SD78-SH-0141

INTEGRATED GUIDANCE, NAVIGATION AND CONTROL VERIFICATION PLAN PRIMARY FLIGHT SYSTEM

Ascent

May 1978

CONTRACT NAS9-14000

IRD (TBD) DCN 589
WBS 2.2.2

APPROVED BY

G. F. Fraser, Manager
Integrated GN&C/Vehicle, GN&C

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FOREWORD

This volume, SD78-SH-0141, formerly numbered as SD74-SH-0043, Vol 2, Book 2, is an element of the Avionics Verification Plan SD76-SH-0160. This volume describes the elements of the Ascent GN&C Subsystem, the interface with other subsystems, and the plan for verification of the Ascent Guidance Subsystem interfaces and the Ascent Integrated GN&C Subsystem interfaces and the Ascent Integrated GN&C Subsystem. Verification of the other subsystems are as follows: Flight Control, SD78-SH-0140; Navigation, SD78-SH-0142; Separation, SD78-SH-0143; Integrated Guidance, Navigation and Control, On-Orbit, SD78-SH-0144; and Integrated Guidance, Navigation and Control, Descent, SD78-SH-0145. The tests identified for verification may be modified or deleted as a result of prior testing.

TABLE OF CONTENTS

1.0 OVERVIEW

This Volume, SD78-SH-0141, is one of six volumes that define the Guidance, Navigation, Control and Separation (SRB and ET) Verification Plans and Methods for the Ascent phase for the Space Shuttle. Figure 1.1 shows the six volumes of this plan in relation to the Avionics Verification Plan. This particular volume presents the plans at the ascent guidance subsystem interface and the integrated GN&C level while the other volumes define verification plans for flight control, navigation, separation, and the on-orbit and descent portions of integrated GN&C.

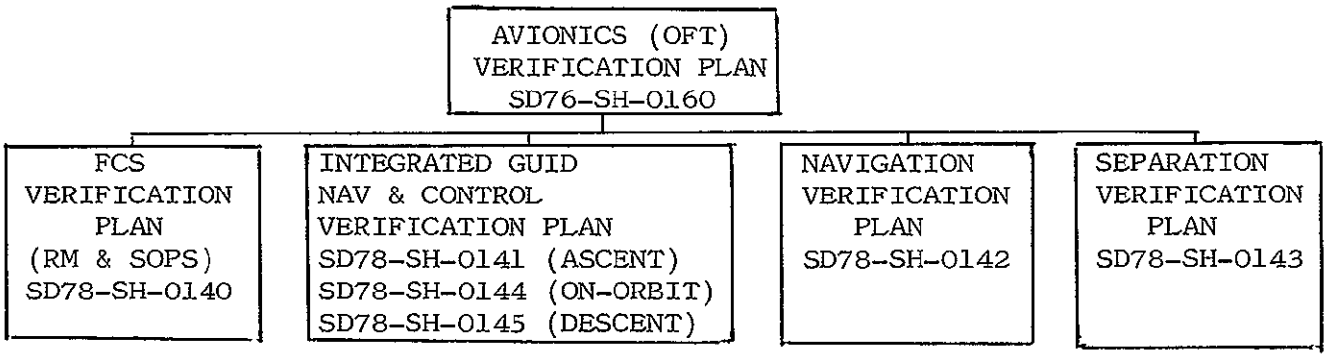


FIGURE 1.0-1 GN&C VERIFICATION PLAN-DOCUMENTATION TREE

1.1 Verification Scope

This Plan defines the verification process and requirements for the Ascent Guidance interfaces and the Ascent Integrated Guidance, Navigation and Control System and includes those portions of supporting systems which directly interface with the system. The Ascent Phase of Verification covers the normal and ATO ascent through the final OMS-2 circularization Burn (all of OPS 1), the AOA ascent through the OMS-1 Burn (all of OPS 1), and the RTLS ascent through ET Separation (all of MM601). In addition OPS translation verification is defined.

1.2 Verification Tree

The verification of Ascent GN&C will be accomplished by progressing from the lowest level of assembly or subsystem to the integrated GN&C level with OPS Transition for the ascent phase of the mission. The Ascent GN&C verification tree describing this process is given in Figures 1.2-1. Lower level verification trees for the GN&C subsystems and related subsystems are given in their respective verification plans. It is intended that a Verification Completion Notice (VCN) will be prepared and approved for each box of the tree as designated by the code building to the top level GN&C VCN for the total mission flight. It is further intended that responsible counterpart personnel at Rockwell and NASA for each verification element will be identified.

