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Ascent – Cycle 3

Mission Planning and Analysis Division

May 1980

National Aeronautics and
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Lyndon B. Johnson Space Center
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SHUTTLE PROGRAM

STS-1
OPERATIONAL FLIGHT PROFILE
ASCENT VOLUME III - CYCLE 3

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FOREWORD

This document, Volume III, contains the ascent profile for the Space Transportation System-1 (STS-1) cycle 3 operational flight profile (OFP). This volume is based on the approved guidelines and constraints documented in volume I of the OFP. Hardware development, software verification, and crew training should be consistent with the data presented in this volume of the OFP.

Volumes I (Groundrules and Constraints) and II (Profile Summary) of the STS-1 OFP are approved and controlled by the office of the Space Shuttle Program Manager (Level II). Volume I was baselined using the standard Level II change process. Volume II will be baselined as outlined in JSC-07700, Volume IV, Appendix L (S04869).

OFT DOCUMENT PUBLICATION SCHEDULE

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Volume I - Groundrules and Constraints, Rev. 2	September 1979 (A)
Volume II - Profile Summary, Rev. 1	April 1980 (A)
Volume III - Ascent Profile, Rev. 1	May 1980 (P)
Volume IV - Onorbit, Rev. 1	November 1979 (A)
Volume V - Descent, Rev. 1	May 1980 (P)
Volume VI - Abort Analysis, Rev. 1	May 1980 (P)
Volume VII - OMS and RCS Analysis, Rev. 1	February 1980 (A)
Volume VIII - Nonpropulsive Consumables Analysis, Rev. 1	February 1980 (A)

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ACRONYMS AND SYMBOLS

ACIP	aerodynamic coefficients identification package
ACN	Ascension (S-band)
ADI	attitude director indicator
AFB	Air Force Base
AGO	Santiago (S-band)
α (alpha)	angle of attack
ANT	Antigua (C-band)
AOA	abort once around
AOS	acquisition of signal
APU	auxiliary power unit
ASC	Ascension (C-band)
ASCENT DAP	ascent digital autopilot principal function
AS MNVR DIP	ascent maneuver display processing principal function
ATO	abort to orbit
ATT PROC	attitude processor principal function
β (beta)	sideslip angle
BDA	Bermuda (S-band)
BDQ	Bermuda (C-band)
BRCS	boost reference coordinate system
BSM	booster separation motor
BUC	Buckhorn (S-band) - entry only
c.g.	center of gravity
CRT	cathode-ray tube
ΔV	incremental velocity
DFI	development flight instrumentation

DOF	degrees-of-freedom
EAFB	Edwards Air Force Base
ET	external tank
ETC	Greenbelt (S-band)
ETR	Eastern Test Range
FCS	flight control system
FPL	full power level
FPR	flight performance reserve
FRC	Flight Research Center, California (C-band) - entry only
g	acceleration due to gravity
γ (gamma)	inertial flightpath angle
γ_e	Earth-relative flightpath angle
GBI	Grand Bahama (C-band)
GC_STEER	guidance/control steering interface principal function
GDS	Goldstone (S-band)
GET	ground elapsed time
GMT	Greenwich mean time
GNC, GN&C	guidance, navigation, and flight control
GPC	general purpose computer
GRTLS	glide return to launch site
GSTDN	Ground Spaceflight Tracking and Data Network
GTI	Grand Turk (C-band)
GWM	Guam (S-band)
h	altitude
HA	apogee altitude
HAW	Hawaii (S-band)

HP	perigee altitude
HTGT	target apsis altitude
HSI	horizontal situation indicator
i	inclination
IECM	induced environment contamination monitor
ILFA	in-plane launch firing azimuth
I-load	onboard computer system's initial loaded values
IMU	inertial measurement unit
INRTL	ADI inertial coordinate system
IOS	Indian Ocean (S-band) - Air Force evaluation site
Isp	specific impulse
I$\overline{Y}$D	unit vector normal to desired orbit plane
J_2	second gravitational harmonic
KMAX	maximum allowed SSME throttle setting
KMR	Kwajalein Island (C-band)
KPT	Hawaii (C-band)
KSC	Kennedy Space Center
λ (lambda)	longitude
L/D	lift/drag ratio
LHS	local horizontal coordinate system
LH_2	liquid hydrogen
LOS	loss of signal
LOX	liquid oxygen
LVLH	ADI local vertical, local horizontal coordinate system
MAD	Madrid (S-band)
MDTSCO	McDonnell Douglas Technical Services Company

MECO	main engine cutoff
MIL	Merritt Island (S-band)
MLA	Merritt Island (C-band)
MNVR EXEC	maneuver execute
MPL	minimum power level
MPS	main propulsion system
MSBLS	microwave scanning beam landing system
OEX	Orbiter experiments
OFT	orbital flight test
OFP	operational flight profile
Ω (omega)	ascending node
OMS	orbital maneuvering system
OMS-1	first OMS maneuver (burn)
OMS-2	second OMS maneuver (burn)
OPS	operational sequence
ORR	Orroral (S-band)
P_c	chamber pressure
PAT	Patrick AFB (C-band)
PDL	New Smyrna Beach (S-band) - ascent only
PEACE	parameterized exoatmospheric/atmospheric control evaluation
PEG	powered explicit guidance
ϕ_D (phi)	geodetic latitude
PIC	pyrotechnic initiation controller
PLBD	payload bay doors
PMBT	propellant mean bulk temperature
PRO	crew-initiated transition

PTM	press to MECO
PTP	Point Pillar (C-band) - entry only
q, Q	dynamic pressure
qα	product of dynamic pressure (q) and angle of attack (α)
qβ	product of dynamic pressure (q) and sideslip angle (β)
QUI	Quito (S-band)
RCS	reaction control system
REF	ADI reference coordinate system
RELQUAT	ADI quaternions
RPL	rated power level
RSS	root-sum-square
RTLS	return to launch site
σ (sigma)	standard deviation
SAR	single-axis rotation
SILTS	Shuttle infrared leeside temperature sensing
SOP	subsystem operations program
SRB	solid rocket booster
SSME	Space Shuttle main engine
STDN	spaceflight tracking and data network
STS-1	Space Transportation System - first orbital flight test
SVDS	space vehicle dynamics simulation
T	time from SRB ignition command
TGO	predicted time to go to cutoff
THETA	target range angle relative to the launch site
TIG	time of ignition
TRANS DAP	transition digital autopilot principal function

T_RTLS_ATO	RTLS/ATO mode boundary time
TVC	thrust vector control
T/W	thrust-to-weight ratio
U	first axis of UVW
UVW	local horizontal coordinate system (LHS)
v, V	inertial velocity
V	second axis of UVW
V_e	Earth-relative velocity
VAN	Vandenberg AFB (C-band)
W	third axis of UVW
WLP	Wallops Island (C-band)
X	first axis of noted coordinate system
Y	second axis of noted coordinate system
Z	third axis of noted coordinate system
Z-LV	Z-axis local vertical

1.0 INTRODUCTION

The orbital flight test (OFT) phase of the Shuttle program consists of four manned orbital flights beginning in March 1980 and continuing through May 1981. The major purpose of the OFT phase is to demonstrate and verify Shuttle systems and flight capabilities by satisfying the flight test requirements as presented in reference 1.

The primary purpose of the first OFT (Space Transportation System-1 (STS-1)) is to demonstrate a safe ascent and return of the Orbiter and the crew. In particular, the ascent phase is designed to maximize subsystem margins by placing the least demanding conditions on the vehicle structure and systems and to verify the performance of the integrated Shuttle vehicle.

This document presents the cycle 3 ascent operational flight profile (OFP) for STS-1 (vol. III) and supersedes the OFT-1 ascent OFP (ref. 2). The document primarily addresses nominal ascent; however, it also contains abort items pertinent to the ascent design. This document contains the flight description, ascent profile summary, flight design groundrules and constraints, pertinent vehicle subsystem descriptions, environmental models, simulation techniques, ascent trajectory, first-stage load indicators, flight performance reserve requirements, and a dispersion analysis.

2.0 STS-1 FLIGHT DESCRIPTION

The STS-1 will be a 54-hour flight with launch from Kennedy Space Center (KSC) on March 31, 1980, at 11:30 Greenwich mean time (GMT). The flight test will be achieved in a 150-n. mi. circular orbit with a 40.3° inclination. This orbit will be achieved by two orbital maneuvering system (OMS) maneuvers, OMS-1 and OMS-2. The OMS-1 maneuver will occur shortly after external tank (ET) separation with the OMS-2 maneuver occuring at the apogee of the orbit resulting from OMS-1. The payload bay doors will be opened as early as possible on day 1. The Orbiter will be placed in a Z-axis local vertical (Z-LV) attitude (payload bay to Earth) for most of the STS-1 flight. This attitude will be maintained unless other requirements (flight test requirements, inertial measurement unit alinement, etc.) preclude Z-LV attitude. Deorbit will occur on April 2 with landing on a descending pass (orbit 37) to Edwards Air Force Base (EAFB). The ground elapsed time (GET) for the nominal landing will be approximately 54 hours 30 minutes.

3.0 ASCENT PROFILE SUMMARY

The ascent operational flight profile for STS-1 is designed (1) to limit the maximum undispersed dynamic pressure to 580 lb/ft^2, (2) to follow the design load indicator profiles ($q\alpha$ is a specified profile, $q\beta$ is desired to be as close to zero as possible), and (3) to maximize nominal and abort performance. Significant trajectory parameters achieved are presented in table 3.0-I. A maximum dynamic pressure of 575 lb/ft^2 was achieved, a minimum $q\alpha$ of -2187 lb-deg/ft^2 (-2200 was the desired minimum) was achieved and $q\beta$ was limited to approximately $\pm$ 100 lb-deg/ft^2 (an acceptable range) in the high q region of the trajectory. The trajectory performance allows a press to MECO (PTM) capability with one Space Shuttle main engine (SSME) out at 262 seconds GET. The OMS burns achieve a final orbit of 150.9 x 149.8 n. mi. and the desired inclination of 40.3°.

A more detailed description of the flight design groundrules and constraints is presented in section 4.0.

4.0 FLIGHT DESIGN GROUNDRULES AND CONSTRAINTS

The following applicable groundrules and constraints were obtained from reference 3 and were used in the generation of cycle 3 of the OFP for STS-1. Only those groundrules and constraints applicable to the ascent profile are reproduced. Paragraph numbers remain consistent with the reference.

4.1 GENERAL

4.1.1 Trajectory techniques will provide maximum vehicle subsystem margins from design specifications when possible. Priorities and trade analyses will determine the best compromise when conflicts exist.

4.1.2 The launch date is March 31, 1980 at 11:30:00 GMT (6:30 a.m. EST).

4.1.3 The nominal orbit is 150/150 nautical miles.

4.1.4 The nominal inclination is 40.3 degrees. This inclination will provide an ET groundtrack that, for excessive MECO overspeeds, passes to the south of King Island and north of the Furneaux Group off the southern coast of Australia.

4.1.5 Nominal and abort to orbit (ATO) landings will be on Rogers Lakebed runway 23 at EAFB. Abort-once-around (AOA) landing will be on runway 17 at Northrup strip. Landing for glide return to launch site (GRTLS) will be on runway 15 at KSC. Because of the high probability of landing on either runway 15 or 33 for RTLS, OFT performance assessment will be based on the capability to achieve either runway for RTLS. Nominal and abort landing site locations are given in appendix A of reference 3.

4.1.6 Standard GSTDN contact data will be provided for selected stations depending on the mission phase. Table II of appendix A of reference 3 establishes the AOS/LOS computational requirements for each phase. Minimum elevation may be computed assuming zero degree or 3 degrees maximum elevation with no masking. However, normally all AOS/LOS is computed assuming zero degree elevation with masking and keyholes considered. Exclusion of a site from table II, appendix A of reference 3 does not preclude it from being used in the tracking network.

4.1.7 All landings (nominal, abort, and contingency) except AOA will be no earlier than 30 minutes after sunrise and no later than 30 minutes before sunset. AOA landings may be as early as sunrise. It is desirable that nominal landing at EAFB occur prior to 10:00 a.m. local time.

4.1.8 A 1-hour launch window (as a minimum) will be provided.

4.1.9 There is no ontime launch requirement.

4.1.10 There are to be two crewmen. Crew provisions will be loaded for 5 days.

4.1.11 The planned flight duration will be approximately 54 hours.

4.1.12 There will be landing opportunities at EAFB on at least four orbits each day.

4.1.13 The payload will include the development flight instrumentation (DFI), the induced environment contamination monitor (IECM), the aerodynamic coefficients identification package (ACIP), and the Orbiter experiments (OEX) tape recorder. Mass properties for total payload weight are given in appendix A of reference 3.

4.1.14 The payload bay doors (PLBD) are to be opened as soon as operationally practicable after OMS-2. However, the contingency capability will exist to leave the PLBD closed for up to 8 hours following OMS-2.

4.1.15 (Deleted)

4.1.16 All nominal deorbit opportunities will be planned such that the entry crossrange is $\leq$550 nautical miles; however, a crossrange of $\leq$690 nautical miles is acceptable for AOA and contingency cases.

4.1.17 (Deleted)

4.1.18 Reaction control system (RCS) backup deorbit capability is required. For this contingency, propellant from both OMS pods is assumed to be available.

4.1.19 The deorbit targeting will be biased to accommodate the designated backup deorbit propulsion mode.

4.1.20 Aerodynamic data, atmosphere and wind models, I-load values, software baseline (including implemented CR's), engine data, assumed constants, geodetic locations for TACAN/MSBLS/launch and landing sites and mass properties data for the nominal, RTLS, ATO, and AOA analysis are specified in appendix A of reference 3. The limitations and constraints defined in volume I and volume II of the SODB (JSC-08934) will be adhered to in the design of the nominal and abort OFP profile except as defined in appendix B of reference 3. (See 4.1.21.)

4.1.21 Appendix B of reference 3 summarizes the groundrules and constraints that deviate either from reference 4 or from reference 5 of this document.

4.2 NOMINAL ASCENT

4.2.1 General

4.2.1.1 (Deleted. Moved to appendix A of reference 3.)

4.2.1.2 The first-stage pitch and yaw attitude profiles will be biased for the steady-state mean vector wind for the month of April. Fifty-percentile groundwinds will be used during the early launch time period and smoothly transitioned into in-flight steady-state winds.

4.2.1.3 The boost phase pitchover maneuver will be initiated through open-loop attitude steering when the Orbiter relative velocity reaches a magnitude which corresponds to a vertical rise of 365 feet which includes dispersions.

4.2.1.4 The undispersed Q_{max} used for ascent shaping will be no greater than 580 psf. Launch opportunities and liftoff wind conditions will comply with the allowed max dispersed Q constraint of 660 psf.

4.2.1.5 The solid rocket booster (SRB) impact ellipse will not be west of a line connecting the following points (including dispersions):

$$\phi = 30.00^\circ \text{ N}, \quad \lambda = 80.310^\circ \text{ W and}$$

$$\phi = 31.44^\circ \text{ N}, \quad \lambda = 79.895^\circ \text{ W}$$

4.2.1.6 The SRB descent dispersion will use the same in-flight winds as the ascent.

4.2.1.7 At lift-off, the Space Shuttle main engines (SSME's) will be at 100-percent thrust rated power level (RPL).

4.2.1.8 The SSME's will be throttled during the first stage for max q control.

4.2.1.9 The main engine cutoff (MECO) conditions will be consistent with the external tank (ET) impact constraints enumerated below:

a. Planned ET impact locations for nominal cutoff, including dispersions, will be no closer than 200 nautical miles to land masses in the Indian Ocean.

b. MECO and ET separation will be within GSTDN coverage.

c. MECO target conditions (r, v, γ, Ω, i) will be the same for normal ascent, AOA, and ATO.

radius = 21 290 308 feet (60 nautical miles altitude)

inertial velocity = 25 668 fps

biased inertial flightpath angle = 0.526 degrees

ascending node = optimum in-plane

inclination = 40.3 degrees

4.2.1.10 (Deleted)

4.2.1.10-a T_{fail} is a direct controlling parameter of the earliest time that a downrange intact abort resulting from one SSME out is possible. For nominal and abort shaping purposes, T_{fail} shall be set at 260 seconds (approximate RTLS abort mode boundary).

4.2.1.11 The ascent trajectory will be shaped for an acceptable propellant margin for nominal, intact aborts, and contingency abort, respectively.

4.2.1.12 A single OMS engine failure will not preclude nominal orbit insertion.

4.2.1.13.a As a minimum, communications (voice, command, and telemetry) above masking for a nominal mission are required through tracking station BDA through OMS-1 ignition + 5 seconds.

4.2.1.13.b For nominal, AOA, and ATO, the OMS-1 time of ignition (TIG) shall occur no earlier than 103.5 seconds from Orbiter/ET structural release. The OMS-1 TIG = 120 seconds will include a nominal 16.5 seconds from MECO to structural release to accommodate tail-off, damp rates, and preparation for separation and 103.5 seconds for tracking, ground evaluation, and appropriate action prior to OMS-1 ignition.

4.2.1.14 The OMS-1 maneuver will provide an orbit with a nominal 150-nautical mile apogee. The OMS-2 cutoff will result in a nominal 150-nautical mile circular orbit.

4.2.1.15 Deleted. Moved to appendix A of reference 3.

4.2.1.16 The FPR allowance for the nominal mission will accommodate the occurrence of both 3-sigma low SSME and SRB performance (10 600 pounds propellant).

4.2.1.17 From T-9 minutes to T-1 minute 57 seconds, propellant capability for a 5-minute launch hold is available. A 5-minute hold after auxiliary power unit (APU) startup at T-5 will preclude a 24-hour recycle.

4.2.1.18 All four nominal SSME throttle change commands provided by the first-stage guidance principal function are available for OFT mission planning.

4.2.1.19 Nominally, the Shuttle vehicle will fly a $+2.0^\circ$ angle of attack and a 0.0° sideslip profile after the $q\alpha$ and $q\beta$ constraint region.

4.2.1.20 Nominal SSME and SRB performance will be used for planning purposes.

4.2.1.21 The vehicle will be oriented on the pad with the -Z body axis (tail) pointed south.

4.2.1.22 During the first orbit, S-band telemetry, voice, and uplink communication coverage for a duration of 3 minutes is required at Madrid for $\geq$1-degree elevation.

4.2.1.23 The ascent steering will be limited until GET = 150 seconds and altitude is greater than 200 000 feet to avoid post-SRB separation heating problems (total delta angle of attack less than 5 degrees from a +2-degree angle of attack and zero-degree sideslip angle).

4.2.2 Space Shuttle Main Engine (SSME) Constraints

4.2.2.1 The general purpose computers (GPC's) will issue the same thrust command to each SSME controller; i.e., no differential throttling.

4.2.2.2 The SSME's must be reduced to and operated at minimum power level for at least 6 seconds before MECO.

4.2.2.3 For flight design analysis, the SSME power levels are assumed to be:

Minimum throttle = 65 percent

Maximum throttle = 100 percent (nominal and aborts)

4.3 SEPARATION

The following groundrules and constraints will apply for nominal, ATO, AOA, RTLS, and contingency abort mission.

4.3.1 Orbiter-ET/SRB

4.3.1.1 The dynamic pressure at SRB separation will not exceed 75 psf and the pitch and yaw angles of attack will not exceed ± 15 degrees. Body rates at separation will not exceed the following: p ± 5 deg/sec; q ± 2 deg/sec; r ± 2 deg/sec.

4.3.1.2 Orbiter/ET three-axis attitude hold will be maintained for 4 seconds after SRB staging to prevent recontact.

4.3.1.3 The time from SRB separation cue (primary or backup) to separation command will be approximately 6 seconds.

4.3.2 Orbiter/ET

4.3.2.1 The Orbiter will perform a -Z axis translational maneuver from the ET. The RCS translational delta-V will be at least 4.0 fps.

4.3.2.2 (Deleted)

4.3.2.3 Separation (nominal, ATO, and AOA) will occur at MECO inertial attitude. Measured attitude rates must be ≤0.5 deg/sec in all axes.

4.3.2.4 The Orbiter will perform a Y body axis translational maneuver. This maneuver will be executed following the completion of the RCS -Z body axis translational maneuver and the correction of attitude errors to within the acceptable deadband. If at ET separation the configuration is within the deadband, then the maneuver will be in the direction of the +Y body axis. If at ET separation the configuration is outside the deadband then for positive roll the translational maneuver shall be in the -Y body direction and if the roll angle is negative then the translational maneuver shall be in the +Y body direction. The RCS translational delta-V will be for a duration of 24 seconds (~4 fps).

4.4 NOT APPLICABLE

4.5 ORBITAL MANEUVERING SYSTEM

4.5.1 Delta-V requirements >6 fps for +X translation (using two OMS engines) or >3 fps for +X translation (using one OMS engine) will be performed with the OMS.

4.5.2 Maneuver computations will be based on nominal engine performance.

4.5.3 All normal OMS maneuvers >6 fps will be performed with two engines. (Deorbit targeting will be biased to protect against one-engine out.)

4.5.4 It is desirable to plan all OMS maneuvers to occur within GSTDN coverage.

4.5.5 The interconnect will be used only for contingency conditions. However, the crossfeed will be used during nominal onorbit system tests.

4.5.6 An OMS engine failure will require that the propellant in the failed pod be used in equal amounts with the operating pod.

4.5.7 Propellant in the OMS retention tanks will be available to the RCS engines for all onorbit conditions.

4.5.8 Loss of both OMS engines will require that the RCS deorbit propellant be obtained from both OMS tanks.

4.5.9 Sufficient OMS/RCS propellant will be provided to allow deorbit to a minimum delta-V entry target line if the propellant in one OMS tank is unavailable for use.

4.5.10 Where possible OMS propellants will be used as a ballasting agent for longitudinal and lateral c.g. requirements.

4.6 REACTION CONTROL SYSTEM

4.6.1 Unless otherwise specified, exoatmospheric attitude maneuvers will be budgeted at 0.5 deg/sec except for time-critical maneuvers, which will be budgeted at 1.0 deg/sec.

4.6.2 RCS propellant tanks will be loaded full for both the fore and aft systems.

4.6.3 Nominal and contingency RCS entry control allowance will be available in either aft RCS pod. However, maximum aft RCS propellant, consistent with mission objectives and c.g. considerations, will be maintained for entry-through-landing control.

4.6.4 Maneuver computations will be based on nominal engine performance.

4.6.5 For nominal mission operation, maximum steady-state firing duration will be 150 seconds for forward thrusters and 150 seconds for aft thrusters. For contingency mission operation, the maximum steady-state firing will be 500 seconds for aft thrusters.

4.7 NOT APPLICABLE

4.8 NOT APPLICABLE

4.9 NOT APPLICABLE

4.10 NOT APPLICABLE

5.0 VEHICLE SUBSYSTEMS, ENVIRONMENT, AND SIMULATION TECHNIQUES DESCRIPTION

5.1 CONFIGURATION

The spacecraft configuration for this flight consists of Orbiter OV-102; external tank 1; solid rocket boosters (SRB's) A07 and A08 (TC-211-79); and Space Shuttle main engines (SSME's) 2005, 2006, and 2007. A representative diagram of the Shuttle vehicle is shown in figure 5.1-1.

5.2 AERODYNAMICS

The aerodynamic data used for the analysis in this report reflect IA156 test data and were obtained from reference 6. These data conform to Space Shuttle Configuration No. 5 as established by MCR 3570, dated August 30, 1976. Four portions of the aerodynamic data are considered negligible for ascent performance and trajectory shaping and were not used in this analysis: (1) separation aerodynamics at Mach 4.45, (2) hypersonic viscous interaction effects, (3) dynamic stability aerodynamics, and (4) aeroelastic effects.

The Orbiter elevons are active during first stage in order to maintain acceptable elevon actuator loads. The elevons will normally follow a predetermined schedule with real-time adjustment based on sensor feedback. Elevon schedule 6 (table 5.2-I) is used in the OFP design without any sensor feedback.

The aerodynamic data used for the analysis in the OMS sections of this report were obtained from references 7 and 8. The data from reference 7 are used at altitudes below 600 000 feet. The data from reference 8 are used at altitudes greater than 600 000 feet.

5.3 ENVIRONMENT

Atmospheric characteristics for the launch simulations were obtained from the 1963 Patrick reference atmosphere model (ref. 9). The Earth model and potential function are those of the Fischer ellipsoid. The wind profile (figs. 5.3-1 and 5.3-2) is the steady-state mean vector wind for the month of April and was obtained from reference 10.

5.4 PROPULSION

The mated Shuttle vehicle is powered by two SRB's and three SSME's. In the exoatmospheric mission phases, the Orbiter is powered and controlled by the SSME's during second stage and the OMS/reaction control system (RCS) during orbit insertion.

5.4.1 Solid Rocket Boosters

The majority of the boost capability for the mated Shuttle configuration is provided by a matched pair of SRB's. The SRB thrust trace obtained from reference 11 and presented in table 5.4-I is designed to control ascent acceleration and dynamic pressure through the lower atmosphere. The SRB is designed to perform nominally at a propellant mean bulk temperature (PMBT) of 60° F (TC-211-79); however, a PMBT of 66° F is expected for STS-1 and the performance characteristics have been adjusted accordingly. A summary of significant parameters obtained from reference 12 follows.

a. Physical characteristics

(1) Number: 2

(2) Nozzle exit area: 16 660.4 in^2

(3) Expansion ratio: 7.16:1

(4) Throat area: 2326.82 in^2

(5) Maximum rate for nulling engine deflection at SRB thrust vectoring control termination: 5 deg/sec

b. Gimbal point (Shuttle coordinate system - center of pivot box), inches

X = 2410.5

Y = $\pm$250.5

Z = 400.0

5.4.2 Space Shuttle Main Engines

The Orbiter is powered by three SSME's that can be both throttled and gimballed and have a nominal rated sea-level thrust of 375 000 pounds each. The engines are being designed to be throttled from 109 to 65 percent of rated power level in 1-percent increments. However, in order to assure safe engine operation for STS-1, the throttle range is restricted to a 65- to 100-percent range. The throttle rate is limited to 10 percent/sec by the engine controller. The permissible throttle schedule is also limited as a function of altitude to avoid engine damage (fig. 5.4-1). Throttling of the SSME will result in the loss of engine efficiency according to the thrust table that follows. Some specific impulse (Isp) test data were available and utilized in this cycle (ref. 13). The Isp (table 5.4-II) is a three-engine average vacuum value. The mixture ratio and thrust were assumed to be spec values and the same Isp ratios at the various throttle levels (shown below) were maintained. A summary of significant engine parameters follows.

a. Physical characteristics

(1) Number: 3

(2) Nozzle exit area: 6461.07 in^2

(3) Throat area: 83.41 in^2

(4) Expansion ratio: 77.5:1

(5) Mixture ratio (LOX/LH2): 6:1

(6) Thrust:

Level, percent	Vacuum thrust, lb	Sea-level thrust, lb	Vacuum specific impulse, sec	Sea-level specific impulse, sec
MPL (65)	305 500	--	453.9	--
RPL (100)	470 000	375 000	455.2	363.2
FPL (109)	512 300	417 300	455.3	370.9

Note: These values are design specifications. For this OFP, full power level (FPL) was limited to 100 percent.

b. Gimbal point (Orbiter coordinate system), inches

Lower engines	Upper engine
X = 1468.17	X = 1445.0
Y = ±53.00	Y = 0.0
Z = 342.64	Z = 443.0

Additional detailed SSME information can be obtained from reference 14.

5.4.3 Orbital Maneuvering System

The OMS consists of two 6 000-pound thrust engines that have an independent propellant supply and can be gimballed. The nominal mode for operating the OMS is the firing of the two engines in parallel and pitched down through the Orbiter center of gravity (c.g.). The OMS is generally used for exoatmospheric flight but can also be used to increase abort capability during second-stage flight. A summary of pertinent OMS characteristics is as follows:

a. Physical characteristics

(1) Number: 2

(2) Thrust: 6000 lb

(3) Specific impulse: 313.2 sec

(4) Mixture ratio: 1.65:1

(5) Nozzle area ratio: 55:1

b. Gimbal point (Orbiter coordinate system), inches

X = 1518.0

Y = ±88.0

Z = 492.0

Additional detailed information is available in reference 14.

5.4.4 Reaction Control System

The RCS consists of 38 primary thrusters and 6 vernier thrusters. The primary thrusters are divided into 3 independent systems that consist of 14 thrusters in the forward module and 12 thrusters in each of 2 aft modules. The aft thrusters have a crossfeed system that allows propellant to be used from either of the aft modules. In addition, the aft thrusters can obtain OMS propellant by use of the OMS/RCS propellant interconnect.

The six vernier thrusters are used for attitude control. Two down-firing thrusters are located in the forward system; one side-firing and one down-firing thruster are located in each of the aft pods.

A summary of pertinent parameters follows:

a. Physical characteristics

(1) Number

Primary: 38
Vernier: 6

(2) Thrust, lb

Primary: 870
Vernier: 24

(3) Specific impulse, sec

Primary: 289
Vernier: 260

Additional information may be obtained from reference 14.

5.5 MASS PROPERTIES

The vehicle mass characteristics are provided by reference 15. Table 5.5-I presents the weight breakdown of the launch vehicle at SRB ignition, while table 5.5-II presents the MPS propellant weight summary. Tables 5.5-III(a), 5.5-III(b), and 5.5-III(c) present the total launch vehicle mass properties used in this analysis for first stage, second stage, and orbit insertion, respectively.

5.6 GUIDANCE, NAVIGATION, AND FLIGHT CONTROL (GNC) SYSTEMS

These sections discuss the GNC software used by the onboard computers to fly the designed ascent trajectory. The predetermined mission-dependent initialization load (I-load) data that feed the GNC systems are contained in reference 16.

5.6.1 Guidance

The powered flight guidance ascent/RTLS functional subsystem software requirements are contained in reference 17. The following subsections summarize the requirements with respect to the ascent trajectory.

5.6.1.1 First-Stage Guidance

The first-stage trajectory must be oriented so that aerodynamic loads are within the Shuttle mated-vehicle structural capability for nominal and perturbed conditions, the maximum dynamic pressure is within flutter limits, the vehicle avoids contact with the launch tower, the Orbiter avoids recontact with the SRB's after jettison, and the vehicle performance is near maximum.

The first-stage trajectory is divided into two distinct phases: a vertical-rise phase and a tilt phase. During the vertical-rise phase, the launch pad nominal attitude is commanded until a specified Earth-relative velocity magnitude, sufficient to assure launch tower clearance, is achieved.

The tilt maneuver begins at termination of the vertical-rise phase. Predetermined pitch, yaw, and roll attitude angle histories (as a function of Earth-relative velocity) determine the desired Shuttle attitude during the first stage. These Euler angles are defined in the boost reference coordinate system, and the order of body rotations is yaw, pitch, and roll.

The first-stage guidance principal function calculates the desired Shuttle attitude in the form of a quaternion for input to the guidance and control steering interface (sec. 5.6.3.1). Predetermined SSME throttling is performed (except in the case of an SSME failure or during manual throttling) to limit the maximum dynamic pressure and to achieve the required performance during the atmospheric flight. The throttle profile is determined prior to the mission. Throttle commands are issued to the SSME subsystem operations program (SOP) principal function.

If an SSME failure occurs during the first-stage ascent, the two remaining SSME's will be set at KMAX, the I-load maximum throttle setting, unless manual throttling is being performed, to maintain structural margins. Additionally, alternate pitch programs are required for each SSME-out prior to a predetermined Earth-relative velocity magnitude. Each alternate pitch history lofts the trajectory, but does not violate the mated vehicle structural limits.

5.6.1.2 Second-Stage Guidance

The second-stage guidance phase begins at the separation command of the SRB's from the SRB/Orbiter/ET vehicle configuration and normally terminates after separation of the ET from the Orbiter/ET configuration as either an automatic transition on completion of the minus Z-translation maneuver or a crew-initiated transition (PRO) to the orbit insertion maneuver phase. The trajectory conditions at which ET separation occurs are chosen preflight to allow the ET to impact the Earth on a free-fall trajectory while sufficient Orbiter propellant is provided to allow the OMS engines to insert the Shuttle into orbit. If an RTLS abort is initiated via the abort mode rotary switch during this major mode, the second-stage major mode (103) will be terminated, and transition to abort major mode (601) will occur. In the event of two SSME failures, N_SSME = 2 (a contingency abort), the ET low level sensor arm command will be issued by AS 2STG GUID.

Procedurally, during second stage for STS-1, an AOA or ATO will not be initiated by the crew to enhance post-MECO capability.

The SSME's are used to boost the Orbiter/ET vehicle along a propellant-optimum powered-flight trajectory until the desired trajectory conditions (altitude, velocity, flightpath angle, and orbital plane) are achieved. The SSME thrust will then be terminated by the SSME OPS principal function using a desired cutoff time supplied by the ascent second-stage guidance principal function.

The mainframe of the second-stage guidance principal function is the powered explicit guidance (PEG) algorithm (ref. 18). PEG is an explicit solution to the two-point boundary-value problem of exoatmospheric guidance and trajectory optimization. The explicit equations converge for off-nominal conditions such as engine failure, abort, target switch, etc.

In order to provide the STS-1 OFP with the earliest possible SSME out press to MECO (PTM) capability, the three-phase PEG capability of second-stage guidance is used. These phases consist of two constant thrust phases and a constant acceleration phase. The first thrust phase assumes all three SSME's will be operating until just before the RTLS/PTM mode boundary (TFAIL = 260 sec). While the trajectory is in the first phase, the algorithms for the last two phases are evaluated assuming two operating SSME's. This advance assumption that an engine will fail results in PEG commands optimized for that case.

When the trajectory reaches the second thrust phase and PEG finds that it still has three SSME's, the PEG commands are optimized for nominal flight for the remainder of the second-stage burn or until an engine actually fails. See reference 19 for the detailed abort plans.

The third PEG thrust phase provides throttling capability to follow a 3-g acceleration profile in order to stay within structural and physiological constraints.

When the predicted time to go to cutoff (TGO) is less than a preset value (10 seconds), the PEG calculations are discontinued, and the guidance frequency is increased to determine an accurate main engine cutoff (MECO) time to achieve the velocity target. During this period, the last set of guidance commands is used by the FCS.

5.6.1.3 Orbit Insertion Guidance

The following section contains a description of the guidance used for the post-MECO OMS maneuvers as documented in reference 17. The powered maneuvers during these phases are nominally performed with the OMS engines. The crew has the capability to select the thrust system for the maneuver, change guidance targets, delay the maneuver, etc., via the maneuver execute (MNVR EXEC) cathode-ray tube (CRT) display.

After the SSME burn has been completed (MECO), a 17.8-second coast period follows until ET separation is commanded. A 4-fps translational burn in the -Z direction completes the separation sequence. A 24-second +Y translation maneuver is performed to ensure no recontact with the ET. The first OMS burn (OMS-1) begins at a fixed time of 121.3 seconds from MECO. Fifteen seconds prior to the OMS-1 time of ignition (TIG), the orbit insertion guidance begins calculating the guidance solution once every 0.96 second.

The purpose of the OMS-1 burn is to raise the energy of the MECO orbit to a premission-selected value of apogee altitude. Normally, this burn is performed with the two OMS engines to achieve the premission-selected I-load targets. The OMS-1 targets are defined as an apogee altitude relative to an equatorial Earth radius and associated downrange angle measured from the launch site. The target position vector, calculated from the altitude and downrange inputs, lies in the target orbit plane defined by a unit vector normal to the orbit plane (IYD) for a nominal burn. By proper I-load input, the target position vector can be defined to be always in the current orbit plane with no OMS propellant expended for controlling the orbit plane. This I-load can also be used to limit the OMS propellant expended for orbit plane control to a specific amount. The burn is near-fuel optimal, leading to a thrust direction very nearly along the current inertial velocity vector. Prior to the OMS-1 maneuver, the crew manually maneuvers to the desired preburn attitude defined by the guidance solution. When the remaining burn time gets smaller than a preselected value (6 seconds), guidance computes the OMS engine cutoff time and sets a flag to initiate a countdown to this time.

In the event of a single OMS engine failure (if the burn was initiated with the two OMS engines), the guidance automatically transitions across the failure (given knowledge of the failure) and completes the burn with the remaining OMS engine. Additionally, the guidance transitions across the failure of both OMS engines and continues to solve the guidance equations by assuming the thrust level of the four +X RCS jets. In the event of a propulsion system failure, the guidance targets remain unchanged throughout the burn.

During the coast between the OMS-1 and OMS-2 maneuver, a guidance solution for the OMS-2 burn is initiated via the CRT, and this solution is used to define the desired preburn attitude. The crew manually maneuvers to this attitude prior to the OMS-2 burn. Fifteen seconds prior to the OMS-2 ignition time, the orbit insertion guidance begins calculating the guidance solution once every 0.96 seconds. The purpose of the OMS-2 burn is to circularize the orbit by raising the perigee altitude up to the current apogee altitude. The remainder of the guidance description for the OMS-2 burn is the same as for the OMS-1 burn.

The parameters defining the OMS-1 and OMS-2 burn may be a crew input. Optionally, the crew may choose to alter the guidance targets or the propulsion system configuration. There are other inputs that can be altered, but these two are of primary importance to the guidance function. A general discussion of the handling of these inputs is presented.

The crew can enter a set of guidance targets in the form of a target apsis altitude (HTGT) and a target range angle relative to the launch site (THETA). It should be noted that these targets are not true targets but are biased to compensate for the noncentral body effects during the powered flight and resulting coast to the target. A set of external ΔV targets (ΔVX, ΔVY, and ΔVZ) can also be entered. If a set of external ΔV targets is entered, the guidance mode switch will automatically be set by the software supporting the CRT (AS MNVR DIP) to the external ΔV guidance mode. It should be noted that while this option is available, it is not the planned mode for performing the burn (the external ΔV mode is not closed loop and would produce target misses if propulsion system failures occur). The orbit insertion guidance principal function accepts either set of inputs.

The engine configuration is also selectable by the crew. The nominal engine configuration for both OMS-1 and OMS-2 is two OMS engines, but either the right OMS, left OMS, both OMS, or the four +X RCS jets could be selected. After the desired configuration has been selected, the AS MNVR DIP will set the number of OMS engines or +X RCS jets for input to the orbit insertion guidance. The selected engine configuration is used to converge guidance and is assumed throughout the burn unless a failure occurs. If the +X RCS jets are selected for the maneuver, the guidance performs essentially the same function as performed for the OMS maneuver with one exception. Guidance does not provide an automatic cutoff for the jets. It is assumed that the crew will perform this manually, given display information.

5.6.2 Navigation

A functional simulation of the Shuttle onboard navigation algorithms was modeled for the generation of this flight profile. The onboard navigation model, which is used to compute the vehicle state, consists of only one ideal inertial measurement unit (IMU) system and no redundancy management. The nav state is initialized at the start of the simulation and then updated each successive nav cycle (every 3.84 seconds for first and second stage and every 0.96 second for OMS) using the super g algorithm and gravitational acceleration model defined in reference 20. The intermediate nav states required by guidance are calculated at a frequency of at least each guidance cycle as specified by the navigation state propagation subfunction in reference 20. Calculation of the intermediate nav states assumes a constant acceleration, but the state is corrected each nav cycle.

5.6.3 Flight Control System

The ascent flight control system (FCS) functional subsystem software requirements are contained in reference 21. The primary function of the FCS is to command engine deflections and RCS on/off operations intended to produce the desired vehicle thrust attitude during ascent. The following subsections discuss four principal functions of the FCS: (1) guidance/control steering interface (GC_STEER), (2) ascent digital autopilot (ASCENT DAP), (3) transition digital autopilot (TRANS DAP), and (4) attitude processor (ATT PROC). The FCS for the first and second stages consists of GC_STEER and ASCENT DAP, while the orbit insertion FCS consists of only the TRANS DAP.

5.6.3.1 Guidance/Control Steering Interface

During ascent first and second-stage mission phases, GC_STEER provides the ASCENT DAP with attitude errors and attitude rate commands for thrust vector control. During the first stage, GC_STEER performs smoothing of the guidance commanded attitude quaternion by means of a second-order filter having rate and acceleration limits. During the second stage, GC_STEER combines the PEG outputs to form a commanded attitude quaternion and then smooths it as in the first stage.

During the high dynamic pressure region of first-stage flight, ASCENT DAP provides load relief capability that is designed to steer the vehicle into the wind by altering the guidance attitude commands. ASCENT DAP compares input reference normal and lateral accelerations to actual measured accelerations and based on the difference, computes incremental attitude commands that, when added to the guidance commands, cause the vehicle to fly the desired angle of attack and sideslip profiles within loads acceptable limits. The reference accelerations are predetermined tables from the design trajectory.

During the period between the SRB separation command and the guidance ready event, GC_STEER generates a set of commands that produces an attitude hold. This attitude hold is for a minimum of 4 seconds to allow for good separation and for recovery from the transition to Orbiter/ET configuration. The attitude hold will be continued beyond 4 seconds, if necessary, to wait for a converged set of PEG commands.

The GC_STEER provides total angle-of-attack limiting capability when it begins accepting PEG commands until 150 seconds GET in order to remain within heating constraints. The total angle-of-attack constraint is defined by I-loads for a cone half-angle (5^{o}) about a nominal pitch angle of attack (2^{o}) at zero sideslip. The GC_STEER determines the angle of attack that would result by meeting the PEG commands and limits the commands when the constraint would be exceeded.

Should PEG go unconverged at a planned target change, or in the event of a failure, or when PEG is turned off during fine countdown, GC_STEER continues to produce attitude and attitude rate commands based on the last good set of PEG data.

5.6.3.2 Ascent Digital Autopilot

The ASCENT DAP module controls the vehicle in response to automatic commands during the ascent flight phase by using both the SRB and SSME thrust vector control (TVC) actuating systems during the first stage and only the latter system during second stage. Rate commands and attitude errors from GC_STEER are processed into incremental engine deflection commands that are summed with I-load values of reference trim deflections.

The ASCENT DAP also evaluates the elevon loads, makes any necessary adjustments to the reference elevon deflection schedule, and sends the commands to the elevons.

5.6.3.3 Transition Digital Autopilot

The transition digital autopilot (TRANS DAP) controls the vehicle in response to either automatic or manual commands during the orbit insertion flight phase. Detailed requirements for the TRANS DAP are given in reference 21. The effectors used to produce control forces and moments on the vehicle are the OMS engines and primary RCS jets.

When the OMS engines are firing, the main control mode is automatic engine thrust vector control (TVC); but the RCS jets are also available to provide additional control authority (e.g., to cover a single OMS engine failure). The two OMS engines typically provide primary vehicle control for pitch, yaw, and roll with the RCS jets operating as a wraparound controller; exercising RCS control only if the TVC control authority is inadequate, as evidenced by excessive attitude or angular rate errors. The automatic TVC mode uses guidance inputs to construct a desired thrust vector and the actual vehicle velocity vector to define current thrust direction. The commanded vehicle body rate is proportional to the cross product of these two vectors. The OMS engine actuator commands required to gimbal the engines and produce the desired vehicle/engine attitude and thrust direction are then constructed from the filtered commanded vehicle body rate and feedback signals from the rate gyro system.

The TRANS DAP also provides manual TVC and manual RCS rotational and translational capability. Manual TVC capability allows the crew to provide the desired thrust information instead of the guidance system. The manual RCS rotational capability is used to attain the desired premaneuver attitude for the OMS burns. The manual translational RCS capability provides for the Y translational maneuver following ET separation and a backup propulsive system for failure of both OMS engines.

Automatic RCS translational control is provided by the TRANS DAP for the Orbiter/ET separation maneuver. This mode generates a continuous -Z jet command until the vehicle has accelerated in -Z to the desired separation velocity, at which time it terminates the command.

Attitude control during coasting flight between the OMS-1 and OMS-2 burn is also maintained by the TRANS DAP. In particular, this capability is used to maintain the premaneuver attitude up to the OMS-2 ignition via the attitude hold mode.

For failure of one OMS engine or an intentional burn with only one OMS engine, the TRANS DAP is reconfigured by the appropriate change of gains. In this configuration, roll control is provided by the RCS jets and the single OMS engine controls pitch and yaw. The single OMS engine is also driven to a premission determined yaw gimbal position to place the thrust through the approximate Orbiter center-of-gravity position.

5.6.3.4 Attitude Processor

The attitude processor (ATT PROC) derives the vehicle attitude quaternion using data from a selected IMU. Attitude processor functional subsystem software requirements are contained in reference 21. Attitude angles are derived from this quaternion and displayed on the attitude director indicator (ADI) and horizontal situation indicator (HSI) in the cockpit. (See sections 6.2 and 6.4 for figures which show first and second stage ADI and HSI angle histories and sections 6.6 and 6.7 for the OMS ADI angles.)

Three options exist for the coordinate system used to derive the attitude angles, which are crew selectable via a hardware switch. The three options are inertial (INRTL); reference (REF); and local vertical, local horizontal (LVLH). The coordinate systems are defined via quaternions (RELQUAT) which are I-loads; RELQUATS are selected at appropriate times for monitoring the ascent trajectory. The coordinate systems are described in reference 22.

The INRTL option is used for alining the vehicle prior to OMS maneuvers and for monitoring the OMS maneuvers. It is alined such that the nominal OMS-2 ignition attitude is 0° pitch, 0° yaw, and 180° roll. The Euler sequence is pitch-yaw-roll with all three angles displayed on the ADI.

The REF option is used for monitoring vertical rise and pitchover. It is alined such that the vertical rise attitude is 90° pitch and the SRB staging attitude is 0° yaw and 180° roll. The Euler sequence is pitch-yaw-roll with all three angles displayed on the ADI.

The LVLH option is used for monitoring the mainstage ascent from the end of pitchover through ET separation and for verifying vehicle attitude for OMS maneuvers. It has two definitions, one for the mainstages (LVIY) and one for the OMS stages (LVLH).

The LVIY system is alined such that the Z-axis is along the instantaneous negative radius vector, the Y-axis is along the projection of the I-load vector normal to the desired orbital plane ($\overline{IYD}$) into the instantaneous local-horizontal plane, and the X-axis completes the right-handed system. The Euler sequence is yaw-pitch-roll, with the pitch and roll angles displayed on the ADI and the yaw angle displayed on the HSI.

The LVLH system is alined such that the Z-axis is along the instantaneous negative radius vector; the Y-axis is along the negative angular momentum vector, and the X-axis completes the right-handed system. The Euler sequence is pitch-yaw-roll with all three angles displayed on the ADI.

For this simulation, a simplified version of the attitude processor was used to obtain the ADI angles. The data for deriving the M50 to body quaternion were taken from the environment rather than an IMU, but calculations were performed at the propagating rate. The algorithm is otherwise as described in reference 21.

5.7 SIMULATION TECHNIQUES

The ascent OFP presented in this document was developed using two NASA Space Shuttle vehicle simulation programs: (1) parameterized exoatmospheric/atmospheric control evaluation (PEACE) program (ref. 23) and (2) space vehicle dynamics simulation (SVDS) program (ref. 24).

The PEACE program is a parameter optimization routine and is used to determine the basic first-stage boost reference coordinate system (BRCS) attitude profile, the initial launch heading, the SSME's throttle schedule for controlling maximum dynamic pressure, and the SRB separation conditions. The simulation includes the effects of three degrees-of-freedom (3-DOF) with an oblate rotating Earth and pitch plane moment balancing. The environment and propulsion are as described in the previous subsections. The aerodynamics is a simplified representation of the data presented in reference 25.

The SVDS program is used to finalize the first-stage shaping and to simulate the actual flight profile. The first-stage shaping is accomplished using the 3-DOF mode, which treats the Shuttle vehicle as a rigid mass and employs static balancing of all aerodynamic and thrusting moments about the three vehicle body axes. The moment balancing is accomplished by gimballing only the SRB's prior to the SRB separation sequence phase and by gimballing both SRB's and SSME's during the SRB separation sequence phase. The final first-stage shaping is performed by utilizing the PEACE program results. The BRCS pitch attitude profile during the pitchover phase is adjusted to achieve the desired maximum dynamic pressure and to closely match the SRB separation results from the PEACE program. After pitchover, the attitude profile is defined by steering to the center of the $q\alpha$ design squatcheloid. The I-loads for the final BRCS attitude profile, normal and lateral acceleration load relief values, and SSME and SRB thrust vector deflection trims are obtained from this final 3-DOF SVDS shaping simulation.

The actual first and second-stage flight profile is then simulated, using the SVDS program and the 3-DOF results, in a 6-DOF mode with slosh effects. The post-MECO actual flight profile is simulated using the SVDS program in a 6-DOF mode during powered maneuvers and alignments, and in a 3-DOF mode during the coast between maneuvers with atmospheric properties and venting of the main propulsion system trapped propellant supply.

6.0 ASCENT TRAJECTORY

6.1 GENERAL

The nominal trajectory was designed according to the guidelines and constraints contained in section 4.0. The sequence of events for nominal ascent is contained in table 6.1-I. The Shuttle ascent guidance targeting is relative to a spherical Earth; however, the following discussion uses both spherical and geodetic values for position. All values of vehicle position are quoted as geodetic unless otherwise specified. The spherical Earth radius used in ascent targeting is 20 925 738 feet. Propellant slosh effects were modeled during first and second-stage flight.

6.2 FIRST-STAGE ASCENT

The ascent profile has been designed to provide earliest press-to-MECO (PTM) capability while adhering to boost (open-loop guidance) structural constraints on q, $q\alpha$, and $q\beta$ as well as to the heating constraint on AOA entry crossrange to the Edwards AFB landing site. The following subsections describe the segments that comprise the first-stage ascent. Refer to the list of figures (6.2-1(a) through 6.2-1(hhh)) for plots of first-stage trajectory parameters.

6.2.1 Launch Site

The vehicle will be launched from the Eastern Test Range (ETR), pad 39A, at a geodetic latitude 28°36'30.32" N and longitude of 279° 23' 45.27" E. The geodetic altitude of the site is assumed to be 104.9 feet below the Fischer ellipsoid. Pad 39A coordinates are defined relative to 1973 Spaceflight Tracking and Data Network (STDN) datum referenced to the Fischer ellipsoid of 1960.

6.2.2 Boost Reference Coordinate System (BRCS)

The BRCS provides the base for the first-stage guidance attitude command tables. The BRCS is Earth-centered inertial and is fixed at SRB ignition command (GET = 0 sec). The BRCS is alined with the Z-axis toward the Earth's center parallel to the launch site gravity gradient; X-axis northward parallel to the plane of the launch site meridian; and the Y-axis eastward, completing the right-handed system. The Euler sequence of rotation for the guidance attitude commands is yaw, pitch, and roll.

The remainder of this section relates the initial yaw commands designed for wind biasing to the classical understanding of the optimum in-plane launch firing azimuth (ILFA). In order to achieve the STS-1 desired orbit inclination of 40.3°, the ILFA would be approximately 59° from north.

Designing the yaw command table to fly zero sideslip in a mean statistical wind (sec. 5.3) requires an initial heading of 67.18° for optimum propellant margin. Since this heading was determined in a closed-loop optimization program, the propellant margin sensitivities to initial heading are not available such that a heading might be selected closer to the ILFA optimum. Note though (fig. 6.2-1(s)) that the yaw attitude at the end of the first stage, and throughout the second stage, approach this optimum. This has resulted in the suggestion that one of the ADI options be relative to the average second-stage flight azimuth (59°) for the purpose of showing the crew the out-of-plane velocity error.

6.2.3 Vehicle Orientation

The vehicle is oriented on the pad with the Z-body axis (tail) pointed south. At approximately 8 seconds, a combined roll, pitch and yaw maneuver (now referred to as single-axis rotation) is begun. The roll, pitch, and yaw BRCS guidance commands at lift-off are 0.0°, 90.0°, and 0.0°, respectively. After the initial combined maneuver is completed at approximately 21 seconds, the commanded roll angle is 180°. Also shown on figure 6.2-1(s) are the actual vehicle BRCS attitude angles.

6.2.4 Propulsion

During the boost phase, the vehicle will be powered by two SRB's plus the three SSME's burning in parallel. The SSME and SRB atmospheric thrust profiles (figs. 6.2-1(nn) and 6.2-1(oo)) are tailored to reduce heating and vehicle loads during the maximum dynamic pressure region. The SRB's are ignited approximately 2.75 seconds after the SSME thrust reaches 90 percent of RPL, and lift-off occurs when the thrust-to-weight ratio (T/W) is 1.0 (0.28 second after SRB ignition). The main engines are set at 100 percent thrust (RPL) from lift-off to 46 seconds GET. At that time, the main engines are throttled to 65 percent thrust at a rate of 10 percent/sec to limit dynamic pressure. The throttle setting is held for approximately 15 seconds; and at 61 seconds GET, the main engines are throttled back up to 100 percent thrust. The main-engine actual and commanded throttle profiles are shown in figure 6.2-1(ll) and 6.2-1(mm). The SSME and SRB deflection angles are shown in figures 6.2-1(hh) through 6.2-1(kk). Staging of the SRB's will occur at 131.44 seconds GET.

6.2.5 Vertical Rise

The vertical rise phase is an attitude hold commanded by the first point of each of the guidance attitude tables and is designed to guarantee tower clearance for the worst performance case. Tower clearance is defined as the point at which the base of the SRB nozzle is above the top of the tower lightning rod. An analysis to determine the three-sigma margin required in the nominal design shows the SRB nozzle needs to be at least 41 feet above the lightning rod. Consistent with the STS-1 objectives of maximum margins, this margin is approximately doubled such that the planned nominal change in altitude for the vehicle center of gravity is 365 feet and occurs at approximately 8 seconds GET and at an Earth-relative velocity of 107.2 fps.

6.2.6 Pitchover

A single-axis rotation (SAR) is flown from tower clearance (about 8 seconds) to wings level (about 21 seconds) via a combined roll, pitch, and yaw maneuver built into the guidance attitude tables. The guidance attitude tables are designed to accomplish three objectives during the pitchover phase starting at tower clearance and ending at about 34 seconds GET: (1) roll to a heads-down, wings-level attitude; (2) yaw to a specified yaw heading optimized for earliest PTM, until wings level and then smoothly transition to zero sideslip; and (3) pitch to a specified attitude in about 13 seconds, followed by a smooth transition to the design $q\alpha$ profile obtained from reference 26. The GC_STEER module will limit the total body angular rate and acceleration during this combined roll, pitch, and yaw maneuver to 10 deg/sec and 5 deg/sec^2, respectively. For the STS-1 trajectory, wings level occurs at approximately 21 seconds GET, the initial yaw heading is 67.18°, and the SAR pitch rate is about 1.0 deg/sec.

6.2.7 High-q Steering

The vehicle pitch and yaw profile during the high-q region (above 350 lb/ft^2) is designed for a zero β and for a value of α so that the product of q and α is in the center of the design squatcheloid (obtained from ref. 26). Coupled with this $q\alpha$ is the use of the April mean statistical wind for the trajectory design. Since wind dispersions are the prime driver of the size and shape of the squatcheloid, a mean wind nominal is expected to have balanced structural margins about it. This phase occurs approximately when the Mach number is 0.6 and terminates when the Mach number is 2.25. Time histories of q, Mach number, β, α, $q\beta$, and $q\alpha$ are shown in figures 6.2-1(k),(l),(n),(o),(q), and (r) (respectively). During that period, the maximum dynamic pressure (fig. 6.2-1(k)) of 575 lb/ft^2 is achieved at 53.7 seconds GET, a minimum $q\alpha$ of -2187 lb-deg/ft^2 is achieved at 53 seconds GET, and a maximum $q\alpha$ of 963 lb-deg/ft^2 is achieved at 87 seconds GET.

6.2.8 Terminal Steering

The pitch and yaw attitude commands for the final phase of the first stage are designed to provide a transition from the $q\alpha$ profile to a positive 2° constant angle-of-attack profile while maintaining zero sideslip. These last objectives come from the heating constraint and SRB separation dynamics groundrules. A summary of SRB separation variables is included in table 6.2-I.

6.2.9 Deterministic Wind Effects

The first-stage digital autopilot performs the load relief function during the high-q region by flying out acceleration errors and attitude errors; i.e., the vehicle is flown into off-nominal winds. Accordingly, a tailwind tends to loft the Shuttle, lower maximum dynamic pressure, and reduce MPS propellant margin at MECO. A headwind has the opposite effect. Figure 6.2-1(fff) shows pitch attitude versus relative velocity profiles for the April mean wind, 95 percent tailwind, and 95 percent headwind. Although the lofted (tailwind) trajectory is initially faster than the depressed (headwind) trajectory, the larger gravity and thrust losses cause the lofted trajectory to be slower at staging. Angle of attack and pitch attitude error histories for the three trajectories are shown in figures 6.2-1(ggg) and (hhh). From a loads indicator standpoint, the tailwind shifts $q\alpha$ toward the top of the design squatcheloid (more positive) and the headwind has the opposite effect.

6.3 SRB SEPARATION AND DISPOSAL

Nominal, ATO, AOA, and RTLS SRB separations occur after SRB burnout and are initiated when the headend chamber pressure on both SRB's is less than or equal to 50 psia. Separation of each SRB is accomplished by eight booster separation motors (BSM's). The SRB's are jettisoned at separation into suborbital free-flight trajectories. The SRB recovery area is located along the groundtrack downrange from the launch pad.

6.3.1 SRB Separation

The SRB separation normally occurs at 131.52 seconds after SRB ignition for the nominal, ATO, AOA, and RTLS missions and always after SRB burnout. The SRB separation sequence is initiated and controlled by the Orbiter. The primary cue for initiation of the separation sequence is the SRB headend chamber pressure, and the backup cue is time elapsed from the command of SRB ignition. Each SRB furnishes redundant chamber pressure signals to the Orbiter during SRB thrust tail-off. Normally, the separation sequence is initiated when the indicated chamber pressure on both SRB's (Pc_4 and Pc_5) is $\leq$ 50 psia. The chamber pressure measurements are accurate to $\pm$20 psia. As a backup, the sequence is initiated on a time (133.0 seconds) that will assure that the chamber pressure of both SRB's is $\leq$50 psia.

The separation is completely automatic but could be inhibited (auto inhibit) if the test on the dynamic pressure limit or the rate inhibit inequality test is failed. SRB separation auto inhibit criteria considered in the separation inhibit test are presented in a listing on the following page.

Commands to null the SRB thrust vector control actuators and to initiate the second-stage flight control system configuration are issued 1.7 seconds before the separation command to ensure that the null has adequate time to be achieved. The command-to-arm separation pyrotechnic initiation controllers (PIC's) is also issued at this time. Commands to separate the SRB's and to initiate a 3-axis attitude control are issued 6 seconds after sequence initiation (to assure that the thrust of each SRB is $\leq$ 60 000 pounds). The attitude hold is terminated 4.0 seconds after the separation command.

The separation is effected by eight BSM's per SRB. Four BSM's are mounted forward in the nose frustum, and four are mounted aft in the SRB skirt. The BSM's nominally burn for 0.68 second with a thrust of 21 700 pounds each.

The SRB separation sequence is shown in figure 6.3-1. Separation trajectory data are presented in figure 6.3-2 for a normal SRB separation. The separation system provides a safe separation for staging conditions that satisfy the dynamic pressure and rate inhibit inequality tests that are based on the following parameters.

P - SELECTED RGA ROLL RATE
Q - SELECTED RGA PITCH RATE
R - SELECTED RGA YAW RATE
QBAR - DERIVED ASCENT DYNAMIC PRESSURE
AP - ROLL RATE LIMIT SLOPE
AQ - PITCH RATE LIMIT SLOPE
AR - YAW RATE LIMIT SLOPE
BP - ROLL RATE LIMIT CONSTANT
BQ - PITCH RATE LIMIT CONSTANT
BR - YAW RATE LIMIT CONSTANT
DPL - DYNAMIC PRESSURE LIMIT

I-load parameter value

AP,0.0
AQ,0.0
AR,0.0
BP,5.0
BQ,2.0
BR,2.0
DPL,55.0

Note: Dynamic pressure and rate inhibit inequality tests are as follows.

If QBAR > DPL
or if $|P| > AP(QBAR) + BP$,
or if $|Q| > AQ(QBAR) + BQ$,
or if $|R| > AR(QBAR) + BR$, then inhibit separation.

If an SRB separation is inhibited, the length of the delay will be a variable. Separation will occur when staging conditions are within specified limits or the crew elects to perform manual separation.

6.3.2 SRB Disposal

The left and right SRB's are jettisoned after burnout (ignition + 131.4 seconds) on tumbling free-fall trajectories. At 78.5 seconds after separation (nominal apogee), the nozzle extension on each SRB is jettisoned. During the descending portion of the trajectory, the SRB's achieve a nose-up trim condition. At an altitude of 17 000 feet, the nosecap on each SRB is jettisoned, beginning the parachute deployment sequence. This culminates at 7000 feet with the deployment of three main parachutes on each SRB. Table 6.3-I presents the sequence of significant events during the trajectory from separation to impact. The altitude time histories of both the left and right SRB's are illustrated in figure 6.3-3.

The right SRB impacts in the Atlantic Ocean 311.3 seconds after separation, 136.9 n. mi. from the launch site. The coordinates of the nominal impact point are 29.739° N latitude, 78.341° W longitude. The left SRB impacts approximately 0.5 n. mi. right crossrange of the right SRB, 311.3 seconds after separation. This is 136.9 n. mi. from the launch site, at 29.732° N latitude, 78.337° W longitude.

The nose cap and frustum impact such that their three-sigma footprints lie mostly within that of the SRB. The nozzle extension impacts 5.6 n. mi. uprange and approximately half of its footprint lies within that of the SRB's. The nominal impact points of the SRB's and all jettisoned components are summarized in table 6.3-II. Footprints consisting of all elements of both SRB's are presented in figure 6.3-4. Figure 6.3-5 shows the location and size of the composite footprint containing all elements of both SRB's. The composite footprint is 13.3 n. mi. long and 9.9 n. mi. wide.

Because the RTLS abort region extends beyond, and the AOA and ATO regions occur after nominal SRB cutoff and separation, the SRB impact areas defined for the nominal missions apply for these conditions. Only for an engine-out RTLS abort occurring between lift-off and nominal SRB cutoff is the SRB impact footprint changed from the nominal planned.

6.4 SECOND-STAGE ASCENT

The second stage of ascent requires no shaping design as does first-stage. This is because of the closed-loop optimization of guidance, PEG (sec. 5.6.1.2). The significant characteristics of this second-stage trajectory are discussed in the following paragraphs. For plots of second-stage trajectory parameters, refer to the list of figures (figs. 6.4-1(a) through 6.4-1(ii)).

The alpha-limiting logic is required at the start of the second stage. Figure 6.4-1(n) shows the angle of attack being limited to no more than 7.0 degrees at approximately 144 seconds GET. It is also seen that the angle of attack is within bounds at 150 seconds; thus, there is no discontinuity when alpha-limiting is ended.

The PEG commands show (figs. 6.4-1(gg) and 6.4-1(hh)) an expected discontinuity after the end of the first phase of T_RTLS_ATO (260 sec GET). (Had an SSME failed at that time, the commands would have continued smoothly since PEG expected the failure.) The commanded attitude change is on the order of 20° in the pitch plane (see fig. 6.4-1(o)). The GC_STEER will limit the rate at which the attitude error is taken out if the total magnitude exceeds 3 deg/sec. This attitude error of 20° did cause the pitch rate to be limited (fig. 6.4-1(s)).

At MECO minus 10.0 seconds, the MECO sequence begins. At approximately 3 seconds later, the SSME's are commanded to begin throttling at 10 percent/sec to 65 percent thrust level. Once achieved, the SSME's are held at that thrust level until the velocity target has been achieved, approximately 6.7 seconds later. MECO (zero thrust) occurs at 518.04 seconds GET. At MECO, the total usable main propulsion system (MPS) propellant (nominal margin) excluding ET FPR (4806 pounds) and other reserved ET propellants (10 522 pounds) is 7788 pounds. Selected trajectory parameters at MECO are shown in table 6.4-I.

6.5 ET SEPARATION AND DISPOSAL

For the nominal, AOA, or ATO mission, the tumble system is activated at 7.2 seconds after MECO-command to produce an ET tumble rate of at least 10 deg/sec entry (dynamic pressure of 1 lb/ft^2). The Orbiter/ET separation occurs approximately 18.0 seconds after MECO-command and the ET is jettisoned on a suborbital trajectory that results in an impact location near the antipode in the Indian Ocean.

6.5.1 Nominal Orbiter/ET Separation

The Orbiter/ET separation sequence, controlled by the Orbiter, is initiated at the MECO-confirmed command when all SSME engine chamber pressures are below 30 percent. The mode of separation may be automatic or manual. In the auto mode, separation takes place if (1) the body rate limit of ±0.5 deg/sec is not exceeded in any axis and (2) the propellant feed umbilical disconnect valves are closed. If these two requirements for auto separation are not met they may be manually bypassed. Separation may then be initiated by placing the auto/manual switch in the manual position and depressing the separation push button. The ET separation time line applicable to the nominal, AOA, and ATO missions is presented in figure 6.5-1.

After initiation of the separation sequence, there is a mated coast with issuance of a series of commands and status checks. The ET tumble system is activated 7.2 seconds after the MECO-command. Rate damping and attitude hold after SSME thrust tailoff is performed with the TRANS DAP using forward and aft RCS systems. The body attitude is snapshot at initiation of the TRANS DAP. The attitude deadbands (roll, pitch, and yaw) are set to ±5.0 deg/axis. Body rates (roll, pitch, and yaw) for attitude rate control are ±0.3 deg/sec/axis.

The Orbiter structurally releases the ET at MECO-confirmed +17 seconds. RCS jet firing is initiated 0.16 seconds prior to structural release to assure a positive separation rate between the Orbiter and ET and to preclude possible damage at the forward attach strut. Maximum time delay from the first to the last structural release is not greater than 0.02 seconds. The Orbiter performs a high mode RCS -Z translation for the translational $\Delta V \geq 4.0$ fps, which is then followed approximately 2.0 seconds later by a +Y translation for a ΔV of 4.0 fps.

Four forward and six aft RCS jets are used to achieve the translational ΔV of 4.1 fps. Thrust duration for this nominal -Z translation is 5.3 seconds. An attitude deadband of ±3.0 deg/axis and rate deadband of ±0.3 deg/sec/axis are maintained during the maneuver. The -Z translation assures Orbiter clearance from the arc of a rotating ET.

Approximately 2.0 seconds following the -Z translation a +Y translational maneuver is executed for a ΔV of 4.0 fps. Two side-firing RCS jets (one forward and one aft) are used to perform the +Y translation and thrust duration is for 24 seconds. An attitude deadband of ±3.5 deg/axis and rate deadband of ±0.3 deg/sec/axis are maintained during the maneuver. The +Y translation places the Orbiter out-of-plane from the ET to a more preferred relative position for performing the OMS-1 burn.

The Orbiter continues to coast away from the ET to obtain additional vertical and horizontal clearance prior to OMS-1 ignition. During the coast period the Orbiter maneuvers at 1.0 deg/sec to the OMS-1 burn attitude. The Orbiter is alined to the burn attitude when ignition occurs at MECO command +121.4 seconds. Relative motion between the Orbiter and ET from structural separation through 10 seconds of the OMS burn is presented in a target-centered curvilinear coordinate system in figure 6.5-2. No recontact problems exist at separation or during the following maneuver for the nominal Orbiter/ET separation.

6.5.2 ET Disposal

The intact ET impact location for the nominal mission is 31.2° S latitude and 93.7° E longitude in the Indian Ocean. Trajectory, drag, rotational lifting effect, and atmospheric uncertainties, together with the debris breakup scatter during entry result in an ET impact footprint of 1059 nautical miles uprange and 745 n. mi. downrange from the nominal impact point. There is also a crossrange deviation of ±29 n. mi. about the groundtrack. The ET breakup occurs during entry at an altitude of 195 000 feet for tumbling drag. From this altitude to ET impact, ballistic numbers of 5.1 and 55 were used with a lift/drag (L/D) of -0.465 and +0.033 to predict the debris scatter. The MECO conditions used and the contributions of the various errors to the footprint are presented in table 6.5-I. Figure 6.5-3 presents the ET groundtrack and the footprint dispersion area. The uprange footprint boundary is 21.9° S latitude and 77.9° E longitude. The downrange footprint boundary is 36.0° S latitude and 106.6° E longitude. The crossrange boundary is ±0.5° in width. Figure 6.5-3 shows that the ET footprint does not violate the constraint of impacting closer than 200 n. mi. from a landmass.

6.6 OMS-1 MANEUVER (INSERTION)

The OMS insertion maneuver (OMS-1) is initiated following the RCS +Y evasive maneuver. The OMS maneuver is performed with two 6000-pound constant thrust engines that have a specific impulse of 313.2 seconds. The engines are oriented parallel to the Orbiter body X-Z plane and are pitched through the center-of-gravity projection in the body Y-Z plane.

The OMS-1 maneuver is designed to raise the orbital apogee to 150 n. mi.. Ignition for OMS-1 occurs at 634.1 seconds GET and insertion occurs at 743.5 seconds GET. A summary of the OMS-1 maneuver parameters is contained in table 6.6-I. After OMS-1, the Orbiter is at an altitude of 67.7 n. mi. above a spherical Earth (72.3 n. mi. local altitude). The downrange distance is 1635 n. mi. from the launch site.

Venting of 4997 pounds of MPS propellant is initiated at the beginning of the OMS-1 maneuver. This is a propulsive event that extends past OMS-1 cutoff and, consequently, the OMS-1 burnout targets are adjusted to account for the extra ΔV. The venting of the fuel and oxidizer are handled sequentially. The LOX is vented at a flow rate of 90 lb/sec and a force of 819 pounds for a period of 52 seconds. The LOX vent sequence continues for an additional 63 seconds, for 115 seconds total, although no thrusting or venting occurs. A 10-second period follows the LOX vent before LH_2 venting is initiated. The LH_2 is vented at 6.7 lb/sec with a force of 143 pounds for a period of 47 seconds. Following this vent period, the Orbiter is in a 149.8- by 57.5-n. mi. orbit. The MPS vent model used in this simulation assumes the entire 4997 pounds of LOX and LH_2 are vented in this 172 second time interval. Selected trajectory parameters at OMS-1 cutoff and MPS propellant dump completion are included in table 6.4-I. In this document, OMS cutoff is defined as the end of thrust tailoff.

Time histories of OMS-1 trajectory parameters of interest are listed in the following figures: inertial velocity (fig. 6.6-1(a)), inertial flightpath angle (fig. 6.6-1(b)), and local vertical local horizontal velocity-to-be-gained components (fig. 6.6-1(c)). The Earth-relative position of the OMS-1 burn as well as the OMS-2 burn is shown on the orbital ground trace of figure 6.6-2.

The dedicated display ADI angle time histories for the two applicable switch positions, inertial and unbiased LVLH, are shown in figures 6.6-1(d) and 6.6-1(e), respectively. The prime monitoring switch position for both the OMS-1 and the OMS-2 maneuvers is inertial although the inertial RELQUAT is constructed to provide easier monitoring of the OMS-2 maneuver (near zero pitch angle).

Representations of the data displayed on the MNVR EXEC CRT display are given for the OMS-1 ignition (fig. 6.6-3) and OMS-1 cutoff time points (fig. 6.6-4). The values for apogee and perigee altitudes shown in table 6.6-I, which reflect environmental values, differ from those in figures 6.6-4 and 6.7-4 that reflect the "onboard" software and navigated state. The values shown in table 6.6-I of ΔV magnitude, cutoff weight, and apogee and perigee altitudes reflect the additional ΔV of the post OMS-1 cutoff MPS dump. Burn monitoring parameters that appear on the CRT display for OMS-1 are shown in figures 6.6-1(f) through 6.6-1(j).

Time histories of OMS commanded and actual gimbal angles are depicted in figures 6.6-1(k) through 6.6-1(n). The control system rate errors (difference of commanded and actual) are depicted in figures 6.6-1(o) through 6.6-1(q).

6.7 OMS-2 MANEUVER (CIRCULARIZATION)

A circularization burn (OMS-2) is initiated at 45:50.6 min:sec GET. The burn places the Orbiter in a 150.9- by 149.8-n. mi. orbit (near circular). The OMS engine cutoff (including OMS engine tailoff) for this burn occurs at 47:20.8 min:sec GET. Selected trajectory parameters at OMS-2 cutoff are included in table 6.4-I. A summary of the OMS-2 maneuver parameters is contained in table 6.6-I.

Time histories of OMS-2 trajectory parameters of interest are listed in the following figures: inertial velocity (fig. 6.7-1(a)), inertial flightpath angle (fig. 6.7-1(b)), and local vertical local horizontal velocity-to-be-gained components (fig. 6.7-1(c)).

Figures 6.7-1(d) and 6.7-1(e) contain ADI angle time histories for the inertial and unbiased LVLH switch positions.

Representations of the data displayed on the CRT are given for the following significant time points: calculation of premaneuver display feedback parameters ("LOAD" command input, assumed to occur at 23:48.0 min:sec GET) (fig. 6.7-2), OMS-2 ignition (fig. 6.7-3) and OMS-2 cutoff (fig. 6.7-4). Burn monitoring parameter values that appear on the CRT display for OMS-2 are shown in figures 6.7-1(f) through 6.7-1(i).

Time histories of OMS commanded and actual gimbal angles are depicted in figures 6.7-1(j) through 6.7-1(m). The control system rate errors (difference of commanded and actual) are depicted in figures 6.7-1(n) through 6.7-1(p).

6.8 RADAR COVERAGE DATA

Table 6.8-I contains a list of acquisition of signal (AOS) and loss of signal (LOS) for the ascent radar tracking network for STS-1. The coverage is from lift-off through OMS-2 cutoff. All AOS and LOS times are for 0° elevation and are rounded off due to program output frequency. Terrain masking is included for certain sites as indicated in the table. The groundtrace and associated radar coverage from lift-off through OMS-2 cutoff are shown in figure 6.6-2.

7.0 FIRST-STAGE LOAD INDICATORS

Shuttle first-stage load indicators are expressed in terms of $q\alpha$ and $q\beta$ versus Mach number. The STS-1 OFP mean wind allowable $q\alpha$ and $q\beta$ envelopes during the high dynamic pressure region (ref. 26) reflect limiting load constraints and Shuttle wind response envelopes (squatcheloids) for a March launch. The $q\alpha$ design profile in figure 7.0-1 was selected so that the Shuttle will nominally fly within the mean wind allowable envelope in the presence of the April steady-state mean wind (fig. 5.3-1). The vehicle yaw profile is designed for a zero β. Figures 7.0-2 and 7.0-3 are the actual $q\alpha$ and $q\beta$ profiles from the 6-DOF simulation using the ascent I-loads.

8.0 FLIGHT PERFORMANCE RESERVE REQUIREMENT

A normal flight performance reserve (FPR) requirement of 6617 pounds of main propulsion system (MPS) propellant has been set aside for STS-1. The contribution of individual error sources (table 8.0-I) was obtained from reference 27. Since most plus and minus error sources produce unsymmetrical changes in MPS usage, each FPR contributor can be defined in terms of a mean and three-sigma component. The mean components are additive and the three-sigma components are root-sum-squared. Error source contributions can also be defined in terms of an allotment. Allotment values are additive.

9.0 REFERENCES

1. Flight Requirements Document, OFT-1 Basic. JSC-10780, Oct. 1, 1977.

2. Flight Analysis Branch: STS-1 Operational Flight Profile, Ascent Profile-Cycle 2, JSC IN 78-FM-51, Vol. III, JSC-14483, Jan. 1979.

3. STS-1 Operational Flight Profile, Groundrules and Constraints - Cycle 3. Vol. I, Revision 2, JSC-14483, Sept. 1979.

4. Shuttle Master Verification Plan - Master Flight Test Assignment Document, Vol. X, JSC-07700.

5. Shuttle Operational Data Book, Vol. I, Amend. 84, Aug. 1979; Vol. II, Amend. 31, JSC-08934, Feb. 7, 1980.

6. Mated Vehicle/Aerodynamic Design Data Book. Vol. II, SD 72-SH-0060-2K, July 1979.

7. Mated Vehicle/Aerodynamic Design Data Book. Vol. I, SD 72-SH-0060-1K, Nov. 1977.

8. Orbital Aerodynamic Characteristics of the SSV Orbiter. JSC IN EX33/7605-97, May 1976.

9. A Reference Atmosphere for Patrick AFB, Florida, Annual (1963 Revision). NASA TM X-53139, 1964.

10. Normal Probabilities for Cape Kennedy Wind Components - Monthly Reference Periods for All Flight Azimuths - Altitudes 0 to 70 kilometers. NASA TM X-64771, 1973.

11. Burbank, P. B. (NASA Houston, Tx): SRB Thrust Characteristics for STS-1 Left and Right Motors for Cycle 3' and 3. NASA JSC Memorandum LT-1002, Aug. 13, 1979.

12. SRB Systems Performance and Design Data. MSFC Document SE-019-125-2H, June 24, 1977.

13. Burbank, P. B. (NASA, Houston, Tx): SSME Isp avg for STS-1, NASA JSC Memorandum LT-997, Aug. 3, 1979.

14. Shuttle Operational Data Book. Vol. I, Amend. 84, JSC-08934, Aug. 1, 1979.

15. Shuttle Operational Data Book. Vol. II, Amend. 31, JSC-08934, Feb. 7, 1980.

16. MPAD I-Load Updates for STS-1 OFP Cycle 3, Orbiter Software Change Requests No. 29093 and 29094. Oct. 25, 1979.

17. Space Shuttle Orbiter; Orbital Flight Test; Level C Functional Subsystem Software Requirements Document; Guidance, Navigation, and Control; Part A; Guidance; Ascent/RTLS. SD 76-SH-0002E, Aug. 15, 1979.

18. Jaggers, R. F. (McDonnell Douglas Technical Services Co., Houston, Tx.): An Explicit Solution to the Exoatmospheric Powered Flight Guidance and Trajectory Optimization Problem for Rocket Propelled Vehicles. AIAA Paper 77-1051 (presented at AIAA 1977 Guidance and Control Conference, Hollywood, Fla.), Aug. 1977.

19. STS-1 Operational Flight Profile, Vol. VI, Abort Analysis. JSC-14483, to be published approx. Feb. 1980.

20. Space Shuttle Orbital Flight Test; Level C Functional Subsystem Software Requirements Document; Guidance, Navigation, and Control; Part B; Navigation-Ascent/RTLS. SD 76-SH-0005C, Aug. 15, 1979.

21. Space Shuttle Orbital Flight Test; Level C Functional Subsystem Software Requirements Document; Guidance, Navigation, and Control; Part C; Flight Control-Ascent Flight Phase. Vol. I, SD 76-SH-0008C, Aug. 15, 1979.

22. Lenoir, W. B. (NASA, Houston, Tx.): SPS Deorbit Maneuver Simulation, Part II-Pilot Comments. NASA JSC Memorandum CB-Le-61, May 24, 1978.

23. Johnson, I. L., Jr. (NASA, Houston, Tx.): An Optimal Space Shuttle Ascent Trajectory for the First Orbital Flight Test. (Paper presented at AAS/AIAA Astrodynamics Conference, Jackson, Wyoming), Sept. 1977.

24. Software Development Branch: Space Vehicle Dynamics Simulation (SVDS) Program. Vols. I-III, JSC IN 76-FM-26, Rev. 3, JSC-11157, Jan. 1979.

25. Mated Vehicle/Aerodynamic Design Data Book. Vol. II, SD 72-SH-0060-2K, July 1979.

26. Recommended OFT-1 α/β Schedules for Shuttle Ascent Vehicle. Aug. 15, 1979 AFSIG meeting No. 33 minutes, LE-M-216, Sept. 25, 1979.

27. STS-1 Cycle 3 March/April Launch Ascent Trajectory, Rockwell International Letter, SAS/MR&I-79-724, Feb. 14, 1980.

TABLE 3.0-I.- SIGNIFICANT TRAJECTORY PARAMETERS FOR NOMINAL ASCENT

Parameter	Value
Weight at SRB ignition command, lb	4 449 965
Payload weight, lb	10 175
Initial launch heading, deg	67.18
In-flight azimuth (average), deg	59.5
Max q (54 sec), lb/ft^2	575
Max $q\alpha$ (19 sec), $lb\text{-}deg/ft^2$	482
(87 sec), $lb\text{-}deg/ft^2$	963
Min $q\alpha$ (53 sec), $lb\text{-}deg/ft^2$	-2 187
Max $q\beta$ (high-q region, 58 sec), $lb\text{-}deg/ft^2$ ...	106
Min $q\beta$ (high-q region, 71 sec), $lb\text{-}deg/ft^2$ ...	-99
SRB staging q, lb/ft^2	16
SRB staging h, n. mi.	27.5
SRB staging V_e, fps	4 186.8
SRB staging γ_e, deg	34.9
Usable SSME propellant, lb (at nominal MECO) .	7 788
Ascent yaw steering (node shift), deg	0.0
MECO orbit	
HA, n. mi.	80.6
HP, n. mi.	13.3
inclination, deg	40.3
OMS-1 cutoff orbit (after MPS dump)	
HA, n. mi.	149.8
HP, n. mi.	57.5
inclination, deg	40.3
OMS-2 cutoff orbit	
HA, n. mi.	150.9
HP, n. mi.	149.8
inclination, deg	40.3

TABLE 5.2-I.- ELEVON DEFLECTION SCHEDULE 6

Earth-relative velocity V_e, fps	Inboard elevon deflection, deg	Outboard elevon deflection, deg
0	10	9
1085	10	9
1246	10	0
1498	10	-5
1721	10	-5
2307	3.532009	-5
2520	1.181015	0
2627	0	0
5000	0	0

TABLE 5.4-I.- SRB OPERATIONAL CHARACTERISTICS

(a) Thiokol prediction for STS-1A
(left-hand motor) at PMBT = 66 deg

Time, sec	Head pressure, psia	Nozzle pressure, psia	Vacuum thrust, lbf	Total flowrate, lb/sec
0.000	14.700	14.700	0.0	0.010
0.010	14.823	14.823	19793.7	0.020
0.020	17.243	14.823	53485.2	0.030
0.030	20.469	14.823	68170.7	0.040
0.040	22.788	14.823	101208.7	0.050
0.049	28.637	14.823	154612.6	0.060
0.059	26.620	14.823	176044.7	0.071
0.069	26.822	14.823	206840.6	0.081
0.079	29.242	14.823	256068.2	0.091
0.089	33.376	18.251	283106.6	274.648
0.099	41.342	22.587	258510.5	340.790
0.109	49.711	27.124	206476.7	409.452
0.119	62.820	34.284	215185.9	516.629
0.129	83.591	45.678	267921.1	687.225
0.139	113.438	62.013	400568.0	929.609
0.149	163.049	89.238	539418.7	1334.927
0.159	235.347	136.025	749807.4	2017.918
0.168	312.384	191.287	951135.2	2851.340
0.178	375.304	244.321	1093602.2	3639.785
0.188	417.655	289.999	1204276.3	4316.331
0.198	444.577	331.039	1308945.7	4924.308
0.208	465.652	354.129	1397693.8	5297.967
0.218	486.929	375.304	1482022.6	5613.550
0.228	511.632	405.765	1606704.2	6080.069
0.238	542.598	452.342	1788226.1	6757.615
0.248	576.872	499.633	1575972.2	7457.947
0.258	606.416	532.706	2107401.5	7948.059
0.268	630.314	555.898	2199290.0	9289.756
0.277	649.876	579.586	2269771.3	8626.614
0.287	665.606	598.148	2367514.9	8915.680
0.297	679.924	612.668	2425423.5	9131.043
0.396	782.170	677.605	2684425.2	10094.329
0.495	818.874	709.570	2811911.4	10566.595
0.595	827.848	741.131	2937492.3	11033.115
0.694	825.529	715.418	2835470.7	10654.617
0.793	822.908	716.830	2841322.2	10676.295
0.892	820.790	729.939	2893580.8	10870.385
0.991	819.076	717.032	2842248.1	10680.128
1.982	801.835	719.050	2852606.1	10721.272
2.973	792.963	716.833	2846093.7	10696.980
3.964	790.948	720.767	2863963.2	10764.943
4.955	798.832	722.584	2873660.5	10802.054
5.947	792.262	727.627	2895626.6	10884.739
6.938	790.852	732.166	2916260.5	10963.088
7.929	794.282	735.495	2931793.1	11021.675
8.920	788.839	735.505	2938035.6	11046.394
9.911	786.723	738.120	2946819.1	11080.370
10.902	788.943	740.944	2960308.4	11131.396
11.893	784.810	741.149	2963816.9	11145.821
12.884	785.820	743.973	2977519.7	11197.956
13.875	785.721	745.789	2986974.0	11234.261
14.866	785.319	746.094	2990431.8	11247.981
15.857	783.405	747.103	2997192.6	11274.405
16.849	786.936	748.214	3003740.2	11299.317
17.840	782.702	749.022	3009505.2	11322.313
18.831	784.216	784.216	3020819.5	11365.575
19.822	783.714	753.059	3030273.9	11401.981
20.813	784.421	754.170	3036750.4	11427.195
21.804	782.003	753.869	3037840.0	11432.547
22.795	780.895	753.064	3036602.1	11429.025
23.786	768.998	743.485	2999933.1	11293.320
24.777	754.176	730.277	2948445.2	11102.260
25.768	743.791	720.396	2910159.9	10960.202
26.759	729.574	707.893	2861527.9	10779.628
27.751	721.710	697.811	2822683.5	10635.149
28.742	710.115	690.047	2793342.2	10526.867
29.733	700.435	681.376	2759782.9	10402.453
30.724	692.773	674.621	2734415.6	10308.690
31.715	684.606	664.539	2695134.0	10162.396
32.706	676.943	657.683	2669095.7	10066.111
33.697	667.163	651.835	2647112.9	9985.254
34.688	661.517	643.769	2615840.2	9868.804

TABLE 5.4-I.- Continued

(a) Continued

Time, sec	Head pressure, psia	Nozzle pressure, psia	Vacuum thrust, lbf	Total flowrate, lb/sec
35.679	652.543	638.123	2594751.6	9791.172
36.670	646.191	629.754	2562269.3	9670.285
37.661	638.125	625.117	2545032.8	9607.072
38.652	631.370	619.462	2519604.2	9512.702
39.643	625.724	613.522	2501086.9	9444.346
40.635	618.767	606.767	2475089.0	9347.859
41.626	612.919	602.028	2457527.1	9283.032
42.617	607.575	594.567	2428490.1	9174.848
43.608	602.534	590.030	2411263.6	9111.231
44.599	599.106	587.005	2400541.9	9071.913
45.590	592.149	582.973	2385470.1	9016.664
46.581	586.301	578.234	2367867.4	8951.634
47.572	582.470	571.579	2342194.5	8855.852
48.563	578.135	567.647	2327366.5	8801.107
49.554	575.917	565.732	2320832.3	8777.518
50.545	570.473	562.506	2309277.1	8734.972
51.536	567.952	558.271	2293361.5	8675.589
52.527	564.222	554.844	2280515.4	8627.901
53.519	559.483	552.323	2271846.7	8596.145
54.510	556.560	547.685	2253377.9	8528.896
55.501	552.325	543.652	2238572.0	8472.033
56.492	551.822	545.267	2247019.5	8504.504
57.483	555.957	547.587	2257794.5	8545.344
58.474	558.076	551.722	2276090.9	8614.820
59.465	561.606	553.438	2284602.6	8647.795
60.456	563.825	555.859	2296207.8	8691.156
61.447	565.944	561.003	2318742.7	8776.663
62.438	570.584	562.920	2328054.2	8811.857
63.429	570.191	564.534	2336278.1	8843.522
64.420	576.737	569.275	2357339.2	8922.980
65.411	577.747	570.486	2363865.8	8949.091
66.402	580.470	573.310	2376979.7	8997.905
67.393	582.589	578.152	2398446.4	9079.380
68.385	590.456	583.497	2422201.2	9168.921
69.376	591.969	585.011	2430221.9	9199.578
70.367	594.794	589.037	2444149.0	9252.417
71.358	596.812	592.476	2463933.8	9327.641
72.349	595.704	593.082	2468107.4	9344.081
73.340	602.159	595.905	2480996.8	9392.585
74.331	601.555	595.302	2490550.9	9391.582
75.322	599.640	593.488	2474575.7	9369.706
76.313	601.355	593.388	2475644.3	9374.047
77.304	600.448	597.423	2493991.9	9444.129
78.295	599.743	597.323	2494826.6	9447.965
79.286	598.030	596.215	2491799.1	9437.181
80.277	605.796	600.249	2510258.5	9506.961
81.268	604.587	603.074	2523534.2	9558.187
82.259	603.277	601.059	2516674.7	9533.096
83.250	605.093	596.521	2499071.8	9466.946
84.241	600.858	595.715	2497091.1	9460.800
85.232	594.102	589.060	2470553.7	9361.891
86.224	583.413	578.572	2428139.9	9203.188
87.215	581.296	576.556	2420690.8	9176.070
88.206	570.103	568.590	2388909.7	9057.699
89.197	561.128	556.691	2340101.4	8874.495
90.188	558.204	550.741	2316369.2	8795.566
91.179	550.742	546.506	2299863.7	8724.568
92.170	542.372	538.238	2256536.4	8599.946
93.161	533.801	532.086	2241645.3	8507.286
94.152	530.574	526.641	2220199.9	8426.928
95.143	527.953	522.003	2201549.6	8357.258
96.134	517.566	513.835	2168181.5	8232.635
97.125	511.314	512.121	2162012.8	8210.557
98.116	506.474	506.474	2139408.5	8126.266
99.107	504.256	500.726	2116235.0	8039.152
100.098	495.987	496.592	2099780.1	7978.455
101.089	489.331	486.104	2056247.6	7814.608
102.080	485.197	478.742	2026202.9	7701.580
103.071	477.196	472.894	2002145.0	7612.347
104.062	476.122	469.465	1988749.4	7561.733
105.053	469.567	466.642	1977722.0	7521.303
106.045	464.726	461.802	1958268.4	7448.607

TABLE 5.4-I.- Continued

(a) Concluded

Time, sec	Head pressure, psia	Nozzle pressure, psia	Vacuum thrust, lbf	Total flowrate, lb/sec
107.036	452.121	452.322	1518974.2	7301.396
108.027	443.145	440.422	1869383.4	7114.458
109.018	439.313	436.691	1854229.3	7057.894
110.009	429.128	428.926	1822090.5	6537.504
111.000	424.489	427.615	1817619.0	6921.676
111.991	414.808	420.052	1784423.1	6804.009
112.982	409.866	407.143	1728306.7	6597.912
113.973	407.648	405.026	1717909.3	6565.648
114.964	398.168	395.647	1676957.9	6417.428
115.955	398.774	396.152	1678117.3	6428.925
116.946	384.856	382.435	1560506.6	6208.913
117.937	364.182	361.963	1420605.5	5879.901
118.928	315.369	313.554	1266647.0	5099.767
119.919	239.931	238.519	963504.5	3887.569
120.910	179.620	178.612	721540.0	2917.870
121.901	136.455	135.547	547752.5	2219.913
122.892	107.308	106.602	430874.0	1749.533
123.427	95.824	95.824	272784.9	1565.459
124.418	71.233	71.233	240258.0	1166.308
125.409	50.434	50.434	210200.4	827.903
126.400	33.841	33.841	150700.4	557.139
127.392	21.607	21.607	98474.1	356.866
128.383	12.680	12.680	57767.3	210.175
129.374	7.913	7.913	36055.9	131.600
130.365	4.897	4.897	22310.7	81.732
131.356	2.686	2.686	12236.8	45.032

TABLE 5.4-I.- Continued

(b) Thiokol prediction for STS-1B (right-hand motor) at PMBT = 66 deg

Time, sec	Head pressure, psia	Nozzle pressure, psia	Vacuum thrust, lbf	Total flowrate, lb/sec
0.000	14.700	14.700	0.0	0.010
0.010	14.822	14.822	19791.3	0.020
0.020	17.242	14.822	53478.8	0.030
0.030	20.469	14.822	68162.5	0.040
0.040	22.788	14.822	101196.5	0.050
0.049	28.636	14.822	154594.0	0.060
0.059	26.619	14.822	176023.6	0.071
0.069	26.821	14.822	206815.8	0.081
0.079	29.241	14.823	256037.5	0.091
0.089	33.375	19.250	283072.7	274.638
0.099	41.341	22.596	258479.6	340.777
0.109	49.709	27.123	206452.0	409.437
0.119	62.817	34.282	215160.1	516.611
0.129	93.568	45.676	287896.6	687.201
0.139	113.434	62.011	400520.0	929.576
0.149	163.043	89.235	539354.1	1334.880
0.159	235.338	136.020	749717.6	2017.646
0.168	312.373	191.275	951021.2	2651.739
0.178	375.291	244.312	1093471.2	3638.657
0.188	417.640	289.989	1204132.0	4316.179
0.198	444.562	331.027	1308789.5	4924.134
0.208	465.635	354.117	1397591.3	5297.780
0.218	486.910	375.291	1481845.0	5613.352
0.228	511.614	406.750	1606511.7	6075.854
0.238	542.569	452.326	1788011.8	6757.376
0.248	576.851	499.515	1975735.5	7457.684
0.258	606.395	532.688	2107149.0	7947.778
0.268	630.292	555.879	2194015.4	8289.463
0.277	649.953	573.565	2289445.9	8626.309
0.287	665.582	598.127	2367231.2	8515.365
0.297	679.900	612.646	2425137.9	9130.720
0.396	782.142	677.581	2684113.5	10093.972
0.495	818.845	709.545	2811474.5	10566.222
0.595	827.819	741.105	2937140.3	11032.725
0.694	825.500	715.393	2835131.0	10654.241
0.793	822.879	716.805	2840951.7	10675.918
0.892	820.761	729.913	2893234.1	10870.001
0.991	822.476	720.037	2853827.4	10724.818
1.982	805.336	722.251	2864886.1	10769.783
2.973	796.364	719.934	2858039.6	10743.283
3.964	794.147	723.666	2875398.0	10809.328
4.955	791.930	725.583	2885215.9	10846.942
5.947	795.562	730.727	2907993.0	10932.648
6.938	793.849	735.064	2927619.7	11007.163
7.929	796.876	738.091	2941787.2	11060.707
8.920	792.139	739.706	2950499.5	11094.692
9.911	790.325	741.522	2960379.5	11132.709
10.902	792.243	744.044	2972656.5	11179.296
11.893	798.312	744.553	2976578.0	11196.746
12.884	788.918	747.073	2989683.2	11245.149
13.875	788.819	743.788	2998699.4	11275.839
14.866	788.720	749.395	3003518.6	11298.701
15.857	786.604	750.304	3009526.7	11322.301
16.849	790.437	751.616	3017120.2	11351.144
17.840	785.599	751.920	3020699.5	11365.973
18.831	787.516	754.543	3032943.4	11416.392
19.822	786.913	755.259	3043041.0	11451.486
20.813	787.121	757.471	3049872.4	11478.010
21.804	785.303	757.170	3050697.6	11482.454
22.795	783.590	755.860	3047498.5	11471.573
23.786	771.088	745.577	3008049.4	11325.588
24.777	756.065	732.268	2956181.4	11132.522
25.768	746.286	727.992	2920533.0	11000.750
26.759	732.876	711.196	2874691.3	10830.567
27.751	724.205	700.301	2832619.8	10674.095
28.742	712.913	692.847	2804403.0	10569.951
29.733	702.932	683.773	2769452.4	10440.298
30.724	694.362	676.312	2740569.3	10334.843
31.715	696.498	666.431	2702595.9	10191.982
32.706	678.533	659.273	2675168.4	10090.458
33.697	666.249	653.027	2651714.6	10004.058
34.688	663.006	645.259	2621675.3	9892.250

TABLE 5.4-I.- Continued

(b) Continued

Time, sec	Head pressure, psia	Nozzle pressure, psia	Vacuum thrust, lbf	Total flowrate, lb/sec
35.679	653.529	639.102	2598545.6	9806.959
36.670	647.883	631.547	2569189.1	9697.671
37.661	638.909	626.002	2548356.1	9621.050
38.652	631.852	619.045	2521822.9	9522.550
39.643	626.307	614.105	2503338.3	9454.297
40.635	619.854	607.854	2479365.8	9365.375
41.626	613.099	602.309	2458198.3	9287.040
42.617	609.067	596.058	2434307.1	9198.118
43.608	603.320	590.916	2414663.5	9125.428
44.599	600.195	589.094	2404990.3	9090.044
45.590	592.532	593.456	2387257.6	9024.815
46.581	586.886	578.819	2370155.0	8961.704
47.572	582.853	572.063	2343631.5	8862.698
48.563	579.224	569.837	2331864.3	8819.449
49.554	576.502	566.317	2323339.0	8788.400
50.545	572.066	564.100	2315433.6	8759.467
51.536	569.848	562.168	2300830.5	8705.026
52.527	565.513	556.236	2285943.6	8649.678
53.519	560.573	553.413	2276107.2	8613.486
54.510	557.649	548.775	2258201.6	8546.542
55.501	555.633	546.860	2251972.9	8523.760
56.492	555.937	549.382	2263681.6	8568.531
57.483	558.660	550.290	2268693.1	8587.591
58.474	561.081	554.829	2289704.8	8663.517
59.465	564.007	555.838	2294661.4	8686.207
60.456	567.133	559.167	2309642.5	8743.077
61.447	568.647	563.706	2329776.6	8819.709
62.438	573.791	564.026	2341017.6	8861.959
63.429	573.388	567.741	2349260.9	8893.724
64.420	579.541	572.079	2368866.2	8967.734
65.411	582.768	575.407	2384010.1	9025.210
66.402	583.677	576.517	2390059.2	9048.505
67.393	587.106	582.569	2416787.8	9149.739
68.385	592.755	585.736	2431464.3	9205.097
69.376	597.394	590.537	2452797.4	9285.863
70.367	599.916	593.160	2465273.7	9333.357
71.358	599.010	594.673	2473024.2	9363.307
72.349	598.406	595.784	2479265.5	9387.510
73.340	606.978	600.625	2500863.0	9468.781
74.331	602.845	596.592	2485741.5	9412.525
75.322	602.341	596.291	2485915.0	9413.841
76.313	605.872	597.804	2493935.9	9444.295
77.304	603.352	600.427	2506092.1	9491.184
78.295	601.638	599.218	2502841.3	9479.594
79.286	601.639	599.824	2506714.7	9494.824
80.277	609.708	604.161	2526554.1	9569.743
81.268	607.894	605.391	2537236.7	9611.188
82.259	606.584	604.365	2530205.3	9585.583
83.250	604.870	596.399	2498101.9	9464.899
84.241	600.131	594.988	2498855.1	9450.183
85.232	594.788	589.745	2473286.6	9373.660
86.224	583.191	579.351	2426883.8	9200.041
87.215	582.688	577.949	2426336.3	9199.735
88.206	570.083	569.671	2398887.0	9059.094
89.197	563.730	559.293	2350919.3	8916.630
90.188	549.613	549.613	2311335.7	8769.016
91.179	549.513	545.277	2294601.7	8706.919
92.170	541.748	537.715	2263917.4	8591.476
93.161	533.076	531.342	2238744.8	8497.711
94.152	533.480	529.547	2232170.4	8473.415
95.143	524.607	518.758	2187850.6	8306.954
96.134	517.750	514.018	2169050.1	8237.185
97.125	512.305	512.103	2161896.3	8211.478
98.116	508.372	508.372	2147354.0	8157.539
99.107	502.927	499.498	2110727.5	8019.812
100.098	493.347	494.053	2068512.1	7937.238
101.089	490.827	487.600	2062312.7	7839.733
102.080	484.071	477.616	2021245.6	7684.369
103.071	473.781	472.579	2002383.0	7614.499
104.062	476.609	470.054	1990909.8	7571.146
105.053	471.466	469.542	1985615.7	7552.295
106.045	458.357	455.533	1931254.4	7347.920

TABLE 5.4-I.- Concluded

(b) Concluded

Time, sec	Head pressure, psia	Nozzle pressure, psia	Vacuum thrust, lbf	Total flowrate, lb/sec
107.036	446.760	446.961	1896162.2	7240.844
108.027	442.525	439.902	1866730.7	7105.637
109.018	440.609	438.088	1859952.7	7080.735
110.009	437.080	436.878	1855806.9	7066.017
111.000	426.390	429.512	1825704.6	6953.395
111.991	414.491	419.735	1782847.7	6799.131
112.982	412.978	410.155	1741017.1	6647.085
113.973	403.499	400.877	1700202.8	6499.576
114.964	401.482	398.860	1690528.2	6470.036
115.955	401.785	399.264	1691006.5	6478.306
116.946	385.751	393.330	1564263.1	6224.726
117.937	350.252	348.134	1364245.8	5657.468
118.928	279.153	277.539	1121193.5	4519.221
119.919	207.751	205.440	834153.1	3369.582
120.910	155.208	154.301	623440.5	2524.537
121.901	121.424	120.719	467478.6	1577.746
122.853	95.821	95.821	372740.2	1565.403
123.844	71.231	71.231	260224.4	1166.267
124.835	50.432	50.432	210175.2	827.874
125.826	33.839	33.839	150692.4	557.120
126.817	21.606	21.606	58462.3	356.854
127.808	12.680	12.680	57780.3	210.168
128.799	7.913	7.913	36051.6	131.595
129.790	4.897	4.897	22308.0	81.729
130.781	2.665	2.686	12235.4	45.030

TABLE 5.4-II.- SSME Isp_{avg} FOR STS-1

Time	Isp_{avg}	$\left(Isp_{avg}/455.15\right)$
0	453.20476	0.99572615
3.7	453.27272	0.995875
20	453.55262	0.99649044
40	453.85509	0.99715498
60	454.11595	0.99772811
80	454.33898	0.99821812
100	454.52771	0.99863278
120	454.68554	0.9987956
140	454.81571	0.99926555
160	454.92130	0.99949754
180	455.00525	0.99968198
200	455.07032	0.99982493
220	455.11912	0.99993216
240	455.15413	1.0000090
260	455.17764	1.0000607
280	455.19180	1.0000918
300	455.19850	1.0001067
↓	↓	↓
END BURN	CONSTANT	CONSTANT

TABLE 5.5-I.- SHUTTLE LAUNCH VEHICLE WEIGHTS AT SRB IGNITION

Item	Subsystem weight, lb	Subsystem totals, lb	System totals, lb
Orbiter			
Inert	145 723		
Personnel	1 986		
SSME (3)	20 858		
Mission kits:			
Radiator kit	387		
EPS T/S 3,4 scar	617		
Galley tanks	141		
Total - Orbiter (without propellants and payload)		169 712	
Orbiter propellant reserved	5 387		
Nonpropulsive consumables	5 123		
OMS propellant	18 000		
RCS propellant	7 508		
Total - Orbiter propellants		36 018	
Cargo:			
(DFI)	10 000		
(ACIP)	145		
H2 samples	30		
Total - Orbiter payload		10 175	
Total - Orbiter			215 905
ET			
Inert	79 114		
Nonpropulsive gases	423		
Total - ET (without propellants)		79 537	
Total - ET propellant at SRB ignition command		1 564 823	
Total - ET			1 644 360
SRB			
Total - Jettison weight		362 713	
Total - SRB consumables		2 226 987	
Total - SRB			2 589 700
Total - Shuttle launch vehicle at SRB ignition command			4 449 965

TABLE 5.5-II.- SHUTTLE MPS FPR AND PERFORMANCE SUMMARY

Item	Nominal weight, lb	Engine out at 262 sec weight, lb
SRB usable propellant plus nonpropulsive consumables	2 226 987	2 226 987
Total MPS propellant loaded L/O - 5 min into the entire integrated vehicle	1 593 323	1 593 323
Orbiter lines	3 656 (1 199 FPR)	3 656
SSME X 3	1 548	1 548
Total MPS propellant loaded in ET at L/O - 5 min	1 588 119	1 588 119
Normal bleedoff prior to SSME ignition	10 229	10 229
Transferred to engines at SSME ignition (dropped at MECO)	183	183
Buildup losses to SRB ignition CMD (0-90 percent plus 2.826-sec burn)	12 884	12 884
Total ET propellant at SRB ignition CMD	1 564 823	1 564 823
KSC launch hold	160	160
Fuel bias	757	700
ET FPR	4 806	0
ET residuals (upper failure)	4 722	5 068
Deterministic winds	1 271	1 271
Mean FPR	612	717
Managers margin	3 000	3 000
Total MPS propellant usable at SRB ignition in ET	1 549 495	1 553 907
MPS propellant prior to L/O	871	871
MPS propellant usable at L/O in ET	1 548 624	1 553 036
MPS propellant usable at MECO in ET	7 788	0

TABLE 5.5-III.- TOTAL LAUNCH VEHICLE MASS PROPERTIES

(a) First stage

Weight, lb	Center of gravity,[a] ft			Moments of inertia, SF^2			Products of inertia, SF^2		
	X	Y	Z	I_{xx}	I_{yy}	I_{zz}	P_{xy}	P_{xz}	P_{yz}
4 449 965	-36.4956	0.0257	-1.3490	42 839 679	312 791 470	343 655 220	2 499	-7 157 436	27 032
4 206 439	-36.4404	.0252	-1.4267	39 835 793	298 519 620	326 519 540	30 744	-7 164 247	29 417
3 949 851	-36.1923	.0242	-1.5192	36 645 137	283 049 160	308 010 820	53 769	-7 207 862	31 571
3 697 818	-35.7527	.02397	-1.6227	33 517 689	267 101 550	289 091 270	41 029	-7 288 023	33 102
3 469 315	-34.9803	.0262	-1.7290	30 712 988	251 684 890	271 027 740	-52 038	-7 429 397	29 724
3 259 522	-33.8217	.0266	-1.8397	28 129 471	236 764 910	253 673 840	-57 535	-7 645 473	26 882
3 066 984	-32.2706	.0244	-1.9562	25 673 060	223 160 240	237 759 500	-41 115	-7 939 329	27 288
2 859 514	-30.6119	.0208	-2.0992	23 108 212	208 004 920	220 200 470	-34 803	-8 253 830	27 891
2 640 326	-28.5966	.0183	-2.2709	20 394 880	191 540 610	201 215 790	-43 155	-8 625 186	28 331
2 423 092	-26.3690	.0197	-2.4750	17 692 581	175 863 500	183 054 740	-36 070	-9 039 411	28 025
2 224 644	-24.2210	.02236	-2.6980	15 246 259	162 178 680	167 144 180	-34 618	-9 438 018	28 815
2 044 334	-22.2450	.0263	-2.9380	13 042 870	150 654 830	153 643 610	-24 204	-9 803 105	28 131
1 889 810	-20.7740	.0390	-3.1800	11 207 778	142 323 290	143 685 940	9 190	-10 069 975	25 782
1 854 759	-20.8010	.0560	-3.2400	10 912 012	140 538 340	141 646 750	33 383	-10 062 025	22 592
1 830 737	-21.1950	.0623	-3.2840	10 850 226	139 128 340	140 193 300	40 515	-9 986 928	21 341

(b) Second stage

Weight, lb	X	Y	Z	I_{xx}	I_{yy}	I_{zz}	P_{xy}	P_{xz}	P_{yz}
1 515 139	-8.4862	0.0603	-3.9653	5 332 452.9	85 304 440	81 579 596	76 225.0	-12 337 324	23 376.7
1 425 353	-10.2700	.0505	-4.2138	5 286 264.3	81 918 970	78 240 295	73 400.6	-12 006 186	23 330.7
1 245 743	-14.0925	.0738	-4.7749	5 189 629.6	75 014 995	71 432 899	60 118.9	-11 322 052	20 875.1
979 359	-20.7639	.0910	-6.0376	4 962 388.4	63 833 420	60 478 452	42 784.2	-10 105 375	17 654.1
722 247	-29.5188	.1258	-8.2736	4 535 837.6	50 849 215	47 920 614	17 108.7	-8 444 124	11 221.4
582 847	-36.3133	.1574	-10.2534	4 167 900.8	42 148 067	39 507 261	-2 812.0	-7 161 738	5 360.3
424 552	-47.9976	.2154	-14.0767	3 457 515.7	29 458 046	27 607 283	-35 637.3	-5 011 369	-5 404.0
346 717	-56.9532	.2811	-17.2713	2 858 807.2	21 250 420	20 009 959	-67 994.6	-3 334 008	-17 162.9
317 647	-60.3814	.2707	-18.7494	2 594 079.4	18 343 906	17 369 916	-74 597.3	-2 714 204	-17 573.4
297 472	-62.5748	.0692	-19.6496	2 446 187.7	16 162 135	15 298 383	-24 949.7	-2 399 199	-1 596.3

(c) Orbit insertion

Weight, lb	X	Y	Z	I_{xx}	I_{yy}	I_{zz}	P_{xy}	P_{xz}	P_{yz}
215 130	-93.7506	0.0074	-31.737	926 008	7 363 557	7 631 493	-1435.8	-275 203	424.59
206 025	-92.7909	-.0073	-31.630	904 145	7 172 146	7 441 486	-2203.0	-257 027	931.77
205 925	-92.7801	-.0074	-31.629	903 902	7 170 016	7 439 371	-2211.6	-256 825	937.42
202 523	-92.4177	.0131	-31.294	906 690	7 076 990	7 385 571	-4408.0	-255 089	687.74

[a]Referenced to the vehicle reference coordinate system parallel to the body coordinate system with the origin at the point where the vertical from the Orbiter nose intersects the longitudinal axis of the tanks.

