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S-IVB-205 STAGE
FLIGHT TEST PLAN

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

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FLIGHT TEST PLAN

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ORIGINAL ISSUE. 18 NOVEMBER 1966
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HUNTINGTON BEACH DEVELOPMENT ENGINEERING

PREPARED FOR:
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
UNDER NASA CONTRACT NAS7-101

APOneal

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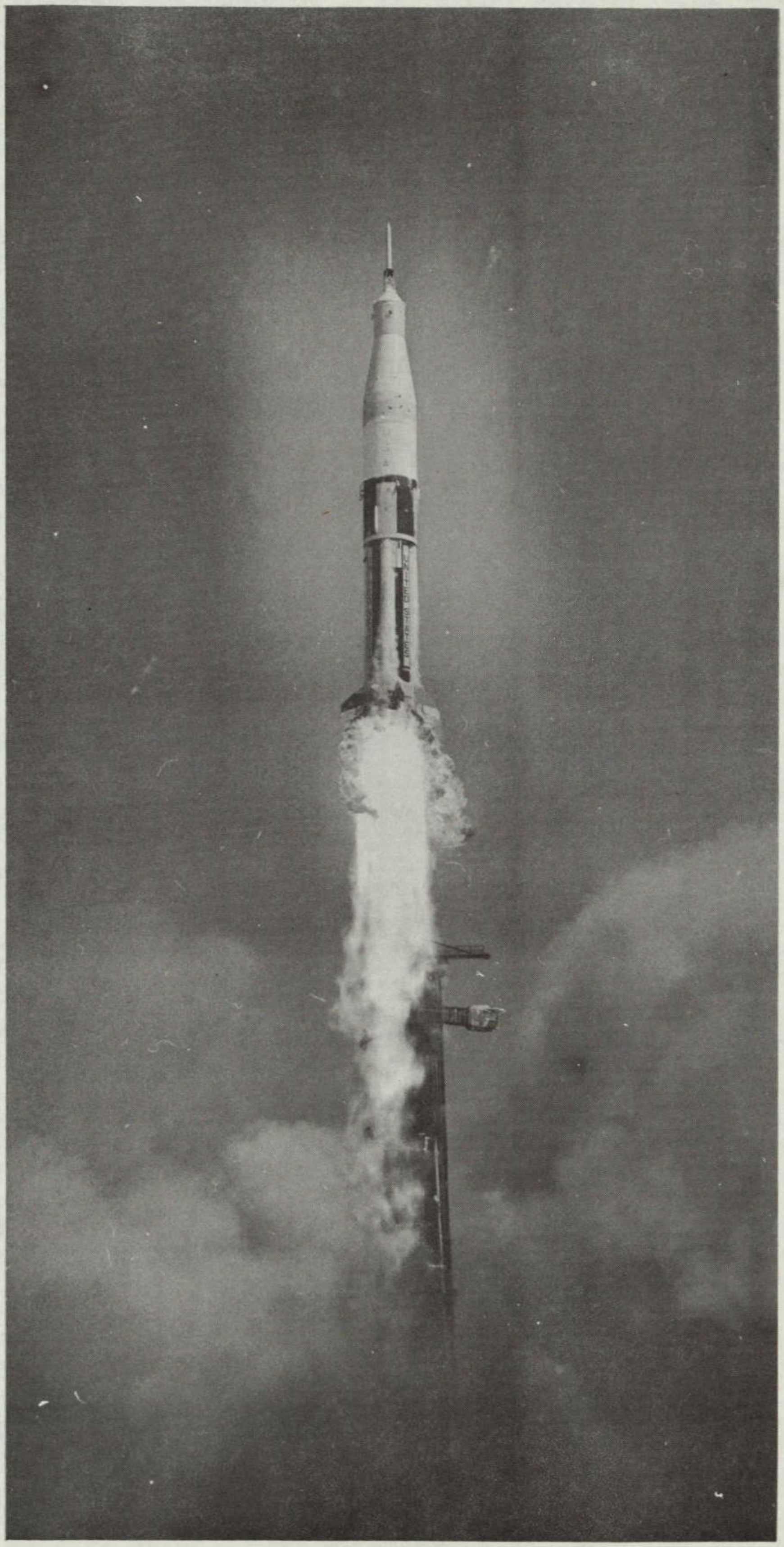

Typical IB Launch

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S-IVB-205 STAGE FLIGHT TEST PLAN, SM-46978A

This is a complete revision to and replaces the original issue dated 18 November 1966. The date of this revision is September 1968. The latest revision date for each page is listed below.

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ABSTRACT

McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) Report No. SM-46978A, S-IVB-205 Stage Flight Test Plan documents the MDAC-WD requirements and responsibilities relative to the S-IVB-205 stage of the Saturn IB vehicle AS-205/CSM-101 flight test that will be conducted by National Aeronautics and Space Administration (NASA) at the Kennedy Space Center. The test plan defines the MDAC-WD support activities and reports required under NASA Contract NAS7-101.

DESCRIPTORS

AS-205/CSM-101 mission

S-IVB-205 stage mission

configuration

sequence of events

mass characteristics

predicted flight performance

J-2 engine

September 1968

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PREFACE

The purpose of this report is to provide a flight test plan for the Saturn S-IVB-205 stage. In general, it provides information and direction to McDonnell Douglas Astronautics Company - Western Division personnel at Huntington Beach, Florida Test Center, and Marshall Space Flight Center.

Included in this report are detailed descriptions of the following: AS-205/CSM-101 mission and objectives, S-IVB-205 stage objectives and configuration, launch mission rules, flight sequence of events, mass characteristics, and propulsion system performance predictions.

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 1 February 1968.

PREFACE TO FIRST REVISION

Dated September 1968

This report contains the second issue of MDAC-WD Report No. SM-46978, S-IVB-205 Stage Flight Test Plan and completely supercedes the original report, dated 18 November 1966.

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1. INTRODUCTION

This document delineates the requirements and responsibilities of the McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) in support of the S-IVB-205 stage flight test. The flight test, as defined in this test plan, will be limited to the S-IVB contribution toward the accomplishment of the AS-205 flight mission and the S-IVB performance verification as the second stage of the AS-205 space vehicle.

1.1 General

This document provides information and direction to MDAC-WD personnel comprising the Saturn S-IVB Test Planning and Evaluation Committees at MDAC-WD Huntington Beach, California, Florida Test Center (FTC), and the liaison team at Marshall Space Flight Center (MSFC), 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

1.2 Background

The S-IVB-205 stage was assembled at MDAC-WD Huntington Beach, California, where production tests of components and systems were accomplished. The stage was then transported to MDAC-WD/Sacramento Test Center (STC), where the acceptance firing test program was conducted. This program consisted of manual and automatic subsystem checkouts, integrated systems tests, a simulated acceptance firing countdown, and an automatic propellant loading test. A full duration acceptance firing test followed these preliminary tests. The firing demonstrated the adequacy of the S-IVB-205 stage systems to perform at sea level conditions. Postfire checkout included manual leak checks, functional tests, and an all systems test (AST) using stage internal power (battery simulator) and a simulated instrument unit (IU). A number of modifications were made prior to and after the stage entered an extended storage at STC. The stage was then shipped to MDAC-WD/FTC. Upon arrival, the S-IVB-205 stage was subjected to post transport receiving inspections and was later mated to the assigned aft interstage. At the time of launch, the S-IVB-205 stage will also have undergone prelaunch stage systems checkouts and integrated launch and space vehicle systems tests. (See figure 1-1 for test history of S-IVB-205.)

SECTION 1

INTRODUCTION

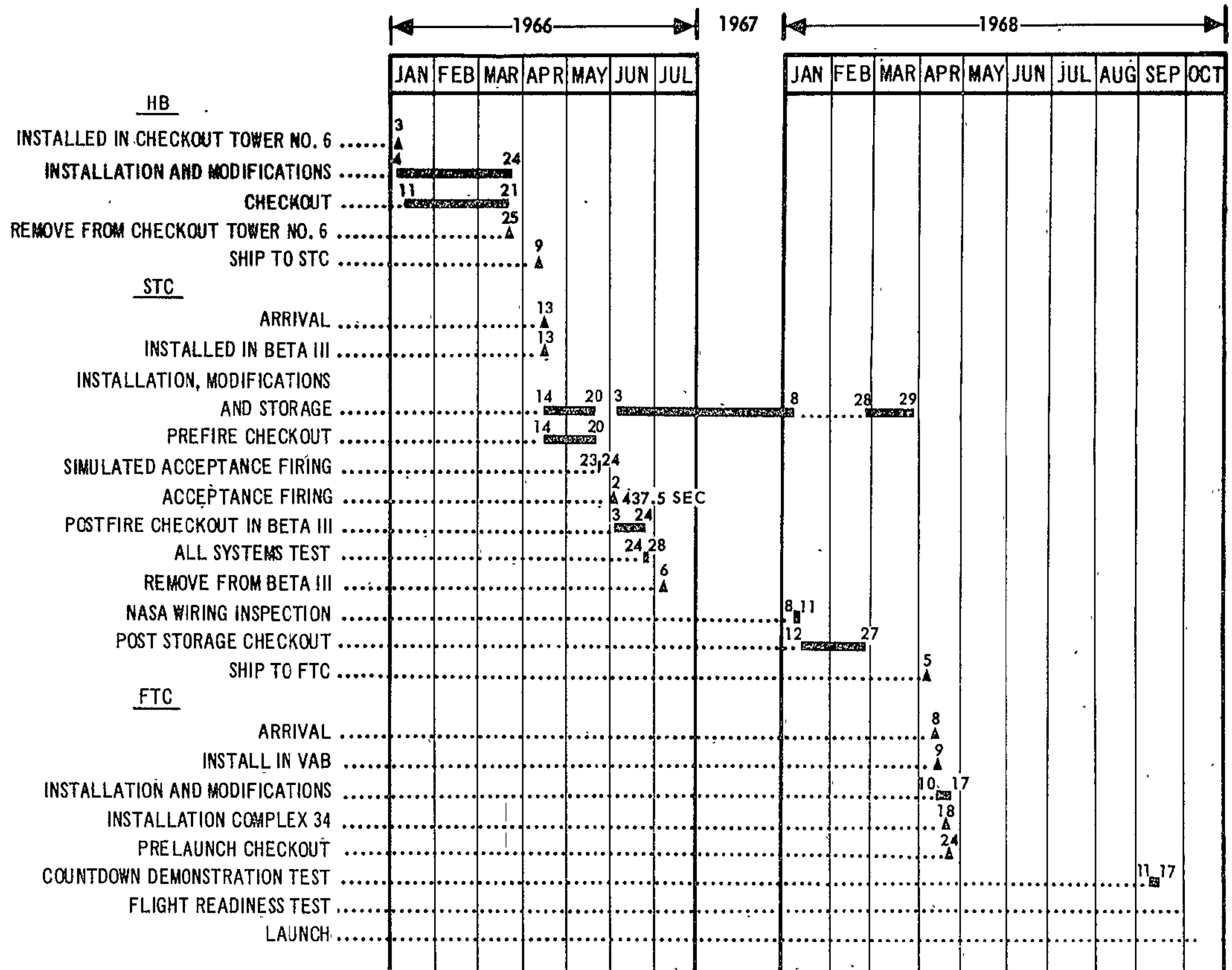


Figure 1-1. S-IVB-205 Stage Checkout and Test History

2. MISSION

The AS-205 is the fifth Saturn IB flight and the first to be manned. The basic purpose of the mission is to launch and insert a manned block II Apollo spacecraft into a near earth orbit to verify the spacecraft/crew operations and systems performance. Figure 2-1 presents the launch configuration and figure 2-2 presents the ground trace.

2.1 Mission Objectives

McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) considers MSFC Flight Mission Directive for Apollo Saturn IB Missions (reference 1)* as the official document for providing necessary 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 a Primary Objective is a statement of the primary purpose of the flight (Note: The primary objectives are defined and controlled by OMSF FMAD). The mission directive gives the primary objectives as:

a. Demonstrate CSM/crew performance

b. Demonstrate crew/space vehicle/mission support facilities performance during a manned CSM mission

c. Demonstrate CSM rendezvous capability.

A Mandatory Detailed Test Objective, as defined in the mission directive, is a principle detailed test objective which must be satisfactorily completed on the assigned mission. Failure to do so would unduly compromise subsequent flight schedules and/or require subsequent space vehicle reconfiguration. There are no launch vehicle mandatory detailed objectives according to the mission directive.

Principle Detailed Objective, as defined in the mission directive, is a detailed test objective which must be accomplished prior to the lunar landing mission. Any principle detailed test objective not satisfactorily completed on the assigned mission can be attempted on a subsequent mission without major impact. The launch vehicle principle detailed

*References are given in appendix 11

objectives, which are listed in the mission directive, are as follows:

a. Demonstrate the adequacy of the launch vehicle attitude control system for orbital operation

b. Demonstrate S-IVB orbital safing capability

c. Evaluate S-IVB J-2 engine ASI line modification.

The mission directive defines a Secondary Detailed Test Objective as a detailed test objective which would provide significant data or experience but which is not a prerequisite to the lunar landing mission. The launch vehicle secondary detailed test objectives, which are listed in the mission directive, are as follows:

a. Evaluate the S-IVB/IU orbital coast lifetime capability

b. Demonstrate CSM manual launch vehicle orbital attitude control.

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 nominally occurs 5.0 sec after Guidance Reference Release (GRR). The time of umbilical disconnect establishes time base one (TB1) which nominally occurs 0.2 sec after first motion.

The AS-205/CSM-101 vehicle will be launched from Kennedy Spacecraft Center launch complex 34 on a ~~90~~ 100 deg launch azimuth. A pitch and roll maneuver will then be initiated at 10.2 sec from first motion to achieve the proper vehicle orientation for a 72 deg flight azimuth.

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 75.0 sec from first motion; the predicted flight conditions at that time are presented in table 2-2. At 134.5 sec from first motion a tilt arrest mode is initiated to freeze vehicle attitude. The S-IB propellant depletion level sensors are actuated at 136.9 sec from first motion, initiating time base two (TB2). When the depletion sensors indicate a dry tank, the inboard engines are cutoff. This nominally occurs at 140.1 sec

SECTION 2

MISSION

in height or flatness of the chip, or the use of devices from different manufacturers in the same hybrid circuit. The face of the bonding transducer's tip must be parallel to the chip face. Otherwise the bond will be made by one edge of the tip, rather than the entire face. This makes the bond area smaller and the concentration of bonding pressure can thin the wire excessively and may damage or fracture the chip surface. It has been found that the ultrasonic vibration during bonding degraded some devices. A type 2N2432 transistor application where low leakage current requirements existed (2 nano-amperes) had 3 out of 4 failures after bonding [Ref. 20].

C. Soldering

Several soldering methods are being used for joining in microelectronics.

1. SLT (Solid Logic Technology). Employed by IBM, this method uses glass-sealed chips and solder-coated copper balls or solder alone. The joint is "made" by reflowing the solder with the device face down on the substrate in position. IBM tests suggest that the method is as reliable as the conventional wire bonding.

2. Microsoldering can bond relatively large leads, .010" to .030" when employing cased miniature parts in a microcircuit. Many of the limitations of manual soldering can be overcome by dynamically-controlled resistance soldering and reflow methods.

But soldering cannot be used to bond thin gold leads .002" to .010" in diameter because molten solder dissolves from first motion, and outboard engines are programmed to cutoff 3 sec later. Outboard engine cutoff initiates time base three (TB3).

S-IVB/S-IB physical separation occurs at approximately 144.49 sec after first motion. Table 2-3 presents predicted trajectory conditions at separation. Figures 2-3 through 2-8 show the predicted time histories of certain trajectory parameters during S-IB powered flight.

2.2.1.2 S-IVB Stage Flight

After S-IB/S-IVB separation retrorockets force the S-IB stage away from the S-IVB/spacecraft, and ullage rockets are fired to ensure that S-IVB propellants are settled. Engine Start Command (ESC) will nominally occur at 145.8 sec from first motion, initiating a one sec fuel lead and subsequent thrust buildup. Ninety percent thrust will be attained at 149.4 sec from first motion.

Vehicle attitude remains frozen from S-IB tilt arrest until the Iterative Guidance Mode (IGM) is initiated at 25 sec after TB3, or nominally at 168.11 sec from first motion. At this time guidance commands in pitch and yaw are issued to obtain a close approximation to an optimal path (that which requires the least propellant consumption) to achieve the desired end conditions of attitude and velocity magnitude and direction. S-IVB-205 will be flown with an open-loop propellant utilization system, with the engine mixture ratio (EMR) shift from 5.5 to 4.5 programmed to occur at 308.6 sec from Engine Start Command. Guidance will be staged (i.e., guidance constants changed) nominally 0.2 sec later and will go into an artificial tau mode for 35 sec. At approximately 589.5 sec from first motion, the chi tilde mode is initiated, at which time the IGM switches from a guidance compute interval of 1.5 sec to 1.25 sec, and the equations are changed such that only the final velocity magnitude and direction constraints are considered. At 5.0 sec before S-IVB cutoff the guidance commands are frozen (chi freeze) and are held constant through the cutoff transient. Predicted J-2 Engine Cutoff Command is 614.5 sec after liftoff.

Appendix 3 shows a tabulation of the predicted S-IVB flight trajectory. Tables 2-4 and 2-5 present predicted trajectory conditions at Guidance Cutoff Command (GCC) and orbit insertion, respectively. Figures 2-9 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 S-IVB Orbital Safing Operation

Approximately one day after orbital insertion, the command service module (CSM) will rendezvous with the spent S-IVB/IU/SLA to demonstrate the CSM active rendezvous capability for subsequent Apollo missions in which a CSM rescue capability may be required. Prior to rendezvous, the S-IVB stage will demonstrate orbital safing capability, with all operations to be completed prior to 4-1/2 hr after insertion.

At 0.4 sec after time base 4 (TB4) a non-propulsive vent (NPV) of the LH2 tank will be initiated and continued for 1,260 sec. At TB4 +30.2 sec a 30 sec propulsive LOX vent will be initiated. A dump of LOX through the J-2 engine is initiated at TB4 +5,052 sec and terminated at TB4 +5,773 sec.

Table 2-6 presents orbital trajectory parameters before and after the LOX dump. The most noticeable effect of the dump impulse upon the trajectory is a 19 nmi increase in apogee altitude.

2.2.2.2 S-IVB Attitude Maneuvers

Vehicle attitude is frozen from approximately 5.0 sec prior to S-IVB cutoff until TB4 +20 sec, at which time a pitch maneuver is initiated to align the vehicle centerline along the local horizontal. This attitude is maintained throughout S-IVB orbital safing operations until approximately 9,000 sec from liftoff. At this time (over Carnarvon) the crew will take over the launch vehicle attitude control system for 3 min and perform a sequence of manual maneuvers in the pitch, yaw, and roll planes. Following manual maneuvers, vehicle control is resumed by the instrument unit (IU), and alignment with the local horizontal is again maintained.

Figure 2-17 presents pictorially the S-IVB orbital attitude maneuvers. S-IVB/CSM separation occurs at approximately 10,495 sec from liftoff in an attitude nearly parallel to the local horizontal. Predicted trajectory conditions at this time are presented in table 2-6. Following separation the S-IVB/IU/SLA is maneuvered as shown in figure 2-17 into a retrograde attitude, parallel to the local horizontal, with fin position I up. This attitude is maintained for the duration of S-IVB stage active lifetime.

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 Service Module Propulsion System (SPS) burn to orbit. Due to the low nominal level of available usable propellants at S-IVB cutoff, there is a relatively low probability of achieving prescribed orbital conditions following an S-IB engine shutdown. In the event of an S-IVB engine failure, an abort mission provides for a SPS burn to accomplish certain spacecraft objectives.

TABLE 2-1
PREDICTED S-IVB-205 FLIGHT MASS SUMMARY

ITEM	S-IB LIFTOFF	S-IB/S-IVB SEPARATION	S-IVB ESC	90 PERCENT THRUST	EMR CUTBACK	S-IVB ECC	S-IVB ETD	START LOX DUMP	END LOX DUMP	CSM SEPARATION
Frost	100	0	0	0	0	0	0	0	0	0
Separation Package	34	0	0	0	0	0	0	0	0	0
Ullage Rockets	398	394	334	222	0	0	0	0	0	0
Launch Escape	8,986	8,986	8,986	8,986	0	0	0	0	0	0
Command Module	13,050	13,050	13,050	13,050	13,050	13,050	13,050	13,050	13,050	0
Service Module	10,918	10,918	10,918	10,918	10,918	10,918	10,918	10,918	10,918	0
SM Propellant	8,887	8,887	8,887	8,887	8,887	8,887	8,887	8,887	8,887	0
SLA Ring	90	90	90	90	90	90	90	90	90	0
Adapter (SLA)	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655
Instrument Unit	4,280	4,280	4,280	4,280	4,280	4,280	4,280	4,280	4,280	4,280
S-IVB-205 Dry Stage	21,834	21,834	21,834	21,834	21,834	21,834	21,834	21,834	21,834	21,834
LOX in Tank	192,906	192,906	192,906	192,504	54,868	1,326	1,237	1,237	0	0
LOX Ullage Gas	36	36	36	37	258	367	365	262	168	128
LOX below Tank	367	367	367	397	397	397	367	367	0	0
LH2 in Tank	39,599	39,599	39,599	39,481	14,271	2,026	1,999	0	0	0
LH2 Ullage Gas	169	169	169	171	364	502	502	436	427	300
LH2 below Tank	48	48	48	58	58	58	48	0	0	0
Cold Helium	330	330	330	329	225	179	179	179	0	0
APS Propellant	131	131	131	131	127	125	125	105	102	85
GH2 Start Tank	5	5	5	1	1	1	1	1	1	1
Service Items	56	56	56	56	56	56	56	56	56	56
Total Mass (lbm)	305,879	305,740	305,681	305,087	133,339	67,751	67,593	65,357	63,468	30,339
Time from Liftoff (sec)	0.000	144.490	145.810	149.310	454.900	614.540	615.940	5,666.100	6,386.100	10,495.000

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TABLE 2-2
PREDICTED AS-205 FLIGHT CONDITIONS AT
MAXIMUM DYNAMIC PRESSURE

PARAMETER		UNITS	MSFC PREDICTED
Flight Time	(t)	sec	75.0
Dynamic Pressure	(q)	lbf/ft^2	659.7
Altitude	(h)	ft	40,427.5
Free Stream Velocity	(V_{RM})	ft/sec	1,458.6
Mach Number	(M)	--	1.51
Ambient Pressure	(P_A)	lbf/ft^2	415.3
Pitch Angle of Attack	(α)	deg	-0.74
Yaw Angle of Attack	(β)	deg	0.04

TABLE 2-3
PREDICTED AS-205 TRAJECTORY CONDITIONS AT
S-IB/S-IVB PHYSICAL SEPARATION

PARAMETER		UNITS	MSFC PREDICTED
Flight Time	(t)	sec	144.49
Downrange Distance	(Z_E)	ft	205,037.9
Vertical Distance	(X_E)	ft	202,402.0
Crossrange Distance	(Y_E)	ft	-109.9
Downrange Velocity	($\dot{Z}_E$)	ft/sec	5,553.7
Vertical Velocity	($\dot{X}_E$	ft/sec	3,365.4
Crossrange Velocity	($\dot{Y}_E$)	ft/sec	3.57
Relative Velocity	(V_E)	ft/sec	6,493.78
Inertial Velocity	(V_I)	ft/sec	7,630.76
Inertial Flight Path Elevation Angle	(${\gamma_1}_I'$)	deg	26.580
Inertial Flight Path Azimuth Angle	(${\gamma_2}_I'$)	deg	75.699
Altitude	(h)	ft	203,396.4
Range	(s)	ft	203,341.9
Dynamic Pressure	(q)	lbf/ft^2	10.52
Pitch Angle of Attack	(α)	deg	-0.02
Yaw Angle of Attack	(β)	deg	0.07

TABLE 2-4
PREDICTED AS-205/CSM-101 TRAJECTORY CONDITIONS
AT S-IVB GUIDANCE CUTOFF

PARAMETER		UNITS	MDAC-WD	MSFC
Flight Time	(t)	sec	614.54	614.63
Vertical Distance	(X_e)	ft	-126,339	-127,925
Crossrange Distance	(Y_e)	ft	304,503	304,934
Downrange Distance	(Z_e)	ft	6,087,587	6,092,903
Vertical Velocity	($\dot{X}_e$)	ft/sec	-6,791.8	-6,797.8
Crossrange Velocity	($\dot{Y}_e$)	ft/sec	1,770.7	1,771.3
Downrange Velocity	($\dot{Z}_e$)	ft/sec	23,141.5	23,139.7
Relative Velocity	(V_e)	ft/sec	24,182.5	24,182.5
Inertial Velocity	(V_I)	ft/sec	25,527.1	25,527.1
Inertial Flight Path Elevation Angle	(γ_{1_I}')	deg	-0.0067	-0.0067
Inertial Flight Path Azimuth Angle	(γ_{2_I}')	deg	85.891	85.901
Altitude	(h)	ft	747,859	747,837
Range	(s)	ft	5,976,419	5,971,037

TABLE 2-5
PREDICTED AS-205/CSM-101 TRAJECTORY CONDITIONS
AT ORBIT INSERTION

PARAMETER		UNITS	MDAC-WD	MSFC
Flight Time	(t)	sec	624.54	624.63
Vertical Distance	(X_e)	ft	-195,598	-197,025
Crossrange Distance	(Y_e)	ft	322,300	322,724
Downrange Distance	(Z_e)	ft	6,318,817	6,324,169
Vertical Velocity	($\dot{X}_e$)	ft/sec	-7,054.5	-7,061.0
Crossrange Velocity	($\dot{Y}_e$)	ft/sec	1,787.0	1,787.7
Downrange Velocity	($\dot{Z}_e$)	ft/sec	23,082.7	23,082.8
Relative Velocity	(V_e)	ft/sec	24,202.7	24,204.2
Inertial Velocity	(V_I)	ft/sec	25,547.4	25,549.2
Inertial Flight Path Elevation Angle	(γ_{1_I}')	deg	-0.002	-0.002
Inertial Flight Path Azimuth Angle	(γ_{2_I}')	deg	86.303	86.313
Altitude	(h)	ft	747,893	747,869
Range	(s)	ft	6,199,275	6,204,634
Inclination	(i)	deg	31.61	31.61
Eccentricity	(e)	deg	0.004	0.004
Period	(P)	min	89.5	89.5
*Apogee Altitude	(h_{AP})	nmi	148.8	149.8
*Perigee Altitude	(h_P)	nmi	120.0	119.9

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

TABLE 2-6
PREDICTED AS-205/CSM-101 ORBIT CONDITIONS

PARAMETER	UNITS	START OF FIRST ORBIT	LOX DUMP		S-IVB-CSM SEPARATION
			BEFORE	AFTER	
Flight Time	sec	624.5	5,666	6,387	10,495
Inclination	deg	31.61	31.61	31.61	31.64
Eccentricity	--	0.0040	0.0046	0.0072	0.0074
Apogee Altitude	nmi	148.8	153.2	172.2	174.9
Perigee Altitude	nmi	120.0	120.1	120.4	121.8
Apogee Velocity	ft/sec	25,342	25,319	25,220	25,208
Perigee Velocity	ft/sec	25,547	25,554	25,586	25,584
Period	min	89.48	89.57	89.92	90.00
Orbit Energy	m^2/sec^2	-60,157,329	-60,115,694.7	-5,996,454	-59,927,391
Longitude of the Descending Node	deg	118.912	118.517	118.404	118.097

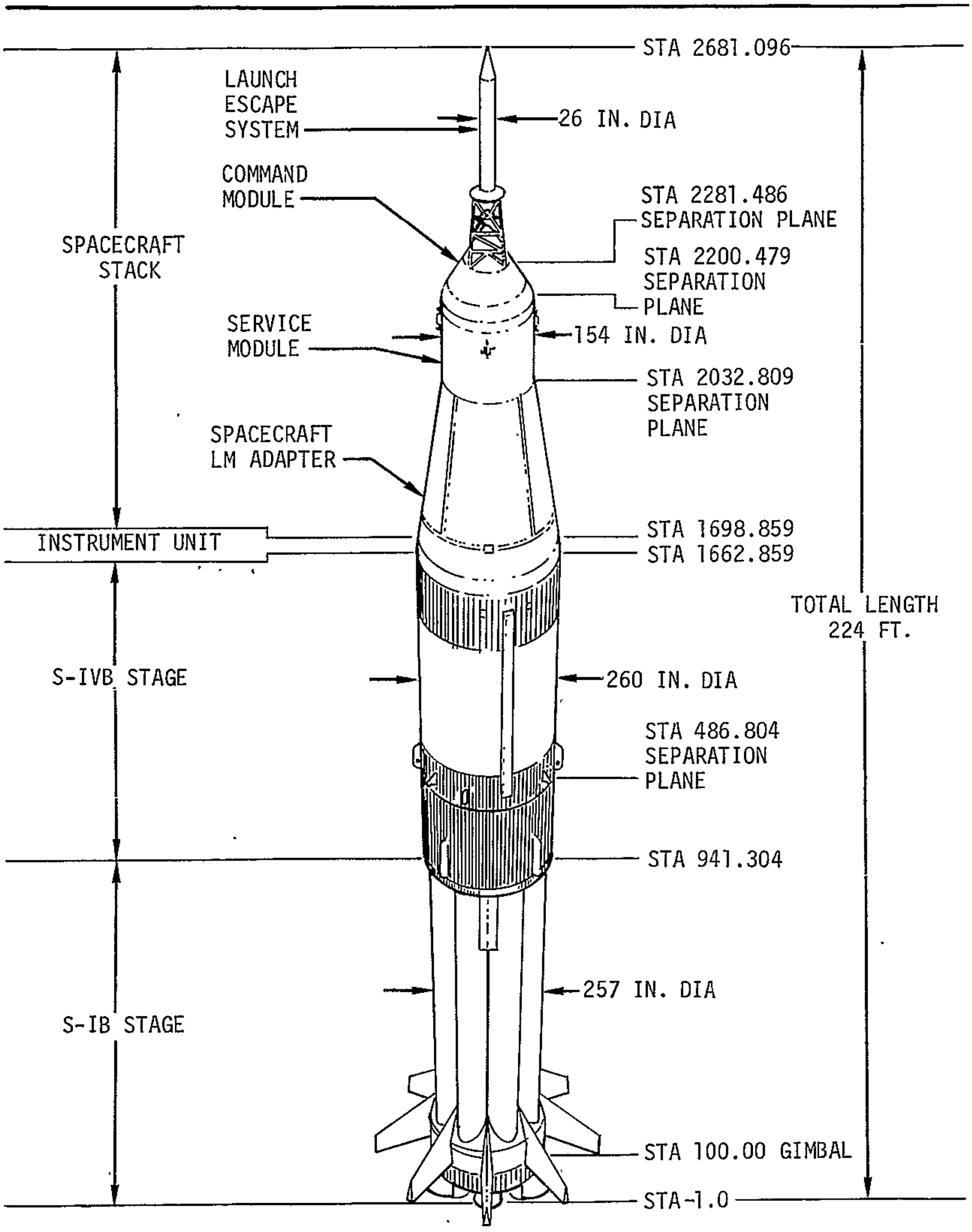
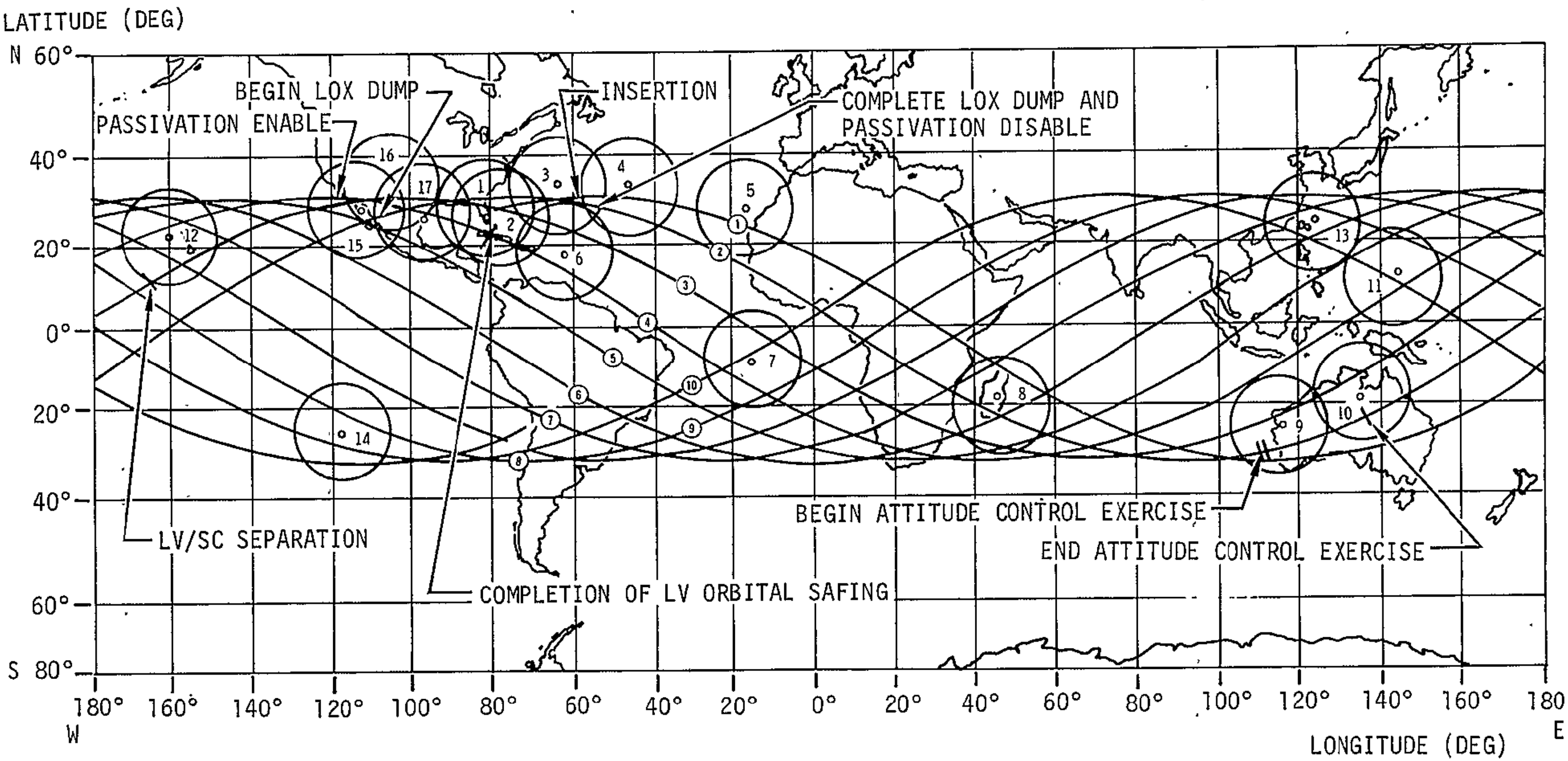


Figure 2-1. SA-205 Vehicle Configuration



1. CAPE AREA
2. GRAND BAHAMA
3. BERMUDA
4. VANGUARD
5. CANARY ISLAND
6. ANTIGUA
7. ASCENSION
8. TANANARIVE
9. CARNARVON
10. ARIA
11. GUAM
12. HAWAII
13. MERCURY
14. REDSTONE
15. GUAYMAS
16. WHITE SANDS
17. CORPUS CHRISTI

Figure 2-2. AS-205 Trajectory Ground Trace

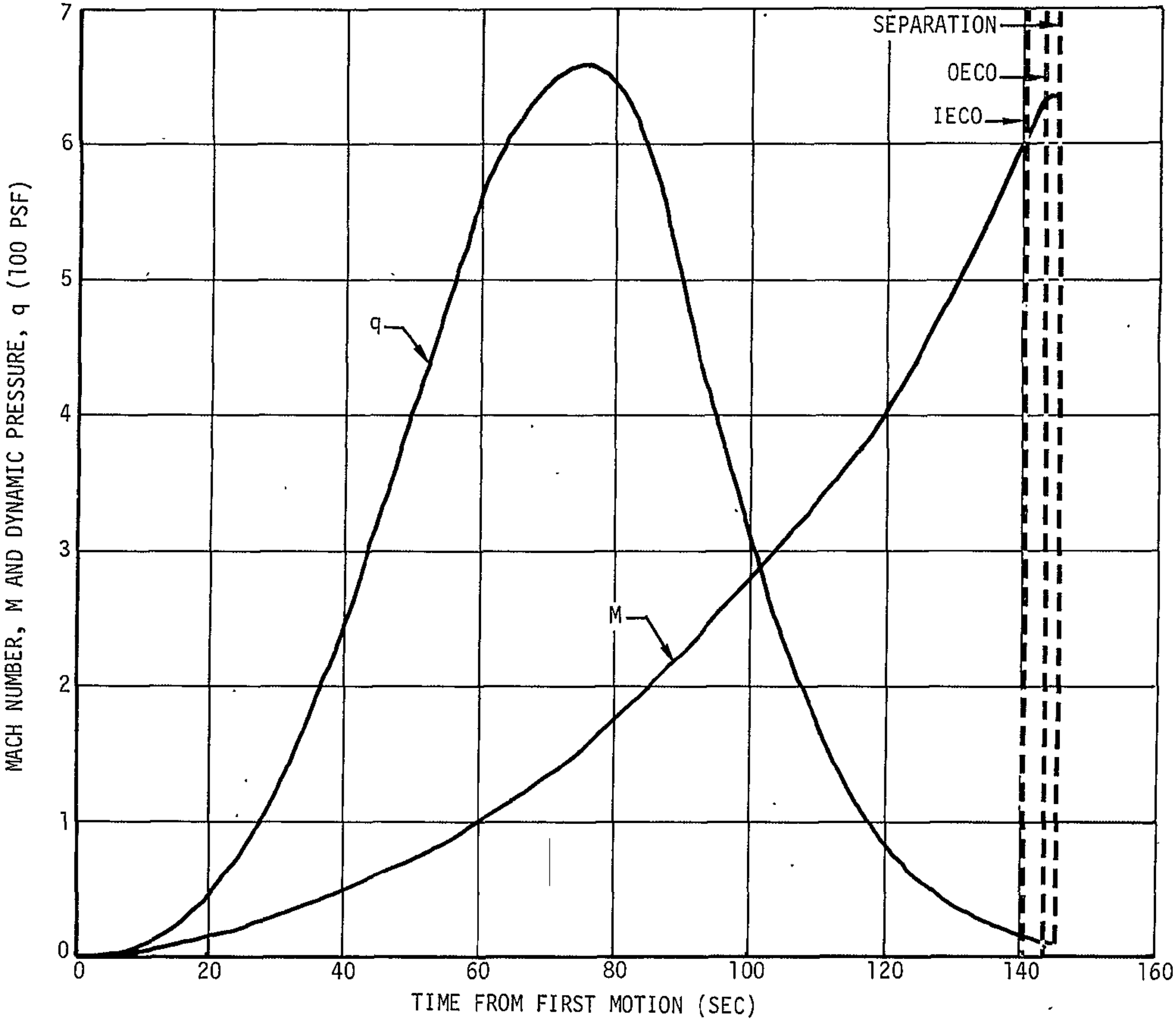


Figure 2-3. Predicted Trajectory, S-IB Powered Flight, Dynamic Pressure and Mach Number

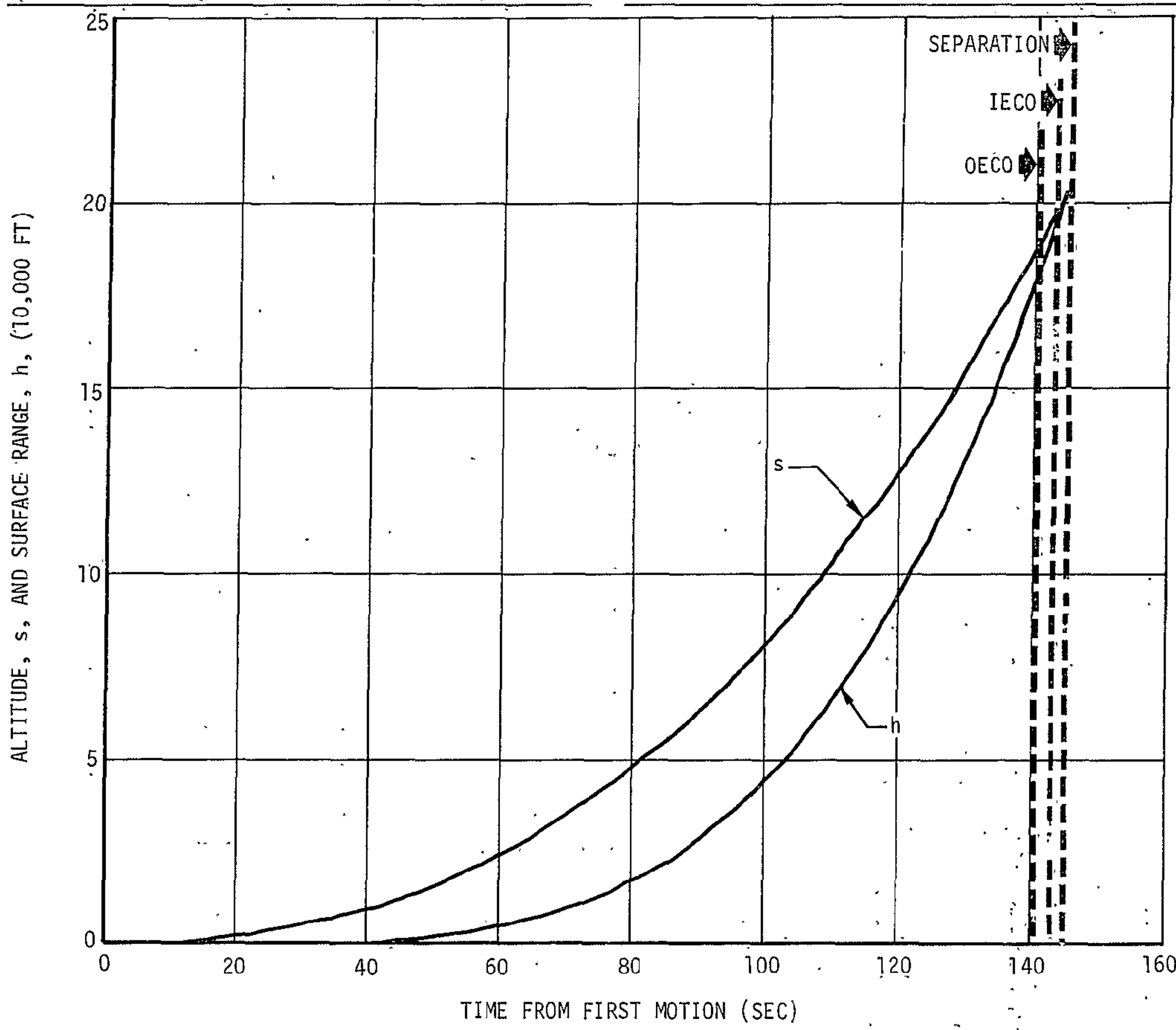


Figure 2-4. Predicted Trajectory, S-IB Powered Flight, Altitude and Surface Range

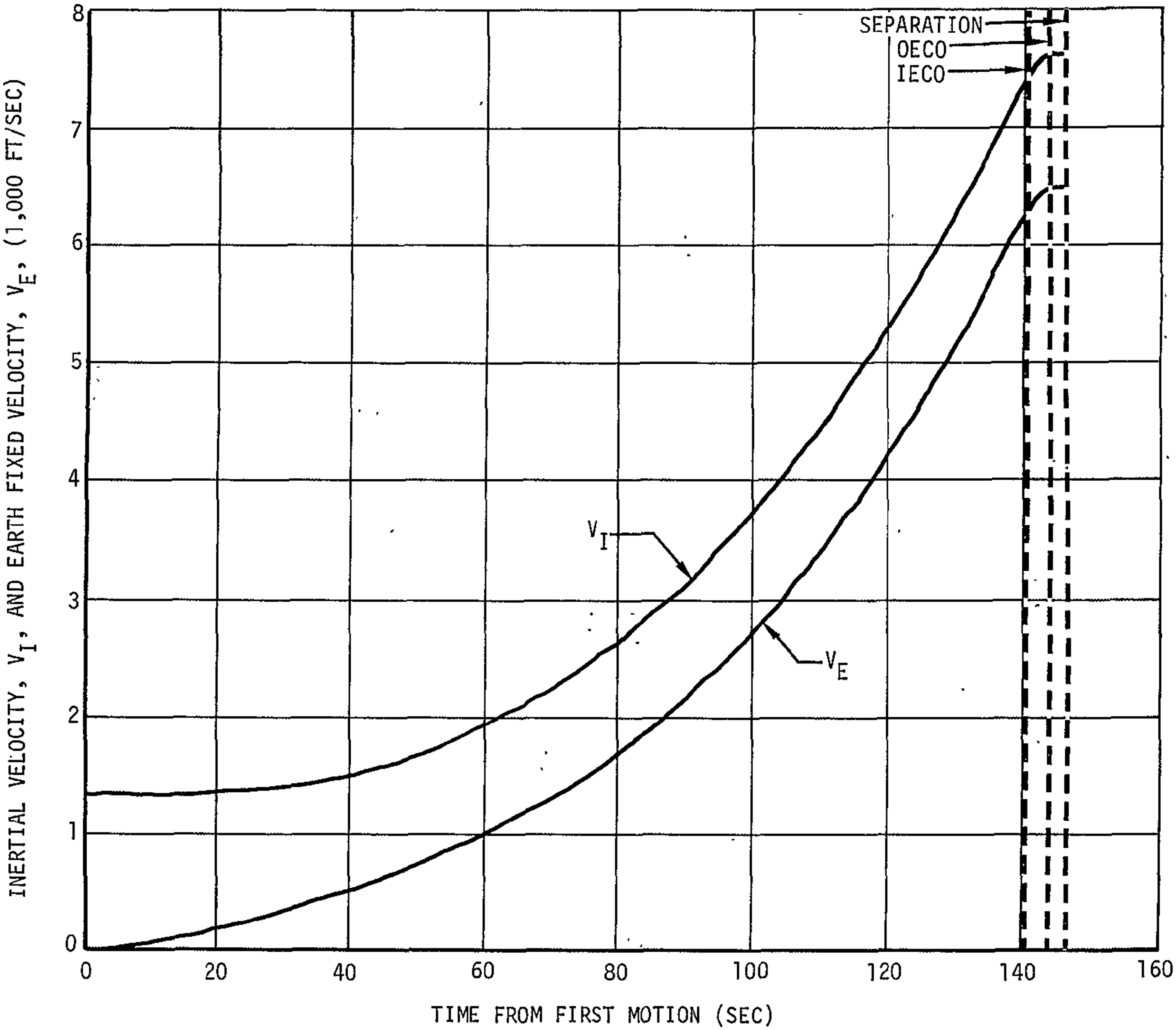


Figure 2-5. Predicted Trajectory, S-IB Powered Flight, Inertial and Earth Fixed Velocity

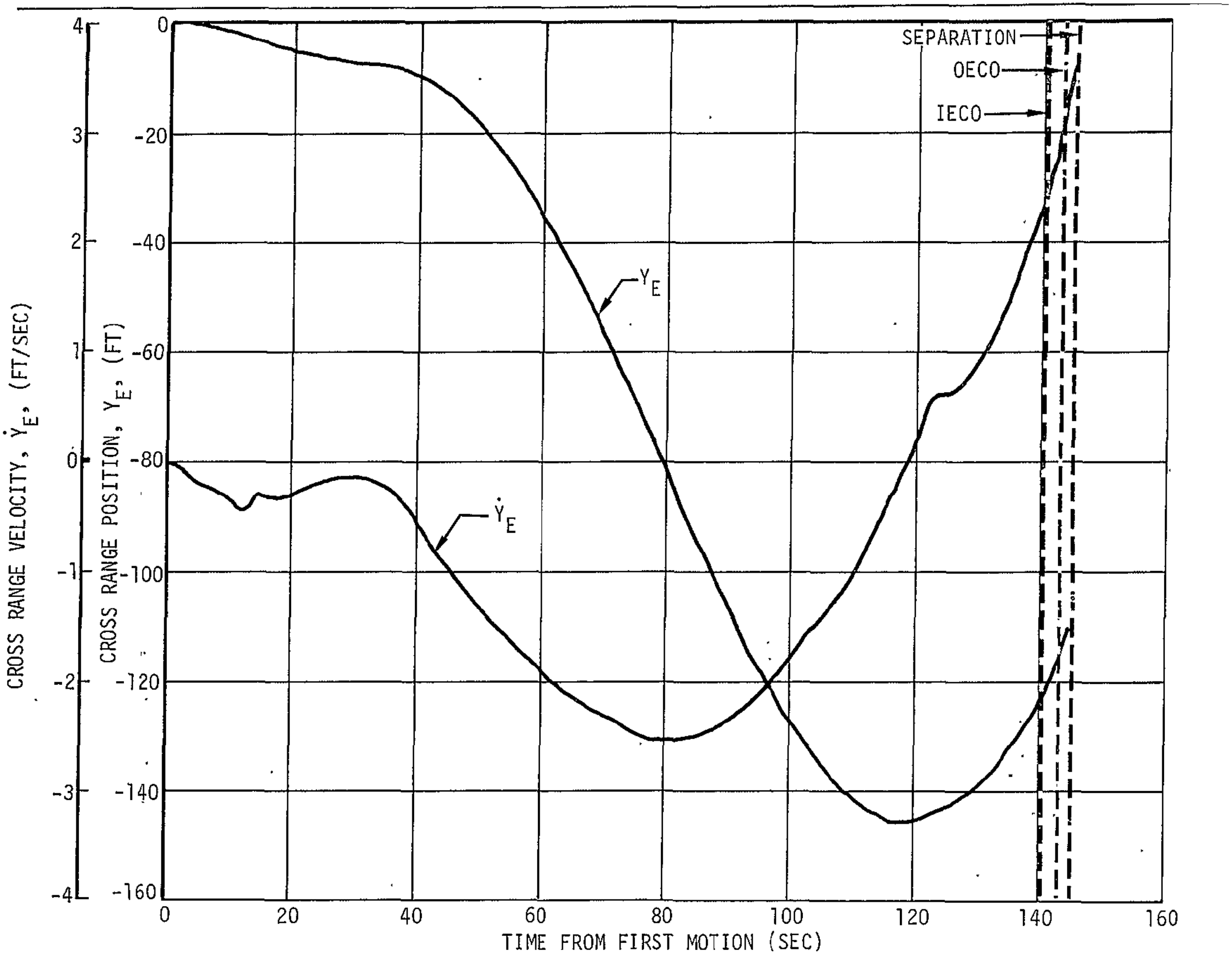


Figure 2-6. Predicted Trajectory, S-IB Powered Flight, Cross Range Velocity and Position

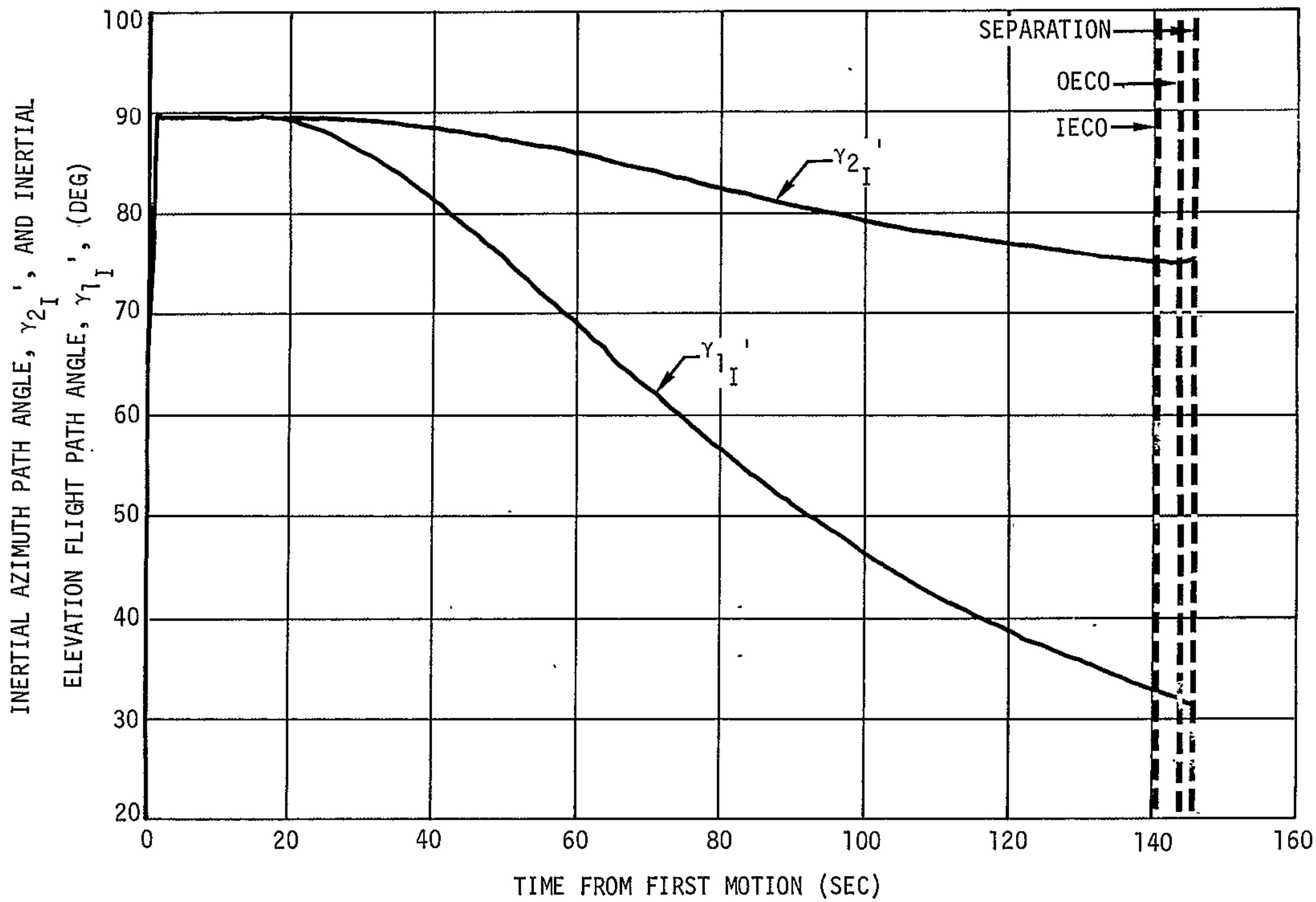


Figure 2-7. Predicted Trajectory, S-IB Powered Flight, Inertial Flight Path Angles

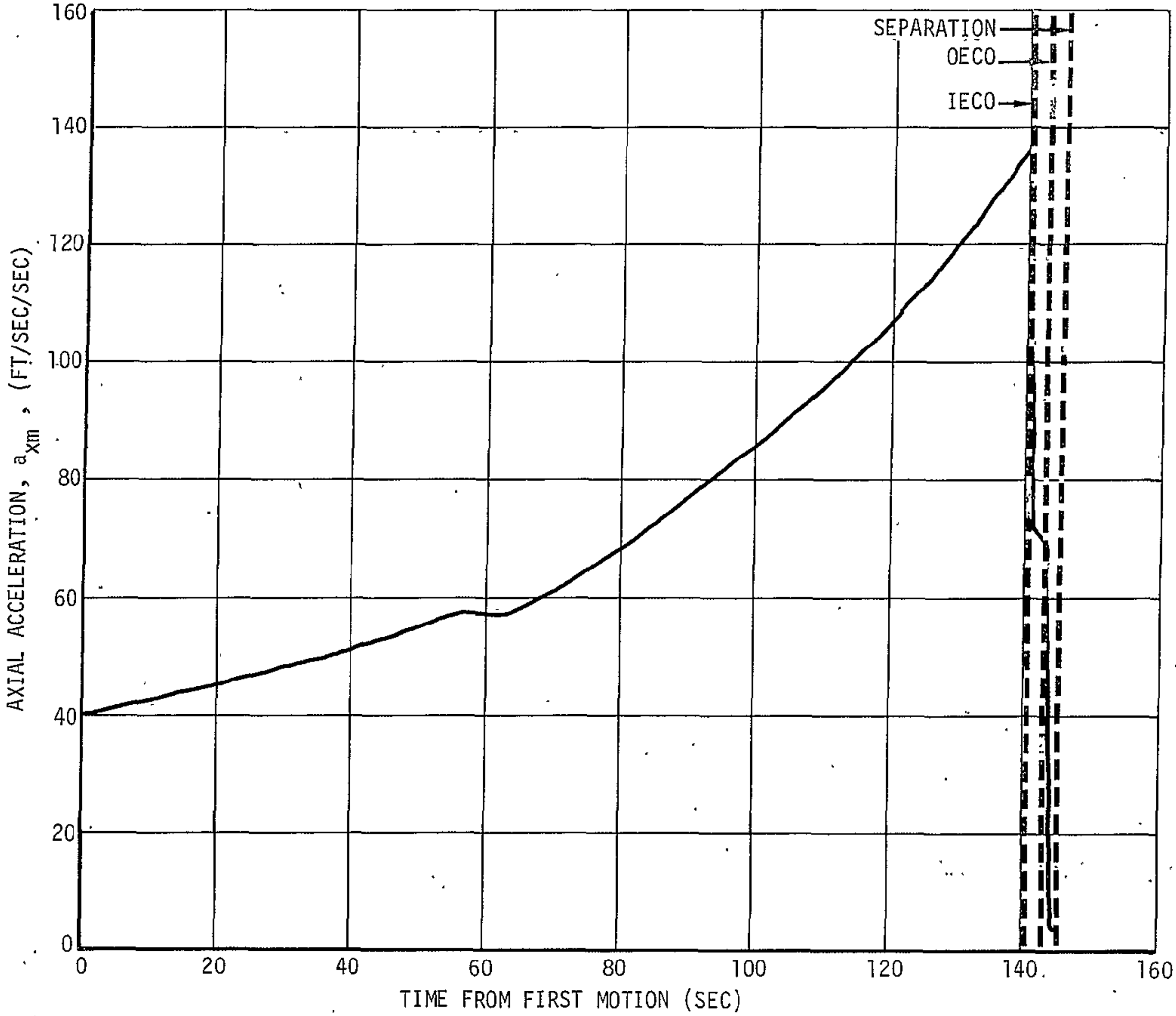


Figure 2-8. Predicted Trajectory, S-IB Powered Flight, Axial Acceleration

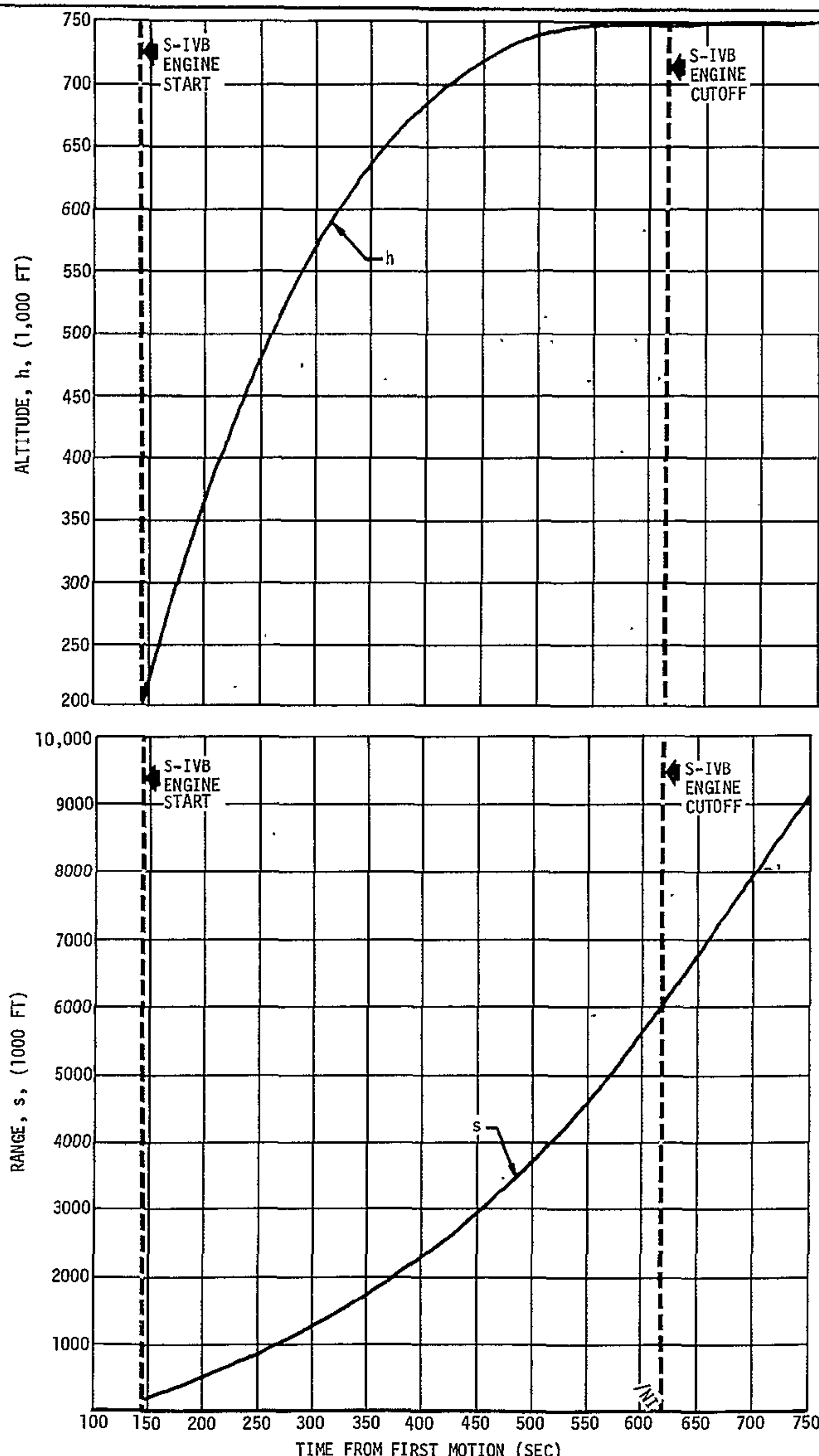


Figure 2-9. Predicted Trajectory, S-IVB Powered Flight, Altitude and Range

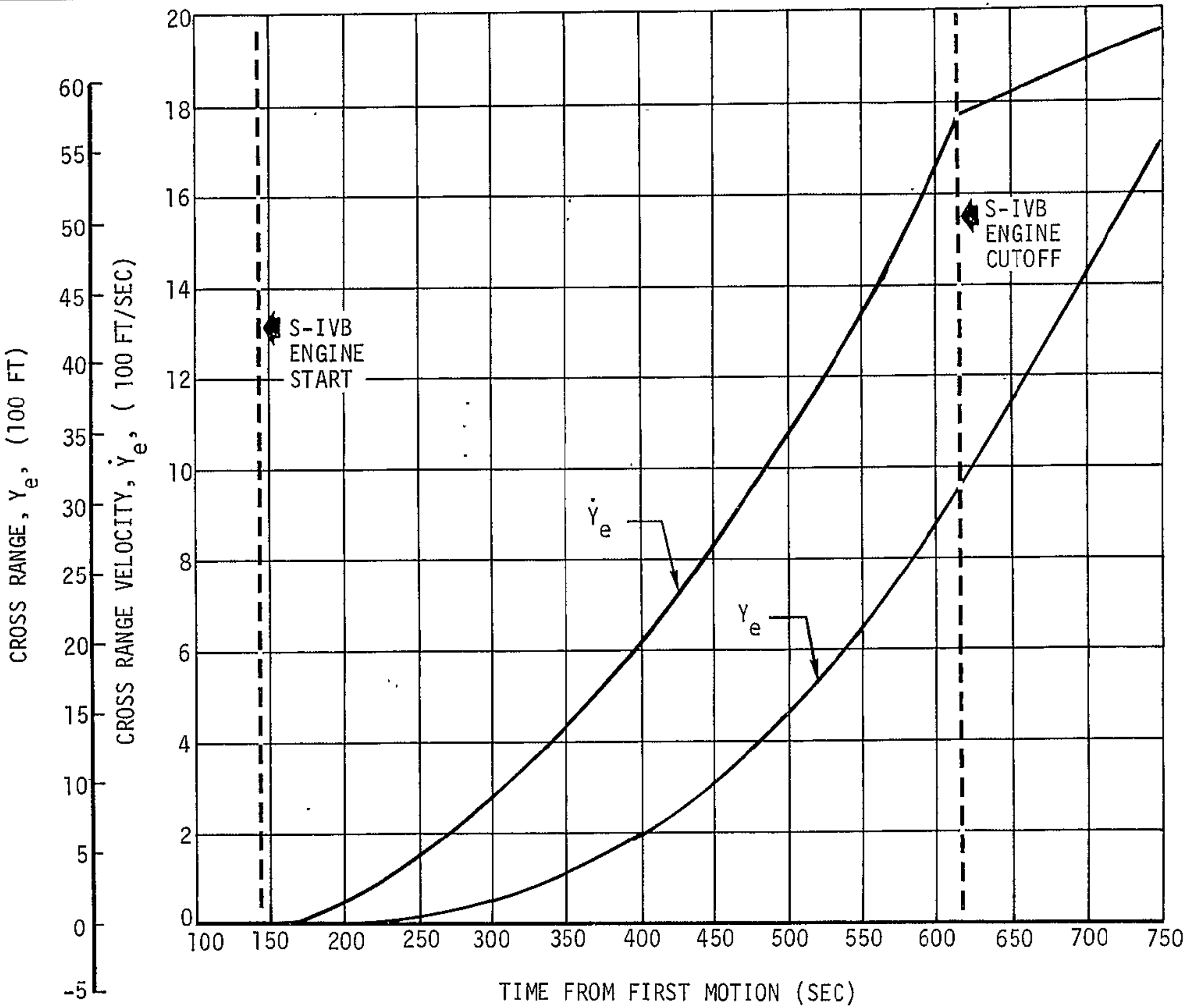


Figure 2-10. Predicted Trajectory, S-IVB Powered Flight, Cross Range Position and Velocity

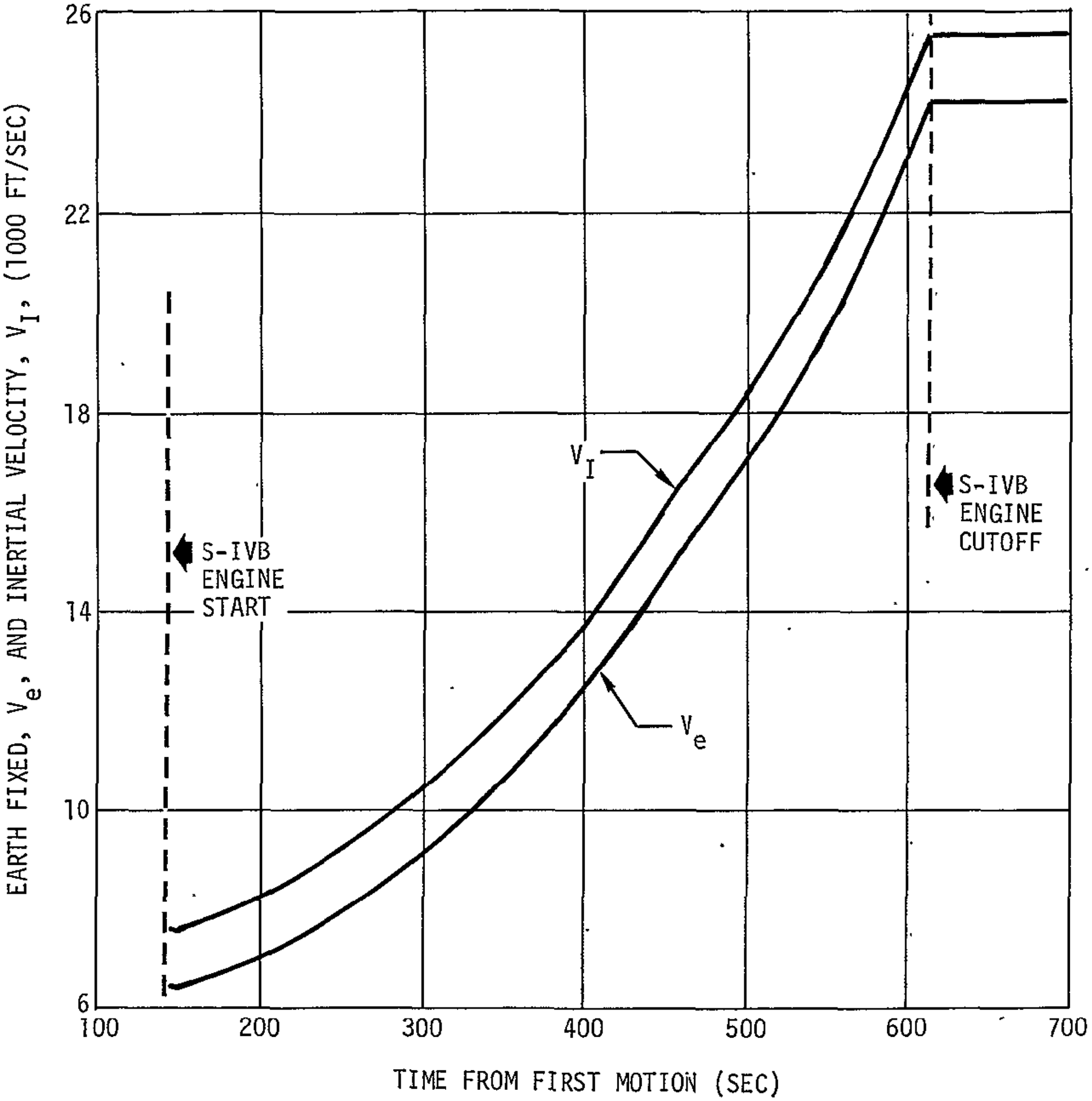


Figure 2-11. Predicted Trajectory, S-IVB Powered Flight, Earth Fixed Velocity and Inertial Velocity

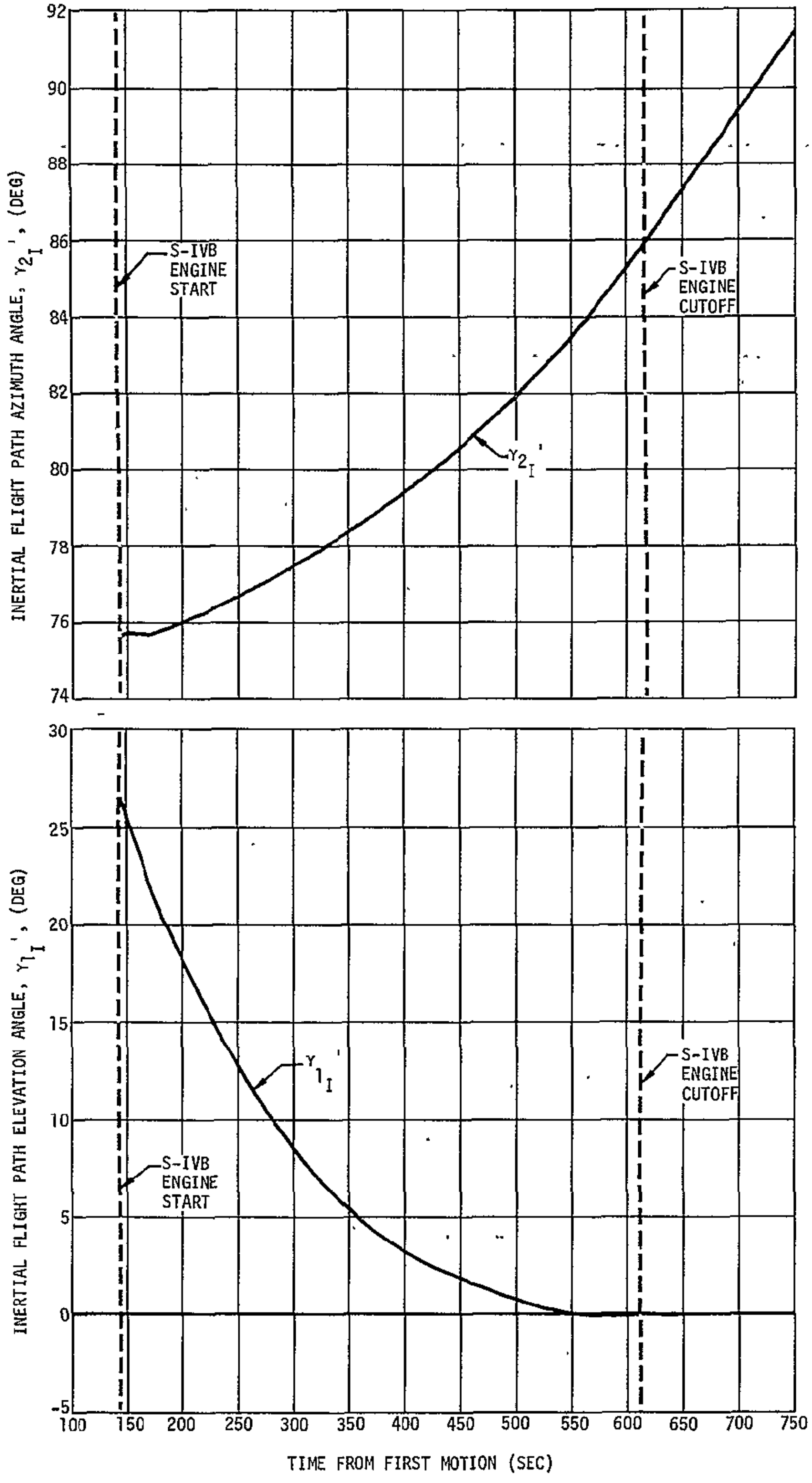


Figure 2-12. Predicted Trajectory, S-IVB Powered Flight, Inertial Elevation Angle and Inertial Azimuth Angle

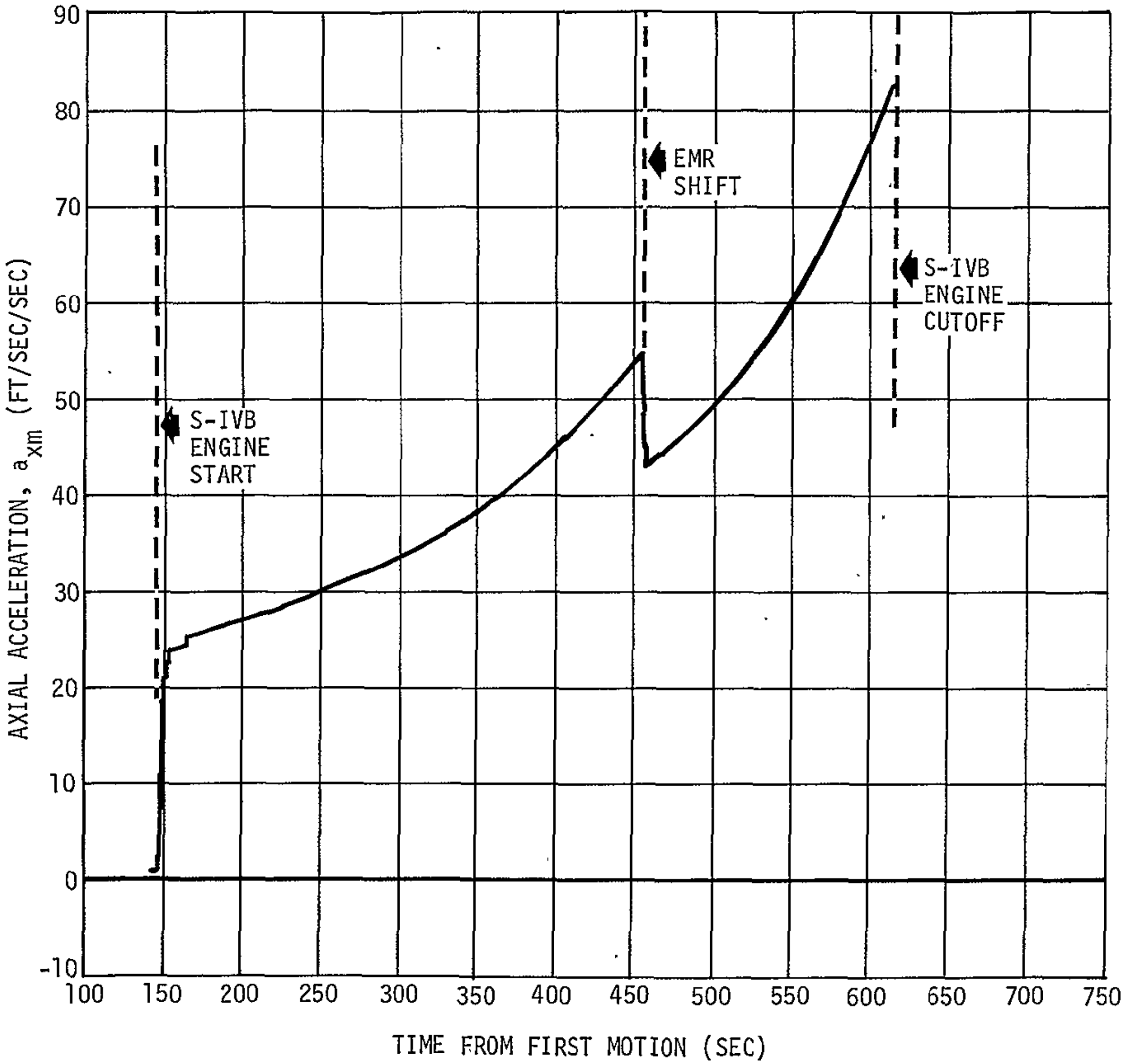


Figure 2-13. Predicted Trajectory, S-IVB Powered Flight, Axial Acceleration

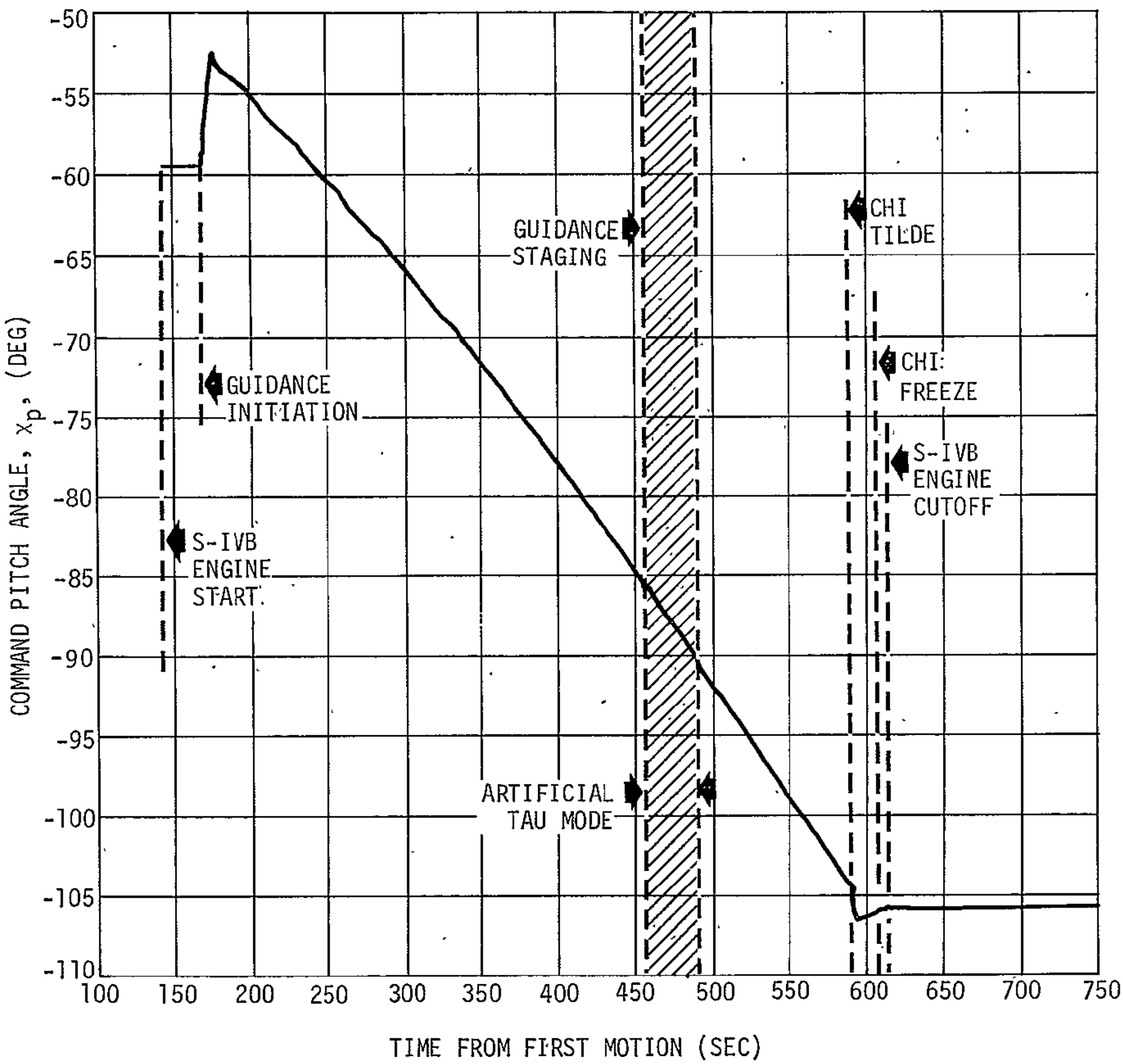


Figure 2-14. Predicted Trajectory, S-IVB Powered Flight, Commanded Pitch Angle

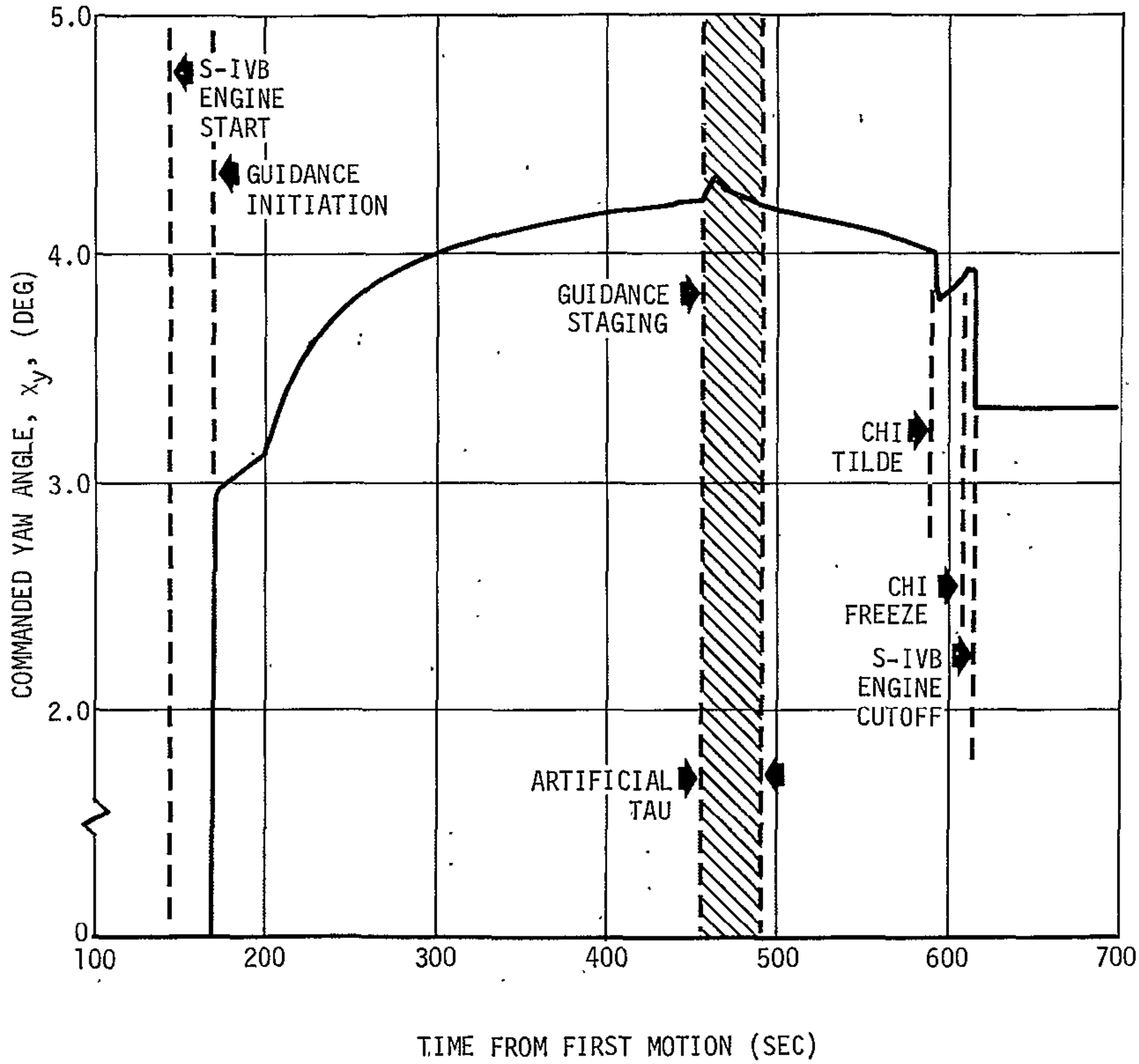


Figure 2-15. Predicted Trajectory, S-IVB Powered Flight, Commanded Yaw Angle

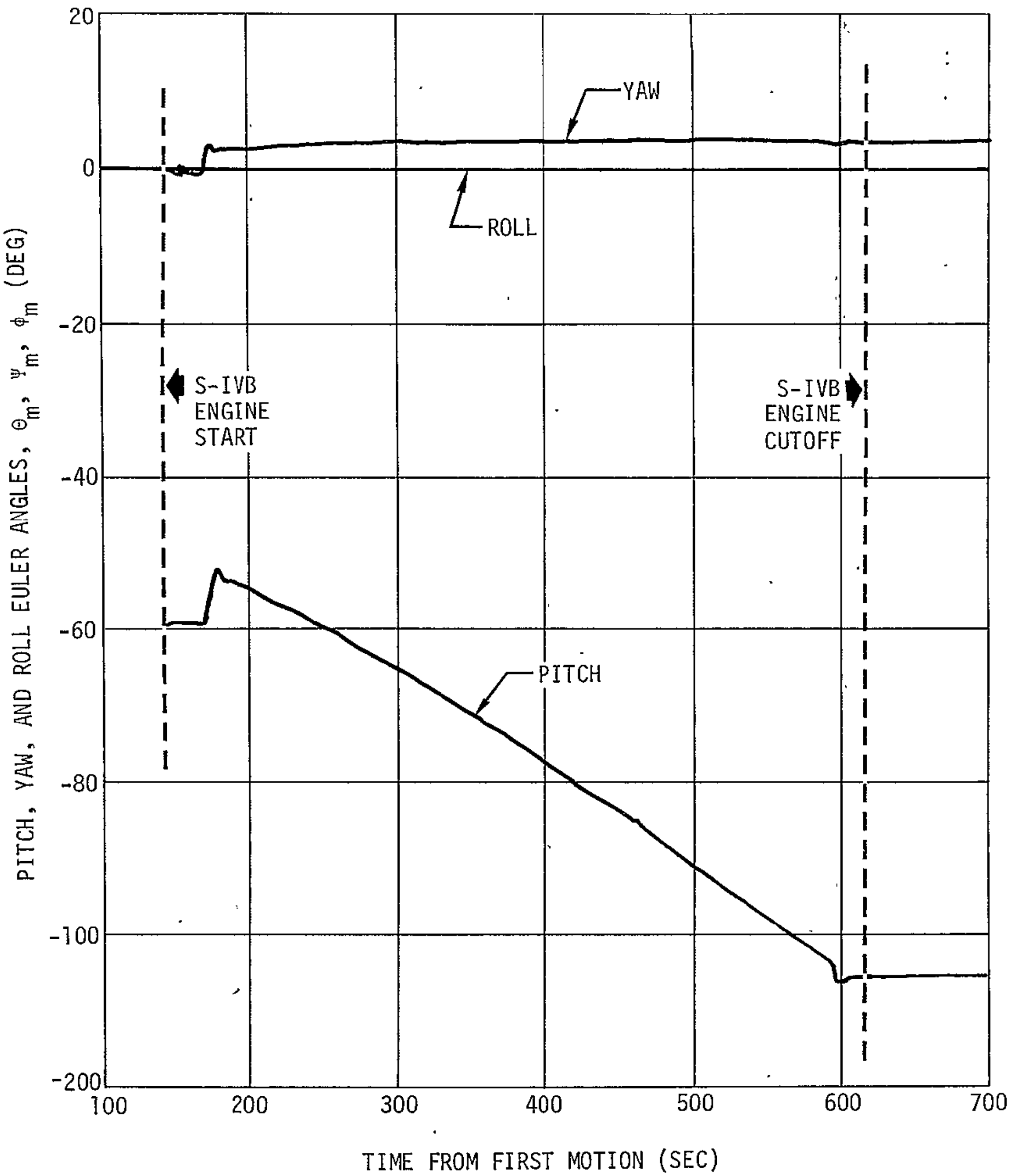


Figure 2-16. Predicted Trajectory, S-IVB Powered Flight, Pitch, Yaw, and Roll Euler Angles

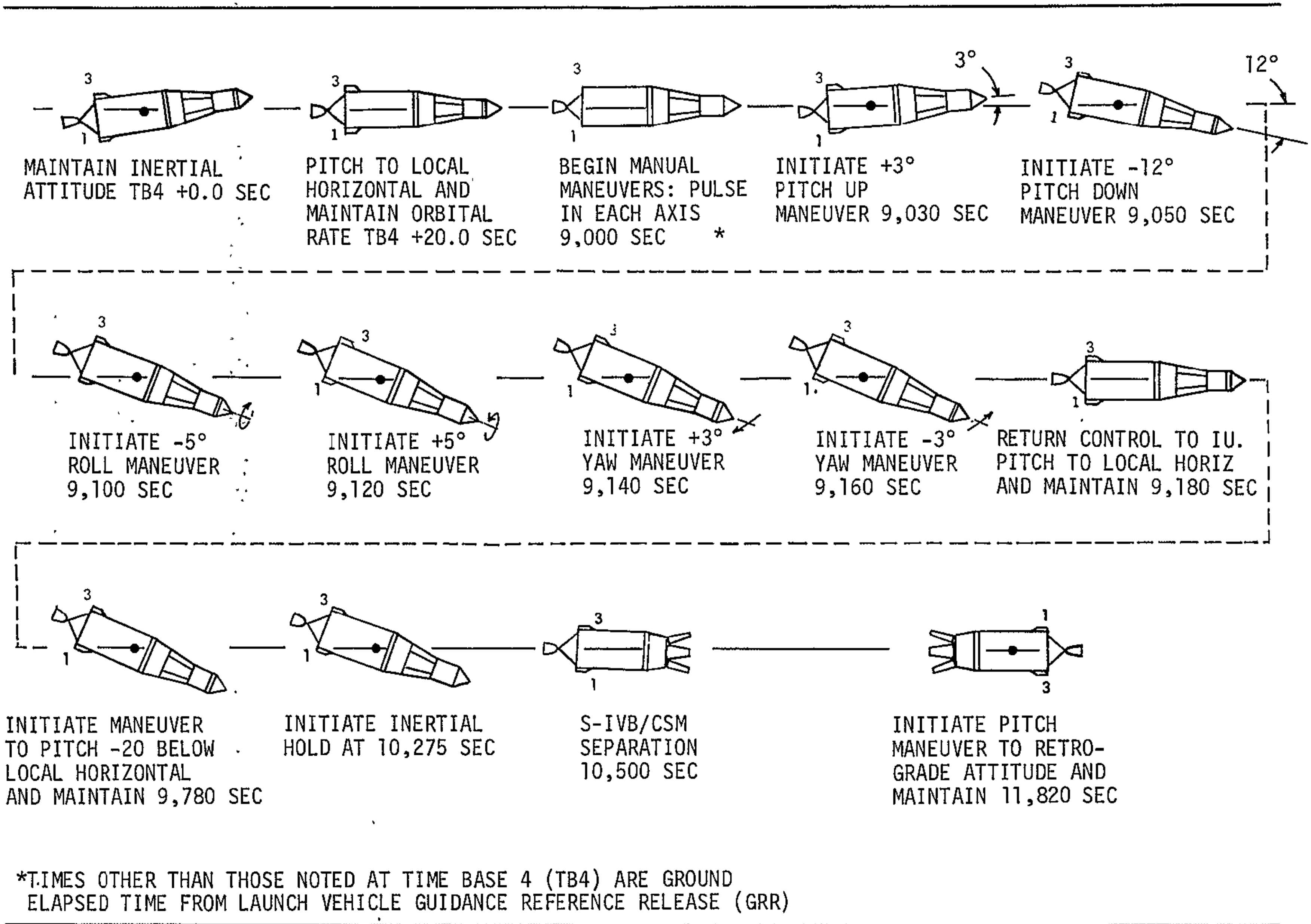


Figure 2-17. S-IVB-205 Orbital Maneuvers

SECTION 3

STAGE OBJECTIVES

3. STAGE OBJECTIVES

This section defines the S-IVB stage flight objectives for the AS-205 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 McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) 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, MDAC-WD, 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. LH2 tank assembly

b. LOX tank assembly

c. Common bulkhead.

3.2 Main Propulsion System

Verify the propulsion system operations during prelaunch, 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 stage pneumatic control and purge system.

Predicted propulsion system performance curves are presented in figures AP 5-1 through AP 5-25. Average predicted propulsion system performance parameters are presented in table AP 5-1.

3.2.1 J-2 Engine Performance and Conditioning

Satisfactory operation of the J-2 engine will be verified by the following:

a. Engine performance during start transient, steady state and cutoff operation.

b. J-2 engine thrust chamber chilldown time, thermal gradients and response of the structure to chilldown.

c. J-2 engine start bottle chilldown, loading, conditions at liftoff, usage during start and environmental effects during flight.

d. J-2 engine control helium sphere prepressurization and loading, conditions at liftoff, usage during burn and environmental effects during flight.

e. J-2 engine sequencing.

f. 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 Pressurization and Feed Systems

Demonstrate the capability of the LH2 system to provide sufficient fuel and net positive suction pressure (NPSP) to the J-2 engine for satisfactory operation. Evaluation of the following will verify these objectives:

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 NPSP supplied to the J-2 engine LH2 interface during prestart and steady-state operation.

e. LH2 recirculation chilldown.

3.2.2.2 LH2 Vent System

Demonstrate the capability of the vent system to provide the required tank pressure during loading, boost, stage powered flight and orbital venting. 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

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

3.2.3.1 LOX Pressurization and Propellant Feed Systems

Demonstrate the capability of the LOX system to provide sufficient oxidizer and NPSP to the J-2 engine for satisfactory operation. Evaluation of the following will verify these objectives:

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 pressurization 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 NPSP supplied to the J-2 engine LOX interface during prestart and steady-state operation.

3.2.3.2 LOX Vent System

Demonstrate the capability of the vent system to provide the required tank pressure during loading, boost, stage powered flight and orbital venting.

Evaluation of the following will verify these objectives:

a. Propulsive and Nonpropulsive vent system flowrates

b. Propulsive and nonpropulsive vent system thrust and NPV system thrust imbalance

c. Tank depressurization rate

d. LOX tank thermodynamics.

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 flight critical pneumatic valves

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

e. LOX recirculation chilldown pump motor container purge pressure.

3.3 Orbital Safing

Satisfactory operation of the orbital safing system will be verified by the following:

a. LH2 tank venting

b. LH2 tank passivation valve permanently open

c. LOX tank venting

d. LOX dump

e. LOX tank NPV valve permanently open

f. Cold helium dump

g. Stage control helium dump.

3.4 Auxiliary Propulsion System

Demonstrate the capability of the auxiliary propulsion system (APS) to provide propulsion on demand for roll control during S-IVB 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. Response of the engines to stage commands during flight

c. Value of the minimum impulse bit

d. APS performance in space environment.

3.5 Ullage Rockets

Demonstrate the capability of the ullage rockets to operate during separation and the J-2 engine start transient.

Performance evaluation will include response of ullage rockets to ignition signal.

3.6 Retrorockets

Demonstrate the capability of the retrorockets to respond to the ignition signal at S-IVB/booster separation.

3.7 Hydraulic

Verification of the hydraulic system performance during powered flight. This objective will be achieved by:

a. Determining that adequate pressurized fluid flow was available to the servo-actuator and that hydraulic system pressures were maintained within expected limits (figure AP 8-1).

b. Verifying that the fluid temperature was maintained within acceptable limits during system operation (figure AP 8-1).

c. Verifying the adequacy of actuator artificial damping mechanism performance.

d. Determining the magnitude of IU command errors just prior to switching guidance to S-IVB burn mode.

e. Evaluating the adequacy of present compensation for thrust vector deflection errors caused by the manufacturers tolerance in the gimbal and thrust structural compression effects.

f. Verifying proper pitch and yaw actuator responses to commands.

During coast the following will also be evaluated:

a. The magnitude of IU command errors in the S-IVB non-burn mode

b. Actuator deflections.

3.8 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 propellant sloshing frequencies with those predicted (figure AP 7-5).

3.8.1 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. Demonstrate overall control stability during S-IVB flight, including controlability immediately after separation.

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

3.8.2 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. Determine actual impulse usage for vehicle maneuvers and disturbances.

d. Verify orbital coast system (AACS/APS) lifetime.

3.9 Stage Separation

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

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.

3.10 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:

a. Radio frequency (RF) system

b. Telemetry system

c. Instrumentation system

d. Data validity.

3.10.1 RF System

Verify the proper operation of the RF system by evaluation of the following:

a. RF power output of the pulse code modulation (PCM) transmitter assembly measured by means of directional couplers and RF power detectors.

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

3.10.2 Telemetry System

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

a. Verification of the compatibility of the PCM system data format, signal synchronization, and system calibrations.

b. Evaluation of the multiplexed FM measurements transmitted through the IU FM/FM data link, for proper channel synchronization and calibration.

3.10.3 Instrumentation System

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

a. The PCM data provided information compatible with the assigned measurements

b. The FM/FM data provided information compatible with the assigned measurements

c. The system responded to calibration commands

d. All instrumentation system elements (transducers, signal conditioning, etc.) are compatible with each other.

3.10.4 <u>Data Validity</u>

Verify the validity of data from the data acquisition system. The achievement of this objective will be established by evaluating the following:

a. The PCM data shall be examined on a channel-by-channel basis to establish validity of measurement responses.

b. The FM/FM data shall be examined on a channel-by-channel basis to ascertain measurement responses.

3.11 <u>Electrical Control System</u>

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. Power distributors

d. Pressure switches

e. EBW and range safety equipment

f. Interconnecting cables.

3.12 <u>Propellant Utilization</u>

The objective will be verified by evaluating the performance of the PU system as utilized in a propellant loading mode and for inflight propellant measurement. (S-IVB-205 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 inflight propellant mass history.

c. Demonstrate the open-loop PU operation in the commanded mixture ratio (CMR) mode with high engine mixture ratio (EMR) from ESC +7.5 sec to ESC +308.6 sec, followed by a cutback to a nominal EMR of 4.5:1 for the duration of powered flight.

3.13 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 3.13a) 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 (±0.3) v to 2.43 (±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.

3.14 Stage Aerodynamics and Thermodynamics

Verify the aerodynamic/thermodynamic performance of the S-IVB stage, as feasible, during launch, boost, powered flight and orbit.

3.15 Vibration Environment

This objective will be achieved by evaluation of the vibration environment of the stage engine during the S-IVB powered portion of flight.

The evaluation will include:

a. Measurements on the combustion chamber done

b. Measurements on each turbopump

c. Measurements on the main fuel valve

d. Measurements on the ASI LOX valve

e. Measurements on the ASI fuel block.

3.16 Ordnance System

Verify proper operation of the ordnance system during powered flight. The objective will be achieved by verification of the operation of the stage separation systems.

3.17 Environmental Control System

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

Powered Flight

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

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

Orbital Coast

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

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

3.18 Stage Sequence of Events

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

SECTION 4

STAGE CONFIGURATION

4. STAGE CONFIGURATION

This section presents the general configuration of the S-IVB-205 stage and significant S-IVB-205 stage configuration differences from the S-IVB-204 stage.

4.1 S-IVB-205 Stage

The S-IVB-205 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 Drawing No. 1B62934, S-IVB-205 End Item Test Plan, (reference 4). Figure 4-2 presents a schematic arrangement of the propulsion system and its associated instrumentation.

4.2 Stage Configuration Differences

The following paragraphs delineate significant configuration differences between the S-IVB-204 and S-IVB-205.

4.2.1 Augmented Spark Igniter (ASI)

The ASI propellant feed system has been modified (removing all flexible hose sections) and additional flight instrumentation has been added.

4.2.2 LH2 Tank

The LH2 tank pressure switch has been changed in order to lower the operating range to 28 psia to 31 psia as a result of the fracture mechanics study.

4.2.3 LH2 Vent and Relief System

The LH2 vent and relief valve switch has been lowered to 31 psia to

34 psia. The backup relief valve setting has been lowered to 35 psia to 38 psia. Both of the above are a result of the fracture mechanics study.

4.2.4 LH2 Tank Safing System

An LH2 tank passivation valve with actuation control module has been added to the LH2 vent system.

The passivation valve latches open and permits safing of the tank by venting it continuously and nonpropulsively after stage orbital insertion.

4.2.5 LOX Nonpropulsive Vent (NPV) System

A nonpropulsive LOX vent system has been added.

A pneumatically controlled latch-open valve provides for LOX tank nonpropulsive venting which permits LOX tank safing after stage orbital insertion.

4.2.6 Stage Pneumatic Control System

The stage pneumatic control system has undergone several changes and is essentially a new configuration. A complete redesign has taken place in the following parts; actuation control module, J-2 engine pump purge control module and LOX chilldown pump purge system.

The ambient helium fill module and the pneumatic power control module have also been improved.

4.2.7 J-2 Engine Instrumentation

Additional engine instrumentation were added primarily to monitor the ASI.

4.2.8 J-2 Engine

a. Start Tank Refill Orifice Blank

The J-2 engine start tank refill orifice has been replaced with a blank orifice. No restart required on a IB.

b. Start Tank Emergency Dump Valve

A J-2 engine start tank emergency dump valve has been added with ground (only) capability to dump the engine start bottle in case of an aborted launch.

4.2.9 Propellant Utilization (PU) System

The PU system will operate in the open-loop mode. The PU valve normally remains in the 5.0:1 or null position during the open loop mode, however, the capability to command the PU valve to the nominal 5.5:1 or 4.5:1 mixture ratio position has been incorporated in the IU switch selector.

4.2.10 Data Acquisition System

The data acquisition system was reduced to one PCM/FM system on the operational S-IVB stages. Subsequent requirements to obtain high frequency data has necessitated the utilization of an FM/FM data link; therefore, the data acquisition system has been modified to multiplex and transmit the required high frequency measurements through the IU FM/FM data system (DF1). As a result, the following telemetry subsystems have been removed:

a. PAM/FM/FM subsystem

b. FM/FM subsystem

c. SS/FM subsystem

d. Airborne tape recorder.

The following components have been added to the PCM/FM subsystem:

a. Remote analog submultiplexer

b. Remote digital submultiplexer.

Figure 4-3 shows a block diagram of the data acquisition system.

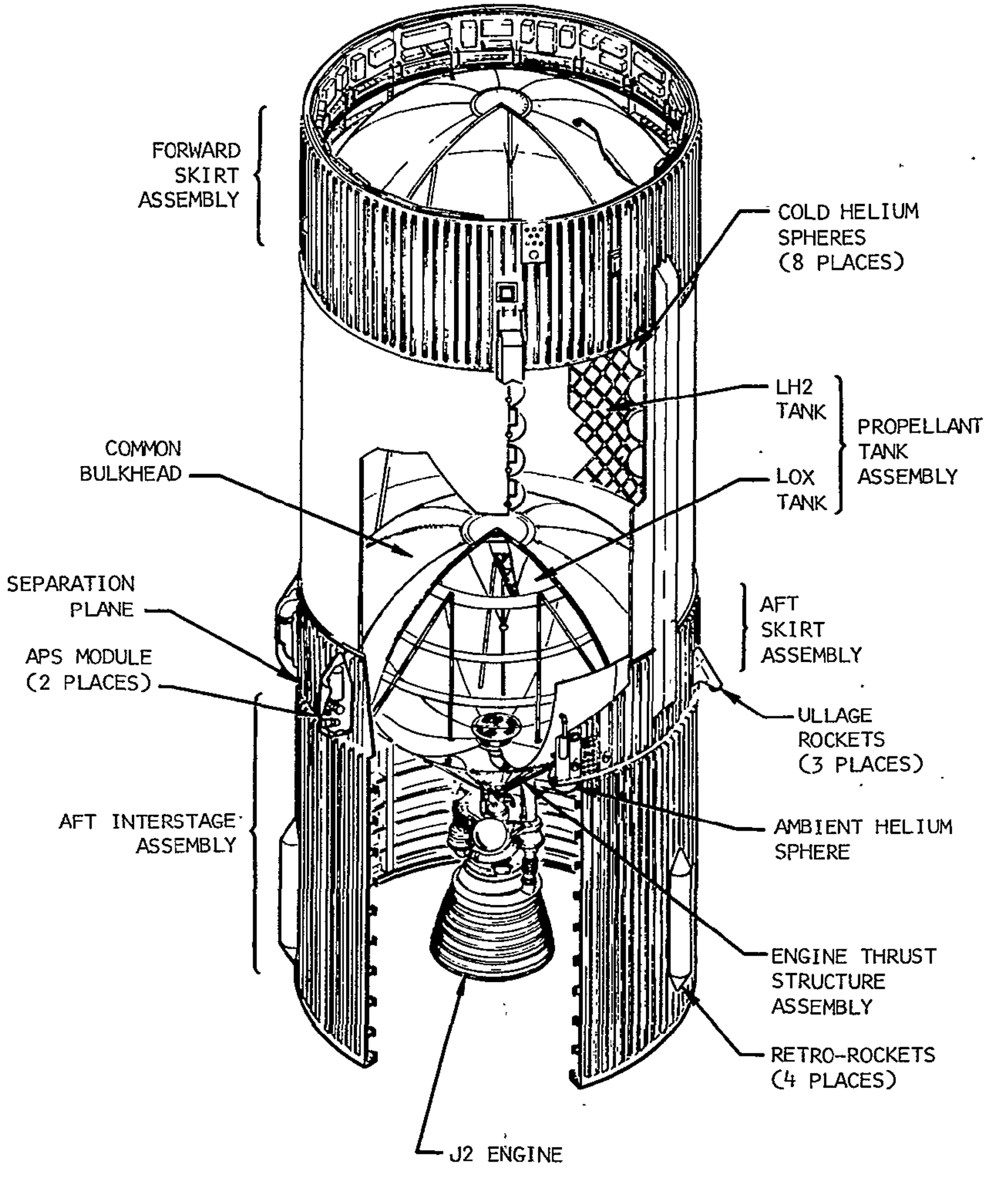


Figure 4-1. S-IVB-205 Stage Cutaway

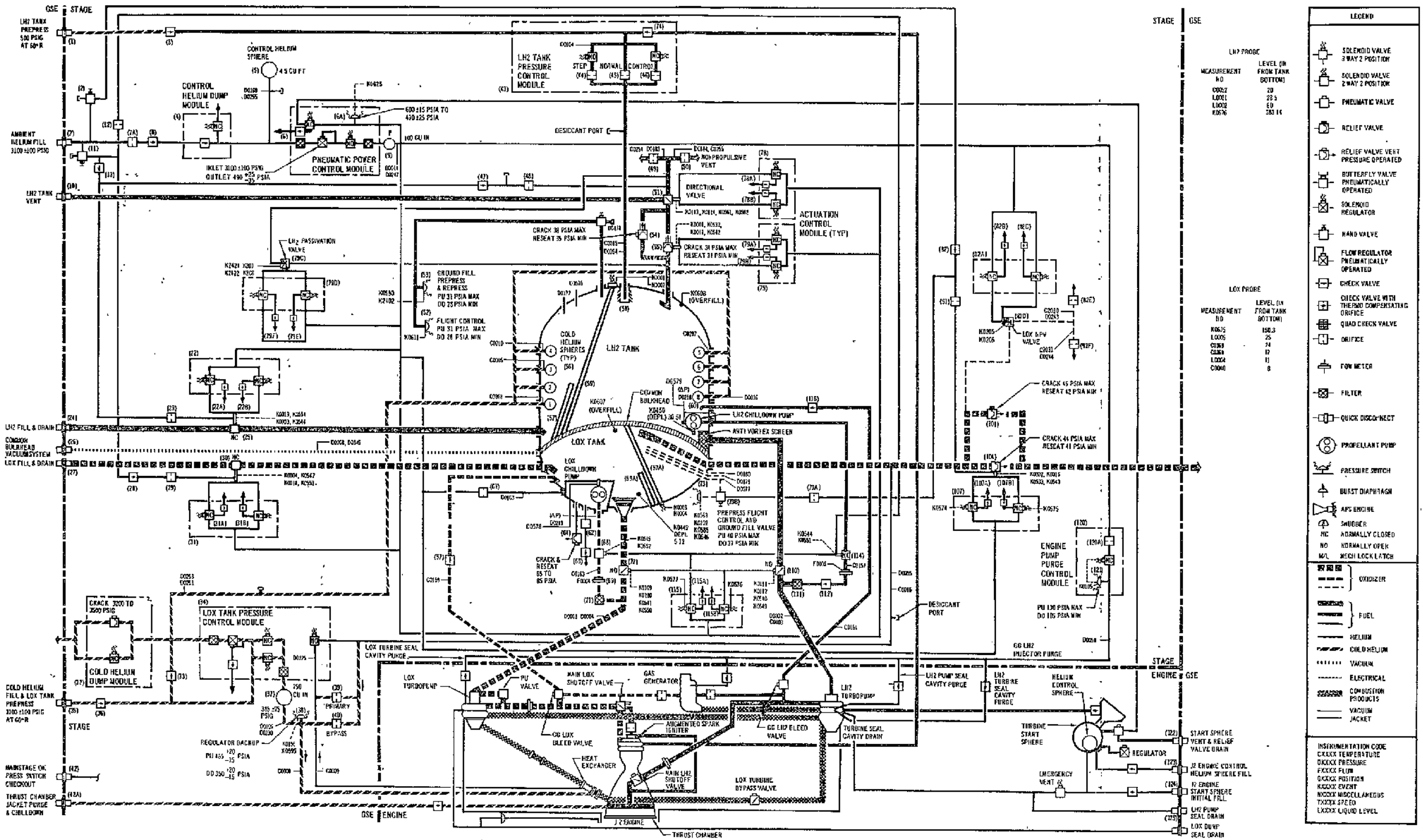


Figure 4-2. Propulsion System Configuration and Instrumentation

FOLDOUT FRAME 1

FOLDOUT FRAME 2

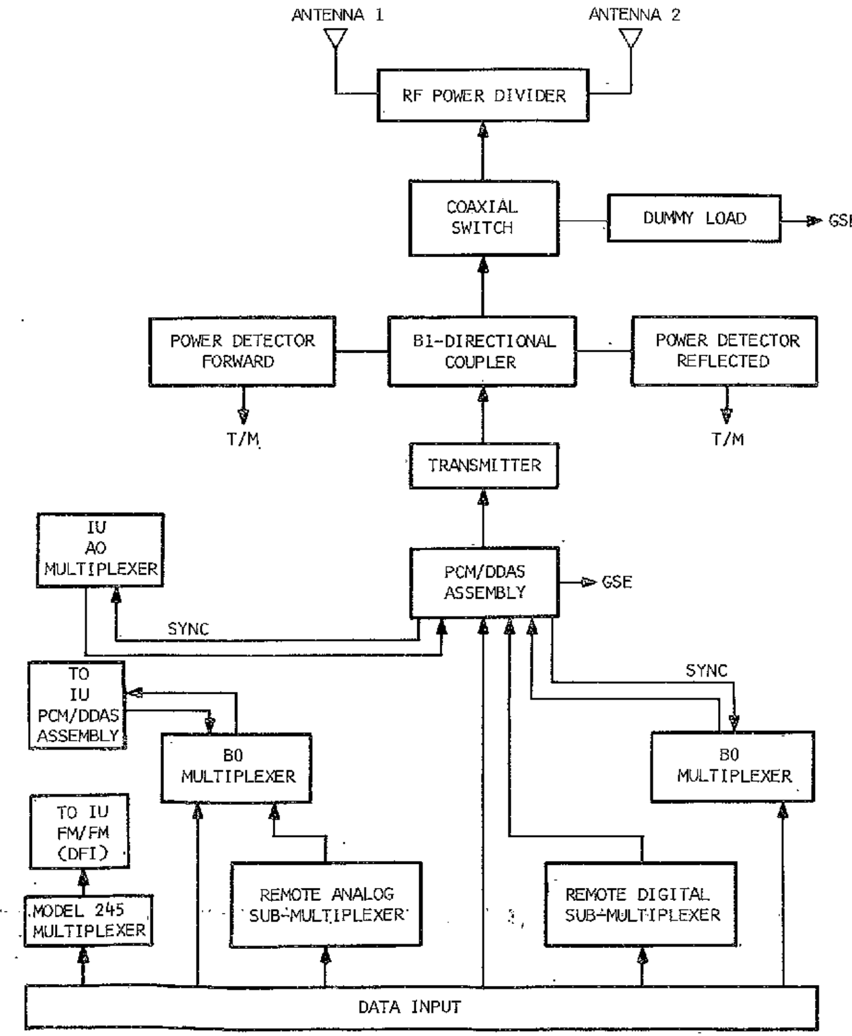


Figure 4-3. Data Acquisition System

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.

