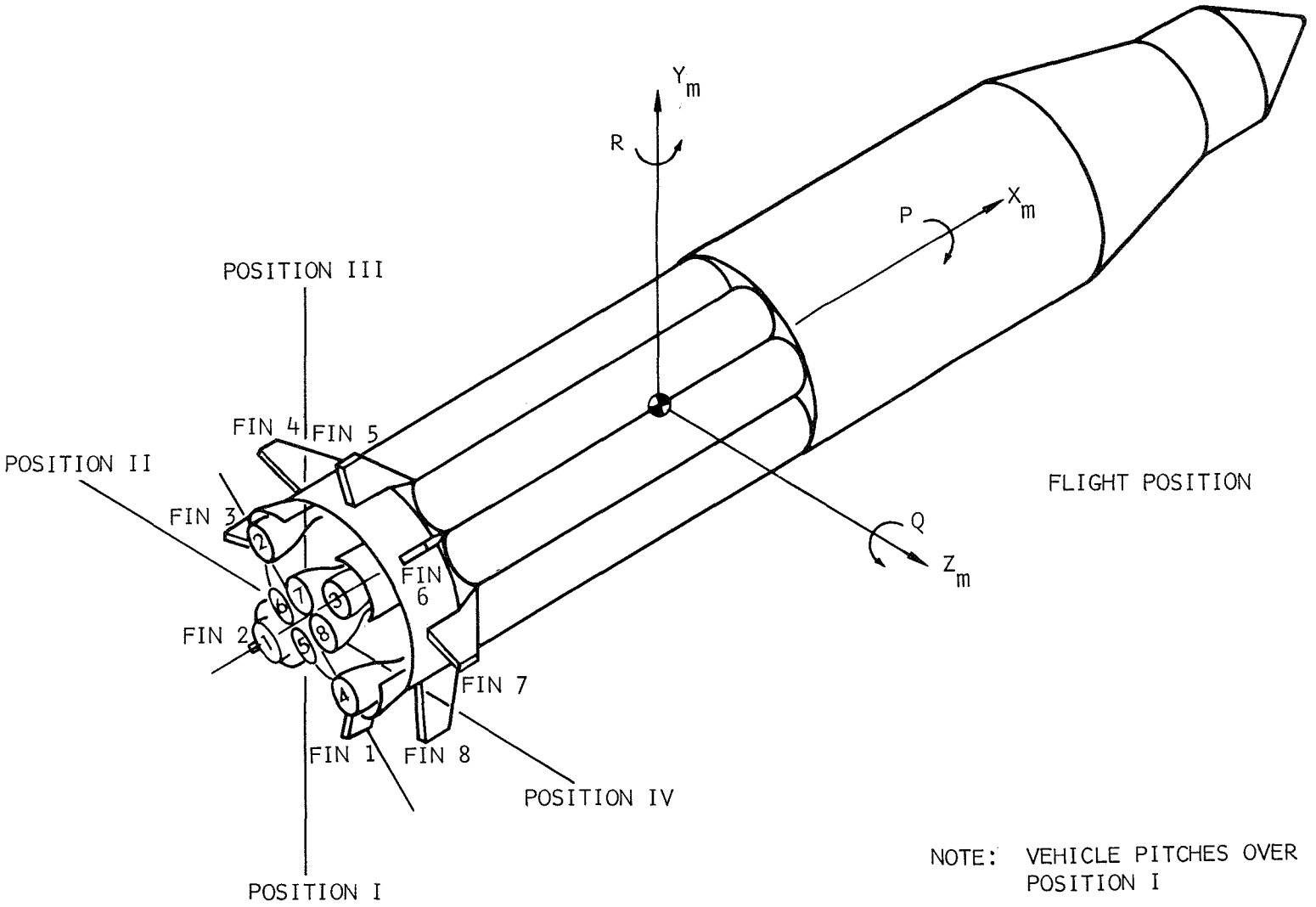


Figure AP 3-2. Body Fixed Coordinate System Orientation

APPENDIX 4

TELEMETRY LOOK ANGLES AND TELEMETRY POWER MARGINS

4. TELEMETRY LOOK ANGLES AND TELEMETRY POWER MARGINS

This appendix presents the telemetry look angles and the telemetry power margins.

Table AP 4-1 lists the times associated with a negative 5 degree acquisition and loss of telemetry signal for slightly over two revolutions.

Figure AP 4-1 presents the elevation look angle versus time for S-IVB powered flight.

The antenna power margins for the following telemetry stations are shown in figures AP 4-2 through AP 4-23:

Tel 4	Ship I
Bermuda	Carnarvon
Insertion ship	Douglas - A3
Canary Islands	Corpus Christi
Tananarive	Hawaii

The power margins are plotted for a 0 deg acquisition and loss of signal.

TABLE AP 4-1 (Sheet 1 of 2)
ORBITAL TELEMETRY SUMMARY

REVOLUTION	STATION	ACQUISITION TIME AT -5 DEG (sec)	MAXIMUM ELEVATION			LOSS TIME AT -5 DEG (sec)	TRACKING TIME (sec)
			ANGLE (deg)	RANGE (ft) X 10^6	TIME (sec)		
1	Powered Flight Ship	150	71	0.6	584	850	700
1	Insertion Ship	600	24	1.8	900	1,150	550
1	Canary Island	950	27	1.2	1,200	1,500	550
1	Tanarive	2,150	12	2.5	2,400	2,700	550
1	Ship I	2,800	29	1.4	3,100	3,400	600
1	Carnarvon	3,050	24	1.6	3,350	3,650	600
1	Hawaii	4,800	-3	6.4	4,900	5,000	200
1	Guaymas	5,250	44	0.8	5,550	5,800	550
2	Cape Tel 4	5,700	22	1.4	5,950	6,200	500
2	Grand Bahama	5,700	13	2.0	5,950	6,250	550
2	Bermuda	5,900	50	0.7	6,150	6,400	500
2	Powered Flight Ship	5,900	46	0.7	6,150	6,450	550
2	Insertion Ship	6,200	33	1.0	6,450	6,750	550
2	Canary Island	6,550	2	4.3	6,800	7,000	450
2	Ascension	7,000	-4.3	6.9	7,100	7,150	150
2	Tanarive	7,700	25	1.6	8,000	8,250	550

TABLE AP 4-1 (Sheet 2 of 2)
ORBITAL TELEMETRY SUMMARY

REVOLUTION	STATION	ACQUISITION TIME AT -5 DEG (sec)	MAXIMUM ELEVATION			LOSS TIME AT -5 DEG (sec)	TRACKING TIME (sec)
			ANGLE (deg)	RANGE (ft) X 10^6	TIME (sec)		
2	Ship I	8,400	20	1.9	8,700	9,000	600
2	Carnarvon	8,650	45	1.0	8,950	9,250	600
2	Hawaii	10,200	11	2.2	10,450	10,700	500
2	Guaymas	10,850	21	1.4	11,100	11,400	550
2	Corpus Christi	11,050	18	1.6	11,300	11,550	500
3	Cape Tel 4	11,250	33	1.0	11,550	11,800	550
3	Grand Bahama	11,300	24	1.3	11,550	11,850	550
3	Bermuda	11,450	13	2.2	11,700	12,000	550
3	Powered Flight Ship	11,500	16	1.9	11,750	12,000*	500
3	Insertion Ship	11,800	4*	3.9*	12,000*	12,000*	200

* End of computer programmed output.

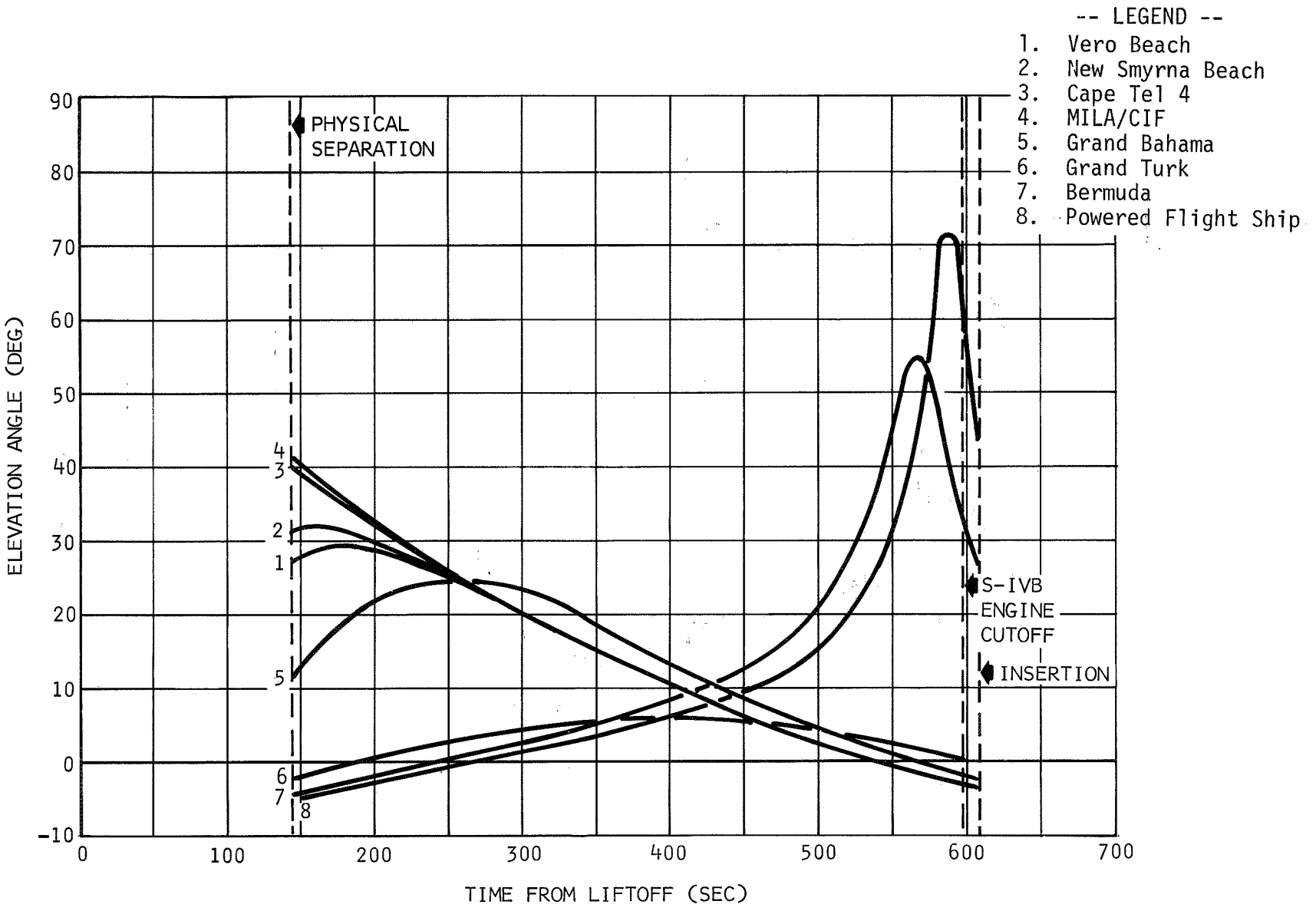


Figure AP 4-1. AS-204/LM-1 Telemetry Elevation Angles (Powered Flight)

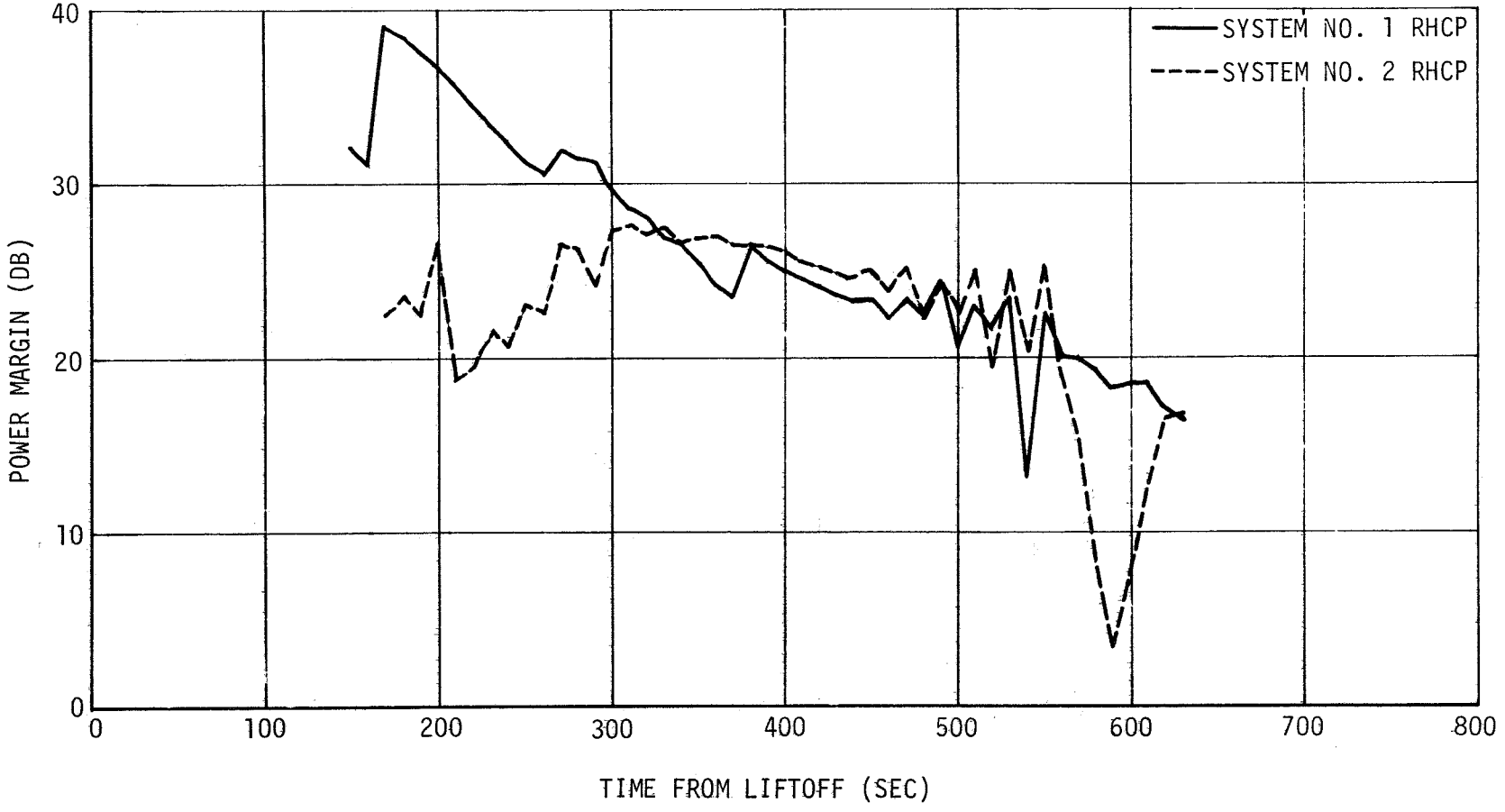


Figure AP 4-2. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tel 4 (Sheet 1 of 2)

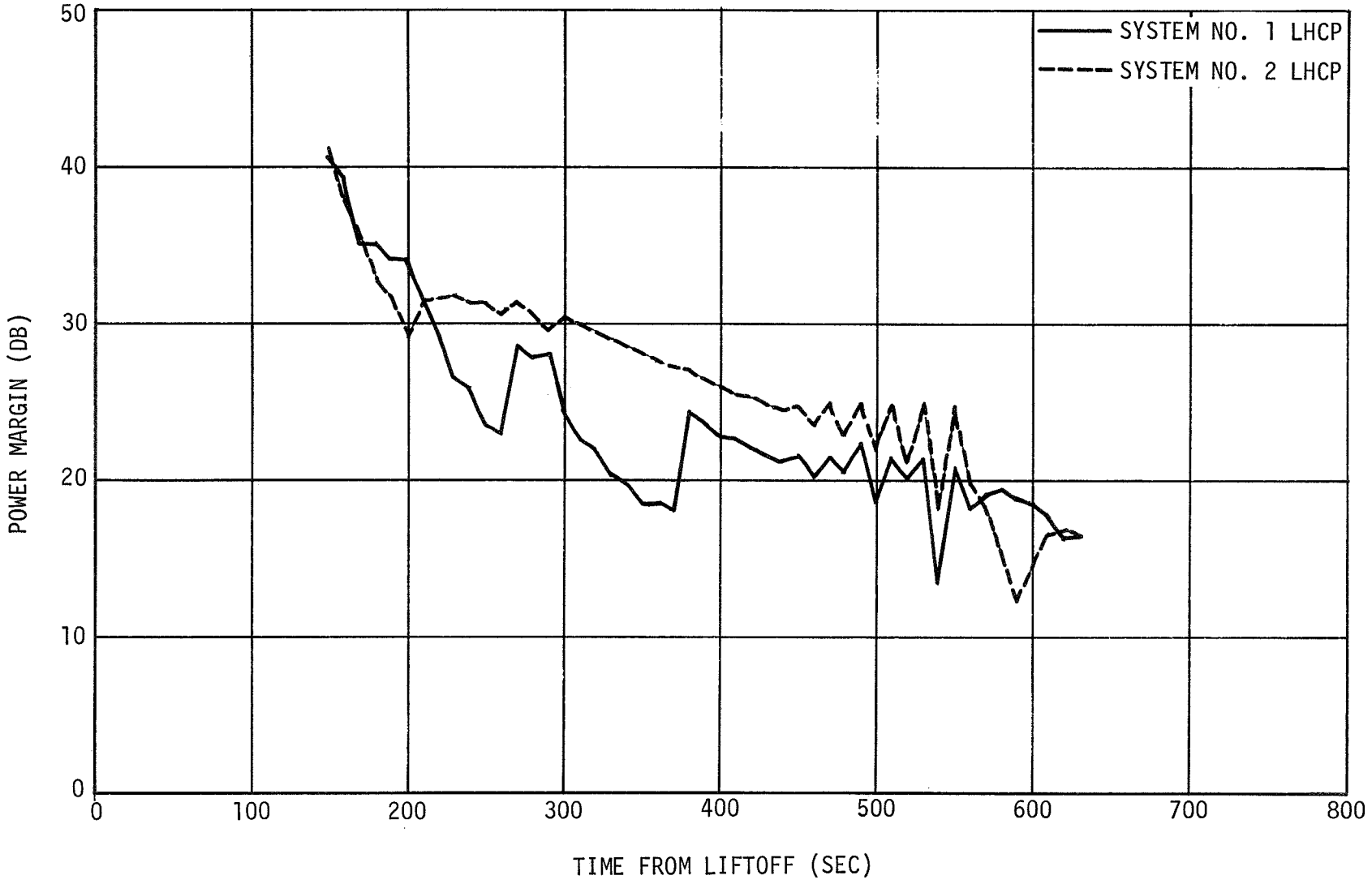


Figure AP 4-2. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tel 4 (Sheet 2 of 2)

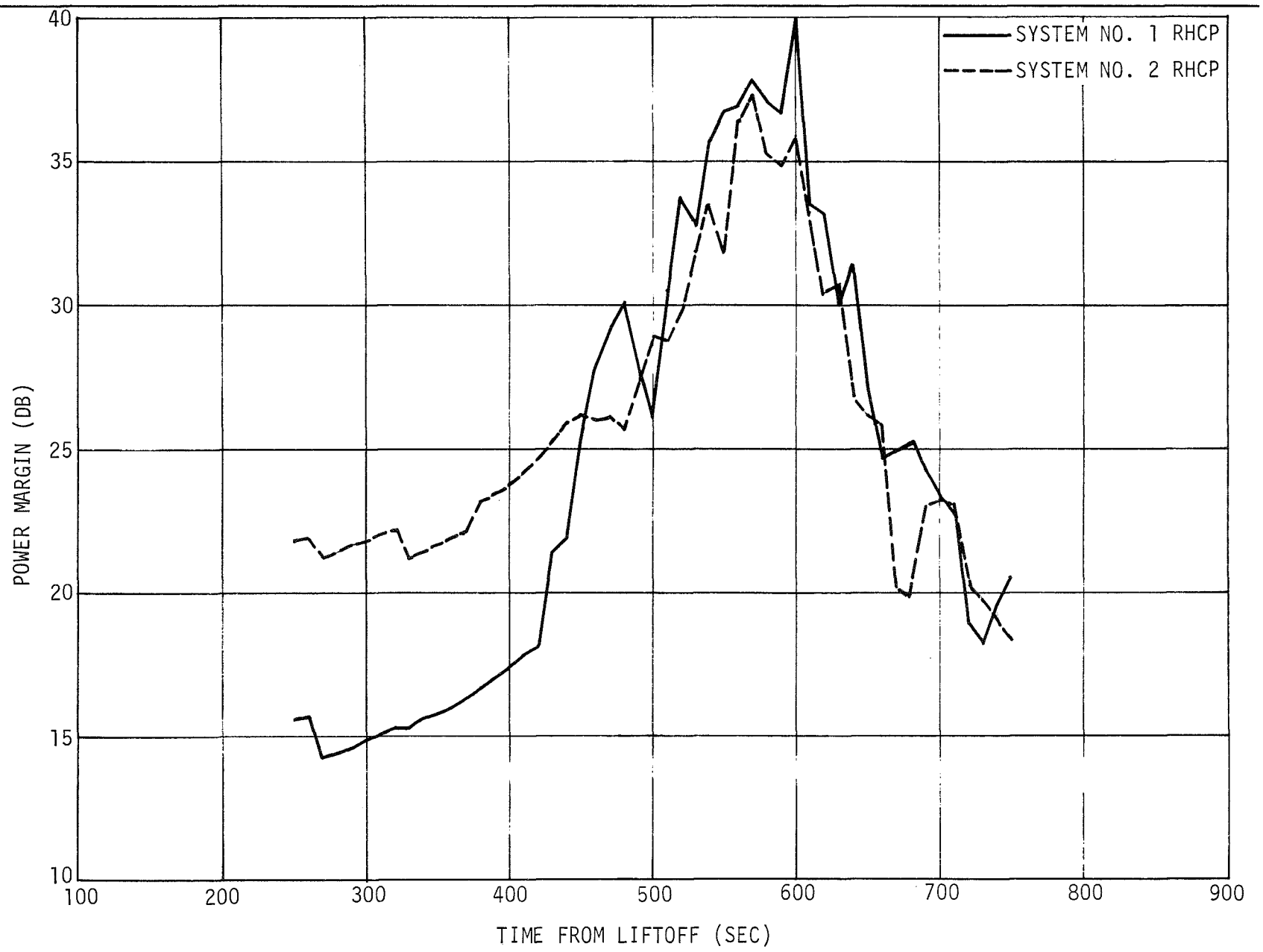


Figure AP 4-3. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Bermuda (Sheet 1 of 2)

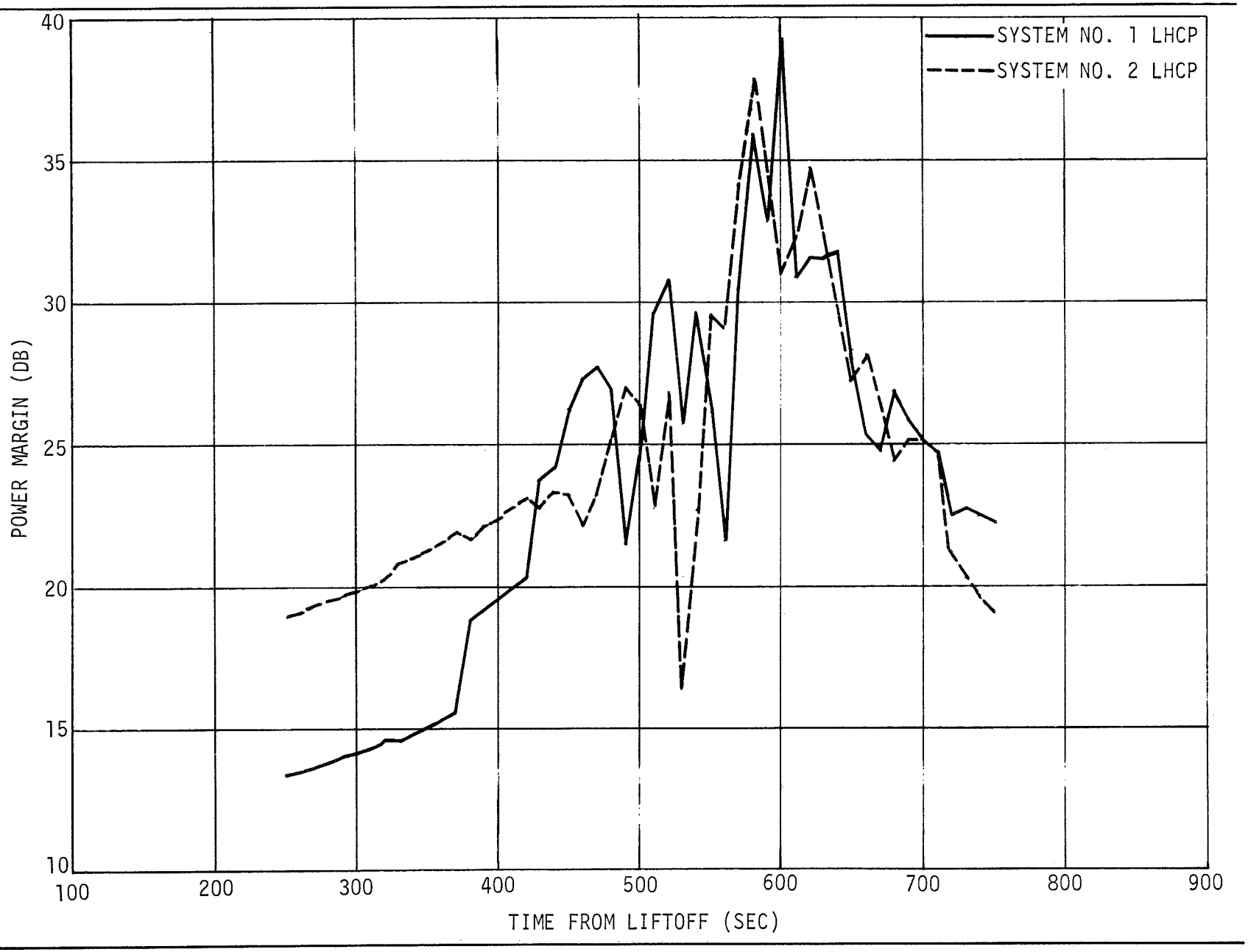


Figure AP 4-3. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Bermuda (Sheet 2 of 2)

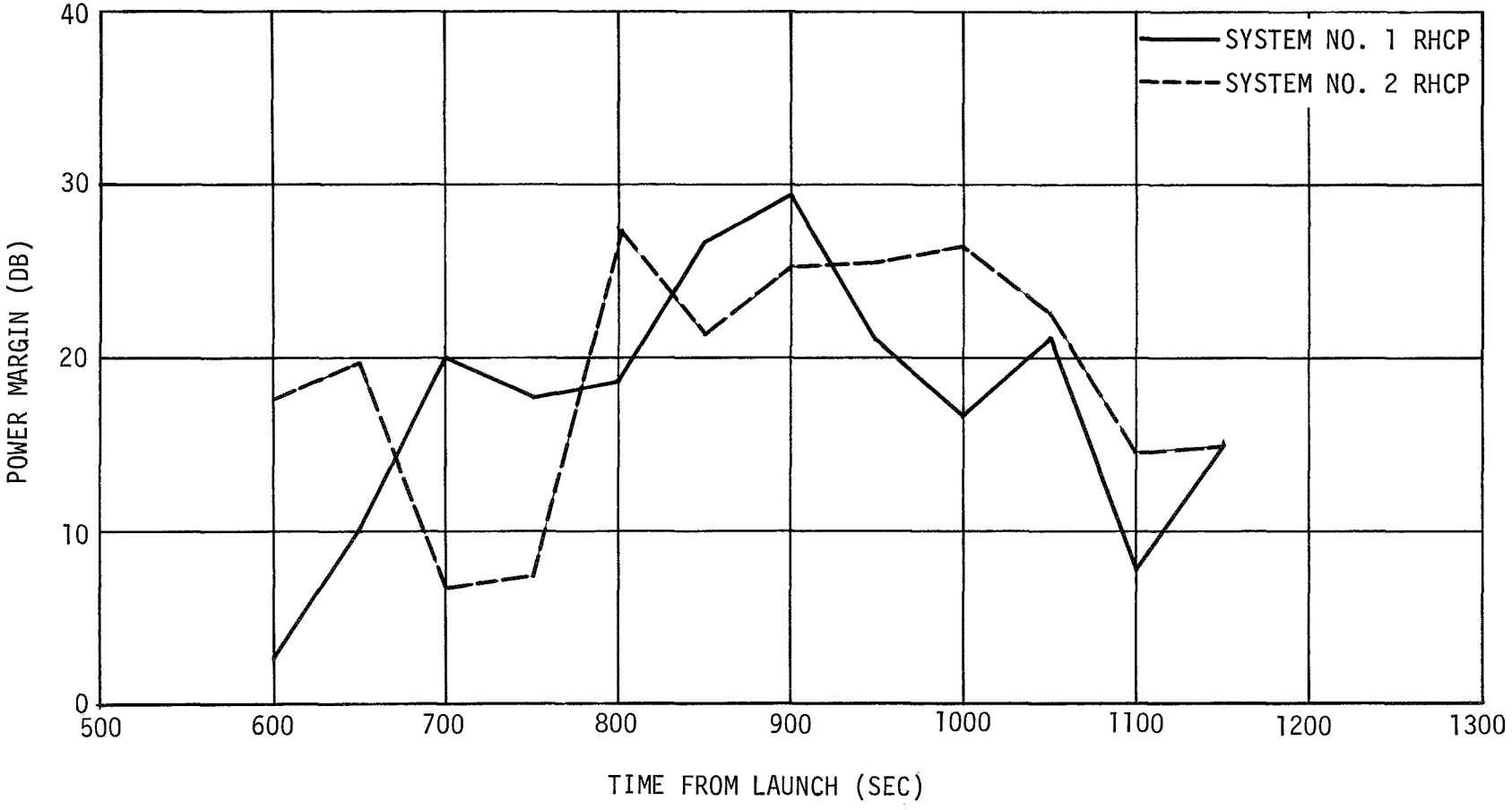


Figure AP 4-4. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Insertion Ship (Sheet 1 of 2)

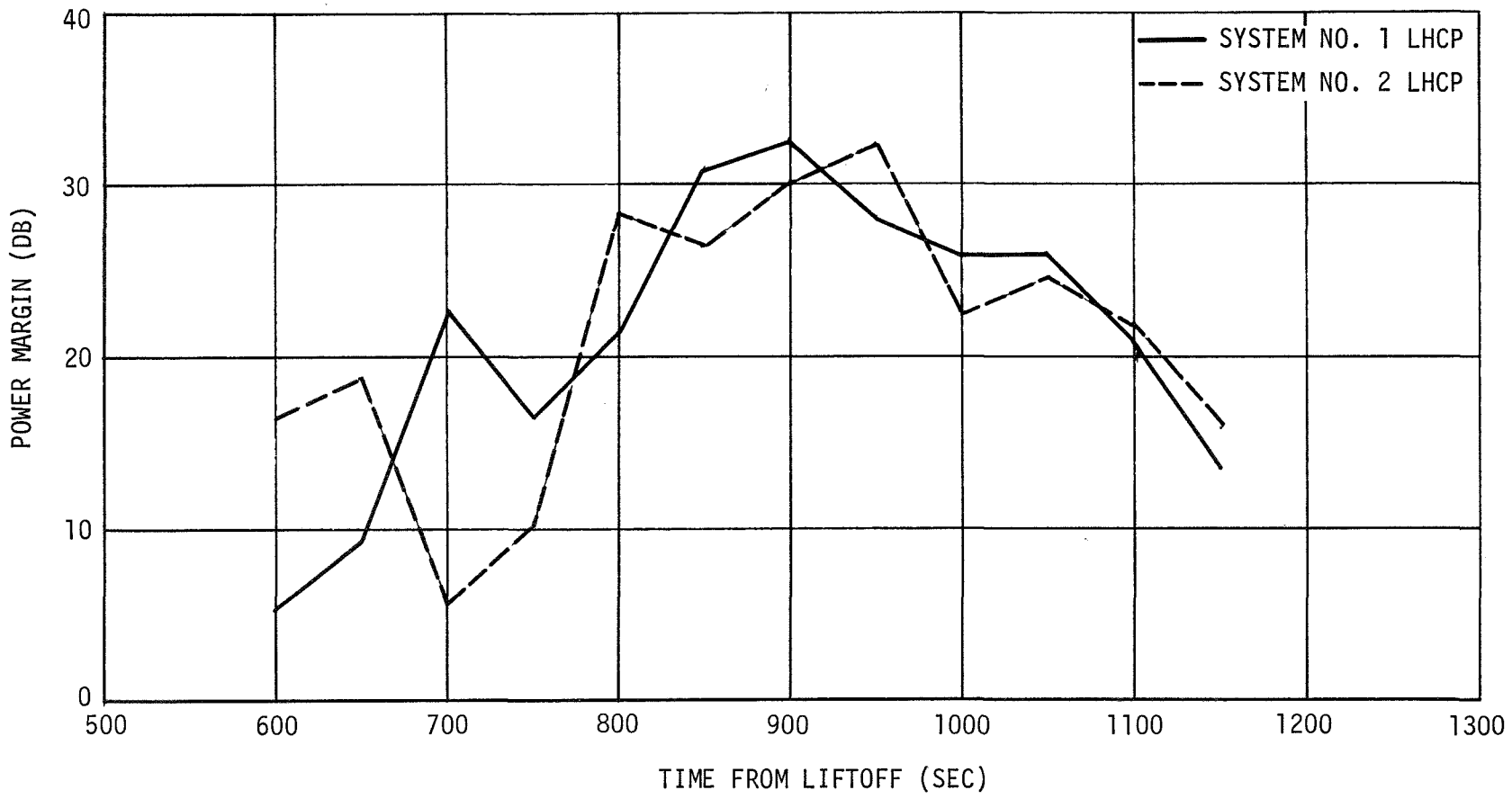


Figure AP 4-4. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Insertion Ship (Sheet 2 of 2)

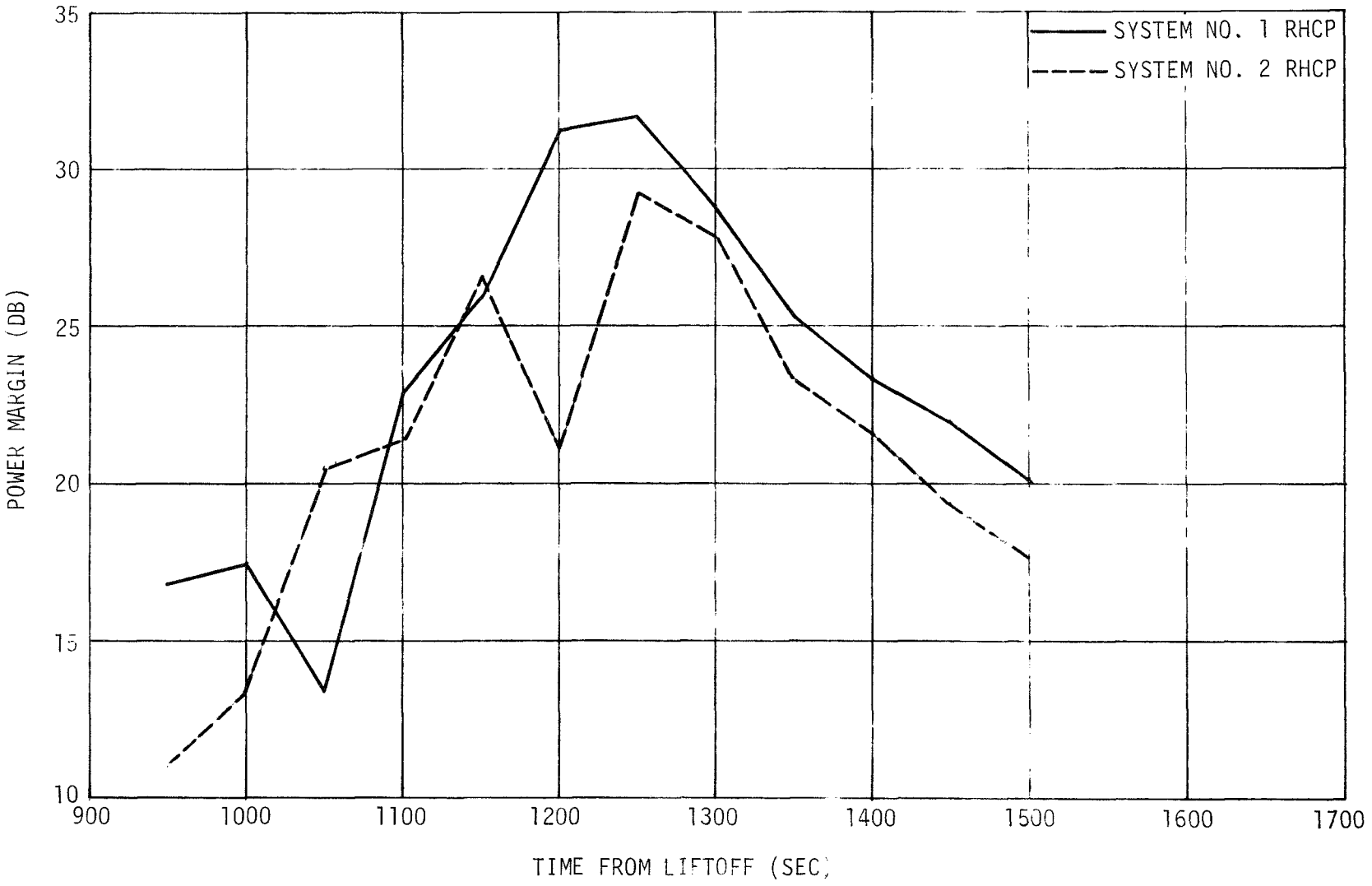


Figure AP 4-5. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Canary Island (Sheet 1 of 2)

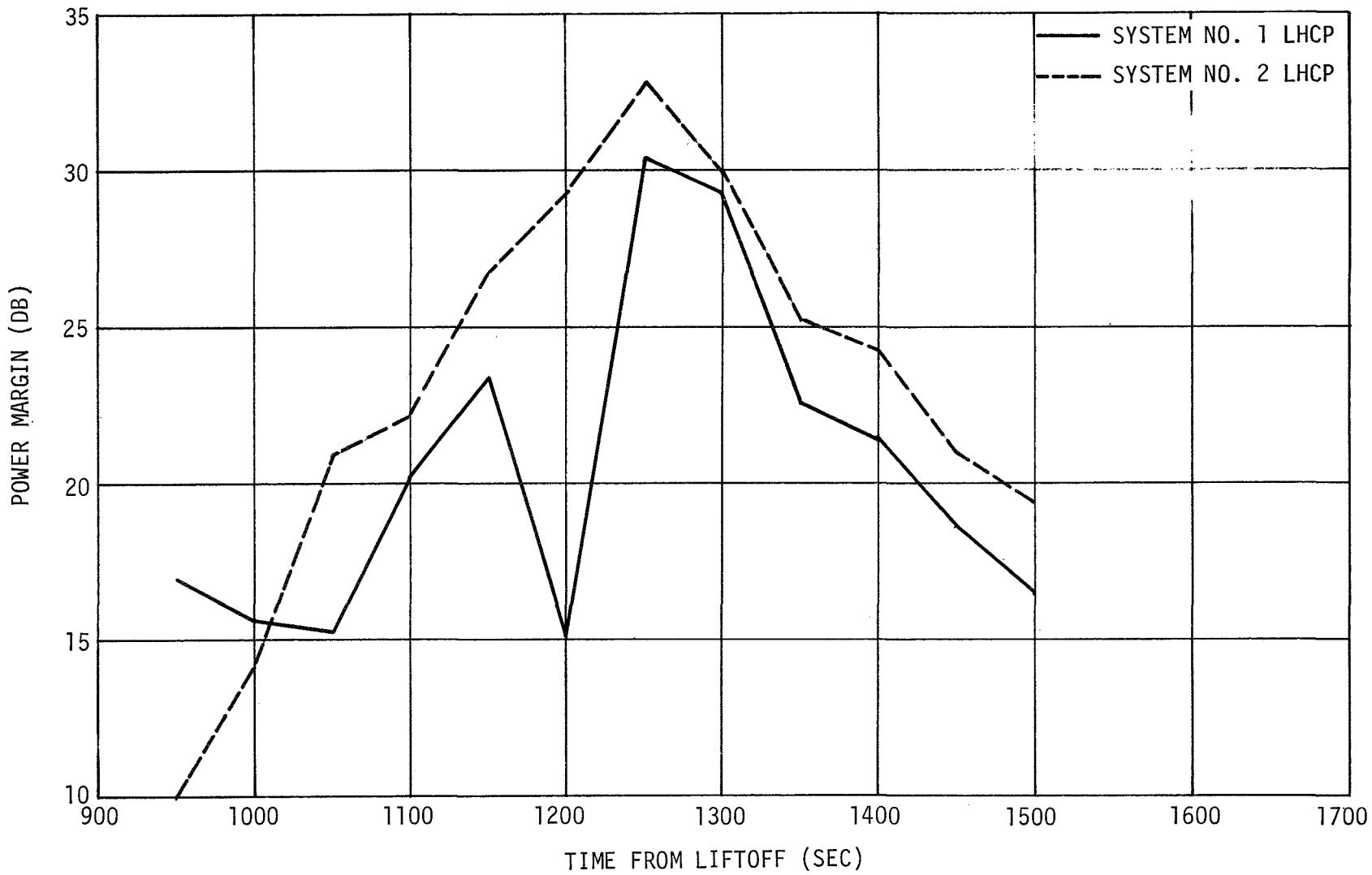


Figure AP 4-5. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Canary Island (Sheet 2 of 2)

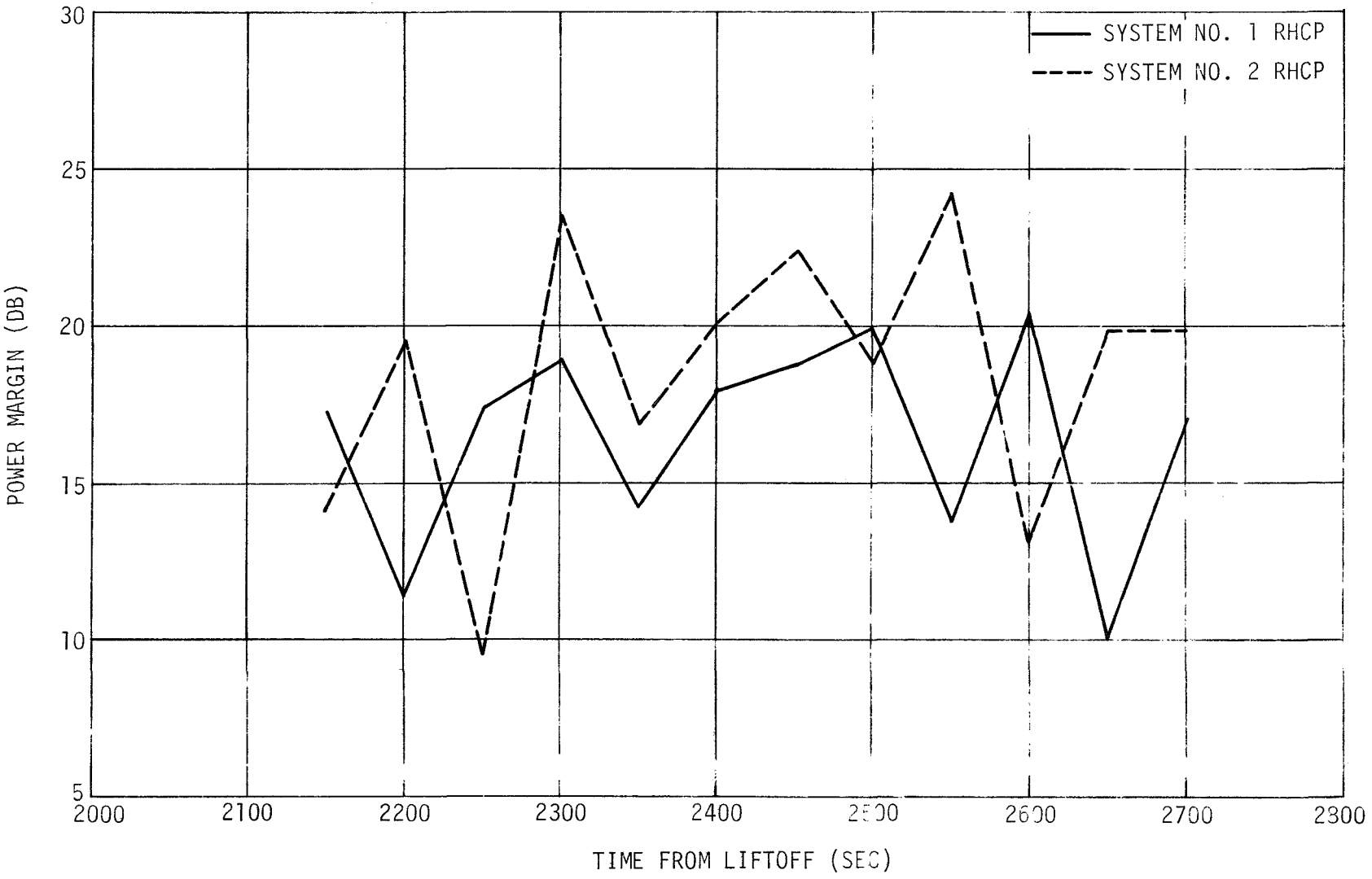


Figure AP 4-6. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tananarive (Sheet 1 of 2)

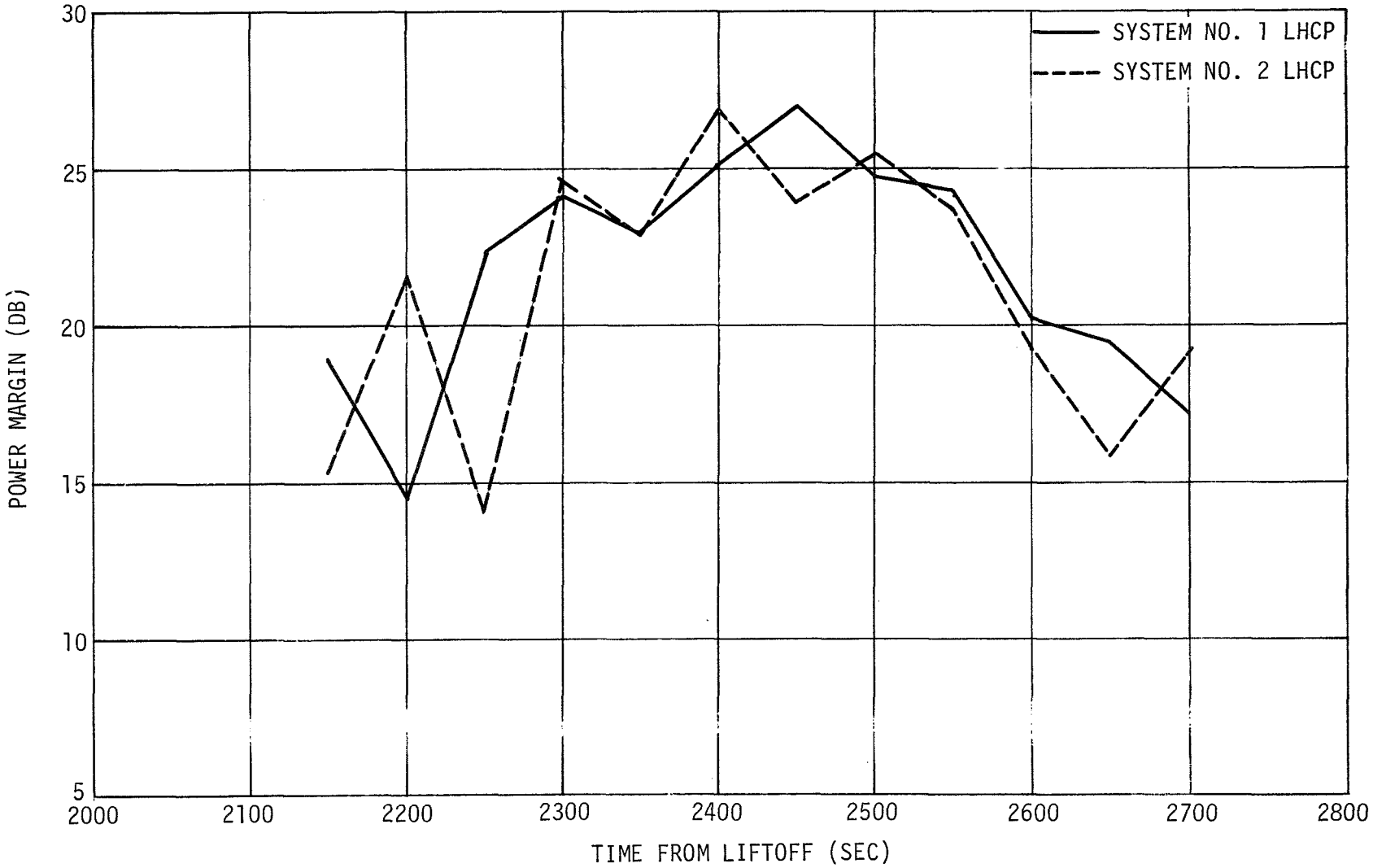


Figure AP 4-6. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tananarive (Sheet 2 of 2)

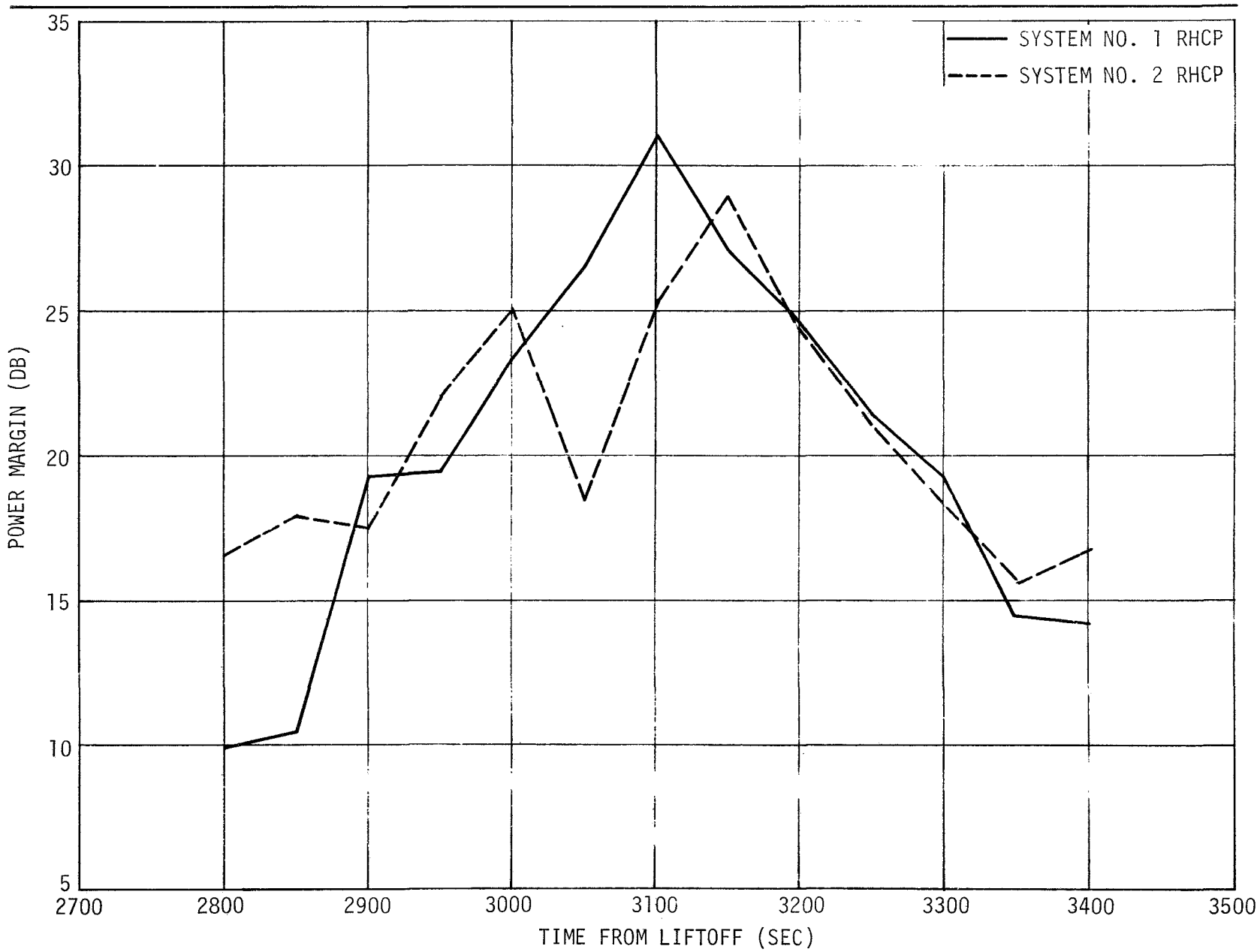


Figure AP 4-7. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Ship I (Sheet 1 of 2)

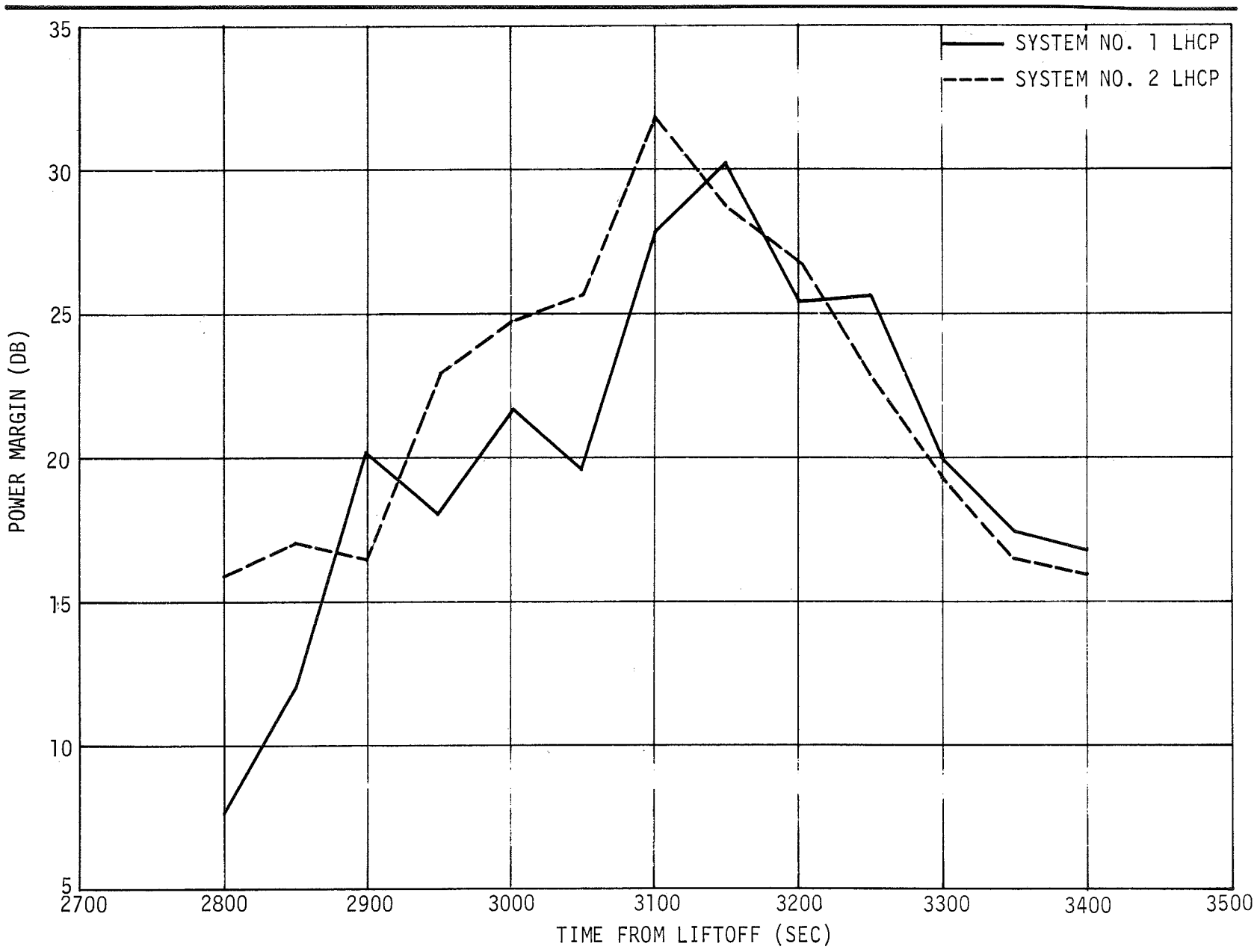


Figure AP 4-7. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Ship I (Sheet 2 of 2)

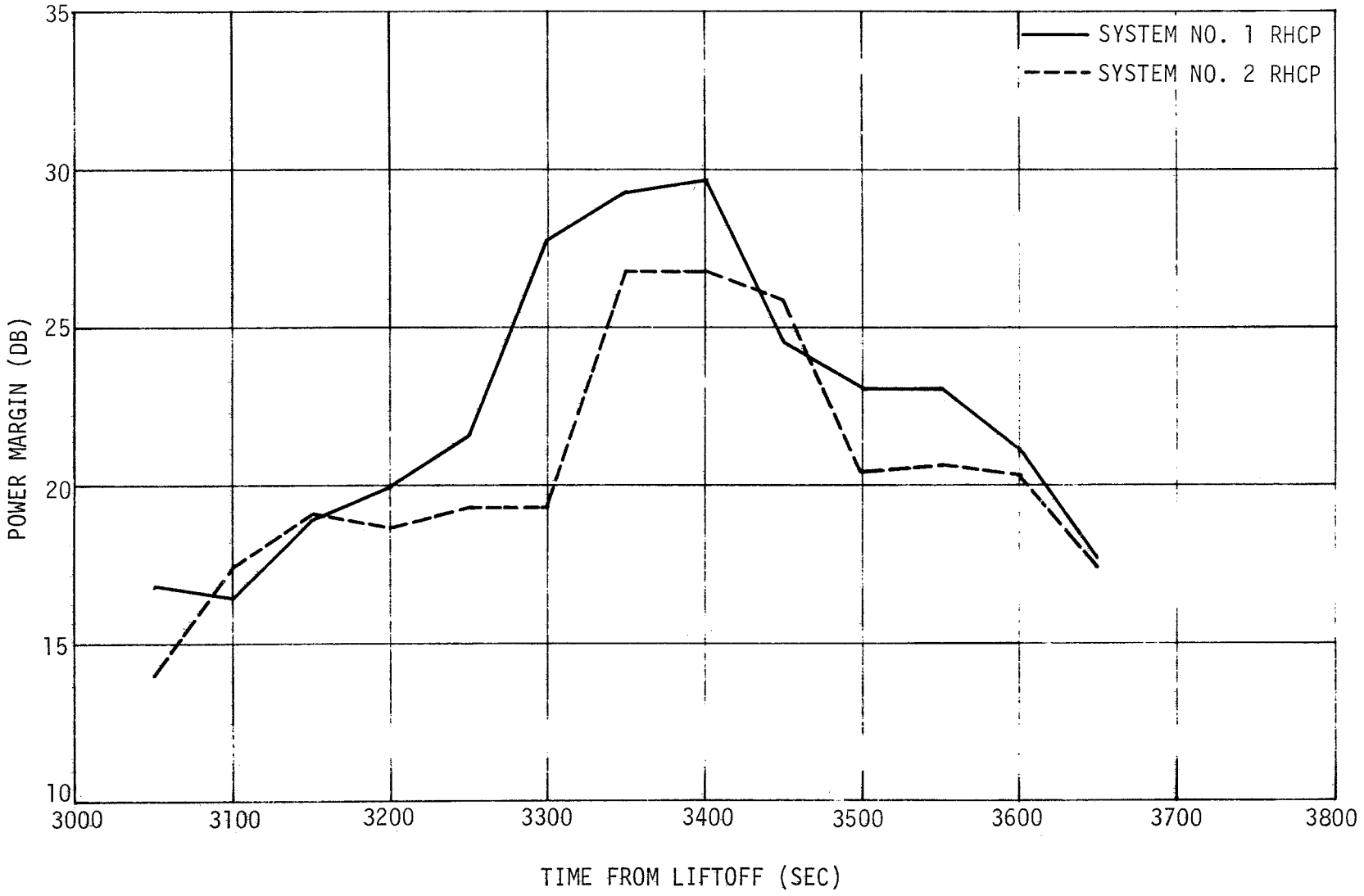


Figure AP 4-8. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Carnarvon (Sheet 1 of 2)

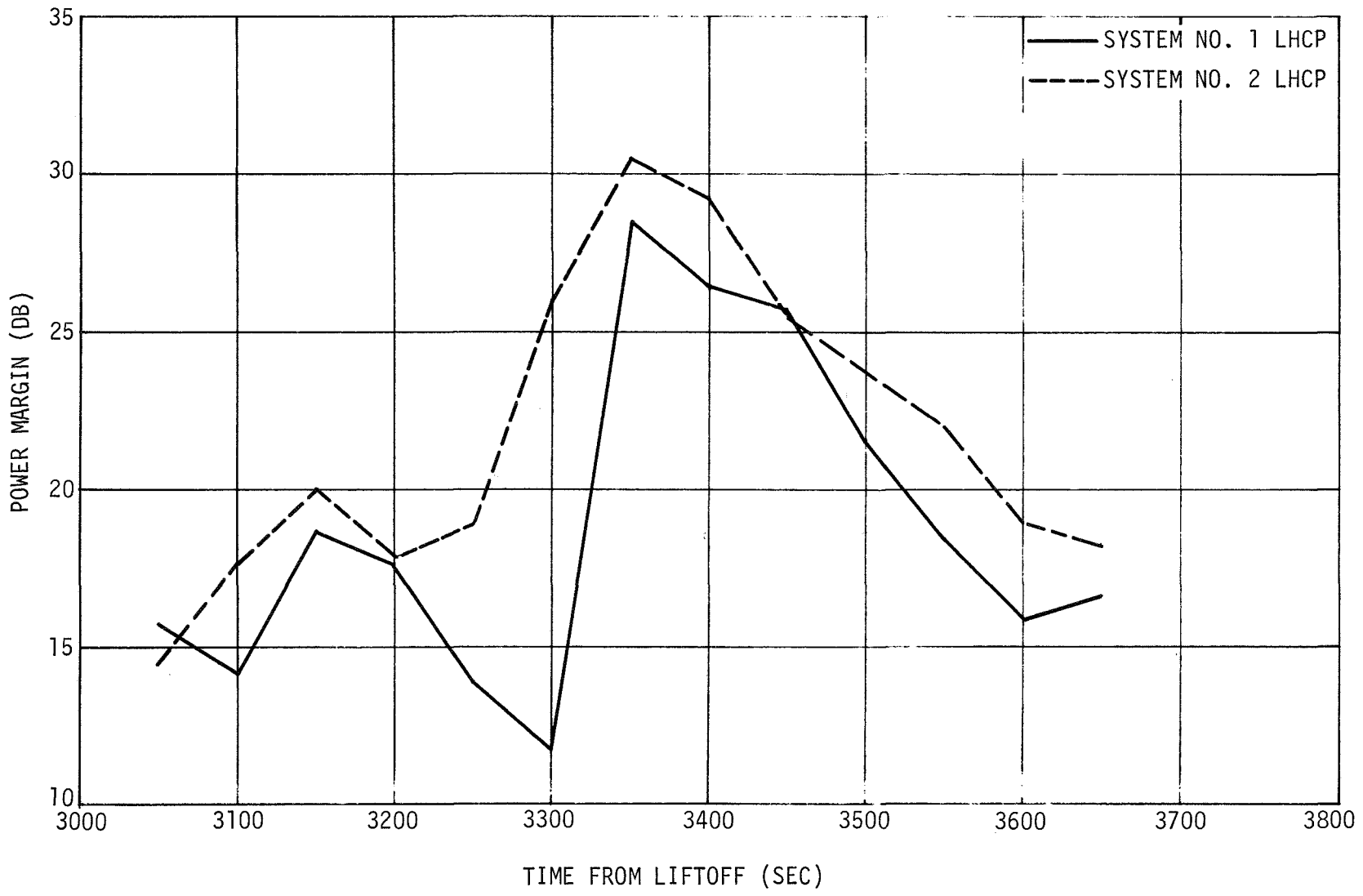


Figure AP 4-8. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Carnarvon (Sheet 2 of 2)

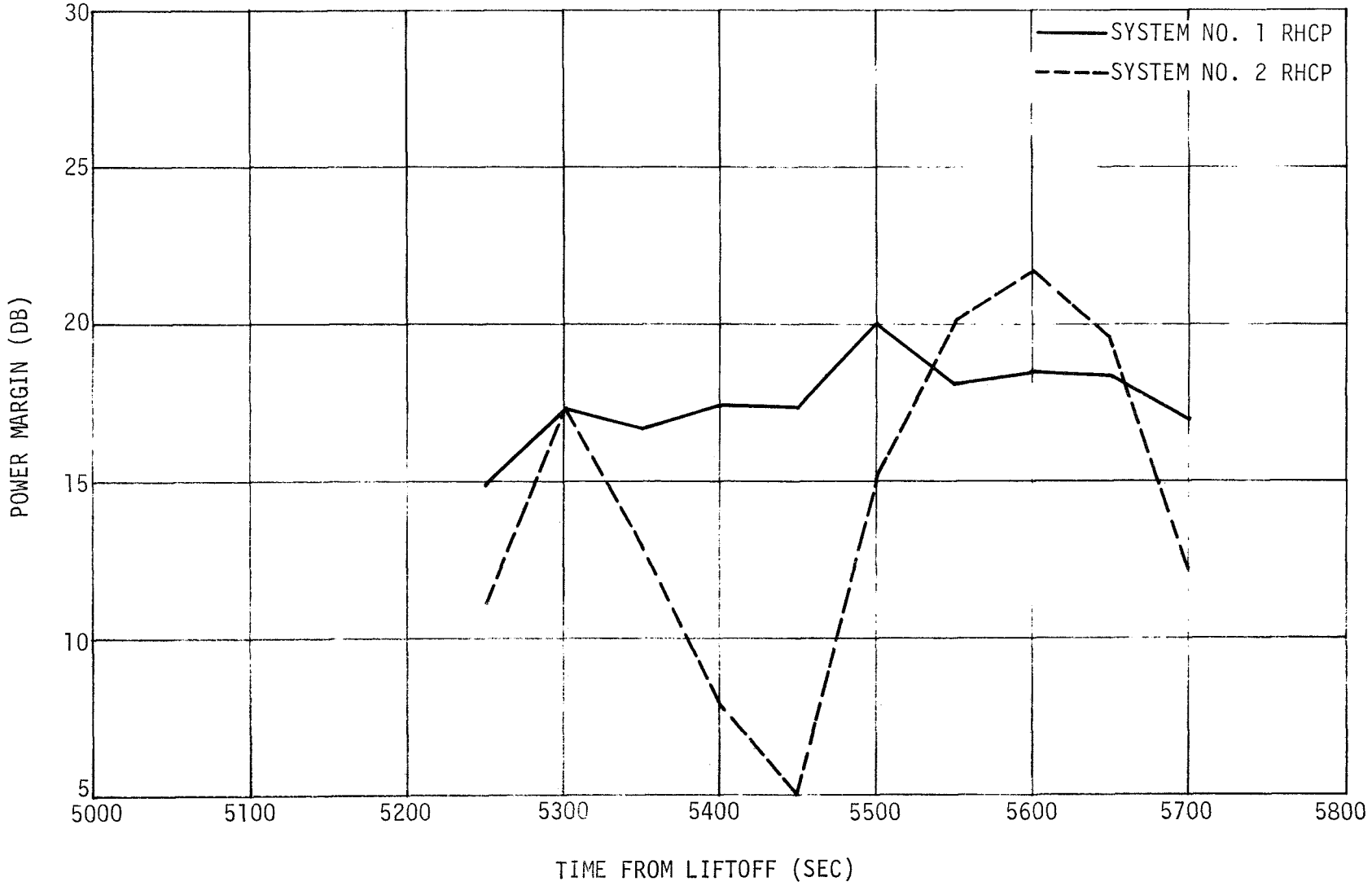


Figure AP 4-9. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Douglas - A3 (Sheet 1 of 2)