TABLE 6.1-I.- SEQUENCE OF EVENTS FOR NOMINAL ASCENT

Event	Time, sec	Total weight, lb	Total propellant remaining (nominal), lb	Geodetic altitude, ft	Inertial velocity, fps	Inertial flightpath angle, deg	Actual ΔV, fps	HA x HP, n. mi.
MPS (in ET)								
ignition	0	4 449 965	1 564 823	-23.5	1 340.7	0	-	-
Lift-off/vertical rise	0.28	4 447 763	1 563 955	-23.5	1 340.7	0	-	-
Begin pitchover maneuver	8.0	4 256 959	1 539 944	400	1 345.4	4.90	-	-
Begin qα squatcheloid steering	34.0	3 604 050	1 459 136	9 911	1 702.2	21.45	-	-
Begin throttledown (10%/sec)	46.0	3 340 464	1 421 862	18 682	1 924.7	25.78	-	-
Maximum dynamic pressure	54.0	3 182 053	1 403 690	25 833	2 056.9	27.30	-	-
Begin throttleup (10%/sec)	61.0	3 047 514	1 389 526	32 761	2 182.6	28.40	-	-
End qα squatcheloid steering	86.0	2 507 777	1 313 787	66 581	3 109.0	33.38	-	-
SRB separation	[a]131.44 [b]131.44	1 830 819 1 468 110	1 172 862 1 172 862	167 274 167 274	5 227.7 5 227.7	27.25 27.25	- -	38.3 x -3447.2 38.3 x -3447.2
Begin closed-loop guidance	135.44	1 455 709	1 160 461	176 801	5 285.9	26.52	-	-
3-g boundary	451.44	476 762	181 513	400 926	19 904.2	-1.76	-	-
MECO (zero thrust)	518.04	318 364	[c]23 116	387 407	25 667.9	0.50	-	80.6 x 13.3
OMS								
ET separation/-Z RCS burn	[a]530.6 [b]530.6	317 665 215 409	18 000 18 000	390 549 390 549	25 664.3 25 664.3	0.49 .49	- -	- -
-Z RCS burn cutoff	536.4	215 358	18 000	391 999	25 663.8	.48	4.0	80.2 x 14.3
OMS-1 ignition/LOX vent	634.1	215 130	18 000	415 193	25 637.1	.45	-	-
End LOX vent	686.1	208 448	16 006	426 714	25 724.0	.44	100.4	103.9 x 46.2
OMS-1 cutoff	[d]743.5	206 335	13 892	439 573	25 813.4	.47	204.5	149.7 x 57.5

[a]Before separation.
[b]After separation.
[c]Table 5.5-II presents the residuals (manager's margin, FPR, etc.) that need to be subtracted from these total weights to obtain usable propellant (ie; for nominal, 23 116 - 15 328 = 7788 lb usable).
[d]Includes OMS tailoff.

TABLE 6.1-I.- Concluded

Event	Time, sec	Total weight, lb	Total propellant remaining (nominal), lb	Geodetic altitude, ft	Inertial velocity, fps	Inertial flightpath angle, deg	Actual ΔV, fps	HA x HP, n. mi.
OMS (Continued)								
Begin LH_2 vent	759.1	206 335	13 892	444 302	25 807.0	0.48	-	-
End LH_2 vent	799.1	206 025	13 892	449 120	25 803.0	.50	0.2	149.8 x 57.5
OMS-2 ignition	2750.6	205 925	13 892	917 760	25 234.9	.04	-	149.8 x 57.4
OMS-2 cutoff	[d]2840.8	202 553	10 520	921 006	25 399.9	-.004	167.1	150.9 x 149.8

[d]Includes OMS tailoff.

TABLE 6.2-I.- SRB SEPARATION TRAJECTORY PARAMETERS

Parameter	Value
Time, sec	131.44
Geodetic altitude, n. mi.	27.53
Geocentric altitude,[a] n. mi.	24.87
Inertial velocity, fps	5 227.7
Inertial flightpath angle, deg	27.248
Inertial azimuth, deg	67.9
Relative velocity, fps	4 186.8
Relative flightpath angle, deg	34.867
Relative azimuth, deg	59.458
Total vehicle weight with SRB's, lb	1 830 819
Total vehicle weight without SRB's, lb	1 468 110
Downrange, n. mi.	24.9
Geocentric latitude, deg N	28.6545
Geodetic latitude, deg N	28.8155
Longitude, deg W	80.1954

[a]Referenced to a spherical Earth radius of 20 925 738 feet.

TABLE 6.3-I.- SRB DISPOSAL SEQUENCE OF EVENTS, STS-1

Event	Time, sec	Altitude, ft
SRB separation (lift-off +131.4 sec)	0	167 274
Terminate separation motor burn	2.0	172 037
Jettison nozzle extension	78.5	261 770
Jettison nose cap and deploy pilot chute	233.8	17 000
Deploy drogue chute	234.8	16 514
Jettison frustum and deploy 3 main parachutes	257.5	7 000
SRB impact	311.3	0
Nose cap impact	353.3	0
Nozzle extension impact	358.3	0
Frustum impact	399.7	0

TABLE 6.3-II.- NOMINAL IMPACT POINT LOCATION OF EACH SRB ELEMENT, STS-1

Element	Geodetic latitude, deg	Longitude, deg	DR, n. mi. (a)	CR, n. mi. (a)
Left SRB	29.732	-78.337	—	—
Left SRB nozzle extension	29.682	-78.426	-5.6	0.4
Left SRB nose cap	29.731	-78.337	-0.1	0.1
Left SRB frustum	29.733	-78.336	0.1	0.0
Right SRB	29.739	-78.341	—	—
Right SRB nozzle extension	29.688	-78.430	-5.6	0.4
Right SRB nose cap	29.738	-78.342	-0.1	0.1
Right SRB frustum	29.740	-78.340	0.1	0.0

[a]DR and CR are the relative downrange and crossrange distances from the impact point of the SRB to those of its components.

TABLE 6.4-I.- MECO AND POST-MECO TRAJECTORY PARAMETERS

Parameter	MECO (zero thrust)	ET separation	OMS-1 cutoff (a)	End of MPS dump	OMS-2 cutoff (a)
Time, sec	518.04	530.60	743.50	806.10	2 840.79
Geodetic altitude, n. mi.	63.76	64.28	72.34	74.79	151.58
Geocentric altitude,[b] n. mi.	60.12	60.45	67.69	69.99	150.50
Inertial velocity, fps	25 667.9	25 664.3	25 813.4	25 796.6	25 399.9
Inertial flightpath angle, deg	0.496	0.493	0.473	0.516	-0.004
Inertial azimuth, deg	67.099	67.643	78.176	81.665	124.010
Relative velocity, fps	24 489.0	24 484.9	24 628.0	24 609.7	24 199.7
Relative flightpath angle, deg	0.520	0.517	0.496	0.541	-0.004
Relative azimuth, deg	65.929	66.502	77.598	81.260	125.950
Total vehicle weight before separation, lb	318 363.7	317 665.0	-	-	-
Total vehicle weight after separation, lb	-	215 409.0	206 335.2	206 024.6	202 552.5
Downrange, n. mi.	740.5	791.8	1 635.1	1 879.1	9 681.4
Geocentric latitude, deg N	34.1127	34.5490	38.8077	39.5673	-23.1078
Geodetic latitude, deg N	34.2883	34.7257	38.9919	39.7523	-23.2412
Longitude, deg W	67.7715	66.5674	50.2151	44.9677	-79.5275
Node shift from planar, deg W	0.0	-	-	-	-
Inclination, deg	40.3	40.3	40.3	40.3	40.3

[a]Includes OMS tailoff.
[b]Referenced to a spherical Earth radius of 20 925 738 feet.

TABLE 6.5-I.- NOMINAL EXTERNAL TANK DISPERSION

SSME cutoff conditions:
Flight path angle = 0.5°
Velocity = 25 668 fps
Altitude = 60 n. mi.
Inclination = 40.3°
Range = 739 n. mi.
Latitude = 34.1° N
Longitude = 67.8° W
ET weight = 101 902 lb

Impact point:
Latitude = 31.2° S
Longitude = 93.7° E
Surface range from pad = 10 483 n. mi.
LH_2 rupture altitude = 343 000 ft
LOX rupture altitude = 260 000 ft
Breakup altitude = 195 000 ft

Error source	3σ Error	Downrange, n. mi.	Uprange, n. mi.	Crossrange, n. mi.
Separation altitude	± 1 923 ft	109	108	±1
Separation velocity	± 10.73 fps	626	562	±11
Separation flightpath angle	± 0.022 deg	63	70	±1
Drag	± tolerances	79	124	±1
Atmosphere	3σ dense/thin	163	256	±2
Weight	± 10 000 lb	55	63	±1
Trajectory dispersion 3σ RSS		666	646	±11
Rotational lifting effect (3σ)		289	413	±9
Debris scatter		95	190	±15
Total footprint with debris scatter (3σ)		745	1 059	±29

TABLE 6.6-I.- OMS MANEUVER SUMMARY TABLE

Item	OMS-1	OMS-2	OMS-1 + OMS-2
Burn time, min:sec	[a]1:49.4	[a]1:30.2	3:19.6
ΔV magnitude, ft/sec	[b]204.5	167.1	371.6
OMS propellant consumed, lb	4 108.0	3 272.0	7 380.0
Orbital inclination, deg	40.30	40.32	
Burnout weight, lb	[b]206 335	202 533	
Premaneuver attitude changes required, deg			
Δ pitch	-25.04	-108.45	
Δ yaw	8.31	-5.42	
Δ roll	1.34	-0.53	
Resulting apogee altitude, n. mi.	149.7	150.9	
Resulting perigee altitude, n. mi.	57.5	149.8	

[a] Includes 2.6-second OMS tailoff.
[b] Includes LOX dump.

TABLE 6.8-I.- AOS AND LOS DATA FOR ASCENT RADAR TRACKING NETWORK

Site ID (a)	Antenna band	AOS GET, sec	LOS GET, sec	Maximum elevation angle, deg	Site geodetic latitude, deg	Site longitude, deg	Site geodetic altitude, ft
MLA	C	ON PAD	501	40.8	28.42485889	279.3356383	-172.014
PAT	C	7	501	35.3	28.2265488	279.4007497	-160.367
MIL[b]	S	8	483	42.9	28.50827056	279.3066258	-178.642
PDL	S	10	503	39.3	29.0638889	279.1008056	-209.121
GBI	C	50	505	18.2	26.6157575	281.6522297	-168.012
WLP	C	189	602	9.2	37.8413342	284.516339	-152.297
ETC	S	208	579	6.0	38.9985555	283.1572778	-6.562
BDA[b]	S	300	715	11.5	32.35138917	295.3422047	-110.728
BDQ[b]	C	300	715	11.5	32.34806528	295.3466439	-118.930
MAD[b]	S	1178	1451	21.1	40.4562086	355.8304286	2644.652
IOS[b]	S	2117	2622	76.4	-4.6717842	55.4776667	1740.289
ORR[b]	S	3688	3957	30.6	-35.6279756	148.9570422	3048.852

[a]See acronym list.
[b]AOS/LOS includes masking data.

TABLE 8.0-I.- NORMAL FLIGHT PERFORMANCE RESERVE

Error source	Mean, lb	3σ, lb	Allotment, lb
[a]Mixture ratio and loading errors	(502.0)	(3651.)	(2722.)
SRB	(13.7)	(3181.)	(1699.)
WEB action time	11.2	2892.	1404.
Isp	2.5	1325.	295.
Aerodynamic variations	(17.1)	(2331.)	(922.)
C_{Nf}	10.2	1461.	365.
C_{AB}	0	1379.	317.
C_{mf}	5.3	1039.	185.
C_{AF}	1.6	565.	55.
GN&C	(31.0)	(1872.)	(615.)
IMU misalinement-pitch	17.8	1327.	311.
Accelerometer error-pitch	13.2	1320.	304.
SSME	(5.2	(1814.)	(553.)
Isp	0	1472.	361.
Thrust	5.2	1060.	192.
Mass properties	(0.7)	(401.)	(27.)
Atmosphere	(-21.7)	(344.)	(-2.)
All others	(63.8)	(321.)	(81.)
[a]FPR	612.	6005.	6617.

[a]Assumes a 757-pound fuel bias.

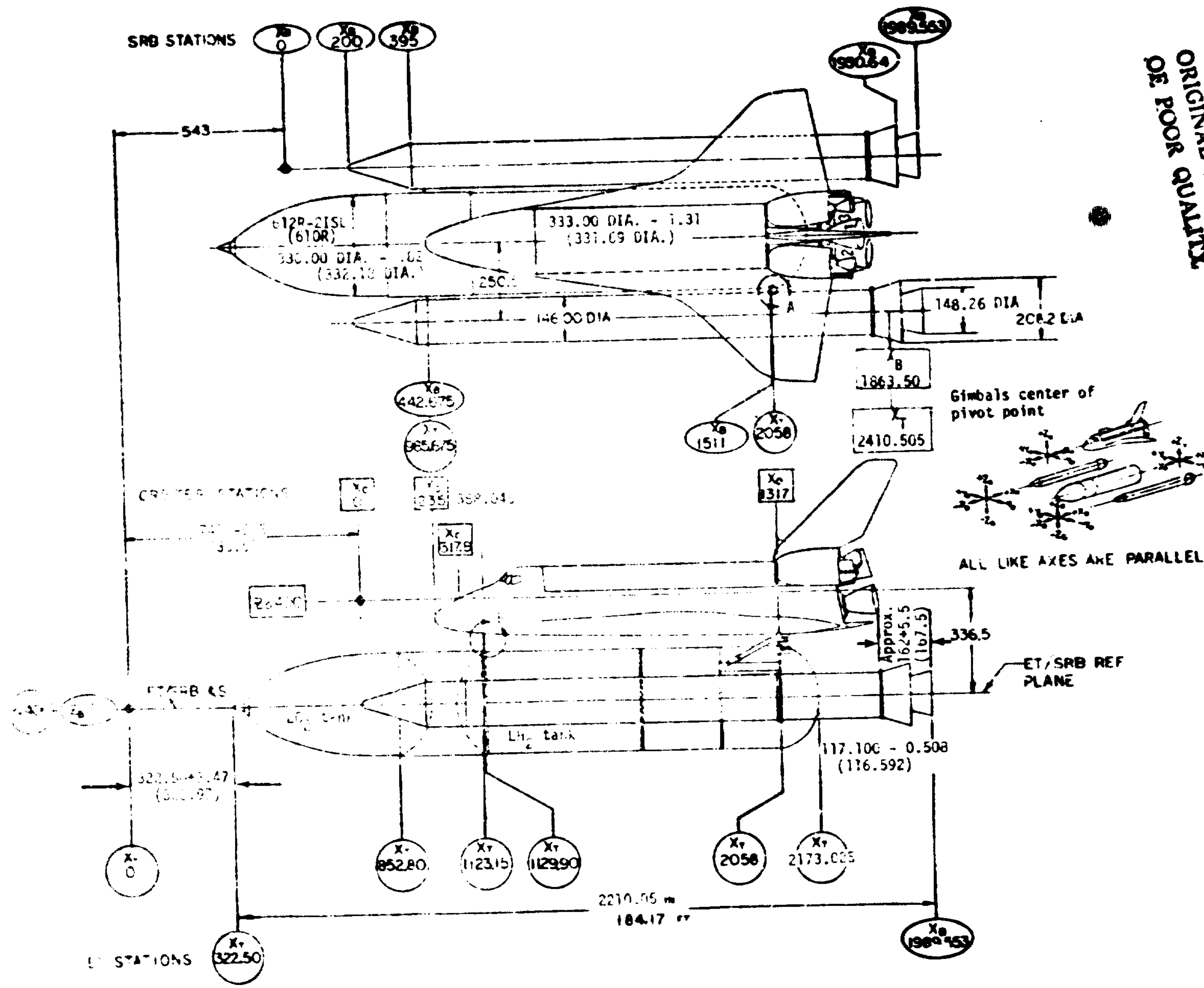


Figure 5.1-1.- Shuttle vehicle configuration.

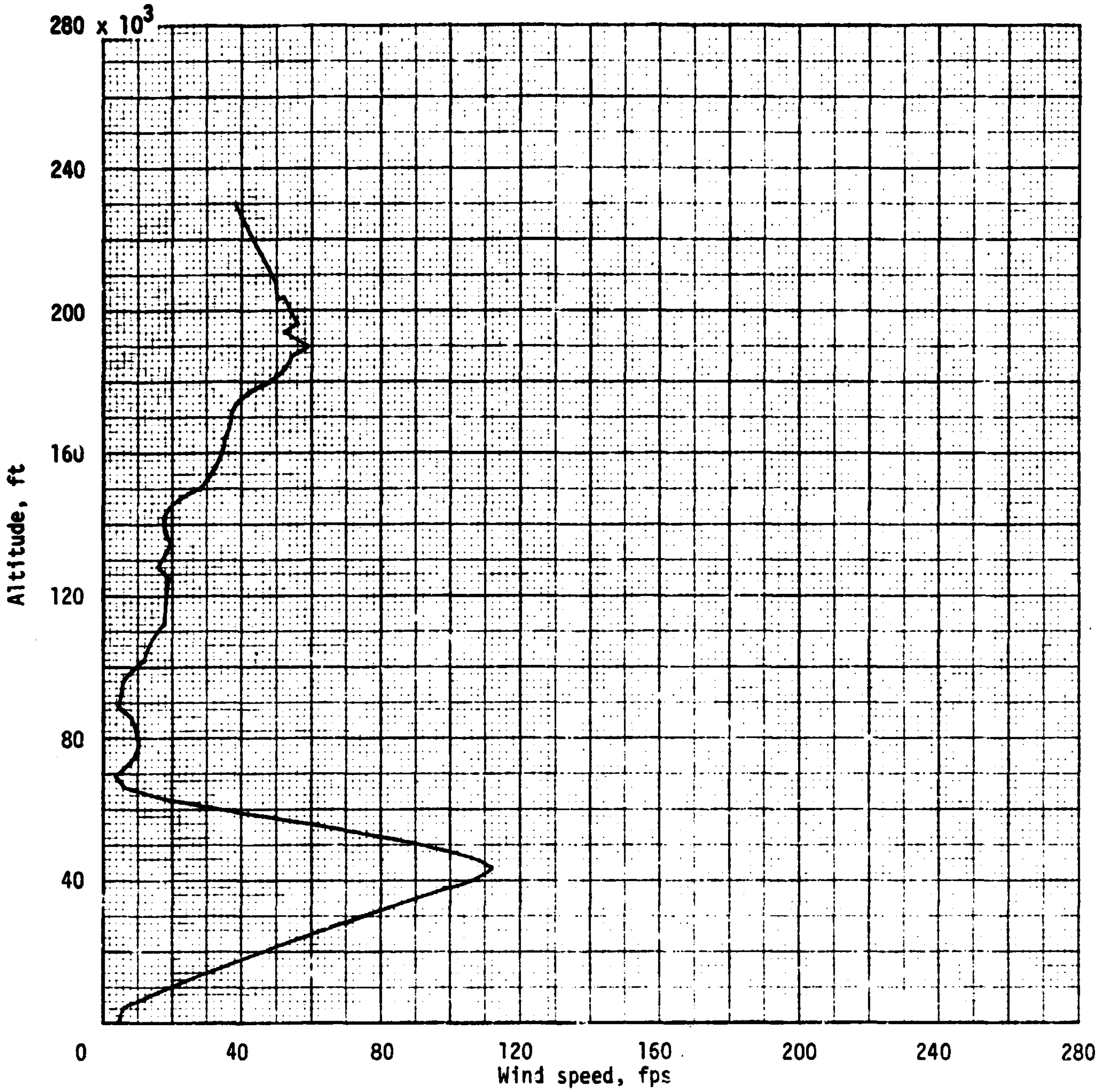


Figure 5.3-1.- Steady-state mean vector wind speed versus altitude for the month of April.

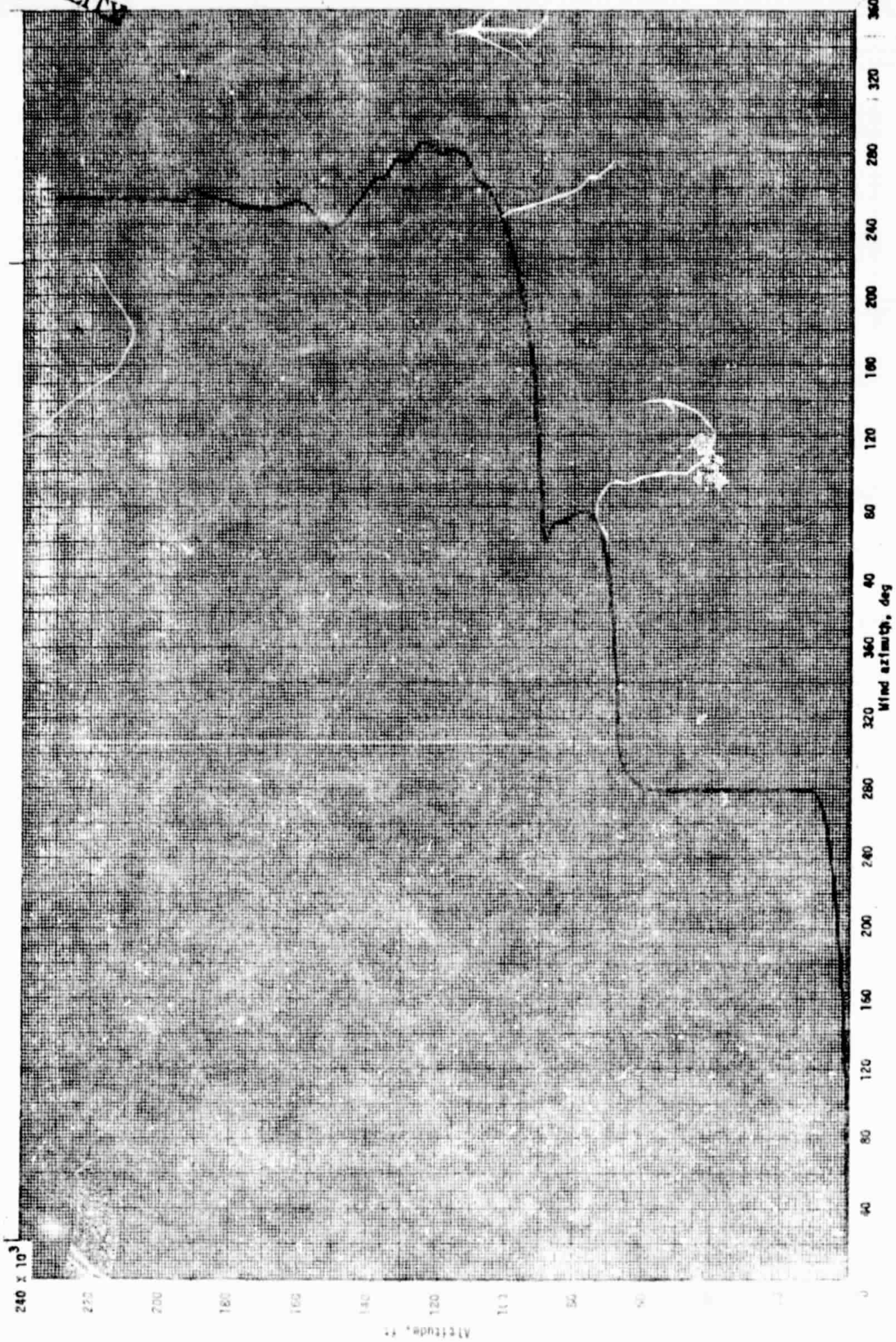


Figure 5.3-2.- Steady-state mean vector wind azimuth versus altitude for the month of April.

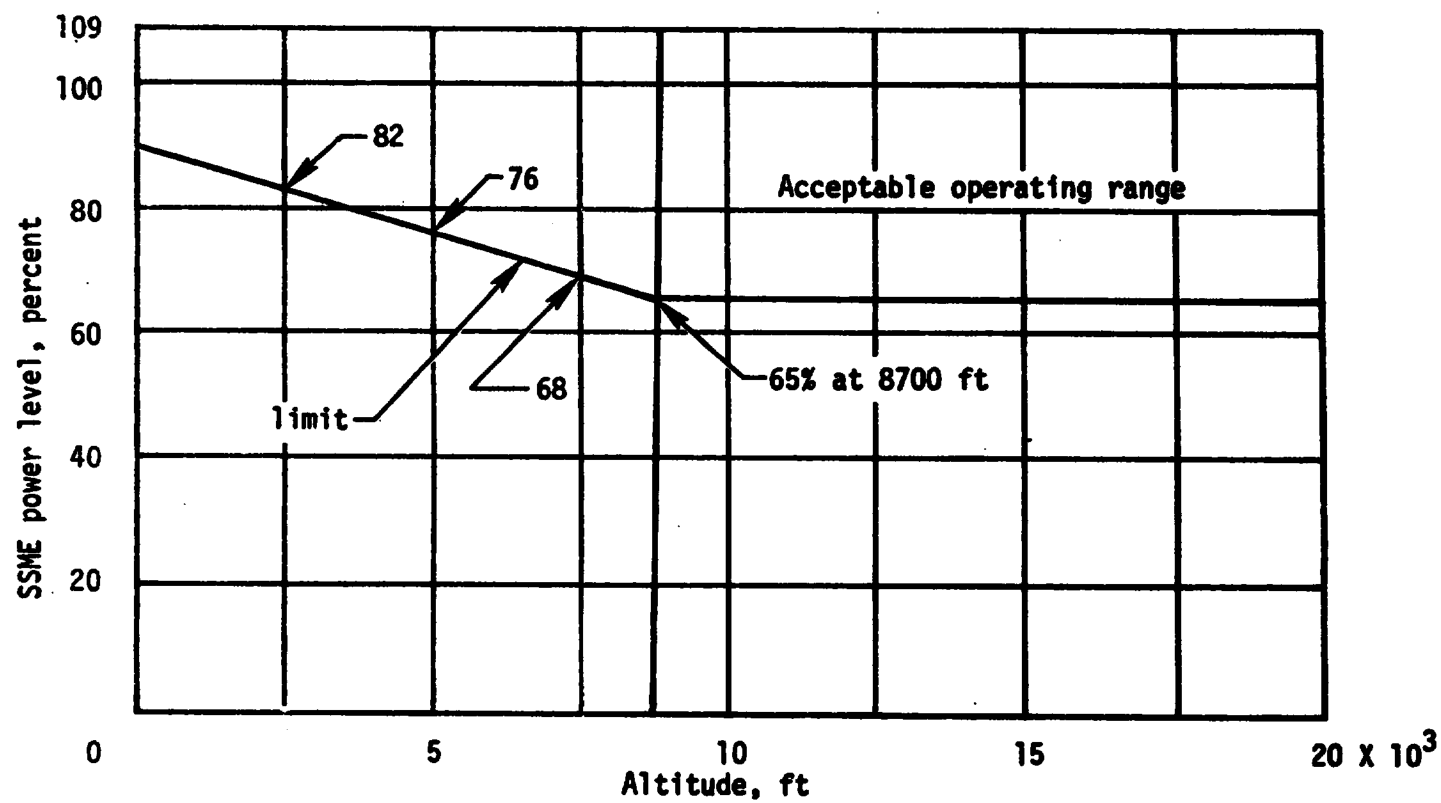
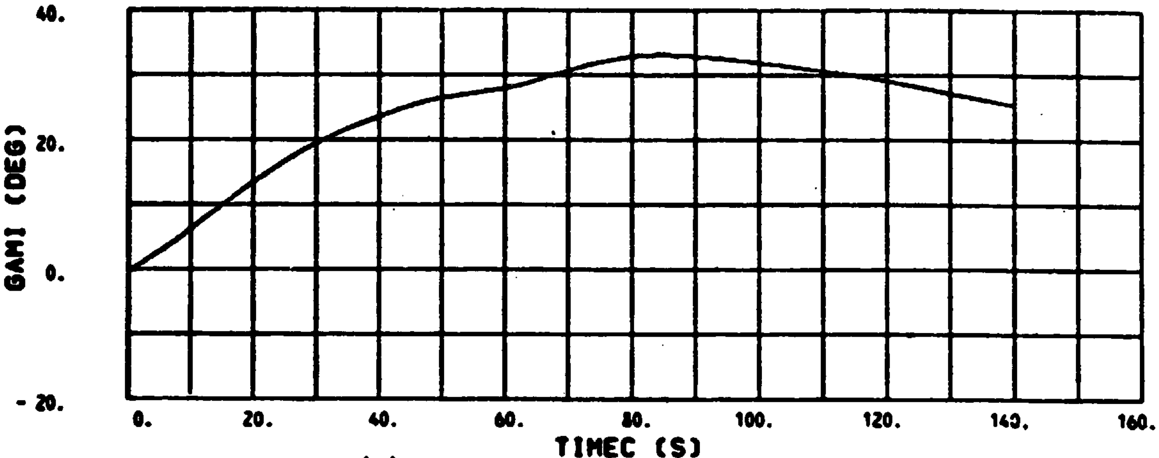
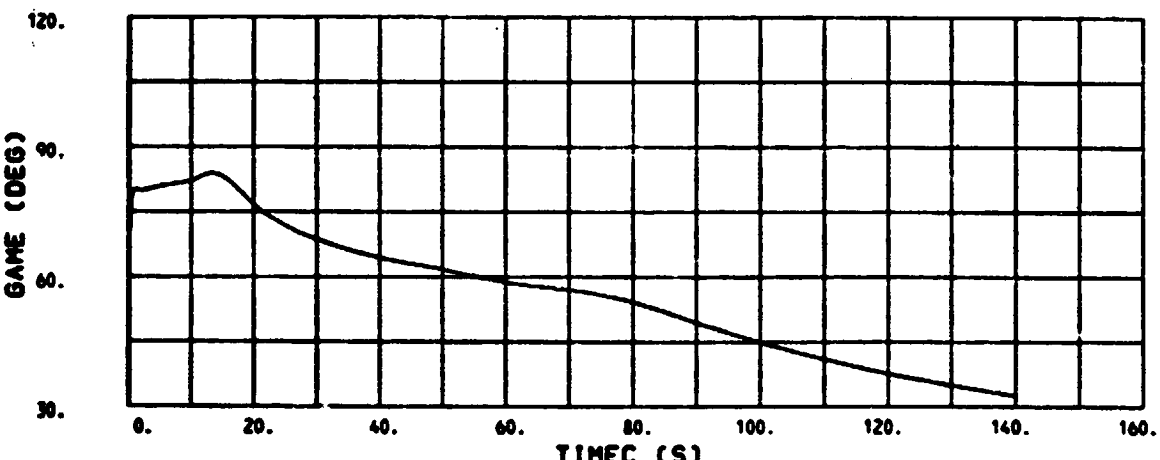


Figure 5.4-1.- SSME power level versus altitude.

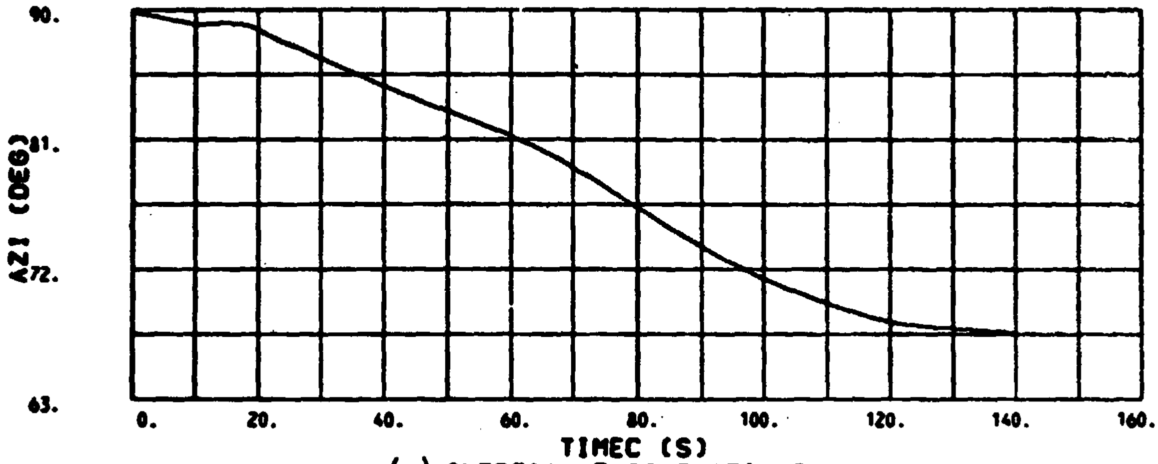


(a) INERTIAL FLIGHT PATH ANGLE

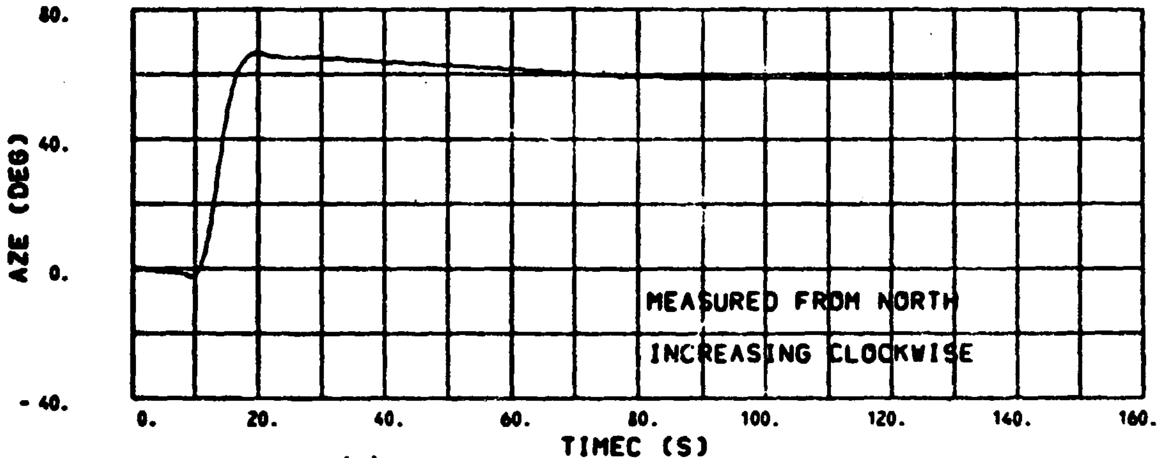


(b) EARTH-RELATIVE FLIGHT PATH ANGLE

Figure 6.2-1.- First-stage parameters as a function of time from SRB ignition command (timec).

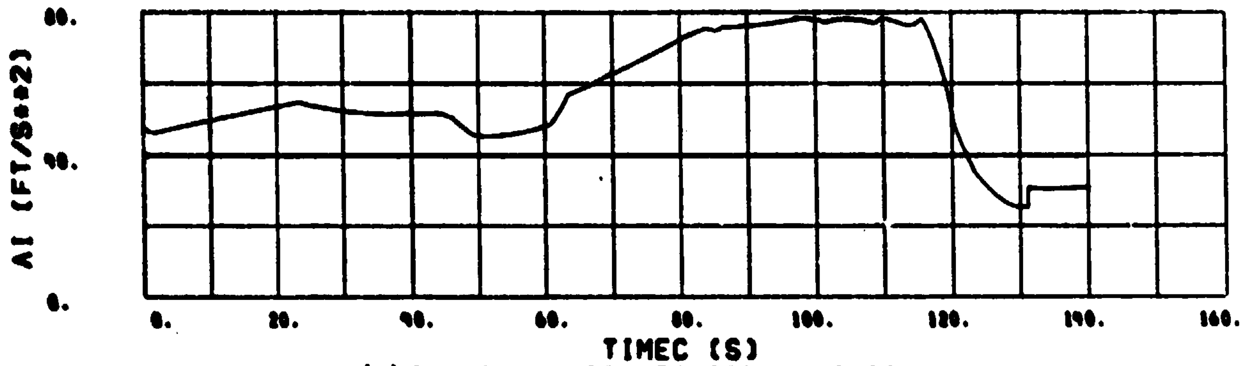


(c) INERTIAL FLIGHT AZIMUTH

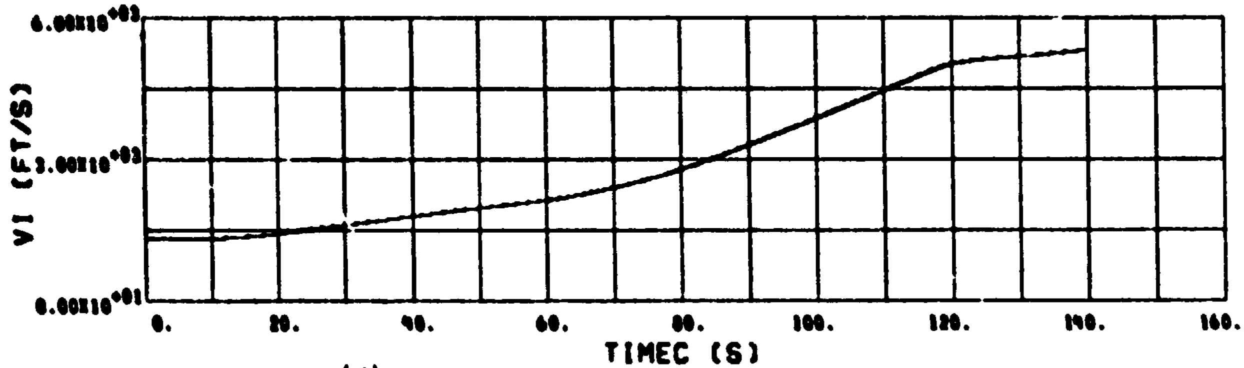


(d) EARTH-RELATIVE FLIGHT AZIMUTH

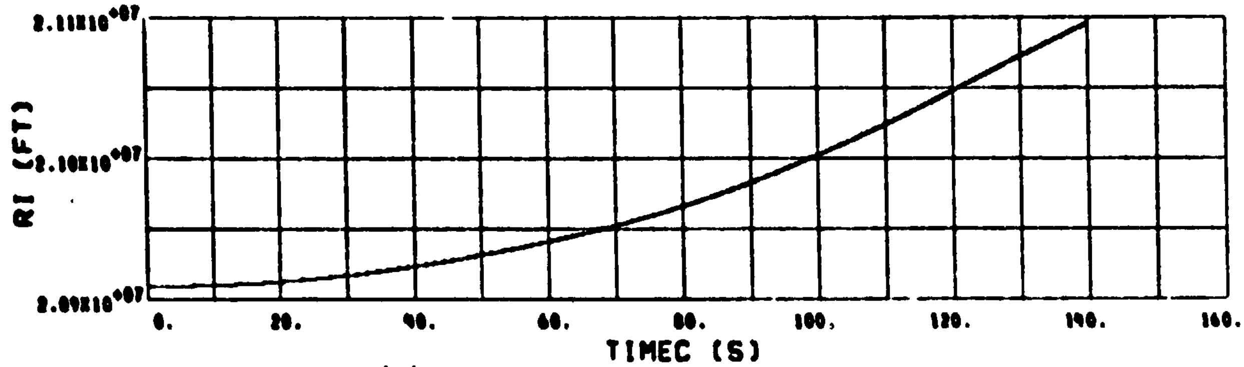
Figure 6.2-1.- Continued.



(e) INERTIAL ACCELERATION MAGNITUDE

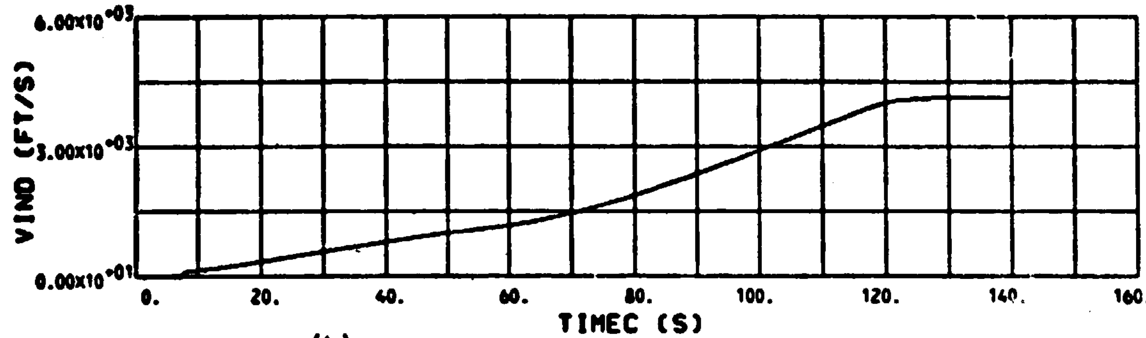


(f) INERTIAL VELOCITY VECTOR MAGNITUDE

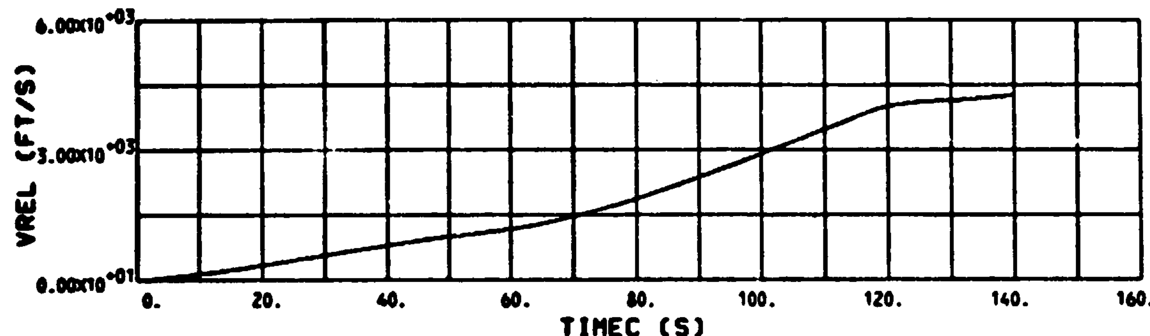


(g) ECI POSITION VECTOR MAGNITUDE

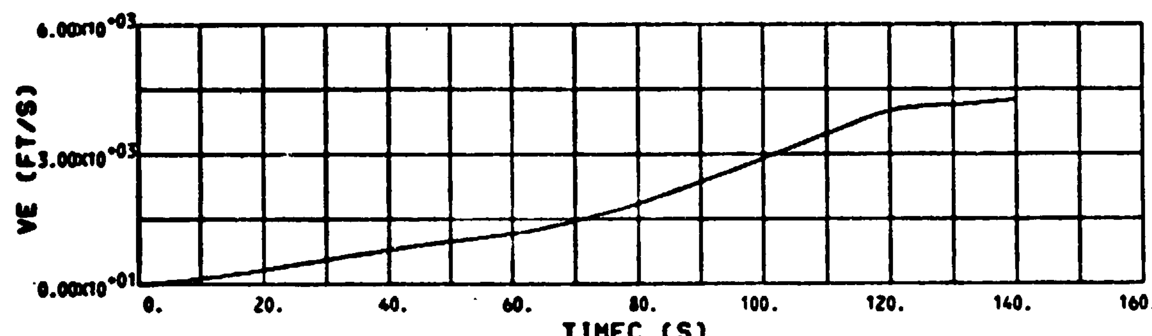
Figure 6.2-1.- Continued.



(h) INDICATED EARTH-RELATIVE VELOCITY

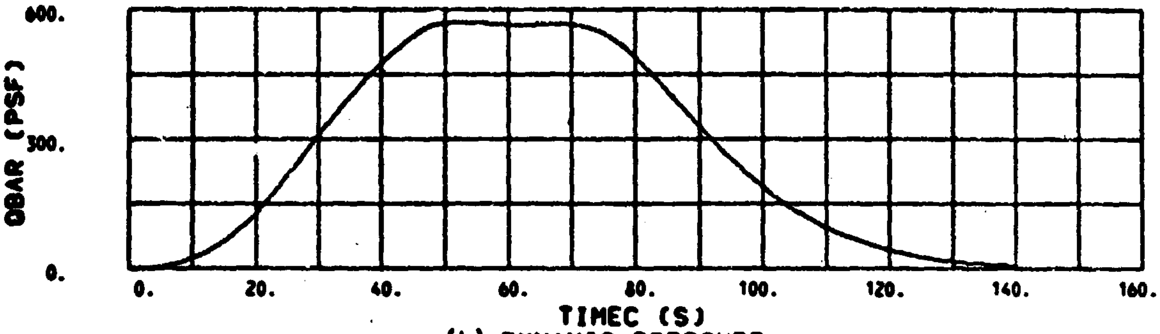


(i) NAVIGATION EARTH-RELATIVE VELOCITY

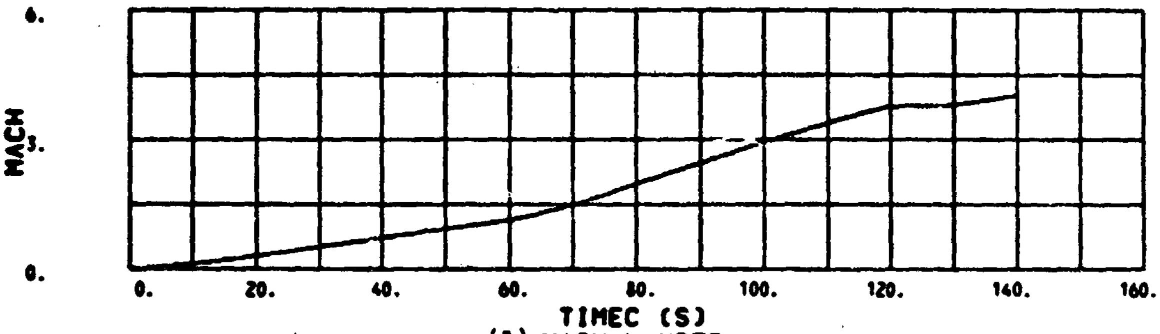


(j) SVDS EARTH RELATIVE VELOCITY

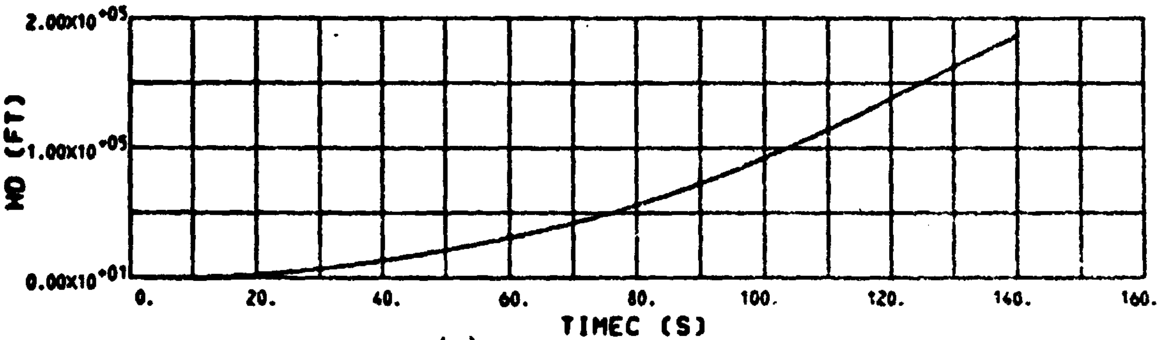
Figure 6.2-1.- Continued.



(k) DYNAMIC PRESSURE

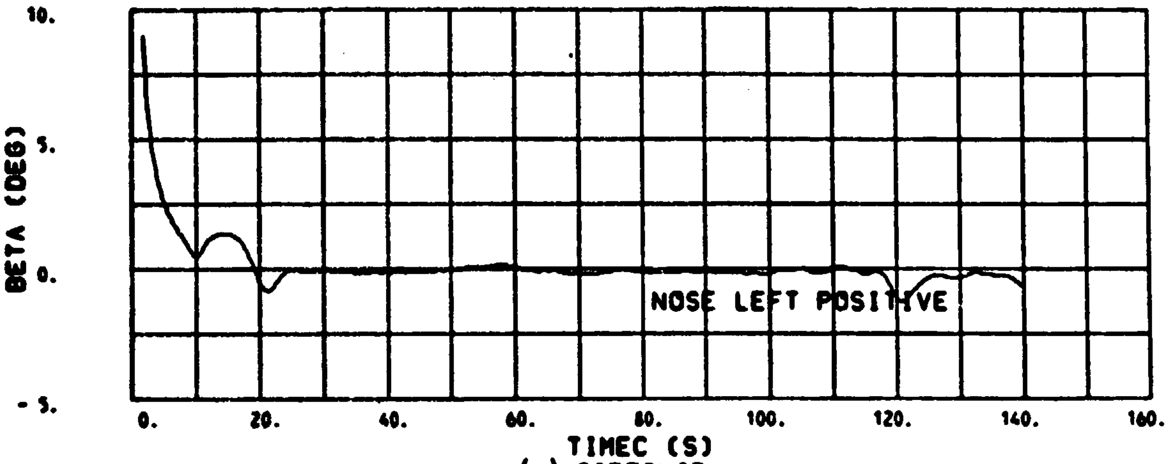


(l) MACH NUMBER

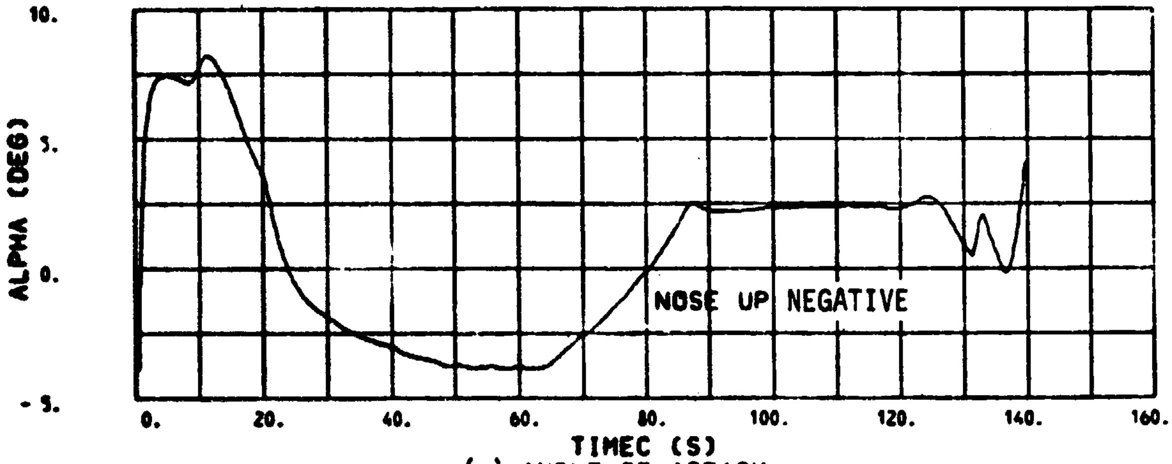


(m) GEODETIC ALTITUDE

Figure 6.2-1.- Continued.

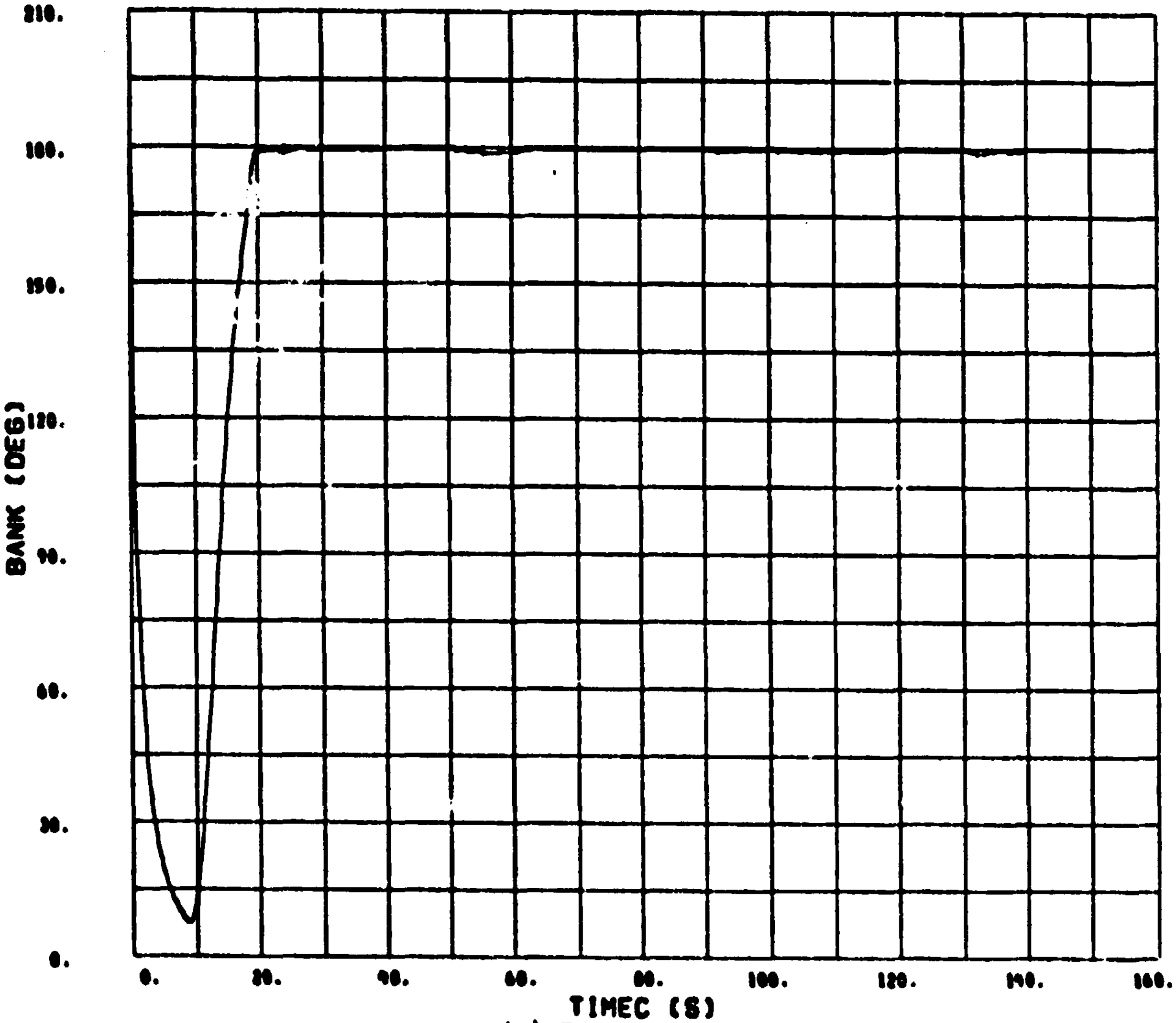


(n) SIDESLIP



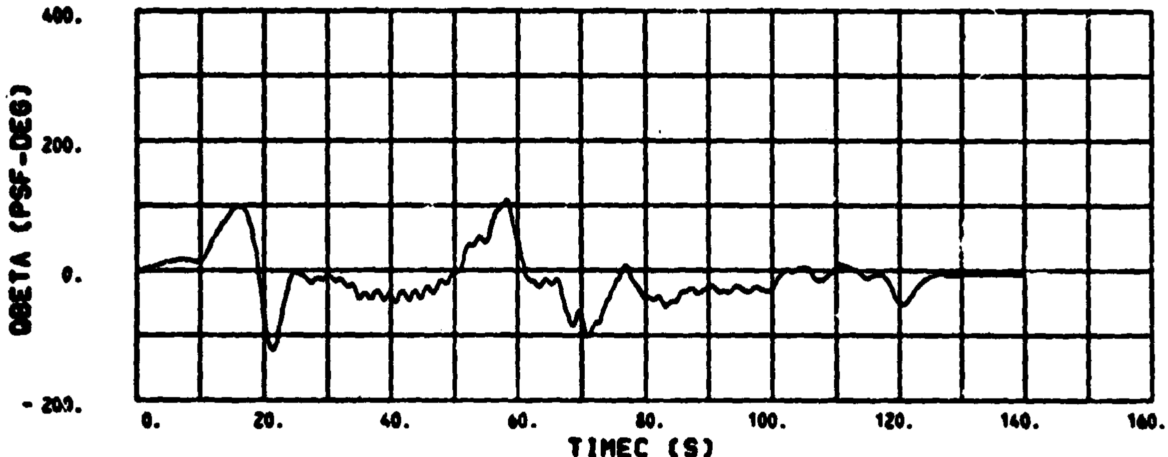
(o) ANGLE OF ATTACK

Figure 6.2-1.- Continued.

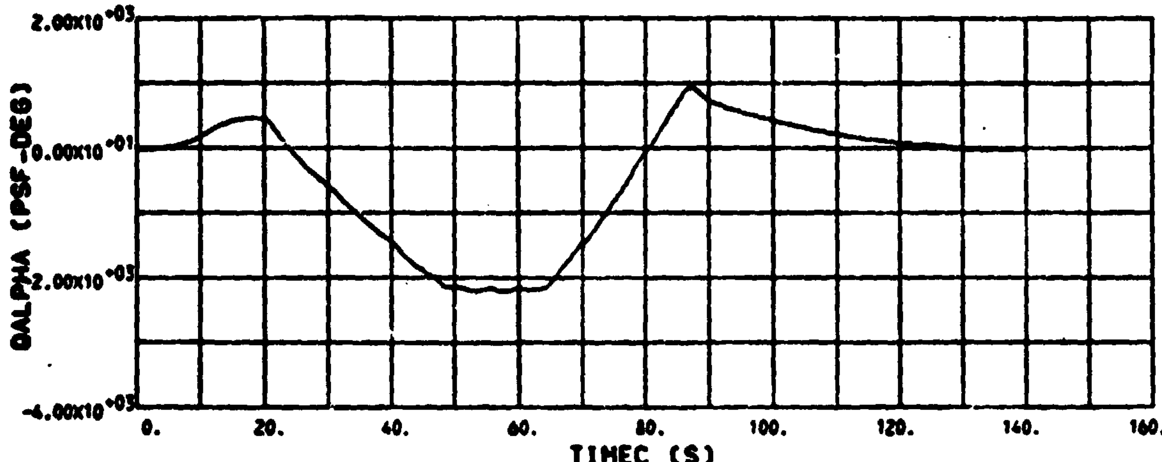


(p) BANK ANGLE

Figure 6.2-1.- Continued.

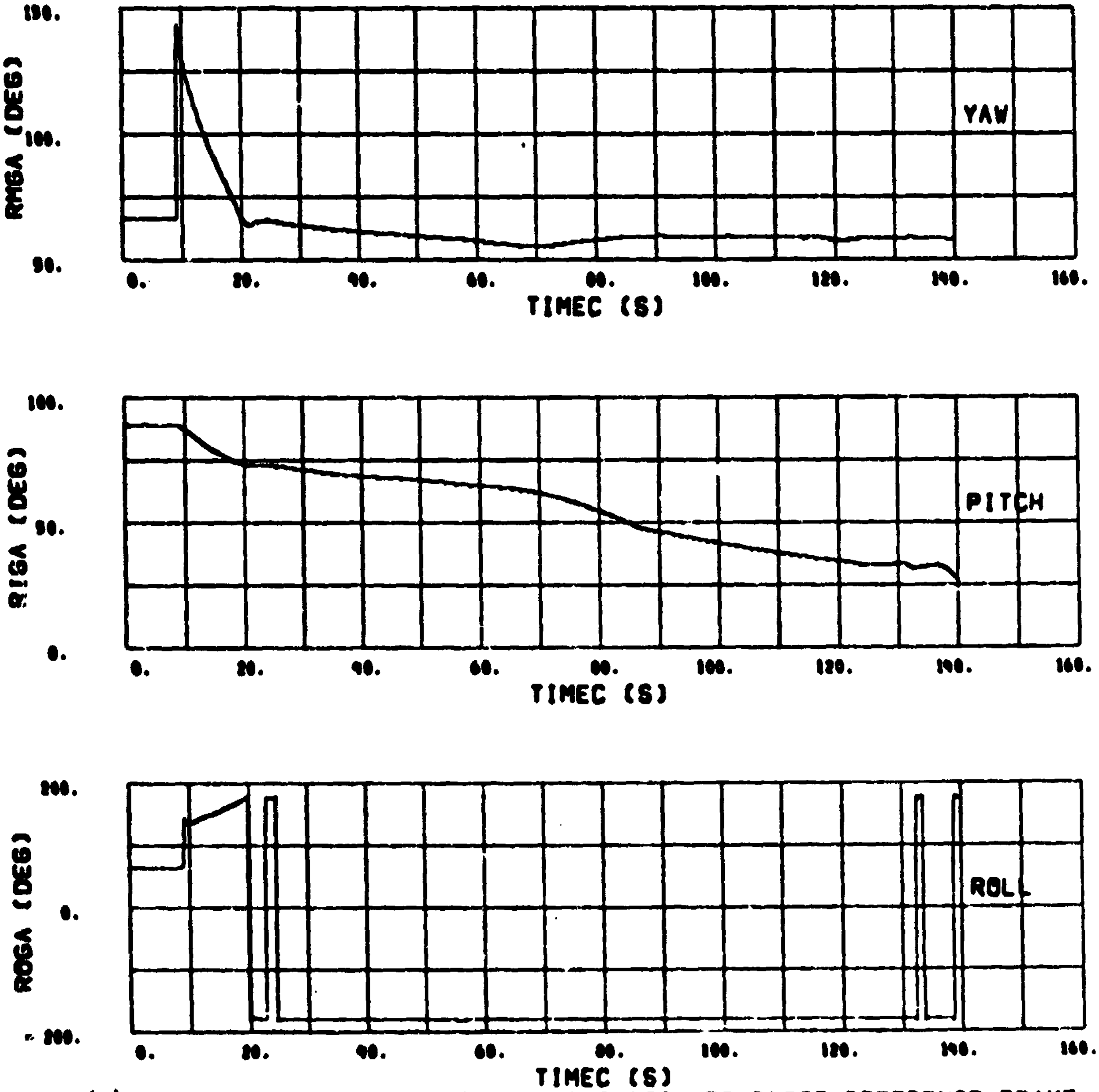


(q) LATERAL AERODYNAMIC LOAD



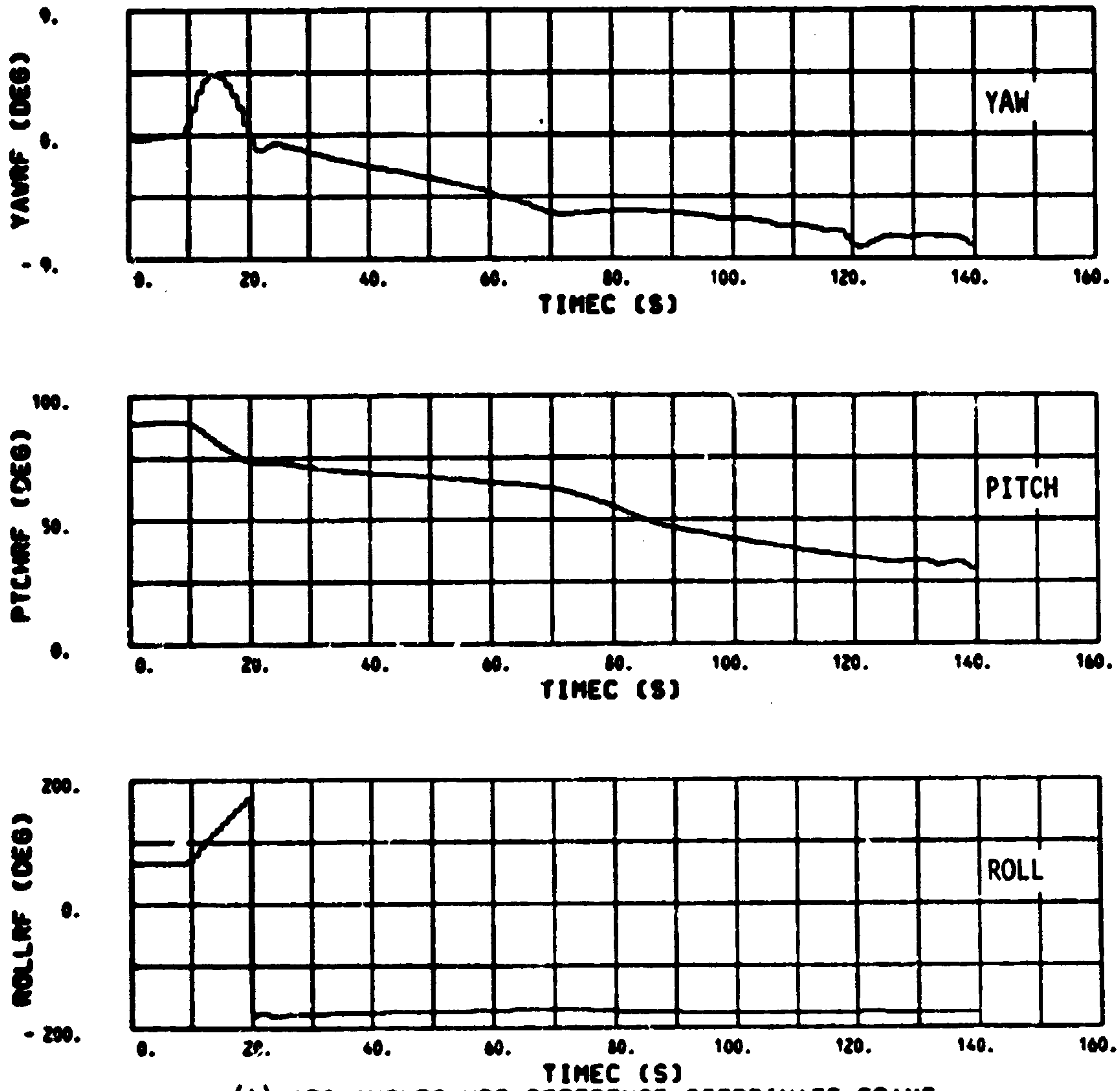
(r) NORMAL AERODYNAMIC LOAD

Figure 6.2-1.- Continued.



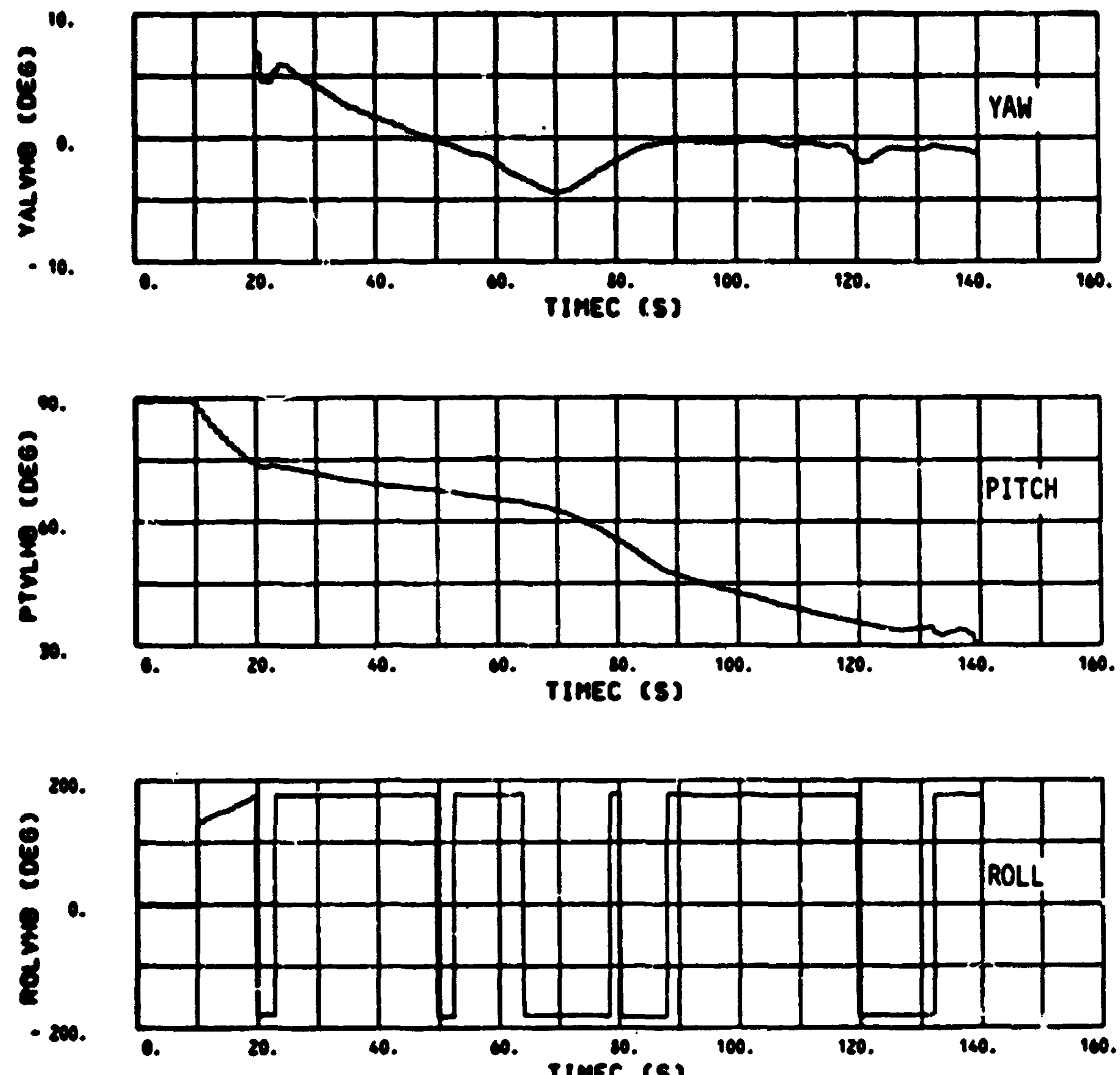
(s) ACTUAL BODY ATTITUDE (EULER ANGLES) WRT BOOST REFERENCE FRAME

Figure 6.2-1.- Continued.



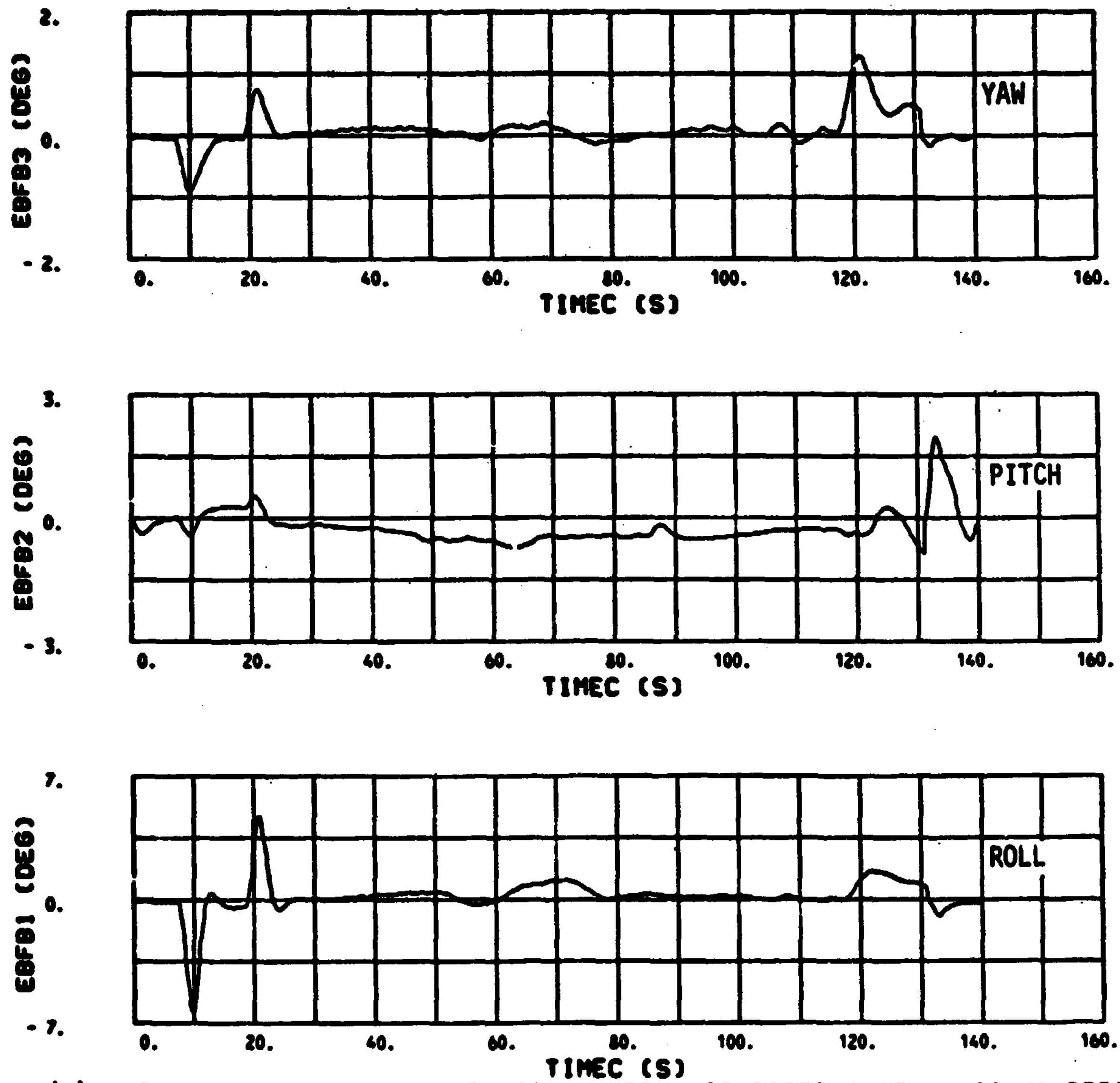
(t) ADI ANGLES WRT REFERENCE COORDINATE FRAME

Figure 6.2-1.- Continued.



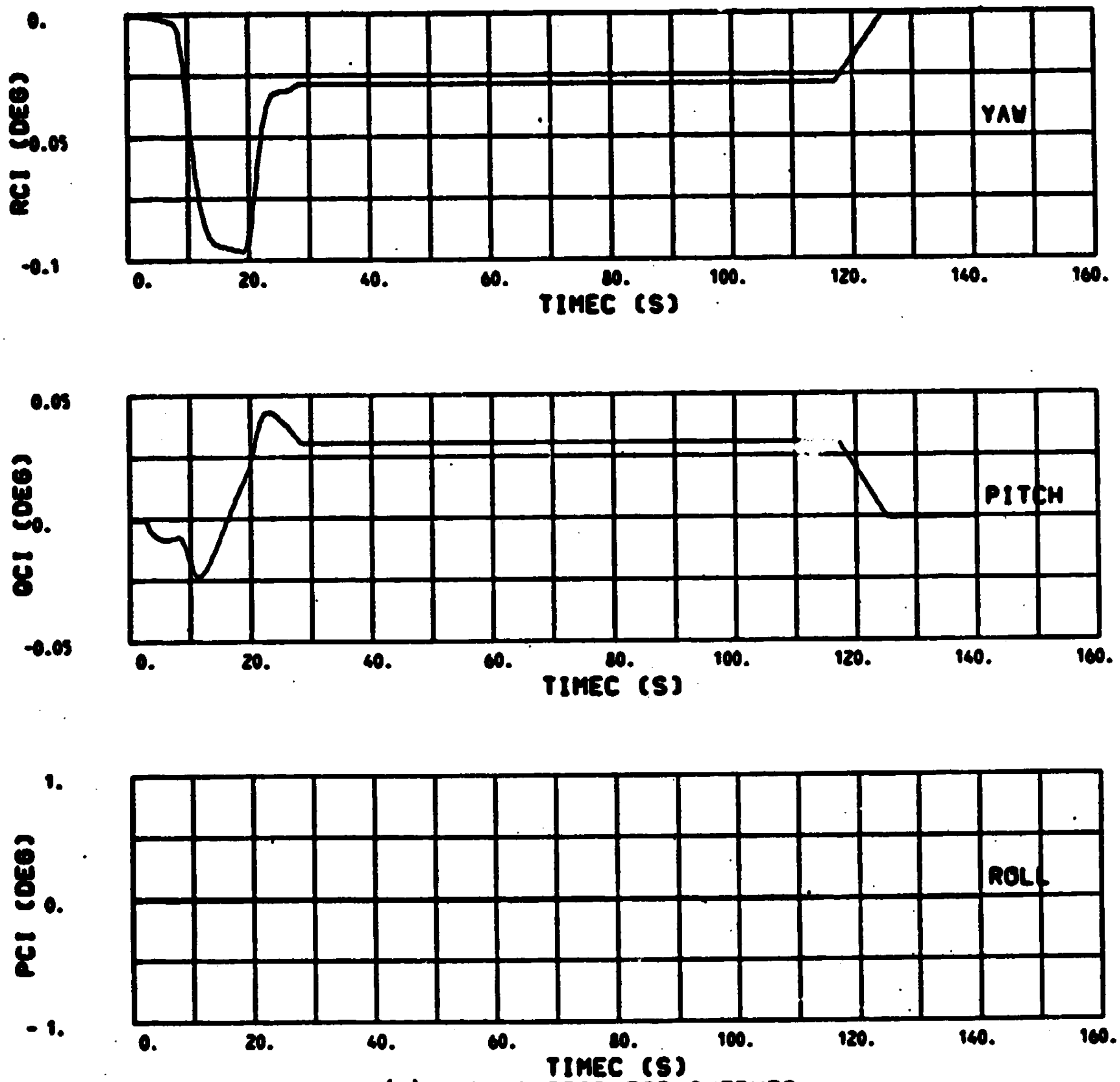
(u) ADI ANGLES WRT LVLV COORDINATE FRAME

Figure 6.2-1.- Continued.



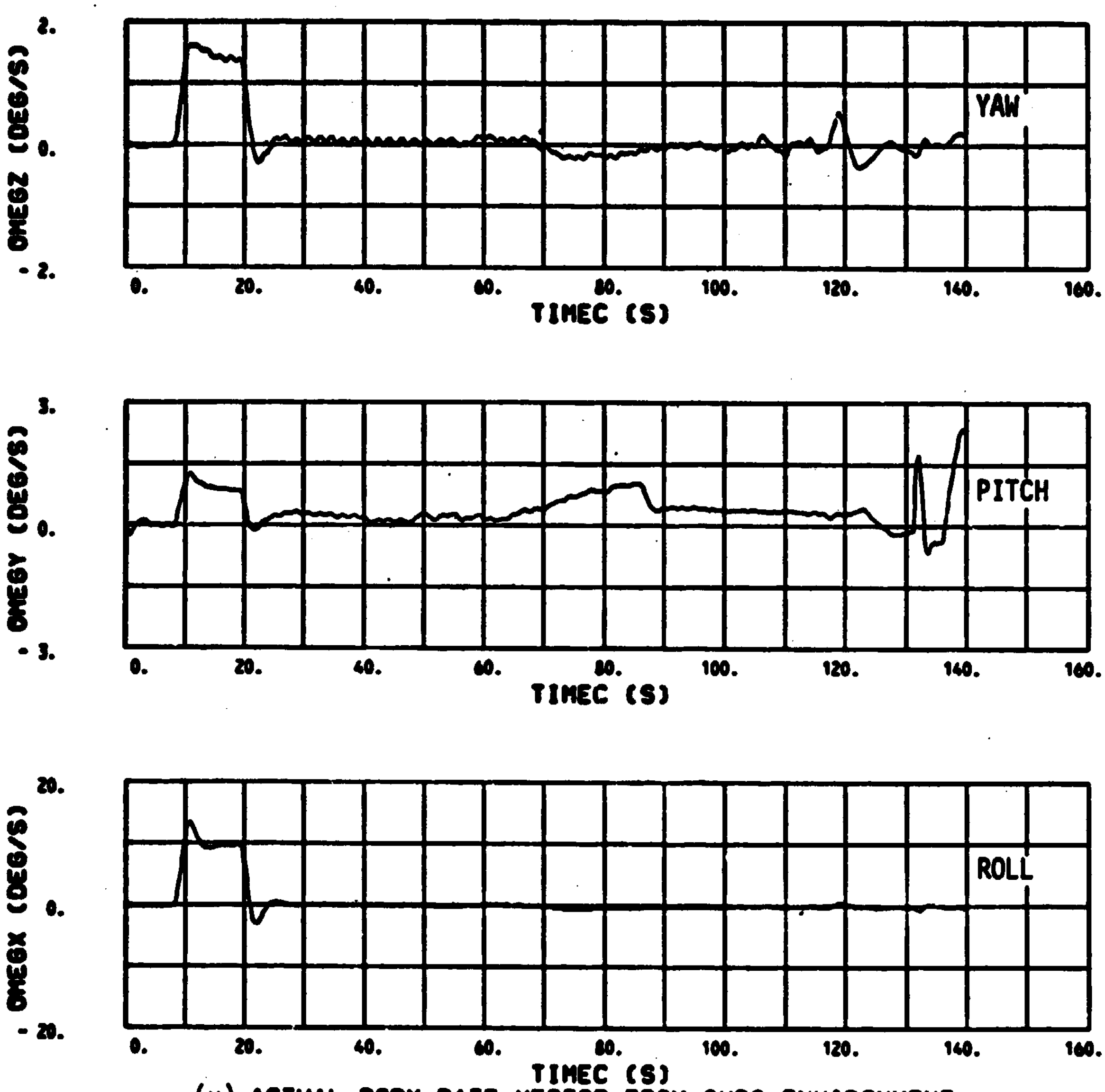
(v) BODY ATTITUDE ERRORS FOR DISPLAY FROM GC STEER (ACTUAL-COMMANDED)

Figure 6.2-1.- Continued.



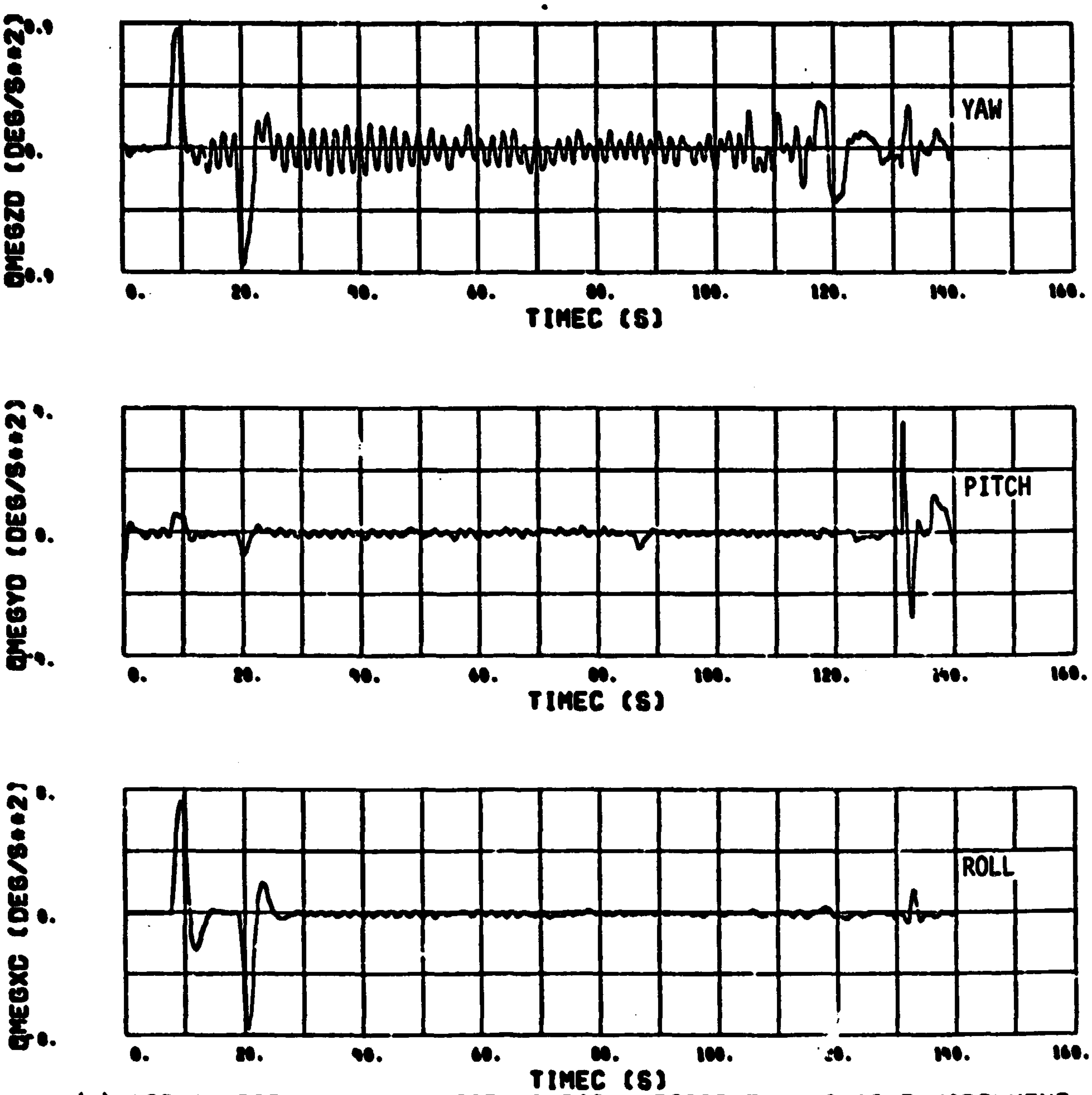
(w) TRIM INTEGRATOR OUTPUTS

Figure 6.2-1.- Continued.



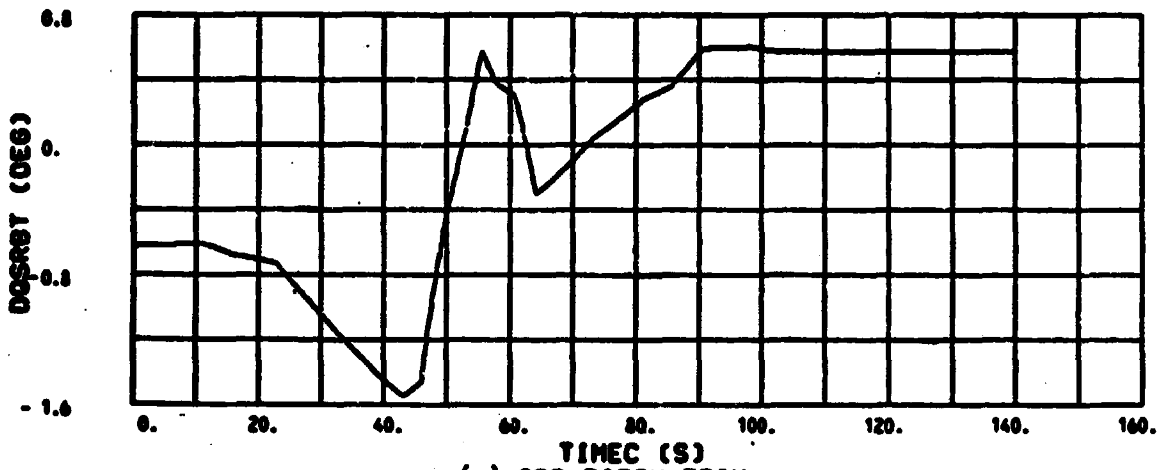
(x) ACTUAL BODY RATE VECTOR FROM SVDS ENVIRONMENT

Figure 6.2-1.- Continued.

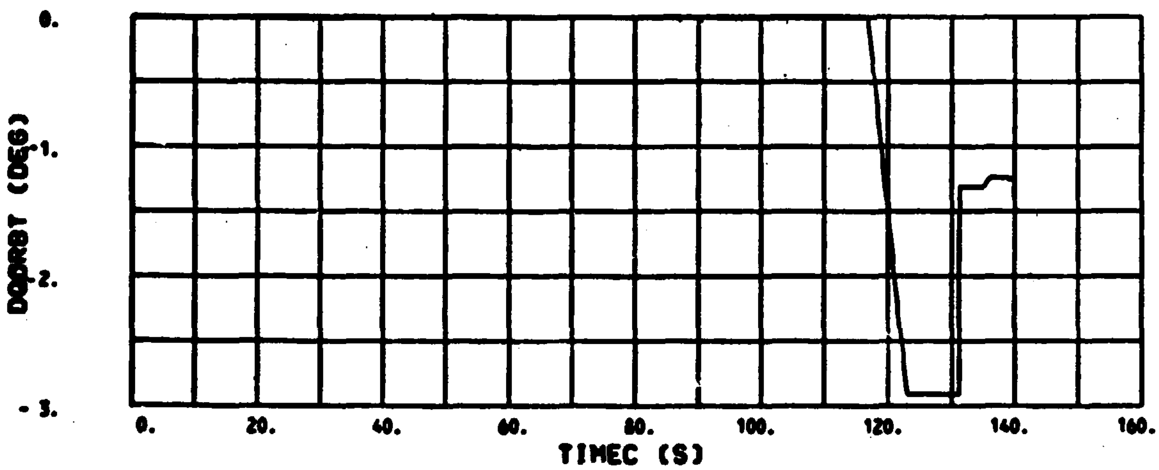


(y) ACTUAL BODY ANGULAR ACCELERATION VECTOR FROM SVDS ENVIRONMENT

Figure 6.2-1.- Continued.