5.1 Launch Mission Rules

Launch mission rules are launch vehicle, space vehicle, and spacecraft launch constraining requirements.

Launch mission rules are developed to aid the launch director in decision making when an anomaly occurs. The launch mission rules are only a guideline and can be changed by the launch director. Before on-the-spot changes are made, the contractors are usually contacted for recommendations.

The launch mission rules are included in a document released by NASA/KSC director of launch operations. McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) has received a preliminary issue of this document, Apollo/Saturn IB Launch Mission Rules (SA-205 CSM-101), (reference 5).

The launch mission rules document is divided into the four following sections and each will be discussed in the following paragraphs:

- Section I - Space Vehicle Operations
- Section II - Launch Vehicle Operations
- Section III - Spacecraft Operations
- Section IV - Technical Support Operations

5.1.1 Space Vehicle Operations

This section includes an introduction to the document, general launch mission rules (LMR) applied to the space vehicle, and detailed launch mission rules applied to the space vehicle. The following is a discussion on each sub-section and how it affects the S-IVB stage:

*Definition: Space Vehicle includes S-IC stage, S-II stage, S-IVB stage, IU, and the Spacecraft.

5.1.1.1 Introduction

The introduction defines the purpose of the LMR to "Provide guidance to the launch director and launch team organization by specifying preplanned decisions which are required to minimize real time rationalization required when non-nominal situations occur during the launch countdown and applicable prelaunch tests".

5.1.1.2 Mission Rules Guidelines

The mission rules guidelines defines terms, outlines procedures to be taken in the event an anomaly occurs and defines duties and authority during the countdown. These guidelines are established by NASA Headquarters in NASA Management Instruction (NMI) 8020.9 and insures compatibility between LMR and flight mission rules. Identical guidelines are included in each LMR document. The most significant guidelines have been included in table 5-1.

5.1.1.3 General Launch Rules

The general launch rules are detailed guidelines and procedures for the development and utilization of launch mission rules. These guidelines are established in the NASA/KSC Apollo/Saturn Launch Mission Rules Handbook. The more significant of these rules have been reiterated in table 5-2 for convenience and emphasis.

5.1.1.4 Launch Window Restrictions

The launch window times were not defined. The only MDAC-WD launch window restriction occurs in the event of a scrub. The rescheduled window must take into account the stage turnaround time for propellant removal and prelaunch preparations. The launch window restrictions are established by NASA/KSC with MDAC-WD/A41 as advisors. MDAC-WD/A3 is not involved. The restrictions were not included in the preliminary launch mission rules.

5.1.1.5 Weather Restrictions

The weather restrictions are established by NASA and are not complete in the preliminary launch mission rules. In the past, the wind velocity, direction and elevation weather restrictions have not exceeded the stage CEI design specification limits. The limits are not expected to be exceeded for this launch.

5.1.1.6 Flight Crew Safety Rules

Flight crew safety rules are established by the flight crew safety panel at KSC. MDAC-WD is represented on this panel at KSC. Flight crew safety rules will also be reviewed by MDAC-WD/A3 engineering.

5.1.1.7 Hold/Cutoff Guidelines

This subsection defines the rules for requesting holds and cutoffs. MDAC-WD does not make a direct input to these rules. However, they do affect the MDAC-WD/FTC launch operations. The more significant points of the rules are as follows:

a. A hold is stopping the clock before the start of automatic sequence.

b. A cutoff is stopping the clock after the start of automatic sequence.

c. After T -5 sec requests for cutoff will be given only if the vehicle fails to liftoff.

5.1.1.8 Functional Sequence

The functional sequence details actions to be followed in the event problems are encountered in the countdown and recommended hold points. The requirements were not included in the preliminary launch mission rules. The only MDAC-WD requirement for this subsection is the maximum 5 min accumulated hold time after the initiation of the engine thrust chamber chilldown.

5.1.2 Launch Vehicle

This section of the launch mission rules document (LMRD) includes constraints imposed upon stage systems and components.

Included are such items as critical systems, redlines, critical flight control measurements and critical postflight evaluation measurements.

5.1.2.1 Critical Systems

Except for the telemetry system, the S-IVB critical systems are covered by the redlines. Since the S-IVB-205 stage is essentially an operational stage, the only telemetry systems or links available for S-IVB data acquisition are CP-1 (via S-IVB) and DP-1, DF-1 (via IU) links. To be consistent with the postflight requirements and primary flight objectives, MDAC-WD requires that CP-1 and DP-1 links be mandatory. The data transmitted by CP-1 and DP-1 is affected by multiplexers and sub-multiplexers. Each multiplexer and sub-multiplexer provides a sufficient percentage of data and critical measurements to warrant a classification of mandatory. The critical systems are as follows:

a. Link CP-1

b. Link DP-1

c. BO Multiplexer (via CP-1)

d. BO Multiplexer (via DP-1)

e. Remote Digital Sub-multiplexer (via CP-1)

f. Remote Analog Sub-multiplexer (via DP-1).

The critical systems listed in the preliminary LMR document are consistent with the above list.

5.1.2.2 Redlines

Redlines are parameters with minimum and/or maximum values that specify acceptable systems operation. The prelaunch operations period is not to be completed if the conditions specified are not met. The LMR defines all redlines as mandatory. The latest MDAC-WD measurements monitoring the parameters with redline limits are listed in table 5-3 with their limits, expected values, and applicable time period.

The NASA/MSFC redlines submitted to NASA/KSC for inclusion into the final edition of the launch mission rules were received by MDAC-WD in letter I-V-S-IVB-L-68-269, dated July 30, 1968.

There are no significant differences between the MDAC-WD and NASA/MSFC recommended redlines.

Additional redlines in table 5-4 are being requested by MDAC-WD in letter A3-860-KKBO-L-2731, dated July 26, 1968. MDAC-WD does not yet have NASA position or concurrence on these redlines.

5.1.2.3 Critical Flight Control Measurements

The categorization of critical flight control measurements and the inclusion of these in the LMR document is to assure that these measurements are operative at or near liftoff. These measurements are included in table 5-5.

5.1.2.4 Critical Postflight Evaluation Measurements

Critical postflight evaluation measurements are those singular measurements that are mandatory or highly desirable to accomplish postflight evaluation of a primary mission objective. MDAC-WD does not recommend any singular measurements as critical because evaluations are based upon several measurements within the system being evaluated. A failure of one measurement would not prevent the evaluation of a system.

5.1.2.5 GSE/ESE

MDAC-WD has no GSE/ESE launch constraints. The S-IVB stage, however, is affected by NASA/MSFC generated rules for pad safety. This involvement is in the area of hazardous gas detection. If a dangerous gas mixture is detected in either forward or aft interstage areas a hold or cutoff is to be initiated.

5.1.3 Section III - Spacecraft Operations

MDAC-WD has no responsibility for inputs to this section.

5.1.4 Section IV - Technical Support

This LMRD section contains launch mission rules that pertain to all operational support equipment not under the direct supervision of launch vehicle or spacecraft elements. MDAC-WD is not responsible for submitting inputs to this section.

5.2 Bluelines and Backup Redlines

5.2.1 Bluelines

Bluelines are maximum and/or minimum values of parameters which, if exceeded, shall result in an engineering judgment as to whether the countdown will be completed without corrective action. Bluelines are not included in the LMR documents, and are not recognized by NASA as launch constraints. The SA-205/CSM-101 bluelines are listed in table 5-6.

The blueline philosophy and limits are implemented by instructions from the design technologies to the instrumentation observer. Under no conditions does exceeding a blueline limit result in a hold or scrub of the launch without the consent of the launch director.

5.2.2 Backup Redlines

Backup redlines are substitutions for redline measurements in the event the redline measurement 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 measurements are not considered as alternates nor considered with the same confidence as primary redlines. The backup redlines are listed in table 5-7.

The MDAC-WD backup redlines have been submitted to NASA by letters A3-860-KKBO-L-1252, dated June 11, 1968 and A3-250-KKBO-L-2914, dated July 8, 1968.

The NASA Countdown Observer Backup Redlines Information document has not been released for the SA-205/CSM-101. However, by preliminary discussion with NASA personnel, discrepancies are not expected.

TABLE 5-1 (Sheet 1 of 2)
MISSION RULES GUIDELINES

ITEM	DESCRIPTION
1-104	Within their respective areas of responsibility, the command pilot, launch director, flight director, Department of Defense (DOD) manager for MSF support operations, and mission director may take or recommend any action required for optimum conduct of the mission.
1-105	The command pilot, spacecraft test conductor, launch vehicle test conductor, space vehicle test supervisor, launch operations manager, launch director, flight director, DOD manager for MSF support operations, or mission director may request a hold for conditions within their respective areas of responsibility.
1-106	During the countdown, the launch vehicle and spacecraft program managers and respective center operations managers shall provide technical advice and support directly to the launch operations manager and launch director. The latter two will keep the mission director fully informed of problems and proposed solutions. During the flight phase of operations, similar support as required will be provided to the flight director and MSC director of flight operations. The mission director will be kept fully informed by these individuals of problems and proposed solutions during the applicable phases of the mission.
1-107	When time permits, the failure of a mandatory or highly desirable item will be reported to the mission director by the launch director or 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.
1-108	If a mandatory item fails during the countdown, it will be corrected prior to launch, holding or recycling the countdown as necessary. If a mandatory item cannot be corrected to permit liftoff within the launch window, the mission director may proceed with the launch after appropriate coordination with the appropriate operations and program managers. Generally, the loss of a mandatory item will result in a scrub.
1-109	As the designated representative of the program director, only the mission director may scrub the mission. Further, the mission director retains the authority to downgrade a mandatory item. This authority shall be exercised as the circumstances dictate after appropriate recommendations from the program managers, launch director, and flight director.

TABLE 5-1 (Sheet 2 of 2)
MISSION RULES GUIDELINES

ITEM	DESCRIPTION
1-110	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/or other aggravating circumstances occur, the mission director may scrub the mission after coordination with the appropriate operations and program managers.
1-111	The countdown will not be held nor the launch scrubbed for failure of desirable items.
1-113	The countdown will continue where possible concurrently with correction of an existing problem.
1-117	Where possible, all manual abort requests from the ground during flight will be based on two independent indications of the failure. Crew abort action will normally be based upon two cues.
1-120	Complete ground control of the space vehicle passes from the launch director to the flight director when the space vehicle reaches sufficient altitude to clear the top of the umbilical tower.
1-122	The command pilot may initiate such inflight action as he deems essential for crew safety.
1-123	Flight crew safety shall take precedence over the accomplishment of mission objectives.

TABLE 5-2
GENERAL LAUNCH RULES

ITEM	DESCRIPTION
1-200	APPLICABLE TIME PERIODS: The applicable time period for all mandatory items will be specified in the time period/action/notes column for each such item. This time period will start at launch vehicle power up unless otherwise specified and will terminate at the specified time (no later than T -5 seconds for manual cutoff actions). The applicable time period for highly desirable items will start at launch vehicle power up and will terminate at T -2 minutes 43 seconds (automatic sequence start) unless otherwise specified in the time period/action/notes column.
1-201	INTERLOCKS: Any function that is interlocked on an automatic sequencing device and will effect an automatic shutdown or will prevent liftoff in the event of a malfunction is defined herein as mandatory and is not reiterated within this document.
1-202	UNVERIFIABLE ITEMS: Items which are received as launch mission rules inputs but which cannot be monitored or verified during the launch mission rules effectivity period do not appear in this document. These items will be verified prior to entering the effectivity period, and appropriate organizations will be notified of malfunctions.
1-203	MSC AND MSFC REPRESENTATIVES: MSC and MSFC will designate a single point of contact within the launch control center (LCC) to consult with the director, spacecraft operations, and the director, launch vehicle operations; and with whom the launch director and launch operations manager may discuss instrumentation or hardware discrepancies and/or malfunctions that occur during the launch countdown. The MSC and MSFC representatives will be notified of LMRD discrepancies when time permits.
1-204	LMR/FMR INTERFACE: For certain operational support elements (required to be operational at liftoff) for which KSC, ETR, or GSFC are operationally responsible, redundant entries may be contained in both the launch mission rules and the flight mission rules. The LMRD will contain rules concerning only those operational support elements for which the launch director or appropriate elements of the launch team organization would call a hold or would call for cutoff in the event of malfunctions.

TABLE 5-3 (Sheet 1 of 6)
AS-205 COUNTDOWN OBSERVER REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH		TIME PERIOD/ACTION/NOTES
		MIN VALUE	MAX VALUE	
XC0003-403	Temperature, Fuel Pump Inlet	Fig. 5-1	Fig. 5-1	Check from T-15 sec to T-5 sec. No check required prior to automatic sequence start.
VXC0006-401	Temperature, GH2 Start Bottle	Fig. 5-3	Fig. 5-3	Check from immediately prior to initiation of automatic sequence to T-5 sec.
VXC0050-401	Temperature, Hydraulic Pump Inlet Oil	None	625°R	Check from final Auxiliary Hydraulic Pump Flight Mode ON Command to initiation of automatic sequence.
XC0168-414	Temperature, Oxidizer Tank Outlet Mod 1 (APS)	535°R	560°R	Check at T-15 min. If redline values have not been exceeded at T-15 min, no further monitoring is required.
XC0169-415	Temperature, Oxidizer Tank Outlet Mod 2 (APS)	535°R	560°R	Check at T-15 min. If redline values have not been exceeded at T-15 min, no further monitoring is required.
VXC0199-401	Temperature, Thrust Chamber Jacket	None	315°R	Check immediately prior to initiation of automatic sequence and verify that thrust chamber jacket chill is continuing.
		None	275°R	Check at T-5 sec.
VXD0014-403	Pressure, Control Helium Regulator Discharge	455 psia	585 psia	Check from sphere pressurization to T-5 sec. NOTE: Violation of the minimum redline for a period not greater than 2 sec is expected and allowable at times of valve activation.

TABLE 5-3 (Sheet 2 of 6)
AS-205 COUNTDOWN OBSERVER REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH MIN VALUE	PRELAUNCH MAX VALUE	TIME PERIOD/ACTION/NOTES
VXD0016-425	Pressure, Cold Helium Sphere	2,800 psia	3,200 psia	From sphere pressurization to T-5 sec. (The spheres must be submerged in the LH2 for at least 30 min of countdown prior to liftoff.) NOTE: The 2,800 to 3,200 psia are design limits. However, 2,500 psia is acceptable from a mission requirements standpoint, if it is verified that no system leakage exists.
VXD0017-401	Pressure, GH2 Start Bottle	Fig. 5-3	Fig. 5-3	Check from immediately prior to initiation of automatic sequence to T-5 sec.
VXD0019-401	Pressure, Engine Control Helium Sphere	2,800 psia	3,300 psia	From sphere pressurization to initiation of automatic sequence.
		2,800 psia	3,375 psia	Check from initiation of automatic sequence to T-5 sec.
XD0576-408	Pressure, Fuel Tank Ullage	None	17.2 psia	From approximately T-30 min to initiation of LH2 tank pressurization.
		None	39.0 psia	Check from initiation of LH2 tank pressurization to T-15 sec.
		Fig. 5-1	Fig. 5-1	From approximately T-15 sec to T-5 sec.

TABLE 5-3 (Sheet 3 of 6)
AS-205 COUNTDOWN OBSERVER REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH		TIME PERIOD/ACTION/NOTES
		MIN VALUE	MAX VALUE	
XD0577-406	Pressure, Oxidizer Tank Ullage	37 psia	44 psia	From T-15 sec to T-5 sec.
		None	44 psia	From initiation of LOX tank pressurization to T-15 sec.
VXD0041-403	Pressure, Hydraulic System	3,400 psia	4,100 psia	Check from Auxiliary Hydraulic Pump Flight Mode ON Command until initiation of automatic sequence.
VXD0042-403	Pressure, Reservoir Oil	45 psia	None	Check from Auxiliary Hydraulic Pump Thermal Coast Mode ON Command to final Flight Mode ON Command.
XD0068-415	Pressure, Helium Regulator Inlet Mod 2 (APS)	2,800 psia	3,200 psia	Check from system pressurization until T-5 sec.
VXD0094-414	Pressure, Oxidizer Tank Outlet Mod 1 (APS)	203 psia	216 psia	Check from T-15 min until T-5 sec. until T-5 sec.
VXD0095-415	Pressure, Oxidizer Tank Outlet Mod 2 (APS)	203 psia	216 psia	Check from T-15 min until T-5 sec. until T-5 sec.
VXD0160-403	Pressure, Helium (Ambient) Sphere	2,800 psia	3,200 psia	From sphere pressurization until T-5 sec.
VXD0064-414	Pressure, Helium Regulator Inlet Mod 1 (APS)	2,800 psia	3,200 psia	Check from system pressurization until T-5 sec.
F0004-424	Flow, LOX Recirculation Pump	30 gpm	None	Check from start of recirculation to T-5 sec.

TABLE 5-3 (Sheet 4 of 6)
AS-205 COUNTDOWN OBSERVER REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH		TIME PERIOD/ACTION/NOTES
		MIN VALUE	MAX VALUE	
F0005-404	Flow, Fuel Recirculation Pump	120 gpm	None	Check from initiation of fuel tank pressurization T-97 sec to T-5 sec. NOTE: 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 prepress is initiated, sharp fluctions in the flowrate may result. These fluctuations have lasted from 15 to 60 sec on previous firings. This is a normal condition and monitoring of this parameter should not be started until the flowrate has attained a steady state value.
G0001-403	Position, Pitch Actuator	-1.5°	+1.5°	Check from final Auxiliary Hydraulic Pump Flight Mode ON Command to T-5 sec.
G0002-403	Position, Yaw Actuator	-1.5°	+1.5°	
VXG0010-401	Position, PU System Ratio Valve	Null -2°	Null +2°	Check from T-5 min to T-5 sec.
K0013-401	Event, Cutoff (Lock-in) Signal	OFF	OFF	Observe drop from ON indication at engine ignition power ON and monitor that indication remains OFF to T-5 sec.

TABLE 5-3 (Sheet 5 of 6)
AS-205 COUNTDOWN OBSERVER REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH		TIME PERIOD/ACTION/NOTES
		MIN VALUE	MAX VALUE	
VXL0007-403	Level, Reservoir Oil	Fig. 5-2	None	Pump ON: Check from Auxiliary Hydraulic Pump Thermal Coast Mode ON Command to T-5 sec.
VXC0051-403 (Temperature)	Temperature, Reservoir Oil			Pump OFF: Check from Auxiliary Hydraulic Pump Thermal Coast Mode ON Command to Flight Mode ON Command.
VXL0007-403	Level, Reservoir Oil	6 percent	None	From Auxiliary Hydraulic Pump Thermal Coast Mode ON (T-5 hr) to T-5 sec (Aux Pump ON).
VXM036-307	4D11 Voltage (Bus) Aft No. 1	26 vdc	*31 vdc	While busses are energized either by ground or internal electrical power to T-7 sec. Transients that occur during power transfer and load switching are not considered as deviations from limits. *NOTE: During the initial application of voltage to the engine buses the maximum allowable voltage may be 32 vdc max for a period not to exceed 60 sec.

TABLE 5-3 (Sheet 6 of 6)
AS-205 COUNTDOWN OBSERVER REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH		TIME PERIOD/ACTION/NOTES
		MIN VALUE	MAX VALUE	
VXM0040-307	4D21 Voltage (Bus) Fwd No. 2	24.5 vdc	**32.0 vdc	While busses are energized, either by ground or internal electrical power to T-5 sec. Transients that occur during power transfer and load switching are not considered as deviations from limits. **30 vdc when on external power and RACS is being used.
VXM050-307	4D31 Voltage (Bus) Fwd No. 1	26 vdc	32 vdc	While busses are energized, either by ground or internal electrical power, to T-7 sec. Transients that occur during power transfer and load switching are not considered as deviations from limits.
VXM083-307	4D41 Voltage (Bus) Aft No. 2	51 vdc	61 vdc	While busses are energized either by ground or internal electrical power to T-7 sec. Transients that occur during power transfer and load switching are not considered as deviations from limits.
N0063-411	Misc, PU Oven Stability Monitor	-0.30 vdc Below stab. strip chart level	+0.30 vdc Above stab. strip chart level	From 45 min after PU power ON to T -20 sec. NOTE: Redline becomes effective when measurement has come on scale and stabilized.

TABLE 5-4
HELIUM BOTTLE PRESSURE DECAY REDLINES

MEAS/TM NO.	DESCRIPTION	PRELAUNCH		TIME PERIOD/ACTION/NOTES
		MIN VALUE	MAX VALUE	
VXD0016-425	Pressure, Cold Helium Sphere	Fig. 5-6 and Fig. 5-7	Fig. 5-6 and Fig. 5-7	One hour of bottle replenish hold. NOTE: C0005-405 is used, in conjunction with this redline to determine mass and must be at a stabilized value.
VXD0019-401	Pressure, Engine Control Helium Sphere	Fig. 5-8	Fig. 5-8	One hour of bottle replenish hold.
VXD0064-414	Pressure, Helium Regulator Inlet Mod 1 (APS)	Fig. 5-9	Fig. 5-9	One hour of bottle replenish hold.
VXD0068-415	Pressure, Helium Regulator Inlet Mod 2 (APS)	Fig. 5-9	Fig. 5-9	One hour of bottle replenish hold.
VXD0160-403	Pressure, Helium (Ambient) Sphere	Fig. 5-10	Fig. 5-10	One hour of bottle replenish hold.

TABLE 5-5 (Sheet 1 of 3)
S-IVB-205 CRITICAL FLIGHT CONTROL MEASUREMENTS

MEASUREMENT NUMBER	TITLE	CATEGORY
C0001-401	Temp - Fuel Turbine Inlet	Highly Desirable
C0002-401	Temp - Oxidizer Turbine Inlet	Highly Desirable
C0003-403	Temp - Fuel Pump Inlet	Highly Desirable
C0004-403	Temp - Oxidizer Pump Inlet	Highly Desirable
C0168-414	Temp - Oxidizer Tank Outlet Mod 1 (APS)	Highly Desirable
C0169-415	Temp - Oxidizer Tank Outlet Mod 2 (APS)	Highly Desirable
C0170-414	Temp - Fuel Tank Outlet Mod 1 (APS)	Highly Desirable
C0171-415	Temp - Fuel Tank Outlet Mod 2 (APS)	Highly Desirable
D0001-401	Press - Thrust Chamber	Mandatory
D0002-403	Press - Fuel Pump Inlet	Highly Desirable
D0003-403	Press - Oxidizer Pump Inlet	Highly Desirable
D0008-401	Press - Fuel Pump Discharge	Highly Desirable
D0014-403	Press - Control Helium Regulator Discharge	Highly Desirable
D0016-425	Press - Cold Helium Spheres	Mandatory
D0017-401	Press - GH2 Start Bottle	Highly Desirable
D0018-401	Press - Engine Regulator Outlet	Highly Desirable
D0019-401	Press - Engine Control Helium Sphere	Mandatory
D0041-403	Press - Hydraulic System	Highly Desirable
D0042-403	Press - Reservoir Oil	Highly Desirable
D0064-414	Press - Helium Regulator Inlet Mod 1 (APS)	Highly Desirable
D0065-414	Press - Helium Regulator Outlet Mod 1 (APS)	Highly Desirable
D0068-415	Press - Helium Regulator Inlet Mod 2 (APS)	Highly Desirable
D0069-415	Press - Helium Regulator Outlet Mod 2 (APS)	Highly Desirable
D0105-403	Press - LOX Tank Press Mod Helium Gas	Highly Desirable
D0160-403	Press - Helium (Ambient) Sphere	Mandatory
D0177-410	Press - Fuel Tank Ullage EDS 1	Mandatory
D0178-410	Press - Fuel Tank Ullage EDS 2	Mandatory
D0179-424	Press - Oxidizer Tank Ullage EDS 1	Mandatory
D0180-424	Press - Oxidizer Tank Ullage EDS 2	Mandatory
D0183-409	Press - LH2 Tank Nonpropulsive Vent 1	Highly Desirable
D0184-409	Press - LH2 Tank Nonpropulsive Vent 2	Highly Desirable
D0241-401	Press - GH2 Start Bottle (Backup Meas)	Highly Desirable
D0242-401	Press - Engine Control Helium Sphere (Backup Meas)	Mandatory

TABLE 5-5 (Sheet 2 of 3)
S-IVB-205 CRITICAL FLIGHT CONTROL MEASUREMENTS

MEASUREMENT NUMBER	TITLE	CATEGORY
D0243-404	Press - LOX NPV Nozzle No. 1	Highly Desirable
D0244-404	Press - LOX NPV Nozzle No. 2	Highly Desirable
D0247-403	Press - Control Helium Regulator Discharge (Backup Meas)	Highly Desirable
*D0248-425	Press - Cold Helium Spheres (Backup Meas)	Mandatory
*D0255-403	Press - Helium (Ambient) Sphere (Backup Meas)	Mandatory
F0005-404	Flowrate - Fuel Circulation Pump	Highly Desirable
G0001-403	Position - Actuator Piston Pot Pitch	Highly Desirable
G0002-403	Position - Actuator Piston Pot Yaw	Highly Desirable
G0003-401	Position - Main Oxidizer Valve	Highly Desirable
G0004-401	Position - Main Fuel Valve	Highly Desirable
G0010-401	Position - PU System Ratio Valve	Highly Desirable
K0001-410	Event - Fuel Tank Vent Valve Closed	Highly Desirable
K0002-424	Event - Oxidizer Tank Vent Valve Closed	Highly Desirable
K0012-401	Event - Engine Ready Signal	Highly Desirable
K0014-401	Event - Mainstage OK Pressure Switch 1	**
K0016-404	Event - Oxidizer Tank Vent Valve 1 Open	Highly Desirable
K0017-410	Event - Fuel Tank Vent Valve 1 Open	Highly Desirable
K0110-403	Event - Oxidizer Prevalve Closed	Highly Desirable
K0112-404	Event - Fuel Prevalve Closed	Highly Desirable
K0128-404	Event - Switch Selector Output Monitor	Highly Desirable
K0132-404	Event - APS Engine 1-1/1-3 Feed Valve Open	Highly Desirable
K0133-404	Event - APS Engine 1-2 Feed Valve Open	Highly Desirable
K0134-404	Event - APS Engine 2-1/2-3 Feed Valve Open	Highly Desirable
K0135-404	Event - APS Engine 2-2 Feed Valve Open	Highly Desirable
K0157-401	Event - Mainstage OK Pressure Switch 2	**
K0205-403	Event - LOX Pass Valve Open Talkback	Highly Desirable
K0206-403	Event - LOX Pass Valve Closed Talkback	Highly Desirable
K0207-411	Event - LH2 Pass Valve Open Talkback	Highly Desirable

*MDAC-WD recommends that this measurement be added to the list of official flight control measurements.
**One of these two measurements is mandatory. The other is highly desirable.

TABLE 5-5 (Sheet 3 of 3)
S-IVB-205 CRITICAL FLIGHT CONTROL MEASUREMENTS

MEASUREMENT NUMBER	TITLE	CATEGORY
K0208-411	Event - LH2 Pass Valve Closed Talkback	Highly Desirable
L0007-403	Level - Reservoir Oil	Highly Desirable
M0014-404	Volt - Output Aft Battery No. 1	Highly Desirable
M0015-404	Volt - Output Aft Battery No. 2	Highly Desirable
M0016-411	Volt - Output Fwd Battery No. 1	Highly Desirable
M0018-411	Volt - Output Fwd Battery No. 2	Highly Desirable
M0019-411	Current - Load Fwd Battery No. 1	Highly Desirable
M0020-411	Current - Load Fwd Battery No. 2	Highly Desirable
M0021-404	Current - Load Aft Battery No. 1	Highly Desirable
M0022-404	Current - Load Aft Battery No. 2	Highly Desirable
M0024-411	Volt - 5 Volt Excitation Module Fwd	Highly Desirable
M0025-404	Volt - 5 Volt Excitation Module Aft	Highly Desirable
M0030-411	Volt - F/U 1 EBW Range Safety	Highly Desirable
M0031-411	Volt - F/U 2 EBW Range Safety	Highly Desirable
M0068-411	Volt - 5 Volt Excitation Module Fwd 2	Highly Desirable
N0001-411	Misc - PU System LH2 Coarse Mass Voltage	Highly Desirable
N0003-411	Misc - PU System LOX Coarse Mass Voltage	Highly Desirable
N0018-411	Misc - PCM/FM Transmitter Output Power	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
N0057-411	Misc - Secure R/S Receiver 1 L/L Signal Strength	Highly Desirable
N0062-411	Misc - Secure R/S Receiver 2 L/L Signal Strength	Highly Desirable
T0002-401	Speed - Fuel Pump	Highly Desirable

TABLE 5-6 (Sheet 1 of 3)
S-IVB-205 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS MINIMUM	LIMITS MAXIMUM	EXPECTED VALUE	TIME PERIOD OF BLUELINE APPLICABILITY
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 5-6 (Sheet 2 of 3)
S-IVB-205 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS MINIMUM	LIMITS MAXIMUM	EXPECTED VALUE	TIME PERIOD OF BLUELINE APPLICABILITY
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	
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	Anytime power is applied.
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)

TABLE 5-6 (Sheet 3 of 3)
S-IVB-205 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	UNITS	LIMITS		EXPECTED VALUE	TIME PERIOD OF BLUELINE APPLICABILITY
			MINIMUM	MAXIMUM		
N0063-411	Misc - PU Oven Stability Monitor	vdc	-0.2 below stabilized strip chart reading	+0.2 above stabilized strip chart reading	0	During PU operation after temperature has stabilized.

TABLE 5-7 (Sheet 1 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Temperature, Fuel Pump Inlet	C0003-403	a. Recirculation system failure b. Excessive facility back pressure	Temperature, GG Fuel Bleed Valve C0012-401 See figure 5-4	1. Measures temperature of LH2 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 D0576-408).
Temperature, GH2 Start Bottle	C0006-401	a. Improper chilldown 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 with the GH2 start bottle. 2. The two sphere temperatures will merge 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).

TABLE 5-7 (Sheet 2 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Temperature, Hydraulic Pump Inlet Oil	C0050-401	a. Auxiliary pump overheating b. High pressure relief valve failed open	a. Temperature, Reservoir Oil VC0051-403 Nominal: 70°F	1. Reservoir oil temperature usually lags pump inlet oil temperature 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.
Temperature, Reservoir Oil	C0051-403	*	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. (Reference: Figure 5-2)
Temperature, Oxidizer Tank Outlet Mod 1 APS	C0168-414	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 hours 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.
Temperature, Oxidizer Tank Outlet Mod 2 APS	C0169-415	Failure of stage environmental control purge system	Temperature, Fuel Tank Outlet Mod 2 S-IVB APS C0171-415	Fuel and oxidizer temperature will be stable and equal after approximately 3 hours of ECS operation.

TABLE 5-7 (Sheet 3 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
			Minimum: 535°R Maximum: 560°R Nominal: 550°R	Consequently, the fuel temperature may be monitored as a redline backup and must be between 535 and 560°R at T -15 min.
Temperature, Thrust Chamber Jacket	C0199-401	a. Insufficient GSE performance	Temperature, LH2 Injection C0200-401 Prior to initiation of automatic sequence. Minimum: None Maximum: 330°R Nominal: 305°R At T -5 sec. Minimum: None Maximum: 290°R Nominal: 280°R	1. In the event of C0199 failure, C0200 can be used. The expected injection temperature will be higher than the T/C jacket temperature. The temperature (C0200) shall be below 290°R at liftoff to prevent excess back-pressure on the injector at J-2 ignition.
Pressure, Control He Regulator Discharge	D0014-403	a. Regulator failure b. Excessive leakage	Pressure, Control He Regulator Discharge Backup Measurement D0247-403 Minimum: 455 psia Maximum: 585 psia Nominal: 540 psia	1. The backup requirements are the same as for primary redline. 2. Check from time of sphere pressurization to T -5 sec.
Pressure, Cold He Sphere	D0016-425	a. Ground regulator failure b. Improper regulator setting	Pressure, Cold He Sphere Backup No. 1 D0263-403 and Pressure, Cold	1. The backup requirements are the same as for primary redline. 2. Check from sphere pressuriza-

TABLE 5-7 (Sheet 4 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
		c. Check valve failed closed d. Vent and/or dump relief valve e. Excessive leakage	He Sphere Backup No. 2 D0261-403. Minimum: 2,800 psia Maximum: 3,200 psia Nominal: 3,000 psia	tion to T -5 sec.
Press, GH2 Start Bottle	D0017-401	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 the same as for primary redline. 2. This backup pressure should be used in conjunction with temperature GH2 start bottle (C0006-401).
Pressure, Engine Control He Sphere	D0019-401	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: 2,800 psia Maximum: 3,300 psia Nominal: 3,100 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). Note: 2,800 to 3,200 psia are design limits. However, for AS-205 only, 2,500 psia is acceptable from Mission Requirements standpoint, as long as it

TABLE 5-7 (Sheet 5 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
				is verified that no system leaks exist.
			Minimum: 2,800 psia Maximum: 3,375 psia Nominal: 3,150 psia	1. Same comment as above. 2. Check from IAS to T -5 sec. (See note)
Pressure, Hydraulic System	D0041-403	a. Auxiliary Hydraulic 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: 3,600 psia b. Pressure, Reservoir Oil D0043-403 Nominal: 170 psia	Loss of excessive fluid from hydraulic lines or reservoir will cause auxiliary hydraulic pump to cavitate and fluctuate in pressure level. High pressure relief valve is set to relieve at 4,000 psid. If pressure setting of valve decays below setting of pump pressure compensator, the system pressure will decay proportionately.
Pressure, Reservoir Oil (Aux Pump Off)	D0042-403	a. Accumulator gas leakage b. External oil leakage	a. Pressure, GN2 Accumulator D0043-403 Nominal: 2,350 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.
Pressure, Helium Regulator Inlet Mod 1 (APS)	D0064-414	a. Ground regulator failure b. Check valves failed closed c. System leakage	Pressure, Helium Regulator Inlet Mod 1 Backup Measurement D0252-414 Minimum: 2,800 psia Maximum: 3,200 psia Nominal: 3,000 psia	1. The backup requirements are same as for primary redline. 2. Check from T -15 min to T -5 sec.

TABLE 5-7 (Sheet 6 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Pressure, Helium Regulator Inlet Mod 2 (APS)	D0068-415	a. Ground regulator failure b. Check valves failed closed c. System leakage	Pressure, Helium Regulator Inlet Mod 2 Backup Measurement D0253-415 Minimum: 2,800 psia Maximum: 3,200 psia Nominal: 3,000 psia	1. The backup requirements are same as for primary redline. 2. Check from T -15 min to T -5 sec.
Pressure, Oxidizer Tank Outlet Mod 1 (APS)	D0094-414	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: 216 psia Nominal: 211 psia Pressure, Fuel Tank Ullage Volume Mod 1 (APS) D0089-414 Minimum: 203 psia Maximum: 216 psia Nominal: 211 psia Pressure, Fuel Tank Supply Manifold Mod 1 (APS) D0063-414 Minimum: 203 psia Maximum: 216 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 mist be between the limits of 203 and 216 psia from system pressurization to T -5 sec.

TABLE 5-7 (Sheet 7 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Pressure, Oxidizer Tank Outlet Mod 2 (APS)	D0095-415	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: 216 psia Nominal: 211 psia Pressure, Fuel Tank Ullage Volume Mod 2 (APS) D0091-415 Minimum: 203 psia Maximum: 216 psia Nominal: 211 psia Pressure, Fuel Tank Supply Manifold Mod 2 (APS) D0067-415 Minimum: 203 psia Maximum: 216 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 216 psia from system pressurization to T -5 sec.
Pressure, Helium Ambient Sphere	D0160-403	a. Ground regulator failure b. Improper regulator setting c. Check valves failed closed	Pressure, Helium Ambient Sphere Backup Measurement D0255-403 Minimum: 2,800 psia Maximum: 3,200 psia Nominal: 3,000 psia	1. The backup requirements are the same as for the primary redline. 2. Check from sphere pressurization to T -5 sec.

TABLE 5-7 (Sheet 8 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
		d. Vent and/or relief valve failed open e. Excessive leakage		
Pressure, Fuel Tank Ullage	D0576-408	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 See figure 5-4 for liftoff box and for back pressure Minimum: None Maximum: 17.2 psia Nominal: 16.5 psia Pressure, Fuel Tank Ullage EDS 2 D0178-424 See figure 5-4 for liftoff box and for back pressure Minimum: None Maximum: 17.2 psia Nominal: 16.5 psia	1. This measurement must be requested via the IU Digital Select.
Pressure, Oxidizer Tank Ullage	D0577-406	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 Minimum: 38 psia Maximum: 44 psia Nominal: 40 psia Pressure, Oxidizer Tank Ullage EDS 2	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

TABLE 5-7 (Sheet 9 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
			D0180-424 Minimum: 38 psia Maximum: 44 psia Nominal: 40 psia	to 44 psia from T -15 min to T -5 sec.
Flow, Oxidizer Recirculation Pump	F0004-424	Recirculation system failure	a. Delta Pressure, Oxidizer Pump Tank Ullage D0003-403 minus D0577-406 Minimum: 13 psid Maximum: 18 psid Nominal: 16 psid b. Temperature, Oxidizer Pump Inlet C0004-403 Minimum: None Maximum: 166°R Nominal: 164°R	The delta pressure is the preferred way to detect the recirculation anomaly. But in case one of the pressure measurements fail, the pump inlet temperature can be used as a backup. The temperature change will be slow if the recirculation fails.
Flow, Fuel Recirculation	F0005-404	Recirculation system failure	Delta Pressure, Fuel Pump Inlet minus Fuel Tank Ullage D0002-403 minus D0576-408 Minimum: 6 psid Maximum: 10 psid Nominal: 8 psid	The delta pressure is the preferred way to detect the recirculation anomaly. But in case D0002-403 pressure measurement fails, the pump inlet temperature redline (see figure 5-1) can be used as a backup. The temperature change will be slow if the recirculation fails.

TABLE 5-7 (Sheet 10 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Position, Pitch Actuator	G0001-403	a. Bias on servo signal from IU guidance computer b. Loss of hydraulic pressure due to auxiliary hydraulic pump failure, hose failure, etc.	During S-IVB Burn Mode the Measurement G0001-403 (via IU) can be used for an alternate. Minimum: -1.5 deg Maximum: +1.5 deg Nominal: 0 deg	The only alternate or backup for this redline is during S-IVB burn mode. The burn mode is a small part of the total applicable time. Essentially there is no backup for this redline.
Position, Yaw Actuator	G0002-403	a. Bias on servo signal from IU guidance computer b. Loss of hydraulic pressure due to auxiliary hydraulic pump failure, hose failure, etc.	During S-IVB Burn Mode the Measurement G0002-403 (via IU) can be used for an alternate. Minimum: -1.5 deg Maximum: +1.5 deg Nominal: 0 deg	The only alternate or backup for this redline is during S-IVB burn mode. The burn mode is a small part of the total applicable time. Essentially there is no backup for this redline.
Position, PU Valve	G0010-401	a. PU activate OFF failure b. Mechanical failure in PU valve motor gear assembly	None	PU activate is interlocked for start of automatic sequence.
Event, Cutoff Signal	K0013-401	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.

TABLE 5-7 (Sheet 11 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Event, Cutoff Signal (Continued)				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 C4EN remains ON). NOTE: If C4EN cutoff indication goes OFF with the removal of K0140, immediately turn off engine control power. 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.

TABLE 5-7 (Sheet 12 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Level, Reservoir Oil (Aux Pump ON)	L0007-403	a. External leakage b. System underfilled	a. Pressure Hydraulic System D0041-403 Nominal: 3,600 psia b. Pressure Reservoir Oil D0042-403 Nominal: 170 psia (Aux Pump ON)	If reservoir oil is too low, the pump will cavitate after start and hydraulic system pressure will not rise to minimum level. Observe low level light. Light indicates when oil level drops below the range of 9.54 to 11.02 percent.
Level, Reservoir Oil (Aux Pump OFF)	L0007-403	a. System leakage b. System underfilled	Pressure Reservoir Oil D0042-403 Nominal: 170 psia (Aux Pump ON)	1. If auxiliary pump is OFF, turn ON and check alternate pressure measurement. 2. If auxiliary pump is OFF, turn ON and observe low level light. Light indicates below the range of 9.54 to 11.02 percent.
Voltage, Aft Bus No. 2	M0540-404 *M0083-307	Ground power malfunction when on external power or battery malfunction when on internal power.	M0015-404 Volt, Output, Aft Battery No. 2/ 56 vdc M0085-307 4D410 ESE Bus Volt/ 56 vdc	1. With proper allowances for the potential difference between GSE and vehicle voltage busses, measurement M0085-307 is a redline alternate when on external power and measurement M0015-404 is a redline alternate when on internal power.

*This measurement of the +4D41 bus is the NASA KSC equivalent of redline measurement M0540-404.

TABLE 5-7 (Sheet 13 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Voltage, Aft Bus No. 2 (Continued)				2. During the time that the chill-down inverters are energized, the inverter phase voltages (M0026-404, M0027-404, M0040-404, M0041-404, M0044-404, M0045,404, M0046-404, and M0047-404) will give a gross indication of whether aft bus No. 2 is ON or OFF. 3. The design limits of the chill-down inverters established the redline limits of the bus. 4. "+4D11 Supervision Network No. 4 OK" is a S-IVB ready for launch interlock.
Voltage, Aft Bus No. 1	M0541-404 **M0036-307	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	1. With proper allowances for the potential difference between GSE and vehicle voltage busses, 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 (M0008-401 and M0007-401) 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.

**This measurement of the +4D11 bus is the KSC equivalent of redline measurement M0541-404.

TABLE 5-7 (Sheet 14 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Voltage, Aft Bus No. 1 (Continued)				4. "+4D11 Supervision Network No. 3 OK" is a S-IVB ready for launch interlock.
Voltage, Fwd Bus No. 2	M0542-411 ***M0040-307	Ground power malfunction when on external power or battery malfunction when on internal power.	M0047-307 4D210 ESE Bus Volt/ 28 vdc M0018-401 Volt, Output Fwd Batt. No. 2/28 vdc	1. With proper allowances for the potential difference between GSE and vehicle voltage buses, measurement M0047-307 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 inverter-converter (M0001-411, M0004-411, and M0023-411) and fwd 5v excit mod No. 2 (M0068-411) 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 inverter-converter and PU elect assy established the redline limits of the bus. 4. "+4D21 Supervison Network No. 2 OK" is a S-IVB ready for launch interlock.

***This measurement of the +4D21 bus is the NASA KSC equivalent of redline measurement M0542-411.

TABLE 5-7 (Sheet 15 of 15)
REDLINE BACKUP INFORMATION S-IVB-205 STAGE

REDLINE MEASUREMENT TITLE	REDLINE MEAS. NO.	PROBABLE CAUSES OF EXCEEDING R.L. LIMITS	ALTERNATIVES/MEAS. NUMBER/NOMINALS	OTHER INFORMATION (SAFETY MARGINS, ETC.)
Voltage, Fwd Bus No. 1	M0543-411 ****M0050-307	Ground power malfunction when on external power or battery malfunction when on internal power.	M0048-307 4D310 ESE Bus Volt/ 28 vdc M0015-411 Volt, Output Fwd Batt 1/28 vdc	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 and aft 5v excit modules (M0024-411 and M0025-404) 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. "+4D31 Supervision Network No. 1 OK" is a S-IVB ready for launch interlock.
Misc, PU Oven Stability Monitor	N0063-411	Temperature in PU oven drops below 80°C due to heater power failure	No Backup	An out of tolerance indication at liftoff would indicate a propellant loading error and the possibility of a depletion cutoff in flight.

****This measurement of the +4D31 bus is the NASA KSC equivalent of redline measurement M0543-411.

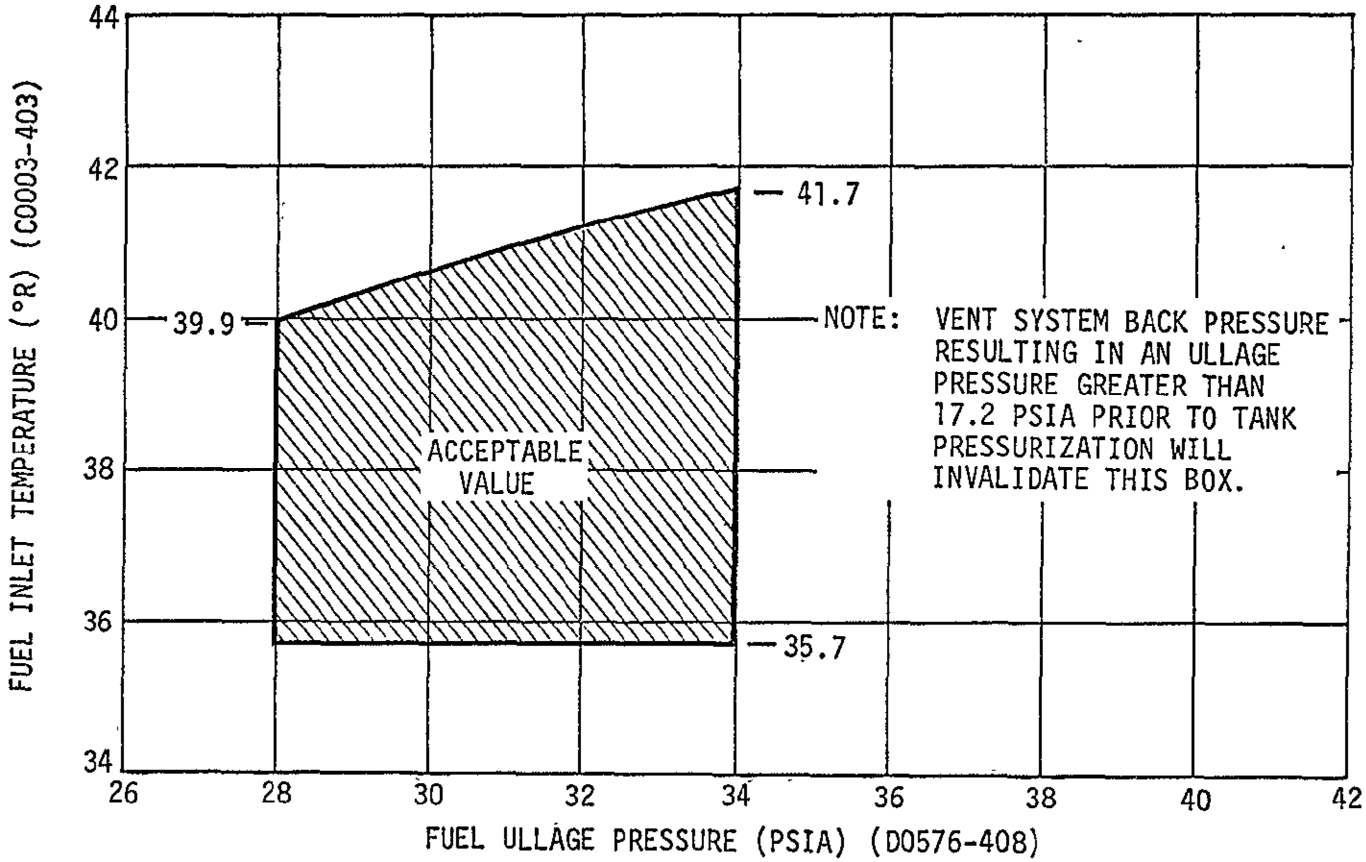


Figure 5-1. Fuel Liftoff Box (S-IVB-205 AND SUBS)

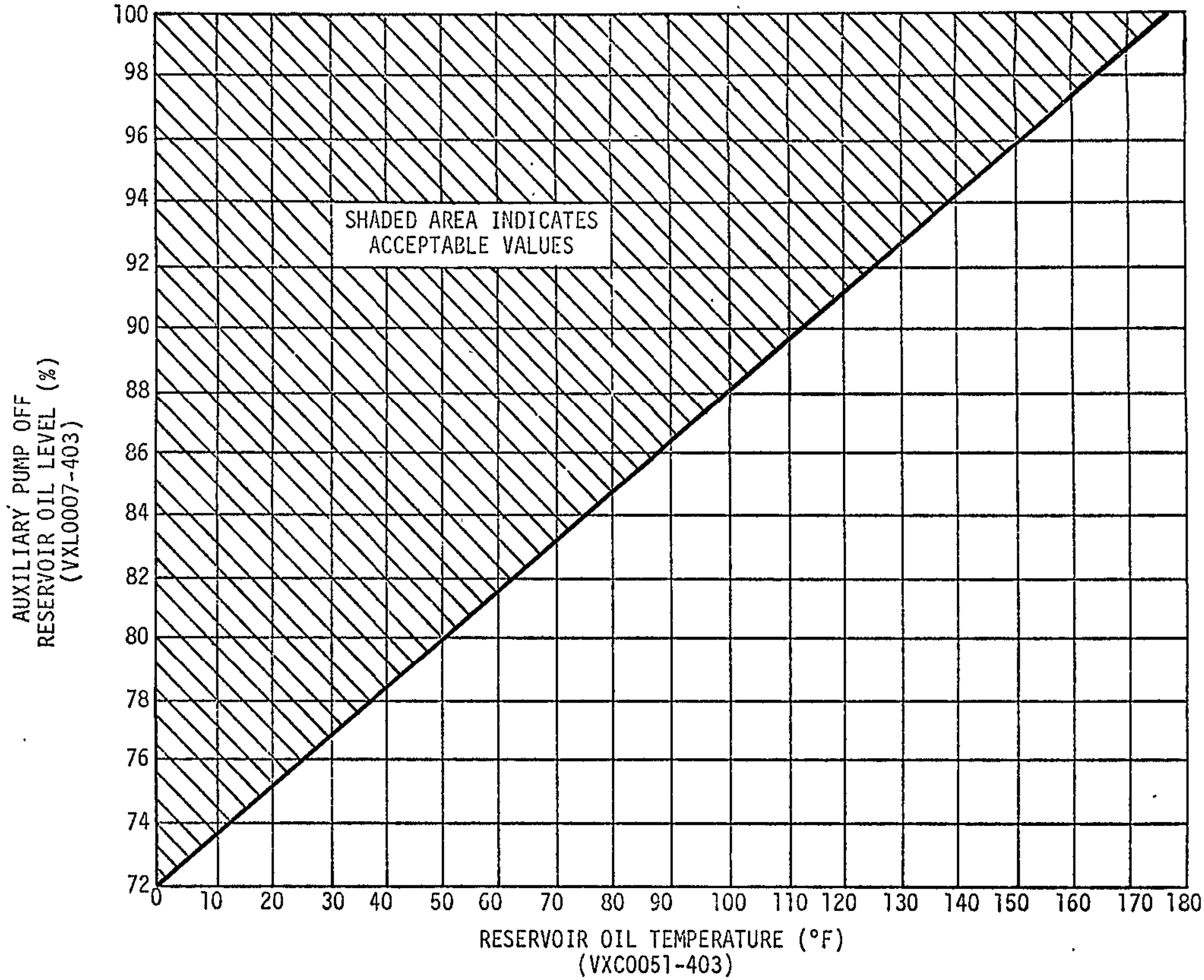


Figure 5-2. Hydraulic Reservoir Level Critical Limits

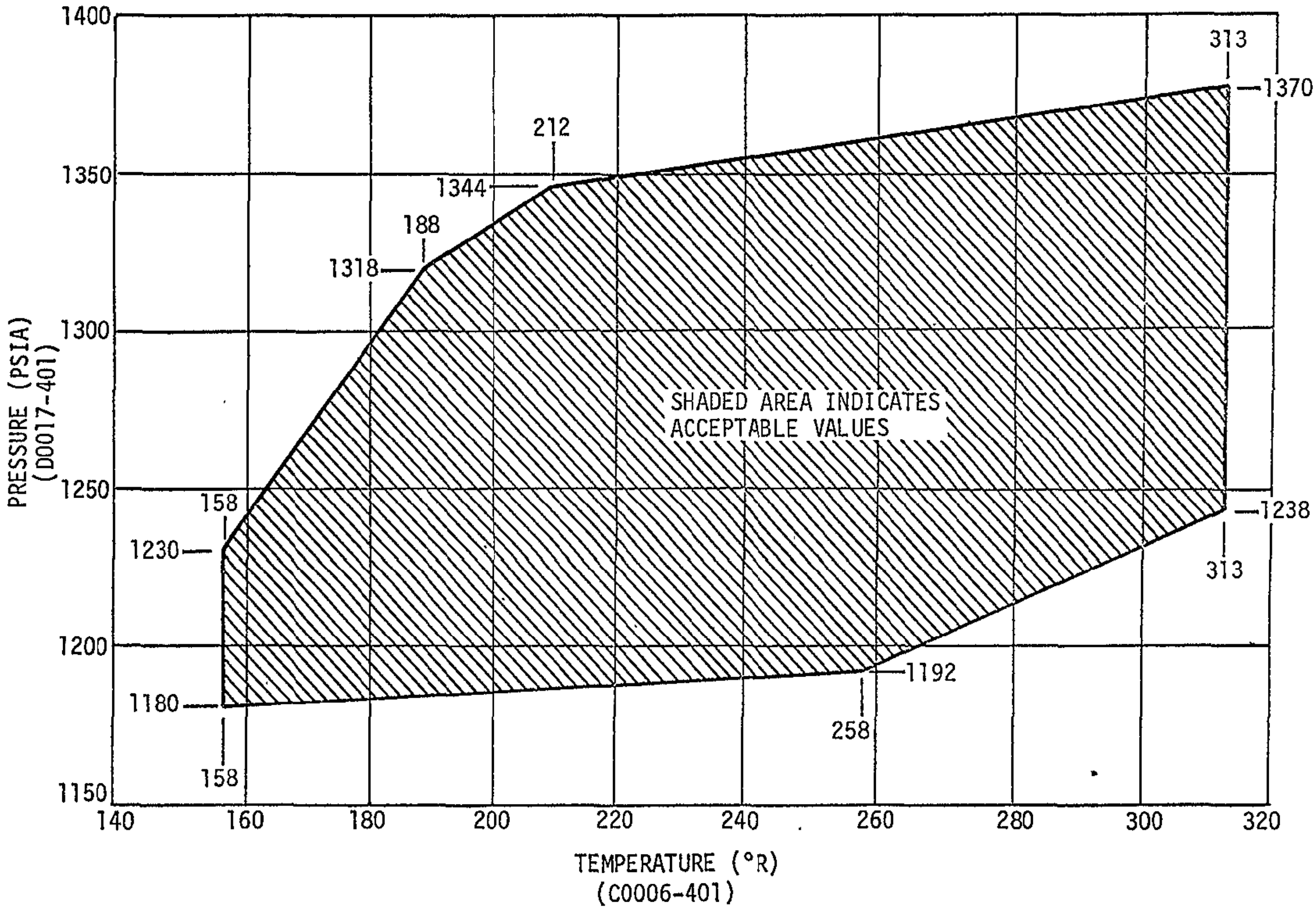


Figure 5-3. GH2 Start Bottle Liftoff Box

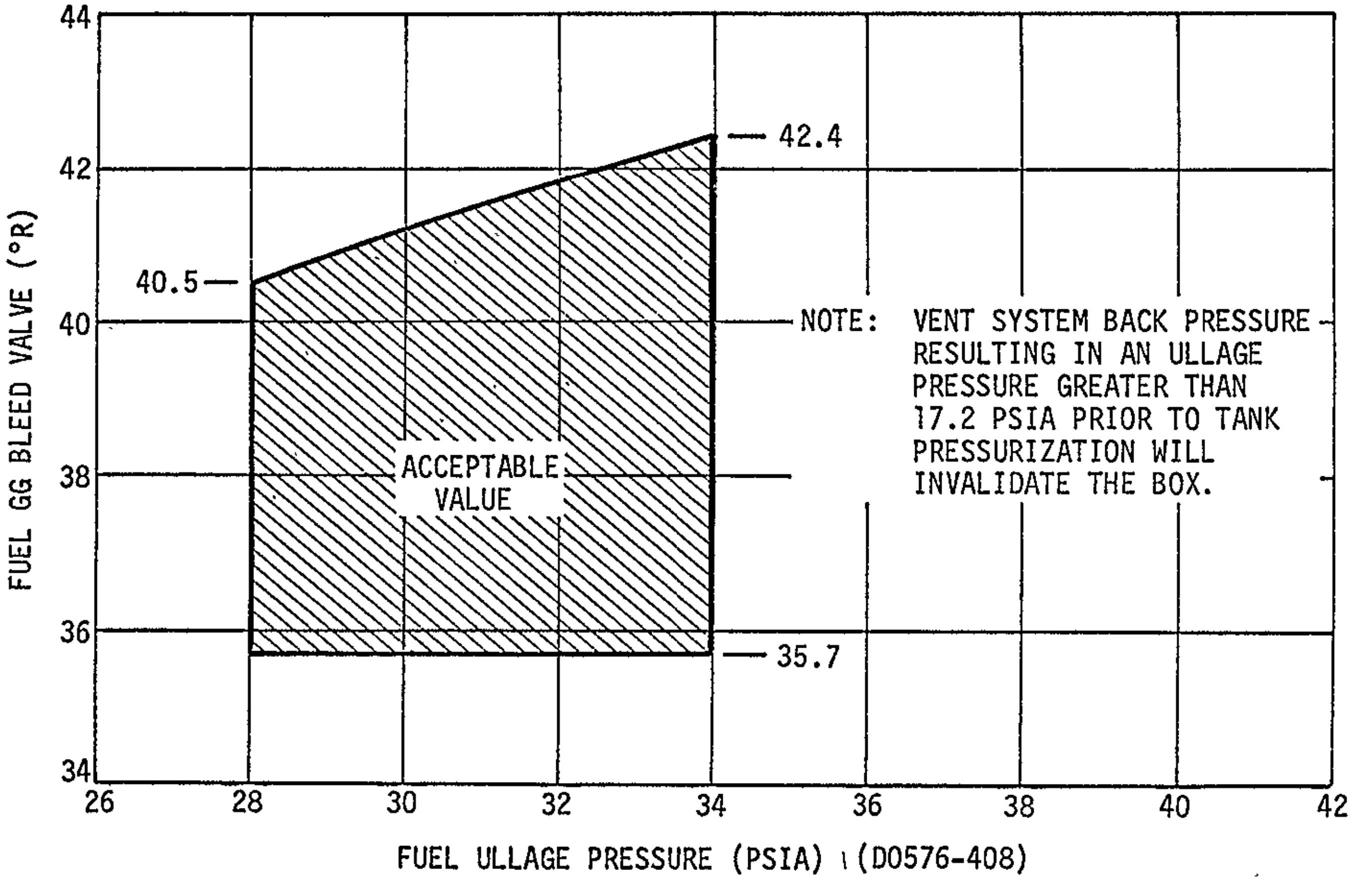


Figure 5-4. Fuel Liftoff Box - Backup (S-IVB-205 and Subs)

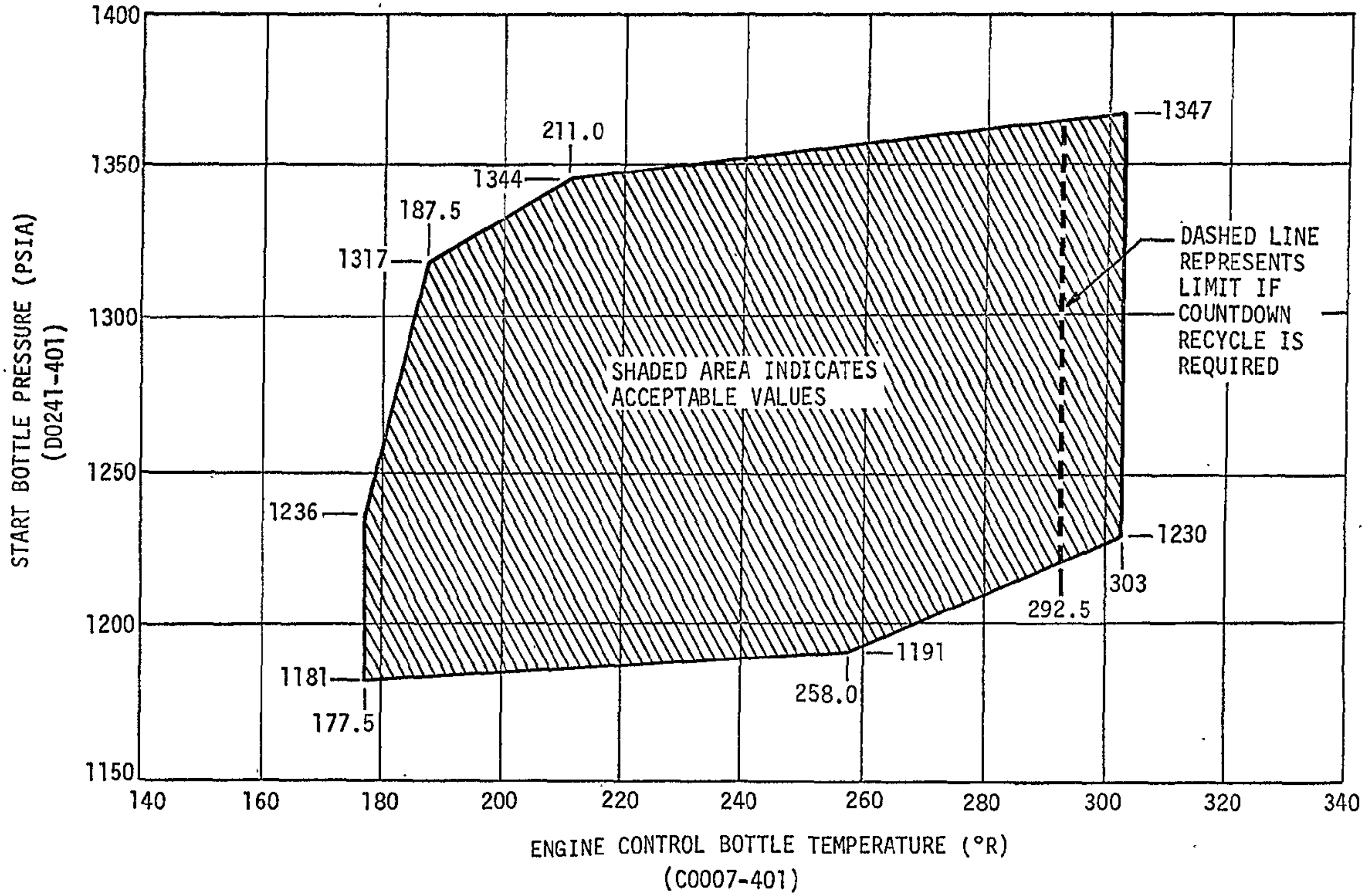


Figure 5-5. GH2 Start Bottle Liftoff Box (Backup) (S-IVB/IB Vehicles)

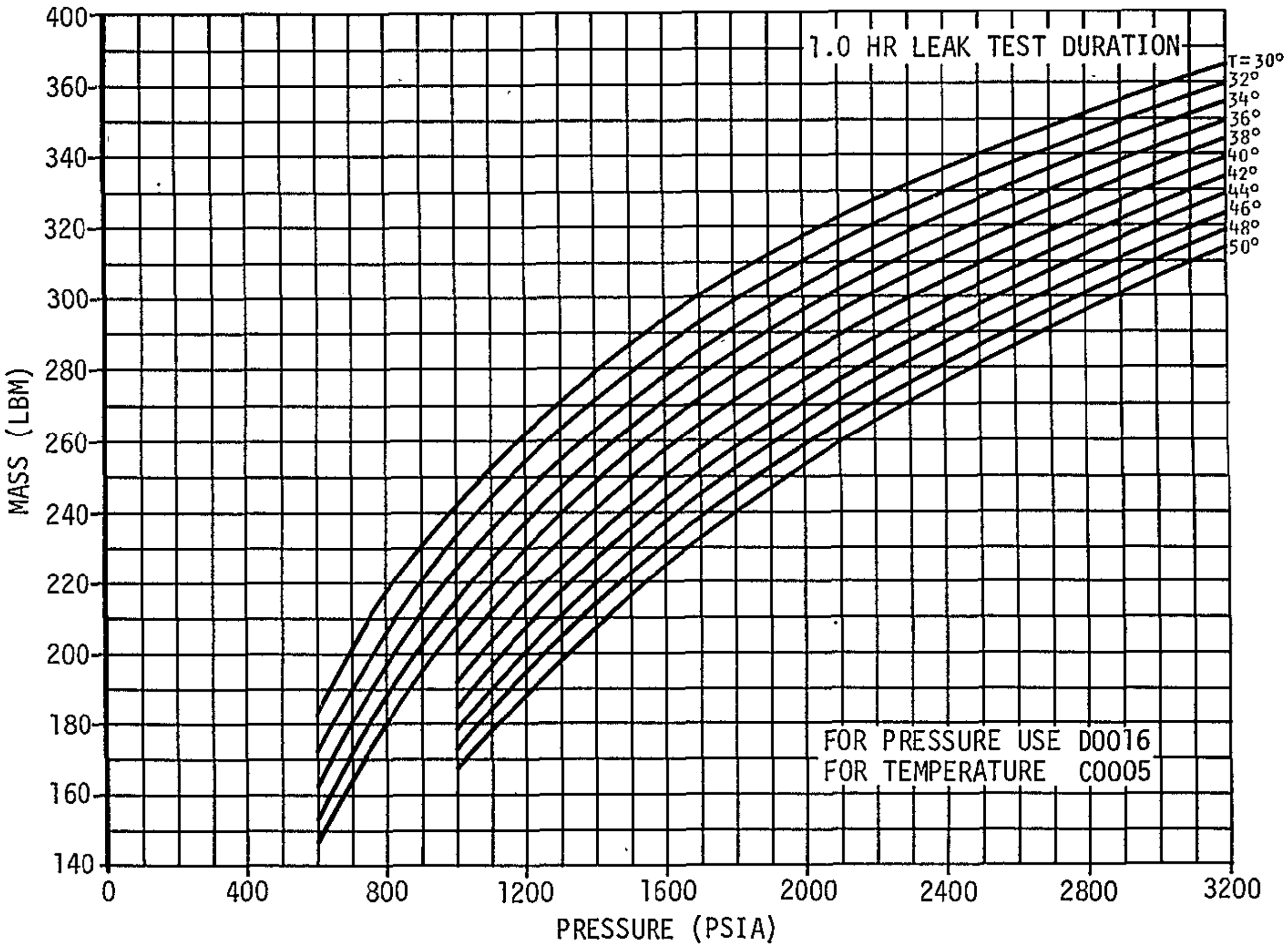


Figure 5-6. AS-205 Cold Helium Leak Check Test

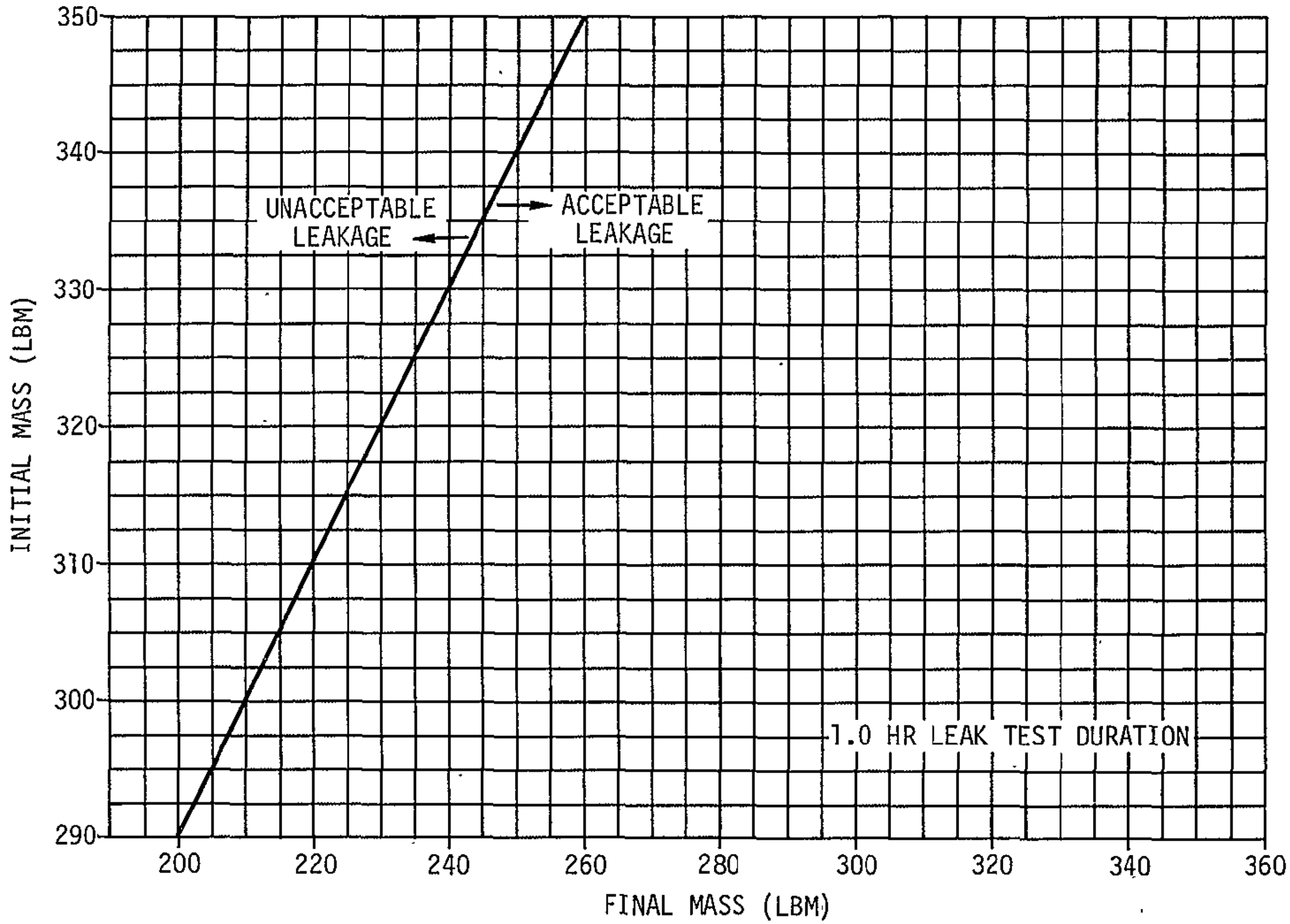


Figure 5-7. AS-205 Cold Helium Leak Check Criteria

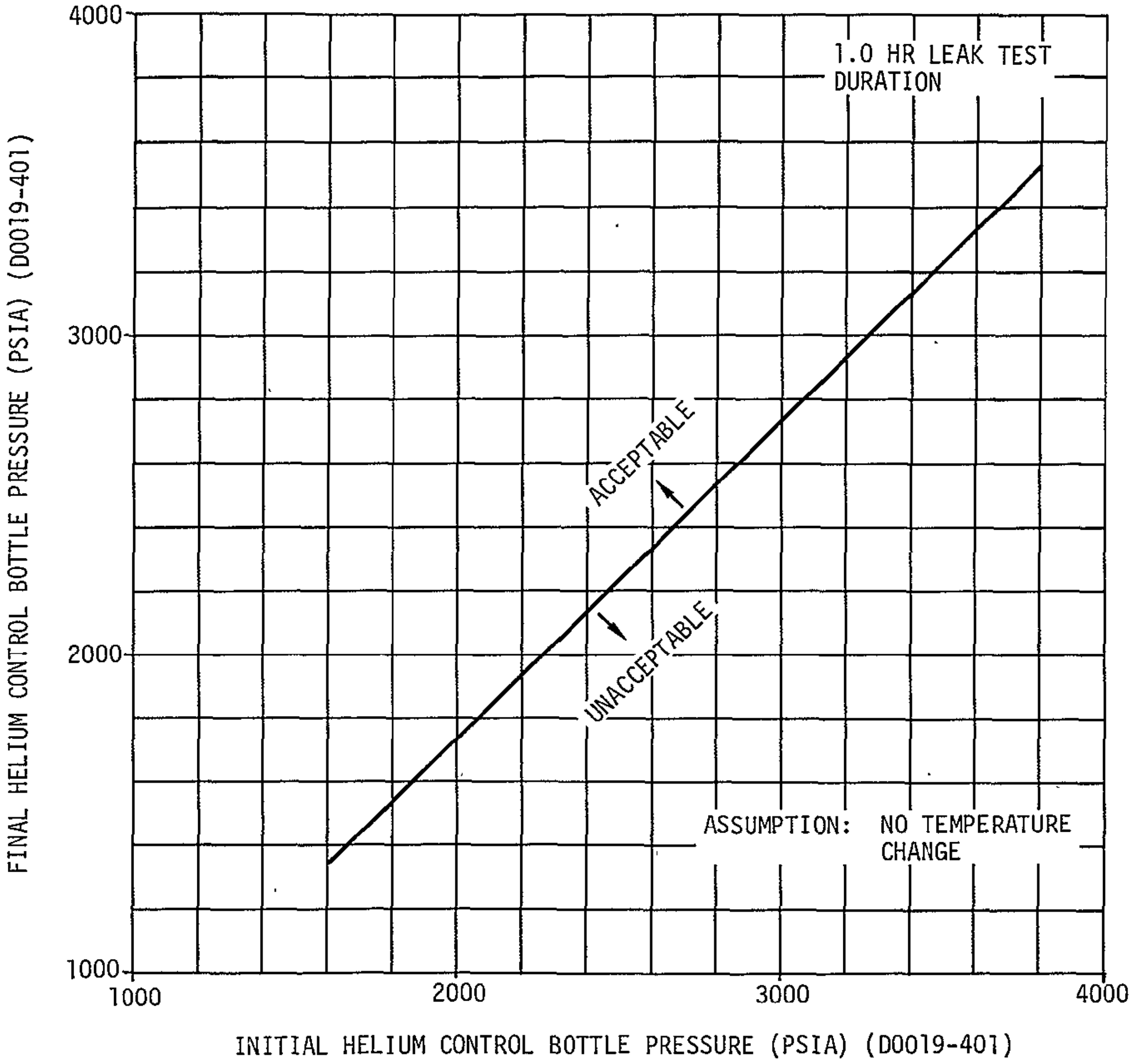


Figure 5-8. S-IVB-205 Ambient Helium Control Bottle (J-2 Engine) Leak Check Criteria

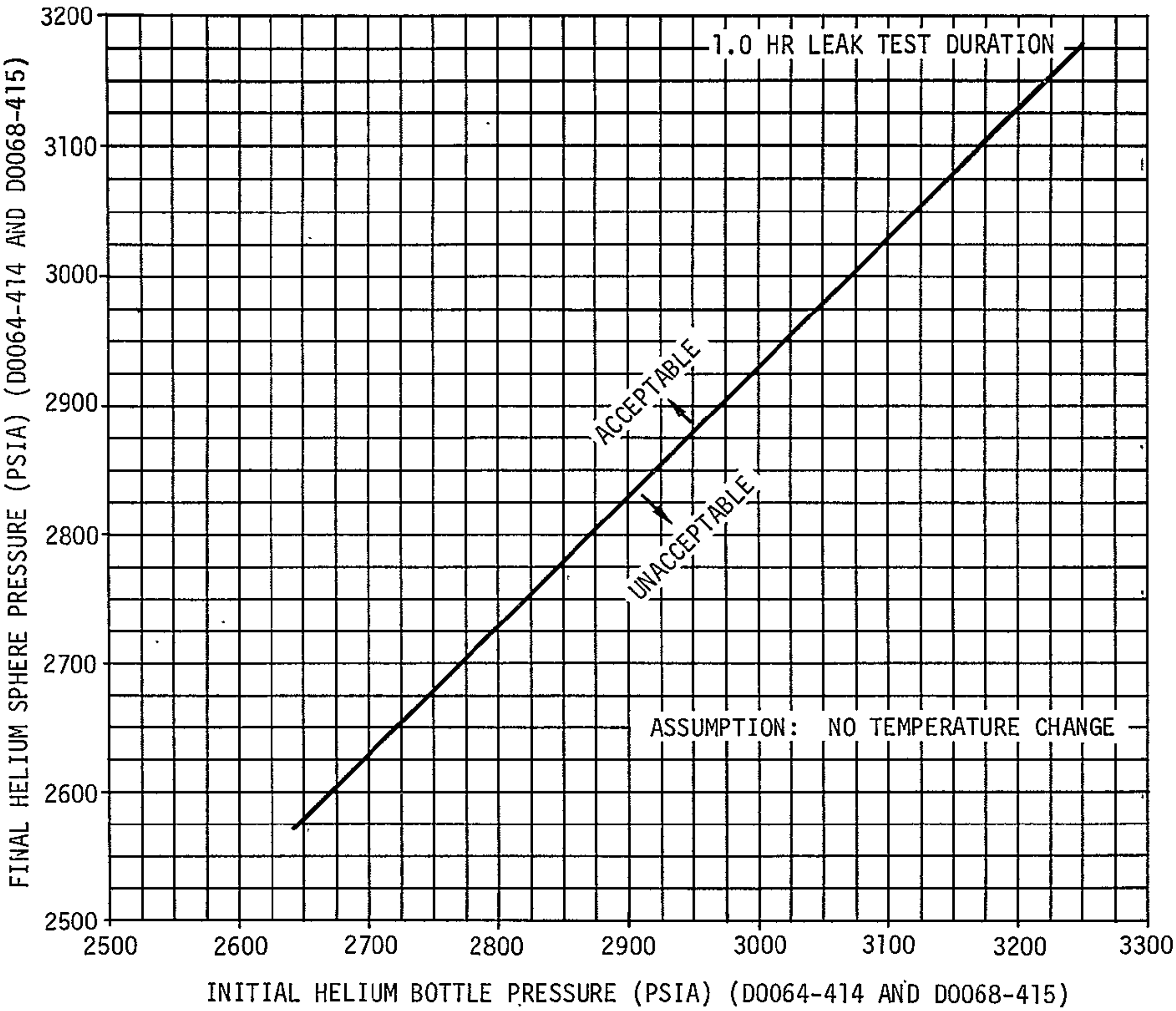


Figure 5-9. S-IVB-205 APS Helium Bottles Leak Check Criteria

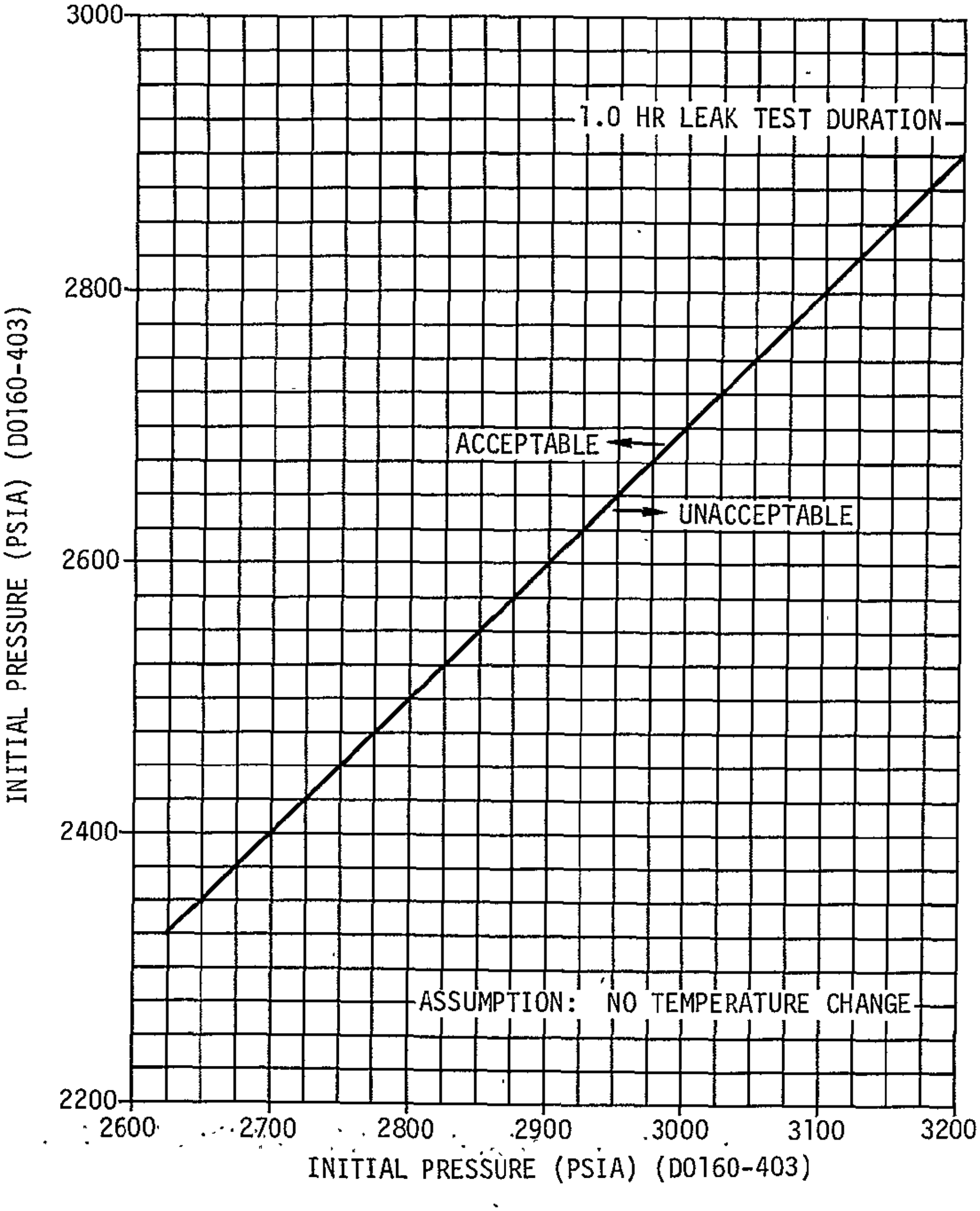


Figure 5-10. S-IVB-205 Stage Pneumatic Helium Leakage Criteria

SECTION 6

FLIGHT TEST MANAGEMENT

6. FLIGHT TEST MANAGEMENT

This section defines the responsibilities of the McDonnell Douglas Astronautics Company - Western Division (MDAC-WD) relative to the data flow, flight test evaluation, and documentation of the S-IVB-205 stage flight test.

6.1 Flight Test Responsibilities

MDAC-WD personnel will perform postflight evaluations of the S-IVB-205 stage at the following locations:

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

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

c. MDAC-WD, Huntington Beach, California.

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

The MDAC-WD/HB and MDAC-WD/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 MDAC-WD/FTC TP&E Committee, and the results are transmitted to:

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

b. MDAC-WD/HB TP&E Committee

c. MDAC-WD/MSFC liaison team.

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

All analyses conducted at MDAC-WD/FTC and MDAC-WD/HB are transmitted to the MDAC-WD/MSFC liaison team. This liaison team transmits information between MDAC-WD 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, MDAC-WD 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. Teletype (TWX) communications between MDAC-WD/HB, MDAC-WD/MSFC, and MDAC-WD/FTC

b. Facsimile communications between MDAC-WD/HB, MDAC-WD/MSFC, and MDAC-WD/FTC

c. Data phone link between MDAC-WD/MSFC and MDAC-WD/HB.

Transmittal of classified material between MDAC-WD 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

MDAC-WD 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 1B43558, Saturn S-IVB-205 Instrumentation Program and Components List (reference 6)

b. Douglas Report No. SM-46538, Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights (reference 7)

c. Douglas Report No. SM-46978, S-IVB-205 Stage Flight Test Plan (reference 8)

d. Douglas Report No. DAC-56671, S-IVB-205 Stage Technical Performance Criteria Document (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 Report (2 wk) (Reference 10)

d. Written Informal Evaluation Inputs to MSFC/FEWG (28 days)

e. Douglas Report No. SM-46990, S-IVB-205 Stage Flight Evaluation Report (60 days) (reference 11).

Descriptions of the contents are presented in the following paragraphs.

6.3.1 Saturn S-IVB-205 Instrumentation Program and Components List, 1B43558 (reference 6)

This drawing contains all the telemetry measurements of the S-IVB-205 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 MDAC-WD/HB.

6.3.2 Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights, SM-46538 (reference 7)

This document describes the detailed data requested by MDAC-WD/HB 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-205 Stage Flight Test Plan, SM-46978 (reference 8)

The contents of the S-IVB-205 Stage Flight Test Plan are described in section 1, Introduction, of this document. This document is prepared by the MDAC-WD/HB Saturn S-IVB TP&E Committee.

6.3.4 S-IVB-205 Stage Technical Performance Criteria Document, DAC-56671 (reference 9)

This document contains the S-IVB-205 stage technical performance criteria which will be used to determine the Contractors cost plus incentive fee bonus or penalty pertaining to mission accomplishment, payload capabilities and telemetry performance. This document is prepared by the MDAC-WD/HB Saturn S-IVB TP&E Committee.

6.3.5 Quick-Look Assessment Report (second morning following launch)

On the second morning following launch, the MDAC-WD/FTC TP&E Committee supplies to KSC an input to the quick-look assessment report. This input is based upon available data on the stage and stage oriented GSE. Included in the quick-look evaluation are a brief description of system performance, mission objective accomplishment, and any malfunction which may have occurred. The time period covered is from the last day of launch countdown through powered flight.

6.3.6 FTC Ground Systems Evaluation Report (10 days)

The MDAC-WD/FTC TP&E Committee will prepare an evaluation report on the performance of the MSFC and KSC supplied, S-IVB oriented GSE. This covers evaluation of both mechanical and electrical GSE used during launch countdown. This report will be transmitted to KSC.

6.3.7 FTC Preliminary Flight Evaluation Report (2 wk) (Reference 10)

The MDAC-WD/FTC TP&E Committee will compile, publish, and distribute the Preliminary Flight Evaluation Report 2 weeks after launch. It will be the final FTC effort and will summarize the CDDT, FRT, countdown and powered flight, discuss possible causes of malfunctions, and recommend any corrective action required.

6.3.8 MDAC-WD Inputs to MSFC/FEWG

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

In addition, 62 days after launch, MDAC-WD will review its portion of the FEWG report to ensure the technical accuracy and adequacy of evaluation.

6.3.9 S-IVB-205 Stage Flight Evaluation Report (60 days) (Reference 11)

Sixty days after launch the MDAC-WD/HB TP&E Committee will write, publish and distribute Douglas Report No. SM-46990, S-IVB-205 Stage Flight Evaluation Report. The data for evaluation will be required at MDAC-WD/HB 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-205 FLIGHT EVALUATION MEETING SCHEDULE

DAYS AFTER LAUNCH	EVENT SCHEDULES	MEETING LOCATION
1	Flight Review Meeting	MSFC
6	First "How-Goes-It" Meeting	MDAC-WD/HB
10	First General Evaluation Meeting	MSFC
13	Second "How-Goes-It" Meeting	MDAC-WD/HB
20	Third "How-Goes-It" Meeting	MDAC-WD/HB
27	Fourth "How-Goes-It" Meeting	MDAC-WD/HB
30	Summary Meeting	MSFC

TABLE 6-2
EVALUATION AND DOCUMENTATION SCHEDULE FOR S-IVB-205
STAGE FLIGHT EVALUATION REPORT

DAYS AFTER LAUNCH	EVENT
0	Launch
1	Support FEWG Flight Review Meeting
10	Support FEWG First General Evaluation Meeting
15	All Final Data Due at A3
26	*First Inputs Due from Design Sections
29	Support S-IVB Stage Instrumentation Splinter Meeting
30	Written Informal Evaluation Inputs to MSFC/FEWG Report Due: Support FEWG Summary Meeting
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
62	Review of FEWG Flight Evaluation Report

*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 2)
S-IVB-205 STAGE FLIGHT EVALUATION REPORT OUTLINE

Section	Engineering Section
1. INTRODUCTION	S-IVB Project
1.1 General	
1.2 History	
2. FLIGHT AND STAGE SUMMARY	S-IVB Project*
3. STAGE CONFIGURATION	MDAC-WD/FTC TP&E Committee and Propulsion
4. COUNTDOWN OPERATIONS	Propulsion
5. CPIF	FD&C and S-IVB Project
6. TRAJECTORY	FD&C
6.1 Comparison of Predicted and Actual Trajectories	
6.2 Evaluation of Vehicle System Performance Effects on Observed Trajectory	
7. MASS CHARACTERISTICS	Weight Control
8. ENGINE CHILLDOWN AND CONDITIONING	Propulsion
8.1 Engine Start Sphere Chilldown and Loading	
8.2 Engine Control Sphere Chilldown and Loading	
8.3 Turbopump Chilldown	
8.4 Thrust Chamber Chilldown	
9. ENGINE SYSTEM	Propulsion
9.1 Start Sphere Performance	
9.2 Engine Control Sphere Performance	
9.3 J-2 Engine Performance	
10. SOLID ROCKETS	Propulsion
11. OXIDIZER SYSTEM	Propulsion
11.1 LOX Tank Pressurization	
11.2 Cold Helium Supply	
11.3 Engine LOX Supply	

TABLE 6-3 (Sheet 2 of 2)
S-IVB-205 STAGE FLIGHT EVALUATION REPORT OUTLINE

Section	Engineering Section
12. FUEL SYSTEM	Propulsion
12.1 Fuel Tank Pressurization	
12.2 Engine LH2 Supply	
13. AUXILIARY PROPULSION SYSTEM	Propulsion
14. PNEUMATIC CONTROL AND PURGE SYSTEMS	Propulsion
15. PROPELLANT UTILIZATION	PU Analysis Panel
15.1 PU System Calibration	
15.2 Propellant Mass History	
15.3 PU System Response	
16. S-IB/S-IVB STAGE SEPARATION	FD&C
17. DATA ACQUISITION SYSTEM	Electronics
18. ELECTRICAL SYSTEM	Electronics
19. RANGE SAFETY SYSTEM	Electronics
20. FLIGHT CONTROL	FD&C
21. HYDRAULIC SYSTEM PERFORMANCE	Structural/Mechanical
22. ACOUSTIC AND VIBRATION ENVIRONMENT	Acoustics
23. ORBITAL SAFING	Propulsion
APPENDIX - SEQUENCE OF EVENTS	FD&C

*S-IVB Project will summarize mission and anomalies. Each Design Technology will summarize its individual areas. The S-IVB TP&E section will insure compatibility between the various analyses.

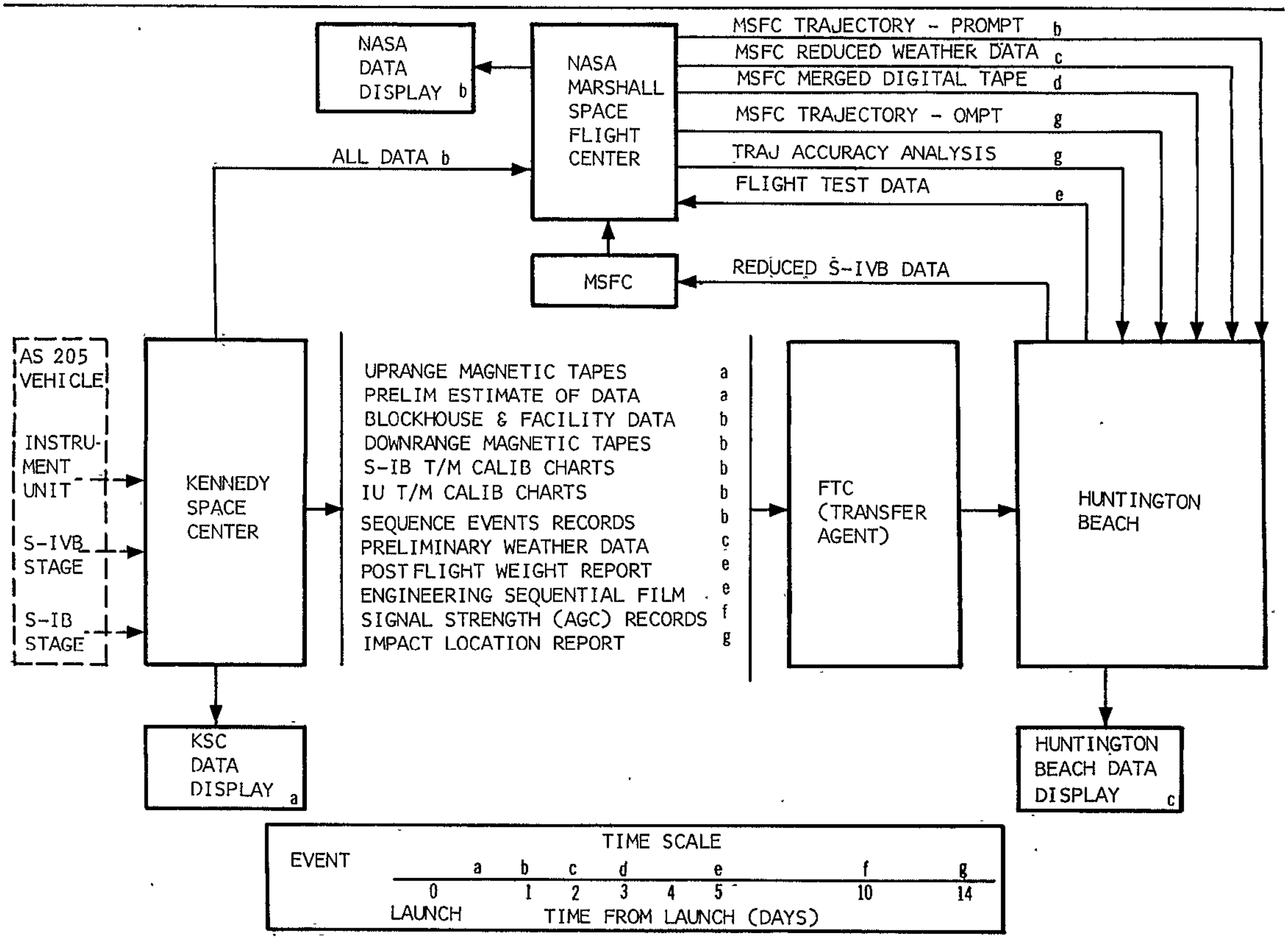


Figure 6-1. Data Flow Chart

APPENDIX I

SEQUENCE OF EVENTS

1. SEQUENCE OF EVENTS

This appendix presents the predicted AS-205 flight sequence of events (table AP 1-1). Definitions of the time bases and symbols used are listed in appendix 10.

The sequence of events is based on the Marshall Space Flight Center's sequence requirements, as indicated in references 12 through 15.

TABLE AP 1-1 (Sheet 1 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Liftoff-Start of Time Base No. 1 (TB1)	00:00:00.0	$+(0.0)_1$	-145.8		Time Base No. 1 (TB1) 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 TB1 prior to receiving Guidance Reference Release which is initiated and verified 5 sec prior to schedule liftoff. A backup method for starting TB1 is provided should the LVDC fail to receive or recognize the liftoff signal. If TB1 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 TB1. 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 Saturn IB vehicle could safely complete TB1 on the pad without catastrophic results, in the event TB1 began by error.
Sensor Bias On	00:00:05.0	$+(5.0)_1$	-140.8	IU	
Multiple Engine Cutoff Enable	00:00:10.0	$+(10.0)_1$	-135.8	S-IB	This signal enables cutoff of any engine due to rough combustion or low thrust
Telemeter Calibration On	00:00:20.0	$+(20.0)_1$	-125.8	S-IB	
5° AOS Cape	00:00:25.0				
Telemeter Calibration Off	00:00:25.0	$+(25.0)_1$	-120.8	S-IB	
Telemeter Calibrator In-Flight Calibrate On	00:00:27.0	$+(27.0)_1$	-118.8	IU	
LOX Tank Relief Control Valve Enable	00:00:29.8	$+(29.8)_1$	-116.0	S-IB	
Telemetry Calibrator In-Flight Calibrate Off	00:00:32.0	$+(32.0)_1$	-113.8	IU	

TABLE AP 1-1 (Sheet 2 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Launch Vehicle Engines EDS Cutoff Enable	00:00:40.0	$+(40.0)_1$	-105.8	IU	
Cooling System Electrical Assembly Power Off Maximum Dynamic Pressure	00:01:15.0	$+(75.0)_1$	-70.8	IU	
Telemetry Calibrator In-Flight Calibrate On	00:01:30.2	$+(90.2)_1$	-55.6	IU	
Telemetry Calibrator In-Flight Calibrate Off	00:01:35.2	$+(95.2)_1$	-50.6	IU	
Flight Control Computer Switch Point No. 1	00:01:40.0	$+(100.0)_1$	-45.8	IU	
Flight Control Computer Switch Point No. 2	00:01:40.2	$+(100.2)_1$	-45.6	IU	
5° AOS GBI	00:01:53.0				
Telemeter Calibration On	00:01:59.8	$+(119.8)_1$	-26.0	S-IB	
Flight Control Computer Switch Point No. 3	00:02:00.0	$+(120.0)_1$	-25.8	IU	
IU Control Accelerometer Power Off	00:02:00.2	$+(120.2)_1$	-25.6	IU	
Telemeter Calibration Off	00:02:04.8	$+(124.8)_1$	-21.0	S-IB	
TM Calibrate On	00:02:07.7	$+(127.7)_1$	-18.1	S-IVB	
TM Calibrate Off	00:02:08.7	$+(128.7)_1$	-17.1	S-IVB	
Excess Rate (P, Y, R) Auto-Abort Inhibit Enable	00:02:12.6	$+(132.6)_1$	-13.2	IU	
Excess Rate (P, Y, R) Auto-Abort Inhibit and Switch Rate Gyro - SC Indication "A"	00:02:12.8	$+(132.8)_1$	-13.0	IU	

TABLE AP 1-1 (Sheet 3 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IB Two Engines Out Auto-Abort Inhibit Enable	00:02:13.0	$+(133.0)_1$	-12.8	IU	
S-IB Two Engines Out Auto-Abort Inhibit	00:02:13.2	$+(133.2)_1$	-12.6	IU	
Propellant Level Sensors Enable	00:02:13.7	$+(133.7)_1$	-12.1	IB	Four level sensors are armed at this time.
S-IB Propellant Level Sensor Actuation - Start of Time Base No. 2 (TB2)	00:02:16.9	$+(0.0)_2$	-8.9	S-IB	Time Base No. 2 (TB2) 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 TB2 is available. The LVDC will monitor the downrange accelerometer after arming the S-IB propellant level sensors. If TB2 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 TB2. However, because of the one engine out capability of the Saturn IB, a time adjustment of 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 TB2 by propellant level sensors actuation at a later time with one S-IB engine out. Use of the downrange velocity reading as a backup provides a safeguard against starting TB2 inadvertently. If a significant downrange velocity value does not appear, the time backup for starting TB2 will not be issued. Furthermore, if TB2 is not established, no subsequent time bases can be started. This insures a safe vehicle, even if TB1 is started without liftoff, requiring at least one additional failure to render the vehicle unsafe on the pad.

TABLE AP 1-1 (Sheet 4 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Excess Rate (Roll) Auto-Abort Inhibit Enable	00:02:17.1	$+(0.2)_2$	-8.7	IU	
Excess Rate (Roll) Auto-Abort Inhibit and Switch Rate Gyros SC Indication "B"	00:02:17.3	$+(0.4)_2$	-8.5	IU	
Inboard Engines Cutoff	00:02:20.1	$+(3.2)_2$	-5.7	S-IB	
Auto-Abort Enable Relays Reset	00:02:20.3	$+(3.4)_2$	-5.5	IU	
Charge Ullage Ignition EBW Firing Units	00:02:20.5	$+(3.6)_2$	-5.3	S-IVB	
Q-Ball Power Off	00:02:20.9	$+(4.0)_2$	-4.9	IU	
Prevalves Open	00:02:21.4	$+(4.5)_2$	-4.4	S-IVB	
LOX Depletion Cutoff Enable	00:02:21.6	$+(4.7)_2$	-4.2	S-IB	
Fuel Depletion Cutoff Enable	00:02:22.6	$+(5.7)_2$	-3.2	S-IB	
S-IB Outboard Engines Cutoff - Start of Time Base No. 3 (TB3)	00:02:23.1	$+(0.0)_3$	-2.7	S-IB	Time Base No. 3 (TB3) 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 No. 3 is inhibited 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 TB3 (TB3 +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 TB3 is available. If TB3 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 TB3.

TABLE AP 1-1 (Sheet 5 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
LOX Tank Flight Pressurization Switch Enable	00:02:23.3	$+(0.2)_3$	-2.5	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.
Engine Cutoff Signal Off	00:02:23.5	$+(0.4)_3$	-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	00:02:24.2	$+(1.1)_3$	-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 6 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IB/S-IVB Separation On	00:02:24.4	$+(1.3)_3$	-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 retrorocket ignition occurs after separation device detonation, thereby preventing possible unseating of the S-IVB propellants.
Flight Control Computer S-IVB Burn Mode On "A"	00:02:24.6	$+(1.5)_3$	-1.2	IU	This signal activates the AACS roll control and enables J-2 engine gimbaling.
Flight Control Computer S-IVB Burn Mode On "B"	00:02:24.8	$+(1.7)_3$	-1.0	IU	
Engine Ready Bypass On	00:02:25.0	$+(1.9)_3$	-0.8	S-IVB	This signal prevents engine cutoff by any of the malfunction cutoff modes.
LH2 Chilldown Pump Off	00:02:25.2	$+(2.1)_3$	-0.6	S-IVB	Chilldown initiated on the ground.
LOX Chilldown Pump Off	00:02:25.4	$+(2.3)_3$	-0.4	S-IVB	Chilldown initiated on the ground.
S-IVB Engine Out Indication "A" Enable	00:02:25.5	$+(2.4)_3$	-0.3	IU	
S-IVB Engine Out Indication "B" Enable	00:02:25.7	$+(2.6)_3$	-0.1	IU	
Engine Ignition Sequence Start	00:02:25.8	$+(2.7)_3$	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	00:02:26.3	$+(3.2)_3$	0.5	S-IVB	
Fuel Injection Temperature OK Bypass	00:02:26.8	$+(3.7)_3$	1.0	S-IVB	Fuel lead is terminated at this time by opening the start tank discharge valve.
LH2 Tank Pressurization Control Switch Enable	00:02:28.4	$+(5.3)_3$	2.6	S-IVB	Enables the LH2 tank pressure switch to control LH2 pressurization.

TABLE AP 1-1 (Sheet 7 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
PU MR 5.5 On	00:02:31.8	$+(8.7)_3$	5.0	S-IVB	The PU mixture ratio is commanded to 5.5 to 1.0 for the first 308.6 sec of burn.
Charge Ullage Jettison EBW Firing Units	00:02:33.3	$+(10.2)_3$	7.5	S-IVB	
Ullage Rockets Jettison	00:02:36.4	$+(13.3)_3$	10.6	S-IVB	
Fuel Injection Temperature OK Bypass Reset	00:02:36.8	$+(13.7)_3$	11.0	S-IVB	
Ullage EBW Firing Units Charge Relays Reset	00:02:42.4	$+(19.3)_3$	16.6	S-IVB	
Ullage Rockets Ignition and Jettison Relays Reset	00:02:42.6	$+(19.5)_3$	16.8	S-IVB	
Heat Exchange Bypass Valve Enable On	00:02:47.1	$+(24.0)_3$	21.3	S-IVB	
Telemetry Calibrator In-Flight Calibrate On	00:02:48.5	$+(25.4)_3$	22.7	IU	
Telemetry Calibrator In-Flight Calibrate Off	00:02:53.5	$+(30.4)_3$	27.7	IU	
Water Coolant Valve Open	00:03:00.1	$+(37.0)_3$	34.3	IU	
Flight Control Computer Switch Point No. 4	00:03:05.1	$+(42.0)_3$	39.3	IU	
5° AOS GTI	00:05:15.0				
5° AOS BDA	00:05:40.0				
Flight Control Computer Switch Point No. 5	00:05:46.8	$+(203.7)_3$	201.0	IU	
Telemetry Calibrator In-Flight Calibrate On	00:05:48.5	$+(205.4)_3$	202.7	IU	

TABLE AP 1-1 (Sheet 8 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Telemetry Calibrator In-Flight Calibrate Off	00:05:53.5	$+(210.4)_3$	207.7	IU	
LH2 Tank Pressurization Control Switch Disable	00:07:26.0	$+(302.9)_3$	300.2	S-IVB	LH2 tank pressure buildup.
Initiation of Guidance Staging Initiation of Artificial Tau Mode	00:07:34.0	N/A	308.2	N/A	
PU MR 5.5 Off	00:07:34.4	$+(311.3)_3$	308.6	S-IVB	
PU MR 4.5 On	00:07:34.6	$+(311.5)_3$	308.8	S-IVB	The PU mixture ratio is commanded to the 4.5 to 1.0 position for the remainder of the burn.
End of Artificial Tau Mode	00:08:09.6	N/A	343.8	N/A	
Telemetry Calibrator In-Flight Calibrate On	00:08:18.5	$+(355.4)_3$	352.7	IU	
Telemetry Calibrator In-Flight Calibrate Off	00:08:23.5	$+(360.4)_3$	357.7	IU	
5° LOS Cape	00:08:29.0				
5° LOS GBI	00:08:56.0				
5° LOS GTI	00:09:15.0				
Initiation of Chi Tilde	00:09:49.5	N/A	443.7	N/A	
Initiation of Chi Freeze	00:10:09.5	N/A	463.7	N/A	
S-IVB Engine Cutoff	00:10:14.5	N/A	468.7	S-IVB	After a predetermined time, sufficient to allow the engine to establish thrust OK, the LVDC will start TB4 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.

TABLE AP 1-1 (Sheet 9 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
S-IVB Engine Cutoff (Cont'd)					A redundant S-IVB engine cutoff command is issued at the start of TB4 (TB4 +0.0), as a safeguard against having started TB4 with the thrust of the S-IVB engine present.
Propellant Depletion Cutoff Arm	00:10:14.7	$+(471.6)_3$	468.9	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 backup for the predicted velocity cutoff.
Set Time Base No. 4 (TB4)	00:10:14.7	$+(0.0)_4$	468.9	S-IVB	
LH2 Tank Vent Valve Open	00:10:15.1	$+(0.4)_4$	469.3	S-IVB	A 1,260 sec LH2 tank blowdown is initiated at this time.
Passivation "B" Enable	00:10:15.2	$+(0.5)_4$	469.4	S-IVB	This command provides power for opening the LH2 passivation valve.
LH2 Tank Passivation Valve Open Enable	00:10:15.3	$+(0.6)_4$	469.5	S-IVB	This command opens a nonpropulsive LH2 tank vent which remains open for LH2 tank passivation.
LOX Tank Flight Pressurization Shutoff Valves Close	00:10:15.5	$+(0.8)_4$	469.7	S-IVB	
Passivation "A" Enable	00:10:15.7	$+(1.0)_4$	469.9	S-IVB	This command provides power to the LOX NPV valve and the engine valves to enable commanding them during dump.
LOX Tank Flight Pressurization Switch Disable	00:10:15.9	$+(1.2)_4$	470.1	S-IVB	
Propellant Depletion Cutoff Disarm	00:10:16.5	$+(1.8)_4$	470.7	S-IVB	
PU MR 4.5 Off	00:10:16.9	$+(2.2)_4$	471.1	S-IVB	
LH2 Tank Passivation Valve Open Disable	00:10:17.4	$+(2.7)_4$	471.6	S-IVB	
Flight Control Computer S-IVB Burn Mode Off "A"	00:10:18.2	$+(3.5)_4$	472.4	IU	Stage control is switched from the J-2 engine to the APS.