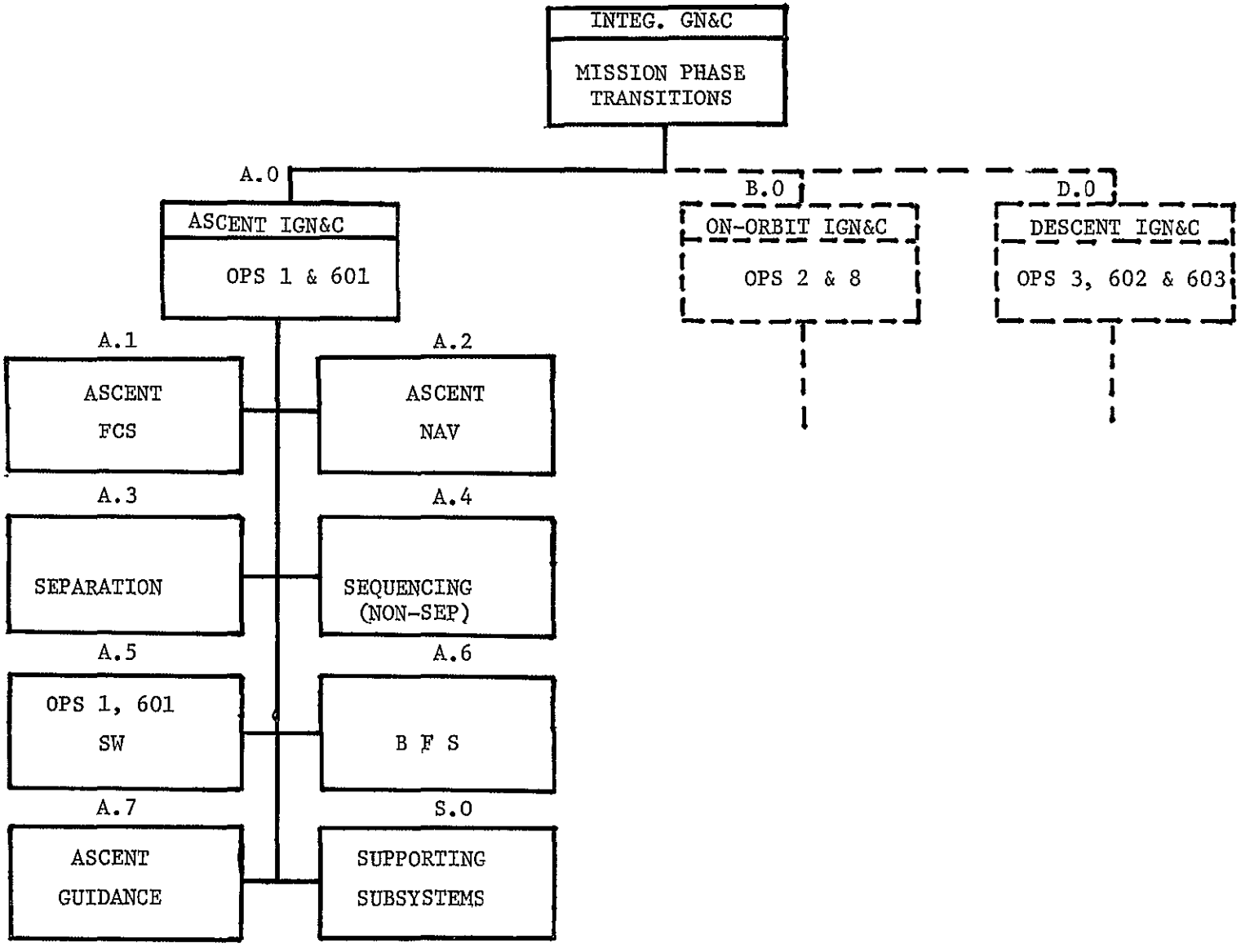
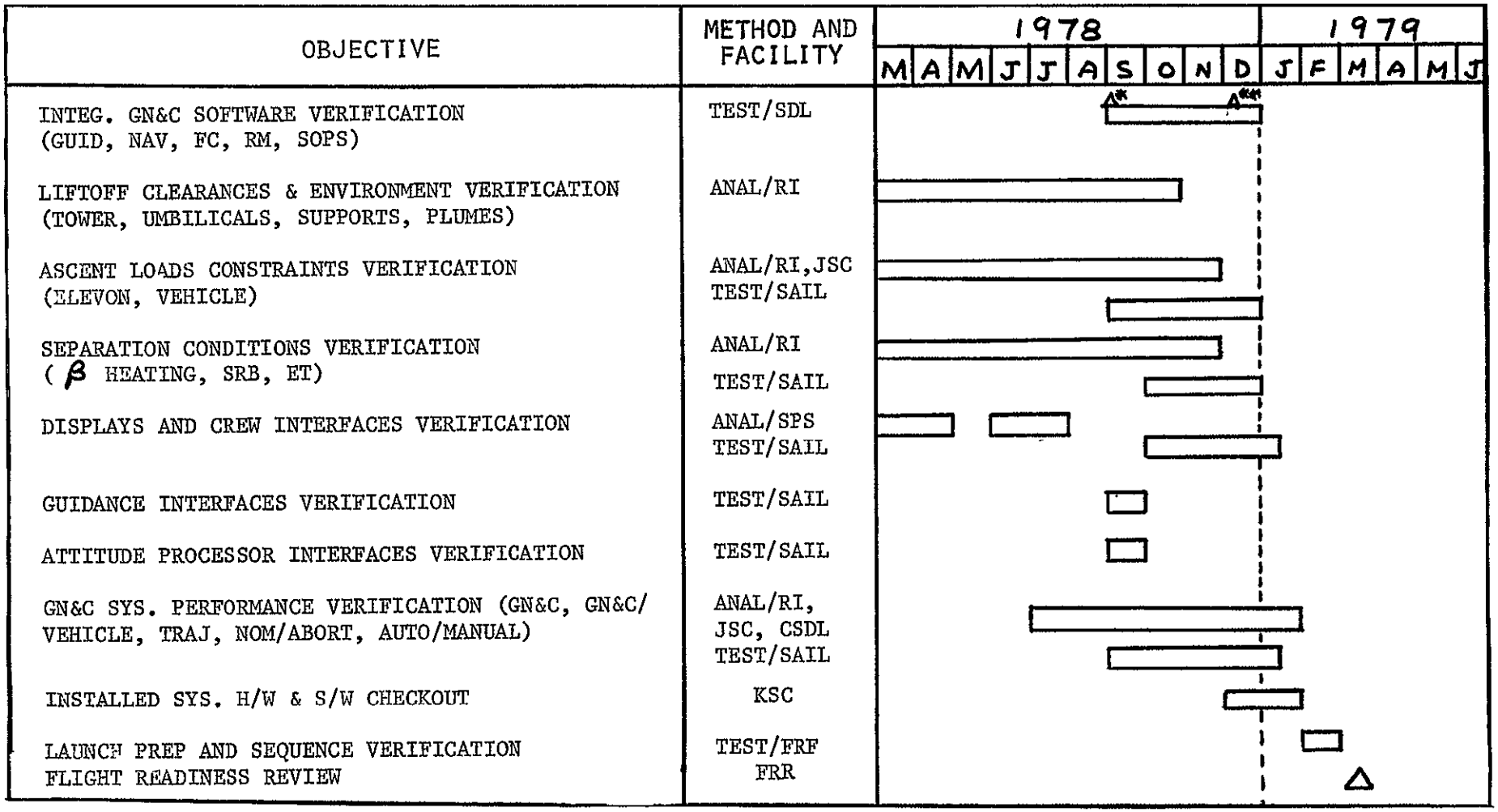


FIGURE 1.2-1. ASCENT INTEGRATED GN&C VERIFICATION TREE

1.3 Verification Roadmap

A verification roadmap for the Ascent Guidance interfaces and the Ascent Integrated GN&C is given in Figure 1.3-1. The roadmap identifies the top level verification requirements giving the associated principal verification methods, facility assignments and general schedule for conducting the verification. Detailed verification requirements, methods and facility assignments are given in Section 5.0.

FIGURE 1.3-1. ASCENT INTEGRATED GN&C VERIFICATION ROADMAP



Δ^{*} SEPT. 4, 1978 SOFTWARE DELIVERY

Δ^{**} DEC. 11, 1978 SOFTWARE DELIVERY

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2.0 SYSTEM DEFINITION

The total ascent/RTLS system functional block diagram is shown in Figure 2.1. This figure depicts the total mated element system required for the integrated ascent/RTLS GN&C verification testing. The system functional block diagrams include the unpowered portion of the RTLS for reference only. Refer to SDM 72-SH-0105 for a detailed description of the system.

2.1 Integrated GN&C

The integrated GN&C system is comprised of both hardware (LRU's) and software (SW). It interfaces with the vehicle, the crew, and other avionic subsystems. A top level functional block diagram of the ascent integrated GN&C along with most of its critical parameters is shown in Figure 2.2. A more detailed functional block diagram of the integrated ascent/RTLS GN&C along with all the supporting subsystems is shown in Figure 2.3.

The integrated ascent GN&C system of the Space Shuttle Integrated Vehicle provides guidance and navigation while maintaining Orbiter stability and control within critical trajectory and loading constraints including failures and dispersions during normal ascent operations. These operations include nominal, AOA, ATO, and the powered portion of RTLS.

2.2 Supporting Subsystems

The primary subsystems of the Integrated GN&C system are guidance, navigation and control. These elements plus supporting subsystems such as the backup flight system, separation system, communication and tracking, displays, and redundancy management tend to comprise the bulk of the integrated ascent GN&C activity.

2.3 Avionic Equipment Location

The GN&C avionics equipment is located in both the forward and aft sections of the Orbiter as shown in Figure 2.4.

2.4 Guidance

The powered flight guidance SW processes position, velocity and acceleration data from the navigation subsystem to generate desired attitude commands for the flight control subsystem. During first stage a preprogrammed body attitude profile is commanded.