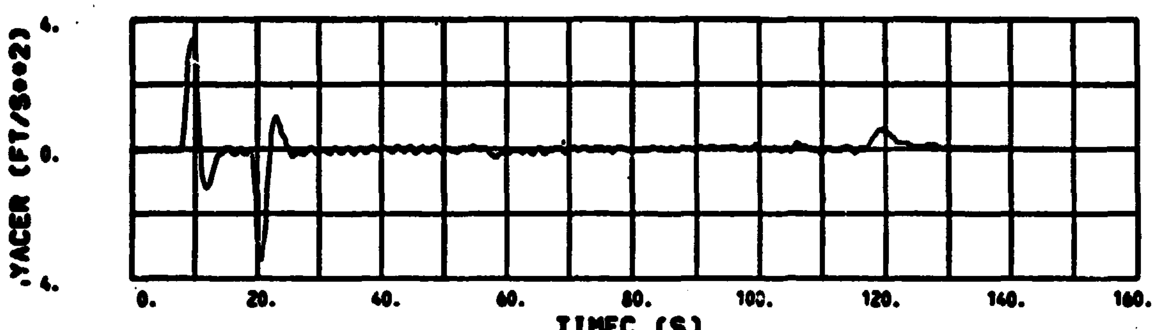


(z) SRB PITCH TRIM

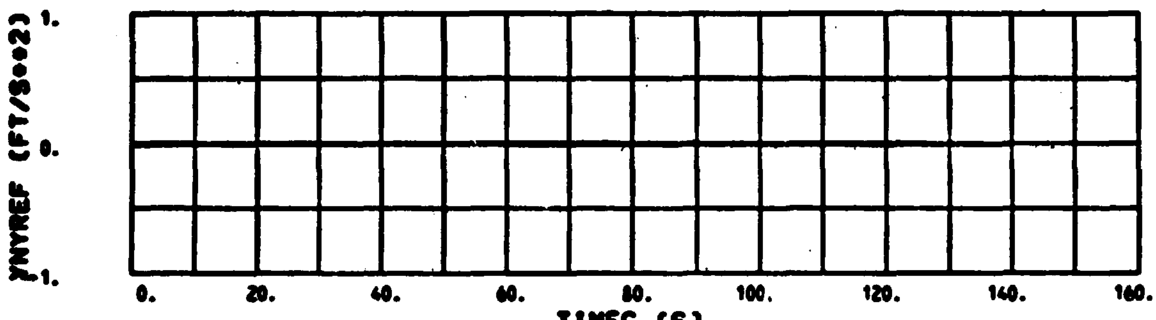


(aa) ORBITER PITCH TRIM

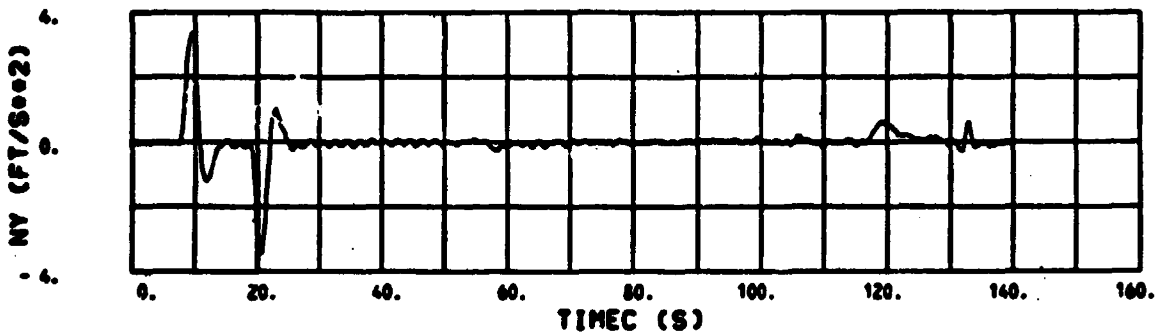
Figure 6.2-1.- Continued.



(bb) Y-ACCELERATION ERROR (ACTUAL-REFERENCE)

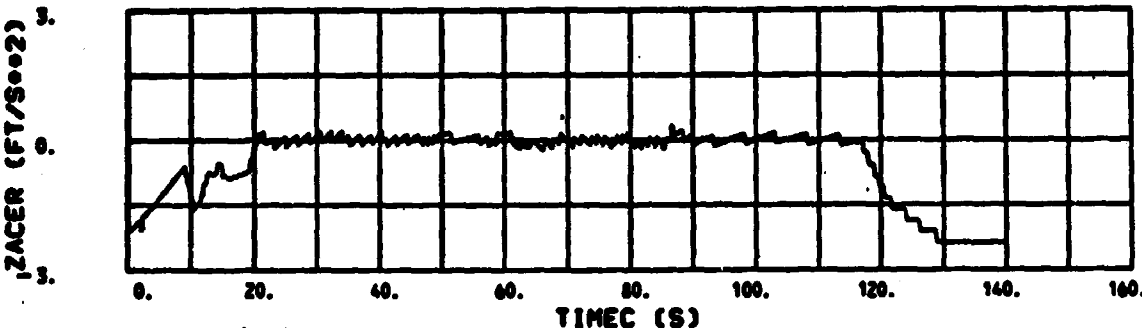


(cc) REFERENCE Y-ACCELERATION

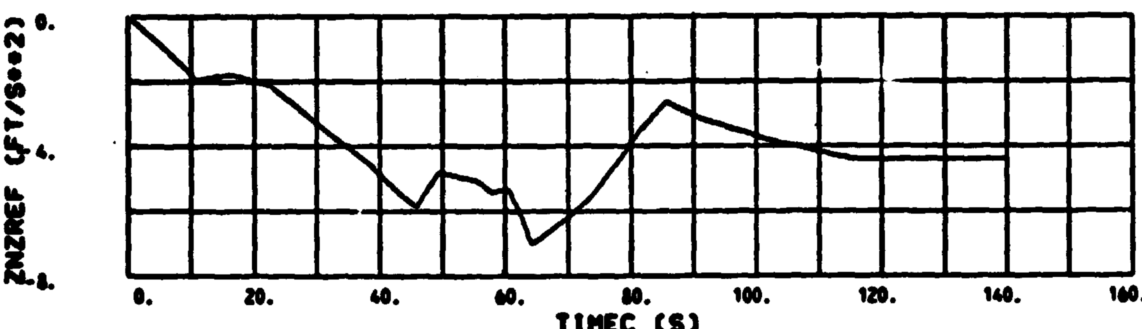


(dd) ACTUAL Y-ACCELERATION FROM ACCELEROMETER

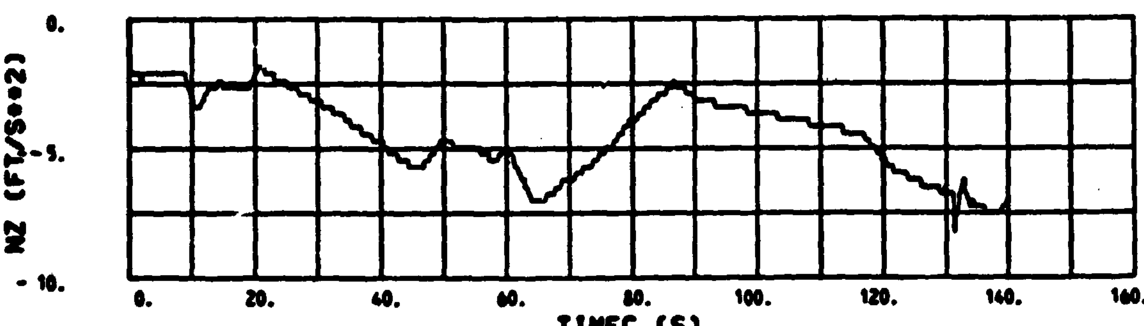
Figure 6.2-1.- Continued.



(ee) Z-ACCELERATION ERROR (ACTUAL-REFERENCE)

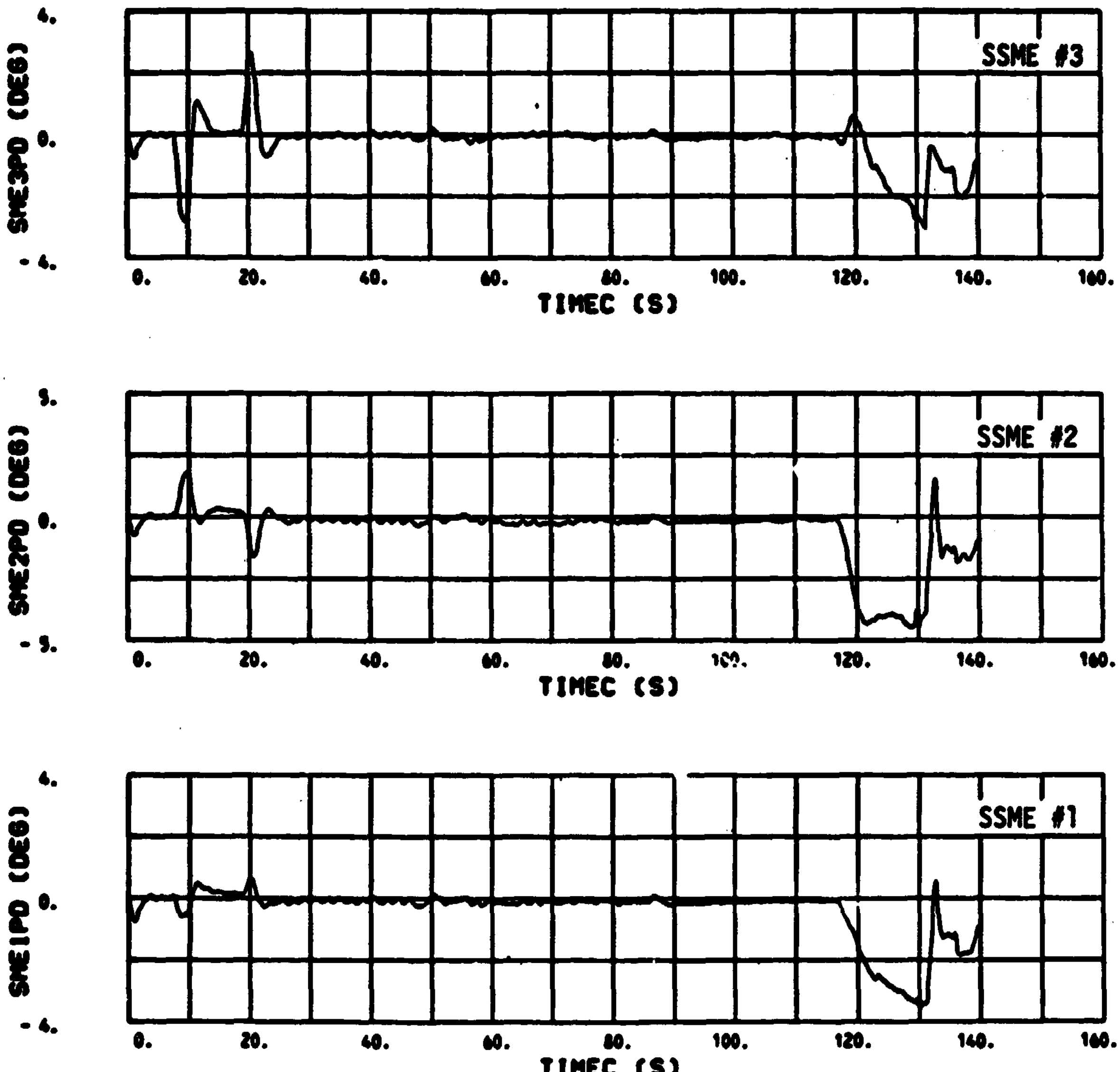


(ff) REFERENCE Z-ACCELERATION



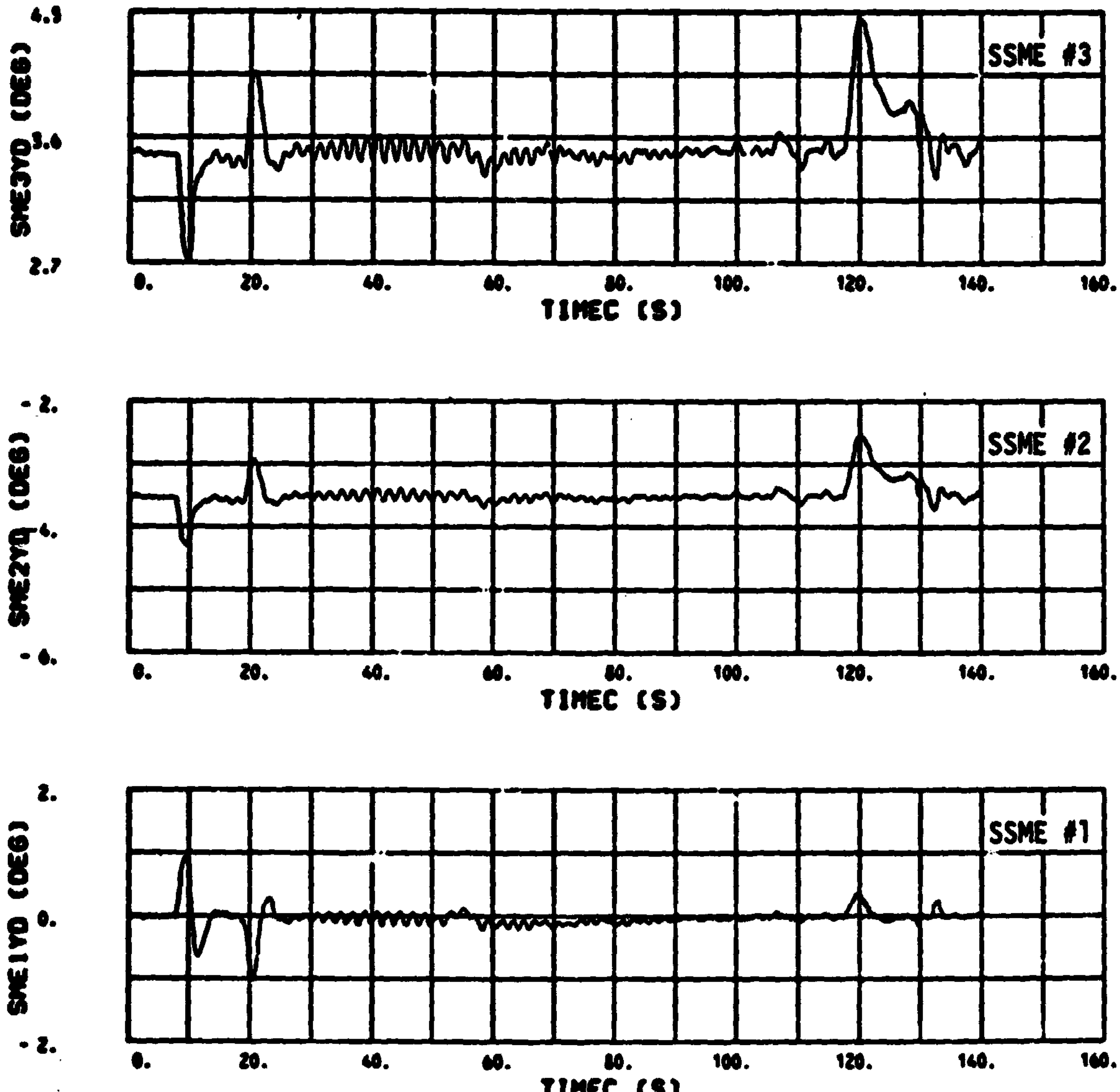
(gg) ACTUAL Z-ACCELERATION FROM ACCELEROMETER

Figure 6.2-1.- Continued.



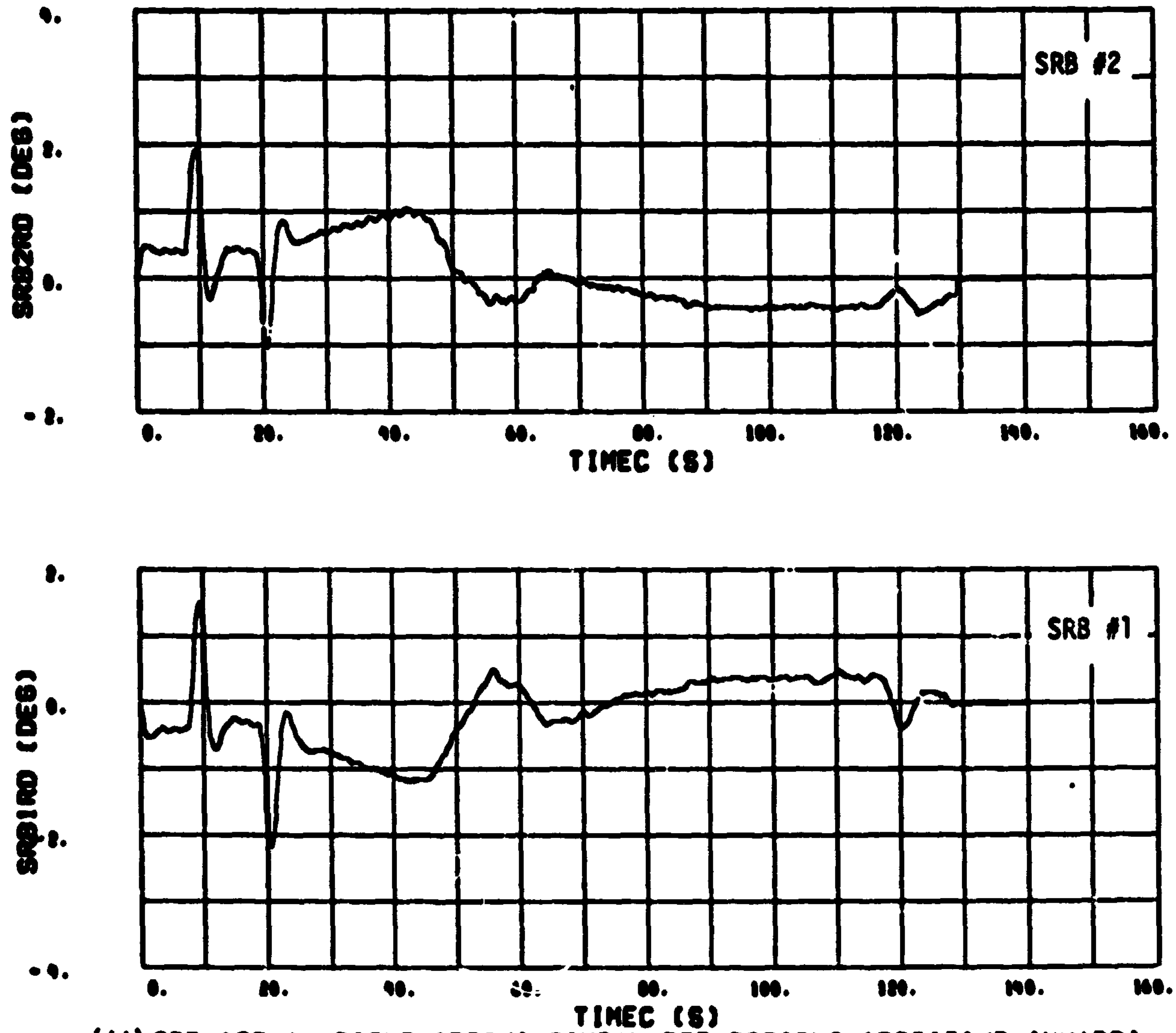
(hh) SSME ACTUAL PITCH GIMBAL DEFLECTION WRT NULL AXIS (POS. DOWN)

Figure 6.2-1.- Continued.



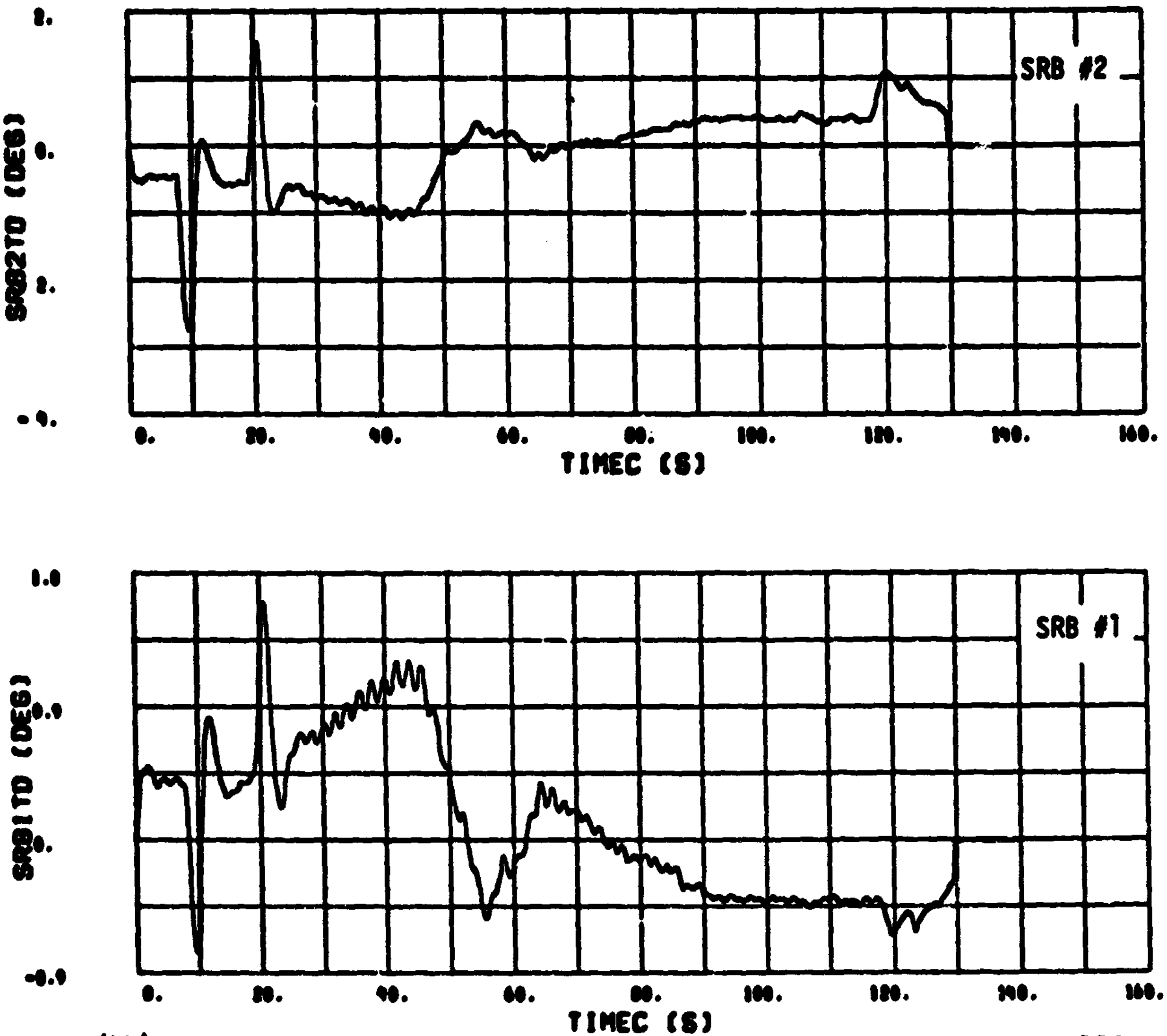
(ii) SSME ACTUAL YAW GIMBAL DEFLECTION WRT NULL AXIS (POS. LEFT)

Figure 6.2-1.- Continued.



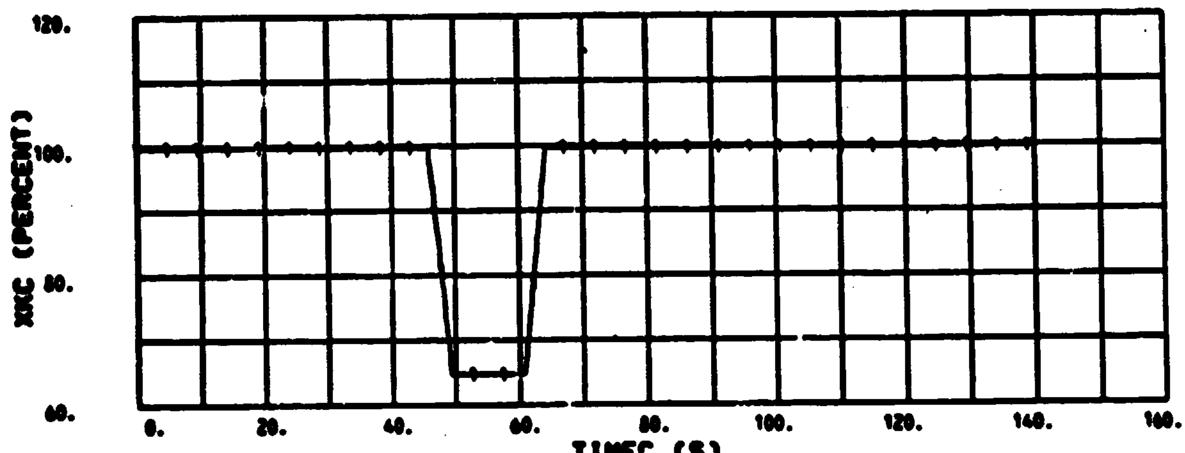
(jj) SRB ACTUAL RIGHT (ROCK) GIMBAL DEFLECTIONS (POSITIVE INWARD)

Figure 6.2-1.- Continued.

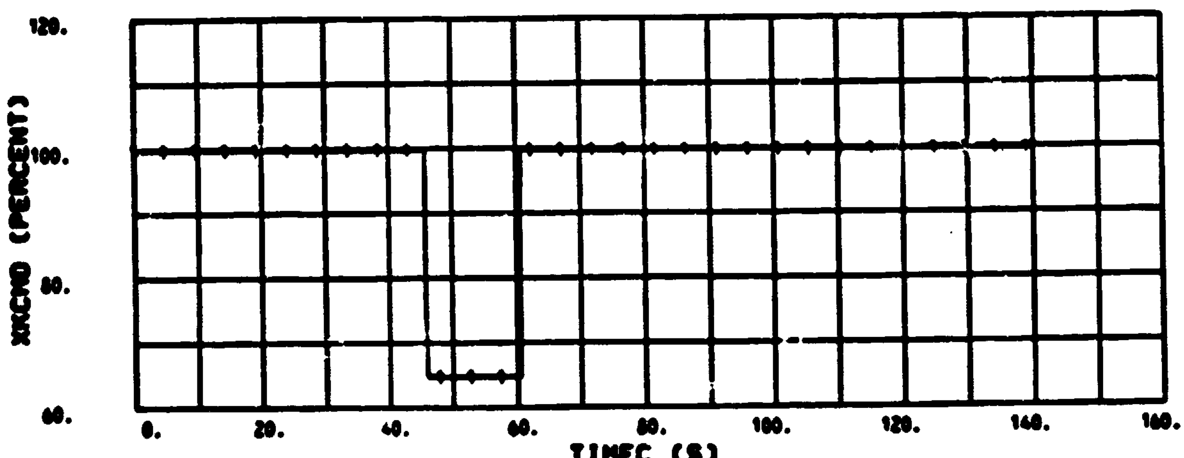


(kk) SRB ACTUAL LEFT (TILT) GIMBAL DEFLECTIONS (POSITIVE INWARD)

Figure 6.2-1.- Continued.

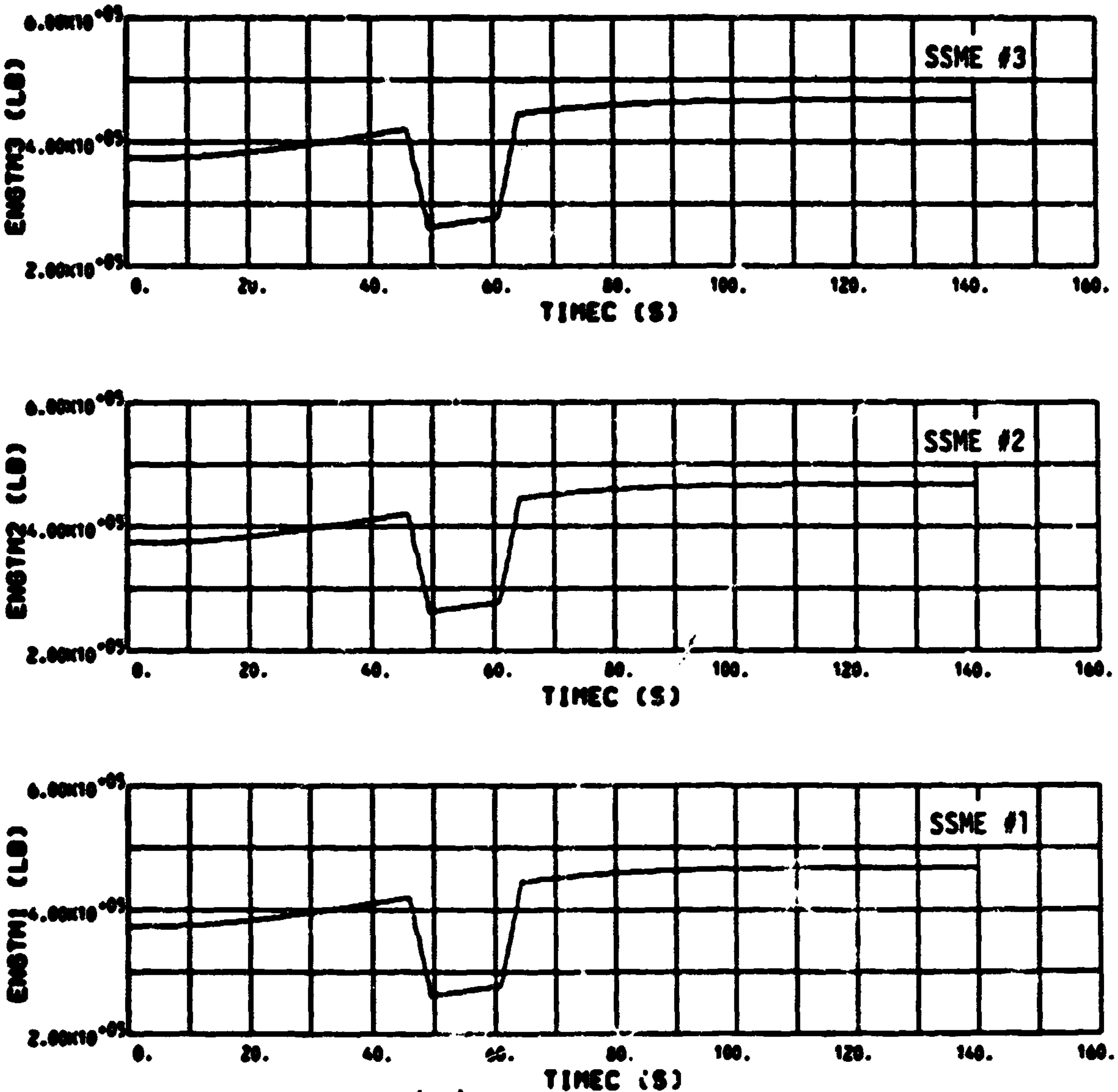


(11) ACTUAL SSME THROTTLE SETTING



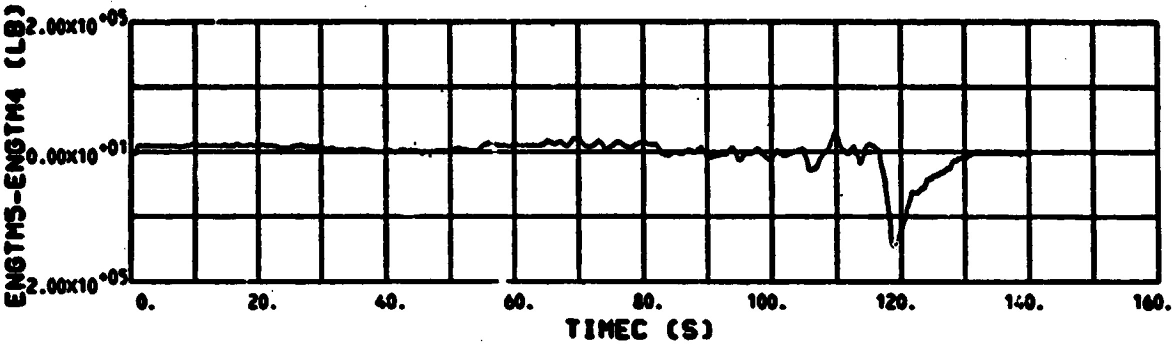
(mm) COMMANDED SSME THROTTLE SETTING FROM GUIDANCE

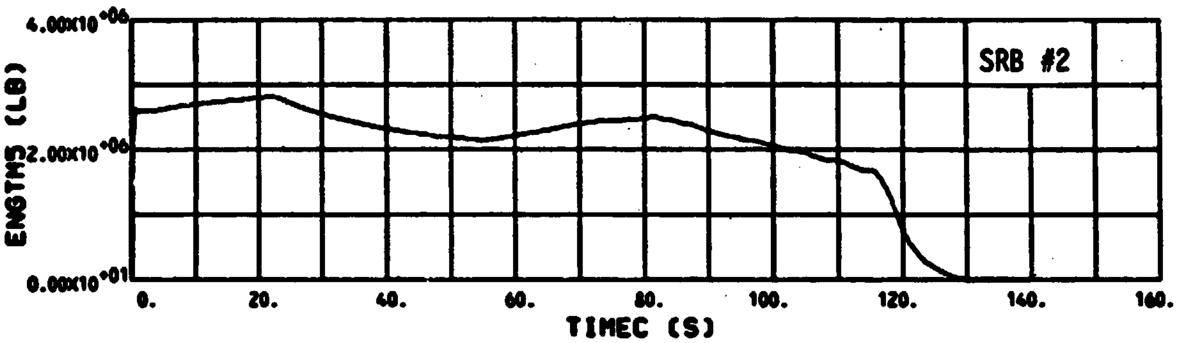
Figure 6.2-1.- Continued.

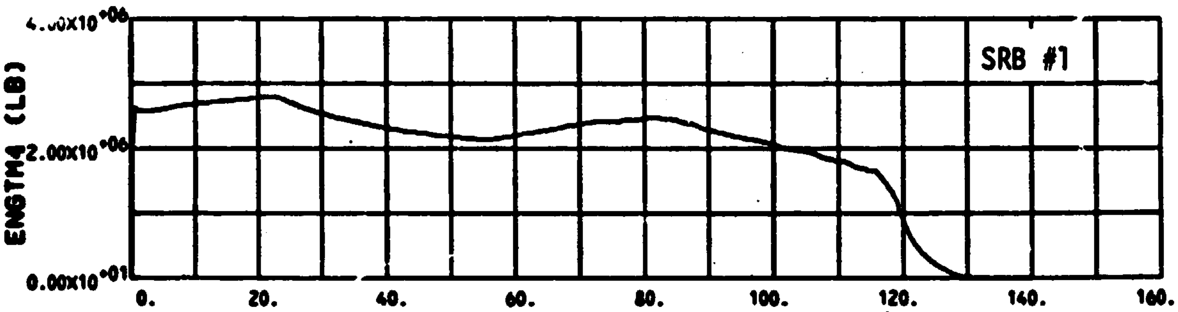


(nn) SSME ENGINE THRUST

Figure 6.2-1.- Continued.

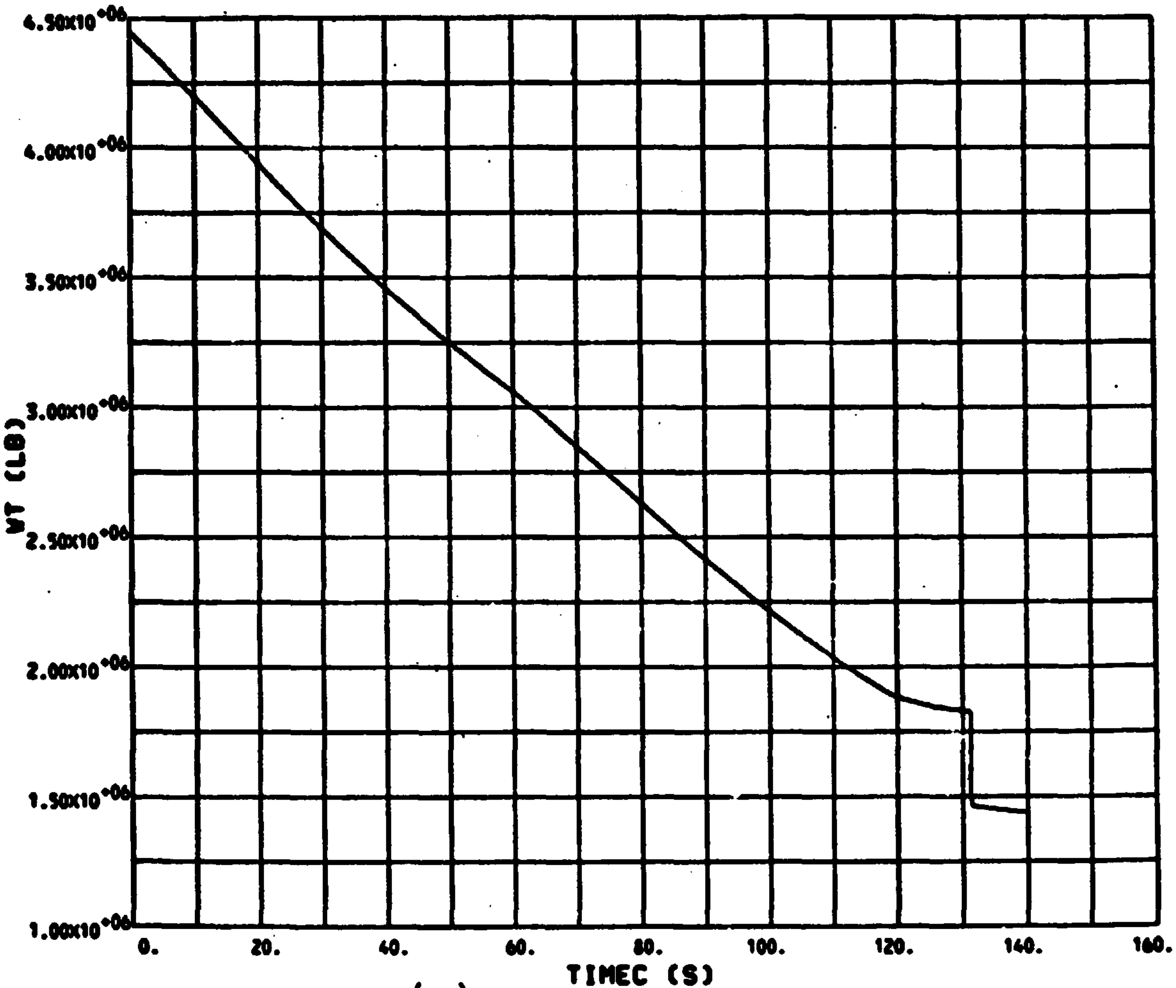






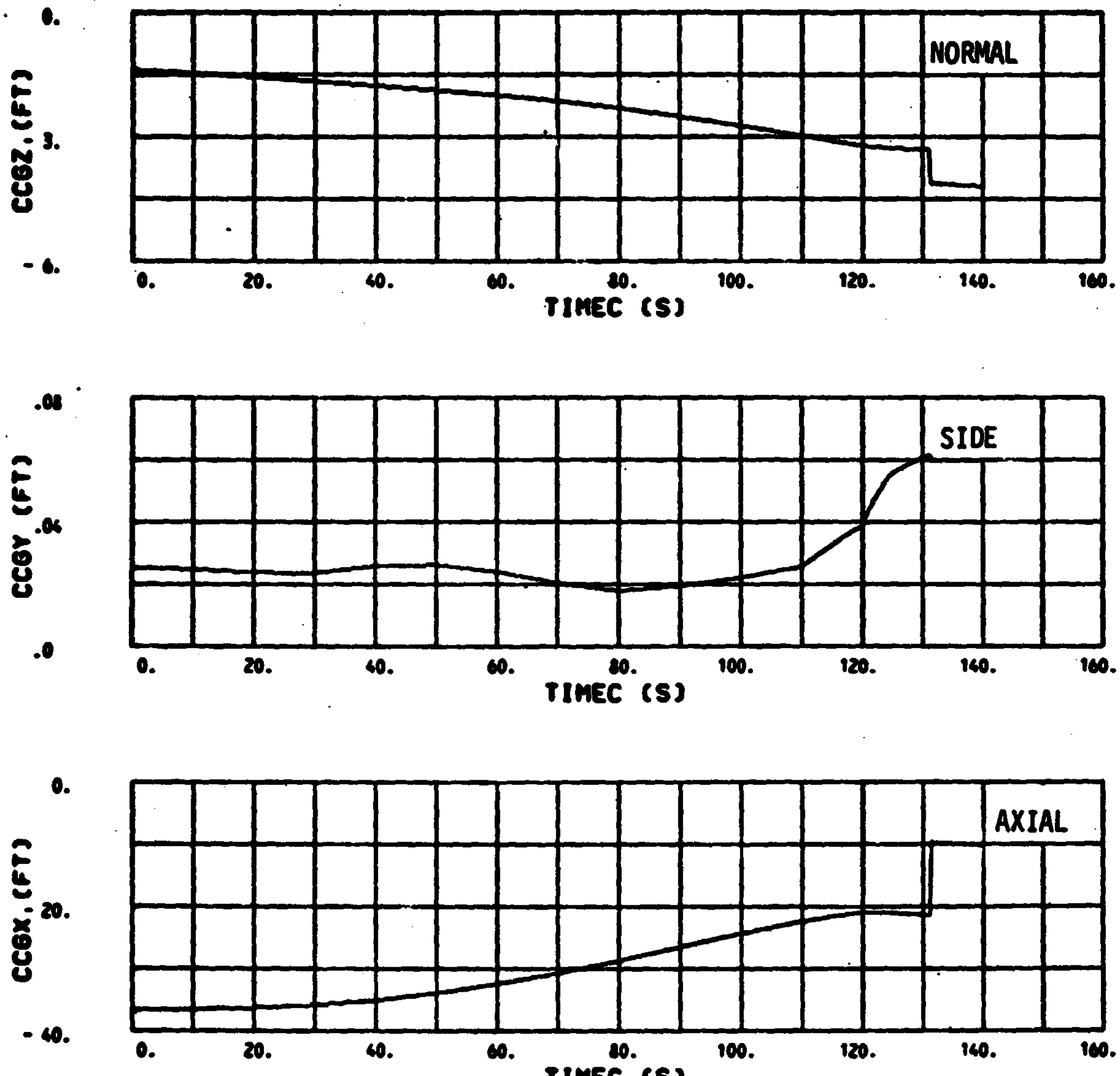
(oo) SRB ENGINE THRUST AND THRUST DIFFERENTIAL

Figure 6.2-1.- Continued.



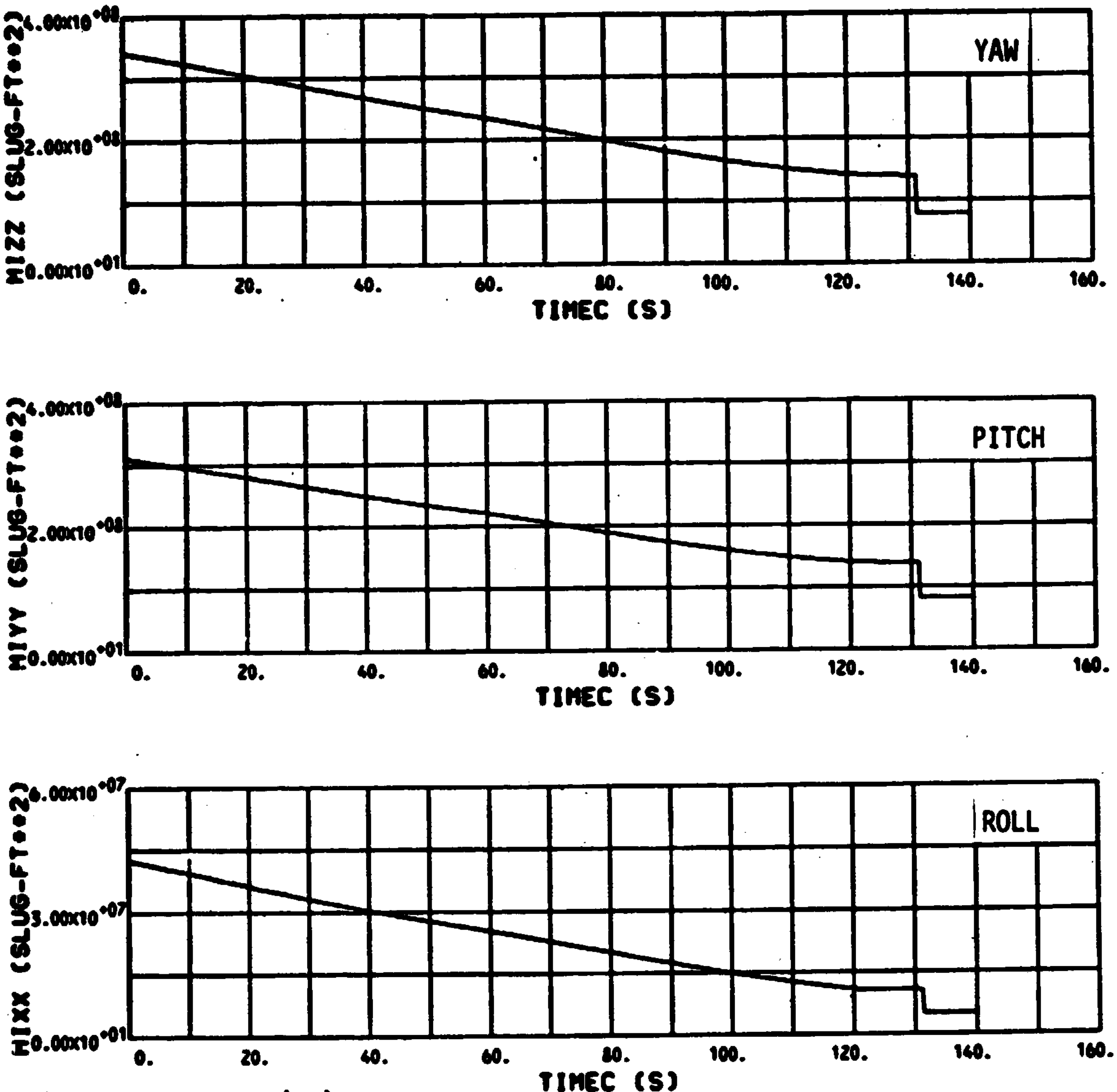
(pp) TOTAL VEHICLE WEIGHT

Figure 6.2-1.- Continued.



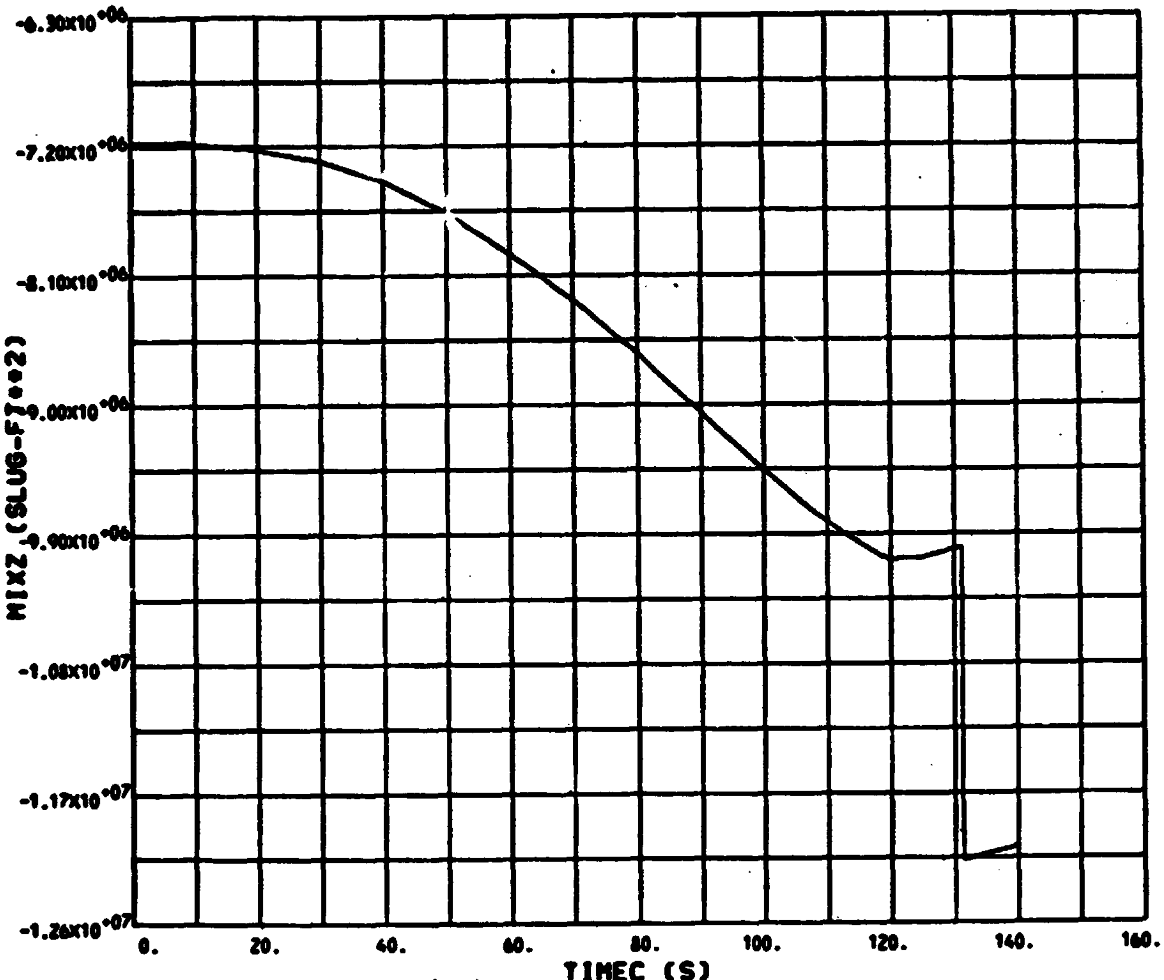
(qq) CG LOCATION WRT SVDS VEHICLE COORDINATE FRAME

Figure 6.2-1.- Continued.



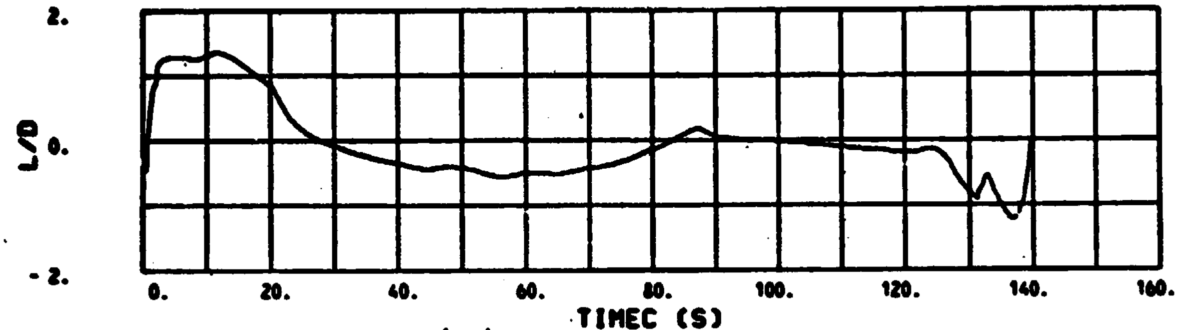
(rr) MOMENTS OF INERTIA ABOUT BODY AXES

Figure 6.2-1.- Continued.

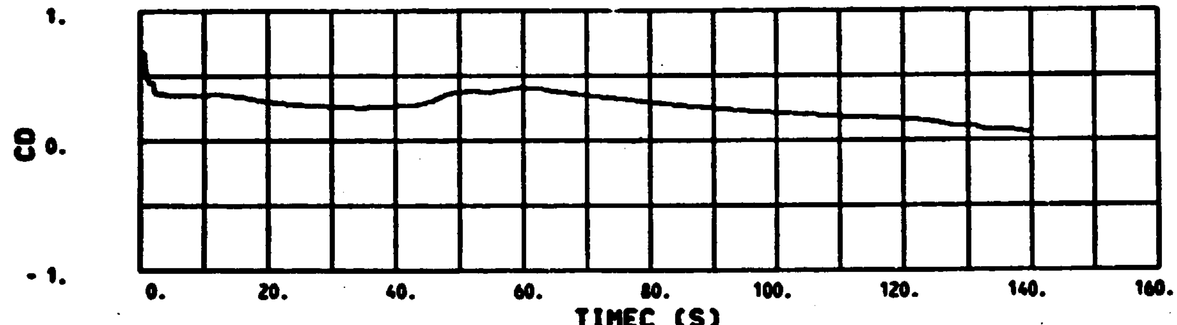


(SS) PRODUCT OF INERTIA

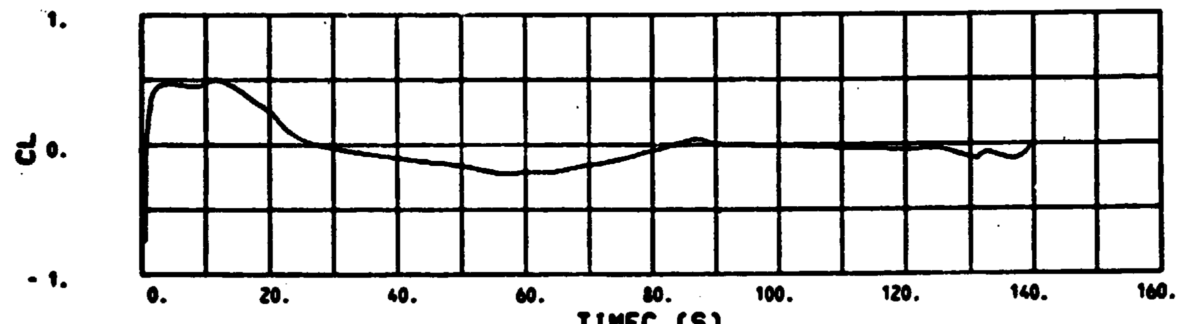
Figure 6.2-1.- Continued.



(tt) LIFT-TO-DRAG RATIO

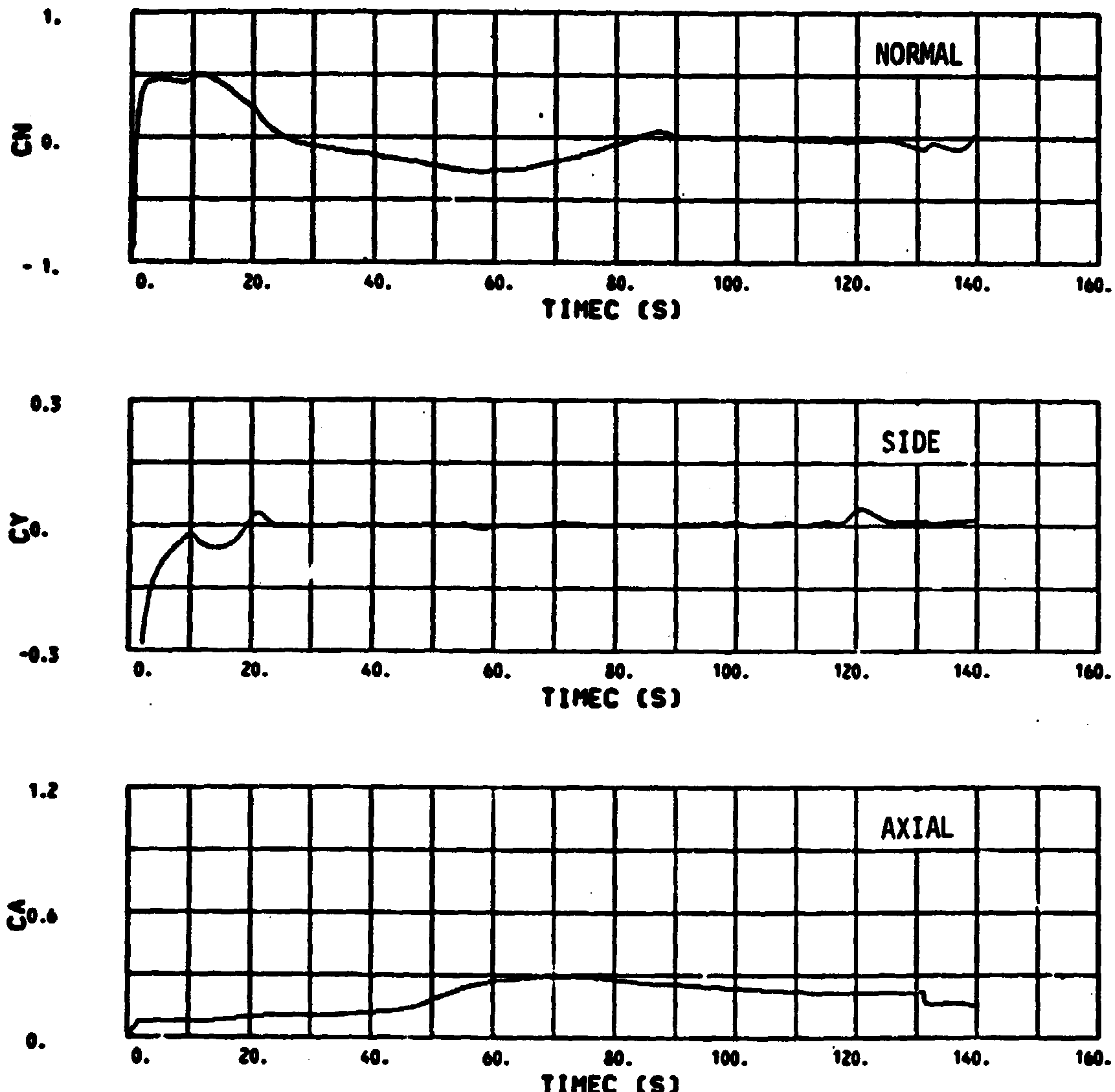


(uu) DRAG COEFFICIENT



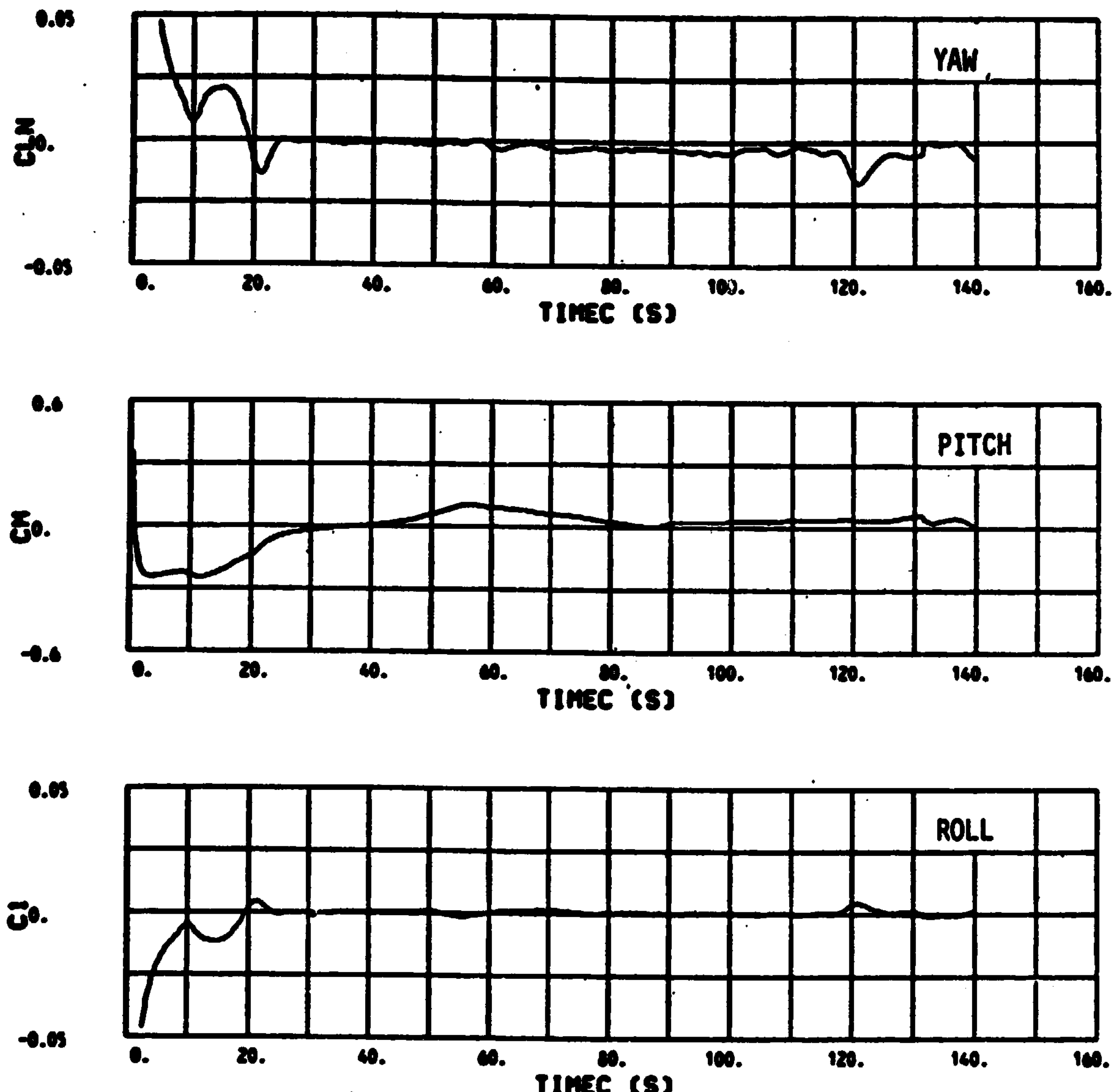
(vv) LIFT COEFFICIENT

Figure 6.2-1.- Continued.



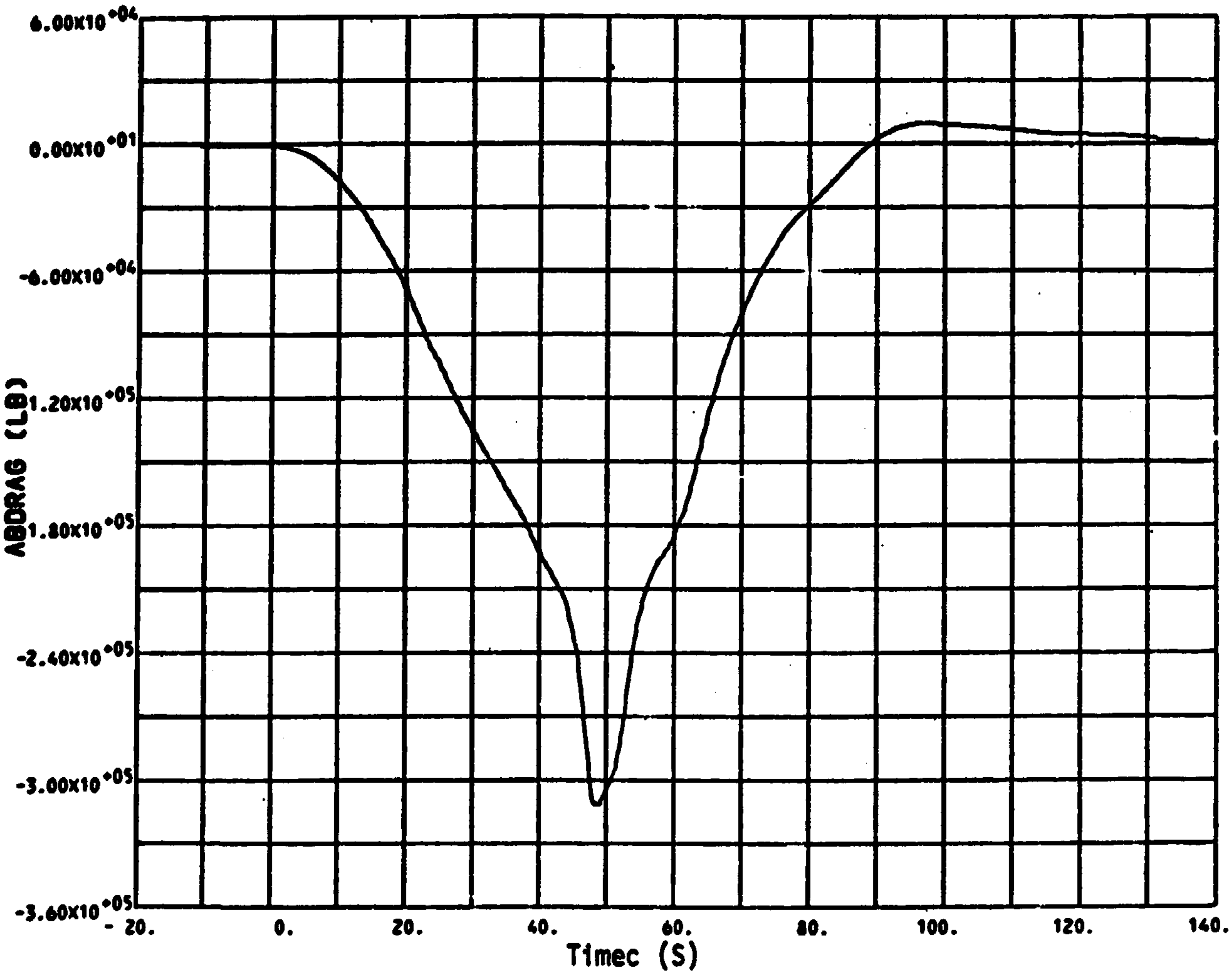
(WW) AERODYNAMIC FORCE COEFFICIENTS

Figure 6.2-1.- Continued.



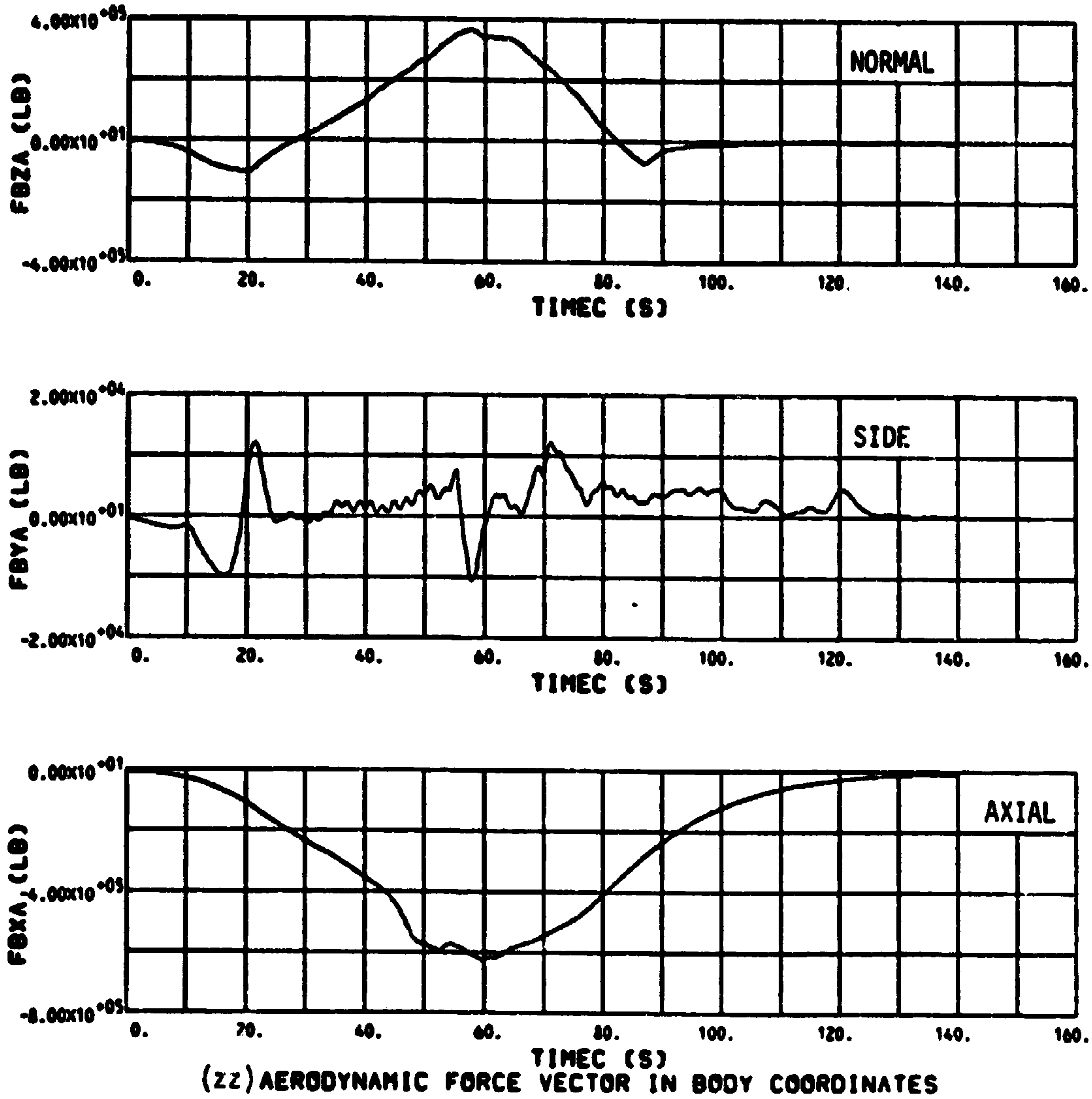
(XX)AERODYNAMIC MOMENT COEFFICIENTS

Figure 6.2-1.- Continued.



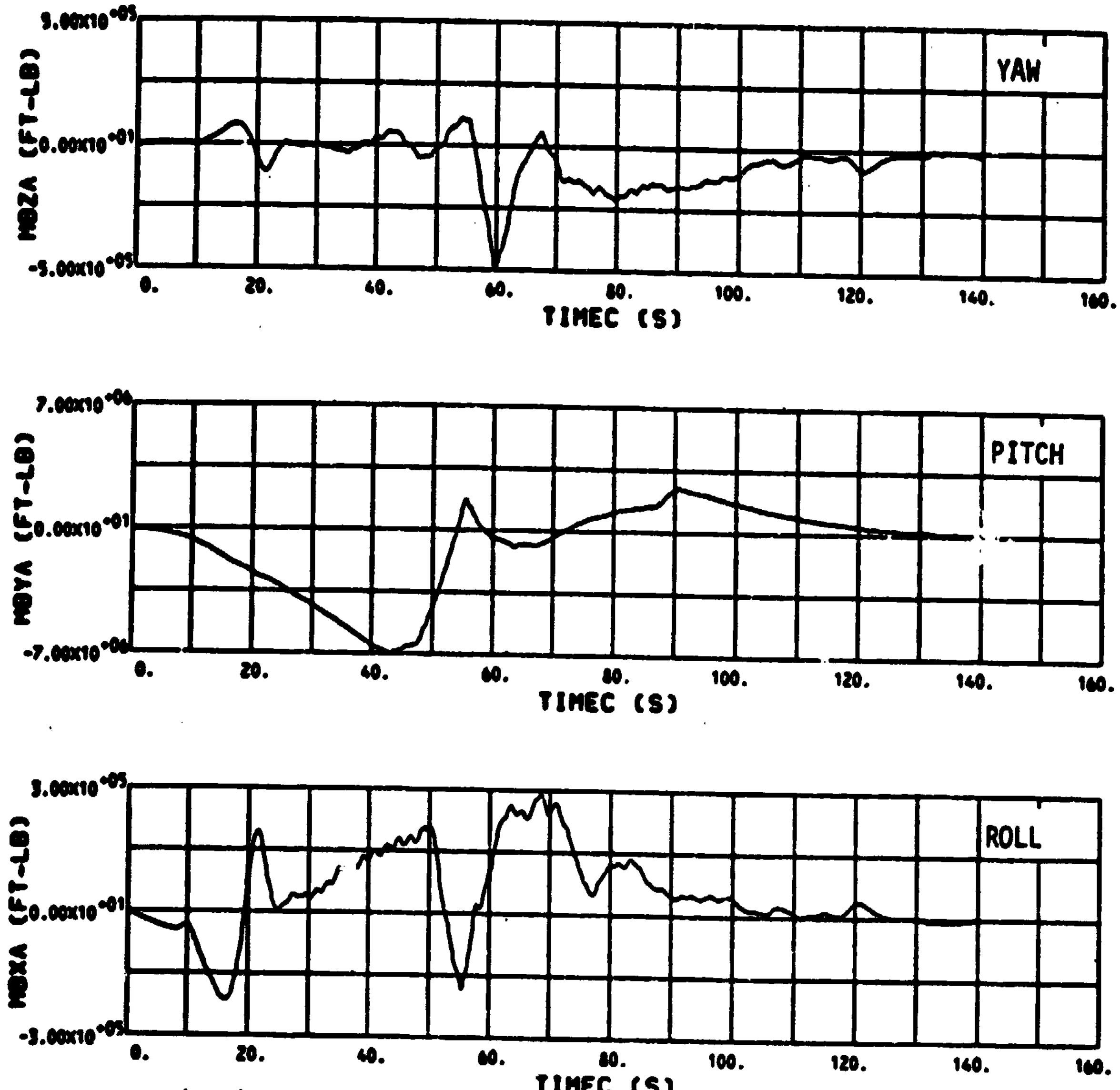
(yy) Base drag

Figure 6.2-1.- Continued.



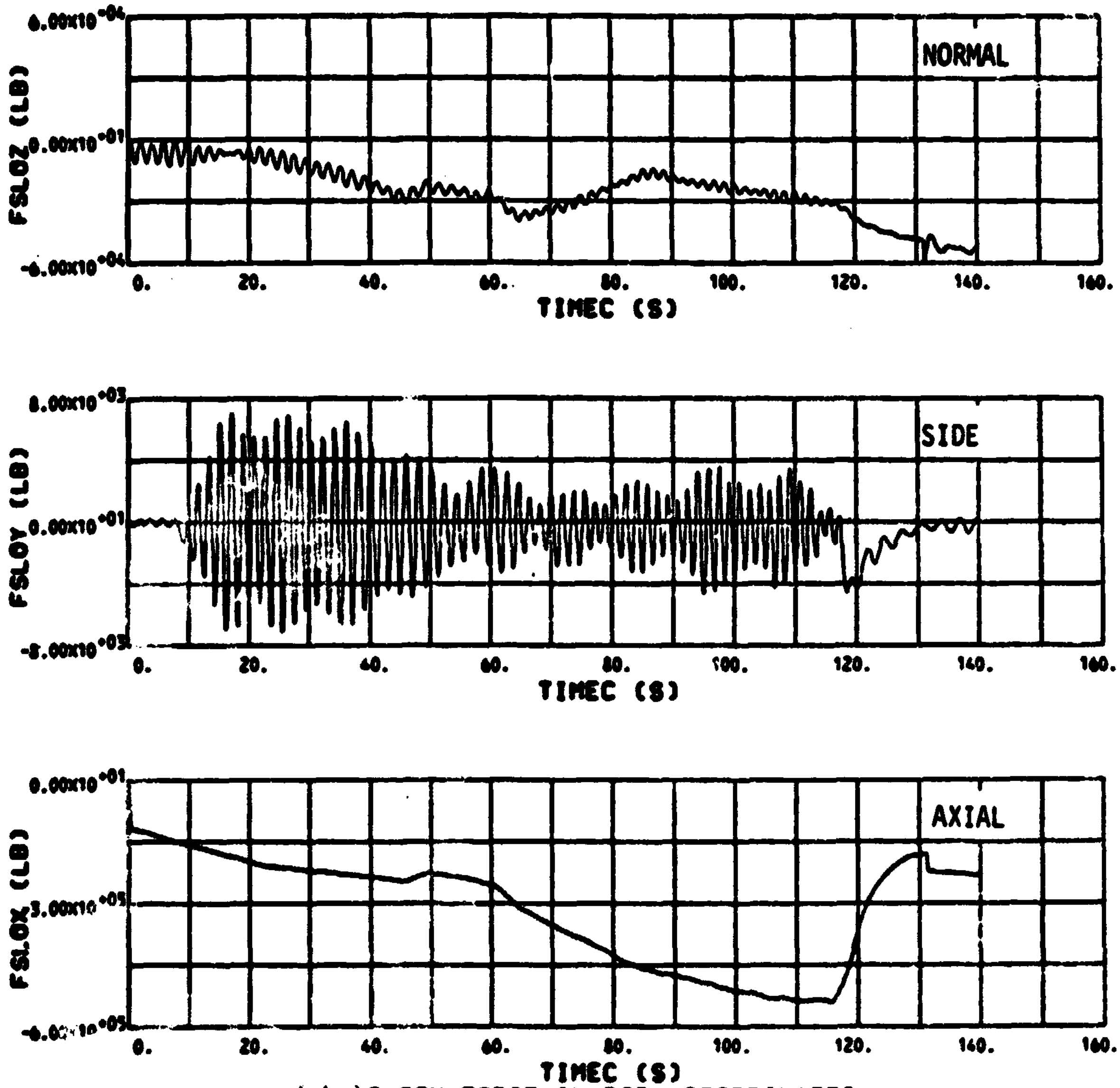
(zz) AERODYNAMIC FORCE VECTOR IN BODY COORDINATES

Figure 6.2-1.- Continued.



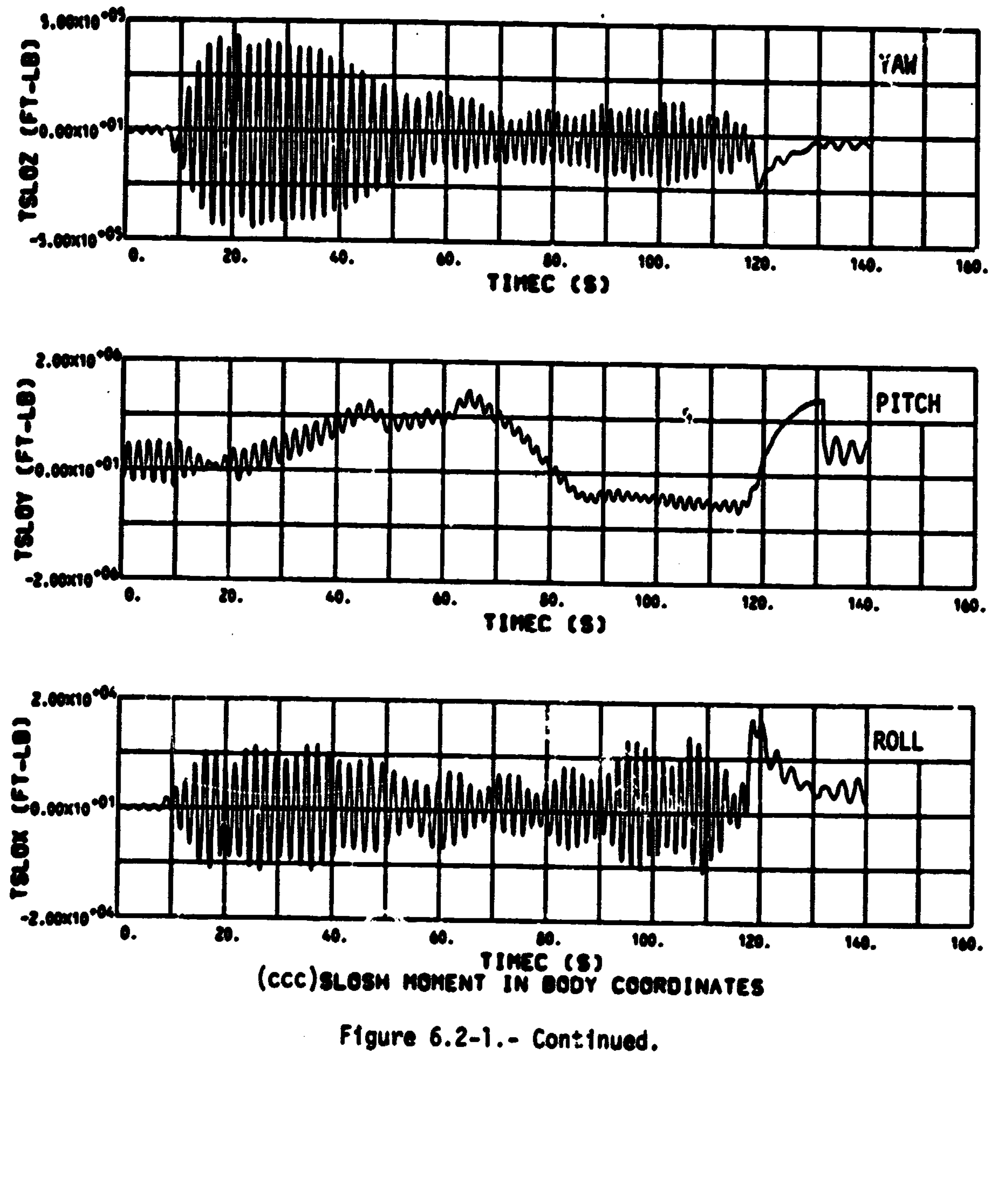
(aaa) AERODYNAMIC MOMENT VECTOR IN BODY COORDINATES

Figure 6.2-1.- Continued.



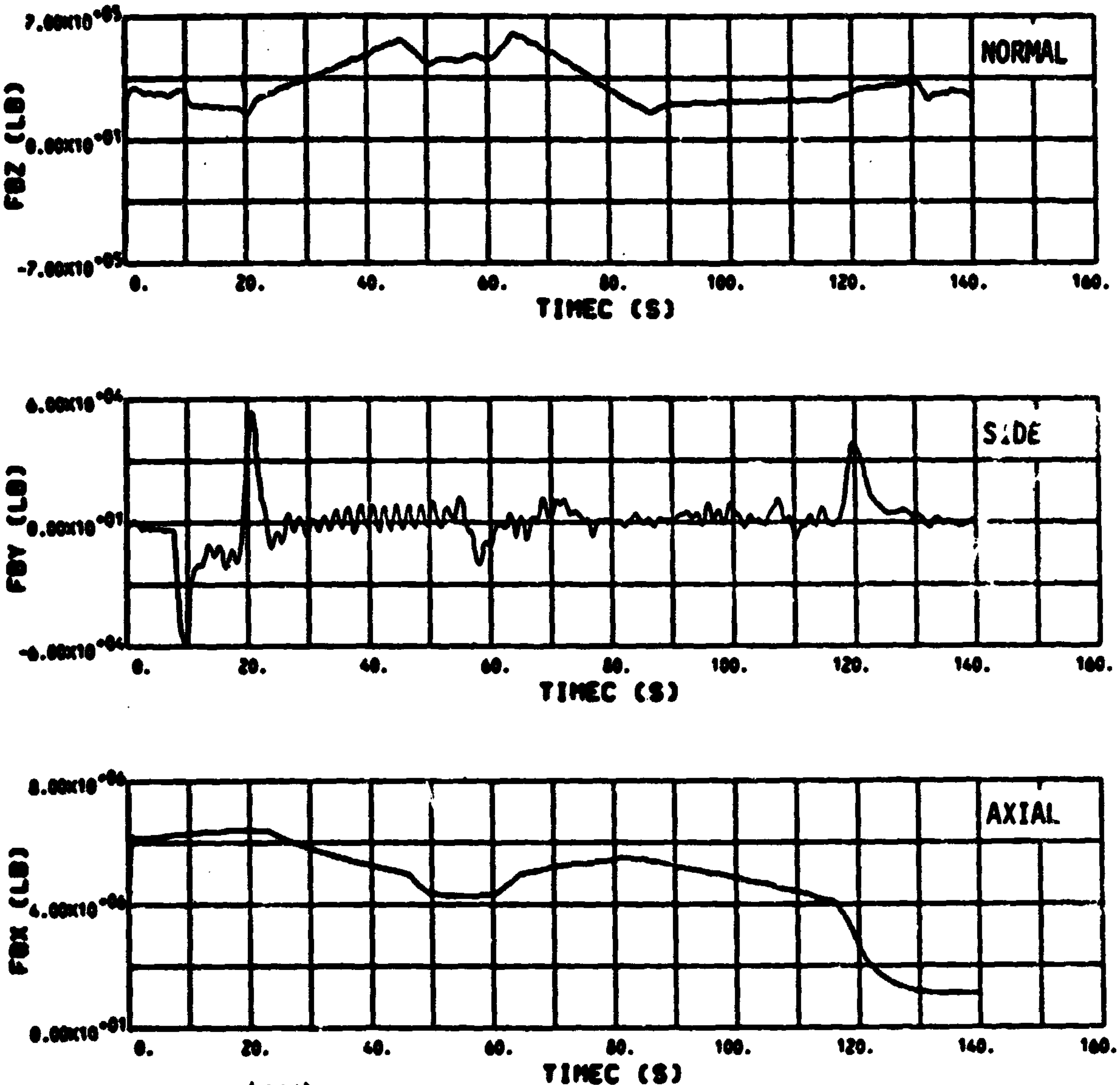
(bb) SLOSH FORCE IN BODY COORDINATES

Figure 6.2-1.- Continued.



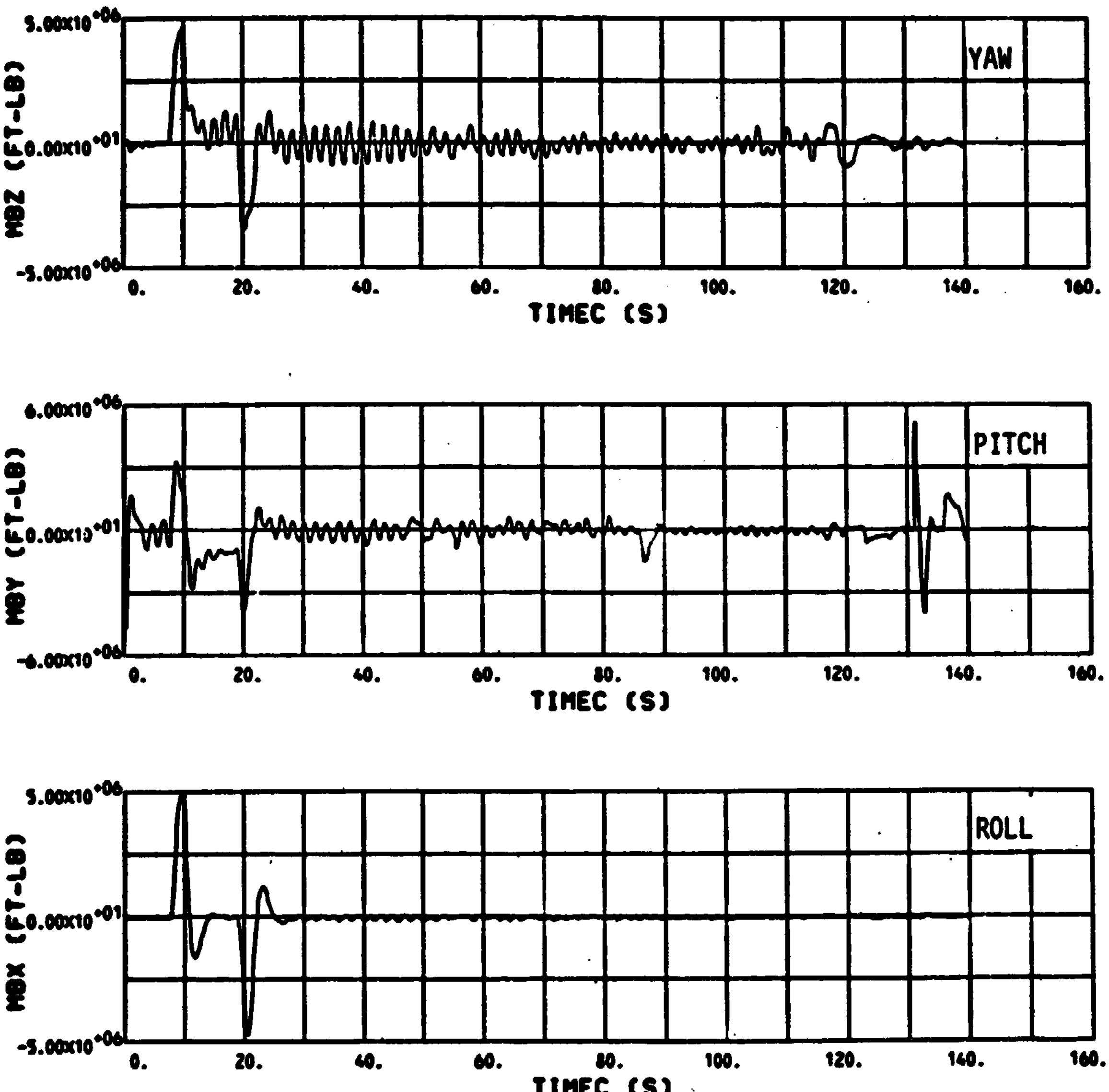
(CCC)SLOSH MOMENT IN BODY COORDINATES

Figure 6.2-1.- Continued.



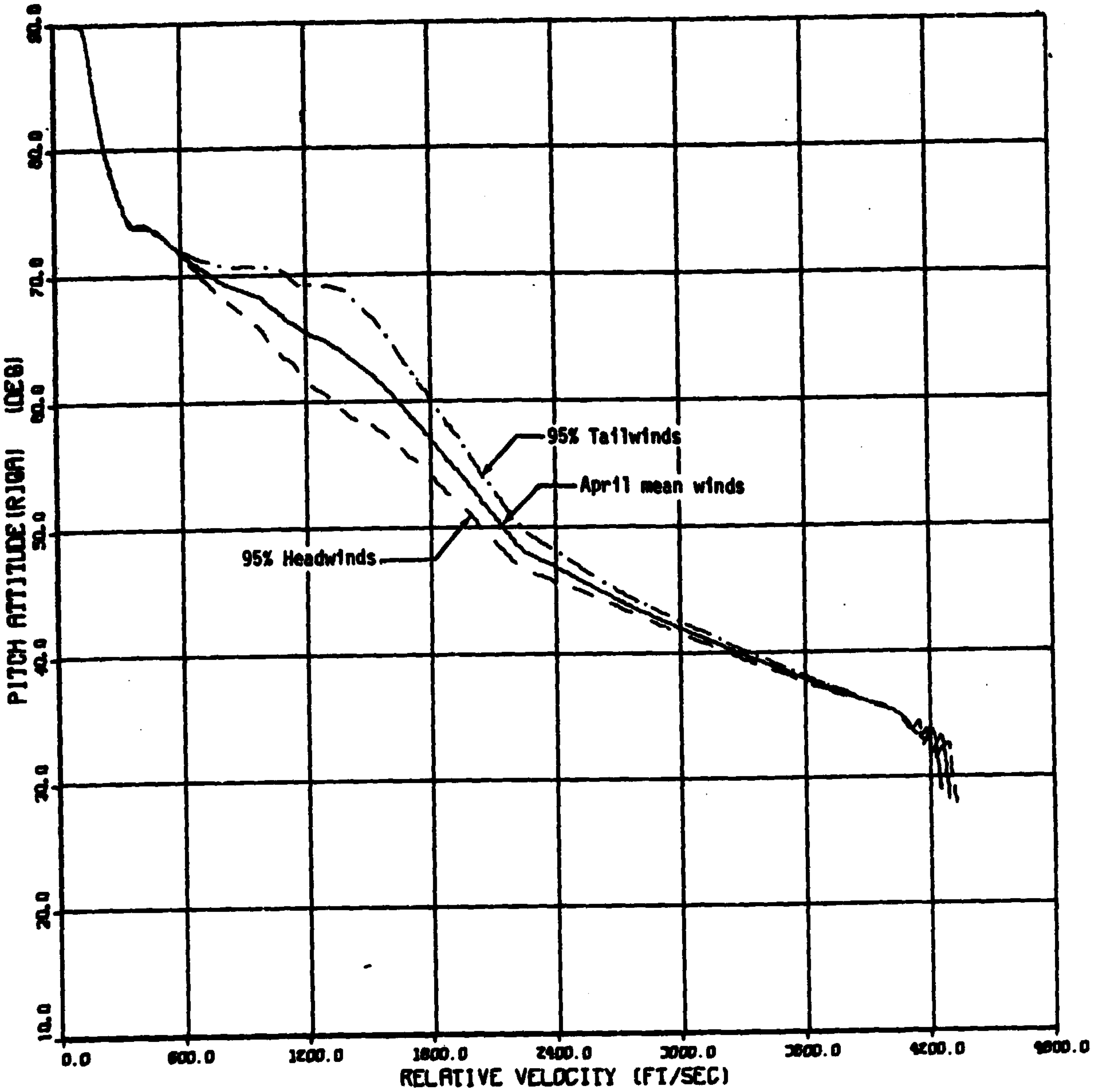
(ddd)TOTAL FORCE VECTOR IN BODY COORDINATES

Figure 6.2-1.- Continued.



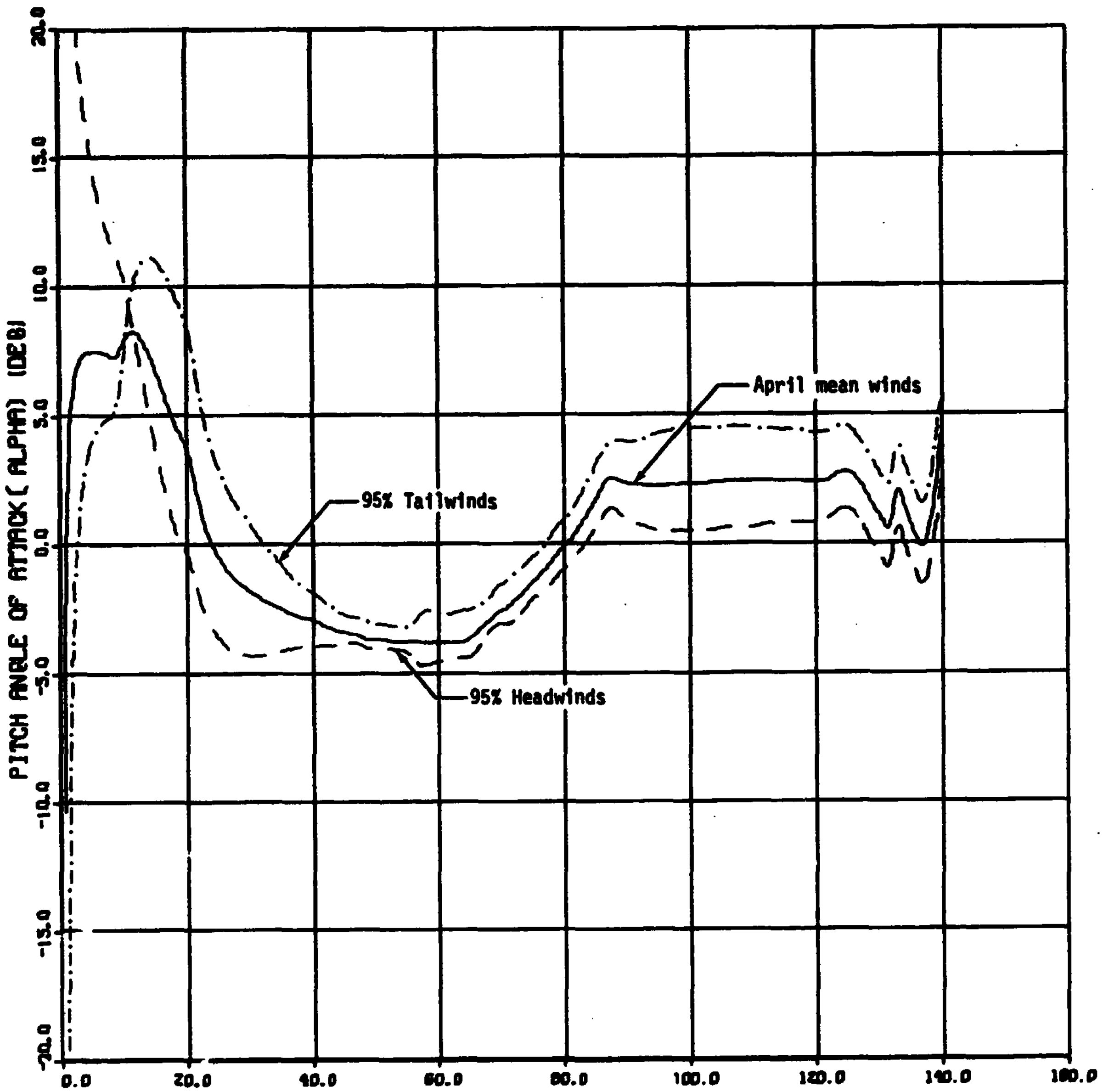
(eee)TOTAL MOMENT VECTOR IN BODY COORDINATES

Figure 6.2-1.- Continued.



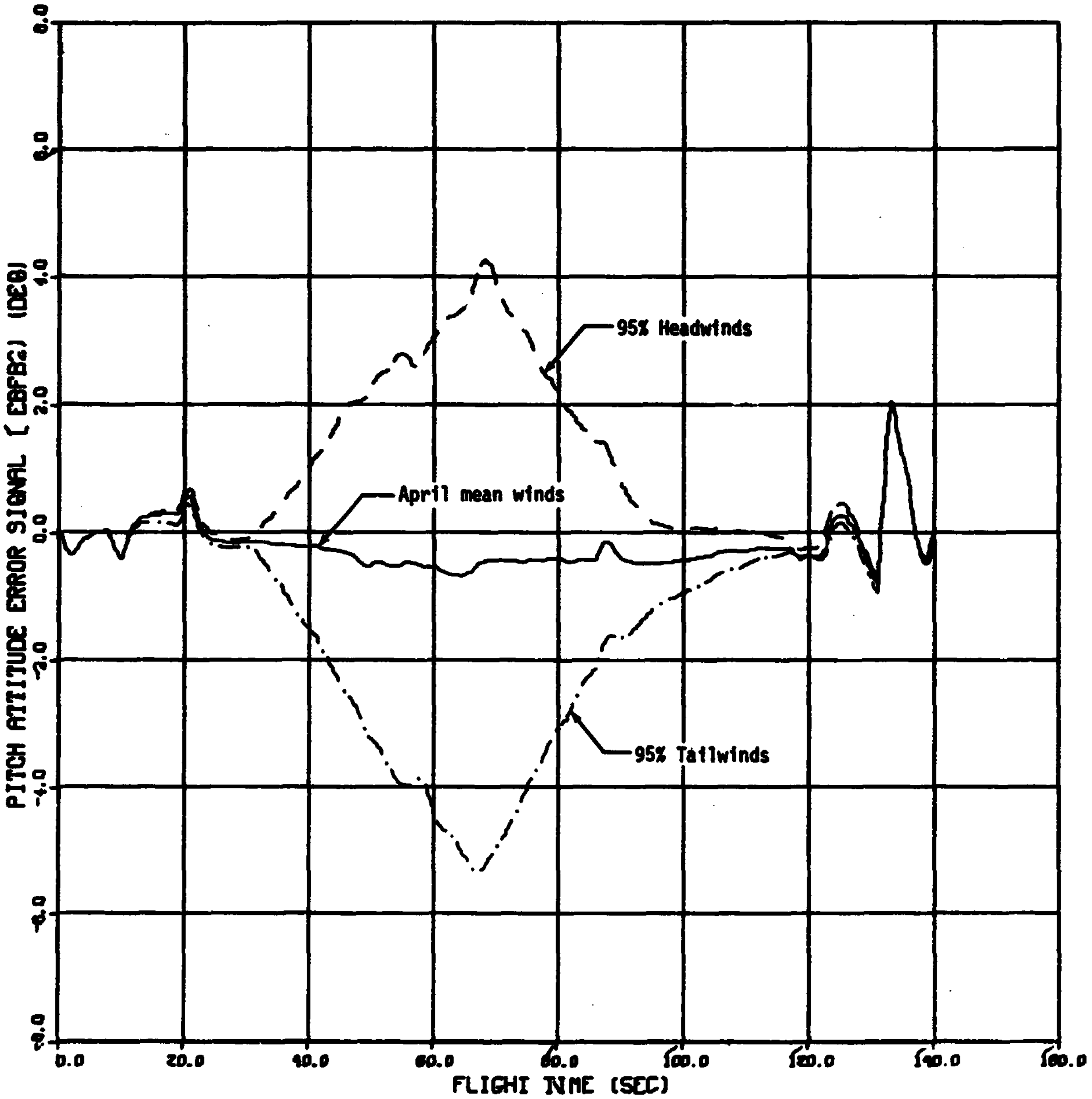
(fff) Wind effects on pitch attitude.