TABLE AP 1-1 (Sheet 10 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Flight Control Computer S-IVB Burn Mode Off "B"	00:10:18.4	$+(3.7)_4$	472.6	IU	
Auxiliary Hydraulic Pump Flight Mode Off	00:10:18.6	$+(3.9)_4$	472.8	S-IVB	
Rate Measurements Switch	00:10:20.7	$+(6.0)_4$	474.9	IU	
5° AOS VAN	00:10:24.0				
Initiate Maneuver to Align the S-IVB/IU/CSM with local Horizontal (Position 1 Down) and Maintain with Respect to Local Horizontal	00:10:34.7	$+(20.0)_4$	488.9	IU	
LOX Tank Vent Valve Open	00:10:44.9	$+(30.2)_4$	499.1	S-IVB	A 30 sec LOX tank blowdown is initiated at this time.
LOX Tank Vent Valve Close	00:11:14.9	$+(60.2)_4$	529.1	S-IVB	
LOX Tank Vent Valve Boost Close On	00:11:17.9	$+(63.2)_4$	532.1	S-IVB	
LOX Tank Vent Valve Boost Close Off	00:11:19.9	$+(65.2)_4$	534.1	S-IVB	
5° LOS BDA	00:12:24.0				
PU Inverter and DC Power Off	00:14:14.7	$+(240.0)_4$	708.9	S-IVB	
5° LOS VAN	00:16:04.0				
5° AOS CYI	00:17:49.0				
5° LOS CYI	00:23:25.0				
LH2 Tank Vent Valve Close	00:31:15.1	$+(1,260.4)_4$	1,729.3	S-IVB	
LH2 Tank Vent Valve Boost Close On	00:31:18.1	$+(1,263.4)_4$	1,732.3	S-IVB	

TABLE AP 1-1 (Sheet 11 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SS	REMARKS
LH2 Tank Vent Valve Boost Close Off	00:31:20.1	+(1,265.4)$_4$	1,734.3	S-IVB	
5° AOS TAN	00:37:58.0				
5° LOS TAN	00:43:12.0				
5° AOS CRO	00:53:40.0				
LH2 Tank Vent Valve Open	00:54:04.7	+(2,630.0)$_4$	3,098.9	S-IVB	A 5 min LH2 tank blowdown is initiated at this time.
Aux Hydraulic Pump Flight Mode On	00:55:24.7	+(2,710.0)$_4$	3,178.9	S-IVB	Auxiliary hydraulic pump cycle is initiated to circulate the hydraulic fluid to prevent freezing.
Aux Hydraulic Pump Flight Mode Off	00:56:12.7	+(2,758.0)$_4$	3,226.9	S-IVB	
LH2 Tank Vent Valve Close	00:59:04.7	+(2,930.0)$_4$	3,398.9	S-IVB	
LH2 Tank Vent Valve Boost Close On	00:59:07.7	+(2,933.0)$_4$	3,401.9	S-IVB	
LH2 Tank Vent Valve Boost Close Off	00:59:09.7	+(2,935.0)$_4$	3,403.9	S-IVB	
5° LOS CRO	00:59:08.0				
PU Inverter and DC Power On	01:24:26.7	+(4,452.0)$_4$	4,920.9	S-IVB	Power is turned on for mass data monitoring.
5° AOS GYM	01:30:43.0				
5° AOS TEX	01:33:43.0				
Aux Hydraulic Pump Flight Mode On	01:34:04.7	+(5,030.0)$_4$	5,498.9	S-IVB	The auxiliary hydraulic pump is turned on to center the J-2 engine for damping.
Engine Mainstage Control Valve Open On	01:34:26.5	+(5,051.8)$_4$	5,520.7	S-IVB	Commands Open main LOX valve.
Engine He Control Valve Open On (Start LOX Dump)	01:34:26.7	+(5,052.0)$_4$	5,520.9	S-IVB	Provides pneumatics to open main LOX valve.

TABLE AP 1-1 (Sheet 12 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
LOX Tank NPV Valve Open On	01:34:36.7	+(5,062.0)[4]	5,530.9	S-IVB	The LOX NPV valve is latched open at this time.
LOX Tank NPV Valve Open Off	01:34:38.7	+(5,064.0)[4]	5,532.9	S-IVB	
LH2 Tank Vent Valve Open	01:34:40.7	+(5,066.0)[4]	5,534.9	S-IVB	A 10 min LH2 tank vent is initiated at this time.
5° LOS GYM	01:36:33.0				
5° AOS CAPE	01:37:39.0				
5° AOS GBI	01:38:23.0				
5° LOS TEX	01:39:17.0				
5° AOS BDA	01:41:05.0				
5° AOS GTI	01:41:34.0				
LOX Tank Flight Pressurization Shutoff Valves Open (Cold He Dump)	01:42:26.7	+(5,532.0)[4]	6,000.9	S-IVB	This command initiates dumping the cold helium bottles into the LOX tank.
5° LOS CAPE	01:43:06.0				
5° LOS GBI	01:43:26.0				
5° LOS GTI	01:43:48.0				
LH2 Tank Vent Valve Close	01:44:40.7	+(5,666.0)[4]	6,134.9	S-IVB	
LH2 Tank Vent Valve Boost Close On	01:44:43.7	+(5,669.0)[4]	6,137.9	S-IVB	
LH2 Tank Vent Valve Boost Close Off	01:44:45.7	+(5,671.0)[4]	6,139.9	S-IVB	
5° AOS VAN	01:44:50.0				
Engine Mainstage Control Valve Open Off	01:46:26.7	+(5,772.0)	6,240.9	S-IVB	

TABLE AP 1-1 (Sheet 13 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Engine He Control Valve Open Off (Terminate LOX Dump)	01:46:27.7	$+(5,773.0)_4$	6,241.9	S-IVB	
Auxiliary Hydraulic Pump Flight Mode Off	01:46:29.7	$+(5,775.0)_4$	6,243.9	S-IVB	
PU Inverter and DC Power Off	01:46:39.7	$+(5,785.0)_4$	6,253.9	S-IVB	
Passivation "A" Disable	01:46:54.7	$+(5,800.0)_4$	6,268.9	S-IVB	The passivation bus is disabled since power to the valves is no longer required.
5° LOS BDA	01:46:47.0				
Passivation "B" Disable	01:46:54.9	$+(5,800.2)_4$	6,269.1	S-IVB	The passivation bus is disabled since power to the valves is no longer required.
5° LOS VAN	01:50:09.0				
0° AOS CYI	01:51:54.0				
5° AOS TAN	02:11:45.0				
5° LOS TAN	02:18:23.0				
5° AOS CRO	02:28:12.0				
Begin Manual Control of S-IVB Attitude from CSM	02:29:55.0				
LOX Tank Flight Pressurization Shutoff Valves Close (Terminate Cold He Dump)	02:30:14.7	$+(8,400.0)_4$	8,868.9	S-IVB	
5° LOS CRO	02:34:44.0				
End Manual Control of S-IVB Attitude from CSM	02:32:55.0				
Pitch Down 20° (Position 1 Down) and Maintain Orbital Rate	02:42:55.0				

TABLE AP 1-1 (Sheet 14 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
Initiate and Maintain Inertial Attitude Hold	02:51:10.0	N/A	10,124.2	—	
5° AOS HAW	02:54:29.0				
LV/CSM Separation	02:54:55.0	N/A	10,349.2	—	
5° LOS HAW	02:59:31.0				
5° AOS GYM	03:05:39.0				
5° AOS TEX	03:08:48.0				
5° LOS GYM	03:11:07.0				
5° AOS CAPE	03:12:26.0				
5° AOS GBI	03:13:08.0				
5° LOS TEX	03:14:10.0				
5° AOS GTI	03:15:30.0				
5° AOS BDA	03:16:00.0				
Initiate Maneuver to Align S-IVB/IU Retrograde with Local Horizontal. Roll to Position 1 Up and Maintain Orbital Rate.	03:16:55.0	N/A	11,669.2	—	
LOX and LH2 Pump Seal Purge On (Start Stage Control Sphere He Dump)	03:17:31.7	$+(11,237.0)_4$	11,705.9	S-IVB	The stage control helium sphere is dumped by initiating the LOX and LH2 pump seal purges.
5° LOS CAPE	03:18:13.0				
5° AOS ANT	03:18:17.0				
5° LOS GBI	03:18:47.0				

TABLE AP 1-1 (Sheet 15 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
5° LOS GTI	03:20:26.0				
5° LOS BDA	03:21:02.0				
5° LOS ANT	03:22:51.0				
5° AOS ASC	03:31:46.0				
5° LOS ASC	03:37:35.0				
5° AOS TAN	03:48:11.0				
5° LOS TAN	03:52:25.0				
5° AOS CRO	04:03:04.0				
5° LOS CRO	04:09:41.0				
5° AOS HAW	04:28:59.0				
LOX Tank Flight Pressurization Shutoff Valves Open (Start Second Cold He Dump)	04:30:14.7	+(15,600.0)$_4$	16,068.9	S-IVB	An additional cold helium sphere dump is initiated at this time to relieve pressure buildup due to heating.
5° LOS HAW	04:34:26.0				
5° AOS GYM	04:40:37.0				
LOX and LH2 Pump Seal Purge Off (Terminate Stage Control Sphere He Dump)	04:41:22.0	+(16,267.3)$_4$	16,736.2	S-IVB	
5° AOS TEX	04:43:32.0				
5° LOS GYM	04:46:11.0				
5° AOS CAPE	04:47:18.0				
5° AOS GBI	04:47:54.0				
5° LOS TEX	04:49:22.0				

TABLE AP 1-1 (Sheet 16 of 16)
PREDICTED AS-205 FLIGHT SEQUENCE OF EVENTS

EVENT	FLIGHT TIME (hr:min:sec)	TIME FROM BASE (sec)	TIME FROM S-IVB ENGINE START (sec)	SSS	REMARKS
5° AOS GTI	04:49:52.0				
LOX Tank Flight Pressurization Shutoff Valves Close	04:50:14.7	+(16,800.0)[4]	17,268.9	S-IVB	
5° AOS ANT	04:52:25.0				
5° LOS CAPE	04:52:46.0				
5° LOS GBI	04:53:33.0				
5° LOS GTI	04:55:50.0				
5° LOS ANT	04:58:26.0				
5° AOS ASC	05:06:31.0				
5° LOS ASC	05:12:22.0				
5° AOS TAN	05:25:00.0				
5° LOS TAN	05:26:50.0				
5° AOS HAW	06:05:07.0				
5° LOS HAW	06:08:33.0				
5° AOS GYM	06:15:19.0				
5° AOS TEX	06:18:34.0				
5° LOS GYM	06:21:08.0				
Telemetry Calibrator In-Flight Calibrate On	Variable			IU	
TM Calibrate On	Variable			S-IVB	
TM Calibrate Off	Variable			S-IVB	
Telemetry Calibrator In-Flight Calibrate Off	Variable			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-205 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-205 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-205 stage station numbers.

All mass characteristics parameters are time referenced from AS-205 vehicle liftoff and progress chronologically from liftoff to 2 hr, 55 min (10,495 sec) of flight time. Data is also presented at predicted guidance cutoff time (614.54 sec).

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

a. S-IVB-205 stage dry mass is based on the stage weight measured at MDAC-WD/STC on April 1, 1968.

b. S-IVB-205 propellant loading is as presented in appendix 6 of this document.

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

d. 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 16).

Figures AP 2-4 through AP 2-7 present the predicted three sigma mass characteristics dispersions for the Saturn IB AS-205 second flight stage during S-IVB open-loop burn. The mass characteristics dispersions are referenced relative to time from Saturn IB liftoff, rather than event. It was assumed that the lower stage will perform nominally.

TABLE AP 2-1 (Sheet 1 of 6)
S-IVB-205 PREDICTED MASS BREAKDOWN SUMMARY

S-IB LIFTOFF — TIME 0.000 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
1	FROST	100.00	420.40	.0	.0	.16926009+07	.14472090+07	.14472090+07
2	SEPARATION PKG	34.00	200.69	.0	.0	.57195104+06	.40439884+06	.40439884+06
5	ULLAGE ROCKETS	398.00	223.71	.2	-.4	.76191086+07	.38255130+07	.38255130+07
7	LAUNCH ESCAPE	8986.00	1513.20	-.1	-.4	.34555851+07	.12626886+09	.12626886+09
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	192906.00	241.64	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	35.50	317.91	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	367.00	114.94	3.2	6.5	.19821582+06	.46407650+06	.46669026+06
66	LH2 IN TANK	39599.00	443.14	.0	.0	.00000000	.15508132+09	.15508132+09
67	LH2 ULLAGE GAS	169.00	628.02	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	48.00	148.00	-39.2	-42.5	.58934476+05	.23972394+06	.23305451+06
69	COLD HELIUM	330.00	494.30	100.1	-27.8	.81644230+06	.10515788+07	.36002369+06
70	APS PROPELLANT	131.00	248.59	.0	.0	.25288663+07	.25172310+07	.47790109+05
71	GH2-START TANK	5.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
TOTAL REMAINING		305878.51	423.84	.8	.2	.46741951+09	.38017748+11	.38027839+11
						(SLUG-FT2) .10088786+06	(SLUG-FT2) .82057533+07	(SLUG-FT2) .82079313+07

S-IB/S-IVB SEPARATION — TIME 144.490 — ITEMS JETTISONED

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
1	FROST	.00	420.40	.0	.0	.00000000	.00000000	.00000000
2	SEPARATION PKG	34.00	200.69	.0	.0	.57195104+06	.40439884+06	.40439884+06
TOTAL JETTISONED		34.00	200.69	.0	.0	.57195104+06	.40439885+06	.40439885+06
						(SLUG-FT2) .12344995+03	(SLUG-FT2) .87285475+02	(SLUG-FT2) .87285475+02

S-IB/S-IVB SEPARATION — TIME 144.490 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
5	ULLAGE ROCKETS	393.94	223.71	.2	-.4	.75413565+07	.37864740+07	.37864740+07
7	LAUNCH ESCAPE	8986.00	1513.20	-.1	-.4	.34555851+07	.12626886+09	.12626886+09
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	192906.00	241.65	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	35.50	317.95	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	367.00	114.94	3.2	6.5	.19821582+06	.46407650+06	.46669026+06
66	LH2 IN TANK	39599.00	443.75	.0	.0	.00000000	.15727515+09	.15727515+09
67	LH2 ULLAGE GAS	169.00	628.86	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	48.00	148.00	-39.2	-42.5	.58934476+05	.23972394+06	.23305451+06
69	COLD HELIUM	330.00	494.30	100.1	-27.8	.81644230+06	.10515788+07	.36002369+06
70	APS PROPELLANT	131.00	248.59	.0	.0	.25288663+07	.25172310+07	.47790109+05
71	GH2-START TANK	5.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
TOTAL REMAINING		305740.44	423.96	.8	.2	.46507710+09	.38015898+11	.38025989+11
						(SLUG-FT2) .10038227+06	(SLUG-FT2) .82053541+07	(SLUG-FT2) .82075322+07

TABLE AP 2-1 (Sheet 2 of 6)
S-IVB-205 PREDICTED MASS BREAKDOWN SUMMARY

S-IB ENGINE START COMMAND — TIME 145.810 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
5	ULLAGE ROCKETS	334.37	223.71	.2	-.4	.64009937+07	.32139041+07	.32139041+07
7	LAUNCH ESCAPE	8986.00	1513.20	-.1	-.4	.34555851+07	.12626886+09	.12626886+09
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	192906.00	241.65	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	35.50	317.95	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	367.00	114.94	3.2	6.5	.19821582+06	.46407650+06	.46669026+06
66	LH2 IN TANK	39599.00	443.75	.0	.0	.00000000	.15729540+09	.15729540+09
67	LH2 ULLAGE GAS	169.00	628.87	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	48.00	148.00	-39.2	-42.5	.58934476+05	.23972394+06	.23305451+06
69	COLD HELIUM	330.00	494.30	100.1	-27.8	.81644230+06	.10515788+07	.36002369+06
70	APS PROPELLANT	131.00	248.59	.0	.0	.25288663+07	.25172310+07	.47790109+05
71	GH2-START TANK	5.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	305680.87	424.00	.8	.2	.46393669+09	.38012947+11	.38023038+11
						(SLUG-FT2) .10013613+06	(SLUG-FT2) .82047171+07	(SLUG-FT2) .82068951+07

NINETY PERCENT THRUST — TIME 149.310 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
5	ULLAGE ROCKETS	222.00	223.71	.2	-.4	.42498545+07	.21338288+07	.21338288+07
7	LAUNCH ESCAPE	8986.00	1513.20	-.1	-.4	.34555851+07	.12626886+09	.12626886+09
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	192504.00	241.51	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	37.31	317.61	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	39481.00	443.31	.0	.0	.00000000	.15522753+09	.15522753+09
67	LH2 ULLAGE GAS	170.58	628.25	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	328.81	494.30	100.1	-27.8	.81350070+06	.10477900+07	.35872655+06
70	APS PROPELLANT	130.96	248.59	.0	.0	.25280014+07	.25163701+07	.47773765+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	305086.65	424.12	.8	.2	.46182983+09	.38004530+11	.38014606+11
						(SLUG-FT2) .99681384+05	(SLUG-FT2) .82029004+07	(SLUG-FT2) .82050753+07

TABLE AP 2-1 (Sheet 3 of 6)
S-IVB-205 PREDICTED MASS BREAKDOWN SUMMARY

SUMMARY PRINTOUT — TIME 200.000 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	169673.52	233.91	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	73.91	302.65	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	35299.27	427.48	.0	.0	.00000000	.90438808+08	.90438808+08
67	LH2 ULLAGE GAS	202.67	608.04	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	311.59	494.30	100.1	-27.8	.77089790+06	.99291757+06	.33994014+06
70	APS PROPELLANT	130.31	248.59	.0	.0	.25154757+07	.25039019+07	.47537055+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	268917.26	396.22	.9	.3	.45385116+09	.26640230+11	.26650175+11
						(SLUG-FT2) .97959266+05	(SLUG-FT2) .57500291+07	(SLUG-FT2) .57521755+07

SUMMARY PRINTOUT — TIME 300.000 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1752.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	124634.08	220.45	.0	.0	.00000000	.00000000	.00000000
64	LO. ULLAGE GAS	146.13	284.13	.0	.0	.00000000	.00000000	.00000000
65	LO. BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	27049.65	395.92	.0	.0	.00000000	.11271872+09	.11271872+09
67	LH2 ULLAGE GAS	265.96	574.75	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	277.62	494.30	100.1	-27.8	.68685211+06	.88466649+06	.30287877+06
70	APS PROPELLANT	129.03	248.59	.0	.0	.24907651+07	.24793050+07	.47070079+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	215728.47	417.14	1.2	.3	.45332006+09	.25914344+11	.25924023+11
						(SLUG-FT2) .97844632+05	(SLUG-FT2) .55933539+07	(SLUG-FT2) .55954430+07

SUMMARY PRINTOUT — TIME 400.000 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1752.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	79594.65	206.21	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	218.35	269.72	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	18800.04	364.14	.0	.0	.00000000	.88756479+08	.88756479+08
67	LH2 ULLAGE GAS	329.25	543.19	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	243.65	494.30	100.1	-27.8	.60780634+06	.77641542+06	.26581740+06
70	APS PROPELLANT	127.75	248.59	.0	.0	.24660545+07	.24547082+07	.46603102+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	162539.69	461.97	1.5	.4	.45275234+09	.24324388+11	.24333773+11
						(SLUG-FT2) .97722096+05	(SLUG-FT2) .52501775+07	(SLUG-FT2) .52522032+07

TABLE AP 2-1 (Sheet 4 of 6)
S-IVB-205 PREDICTED MASS BREAKDOWN SUMMARY

ENGINE MIXTURE RATIO CUTBACK — TIME 454.900 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	54868.00	197.12	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	258.00	262.40	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	14271.00	346.39	.0	.0	.00000000	.73556300+08	.73556300+08
67	LH2 ULLAGE GAS	364.00	525.29	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	225.00	494.30	100.1	-27.8	.55666521+06	.71698557+06	.24547070+06
70	APS PROPELLANT	127.04	248.59	.0	.0	.24524883+07	.24412045+07	.46346731+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
TOTAL REMAINING		133339.04	506.98	1.8	.5	.45240927+09	.22693367+11	.22702565+11
						(SLUG-FT2) .97648048+05	(SLUG-FT2) .48981380+07	(SLUG-FT2) .49001233+07

SUMMARY PRINTOUT — TIME 500.000 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	39578.90	190.61	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	288.79	257.81	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	10802.51	332.22	.0	.0	.00000000	.59115259+08	.59115259+08
67	LH2 ULLAGE GAS	402.99	511.49	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	212.00	494.30	100.1	-27.8	.52451348+06	.67557410+06	.23129287+06
70	APS PROPELLANT	126.47	248.59	.0	.0	.24413439+07	.24301112+07	.46136125+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
TOTAL REMAINING		114637.66	549.46	2.1	.6	.45215155+09	.21129707+11	.21138760+11
						(SLUG-FT2) .97592422+05	(SLUG-FT2) .45606374+07	(SLUG-FT2) .45625915+07

SUMMARY PRINTOUT — TIME 600.000 — ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	6181.92	169.78	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	357.07	246.85	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	3140.11	294.38	.0	.0	.00000000	.24606416+08	.24606416+08
67	LH2 ULLAGE GAS	489.43	482.45	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	183.19	494.30	100.1	-27.8	.45322365+06	.58375268+06	.19985644+06
70	APS PROPELLANT	125.19	248.59	.0	.0	.24166333+07	.24055143+07	.45669148+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
TOTAL REMAINING		73702.91	730.76	3.3	1.0	.45145095+09	.14170971+11	.14179603+11
						(SLUG-FT2) .97441205+05	(SLUG-FT2) .30586635+07	(SLUG-FT2) .30605265+07

TABLE AP 2-1 (Sheet 5 of 6)
S-IVB-205 PREDICTED MASS BREAKDOWN SUMMARY

ENGINE CUTOFF COMMAND TIME 614.540 ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	1326.00	161.82	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	367.00	245.08	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	397.00	114.94	3.2	6.5	.21441875+06	.50201190+06	.50483932+06
66	LH2 IN TANK	2026.00	285.10	.0	.0	.00000000	.15623343+08	.15623343+08
67	LH2 ULLAGE GAS	502.00	477.98	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	58.00	148.00	-39.2	-42.5	.71212492+05	.28966642+06	.28160753+06
69	COLD HELIUM	179.00	494.30	100.1	-27.8	.44285810+06	.57040185+06	.19528558+06
70	APS PROPELLANT	125.00	248.59	.0	.0	.24130403+07	.24019380+07	.45601249+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	67751.00	777.56	3.5	1.1	.45131952+09	.12306331+11	.12314877+11
						(SLUG-FT2) .97412838+05	(SLUG-FT2) .26561993+07	(SLUG-FT2) .26580440+07

S-IVB END THRUST DECAY TIME 615.940 ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
60	ADAPTER (SLA)	3655.00	849.70	1.0	-1.2	.43059297+08	.54365345+08	.53663328+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	1237.00	161.57	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	364.55	245.05	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	367.00	114.94	3.2	6.5	.19821582+06	.46407650+06	.46669026+06
66	LH2 IN TANK	1999.00	284.83	.0	.0	.00000000	.15410122+08	.15410122+08
67	LH2 ULLAGE GAS	502.00	477.87	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	48.00	148.00	-39.2	-42.5	.58934476+05	.23972394+06	.23305451+06
69	COLD HELIUM	179.00	494.30	100.1	-27.8	.44285810+06	.57040184+06	.19528558+06
70	APS PROPELLANT	124.99	248.59	.0	.0	.24129311+07	.24018292+07	.45599185+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	67592.54	778.96	3.5	1.1	.45125116+09	.12248705+11	.12257252+11
						(SLUG-FT2) .97398081+05	(SLUG-FT2) .26437613+07	(SLUG-FT2) .26456062+07

TABLE AP 2-1 (Sheet 6 of 6)
S-IVB-205 PREDICTED MASS BREAKDOWN-SUMMARY

CSM SEPARATION TIME 10,495.000 ITEMS JETTISONED

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
50	COMMAND MODULE	13050.00	1252.20	-.1	6.5	.28839718+08	.27266723+08	.24614452+08
51	SERVICE MODULE	10918.00	1130.50	-6.3	9.5	.35013555+08	.55410351+08	.51890235+08
52	SM PROPELLANT	8887.00	1077.90	11.2	1.5	.20017537+08	.37129316+07	.22943177+08
53	SLA RING	90.00	1047.70	-.2	1.8	.53652455+06	.26830440+06	.26830440+06
	TOTAL JETTISONED	32945.00	1164.29	.9	6.1	.86247278+08	.26784668+09	.78210825+09
						(SLUG-FT2) .18615618+05	(SLUG-FT2) .57812046+05	(SLUG-FT2) .60890263+05

CSM SEPARATION TIME 10,495.000 ITEMS REMAINING

SEQ	ITEM	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (LB-IN2)	IYY (LB-IN2)	IZZ (LB-IN2)
60	ADAPTER (SLA)	3655.00	837.20	1.0	-1.2	.10939669+09	.77637617+08	.74720740+08
61	INSTRUMNT UNIT	4280.00	698.70	.2	-15.0	.63776642+08	.34245574+08	.30589209+08
62	S4B205 DRY STG	21834.00	316.50	8.6	-2.6	.24941707+09	.90989132+09	.91113976+09
63	LOX IN TANK	.00	159.85	.0	.0	.00000000	.00000000	.00000000
64	LOX ULLAGE GAS	128.10	244.84	.0	.0	.00000000	.00000000	.00000000
65	LOX BELOW TANK	.00	114.94	3.2	6.5	.00000000	.00000000	.00000000
66	LH2 IN TANK	.00	251.77	.0	.0	.00000000	.14523048-01	.14523048-01
67	LH2 ULLAGE GAS	300.31	469.59	.0	.0	.00000000	.00000000	.00000000
68	LH2 BELOW TANK	.00	148.00	-39.2	-42.5	.58546142-03	.23814434-02	.23151886-02
69	COLD HELIUM	.00	494.30	100.1	-27.8	.00000000	.00000000	.00000000
70	APS PROPELLANT	85.04	248.59	.0	.0	.16416478+07	.16340946+07	.31023596+05
71	GH2-START TANK	1.00	88.40	-22.0	14.6	.00000000	.00000000	.00000000
72	SERVICE ITEMS	56.00	368.67	18.7	15.4	.42337694+06	.40492036+07	.40263473+07
	TOTAL REMAINING	30339.45	434.26	6.4	-4.1	.42568114+09	.22318433+10	.22246809+10
						(SLUG-FT2) .91879045+05	(SLUG-FT2) .48172122+06	(SLUG-FT2) .48017529+06

TABLE AP 2-2 (Sheet 1 of 3)
S-IVB-205 MASS CHARACTERISTICS SUMMARY

TIME (SEC)	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (SLUG-FT2)	IYY (SLUG-FT2)	IZZ (SLUG-FT2)
0.000	305878.51	423.84	.8	.2	.10088786+06	.82057533+07	.82079313+07
60.000	305878.51	423.88	.8	.2	.10088786+06	.82059487+07	.82081265+07
80.000	305778.50	423.89	.8	.2	.10052251+06	.82057025+07	.82078805+07
100.000	305778.50	423.90	.8	.2	.10052251+06	.82057683+07	.82079463+07
120.000	305778.50	423.92	.8	.2	.10052251+06	.82058053+07	.82079832+07
144.400	305778.50	423.93	.8	.2	.10052251+06	.82058503+07	.82080284+07
144.490	305774.44	423.94	.8	.2	.10050573+06	.82058072+07	.82079852+07
144.490	305740.44	423.96	.8	.2	.10038227+06	.82053541+07	.82075322+07
145.810	305680.87	424.00	.8	.2	.10013613+06	.82047171+07	.82068951+07
146.810	305633.10	424.03	.8	.2	.99951331+05	.82042356+07	.82064125+07
148.300	305280.24	424.10	.8	.2	.99678192+05	.82031487+07	.82053243+07
149.310	305086.65	424.12	.8	.2	.99681384+05	.82029004+07	.82050753+07
156.910	301044.30	425.09	.8	.2	.99673020+05	.81931027+07	.81952734+07
156.910	300822.30	425.24	.8	.2	.98755693+05	.81906974+07	.81928682+07
160.000	299178.77	425.66	.8	.2	.98752289+05	.81864675+07	.81886368+07
163.110	297524.60	426.10	.9	.2	.98748859+05	.81820703+07	.81842374+07
163.110	288538.60	392.24	.9	.2	.98000430+05	.57913021+07	.57934686+07
170.000	284873.89	392.85	.9	.2	.97992777+05	.57845455+07	.57867081+07
180.000	279555.01	393.84	.9	.2	.97981640+05	.57739753+07	.57761324+07
190.000	274236.14	394.97	.9	.3	.97970470+05	.57624798+07	.57646315+07
200.000	268917.26	396.22	.9	.3	.97959266+05	.57500291+07	.57521755+07
210.000	263598.38	397.60	1.0	.3	.97948021+05	.57365849+07	.57387256+07
220.000	258279.50	399.10	1.0	.3	.97936737+05	.57389227+07	.57410578+07
230.000	252960.62	400.77	1.0	.3	.97925410+05	.57246225+07	.57267521+07
240.000	247641.74	402.60	1.0	.3	.97914033+05	.57093242+07	.57114482+07
250.000	242322.86	404.58	1.0	.3	.97902611+05	.56929830+07	.56951014+07
260.000	237003.98	406.72	1.1	.3	.97891137+05	.56755441+07	.56776568+07
270.000	231685.11	409.04	1.1	.3	.97879604+05	.56569431+07	.56590500+07
280.000	226366.23	411.54	1.1	.3	.97868012+05	.56371040+07	.56392048+07
290.000	221047.35	414.23	1.1	.3	.97856358+05	.56159404+07	.56180355+07
300.000	215728.47	417.14	1.2	.3	.97844632+05	.55933539+07	.55954430+07
310.000	210409.60	420.26	1.2	.3	.97832832+05	.55692323+07	.55713154+07
320.000	205090.72	423.62	1.2	.3	.97820953+05	.55434479+07	.55455250+07
330.000	199771.84	427.24	1.2	.4	.97808988+05	.55158585+07	.55179296+07
340.000	194452.96	431.13	1.3	.4	.97796929+05	.54863022+07	.54883669+07
350.000	189134.08	435.31	1.3	.4	.97784769+05	.54545946+07	.54566532+07
360.000	183815.20	439.88	1.3	.4	.97772498+05	.54194479+07	.54215001+07
370.000	178496.32	444.77	1.4	.4	.97760108+05	.53820684+07	.53841142+07

TABLE AP 2-2 (Sheet 2 of 3)
S-IVB-205 MASS CHARACTERISTICS SUMMARY

TIME (SEC)	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (SLUG-FT2)	IYY (SLUG-FT2)	IZZ (SLUG-FT2)
380.000	173177.44	450.06	1.4	.4	.97747585+05	.53416394+07	.53436784+07
390.000	167858.56	455.78	1.5	.4	.97734919+05	.52978069+07	.52998392+07
400.000	162539.69	461.97	1.5	.4	.97722096+05	.52501775+07	.52522032+07
410.000	157220.80	468.68	1.6	.5	.97709099+05	.51983129+07	.52003315+07
420.000	151901.93	475.97	1.6	.5	.97695912+05	.51417153+07	.51437267+07
430.000	146583.05	483.91	1.7	.5	.97682510+05	.50798180+07	.50818222+07
440.000	141264.17	492.56	1.7	.5	.97668871+05	.50119662+07	.50139630+07
450.000	135945.30	502.02	1.8	.5	.97654966+05	.49373990+07	.49393880+07
454.900	133339.04	506.98	1.8	.5	.97648048+05	.48981380+07	.49001233+07
456.900	132280.54	509.05	1.8	.5	.97645494+05	.48816632+07	.48836470+07
460.000	131011.56	511.54	1.9	.5	.97641814+05	.48620714+07	.48640531+07
470.000	126918.08	519.97	1.9	.6	.97629814+05	.47955687+07	.47975437+07
475.000	124871.35	524.42	2.0	.6	.97623731+05	.47603022+07	.47622738+07
480.000	122824.61	529.04	2.0	.6	.97617594+05	.47235938+07	.47255622+07
490.000	118731.13	538.85	2.0	.6	.97605141+05	.46455228+07	.46474841+07
500.000	114637.66	549.46	2.1	.6	.97592422+05	.45606374+07	.45625915+07
510.000	110544.18	560.97	2.2	.7	.97579416+05	.44680892+07	.44700362+07
520.000	106450.71	573.49	2.3	.7	.97566082+05	.43669236+07	.43688629+07
525.000	104403.97	580.16	2.3	.7	.97559281+05	.43127608+07	.43146960+07
530.000	102357.23	587.06	2.4	.7	.97552384+05	.42572903+07	.42592216+07
540.000	98263.76	602.03	2.5	.7	.97538278+05	.41344620+07	.41363850+07
550.000	94170.28	618.46	2.6	.8	.97523707+05	.39990056+07	.40009199+07
560.000	90076.81	636.47	2.7	.8	.97508610+05	.38501967+07	.38521019+07
570.000	85983.34	656.34	2.8	.8	.97492912+05	.36854669+07	.36873626+07
580.000	81889.86	678.41	2.9	.9	.97476521+05	.35030866+07	.35049721+07
590.000	77796.39	703.04	3.1	.9	.97459332+05	.32949155+07	.32967903+07
600.000	73702.91	730.76	3.3	1.0	.97441205+05	.30586635+07	.30605265+07
610.000	69609.44	761.99	3.4	1.0	.97421980+05	.27907965+07	.27926471+07
614.540	67751.00	777.56	3.5	1.1	.97412838+05	.26561993+07	.26580440+07
615.940	67592.54	778.96	3.5	1.1	.97398081+05	.26437613+07	.26456062+07
674.540	67452.90	780.04	3.6	1.1	.97396085+05	.26355566+07	.26374023+07
1200.000	67113.38	782.45	3.6	1.1	.97380886+05	.26182023+07	.26200559+07
1800.000	66725.70	785.26	3.6	1.1	.97363514+05	.25976507+07	.25995134+07
2400.000	66338.01	788.15	3.6	1.1	.97346123+05	.25763217+07	.25781937+07
3000.000	65950.33	791.11	3.7	1.1	.97328711+05	.25542209+07	.25561021+07
3544.300	65598.64	793.87	3.7	1.1	.97312898+05	.25332592+07	.25351484+07
3600.000	65592.30	793.92	3.7	1.1	.97311374+05	.25328789+07	.25347691+07
4200.000	65523.98	794.46	3.7	1.1	.97294950+05	.25287545+07	.25306547+07

TABLE AP 2-2 (Sheet 3 of 3)
S-IVB-205 MASS CHARACTERISTICS SUMMARY

TIME (SEC)	MASS (LBM)	X ARM (STA-IN)	Y ARM (STA-IN)	Z ARM (STA-IN)	IXX (SLUG-FT2)	IYY (SLUG-FT2)	IZZ (SLUG-FT2)
4800.000	65455.66	795.00	3.7	1.1	.97278524+05	.25245815+07	.25264917+07
5400.000	65387.33	795.55	3.7	1.1	.97262097+05	.25203530+07	.25222731+07
5666.100	65357.03	795.79	3.7	1.1	.97254810+05	.25184520+07	.25203765+07
6000.000	64480.84	804.01	3.6	1.2	.97000302+05	.24462100+07	.24480252+07
6386.100	63467.67	813.83	3.5	1.2	.96705689+05	.23595500+07	.23612384+07
6600.000	63458.14	813.89	3.5	1.2	.96702059+05	.23591732+07	.23608651+07
7200.000	63431.42	814.06	3.5	1.2	.96691874+05	.23581163+07	.23598178+07
7800.000	63404.70	814.24	3.5	1.2	.96681689+05	.23570579+07	.23587693+07
8400.000	63377.97	814.41	3.5	1.2	.96671502+05	.23559988+07	.23577202+07
9000.000	63351.25	814.59	3.5	1.2	.96661318+05	.23549391+07	.23566703+07
9600.000	63324.53	814.76	3.5	1.2	.96651132+05	.23538785+07	.23556194+07
10200.000	63297.81	814.94	3.5	1.2	.96640946+05	.23528171+07	.23545679+07
10499.900	63284.45	815.02	3.5	1.2	.96635855+05	.23522864+07	.23540419+07
10495.000	63284.44	814.30	3.5	1.2	.11095412+06	.23567414+07	.23580188+07
10495.000	30339.45	434.26	6.4	-4.1	.91879045+05	.48172122+06	.48017529+06
10510.000	30339.00	434.26	6.4	-4.1	.91878872+05	.48171989+06	.48017414+06

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

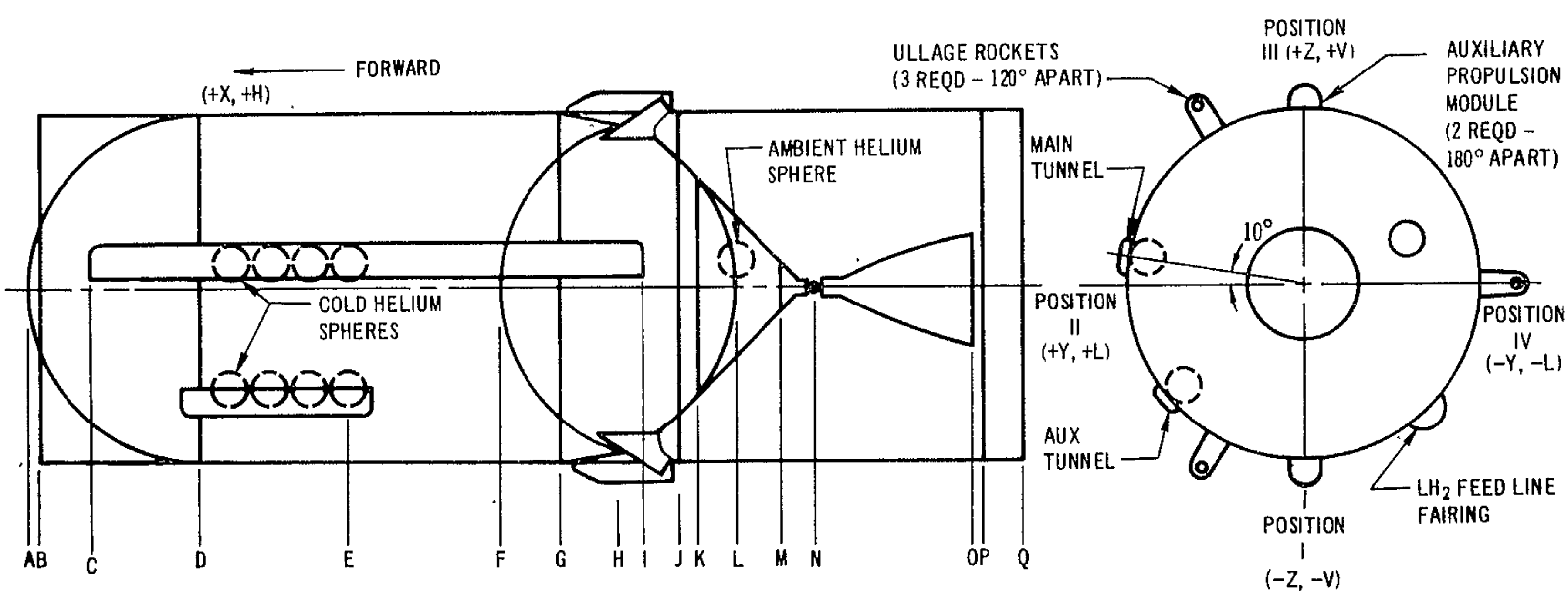
TERM	DEFINITIONS	UNITS
Douglas Station	Distance along the H axis from an arbitrary S-IVB-205 stage reference zero. The ZERO station is located so that the S-IVB-205 stage engine gimbal point is station 100.0. Positive values increase in the forward direction and negative values are aft of station zero.	Inches
H Arm	Distance along the centerline of the S-IVB-205 stage from the center of gravity of the item under consideration to S-IVB-205 stage Douglas 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-205 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.	$Lbm-In^2$
Pound Inches Square	Moment of inertia about the center of gravity of each item or total of items.	$Lbm-In^2$
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-205 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)	647.7
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
LH_2 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)	220.9

INSTALLATION	STATION
AUXILIARY PROPULSION MODULE (AFT END)	205.1
ULLAGE ROCKET FAIRING (AFT END)	204.6
LH_2 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
L. AMBIENT HELIUM SPHERES	158.6
AFT BULKHEAD (AFT END)	156.3
M. THRUST STRUCTURE SKIN (AFT END)	121.4
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-205 Stage Station Numbers

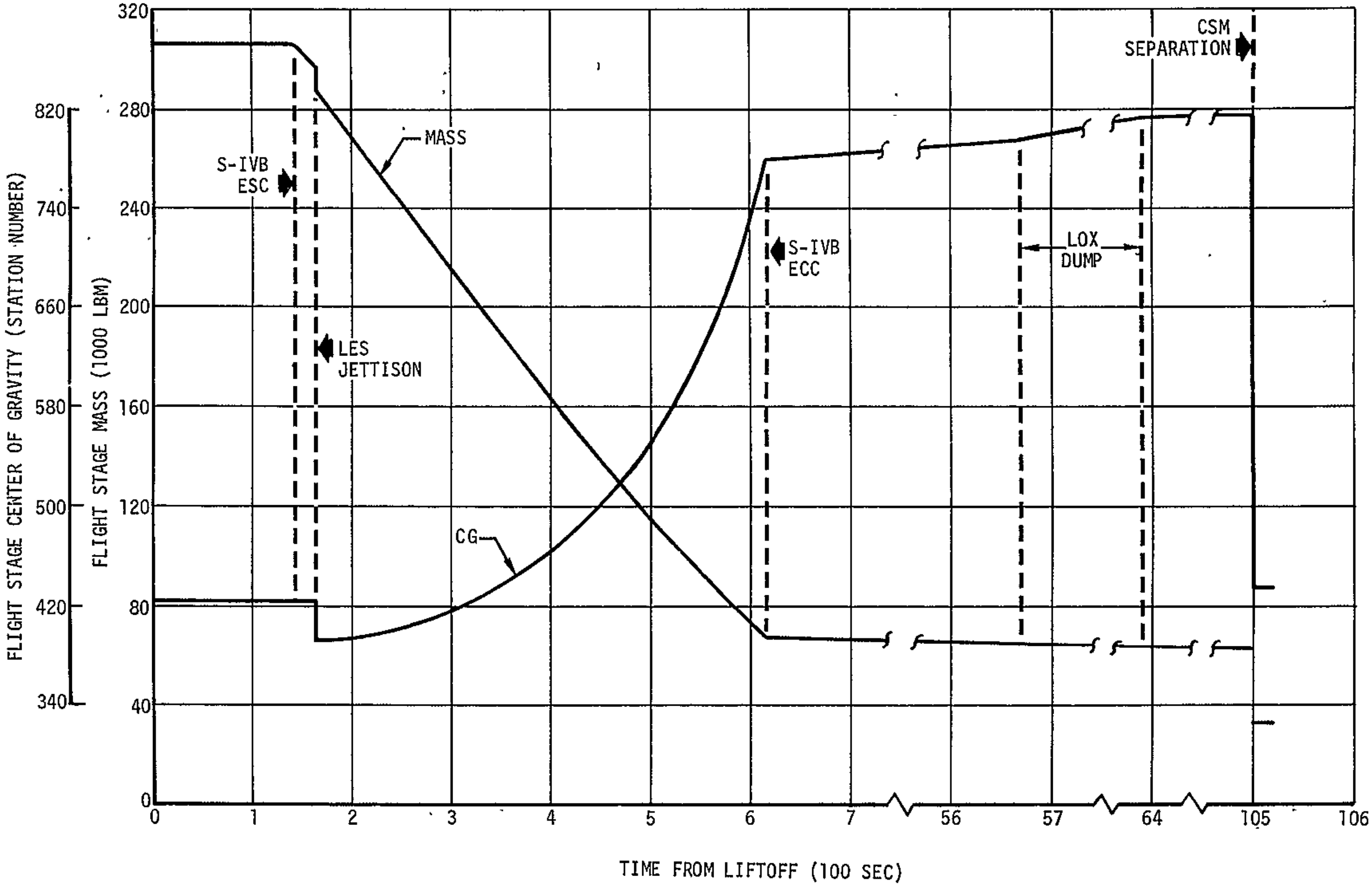


Figure AP 2-2. S-IVB-205 Stage Mass and Center of Gravity

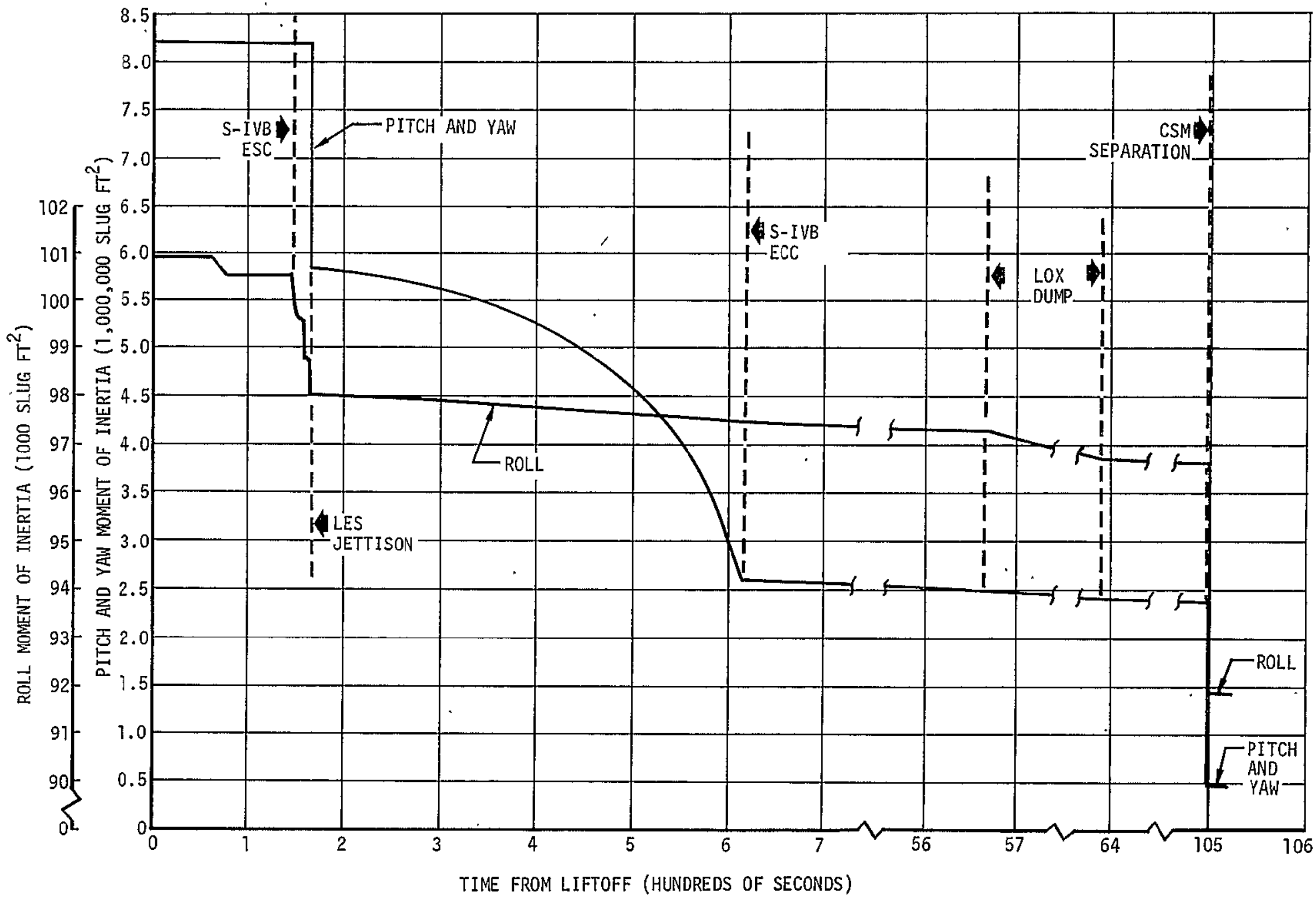


Figure AP 2-3. S-IVB-205 Stage Mass Moment of Inertia

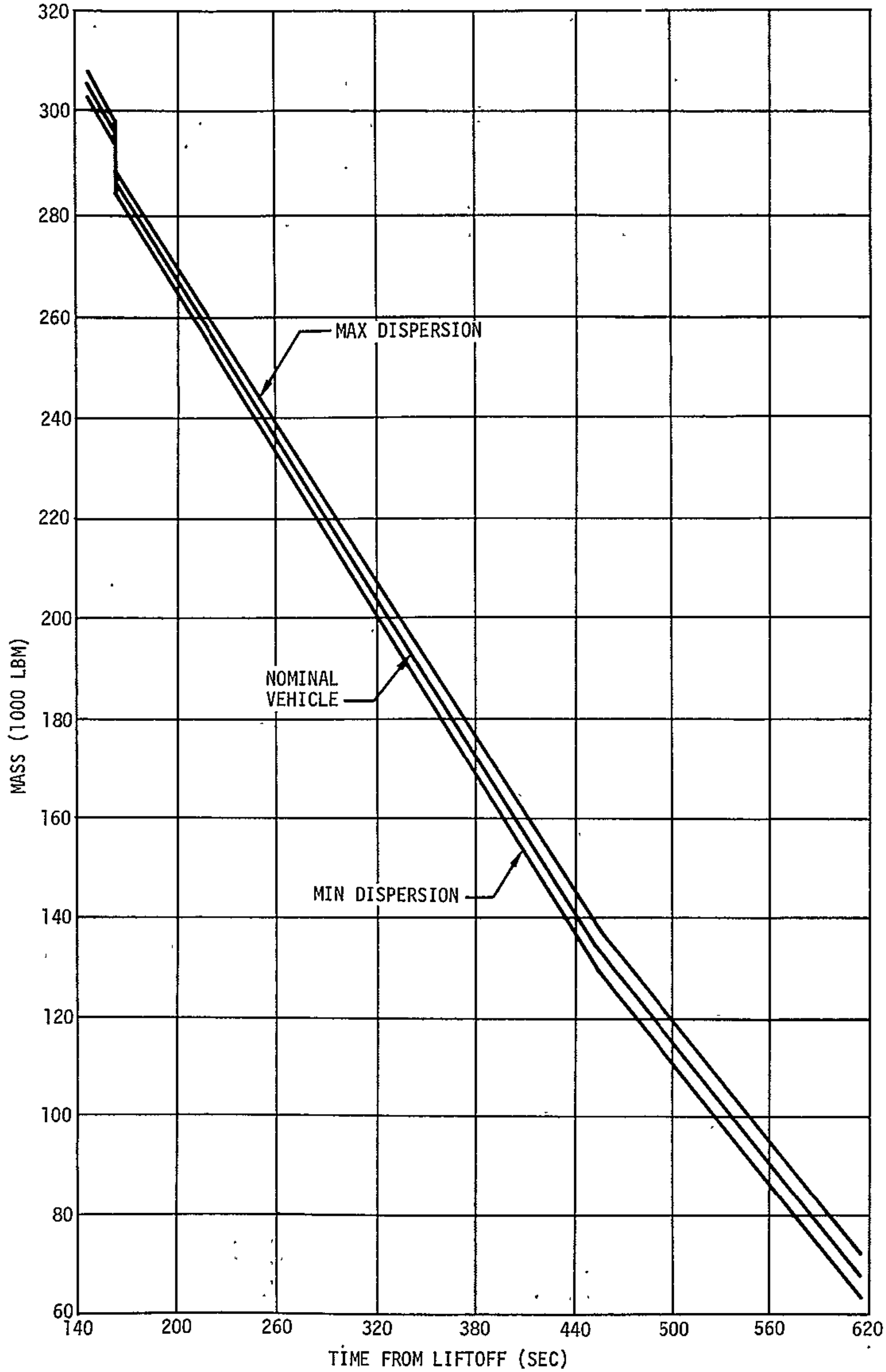


Figure AP 2-4. Second Flight Stage Vehicle Mass During S-IVB Burn

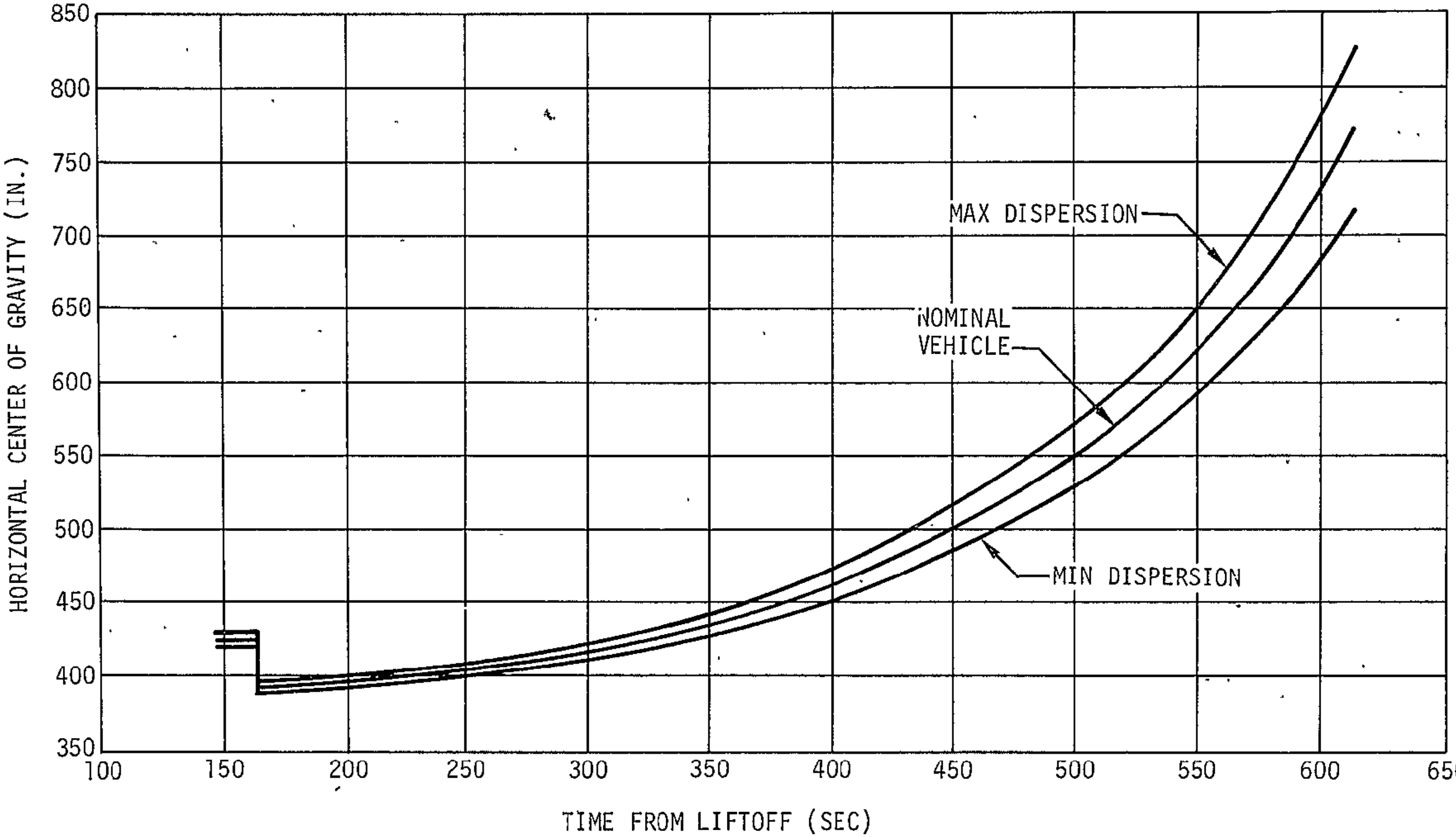


Figure AP 2-5. Second Flight Stage Vehicle Horizontal Center of Gravity During S-IVB Burn

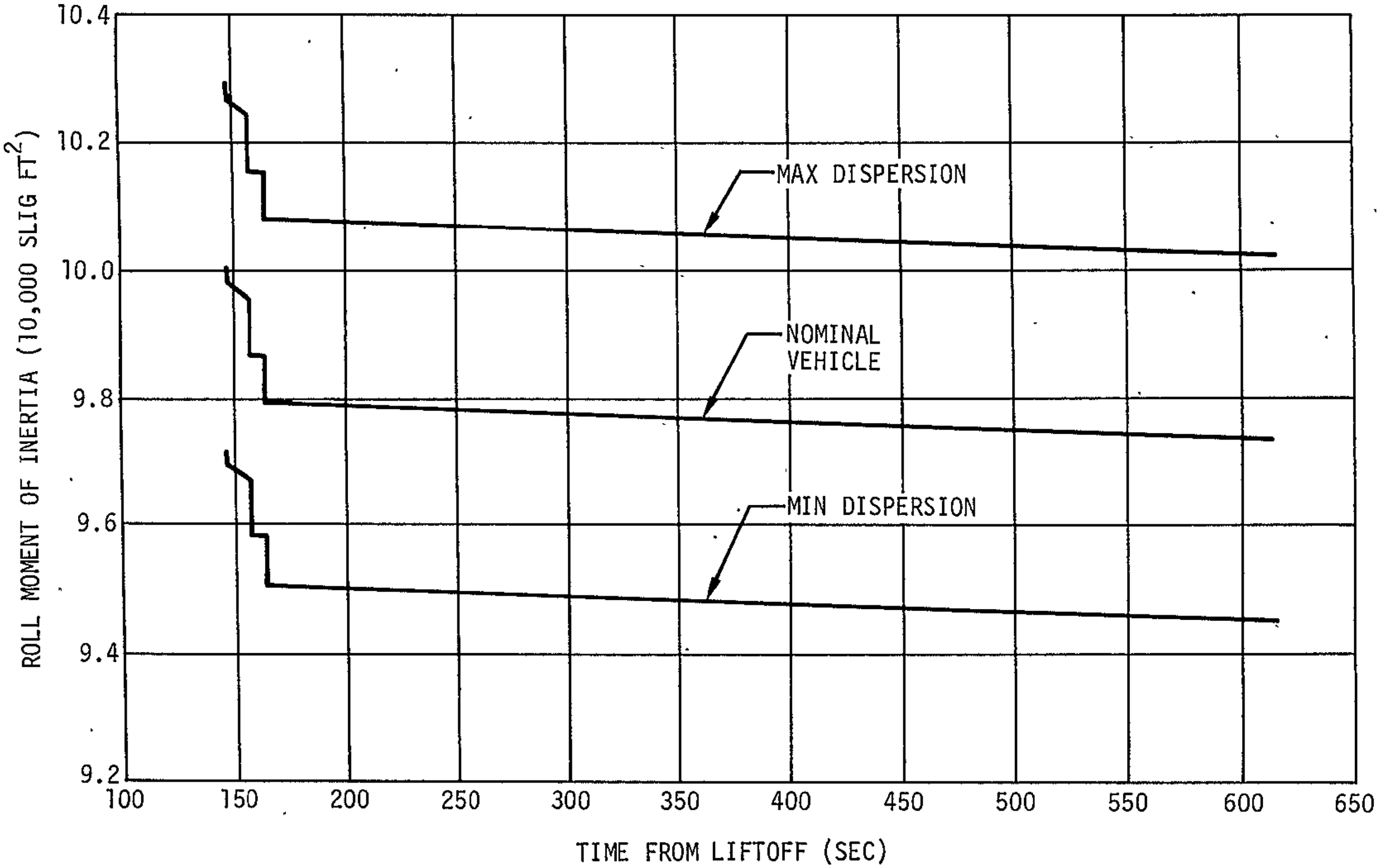


Figure AP 2-6. Second Flight Stage Vehicle Roll Moment of Inertia During S-IVB Burn

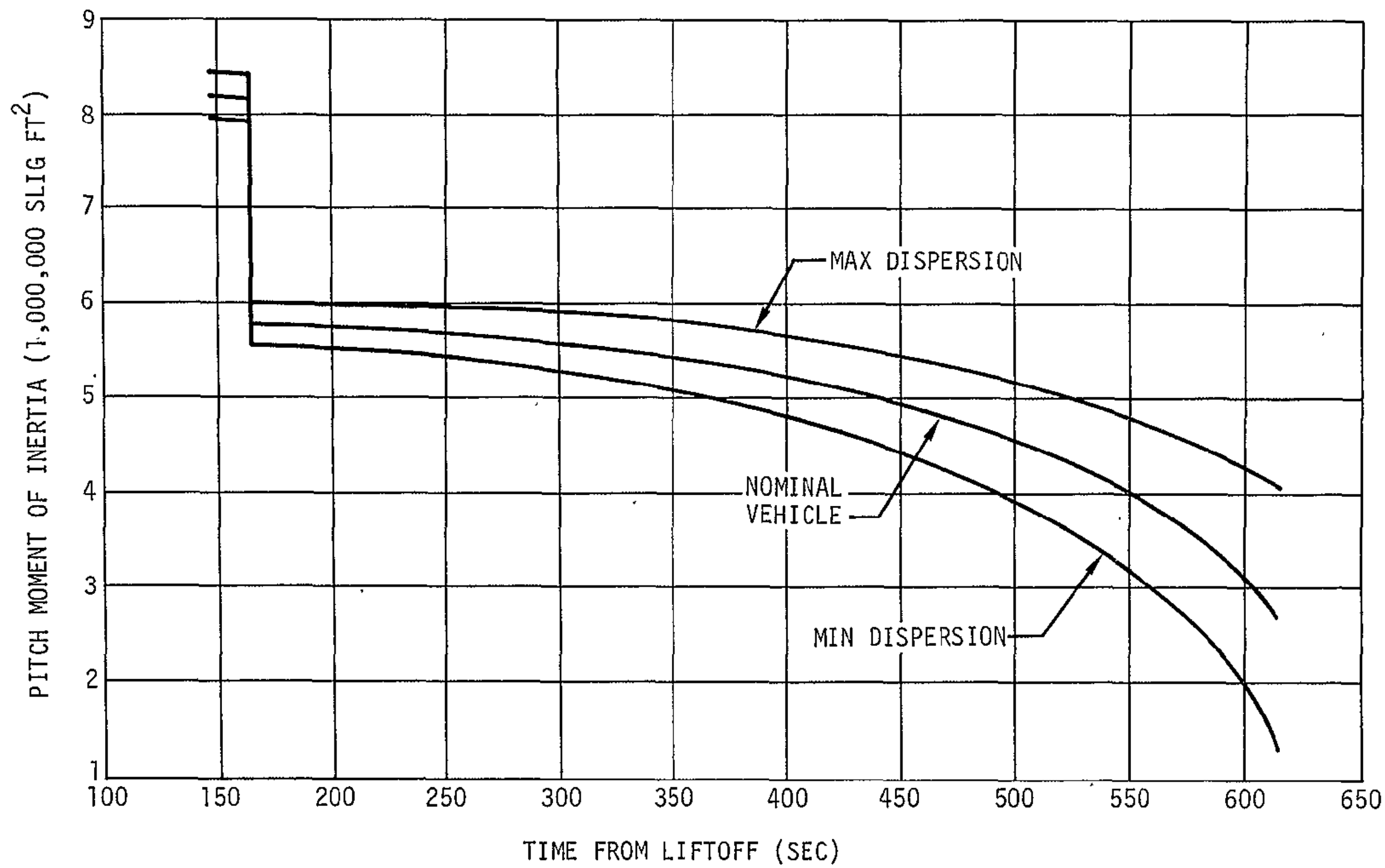


Figure AP 2-7. Second Flight Stage Vehicle Pitch Moment of Inertia During S-IVB Burn

APPENDIX 3

PREDICTED FLIGHT TRAJECTORY

3. PREDICTED FLIGHT TRAJECTORY

This appendix presents the AS-205 predicted launch vehicle trajectory. Predictions of the S-IB stage trajectory were generated by MSFC and transmitted to MDAC-WD where the data were reformatted to conform to MDAC-WD coordinate system conventions and symbology. The S-IVB stage trajectory simulation was derived using S-IVB stage predicted performance characteristics documented in this report. These predictions are based on MSFC predicted AS-205 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.

TABLE AP 3-1 (Sheet 1 of 15)

PREDICTED S-IB-205 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 L (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 IX (LB)	F SB AX (LB)	M SB X (LB-FT)	M SB AX (LB-FT)
10	F SB Y (LB)	F SB IY (LB)	F SB AY (LB)	M SB Y (LB-FT)	M SB AY (LB-FT)
11	F SB Z (LB)	F SB IZ (LB)	F SB AZ (LB)	M SB Z (LB-FT)	M SB AZ (LB-FT)
12	THETA M GRP (DEG)	D-THET M GRP (DEG/SEC)	V SB RM (FT/SEC)	I SB XX (SLUG/FT/FT)	EPS (THETA) (DEG)
13	PSI M GRP (DEG)	D-PSI M GRP (DEG/SEC)	V SB W (FT/SEC)	I SB YY (SLUG/FT/FT)	EPS (PSI) (DEG)
14	PHI M GRP (DEG)	D-PHI M GRP (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 A (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	T 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 3 (DEG)	K SB 2 (DEG/SEC)	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) (M/SEC)	DELTA D-Y(V) (M/SEC)	DELTA D-Z(V) (M/SEC)	N SB 1 (DEG)	N SB 2 (DEG)
27	T SB 1V (SEC)	T SB 1V2-4V (SEC)	T SB 3-5V (SEC)	T SB 1S SEC	T SB 2S (SEC)
28	T SB F (SEC)	S SB F (FT)	MU SB F (DEG)	RHO SB F (DEG)	LAMBDA SB N DEG

GUIDANCE REFERENCE RELEASE

1	-4.9999	.0	.0	115.0	.1
2	1341.76	.00	20909960.0	20909848.0	.0000
3	113.9	6373330.8	114.1	3017632.6	-80.5611
4	.0	17047.4	.0	-18150964.0	28.5220
5	-.0	-5539.0	.0	9932680.7	28.3608
6	.00	.00	1276.09	1323.59	.00
7	.00	126.38	-.01	220.03	.00
8	.00	388.95	414.62	-.04	-.00
9	-5.3	.0	-5.3	.0	-.0
10	.0	.0	.0	.0	-.0
11	.0	-.0	-.0	.0	.0
12	.000	-.003	3.99	1554538.40	.0000
13	.000	.001	-3.99	56657302.00	.0000
14	28.000	-.002	72.000	56657302.00	-28.0000
15	.000	.000	.0000	.000	100.0
16	.000	.000	89.9436	.000	-.0
17	.000	.000	89.8939	.000	-.0
18	.4833	.0000	.0000	.000	1137.48
19	74.3912	90.0000	90.0000	.000	.0
20	.00	.000	-.00	-.00	-3.99
21	-39.08	-.053	.0023	5.26	.00
22	.02	.004	2115.74	1.642	896.69
23	.000	.000	.000	.000	55920.4
24	27997.6	1002099.72	.9973	180.0000	1793.86
25	20909960.0	1341.78	28.3608	180.0000	10468978.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	3.2952	8465.6	80.5611	28.5220	90.0000

TABLE AP 3-1 (Sheet 2 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	.0000	1291782.9	1562203.1	112.8	.4
2	1341.76	.00	20909960.0	20909848.0	.0000
3	113.9	6373330.4	6494.6	3024250.2	-80.5611
4	-.0	17679.2	-1.2	-18149862.0	28.5220
5	-.0	-3594.2	2072.5	9932680.5	28.3608
6	-.00	-.13	1276.16	1323.51	39.14
7	-.00	126.31	-.44	220.51	.01
8	.00	388.98	414.40	-.04	.00
9	11221.8	1562203.3	6439.6	-1.1	.0
10	279.8	279.9	.0	-7417.2	-26.8
11	89.1	113.1	.0	7946.7	128.8
12	-.017	-.003	3.99	1554538.40	.0175
13	.006	.001	-3.99	56657302.00	-.0057
14	27.990	-.002	72.000	56657302.00	-55.9900
15	.000	.000	.0000	.002	745.1
16	.000	.000	89.9436	-.004	.2
17	-28.000	.000	89.8940	-.001	.1
18	-61.6392	-.0000	.0000	.000	1137.48
19	.0440	90.0000	90.0000	.000	39.1
20	-.00	1291912.700	-.00	.00	-3.99
21	-39.08	-.053	.0023	5.26	.00
22	.02	.004	2115.75	1.642	896.69
23	.000	.000	.000	.000	55920.2
24	27997.5	1002101.11	.9973	180.0000	1793.86
25	20909960.0	1341.78	28.3608	180.0000	10468978.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	2.6905	8465.6	80.5611	28.5220	90.0209

1	5.0000	1261108.0	1607473.0	213.0	.8
2	1342.25	41.69	20910060.0	20909848.0	.0000
3	214.0	6373360.0	12975.6	3030959.1	-80.5611
4	-.3	18310.5	-4.6	-18148728.0	28.5220
5	-.1	-1649.3	4144.1	9932707.4	28.3608
6	41.69	12.44	1317.92	1361.47	41.23
7	-.16	126.20	-1.03	233.75	.01
8	-.13	388.97	414.07	11.29	.02
9	10691.2	1607473.3	5867.9	-12.7	-6.4
10	285.4	79.7	205.7	-22045.1	-4577.9
11	679.1	325.2	354.5	7248.8	2761.7
12	.022	-.010	41.38	1511413.50	-.0216
13	-.015	.009	-4.04	56555574.00	.0153
14	28.008	.009	72.000	56555574.00	-56.0084
15	.000	.000	5.4260	-.009	742.5
16	.000	.000	4.6968	-.013	.2
17	-28.000	.000	2.7291	.003	.1
18	89.6010	-.0070	1.7798	-.015	1137.04
19	323.6831	89.8742	89.9900	.014	41.2
20	.79	-6134.984	-.00	.00	-4.04
21	-39.08	-.053	.0023	613.13	409.80
22	2.00	.037	2108.37	9.403	896.69
23	.000	.000	.000	.000	55906.8
24	27990.8	1002221.26	.9973	179.9952	1793.88
25	20910086.0	1341.61	28.3608	179.8695	10469038.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	3.8051	8465.6	80.5611	28.5220	90.0628

1	7.5000	1245770.6	1610912.4	347.5	-1.6
2	1343.03	65.19	20910195.0	20909848.0	.0000
3	348.5	6373400.2	16300.7	3034390.3	-80.5611
4	-.8	18625.9	-7.6	-18148135.0	28.5220
5	-.6	-676.9	5179.0	9932743.8	28.3608
6	65.18	19.34	1341.45	1382.84	41.80
7	-.23	126.14	-1.31	241.19	.00
8	-.28	388.94	413.83	17.75	.02
9	9869.3	1610912.5	5039.6	-18.1	-9.7
10	67.5	-253.8	321.3	-25809.3	-6972.2
11	889.9	352.7	536.6	-9231.5	4265.7
12	.008	.002	65.30	1489851.10	-.0082
13	-.021	-.005	-4.11	56504711.00	.0207
14	28.014	-.004	72.000	56504711.00	-56.0137
15	.000	.000	3.4382	.004	741.3
16	.000	.000	2.9517	.004	.2
17	-28.000	.000	1.7663	-.003	.1
18	89.5909	-.0100	2.7819	-.038	1136.45
19	313.3598	89.8061	89.9864	.018	41.8
20	.79	-6134.980	-.00	.00	-4.11
21	-39.08	-.053	.0023	1440.14	625.42
22	4.88	.057	2098.50	14.229	896.69
23	.000	.000	.000	.000	55894.1
24	27984.5	1002334.73	.9973	179.9925	1793.90
25	20910261.0	1341.44	28.3608	179.7960	10469122.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	5.0343	8061.5	80.5611	28.5220	90.0809

TABLE AP 3-1 (Sheet 3 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	10.0000	1230433.1	1617233.8	539.9	-3.1
2	1344.26	90.16	20910387.0	20909848.0	.0000
3	541.1	6573458.0	19684.0	3037874.3	-80.5611
4	-1.5	18941.2	-11.2	-18147522.0	28.5220
5	-1.5	295.4	6213.3	9932796.4	28.3608
6	90.15	27.09	1366.46	1405.55	42.45
7	-.33	126.08	-1.63	249.11	.01
8	-.48	388.91	413.54	24.63	.03
9	8529.7	1617234.0	3789.7	-24.0	-13.1
10	331.7	-119.4	451.1	-36088.9	-9400.8
11	1217.5	499.4	718.6	-298.8	5970.2
12	.017	.002	90.24	1468288.70	-.0172
13	-.022	.003	-4.21	56453847.00	.0216
14	27.998	-.006	72.000	56453847.00	-55.9984
15	.000	.000	2.4413	.006	740.0
16	.000	.000	2.0680	.000	.3
17	-28.000	.000	1.2985	.003	.1
18	89.5528	-.0143	3.8455	-.028	1135.62
19	306.9452	89.7352	89.9819	.027	42.5
20	.77	-6134.977	.00	.00	-4.21
21	-39.08	-.053	.0023	2688.91	848.50
22	9.21	.079	2084.44	19.053	896.69
23	.000	.000	.000	.000	55878.0
24	27976.4	1002479.97	.9973	179.9897	1793.93
25	20910513.0	1341.24	28.3608	179.7179	10469244.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	9.0036	8465.6	80.5612	28.5220	90.1007
1	15.0000	1199440.3	1632437.0	1125.5	-7.4
2	1349.28	145.28	20910973.0	20909848.0	.0001
3	1126.7	6573634.3	26651.3	3045025.2	-80.5612
4	-3.4	19571.4	-20.3	-18146235.0	28.5220
5	-4.6	2239.9	8280.3	9932956.2	28.3608
6	145.28	43.76	1421.65	1455.94	43.85
7	-.30	126.04	-2.03	266.09	-.00
8	-.32	389.02	413.55	39.41	.03
9	4771.3	1632437.0	-332.9	-25.5	-16.6
10	-89.1	-640.5	551.3	-26534.0	-11723.8
11	1197.2	293.5	888.2	-25800.2	7270.7
12	-.549	-.121	145.34	1424970.30	1.2191
13	.051	-.040	-4.50	56394047.00	-.0513
14	24.680	-1.530	72.000	56394047.00	-47.8804
15	.670	.149	1.1783	1.530	738.3
16	.000	.000	1.0012	-.093	.3
17	-23.200	.000	.6215	-.087	.1
18	89.7194	-.0126	6.1809	-.067	1133.14
19	326.2478	89.5962	89.9747	.017	43.8
20	.82	-6198.502	.00	.00	-4.50
21	-39.07	-.053	.0022	6797.89	1045.42
22	23.52	.128	2042.11	23.546	896.69
23	.000	.000	.000	.000	55898.2
24	27986.5	1002298.59	.9973	179.9834	1794.03
25	20911301.0	1341.43	28.3608	179.5454	10469643.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	14.3645	8465.6	80.5612	28.5220	90.1367
1	20.0000	1168447.5	1644746.9	2004.2	10.2
2	1360.10	207.29	20911852.0	20909848.0	.0001
3	2005.2	6573899.1	33911.9	3052446.3	-80.5611
4	-5.0	20201.4	-31.0	-18144860.0	28.5220
5	-.4	4186.9	10354.3	9933189.1	28.3608
6	207.28	62.52	1483.72	1513.65	45.25
7	-.29	125.99	-2.46	284.09	.02
8	2.54	389.97	416.30	53.76	.06
9	1084.1	1644747.0	-3740.1	-39.7	-23.1
10	649.4	9.7	639.7	-55945.5	-15871.4
11	1972.5	768.4	1190.7	11123.6	8453.7
12	-1.397	-.229	207.42	1381651.80	3.0614
13	.068	.000	-4.94	56334248.00	-.0685
14	19.172	-.860	72.000	56334248.00	-37.3720
15	1.664	.247	.7667	.860	736.6
16	.000	.000	.6754	-.217	.3
17	-18.200	.000	.3629	-.075	.1
18	89.2125	-.0120	8.7658	-.019	1129.59
19	54.8495	89.4726	89.9301	.046	45.3
20	.78	-6198.562	.00	.00	-4.94
21	-39.07	-.053	.0022	10202.18	1351.70
22	46.73	.184	1979.91	31.565	896.69
23	.000	.000	.000	.000	56134.8
24	28105.2	1000177.93	.9973	179.9762	1794.21
25	20912520.0	1344.18	28.3609	179.3514	10470312.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	19.0376	8465.6	80.5610	28.5221	90.2516

TABLE AP 3-1 (Sheet 4 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	25.0000	1137284.0	1655889.9	3210.7	34.4
2	1379.25	276.06	20913058.0	20909848.0	.0002
3	3211.7	6374263.2	41500.7	3060176.6	-80.5611
4	-6.1	20831.4	-43.1	-18143395.0	28.5220
5	28.3	6141.9	12452.9	9933490.0	28.3609
6	276.49	83.48	1552.99	1579.64	46.70
7	-.19	125.98	-2.81	302.41	.02
8	9.83	392.29	423.51	66.37	.08
9	-2382.1	1655889.8	-7267.8	-54.4	-32.6
10	560.9	-71.4	632.2	-70959.0	-20957.6
11	2537.1	956.9	1566.4	7483.1	8307.8
12	-2.736	-.310	276.92	1337657.80	5.8360
13	.068	-.001	-5.54	56302166.00	-.0682
14	14.114	-.982	72.000	56302166.00	-27.3138
15	3.100	.334	.5565	.981	735.9
16	.000	.000	.5160	-.300	.3
17	-13.200	.000	.2083	-.077	.1
18	87.9054	-.0077	11.5635	-.025	1125.00
19	66.7461	89.3790	89.8307	.058	46.7
20	.78	-6232.703	.01	.01	-5.54
21	-39.07	-.053	.0021	13728.46	1689.19
22	80.46	.246	1897.02	41.522	896.69
23	.000	.000	.000	.000	56731.0
24	28404.1	994894.91	.9973	179.9681	1794.47
25	20914248.0	1351.20	28.3613	179.1347	10471326.1
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	25.0276	6753.2	80.5603	28.5223	90.4818

1	30.0000	1106120.5	1667433.7	4780.6	114.6
2	1409.44	353.48	20914628.0	20909848.0	.0002
3	4781.7	6374737.3	49453.3	3068259.1	-80.5608
4	-6.9	21461.2	-56.5	-18141840.0	28.5221
5	108.9	8113.2	14603.7	9933845.4	28.3610
6	352.69	106.56	1629.23	1654.52	48.19
7	-.14	125.95	-3.23	320.26	-.00
8	23.72	396.65	437.37	75.29	.03
9	-7220.2	1667433.8	-12839.8	-14.1	-.1
10	-55.8	-247.6	191.8	-29260.4	-439.7
11	604.9	556.1	36.7	-7051.6	2280.8
12	-4.493	-.390	353.72	1293663.70	9.4257
13	.051	-.006	-3.33	56270083.00	-.0505
14	9.132	-1.000	72.000	56270083.00	-17.3318
15	4.932	.401	.0413	1.000	735.2
16	.000	.000	.0078	-.384	.3
17	-8.200	.000	.0405	-.068	.1
18	86.0991	-.0056	14.4903	-.037	1119.37
19	69.4222	89.3279	89.6451	.030	48.2
20	.90	-6232.703	.00	.00	-3.33
21	-39.06	-.053	.0020	19284.86	195.24
22	125.37	.316	1793.47	.972	896.69
23	.000	.000	.000	.000	57865.6
24	28973.0	985065.25	.9972	179.9589	1794.84
25	20916565.0	1364.48	28.3630	178.8962	10472769.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	31.4792	9203.1	80.5586	28.5228	90.8936

1	35.0000	1074901.2	1680360.7	6749.3	287.3
2	1453.41	438.40	20916596.0	20909848.0	.0003
3	6750.2	6375332.3	57804.5	3076740.4	-80.5603
4	-7.8	22090.8	-71.7	-18140200.0	28.5223
5	280.5	10113.0	16846.3	9934231.3	28.3611
6	435.92	131.78	1712.47	1739.21	49.78
7	-.24	125.89	-3.82	336.77	-.01
8	46.60	403.78	460.27	78.47	-.05
9	-12551.2	1680361.0	-19218.1	51.4	51.9
10	-454.2	-374.1	-80.1	32014.3	29092.1
11	-2203.9	-48.4	-2162.8	-16878.4	-1538.4
12	-6.615	-.456	438.45	1249490.80	13.7228
13	.016	-.008	-.45	56239656.00	-.0162
14	4.132	-1.000	72.000	56239656.00	-7.3318
15	7.108	.468	.3160	1.000	735.8
16	.000	.000	-.3158	-.454	.3
17	-3.200	.000	-.0117	-.041	.1
18	83.8470	-.0092	17.4515	-.045	1112.68
19	70.2862	89.3302	89.3450	-.012	49.8
20	1.07	-6243.867	.00	.00	-.45
21	-39.05	-.053	.0019	25674.60	2164.26
22	181.55	.394	1670.29	-57.331	896.69
23	.000	.000	.000	.000	59750.3
24	29917.9	969362.54	.9971	179.9484	1795.34
25	20919557.0	1386.33	28.3681	178.6356	10474737.4
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	38.2969	9203.1	80.5550	28.5238	91.5466

TABLE AP 3-1 (Sheet 5 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	40.0000	1043681.9	1694983.9	9151.7	601.7
2	1513.34	532.36	20918998.0	20909848.0	.0004
3	9152.7	6376058.8	66589.5	3085671.8	-80.5594
4	-9.7	22720.0	-89.7	-18138483.0	28.5226
5	593.1	12156.6	19231.3	9934614.7	28.3614
6	526.25	159.14	1802.77	1834.49	51.49
7	-.55	125.75	-4.65	351.24	-.02
8	80.45	414.28	494.20	74.24	-.12
9	-18683.6	1694984.1	-26370.7	105.6	96.2
10	-500.0	-473.4	-26.7	76602.2	51623.3
11	-4322.2	-470.7	-3852.5	-21084.3	-1015.9
12	-9.027	-.508	532.03	1205317.80	18.6048
13	-.026	-.008	2.19	56209230.00	.0264
14	-.193	-.056	72.000	56209230.00	.1929
15	9.578	.524	.4112	.056	736.3
16	.000	.000	-.4112	-.508	.3
17	.000	.000	-.0028	-.006	.1
18	81.2572	-.0203	20.3462	-.052	1104.74
19	70.6146	89.3909	88.9154	-.040	51.5
20	1.23	-6243.859	-.00	-.00	2.19
21	-39.04	-.053	.0018	32842.43	3852.64
22	248.35	.482	1529.66	-102.123	896.69
23	.000	.000	.000	.000	62591.0
24	31342.4	947045.11	.9970	179.9362	1796.01
25	20923315.0	1418.64	28.3804	178.3527	1047328.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	45.2633	9203.1	80.5487	28.5258	92.4721

1	45.0000	1012430.0	1710294.3	12023.3	1117.1
2	1590.96	636.33	20921869.0	20909848.0	.0006
3	12024.2	6376927.2	75843.1	3095107.7	-80.5579
4	-13.5	23348.3	-111.3	-18136702.0	28.5230
5	1106.4	14262.4	21818.6	9934954.6	28.3619
6	623.49	188.59	1899.94	1940.93	53.31
7	-.97	125.59	-5.63	362.77	-.00
8	127.18	428.73	541.06	60.99	-.21
9	-25302.4	1710294.2	-34256.2	189.8	163.6
10	-26.4	-341.9	315.5	137826.2	80521.8
11	-7350.4	-1078.1	-6272.2	-9520.0	3157.5
12	-11.682	-.550	635.15	1161154.40	23.9775
13	-.025	.000	6.01	56148239.00	.0254
14	-.009	-.001	72.000	56148239.00	.0087
15	12.295	.564	.5107	.001	738.3
16	.000	.000	-.5100	-.550	.3
17	.000	.000	.0257	.000	.1
18	78.4220	-.0337	23.0683	-.042	1095.11
19	70.8191	89.5143	88.3573	-.081	53.3
20	1.43	-6250.387	-.01	-.01	6.01
21	-39.03	-.053	.0016	40755.48	6280.08
22	323.73	.580	1374.73	-165.107	892.07
23	.000	.000	.000	.000	66624.9
24	33365.6	917839.29	.9968	179.9220	1796.86
25	20927932.0	1463.32	28.4055	178.0479	10480648.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	53.1678	10209.9	80.5379	28.5289	93.6669

1	50.0000	981178.1	1726047.7	15397.8	1902.3
2	1687.63	751.37	20925243.0	20909848.0	.0007
3	15398.6	6377947.9	85598.6	3105105.2	-80.5556
4	-19.2	23975.0	-136.2	-18134876.0	28.5237
5	1889.5	16451.5	24678.2	9935201.5	28.3626
6	727.30	220.01	2003.59	2058.93	55.23
7	-1.31	125.44	-6.58	370.34	.01
8	188.67	447.73	602.75	37.13	-.33
9	-33118.9	1726047.2	-43114.7	285.8	246.5
10	279.2	-326.1	605.3	184788.5	102919.5
11	-10663.4	-1535.0	-9128.5	-5903.7	5660.2
12	-14.507	-.577	748.69	1116990.80	29.7155
13	-.027	-.001	10.96	56087248.00	.0270
14	-.007	-.000	72.000	56087248.00	.0066
15	15.208	.600	.5856	.001	740.4
16	.000	.000	-.5843	-.577	.3
17	.000	.000	.0387	-.001	.1
18	75.4105	-.0422	25.5227	-.041	1083.07
19	71.0185	89.7031	87.6833	-.110	55.2
20	1.60	-6250.383	-.03	-.02	10.96
21	-39.02	-.053	.0014	40650.51	9148.59
22	404.63	.691	1209.57	-236.413	875.38
23	.000	.000	.000	.000	72146.7
24	36135.7	881900.47	.9966	179.9053	1797.94
25	20933498.0	1522.35	28.4492	177.7223	10484816.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	61.2318	15940.2	80.5215	28.5338	95.1029

TABLE AP 3-1 (Sheet 6 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	55.0000	949924.8	1741472.5	19305.9	3035.0
2	1803.61	877.98	20929150.0	20909848.0	.0009
3	19306.5	6379130.1	95886.3	3115721.4	-80.5522
4	-26.5	24602.7	-164.9	-18133024.0	28.5247
5	3020.1	18747.9	27888.0	9935298.6	28.3636
6	836.61	253.07	2112.67	2188.03	56.96
7	-1.61	125.29	-7.57	373.14	.02
8	266.31	471.67	680.64	1.18	-.43
9	-50434.4	1741472.2	-60849.9	369.6	334.1
10	448.1	-362.5	810.6	165112.2	92426.5
11	-13357.6	-1354.8	-12003.1	-8890.5	4548.1
12	-17.433	-.587	873.01	1072750.60	35.7010
13	-.033	-.002	16.82	55968007.00	.0334
14	-.009	-.000	72.000	55968007.00	.0089
15	18.269	.625	.6193	.001	744.1
16	.000	.000	-.6179	-.587	.3
17	.000	.000	.0417	-.002	.1
18	72.2996	-.0474	27.6288	-.043	1067.68
19	71.1784	89.9533	86.9106	-.096	57.0
20	1.67	-6250.660	-.05	-.04	16.82
21	-39.01	-.053	.0013	67420.93	12030.49
22	486.30	.818	1039.02	-300.499	836.23
23	.000	.000	.000	.000	79457.9
24	39804.5	840201.31	.9962	179.6857	1799.25
25	20940082.0	1597.13	28.5175	177.3790	10489943.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	69.6102	22830.0	80.4976	28.5408	96.7413

1	60.0000	918671.6	1754690.6	23767.4	4596.0
2	1936.40	1013.71	20933610.0	20909848.0	.0012
3	23767.9	6380479.6	106725.4	3127005.1	-80.5476
4	-35.4	25228.7	-196.9	-18131176.0	28.5261
5	4579.5	21176.5	31530.2	9935182.3	28.3650
6	947.61	286.01	2223.34	2324.70	57.55
7	-1.92	125.13	-8.64	370.07	.02
8	360.03	500.55	774.68	-47.87	-.55
9	-102389.2	1754690.8	-112215.3	469.6	466.7
10	520.9	-454.8	975.7	53437.8	43673.3
11	-16481.8	-181.5	-16300.6	-18986.7	-598.9
12	-20.385	-.596	1005.20	1028510.41	41.8127
13	-.043	-.002	24.65	55848764.00	.0432
14	-.012	-.001	72.000	55848764.00	.0119
15	21.427	.638	.6694	.001	747.9
16	.000	.000	-.6682	-.596	.3
17	.000	.000	.0400	-.002	.1
18	69.1575	-.0506	29.2908	-.048	1048.11
19	71.3003	90.2582	86.0738	-.019	57.6
20	1.57	-6250.656	-.08	-.06	24.65
21	-38.99	-.053	.0011	118842.89	16329.76
22	559.24	.959	868.54	-373.660	779.64
23	.000	.000	.000	.000	88790.8
24	44489.7	794642.08	.9958	179.8631	1800.83
25	20947649.0	1687.71	28.6130	177.0299	10496069.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	78.3005	33766.0	80.4645	28.5504	98.5053

1	65.0000	887314.2	1768246.0	28771.7	6662.1
2	2081.37	1153.38	20938613.0	20909848.0	.0014
3	28771.8	6381992.8	118104.3	3138975.1	-80.5415
4	-45.6	25853.9	-232.9	-18129363.0	28.5279
5	6645.3	23761.1	35682.6	9934784.6	28.3668
6	1053.59	318.56	2328.88	2462.57	58.37
7	-2.15	124.97	-9.74	359.29	.03
8	469.30	534.20	884.29	-111.34	-.91
9	-143209.3	1768237.3	-159044.8	757.2	594.4
10	895.0	-174.7	1069.7	614213.5	308290.7
11	-25795.9	-5615.7	-20180.3	8829.4	11656.8
12	-23.537	-.617	1139.70	984278.65	48.1535
13	-.042	-.001	34.65	55621711.00	.0418
14	-.017	-.001	72.000	55621711.00	.0167
15	24.616	.570	.8759	.001	753.9
16	.000	.000	-.8746	-.617	.4
17	.000	.000	.0464	-.001	.1
18	65.9573	-.0500	30.4023	-.030	1024.19
19	71.4046	90.6171	85.2119	-.380	58.4
20	2.52	-6271.469	-.13	-.09	34.65
21	-38.97	-.053	.0009	165779.23	20208.64
22	610.62	1.113	704.42	-534.070	936.69
23	.000	.000	.000	.000	100372.3
24	50306.6	747186.05	.9952	179.8381	1802.65
25	20955988.0	1793.69	28.7349	176.6959	10503147.2
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	86.8080	47888.6	80.4214	28.5628	100.3107

TABLE AP 3-1 (Sheet 7 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	70.0000	855956.9	1782924.9	34313.5	9321.9
2	2246.45	1308.86	20944152.0	20909848.0	.0017
3	34312.2	6383667.7	130016.0	3151659.0	-80.5337
4	-56.7	26478.4	-272.2	-18127625.0	28.5303
5	9306.3	26528.8	40434.7	9934028.6	28.3691
6	1163.86	351.77	2438.57	2611.93	61.64
7	-2.31	124.81	-10.87	341.75	.03
8	598.78	574.04	1014.17	-190.[illegible]	-1.14
9	-124728.5	1782907.7	-143399.9	934.[illegible]	698.6
10	895.0	-155.4	1050.4	834175.8	399572.5
11	-30988.6	-7905.1	-23083.9	11957.0	13842.3
12	-26.560	-.593	1287.91	940046.91	54.3463
13	-.047	-.002	47.25	55394659.00	.0472
14	-.020	-.001	72.000	55394659.00	.0196
15	27.786	.631	.9435	.002	759.9
16	.000	.000	-.9425	-.593	.4
17	.000	.000	.0429	-.002	.1
18	62.7499	-.0458	31.1964	-.029	996.88
19	71.4956	91.0255	84.3195	-.514	61.7
20	2.98	-6271.473	-.20	-.13	47.25
21	-38.95	-.053	.0008	150204.96	23107.74
22	645.06	1.292	552.04	-607.982	967.15
23	.000	.000	.000	.000	115069.6
24	57693.1	697594.86	.9945	179.8083	1804.81
25	20965386.0	1919.67	28.8858	176.3475	10511539.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	95.5641	66804.6	80.3649	28.5790	102.1646

MAXIMUM DYNAMIC PRESSURE

1	75.0000	824555.2	1796100.5	40427.5	12681.3
2	2434.82	1485.79	20950263.0	20909848.0	.0020
3	40424.4	6385514.6	142494.8	3165128.9	-80.5238
4	-68.7	27102.0	-315.4	-18125995.0	28.5332
5	12669.6	29512.6	45894.0	9932833.8	28.3720
6	1282.58	387.48	2556.55	2777.13	65.27
7	-2.48	124.62	-12.14	318.12	.03
8	750.04	620.56	1165.92	-286.02	-.91
9	-107757.5	1796094.6	-123744.5	759.5	612.0
10	732.9	-305.1	1038.0	558268.9	295185.1
11	-23910.8	-4728.9	-19181.7	2096.9	12025.9
12	-29.454	-.620	1458.57	896026.37	60.3505
13	-.054	.001	55.45	55052034.00	.0536
14	-.018	.001	72.000	55052034.00	.0180
15	30.896	.612	.7377	-.000	767.9
16	.000	.000	-.7366	-.620	.4
17	.000	.000	.0399	.001	.1
18	59.6653	-.0402	31.7813	-.038	968.40
19	71.5676	91.4694	83.4175	-.312	65.3
20	2.55	-6280.344	-.26	-.17	55.45
21	-38.93	-.053	.0006	130425.95	19209.73
22	659.66	1.506	415.26	-485.917	952.07
23	.000	.000	.000	.000	133574.9
24	67000.8	647186.72	.9936	179.7722	1807.39
25	20976096.0	2067.21	29.0637	175.9712	10521548.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	104.8805	91355.8	80.2918	28.5998	104.0210

1	80.0000	793166.8	1807261.6	47157.8	16849.4
2	2647.34	1685.71	20956990.0	20909848.0	.0024
3	47151.9	6387546.5	155583.0	3179465.4	-80.5114
4	-81.3	27724.7	-363.0	-18124501.0	28.5368
5	16845.2	32746.2	52171.3	9931118.9	28.3756
6	1409.81	425.70	2682.86	2958.65	69.12
7	-2.54	124.44	-13.43	287.92	.04
8	924.14	674.09	1340.62	-398.32	-.47
9	-87982.4	1807257.5	-103575.1	400.1	273.5
10	952.6	-91.0	1043.6	454004.0	233200.6
11	-12140.4	-3913.8	-8226.5	28187.2	26139.4
12	-32.591	-.615	1661.07	852205.13	66.4815
13	-.049	.000	45.74	54620776.00	.0486
14	-.010	.003	72.000	54620776.00	.0100
15	33.891	.586	.3714	-.002	777.3
16	.000	.000	-.3684	-.615	.4
17	.000	.000	.0467	.000	.1
18	56.7503	-.0306	32.1753	-.024	945.67
19	71.6334	91.9418	82.5323	-.252	69.1
20	2.48	-6277.531	-.23	-.15	45.74
21	-38.90	-.053	.0005	110071.48	8292.46
22	644.72	1.756	298.60	-237.515	1116.59
23	.000	.000	.000	.000	156660.9
24	78623.9	597272.84	.9925	179.7285	1810.46
25	20988273.0	2237.44	29.2626	175.5665	10533448.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	114.6852	122545.6	80.1990	28.6261	105.8243

TABLE AP 3-1 (Sheet 8 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	85.0000	761868.9	1816406.3	54547.4	21940.6
2	2884.27	1909.59	20964375.0	20909848.0	.0028
3	54537.0	6389775.9	169321.4	3194750.3	-80.4964
4	-93.9	28346.4	-414.4	-18123180.0	28.5412
5	21949.2	36265.2	59383.7	9928797.3	28.3800
6	1545.59	466.44	2817.51	3156.63	73.16
7	-2.49	124.25	-14.76	251.00	.04
8	1121.47	734.75	1538.62	-527.87	.22
9	-74310.2	1816405.4	-84206.5	-156.5	-84.4
10	852.2	-67.1	919.3	-220613.6	-98600.5
11	4793.7	2122.9	2670.9	34980.2	31277.6
12	-35.720	-.645	1899.63	808345.77	72.4755
13	-.048	.000	17.05	54014573.00	.0478
14	.003	.001	72.000	54014573.00	-.0030
15	36.755	.557	.1501	-.001	789.3
16	.000	.000	.1419	-.645	.4
17	.000	.000	.0488	.000	.1
18	54.0453	-.0176	32.4073	-.022	936.48
19	71.6933	92.4328	81.6844	.129	73.2
20	1.58	-6259.570	-.10	-.06	17.05
21	-38.87	-.053	.0003	90658.46	2824.64
22	590.95	2.028	205.17	83.863	1234.70
23	.000	.000	.000	.000	185138.3
24	92979.0	549048.04	.9912	179.6759	1814.09
25	21002077.0	2430.71	29.4757	175.1326	10547527.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	125.1173	161594.9	80.0829	28.6587	107.5337

1	90.0000	730571.1	1822643.4	62636.8	28076.8
2	3147.73	2158.83	20972459.0	20909848.0	.0033
3	62618.8	6392214.1	183747.6	3211065.1	-80.4782
4	-106.0	28967.1	-470.1	-18122068.0	28.5965
5	28105.2	40107.6	67655.4	9925775.0	28.3853
6	1687.97	509.09	2958.52	3370.71	77.46
7	-2.35	124.05	-16.19	205.30	.02
8	1345.85	803.70	1763.79	-678.42	.16
9	-52700.9	1822643.3	-63728.7	-114.7	-69.8
10	549.5	-225.4	774.9	-150294.5	-77802.2
11	3381.5	1239.0	2142.6	20111.5	26060.0
12	-38.844	-.589	2161.46	764486.41	78.3172
13	-.046	.000	-4.21	53408368.00	.0464
14	.004	-.001	72.000	53408368.00	-.0037
15	39.473	.529	.1498	.001	801.4
16	.000	.000	.1409	-.589	.4
17	.000	.000	.0509	.000	.1
18	51.4606	-.0020	32.4422	-.032	948.60
19	71.7478	92.9498	80.8753	.070	77.5
20	1.76	-6259.574	.03	.02	-4.21
21	-38.84	-.052	.0002	70179.33	2278.43
22	494.91	2.279	136.33	69.718	1239.47
23	.000	.000	.000	.000	220504.1
24	110833.5	502671.79	.9895	179.6130	1818.39
25	21017576.0	2650.78	29.6993	174.6748	10564204.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	136.0788	210035.5	79.9387	28.6989	109.1477

1	95.0000	699404.7	1826568.8	71453.6	35399.4
2	3438.74	2434.48	20981269.0	20909848.0	.0038
3	71424.4	6394869.0	198887.0	3228487.6	-80.4566
4	-117.3	29586.8	-530.3	-18121216.0	28.5528
5	35456.9	44317.4	77131.0	9921938.1	28.3916
6	1835.19	553.10	3104.10	3600.12	81.90
7	-2.13	123.82	-17.74	149.37	.01
8	1599.61	881.66	2018.42	-852.42	.08
9	-34352.9	1826568.9	-46121.6	-53.9	-26.7
10	270.9	-383.0	653.9	-68496.5	-28173.5
11	1520.2	672.8	847.5	3858.8	20282.3
12	-41.524	-.500	2440.76	720535.00	83.5546
13	-.042	.001	-9.55	52493110.00	.0424
14	.002	-.000	72.000	52493110.00	-.0015
15	42.031	.494	.0894	.000	817.6
16	.000	.000	.0708	-.500	.4
17	.000	.000	.0546	.001	.1
18	48.9704	.0158	32.2802	-.042	964.03
19	71.7985	93.4933	80.1132	.035	81.9
20	1.89	-6233.266	.07	.04	-9.55
21	-38.81	-.052	.0001	52568.16	1070.48
22	397.11	2.532	88.46	28.121	1220.80
23	.000	.000	.000	.000	264327.2
24	132999.3	458636.67	.9874	179.5382	1823.48
25	21034815.0	2899.88	29.9279	174.1976	10583906.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	147.4851	269385.4	79.7618	28.7479	110.6525

TABLE AP 3-1 (Sheet 9 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	100.0000	668238.5	1828100.5	81025.7	44049.2
2	3756.80	2737.13	20990834.0	20909848.0	.0044
3	80979.7	6397747.7	214763.2	3247094.4	-80.4310
4	-127.1	30205.3	-595.5	-18120673.0	28.5602
5	44148.2	48938.6	87955.2	9917172.1	28.3989
6	1987.79	598.62	3254.76	3844.92	86.47
7	-1.77	123.58	-19.39	83.79	.00
8	1881.64	968.28	2301.41	-1048.78	.04
9	-19912.4	1828100.7	-32115.6	-24.5	-7.7
10	23.5	-507.2	530.7	-30833.3	-9320.1
11	643.8	350.4	293.4	-8666.7	16011.7
12	-43.932	-.464	2744.80	676583.64	88.3457
13	-.039	.000	-11.15	51577853.00	.0386
14	.001	-.000	72.000	51577853.00	-.0008
15	44.413	.455	.0657	.001	833.8
16	.000	.000	.0318	-.464	.5
17	.000	.000	.0575	.000	.1
18	46.6420	.0363	31.9875	-.050	978.12
19	71.8469	94.0495	79.4121	.015	86.5
20	1.96	-6233.202	.09	.05	-11.15
21	-38.78	-.052	.0001	38561.19	606.42
22	309.81	2.806	56.13	9.849	1223.66
23	.000	.000	.000	.000	317804.5
24	160110.7	417740.70	.9849	179.4499	1829.46
25	21053959.0	3176.83	30.1538	173.6982	10607034.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	159.3988	341099.7	79.5479	28.8065	112.0249

1	105.0000	637127.3	1827944.5	91380.4	54164.9
2	4102.23	3067.55	21001180.0	20909848.0	.0051
3	91311.0	6400857.6	231400.5	3266961.6	-80.4010
4	-135.0	30822.5	-665.9	-18120489.0	28.5689
5	54320.9	54014.8	100270.7	9911364.0	28.4076
6	2145.67	645.61	3410.39	4105.10	91.26
7	-1.42	123.27	-21.29	8.52	-.02
8	2192.25	1063.67	2613.09	-1267.89	-.00
9	-8276.1	1827944.7	-20804.8	.2	8.9
10	-402.2	-688.1	285.9	-629.8	5327.0
11	-76.4	93.0	-169.2	-29257.1	7912.5
12	-46.124	-.422	3073.07	632678.31	92.7281
13	-.056	.001	-7.73	50217815.00	.0562
14	-.000	.000	72.000	50217815.00	.0003
15	46.604	.419	.0480	.000	855.6
16	.000	.000	-.0244	-.422	.5
17	.000	.000	.0413	.001	.1
18	44.4831	.0570	31.5986	-.061	989.20
19	71.8898	94.6112	78.7725	-.001	91.3
20	2.01	-6222.227	.07	.04	-7.73
21	-38.74	-.052	.0000	27250.02	332.23
22	235.30	3.107	34.86	-5.746	1222.92
23	.000	.000	.000	.000	382515.1
24	193009.1	380183.75	.9818	179.3461	1836.47
25	21075158.0	3481.77	30.3730	173.1755	10634083.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	171.8782	426811.8	79.2921	28.8759	113.2682

1	110.0000	606016.3	1826471.4	102548.6	65886.6
2	4475.85	3426.78	21012338.0	20909848.0	.0058
3	102445.4	6404206.2	248823.6	3288166.7	-80.3663
4	-141.1	31438.0	-743.1	-18120712.0	28.5789
5	66119.2	59590.2	114222.4	9904398.6	28.4175
6	2309.03	694.12	3571.17	4381.07	96.33
7	-.99	122.92	-23.37	-76.66	-.03
8	2532.04	1168.01	2954.04	-1510.15	-.04
9	818.4	1826471.5	-11952.0	30.0	31.2
10	-576.5	-780.9	204.4	26856.8	19717.5
11	-808.3	-111.4	-697.2	-39318.8	5245.6
12	-48.150	-.387	3424.96	588773.04	96.7386
13	-.058	-.001	2.47	48857781.00	.0580
14	-.001	-.000	72.000	48857781.00	.0011
15	48.589	.374	.1452	.001	877.3
16	.000	.000	-.1393	-.387	.5
17	.000	.000	.0408	-.001	.1
18	42.4931	.0796	31.1429	-.067	1005.26
19	71.9313	95.1743	78.1952	-.014	96.3
20	2.05	-6222.211	-.02	-.01	2.47
21	-38.70	-.052	.0000	18398.71	726.51
22	171.69	3.407	21.13	-23.924	1215.19
23	.000	.000	.000	.000	460291.4
24	232683.9	345937.17	.9782	179.2246	1844.65
25	21098601.0	3815.14	30.5820	172.6269	10665642.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	184.9558	528304.2	78.9886	28.9572	114.3850

TABLE AP 3-1 (Sheet 10 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	115.0000	575010.8	1823611.0	114560.4	79358.7
2	4879.19	3816.26	21024337.0	20909848.0	.0066
3	114410.0	6407801.1	267057.1	3310788.9	-80.3264
4	-144.7	32051.6	-827.4	-18121395.0	28.5904
5	79692.5	65710.6	129960.6	9896157.0	28.4290
6	2477.23	743.93	3736.40	4672.93	101.77
7	-.45	122.52	-25.63	-172.76	-.04
8	2902.96	1281.80	3326.24	-1777.39	-.13
9	8354.9	1823611.0	-4726.4	97.2	85.6
10	-733.9	-863.7	129.8	74700.9	47276.7
11	-2288.2	-409.4	-1879.0	-47340.0	3051.2
12	-50.437	-.465	3813.28	544965.35	101.3914
13	-.064	-.001	3.94	46878893.00	.0644
14	-.003	.000	72.000	46878893.00	.0032
15	50.955	.458	.5333	.000	906.5
16	.000	.000	-.5321	-.465	.5
17	.000	.000	.0368	-.001	.1
18	40.6431	.1041	30.6272	-.073	1023.83
19	71.9728	95.7402	77.6761	-.033	101.8
20	2.11	-6201.086	-.04	-.02	3.94
21	-38.65	-.052	.0000	11188.39	1883.52
22	122.05	3.725	12.57	-64.940	1208.20
23	.000	.000	.000	.000	553538.7
24	280443.7	314756.98	.9738	179.0828	1854.20
25	21124439.0	4178.65	30.7795	172.0525	10702441.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	198.6919	647900.2	78.6303	29.0519	115.3869

1	120.0000	544005.4	1819090.2	127436.4	94742.1
2	5314.69	4238.00	21037200.0	20909848.0	.0076
3	127221.8	6411646.5	286114.8	3334904.8	-80.2808
4	-145.2	32663.1	-919.4	-18122598.0	28.6035
5	95207.3	72427.0	147653.0	9886502.5	28.4420
6	2647.93	794.33	3903.71	4980.00	107.68
7	.25	122.09	-28.07	-282.04	-.05
8	3308.95	1406.51	3733.59	-2073.53	-.17
9	14734.0	1819090.2	1593.2	130.2	115.2
10	-832.6	-918.4	85.8	86890.6	53838.5
11	-2886.7	-476.0	-2410.8	-54036.5	1992.0
12	-52.720	-.448	4234.94	501157.70	105.9347
13	-.068	-.001	3.94	44900005.00	.0684
14	-.004	-.000	72.000	44900005.00	.0043
15	53.215	.445	.9858	.001	935.7
16	.000	.000	-.9852	-.448	.6
17	.000	.000	.0351	-.001	.1
18	38.8776	.1300	30.0333	-.076	1044.77
19	72.0159	96.3175	77.2092	-.037	107.7
20	2.12	-6201.086	-.04	-.03	3.94
21	-38.60	-.052	.0000	4892.46	2412.31
22	84.62	4.053	7.36	-83.374	1203.74
23	.000	.000	.000	.000	665592.6
24	338116.0	286276.48	.9685	178.9179	1865.38
25	21152684.0	4576.00	30.9652	171.4566	10745400.0
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	213.0175	788241.3	78.2089	29.1615	116.2886

1	125.0000	513161.7	1814072.7	141195.0	112210.5
2	5784.50	4694.33	21050943.0	20909848.0	.0086
3	140893.4	6415745.3	306006.4	3360591.0	-80.2290
4	-142.7	33272.1	-1021.1	-18124390.0	28.6183
5	112843.9	79794.7	167480.4	9875285.8	28.4568
6	2820.95	845.22	4072.87	5302.81	114.11
7	.59	121.44	-31.24	-404.97	-.07
8	3752.19	1542.54	4178.28	-2400.72	-.18
9	19000.7	1814072.6	5951.7	137.2	126.0
10	-1082.9	-1010.6	-72.3	74781.4	45943.3
11	-2912.4	-399.3	-2510.7	-66661.8	-1025.1
12	-54.997	-.416	4691.19	457667.01	110.3944
13	-.156	.009	3.94	42041585.00	.1559
14	-.005	.000	72.000	42041585.00	.0047
15	55.397	.428	1.5094	.001	975.0
16	.000	.000	-1.5087	-.416	.6
17	.000	.000	-.0435	.009	.1
18	37.1939	.1544	29.3790	-.082	1066.03
19	72.0526	96.9033	76.7851	-.032	114.1
20	2.12	-6168.770	-.05	-.03	3.94
21	-38.55	-.052	.0000	559.18	2511.78
22	57.64	4.401	4.25	-86.962	1194.80
23	.000	.000	.000	.000	799850.8
24	407621.0	260312.53	.9622	178.7262	1878.46
25	21183522.0	5009.03	31.1412	170.8362	10795571.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	228.0301	952342.0	77.7149	29.2878	117.1099