During the second stage, powered RTLS, OMS-1 and OMS-2 phases a thrust direction profile which satisfies the target conditions at MECO or OMS cutoff is commanded. If an engine out occurs during first stage, an alternate body attitude profile is selected. If an RTLS, AOA or ATO abort is selected, appropriate alternate end-burn target parameters within the vehicle performance capability, are selected for the second stage, powered RTLS and OMS burns.

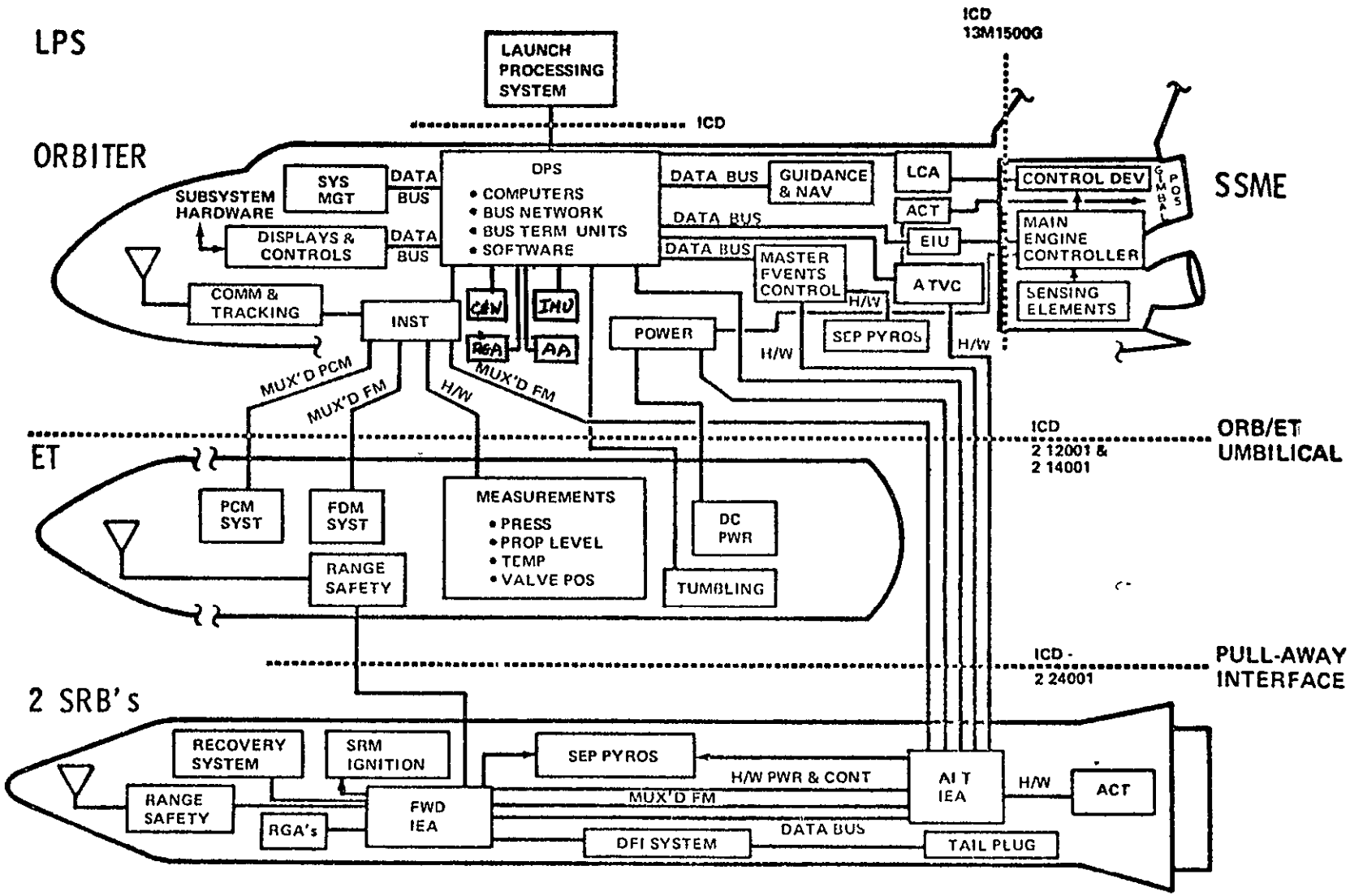

FIGURE 2.0-1 ASCENT/RTLS SYSTEM FUNCTIONAL BLOCK DIAGRAM

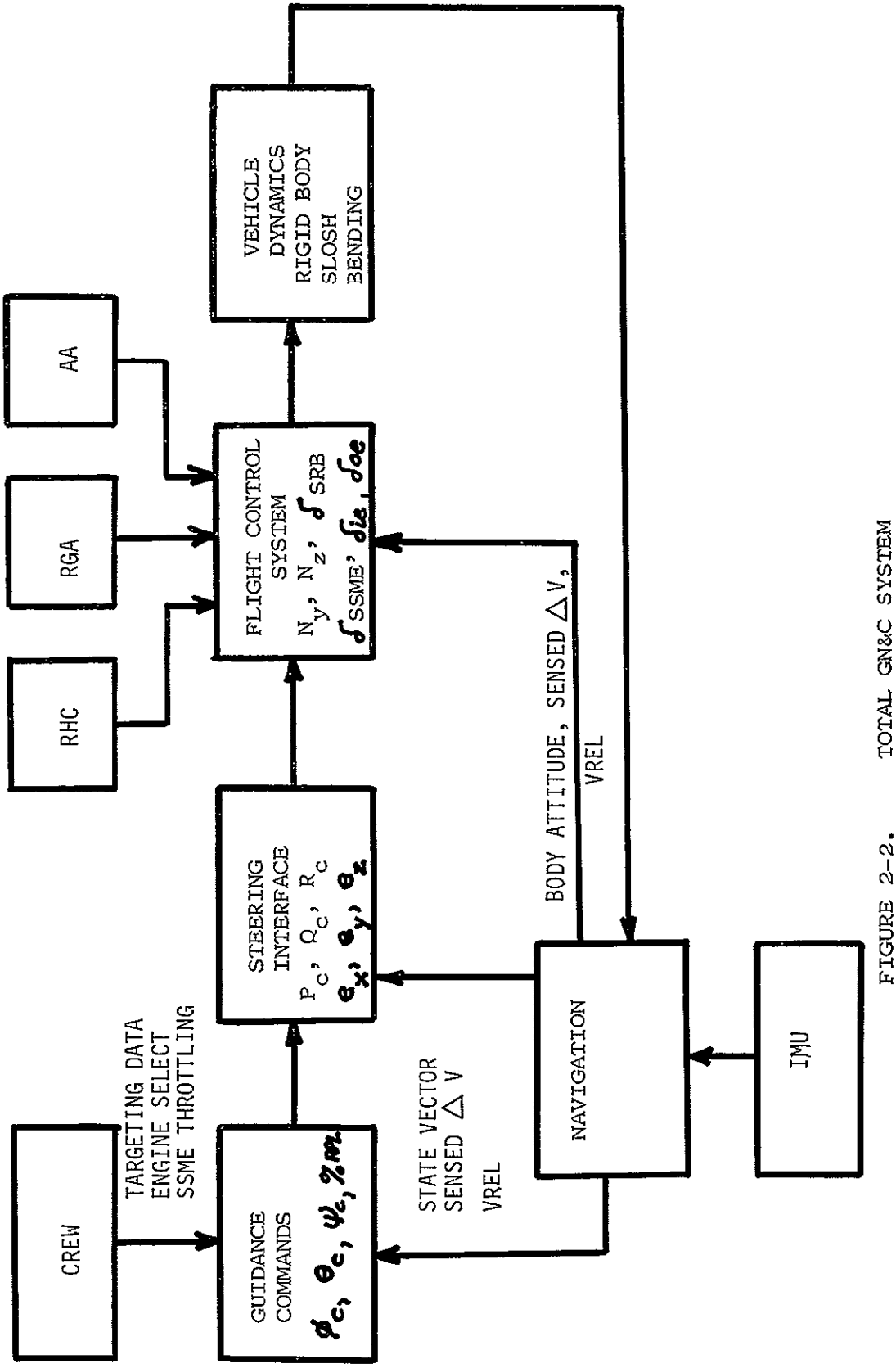

FIGURE 2-2. TOTAL GN&C SYSTEM

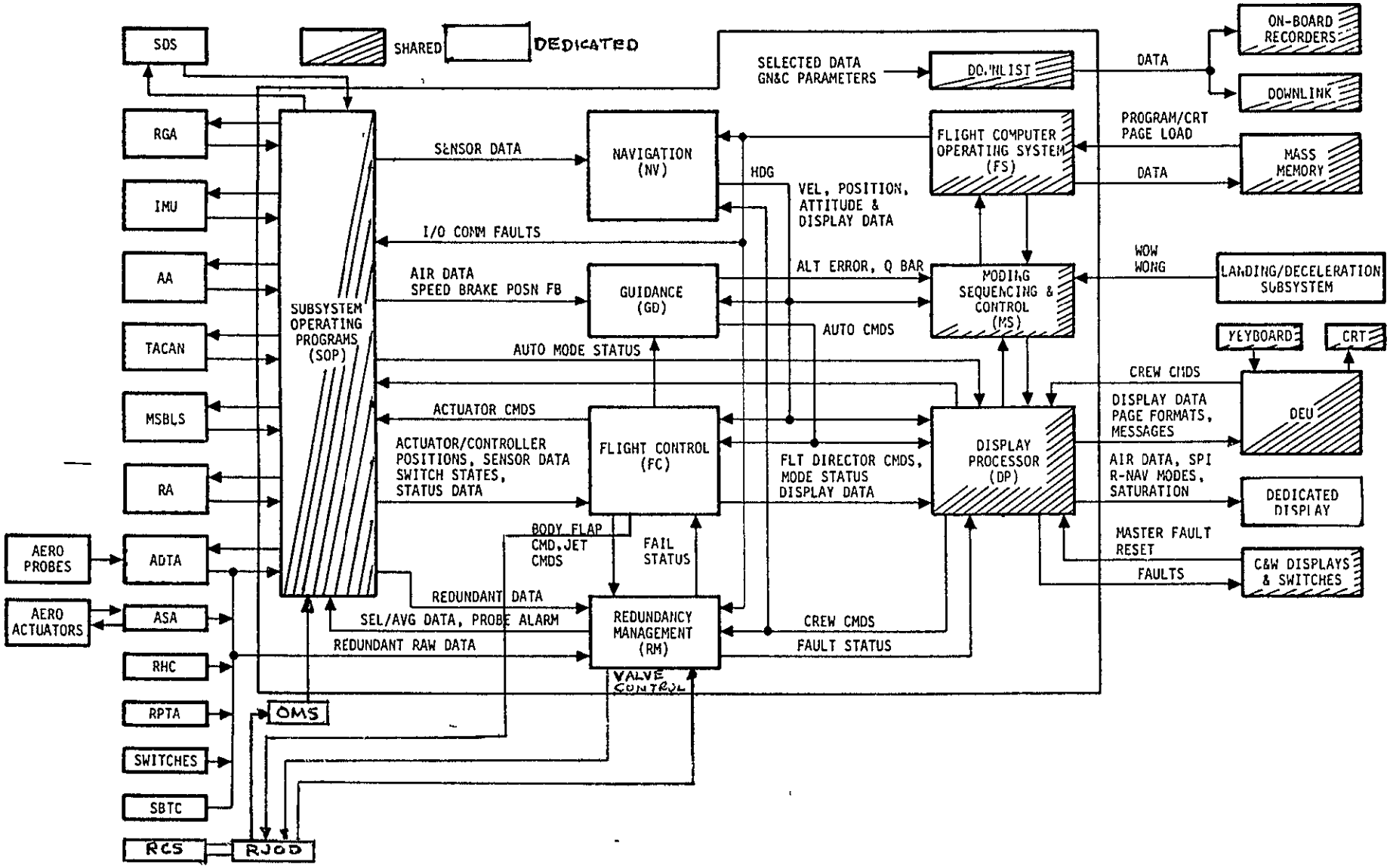

FIGURE 2-3 GN&C FUNCTIONAL BLOCK DIAGRAM-HARDWARE/SOFTWARE

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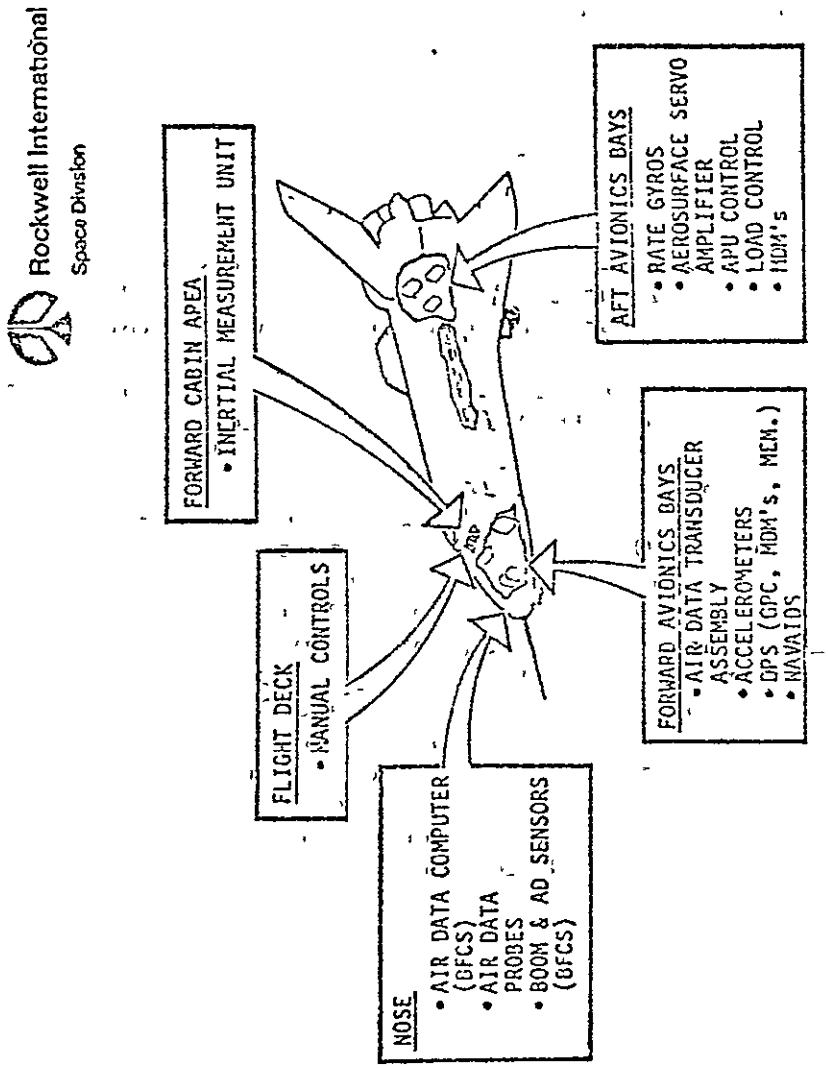