Figure 6.2-1.- Continued.



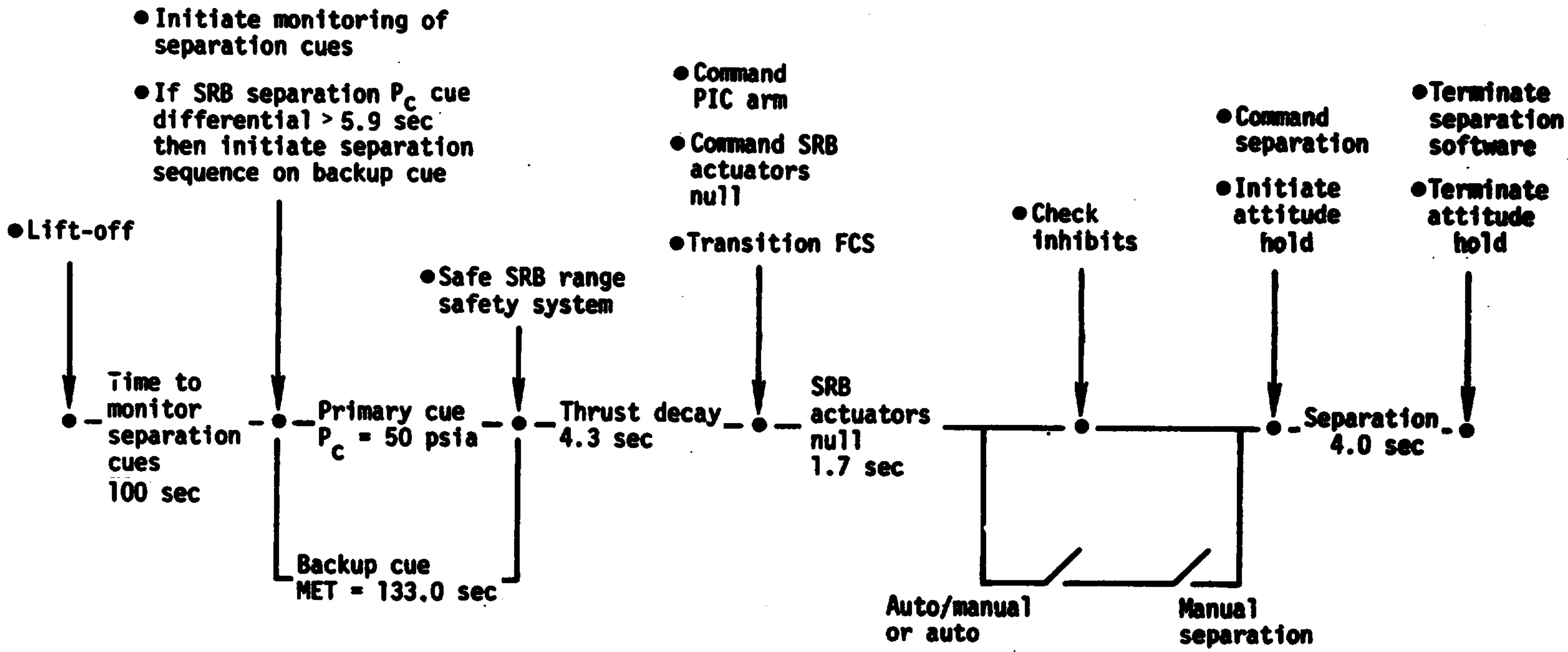
(ggg) Wind effects on angle of attack.

Figure 6.2-1.- Continued.



(hhh) Wind effects on pitch attitude error.

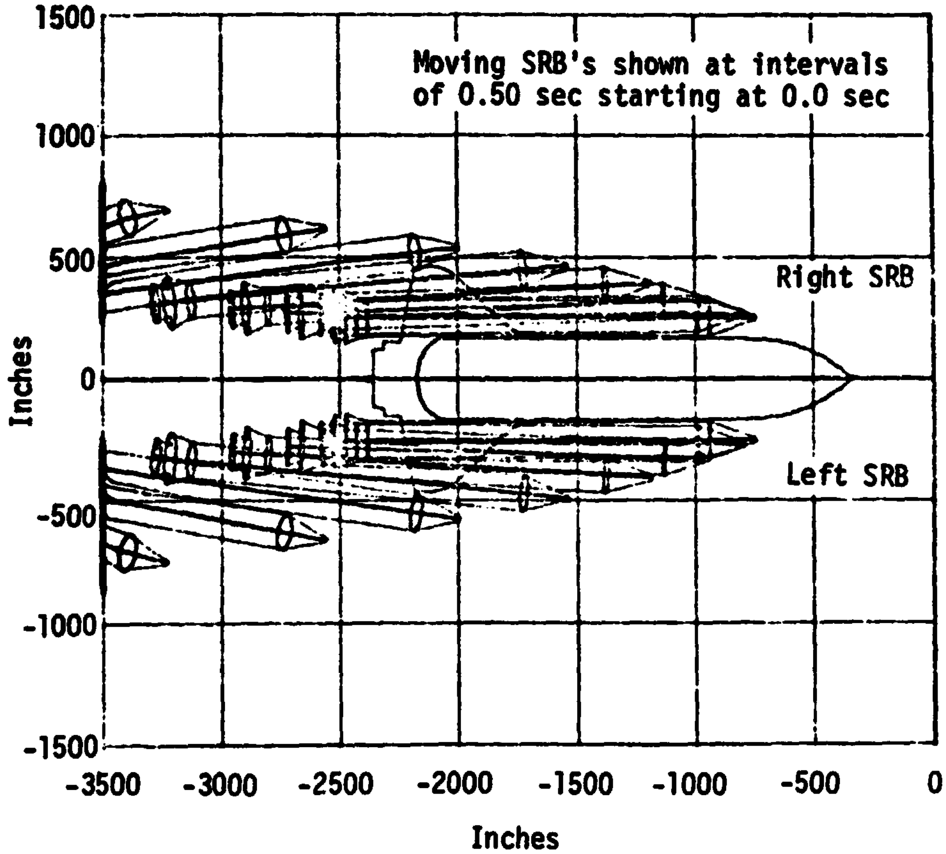
Figure 6.2-1.- Concluded.



•Sequence resides in redundant flight computer set

•Separation inhibit a function of body rates and dynamic pressure

Figure 6.3-1.- SRB separation sequence.



(a) Bottom view.

Figure 6.3-2.- Nominal SRB separation trajectories.

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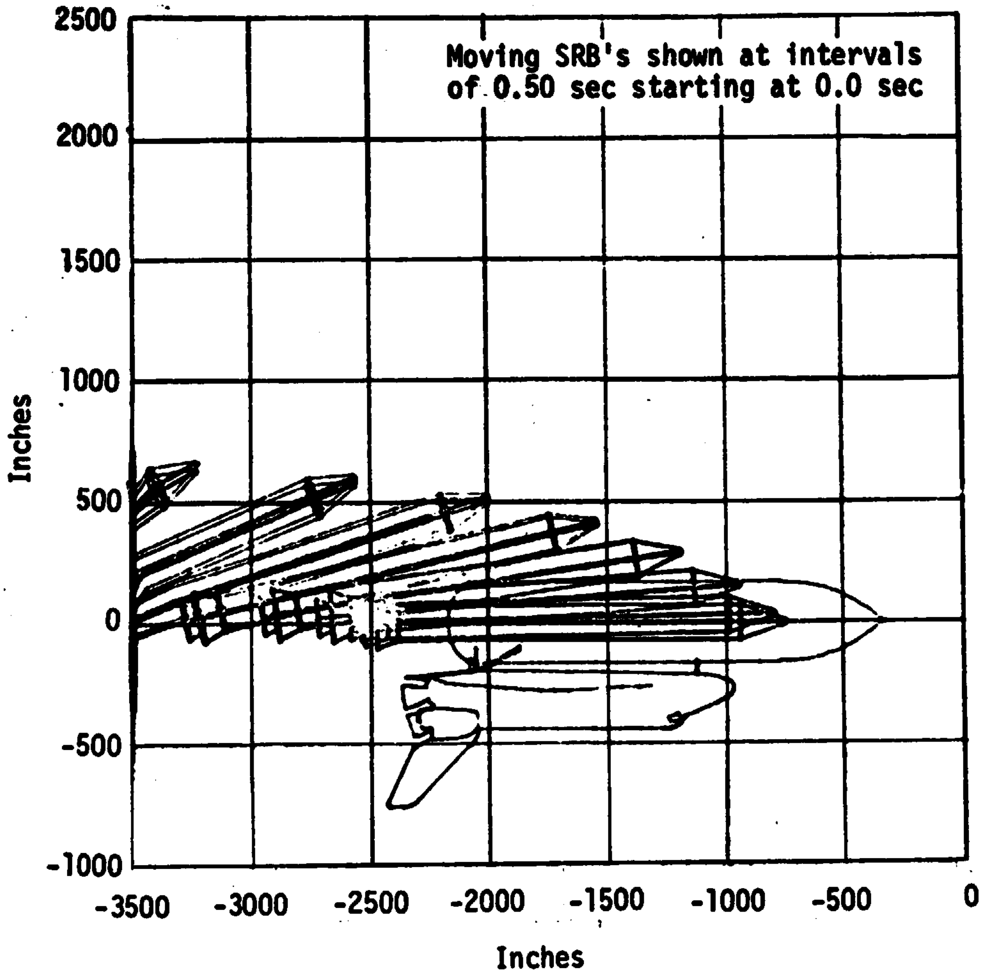
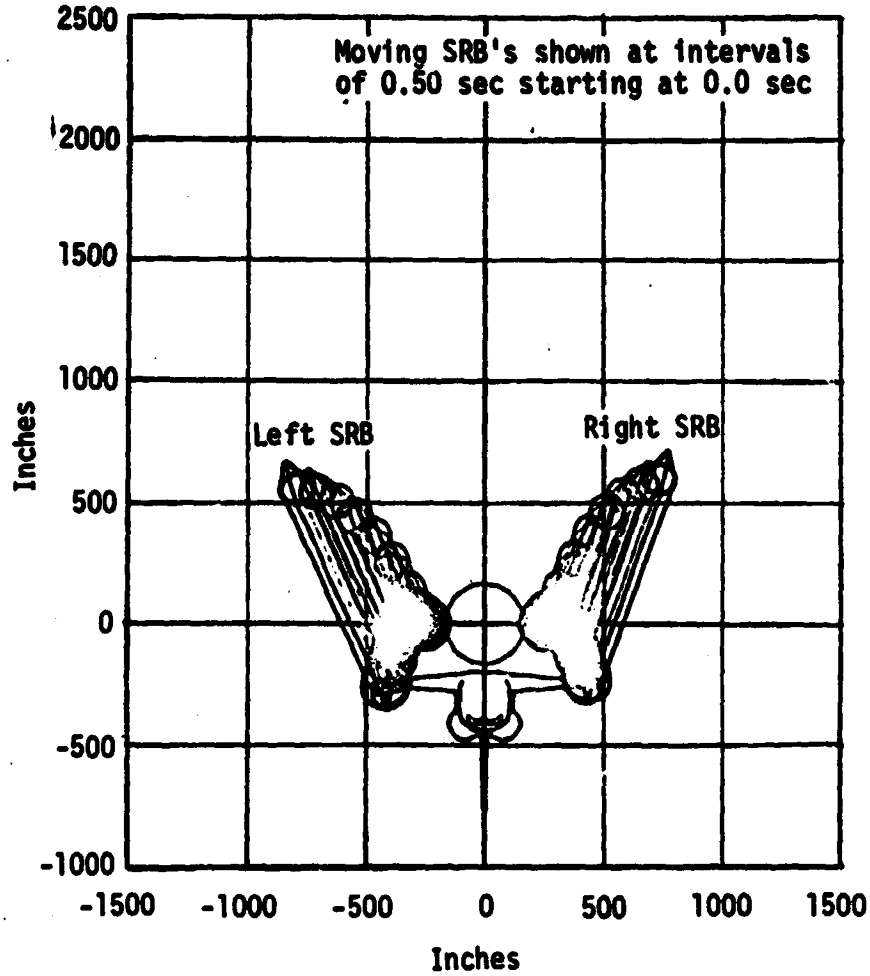
OF POOR QUALITY



(b) Side view.

Figure 6.3-2.- Continued.



(c) Front view.

Figure 6.3-2.- Concluded.

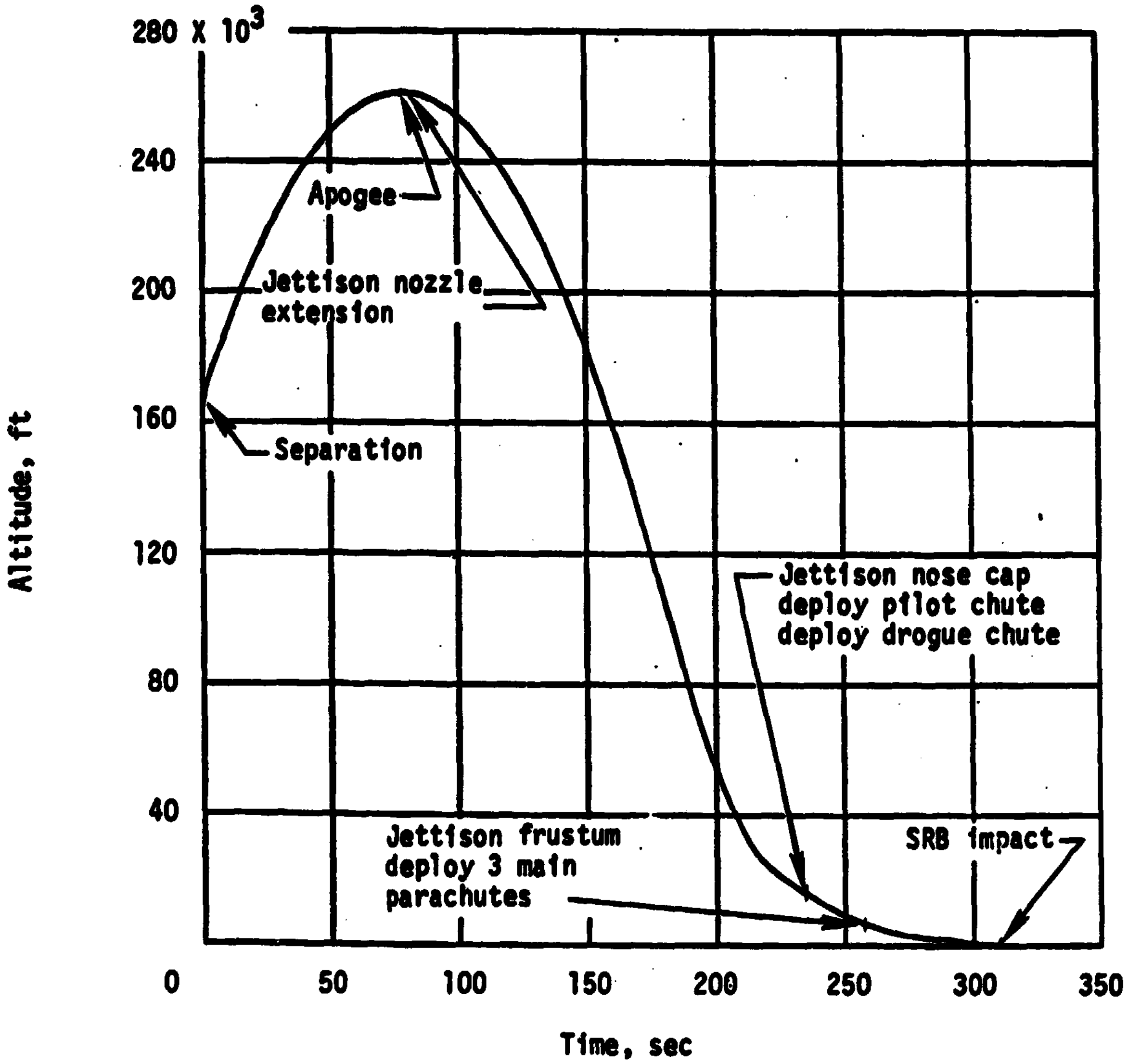


Figure 6.3-3.- Left and right SRB altitude time histories.

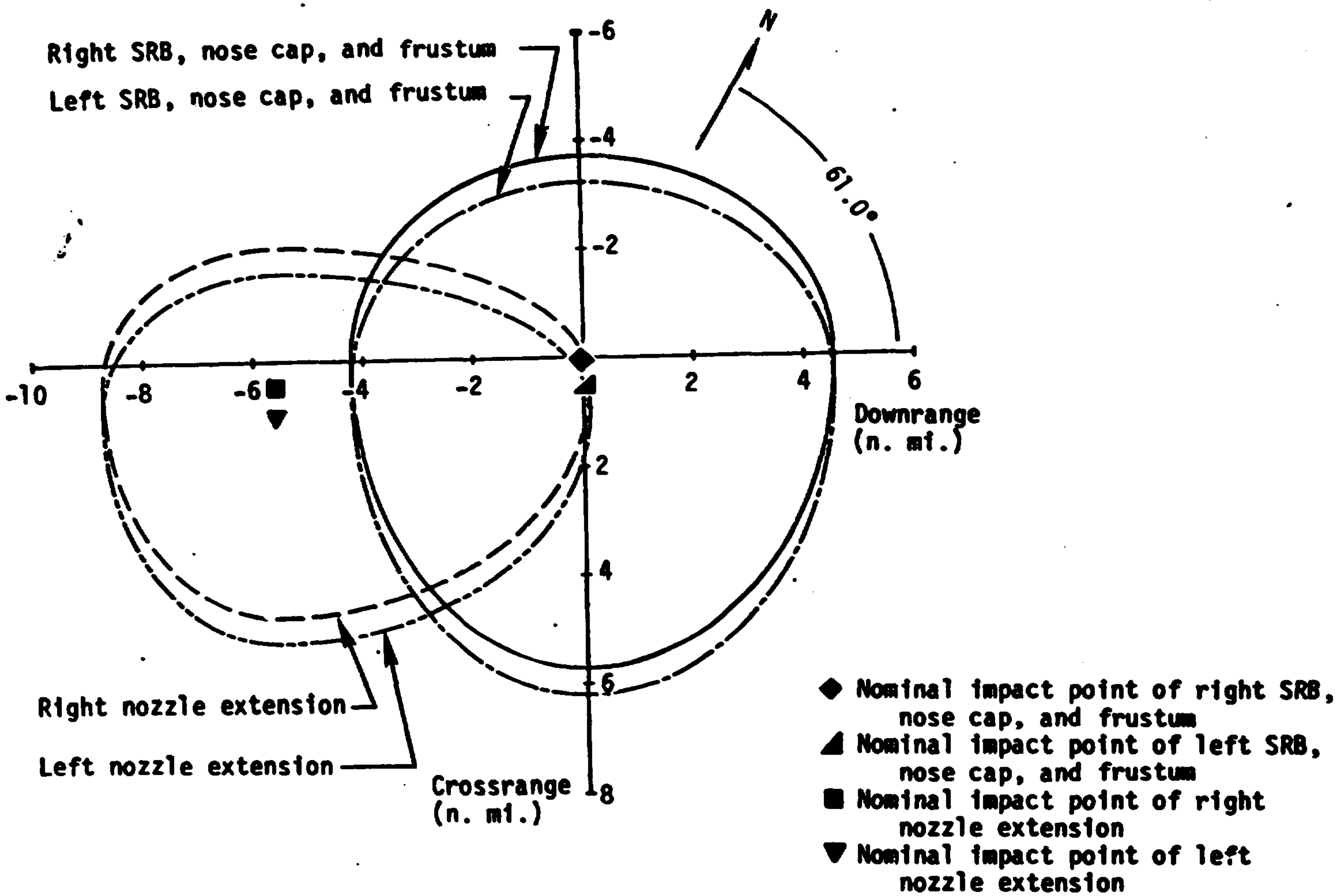


Figure 6.3-4.- STS-1 cycle 3 left and right SRB's and elements impact footprints.

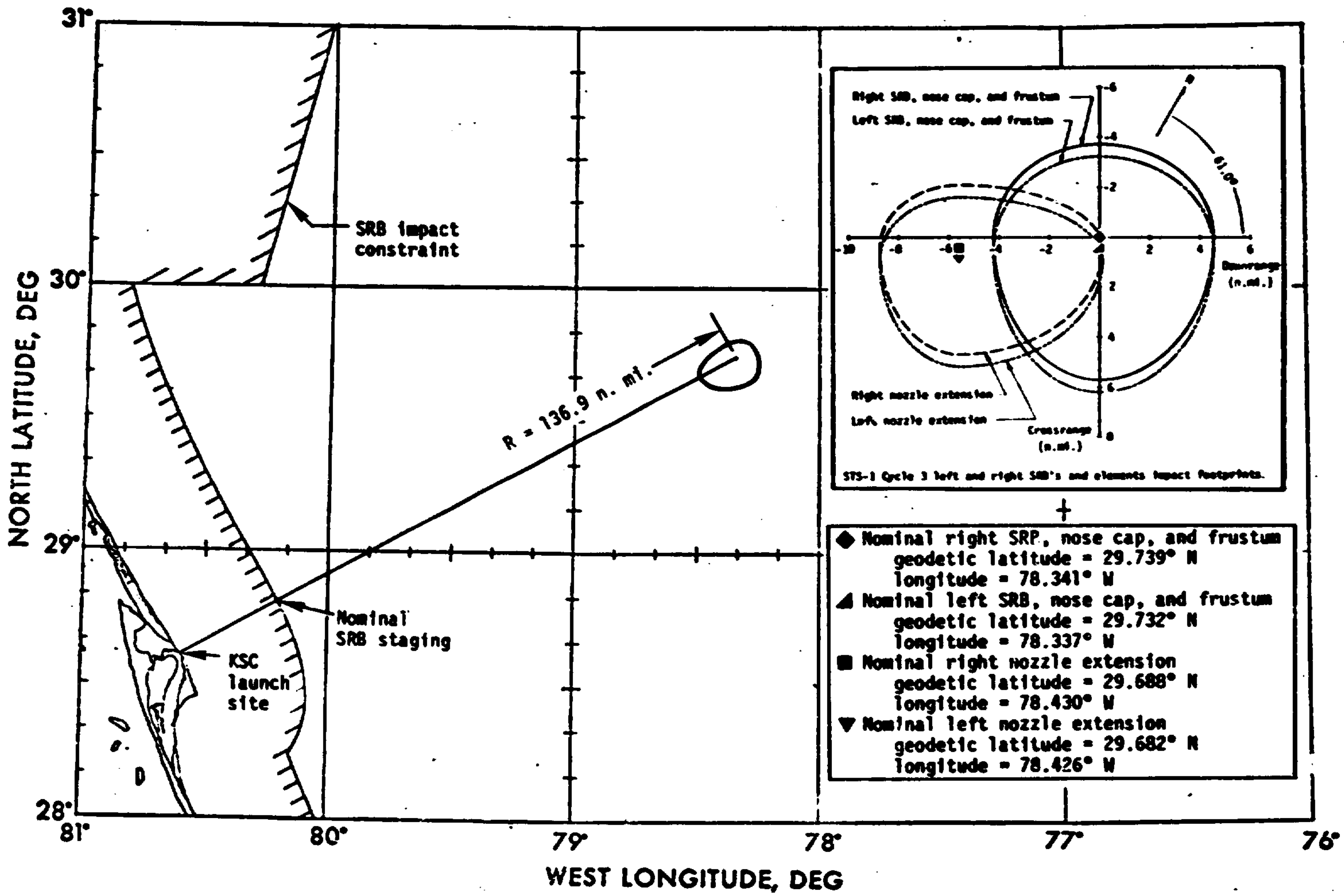
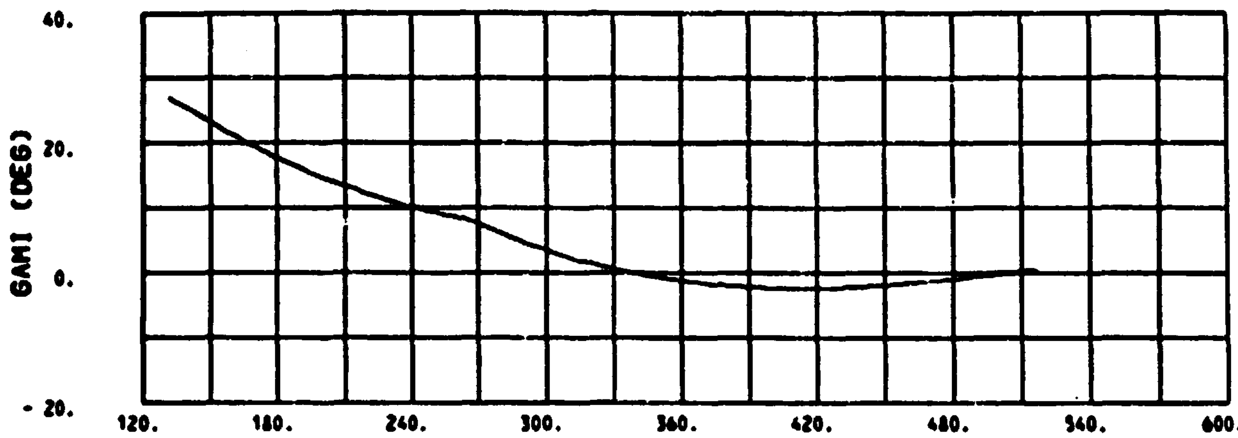
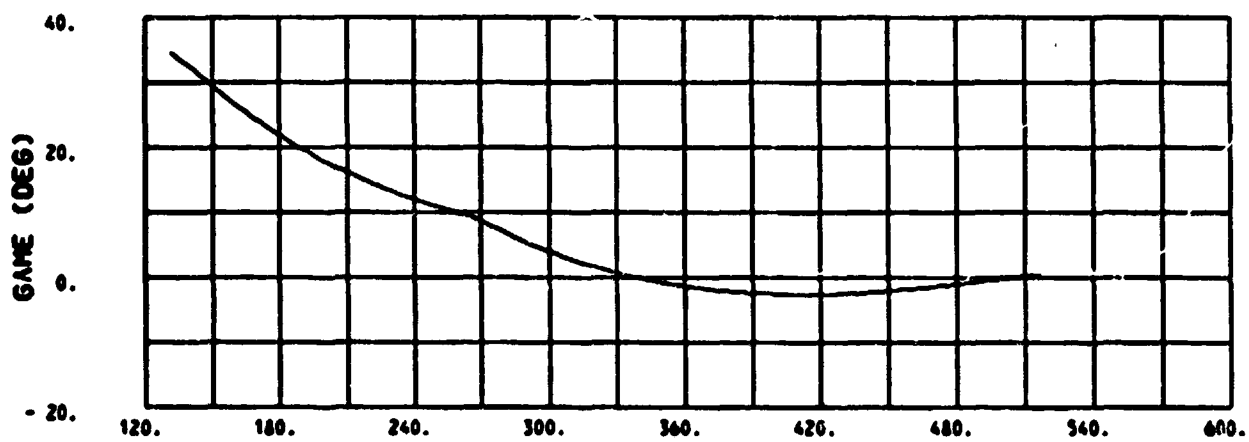


Figure 6.3-5.- STS-1 Composite SRB impact footprint.

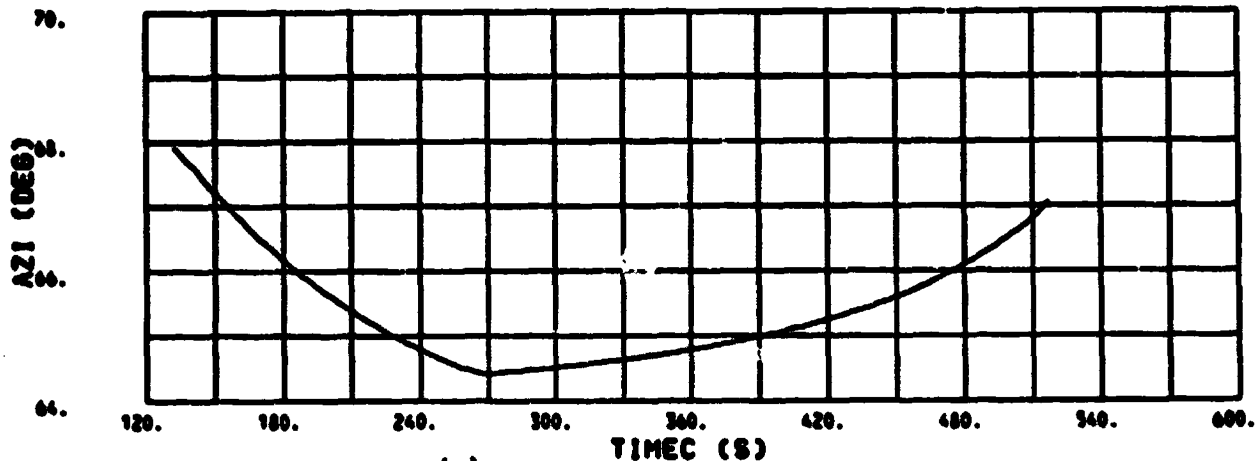


(a) INERTIAL FLIGHT PATH ANGLE

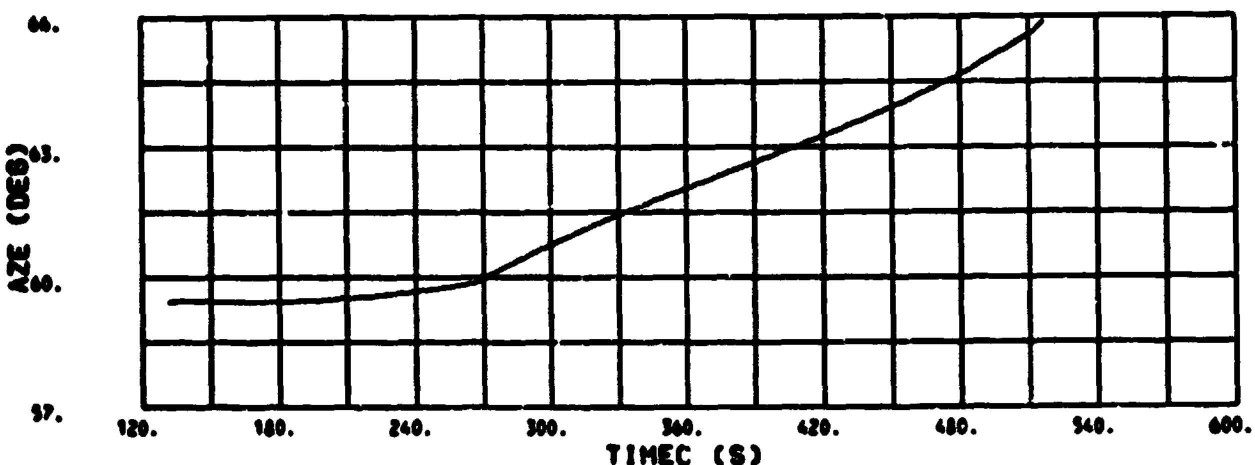


(b) EARTH-RELATIVE FLIGHT PATH ANGLE

Figure 6.4-1.- Second-stage parameters as a function of time from SRB ignition command (timec).

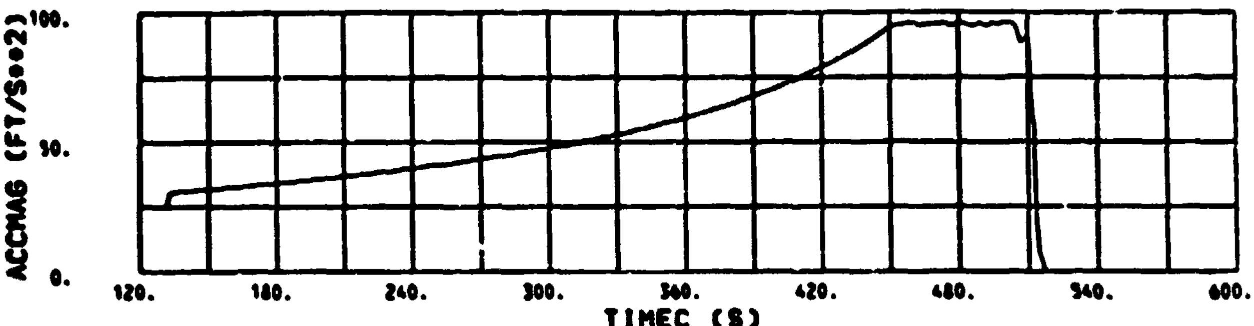


(c) INERTIAL FLIGHT AZIMUTH

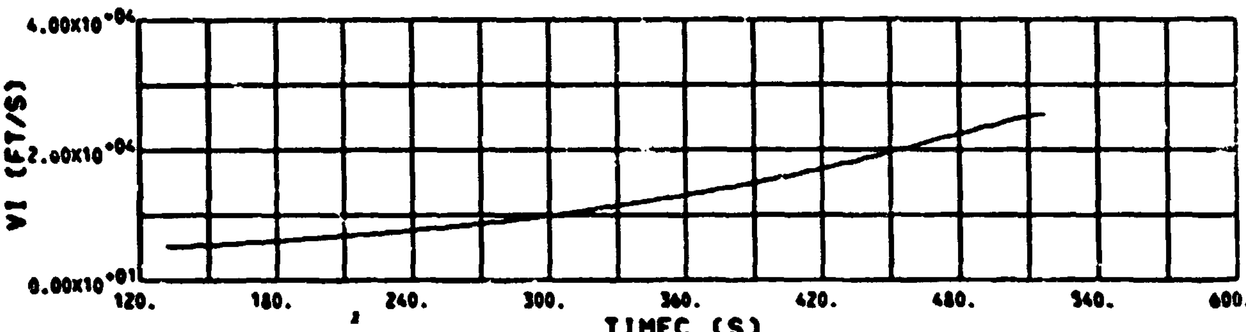


(d) EARTH-RELATIVE FLIGHT AZIMUTH

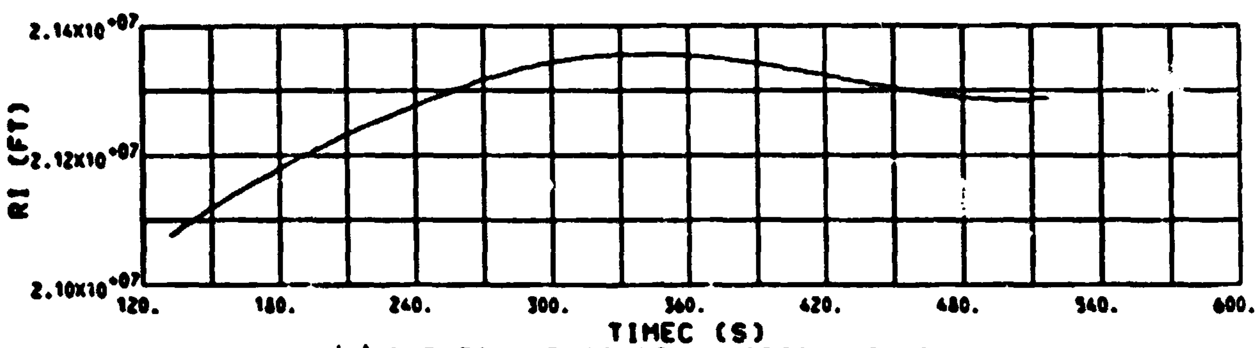
Figure 6.4-1.- Continued.



(e) VEHICLE ACCELERATION

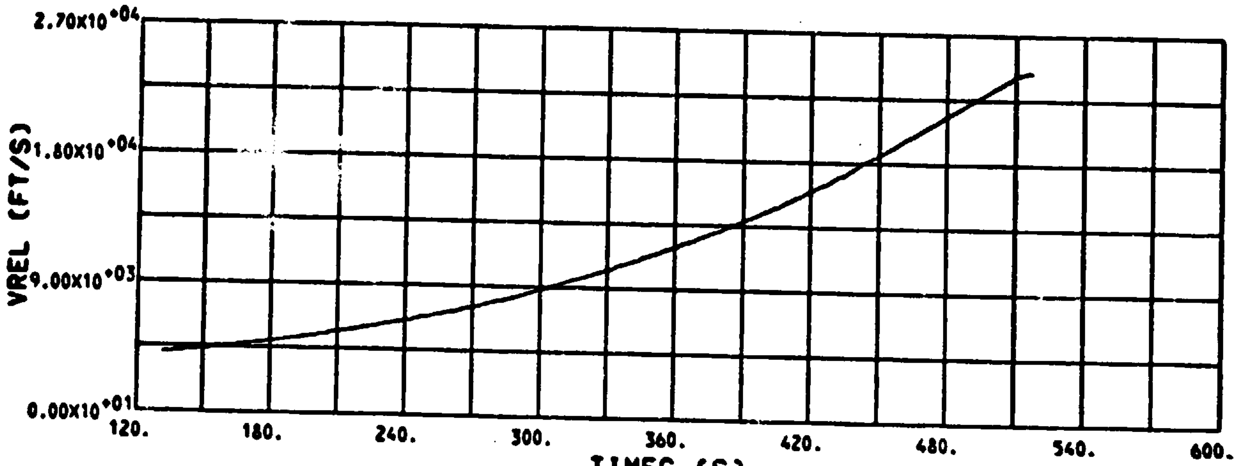


(f) INERTIAL VELOCITY VECTOR MAGNITUDE

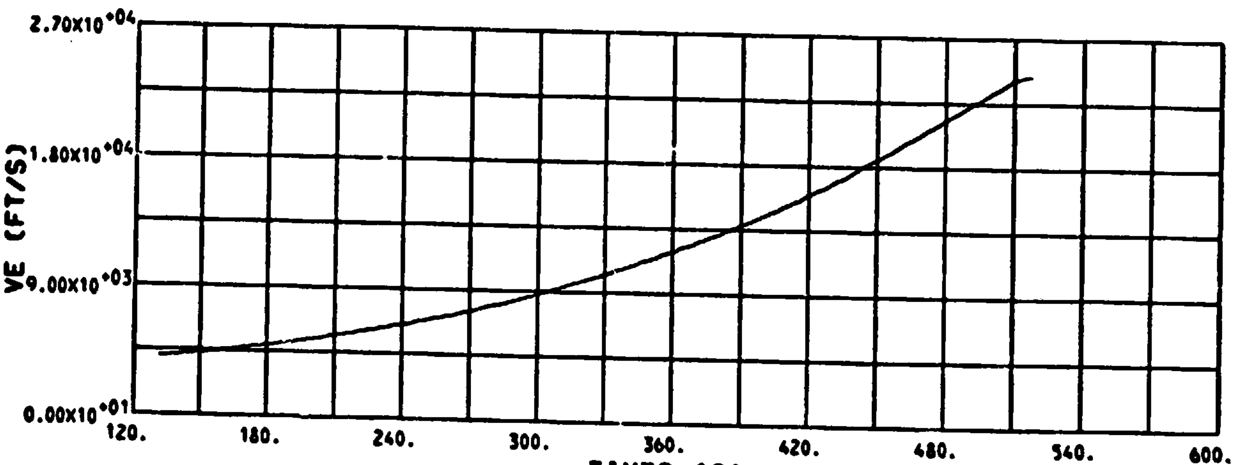


(g) INERTIAL POSITION VECTOR MAGNITUDE

Figure 6.4-1.- Continued.



(h) NAVIGATION EARTH-RELATIVE VELOCITY



(i) SVDS EARTH-RELATIVE VELOCITY

Figure 6.4-1.- Continued.

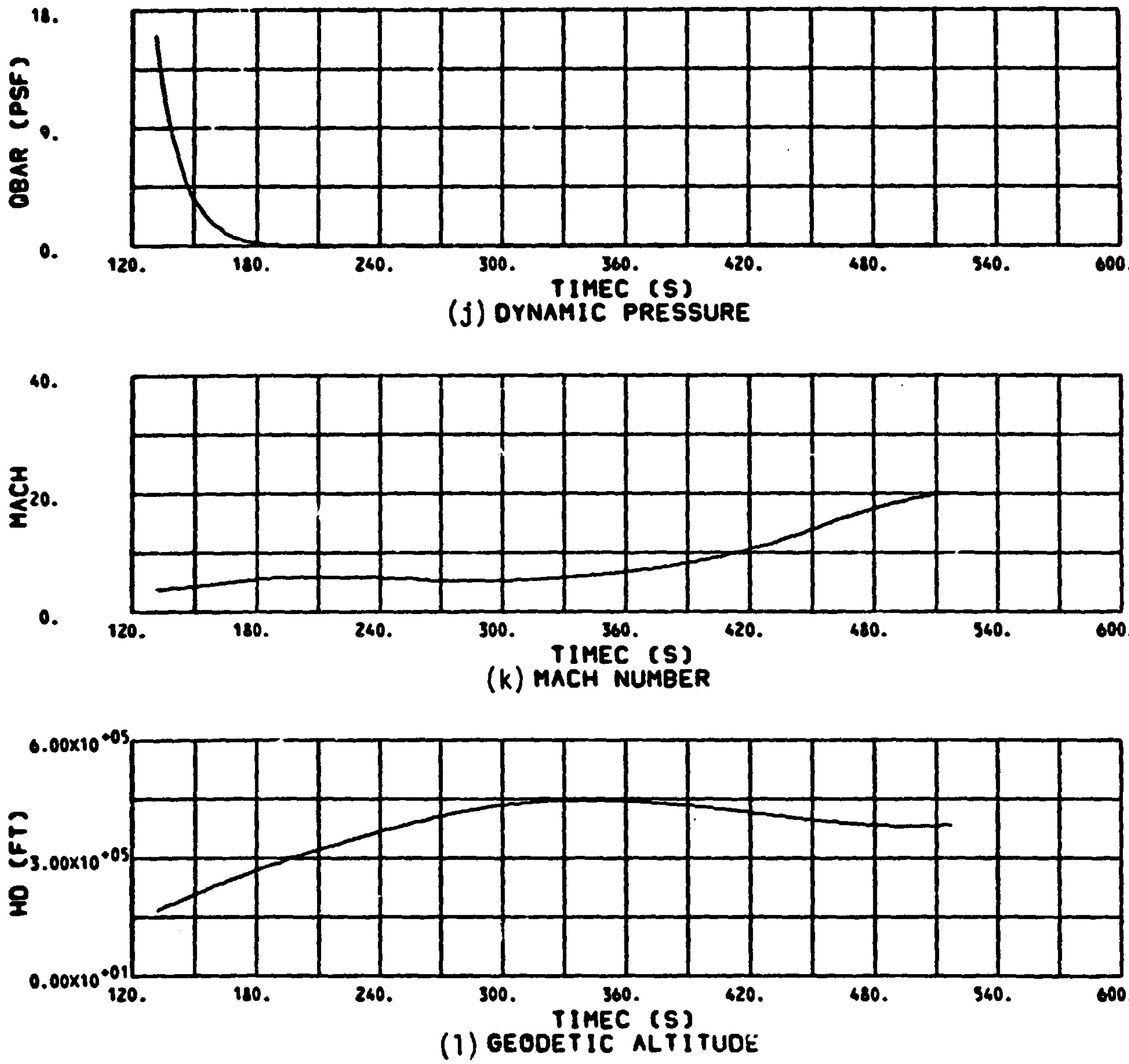
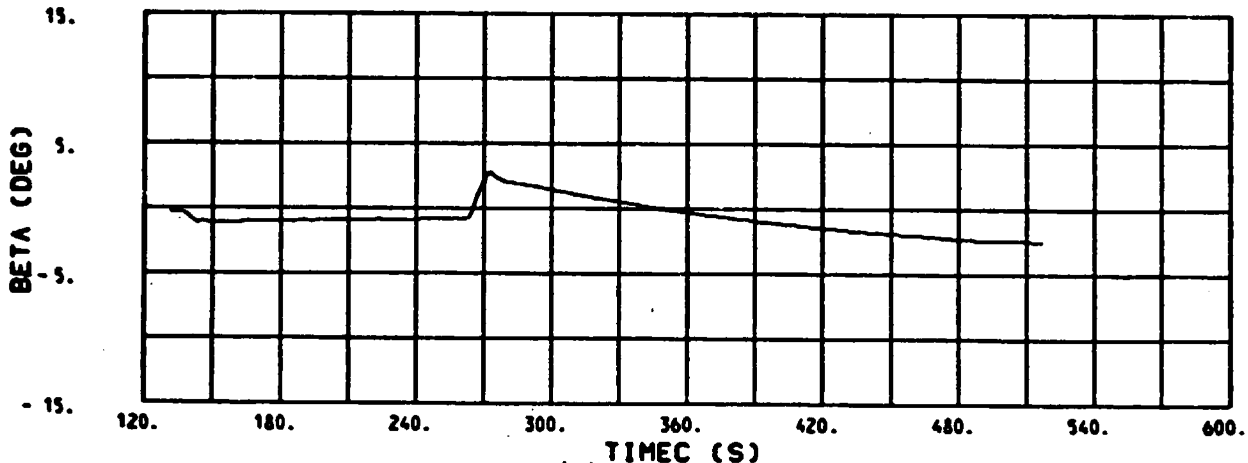
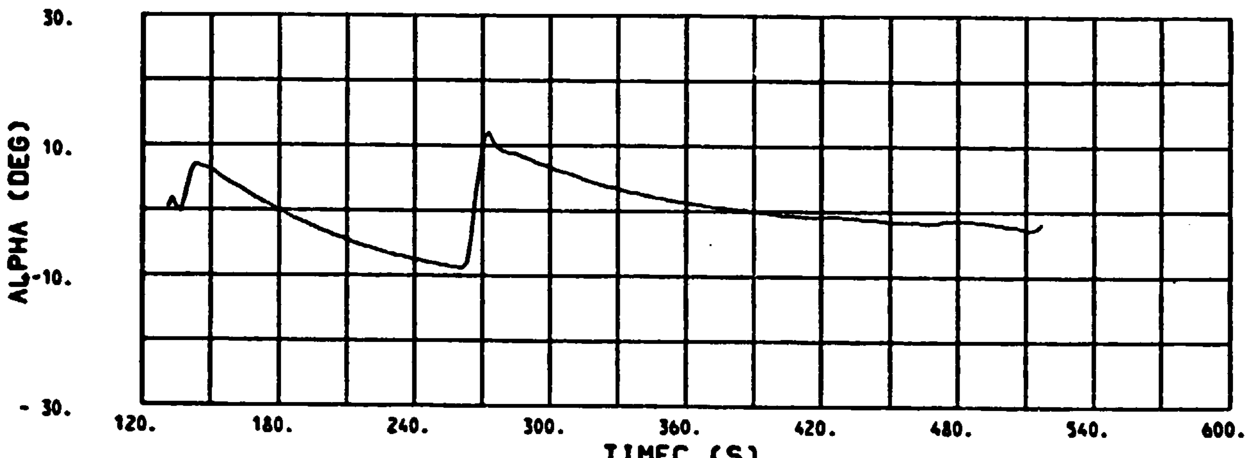


Figure 6.4-1.- Continued.

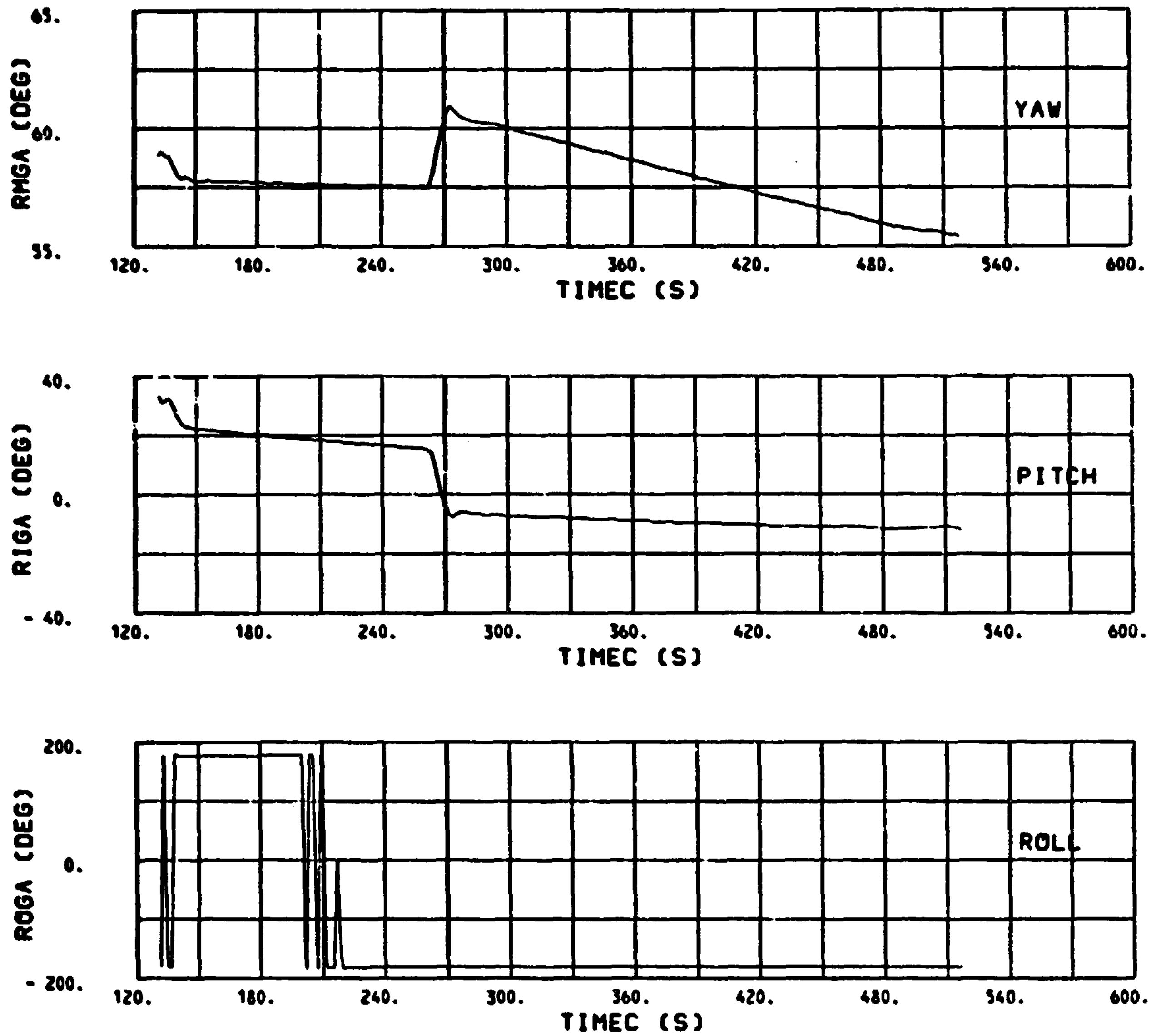


(m) SIDESLIP



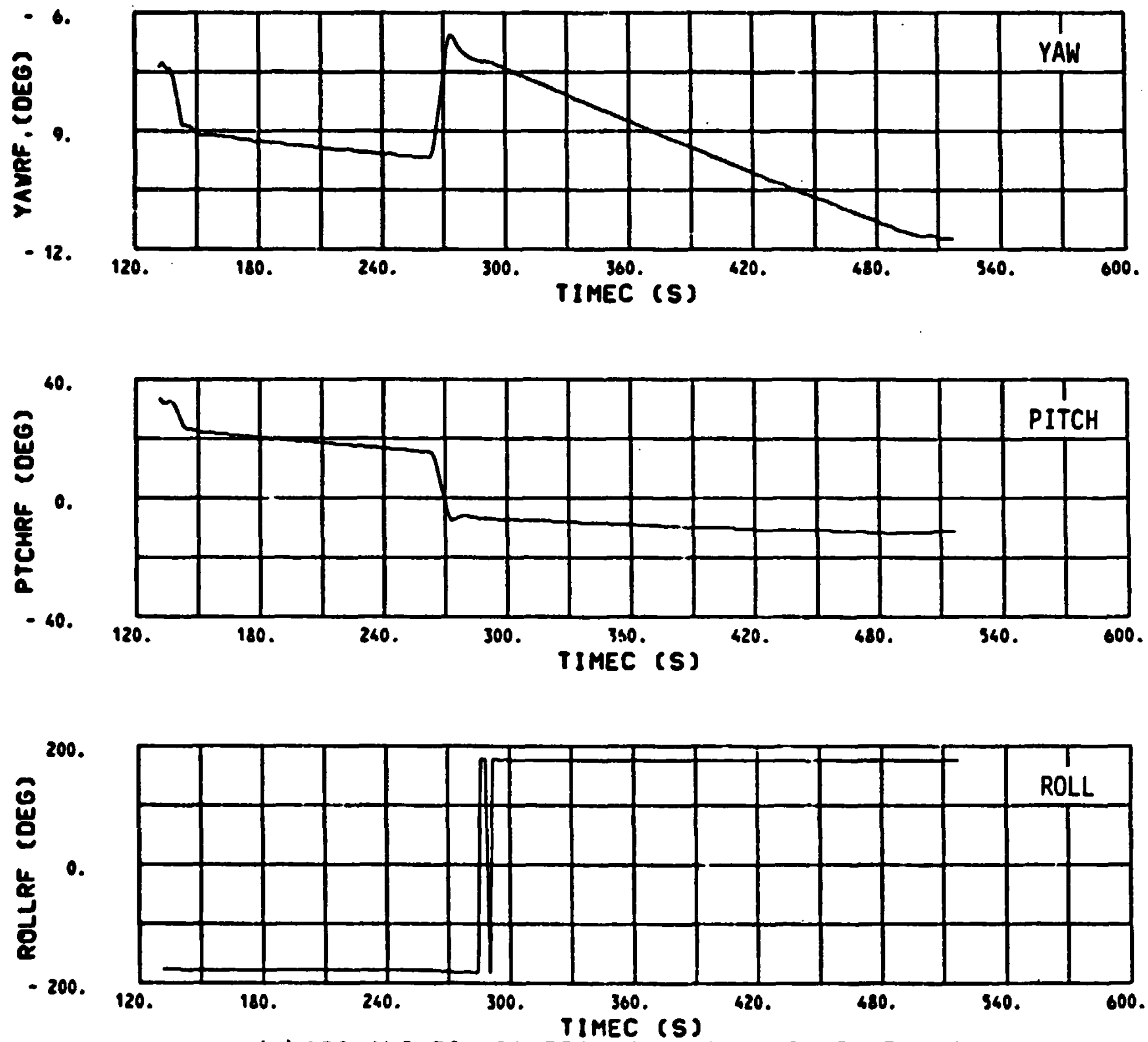
(n) ANGLE OF ATTACK

Figure 6.4-1.- Continued.



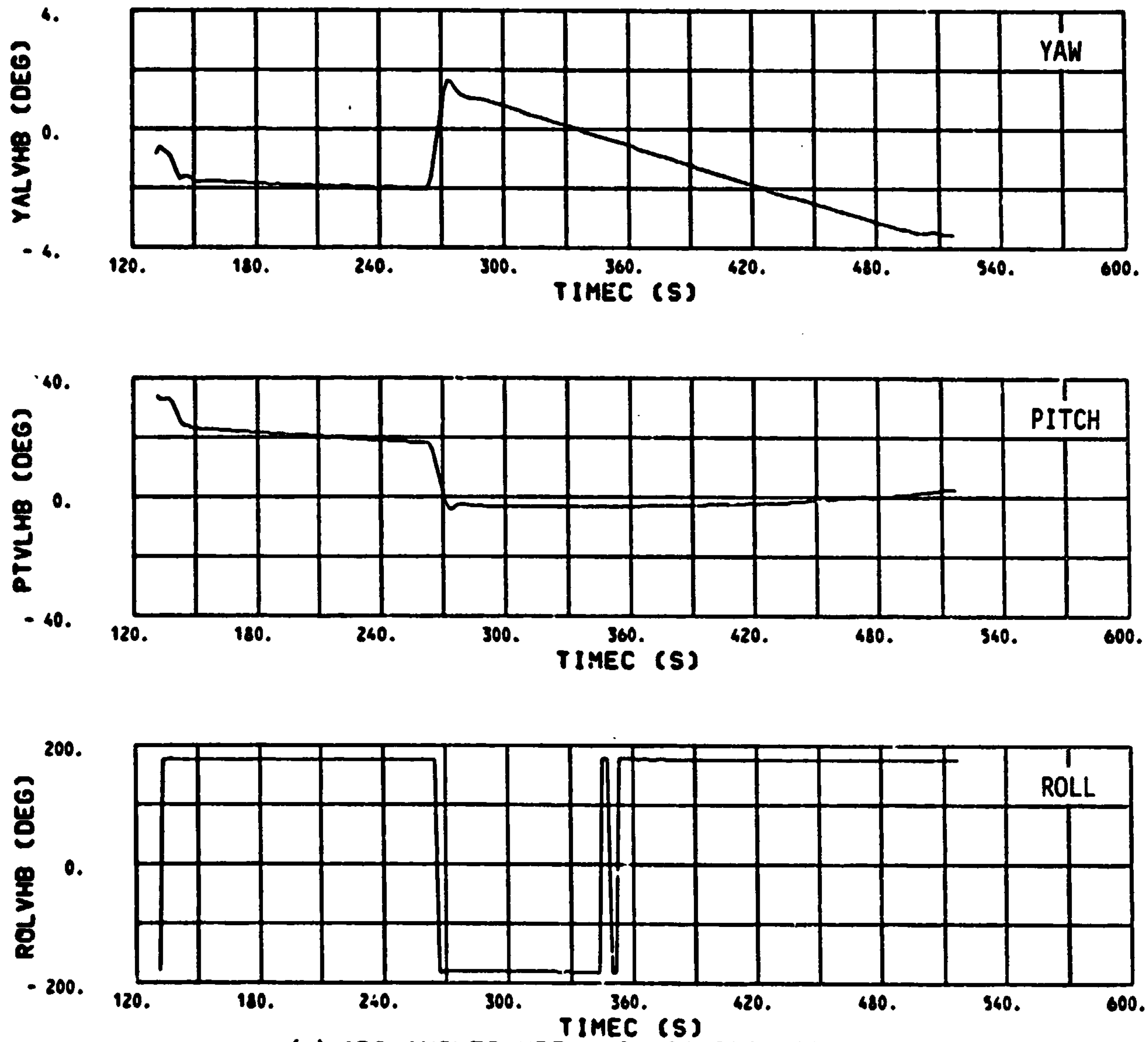
(o) ACTUAL BODY ATTITUDE (EULER ANGLES) WRT BOOST REFERENCE FRAME

Figure 6.4-1.- Continued.



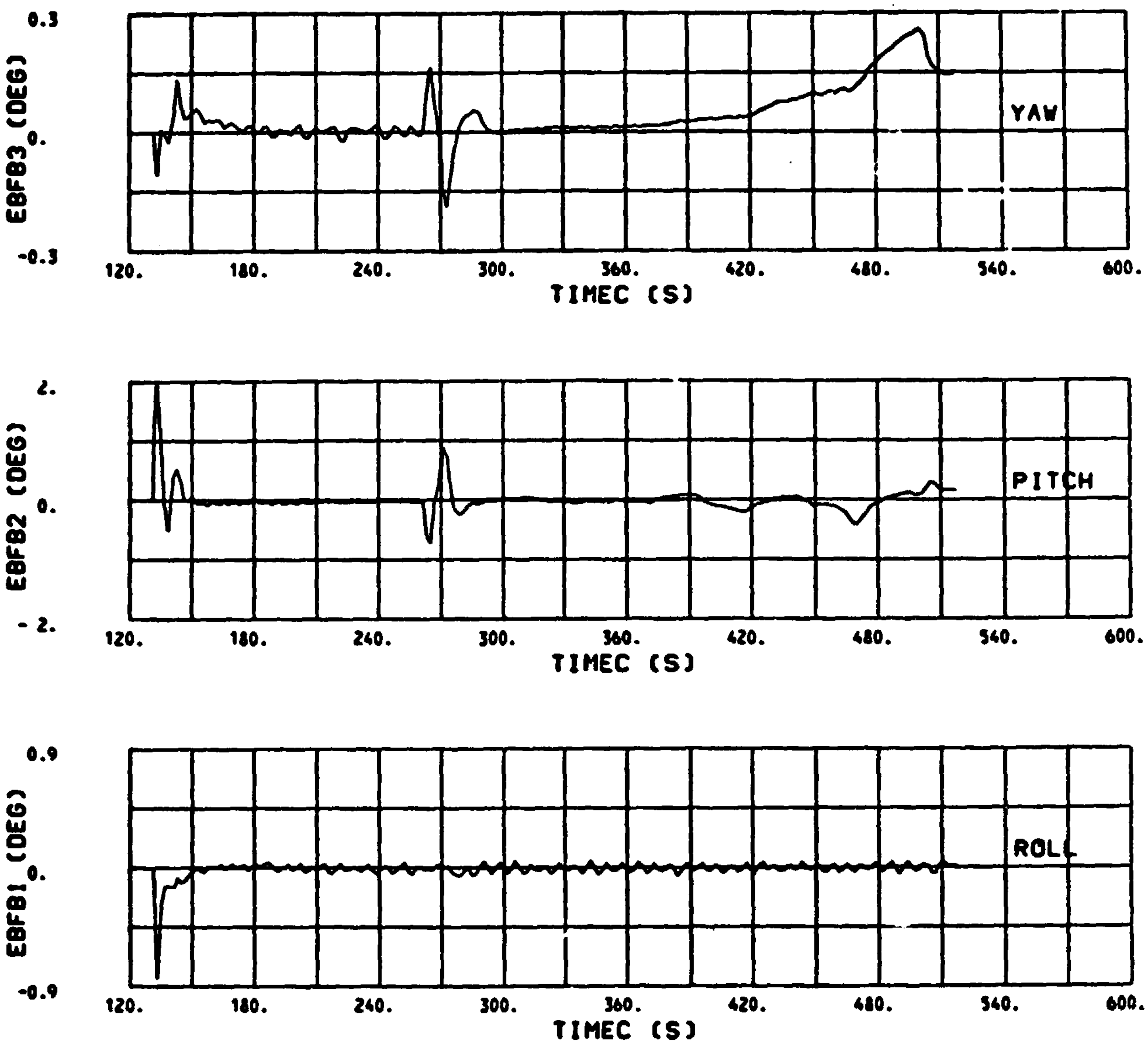
(p) ADI ANGLES WRT REFERENCE COORDINATE FRAME

Figure 6.4-1.- Continued.



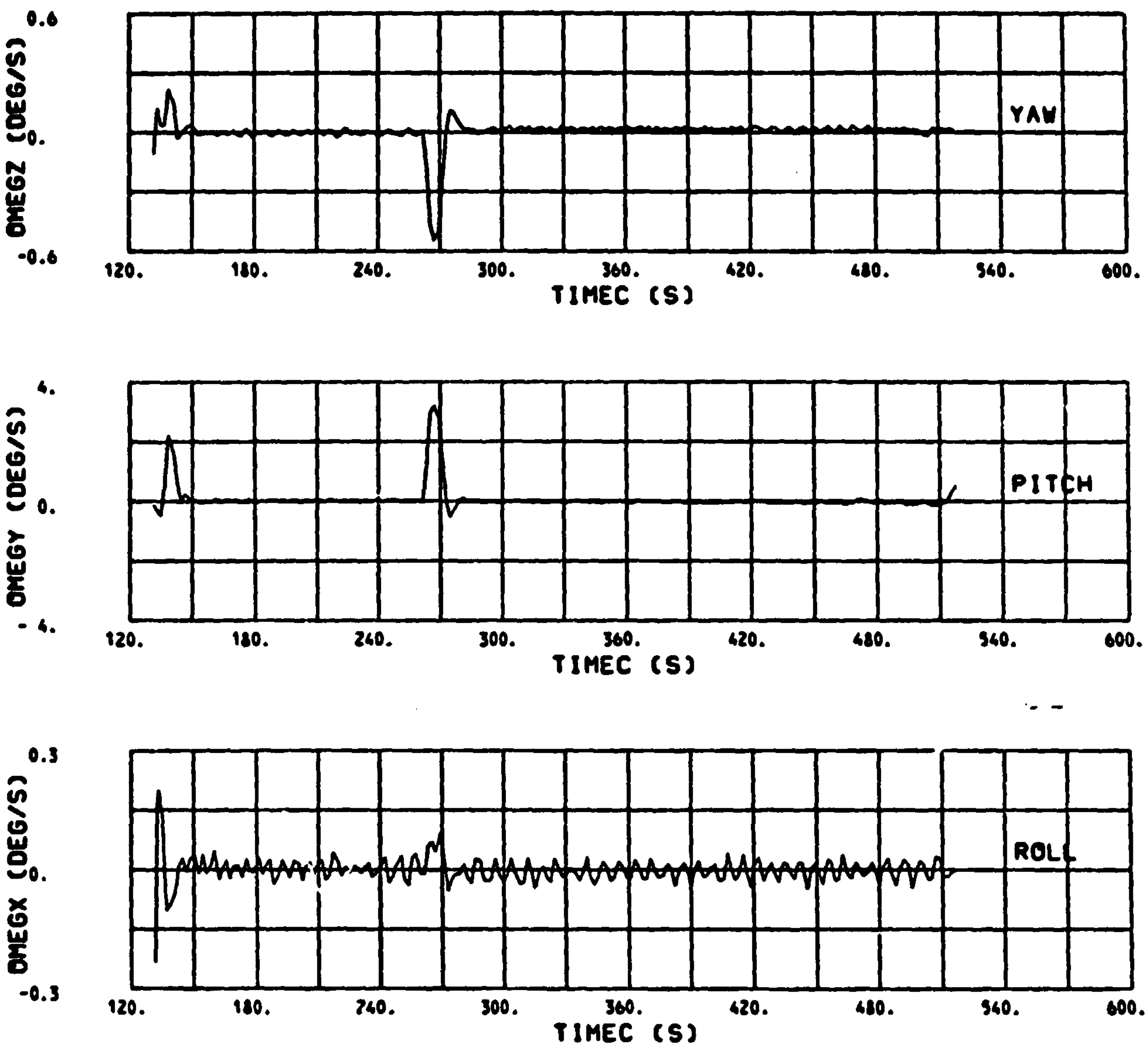
(q) ADI ANGLES WRT LVIY COORDINATE FRAME

Figure 6.4-1.- Continued.



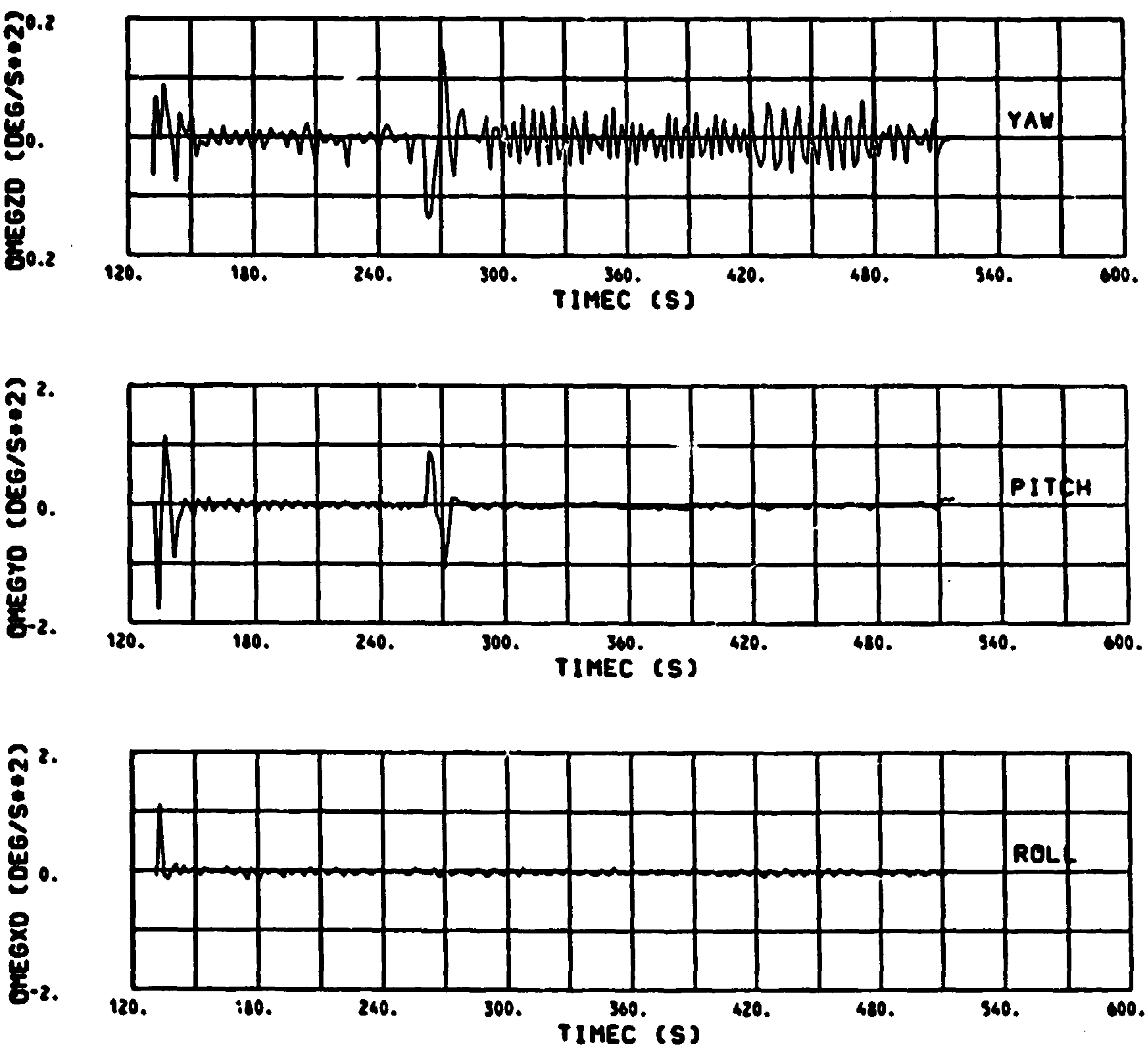
(r) BODY ATTITUDE ERRORS FOR DISPLAY FROM GC STEER (ACTUAL-COMMANDED)

Figure 6.4-1.- Continued.



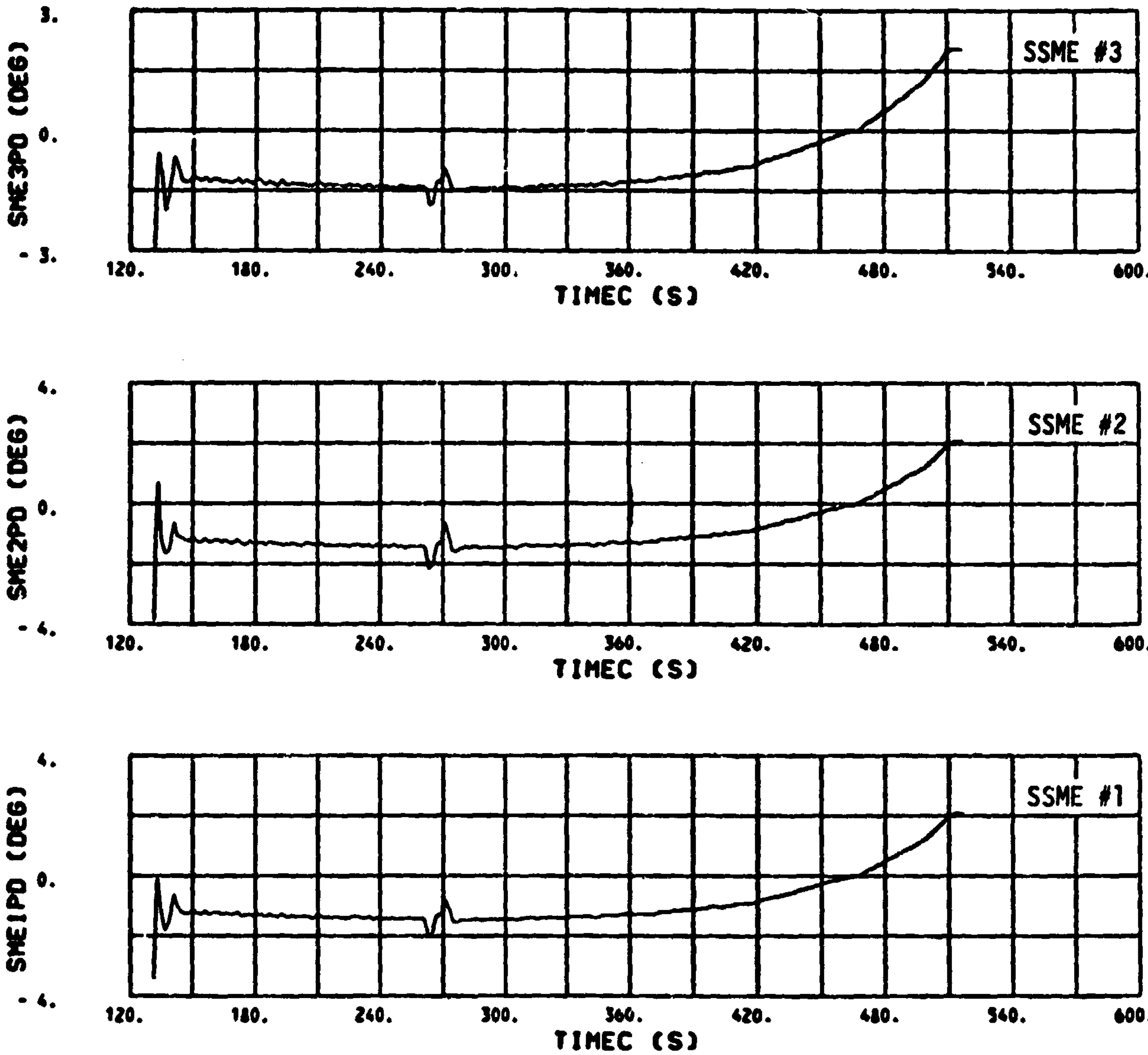
(s) Actual body rate vector from SVDS environment

Figure 6.4-1.- Continued.



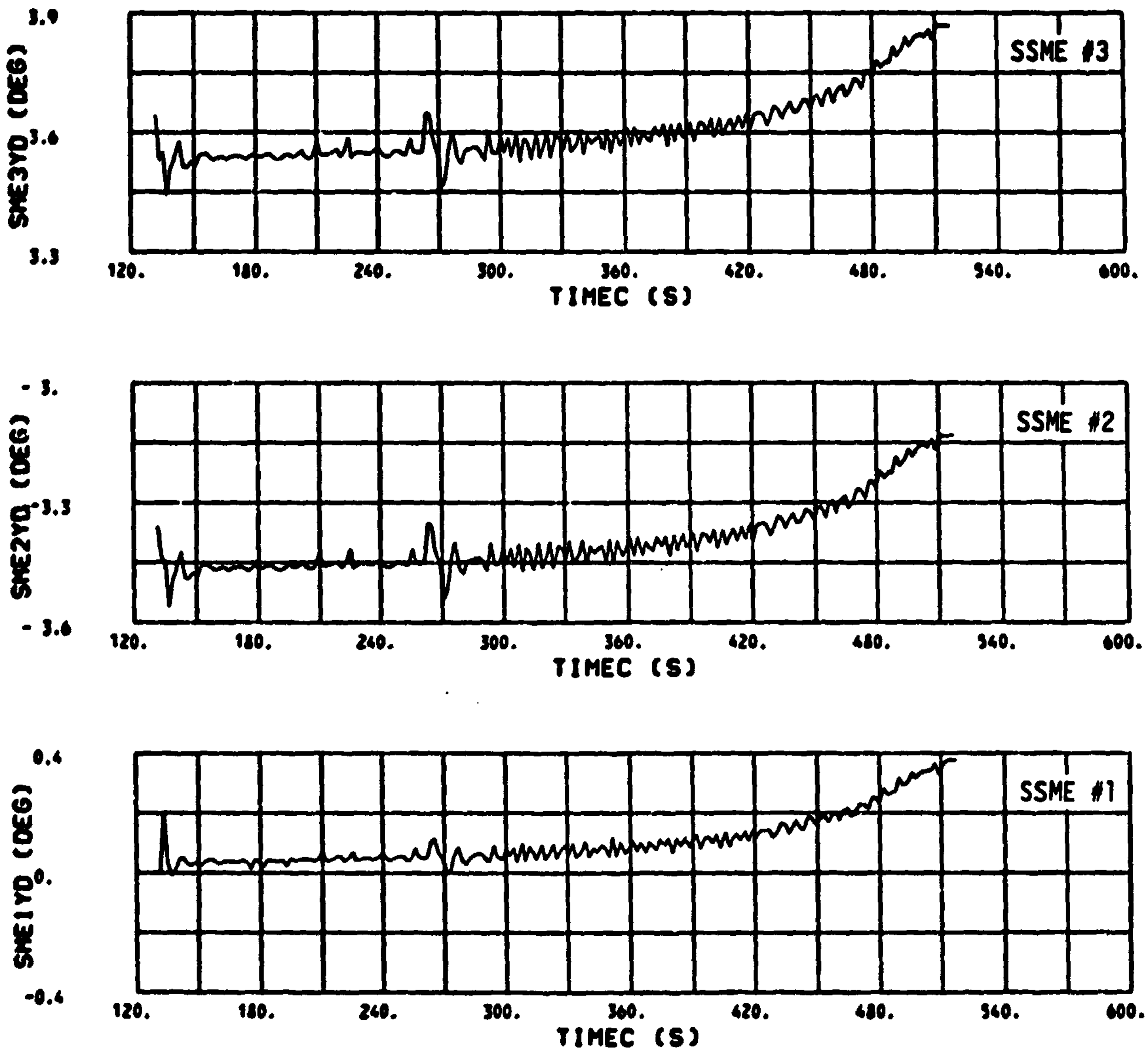
(t) Actual body angular acceleration vector from SVDS environment

Figure 6.4-1.- Continued.



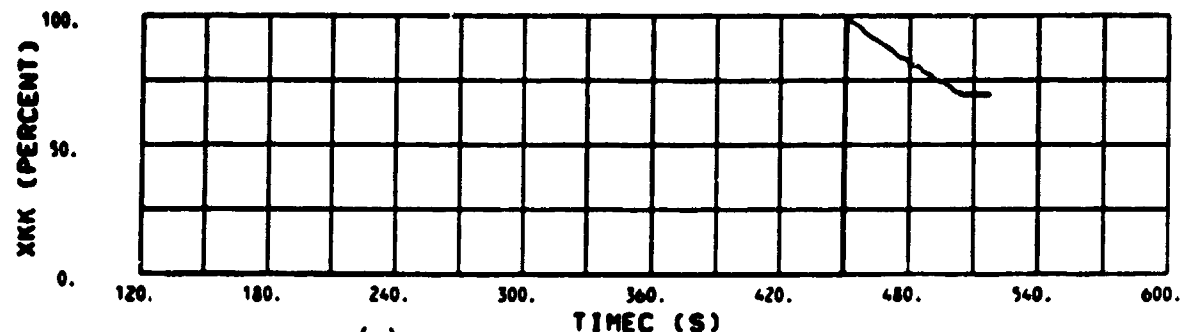
(u) SSME ACTUAL PITCH GIMBAL DEFLECTION WRT NULL AXIS (POS. DOWN)

Figure 6.4-1.- Continued.

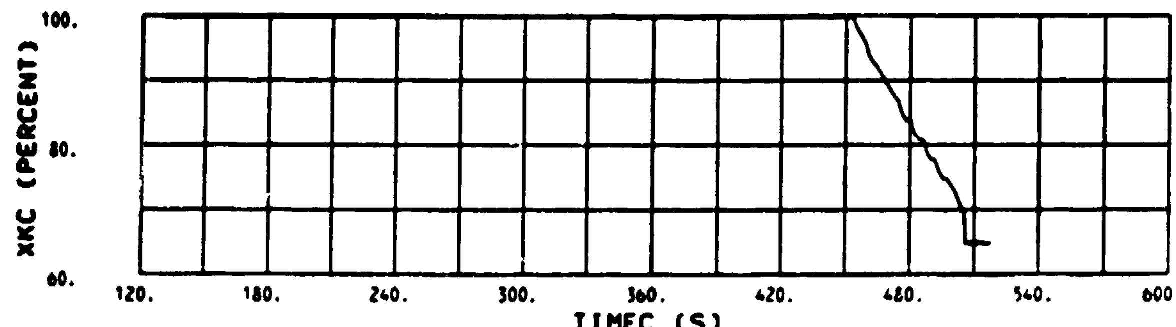


(v) SSME ACTUAL YAW GIMBAL DEFLECTION WRT NULL AXIS (POS. LEFT)

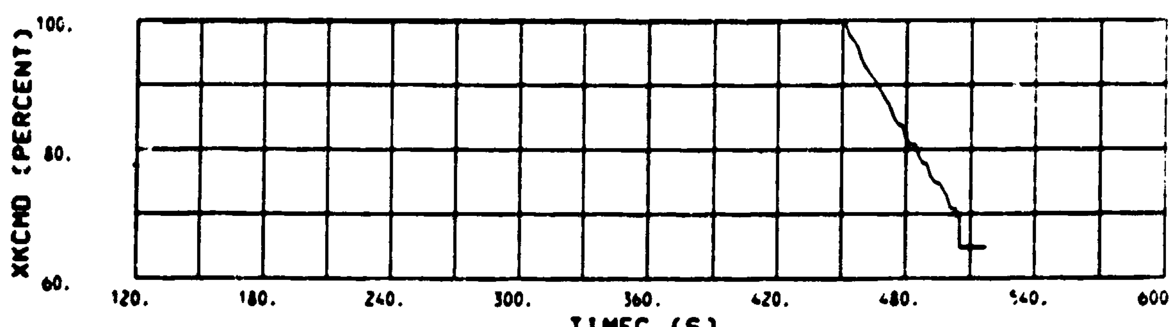
Figure 6.4-1.- Continued.



(w) DESIRED SSME THROTTLE SETTING

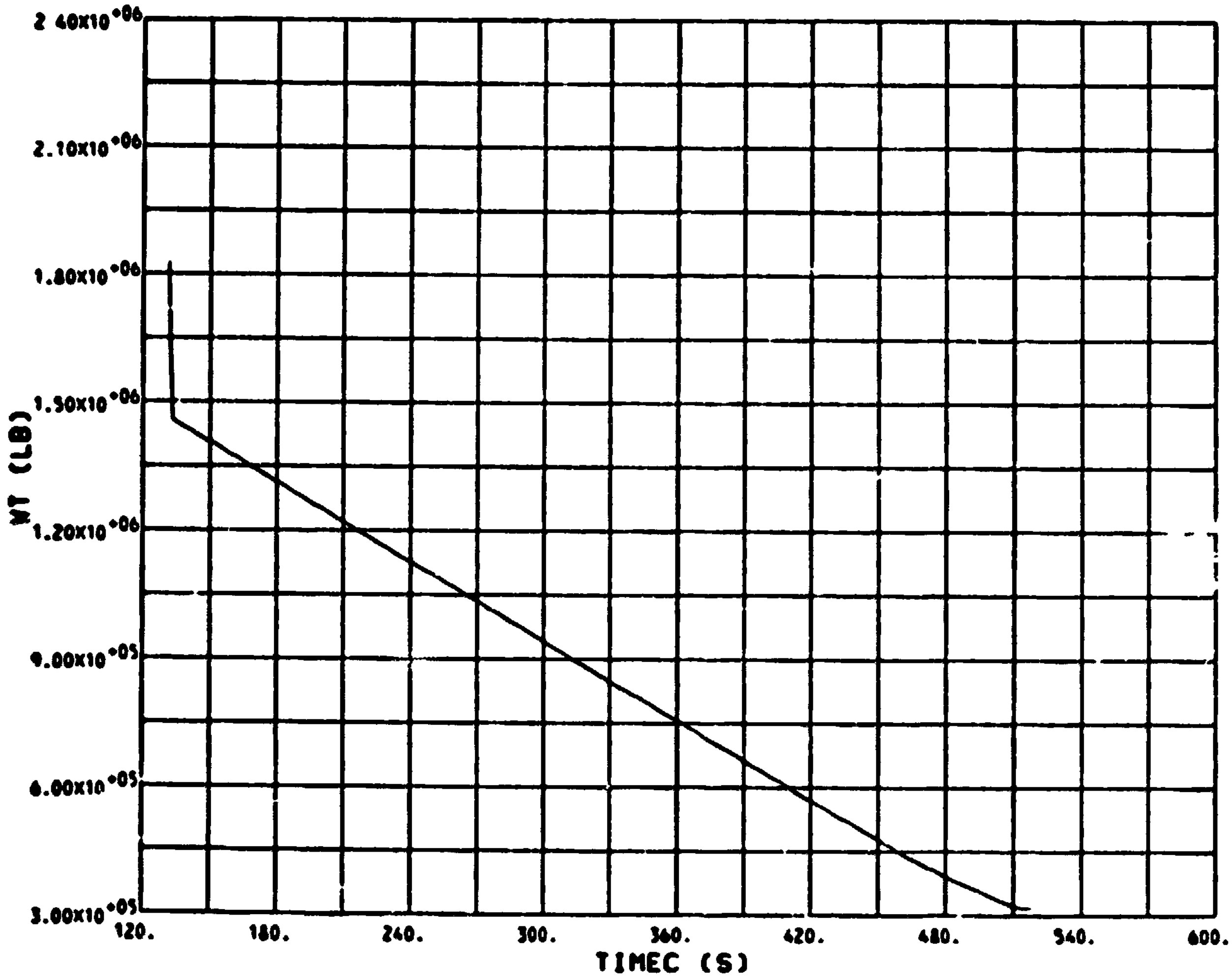


(x) ACTUAL SSME THROTTLE SETTING



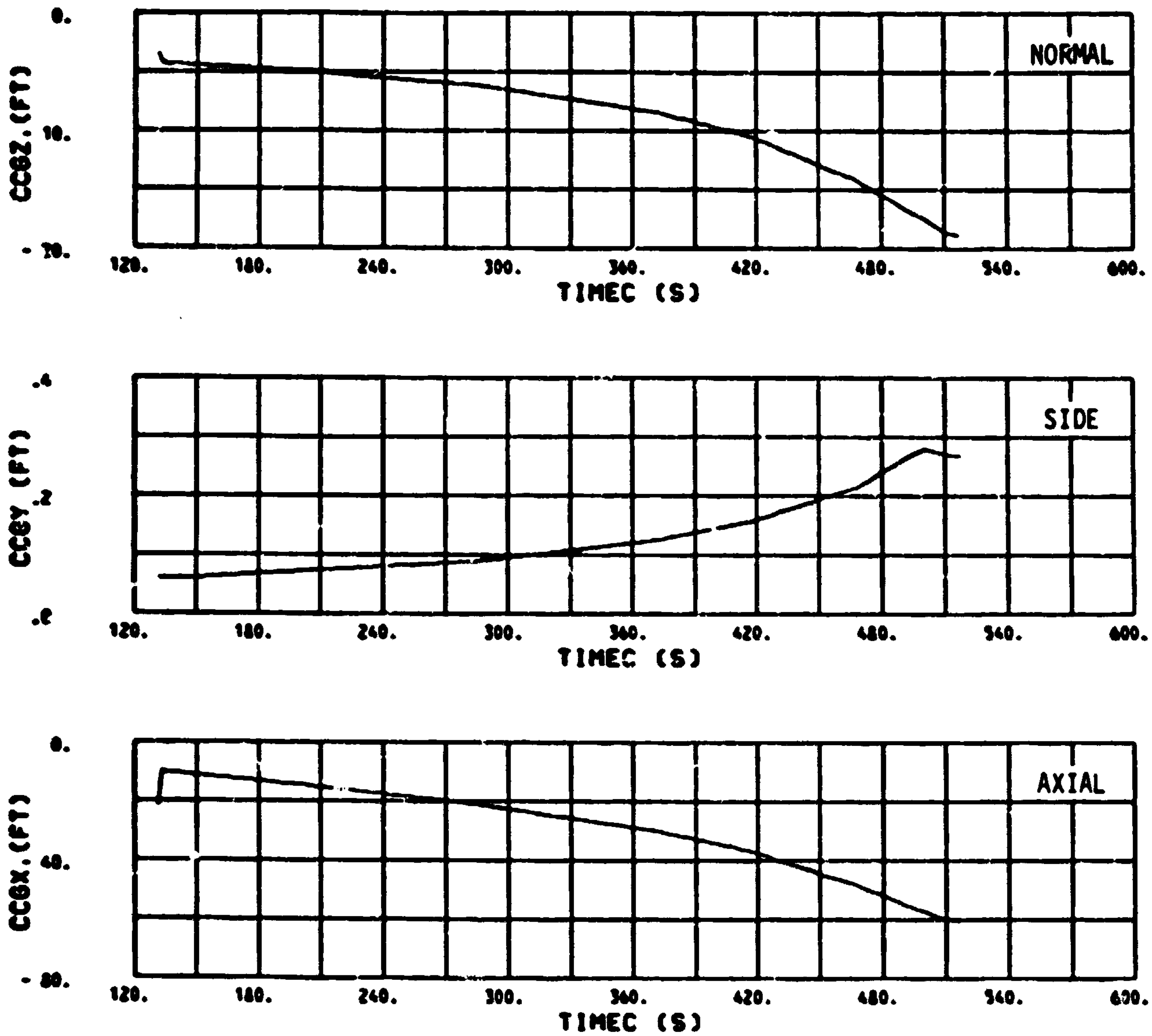
(y) COMMANDED SSME THROTTLE SETTING FROM GUIDANCE

Figure 6.4-1.- Continued.



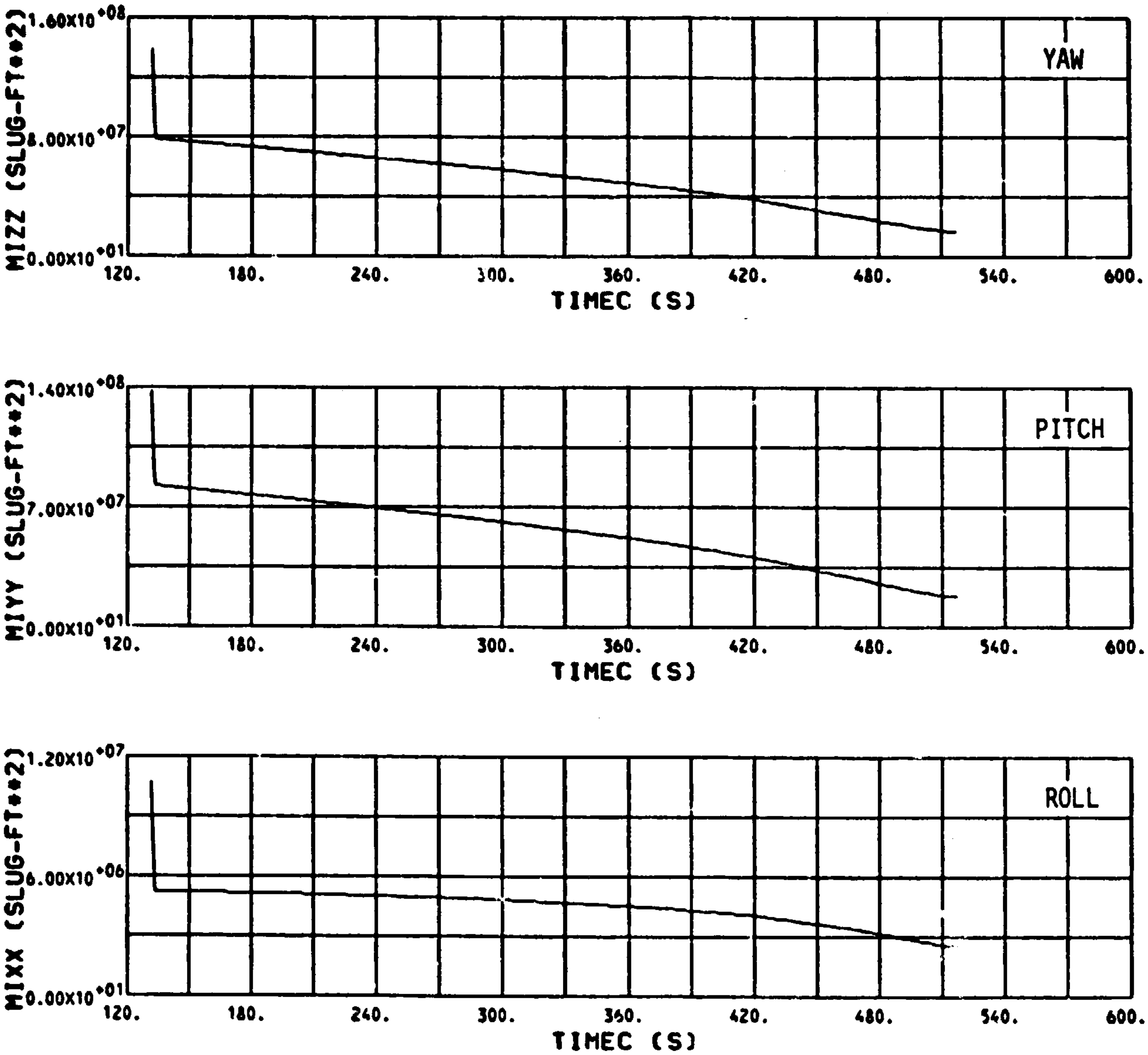
(z) TOTAL VEHICLE WEIGHT

Figure 6.4-1.- Continued.



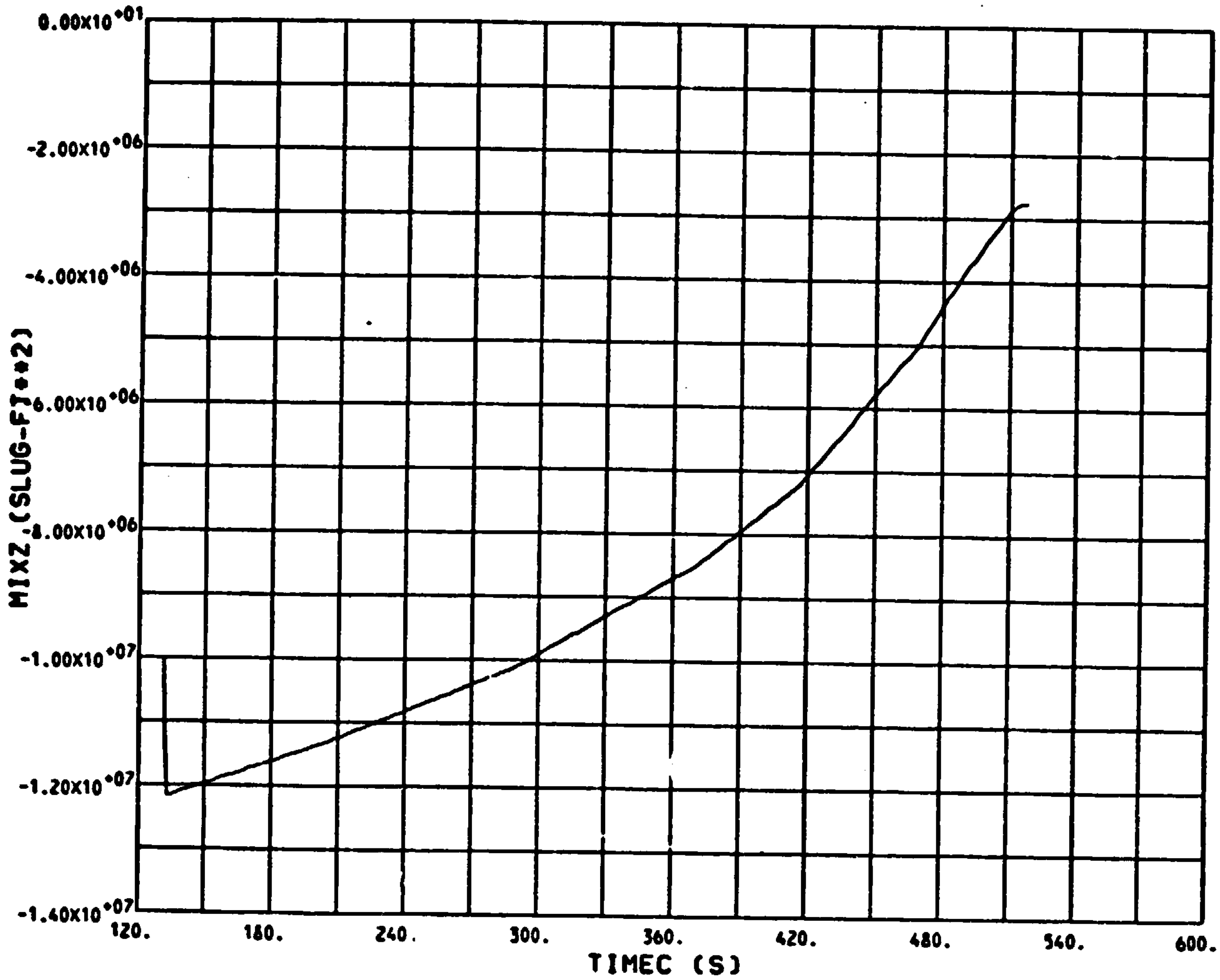
(aa) CG LOCATION WRT SVDS VEHICLE COORDINATE FRAME

Figure 6.4-1.- Continued.