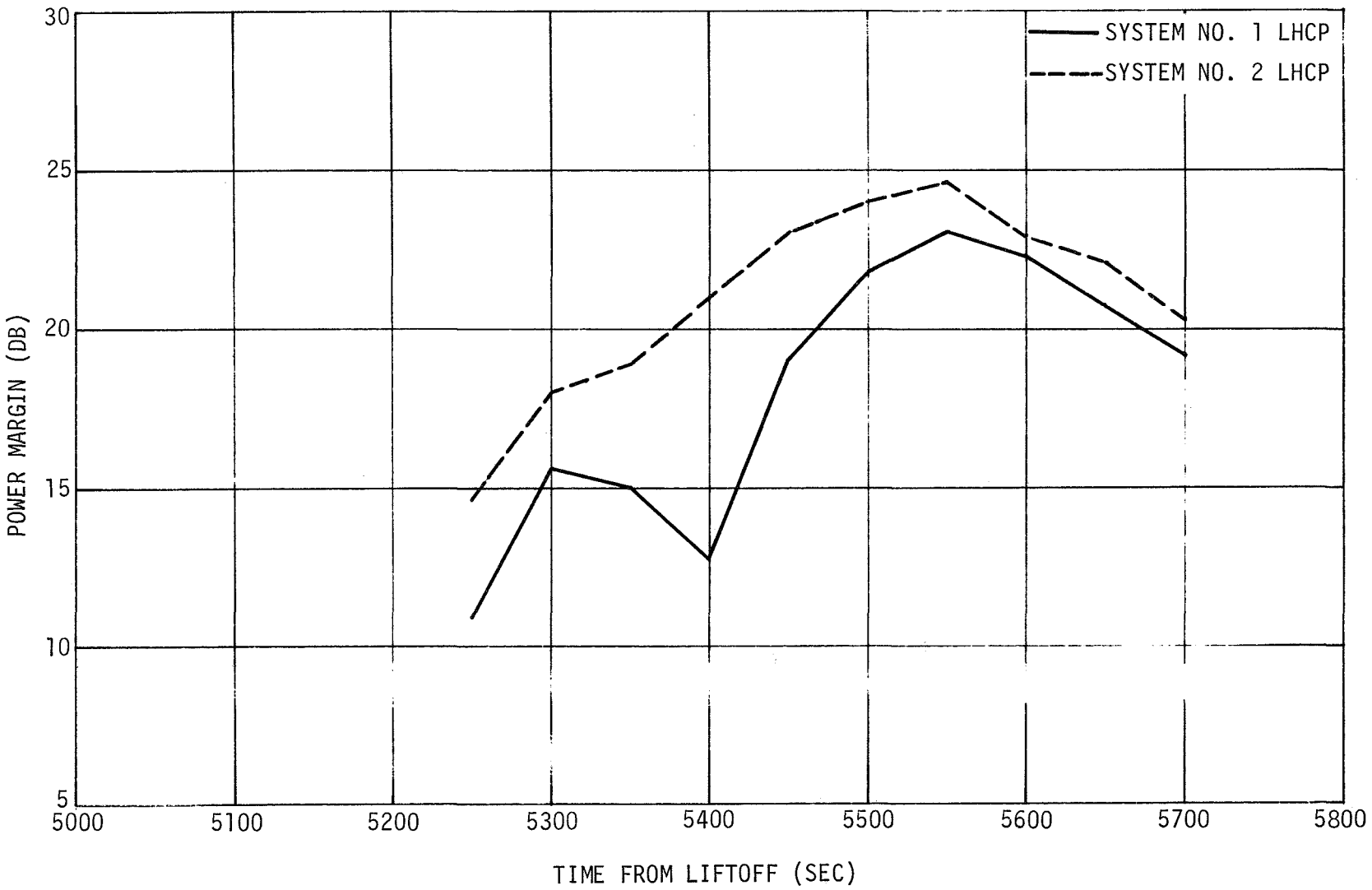


Figure AP 4-9. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Douglas - A3 (Sheet 2 of 2)

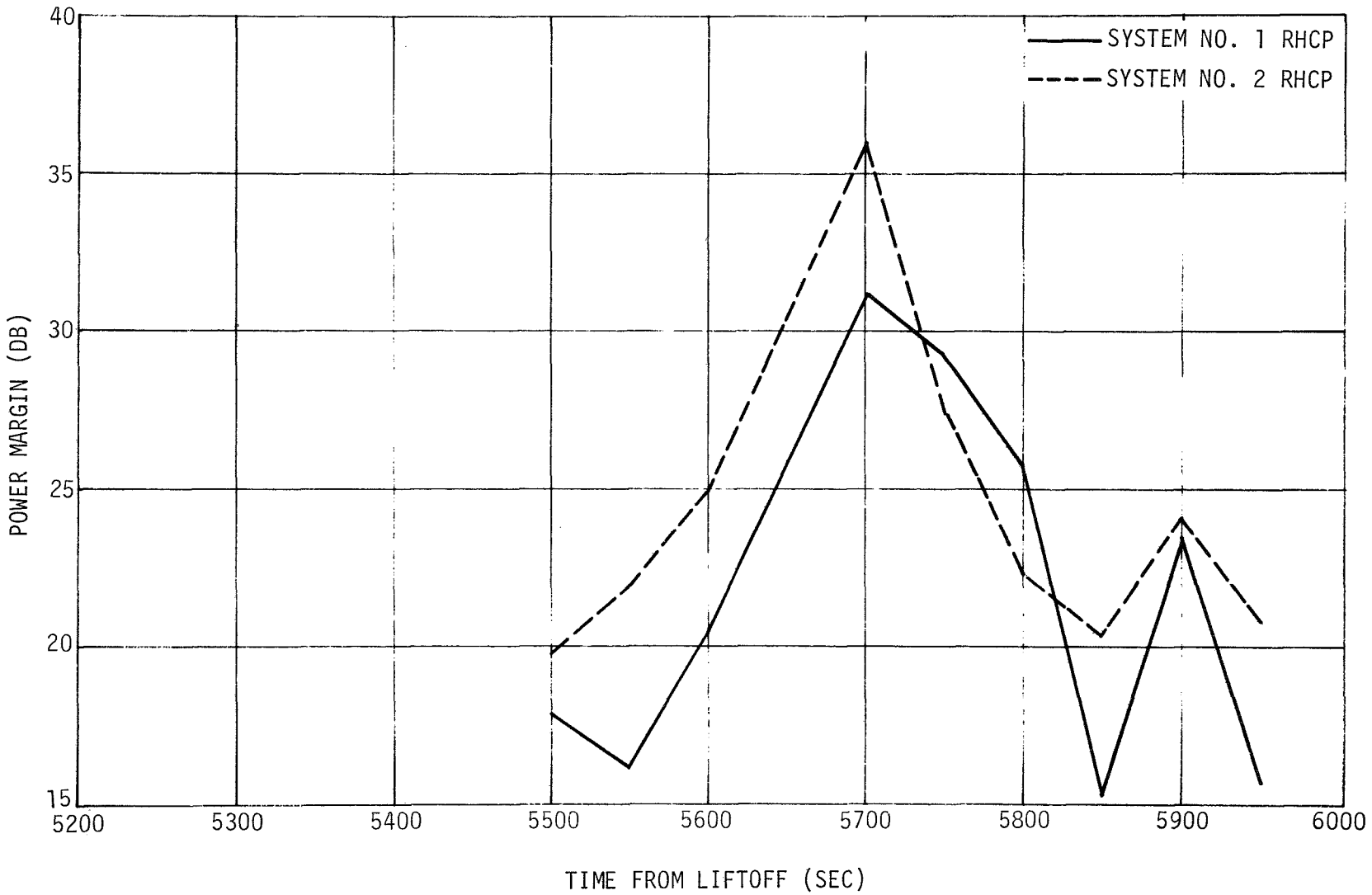


Figure AP 4-10. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Corpus Christi (Sheet 1 of 2)

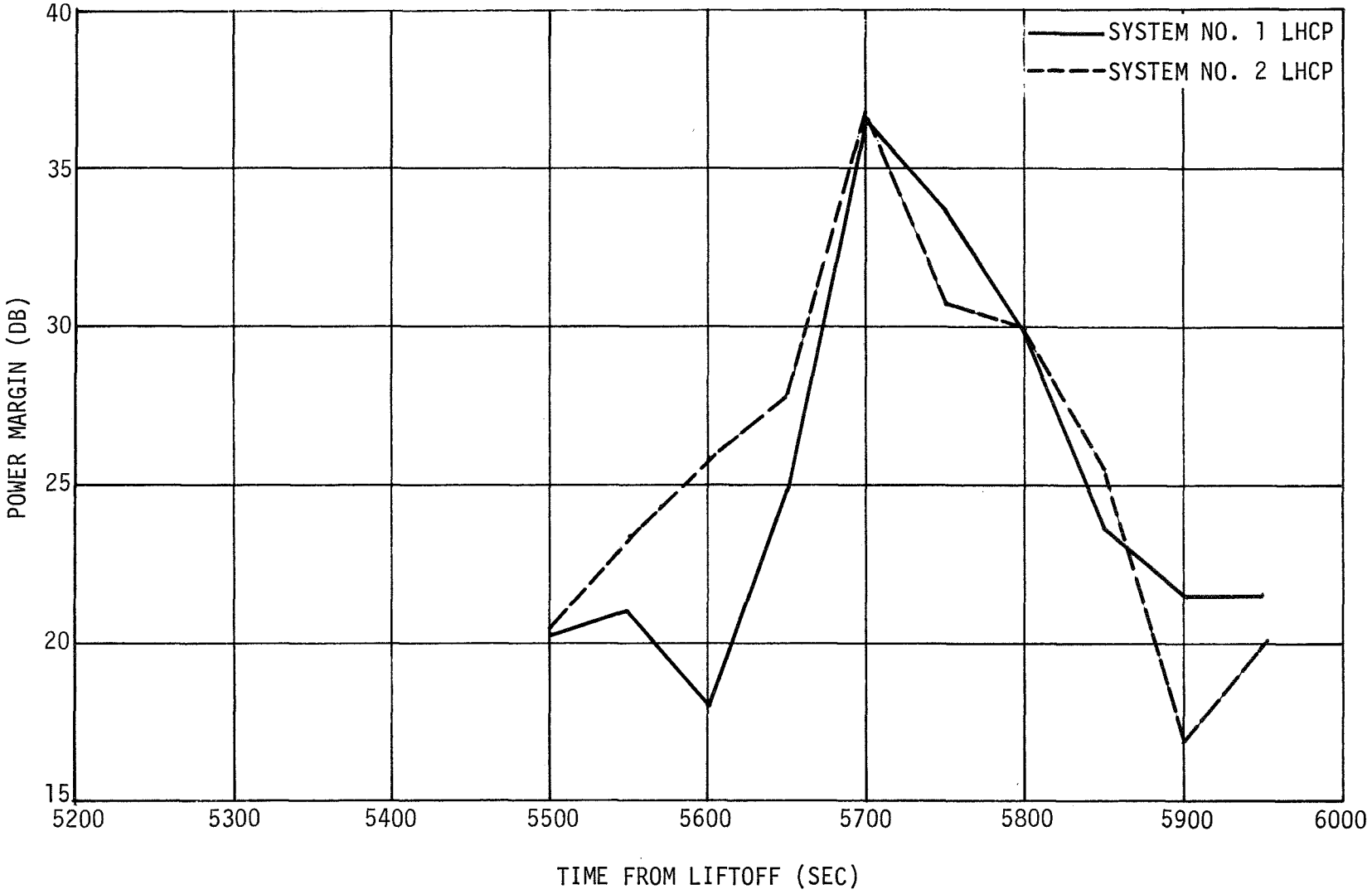


Figure AP 4-10. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Corpus Christi (Sheet 2 of 2)

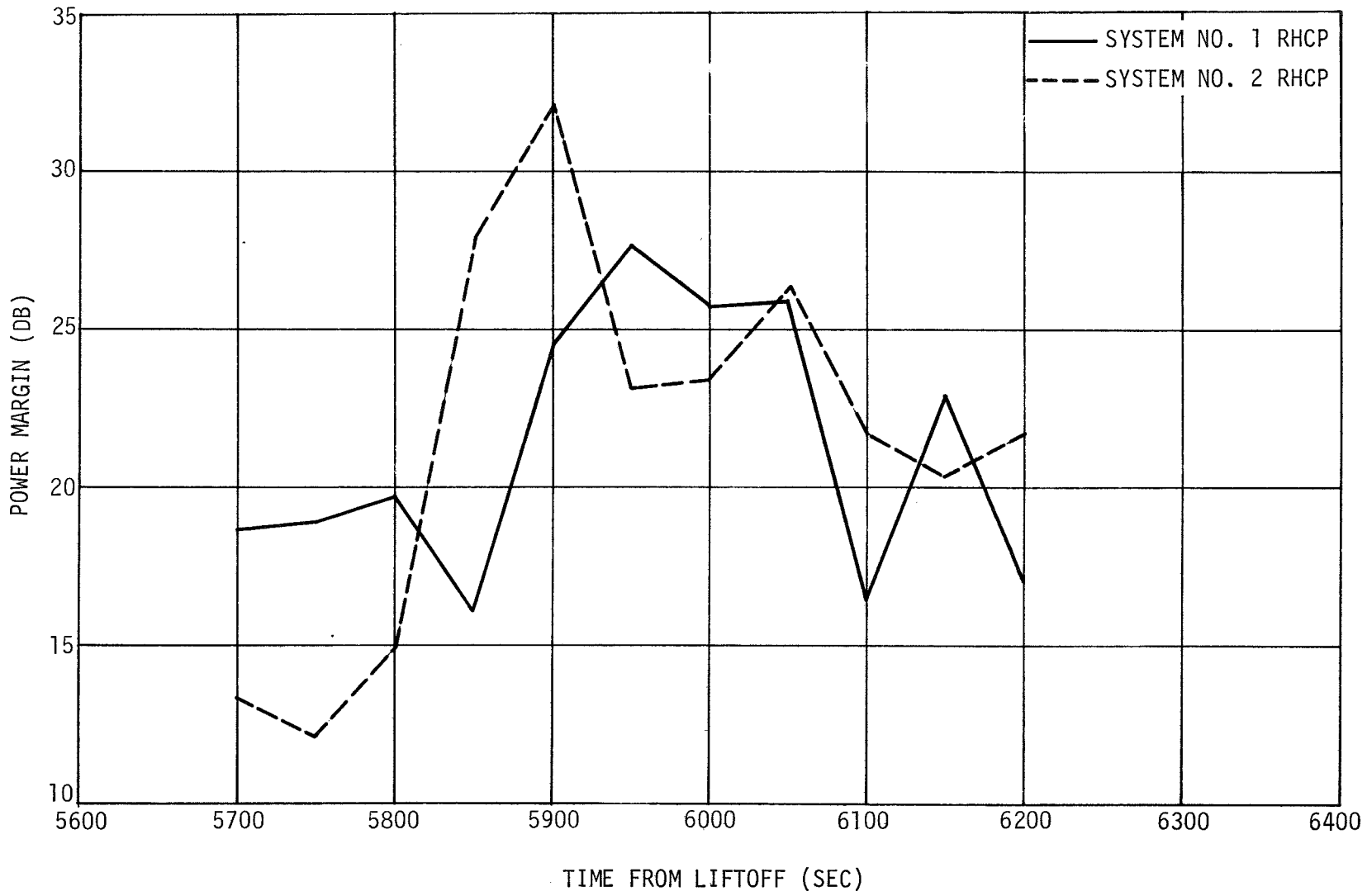


Figure AP 4-11. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tel 4 (Sheet 1 of 2)

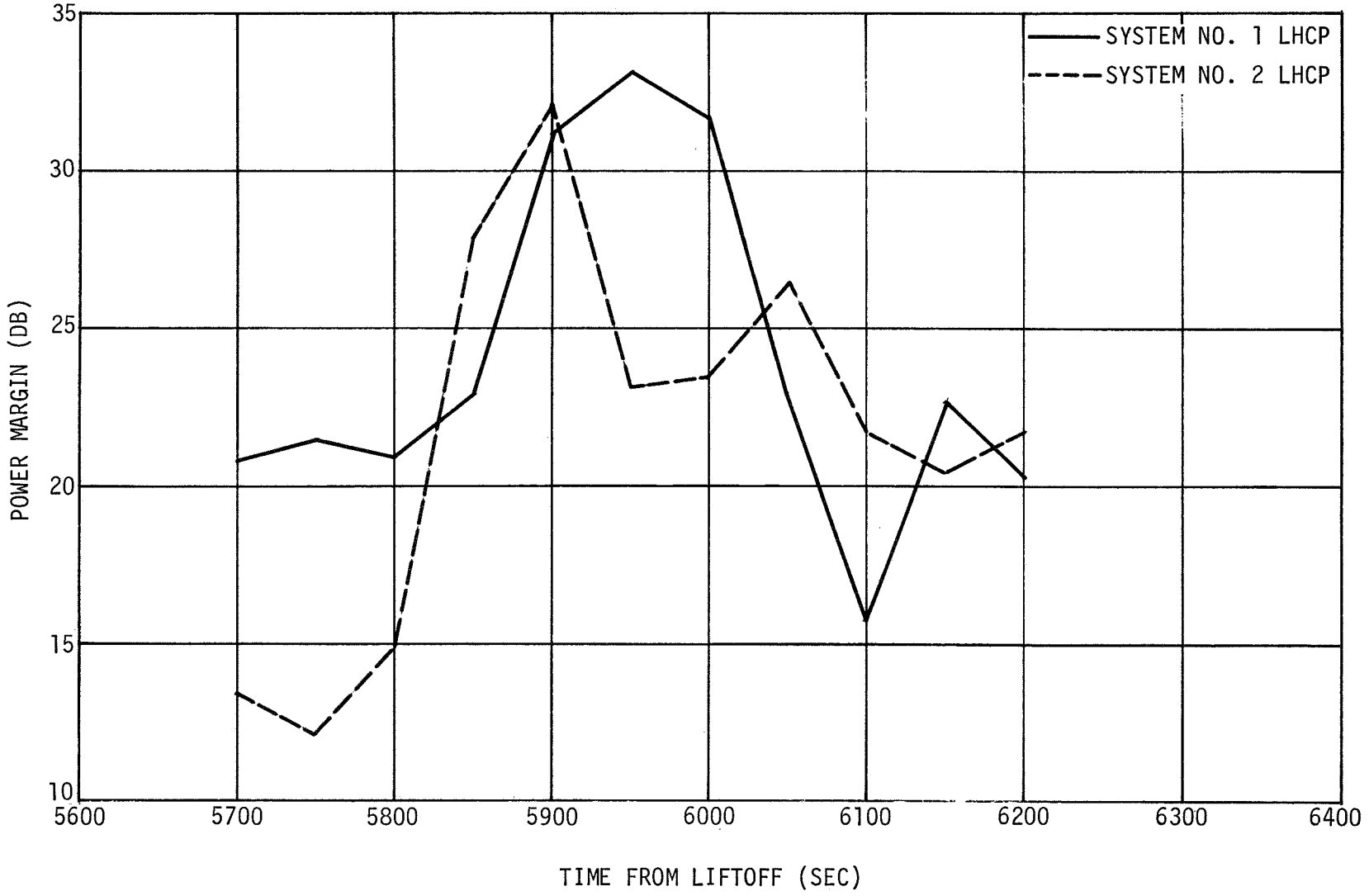


Figure AP 4-11. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tel 4 (Sheet 2 of 2)

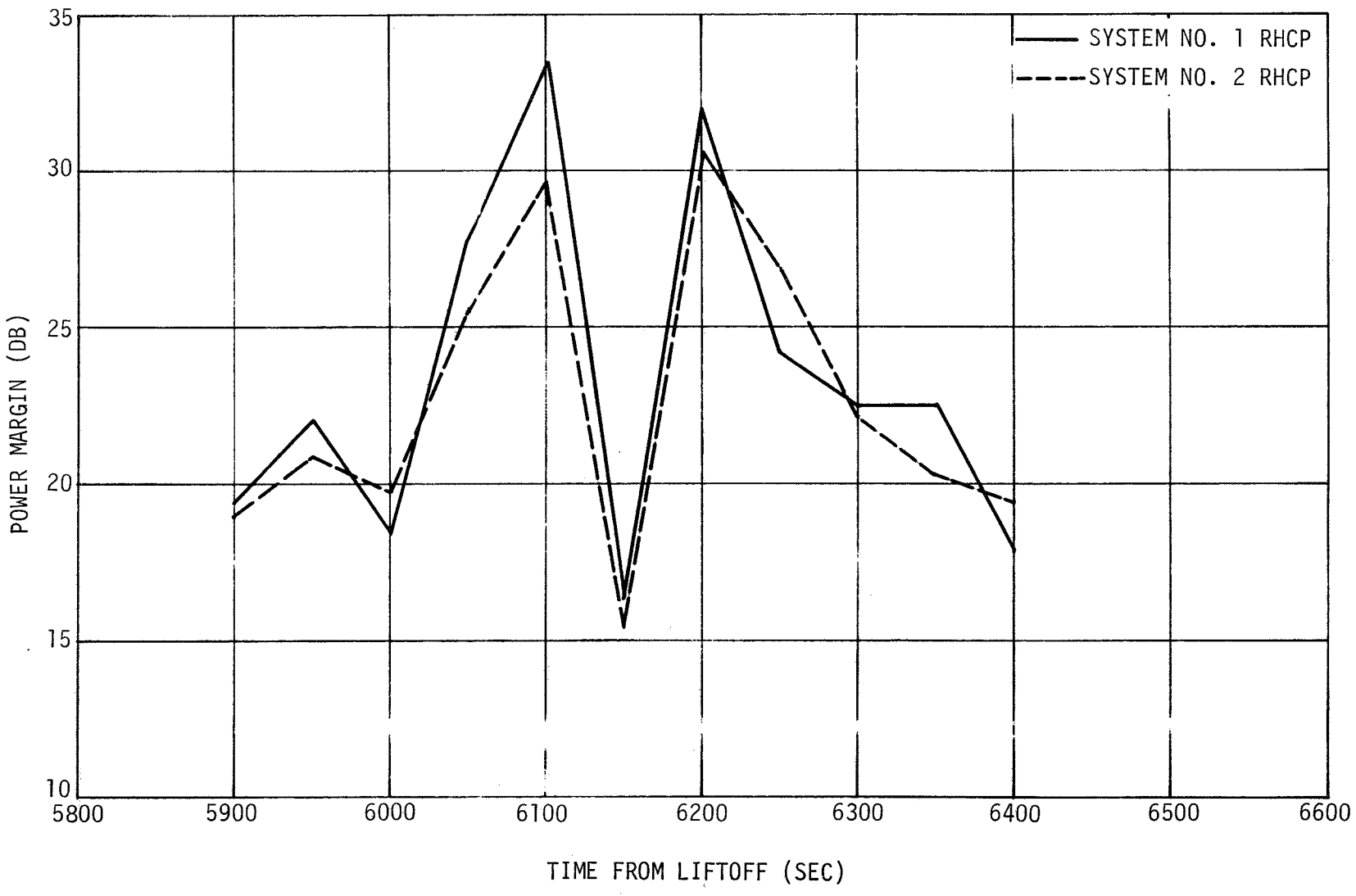


Figure AP 4-12. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Bermuda (Sheet 1 of 2)

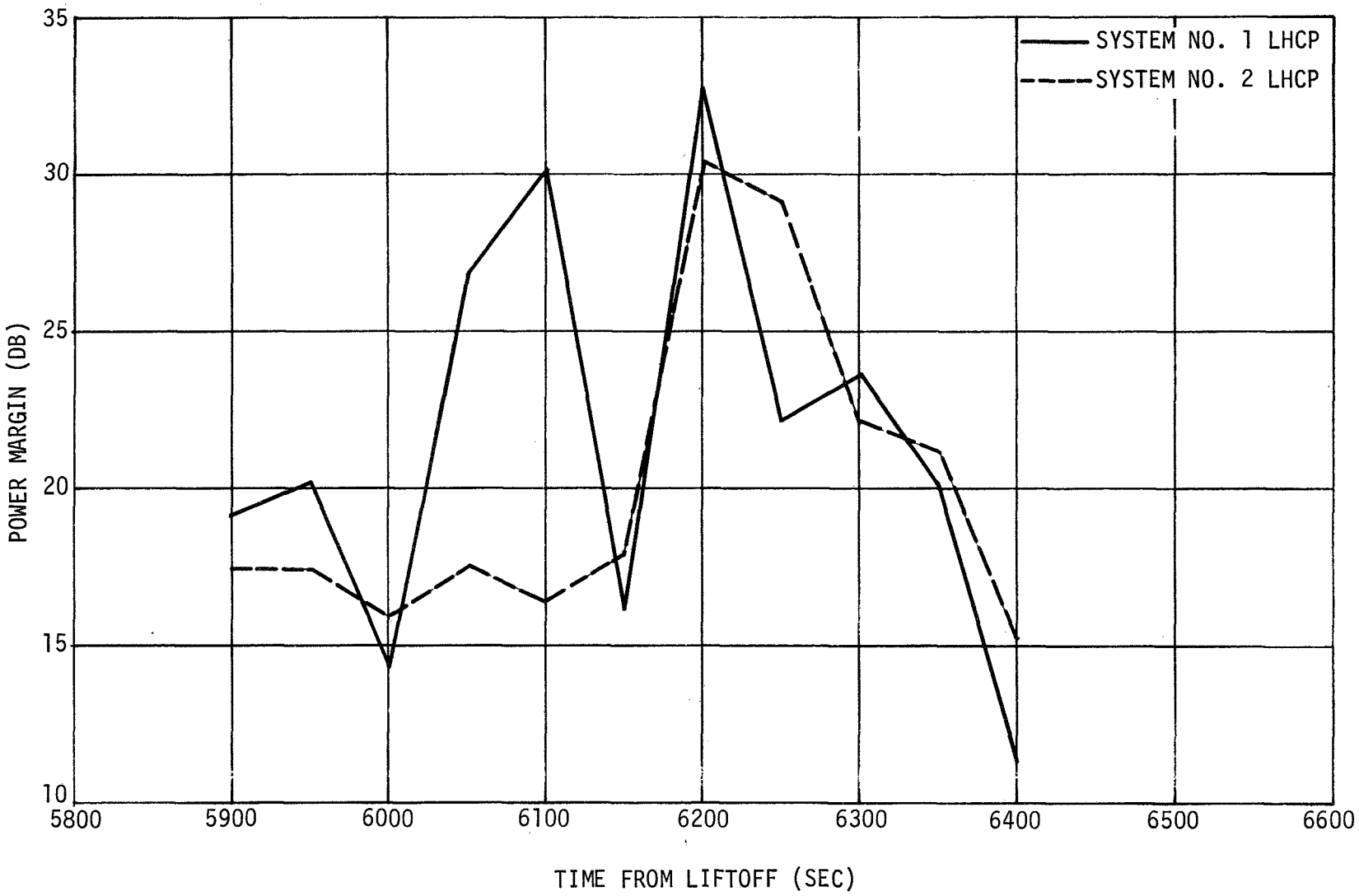


Figure AP 4-12. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Bermuda (Sheet 2 of 2)

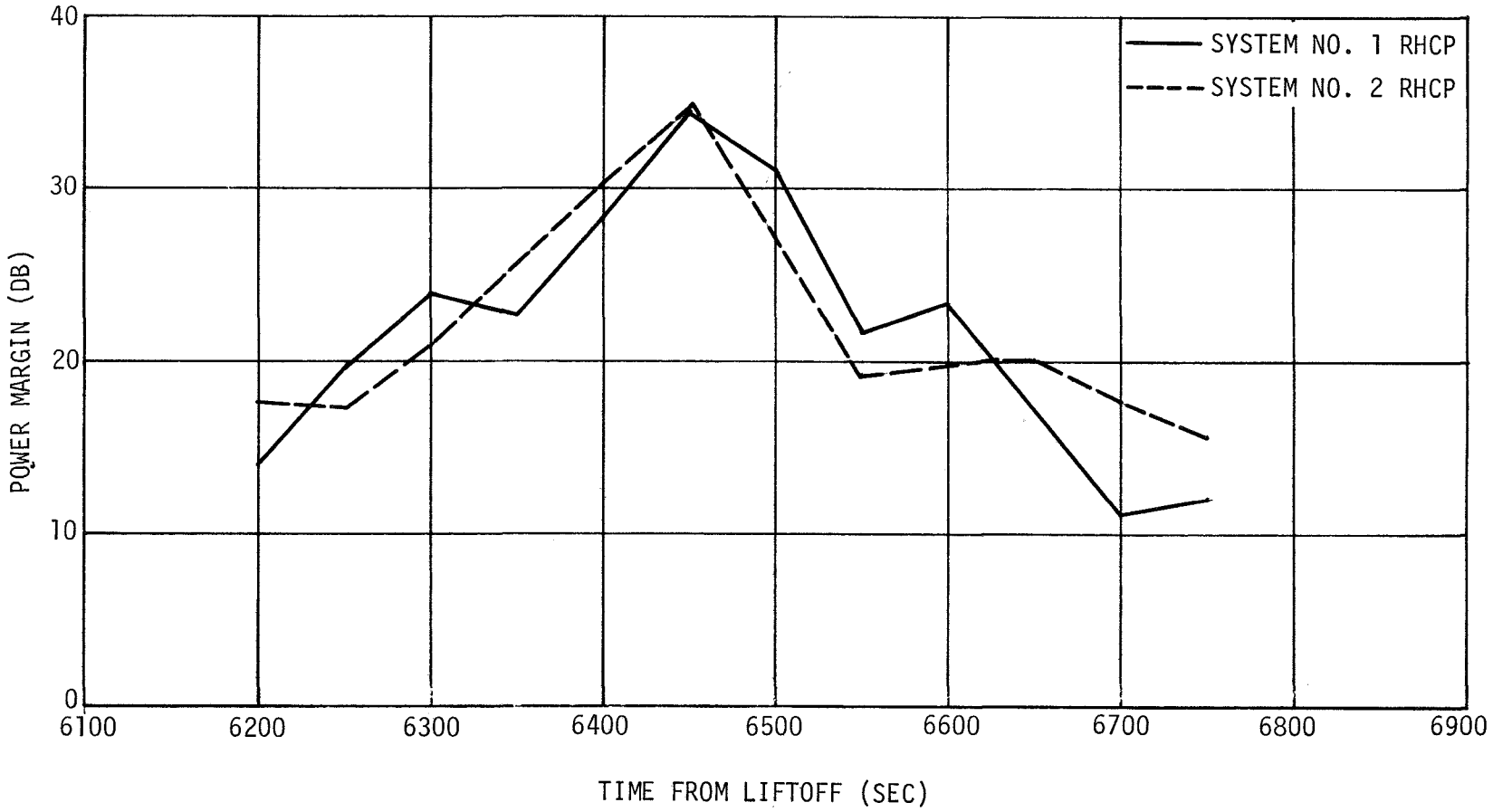


Figure AP 4-13. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Insertion Ship (Sheet 1 of 2)

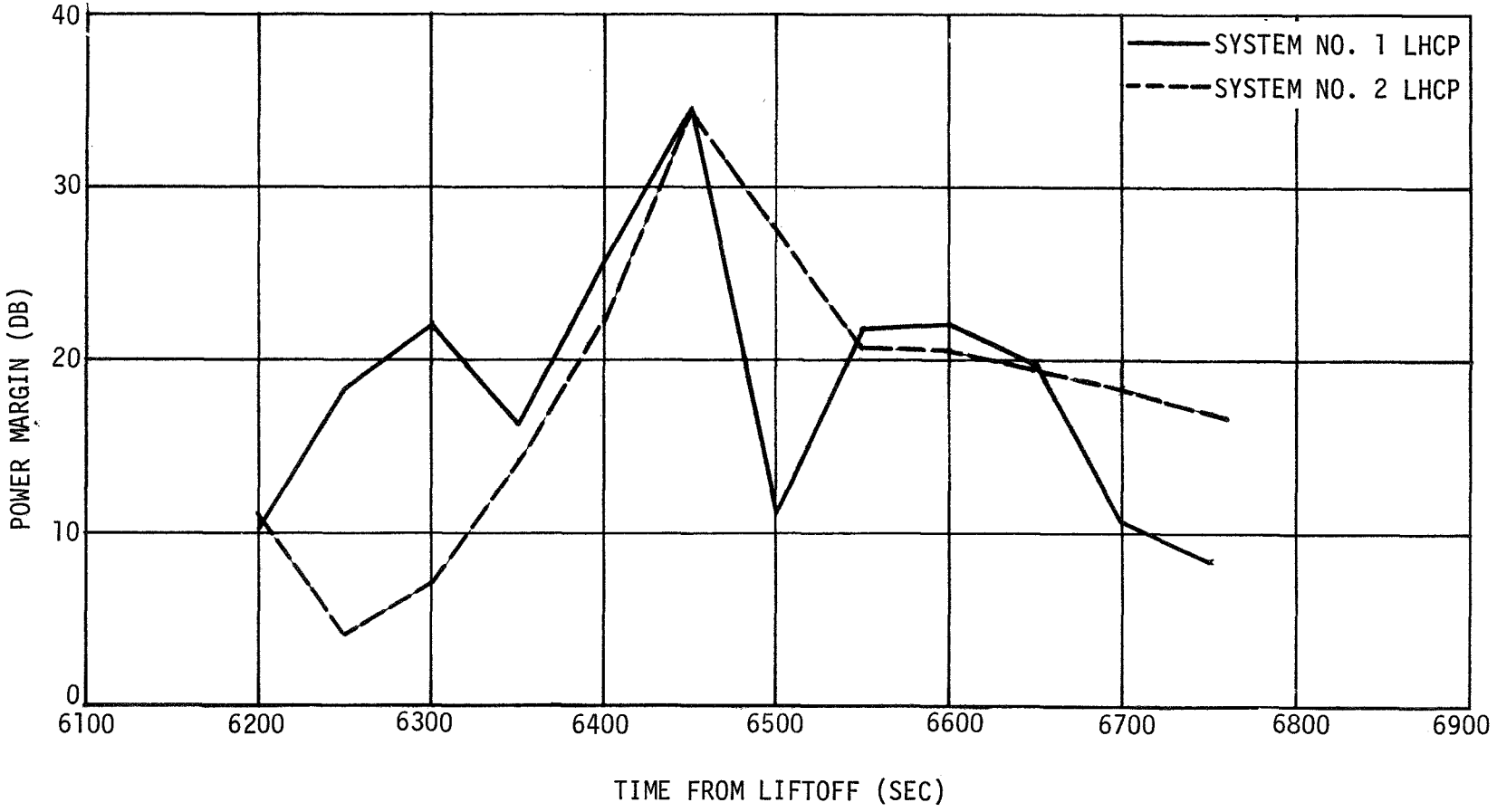


Figure AP 4-13. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Insertion Ship (Sheet 2 of 2)

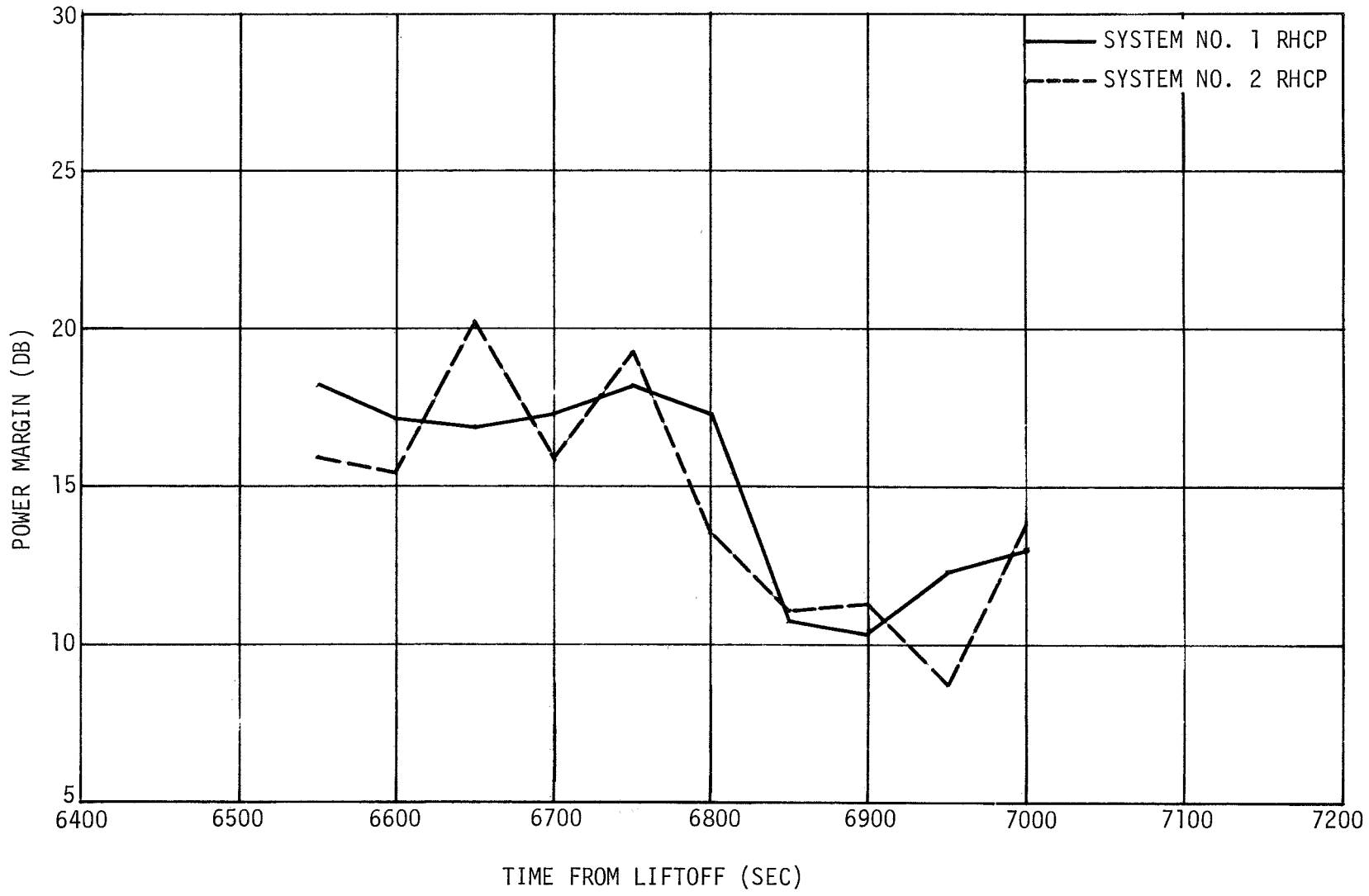


Figure AP 4-14. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Canary Island (Sheet 1 of 2)

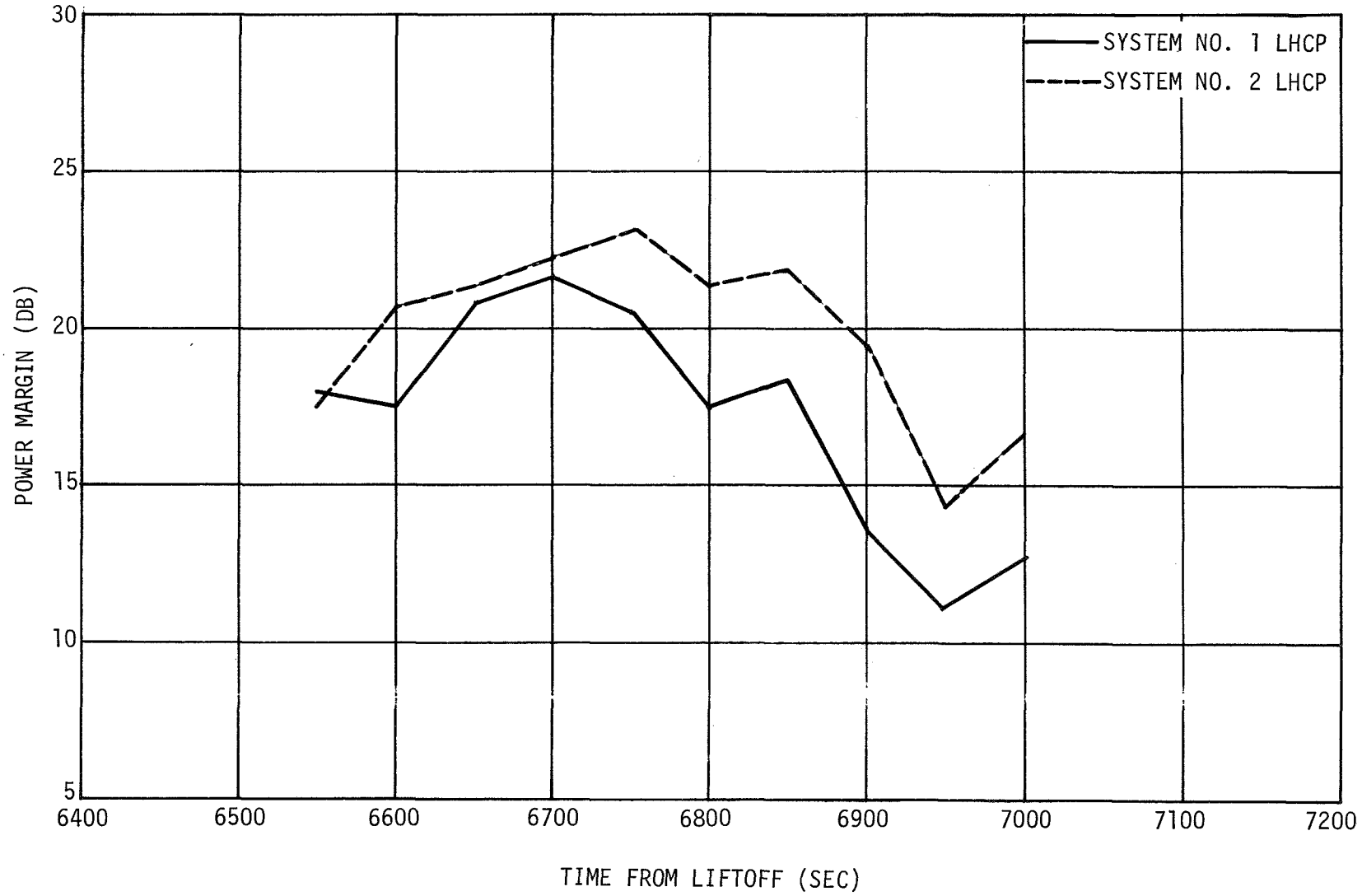


Figure AP 4-14. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Canary Island (Sheet 2 of 2)

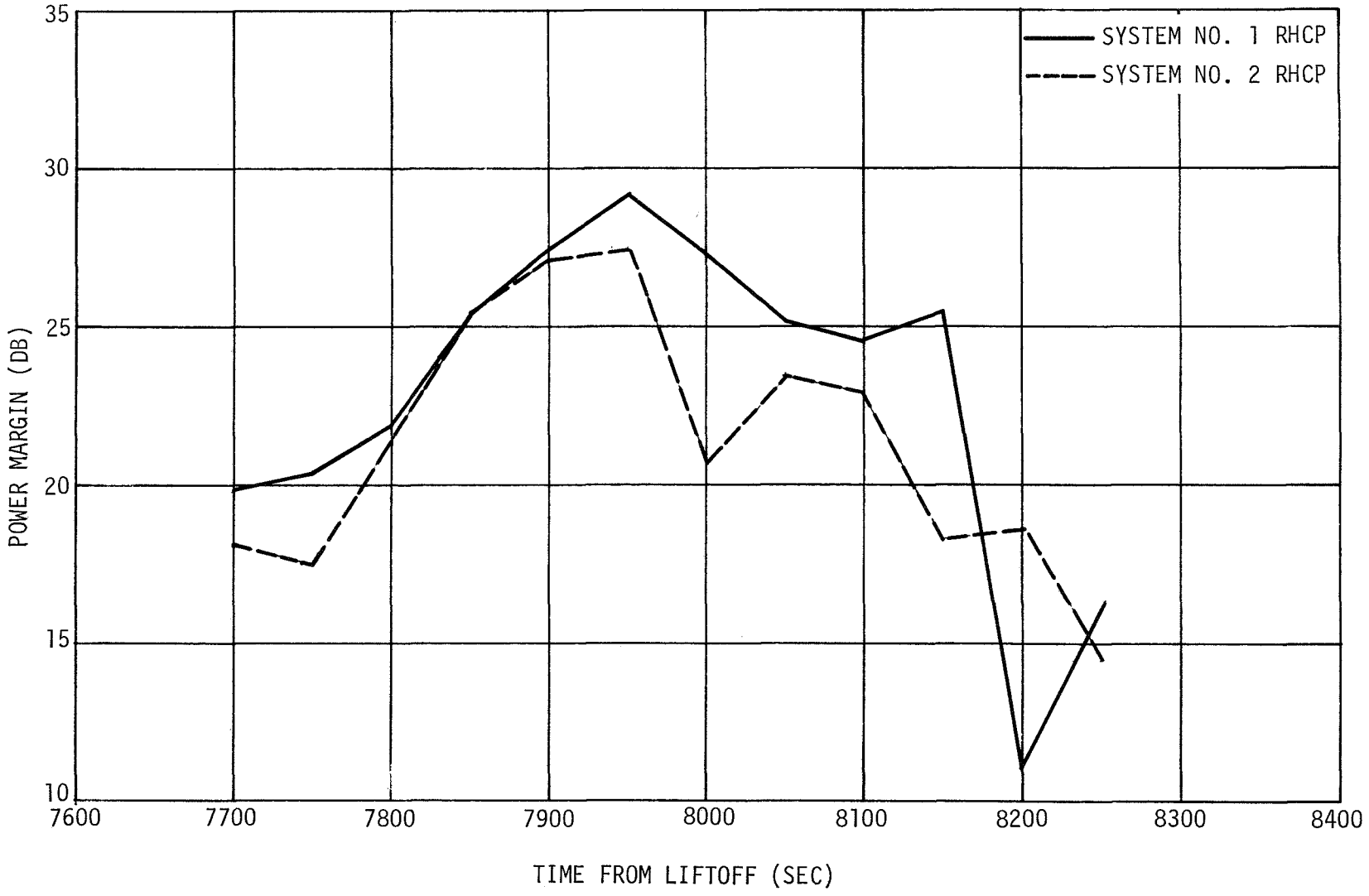


Figure AP 4-15. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tananarive (Sheet 1 of 2)

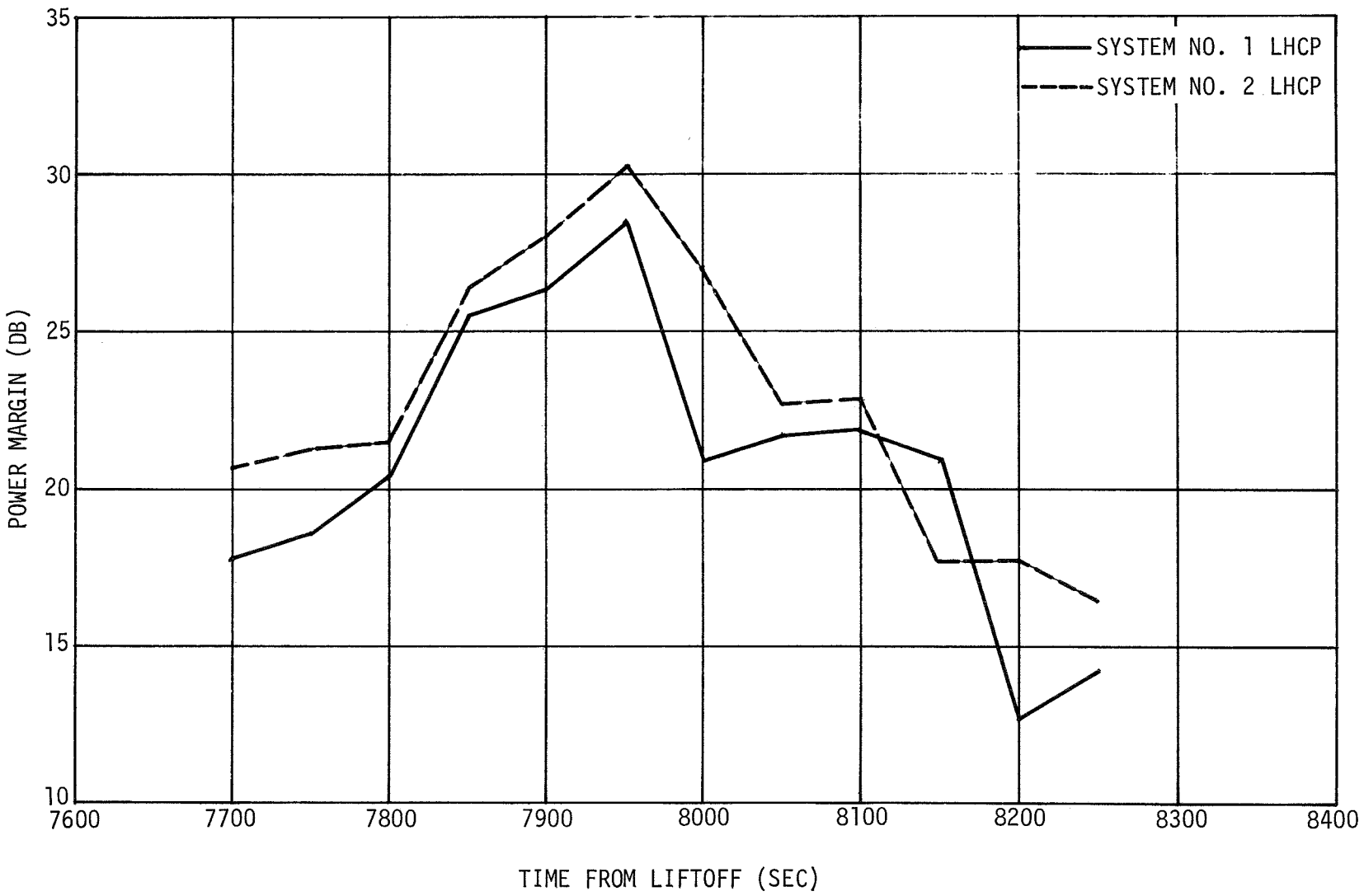


Figure AP 4-15. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tananarive (Sheet 2 of 2)

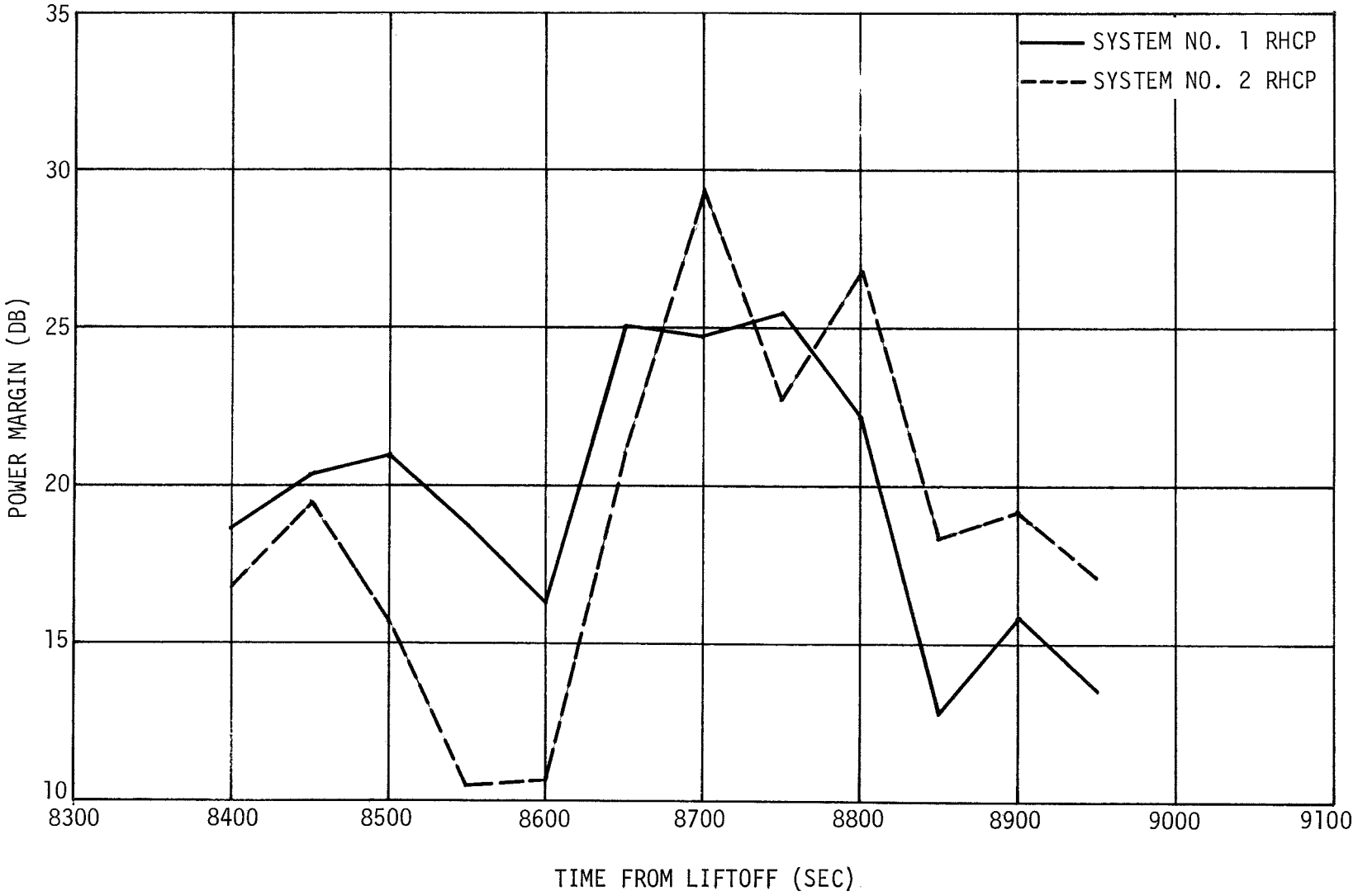


Figure AP 4-16. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Ship I (Sheet 1 of 2)

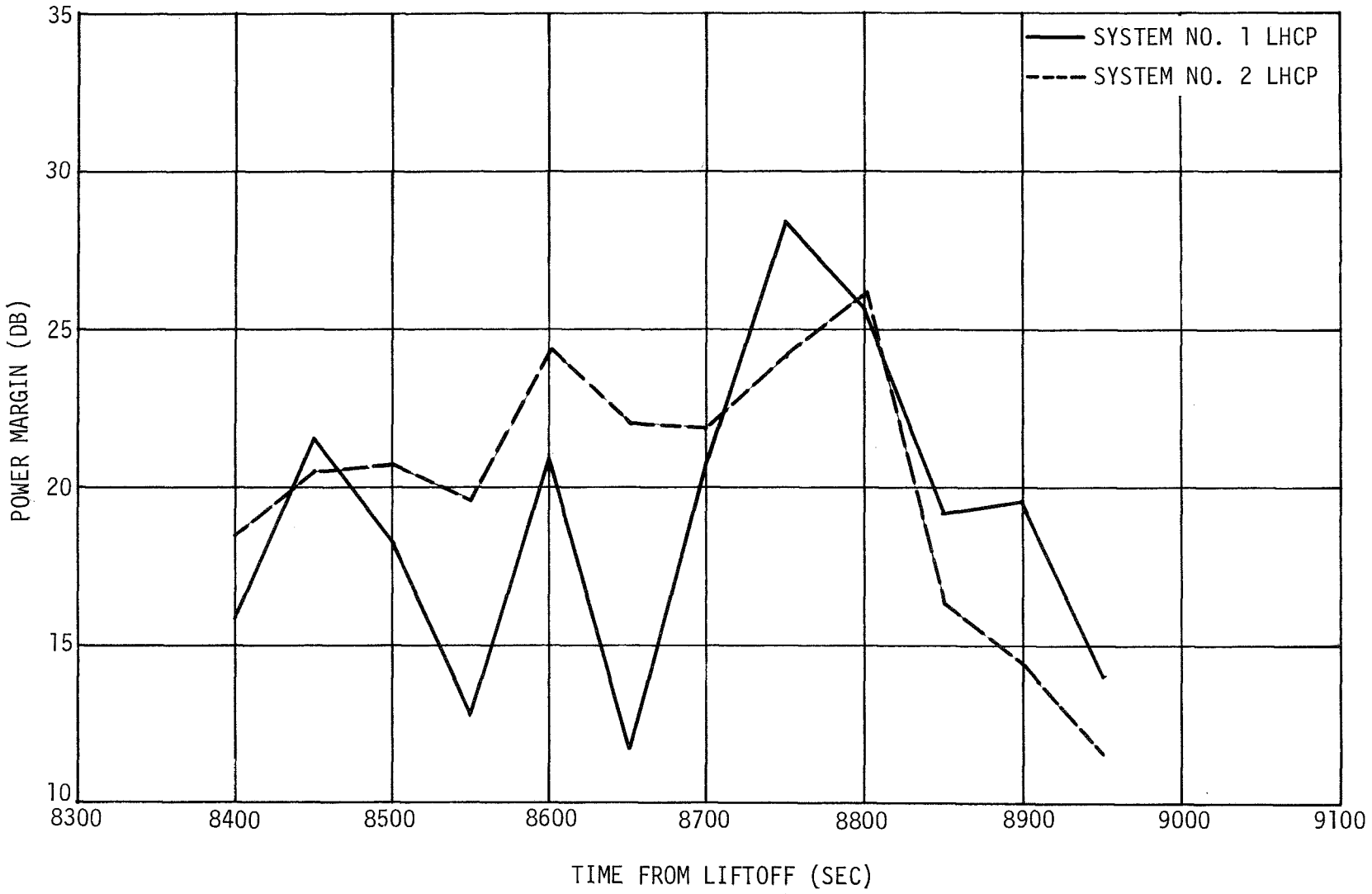


Figure AP 4-16. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Ship I (Sheet 2 of 2)

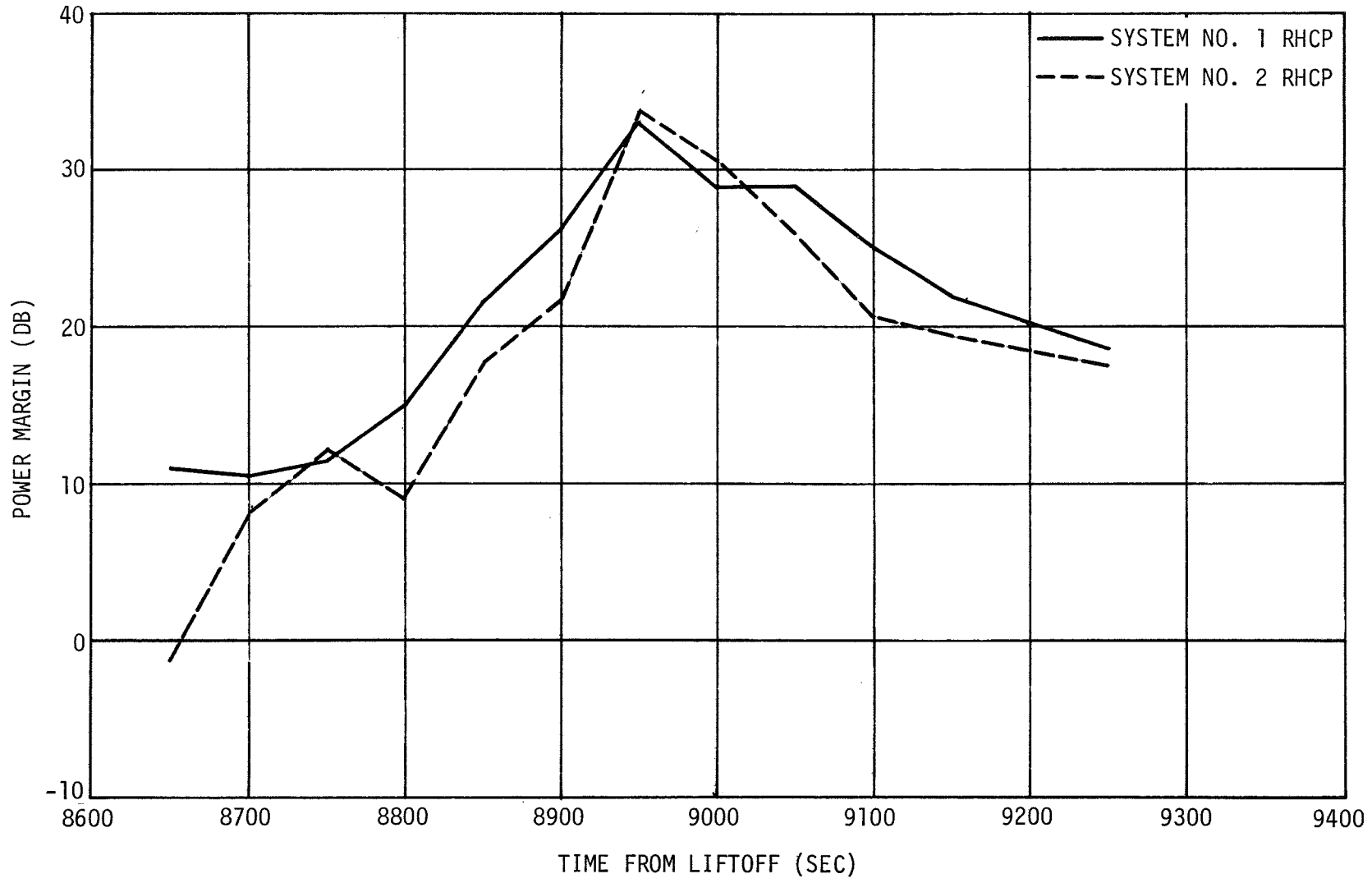


Figure AP 4-17. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Carnarvon (Sheet 1 of 2)

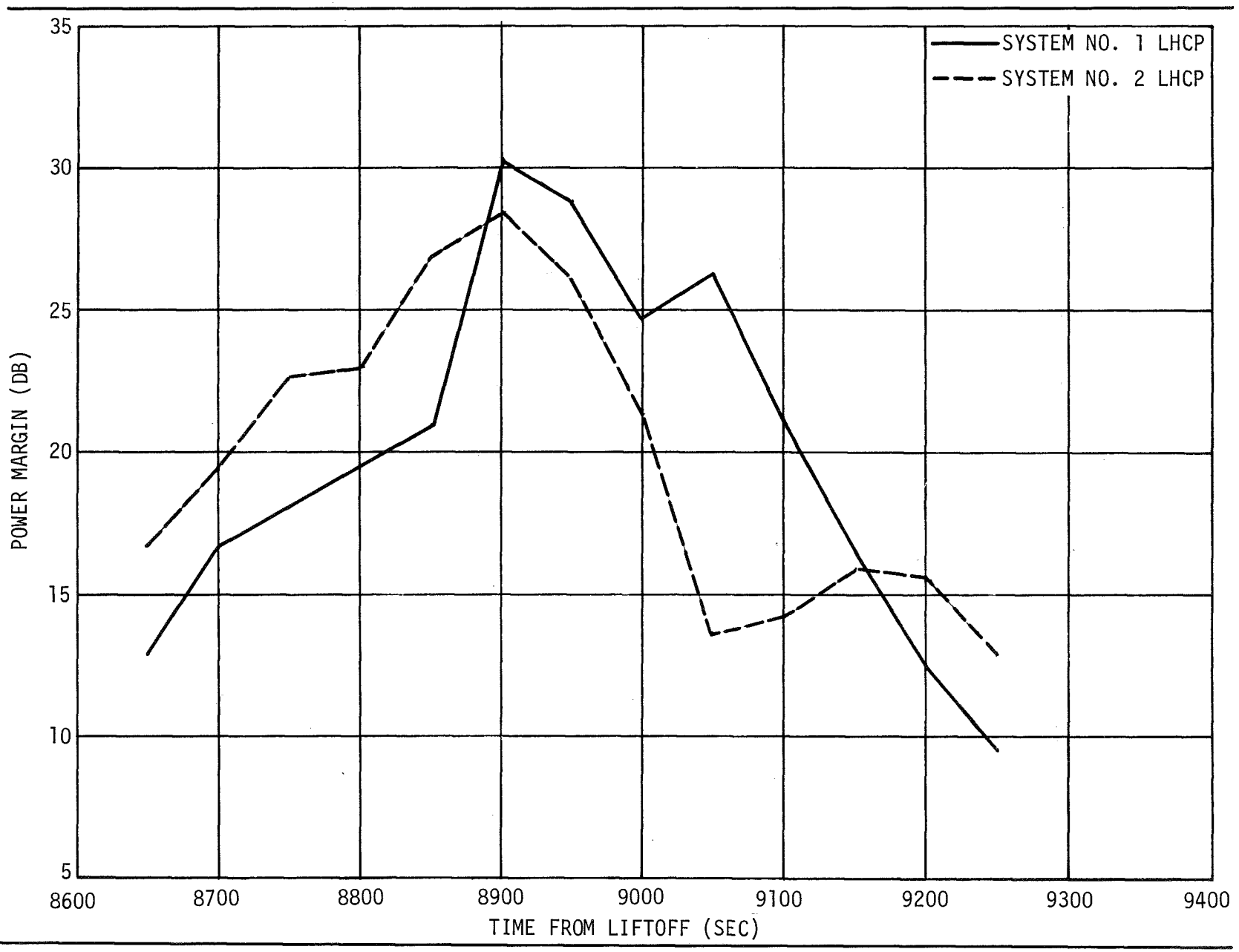


Figure AP 4-17. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Carnarvon (Sheet 2 of 2)