TABLE AP 3-1 (Sheet 11 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	130.0000	482317.9	1807687.1	155853.8	131948.4
2	6291.05	5187.81	21065585.0	20909848.0	.0097
3	155436.0	6420099.8	326739.4	3387927.6	-80.1705
4	-138.9	33877.4	-1135.6	-18126842.0	28.6350
5	132794.6	87872.4	189636.2	9862345.6	28.4734
6	2996.57	896.69	4244.11	5642.46	121.13
7	.95	120.68	-34.78	-542.64	-.07
8	4234.85	1690.63	4662.47	-2760.53	-.15
9	20905.9	1607687.1	8167.8	110.9	114.1
10	-1046.3	-1015.6	-30.7	39094.2	30388.8
11	-2259.3	-115.6	-2143.9	-68709.3	-1.0
12	-57.075	-.411	5184.61	414176.29	114.5735
13	-.149	-.001	3.94	39183164.00	.1494
14	-.004	.000	72.000	39183164.00	.0039
15	57.498	.410	1.9127	.001	1014.3
16	.000	.000	-1.9125	-.411	.6
17	.000	.000	-.0274	-.001	.1
18	35.5948	.1793	28.6839	-.083	1082.07
19	72.0911	97.4970	76.4059	-.014	121.1
20	2.06	-6168.746	-.05	-.03	3.94
21	-38.50	-.052	.0000	-1650.36	2144.13
22	38.94	4.791	2.42	-74.478	1184.77
23	.000	.000	.000	.000	960232.5
24	491232.2	236672.87	.9547	178.5032	1893.79
25	21217225.0	5479.57	31.3052	170.1863	10854228.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	243.8597	1143795.5	77.1371	29.4324	117.8497

TILT ARREST

1	134.5000	454782.3	1800288.3	169834.5	151813.3
2	6780.82	5666.25	21079548.0	20909848.0	.0108
3	169280.8	6424240.1	346127.3	3414013.1	-80.1116
4	-133.5	34418.9	-1250.6	-18129677.0	28.6518
5	152896.4	95800.9	211735.3	9849087.2	28.4901
6	3157.12	943.55	4400.23	5963.62	128.05
7	1.47	119.96	-38.14	-680.12	-.07
8	4705.21	1834.93	5134.30	-3114.03	-.12
9	22156.1	1800288.3	9641.1	89.3	103.2
10	-1042.7	-1024.9	-17.8	11774.6	17672.2
11	-1750.3	72.2	-1822.7	-72662.2	373.4
12	-58.887	-.396	5663.00	375156.27	118.2028
13	-.152	-.001	3.94	35464966.00	.1515
14	-.003	.000	72.000	35464966.00	.0033
15	59.315	.000	2.2841	.001	1062.5
16	.000	.000	-2.2839	-.396	.7
17	.000	.000	-.0223	-.001	.1
18	34.2271	.2044	28.0356	-.084	1076.19
19	72.1299	98.0407	76.1017	-.003	128.0
20	2.05	-6119.027	-.06	-.03	3.94
21	-38.45	-.052	.0000	-3121.05	1822.76
22	27.68	5.262	1.43	-63.216	1179.41
23	.000	.000	.000	.000	1130775.3
24	580841.6	217208.85	.9468	178.2711	1909.86
25	21250292.0	5937.05	31.4420	169.5706	10915566.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	258.9512	1343095.1	76.5336	29.5797	118.4500

1	135.0000	451722.8	1799343.4	171434.5	154150.2
2	6837.35	5721.54	21081147.0	20909848.0	.0110
3	170863.9	6424713.1	348324.4	3417001.2	-80.1046
4	-132.8	34478.0	-1264.1	-18130031.0	28.6537
5	155262.6	96722.5	214324.2	9847514.0	28.4921
6	3175.10	948.79	4417.69	6000.25	128.86
7	1.54	119.88	-38.53	-696.23	-.07
8	4759.70	1851.64	5188.95	-3155.15	-.18
9	23178.6	1799343.2	9788.1	138.0	101.7
10	-1043.9	-1027.1	-16.8	81563.9	16508.3
11	-2593.1	-808.1	-1785.2	-73598.8	402.2
12	-59.082	-.374	5718.28	370820.75	118.3979
13	-.152	-.001	3.94	35051835.00	.1518
14	-.003	-.001	72.000	35051835.00	.0034
15	59.315	.000	2.3226	.002	1067.8
16	.000	.000	-2.3225	-.374	.7
17	.000	.000	-.0219	-.001	.1
18	34.0790	.2073	27.9625	-.084	1074.34
19	72.1345	98.1015	76.0700	-.070	128.9
20	2.19	-6119.031	-.06	-.03	3.94
21	-38.44	-.052	.0000	-3268.13	1785.27
22	26.64	5.323	1.34	-61.867	1179.41
23	.000	.000	.000	.000	1151441.5
24	591749.7	215144.34	.9458	178.2432	1911.80
25	21254139.0	5989.97	31.4566	169.5001	10922944.2
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	260.6836	1366996.0	76.4611	29.5971	118.5132

TABLE AP 3-1 (Sheet 12 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	136.0000	445603.8	1797419.4	174663.7	158904.3
2	6951.70	5833.44	21084372.0	20909848.0	.0112
3	174057.0	6425667.3	352744.5	3423032.5	-80.0905
4	-131.2	34598.7	-1291.5	-18130705.0	28.6577
5	160077.3	98591.0	219584.8	9844304.8	28.4961
6	3211.17	959.29	4452.69	6074.12	130.50
7	1.70	119.71	-39.30	-728.99	-.08
8	4870.06	1885.49	5299.65	-3238.52	-.25
9	24448.1	1797418.4	10046.7	189.5	93.7
10	-1045.4	-1030.5	-15.0	162513.2	13540.2
11	-3450.4	-1828.5	-1622.1	-79805.0	455.2
12	-59.348	-.133	5830.17	362149.61	118.6639
13	-.152	-.001	3.94	34225567.00	.1525
14	-.006	-.002	72.000	34225567.00	.0057
15	59.315	.000	2.2777	.002	1078.5
16	.000	.000	-2.2776	-.133	.7
17	.000	.000	-.0210	-.001	.1
18	33.7852	.2133	27.8157	-.084	1070.29
19	72.1437	98.2235	76.0077	-.121	130.5
20	2.35	-6119.010	-.06	-.03	3.94
21	-38.43	-.051	.0000	-3534.48	1622.16
22	24.64	5.447	1.19	-56.123	1179.41
23	.000	.000	.000	.000	1193875.8
24	614181.3	211071.71	.9438	178.1862	1915.77
25	21261942.0	6097.11	31.4855	169.3579	10938061.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	264.1858	1415919.4	76.3126	29.6327	118.6375
1	137.0000	439484.7	1795476.5	177931.0	163767.0
2	7067.80	5947.17	21087635.0	20909848.0	.0115
3	177266.4	6426631.8	357199.4	3429137.9	-80.0761
4	-129.4	34718.3	-1319.4	-18131532.0	28.6618
5	165003.2	100493.7	224957.4	9841011.5	28.5002
6	3247.90	969.98	4488.34	6149.16	132.21
7	1.85	119.54	-40.09	-762.17	-.08
8	4981.97	1919.82	5411.91	-3323.02	-.12
9	23309.3	1795476.5	10411.2	87.9	78.3
10	-1047.8	-1034.2	-13.6	40876.3	13385.1
11	-1674.1	-334.8	-1339.4	-85044.1	473.1
12	-59.375	.045	5943.89	353478.49	118.6903
13	-.153	-.001	3.94	33390301.00	.1531
14	-.005	.002	72.000	33390301.00	.0051
15	59.315	.000	2.0019	-.002	1089.2
16	.000	.000	-2.0018	.045	.7
17	.000	.000	-.0203	-.001	.1
18	33.5004	.2194	27.6734	-.085	1065.79
19	72.1531	98.3442	75.9470	-.023	132.2
20	2.11	-6119.035	-.06	-.04	3.94
21	-38.42	-.051	.0000	-3917.07	1339.49
22	22.75	5.577	1.05	-45.549	1210.06
23	.000	.000	.000	.000	1237697.5
24	637393.7	207084.00	.9418	178.1272	1919.87
25	21269953.0	6205.65	31.5138	169.2122	10953673.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	267.7675	1466433.3	76.1592	29.6692	118.7590
1	138.0000	433365.7	1793361.6	181237.5	168739.5
2	7185.65	6062.78	21090937.0	20909848.0	.0118
3	180553.1	6427607.2	361690.1	3435318.8	-80.0613
4	-127.5	34837.8	-1348.0	-18132333.0	28.6660
5	170041.7	102430.8	230443.0	9837633.0	28.5044
6	3285.70	980.98	4525.03	6225.68	133.95
7	2.02	119.37	-40.88	-795.56	-.08
8	5095.24	1954.57	5525.54	-3408.39	-.05
9	22931.4	1793381.5	10825.0	25.9	62.6
10	-1051.5	-1038.0	-12.6	-22713.7	14606.1
11	-610.5	446.6	-1057.3	-86334.0	467.1
12	-59.322	.041	6059.49	344807.34	118.6377
13	-.154	-.001	3.94	32573032.00	.1537
14	-.003	.002	72.000	32573032.00	.0028
15	59.315	.000	1.6600	-.002	1099.9
16	.000	.000	-1.6598	.041	.7
17	.000	.000	-.0198	-.001	.1
18	33.2287	.2256	27.5390	-.085	1060.88
19	72.1626	98.4627	75.8881	.022	133.9
20	1.98	-6119.043	-.06	-.04	3.94
21	-38.41	-.051	.0000	-4347.60	1057.41
22	20.97	5.712	.92	-34.807	1266.92
23	.000	.000	.000	.000	1282864.3
24	661369.1	203185.87	.9397	178.0658	1924.11
25	21278226.0	6315.42	31.5416	169.0615	10969797.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	271.4583	1518671.8	76.0004	29.7068	118.8776

TABLE AP 3-1 (Sheet 13 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	139.0000	427246.7	1790691.7	184584.6	173823.1
2	7305.30	6180.30	21094280.0	20909848.0	.0120
3	183858.1	6428593.0	366217.4	3441576.7	-80.0462
4	-125.4	34957.0	-1377.2	-18133167.0	28.6703
5	175194.2	104402.0	236043.4	9834168.3	28.5086
6	3324.55	992.30	4562.75	6303.68	135.70
7	2.19	119.20	-41.68	-829.21	-.08
8	5209.94	1989.75	5640.61	-3494.69	-.04
9	23542.4	1790691.6	11283.6	24.4	51.6
10	-1055.9	-1043.9	-12.2	-5916.2	17815.2
11	-580.3	280.5	-861.0	-96696.6	424.7
12	-59.304	-.002	6176.99	336136.24	118.6198
13	-.154	-.001	3.94	31746766.00	.1544
14	-.002	.000	72.000	31746766.00	.0020
15	59.315	.000	1.3645	-.000	1110.7
16	.000	.000	-1.3644	-.002	.7
17	.000	.000	-.0193	-.001	.1
18	32.9691	.2320	27.4118	-.085	1055.57
19	72.1722	98.5790	75.8309	.009	135.7
20	2.00	-6119.035	-.06	-.04	3.94
21	-38.40	-.051	.0000	-4816.81	861.12
22	19.28	5.852	.80	-26.311	1360.50
23	.000	.000	.000	.000	1329425.0
24	686138.3	199373.47	.9375	178.0022	1928.50
25	21286767.0	6426.42	31.5688	168.9059	10986452.7
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	275.2560	1572685.7	75.8360	29.7453	118.9933

1	140.0000	421127.6	1787092.5	187973.3	179019.3
2	7426.72	6299.09	21097664.0	20909848.0	.0123
3	187202.5	6429591.9	370782.4	3447912.9	-80.0308
4	-123.1	35076.1	-1407.1	-18134036.0	28.6747
5	180462.0	106410.5	241759.8	9830616.5	28.5130
6	3364.33	1003.89	4601.37	6383.07	137.42
7	2.36	119.02	-42.49	-863.17	-.08
8	5326.11	2025.39	5757.16	-3581.90	-.05
9	24116.5	1787092.5	11656.0	27.6	41.7
10	-1060.5	-1048.8	-11.7	13912.5	19147.7
11	-627.1	60.2	-687.5	-87908.4	381.7
12	-59.312	-.000	6296.38	327465.09	118.6279
13	-.155	-.001	3.94	30920496.00	.1551
14	-.002	.000	72.000	30920496.00	.0020
15	59.315	.000	1.1053	.000	1121.4
16	.000	.000	-1.1051	-.009	.7
17	.000	.000	-.0188	-.001	.1
18	32.7199	.2364	27.2907	-.086	1049.89
19	72.1819	98.6936	75.7754	-.004	137.4
20	2.04	-6119.035	-.06	-.04	3.94
21	-38.38	-.051	.0000	-5196.82	687.58
22	17.69	5.997	.70	-19.552	1457.63
23	.000	.000	.000	.000	1377437.0
24	711736.8	195642.65	.9353	177.9361	1933.03
25	21295571.0	6536.74	31.5956	168.7457	11003654.2
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	279.1556	1626505.7	75.6661	29.7850	119.1063

INBOARD ENGINE CUTOFF

1	140.1100	420458.0	1786679.8	188348.5	179597.7
2	7440.19	6312.94	21098039.0	20909848.0	.0124
3	187572.8	6429702.4	371287.0	3448614.7	-80.0291
4	-122.8	35089.2	-1410.5	-18134134.0	28.6752
5	181048.6	106633.5	242395.9	9830220.3	28.5135
6	3368.76	1005.18	4605.68	6391.89	137.61
7	2.38	119.00	-42.58	-866.92	-.08
8	5338.97	2029.30	5770.07	-3591.65	-.05
9	24088.8	1786679.8	11621.0	26.9	40.5
10	-1060.9	-1049.3	-11.6	14336.9	18809.8
11	-616.1	51.2	-667.5	-88090.1	378.0
12	-59.313	-.000	6309.62	326503.30	118.6289
13	-.155	-.001	3.94	30810688.00	.1552
14	-.002	.000	72.000	30810688.00	.0020
15	59.315	.000	1.0775	-.000	1122.8
16	.000	.000	-1.0773	-.009	.7
17	.000	.000	-.0187	-.001	.1
18	32.6932	.2392	27.2777	-.086	1049.25
19	72.1830	98.7060	75.7693	-.004	137.6
20	2.04	-6119.035	-.07	-.04	3.94
21	-38.38	-.051	.0000	-5162.60	667.63
22	17.52	6.013	.69	-18.877	1462.09
23	.000	.000	.000	.000	1382807.5
24	714603.8	195237.23	.9351	177.9287	1933.54
25	21296556.0	6551.17	31.5985	168.7278	11005580.3
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	279.5917	1634758.6	75.6470	29.7894	119.1186

TABLE AP 3-1 (Sheet 14 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

1	141.0000	415901.1	919204.9	191398.0	184319.2
2	7510.54	6381.39	21101084.0	20909848.0	.0126
3	190560.9	6430599.8	375380.0	3454319.5	-80.0151
4	-120.6	35195.1	-1437.6	-18134937.0	28.6791
5	185836.7	108450.7	247583.7	9826983.5	28.5174
6	3384.53	1009.60	4620.70	6432.50	71.97
7	2.55	116.88	-43.20	-890.11	-.05
8	5409.91	2051.12	5841.17	-3647.28	-.04
9	17642.3	919204.0	11169.4	24.7	30.8
10	-647.9	-646.1	-1.8	14017.9	14733.5
11	-518.6	-4.6	-501.8	-54389.6	634.7
12	-59.320	-.007	6378.07	320157.04	118.6357
13	-.140	.043	3.94	29991758.00	.1403
14	-.002	.000	72.000	29991758.00	.0019
15	59.315	.000	.8607	-.000	1132.7
16	.000	.000	-.8607	-.007	.7
17	.000	.000	-.0030	.043	.1
18	32.4860	.2450	27.1516	-.057	1043.89
19	72.1920	96.7930	75.7393	-.007	72.0
20	1.06	-6099.030	-.07	-.04	3.94
21	-38.37	-.051	.0000	-4716.43	501.79
22	15.99	6.110	.61	-13.765	1487.77
23	.000	.000	.000	.000	1412684.8
24	730567.0	193023.20	.9337	177.8925	1936.36
25	21302030.0	6619.86	31.6144	168.6559	11016298.5
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	281.7246	1669568.3	75.5410	29.8139	119.1865

1	142.0000	412686.2	894978.6	194834.3	189682.3
2	7567.35	6436.01	21104515.0	20909848.0	.0129
3	193968.5	6431610.2	379985.5	3460758.4	-79.9991
4	-117.9	35313.0	-1468.3	-18135862.0	28.6837
5	191276.9	110511.2	253473.6	9823297.3	28.5219
6	3390.68	1011.07	4626.17	6460.41	70.61
7	2.83	118.78	-43.74	-912.07	-.02
8	5470.43	2069.71	5901.78	-3696.70	-.02
9	16948.6	894978.7	10672.5	16.4	20.7
10	-238.1	-259.5	21.4	6518.2	9758.4
11	-312.6	26.9	-329.8	-20817.1	1301.7
12	-59.324	.001	6432.69	315680.66	118.6393
13	-.097	.034	3.94	29414122.00	.0970
14	-.001	.001	72.000	29414122.00	.0012
15	59.315	.000	.6224	-.001	1139.8
16	.000	.000	-.6211	.001	.7
17	.000	.000	.0403	.034	.1
18	32.2614	.2522	26.9994	-.033	1037.64
19	72.2031	96.8836	75.7172	-.005	70.6
20	1.03	-6099.030	-.07	-.04	3.94
21	-38.36	-.051	.0000	-4223.75	330.52
22	14.31	6.190	.53	-8.888	1498.71
23	.000	.000	.000	.000	1438503.3
24	744379.7	191164.82	.9325	177.8656	1938.80
25	21306742.0	6678.60	31.6274	168.6172	11025560.8
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	283.3197	1699642.0	75.4492	29.8359	119.2405

1	143.0000	409650.6	869288.7	198277.8	195102.9
2	7622.35	6488.88	21107955.0	20909848.0	.0132
3	197361.8	6432621.0	384595.5	3467224.2	-79.9831
4	-115.0	35432.7	-1499.6	-18136809.0	28.6882
5	196776.9	112590.0	259423.7	9819561.8	28.5265
6	3395.89	1012.27	4630.72	6486.87	69.08
7	3.16	118.70	-44.22	-933.71	-.02
8	5529.32	2087.60	5960.76	-3744.99	-.01
9	10238.1	869288.8	10219.7	1.6	11.6
10	-276.5	-305.3	28.8	-4610.1	5231.6
11	-71.4	110.9	-181.1	-24840.3	1486.9
12	-59.320	.006	6485.54	311453.98	118.6350
13	-.077	.008	3.94	28869705.00	.0768
14	-.001	.000	72.000	28860705.00	.0007
15	59.315	.000	.3829	-.000	1146.5
16	.000	.000	-.3781	.006	..7
17	.000	.000	.0602	.008	.1
18	32.0414	.2598	26.8489	-.036	1031.18
19	72.2148	98.9720	75.6971	.001	69.1
20	1.96	-3072.000	-.07	-.04	3.94
21	-38.35	-.051	.0000	-3773.49	183.38
22	12.78	6.280	.46	-4.832	1499.88
23	.000	.000	.000	.000	1463867.6
24	757966.0	189386.16	.9313	177.8397	1941.20
25	21311355.0	6735.77	31.6398	168.5816	11034660.6
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	284.8566	1729203.0	75.3591	29.8556	119.2923

TABLE AP 3-1 (Sheet 15 of 15)
PREDICTED S-IB-205 STAGE POWERED FLIGHT TRAJECTORY

			OUTBOARD ENGINE CUTOFF		
1	143.1100	409321.1	786845.5	198657.3	195702.6
2	7627.97	6494.26	21108334.0	20909848.0	.0132
3	197735.4	6432733.3	385102.8	3467937.0	-79.9813
4	-114.6	35445.7	-1502.8	-18136915.0	28.6887
5	197365.5	112819.7	260081.9	9819147.9	28.5270
6	3396.24	1012.33	4631.00	6489.43	62.14
7	3.19	118.70	-44.28	-936.01	-.02
8	5535.43	2089.68	5966.87	-3750.04	-.01
9	9198.3	786845.6	3727.1	2.0	10.7
10	-273.7	-302.5	28.9	-3124.3	4854.4
11	-77.5	89.8	-166.4	-25059.0	1081.3
12	-59.319	.007	6490.92	310995.21	118.6343
13	-.076	.007	3.94	28800503.00	.0759
14	-.001	.000	72.000	28809503.00	.0006
15	59.315	.000	.3567	-.000	1147.2
16	.000	.000	-.3515	.007	.8
17	.000	.000	.0610	.007	.1
18	32.0174	.2606	26.8322	-.037	1030.45
19	72.2160	96.9826	75.6951	.002	62.1
20	1.78	-3072.000	-.07	-.04	3.94
21	-38.34	-.051	.0000	-3726.00	168.85
22	12.62	6.290	.45	-4.435	1500.01
23	.000	.000	.000	.000	1466511.3
24	759363.1	189203.37	.9312	177.8371	1941.45
25	21311835.0	6741.60	31.6411	168.5785	11035609.2
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	285.0094	1732279.0	75.3497	29.6578	119.2976
1	144.0000	407682.0	59726.9	201721.0	200567.6
2	7635.52	6499.73	21111393.0	20909848.0	.0135
3	200752.8	6433632.4	389202.0	3473704.4	-79.9668
4	-111.6	35551.3	-1531.0	-18137775.0	28.6928
5	202323.2	114683.0	265420.4	9815786.3	28.5310
6	3379.31	1006.92	4613.80	6479.97	4.98
7	3.45	118.65	-44.63	-947.50	.00
8	5552.18	2094.65	5983.50	-3768.78	-.00
9	3727.7	59727.0	3322.5	2.8	4.0
10	6.7	-20.7	27.4	347.0	1703.3
11	-44.9	14.8	-59.0	-825.3	1014.2
12	-59.314	.003	6496.38	310992.78	118.6296
13	-.072	.004	3.94	28809277.00	.0721
14	-.001	-.000	72.000	28809277.00	.0005
15	59.315	.000	.1534	.000	1147.2
16	.000	.000	-.1391	.003	.8
17	.000	.000	.0646	.004	.1
18	31.8264	.2660	26.6734	-.038	1024.66
19	72.2262	99.0480	75.6954	.003	5.0
20	.10	-4058.201	-.07	-.04	3.94
21	-38.33	-.051	.0000	-3322.28	65.02
22	11.25	6.341	.40	-1.565	1500.55
23	.000	.000	.000	.000	1473955.4
24	763374.1	168691.20	.9308	177.8406	1942.16
25	21313184.0	6758.35	31.6445	168.6260	11038278.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	284.8603	1740944.8	75.3232	29.8638	119.3121
			S-IB/S-IVB PHYSICAL SEPARATION		
1	144.4889	407516.1	44461.4	203396.4	203241.9
2	7630.76	6493.78	21113066.0	20909848.0	.0136
3	202402.0	6434123.0	391445.3	3476865.7	-79.9589
4	-109.9	35609.3	-1546.5	-18138252.0	28.6950
5	205037.9	115707.3	268355.4	9813935.4	28.5333
6	3365.37	1002.55	4599.77	6467.66	3.76
7	3.57	118.63	-44.81	-952.13	.00
8	5553.70	2095.33	5984.91	-3773.85	.00
9	3412.6	44481.4	3109.0	.1	.8
10	11.4	-15.0	26.4	-674.8	233.2
11	-.1	9.6	-9.0	-361.5	971.9
12	-59.313	.003	6490.44	310992.55	118.6281
13	-.070	.004	3.94	28800255.00	.0703
14	-.001	-.000	72.000	28800255.00	.0006
15	59.315	.000	.0642	.000	1147.2
16	.000	.000	-.0238	.003	.8
17	.000	.000	.0664	.004	.1
18	31.7217	.2703	26.5802	-.036	1021.29
19	72.2317	99.0827	75.6994	.003	3.8
20	.07	-4058.261	-.07	-.04	3.94
21	-38.33	-.051	.0000	-3108.93	25.11
22	10.52	6.355	.37	-.237	1500.69
23	.000	.000	.000	.000	1474754.6
24	763802.6	188636.53	.9308	177.8482	1942.23
25	21313328.0	6760.14	31.6448	168.6692	11038564.9
26	.000	.000	.000	.0000	.0000
27	.00	.00	.00	.00	.00
28	284.4533	1741896.0	75.3203	29.8644	119.3134

TABLE AP 3-2 (Sheet 1 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

CONSTANT VALUE FOR THE ENTIRE ANALYSIS

.805611+02	.285220+02	.720000+02	.100000+01	.321740+02
.140765+17	.209257+08	.208556+08	.729211-04	
.162345-02	.230000-05	.787500-05	.000000	
.805611+02	.806530+02	.806435+02	.782994+02	.646538+02
.285220+02	.284637+02	.285424+02	.266285+02	.323481+02
.000000	.000000	.000000	.000000	.180000+02

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) GRP	DTHETA(M)GRP	F AUX SB X	I SB XX	EPS(THETA)
13	PSI(M) GRP	D-PSI(M)GRP	F AUX SB Y	I SB YY	EPS(PSI)
14	PHI(M) GRP	D-PHI(M)GRP	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	Y(V,T)	DELTA-D-X(V)	SMCY	DELTA-D-Z(V)	TAU(3)
25	DELTA-T(3)	DELTA-D-Y(V)	T(3)	THETA(T)	PHI(T)
26	T(2)	DELTA-T(CO)	V(T)	TAU(2)	CHI(P)-TILDE
27	SAF(1)			V SB W	E SB W
28	THETA SB C	D-THETA SB C	X SB CG		
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
34	AVG FL HMR	AVG ISP HMR	AVG WDT HMR	AVG FL RMR	AVG ISP RMR
35	AVG WDT RMR	W(LOX)RES	W(LH2)RES	D-W(LOX)	D-W(LH2)

1	145.0000	305741.160	.000	205162.010	206050.120
2	7624.5390	6486.3291	21114831.00	20909669.00	.5646
3	204140.380	6434676.300	201265.740	.021	291362.490
4	-108.292	35669.892	61097.298	.000	71.9703
5	207889.300	116762.123	401316.180	.035	44.4784
6	3350.2442	997.8214	3273.6924	.0822	1.0203
7	3.7052	118.6062	389.1280	.0000	.0012
8	5554.1261	2095.4887	6874.9630	.1382	-.0021
9	9781.352	.000	-424.436	-1.586	-1.586
10	11.820	-.000	11.821	432.660	432.648
11	-19.854	.000	-19.855	291.505	291.487
12	-59.3125	.0007	10205.7883	100339.280	.0025
13	-.0700	.0011	.0000	8205392.600	.0700
14	-.0000	.0000	.0000	8207571.200	.0000
15	-59.3100	.0000	.0000	.0000	-.0007
16	.0000	.0000	.0000	.0007	-.0011
17	.0000	-.0000	.0000	.0011	-.0000
18	31.6619	26.5225	26.4829	.0328	.0057
19	72.3315	75.7816	75.7042	.0011	-.0016
20	228.2459	.0000	-44.7140	.0000	.000
21	9.8249	6.3729	.3456	431.0738	690.000
22	79.9505	28.6958	28.5356	-31.5890	-.0423
23	.1307	.1126	-.0670	-424.4362	6486.329
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.2887			.0000	.0000
28	-59.3100	.0000	423.9693		
29	.0000	.0000	-.8320		
30	.0000	.0000	-.2125		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193273.0000	39647.0000	.000	.000

FLOATING POINT DIVIDE BY ZERO AT LOCATION 056670

S-IB/S-IVB PHYSICAL SEPARATION

1	144.4890	305764.000	.000	203418.670	203254.750
2	7631.2288	6494.2639	21113089.00	20909671.00	.5569
3	202424.380	6434105.200	199588.840	.000	288136.150
4	-110.188	35609.279	60898.437	.000	71.9694
5	205051.200	115711.345	397803.140	.000	44.6303
6	3365.7216	1002.6585	3289.5621	.0000	1.0472
7	3.5729	118.6272	389.1967	.0000	.0013
8	5554.0407	2095.4410	6874.8064	.0000	.0001
9	9904.926	.000	-455.074	-.136	-.136
10	12.589	-.000	12.589	-35.871	-35.871
11	1.255	.000	1.255	310.648	310.648
12	-59.3126	.0000	10360.0000	100432.214	.0026
13	-.0703	.0000	.0000	8205633.200	.0703
14	-.0006	-.0000	.0000	8207811.600	.0000
15	-59.3100	.0000	.0000	.0588	-.0000
16	.0000	.0000	.0000	.0000	-.0000
17	.0000	-.0000	.0000	.0000	-.0000
18	31.7715	26.6210	26.5815	.0000	.0000
19	72.3262	75.7770	75.6992	.0000	.0000
20	231.6948	.0000	-44.7140	.0000	.000
21	10.5341	6.3593	.3721	433.9823	690.000
22	79.9588	28.6935	28.5333	-31.5943	-.0423
23	.0667	-.0067	-.0668	-455.0740	6494.264
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.1920			.0000	.0000
28	-59.3100	.0000	423.9542		
29	.0000	.0000	-.8320		
30	.0000	.0000	-.2125		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193273.0000	39647.0000	.000	.000

S-IVB ENGINE START COMMAND

1	145.8100	305704.900	300.000	207910.810	210480.440
2	7613.9778	6473.7982	21117575.00	20909665.00	.5767
3	206844.250	6435481.500	203907.240	.140	296469.380
4	-105.148	35765.949	61412.445	-.000	71.9718
5	212388.170	118479.492	406884.980	.235	44.2421
6	3325.7122	990.1546	3248.5388	.2119	1.0525
7	3.9154	118.5729	389.0187	-.0000	.0011
8	5554.2494	2095.5597	6875.1960	.3551	-.0051
9	10000.058	300.000	-379.942	-3.525	-3.527
10	10.671	-.169	10.842	1064.648	1059.502
11	-48.106	-.010	-48.099	250.479	266.681
12	-59.3104	.0050	10080.0000	100192.028	.0004
13	-.0685	.0026	.0000	8205011.700	.0685
14	-.0000	.0000	.0000	8207190.400	.0000
15	-59.3100	.0000	.0000	-.0000	-.0050
16	.0000	.0000	.0000	.0050	-.0026
17	.0000	-.0000	.0000	.0026	-.0000
18	31.4875	26.3656	26.3262	.0322	-.0032
19	72.3400	75.7889	75.7120	-.0019	-.0084
20	217.5462	.0000	-47.7140	.0000	.000
21	8.7949	6.3949	.3072	426.4683	690.000
22	79.9374	28.6995	28.5393	-31.5808	-.0423
23	.3115	.3040	-.0685	-379.9417	6473.798
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.4396			.0000	.0000
28	-59.3100	.0000	423.9931		
29	.0000	.0000	-.8321		
30	.0000	.0000	-.2126		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193273.0000	39646.9960	.000	-3.000

1	144.9880	305741.700	.000	205121.440	205984.470
2	7624.6960	6486.5153	21114790.00	20909669.00	.5644
3	204100.260	6434664.400	201226.470	.020	291286.710
4	-108.292	35668.468	61092.628	.000	71.9703
5	207822.650	116756.977	401233.690	.034	44.4819
6	3350.6076	997.9350	3274.0650	.0803	1.0296
7	3.7021	118.6067	389.1296	.0000	.0012
8	5554.1243	2095.4876	6874.9595	.1350	-.0020
9	9784.283	.000	-425.128	-1.558	-1.558
10	11.868	-.000	11.868	423.471	423.458
11	-19.440	.000	-19.441	292.605	292.587
12	-59.3125	.0007	10209.4100	100341.463	.0025
13	-.0700	.0010	.0000	8205398.300	.0700
14	-.0000	.0000	.0000	8207576.900	.0000
15	-59.3100	.0000	.0000	.0000	-.0007
16	.0000	.0000	.0000	.0007	-.0010
17	.0000	-.0000	.0000	.0010	-.0000
18	31.6645	26.5246	26.4852	.0327	.0096
19	72.3314	75.7815	75.7041	.0011	-.0006
20	228.3269	.0000	-44.7140	.0000	.000
21	9.8409	6.3726	.3462	431.1416	690.000
22	79.9507	28.6958	28.5356	-31.5892	-.0423
23	.1286	.1098	-.0670	-425.1275	6486.515
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.2864			.0000	.0000
28	-59.3100	.0000	423.9689		
29	.0000	.0000	-.8320		
30	.0000	.0000	-.2125		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193273.0000	39647.0000	.000	.000

1	146.0000	305695.890	300.000	208552.390	211519.560
2	7611.5155	6470.6745	21118216.00	20909664.00	.5796
3	207475.390	6435669.400	204523.910	.183	297665.960
4	-104.497	35788.476	61486.356	-.000	71.9721
5	213443.500	118877.649	408191.270	.308	44.1874
6	3319.9620	988.3575	3242.6428	.2433	1.0537
7	3.9648	118.5651	388.9930	-.0000	.0011
8	5554.2826	2095.5775	6875.2544	.4074	-.0057
9	10011.730	300.000	-370.190	-3.923	-3.925
10	10.477	-.166	10.645	1193.077	1188.104
11	-53.906	-.017	-53.894	245.374	261.638
12	-59.3093	.0065	10081.9200	100158.492	-.0007
13	-.0679	.0030	.0000	8204928.600	.0679
14	.0000	.0000	.0000	8207107.000	.0000
15	-59.3100	.0000	.0000	-.0000	-.0065
16	.0000	.0000	.0000	.0065	-.0030
17	.0000	-.0000	.0000	.0030	-.0000
18	31.4465	26.3288	26.2894	.0317	-.0024
19	72.3420	75.7906	75.7139	-.0033	-.0067
20	217.5865	.0000	-47.7140	.0000	.000
21	8.5692	6.4001	.2989	425.3911	690.000
22	79.9343	28.7004	28.5402	-31.5789	-.0423
23	.3562	.3495	-.0690	-370.1898	6470.875
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.4746			.0000	.0000
28	-59.3100	.0000	423.9977		
29	.0000	.0000	-.8320		
30	.0000	.0000	-.2124		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193273.0000	39646.4260	.000	-3.000

TABLE AP 3-2 (Sheet 2 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	147.0000	305647.490	.000	211913.980	216987.680
2	7598.6174	6455.5524	21121573.00	20909660.00	.5946
3	210780.230	6436653.100	207751.020	.510	303956.000
4	-100.398	35907.020	61875.278	-.000	71.9739
5	218997.850	120973.267	415066.660	.853	43.9043
6	3289.7065	978.9017	3211.6197	.4094	1.0384
7	4.2257	118.5237	388.8574	-.0001	.0010
8	5554.4550	2095.6697	6875.5566	.6829	-.0084
9	9864.201	.000	-322.719	-5.726	-5.726
10	9.788	-.000	9.791	1769.790	1769.428
11	-80.081	.000	-80.094	239.476	239.377
12	-59.2980	.0170	10186.9200	99983.505	-.0120
13	-.0641	.0046	.0000	8204212.300	.0641
14	.0000	.0000	.0000	8206389.400	.0000
15	-59.3100	.0000	.0000	-.0000	-.0170
16	.0000	.0000	.0000	.0170	-.0046
17	.0000	-.0000	.0000	.0046	-.0000
18	31.2302	26.1347	26.0953	.0288	-.0030
19	72.3525	75.7996	75.7235	-.0148	-.0139
20	188.4955	.0000	-54.0433	.0000	.000
21	7.4704	6.4277	.2583	419.7426	690.000
22	79.9180	28.7049	28.5498	-31.5688	-.0423
23	.6001	.5957	-.0728	-322.7192	6455.552
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.6562			.0000	.0000
28	-59.3100	.0000	424.0446		
29	.0000	.0000	-.8320		
30	.0000	.0000	-.2119		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193273.0000	39642.7060	.000	-9.329

1	148.0000	305522.020	66793.234	215247.070	222454.790
2	7587.4952	6442.0243	21124901.00	20909655.00	.6096
3	214055.080	6437627.400	210947.290	1.048	310232.770
4	-95.990	36025.523	62264.065	-.000	71.9757
5	224552.640	123069.061	421942.630	1.749	43.6287
6	3260.3397	969.7126	3181.4719	.8118	8.0768
7	4.4904	118.4815	388.7187	-.0008	-.0024
8	5556.0636	2096.2003	6877.2975	1.3541	-.0148
9	76696.528	66793.213	-281.324	-9.361	-7.123
10	-22.519	-31.541	9.021	2312.912	2214.998
11	-140.381	-40.245	-100.222	-3569.191	219.374
12	-59.2742	.0313	10184.6392	99804.629	-.0358
13	-.0599	-.0002	.0000	8202471.100	.0599
14	-.0000	.0000	.0000	8204647.200	.0000
15	-59.3100	.0000	.0000	-.0000	-.0313
16	.0000	.0000	.0000	.0313	.0002
17	.0000	-.0000	.0000	-.0002	-.0000
18	31.0131	25.9413	25.9020	.0271	.0038
19	72.3631	75.6079	75.7325	-.0345	-.0244
20	414.1434	.0000	-185.8725	.0000	.000
21	6.5121	6.4574	.2231	414.1494	690.000
22	79.9018	28.7095	28.5493	-31.5589	-.0423
23	.8585	.8550	-.0770	-281.3241	6442.024
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	109.8338			.0000	.0000
28	-59.3100	.0000	424.1921		
29	.0000	.0000	-.8337		
30	.0000	.0000	-.2125		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193230.0000	39504.9380	-97.116	-44.043

1	149.0000	305225.630	178002.510	218554.790	227926.900
2	7568.7613	6440.9798	21128204.00	20909650.00	.6246
3	217303.400	6438593.200	214116.360	2.665	316502.910
4	-91.391	36143.979	62652.703	-.004	71.9774
5	230113.960	125166.892	428825.270	4.788	43.3597
6	3237.4244	962.4595	3157.6755	3.1308	19.1688
7	4.7691	118.4315	388.5548	-.0089	-.0100
8	5568.2386	2099.9683	6889.6598	5.2386	-.0323
9	181848.790	178002.310	-246.002	-18.170	-8.142
10	-179.995	-185.990	5.732	542.473	2553.521
11	-306.813	-191.519	-115.536	-7223.977	144.022
12	-59.2361	.0425	4092.4750	99751.002	-.0739
13	-.0809	-.0462	.0000	8201053.100	.0809
14	-.0000	.0000	.0000	8203228.600	.0000
15	-59.3100	.0000	.0000	-.0001	-.0425
16	.0000	.0000	.0000	.0425	.0462
17	.0000	-.0000	.0000	-.0462	-.0000
18	30.7975	25.7577	25.7163	.0599	.0542
19	72.3737	75.6110	75.7361	-.0616	-.0262
20	469.6588	.0000	-387.7172	.0000	.000
21	5.6945	6.4999	.1925	408.6241	690.000
22	79.8855	28.7141	28.5539	-31.5490	-.0422
23	1.1286	1.1272	-.0559	-246.0016	6440.980
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	110.0075			.0000	.0000
28	-59.3100	.0000	424.3274		
29	.0000	.0000	-.8351		
30	.0000	.0000	-.2129		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	193011.4200	39554.6820	-328.726	-58.941

S-IVB NINETY PERCENT THRUST

1	149.4100	305056.200	188737.560	219905.030	230174.180
2	7591.2011	6442.4913	21129553.00	20909648.00	.6307
3	218628.900	6438987.300	215409.200	4.406	319074.380
4	-89.469	36192.531	62811.993	-.009	71.9781
5	232398.290	126028.292	431651.380	7.366	43.2511
6	3229.0317	959.7864	3148.9055	4.3954	20.1386
7	4.8782	118.4074	388.4759	-.0158	-.0289
8	5574.8566	2102.0113	6896.3625	7.3538	-.0375
9	190942.700	188737.210	-232.908	-19.919	-8.439
10	-273.595	-277.208	3.206	-348.171	2660.048
11	-355.640	-235.548	-120.361	-5573.931	87.190
12	-59.2186	.0427	2438.3935	99750.550	-.0914
13	-.1038	-.0647	.0000	8200520.100	.1038
14	-.0000	.0000	.0000	8202695.400	.0000
15	-59.3100	.0000	.0000	-.0001	-.0427
16	.0000	.0000	.0000	.0427	.0647
17	.0000	-.0000	.0000	-.0647	-.0000
18	30.7095	25.6841	25.6447	.0842	.0786
19	72.3780	75.8114	75.7368	-.0715	-.0277
20	445.7975	.0000	-428.8395	.0000	.000
21	5.3914	6.5193	.1812	406.3795	690.000
22	79.8789	28.7159	28.5558	-31.5450	-.0422
23	1.2407	1.2403	-.0330	-232.9076	6442.401
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	110.0778			.0000	.0000
28	-59.3100	.0000	424.3802		
29	.0000	.0000	-.8357		
30	.0000	.0000	-.2131		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	192867.3300	39529.3390	-364.115	-64.640

1	150.0000	304794.010	197408.140	221843.170	233412.420
2	7595.2016	6445.1665	21131488.00	20909645.00	.6396
3	220530.660	6439552.400	217263.390	7.555	322776.440
4	-86.476	36262.380	63041.156	-.023	71.9791
5	235690.340	127269.372	435723.170	12.633	43.0966
6	3217.2085	956.0158	3136.5349	6.2927	20.9762
7	5.0221	118.3682	388.3471	-.0303	-.0434
8	5584.7754	2105.0721	6906.4046	10.5231	-.0932
9	198713.870	197407.510	-215.236	-21.221	-8.746
10	-411.511	-411.113	-.943	-1379.063	2778.036
11	-409.269	-283.816	-125.713	-2665.405	-5.871
12	-59.1943	.0390	1521.5982	99749.901	-.1157
13	-.1475	-.0816	.0000	8199753.000	.1475
14	-.0000	.0000	.0000	8201928.100	.0000
15	-59.3100	.0000	.0000	-.0001	-.0390
16	.0000	.0000	.0000	.0390	.0816
17	.0000	-.0000	.0000	-.0816	-.0000
18	30.5832	25.5787	25.5394	.1193	.0588
19	72.3840	75.8117	75.7374	-.0824	-.0157
20	437.0324	439.3511	-455.1816	-444.4112	195223.570
21	4.9823	6.5480	.1660	403.1713	690.000
22	79.8692	28.7186	28.5585	-31.5392	-.0422
23	1.4018	1.4018	.0105	-215.2361	6445.167
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	110.1780			.0000	.0000
28	-59.3100	.0000	424.4562		
29	.0000	.0000	-.8365		
30	.0000	.0000	-.2133		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	192646.2200	39488.2720	-381.359	-73.788

1	155.0000	302277.680	227314.090	238020.830	261083.990
2	7641.8007	6481.0292	21147642.00	20909622.00	.7184
3	236377.480	6444256.000	232695.000	82.546	354242.410
4	-59.354	36853.030	64978.988	-.832	71.9872
5	263841.570	137864.830	470485.170	137.796	41.8571
6	3123.4244	925.9739	3037.9723	24.2559	24.1833
7	5.7422	117.8596	386.6784	-.3274	-.0704
8	5678.7260	2134.0288	7001.4070	40.4665	-.0377
9	227204.170	227313.030	-108.869	-13.036	-8.048
10	-661.264	-651.554	-9.567	225.707	2580.320
11	-354.485	-237.386	-116.977	1478.435	-203.547
12	-59.1678	-.0156	.0000	99744.391	-.1422
13	-.3542	.0183	.0000	8193252.500	.3542
14	-.0000	.0000	.0000	8195425.000	.0000
15	-59.3100	.0000	.0000	.0001	.0156
16	.0000	.0000	.0000	-.0156	-.0183
17	.0000	-.0000	.0000	.0183	-.0000
18	29.5259	24.7055	24.6661	.1642	-.0177
19	72.4300	75.8057	75.7343	-.0598	.0077
20	427.3908	431.2671	-531.8622	-497.0703	214231.680
21	2.5201	6.8069	.0777	377.2401	690.000
22	79.7870	28.7416	28.5815	-31.4909	-.0421
23	2.5874	2.5788	.2111	-108.8685	6481.029
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	110.9860			.0000	.0000
28	-59.3100	.0000	425.1000		
29	.0000	.0000	-.8433		
30	.0000	.0000	-.2154		
31					
32					
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	190530.9600	39087.1540	-449.779	-82.084

PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

ULLAGE ROCKET JETTISON

1	156.4100	301313.680	227242.750	242508.250	268967.770
2	7657.2137	6493.4044	21152122.00	20909615.00	.7370
3	240763.490	6445555.600	236959.580	120.513	363153.450
4	-51.141	37019.105	65523.851	-1.358	71.9894
5	271868.300	140879.880	480377.080	201.145	41.5275
6	3097.9540	917.7905	3011.1238	29.5997	24.2551
7	5.9430	117.7095	386.1860	-.4173	-.0620
8	5706.7457	2142.0577	7029.7169	49.3930	-.0340
9	227152.560	227241.920	-89.367	-11.998	-7.440
10	-580.611	-573.792	-6.651	723.227	2363.625
11	-318.881	-211.522	-107.279	-588.828	-140.358
12	-59.1865	-.0102	.0000	98825.508	-.1235
13	-.3237	.0215	.0000	8189010.000	.3237
14	.0000	.0000	.0000	8191181.600	.0000
15	-59.3100	.0000	.0000	.0001	.0102
16	.0000	.0000	.0000	-.0102	-.0215
17	.0000	-.0000	.0000	.0215	-.0000
18	29.2313	24.4636	24.4243	.1447	-.0115
19	72.4430	75.8035	75.7330	-.0533	.0024
20	427.1010	430.4576	-532.0566	-504.0937	216857.900
21	2.0687	6.8831	.0624	370.3428	690.000
22	79.7635	28.7481	28.5880	-31.4776	-.0421
23	2.8866	2.8811	.1788	-89.3670	6493.414
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	111.2016			.0000	.0000
28	-59.3100	.0000	425.4308		
29	.0000	.0000	-.8456		
30	.0000	.0000	-.2164		
31					
32					
33					
34	227249.2600	427.165	-531.9942	.0000	.000
35	.0000	169890.0800	38971.3950	-449.944	-82.112

1	165.0000	287747.900	227242.200	269152.980	317784.290
2	7757.3279	6576.4466	21178725.00	20909574.00	.8708
3	266713.720	6453227.000	262127.350	515.680	417830.040
4	6.165	38026.477	68828.878	-7.085	72.0012
5	321627.990	159512.680	541508.290	861.057	39.6674
6	2945.0578	868.5722	2849.6462	62.6646	25.4057
7	7.4088	116.8247	383.2830	-.9283	-.0777
8	5880.1556	2196.0147	7204.7726	104.6932	-.0319
9	227215.450	227241.020	-25.575	-7.255	-3.740
10	-695.210	-693.459	-1.890	81.959	1265.334
11	-285.601	-234.575	-51.071	48.189	-44.954
12	-59.1968	.0064	.0000	98067.565	-.1132
13	-.3323	-.0196	.0000	5787846.000	.3323
14	-.0000	.0000	.0000	5790011.900	.0000
15	-59.3100	.0000	.0000	-.0000	-.0064
16	.0000	.0000	.0000	.0064	.0196
17	.0000	-.0000	.0000	-.0196	-.0000
18	27.4731	23.0232	22.9839	.1748	.0117
19	72.5255	75.7940	75.7281	-.0591	-.0048
20	425.2439	428.0972	-534.3781	-520.1156	222569.360
21	.5920	7.3826	.0155	330.2190	690.000
22	79.6183	28.7885	28.6285	-31.3984	-.0419
23	4.7959	4.7926	.1778	-25.5751	6576.447
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	266.3000	.0000	7780.6699	.000	.0000
27	112.4200			.0000	.0000
28	-59.3100	.0000	392.5691		
29	.0000	.0000	-.8877		
30	.0000	.0000	-.2395		
31					
32					
33					
34	227225.3900	426.239	-533.0951	.0000	.000
35	.0000	186022.0800	38265.2510	-452.075	-82.303

1	160.0000	299402.140	227218.320	253787.480	289204.290
2	7697.3748	6526.2391	21163385.00	20909598.00	.7925
3	251769.160	6448813.500	247647.170	251.280	385921.840
4	-28.736	37441.027	66908.110	-3.229	71.9945
5	292483.960	148611.570	505743.500	419.433	40.7215
6	3033.4204	897.0400	2943.0447	43.2644	24.4112
7	6.5553	117.3491	385.0037	-.6229	-.0623
8	5778.4180	2164.7204	7102.1011	72.2413	-.0323
9	227164.020	227217.490	-53.473	-10.793	-5.754
10	-579.465	-576.274	-3.219	-10.638	1803.584
11	-300.708	-218.708	-82.002	-522.425	-67.041
12	-59.1978	.0004	.0000	98821.548	-.1122
13	-.2935	-.0035	.0000	8184019.300	.2935
14	-.0000	.0000	.0000	8186188.900	.0000
15	-59.3100	.0000	.0000	-.0000	-.0004
16	.0000	.0000	.0000	.0004	.0035
17	.0000	-.0000	.0000	-.0035	-.0000
18	28.4886	23.8543	23.8149	.1453	.0046
19	72.4773	75.7993	75.7307	-.0552	-.0004
20	426.3268	429.1890	-532.9655	-513.7165	220369.740
21	1.2376	7.0816	.0353	353.4218	690.000
22	79.7033	28.7649	28.6048	-31.4440	-.0420
23	3.6833	3.6804	.1447	-53.4734	6526.239
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	266.3000	.0000	7780.6699	.000	.0000
27	111.7300			.0000	.0000
28	-59.3100	.0000	425.9250		
29	.0000	.0000	-.8506		
30	.0000	.0000	-.2179		
31					
32					
33					
34	227222.0200	426.780	-532.4103	.0000	.000
35	.0000	188279.9900	38676.4800	-450.776	-82.189

1	166.0000	287213.390	227254.600	272179.150	323556.940
2	7770.1476	6587.3854	21181747.00	20909569.00	.8866
3	269650.050	6454092.800	264967.810	580.333	424241.420
4	13.623	38143.244	69211.969	-8.048	72.0025
5	327518.550	161711.890	548723.540	969.075	39.4648
6	2927.7492	862.9845	2831.3140	66.6424	25.4547
7	7.5585	110.7099	382.9065	-.9988	-.0811
8	5901.0062	2202.4249	7225.8037	111.3451	-.0327
9	227231.290	227253.310	-22.018	-7.135	-3.376
10	-724.168	-722.497	-1.778	-306.429	1140.239
11	-291.669	-245.669	-46.035	735.033	-42.433
12	-59.1908	.0050	.0000	98066.453	-.1192
13	-.3503	-.0151	.0000	5786854.300	.3503
14	-.0000	-.0000	.0000	5789019.600	.0000
15	-59.3100	.0000	.0000	-.0000	-.0050
16	.0000	.0000	.0000	.0050	.0151
17	.0000	-.0000	.0000	-.0151	-.0000
18	27.2730	22.8600	22.8206	.1822	.0039
19	72.5350	75.7927	75.7274	-.0619	-.0012
20	425.0579	427.9188	-534.6408	-520.9844	222851.400
21	.5097	7.4493	.0131	325.4066	690.000
22	79.6011	28.7933	28.6332	-31.3895	-.0419
23	5.0216	5.0179	.1943	-22.0181	6587.385
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	112.5523			.0000	.0000
28	-59.3100	.0000	392.6595		
29	.0000	.0000	-.8892		
30	.0000	.0000	-.2399		
31					
32					
33					
34	227227.6400	426.131	-533.2358	.0000	.000
35	.0000	185570.0600	38182.9370	-452.317	-82.323

LAUNCH SYSTEM (LES) JETTISON

1	163.1100	288757.320	227231.850	263391.250	306926.130
2	7733.4263	6556.1583	21172974.00	20909583.00	.8410
3	261116.570	6451575.400	256708.730	404.331	405740.690
4	-7.541	37805.485	68103.838	-5.448	71.9987
5	310551.760	155373.660	527928.850	675.043	40.0574
6	2977.8840	879.1638	2884.3958	55.1718	25.3148
7	7.0973	117.0301	383.9571	-.8061	-.0680
8	5840.8363	2183.9238	7105.1044	92.1577	-.0299
9	227197.060	227230.940	-33.878	-7.978	-4.357
10	-610.292	-608.116	-2.200	-117.061	1355.134
11	-268.465	-206.734	-61.711	302.422	-45.917
12	-59.2007	-.0025	.0000	98818.112	-.1093
13	-.3084	-.0030	.0000	8179561.400	.3084
14	.0000	-.0000	.0000	8181729.400	.0000
15	-59.3100	.0000	.0000	.0000	.0025
16	.0000	.0000	.0000	-.0025	.0030
17	.0000	-.0000	.0000	-.0030	-.0000
18	27.8538	23.3341	23.2947	.1533	.0002
19	72.5074	75.7963	75.7294	-.0521	.0024
20	425.6530	428.4627	-533.8408	-518.1855	221925.730
21	.7842	7.2630	.0212	339.0807	690.000
22	79.6506	28.7796	28.6195	-31.4155	-.0419
23	4.3745	4.3717	.1562	-33.8781	6556.158
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	112.1650			.0000	.0000
28	-59.3100	.0000	426.3662		
29	.0000	.0000	-.8550		
30	.0000	.0000	-.2192		
31					
32					
33					
34	227222.9200	426.043	-532.8332	.0000	.000
35	.0000	186876.8300	38420.7630	-451.581	-82.260

1	167.0000	286678.730	227252.950	275189.950	329348.840
2	7783.0666	6598.4645	21184753.00	20909564.00	.9025
3	272569.190	6454953.000	267789.950	648.968	430663.120
4	21.274	38259.893	69594.678	-9.083	72.0038
5	333429.950	163917.500	555959.830	1083.752	39.2648
6	2910.4803	857.4077	2813.0174	70.6283	25.5024
7	7.7023	116.5923	382.5207	-1.0719	-.0816
8	5921.8896	2208.0443	7246.8648	118.0093	-.0319
9	227232.980	227251.660	-16.675	-6.553	-2.995
10	-727.034	-725.501	-1.584	-383.594	1009.517
11	-284.502	-243.742	-40.769	790.900	-37.839
12	-59.1876	.0013	.0000	98065.341	-.1274
13	-.3615	-.0072	.0000	5785862.500	.3615
14	-.0000	-.0000	.0000	5788027.300	.0000
15	-59.3100	.0000	.0000	-.0000	-.0013
16	.0000	.0000	.0000	.0013	.0072
17	.0000	-.0000	.0000	-.0072	-.0000
18	27.0740	22.6975	22.6581	.1829	-.0014
19	72.5445	75.7915	75.7267	-.0615	.0016
20	425.0075	427.7547	-534.7004	-521.7624	223101.500
21	.4323	7.4646	.0111	325.1700	690.000
22	79.5839	28.7981	28.6380	-31.3805	-.0419
23	5.2435	5.2396	.2041	-18.6746	6598.464
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	112.6827			.0000	.0000
28	-59.3100	.0000	392.7498		
29	.0000	.0000	-.8908		
30	.0000	.0000	-.2404		
31					
32					
33					
34	227229.8500	426.032	-533.3640	.0000	.000
35	.0000	185118.3300	38100.6110	-452.372	-82.328

TABLE AP 3-2 (Sheet 4 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	168.0000	286144.020	227251.360	278185.370	335159.900
2	7796.1443	6609.6827	21187744.00	20909559.00	.9184
3	275470.930	6455807.600	270593.810	721.592	437095.260
4	28.988	38376.426	69977.002	-10.192	72.0050
5	339362.270	166129.560	563217.220	1205.098	39.0671
6	2893.2487	851.6410	2794.7540	74.6215	25.5502
7	7.8458	110.4736	382.1313	-1.1461	-.0805
8	5942.8072	2215.2732	7267.9567	124.6860	-.0304
9	227234.270	227250.110	-15.842	-5.719	-2.651
10	-716.082	-714.729	-1.357	-262.288	891.606
11	-270.242	-234.211	-36.018	511.184	-32.435
12	-59.1880	-.0019	.0000	98064.228	-.1220
13	-.3651	-.0006	.0000	5784870.800	.3651
14	.0000	-.0000	.0000	5787035.000	.0000
15	-59.3100	.0000	.0000	.0000	.0019
16	.0000	.0000	.0000	-.0019	.0006
17	.0000	-.0000	.0000	-.0006	-.0000
18	26.8758	22.5359	22.4965	.1802	-.0034
19	72.5539	75.7903	75.7260	-.0591	.0028
20	424.9571	427.0056	-534.7601	-522.4600	223324.790
21	.3667	7.4772	.0094	325.1700	690.000
22	79.5660	28.8029	28.6428	-31.3717	-.0418
23	5.4605	5.4567	.2063	-15.8418	6609.683
24	6600404.9000	.0000	.0000	.000	.0000
25	.0000	.0000	159.8000	.000	.0000
26	286.3000	.0000	7780.6699	.000	.0000
27	112.8115			.0000	.0000
28	-59.3100	.0000	392.8402		
29	.0000	.0000	-.8925		
30	.0000	.0000	-.2409		
31					
32					
33					
34	227231.5600	425.946	-533.4760	.0000	.000
35	.0000	184665.9300	38018.2800	-452.427	-82.333

1	169.0000	285609.250	227249.770	281165.990	340990.370
2	7809.3260	6621.0438	21190719.00	20909554.00	.9344
3	278355.750	6456656.600	273379.410	798.210	443538.080
4	37.009	38492.835	70398.921	-11.379	72.0062
5	345315.480	168348.040	570495.690	1333.129	38.8718
6	2876.0152	846.2724	2776.4844	78.6109	25.5973
7	7.9495	116.3417	381.6985	-1.2324	-.2029
8	5963.7818	2221.7164	7269.1023	131.3819	.0950
9	227227.520	227240.960	-13.451	98.982	-2.357
10	-1801.090	-1799.378	-1.000	26726.796	789.866
11	843.353	874.602	-31.917	26991.608	-23.757
12	-59.1669	.0942	.0000	98063.115	.7468
13	-.3397	.1006	.0000	5783879.000	1.2207
14	.0000	.0001	.0000	5786042.700	.0000
15	-58.4200	1.0000	.0000	-.0006	-.0942
16	.8900	1.0000	.0000	.0942	-.1006
17	.0000	.0000	.0000	.1006	-.0000
18	26.6783	22.3747	22.3353	.4537	.3785
19	72.5630	75.7869	75.7251	.2205	.3848
20	424.8925	427.4689	-534.8199	-523.0893	223525.000
21	.3114	7.4901	.0079	325.1700	690.000
22	79.5492	28.8077	28.6476	-31.3628	-.0418
23	5.6976	5.0948	.1790	-13.4509	6621.044
24	6600404.9000	5330.5357	.0000	12.276	326.5000
25	-2.4847	2591.0602	157.3153	.000	-1.7061
26	264.8000	446.1000	7780.6699	537.554	.4520
27	112.9386			.0000	.0000
28	-58.4200	.0000	392.9306		
29	.8900	.0000	-.8938		
30	.0000	.0000	-.2414		
31					
32					
33					
34	227232.7300	425.869	-533.5756	.0000	.000
35	.0000	184213.4700	37939.0450	-452.482	-82.338

1	170.0000	285074.430	227246.160	284130.920	346840.200
2	7822.6343	6632.5498	21193679.00	20909549.00	.9504
3	281222.430	6457500.000	276146.710	878.808	449991.330
4	44.874	38609.097	70740.359	-12.666	72.0074
5	351289.770	170572.970	577795.360	1467.870	38.6786
6	2858.7555	840.6945	2758.1841	82.5878	25.6441
7	7.9874	110.1885	381.1960	-1.3401	-.2720
8	5984.8283	2228.1843	7310.3160	138.1018	.1679
9	227216.940	227228.370	-11.432	159.272	-2.205
10	-2409.893	-2407.022	.458	42356.586	728.015
11	1487.795	1513.938	-29.427	41915.368	12.193
12	-58.9006	.4634	.0000	98062.001	1.4804
13	-.0666	.4699	.0000	5782850.200	1.9385
14	.0000	-.0003	.0000	5785013.400	.0000
15	-57.4200	1.0000	.0000	-.0005	-.4634
16	1.8719	.9537	.0000	.4634	-.4699
17	.0000	.0000	.0000	.4699	-.0000
18	26.4810	22.2138	22.1745	.6069	-.0025
19	72.5715	75.7869	75.7237	.3817	.0191
20	424.8256	427.3420	-534.8745	-523.6604	223705.120
21	.2646	7.5031	.0067	325.1700	600.000
22	79.5318	28.8125	28.6525	-31.3541	-.0418
23	6.1785	6.1778	-.0966	-11.4319	6632.550
24	6600404.9000	5326.4988	.0000	13.011	326.5000
25	.0364	2575.4472	157.3517	.000	-1.7034
26	283.3000	442.1153	7780.6699	537.554	.4504
27	113.0641			.0000	.0000
28	-57.4200	.0000	393.0261		
29	1.8719	.0000	-.8954		
30	.0000	.0000	-.2419		
31					
32					
33					
34	227232.8100	425.798	-533.6654	.0000	.000
35	.0000	183760.9600	37853.6050	-452.532	-82.342

1	175.0000	282399.670	227184.340	298737.420	376375.520
2	7889.7133	6691.0473	21208260.00	20909524.00	1.0313
3	295310.470	6461636.600	289718.120	1344.170	482421.850
4	95.591	39191.232	72650.252	-17.661	72.0145
5	381472.280	181793.320	614607.500	2241.079	37.7445
6	2778.2833	814.5670	2672.4640	104.1777	25.8824
7	14.1987	117.2557	384.6973	-.0622	.0755
8	6086.9578	2259.5841	7413.3339	170.8217	-.1004
9	227176.490	227161.450	-5.056	-86.307	-2.109
10	662.742	654.580	6.898	-17581.433	645.976
11	-960.418	-941.531	-26.151	-32972.066	170.812
12	-53.6891	1.0248	.0000	98056[illegible]25	.9754
13	3.2015	-.4780	.0000	577752[illegible]00	-.2142
14	.0000	.0041	.0000	5779689.[illegible]00	.0000
15	-52.7122	.0717	.0000	.0572	-1.0232
16	2.9874	.0043	.0000	1.0232	.1780
17	.0000	.0000	.0000	-.1780	-.0000
18	25.5630	21.4658	21.4265	-.1651	.3613
19	72.6716	75.8268	75.7658	-.2375	-.1039
20	424.6098	426.8303	-535.0358	-525.8674	224389.550
21	.1170	7.5038	.0030	330.8689	690.000
22	79.4438	28.8367	28.6767	-31.3109	-.0417
23	12.8374	12.4262	-3.3266	-5.0562	6691.047
24	6600404.9000	5300.9297	.0000	13.924	326.5000
25	-.2033	2551.9168	157.9758	.000	-1.7031
26	278.8000	438.4791	7780.6699	534.605	.4487
27	113.6685			.0000	.0000
28	-52.7122	.0000	393.5285		
29	2.9874	.0000	-.9033		
30	.0000	.0000	-.2443		
31					
32					
33					
34	227226.3700	425.518	-534.0015	.0000	.000
35	.0000	181497.9400	37441.8510	-452.676	-82.359

1	180.0000	279723.760	227188.400	313020.590	406364.110
2	7956.6227	6750.4474	21222518.00	20909499.00	1.1135
3	309022.790	6465650.900	302888.270	1925.653	515134.770
4	186.088	39781.406	74586.519	-13.465	72.0260
5	412149.320	193165.790	651918.750	3173.211	36.8618
6	2707.1694	791.2799	2596.0627	128.5523	26.1310
7	21.6744	118.7056	389.4541	1.6241	-.0840
8	6183.7938	2289.3834	7511.1005	202.0121	-.0042
9	227184.970	227187.220	-2.251	12.486	-1.075
10	-730.615	-732.231	2.416	4432.147	332.929
11	-36.891	-19.732	-13.501	770.649	59.762
12	-52.6167	-.5146	.0000	98050.848	-.5385
13	2.5969	.1123	.0000	5772161.700	.4615
14	-.0000	.0004	.0000	5774319.400	.0000
15	-53.1558	-.1396	.0000	-.0230	.5141
16	3.0184	.0088	.0000	-.5141	-.1123
17	.0000	.0000	.0000	.1123	-.0000
18	24.7545	20.8090	20.7699	.1847	-.1084
19	72.7825	75.8792	75.8203	-.0050	.3429
20	424.3587	426.4450	-535.3660	-527.3906	224844.430
21	.0521	7.3150	.0014	354.3779	690.000
22	79.3544	28.8612	28.7012	-31.2688	-.0416
23	14.6201	14.4010	-2.6311	-2.2515	6750.447
24	6600404.9000	5280.4954	.0000	13.915	326.5000
25	-.4063	2506.4328	156.4128	.000	-1.7030
26	274.3000	432.6181	7780.6699	525.840	.4432
27	114.2384			.0000	.0000
28	-53.1558	.0000	394.0375		
29	3.0184	.0000	-.9112		
30	.0000	.0000	-.2468		
31					
32					
33					
34	227215.2300	425.302	-534.2464	.0000	.000
35	.0000	179233.8600	37029.9940	-452.981	-82.385

1	165.0000	277046.030	227205.920	326999.700	436801.660
2	8026.8640	6813.3682	21236472.00	20909473.00	1.1969
3	322377.430	6469548.000	315674.010	2628.129	548140.870
4	313.935	40378.755	76546.323	-.942	72.0407
5	445316.320	204688.950	689724.420	4263.186	36.0243
6	2634.8349	767.5836	2518.3191	152.4467	26.3856
7	29.5198	120.2393	394.4859	3.3922	-.0893
8	6283.2126	2319.9464	7611.3729	234.0518	-.0509
9	227203.120	227204.200	-1.076	-17.580	-.527
10	-769.371	-770.689	1.181	-5710.102	161.317
11	-438.018	-431.617	-6.554	1539.561	29.156
12	-53.3030	.0216	.0000	98045.254	-.2133
13	2.6718	-.0192	.0000	5766381.400	.3743
14	.0000	.0009	.0000	5768536.300	.0000
15	-53.5165	-.0700	.0000	.0010	-.0216
16	3.0461	.0052	.0000	.0216	.0192
17	.0000	.0000	.0000	-.0192	-.0000
18	23.9451	20.1515	20.1126	.1943	.0155
19	72.8952	75.9336	75.8767	-.1088	-.0520
20	424.1013	426.1339	-535.7309	-528.5366	225174.780
21	.0249	7.1546	.0007	377.3865	690.000
22	79.2636	28.8859	28.7259	-31.2276	-.0415
23	14.8512	14.6260	-2.6924	-1.0762	6813.368
24	6600404.9000	5249.3406	.0000	14.107	326.5000
25	.1202	2463.4740	156.4776	.000	-1.7019
26	268.3000	426.1573	7780.6699	520.065	.4388
27	114.7778			.0000	.0000
28	-53.5165	.0000	394.6035		
29	3.0461	.0000	-.9194		
30	.0000	.0000	-.2494		
31					
32					
33					
34	227211.9100	425.118	-534.4694	.0000	.000
35	.0000	176968.1100	36618.0040	-453.319	-82.412

TABLE AP 3-2 (Sheet 5 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	190.0000	274373.100	226514.090	340675.790	467697.460
2	8099.2931	6876.8481	21250122.00	20909448.00	1.2816
3	335372.740	6473327.200	328072.900	3450.490	581450.760
4	481.125	40983.712	78531.094	20.375	72.0581
5	474982.130	216365.430	728033.070	5514.070	35.2248
6	2563.2162	744.0747	2441.1890	176.4688	26.5617
7	37.3822	121.7549	390.4582	5.1454	-.0887
8	6383.3437	2350.7091	7712.3003	266.3731	-.0147
9	226512.470	226513.010	-.534	4.807	-.272
10	-688.242	-688.770	.581	1835.784	82.535
11	-125.402	-121.358	-3.360	-551.047	14.314
12	-53.7075	-.0960	.0000	98039.658	-.2067
13	2.7052	.0074	.0000	5760552.600	.3605
14	.0000	-.0003	.0000	5762704.800	.0000
15	-53.9143	-.0730	.0000	-.0045	.0959
16	3.0748	.0055	.0000	-.0959	-.0074
17	.0000	.0000	.0000	.0074	-.0000
18	23.1569	19.5113	19.4725	.1742	.0010
19	73.0067	75.9880	75.9330	-.0307	.0066
20	423.9376	425.8761	-534.3074	-529.2825	225361.290
21	.0124	6.8989	.0004	413.7138	690.000
22	79.1713	28.9108	28.7509	-31.1874	-.0415
23	15.3262	15.1124	-2.6734	-.5339	6878.848
24	6600404.9000	5225.5955	.0000	14.247	326.5000
25	.0093	2434.0801	156.7392	.000	-1.7016
26	263.8000	421.9399	7780.6699	516.075	.4359
27	115.2903			.0000	.0000
28	-53.9143	.0000	395.1762		
29	3.0748	.0000	-.9276		
30	.0000	.0000	-.2519		
31					
32					
33					
34	227135.4300	424.961	-534.4873	.0000	.000
35	.0000	174706.9600	36206.2040	-451.956	-82.381

1	195.0000	271700.640	226536.330	354052.130	499057.200
2	8174.3414	6947.2525	21263473.00	20909422.00	1.3675
3	348010.030	6476988.700	340085.950	4392.732	615074.490
4	688.217	41596.367	80541.117	50.589	72.0778
5	507152.070	228196.730	766849.670	6927.766	34.4579
6	2491.7693	720.5841	2364.1212	200.4424	26.8256
7	45.4608	123.3108	404.5630	6.9434	-.0854
8	6464.8544	2381.8734	7814.5453	299.1778	-.0297
9	226534.750	226535.040	-.285	-4.210	-.152
10	-721.257	-721.526	.306	-1277.460	45.606
11	-250.501	-248.252	-1.864	123.167	7.519
12	-54.0150	-.0539	.0000	98034.050	-.2166
13	2.7216	.0052	.0000	5754297.100	.3706
14	.0000	.0002	.0000	5756446.600	.0000
15	-54.2319	-.0756	.0000	-.0026	.0539
16	3.1012	.0056	.0000	-.0539	-.0052
17	.0000	.0000	.0000	.0052	-.0000
18	22.3837	18.8834	18.8447	.1825	-.0005
19	73.1187	76.0436	75.9906	-.0628	-.0124
20	423.6801	425.6493	-534.6841	-529.8542	225488.790
21	.0066	6.6777	.0002	450.4078	690.000
22	79.0775	28.9359	28.7760	-31.1482	-.0414
23	15.8806	15.6815	-2.6367	-.2855	6947.252
24	6600404.9000	5201.1156	.0000	14.366	326.5000
25	.1493	2406.7737	157.2541	.000	-1.7011
26	259.3000	417.9048	7780.6699	512.805	.4354
27	115.7786			.0000	.0000
28	-54.2319	.0000	395.8071		
29	3.1012	.0000	-.9361		
30	.0000	.0000	-.2546		
31					
32					
33					
34	227057.4100	424.814	-534.4883	.0000	.000
35	.0000	172446.3000	35794.3750	-452.304	-82.380

1	200.0000	269019.570	227285.650	367133.220	530888.240
2	8252.2905	7018.8843	21276528.00	20909396.00	1.4547
3	360291.600	6480533.300	351715.160	5455.139	649024.550
4	936.007	42216.875	82576.903	89.873	72.0994
5	539833.140	240184.890	806180.890	8506.727	33.7195
6	2421.0203	697.2713	2287.6357	224.5303	27.1826
7	53.7312	124.8998	409.7763	8.7782	-.0866
8	6587.9066	2413.4908	7918.2769	332.5163	-.0262
9	227284.240	227284.390	-.158	-1.686	-.087
10	-724.303	-724.430	.167	-497.330	25.887
11	-219.470	-217.598	-1.058	9.682	4.107
12	-54.4631	-.1132	.0000	98028.437	-.2917
13	2.7506	.0056	.0000	5747991.100	.3820
14	.0000	.0001	.0000	5750137.800	.0000
15	-54.7552	-.1406	.0000	-.0054	.1131
16	3.1325	.0070	.0000	-.1131	-.0056
17	.0000	.0000	.0000	.0056	-.0000
18	21.6298	18.2712	18.2327	.1826	.0006
19	73.2309	76.1002	76.0490	-.0549	.0015
20	423.3320	425.4353	-536.8940	-530.4832	225646.080
21	.0037	6.3815	.0001	503.4139	690.000
22	78.9823	28.9612	28.8013	-31.1099	-.0413
23	16.2816	16.0921	-2.6124	-.1579	7018.884
24	6600404.9000	5169.0978	.0000	14.525	326.5000
25	-.1429	2364.1866	157.1893	.000	-1.7009
26	253.3000	412.1322	7780.6699	506.279	.4200
27	116.2452			.0000	.0000
28	-54.7552	.0000	396.4448		
29	3.1325	.0000	-.9446		
30	.0000	.0000	-.2572		
31					
32					
33					
34	227059.9900	424.663	-534.6841	.0000	.000
35	.0000	170177.5200	35382.0710	-454.395	-82.499

1	210.0000	263647.320	227399.660	392427.920	596000.950
2	8416.9862	7171.7475	21301769.00	20909343.00	1.6331
3	383794.300	6487272.500	373825.160	7940.182	717959.070
4	1558.939	43482.319	66728.623	196.012	72.1473
5	606763.860	264642.190	886421.390	12172.539	32.3143
6	2279.3439	650.4802	2134.1213	272.3622	27.7504
7	71.1076	128.2500	420.7676	12.6326	-.0804
8	6799.5219	2478.3471	8131.0602	401.0751	-.0259
9	227398.330	227398.380	-.058	-.919	-.033
10	-732.337	-732.277	.063	-263.558	9.701
11	-212.042	-211.011	-.399	-56.566	1.539
12	-55.7428	-.0875	.0000	98017.173	-.2475
13	2.9279	.0169	.0000	5735305.400	.4041
14	.0000	.0000	.0000	5737446.700	.0000
15	-55.9906	-.0975	.0000	-.0045	.0874
16	3.3320	.0187	.0000	-.0874	-.0149
17	.0000	.0000	.0000	.0169	-.0000
18	20.1617	17.0785	17.0402	.1845	.0020
19	73.4583	76.2178	76.1701	-.0532	-.0086
20	423.1688	425.0578	-537.3704	-531.5968	225923.640
21	.0013	5.7731	.0001	642.1910	690.000
22	78.7872	29.0126	28.8526	-31.0361	-.0411
23	16.6888	16.4951	-2.6813	-.0580	7171.747
24	6600404.9000	5119.6605	.0024	14.707	326.5000
25	.0417	2295.7241	156.7523	.000	-1.7000
26	244.3000	402.5105	7780.6699	495.863	.4215
27	117.1220			.0000	.0000
28	-55.9906	.0000	397.8453		
29	3.3320	.0000	-.9624		
30	.0000	.0000	-.2628		
31					
32					
33					
34	227109.4200	424.384	-535.1539	.0000	.000
35	.0000	165630.4100	34556.8830	-454.862	-82.508

1	220.0000	258201.200	226682.960	416579.460	663109.940
2	8592.6627	7336.0310	21325867.00	20909289.00	1.8170
3	405679.410	6493542.700	394396.770	10901.386	788361.150
4	2365.139	44783.010	90995.983	343.723	72.2004
5	675845.320	289758.210	968823.050	16535.828	30.9867
6	2137.5652	603.5074	1980.0112	319.7805	28.2377
7	89.9555	131.9381	432.8677	16.8417	-.0923
8	7017.7546	2545.1446	8350.2119	471.9246	-.0220
9	226681.660	226681.680	-.024	2.187	-.015
10	-741.323	-741.246	.027	666.846	4.205
11	-176.972	-176.024	-.174	-33.149	.656
12	-56.8090	-.1071	.0000	98005.871	-.2443
13	3.0913	.0144	.0000	5736876.900	.4042
14	.0000	-.0001	.0000	5739012.500	.0000
15	-57.0537	-.0849	.0000	-.0058	.1069
16	3.4955	.0140	.0000	-.1069	-.0144
17	.0000	.0000	.0000	.0144	-.0000
18	18.7531	15.9321	15.8942	.1874	.0001
19	73.6922	76.3439	76.2996	-.0445	.0086
20	423.6109	424.8186	-535.1176	-532.3075	226102.480
21	.0006	4.9881	.0000	900.2227	690.000
22	78.5858	29.4647	28.9048	-30.9658	-.0410
23	17.2502	17.0575	-2.7305	-.0244	7336.631
24	6600404.9000	5058.9503	.0046	14.683	326.5000
25	.0700	2221.9118	156.9860	.000	-1.6902
26	233.8000	392.1160	7780.6699	485.362	.4138
27	117.9345			.0000	.0000
28	-57.0537	.0000	399.3582		
29	3.4955	.0000	-.9806		
30	.0000	.0000	-.2686		
31					
32					
33					
34	227121.3500	424.226	-535.3814	.0000	.000
35	.0000	161086.6600	33732.4860	-452.782	-82.335

1	230.0000	252929.450	227261.600	439609.370	732280.070
2	8778.6984	7512.8974	21348841.00	20909233.00	2.0066
3	426545.980	6499342.200	413424.040	14334.638	860332.460
4	3362.185	46121.980	95388.927	534.408	72.2579
5	747138.730	315550.850	1053444.600	21618.011	29.7220
6	1996.0974	556.4767	1825.7111	366.9122	28.9087
7	110.0683	135.9003	445.8671	21.3420	-.0958
8	7242.0376	2613.7116	8575.1694	544.8933	-.0269
9	227260.240	227260.250	-.013	-.332	-.009
10	-753.278	-753.214	.015	-104.146	2.385
11	-211.618	-210.678	-.099	-40.924	.355
12	-57.6151	-.1154	.0000	97994.523	-.2832
13	3.2110	.0108	.0000	5722488.400	.4042
14	.0000	.0001	.0000	5724618.400	.0000
15	-57.8988	-.1218	.0000	-.0065	.1152
16	3.6152	.0107	.0000	-.1152	-.0108
17	.0000	.0000	.0000	.0108	-.0000
18	17.4112	14.8377	14.8002	.1899	.0001
19	73.9305	76.4771	76.4359	-.0531	.0071
20	423.6954	424.6844	-536.3765	-532.6635	226185.810
21	.0003	4.5136	.0000	1152.9258	690.000
22	78.3779	29.1177	28.9578	-30.8991	-.0409
23	18.0012	17.8184	-2.7325	-.0133	7512.807
24	6600404.9000	4995.3116	.0061	14.465	326.5000
25	-.0178	2153.6051	157.6394	.000	-1.6984
26	223.3000	382.4571	7780.6699	476.582	.4070
27	118.6933			.0000	.0000
28	-57.8988	.0000	401.0508		
29	3.6152	.0000	-1.0001		
30	.0000	.0000	-.2746		
31					
32					
33					
34	227074.5600	424.160	-535.3538	.0000	.000
35	.0000	156560.0300	32909.3570	-454.016	-82.361

TABLE AP 3-2 (Sheet 6 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	240.0000	247564.260	227314.020	461550.010	803582.540
2	8976.4443	7701.8205	21370726.00	20909178.00	2.2020
3	445802.030	6504671.900	430909.840	18238.588	933986.810
4	4568.555	47501.852	99916.064	771.464	72.3100
5	820711.750	342040.020	1140351.300	27442.583	28.5099
6	1854.8750	509.3562	1671.1161	413.7389	29.5421
7	131.3927	140.1135	459.6900	26.1111	-.0903
8	7473.9691	2684.5355	8807.5314	620.4834	-.0244
9	227312.650	227312.650	-.009	2.006	-.006
10	-764.262	-764.213	.009	591.195	1.530
11	-187.470	-186.732	-.064	-32.880	.223
12	-58.9050	-.0918	.0000	97983.132	-.2445
13	3.3074	.0079	.0000	5707105.200	.4057
14	.0000	-.0002	.0000	5709229.600	.0000
15	-59.1500	-.0968	.0000	-.0053	.0917
16	3.7130	.0083	.0000	-.0917	-.0079
17	.0000	.0000	.0000	.0079	-.0000
18	16.1342	13.7938	13.7568	.1926	.0005
19	74.1722	76.6160	76.5778	-.0471	-.0002
20	423.5639	424.5679	-536.6668	-533.0893	226307.270
21	.0002	4.2085	.0000	1393.6765	690.000
22	78.1632	29.1716	29.0116	-30.8357	-.0408
23	18.2128	18.0356	-2.7110	-.0085	7701.820
24	6600404.9000	4940.0470	.0070	14.174	326.5000
25	.0269	2084.7883	157.1778	.000	-1.6977
26	214.3000	372.9510	7780.6699	465.915	.3903
27	119.4068			.0000	.0000
28	-59.1500	.0000	402.8909		
29	3.7130	.0000	-1.0201		
30	.0000	.0000	-.2808		
31					
32					
33					
34	227099.6800	424.097	-535.4924	.0000	.000
35	.0000	152018.4800	32085.6990	-454.296	-82.371

1	270.0000	231504.850	227311.310	521068.880	1031057.280
2	9634.8624	8338.7987	21430071.00	20909005.00	2.8253
3	495070.130	6517813.700	474025.860	32725.653	1166186.100
4	9540.555	51908.143	114372.401	1783.967	72.5197
5	1055841.100	425902.220	1415489.700	49623.168	25.1203
6	1429.6737	366.4975	1202.4198	551.5018	31.5910
7	201.6081	153.9175	504.9787	41.6953	-.1108
8	8212.8529	2909.0789	9546.1908	862.1886	-.0268
9	227309.840	227309.840	-.004	2.669	-.003
10	-797.079	-797.054	.004	746.658	.607
11	-192.533	-191.706	-.030	-18.572	.090
12	-62.0790	-.1065	.0000	97948.646	-.2678
13	3.4780	.0039	.0000	5654480.600	.4164
14	.0000	-.0002	.0000	5656587.800	.0000
15	-62.3474	-.1075	.0000	-.0065	.1063
16	3.8944	.0044	.0000	-.1063	-.0039
17	.0000	.0000	.0000	.0039	-.0000
18	12.6926	10.9624	10.9265	.2009	.0004
19	74.9086	77.0609	77.0307	-.0483	-.0066
20	424.1850	424.3779	-535.8742	-533.6430	226447.060
21	.0001	3.6351	.0000	1967.3674	690.000
22	77.4757	29.3383	29.1782	-30.6647	-.0404
23	19.1732	19.0288	-2.5313	-.0038	8338.709
24	6600404.9000	4739.5400	.0089	12.768	326.5000
25	-.0033	1872.3823	157.6438	.000	-1.6957
26	184.3000	343.4471	7780.6699	436.096	.3762
27	121.3354			.0000	.0000
28	-62.3474	.0000	409.3754		
29	3.8944	.0000	-1.0858		
30	.0000	.0000	-.3014		
31					
32					
33					
34	227039.1300	424.020	-535.4458	.0000	.000
35	.0000	138428.0500	29616.6730	-453.539	-82.335

1	250.0000	242206.340	226402.330	482422.080	877098.360
2	9184.9929	7902.4110	21391642.00	20909121.00	2.4034
3	463642.280	6509528.400	446843.320	22607.826	1009440.170
4	5993.662	48924.933	104584.970	1057.382	72.3830
5	896641.430	369248.420	1229617.700	34035.881	27.3493
6	1713.0248	461.8767	1515.3437	460.0007	30.0745
7	153.7885	144.5321	474.1866	31.1042	-.1025
8	7712.9758	2757.4375	9046.7110	698.5265	-.0220
9	226400.940	226400.950	-.006	4.165	-.004
10	-771.833	-771.791	.006	1212.974	1.099
11	-165.757	-164.593	-.046	-31.227	.154
12	-59.9154	-.0976	.0000	97971.690	-.2206
13	3.3788	.0065	.0000	5690681.000	.4085
14	.0000	-.0002	.0000	5692799.800	.0000
15	-60.1365	-.0639	.0000	-.0058	.0975
16	3.7873	.0061	.0000	-.0975	-.0065
17	.0000	.0000	.0000	.0065	-.0000
18	14.9190	12.7973	12.7606	.1953	-.0001
19	74.4161	76.7599	76.7246	-.0418	.0127
20	423.5598	424.4667	-534.5194	-533.3580	226369.600
21	.0001	4.0018	.0000	1622.7020	690.000
22	77.9414	29.2263	29.0663	-30.7756	-.0406
23	18.6423	18.4763	-2.6639	-.0060	7902.411
24	6600404.9000	4871.9719	.0079	13.742	326.5000
25	.1487	2011.9754	157.5171	.000	-1.6969
26	203.8000	362.6684	7780.6699	456.089	.3916
27	120.0816			.0000	.0000
28	-60.1365	.0000	404.8860		
29	3.7873	.0000	-1.0411		
30	.0000	.0000	-.2874		
31					
32					
33					
34	227082.2200	424.039	-535.5242	.0000	.000
35	.0000	147483.8000	31262.4410	-452.259	-82.261

1	280.0000	226152.110	226532.270	538900.760	1111674.500
2	9877.3190	8575.5531	21447844.00	20908945.00	3.0462
3	508652.340	6521237.100	485257.680	38465.115	1247725.800
4	11682.928	53471.975	119503.085	2228.730	72.5876
5	1139276.700	455396.570	1512256.000	56673.868	24.0581
6	1286.5911	318.0952	1043.6194	596.2594	32.2279
7	227.0407	158.4727	521.2358	47.2837	-.1146
8	8475.4497	2989.5364	9808.1907	948.3558	-.0264
9	226530.750	226530.750	-.003	3.672	-.002
10	-805.456	-805.432	.003	1017.514	.509
11	-186.238	-184.426	-.026	-15.697	.074
12	-63.1506	-.1045	.0000	97937.036	-.2430
13	3.5141	.0036	.0000	5634562.100	.4212
14	.0000	-.0002	.0000	5636663.400	.0000
15	-63.3941	-.0760	.0000	-.0064	.1043
16	3.9353	.0035	.0000	-.1043	-.0036
17	.0000	.0000	.0000	.0036	-.0000
18	11.6698	10.1143	10.0788	.2037	.0000
19	75.1570	77.2175	77.1897	-.0466	.0110
20	423.9596	424.3537	-534.3215	-533.7680	226488.650
21	.0001	3.8396	.0000	2075.8013	690.000
22	77.2312	29.3955	29.2354	-30.6138	-.0404
23	19.3688	19.2348	-2.4551	-.0032	8575.553
24	6600404.9000	4663.5500	.0094	12.192	326.5000
25	.1202	1798.1813	157.8955	.000	-1.6950
26	173.8000	333.0753	7780.6699	426.064	.3680
27	121.9224			.0000	.0000
28	-63.3941	.0000	411.8894		
29	3.9353	.0000	-1.1098		
30	.0000	.0000	-.3089		
31					
32					
33					
34	227035.1800	424.023	-535.4321	.0000	.000
35	.0000	133898.4100	28793.5500	-452.049	-82.273

1	260.0000	236860.520	227049.700	502249.660	952896.360
2	9403.7791	8114.0811	21411311.00	20909064.00	2.6111
3	480062.900	6513909.000	461215.290	27437.501	1086799.300
4	7647.525	50393.071	109401.694	1394.195	72.4404
5	974992.280	397194.920	1321305.700	41420.592	26.2138
6	1571.4033	414.2972	1359.2426	505.9574	30.8411
7	177.1651	149.1281	489.2654	36.2932	-.1066
8	7958.4934	2832.2489	9292.1551	778.8529	-.0283
9	227048.240	227048.250	-.005	.827	-.003
10	-784.720	-784.689	.005	229.124	.864
11	-208.688	-207.827	-.037	-32.919	.114
12	-60.7321	-.1111	.0000	97960.196	-.2805
13	3.4316	.0049	.0000	5673161.500	.4119
14	.0000	-.0000	.0000	5675274.400	.0000
15	-61.0132	-.1209	.0000	-.0067	.1109
16	3.8435	.0051	.0000	-.1109	-.0049
17	.0000	.0000	.0000	.0049	-.0000
18	13.7734	11.8547	11.8184	.1980	.0002
19	74.6615	76.9083	76.8756	-.0524	.0019
20	423.9424	424.3898	-535.5639	-533.4689	226377.740
21	.0001	3.8879	.0000	1812.4924	690.000
22	77.7123	29.2819	29.1218	-30.7186	-.0405
23	19.1990	19.0471	-2.5986	-.0046	8114.081
24	6600404.9000	4801.2385	.0085	13.235	326.5000
25	-.0096	1942.3409	158.1919	.000	-1.6962
26	193.3000	353.0015	7780.6699	447.215	.3844
27	120.7230			.0000	.0000
28	-61.0132	.0000	407.0444		
29	3.8435	.0000	-1.0630		
30	.0000	.0000	-.2942		
31					
32					
33					
34	227022.3800	423.998	-535.4340	.0000	.000
35	.0000	142960.5900	30430.8160	-453.253	-82.311

1	290.0000	220810.830	226248.650	555770.510	1194828.500
2	10130.2956	8823.4636	21464653.00	20908885.00	3.2741
3	520800.210	6524174.400	494894.450	44649.088	1331532.600
4	14084.467	55086.093	124798.746	2730.213	72.6586
5	1225374.600	485700.180	1611677.300	68598.958	23.0247
6	1142.9901	269.3431	883.6715	640.4854	32.9661
7	253.4056	163.9765	537.9807	53.0415	-.1189
8	8745.4486	3071.5703	10077.3306	1037.1065	-.0320
9	226247.070	226247.070	-.003	.832	-.002
10	-815.978	-815.959	.003	210.137	.530
11	-219.800	-218.891	-.023	-5.271	.062
12	-64.0656	-.1170	.0000	97925.362	-.2808
13	3.5419	.0028	.0000	5613319.400	.4252
14	.0000	-.0000	.0000	5615415.000	.0000
15	-64.3560	-.1122	.0000	-.0072	.1168
16	3.9682	.0032	.0000	-.1168	-.0028
17	.0000	.0000	.0000	.0028	-.0000
18	10.7116	9.3165	9.2814	.2066	.0003
19	75.4063	77.3780	77.3524	-.0554	.0017
20	423.9673	424.3197	-533.6427	-533.7937	226482.700
21	.0001	3.8654	.0000	2168.3557	690.000
22	76.9785	29.4536	29.2934	-30.5657	-.0403
23	19.6622	19.5396	-2.3728	-.0028	8823.463
24	6600404.9000	4584.5692	.0097	11.584	326.5000
25	.0204	1726.5394	158.4254	.000	-1.6943
26	163.3000	323.2050	7780.6699	416.917	.3602
27	122.4870			.0000	.0000
28	-64.3560	.0000	414.5977		
29	3.9682	.0000	-1.1349		
30	.0000	.0000	-.3167		
31					
32					
33					
34	226988.2300	424.012	-535.3351	.0000	.000
35	.0000	129379.7900	27970.8740	-451.405	-82.238

TABLE AP 3-2 (Sheet 7 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	300.0000	215460.840	226966.520	571711.450	1280606.700
2	10395.5628	9084.2369	21480532.00	20908823.00	3.5091
3	531510.320	6526622.700	502926.930	51272.965	1417729.400
4	16754.586	56752.090	130264.619	3290.223	72.7304
5	1314217.400	516837.400	1713833.500	79426.874	22.0183
6	998.8921	220.2308	722.5421	684.1747	33.8919
7	280.8123	169.2528	559.2913	58.9931	-.1240
8	9024.7837	3150.3702	10355.5454	1129.0380	-.0318
9	226964.900	226964.900	-.003	2.009	-.002
10	-830.066	-830.048	.002	520.530	.473
11	-212.648	-211.485	-.021	-.477	.054
12	-65.2843	-.1491	.0000	97913.617	-.3287
13	3.5664	.0027	.0000	5590653.900	.4319
14	.0000	-.0001	.0000	5592743.500	.0000
15	-65.6137	-.1349	.0000	-.0093	.1488
16	3.9983	.0031	.0000	-.1488	-.0027
17	.0000	.0000	.0000	.0027	-.0000
18	9.8161	8.5679	8.5333	.2095	.0002
19	75.6571	77.5426	77.5191	-.0534	.0110
20	424.0755	424.3009	-535.1992	-533.8739	226507.770
21	.0001	3.9217	.0000	2232.8209	690.000
22	76.7175	29.5125	29.3522	-30.5204	-.0402
23	19.6000	19.4851	-2.2927	-.0026	9084.237
24	6600404.9000	4515.0017	.0099	11.064	326.5000
25	-.0656	1659.6390	158.2590	.000	-1.6939
26	154.3000	314.1246	7780.6699	406.898	.3523
27	123.0319			.0000	.0000
28	-65.6137	.0000	417.5130		
29	3.9983	.0000	-1.1613		
30	.0000	.0000	-.3250		
31					
32					
33					
34	226979.3500	424.014	-535.3118	.0000	.000
35	.0000	124852.7330	27147.9290	-452.896	-82.303

1	310.0000	210107.780	227165.290	586751.740	1369112.100
2	10673.4625	9358.1349	21495510.00	20908760.00	3.7516
3	540770.500	6528576.000	509335.440	58329.030	1506449.500
4	19704.174	58471.704	135906.400	3910.714	72.8030
5	1405903.100	548837.270	1818819.900	91190.937	21.0370
6	852.9663	170.3423	558.5657	726.9193	34.7842
7	309.2855	174.7003	573.1636	65.1383	-.1200
8	9314.0475	3244.1082	10643.3997	1224.3403	-.0381
9	227153.590	227153.590	-.002	-1.128	-.002
10	-842.278	-842.265	.002	-327.799	.429
11	-248.632	-247.695	-.019	.636	.047
12	-66.4618	-.1185	.0000	97901.800	-.3082
13	3.5880	.0019	.0000	5566452.900	.4368
14	.0000	.0001	.0000	5568536.500	.0000
15	-66.7707	-.1232	.0000	-.0074	.1183
16	4.0248	.0025	.0000	-.1183	-.0019
17	.0000	.0000	.0000	.0019	-.0000
18	8.9749	7.8614	7.8272	.2124	.0004
19	75.9095	77.7112	77.6896	-.0625	-.0005
20	424.5070	424.2958	-535.0998	-533.9630	226543.800
21	.0001	3.9887	.0000	2290.5830	690.000
22	76.4477	29.5723	29.4119	-30.4777	-.0402
23	19.5326	19.4251	-2.2131	-.0024	9358.135
24	6600404.9000	4430.1173	.0101	10.447	325.5000
25	-.0037	1583.4866	158.3264	.000	-1.6933
26	143.8000	303.6300	7780.6699	396.243	.3433
27	123.5591			.0000	.0000
28	-66.7707	.0000	420.6493		
29	4.0248	.0000	-1.1889		
30	.0000	.0000	-.3336		
31					
32					
33					
34	226986.3300	424.027	-535.3115	.0000	.000
35	.0000	120322.9670	26324.6380	-452.747	-82.353

1	320.0000	204769.660	226463.500	600916.370	1460445.300
2	10962.9002	9644.0221	21509611.00	20908697.00	4.0019
3	548562.210	6530026.600	514094.440	65807.854	1597821.300
4	22943.504	60246.561	141729.410	4593.545	72.8760
5	1500526.600	581727.830	1926728.600	103923.568	20.0702
6	705.1438	119.6552	392.5696	768.7034	35.5823
7	338.7663	180.2997	591.5344	71.4588	-.1338
8	9612.2408	3334.4781	10939.8888	1322.7216	-.0435
9	226461.730	226461.730	-.002	-3.691	-.002
10	-851.510	-851.500	.002	-1002.419	.394
11	-276.671	-275.919	-.016	5.890	.042
12	-67.5397	-.0941	.0000	97889.902	-.2877
13	3.6067	.0015	.0000	5540589.900	.4423
14	.0000	.0003	.0000	5542667.400	.0000
15	-67.8280	-.1121	.0000	-.0059	.0940
16	4.0489	.0022	.0000	-.0940	-.0015
17	.0000	.0000	.0000	.0015	-.0000
18	8.1881	7.1975	7.1638	.2154	.0004
19	76.1633	77.8839	77.8641	-.0698	-.0020
20	424.1044	424.3010	-533.9764	-533.9542	226543.700
21	.0001	4.0626	.0000	2344.9821	690.000
22	76.1687	29.6329	29.4724	-30.4376	-.0401
23	19.5180	19.4180	-2.1337	-.0022	9644.022
24	6600404.9000	4341.4850	.0104	9.826	326.5000
25	.0489	1509.9951	158.7111	.000	-1.6927
26	133.3000	293.4622	7780.6699	386.845	.3347
27	124.0706			.0000	.0000
28	-67.8280	.0000	424.0223		
29	4.0489	.0000	-1.2180		
30	.0000	.0000	-.3427		
31					
32					
33					
34	226959.3400	424.049	-535.2202	.0000	.000
35	.0000	115807.1070	25502.3700	-451.822	-82.155

1	330.0000	199433.720	225982.010	614234.360	1554703.400
2	11264.2877	9942.2739	21522865.00	20908632.00	4.2602
3	554869.380	6530967.100	517180.250	73709.576	1691970.200
4	26482.990	62078.218	147738.790	5340.503	72.9404
5	1598178.800	615535.940	2037647.700	117656.094	19.1439
6	555.8666	68.2945	224.0634	809.6530	36.4567
7	369.2095	186.0595	610.4315	77.9635	-.1389
8	9919.8509	3427.0295	11245.5039	1424.3373	-.0380
9	225980.240	225980.240	-.002	.859	-.002
10	-861.114	-861.104	.002	203.289	.364
11	-235.552	-234.660	-.017	-2.897	.038
12	-68.6975	-.1111	.0000	97877.918	-.2916
13	3.6226	.0013	.0000	5512920.800	.4482
14	.0000	-.0001	.0000	5514992.300	.0000
15	-68.9896	-.1104	.0000	-.0070	.1109
16	4.0708	.0021	.0000	-.1100	-.0015
17	.0000	.0000	.0000	.0015	-.0000
18	7.4579	6.5789	6.5453	.2183	.0004
19	76.4189	76.0609	78.0429	-.0595	-.0007
20	423.8002	424.2834	-533.1103	-533.9344	226526.600
21	.0000	4.1433	.0000	2396.1297	690.000
22	75.8804	29.6943	29.5337	-30.4000	-.0401
23	19.3764	19.2826	-2.0564	-.0021	9942.274
24	6600404.9000	4262.9745	.0105	9.294	326.5000
25	.0455	1445.5879	158.8696	.000	-1.6923
26	124.3000	284.6241	7780.6699	378.110	.3269
27	124.5879			.0000	.0000
28	-68.9896	.0000	427.6496		
29	4.0708	.0000	-1.2487		
30	.0000	.0000	-.3523		
31					
32					
33					
34	226917.7600	424.045	-535.1269	.0000	.000
35	.0000	111292.2440	24681.2780	-451.042	-82.068

1	340.0000	194086.310	226754.310	626738.460	1651903.700
2	11579.2030	10254.4196	21535303.00	20908567.00	4.5268
3	559674.530	6531390.000	518567.820	81997.985	1789030.600
4	30333.504	63968.375	153940.100	6153.530	73.0229
5	1698960.900	650291.490	2151675.000	132422.990	18.2303
6	404.8259	16.1478	52.9782	849.6592	37.5801
7	401.0055	192.0052	620.9382	84.6782	-.1453
8	10238.5758	3524.0775	11561.9342	1529.7085	-.0379
9	226752.500	226752.500	-.002	2.163	-.002
10	-876.206	-876.195	.002	526.625	.337
11	-228.807	-227.585	-.016	2.765	.034
12	-69.9381	-.1508	.0000	97865.839	-.3408
13	3.6355	.0015	.0000	5483285.000	.4544
14	.0000	-.0001	.0000	5485350.100	.0000
15	-70.2797	-.1370	.0000	-.0096	.1505
16	4.0899	.0020	.0000	-.1505	-.0015
17	.0000	.0000	.0000	.0015	-.0000
18	6.7815	6.0026	5.9698	.2214	.0003
19	76.6767	76.2425	78.2260	-.0575	.0077
20	423.7956	424.2570	-535.1020	-533.9767	226531.270
21	.0000	4.2344	.0000	2440.4424	690.000
22	75.5822	29.7566	29.5959	-30.3648	-.0400
23	19.1076	19.0190	-1.9807	-.0020	10254.420
24	6600404.9000	4167.9310	.0107	8.676	326.5000
25	-.0385	1368.4817	158.9140	.000	-1.6919
26	113.8000	274.1525	7780.6699	366.856	.3172
27	125.0524			.0000	.0000
28	-70.2797	.0000	431.5506		
29	4.0899	.0000	-1.2810		
30	.0000	.0000	-.3624		
31					
32					
33					
34	226901.2600	424.031	-535.1060	.0000	.000
35	.0000	106760.4070	23859.7010	-452.913	-82.189

1	350.0000	188734.110	226841.090	638458.850	1752438.200
2	11908.1838	10580.9431	21546959.00	20908501.00	4.8021
3	562954.090	6531205.600	518225.160	90688.769	1889149.000
4	34507.102	65918.932	160339.560	7034.775	73.0965
5	1802988.800	680028.890	2268923.700	148263.440	17.3371
6	250.5507	-37.2461	-122.1985	888.2661	38.6609
7	433.9292	198.1394	650.0636	91.6071	-.1515
8	10569.0722	3624.0109	11889.7997	1639.0479	-.0435
9	226839.210	226839.210	-.002	-.221	-.002
10	-888.571	-888.564	.001	-80.475	.314
11	-254.945	-254.052	-.015	.723	.031
12	-71.2398	-.1083	.0000	97853.661	-.2668
13	3.6487	.0010	.0000	5451441.800	.4596
14	.0000	-.0000	.0000	5453500.500	.0000
15	-71.5072	-.1226	.0000	-.0069	.1081
16	4.1083	.0017	.0000	-.1081	-.0010
17	.0000	.0000	.0000	.0010	-.0000
18	6.1506	5.4629	5.4306	.2240	.0005
19	76.9370	76.4288	78.4138	-.0642	-.0103
20	423.7271	424.2313	-535.3427	-534.0388	226544.450
21	.0000	4.3407	.0000	2472.5939	690.000
22	75.2739	29.8196	29.6588	-30.3318	-.0400
23	18.7421	18.6576	-1.9100	-.0019	10590.943
24	6600404.9000	4068.3074	.0108	8.067	326.5000
25	.0098	1292.4407	158.8956	.000	-1.6974
26	103.3000	263.6857	7780.6699	356.308	.3076
27	125.5253			.0000	.0000
28	-71.5072	.0000	435.7506		
29	4.1083	.0000	-1.3152		
30	.0000	.0000	-.3731		
31					
32					
33					
34	226895.8200	424.016	-535.1120	.0000	.000
35	.0000	102236.2750	23037.6130	-453.115	-82.228

TABLE AP 3-2 (Sheet 8 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	360.0000	183368.470	226327.140	649421.740	1856161.600
2	12250.7712	10921.3574	21557453.00	20908434.00	5.0863
3	564675.670	6530641.200	516111.200	99758.919	1992470.500
4	39016.012	67931.766	166943.350	7986.375	73.1700
5	1910379.600	722762.720	2389507.100	165216.830	16.4695
6	93.1566	-91.8578	-301.3708	925.5057	39.7069
7	468.0653	204.4566	670.7893	98.7456	-.1576
8	10910.9251	3727.3017	12228.6801	1752.2402	-.0405
9	226325.240	226325.240	-.002	2.897	-.002
10	-898.161	-898.151	.001	707.921	.295
11	-230.658	-229.717	-.014	-13.141	.079
12	-72.4629	-.1131	.0000	97841.369	-.2492
13	3.6601	.0013	.0000	5416206.200	.4658
14	.0000	-.0002	.0000	5418258.800	.0000
15	-72.7126	-.1054	.0000	-.0072	.1128
16	4.1259	.0017	.0000	-.1128	-.0013
17	.0000	.0000	.0000	.0013	-.0000
18	5.5662	4.9605	4.9287	.2274	.0002
19	77.1999	78.0200	78.6063	-.0582	.0042
20	423.8772	424.2108	-533.9405	-534.0638	226544.670
21	.0000	4.4534	.0000	2502.6675	690.000
22	74.9549	29.8834	29.7225	-30.3010	-.0399
23	18.4178	18.3376	-1.8408	-.0019	10921.357
24	6600404.9000	3979.4267	.0110	7.551	326.5000
25	.0642	1227.9524	159.0206	.000	-1.6910
26	94.3000	254.7564	7780.6699	347.564	.2903
27	125.9878			.0000	.0000
28	-72.7126	.0000	440.3284		
29	4.1259	.0000	-1.3513		
30	.0000	.0000	-.3843		
31					
32					
33					
34	226878.8400	424.005	-535.0851	.0000	.000
35	.0000	97712.3520	22215.8980	-451.823	-82.118

1	390.0000	167380.450	226168.180	678086.540	2188256.400
2	13365.3335	12030.8201	21586311.00	20908227.00	5.9963
3	560170.370	6525342.500	498727.000	129104.438	2323116.100
4	54681.131	74362.914	188042.920	11285.020	73.3898
5	2253903.000	839490.180	2772405.700	223152.700	13.9532
6	-399.1822	-263.5686	-864.7263	1028.4678	43.4738
7	578.3386	224.0021	736.8837	121.5211	-.1799
8	12010.2796	4059.0092	13316.9594	2116.7386	-.0513
9	226166.080	226166.080	-.002	.357	-.002
10	-935.817	-935.812	.001	44.296	.249
11	-266.738	-265.434	-.013	14.941	.023
12	-76.1753	-.1504	.0000	97803.735	-.3078
13	3.6824	.0007	.0000	5294292.100	.4849
14	.0000	.0000	.0000	5296324.900	.0000
15	-76.4838	-.1430	.0000	-.0097	.1501
16	4.1673	.0013	.0000	-.1501	-.0007
17	.0000	.0000	.0000	.0007	-.0000
18	4.0843	3.6759	3.6457	.2371	.0003
19	78.0079	79.2258	79.2156	-.0672	.0063
20	423.4504	424.1659	-534.1029	-534.0062	226497.600
21	.0000	4.8305	.0000	2581.3009	690.000
22	73.9302	30.0794	29.9180	-30.2207	-.0399
23	17.1906	17.1208	-1.6943	-.0018	12030.820
24	6600404.9000	3658.7418	.0114	5.869	326.5000
25	-.0225	1013.5514	159.3765	.000	-1.6900
26	64.3000	225.1990	7780.6699	318.208	.2702
27	127.3214			.0000	.0000
28	-76.4838	.0000	456.2596		
29	4.1673	.0000	-1.4733		
30	.0000	.0000	-.4225		
31					
32					
33					
34	226787.7600	423.986	-534.8951	.0000	.000
35	.0000	84167.2580	19752.9460	-451.935	-82.168

1	370.0000	178049.040	226235.990	659657.890	1963284.500
2	12607.3532	11276.0246	21568021.00	20908365.00	5.3749
3	564608.340	6529444.800	512186.890	109194.742	2099137.500
4	43872.600	70008.712	173757.470	9010.435	73.2495
5	2021246.400	760586.490	2513535.200	183321.670	15.6087
6	-67.1452	-147.6349	-484.3663	961.4329	40.8812
7	503.4698	210.9669	692.1486	106.1042	-.1645
8	11264.5790	3834.0846	12579.0176	1869.4289	-.0451
9	226234.020	226234.020	-.002	1.324	-.002
10	-910.607	-910.601	.001	298.028	.279
11	-249.361	-248.260	-.014	1.108	.027
12	-73.6504	-.1309	.0000	97828.961	-.2822
13	3.6687	.0009	.0000	5378736.100	.4720
14	.0000	-.0001	.0000	5380782.200	.0000
15	-73.9332	-.1297	.0000	-.0084	.1307
16	4.1408	.0015	.0000	-.1307	-.0009
17	.0000	.0000	.0000	.0009	-.0000
18	5.0292	4.4970	4.4657	.2306	.0004
19	77.4659	78.8164	78.8040	-.0629	-.0003
20	423.9680	424.1975	-533.6110	-534.0583	226535.800
21	.0000	4.5724	.0000	2530.7475	690.000
22	74.6249	29.9460	29.7869	-30.2723	-.0399
23	18.0910	18.0149	-1.7722	-.0018	11276.025
24	6600404.9000	3871.0306	.0111	6.954	326.5000
25	.0013	1152.9861	159.1840	.000	-1.6906
26	83.8000	244.4827	7780.6699	337.448	.2804
27	126.4408			.0000	.0000
28	-73.9332	.0000	445.2351		
29	4.1408	.0000	-1.3895		
30	.0000	.0000	-.3963		
31					
32					
33					
34	226854.1000	424.001	-535.0319	.0000	.000
35	.0000	93193.9090	21394.9000	-451.531	-82.080