Figure 2-4 GN&C Equipment Location

2.5 Navigation

The NAV subsystem outputs include vehicle attitudes and velocity to flight control (FC), vehicle position and heading data to guidance (GD) and to displays (D18, D19, D110); IMU-derived body rates and accelerations (RM) for use in failure detection plus selected data to telemetry (TLM).

Figure 2-5 is a simplified block diagram of the navigation subsystem interfaces. A more complete system definition is contained in Volume 3 of this series.

2.6 Flight Control

2.6.1 Ascent

The ascent flight control subsystem functions provide attitude control and stabilization, mated vehicle structural load alleviation, elevon load alleviation and fault detection and isolation.

During the nominal ascent Stage 1 and Stage 2 mission phases, the flight control subsystem (FCS) receives vehicle attitude errors and attitude rate commands for thrust vector control from the guidance/control steering (GC-Steer) interface. GC-Steer also provides the ascent ADI processor with attitude errors for display. Three axes rate signals from the Orbiter RGA's, pitch and yaw rate signals from the SRB rate gyros, and normal and lateral acceleration signals are received by the Ascent DAP to be combined with the vehicle attitude error and rate signals for subsequent automatic commanding of the main propulsion engine and solid rocket booster motor actuators via the command processors and actuator command SOP's. The flight control subsystem provides elevon repositioning commands to relieve in flight elevon actuator loading. Elevon actuator primary feedback pressures are processed by means of hinge moment relief logic and summed with a relative velocity schedule profile to provide slaved elevon position commands. Management of redundant flight control elements is provided to minimize system effects of element failures, identify faulted elements and switch out of active control, assure that good elements are not switched out, and to control transients incurred during reconfiguration.

Many FCS functions are dependent upon outside indicators for the proper execution of the ascent control laws and sequence of events.

Examples of some of these indicators are: initiate SRB null command, begin monitoring of SRB chamber pressure, initiate SRB separation command, main engine cut indicators, initiate main engine pitch retrim, initiate main engine cutoff, hydraulic system failure indicators, initiate ORB hydraulic slew test, and initiate SRB hydraulic slew test.

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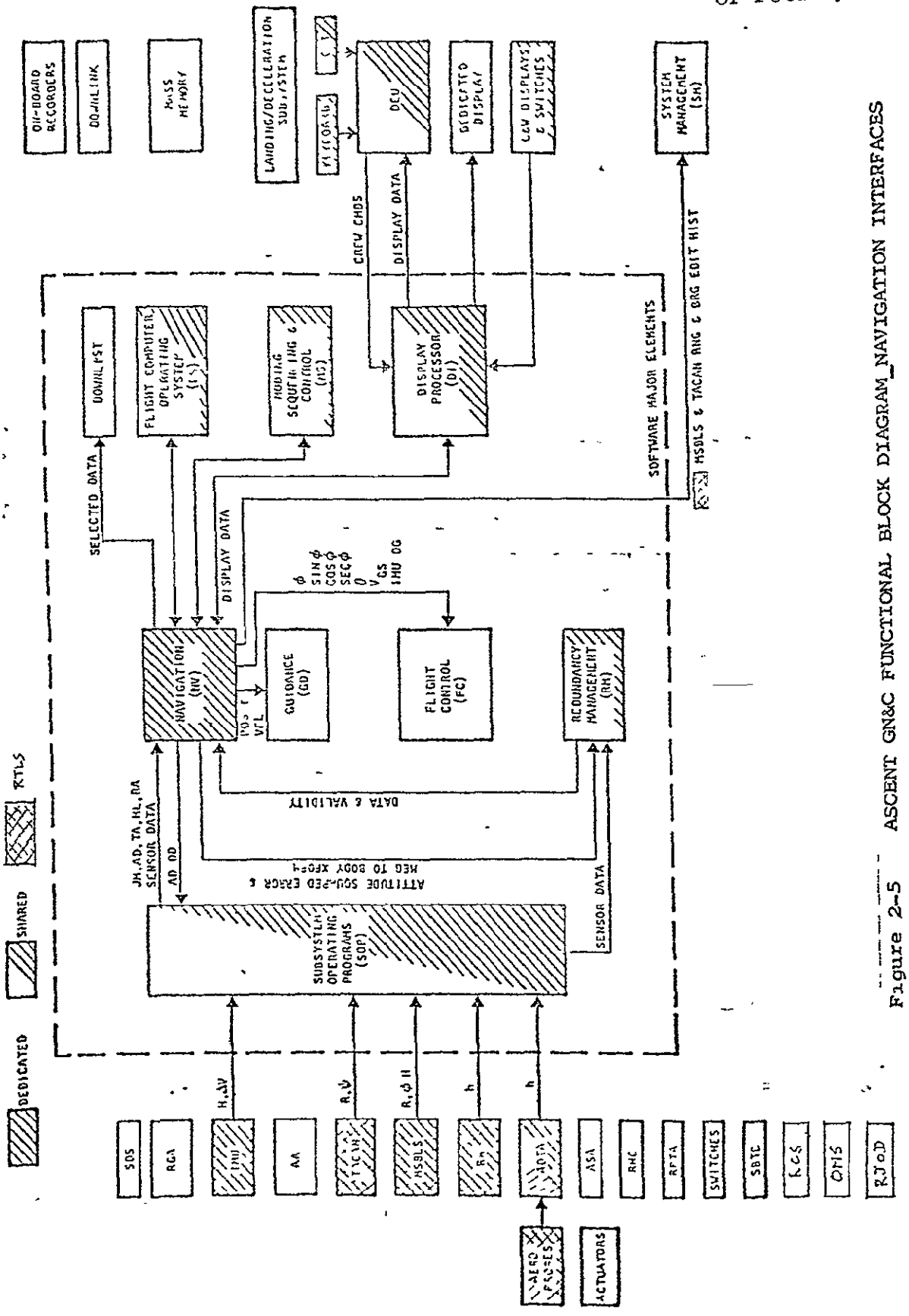

Figure 2-5 ASCENT GN&C FUNCTIONAL BLOCK DIAGRAM_NAVIGATION INTERFACES

2.6.1 (Continued)

Flight control mode switches provide pitch and roll/yaw Auto, CSS, and Gain Enable selection at each of the two crew positions. Normal ascent FCS operation will be in the Auto mode. CSS selection provides the manual guidance mode for an abort situation. Selection of the Gain Enable push button in conjunction with either Auto or CSS switches permits the crew to adjust the forward loop gain to improve the handling characteristics of the vehicle.