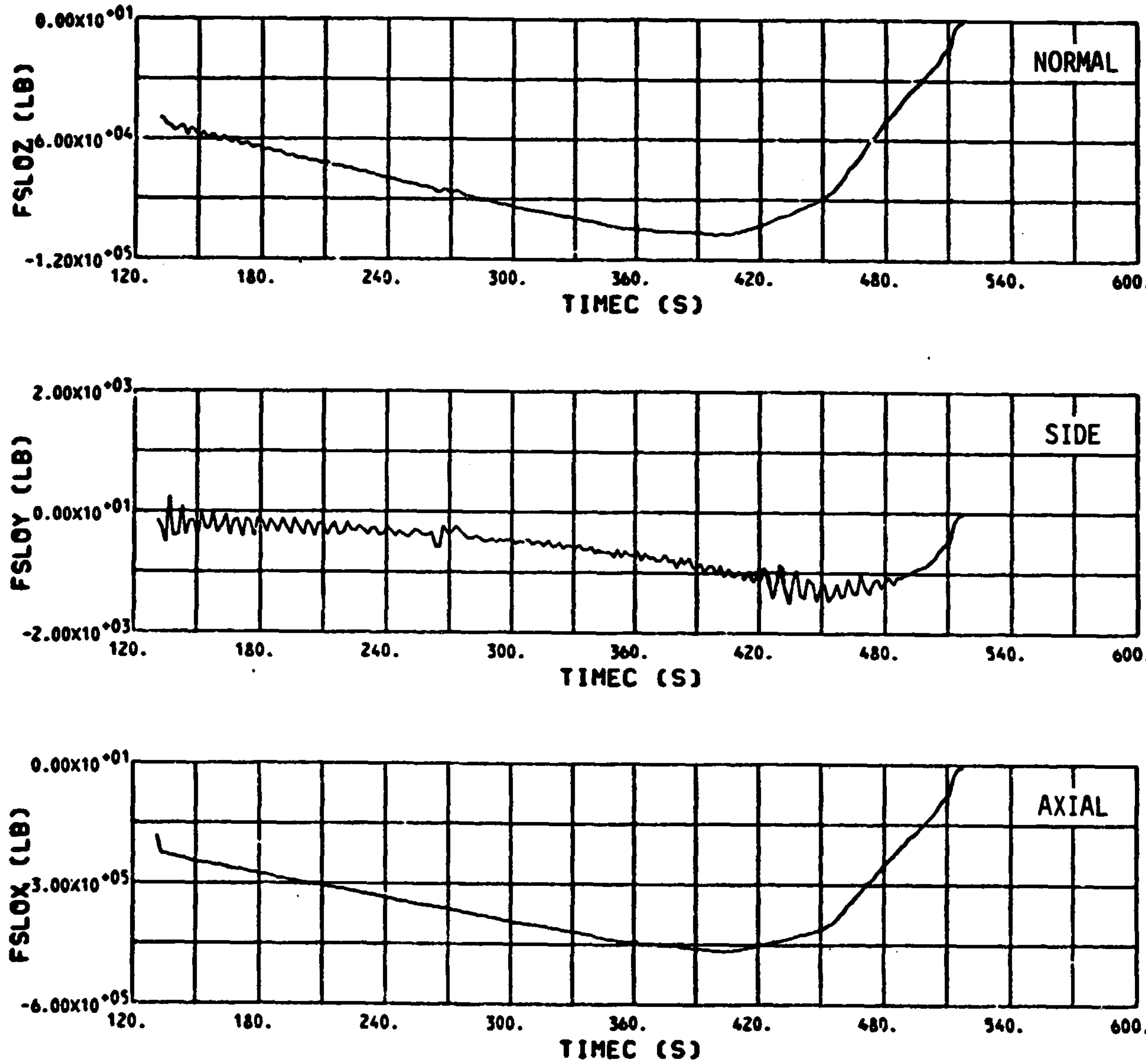
(bb) MOMENTS OF INERTIA ABOUT BODY AXES

Figure 6.4-1.- Continued.



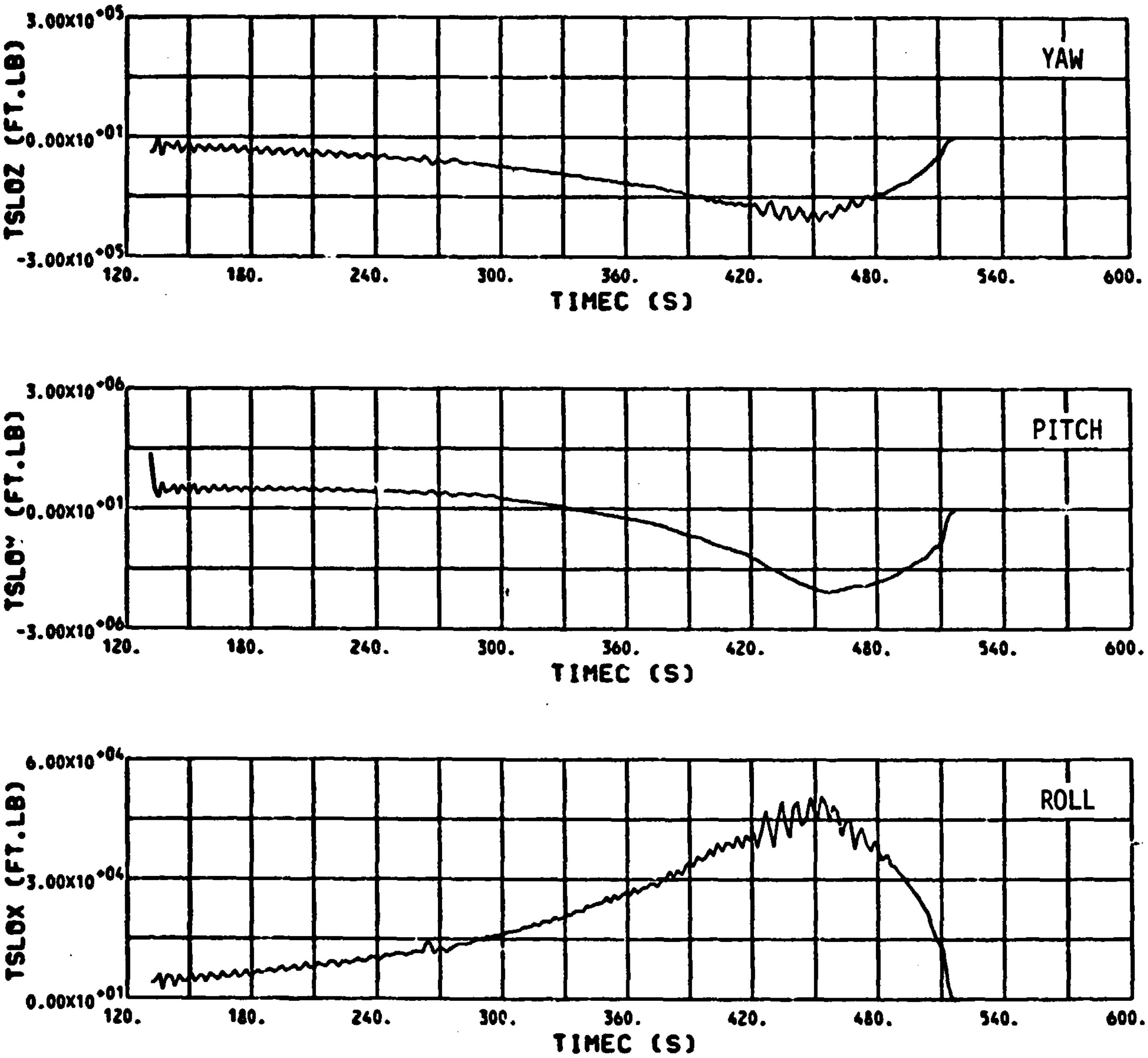
(cc) PRODUCT OF INERTIA

Figure 6.4-1.- Continued.



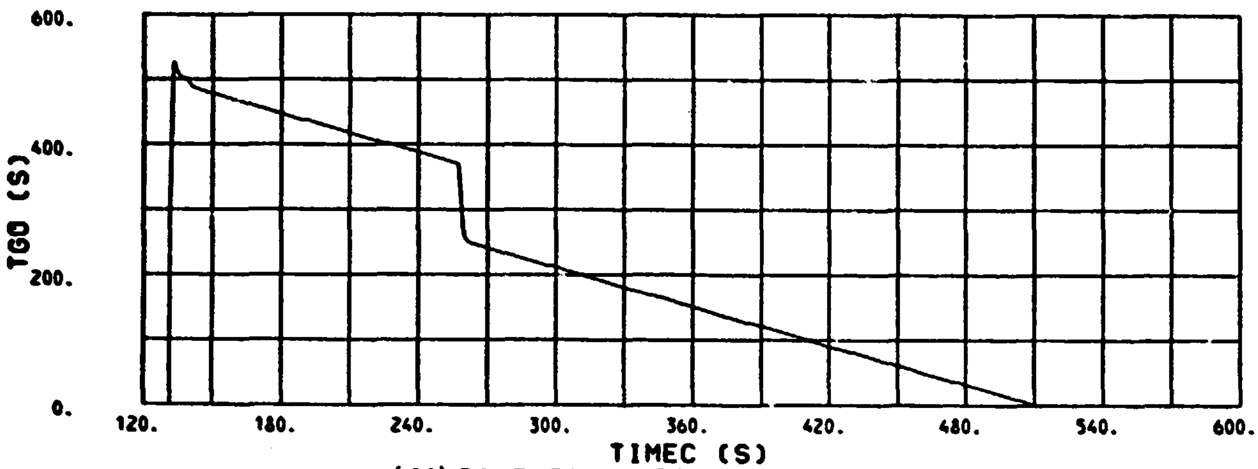
(dd) SLOSH FORCE IN BODY COORDINATES

Figure 6.4-1.- Continued.



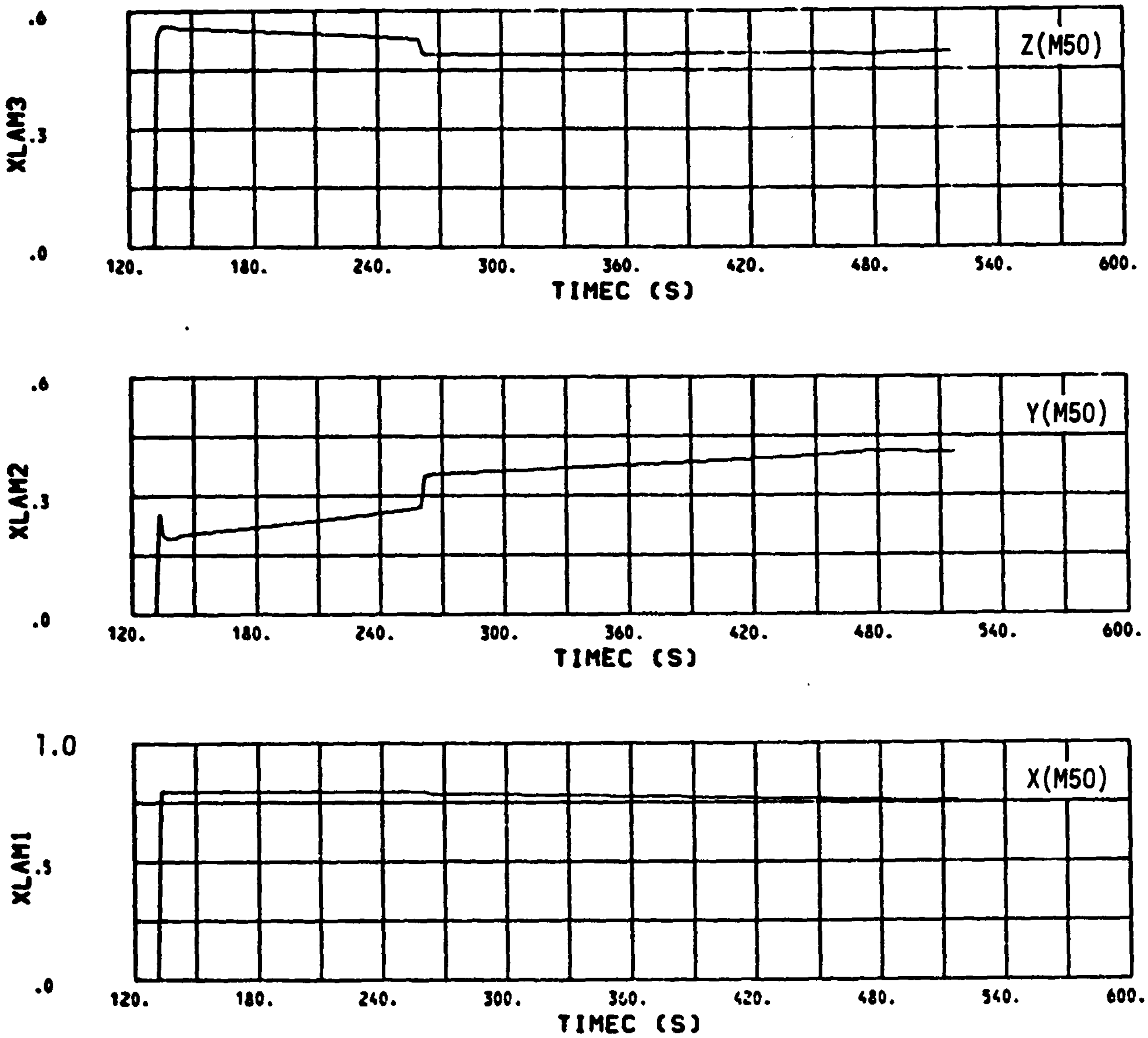
(ee) SLOSH MOMENT IN BODY COORDINATES

Figure 6.4-1.- Continued.



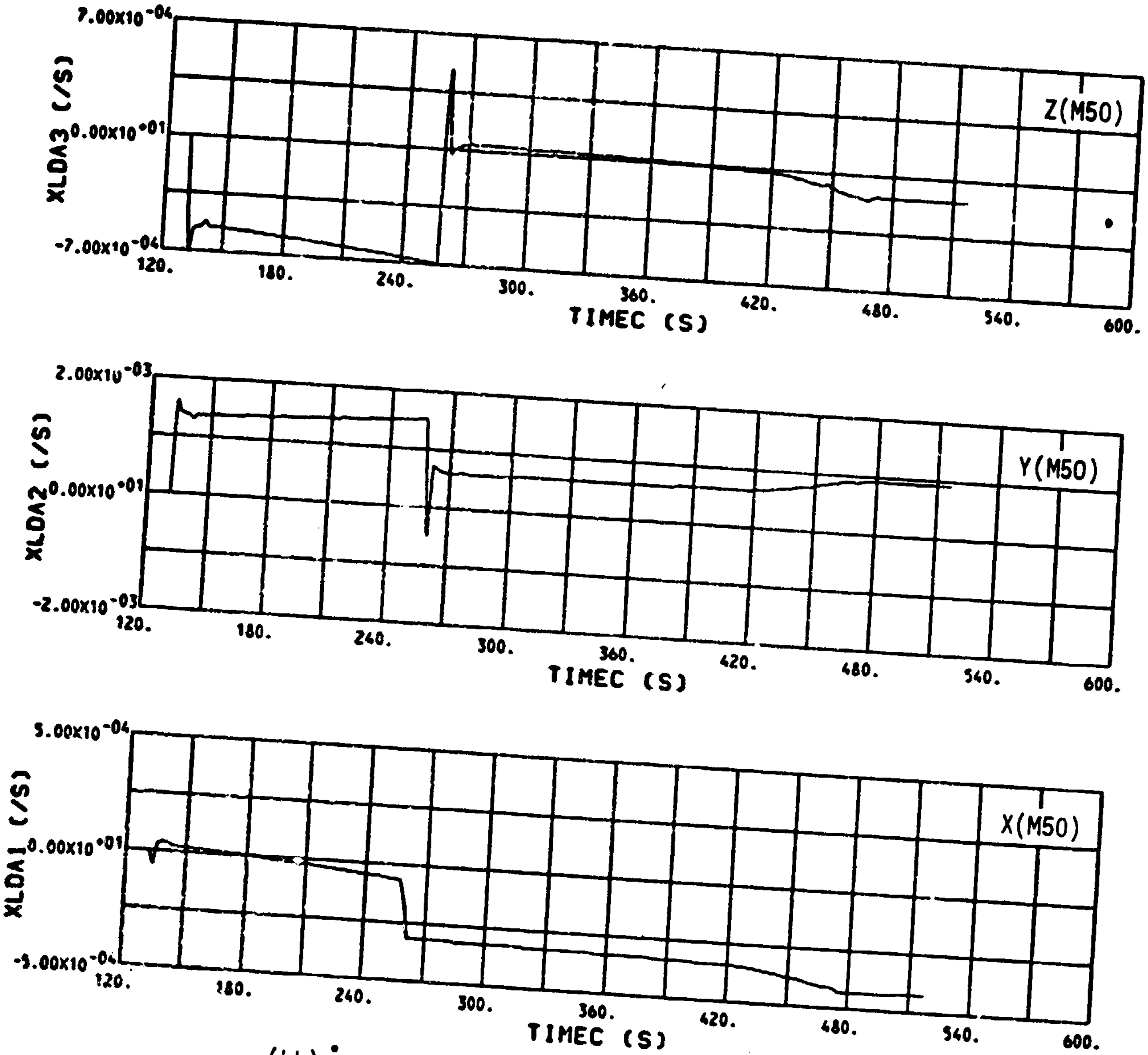
(ff) TIME-TO-GO TILL MECO (MET)

Figure 6.4-1.- Continued.



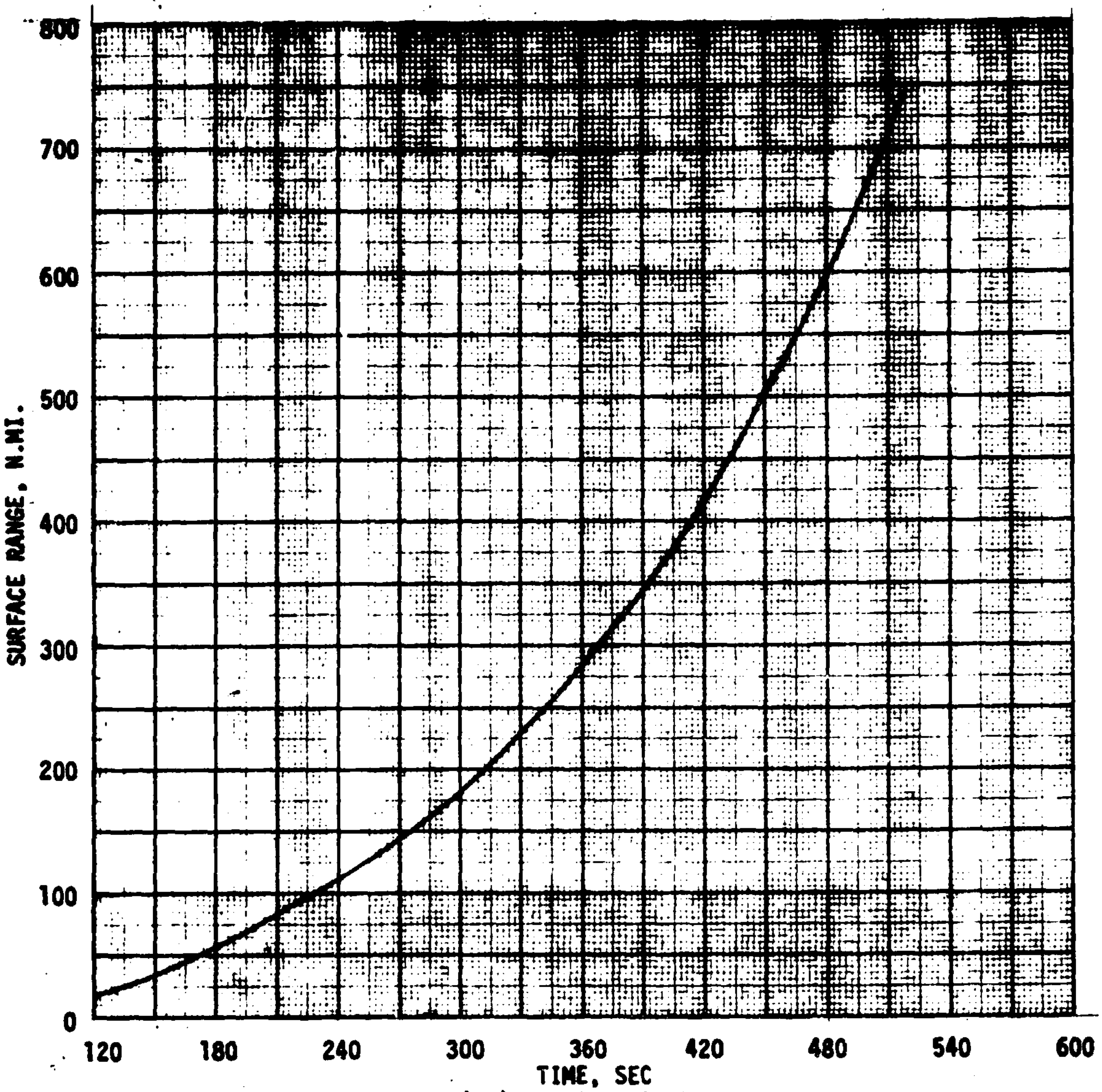
(gg) DESIRED REFERENCE THRUST VECTOR

Figure 6.4-1.- Continued.



(hh) DESIRED THRUST TURNING RATE VECTOR

Figure 6.4-1.- Continued.



(11) SURFACE RANGE

Figure 6.4-1.- Concluded.

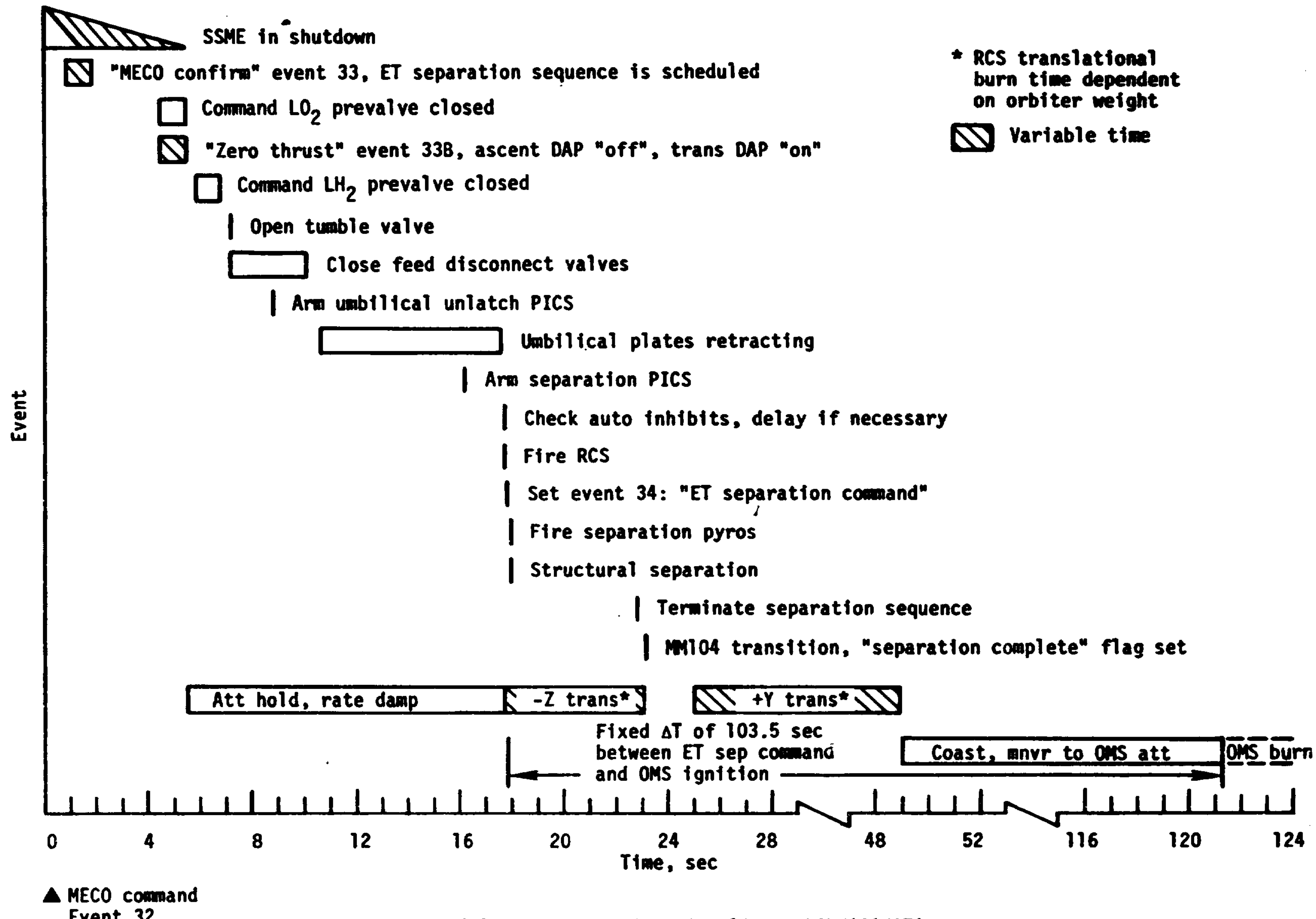
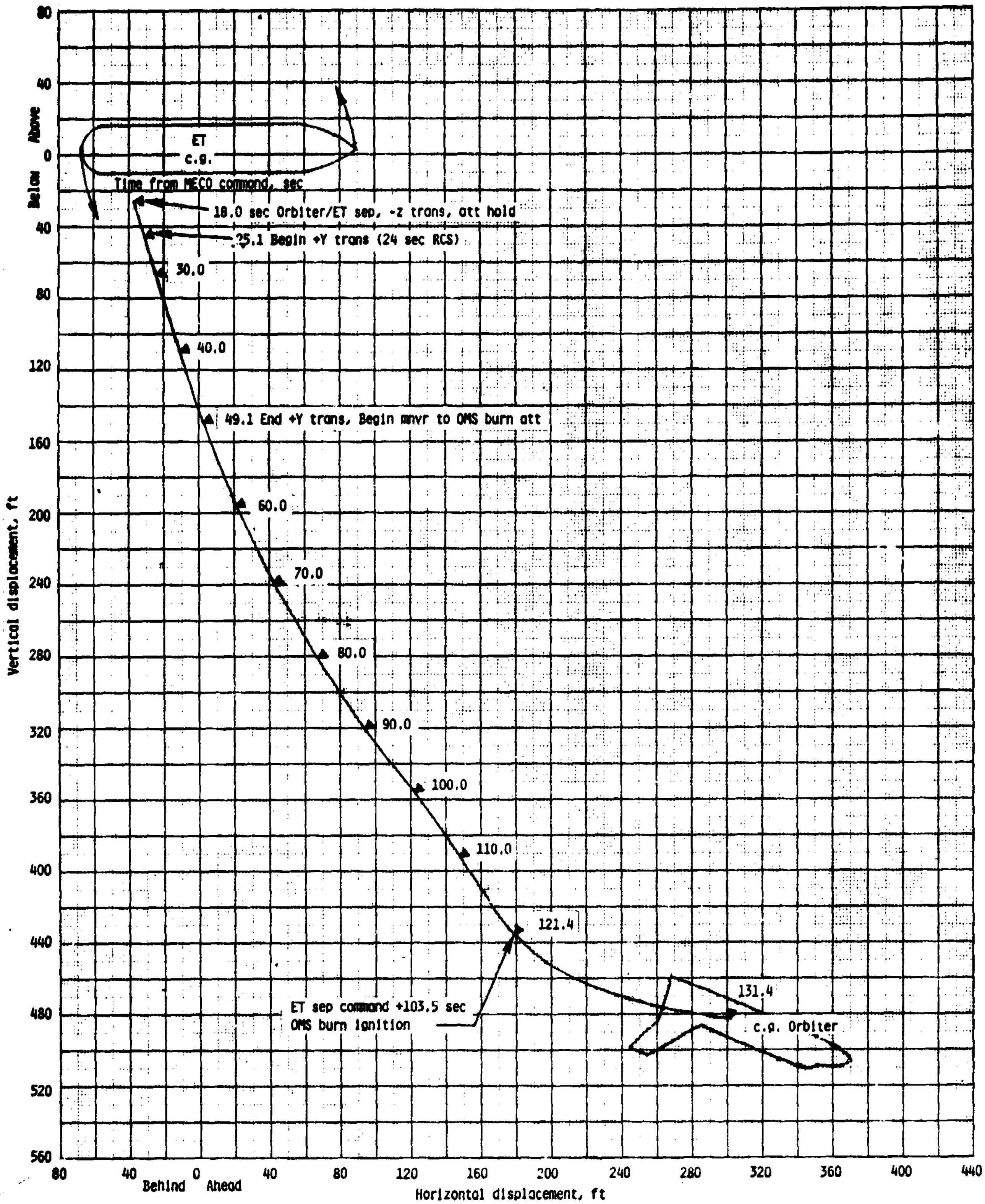
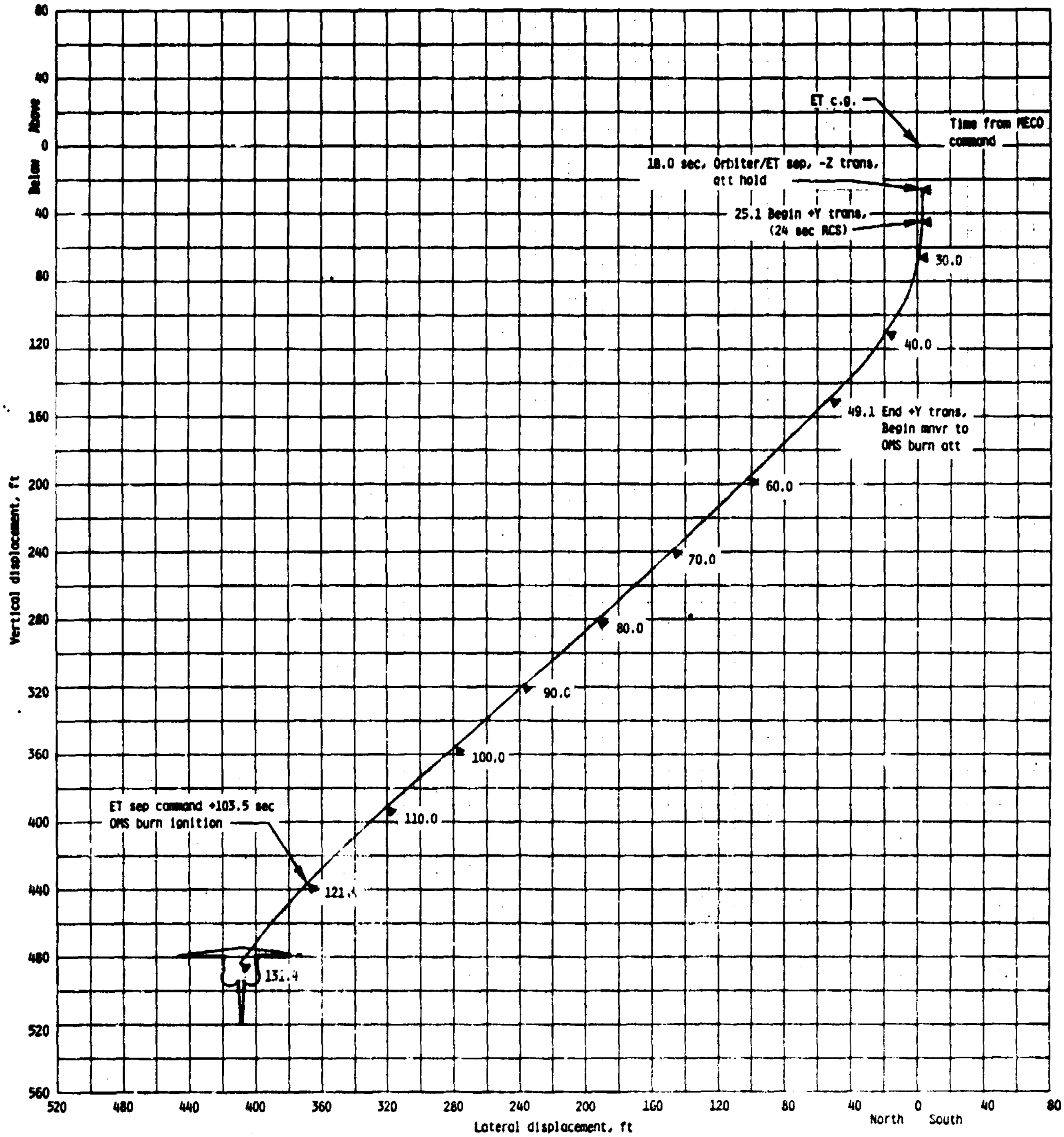


Figure 6.5-1.- ET separation time line - NOM/AOA/ATO.



(a) Vertical and horizontal displacement.

Figure 6.5-2.- Nominal Orbiter/ET relative motion for the separation maneuver.



(b) Vertical and lateral displacement.

Figure 6.5-2.- Concluded.

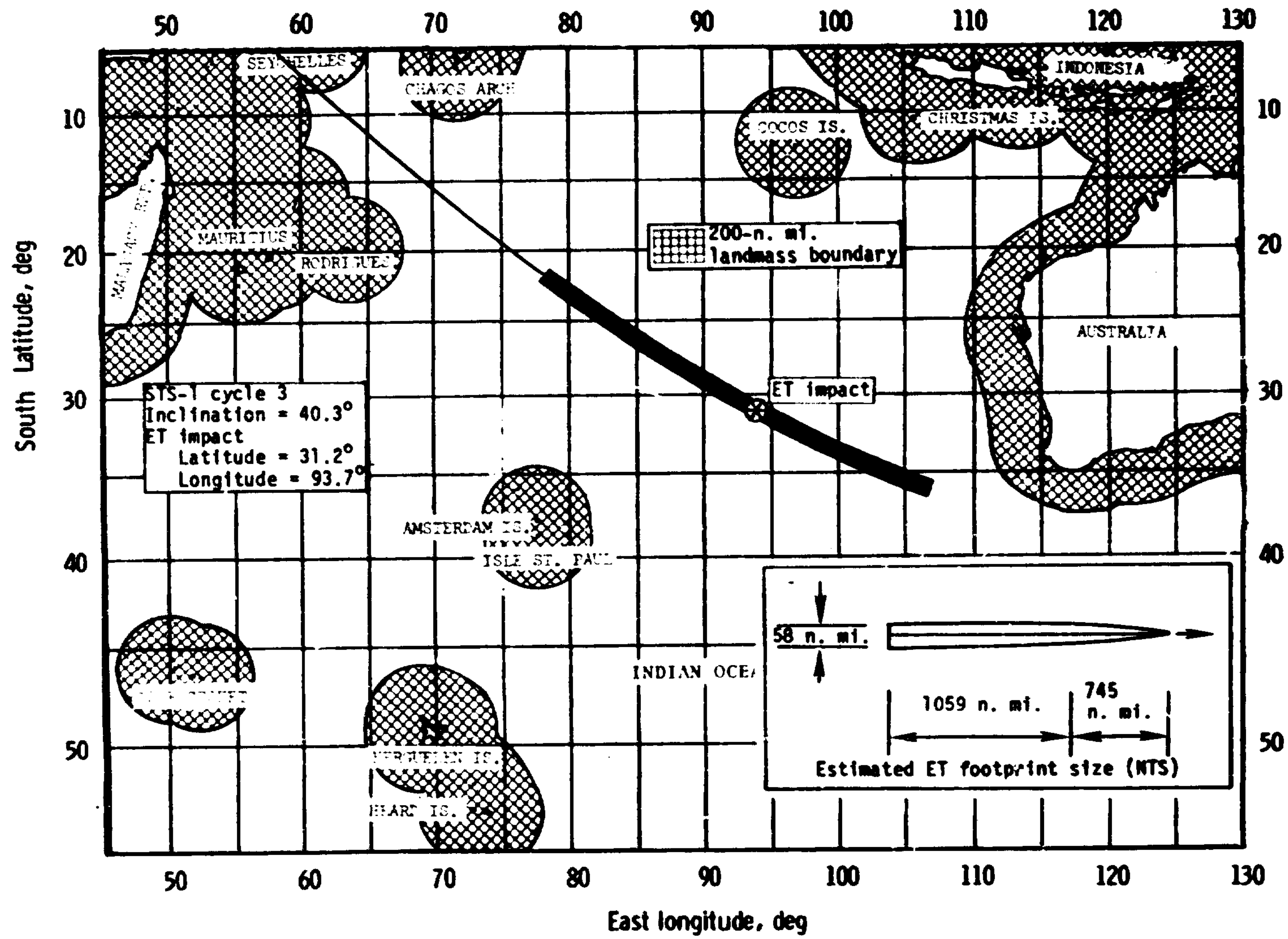
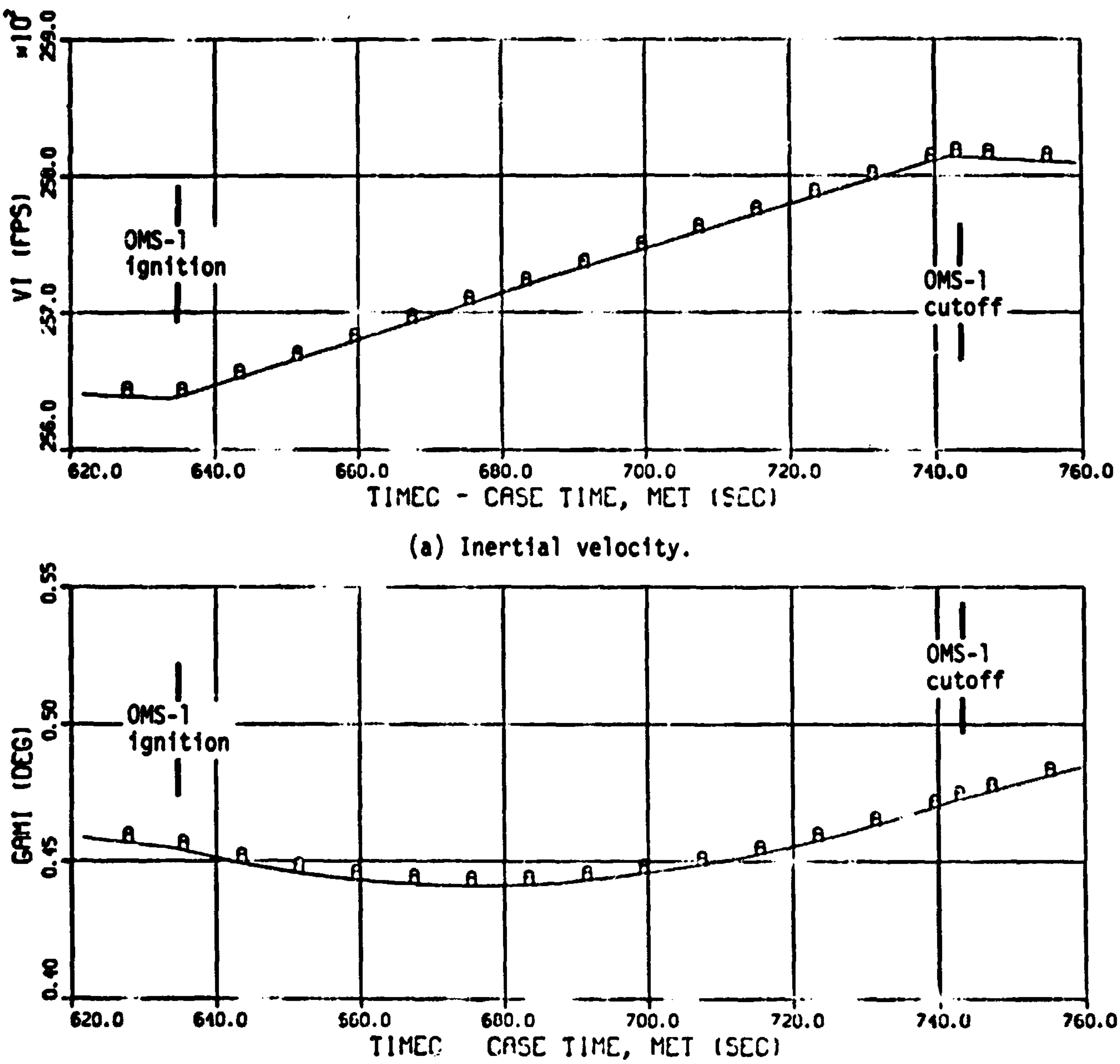


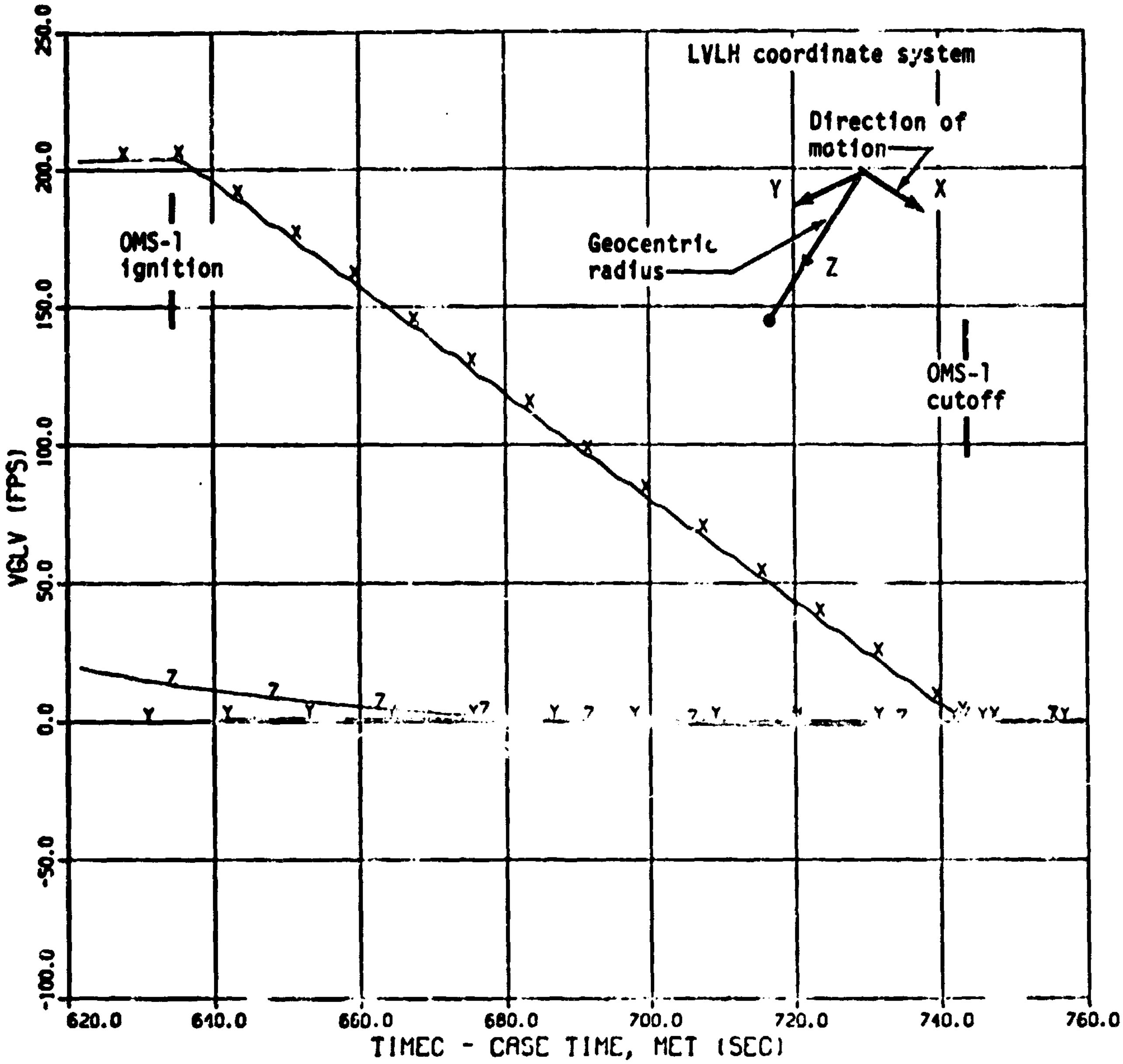
Figure 6.5-3.- STS-1 nominal ET footprint.



(a) Inertial velocity.

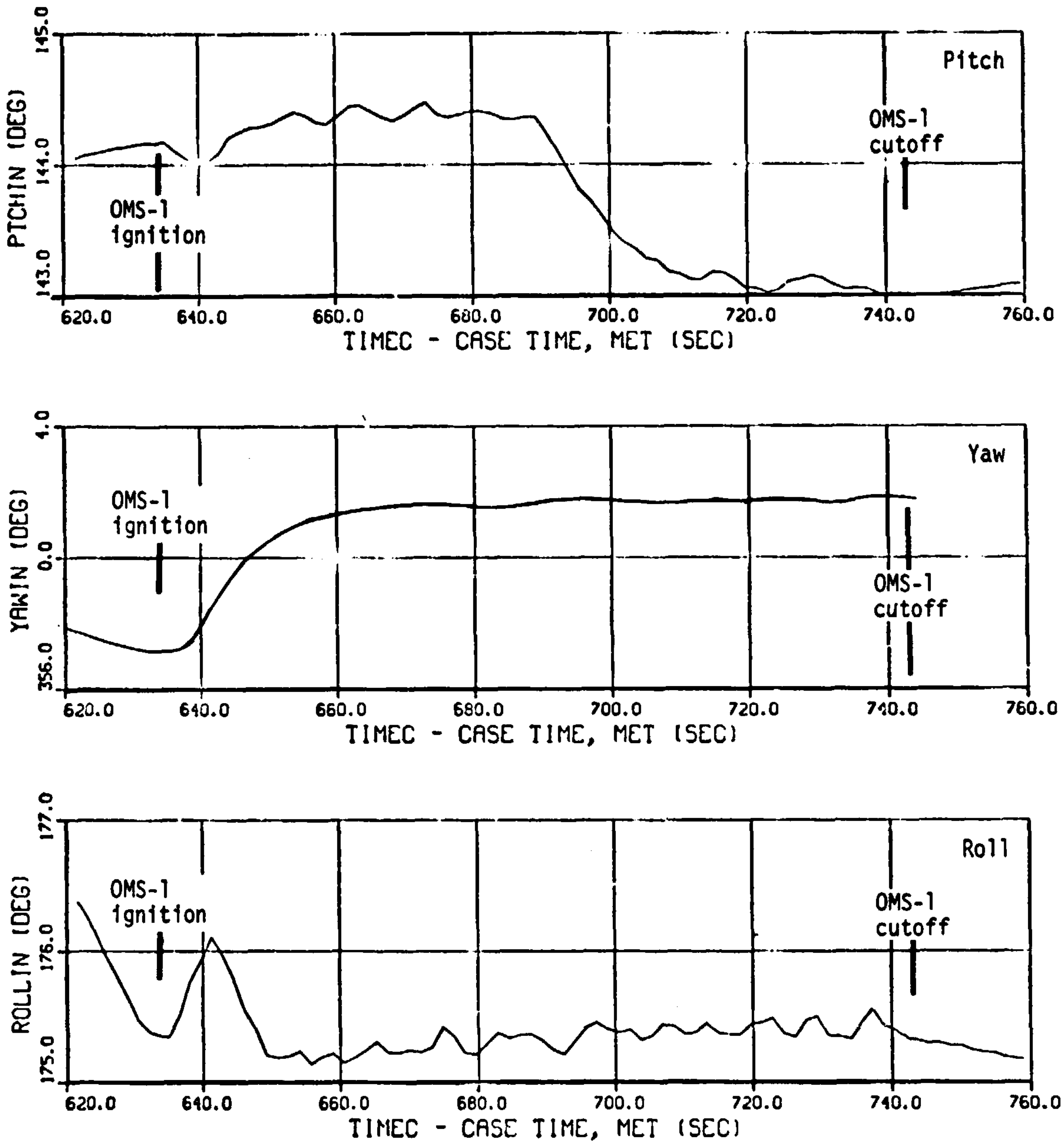
(b) Inertial flightpath angle.

Figure 6.6-1.- OMS-1 parameters versus time.



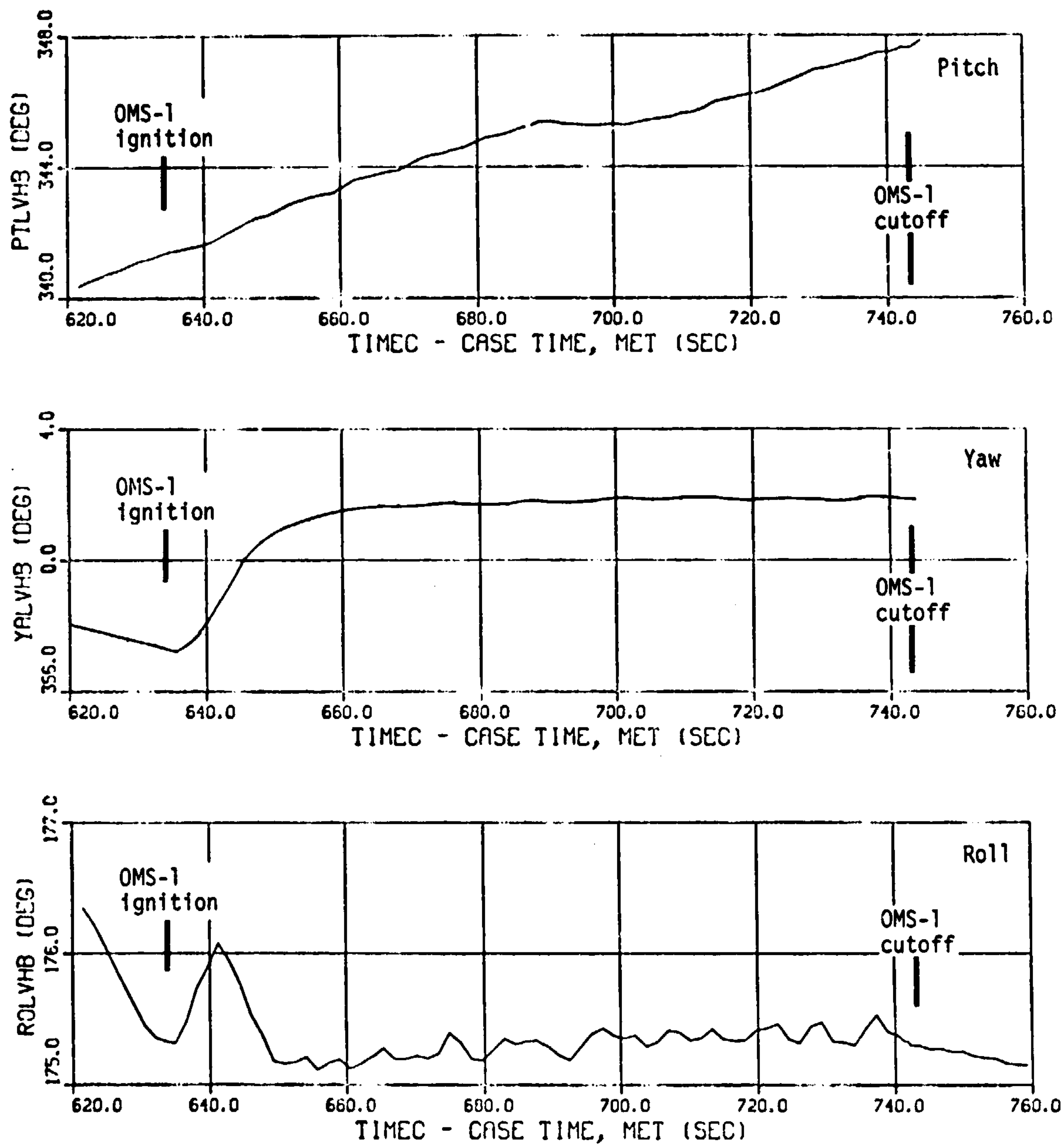
(c) LVLH velocity to be gained.

Figure 6.6-1.- Continued.



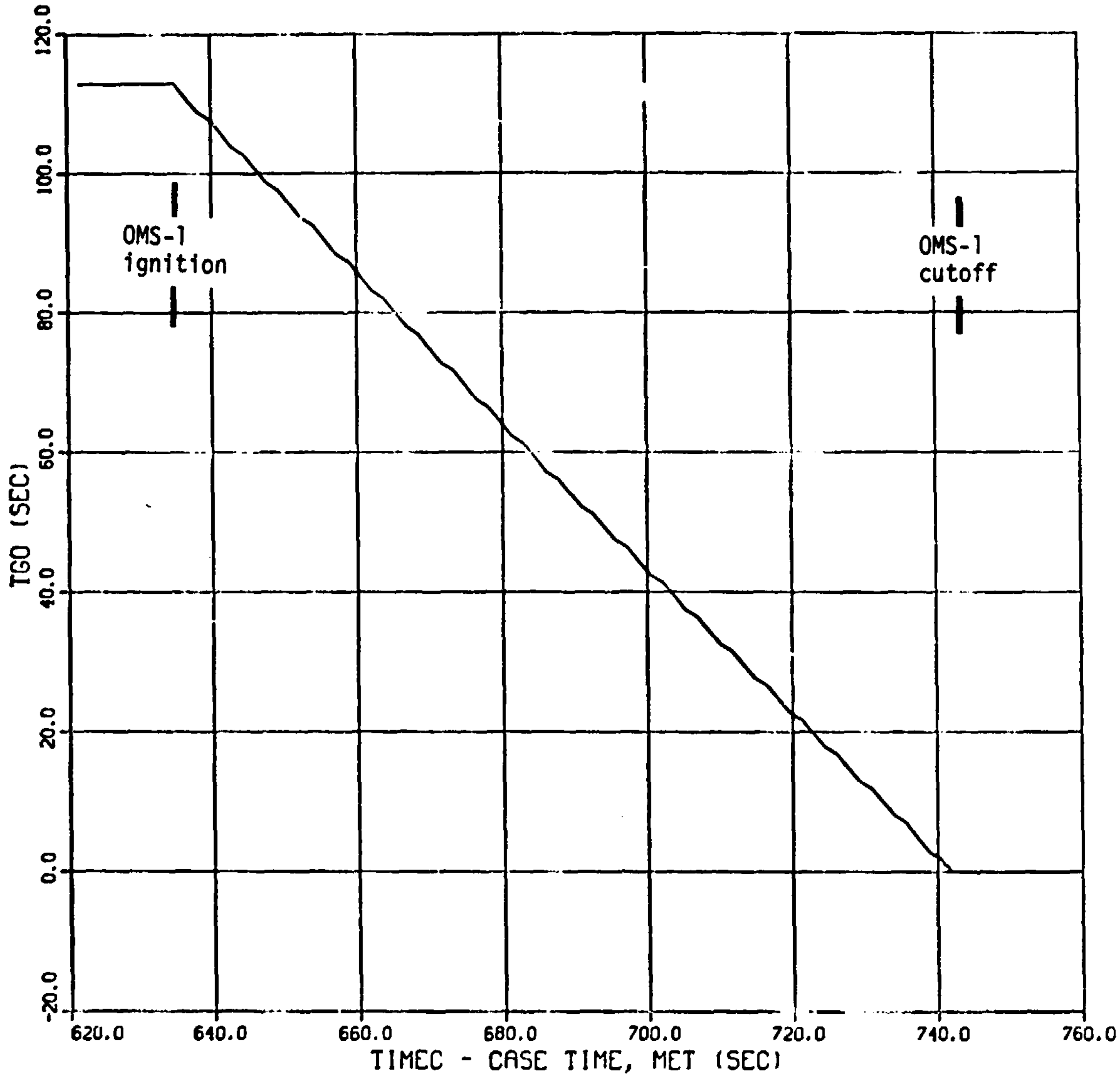
(d) ADI inertial angles.

Figure 6.6-1.- Continued.



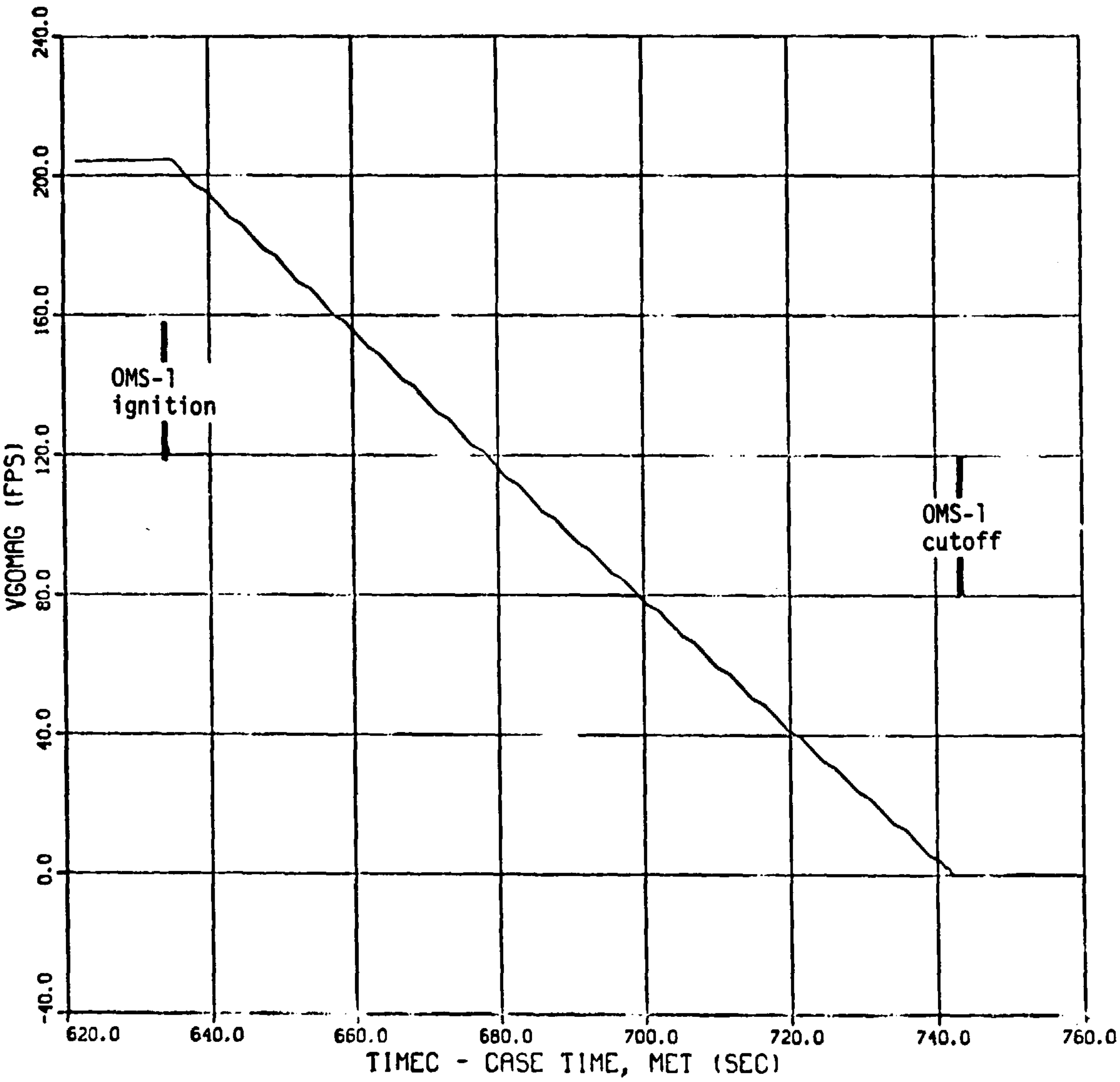
(e) ADI LVLH angles.

Figure 6.6-1.- Continued.



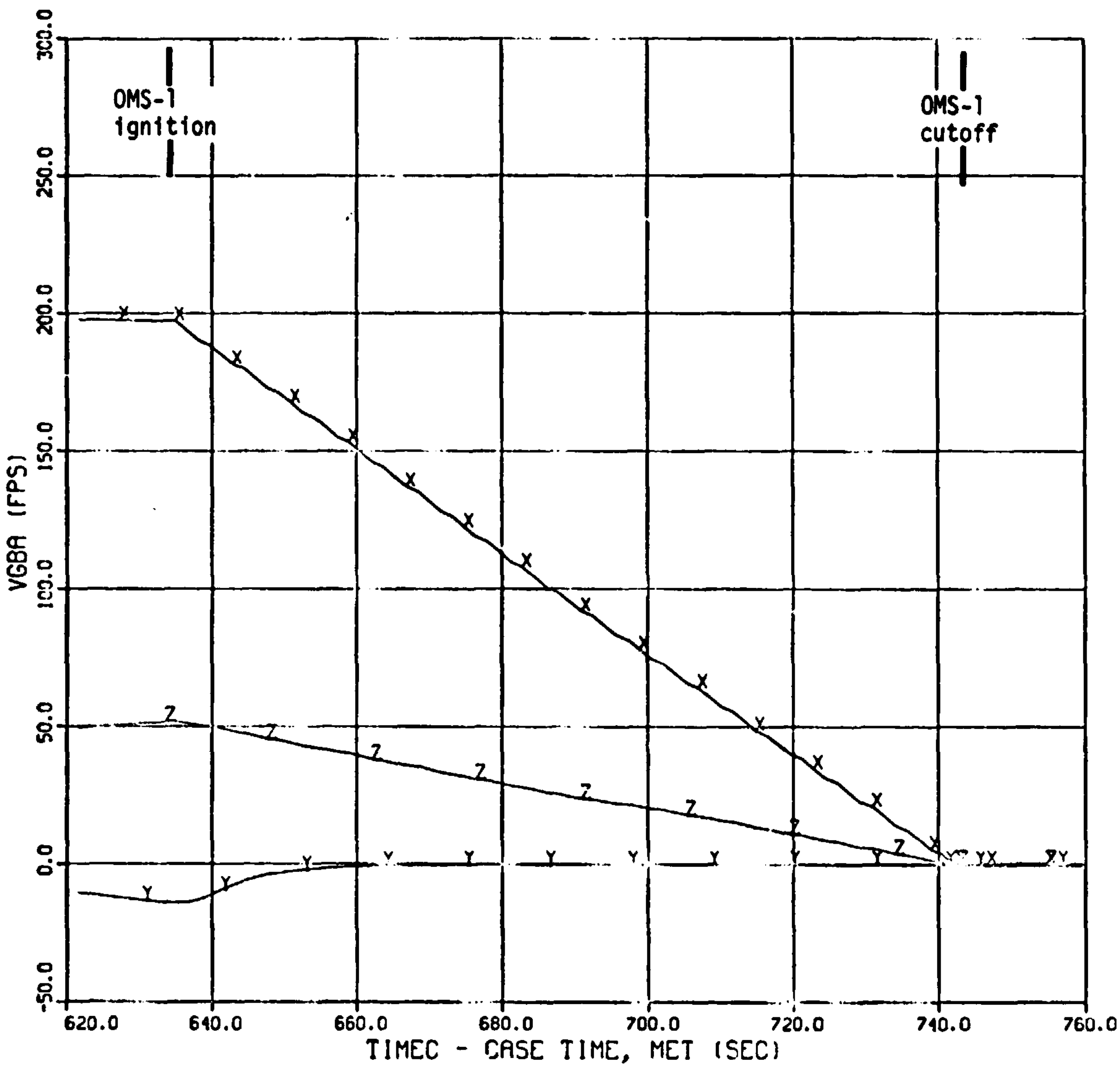
(f) Time to go to OMS-1 engine cutoff.

Figure 6.6-1.- Continued.



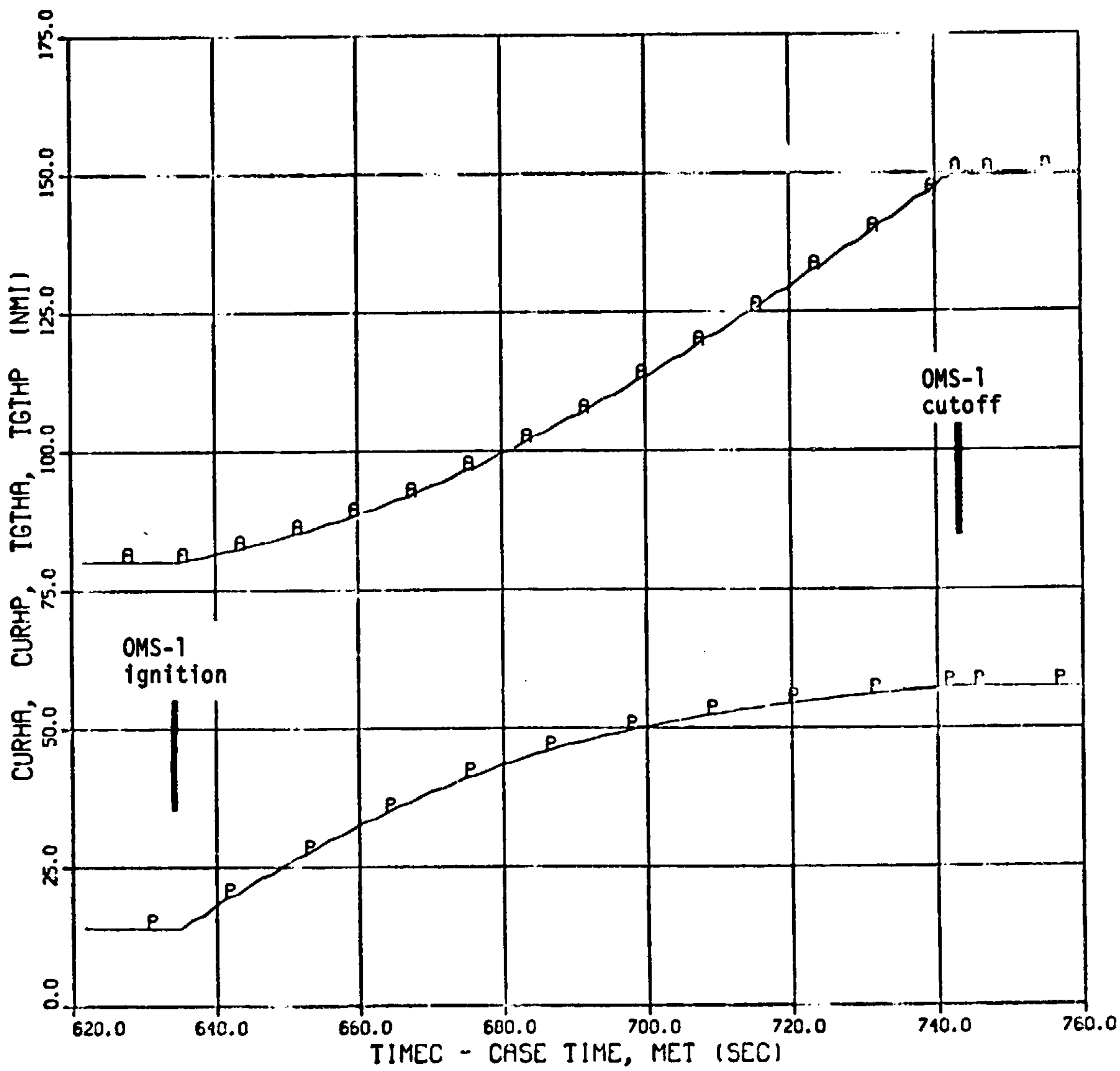
(g) Velocity to be gained magnitude.

Figure 6.6-1.- Continued.



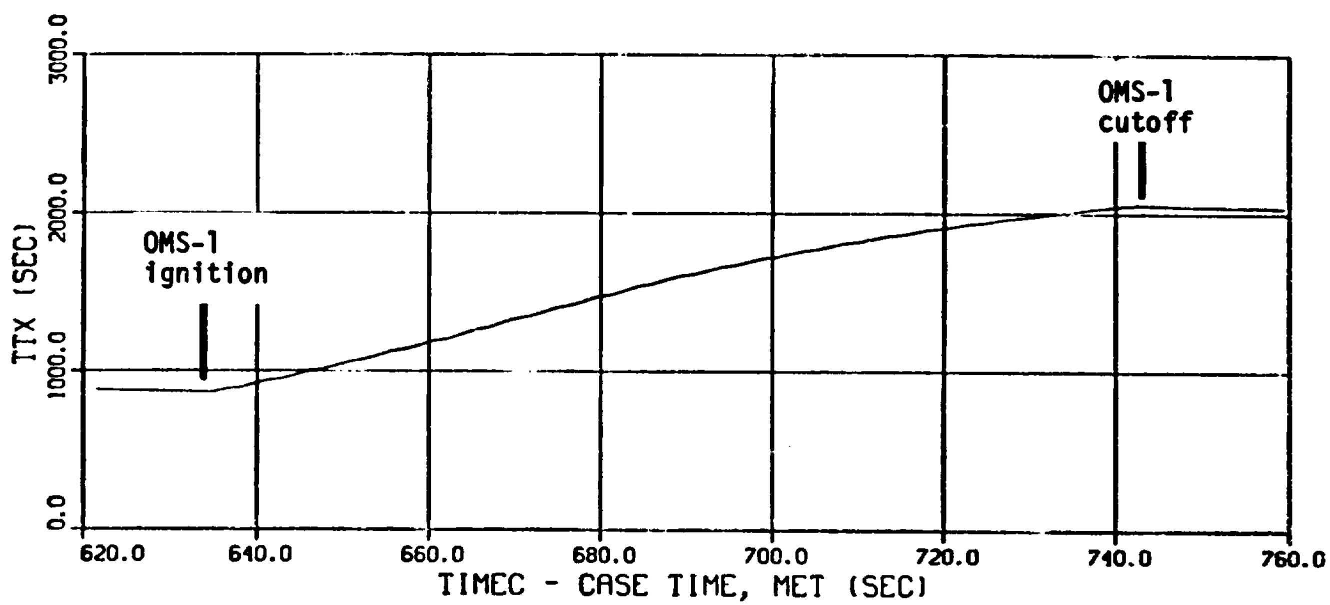
(h) Displayed velocity to be gained in current Orbiter body coordinates.

Figure 6.6-1.- Continued.



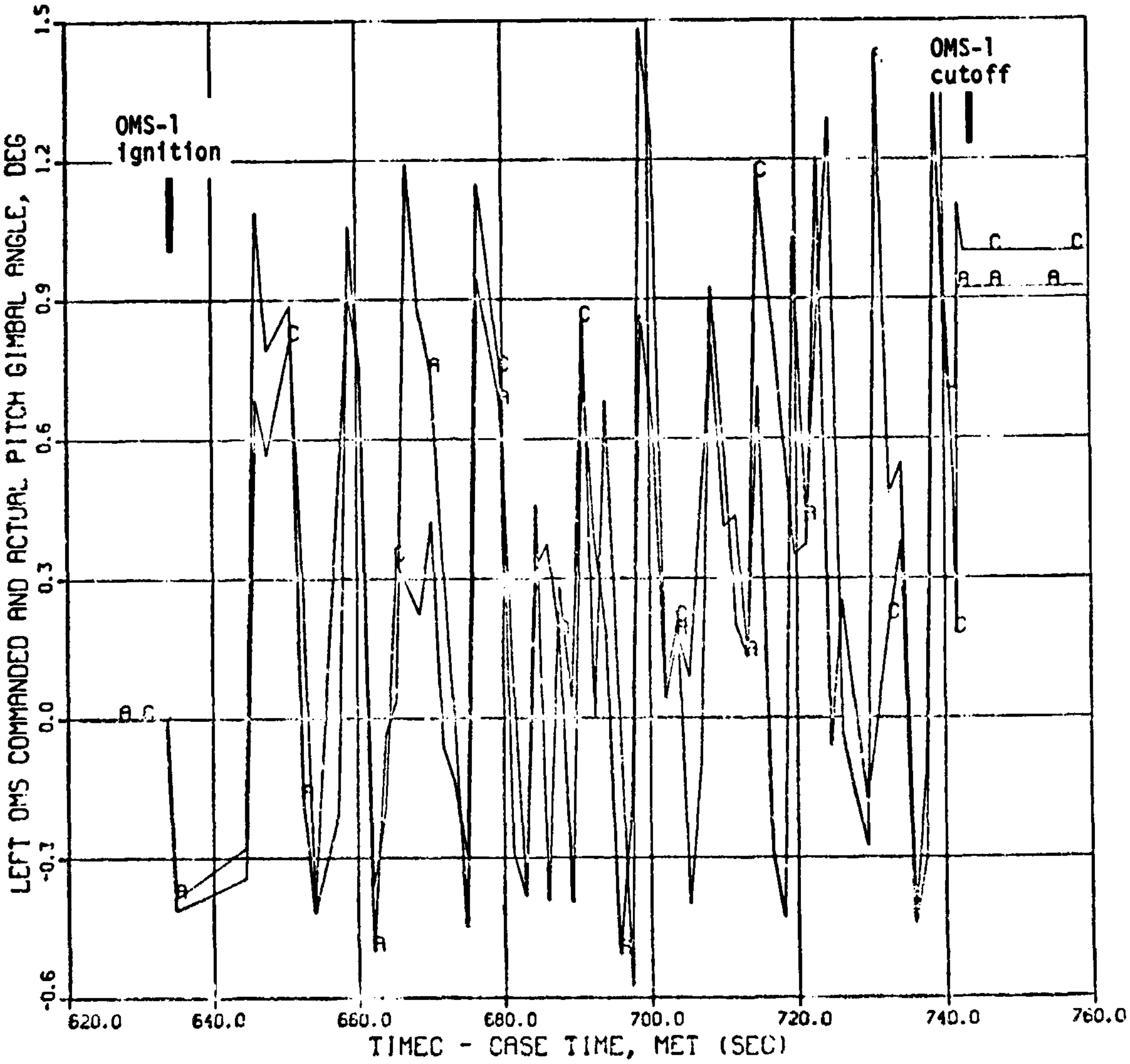
(i) Displayed current apogee and perigee altitude.

Figure 6.6-1.- Continued.



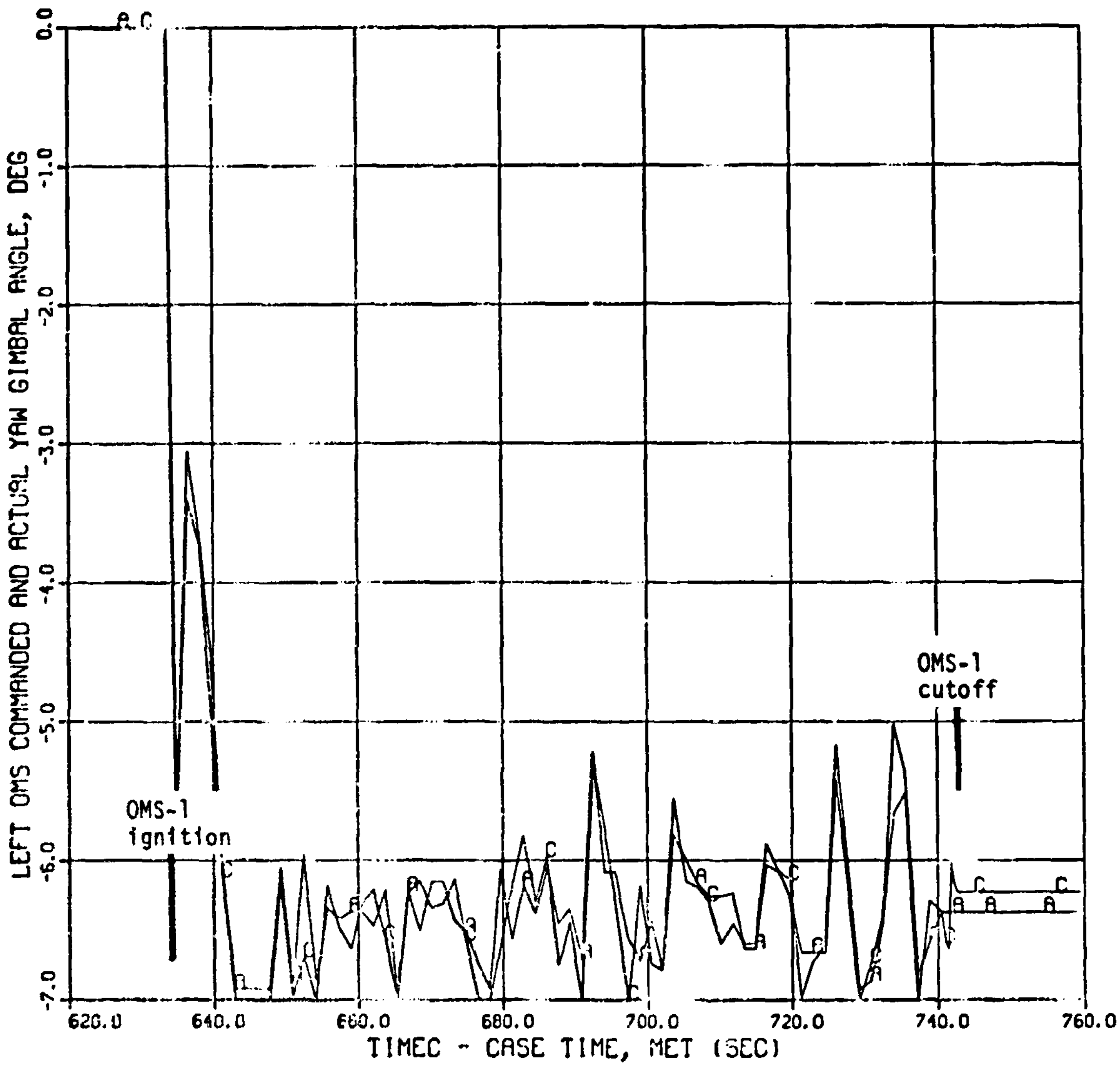
(j) Displayed time to next apsis.

Figure 6.6-1.- Continued.



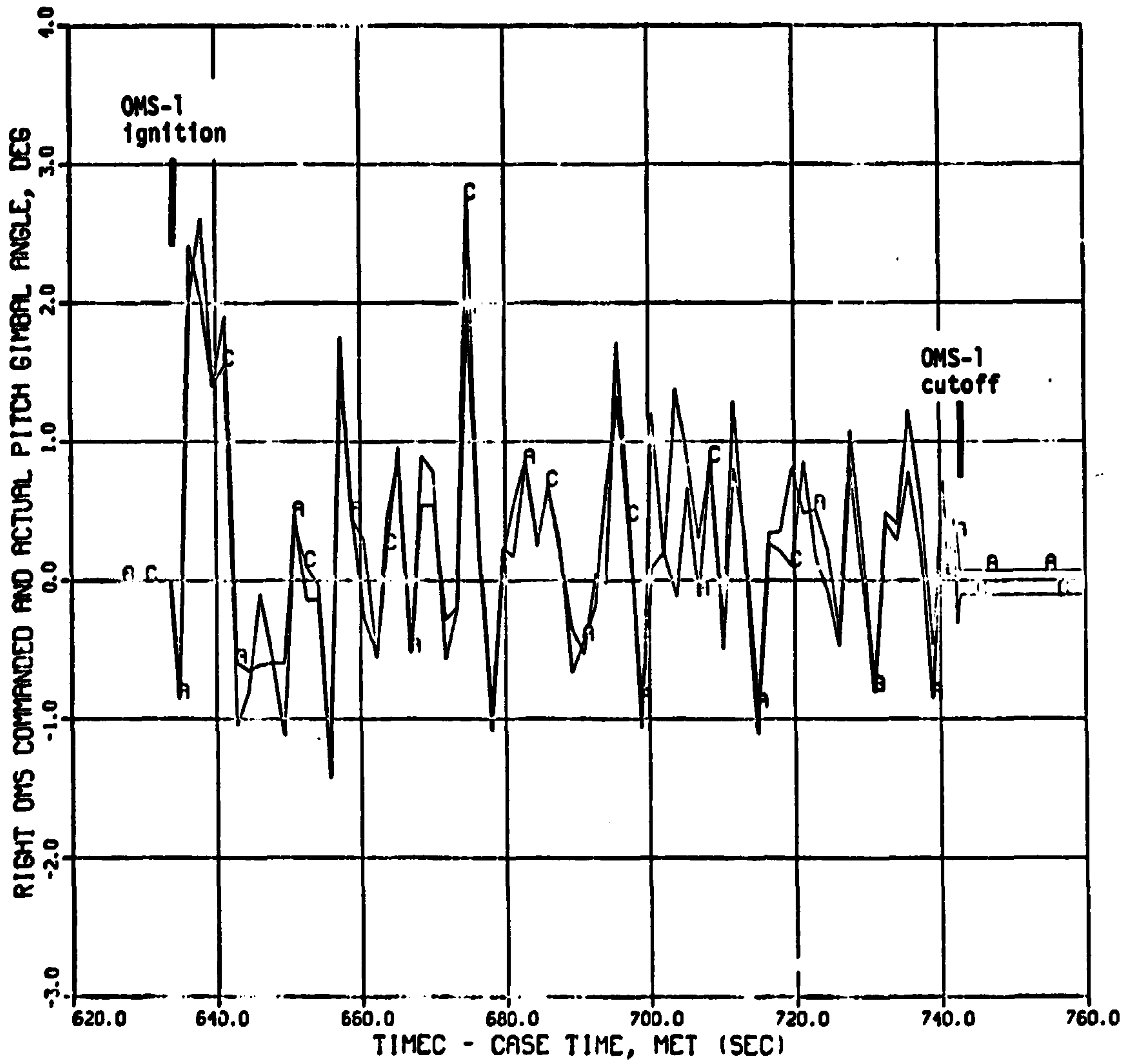
(k) Left OMS actual and commanded pitch gimbal angle.

Figure 6.6-1.- Continued.



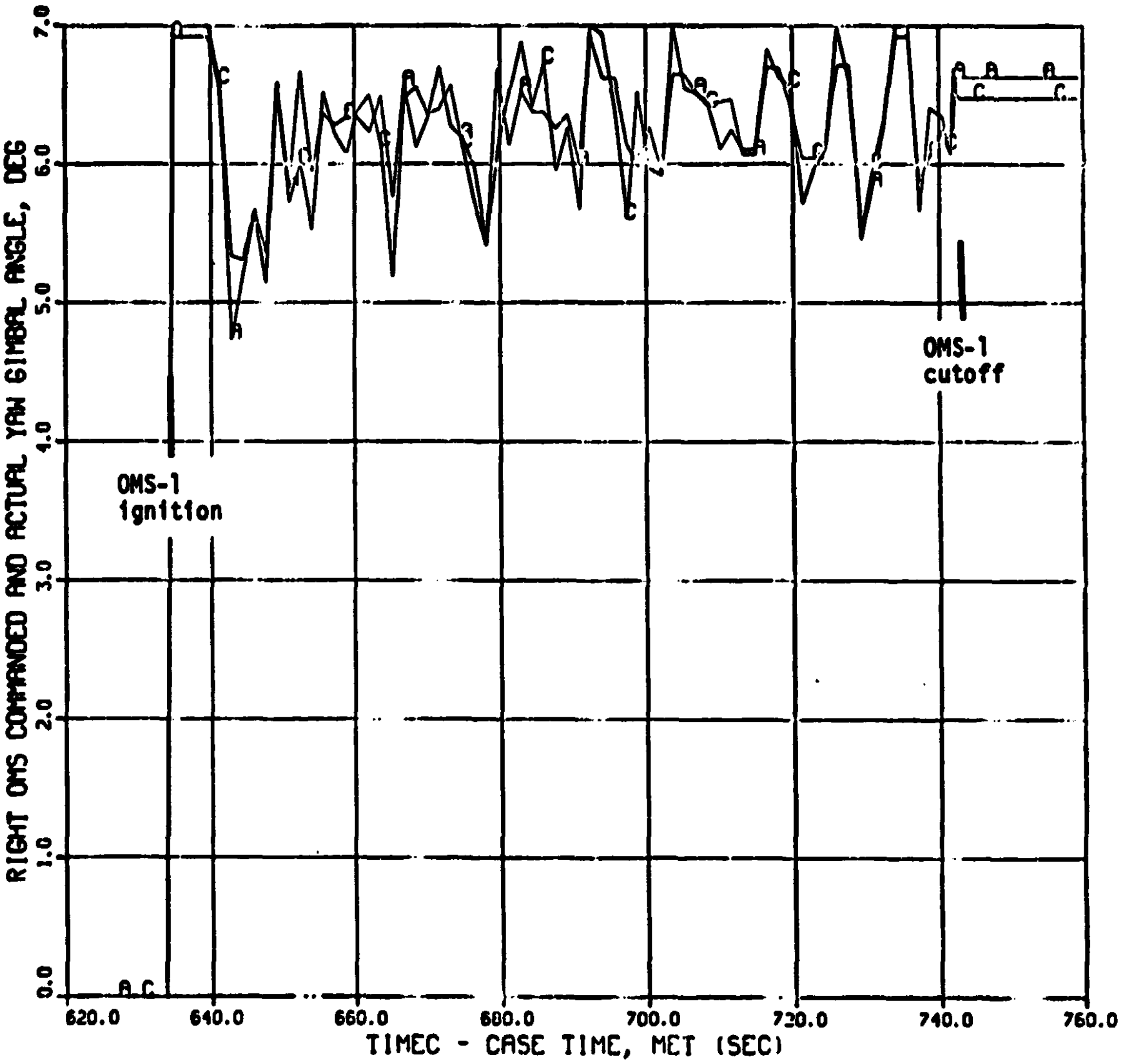
(1) Left OMS actual and commanded yaw gimbal angle.

Figure 6.6-1.- Continued.



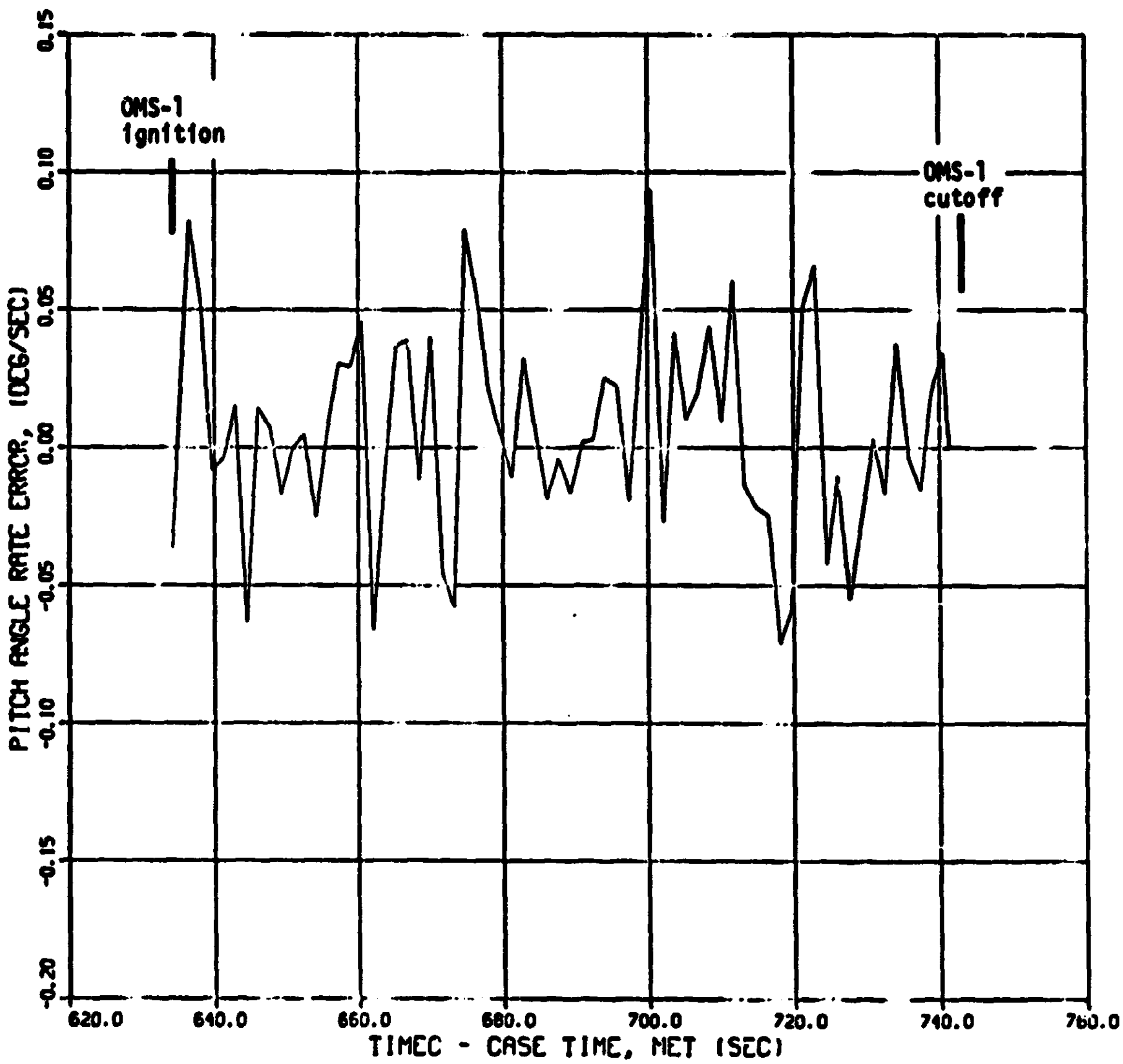
(m) Right OMS actual and commanded pitch gimbal angle.

Figure 6.6-1.- Continued.



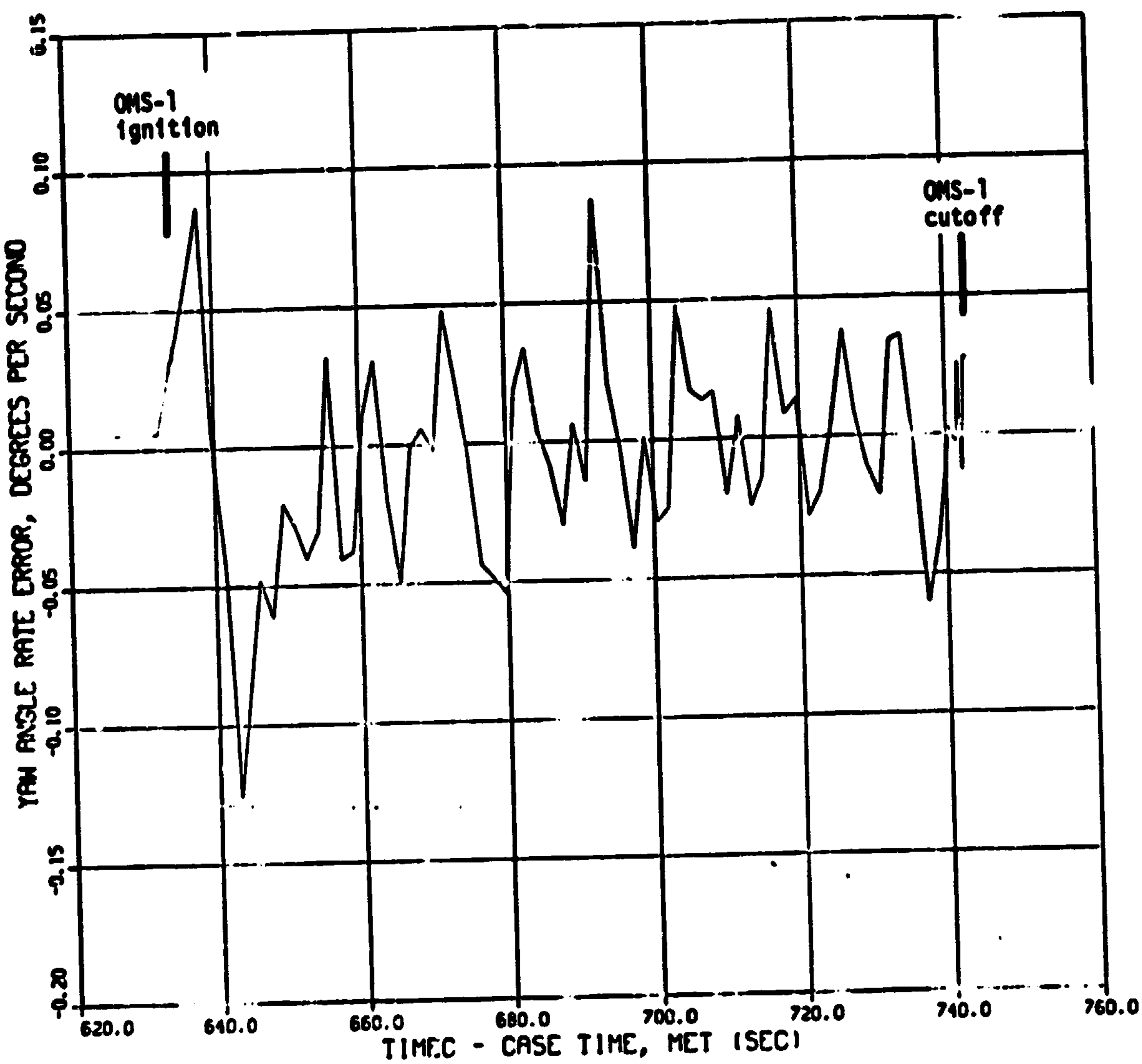
(n) Right OMS actual and commanded yaw gimbal angle.

Figure 6.6-1.- Continued.



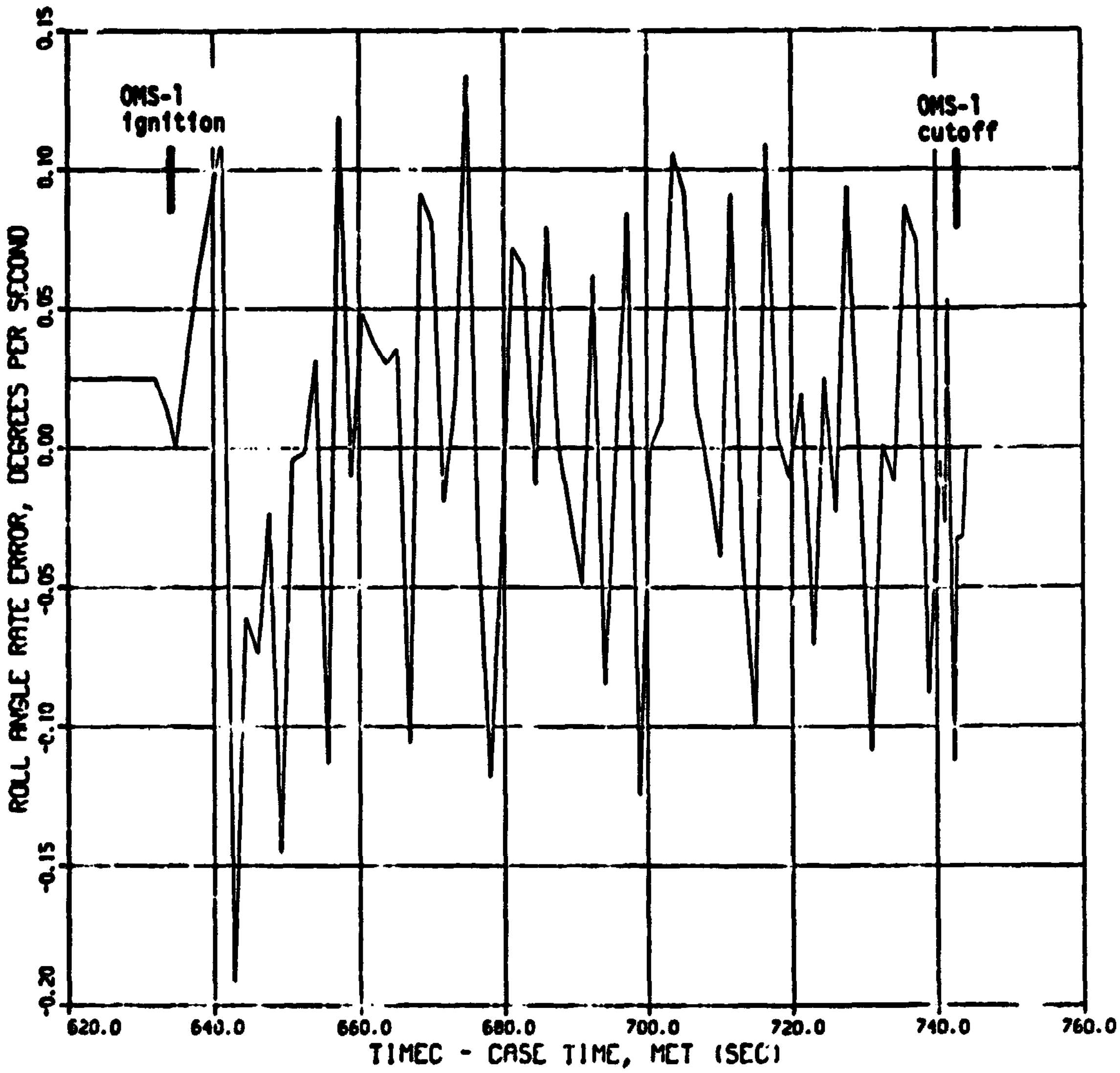
(o) Pitch angle rate error.

Figure 6.6-1.- Continued.



(p) Yaw angle rate error.

Figure 6.6-1.- Continued.



(q) Roll angle rate error.

Figure 6.6-1.- Concluded.

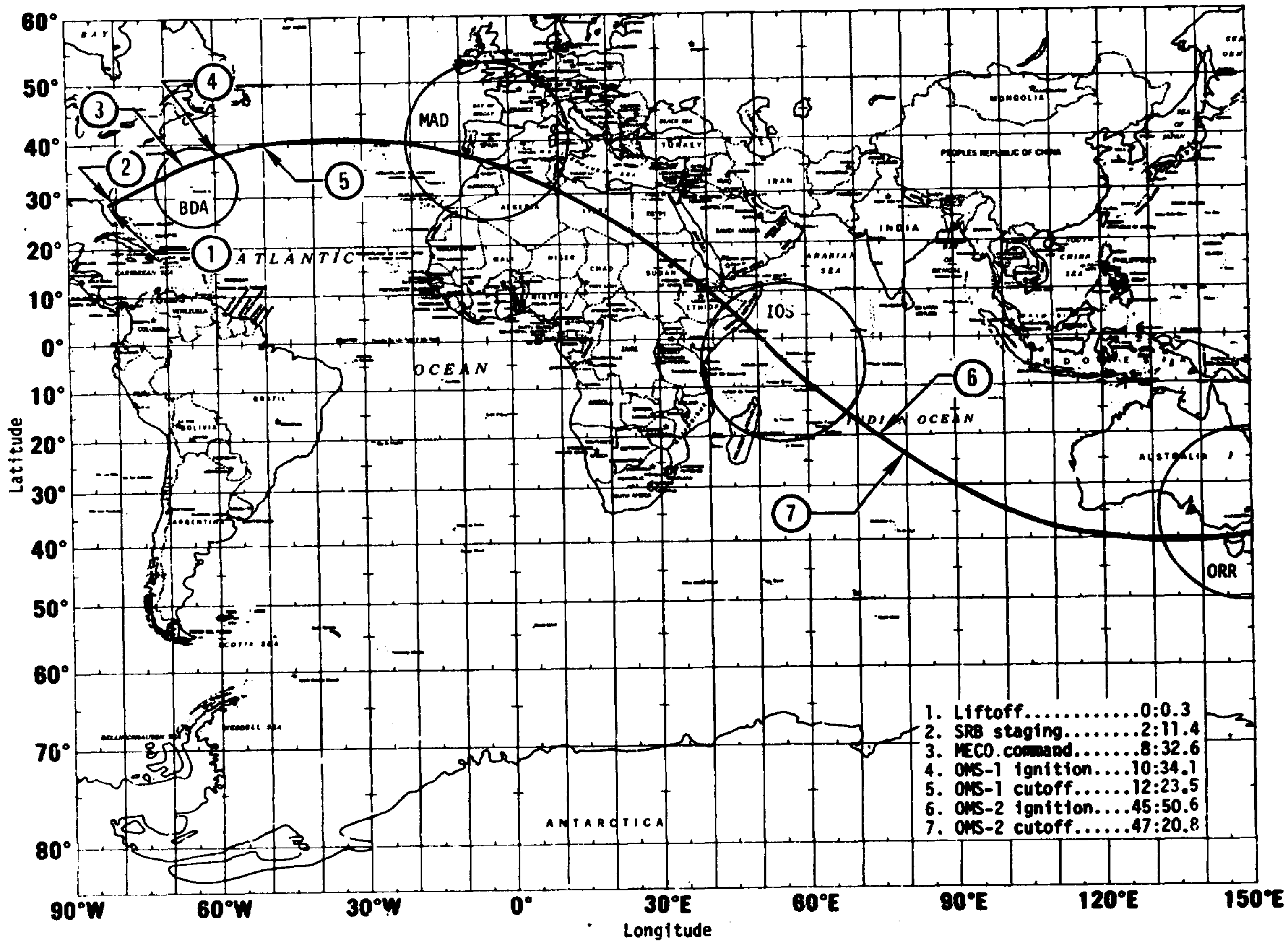


Figure 6.6-2.- STS-1 cycle 3 ascent groundtrack and post-MECO communication coverage.