1	400.0000	162035.700	226834.650	686349.040	2306396.100
2	13769.4827	12433.6486	21594503.00	20908156.00	6.3201
3	556318.270	6522405.800	489091.780	139544.410	2440754.500
4	60661.512	76644.556	195528.620	12540.505	73.4625
5	2375966.200	880671.050	2907513.500	244970.520	13.1510
6	-571.9448	-324.0792	-1063.2520	1059.2225	45.0401
7	618.0383	231.7713	760.4096	129.6252	-.1888
8	12405.1008	4177.9836	13707.2955	2247.7188	-.0556
9	226832.490	226832.490	-.002	-.694	-.002
10	-950.845	-950.844	.001	-201.950	.235
11	-280.100	-278.873	-.012	1.138	.022
12	-77.5049	-.1388	.0000	97790.895	-.3055
13	3.6875	.0003	.0000	5246575.500	.4909
14	.0000	.0001	.0000	5248601.400	.0000
15	-77.8111	-.1402	.0000	-.0089	.1385
16	4.1784	.0010	.0000	-.1385	-.0003
17	.0000	.0000	.0000	.0003	-.0000
18	3.6723	3.3156	3.2860	.2402	.0004
19	78.2849	79.4393	79.4302	-.0704	.0006
20	424.0338	424.1474	-534.9396	-534.0249	226496.180
21	.0000	4.9705	.0000	2603.9666	690.000
22	73.5644	30.1461	29.9846	-30.1976	-.0399
23	16.6293	16.5618	-1.5846	-.0018	12433.649
24	6600404.9000	3536.3320	.0116	5.301	326.5000
25	-.0109	934.3801	159.4063	.000	-1.6847
26	53.8000	214.7173	7780.6699	307.475	.2594
27	127.7505			.0000	.0000
28	-77.8111	.0000	462.4594		
29	4.1784	.0000	-1.5193		
30	.0000	.0000	-.4369		
31					
32					
33					
34	226774.3400	423.974	-534.8780	.0000	.000
35	.0000	79644.3680	18931.0680	-452.729	-82.210

1	380.0000	172718.400	225765.620	669201.210	2073937.300
2	12978.4170	11645.3956	21577495.00	20908297.00	5.6831
3	563319.280	6527683.500	506407.220	118981.968	2209300.900
4	49089.727	72151.741	180788.410	10109.202	73.3167
5	2135711.500	799476.340	2641126.700	202619.240	14.7722
6	-231.3026	-204.8767	-672.1742	995.7468	42.0553
7	540.1859	217.6734	714.1515	113.6872	-.1716
8	11630.5605	3944.5110	12941.3092	1990.7831	-.0497
9	225763.570	225763.570	-.002	-.292	-.002
10	-921.129	-921.124	.001	-100.950	.264
11	-266.893	-265.854	-.013	.978	.025
12	-74.8795	-.1217	.0000	97816.421	-.2797
13	3.6771	.0008	.0000	5338215.200	.4783
14	.0000	.0000	.0000	5340254.600	.0000
15	-75.1599	-.1226	.0000	-.0078	.1215
16	4.1554	.0014	.0000	-.1215	-.0008
17	.0000	.0000	.0000	.0008	-.0000
18	4.5350	4.0683	4.0376	.2338	.0004
19	77.7350	79.0182	79.0070	-.0675	.0002
20	423.8970	424.1882	-532.5907	-534.0153	226513.070
21	.0000	4.6980	.0000	2556.9265	690.000
22	74.2835	30.0133	29.8521	-30.2455	-.0399
23	17.6906	17.6179	-1.7076	-.0018	11645.396
24	6600404.9000	3759.1176	.0113	6.366	326.5000
25	.0284	1078.4191	159.3671	.000	-1.6903
26	73.3000	234.1367	7780.6699	327.582	.2704
27	126.8851			.0000	.0000
28	-75.1599	.0000	450.5326		
29	4.1554	.0000	-1.4301		
30	.0000	.0000	-.4090		
31					
32					
33					
34	226816.5200	424.001	-534.9442	.0000	.000
35	.0000	86683.8830	20574.2770	-450.536	-82.054

1	410.0000	156691.450	226190.470	694025.640	2428522.800
2	14191.5049	12854.5003	21602108.00	20908085.00	6.6548
3	548713.460	6518854.300	477440.110	150281.690	2562398.300
4	67047.305	78999.174	203253.740	13878.474	73.5350
5	2502057.900	923065.480	3046602.800	268124.830	12.3651
6	-750.1649	-386.6019	-1268.3789	1087.8220	46.4440
7	659.3525	239.1895	784.7426	138.0099	-.1974
8	12815.6424	4301.6147	14112.9094	2383.9317	-.0546
9	226188.260	226188.260	-.002	1.635	-.002
10	-961.315	-961.309	.001	346.317	.221
11	-265.817	-264.642	-.012	11.964	.021
12	-78.8474	-.1309	.0000	97777.878	-.2878
13	3.6915	.0008	.0000	5194628.600	.4981
14	.0000	-.0001	.0000	5196647.400	.0000
15	-79.1859	-.1219	.0000	-.0084	.1307
16	4.1896	.0013	.0000	-.1307	-.0008
17	.0000	.0000	.0000	.0008	-.0000
18	3.2973	2.9863	2.9573	.2435	.0003
19	78.5664	79.6592	79.6509	-.0670	.0001
20	424.1713	424.1460	-533.2475	-534.0403	226502.340
21	.0000	5.1181	.0000	2625.0251	690.000
22	73.1856	30.2135	30.0518	-30.1762	-.0399
23	15.9801	15.9142	-1.5277	-.0018	12854.501
24	6600404.9000	3407.9134	.0117	4.745	326.5000
25	.0333	863.5058	159.4051	.000	-1.6845
26	43.3000	204.1718	7780.6699	296.537	.2482
27	128.1729			.0000	.0000
28	-79.1859	.0000	469.1811		
29	4.1896	.0000	-1.5684		
30	.0000	.0000	-.4522		
31					
32					
33					
34	226769.6900	423.979	-534.8602	.0000	.000
35	.0000	75121.9100	18109.2710	-451.131	-82.116

TABLE AP 3-2 (Sheet 9 of 13)

PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	420.0000	151360.100	226100.860	701148.580	2554798.000
2	14630.7738	13292.7327	21609158.00	20908012.00	7.0008
3	540295.910	6514606.700	463701.200	161293.270	2688222.000
4	73853.961	81429.148	211276.100	15301.622	73.6071
5	2632328.500	966717.930	3189819.500	292665.830	11.5946
6	-934.2062	-451.2540	-1480.4921	1114.1444	48.0609
7	702.2808	246.8507	809.8778	146.6692	-.2069
8	13241.2539	4429.6972	14533.1277	2525.1750	-.0594
9	226098.600	226098.600	-.002	.408	-.002
10	-973.514	-973.513	.001	56.023	.209
11	-279.668	-278.417	-.012	1.435	.020
12	-80.1536	-.1368	.0000	97764.672	-.3039
13	3.6951	.0001	.0000	5137957.000	.5040
14	.0000	-.0000	.0000	5139968.600	.0000
15	-80.4582	-.1365	.0000	-.0088	.1366
16	4.1991	.0008	.0000	-.1366	-.0001
17	.0000	-.0000	.0000	.0001	-.0000
18	2.9582	2.6874	2.6590	.2467	.0004
19	78.8526	79.8857	79.8785	-.0706	.0004
20	424.1781	424.1470	-533.0275	-534.0068	226489.040
21	.0000	5.4729	.0000	2644.5547	690.000
22	72.7933	30.2815	30.1195	-30.1564	-.0309
23	15.4421	15.3783	-1.4722	-.0018	13292.733
24	6600404.9000	3293.0996	.0119	9.273	326.5000
25	.0034	800.8058	159.5338	.000	-1.6803
26	34.3000	195.3304	7780.6699	288.428	.2385
27	128.5893			.0000	.0000
28	-80.4582	.0000	476.4802		
29	4.1991	.0000	-1.6209		
30	.0000	.0000	-.4686		
31					
32					
33					
34	226745.9800	423.987	-534.7949	.0000	.000
35	.0000	70611.6060	17288.2180	-450.933	-82.095

1	450.0000	135363.880	226553.830	719609.200	2960307.200
2	16069.3265	14728.8166	21627399.00	20907792.00	8.1120
3	503542.140	6498057.500	409209.210	195729.710	3092702.200
4	96976.259	89198.212	236715.150	20112.424	73.8212
5	3049891.100	1105719.500	3645861.600	375165.190	9.3704
6	-1527.2175	-660.0624	-2165.5592	1177.3555	53.8479
7	842.1890	271.5526	890.9207	174.5676	-.2413
8	14625.1963	4845.6479	15897.7953	2984.2772	-.0692
9	226551.360	226551.360	-.002	.900	-.002
10	-1015.300	-1015.301	.001	150.193	.169
11	-291.327	-289.928	-.011	16.499	[illegible]17
12	-84.2681	-.1430	.0000	97723.681	-.[illegible]65
13	3.6940	-.0000	.0000	4933600.100	[illegible]43
14	.0000	-.0000	.0000	4935589.300	.0000
15	-84.5854	-.1417	.0000	-.0092	.1427
16	4.2183	.0006	.0000	-.1427	.0000
17	.0000	-.0000	.0000	-.0000	-.0000
18	2.1456	1.9666	1.9401	.2568	.0003
19	79.7444	80.0091	80.6036	-.0733	.0009
20	423.8041	424.1459	-534.4528	-533.9270	226455.540
21	.0000	5.7875	.0000	2695.2060	690.000
22	71.5292	30.4885	30.3261	-30.1051	-.0399
23	13.3544	13.2941	-1.3145	-.0020	14728.817
24	6600404.9000	2874.4125	.0123	2.748	326.5000
25	-.0026	593.3261	159.5990	.000	-1.6888
26	4.3000	165.4016	7780.6699	257.911	.2036
27	129.8068			.0000	.0000
28	-84.5854	.0000	502.5200		
29	4.2183	.0000	-1.8030		
30	.0000	.0000	-.5255		
31					
32					
33					
34	226685.5500	424.002	-534.6330	.0000	.000
35	.0000	57077.0570	14826.5463	-452.579	-81.874

1	430.0000	146030.930	226012.050	707768.800	2685393.100
2	15089.1337	13750.1727	21615696.00	20907940.00	7.3587
3	530007.960	6509821.500	447804.790	172556.250	2818411.800
4	81098.700	83937.074	219454.200	16812.865	73.6789
5	2766938.500	1011675.880	3337319.300	318646.920	10.8391
6	-1124.5389	-518.2050	-1700.1477	1138.0193	49.7952
7	746.9496	254.7819	835.8987	155.6316	-.2173
8	13683.7386	4562.7729	14969.7275	2672.0122	-.0631
9	226009.710	226009.710	-.002	.094	-.002
10	-986.125	-986.126	.001	-18.021	.196
11	-280.444	-285.163	-.011	.735	.019
12	-81.5085	-.1352	.0000	97751.252	-.3058
13	3.6964	.0001	.0000	5075996.300	.5106
14	.0000	.0000	.0000	5078000.600	.0000
15	-81.8150	-.1358	.0000	-.0087	.1350
16	4.2071	.0007	.0000	-.1350	-.0001
17	.0000	-.0000	.0000	.0001	-.0000
18	2.6543	2.4186	2.3908	.2500	.0004
19	79.1440	80.1193	80.1126	-.0723	-.0002
20	424.1848	424.1082	-532.8095	-533.9680	226473.530
21	.0000	5.4358	.0000	2662.6980	690.000
22	72.3869	30.3500	30.1880	-30.1380	-.0399
23	14.7829	14.7205	-1.4185	-.0019	13750.173
24	6600404.9000	3153.2317	.0120	3.731	326.5000
25	.0063	727.5276	159.5746	.000	-1.6801
26	23.8000	184.8683	7780.6699	277.996	.2268
27	129.0001			.0000	.0000
28	-81.8150	.0000	484.4207		
29	4.2071	.0000	-1.6773		
30	.0000	.0000	-.4862		
31					
32					
33					
34	226720.7200	423.994	-534.7264	.0000	.000
35	.0500	66103.2760	16467.3770	-450.736	-82.074

IGM STAGING

1	454.6100	132899.700	226621.940	722111.580	3026408.900
2	16308.4872	14967.6658	21629867.00	20907758.00	8.2932
3	496277.590	6494935.600	398966.740	201174.360	3158703.100
4	100911.961	90459.387	240852.870	20927.694	73.8538
5	3117838.800	1128215.800	3719668.100	389096.950	9.0309
6	-1624.7732	-694.4597	-2278.4112	1184.6343	54.8628
7	865.3495	275.6091	904.2294	179.1436	-.2473
8	14854.0344	4914.4551	16123.2123	3060.1269	-.0724
9	226619.440	226619.440	-.002	.076	-.002
10	-1021.466	-1021.468	.001	-31.103	.163
11	-298.961	-297.594	-.011	8.155	.016
12	-84.9112	-.1381	.0000	97717.202	-.3152
13	3.6939	-.0001	.0000	4896792.600	.5272
14	.0000	.0000	.0000	4898778.200	.0000
15	-85.2272	-.1953	.0000	-.0089	.1379
16	4.2212	.0004	.0000	-.1370	.0001
17	.0000	-.0000	.0000	-.0001	-.0000
18	2.0462	1.8779	1.8517	.2583	.0005
19	79.8864	80.7265	80.7213	-.0752	-.0005
20	423.8911	424.1421	-534.6171	-533.9361	226457.450
21	.0000	5.8738	.0000	2702.0706	690.000
22	71.3226	30.5206	30.3582	-30.0981	-.0399
23	13.0081	12.9480	-1.2925	-.0020	14967.666
24	6600404.9000	2780.7584	.0124	2.429	334.2106
25	3.6738	577.4972	161.7761	.000	-1.6866
26	.0000	159.4024	7780.6699	253.375	.2048
27	129.9902			.0000	.0000
28	-85.2272	.0000	507.1663		
29	4.2212	.0000	-1.8348		
30	.0000	.0000	-.5355		
31					
32					
33					
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	54990.3360	14449.0848	-452.726	-81.891

1	440.0000	140703.950	225923.530	713897.610	2820495.000
2	15567.7816	14228.0018	21621761.00	20907866.00	7.7289
3	517781.490	6504294.100	429670.170	184044.530	2953166.700
4	88799.563	86525.737	227947.190	18415.325	73.7502
5	2906062.400	1057990.900	3489271.500	346125.790	10.0979
6	-1322.0055	-587.7339	-1928.2609	1159.1651	51.6601
7	793.5325	263.0014	862.8656	164.9164	-.2284
8	14144.2090	4701.1694	15423.7841	2824.7884	-.0663
9	225921.130	225921.130	-.002	.240	-.002
10	-998.860	-998.861	.001	11.924	.183
11	-289.991	-288.685	-.011	1.398	.018
12	-82.8718	-.1371	.0000	97737.597	-.3098
13	3.6965	-.0000	.0000	5008095.300	.5173
14	.0000	.0000	.0000	5010092.200	.0000
15	-83.1824	-.1375	.0000	-.0088	.1368
16	4.2139	.0006	.0000	-.1368	.0000
17	.0000	-.0000	.0000	-.0000	-.0000
18	2.3835	2.1783	2.1511	.2533	.0004
19	79.4411	80.3603	80.3542	-.0732	-.0001
20	424.1015	424.1495	-532.5923	-533.9243	226456.020
21	.0000	5.6070	.0000	2679.5380	690.000
22	71.9658	30.4191	30.2569	-30.1209	-.0399
23	14.0949	14.0337	-1.3664	-.0019	14228.002
24	6600404.9000	3006.4301	.0122	3.199	326.5000
25	.0039	655.0492	159.6076	.000	-1.6889
26	13.3000	174.4038	7780.6699	267.630	.2145
27	129.4058			.0000	.0000
28	-83.1824	.0000	493.0763		
29	4.2139	.0000	-1.7378		
30	.0000	.0000	-.5052		
31					
32					
33					
34	226694.1200	424.001	-534.6550	.0000	.000
35	.0000	61590.9160	15646.7466	-450.539	-82.053

1	455.0000	132691.200	226633.330	722320.150	3032049.800
2	16328.9563	14988.1098	21630073.00	20907755.00	8.3086
3	495642.300	6494664.300	398076.270	201636.480	3164336.400
4	101249.829	90566.942	241205.740	20997.637	73.8565
5	3123635.700	1130133.500	3725959.900	390291.660	9.0116
6	-1633.1133	-697.4008	-2288.0603	1185.2176	54.9518
7	867.3309	275.9558	905.3667	179.5346	-.2478
8	14873.6046	4920.2303	16142.4881	3066.6134	-.0726
9	226630.820	226630.820	-.002	.062	-.002
10	-1021.956	-1021.957	.001	-33.455	.162
11	-299.225	-297.854	-.011	5.110	.016
12	-84.9651	-.1384	.0000	97716.703	-.3374
13	3.6939	-.0001	.0000	4893580.900	.5274
14	.0000	.0000	.0000	4895566.200	.0000
15	-85.3033	-.1953	.0000	-.0089	.1381
16	4.2213	.0004	.0000	-.1381	.0001
17	.0000	-.0000	.0000	-.0001	-.0000
18	2.0381	1.8707	1.8445	.2584	.0003
19	79.8985	80.7365	80.7313	-.0753	-.0002
20	423.8962	424.1417	-534.6375	-533.9370	226457.660
21	.0000	5.8812	.0000	2702.6428	690.000
22	71.3049	30.5234	30.3609	-30.0976	-.0399
23	12.9791	12.9190	-1.2906	-.0020	14988.110
24	6600404.9000	2780.7584	.0124	2.429	334.2106
25	3.6738	577.4972	161.7761	.000	-1.6866
26	.0000	159.4024	7780.6699	253.375	.2048
27	130.0057			.0000	.0000
28	-85.3033	.0000	507.5711		
29	4.2213	.0000	-1.8376		
30	.0000	.0000	-.5363		
31					
32					
33					
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	54813.7720	14417.1460	-452.737	-81.900

TABLE AP 3-2 (Sheet 10 of 13)

PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	460.0000	130510.196	175881.990	724916.910	3104965.200
2	16547.3130	15206.1267	21632632.00	20907718.00	8.5085
3	487196.330	6491079.700	386316.000	207578.090	3237158.800
4	105643.308	91956.159	245763.540	21906.281	73.8917
5	3198540.400	1154895.400	3807199.500	405806.870	8.6540
6	-1746.6088	-736.7459	-2417.1454	1191.0692	43.3586
7	889.3924	279.5630	917.2016	183.7426	-.2013
8	15079.2783	4981.6828	16344.1090	3136.4433	-.1248
9	175879.360	175879.360	-.002	-41.709	-.002
10	-816.586	-816.392	.001	-9382.255	.160
11	-506.339	-506.533	-.011	658.264	.016
12	-85.3351	.0270	.0000	97710.631	-.3727
13	3.7270	.0257	.0000	4859230.800	.5639
14	.0000	.0022	.0000	4861212.700	.0000
15	-85.7087	-.1373	.0000	.0018	-.0269
16	4.2909	.0184	.0000	.0269	-.0257
17	.0000	-.0000	.0000	.0257	-.0000
18	1.8972	1.7434	1.7176	.2660	-.0064
19	80.0510	80.8654	80.8605	-.1650	-.1278
20	430.9442	424.2287	-408.1256	-532.3636	225826.930
21	.0000	5.9569	.0000	2709.7662	690.000
22	71.0768	30.5583	30.3957	-30.0904	-.0309
23	12.9687	12.9076	-1.3006	-.0020	15206.127
24	6600404.9000	2721.3649	.0138	2.238	329.6938
25	-.0191	542.4101	157.0248	.000	-1.6842
26	.0000	158.5439	7780.6699	253.375	.1967
27	130.2033			.0000	.0000
28	-85.7087	.0000	511.9214		
29	4.2909	.0000	-1.8676		
30	.0000	.0000	-.5457		
31					
32					
33					
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	53017.4050	14042.5244	-332.696	-75.430

1	470.0000	126432.507	175225.040	729639.020	3253814.900
2	16968.2270	15626.4146	21637280.00	20907643.00	8.9164
3	468567.890	6483310.700	360827.110	219538.340	3385834.200
4	114754.750	94786.860	255050.610	23784.630	73.9612
5	3351288.700	1205295.100	3972553.000	437835.650	7.9547
6	-1980.8219	-817.6437	-2682.5581	1200.3731	44.5900
7	933.0981	286.5948	940.2715	191.9511	-.2048
8	15472.2497	5098.8267	16728.4350	3269.9805	-.0612
9	175223.020	175223.020	-.002	-.542	-.002
10	-804.871	-804.915	.001	-169.799	.146
11	-240.356	-239.105	-.010	78.812	.015
12	-86.8435	-.1609	.0000	97698.618	-.3386
13	3.7360	-.0056	.0000	4792759.300	.5306
14	.0000	.0001	.0000	4794734.600	.0000
15	-87.1830	-.1473	.0000	-.0105	.1606
16	4.2667	-.0042	.0000	-.1606	.0056
17	.0000	-.0000	.0000	-.0056	-.0000
18	1.6175	1.4896	1.4645	.2632	-.0007
19	80.3607	81.1299	81.1258	-.0782	.0147
20	431.0738	424.4389	-406.4803	-528.4771	224264.440
21	.0000	6.1091	.0000	2722.7199	690.000
22	70.6104	30.6279	30.4652	-30.0773	-.0399
23	12.1855	12.1228	-1.2721	-.0020	15626.415
24	6600404.9000	2590.4615	.0136	1.641	319.1335
25	-.0611	487.1202	146.4169	.000	-1.6852
26	.0000	147.9780	7780.6699	253.375	.1859
27	130.5933			.0000	.0000
28	-87.1830	.0000	520.3394		
29	4.2667	.0000	-1.9254		
30	.0000	.0000	-.5639		
31					
32					
33					
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	49693.7950	13278.4569	-331.142	-75.338

1	480.0000	122367.886	175208.870	733746.040	3406784.400
2	17404.5410	16062.1922	21641313.00	20907570.00	9.3356
3	447549.840	6474716.500	332631.100	231574.620	3538644.600
4	124308.535	97688.178	264569.370	25745.562	74.0205
5	3508024.900	1256883.100	4141804.900	471220.060	7.2659
6	-2224.3808	-901.7218	-2958.4049	1206.3269	46.0669
7	977.8801	293.0051	963.5665	200.2665	-.2131
8	15877.3392	5219.4490	17124.1770	3407.6846	-.0606
9	175206.850	175206.850	-.002	1.401	-.002
10	-810.554	-810.585	.001	264.296	.132
11	-230.625	-229.473	-.010	-7.244	.014
12	-88.3417	-.1450	.0000	97686.382	-.3249
13	3.6992	-.0038	.0000	4720675.800	.5370
14	.0000	-.0001	.0000	4722644.200	.0000
15	-88.6674	-.1459	.0000	-.0094	.1407
16	4.2362	-.0031	.0000	-.1447	.0038
17	.0000	-.0000	.0000	-.0038	-.0000
18	1.3582	1.2534	1.2290	.2651	.0003
19	80.6752	81.4004	81.3969	-.0750	-.0010
20	431.0696	424.6394	-406.4468	-524.7863	222780.700
21	.0000	6.2665	.0000	2733.9863	690.000
22	70.1304	30.0972	30.5343	-30.0659	-.0400
23	11.3994	11.3392	-1.2006	-.0021	16062.103
24	6600404.9000	2474.1230	.0136	1.224	309.4233
25	-.0545	440.3041	137.0270	.000	-1.6865
26	.0000	138.5815	7780.6699	253.375	.1761
27	130.9767			.0000	.0000
28	-88.6674	.0000	529.4292		
29	4.2362	.0000	-1.9872		-15.2763
30	.0000	.0000	-.5833		90.6716
31	1080.3789	57364.7360	.5346	46.7567	178.9296
32	3562.4230	17397.0490	31.6102	151385660.0	-165.7487
33	805.6340	1411.0000	18671.7790	53.6269	31.7758
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	46382.5120	12525.1338	-331.120	-75.327

1	490.0000	118303.593	175192.920	737262.670	3564033.500
2	17858.2760	16515.4710	21644755.00	20907496.00	9.7665
3	424048.450	6465265.300	301623.120	243653.290	3695749.100
4	134316.490	100661.223	274323.460	27790.572	74.0947
5	3668881.200	1309697.300	4315079.740	506005.090	6.5886
6	-2477.6135	-989.1074	-3245.1032	1208.8017	47.6451
7	1024.0559	300.9423	987.3435	208.7684	-.2228
8	16296.4272	5344.1138	17533.1820	3550.1390	-.0659
9	175190.840	175190.840	-.002	.000	-.002
10	-819.070	-819.096	.001	-48.553	.119
11	-242.279	-240.989	-.009	6.564	.013
12	-89.8461	-.1590	.0000	97673.912	-.3465
13	3.6652	-.0030	.0000	4642578.300	.5445
14	.0000	.0000	.0000	4644540.000	.0000
15	-90.1955	-.1595	.0000	-.0102	.1547
16	4.2087	-.0024	.0000	-.1587	.0030
17	.0000	-.0000	.0000	-.0030	-.0000
18	1.1205	1.0363	1.0127	.2670	.0003
19	80.9953	81.6777	81.6748	-.0788	.0002
20	431.0653	424.8281	-406.4137	-521.3112	221383.630
21	.0000	6.4320	.0000	2743.6332	690.000
22	69.6362	30.7661	30.6030	-30.0562	-.0400
23	10.5456	10.5374	-1.1343	-.0022	16515.472
24	6600404.9000	2333.0752	.0135	.817	296.2024
25	-.2536	384.0686	125.2742	.000	-1.6865
26	.0000	127.0280	7780.6699	253.375	.1632
27	131.3540			.0000	.0000
28	-90.1955	.0000	559.2342		
29	4.2087	.0000	-2.0531		-14.5776
30	.0000	.0000	-.6041		91.3671
31	1156.6336	54992.4930	.5098	47.9192	179.0262
32	3562.8108	17652.6040	31.6089	159386710.0	-164.9959
33	820.8558	1475.1539	19100.8010	52.3725	31.7543
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	43071.4460	11771.9229	-331.098	-75.316

1	500.0000	114239.644	175176.160	740212.700	3725736.100
2	18330.4760	16987.2880	21647632.00	20907422.00	10.2096
3	397960.480	6454921.900	267687.860	255737.450	3857320.300
4	144794.630	103707.562	284318.010	29921.627	74.1628
5	3834001.400	1363779.200	4492513.800	542239.370	5.9218
6	-2741.7562	-1080.1955	-3543.9486	1207.3988	49.3353
7	1071.7528	308.3591	1011.6769	217.4807	-.2330
8	16730.2740	5473.0343	17956.1500	3697.5785	-.0705
9	175174.030	175174.030	-.002	-.898	-.002
10	-827.142	-827.165	.001	-235.310	.106
11	-250.181	-249.003	-.009	4.757	.012
12	-91.3194	-.1417	.0000	97661.181	-.3274
13	3.6372	-.0026	.0000	4557675.900	.5404
14	.0000	.0001	.0000	4559630.500	.0000
15	-91.6476	-.1384	.0000	-.0090	.1414
16	4.1866	-.0020	.0000	-.1414	.0026
17	.0000	-.0000	.0000	-.0026	-.0000
18	.9026	.8364	.8136	.2705	.0003
19	81.3218	81.9622	81.95[illegible]	-.0814	.0046
20	431.0611	425.0059	-406.3786	-518.0334	220065.700
21	.0001	6.6060	.0000	2751.7257	690.000
22	69.1271	30.8344	30.6711	-30.0481	-.0400
23	9.8203	9.7634	-1.0757	-.0022	16987.288
24	6600404.9000	2185.0692	.0135	.471	285.5676
25	-.0066	336.0631	114.6725	.000	-1.6867
26	.0000	116.1791	7780.6699	253.375	.1526
27	131.7257			.0000	.0000
28	-91.6476	.0000	549.8434		
29	4.1866	.0000	-2.1238		-13.8598
30	.0000	.0000	-.6263		92.1169
31	1240.7722	52628.7610	.4834	49.2113	179.1304
32	3563.1331	18320.0530	31.6079	167931940.0	-164.1562
33	837.0774	1544.5895	19547.3510	51.0158	31.7160
34	226684.0000	424.000	-534.6314	.0000	.000
35	.0000	49760.6100	11018.8252	-331.074	-75.304

1	510.0000	110176.049	175157.090	742627.170	3892074.200
2	18821.9850	17478.4780	21649974.00	20907350.00	10.6654
3	369178.710	6443649.500	230705.430	267783.780	4023540.500
4	155757.350	106829.034	294559.060	32140.974	74.2280
5	4003537.200	1419172.500	4674250.600	579974.020	5.2646
6	-3016.3600	-1174.8665	-3854.5489	1202.2321	51.1404
7	1121.0971	315.9720	1036.6535	226.4309	-.2439
8	17179.6950	5606.4554	18393.8830	3850.2672	-.0719
9	175154.920	175154.930	-.002	.311	-.002
10	-835.251	-835.271	.001	19.003	.044
11	-246.365	-245.191	-.009	5.483	.011
12	-92.7041	-.1378	.0000	97648.158	-.3252
13	3.6125	-.0023	.0000	4465125.800	.5552
14	.0000	-.0000	.0000	4467072.700	.0000
15	-93.0300	-.1384	.0000	-.0087	.1375
16	4.1676	-.0018	.0000	-.1375	.0023
17	.0000	-.0000	.0000	-.0023	-.0000
18	.7081	.6575	.6355	.2732	.0003
19	81.6550	82.2545	82.2527	-.0802	-.0005
20	431.0455	425.1737	-406.3396	-514.9364	218820.560
21	.0001	6.7888	.0000	2758.3491	690.000
22	68.6026	30.9021	30.7386	-30.0415	-.0401
23	9.1208	9.0653	-1.0217	-.0023	17478.478
24	6600404.9000	2052.9040	.0135	.217	276.5756
25	-.0066	296.1944	105.6340	.000	-1.6867
26	.0000	107.1406	7780.6699	253.375	.1433
27	132.0922			.0000	.0000
28	-93.0300	.0000	561.3505		
29	4.1676	.0000	-2.1996		-13.1212
30	.0000	.0000	-.6502		92.9347
31	1333.9424	50272.8870	.4552	50.6540	179.2304
32	3563.3069	18819.4410	31.6070	177063360.0	-163.2095
33	854.6418	1620.6382	20012.3940	49.5315	31.6542
34	226684.0000	424.000	-534.6314	175161.3300	-431.058
35	-406.3525	36450.0060	10265.8471	-331.049	-75.200

PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	520.0000	106112.911	175132.960	744546.450	4063242.200
2	19333.9590	17990.1910	21651821.00	20907278.00	11.1345
3	337596.000	6431411.800	190555.160	279768.650	4194603.900
4	167222.360	110027.710	305053.410	34451.113	74.2922
5	4177649.100	1475923.700	4860442.400	619263.020	4.6164
6	-3302.1303	-1273.3582	-4177.6846	1193.0569	53.1006
7	1172.2208	323.8044	1062.3504	235.6436	-.2557
8	17645.6460	5744.0542	18847.2910	4008.4995	-.0756
9	175130.750	175130.750	-.002	.333	-.002
10	-843.223	-843.243	.001	20.790	.082
11	-249.280	-248.067	-.008	3.346	.010
12	-94.0880	-.1387	.0000	97634.816	-.3278
13	3.5899	-.0022	.0000	4364105.500	.5667
14	.0000	.0000	.0000	4366045.100	.0000
15	-94.4166	-.1388	.0000	-.0087	.1385
16	4.1506	-.0016	.0000	-.1385	.0022
17	.0000	-.0000	.0000	-.0022	-.0000
18	.5371	.4998	.4786	.2759	.0003
19	61.9955	82.5551	82.5537	-.0812	.0000
20	431.0481	425.3322	-406.2905	-512.0053	217641.930
21	.0001	6.9809	.0000	2763.6141	690.000
22	68.0620	30.9690	30.8054	-30.0362	-.0401
23	8.4124	8.3578	-.9713	-.0024	17990.191
24	6600404.9000	1892.1590	.0135	-.038	266.0902
25	-.0080	251.7527	95.0831	.000	-1.6867
26	.0000	96.5911	7780.6699	253.375	.1323
27	132.4538			.0000	.0000
28	-94.4166	.0000	573.8461		
29	4.1506	.0000	-2.2813		-12.3589
30	.0000	.0000	-.6759		93.8368
31	1437.5819	47922.8170	.4251	52.2737	179.3526
32	3563.6067	19332.3720	31.6064	186831840.0	-162.1279
33	873.9443	1704.9559	20497.2040	47.8885	31.5680
34	226684.0000	424.000	-534.6314	175149.4000	431.054
35	-406.3284	33139.6940	9513.0361	-331.018	-75.272

1	550.0000	93926.734	175046.500	747790.190	4607849.300
2	21007.0120	19662.7240	21654855.00	20907068.00	12.6240
3	224826.350	6388490.600	49737.736	314845.680	4738977.200
4	204822.830	120111.285	338136.000	41955.002	74.4709
5	4729206.000	1654834.800	5447420.800	747044.910	2.7102
6	-4236.4798	-1595.0596	-5233.1351	1138.1005	59.9603
7	1337.7006	348.8553	1144.5384	265.1041	-.2969
8	19154.2570	6191.2590	20312.5300	4520.0019	-.0884
9	175044.160	175044.160	-.003	.411	-.002
10	-866.832	-866.854	.001	25.154	.043
11	-258.013	-256.682	-.007	1.974	.006
12	-98.2620	-.1393	.0000	97592.396	-.3346
13	3.5246	-.0022	.0000	3996275.600	.5767
14	.0000	.0000	.0000	3998190.200	.0000
15	-98.5973	-.1398	.0000	-.0086	.1391
16	4.1014	-.0017	.0000	-.1391	.0022
17	.0000	-.0000	.0000	-.0022	-.0000
18	.1610	.1507	.1321	.2837	.0003
19	83.0657	83.5114	83.5110	-.0840	-.0002
20	431.0258	425.7593	-406.1106	-504.0819	214455.180
21	.0001	7.0177	.0000	2772.5123	690.000
22	66.3368	31.1637	30.9994	-30.0274	-.0402
23	6.2167	6.1618	-.8314	-.0028	19662.724
24	6600404.9000	1389.5369	.0138	-.580	236.1737
25	-.0138	139.0716	64.8640	.000	-1.6868
26	.0000	66.3778	7780.6699	253.375	.0998
27	133.5137			.0000	.0000
28	-98.5973	.0000	618.7958		
29	4.1014	.0000	-2.5690		-9.8808
30	.0000	.0000	-.7664		97.3185
31	1831.3375	40881.3130	.3211	58.5728	179.7106
32	3563.9580	21006.8370	31.6050	220581080.0	-157.5809
33	949.0447	2035.9108	22065.5030	41.4826	31.0013
34	226684.0000	424.000	-534.6314	175110.4600	431.043
35	-406.2484	23210.8730	7255.7177	-330.897	-75.213

1	530.0000	102050.261	175107.670	746014.990	4239445.300
2	19867.7480	18523.7660	21653219.00	20907206.00	11.6174
3	303095.710	6418168.700	147106.580	291635.400	4370715.600
4	179208.030	113305.905	315808.640	36854.794	74.3556
5	4356507.400	1534082.100	5051250.700	660163.050	3.9765
6	-3600.0229	-1375.9848	-4514.3860	1179.6520	55.2065
7	1225.2633	331.8798	1088.8446	245.1433	-.2644
8	18129.2160	5887.9451	19317.4060	4172.6100	-.0706
9	175105.420	175105.420	-.003	.331	-.002
10	-851.343	-851.363	.001	16.643	.069
11	-252.382	-251.132	-.008	3.881	.009
12	-95.4766	-.1390	.0000	97621.099	-.3303
13	3.5681	-.0021	.0000	4254339.800	.5663
14	.0000	.0000	.0000	4256271.300	.0000
15	-95.8077	-.1393	.0000	-.0087	.1387
16	4.1343	-.0016	.0000	-.1387	.0021
17	.0000	-.0000	.0000	-.0021	-.0000
18	.3892	.3629	.3425	.2786	.0003
19	82.3438	82.8645	82.8635	-.0822	-.0001
20	431.0406	425.4823	-406.2388	-509.2269	216524.600
21	.0001	7.1827	.0000	2767.6426	690.000
22	67.5047	31.0350	30.8712	-30.0322	-.0401
23	7.6906	7.6363	-.9232	-.0025	18523.767
24	6600404.9000	1723.8941	.0136	-.256	255.6222
25	-.0101	209.7411	84.5186	.000	-1.6867
26	.0000	86.0287	7780.6699	253.375	.1211
27	132.8110			.0000	.0000
28	-95.8077	.0000	587.4306		
29	4.1343	.0000	-2.3696		-11.5689
30	.0000	.0000	-.7037		94.8450
31	1553.4647	45570.0610	.3928	54.1036	179.4702
32	3563.7670	19860.8440	31.6058	197295550.0	-160.8724
33	895.5207	1799.7090	21003.2270	46.0499	31.4413
34	226684.0000	424.000	-534.6314	175137.3800	431.050
35	-406.3039	29829.6900	8760.4047	-330.985	-75.254

1	560.0000	89806.038	175007.820	748203.030	4800538.500
2	21616.1370	20271.7450	21655200.00	20907000.00	13.1550
3	180770.020	6371958.400	-4502.002	326087.560	4931613.000
4	218496.280	123644.301	349727.260	44658.292	74.5410
5	4923451.000	1717546.100	5653166.500	793159.570	2.1007
6	-4577.4938	-1712.3144	-5617.8295	1109.3267	62.6558
7	1397.4209	357.8054	1173.9024	275.6177	-.3131
8	19698.6650	6352.1324	20840.3300	4704.1765	-.0935
9	175005.440	175005.440	-.003	.381	-.002
10	-874.478	-874.503	.001	15.038	.030
11	-261.155	-259.760	-.007	.040	.005
12	-99.6565	-.1392	.0000	97577.289	-.3364
13	3.5013	-.0024	.0000	3847612.100	.5818
14	.0000	.0000	.0000	3849517.500	.0000
15	-99.9937	-.1396	.0000	-.0085	.1389
16	4.0431	-.0019	.0000	-.1389	.0024
17	.0000	-.0000	.0000	-.0024	-.0000
18	.0800	.0750	.0574	.2863	.0003
19	83.4403	83.8499	83.8498	-.0851	-.0003
20	431.0177	425.8874	-406.0285	-501.6948	213494.830
21	.0001	7.8520	.0000	2773.6448	690.000
22	65.7246	31.2259	31.0615	-30.0263	-.0403
23	5.4689	5.4128	-.7856	-.0030	20271.745
24	6600404.9000	1190.5323	.0139	-.717	225.7104
25	-.0157	105.5223	54.2612	.000	-1.6869
26	.0000	55.7769	7780.6699	253.375	.0880
27	133.8598			.0000	.0000
28	-99.9937	.0000	636.7876		
29	4.0431	.0000	-2.6823		-8.9630
30	.0000	.0000	-.8020		98.9009
31	1999.6301	38527.0040	.2812	61.3353	179.8536
32	3563.9993	21616.0980	31.6047	233563450.0	-155.3153
33	984.1463	2190.2428	22665.5230	38.5279	30.6101
34	226684.0000	424.000	-534.6314	175095.1000	431.039
35	-406.2164	19902.2030	6503.7080	-330.839	-75.189

1	540.0000	97988.188	175078.650	747078.970	4420902.400
2	20424.8600	19080.7080	21654212.00	20907136.00	12.1147
3	265551.720	6403877.100	100218.484	303394.000	4552095.400
4	191734.430	116666.165	326833.110	39355.006	74.4181
5	4540294.700	1593700.300	5246848.500	702735.890	3.3443
6	-3911.0872	-1483.0916	-4865.7862	1161.3635	57.4856
7	1260.3704	340.2218	1116.2132	254.9547	-.2821
8	18631.6260	6036.6800	19805.3810	4342.9705	-.0839
9	175076.350	175076.350	-.003	.323	-.002
10	-859.117	-859.138	.001	11.601	.056
11	-255.424	-254.134	-.008	2.201	.008
12	-96.8685	-.1393	.0000	97606.980	-.3326
13	3.5467	-.0021	.0000	4131596.400	.5716
14	.0000	.0000	.0000	4133519.500	.0000
15	-97.2018	-.1395	.0000	-.0086	.1390
16	4.1182	-.0016	.0000	-.1390	.0021
17	.0000	-.0000	.0000	-.0021	-.0000
18	.2639	.2466	.2271	.2812	.0003
19	82.7004	83.1831	83.1824	-.0832	-.0001
20	431.0336	425.6244	-406.1780	-506.5893	215463.770
21	.0001	7.3948	.0000	2770.5613	690.000
22	66.9298	31.1000	30.9359	-30.0293	-.0402
23	6.9579	6.9035	-.8770	-.0027	19080.708
24	6600404.9000	1573.2694	.0137	-.417	246.6466
25	-.0115	175.8662	75.4538	.000	-1.6867
26	.0000	76.9653	7780.6699	253.375	.1113
27	133.1642			.0000	.0000
28	-97.2018	.0000	602.3905		
29	4.1182	.0000	-2.4651		-10.7455
30	.0000	.0000	-.7337		95.9809
31	1683.7928	43229.9010	.3583	56.1854	179.5929
32	3563.8823	20424.4110	31.6054	208520290.0	-159.3849
33	920.1425	1906.4199	21532.0640	43.9406	31.2609
34	226684.0000	424.000	-534.6314	175124.2700	431.046
35	-406.2770	26520.0760	8007.9624	-330.943	-75.235

1	570.0000	85806.264	174959.790	748376.860	4999243.200
2	22254.4490	20909.9750	21655308.00	20906935.00	13.6906
3	133219.420	6354225.200	-62681.834	337012.130	5130273.800
4	232779.600	127268.513	361617.710	47468.653	74.6015
5	5123266.400	1781899.800	5864300.600	841153.890	1.4880
6	-4935.5726	-1835.3315	-6021.4287	1074.5541	65.6022
7	1459.7127	367.0986	1204.3916	286.5231	-.3307
8	20266.6330	6519.8164	21390.4750	4896.0321	-.0988
9	174957.360	174957.360	-.003	.537	-.002
10	-882.055	-882.083	.001	40.431	.017
11	-263.496	-262.066	-.006	-.321	.003
12	-101.0505	-.1397	.0000	97561.580	-.3381
13	3.4759	-.0027	.0000	3683157.000	.5867
14	.0000	.0000	.0000	3685052.500	.0000
15	-101.3893	-.1393	.0000	-.0085	.1394
16	4.0626	-.0022	.0000	-.1394	.0027
17	.0000	-.0000	.0000	-.0027	-.0000
18	.0209	.0196	.0030	.2880	.0003
19	83.8247	84.1991	84.1991	-.0858	.0003
20	431.0096	426.0093	-405.9246	-499.4190	212579.120
21	.0001	8.0985	.0000	2774.1217	690.000
22	65.0924	31.2865	31.1219	-30.0258	-.0403
23	4.7168	4.6591	-.7389	-.0032	20909.975
24	6600404.9000	1023.1338	.0139	-.812	216.7457
25	-.0175	79.6053	45.1605	.000	-1.6870
26	.0000	46.0780	7780.6699	253.375	.0776
27	134.2028			.0000	.0000
28	-101.3893	.0000	656.6277		
29	4.0626	.0000	-2.8063		-7.9757
30	.0000	.0000	-.8411		100.8581
31	2193.2507	36163.2790	.2381	64.5651	180.0000
32	3564.0125	22254.4490	31.6045	247565930.0	-152.3383
33	1028.8670	2385.4877	23274.3270	34.8283	30.0312
34	226684.0000	424.000	-534.6314	175077.9000	431.035
35	-406.1801	16594.2090	5751.9526	-330.763	-75.161

TABLE AP 3-2 (Sheet 12 of 13)

PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

1	580.0000	81747.740	174892.830	748377.490	5204258.300
2	22924.4610	21579.9220	21655246.00	20906872.00	14.2614
3	81996.140	6335230.800	-124909.428	347556.720	5335253.400
4	247699.590	130987.477	373619.050	50390.141	74.6613
5	5328867.700	1647966.700	6081055.700	891107.660	.8806
6	-5312.3496	-1964.0481	-6445.6961	1033.2314	68.8328
7	1524.7688	376.7610	1236.0924	297.8479	-.3500
8	20860.1790	6694.8958	21964.8820	5096.1768	-.1068
9	174890.360	174890.360	-.003	.605	-.001
10	-889.297	-889.331	.001	49.228	.005
11	-266.155	-264.682	-.006	-3.891	.002
12	-102.4430	-.1385	.0000	97545.182	-.3405
13	3.4471	-.0031	.0000	3500904.700	.5912
14	.0000	-.0000	.0000	3502790.300	.0000
15	-102.7843	-.1408	.0000	-.0083	.1302
16	4.0383	-.0027	.0000	-.1382	.0031
17	.0000	-.0000	.0000	-.0031	-.0000
18	-.0166	-.0156	-.0312	.2914	.0002
19	84.2194	84.5595	84.5596	-.0867	-.0013
20	431.0029	420.1252	-405.7754	-497.2460	211704.630
21	.0001	8.3580	.0000	2774.1233	690.000
22	64.4392	31.3452	31.1804	-30.0259	-.0403
23	3.9627	3.9025	-.6899	-.0034	21579.923
24	6600404.9000	810.7679	.0140	-.894	206.3031
25	-.0198	53.0327	34.5291	.000	-1.6871
26	.0000	36.0489	7780.6699	253.375	.0653
27	134.5431			.0000	.0000
28	-102.7843	.0000	678.6598		
29	4.0383	.0000	-2.9427		-6.8821
30	.0000	.0000	-.8840		103.4133
31	2418.2384	33780.0870	.1915	68.3804	-179.8613
32	3564.0045	22924.4430	31.6043	262702030.0	-148.1533
33	1090.5466	2651.1624	23914.2890	29.8756	29.0504
34	226684.0000	424.000	-534.6314	175057.6900	431.031
35	-406.1369	13287.1386	5000.5131	-330.648	-75.127

1	600.0000	73636.642	174674.030	748104.560	5634535.400
2	24372.0390	23027.4150	21654653.00	20906752.00	15.4405
3	-32319.170	6293174.100	-262980.890	367211.070	5765464.000
4	279559.750	138723.220	399198.790	56582.090	74.7703
5	5758589.700	1985552.800	6532453.500	997242.520	-.3212
6	-6142.5333	-2248.5821	-7377.2381	924.4702	76.3100
7	1662.3406	396.7613	1301.7104	321.3303	-.3921
8	22130.6960	7068.9830	23192.2020	5523.1813	-.1600
9	174671.340	174671.340	-.004	-26.172	-.001
10	-897.511	-897.478	.001	-4928.019	-.008
11	-366.189	-367.161	-.002	-277.533	-.001
12	-106.1749	.0844	.0000	97509.860	-.1544
13	3.2239	.0030	.0000	3057324.600	.6002
14	.0000	.0006	.0000	3059187.800	.0000
15	-106.3296	.0405	.0000	.0047	-.0843
16	3.8330	.0062	.0000	.0843	-.0030
17	.0000	.0000	.0000	.0030	-.0000
18	-.0596	-.0563	-.0698	.2944	.0162
19	85.0377	85.3121	85.3123	-.1204	-.0644
20	430.9023	420.3414	-405.2771	-493.1761	210060.220
21	.0001	6.9198	.0000	2773.3747	690.000
22	63.0658	31.4559	31.2908	-30.0268	-.0404
23	1.5304	1.4671	-.4357	-.0039	23027.415
24	6600404.9000	355.1093	.0142	-.458	185.6465
25	-.0191	17.6696	13.7064	.000	-1.6875
26	.0000	14.9755	7780.6699	253.375	.0503
27	135.2167			.0000	.0000
28	-106.3296	.0000	730.9035		
29	3.8330	.0000	-3.2608		-4.0607
30	.0000	.0000	-.9841		112.7217
31	2998.1440	28971.3760	.0862	78.4667	-179.2601
32	3563.9654	24371.8300	31.6047	296936390.0	-128.7152
33	1365.1790	3798.0465	25296.9330	9.8103	22.7170
34	226664.0000	424.000	-534.6314	175002.3500	431.024
35	-406.0152	6677.7441	3498.8535	-330.247	-75.030

1	590.0000	77690.913	174803.670	748276.310	5415905.500
2	23629.0630	22284.4730	21655083.00	20906810.00	14.8414
3	26903.861	6314909.200	-191671.300	357652.730	5546870.800
4	263284.710	134805.010	386343.750	53427.076	74.7206
5	5540551.500	1915824.100	6303685.000	943107.190	.2779
6	-5709.6891	-2100.8774	-6892.6425	984.7305	72.3901
7	1592.7818	386.0146	1260.0767	309.6153	-.3711
8	21481.6250	6878.0440	22565.7620	5305.3073	-.1103
9	174801.170	174801.170	-.004	1.284	-.001
10	-896.124	-896.170	.001	175.860	-.006
11	-266.397	-264.845	-.005	-11.984	-.000
12	-103.8363	-.1402	.0000	97527.987	-.3422
13	3.4115	-.0041	.0000	3293081.800	.5949
14	.0000	-.0000	.0000	3294956.500	.0000
15	-104.1792	-.1419	.0000	-.0083	.1309
16	4.0065	-.0039	.0000	-.1399	.0041
17	.0000	-.0000	.0000	-.0041	-.0000
18	-.0325	-.0306	-.0452	.2937	.0003
19	84.6248	84.9315	84.9316	-.0868	.0009
20	430.9971	420.2358	-405.5739	-495.1677	210868.110
21	.0001	8.6313	.0000	2773.8459	690.000
22	63.7641	31.4018	31.2368	-30.0262	-.0404
23	3.2051	3.1418	-.6353	-.0036	22284.473
24	6600404.9000	586.0074	.0141	-.928	195.8706
25	-.0226	30.8296	23.8799	.000	-1.6873
26	.0000	25.4024	7780.6699	253.375	.0525
27	134.8810			.0000	.0000
28	-104.1792	.0000	703.2507		
29	4.0065	.0000	-3.0934		-5.6287
30	.0000	.0000	-.9314		107.0313
31	2682.7346	31390.8710	.1411	72.9711	-179.7268
32	3563.9821	23629.0120	31.6043	279103750.0	-141.5816
33	1185.8126	3054.3411	24587.8110	22.5680	27.1882
34	226684.0000	424.000	-534.6314	175033.3800	431.027
35	-406.0838	9981.4141	4249.4331	-330.488	-75.086

1	605.0000	71610.706	174507.060	747983.560	5746590.200
2	24758.8730	23414.2360	21654703.00	20906723.00	15.7476
3	-63588.201	6281741.300	-300400.100	371752.560	5877487.500
4	287960.950	140719.790	405749.180	58703.764	74.8044
5	5870082.800	2021144.600	6649224.600	1025139.870	-.6109
6	-6365.2043	-2324.6256	-7626.7245	892.0383	78.4436
7	1698.3759	401.9016	1318.5748	327.3747	-.4074
8	22468.3370	7168.2858	23517.9990	5636.3131	-.1146
9	174594.510	174594.520	-.004	5.126	-.001
10	-906.758	-906.665	.001	998.769	-.016
11	-255.175	-255.600	-.003	46.373	-.002
12	-105.9468	.0362	.0000	97500.282	-.1208
13	3.2540	.0079	.0000	2924668.900	.6166
14	.0000	-.0001	.0000	2926525.900	.0000
15	-106.1259	.0466	.0000	.0021	-.0362
16	3.8706	.0097	.0000	.0362	-.0079
17	.0000	.0000	.0000	.0070	-.0000
18	-.0568	-.0537	-.0666	.2975	-.0001
19	85.2486	85.5072	85.5073	-.0839	.0087
20	430.9422	420.3924	-405.0990	-492.2104	209677.340
21	.0001	9.0702	.0000	2773.0428	690.000
22	62.7075	31.4820	31.3166	-30.0271	-.0404
23	2.0193	1.9667	-.4581	-.0040	23414.236
24	6600404.9000	237.3982	.0143	-.174	180.7103
25	-.0227	12.5490	8.6196	.000	-1.6875
26	.0000	9.8923	7780.6699	253.375	.0528
27	135.3836			.0000	.0000
28	-106.1259	.0000	746.3754		
29	3.8706	.0000	-3.3538		-3.0348
30	.0000	.0000	-1.0133		117.2365
31	3179.5844	27751.5530	.0570	81.8474	-178.8927
32	3563.9530	24758.5770	31.6050	306439540.0	-114.7809
33	1560.0945	4591.5876	25603.8040	-2.7435	16.7932
34	226684.0000	424.000	-534.6314	174983.9800	431.022
35	-405.9740	5020.8886	3123.7856	-330.100	-74.909

CHI TILDE ($\tilde{\chi}$) INITIATION

1	591.1100	77240.744	174789.730	748262.530	5439821.600
2	23709.5450	22364.9490	21655063.00	20906803.00	14.9069
3	20541.088	6312568.600	-199350.460	358742.540	5570784.400
4	265057.090	135235.000	387754.510	53771.488	74.7272
5	5564435.300	1923470.300	6328770.900	949009.270	..2113
6	-5755.1544	-2116.4554	-6943.7514	978.8730	72.8062
7	1600.5210	387.9552	1272.8187	310.9494	-.3736
8	21552.4360	6898.9027	22634.1960	5329.1083	-.1129
9	174787.220	174787.220	-.004	.153	-.001
10	-896.914	-896.963	.001	-45.966	-.007
11	-271.101	-269.547	-.005	-9.805	-.000
12	-103.9912	-.1397	.0000	97525.981	-.3448
13	3.4069	-.0044	.0000	3267089.700	.5953
14	.0000	.0000	.0000	3268963.000	.0000
15	-104.3367	-1.0000	.0000	-.0083	.1304
16	4.0021	-.1569	.0000	-.1394	.0044
17	.0000	-.0000	.0000	-.0044	-.0000
18	-.0329	-.0311	-.0455	.2940	.0006
19	84.6705	84.9735	84.9736	-.0884	-.0029
20	430.9967	420.2478	-405.5419	-494.9425	210777.450
21	.0001	8.0626	.0000	2773.8080	690.000
22	63.6877	31.4079	31.2429	-30.0263	-.0404
23	3.1207	3.0569	-.6286	-.0036	22364.949
24	6600404.9000	553.5575	.0140	-.928	194.3992
25	-.0229	28.0458	22.6069	.000	-1.6873
26	.0000	23.8799	7780.6699	253.375	.0506
27	134.9183			.0000	.0000
28	-104.3367	.0000	706.3005		
29	4.0021	.0000	-3.1119		-5.4750
30	.0000	.0000	-.9372		107.5339
31	2714.9786	31123.6810	.1352	73.5368	-179.7087
32	3563.9792	23709.4890	31.6042	281008780.0	-140.5966
33	1199.9725	3113.6726	24664.7300	21.5156	26.8785
34	226684.0000	424.000	-534.6314	175030.3100	431.027
35	-406.0771	9614.5898	4166.0918	-330.462	-75.080

1	610.0000	69585.725	174501.410	747886.800	5860538.700
2	25156.4470	23811.7060	21654579.00	20904696.00	16.0509
3	-95972.193	6209927.100	-339250.280	376130.600	5991404.200
4	296545.550	142742.620	412385.790	59856.261	74.8374
5	5983289.400	2057240.500	6767649.400	1053611.000	-.9178
6	-6588.4910	-2401.0719	-7877.5326	859.1226	80.6821
7	1735.6735	407.2822	1336.2277	333.6730	-.4108
8	22816.2410	7270.6514	23853.8440	5752.7521	-.1308
9	174498.820	174498.820	-.004	-2.604	-.001
10	-908.038	-907.861	.001	-442.702	-.027
11	-282.913	-283.676	-.004	-39.097	-.004
12	-105.7355	.0634	.0000	97490.659	-.1342
13	3.3068	.0147	.0000	2790616.000	.6211
14	.0000	.0000	.0000	2792466.800	.0000
15	-105.8690	.0000	.0000	.0037	-.0673
16	3.9280	.0000	.0000	.0633	-.0147
17	.0000	.0000	.0000	.0147	-.0000
18	-.0334	-.0316	-.0440	.2981	-.0114
19	85.4633	85.7062	85.7063	-.0931	-.0443
20	430.9881	420.4423	-404.8808	-491.2636	209295.940
21	.0001	9.2247	.0000	2772.7773	690.000
22	62.3430	31.5074	31.3421	-30.0274	-.0405
23	2.5833	2.5341	-.5023	-.0041	23811.706
24	6600404.9000	146.9616	.0144	-.001	177.0125
25	-.0237	6.2179	4.6996	.000	-1.6876
26	.0000	4.0096	7780.6699	253.375	.0559
27	135.5506			.0000	.0000
28	-105.8690	.0000	761.9978		
29	3.9280	.0000	-3.4475		-1.4439
30	.0000	.0000	-1.0428		121.3606
31	3380.0934	26524.3700	.0265	85.5245	-178.3661
32	3563.9317	25150.1620	31.6052	316362460.0	-73.5851
33	2143.5433	6928.0555	26041.8560	-36.0941	-4.0916
34	226684.0000	424.000	-534.6314	174963.4100	431.021
35	-405.9278	3370.8067	2748.8995	-329.924	-74.957

TABLE AP 3-2. (Sheet 13 of 13)
PREDICTED S-IVB-205 STAGE POWERED FLIGHT TRAJECTORY

GUIDANCE CUTOFF COMMAND

1	614.5396	67748.272	254414.000	747857.320	5965677.300
2	25527.1300	24182.4610	21654525.00	20906671.00	16.3480
3	-186344.341	6258869.200	-375529.950	379961.970	6096521.000
4	304503.790	144603.040	418489.510	61384.451	74.6636
5	6087599.000	2090462.100	6876644.300	1079971.600	-1.1875
6	-6791.8568	-2470.8691	-8106.5261	828.7621	120.8295
7	1770.6972	412.3907	1352.9878	339.6295	.0000
8	23141.4510	7366.3799	24167.9140	5861.5270	-.0000
9	254414.000	254414.000	-.004	-.002	-.002
10	.001	.000	.001	3.515	-.037
11	-.005	.000	-.005	-11.699	-.005
12	-105.6837	.0004	.0000	97475.151	.0000
13	3.3174	-.0005	.0000	2673455.800	.0000
14	.0000	-.0000	.0000	2675301.800	.0000
15	-105.6837	.0000	.0000	.0000	.0000
16	3.3174	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0085	.0082	-.0067	.0000	.0000
19	85.6616	85.8905	85.8905	.0000	.0000
20	4733.9002	426.4865	-53.7430	-490.4193	208955.830
21	.0001	9.3684	.0000	2772.6965	690.000
22	62.0065	31.5297	31.3644	-30.0275	-.0405
23	2.8952	2.8510	-.5046	-.0043	24182.461
24	6600404.9000	146.9616	.0144	-.001	177.0125
25	-.0237	8.2179	4.5996	.000	-1.6876
26	.0000	.0000	7780.6699	253.375	.0559
27	135.7016			.0000	.0000
28	-105.6837	.0000	775.5635		
29	3.3174	.0000	-3.5308		
30	.0000	.0000	-1.0701		
31	3563.8869	25527.1060	.0024	89.2673	.0000
32	3581.2907	25403.0540	31.6052	325756560.0	
33					
34	226684.0000	424.000	-534.6314	174942.1300	431.019
35	-405.8798	1879.5586	2408.7261	.000	.000

1	620.0000	67667.103	.000	747876.320	6093229.400
2	25547.4050	24202.7160	21654516.00	20906643.00	16.6975
3	-163838.680	6245238.900	-420248.280	384977.440	6224046.700
4	314203.260	146853.920	425874.330	63241.091	74.8946
5	6213949.500	2130673.500	7008571.600	1112013.400	-1.5084
6	-6937.5695	-2519.8759	-8267.3127	826.8780	-.0000
7	1780.3766	411.7123	1350.7621	340.0315	.0000
8	23118.6470	7356.3398	24134.9730	5868.2393	-.0000
9	-.004	.000	-.004	-.002	-.002
10	.001	.000	.001	3.515	-.037
11	-.006	.000	-.006	-11.699	-.005
12	-105.6837	.0000	.0000	97468.143	.0000
13	3.3174	.0000	.0000	2667361.300	.0000
14	.0000	-.0000	.0000	2669207.500	.0000
15	-105.6837	.0000	.0000	.0000	.0000
16	3.3174	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0086	.0082	-.0030	.0000	.0000
19	85.8996	86.1157	86.1157	.0000	.0000
20	.0000	423.2281	.0000	-484.9013	206622.080
21	.0001	9.3762	.0000	2772.7485	690.000
22	61.5981	31.5855	31.3901	-30.0275	-.0405
23	3.2547	3.2165	-.4983	-.0043	24202.716
24	6600404.9000	146.9616	.0144	-.001	177.0125
25	-.0237	8.2179	4.5996	.000	-1.6876
26	.0000	.0000	7780.6699	253.375	.0559
27	135.8815			.0000	.0000
28	-105.6837	.0000	776.2782		
29	3.3174	.0000	-3.5373		
30	.0000	.0000	-1.0730		
31	3563.8773	25547.4390	.0040	89.4815	.0000
32	3592.7147	25342.3800	31.6052	326274730.0	
33					
34	226684.0000	424.000	-534.6314	174942.1300	431.019
35	-405.8798	1879.5586	2408.7261	.000	.000

1	615.0000	67723.531	8847.120	747859.050	5976430.000
2	25545.1870	24200.5160	21654525.00	20906669.00	16.3775
3	-129473.528	6257730.100	-379267.130	380342.980	6107272.000
4	305319.850	144793.000	419112.750	61540.946	74.8662
5	6098259.200	2093855.300	6887776.700	1082672.500	-1.2148
6	-6807.9603	-2476.3518	-8124.5138	827.0880	4.2031
7	1772.8541	412.6228	1353.7495	339.9864	.0000
8	23155.4240	7370.3403	24180.9070	5867.4914	-.0000
9	8847.116	8847.120	-.004	-.002	-.002
10	.001	.000	.001	3.515	-.037
11	-.005	.000	-.005	-11.699	-.005
12	-105.6837	.0000	.0000	97470.298	.0000
13	3.3174	.0000	.0000	2669604.900	.0000
14	.0000	-.0000	.0000	2671451.000	.0000
15	-105.6837	.0000	.0000	.0000	.0000
16	3.3174	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0076	.0072	-.0046	.0000	.0000
19	85.6819	85.9096	85.9096	.0000	.0000
20	164.6190	427.5861	-53.7430	-489.9875	208830.940
21	.0001	9.3754	.0000	2772.7012	690.000
22	61.9721	31.5320	31.3666	-30.0275	-.0405
23	2.9235	2.8799	-.5037	-.0043	24200.516
24	6600404.9000	146.9616	.0144	-.001	177.0125
25	-.0237	8.2179	4.5996	.000	-1.6876
26	.0000	.0000	7780.6699	253.375	.0559
27	135.7169			.0000	.0000
28	-105.6837	.0000	776.0087		
29	3.3174	.0000	-3.5350		
30	.0000	.0000	-1.0720		
31	3563.8852	25545.1750	.0039	89.4581	.0000
32	3591.4663	25348.9980	31.6052	326217700.0	
33					
34	226684.0000	424.000	-534.6314	174942.1300	431.019
35	-405.8798	1879.5586	2408.7261	.000	.000

ORBIT INSERTION

1	624.5396	67667.103	.000	747893.360	6199274.600
2	25547.3990	24202.6930	21654510.00	20906621.00	16.9882
3	-195598.390	6233710.600	-458071.120	388231.130	6330056.000
4	322300.460	148720.950	431999.730	64784.697	74.9199
5	6318817.100	2164037.600	7118033.800	1138652.700	-1.7707
6	-7054.5863	-2559.1523	-8396.1692	826.8780	-.0000
7	1787.0023	410.8376	1347.8925	340.0315	.0000
8	23082.6740	7342.8160	24090.6090	5868.2393	-.0000
9	-.004	.000	-.004	-.002	-.002
10	.001	.000	.001	3.515	-.037
11	-.006	.000	-.006	-11.699	-.005
12	-105.6837	.0000	.0000	97467.989	.0000
13	3.3174	.0000	.0000	2666735.200	.0000
14	.0000	-.0000	.0000	2668581.500	.0000
15	-105.6837	.0000	.0000	.0000	.0000
16	3.3174	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0093	.0088	-.0019	.0000	.0000
19	86.0973	86.3031	86.3031	.0000	.0000
20	.0000	419.1844	.0000	-480.2684	204647.970
21	.0001	9.3761	.0000	2772.7953	690.000
22	61.2583	31.5759	31.4104	-30.0274	-.0405
23	3.5565	3.5223	-.4934	-.0043	24202.693
24	6600404.9000	146.9616	.0144	-.001	177.0125
25	-.0237	8.2179	4.5996	.000	-1.6876
26	.0000	.0000	7780.6699	253.375	.0559
27	136.0281			.0000	.0000
28	-105.6837	.0000	776.3602		
29	3.3174	.0000	-3.5379		
30	.0000	.0000	-1.0732		
31	3563.8805	25547.4050	.0040	89.4814	.0000
32	3592.7089	25342.4090	31.6051	326274890.0	
33					
34	226684.0000	424.000	-534.6314	174942.1300	431.019
35	-405.8798	1879.5586	2408.7261	.000	.000

TABLE AP 3-3 (Sheet 1 of 4)
PREDICTED S-IVB-205 STAGE ORBITAL TRAJECTORY

CONSTANT VALUE FOR THE ENTIRE ANALYSIS

.805611+02	.285220+02	.720000+02	.100000+01	.321740+02
.140765+17	.209257+08	.208556+08	.729211-04	
.102345-02	.230000-05	.787500-05	.000000	
.805611+02	.806540+02	.806435+02	.782994+02	.646538+02
.285220+02	.284637+02	.285424+02	.266285+02	.323481+02
.000000	.000000	.000000	.000000	.180000+02

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) GRP	DTHETA(M)GRP	F AUX SB X	I SB XX	EPS(THETA)
13	PSI(M) GRP	D-PSI(M)GRP	F AUX SB Y	I SB YY	EPS(PSI)
14	PHI(M) GRP	D-PHI(M)GRP	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	RU	RHO	RHO PRIME	G(RHO)	G(PSI)
23	ALPHA*	ALPHA	BETA	CHORD FORCE	V SB RM
24	Y(V,T)	DELTA-D-X(V)	SPCY	DELTA-D-Z(V)	TAU(3)
25	DELTA-T(3)	DELTA-D-Y(V)	T(3)	THETA(T)	PHI(T)
26	T(2)	DELTA-T(CO)	V(T)	TAU(2)	CHI(P)-TILDE
27	SAF(1)			V SB W	E SB W
28	THETA SB C	D-THETA SB C	X SB CG		
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
34	AVG FL HMR	AVG ISP HMR	AVG WDT HMR	AVG FL RMR	AVG ISP RMR
35	AVG WDT HMR	W(LOX)RES	W(LH2)RES	D-W(LOX)	D-W(LH2)

INSERTION

1	624.5395	67667.103	.000	747890.760	6199275.400
2	25547.4030	24202.6930	21654539.00	20906651.00	16.9881
3	-195898.510	.000	-455860.910	.000	17085943.000
4	322300.350	.000	431210.940	.000	76.1245
5	6318816.900	.000	7111719.100	.000	-21.3019
6	-7054.5863	.0000	-8388.6950	.0000	.1514
7	1787.0022	.0000	1352.9186	.0000	-.0381
8	23082.6740	.0000	24092.9300	.0000	.0403
9	318.496	.000	-.004	.000	-.000
10	-80.099	.000	.001	.359	.359
11	84.794	.000	-.006	.049	.049
12	-105.6837	.0000	318.5000	.000	.0000
13	3.3174	.0000	-80.1000	.000	.0000
14	.0000	-.3000	84.8000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0092	.0087	-.0019	.0000	.0000
19	86.0973	86.3030	86.3030	.0000	.0000
20	58.9815	.0000	-5.4000	.0000	.000
21	.0001	9.3761	.0000	2772.7882	690.000
22	61.2584	31.5759	31.4103	-30.0274	-.0405
23	3.5376	3.5047	-.4821	-.0043	24202.693
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	144.6528			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3563.8909	25547.3670	.00403	89.4818	.0000
32	3592.7251	25342.3310	31.6050	326274980.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

INITIATE PITCH TO LOCAL HORIZONTAL

1	634.5395	67622.200	.000	747931.370	6432883.200
2	25548.9250	24204.1830	21654535.00	20906606.00	17.6283
3	-267434.560	.000	-541168.000	.000	17287032.000
4	340241.460	.000	444706.570	.000	75.7961
5	6549246.400	.000	7352157.500	.000	-21.6291
6	-7312.4627	.0000	-8672.5282	.0000	.1515
7	1801.1954	.0000	1346.1794	.0000	-.0381
8	23002.7400	.0000	23994.2210	.0000	.0403
9	318.496	.000	-.004	.000	-.000
10	-80.099	.000	.001	.405	.405
11	84.793	.000	-.007	.048	.048
12	-105.9111	-.3005	318.5000	.000	.0000
13	3.3174	-.0001	-80.1000	.000	.0000
14	.0132	.0174	84.8000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.3000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0100	.0094	-.0001	.0000	.0000
19	86.5328	86.7155	86.7155	.0000	.0000
20	58.9815	.9295	-5.4000	-.0851	5.019
21	.0001	9.3765	.0000	2772.8996	690.000
22	60.5094	31.6172	31.4315	-30.0273	-.0405
23	3.9800	3.9521	-.4720	-.0043	24204.182
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	144.7544			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3563.8870	25548.7120	.00415	89.4978	.0000
32	3593.5821	25337.7910	31.6050	326314470.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

MAINTAIN LOCAL HORIZONTAL

1	648.5512	67547.311	.000	747993.530	6760234.400
2	25550.9910	24206.2080	21654543.00	20906553.00	18.5254
3	-372617.560	.000	-665400.040	.000	17558678.000
4	365616.760	.000	463500.910	.000	75.3423
5	6870741.700	.000	7687356.600	.000	-22.0875
6	-7672.2962	.0000	-9068.2462	.0000	.1334
7	1820.7473	.0000	1336.4303	.0000	-.0336
8	22885.8310	.0000	23850.2410	.0000	.0355
9	279.983	.000	-.004	.000	-.000
10	-70.551	.000	.001	.071	.071
11	74.529	.000	-.001	.047	.047
12	-110.1716	-.3005	279.9876	.000	.0000
13	3.3075	-.0013	-70.5521	.000	.0000
14	.2566	.0173	74.5300	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.3000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0110	.0104	.0026	.0000	.0000
19	87.1444	87.2948	87.2948	.0000	.0000
20	55.2348	2.1702	-5.0690	-.4887	11.653
21	.0001	9.3770	.0000	2773.0701	690.000
22	59.4588	31.6668	31.5010	-30.0272	-.0406
23	.8301	.6935	-.4563	-.0043	24206.208
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	144.8948			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3563.8908	25550.9590	.00431	89.5198	.0000
32	3594.7536	25331.5910	31.6050	326368020.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	1000.0000	66981.859	.000	753863.680	14870477.800
2	25545.1060	24201.3750	21662427.00	20908566.00	41.0224
3	-4557146.700	.000	-3471598.300	.000	24463578.000
4	1074360.300	.000	878362.750	.000	66.9085
5	14180576.800	.000	15185576.700	.000	-33.5088
6	-15833.0078	.0000	-17888.4950	.0000	-.0000
7	2154.9149	.0000	991.0266	.0000	.0000
8	18176.3240	.0000	18209.1220	.0000	-.0000
9	-.004	.000	-.004	.000	-.001
10	.000	.000	.000	.001	.001
11	-.000	.000	-.000	.003	.003
12	-134.5017	-.0671	.0000	.000	.0000
13	2.9073	-.0019	.0000	.000	.0000
14	1.5986	.0034	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0096	.0658	.0978	.0000	.0000
19	102.2049	101.5538	101.5536	.0000	.0000
20	-.0000	2.4873	-1.0737	-.6963	12.326
21	.0001	9.3480	.0000	2789.1731	690.000
22	33.3510	29.7876	29.6276	-30.0092	-.0391
23	.0350	.0129	-.0329	-.0041	24201.375
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	147.7633			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3563.9977	25553.5770	.00435	89.5558	22.1089
32	3596.5509	25322.2810	31.6091	326189540.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	2000.0000	66447.168	.000	819774.590	38245754.000
2	25457.0030	24121.4220	21745494.00	20925720.00	104.7587
3	-26438962.000	.000	-29019916.000	.000	38949480.000
4	2794963.400	.000	1094988.800	.000	69.7096
5	20854861.000	.000	20161865.000	.000	-65.3339
6	-23311.2980	.0000	-23657.6170	.0000	-.0000
7	629.9491	.0000	-612.3186	.0000	-.0000
8	-6166.8074	.0000	-9381.0619	.0000	-.0000
9	-.003	.000	-.003	.000	-.000
10	-.001	.000	-.001	.059	.059
11	-.000	.000	-.000	-.058	-.058
12	158.4806	-.0670	.0000	.000	.0000
13	-.3377	-.0039	.0000	.000	.0000
14	3.3002	-.0006	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.2335	.2212	.2269	.0000	.0000
19	123.5771	121.6038	121.6037	.0000	.0000
20	-.0000	1.2437	-.0241	-.6145	6.163
21	.0001	9.0839	.0000	2916.2185	690.000
22	-27.2204	1.6861	1.6732	-29.8132	-.0027
23	.9524	.1437	.9408	-.0026	24121.422
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	151.8101			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3568.1391	25533.3170	.00412	89.6541	74.3244
32	3597.6604	25323.7990	31.6434	323707140.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

TABLE AP 3-3 (Sheet 2 of 4)
PREDICTED S-IVB-205 STAGE ORBITAL TRAJECTORY

1	3000.0000	66412.657	.000	910501.360	61216946.000
2	25360.7450	24008.5250	21820737.00	20910238.00	167.7410
3	-42233274.000	.000	-42724801.000	.000	42016138.000
4	1448729.100	.000	-93423.014	.000	279.9925
5	4398800.000	.000	516966.690	.000	-79.2897
6	-5044.2244	.0000	-610.3183	.0000	-.0000
7	-3351.7231	.0000	-1493.0550	.0000	-.0000
8	-23232.1120	.0000	-25309.4000	.0000	-.0000
9	-.001	.000	-.001	.000	-.000
10	-.000	.000	-.000	.001	.001
11	-.000	.000	-.000	-.023	-.023
12	91.4299	-.0672	.0000	.000	.0000
13	-3.1708	-.0011	.0000	.000	.0000
14	.9757	-.0037	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.1243	.1176	.0772	.0000	.0000
19	106.1613	105.2779	105.2782	.0000	.0000
20	-.0000	.8291	-.0450	-.4212	4.109
21	.0000	8.7494	.0000	3133.3240	690.000
22	-85.5280	-28.1700	-28.0167	-29.5786	.0367
23	.6804	.0311	.6797	-.0014	24008.525
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	132.4683			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3568.7479	25520.5480	.00329	89.5647	155.7322
32	3592.2850	25353.3340	31.6128	321474810.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

START LOX DUMP

1	5665.9999	66114.692	.000	751452.770	8808644.900
2	25546.6610	24204.5000	21662044.00	20910593.00	23.5336
3	-1047554.970	.000	726314.300	.000	6133768.000
4	-3340850.900	.000	-73241.397	.000	119.7649
5	-7978378.800	.000	-1041323.140	.000	4.9464
6	9516.2482	.0000	1205.9961	.0000	-.0000
7	5065.4880	.0000	1551.4792	.0000	.0000
8	21671.1710	.0000	25470.9720	.0000	.0000
9	-.004	.000	-.004	.000	-.000
10	.001	.000	.001	-.009	-.009
11	.000	.000	.000	.058	.058
12	-87.3718	-.0672	.0000	.000	.0000
13	3.1498	.0012	.0000	.000	.0000
14	-1.0418	.0037	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.0762	-.0532	-.0953	.0000	.0000
19	73.1474	74.0571	74.0572	.0000	.0000
20	-.0000	.4390	-.0200	-.2756	2.175
21	.0001	9.3603	.0000	2782.5595	690.000
22	107.2407	27.8187	27.6636	-30.0142	-.0374
23	.5827	-.0871	-.5762	-.0042	24204.499
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	132.3269			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3564.0180	25554.5330	.00463	89.5673	-21.1199
32	3597.1356	25319.1200	31.6132	326200870.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	4000.0000	66174.114	.000	887669.370	47110007.000
2	25384.7030	24036.9740	21802206.00	20914539.00	129.0732
3	-34638923.000	.000	-30027292.000	.000	32573095.000
4	-2910082.700	.000	-1265590.300	.000	248.0905
5	-16659698.800	.000	-19750915.000	.000	-48.7386
6	-18638.5620	.0000	23088.6380	.0000	-.0000
7	-4417.3769	.0000	-578.9428	.0000	.0000
8	-14521.2561	.0000	-10533.8882	.0000	.0000
9	-.002	.000	-.002	.000	-.000
10	.000	.000	.000	-.007	-.007
11	.000	.000	.000	.018	.018
12	24.2875	-.0670	.0000	.000	.0000
13	-2.1325	.0030	.0000	.000	.0000
14	-2.5418	-.0025	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.2140	-.2026	-.1524	.0000	.0000
19	66.9687	68.2559	68.2555	.0000	.0000
20	-.0000	.6218	-.0514	-.3755	3.081
21	.0000	8.8307	.0000	3083.2177	690.000
22	-156.3372	-23.6780	-23.5424	-29.6370	.0325
23	.4849	-.1766	-.4517	-.0017	24036.973
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	150.2572			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3569.3324	25518.7170	.00331	89.5895	-126.4603
32	3593.0195	25350.4830	31.6213	322023290.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	5999.9999	63063.470	.000	750062.940	1359369.800
2	25585.5050	24240.6200	21656646.00	20906585.00	3.7525
3	703860.570	.000	-532968.780	.000	10846074.200
4	-1364343.200	.000	435308.690	.000	84.2838
5	-377949.380	.000	7336219.700	.000	-10.8655
6	845.1153	.0000	-8649.8534	.0000	-.0000
7	6641.2913	.0000	1455.2136	.0000	.0000
8	23297.7830	.0000	24034.9850	.0000	.0000
9	-.004	.000	-.004	.000	-.000
10	.000	.000	.000	-.002	-.002
11	.000	.000	.000	.022	.022
12	-109.8080	-.0672	.0000	.000	.0000
13	3.3088	-.0003	.0000	.000	.0000
14	.2385	.0039	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.0473	.0448	.0359	.0000	.0000
19	86.7528	86.9237	86.9236	.0000	.0000
20	-.0000	6.5815	-.4088	-.7688	13.527
21	.0001	9.3807	.0000	2778.7469	690.000
22	82.9846	31.6364	31.4706	-30.0214	-.0405
23	.2197	-.0199	-.2191	-.0042	24240.620
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	140.7055			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3564.1263	25586.2620	.00715	89.9136	5.2523
32	3615.4921	25222.7550	31.6053	327250060.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	5000.0000	66132.169	.000	786727.700	24036045.000
2	25496.8320	24161.9940	21710775.00	20924047.00	65.8396
3	-12026388.900	.000	-6304122.100	.000	13496595.300
4	-5262882.200	.000	-993090.900	.000	235.1877
5	-19095446.000	.000	-16017833.400	.000	-15.2850
6	21922.6380	.0000	18800.3420	.0000	-.0000
7	565.8863	.0000	1071.3890	.0000	.0000
8	10142.9614	.0000	17189.7580	.0000	.0000
9	-.003	.000	-.003	.000	-.000
10	.001	.000	.001	-.017	-.017
11	.000	.000	.000	.075	.075
12	-42.6942	-.0670	.0000	.000	.0000
13	1.5079	.0035	.0000	.000	.0000
14	-2.9552	.0018	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.1950	-.1848	-.2140	.0000	.0000
19	57.6639	59.5436	59.5438	.0000	.0000
20	-.0000	.4975	-.0325	-.3088	2.465
21	.0001	9.2138	.0000	2861.6947	690.000
22	147.9010	9.0762	9.0185	-29.9055	-.0141
23	.9907	-.2139	-.9674	-.0033	24161.994
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	142.6045			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3566.2361	25546.0360	.00458	89.6450	-54.8037
32	3599.0780	25312.9120	31.6401	324742320.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	7000.0000	62768.207	.000	838063.050	22579515.000
2	25473.0310	24133.4050	21759721.00	20921659.00	61.8534
3	-10643909.600	.000	-19866388.000	.000	30837504.000
4	5482675.100	.000	1292523.900	.000	71.1653
5	18387254.000	.000	21711002.000	.000	-45.1193
6	-21110.6910	.0000	-25435.3370	.0000	-.0000
7	5441.4023	.0000	56.5737	.0000	-.0000
8	10351.3817	.0000	1384.1146	.0000	-.0000
9	-.002	.000	-.002	.000	-.000
10	-.001	.000	-.001	.002	.002
11	-.000	.000	-.000	-.045	-.045
12	-176.8984	-.0670	.0000	.000	.0000
13	1.0693	-.0037	.0000	.000	.0000
14	3.1405	.0012	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.3446	.3264	.2682	.0000	.0000
19	120.4193	118.6655	118.6650	.0000	.0000
20	-.0000	5.6413	-.1817	-.7012	11.595
21	.0001	9.0269	.0000	2974.3534	690.000
22	15.2665	14.0793	13.9922	-29.7664	-.0211
23	.8129	.0304	.8124	-.0023	24133.405
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	149.7816			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3566.5783	25576.9100	.00711	90.0004	65.0491
32	3617.6619	25215.7470	31.6353	324170940.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

TABLE AP 3-3 (Sheet 3 of 4)
PREDICTED S-IVB-205 STAGE ORBITAL TRAJECTORY

1	8000.0000	62695.533	.000	993418.430	45476162.000
2	25294.4250	23942.7750	21911474.00	20918057.00	124.6411
3	-33369238.000	.000	-40575298.000	.000	41813619.000
4	6907005.400	.000	521723.340	.000	60.1312
5	16643227.200	.000	9664272.900	.000	-77.1912
6	-19673.7180	.0000	-11249.8546	.0000	-.0000
7	-3199.5781	.0000	-1422.4429	.0000	-.0000
8	-13265.1436	.0000	-22610.2950	.0000	.0000
9	-.001	.000	-.001	.000	-.000
10	-.000	.000	-.000	-.007	-.007
11	.000	.000	.000	-.017	-.017
12	116.1106	-.0671	.0000	.000	.0000
13	-2.4745	-.0026	.0000	.000	.0000
14	2.2102	-.0029	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.3048	.2886	.2389	.0000	.0000
19	117.0861	115.5319	115.5313	.0000	.0000
20	.0000	4.9361	.0000	-.6226	10.145
21	.0000	8.4871	.0000	3311.7697	690.000
22	-39.1206	-19.4479	-19.3328	-29.3485	.0272
23	.8648	-.3451	.7931	-.0009	23942.776
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	152.4263			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3570.5729	25546.3910	.00583	89.9781	134.5877
32	3612.4779	25250.0500	31.6283	319690600.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

INITIATE 20 DEG PITCH DOWN

1	9780.0000	62695.533	.000	910660.200	45338518.000
2	25387.4090	24044.2170	21833679.00	20922820.00	124.1124
3	-33150323.000	.000	-20333777.000	.000	30883192.000
4	-7105939.400	.000	-1450090.000	.000	257.6406
5	-16630448.400	.000	-21763328.000	.000	-45.1041
6	19930.0620	.0000	25373.8010	.0000	-.0000
7	-7044.0488	.0000	59.0986	.0000	.0000
8	-11458.5526	.0000	829.0637	.0000	-.0000
9	-.001	.000	-.001	.000	-.000
10	.001	.000	.001	.024	.024
11	-.000	.000	-.000	.031	.031
12	-1.2738	-.2996	.0000	.000	.0000
13	-.8264	.0168	.0000	.000	.0000
14	-3.2130	-.0043	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.3000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.4234	-.4010	-.3643	.0000	.0000
19	58.6080	60.4403	60.4399	.0000	.0000
20	.0000	4.0377	.0000	-.5093	8.299
21	.0000	8.7613	.0000	3134.1115	690.000
22	-156.8828	-11.8954	-11.8242	-29.5672	.0177
23	1.1369	.6652	-.9074	-.0014	24044.219
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	149.7944			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3569.3971	25557.3900	.00637	90.0063	-93.1033
32	3615.1536	25233.9140	31.6377	321979580.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	9000.0000	62695.533	.000	1022559.180	62921303.000
2	25267.0640	23906.1360	21930328.00	20907773.00	172.4213
3	-42650909.000	.000	-37755088.000	.000	40417612.000
4	-142228.310	.000	-964012.370	.000	262.3163
5	-2855128.600	.000	-13994346.300	.000	-70.1975
6	2978.2186	.0000	16232.7200	.0000	-.0000
7	-9561.3280	.0000	-1213.2981	.0000	.0000
8	-21707.4770	.0000	-19324.8870	.0000	.0000
9	-.001	.000	-.001	.000	-.000
10	.000	.000	.000	-.017	-.017
11	.000	.000	.000	.005	.005
12	48.9577	-.0671	.0000	.000	.0000
13	-2.9984	.0017	.0000	.000	.0000
14	-1.4201	-.0035	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.1968	-.1862	-.1605	.0000	.0000
19	80.2803	80.8085	80.8080	.0000	.0000
20	.0000	4.3877	.0000	-.5534	9.018
21	.0000	8.4074	.0000	3364.5295	690.000
22	-107.8249	-30.5357	-30.3753	-29.2790	.0378
23	1.0193	-.9862	-.2575	-.0007	23906.137
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	152.1314			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3568.2032	25557.8000	.00606	89.9198	-152.6039
32	3611.7448	25249.6860	31.6081	319138310.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	9865.8619	62695.533	.000	895590.800	43338031.000
2	25404.4150	24063.0400	21819661.00	20924070.00	118.7116
3	-31386882.000	.000	-18161604.000	.000	29443527.000
4	-7680579.600	.000	-1438118.100	.000	257.4029
5	-17537259.000	.000	-21583547.000	.000	-42.2975
6	21115.9990	.0000	25180.8140	.0000	-.0000
7	-6328.5045	.0000	219.6427	.0000	.0000
8	-9646.5503	.0000	3355.9947	.0000	.0000
9	-.002	.000	-.002	.000	-.000
10	.001	.000	.001	-.734	-.734
11	.013	.000	.013	.036	.036
12	-26.9907	-.2795	.0000	.000	.0000
13	.6511	.0170	.0000	.000	.0000
14	-3.2530	.0034	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.3000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.4230	-.4017	-.3718	.0000	.0000
19	57.6298	59.5280	59.5276	.0000	.0000
20	.0000	4.0026	.0000	-.5049	8.227
21	.0000	8.8154	.0000	3100.6018	690.000
22	-161.5624	-9.0160	-8.9590	-29.6076	.0136
23	19.3655	19.3437	-.9927	-.0016	24063.041
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	149.3798			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3569.1100	25560.1230	.00650	90.0137	-86.9106
32	3615.8339	25229.8350	31.6402	322393830.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

END MANUAL MANEUVERS, PITCH TO LOCAL HORIZONTAL

1	9175.0000	62695.533	.000	1005092.840	59070490.000
2	25285.6940	23927.7410	21915437.00	20910368.00	161.8590
3	-41736967.000	.000	-34590192.000	.000	38878990.000
4	-1829103.800	.000	-1156942.800	.000	260.4636
5	-6567577.900	.000	-17067541.000	.000	-64.6241
6	7437.0680	.0000	19815.5400	.0000	-.0000
7	-9654.3936	.0000	-983.9343	.0000	.0000
8	-20591.7340	.0000	-15676.1801	.0000	-.0000
9	-.001	.000	-.001	.000	-.000
10	.000	.000	.000	.016	.016
11	-.000	.000	-.000	.009	.009
12	39.1390	.3002	.0000	.000	.0000
13	-2.7126	-.0100	.0000	.000	.0000
14	-1.9105	.0142	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.3000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.2793	-.2643	-.2236	.0000	.0000
19	73.5709	74.4762	74.4756	.0000	.0000
20	.0000	4.3040	.0000	-.5429	8.846
21	.0000	8.4549	.0000	3332.9064	690.000
22	-120.0265	-28.0415	-27.8894	-29.3235	.0359
23	.9473	.8340	-.4494	-.0008	23927.742
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	151.7943			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3568.7493	25555.2950	.00602	89.9346	-139.8107
32	3611.9857	25249.3920	31.6132	319573930.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	10000.0000	62695.533	.000	871984.140	40252353.000
2	25431.1200	24092.0950	21797358.00	20925374.00	110.2559
3	-28450116.000	.000	-14831114.600	.000	27[illegible]51172.000
4	-8446724.900	.000	-1392005.800	.000	257.0485
5	-18632918.000	.000	-20871755.000	.000	-37.8871
6	22592.3150	.0000	24375.1180	.0000	-.0000
7	-5067.1041	.0000	466.7553	.0000	.0000
8	-6658.9005	.0000	7237.2434	.0000	.0000
9	-.002	.000	-.002	.000	-.000
10	.001	.000	.001	-.880	-.880
11	.015	.000	.015	.043	.043
12	-36.5223	-.0670	.0000	.000	.0000
13	1.1813	.0036	.0000	.000	.0000
14	-3.1002	.0014	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.0671	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.4126	-.3909	-.3763	.0000	.0000
19	56.6642	58.6269	58.6268	.0000	.0000
20	.0000	3.9499	.0000	-.4981	8.116
21	.0000	8.9308	.0000	3048.7955	690.000
22	-168.7362	-4.3770	-4.3489	-29.6707	.0066
23	19.9527	-19.9304	-1.0234	-.0018	24092.099
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	148.6469			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3568.5001	25565.1960	.00673	90.0215	-77.7406
32	3616.8610	25223.3640	31.6428	323053910.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

TABLE AP 3-3 (Sheet 4 of 4)
PREDICTED S-IVB-205 STAGE ORBITAL TRAJECTORY

INITIATE INERTIAL HOLD

1	10274.9999	62695.533	.000	826976.040	33900001.000
2	28483.7960	24147.3380	21782158.00	20925182.00	92.8565
3	-21983734.000	.000	-8553550.400	.000	21720063.000
4	-8433433.100	.000	-1197576.600	.000	256.2668
5	-19578354.000	.000	-17847323.000	.000	-28.7071
6	24060.5180	.0000	20882.4060	.0000	-.0000
7	-2038.8414	.0000	936.1501	.0000	.0000
8	-148.8193	.0000	14576.4418	.0000	.0000
9	-.002	.000	-.002	.000	-.000
10	.001	.000	.001	-1.176	-1.176
11	.020	.000	.020	.057	.057
12	-54.7832	.0000	.0000	.000	.0000
13	2.0936	.0000	.0000	.000	.0000
14	-2.5740	-.0000	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.3583	-.3396	-.3572	.0000	.0000
19	56.8124	58.7566	58.7568	.0000	.0000
20	.0000	3.4432	.0000	-.4847	7.899
21	.0001	9.0692	.0000	2930.0228	690.000
22	176.6920	5.2188	5.2842	-29.7939	-.0058
23	-19.8348	-19.8137	-.9931	-.0028	24147.338
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	146.7372			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3566.9068	25576.4990	.00717	90.0211	-60.7769
32	3618.4332	25212.2910	31.6423	324395920.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	10500.0000	26095.533	.000	796107.270	28679319.000
2	25521.7370	24185.0600	21718360.00	20922253.00	78.9618
3	-14593448.200	.000	-4333950.500	.000	-16956102.000
4	-9586864.700	.000	-949702.910	.000	255.3526
5	-19013939.000	.000	-13988816.400	.000	-20.9542
6	23618.2050	.0000	16386.5420	.0000	-.0000
7	718.1324	.0000	1255.0010	.0000	.0000
8	5135.7574	.0000	19526.0160	.0000	.0000
9	-.003	.000	-.003	.000	-.000
10	.001	.000	.001	-.347	-.347
11	.006	.000	.006	.061	.061
12	-54.7832	.0000	.0000	.000	.0000
13	2.0936	.0000	.0000	.000	.0000
14	-2.5740	-.0000	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.2894	-.2742	-.3137	.0000	.0000
19	59.0899	60.8703	60.8707	.0000	.0000
20	.0000	3.7609	.0000	-.4744	7.730
21	.0001	9.1896	.0000	2882.2788	690.000
22	164.3991	13.0036	12.9245	-29.8812	-.0197
23	4.8117	-4.7389	-.8373	-.0031	24185.060
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	144.5916			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3565.6764	25583.7190	.00739	90.0046	-48.1029
32	3618.7842	25208.2620	31.6365	325403000.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

1	10999.9999	26095.533	.000	754462.850	17026166.000
2	25577.2270	24235.3480	21666009.00	20911548.00	46.6521
3	-6029171.600	.000	616613.000	.000	5641626.600
4	-7682814.300	.000	-205143.650	.000	247.0898
5	-13759119.100	.000	-2432811.900	.000	.0763
6	17538.6140	.0000	2836.2399	.0000	-.0000
7	6767.8810	.0000	1638.9330	.0000	.0000
8	15295.5743	.0000	25366.5970	.0000	-.0001
9	-.004	.000	-.004	.000	-.000
10	.001	.000	.001	2.827	2.827
11	-.049	.000	-.049	.042	.042
12	-54.7832	.0000	.0000	.000	.0000
13	2.0936	.0000	.0000	.000	.0000
14	-2.5740	-.0000	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	-.1012	-.0959	-.1410	.0000	.0000
19	71.4135	72.4212	72.4215	.0000	.0000
20	.0000	3.5899	.0000	-.4528	7.379
21	.0001	9.3584	.0000	2790.8168	690.000
22	133.5749	26.8584	26.7089	-30.0051	-.0365
23	28.8318	28.8291	-.4668	-.0041	24235.949
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	135.0281			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3564.2438	25588.1280	.00723	89.9425	-19.7675
32	3616.9130	25215.9140	31.6152	326968860.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

INITIATE PITCH TO RETROGRADE ATTITUDE

1	11820.0000	26095.533	.000	771828.260	2210335.100
2	28557.8860	24213.9050	21681610.00	20909784.00	6.0366
3	690991.940	.000	-6676618.100	.000	13899360.700
4	610474.800	.000	1015789.940	.000	83.3662
5	2204810.000	.000	16328728.700	.000	-19.9768
6	-2390.1881	.0000	-19218.2670	.0000	-.0000
7	12037.6296	.0000	1104.9402	.0000	.0000
8	20873.3280	.0000	16815.4130	.0000	-.0002
9	-.004	.000	-.004	.000	-.000
10	.001	.000	.001	7.280	7.280
11	-.127	.000	-.127	.040	.040
12	-54.7832	.0000	.0000	.000	.0000
13	2.0936	.0000	.0000	.000	.0000
14	-3.4072	.0000	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	.0000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.1912	.1812	.2199	.0000	.0000
19	105.1957	104.3789	104.3784	.0000	.0000
20	.0000	3.3409	.0000	-.4214	6.867
21	.0001	9.2868	.0000	2828.9969	690.000
22	73.6752	28.6148	28.4590	-29.9585	-.0380
23	83.9484	83.9483	-2.9659	-.0036	24213.906
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	142.8599			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3564.3681	25586.1850	.00722	89.9312	32.3700
32	3616.1872	25219.3410	31.6116	326699280.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

MAINTAIN LOCAL HORIZONTAL ATTITUDE

1	12376.7889	26095.533	.000	835582.200	15135617.200
2	25475.8260	24136.2700	21757128.00	20921567.00	41.3798
3	-4592282.000	.000	-19565856.000	.000	25544272.000
4	6968862.700	.000	1372104.100	.000	83.5306
5	12578564.400	.000	21686758.000	.000	-35.2139
6	-15819.8981	.0000	-25416.6100	.0000	.0000
7	10001.9667	.0000	-129.0096	.0000	-.0002
8	15239.7840	.0000	1731.1868	.0000	.0001
9	.002	.000	.002	.000	-.000
10	-.165	.000	-.165	-3.406	-3.406
11	.059	.000	.059	-9.466	-9.466
12	3.5867	.2998	.0000	.000	.0000
13	-2.5235	-.0209	.0000	.000	.0000
14	-3.4072	.0132	.0000	.000	.0000
15	.0000	.0000	.0000	.0000	.0000
16	.0000	.0000	.0000	-.3000	.0000
17	.0000	.0000	.0000	.0000	.0000
18	.3415	.3235	.3657	.0000	.0000
19	120.3234	118.5765	118.3761	.0000	.0000
20	.0000	3.1906	.0000	-.4024	6.558
21	.0001	9.0362	.0000	2968.9091	690.000
22	38.5540	14.2733	14.1851	-29.7733	-.0214
23	179.4658	-179.8191	179.4972	.0023	24136.270
24	.0000	.0000	.0000	.000	.0000
25	.0000	.0000	.0000	.000	.0000
26	.0000	.0000	.0000	.000	.0000
27	148.1459			.0000	.0000
28	.0000	.0000	.0000	.0000	.0000
29	.0000	.0000	.0000		
30	.0000	.0000	.0000		
31	3566.4980	25577.2500	.00711	89.9980	64.1633
32	3617.6109	25215.8720	31.6350	324243600.0	
33					
34	.0000	.000	.0000	.0000	.000
35	.0000	.0000	.0000	.000	.000

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 Right (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 centerline 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	τ	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	τ_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	τ_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

LIST OF COORDINATE SUBSCRIPT DEFINITIONS

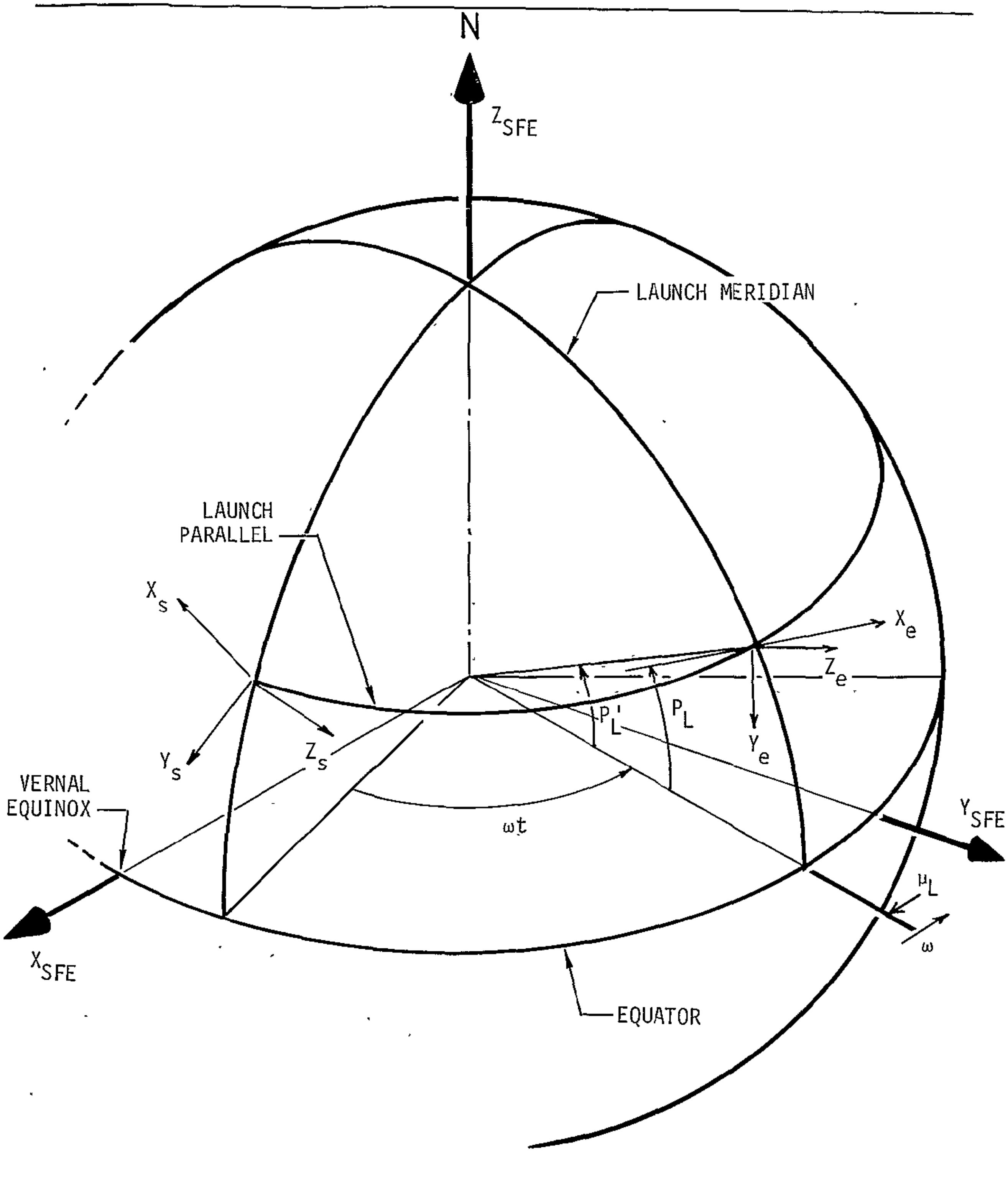
ee Coordinate system on the surface of the spheroid representing the earth and whose origin is at the same latitude and longitude as the launcher. Z_{ee} positive downrange, X_{ee} perpendicular to the surface of the spheroid, positive up, and Y_{ee} crossrange positive in the right handed coordinate system. (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, Z_m at the 180 deg bank angle position, and Y_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 Z_P axis is parallel to the plane defined by the X_s and Y_s axes at launch and Y_P forms a right-handed coordinate system. (Metric)

s Coordinates initially coincident with the e system, but remaining fixed in space. (English)

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, AB21 and AD77 Computer Programs

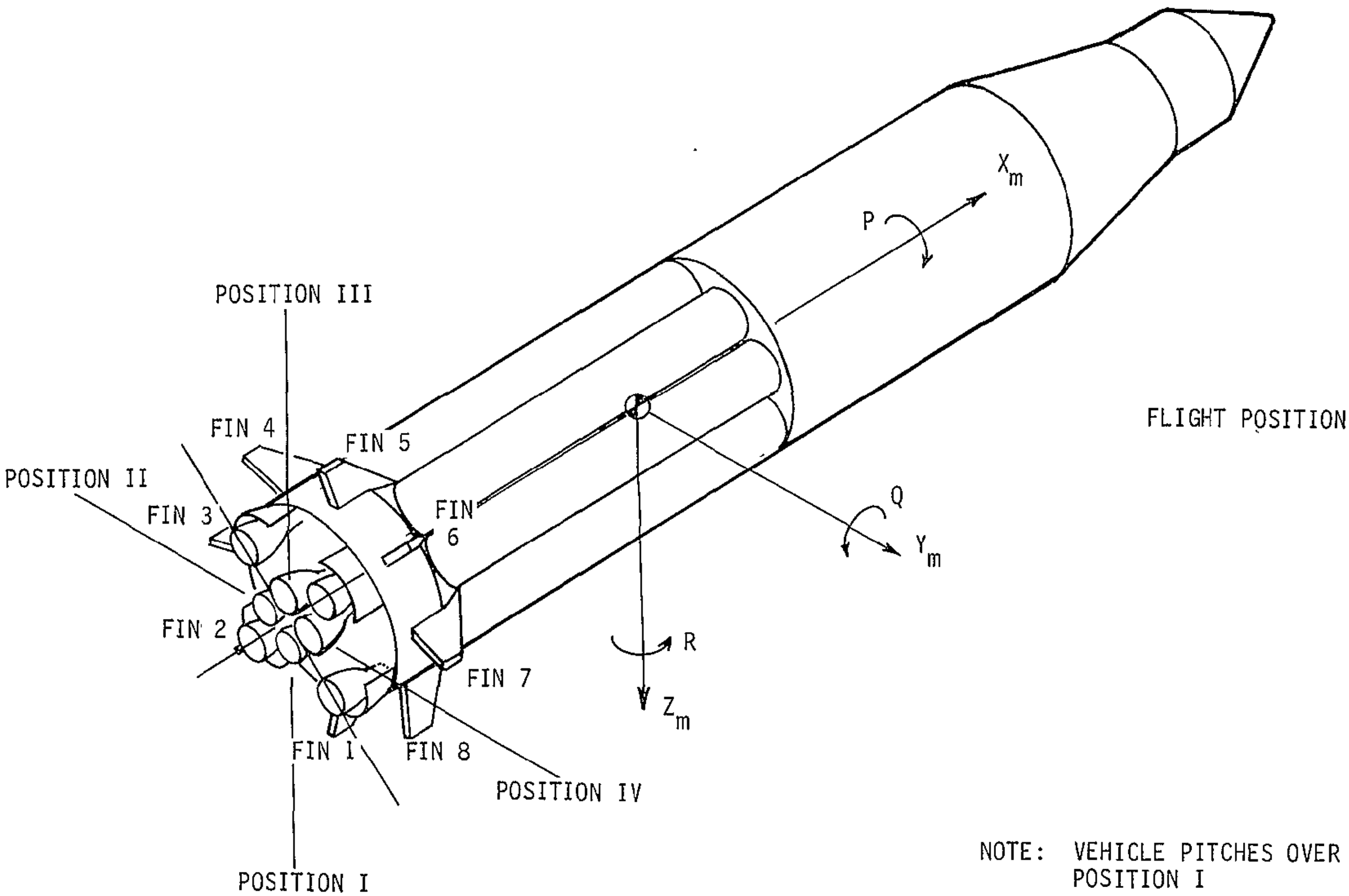


Figure AP 3-2. Body Fixed Coordinate System Orientation

APPENDIX 4

TELEMETRY LOOK ANGLES AND TELEMETRY POWER MARGINS

4. TELEMETRY LOOK ANGLES

This appendix presents the telemetry look angles for the AS-205 mission. Figure AP 4-1 presents the telemetry look angles versus time for S-IB and S-IVB powered flight. Table AP 4-1 summarizes orbital telemetry coverage through three revolutions with times associated with an acquisition elevation angle of 2 deg and a loss-of-signal elevation angle of 0 deg. Table AP 4-2 presents a summary of telemetry coverage during certain significant S-IVB stage events.

Data are presented in this appendix for those stations of which telemetry coverage is required during powered flight and the first three revolutions. These stations, as listed in the SA-205/CSM-101 Launch Vehicle Ground Support Plan (reference 17), are as follows:

a. Powered flight phase:
   - Tel 4
   - MILA-CIF
   - Grand Bahama
   - Bermuda
   - Vanguard (Insertion Ship)

b. Orbital phase:
   - Tel 4
   - MILA-CIF
   - Bermuda
   - Vanguard
   - Canary Islands
   - Antigua
   - Ascension
   - Tananarive
   - Carnarvon
   - ARIA (aircraft)
   - Hawaii
   - Guaymas
   - Corpus Christi

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

REVOLUTION	STATION	ACQUISITION TIME AT +2 DEG (sec)	MAXIMUM ELEVATION			LOSS TIME AT 0 DEG (sec)	TRACKING TIME (sec)
			ANGLE (deg)	SLANT RANGE (ft x 10^6)	TIME (sec)		
1	Vanguard (Insert. Ship)	575	61	.9	800	1,035	460
1	Canary	1,040	37	1.2	1,250	1,490	450
1	Tananarive	2,245	16	2.6	2,450	2,690	445
1	Carnarvon	3,180	16	2.7	3,400	3,625	445
1	Guaymas	5,410	61	.9	5,625	5,850	440
1	Corpus Christi	5,590	40	1.1	5,800	6,025	435
2	Cape Tel 4	5,825	30	1.4	6,025	6,250	425
2	MILA CIF	5,825	31	1.4	6,025	6,255	430
2	Grand Bahama	5,865	19	2.1	6,050	6,280	415
2	Bermuda	6,035	55	.9	6,250	6,475	440
2	Vanguard (Insert. Ship)	6,255	22	1.9	6,450	6,675	420
2	Canary	6,760	5	4.4	6,900	7,050	290
2	Tananarive	7,870	34	1.7	8,100	8,375	505
2	Carnarvon	8,855	29	2.0	9,095	9,360	505
2	ARIA	9,240	20	2.4	9,460	9,700	460
2	Hawaii	10,430	18	2.2	10,620	10,840	410
2	Guaymas	11,110	29	1.5	11,320	11,540	430
2	Corpus Christi	11,290	24	1.7	11,500	11,720	430
3	Cape Tel 4	11,520	52	.9	11,720	11,960	440
3	MILA CIF	11,520	53	.9	11,720	11,960	440

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

REVOLUTION	STATION	ACQUISITION TIME AT +2 DEG (sec)	MAXIMUM ELEVATION			LOSS TIME AT 0 DEG (sec)	TRACKING TIME (sec)
			ANGLE (deg)	SLANT RANGE (ft x 10^6)	TIME (sec)		
3	Grand Bahama	11,560	34	1.3	11,760	12,000	440
3	Bermuda	11,730	17	2.3	11,920	12,140	410
3	Antigua	11,860	12	2.9	12,040	12,250	390
3	Vanguard (Insert. Ship)	12,010	4	4.5	12,120	12,270	260
3	Ascension	12,670	20	2.3	12,880	13,125	455
3	Tananarive	13,625	9	4.1	13,825	14,050	425
3	Carnarvon	14,550	47	1.3	14,800	15,050	500
3	ARIA	14,930	25	1.9	15,150	15,380	450
3	Hawaii	16,100	28	1.5	16,300	16,530	430
3	Guaymas	16,810	31	1.4	17,000	17,240	430
3	Corpus Christi	16,980	59	.9	17,200	17,425	445

TABLE AP 4-2
AS-205 TELEMETRY COVERAGE OF SIGNIFICANT EVENTS

EVENT	REVOLUTION	APPROXIMATE TIME FROM FIRST MOTION (sec)	TELEMETRY STATION COVERAGE
LH2 Tank Vent	1	615 to 1,875	Bermuda, Vanguard, Canary Island
LOX Tank Vent (Propulsive)	1	645 to 675	Bermuda, Vanguard
LH2 Tank Vent	1	3,245 to 3,545	Carnarvon
LOX Dump (Propulsive)	1&2	5,666 to 6,387	Continental United States, Bermuda, Vanguard
Manual Maneuvers	2	9,000 to 9,180	Carnarvon, ARIA
S-IVB/CSM Separation	2	10,500	Hawaii
CSM/S-IVB Rendezvous	19	29 hr 45 min to 30 hr 20 min	Hawaii, Guaymas, Western United States

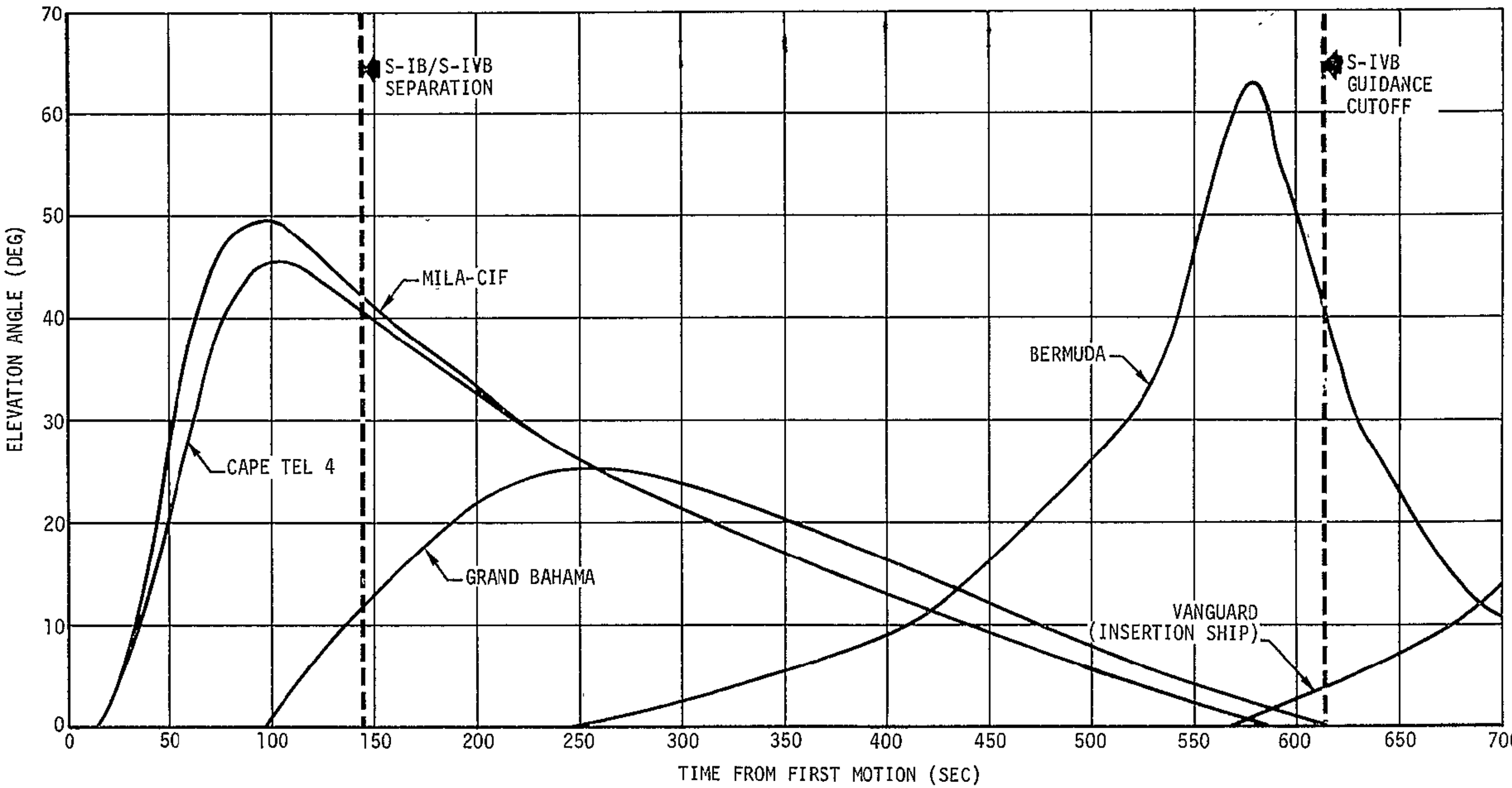


Figure AP 4-1. AS-205 Powered Flight Telemetry Elevation Angles

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 A3-250-KCBC-L-4184, Contract NAS7-101, S-IVB Final Propulsion Performance Prediction, S-IVB-205 (Rev 5), dated September 1968. 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 5-25 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-205. Table AP 5-4 presents the tag values.