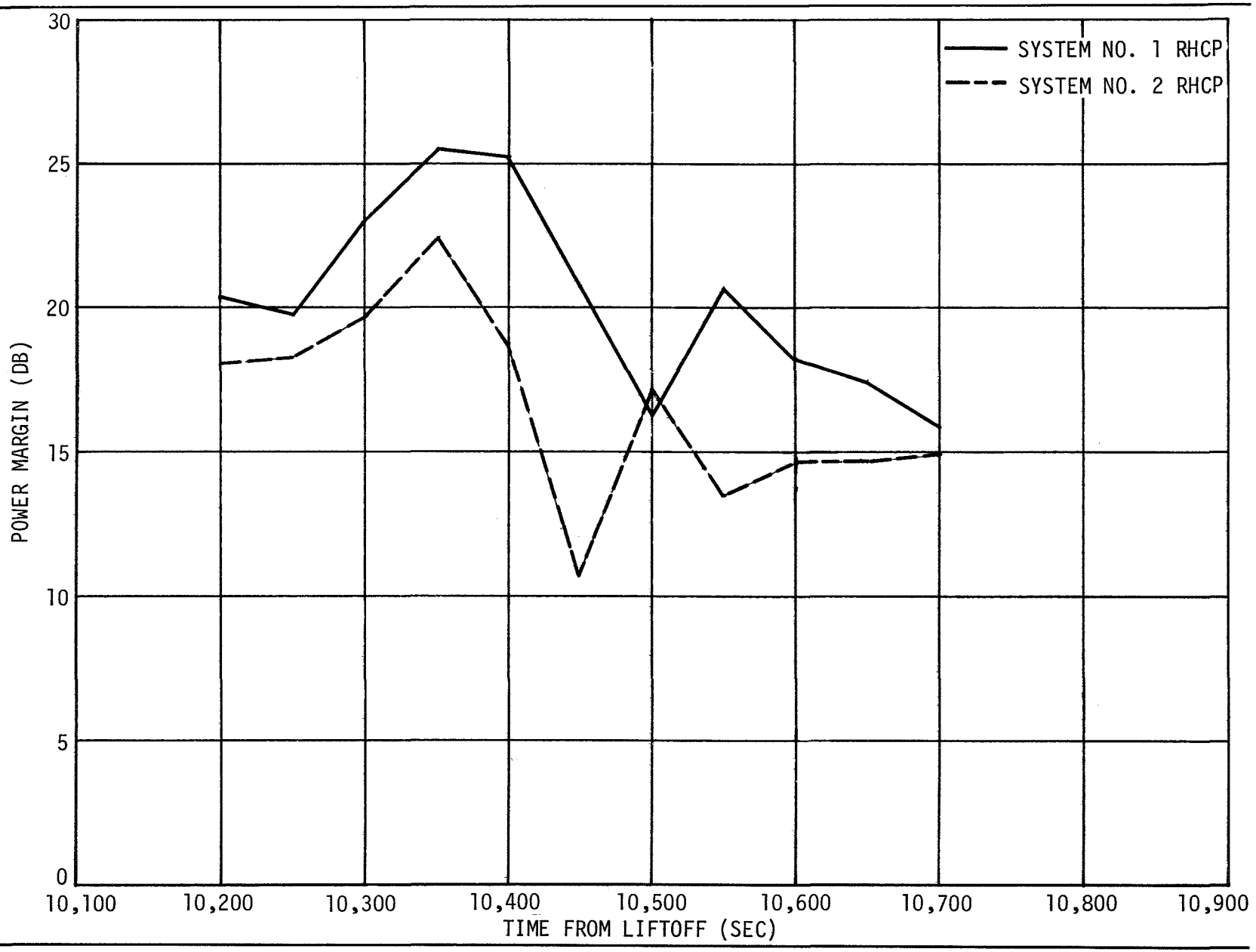


Figure AP 4-18. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Hawaii (Sheet 1 of 2)

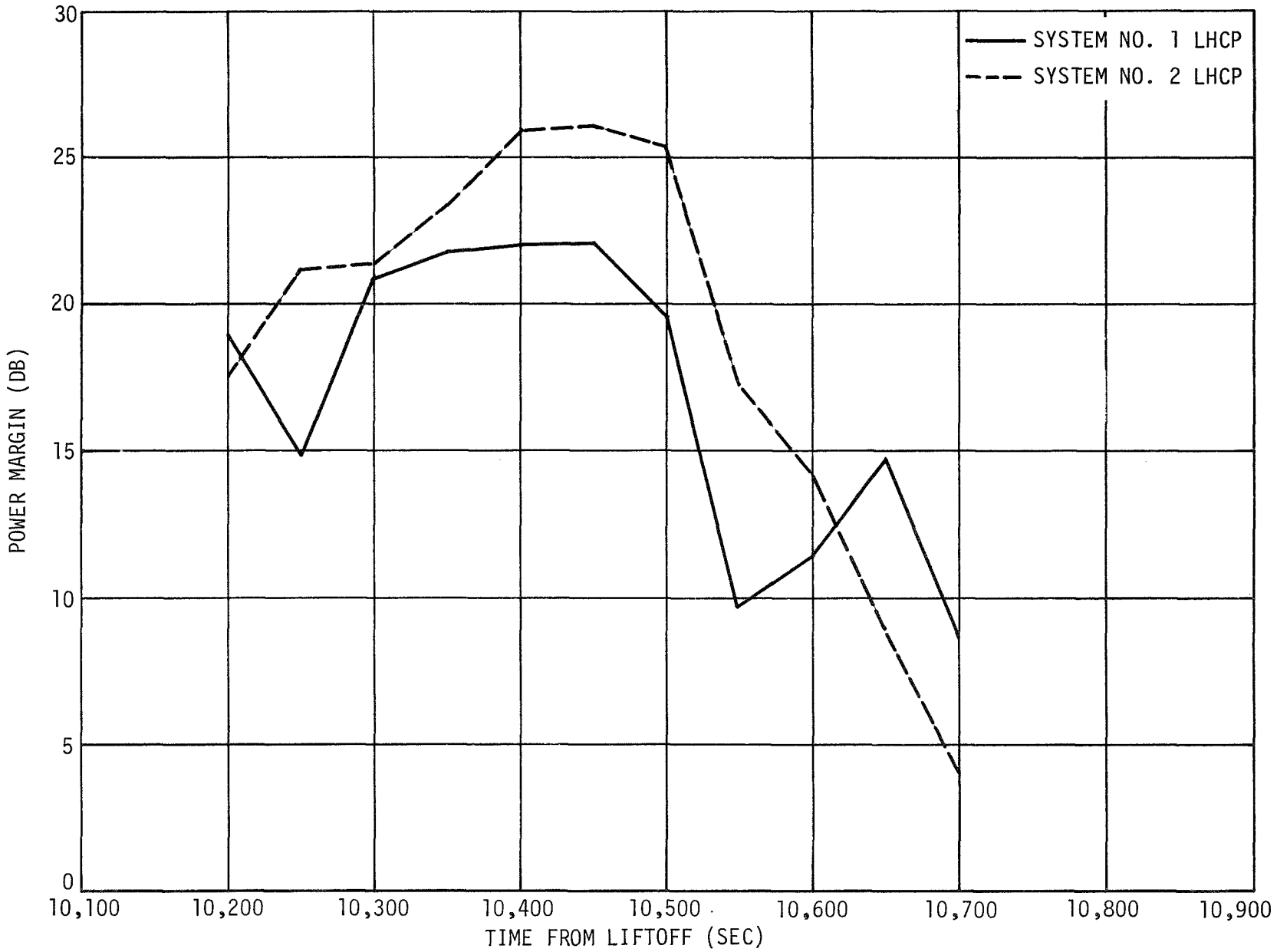


Figure AP 4-18. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Hawaii (Sheet 2 of 2)

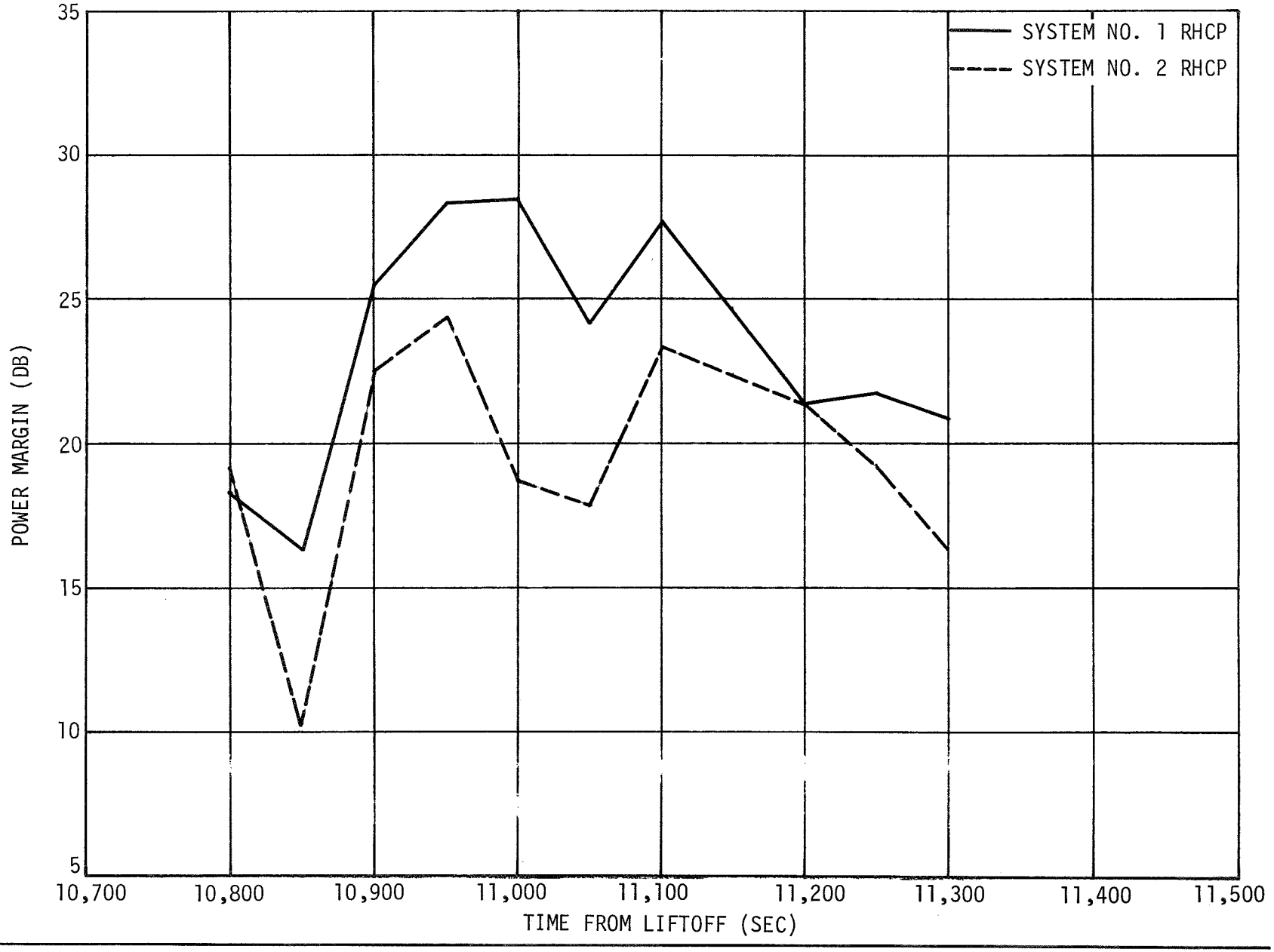


Figure AP 4-19. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Douglas-A3 (Sheet 1 of 2)

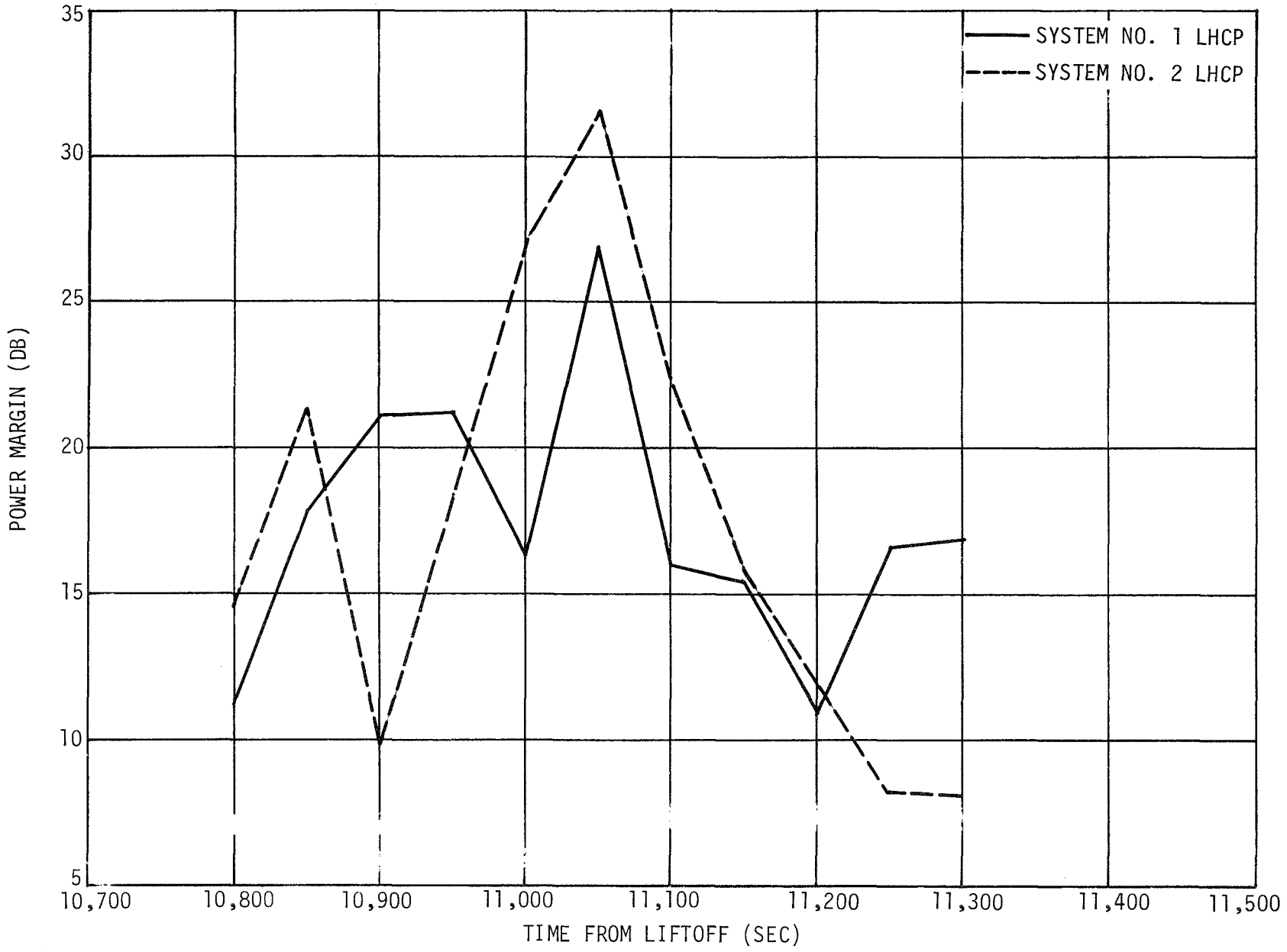


Figure AP 4-19. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Douglas-A3 (Sheet 2 of 2)

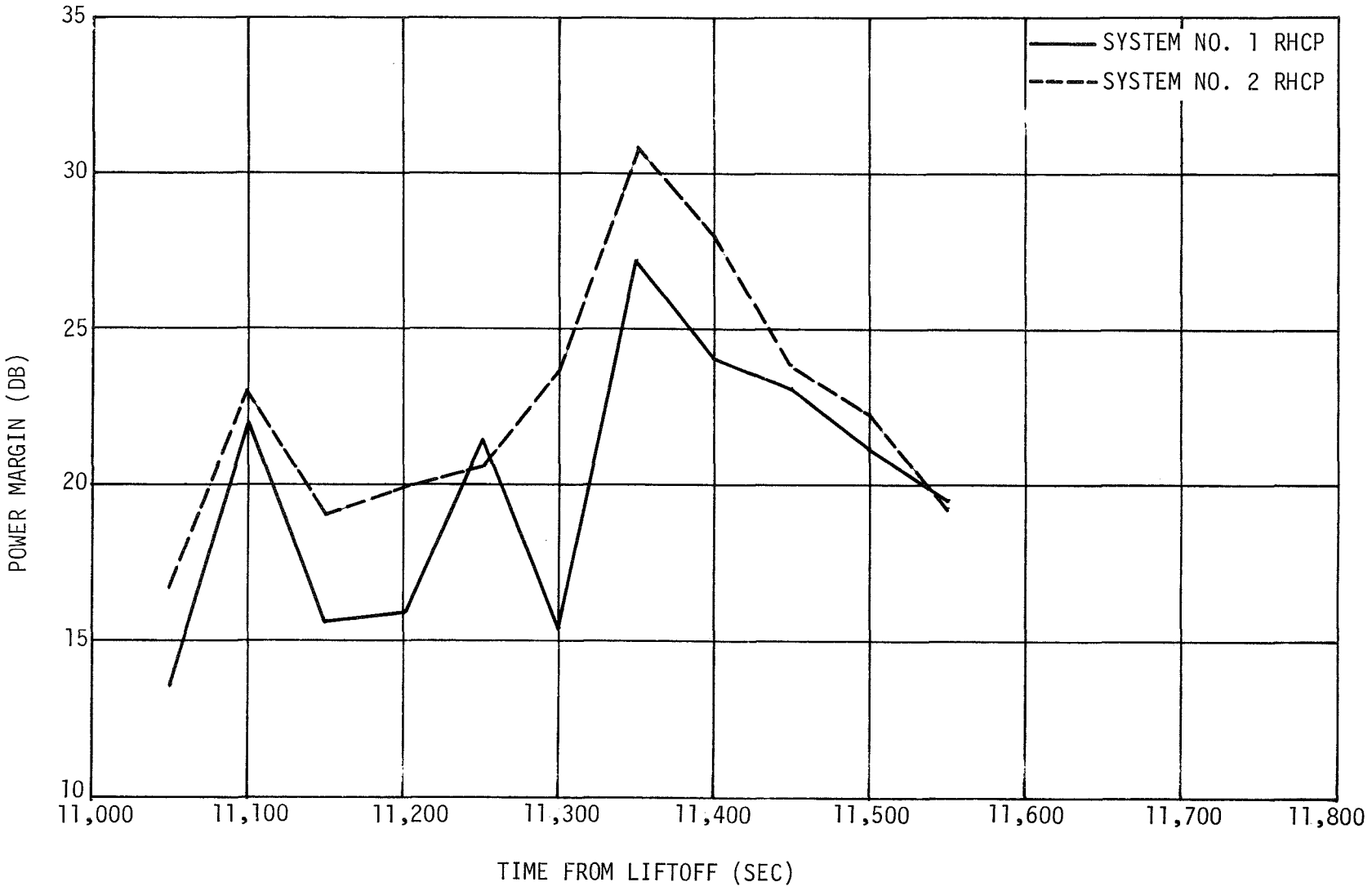


Figure AP 4-20. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Corpus Christi (Sheet 1 of 2)

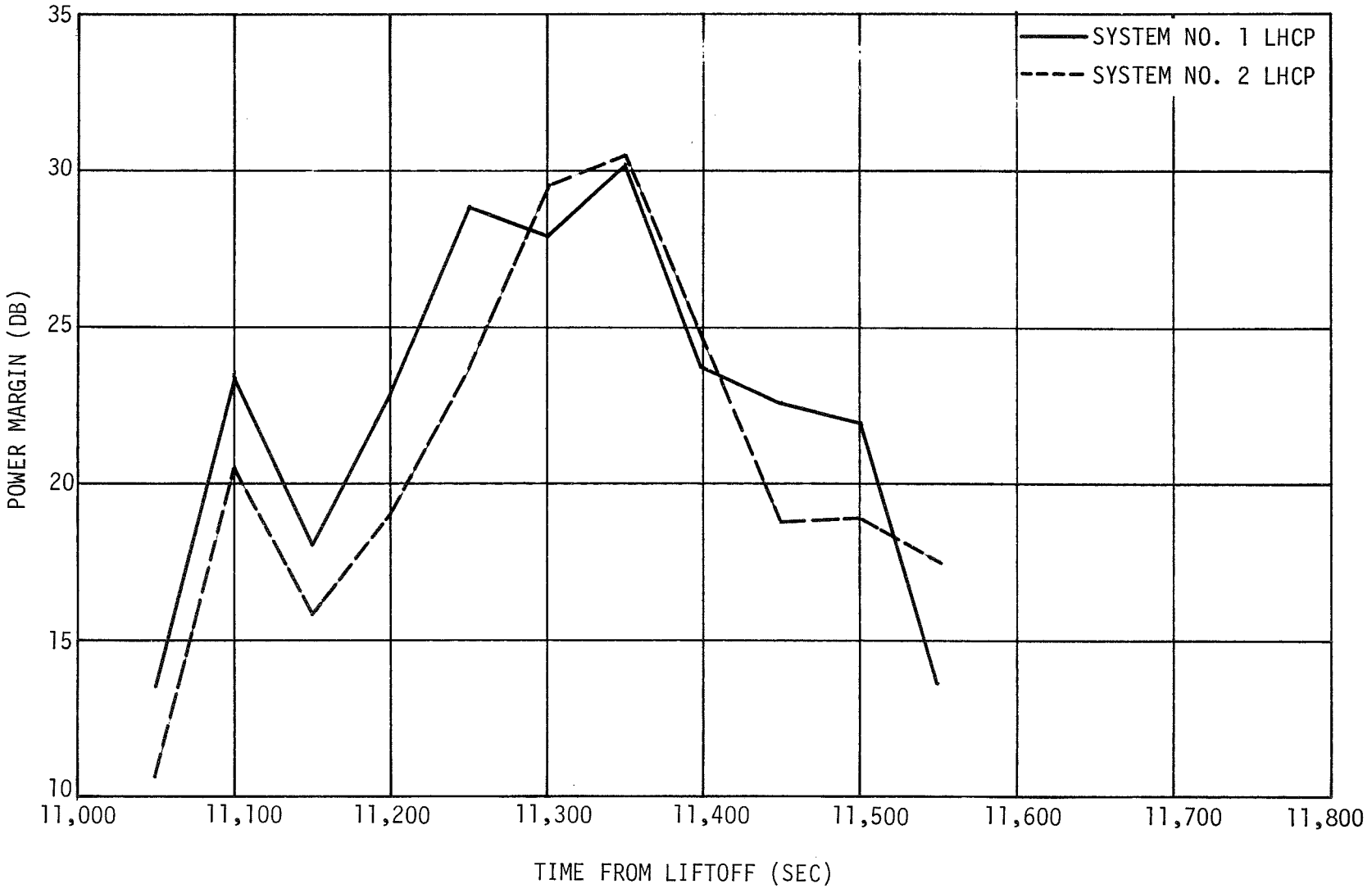


Figure AP 4-20. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Corpus Christi (Sheet 2 of 2)

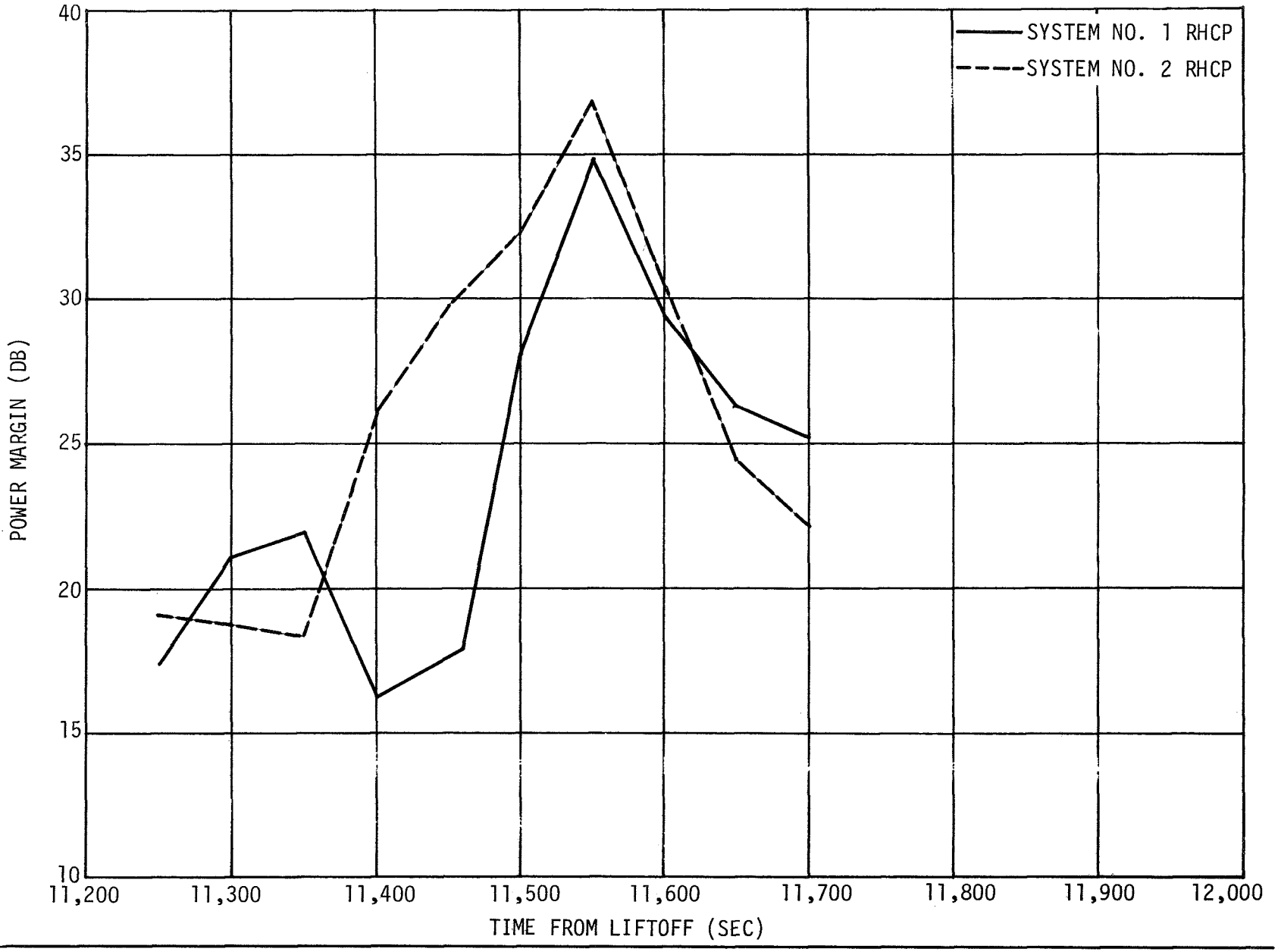


Figure AP 4-21. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tel 4 (Sheet 1 of 2)

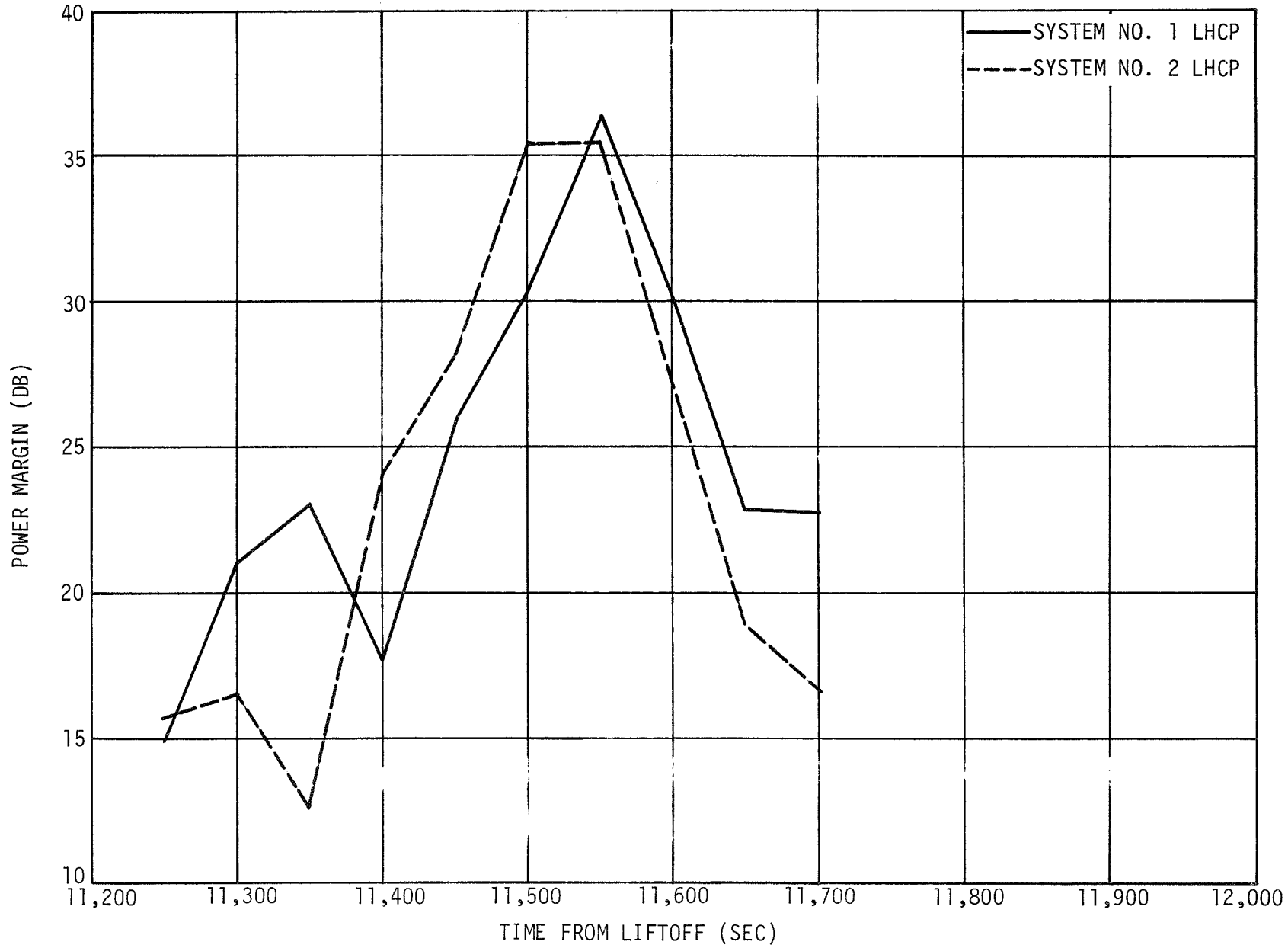


Figure AP 4-21. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Tel 4 (Sheet 2 of 2)

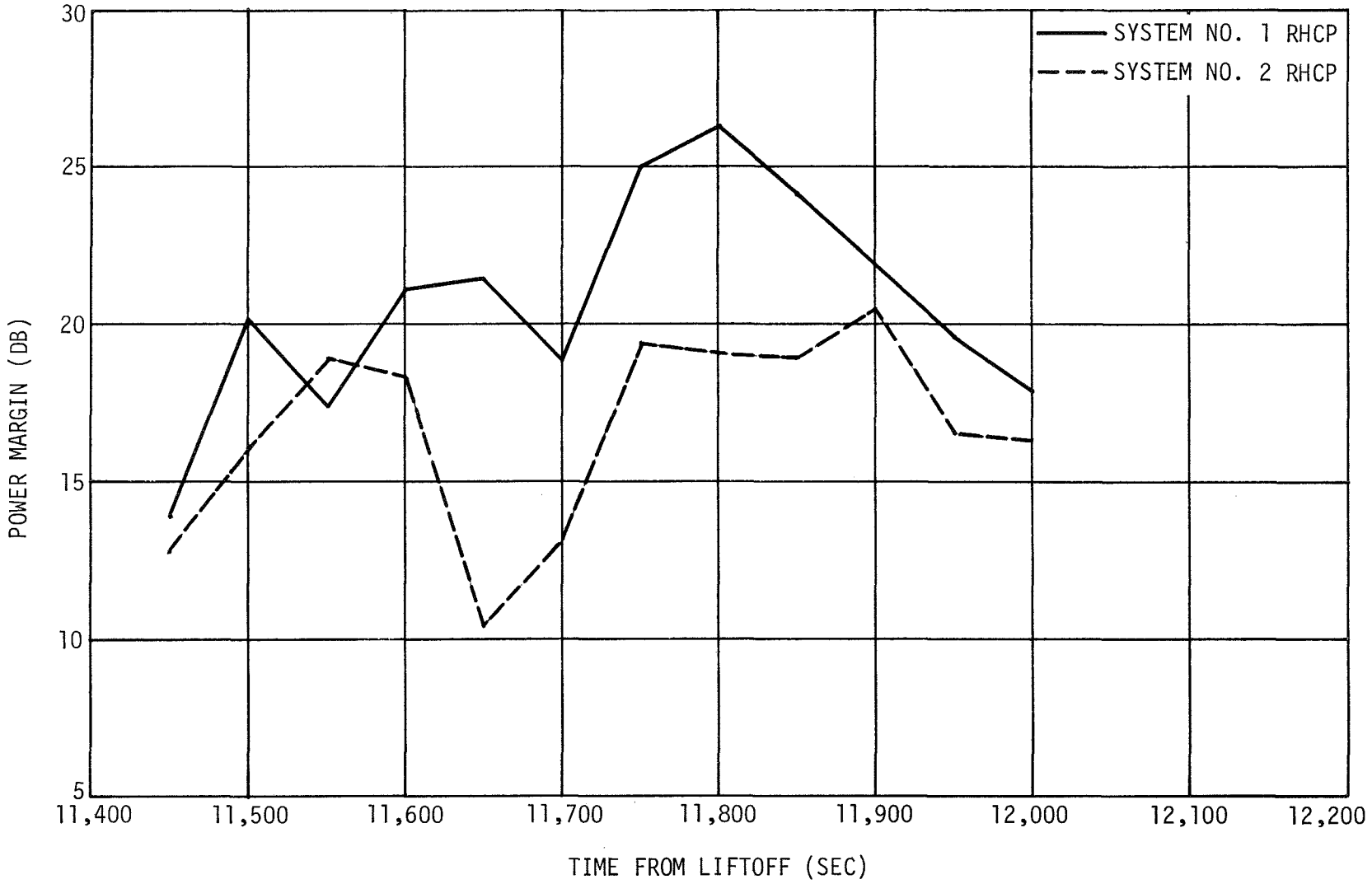


Figure AP 4-22. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Bermuda (Sheet 1 of 2)

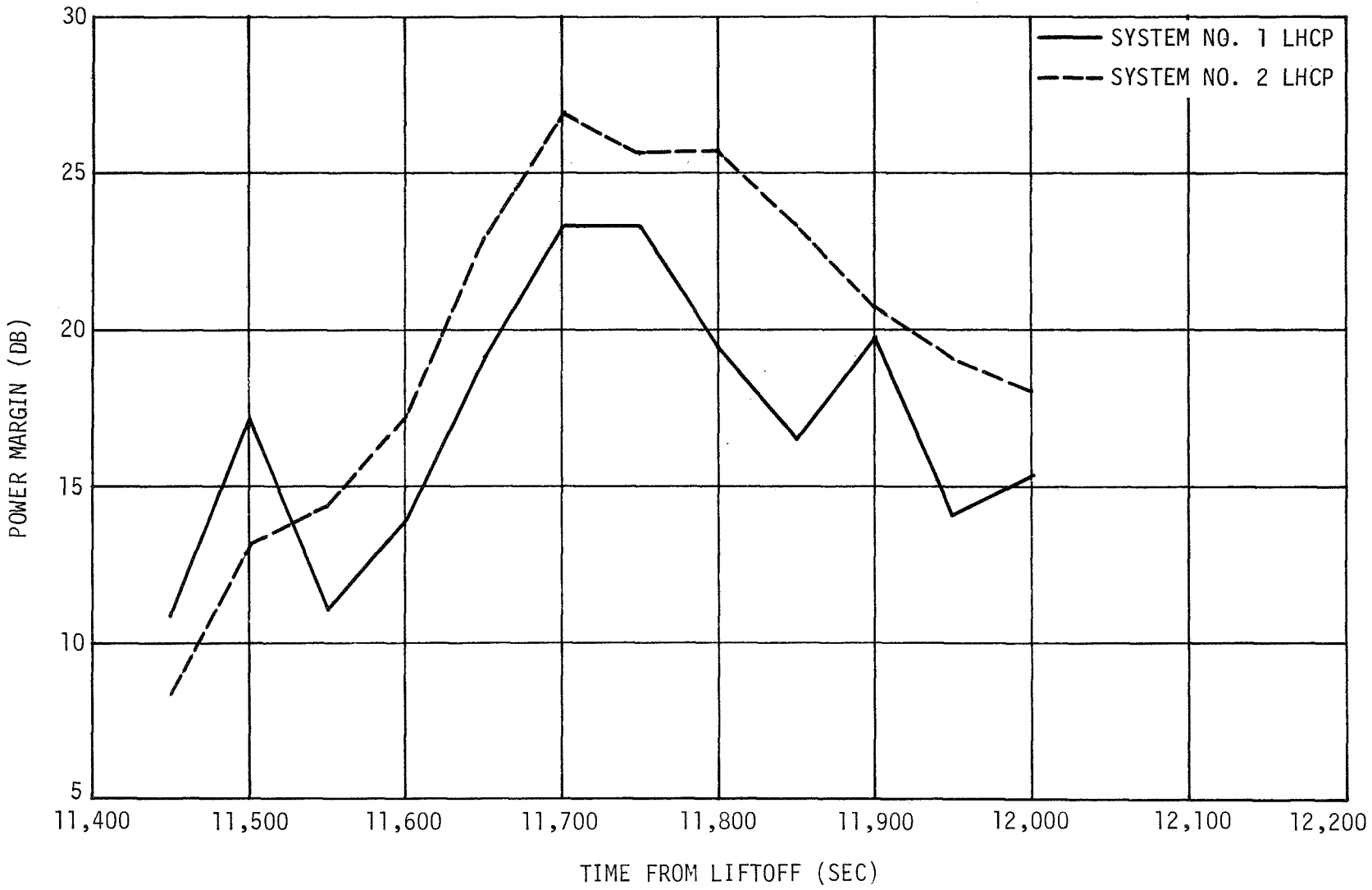


Figure AP 4-22. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Bermuda (Sheet 2 of 2)

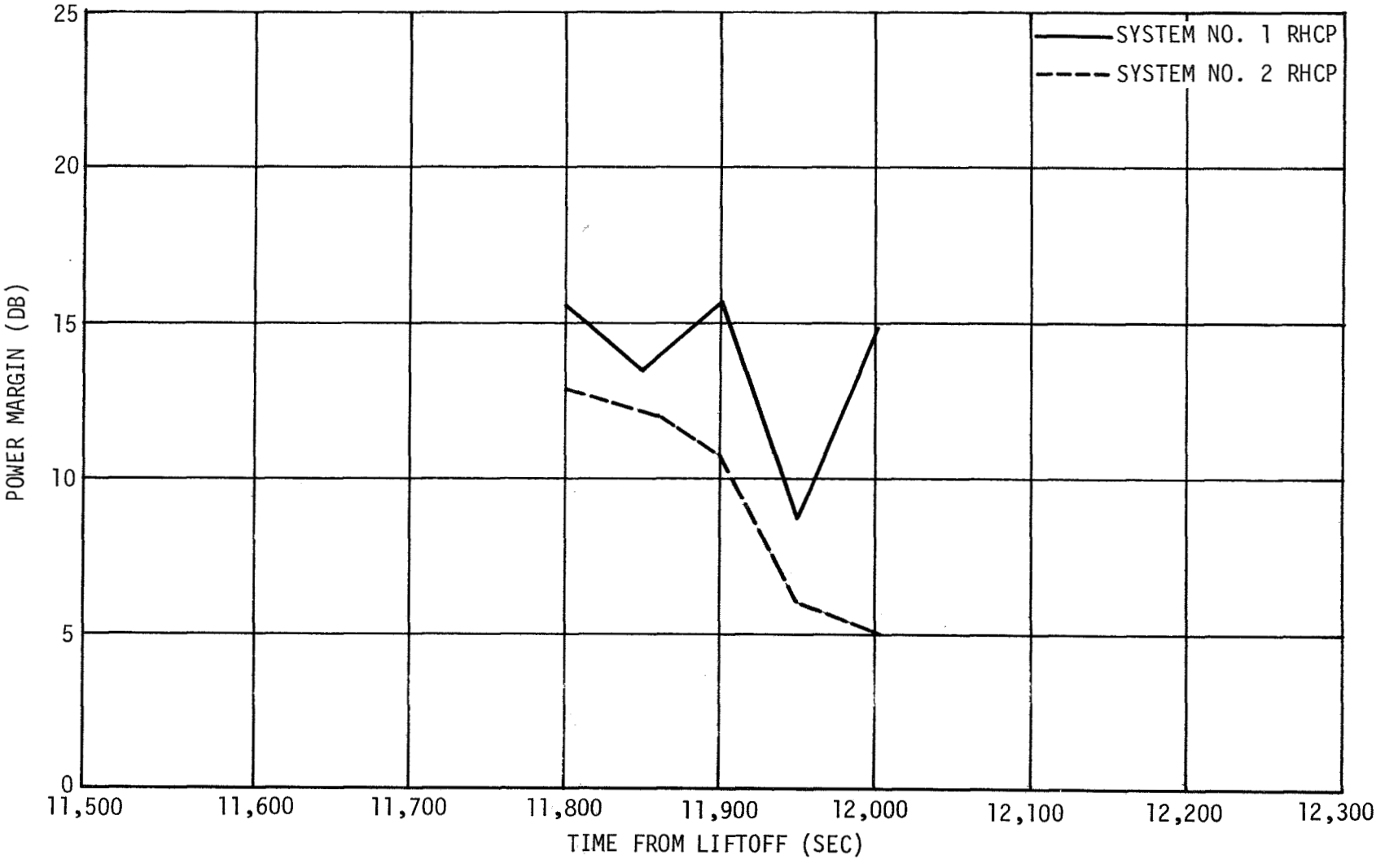


Figure AP 4-23. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Insertion Ship (Sheet 1 of 2)

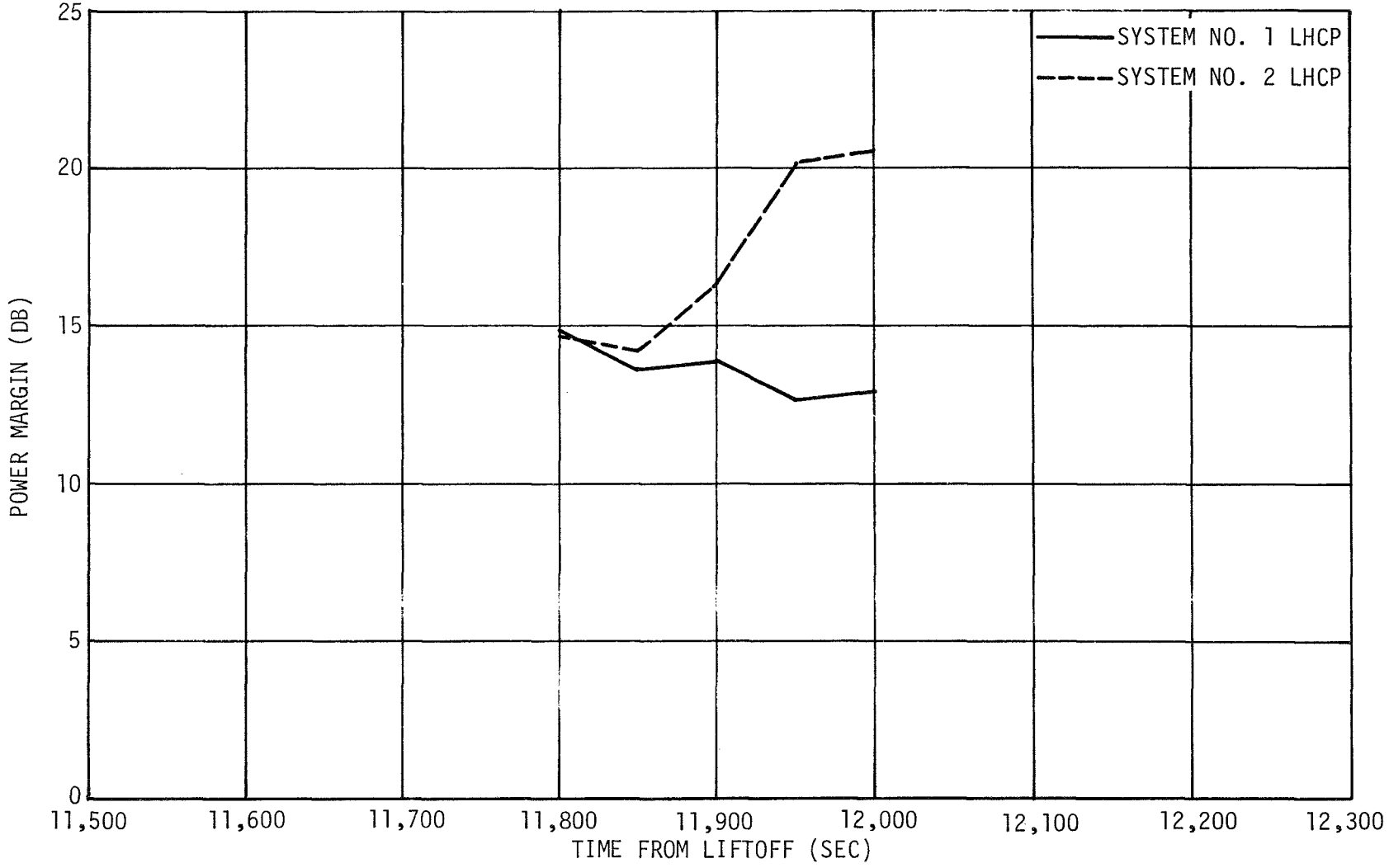


Figure AP 4-23. Predicted S-IVB-204 Telemetry Signal Strength Power Margin - Insertion Ship (Sheet 2 of 2)

APPENDIX 5

PREDICTED PROPULSION SYSTEM PERFORMANCE

5. PREDICTED PROPULSION SYSTEM PERFORMANCE

This appendix contains predicted propulsion performance data in support of the stage objectives presented in section 3. The data are submitted in accordance with the requirements of the Douglas contract letter A3-131-4.35.12-L-595, contract NAS7-101, *S-IVB Stage Propulsion System Performance Prediction Requirements* (RFQ1384), dated 9 August 1967. The data were forwarded to NASA/MSFC by Contractor letter A3-860-KCBO-4.23-L-1729, Contract NAS7-101, *S-IVB Final Propulsion Performance Prediction*, S-IVB-204 (Rev 2), dated 28 June 1967. The predictions are presented in accordance with Change Orders 501, 575, and ECP X189.

Predicted propulsion system performance parameters are presented in table AP 5-1, and table AP 5-2 is a programmed AA89 computer printout. Table AP 5-3 consists of a list of symbols with their definitions as used in the computer printout. Figures AP 5-1 through AP 5-32 represent a graphical presentation of plots obtained from the programmed AA89 computer printout.

The tables and figures presented in this appendix are based upon acceptance firing results and engine tag values. The engine tag values are variable for S-IVB-204. Figure 5-33 presents the tag values, normalized to the 60 sec value.

TABLE AP 5-1 (Sheet 1 of 2)
PREDICTED AS-204 PROPULSION SYSTEM PERFORMANCE PARAMETERS

PARAMETER	UNIT	VALUE	DISPERSION	REMARKS
Average Stage Longitudinal Thrust	lbf	212,744.0	±4,700	1
Before PU Valve Cutback	lbf	223,313.0	±4,100	2
After PU Valve Cutback	lbf	192,355.0	±5,400	3
Average LOX Flowrate	lbm/sec	419.7	±16.0	1
Before PU Valve Cutback	lbm/sec	444.2	±7.6	
After PU Valve Cutback	lbm/sec	372.4	±11.6	
Average LH2 Flowrate	lbm/sec	78.8	±2.9	1
Before PU Valve Cutback	lbm/sec	80.2	±1.9	
After PU Valve Cutback	lbm/sec	76.1	±2.8	
Average Stage Mass Flowrate	lbm/sec	498.5	±19.0	1
Before PU Valve Cutback	lbm/sec	524.4	±7.8	
After PU Valve Cutback	lbm/sec	448.5	±14.0	
Average Stage Longitudinal Specific Impulse	sec	426.8	±7.3	1
Before PU Valve Cutback	sec	425.8	±2.3	
After PU Valve Cutback	sec	428.9	±2.8	
Engine Total Impulse*	lb-sec	9.7456×10^7	$\pm 2.321 \times 10^6$	1
PU Valve Cutback Time from ESC	sec	305.0	+75 -55	
Start Impulse	lb-sec	251,825.0	±30,000.0	4
Cutoff Impulse	lb-sec	36,797.0	±2,000.0	5
Time from 90 percent Thrust to ECC*	sec	458.089	±16.0	
Total Depletion Burntime* (ESC to ECC)	sec	461.389	±16.0	
Loaded Propellants (LOX)	lbm	193,273.0	±2,165.0	
(LH2)	lbm	37,440.0	±419.0	
(Total)	lbm	230,713.0	±2,205.0	
Engine Propellant Consumption (90 percent thrust to ECC)* (LOX)	lbm	192,248.0	±2,153.0	
(LH2)	lbm	36,111.0	±404.0	
(Total)	lbm	228,359.0	±2,190.0	

*As used in this table, ECC refers to propellant depletion engine cutoff.

TABLE AP 5-1 (Sheet 2 of 2)
PREDICTED AS-204 PROPULSION SYSTEM PERFORMANCE PARAMETERS

NOTES:

1. Determined from 90 percent thrust buildup to ECC. Does not include ullage rocket operation.

2. During period when PU valve is against the LOX rich stop.

3. During period after PU valve cutback until ECC received by the engine.

4. Determined for time period of ESC to 90 percent thrust buildup.

5. Determined for time period of ECC as monitored on the S-IVB stage until thrust decay to zero.

TABLE AP 5-2 (Sheet 1 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	TIME	WDOTSUBO	WDOTSUBF	WDOTSUBT	DEL	1	0.700	0.000	5.651	5.651	0.000
2	PSUBE	TIPSUBO	TTPSUBF	HSUBO	HSUBF	2	0.00	40.140	36.600	226.557	487.774
3	EMR	PUPI	PFPI	VSUBO	VSUBF	3	0.000	40.140	36.591	2725.069	8573.177
4	ENGINE ISP	TUPI	TFPI	WO PU	WF PU	4	0.000	164.640	37.851	191160.568	36015.922
5	CSUBFEV	RHOSUBO	RHOSUBF	WOPU USABLE	WFPU USABLE	5	1.687	70.789	4.361	191760.727	36258.363
6	PCC	WOUTOBO	WOUTFBO	WO USABLF	WF USABLE	6	0.000	0.391	0.000	192680.725	36422.363
7	LPS	WOUTHE	WOUTFPR	WO IN TANK	WF IN TANK	7	0.000	0.250	0.380	192905.725	37390.351
8	FPS	TTOHE	TTFHE	WSUBOT	WSUBFT	8	1875.101	3.286	37.860	193272.725	37438.351
9	FSUBAUX	TTOLOX	TTFLH2	OXID OVB	FUEL OVB	9	0.000	34.163	125.266	0.000	1.383
10	WSUBO ERROR	WOBUT	WFBUT	WOUTOVO	WOUTFVO	10	8.653	0.274	0.000	0.000	0.000
11	WSUBHE	TTMO	TTMF	WOVOT	WFVOT	11	329.825	37.449	163.126	0.000	0.000
12	GGMR	WOUTOGG	WOUTFGG	DRAG	WSUBV	12	0.000	0.000	0.236	0.000	295996.074
13	ASUBM		WFPRT		IMPSUBT	13	0.000		0.266		0.000

1	0.000	0.000	0.000	0.000	0.000	1	0.800	0.000	5.808	5.808	0.000
2	0.00	40.000	36.600	226.555	485.272	2	0.00	40.160	36.600	226.557	487.770
3	0.000	40.000	36.600	2725.071	8621.112	3	0.000	40.160	36.591	2725.069	8573.051
4	0.000	164.640	37.850	0.000	0.000	4	0.000	164.640	37.851	191160.527	36015.331
5	1.687	70.789	4.337	191761.000	36260.000	5	1.667	70.789	4.361	191760.688	36257.757
6	0.000	0.391	0.000	192681.000	36424.000	6	0.000	0.391	0.000	192680.686	36421.756
7	0.000	0.250	0.380	192906.000	37392.000	7	0.000	0.250	0.380	192905.686	37389.739
8	0.000	3.111	37.860	193273.000	37440.000	8	1927.198	3.311	37.860	193272.686	37437.739
9	0.000	33.889	125.000	0.000	0.000	9	0.000	34.202	125.304	0.000	1.957
10	0.000	0.000	0.000	0.000	0.000	10	8.655	0.313	0.000	0.000	0.000
11	330.000	37.000	162.860	0.000	0.000	11	329.860	37.513	163.164	0.000	0.000
12	0.000	0.000	0.000	0.000	295998.000	12	0.000	0.000	0.242	0.000	295995.422
13	0.000		0.000		0.000	13	0.000		0.304		0.000

1	0.100	0.000	0.000	0.000	0.000	1	0.900	0.000	5.965	5.965	0.000
2	0.00	40.020	36.600	226.557	487.782	2	0.00	40.180	36.600	226.557	487.766
3	0.000	40.020	36.600	2725.070	8573.460	3	0.000	40.180	36.590	2725.069	8572.920
4	0.000	164.640	37.850	191160.818	36017.500	4	0.000	164.640	37.851	191160.486	36014.725
5	1.687	70.789	4.361	191760.959	36259.962	5	1.687	70.789	4.361	191760.648	36257.135
6	0.000	0.391	0.000	192680.959	36423.962	6	0.000	0.391	0.000	192680.646	36421.134
7	0.000	0.250	0.380	192905.959	37391.962	7	0.000	0.250	0.380	192905.646	37389.112
8	0.000	3.136	37.860	193272.959	37439.962	8	1979.296	3.336	37.860	193272.646	37437.112
9	0.000	33.928	125.038	0.000	0.000	9	0.000	34.241	125.342	0.000	2.545
10	8.650	0.039	0.000	0.000	0.000	10	8.656	0.352	0.000	0.000	0.000
11	329.975	37.064	162.898	0.000	0.000	11	329.775	37.577	163.202	0.000	0.000
12	0.000	0.000	0.000	0.000	295997.918	12	0.000	0.000	0.249	0.000	295994.758
13	0.000		0.038		0.000	13	0.000		0.342		0.000

1	0.200	0.000	0.000	0.000	0.000	1	1.000	0.000	6.122	6.122	0.000
2	0.00	40.040	36.600	226.557	487.782	2	0.00	40.200	36.600	226.557	487.762
3	0.000	40.040	36.600	2725.070	8573.464	3	0.000	40.200	36.590	2725.069	8572.786
4	0.000	164.640	37.850	191160.777	36017.459	4	0.000	164.640	37.851	191160.443	36014.103
5	1.687	70.789	4.361	191760.920	36259.924	5	1.687	70.789	4.361	191760.609	36256.497
6	0.000	0.391	0.000	192680.920	36423.924	6	0.000	0.391	0.000	192680.607	36420.497
7	0.000	0.250	0.380	192905.920	37391.924	7	0.000	0.250	0.380	192905.607	37388.470
8	0.000	3.161	37.860	193272.920	37439.924	8	2031.395	3.361	37.860	193272.607	37436.470
9	0.000	33.967	125.076	0.000	0.000	9	0.000	34.280	125.380	0.000	3.150
10	8.650	0.078	0.000	0.000	0.000	10	8.658	0.391	0.000	0.000	0.000
11	329.950	37.128	162.936	0.000	0.000	11	329.750	37.641	163.240	0.000	0.000
12	0.000	0.000	0.000	0.000	295997.844	12	0.000	0.000	0.255	0.000	295994.074
13	0.000		0.076		0.000	13	0.000		0.380		0.000

1	0.300	0.000	0.000	0.000	0.000	1	1.100	0.000	6.279	6.279	0.000
2	0.00	40.060	36.600	226.557	487.783	2	0.00	40.220	36.600	226.557	487.758
3	0.000	40.060	36.600	2725.070	8573.468	3	0.000	40.220	36.589	2725.068	8572.648
4	0.000	164.640	37.850	191160.734	36017.420	4	0.000	164.641	37.852	191160.402	36013.466
5	1.687	70.789	4.361	191760.881	36259.887	5	1.687	70.789	4.361	191760.570	36255.844
6	0.000	0.391	0.000	192680.881	36423.886	6	0.000	0.391	0.000	192680.568	36419.844
7	0.000	0.250	0.380	192905.881	37391.886	7	0.000	0.250	0.380	192905.568	37387.812
8	0.000	3.186	37.860	193272.881	37439.886	8	2083.494	3.386	37.860	193272.568	37435.812
9	0.000	34.006	125.114	0.000	0.000	9	0.000	34.319	125.418	0.000	3.770
10	8.650	0.117	0.000	0.000	0.000	10	8.659	0.430	0.000	0.000	0.000
11	329.925	37.192	162.974	0.000	0.000	11	329.725	37.705	163.278	0.000	0.000
12	0.000	0.000	0.000	0.000	295997.766	12	0.000	0.000	0.262	0.000	295993.379
13	0.000		0.114		0.000	13	0.000		0.418		0.000

1	0.400	0.000	1.831	1.831	0.000	1	1.200	0.000	9.418	9.418	0.000
2	0.00	40.080	36.600	226.557	487.783	2	0.00	40.240	36.600	226.557	487.752
3	0.000	40.080	36.599	2725.070	8573.451	3	0.000	40.240	36.577	2725.068	8572.479
4	0.000	164.640	37.851	191160.693	36017.291	4	0.000	164.641	37.852	191160.359	36012.669
5	1.687	70.789	4.361	191760.842	36259.758	5	1.687	70.789	4.361	191760.531	36255.027
6	0.000	0.391	0.000	192680.842	36423.757	6	0.000	0.391	0.000	192680.529	36419.027
7	0.000	0.250	0.380	192905.842	37391.756	7	0.000	0.250	0.380	192905.529	37386.989
8	607.661	3.211	37.860	193272.842	37439.756	8	3125.257	3.411	37.860	193272.529	37434.989
9	0.000	34.045	125.152	0.000	0.092	9	0.000	34.358	125.456	0.000	4.555
10	8.650	0.156	0.000	0.000	0.000	10	8.661	0.469	0.000	0.000	0.000
11	329.900	37.256	163.012	0.000	0.000	11	329.700	37.769	163.316	0.000	0.000
12	0.000	0.000	0.076	0.000	295997.598	12	0.000	0.000	0.393	0.000	295992.516
13	0.000		0.152		0.000	13	0.000		0.456		0.000

1	0.500	0.000	3.663	3.663	0.000	1	1.300	0.000	21.974	21.974	0.000
2	0.00	40.100	36.600	226.557	487.781	2	0.00	40.260	36.600	226.557	487.743
3	0.000	40.100	36.596	2725.070	8573.396	3	0.000	40.260	36.485	2725.068	8572.180
4	0.000	164.640	37.851	191160.652	36016.986	4	0.000	164.641	37.852	191160.318	36011.106
5	1.687	70.789	4.361	191760.805	36259.447	5	1.687	70.789	4.361	191760.492	36253.432
6	0.000	0.391	0.000	192680.803	36423.446	6	0.000	0.391	0.000	192680.490	36417.432
7	0.000	0.250	0.380	192905.803	37391.442	7	0.000	0.250	0.380	192905.490	37385.381
8	1215.329	3.236	37.860	193272.803	37439.442	8	7292.255	3.436	37.860	193272.490	37433.381
9	0.000	34.084	125.190	0.000	0.367	9	0.000	34.397	125.494	0.000	6.125
10	8.651	0.195	0.000	0.000	0.000	10	8.665	0.508	0.000	0.000	0.000
11	329.875	37.320	163.050	0.000	0.000	11	329.675	37.833	163.354	0.000	0.000
12	0.000	0.000	0.153	0.000	295997.242	12	0.000	0.000	0.916	0.000	295990.871
13	0.000		0.190		0.000	13	0.000		0.494		0.000

1	0.600	0.000	5.494	5.494	0.000	1	1.400	0.000	30.996	30.996	0.000
2	0.00	40.120	36.600	226.557	487.778	2	0.00	40.280	36.600	226.557	487.728
3	0.000	40.120	36.591	2725.069	8573.298	3	0.000	40.280	36.374	2725.068	8571.714
4	0.000	164.640	37.851	191160.611	36016.501	4	0.000	164.641	37.852	191160.277	36008.486
5	1.687	70.789	4.361	191760.766	36258.955	5	1.687	70.789	4.361	191760.453	36250.766
6	0.000	0.391	0.000	192680.764	36422.954	6	0.000	0.391	0.000	192680.451	36414.766
7	0.000	0.250	0.380	192905.764	37390.946	7	0.000	0.250	0.380	192905.451	37382.694
8	1823.004	3.261	37.860	193272.764	37438.946	8	10247.256	3.461	37.860	193272.451	37430.694
9	0.000	34.123	125.228	0.000	0.826	9	0.000	34.436	125.532	0.000	8.774
10	8.652	0.235	0.000	0.000	0.000	10	8.671	0.547	0.000	0.000	0.000
11	329.850	37.385	163.088	0.000	0.000	11	329.650	37.897	163.392	0.000	0.000
12	0.000	0.000	0.229	0.000	295996.707	12	0.000	0.000	1.293	0.000	295988.145
13	0.000		0.228		0.000	13	0.000		0.532		0.000

TABLE AP 5-2 (Sheet 2 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	1.500	0.000	40.016	40.016	0.000
2	0.00	40.300	36.600	226.557	487.207
3	0.000	40.300	36.[illegible]	2725.068	8571.098
4	0.000	164.641	37.[illegible]	191160.234	36005.005
5	1.687	70.789	4.361	191760.414	36247.205
6	0.000	0.391	0.000	192680.412	36411.204
7	0.000	0.250	0.380	192905.412	37379.104
8	13282.158	3.486	37.860	193272.412	37427.104
9	0.000	34.475	125.570	0.000	12.325
10	8.685	0.586	0.000	0.000	0.000
11	329.625	37.961	163.436	0.000	0.000
12	0.000	0.000	1.669	0.000	295984.516
13	0.000		0.570		0.000

1	1.600	62.141	40.799	102.940	0.000
2	10008.[illegible]	40.320	36.600	226.553	487.680
3	1.5[illegible]	40.240	36.[illegible]	2725.024	8570.257
4	97.222	164.641	37.852	191157.266	36001.038
5	1.687	70.789	4.361	191757.270	36243.157
6	34.850	0.391	0.000	192677.268	36407.157
7	1306.124	0.250	0.380	192902.266	37375.025
8	13542.403	3.511	37.860	193267.266	37423.025
9	0.000	34.514	125.668	3.107	16.366
10	8.688	0.626	0.000	0.000	0.000
11	329.600	38.026	163.468	0.000	0.000
12	0.281	0.478	1.702	0.000	295977.289
13	0.034		0.608		500.427

1	1.700	66.046	41.588	107.634	0.000
2	10582.68	40.340	36.600	226.544	487.647
3	1.588	40.564	36.240	2724.933	8569.281
4	98.321	164.641	37.853	191151.361	35997.038
5	1.687	70.789	4.361	191750.826	36239.031
6	36.850	0.391	0.000	192670.824	36403.031
7	1387.841	0.250	0.380	192895.816	37370.668
8	13804.096	3.536	37.860	193262.816	37418.868
9	0.000	34.554	125.646	9.518	20.486
10	8.695	0.665	0.000	0.000	0.000
11	329.575	38.090	163.506	0.000	0.000
12	0.293	0.508	1.735	0.000	295966.684
13	0.036		0.646		1530.052

1	1.800	62.811	42.373	105.184	0.000
2	11155.08	40.360	36.600	226.536	487.616
3	1.482	40.611	36.227	2724.842	8568.339
4	106.053	164.641	37.853	191145.613	35992.956
5	1.687	70.789	4.361	191744.350	36234.828
6	38.842	0.391	0.000	192664.348	36398.828
7	1319.820	0.250	0.380	192889.334	37366.632
8	14064.721	3.561	37.860	193256.334	37414.632
9	0.000	34.593	125.684	15.961	24.684
10	8.702	0.704	0.000	0.000	0.000
11	329.550	38.154	163.544	0.000	0.000
12	0.273	0.483	1.767	0.000	295955.965
13	0.038		0.664		2616.944

1	1.900	59.576	42.530	102.107	0.000
2	11727.55	40.380	36.600	226.527	487.584
3	1.401	40.656	36.227	2724.755	8567.377
4	114.856	164.641	37.853	191140.170	35988.829
5	1.687	70.789	4.361	191738.193	36230.578
6	40.836	0.391	0.000	192658.191	36394.578
7	1251.798	0.250	0.380	192883.174	37362.348
8	14116.995	3.586	37.860	193250.174	37410.348
9	0.000	34.632	125.722	22.082	28.930
10	8.709	0.743	0.000	0.000	0.000
11	329.525	38.218	163.562	0.000	0.000
12	0.258	0.458	1.774	0.000	295945.520
13	0.040		0.722		3761.079

1	2.000	56.341	42.688	99.029	0.000
2	36042.03	40.400	36.600	226.519	487.552
3	1.320	40.702	36.[illegible]	2724.673	8566.405
4	363.956	164.641	37.853	191135.018	35984.689
5	1.687	70.789	4.361	191732.363	36226.312
6	125.498	0.391	0.000	192652.361	36390.312
7	1193.775	0.250	0.380	192877.338	37358.049
8	14169.270	3.611	37.860	193244.338	37406.049
9	0.000	34.671	125.760	27.879	33.191
10	8.716	0.782	0.000	0.000	0.000
11	329.500	38.282	163.620	0.000	0.000
12	0.243	0.433	1.780	0.000	295935.387
13	0.122		0.760		5358.162

1	2.100	77.002	42.856	119.857	0.000
2	51557.15	40.420	36.600	226.510	487.516
3	1.797	41.430	36.324	2724.579	8565.301
4	430.154	164.641	37.853	191129.021	35980.550
5	1.687	70.789	4.361	191725.660	36222.029
6	179.507	0.391	0.000	192645.658	36386.029
7	1616.941	0.250	0.380	192870.629	37353.733
8	14224.320	3.636	37.860	193237.629	37401.733
9	0.000	34.710	125.798	34.549	37.469
10	8.724	0.821	0.000	0.000	0.000
11	329.475	38.346	163.658	0.000	0.000
12	0.331	0.592	1.788	0.000	295924.359
13	0.174		0.798		9738.925

1	2.200	97.663	43.020	140.683	0.000
2	67074.69	40.440	36.600	226.498	487.481
3	2.270	41.865	36.385	2724.456	8564.241
4	476.779	164.641	37.853	191121.129	35976.390
5	1.688	70.789	4.361	191716.893	36217.730
6	233.522	0.391	0.000	192636.891	36381.730
7	2050.113	0.250	0.380	192861.854	37349.400
8	14278.205	3.661	37.860	193228.854	37397.400
9	0.000	34.749	125.836	43.785	41.763
10	8.733	0.860	0.000	0.000	0.000
11	329.450	38.410	163.696	0.000	0.000
12	0.418	0.750	1.794	0.000	295911.254
13	0.227		0.836		15671.276

1	2.300	118.341	43.183	161.524	0.000
2	82602.12	40.460	36.600	226.483	487.446
3	2.740	42.284	36.446	2724.303	8563.177
4	511.491	164.641	37.853	191111.404	35972.213
5	1.688	70.789	4.361	191706.059	36213.416
6	267.567	0.391	0.000	192626.057	36377.416
7	2483.350	0.250	0.380	192851.012	37345.052
8	14342.059	3.686	37.860	193218.012	37393.052
9	0.000	34.788	125.834	54.088	46.074
10	8.725	0.899	0.000	0.000	0.000
11	329.425	38.474	163.734	0.000	0.000
12	0.515	0.909	1.801	0.000	295896.063
13	0.279		0.874		23156.171

1	2.400	142.747	44.367	187.114	0.000
2	98136.84	40.480	36.600	226.465	487.410
3	3.217	42.666	36.487	2724.120	8562.111
4	524.477	164.641	37.854	191099.727	35967.971
5	1.688	70.789	4.361	191691.027	36209.034
6	341.633	0.391	0.000	192611.025	36373.034
7	2994.593	0.250	0.380	192837.969	37340.636
8	14724.511	3.711	37.860	193204.969	37388.636
9	0.000	34.827	125.912	67.092	50.452
10	8.739	0.938	0.000	0.000	0.000
11	329.400	38.538	163.772	0.000	0.000
12	0.553	1.097	1.851	0.000	295878.602
13	0.332		0.912		32194.489