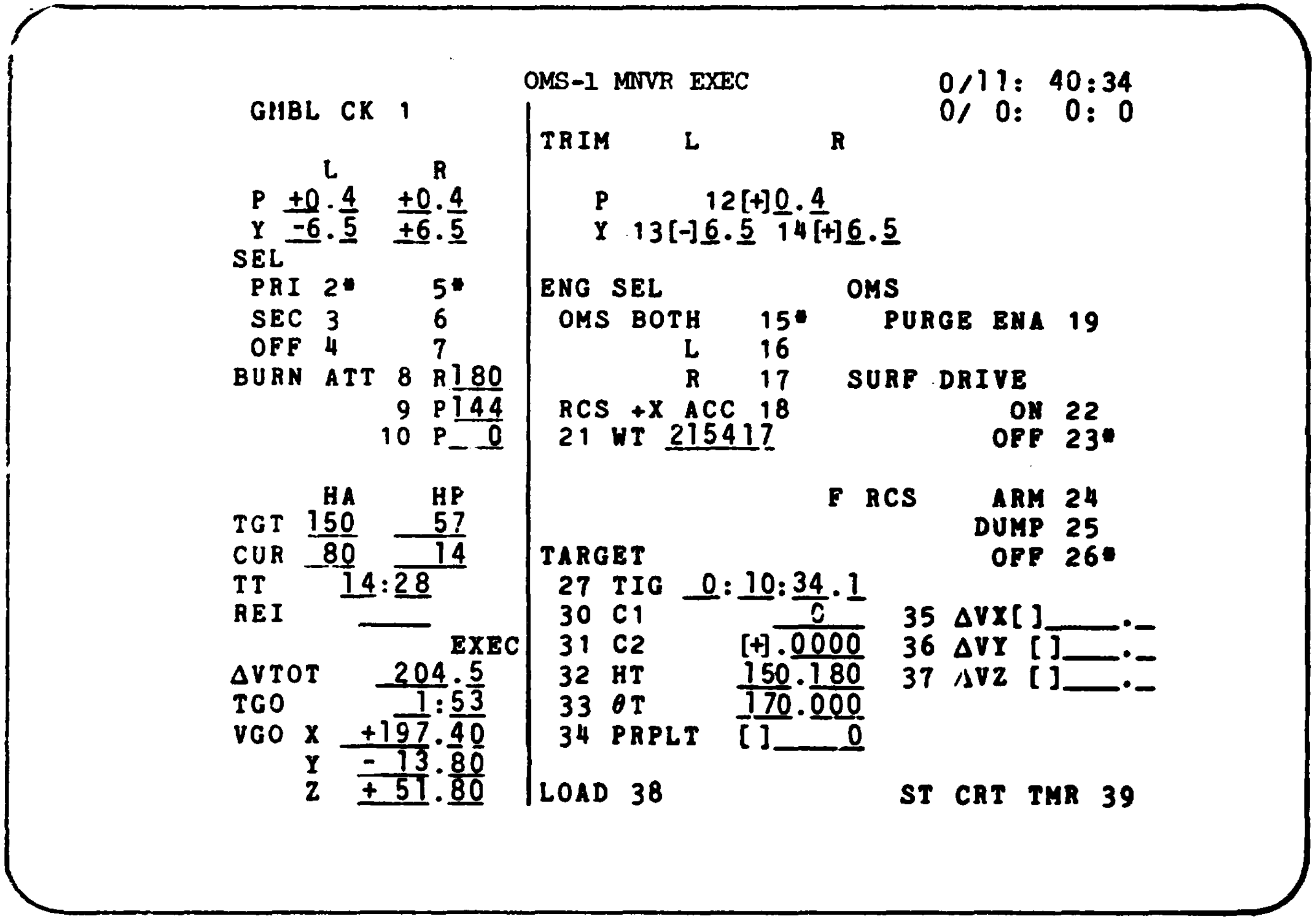


Figure 6.6-3.- OMS-1 ignition point maneuver execute CRT display.

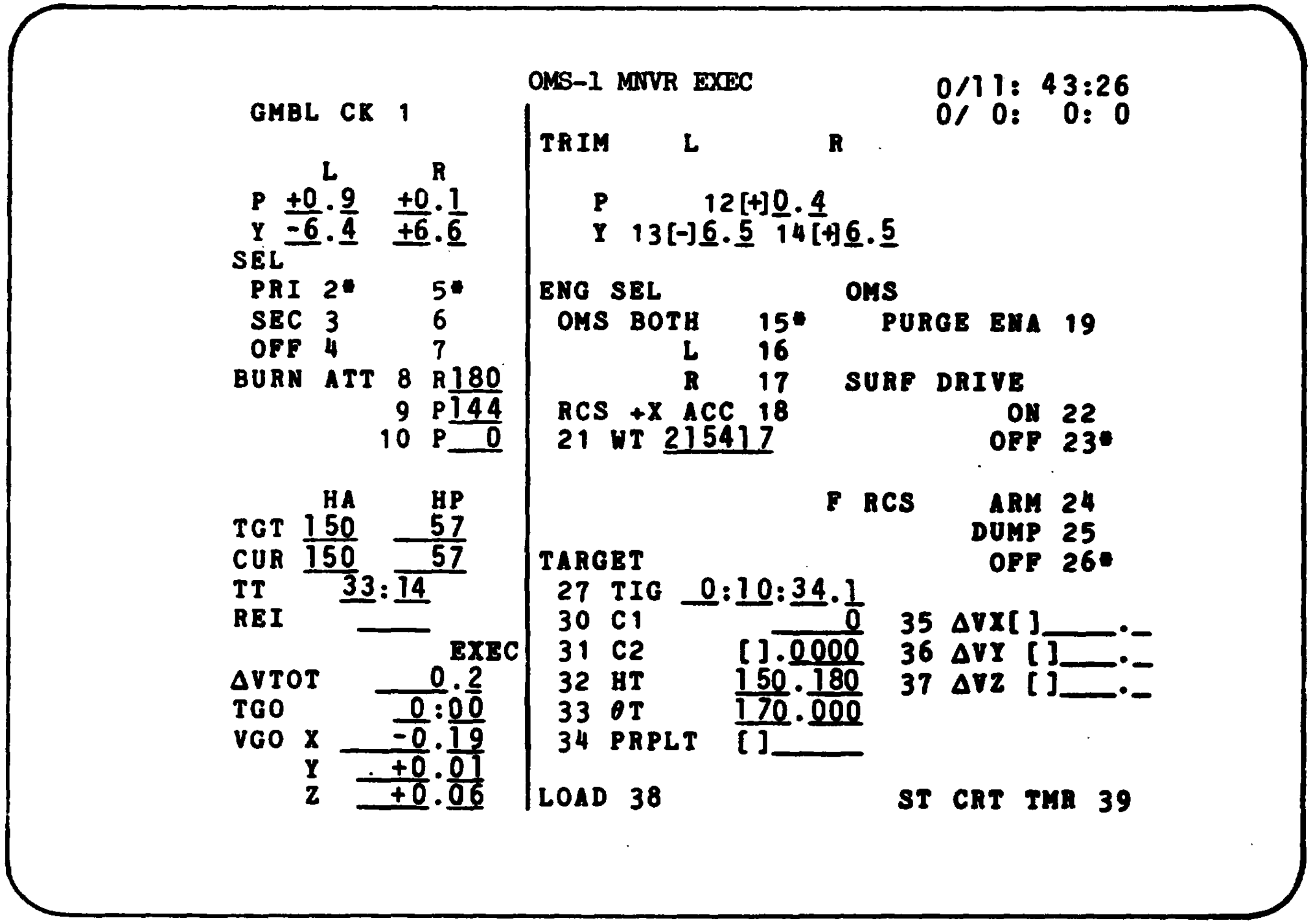
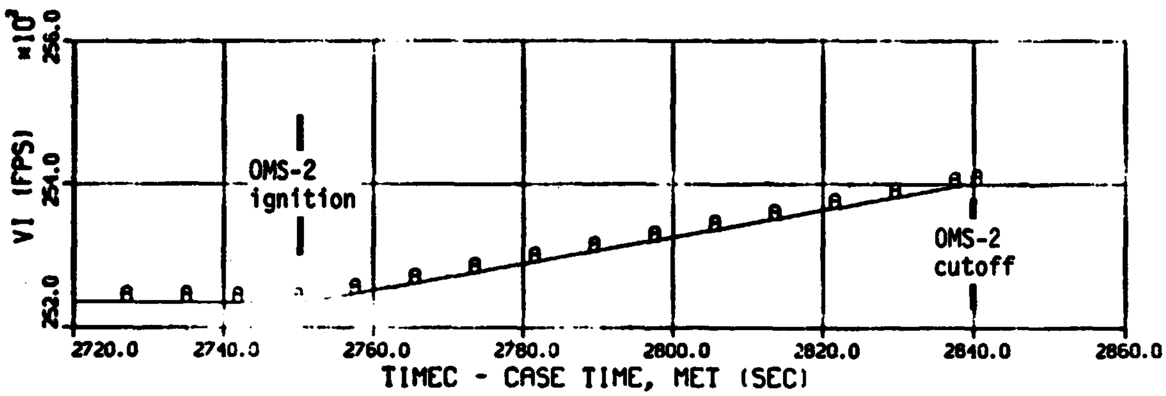
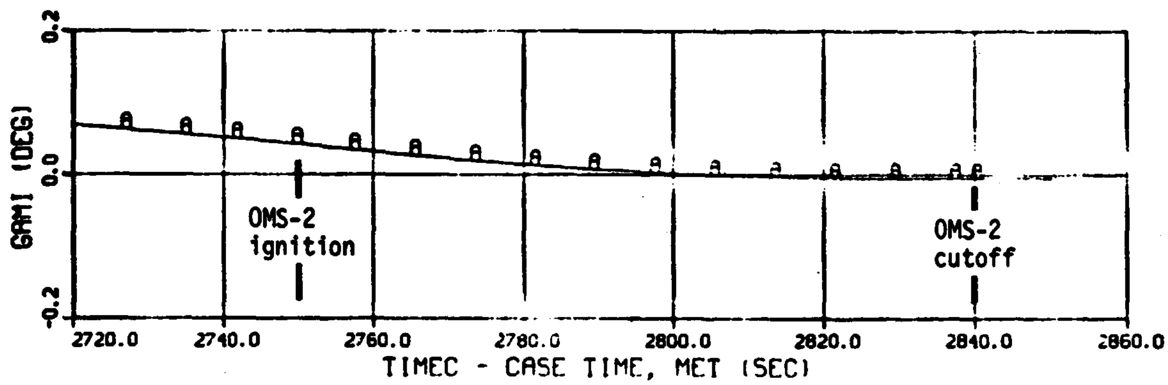


Figure 6.6-4.- OMS-1 engine cutoff point maneuver execute CRT display.

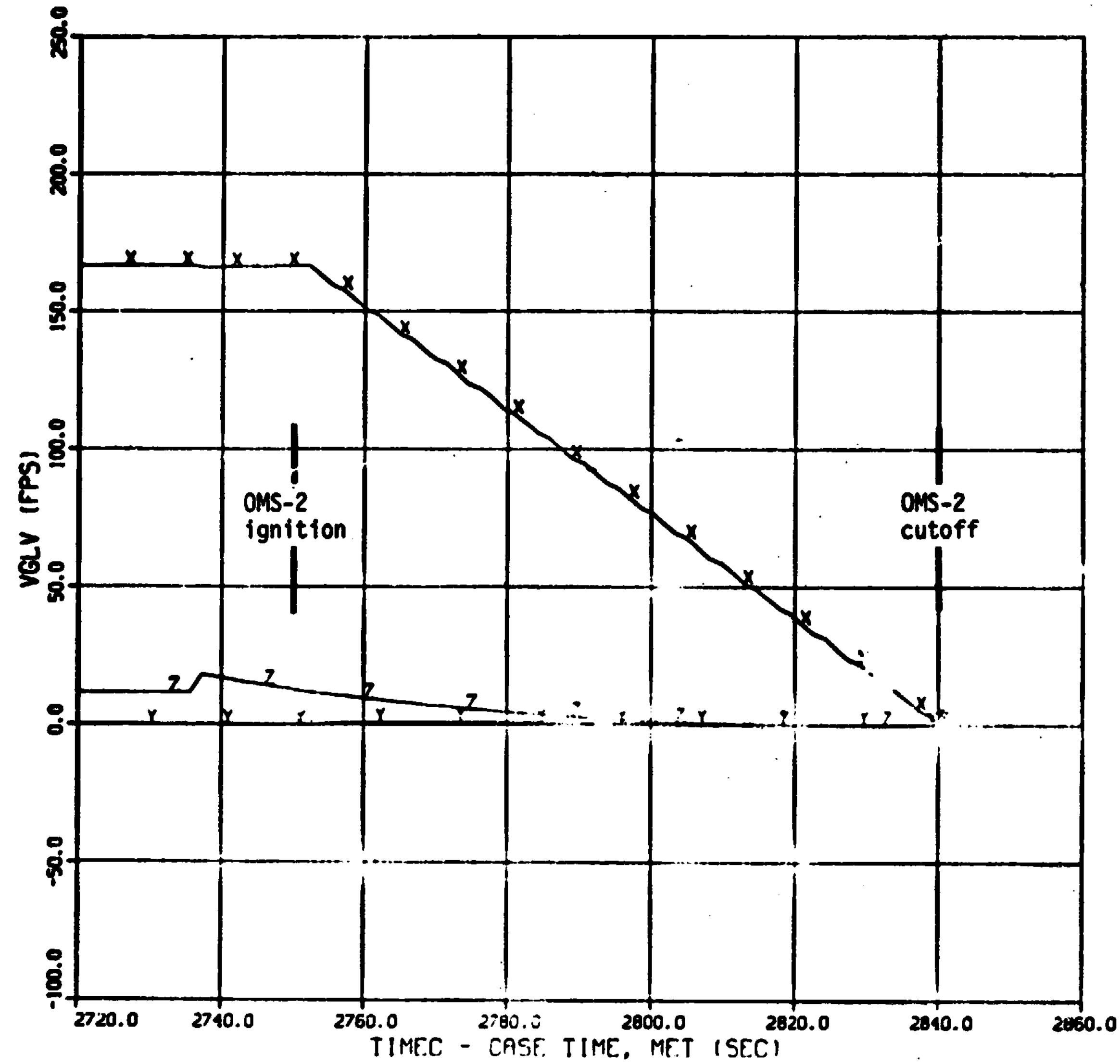


(a) Inertial velocity magnitude.



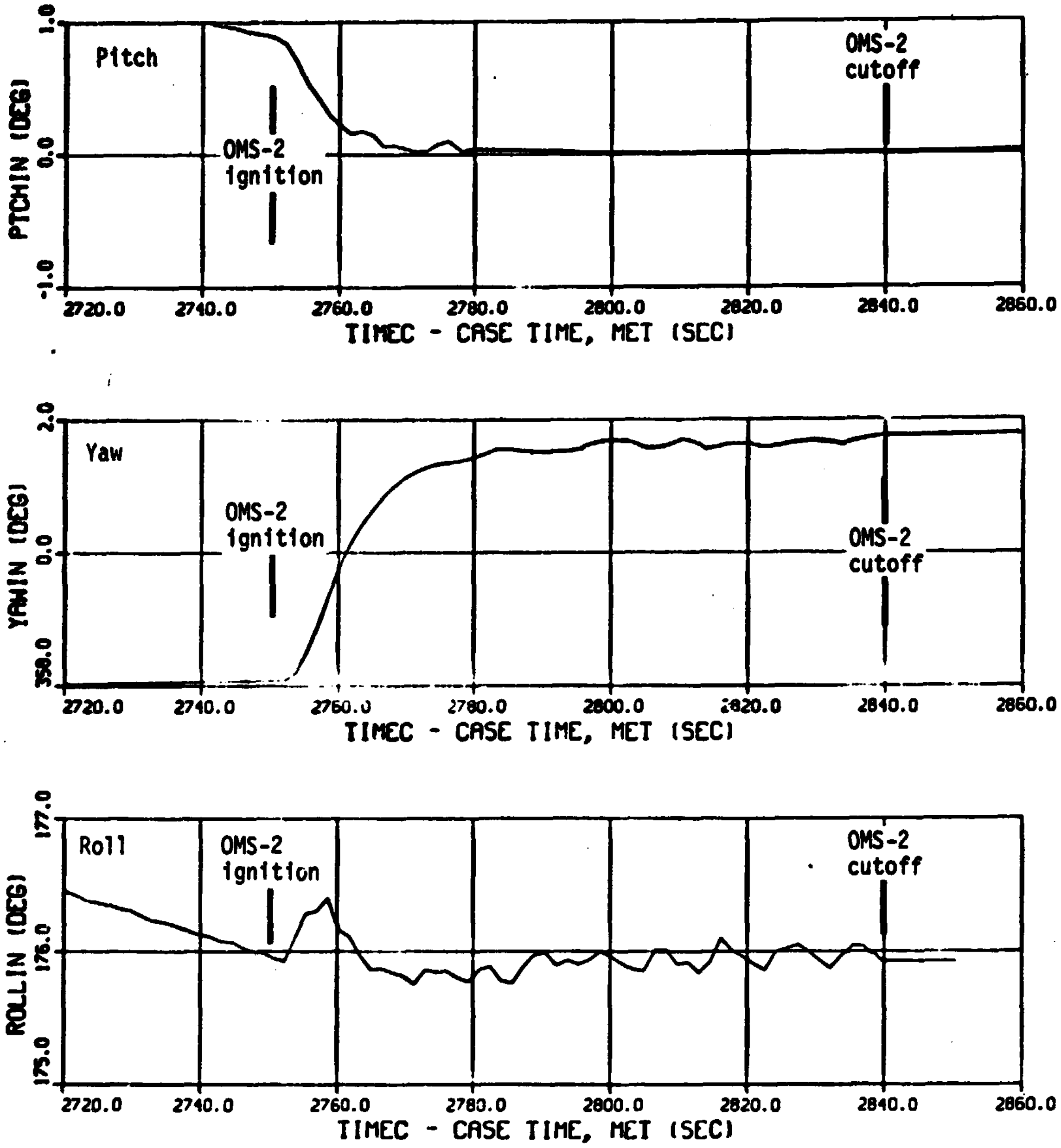
(b) Inertial flightpath angle.

Figure 6.7-1.- OMS-2 parameters versus time.



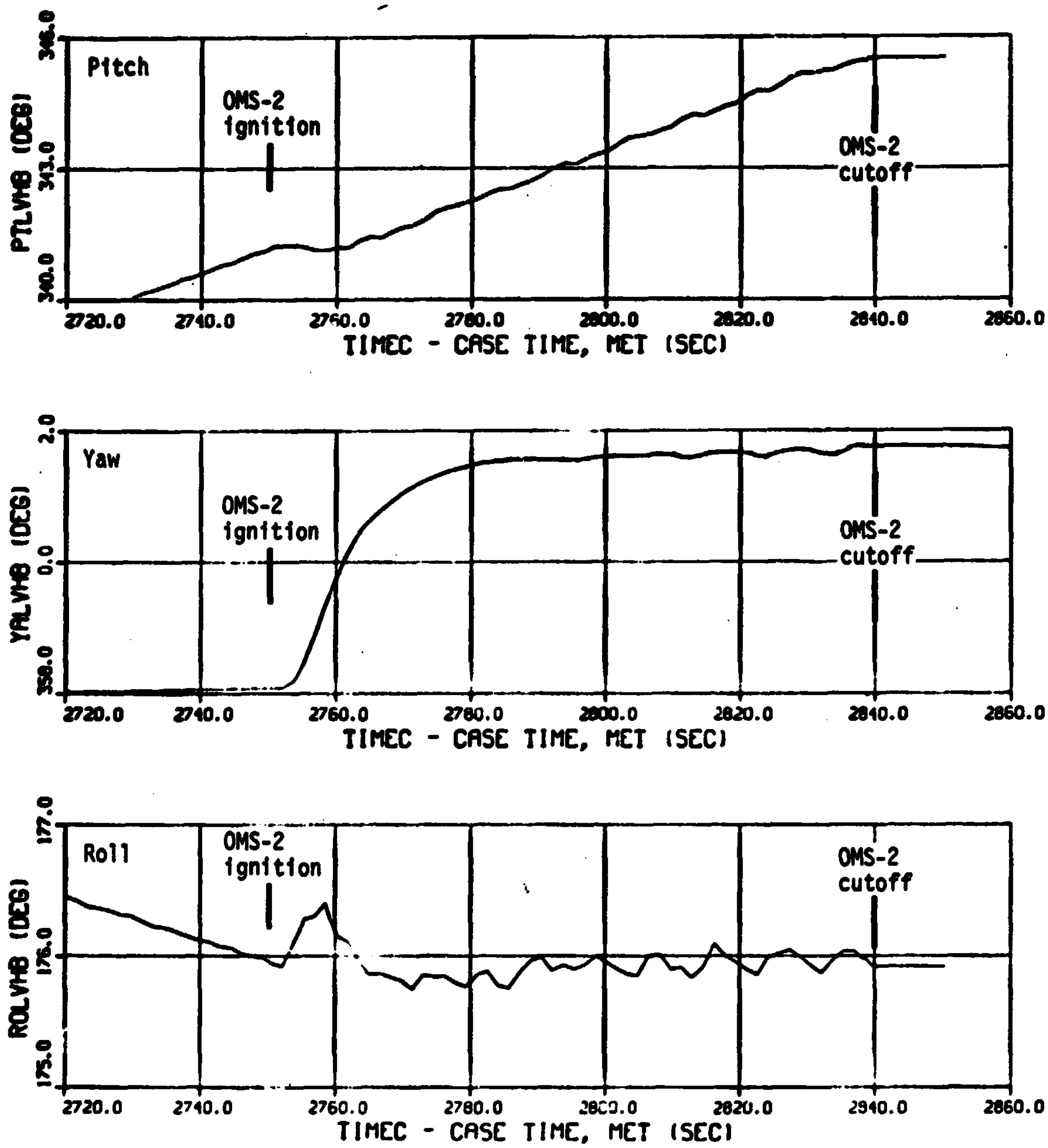
(c) LVLH velocity to be gained.

Figure 6.7-1.- Continued.



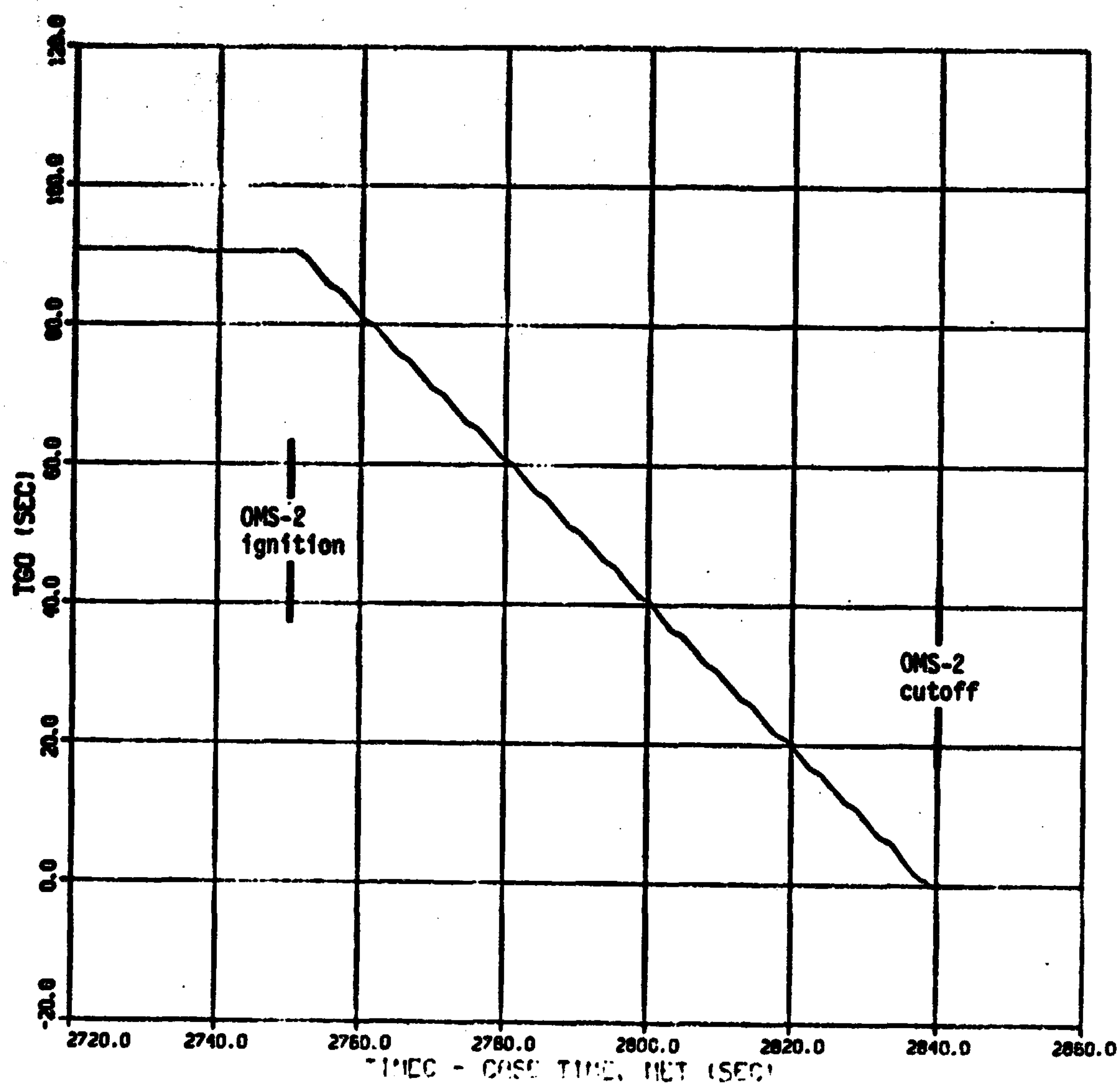
(d) ADI inertial angles.

Figure 6.7-1.- Continued.



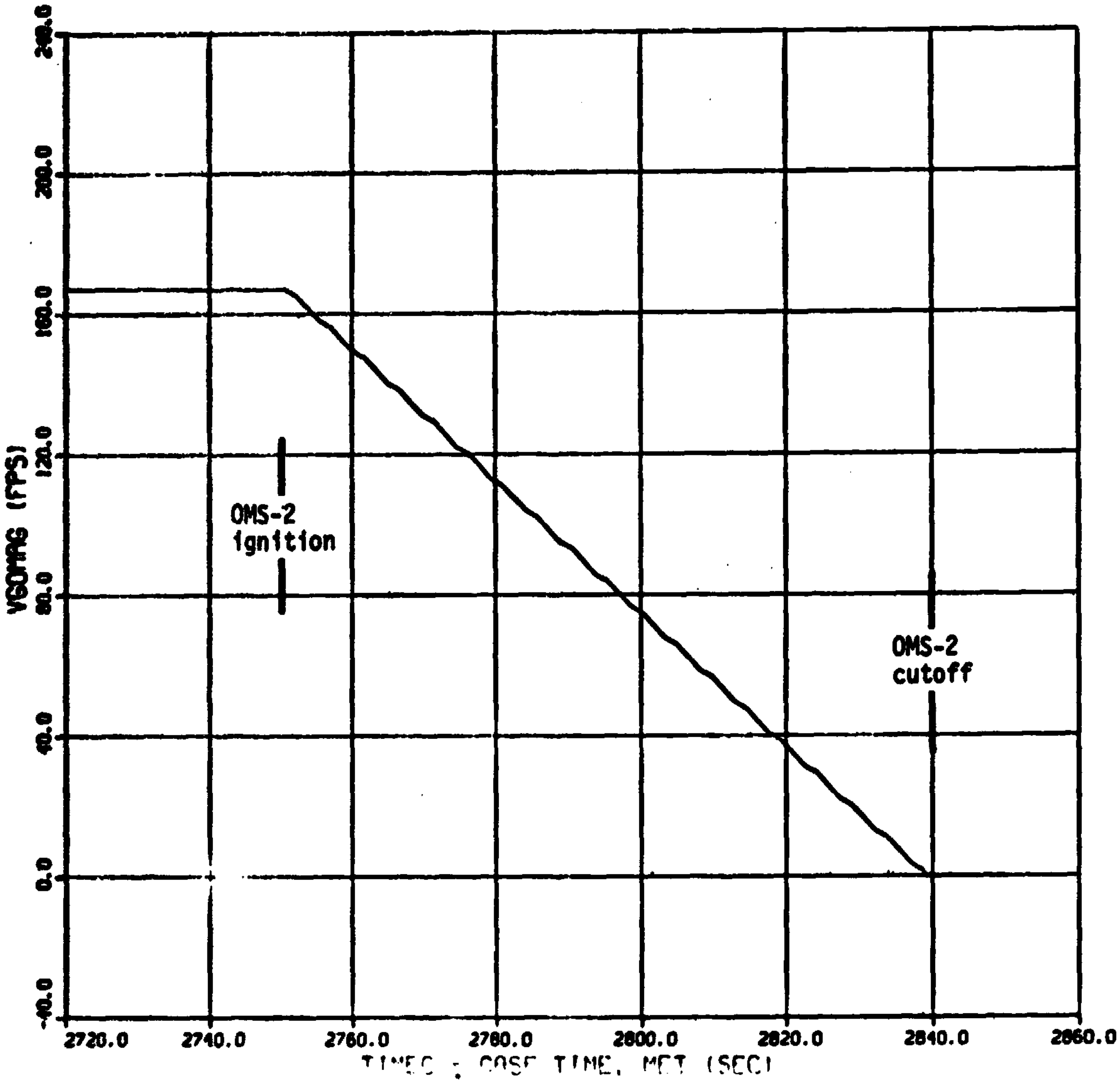
(e) ADI LVLH angles.

Figure 6.7-1.- Continued.



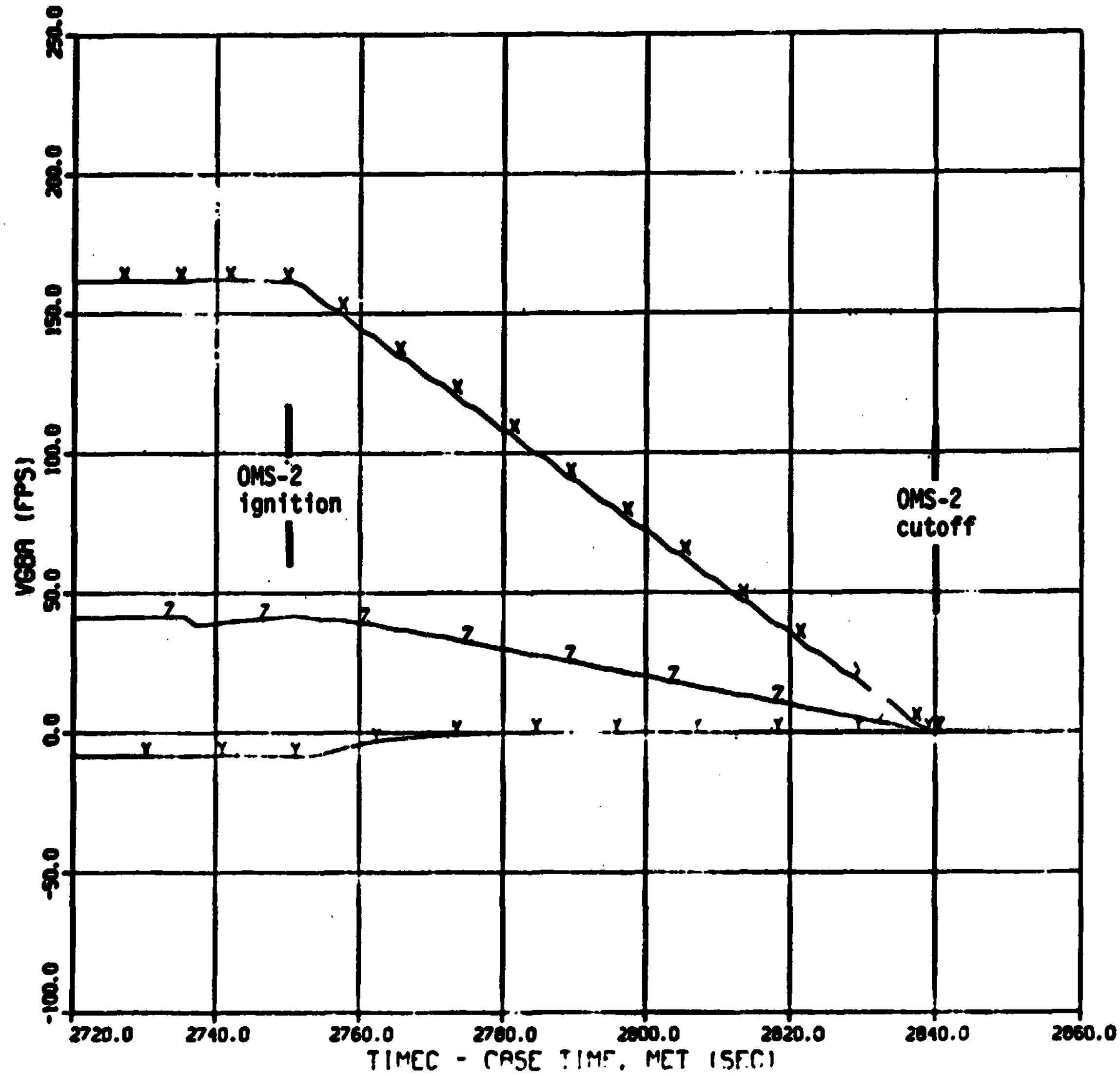
(f) Time to go to engine cutoff.

Figure 6.7-1.- Continued.



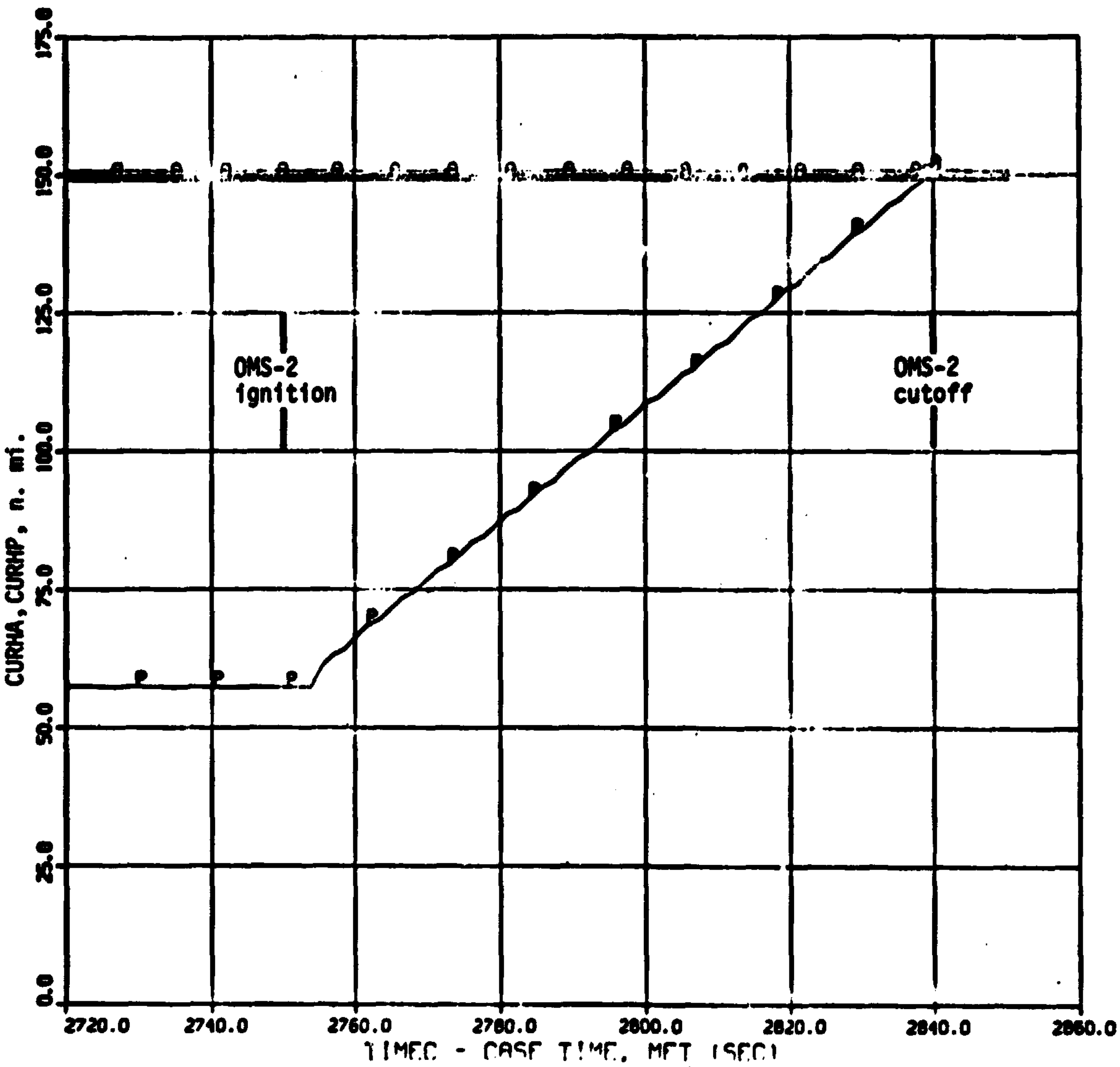
(g) Velocity to be gained magnitude.

Figure 6.7-1.- Continued.



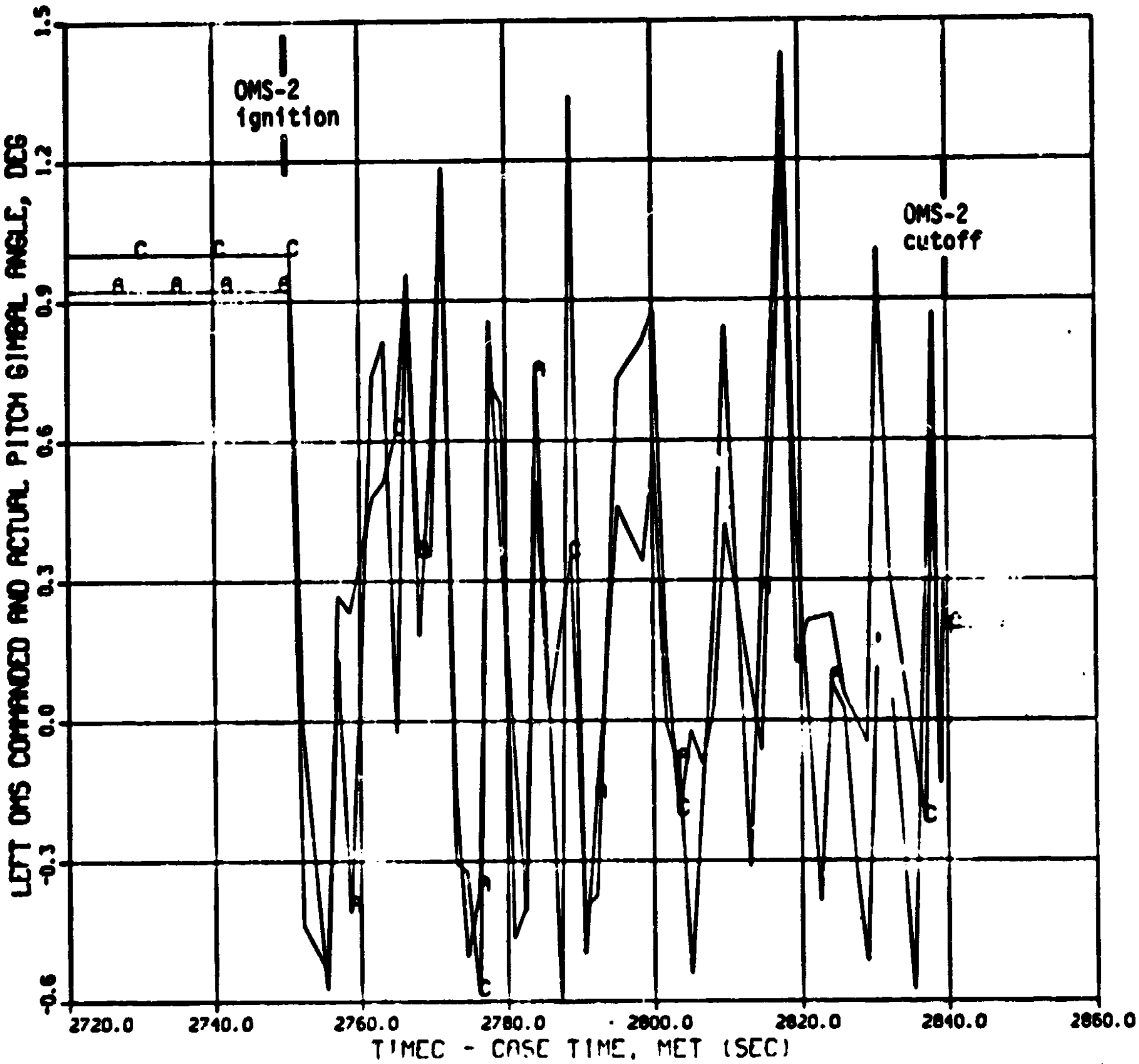
(h) Displayed velocity to be gained in current Orbiter body coordinates.

Figure 6.7-1.- Continued.



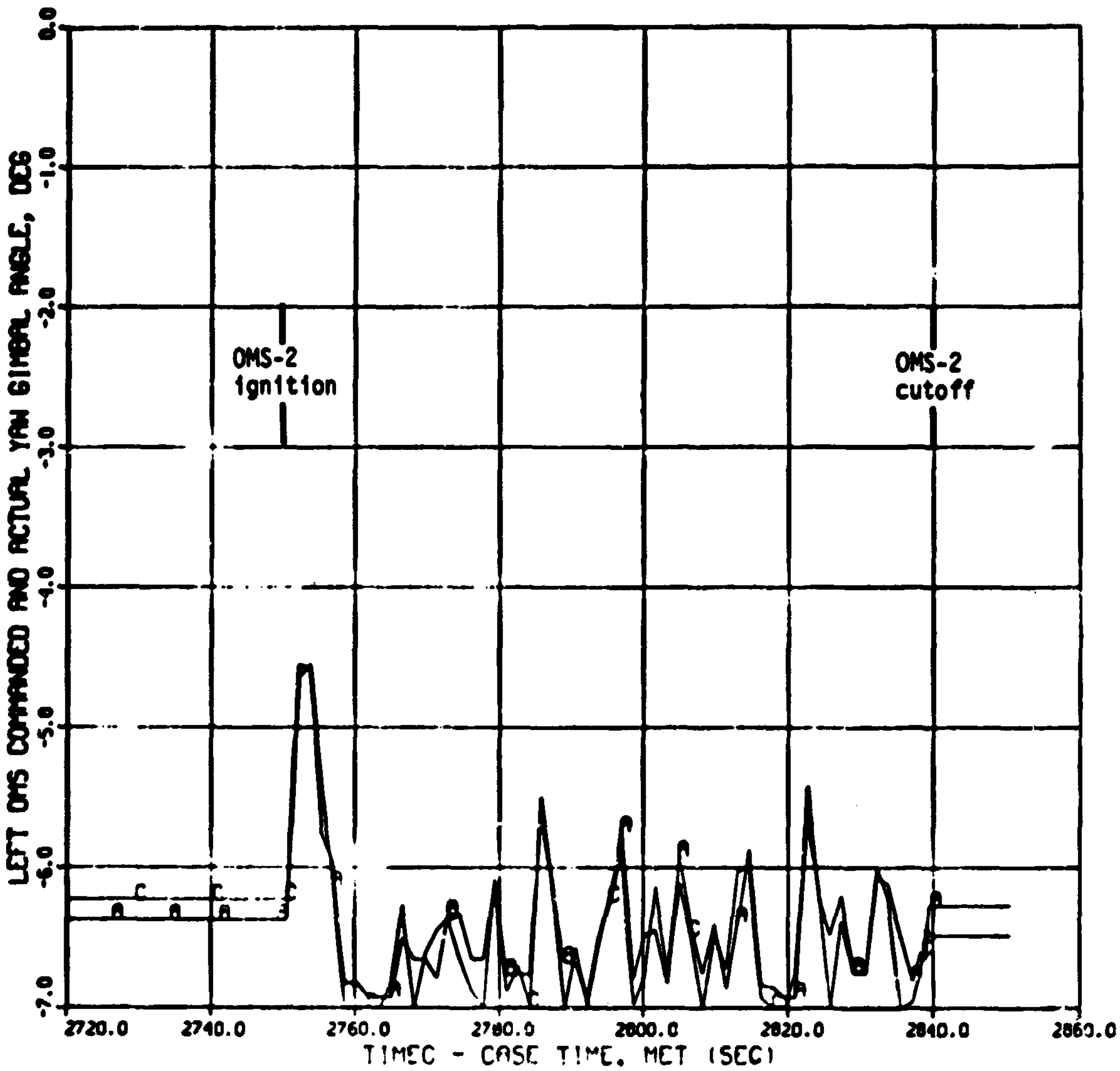
(1) Displayed current apogee and perigee altitude.

Figure 6.7-1.- Continued.



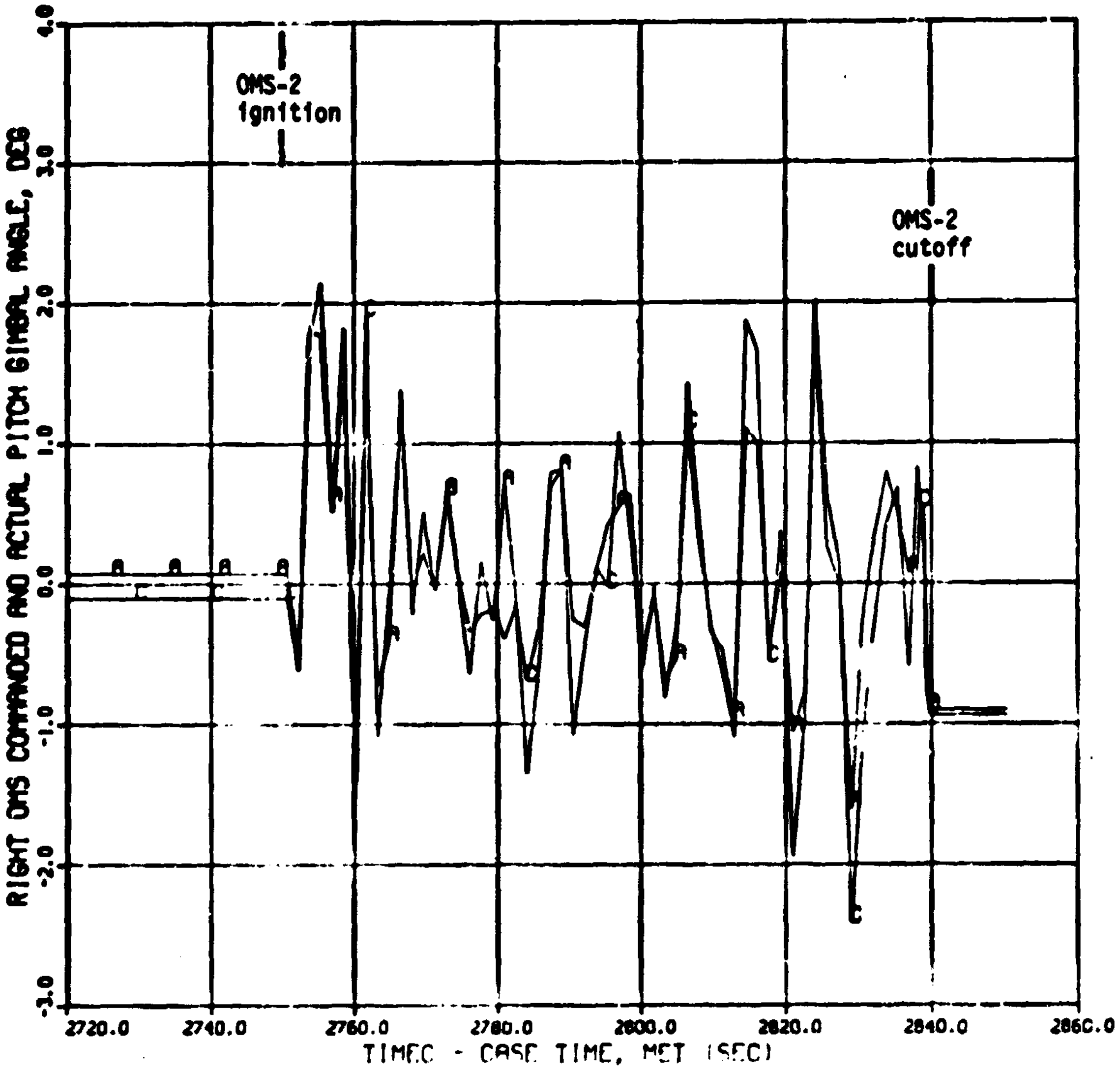
(j) Left OMS commanded and actual pitch gimbal angle.

Figure 6.7-1.- Continued.



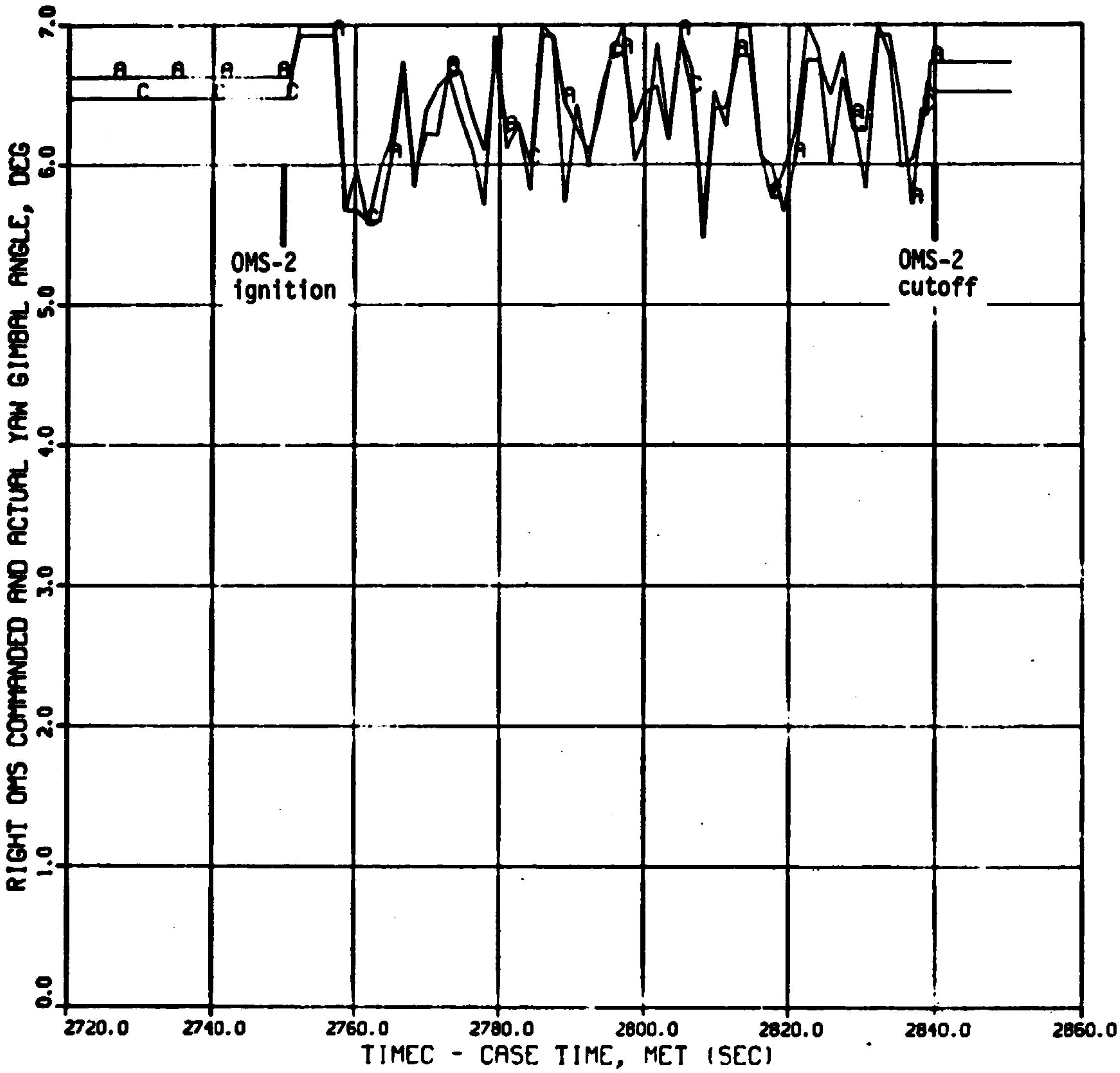
(k) Left OMS commanded and actual yaw gimbal angle.

Figure 6.7-1.- Continued.



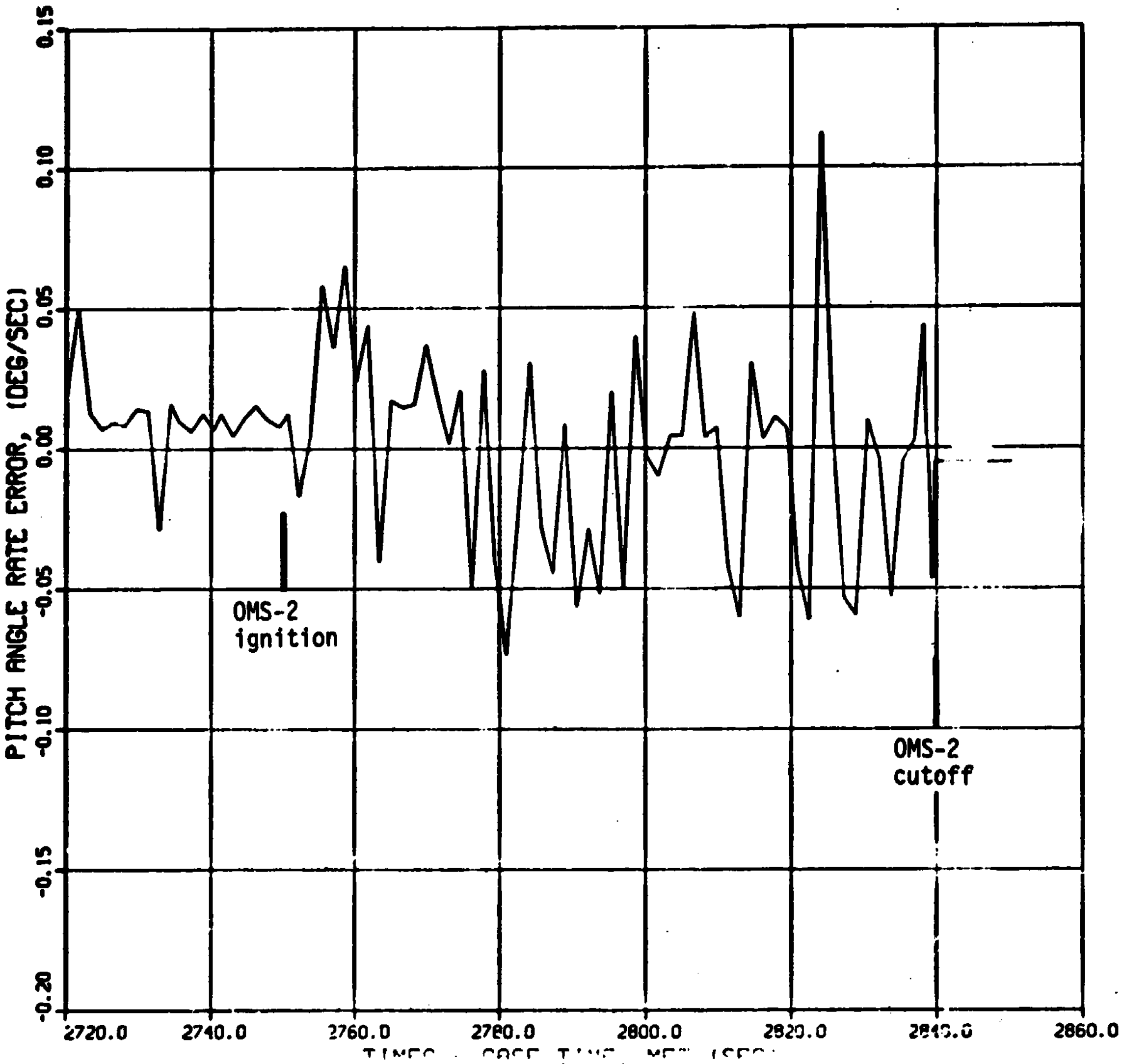
(1) Right OMS commanded and actual pitch gimbal angle.

Figure 6.7-1.- Continued.



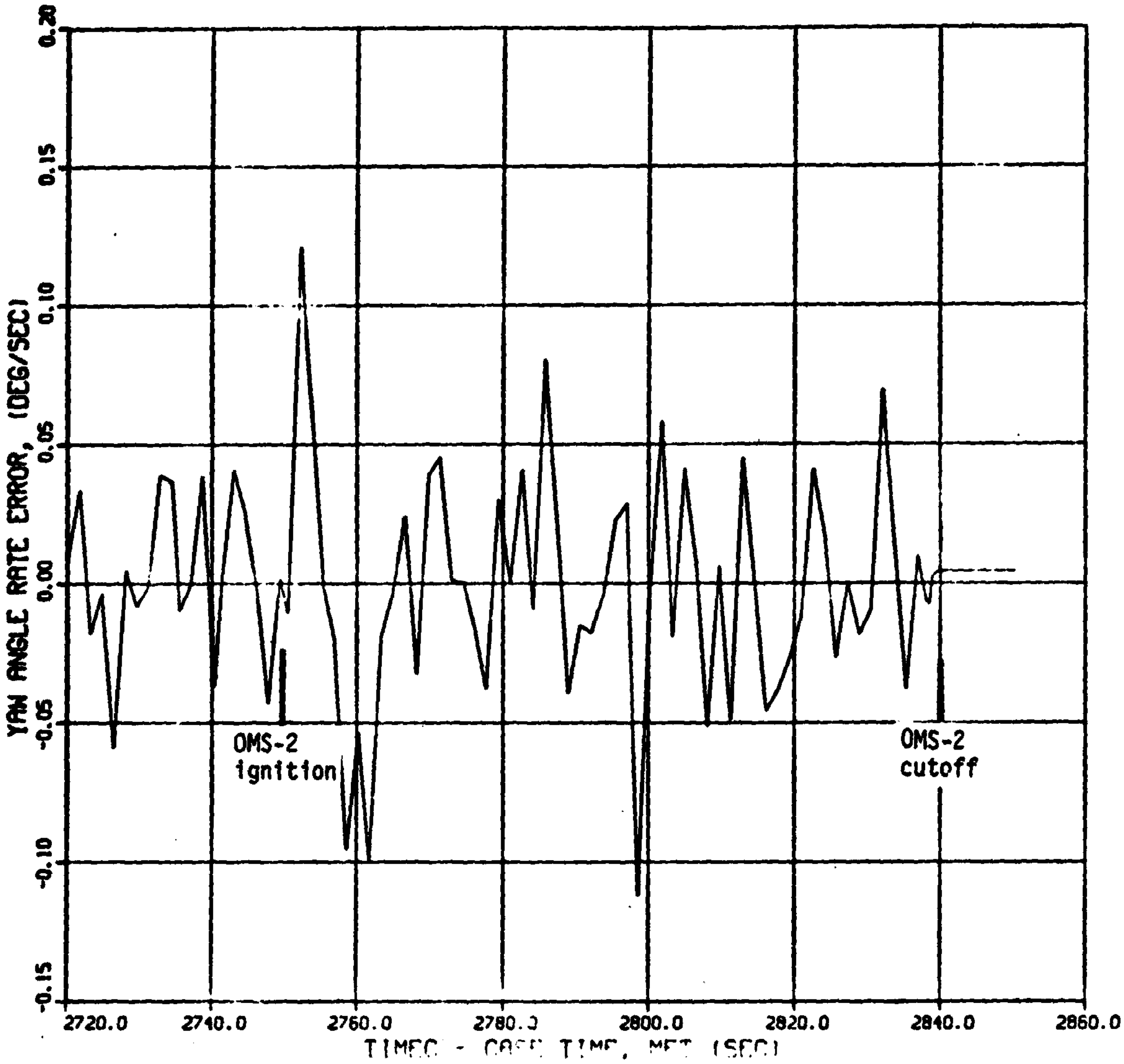
(m) Right OMS commanded and actual yaw gimbal angle.

Figure 6.7-1.- Continued.



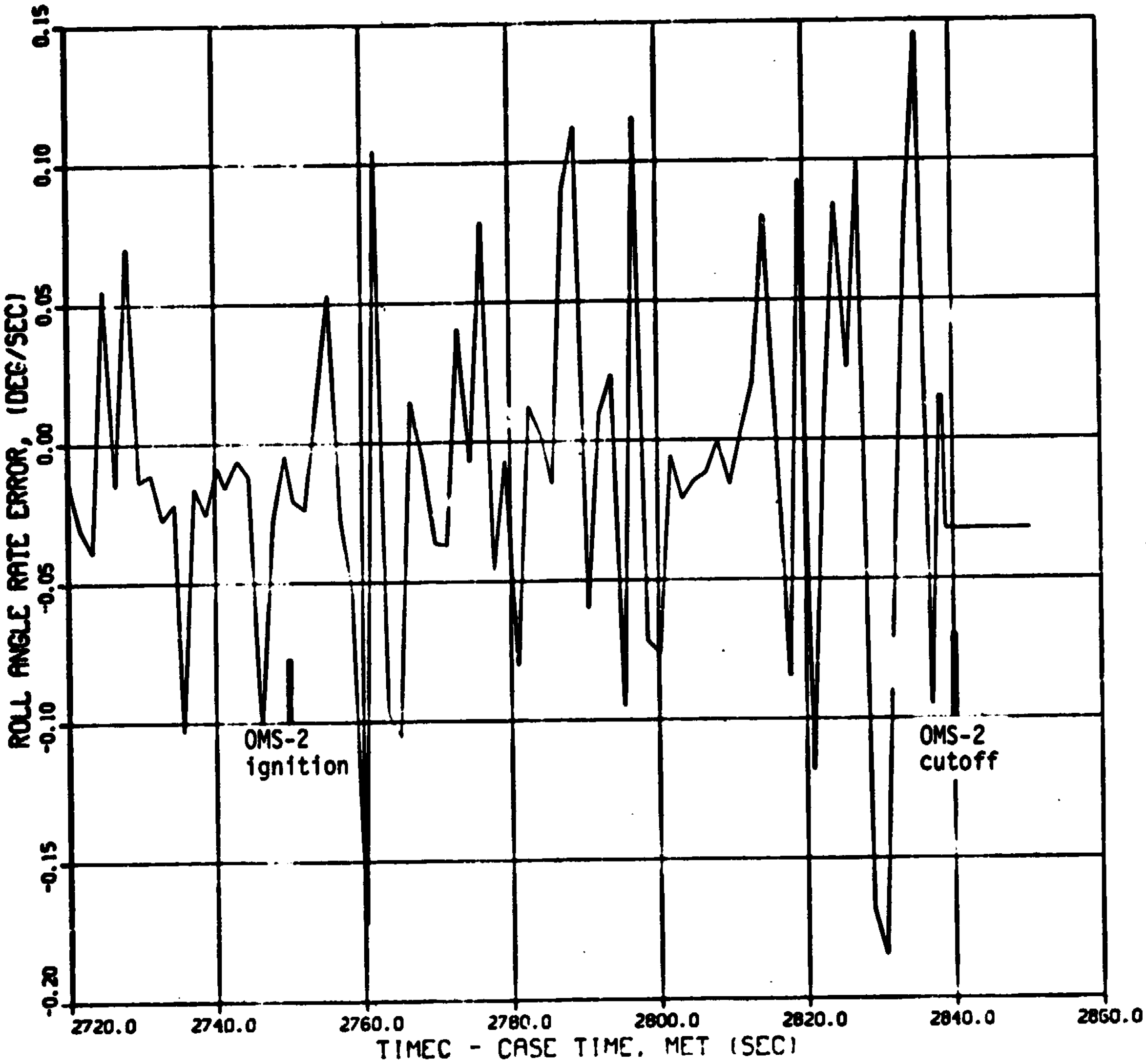
(n) Pitch angle rate error.

Figure 6.7-1.- Continued.



(o) Yaw angle rate error.

Figure 6.7-1.- Continued.



(p) Roll angle rate error.

Figure 6.7-1.- Concluded.

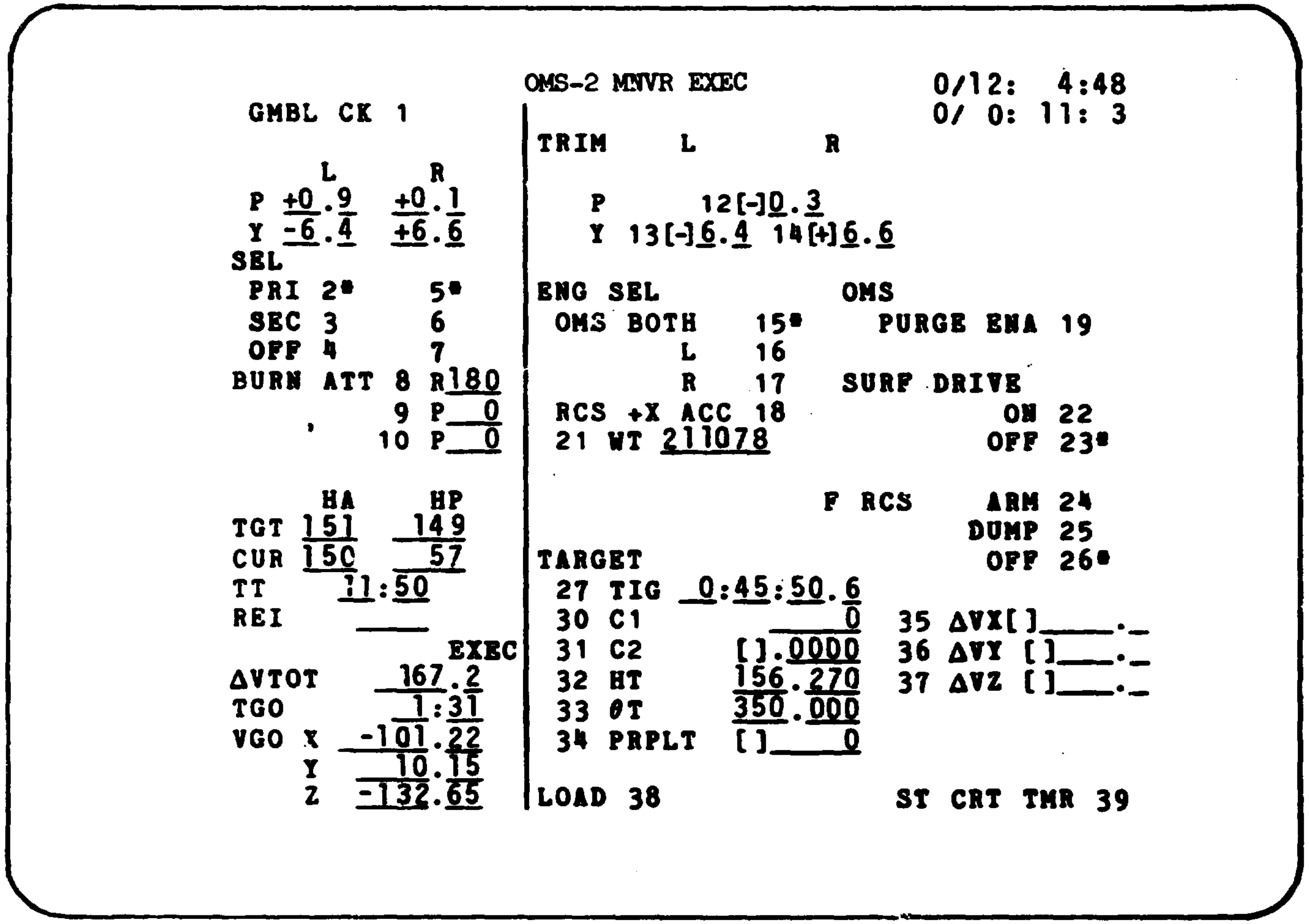


Figure 6.7-2.- OMS-2 load command entry point maneuver execute CRT display.

```
                                OMS 2 MNVR EXEC                 0/12: 15:51
 GMBL CK 1                                                      0/ 0:  0: 0
                             | TRIM      L        R
      L      R               |
 P  +0.9   +0.1              |   P      12[-]0.3
 Y  -6.4   +6.6              |   Y  13[-]6.4  14[+]6.6
SEL                          |
 PRI 2*     5*               | ENG SEL              OMS
 SEC 3      6                |  OMS BOTH    15*       PURGE ENA 19
 OFF 4      7                |           L  16
BURN ATT 8 R180              |           R  17     SURF DRIVE
          9 P  0             |  RCS +X ACC  18                ON 22
         10 P  0             |  21 WT 211078                 OFF 23*
                             |
     HA     HP               |                   F RCS       ARM 24
TGT 151    149               |                              DUMP 25
CUR 150     57               | TARGET                        OFF 26*
TT      0:48                 |  27 TIG  0:45:50.6
REI                          |  30 C1            0   35 ΔVX[]    .
                        EXEC |  31 C2      [].0000   36 ΔVY []   .
ΔVTOT      167.1             |  32 HT      156.270   37 ΔVZ []   .
TGO          1:31            |  33 θT      350.000
VGO X  +161.58               |  34 PRPLT  []     0
    Y    -8.40               |
    Z    41.94               | LOAD 38                ST CRT TMR 39
```

Figure 6.7-3.- OMS-2 ignition point maneuver execute CRT display.

```
                                    MNVR                         0/12: 17:20.0
   GMBL CK 1                                                     0/ 0:  1:30.0
                         | TRIM     L        R
        L       R        |
   P  -0.4    -0.8       |   P       12[-]0.3
   Y  -6.1    +6.7       |   Y  13[-]6.4  14[+]6.6
  SEL                    |
   PRI 2*      5*        | ENG SEL             OMS
   SEC 3       6         |  OMS BOTH    15*      PURGE ENA 19
   OFF 4       7         |          L   16
  BURN ATT  8 R180       |          R   17     SURF DRIVE
             9 P  0      |  RCS +X ACC  18               ON 22
            10 P  0      |  21 WT 211078                OFF 23*
                         |
        HA      HP       |                    F RCS     ARM 24
  TGT  151     149       |                             DUMP 25
  CUR  151     150       | TARGET                       OFF 26*
  TT      0:00           |  27 TIG  0:45:50.6
  REI     ____           |  30 C1          0    35 ΔVX[]____._
                  EXEC   |  31 C2     [].0000   36 ΔVY []____._
  ΔVTOT        +0.30     |  32 HT     156.270   37 ΔVZ []____._
  TGO           __:00    |  33 θT     350.000
  VGO X        +0.29     |  34 PRPLT  []    0
      Y        -0.02     |
      Z        -0.02     | LOAD 38                  ST CRT TMR 39
```

Figure 6.7-4.- OMS-2 engine cutoff point maneuver execute CRT display.

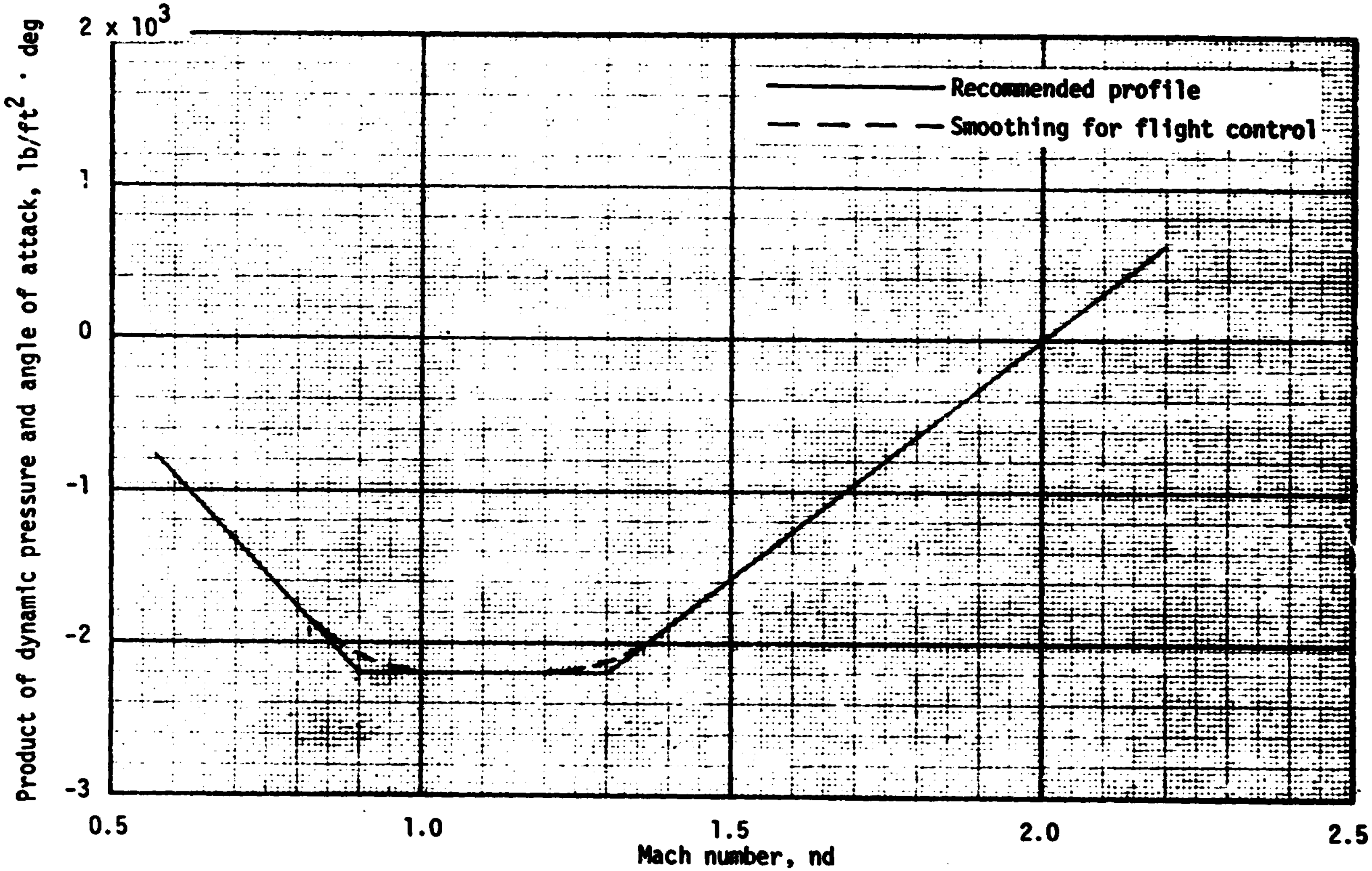


Figure 7.0-1.- Product of dynamic pressure and angle-of-attack design profile.

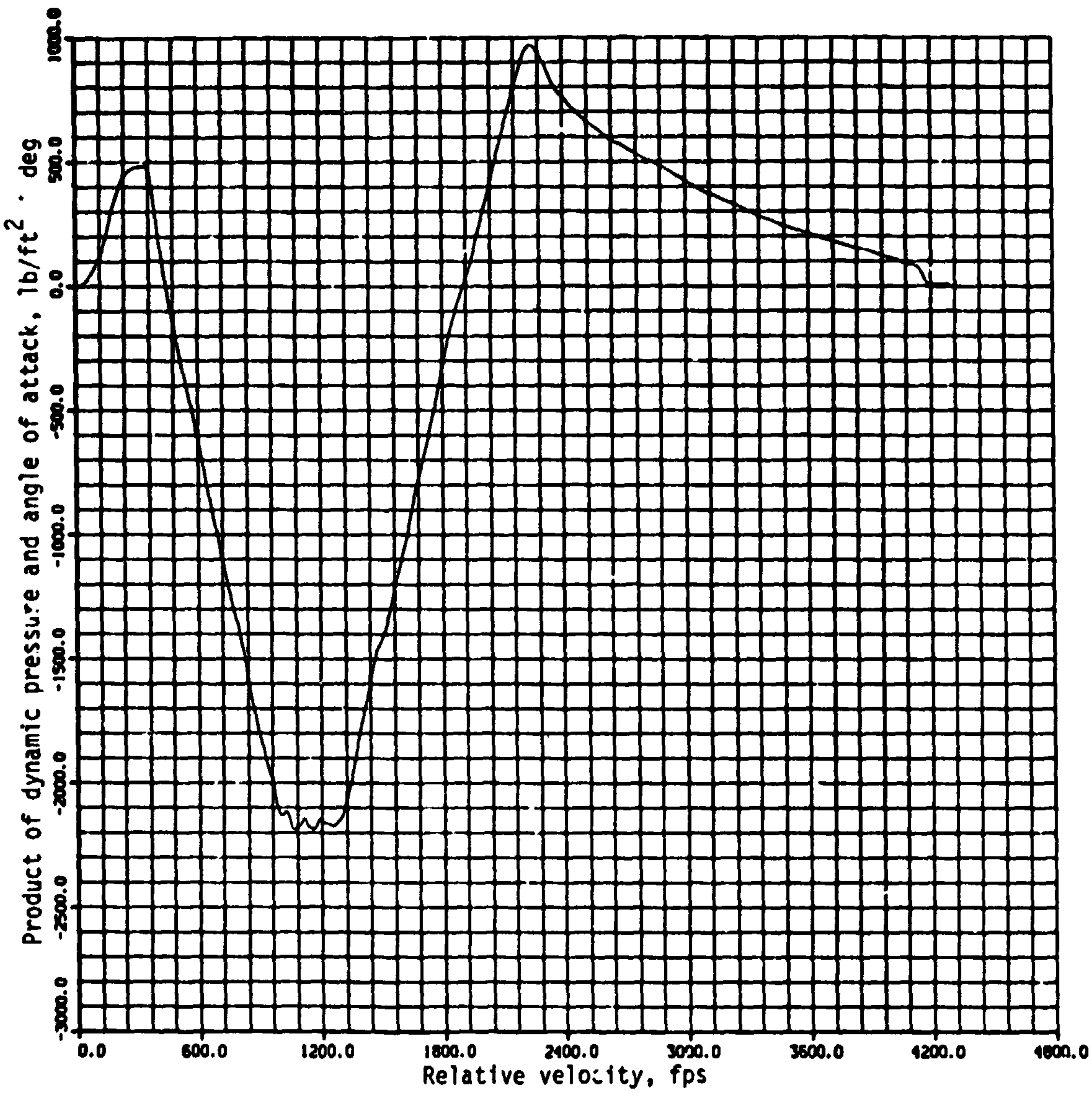


Figure 7.0-2.- First-stage product of dynamic pressure and angle of attack versus relative velocity.

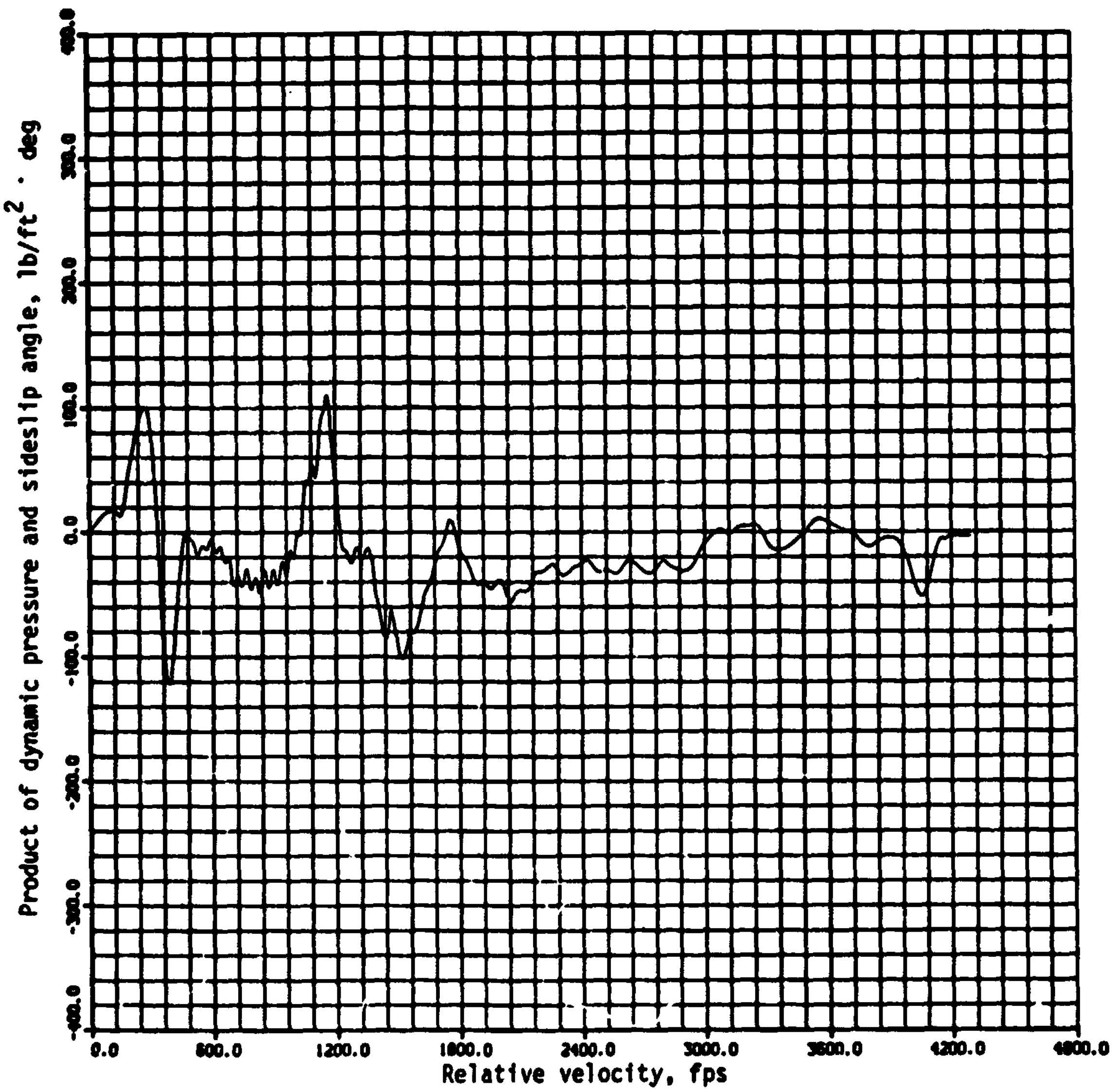


Figure 7.0-3.- First-stage product of dynamic pressure and sideslip angle versus relative velocity.

APPENDIX A

DISPERSION ANALYSIS

APPENDIX

DISPERSION ANALYSIS

A1.0 SUMMARY

A dispersion analysis considering three-sigma uncertainties (or perturbations) in platform, vehicle, and environmental parameters has been performed for the first orbital flight test (STS-1). The dispersion analysis is based on the nominal trajectory for the STS-1 operational flight profile (OFP). The analysis has been performed to determine state vector and performance dispersions that result from the indicated three-sigma uncertainties. The dispersions are determined at major mission events and fixed times from lift-off using the root-sum-square (RSS) procedure. The dispersion results will be used to evaluate the capability of the vehicle to perform the mission within a three-sigma level of confidence and to aid in the determination of flight performance reserve (FPR). A quick assessment of the three-sigma dispersions may be obtained from the RSS summary data, table A3.4-I.

A2.0 METHODOLOGY

A2.1 DISPERSION SIMULATION TECHNIQUES

A dispersion analysis is based on a nominal or reference trajectory generated without including any of the uncertainties. Performance optimum first-stage steering commands and second-stage guidance inputs are determined for the nominal profile. Since perturbations are unplanned occurrences, the nominal steering and guidance inputs are used in simulating trajectories with perturbations.

The perturbation simulations in this analysis are determined by independently simulating three-sigma values of the indicated uncertainties. That is, a complete trajectory simulation (lift-off through orbit circularization) is developed using only one error source. The dispersion results from these independent simulations are then statistically correlated at each time or event slice by: (1) an RSS process, (2) determining a covariance matrix indicative of all error sources, and (3) using the elements of the covariance matrix to compute a correlation matrix.

Inherent in the RSS method are the following assumptions:

a. The perturbations are statistically independent; i.e., the occurrence of one perturbation will not affect the probability of a second perturbation.

b. A perturbation and its associated flight dispersions are linearly related.

c. The perturbations are assumed normally distributed about their statistical mean.

Figure A2.1-1 contains the definition of a UVW or local horizontal coordinate system (LHS). The RSS data and covariance matrices indicate state vector dispersions in the LHS. Since the LHS is determined from the nominal state, a different LHS is determined at each instance or event for which RSS or covariance data are required.

A2.2 MODEL DESCRIPTION

The same groundrules describing the STS-1 OFP are also used for this dispersion analysis. The description of the model is summarized below.

a. Dispersion analysis simulations are generated using the Space Vehicle Dynamics Simulation (SVDS) program operating in a 3-DOF mode with moment balance.

b. The three-IMU platform with midvalue select is represented as a single IMU. The initial IMU orientation is defined by the alinement specified in reference 1. The platform alinement errors at lift-off reflect the nominal alinement schedule (platform release 30 minutes before lift-off, gyrocompass completed 40 minutes before lift-off).

c. The acceleration threshold used by the navigation software is reset from zero to 1000 micro-g at the completion of the MPS dump. Accelerometer data below this threshold are not incorporated by navigation.

d. There was no onorbit drag model in either the navigation or the environment.

e. Reaction control system (RCS) activity is not modeled except for the -Z external tank (ET) separation burn.

f. The main propulsion system (MPS) propellant dumps are simulated; no other vents are modeled.

A2.3 ERROR SOURCES, SYMBOLS, AND DEFINITIONS

A list of the error sources and their three-sigma values is given in table A2.3-I. Included in table A2.3-I are symbols used in the RSS data tables to identify dispersions resulting from the error sources. The references for the various error sources are also noted in table A2.3-I. Propulsion system uncertainties for the orbital maneuvering system (OMS) were not included. It should be noted that the hot atmosphere was analyzed, but was not included in the RSS results in as much as the cold atmosphere produced larger dispersions. It should also be noted that uncertainties in atmospheric winds, aerodynamics, and SSME thrust tailoff were not simulated.

A2.4 EVENTS AND TIME SLICES FOR DISPERSION ANALYSIS

RSS, covariance matrix, and correlation matrix data are presented for several events and time slices in this analysis. An event is defined as a fixed occurrence (sensed by attaining a given target value) and may have a time-from-lift-off dispersion associated with it. A time slice is indicative of a fixed time from lift-off.

The seven events and time slices for which data are presented are as follows.

a. Solid rocket booster (SRB) separation (See tables A3.1-II and A3.2-II.)

b. Main engine cutoff (MECO) at zero thrust (See tables A3.1-III and A3.2-III.)

c. Time slice defined as nominal MECO time plus 62 seconds (See tables A3.1-IV and A3.2-IV.)

d. Insertion; i.e., completion of the OMS first burn maneuver (OMS-1) (See tables A3.1-V and A3.2-V.)

e. Time slice defined as nominal OMS-1 cutoff time plus 691 seconds (See tables A3.1-VI and A3.2-VI.)

f. Circularization; i.e., completion of the OMS second burn maneuver (OMS-2) (See tables A3.1-VII and A3.2-VII.)

g. Time slice defined as nominal OMS-2 cutoff time plus 61 seconds (See tables A3.1-VIII and A3.2-VIII.)

Each event and time slice has its own LHS or UVW system for the calculation of state vector dispersions. The UVW system is always defined using the state at the event or time slice of interest. It is important to note the distinction between a radial velocity error (U-DOT) in the UVW system and an altitude rate error (HDOT) in the current local horizontal system (see figure A2.4-1). A U-DOT error is computed in a fixed UVW coordinate system defined by the nominal state vector. In this system, a downrange position error will also result in a U-DOT error. But an HDOT error is computed using two distinct coordinate systems: a local horizontal system defined by the nominal state vector and a local horizontal system defined by the errored state vector. Thus, a downrange position error rotates the local horizontal such that an HDOT error will not correspond to a U-DOT error. Only when there is no position error will an HDOT error equal a U-DOT error.

A3.0 RESULTS

A3.1 RSS DATA

The RSS technique is the method used in this analysis to statistically combine dispersions in the flight parameters to determine the three-sigma limits in the significant parameters. In actual vehicle flight, there is a 99.73-percent probability that the value of the parameter will be inside the three-sigma band (the RSS value) if all assumptions required for this method are valid. Since this study assumes all error sources to be normally distributed, the RSS data are computed without regard to sign. Actual state dispersions are computed as the actual state of the perturbed trajectory minus the actual state of the nominal trajectory. Navigation uncertainties are computed as the navigated state of the perturbed trajectory minus the actual state of the perturbed trajectory.

RSS data are presented in tables A3.1-II through A3.1-VIII for the seven major events and time slices defined in section A2.4. Data are included in the tables to indicate parameter dispersions for each individual error source and the three-sigma RSS of the dispersions. Four RSS tables are provided for each of the slices:

"a" - Actual minus nominal state parameters

"b" - Actual minus nominal vehicle parameters

"c" - Actual minus nominal orbital parameters

"d" - Navigated minus actual state parameters

Parameter names used in the "a" through "d" tables are defined in table A3.1-I.

A3.2 COVARIANCE MATRIX AND CORRELATION MATRIX DATA

Covariance and correlation matrix data are presented at each of the event and time slices. The covariance matrix represents a multivariate normal distribution of one-sigma dispersions in the actual state, navigated state, vehicle weight, time, accelerometer biases, and platform misalinement angles. Although three-sigma values of the error sources are used in the trajectory simulations, the dispersions are adjusted to a one-sigma level for determining the covariance matrices.

The symbols used to identify the elements of the covariance matrix are defined in table A3.2-I. The matrices are given in tables A3.2-II(a) through A3.2-VIII(a). Because a covariance matrix is symmetrical, only the lower triangle is given. Each diagonal element of the matrix represents the variance of the associated parameter. Each off-diagonal element represents the linear covariance between the "row" parameter and the "column" parameter. The covariance measures how two parameters, X and Y, tend to vary together. The covariance will be positive if both parameters are, at the same time, greater than or less than their respective means; negative if one parameter is greater than its mean while the other parameter is less than its mean; and zero if X and Y are independent. The correlation matrix measures the linear interdependence between any two parameters appearing in the covariance matrix. The correlation matrices, provided in tables A3.2-II(b) through A3.2-VIII(b), have an identical format to the covariance matrices. Each element of the correlation has values between -1 and +1: -1 denotes perfect negative or inverse correlation, 0 denotes statistical independence, and +1 denotes perfect positive correlation.

A3.3 EXCHANGE RATIOS

An exchange ratio is defined as the ratio of a dispersion in a given variable to the magnitude of the error source causing the dispersion. The use of exchange ratios enables a quick-look assessment of the variations from nominal that may be expected to result from the application of error sources of various magnitudes. To use an exchange ratio, multiply a change in a parameter by its corresponding exchange ratio. This defines the predicted performance change at the event or time slice for which the ratio has been calculated.

Table A3.3-I contains exchange ratios indicating Space Shuttle main engine (SSME) propellant dispersion at MECO for several performance error sources. The exchange ratios are valid for perturbations only within a specified range. The exchange ratios show a sensitivity to an unplanned anomaly; i.e., the trajectory is not optimized for the uncertainties. These exchange ratios may be used to predict SSME propellant variations at MECO.

A3.4 RSS SUMMARY DATA

A summary of the 3σ RSS data tables is provided in tables A3.4-I(a) through A3.4-I(h). To allow a comparison of the dispersions from one event to the next, each table includes 3σ data for all of the event and time slices. A description of each table is given below:

"a" - Actual minus nominal UVW state parameters
"b" - Actual minus nominal trajectory state parameters
"c" - Actual minus nominal vehicle parameters
"d" - Actual minus nominal orbital parameters
"e" - Navigated minus actual UVW state parameters
"f" - Navigated minus actual trajectory state parameters
"g" - Navigated minus nominal UVW state parameters
"h" - Navigated minus nominal trajectory state parameters

A4.0 CONCLUSIONS

This dispersion analysis has presented three-sigma dispersions in the actual and navigated states at major events from SRB separation through nominal OMS-2 cutoff plus approximately one minute. The purpose of the conclusions below is to identify trends that are evident in the dispersion results. The first two paragraphs pertain to actual state dispersions, and the last paragraph pertains to navigation errors. The principal error contributors at MECO and OMS-2 cutoff are summarized in tables A4.0-I(a) and A4.0-I(b), respectively.

The dispersions in the actual state result from both vehicle performance uncertainties and navigation errors. During first-stage flight the dispersions result because the open loop guidance flies an attitude profile. The largest dispersion occurs in the downrange channel, most of which results from uncertainty in the SRB web action time. During second stage flight the actual trajectory is driven back to the nominal since the closed-loop guidance drives the navigated altitude, velocity, flightpath angle, and orbit plane to the MECO target values. The downrange dispersions at SRB separation carry through as downrange dispersions at MECO since guidance does not constrain the downrange MECO position. From MECO through the OMS-2 burn, the IMU errors produce a noticeable increase in the actual state dispersions. The dispersions in the orbital elements after orbit circularization are a direct result of the navigation error sources.

The downrange dispersions computed for a fixed time slice are two to three times larger than those for an event slice. This is because a vehicle with an underperforming first stage will arrive at MECO at a later time but with an uprange dispersion (closer to the launch site). If dispersions are computed at a fixed time, the downrange error grows because at the fixed time the perturbed trajectory will be even further uprange from the nominal.

The navigation errors are a direct result of the IMU error sources. During first and second stage flight, the navigation errors increase as a function of time. From MECO to OMS-2 ignition the errors grow significantly during the long propagation. After OMS-2 cutoff the predominant effect of the navigation errors is seen in terms of the actual dispersions in the orbital elements.

A5.0 REFERENCES

1. Thibodeau, Joseph R., III: Prelaunch IMU Alinements for OFT. JSC Memorandum FM83(78-134), May 8, 1978.

2. Requirements/Definition Document, Guidance and Navigation. Rockwell International SD-72-SH-0105-1, May 16, 1975.

3. Thibodeau, Joseph R., III: Prelaunch IMU Alinement Errors. JSC Memorandum FM83 (78-24), Feb. 22, 1978.

4. CDR Mission I Flight Performance Reserve for Winter (February) Launch. Rockwell International Internal Letter SAS/MR&I 77-116, June 22, 1977.

5. SRB Systems Performance and Design Data. MSFC Document SE-019-125-2H, June 24, 1977.

6. Shuttle Operational Data Book. Volume I, Amendment 84, JSC-08934, Aug. 1, 1979.

7. Shuttle Operational Data Book. Volume II, Amendment 31, JSC-08934, Feb. 7, 1980.

8. Terrestrial Environment (Climatic) Criteria Guidelines for Use in Aerospace Vehicle Development, 1973 Version. NASA TMX-64757, Mar. 1974.

9. Space Shuttle Flight and Ground System Specification, Level II Program Definition and Requirements. JSC 07700, Volume X, Revision C, April 27, 1978.