A simplified block diagram of the ascent/RTLS flight control system interfaces is presented in Figure 2-6.

2.6.2 Return to Launch Site (RTLS)

Flight control of the Orbiter during the unpowered portion of a return-to-launch-site (RTLS) abort is provided through the GRTLS DAP.

GRTLS DAP is first called at MECO COMMAND, and provides attitude stabilization during the brief mated coast (MC) phase prior to separation from the external tank. Body mounted rate gyros provide rate feedback on all axes. Attitude error signals are provided by the GC_STEER module. The reference attitude is defined by an axis along the earth relative velocity vector, a horizontal axis normal to the velocity vector, and a third axes normal to the other two.

RTLS ET SEPARATION COMMAND causes the GRTLS DAP to change from the MC to the ET SEP configuration and initiates the -Z translational burn. Angular rate feedback is provided on all axes, and roll and yaw error signals are supplied by GC_STEER. However, the pitch error signal is not used during ETSEP. Pitch control is invoked only if the pitch rate exceeds a preset level. The crew can modify the orientation of the Orbiter with three-axes RHC inputs during ETSEP. In addition, the translational hand controller (THC) can be used to override the roll/pitch loops and turn on all the -Z RCS jets. The completion of the ET Separation translation burn is the transition to the glide phase of RTLS.

A simplified block diagram of the Ascent/RTLS flight control system interfaces is presented in Figure 2.6.

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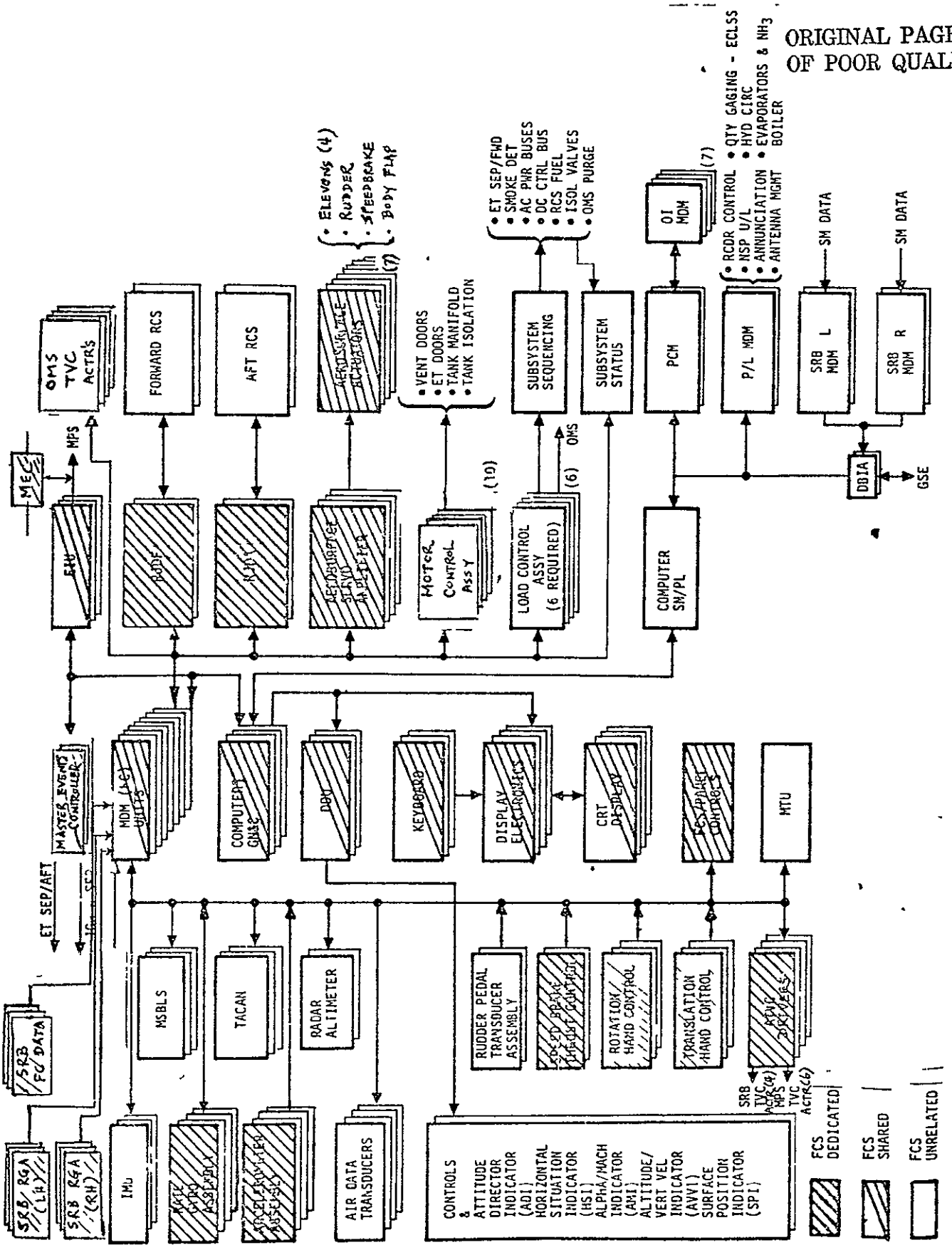


FIGURE 2.6 ORBITER ASCENT/RTLS FUNCTIONAL BLOCK DIAGRAM (FCS)

2.7 Backup Flight System

The backup GN&C system as shown in Figures 2.7.a and 2.7.b are designed to provide protection against a generic software failure of the 4 Primary GN&C computers. The BFS will be available only in OPS 1 and 3, and constitute one computer load. Because the BFS will fit into one computer coupled with the fact that on orbit operations is not a baseline requirement, some of the capabilities of the primary system in OPS 1 and 3 are not available to the BFS. However, guidance laws, navigation and flight control algorithms, display formats, etc., which are used by the BFS are identical to those used by the primary.

2.7.1 BFS Ascent Guidance

The BFS guidance subsystem is based on the identical algorithms used by the Primary Guidance Subsystem. However, the BFS does not support the entire abort capability available to the primary. Specifically, the BFS covers only ATO.

First Stage Guidance, with the exception of Aborts, is identical to that utilized by the primary. An I-loaded table of pitch, yaw and roll tables is used to generate commanded body attitudes as a function of relative velocity. A throttle table, also as a function of relative velocity, is used to constrain variable structural loading. The generated body attitudes are passed to the flight control subsystem as steering commands, while throttling commands are passed to the SSME HARDWARE INTERFACE PROGRAM (HIP).

Subsequent to SRB jettison, Second Stage Guidance is initiated. The BFS, with the exception of abort coverage, uses guidance algorithms identical to those used by the primary guidance subsystem. Navigation inputs, in the form of state vectors and velocities, are used to develop steering commands to be sent to the flight control subsystem. Acceleration limiting throttle commands are sent to the SSME HIP.

Subsequent to MECO, and ET separation, OMS guidance is used for two burns which culminate in placing the vehicle into a safe orbit. The guidance laws used are the same as those used by the primary.