1	2.500	168.759	45.550	214.309	0.000
2	113678.12	40.500	36.600	226.444	487.375
3	3.705	43.015	36.527	2723.900	8561.031
4	530.441	164.641	37.854	191085.748	35963.610
5	1.688	70.789	4.361	191677.422	36204.535
6	395.719	0.391	0.000	192597.420	36368.534
7	3539.302	0.250	0.380	192822.350	37336.102
8	15116.930	3.736	37.860	193189.350	37384.102
9	0.000	34.866	125.950	82.672	54.948
10	8.743	0.977	0.000	0.000	0.000
11	329.375	38.602	163.810	0.000	0.000
12	0.682	1.296	1.900	0.000	295858.449
13	0.384		0.950		42786.918

1	2.600	194.783	46.734	241.517	0.000
2	129225.49	40.520	36.600	226.419	487.338
3	4.168	43.339	36.567	2723.643	8559.925
4	535.058	164.641	37.854	191069.465	35959.136
5	1.688	70.789	4.361	191659.217	36199.917
6	449.823	0.391	0.000	192579.215	36363.917
7	4084.064	0.250	0.380	192804.129	37331.449
8	15509.316	3.761	37.860	193171.129	37379.449
9	0.000	34.905	125.988	100.854	59.563
10	8.746	1.017	0.000	0.000	0.000
11	329.350	38.667	163.948	0.000	0.000
12	0.768	1.496	1.949	0.000	295835.574
13	0.437		0.988		54934.105

1	2.700	220.819	47.917	268.735	0.000
2	144778.00	40.540	36.600	226.390	487.301
3	4.608	43.636	36.606	2723.350	8558.792
4	538.738	164.641	37.854	191050.875	35954.547
5	1.688	70.789	4.361	191638.410	36195.184
6	503.943	0.391	0.000	192558.408	36359.184
7	4628.871	0.250	0.380	192783.305	37326.678
8	15961.660	3.786	37.860	193150.305	37374.678
9	0.000	34.945	126.026	121.639	64.296
10	8.747	1.056	0.000	0.000	0.000
11	329.325	38.731	163.986	0.000	0.000
12	0.849	1.696	1.999	0.000	295809.980
13	0.489		1.026		68636.627

1	2.800	246.863	50.277	297.140	0.000
2	155381.83	40.560	36.600	226.358	487.262
3	4.910	43.907	36.618	2723.020	8557.637
4	562.924	164.641	37.854	191029.979	35949.788
5	1.688	70.789	4.361	191615.000	36190.274
6	540.845	0.391	0.000	192534.998	36354.273
7	5173.704	0.250	0.380	192759.875	37321.729
8	16684.972	3.811	37.860	193126.875	37369.729
9	0.000	34.984	126.064	145.029	69.296
10	8.748	1.095	0.000	0.000	0.000
11	329.300	38.795	163.924	0.000	0.000
12	0.904	1.896	2.097	0.000	295781.602
13	0.525		1.064		83812.403

1	2.900	272.873	52.635	325.508	0.000
2	161013.73	40.580	36.600	226.322	487.224
3	5.154	43.998	36.607	2722.653	8556.474
4	494.654	164.641	37.854	191006.731	35944.793
5	1.688	70.789	4.361	191588.990	36185.130
6	560.461	0.391	0.000	192508.988	36349.130
7	5718.396	0.250	0.380	192733.844	37316.546
8	17467.504	3.836	37.860	193100.844	37364.546
9	0.000	35.023	126.102	171.021	74.352
10	8.749	1.134	0.000	0.000	0.000
11	329.275	38.859	163.962	0.000	0.000
12	0.955	2.096	2.196	0.000	295750.387
13	0.544		1.102		99634.477

1	3.000	289.196	54.990	344.187	0.000
2	166036.23	40.600	36.600	226.283	487.185
3	5.259	44.017	36.572	2722.256	8555.286
4	484.145	164.641	37.854	190981.738	35939.566
5	1.688	70.789	4.361	191560.869	36179.752
6	579.959	0.391	0.000	192480.867	36343.752
7	6060.365	0.250	0.380	192705.697	37311.126
8	18249.683	3.861	37.860	193072.697	37359.126
9	0.000	35.062	126.140	199.129	79.734
10	8.749	1.173	0.000	0.000	0.000
11	329.250	38.923	164.000	0.000	0.000
12	0.968	2.221	2.294	0.000	295614.820
13	0.564		1.140		116018.391

TABLE AP 5-2 (Sheet 3 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	3.100	305.518	56.365	361.882	0.000
2	170895.73	40.620	36.600	226.242	487.143
3	5.420	44.027	36.561	2721.837	8554.043
4	472.241	164.642	37.855	190955.277	35934.161
5	1.688	70.789	4.361	191531.113	36174.189
6	594.824	0.391	0.000	192451.113	36338.189
7	6402.335	0.250	0.380	192675.918	37305.520
8	18705.968	3.886	37.860	193042.918	37353.520
9	0.000	35.101	126.178	228.869	85.302
10	8.749	1.212	0.000	0.000	0.000
11	329.225	38.987	164.036	0.000	0.000
12	0.998	2.346	2.351	0.000	295477.438
13	0.578		1.178		132896.463

1	3.200	321.823	57.738	379.561	0.000
2	175147.83	40.640	36.600	226.199	487.101
3	5.574	43.984	36.543	2721.394	8552.760
4	461.449	164.642	37.855	190927.373	35928.627
5	1.688	70.789	4.361	191499.730	36168.490
6	609.626	0.391	0.000	192419.729	36332.490
7	6744.237	0.250	0.380	192644.508	37299.776
8	19161.968	3.911	37.860	193011.508	37347.776
9	0.000	35.140	126.216	260.240	91.008
10	8.749	1.251	0.000	0.000	0.000
11	329.200	39.051	164.076	0.000	0.000
12	1.026	2.472	2.408	0.000	295440.281
13	0.593		1.216		150199.994

1	3.300	338.122	59.111	397.233	0.000
2	179397.86	40.660	36.600	226.153	487.057
3	5.720	43.929	36.525	2720.929	8551.448
4	451.619	164.642	37.855	190898.027	35922.960
5	1.688	70.789	4.361	191466.719	36162.655
6	624.423	0.391	0.000	192386.717	36326.654
7	7086.116	0.250	0.380	192611.467	37293.895
8	19617.889	3.936	37.860	192978.467	37341.895
9	0.000	35.179	126.254	293.242	96.851
10	8.747	1.290	0.000	0.000	0.000
11	329.175	39.115	164.114	0.000	0.000
12	1.053	2.597	2.466	0.000	295401.359
13	0.607		1.254		167928.691

1	3.400	347.072	60.485	407.557	0.000
2	181675.35	40.680	36.600	226.106	487.013
3	5.738	43.964	36.505	2720.444	8550.105
4	446.258	164.642	37.855	190867.484	35917.162
5	1.688	70.789	4.361	191432.338	36156.683
6	633.043	0.391	0.000	192352.338	36320.683
7	7273.453	0.250	0.380	192577.059	37287.877
8	20074.288	3.961	37.860	192944.059	37335.877
9	0.000	35.218	126.292	327.611	102.831
10	8.746	1.329	0.000	0.000	0.000
11	329.150	39.179	164.152	0.000	0.000
12	1.056	2.666	2.523	0.000	295360.934
13	0.616		1.292		186018.818

1	3.500	352.853	61.858	414.712	0.000
2	183585.38	40.700	36.600	226.058	486.968
3	5.704	43.983	36.477	2719.950	8548.742
4	442.682	164.642	37.855	190836.426	35911.230
5	1.688	70.789	4.361	191397.332	36150.576
6	638.993	0.391	0.000	192317.330	36314.576
7	7394.486	0.250	0.380	192542.021	37281.722
8	20530.591	3.986	37.860	192909.021	37329.722
9	0.000	35.257	126.330	362.609	108.948
10	8.745	1.368	0.000	0.000	0.000
11	329.125	39.243	164.190	0.000	0.000
12	1.050	2.710	2.580	0.000	295319.742
13	0.622		1.330		204292.564

1	3.600	358.626	63.231	421.858	0.000
2	185291.64	40.720	36.600	226.009	486.922
3	5.672	43.977	36.445	2719.448	8547.352
4	439.228	164.642	37.855	190804.859	35905.166
5	1.688	70.789	4.361	191361.746	36144.332
6	644.931	0.391	0.000	192281.744	36308.331
7	7515.481	0.250	0.380	192506.406	37275.429
8	20986.747	4.011	37.860	192873.406	37323.429
9	0.000	35.296	126.368	398.186	115.203
10	8.744	1.408	0.000	0.000	0.000
11	329.100	39.308	164.228	0.000	0.000
12	1.044	2.754	2.638	0.000	295277.832
13	0.628		1.368		222737.018

1	3.700	362.532	64.604	427.136	0.000
2	187001.43	40.740	36.600	225.959	486.875
3	5.612	43.995	36.412	2718.939	8545.932
4	437.803	164.642	37.856	190772.869	35898.969
5	1.688	70.789	4.361	191325.678	36137.951
6	650.880	0.391	0.000	192245.676	36301.951
7	7597.178	0.250	0.380	192470.307	37268.999
8	21443.042	4.036	37.860	192837.307	37316.999
9	0.000	35.336	126.406	434.246	121.595
10	8.743	1.447	0.000	0.000	0.000
11	329.075	39.372	164.266	0.000	0.000
12	1.033	2.784	2.695	0.000	295235.305
13	0.633		1.406		241352.188

1	3.800	366.437	65.977	432.414	0.000
2	188711.14	40.760	36.600	225.909	486.827
3	5.554	44.013	36.379	2718.425	8544.481
4	436.413	164.642	37.856	190740.539	35892.639
5	1.688	70.789	4.361	191289.219	36131.435
6	656.828	0.391	0.000	192209.217	36295.435
7	7678.874	0.250	0.380	192433.816	37262.431
8	21899.336	4.061	37.860	192800.816	37310.431
9	0.000	35.375	126.444	470.697	128.125
10	8.742	1.486	0.000	0.000	0.000
11	329.050	39.436	164.304	0.000	0.000
12	1.022	2.814	2.752	0.000	295192.246
13	0.639		1.444		260138.340

1	3.900	370.342	68.330	438.672	0.000
2	190036.60	40.780	36.600	225.858	486.778
3	5.420	44.031	36.314	2717.906	8543.008
4	433.209	164.642	37.856	190707.863	35886.130
5	1.688	70.789	4.361	191252.369	36124.733
6	661.438	0.391	0.000	192172.367	36288.733
7	7760.551	0.250	0.380	192396.936	37255.677
8	22681.455	4.086	37.860	192763.936	37303.677
9	0.000	35.414	126.482	507.539	134.840
10	8.741	1.525	0.000	0.000	0.000
11	329.025	39.500	164.342	0.000	0.000
12	0.998	2.844	2.851	0.000	295148.609
13	0.644		1.482		279076.289

1	4.000	374.243	70.662	444.925	0.000
2	191366.01	40.800	36.600	225.806	486.728
3	5.295	44.036	36.245	2717.380	8541.504
4	430.095	164.642	37.856	190674.844	35879.388
5	1.688	70.789	4.361	191215.131	36117.798
6	666.042	0.391	0.000	192135.129	36281.798
7	7842.208	0.250	0.380	192359.666	37248.688
8	23463.465	4.111	37.860	192726.666	37296.688
9	0.000	35.453	126.520	544.770	141.792
10	8.741	1.564	0.000	0.000	0.000
11	329.000	39.564	164.380	0.000	0.000
12	0.975	2.874	2.949	0.000	295104.352
13	0.648		1.520		298146.633

1	4.100	375.041	71.468	446.508	0.000
2	192692.23	40.820	36.600	225.755	486.676
3	5.248	44.086	36.226	2716.852	8539.935
4	431.554	164.642	37.856	190641.623	35872.496
5	1.688	70.789	4.361	191177.658	36110.708
6	670.674	0.391	0.000	192097.656	36274.708
7	7858.605	0.250	0.380	192322.162	37241.542
8	23724.485	4.136	37.860	192689.162	37289.542
9	0.000	35.492	126.558	582.234	148.899
10	8.741	1.603	0.000	0.000	0.000
11	328.975	39.628	164.418	0.000	0.000
12	0.966	2.880	2.982	0.000	295059.703
13	0.653		1.558		317349.539

1	4.200	375.839	72.253	448.091	0.000
2	194024.55	40.840	36.600	225.703	486.622
3	5.202	44.135	36.206	2716.322	8538.317
4	433.002	164.642	37.856	190608.344	35865.538
5	1.688	70.789	4.361	191140.107	36103.539
6	675.307	0.391	0.000	192060.105	36267.539
7	7875.002	0.250	0.380	192284.578	37234.318
8	23985.492	4.161	37.860	192651.578	37282.318
9	0.000	35.531	126.596	619.779	156.086
10	8.741	1.642	0.000	0.000	0.000
11	328.950	39.692	164.456	0.000	0.000
12	0.957	2.886	3.014	0.000	295014.895
13	0.658		1.596		336685.672

1	4.300	376.637	73.038	449.675	0.000
2	195356.94	40.860	36.600	225.651	486.568
3	5.157	44.185	36.185	2715.791	8536.681
4	434.441	164.642	37.856	190574.992	35858.504
5	1.688	70.789	4.361	191102.475	36096.293
6	679.940	0.391	0.000	192022.473	36260.292
7	7891.399	0.250	0.380	192246.914	37227.015
8	24246.505	4.186	37.860	192613.914	37275.015
9	0.000	35.570	126.634	657.404	163.351
10	8.741	1.681	0.000	0.000	0.000
11	328.925	39.756	164.494	0.000	0.000
12	0.949	2.892	3.047	0.000	294969.926
13	0.662		1.634		356155.043

1	4.400	377.435	73.391	450.827	0.000
2	195866.79	40.880	36.600	225.599	486.513
3	5.143	44.235	36.179	2715.259	8535.022
4	434.461	164.642	37.857	190541.568	35851.415
5	1.688	70.789	4.361	191064.762	36088.990
6	681.719	0.391	0.000	191984.762	36252.990
7	7907.805	0.250	0.380	192209.170	37219.655
8	24364.156	4.211	37.860	192576.170	37267.655
9	0.000	35.609	126.672	695.109	170.672
10	8.742	1.720	0.000	0.000	0.000
11	328.900	39.820	164.532	0.000	0.000
12	0.947	2.898	3.062	0.000	294924.824
13	0.664		1.672		375728.273

1	4.500	378.224	73.745	451.969	0.000
2	196619.77	40.900	36.600	225.547	486.458
3	5.129	44.259	36.169	2714.726	8533.351
4	433.702	164.642	37.857	190508.076	35844.295
5	1.688	70.788	4.361	191026.971	36081.652
6	682.240	0.391	0.000	191946.969	36245.652
7	7924.172	0.250	0.380	192171.346	37212.260
8	24461.633	4.236	37.860	192538.346	37260.260
9	0.000	35.648	126.710	732.895	178.029
10	8.742	1.759	0.000	0.000	0.000
11	328.875	39.884	164.570	0.000	0.000
12	0.944	2.905	3.077	0.000	294879.605
13	0.665		1.710		395322.750

1	4.600	379.009	74.098	453.106	0.000
2	196171.00	40.920	36.600	225.495	486.402
3	5.115	44.271	36.158	2714.192	8531.674
4	432.947	164.642	37.857	190474.514	35837.142
5	1.688	70.788	4.361	190989.100	36074.280
6	682.765	0.391	0.000	191909.098	36238.279
7	7940.522	0.250	0.380	192133.443	37204.830
8	24599.032	4.261	37.860	192500.443	37252.830
9	0.000	35.687	126.748	770.758	185.422
10	8.743	1.799	0.000	0.000	0.000
11	328.850	39.949	164.608	0.000	0.000
12	0.941	2.911	3.092	0.000	294834.273
13	0.665		1.748		414932.379

TABLE AP 5-2 (Sheet 4 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	4.700	379.793	74.450	454.244	0.000
2	196322.20	40.940	36.600	225.442	486.346
3	5.101	44.284	36.147	2713.657	8529.989
4	432.196	164.642	37.857	190440.883	35829.953
5	1.688	70.788	4.361	190951.152	36066.872
6	683.290	0.391	0.000	191871.150	36230.871
7	7956.872	0.250	0.380	192095.493	37197.364
8	24716.432	4.286	37.860	192462.493	37245.364
9	0.000	35.727	126.746	808.699	192.850
10	8.743	1.838	0.000	0.000	0.000
11	328.825	40.013	164.646	0.000	0.000
12	0.939	2.917	3.106	0.000	294788.824
13	0.666		1.786		434557.129

1	4.800	380.578	74.903	455.381	0.000
2	196473.40	40.960	36.600	225.390	486.290
3	5.088	44.297	36.136	2713.121	8528.296
4	431.448	164.642	37.857	190407.190	35822.730
5	1.688	70.788	4.361	190913.125	36059.429
6	683.814	0.391	0.000	191833.125	36223.428
7	7973.221	0.250	0.380	192057.404	37189.863
8	24833.823	4.311	37.860	192424.404	37237.863
9	0.000	35.766	126.824	846.719	200.313
10	8.744	1.877	0.000	0.000	0.000
11	328.800	40.077	164.684	0.000	0.000
12	0.936	2.923	3.121	0.000	294743.266
13	0.667		1.824		454197.000

1	4.900	381.363	75.156	456.519	0.000
2	196624.60	40.980	36.600	225.337	486.234
3	5.074	44.310	36.124	2712.583	8526.594
4	430.704	164.642	37.857	190373.412	35815.475
5	1.688	70.788	4.361	190875.021	36051.951
6	684.339	0.391	0.000	191795.020	36215.951
7	7989.571	0.250	0.380	192019.268	37182.327
8	24951.233	4.336	37.860	192386.268	37230.327
9	0.000	35.805	126.862	884.816	207.811
10	8.744	1.916	0.000	0.000	0.000
11	328.775	40.141	164.722	0.000	0.000
12	0.934	2.929	3.136	0.000	294697.594
13	0.667		1.862		473851.992

1	5.000	382.147	75.509	457.657	0.000
2	196775.80	41.000	36.600	225.285	486.177
3	5.061	44.322	36.113	2712.045	8524.885
4	429.964	164.642	37.857	190339.574	35808.185
5	1.688	70.788	4.361	190836.840	36044.438
6	684.864	0.391	0.000	191756.838	36208.438
7	8005.920	0.250	0.380	191981.053	37174.755
8	25068.634	4.361	37.860	192348.053	37222.755
9	0.000	35.844	126.900	922.992	215.344
10	8.745	1.955	0.000	0.000	0.000
11	328.750	40.205	164.760	0.000	0.000
12	0.931	2.935	3.151	0.000	294651.805
13	0.668		1.900		493522.102

1	6.000	381.957	76.611	458.568	0.000
2	196764.64	40.286	36.600	224.758	485.599
3	4.986	43.610	36.076	2706.655	8507.451
4	429.085	164.643	37.859	190000.957	35734.250
5	1.688	70.788	4.361	190454.711	35968.229
6	684.884	0.391	0.000	191374.709	36132.228
7	8006.475	0.250	0.380	191598.600	37097.951
8	25435.114	4.611	37.860	191965.600	37145.951
9	0.000	36.235	127.280	1305.053	291.769
10	8.754	2.346	0.000	0.000	0.000
11	328.500	40.846	165.140	0.000	0.000
12	0.918	2.933	3.196	0.000	294192.551
13	0.669		2.280		690292.227

1	7.000	383.040	76.741	459.781	0.321
2	197294.39	39.571	36.600	224.230	485.017
3	4.991	42.893	36.074	2701.264	8489.910
4	429.105	164.643	37.860	189662.314	35660.100
5	1.689	70.788	4.361	190072.555	35891.787
6	686.491	0.391	0.000	190992.553	36055.787
7	8016.096	0.250	0.380	191216.119	37020.913
8	25460.001	4.861	37.860	191583.119	37068.913
9	0.000	36.626	127.660	1687.143	368.427
10	8.764	2.737	0.000	0.000	0.000
11	328.250	41.487	165.520	0.000	0.000
12	0.918	2.940	3.202	0.000	293733.031
13	0.672		2.660		887144.180

1	9.000	424.547	78.720	503.266	10.336
2	214666.48	38.143	36.600	223.137	483.841
3	5.393	41.363	36.074	2690.079	8454.458
4	426.546	164.644	37.863	188959.424	35510.281
5	1.710	70.787	4.360	189279.574	35737.339
6	737.506	0.391	0.000	190199.572	35901.339
7	8314.796	0.250	0.380	190422.465	36865.260
8	26187.367	5.361	37.860	190789.465	36913.260
9	0.000	37.408	128.420	2480.016	523.319
10	8.775	3.519	0.000	0.000	0.000
11	327.750	42.769	166.280	0.000	0.000
12	0.968	3.205	3.310	0.000	292783.723
13	0.733		3.420		1293067.781

1	10.000	438.882	79.108	517.990	21.718
2	220519.14	37.429	36.600	222.536	483.240
3	5.548	40.572	36.088	2683.934	8436.366
4	425.721	164.645	37.865	188573.324	35433.918
5	1.717	70.787	4.360	188843.965	35658.613
6	754.711	0.391	0.000	189763.963	35822.613
7	8418.599	0.250	0.380	189986.484	36785.919
8	26324.532	5.611	37.860	190353.484	36833.919
9	0.000	37.799	128.800	2915.605	602.280
10	8.766	3.910	0.000	0.000	0.000
11	327.500	43.410	166.660	0.000	0.000
12	0.990	3.296	3.331	0.000	292268.402
13	0.755		3.500		1512271.922

1	20.000	443.764	80.215	523.979	31.000
2	222062.19	34.500	35.437	217.273	477.257
3	5.532	37.566	34.897	2621.860	8256.001
4	423.800	164.650	37.880	184706.275	34665.512
5	1.716	70.783	4.359	184443.861	34866.639
6	760.367	0.391	0.000	185363.859	35030.639
7	8521.885	0.296	0.380	185582.641	35987.764
8	26719.738	8.342	37.860	185949.641	36035.764
9	0.000	41.709	132.600	7315.539	1396.636
10	8.668	7.820	0.000	0.000	0.000
11	324.749	50.051	170.460	0.000	0.000
12	0.986	3.333	3.379	0.000	287066.402
13	0.774		7.600		3722299.563

1	30.000	445.768	80.129	525.896	31.000
2	223124.03	34.667	34.330	212.676	471.209
3	5.563	37.711	33.802	2559.101	8073.706
4	424.274	164.655	37.895	180468.229	33890.019
5	1.716	70.779	4.358	179995.732	34067.325
6	764.024	0.391	0.000	180915.730	34231.324
7	8557.102	0.328	0.380	181130.730	35182.211
8	26715.910	11.484	37.860	181497.730	35230.211
9	0.000	45.619	136.400	11763.539	2198.388
10	8.440	11.730	0.000	0.000	0.000
11	321.627	57.103	174.259	0.000	0.000
12	0.991	3.347	3.377	0.000	281808.941
13	0.792		11.400		5948227.750

1	40.000	447.964	80.041	528.005	31.000
2	224282.09	35.688	33.037	208.518	465.171
3	5.597	38.723	32.523	2496.044	7891.719
4	424.774	164.660	37.910	176189.424	33115.345
5	1.716	70.775	4.356	175526.906	33268.870
6	767.878	0.391	0.000	176446.904	33432.869
7	8592.213	0.354	0.380	176658.105	34377.524
8	26715.159	14.891	37.860	177025.105	34425.524
9	0.000	49.529	140.199	16232.254	2999.275
10	8.170	15.640	0.000	0.000	0.000
11	318.219	64.420	178.059	0.000	0.000
12	0.996	3.363	3.376	0.000	276531.629
13	0.811		15.200		8185255.313

1	50.000	448.291	80.204	528.495	31.000
2	224380.73	37.067	31.800	204.664	459.125
3	5.589	40.105	31.285	2432.803	7709.490
4	424.565	164.665	37.925	171812.859	32336.699
5	1.716	70.771	4.355	171045.623	32470.096
6	768.072	0.391	0.000	171965.621	32634.096
7	8589.292	0.375	0.380	172173.014	33572.517
8	26797.747	18.550	37.860	172540.014	33620.517
9	0.000	53.439	143.999	20713.436	3800.483
10	7.860	19.550	0.000	0.000	0.000
11	314.560	71.989	181.859	0.000	0.000
12	0.994	3.364	3.385	0.000	271241.527
13	0.827		19.000		10428463.375

1	60.000	448.677	80.393	529.070	31.000
2	224519.90	38.590	30.917	201.034	453.048
3	5.581	41.638	30.402	2369.503	7526.326
4	424.367	164.670	37.940	167404.008	31554.853
5	1.717	70.768	4.353	166560.588	31669.545
6	768.410	0.391	0.000	167480.586	31833.545
7	8586.561	0.382	0.380	167684.166	32765.718
8	26882.332	22.336	37.860	168051.166	32813.718
9	0.000	57.349	147.799	25198.373	4603.482
10	7.542	23.460	0.000	0.000	0.000
11	310.774	79.684	185.659	0.000	0.000
12	0.991	3.366	3.395	0.000	265945.883
13	0.844		22.800		12672951.875

1	70.000	447.168	80.442	527.610	31.000
2	224247.86	38.171	30.083	197.646	446.956
3	5.559	41.258	29.571	2306.235	7342.695
4	425.026	164.675	37.955	162950.264	30770.692
5	1.718	70.764	4.352	162078.266	30867.670
6	767.076	0.391	0.000	162998.266	31031.669
7	8568.814	0.260	0.380	163198.035	31957.584
8	26915.613	25.740	37.860	163565.035	32005.584
9	0.000	61.259	151.599	29680.594	5407.816
10	7.207	27.370	0.000	0.000	0.000
11	307.370	86.999	189.459	0.000	0.000
12	0.988	3.355	3.398	0.000	260651.617
13	0.860		26.600		14917686.250

1	80.000	447.251	80.530	527.781	31.000
2	224273.53	37.120	29.494	194.440	440.849
3	5.554	40.234	28.985	2243.174	7158.637
4	424.937	164.680	37.970	158549.373	29980.305
5	1.717	70.760	4.351	157611.121	30065.518
6	767.631	0.391	0.000	158531.119	30229.518
7	8566.621	0.393	0.380	158727.092	31149.172
8	26961.980	28.407	37.860	159094.092	31197.172
9	0.000	65.169	155.399	34147.627	6212.428
10	6.913	31.280	0.000	0.000	0.000
11	304.703	93.575	193.259	0.000	0.000
12	0.986	3.355	3.402	0.000	255372.264
13	0.878		30.400		17158996.250

1	90.000	447.427	80.628	528.055	31.000
2	224521.68	38.720	28.931	191.320	434.729
3	5.549	41.872	28.427	2180.015	6974.190
4	425.186	164.685	37.985	154129.145	29188.763
5	1.717	70.756	4.350	153137.521	29262.186
6	768.335	0.391	0.000	154057.520	29426.186
7	8560.066	0.398	0.380	154249.689	30339.570
8	27010.051	32.363	37.860	154616.689	30387.570
9	0.000	69.079	159.198	38621.119	7018.230
10	6.613	35.190	0.000	0.000	0.000
11	300.746	101.442	197.058	0.000	0.000
12	0.985	3.355	3.408	0.000	250085.258
13	0.898		34.200		19402958.750

TABLE AP 5-2 (Sheet 5 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	100.000	445.831	80.601	526.432	31.000
2	224228.73	38.080	28.469	188.376	428.604
3	5.531	41.291	27.871	2116.952	6789.574
4	425.940	164.690	38.000	149712.980	28390.813
5	1.718	70.752	4.349	148671.117	28458.499
6	766.949	0.391	0.000	149591.117	28622.498
7	8541.820	0.280	0.380	149779.490	29529.610
8	27012.642	35.581	37.860	150146.490	29577.610
9	0.000	72.989	162.998	43087.408	7824.390
10	6.330	39.100	0.000	0.000	0.000
11	297.528	108.570	200.858	0.000	0.000
12	0.982	3.345	3.407	0.000	244805.100
13	0.916		38.000		21646931.000

1	110.000	446.129	80.607	526.736	31.000
2	224275.94	37.120	27.920	185.506	422.481
3	5.535	40.372	27.429	2054.023	6605.022
4	425.784	164.696	38.018	145286.723	27591.297
5	1.717	70.748	4.348	144214.371	27655.090
6	767.574	0.391	0.000	145134.369	27819.089
7	8543.278	0.407	0.380	145318.955	28719.930
8	27029.465	38.697	37.860	145685.955	28767.930
9	0.000	76.899	166.798	47544.033	8630.270
10	6.046	43.010	0.000	0.000	0.000
11	294.412	115.596	204.658	0.000	0.000
12	0.982	3.346	3.408	0.000	239534.885
13	0.936		41.800		23888547.000

1	120.000	446.485	80.623	527.108	31.000
2	224532.61	38.720	27.520	182.725	416.351
3	5.538	42.025	27.037	1991.036	6420.269
4	425.971	164.702	38.036	140849.879	26790.829
5	1.717	70.743	4.347	139751.082	26851.404
6	768.311	0.391	0.000	140671.082	27015.404
7	8540.245	0.412	0.380	140851.873	27909.972
8	27047.361	42.790	37.860	141218.873	27957.972
9	0.000	80.809	170.598	52007.207	9436.428
10	5.759	46.920	0.000	0.000	0.000
11	290.319	123.598	208.458	0.000	0.000
12	0.982	3.347	3.410	0.000	234257.844
13	0.958		45.600		26132578.250

1	130.000	445.313	80.555	525.868	31.000
2	224242.57	38.360	27.120	180.157	410.220
3	5.528	41.737	26.646	1928.108	6235.490
4	426.424	164.708	38.054	136378.570	25987.408
5	1.718	70.737	4.346	135292.131	26047.983
6	766.918	0.391	0.000	136212.129	26211.983
7	8528.541	0.297	0.380	136389.131	27100.281
8	27033.834	46.155	37.860	136756.131	27148.281
9	0.000	84.718	174.398	56466.039	10242.319
10	5.462	50.830	0.000	0.000	0.000
11	286.953	130.874	212.258	0.000	0.000
12	0.980	3.340	3.408	0.000	228985.412
13	0.979		49.400		28376608.750

1	140.000	444.783	80.232	525.015	31.000
2	223820.56	37.160	27.459	177.719	404.078
3	5.544	40.602	27.003	1865.287	6050.047
4	426.313	164.714	38.072	131934.510	25184.494
5	1.718	70.732	4.346	130841.436	25245.070
6	765.420	0.391	0.000	131761.434	25409.069
7	8521.476	0.299	0.680	131934.652	26291.101
8	27020.870	49.134	37.860	132301.652	26339.101
9	0.000	88.628	179.548	60916.607	11046.349
10	5.178	54.740	0.000	0.000	0.000
11	283.974	137.763	217.408	0.000	0.000
12	0.979	3.334	3.405	0.000	223721.752
13	1.000		54.550		30616975.500

1	150.000	445.797	80.324	526.121	31.000
2	224113.27	37.733	28.116	175.278	397.934
3	5.550	41.240	27.666	1802.417	5864.186
4	425.973	164.720	38.090	127517.575	24380.799
5	1.717	70.726	4.345	126387.997	24441.734
6	766.801	0.391	0.000	127307.986	24605.734
7	8528.485	0.422	0.680	127477.419	25481.495
8	27045.886	52.919	37.860	127844.419	25529.495
9	0.000	92.538	186.347	65369.931	11849.155
10	4.908	58.650	0.000	0.000	0.000
11	280.189	145.457	224.207	0.000	0.000
12	0.980	3.340	3.409	0.000	218454.914
13	1.026		61.350		32856507.250

1	160.000	445.265	80.343	525.608	31.000
2	224138.74	39.067	28.772	172.834	391.784
3	5.542	42.660	28.331	1739.449	5678.125
4	426.437	164.726	38.108	123097.399	23575.757
5	1.718	70.720	4.345	121928.383	23637.662
6	766.391	0.391	0.000	122848.382	23801.662
7	8519.971	0.310	0.680	123014.023	24671.148
8	27041.522	57.098	37.860	123381.023	24719.148
9	0.000	96.448	193.147	69829.416	12652.702
10	4.641	62.560	0.000	0.000	0.000
11	276.010	153.546	231.007	0.000	0.000
12	0.979	3.337	3.409	0.000	213181.170
13	1.051		68.150		35098615.000

1	170.000	444.952	80.644	525.596	31.000
2	224255.26	38.525	28.941	170.394	385.636
3	5.517	42.207	28.499	1676.584	5492.457
4	426.668	164.732	38.126	118695.739	22770.649
5	1.718	70.714	4.344	117476.752	22833.601
6	766.980	0.391	0.000	118396.751	22997.601
7	8520.677	0.310	0.380	118558.608	23860.812
8	27044.537	60.198	37.860	118925.608	23908.812
9	0.000	100.358	198.597	74280.922	13457.588
10	4.383	66.470	0.000	0.000	0.000
11	272.910	160.556	236.457	0.000	0.000
12	0.979	3.338	3.410	0.000	207915.420
13	1.079		73.600		37340645.500

1	180.000	444.614	80.595	525.209	31.000
2	224088.11	37.775	28.624	167.956	379.489
3	5.517	41.541	28.193	1613.760	5307.198
4	426.665	164.738	38.144	114296.491	21964.602
5	1.718	70.709	4.343	113028.743	22029.870
6	766.448	0.391	0.000	113948.742	22193.870
7	8517.886	0.310	0.380	114106.819	23050.808
8	27037.913	63.298	37.860	114473.819	23098.808
9	0.000	104.268	202.397	78728.801	14263.793
10	4.128	70.380	0.000	0.000	0.000
11	269.809	167.566	240.257	0.000	0.000
12	0.979	3.335	3.408	0.000	202653.627
13	1.106		77.400		39582337.000

1	190.000	444.277	80.545	524.823	31.000
2	223921.70	37.025	28.306	165.519	373.344
3	5.516	40.880	27.886	1550.974	5121.970
4	426.662	164.744	38.162	109875.389	21159.044
5	1.718	70.703	4.342	108584.107	21226.628
6	765.918	0.391	0.000	109504.106	21390.628
7	8515.101	0.310	0.380	109658.405	22241.296
8	27031.322	66.398	37.860	110025.405	22289.296
9	0.000	108.178	206.197	83173.305	15069.504
10	3.862	74.290	0.000	0.000	0.000
11	266.709	174.576	244.057	0.000	0.000
12	0.978	3.333	3.406	0.000	197395.701
13	1.134		81.199		41822362.000

1	200.000	445.379	80.568	525.947	31.000
2	224162.21	37.640	27.989	163.079	367.196
3	5.528	41.577	27.580	1488.115	4936.685
4	426.207	164.750	38.180	105422.469	20350.871
5	1.717	70.697	4.341	104135.056	20423.492
6	767.084	0.391	0.000	105055.055	20587.492
7	8522.678	0.433	0.380	105205.571	21431.892
8	27051.979	70.294	37.860	105572.571	21479.892
9	0.000	112.088	209.997	87622.229	15875.108
10	3.585	78.200	0.000	0.000	0.000
11	262.813	182.382	247.857	0.000	0.000
12	0.980	3.339	3.408	0.000	192133.463
13	1.167		84.999		44062726.000

1	210.000	445.745	80.549	526.294	31.000
2	224252.39	38.840	27.671	160.635	361.078
3	5.534	42.873	27.275	1425.165	4752.278
4	426.097	164.760	38.218	100986.518	19539.725
5	1.717	70.691	4.339	99679.269	19620.361
6	767.279	0.391	0.000	100599.268	19784.360
7	8522.031	0.435	0.380	100745.997	20622.492
8	27061.163	74.631	37.860	101112.997	20670.492
9	0.000	115.998	213.797	92077.893	16680.708
10	3.325	82.110	0.000	0.000	0.000
11	258.476	190.629	251.656	0.000	0.000
12	0.980	3.341	3.408	0.000	186864.488
13	1.200		88.799		46304773.500

1	220.000	444.718	80.461	525.179	31.000
2	223953.87	38.780	27.354	158.194	354.960
3	5.527	42.925	26.972	1362.258	4567.846
4	426.434	164.770	38.256	96615.818	18729.991
5	1.718	70.684	4.338	95227.437	18817.789
6	765.833	0.391	0.000	96147.436	18981.789
7	8511.200	0.325	0.380	96290.381	19813.657
8	27043.929	78.265	37.860	96657.381	19861.657
9	0.000	119.908	217.596	96529.599	17485.744
10	3.093	86.020	0.000	0.000	0.000
11	254.841	198.173	255.456	0.000	0.000
12	0.979	3.335	3.405	0.000	181600.037
13	1.233		92.599		48545784.000

1	230.000	444.450	80.102	524.552	31.000
2	223543.13	38.180	27.189	155.753	348.841
3	5.549	42.425	26.830	1299.365	4383.309
4	426.160	164.780	38.294	92176.687	17928.862
5	1.718	70.681	4.336	90781.582	18015.908
6	764.307	0.391	0.000	91701.581	18179.908
7	8505.088	0.325	0.680	91840.747	19005.518
8	27033.500	81.515	37.860	92207.747	19053.518
9	0.000	123.818	221.846	100975.323	18289.633
10	2.807	89.930	0.000	0.000	0.000
11	251.591	205.333	259.706	0.000	0.000
12	0.979	3.330	3.402	0.000	176342.264
13	1.268		96.849		50784018.000

1	240.000	444.131	80.097	524.229	31.000
2	223390.85	37.580	27.633	153.313	342.726
3	5.545	41.942	27.288	1236.506	4198.309
4	426.133	164.790	38.332	87719.689	17128.060
5	1.718	70.678	4.335	86338.497	17214.355
6	763.834	0.391	0.000	87258.496	17378.355
7	8502.253	0.325	0.680	87393.886	18197.708
8	27031.566	84.765	37.860	87760.886	18245.708
9	0.000	127.728	228.646	105418.274	19090.642
10	2.511	93.839	0.000	0.000	0.000
11	248.341	212.493	266.506	0.000	0.000
12	0.978	3.328	3.402	0.000	171087.594
13	1.306		103.649		53018662.000

1	250.000	443.827	80.083	523.910	31.000
2	223267.88	36.980	28.078	150.874	336.608
3	5.542	41.467	27.747	1173.686	4013.217
4	426.157	164.800	38.370	83281.739	16325.648
5	1.718	70.675	4.333	81898.520	16412.899
6	763.461	0.391	0.000	82818.520	16576.898
7	8499.644	0.325	0.680	82950.135	17389.997
8	27026.331	88.015	37.860	83317.135	17437.997
9	0.000	131.638	235.446	109858.115	19891.554
10	2.228	97.749	0.000	0.000	0.000
11	245.091	219.653	273.305	0.000	0.000
12	0.978	3.326	3.401	0.000	165836.131
13	1.346		110.449		55251929.500

TABLE AP 5-2 (Sheet 6 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	260.000	444.884	80.133	525.017	31.000
2	223517.75	37.564	28.522	148.434	330.476
3	5.552	42.175	28.206	1110.814	3828.276
4	425.734	164.816	38.416	78850.653	15522.959
5	1.717	70.671	4.331	77454.083	15611.237
6	764.681	0.391	0.000	78374.082	15775.237
7	8507.077	0.440	0.680	78501.920	16582.079
8	27047.649	92.012	37.860	78868.920	16630.079
9	0.000	135.548	242.246	114302.420	20692.672
10	1.949	101.659	0.000	0.000	0.000
11	241.093	227.561	280.105	0.000	0.000
12	0.979	3.332	3.403	0.000	160579.998
13	1.392		117.249		57485845.000

1	270.000	445.221	80.148	525.369	31.000
2	223654.81	38.655	28.967	145.956	324.376
3	5.555	43.405	28.667	1047.845	3643.121
4	425.710	164.832	38.462	74457.384	14725.817
5	1.718	70.666	4.330	73003.379	14809.283
6	765.067	0.391	0.000	73923.378	14973.283
7	8506.962	0.440	0.680	74047.433	15773.866
8	27055.231	96.412	37.860	74414.433	15821.866
9	0.000	139.458	249.046	118752.997	21494.085
10	1.676	105.569	0.000	0.000	0.000
11	236.693	235.871	286.905	0.000	0.000
12	0.980	3.334	3.403	0.000	155317.297
13	1.440		124.049		59721682.000

1	280.000	444.299	80.383	524.687	31.000
2	223683.16	38.950	28.938	143.394	318.254
3	5.527	43.862	28.648	984.882	3458.138
4	426.317	164.848	38.508	70058.843	13928.222
5	1.718	70.665	4.328	68556.161	14007.556
6	764.868	0.391	0.000	69476.160	14171.556
7	8499.978	0.325	0.380	69596.435	14965.882
8	27045.838	100.064	37.860	69963.435	15013.882
9	0.000	143.368	254.796	123200.086	22296.319
10	1.401	109.479	0.000	0.000	0.000
11	233.042	243.432	292.655	0.000	0.000
12	0.979	3.331	3.402	0.000	150058.314
13	1.491		129.799		61958055.000

1	290.000	444.187	80.348	524.535	31.000
2	223537.35	38.450	28.768	140.795	312.118
3	5.528	43.511	28.437	921.974	3273.199
4	426.163	164.864	38.554	65579.531	13131.060
5	1.718	70.664	4.326	64113.551	13206.323
6	764.385	0.391	0.000	65033.550	13370.323
7	8499.896	0.324	0.380	65150.048	14158.395
8	27047.362	103.307	37.860	65517.048	14206.395
9	0.000	147.278	258.595	127642.562	23100.006
10	1.085	113.389	0.000	0.000	0.000
11	229.798	250.585	296.454	0.000	0.000
12	0.979	3.330	3.401	0.000	144804.443
13	1.544		133.599		64194132.000

1	300.000	444.205	79.448	523.653	31.000
2	222765.13	37.950	28.607	138.119	305.987
3	5.591	43.138	28.385	859.078	3088.102
4	425.406	164.880	38.600	61084.857	12334.816
5	1.719	70.663	4.323	59671.881	12405.535
6	761.350	0.391	0.000	60591.880	12569.535
7	8491.884	0.323	1.210	60704.603	13351.357
8	27029.500	106.544	37.860	61071.603	13399.357
9	0.000	151.187	263.640	132084.098	23901.999
10	0.758	117.299	0.000	0.000	0.000
11	226.561	257.732	301.499	0.000	0.000
12	0.978	3.323	3.396	0.000	139551.959
13	1.596		138.644		66427808.500

1	301.000	444.191	79.452	523.643	31.000
2	222755.45	37.900	28.714	137.851	305.380
3	5.591	43.104	28.494	852.789	3069.613
4	425.396	164.882	38.607	60642.189	12255.295
5	1.719	70.662	4.323	59227.667	12325.499
6	761.322	0.391	0.000	60147.667	12489.499
7	8491.941	0.323	1.210	60260.011	13270.696
8	27030.144	106.867	37.860	60627.011	13318.696
9	0.000	151.578	264.850	132528.297	23981.450
10	0.729	117.690	0.000	0.000	0.000
11	226.238	258.446	302.769	0.000	0.000
12	0.978	3.323	3.396	0.000	139026.707
13	1.602		139.454		66650566.000

1	302.000	444.178	79.455	523.633	31.000
2	222745.79	37.850	28.821	137.583	304.773
3	5.590	43.071	28.603	846.500	3051.121
4	425.385	164.885	38.614	60199.534	12175.770
5	1.719	70.662	4.323	58783.466	12245.460
6	761.295	0.391	0.000	59703.466	12409.460
7	8491.998	0.323	1.210	59815.433	13190.032
8	27030.789	107.191	37.860	60182.433	13238.032
9	0.000	151.969	266.060	132972.484	24060.904
10	0.699	118.081	0.000	0.000	0.000
11	225.914	259.161	303.919	0.000	0.000
12	0.978	3.323	3.396	0.000	138501.465
13	1.608		141.064		66873314.000

1	303.000	444.165	79.459	523.623	31.000
2	222736.14	37.800	28.929	137.316	304.166
3	5.590	43.037	28.712	840.212	3032.626
4	425.375	164.887	38.621	59756.894	12096.242
5	1.719	70.662	4.323	58339.279	12165.417
6	761.267	0.391	0.000	59259.279	12329.417
7	8492.055	0.323	1.210	59370.868	13109.365
8	27031.434	107.514	37.860	59737.868	13157.365
9	0.000	152.360	267.270	133416.658	24140.361
10	0.670	118.472	0.000	0.000	0.000
11	225.591	259.875	305.129	0.000	0.000
12	0.978	3.323	3.396	0.000	137976.232
13	1.614		142.274		67096052.500

1	304.000	444.152	79.462	523.614	31.000
2	222726.52	37.750	29.036	137.048	303.559
3	5.589	43.004	28.821	833.924	3014.129
4	425.364	164.890	38.628	59314.266	12016.711
5	1.719	70.662	4.323	57895.106	12085.371
6	761.240	0.391	0.000	58815.105	12249.371
7	8492.112	0.323	1.210	58926.317	13028.694
8	27032.081	107.837	37.860	59293.317	13076.694
9	0.000	152.751	268.480	133860.818	24219.822
10	0.641	118.863	0.000	0.000	0.000
11	225.268	260.589	306.339	0.000	0.000
12	0.978	3.323	3.396	0.000	137451.012
13	1.620		143.484		67318779.000

1	305.000	444.138	79.466	523.604	31.000
2	222716.92	37.700	29.143	136.780	302.951
3	5.589	42.971	28.930	827.636	2995.629
4	425.354	164.892	38.635	58871.651	11937.176
5	1.719	70.661	4.322	57450.945	12005.322
6	761.213	0.391	0.000	58370.944	12169.322
7	8492.169	0.323	1.210	58481.779	12948.020
8	27032.728	108.160	37.860	58848.779	12996.020
9	0.000	153.142	269.690	134304.967	24299.286
10	0.611	119.254	0.000	0.000	0.000
11	224.945	261.303	307.549	0.000	0.000
12	0.978	3.323	3.396	0.000	136925.799
13	1.627		144.694		67541496.000

1	306.000	443.832	79.440	523.272	30.353
2	222598.64	37.650	29.250	136.503	302.344
3	5.587	42.938	29.040	821.349	2977.127
4	425.397	164.894	38.642	58429.175	11857.646
5	1.719	70.661	4.322	57006.874	11925.276
6	760.865	0.391	0.000	57926.874	12089.276
7	8490.142	0.323	1.210	58037.331	12867.350
8	27022.971	108.483	37.860	58404.331	12915.350
9	0.000	153.533	270.900	134749.023	24378.746
10	0.582	119.645	0.000	0.000	0.000
11	224.622	262.017	308.759	0.000	0.000
12	0.978	3.321	3.395	0.000	136400.680
13	1.632		145.904		67764174.000

1	307.000	443.919	79.453	523.372	29.378
2	222525.71	37.600	29.357	136.222	301.737
3	5.587	42.904	29.149	815.064	2958.627
4	425.368	164.897	38.649	57986.894	11778.126
5	1.719	70.661	4.322	56562.966	11845.242
6	760.947	0.391	0.000	57482.966	12009.242
7	8490.912	0.323	1.210	57593.045	12786.691
8	27027.174	108.806	37.860	57960.045	12834.691
9	0.000	153.924	272.110	135192.918	24458.195
10	0.553	120.036	0.000	0.000	0.000
11	224.299	262.731	309.969	0.000	0.000
12	0.978	3.321	3.395	0.000	135875.736
13	1.638		147.114		67986787.000

1	308.000	443.921	79.458	523.379	28.407
2	222621.64	37.550	29.464	135.940	301.129
3	5.587	42.870	29.258	808.779	2940.122
4	425.355	164.899	38.656	57544.584	11698.599
5	1.719	70.660	4.322	56119.031	11765.200
6	760.926	0.391	0.000	57039.030	11929.200
7	8491.076	0.323	1.210	57148.732	12706.025
8	27028.353	109.129	37.860	57515.732	12754.025
9	0.000	154.315	273.320	135636.840	24537.652
10	0.523	120.427	0.000	0.000	0.000
11	223.976	263.445	311.179	0.000	0.000
12	0.978	3.321	3.395	0.000	135350.756
13	1.645		148.324		68209407.000

1	309.000	443.913	79.462	523.376	27.442
2	222614.25	37.500	29.571	135.659	300.522
3	5.586	42.836	29.367	802.494	2921.615
4	425.343	164.902	38.663	57102.278	11619.068
5	1.719	70.660	4.321	55675.098	11685.154
6	760.915	0.391	0.000	56595.097	11849.154
7	8491.176	0.323	1.210	56704.422	12625.354
8	27029.213	109.452	37.860	57071.422	12673.354
9	0.000	154.706	274.530	136080.758	24617.113
10	0.494	120.818	0.000	0.000	0.000
11	223.653	264.159	312.389	0.000	0.000
12	0.978	3.321	3.395	0.000	134825.775
13	1.651		149.534		68432019.000

1	310.000	443.903	79.466	523.370	26.482
2	222605.83	37.450	29.679	135.377	299.914
3	5.586	42.803	29.476	796.209	2903.104
4	425.332	164.904	38.670	56659.979	11539.534
5	1.719	70.660	4.321	55231.173	11605.104
6	760.891	0.391	0.000	56151.173	11769.104
7	8491.256	0.323	1.210	56260.121	12544.679
8	27029.975	109.775	37.860	56627.121	12592.679
9	0.000	155.097	275.740	136524.670	24696.577
10	0.465	121.209	0.000	0.000	0.000
11	223.330	264.873	313.599	0.000	0.000
12	0.978	3.321	3.395	0.000	134300.799
13	1.658		150.744		68654624.000

1	320.000	443.569	79.525	523.095	17.098
2	222405.37	36.950	31.400	132.562	293.822
3	5.578	42.477	31.219	733.371	2717.534
4	425.287	164.928	38.740	52237.979	10744.044
5	1.719	70.657	4.319	50792.913	10804.291
6	760.524	0.391	0.000	51712.912	10968.291
7	8490.821	0.322	1.210	51818.087	11737.616
8	27031.595	113.000	37.860	52185.087	11785.616
9	0.000	159.007	287.340	140962.793	25491.541
10	0.173	125.119	0.000	0.000	0.000
11	220.105	272.008	325.699	0.000	0.000
12	0.978	3.320	3.396	0.000	129051.703
13	1.724		162.843		70880158.000

TABLE AP 5-2 (Sheet 7 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	330.000	419.345	78.988	498.332	7.912
2	212436.33	37.360	32.770	129.681	287.738
3	5.309	43.039	32.575	671.598	2532.231
4	426.295	164.952	38.810	47881.074	9954.455
5	1.706	70.656	4.317	46430.773	10004.688
6	731.658	0.391	0.000	47350.772	10168.688
7	8318.591	0.429	1.207	47452.240	10931.772
8	26827.143	116.918	37.960	47819.240	10979.772
9	0.000	162.917	299.931	145324.730	26285.293
10	-0.100	129.029	0.000	0.000	0.000
11	216.187	279.835	337.790	0.000	0.000
12	0.941	3.166	3.363	0.000	123880.012
13	1.715		174.935		73074457.000

1	340.000	385.797	77.412	463.209	-0.205
2	198446.75	38.160	33.870	126.980	281.747
3	4.984	43.922	33.671	614.696	2349.682
4	428.417	164.976	38.880	43855.875	9177.046
5	1.688	70.657	4.315	42414.709	9217.415
6	690.674	0.391	0.000	43334.709	9381.415
7	8077.815	0.426	1.200	43432.762	10138.354
8	26252.219	121.191	37.860	43799.762	10186.354
9	0.000	166.827	311.962	149340.297	27066.680
10	-0.236	132.939	0.000	0.000	0.000
11	211.913	288.019	349.821	0.000	0.000
12	0.902	2.952	3.273	0.000	119067.116
13	1.667		186.966		75125058.000

1	350.000	370.747	76.501	447.248	-5.276
2	191880.68	38.960	34.773	124.288	275.843
3	4.846	44.804	34.586	561.256	2169.765
4	429.026	165.000	38.950	40092.519	8411.779
5	1.679	70.659	4.313	38642.703	8442.374
6	671.432	0.391	0.000	39562.703	8606.374
7	7968.242	0.424	1.193	39657.550	9357.264
8	25919.990	125.440	37.860	40024.550	9405.264
9	0.000	170.737	323.924	153111.600	27835.808
10	-0.270	136.849	0.000	0.000	0.000
11	207.664	296.178	361.783	0.000	0.000
12	0.887	2.856	3.220	0.000	114510.813
13	1.676		198.928		77071867.000

1	360.000	363.478	76.007	439.485	-7.572
2	188857.98	39.083	35.591	121.649	269.988
3	4.782	45.049	35.423	509.316	1991.345
4	429.725	165.042	39.024	36392.606	7653.345
5	1.676	70.656	4.310	34974.724	7674.194
6	662.066	0.391	0.000	35894.723	7838.194
7	7912.998	0.309	1.186	35986.453	8583.089
8	25739.155	128.934	37.860	36353.453	8631.089
9	0.000	174.647	335.817	156778.787	28598.090
10	-0.288	140.759	0.000	0.000	0.000
11	204.170	303.581	373.676	0.000	0.000
12	0.880	2.810	3.192	0.000	110065.541
13	1.716		210.821		78974043.000

1	370.000	360.297	75.776	436.073	-8.580
2	187443.71	38.917	36.291	118.844	264.153
3	4.755	45.010	36.144	458.085	1813.507
4	429.845	165.084	39.098	32736.339	6898.413
5	1.674	70.654	4.308	31356.980	6909.548
6	657.941	0.391	0.000	32276.980	7073.548
7	7890.992	0.308	1.179	32365.634	7812.476
8	25656.564	132.017	37.860	32732.634	7860.476
9	0.000	178.557	347.641	160395.697	29356.880
10	-0.293	144.669	0.000	0.000	0.000
11	201.087	310.574	385.500	0.000	0.000
12	0.878	2.790	3.178	0.000	105674.109
13	1.774		222.645		80854617.000

1	380.000	358.823	75.669	434.492	-9.039
2	186790.24	38.750	36.872	115.997	258.323
3	4.742	44.989	36.747	407.158	1635.856
4	429.905	165.126	39.172	29060.807	6150.556
5	1.673	70.652	4.306	27760.911	6146.547
6	656.039	0.391	0.000	28680.911	6310.547
7	7841.007	0.306	1.172	28766.508	7043.520
8	25621.181	135.085	37.860	29133.508	7091.520
9	0.000	182.466	359.396	163990.912	30114.081
10	-0.325	148.579	0.000	0.000	0.000
11	198.019	317.552	397.255	0.000	0.000
12	0.877	2.781	3.172	0.000	101306.027
13	1.844		234.400		82725561.000

1	390.000	356.339	75.444	431.783	-10.001
2	185654.11	38.612	37.453	112.966	252.509
3	4.723	44.985	37.354	356.474	1458.354
4	429.971	165.168	39.246	25383.379	5412.552
5	1.671	70.650	4.304	24182.355	5385.024
6	652.719	0.391	0.000	25102.354	5549.024
7	7863.786	0.305	1.170	25184.910	6276.053
8	25544.714	138.138	37.860	25551.910	6324.053
9	0.000	186.376	371.098	167566.602	30869.844
10	-0.382	152.488	0.000	0.000	0.000
11	194.966	324.515	408.957	0.000	0.000
12	0.875	2.765	3.159	0.000	96956.963
13	1.915		246.103		84588605.000

1	400.000	353.241	75.217	428.458	-11.346
2	184260.35	38.487	38.035	109.774	246.731
3	4.696	44.985	37.960	306.208	1281.233
4	430.055	165.210	39.320	21778.633	4674.800
5	1.669	70.649	4.301	20633.703	4625.950
6	648.642	0.391	0.000	21553.703	4789.950
7	7842.176	0.303	1.170	21633.242	5511.055
8	25468.538	141.175	37.860	22000.242	5559.055
9	0.000	190.286	382.798	171116.359	31623.143
10	-0.403	156.398	0.000	0.000	0.000
11	191.928	331.462	420.657	0.000	0.000
12	0.873	2.746	3.146	0.000	92640.297
13	1.989		257.802		86438060.000

1	410.000	351.305	75.051	426.356	-12.149
2	183372.57	38.362	38.500	106.444	240.949
3	4.681	44.991	38.453	256.343	1104.827
4	430.093	165.295	39.435	18191.879	3931.831
5	1.668	70.640	4.298	17111.426	3868.895
6	646.026	0.391	0.000	18031.426	4032.895
7	7828.910	0.301	1.170	18107.971	4748.091
8	25426.749	144.195	37.860	18474.971	4796.091
9	0.000	194.196	394.498	174637.719	32374.407
10	-0.402	160.308	0.000	0.000	0.000
11	168.909	338.391	432.357	0.000	0.000
12	0.871	2.733	3.137	0.000	88352.062
13	2.075		269.502		88275569.000

1	420.000	350.817	74.968	425.785	-12.315
2	183119.27	38.237	38.500	102.732	234.840
3	4.680	44.987	38.483	206.632	928.478
4	430.075	165.380	39.550	14599.329	3181.133
5	1.667	70.630	4.293	13600.965	3113.085
6	645.245	0.391	0.000	14520.965	3277.085
7	7825.624	0.299	1.170	14594.526	3986.381
8	25424.594	147.192	37.860	14961.526	4034.381
9	0.000	198.106	406.198	178147.254	33124.417
10	-0.385	164.218	0.000	0.000	0.000
11	185.911	345.299	444.057	0.000	0.000
12	0.871	2.730	3.134	0.000	84076.907
13	2.178		281.202		90107482.000

1	430.000	350.772	74.886	425.658	-12.262
2	183042.87	38.165	38.500	98.603	228.015
3	4.684	45.011	38.512	156.934	752.585
4	430.023	165.510	39.750	10854.503	2429.310
5	1.667	70.613	4.286	10091.002	2357.923
6	644.952	0.391	0.000	11011.001	2521.923
7	7825.402	0.296	1.170	11081.579	3225.326
8	25443.568	150.168	37.860	11448.579	3273.326
9	0.000	202.016	417.897	181656.293	33873.772
10	-0.442	168.128	0.000	0.000	0.000
11	182.935	352.184	455.756	0.000	0.000
12	0.871	2.729	3.132	0.000	79802.905
13	2.294		292.901		91938729.000

1	440.000	347.796	74.505	422.301	-13.469
2	181583.32	38.115	38.500	93.861	220.333
3	4.668	44.976	38.537	107.412	577.511
4	429.985	165.640	40.100	7159.133	1677.182
5	1.666	70.596	4.271	6595.204	1604.979
6	640.554	0.391	0.000	7515.204	1768.978
7	7803.576	0.294	1.170	7582.810	2466.505
8	25391.998	153.122	37.860	7949.810	2514.505
9	0.000	205.926	429.597	185151.150	34620.894
10	-0.474	172.038	0.000	0.000	0.000
11	179.981	359.048	467.456	0.000	0.000
12	0.869	2.709	3.116	0.000	75545.314
13	2.404		304.601		93762729.000

1	450.000	345.427	74.152	419.579	-14.306
2	180389.98	38.065	38.500	88.037	211.277
3	4.658	44.831	38.555	58.325	402.395
4	429.931	165.940	40.500	3534.702	924.770
5	1.664	70.547	4.254	3130.022	855.995
6	636.916	0.391	0.000	4050.021	1019.995
7	7787.524	0.292	1.170	4114.682	1711.675
8	25363.084	156.054	37.860	4481.682	1759.675
9	0.000	209.836	441.297	188615.369	35364.023
10	-0.469	175.948	0.000	0.000	0.000
11	177.048	365.890	479.156	0.000	0.000
12	0.868	2.693	3.102	0.000	71322.357
13	2.529		316.301		95571675.000

1	451.000	345.307	74.143	419.450	-14.341
2	180336.74	38.060	38.500	87.400	210.284
3	4.657	44.812	38.557	53.428	384.667
4	429.936	165.970	40.500	3172.986	848.527
5	1.664	70.542	4.254	2784.557	781.261
6	636.760	0.391	0.000	3704.557	945.261
7	7786.984	0.292	1.170	3768.924	1636.358
8	25359.821	156.346	37.860	4135.924	1684.358
9	0.000	210.226	442.467	188960.736	35438.171
10	-0.465	176.339	0.000	0.000	0.000
11	176.756	366.574	480.326	0.000	0.000
12	0.868	2.692	3.101	0.000	70901.281
13	2.543		317.471		95752033.000

1	452.000	345.201	74.135	419.336	-14.371
2	180289.60	38.055	38.500	86.763	209.275
3	4.656	44.793	38.558	48.531	366.943
4	429.941	166.000	40.500	2811.916	772.274
5	1.664	70.537	4.254	2439.207	706.535
6	636.621	0.391	0.000	3359.207	870.535
7	7786.539	0.292	1.170	3423.280	1561.050
8	25356.980	156.638	37.860	3790.280	1609.050
9	0.000	210.617	443.036	189305.990	35512.310
10	-0.462	176.730	0.000	0.000	0.000
11	176.464	367.256	481.495	0.000	0.000
12	0.868	2.691	3.101	0.000	70480.329
13	2.558		318.641		95932340.000

1	453.000	345.100	74.128	419.228	-14.394
2	180245.70	38.050	38.500	85.917	208.169
3	4.655	44.752	38.559	43.636	349.224
4	429.947	166.030	40.500	2446.073	695.874
5	1.664	70.533	4.254	2093.961	631.818
6	636.492	0.391	0.000	3013.961	795.818
7	7786.164	0.292	1.170	3077.741	1485.749
8	25354.381	156.930	37.860	3444.741	1533.749
9	0.000	211.008	444.806	189651.137	35586.440
10	-0.460	177.121	0.000	0.000	0.000
11	176.173	367.939	482.665	0.000	0.000
12	0.868	2.691	3.101	0.000	70059.489
13	2.573		319.811		96112601.000

TABLE AP 5-2 (Sheet 8 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	454.000	345.015	74.122	419.136	-14.411
2	180208.39	38.045	38.500	85.043	207.064
3	4.655	44.708	38.560	38.741	331.507
4	429.952	166.060	40.500	2079.363	619.481
5	1.664	70.528	4.255	1748.809	557.107
6	636.382	0.391	0.000	2668.809	721.107
7	7785.895	0.291	1.170	2732.296	1410.455
8	25352.247	157.221	37.860	3099.296	1458.455
9	0.000	211.399	445.976	189996.191	35660.564
10	-0.459	177.512	0.000	0.000	0.000
11	175.861	368.621	483.835	0.000	0.000
12	0.868	2.690	3.100	0.000	69638.750
13	2.588		320.981		96292821.000

1	455.000	344.944	74.117	419.061	-14.421
2	180178.20	38.040	38.500	84.169	205.958
3	4.654	44.663	38.561	33.846	313.795
4	429.957	166.090	40.500	1712.733	543.094
5	1.664	70.523	4.255	1403.737	482.401
6	636.293	0.391	0.000	2323.737	646.401
7	7785.745	0.291	1.170	2386.930	1335.166
8	25350.585	157.512	37.860	2755.930	1383.166
9	0.000	211.790	447.146	190341.166	35734.683
10	-0.458	177.903	0.000	0.000	0.000
11	175.590	369.304	485.005	0.000	0.000
12	0.868	2.690	3.100	0.000	69218.096
13	2.603		322.151		96473007.000

1	456.000	344.888	74.113	419.002	-14.425
2	180154.67	38.035	38.500	83.296	204.853
3	4.654	44.619	38.562	28.952	296.085
4	429.962	166.120	40.500	1346.169	466.711
5	1.664	70.518	4.255	1058.727	407.700
6	636.224	0.391	0.000	1978.727	571.700
7	7785.680	0.291	1.170	2041.627	1259.882
8	25349.365	157.803	37.860	2408.627	1307.882
9	0.000	212.181	448.316	190686.078	35808.797
10	-0.457	178.294	0.000	0.000	0.000
11	175.299	369.985	486.175	0.000	0.000
12	0.868	2.689	3.100	0.000	68797.509
13	2.619		323.321		96653165.000

1	457.000	344.845	74.111	418.956	-14.422
2	180137.06	38.030	38.500	82.422	203.664
3	4.653	44.574	38.562	24.058	278.377
4	429.966	166.150	40.500	979.655	390.215
5	1.664	70.513	4.255	713.768	333.002
6	636.172	0.391	0.000	1633.768	497.002
7	7785.716	0.291	1.170	1696.375	1184.601
8	25348.537	158.094	37.860	2063.375	1232.601
9	0.000	212.572	449.486	191030.939	35882.908
10	-0.455	178.685	0.000	0.000	0.000
11	175.008	370.667	487.345	0.000	0.000
12	0.867	2.689	3.100	0.000	68376.976
13	2.634		324.491		96833303.000

1	458.000	344.812	74.109	418.921	-14.415
2	180123.94	38.025	38.500	81.506	202.425
3	4.653	44.523	38.562	19.163	260.673
4	429.971	166.180	40.500	612.456	313.634
5	1.664	70.508	4.256	368.848	258.306
6	636.133	0.391	0.000	1288.848	422.306
7	7785.826	0.290	1.170	1351.161	1109.322
8	25348.073	158.384	37.860	1718.161	1157.322
9	0.000	212.963	450.656	191375.762	35957.017
10	-0.454	179.076	0.000	0.000	0.000
11	174.718	371.349	488.515	0.000	0.000
12	0.867	2.689	3.100	0.000	67956.483
13	2.651		325.661		97013426.000

1	459.000	344.778	74.108	418.886	-14.404
2	180110.83	38.020	38.500	80.335	201.187
3	4.652	44.445	38.563	14.269	242.970
4	429.976	166.210	40.500	238.832	237.055
5	1.664	70.503	4.256	23.963	183.612
6	636.095	0.391	0.000	943.963	347.612
7	7785.964	0.290	1.170	1005.983	1034.045
8	25347.661	158.675	37.860	1372.983	1082.045
9	0.000	213.354	451.826	191720.549	36031.124
10	-0.456	179.467	0.000	0.000	0.000
11	174.427	372.030	489.685	0.000	0.000
12	0.867	2.688	3.100	0.000	67536.027
13	2.667		326.831		97193534.000

1	460.000	344.742	74.107	418.849	-14.390
2	180097.57	38.015	38.500	78.992	199.949
3	4.652	44.347	38.563	9.374	225.270
4	429.982	166.240	40.500	-138.955	160.478
5	1.664	70.499	4.256	-320.887	108.919
6	636.055	0.391	0.000	599.113	272.919
7	7786.115	0.290	1.170	660.841	958.769
8	25347.223	158.965	37.860	1027.841	1006.769
9	0.000	213.745	452.996	192065.301	36105.230
10	-0.460	179.858	0.000	0.000	0.000
11	174.187	372.711	490.855	0.000	0.000
12	0.867	2.688	3.100	0.000	67115.609
13	2.683		328.001		97373629.000

1	461.000	344.725	74.107	418.832	-14.376
2	180092.05	38.010	38.500	77.345	198.616
3	4.652	44.215	38.562	4.478	207.572
4	429.987	166.240	40.500	-523.782	83.771
5	1.664	70.499	4.256	-665.708	34.227
6	636.039	0.391	0.000	254.292	198.227
7	7786.151	0.290	1.170	315.726	883.494
8	25347.268	159.255	37.860	682.726	931.494
9	0.000	214.136	454.166	192410.025	36179.335
10	-0.467	180.249	0.000	0.000	0.000
11	173.848	373.392	492.025	0.000	0.000
12	0.867	2.688	3.100	0.000	66695.220
13	2.700		329.170		97553714.000

1	461.369	344.713	74.106	418.819	-14.371
2	180087.70	38.008	38.500	76.574	198.072
3	4.652	44.154	38.563	2.575	200.692
4	429.989	166.240	40.500	-679.239	53.798
5	1.664	70.499	4.256	-799.767	5.187
6	636.026	0.391	0.000	120.233	169.187
7	7786.140	0.290	1.170	181.553	854.227
8	25347.170	159.367	37.860	548.553	902.227
9	0.000	214.288	454.621	192544.045	36208.147
10	-0.472	180.401	0.000	0.000	0.000
11	173.725	373.657	492.460	0.000	0.000
12	0.867	2.688	3.100	0.000	66531.779
13	2.707		329.625		97623726.000