TABLE AP 5-1 (Sheet 1 of 2)
PREDICTED AS-205 PROPULSION SYSTEM PERFORMANCE PARAMETERS

PARAMETER	UNIT	VALUE	DISPERSION	REMARKS
Average Stage Longitudinal Thrust	lbf	211,754.0	±4,700	1
Before PU Valve Cutback	lbf	226,932.0	±4,100	2
After PU Valve Cutback	lbf	175,104.0	±5,400	3
Average LOX Flowrate	lbm/sec	415.4	±16.0	1
Before PU Valve Cutback	lbm/sec	451.4	±7.6	
After PU Valve Cutback	lbm/sec	331.2	±11.6	
Average LH2 Flowrate	lbm/sec	80.7	±2.9	1
Before PU Valve Cutback	lbm/sec	82.0	±1.9	
After PU Valve Cutback	lbm/sec	75.6	±2.8	
Average Stage Mass Flowrate	lbm/sec	496.1	±19.0	1
Before PU Valve Cutback	lbm/sec	533.4	±7.8	
After PU Valve Cutback	lbm/sec	406.8	±14.0	
Average Stage Longitudinal Specific Impulse	sec	426.8	±7.3	1
Before PU Valve Cutback	sec	425.4	±2.3	
After PU Valve Cutback	sec	430.4	±2.8	
Engine Total Impulse	lb-sec	9.7816×10^7	$\pm 2.321 \times 10^6$	1
PU Valve Cutback Time from ESC	sec	308.7	+75 -55	
Start Impulse (3.5 sec)	lb-sec	224,306	±30,000.0	4
Cutoff Impulse	lb-sec	60,144.0	±2,000.0	5
Time from 90 percent Thrust to ECC*	sec	468.8	±16.0	
Total Depletion Burntime (ESC to ECC)*	sec	472.3	±16.0	
Loaded Propellants (LOX)	lbm	193,273	±2,165.0	
(LH2)	lbm	39,647	±419.0	
(TOTAL)	lbm	232,920	±2,205.0	
Engine Propellant Consumption (90 percent Thrust to ECC)*				
(LOX)	lbm	192,176.0	±2,153.0	
(LH2)	lbm	37,390.0	±404.0	
(TOTAL)	lbm	229,566.0	±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-205 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 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	TIME	WDOTSUBO	WDOTSUBF	WDOTSUBT	DEL
2	FSUBE	TTPSUBO	TTPSUBF	HSUBO	HSUBF
3	EMR	POPI	PFPI	VSUBO	VSUBF
4	ENGINE ISP	TOPI	TFPI	WO PU	WF PU
5	CSUBFEV	RHOSUBO	RHOSUBF	WOPU USABLE	WFPU USABLE
6	PCC	WDOTOBO	WDOTFBO	WO USABLE	WF USABLE
7	LPS	WDOTHE	WDOTFPR	WO IN TANK	WF IN TANK
8	FPS	TTOHE	TTFHE	WSUBOT	WSUBFT
9	FSUBAUX	TTOLOX	TTFLH2	OXID OVB	FUEL OVB
10	WSUBO ERROR	WOBOT	WFBOT	WDOTOVO	WDOTFVO
11	WSUBHE	TTMO	TTMF	WOVOT	WFVOT
12	GGMR	WDOTOGG	WDOTFGG	DRAG	WSUBV
13	ASUBM		WFPRT		IMPSUBT

1	0.000	0.000	0.000	0.000	0.000
2	0.00	41.300	32.500	199.281	479.891
3	0.000	41.300	32.500	2728.539	9150.586
4	0.000	165.140	38.070	0.000	0.000
5	1.692	70.699	4.327	191564.000	38577.000
6	0.000	0.382	0.000	192709.000	38577.000
7	0.000	0.350	0.000	192906.000	39599.000
8	0.000	3.500	38.000	193273.000	39647.000
9	0.000	32.000	131.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000
11	330.000	35.500	169.000	0.000	0.000
12	0.000	0.000	0.000	0.000	295073.000
13	0.000		0.000		0.000

1	0.200	0.000	0.000	0.000	0.000
2	0.00	41.420	32.500	199.280	479.891
3	0.000	41.420	32.500	2727.842	9101.885
4	0.000	165.040	38.036	191234.094	38336.355
5	1.692	70.717	4.351	191563.922	38577.000
6	0.000	0.382	0.000	192708.922	38577.000
7	0.000	0.350	0.000	192905.922	39599.000
8	0.000	3.570	38.000	193272.922	39647.000
9	0.000	32.076	131.000	0.000	0.000
10	0.000	0.076	0.000	0.000	0.000
11	329.930	35.646	169.000	0.000	0.000
12	0.000	0.000	0.000	0.000	295072.922
13	0.000		0.000		0.000

1	0.400	0.000	1.875	1.875	0.000
2	0.00	41.540	32.500	199.280	479.890
3	0.000	41.540	32.499	2727.146	9098.784
4	0.000	164.940	38.002	191234.021	38336.262
5	1.692	70.735	4.352	191563.846	38576.907
6	0.000	0.382	0.000	192708.846	38576.906
7	0.000	0.350	0.000	192905.846	39598.906
8	598.879	3.640	38.000	193272.846	39646.906
9	0.000	32.153	131.000	0.000	0.094
10	0.000	0.153	0.000	0.000	0.000
11	329.860	35.793	169.000	0.000	0.000
12	0.000	0.000	0.074	0.000	295072.750
13	0.000		0.000		0.000

1	0.600	0.000	5.628	5.628	0.000
2	0.00	41.660	32.500	199.280	479.884
3	0.000	41.660	32.495	2726.451	9095.543
4	0.000	164.840	37.968	191233.949	38335.526
5	1.692	70.753	4.354	191563.770	38576.162
6	0.000	0.382	0.000	192708.770	38576.161
7	0.000	0.350	0.000	192905.770	39598.154
8	1796.616	3.710	38.000	193272.770	39646.154
9	0.000	32.229	131.000	0.000	0.846
10	0.000	0.229	0.000	0.000	0.000
11	329.790	35.939	169.000	0.000	0.000
12	0.000	0.000	0.223	0.000	295071.922
13	0.000		0.000		0.000

TABLE AP 5-2 (Sheet 2 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	0.800	0.000	5.951	5.951	0.000
2	0.00	41.780	32.500	199.280	479.874
3	0.000	41.780	32.494	2725.758	9092.212
4	0.000	164.740	37.934	191233.877	38334.398
5	1.692	70.771	4.355	191563.693	38575.013
6	0.000	0.382	0.000	192708.693	38575.012
7	0.000	0.350	0.000	192905.693	39596.995
8	1899.258	3.780	38.000	193272.693	39644.995
9	0.000	32.306	131.000	0.000	2.005
10	0.000	0.306	0.000	0.000	0.000
11	329.720	36.086	169.000	0.000	0.000
12	0.000	0.000	0.236	0.000	295070.688
13	0.000		0.000		0.000
1	1.000	0.000	6.274	6.274	0.000
2	0.00	41.900	32.500	199.280	479.864
3	0.000	41.900	32.493	2725.065	9088.872
4	0.000	164.640	37.900	191233.805	38333.211
5	1.692	70.789	4.357	191563.617	38573.800
6	0.000	0.382	0.000	192708.617	38573.800
7	0.000	0.350	0.000	192905.617	39595.772
8	2001.897	3.850	38.000	193272.617	39643.772
9	0.000	32.382	131.000	0.000	3.228
10	0.000	0.382	0.000	0.000	0.000
11	329.650	36.232	169.000	0.000	0.000
12	0.000	0.000	0.249	0.000	295069.387
13	0.000		0.000		0.000
1	1.200	0.000	9.651	9.651	0.000
2	0.00	42.020	32.533	199.280	479.852
3	0.000	42.020	32.517	2725.065	9086.704
4	0.000	164.640	37.880	191233.734	38331.809
5	1.692	70.789	4.357	191563.543	38572.370
6	0.000	0.382	0.000	192708.541	38572.370
7	0.000	0.350	0.019	192905.541	39594.330
8	3079.674	3.920	38.000	193272.541	39642.330
9	0.000	32.458	131.002	0.000	4.668
10	0.000	0.458	0.000	0.000	0.000
11	329.580	36.379	169.002	0.000	0.000
12	0.000	0.000	0.383	0.000	295067.867
13	0.000		0.002		0.000
1	1.400	0.000	31.762	31.762	0.000
2	0.00	42.140	32.567	199.280	479.816
3	0.000	42.140	32.395	2725.065	9084.027
4	0.000	164.640	37.860	191233.664	38327.569
5	1.692	70.789	4.358	191563.467	38568.079
6	0.000	0.382	0.000	192708.465	38568.078
7	0.000	0.350	0.039	192905.465	39590.000
8	10136.653	3.990	38.000	193272.465	39638.000
9	0.000	32.535	131.008	0.000	8.992
10	0.000	0.535	0.000	0.000	0.000
11	329.510	36.525	169.008	0.000	0.000
12	0.000	0.000	1.261	0.000	295063.465
13	0.000		0.008		0.000
1	1.600	63.132	41.805	104.937	0.000
2	10203.91	42.260	32.600	199.275	479.751
3	1.510	42.210	32.303	2725.021	9080.630
4	97.239	164.640	37.840	191230.436	38319.986
5	1.693	70.789	4.359	191560.234	38560.357
6	35.418	0.382	0.000	192705.232	38560.356
7	1303.254	0.351	0.058	192902.230	39582.211
8	13343.484	4.060	38.000	193269.230	39630.211
9	0.000	32.611	131.018	3.158	16.771
10	0.000	0.611	0.000	0.000	0.000
11	329.440	36.672	169.018	0.000	0.000
12	0.274	0.455	1.660	0.000	295052.441
13	0.035		0.018		510.207

TABLE AP 5-2 (Sheet 3 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	1.800	63.817	43.412	107.229	0.000
2	11373.49	42.380	32.633	199.257	479.681
3	1.470	42.628	32.357	2724.837	9076.807
4	106.068	164.641	37.820	191217.844	38311.705
5	1.693	70.789	4.360	191547.107	38551.895
6	39.475	0.382	0.000	192692.105	38551.895
7	1316.932	0.351	0.078	192889.092	39573.675
8	13857.118	4.131	38.000	193256.092	39621.675
9	0.000	32.688	131.031	16.219	25.293
10	0.000	0.688	0.000	0.000	0.000
11	329.369	36.818	169.031	0.000	0.000
12	0.267	0.460	1.725	0.000	295030.766
13	0.039		0.031		2668.131

1	2.000	57.248	43.730	100.977	0.000
2	36748.70	42.500	32.667	199.240	479.608
3	1.309	42.790	32.391	2724.666	9072.978
4	363.930	164.641	37.800	191206.377	38303.236
5	1.693	70.789	4.361	191534.934	38543.238
6	127.545	0.382	0.000	192679.932	38543.238
7	1181.197	0.351	0.097	192876.906	39564.943
8	13959.171	4.201	38.000	193243.906	39612.943
9	0.000	32.764	131.049	28.328	34.008
10	0.000	0.764	0.000	0.000	0.000
11	329.299	36.965	169.049	0.000	0.000
12	0.238	0.413	1.738	0.000	295009.848
13	0.125		0.049		5463.064

1	2.200	99.214	44.059	143.273	0.000
2	68374.45	42.387	32.700	199.219	479.535
3	2.252	43.719	32.586	2724.445	9068.909
4	477.233	164.641	37.780	191191.365	38294.701
5	1.693	70.789	4.362	191519.221	38534.513
6	237.279	0.382	0.000	192664.219	38534.512
7	2045.562	0.351	0.117	192861.180	39556.141
8	14064.344	4.271	38.000	193228.180	39604.141
9	0.000	32.840	131.070	43.979	42.789
10	0.000	0.840	0.000	0.000	0.000
11	329.229	37.111	169.070	0.000	0.000
12	0.408	0.715	1.752	0.000	294985.320
13	0.232		0.070		15976.790

1	2.400	144.989	45.629	190.419	0.000
2	100020.96	42.275	32.733	199.185	479.461
3	3.192	44.341	32.728	2724.104	9064.877
4	525.269	164.641	37.760	191168.223	38286.046
5	1.693	70.789	4.363	191494.982	38525.667
6	347.072	0.382	0.000	192639.980	38525.667
7	2987.845	0.351	0.136	192836.920	39547.218
8	14501.976	4.341	38.000	193203.920	39595.218
9	0.000	32.917	131.095	68.162	51.686
10	0.000	0.917	0.000	0.000	0.000
11	329.139	37.258	169.095	0.000	0.000
12	0.579	1.045	1.807	0.000	294952.137
13	0.339		0.095		32818.159

1	2.600	197.820	47.844	245.664	0.000
2	131688.12	42.162	32.767	199.137	479.383
3	4.135	44.878	32.853	2723.621	9060.782
4	536.050	164.641	37.740	191135.488	38276.967
5	1.693	70.789	4.364	191460.648	38516.390
6	456.922	0.382	0.000	192605.646	38516.390
7	4074.756	0.351	0.156	192802.557	39537.860
8	15273.010	4.411	38.000	193169.557	39585.860
9	0.000	32.993	131.125	102.449	61.015
10	0.000	0.993	0.000	0.000	0.000
11	329.089	37.404	169.125	0.000	0.000
12	0.749	1.426	1.903	0.000	294908.414
13	0.447		0.125		55991.993

TABLE AP 5-2 (Sheet 4 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	2.800	250.691	51.463	302.154	0.000
2	158325.61	42.050	32.800	199.075	479.301
3	4.871	45.344	32.955	2722.988	9056.583
4	523.990	164.641	37.720	191092.775	38267.356
5	1.693	70.789	4.365	191415.754	38506.571
6	549.310	0.382	0.000	192560.752	38506.571
7	5161.817	0.351	0.175	192757.621	39527.956
8	16428.869	4.481	38.000	193124.621	39575.956
9	0.000	33.070	131.158	147.309	70.886
10	0.000	1.070	0.000	0.000	0.000
11	329.019	37.551	169.158	0.000	0.000
12	0.882	1.807	2.048	0.000	294853.574
13	0.537		0.158		85417.969

1	3.000	294.910	56.280	351.190	0.000
2	169780.89	41.938	32.833	198.999	479.211
3	5.240	45.387	32.969	2722.213	9052.313
4	483.445	164.642	37.700	191040.512	38256.862
5	1.693	70.789	4.365	191360.729	38495.853
6	589.046	0.382	0.000	192505.727	38495.853
7	6071.941	0.351	0.195	192702.547	39517.144
8	17967.693	4.551	38.000	193069.547	39565.144
9	0.000	33.146	131.195	202.307	81.661
10	0.000	1.146	0.000	0.000	0.000
11	328.948	37.697	169.195	0.000	0.000
12	0.949	2.126	2.240	0.000	294685.688
13	0.576		0.195		118232.268

1	3.200	330.505	59.081	389.586	0.000
2	178434.83	41.825	32.867	198.913	479.115
3	5.594	45.276	32.989	2721.331	9049.124
4	458.012	164.642	37.694	190981.191	38245.628
5	1.693	70.789	4.366	191298.158	38484.376
6	619.073	0.382	0.000	192443.156	38484.375
7	6805.220	0.351	0.214	192639.922	39505.566
8	18864.847	4.622	38.000	193006.922	39553.566
9	0.000	33.222	131.236	264.855	93.198
10	0.000	1.222	0.000	0.000	0.000
11	328.878	37.844	169.236	0.000	0.000
12	1.013	2.382	2.352	0.000	294509.488
13	0.606		0.236		153056.502

1	3.400	353.573	61.881	415.455	0.000
2	185273.64	41.712	32.900	198.817	479.015
3	5.714	45.205	33.000	2720.357	9045.806
4	445.954	164.642	37.688	190915.775	38233.848
5	1.693	70.789	4.366	191229.104	38472.339
6	642.799	0.382	0.000	192374.104	38472.338
7	7280.427	0.351	0.234	192570.807	39493.424
8	19762.096	4.692	38.000	192937.807	39541.424
9	0.000	33.299	131.280	333.895	105.295
10	0.000	1.299	0.000	0.000	0.000
11	328.808	37.991	169.280	0.000	0.000
12	1.034	2.548	2.464	0.000	294428.230
13	0.629		0.280		189545.434

1	3.586	363.367	64.484	427.851	0.000
2	188490.52	41.608	32.931	198.725	478.917
3	5.635	45.129	32.993	2719.417	9042.631
4	440.552	164.642	37.683	190852.979	38222.422
5	1.693	70.789	4.366	191162.412	38460.644
6	653.960	0.382	0.000	192307.410	38460.643
7	7482.324	0.351	0.252	192504.055	39481.627
8	20596.383	4.757	38.000	192871.055	39529.627
9	0.000	33.370	131.326	400.574	117.047
10	0.000	1.370	0.000	0.000	0.000
11	328.743	38.127	169.326	0.000	0.000
12	1.020	2.619	2.568	0.000	294349.680
13	0.640		0.326		224306.494

TABLE AP 5-2 (Sheet 5 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	3.600	364.115	64.680	428.796	0.000
2	188737.55	41.600	32.933	198.718	478.909
3	5.629	45.156	32.997	2719.345	9042.396
4	440.157	164.642	37.682	190849.392	38221.641
5	1.693	70.789	4.366	191157.316	38459.743
6	654.815	0.382	0.000	192302.314	38459.743
7	7497.570	0.351	0.253	192498.955	39480.719
8	20659.370	4.762	38.000	192865.955	39528.719
9	0.000	33.375	131.329	405.668	117.952
10	0.000	1.375	0.000	0.000	0.000
11	328.738	38.137	169.329	0.000	0.000
12	1.019	2.624	2.576	0.000	294343.672
13	0.641		0.329		226947.123
1	3.800	371.988	67.476	439.464	0.000
2	192187.86	41.487	32.967	198.616	478.799
3	5.513	45.023	32.976	2718.307	9038.847
4	437.323	164.642	37.676	190778.266	38208.649
5	1.693	70.789	4.366	191083.693	38446.590
6	666.789	0.382	0.000	192228.691	38446.589
7	7660.241	0.351	0.273	192425.266	39467.450
8	21556.033	4.832	38.000	192792.266	39515.450
9	0.000	33.432	131.382	479.281	131.168
10	0.000	1.432	0.000	0.000	0.000
11	328.668	38.284	169.382	0.000	0.000
12	0.997	2.681	2.688	0.000	294256.715
13	0.653		0.382		265039.961
1	4.000	379.870	72.277	452.147	0.000
2	194860.74	41.375	33.000	198.512	478.683
3	5.256	44.920	32.908	2717.247	9035.188
4	430.968	164.642	37.671	190707.162	38195.033
5	1.693	70.789	4.367	191008.494	38432.679
6	676.064	0.382	0.000	192153.492	38432.678
7	7822.932	0.351	0.292	192350.000	39453.417
8	23094.221	4.903	38.000	192717.000	39501.417
9	0.000	33.528	131.438	554.471	145.144
10	0.000	1.528	0.000	0.000	0.000
11	328.597	38.431	169.438	0.000	0.000
12	0.951	2.738	2.880	0.000	294167.414
13	0.662		0.438		303745.719
1	4.200	381.438	73.868	455.305	0.000
2	197542.20	41.262	33.033	198.406	478.561
3	5.164	44.866	32.912	2716.173	9031.327
4	433.868	164.643	37.665	190635.193	38180.797
5	1.693	70.788	4.367	190932.352	38418.130
6	685.365	0.382	0.000	192077.352	38418.130
7	7855.328	0.351	0.312	192273.791	39438.742
8	23606.247	4.973	38.000	192640.791	39486.742
9	0.000	33.604	131.499	630.604	159.759
10	0.000	1.604	0.000	0.000	0.000
11	328.527	38.577	169.499	0.000	0.000
12	0.934	2.749	2.944	0.000	294076.531
13	0.672		0.499		342986.496
1	4.400	383.005	75.016	458.021	0.000
2	199385.37	41.150	33.067	198.301	478.437
3	5.106	44.811	32.928	2715.095	9027.365
4	435.319	164.643	37.659	190562.939	38166.274
5	1.693	70.788	4.367	190855.896	38403.285
6	691.758	0.382	0.000	192000.895	38403.284
7	7887.725	0.351	0.331	192197.268	39423.767
8	23977.113	5.043	38.000	192564.268	39471.767
9	0.000	33.681	131.563	707.051	174.670
10	0.000	1.681	0.000	0.000	0.000
11	328.457	38.724	169.563	0.000	0.000
12	0.923	2.760	2.990	0.000	293985.031
13	0.678		0.563		382733.598

TABLE AP 5-2 (Sheet 6 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	4.600	384.550	75.722	460.273	0.000
2	199663.27	41.037	33.100	198.194	478.311
3	5.078	44.700	32.946	2714.013	9023.355
4	433.794	164.643	37.653	190490.391	38151.588
5	1.693	70.788	4.367	190779.131	38388.273
6	692.725	0.382	0.000	191924.129	38388.273
7	7920.034	0.351	0.351	192120.434	39408.625
8	24206.450	5.113	38.000	192487.434	39456.625
9	0.000	33.757	131.631	783.809	189.744
10	0.000	1.757	0.000	0.000	0.000
11	328.386	38.871	169.631	0.000	0.000
12	0.918	2.771	3.019	0.000	293893.055
13	0.679		0.631		422638.711

1	4.800	386.091	76.427	462.518	0.000
2	199938.60	40.925	33.133	198.088	478.184
3	5.052	44.579	32.962	2712.926	9019.606
4	432.283	164.643	37.650	190417.551	38136.763
5	1.693	70.788	4.368	190702.057	38373.118
6	693.684	0.382	0.000	191847.055	38373.118
7	7952.308	0.352	0.370	192043.291	39393.337
8	24435.999	5.184	38.000	192410.291	39441.337
9	0.000	33.834	131.703	860.875	204.960
10	0.000	1.834	0.000	0.000	0.000
11	328.316	39.017	169.703	0.000	0.000
12	0.913	2.782	3.047	0.000	293800.625
13	0.681		0.703		462599.059

1	5.000	387.632	77.130	464.761	0.000
2	200212.98	40.813	33.167	197.980	478.056
3	5.026	44.458	32.978	2711.835	9016.117
4	430.787	164.643	37.651	190344.420	38121.797
5	1.693	70.788	4.368	190624.674	38357.819
6	694.640	0.382	0.000	191769.672	38357.819
7	7984.564	0.352	0.390	191965.840	39377.904
8	24665.839	5.254	38.000	192332.840	39425.904
9	0.000	33.910	131.779	938.250	220.316
10	0.000	1.910	0.000	0.000	0.000
11	328.246	39.164	169.779	0.000	0.000
12	0.908	2.793	3.076	0.000	293707.742
13	0.682		0.779		502614.336

1	6.000	391.883	79.770	471.654	0.000
2	203954.16	40.250	33.333	197.441	477.400
3	4.913	43.945	33.089	2706.339	8998.205
4	432.423	164.644	37.655	189976.049	38045.164
5	1.693	70.788	4.367	190234.869	38279.480
6	707.630	0.382	0.000	191379.867	38279.480
7	8074.273	0.352	0.487	191575.689	39298.881
8	25535.874	5.606	38.000	191942.689	39346.881
9	0.000	34.292	132.217	1328.018	298.901
10	0.000	2.292	0.000	0.000	0.000
11	327.894	39.898	170.217	0.000	0.000
12	0.887	2.823	3.184	0.000	293238.570
13	0.696		1.217		704698.563

1	7.000	449.627	82.082	531.709	21.133
2	227498.22	39.688	33.500	196.851	476.721
3	5.478	43.427	33.291	2700.327	8979.506
4	427.862	164.645	37.659	189572.867	37965.704
5	1.723	70.787	4.367	189808.537	38198.250
6	775.638	0.382	0.000	190953.535	38198.250
7	8595.820	0.352	0.584	191148.979	39216.941
8	26433.005	5.958	38.000	191515.979	39264.941
9	0.000	34.674	132.753	1754.346	380.306
10	0.000	2.674	0.000	0.000	0.000
11	327.542	40.632	170.753	0.000	0.000
12	0.961	3.195	3.326	0.000	292729.918
13	0.777		1.753		922888.773

TABLE AP 5-2 (Sheet 7 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	8.000	449.701	82.058	531.760	31.700
2	227397.14	39.125	33.667	196.229	476.052
3	5.480	42.852	33.458	2693.986	8960.678
4	427.631	164.646	37.662	189147.961	37885.529
5	1.723	70.787	4.367	189358.879	38116.284
6	775.323	0.382	0.000	190503.877	38116.283
7	8600.056	0.353	0.633	190698.922	39134.259
8	26437.010	6.310	38.000	191065.922	39182.259
9	0.000	35.056	133.374	2204.021	462.367
10	0.000	3.056	0.000	0.000	0.000
11	327.189	41.366	171.374	0.000	0.000
12	0.961	3.195	3.326	0.000	292197.180
13	0.778		2.374		1150328.563

1	9.000	449.766	82.080	531.846	31.700
2	227327.35	38.563	33.833	195.606	475.382
3	5.480	42.278	33.624	2687.643	8941.845
4	427.431	164.646	37.666	188722.994	37805.333
5	1.723	70.786	4.367	188909.154	38034.296
6	775.135	0.382	0.000	190054.152	38034.295
7	8604.696	0.353	0.633	190248.797	39051.555
8	26441.816	6.663	38.000	190615.797	39099.555
9	0.000	35.438	134.007	2653.764	544.438
10	0.000	3.438	0.000	0.000	0.000
11	326.837	42.101	172.007	0.000	0.000
12	0.961	3.196	3.327	0.000	291664.352
13	0.779		3.007		1377690.797

1	10.000	449.831	82.101	531.932	31.700
2	227257.54	38.000	34.000	194.984	474.713
3	5.479	41.705	33.791	2681.300	8923.008
4	427.231	164.647	37.670	188290.822	37725.115
5	1.723	70.786	4.367	188459.363	37952.286
6	774.947	0.382	0.000	189604.361	37952.286
7	8609.335	0.353	0.633	189798.607	38968.829
8	26446.620	7.016	38.000	190165.607	39016.829
9	0.000	35.820	134.640	3103.572	626.531
10	0.000	3.820	0.000	0.000	0.000
11	326.484	42.836	172.640	0.000	0.000
12	0.961	3.196	3.327	0.000	291131.434
13	0.781		3.640		1604983.250

1	20.000	452.307	82.323	534.630	31.700
2	227254.96	37.000	33.700	189.620	468.246
3	5.494	40.618	33.489	2617.693	8735.387
4	425.070	164.655	37.690	183823.020	36921.803
5	1.723	70.782	4.366	183949.434	37131.025
6	775.009	0.382	0.000	185094.432	37131.024
7	8662.656	0.356	0.633	185284.676	38140.393
8	26524.773	10.565	38.000	185651.676	38188.393
9	0.000	39.640	140.970	7613.684	1448.637
10	0.000	7.640	0.000	0.000	0.000
11	322.935	50.205	178.970	0.000	0.000
12	0.964	3.214	3.336	0.000	285789.066
13	0.795		9.970		3877264.094

1	30.000	452.699	82.362	535.061	31.700
2	227174.03	36.600	33.525	184.979	461.959
3	5.496	40.175	33.317	2553.862	8547.202
4	424.576	164.663	37.710	179379.410	36117.175
5	1.722	70.777	4.365	179424.184	36308.418
6	774.855	0.382	0.000	180569.182	36308.417
7	8662.089	0.359	0.633	180755.410	37310.600
8	26547.670	14.141	38.000	181122.410	37358.600
9	0.000	43.460	147.300	12139.129	2272.100
10	0.000	11.460	0.000	0.000	0.000
11	319.358	57.601	185.300	0.000	0.000
12	0.964	3.208	3.327	0.000	280430.008
13	0.810		16.300		6149538.313

TABLE AP 5-2 (Sheet 8 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	40.000	453.374	82.416	535.790	31.700
2	227208.75	36.933	33.350	180.800	455.669
3	5.501	40.479	33.146	2489.952	8358.833
4	424.063	164.672	37.730	174943.590	35337.797
5	1.722	70.773	4.364	174893.922	35485.362
6	775.035	0.382	0.000	176038.920	35485.363
7	8662.616	0.361	0.633	176221.127	36480.355
8	26575.888	17.740	38.000	176588.127	36528.355
9	0.000	47.280	153.629	16669.592	3096.015
10	0.000	15.280	0.000	0.000	0.000
11	315.759	65.020	191.629	0.000	0.000
12	0.965	3.204	3.319	0.000	275065.480
13	0.826		22.630		8421448.875
1	50.000	452.361	82.385	534.745	31.700
2	226539.93	37.364	33.237	176.944	449.381
3	5.491	40.891	33.037	2426.167	8170.372
4	423.641	164.680	37.750	170513.197	34527.592
5	1.721	70.769	4.363	170373.027	34662.592
6	773.210	0.382	0.000	171518.025	34662.591
7	8641.330	0.236	0.633	171696.221	35650.396
8	26573.157	20.147	38.000	172063.221	35698.396
9	0.000	51.100	159.959	21190.678	3919.644
10	0.000	19.100	0.000	0.000	0.000
11	313.352	71.247	197.959	0.000	0.000
12	0.965	3.189	3.306	0.000	269710.613
13	0.840		28.960		10686980.250
1	60.000	454.836	82.535	537.371	31.700
2	227326.65	37.889	33.125	173.297	443.082
3	5.511	41.405	32.929	2362.053	7981.513
4	423.035	164.688	37.770	166011.605	33717.400
5	1.722	70.764	4.362	165829.422	33838.436
6	775.539	0.382	0.000	166974.420	33838.436
7	8664.082	0.370	0.633	167148.584	34819.041
8	26634.686	23.762	38.000	167515.584	34867.041
9	0.000	54.920	166.289	25734.494	4744.669
10	0.000	22.920	0.000	0.000	0.000
11	309.737	78.681	204.289	0.000	0.000
12	0.968	3.197	3.303	0.000	264331.621
13	0.860		35.290		12959536.000
1	70.000	454.919	82.473	537.392	31.700
2	227509.54	38.600	33.012	169.850	436.783
3	5.516	42.123	32.825	2297.861	7792.564
4	423.359	164.696	37.790	161506.893	32911.406
5	1.722	70.760	4.362	161280.836	33014.245
6	776.136	0.382	0.000	162425.834	33014.244
7	8666.175	0.375	0.633	162595.961	33987.649
8	26664.518	27.488	38.000	162962.961	34035.649
9	0.000	58.740	172.619	30283.299	5569.730
10	0.000	26.740	0.000	0.000	0.000
11	306.011	86.228	210.619	0.000	0.000
12	0.969	3.173	3.273	0.000	258947.609
13	0.879		41.620		15233687.500
1	80.000	452.257	82.271	534.528	31.700
2	226553.68	36.782	32.900	166.630	430.497
3	5.497	40.319	32.720	2233.953	7603.934
4	423.839	164.704	37.810	157049.264	32110.101
5	1.721	70.735	4.361	156752.959	32191.767
6	773.471	0.382	0.000	157897.957	32191.766
7	8641.797	0.250	0.633	158064.066	33157.986
8	26643.642	30.033	38.000	158431.066	33205.986
9	0.000	62.560	178.949	34811.373	6393.064
10	0.000	30.560	0.000	0.000	0.000
11	303.466	92.592	216.949	0.000	0.000
12	0.968	3.132	3.236	0.000	253586.053
13	0.893		47.950		17500696.750

TABLE AP 5-2 (Sheet 9 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	90.000	454.178	82.367	536.545	31.700
2	227291.90	37.600	32.820	163.494	424.210
3	5.514	41.150	32.647	2169.899	7415.152
4	423.621	164.712	37.830	152581.961	31281.485
5	1.722	70.751	4.360	152215.264	31369.120
6	775.574	0.382	0.000	153360.262	31369.120
7	8655.723	0.382	0.633	153522.344	32328.153
8	26676.298	33.642	38.000	153889.344	32376.153
9	0.000	66.380	185.279	39349.275	7216.567
10	0.000	34.380	0.000	0.000	0.000
11	299.856	100.021	223.279	0.000	0.000
12	0.971	3.166	3.261	0.000	248214.496
13	0.916		54.280		19772268.000
1	100.000	452.595	82.280	534.875	31.700
2	226567.49	38.433	32.740	160.493	417.921
3	5.501	42.004	32.573	2105.774	7226.253
4	423.589	164.720	37.850	148110.283	30464.716
5	1.721	70.747	4.359	147673.117	30546.297
6	773.504	0.382	0.000	148818.115	30546.296
7	8624.994	0.259	0.633	148976.166	31498.142
8	26644.464	37.414	38.000	149343.166	31546.142
9	0.000	70.200	191.609	43891.633	8040.249
10	0.000	38.200	0.000	0.000	0.000
11	296.084	107.614	229.609	0.000	0.000
12	0.970	3.177	3.276	0.000	242838.307
13	0.933		60.610		22045052.250
1	110.000	451.794	82.234	534.028	31.700
2	226174.30	36.767	32.660	157.609	411.641
3	5.494	40.359	32.499	2041.930	7038.226
4	423.525	164.728	37.880	143658.582	29643.472
5	1.720	70.742	4.358	143151.264	29724.561
6	772.364	0.382	0.000	144296.264	29724.560
7	8612.552	0.264	0.633	144450.301	30669.227
8	26627.805	40.027	38.000	144817.301	30717.227
9	0.000	74.020	197.939	48413.678	8862.833
10	0.000	42.020	0.000	0.000	0.000
11	293.471	114.047	235.939	0.000	0.000
12	0.969	3.192	3.293	0.000	237483.527
13	0.952		66.939		24308747.500
1	120.000	453.229	82.313	535.542	31.700
2	227248.90	37.600	32.580	154.779	405.358
3	5.506	41.234	32.428	1978.013	6849.991
4	424.335	164.736	37.910	139152.691	28831.412
5	1.722	70.736	4.356	138621.541	28902.426
6	775.421	0.382	0.000	139766.541	28902.426
7	8634.770	0.391	0.633	139916.559	29839.911
8	26672.542	43.739	38.000	140283.559	29887.911
9	0.000	77.840	204.269	52943.600	9685.820
10	0.000	45.840	0.000	0.000	0.000
11	289.759	121.578	242.269	0.000	0.000
12	0.966	3.193	3.305	0.000	232120.469
13	0.979		73.269		26578457.250
1	130.000	452.123	82.270	534.393	31.700
2	226627.72	38.475	32.500	152.244	399.071
3	5.496	42.149	32.355	1914.012	6661.562
4	424.085	164.744	37.940	134635.885	28018.441
5	1.721	70.730	4.355	134086.576	28079.922
6	773.748	0.382	0.000	135231.574	28079.921
7	8611.946	0.271	0.633	135377.568	29010.221
8	26657.100	47.605	38.000	135744.568	29058.221
9	0.000	81.660	210.599	57478.771	10509.179
10	0.000	49.660	0.000	0.000	0.000
11	285.892	129.265	248.599	0.000	0.000
12	0.966	3.170	3.281	0.000	226751.789
13	0.999		79.599		28851296.000

TABLE AP 5-2 (Sheet 10 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	140.000	451.947	82.277	534.224	31.700
2	226400.45	37.225	32.433	149.762	392.790
3	5.493	40.938	32.294	1850.207	6473.148
4	423.793	164.752	37.970	130170.055	27192.350
5	1.720	70.724	4.356	129566.317	27258.024
6	773.189	0.382	0.000	130711.316	27258.024
7	8608.066	0.274	0.633	130853.298	28181.144
8	26658.594	50.332	38.000	131220.297	28229.144
9	0.000	85.480	216.929	61999.222	11331.927
10	0.000	53.480	0.000	0.000	0.000
11	283.165	135.812	254.929	0.000	0.000
12	0.967	3.154	3.261	0.000	221398.441
13	1.023		85.929		31116424.750
1	150.000	452.859	82.297	535.156	31.700
2	226955.56	37.126	32.367	147.278	386.508
3	5.503	40.893	32.238	1786.369	6284.610
4	424.092	164.760	38.000	125719.283	26376.057
5	1.721	70.717	4.352	125044.427	26436.092
6	774.614	0.382	0.000	126189.426	26436.091
7	8630.236	0.399	0.633	126327.395	27352.031
8	26751.769	53.639	38.000	126694.395	27400.031
9	0.000	89.300	223.259	66521.305	12154.710
10	0.000	57.300	0.000	0.000	0.000
11	279.858	142.938	261.258	0.000	0.000
12	0.969	3.165	3.265	0.000	216043.424
13	1.051		92.259		33382367.750
1	160.000	452.994	82.334	535.327	31.700
2	227110.08	38.179	32.300	144.790	380.224
3	5.502	41.999	32.179	1722.419	6095.892
4	424.248	164.768	38.030	121261.554	25556.518
5	1.721	70.711	4.351	120515.465	25613.857
6	775.277	0.382	0.000	121660.464	25613.857
7	8647.673	0.401	0.633	121794.414	26522.614
8	26771.696	57.639	38.000	122161.414	26570.614
9	0.000	93.119	229.588	71050.466	12977.797
10	0.000	61.120	0.000	0.000	0.000
11	275.858	150.758	267.588	0.000	0.000
12	0.968	3.194	3.298	0.000	210681.027
13	1.078		98.589		35652225.000
1	170.000	451.574	82.213	533.787	31.700
2	226512.83	38.029	32.233	142.307	373.941
3	5.493	41.902	32.122	1658.566	5907.083
4	424.350	164.776	38.060	116797.654	24728.625
5	1.720	70.705	4.350	115994.119	24791.723
6	773.744	0.382	0.000	117139.118	24791.722
7	8627.659	0.285	0.633	117269.056	25693.297
8	26760.308	61.011	38.000	117636.056	25741.297
9	0.000	96.939	235.918	75572.004	13800.783
10	0.000	64.940	0.000	0.000	0.000
11	272.486	157.950	273.918	0.000	0.000
12	0.967	3.171	3.279	0.000	205326.352
13	1.103		104.919		37920650.500
1	180.000	451.419	82.103	533.522	31.700
2	226197.16	37.076	32.167	139.826	367.669
3	5.498	40.998	32.067	1594.767	5718.497
4	423.970	164.784	38.090	112328.990	23916.802
5	1.719	70.699	4.348	111477.422	23971.041
6	772.832	0.382	0.000	112622.421	23971.041
7	8633.558	0.288	0.633	112748.350	24865.446
8	26740.758	63.876	38.000	113115.350	24913.446
9	0.000	100.759	242.248	80088.890	14622.305
10	0.000	68.760	0.000	0.000	0.000
11	269.620	164.635	280.248	0.000	0.000
12	0.967	3.164	3.272	0.000	199977.795
13	1.131		111.249		40184675.500

TABLE AP 5-2 (Sheet 11 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	190,000	452,828	82,172	535,000	31,700
2	226717,45	37,035	32,100	137,344	361,399
3	5,511	41,015	32,011	1530,927	5529,875
4	423,771	164,792	38,120	107810,385	23094,556
5	1,720	70,693	4,347	106958,576	23150,687
6	774,285	0,382	0,000	108103,575	23150,687
7	8654,807	0,406	0,633	108225,494	24037,926
8	26787,726	67,290	38,000	108592,494	24085,926
9	0,000	104,579	248,578	84607,926	15443,495
10	0,000	72,580	0,000	0,000	0,000
11	266,206	171,869	286,577	0,000	0,000
12	0,970	3,170	3,269	0,000	194627,420
13	1,165		117,579		42448107,500
1	200,000	453,031	82,212	535,244	31,700
2	226805,59	37,904	32,050	134,856	355,123
3	5,510	41,948	31,971	1466,930	5340,955
4	423,743	164,800	38,150	103290,835	22284,353
5	1,720	70,687	4,346	102429,425	22329,592
6	774,671	0,382	0,000	103574,424	22329,592
7	8648,186	0,407	0,633	103692,323	23209,658
8	26807,027	71,358	38,000	104059,323	23257,658
9	0,000	108,399	254,908	89137,276	16265,433
10	0,000	76,400	0,000	0,000	0,000
11	262,138	179,757	292,907	0,000	0,000
12	0,969	3,162	3,264	0,000	189265,980
13	1,198		123,909		44715700,500
1	210,000	451,702	82,132	533,834	31,700
2	226264,76	38,457	32,000	132,368	348,847
3	5,500	42,566	31,932	1402,935	5152,291
4	423,848	164,812	38,188	98815,109	21464,728
5	1,719	70,680	4,344	97900,137	21508,307
6	773,140	0,382	0,000	99045,137	21508,307
7	8623,326	0,295	0,633	99159,017	22381,199
8	26806,515	75,266	38,000	99526,017	22429,199
9	0,000	112,219	261,238	93666,764	17087,562
10	0,000	80,220	0,000	0,000	0,000
11	258,230	187,485	299,237	0,000	0,000
12	0,967	3,134	3,240	0,000	183904,215
13	1,230		130,239		46983405,000
1	220,000	451,991	82,098	534,089	31,700
2	226413,89	37,743	31,950	129,886	342,577
3	5,505	41,923	31,895	1339,056	4963,705
4	423,926	164,824	38,226	94325,043	20647,175
5	1,720	70,674	4,342	93381,806	20687,979
6	773,454	0,382	0,000	94526,806	20687,979
7	8623,428	0,297	0,633	94636,676	21553,704
8	26843,247	78,227	38,000	95003,676	21601,704
9	0,000	116,039	267,568	98185,284	17908,727
10	0,000	84,040	0,000	0,000	0,000
11	255,269	194,266	305,566	0,000	0,000
12	0,969	3,106	3,205	0,000	178554,379
13	1,268		136,569		49246777,500
1	230,000	450,894	82,056	532,949	31,700
2	225989,47	37,029	31,900	127,406	336,310
3	5,495	41,284	31,857	1275,189	4775,067
4	424,036	164,836	38,264	89803,766	19829,145
5	1,720	70,671	4,341	88867,512	19868,029
6	771,902	0,382	0,000	90012,511	19868,029
7	8625,231	0,299	0,633	90118,375	20726,591
8	26776,567	81,206	38,000	90485,375	20774,591
9	0,000	119,859	273,897	102699,765	18729,510
10	0,000	87,859	0,000	0,000	0,000
11	252,289	201,065	311,896	0,000	0,000
12	0,970	3,154	3,252	0,000	173208,965
13	1,305		142,899		51508773,500

TABLE AP 5-2 (Sheet 12 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	240.000	452.040	82.156	534.196	31.700
2	226288.00	36.933	31.850	124.929	330.043
3	5.502	41.264	31.819	1211.359	4586.259
4	423.605	164.848	38.302	85276.847	18997.854
5	1.720	70.667	4.339	84356.331	19047.964
6	772.861	0.382	0.000	85501.330	19047.964
7	8641.388	0.410	0.633	85603.191	19899.363
8	26816.712	84.588	38.000	85970.191	19947.363
9	0.000	123.679	280.227	107211.129	19550.408
10	0.000	91.679	0.000	0.000	0.000
11	248.907	208.267	318.226	0.000	0.000
12	0.970	3.172	3.270	0.000	167866.553
13	1.348		149.228		53768743.500

1	250.000	452.358	82.192	534.550	31.700
2	226519.97	37.767	31.800	122.446	323.769
3	5.504	42.186	31.784	1147.392	4397.113
4	423.758	164.860	38.340	80761.578	18178.885
5	1.720	70.663	4.337	79835.892	18227.074
6	773.596	0.382	0.000	80980.891	18227.073
7	8642.205	0.410	0.633	81078.740	19071.301
8	26824.910	88.688	38.000	81445.740	19119.301
9	0.000	127.499	286.557	111731.760	20372.140
10	0.000	95.499	0.000	0.000	0.000
11	244.807	216.187	324.556	0.000	0.000
12	0.970	3.207	3.307	0.000	162514.041
13	1.394		155.558		56031465.000

1	260.000	452.973	82.217	535.189	31.700
2	226961.77	38.600	31.770	119.959	317.492
3	5.510	43.117	31.771	1083.323	4207.726
4	424.078	164.872	38.378	76253.059	17349.603
5	1.721	70.660	4.336	75308.696	17405.815
6	774.871	0.382	0.000	76453.695	17405.814
7	8646.036	0.410	0.633	76547.527	18242.868
8	26830.941	92.788	38.000	76914.527	18290.868
9	0.000	131.319	292.887	116239.153	21194.244
10	0.000	99.319	0.000	0.000	0.000
11	240.707	224.107	330.885	0.000	0.000
12	0.971	3.240	3.337	0.000	157154.395
13	1.444		161.888		58299624.000

1	270.000	451.015	82.104	533.119	31.700
2	226138.27	38.044	31.740	117.387	311.223
3	5.493	42.649	31.756	1019.431	4018.402
4	424.179	164.884	38.416	71770.622	16533.404
5	1.720	70.657	4.334	70796.787	16585.446
6	772.509	0.382	0.000	71941.786	16585.446
7	8622.777	0.302	0.633	72031.614	17415.333
8	26798.726	95.861	38.000	72398.614	17463.333
9	0.000	135.139	299.216	120771.246	22015.449
10	0.000	103.139	0.000	0.000	0.000
11	237.634	231.000	337.215	0.000	0.000
12	0.969	3.227	3.330	0.000	151810.945
13	1.490		168.218		60561805.000

1	280.000	450.818	82.083	532.901	31.700
2	226049.31	37.489	31.710	114.791	304.955
3	5.492	42.190	31.744	955.583	3828.993
4	424.186	164.896	38.454	67226.829	15702.010
5	1.720	70.657	4.332	66287.737	15765.333
6	772.243	0.382	0.000	67432.737	15765.333
7	8621.877	0.302	0.633	67518.563	16588.055
8	26798.900	98.879	38.000	67885.563	16636.055
9	0.000	138.959	305.546	125280.477	22836.397
10	0.000	106.959	0.000	0.000	0.000
11	234.615	237.838	343.545	0.000	0.000
12	0.969	3.226	3.328	0.000	146470.617
13	1.543		174.548		62822724.000

TABLE AP 5-2 (Sheet 13 of 25
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	290.000	450.621	82.062	532.683	31.700
2	225960.47	36.933	31.680	112.094	298.688
3	5.491	41.731	31.733	891.743	3639.489
4	424.193	164.908	38.492	62606.982	14892.648
5	1.720	70.657	4.331	61780.667	14945.432
6	771.977	0.382	0.000	62925.667	14945.432
7	8620.978	0.302	0.633	63007.493	15760.992
8	26799.078	101.896	38.000	63374.493	15808.992
9	0.000	142.778	311.876	129787.728	23657.130
10	0.000	110.779	0.000	0.000	0.000
11	231.399	244.674	349.875	0.000	0.000
12	0.969	3.224	3.327	0.000	141132.484
13	1.601		180.878		65082755.500
1	300.000	452.397	82.143	534.539	31.700
2	226693.31	36.920	31.650	109.374	292.421
3	5.507	41.825	31.725	827.837	3449.809
4	424.091	164.920	38.530	58112.741	14067.657
5	1.721	70.656	4.329	57268.996	14125.404
6	774.059	0.382	0.000	58413.996	14125.404
7	8643.313	0.408	0.633	58491.818	14933.801
8	26835.602	105.283	38.000	58858.818	14981.801
9	0.000	146.598	318.205	134299.582	24477.991
10	0.000	114.599	0.000	0.000	0.000
11	228.211	251.882	356.204	0.000	0.000
12	0.971	3.236	3.331	0.000	135789.617
13	1.669		187.208		67344643.000
1	301.000	452.477	81.867	534.344	31.700
2	226510.16	37.000	31.695	109.087	291.794
3	5.527	41.908	31.779	821.429	3430.823
4	423.904	164.921	38.535	57655.289	13986.471
5	1.721	70.656	4.329	56816.575	14043.332
6	773.299	0.382	0.000	57961.574	14043.331
7	8640.845	0.407	0.936	58038.995	14851.011
8	26831.647	105.691	38.000	58405.995	14899.011
9	0.000	146.980	318.990	134752.023	24559.997
10	0.000	114.981	0.000	0.000	0.000
11	227.804	252.671	356.989	0.000	0.000
12	0.972	3.234	3.329	0.000	135254.006
13	1.675		187.992		67571241.000
1	302.000	452.509	81.869	534.378	31.700
2	226523.76	37.080	31.740	108.801	291.167
3	5.527	41.998	31.826	815.021	3411.836
4	423.902	164.923	38.540	57197.780	13906.702
5	1.721	70.656	4.329	56364.098	13961.244
6	773.339	0.382	0.000	57509.097	13961.244
7	8640.981	0.407	0.936	57586.117	14768.206
8	26832.786	106.098	38.000	57953.117	14816.206
9	0.000	147.362	319.926	135204.520	24641.865
10	0.000	115.363	0.000	0.000	0.000
11	227.396	253.461	357.925	0.000	0.000
12	0.972	3.234	3.329	0.000	134718.322
13	1.681		188.928		67797754.000
1	303.000	452.541	81.871	534.412	31.700
2	226537.48	37.160	31.785	108.514	290.539
3	5.527	42.088	31.874	808.612	3392.847
4	423.901	164.924	38.544	56741.684	13826.931
5	1.721	70.656	4.328	55911.588	13879.154
6	773.379	0.382	0.000	57056.587	13879.154
7	8641.119	0.407	0.936	57133.206	14685.399
8	26833.931	106.505	38.000	57500.206	14733.399
9	0.000	147.744	320.862	135657.049	24723.736
10	0.000	115.745	0.000	0.000	0.000
11	226.989	254.250	358.861	0.000	0.000
12	0.972	3.235	3.329	0.000	134182.604
13	1.688		189.864		68024280.000

TABLE AP 5-2 (Sheet 14 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	304.000	452.573	81.873	534.446	31.700
2	226551.22	37.240	31.830	108.227	289.912
3	5.528	42.178	31.921	802.202	3373.856
4	423.899	164.926	38.549	56289.501	13747.158
5	1.721	70.656	4.328	55459.045	13797.062
6	773.419	0.382	0.000	56604.045	13797.062
7	8641.257	0.407	0.936	56680.261	14602.590
8	26835.076	106.913	38.000	57047.261	14650.590
9	0.000	148.126	321.798	136109.611	24805.609
10	0.000	116.127	0.000	0.000	0.000
11	226.582	255.039	359.797	0.000	0.000
12	0.972	3.235	3.329	0.000	133646.850
13	1.695		190.800		68250821.000

1	305.000	452.605	81.876	534.481	31.700
2	226564.96	37.320	31.875	107.940	289.284
3	5.528	42.268	31.968	795.792	3354.863
4	423.897	164.927	38.554	55837.287	13667.382
5	1.721	70.656	4.328	55006.472	13714.968
6	773.459	0.382	0.000	56151.472	13714.968
7	8641.395	0.407	0.936	56227.287	14519.779
8	26836.222	107.320	38.000	56594.287	14567.779
9	0.000	148.508	322.734	136562.203	24887.485
10	0.000	116.509	0.000	0.000	0.000
11	226.175	255.828	360.733	0.000	0.000
12	0.972	3.235	3.329	0.000	133111.064
13	1.702		191.736		68477375.000

1	306.000	452.637	81.878	534.515	31.700
2	226578.73	37.400	31.920	107.653	288.657
3	5.528	42.359	32.015	789.382	3335.868
4	423.896	164.929	38.559	55385.042	13587.604
5	1.721	70.656	4.328	54553.867	13632.871
6	773.500	0.382	0.000	55698.866	13632.871
7	8641.533	0.407	0.936	55774.279	14436.965
8	26837.369	107.727	38.000	56141.279	14484.965
9	0.000	148.890	323.670	137014.828	24969.362
10	0.000	116.891	0.000	0.000	0.000
11	225.768	256.617	361.669	0.000	0.000
12	0.972	3.235	3.329	0.000	132575.244
13	1.709		192.672		68703942.000

1	307.000	452.669	81.880	534.550	31.700
2	226592.50	37.480	31.965	107.366	288.030
3	5.528	42.449	32.063	782.971	3316.870
4	423.894	164.930	38.564	54932.763	13506.648
5	1.721	70.656	4.328	54101.229	13550.773
6	773.540	0.382	0.000	55246.228	13550.773
7	8641.672	0.407	0.936	55321.239	14354.149
8	26838.515	108.133	38.000	55688.239	14402.149
9	0.000	149.272	324.606	137467.486	25051.242
10	0.000	117.273	0.000	0.000	0.000
11	225.361	257.406	362.605	0.000	0.000
12	0.972	3.236	3.329	0.000	132039.387
13	1.716		193.608		68930525.000

1	308.000	452.702	81.882	534.584	31.700
2	226606.29	37.560	32.010	107.079	287.402
3	5.529	42.540	32.110	776.559	3297.871
4	423.893	164.932	38.569	54480.452	13424.271
5	1.721	70.655	4.327	53648.558	13468.672
6	773.580	0.382	0.000	54793.557	13468.672
7	8641.810	0.407	0.936	54868.167	14271.331
8	26839.664	108.540	38.000	55235.167	14319.331
9	0.000	149.634	325.542	137920.178	25133.123
10	0.000	117.655	0.000	0.000	0.000
11	224.954	258.195	363.541	0.000	0.000
12	0.972	3.236	3.329	0.000	131503.498
13	1.723		194.544		69157120.000

TABLE AP 5-2 (Sheet 15 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	309.000	452.732	81.896	534.628	23.392
2	226627.78	37.640	32.055	106.792	286.775
3	5.528	42.631	32.157	770.147	3278.869
4	423.898	164.933	38.573	54028.109	13341.891
5	1.721	70.655	4.327	53195.855	13386.569
6	773.652	0.382	0.000	54340.855	13386.569
7	8642.050	0.406	0.924	54415.063	14188.511
8	26841.010	108.947	38.000	54782.063	14236.511
9	0.000	150.036	326.475	138372.898	25215.012
10	0.000	118.037	0.000	0.000	0.000
11	224.548	258.983	364.474	0.000	0.000
12	0.972	3.236	3.329	0.000	130967.573
13	1.730		195.477		69383731.000

1	310.000	407.503	80.434	487.937	3.326
2	208586.09	37.720	32.100	106.512	286.149
3	5.066	42.635	32.152	763.888	3259.948
4	427.486	164.935	38.578	53586.555	13259.746
5	1.698	70.655	4.327	52753.948	13304.699
6	721.510	0.382	0.000	53898.947	13304.699
7	8236.108	0.406	0.900	53972.763	14105.926
8	26285.096	109.353	38.000	54339.763	14153.926
9	0.000	150.418	327.387	138814.816	25296.684
10	0.000	118.419	0.000	0.000	0.000
11	224.141	259.772	365.386	0.000	0.000
12	0.909	2.945	3.241	0.000	130442.688
13	1.599		196.390		69606104.000

1	320.000	332.879	75.433	408.312	-28.500
2	175953.07	38.520	32.171	104.366	280.347
3	4.413	43.078	32.181	716.008	3084.479
4	430.928	164.950	38.627	50211.110	12498.040
5	1.648	70.654	4.325	49372.972	12545.548
6	627.183	0.382	0.000	50517.971	12545.548
7	7565.503	0.405	0.865	50588.787	13340.143
8	24402.916	113.410	38.000	50955.787	13388.143
9	0.000	154.238	336.063	142194.973	26059.791
10	0.000	122.239	0.000	0.000	0.000
11	220.084	267.649	374.062	0.000	0.000
12	0.838	2.464	2.939	0.000	126292.929
13	1.393		205.066		71387822.000

1	330.000	331.129	75.332	406.461	-28.500
2	175215.55	38.543	32.243	102.138	274.572
3	4.396	43.158	32.263	669.051	2909.653
4	431.076	164.965	38.675	46923.726	11754.406
5	1.647	70.654	4.323	46058.025	11789.979
6	625.070	0.382	0.000	47203.025	11789.978
7	7543.106	0.297	0.865	47270.898	12577.973
8	24375.724	116.545	38.000	47637.898	12625.973
9	0.000	158.058	344.713	145509.041	26807.311
10	0.000	126.059	0.000	0.000	0.000
11	216.948	274.604	382.712	0.000	0.000
12	0.836	2.453	2.932	0.000	122212.871
13	1.436		213.716		73141108.000

1	340.000	331.108	75.320	406.428	-28.500
2	175199.85	38.480	32.314	99.912	268.800
3	4.396	43.166	32.346	622.112	2734.716
4	431.072	164.980	38.723	43639.157	10995.275
5	1.647	70.656	4.321	42745.920	11034.657
6	625.016	0.382	0.000	43890.920	11034.657
7	7542.940	0.295	0.865	43955.854	11816.053
8	24380.341	119.503	38.000	44322.854	11864.053
9	0.000	161.878	353.363	148820.266	27560.581
10	0.000	129.879	0.000	0.000	0.000
11	213.991	281.381	391.362	0.000	0.000
12	0.837	2.452	2.931	0.000	118135.907
13	1.483		222.366		74893149.000

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TABLE AP 5-2 (Sheet 16 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	350.000	331.084	75.309	406.393	-28.500
2	175183.08	38.440	32.386	97.568	263.028
3	4.396	43.195	32.431	575.194	2559.618
4	431.068	165.005	38.772	40354.806	10254.447
5	1.647	70.656	4.319	39434.035	10279.447
6	624.960	0.382	0.000	40579.035	10279.447
7	7542.828	0.293	0.865	40641.030	11054.246
8	24384.890	122.443	38.000	41008.030	11102.246
9	0.000	165.697	362.013	152131.270	28313.738
10	0.000	133.699	0.000	0.000	0.000
11	211.050	288.141	400.012	0.000	0.000
12	0.837	2.452	2.930	0.000	114059.275
13	1.536		231.016		76645019.000
1	360.000	331.061	75.298	406.359	-28.500
2	175166.81	38.400	32.457	95.190	257.257
3	4.397	43.227	32.516	528.280	2384.284
4	431.064	165.030	38.820	37059.762	9499.350
5	1.647	70.657	4.317	36122.382	9524.350
6	624.904	0.382	0.000	37267.382	9524.349
7	7542.721	0.291	0.865	37326.438	10292.552
8	24389.461	125.366	38.000	37693.438	10340.552
9	0.000	169.517	370.663	155442.043	29066.782
10	0.000	137.519	0.000	0.000	0.000
11	208.127	294.884	408.662	0.000	0.000
12	0.837	2.452	2.929	0.000	109982.990
13	1.593		239.666		78396731.000
1	370.000	331.031	75.280	406.311	-28.500
2	175142.97	38.365	32.529	92.684	251.487
3	4.397	43.260	32.603	481.376	2209.290
4	431.057	165.060	38.890	33746.709	8762.013
5	1.647	70.656	4.314	32810.987	8769.396
6	624.822	0.382	0.000	33955.987	8769.396
7	7542.522	0.290	0.865	34012.104	9531.004
8	24396.092	128.272	38.000	34379.104	9579.004
9	0.000	173.337	379.313	158752.557	29819.681
10	0.000	141.338	0.000	0.000	0.000
11	205.221	301.610	417.311	0.000	0.000
12	0.838	2.452	2.927	0.000	105907.107
13	1.654		248.315		80148242.000
1	380.000	331.001	75.262	406.263	-28.500
2	175119.35	38.330	32.600	90.118	245.718
3	4.398	43.295	32.691	434.475	2034.076
4	431.049	165.090	38.960	30405.240	8000.710
5	1.647	70.656	4.311	29499.903	8014.619
6	624.741	0.382	0.000	30644.903	8014.619
7	7542.325	0.288	0.865	30698.082	8769.633
8	24402.733	131.161	38.000	31065.082	8817.633
9	0.000	177.157	387.962	162062.758	30572.402
10	0.000	145.158	0.000	0.000	0.000
11	202.332	308.318	425.961	0.000	0.000
12	0.838	2.452	2.926	0.000	101831.715
13	1.720		256.965		81899520.000
1	390.000	330.960	75.243	406.203	-28.500
2	175090.70	38.315	32.650	87.380	239.951
3	4.399	43.342	32.759	387.594	1858.610
4	431.042	165.135	39.030	27041.906	7260.293
5	1.647	70.652	4.309	26189.168	7260.026
6	624.644	0.382	0.000	27334.167	7260.025
7	7542.175	0.286	0.865	27384.409	8008.447
8	24409.120	134.030	38.000	27751.409	8056.447
9	0.000	180.977	396.612	165372.611	31324.938
10	0.000	148.978	0.000	0.000	0.000
11	199.463	315.007	434.611	0.000	0.000
12	0.839	2.452	2.924	0.000	97756.855
13	1.791		265.615		83650535.000

TABLE AP 5-2 (Sheet 17 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	400.000	330.920	75.224	406.144	-28.500
2	175062.20	38.300	32.700	84.579	234.186
3	4.399	43.390	32.828	340.710	1682.953
4	431.035	165.180	39.100	23705.647	6519.461
5	1.647	70.650	4.306	22878.840	6505.625
6	624.547	0.382	0.000	24023.840	6505.625
7	7542.026	0.284	0.865	24071.143	7247.457
8	24415.514	136.878	38.000	24438.143	7295.457
9	0.000	184.797	405.262	168682.059	32077.278
10	0.000	152.798	0.000	0.000	0.000
11	196.615	321.675	442.261	0.000	0.000
12	0.839	2.451	2.922	0.000	93682.600
13	1.869		274.265		85401264.000

1	410.000	330.865	75.199	406.064	-28.500
2	175024.64	38.295	32.750	81.494	228.442
3	4.400	43.431	32.899	293.836	1507.383
4	431.027	165.234	39.185	20383.425	5790.001
5	1.647	70.646	4.303	19568.979	5751.440
6	624.421	0.382	0.000	20713.979	5751.440
7	7541.812	0.282	0.865	20758.346	6486.683
8	24423.148	139.704	38.000	21125.346	6534.683
9	0.000	188.617	413.912	171991.035	32829.402
10	0.000	156.618	0.000	0.000	0.000
11	193.789	328.321	451.911	0.000	0.000
12	0.839	2.451	2.920	0.000	89609.028
13	1.953		282.915		87151668.000

1	420.000	330.796	75.175	405.971	-28.500
2	174981.45	38.290	32.800	78.261	222.715
3	4.400	43.464	32.973	246.972	1331.587
4	431.020	165.298	39.270	17022.583	5038.799
5	1.647	70.640	4.300	16259.711	4997.497
6	624.279	0.382	0.000	17404.711	4997.497
7	7541.606	0.279	0.865	17446.140	5726.154
8	24430.506	142.509	38.000	17813.140	5774.154
9	0.000	192.436	422.562	175299.422	33581.282
10	0.000	160.438	0.000	0.000	0.000
11	190.983	334.946	460.561	0.000	0.000
12	0.840	2.451	2.918	0.000	85536.294
13	2.046		291.564		88901679.000

1	430.000	330.702	75.142	405.844	-28.500
2	174923.22	38.297	32.833	74.763	216.948
3	4.401	43.489	33.031	200.121	1155.794
4	431.011	165.381	39.375	13671.231	4303.837
5	1.647	70.631	4.297	12951.244	4243.837
6	624.088	0.382	0.000	14096.244	4243.837
7	7541.326	0.277	0.865	14134.737	4965.910
8	24439.375	145.292	38.000	14501.737	5013.910
9	0.000	196.256	431.212	178607.004	34332.875
10	0.000	164.257	0.000	0.000	0.000
11	188.200	341.550	469.210	0.000	0.000
12	0.841	2.450	2.915	0.000	81464.647
13	2.147		300.214		90651189.000

1	440.000	330.565	75.107	405.672	-28.500
2	174847.50	38.305	32.867	70.775	210.693
3	4.401	43.470	33.090	153.284	979.778
4	431.007	165.488	39.480	10268.407	3534.437
5	1.647	70.617	4.293	9643.931	3490.512
6	623.846	0.382	0.000	10788.931	3490.512
7	7541.024	0.275	0.865	10824.490	4206.005
8	24447.401	148.054	38.000	11191.490	4254.005
9	0.000	200.076	439.861	181913.432	35084.131
10	0.000	168.077	0.000	0.000	0.000
11	185.438	348.131	477.860	0.000	0.000
12	0.841	2.449	2.912	0.000	77394.494
13	2.259		308.864		92400031.000

TABLE AP 5-2 (Sheet 18 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	450.000	330.351	75.055	405.406	-28.500
2	174730.44	38.312	32.900	66.207	203.714
3	4.401	43.390	33.146	106.464	803.901
4	431.001	165.640	39.630	6737.132	2796.208
5	1.646	70.596	4.287	6338.303	2737.615
6	623.474	0.382	0.000	7483.303	2737.615
7	7540.500	0.273	0.865	7515.928	3446.530
8	24458.472	150.795	38.000	7882.928	3494.530
9	0.000	203.896	448.511	185218.174	35834.956
10	0.000	171.897	0.000	0.000	0.000
11	182.697	354.692	486.510	0.000	0.000
12	0.842	2.448	2.908	0.000	73326.457
13	2.383		317.514		94147940.000

1	451.000	330.327	75.049	405.376	-28.500
2	174717.24	38.313	32.903	65.724	202.980
3	4.401	43.379	33.152	101.783	786.310
4	431.001	165.656	39.647	6377.481	2719.239
5	1.646	70.593	4.287	6007.867	2662.354
6	623.432	0.382	0.000	7152.867	2662.354
7	7540.435	0.273	0.865	7185.199	3370.612
8	24459.733	151.068	38.000	7552.199	3418.612
9	0.000	204.278	449.376	185548.521	35910.009
10	0.000	172.279	0.000	0.000	0.000
11	182.424	355.347	487.375	0.000	0.000
12	0.842	2.448	2.907	0.000	72919.811
13	2.396		318.379		94322663.000

1	452.000	330.303	75.043	405.346	-28.500
2	174704.03	38.314	32.907	65.240	202.247
3	4.402	43.368	33.157	97.102	768.715
4	431.000	165.672	39.664	6017.856	2642.276
5	1.646	70.591	4.286	5677.455	2587.099
6	623.390	0.382	0.000	6822.455	2587.099
7	7540.370	0.273	0.865	6854.493	3294.700
8	24460.992	151.341	38.000	7221.493	3342.700
9	0.000	204.660	450.241	185878.844	35985.056
10	0.000	172.661	0.000	0.000	0.000
11	182.151	356.002	488.240	0.000	0.000
12	0.842	2.448	2.907	0.000	72513.192
13	2.409		319.244		94497372.000

1	453.000	330.279	75.037	405.316	-28.500
2	174690.79	38.315	32.910	64.757	201.490
3	4.402	43.356	33.163	92.420	751.116
4	430.999	165.689	39.681	5662.067	2565.319
5	1.646	70.589	4.285	5347.067	2511.851
6	623.347	0.382	0.000	6492.067	2511.851
7	7540.304	0.272	0.865	6523.812	3218.794
8	24462.250	151.613	38.000	6890.812	3266.794
9	0.000	205.042	451.106	186209.145	36060.097
10	0.000	173.043	0.000	0.000	0.000
11	181.879	356.656	489.105	0.000	0.000
12	0.842	2.447	2.906	0.000	72106.605
13	2.423		320.109		94672068.000

1	454.000	330.253	75.031	405.284	-28.500
2	174676.94	38.315	32.913	64.237	200.686
3	4.402	43.341	33.168	87.739	733.514
4	430.999	165.705	39.698	5331.703	2488.369
5	1.646	70.586	4.285	5016.703	2436.608
6	623.304	0.382	0.000	6161.703	2436.608
7	7540.232	0.272	0.865	6193.155	3142.893
8	24463.480	151.885	38.000	6560.155	3190.893
9	0.000	205.424	451.971	186539.420	36135.132
10	0.000	173.425	0.000	0.000	0.000
11	181.606	357.310	489.970	0.000	0.000
12	0.842	2.447	2.906	0.000	71700.048
13	2.436		320.974		94846752.000

TABLE AP 5-2 (Sheet 19 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	455.000	330.224	75.025	405.248	-28.500
2	174661.64	38.316	32.917	63.629	199.882
3	4.402	43.317	33.173	83.058	715.908
4	430.999	165.721	39.715	5001.365	2411.424
5	1.646	70.584	4.284	4686.365	2361.371
6	623.255	0.382	0.000	5831.365	2361.371
7	7540.146	0.272	0.865	5862.524	3066.999
8	24464.645	152.157	38.000	6229.524	3114.999
9	0.000	205.806	452.836	186869.668	36210.162
10	0.000	173.807	0.000	0.000	0.000
11	181.334	357.964	490.835	0.000	0.000
12	0.842	2.447	2.905	0.000	71293.522
13	2.450		321.839		95021421.000

1	456.000	330.194	75.019	405.213	-28.500
2	174646.30	38.317	32.920	63.020	199.077
3	4.401	43.292	33.178	78.376	698.298
4	430.999	165.737	39.732	4671.056	2334.485
5	1.646	70.581	4.283	4356.056	2286.140
6	623.207	0.382	0.000	5501.056	2286.140
7	7540.060	0.272	0.865	5531.922	2991.111
8	24465.808	152.429	38.000	5898.922	3039.111
9	0.000	206.188	453.701	187199.889	36285.185
10	0.000	174.189	0.000	0.000	0.000
11	181.063	358.618	491.700	0.000	0.000
12	0.842	2.447	2.905	0.000	70887.032
13	2.464		322.704		95196075.000

1	457.000	330.165	75.012	405.177	-28.500
2	174630.92	38.318	32.923	62.412	198.273
3	4.401	43.268	33.184	73.695	680.684
4	430.999	165.754	39.749	4340.777	2257.553
5	1.646	70.579	4.283	4025.777	2210.915
6	623.159	0.382	0.000	5170.777	2210.915
7	7539.973	0.271	0.865	5201.349	2915.229
8	24466.969	152.701	38.000	5568.349	2963.229
9	0.000	206.570	454.566	187530.078	36360.202
10	0.000	174.571	0.000	0.000	0.000
11	180.791	359.271	492.565	0.000	0.000
12	0.843	2.447	2.904	0.000	70480.578
13	2.478		323.569		95370713.000

1	458.000	330.135	75.006	405.142	-28.500
2	174615.49	38.318	32.927	61.804	197.469
3	4.401	43.243	33.189	69.014	663.067
4	430.999	165.770	39.766	3998.366	2180.806
5	1.646	70.577	4.282	3695.527	2135.696
6	623.111	0.382	0.000	4840.526	2135.696
7	7539.885	0.271	0.865	4870.806	2839.353
8	24468.128	152.972	38.000	5237.806	2887.353
9	0.000	206.952	455.431	187860.240	36435.213
10	0.000	174.953	0.000	0.000	0.000
11	180.520	359.925	493.430	0.000	0.000
12	0.843	2.446	2.904	0.000	70074.159
13	2.492		324.434		95545337.000

1	459.000	330.106	75.000	405.106	-28.500
2	174600.01	38.319	32.930	61.196	196.656
3	4.401	43.217	33.194	64.333	645.446
4	430.998	165.786	39.783	3647.653	2108.325
5	1.646	70.574	4.282	3365.306	2060.484
6	623.062	0.382	0.000	4510.306	2060.484
7	7539.797	0.271	0.865	4540.292	2763.484
8	24469.285	153.243	38.000	4907.292	2811.484
9	0.000	207.334	456.296	188190.371	36510.217
10	0.000	175.335	0.000	0.000	0.000
11	180.249	360.578	494.295	0.000	0.000
12	0.843	2.446	2.903	0.000	69667.775
13	2.506		325.299		95719944.000

TABLE AP 5-2 (Sheet 20 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	460.000	330.076	74.994	405.070	-28.500
2	174584.48	38.320	32.933	60.588	195.771
3	4.401	43.192	33.199	59.653	627.821
4	430.998	165.803	39.800	3296.972	2035.850
5	1.646	70.572	4.281	3035.115	1985.277
6	623.013	0.382	0.000	4180.115	1985.277
7	7539.709	0.271	0.865	4209.808	2687.620
8	24470.438	153.514	38.000	4576.808	2735.620
9	0.000	207.716	457.161	188520.475	36585.216
10	0.000	175.717	0.000	0.000	0.000
11	179.978	361.231	495.160	0.000	0.000
12	0.843	2.446	2.903	0.000	69261.428
13	2.521		326.164		95894537.000

1	461.000	330.045	74.985	405.030	-28.500
2	174566.80	38.321	32.937	59.979	194.885
3	4.401	43.166	33.204	54.972	610.246
4	430.997	165.819	39.825	2946.322	1963.382
5	1.646	70.570	4.280	2704.954	1910.078
6	622.956	0.382	0.000	3849.954	1910.078
7	7539.581	0.271	0.865	3879.354	2611.764
8	24472.387	153.785	38.000	4246.354	2659.764
9	0.000	208.098	458.026	188850.547	36660.207
10	0.000	176.099	0.000	0.000	0.000
11	179.707	361.883	496.025	0.000	0.000
12	0.843	2.446	2.902	0.000	68855.118
13	2.535		327.029		96069112.000

1	462.000	330.013	74.977	404.990	-28.500
2	174548.79	38.321	32.940	59.355	193.999
3	4.402	43.138	33.209	50.291	592.665
4	430.996	165.835	39.850	2595.706	1890.922
5	1.646	70.567	4.279	2374.824	1834.888
6	622.899	0.382	0.000	3519.824	1834.888
7	7539.450	0.270	0.865	3548.931	2535.917
8	24474.321	154.055	38.000	3915.931	2583.917
9	0.000	208.480	458.891	189180.586	36735.189
10	0.000	176.481	0.000	0.000	0.000
11	179.436	362.536	496.890	0.000	0.000
12	0.843	2.446	2.901	0.000	68448.848
13	2.550		327.894		96243670.000

1	463.000	329.973	74.968	404.940	-28.500
2	174527.21	38.322	32.943	58.521	193.114
3	4.402	43.087	33.213	45.611	575.077
4	430.995	165.851	39.875	2245.125	1818.470
5	1.646	70.565	4.278	2044.727	1759.706
6	622.831	0.382	0.000	3189.727	1759.706
7	7539.283	0.270	0.865	3218.542	2460.078
8	24476.091	154.325	38.000	3585.542	2508.078
9	0.000	208.862	459.756	189510.594	36810.163
10	0.000	176.863	0.000	0.000	0.000
11	179.166	363.188	497.755	0.000	0.000
12	0.843	2.445	2.900	0.000	68042.619
13	2.565		328.759		96418209.000

1	464.000	329.932	74.959	404.890	-28.500
2	174505.54	38.323	32.947	57.687	192.228
3	4.402	43.036	33.218	40.931	557.483
4	430.995	165.868	39.900	1894.586	1746.027
5	1.646	70.563	4.277	1714.671	1684.532
6	622.762	0.382	0.000	2859.671	1684.532
7	7539.115	0.270	0.865	2888.192	2384.248
8	24477.859	154.595	38.000	3255.192	2432.248
9	0.000	209.244	460.621	189840.563	36885.128
10	0.000	177.245	0.000	0.000	0.000
11	178.896	363.840	498.620	0.000	0.000
12	0.843	2.445	2.900	0.000	67636.439
13	2.580		329.624		96592728.000

TABLE AP 5-2 (Sheet 21 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	465.000	329.891	74.949	404.840	-28.500
2	174483.77	38.324	32.950	56.853	191.300
3	4.402	42.985	33.223	36.251	539.884
4	430.994	165.884	39.925	1544.091	1672.368
5	1.646	70.560	4.276	1384.654	1609.368
6	622.694	0.382	0.000	2529.654	1609.368
7	7538.946	0.270	0.865	2557.883	2308.427
8	24479.622	154.865	38.000	2924.883	2356.427
9	0.000	209.626	461.486	190170.488	36960.084
10	0.000	177.627	0.000	0.000	0.000
11	178.626	364.492	499.485	0.000	0.000
12	0.843	2.445	2.899	0.000	67230.310
13	2.595		330.489		96767225.000

1	466.000	329.850	74.940	404.790	-28.500
2	174461.90	38.324	32.953	56.019	190.320
3	4.401	42.933	33.227	31.572	522.278
4	430.994	165.900	39.950	1193.639	1597.213
5	1.646	70.558	4.275	1054.679	1534.213
6	622.625	0.382	0.000	2199.679	1534.213
7	7538.776	0.269	0.865	2227.615	2232.616
8	24481.380	155.135	38.000	2594.615	2280.616
9	0.000	210.008	462.351	190500.375	37035.031
10	0.000	178.009	0.000	0.000	0.000
11	178.357	365.144	500.350	0.000	0.000
12	0.844	2.445	2.898	0.000	66824.230
13	2.611		331.354		96941700.000

1	467.000	329.808	74.931	404.739	-28.500
2	174439.93	38.325	32.957	55.186	189.340
3	4.401	42.880	33.231	26.892	504.666
4	430.993	165.916	39.975	843.231	1522.067
5	1.646	70.555	4.274	724.745	1459.067
6	622.555	0.382	0.000	1869.745	1459.067
7	7538.605	0.269	0.865	1897.389	2156.813
8	24483.133	155.404	38.000	2264.389	2204.813
9	0.000	210.390	463.216	190830.219	37109.968
10	0.000	178.391	0.000	0.000	0.000
11	178.087	365.795	501.215	0.000	0.000
12	0.844	2.444	2.897	0.000	66418.201
13	2.626		332.219		97116153.000

1	468.000	329.766	74.922	404.688	-28.500
2	174417.52	38.326	32.960	54.333	188.360
3	4.401	42.824	33.236	22.213	487.047
4	430.993	165.932	40.000	492.867	1446.930
5	1.646	70.553	4.273	394.853	1383.930
6	622.485	0.382	0.000	1539.853	1383.930
7	7538.430	0.269	0.865	1567.204	2081.019
8	24484.868	155.673	38.000	1934.204	2129.019
9	0.000	210.772	464.081	191160.023	37184.897
10	0.000	178.773	0.000	0.000	0.000
11	177.818	366.446	502.080	0.000	0.000
12	0.844	2.444	2.897	0.000	66012.223
13	2.642		333.084		97290584.000

1	469.000	329.712	74.912	404.625	-28.500
2	174390.68	38.327	32.963	53.232	187.380
3	4.401	42.741	33.240	17.534	469.423
4	430.994	165.949	40.025	142.549	1371.281
5	1.646	70.551	4.272	65.005	1308.801
6	622.402	0.382	0.000	1210.005	1308.801
7	7538.210	0.269	0.865	1237.062	2005.235
8	24486.400	155.942	38.000	1604.062	2053.235
9	0.000	211.154	464.946	191489.781	37259.816
10	0.000	179.155	0.000	0.000	0.000
11	177.549	367.097	502.945	0.000	0.000
12	0.844	2.444	2.896	0.000	65606.297
13	2.658		333.949		97464992.000

TABLE AP 5-2 (Sheet 22 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	470.000	329.652	74.902	404.554	-28.500
2	174360.99	38.327	32.967	51.977	186.362
3	4.401	42.640	33.244	12.856	451.787
4	430.995	165.965	40.050	-207.712	1295.101
5	1.646	70.548	4.271	-264.791	1233.683
6	622.310	0.382	0.000	880.209	1233.683
7	7537.962	0.269	0.865	906.974	1929.460
8	24487.803	156.211	38.000	1273.974	1977.460
9	0.000	211.536	465.811	191819.488	37334.726
10	-0.000	179.537	0.000	0.000	0.000
11	177.281	367.748	503.810	0.000	0.000
12	0.844	2.443	2.895	0.000	65200.434
13	2.674		334.814		97639373.000
1	471.000	329.578	74.886	404.464	-28.500
2	174321.89	38.328	32.970	50.497	185.270
3	4.401	42.513	33.247	8.178	434.240
4	430.994	165.981	40.095	-557.907	1218.935
5	1.646	70.546	4.269	-594.524	1158.577
6	622.187	0.382	0.000	550.476	1158.577
7	7537.575	0.268	0.865	576.949	1853.698
8	24491.008	156.479	38.000	943.949	1901.698
9	0.000	211.918	466.676	192149.131	37409.623
10	-0.000	179.919	0.000	0.000	0.000
11	177.012	368.398	504.675	0.000	0.000
12	0.844	2.443	2.894	0.000	64794.646
13	2.690		335.679		97813722.000
1	472.000	329.482	74.869	404.351	-28.500
2	174273.51	38.329	32.973	48.507	184.180
3	4.401	42.328	33.251	3.501	416.681
4	430.996	165.998	40.140	-908.022	1142.785
5	1.646	70.544	4.267	-924.182	1083.488
6	622.037	0.382	0.000	220.818	1083.488
7	7537.094	0.268	0.865	246.998	1777.953
8	24493.791	156.748	38.000	613.998	1825.953
9	0.000	212.300	467.541	192478.699	37484.503
10	-0.000	180.301	0.000	0.000	0.000
11	176.744	369.048	505.540	0.000	0.000
12	0.844	2.442	2.892	0.000	64388.951
13	2.707		336.544		97988031.000
1	472.299	329.443	74.863	404.306	-28.500
2	174254.87	38.329	32.974	47.652	183.853
3	4.401	42.247	33.252	2.103	411.427
4	430.997	166.002	40.153	-1014.752	1119.907
5	1.646	70.543	4.266	-1022.765	1061.032
6	621.980	0.382	0.000	122.235	1061.032
7	7536.908	0.268	0.865	148.328	1755.301
8	24494.434	156.828	38.000	515.328	1803.301
9	0.000	212.414	467.800	192577.256	37506.897
10	-0.000	180.415	0.000	0.000	0.000
11	176.664	369.243	505.798	0.000	0.000
12	0.845	2.442	2.892	0.000	64267.628
13	2.711		336.802		98040154.000
1	472.300	329.504	74.867	404.371	-28.500
2	174280.71	38.329	32.974	47.650	183.853
3	4.401	42.246	33.252	2.099	411.413
4	430.992	166.002	40.153	-1015.032	1119.846
5	1.646	70.543	4.266	-1023.028	1060.972
6	595.748	0.382	0.000	121.972	1060.972
7	6316.024	0.268	0.865	148.064	1755.240
8	24269.824	156.828	38.000	515.064	1803.240
9	0.000	212.414	467.800	192577.520	37506.957
10	-0.000	180.415	0.000	0.000	0.000
11	176.663	369.243	505.799	0.000	0.000
12	0.772	2.357	3.054	0.000	64267.304
13	2.712		336.803		98040293.000

PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	472.399	329.504	74.867	404.371	-28.500
2	175148.11	38.329	32.975	47.328	183.744
3	4.401	42.212	33.252	1.635	409.670
4	433.137	166.004	40.158	-1047.744	1112.397
5	1.646	70.543	4.266	-1055.724	1053.524
6	598.713	0.382	0.000	89.276	1053.524
7	6316.027	0.268	0.865	115.339	1747.727
8	24269.824	156.855	38.000	482.339	1795.727
9	0.000	212.452	467.886	192610.207	37514.384
10	-0.000	180.453	0.000	0.000	0.000
11	176.637	369.308	505.885	0.000	0.000
12	0.772	2.357	3.054	0.000	64227.066
13	2.727		336.889		98057581.000
1	472.499	283.954	64.513	348.467	-28.500
2	151019.03	38.329	32.975	46.911	183.640
3	4.402	42.544	33.504	1.188	407.987
4	433.381	166.006	40.162	-1081.257	1105.118
5	1.646	70.542	4.266	-1087.208	1046.349
6	516.232	0.382	0.000	57.792	1046.349
7	5442.916	0.268	0.865	83.827	1740.490
8	20913.269	156.881	38.000	450.827	1788.490
9	0.000	212.490	467.973	192641.680	37521.535
10	-0.000	180.491	0.000	0.000	0.000
11	176.610	369.373	505.971	0.000	0.000
12	0.772	2.031	2.632	0.000	64188.317
13	2.353		336.975		98074311.000
1	472.599	174.080	39.570	213.650	-28.500
2	92383.28	38.329	32.975	46.606	183.564
3	4.399	42.427	33.775	0.862	406.743
4	432.405	166.007	40.167	-1106.035	1099.750
5	1.646	70.542	4.266	-1110.227	1041.083
6	315.796	0.382	0.000	34.773	1041.083
7	3336.806	0.268	0.865	60.788	1735.178
8	12827.632	156.908	38.000	427.788	1783.178
9	0.000	212.528	468.059	192664.682	37526.760
10	-0.000	180.530	0.000	0.000	0.000
11	176.583	369.438	506.058	0.000	0.000
12	0.771	1.245	1.614	0.000	64159.965
13	1.440		337.062		98086549.000
1	472.699	66.223	15.123	81.346	-28.500
2	35171.77	38.330	32.976	46.451	183.524
3	4.379	41.005	33.589	0.696	406.124
4	432.373	166.009	40.171	-1118.882	1096.952
5	1.646	70.542	4.266	-1121.922	1038.360
6	120.228	0.382	0.000	23.078	1038.360
7	1269.380	0.268	0.865	49.083	1732.430
8	4902.463	156.935	38.000	416.083	1780.430
9	0.000	212.567	468.146	192676.348	37529.421
10	-0.000	180.568	0.000	0.000	0.000
11	176.556	369.503	506.144	0.000	0.000
12	0.768	0.474	0.617	0.000	64145.513
13	0.548		337.148		98092723.000
1	472.799	28.438	6.163	34.601	-28.500
2	14426.59	38.330	32.976	46.379	183.510
3	4.615	39.358	33.218	0.638	405.931
4	416.943	166.010	40.176	-1123.541	1095.922
5	1.646	70.542	4.265	-1125.995	1037.368
6	49.315	0.382	0.000	19.005	1037.368
7	545.113	0.268	0.865	45.006	1731.430
8	1997.731	156.962	38.000	412.006	1779.430
9	0.000	212.605	468.232	192680.387	37530.335
10	-0.000	180.606	0.000	0.000	0.000
11	176.530	369.568	506.231	0.000	0.000
12	0.809	0.203	0.251	0.000	64140.436
13	0.225		337.235		98094875.000

TABLE AP 5-2 (Sheet 24 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	472.899	20.990	4.661	25.651	-28.500
2	10485.72	38.330	32.976	46.317	183.501
3	4.503	38.749	33.075	0.603	405.816
4	408.786	166.012	40.180	-1126.199	1095.291
5	1.646	70.541	4.265	-1128.449	1036.751
6	35.844	0.382	0.000	16.551	1036.751
7	402.340	0.268	0.865	42.550	1730.808
8	1510.983	156.989	38.000	409.550	1778.808
9	0.000	212.643	468.319	192682.805	37530.871
10	-0.000	180.644	0.000	0.000	0.000
11	176.503	369.633	506.317	0.000	0.000
12	0.790	0.150	0.190	0.000	64137.357
13	0.163		337.321		98096092.000

1	472.999	18.066	3.997	22.063	-28.500
2	8940.32	38.330	32.977	46.267	183.493
3	4.520	38.634	33.048	0.575	405.717
4	405.220	166.014	40.185	-1128.288	1094.773
5	1.646	70.541	4.265	-1130.415	1036.241
6	30.561	0.382	0.000	14.585	1036.241
7	346.295	0.268	0.865	40.582	1730.294
8	1295.654	157.015	38.000	407.582	1778.294
9	0.000	212.681	468.405	192684.734	37531.298
10	-0.000	180.682	0.000	0.000	0.000
11	176.476	369.698	506.404	0.000	0.000
12	0.793	0.129	0.163	0.000	64134.875
13	0.139		337.408		98097051.000

1	473.099	16.533	3.648	20.182	-28.500
2	8130.70	38.330	32.977	46.222	183.487
3	4.532	38.589	33.038	0.550	405.628
4	402.870	166.015	40.189	-1130.151	1094.301
5	1.646	70.541	4.265	-1132.180	1035.777
6	27.793	0.382	0.000	12.820	1035.777
7	316.918	0.268	0.865	38.815	1729.825
8	1182.737	157.042	38.000	405.815	1777.825
9	0.000	212.719	468.492	192686.463	37531.680
10	-0.000	180.721	0.000	0.000	0.000
11	176.449	369.763	506.490	0.000	0.000
12	0.795	0.118	0.149	0.000	64132.640
13	0.127		337.494		98097903.000

1	473.199	14.509	3.188	17.697	-28.500
2	7059.68	38.330	32.977	46.181	183.480
3	4.551	38.566	33.033	0.528	405.548
4	398.917	166.017	40.194	-1131.837	1093.868
5	1.646	70.540	4.264	-1133.777	1035.350
6	24.132	0.382	0.000	11.223	1035.350
7	278.108	0.268	0.865	37.216	1729.395
8	1033.570	157.069	38.000	404.216	1777.395
9	0.000	212.758	468.578	192688.023	37532.024
10	-0.000	180.759	0.000	0.000	0.000
11	176.422	369.828	506.577	0.000	0.000
12	0.798	0.104	0.130	0.000	64130.611
13	0.110		337.581		98098666.000

1	473.299	11.489	2.502	13.991	-28.500
2	5461.32	38.330	32.978	46.147	183.475
3	4.591	38.536	33.026	0.509	405.481
4	390.347	166.019	40.198	-1133.260	1093.493
5	1.646	70.540	4.264	-1135.121	1034.981
6	18.669	0.382	0.000	9.879	1034.981
7	220.219	0.268	0.865	35.871	1729.022
8	811.142	157.096	38.000	402.871	1777.022
9	0.000	212.796	468.665	192689.330	37532.310
10	-0.000	180.797	0.000	0.000	0.000
11	176.396	369.893	506.663	0.000	0.000
12	0.805	0.082	0.102	0.000	64128.894
13	0.085		337.667		98099295.000

TABLE AP 5-2 (Sheet 25 of 25)
PREDICTED S-IVB PROPULSION SYSTEM PERFORMANCE
COMPUTER PROGRAM AA89

1	473.399	8.113	1.735	9.848	-28.500
2	3674.89	38.330	32.978	46.121	183.471
3	4.675	38.490	33.016	0.494	405.432
4	373.161	166.020	40.203	-1134.343	1093.192
5	1.646	70.540	4.264	-1136.137	1034.686
6	12.562	0.382	0.000	8.863	1034.686
7	155.507	0.268	0.865	34.855	1728.724
8	562.531	157.122	38.000	401.855	1776.724
9	0.000	212.834	468.751	192690.309	37532.521
10	-0.000	180.835	0.000	0.000	0.000
11	176.369	369.958	506.750	0.000	0.000
12	0.820	0.058	0.071	0.000	64127.579
13	0.057		337.754		98099750.000

1	473.499	5.458	1.132	6.590	-28.500
2	2271.37	38.330	32.978	46.103	183.467
3	4.821	38.438	33.004	0.484	405.399
4	344.648	166.022	40.207	-1135.101	1092.962
5	1.646	70.539	4.264	-1136.844	1034.460
6	7.764	0.382	0.000	8.156	1034.460
7	104.625	0.268	0.865	34.148	1728.497
8	367.023	157.149	38.000	401.148	1776.497
9	0.000	212.872	468.838	192690.979	37532.663
10	-0.000	180.873	0.000	0.000	0.000
11	176.342	370.023	506.836	0.000	0.000
12	0.845	0.039	0.046	0.000	64126.644
13	0.035		337.840		98100042.000

1	473.599	3.770	0.748	4.519	-28.500
2	1379.98	38.330	32.979	46.090	183.465
3	5.038	38.397	32.995	0.477	405.378
4	305.392	166.023	40.212	-1135.632	1092.781
5	1.646	70.539	4.263	-1137.339	1034.282
6	4.717	0.382	0.000	7.661	1034.282
7	72.270	0.268	0.865	33.652	1728.317
8	242.620	157.176	38.000	400.652	1776.317
9	0.000	212.910	468.924	192691.436	37532.756
10	-0.000	180.912	0.000	0.000	0.000
11	176.315	370.088	506.923	0.000	0.000
12	0.883	0.027	0.031	0.000	64125.968
13	0.022		337.927		98100222.000

1	473.699	0.000	0.000	0.000	-28.500
2	0.00	38.330	32.979	46.083	183.463
3	0.000	38.371	32.989	0.473	405.368
4	0.000	166.025	40.216	-1135.944	1092.647
5	1.646	70.539	4.263	-1137.627	1034.150
6	0.000	0.382	0.000	7.373	1034.150
7	0.000	0.268	0.865	33.363	1728.185
8	0.000	157.203	38.000	400.363	1776.185
9	0.000	212.949	469.011	192691.686	37532.802
10	-0.000	180.950	0.000	0.000	0.000
11	176.288	370.153	507.009	0.000	0.000
12	0.000	0.000	0.000	0.000	64125.548
13	0.000		338.013		98100298.000

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)

TABLE AP 5-4
AS-205 VARIABLE TAG VALUES

TIME FROM ESC (sec)	THRUST (psia)	LOX FLOWRATE (lbm/sec)	LH2 FLOWRATE (lbm/sec)
20	225,714	448.85	81.99
60	225,657	450.98	82.24
80	225,811	450.60	82.10
110	225,460	450.15	82.10
118	225,679	449.44	82.07
140	225,633	450.11	82.17
150	225,475	449.29	82.11
157	225,379	449.07	82.11
165	225,610	448.92	82.18
175	225,650	449.88	82.06
185	225,293	449.34	82.01
205	225,196	449.04	82.08
220	225,598	449.88	82.06
230	225,292	449.05	82.05
245	224,669	448.17	82.08
255	225,286	448.71	82.12

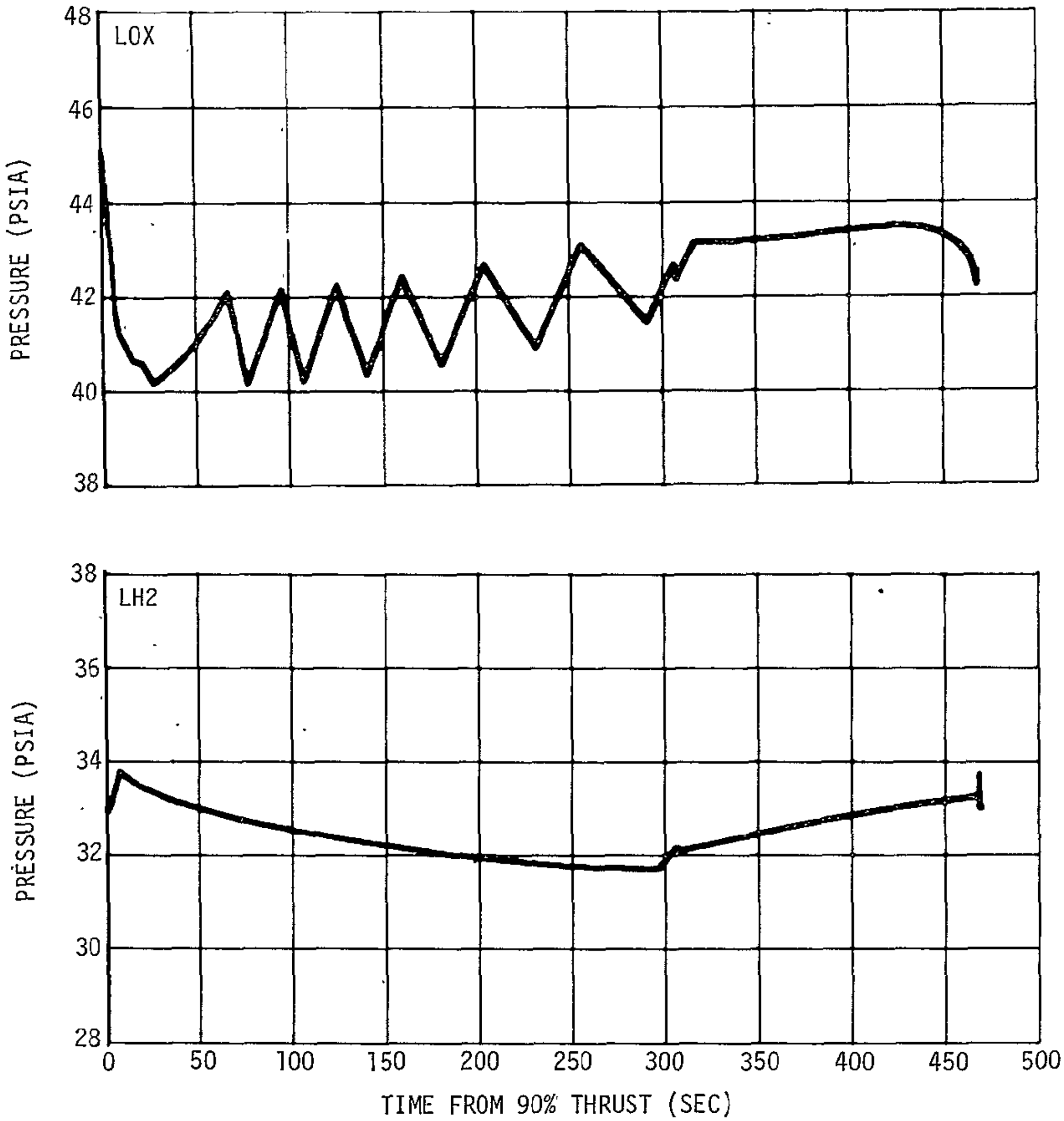

Figure AP 5-1. LOX and LH2 Pump Inlet Pressure

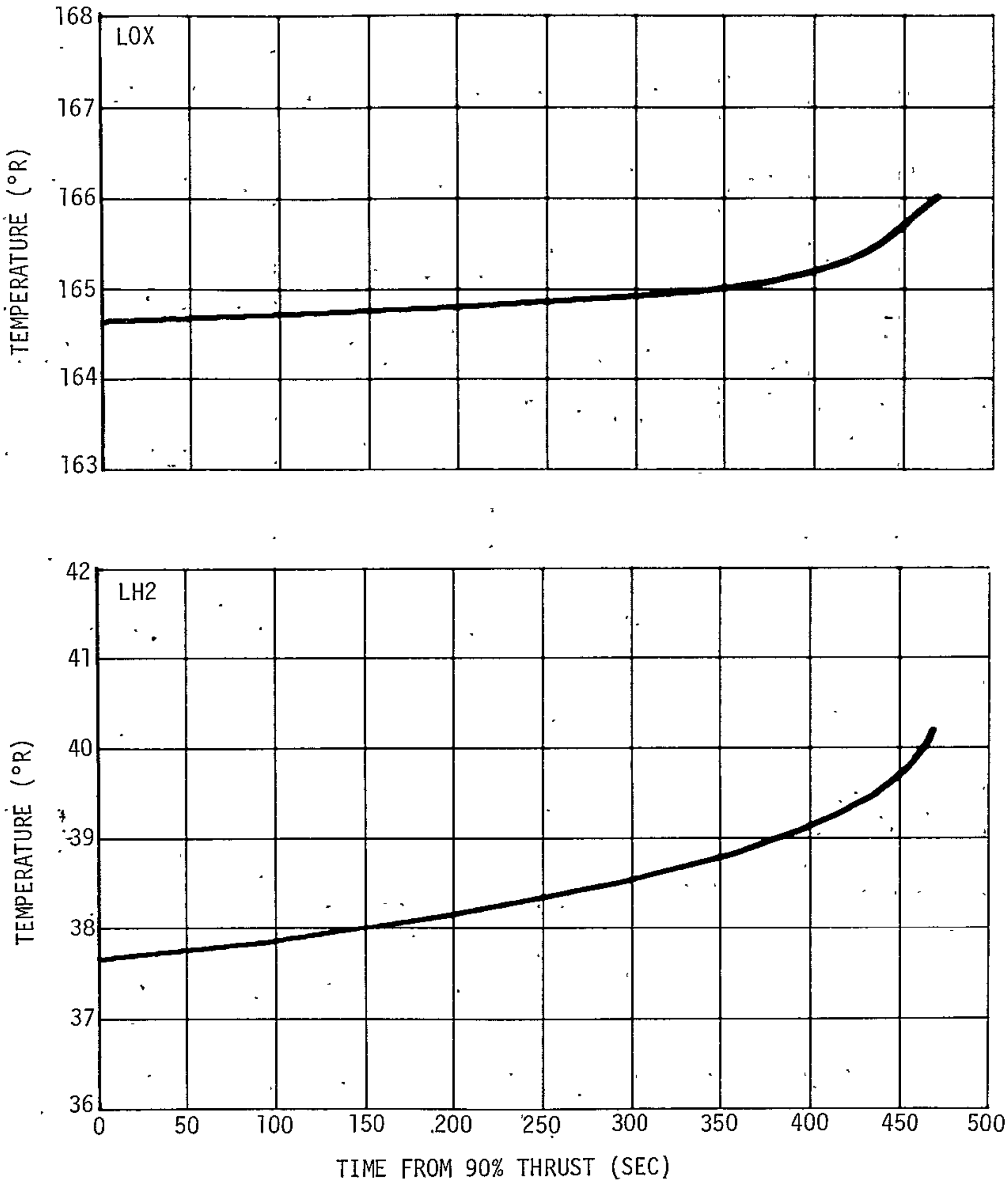

Figure AP 5-2. LOX and LH2 Pump Inlet Temperature

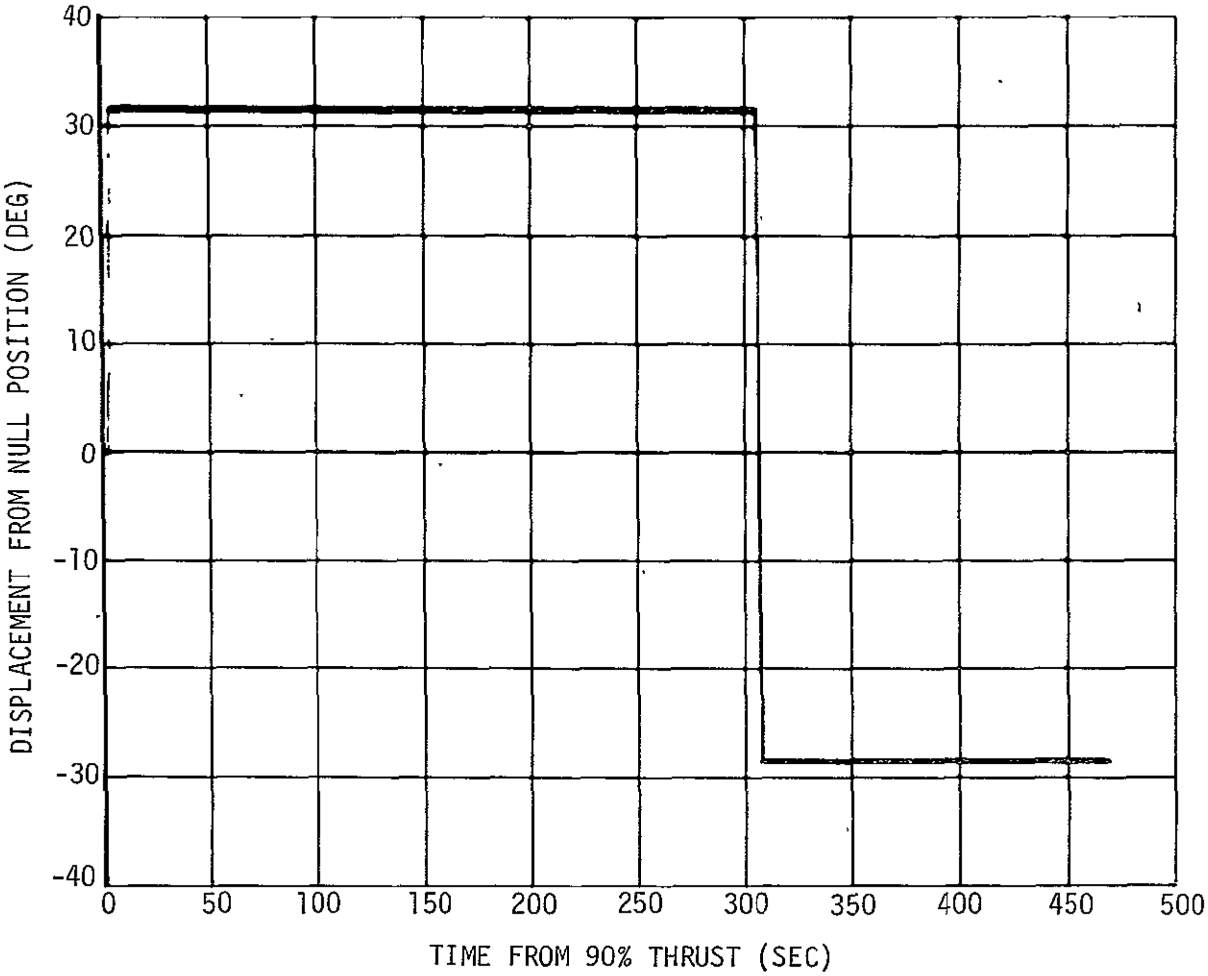

Figure AP 5-3. PU Valve Position

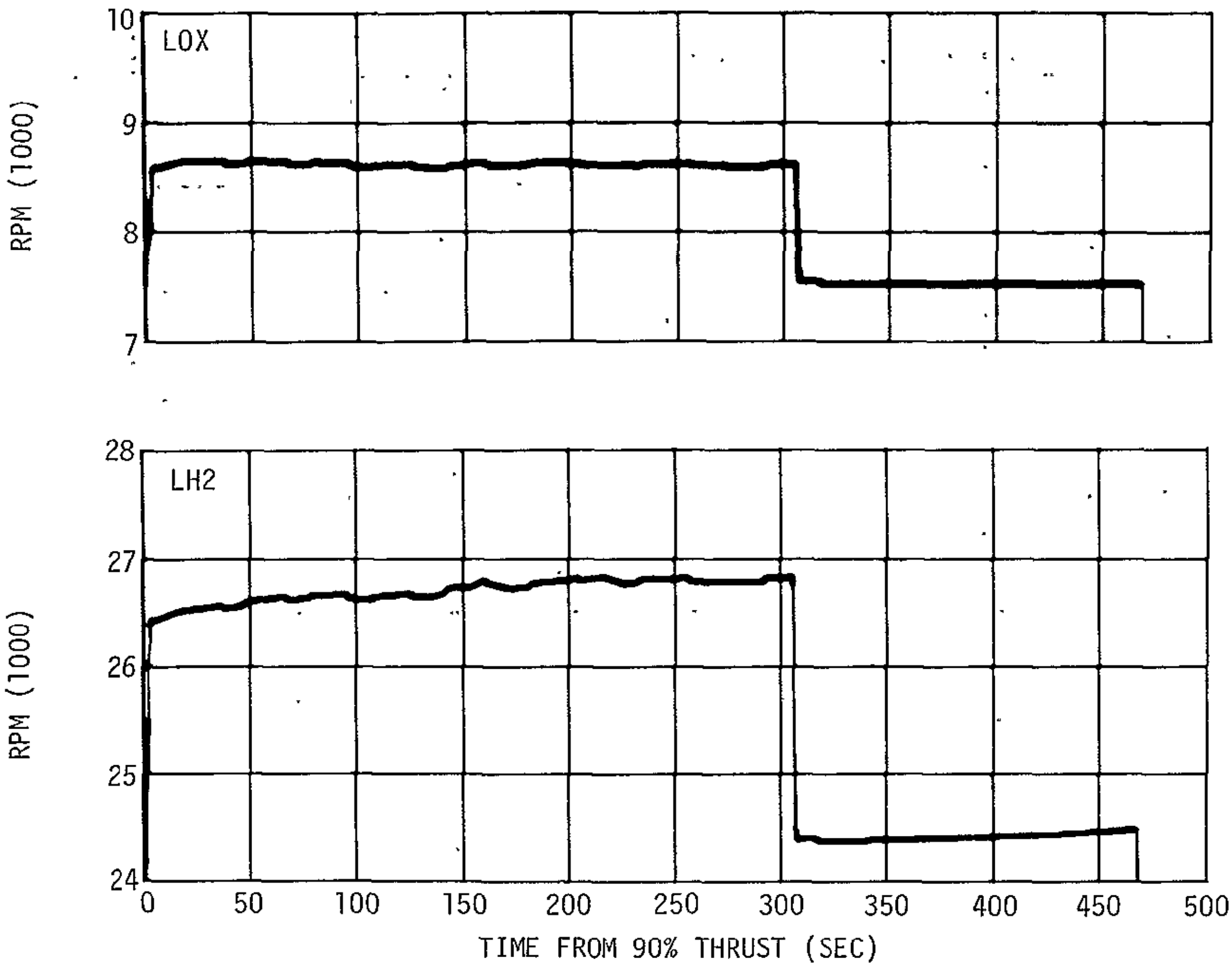

Figure AP 5-4. LOX and LH2 Pump Speed

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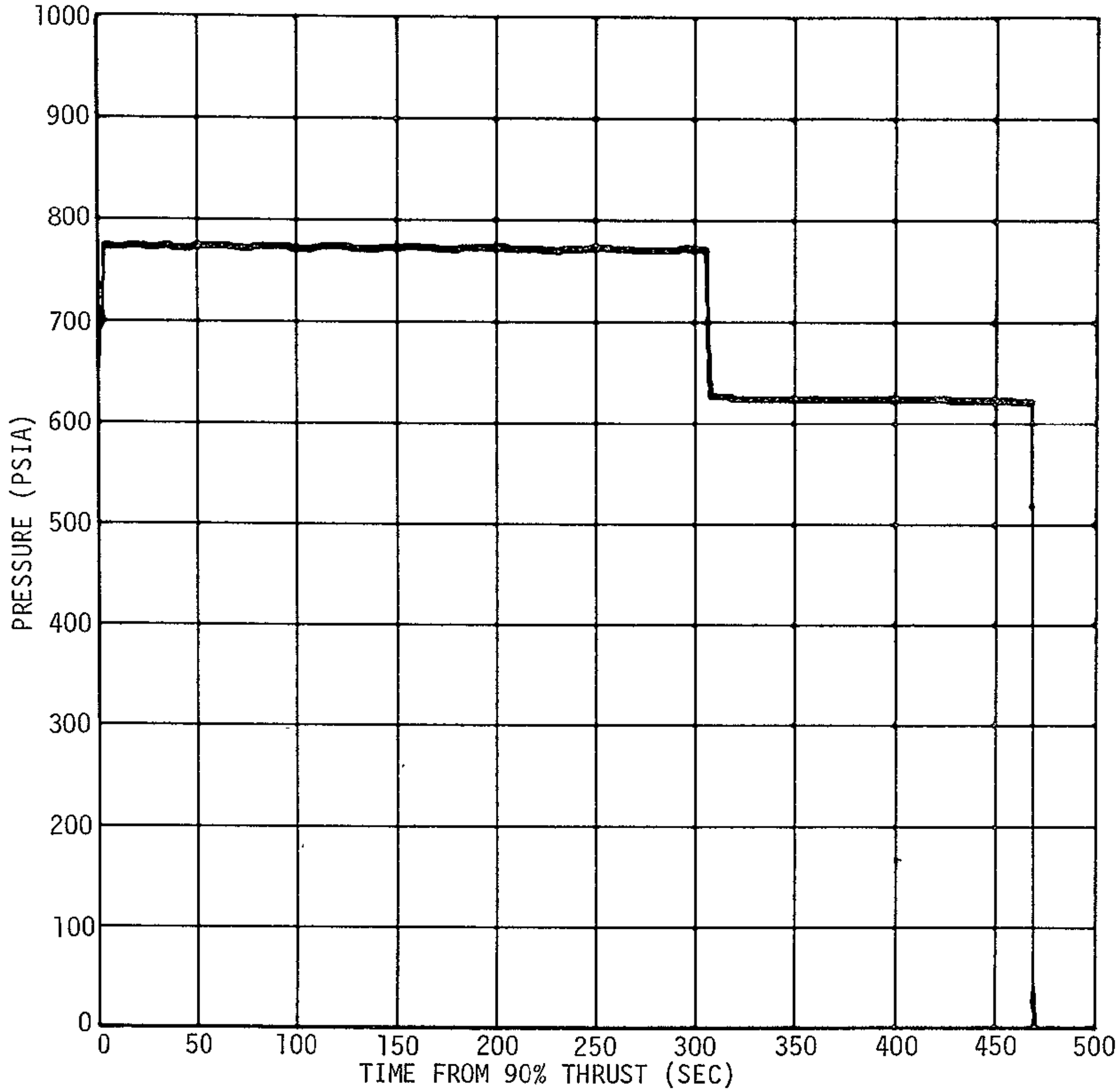