2.7.2 BFS Navigation

The navigation system during the ascent phase receives vehicle state data from the inertial measurements unit HIP (IMU HIP) in the form of IMU measured accumulated sensed velocity and corresponding time tag, angle of attack and sideslip from the attitude processor portion of the IMU (ATT_PROC), current vehicle mass from ascent guidance, time of epoch and corresponding updated M50 to earth-fixed coordinate transformation matrix via the primary/backup data exchange HIP and mission sequencing and major moding from the backup events controller (BEC).

The NAV ascent subsystem outputs include vehicle attitudes and relative velocity magnitude to flight control (FC), vehicle state and time lag to guidance, altitude, dynamic pressure, vehicle state, and total load factor to user interface (UI) for pilot use, relative velocity and vehicle state to attitude processor (ATT_PROC), and finally dynamic pressure and total load factor to systems management and sequencing (SM & SEQ).

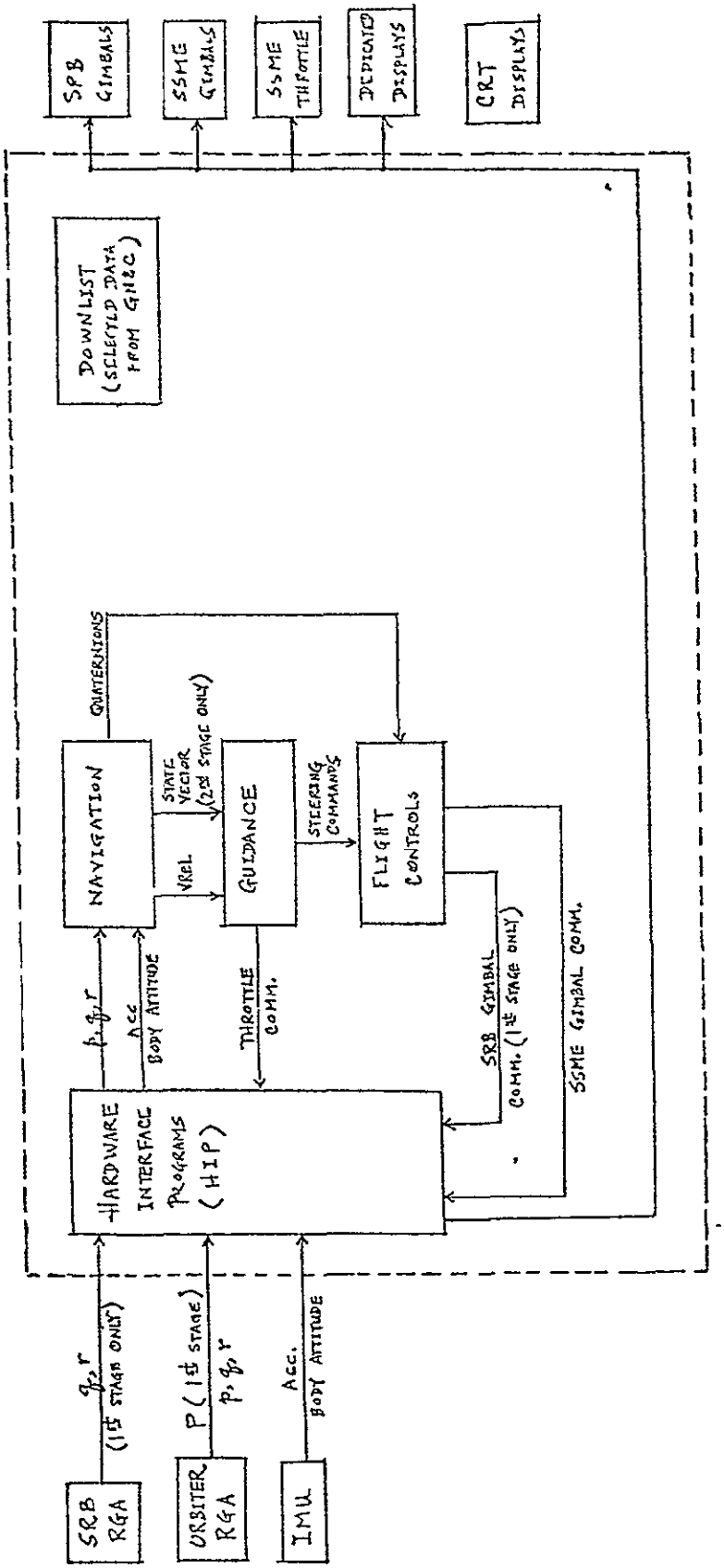


FIGURE 2.7a BFS ASCENT GN&C BLOCK DIAGRAM-FIRST AND SECOND STAGE

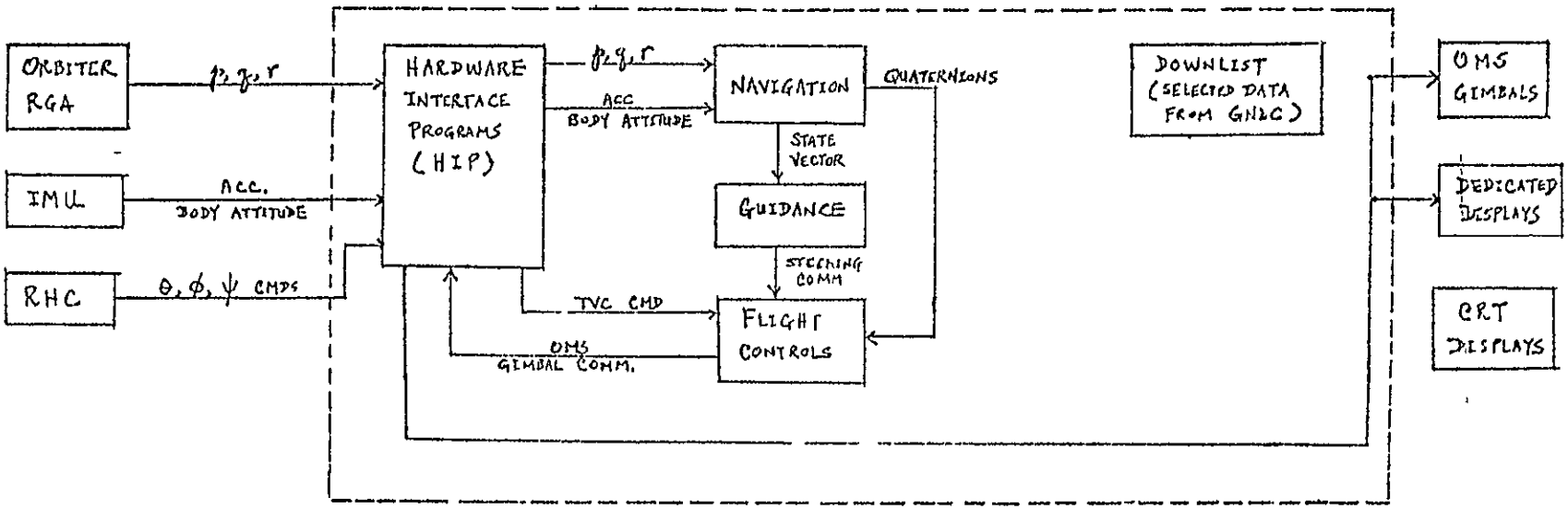


FIGURE 2.7b BFS ASCENT GN&C BLOCK DIAGRAM–OMS BURNS

2.7.3 BFS Flight Control

BFS Flight Control undergoes three distinct changes during Ascent and Insertion. First and second stage boost are purely automatic modes. Flight control receives steering inputs from guidance, present attitude and velocity from navigation. During first stage when the SRB's are burning, these are combined with rate gyro and acceleration data to yield TVC actuator commands. Aerosurface load relief is accomplished simultaneously by sensing actuator P and generating appropriate drive signals to reduce hinge moments. Redundant sensor/controller data is mid value selected prior to use by flight control, to enhance fault tolerance.