1	461.400	344.657	74.101	418.758	-14.371
2	180062.62	38.008	38.500	76.548	198.057
3	4.651	44.152	38.563	2.520	200.494
4	429.992	166.240	40.500	-683.446	52.948
5	1.664	70.499	4.256	-803.629	4.350
6	616.597	0.391	0.000	116.371	168.350
7	6623.076	0.290	1.170	177.688	853.384
8	24703.262	159.371	37.860	544.688	901.384
9	0.000	214.293	454.634	192547.906	36208.977
10	-0.472	180.405	0.000	0.000	0.000
11	173.732	373.664	492.493	0.000	0.000
12	0.825	2.588	3.135	0.000	66527.072
13	2.707		329.638		97625742.000

1	461.489	344.657	74.101	418.758	-14.370
2	180058.79	38.008	38.500	76.338	197.932
3	4.651	44.128	38.562	2.086	198.923
4	432.132	166.240	40.500	-716.967	46.210
5	1.664	70.500	4.256	-834.243	-2.282
6	619.606	0.391	0.000	85.757	161.718
7	6623.079	0.290	1.170	147.048	846.700
8	24703.263	159.396	37.860	514.048	894.700
9	0.000	214.327	454.738	192578.512	36215.557
10	-0.473	180.440	0.000	0.000	0.000
11	173.706	373.725	492.597	0.000	0.000
12	0.825	2.588	3.135	0.000	66489.748
13	2.722		329.742		97641731.000

1	461.569	297.013	63.852	360.865	-14.369
2	156029.22	38.007	38.500	76.110	197.797
3	4.652	44.740	38.889	1.618	197.228
4	432.375	166.240	40.500	-755.292	38.874
5	1.664	70.500	4.257	-867.175	-9.421
6	534.246	0.391	0.000	52.825	154.579
7	5707.522	0.290	1.170	114.088	839.506
8	21266.762	159.425	37.860	481.088	887.506
9	0.000	214.367	454.855	192611.432	36222.635
10	-0.474	180.479	0.000	0.000	0.000
11	173.677	373.793	492.714	0.000	0.000
12	0.825	2.230	2.702	0.000	66449.593
13	2.348		329.859		97659016.000

1	461.689	182.085	39.165	221.250	-14.368
2	95448.17	38.007	38.500	75.948	197.699
3	4.649	44.633	39.287	1.276	195.972
4	431.423	166.240	40.500	-784.144	33.449
5	1.664	70.500	4.257	-891.252	-14.669
6	326.816	0.391	0.000	28.748	149.331
7	3499.023	0.289	1.170	89.990	834.216
8	13056.723	159.454	37.860	456.990	882.216
9	0.000	214.406	454.972	192635.490	36227.807
10	-0.476	180.518	0.000	0.000	0.000
11	173.648	373.861	492.831	0.000	0.000
12	0.825	1.367	1.657	0.000	66420.206
13	1.437		329.976		97671660.000

1	461.789	69.268	14.968	84.237	-14.367
2	36338.63	38.006	38.500	75.867	197.650
3	4.628	42.356	39.145	1.103	195.325
4	431.388	166.240	40.500	-799.415	30.608
5	1.664	70.500	4.257	-903.485	-17.398
6	124.424	0.391	0.000	16.515	146.602
7	1331.050	0.289	1.170	77.747	831.466
8	4990.017	159.483	37.860	444.747	879.466
9	0.000	214.445	455.089	192647.695	36230.441
10	-0.476	180.557	0.000	0.000	0.000
11	173.619	373.929	492.948	0.000	0.000
12	0.821	0.520	0.633	0.000	66405.212
13	0.547		330.093		97678039.000

1	461.889	29.746	8.099	35.846	-14.366
2	14905.21	38.006	38.500	75.839	197.635
3	4.877	39.679	38.756	1.042	195.095
4	415.817	166.240	40.500	-805.045	29.545
5	1.664	70.500	4.257	-907.745	-18.412
6	51.026	0.391	0.000	12.255	145.588
7	571.614	0.289	1.170	73.484	830.444
8	2033.408	159.512	37.860	440.484	878.444
9	0.000	214.484	455.206	192651.920	36231.345
10	-0.477	180.596	0.000	0.000	0.000
11	173.590	373.997	493.065	0.000	0.000
12	0.865	0.223	0.258	0.000	66399.928
13	0.224		330.210		97680262.000

1	461.989	21.955	4.613	26.568	-14.364
2	10833.60	38.005	38.500	75.819	197.624
3	4.759	38.688	38.603	1.006	194.948
4	407.761	166.240	40.500	-808.209	28.882
5	1.664	70.500	4.257	-910.311	-19.054
6	37.094	0.391	0.000	9.689	144.946
7	421.899	0.289	1.170	70.915	829.797
8	1537.967	159.541	37.860	437.915	877.797
9	0.000	214.523	455.323	192654.449	36231.875
10	-0.477	180.635	0.000	0.000	0.000
11	173.561	374.065	493.182	0.000	0.000
12	0.844	0.165	0.195	0.000	66396.712
13	0.163		330.327		97681519.000

TABLE AP 5-2 (Sheet 9 of 9)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	462.089	18.897	3.956	22.853	-14.363	1	462.489	8.486	1.718	10.203	-14.358
2	9236.92	38.005	38.500	75.805	197.616	2	3796.81	38.003	38.500	75.766	197.594
3	4.777	38.501	38.575	0.977	194.821	3	4.941	38.263	38.540	0.892	194.428
4	404.193	166.240	40.500	-810.650	28.332	4	372.115	166.240	40.500	-817.700	26.629
5	1.664	70.500	4.256	-912.367	-19.590	5	1.664	70.500	4.256	-918.349	-21.256
6	31.627	0.391	0.000	7.633	144.410	6	13.000	0.391	0.000	1.651	142.744
7	363.130	0.289	1.170	68.858	829.257	7	163.067	0.289	1.170	62.871	827.578
8	1318.793	159.570	37.860	435.858	877.257	8	572.577	159.686	37.860	429.871	875.578
9	0.000	214.562	455.446	192656.467	36232.299	9	0.000	214.718	455.908	192662.297	36233.509
10	-0.477	180.674	0.000	0.000	0.000	10	-0.476	180.831	0.000	0.000	0.000
11	173.532	374.133	493.299	0.000	0.000	11	173.417	374.405	493.767	0.000	0.000
12	0.848	0.142	0.167	0.000	66394.114	12	0.877	0.064	0.073	0.000	66386.448
13	0.139		330.444		97682509.000	13	0.057		330.912		97685300.000

1	462.189	17.294	3.611	20.905	-14.362	1	462.589	5.709	1.121	6.830	-14.356
2	8400.44	38.004	38.500	75.793	197.609	2	2346.72	38.002	38.500	75.761	197.591
3	4.789	38.427	38.564	0.951	194.705	3	5.095	38.178	38.527	0.881	194.368
4	401.840	166.240	40.500	-812.819	27.830	4	343.599	166.240	40.500	-818.583	26.369
5	1.664	70.500	4.256	-914.212	-20.081	5	1.664	70.500	4.256	-919.087	-21.511
6	28.763	0.391	0.000	5.788	143.919	6	8.035	0.391	0.000	0.913	142.489
7	332.325	0.289	1.170	67.011	828.762	7	109.711	0.289	1.170	62.132	827.321
8	1203.860	159.599	37.860	434.011	876.762	8	373.578	159.715	37.860	429.132	875.321
9	0.000	214.601	455.557	192658.275	36232.677	9	0.000	214.758	456.025	192662.998	36233.649
10	-0.476	180.713	0.000	0.000	0.000	10	-0.476	180.870	0.000	0.000	0.000
11	173.503	374.201	493.416	0.000	0.000	11	173.388	374.473	493.884	0.000	0.000
12	0.850	0.130	0.153	0.000	66391.772	12	0.904	0.043	0.047	0.000	66385.453
13	0.127		330.561		97683390.000	13	0.035		331.029		97685601.000

1	462.289	15.176	3.156	18.332	-14.361	1	462.689	3.944	0.741	4.684	-14.355
2	7293.89	38.004	38.500	75.782	197.603	2	1425.76	38.002	38.500	75.758	197.589
3	4.809	38.389	38.558	0.927	194.598	3	5.324	38.110	38.517	0.874	194.319
4	397.884	166.240	40.500	-814.779	27.366	4	304.361	166.240	40.500	-819.200	26.158
5	1.664	70.500	4.256	-915.882	-20.535	5	1.664	70.500	4.256	-919.604	-21.718
6	24.974	0.391	0.000	4.118	143.465	6	4.882	0.391	0.000	0.396	142.282
7	291.628	0.289	1.170	65.339	828.305	7	75.783	0.289	1.170	61.614	827.112
8	1052.029	159.628	37.860	432.339	876.305	8	246.953	159.744	37.860	428.614	875.112
9	0.000	214.640	455.674	192659.906	36233.017	9	0.000	214.797	456.142	192663.477	36233.741
10	-0.476	180.752	0.000	0.000	0.000	10	-0.476	180.909	0.000	0.000	0.000
11	173.474	374.269	493.533	0.000	0.000	11	173.359	374.541	494.001	0.000	0.000
12	0.853	0.114	0.134	0.000	66389.644	12	0.945	0.030	0.031	0.000	66384.726
13	0.110		330.678		97684179.000	13	0.021		331.146		97685787.000

1	462.389	12.017	2.477	14.494	-14.359	1	462.789	0.000	0.000	0.000	-14.353
2	5642.51	38.003	38.500	75.773	197.598	2	0.00	38.001	38.500	75.756	197.588
3	4.852	38.339	38.551	0.907	194.504	3	0.000	38.067	38.510	0.870	194.281
4	389.309	166.240	40.500	-816.437	26.960	4	0.000	166.240	40.500	-819.565	25.995
5	1.664	70.500	4.256	-917.287	-20.932	5	1.664	70.500	4.256	-919.905	-21.880
6	19.320	0.391	0.000	2.713	143.068	6	0.000	0.391	0.000	0.095	142.120
7	230.925	0.289	1.170	63.933	827.904	7	0.000	0.289	1.170	61.314	826.950
8	825.629	159.657	37.860	430.933	875.904	8	0.000	159.772	37.860	428.314	874.950
9	0.000	214.679	455.791	192661.273	36233.300	9	0.000	214.836	456.259	192663.738	36233.787
10	-0.476	180.792	0.000	0.000	0.000	10	-0.475	180.948	0.000	0.000	0.000
11	173.445	374.337	493.650	0.000	0.000	11	173.330	374.609	494.118	0.000	0.000
12	0.861	0.090	0.105	0.000	66387.837	12	0.000	0.000	0.000	0.000	66384.263
13	0.085		330.795		97684829.000	13	0.000		331.263		97685865.000

TABLE AP 5-3 (Sheet 1 of 3)
DEFINITION OF SYMBOLS USED WITH COMPUTER PROGRAM AA89

PRINTOUT SYMBOL	DEFINITION
ASUMB	Stage axial acceleration, (g's)
CSUBFEV	Vacuum thrust coefficient
DEL	PU valve position (deg)
DRAG	Atmospheric resistance to the motion of the vehicle
EMR	Total engine propellant mixture ratio. The ratio of the total engine LOX mass flowrate to the total engine LH2 mass flowrate
ENGINE ISP	Engine specific impulse (sec) engine thrust divided by engine mass flowrate
FPS	LH2 pump speed (RPM)
FSUBAUX	Auxiliary thrust (lbf)
FSUBE	Stage thrust (lbf)
FUEL OVB	LH2 overboard (lbm) thru engine and vented
GGMR	Gas generator mixture ratio
HSUBF	Height of LH2 above pump inlet (in); computed from height versus volume polynominal
HSUBO	Height of LOX above pump inlet (in); computed from height versus volume polynominal
IMPSUBT	Stage total impulse (lbf/sec)
LPS	LOX pump speed (RPM)
OXID OVB	LOX overboard (lbm) thru engine and vented
PCC	Thrust chamber pressure (psia) (Injector static pressure)
PFPI	LH2 pump inlet pressure, total (psia)
POPI	LOX pump inlet pressure, total (psia)
RHOSUBF	LH2 bulk density (lbm/ft^3); calculated from pump inlet temperature plus a bias

TABLE AP 5-3 (Sheet 2 of 3)
DEFINITION OF SYMBOLS USED WITH COMPUTER PROGRAM AA89

PRINTOUT SYMBOL	DEFINITION
RHOSUBO	LOX bulk density (lbm/ft^3); calculated from pump inlet temperature plus a bias
TFPI	LH2 pump inlet temperature (deg R)
TIME	Time from S-IVB stage engine start (sec)
TOPI	LOX pump inlet temperature (deg R)
TTFHE	GHE in LH2 tank ullage (lbm)
TTFLH2	GH2 in LH2 tank ullage (lbm)
TTMF	Total mass in LH2 tank ullage (lbm)
TTMO	Total mass in LOX tank ullage (lbm)
TTOHE	GHE in LOX tank ullage (lbm)
TTOLOX	GOX in LOX tank ullage (lbm)
TTPSUBF	LH2 tank top pressure (psia)
TTPSUBO	Oxidizer tank top pressure (psia)
VSUBF	LH2 volume in tank (ft^3)
VSUBO	Oxidizer volume in tank (ft^3)
WDOTFBO	Rate of LH2 boiloff (lbm/sec)
WDOTFGG	Gas generator fuel flowrate (lbm/sec)
WDOTFPR	LH2 tank pressurant flowrate (lbm/sec)
WDOTFVO	Rate of GH2 vented overboard (lbm/sec)
WDOTHE	LOX tank pressurant (GHe) flowrate (lbm/sec)
WDOTOBO	Rate of LOX boiloff (lbm/sec)
WDOTOGG	Gas generator LOX flowrate (lbm/sec)
WDOTOVO	Rate of GOX vented overboard (lbm/sec)
WDOTSUBF	Engine fuel flowrate (lbm/sec)

TABLE AP 5-3 (Sheet 3 of 3)
DEFINITION OF SYMBOLS USED WITH COMPUTER PROGRAM AA89

PRINTOUT SYMBOL	DEFINITION
WDOTSUBO	Engine oxidizer flowrate (lbm/sec)
WDOTSUBT	Total propellant consumption, includes auxiliary flows (lbm/sec)
WFBOT	Accumulated LH2 boiloff (lbm)
WF IN TANK	Weight of LH2 in tank (lbm)
WFPRT	Accumulated LH2 tank pressurant (lbm)
WF PU	PU indicated LH2 weight (lbm)
WFPU USABLE	PU indicated usable LH2 weight (lbm)
WF USABLE	Usable LH2 in tank (lbm)
WFVOT	Total GH2 vented overboard (lbm)
WOBOT	Accumulated LOX boiloff (lbm)
WO IN TANK	Weight of LOX in tank (lbm)
WO PU	PU indicated LOX weight (lbm)
WOPU USABLE	PU indicated usable LOX weight (lbm)
WO USABLE	Usable LOX in tank (lbm)
WOVOT	Total GOX vented overboard (lbm)
WSUBFT	Total LH2 onboard (lbm)
WSUBHE	Weight of helium in cold helium spheres (lbm)
WSUBO ERROR	Equivalent LOX weight error, defined as LH2 weight (PU indicated) times reference mixture ratio of PU system, subtracted from oxidizer weight (PU indicated) (lbm)
WSUBOT	Total LOX onboard (lbm)
WSUBV	Total weight of S-IVB plus payload (lbm)

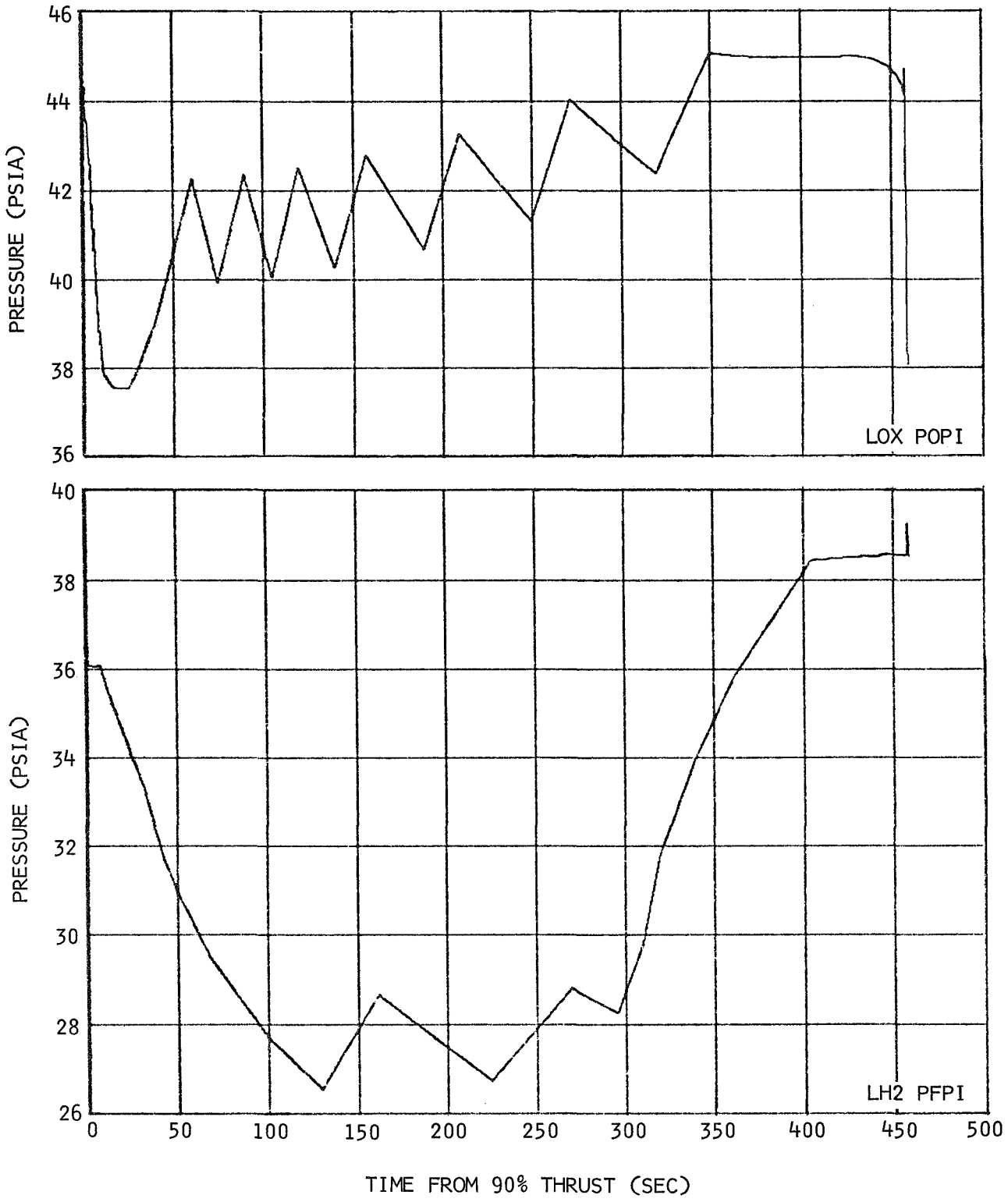


Figure AP 5-1. LOX and LH2 Pump Inlet Pressures

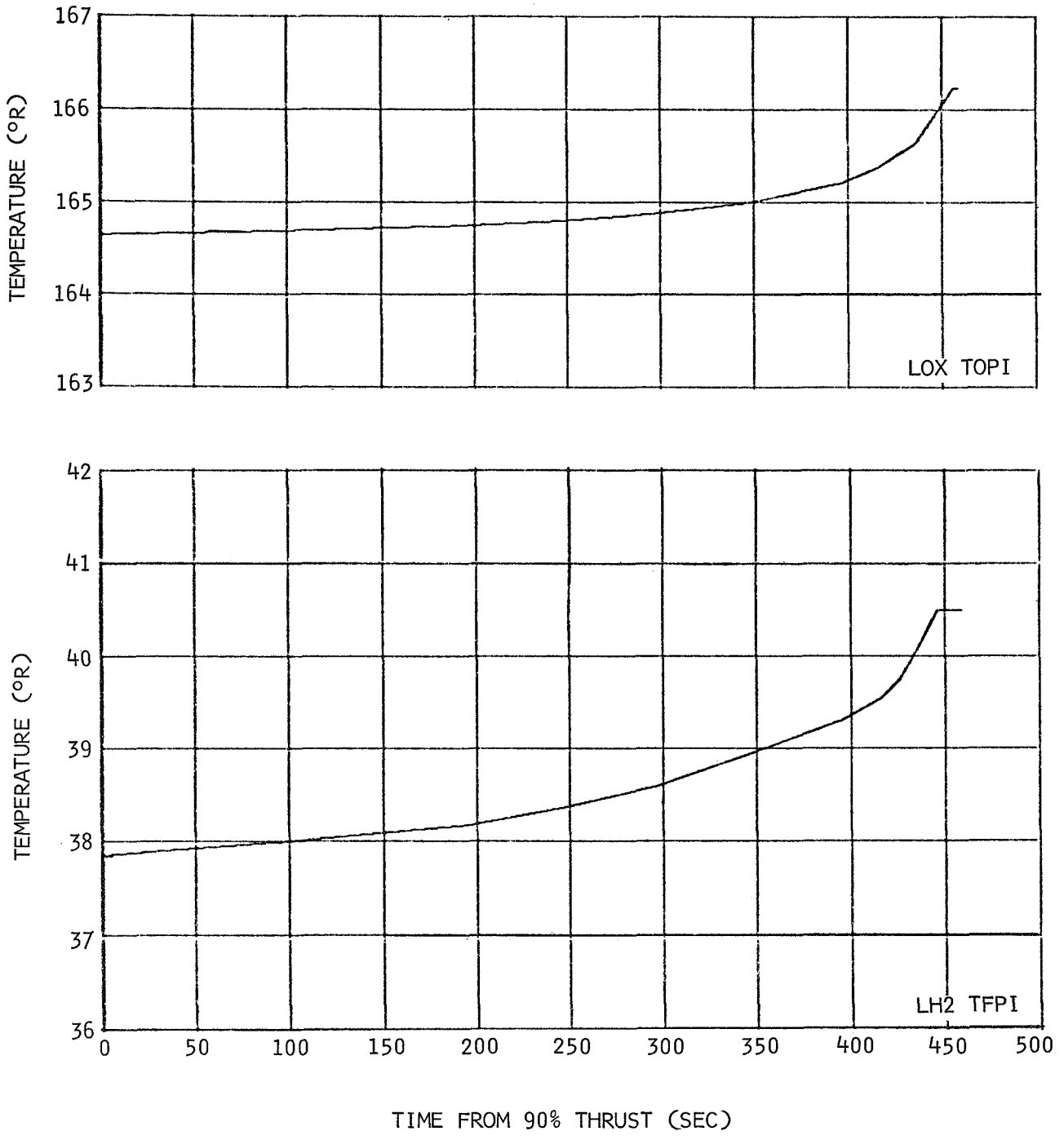


Figure AP 5-2. LOX and LH2 Pump Inlet Temperatures

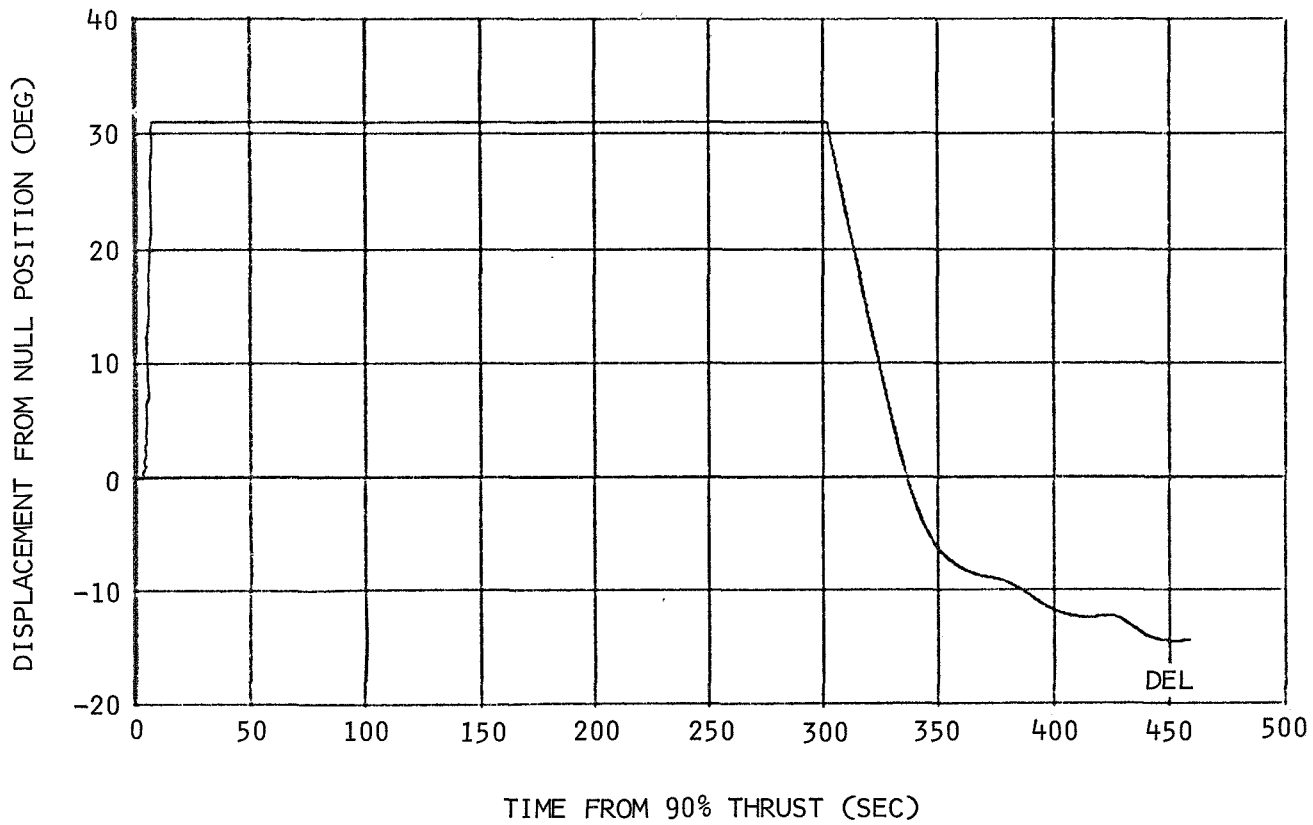


Figure AP 5-3. PU Valve Position

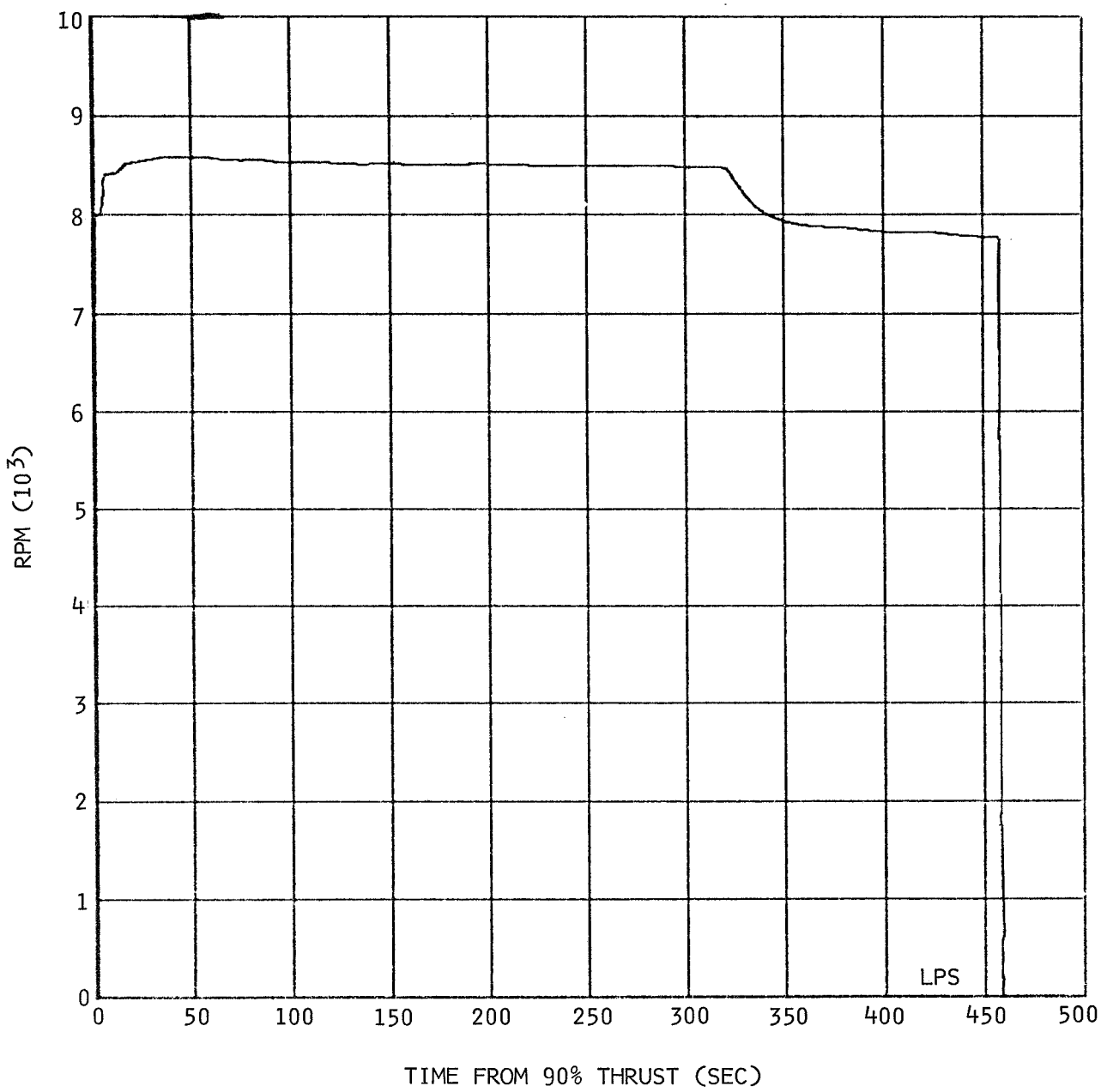


Figure AP 5-4. LOX Pump Speed

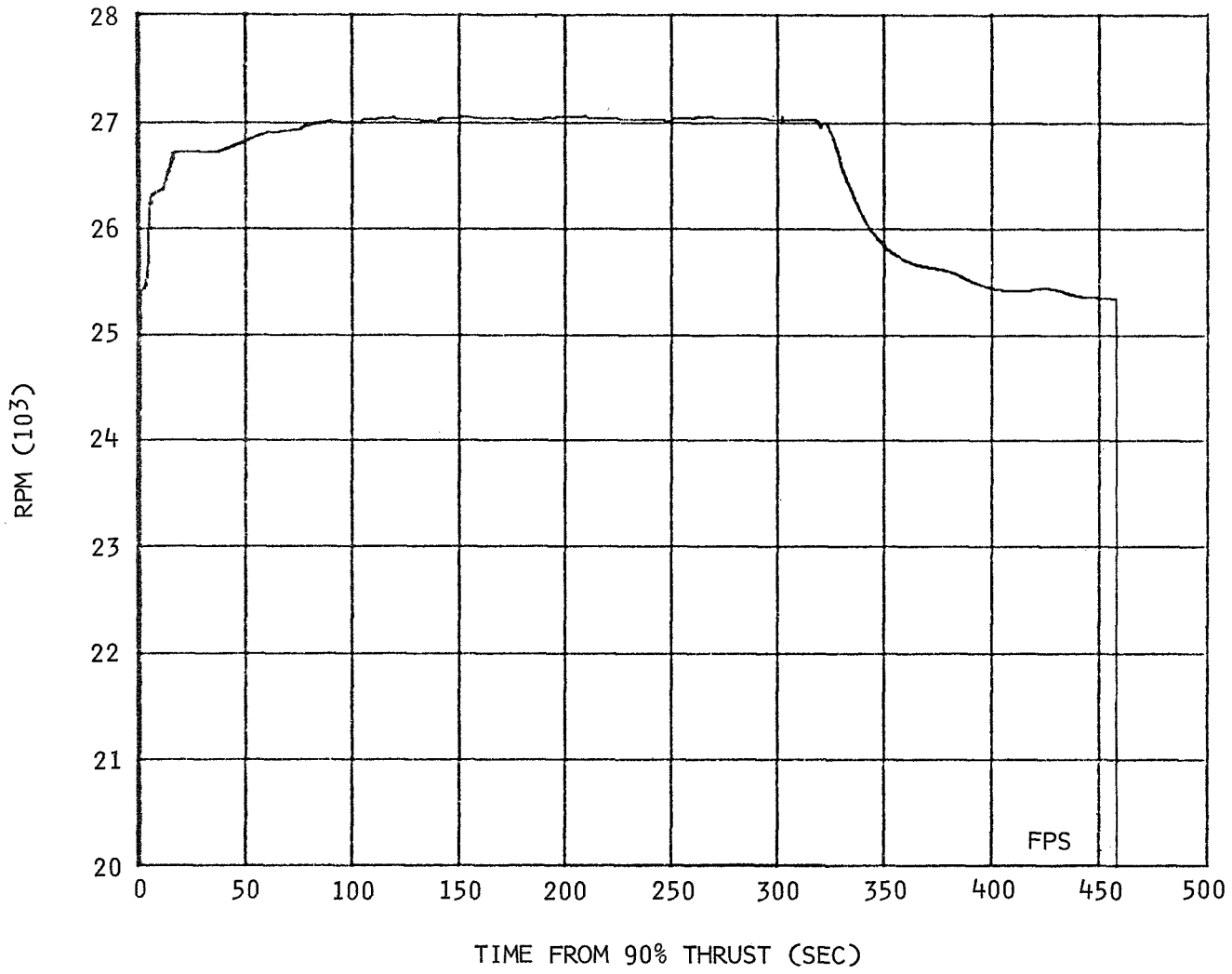


Figure AP 5-5. LH2 Pump Speed

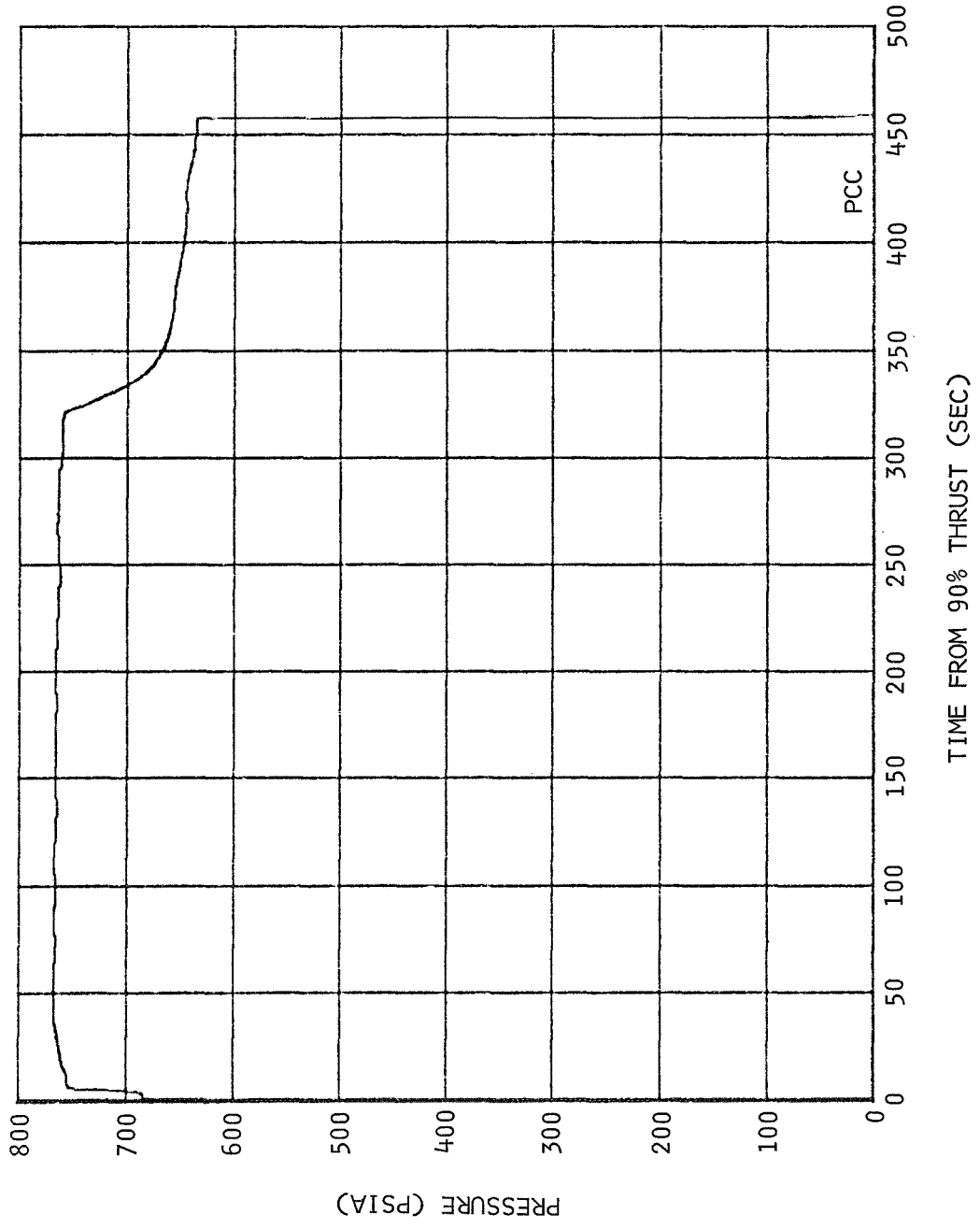


Figure AP 5-6. Thrust Chamber Pressure (Injector)

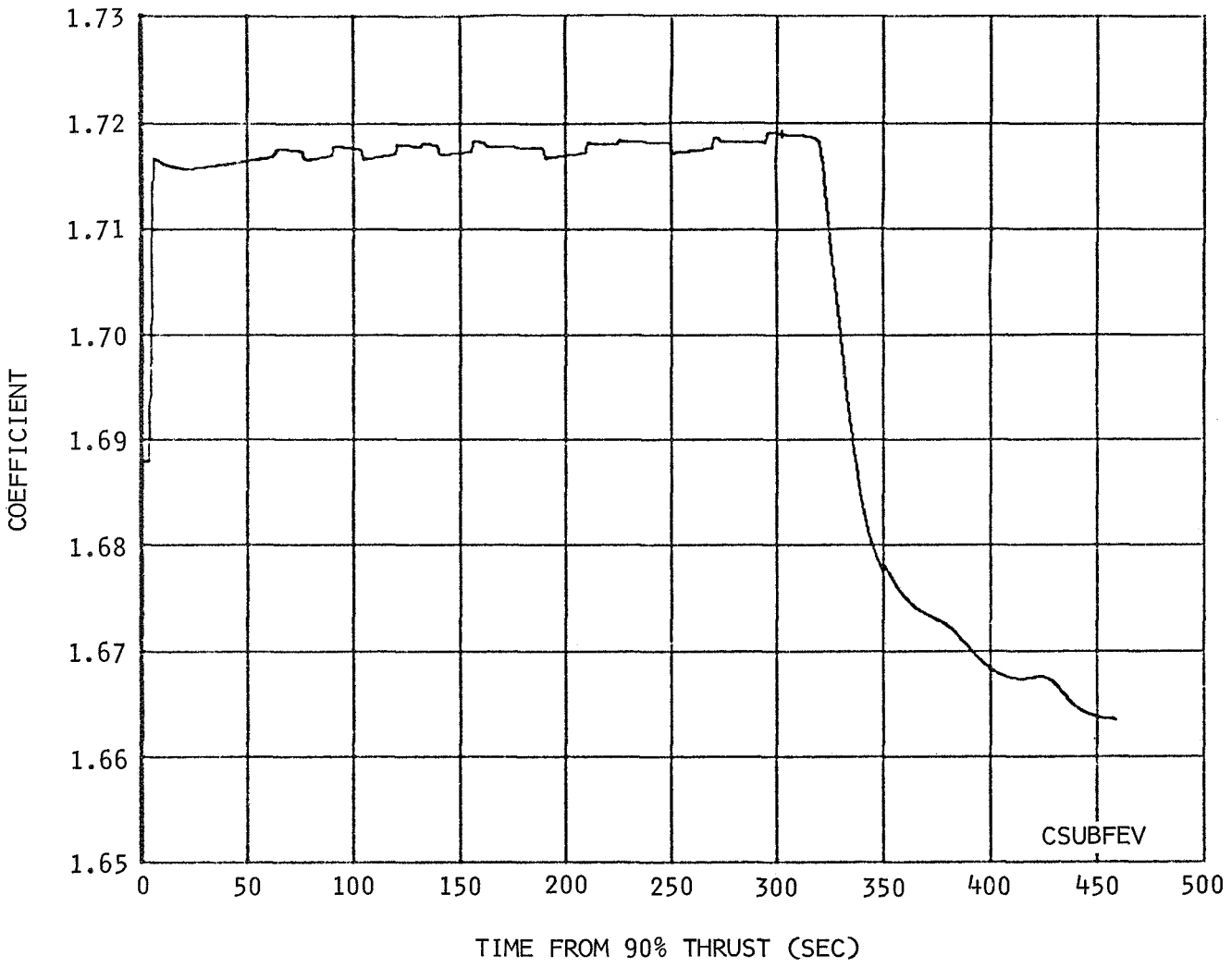


Figure AP 5-7. Vacuum Thrust Coefficient (Injector)