Figure AP 5-5. Thrust Chamber Pressure (Injector)

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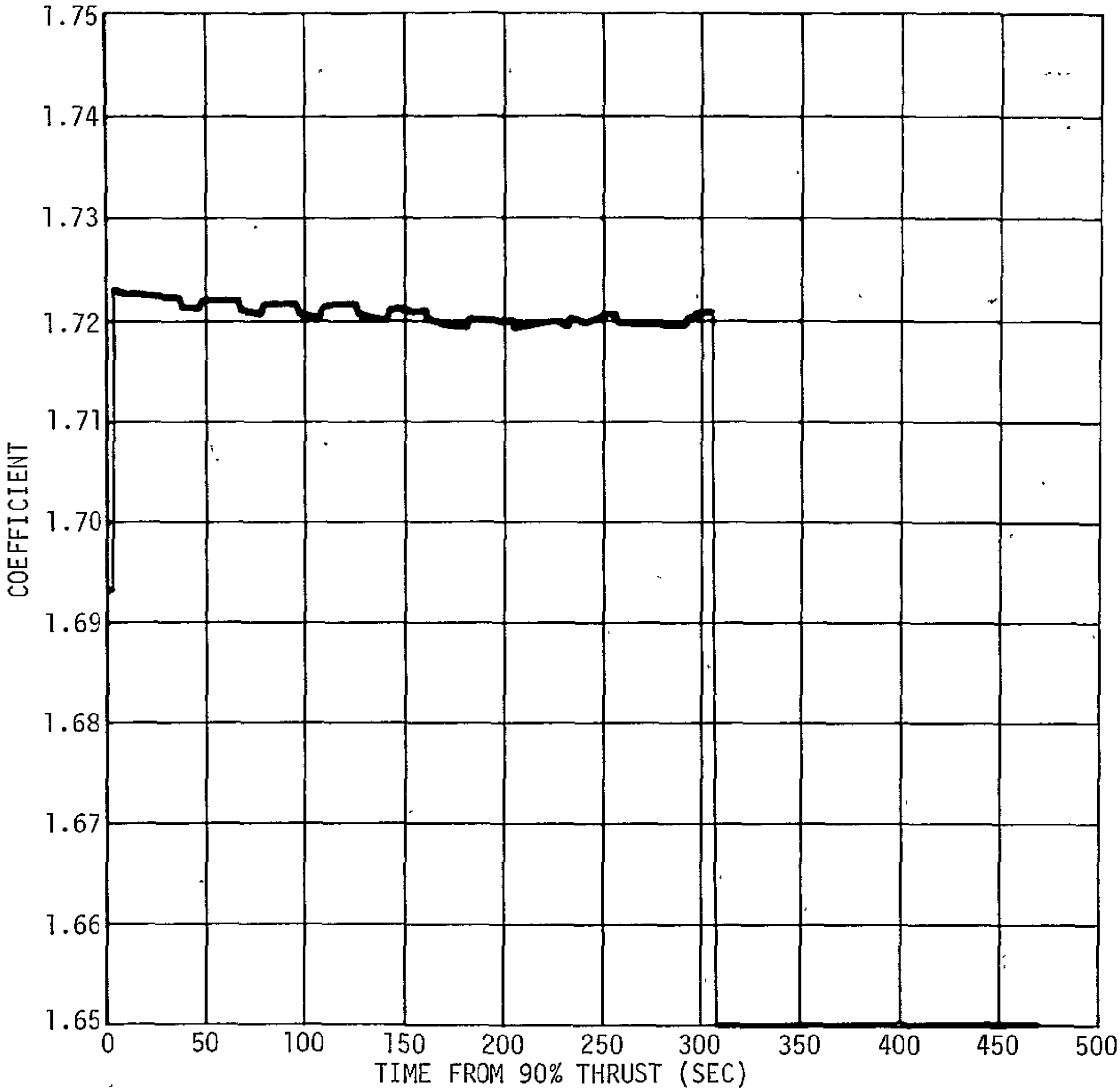

Figure AP 5-6. Vacuum Thrust Coefficient (Injector)

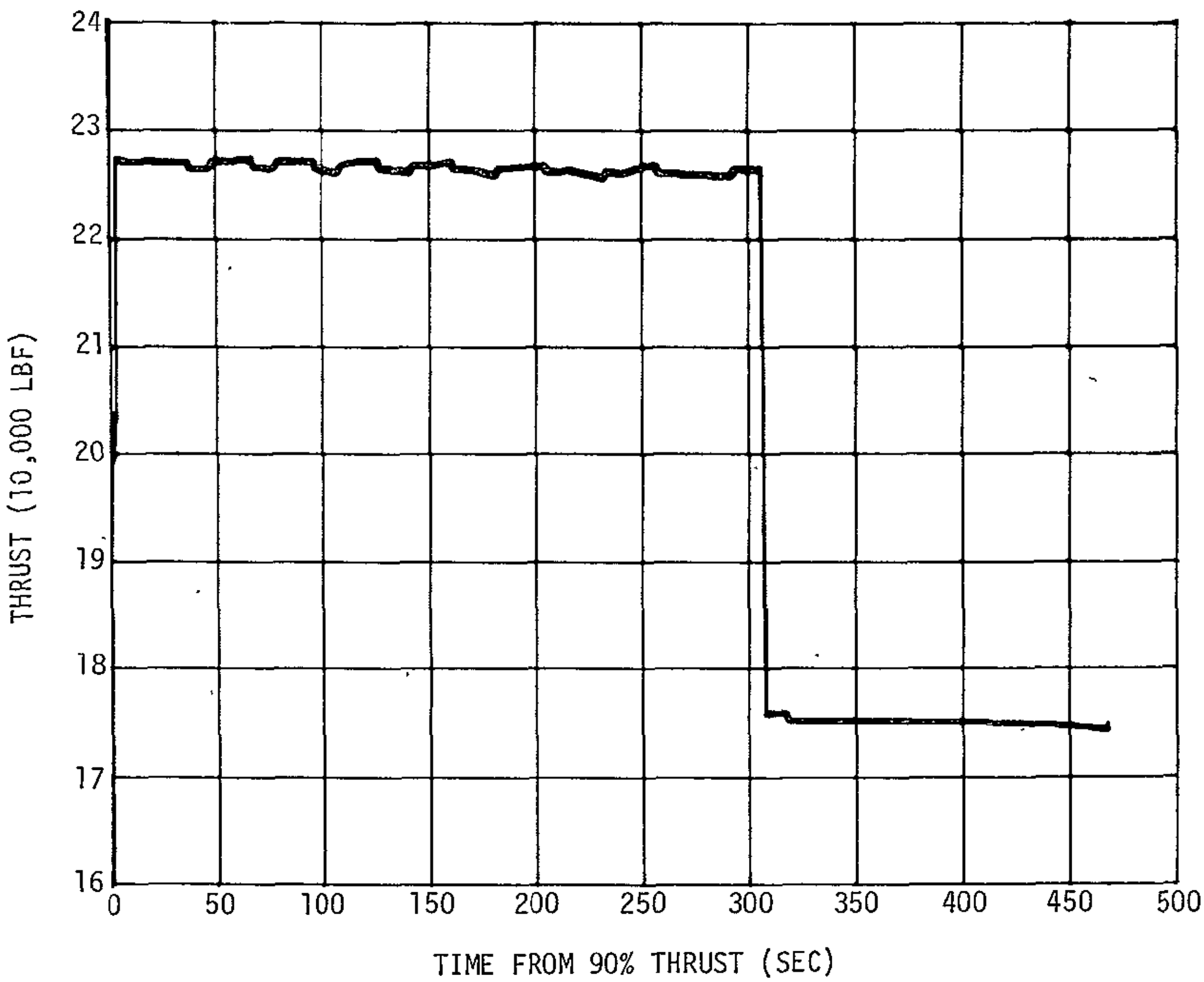

Figure AP 5-7. Engine Thrust

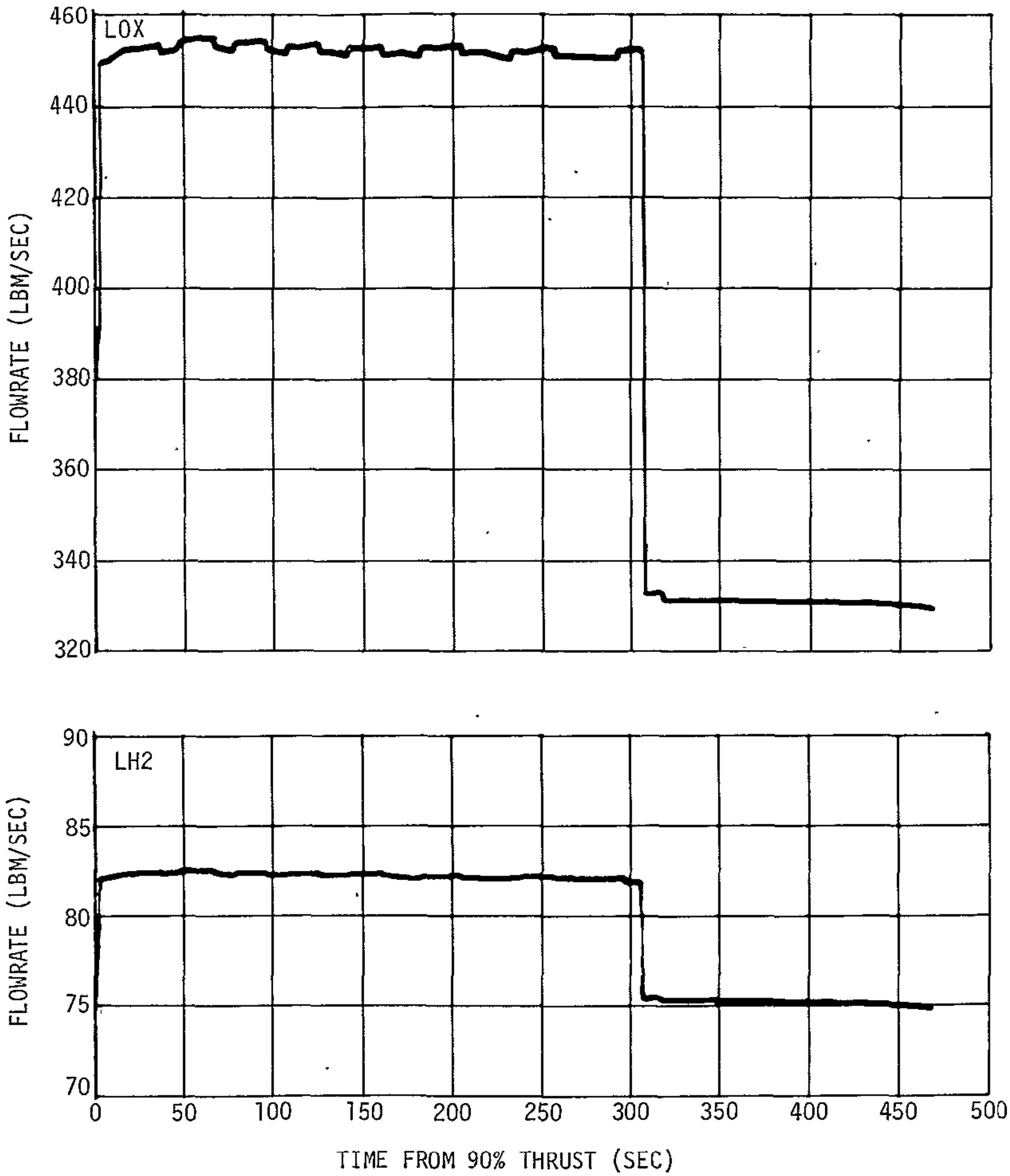

Figure AP 5-8. LOX and LH2 Flowrate - Pump Inlet

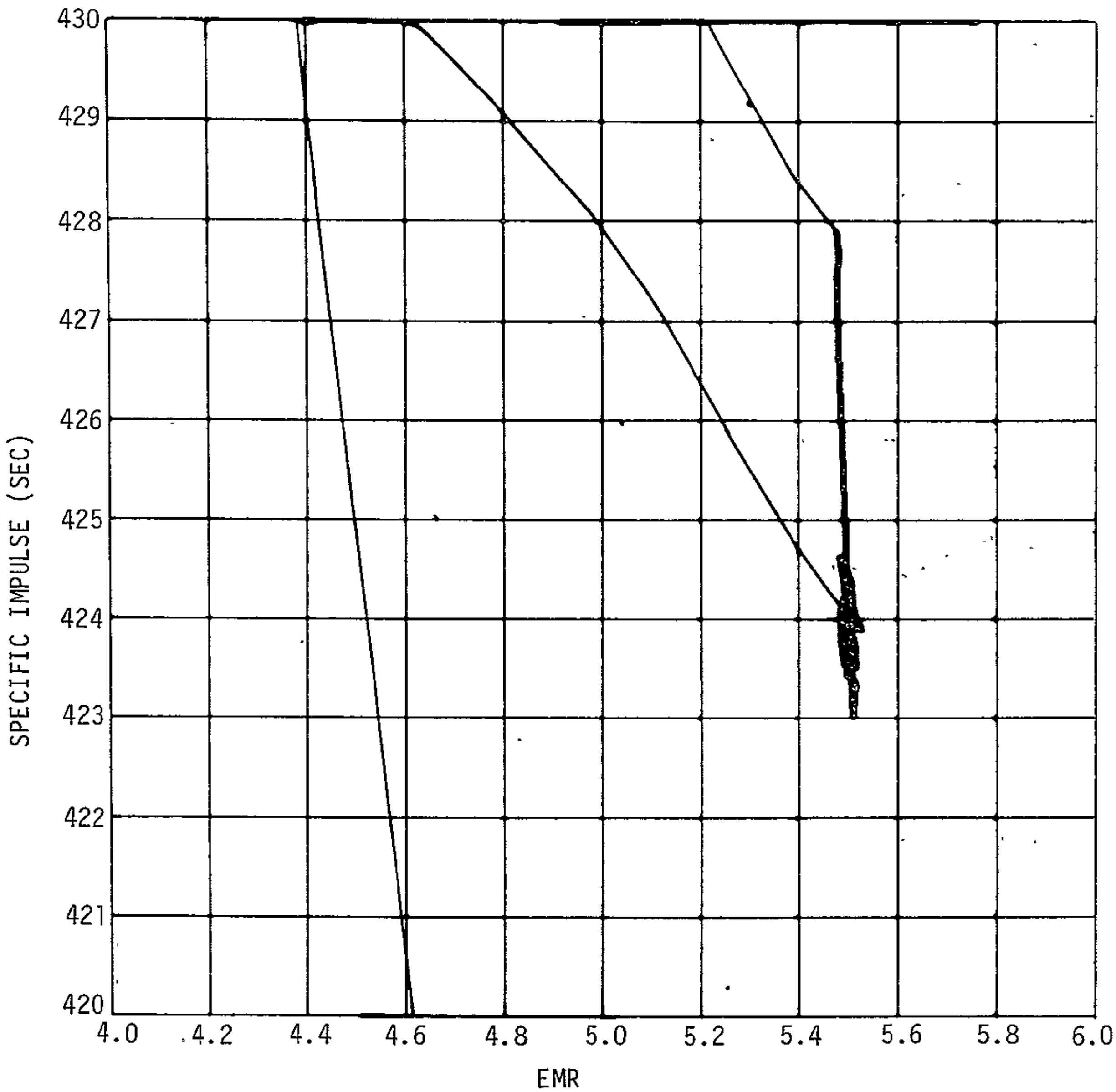

Figure AP 5-9. Specific Impulse vs Engine Mixture Ratio

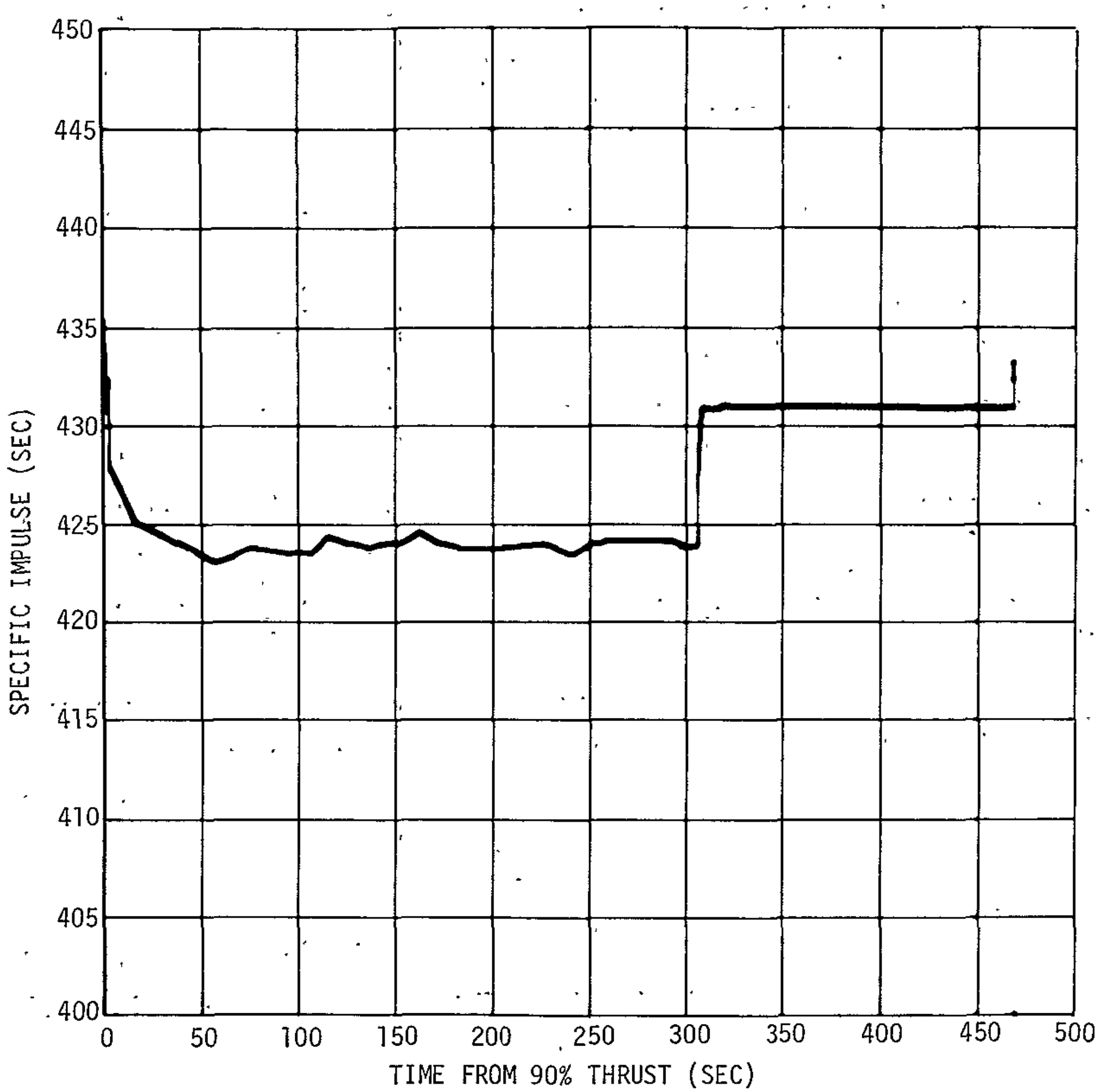

Figure AP 5-10. Engine Specific Impulse

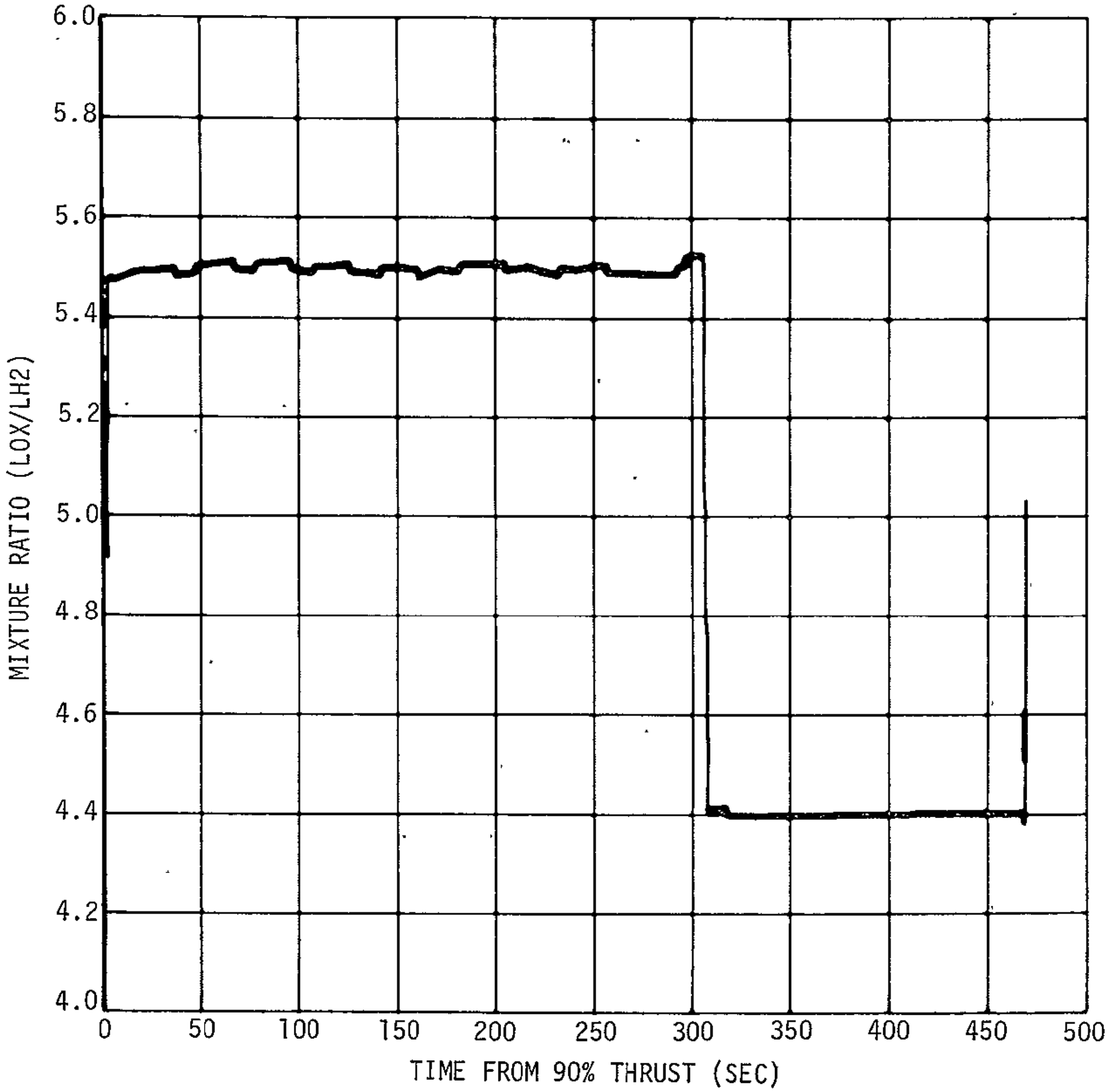

Figure AP 5-11. Engine Mixture Ratio

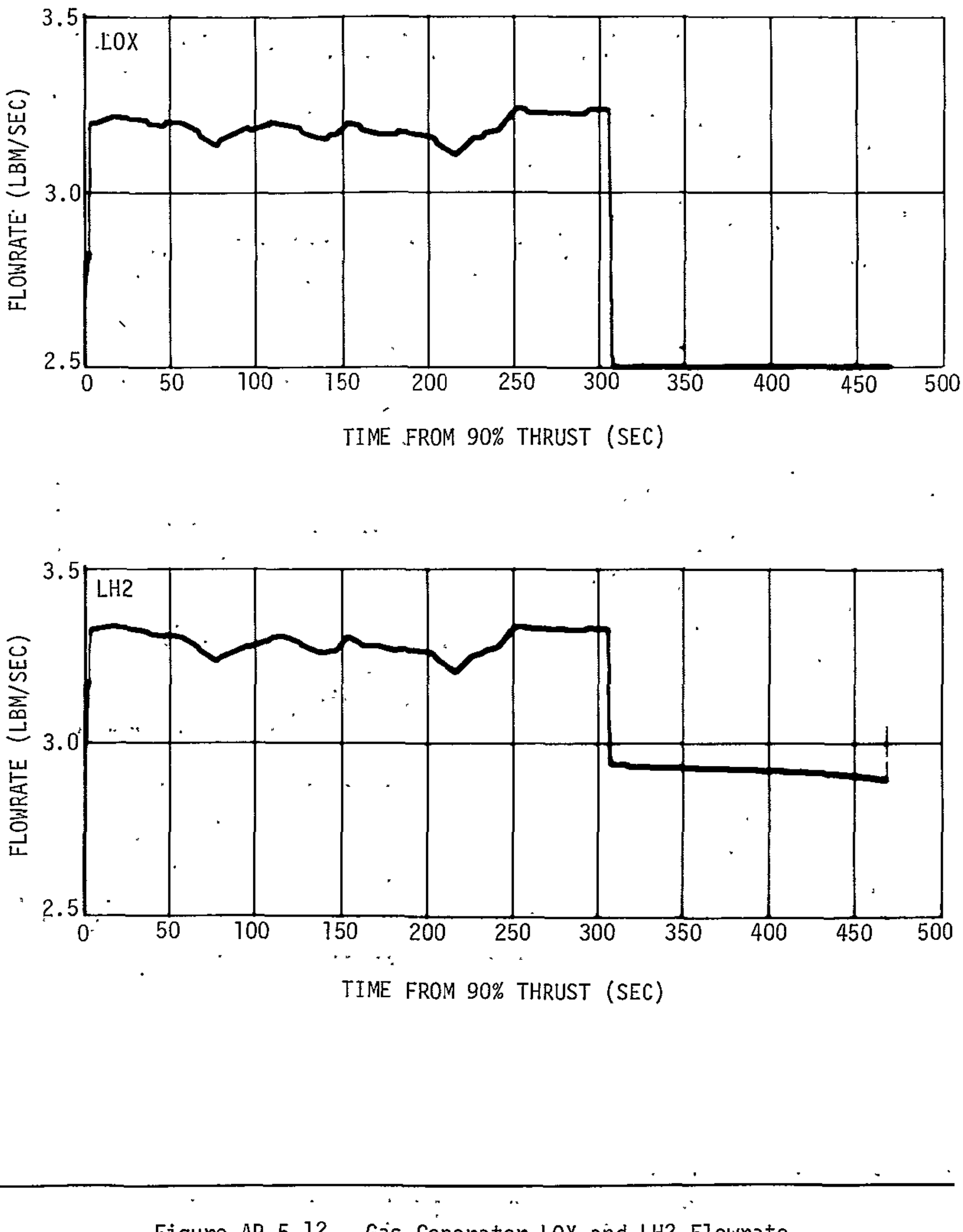

Figure AP 5-12. Gas Generator LOX and LH2 Flowrate

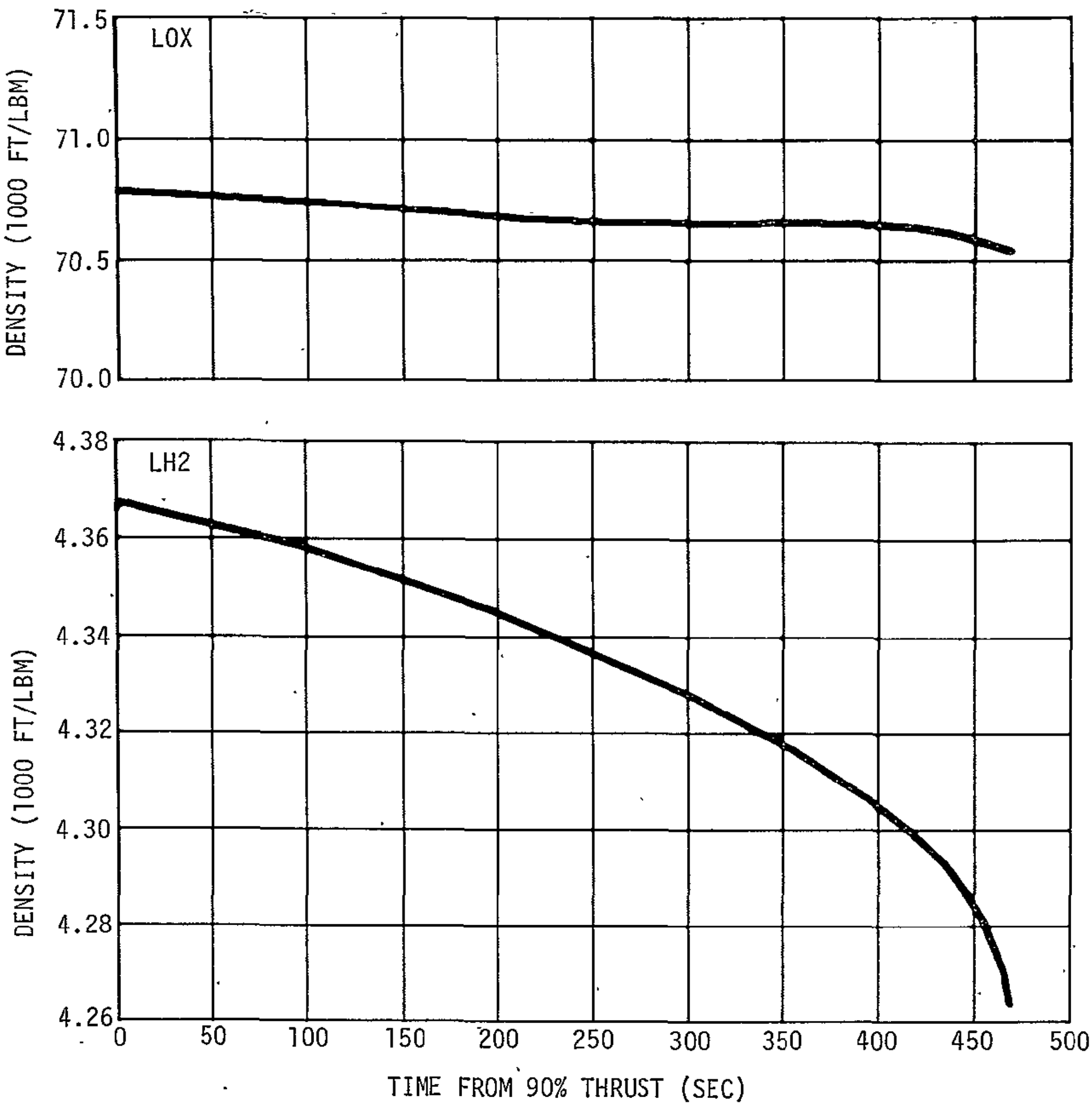

Figure AP 5-13. LOX and LH2 Bulk Densities

September 1968

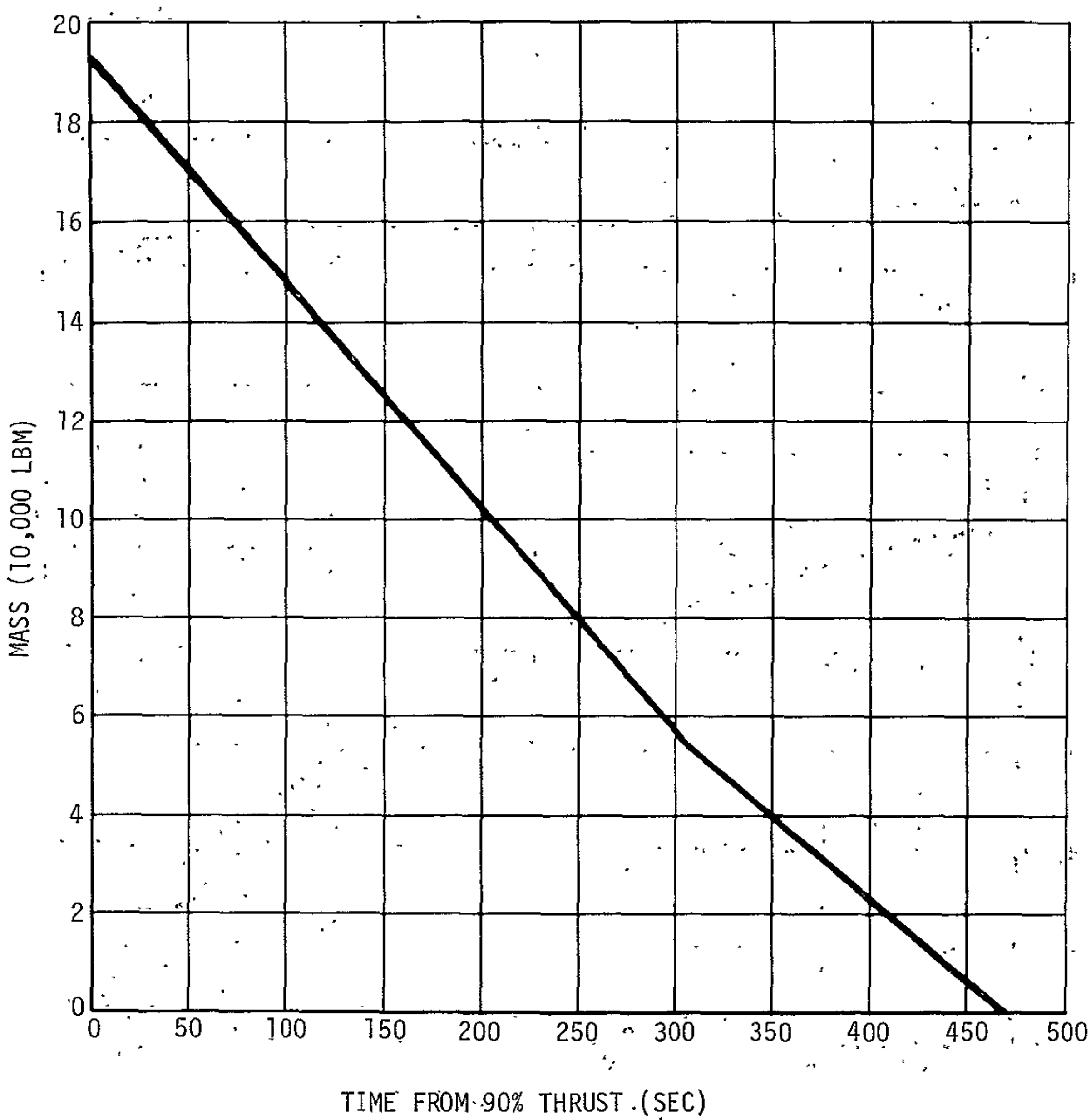

Figure AP 5-14. LOX Mass Onboard

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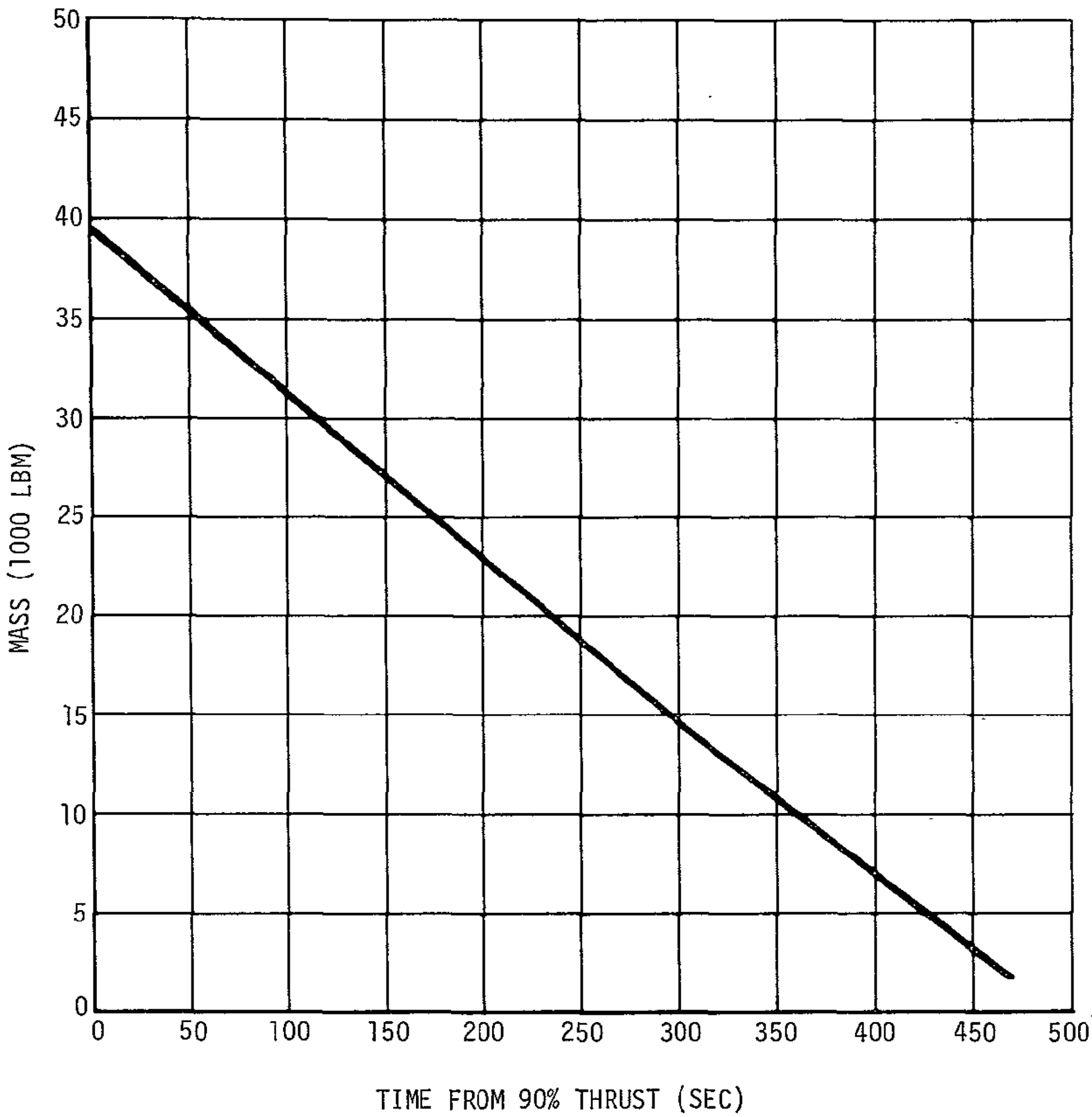

Figure AP 5-15. LH2 Mass Onboard

September 1968

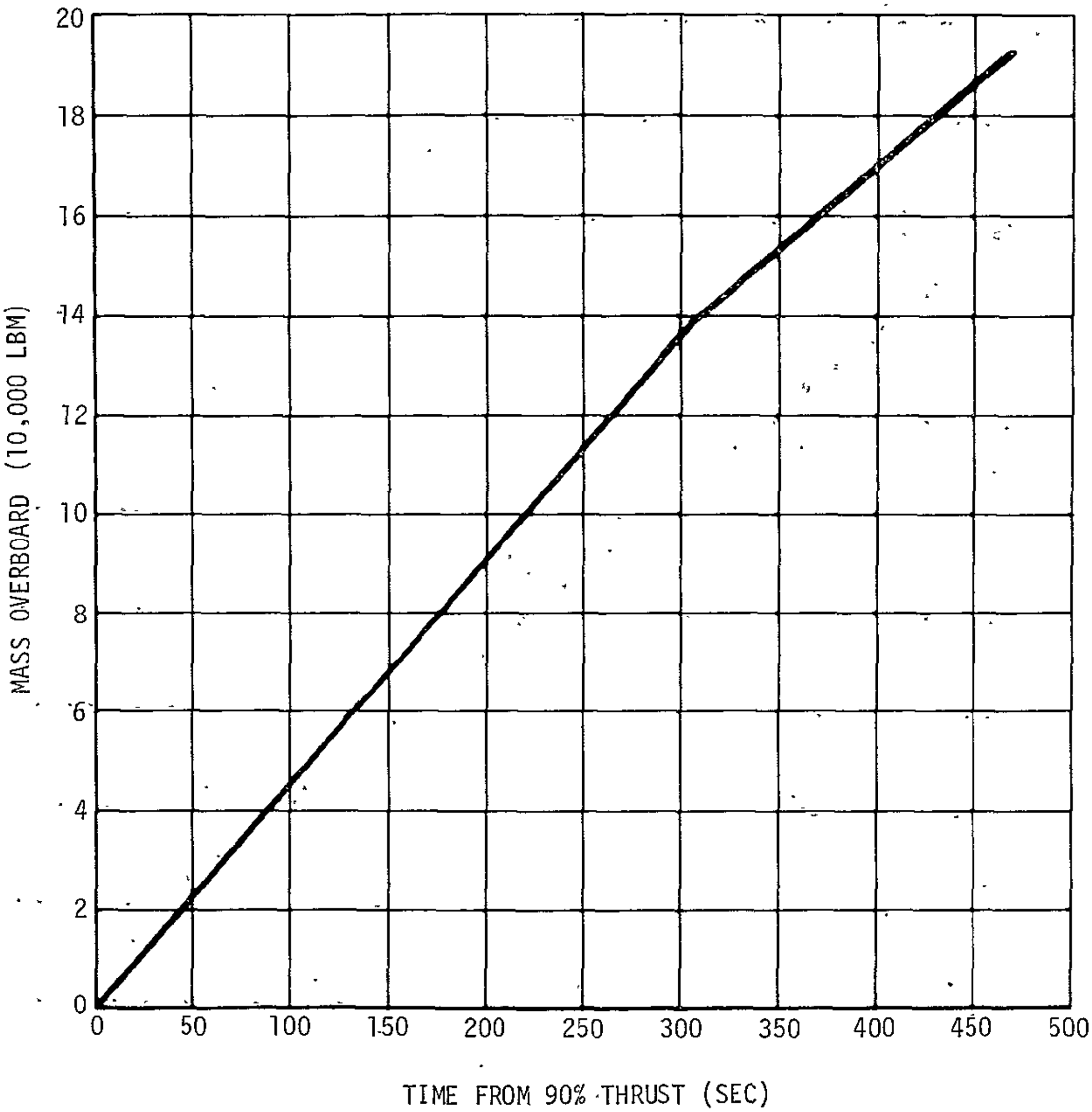

Figure AP 5-16. LOX Mass Overboard

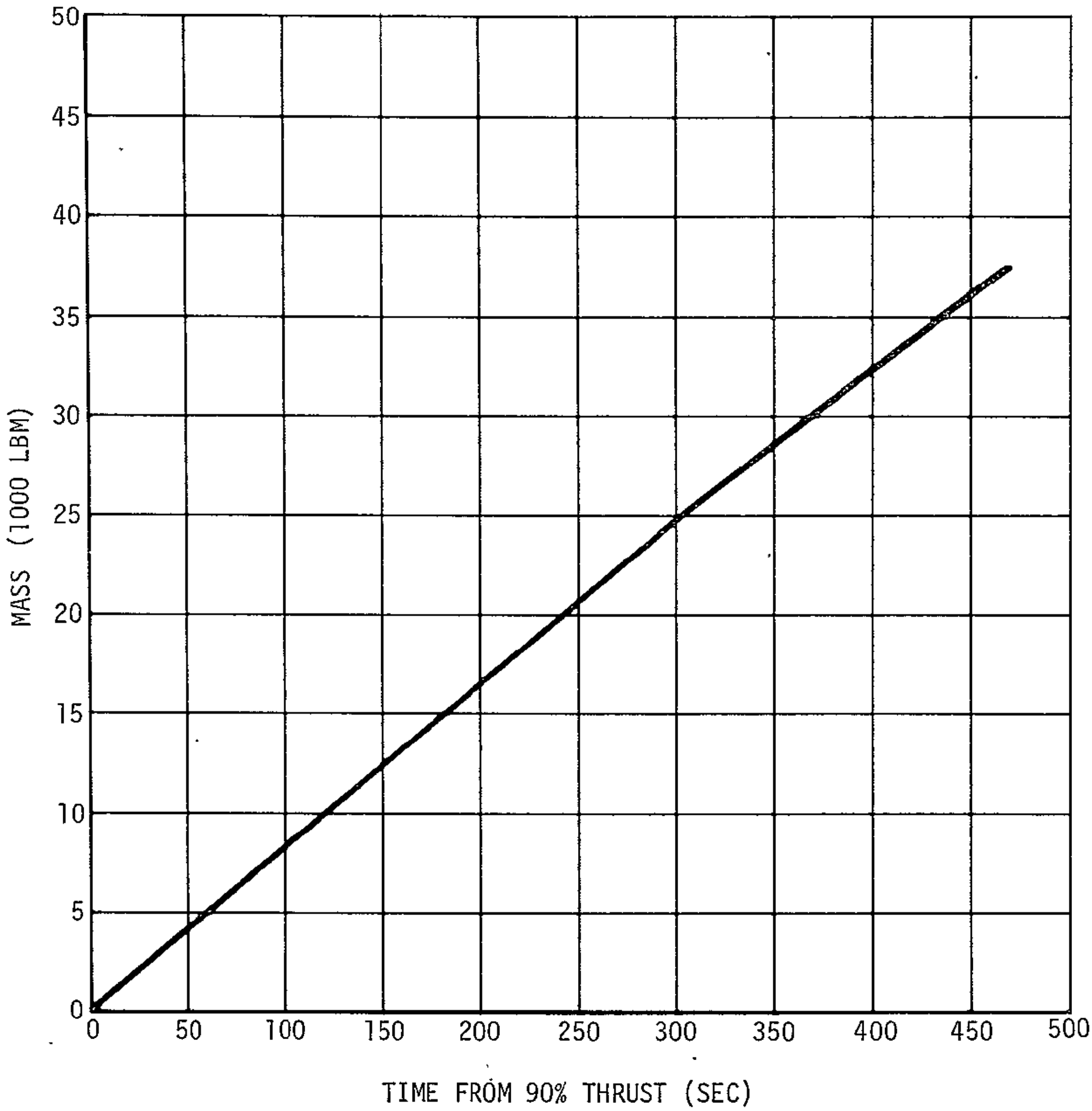

Figure AP 5-17. LH2 Mass Overboard

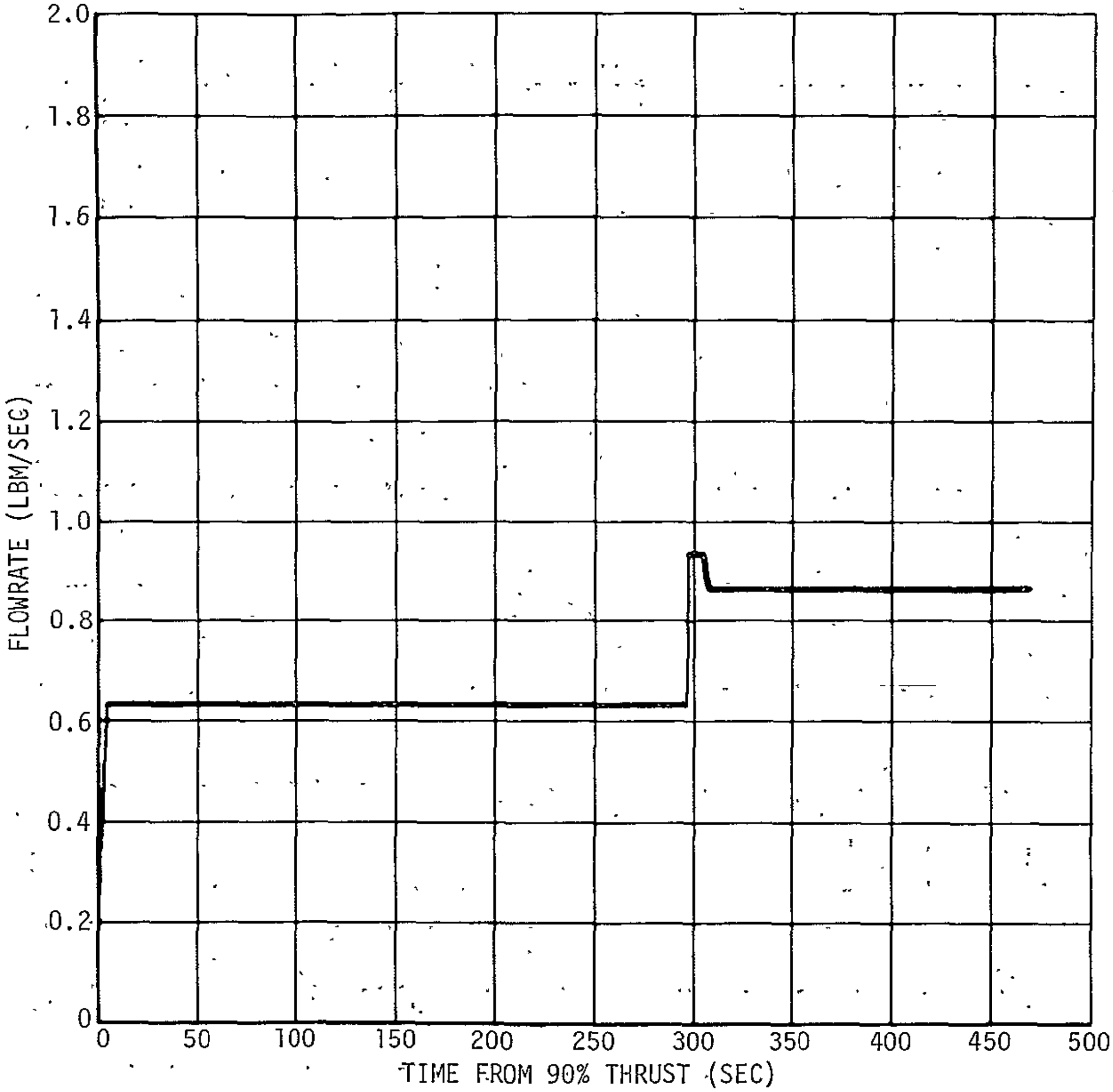

Figure AP 5-18. LH2 Tank GH2 Pressurant Flowrate

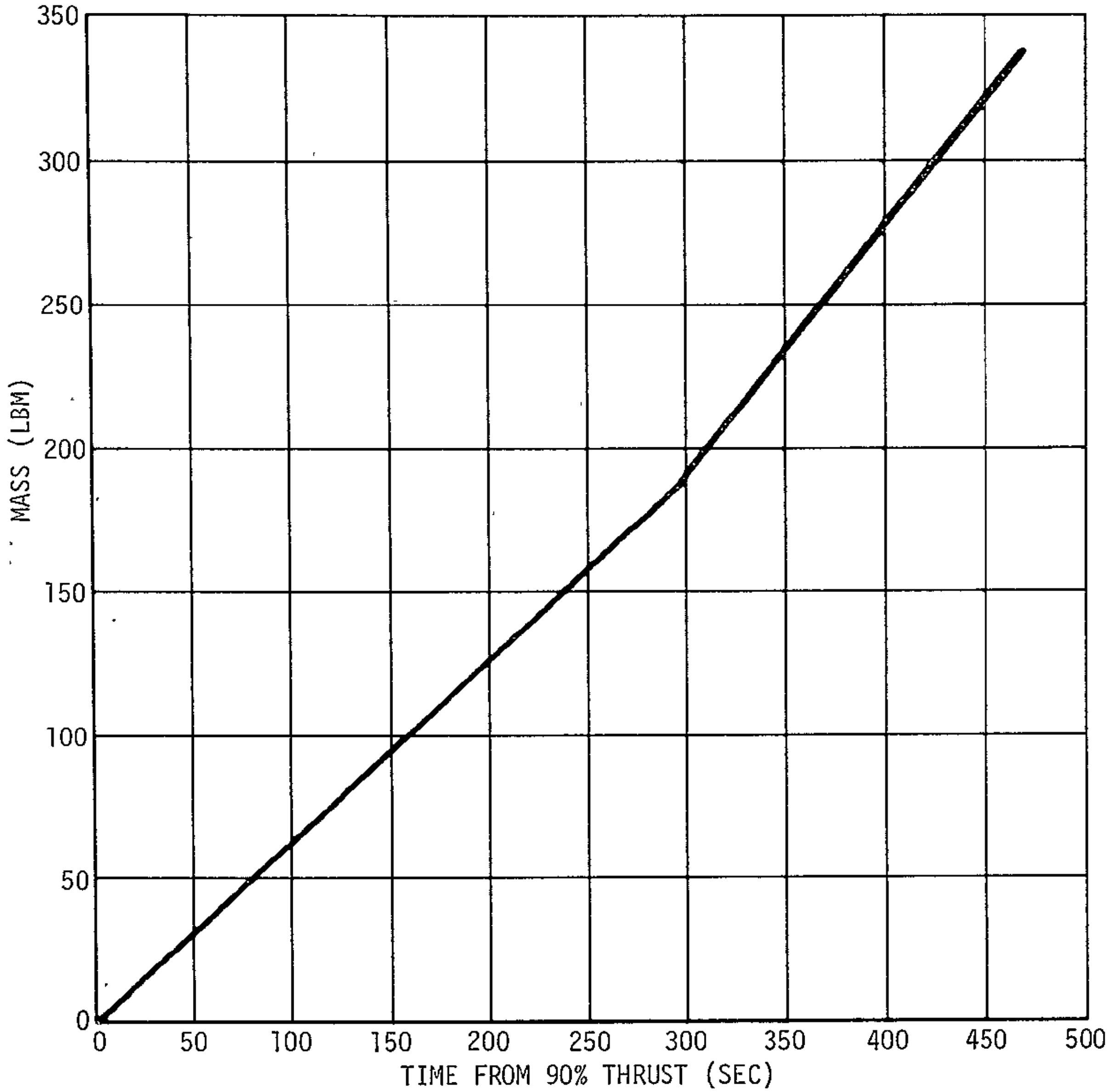

Figure AP 5-19. LH2 Tank Accumulated GH2 Pressurant

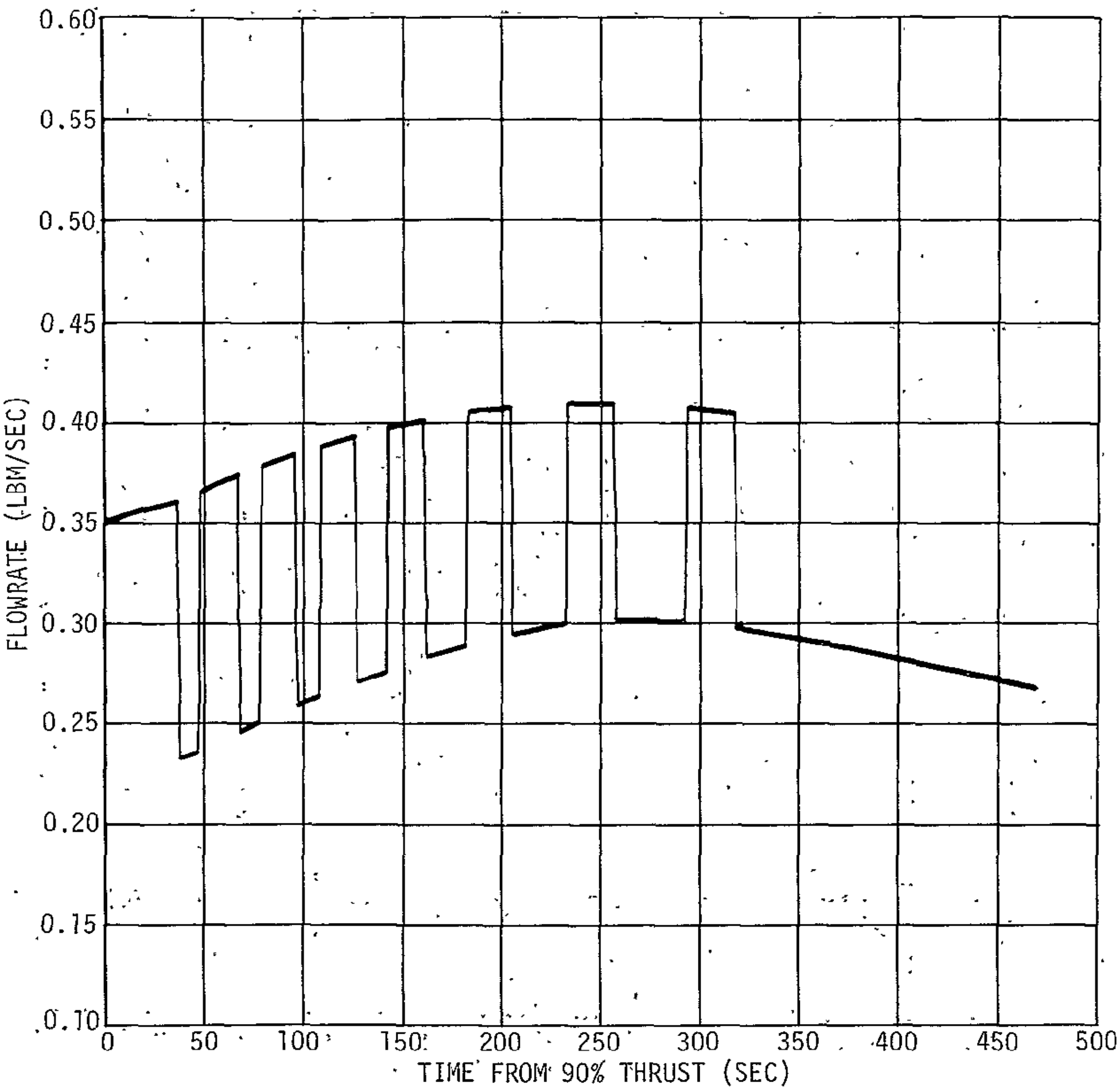

Figure AP 5-20. LOX Tank Helium Pressurant Flowrate

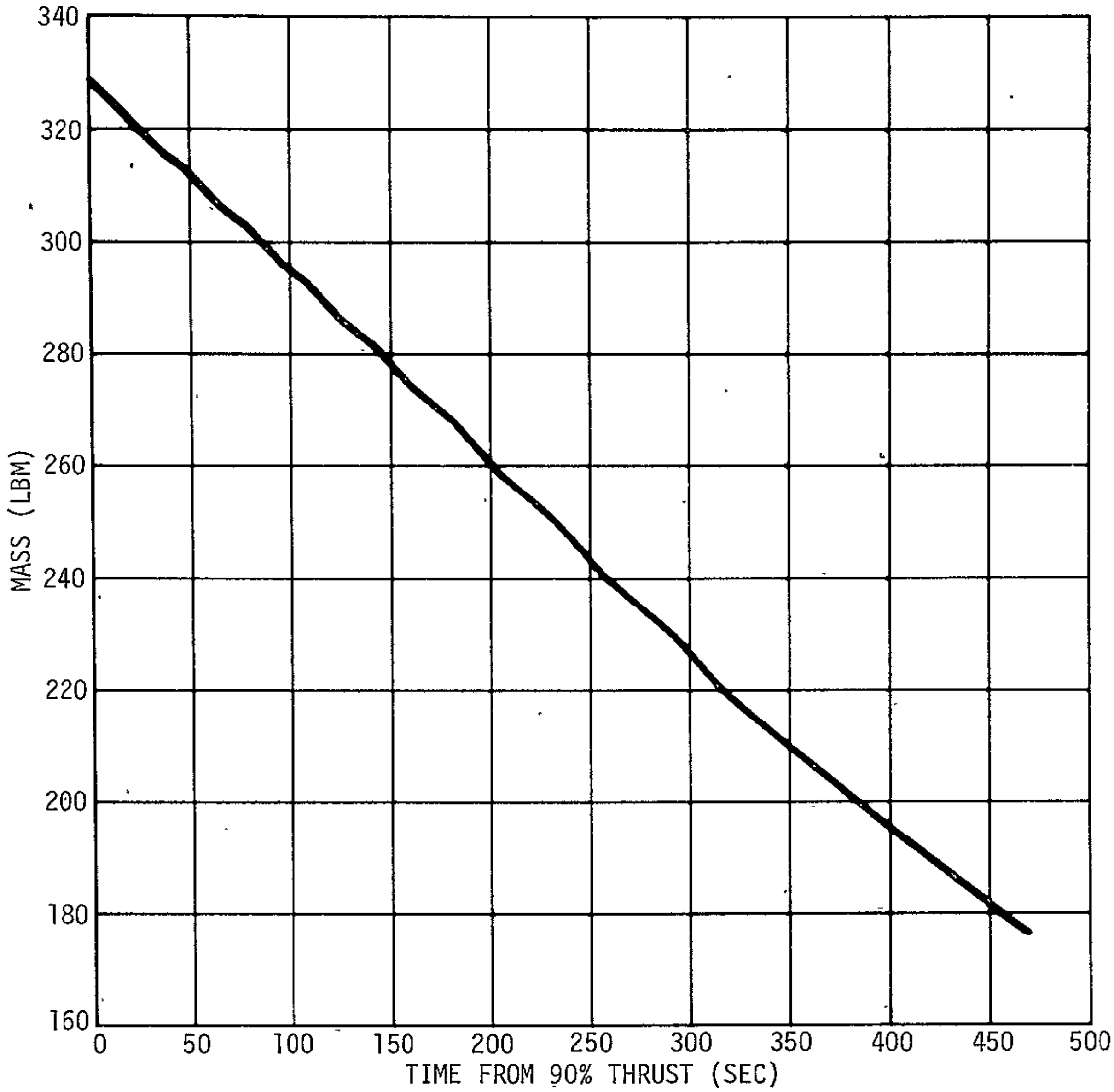

Figure AP 5-21. Mass in Cold Helium Spheres

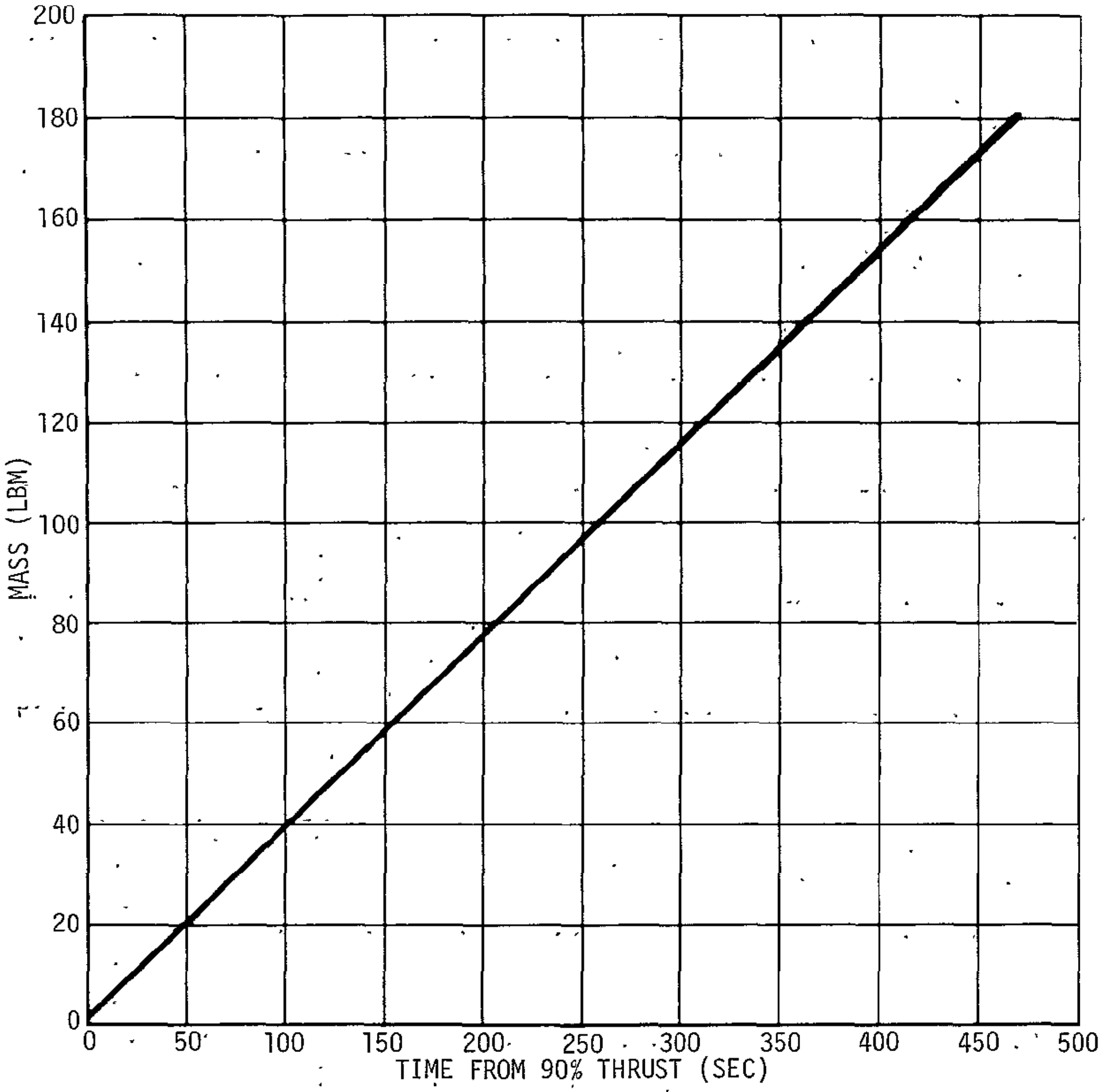

Figure AP 5-22. Total LOX Boiloff

MDAC-WD HAS PREDICTED THAT
LH2 BOILOFF WILL BE ZERO FOR
THE S-IVB-205 STAGE

Figure AP 5-23. Total LH2 Boiloff

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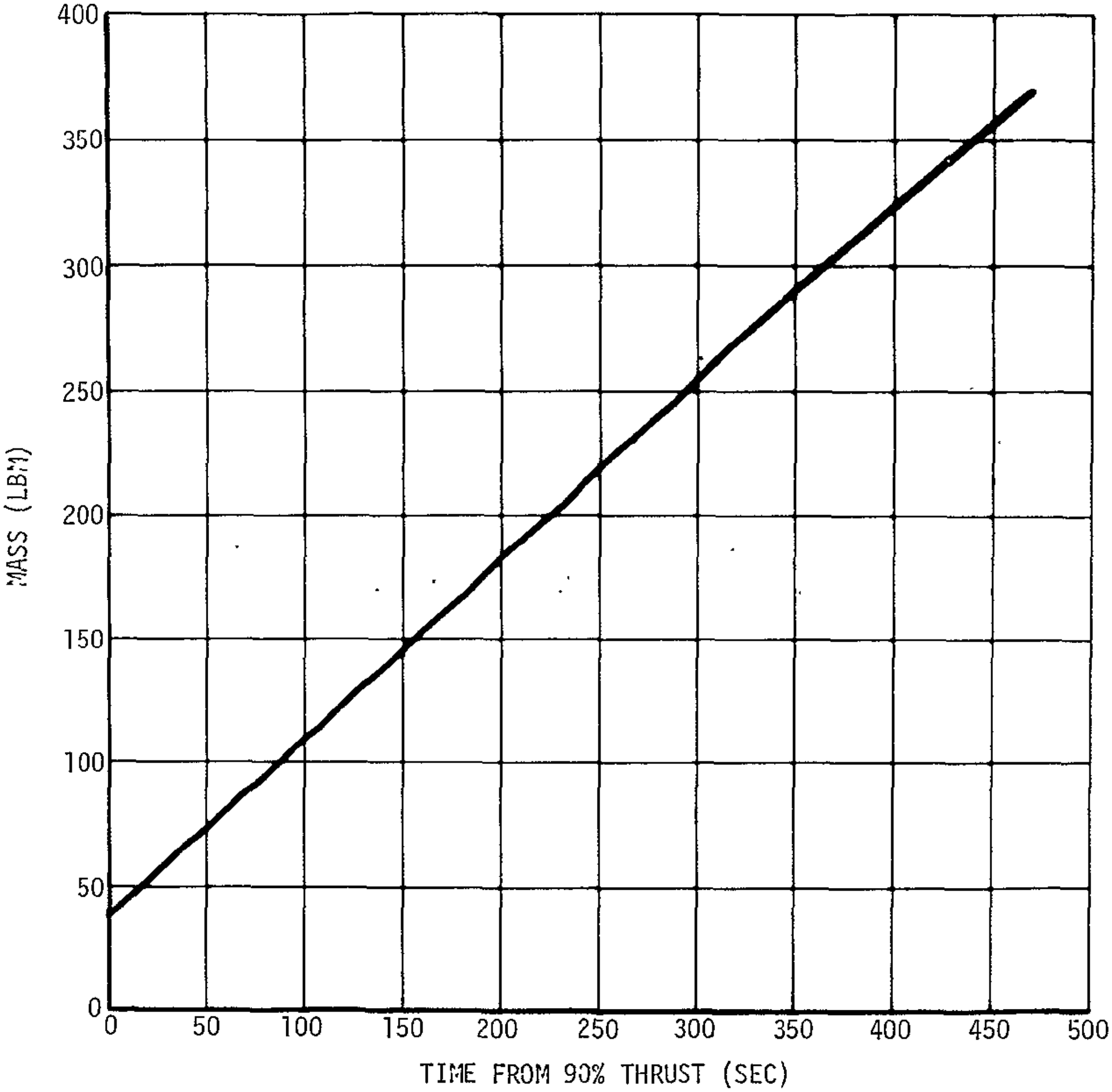

Figure AP 5-24. LOX Tank Ullage Mass

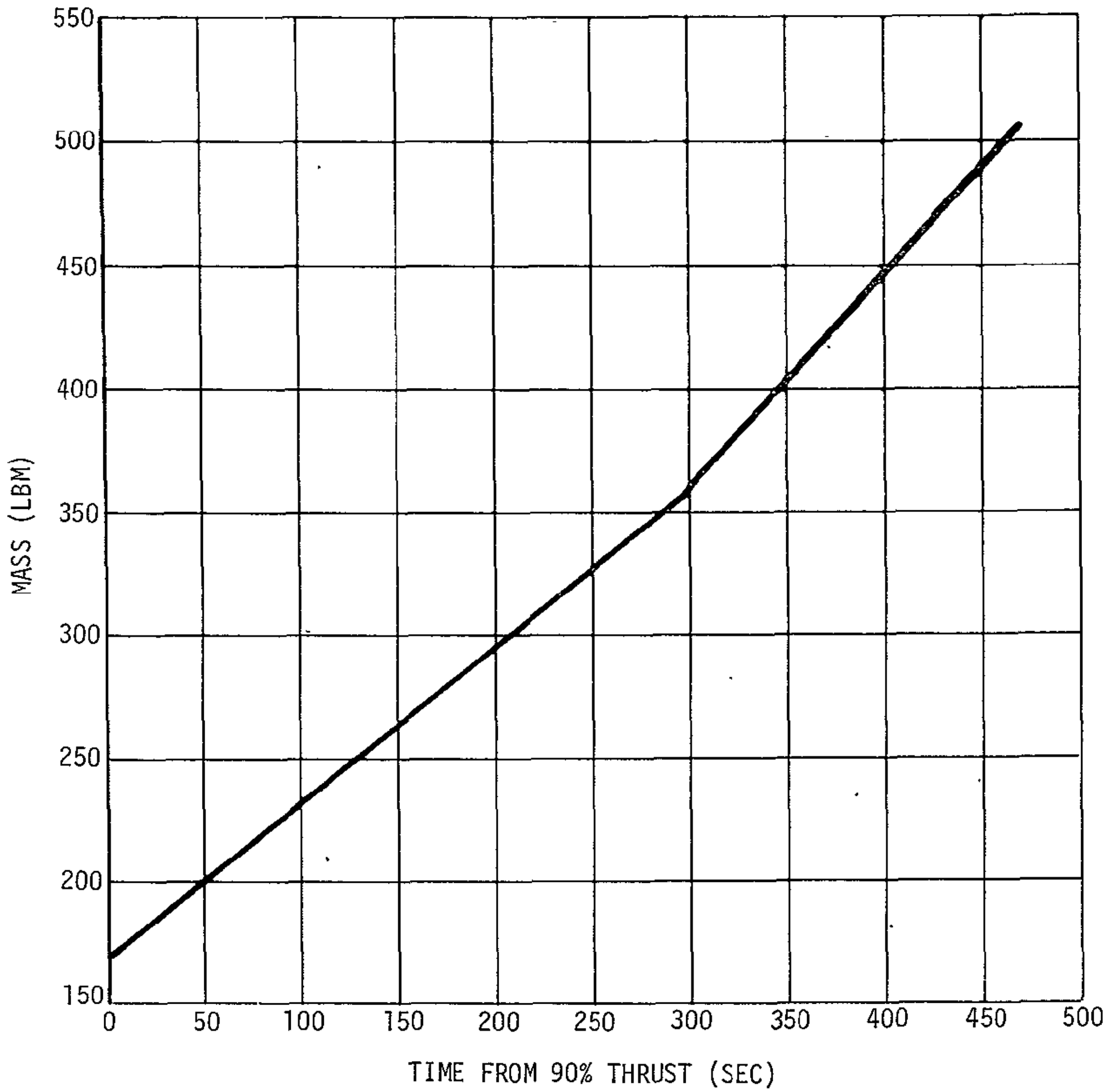

Figure AP 5-25. LH2 Tank Ullage Mass

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-205 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.

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 figures AP 6-1 and AP 6-2.

Predicted mass corrections for flight dynamics effects are presented in figures AP 6-3 and AP 6-4. These corrections compensate for tank geometry changes caused by variations in tank skin temperature, vehicle acceleration, and differential tank pressures, and 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. Figures AP 6-5 and AP 6-6 present the total predicted mass sensor corrections for flight using the flow integral and volumetric calibration results.

Mass sensor nonlinearities resulting from tank-to-sensor mismatch including mass sensor manufacturing nonlinearities are presented in figure AP 6-7 for both the flow integral and volumetric calibrations. These corrections are based on acceptance firing data and unique tank measurements as normalized to the desired liftoff and cutoff masses. The flow integral nonlinearities were used in the predictions presented in this report.

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 figures AP 6-8 and AP 6-9.

TABLE AP 6-1 (Sheet 1 of 2)
PROPELLANT LOADING REQUIREMENTS SUMMARY*

DESCRIPTION	LH2 (lbm)	LOX (lbm)	REMARKS
Usable Propellants			
Total Usable Propellants	38,454	192,284	The propellant load for the AS-205 flight was defined using a nominal burntime to propellant depletion of 472.3 sec.
Nominal Propellant Consumption	37,187	191,077	This quantity will normally be burned by the J-2 engine between the 90 percent thrust level at ignition and predicted guidance cutoff at ESC +469.5.
Available Flight Performance Reserve	1,267	1,207	Nominal flight performance and reserve and flight geometry reserve available following a predicted guidance cutoff.
LH2 Bias	1,040	--	The LH2 bias is included as a linear bias to empty and full calibration points to minimize residuals at depletion.
Unusuable Propellants			
Total Unusuable Propellants	1,193	989	The total unusable propellant load is 2,182 lbm.
Boiloff	0	173	
LH2 Tank Pressurant	337	--	This is required to pressurize the LH2 tank during burn. The LOX tank is pressurized by helium.
J-2 Start Transient	96	298	This is the propellants consumed during the J-2 engine start transient, which is from Engine Start Command to 90 percent thrust.
J-2 Cutoff Transient	27	122	This is the propellants consumed during the J-2 engine cutoff transient, which is from Engine Cutoff Command to zero thrust.

*The allowable indicated-to-desired propellant load mismatch is ± 0.5 percent of the desired propellant load in each tank. Therefore, by root-sum-square (RSS) of the indicated-to-actual mass accuracy and indicated-to-desired propellant load mismatch, the desired-to-actual loading accuracy is 1.12 percent of the desired propellant load in each tank, or 444 lbm LH2 and 2,165 lbm LOX.

TABLE AP 6-1 (Sheet 2 of 2)
PROPELLANT LOADING REQUIREMENTS SUMMARY*

DESCRIPTION	LH2 (lbm)	LOX (lbm)	REMARKS
J-2 Trapped	10	108	This is the propellant trapped in the J-2 engine following the cutoff transient.
Unavailable	723	288	This is the unavailable propellant trapped in the tanks and lines, based upon depletion sensor cutoff and thrust decay.
Total Desired Load	39,647	193,273	

*The allowable indicated-to-desired propellant load mismatch is ±0.5 percent of the desired propellant load in each tank. Therefore, by root-sum-square (RSS) of the indicated-to-actual mass accuracy and indicated-to desired propellant load mismatch, the desired-to-actual loading accuracy is 1.12 percent of the desired propellant load in each tank, or 444 lbm LH2 and 2,165 lbm LOX.

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 (E-14)				
Helium Calibration Point (1)	282.52	1,957	0.01509	Tap +0.01479
Air Calibration Point (GN2)	282.67	2,171	0.01605	Tap +0.01573
Probe Bottom (Cryogenic)	282.06	1,270	0.01203	Tap +0.01179
Empty Calibration Point	280.24	-1,427	0.0	Tap
Full Calibration Point (2)	404.88	183,044	0.82264	Tap +0.80618
Probe Calibration Point	409.55	189,957	0.85346	Tap +0.83640
Full Load (Pressurized) (3)	411.79	193,273	0.86825	Tap +0.85089
Full Load (Unpressurized) (4)	412.23	193,273	0.87117	Tap +0.85375
Reference Mixture Ratio Calibration Point	399.00	174,340	0.78382	Tap +0.76815

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 122.35 pf, which is equal to a coarse mass ratio (CMR) of 0.82269 and a LOX mass of 183,044 lbm.

(3) The loading computer (L/C) will be programmed to load to a CMR of 0.86825, 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 0.86391 and a maximum of 0.87259.

(4) The L/C will be programmed to load to a CMR of 0.87117, 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 0.86681 and a maximum of 0.87553. The nominal CMR of 0.87117 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-205 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 (F-5)				
Helium Calibration Point (5)	973.61	15	-0.00626	Tap -0.00614
Air Calibration Point (GN2)	974.11	117	-0.00400	Tap -0.00392
Probe Bottom (Cryogenic)	974.55	206	-0.00203	Tap -0.00199
Empty Calibration Point	975.00	298	0.0	Tap
Full Calibration Point (6)	1,157.86	37,487	0.82264	Tap +0.80618
Probe Calibration Point	1,152.24	36,344	0.79735	Tap +0.78141
Full Load (Pressurized) (7)	1,168.48	39,647	0.87042	Tap +0.85301
Full Load (Unpressurized) (8)	1,169.73	37,647	0.87606	Tap +0.85854
Reference Mixture Ratio Calibration Point	1,157.86	37,487	0.82264	Tap +0.86618

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 184.25 pf, which is equal to a CMR of 0.82264 and an LH2 mass of 37,487 lbm.

(7) The L/C will be programmed to load to a CMR of 0.87042, which is equal to an LH2 mass of 39,647 lbm (pressurized). The maximum acceptable deviation from the nominal load is ±0.5 percent; i.e., a minimum CMR of 0.83607 and a maximum of 0.84477.

(8) The L/C will be programmed to load to a CMR of 0.87606, which is equal to an LH2 mass of 37,647 lbm (unpressurized). An L/C tolerance of ±0.5 percent of the desired load will yield a minimum CMR of 0.87168 and a maximum of 0.88044. The nominal CMR of 0.87606 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-205 Countdown Demonstration Test.

TABLE AP·6-2 (Sheet 3 of 3)
PROPELLANT UTILIZATION CALIBRATION DATA

MASS AND CAPACITANCE REDUCTION FORMULAE

LOX Mass = λ(224,244) -1,427

LH2 Mass = λ(45,207) +298

LOX Capacitance = λ(151.51) +280.24

LH2 Capacitance = λ(222.28) +975.00

$$\lambda = \frac{LEG}{20} = \text{Fine Mass Ratio}$$

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 4.76

a. Calibrate bridges as shown in table

b. Put in ΔC = 184.25 pf on LH2 bridge

c. Put in ΔC = 122.35 pf on LOX bridge

d. Adjust bias potentiometers for 0.000 ±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	CDDT AND FLIGHT			
			LOX TANK (±1bm)		LH2 TANK (±1bm)	
			LEVEL SENSOR NO.		LEVEL SENSOR NO.	
			L0004	L0005	L0001	L0002
1.	Predicted accuracies of level sensors	Flight CDDT**	183 111	393 228	*	85 38
2.	Predicted accuracy of PU mass sensor at level sensor activation	Flight and CDDT	495	495		130
3.	Probable deviation between level sensor and PU mass sensor (RSS of items 1 and 2)	Flight CDDT	528 507	632 545		155 135
4.	Predicted accuracy of propellant residuals at ECC as determined by individual level sensors	Flight	183	401		85
5.	Probable deviation between mass sensor and level sensor determined residuals at ECC (RSS of item 4 of this table and item 1 in table AP 6-4)	Flight	528	637		155

*This level sensor is not expected to deactivate during flight because the predicted residual is higher than this level.

**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 TANK ($\pm$lbm)	LH2 TANK ($\pm$lbm)	TOTAL ($\pm$lbm)
1.	PU system mass sensor accuracy of propellant residuals at ECC based on a predicted residual above the main propellant valves of 1,934 lbm LOX and 2,129 lbm LH2.	495	130	512
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.	166	85	186
3.	Estimated residual accuracy based on the weighted average of PU mass sensor and level sensor residual accuracies (items 1 and 2).	158	71	175

NOTE: Total represent root-sum-square (RSS) values of individual propellant tank accuracies.

TABLE AP 6-5 (Sheet 1 of 2)
SATURN S-IVB-205 VOLUME VERSUS HEIGHT LOX TANK -
GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)
1.00	.000	51.00	532.355	101.00	1752.100
2.00	.248	52.00	551.790	102.00	1777.116
3.00	1.390	53.00	571.506	103.00	1801.932
4.00	3.004	54.00	591.500	104.00	1826.546
5.00	5.083	55.00	611.768	105.00	1850.953
6.00	7.623	56.00	632.306	106.00	1875.150
7.00	10.619	57.00	653.111	107.00	1899.133
8.00	14.067	58.00	674.179	108.00	1922.899
9.00	17.961	59.00	695.506	109.00	1946.444
10.00	22.298	60.00	717.089	110.00	1969.763
11.00	27.073	61.00	738.924	111.00	1992.854
12.00	32.281	62.00	761.007	112.00	2015.713
13.00	37.919	63.00	783.335	113.00	2038.335
14.00	43.981	64.00	805.904	114.00	2060.718
15.00	50.465	65.00	828.710	115.00	2082.857
16.00	57.366	66.00	851.750	116.00	2104.749
17.00	64.679	67.00	875.020	117.00	2126.389
18.00	72.402	68.00	898.517	118.00	2147.776
19.00	80.530	69.00	922.236	119.00	2168.903
20.00	89.059	70.00	946.175	120.00	2189.769
21.00	97.985	71.00	970.329	121.00	2210.369
22.00	107.305	72.00	994.694	122.00	2230.699
23.00	117.014	73.00	1019.269	123.00	2250.755
24.00	127.110	74.00	1044.047	124.00	2270.535
25.00	137.588	75.00	1069.027	125.00	2290.034
26.00	148.445	76.00	1094.204	126.00	2309.249
27.00	159.676	77.00	1119.575	127.00	2328.176
28.00	171.279	78.00	1145.135	128.00	2346.810
29.00	183.250	79.00	1170.883	129.00	2365.149
30.00	195.585	80.00	1196.813	130.00	2383.189
31.00	208.280	81.00	1222.923	131.00	2400.926
32.00	221.332	82.00	1249.208	132.00	2418.356
33.00	234.738	83.00	1275.666	133.00	2435.475
34.00	248.493	84.00	1302.292	134.00	2452.280
35.00	262.594	85.00	1329.083	135.00	2468.768
36.00	277.038	86.00	1356.036	136.00	2484.933
37.00	291.821	87.00	1383.146	137.00	2500.774
38.00	306.939	88.00	1410.411	138.00	2516.285
39.00	322.388	89.00	1437.754	139.00	2531.464
40.00	338.166	90.00	1464.866	140.00	2546.306
41.00	354.269	91.00	1491.825	141.00	2560.808
42.00	370.692	92.00	1518.625	142.00	2574.966
43.00	387.433	93.00	1545.263	143.00	2588.776
44.00	404.488	94.00	1571.736	144.00	2602.235
45.00	421.853	95.00	1598.040	145.00	2615.339
46.00	439.525	96.00	1624.170	146.00	2628.084
47.00	457.499	97.00	1650.125	147.00	2640.467
48.00	475.773	98.00	1675.898	148.00	2652.483
49.00	494.343	99.00	1701.488	149.00	2664.130
50.00	513.204	100.00	1726.890	150.00	2675.403

TABLE AP 6-5 (Sheet 2 of 2)
SATURN S-IVB-205 VOLUME VERSUS HEIGHT LOX TANK -
GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)
151.00	2686.298	160.00	2766.761	169.00	2813.644
152.00	2696.812	161.00	2773.678	170.00	2816.663
153.00	2706.942	162.00	2780.177	171.00	2819.230
154.00	2716.683	163.00	2786.254	172.00	2821.342
155.00	2726.031	164.00	2791.905	173.00	2822.994
156.00	2734.984	165.00	2797.126	174.00	2824.184
157.00	2743.537	166.00	2801.915	175.00	2824.907
158.00	2751.687	167.00	2806.267	176.00	2825.160
159.00	2759.429	168.00	2810.178		

TABLE AP 6-6 (Sheet 1 of 3)
SATURN S-IVB-205 VOLUME VERSUS HEIGHT LH2 TANK -
GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)
1.00	.000	51.00	381.999	101.00	1610.308
2.00	.000	52.00	397.516	102.00	1640.472
3.00	.000	53.00	413.387	103.00	1670.642
4.00	.430	54.00	429.615	104.00	1700.818
5.00	1.456	55.00	446.202	105.00	1730.999
6.00	2.841	56.00	463.154	106.00	1761.186
7.00	4.576	57.00	480.472	107.00	1791.377
8.00	6.650	58.00	498.161	108.00	1821.572
9.00	9.055	59.00	516.223	109.00	1851.771
10.00	11.785	60.00	534.663	110.00	1881.974
11.00	14.832	61.00	553.484	111.00	1912.180
12.00	18.191	62.00	572.689	112.00	1942.389
13.00	21.858	63.00	592.281	113.00	1972.601
14.00	25.829	64.00	612.264	114.00	2002.815
15.00	30.102	65.00	632.642	115.00	2033.032
16.00	34.673	66.00	653.418	116.00	2063.250
17.00	39.542	67.00	674.594	117.00	2093.470
18.00	44.707	68.00	696.176	118.00	2123.692
19.00	50.167	69.00	718.166	119.00	2153.915
20.00	55.923	70.00	740.567	120.00	2184.139
21.00	61.975	71.00	763.383	121.00	2214.364
22.00	68.323	72.00	786.617	122.00	2244.589
23.00	74.968	73.00	810.274	123.00	2274.816
24.00	81.911	74.00	834.355	124.00	2305.042
25.00	89.152	75.00	858.866	125.00	2335.269
26.00	96.693	76.00	883.808	126.00	2365.495
27.00	104.535	77.00	909.186	127.00	2395.722
28.00	112.679	78.00	935.003	128.00	2425.948
29.00	121.125	79.00	961.262	129.00	2456.174
30.00	129.874	80.00	987.967	130.00	2486.399
31.00	138.926	81.00	1015.121	131.00	2516.624
32.00	148.281	82.00	1042.728	132.00	2546.849
33.00	157.939	83.00	1070.791	133.00	2577.072
34.00	167.897	84.00	1099.314	134.00	2607.295
35.00	178.156	85.00	1128.299	135.00	2637.516
36.00	188.712	86.00	1157.751	136.00	2667.737
37.00	199.562	87.00	1187.672	137.00	2697.957
38.00	210.704	88.00	1218.067	138.00	2728.175
39.00	222.099	89.00	1248.985	139.00	2758.392
40.00	233.644	90.00	1279.038	140.00	2788.609
41.00	245.502	91.00	1309.104	141.00	2818.823
42.00	257.674	92.00	1339.182	142.00	2849.037
43.00	270.166	93.00	1369.270	143.00	2879.249
44.00	282.981	94.00	1399.369	144.00	2909.460
45.00	296.121	95.00	1429.477	145.00	2939.669
46.00	309.591	96.00	1459.595	146.00	2969.878
47.00	323.393	97.00	1489.722	147.00	3000.084
48.00	337.532	98.00	1519.857	148.00	3030.290
49.00	352.010	99.00	1550.000	149.00	3060.494
50.00	366.831	100.00	1580.150	150.00	3090.696

TABLE AP 6-6 (Sheet 2 of 3)
SATURN S-IVB-205 VOLUME VERSUS HEIGHT LH2 TANK -
GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)
151.00	3120.897	201.00	4629.579	251.00	6133.802
152.00	3151.097	202.00	4659.729	252.00	6163.773
153.00	3181.295	203.00	4689.878	253.00	6193.737
154.00	3211.492	204.00	4720.026	254.00	6223.696
155.00	3241.688	205.00	4750.173	255.00	6253.648
156.00	3271.882	206.00	4780.318	256.00	6283.595
157.00	3302.075	207.00	4810.461	257.00	6313.535
158.00	3332.267	208.00	4840.603	258.00	6343.469
159.00	3362.457	209.00	4870.743	259.00	6373.397
160.00	3392.646	210.00	4900.882	260.00	6403.319
161.00	3422.834	211.00	4931.019	261.00	6433.234
162.00	3453.021	212.00	4961.153	262.00	6463.144
163.00	3483.206	213.00	4991.286	263.00	6493.048
164.00	3513.391	214.00	5021.417	264.00	6522.945
165.00	3543.574	215.00	5051.546	265.00	6552.837
166.00	3573.756	216.00	5081.672	266.00	6582.723
167.00	3603.937	217.00	5111.796	267.00	6612.604
168.00	3634.117	218.00	5141.918	268.00	6642.479
169.00	3664.296	219.00	5172.037	269.00	6672.349
170.00	3694.474	220.00	5202.153	270.00	6702.213
171.00	3724.651	221.00	5232.267	271.00	6732.073
172.00	3754.827	222.00	5262.378	272.00	6761.928
173.00	3785.003	223.00	5292.485	273.00	6791.779
174.00	3815.177	224.00	5322.590	274.00	6821.625
175.00	3845.350	225.00	5352.691	275.00	6851.467
176.00	3875.523	226.00	5382.789	276.00	6881.305
177.00	3905.695	227.00	5412.883	277.00	6911.140
178.00	3935.866	228.00	5442.974	278.00	6940.972
179.00	3966.036	229.00	5473.061	279.00	6970.801
180.00	3996.205	230.00	5503.144	280.00	7000.628
181.00	4026.374	231.00	5533.224	281.00	7030.453
182.00	4056.542	232.00	5563.299	282.00	7060.277
183.00	4086.709	233.00	5593.370	283.00	7090.099
184.00	4116.875	234.00	5623.437	284.00	7119.921
185.00	4147.041	235.00	5653.499	285.00	7149.744
186.00	4177.205	236.00	5683.557	286.00	7179.566
187.00	4207.370	237.00	5713.610	287.00	7209.390
188.00	4237.533	238.00	5743.658	288.00	7239.216
189.00	4267.695	239.00	5773.701	289.00	7269.044
190.00	4297.857	240.00	5803.740	290.00	7298.875
191.00	4328.018	241.00	5833.773	291.00	7328.710
192.00	4358.179	242.00	5863.801	292.00	7358.550
193.00	4388.338	243.00	5893.824	293.00	7388.395
194.00	4418.496	244.00	5923.841	294.00	7418.247
195.00	4448.654	245.00	5953.852	295.00	7448.105
196.00	4478.811	246.00	5983.858	296.00	7477.972
197.00	4508.966	247.00	6013.859	297.00	7507.848
198.00	4539.121	248.00	6043.853	298.00	7537.734
199.00	4569.275	249.00	6073.842	299.00	7567.631
200.00	4599.427	250.00	6103.825	300.00	7597.540

TABLE AP 6-6 (Sheet 3 of 3)
SATURN S-IVB-205 VOLUME VERSUS HEIGHT LH2 TANK -
GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)	HEIGHT (IN.)	VOLUME (FT^3)
301.00	7627.462	347.00	8977.240	392.00	10011.595
302.00	7657.399	348.00	9004.499	393.00	10028.839
303.00	7687.352	349.00	9031.612	394.00	10045.771
304.00	7717.321	350.00	9058.577	395.00	10062.387
305.00	7747.309	351.00	9085.392	396.00	10078.683
306.00	7777.317	352.00	9112.051	397.00	10094.654
307.00	7807.346	353.00	9138.553	398.00	10110.296
308.00	7837.398	354.00	9164.893	399.00	10125.606
309.00	7863.502	355.00	9191.070	400.00	10140.577
310.00	7894.107	356.00	9217.078	401.00	10155.207
311.00	7924.673	357.00	9242.915	402.00	10169.490
312.00	7955.197	358.00	9268.578	403.00	10183.422
313.00	7985.677	359.00	9294.063	404.00	10196.999
314.00	8016.112	360.00	9319.366	405.00	10210.216
315.00	8046.497	361.00	9344.485	406.00	10223.069
316.00	8076.831	362.00	9369.415	407.00	10235.552
317.00	8107.111	363.00	9394.153	408.00	10247.662
318.00	8137.334	364.00	9418.697	409.00	10259.394
319.00	8167.499	365.00	9443.041	410.00	10270.744
320.00	8197.602	366.00	9467.183	411.00	10281.706
321.00	8227.642	367.00	9491.119	412.00	10292.276
322.00	8257.614	368.00	9514.846	413.00	10302.450
323.00	8287.518	369.00	9538.359	414.00	10312.222
324.00	8317.349	370.00	9561.655	415.00	10321.588
325.00	8347.106	371.00	9584.730	416.00	10330.543
326.00	8376.786	372.00	9607.581	417.00	10339.082
327.00	8406.386	373.00	9630.205	418.00	10347.201
328.00	8435.903	374.00	9652.596	419.00	10354.895
329.00	8465.335	375.00	9674.753	420.00	10362.158
330.00	8494.678	376.00	9696.669	421.00	10368.986
331.00	8523.931	377.00	9718.342	422.00	10375.374
332.00	8553.089	378.00	9739.769	423.00	10381.317
333.00	8582.152	379.00	9760.945	424.00	10386.811
334.00	8611.114	380.00	9781.866	425.00	10391.848
335.00	8639.975	381.00	9802.528	426.00	10396.427
336.00	8668.730	382.00	9822.927	427.00	10400.540
337.00	8697.377	383.00	9843.060	428.00	10404.183
338.00	8725.913	384.00	9862.923	429.00	10407.352
339.00	8754.335	385.00	9882.511	430.00	10410.039
340.00	8782.639	386.00	9901.820	431.00	10412.241
341.00	8810.824	387.00	9920.846	432.00	10413.953
342.00	8838.886	388.00	9939.586	433.00	10415.169
343.00	8866.821	389.00	9958.035	434.00	10415.884
344.00	8894.628	390.00	9976.189	435.00	10416.093
345.00	8922.302	391.00	9994.043	436.00	10416.302
346.00	8949.840				

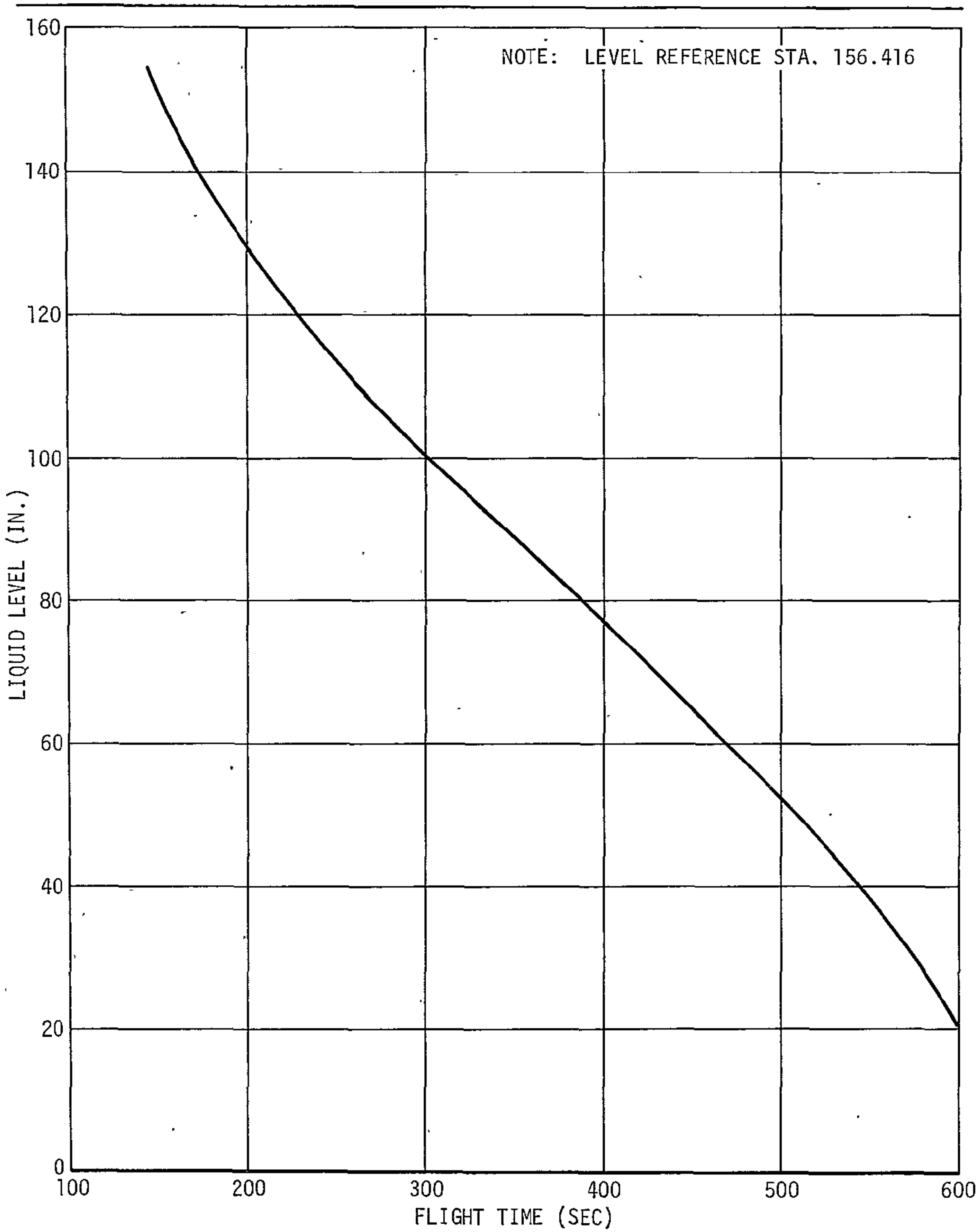

Figure AP 6-1. Predicted S-IVB 205 Stage LOX Propellant Level History

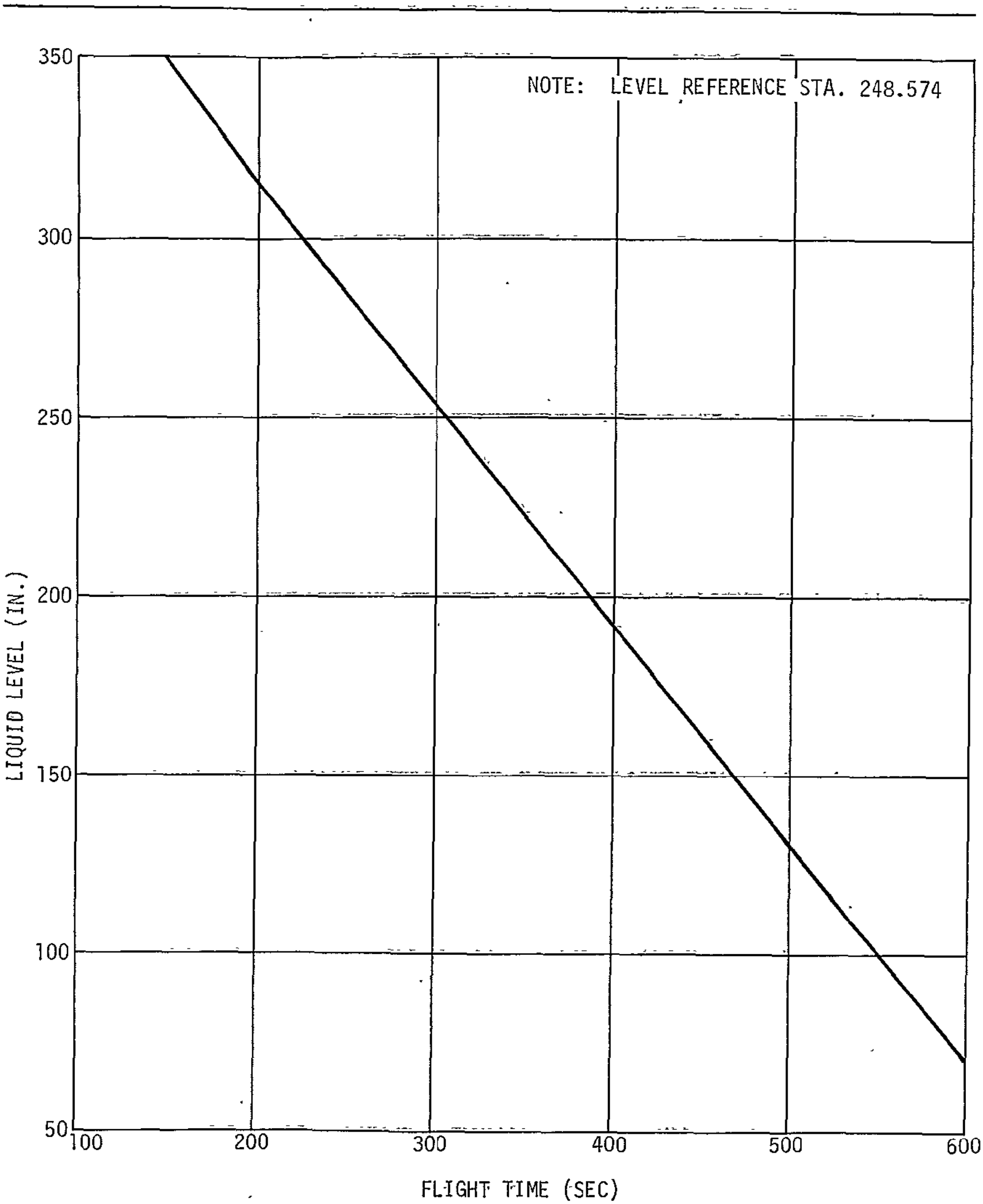

Figure AP 6-2. Predicted S-IVB 205 Stage LH2 Propellant Level History

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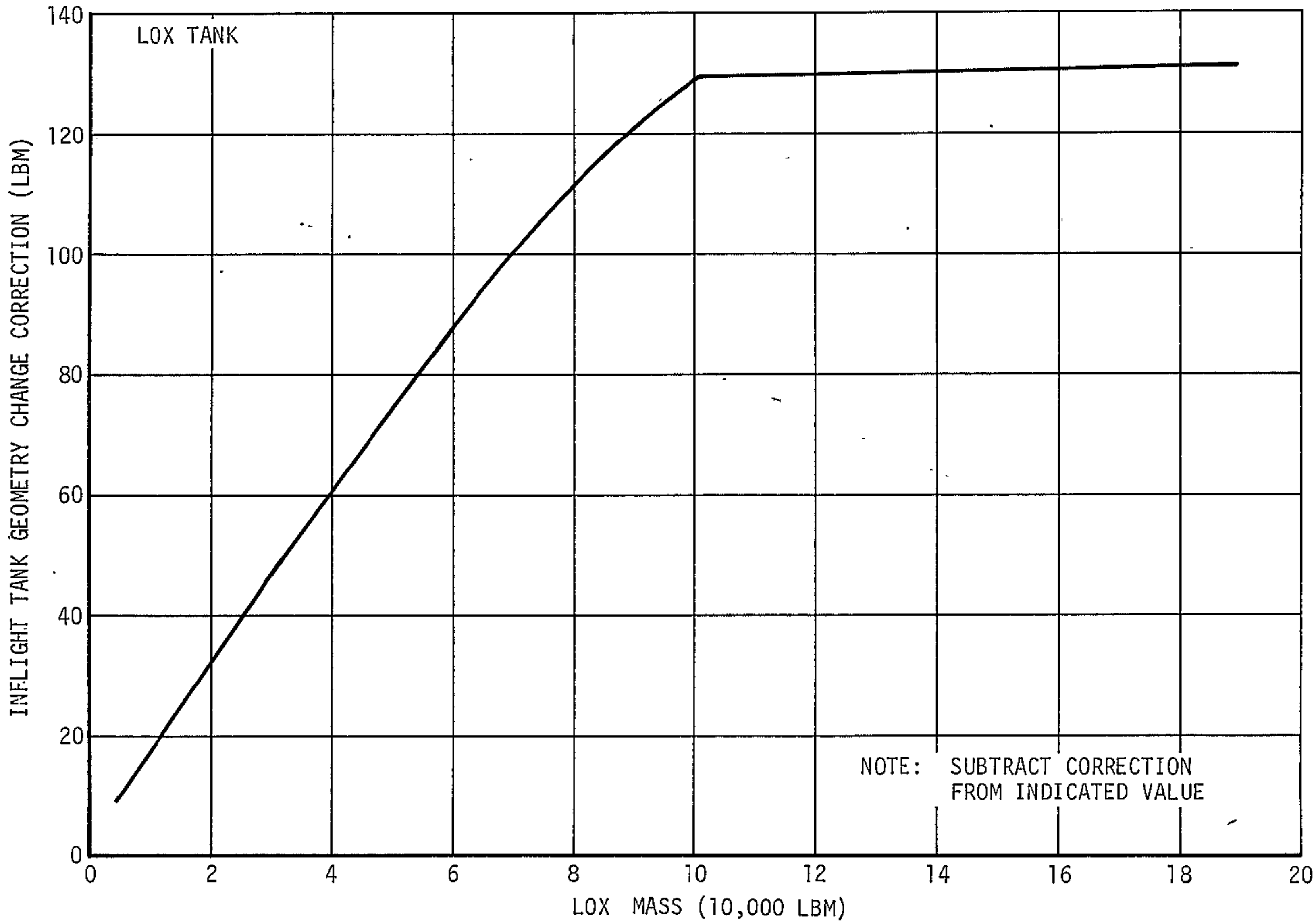