TABLE A2.3-I.- ERROR SOURCE DEFINITIONS

Error source symbol	Definition	3σ value	Reference	Unit
PLATFORM ALINE	Initial platform misalinement		3	
	azimuth	276.50		arc sec
	tilt, roll	78.60		arc sec
DRIFT BIAS	Free gyro bias	.045	2	deg/hr
G-SENS IA DRIFT	Gyro input axis acceleration sensitive drift	.075	2	deg/hr/g
G-SENS OA DRIFT	Gyro output axis acceleration sensitive drift	.075	2	deg/hr/g
G-SENS-SQ DRIFT	Gyro acceleration squared sensitive drift	.075	2	deg/hr/g**2
ACCEL BIAS	Accelerometer bias	150.000	2	micro-g
ACCEL SCALE FAC	Accelerometer scale factor	120.000	2	ppm
ACCEL IA ALINE	Accelerometer input axis misalinement			
- TOWARD SA	- Toward spin axis	45.000	2	arc sec
- TOWARD OA	- Toward output axis	45.000		arc sec
CG	Center of gravity - X component	.083	4	ft
	Y component	.043		ft
	Z component	.250		ft
WEB ACT	Web action time	4.900	5,6	percent
S ISP	SRB specific impulse	- .500	5,6	percent
S PROP	SRB propellant loading	- .210	5,7	percent
S INERT	SRB inert weight	.850 (3083.000)	5,7	percent (lb)

TABLE A2.3-I.- Concluded

Error source symbol	Definition	3 value	Reference	Unit
O THRST	Orbiter thrust	- 6000.000 (-10392.000)	4,6	lb/eng (lb/3 eng)
O ISP	Orbiter specific impulse	- 2.300 (-1.328)	4,6	sec/1 eng (sec/3 eng)
O INERT	Orbiter inert weight	.100 (185.000)	4,7	percent, (lb)
ET INERT	External tank inert weight	.250 (198.000)	4,7	percent (lb)
ET OXID	External tank oxidizer loading	0.54 (7376.0)	4,7	percent (lb)
ET FUEL	External tank fuel loading	0.69 (1569.0)	4,7	percent (lb)
MIX RATIO	SSME mixture ratio	1.0 (0.57735) (0.03464)	7	percent/1 eng (percent/3 eng) (mr/3 eng)
ATMOSPHERE -COLD	63 Patrick Cold Atmosphere		8	

TABLE A3.1-I.- PARAMETER DEFINITIONS FOR RSS DATA TABLES

Name	Definition	Unit
	State Parameter	
U	Radial position component in the LHS	ft
V	Downrange position component in the LHS	ft
W	Crossrange position component in the LHS	ft
U-DOT	Radial velocity component in the LHS	fps
V-DOT	Downrange velocity component in the LHS	fps
W-DOT	Crossrange velocity component in the LHS	fps
ALTITUDE	Inertial position vector magnitude	ft
SPEED	Inertial velocity vector magnitude	fps
H-DOT	Inertial altitude rate (velocity x sin γ)	fps
DR-DOT	Inertial downrange rate (velocity x cos γ)	fps
GAMMA	Inertial flightpath angle (γ)	deg
	Vehicle Parameter	
LATD	Geodetic latitude	deg
LONG	Longitude	deg
AZIM	Inertial azimuth	deg
RANGE	Surface range from launch site	n. mi.
TIME	Elapsed time	sec
WEIGHT	Total vehicle weight	lb
PROP	MPS propellant remaining	lb
OXID	MPS oxidizer remaining	lb
FUEL	MPS fuel remaining	lb

TABLE A3.1-I.- Concluded

Name	Definition	Unit
	Orbital Parameter	
HA	Apogee altitude	n. mi.
HP	Perigee altitude	n. mi.
PERIOD	Orbital period	sec
INCLIN	Inclination	deg
ASC NOD	Longitude of ascending node	deg
ARG PER	Argument of perigee	deg
TRU ANOM	True anomaly	deg
SMAJ AXIS	Semi-major axis	n. mi.
ECCENT	Orbital eccentricity	ND

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	0.	0.	-0.	-.0	-.0	-.0	0.	-.0	-.0	-.0	-.000
TILT	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
ROLL	-0.	0.	0.	-.0	-.0	-.0	-0.	-.0	-.0	-.0	-.000
DRIFT BIAS											
X	-0.	-0.	0.	-.0	-.0	-.0	0.	-.0	-.0	-.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	-.0	-.0	-.0	0.	-.0	-.0	-.0	-.000
G-SENS IA DRIFT											
X	-0.	-0.	0.	-.0	-.0	.0	0.	-.0	-.0	-.0	-.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	-.0	.0	0.	.0	.0	.0	.000
G-SENS OA DRIFT											
X	0.	0.	0.	-.0	-.0	.0	0.	-.0	-.0	-.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	-.0	-.0	.0	0.	-.0	-.0	-.0	.000
G-SQ SEN DRIFT											
X	-0.	-0.	0.	-.0	-.0	-.0	0.	-.0	-.0	-.0	.000
Y	0.	0.	0.	-.0	-.0	.0	0.	.0	-.0	.0	-.000
Z	0.	0.	0.	-.0	-.0	.0	0.	-.0	-.0	-.0	.000
ACCEL BIAS											
X	0.	-0.	-0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
ACCEL SCALE FAC											
X	0.	-0.	-0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
ACCEL IA ALINE - OA											
X	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
ACCEL IA ALINE - SA											
X	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	-0.	-0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	-0.	-0.	0.	.0	.0	.0	0.	.0	.0	.0	.000

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	H (FT)	U-DOT (FPS)	V-DOT (FPS)	H-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CG											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	1959.	9079.	-2016.	-30.0	-41.7	-5.2	1961.	-50.7	-20.0	-42.7	-.067
S ISP	-1222.	-1932.	-291.	-11.2	-39.3	-5.7	-1221.	-40.2	-11.6	-39.1	.076
S PROP	-301.	-407.	-74.	-3.3	-10.7	-1.5	-301.	-11.0	-3.4	-10.0	.019
S INERT	-269.	-406.	-64.	-3.6	-9.6	-1.4	-269.	-10.2	-3.7	-9.6	.010
O THRST	-630.	-796.	-147.	-10.1	-19.9	-3.0	-630.	-22.4	-10.3	-19.9	-.004
O ISP	41.	64.	10.	.9	1.9	.3	41.	2.1	.9	1.9	-.000
O INERT	-16.	-24.	-4.	-.2	-.6	-.1	-16.	-.6	-.2	-.6	.001
ET INERT	-17.	-26.	-4.	-.2	-.6	-.1	-17.	-.7	-.2	-.6	.001
ET OXID	-643.	-978.	-153.	-8.7	-23.0	-3.3	-643.	-24.4	-8.9	-22.0	.024
ET FUEL	-137.	-207.	-33.	-1.0	-4.9	-.7	-137.	-5.2	-1.9	-4.9	.005
MIX RATIO	0.	0.	0.	.0	-.0	.0	0.	.0	.0	.0	.000
ATMOSPHERE											
COLD	310.	623.	102.	5.6	20.1	2.6	310.	20.5	5.0	20.0	-.040
3-SIGMA RSS =	2536.	9426.	2043.	35.6	69.6	9.5	2530.	77.2	34.2	70.0	.114

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATG (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	.000	.000	.000	.00	.00	0.	0.	0.	0.
TILT	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
ROLL	.000	.000	.000	.00	.00	0.	0.	0.	0.
DRIFT BIAS									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
G-SENS IA DRIFT									
X	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	-.000	.00	.00	0.	0.	0.	0.
G-SENS OA DRIFT									
X	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	-.000	.00	.00	0.	0.	0.	0.
G-SQ SEN DRIFT									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	-.000	.00	.00	0.	0.	0.	0.
ACCEL BIAS									
X	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
Y	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
Z	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
ACCEL SCALE FAC									
X	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
Y	.000	.000	-.000	.00	.00	0.	0.	-0.	0.
Z	.000	.000	-.000	.00	.00	0.	0.	0.	0.
ACCEL IA ALINE - OA									
X	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
Y	.000	.000	-.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
ACCEL IA ALINE - SA									
X	.000	.000	-.000	.00	.00	0.	-0.	-0.	-0.
Y	.000	.000	-.000	.00	.00	-0.	-0.	-0.	-0.
Z	.000	.000	-.000	.00	.00	0.	0.	-0.	0.

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)
(CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CG									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
PERFORMANCE									
WEB ACT	.002	.005	.074	.20	5.92	-17884.	-17890.	-15341.	-2557.
S ISP	-.003	-.005	.087	-.32	.00	1.	1.	1.	0.
S PROP	-.001	-.001	.018	-.00	.00	10.	10.	0.	1.
S INERT	-.001	-.001	.316	-.07	.00	3007.	4.	3.	1.
O THRST	-.001	-.002	.035	-.13	.00	2092.	2092.	2479.	413.
O ISP	.000	.000	-.003	.01	.00	-1153.	-1154.	-989.	-165.
O INERT	-.000	-.000	.001	-.00	.00	185.	0.	0.	0.
ET INERT	-.000	-.000	.001	-.00	.00	190.	0.	0.	0.
ET OXID	-.001	-.003	.039	-.16	.00	7385.	7385.	7384.	1.
ET FUEL	-.000	-.001	.000	-.03	.00	1571.	1571.	2.	1569.
MIX RATIO	.000	.000	-.000	.00	.00	0.	0.	-278.	278.
ATMOSPHERE									
COLD	.001	.002	-.031	.14	.00	-142.	-142.	-122.	-20.
3-SIGMA RSS =	.004	.008	.119	.58	5.92	19984.	19673.	17236.	3045.

TABLE A3.1-II. - RSS DATA AT SRB SEPARATION (EVENT)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	.00	.00	-.00	.0000	-.0000	.00	.00	.00	-.00000
TILT	.00	.00	.00	.0000	.0000	.00	.00	.00	-.00000
ROLL	-.00	.00	-.00	-.0000	-.0000	.00	.00	-.00	.00000
DRIFT BIAS									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	-.0000	.00	.00	.00	.00000
G-SENS IA DRIFT									
X	.00	.00	.00	.0000	-.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
G-SENS OA DRIFT									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
G-SQ SEN DRIFT									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
ACCEL BIAS									
X	.00	.00	.00	.0000	.0000	.00	-.00	.00	-.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
ACCEL SCALE FAC									
X	.00	.00	.00	.0000	.0000	.00	-.00	.00	-.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
ACCEL IA ALINE - OA									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
ACCEL IA ALINE - SA									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	-.00	.00	-.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CG									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	-2.29	-.08	-.87	-.0402	-.0767	.07	.02	-.55	.00059
S ISP	-2.46	-.07	-1.07	-.0399	-.0987	.06	.01	-.67	.00055
S PROP	-.66	-.02	-.29	-.0107	-.0250	.02	.00	-.18	.00015
S INERT	-.61	-.02	-.27	-.0097	-.0236	.01	.00	-.17	.00013
O THRST	-1.31	-.04	-.59	-.0207	-.0503	.03	.01	-.37	.00028
O ISP	.12	.00	.05	.0019	.0045	-.00	-.00	.03	-.00003
O INERT	-.04	-.00	-.02	-.0006	-.0014	.00	.00	-.01	.00001
ET INERT	-.04	-.00	-.02	-.0006	-.0015	.00	.00	-.01	.00001
ET OXID	-1.45	-.04	-.64	-.0233	-.0585	.03	.01	-.40	.00032
ET FUEL	-.31	-.01	-.14	-.0049	-.0120	.01	.00	-.09	.00007
MIX RATIO	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
ATMOSPHERE									
COLD	1.19	.04	.51	.0184	.0448	-.03	-.01	.32	-.00028
3-SIGMA RSS =	4.17	.13	1.76	.0689	.1561	.11	.03	1.11	.00090

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	9.	13.	-253.	.2	.5	-.4	9.	.5	.2	.5	-.008
TILT	-32.	72.	147.	-.7	1.1	2.1	-32.	.6	-.7	1.1	-.012
ROLL	48.	-152.	78.	1.1	-2.2	1.0	48.	-1.5	1.1	-2.2	.021
DRIFT BIAS											
X	1.	0.	-3.	.0	.0	-.1	1.	.0	.0	.0	.000
Y	-1.	2.	4.	-.0	.0	.1	-1.	.0	-.0	.0	-.000
Z	2.	-3.	2.	.1	-.1	.0	1.	-.0	.1	-.1	.001
G-SENS IA DRIFT											
X	0.	1.	-7.	.0	.0	-.2	0.	.0	.0	.0	-.000
Y	-1.	2.	3.	-.0	.0	.1	-1.	.0	-.0	.0	-.000
Z	1.	-1.	1.	.0	-.0	.0	1.	-.0	.0	-.0	.000
G-SENS OA DRIFT											
X	-0.	-0.	-1.	.0	.0	-.0	0.	.0	.0	.0	-.000
Y	-4.	5.	10.	-.1	.1	.2	-4.	.0	-.1	.1	-.001
Z	2.	-3.	2.	.1	-.1	.0	1.	-.0	.1	-.1	.001
G-SQ SEN DRIFT											
X	1.	1.	-4.	.0	.0	-.1	1.	.0	.0	.0	-.000
Y	-1.	1.	2.	-.1	.0	.0	-1.	-.0	-.1	.0	-.001
Z	1.	-2.	1.	.0	-.1	.0	1.	-.1	.0	-.1	.000
ACCEL BIAS											
X	41.	-3.	1.	.6	-.1	.0	41.	.2	.6	-.1	.006
Y	4.	38.	-17.	.1	.6	-.3	4.	.6	.1	.6	-.002
Z	0.	10.	30.	.0	.3	.6	1.	.2	.0	.3	-.001
ACCEL SCALE FAC											
X	52.	-5.	1.	.7	-.1	.0	52.	.3	.7	-.1	.007
Y	1.	19.	-8.	.0	.4	-.2	1.	.3	.0	.4	-.001
Z	-0.	4.	9.	.0	.1	.2	0.	.1	.0	.1	-.001
ACCEL IA ALINE - OA											
X	38.	-3.	1.	.0	-.1	.0	38.	.3	.0	-.1	.000
Y	1.	17.	-8.	.0	.4	-.2	1.	.4	.0	.4	-.001
Z	1.	48.	85.	.0	.6	1.2	1.	.5	.0	.6	-.003
ACCEL IA ALINE - SA											
X	19.	-2.	1.	.4	-.0	.0	19.	.1	.4	-.0	.004
Y	0.	84.	-39.	.1	1.3	-.6	8.	1.2	.1	1.2	-.005
Z	0.	16.	34.	.0	.3	.7	1.	.3	.0	.3	-.001

TABLE A3.1-11. - RSS DATA AT SRB SEPARATION (EVENT)
(CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	2.	4.	1.	.5	.9	.2	3.	1.0	.5	.0	.001
S ISP	-1.	-0.	1.	-.0	-.0	-.0	-1.	-.0	-.0	-.0	.000
S PROP	1.	0.	-0.	-.0	.0	.0	1.	-.0	-.0	.0	-.001
S INERT	-1.	-0.	-0.	-.0	-.0	-.0	-1.	-.0	-.0	-.0	-.000
O THRST	-1.	-0.	-0.	-.0	.0	-.0	-1.	.0	-.0	.0	-.000
O ISP	0.	0.	-1.	.0	.0	.0	0.	.0	.0	.0	-.000
O INERT	0.	1.	1.	-.0	.0	.0	1.	.0	-.0	.0	-.000
ET INERT	-0.	0.	0.	.0	.0	-.0	-0.	.0	.0	.0	.000
ET OXID	1.	-0.	1.	-.0	-.0	.0	1.	-.0	-.0	-.0	-.000
ET FUEL	0.	-0.	-1.	.0	.0	-.0	0.	.0	.0	.0	-.000
MIX RATIO	0.	0.	0.	-.0	.0	-.0	0.	.0	-.0	.0	-.000
ATMOSPHERE											
COLD	-0.	-0.	-0.	-.0	.0	.0	0.	.0	-.0	.0	-.001
3-SIGMA RSS =	98.	200.	321.	1.9	3.2	6.1	98.	2.6	1.9	3.1	.020

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	-304.	8.	6428.	-1.8	-.3	32.4	-303.	-.3	-1.8	-.2	-.004
TILT	813.	-1425.	-1064.	5.6	-3.1	-2.1	813.	-3.1	3.8	-3.1	.009
ROLL	-1194.	616.	-798.	-6.2	4.6	-1.9	-1194.	4.6	-5.5	4.6	-.012
DRIFT BIAS											
X	-15.	1.	233.	-.1	-.0	1.7	-15.	-.0	-.1	-.0	-.000
Y	116.	-50.	-52.	.9	-.3	-.1	116.	-.3	.9	-.3	.002
Z	-174.	89.	-49.	-1.4	.3	-.2	-174.	.3	-1.3	.3	-.003
G-SENS IA DRIFT											
X	-21.	0.	372.	-.2	-.0	2.2	-21.	-.0	-.2	-.0	-.000
Y	179.	-72.	-55.	1.6	-.7	-.0	179.	-.7	1.5	-.7	.003
Z	-165.	62.	-34.	-1.5	.6	-.1	-165.	.6	-1.4	.6	-.003
G-SENS OA DRIFT											
X	-13.	-4.	214.	-.1	-.0	1.9	-13.	-.0	-.1	-.0	-.000
Y	182.	-82.	-122.	1.1	-.5	-.2	182.	-.5	1.0	-.5	.002
Z	-266.	103.	-57.	-2.4	.7	-.2	-265.	.7	-2.3	.7	-.005
G-SQ SEN DRIFT											
X	-17.	0.	296.	-.1	-.1	1.8	-17.	-.1	-.1	-.1	-.000
Y	129.	-51.	-29.	1.3	-.6	.0	129.	-.6	1.2	-.6	.003
Z	-129.	59.	-39.	-.9	.4	-.1	-129.	.4	-.8	.4	-.002
ACCEL BIAS											
X	-662.	-817.	-32.	-1.7	.7	-.1	-662.	.7	-2.4	.7	-.005
Y	-192.	-903.	339.	-.3	-1.9	1.3	-192.	-1.9	-1.4	-1.9	-.003
Z	-88.	-953.	-524.	.4	-1.2	-1.9	-88.	-1.2	-.7	-1.2	-.002
ACCEL SCALE FAC											
X	-456.	321.	-20.	-1.5	.4	-.0	-456.	.4	-1.1	.4	-.002
Y	-146.	59.	263.	-1.4	-1.9	1.3	-146.	-1.9	-1.3	-1.9	-.003
Z	-47.	-999.	-250.	.7	-1.0	-1.4	-47.	-1.0	-.5	-1.0	-.001
ACCEL IA ALINE - OA											
X	-921.	-506.	-44.	-3.8	1.3	-.2	-921.	1.3	-4.4	1.3	-.010
Y	-171.	-946.	301.	-.3	-2.3	1.6	-170.	-2.3	-1.4	-2.3	-.003
Z	-107.	-934.	-837.	.4	-.9	-1.4	-107.	-.8	-.7	-.8	-.002
ACCEL IA ALINE - SA											
X	-570.	321.	-29.	-3.3	1.0	-.1	-570.	.9	-2.9	.9	-.007
Y	-237.	-858.	412.	-.3	-1.2	.9	-236.	-1.2	-1.3	-1.2	-.003
Z	-122.	-949.	-745.	-.0	-2.5	-3.7	-121.	-2.5	-1.2	-2.5	-.003

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-82.	-40539.	3.	48.8	-.4	-.0	-23.	.0	-.0	.0	-.000
S ISP	-1.	-7173.	2.	8.5	-.2	-.1	1.	-.1	-.2	-.1	-.000
S PROP	-12.	-2794.	-0.	3.3	-.0	-.0	-11.	.0	-.1	.0	-.000
S INERT	1.	-1272.	1.	1.5	.2	-.0	1.	.2	-.0	.2	-.000
O THRST	-16.	28722.	4.	-34.2	1.1	.2	3.	.9	.5	.9	.001
O ISP	-15.	-10170.	5.	12.7	.2	.3	-12.	.3	.5	.3	.001
O INERT	-8.	984.	-5.	-1.4	.1	-.0	-8.	.0	-.2	.0	-.000
ET INERT	-13.	-104.	-3.	-.1	-.0	-.0	-13.	-.0	-.2	-.0	-.000
ET OXID	-10.	14177.	-2.	-17.1	.2	-.0	-5.	.1	-.1	.1	-.000
ET FUEL	-5.	3287.	-1.	-4.3	-.0	-.1	-5.	-.1	-.4	-.1	-.001
MIX RATIO	-1.	-0.	-0.	-.0	-.1	-.0	-1.	-.1	-.0	-.1	-.000
ATMOSPHERE											
COLD	-12.	1987.	0.	-2.3	-.1	.1	-12.	-.1	.0	-.1	.000
3-SIGMA RSS =	2103.	53465.	6723.	65.1	7.9	33.2	2102.	7.8	10.4	7.8	.023

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	.016	-.008	-.077	.02	.00	8.	8.	7.	1.
TILT	-.004	-.003	.003	-.23	-.04	25.	25.	22.	4.
ROLL	-.001	.003	.006	.10	.00	-41.	-41.	-35.	-6.
DRIFT BIAS									
X	.001	-.000	-.004	.00	.00	0.	0.	0.	0.
Y	-.000	-.000	.000	-.01	.00	-0.	-0.	-0.	-0.
Z	-.000	.000	.001	.01	.00	3.	3.	2.	0.
G-SENS IA DRIFT									
X	.001	-.000	-.005	.00	.00	0.	0.	0.	0.
Y	-.000	-.000	-.000	-.01	.00	4.	4.	4.	1.
Z	-.000	.000	.000	.01	.00	-3.	-3.	-3.	-0.
G-SENS OA DRIFT									
X	.001	-.000	-.004	-.00	.00	0.	0.	0.	0.
Y	-.000	-.000	.000	-.01	.00	1.	1.	1.	0.
Z	-.000	.000	.001	.02	.00	1.	1.	1.	0.
G-SQ SEN DRIFT									
X	.001	-.000	-.004	.00	.00	1.	1.	1.	0.
Y	-.000	-.000	-.000	-.01	.00	4.	4.	3.	1.
Z	-.000	.000	.000	.01	.00	-1.	-1.	-1.	-0.
ACCEL BIAS									
X	-.001	-.002	-.001	-.09	-.04	18.	18.	16.	3.
Y	-.000	-.003	-.005	-.14	-.04	55.	55.	47.	8.
Z	-.002	-.002	.003	-.15	-.04	34.	34.	29.	5.
ACCEL SCALE FAC									
X	.000	.001	.001	.05	.00	14.	14.	12.	2.
Y	.001	-.000	-.003	.01	.00	47.	47.	41.	7.
Z	-.002	-.002	.002	-.15	-.04	25.	25.	22.	4.
ACCEL IA ALINE - OA									
X	-.001	-.001	-.000	-.07	-.04	21.	21.	18.	3.
Y	-.000	-.003	-.005	-.14	-.04	61.	61.	52.	9.
Z	-.003	-.002	.002	-.15	-.04	25.	25.	22.	4.
ACCEL IA ALINE - SA									
X	.000	.001	.001	.05	.00	11.	11.	9.	2.
Y	.000	-.003	-.004	-.13	-.04	42.	42.	36.	6.
Z	-.003	-.002	.007	-.15	-.04	65.	65.	55.	9.

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TABLE A3.1-III. - RSS DATA AT MECO (EVENT)
(CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CG									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
PERFORMANCE									
WEB ACT	-.043	-.130	-.088	-6.98	2.18	-4379.	-4370.	-3754.	-828.
S ISP	-.008	-.024	-.012	-1.27	.58	-1211.	-1211.	-1038.	-173.
S PROP	-.003	-.009	-.005	-.47	.12	-330.	-338.	-283.	-47.
S INERT	-.001	-.004	-.002	-.24	.18	-313.	-313.	-269.	-45.
O THRST	.030	.071	.040	3.93	3.72	-797.	-797.	-683.	-114.
O ISP	-.011	-.027	-.018	-1.48	-.04	-1509.	-1509.	-1293.	-216.
O INERT	.001	.003	.002	.14	.08	7.	-178.	-152.	-25.
ET INERT	-.000	-.000	-.008	-.02	.0.	10.	-188.	-162.	-27.
ET OXID	.015	.033	.024	1.07	2.28	476.	476.	1462.	-986.
ET FUEL	.003	.008	.006	.44	.49	105.	105.	-1255.	1360.
MIX RATIO	-.000	-.000	.000	-.00	.00	3.	3.	-1082.	1085.
ATMOSPHERE									
COLD	.002	.007	.003	.38	-.36	582.	582.	499.	83.
3-SIGMA RSS =	.059	.157	.119	8.49	4.98	4936.	4943.	4780.	2119.

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	-.34	.01	-.36	.0510	.0834	-.41	.35	-.17	-.00005
TILT	.18	-1.34	-1.28	-.0048	-.0041	-.79	.79	-.57	.00022
ROLL	-.23	1.94	1.87	-.0040	-.0041	1.27	-1.26	.84	-.00031
DRIFT BIAS									
X	-.02	.00	-.02	.0025	.0047	-.03	.02	-.01	-.00000
Y	.09	-.18	-.11	-.0002	-.0001	-.03	.03	-.05	.00004
Z	-.16	.22	.07	-.0003	-.0004	-.02	.02	.03	-.00005
G-SENS IA DRIFT									
X	-.03	.01	-.02	.0033	.0057	-.03	.02	-.01	-.00000
Y	.12	-.39	-.30	-.0002	.0001	-.14	.14	-.13	.00007
Z	-.12	.34	.24	-.0002	-.0002	.10	-.10	.11	-.00007
G-SENS OA DRIFT									
X	-.03	-.01	-.04	.0026	.0052	-.04	.04	-.02	-.00000
Y	.10	-.25	-.17	-.0005	-.0004	-.08	.08	-.07	.00005
Z	-.24	.44	.23	-.0004	-.0005	.04	-.04	.10	-.00010
G-SQ SEN DRIFT									
X	-.03	-.01	-.05	.0027	.0047	-.05	.05	-.02	-.00000
Y	.09	-.32	-.25	-.0000	.0002	-.11	.11	-.11	.00006
Z	-.07	.19	.14	-.0002	-.0003	.07	-.07	.06	-.00004
ACCEL BIAS									
X	-.37	.30	-.07	-.0002	-.0003	-.09	.09	-.03	-.00010
Y	-.55	-.65	-1.30	.0022	.0031	-1.04	1.04	-.59	.00001
Z	-.32	-.42	-.81	-.0034	-.0047	-.64	.64	-.36	.00001
ACCEL SCALE FAC									
X	-.20	.10	-.11	-.0001	-.0001	-.05	.05	-.05	-.00004
Y	-.53	-.64	-1.27	.0021	.0034	-1.02	1.02	-.57	.00001
Z	-.24	-.33	-.82	-.0021	-.0035	-.49	.49	-.28	.00001
ACCEL IA ALINE - OA									
X	-.50	.67	.09	-.0003	-.0005	-.08	.08	.04	-.00018
Y	-.61	-.78	-1.51	.0025	.0042	-1.20	1.19	-.68	.00002
Z	-.26	-.28	-.59	-.0030	-.0027	-.47	.47	-.26	.00000
ACCEL IA ALINE - SA									
X	-.36	.49	.14	-.0002	-.0003	-.00	.00	.06	-.00012
Y	-.43	-.39	-.89	.0020	.0018	-.72	.71	-.48	-.00001
Z	-.59	-.85	-1.58	-.0058	-.0094	-1.23	1.24	-.71	.00003

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CG									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	-.01	.00	-.01	.0000	-.0000	-.10	-.01	.00	-.00000
S ISP	-.05	-.04	-.09	-.0001	-.0003	-.10	.00	-.04	-.00000
S PROP	-.01	.01	-.00	-.0000	-.0001	-.01	.01	-.00	-.00000
S INERT	.03	.08	.12	-.0000	-.0000	.09	-.09	.05	-.00001
O THRST	.21	.29	.54	.0003	.0007	.51	-.43	.24	-.00001
O ISP	.11	.05	.17	.0003	.0000	.15	-.10	.00	.00001
O INERT	-.02	.04	.02	-.0001	-.0001	.00	.00	.01	-.00001
ET INERT	-.03	.01	-.02	-.0000	-.0001	-.03	.03	-.01	-.00001
ET OXID	.01	.04	.06	-.0000	-.0000	.07	-.03	.02	-.00000
ET FUEL	-.06	.02	-.04	-.0002	-.0004	-.06	.06	-.02	-.00001
MIX RATIO	-.02	-.04	-.07	-.0000	-.0000	-.06	.06	-.03	.00000
ATMOSPHERE									
COLD	-.01	-.04	-.06	.0001	.0003	-.03	.03	-.03	.00000
3-SIGMA RSS =	1.87	3.14	4.02	.0524	.0852	3.05	3.02	1.81	.00049

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	307.	-173.	-6481.	2.0	.0	-32.9	306.	.0	1.7	.0	.004
TILT	-827.	1011.	1062.	-5.1	3.1	2.1	-827.	3.1	-3.9	3.1	-.009
ROLL	1202.	-1539.	790.	7.4	-4.7	1.9	1202.	-4.6	5.6	-4.7	.012
DRIFT BIAS											
X	15.	-1.	-237.	.1	.1	-1.0	15.	.1	.1	.0	.000
Y	-110.	77.	51.	-1.0	.4	.1	-110.	.4	-.9	.4	-.002
Z	177.	-116.	40.	1.4	-.6	.1	177.	-.6	1.3	-.6	.003
O-SENS IA DRIFT											
X	21.	-5.	-376.	.2	.0	-2.2	21.	.0	.2	.0	.000
Y	-105.	104.	55.	-1.7	.6	.0	-105.	.6	-1.6	.6	-.004
Z	170.	-91.	34.	1.6	-.6	.1	170.	-.5	1.5	-.6	.003
O-SENS OA DRIFT											
X	13.	-0.	-220.	.1	.0	-2.0	13.	.0	.1	.0	.000
Y	-104.	140.	122.	-1.2	.6	.2	-104.	.6	-1.1	.6	-.002
Z	273.	-153.	50.	2.5	-.9	.2	272.	-.9	2.3	-.9	.005
O-SQ SEN DRIFT											
X	10.	-4.	-299.	.1	.0	-1.0	17.	.0	.1	.0	.000
Y	-135.	60.	29.	-1.5	.5	-.1	-135.	.5	-1.4	.5	-.003
Z	130.	-92.	39.	.9	-.4	.1	130.	-.4	.0	-.4	.002
ACCEL BIAS											
X	650.	-202.	32.	2.7	-.0	.1	650.	-.0	2.5	-.0	.006
Y	100.	400.	-340.	.0	1.0	-1.3	100.	1.0	1.4	1.0	.003
Z	82.	327.	525.	.3	1.2	2.0	82.	1.2	.7	1.2	.002
ACCEL SCALE FAC											
X	450.	-139.	20.	1.3	-.3	.0	450.	-.3	1.1	-.3	.002
Y	146.	307.	-260.	.0	2.0	-1.3	146.	2.0	1.2	1.0	.003
Z	39.	160.	260.	.2	.0	1.4	39.	.0	.4	.0	.001
ACCEL IA ALINE - OA											
X	921.	-207.	45.	4.0	-1.5	.2	921.	-1.4	4.5	-1.5	.010
Y	167.	442	-304.	.9	2.3	-1.6	167.	2.3	1.5	2.3	.003
Z	102.	400.	837.	.3	.0	1.3	102.	.0	.0	.0	.002
ACCEL IA ALINE - SA											
X	570.	-179.	29.	3.2	-.9	.2	577.	-.9	3.0	-.9	.007
Y	233.	595.	-412.	.6	1.2	-.9	232.	1.2	1.3	1.2	.003
Z	117.	470.	750.	.6	2.3	3.7	117.	2.3	1.2	2.3	.003

TABLE A3.1-III. - RSS DATA AT MECO (EVENT)
(CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CG											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-4.	-71.	-6.	-.0	.1	-.0	-4.	.1	-.1	.1	-.000
S ISP	3.	21.	2.	-.0	-.1	-.0	3.	-.1	.0	-.1	.000
S PROP	4.	12.	1.	.0	-.0	-.0	4.	-.0	.0	-.0	.000
S INERT	2.	15.	-0.	.0	.1	-.0	2.	.1	.0	.1	.000
O THRST	-3.	-3.	-1.	.0	.0	-.0	-3.	.0	.0	.0	.000
O ISP	-8.	-39.	-5.	.1	.6	.0	-8.	.5	.0	.5	.000
O INERT	3.	9.	0.	-.0	-.1	-.0	3.	-.1	-.0	-.1	-.000
ET INERT	2.	4.	1.	-.0	.0	.0	2.	.0	-.0	.0	-.000
ET OXID	-13.	-85.	-4.	.0	.3	-.0	-13.	.3	-.0	.3	-.000
ET FUEL	3.	14.	1.	-.0	.1	-.0	3.	.1	.0	.1	.000
MIX RATIO	1.	-0.	0.	.0	-.0	.0	1.	-.0	.0	-.0	.000
ATMOSPHERE											
COLD	-5.	-21.	-1.	-.0	-.1	-.0	-4.	-.1	-.0	-.1	-.000
3-SIGMA RSS =	2115.	2271.	6774.	12.3	7.0	33.7	2115.	7.7	10.6	7.0	.024

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 62 SECONDS

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	-415.	22.	8420.	-1.8	-.1	31.7	-414.	-.1	-1.8	-.1	-.004
TILT	1030.	-1697.	-1193.	5.5	-3.4	-2.0	1030.	-3.4	3.4	-3.4	.000
ROLL	-1515.	1016.	-915.	-6.1	5.0	-1.8	-1515.	4.8	-4.9	5.0	-.011
DRIFT BIAS											
X	-24.	2.	341.	-.1	-.0	1.7	-24.	-.0	-.1	-.0	-.000
Y	169.	-82.	-55.	.9	-.4	-.1	169.	-.4	.0	-.4	.002
Z	-254.	109.	-58.	-1.4	.4	-.2	-254.	.4	-1.3	.4	-.003
G-SENS IA DRIFT											
X	-31.	2.	505.	-.2	.0	2.1	-31.	.0	-.2	.0	-.000
Y	270.	-138.	-57.	1.6	-.0	-.0	269.	-.0	1.4	-.0	.003
Z	-251.	119.	-40.	-1.5	.7	-.1	-251.	.7	-1.3	.7	-.003
G-SENS OA DRIFT											
X	-21.	-5.	330.	-.1	-.0	1.9	-21.	-.0	-.1	-.0	-.000
Y	244.	-131.	-135.	1.1	-.6	-.2	244.	-.6	1.0	-.6	.002
Z	-403.	170.	-78.	-2.4	.9	-.2	-403.	.9	-2.2	.9	-.005
G-SQ SEN DRIFT											
X	-26.	-2.	406.	-.1	-.1	1.0	-26.	-.1	-.1	-.1	-.000
Y	202.	-102.	-27.	1.3	-.7	.0	202.	-.7	1.1	-.7	.003
Z	-177.	97.	-46.	-.9	.4	-.1	-177.	.4	-.7	.4	-.002
ACCEL BIAS											
X	-812.	-513.	-30.	-1.0	.9	-.1	-813.	.9	-2.4	.9	-.005
Y	-200.	-1002.	417.	-.5	-1.0	1.2	-200.	-1.0	-1.7	-1.0	-.004
Z	-139.	-1020.	-642.	.3	-1.2	-1.9	-139.	-1.2	-.9	-1.2	-.002
ACCEL SCALE FAC											
X	-523.	304.	-22.	-1.5	.5	-.0	-523.	.4	-1.1	.5	-.002
Y	-236.	-44.	344.	-1.6	-1.0	1.3	-236.	-1.0	-1.6	-1.0	-.004
Z	-83.	-1053.	-341.	.6	-.9	-1.3	-83.	-.9	-.6	-.9	-.001
ACCEL IA ALINE - OA											
X	-1193.	-336.	-57.	-3.9	1.6	-.2	-1193.	1.6	-4.3	1.6	-.010
Y	-270.	-1069.	400.	-.5	-2.2	1.6	-270.	-2.2	-1.0	-2.2	-.004
Z	-157.	-975.	-720.	.3	-.0	-1.3	-157.	-.0	-.9	-.0	-.002
ACCEL IA ALINE - SA											
X	-749.	436.	-36.	-3.3	1.2	-.1	-749.	1.1	-2.0	1.2	-.008
Y	-323.	-900.	467.	-.4	-1.1	.9	-323.	-1.1	-1.5	-1.1	-.003
Z	-237.	-1000.	-971.	-.3	-2.4	-3.6	-207.	-2.4	-1.6	-2.4	-.003

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 62 SECONDS
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CG											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
MEO ACT	-933.	-114431.	-2.	130.1	-.7	.1	-825.	.0	.2	.0	.001
S ISP	-235.	-31010.	-5.	30.2	-.2	-.1	-211.	.0	-.1	.0	-.000
S PROP	-17.	-2794.	-3.	3.3	-.0	-.0	-17.	.0	-.1	.0	-.000
S INERT	1.	-1261.	-0.	1.5	.2	-.0	1.	.2	.0	.2	.000
O THRST	-801.	-69709.	21.	85.0	1.0	.4	-767.	1.0	1.1	1.0	.002
O ISP	213.	14488.	21.	-17.0	.2	.2	210.	.1	.4	.1	.001
O INERT	-20.	909.	-7.	-1.4	.1	-.0	-20.	.1	-.2	.1	-.000
ET INERT	-25.	-103.	-5.	-.1	-.0	-.0	-25.	.0	-.2	.0	-.000
ET OXID	-691.	-59601.	-1.	72.2	.2	.1	-600.	.7	.2	.7	.001
ET FUEL	-230.	-21337.	-9.	25.4	-.0	-.1	-220.	.1	-.3	.1	-.001
MIX RATIO	-3.	-0.	-0.	-.0	-.1	-.0	-3.	-.1	-.0	-.1	-.000
ATMOSPHERE											
COLD	-9.	1904.	0.	-2.3	-.1	.1	-9.	-.2	-.0	-.2	-.000
3-SIGMA RSS =	3111.	152375.	8747.	184.5	9.2	32.5	2002.	9.3	10.1	8.4	.023

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 82 SECONDS

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	.021	-.010	-.075	.03	.00	0.	0.	0.	0.
TILT	-.004	-.001	.004	-.11	.00	0.	0.	0.	0.
ROLL	-.001	.004	.007	.16	.00	0.	0.	0.	0.
DRIFT BIAS									
X	.001	-.000	-.004	.00	.00	0.	0.	0.	0.
Y	-.000	-.000	.000	-.01	.00	0.	0.	0.	0.
Z	-.000	.000	.001	.02	.00	0.	0.	0.	0.
G-SENS IA DRIFT									
X	.001	-.001	-.005	.00	.00	0.	0.	0.	0.
Y	-.000	-.000	-.000	-.02	.00	0.	0.	0.	0.
Z	.000	.000	.000	.02	.00	0.	0.	0.	0.
G-SENS OA DRIFT									
X	.001	-.000	-.004	.00	.00	0.	0.	0.	0.
Y	-.000	-.000	.002	-.02	.00	0.	0.	0.	0.
Z	-.000	.001	.001	.03	.00	0.	0.	0.	0.
G-SQ SEN DRIFT									
X	.001	-.000	-.004	.00	.00	0.	0.	0.	0.
Y	-.000	-.000	-.000	-.02	.00	0.	0.	0.	0.
Z	-.000	.000	.000	.02	.00	0.	0.	0.	0.
ACCEL BIAS									
X	.000	.002	.001	.05	.00	0.	0.	0.	0.
Y	.001	-.000	-.003	.01	.00	0.	0.	0.	0.
Z	-.002	.001	.005	-.00	.00	0.	0.	0.	0.
ACCEL SCALE FAC									
X	.000	.001	.001	.06	.00	0.	0.	0.	0.
Y	.001	-.001	-.003	-.01	.00	0.	0.	0.	0.
Z	-.001	.000	.003	-.01	.00	0.	0.	0.	0.
ACCEL IA ALINE - OA									
X	.001	.002	.002	.11	.00	0.	0.	0.	0.
Y	.001	-.001	-.004	-.01	.00	0.	0.	0.	0.
Z	-.002	.001	.003	.01	.00	0.	0.	0.	0.
ACCEL IA ALINE - SA									
X	[illegible]	.001	.001	.07	.00	0.	0.	0.	0.
Y	.001	-.000	-.002	.02	.00	0.	0.	0.	0.
Z	-.003	.001	.030	-.01	.00	0.	0.	0.	0.

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 82 SECONDS
(CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CG									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	[illegible]	0.	0.
PERFORMANCE									
WEB ACT	-.089	-.298	-.174	-15.49	.00	-0.	0.	0.	0.
S ISP	-.020	-.067	-.039	-3.48	.00	0.	0.	0.	0.
S PROP	-.005	-.018	-.011	-.95	.00	0.	0.	0.	0.
S INERT	-.005	-.017	-.010	-.87	.00	0.	0.	0.	0.
O THRST	-.062	-.207	-.122	-10.76	.00	0.	0.	0.	0.
O ISP	.011	.035	.020	1.84	.00	0.	0.	0.	0.
O INERT	-.001	-.003	-.002	-.17	.00	185.	0.	0.	0.
ET INERT	-.001	-.004	-.002	-.18	.00	0.	0.	0.	0.
ET OXID	-.039	-.131	-.077	-6.82	.00	0.	0.	0.	0.
ET FUEL	-.008	-.028	-.016	-1.46	.00	0.	0.	0.	0.
MIX RATIO	-.000	-.000	-.000	-.00	.00	0.	0.	0.	0.
ATMOSPHERE									
COLD	.010	.035	.020	1.80	.00	0.	0.	0.	0.
3-SIGMA RSS =	.121	.397	.245	20.61	.00	185.	0.	0.	0.

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 62 SECONDS

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	-.34	.00	-.36	.0510	.0034	-.42	.36	-.17	-.00005
TILT	.18	-1.34	-1.26	-.0048	-.0041	-.79	.79	-.57	.00022
ROLL	-.23	1.95	1.87	-.0040	-.0041	1.26	-1.26	.84	-.00031
DRIFT BIAS									
X	-.02	.00	-.02	.0025	.0047	-.03	.03	-.01	-.00000
Y	.09	-.18	-.11	-.0002	-.0001	-.03	.03	-.05	.00004
Z	-.16	.22	.07	-.0003	-.0004	-.02	.02	.03	-.00005
G-SENS IA DRIFT									
X	-.03	.01	-.02	.0033	.0057	-.03	.03	-.01	-.00000
Y	.12	-.39	-.38	-.0002	.0001	-.13	.13	-.13	.00007
Z	-.12	.34	.24	-.0002	-.0002	.10	-.10	.11	-.00007
G-SENS OA DRIFT									
X	-.03	-.01	-.04	.0026	.0052	-.04	.04	-.02	-.00000
Y	.10	-.25	-.17	-.0005	-.0004	-.08	.08	-.07	.00005
Z	-.24	.44	.23	-.0004	-.0005	.03	-.03	.18	-.00010
G-SQ SEN DRIFT									
X	-.03	-.02	-.05	.0027	.0047	-.05	.05	-.02	-.00000
Y	.09	-.32	-.25	-.0000	.0002	-.11	.11	-.11	.00006
Z	-.07	.19	.14	-.0002	-.0003	.06	-.06	.06	-.00004
ACCEL BIAS									
X	-.37	.30	-.07	-.0002	-.0003	-.10	.10	-.03	-.00010
Y	-.55	-.85	-1.30	.0022	.0031	-1.05	1.05	-.59	.00001
Z	-.32	-.42	-.81	-.0034	-.0047	-.85	.85	-.36	.00001
ACCEL SCALE FAC									
X	-.20	.10	-.11	-.0001	-.0001	-.06	.06	-.05	-.00004
Y	-.52	-.85	-1.27	.0021	.0034	-1.04	1.03	-.57	.00002
Z	-.24	-.33	-.62	-.0021	-.0035	-.49	.50	-.28	.00001
ACCEL IA ALINE - OA									
X	-.59	.67	.09	-.0003	-.0005	-.10	.10	.04	-.00018
Y	-.60	-.78	-1.51	.0025	.0042	-1.22	1.21	-.68	.00002
Z	-.26	-.28	-.59	-.0030	-.0027	-.48	.48	-.26	.00000
ACCEL IA ALINE - SA									
X	-.36	.49	.14	-.0002	-.0003	-.01	.01	.06	-.00012
Y	-.42	-.40	-.89	.0020	.0018	-.73	.73	-.40	-.00000
Z	-.59	-.86	-1.58	-.0058	-.0094	-1.25	1.25	-.71	.00004

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 82 SECONDS
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETER*

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CO									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	-.01	-.00	-.01	.0001	.0003	-.09	-.17	.01	-.00000
S ISP	-.05	-.04	-.10	-.0001	-.0003	-.10	.05	-.04	-.00000
S FROP	-.01	.01	-.00	-.0000	-.0001	-.01	-.00	-.00	-.00000
S INERT	.03	.00	.12	-.0000	-.0000	.09	-.10	.05	-.00001
O THRST	.21	.29	.54	.0004	.0012	.54	-.72	.25	-.00001
O ISP	.11	.08	.18	.0003	.0007	.15	-.12	.08	.00001
O INERT	-.02	.04	.02	-.0000	-.0001	.00	-.01	.01	-.00001
ET INERT	-.03	.01	-.02	-.0000	-.0001	-.03	.03	-.01	-.00001
ET OXID	.01	.04	.05	.0001	.0003	.08	-.20	.03	-.00001
ET FUEL	-.08	.02	-.04	-.0001	-.0003	-.06	.03	-.02	-.00001
MIX RATIO	-.02	-.04	-.07	-.0000	-.0000	-.06	.06	-.03	.00000
ATMOSPHERE									
COLD	-.01	-.04	-.05	.0001	.0002	-.03	.06	-.03	.00000
3-SIGMA RSS =	1.68	3.15	4.02	.0524	.0853	3.07	3.11	1.01	.00049

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 62 SECONDS

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	414.	-202.	-8504.	2.0	-.1	-32.2	412.	-.1	1.7	-.1	.004
TILT	-1059.	1207.	1190.	-5.1	3.4	2.0	-1058.	3.4	-3.5	3.4	-.008
ROLL	1527.	-1943.	914.	7.3	-5.0	1.8	1528.	-5.0	4.9	-5.0	.011
DRIFT BIAS											
X	22.	-1.	-346.	.1	.0	-1.8	22.	.0	.1	.0	.000
Y	-173.	115.	57.	-1.0	.5	.1	-172.	.5	-.8	.5	-.002
Z	256.	-170.	57.	1.4	-.7	.1	258.	-.7	1.2	-.7	.003
G-SENS IA DRIFT											
X	28.	-5.	-511.	.1	.0	-2.2	29.	.0	.1	.0	.000
Y	-284.	163.	56.	-1.7	.7	.0	-284.	.7	-1.5	.7	-.003
Z	261.	-144.	41.	1.6	-.7	.1	261.	-.6	1.4	-.7	.003
G-SENS OA DRIFT											
X	21.	1.	-340.	.1	.0	-1.9	21.	.0	.1	.0	.000
Y	-248.	203.	137.	-1.2	.7	.2	-247.	.6	-1.0	.7	-.002
Z	413.	-239.	69.	2.5	-1.1	.2	413.	-1.0	2.2	-1.1	.005
G-SQ SEN DRIFT											
X	23.	-5.	-411.	.1	.0	-1.8	23.	.0	.1	.0	.000
Y	-221.	116.	26.	-1.5	.6	-.0	-221.	.6	-1.3	.6	-.003
Z	176.	-129.	46.	.9	-.4	.1	176.	-.4	.7	-.4	.002
ACCEL BIAS											
X	812.	-311.	40.	2.8	-1.0	.1	812.	-.9	2.5	-1.0	.006
Y	280.	585.	-418.	.9	1.8	-1.2	280.	1.8	1.7	1.8	.004
Z	133.	396.	648.	.4	1.2	2.0	133.	1.2	.9	1.2	.002
ACCEL SCALE FAC											
X	524.	-198.	23.	1.3	-.4	.0	524.	-.4	1.1	-.4	.002
Y	231.	491.	-347.	.9	1.8	-1.3	231.	1.9	1.5	1.8	.003
Z	69.	209.	344.	.3	.9	1.3	69.	.9	.6	.9	.001
ACCEL IA ALINE - OA											
X	1195.	-465.	60.	4.9	-1.8	.2	1195.	-1.7	4.3	-1.8	.010
Y	267.	569.	-404.	1.1	2.3	-1.6	268.	2.3	1.8	2.3	.004
Z	151.	442.	719.	.3	.8	1.3	152.	.8	.9	.8	.002
ACCEL IA ALINE - SA											
X	759.	-294.	39.	3.2	-1.2	.2	760.	-1.1	2.9	-1.2	.006
Y	320.	649.	-464.	.7	1.1	-.8	320.	1.2	1.5	1.1	.003
Z	201.	602.	980.	.8	2.3	3.7	201.	2.3	1.5	2.3	.003

TABLE A3.1-IV. - RSS DATA AT NOMINAL MECO + 62 SECONDS
(CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
)											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-13.	-90.	-7.	-.0	.2	.0	-12.	.3	-.0	.3	-.000
S ISP	5.	20.	1.	-.0	.2	.0	5.	.3	.1	.3	.000
S PROP	5.	11.	0.	.0	.0	.0	5.	-.0	.0	-.0	.000
S INERT	2.	18.	0.	-.0	.0	.0	2.	-.0	-.0	-.0	-.000
O THRST	-2.	-10.	0.	.0	.0	.0	-2.	.0	.0	.0	.000
O ISP	-13.	-52.	-5.	.0	.0	-.0	-13.	-.0	-.1	-.0	-.000
O INERT	3.	9.	0.	-.0	.0	-.0	3.	-.0	-.0	-.0	-.000
ET INERT	1.	4.	1.	-.0	.0	.0	1.	-.0	-.0	-.0	-.000
ET OXID	-22.	-83.	-4.	-.0	.2	.0	-22.	.3	-.0	.3	-.000
ET FUEL	3.	13.	2.	-.0	.2	.0	3.	.3	.1	.3	.000
MIX RATIO	0.	-0.	0.	-.0	.0	.0	1.	.0	-.0	.0	-.000
ATMOSPHERE											
COLD	-8.	-21.	0.	-.0	.1	.0	-8.	.2	-.0	.2	-.000
3-SIGMA RSS =	2741.	2870.	8830.	12.3	8.2	33.0	2741.	8.2	10.2	8.2	.023

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	-701.	2755.	13649.	-5.0	.5	29.3	-698.	.5	-1.6	.5	-.004
TILT	1527.	-2968.	-1511.	5.9	-4.0	-1.6	1527.	-4.0	2.3	-4.0	.005
ROLL	-2194.	3434.	-1208.	-7.3	5.9	-1.6	-2194.	5.9	-3.2	5.9	-.007
DRIFT BIAS											
X	-50.	-457.	625.	.4	.0	1.6	-50.	.0	-.1	.0	-.000
Y	293.	-1082.	-62.	2.0	-.6	-.0	293.	-.6	.7	-.6	.002
Z	-424.	3278.	-82.	-4.9	1.0	-.1	-424.	.9	-.9	.9	-.002
G-SENS IA DRIFT											
X	-56.	51.	850.	-.2	.1	2.0	-56.	.1	-.1	.1	-.000
Y	511.	1051.	-56.	.1	-1.0	.0	511.	-1.0	1.4	-1.0	.003
Z	-475.	-706.	-56.	-.4	.9	-.1	-475.	.9	-1.2	.9	-.003
G-SENS OA DRIFT											
X	-46.	-41.	641.	-.1	-.0	1.0	-46.	-.0	-.1	.0	-.000
Y	381.	-1713.	-167.	2.9	-.8	-.1	381.	-.8	.0	-.8	.002
Z	-720.	2616.	-103.	-4.9	1.5	-.2	-720.	1.5	-1.0	1.5	-.004
G-SQ SEN DRIFT											
X	-43.	730.	696.	-1.0	.1	1.6	-43.	.0	-.1	.0	-.000
Y	402.	545.	-19.	.6	-.8	.1	401.	-.8	1.2	-.8	.003
Z	-292.	-93.	-64.	-.4	.6	-.1	-292.	.6	-.5	.6	-.001
ACCEL BIAS											
X	-1169.	5613.	-56.	-9.2	1.8	-.1	-1168.	1.7	-2.4	1.7	-.005
Y	-696.	-6202.	629.	5.2	-1.4	1.6	-695.	-1.3	-2.3	-1.3	-.005
Z	-379.	-4898.	-965.	4.7	-.9	-2.0	-379.	-.9	-1.2	-.9	-.003
ACCEL SCALE FAC											
X	-710.	-551.	-20.	-.3	.6	-.0	-710.	.6	-1.0	.6	-.002
Y	-577.	-821.	557.	-1.5	-1.4	1.2	-577.	-1.5	-2.3	-1.4	-.005
Z	-205.	216.	-560.	-1.1	-.7	-1.2	-205.	-.7	-.9	-.7	-.002
ACCEL IA ALINE - OA											
X	-1080.	1987.	-90.	-6.2	2.6	-.2	-1080.	2.6	-3.0	2.6	-.000
Y	-671.	-2580.	659.	.3	-1.0	1.5	-671.	-1.0	-2.0	-1.0	-.006
Z	-335.	-1107.	-923.	.1	-.6	-1.0	-335.	-.6	-1.2	-.5	-.003
ACCEL IA ALINE - SA											
X	-1206.	1077.	-56.	-3.8	1.0	-.1	-1208.	1.7	-2.5	1.0	-.006
Y	-63'.	-1778.	604.	.1	-.8	.7	-631.	-.8	-2.0	-.8	-.004
Z	-545.	-87.	-1583.	-2.3	-1.8	-3.3	-545.	-1.8	-2.4	-1.8	-.005

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-66.	-37600.	-10.	45.2	-.1	.0	-33.	.3	-.4	.3	-.001
S ISP	-12.	-3973.	-24.	4.8	.1	-.1	-12.	.2	.0	.2	.000
S PROP	-30.	-2926.	-10.	3.5	.0	-.0	-30.	.0	-.0	.0	-.000
S INERT	-32.	-5195.	-2.	6.6	.3	.2	-31.	.3	.4	.3	.001
O THRST	3.	15355.	63.	-18.1	.3	.4	8.	.2	.5	.2	.001
O ISP	38.	-13527.	63.	16.7	.3	.4	42.	.4	.3	.4	.001
O INERT	15.	5149.	-6.	-8.1	.1	-.0	15.	.0	.1	.0	.000
ET INERT	-44.	57.	-9.	-.0	.1	.0	-44.	.1	.0	.1	.000
ET OXID	12.	14803.	2.	-17.5	.3	.0	16.	.1	.4	.1	.001
ET FUEL	-50.	5088.	-29.	-6.0	.2	-.1	-49.	.2	.2	.2	.000
MIX RATIO	5.	1423.	0.	-1.6	.0	.0	4.	.0	.1	.0	.000
ATMOSPHERE											
COLD	23.	4367.	23.	-5.1	.2	.1	23.	.1	.2	.1	.000
3-SIGMA RSS =	4296.	40433.	14078.	59.2	9.2	30.0	4294.	9.1	9.4	9.2	.021

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	.037	-.000	-.085	.48	.10	-0.	0.	0.	0.
TILT	-.008	-.009	-.002	-.47	-.05	1.	0.	0.	0.
ROLL	-.001	.012	.011	.54	.04	-3.	0.	0.	0.
DRIFT BIAS									
X	.001	-.002	-.005	-.07	-.02	1.	0.	0.	0.
Y	-.001	-.003	-.002	-.17	-.03	3.	0.	0.	0.
Z	.002	.011	.007	.51	.12	-9.	0.	0.	0.
G-SENS IA DRIFT									
X	.002	-.000	-.005	.01	.00	-0.	0.	0.	0.
Y	.005	.003	.002	.18	.08	-4.	0.	0.	0.
Z	-.001	-.002	-.001	-.11	-.04	3.	0.	0.	0.
G-SENS OA DRIFT									
X	.002	-.001	-.004	-.00	-.00	0.	0.	0.	0.
Y	-.001	-.005	-.003	-.27	-.05	4.	0.	0.	0.
Z	.001	.009	.006	.41	.08	-7.	0.	0.	0.
G-SQ SEN DRIFT									
X	.002	.002	-.002	.11	.03	-2.	0.	0.	0.
Y	.000	.002	.001	.08	.03	-3.	0.	0.	0.
Z	-.000	-.000	.000	-.01	-.01	1.	0.	0.	0.
ACCEL BIAS									
X	.003	.018	.012	.07	.18	2.	0.	0.	0.
Y	-.002	-.020	-.017	-.95	-.23	15.	0.	0.	0.
Z	-.005	-.015	-.006	-.76	-.19	11.	0.	0.	0.
ACCEL SCALE FAC									
X	-.000	-.002	-.001	-.08	-.04	4.	0.	0.	0.
Y	.001	-.002	-.004	-.10	-.01	1.	0.	0.	0.
Z	-.001	.001	.003	.03	.01	-4.	0.	0.	0.
ACCEL IA ALINE - OA									
X	.001	.007	.005	.32	.02	-5.	0.	0.	0.
Y	.000	-.009	-.009	-.39	-.09	4.	0.	0.	0.
Z	-.003	-.003	.000	-.17	-.04	0.	0.	0.	0.
ACCEL IA ALINE - SA									
X	.000	.004	.002	.17	.01	-1.	0.	0.	0.
Y	.001	-.006	-.006	-.27	-.07	2.	0.	0.	0.
Z	-.004	.001	.008	-.02	.01	-4.	0.	0.	0.

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT) (CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CG									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
PERFORMANCE									
WEB ACT	-.020	-.137	-.000	-6.50	2.27	-9.	0.	0.	0.
S ISP	-.002	-.016	-.008	-.77	.69	-10.	0.	0.	0.
S PROP	-.002	-.010	-.006	-.49	.11	0.	0.	0.	0.
S INERT	-.003	-.010	-.012	-.84	.01	12.	0.	0.	0.
O THRST	.000	.039	.032	1.07	3.19	22.	0.	0.	0.
O ISP	-.007	-.042	-.030	-1.99	-.97	10.	0.	0.	0.
O INERT	.003	.016	.011	.70	.24	172.	0.	0.	0.
ET INERT	.000	.000	.000	.00	.05	-0.	0.	0.	0.
ET OXID	.008	.041	.031	1.98	2.22	-2.	0.	0.	0.
ET FUEL	.003	.015	.011	.72	.55	-5.	0.	0.	0.
MIX RATIO	.001	.005	.003	.22	.06	-4.	0.	0.	0.
ATMOSPHERE									
COLD	.002	.016	.009	.75	-.26	-0.	0.	0.	0.
3-SIGMA RSS =	.048	.184	.123	7.80	4.73	177.	0.	0.	0.

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	-.21	.03	-.20	.0509	.0036	.17	-.23	-.10	-.00004
TILT	-1.03	-.15	-1.35	-.0040	-.0039	-.09	.00	-.60	-.00012
ROLL	1.59	.19	2.03	-.0040	-.0040	1.40	-1.30	.08	.00020
DRIFT BIAS									
X	-.03	.00	-.03	.0025	.0049	.01	-.01	-.01	-.00000
Y	-.10	-.04	-.10	-.0002	-.0000	-.19	.10	-.07	-.00001
Z	.17	.05	.28	-.0003	-.0003	.27	-.20	.11	.00002
G-SENS IA DRIFT									
X	-.01	.00	-.01	.0033	.0050	.02	-.02	-.00	-.00000
Y	-.13	-.00	-.24	-.0001	.0001	-.33	.33	-.11	-.00001
Z	.11	.07	.21	-.0002	-.0001	.29	-.29	.09	.00001
G-SENS OA DRIFT									
X	-.03	.00	-.03	.0026	.0053	.01	-.01	-.02	-.00000
Y	-.15	-.04	-.22	-.0005	-.0003	-.23	.23	-.10	-.00002
Z	.22	.10	.37	-.0004	-.0004	.46	-.46	.16	.00002
G-SQ SEN DRIFT									
X	-.00	.00	-.00	.0027	.0047	.01	-.01	-.00	-.00000
Y	-.00	-.00	-.20	-.0000	.0003	-.20	.20	-.09	-.00000
Z	.10	.02	.14	-.0002	-.0003	.16	-.16	.06	.00001
ACCEL BIAS									
X	.00	.00	.20	-.0002	-.0002	.58	-.54	.09	.00000
Y	-1.20	-.02	-1.37	.0025	.0040	-.10	.00	-.61	-.00016
Z	-.72	-.03	-.04	-.0036	-.0058	-.09	.00	-.37	-.00010
ACCEL SCALE FAC									
X	-.13	-.02	-.16	-.0001	-.0001	.17	-.17	-.07	-.00001
Y	-1.19	-.01	-1.35	.0021	.0035	-.10	.09	-.60	-.00017
Z	-.50	-.01	-.57	-.0021	-.0035	-.05	.06	-.25	-.00007
ACCEL IA ALINE - OA									
X	.05	.11	.20	-.0003	-.0005	.02	-.01	.09	-.00001
Y	-1.46	-.00	-1.64	.0025	.0043	-.12	.11	-.73	-.00020
Z	-.54	.00	-.60	-.0030	-.0025	-.01	.01	-.27	-.00008
ACCEL IA ALINE - SA									
X	.07	.00	.19	-.0002	-.0002	.56	-.55	.00	-.00000
Y	-.06	-.00	-.96	.0020	.0010	.01	-.02	-.43	-.00012
Z	-1.39	-.01	-1.57	-.0050	-.0094	-.15	.15	-.70	-.00017

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CO									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	.11	.04	.17	-.0000	.0001	.01	-.11	.60	.00001
S ISP	.07	.01	.00	-.0001	-.0002	.02	-.03	.04	.00001
S PROP	.00	-.00	.00	-.0000	-.0000	.00	-.01	.00	.00000
S INERT	.10	-.02	.19	.0001	.0007	.01	-.02	.00	.00003
O THRST	.13	-.03	.11	.0004	.0011	.01	.03	.05	.00002
O ISP	.24	.01	.20	.0004	.0014	.02	-.05	.13	.00003
O INERT	.04	-.01	.04	-.0000	-.0000	.01	.01	.02	.00001
ET INERT	.01	-.01	-.00	-.0000	.0000	.00	-.00	-.00	.00000
ET OXID	.11	-.03	.10	.0000	.0000	.01	.03	.04	.00002
ET FUEL	.00	-.01	.07	-.0001	-.0002	.02	-.01	.03	.00001
MIX RATIO	.02	-.00	.02	.0000	.0001	-.00	.00	.01	.00000
ATMOSPHERE									
COLD	.09	-.01	.00	.0001	.0003	.01	-.00	.04	.00001
3-SIGMA RSS =	3.56	.35	4.23	.0524	.0058	2.24	2.23	1.80	.00047

ORIGINAL PAGE IS OF POOR QUALITY

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	712.	-385.	-13022.	2.2	-.5	-20.7	780.	-.5	1.7	-.5	.004
TILT	-1561.	2203.	1501.	-5.0	4.0	1.6	-1561.	4.0	-2.3	4.0	-.005
ROLL	2225.	-3281.	1285.	7.1	-5.9	1.6	2225.	-5.9	3.1	-5.9	.007
DRIFT BIAS											
X	42.	-5.	-630.	.1	-.0	-1.7	42.	-.0	.1	-.0	.008
Y	-308.	250.	60.	-1.0	.6	.0	-308.	.6	-.7	.6	-.002
Z	448.	-377.	80.	1.5	-.9	.1	448.	-.9	1.0	-.9	.002
G-SENS IA DRIFT											
X	51.	-14.	-869.	.1	-.0	-2.0	51.	-.0	.1	-.0	.000
Y	-529.	460.	57.	-1.0	1.0	-.0	-528.	1.0	-1.3	1.0	-.003
Z	485.	-359.	81.	1.6	-.9	.1	485.	-.9	1.2	-.9	.003
G-SENS OA DRIFT											
X	45.	-3.	-684.	.1	-.8	-1.0	45.	-.0	.1	-.0	.000
Y	-390.	399.	173.	-1.3	.9	.2	-390.	.0	-.0	.0	-.002
Z	759.	-579.	180.	2.5	-1.5	.2	759.	-1.5	1.0	-1.5	.004
G-SQ SEN DRIFT											
X	41.	-13.	-704.	.1	-.0	-1.6	41.	-.6	.1	-.0	.000
Y	-436.	318.	16.	-1.5	.0	-.1	-435.	.0	-1.2	.0	-.003
Z	206.	-265.	66.	.9	-.6	.1	206.	-.6	.5	-.6	.001
ACCEL BIAS											
X	1244.	-750.	83.	3.6	-1.0	.1	1244.	-1.0	2.7	-1.0	.006
Y	647.	705.	-630.	1.0	1.7	-1.5	647.	1.7	2.7	1.7	.000
Z	344.	553.	996.	.9	1.2	2.2	344.	1.2	1.6	1.2	.004
ACCEL SCALE FAC											
X	702.	-410.	30.	1.5	-.6	.0	702.	-.6	1.0	-.6	.002
Y	560.	696.	-560.	1.5	1.4	-1.2	560.	1.4	2.3	1.4	.005
Z	193.	316.	560.	.5	.7	1.2	193.	.7	.9	.7	.002
ACCEL IA ALINE - OA											
X	1090.	-1161.	97.	5.2	-2.6	.2	1090.	-2.6	3.0	-2.6	.000
Y	661.	825.	-664.	1.7	1.0	-1.5	661.	1.0	2.7	1.0	.006
Z	330.	511.	922.	.6	.5	1.1	330.	.5	1.2	.5	.003
ACCEL IA ALINE - SA											
X	1226.	-750.	66.	3.4	-1.0	.1	1226.	-1.7	2.5	-1.0	.000
Y	623.	720.	-592.	1.1	.7	-.7	623.	.0	2.0	.7	.004
Z	546.	803.	1504.	1.4	1.0	3.4	548.	1.0	2.5	1.0	.005

TABLE A3.1-V. - RSS DATA AT OMS-1 CUTOFF (EVENT)
(CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CG											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-33.	-79.	-6.	-.0	.1	.0	-32.	.1	-.1	.1	-.000
S ISP	9.	17.	3.	-.0	-.1	-.0	9.	-.1	-.0	-.1	-.000
S PROP	0.	7.	1.	-.0	-.0	.0	0.	-.0	-.0	-.0	-.000
S INERT	4.	13.	2.	-.0	.0	-.0	4.	.0	-.0	.0	-.000
O THRST	-4.	-10.	3.	-.0	-.0	.0	-4.	-.0	-.0	-.0	-.000
O ISP	-21.	-47.	-4.	-.0	-.0	-.0	-21.	-.0	-.1	-.0	-.000
O INERT	4.	0.	1.	-.0	-.0	.0	4.	-.0	-.0	-.0	-.000
ET INERT	1.	3.	1.	-.0	-.0	-.0	1.	-.0	-.0	-.0	-.000
ET OXID	-42.	-72.	-3.	-.0	.1	-.0	-42.	.1	-.1	.1	-.000
ET FUEL	9.	12.	5.	-.0	-.0	-.0	8.	-.0	.0	-.0	.000
MIX RATIO	-1.	1.	1.	-.0	-.0	.0	-1.	-.0	-.0	-.0	-.000
ATMOSPHERE											
COLD	-15.	-24.	5.	-.0	-.0	.0	-15.	-.0	-.1	-.0	-.000
3-SIGMA RSS =	4357.	4020.	14252.	12.9	9.3	30.4	4357.	9.2	9.6	9.2	.021

TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 601 SECONDS

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	-1630.	4506.	27206.	-6.3	1.6	0.0	-1020.	1.6	-.9	1.6	-.002
TILT	1624.	17225.	-2034.	-23.3	-3.0	.2	1031.	-3.7	-2.9	-3.7	-.000
ROLL	-1607.	9650.	-1770.	-6.9	5.4	-.0	-1575	5.3	4.5	5.2	.010
DRIFT BIAS											
X	-124.	-340.	1435.	.3	.1	.6	-124.	.1	-.1	.1	-.000
Y	791.	22550.	-56.	-26.9	-.9	.0	803.	-.0	-.2	-.0	-.000
Z	-599.	4560.	-129.	-5.0	1.2	-.0	-599.	1.2	.4	1.2	.001
G-SENS IA DRIFT											
X	-115.	100.	1004.	-.3	.1	.6	-115.	.1	-.0	.1	-.000
Y	964.	-569.	-22.	.6	-1.5	.1	964.	-1.5	-.1	-1.5	-.000
Z	-572.	25320.	-75.	-29.9	1.4	-.0	-557.	1.4	.1	1.4	.000
G-SENS OA DRIFT											
X	-136.	72.	1520.	-.2	.1	.7	-130.	.1	-.1	.1	-.000
Y	059.	21701.	-200.	-26.1	-1.0	.0	070.	-1.0	-.3	-1.0	-.001
Z	-1258.	4094.	-162.	-5.5	2.2	-.0	-1250.	2.1	.3	2.1	.001
G-SQ SEN DRIFT											
X	-60.	033.	1476.	-1.0	.1	.5	-07.	.1	-.0	.1	-.000
Y	055.	-025.	30.	1.0	-1.3	.1	055.	-1.3	.0	-1.3	.000
Z	-403.	709.	-109.	-.6	.7	-.0	-403.	.7	.2	.7	.000
ACCEL BIAS											
X	-2090.	0015.	-75.	-10.6	3.0	-.0	-2080.	2.9	-.1	2.9	-.000
Y	-2703.	19716.	1420.	-27.4	1.4	.5	-2694.	1.3	-4.1	1.4	-.009
Z	-1304.	20297.	-1070.	-26.4	.6	-.5	-1355.	.6	-2.4	.6	-.005
ACCEL SCALE FAC											
X	-914.	25474.	-42.	-30.6	1.2	-.0	-090.	1.2	-.4	1.2	-.001
Y	-2934.	824.	1115.	-4.9	1.4	.3	-2934.	1.3	-4.2	1.4	-.009
Z	-1150.	637.	-1133.	-2.5	.5	-.3	-1150.	.5	-1.7	.5	-.004
ACCEL IA ALINE - OA											
X	-3305.	6930.	-165.	-0.6	4.5	-.0	-3393.	4.4	-.4	4.4	-.001
Y	-3253.	23456.	1340.	-32.9	1.6	.4	-3240.	1.6	-5.1	1.6	-.011
Z	-1157.	24205.	-1264.	-30.6	.0	.1	-1144.	.0	-1.9	.0	-.004
ACCEL IA ALINE - SA											
X	-2170.	4320.	-76.	-5.3	3.0	-.0	-2170.	2.9	-.2	2.9	-.000
Y	-2156.	24175.	055.	-31.7	1.4	-.1	-2143.	1.4	-3.0	1.4	-.007
Z	-3104.	1063.	-3079.	-6.1	1.3	-.9	-3103.	1.3	-4.0	1.3	-.011

TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-929.	-86793.	-28.	103.2	-.5	.1	-754.	1.2	.1	1.2	.000
S ISP	80.	-3948.	-66.	4.9	-.0	-.0	80.	.3	.2	.3	.000
S PROP	-36.	-2890.	-16.	3.4	.0	.0	-36.	.1	.0	.1	.000
S INERT	388.	-5280.	129.	7.0	-.2	.2	388.	-.1	.0	-.1	.002
O THRST	-847.	-50356.	282.	69.0	-.2	.3	-568.	.9	.5	.9	.001
O ISP	810.	10828.	308.	-12.0	-.3	.2	813.	-.5	.9	-.5	.002
O INERT	135.	5122.	-4.	-5.9	-.0	-.0	136.	.0	.2	-.0	.000
ET INERT	-6.	101.	-2.	-.1	.0	.0	-6.	.0	.1	.0	.000
ET OXID	-323.	-34348.	23.	41.2	-.1	.1	-296.	.6	.5	.6	.001
ET FUEL	150.	5155.	-59.	-5.0	.0	-.0	150.	.2	.3	.2	.001
MIX RATIO	74.	1400.	19.	-1.6	-.0	.0	74.	-.0	.1	-.0	.000
ATMOSPHERE											
COLD	531.	28871.	80.	-13.9	-.0	.0	550.	-.2	.3	-.2	.001
3-SIGMA RSS =	9137.	136273.	27916.	16[illegible].4	10.6	8.2	9098.	10.5	11.7	10.5	.026

TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	.063	.042	.006	.45	.00	-8.	0.	0.	0.
TILT	.002	-.020	-.011	-.06	.00	1.	0.	0.	0.
ROLL	-.014	.022	.012	1.36	.00	-3.	0.	0.	0.
DRIFT BIAS									
X	.003	.002	-.000	.03	.00	1.	0.	0.	0.
Y	.001	-.003	-.002	-.18	.00	3.	0.	0.	0.
Z	-.002	.004	.002	.25	.00	-9.	0.	0.	0.
G-SENS IA DRIFT									
X	.004	.003	.000	.03	.00	-0.	0.	0.	0.
Y	.002	-.006	-.003	-.32	.00	-4.	0.	0.	0.
Z	-.002	.005	.003	.29	.00	3.	0.	0.	0.
G-SENS OA DRIFT									
X	.004	.002	-.000	.63	.00	0.	0.	0.	0.
Y	.001	-.004	-.003	-.23	.00	4.	0.	0.	0.
Z	-.004	.008	.004	.44	.00	-7.	0.	0.	0.
G-SQ SEN DRIFT									
X	.003	.002	.000	.03	.00	-2.	0.	0.	0.
Y	.002	-.005	-.003	-.27	.00	-3.	0.	0.	0.
Z	-.001	.003	.002	.16	.00	1.	0.	0.	0.
ACCEL BIAS									
X	-.005	.012	.006	.67	.00	2.	0.	0.	0.
Y	.002	.005	.002	.19	.00	15.	0.	0.	0.
Z	-.005	-.001	.000	.07	.00	12.	0.	0.	0.
ACCEL SCALE FAC									
X	-.002	.006	.003	.33	.00	4.	0.	0.	0.
Y	.002	.004	.002	.17	.00	1.	0.	0.	0.
Z	-.003	-.001	.000	.04	.00	-4.	0.	0.	0.
ACCEL IA ALINE - OA									
X	-.008	.018	.010	1.01	.00	-5.	0.	0.	0.
Y	.002	.005	.002	.19	.00	4.	0.	0.	0.
Z	-.004	.000	-.000	.11	.00	0.	0.	0.	0.
ACCEL IA ALINE - SA									
X	-.005	.012	.006	.66	.00	-1.	0.	0.	0.
Y	.000	.005	.003	.24	.00	2.	0.	0.	0.
Z	-.008	-.002	.001	.11	.00	-4.	0.	0.	0.

TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS (CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CG									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
PERFORMANCE									
WEB ACT	.108	-.274	-.148	-15.30	.00	-9.	0.	0.	0.
S ISP	.024	-.061	-.033	-3.43	.00	-10.	0.	0.	0.
S PROP	.007	-.017	-.009	-.93	.00	0.	0.	0.	0.
S INERT	.006	-.015	-.009	-.87	.00	12.	0.	0.	0.
O THRST	.076	-.189	-.103	-10.59	.00	22.	0.	0.	0.
O ISP	-.012	.032	.017	1.78	.00	14.	0.	0.	0.
O INERT	.001	-.003	-.002	-.17	.00	172.	0.	0.	0.
ET INERT	.001	-.003	-.002	-.17	.00	-0.	0.	0.	0.
ET OXID	.048	-.120	-.065	-6.72	.00	-2.	0.	0.	0.
ET FUEL	.010	-.025	-.014	-1.42	.00	-5.	0.	0.	0.
MIX RATIO	.000	-.000	-.000	-.01	.00	-4.	0.	0.	0.
ATMOSPHERE									
COLD	-.012	.032	.017	1.77	.00	-8.	0.	0.	0.
3-SIGMA RSS =	.159	.389	.198	20.46	.00	178.	0.	0.	0.

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TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	-.21	.03	-.20	.0509	.0037	.16	-.22	-.10	-.00003
TILT	-1.03	-.15	-1.35	-.0048	-.0039	-.96	.95	-.60	-.00013
ROLL	1.59	.18	2.03	-.0039	-.0040	1.36	-1.33	.91	.00028
DRIFT BIAS									
X	-.02	.00	-.03	.0025	.0049	.01	-.01	-.01	-.00000
Y	-.10	-.04	-.18	-.0002	-.0000	-.18	.18	-.07	-.00001
Z	.18	.05	.26	-.0003	-.0003	.26	-.26	.12	.00002
G-SENS IA DRIFT									
X	-.01	.00	-.01	.0033	.0058	.01	-.02	-.00	-.00000
Y	-.13	-.08	-.24	-.0001	.0002	-.32	.31	-.11	-.00001
Z	.11	.07	.21	-.0002	-.0002	.29	-.28	.09	.00001
G-SENS OA DRIFT									
X	-.03	.00	-.03	.0026	.0053	.01	-.01	-.02	-.00000
Y	-.15	-.04	-.22	-.0005	-.0003	-.23	.23	-.10	-.00002
Z	.22	.10	.37	-.0003	-.0004	.45	-.45	.17	.00002
G-SQ SEN DRIFT									
X	.00	.00	.00	.0027	.0047	.01	-.02	.00	.00000
Y	-.09	-.08	-.20	-.0000	.0003	-.28	.27	-.09	-.00000
Z	.10	.02	.14	-.0002	-.0003	.15	-.15	.06	.00001
ACCEL BIAS									
X	.09	.08	.21	-.0002	-.0002	.55	-.54	.09	.00000
Y	-1.18	-.02	-1.35	.0025	.0048	-.08	.08	-.60	-.00016
Z	-.71	-.03	-.82	-.0035	-.0056	-.08	.08	-.37	-.00009
ACCEL SCALE FAC									
X	-.13	-.02	-.16	-.0001	-.0001	.17	-.16	-.07	-.00001
Y	-1.19	-.01	-1.35	.0021	.0034	-.08	.08	-.60	-.00017
Z	-.50	-.01	-.57	-.0021	-.0035	-.05	.05	-.25	-.00007
ACCEL IA ALINE - OA									
X	.06	.10	.21	-.0003	-.0005	.81	-.79	.09	-.00000
Y	-1.46	-.00	-1.64	.0025	.0042	-.10	.10	-.73	-.00020
Z	-.54	.00	-.60	-.0029	-.0025	.00	.00	-.27	-.00008
ACCEL IA ALINE - SA									
X	.08	.08	.19	-.0002	-.0002	.55	-.54	.09	.00000
Y	-.86	-.00	-.96	.0020	.0018	.02	-.02	-.43	-.00012
Z	-1.38	-.01	-1.57	-.0058	-.0094	-.13	.14	-.70	-.00019

TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CG									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	.11	.04	.17	-.0002	.0003	-.02	-.24	.08	.00001
S ISP	.08	.01	.09	-.0001	-.0002	.01	-.07	.04	.00001
S PROP	.00	-.00	.00	-.0000	-.0000	.00	-.02	.00	.00000
S INERT	.20	-.02	.21	.0001	.0007	.01	-.02	.09	.00003
O THRST	.14	-.03	.12	.0002	.0015	-.00	-.17	.04	.00002
O ISP	.28	.01	.30	.0004	.0013	.01	.01	.13	.00004
O INERT	.04	-.01	.04	-.0000	.0000	.01	-.01	.02	.00001
ET INERT	.01	-.01	.00	-.0000	.0000	.00	-.00	-.00	.00000
ET OXID	.12	-.03	.10	-.0001	.0003	.00	-.12	.04	.00002
ET FUEL	.09	-.02	.08	-.0001	-.0001	.02	-.04	.03	.00001
MIX RATIO	.03	-.00	.02	.0000	.0001	.00	-.00	.01	.00000
ATMOSPHERE									
COLD	.09	-.01	.09	.0001	.0003	.02	.01	.04	.00001
3-SIGMA RSS =	3.56	.34	4.23	.0523	.0857	2.18	2.18	1.89	.00048

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TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	1727.	-2147.	-27574.	3.6	-1.7	-8.1	1710.	-1.7	1.0	-1.7	.002
TILT	-1333.	6585.	2001.	-4.9	3.8	-.2	-1327.	3.4	2.9	3.4	.006
ROLL	1749.	-9538.	1763.	6.9	-5.4	.0	1747.	-5.3	-4.5	-5.2	-.018
DRIFT BIAS											
X	139.	-110.	-1447.	.3	-.1	-.6	138.	-.1	.1	-.1	.000
Y	-494.	1200.	55.	-1.2	.9	-.1	-493.	.6	.2	.5	.000
Z	745.	-1719.	120.	1.6	-1.2	.0	745.	-1.3	-.2	-1.3	-.000
G-SENS IA DRIFT											
X	143.	-149.	-1840.	.3	-.1	-.6	142.	-.1	.1	-.1	.000
Y	-940.	2039.	15.	-2.2	1.5	-.1	-939.	1.5	.2	1.5	.000
Z	882.	-1846.	87.	2.1	-1.3	.0	879.	-1.7	-.1	-1.7	-.000
G-SENS OA DRIFT											
X	153.	-115.	-1594.	.3	-.1	-.7	153.	-.1	.2	-.1	.000
Y	-545.	1545.	212.	-1.5	1.1	-.0	-544.	.7	.4	.7	.001
Z	1354.	-2905.	155.	3.2	-2.2	.0	1353.	-2.2	-.2	-2.2	-.000
G-SQ SEN DRIFT											
X	104.	-105.	-1495.	.2	-.1	-.5	104.	-.1	.1	-.1	.000
Y	-818.	1696.	-58.	-1.9	1.3	-.1	-818.	1.3	.1	1.3	.000
Z	421.	-1067.	98.	1.1	-.7	.0	421.	-.7	-.2	-.7	-.000
ACCEL BIAS											
X	2326.	-4122.	115.	5.2	-3.1	.0	2324.	-3.1	.3	-3.1	.001
Y	3420.	-576.	-1355.	5.6	-1.5	-.5	3419.	-1.7	5.0	-1.8	.011
Z	2056.	-163.	2035.	3.3	-.8	.6	2056.	-1.0	3.1	-1.1	.007
ACCEL SCALE FAC											
X	1226.	-1893.	28.	2.7	-1.2	-.0	1223.	-1.5	.4	-1.5	.001
Y	2939.	-539.	-1110.	4.8	-1.4	-.3	2938.	-1.3	4.2	-1.4	.009
Z	1164.	-90.	1139.	1.9	-.5	.3	1164.	-.5	1.8	-.5	.004
ACCEL IA ALINE - OA											
X	3462.	-6155.	188.	7.8	-4.5	.1	3461.	-4.4	.5	-4.4	.001
Y	3523.	-626.	-1360.	5.8	-1.6	-.4	3522.	-1.8	5.1	-1.9	.011
Z	1476.	-251.	1262.	2.2	-.8	-.1	1475.	-1.1	1.9	-1.1	.004
ACCEL IA ALINE - SA											
X	2239.	-4014.	122.	5.0	-3.0	.0	2238.	-2.9	.3	-2.9	.001
Y	2467.	-684.	-824.	3.8	-1.4	.1	2467.	-1.7	3.0	-1.7	.007
Z	3245.	-287.	3122.	5.2	-1.4	.9	3244.	-1.3	4.9	-1.4	.011

TABLE A3.1-VI. - RSS DATA AT NOMINAL OMS-1 CUTOFF + 691 SECONDS
(CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CG											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	-65.	101.	-32.	-.0	.2	-.0	-64.	.0	.1	.0	.000
S ISP	11.	61.	-28.	-.0	.0	-.0	11.	-.2	.1	-.2	.000
S PROP	22.	-2.	-7.	.0	-.0	-.0	22.	-.0	.0	-.0	.000
S INERT	-12.	72.	-41.	-.0	.1	-.1	-11.	.1	.0	.1	.000
O THRST	-18.	83.	-23.	-.0	.1	-.0	-18.	-.0	.1	-.0	.000
O ISP	-77.	98.	-47.	-.1	.2	-.0	-77.	.2	.0	.2	.000
O INERT	-0.	1.	-12.	-.0	-.0	-.0	-0.	-.1	-.0	-.1	-.000
ET INERT	0.	84.	-35.	-.0	.1	-.0	0.	.1	.1	.1	.000
ET OXID	-92.	110.	-29.	-.1	.2	-.0	-92.	.1	.0	.1	.000
ET FUEL	24.	82.	-25.	.0	.0	-.0	24.	-.2	.1	-.2	.000
MIX RATIO	5.	-5.	-4.	.0	-.0	-.8	5.	-.0	.0	-.0	.000
ATMOSPHERE											
COLD	-52.	92.	-10.	-.1	.1	-.0	-51.	-.1	.0	-.1	.000
3-SIGMA RSS =	9715.	15560.	28289.	19.8	10.7	8.3	9708.	10.6	12.2	10.8	.027

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TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	-1226.	7290.	4531.	-7.1	1.1	-32.5	-1224.	1.1	1.4	1.1	.003
TILT	-6497.	-2890.	340.	-2.3	5.4	2.4	-6497.	5.4	-5.8	5.4	-.013
ROLL	9884.	903.	154.	7.1	-8.3	2.1	9884.	-8.3	8.1	-8.3	.018
DRIFT BIAS											
X	-147.	662.	368.	-.7	.1	-1.8	-147.	.1	.0	.1	.000
Y	-660.	-2237.	38.	1.5	.5	.1	-660.	.5	-1.1	.5	-.002
Z	1137.	1812.	2.	-.4	-.9	.2	1137.	-.9	1.5	-.9	.003
G-SENS IA DRIFT											
X	-52.	115.	368.	-.0	.0	-2.1	-52.	.0	.1	.0	.000
Y	-861.	-3695.	59.	2.4	.6	.0	-861.	.6	-1.9	.6	-.004
Z	741.	2767.	12.	-1.5	-.6	.1	741.	-.6	1.7	-.6	.004
G-SENS OA DRIFT											
X	-194.	481.	428.	-.5	.2	-1.9	-194.	.2	.1	.2	.000
Y	-975.	-2339.	60.	1.4	.7	.2	-975.	.7	-1.4	.7	-.003
Z	1430.	4254.	3.	-2.3	-1.1	.2	1431.	-1.1	2.7	-1.1	.006
G-SQ SEN DRIFT											
X	7.	118.	307.	-.1	-.0	-1.8	7.	-.0	.1	-.0	.000
Y	-617.	-3064.	61.	2.0	.4	-.0	-617.	.4	-1.6	.4	-.004
Z	627.	741.	-6.	.1	-.5	.1	627.	-.5	.9	-.5	.002
ACCEL BIAS											
X	667.	6893.	12.	-4.2	-.4	.1	668.	-.4	3.8	-.4	.009
Y	-7208.	20372.	361.	-24.4	6.7	-1.4	-7198.	6.7	-.7	6.7	-.002
Z	-4323.	12084.	-289.	-14.6	4.0	1.8	-4319.	4.0	-.6	4.0	-.001
ACCEL SCALE FAC											
X	-754.	5206.	0.	-5.1	.6	.1	-753.	.6	.9	.6	.002
Y	-7284.	15905.	181.	-19.1	6.3	-1.3	-7277.	6.3	-.6	6.3	-.001
Z	-3054.	5215.	-203.	-6.4	2.6	1.4	-3053.	2.6	-.4	2.6	-.001
ACCEL IA ALINE - OA											
X	496.	12519.	-22.	-9.8	-.3	.2	500.	-.3	4.7	-.3	.011
Y	-8900.	18001.	238.	-21.7	7.7	-1.6	-8893.	7.7	-.7	7.7	-.002
Z	-3282.	6325.	187.	-7.4	2.8	1.5	-3281.	2.8	-.1	2.8	-.000
ACCEL IA ALINE - SA											
X	561.	8548.	9.	-6.8	-.4	.1	562.	-.4	3.2	-.4	.007
Y	-5207.	11932.	-108.	-13.8	4.5	-1.0	-5203.	4.5	.0	4.5	.000
Z	-8452.	16497.	-495.	-20.1	7.3	3.7	-8446.	7.3	-.9	7.3	-.002

TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	593.	-43031.	-9.	43.8	-.7	-.0	835.	-.6	-.4	-.6	-.001
S ISP	443.	-8715.	-23.	10.0	-.4	.1	445.	-.4	-.2	-.4	-.000
S PROP	26.	-3192.	-1.	3.7	-.0	.0	26.	-.0	.0	-.0	.000
S INERT	1217.	-4096.	117.	4.6	-1.1	-.2	1217.	-1.1	-.2	-1.1	-.000
O THRST	826.	27337.	157.	-31.9	-.0	-.3	943.	-.0	-.1	-.0	-.000
O ISP	1544.	-15952.	181.	18.2	-1.6	-.4	1550.	-1.5	-.3	-1.5	-.001
O INERT	270.	2750.	7.	-3.1	-.2	.0	271.	-.2	.1	-.2	.000
ET INERT	45.	-522.	10.	.4	-.1	-.0	45.	-.1	-.2	-.1	-.000
ET OXID	687.	11783.	15.	-13.9	-.7	-.0	690.	-.7	-.3	-.7	-.001
ET FUEL	509.	2511.	-12.	-3.1	-.5	.0	509.	-.5	-.2	-.5	-.000
MIX RATIO	156.	-335.	16.	.4	-.2	-.0	156.	-.2	-.0	-.2	-.000
ATMOSPHERE											
COLD	537.	285.	44.	-.5	-.5	-.1	537.	-.5	-.2	-.5	-.000
3-SIGMA RSS =	21854.	71814.	4883.	82.5	18.9	33.3	21844.	18.9	13.1	18.9	.038

TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	-.001	.024	.064	1.20	.01	-0.	0.	0.	0.
TILT	.005	-.006	-.003	-.42	-.05	1.	0.	0.	0.
ROLL	-.001	.002	-.006	.15	-.02	-3.	0.	0.	0.
DRIFT BIAS									
X	-.000	.002	.003	.11	.00	1.	0.	0.	0.
Y	.003	-.005	.002	-.34	-.03	4.	0.	0.	0.
Z	-.002	.004	-.002	.25	-.01	-9.	0.	0.	0.
G-SENS IA DRIFT									
X	.001	.001	.005	.03	-.01	0.	0.	0.	0.
Y	.006	-.009	.003	-.56	-.01	-4.	0.	0.	0.
Z	-.004	.007	-.003	.43	-.02	4.	0.	0.	0.
G-SENS OA DRIFT									
X	.000	.002	.003	.09	-.01	0.	0.	0.	0.
Y	.004	-.005	.002	-.35	-.02	5.	0.	0.	0.
Z	-.006	.010	-.004	.65	-.00	-6.	0.	0.	0.
G-SQ SEN DRIFT									
X	.000	.001	.004	.03	-.01	-2.	0.	0.	0.
Y	.005	-.007	.003	-.47	.00	-3.	0.	0.	0.
Z	-.001	.002	-.001	.12	-.02	2.	0.	0.	0.
ACCEL BIAS									
X	-.010	.017	-.007	1.07	-.08	3.	0.	0.	0.
Y	-.029	.048	-.016	3.11	.16	0.	0.	0.	0.
Z	-.018	.028	-.015	1.82	.12	6.	0.	0.	0.
ACCEL SCALE FAC									
X	-.008	.012	-.005	.80	-.01	4.	0.	0.	0.
Y	-.023	.038	-.012	2.45	-.01	2.	0.	0.	0.
Z	-.008	.012	-.008	.81	-.05	-4.	0.	0.	0.
ACCEL IA ALINE - OA									
X	-.018	.030	-.012	1.93	-.05	-5.	0.	0.	0.
Y	-.026	.043	-.013	2.79	-.07	5.	0.	0.	0.
Z	-.009	.016	-.009	.99	-.06	1.	0.	0.	0.
ACCEL IA ALINE - SA									
X	-.013	.020	-.008	1.31	-.00	-0.	0.	0.	0.
Y	-.018	.028	-.009	1.84	-.05	3.	0.	0.	0.
Z	-.025	.039	-.024	2.53	-.06	-3.	0.	0.	0.

TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)
(CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CO									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
PERFORMANCE									
WEB ACT	.063	-.111	.040	-7.06	2.10	-7.	0.	0.	0.
S ISP	.013	-.023	.008	-1.45	.53	-8.	0.	0.	0.
S PROP	.005	-.008	.003	-.51	.10	1.	0.	0.	0.
S INERT	.006	-.010	.004	-.66	.15	12.	0.	0.	0.
O THRST	-.040	.049	-.025	3.39	3.75	21.	0.	0.	0.
O ISP	.024	-.034	.016	-2.24	-.93	17.	0.	0.	0.
O INERT	-.004	.006	-.003	.39	.17	169.	0.	0.	0.
ET INERT	.001	-.001	.001	-.00	.03	0.	0.	0.	0.
ET OXID	-.017	.019	-.011	1.33	2.16	-0.	0.	0.	0.
ET FUEL	-.004	.004	-.002	.20	.40	-6.	0.	0.	0.
MIX RATIO	.001	-.001	.000	-.05	.00	-4.	0.	0.	0.
ATMOSPHERE									
COLD	-.000	.002	-.000	.13	-.38	-7.	0.	0.	0.
3-SIGMA RSS =	.105	.170	.094	10.95	4.90	173.	0.	0.	0.

TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	.19	-.23	-.10	.0518	.0037	-3.99	3.95	-.00	.00004
TILT	-.71	-.06	-1.37	-.0040	-.0039	15.46	-15.46	-.60	.00015
ROLL	1.07	-.80	2.04	-.0040	-.0039	-31.78	31.79	.90	-.00009
DRIFT BIAS									
X	.00	-.01	-.03	.0026	.0050	-.13	.13	-.01	.00000
Y	-.10	.11	-.10	-.0002	-.0006	3.32	-3.32	-.00	.00001
Z	.25	-.15	.26	-.0003	-.0004	-4.02	4.03	.11	-.00001
G-SENS IA DRIFT									
X	-.00	-.03	-.02	.0033	.0057	-.29	.20	-.01	-.00000
Y	-.30	.22	-.25	-.0001	.0001	5.90	-5.91	-.11	.00001
Z	.27	-.19	.10	-.0001	-.0001	-5.35	5.36	.00	-.00000
G-SENS OA DRIFT									
X	.01	-.02	-.04	.0027	.0053	-.25	.25	-.02	.00000
Y	-.23	.13	-.27	-.0005	-.0003	4.26	-4.27	-.12	.00001
Z	.47	-.27	.37	-.0003	-.0003	-8.52	8.53	.16	-.00000
G-SQ SEN DRIFT									
X	.01	-.01	-.00	.0027	.0040	-.20	.20	.00	-.00000
Y	-.27	.17	-.20	-.0000	.0003	5.00	-5.01	-.09	.00000
Z	.14	-.11	.13	-.0002	-.0003	-3.00	3.00	.06	-.00001
ACCEL BIAS									
X	.60	-.47	.23	-.0001	-.0001	-11.66	11.67	.10	.00002
Y	.13	-.34	-1.00	.0019	.0041	2.61	-2.56	-.40	.00019
Z	.09	-.04	-.64	-.0020	-.0040	2.19	-2.16	-.29	.00012
ACCEL SCALE FAC									
X	.07	-.20	-.19	-.0001	-.0001	-2.05	2.06	-.09	.00001
Y	-.10	-.42	-1.30	.0020	.0033	2.22	-2.10	-.62	.00016
Z	-.06	-.00	-.59	-.0021	-.0036	1.39	-1.37	-.26	.00007
ACCEL IA ALINE - OA									
X	.73	-.60	.21	-.0003	-.0065	-14.10	14.21	.09	.00004
Y	-.15	-.61	-1.70	.0024	.0041	2.60	-2.64	-.76	.00020
Z	-.04	-.14	-.84	-.0030	-.0026	.63	-.61	-.29	.00007
ACCEL IA ALINE - SA									
X	.49	-.39	.19	-.0001	-.0001	-9.75	9.77	.00	.00002
Y	-.02	-.30	-.99	.0020	.0010	.40	-.45	-.44	.00012
Z	-.14	-.52	-1.60	-.0059	-.0095	3.10	-3.12	-.71	.00019

TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CG									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	-.09	.03	.07	.0001	.0000	1.05	-1.17	.04	-.00002
S ISP	-.03	.02	.07	-.0001	-.0002	.41	-.43	.03	-.00001
S PROP	-.01	-.01	-.01	-.0000	-.0000	-.04	.03	-.01	-.00000
S INERT	-.03	.03	.20	.0001	.0007	.41	-.42	.09	-.00003
O THRST	-.02	.03	.15	.0003	.0011	.43	-.38	.06	-.00002
O ISP	-.14	-.03	.15	.0004	.0014	.05	-.09	.07	-.00005
O INERT	.02	-.00	.06	-.0001	-.0001	-.24	.25	.02	-.00001
ET INERT	-.05	.01	-.02	.0000	.0001	.60	-.61	-.01	-.00001
ET OXID	-.10	-.00	.05	.0001	.0001	.02	-.79	.02	-.00003
ET FUEL	-.04	.02	.07	-.0001	-.0001	.44	-.43	.03	-.00002
MIX RATIO	-.01	-.00	.02	.0000	.0001	-.01	.01	.01	-.00000
ATMOSPHERE									
COLD	-.05	.02	.07	.0001	.0004	.54	-.54	.03	-.00002
3-SIGMA RSS =	2.44	1.50	4.10	.0524	.0056	44.36	44.30	1.08	.00048

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TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)

(B) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	N-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	1393.	-7710.	-4805.	7.6	-1.3	33.0	1393.	-1.3	-1.4	-1.3	-.003
TILT	6473.	2317.	-350.	2.9	-5.3	-2.3	6472.	-5.3	5.6	-5.3	.013
ROLL	-9750.	-2505.	-156.	-5.2	8.2	-2.0	-9750.	8.2	-0.1	8.2	-.010
DRIFT BIAS											
X	211.	-679.	-382.	.7	-.2	1.0	211.	-.2	-.0	-.2	-.000
Y	697.	1836.	-49.	-.0	-.5	-.1	696.	-.5	1.1	-.5	.002
Z	-834.	-2805.	-0.	1.6	.7	-.1	-834.	.7	-1.4	.7	-.003
G-SENS IA DRIFT											
X	146.	-852.	-304.	.7	-.1	2.2	148.	-.1	-.1	-.1	-.000
Y	949.	3321.	-66.	-2.0	-.7	.0	940.	-.7	1.0	-.7	.004
Z	-741.	-3197.	-0.	2.1	.6	-.1	-740.	.6	-1.7	.6	-.004
G-SENS OA DRIFT											
X	245.	-750.	-453.	.0	-.2	2.0	245.	-.2	-.0	-.2	-.000
Y	1023.	1690.	-59.	-.6	-.7	-.2	1023.	-.7	1.3	-.7	.003
Z	-1282.	-4051.	-2.	3.0	.9	-.2	-1282.	.9	-2.6	.9	-.006
G-SQ SEN DRIFT											
X	130.	-400.	-311.	.5	-.1	1.0	129.	-.1	-.1	-.1	-.000
Y	727.	2045.	-76.	-1.0	-.5	.1	726.	-.5	1.6	-.5	.004
Z	-587.	-1430.	-5.	.7	.4	-.1	-586.	.4	-.9	.4	-.002
ACCEL BIAS											
X	-400.	-9214.	15.	6.9	.1	-.1	-407.	.1	-3.0	.1	-.000
Y	8717.	-10500.	-290.	22.4	-0.0	1.3	8711.	-0.0	.0	-0.0	.002
Z	5509.	-11312.	402.	13.0	-5.0	-2.0	5500.	-5.0	.7	-5.0	.002
ACCEL SCALE FAC											
X	745.	-5356.	-17.	5.3	-.5	-.0	746.	-.5	-1.0	-.5	-.002
Y	7302.	-15019.	-172.	19.0	-6.3	1.3	7299.	-6.3	.6	-6.3	.001
Z	3110.	-6401.	197.	7.0	-2.7	-1.4	3110.	-2.7	.4	-2.7	.001
ACCEL IA ALINE - OA											
X	-413.	-13794.	31.	11.3	.2	-.2	-414.	.2	-4.7	.2	-.011
Y	8025.	-19008.	-243.	22.0	-7.5	1.6	8021.	-7.5	.7	-7.5	.002
Z	3311.	-7509.	-109.	8.0	-2.0	-1.5	3312.	-2.0	.1	-2.0	.000
ACCEL IA ALINE - SA											
X	-379.	-8059.	15.	7.2	.2	-.1	-379.	.2	-3.1	.2	-.007
Y	5214.	-12399.	118.	14.4	-4.4	1.0	5213.	-4.4	-.0	-4.4	-.000
Z	8502.	-17766.	508.	21.6	-7.4	-3.0	8570.	-7.4	.9	-7.4	.002

TABLE A3.1-VII. - RSS DATA AT OMS-2 CUTOFF (EVENT)
(CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	271.	41.	-19.	.3	-.1	.0	263.	-.1	.3	-.1	.001
S ISP	179.	-120.	-27.	.3	-.1	.1	178.	-.1	.1	-.1	.000
S PROP	54.	-104.	-6.	.1	-.0	.0	53.	-.0	.0	-.0	.000
S INERT	181.	-30.	-40.	.2	-.1	.0	180.	-.1	.2	-.1	.000
O THRST	179.	-16.	-26.	.2	-.2	.0	184.	-.2	.2	-.2	.000
O ISP	147.	182.	-38.	.0	-.1	.1	144.	-.1	.2	-.1	.001
O INERT	-23.	26.	-14.	-.1	.0	.0	-23.	.0	-.0	.0	-.000
ET INERT	244.	-136.	-32.	.3	-.2	.1	244.	-.2	.2	-.2	.000
ET OXID	164.	208.	-20.	.0	.1	.1	166.	.1	.3	.1	.001
ET FUEL	238.	-223.	-28.	.4	-.2	.1	239.	-.2	.1	-.2	.000
MIX RATIO	1.	-20.	-3.	.0	.0	.0	1.	.0	-.0	.0	-.000
ATMOSPHERE											
COLD	151.	88.	-14.	.1	-.1	.0	151.	-.1	.2	-.1	.000
3-SIGMA RSS =	22489.	48834.	4757.	52.5	19.4	33.8	22482.	19.4	13.1	19.4	.030

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 61 SECONDS

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	-1141.	7436.	2582.	-7.2	1.0	-32.8	-1140.	1.0	1.4	1.0	.003
TILT	-6829.	-2086.	481.	-3.0	5.8	2.3	-6829.	5.8	-5.4	5.8	-.012
ROLL	10362.	-321.	270.	8.1	-8.9	2.1	10362.	-8.9	7.7	-8.9	.017
DRIFT BIAS											
X	-144.	680.	258.	-.7	.1	-1.8	-144.	.1	.1	.1	.000
Y	-723.	-2158.	42.	1.5	.6	.1	-723.	.6	-1.0	.6	-.002
Z	1224.	1471.	13.	-.3	-1.0	.2	1224.	-1.0	1.4	-1.0	.003
G-SENS IA DRIFT											
X	-47.	120.	236.	-.1	.0	-2.2	-47.	.0	.1	.0	.000
Y	-974.	-3590.	60.	2.3	.7	.0	-973.	.7	-1.9	.7	-.004
Z	841.	2674.	15.	-1.5	-.7	.1	841.	-.7	1.8	-.7	.004
G-SENS OA DRIFT											
X	-188.	504.	315.	-.5	.2	-1.9	-188.	.2	.1	.2	.000
Y	-1056.	-2222.	73.	1.3	.8	.2	-1056.	.8	-1.3	.8	-.003
Z	1589.	4078.	13.	-2.1	-1.3	.2	1590.	-1.3	2.8	-1.3	.006
G-SQ SEN DRIFT											
X	11.	115.	198.	-.1	-.0	-1.8	10.	-.0	.1	-.0	.000
Y	-713.	-2989.	59.	1.9	.5	-.0	-712.	.5	-1.6	.5	-.004
Z	682.	662.	2.	.1	-.6	.1	682.	-.6	.9	-.6	.002
ACCEL BIAS											
X	895.	6805.	15.	-4.1	-.7	.1	896.	-.7	3.8	-.7	.009
Y	-7241.	21280.	277.	-25.1	6.7	-1.4	-7231.	6.7	-.4	6.7	-.001
Z	-4353.	12630.	-179.	-15.1	4.0	1.8	-4349.	4.0	-.4	4.0	-.001
ACCEL SCALE FAC											
X	-698.	5290.	4.	-5.2	.5	.1	-696.	.5	1.0	.5	.002
Y	-7310.	16795.	102.	-19.8	6.3	-1.3	-7304.	6.3	-.3	6.3	-.001
Z	-3072.	5588.	-121.	-6.7	2.6	1.4	-3071.	2.6	-.2	2.6	-.001
ACCEL IA ALINE - OA											
X	780.	12449.	-11.	-9.8	-.6	.2	783.	-.6	4.7	-.6	.011
Y	-8935.	19087.	141.	-22.6	7.7	-1.6	-8927.	7.7	-.4	7.7	-.001
Z	-3284.	6723.	276.	-7.8	2.8	1.5	-3283.	2.8	.0	2.8	.000
ACCEL IA ALINE - SA											
X	750.	8473.	13.	-6.7	-.6	.1	752.	-.6	3.1	-.6	.007
Y	-5199.	12566.	-169.	-14.4	4.5	-1.0	-5195.	4.5	.2	4.5	.001
Z	-8499.	17532.	-270.	-21.0	7.4	3.8	-8492.	7.4	-.6	7.4	-.001

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 81 SECONDS
(CONTINUED)

(A) ACTUAL MINUS NOMINAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
WEB ACT	418.	-91859.	-7.	108.3	-.8	-.1	609.	-.5	-.4	-.5	-.001
S ISP	433.	-8770.	-18.	10.0	-.4	.1	435.	-.4	-.2	-.4	-.000
S PROP	27.	-3197.	0.	3.7	-.0	.0	27.	-.0	-.0	-.0	-.000
S INERT	1204.	-4246.	107.	4.7	-1.1	-.2	1204.	-1.1	-.2	-1.1	-.001
O THRST	717.	-70265.	138.	81.5	-.8	-.4	830.	-.7	-.2	-.7	-.000
O ISP	1525.	8222.	158.	-10.0	-1.5	-.4	1527.	-1.5	-.4	-1.5	-.001
O INERT	275.	2717.	9.	-3.1	-.2	.0	275.	-.2	.1	-.2	.000
ET INERT	33.	-530.	9.	.4	-.1	-.0	33.	-.1	-.2	-.1	-.000
ET OXID	638.	-37136.	12.	42.8	-.7	-.1	670.	-.7	-.3	-.7	-.001
ET FUEL	498.	2447.	-10.	-3.0	-.5	.0	498.	-.5	-.2	-.5	-.000
MIX RATIO	156.	-355.	14.	.4	-.2	-.0	155.	-.2	-.0	-.2	-.000
ATMOSPHERE											
COLD	511.	24592.	37.	-28.8	-.5	-.1	525.	-.5	-.2	-.5	-.001
3-SIGMA RSS =	22269.	133287.	2746.	154.0	19.4	33.6	22266.	19.4	12.7	19.4	.029

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 61 SECONDS

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
PLATFORM ALINE									
AZIMUTH	-.005	.022	.065	1.21	.00	-8.	0.	0.	0.
TILT	.002	-.001	-.005	-.10	.00	1.	0.	0.	0.
ROLL	.001	.001	-.005	.02	.00	-3.	0.	0.	0.
D[illegible] BIAS									
X	-.000	.002	.003	.10	.00	1.	0.	0.	0.
Y	.002	-.004	.001	-.23	.00	4.	0.	0.	0.
Z	-.002	.004	-.002	.26	.00	-9.	0.	0.	0.
G-SENS IA DRIFT									
X	-.000	.002	.004	.08	.00	0.	0.	0.	0.
Y	.005	-.008	.003	-.50	.00	-4.	0.	0.	0.
Z	-.004	.008	-.003	.46	.00	4.	0.	0.	0.
G-SENS OA DRIFT									
X	-.000	.002	.003	.12	.00	0.	0.	0.	0.
Y	.002	-.004	.001	-.24	.00	5.	0.	0.	0.
Z	-.006	.010	-.005	.63	.00	-6.	0.	0.	0.
G-SQ SEN DRIFT									
X	.000	.001	.004	.05	.00	-2.	0.	0.	0.
Y	.004	-.007	.003	-.46	.00	-3.	0.	0.	0.
Z	-.002	.003	-.002	.18	.00	2.	0.	0.	0.
ACCEL BIAS									
X	-.012	.021	-.009	1.27	.00	3.	0.	0.	0.
Y	-.024	.042	-.015	2.60	.00	8.	0.	0.	0.
Z	-.014	.023	-.014	1.45	.00	6.	0.	0.	0.
ACCEL SCALE FAC									
X	-.008	.014	-.006	.84	.00	4.	0.	0.	0.
Y	-.024	.042	-.015	2.59	.00	2.	0.	0.	0.
Z	-.010	.017	-.010	1.03	.00	-4.	0.	0.	0.
ACCEL IA ALINE - OA									
X	-.019	.033	-.015	2.06	.00	-5.	0.	0.	0.
Y	-.029	.051	-.018	3.14	.00	5.	0.	0.	0.
Z	-.011	.021	-.012	1.27	.00	1.	0.	0.	0.
ACCEL IA ALINE - SA									
X	-.012	.021	-.009	1.29	.00	-0.	0.	0.	0.
Y	-.020	.034	-.012	2.07	.00	3.	0.	0.	0.
Z	-.027	.046	-.028	2.86	.00	-3.	0.	0.	0.

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 61 SECONDS (CONTINUED)

(B) ACTUAL MINUS NOMINAL VEHICLE PARAMETERS

	LATD (DEG)	LONG (DEG)	AZIM (DEG)	RANGE (NM)	TIME (SEC)	WEIGHT (LBS)	PROP (LBS)	OXID (LBS)	FUEL (LBS)
CO									
X	.000	.000	.000	.00	.00	0.	0.	0.	0.
Y	.000	.000	.000	.00	.00	0.	0.	0.	0.
Z	.000	.000	.000	.00	.00	0.	0.	0.	0.
PERFORMANCE									
WEB ACT	.136	-.236	.101	-14.55	.00	-7.	0.	0.	0.
S ISP	.031	-.054	.023	-3.34	.00	-9.	0.	0.	0.
S PROP	.008	-.014	.006	-.88	.00	1.	0.	0.	0.
S INERT	.012	-.020	.009	-1.22	.00	12.	0.	0.	0.
O THRST	.096	-.166	.072	-10.23	.00	21.	0.	0.	0.
O ISP	-.010	.019	-.007	1.15	.00	17.	0.	0.	0.
O INERT	.002	-.004	.002	-.24	.00	169.	0.	0.	0.
ET INERT	.002	-.003	.001	-.18	.00	0.	0.	0.	0.
ET OXID	.061	-.106	.046	-6.54	.00	-0.	0.	0.	0.
ET FUEL	.014	-.024	.010	-1.48	.00	-6.	0.	0.	0.
MIX RATIO	.001	-.001	.000	-.06	.00	-4.	0.	0.	0.
ATMOSPHERE									
COLD	-.014	.024	-.010	1.49	.00	-7.	0.	0.	0.
3-SIGMA RSS =	.194	.337	.160	20.74	.00	173.	0.	0.	0.

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 61 SECONDS

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
PLATFORM ALINE									
AZIMUTH	.19	-.23	-.19	.051C	.0037	-4.74	4.70	-.09	.00003
TILT	-.71	-.05	-1.37	-.0048	-.0039	16.33	-16.33	-.61	.00016
ROLL	1.87	-.60	2.04	-.0040	-.0039	-36.87	36.87	.90	-.00009
DRIFT BIAS									
X	.00	-.01	-.03	.0026	.0050	-.17	.17	-.01	.00000
Y	-.18	.11	-.18	-.0002	-.0000	3.73	-3.73	-.08	.00001
Z	.25	-.15	.26	-.0003	-.0004	-5.44	5.44	.11	-.00002
G-SENS IA DRIFT									
X	-.00	-.03	-.02	.0033	.0057	-.32	.32	-.01	-.00000
Y	-.30	.22	-.25	-.0001	.0001	6.64	-6.65	-.11	.00001
Z	.27	-.19	.18	-.0001	-.0001	-6.09	6.10	.08	-.00001
G-SENS OA DRIFT									
X	.01	-.02	-.04	.0027	.0053	-.31	.31	-.02	.00000
Y	-.23	.13	-.27	-.0005	-.0003	4.77	-4.78	-.12	.00001
Z	.47	-.27	.37	-.0003	-.0003	-9.74	9.75	.16	-.00001
G-SQ SEN DRIFT									
X	.01	-.01	.00	.0027	.0048	-.22	.22	.00	-.00000
Y	-.27	.18	-.20	-.0000	.0003	5.66	-5.67	-.09	.00001
Z	.14	-.11	.13	-.0002	-.0003	-3.37	3.37	.06	-.00001
ACCEL BIAS									
X	.60	-.47	.23	-.0001	-.0001	-13.45	13.47	.10	.00001
Y	.13	-.34	-1.08	.0019	.0041	1.97	-1.93	-.48	.00020
Z	.09	-.05	-.64	-.0028	-.0048	1.84	-1.81	-.28	.00012
ACCEL SCALE FAC									
X	.07	-.20	-.19	-.0001	-.0001	-3.33	3.34	-.09	.00001
Y	-.10	-.42	-1.38	.0020	.0033	1.69	-1.64	-.62	.00018
Z	-.06	-.08	-.59	-.0021	-.0036	1.20	-1.18	-.28	.00007
ACCEL IA ALINE - OA									
X	.73	-.61	.21	-.0003	-.0005	-16.39	16.43	.09	.00003
Y	-.15	-.61	-1.70	.0024	.0041	2.06	-2.01	-.76	.00020
Z	-.04	-.14	-.64	-.0030	-.0026	.33	-.31	-.29	.00007
ACCEL IA ALINE - SA									
X	.49	-.39	.19	-.0001	-.0001	-11.24	11.26	.08	.00001
Y	-.02	-.30	-.99	.0020	.0018	-.05	.09	-.44	.00012
Z	-.14	-.52	-1.60	-.0059	-.0095	2.64	-2.58	-.71	.00019

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 61 SECONDS
(CONTINUED)

(C) ACTUAL MINUS NOMINAL ORBITAL PARAMETERS

	HA (NM)	HP (NM)	PERIOD (SEC)	INCLIN (DEG)	ASC NOD (DEG)	ARG PER (DEG)	TRU ANOM (DEG)	SMAJ AXS (NM)	ECCENT (ND)
CG									
X	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Y	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
Z	.00	.00	.00	.0000	.0000	.00	.00	.00	.00000
PERFORMANCE									
WEB ACT	-.09	.03	.07	.0002	.0002	1.22	-1.47	.05	-.00001
S ISP	-.03	.02	.07	-.0001	-.0002	.52	-.50	.03	-.00001
S PROP	-.01	-.01	-.01	-.0000	-.0000	-.03	.02	-.00	-.00000
S INERT	-.03	.03	.20	.0001	.0007	.66	-.60	.09	-.00003
O THRST	-.02	.03	.15	.0005	.0014	.37	-.55	.08	-.00002
O ISP	-.14	-.03	.15	.0004	.0013	1.40	-1.38	.07	-.00005
O INERT	.02	.00	.06	-.0001	-.0001	-.25	.25	.03	-.00001
ET INERT	-.05	.01	-.02	.0000	.0001	.72	-.72	-.01	-.00000
ET OXID	-.10	-.00	.05	.0002	.0003	.95	-1.07	.03	-.00002
ET FUEL	-.04	.02	.07	-.0000	-.0001	.56	-.59	.03	-.00001
MIX RATIO	-.01	-.00	.02	.0000	.0001	.02	-.02	.01	-.00000
ATMOSPHERE									
COLD	-.05	.02	.07	.0001	.0004	.74	-.71	.03	-.00002
3-SIGMA RSS =	2.44	1.59	4.18	.0524	.0856	50.51	50.54	1.86	.00047

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 81 SECONDS

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
PLATFORM ALINE											
AZIMUTH	1309.	-7885.	-2609.	7.7	-1.1	33.3	1309.	-1.1	-1.4	-1.1	-.003
TILT	6806.	1513.	-497.	3.6	-5.9	-2.3	6806.	-5.9	5.4	-5.9	.012
ROLL	-10236.	-1297.	-279.	-8.2	8.7	-2.0	-10236.	8.7	-7.8	8.7	-.017
DRIFT BIAS											
X	288.	-703.	-250.	.8	-.2	1.9	209.	-.2	-.9	-.2	-.008
Y	781.	1549.	-51.	-.8	-.7	-.0	760.	-.7	1.0	-.7	.002
Z	-921.	-2501.	-15.	1.5	.8	-.1	-920.	.8	-1.4	.8	-.003
G-SENS IA DRIFT											
X	139.	-670.	-250.	.7	-.1	2.2	139.	-.1	-.1	-.1	-.000
Y	1060.	3206.	-64.	-1.9	-.8	.0	1059.	-.8	1.8	-.8	.004
Z	-840.	-3107.	-13.	2.0	.5	-.1	-839.	.5	-1.6	.5	-.004
G-SENS OA DRIFT											
X	241.	-790.	-334.	.8	-.2	2.0	241.	-.2	-.1	-.2	-.000
Y	1103.	1570.	-73.	-.5	-1.0	-.2	1103.	-1.0	1.3	-1.0	.003
Z	-1420.	-4E96.	-12.	2.9	1.1	-.2	-1420.	1.1	-2.6	1.1	-.006
G-SQ SEN DRIFT											
X	124.	-504.	-201.	.5	-.1	1.8	124.	-.1	-.1	-.1	-.000
Y	822.	2856.	-73.	-1.8	-.6	.1	821.	-.6	1.6	-.6	.004
Z	-621.	-1360.	-10.	.7	.5	-.1	-621.	.5	-.9	.5	-.002
ACCEL BIAS											
X	-849.	-9159.	9.	6.5	.4	-.1	-848.	.4	-4.1	.4	-.009
Y	8753.	-19680.	-214.	23.2	-8.2	1.2	8747.	-8.2	.4	-8.2	.001
Z	5542.	-12010.	291.	14.4	-5.4	-1.8	5541.	-5.4	.4	-5.4	.001
ACCEL SCALE FAC											
X	688.	-5443.	-19.	5.3	-.7	-.6	609.	-.7	-1.8	-.7	-.002
Y	7327.	-16711.	-90.	19.7	-6.3	1.3	7324.	-6.3	.3	-6.3	.001
Z	31[illegible].	-6783.	114.	8.1	-2.7	-1.4	3136.	-2.7	.2	-2.7	.001
ACCEL IA ALINE - OA											
X	-698.	-13733.	18.	11.3	.5	-.2	-897.	.5	-4.7	.5	-.011
Y	8859.	-20088.	-143.	23.7	-7.8	1.6	8855.	-7.8	.4	-7.8	.001
Z	3313.	-7915.	-276.	9.1	-3.0	-1.4	3313.	-3.0	-.1	-3.0	-.000
ACCEL IA ALINE - SA											
X	-568.	-8807.	8.	7.1	.4	-.1	-567.	.4	-3.1	.4	-.007
Y	5207.	-13036.	177.	14.9	-4.6	1.0	5206.	-4.6	-.2	-4.6	-.001
Z	8628.	-18817.	272.	22.5	-7.5	-3.8	8825.	-7.5	.6	-7.5	.001

TABLE A3.1-VIII. - RSS DATA AT NOMINAL OMS-2 CUTOFF + 61 SECONDS (CONTINUED)

(D) NAVIGATED MINUS ACTUAL STATE PARAMETERS

	U (FT)	V (FT)	W (FT)	U-DOT (FPS)	V-DOT (FPS)	W-DOT (FPS)	ALTITUDE (FT)	SPEED (FPS)	H-DOT (FPS)	DR-DOT (FPS)	GAMMA (DEG)
CO											
X	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Y	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
Z	0.	0.	0.	.0	.0	.0	0.	.0	.0	.0	.000
PERFORMANCE											
NEB ACT	303.	-7.	-15.	.3	-.2	.1	284.	-.2	.3	-.2	.001
S ISP	186.	-142.	-24.	.3	-.1	.1	185.	-.2	.1	-.2	.000
S PROP	54.	-109.	-4.	.1	-.0	.0	54.	-.0	.0	-.0	.000
S INERT	192.	-50.	-38.	.2	-.1	.0	191.	-.1	.2	-.1	.000
O THRST	211.	-55.	-24.	.2	-.1	.0	197.	-.1	.1	-.1	.000
O ISP	155.	160.	-31.	.0	-.1	.1	156.	-.1	.2	-.1	.001
O INERT	-25.	29.	-13.	-.1	.0	.0	-24.	.0	-.0	.0	-.000
ET INERT	255.	-163.	-29.	.4	-.2	.0	255.	-.2	.2	-.2	.000
ET OXID	192.	173.	-16.	.1	-.3	.1	184.	-.3	.3	-.3	.001
ET FUEL	246.	-250.	-22.	.4	-.2	.1	246.	-.2	.1	-.2	.000
MIX RATIO	1.	-20.	-2.	.0	.0	.0	1.	.0	.0	.0	.000
ATMOSPHERE											
COLD	156.	71.	-13.	.1	-.3	.0	161.	-.3	.2	-.3	.000
3-SIGMA RSS =	22902.	48559.	2790.	54.4	20.2	34.1	22895.	20.2	12.0	20.2	.020

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TABLE A3.2-I.- DEFINITION OF COVARIANCE AND CORRELATION MATRIX ELEMENTS

Matrix element	Definition	Unit
U ACT[a]	Actual position dispersion - radial	ft
V ACT	Actual position dispersion - downrange	ft
W ACT	Actual position dispersion - crossrange	ft
U-DOT ACT	Actual velocity dispersion - radial	fps
V-DOT ACT	Actual velocity dispersion - downrange	fps
W-DOT ACT	Actual velocity dispersion - crossrange	fps
U NAV[b]	Navigated position uncertainty - radial	ft
V NAV	Navigated position uncertainty - downrange	ft
W NAV	Navigated position uncertainty - crossrange	ft
U-DOT NAV	Navigated velocity uncertainty - radial	fps
V-DOT NAV	Navigated velocity uncertainty - downrange	fps
W-DOT NAV	Navigated velocity uncertainty - crossrange	fps
WT	Total vehicle weight	lb
TIME	Time from lift-off	sec
X ACC BIAS	Platform X accelerometer bias	fps^2
Y ACC BIAS	Platform Y accelerometer bias	fps^2
Z ACC BIAS	Platform Z accelerometer bias	fps^2
X MISALIGN	Misalinement about platform X-axis	rad
Y MISALIGN	Misalinement about platform Y-axis	rad
Z MISALIGN	Misalinement about platform Z-axis	rad

[a]The actual state dispersion is computed by constructing a UVW system defined by the nominal actual state at the event/time slice of interest. Then,

Actual dispersion = (Perturbed actual state in UVW) minus (Nominal actual state in UVW)

[b]The navigated state uncertainty is computed by constructing a UVW system defined by the nominal navigated state at the event/time slice of interest. Then,

Navigated uncertainty = (Perturbed navigated state in UVW) minus (Perturbed actual state in UVW)

TABLE A3.2-II.- COVARIANCE AND CORRELATION MATRICES AT SRB SEPARATION

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	7.1484021+05						
V ACT	2.4246452+06	9.8726820+06					
W ACT	-5.8347288+05	-2.7318657+06	6.98C8552+05				
U-DOT ACT	-3.2243012+03	-2.5145488+04	1.C197160+04	1.4060081+02			
V-DOT ACT	7.4864176+02	-2.6430136+04	1.5446314+04	2.5451642+02	5.3865761+02		
W-DOT ACT	2.8867496+02	-2.9719555+03	1.9599637+03	3.3766966+01	7.3332479+01	1.0036090+01	
U NAV	7.3018291+02	2.7523719+03	-7.1447343+02	-6.1121538+00	-5.0882007+00	-4.9670678-01	1.0726228+03
V NAV	1.0207076+03	4.4480682+03	-1.3276425+03	-1.3240835+01	-1.740C496+01	-2.0892115+00	-1.0197553+03
W NAV	3.8568355+01	3.1893103+02	-2.2306602+02	-2.8834718+00	-5.9463528+00	-7.8577297-01	-4.0914009+02
U-DOT NAV	1.2071683+02	5.4874190+02	-1.6871200+02	-1.7809402+00	-2.4502647+00	-3.0111402-01	1.9914438+01
V-DOT NAV	1.9834306+02	9.1641344+02	-2.8232347+02	-3.0049914+00	-4.0932234+00	-5.C626026-01	-1.4513010+01
W-DOT NAV	3.2950764+01	1.5369563+02	-4.7673135+01	-5.0776160-01	-7.0434433-01	-8.7359950-02	-7.5070737+00
WT	-4.7520074+06	-1.9290492+07	5.3928227+06	4.7496472+04	5.2899103+04	5.9152380+03	-4.7781204+03
TIME	1.2883160+03	5.9716708+03	-1.8525273+03	-1.9752224+01	-2.7441CC4+01	-3.3985509+00	1.5996490+00
X ACC BIAS	1.4970249-06	-8.0324633-06	-2.5962650-06	7.8244553-07	3.3279966-07	1.4754760-07	2.1842650-02
Y ACC BIAS	-6.2174905-08	-3.8454035-06	1.6140481-06	5.3489327-07	1.7368980-07	9.6766245-08	2.0405198-C3
Z ACC BIAS	-3.1087453-08	-1.9327018-06	8.0703404-07	3.0401027-07	8.5827551-C8	4.7355208-08	2.3885238-04
X MISALIGN	7.6171136-09	4.7355469-07	-1.9774119-07	-3.9986849-C8	-2.3786413-08	-6.8977614-09	1.2985272-03
Y MISALIGN	2.5310657-06	1.2968169-06	4.4909592-06	6.0503276-08	1.7910372-08	1.0914691-08	-1.393?847-03
Z MISALIGN	-1.1815324-05	9.3943373-07	7.7552485-08	-9.3879485-08	-3.9835385-C8	-1.6339362-08	2.0615119-03

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	4.4469566+03						
W NAV	-3.2316833+02	1.1420196+04					
U-DOT NAV	-2.3283306+01	-9.4483691+00	4.1490912-01				
V-DOT NAV	6.7018600+01	-1.2427150+01	-2.8617235-01	1.1031431+00			
W-DOT NAV	-7.2168137+00	2.1424205+02	-1.6595267-01	-2.5574951-01	4.1375358+00		
WT	-8.9702070+03	-1.0127786+03	-1.0913276+03	-1.7933515+03	-3.0248463+02	4.4017476+07	
TIME	2.8303158+00	4.3074494-01	3.5585770-01	5.9451926-01	1.0022282-01	-1.1763698+04	3.8940445+00
X ACC BIAS	-1.7632990-03	7.7772181-04	3.3313646-04	-2.9300679-05	9.6028351-06	-1.6757291-05	0.CCOCCCO
Y ACC BIAS	2.0165340-02	-9.2688982-03	3.2682199-05	3.2347543-04	-1.5154282-04	-8.3786457-06	0.0C00C00
Z ACC BIAS	9.5557362-03	2.0380850-02	3.1300324-06	1.3988374-04	2.9985065-04	-8.3786457-06	0.CCCCCCO
X MISALIGN	1.8742867-03	-3.7821531-02	3.0025685-05	6.9954985-05	-7.9983962-04	2.4493883-06	0.CCCCCCO
Y MISALIGN	3.1050794-03	6.3344684-03	-3.2334166-05	4.6504924-05	9.2457927-05	-1.3231250-06	0.000C?00
Z MISALIGN	-6.4838742-03	2.9950328-03	4.6949192-05	-9.5179341-05	4.3942257-05	3.3078124-06	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.000C000	2.5879156-06				
Z ACC BIAS	0.CCCOCOO	0.0000000	2.5879156-06			
X MISALIGN	0.CCCCCCO	0.000CCCO	0.CCC?000	2.0074403-07		
Y MISALIGN	0.0CCCC00	0.C0CC000	0.0000000	0.000C000	1.7024872-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.C000000	1.6579854-08

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TABLE A3.2-II.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	9.1269597-01	1.0000000+00					
W ACT	-6.7828865-01	-9.1765111-01	1.0000000+00				
U-DOT ACT	-3.2161567-01	-6.7491423-01	9.0745843-01	1.0000000+00			
V-DOT ACT	3.8151635-02	-3.6243108-01	7.0227889-01	9.2411091-01	1.0000000+00		
W-DOT ACT	1.0777807-01	-2.9858745-01	8.5283927-01	8.9890927-01	9.9737319-01	1.0000000+00	
U NAV	2.6369607-02	2.6746442-02	-2.3019915-02	-1.5738989-02	-6.6939786-03	-4.7873401-03	1.0000000+00
V NAV	1.8103620-02	2.1228652-02	-2.1008298-02	-1.6745187-02	-1.1242782-02	-9.8893713-03	-4.6691843-01
W NAV	6.4819687-04	1.5454512-03	-2.2026139-03	-2.2755428-03	-2.3974938-03	-2.3210154-03	-1.1689925-01
U-DOT NAV	2.2165975-01	2.7112781-01	-2.7630255-01	-2.3317336-01	-1.6390044-01	-1.4756121-01	9.4399142-01
V-DOT NAV	2.2335548-01	2.7768854-01	-2.8564309-01	-2.4128671-01	-1.6791641-01	-1.5215129-01	-4.2190830-01
W-DOT NAV	1.9159762-02	2.4047676-02	-2.4731132-02	-2.1052085-02	-1.4919619-02	-1.3556863-02	-1.1268764-01
WT	-8.4714948-01	-9.2536520-01	8.5771842-01	6.0374685-01	3.4354160-01	2.8143452-01	-2.1989786-02
TIME	7.7217805-01	9.6311430-01	-9.9061595-01	-8.4415391-01	-5.9916046-01	-5.4363956-01	2.4751455-02
X ACC BIAS	1.1006506-06	-1.5891179-06	-1.7030018-06	4.1019008-05	8.9135647-06	2.8951749-05	4.1457848-01
Y ACC BIAS	-4.5712564-08	-7.6471958-07	1.0587366-06	2.8041302-05	4.6520338-06	1.8987446-05	3.8729530-02
Z ACC BIAS	-2.2856282-08	-3.8235979-07	5.2936832-07	1.5937467-05	2.2987687-06	9.2520259-06	4.5334726-03
X MISALIGN	2.0107805-08	5.3638084-07	-4.6571152-07	-7.5266540-06	-2.2874490-06	-4.8596452-06	8.8492446-02
Y MISALIGN	2.2943359-05	3.1631455-06	3.6319372-05	3.9105969-05	5.9143399-06	2.6405066-05	-3.2667448-01
Z MISALIGN	-1.0853025-04	2.3219787-06	6.3554532-07	-6.1487443-05	-1.3329758-05	-4.0055528-05	4.8884591-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	-4.5348254-02	1.0000000+00					
U-DOT NAV	-5.4204670-01	-1.3725987-01	1.0000000+00				
V-DOT NAV	9.5685910-01	-1.1071816-01	-4.2299502-01	1.0000000+00			
W-DOT NAV	-3.3203864-02	9.8559172-01	-1.2685926-01	-1.1970933-01	1.0000000+00		
WT	-2.0274888-02	-1.4284504-03	-2.5536776-01	-2.5735756-01	-2.2414026-02	1.0000000+00	
TIME	2.1508147-02	2.0426077-03	2.7996221-01	2.8684650-01	2.4968462-02	-8.9852639-01	1.0000000+00
X ACC BIAS	-1.6436883-02	4.5238942-03	3.2149234-01	-1.7361502-02	2.9346312-03	-1.3700598-06	0.0000000
Y ACC BIAS	1.8797473-01	-5.3915828-02	3.1539857-02	1.9144777-01	-4.6311561-02	-7.8502990-07	0.0000000
Z ACC BIAS	8.9075373-02	1.1855243-01	3.0206283-03	8.2789688-02	9.1674509-02	-7.8502990-07	0.0000000
X MISALIGN	6.2731083-02	-7.8991617-01	1.0403875-01	1.4065565-01	-8.7762849-01	8.2399345-07	0.0000000
Y MISALIGN	3.5684121-01	4.5428821-01	-3.8471866-01	3.3934472-01	3.4836246-01	-1.5284329-06	0.0000000
Z MISALIGN	-7.5511447-01	2.1765791-01	5.6905846-01	-7.0377920-01	1.6777264-01	3.8720232-06	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

TABLE A3.2-III.- COVARIANCE AND CORRELATION MATRICES AT MECO

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	4.9155962+05						
V ACT	1.6139649+05	3.1760758+08					
W ACT	-2.0449864+05	2.3874524+05	5.0275291+06				
U-DOT ACT	2.1651139+03	-3.8186527+05	-1.4817573+03	4.7121334+02			
V-DOT ACT	-1.0198905+03	7.7619258+03	-1.2791536+02	-1.3522901+01	6.8801441+00		
W-DOT ACT	-1.0049561+03	1.2599333+03	2.4539977+00	-7.3637895+00	-7.6645479-01	1.2225277+02	
U NAV	-4.9393884+05	6.3987644+04	2.0876474+05	-2.4532988+03	1.0371632+03	1.0242641+03	4.9709276+05
V NAV	3.2539361+05	-3.1698219+05	-1.2384930+05	1.7609372+03	-1.8761316+03	-6.0120764+02	-3.2964000+05
W NAV	2.0802627+05	-2.2690426+05	-5.0602225+06	1.4768312+03	1.3060378+02	-2.6736617+04	-2.1027499+05
U-DOT NAV	-2.7928101+03	8.6351746+02	1.3316381+03	-1.4937428+01	6.6290643+00	6.5367534+00	2.8144353+03
V-DOT NAV	1.0716607+03	-2.0168207+03	-1.1649887+00	6.9914863+00	-6.6714185+00	1.2308429-01	-1.0916783+03
W-DOT NAV	1.0211908+03	-6.2747578+02	-2.4911326+06	6.7208332+00	8.2423389-01	-1.2416125+02	-1.0385408+03
WT	2.9854552+04	2.0873956+07	6.7210500+02	-2.5265186+04	8.7830564+00	-2.4833893+01	4.7774242+03
TIME	-1.5067629+01	6.1984844+03	1.1576190+01	-7.3463378+00	4.5597631-01	8.0379107-02	-1.1754941+01
X ACC BIAS	-3.5502361-01	-3.3092550-01	-1.7104130-02	-9.1076255-06	3.7281950-06	-6.5521330-05	3.5266891-01
Y ACC BIAS	-1.0293729-01	-6.8416291-01	1.2188681-01	-1.6247638-04	-1.0368914-03	6.7959868-04	1.0064957-01
Z ACC BIAS	-4.7269842-02	-5.1127142-01	-2.8088495-01	2.2757795-04	-6.6934878-04	-1.0356939-03	4.4208920-02
X MISALIGN	-6.6053433-02	1.0896343-03	9.7049284-01	-2.7025442-04	-3.9891416-05	4.9181879-03	4.6591484-02
Y MISALIGN	4.6387324-02	-6.5252557-02	-6.9338912-02	3.3900262-04	-1.7851684-04	-9.2718634-05	-4.7381547-02
Z MISALIGN	-6.3395322-02	3.1088523-02	-3.6705794-02	-3.7470102-04	2.3114743-04	-9.1817249-05	4.4079776-02

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	5.7298198+05						
W NAV	1.2472725+05	5.0992710+06					
U-DOT NAV	-2.1005100+03	-1.3414726+03	1.6701644+01				
V-DOT NAV	1.8891464+03	-1.1821840-01	-6.9296998+00	6.7849554+00			
W-DOT NAV	6.3694086+02	2.5111320+06	-6.6226653+00	-1.0956908-01	1.2612514+02		
WT	5.8203099+04	-4.5870471+02	-1.0682533+00	-6.8328230+00	-6.6888122+00	2.7068376+06	
TIME	-6.2270976+01	-1.2226083+01	-2.5906722-02	1.1311940-02	-6.6270015-02	-1.2276093+03	2.7541343+00
X ACC BIAS	-1.0823055-01	1.7256675-02	1.4645172-03	-4.2656595-04	3.0044830-05	9.8523406-03	-2.1449824-05
Y ACC BIAS	2.6191337-01	-1.8237273-01	4.1558190-04	9.7926510-04	-6.9654129-04	2.9603850-02	-2.1449824-05
Z ACC BIAS	1.7559658-01	2.8164631-01	1.8125602-04	6.3688373-04	1.0487453-03	1.8252880-02	-2.1449824-05
X MISALIGN	-2.3855932-02	-9.7856029-01	2.5733463-06	5.4963269-06	-4.9990574-05	1.1841847-03	0.0000000
Y MISALIGN	5.0147054-02	4.9245755-02	-3.3293458-04	1.7432305-04	8.0380097-05	1.2897549-03	-1.6936387-06
Z MISALIGN	-7.2760373-02	3.6717166-02	4.3129957-04	-2.4196299-04	8.9782225-05	-1.7574608-03	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.0000000	2.5879156-06				
Z ACC BIAS	0.0000000	0.0000000	2.5879156-06			
X MISALIGN	0.0000000	0.0000000	0.0000000	2.0555551-07		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	3.2792236-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	2.7072903-08

TABLE A3.2-III.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	1.2916967-02	1.0000000+00					
W ACT	-1.3016227-01	3.9782238-03	1.0000000+00				
U-DOT ACT	1.4226034-01	-9.8708818-01	-3.0461492-02	1.0000000+00			
V-DOT ACT	-5.5458318-01	1.6604481-01	-2.1762401-02	-7.3749929-01	1.0000000+00		
W-DOT ACT	-1.3002181-01	6.3940019-03	9.9043863-01	-3.0678056-02	-2.6427642-02	1.0000000+00	
U NAV	-9.9923205-01	5.0925142-03	1.3213636-01	-1.6029609-01	5.4082792-01	1.3139048-01	1.0000000+00
V NAV	6.1312699-01	-2.3497353-02	-7.3013968-02	1.0716787-01	-9.4491784-01	-7.1833109-02	-6.1764174-01
W NAV	1.3013090-01	-5.6382330-03	-9.9999642-01	3.0127842-02	2.2050049-02	-9.9073364-01	-1.3207325-01
U-DOT NAV	-9.7470612-01	1.1856216-02	1.4540840-01	-1.6837881-01	6.1848086-01	1.4466156-01	9.7684085-01
V-DOT NAV	5.8673543-01	-4.3439454-02	-1.9955706-04	1.2362982-01	-9.7629692-01	4.2730285-03	-5.9434478-01
W-DOT NAV	1.2969343-01	-3.1350950-03	-9.8987165-01	2.7568522-02	2.7980203-02	-9.9989841-01	-1.3116078-01
WT	2.5881414-02	7.1191515-01	1.8230039-04	-7.0742860-01	2.0352408-03	-1.3451425-03	4.1185466-03
TIME	-1.2949836-02	2.0957889-01	3.1128349-03	-2.0392457-01	1.0474926-01	4.3864757-03	-1.0046379-02
X ACC BIAS	-3.1677056-01	-1.1562762-02	-6.7447005-03	-2.6080825-02	8.8355664-02	-3.6836495-03	3.1093771-01
Y ACC BIAS	-9.1266116-02	-1.6887720-02	5.0455559-02	-4.6527142-03	-2.4573073-01	3.8207456-02	8.8739735-02
Z ACC BIAS	-6.1910321-02	-1.7833272-02	-7.7917730-02	6.5169793-03	-1.5839057-01	-5.8227346-02	3.8977692-02
X MISALIGN	-1.4487087-01	1.3485616-04	9.3523594-01	-2.7459973-02	-3.3544090-02	9.8109532-01	1.4575494-01
Y MISALIGN	3.6536396-01	-2.0219323-02	-1.2158494-01	8.6240002-02	-3.7583299-01	-4.6307588-02	-3.7111201-01
Z MISALIGN	-5.4954301-01	1.0601986-02	-9.9552020-02	-1.0490801-01	5.3557818-01	-5.0449324-02	5.5237405-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	7.2968736-02	1.0000000+00					
U-DOT NAV	-6.7900764-01	-1.4336107-01	1.0000000+00				
V-DOT NAV	9.5798262-01	-2.0095255-05	-6.5087459-01	1.0000000+00			
W-DOT NAV	7.1396193-02	9.9018116-01	-1.6429100-01	-3.7442978-03	1.0000000+00		
WT	4.6735245-02	-1.2346619-04	-1.5590337-04	-1.1275409-03	-2.6458878-04	1.0000000+00	
TIME	-3.3649548-02	-3.2624245-03	-3.8197972-03	2.6154175-03	-2.4825982-03	-6.4961059-01	1.0000000+00
X ACC BIAS	-8.8800042-02	4.7498092-03	2.2276133-01	-1.0177785-01	2.7701334-03	3.7149311-03	-8.0344493-03
Y ACC BIAS	2.1508600-01	-5.0203130-02	6.3648670-02	2.3366276-01	-3.8554136-02	1.1185156-02	-8.0344493-03
Z ACC BIAS	1.4420174-01	7.7530926-02	2.7567022-02	1.5196713-01	5.8050024-02	6.8964443-03	-8.0344493-03
X MISALIGN	-7.3194230-02	-9.3381310-01	1.6038070-01	4.6534013-03	-9.8179936-01	1.5875368-03	0.0000000
Y MISALIGN	3.6583852-01	1.2042849-01	-4.4987699-01	3.6951478-01	4.3457839-02	4.3290299-03	-5.6356331-03
Z MISALIGN	-5.8419390-01	9.8820644-02	6.4140450-01	-5.6447611-01	4.8587226-02	-6.4921289-03	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

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TABLE A3.2-IV.- COVARIAN[illegible] [illegible] CORRELATION MATRICES AT NOMINAL MECO + 62 SECONDS

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0756321+06						
V ACT	2.4808721+07	2.5797835+09					
W ACT	-3.6543213+05	2.5325682+05	8.5007630+06				
U-DOT ACT	-2.7061957+04	-3.1194353+06	-1.9018503+03	3.7833248+03			
V-DOT ACT	-1.5170145+03	3.0376152+ 3	-4.2281162+01	-7.7254063+00	7.5151713+00		
W-DOT ACT	-1.4005736+03	-3.8151521+03	3.1377591+04	-1.2738402+00	-3.2874591-01	1.1720388+02	
U NAV	-8.2549403+05	4.8752375+05	3.6566602+05	-3.5637109+03	1.5127265+03	1.3478445+03	8.3474485+05
V NAV	5.6091895+05	7.2514949+05	-1.8953013+05	6.8740495+02	-2.5120521+03	-6.8989449+02	-5.5540605+05
W NAV	3.6833426+05	-2.1527024+05	-8.5815947+06	1.8727811+03	6.561[illegible]+01	-3.1683636+04	-3.6861500+05
U-DOT NAV	-3.6479367+03	1.4924045+03	1.7448429+03	-1.5051370+01	7.3364927+00	6.4265507+00	3.6840537+03
V-DOT NAV	1.5039403+03	-6.4860862+02	-1.4095775+02	1.2232365+01	-7.4060778+00	-4.0335977-01	-1.5708202+03
W-DOT NAV	1.3583108+03	-1.1261499+03	-3.1633680+04	7.3559744+00	3.6373751-01	-1.1899186+02	-1.3616169+03
WT	-4.1426524+02	2.0447421+04	-1.4283813-02	-2.8519644+01	1.4265669+03	-7.3227482-01	5.3819067+01
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-4.3562379-01	-2.7486182-01	-2.1102555-02	-9.5002625-04	4.7291486-04	-6.3748806-05	4.3533355-01
Y ACC BIAS	-1.5432881-01	-5.3707731-01	2.2355020-01	-2.6069410-04	-9.7444877-04	6.6119885-04	[illegible].5030339-01
Z ACC BIAS	-7.4680354-02	-5.4709280-01	-3.4438832-01	1.680[illegible]560-04	-6.3357384-04	-1.0072113-03	7.1055931-02
X MISALIGN	-6.3094201-02	3.2081113-03	1.2734347+00	-2.8197601-04	-2.0088789-05	4.8194128-03	6.2810786-02
Y MISALIGN	6.2085052-02	-8.1090857-02	-5.5050544-02	3.3615103-04	-1.9763739-04	-8.8050627-05	-6.3976060-[illegible]
Z MISALIGN	-8.3807718-02	5.1898381-02	-4.2375584-02	-3.7183307-04	2.5612162-04	-8.847[illegible]219-05	8.4778830-02

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	9.1529305+05						
W NAV	1.9147584+05	8.6633613+06					
U-DOT NAV	-2.7178931+03	-1.7596313+03	1.6731603+01				
V-DOT NAV	2.5553170+03	1.4171499+02	-7.656[illegible]279+00	7.5034027+00			
W-DOT NAV	7.0315839+02	3.2166049+04	-6.5013189+00	4.3220239-01	1.2084111+02		
WT	1.8210916+02	7.3595223-02	-2.5159591-01	2.9989591-01	-2.0927995-02	3.8028581+03	
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-1.8697425-01	2.1584410-02	1.5199601-03	-5.1989819-04	7.[illegible]312020-05	0.0000000	0.0000000
Y ACC BIAS	3.13[illegible]6204-01	-2.2434215-01	5.0449879-04	9.5438112-04	-6.6592571-04	0.0000000	0.0000000
Z ACC BIAS	2.12[illegible]0864-01	3.4737700-01	2.3199592-04	6.4454030-04	1.0502397-03	0.0000000	0.0000000
X MISALIGN	-5.0241217-02	-1.2863394+00	2.9917576-04	-1.6199104-05	-6.8957604-03	0.0000000	0.0000000
Y MISALIGN	6.6052813-02	5.4890442-02	-3.3180832-04	1.9631720-04	8.7194625-05	0.0000000	0.0000000
Z MISALIGN	-9.4254554-02	4.2366338-02	4.2739680-04	-2.6496626-04	8.7277143-05	0.0000000	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.0000000	2.5879156-06				
Z ACC BIAS	0.0000000	0.0000000	2.5879156-06			
X MISALIGN	0.0000000	0.0000000	0.0000000	2.0591434-07		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	3.3150626-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	2.7432044-08

TABLE A3.2-IV.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	4.7095659-01	1.0000000+00					
W ACT	-1.2084979-01	1.7101750-03	1.0000000+00				
U-DOT ACT	-4.2421937-01	-9.9849869-01	-1.0604997-02	1.0000000+00			
V-DOT ACT	-5.3356632-01	2.1815827-02	-7.7921680-03	-4.5815779-02	1.0000000+00		
W-DOT ACT	-1.2473923-01	-6.9382386-03	9.9407611-01	-1.9129652-03	-1.1076943-02	1.0000000+00	
U NAV	-8.7117455-01	1.0505755-02	1.3727099-01	-6.3414530-02	6.0396826-01	1.3626739-01	1.0000000+00
V NAV	5.6531192-01	1.4922990-02	-6.7946833-02	1.1681423-02	-9.6009715-01	-6.6608798-02	-6.3540942-01
W NAV	1.2066103-01	-1.4399558-03	-9.9999040-01	1.0344440-02	8.2554709-03	-9.9430770-01	-1.3707331-01
U-DOT NAV	-8.5989740-01	7.1833353-03	1.4630480-01	-5.9823310-02	6.5871879-01	1.4512364-01	9.8573067-01
V-DOT NAV	5.2906573-01	-4.6618893-02	-1.7649438-02	7.2601316-02	-9.8625609-01	-1.3601677-02	-6.2765425-01
W-DOT NAV	1.1914064-01	-2.0169598-03	-9.9385564-01	1.0879177-02	1.2070112-02	-9.9985933-01	-1.3557242-01
WT	-6.4772633-03	6.5281761-03	-7.9443825-04	-7.5188641-03	8.4385463-03	-1.0968521-03	9.5522182-04
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-2.6109866-01	-3.3639360-03	-4.4992196-03	-9.6011605-03	1.0723547-01	-3.6603785-03	2.9618988-01
Y ACC BIAS	-9.2499645-02	-4.5730982-03	4.7661867-02	-2.6346282-03	-2.2096043-01	3.7965230-02	1.0226261-01
Z ACC BIAS	-6.4760963-02	-6.6956743-03	-7.3425076-02	1.6980002-03	-1.4366558-01	-5.7832843-02	4.8344648-02
X MISALIGN	-1.3406465-01	1.3919207-04	9.6250820-01	-1.0102646-02	-1.6148828-02	9.8102446-01	1.5150050-01
Y MISALIGN	3.2878296-01	-8.7686836-03	-1.0370192-01	3.0015928-02	-3.9596228-01	-4.4669963-02	-3.8458[illegible]-01
Z MISALIGN	-6.8790274-01	6.1692582-03	-8.7752096-02	-3.6503992-02	5.6408890-01	-4.9344760-02	5.6024929-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	6.7997499-02	1.0000000+00					
U-DOT NAV	-6.9451798-01	-1.4615366-01	1.0000000+00				
V-DOT NAV	9.7506951-01	1.7576947-02	-6.8336224-01	1.0000000+00			
W-DOT NAV	6.6859900-02	9.9413907-01	-1.4458570-01	1.4353264-02	1.0000000+00		
WT	3.0867158-03	4.0546312-07	-9.9742382-04	1.7753597-03	-3.0872032-05	1.0000000+00	
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00
X ACC BIAS	-1.0847817-01	4.5584994-03	2.3098742-01	-1.1798156-01	4.0891033-03	0.0000000	0.0000000
Y ACC BIAS	2.0379474-01	-4.7379733-02	7.6668381-02	2.1657966-01	-3.7656796-02	0.0000000	0.0000000
Z ACC BIAS	1.3794709-01	7.3363964-02	3.5255978-02	1.4626684-01	5.9389003-02	0.0000000	0.0000000
X MISALIGN	-6.9658783-02	-9.6309481-01	1.6118118-01	-1.3032225-02	-1.8145297-01	0.0000000	0.0000000
Y MISALIGN	3.7908260-01	1.0242539-01	-4.4552556-01	3.9362563-01	4.3564877-02	0.0000000	0.0000000
Z MISALIGN	-5.9483021-01	8.6782664-02	6.3084036-01	-5.8402603-01	4.7936234-02	0.0000000	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

TABLE A3.2-V.- COVARIANCE AND CORRELATION MATRICES AT OMS-1 CUTOFF

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	2.0502449+06						
V ACT	-1.7989196+06	2.6063997+08					
W ACT	-9.9317750+05	4.0872157+06	2.2921357+07				
U-DOT ACT	6.3942404+03	-3.1453934+05	-7.2731646+03	3.8947686+02			
V-DOT ACT	-3.0348952+03	9.7219614+03	7.5336362+02	-1.5765458+01	9.4607991+00		
W-DOT ACT	-2.1486110+03	8.0084348+03	4.6744877+04	-1.4735138+01	1.5118184+00	9.9831609+01	
U NAV	-2.0780334+06	2.3053680+06	1.0096269+06	-7.0505427+03	3.1263912+03	2.1777546+03	2.1095127+06
V NAV	1.5085300+06	-6.2762768+06	-5.4057698+05	7.0696010+03	-4.8893006+03	-1.0934043+03	-1.5537209+06
W NAV	1.0012678+06	-6.0475295+06	-2.2292122+07	7.2477231+03	-7.5877943+02	-4.7326066+04	-1.0174268+06
U-DOT NAV	-6.1236149+03	7.3001426+03	3.0910791+03	-2.1152233+01	9.9476080+00	6.6415853+00	6.2236937+03
V-DOT NAV	3.0002165+03	-9.2195530+03	-7.1857431+02	1.5113614+01	-9.4775995+00	-1.4019093+00	-3.0967266+03
W-DOT NAV	2.1158877+03	-8.6219786+03	-4.7441067+04	1.5412623+01	-1.5223239+00	-1.0129313+02	-2.1464326+03
WT	1.3948844+03	1.1478031+05	-1.0405215+04	-1.3466081+02	-6.4654350+00	-2.0881811+01	-1.1213500+03
TIME	-4.4535324+01	1.6208709+03	1.5782127+02	-1.7775617+00	3.4381265-01	3.7951708-01	1.1438624+01
X ACC BIAS	-6.2686202-01	3.0099184+00	-3.0288085-02	-4.9426038-03	9.6082801-04	-3.8913859-05	6.6708379-01
Y ACC BIAS	-3.7315434-01	-3.3258151+00	3.3708850-01	2.7739714-03	-7.4530290-04	8.7521173-04	3.4700907-01
Z ACC BIAS	-2.0347024-01	-2.6263877+00	-5.1740915-01	2.5215271-03	-4.9174128-04	-1.0621797-03	1.8438868-01
X MISALIGN	-1.0709198-01	4.0771522-01	2.0704974+00	-7.4503735-04	7.7352745-05	4.4543201-03	1.0853614-01
Y MISALIGN	9.9559453-02	-1.1897194-01	-6.8940761-02	3.3592507-04	-2.4047208-04	-6.8134131-05	-1.0290883-01
Z MISALIGN	-1.3016184-01	2.6248896-01	-5.6749021-02	-5.4022705-04	3.2688841-04	-7.4058731-05	1.3285457-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	2.5897796+06						
W NAV	5.4753391+05	2.2567636+07					
U-DOT NAV	-5.0023671+03	-3.1171681+03	1.8602533+01				
V-DOT NAV	4.9217862+03	7.2756865+02	-9.8618722+00	9.5641079+00			
W-DOT NAV	1.1247091+03	4.8038260+04	-6.3650744+00	1.4549359+00	1.0283302+02		
WT	5.1475580+03	1.0725267+04	-5.1617841+00	9.4391556+00	2.3276661+01	3.4942564+03	
TIME	-1.3848727+02	-1.5114344+02	8.7199205-02	-1.8380413-01	-3.0922186-01	6.6867053+00	2.4833751+00
X ACC BIAS	-4.0195373-01	3.3550417-02	1.9096489-03	-9.6221743-04	7.3155383-05	1.0860819-03	9.7401756-05
Y ACC BIAS	4.2084812-01	-3.4235116-01	9.4024265-04	9.1260758-04	-7.7786071-04	8.2362087-03	-1.2570423-04
Z ACC BIAS	2.9642717-01	5.3401721-01	4.9522802-04	6.6041431-04	1.1912228-03	6.1446893-03	-9.9234585-05
X MISALIGN	-3.4762825-02	-2.0970293+00	3.3076211-06	-7.2569153-05	-4.5221041-03	-1.1816516-03	1.4943699-05
Y MISALIGN	1.2205133-01	6.8616256-02	-3.3797822-04	2.4205080-04	6.7413816-05	-5.3938227-05	-1.0136662-06
Z MISALIGN	-1.6905756-01	5.6558553-02	4.2950937-04	-3.2612463-06	7.5304280-05	-4.2324119-04	5.3511813-06

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.0000000	2.5879156-06				
Z ACC BIAS	0.0000000	0.0000000	2.5879156-06			
X MISALIGN	0.0000000	0.0000000	0.0000000	2.0713733-07		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	3.4425982-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	2.8770347-08

TABLE A3.2-V.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	-7.7819490-02	1.0000000+00					
W ACT	-1.4780937-01	5.3949201-02	1.0000000+00				
U-DOT ACT	2.2627953-01	-9.8721930-01	-7.8534511-02	1.0000000+00			
V-DOT ACT	-6.8909156-01	1.9578052-01	5.2193773-02	-2.5971788-01	1.0000000+00		
W-DOT ACT	-1.5018304-01	4.9647010-02	9.9696053-01	-7.4727308-02	4.9192816-02	1.0000000+00	
U NAV	-9.9921416-01	9.8317016-02	1.4813163-01	-2.4597481-01	6.9982322-01	1.5006653-01	1.0000000+00
V NAV	6.5466587-01	-1.6459396-01	-7.1582045-02	2.2259872-01	-9.8776000-01	-6.8001005-02	-6.6473807-01
W NAV	1.4719883-01	-5.2774786-02	-9.9996855-01	7.7306806-02	-5.1928839-02	-9.9706469-01	-1.4745825-01
U-DOT NAV	-9.9155993-01	1.0483947-01	1.5272215-01	-2.4850169-01	7.4984019-01	1.5411740-01	9.9350740-01
V-DOT NAV	6.7752839-01	-1.8465757-01	-4.9513931-02	2.4763114-01	-9.9635066-01	-4.5369465-02	-6.8942902-01
W-DOT NAV	1.4572144-01	-5.2664765-02	-9.9693336-01	7.7013955-02	-4.8806411-02	-9.9972301-01	-1.4573367-01
WT	1.6480029-02	1.2027338-01	-3.7510396-02	-1.1543114-01	-3.5559566-02	-3.5355480-02	-1.3060889-02
TIME	-1.9736975-02	6.3709977-02	2.1341372-02	-5.7156114-02	7.0931115-02	2.4103279-02	4.9976007-03
X ACC BIAS	-2.7214104-01	1.1589352-01	-4.0121275-03	-1.5568260-01	1.9418098-01	-2.4210023-03	2.8550535-01
Y ACC BIAS	-1.6199834-01	-1.2805677-01	4.4652609-02	8.7374779-02	-1.5062388-01	5.4450771-02	1.4851650-01
Z ACC BIAS	-8.8332999-02	-1.0112610-01	-6.8538881-02	7.9423266-02	-9.9379704-02	-6.6082872-02	7.8916556-02
X MISALIGN	-1.6433304-01	5.5489042-02	9.6944562-01	-8.2948402-02	5.5256049-02	9.7955103-01	1.6419280-01
Y MISALIGN	3.7474554-01	-3.9717406-02	-7.9179155-02	9.1739932-02	-4.2136415-01	-3.6752553-02	-3.8187253-01
Z MISALIGN	-5.3593025-01	9.5855711-02	-7.1295773-02	-1.6138492-01	6.2656059-01	-4.3698817-02	5.3927932-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	7.1620374-02	1.0000000+00					
U-DOT NAV	-7.2070597-01	-1.5213570-01	1.0000000+00				
V-DOT NAV	9.8893810-01	4.9523201-02	-7.3935173-01	1.0000000+00			
W-DOT NAV	6.8919563-02	9.9719008-01	-1.5010229-01	4.6395308-02	1.0000000+00		
WT	5.4111860-02	3.8193345-02	-2.0245868-02	5.1633732-02	3.8830860-02	1.0000000+00	
TIME	-5.4608129-02	-7.0189479-02	1.2829370-02	-3.7714806-02	-1.9350079-02	7.1781685-02	1.0000000+00
X ACC BIAS	-1.5526358-01	4.3901548-03	2.7522788-01	-1.9340866-01	4.6070057-03	1.1421158-02	3.8421168-02
Y ACC BIAS	1.6256196-01	-4.4797494-02	1.3551234-01	1.8343693-01	-4.7682662-02	8.6611368-02	-4.9585384-02
Z ACC BIAS	1.1450160-01	6.9877469-02	7.1374671-02	1.3274531-01	7.3021652-02	6.4617102-02	-3.9144148-02
X MISALIGN	-7.4769635-02	-9.6991190-01	1.6850024-01	-5. 358543-02	-9.7981726-01	-4.3922449-02	2.0855684-02
Y MISALIGN	4.0875960-01	7.7846809-02	-4.2233738-01	4.2183356-01	3.5829394-02	-4.9178594-03	-3.4668149-03
Z MISALIGN	-6.1934218-01	7.0191207-02	5.8710267-01	-6.2171139-01	4.3780511-02	-4.2212201-02	2.0019626-02

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

TABLE A3.2-VI.- COVARIANCE AND CORRELATION MATRICES AT NOMINAL OMS-1 CUTOFF + 691 SECONDS

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	9.2753579+06						
V ACT	-1.6590258+07	2.0633637+09					
W ACT	-4.7282805+06	6.4973960+06	8.6591048+07				
U-DOT ACT	2.6338668+04	-2.4986622+06	-1.0299019+04	3.0397463+03			
V-DOT ACT	-8.6871675+03	3.2805017+04	4.6551024+03	-3.9224520+01	1.2369419+01		
W-DOT ACT	-1.3647981+03	1.8463974+03	2.5136666+04	-2.9427496+00	1.3188913+00	7.4478579+00	
U NAV	-9.6357877+06	4.4314237+07	4.9048599+06	-6.0145586+04	9.1413531+03	1.4460272+03	1.0486897+07
V NAV	1.0040242+07	-2.3449924+07	-6.0625441+06	2.2726767+04	-1.7507184+04	-1.7247383+03	-1.0298254+07
W NAV	4.7146617+06	-6.6544944+06	-8.7734565+07	1.0468531+04	-4.6372379+03	-2.5466949+04	-4.8612038+06
U-DOT NAV	-1.9054989+04	7.6219860+04	1.0135560+04	-9.9951037+01	2.1382906+01	2.9714698+00	2.0463430+04
V-DOT NAV	8.8218892+03	-2.9247170+04	-4.7250121+03	3.4996006+01	-1.2481291+01	-1.3485174+00	-9.2667347+03
W-DOT NAV	1.3304099+03	-4.9498339+03	-2.5530423+04	6.6713752+00	-1.3122272+00	-7.5577540+00	-1.4249187+03
WT	9.7146546+02	1.2960925+05	-1.9584303+04	-1.6015627+02	-4.6470803+00	-5.0205902+00	4.4743544+03
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-1.1205137+00	4.7269847+00	-4.0004400-02	-5.6739036 [illegible]	1.5831536-03	-2.5953780-06	1.2471905+00
Y ACC BIAS	-1.4495381+00	1.0572152+01	7.6586951-01	-1.4716665-02	7.4734343-04	2.8271665-04	1.8339808+00
Z ACC BIAS	-7.3153657-01	1.0883882+01	-1.0030240+00	-1.4182064-02	3.4330384-04	-2.8716294-04	1.1024695+00
X MISALIGN	-2.5249738-01	6.6901966-01	4.1606095+00	-9.3692252- 4	2.5280392-04	1.2309585-03	2.6719971-01
Y MISALIGN	1.5651661-01	1.7045583+00	-8.9626650-02	-2.1564100-03	-2.8147942-04	1.1974029-05	-1.2880799-01
Z MISALIGN	-1.3842209-01	1.1589402+00	-8.5636053-02	-1.1596014-03	3.5522716-04	-2.0698321-06	1.5438483-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	2.6900986+07						
W NAV	6.0764153+06	8.8917592+07					
U-DOT NAV	-2.7123635+04	-1.0072450+04	4.2901771+01				
V-DOT NAV	1.7695414+04	4.7160922+03	-2.1660799+01	1.2622426+01			
W-DOT NAV	1.6919529+03	2.5884381+04	-2.9201880+00	1.3259759+00	7.6884292+00		
WT	9.6384362+03	2.1235222+04	2.8648276+00	3.6404434+00	6.0828403+00	3.5032000+03	
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-2.2103976+00	6.1487297-02	2.7902679-03	-1.6570829-03	1.6926866-05	1.0871293-03	0.0000000
Y ACC BIAS	-3.0864733-01	-7.2663150-01	3.0222576-03	-8.1548442-04	-2.4617783-04	8.2372560-03	0.0000000
Z ACC BIAS	-8.7472922-02	1.0914425+00	1.7770501-03	-4.2243915-04	3.4152229-04	6.2127658-03	0.0000000
X MISALIGN	-3.2809436-01	-4.2175782+00	5.5222833-04	-2.5706133-04	-1.2514464-03	-1.1574865-03	0.0000000
Y MISALIGN	4.4172781-01	8.7551937-02	-3.8300942-04	2.8632656-04	-1.7358831-05	-9.2003684-06	0.0000000
Z MISALIGN	-5.8033424-01	8.5018067-02	4.8470837-04	-3.5804452-04	7.9926384-07	-5.7623084-04	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.0000000	2.5879156-06				
Z ACC BIAS	0.0000000	0.0000000	2.5879156-06			
X MISALIGN	0.0000000	0.0000000	0.0000000	2.1510625-07		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	4.2409581-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	3.6740597-08

TABLE A3.2-VI.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	-1.1992229-01	1.0000000+00					
W ACT	-1.6684047-01	1.5371454-02	1.0000000+00				
U-DOT ACT	1.5685913-01	-9.9770231-01	-2.0074314-02	1.0000000+00			
V-DOT ACT	-8.1103240-01	2.0534196-01	1.4223980-01	-2.0220530-01	1.0000000+00		
W-DOT ACT	-1.6420538-01	1.4894351-02	9.8981837-01	-1.9557753-02	1.3741009-01	1.0000000+00	
U NAV	-9.7700858-01	3.0125334-01	1.6276709-01	-3.3684942-01	8.0262434-01	1.6362033-01	1.0000000+00
V NAV	6.3561592-01	-9.9533537-02	-1.2561292-01	7.9475795-02	-9.5974870-01	-1.2184941-01	-6.1313483-01
W NAV	1.6418917-01	-1.5535798-02	-9.9986330-01	2.0136012-02	-1.4043009-01	-9.8961811-01	-1.5919401-01
U-DOT NAV	-9.5522515-01	2.5617848-01	1.6629287-01	-2.7677766-01	9.2822759-01	1.6623330-01	9.6475562-01
V-DOT NAV	8.1531390-01	-1.8122769-01	-1.4292066-01	1.7866044-01	-9.9988027-01	-1.3908153-01	-8.0543743-01
W-DOT NAV	1.5734380-01	-3.9299219-02	-9.8947013-01	4.3639311-02	-1.3455987-01	-9.9875335-01	-1.5868934-01
WT	5.3892654-03	4.8207614-02	-3.5558150-02	-4.9078675-02	-2.2324054-02	-3.1081833-02	2.3343953-02
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-2.2870558-01	6.4487631-02	-2.6723676-03	-6.3971750-02	2.7981651-01	-5.9116659-04	2.3940556-01
Y ACC BIAS	-2.9586203-01	1.4467732-01	5.1161495-02	-1.6592647-01	1.3209017-01	6.4396258-02	3.5204341-01
Z ACC BIAS	-1.4931232-01	1.4894326-01	-6.7003852-02	-1.5909899-01	6.0677677-02	-6.5409021-02	2.1162552-01
X MISALIGN	-1.7875781-01	3.1755903-02	9.6403754-01	-3.6640256-02	1.5498249-01	9.7252598-01	1.7790410-01
Y MISALIGN	2.4955318-01	1.8221829-01	-4.6770141-02	-1.8992436-01	-3.8863330-01	2.1305545-02	-1.9314670-01
Z MISALIGN	-2.3711934-01	1.3310673-01	-4.8011695-02	-1.0972787-01	5.2693665-01	-3.9568202-03	2.4871846-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	1.2424238-01	1.0000000+00					
U-DOT NAV	-7.9841038-01	-1.6308121-01	1.0000000+00				
V-DOT NAV	9.6029621-01	1.4077232-01	-9.3081942-01	1.0000000+00			
W-DOT NAV	1.1764822-01	9.8997761-01	-1.6078828-01	1.3460010-01	1.0000000+00		
WT	3.1397134-02	3.8047905-02	7.3897275-03	1.7312126-02	3.7064244-02	1.0000000+00	
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00
X ACC BIAS	-2.6491786-01	4.0533746-03	2.6480930-01	-2.8993307-01	3.7967457-03	1.1417570-02	0.0000000
Y ACC BIAS	-3.6991621-02	-4.7901108-02	2.8682619-01	-1.4268200-01	-5.5189325-02	8.6511739-02	0.0000000
Z ACC BIAS	-1.0483697-02	7.1950233-02	1.6865026-01	-7.3912465-02	7.6564100-02	6.5249541-02	0.0000000
X MISALIGN	-1.3639176-01	-9.6436853-01	1.8178354-01	-1.3600511-01	-9.7312120-01	-4.2165469-02	0.0000000
Y MISALIGN	4.1356011-01	4.5085839-02	-2.8394868-01	3.9134359-01	-3.0399726-02	-7.5481542-04	0.0000000
Z MISALIGN	-5.8374206-01	4.7037531-02	3.8407330-01	-5.2576602-01	1.5038283-03	-5.0791488-02	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

TABLE A3.2-VII.- COVARIANCE AND CORRELATION MATRICES AT OMS-2 CUTOFF

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	5.3066643+07						
V ACT	-7.6492086+07	5.7303374+08					
W ACT	-6.6941754+05	3.9292768+06	2.4372032+06				
U-DOT ACT	1.0685246+05	-6.5026458+05	-3.9655943+03	7.5660797+02			
V-DOT ACT	-4.5816753+04	6.8971062+04	5.9264105+02	-9.4812755+01	3.9626409+01		
W-DOT ACT	3.9203918+03	-2.5592485+04	-1.695[illegible]153+06	2.5070274+01	-3.5187011+00	1.2350451+02	
U NAV	-5.3913188+07	7.8626346+07	8.5519327+05	-1.0910155+05	4.6575423+04	-4.6075731+03	5.6196605+07
V NAV	7.3536598+07	-2.3356766+08	-3.9652724+06	2.5455329+05	-6.5505993+04	2.5818073+04	-7.9205674+07
W NAV	6.1660108+05	-3.3212632+06	-2.4716927+06	3.2629173+03	-5.4462785+02	1.7220790+04	-7.3284481+05
U-DOT NAV	-1.0326981+05	2.5654154+05	4.0143442+03	-2.9764227+02	9.0870740+01	-2.5379948+01	1.0984759+05
V-DOT NAV	4.6340913+04	-7.0239771+04	-7.7236440+02	9.6197384+01	-4.0102355+01	4.2679808+00	-4.8385511+04
W-DOT NAV	-3.9566128+03	2.5743734+04	1.7193862+04	-2.4495479+01	3.5518570+00	-1.2524507+02	4.5377603+03
WT	-7.8654162+03	1.3806363+05	-2.5433833+03	-1.6869586+02	6.5659024+00	2.5217585+01	1.9005947+04
TIME	5.6733318+02	5.3960937+03	5.0211571+01	-6.5034655+00	-5.5239385-01	-1.5251550-01	1.9749188+02
X ACC BIAS	3.5755096-01	3.6962730+00	6.3070091-03	-2.2583131-03	-2.2621412-04	3.4298243-05	-2.1867905-01
Y ACC BIAS	-3.8652560+00	1.0924391+01	1.9350073-01	-1.3082399-02	3.5682996-03	-7.2955134-04	4.6744151+00
Z ACC BIAS	-2.3179262+00	6.4796450+00	-1.5516082-01	-7.8552450-03	2.1492713-03	9.7992044-04	2.9539450+00
X MISALIGN	-1.9671801-01	1.1421969+00	7.1413928-01	-1.1153879-03	1.7582168-04	-5.0402433-03	2.2906119-01
Y MISALIGN	-3.7201365-01	-4.9011312-01	2.1030165-02	1.4754281-04	2.9828745-04	1.0661468-04	3.7959296-01
Z MISALIGN	5.5[illegible]4115-01	3.1624044-01	6.9448571-03	1.8274643-04	-4.5632628-04	1.0579258-04	-5.2034146-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	2.4163678+08						
W NAV	3.6592387+06	2.5148078+06					
U-DOT NAV	-2.6410892+05	-3.6627114+03	3.0664388+02				
V-DOT NAV	7.0299430+04	6.5871832+02	-9.6338775+01	4.1739702+01			
W-DOT NAV	-2.5813937+04	-1.7483573+04	2.5325132+01	-4.2024524+00	1.2704397+02		
WT	-1.6278275+04	3.3641890+03	2.7977240+01	-1.6609196+01	-2.6082954+01	3.3441084+03	
TIME	9.8053265+01	-2.0974845+01	1.1816035-01	-9.9183373-02	9.6216965-02	8.4609346+00	2.7527688+00
X ACC BIAS	-4.9409592+00	7.8644389-03	3.6805602-03	6.7377815-05	-5.4708518-05	1.5772801-03	-3.4316445-05
Y ACC BIAS	-9.9632075+00	-1.5553830-01	1.2012991-02	-4.2895456-03	7.1248740-04	4.0542171-03	8.7697583-05
Z ACC BIAS	-6.0656867+00	2.1538577-01	7.4091944-03	-2.6581642-03	-1.0618384-03	3.0037445-03	6.2316177-05
X MISALIGN	-1.2208025+00	-7.2540963-01	1.2097367-03	-2.0724135-04	3.1147684-03	-1.1410401-03	8.5794562-07
Y MISALIGN	4.0417513-01	-2.3137690-02	-4.7615211-05	-2.9839711-04	-1.0190837-04	1.7969080-04	-4.2462829-06
Z MISALIGN	-4.7943912-01	-7.3965585-03	9.3330446-06	4.3023104-04	-1.0061355-04	-8.1799285-04	-1.8201337-06

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.0000000	2.5879156-06				
Z ACC BIAS	0.0000000	0.0000000	2.5879156-06			
X MISALIGN	0.0000000	0.0000000	0.0000000	2.4689028-07		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	7.4131308-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	6.8440993-08

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TABLE A3.2-VII.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	-4.3979435-01	1.0000000+00					
W ACT	-5.8862741-02	1.0514210-01	1.0000000+00				
U-DOT ACT	5.3325911-01	-9.8756239-01	-9.2347987-02	1.0000000+00			
V-DOT ACT	-9.9912802-01	4.5770373-01	6.0305025-02	-5.4756912-01	1.0000000+00		
W-DOT ACT	-1.8425850-02	-9.6201302-02	-9.7598152-01	8.2012910-02	-5.0297756-02	1.0000000+00	
U NAV	-9.8725460-01	4.3815014-01	7.3074081-02	-5.2910326-01	9.8698241-01	-5.5306450-02	1.0000000+00
V NAV	6.4939839-01	-6.2768403-01	-1.6339759-01	5.9533544-01	-6.6943305-01	1.4945171-01	-6.7970385-01
W NAV	3.3548519-02	-8.7491006-02	-9.7835077-01	7.4802862-02	-5.4557579-02	9.7714554-01	-6.1645954-02
U-DOT NAV	-8.0955328-01	6.1199863-01	1.4684244-01	-6.1793385-01	8.2435552-01	-1.3041639-01	8.3679355-01
V-DOT NAV	9.8464371-01	-4.5416987-01	-7.6577593-02	5.4131883-01	-9.8605888-01	5.9443775-02	-9.9904633-01
W-DOT NAV	-4.8187847-02	9.3188571-02	9.7712592-01	-7.9008434-02	5.0059452-02	-9.9986695-01	5.3704353-02
WT	-1.8671135-02	9.9735328-02	-2.8172525-02	-1.0605443-01	1.8036900-02	3.9239360-02	4.3842397-02
TIME	4.6939938-02	1.3571297-01	1.9385324-02	-1.4250316-01	-5.2889762-02	-8.2715654-03	1.5878495-02
X ACC BIAS	3.0510694-02	9.5984009-02	2.5113228-03	-5.1035649-02	-2.2338412-02	1.9184717-03	-1.8133310-02
Y ACC BIAS	-3.2983170-01	2.8368219-01	7.7048056-02	-2.9564932-01	3.5236592-01	-4.0807445-02	3.8761197-01
Z ACC BIAS	-1.9779428-01	1.6826200-01	-6.1781882-02	-1.7752079-01	2.1223833-01	5.4811837-02	2.4494710-01
X MISALIGN	-5.4347719-02	9.6029222-02	9.2062986-01	-8.1609075-02	5.6211873-02	-9.1276314-01	6.1495660-02
Y MISALIGN	-1.8756303-01	-7.3197846-02	4.9476159-02	1.9700734-02	1.7403708-01	3.5235041-02	1.8597830-01
Z MISALIGN	2.9930201-01	5.0497416-02	1.7004321-02	2.5395414-02	-2.7709262-01	3.6387788-02	-2.6532321-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	1.6844201-01	1.0000000+00					
U-DOT NAV	-9.7025167-01	-1.3189646-01	1.0000000+00				
V-DOT NAV	6.9999608-01	6.4294329-02	-8.5154831-01	1.0000000+00			
W-DOT NAV	-1.6733153-01	-9.7813746-01	1.2830913-01	-5.7710005-02	1.0000000+00		
WT	-1.8109343-02	3.6684740-02	2.7627878-02	-4.4456345-02	-4.0016544-02	1.0000000+00	
TIME	3.8018560-03	-7.9718936-03	4.0669595-03	-9.2529312-03	5.1450518-03	8.8184711-02	1.0000000+00
X ACC BIAS	-1.9758533-01	3.0827641-03	1.3065370-01	6.4828682-03	-3.0171915-03	1.6954836-02	-1.2857081-02
Y ACC BIAS	-3.9842134-01	-6.0969114-02	4.2544097-01	-4.1272574-01	3.9293897-02	4.3580456-02	3.2856984-02
Z ACC BIAS	-2.4256235-01	8.4428593-02	2.6301394-01	-2.5575968-01	-5.8560713-02	3.2288491-02	2.3347526-02
X MISALIGN	-1.5805633-01	-9.2061686-01	1.3903422-[illegible]	-6.4557945-02	9.1326529-01	-1.9710808-02	1.0406936-03
Y MISALIGN	9.5496452-02	-5.3587904-02	-9.9868316-03	-1.6963643-01	-3.3207181-02	[illegible]12606-02	-9.3998997-03
Z MISALIGN	-1.1789949-01	-1.7828678-02	2.0307188-03	2.5454755-01	-3.4120964-02	-5.4069354-02	-4.1933419-03

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

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TABLE A3.2-VIII.- COVARIANCE AND CORRELATION MATRICES AT NOMINAL OMS-2 CUTOFF + 61 SECONDS

(a) Covariance matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	5.5101985+07						
V ACT	-8.9896947+07	1.9739377+09					
W ACT	-4.0879138+05	1.4104900+06	8.3773865+05				
U-DOT ACT	1.2115598+05	-2.2725315+04	-1.3046075+03	2.6339766+03			
V-DOT ACT	-4.7860551+04	8.5208264+04	3.5077194+02	-1.1308057+02	4.1642109+01		
W-DOT ACT	3.6506669+03	-2.2160872+04	-9.5704365+02	2.0080616+0[illegible]	-3.1803654+00	1.2566768+02	
U NAV	-5.5996928+07	8.0300007+07	5.5162844+05	-1.0995914+05	4.8621983+04	-4.3614613+03	5.8275531+07
V NAV	7.9206871+07	-2.5275022+08	-2.4576131+06	2.7559303+05	-7.0074713+04	2.6588117+04	-8.5160684+07
W NAV	3.5413859+05	-1.5298039+06	-8.4798459+05	1.6524318+03	-3.0077870+02	9.7407145+03	-4.3210451+05
U-DOT NAV	-1.0877224+05	2.7318098+05	2.5153175+03	-3.1442565+02	9.5538857+01	-2.6024607+01	1.1556125+05
V-DOT NAV	4.9292711+04	-7.3726980+04	-4.9194718+02	9.9822491+01	-4.2852913+01	3.6979586+00	-5.1444407+04
W-DOT NAV	-3.7130654+03	2.5400644+04	9.6962194+03	-2.4589426+01	3.2445910+00	-1.2732718+02	4.3097463+03
WT	-8.4502666+03	-2.4564600+04	-1.0262978+03	2.0633876+01	7.1338062+00	2.5196791+01	1.9560140+04
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	4.8012615-01	3.6490553+00	8.1436671-03	-2.2100679-03	-3.6847886-04	3.3905550-05	-3.4801495-01
Y ACC BIAS	-3.8829387+00	1.1410945+01	1.4844614-01	-1.3459484-02	3.5869426-03	-7.4141691-04	4.6935016+00
Z ACC BIAS	-2.3339961+00	6.7723889+00	-9.6227469-02	-8.0811117-03	2.1672396-03	9.9137891-04	2.9719339+00
X MISALIGN	-1.8389749-01	1.1666624+00	4.0951747-01	-1.1355624-03	1.6053442-04	-5.0884958-03	2.1643977-01
Y MISALIGN	-3.9810198-01	-4.4751623-01	2.7493194-02	1.0886614-04	3.2819019-04	1.0480281-04	4.0581468-01
Z MISALIGN	5.8567918-01	2.5005827-01	1.3289922-02	2.4147589-04	-4.9546927-04	1.0511898-04	-5.5413692-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	2.6199591+08						
W NAV	2.1345179+06	8.6487589+05					
U-DOT NAV	-2.8587402+05	-2.1527381+03	3.2877433+02				
V-DOT NAV	7.6928104+04	3.7743933+02	-1.0349853+02	4.5501564+01			
W-DOT NAV	-2.6625185+04	-9.8812980+03	2.6020440+01	-3.6473595+00	1.2905560+02		
WT	-1.8689991+04	1.7859722+03	2.9872665+01	-1.7904880+01	-2.6261051+01	3.3441086+03	
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	-4.9114581+00	4.7898688-03	3.4870629-03	2.3351665-04	-4.8163773-05	1.5772801-03	0.0000000
Y ACC BIAS	-1.0552972+01	-1.1464756-01	1.2462750-02	-4.4107343-03	6.4020723-04	4.0542171-03	0.0000000
Z ACC BIAS	-6.4400948+00	1.5601542-01	7.6996312-03	-2.8713664-03	-9.3910930-04	3.0037445-03	0.0000000
X MISALIGN	-1.2490672+00	-4.1653921-01	1.2320235-03	-1.8506203-04	5.1623933-03	-1.1391988-03	0.0000000
Y MISALIGN	3.5934605-01	-2.9239581-02	-7.5758343-06	-3.5359426-04	-9.8613221-05	1.8499504-04	0.0000000
Z MISALIGN	-4.1864664-01	-1.3433291-02	-4.4504683-05	4.6493061-04	-9.9818668-05	-8.3084718-04	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	2.5879156-06					
Y ACC BIAS	0.0000000	2.5879156-06				
Z ACC BIAS	0.0000000	0.0000000	2.5879156-06			
X MISALIGN	0.0000000	0.0000000	0.0000000	2.4872036-07		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	7.5961371-08	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	7.0271063-08

TABLE A3.2-VIII.- Concluded

(b) Correlation matrix

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.0000000+00						
V ACT	-2.7258038-01	1.0000000+00					
W ACT	-6.0167758-02	3.4685585-02	1.0000000+00				
U-DOT ACT	3.1802062-01	-9.9663759-01	-2.7772798-02	1.0000000+00			
V-DOT ACT	-9.9914314-01	2.9719988-01	5.9358753-02	-3.4144101-01	1.0000000+00		
W-DOT ACT	4.3870925-02	-4.4494704-02	-9.3275391-01	3.6293225-02	-4.3964169-02	1.0000000+00	
U NAV	-9.8818319-01	2.3675859-01	7.8949476-02	-2.8066112-01	9.8701372-01	-5.0965596-02	1.0000000+00
V NAV	6.5922243-01	-3.5146135-01	-1.6598686-01	3.3175312-01	-6.7088443-01	1.4653067-01	-6.8920555-01
W NAV	5.1299454-02	-3.7024750-02	-9.9622352-01	3.0430766-02	-5.0119165-0[illegible]	9.3[illegible]3394-01	-6.0865162-02
U-DOT NAV	-8.0813790-01	3.3910546-01	1.5156174-01	-3.3788045-01	8.1651[illegible]06-01	-1.28[illegible]344-01	8.3487248-01
V-DOT NAV	9.8443244-01	-2.4600649-01	-7.9680314-02	2.8834292-01	-9.8444425-01	4.89[illegible]179-02	-9.9903771-01
W-DOT NAV	-4.4031203-02	5.0325670-02	9.3252337-01	-4.2174894-02	4.42593[illegible]4-02	-9.7981790-01	4.9695853-02
WT	-1.9685507-02	-9.5609885-03	-1.9390050-02	6.9523989-03	1.9116781-02	[illegible].3868097-02	4.4308665-02
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
X ACC BIAS	4.0206371-02	5.1055045-02	5.5308347-03	-2.6768535-02	-3.5497252-02	1.8801130-03	-2.8338687-02
Y ACC BIAS	-3.2516355-01	1.5965401-01	1.0081834-01	-1.6302244-01	3.4552781-01	-4.1112666-02	3.8218953-01
Z ACC BIAS	-1.9545260-01	9.4754553-02	-6.5353632-02	-9.7879129-02	2.0876876-01	5.4973429-02	2.4200312-01
X MISALIGN	-6.9674843-02	5.2652963-02	8.9714468-01	-4.4365907-02	4.9882260-02	-9.1016883-01	5.6851021-02
Y MISALIGN	-1.9458722-01	-3.6546489-02	1.0898496-01	7.6964503-03	1.8452824-01	3.3920696-02	1.9288046-01
Z MISALIGN	2.9763767-01	2.1231772-02	5.4774684-02	1.7749232-02	-2.8964238-01	3.5373748-02	-2.7383295-01

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT	TIME
V NAV	1.0000000+00						
W NAV	1.4179981-01	1.0000000+00					
U-DOT NAV	-9.7404379-01	-1.2766309-01	1.0000000+00				
V-DOT NAV	7.0457076-01	6.0166825-02	-8.4619816-01	1.0000000+00			
W-DOT NAV	-1.4479613-01	-9.3529513-01	1.2632149-01	-4.7596716-02	1.0000000+00		
WT	-1.9967407-02	3.3209140-02	2.8489501-02	-4.5900571-02	-3.9974542-02	1.0000000+00	
TIME	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00
X ACC BIAS	-1.8862017-01	3.2016339-03	1.1954620-01	2.1519374-02	-2.6354635-03	1.6954936-02	0.0000000
Y ACC BIAS	-4.0527747-01	-7.6632478-02	4.2725768-01	-4.0646455-01	3.5031367-02	4.3580456-02	0.0000000
Z ACC BIAS	-2.4732610-01	1.0428350-01	2.6396473-01	-2.6460645-01	-5.1386928-02	3.2288491-02	0.0000000
X MISALIGN	-1.3473298-01	-8.9766595-01	1.3624305-01	-5.5010867-02	9.1118589-01	-3.9500599-02	0.0000000
Y MISALIGN	8.0550683-02	-1.1407694-01	-1.4759305-03	-1.9019349-01	-3.1495631-02	1.1607095-02	0.0000000
Z MISALIGN	-9.7568916-02	-5.4490058-02	-9.2595102-03	2.6000800-01	-3.3146302-02	-5.4199180-02	0.0000000

	X ACC BIAS	Y ACC BIAS	Z ACC BIAS	X MISALIGN	Y MISALIGN	Z MISALIGN
X ACC BIAS	1.0000000+00					
Y ACC BIAS	0.0000000	1.0000000+00				
Z ACC BIAS	0.0000000	0.0000000	1.0000000+00			
X MISALIGN	0.0000000	0.0000000	0.0000000	1.0000000+00		
Y MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00	
Z MISALIGN	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	1.0000000+00

TABLE A3.3-I.- EXCHANGE RATIOS AT NOMINAL MECO

Parameter varied	Δ ET propellant/Δ parameter	
SRB web action time[a] (constant ISP)	-894	lb/percent
SRB vacuum ISP[a] (constant $\dot{W}$)	2422	lb/percent
SRB propellant loading[a]	1571	lb/percent
SRB inert weight[a]	-0.102	lb/lb
Orbiter thrust[b] (constant ISP)	0.077	lb/lb
Orbiter ISP[c] (constant $\dot{W}$)	1136	lb/sec
Orbiter inert weight	-0.96	lb/lb
External tank inert weight	-0.95	lb/lb
External tank oxidizer loading	0.064	lb/lb
External tank fuel loading	0.067	lb/lb

[a]Based on variation for matched SRM pair.
[b]Exchange ratio based on total system thrust variation (10 392 lb/3 eng).
[c]Exchange ratio based on total system ISP variation (1.328 sec/3 eng).

TABLE A3.4-I.- THREE-SIGMA RSS SUMMARY DATA

(a) Actual minus nominal UVW state parameters

Event slice	U, ft	V, ft	W, ft	U-DOT, fps	V-DOT, fps	W-DOT, fps
SRB separation	2 536	9 426	2 843	35.6	69.6	9.5
MECO	2 103	53 465	6 723	65.1	7.9	33.2
OMS-1 cutoff	4 296	48 433	14 078	59.2	9.2	30.0
OMS-2 ignition	21 118	67 108	7 726	77.7	17.9	32.4
OMS-2 cutoff	21 854	71 814	4 683	82.5	18.9	33.3
Fixed time slice						
Nominal MECO +62 sec (GET = 580 sec)	3 111	152 375	8 747	184.5	8.2	32.5
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	9 137	136 273	27 916	165.4	10.6	8.2
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	22 269	133 287	2 746	154.0	19.4	33.6

TABLE A3.4-I.- Continued

(b) Actual minus nominal trajectory state parameters

Event slice	Altitude, ft	Velocity magnitude, fps	Altitude rate, fps	Downrange rate, fps	Flightpath angle, deg
SRB separation	2 538	77.2	34.2	70.0	0.114
MECO	2 102	7.8	10.4	7.8	.023
OMS-1 cutoff	4 294	9.1	9.4	9.2	.021
OMS-2 ignition	21 111	17.9	13.6	17.9	.031
OMS-2 cutoff	21 844	18.9	13.1	18.9	.030
Fixed time slice					
Nominal MECO +62 sec (GET = 580 sec)	2 982	8.3	10.1	8.4	.023
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	9 098	10.5	11.7	10.5	.026
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	22 266	19.4	12.7	19.4	.029

TABLE A3.4-I.- Continued

(c) Actual minus nominal vehicle parameters

Event slice	Latitude, deg	Longitude, deg	Azimuth, deg	Range, n.mi.	Time, sec	Weight, lb	Propellant, lb
SRB separation	0.004	0.008	0.119	0.50	5.92	19 904	19 673
MECO	.059	.157	.119	8.49	4.98	4 936	4 943
OMS-1 cutoff	.046	.164	.123	7.80	4.73	177	0
OMS-2 ignition	.103	.152	.082	10.37	4.98	178	0
OMS-2 cutoff	.105	.170	.094	10.95	4.98	173	0
<u>Fixed time slice</u>							
Nominal MECO +62 sec (GET = 580 sec)	.121	.397	.245	20.61	0	185	0
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	.159	.369	.198	20.46	0	178	0
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	.194	.337	.160	20.74	0	173	0

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TABLE A3.4-I.- Continued

(d) Actual minus nominal orbital parameters

Event slice	Apogee altitude, n. mi.	Perigee altitude, n. mi.	Period, sec	Inclination, deg	Longitude of ascending node, deg	Argument of perigee, deg	True anomaly, deg	Semi-major axis, n. mi.
SRB separation	4.2	0.1	1.8	0.069	0.156	0.11	0.03	1.1
MECO	1.7	3.1	4.0	.052	.085	3.05	3.02	1.8
OMS-1 cutoff	3.6	0.4	4.2	.052	.086	2.24	2.23	1.9
OMS-2 ignition	3.6	0.3	4.2	.052	.086	2.40	2.40	1.9
OMS-2 cutoff	2.4	1.6	4.2	.052	.086	[a]44.4	[a]44.4	1.9
Fixed time slice								
Nominal MECO +62 sec (GET = 580 sec)	1.7	3.2	4.0	.052	.085	3.07	3.11	1.8
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	3.6	0.3	4.2	.052	.086	2.18	2.18	1.9
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	2.4	1.6	4.2	.052	.086	[a]50.5	[a]50.5	1.9

[a]Large dispersions are a result of the near circular orbit.

TABLE A3.4-I.- Continued

(e) Navigated minus actual UVW state parameters

Event slice	U, ft	V, ft	W, ft	U-DOT, fps	V-DOT, fps	W-DOT, fps
SRB separation	98	200	321	1.9	3.2	6.1
MECO	2 115	2 271	6 774	12.3	7.8	33.7
OMS-1 cutoff	4 357	4 828	14 252	12.9	9.3	30.4
OMS-2 ignition	21 771	43 770	7 846	49.6	18.5	32.8
OMS-2 cutoff	22 489	46 634	4 757	52.5	19.4	33.8
Fixed time slice						
Nominal MECO +62 sec (GET = 580 sec)	2 741	2 870	8 830	12.3	8.2	33.0
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	9 715	15 560	28 289	19.6	10.7	8.3
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	22 902	48 559	2 790	54.4	20.2	34.1

TABLE A3.4-I.- Continued

(f) Navigated minus actual trajectory state parameters

Event slice	Altitude, ft	Velocity magnitude, fps	Altitude rate, fps	Downrange rate, fps	Flightpath angle, deg
SRB separation	98	2.6	1.9	3.1	0.028
MECO	2 115	7.7	10.6	7.8	.024
OMS-1 cutoff	4 357	9.2	9.6	9.2	.021
OMS-2 ignition	21 776	18.5	13.6	18.5	.031
OMS-2 cutoff	22 482	19.4	13.1	19.4	.030
<u>Fixed time slice</u>					
Nominal MECO +62 sec (GET = 580 sec)	2 741	8.2	10.2	8.2	.023
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	9 708	10.6	12.2	10.6	.027
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	22 895	20.2	12.8	20.2	.029

TABLE A3.4-I.- Continued

(g) Navigated minus nominal UVW state parameters

Event slice	U, ft	V, ft	W, ft	U-DOT, fps	V-DOT, fps	W-DOT, fps
SRB separation	2 541	9 433	2 860	35.2	69.2	11.2
MECO	84	53 460	55	64.2	1.7	0.7
OMS-1 cutoff	182	47 876	207	57.4	0.8	0.8
OMS-2 ignition	3 548	53 705	340	63.1	3.0	0.7
OMS-2 cutoff	3 597	55 927	279	64.9	3.2	0.7
Fixed time slice						
Nominal MECO +62 sec (GET = 580 sec)	1 528	152 445	92	184.2	1.4	0.7
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	2 101	135 611	596	161.1	0.5	0.4
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	3 524	124 796	245	144.9	3.6	0.8

TABLE A3.4-I.- Concluded

(h) Navigated minus nominal trajectory state parameters

Event slice	Altitude, ft	Velocity magnitude, fps	Altitude rate, fps	Downrange rate, fps	Flightpath angle, deg
SRB separation	2543	76.6	33.8	69.5	0.117
MECO	52	1.5	0.9	1.5	.002
OMS-1 cutoff	166	0.9	1.1	0.9	.002
OMS-2 ignition	3565	3.0	1.5	3.0	.003
OMS-2 cutoff	3616	3.2	0.2	3.2	.001
<u>Fixed time slice</u>					
Nominal MECO +62 sec (GET = 580 sec)	1238	2.4	1.3	2.4	.003
Nominal OMS-1 cutoff +691 sec (GET = 1440 sec)	2022	2.1	2.0	2.1	.005
Nominal OMS-2 cutoff +61 sec (GET = 2905 sec)	3610	3.5	0.5	3.5	.001

TABLE A4.0-I.- PRINCIPAL ERROR CONTRIBUTORS

(a) MECO

State vector component (a)	Principal error source
U	Platform misalinement (tilt) Accelerometer IA misalinement toward SA (X) Accelerometer bias (X) Accelerometer scale factor (X)
V	SRB web action time SSME thrust ET propellant loading Platform misalinement (tilt)
W	Platform misalinement (azimuth) SRB web action time
$\dot{U}$	SRB web action time SSME thrust ET propellant loading SSME ISP Platform misalinement tilt) Accelerometer IA misalinement toward SA (X)
$\dot{V}$	Platform misalinement (tilt) Accelerometer scale factor (Z) Accelerometer bias (Z)
$\dot{W}$	Platform misalinement (azimuth) SRB web action time Accelerometer IA misalinement toward OA (Y)

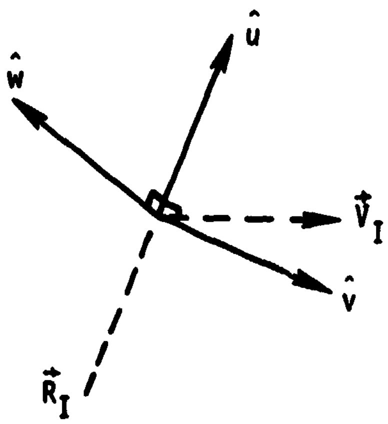
[a]Both the actual and navigated state vectors.

TABLE A4.0-I.- Concluded

(b) OMS-2 Cutoff

State vector component (a)	Principal error source
U	Accelerometer bias (Z) Accelerometer scale factor (Z) Platform misalinement (tilt)
V	Accelerometer bias (X,Z) SRB web action time SSME thrust Accelerometer scale factor (Z)
W	Platform misalinement (azimuth) Accelerometer bias (Y)
$\dot{U}$	Accelerometer bias (X,Z) SRB web action time SSME thrust
$\dot{V}$	Accelerometer bias (Z) Accelerometer scale factor (Z) Platform misalinement (tilt)
$\dot{W}$	Platform misalinement (azimuth) Accelerometer bias (Y)

[a]Both the actual and navigated state vectors.



Let R_I be the inertial position vector and V_I be the inertial velocity vector. The LHS or UVW coordinate system is defined by the following three vector equations.

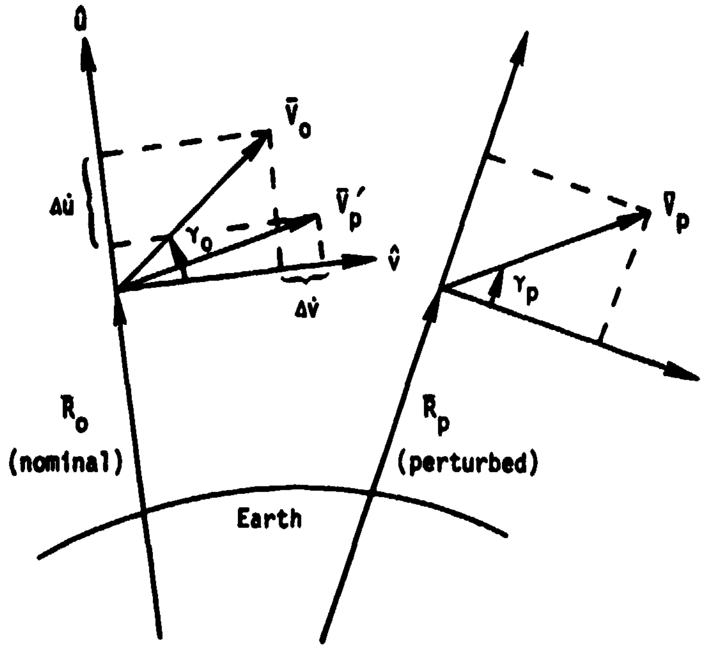
$\hat{u} = \vec{R}_I/|\vec{R}_I|$ (Radial direction)

$\hat{v} = (\vec{R}_I \times \vec{V}_I \times \vec{R}_I)/|\ \vec{R}_I \times \vec{V}_I \times \vec{R}_I|$ (Downrange direction)

$\hat{w} = \hat{u} \times \hat{v}$ (Crossrange direction)

Figure A2 .1-1.- Local horizontal coordinate system.

- Nominal actual state : $\bar{R}_o, \bar{V}_o, \gamma_o$
- Perturbed actual state : $\bar{R}_p, \bar{V}_p, \gamma_p$
- UVW system constructed at nominal actual state
- Perturbed state ($\bar{R}_p, \bar{V}_p$) transformed into UVW system ($\bar{R}_p', \bar{V}_p'$)



- UVW Errors

  $\dot{u}$ error = $\Delta\dot{u}$ = u component of $\bar{V}_p'$, - u component of $\bar{V}_o$

  $\dot{v}$ error = $\Delta\dot{v}$ = v component of $\bar{V}_p'$, - v component of $\bar{V}_o$

- Trajectory Errors

  speed error = $\Delta|\bar{V}| = |\bar{V}_p| - |\bar{V}_o|$

  altitude rate error = $\Delta\dot{H} = |\bar{V}_p| \sin\gamma_p - |\bar{V}_o| \sin\gamma_o$

  downrange rate error = $\Delta\dot{DR} = |\bar{V}_p| \cos\gamma_p - |\bar{V}_o| \cos\gamma_o$

- Note that due to downrange position error :

  $\Delta\dot{u} \neq \Delta\dot{H}$

  $\Delta\dot{v} \neq \Delta\dot{DR}$

Figure A2 .4-1.- Illustration of velocity errors in UVW and trajectory coordinates.

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