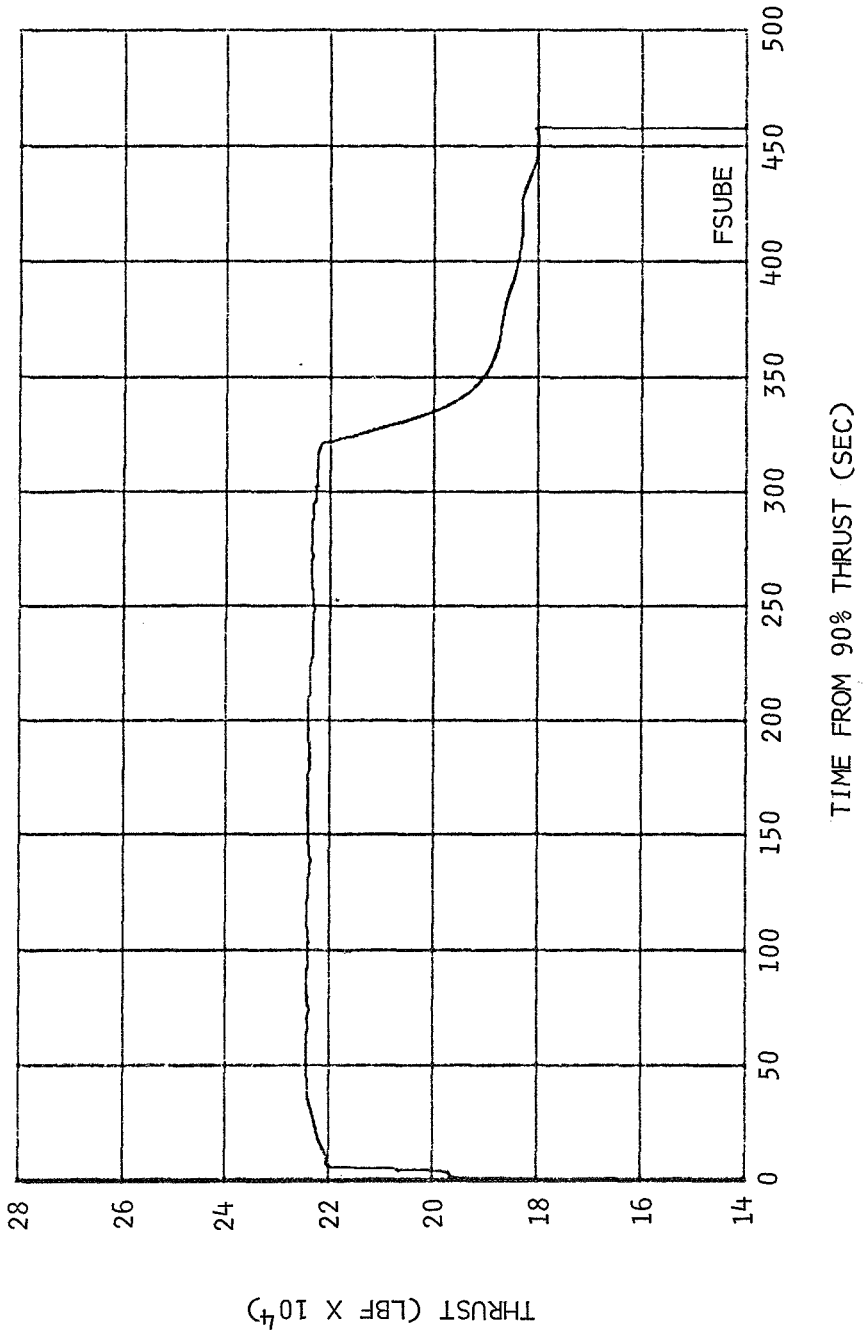


Figure AP 5-8. Engine Thrust

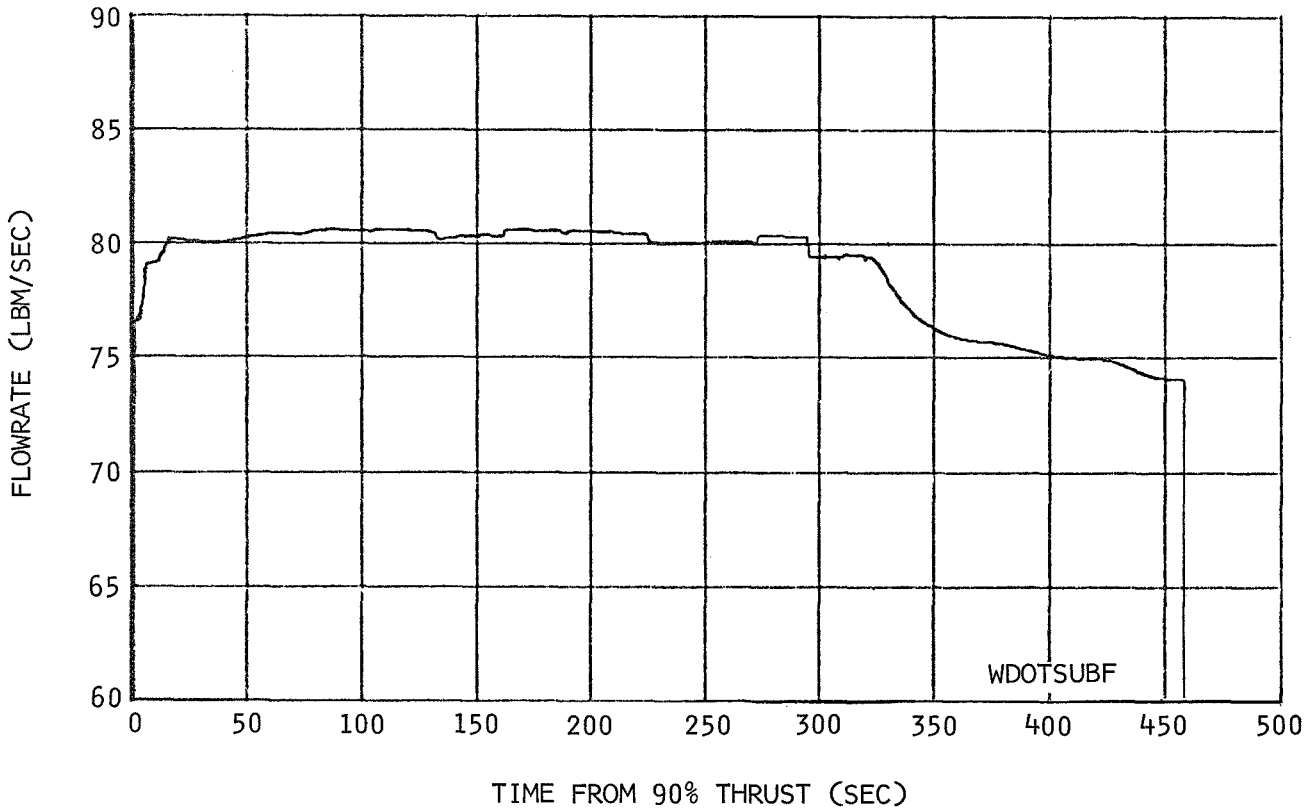


Figure AP 5-9. LH2 Flowrate, Pump Inlet

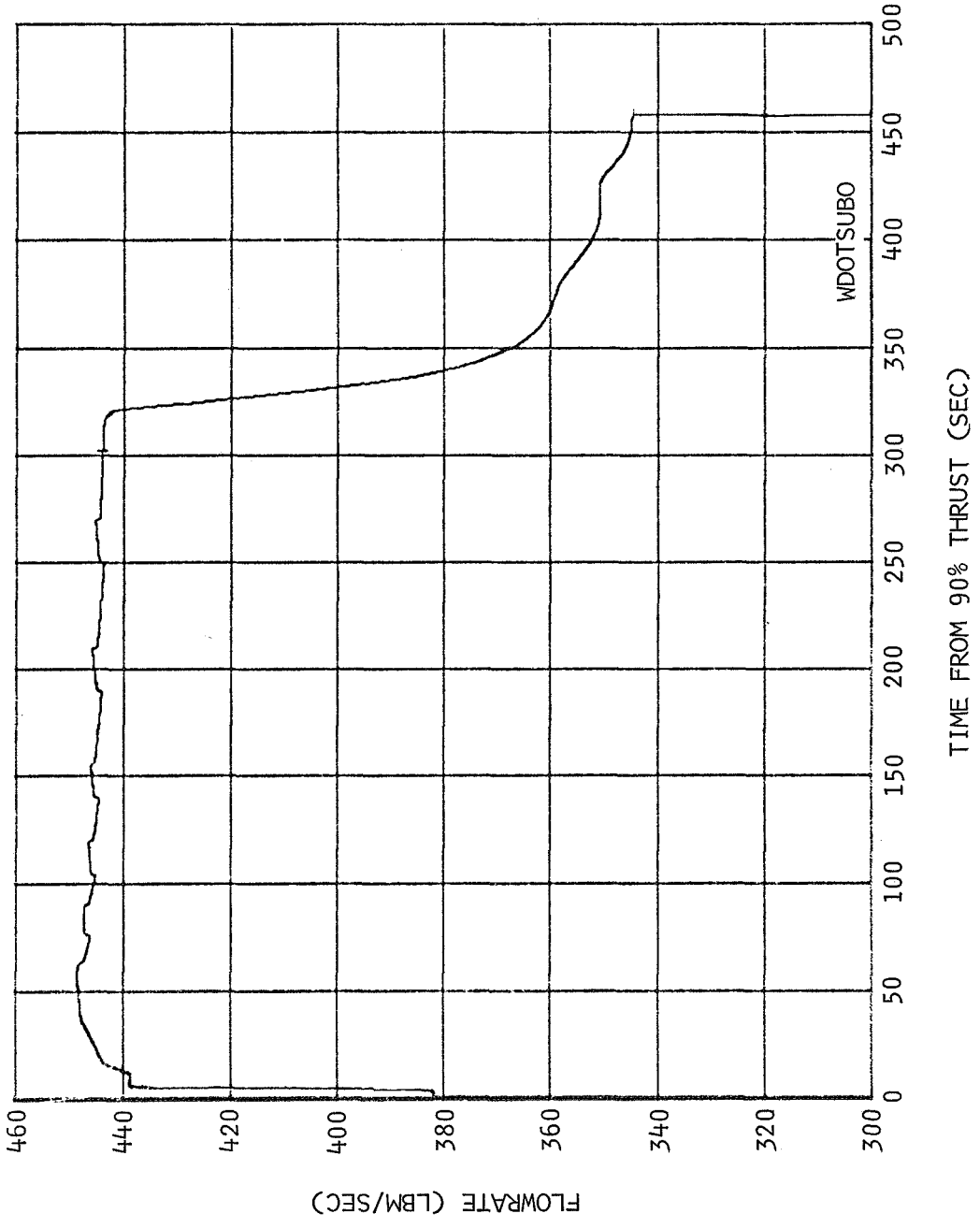


Figure AP 5-10. LOX Flowrate, Pump Inlet

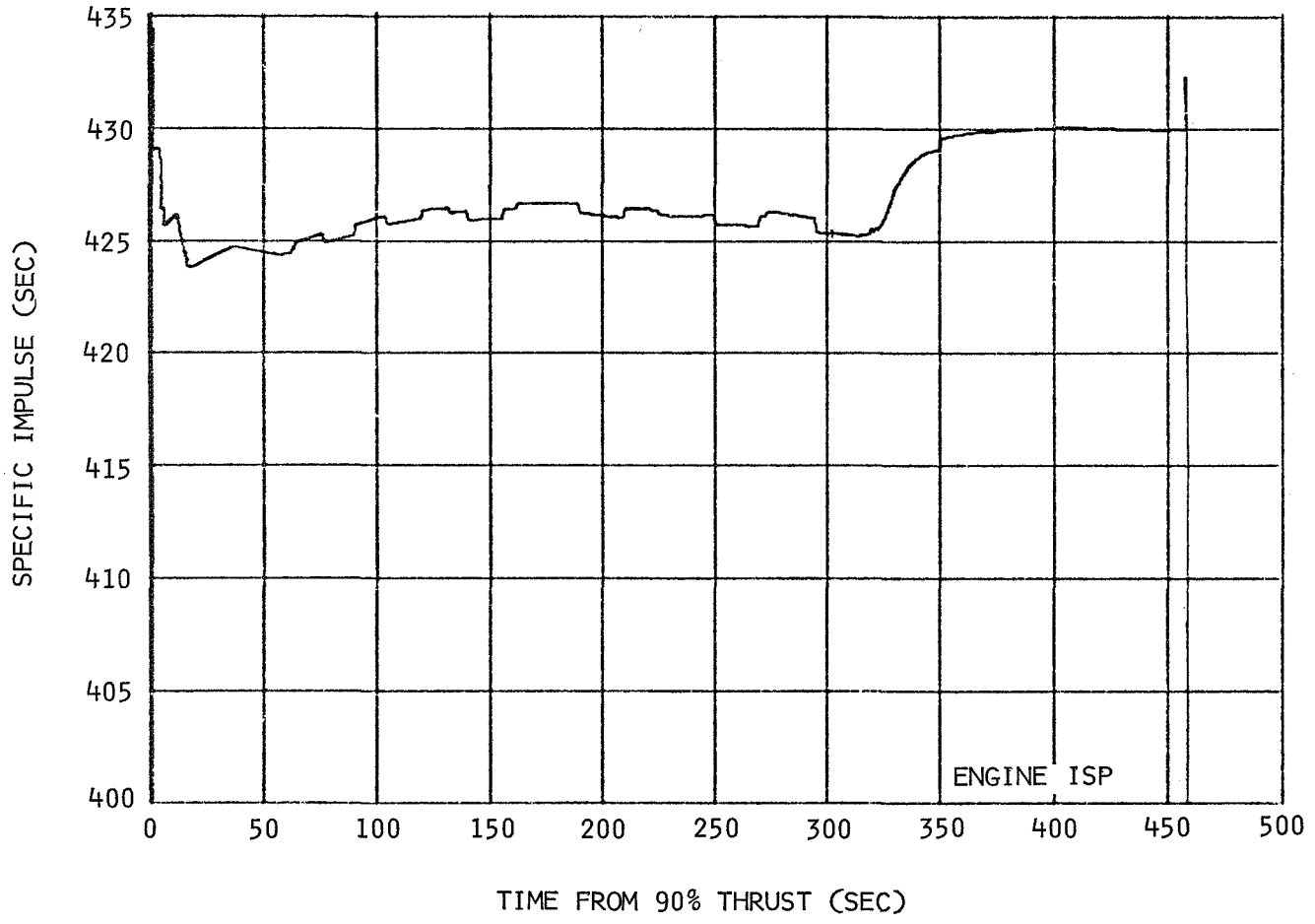


Figure AP 5-11. Engine Specific Impulse

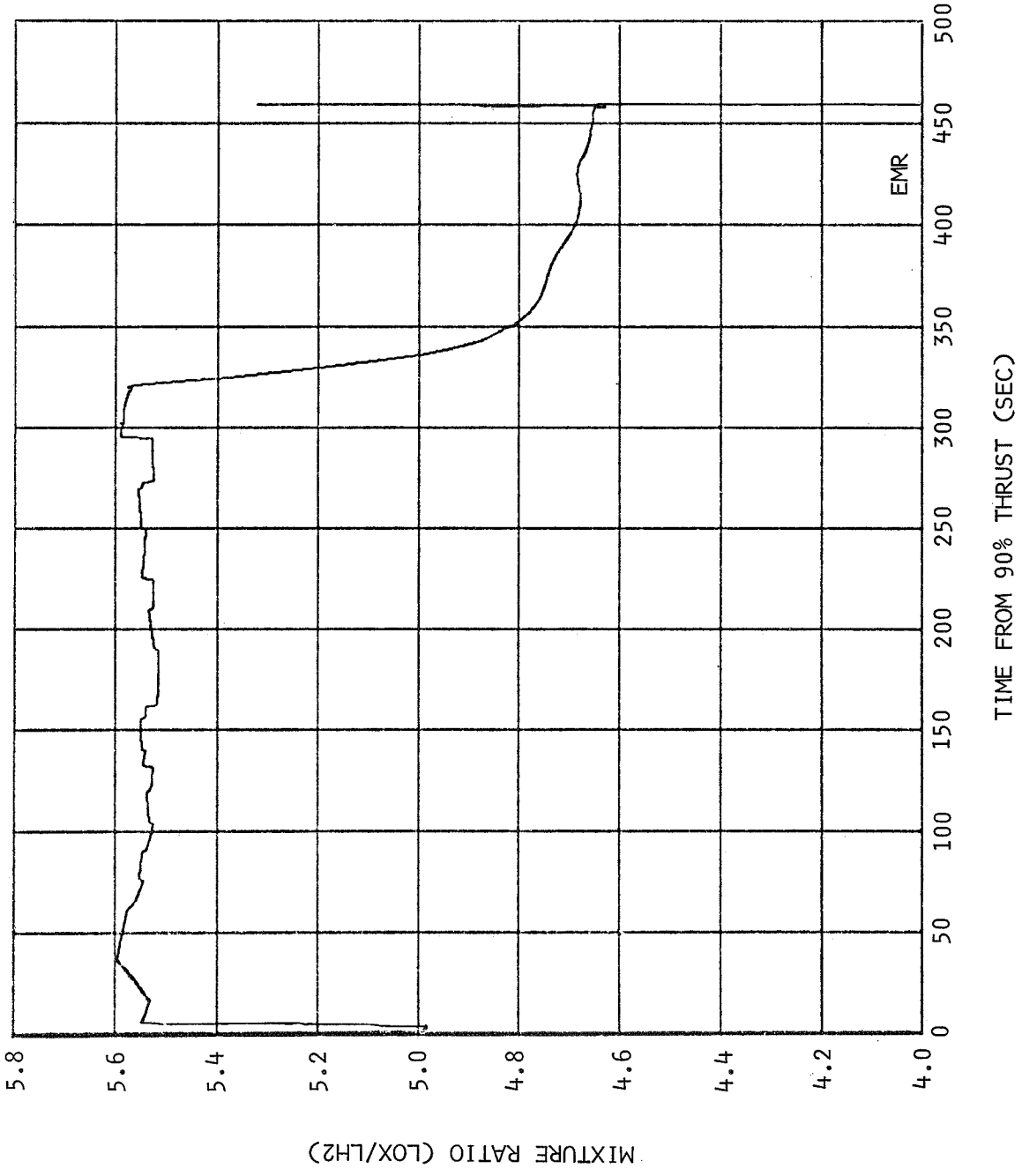


Figure AP 5-12. Engine Mixture Ratio

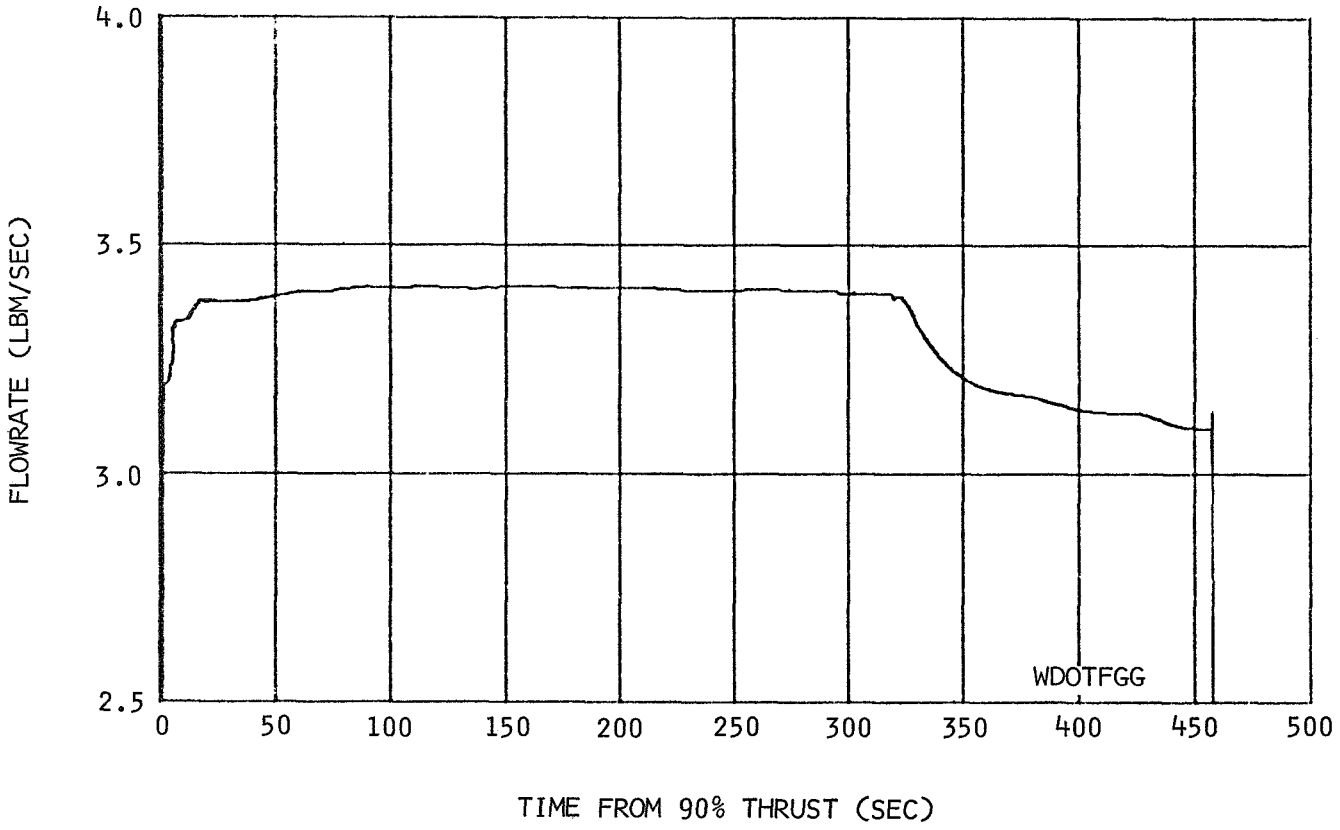


Figure AP 5-13. Gas Generator LH2 Flowrate

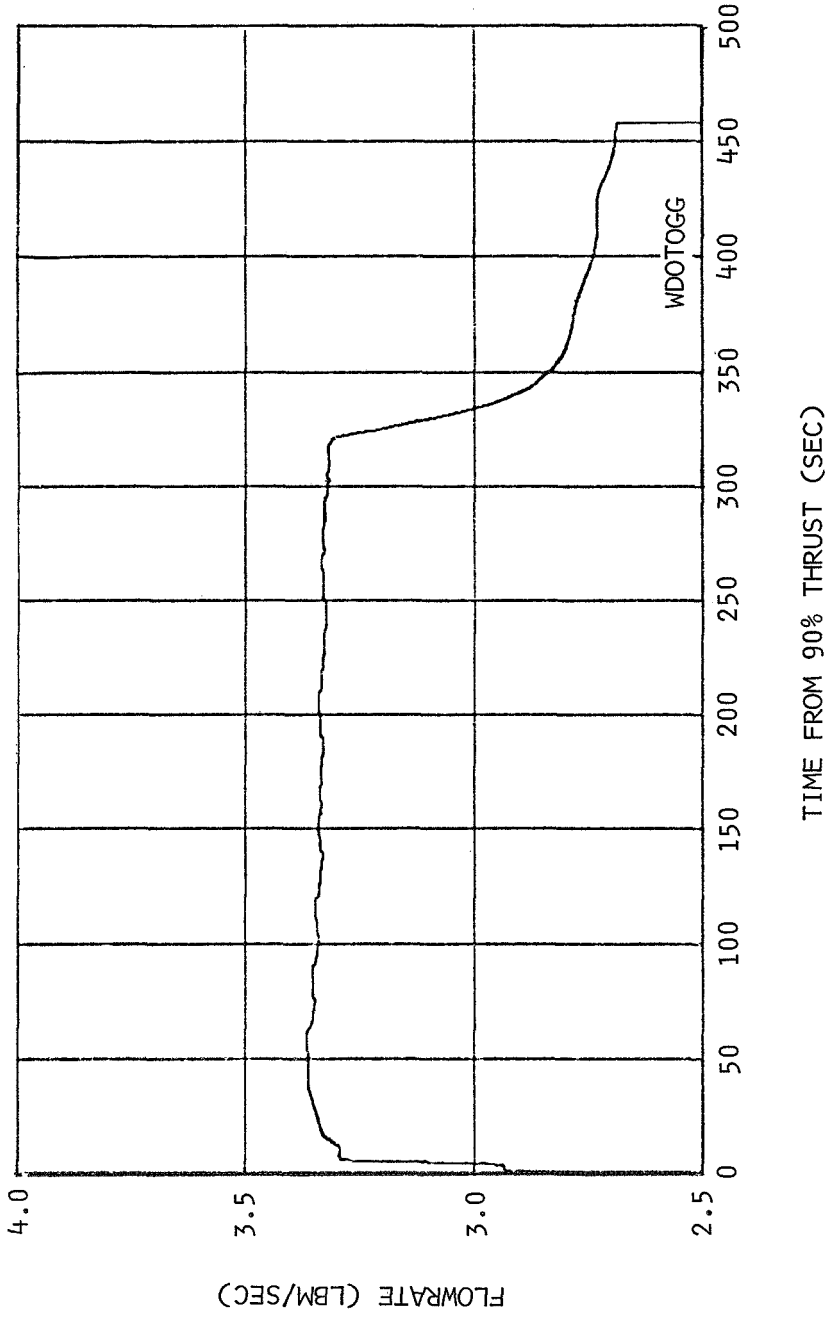


Figure AP 5-14. Gas Generator LOX Flowrate

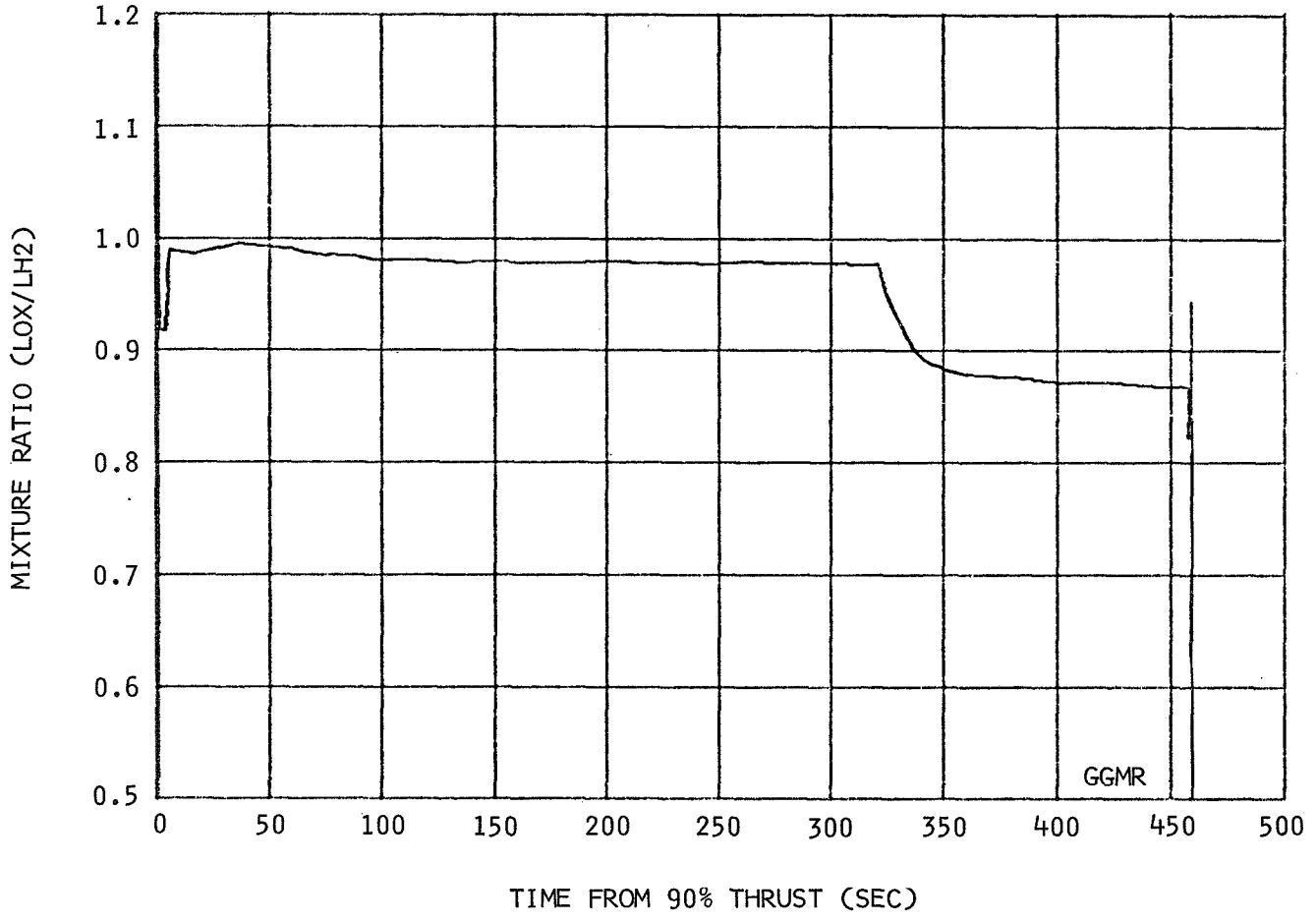


Figure AP 5-15. Gas Generator Mixture Ratio

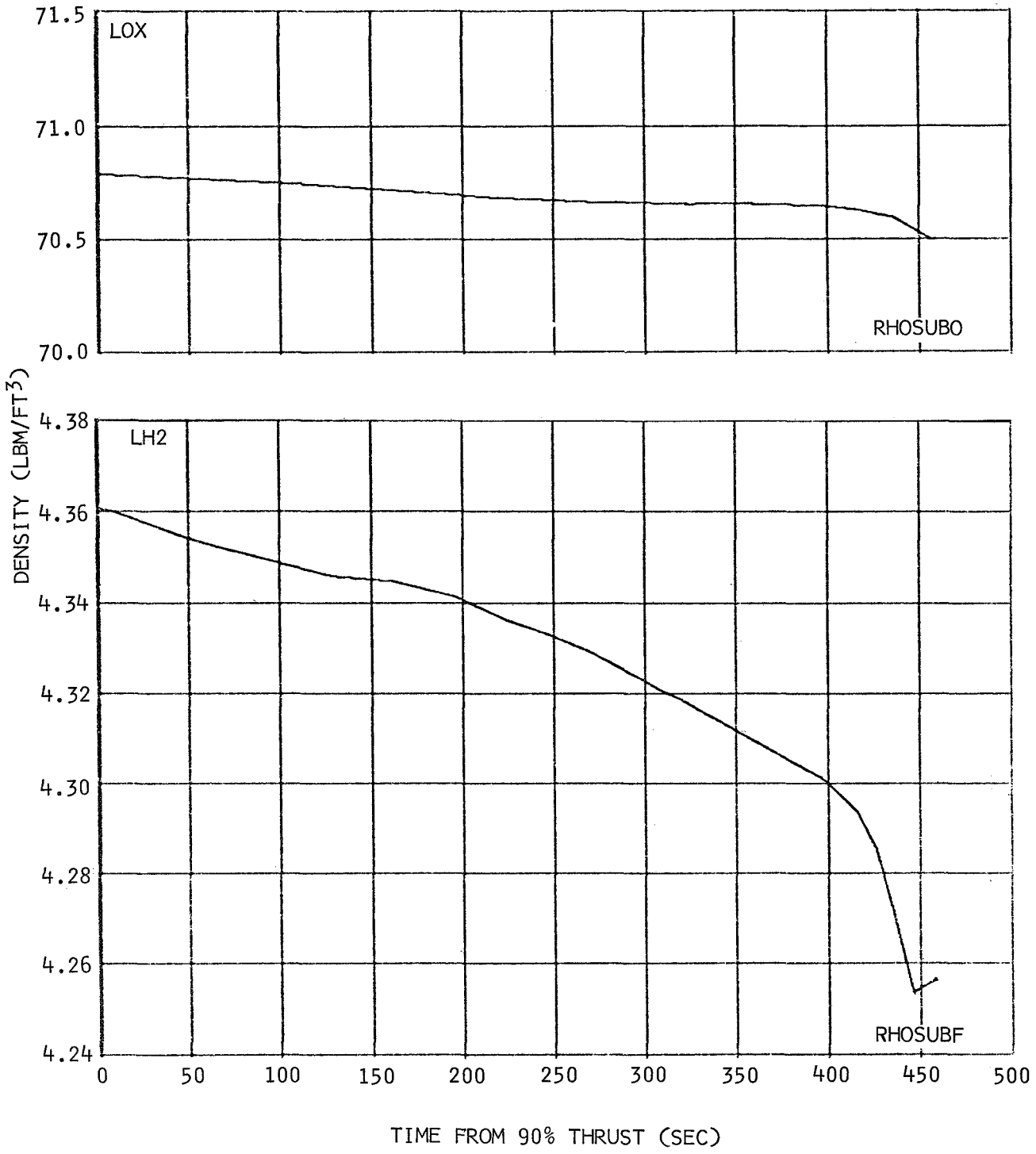


Figure AP 5-16. LOX and LH2 Bulk Densities

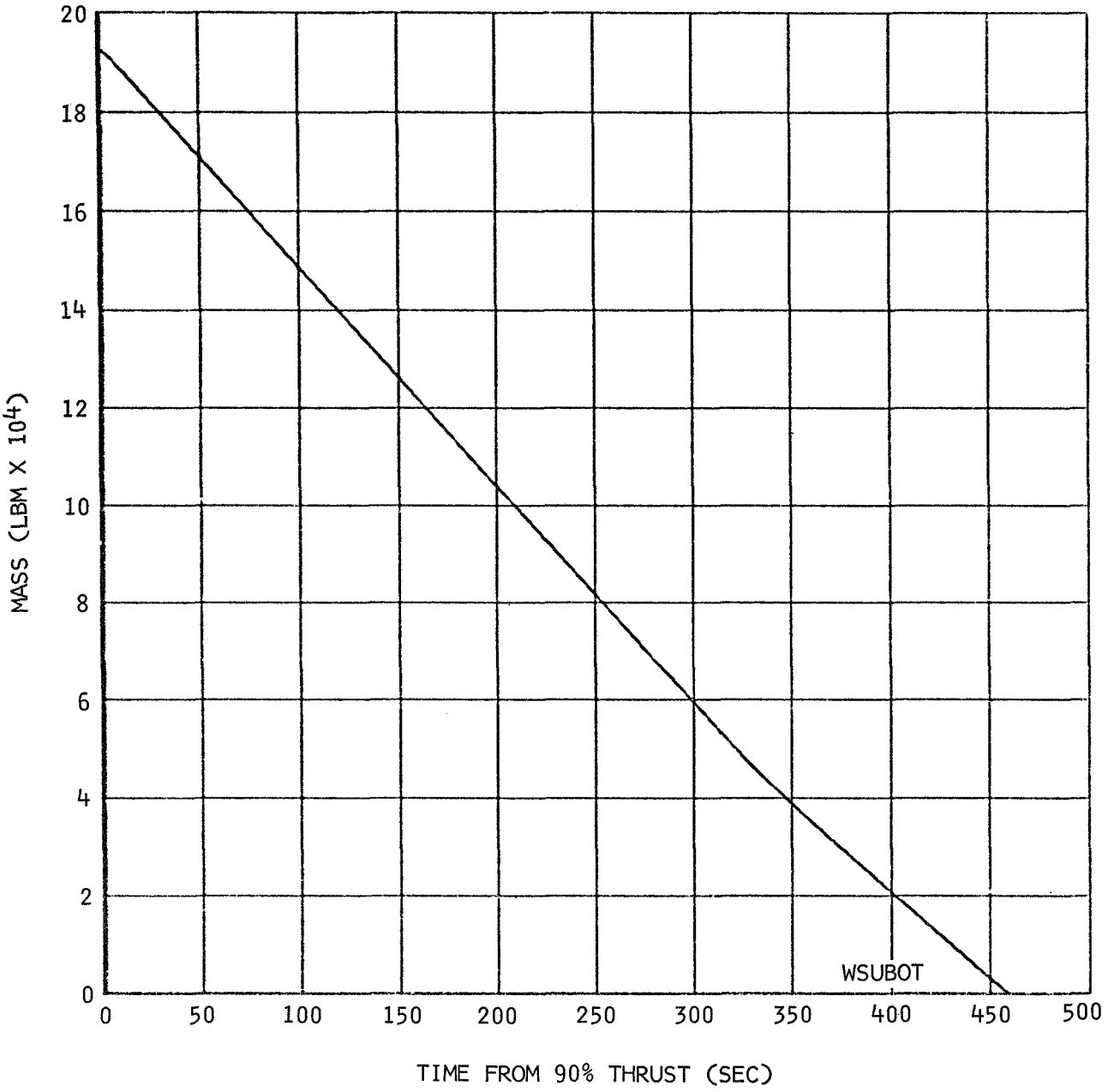


Figure AP 5-17. LOX Mass Onboard

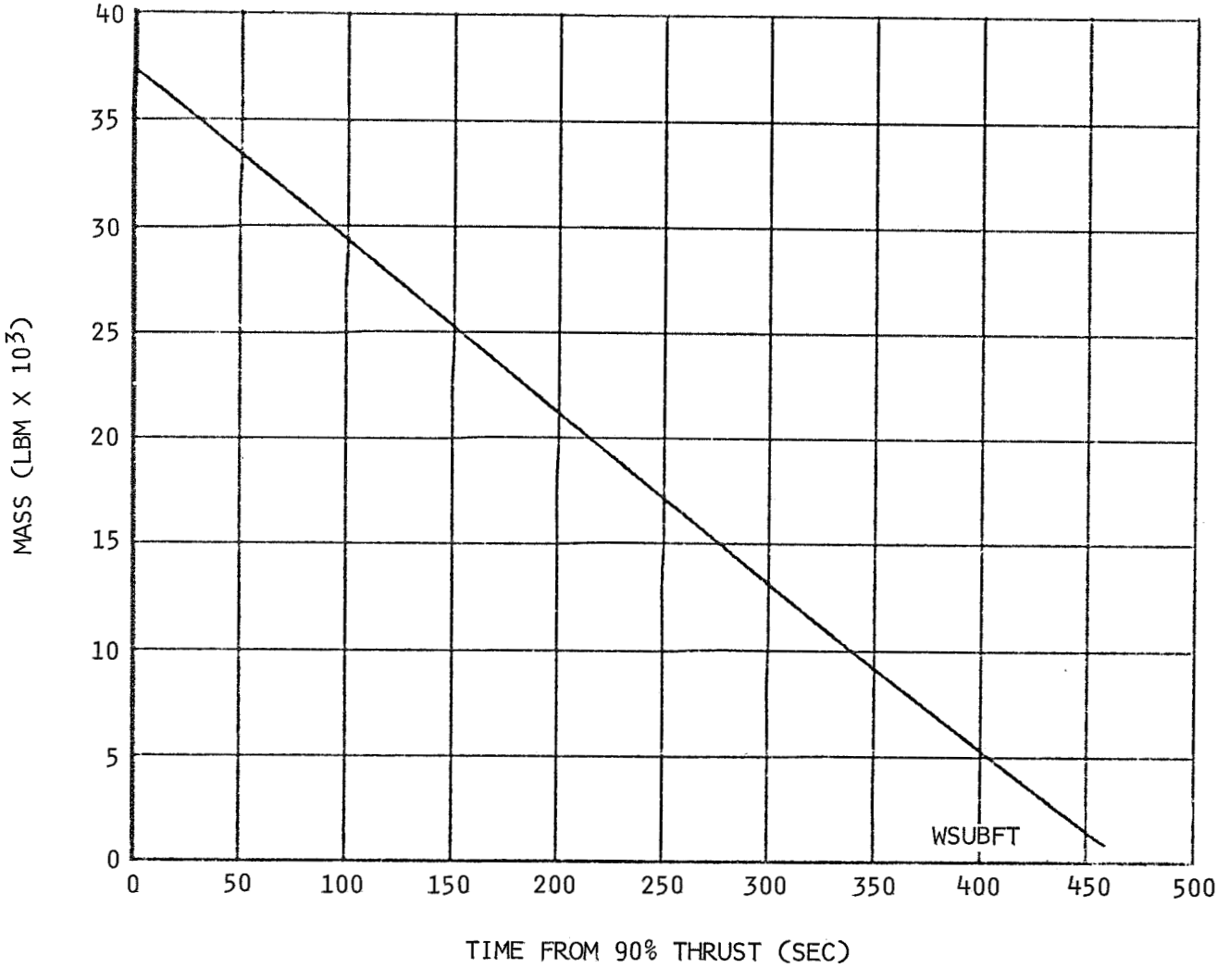


Figure AP 5-18. LH2 Mass Onboard

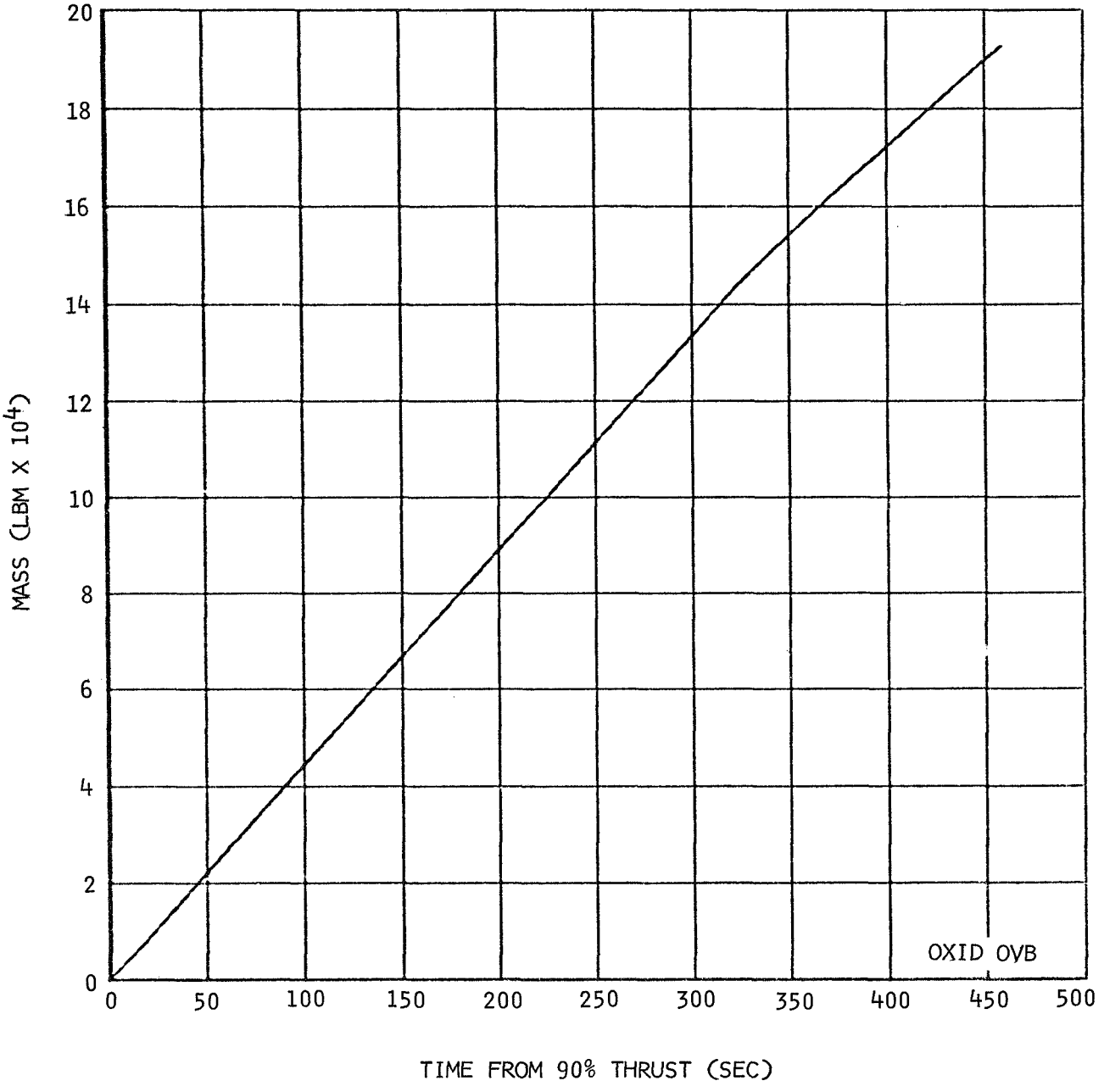


Figure AP 5-19. LOX Mass Overboard

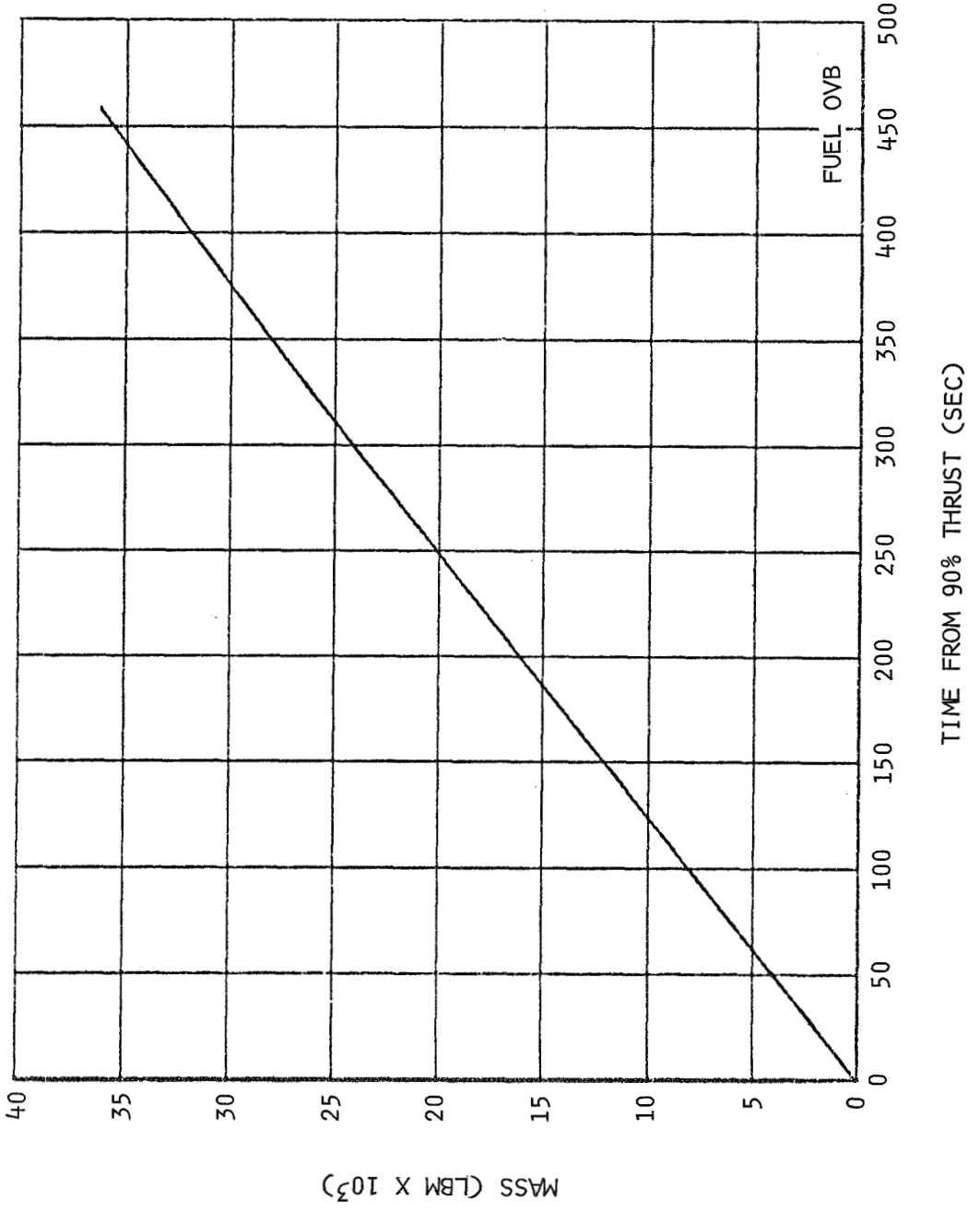


Figure AP 5-20. LH2 Mass Overboard

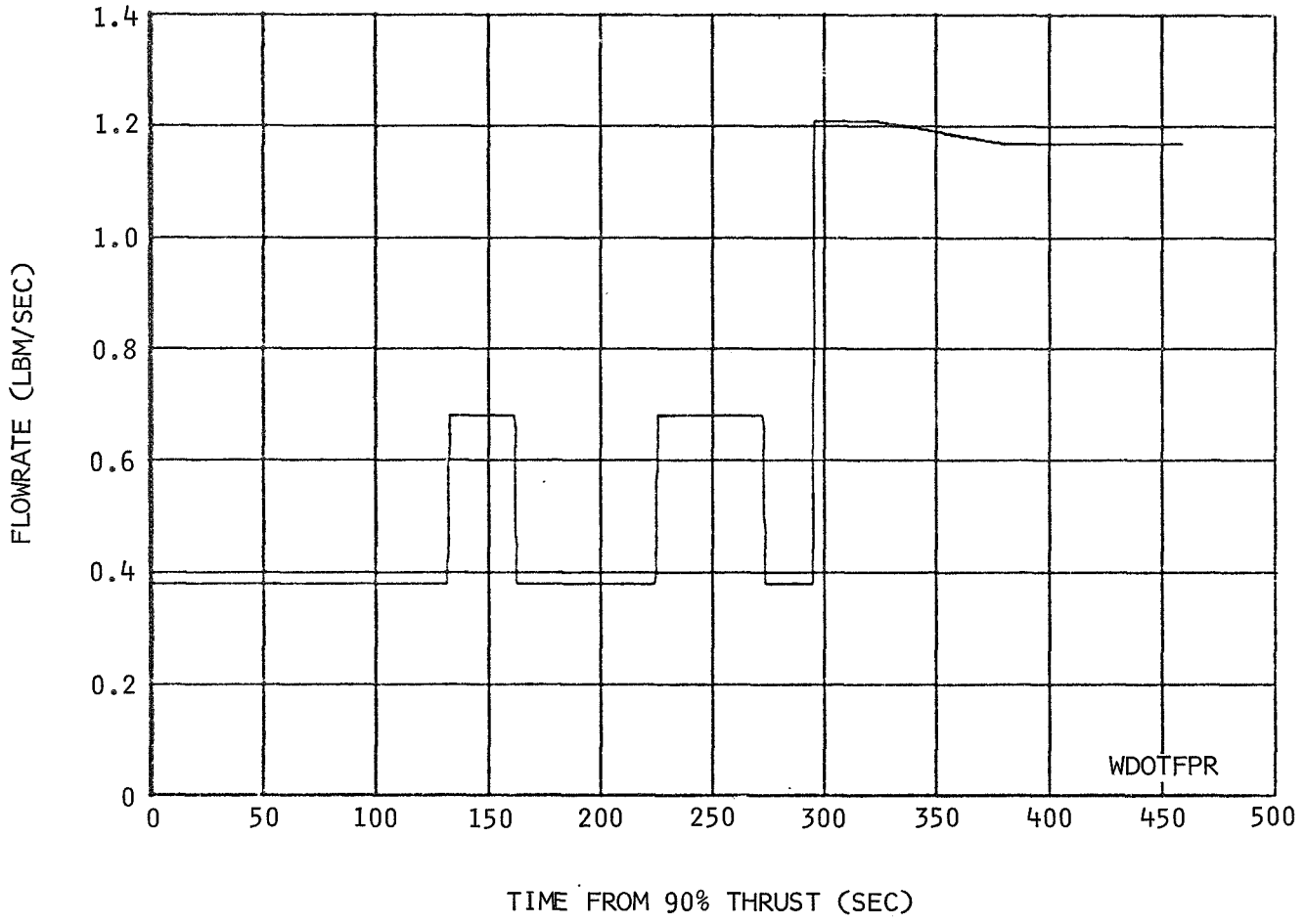


Figure AP 5-21. LH2 Tank GH2 Pressurant Flowrate

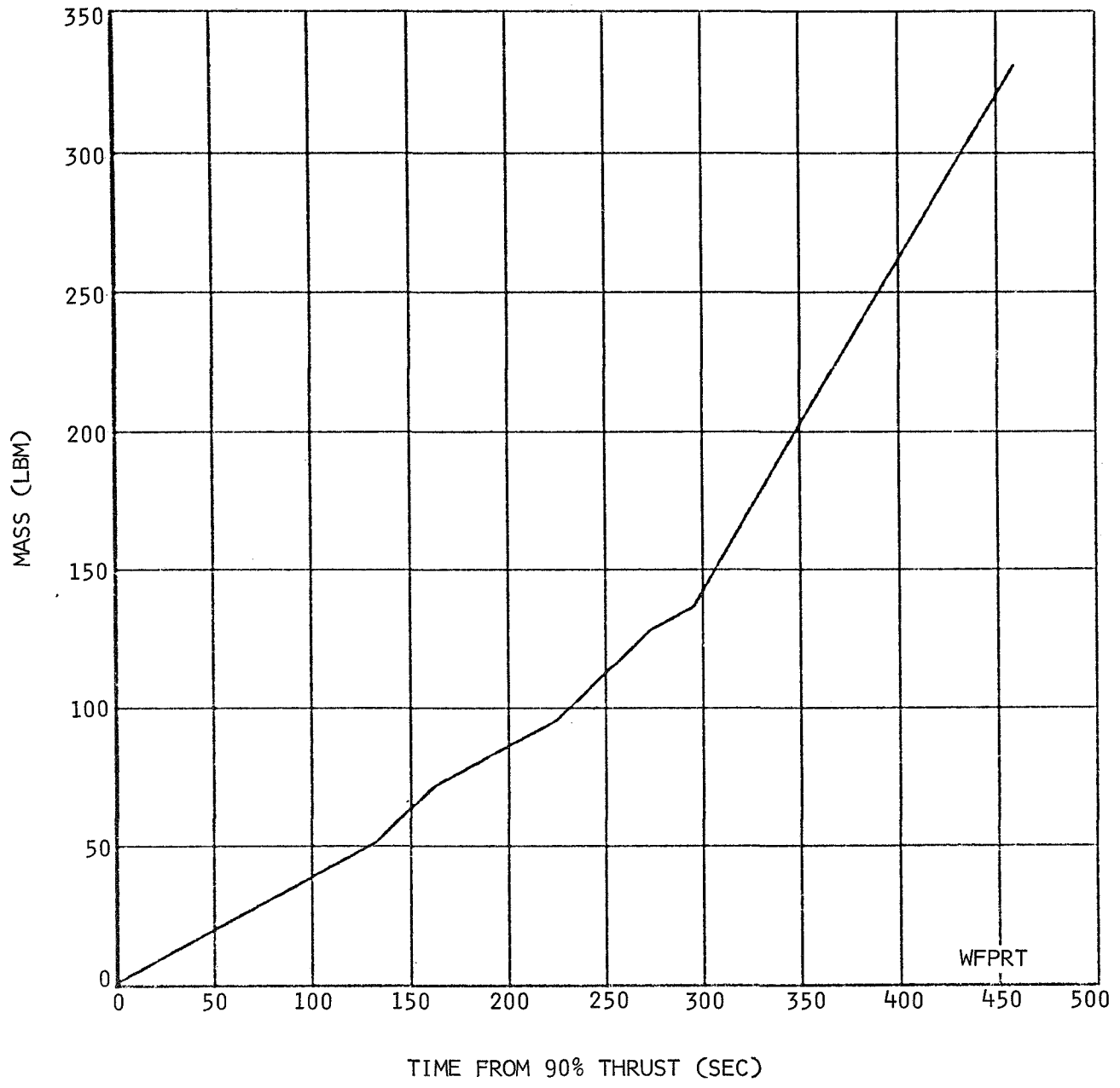


Figure AP 5-22. LH2 Tank Accumulated GH2 Pressurant

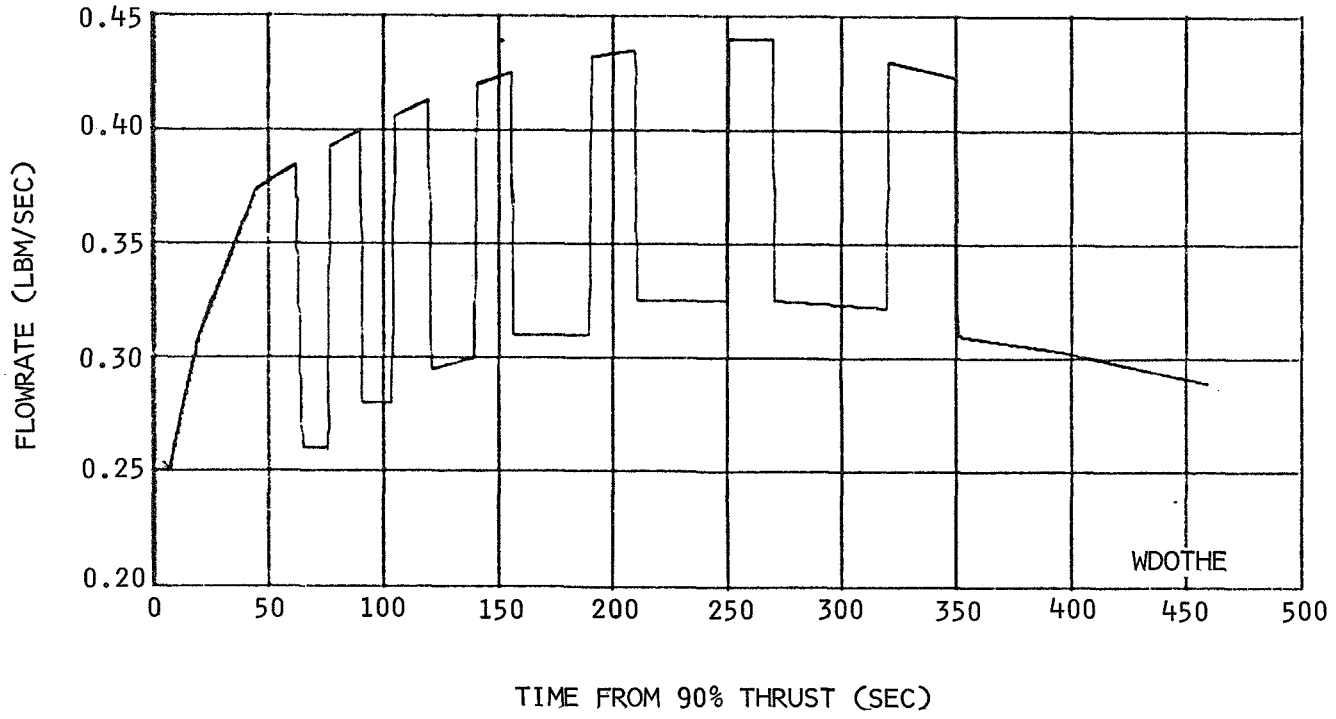


Figure AP 5-23. LOX Tank Helium Pressurant Flowrate

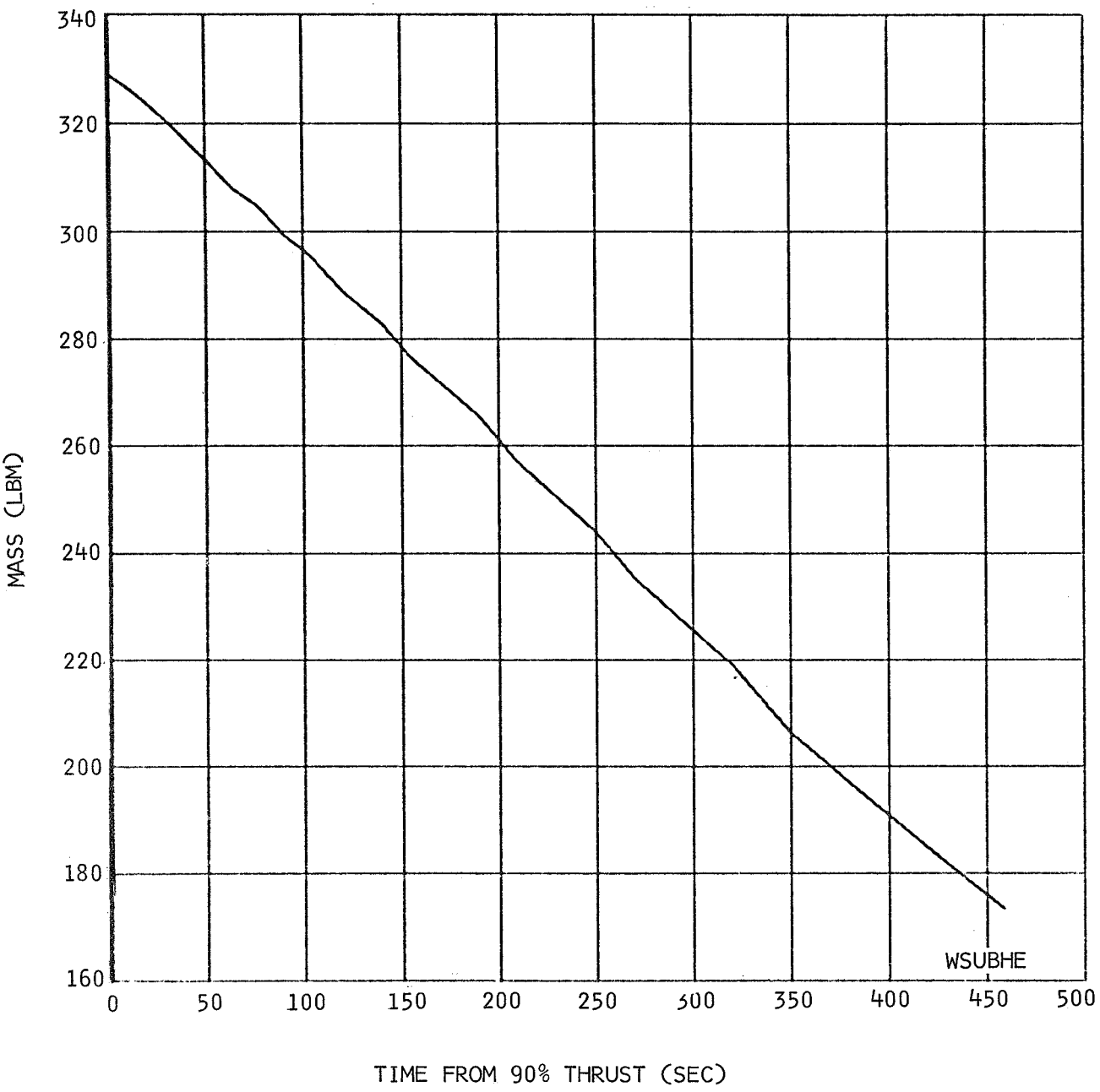


Figure AP 5-24. Mass in Cold Helium Spheres

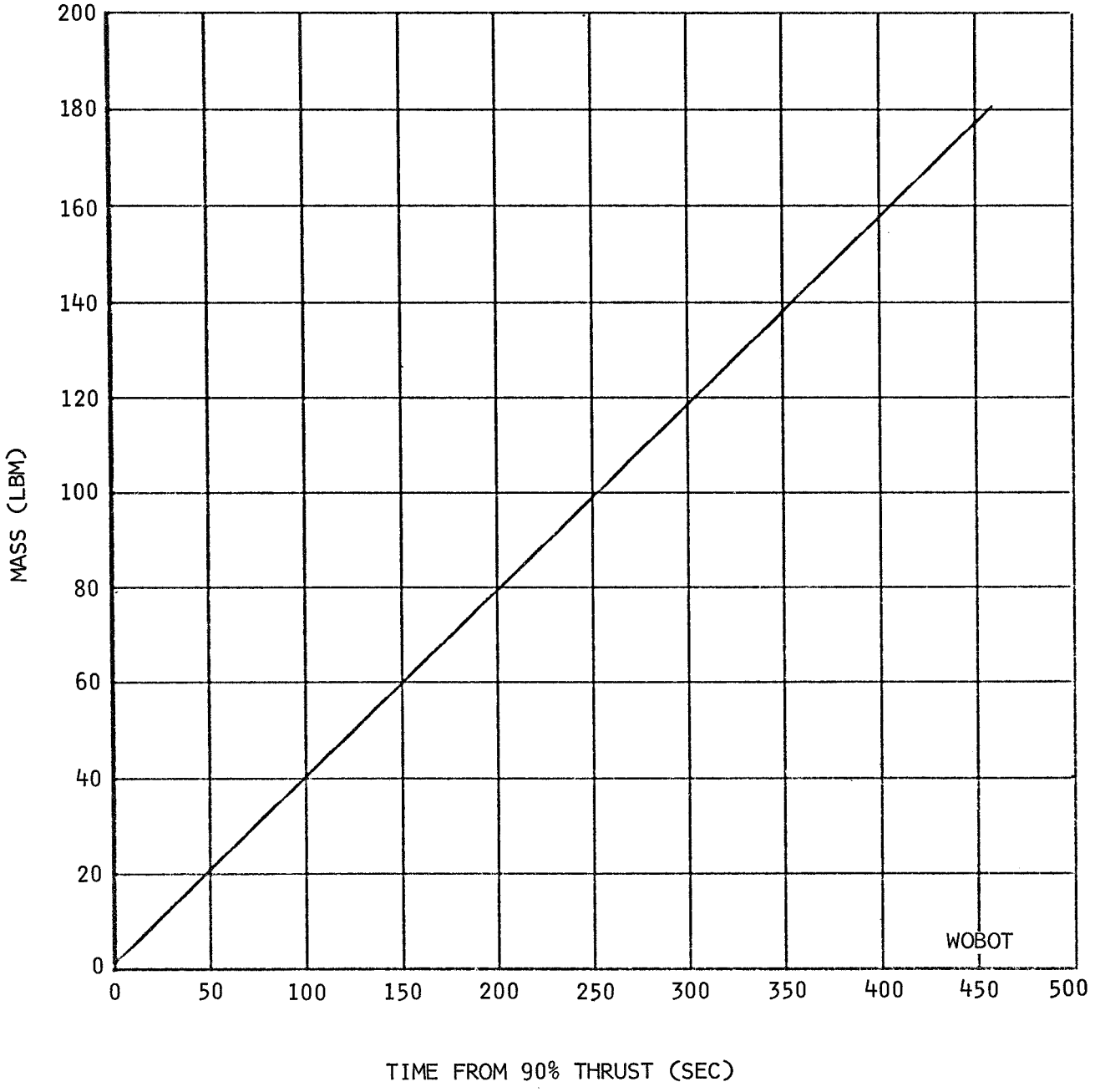


Figure AP 5-25. Total LOX Boiloff

DAC HAS PREDICTED THAT
LH2 BOILOFF WILL BE ZERO
FOR THE S-IVB-204 STAGE.

Figure AP 5-26. Total LH2 Boiloff

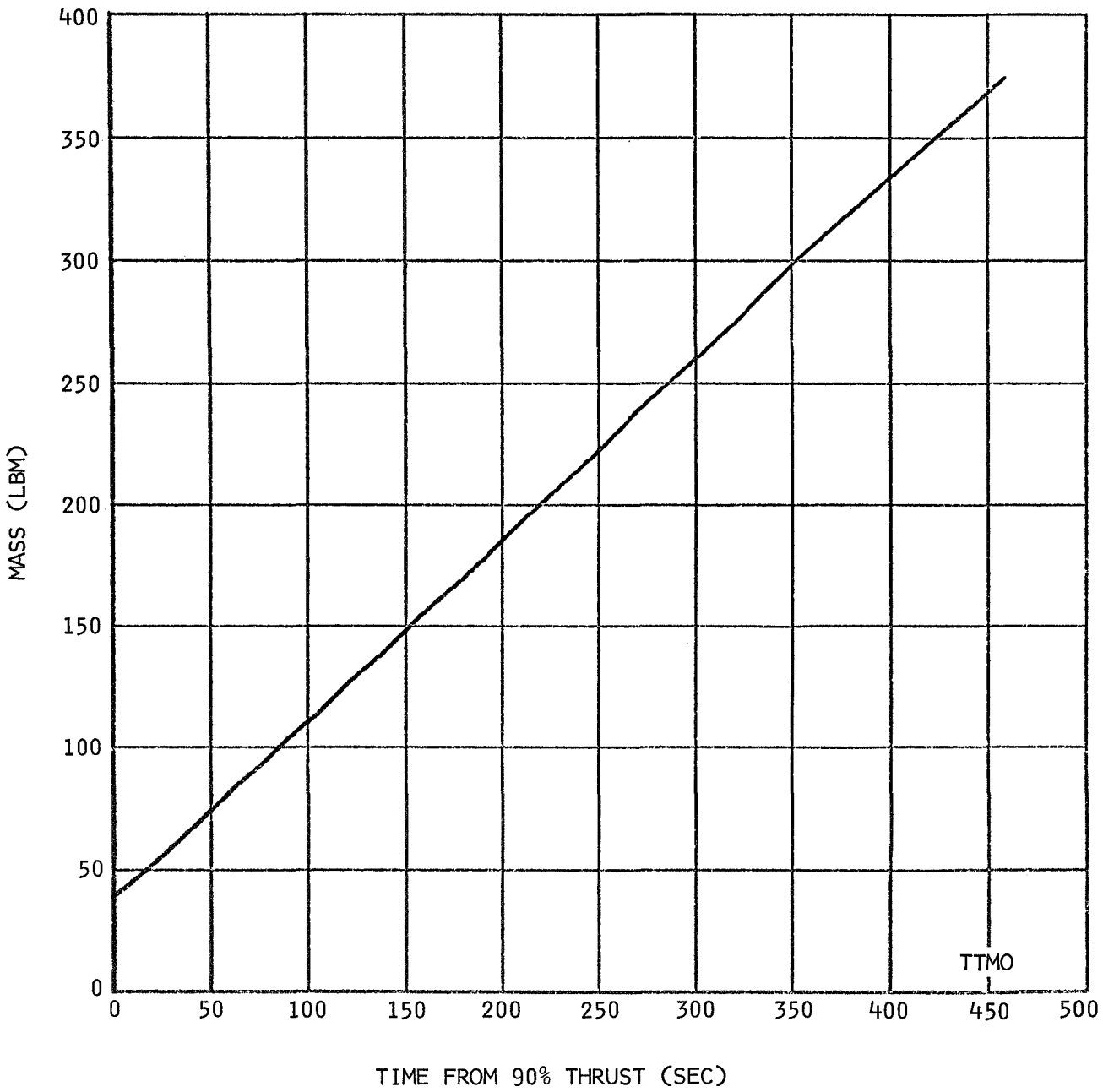


Figure AP 5-27. LOX Tank Ullage Mass

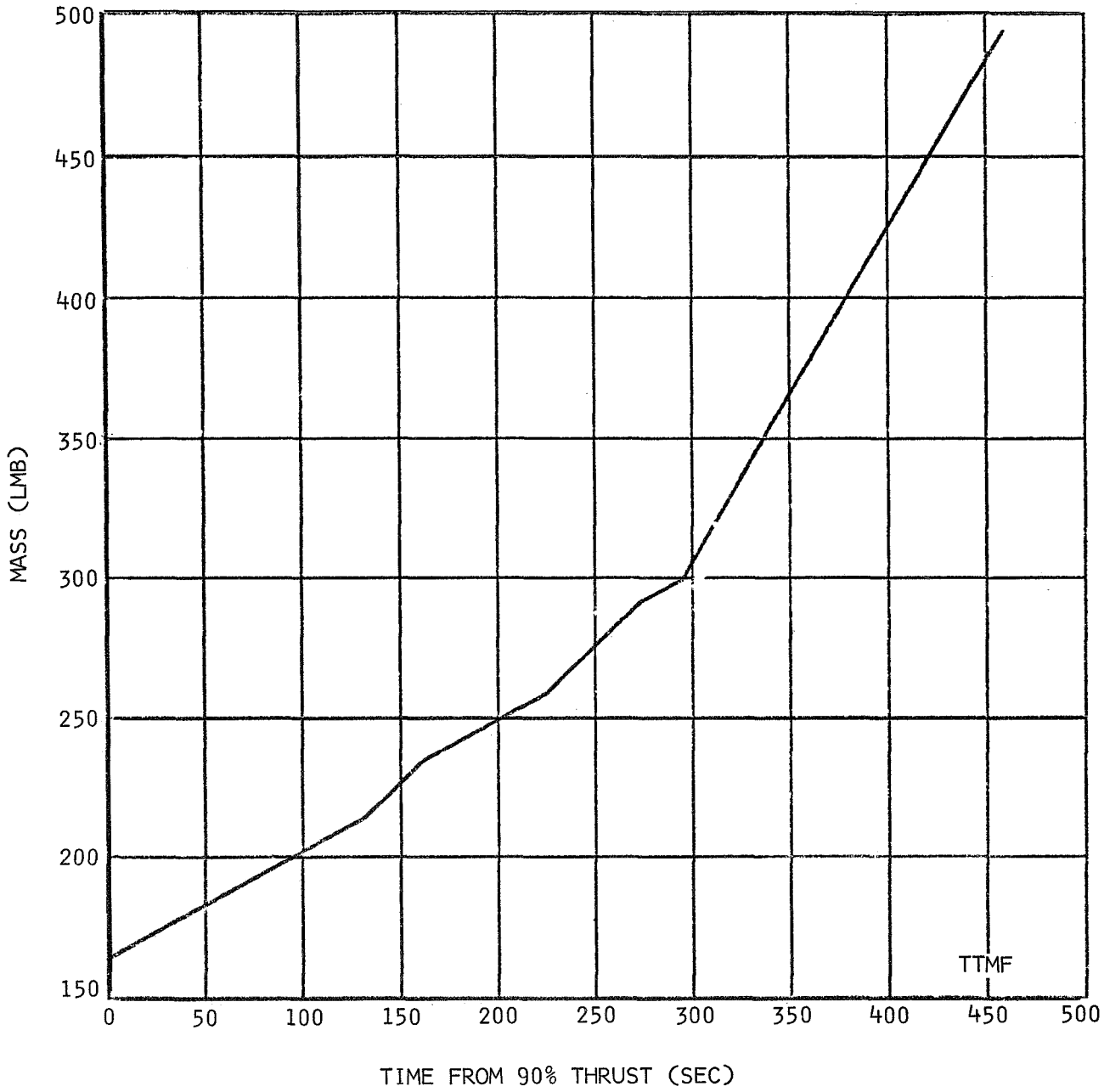


Figure AP 5-28. LH2 Tank Ullage Mass

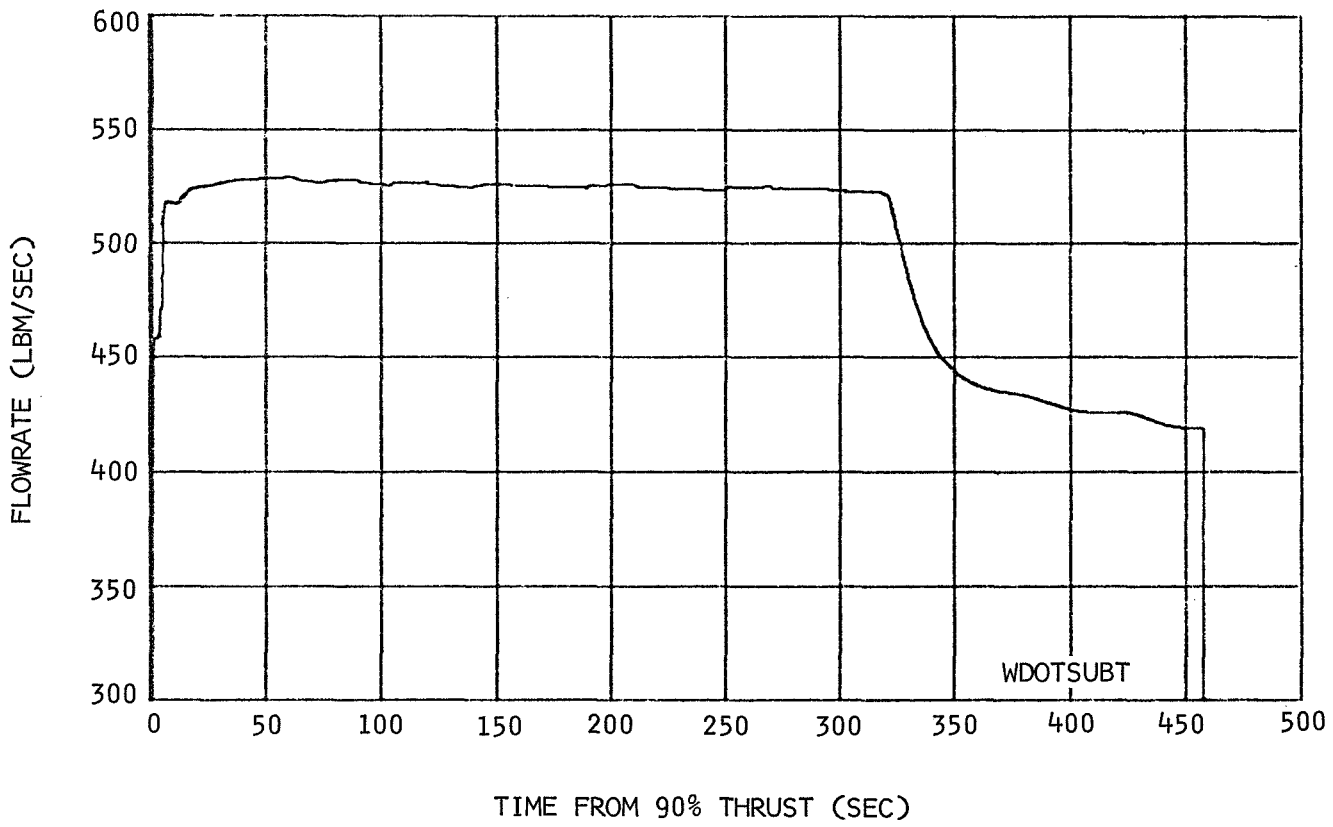


Figure AP 5-29. Engine Propellant Flowrate

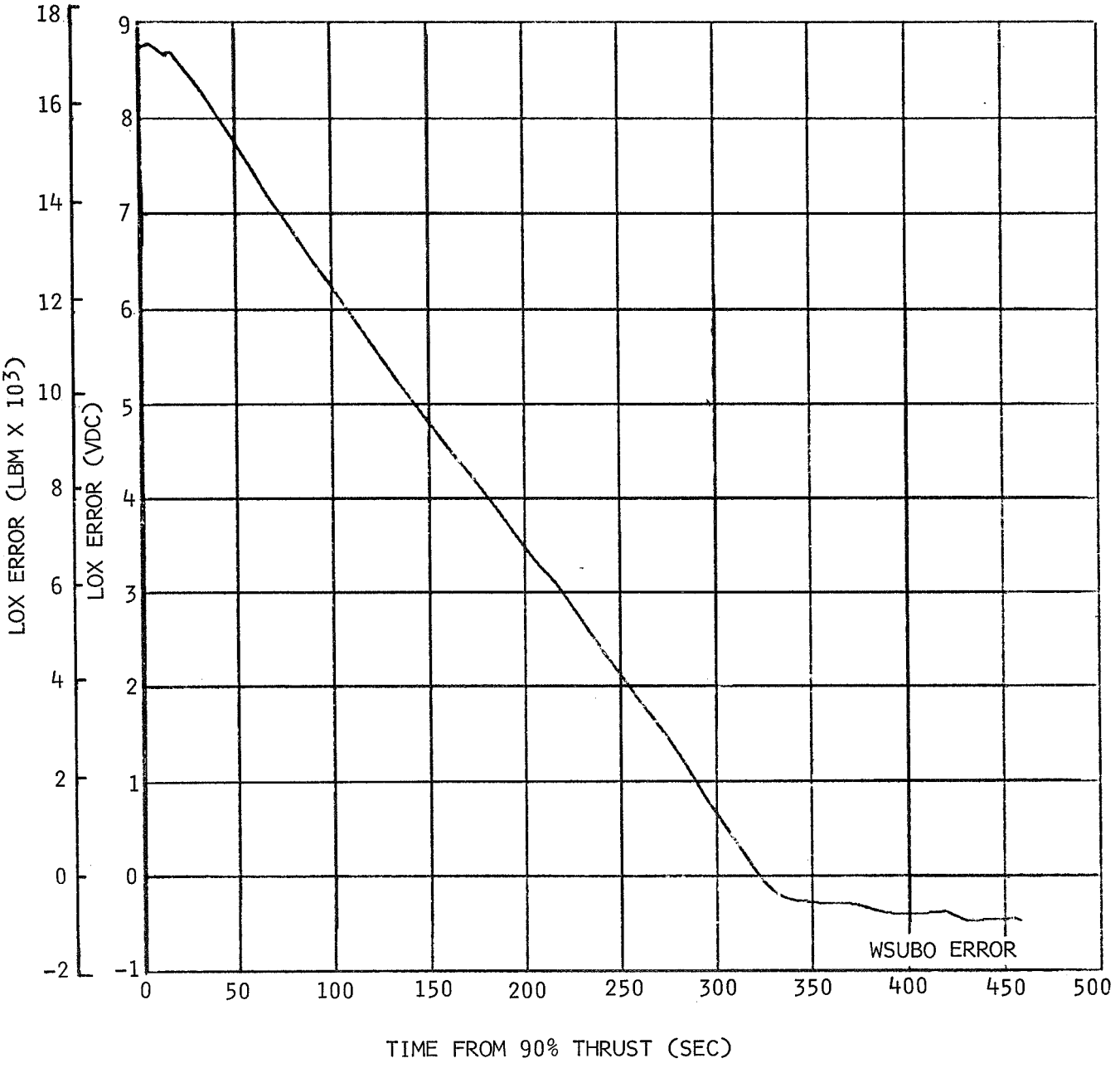


Figure AP 5-30. Equivalent LOX Weight Error

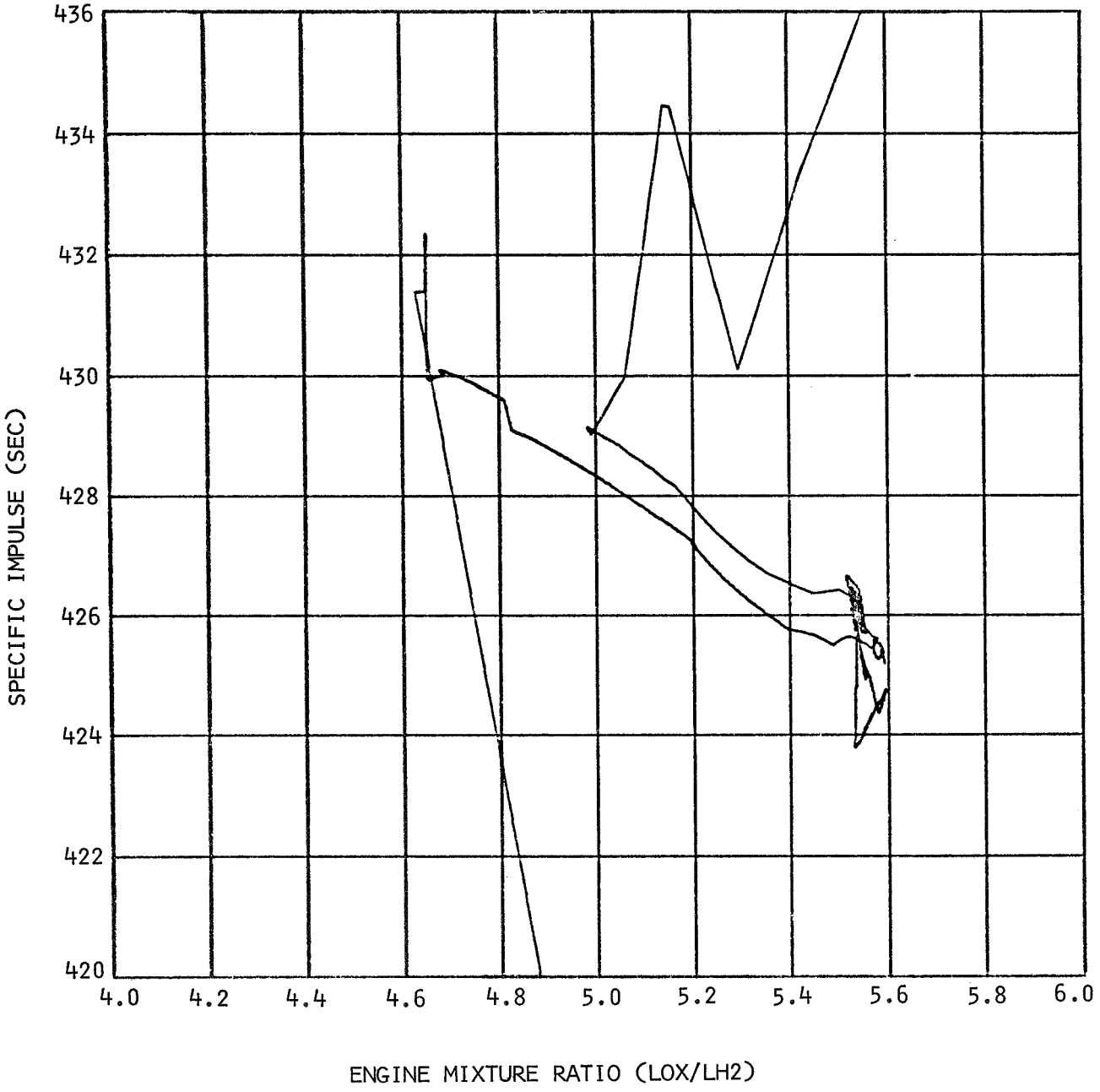


Figure AP 5-31. Specific Impulse vs Engine Mixture Ratio

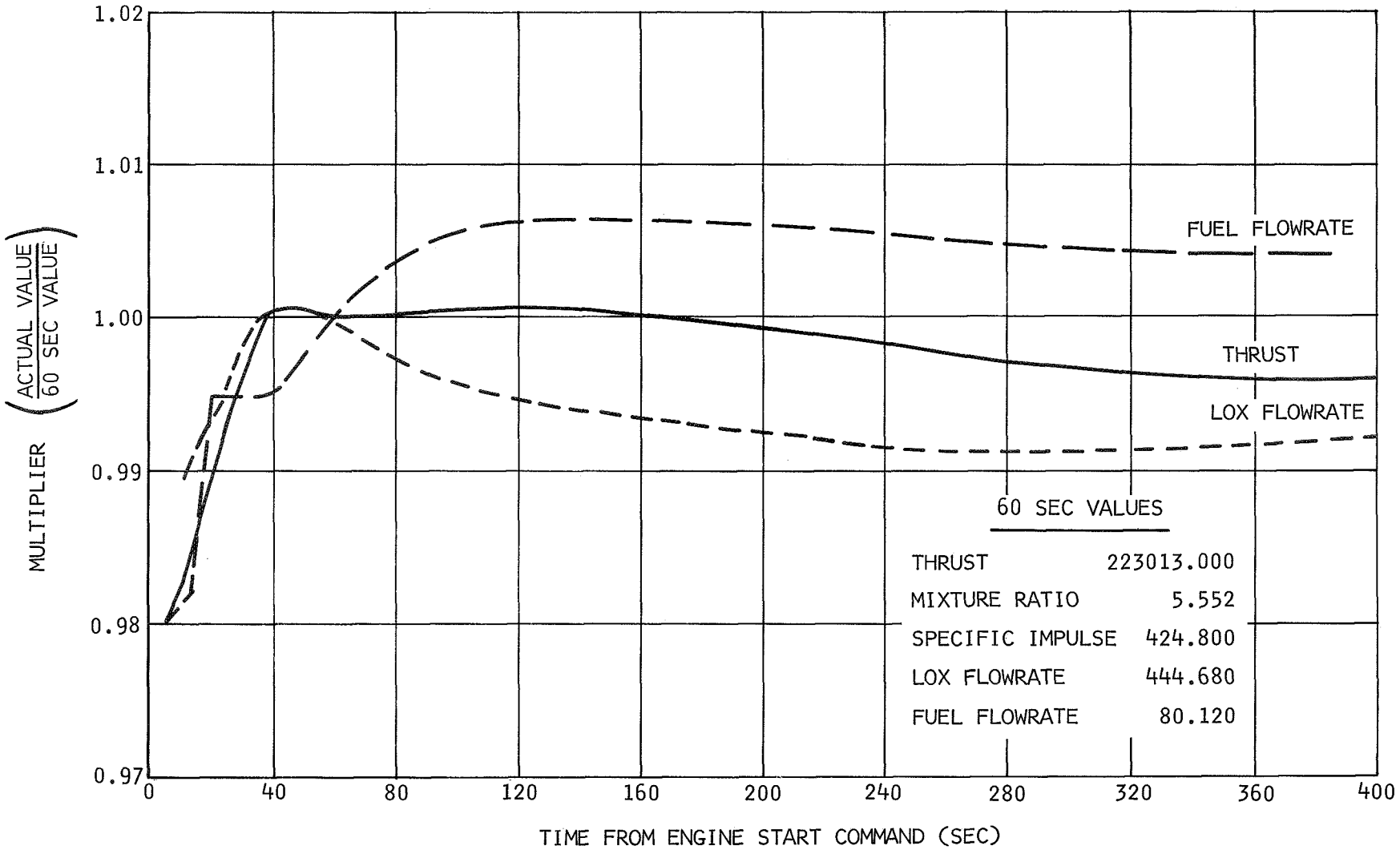


Figure AP 5-32. S-IVB-204 Variable Tag Values

APPENDIX 6

PROPELLANT UTILIZATION DATA

6. PROPELLANT UTILIZATION DATA

This appendix presents the data required for S-IVB stage propellant loading as well as data for flight control and evaluation. The propellant loading requirements for the S-IVB-204 stage are summarized in table AP 6-1. These requirements are based on the S-IVB final propulsion performance predictions (appendix 5) and on a programmed mixture ratio mode of operation with depletion cutoff.

Propellant utilization (PU) system calibration data is presented in table AP 6-2. Figure AP 6-1 is a block diagram of the S-IVB-204 PU system. The motor, bridge, and feedback shaping network dynamics have been omitted as their effect on overall system response is negligible.

The estimated PU analysis accuracies for ground loading and flight, based on the inflight mass characteristics (appendix 2), are presented in table AP 6-3; table AP 6-4 presents estimated flight propellant residual accuracies.

Tabulations of the LH2 and LOX tank unique volume versus height data during ground loading, based on tank measurement data, are presented in tables AP 6-5 and AP 6-6. The predicted LOX and LH2 level histories for flight are shown in figure AP 6-2.

Mass sensor nonlinearities resulting from tank-to-sensor mismatch including mass sensor manufacturing nonlinearities are presented in figure AP 6-3 for both the flow integral and volumetric calibrations. These corrections are based on acceptance firing data and unique tank measurements. The flow integral nonlinearities were used in the predictions presented in this report.

Predicted mass corrections for flight dynamics effects are presented in figure AP 6-4. These corrections compensate for tank geometry changes caused by variations in tank skin temperature, vehicle acceleration, and differential tank pressures. Figure AP 6-5 provides the flight corrections for vehicle tilt caused by cg offset.

The actual propellant mass onboard is determined by adding the appropriate corrections to the indicated mass values. During loading

operations, tank-to-sensor mismatch and manufacturing nonlinearities are added to the indicated value. During powered flight, tank-to-sensor mismatch, manufacturing nonlinearities, flight dynamics, and vehicle tilt corrections must all be added to determine actual mass. Figure AP 6-6 presents the total predicted mass sensor corrections for flight using both the flow integral and volumetric calibration results. Again it should be pointed out that the flow integral values were used in the predictions presented in this report. The volumetric data will be used in conjunction with the stage and interstage weight and balance logs, to provide vehicle mass evaluation within 24 hr after launch.

APS fuel and oxidizer loading requirements are presented in figure AP 6-7.

TABLE AP 6-1 (Sheet 1 of 2)
PROPELLANT LOADING REQUIREMENTS SUMMARY

DESCRIPTION	LH2 (lbm)	LOX (lbm)	REMARKS
Usable Propellants			
Total Usable Propellants	36,268	192,376	The propellant load for the S-IVB-204 flight was defined using a nominal burntime to depletion of 461.39 sec.
Nominal Propellant Consumption	35,527	189,610	This quantity will nominally be burned by the J-2 engine between Engine Start Command (ESC) and predicted guidance cutoff at ESC +453.37.
Total Available Flight Performance Reserve	602	2,766	This quantity is the nominal flight performance reserve and flight geometry reserve available following a predicted guidance cutoff command.
LH2 Bias	139	--	The bias is included as a straight line bias to the empty and full calibration points to minimize residuals at depletion.
Unusable Propellants			
Total Unusable Propellants	1,172	897	The total unusable mainstage propellant is 2,069 lbm.
Boiloff, Powered Flight		181	
LH2 Tank Pressurant	331		This quantity is required to pressurize the LH2 tank during burn and to refill the engine start sphere.
J-2 Start Transient	81	200	These are the propellants consumed during the J-2 engine start transient, from Engine Start Command to 90 percent thrust.

TABLE AP 6-1 (Sheet 2 of 2)
PROPELLANT LOADING REQUIREMENTS SUMMARY

DESCRIPTION	LH2 (lbm)	LOX (lbm)	REMARKS
J-2 Cutoff Transient	27	120	These are the propellants consumed during the J-2 engine cutoff transient, from Engine Cutoff Command to zero thrust.
J-2 Trapped	10	108	These are the propellants trapped in the J-2 engine following the cutoff transient.
Unavailable	723	288	These are the unavailable propellants trapped in the tanks and lines, based upon depletion sensor cutoff and thrust decay.
Total Desired Load	37,440	193,273	

NOTE:

1. The allowable indicated-to-desired propellant load mismatch is ±0.5 percent of the desired propellant load in each tank, and the indicated-to-actual mass accuracy is ±1.0 percent. The RSS of these accuracies yields a desired-to-actual loading accuracy of 1.12 percent of the desired propellant load for each tank.