Figure AP 6-3. Predicted S-IVB-205 Stage Indicated PU Mass Correction due to Inflight Tank Geometry Change (Sheet 1 of 2)

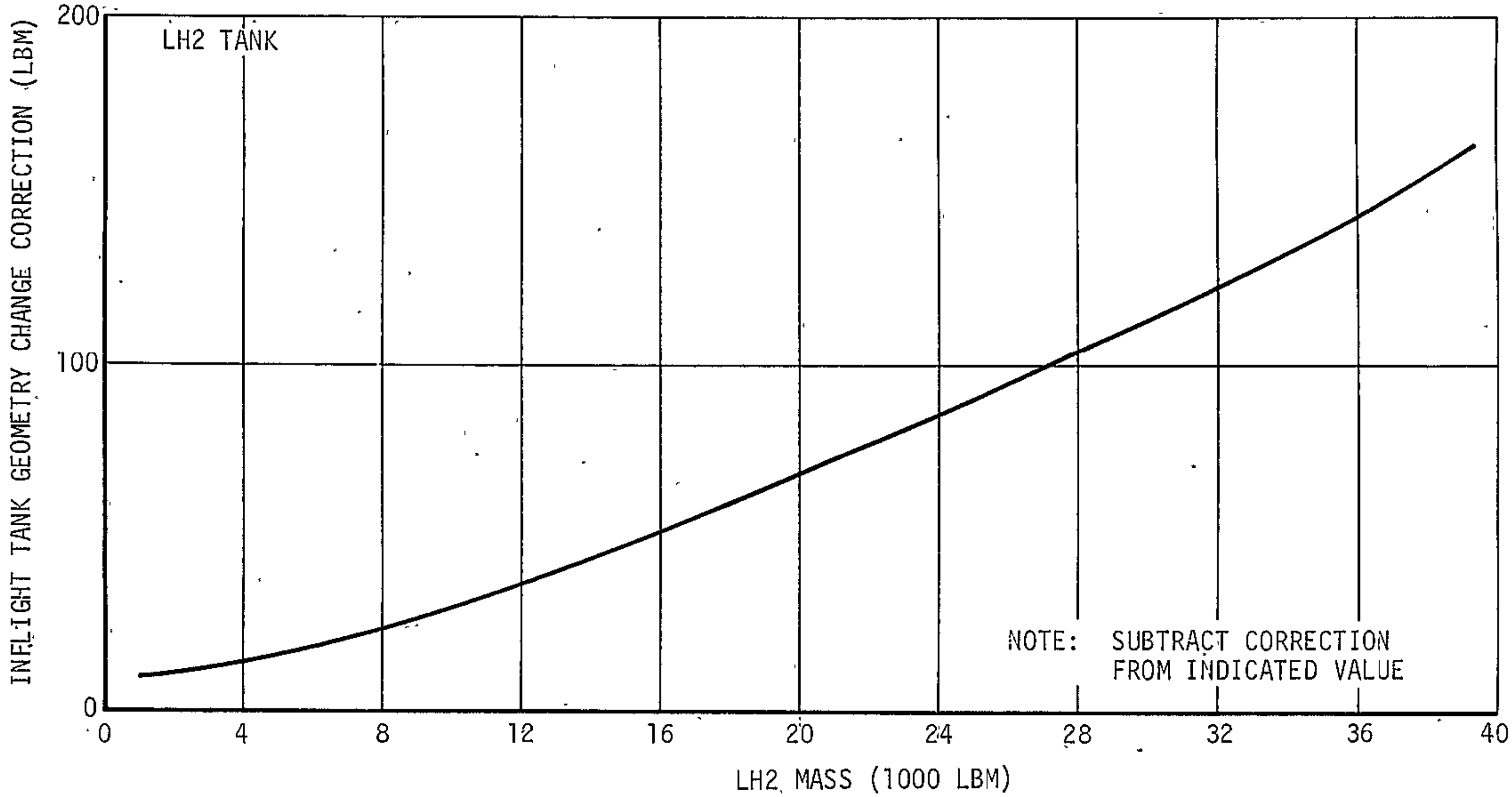

Figure AP 6-3. Predicted S-IVB-205 Stage Indicated PU Mass Correction due to Inflight Tank Geometry Change (Sheet 2 of 2)

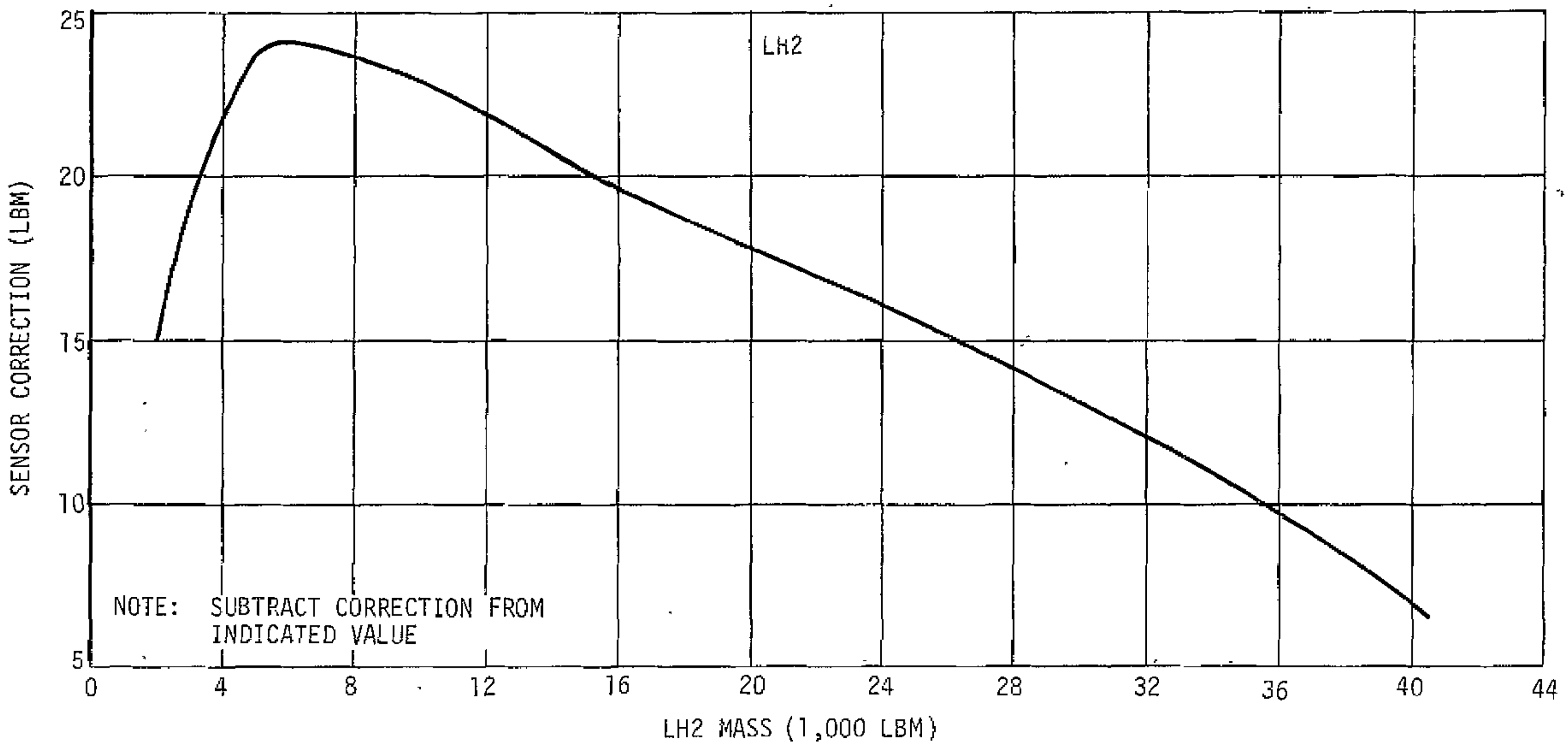

Figure AP 6-4. Predicted S-IVB-205 Stage PU Mass Sensor Correction due to Center-of-Gravity Offset (Sheet 2 of 2)

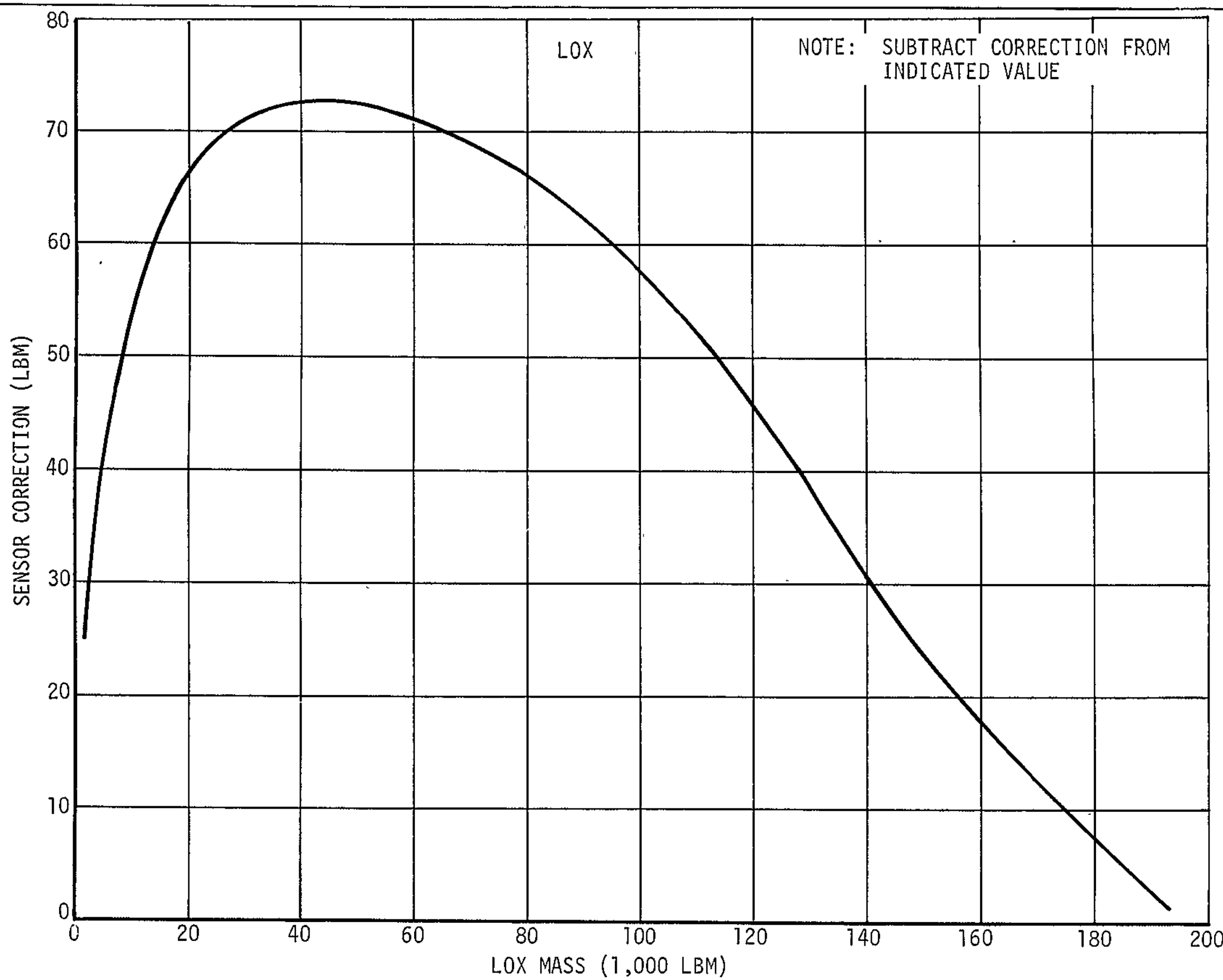

Figure AP 6-4. Predicted S-IVB-205 Stage PU Mass Sensor Correction due to Center-of-Gravity Offset (Sheet 1 of 2)

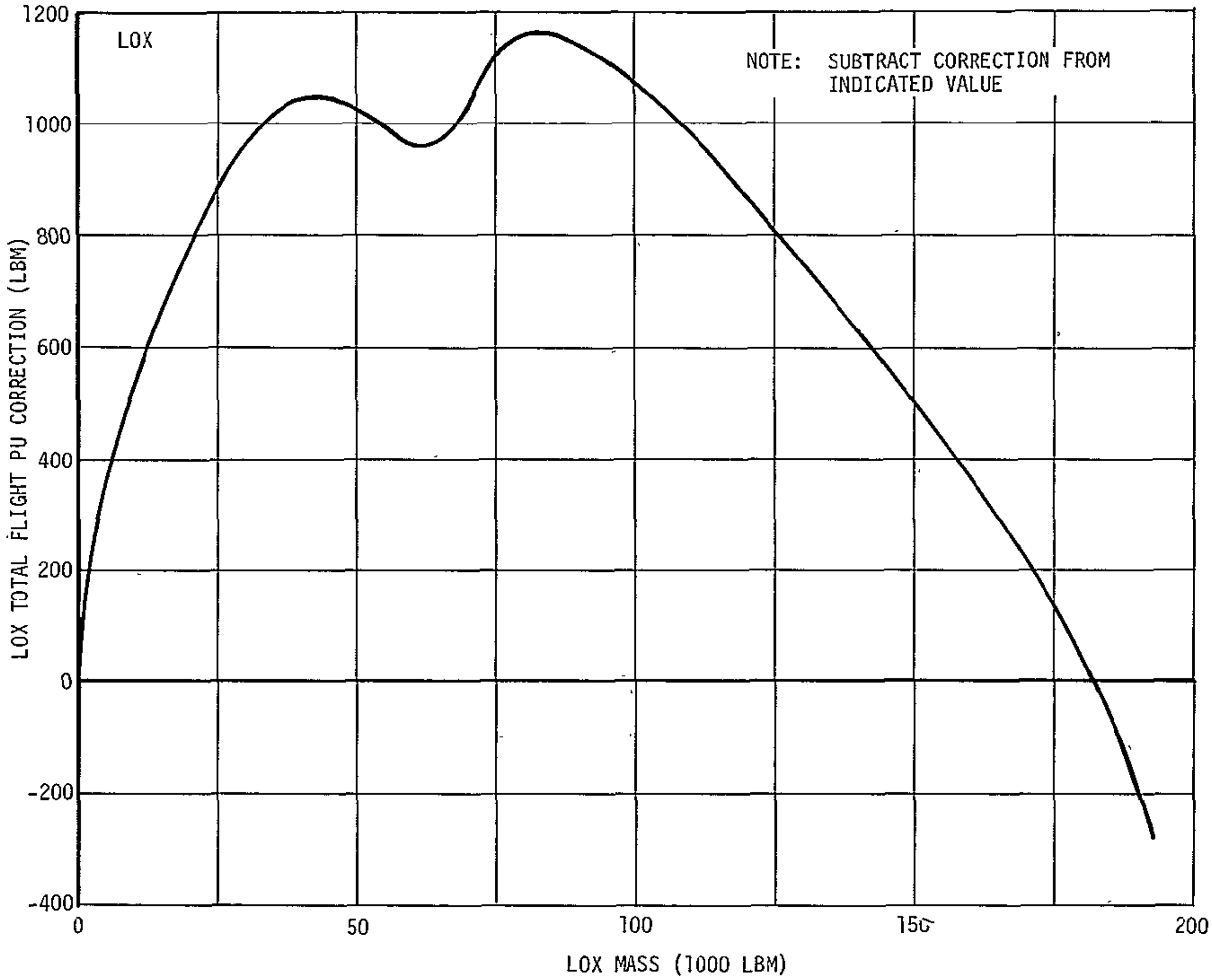

Figure AP 6-5. Predicted S-IVB-205 Stage Total Flight Sensor Mass Correction as Determined by the Volumetric Method (Sheet 1 of 2)

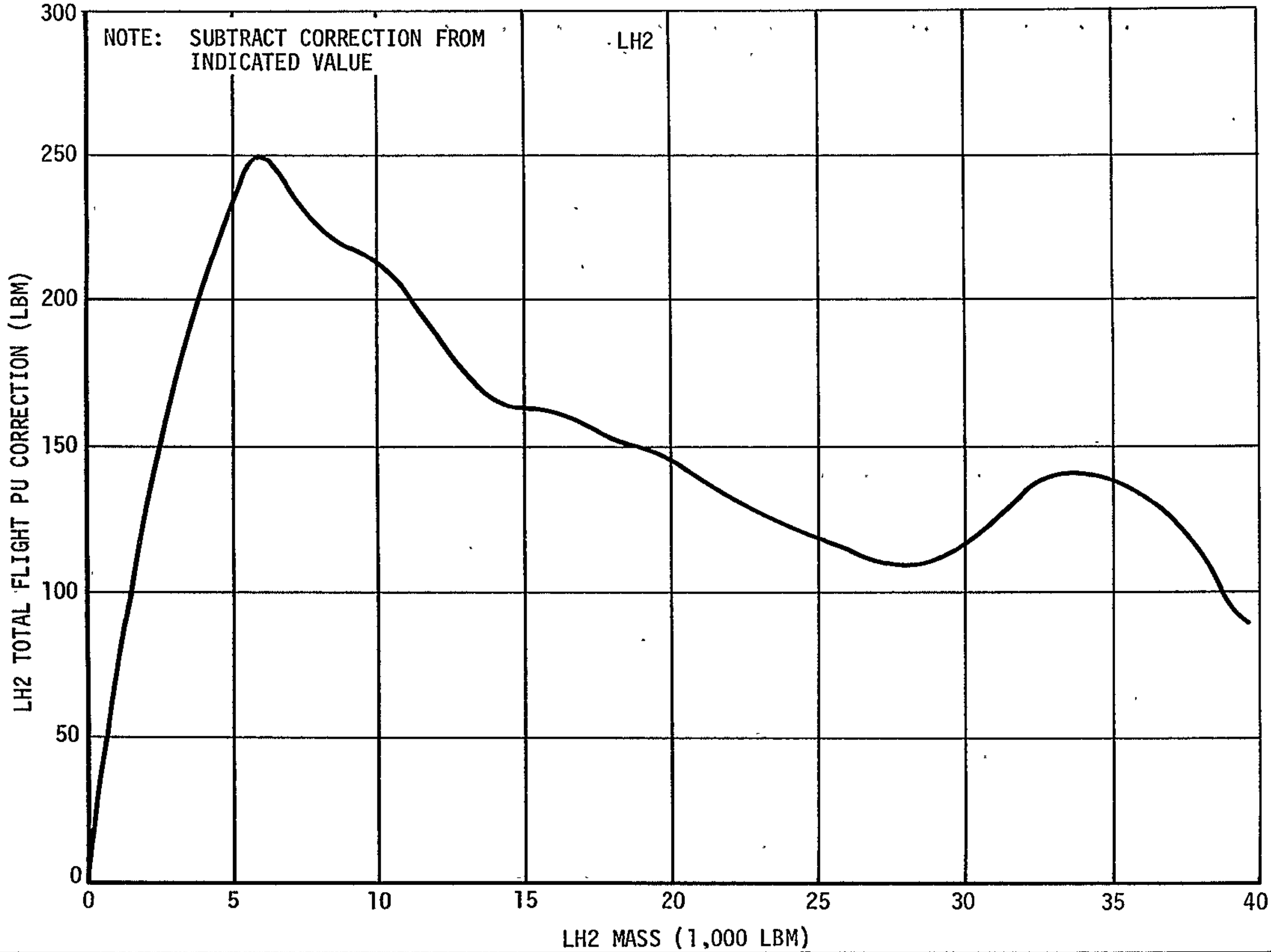

Figure AP 6-5. Predicted S-IVB-205 Stage Total Flight Sensor Mass Correction as Determined by the Volumetric Method (Sheet 2 of 2)

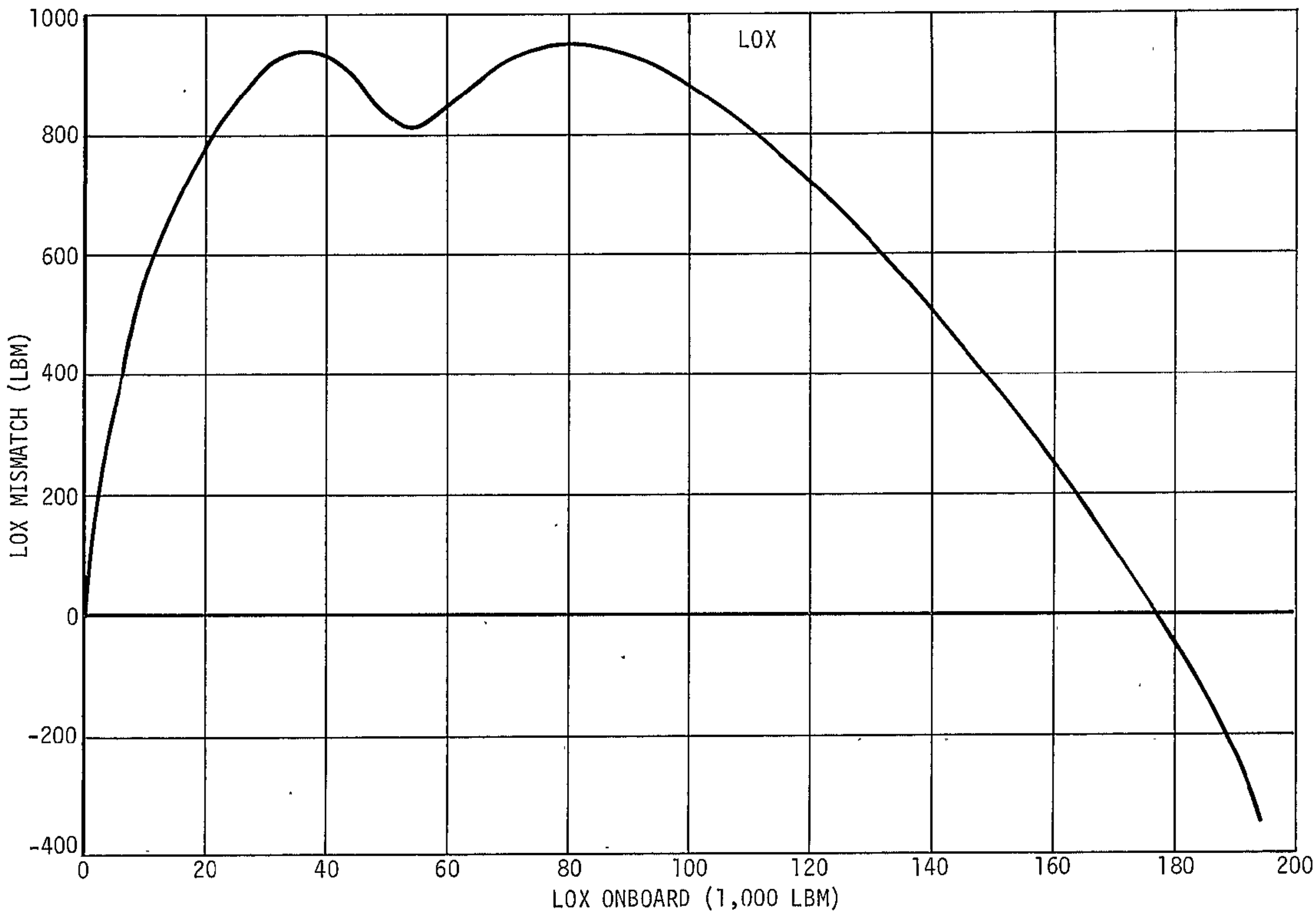

Figure AP 6-6. Predicted Total Flight Tank-to-Sensor Mismatch as Determined by the Flow Integral Method (Sheet 1 of 2)

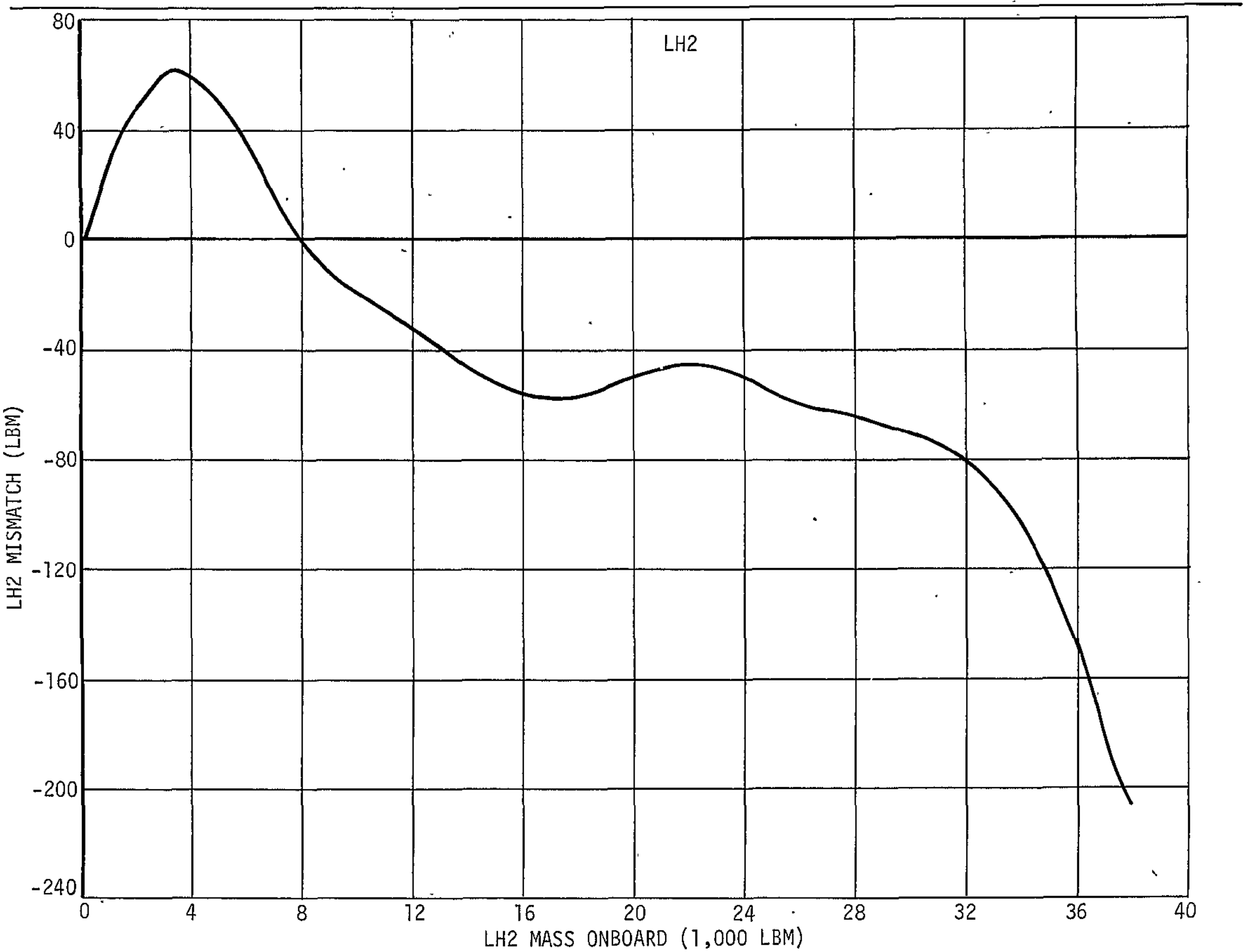

Figure AP 6-6. Predicted Total Flight Tank-to-Sensor Mismatch as Determined by the Flow Integral Method (Sheet 2 of 2)

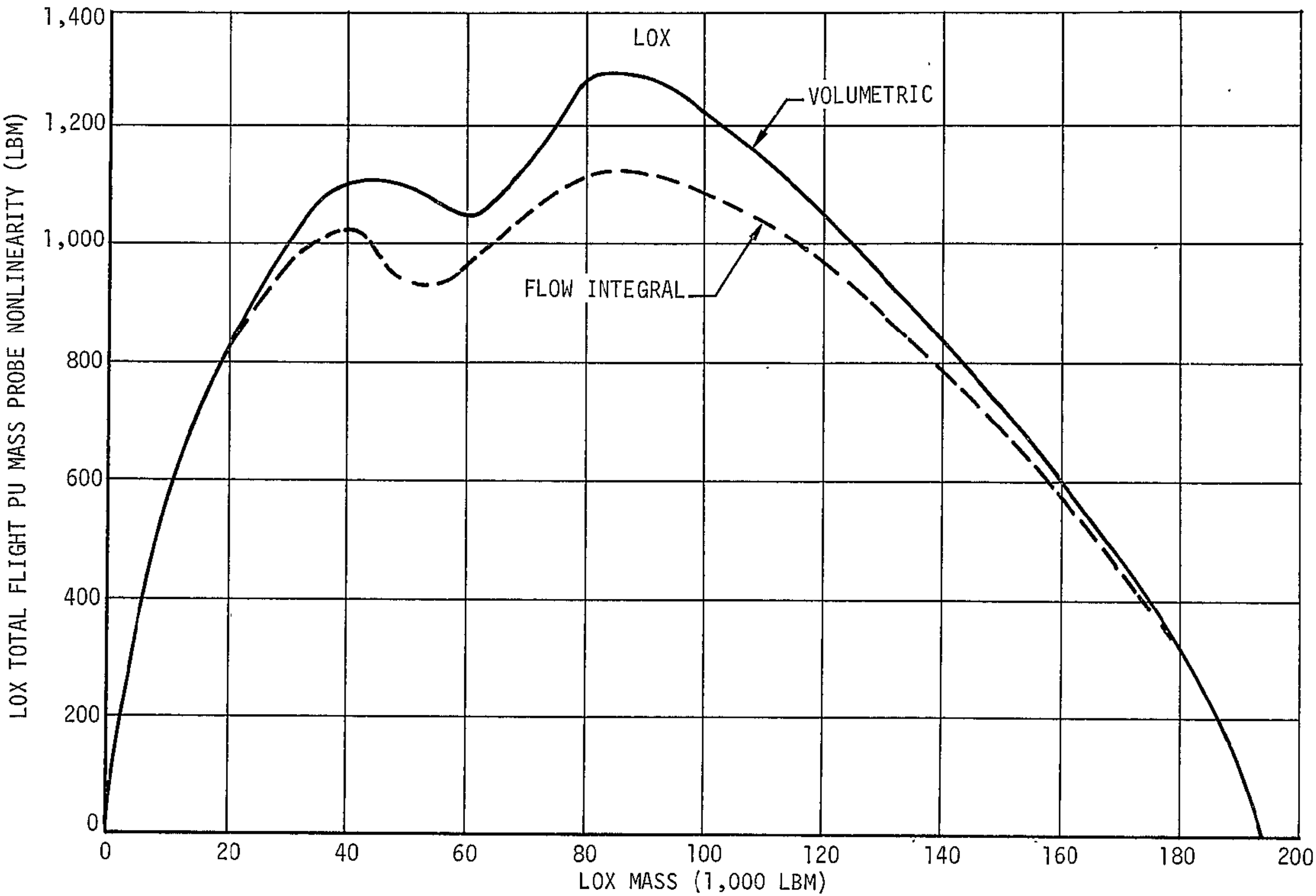

Figure AP 6-7. Predicted S-IVB-205 Stage Total Flight Sensor Mass as Determined by the Volumetric Nonlinearity and Flow Integral Methods (Sheet 1 of 2)

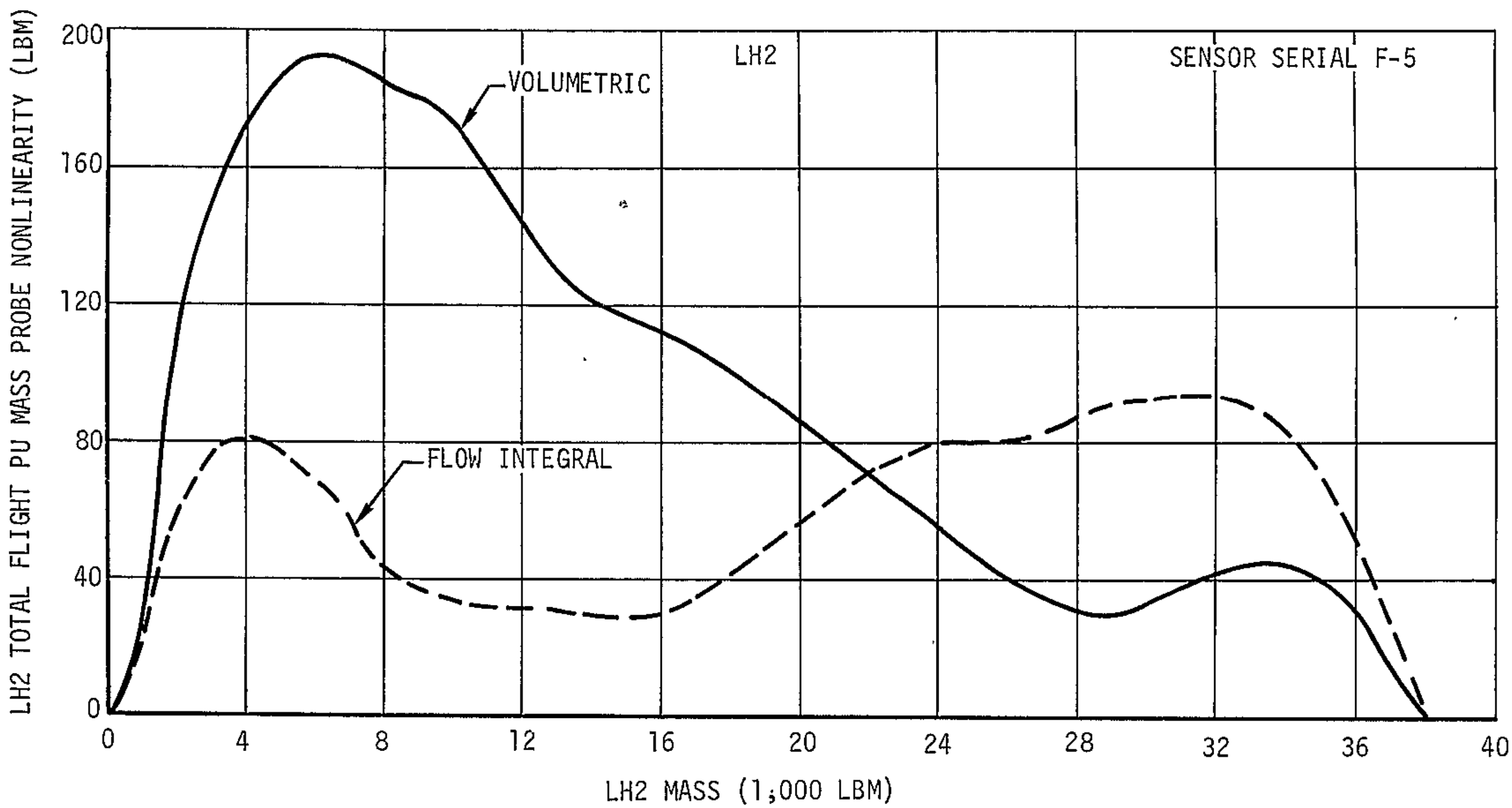

Figure AP 6-7. Predicted S-IVB-205 Stage Total Flight Sensor Mass Probe Nonlinearity as Determined by the Volumetric and Flow Integral Methods (Sheet 2 of 2)

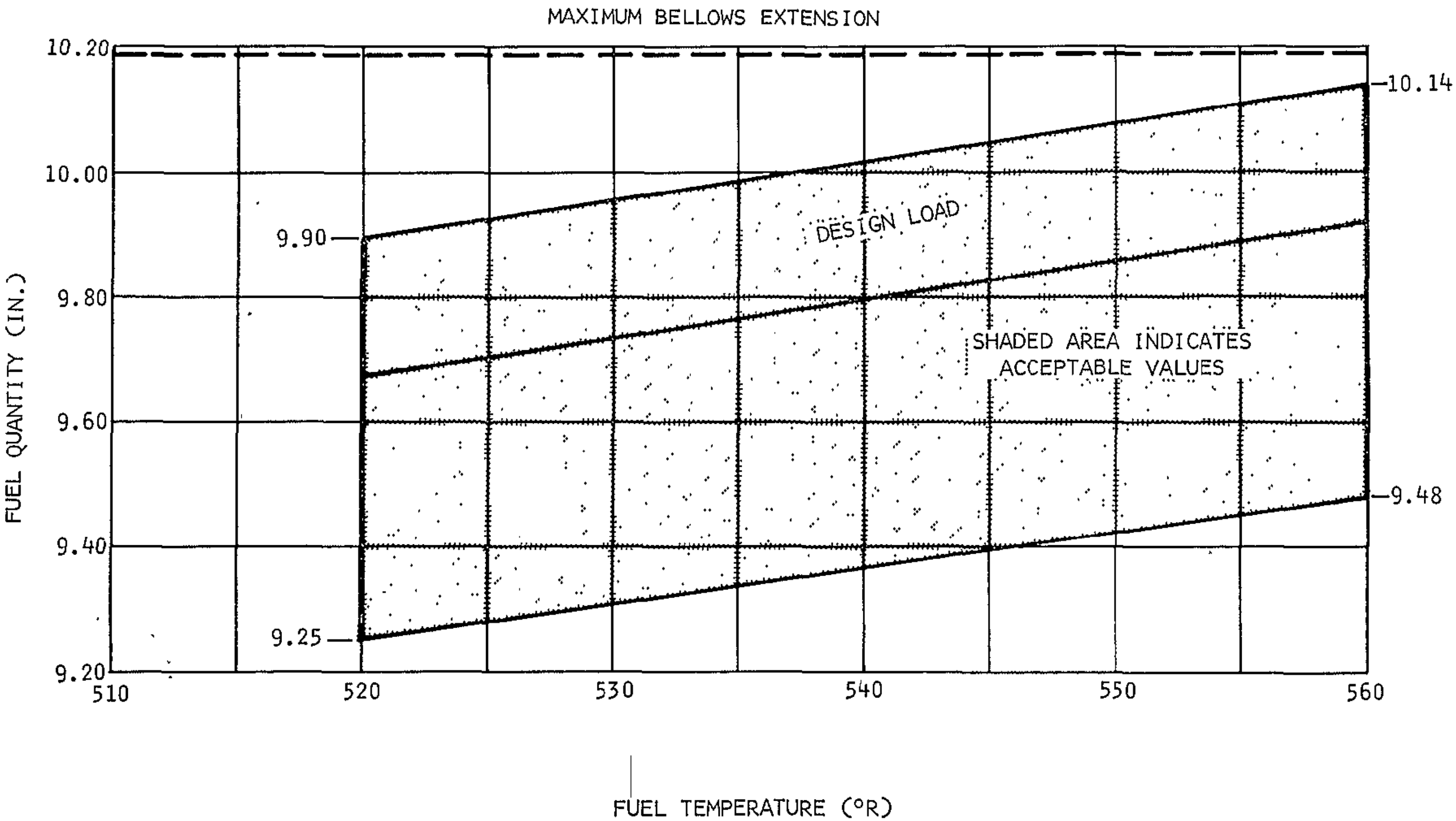

Figure AP 6-9. APS Fuel Loading Requirements

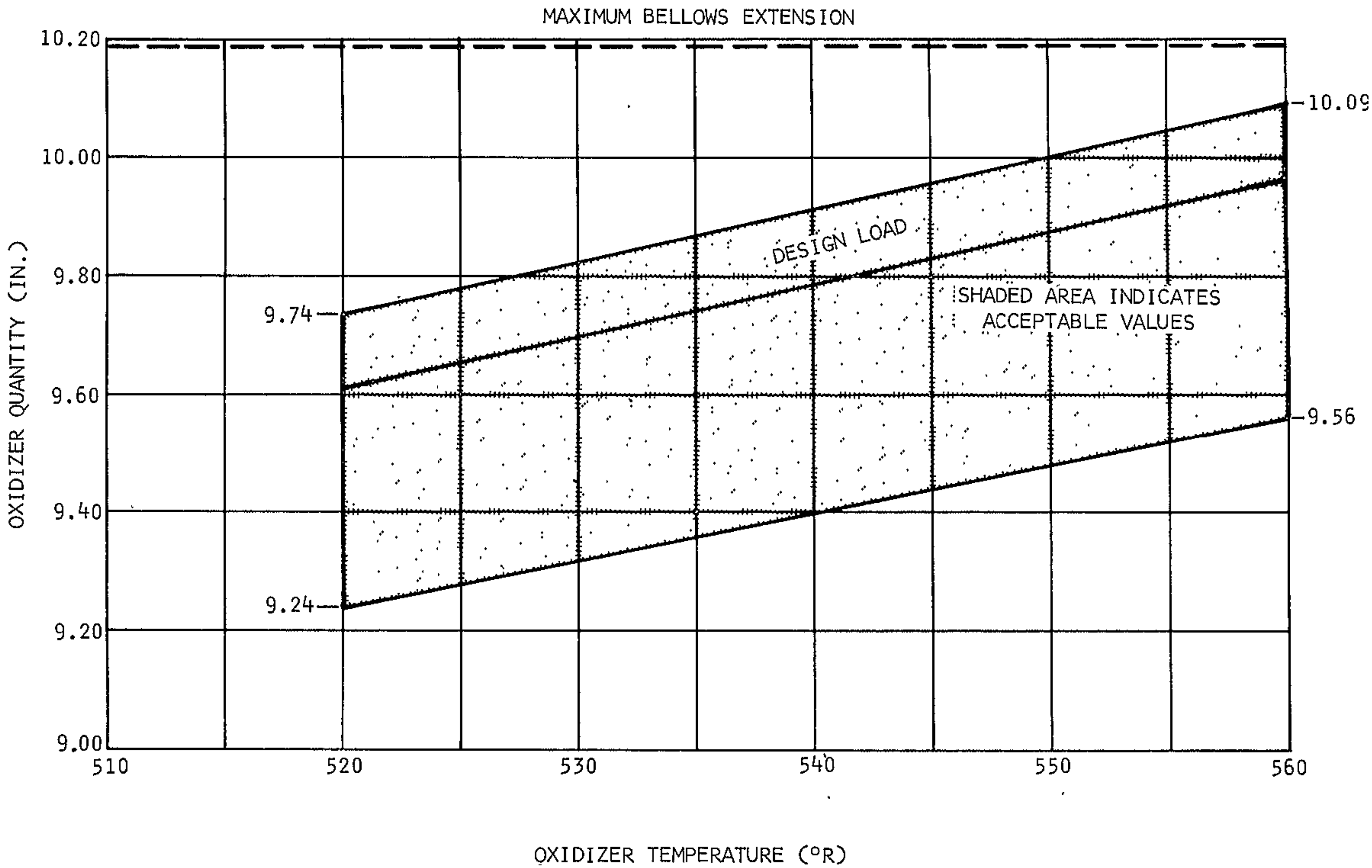

Figure AP 6-8. APS Oxidizer Loading Requirements

APPENDIX 7

PREDICTED SEPARATION AND CONTROL PERFORMANCE

7. PREDICTED SEPARATION AND CONTROL PERFORMANCE

7.1 Predicted Control System Transient Simulation

Body attitude transients of varying magnitude are expected following S-IB/S-IVB separation, guidance initiation and introduction of the Chi Tilde ($\tilde{\chi}$) guidance mode. The results of simulations for nominal control system transients expected during these periods of flight are included in this section. Flight control parameters presented include pitch and yaw attitude errors (figures AP 7-1 and AP 7-2), vehicle angular rates (figure AP 7-3) and engine deflections (figure AP 7-4).

LOX and LH2 predicted sloshing frequencies during powered flight are shown in figure AP 7-5.

7.2 Predicted Stage Separation

The predicted stage separation history is given in figure AP 7-6 and the probability of lateral displacement exceeding a specified valve is given in figure AP 7-7.

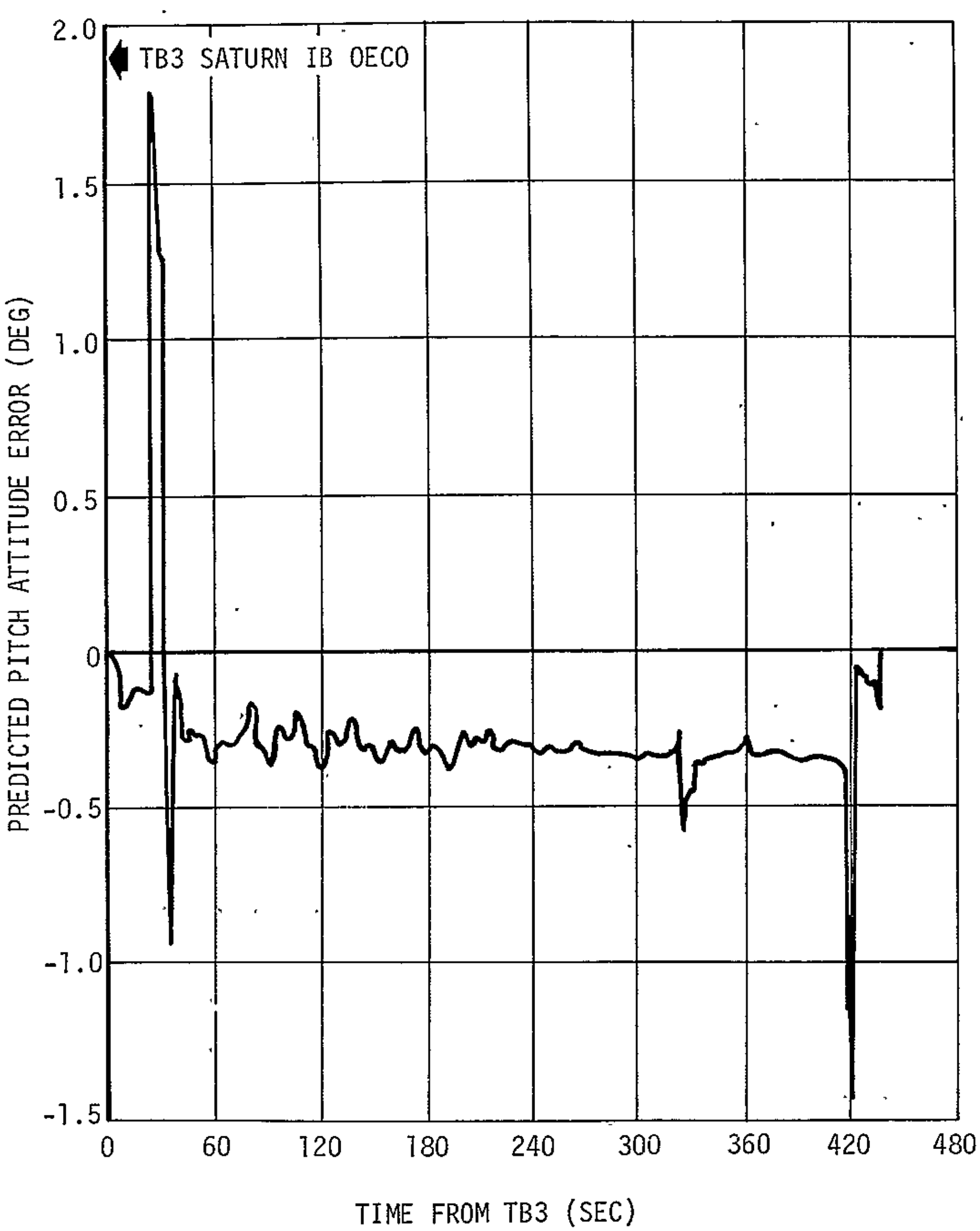

Figure AP 7-1. Predicted Pitch Attitude Error During Powered Flight

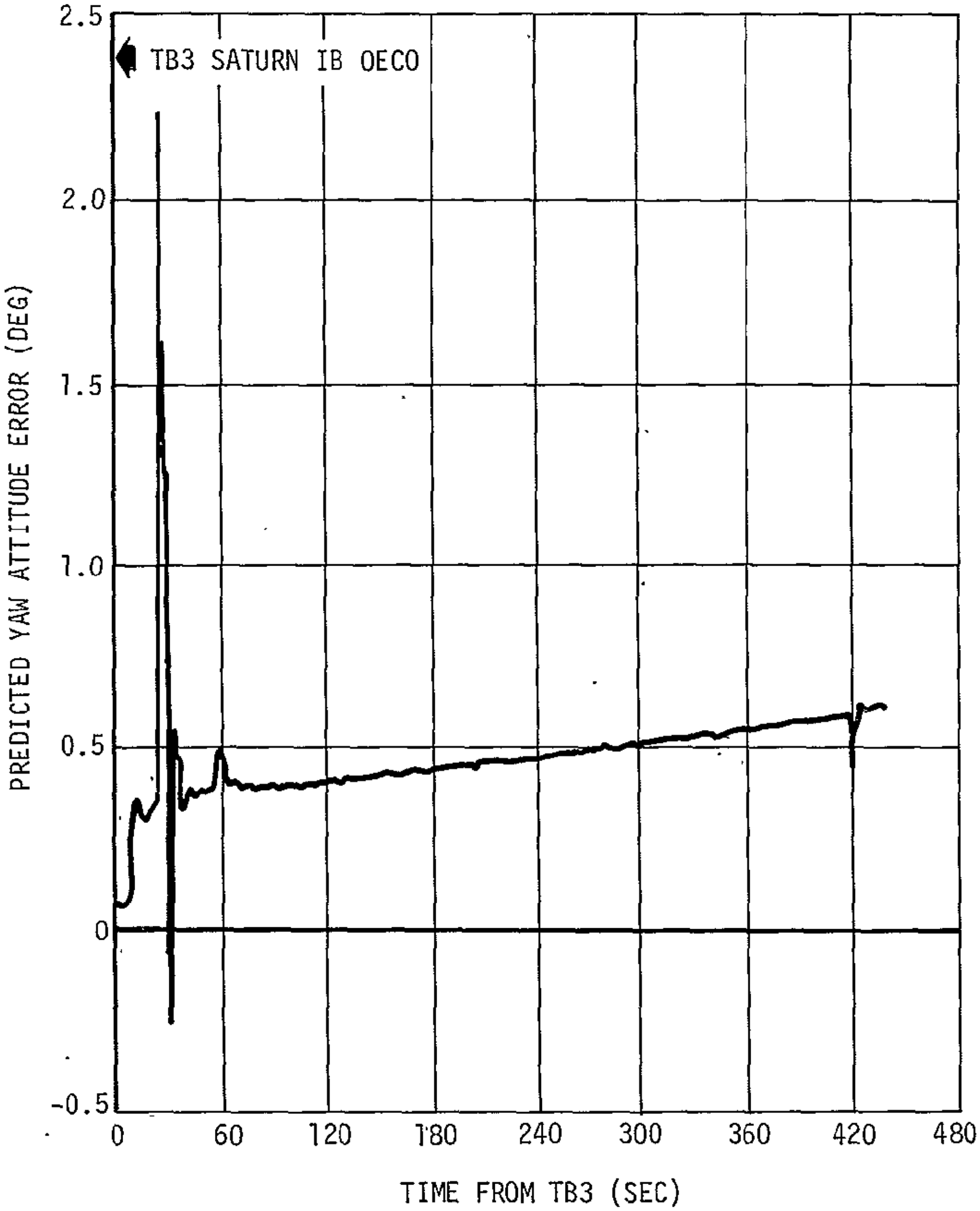

Figure AP 7-2. Predicted Yaw Attitude Error During Powered Flight

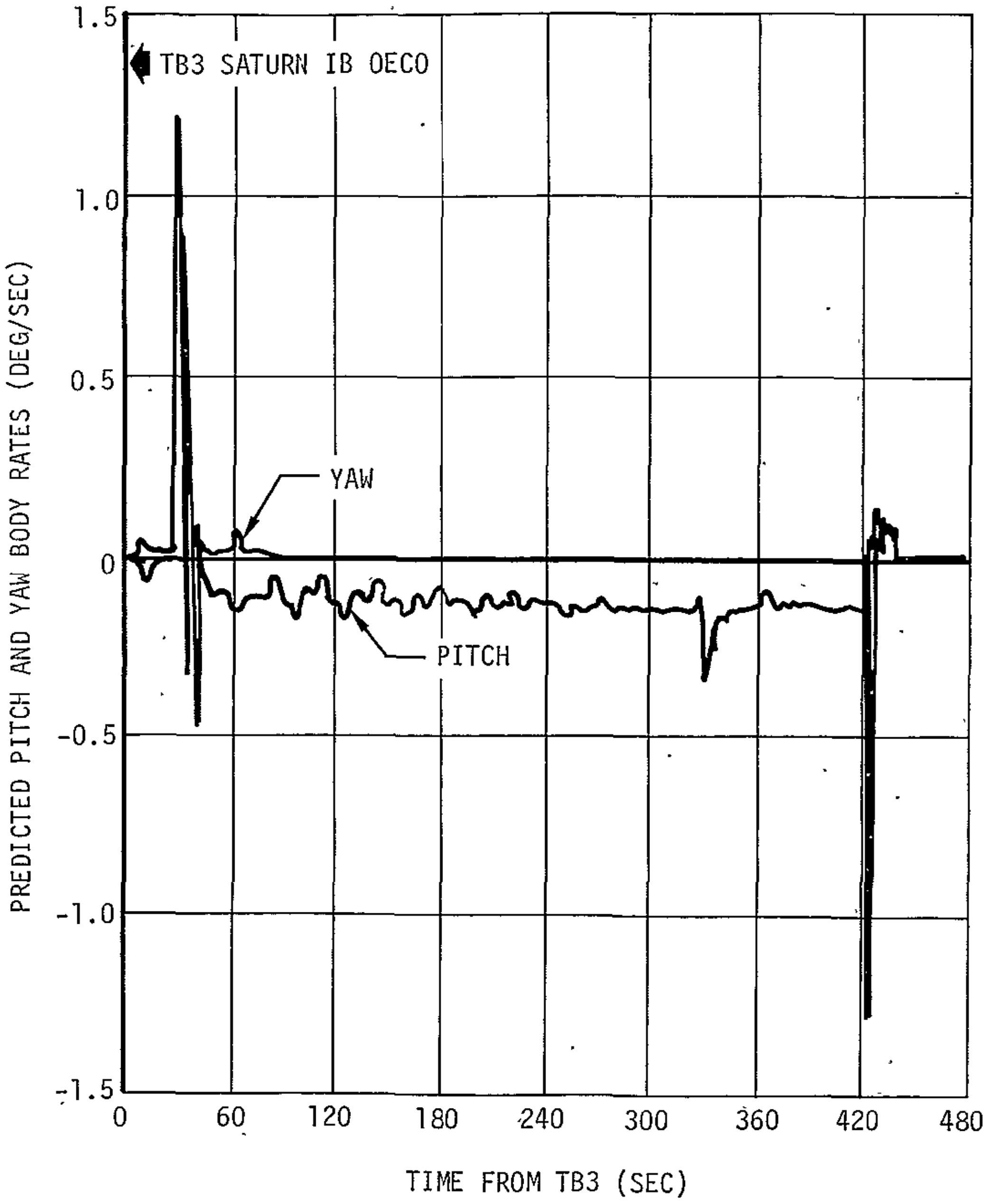

Figure AP 7-3. Predicted Pitch and Yaw Body Rates During Powered Flight

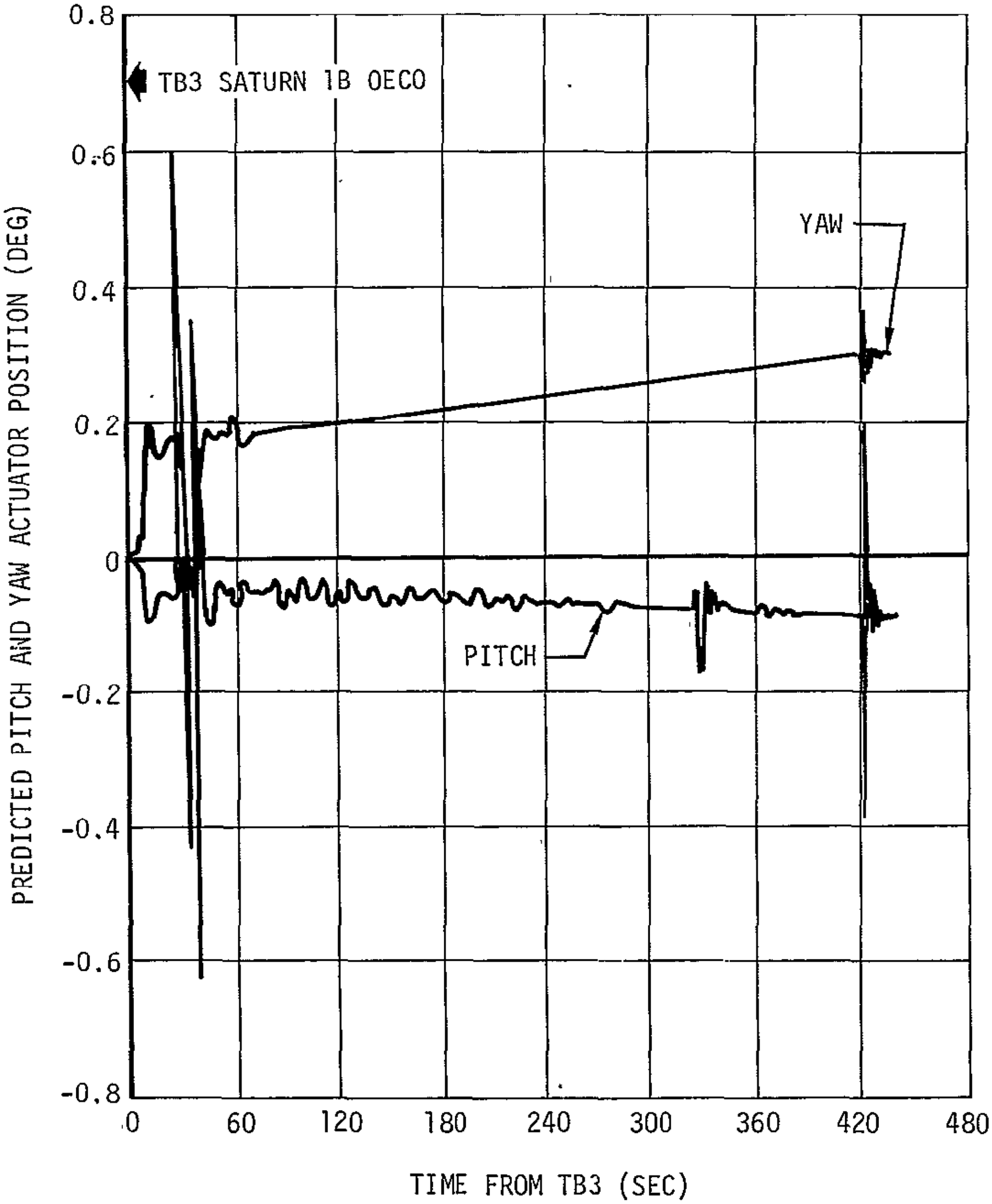

Figure AP 7-4. Predicted Pitch and Yaw Actuator Positions During Powered Flight

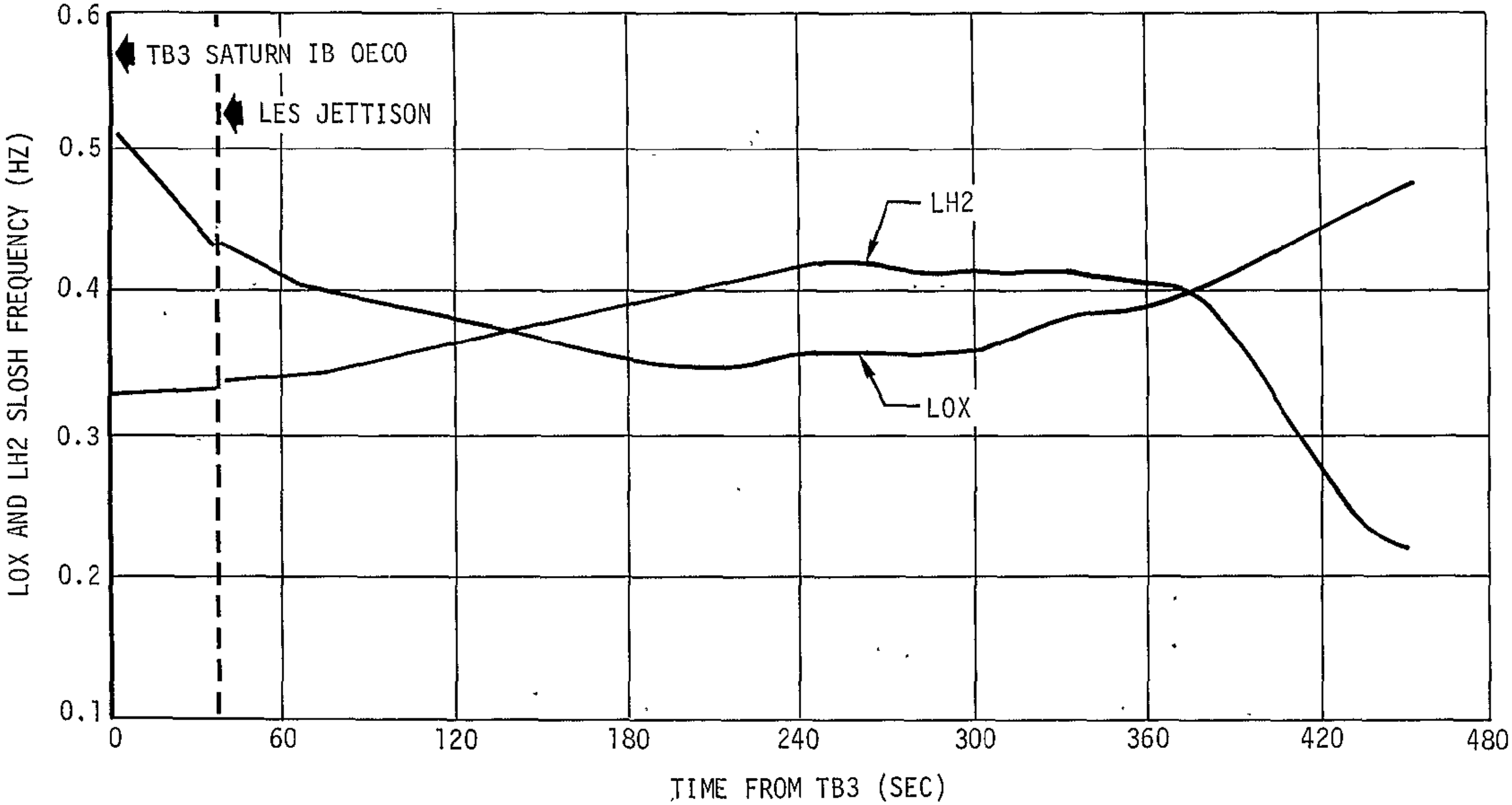

Figure AP 7-5. LH2 and LOX First Mode Sloshing Frequency During Powered Flight

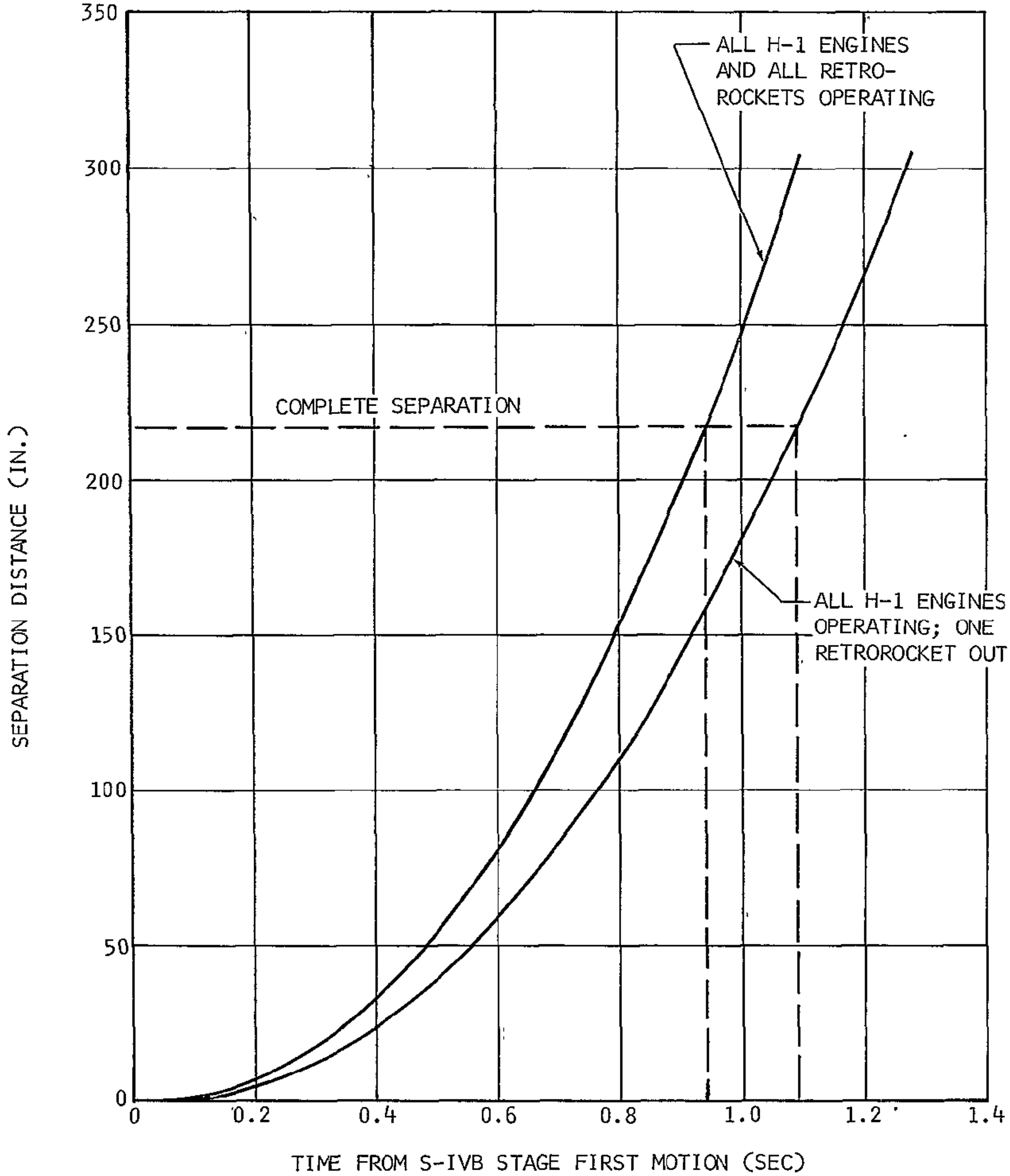

Figure AP 7-6. AS-205 S-IB/S-IVB Predicted Separation History

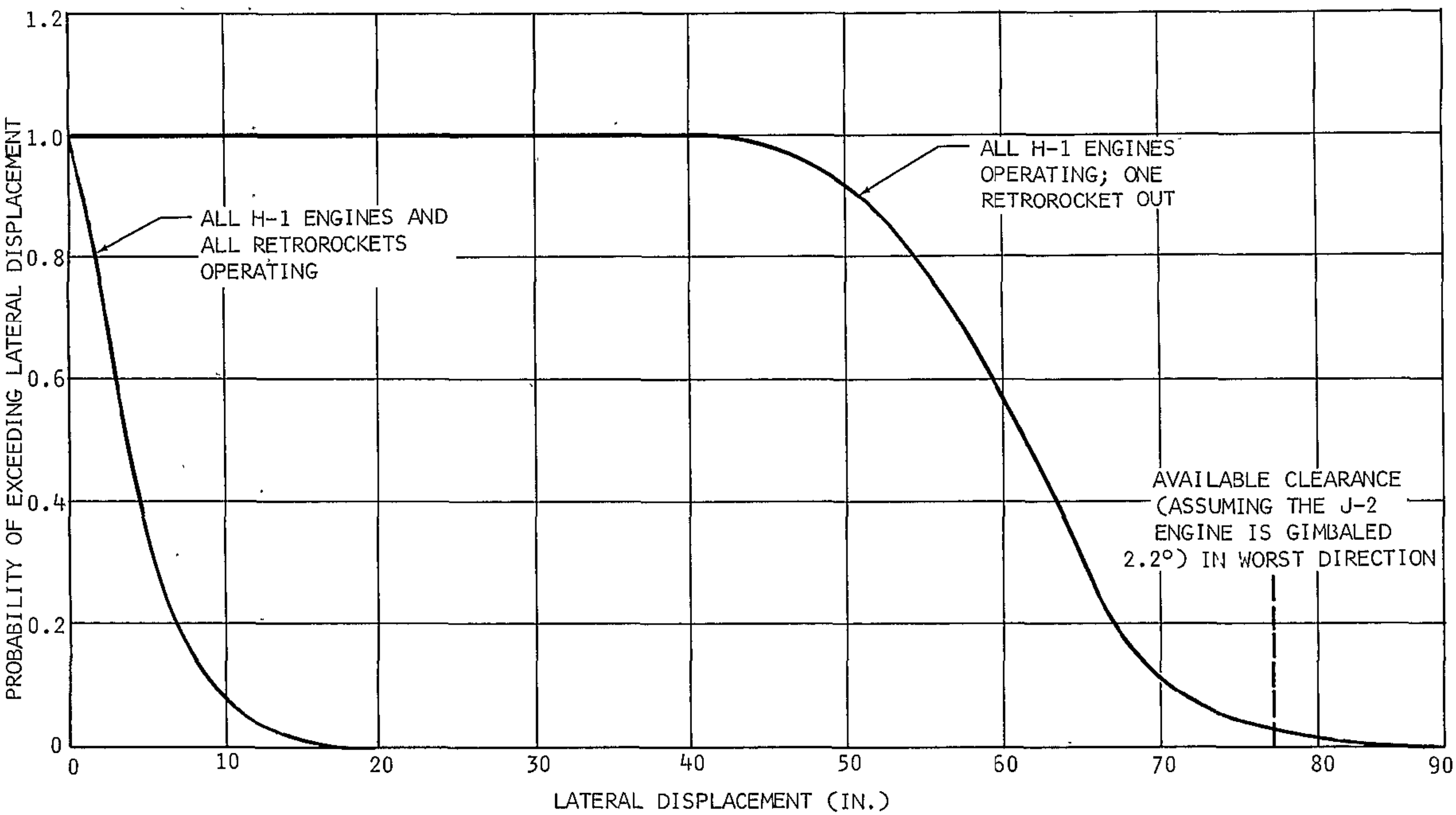

Figure AP 7-7. AS-205 S-IB/S-IVB Separation Probability of Lateral Displacement Exceeding a Specified Value

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-205 hydraulic system operating levels, which are based upon acceptance firing data.

Figures AP 8-2 and AP 8-3 are the predicted profiles of battery currents, voltages and temperatures. These predictions are based on data from vehicles 501, 502 and 204 and the 205 mission timeline. Figures AP 8-4 through AP 8-6 are predicted profiles of PU parameters (voltage, frequency and temperature) based on the 205 mission timeline and data from vehicles 501, 502 and 204.

The predicted envelopes of composite vibration levels for the S-IVB-205 engine are given in figure AP 8-7.

The data acquisition system performance levels include the following:

a. Radio Frequency (RF)

(1) The signal strengths received at the ground station are greater than threshold whenever the stage is at a positive elevation relative to the ground station horizon.

(2) The output of all RF amplifiers shall be 15 watts minimum under all operative and environmental conditions.

(3) The voltage standing wave ratio (VSWR) as computed from forward and reflected power shall not exceed 1.7:1.

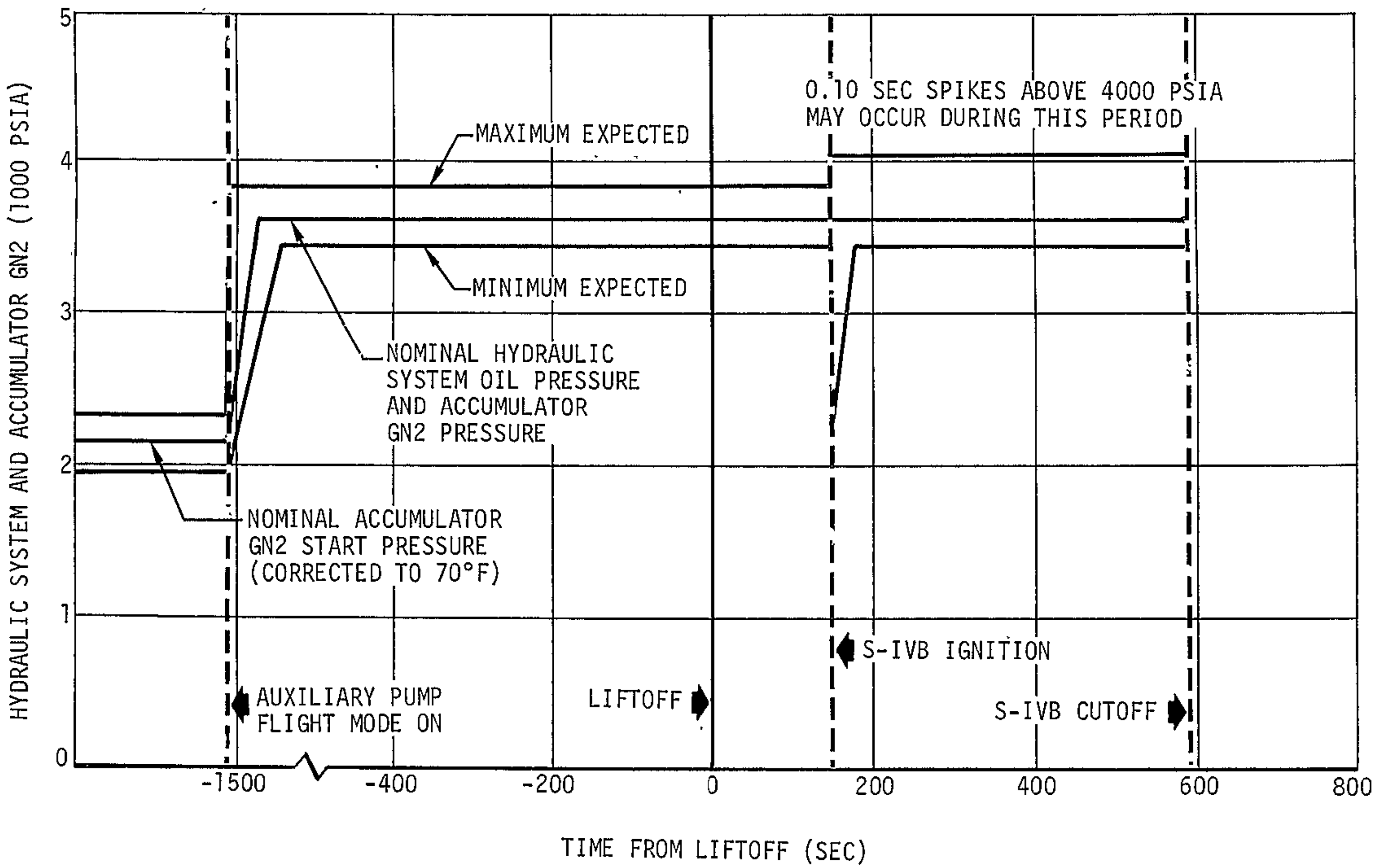

Figure AP 8-1. Predicted S-IVB-205 Hydraulic Operating Limits

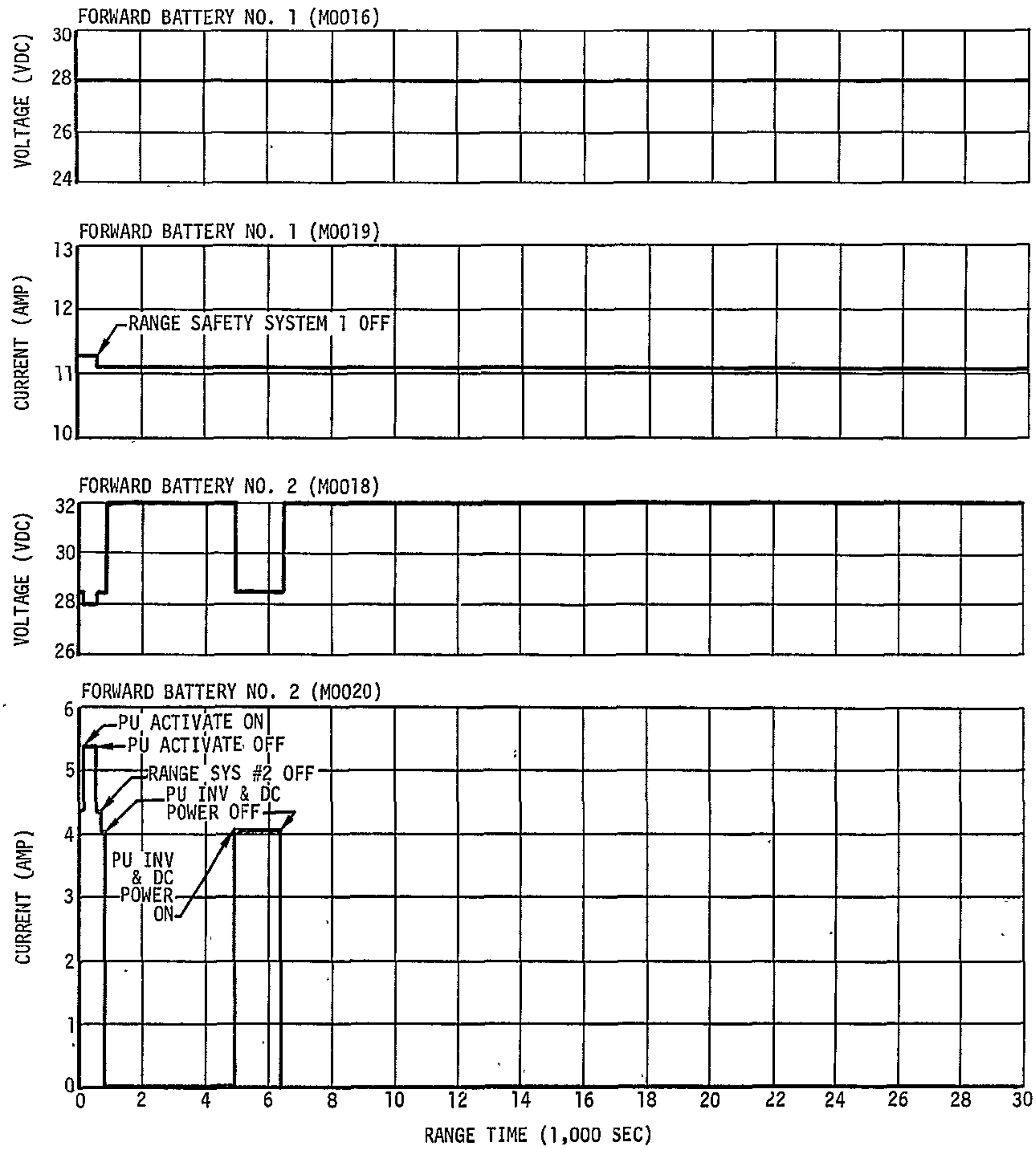

Figure AP 8-2. Predicted Battery Load Profiles (Sheet 1 of 2)

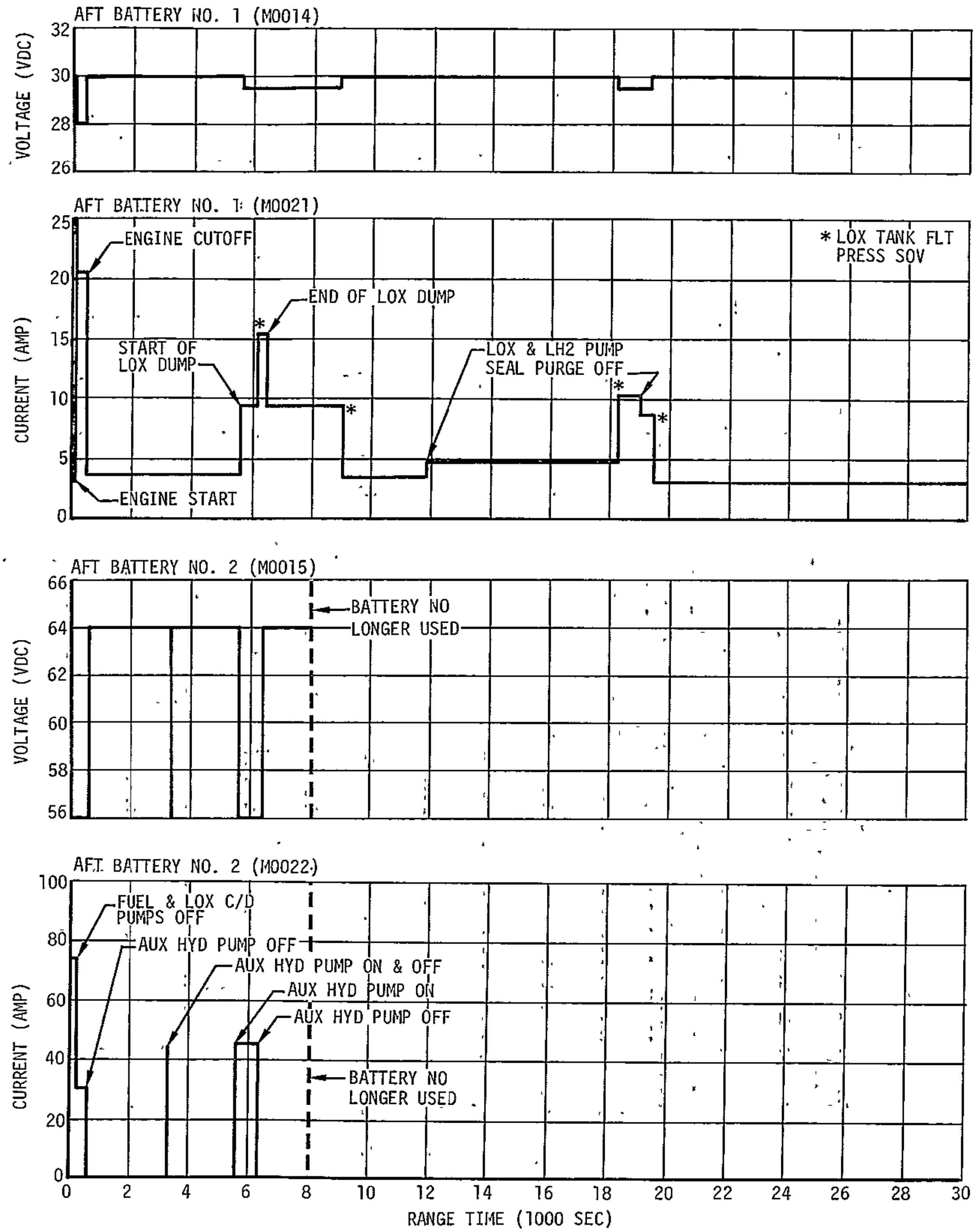

Figure AP 8-2. Predicted Battery Load Profiles (Sheet 2 of 2)

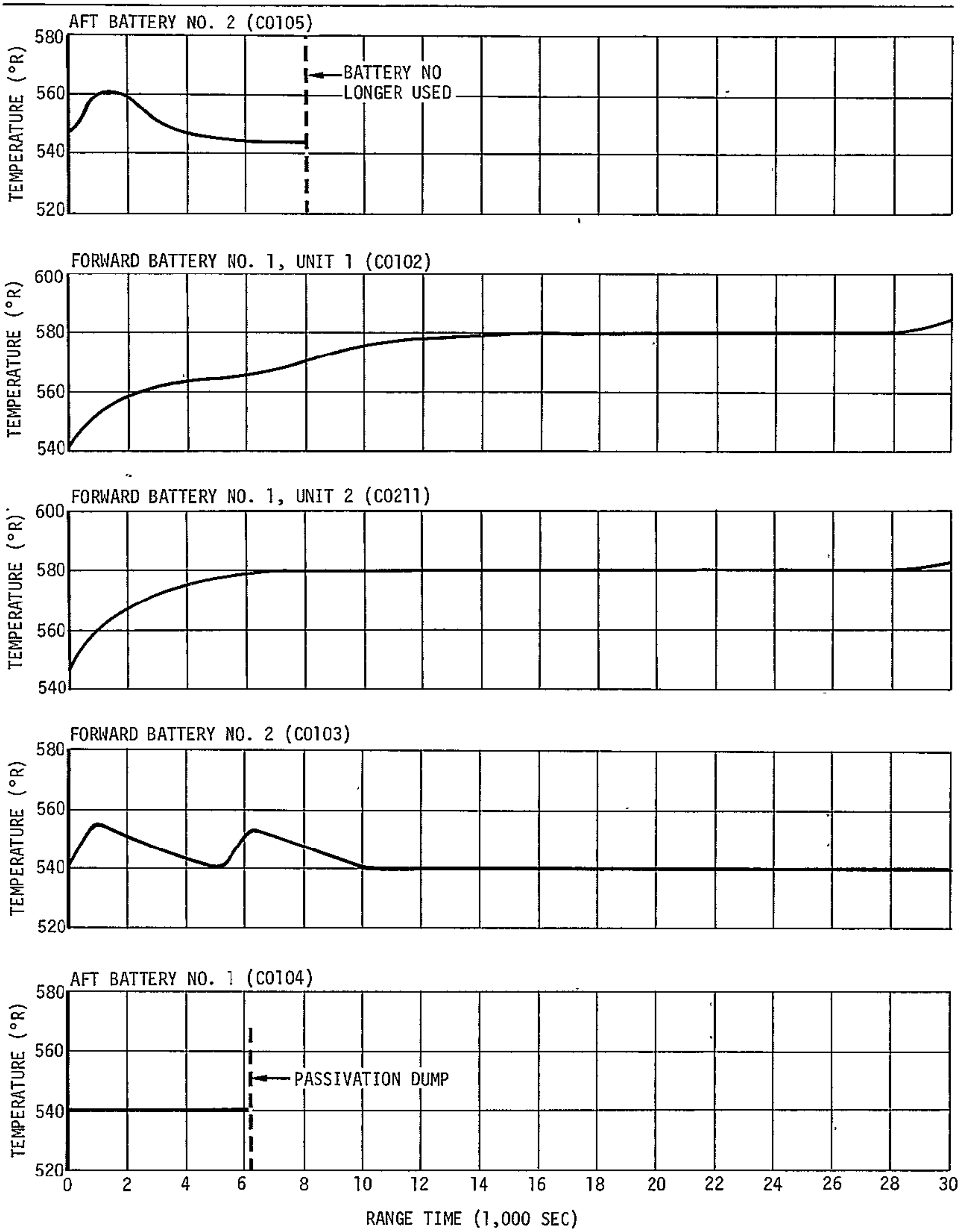

Figure AP 8-3. Predicted Battery Temperatures

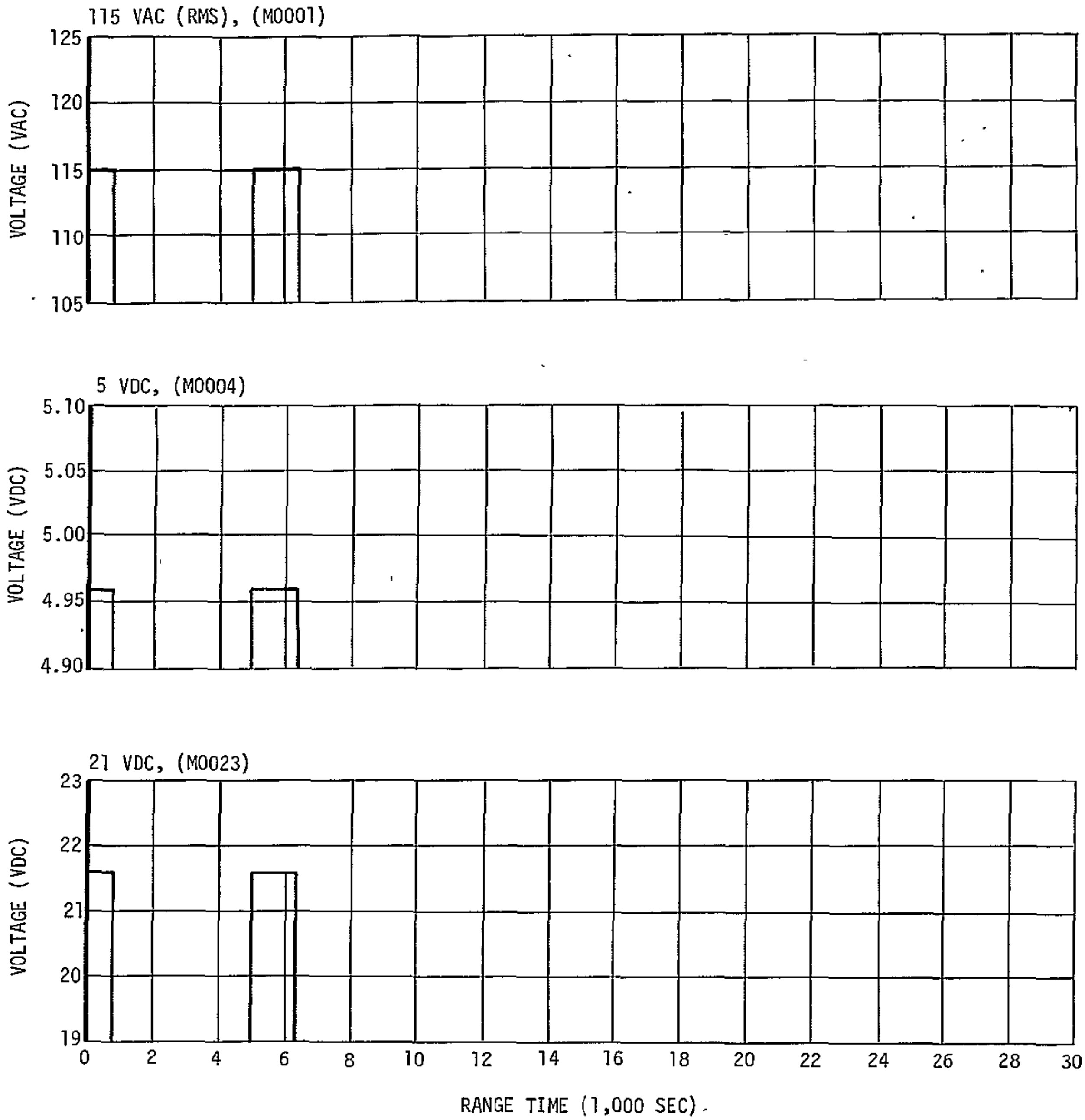

Figure AP 8-4. Predicted PU Inverter Voltages

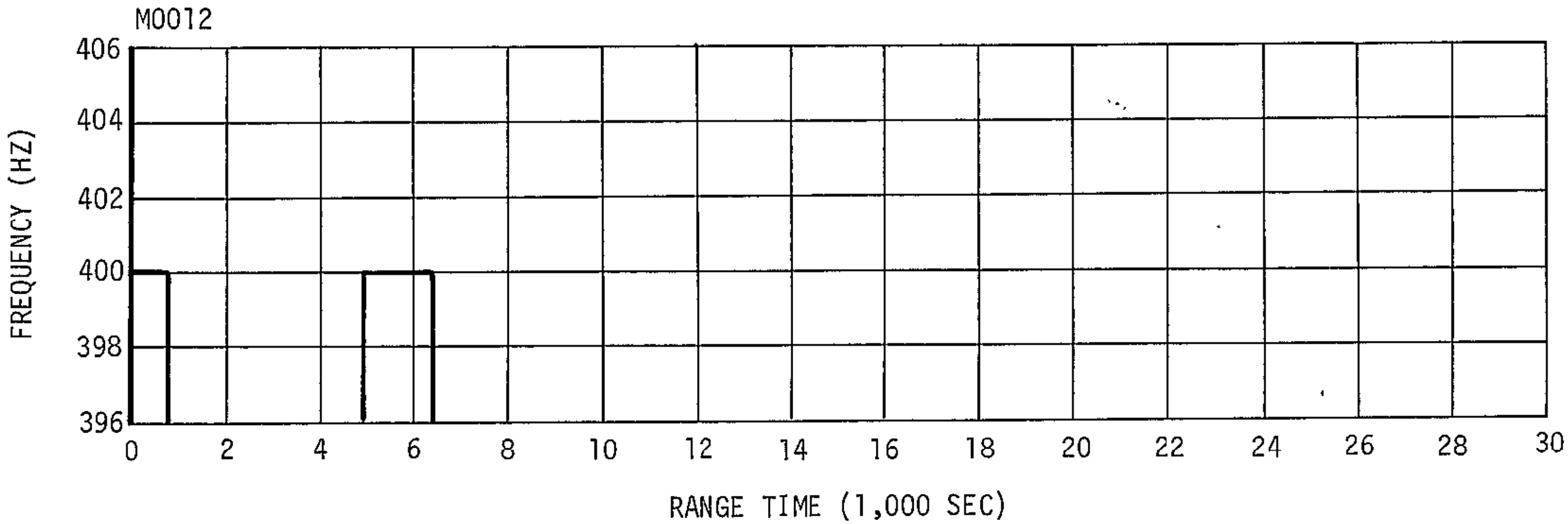

Figure AP 8-5. Predicted PU Inverter Frequency

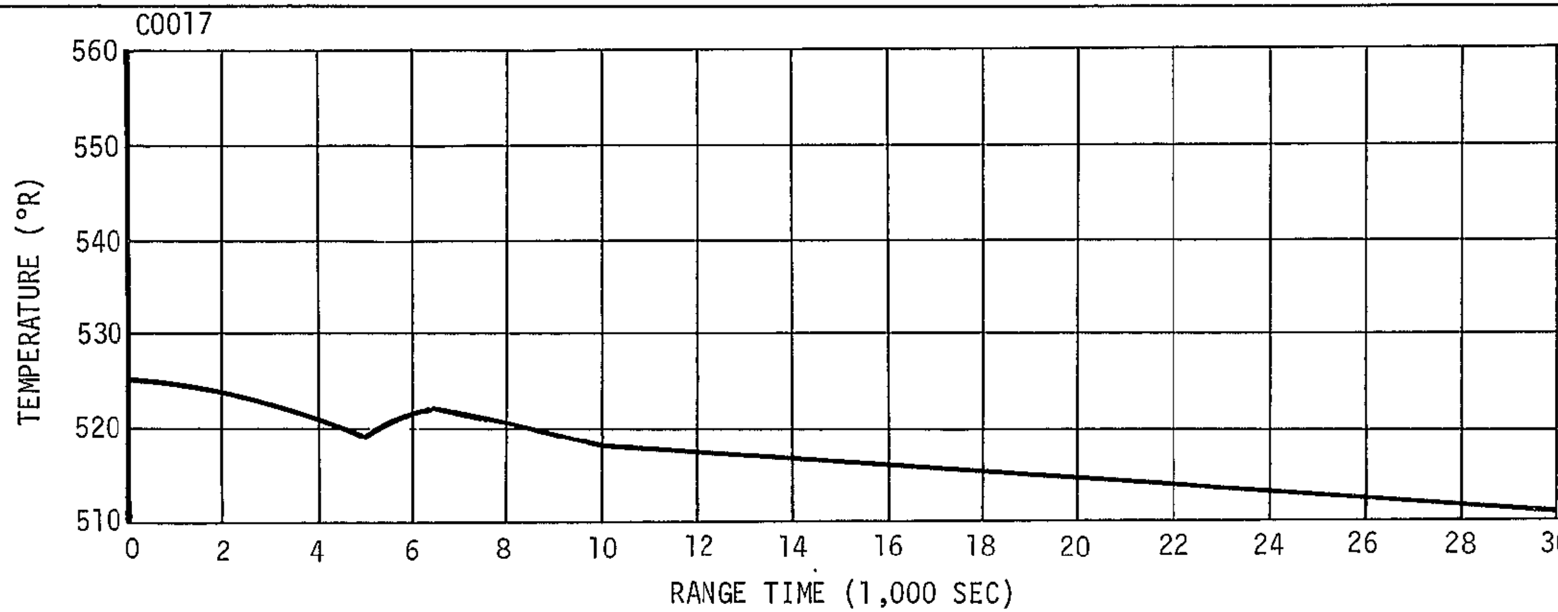

Figure AP 8-6. Predicted PU Assembly Internal Temperature

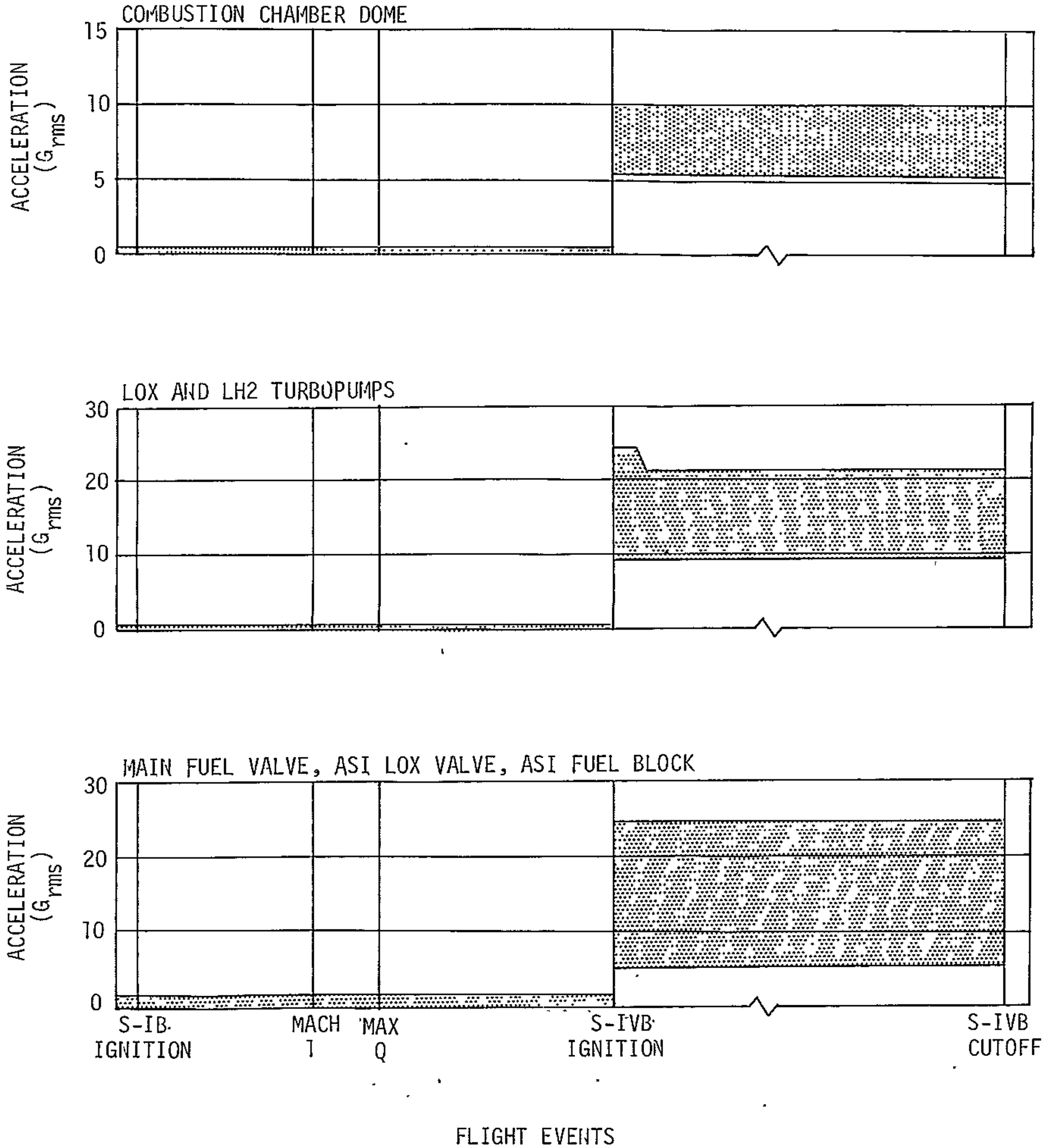

Figure AP 8-7. Predicted Envelopes of Composite Vibration Levels for S-IVB-205 Engine During Flight

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
PCM/FM	258.5 MHz
Secure Range Safety	450.0 MHz

APPENDIX 10

GLOSSARY AND ABBREVIATIONS

TABLE AP 10-1 (Sheet 1 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
AA89	--	Designation of MDAC-WD propulsion system performance computer program
AACS	--	Auxiliary attitude control system
AB77	--	Designation of MDAC-WD S-IB trajectory simulation computer program
AB79	--	Designation of MDAC-WD Saturn S-IVB radar look angle computer program
ac	--	Alternating current
AC77	--	Designation of MDAC-WD 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
ARIA	--	Apollo Range Instrumentation Ship
AS	--	Apollo Saturn
ASC	--	Air Force Eastern Test Range on Ascension Island
--	Average Misture 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

TABLE AP 10-1 (Sheet 2 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
°C	--	Degree Centigrade
cont	--	Control
cps	--	Cycles per second
CPIF	--	Cost plus incentive fee
CRO	--	Carnarvon, Australia
CYI	--	Grand Canary Island
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	--	Emergency detection system
--	Effective burntime	The engine burntime from 90 percent thrust buildup to Engine Cutoff Command
EMR	Engine Propellant misture ratio	The ratio of engine LOX mass flowrate to LH2 mass flowrate. Includes gas generator operations
eng	--	Engine
--	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 MDAC-WD predicted guidance cutoff time. The MDAC-WD predicted guidance cutoff time is undetermined at this date due to lack of trajectory information.

TABLE AP 10-1 (Sheet 3 of 9)
GLOSSARY AND ABBREVIATIONS

ABBRAVIATION	TERM	DEFINITION
--	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
--	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
GBI	--	Grand Bahama Island
GCC	--	Guidance Cutoff Command
GG	--	Gas generator
GH2	--	Gaseous hydrogen
GHe	--	Gaseous helium
GN2	--	Gaseous nitrogen
GOX	--	Gaseous oxygen

TABLE AP 10-1 (Sheet 4 of 9)
GLOSSARY AND ABBREVIATIONS

ABBRAVIATION	TERM	DEFINITION
gpm	--	Gallons per minute
GRR	--	Guidance reference release
GSE	--	Ground support equipment
GSFC	--	Goddard Space Flight Center, Greenbelt, Maryland
GYM	--	Guaymas
GWM	--	Guam
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	That portion of the launch vehicle between the S-IB stage and the LM adapter. This section contains the launch vehicle digital computer
kc	--	Kilocycles
km	--	Kilometer
KSC	--	Kennedy Space Center
lbf	--	Pounds force
lbm	Pounds mass	1/32.1739 slug
L/C	--	Loading computer
LH2	--	Liquid hydrogen
LM	--	Lunar Module

TABLE AP 10-1 (Sheet 5 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
LOX	--	Liquid oxygen
LV	--	Launch vehicle
LVDC	--	Launch Vehicle Digital Computer
m	--	Mach number
Mc	--	Megacycles
MCC-H	--	Mission Control Center-Houston
MDAC-WD	--	McDonnell Douglas Astronautics Company-Western Division
MDAC-WD/FTC	--	McDonnell Douglas Astronautics Company-Western Division/ Florida Test Center
MDAC-WD/HB	--	McDonnell Douglas Astronautics Company-Western Division/ Huntington Beach
MDAC-WD/MSFC	--	McDonnell Douglas Astronautics Company-Western Division/Marshall Space Flight Center
MDAC-WD/STC	--	McDonnell Douglas Astronautics Company-Western Division/ Sacramento Test Center
MER	--	Mercury (Ship)
Mod	--	Module
min	--	Minute
M/S	--	Mainstage
MSC	--	Manned Spacecraft Center, Houston, Texas
MSF	--	Manned space flight
MSFC	--	Marshall Space Flight Center
MSFC/MDAC-WD	--	Marshall Space Flight Center/ McDonnell Douglas Astronautics Company - Western Division
MSS	--	Mobile service structure
N/A	--	Not applicable
NASA	--	National Aeronautics and Space Administration
NC	--	Normally closed

TABLE AP 10-1 (Sheet 6 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
--	Ninety percent thrust buildup	Time from Engine Start Command until the last engine chamber pressure (injector end) reaches 618 psia
nmi	--	Nautical mile
NO	--	Normally open
No.	--	Number
NPSP	--	Net positive suction pressure
OECO	--	S-IB or S-IC stage Outboard Engine Cutoff Command
OVRD	--	Override
PAM	--	Pulse amplitude modulation
--	Payload	All portions of the vehicle above the S-IVB/IU
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

TABLE AP 10-1 (Sheet 7 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
--	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
RED	--	Redstone
RF	--	Radio frequency
rms	--	Root mean square
RMR	--	Reference misture 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	The switch activated by the LVDC which initiated an event
STC	--	Sacramento Test Center
t	--	Time

GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
	--	Countdown time from prospective lift-off or as specifically defined in the test
TB1	--	Time base No. 1: Initiated at liftoff by umbilical disconnect
TB2	--	Time base No. 2: Initiated by S-IB low level sensor dry signal
TB3	--	Time base No. 3: Initiated by the S-IB outboard engines cutoff
TB4	--	Time base No. 4: Initiated at S-IVB engine cutoff
TAN	--	Tananarive, Malagasy
TBD	--	To be determined
TEX	--	Corpus Christi, Texas
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

TABLE AP 10-1 (Sheet 9 of 9)
GLOSSARY AND ABBREVIATIONS

ABBREVIATION	TERM	DEFINITION
--	Unusable propellants	Those propellant 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
V_I	--	Inerital velocity
VAB	--	Vehicle Assembly Building, KSC, Florida
VAN	--	Vanguard
vco	--	Voltage controlled oscillator
vac	--	Voltage, alternating current
VCL	--	Vertical checkout laboratory
vdc	--	Voltage, direct current
VSWR	--	Voltage standing wave ratio
WHS	--	White Sands

APPENDIX 11

REFERENCES

11. REFERENCES

The following listed documents are referenced in the text:

(1) Flight Mission Directive for Apollo Saturn IB Missions Revision 1, (prepared by Saturn I/IB Program Office), Marshall Space Flight Center, Huntsville, Alabama, dated 15 August 1968.

(2) Apollo Flight Mission Assignments (U), (prepared by Office of Manned Space Flight, Apollo Program), M-D MA500-11, SE 010-000-1, Washington, D. C., dated June, 1968.

(3) Apollo-Saturn IB Program Support Requirements, (prepared by Office of Manned Space Flight, Apollo Program), Revision No. 33, Washington, D. C., dated 9 February 1968.

(4) S-IVB-205 Stage End Item Test Plan, IB62934D, Huntington Beach, California, dated 6 October 1967.

(5) Apollo Saturn IB Launch Mission Rules (Preliminary) (SA-205 CSM-101) K-1B-02.10/5 (prepared by NASA/KSC) dated 14 June 1968.

(6) Saturn S-IVB-205 Instrumentation Program and Components List, 1B43558AE, Huntington Beach, California, dated 20 August 1968.

(7) Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights, SM-46538C (prepared by Saturn Data Engineering Section) Huntington Beach, California, dated June, 1968.

(8) S-IVB-205 Stage Flight Test Plan, Douglas Report SM-46978, dated September, 1968.

(9) S-IVB-205 Stage Technical Performance Criteria Document, Douglas Report DAC-56671, dated June, 1968.

(10) FTC Preliminary Flight Evaluation Report, (prepared by MDAC-WD, Florida Test Center, TP&E Committee), report number and date to be determined.

(11) S-IVB-205 Stage Flight Evaluation Report, Douglas Report SM-46990 (publication date to be determined).

(12) Definition of Saturn SA-205 Flight Sequence Program Interface Control Document No. 40M33605B, (prepared by Airborne Electrical Systems Branch, Astrionics Laboratory), Marshall Space Flight Center, Huntsville, Alabama, dated 4 April 1966 (Revision B, dated 2 August 1968).

(13) Interface Revision Notices against Reference (1), IRN 27, 19 August 1968.

(14) Tracking and Communications for the AS-205/CSM 101 Operational Trajectory, Marshall Space Flight Center Memorandum No. R-AEKO-FT-20-68, dated 28 May 1968.

(15) S-IVB/CSM Orbital Attitude Timeline and Vent Schedule for the AS-205 Revision D, Marshall Space Flight Center Document No. 80M92051, dated 8 July 1968.

(16) 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.

(17) SA-205/CSM-101 Launch Vehicle Ground Support Plan, No. 1-MO-8-68, prepared by NASA Mission Operations), Marshall Space Flight Center, Huntsville, Alabama, dated April, 1968.

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