2. A LOX calibration bias of 800 lbm was required to minimize residuals at the 4.7 reference mixture ratio.

TABLE AP 6-2 (Sheet 1 of 3)
PROPELLANT UTILIZATION CALIBRATION DATA

PROPELLANT LEVEL	CAPACITANCE (pf)	MASS (lbm)	COARSE MASS RATIO	FINE MASS RATIO (λ)
LOX MASS SENSOR (E12)				
Helium Calibration Point (1)	282.75	2,040	0.01762	Tap +0.01726
Air Calibration Point (GN2)	282.85	2,187	0.01836	Tap +0.01799
Probe Bottom (Cryogenic)	282.23	1,270	0.01375	Tap +0.01347
Empty Calibration Point	280.38	-1,463	0.0	Tap
Full Calibration Point (2)	404.94	182,157	0.92347	Tap +0.90500
Probe Calibration Point	408.65	187,633	0.95101	Tap +0.93199
Full Load (Pressurized) (3)	412.48	193,273	0.97937	Tap +0.95979
Full Load (Unpressurized) (4)	412.92	193,273	0.98267	Tap +0.96302
Reference Mixture Ratio Calibration Point	400.03	174,931	0.88713	Tap +0.86938

The above data are valid only when probe is immersed in GHe at ambient room conditions.

NOTES:

(1) When LOX tank is empty of propellant and filled only with GHe at one atmosphere.

(2) The delta capacitance (full calibration point minus the helium calibration point) is 122.19 pf, which is equal to a coarse mass ratio (CMR) of 0.92347 and a LOX mass of 182,157 lbm.

(3) The loading computer (L/C) will be programmed to load to a CMR of 0.97937, which is equal to a LOX mass of 193,273 lbm (pressurized). The maximum acceptable deviation from the nominal load is ±0.5 percent; i.e., a minimum CMR of 0.97447 and a maximum of 0.98427.

(4) The L/C will be programmed to load to a CMR of 0.98267, which is equal to a LOX mass of 193,273 lbm (unpressurized). An L/C tolerance of ±0.5 percent of the desired load will yield a minimum CMR of 0.97776 and a maximum of 0.98758. The nominal CMR of 0.98267 will be used as the initial 100 percent value for the KSC propellant loading test. This value was based upon data obtained from the AS-201 and AS-203 propellant loading tests and launch countdowns. Additional adjustments to the CMR (unpressurized) may be required after the AS-204 Countdown Demonstration Test.

TABLE AP 6-2 (Sheet 2 of 3)
PROPELLANT UTILIZATION CALIBRATION DATA

PROPELLANT LEVEL	CAPACITANCE (pf)	MASS (lbm)	COARSE MASS RATIO	FINE MASS RATIO (λ)
LH2 MASS SENSOR (E-6)				
Helium Calibration Point(5)	971.53	54	-0.00703	Tap -0.00689
Air Calibration Point (GN2)	971.73	95	-0.00601	Tap -0.00589
Probe Bottom (Cryogenic)	972.27	206	-0.00323	Tap -0.00317
Empty Calibration Point	972.90	336	0.0	Tap
Full Calibration Point(6)	1,152.63	37,359	00.92347	Tap +0.90500
Probe Calibration Point	1,149.84	36,785	0.90915	Tap +0.89097
Full Load (Pressurized)(7)	1,153.02	37,440	0.92549	Tap +0.90698
Full Load (Unpressurized)(8)	1,154.23	37,690	0.93173	Tap +0.91309
Reference Mixture Ratio Calibration Point	1,152.63	37,359	0.92347	Tap +0.90500

The above data are valid only when probe is immersed in GHe at ambient room conditions.

NOTES:

(5) When LH2 tank is empty of propellant and filled only with GHe at one atmosphere.

(6) The delta capacitance (full calibration point minus the helium calibration point) is 181.10 pf, which is equal to a coarse mass ratio (CMR) of 0.92347 and an LH2 mass of 37,359 lbm.

(7) The loading computer (L/C) will be programmed to load to a CMR of 0.92549, which is equal to an LH2 mass of 37,440 lbm (pressurized). The maximum acceptable deviation from the nominal load is ±0.5 percent; i.e., a minimum CMR of 0.92086 and a maximum of 0.93012.

(8) The L/C will be programmed to load to a CMR of 0.93173, which is equal to an LH2 mass of 37,690 lbm (unpressurized). An L/C tolerance of ±0.5 percent of the desired load will yield a minimum CMR of 0.92707 and a maximum of 0.93639. The nominal CMR of 0.93173 will be used as the initial 100 percent value for the KSC propellant loading test. This value was based upon data obtained from the AS-201 and AS-203 propellant loading tests and launch countdowns. Additional adjustments to the CMR (unpressurized) may be required after the AS-204 Countdown Demonstration Test.

TABLE AP 6-2 (Sheet 3 of 3)
PROPELLANT UTILIZATION CALIBRATION DATA

MASS AND CAPACITANCE REDUCTION FORMULAE

LOX Mass $\lambda = \lambda(202{,}895) - 5{,}521$

LH2 Mass $\lambda = \lambda(40{,}910) - 483$

LOX Capacitance $= \lambda(137.63) + 277.62$

LH2 Capacitance $= \lambda(198.59) + 968.93$

$$\lambda = \frac{LEG}{20} = \text{Fine Mass Ratio}$$

LEG = Total integral number plus fractional part of fine mass LEGS traversed expressed as a decimal.
Example: LEG = 18.49 indicates that 18 full LEGS have been traversed plus 49/100 of the nineteenth LEG.

REFERENCE MIXTURE RATIO ADJUSTMENT TO 4.7

a. Calibrate bridges as shown in table

b. Put in ΔC = 181.10 pf on LH2 bridge

c. Put in ΔC = 122.19 pf on LOX bridge

d. Adjust bias potentiometers for 0.000 $\pm$0.01 volts at the empty calibration point and with the above ΔC's in the bridges.

TABLE AP 6-3
ESTIMATED PU ANALYSIS ACCURACIES

ITEM	DESCRIPTION	TEST	LOX TANK (± lbm)		LH2 TANK (± lbm)	
			LEVEL SENSOR NO.		LEVEL SENSOR NO.	
			L0006	L0005	N0032	L0002
1.	Predicted accuracies of level sensors	FLIGHT	470	330	88	49
		CDDT*	344	235	78	42
2.	Predicted accuracy of PU mass sensor at level sensor activation	FLIGHT and CDDT	500	490	137	130
3.	Probable deviation between level sensor and PU mass sensor (RSS of items 1 and 2)	FLIGHT	686	591	163	158
		CDDT	574	455	139	92
4.	Predicted accuracy of propellant residuals at ECC as determined by individual level sensor	FLIGHT	493	335	98	47
5.	Probable deviation between mass sensor and level sensor determined residuals at ECC (RSS of item 4 and item 1 in table AP 6-4)	FLIGHT	695	594	179	158

* Countdown demonstration test (CDDT) predictions are valid only if propellant is maintained at a minimum of 2 deg R below saturation and at nominal tank pressurization.

TABLE AP 6-4
ACCURACY OF DETERMINING PROPELLANT RESIDUALS

ITEM	DESCRIPTION	LOX (± lbm)	LH2 (± lbm)	TOTAL (± lbm)
1.	PU system mass sensor accuracy of propellant residuals at ECC based on a predicted residual, above the main propellant valves of 3,282 lbm LOX and 1,501 lbm LH2.	490	130	507
2.	Estimated overall level sensor accuracy of propellant residuals at ECC as determined by the weighted average technique based on predicted residuals noted in item 1.	277	42	280
3.	Combining the estimated level sensor residual accuracy (item 2) with the mass sensor residual accuracy (item 1) using the weighted average technique, the stage estimated residual accuracy at ECC is:	241	40	244

NOTE: Totals represent RSS (root-sum-square) values of individual propellant tank accuracies.

TABLE AP 6-5
SATURN S-IVB-204 VOLUME VERSUS HEIGHT
LOX TANK - GROUND LOADING CONDITION

HEIGHT (In.)	VOLUME ($Ft.^3$)	HEIGHT (In.)	VOLUME ($Ft.^3$)	HEIGHT (In.)	VOLUME ($Ft.^3$)
0	0.000	60	716.889	120	2,189.37
2	0.736	62	760.763	122	2,230.23
4	3.440	64	805.617	124	2,270.10
6	8.108	66	851.474	126	2,308.74
8	14.578	68	898.204	128	2,346.36
10	22.805	70	945.828	130	2,382.79
12	32.790	72	994.367	132	2,417.90
14	44.412	74	1,043.69	134	2,451.90
16	57.834	76	1,093.88	136	2,484.49
18	72.787	78	1,144.78	138	2,515.93
20	89.360	80	1,196.44	140	2,546.05
22	107.625	82	1,248.85	142	2,574.68
24	127.354	84	1,301.91	144	2,602.07
26	148.716	86	1,355.66	146	2,627.89
28	171.483	88	1,410.02	148	2,652.43
30	195.726	90	1,464.46	150	2,675.51
32	221.515	92	1,518.28	152	2,696.93
34	248.622	94	1,571.44	154	2,716.98
36	277.217	96	1,623.84	156	2,735.32
38	307.055	98	1,675.61	158	2,752.24
40	338.216	100	1,726.63	160	2,767.54
42	370.728	102	1,776.78	162	2,781.03
44	404.462	104	1,826.24	164	2,793.02
46	439.439	106	1,874.77	166	2,803.15
48	475.630	108	1,922.54	168	2,811.71
50	513.056	110	1,969.43	170	2,818.52
52	551.688	112	2,015.30	172	2,823.33
54	591.346	114	2,060.33	174	2,826.54
56	632.201	116	2,104.29	176	2,827.79
58	674.025	118	2,147.35		

NOTE: Height is the distance above the LOX tank reference station 156.416.

TABLE AP 6-6 (Sheet 1 of 3)
SATURN S-IVB-204 VOLUME VERSUS HEIGHT
LH2 TANK - GROUND LOADING CONDITION

HEIGHT (In.)	VOLUME ($Ft.^3$)	HEIGHT (In.)	VOLUME ($Ft.^3$)	HEIGHT (In.)	VOLUME ($Ft.^3$)
0	0.00	60	534.25	120	2,181.22
2	0.00	62	572.02	122	2,241.58
4	0.23	64	611.33	124	2,301.94
6	2.72	66	652.21	126	2,362.30
8	6.75	68	694.68	128	2,422.66
10	12.03	70	738.78	130	2,483.03
12	18.63	72	785.64	132	2,543.69
14	26.23	74	833.08	134	2,604.05
16	35.02	76	882.23	136	2,664.41
18	45.00	78	933.13	138	2,724.77
20	56.18	80	985.79	140	2,785.13
22	68.56	82	1,040.26	142	2,845.49
24	82.12	84	1,096.55	144	2,905.85
26	96.88	86	1,154.71	146	2,966.21
28	112.83	88	1,214.64	148	3,026.58
30	129.98	90	1,275.00	150	3,086.94
32	148.92	92	1,335.87	152	3,147.60
34	168.46	94	1,396.23	154	3,207.96
36	189.18	96	1,456.54	156	3,268.32
38	211.11	98	1,516.95	158	3,328.78
40	233.93	100	1,577.31	160	3,389.04
42	257.92	102	1,637.67	162	3,449.40
44	283.15	104	1,698.03	164	3,509.76
46	309.67	106	1,758.38	166	3,570.12
48	337.49	108	1,818.75	168	3,630.49
50	366.64	110	1,879.12	170	3,690.85
52	397.96	112	1,939.78	172	3,751.51
54	429.87	114	2,000.14	174	3,811.88
56	463.20	116	2,060.50	176	3,872.23
58	497.98	118	2,120.86	178	3,932.59

NOTE: Height is the distance above the LH2 tank reference station 248.574.

TABLE AP 6-6 (Sheet 2 of 3)
SATURN S-IVB-204 VOLUME VERSUS HEIGHT
LH2 TANK - GROUND LOADING CONDITION

HEIGHT (In.)	VOLUME (Ft.^{3})	HEIGHT (In.)	VOLUME (Ft.^{3})	HEIGHT (In.)	VOLUME (Ft.^{3})
180	3,992.95	240	5,797.56	300	7,594.83
182	4,053.31	242	5,857.86	302	7,654.91
184	4,113.67	244	5,918.22	304	7,714.74
186	4,174.03	246	5,978.58	306	7,774.37
188	4,234.40	248	6,038.94	308	7,834.09
190	4,294.76	250	6,099.31	310	7,893.90
192	4,355.42	252	6,159.97	312	7,954.05
194	4,415.78	254	6,220.33	314	8,013.78
196	4,476.14	256	6,280.69	316	8,073.50
198	4,536.50	258	6,341.05	318	8,133.26
200	4,596.86	260	6,401.41	320	8,193.07
202	4,657.22	262	6,461.77	322	8,252.97
204	4,717.58	264	6,522.13	324	8,312.79
206	4,777.95	266	6,582.49	326	8,372.36
208	4,838.31	268	6,642.85	328	8,431.66
210	4,898.67	270	6,703.22	330	8,490.65
212	4,959.33	272	6,763.88	332	8,549.70
214	5,019.69	274	6,816.93	334	8,607.99
216	5,080.05	276	6,876.88	336	8,665.89
218	5,140.41	278	6,936.62	338	8,723.37
220	5,200.67	280	6,996.19	340	8,780.39
222	5,260.65	282	7,055.66	342	8,836.94
224	5,320.40	284	7,115.08	344	8,892.97
226	5,379.98	286	7,174.51	346	8,948.47
228	5,439.46	288	7,234.02	348	9,003.40
230	5,498.88	290	7,293.65	350	9,057.73
232	5,558.61	292	7,353.76	352	9,111.84
234	5,618.11	294	7,413.82	354	9,164.89
236	5,677.72	296	7,474.14	356	9,217.26
238	5,737.52	298	7,534.51	358	9,268.91

NOTE: Height is the distance above the LH2 tank reference station 248.574.

TABLE AP 6-6 (Sheet 3 of 3)
SATURN S-IVB-204 VOLUME VERSUS HEIGHT
LH2 TANK - GROUND LOADING CONDITION

HEIGHT (In.)	VOLUME ($Ft.^3$)	HEIGHT (In.)	VOLUME ($Ft.^3$)	HEIGHT (In.)	VOLUME ($Ft.^3$)
360	9,319.82	420	10,358.6		
362	9,369.96	422	10,372.1		
364	9,419.30	424	10,383.9		
366	9,467.81	426	10,394.0		
368	9,515.47	428	10,402.3		
370	9,562.23	430	10,408.9		
372	9,608.28	432	10,413.8		
374	9,653.18	434	10,416.8		
376	9,697.11	436	10,417.9		
378	9,740.04				
380	9,781.93				
382	9,822.75				
384	9,862.49				
386	9,901.11				
388	9,938.57				
390	9,974.87				
392	10,010.1				
394	10,044.0				
396	10,076.5				
398	10,107.7				
400	10,137.8				
402	10,164.4				
404	10,193.6				
406	10,219.4				
408	10,243.8				
410	10,266.7				
412	10,288.5				
414	10,308.4				
416	10,326.7				
418	10,343.5				

NOTE: Height is the distance above the LH2 tank reference station 248.574.

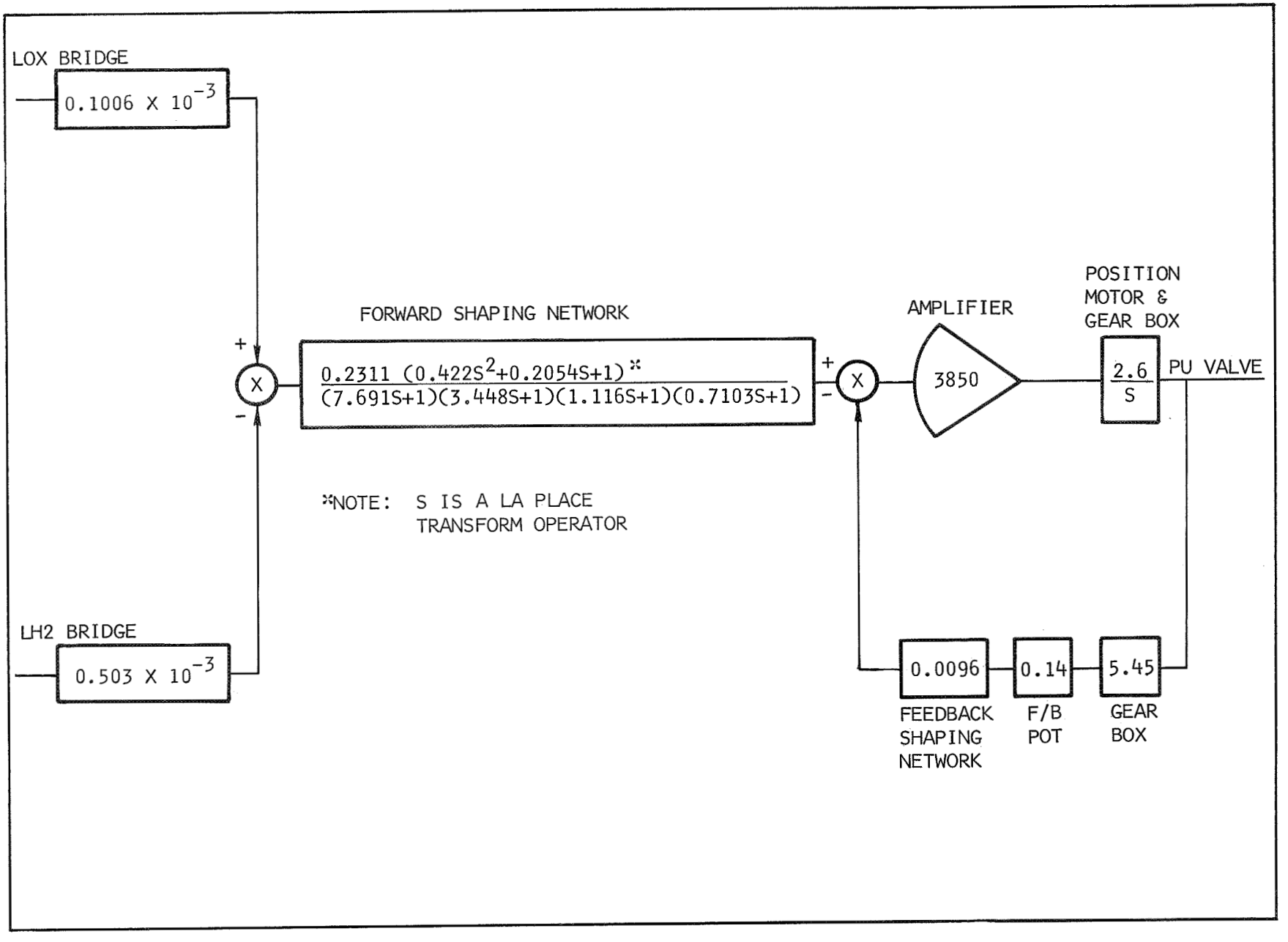


Figure AP 6-1. S-IVB-204 PU System Block Diagram

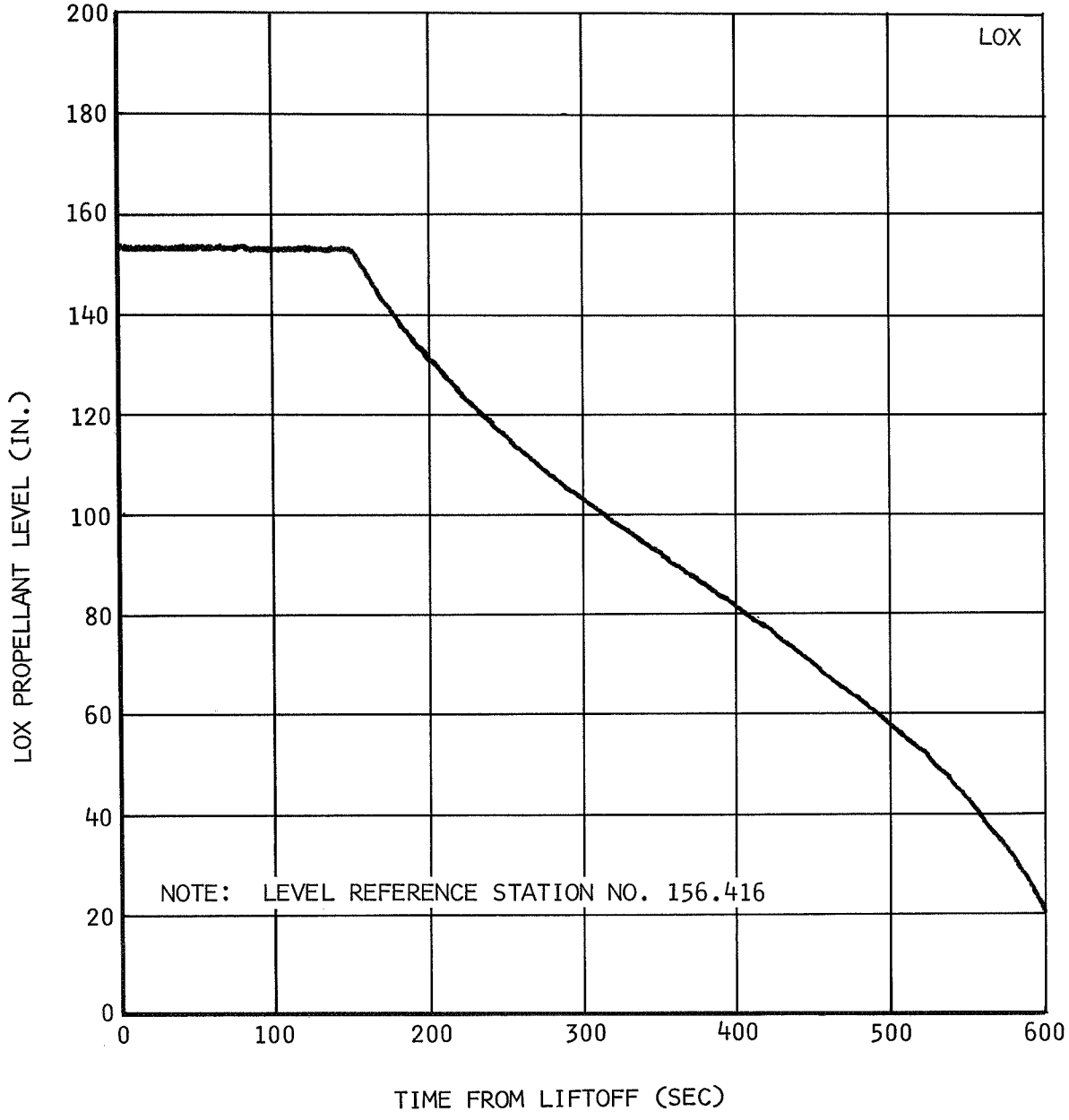


Figure AP 6-2. Predicted Propellant Level Histories (Sheet 1 of 2)

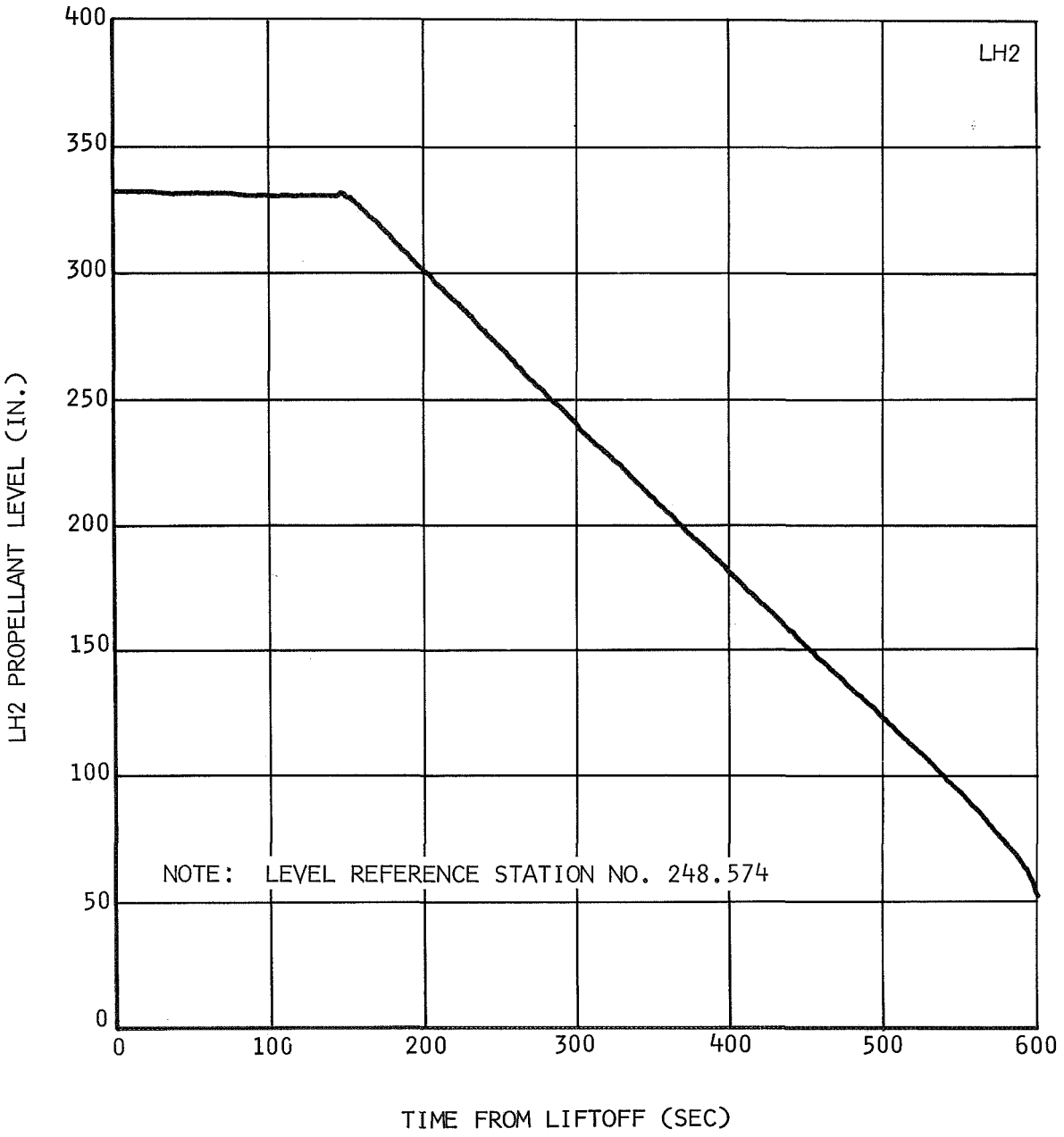


Figure AP 6-2. Predicted Propellant Level Histories (Sheet 2 of 2)

16 December 1967

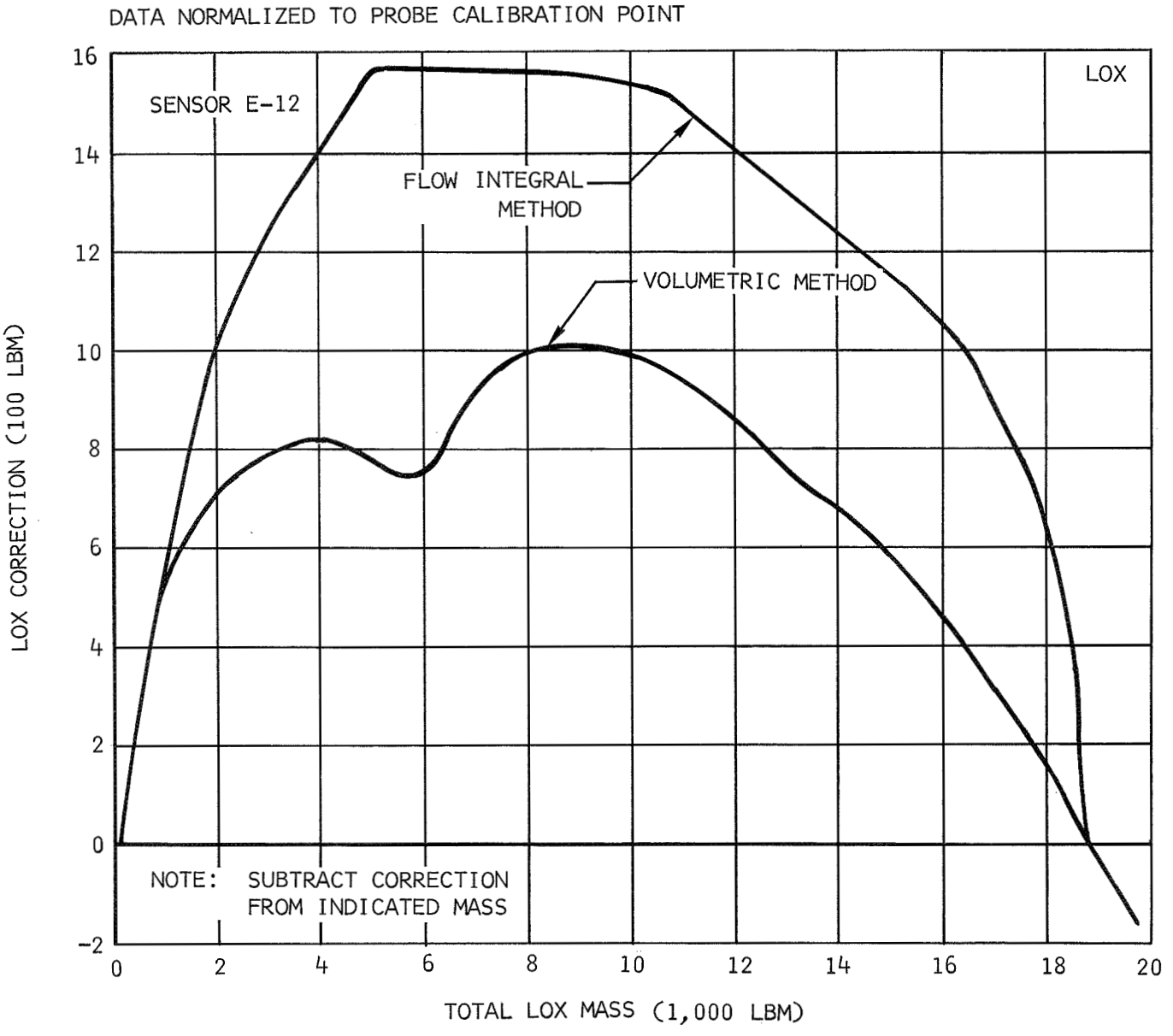


Figure AP 6-3. Tank to Sensor Mismatches Including Manufacturing Nonlinearities (Sheet 1 of 2)

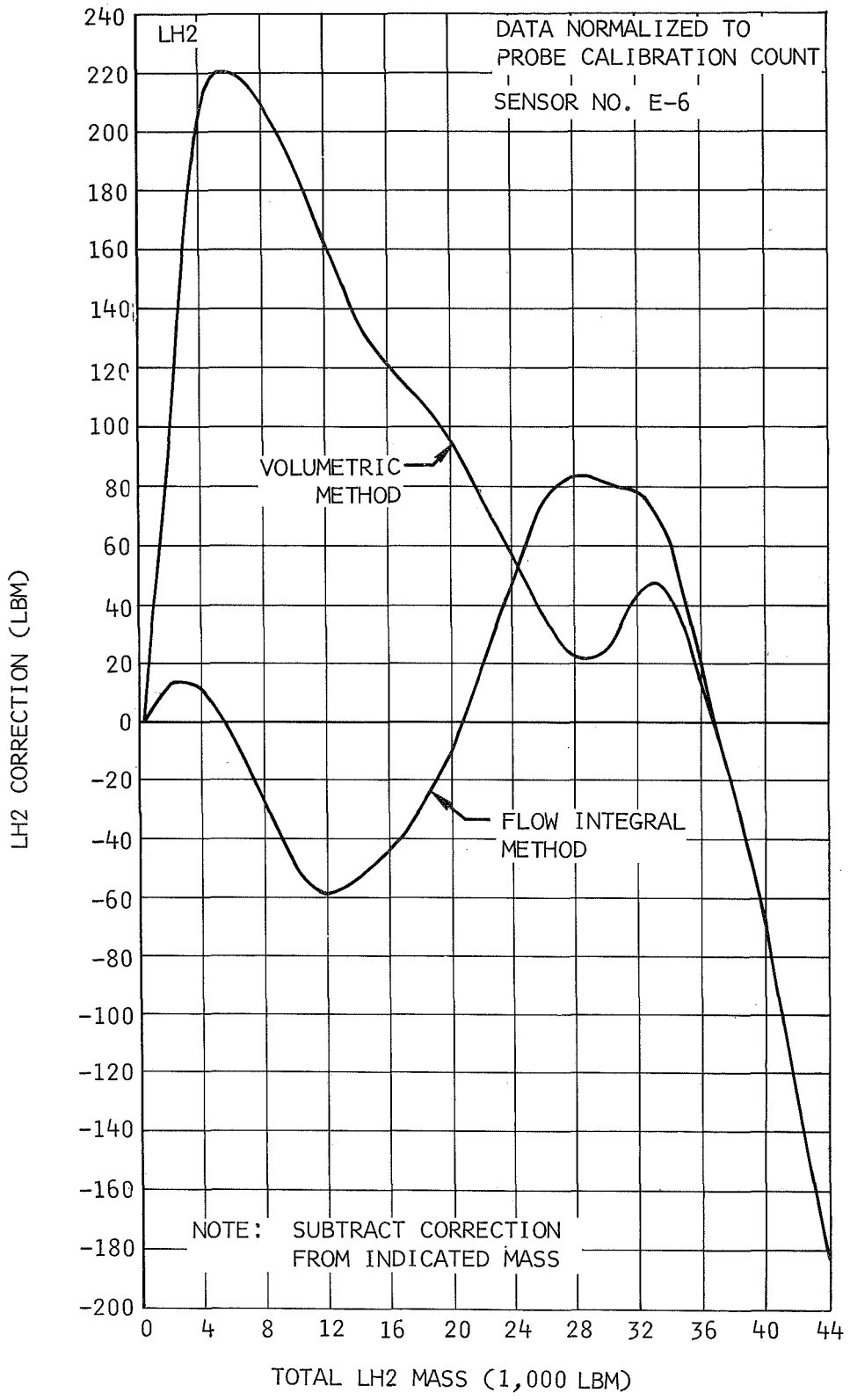


Figure AP 6-3. Tank to Sensor Mismatches Including Manufacturing Nonlinearities (Sheet 2 of 2)

16 December 1967

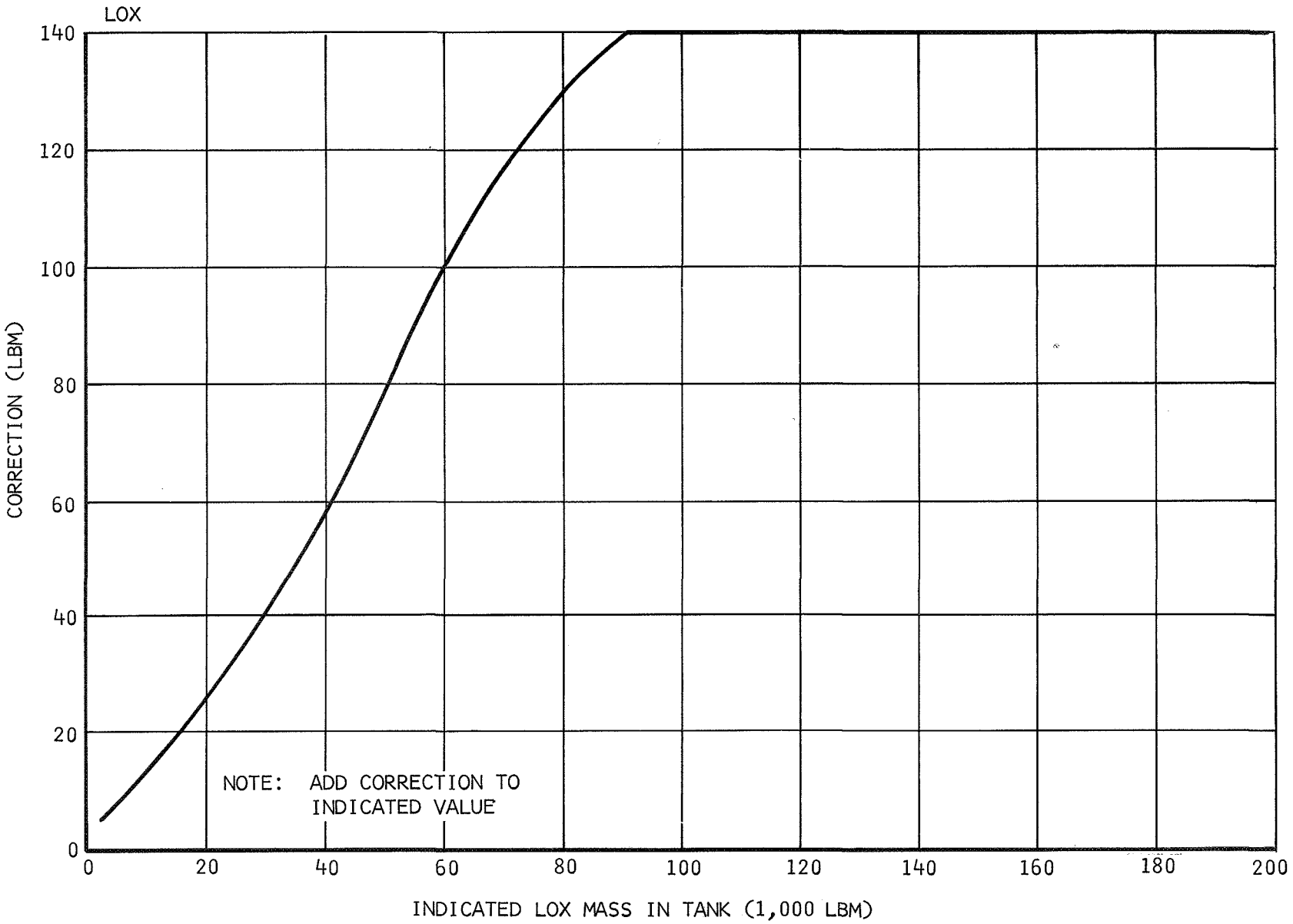


Figure AP 6-4. Predicted Sensor Correction for Flight Dynamic Effects (Sheet 1 of 2)

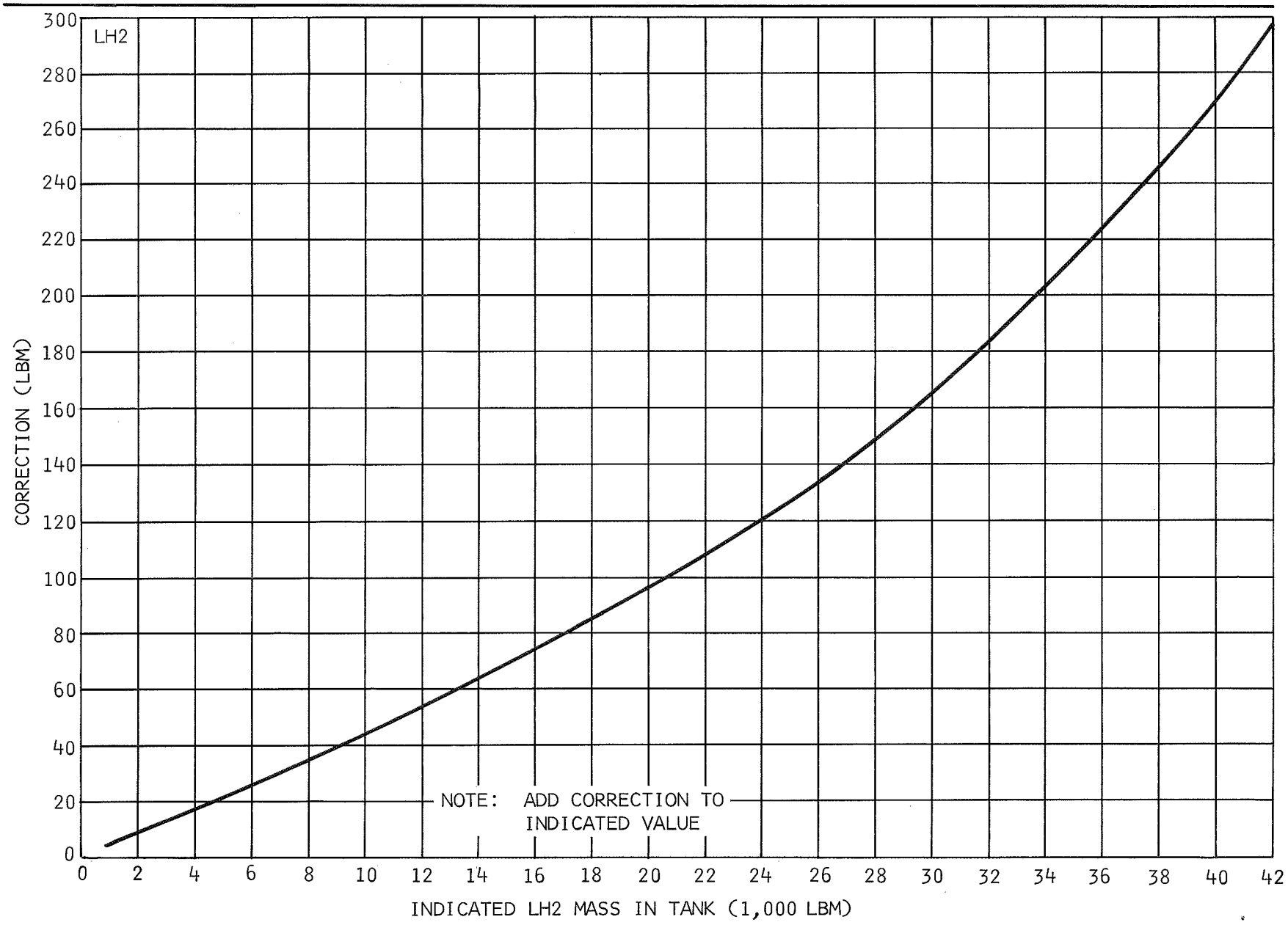


Figure AP 6-4. Predicted Sensor Correction for Flight Dynamics Effects (Sheet 2 of 2)

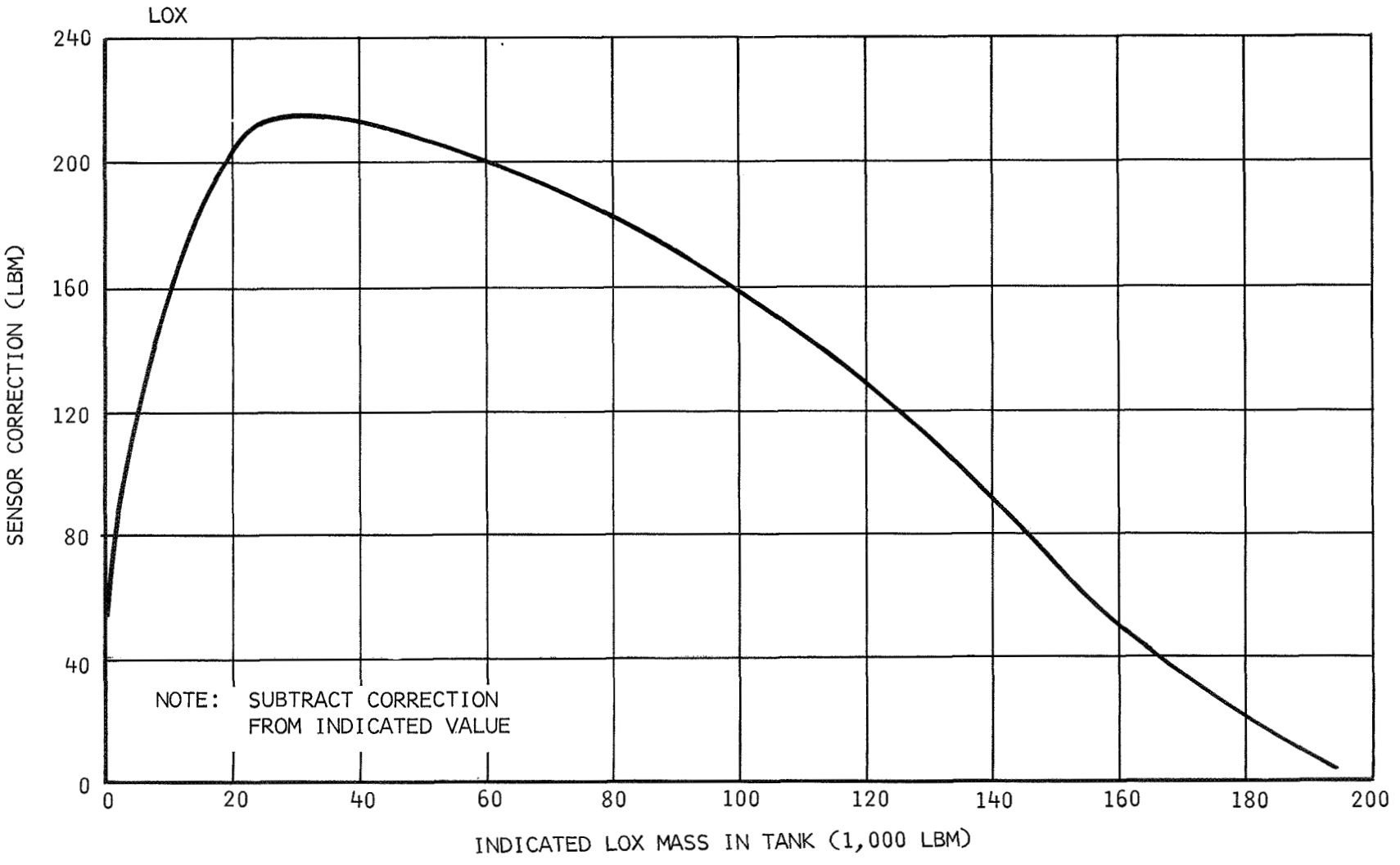


Figure AP 6-5. Mass Sensor Corrections for Center-of-Gravity Offset (Sheet 1 of 2)

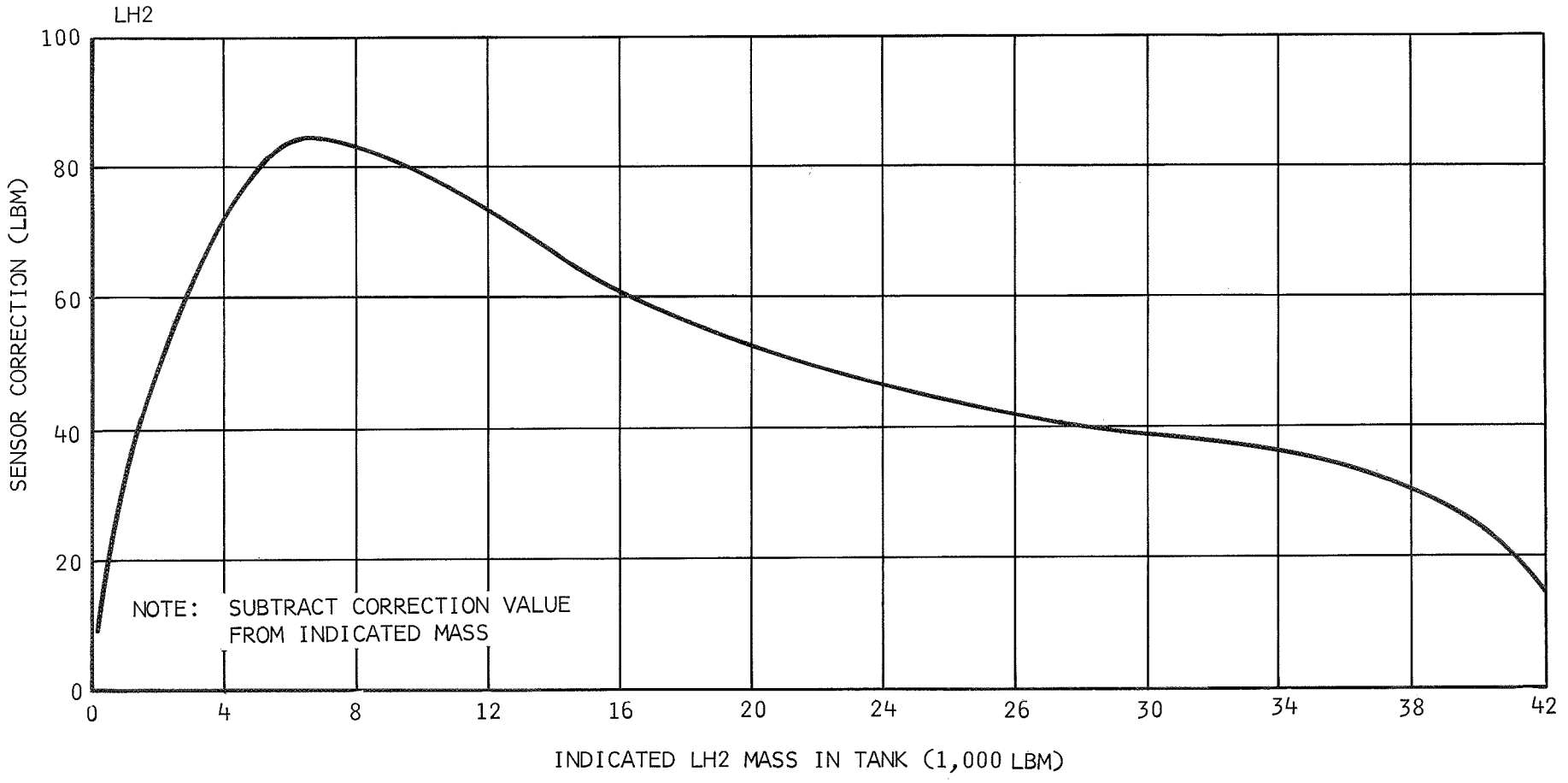


Figure AP 6-5. Mass Sensor Corrections for Center-of-Gravity Offset (Sheet 2 of 2)

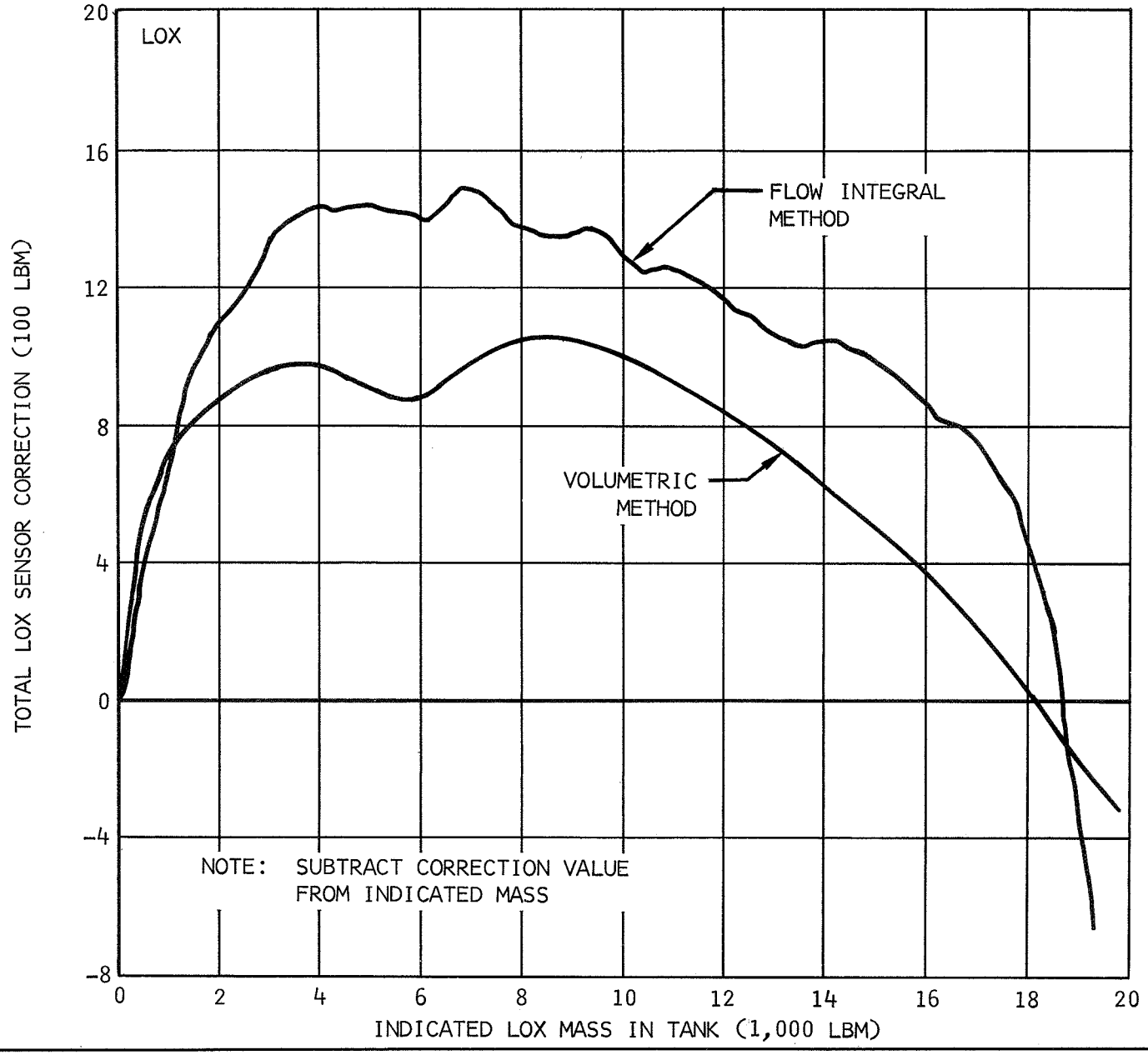


Figure AP 6-6. Total Flight LH2 and LOX Sensor Corrections (Sheet 1 of 2)

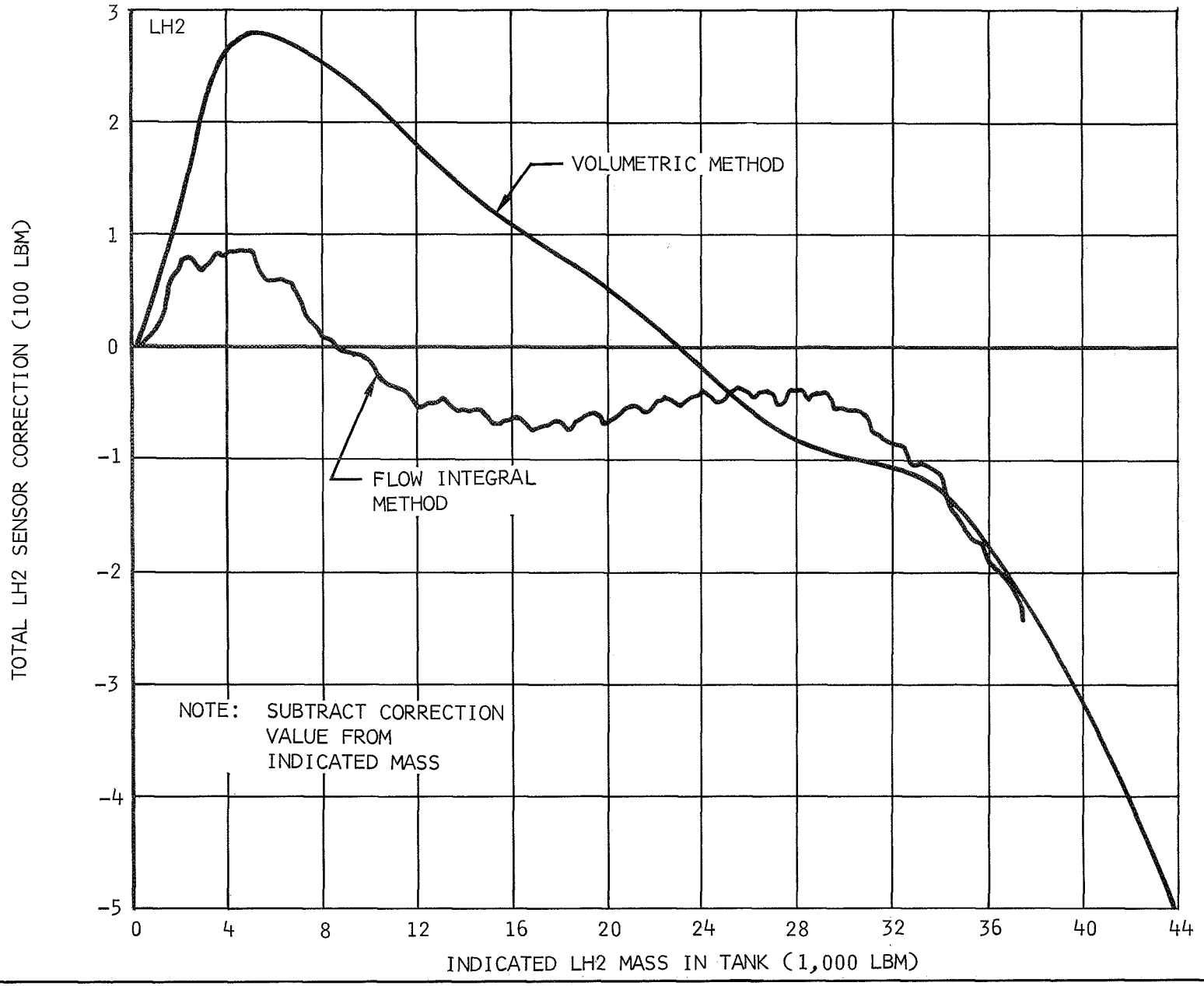


Figure AP 6-6. Total Flight LH2 and LOX Sensor Corrections (Sheet 2 of 2)

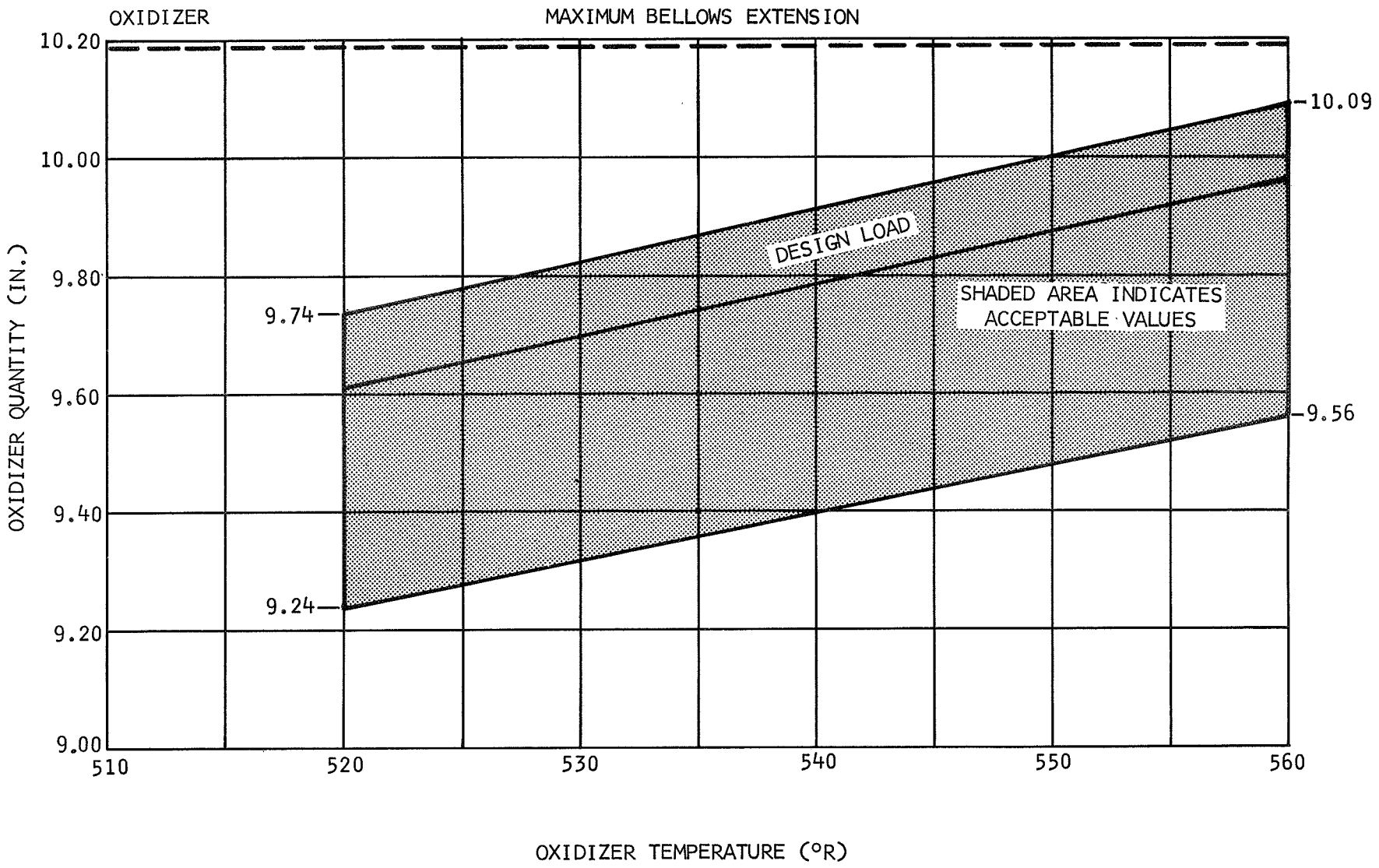


Figure AP 6-7. APS Loading Requirements (Sheet 1 of 2)

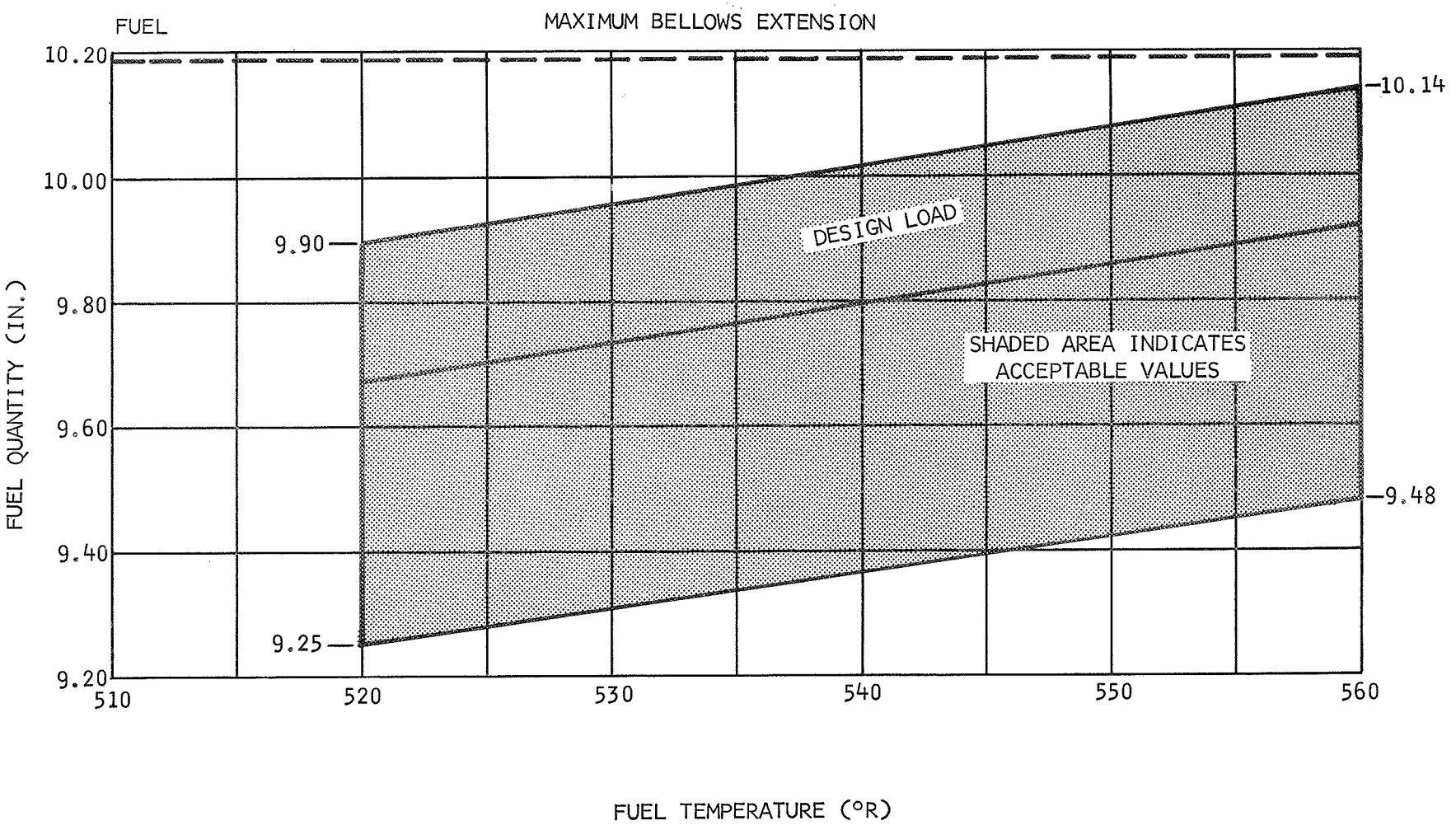


Figure AP 6-7. APS Loading Requirements (Sheet 2 of 2)

APPENDIX 7

PREDICTED SEPARATION AND CONTROL PERFORMANCE

7. PREDICTED SEPARATION AND CONTROL PERFORMANCE

7.1 General

This appendix contains predicted control performance curves (figures AP 7-1 through AP 7-3), predicted preflight control transient simulations (figure AP 7-4), and predicted stage separation (figures AP 7-5 and AP 7-6).

7.2 Predicted Preflight Control Transient Simulations

Body attitude transients of varying magnitude are expected following S-IB/S-IVB separation, active guidance initiation and introduction to Chi Tilde guidance mode. The results of a digital control simulation program during these flight periods include graphical presentations of attitude errors, APS and engine deflection histories (figure AP 7-4). The simulation program solves the three rotational degrees of freedom vehicle equations of motion; including main engine control system equations (with servo-loop nonlinearities), roll control system equations, representing aerodynamic forces, propellant sloshing forces, ullage rocket and main engine thrust vector misalignments.

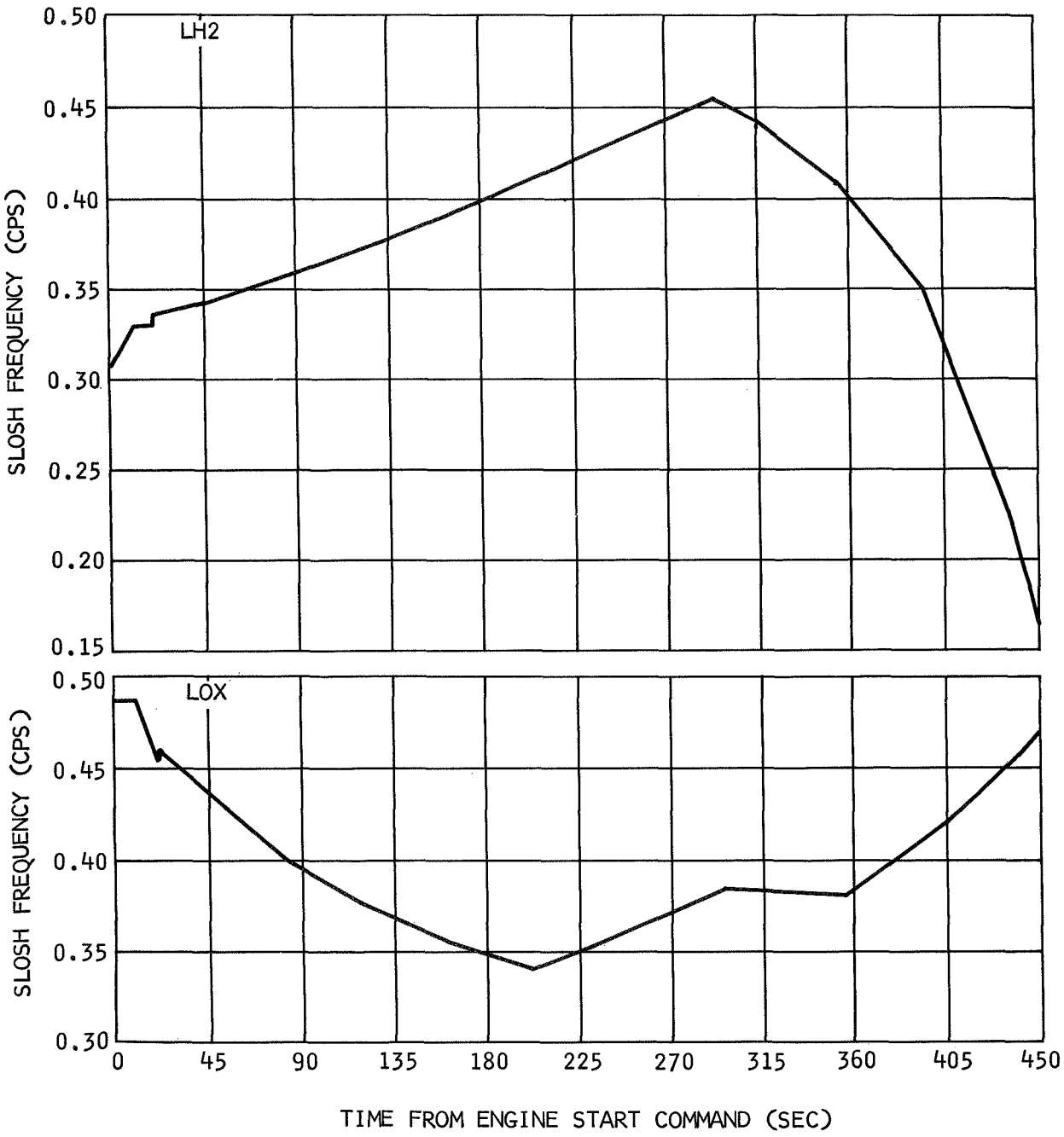


Figure AP 7-1. Propellant Slosh Frequency

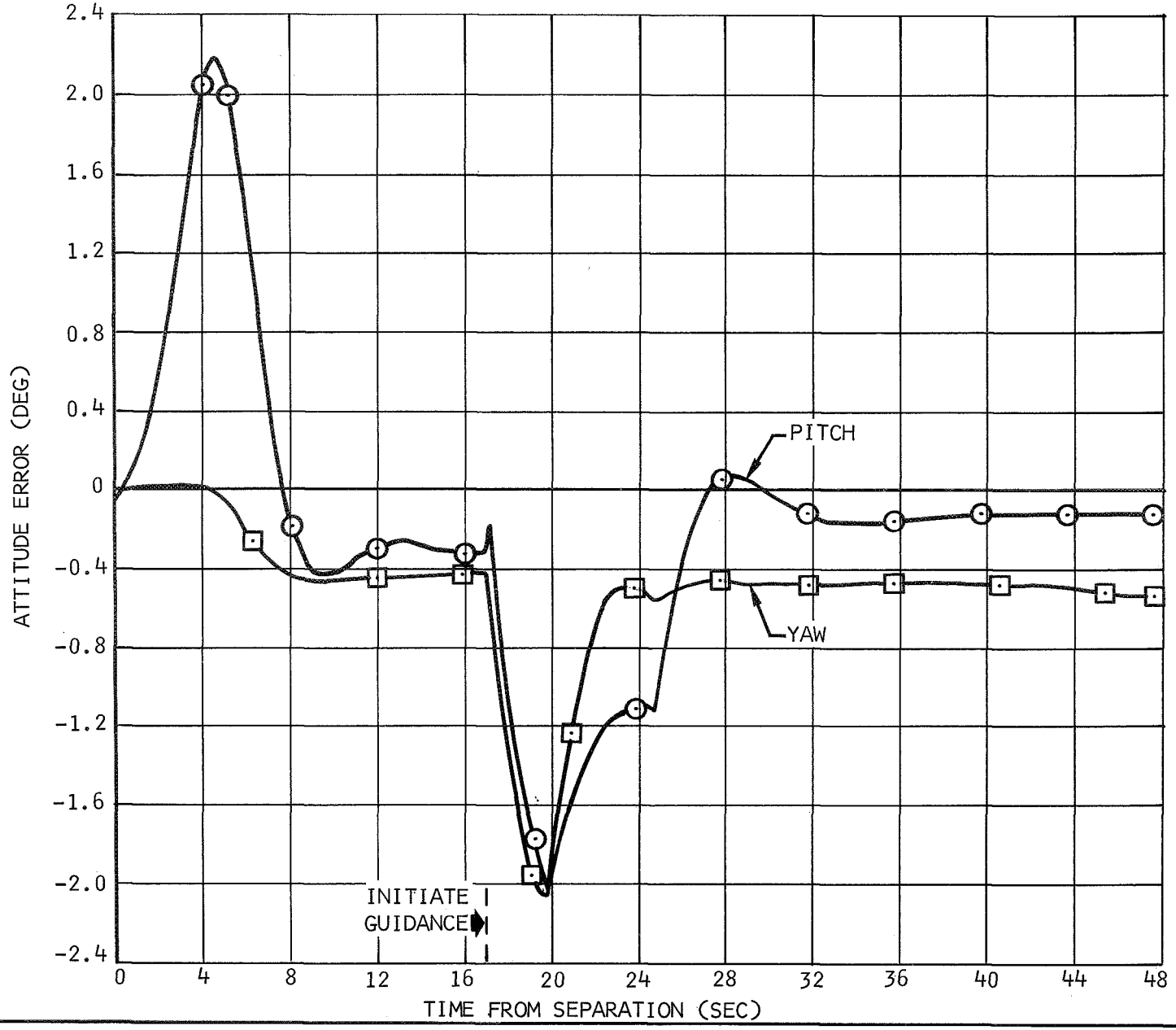


Figure AP 7-2. Attitude Error History

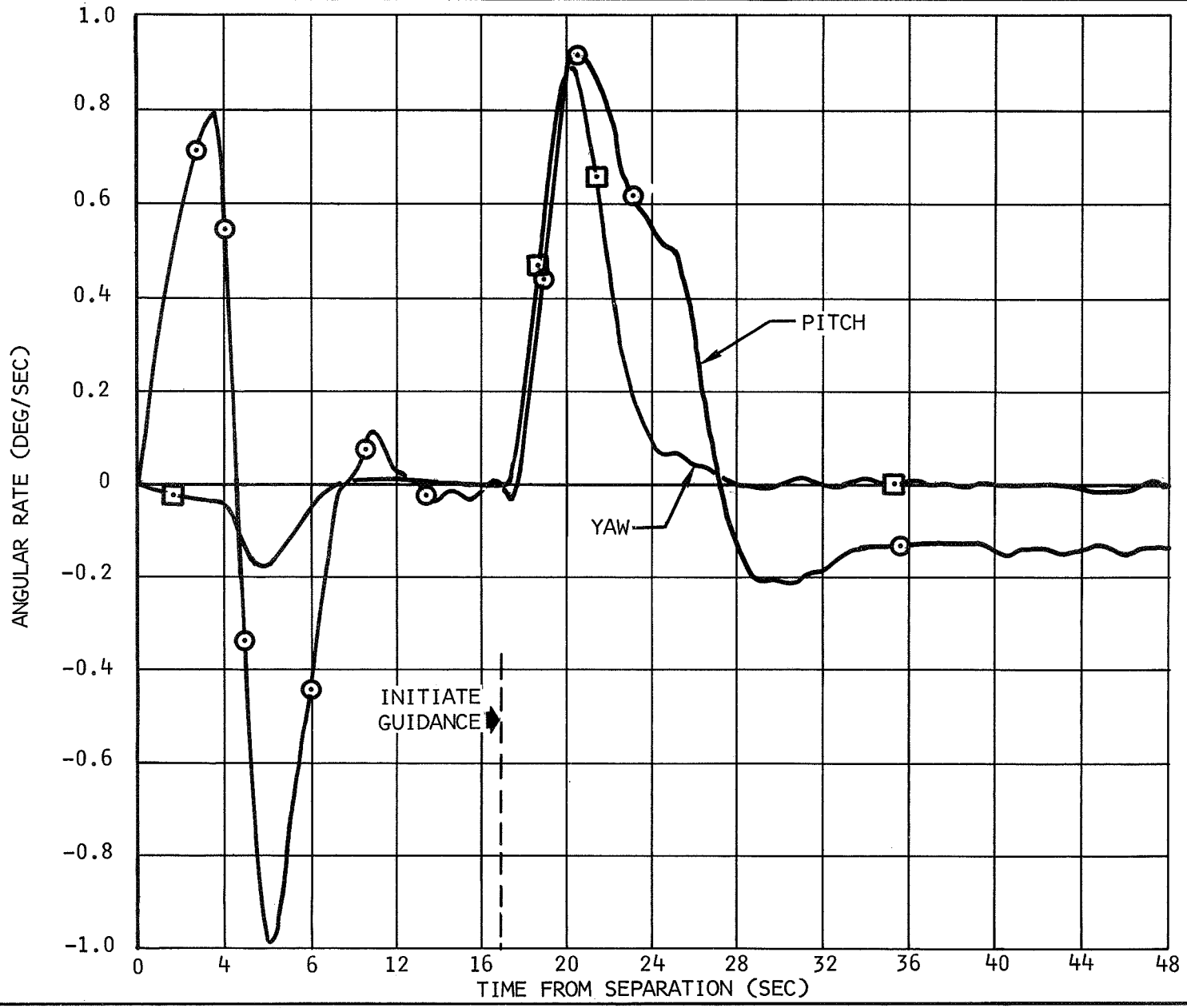


Figure AP 7-3. Angular Rate History

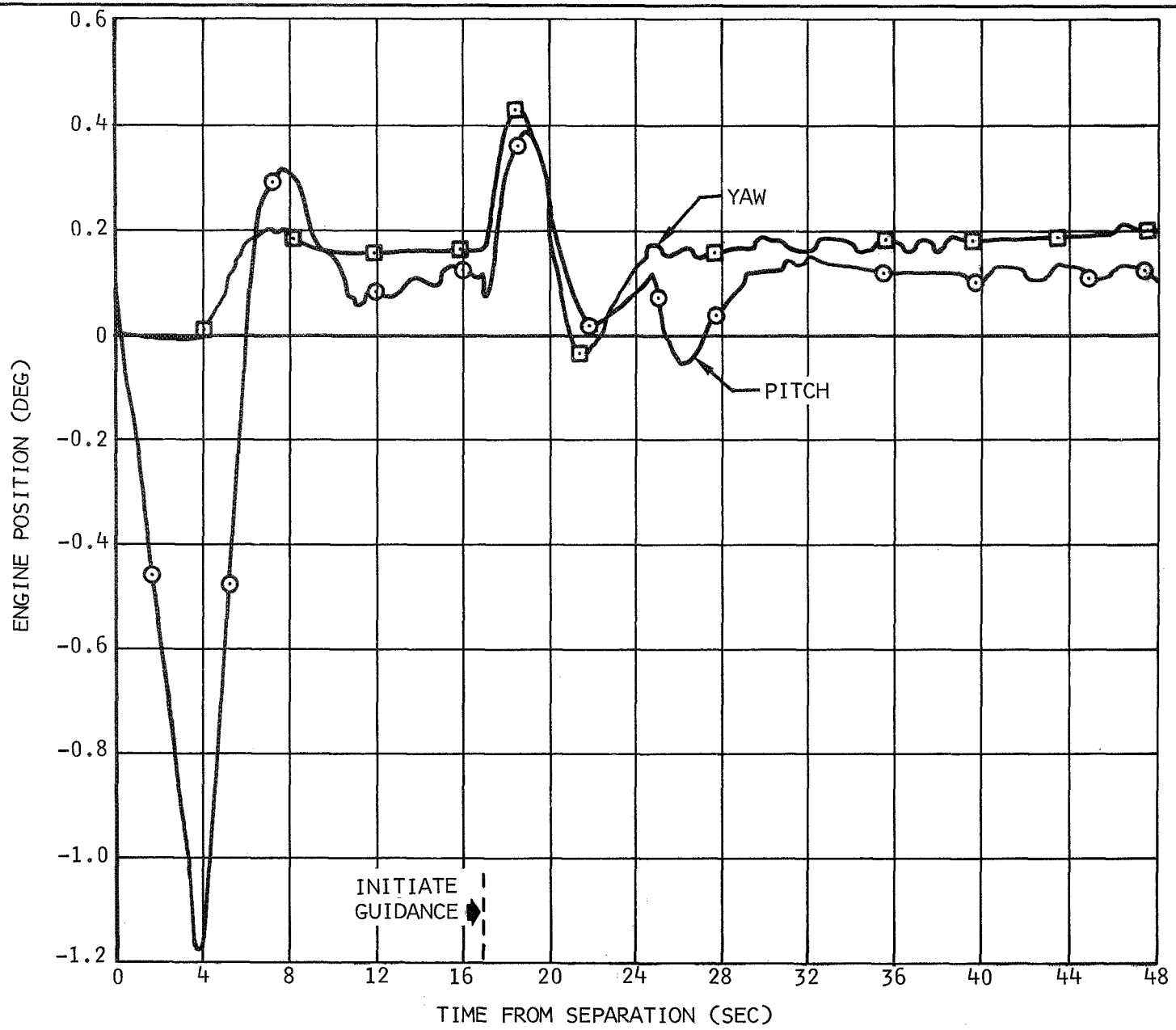


Figure AP 7-4. Engine Position History

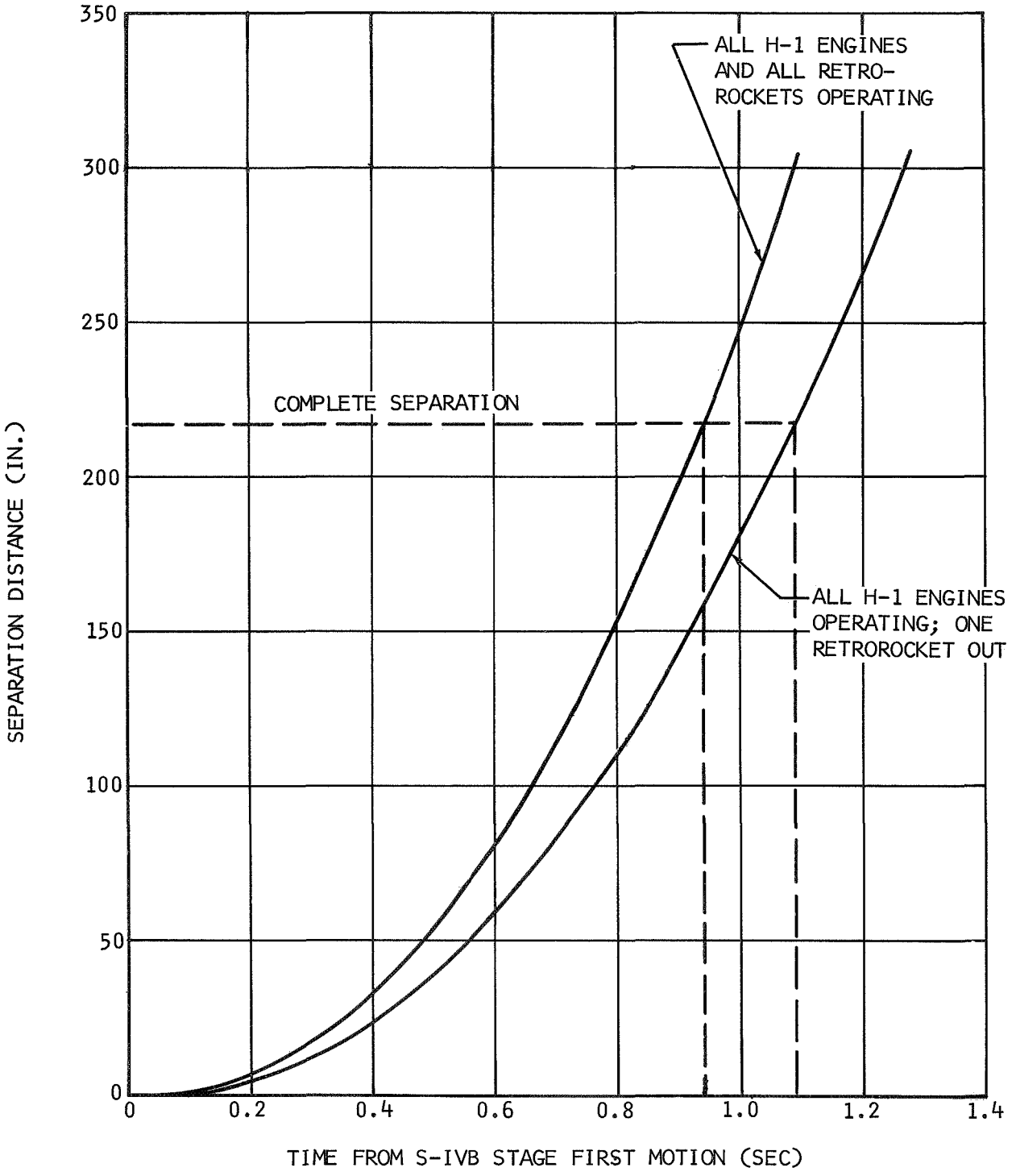


Figure AP 7-5. AS-204 S-IB/S-IVB Predicted Separation History

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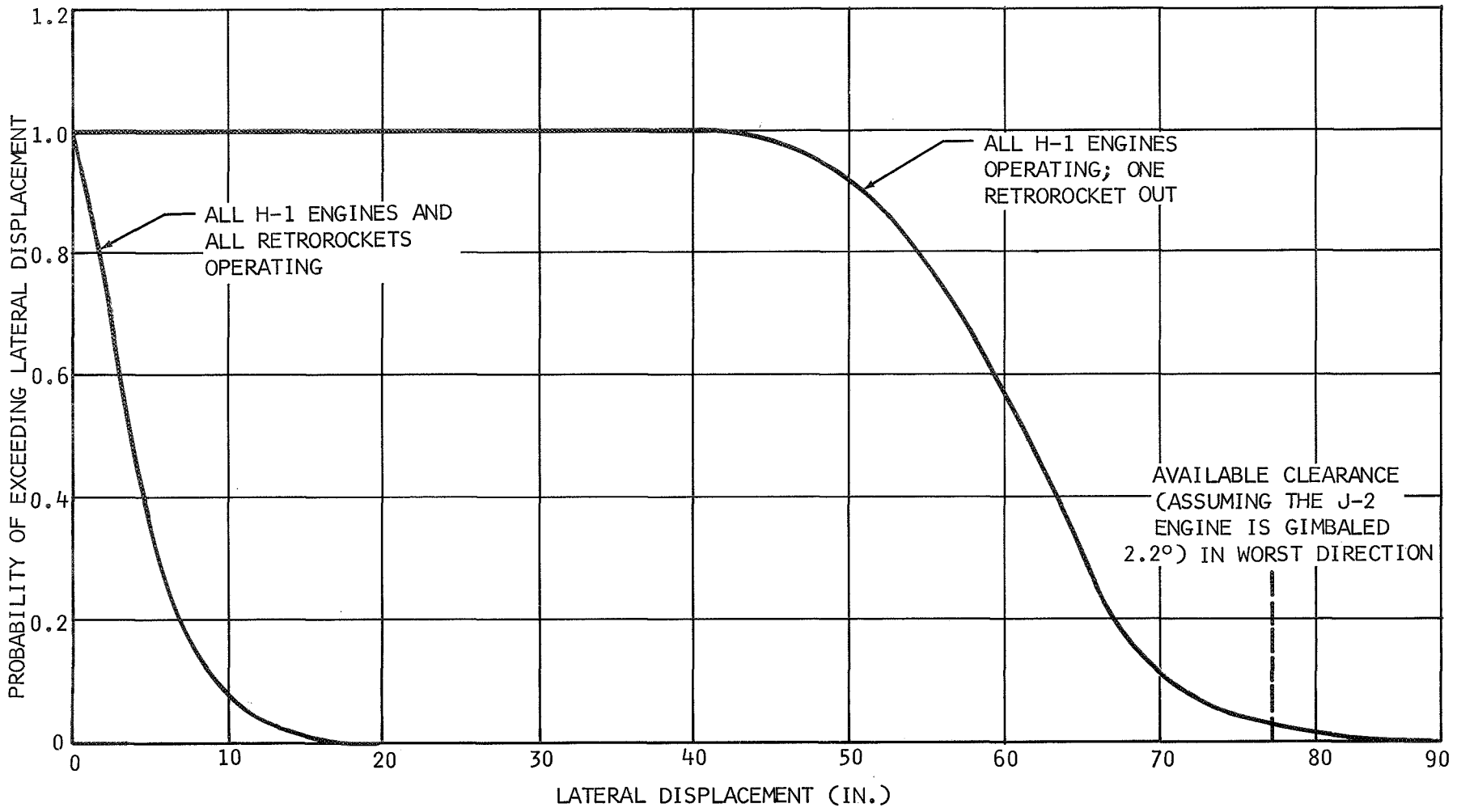

Figure AP 7-6. AS-204 S-IB/S-IVB Separation Probability of Lateral Displacement Exceeding a Specified Value

APPENDIX 8

ADDITIONAL PREDICTED PERFORMANCE DATA

8. ADDITIONAL PREDICTED PERFORMANCE DATA

This appendix presents additional predicted performance data and design performance levels.

Figure AP 8-1 presents predicted S-IVB-204 hydraulic system operating levels, which are based upon acceptance firing data. Figures AP 8-2 through AP 8-5 show the forward and aft predicted battery load profiles based on the S-IVB-204 acceptance firing performance. Figure AP 8-6 depicts the predicted envelopes of composite vibration and acoustic levels for the S-IVB-204 stage during flight. These predictions were based on data from past Saturn IB flights and S-IVB acceptance firing. A predicted envelope of the dynamic peak strain time-history is presented in figure AP 8-7. This prediction was based on the results from the wind tunnel tests of a section of the forward skirt.

The data acquisition system performance levels include the following:

a. Radio Frequency

1. The signal strength of each RF link shall be greater than five microvolts at the receiver of one or more ground stations. The time shall be from acquisition at any station to loss of signal at that station.

2. The output of all RF amplifiers shall be 25 watts minimum under all operative and environmental conditions.

3. The RF insertion loss between the power amplifier output and the input to any of the applicable antennas shall not exceed 8 db.

4. The VSWR as computed from forward and reflected power of the antenna elements, shall not exceed 1.7:1.

b. Accuracy of FM/FM telemetry systems Nos. 1, 2, 3 and SSB/FM system

1. Each VCO center frequency and bandedge frequency at the calibration points should be ± 5 percent as compared to ground calibration.

2. Amplitude of the calibration signal for each channel of the SSB/FM system should be ± 15 percent as compared to the ground calibration.

c. Accuracy of PAM/FM/FM and PCM/FM

1. Correlation of PAM and PCM data shall be within three percent.

d. Inflight Tape Recorder

1. The tape recorder, fast-record and playback speed shall become stabilized to design tolerance within 4 sec after turn-on

2. Wow and flutter, after stabilization of tape speed shall be within the design tolerance of 1 percent, root-mean-square (RMS) of mean speed under any and all environmental conditions encountered

3. Recovered recorded data after tape speed compensation shall agree with real time data within the tolerance:

1.5 percent of full scale	FM/FM
0.5 percent of full scale	PAM/FM/FM
3.0 percent of full scale	PCM/FM

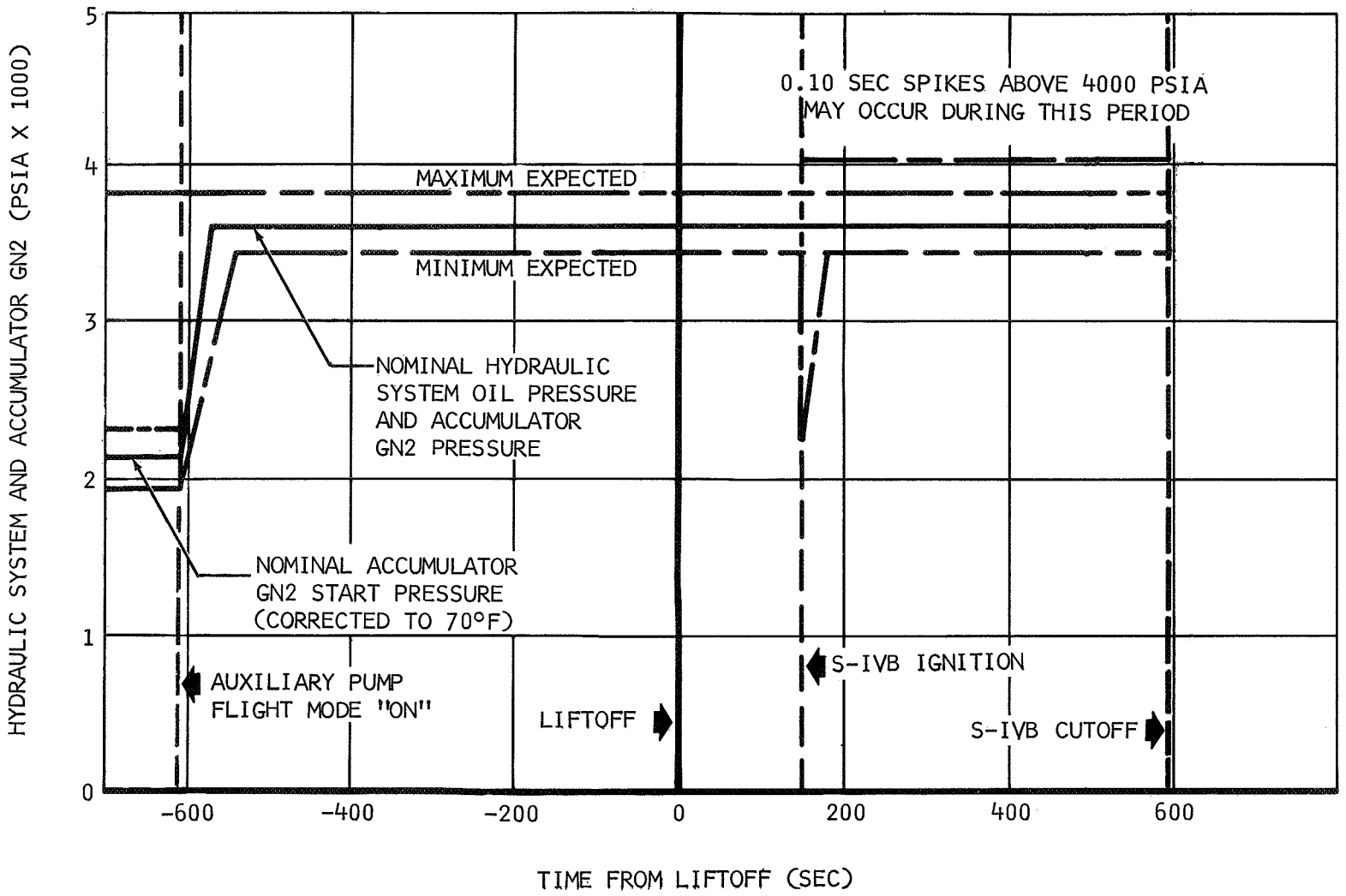

Figure AP 8-1. Predicted S-IVB-204 Hydraulic Operating Limits

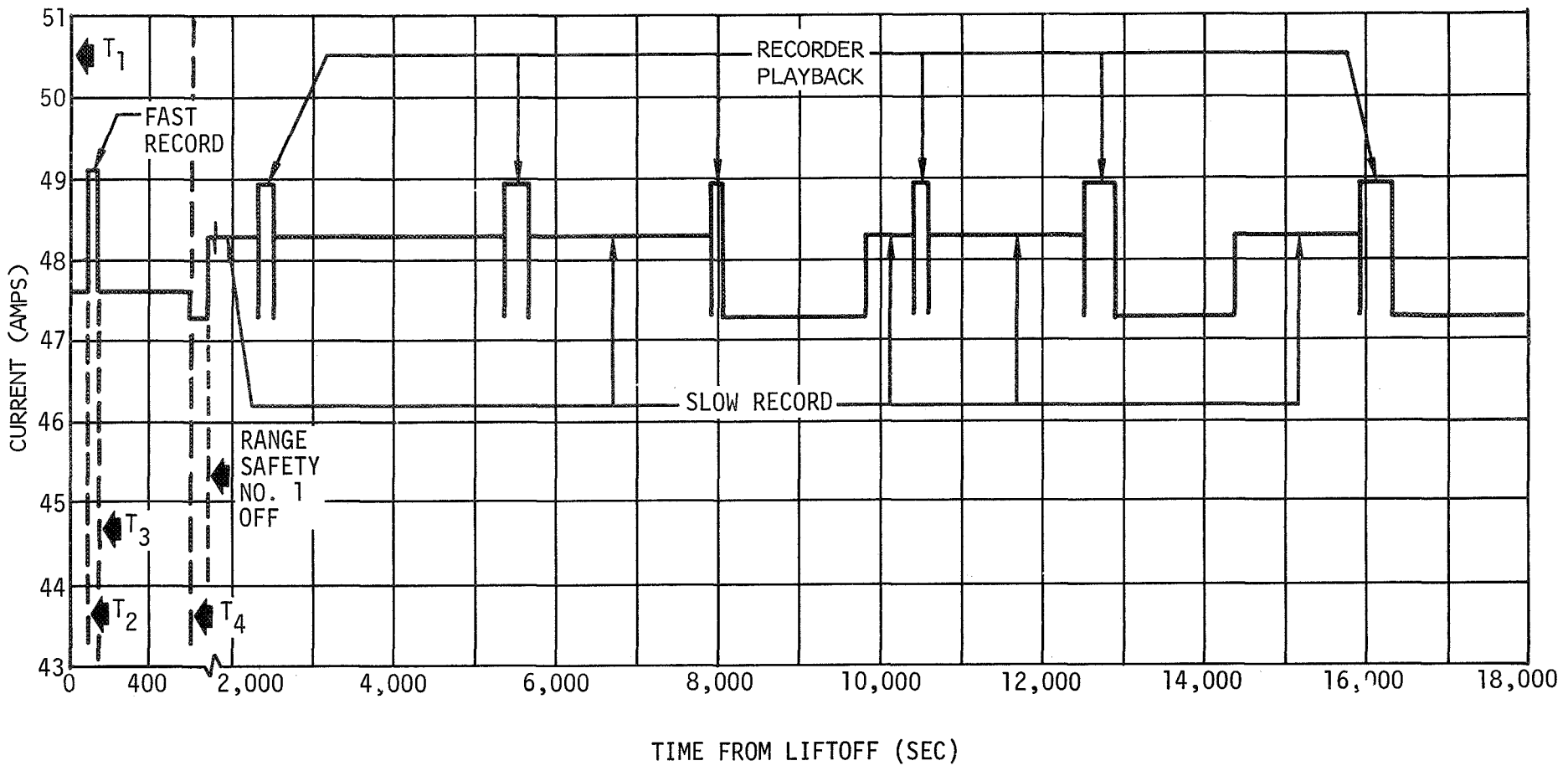

Figure AP 8-2. Predicted Load Profile For Forward Battery No. 1

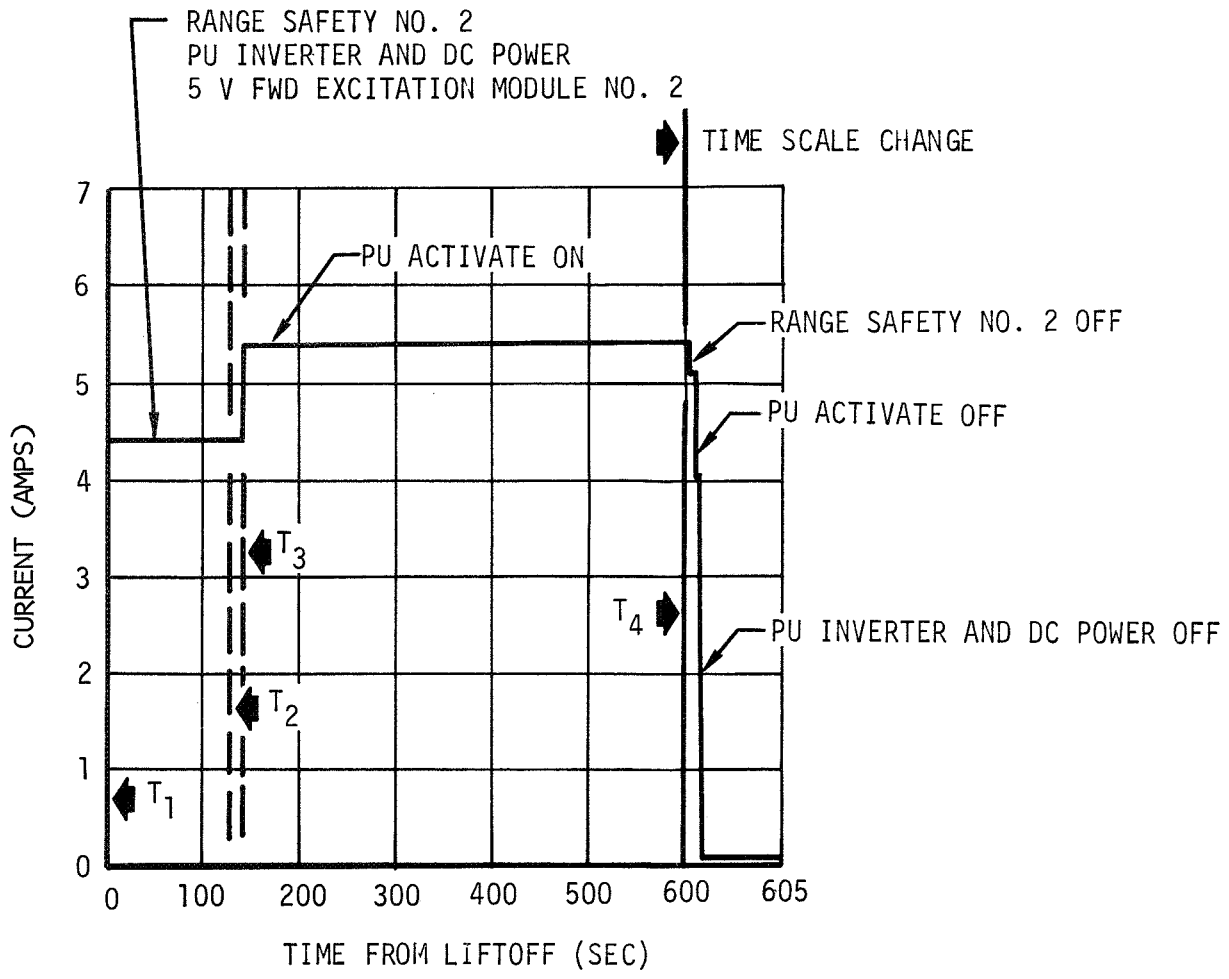

Figure AP 8-3. Predicted Load Profile For Forward Battery No. 2.

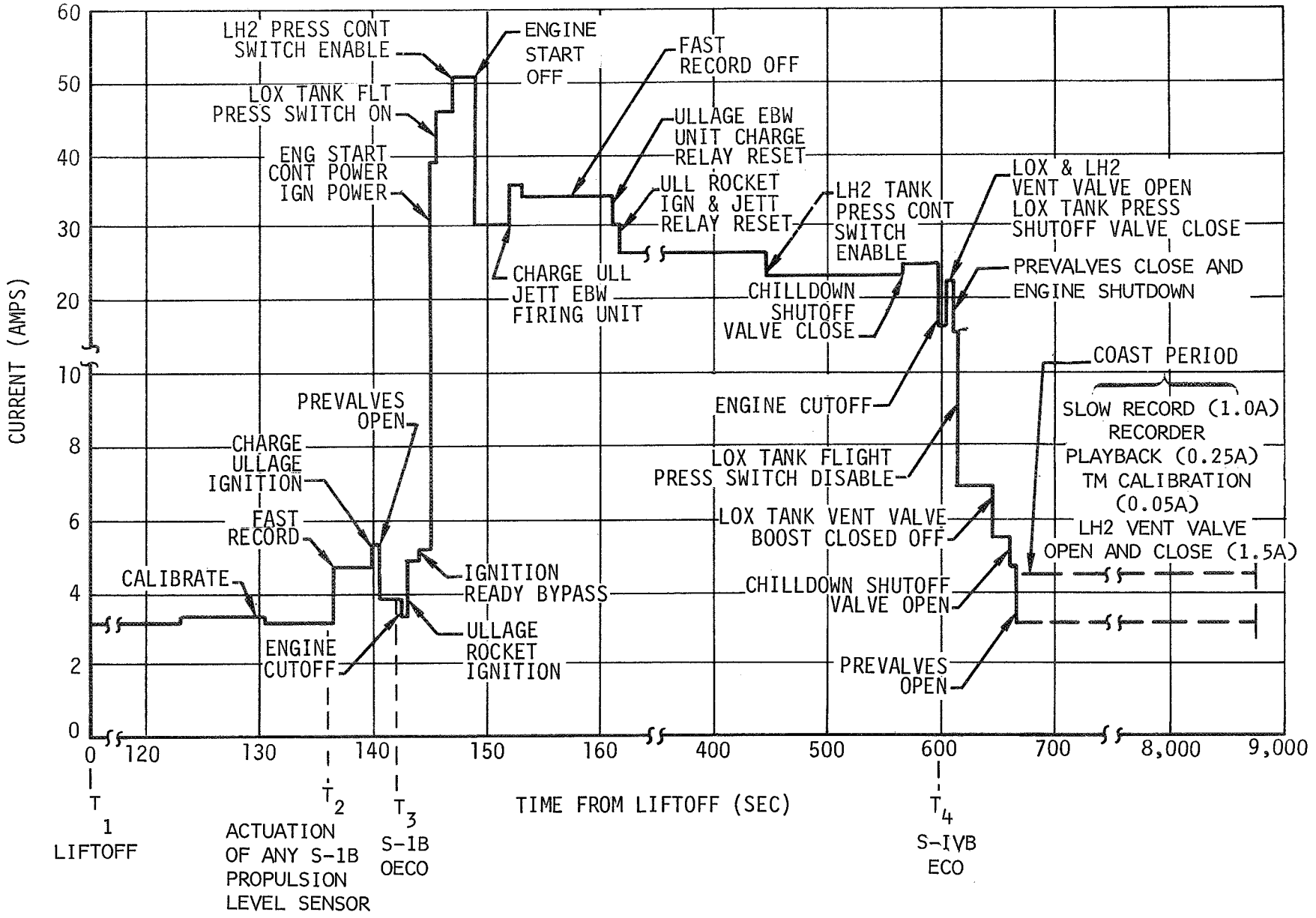

Figure AP 8-4. Predicted Load Profile For Aft Battery No. 1 (Sheet 1 of 2)

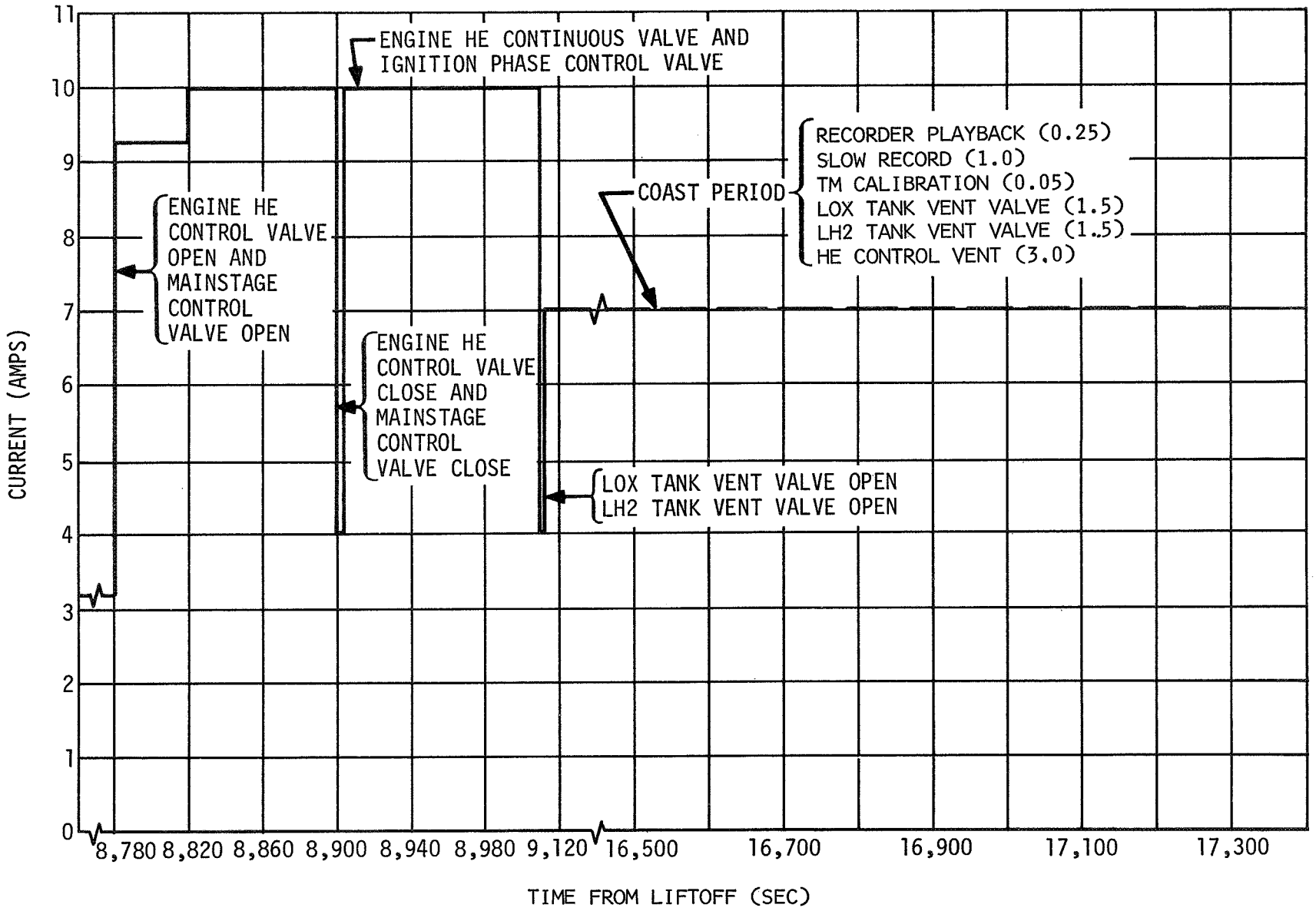

Figure AP 8-4. Predicted Load Profile For Aft Battery No. 1 (Sheet 2 of 2)

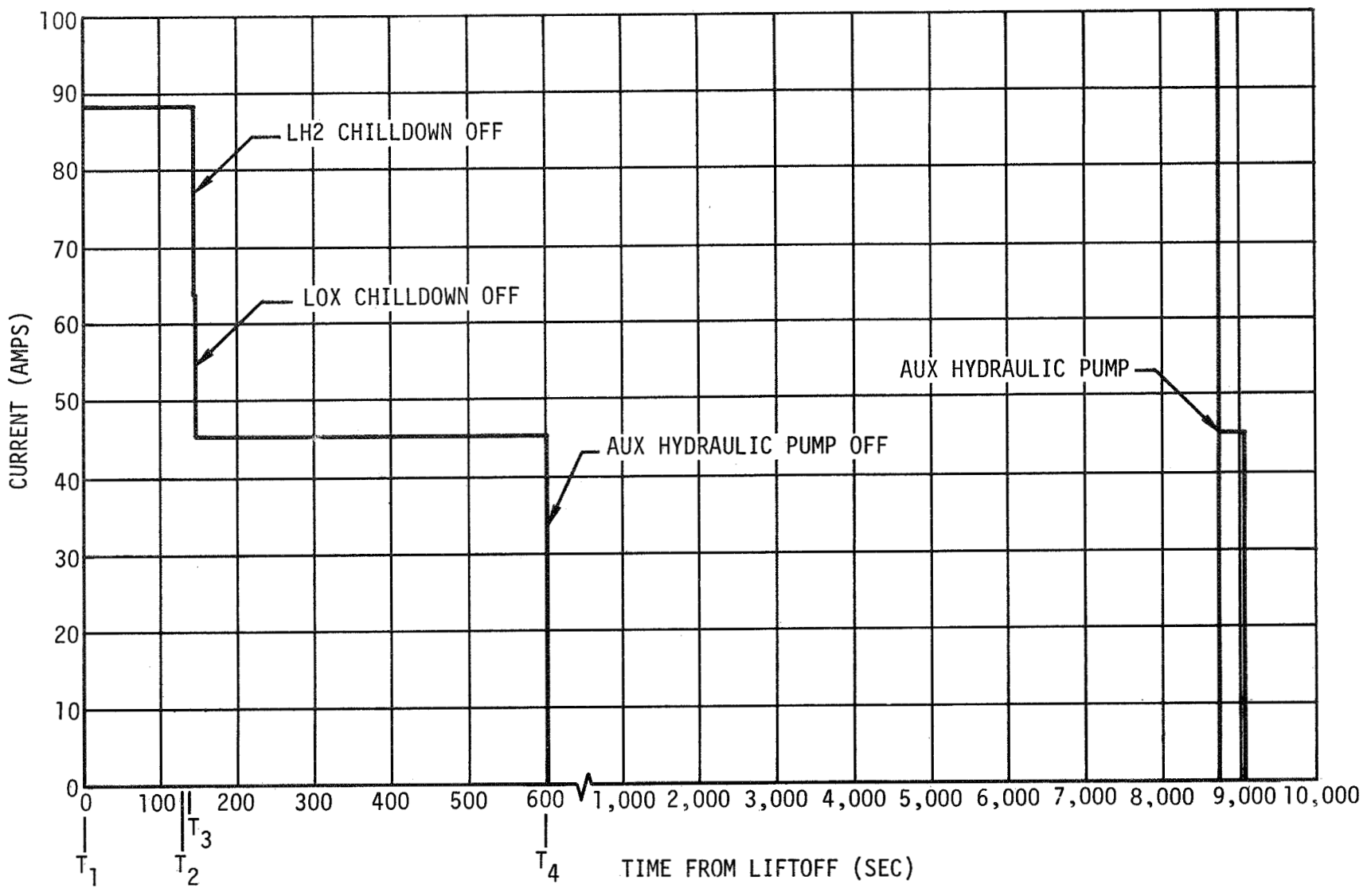

Figure AP 8-5. Predicted Load Profile For Aft Battery No. 2.

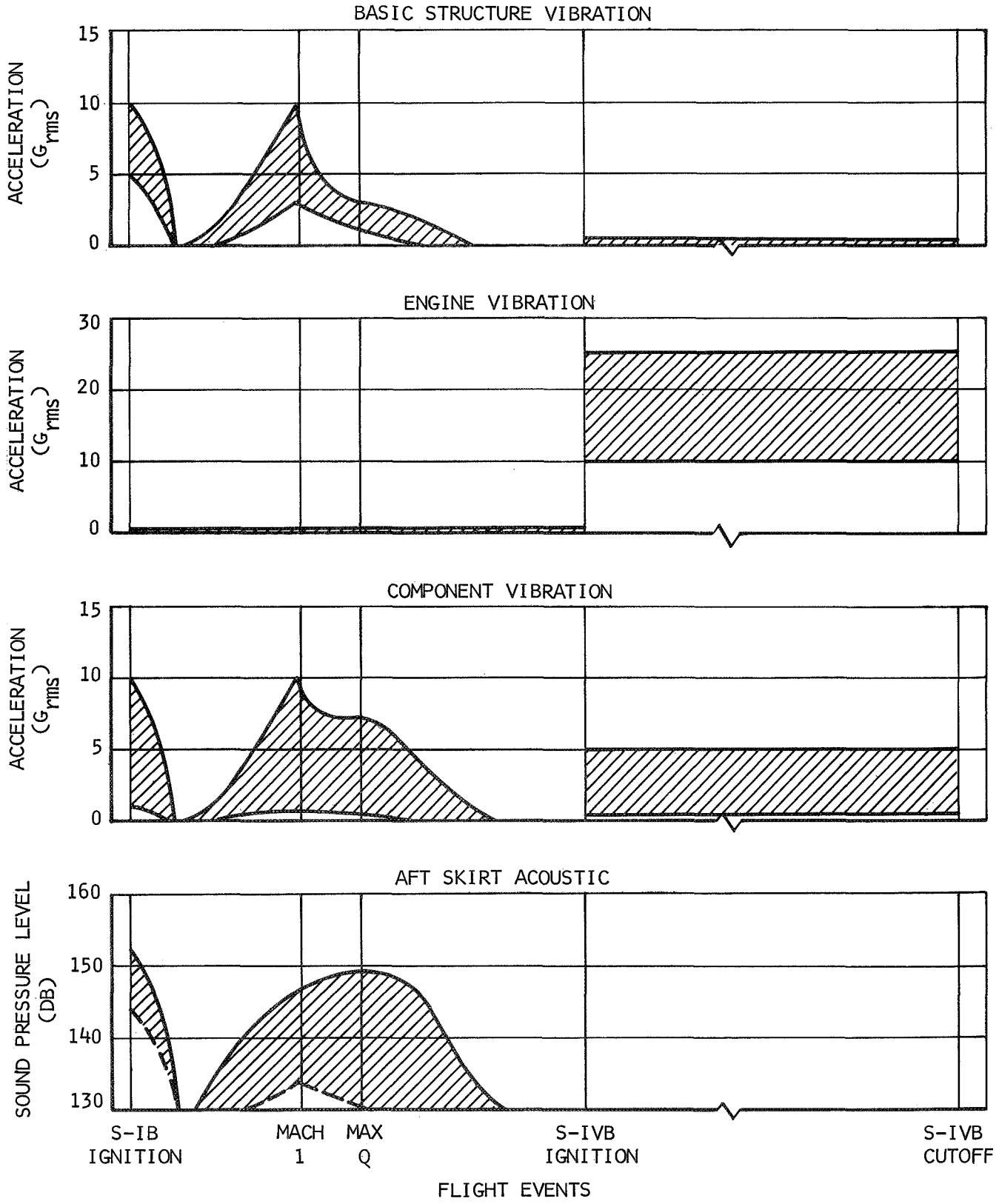

Figure AP 8-6. Predicted Envelopes of Composite Vibration and Acoustic Levels for S-IVB-204 Stage During Flight

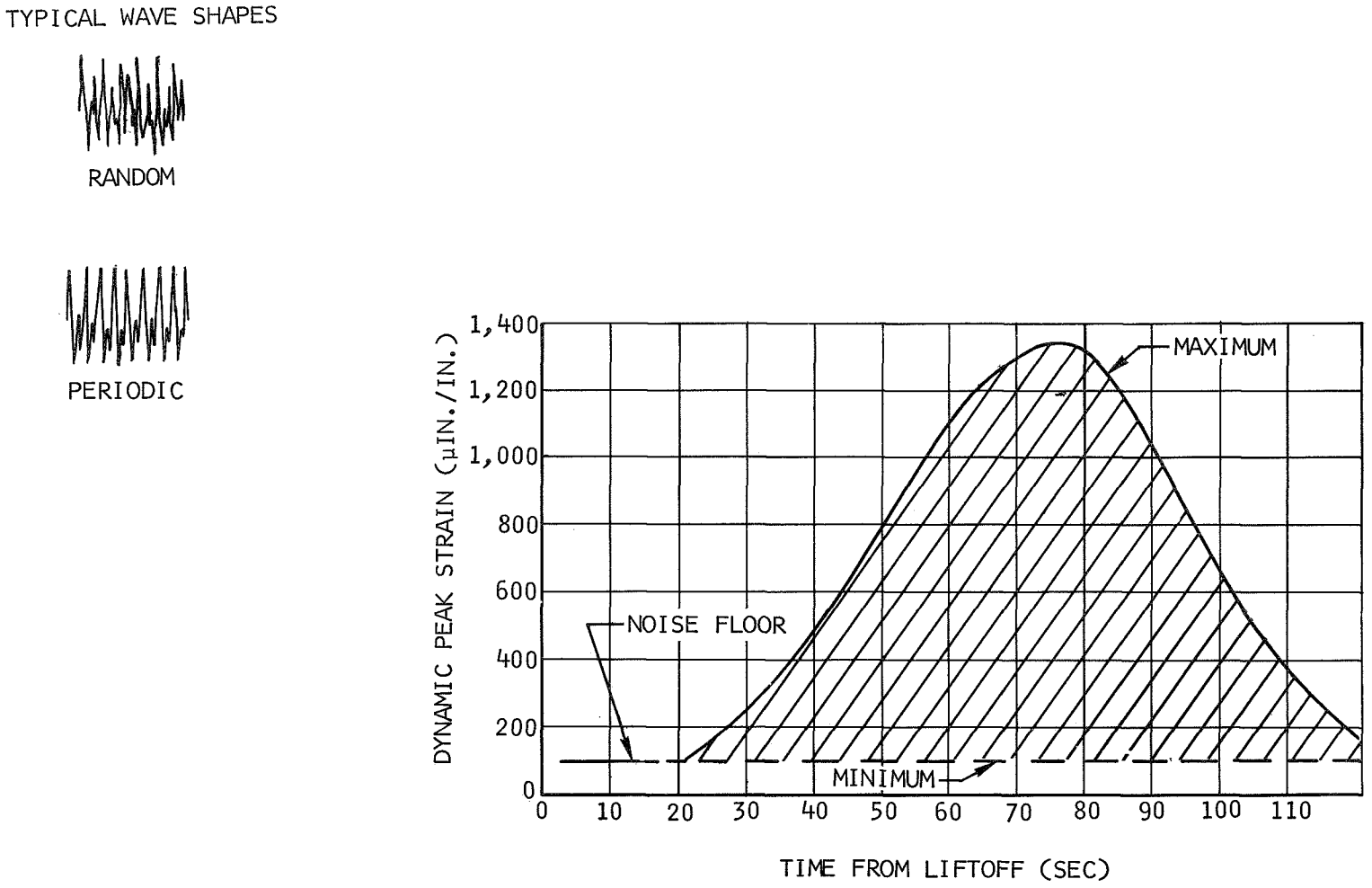

Figure AP 8-7. Predicted Envelope of Dynamic Peak Strain on S-IVB-204 Forward Skirt Skin Panels During Flight

APPENDIX 9

RADIO FREQUENCY ALLOCATION

9. RADIO FREQUENCY ALLOCATION

The following radio frequencies are used for S-IVB telemetry and range safety transmitters:

USAGE	FREQUENCY
SSB/FM	226.2 Mc
PCM/FM	232.9 Mc
PAM/FM No. 1	258.5 Mc
PAM/FM No. 2	246.3 Mc
PAM/FM No. 3	253.8 Mc
Secure Range Safety	450 Mc

APPENDIX 10

GLOSSARY AND ABBREVIATIONS

TABLE AP 10-1 (Sheet 1 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
AA89	--	Designation of Douglas propulsion system performance computer program
AA83	--	Designation of Douglas observed trajectory from guidance reference release to orbital insertion
AACS	--	Auxiliary attitude control system
AB77	--	Designation of Douglas S-IB trajectory simulation computer program
AB79	--	Designation of Douglas Saturn S-IVB radar look angle computer program
ac	--	Alternating current
AC77	--	Designation of Douglas S-IVB trajectory simulation computer program
AGC	--	Apollo guidance computer
amp	--	Ampere
ANT	--	Air Force Eastern Test Range on Antigua Island
APS	--	Auxiliary propulsion system
AS	--	Apollo Saturn
ASC	--	Air Force Eastern Test Range on Ascension Island
--	Average Mixture ratio	The time average of the propellant mixture ratio over 1-sec time intervals between 90 percent thrust buildup and Engine Cutoff Command
--	Average thrust or specific impulse	Determined between the time of 90 percent thrust and Engine Cutoff Command
BDA	--	Bermuda
cg	--	Center of gravity
CIF	--	Central Instrumentation Facility
CMR	--	Coarse mass ratio
--	Composite data (acoustic and vibration)	The total energy of the oscillatory phenomenon, consisting of all frequencies and amplitudes sensed by the transducers, and represents the phenomenon at the point of measurement within the limitations of the data acquisition and reduction systems
°C	--	Degree Centigrade

TABLE 10-1 (Sheet 2 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
cont	--	Control
cps	--	Cycles per second
CPIF	--	Cost plus incentive fee
CRO	--	Carnarvon
DAC	--	Douglas Aircraft Company
DAC/FTC	--	Douglas Aircraft Company, Florida Test Center
DAC/HB	--	Douglas Aircraft Company, Huntington Beach
DAC/MSFC	--	Douglas Aircraft Company, Marshall Space Flight Center
DAC/STC	--	Douglas Aircraft Company, Sacramento Test Center
db	--	Decibel
DCS	--	Digital command system
deg	--	Degree
dc	--	Direct current
--	Depletion Engine Cutoff Command	The time that engine cutoff was, or would be, initiated by the depletion level sensors
DDAS	--	Digital data acquisition system
DOD	--	Department of Defense
DPS	--	Descent propulsion system
DRSCR	--	Digital range safety command receiver
EBW	--	Exploding bridgewire
ECC	--	Engine Cutoff Command
ECS	--	Environmental control system
EDS	--	Emregency detection system
--	Effective burntime	The engine burntime from 90 percent thrust buildup to Engine Cutoff Command
EMR	Engine Propellant mixture ratio	The ratio of engine LOX mass flowrate to LH2 mass flowrate. Includes gas generator operations
eng	--	Engine

TABLE AP 10-1 (Sheet 3 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
--	Engine cutoff (applicable for original issue of flight test plans only)	The guidance cutoff time referred to in this issue of the test plan is intended to be a representative event time and should not be construed as the Douglas predicted guidance cutoff time. The Douglas predicted guidance cutoff time is undetermined at this date due to lack of trajectory information
--	Engine cutoff transient	Engine operation during the period from the Engine Cutoff Command until the end of thrust decay
ESC	--	Engine Start Command
--	Engine start transient	Engine operation during the period from the Engine Start Command until the time of 90 percent thrust (approximately a 3-sec period)
--	Engine steady-state operation	Engine operation during the period from the time of 90 percent thrust until Engine Cutoff Command
ETD	--	End of thrust decay
°F	--	Degree fahrenheit
F823	--	Designation of Douglas propulsion system performance computer program
--	Flow integral propellant mass history	That propellant mass history determined by combining independent engine analyses by a statistical method
FD&C	--	Flight Dynamics and Control
FEWG	--	Flight Evaluation Working Group
FM	--	Frequency modulation
FPR	Flight performance reserve	Usable mass onboard at predicted guidance cutoff
ft	--	Foot
FTC	--	Florida Test Center
g	Gravitational acceleration	The acceleration produced by the force of gravity, which varies with the altitude and elevation of the point of observation. The value 32.1739 ft/sec^2 has been chosen as the standard by international agreement for sea level at 45° north latitude

TABLE AP 10-1 (Sheet 4 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
GCC	--	Guidance Cutoff Command
GG	--	Gas generator
GH2	--	Gaseous hydrogen
GHe	--	Gaseous helium
GN2	--	Gaseous nitrogen
GOX	--	Gaseous oxygen
gpm	--	Gallons per minute
GRR	--	Guidance reference release
GSE	--	Ground support equipment
GSFC	--	Goddard Space Flight Center, Greenbelt, Maryland
GYM	--	Guaymas
G105	--	Designation of Douglas engine performance program using flowmeter reconstruction
h	--	Altitude
HAW	--	Hawaii
HB	--	Huntington Beach, California
He	--	Helium
HOSC	--	Huntsville Operations Support Center
hr	--	Hour
IAS	--	Initiation of automatic sequence
IECO	--	S-IB stage Inboard Engine Cutoff Command
IGM	--	Iterative guidance mode
in.	--	Inch
IP&CL	--	Instrumentation Program and Components List
I_{sp}	--	Specific impulse
IU	--	Instrument Unit
kc	--	Kilocycles
km	--	Kilometer
KSC	--	Kennedy Space Center
lbf	--	Pounds force

TABLE AP 10-1 (Sheet 5 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
lbm	Pounds mass	1/32.1739 slug
L/C	--	Loading computer
LH2	--	Liquid hydrogen
LM	--	Lunar Module
LOX	--	Liquid oxygen
LV	--	Launch vehicle
Mc	--	Megacycles
LVDC	--	Launch Vehicle Digital Computer
Mod	--	Module
MCC-H	--	Mission Control Center-Houston
m	--	Mach number
min	--	Minute
M/S	--	Mainstage
MSC	--	Manned Spacecraft Center, Houston, Texas
MSF	--	Manned space flight
MSFC	--	Marshall Space Flight Center
MSFC/DAC	--	Marshall Space Flight Center/ Douglas Aircraft Company
MSS	--	Mobile service structure
MSSD	--	Missile and Space Systems Division
N/A	--	Not applicable
NASA	--	National Aeronautics and Space Administration
NC	--	Normally closed
--	Ninety percent thrust buildup	Time from Engine Start Command until the last engine chamber pressure (injector end) reaches 618 psia
n.mi.	--	Nautical mile
NO	--	Normally open
No.	--	Number
NPSH	--	Net positive suction head
OECO	--	S-IB or S-IC stage Outboard Engine Cutoff Command

TABLE AP 10-1 (Sheet 6 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
OVRD	--	Override
PAM	--	Pulse amplitude modulation
--	Payload	All portions of the vehicle above the S-IVB/IU
PA49	--	Designation of Douglas propulsion system performance computer program
PCM	--	Pulse code modulation
PD	--	Propellant dispersion
pf	--	Capacitance
PMR	Programmed mixture ratio	A method of controlling the PU valve mixture ratio to obtain maximum efficiency of the stage. The propellant loading is provided to cause the PU system to command the PU valve against the LOX rich stop for the initial portion of flight and then decrease to a lower mixture ratio during the final portion of flight
--	Propellant residuals	The sum of LOX and LH2 remaining onboard at Engine Cutoff Command. The residuals include both usable and trapped propellants
psia	--	Pounds per square inch absolute
psid	--	Pounds per square inch differential
psig	--	Pounds per square inch gauge
PTCS	--	Propellant tanking computer system
PU	--	Propellant utilization
--	PU system propellant mass history	That propellant mass history determined for flight by the PU system
--	PU system residuals	Those propellant residuals above the main propellant valves determined by the PU system
q	--	Dynamic pressure
°R	--	Degree rankine
RACS	--	Remote automatic calibration system
RF	--	Radio frequency
rms	--	Root mean square

TABLE AP 10-1 (Sheet 7 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
RMR	--	Reference mixture ratio
rpm	--	Revolutions per minute
S	--	Surface range (ft)
SA	--	System address (digital up-data system)
SC	Spacecraft	Includes Apollo command and service module and LM adapter
sco	--	Sub-carrier oscillator
sec	--	Second
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
SLA	--	Spacecraft LM adapter
SLG	--	Slug
SLF	--	Slug feet squared
--	Slug	Engine system unit of mass
SOV	--	Shutoff valve
SSB/FM	--	Single sideband modulation
SSB	--	Single sideband
SSS	--	Stage switch selector
STC	--	Sacramento Test Center
t	--	Time
T	--	Countdown time from prospective lift-off or as specifically defined in the text
T_1	--	Time base No. 1: Initiated at liftoff by umbilical disconnect
T_2	--	Time base No. 2: Initiated by S-IB low level sensor dry signal
T_3	--	Time Base No. 3: Initiated by the S-IB outboard engines cutoff
T_4	--	Time base No. 4: Initiated at S-IVB engine cutoff

TABLE AP 10-1 (Sheet 8 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
TAN	--	Tananarive, Malagasy
TBD	--	To be determined
T/M	--	Telemetry
TWX	--	Teletype
--	Total depletion burntime	The engine burntime from Engine Start Command to the time that the depletion Engine Cutoff Command would have been initiated
--	Total propellants consumed	That amount of liquid propellants consumed from Engine Start Command to Engine Cutoff Command. Includes engine consumption, boiloff, and LH2 tank pressurant
--	Total stage burntime	The engine burntime from Engine Start Command to Engine Cutoff Command
--	Total stage mass history	A compilation of all final hardware, propellant, and gas masses. The measured and computed mass of each constituent is adjusted within its accuracy band so that the total stage mass at Engine Start Command and Engine Cutoff Command agrees with the total stage mass as determined by the Statistical Weighted Average mass determination method
TP&E	--	Test Planning and Evaluation
--	Unusable propellants	Those propellants remaining after a propellant depletion cutoff. This includes the propellants in the tank below the depletion sensor, propellants in the feed duct, and trapped propellants. It does not include sensor lag time or the propellant consumed during engine cutoff but does include sensor time delay
--	Usable residuals	Propellants in excess of trapped propellants left onboard a stage after powered flight has been terminated by some specified cutoff criteria
v	--	Volt
V_E	--	Earth-fixed velocity

TABLE AP 10-1 (Sheet 9 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
V_I	--	Inertial velocity
VAB	--	Vehicle Assembly Building, KSC, Florida
vco	--	Voltage controlled oscillator
vac	--	Voltage, alternating current
VCL	--	Vertical checkout laboratory
vdc	--	Voltage, direct current
VSWR	--	Voltage standing wave ratio
WS11	--	Designation of Douglas mass characteristics computer program
α	--	Angle of Attack
α'	--	Total Angle of Attack
a_{xm}	--	Axial acceleration
X_Y	--	Yaw attitude command
X_P	--	Pitch attitude command
γ_1	--	Earth fixed flight path elevation angle
γ_{1_I}'	--	Inertial flight path elevation angle
γ_{2_I}'	--	Inertial flight path azimuth angle
μ	--	Longitude
ρ	--	Geodetic latitude
Z_E	--	Cross-Range Position
$\dot{Z}_E$	--	Cross-Range Velocity
ξ_ψ	--	Pitch attitude error
ξ_Θ	--	Yaw attitude error
$\tilde{\chi}$	chi tilde	Guidance mode
Θ_M	--	Pitch Euler angle
Ψ_M	--	Yaw Euler angle
Φ_M	--	Roll Euler angle

APPENDIX 11

REFERENCES

11. REFERENCES

The following listed documents are referenced in the text:

(1) *Flight Mission Directive AS-204/LM-1 Mission (Apollo 5)*, prepared by Saturn IB Program Office), Marshall Space Flight Center, Huntsville, Alabama, dated April 15, 1967.

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(4) *S-IVB-201 Stage Flight Test Plan*, SM-46974, Huntington Beach, California, dated January 14, 1966.

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(7) *Saturn S-IVB-204 Instrumentation Program and Components List*, 1B43557AR, Huntington Beach, California, dated October 17, 1967.

(8) *Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights*, SM-46538B (prepared by Saturn Data Engineering Section), Huntington Beach, California, dated December, 1966.

(9) *S-IVB-204 Stage Flight Test Plan*, SM-46977B, Huntington Beach, California, dated December 16, 1967.

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(11) *Contract End Item Detail Specification (Prime Equipment) Performance Design Requirements, CEI No. CP208004A, S-IVB Stage for use with the Saturn Vehicle SA-204,* Huntington Beach, California, dated November 28, 1966.

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(15) *Project Apollo Coordinate Standards,* Standard Coordinate System 9, Mass Properties SE 008-001-1, (prepared by Office of Manned Space Flight), Washington, D.C., dated June, 1965.

(16) *AS-204/LM-1 Launch Vehicle Operational Flight Trajectory* (Revision 1), Christler Corporation No. TN-AP-67-255 (part IV), dated July 25, 1967.

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