Following SRB jettison, second stage flight continues, switching to Orbiter rate gyros for yaw and pitch and using only the SSME's for control.

External tank separation and the subsequent two insertion burns are accomplished via the backup Transition DAP, using gimballed OMS engines and 38 RCS jets (the vernier RCS are not used in BFS) Control during OMS burns is accomplished via manual thrust vector control, using the RHC and Orbiter rate gyros.

Flight control panel switches and CRT displays will be the same as what will be available for the Entry Phase of the OFT mission.

A simplified block diagram of the Ascent/RTLS flight control system interfaces is presented in Figure 2.7.a and 2.7.b.

2.8 Redundancy Management, Moding, Sequencing and Control (RM/MS&C)

The basic function of the RM/MS&C is to direct the utilization of the GN&C system hardware and software during all orbiter flight phases.

2.8.1 Redundancy Management

The GN&C redundancy management is designed to maximize the operational reliability of the GN&C system. This is accomplished by management of redundant data to minimize usage of incorrect or faulty data within the GN&C software application programs. Data from sensors, transducers, and switchines are processed to minimize the probability of degradation of system performance (i.e., maximize vehicle safety and mission success probabilities).

Redundancy management consists of five software functional modules, as shown in Figure 2-8. The functional modules are:

- Redundancy management control (RMC)
- Redundancy status (RS)
- Selection filter control (SFC)
- Selection filter (SF)
- Fault detection (FD)

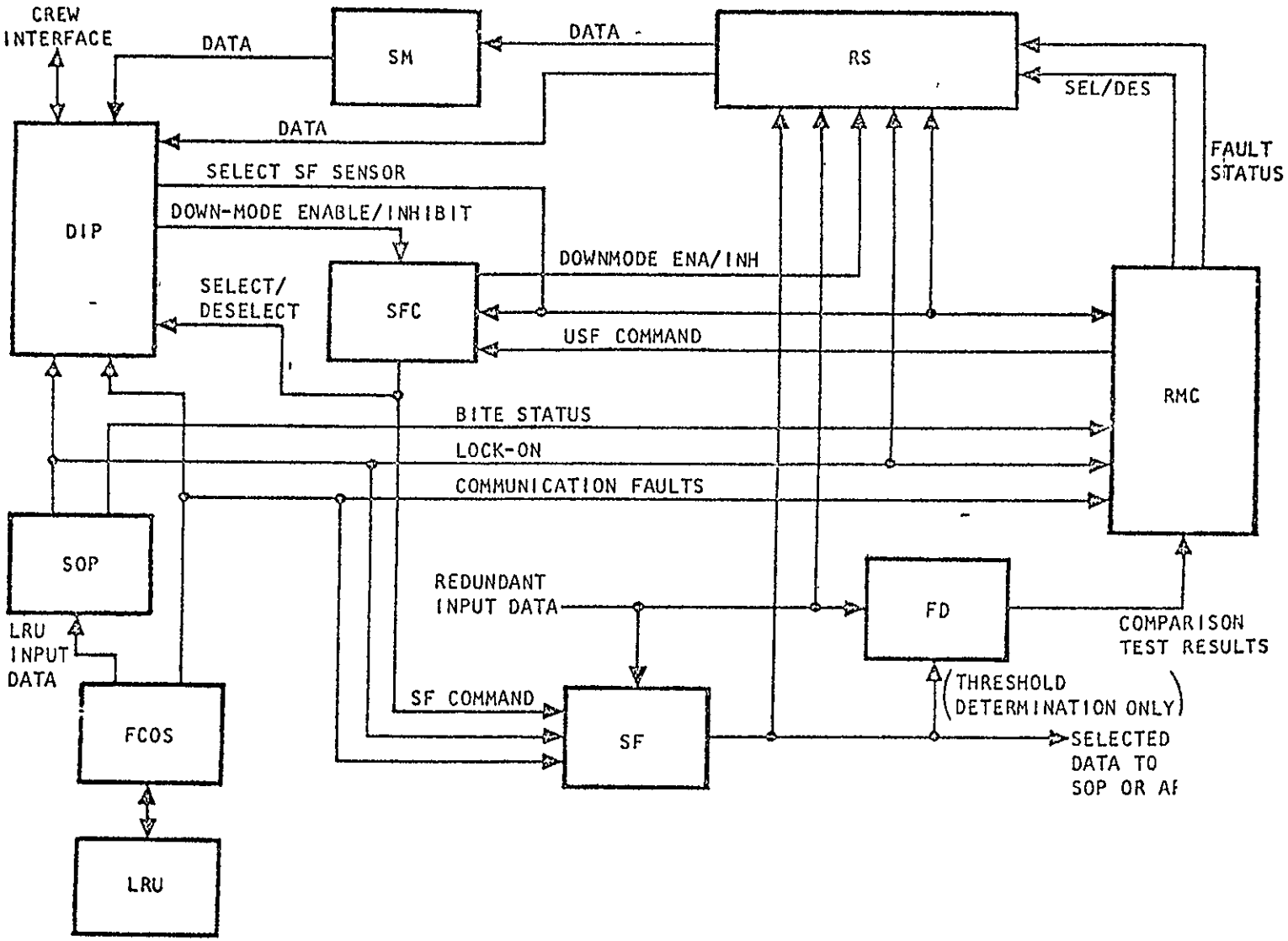


Figure 2.8 RM FUNCTIONAL MODULES

Major interfaces exist between RM and the following major software functions:

- System management (SM)
- Display interface processor (DIP)
- Subsystem operating programs (SOP)
- NAV and FC application programs (AP)
- Flight computer operating systems (FCOS)

The FCOS interface is an indirect interface via SOP.

One major feature of the RM system is the selection filter. The SF provides a single data output source to user programs derived from redundant input data. Redundant data are input to the SF from SOP's, AP (application programs) or hardware. The SF is controlled by an input from the FDIR and SFC, by digital communication status from FCOS, and by data lock-on status (RF navigation aids).

Input data to an SF from an SOP or AP are also provided to the FD function. The input data are periodically examined for an out-of-tolerance condition by the FD function. This function is performed on the same set of data that the RMC FI is using. The FD results are provided to the RMC function for failure identification and fault/usage status.

The RMC function determines the fault and usage status of the equipment. Fault status is based on the FD status, the built-in test equipment (BITE) status, and the lock-on status. In general, the RMC declares equipment faults after noting three consecutive fault status inputs. Fault declaration is contingent on fault detection and identification. All detected faults are annunciated to the crew and are noted to be equipment specific only if the fault is identified.

The selection filter controller modes the SF on the basis of crew inputs or RMC usage input. Direct crew inputs are applicable only during the down-mode-inhibit mode, which is applicable to all equipment simultaneously. During the time down-mode inhibit is selected, crew inputs go the RMC for use in determining the RMC usage status.

The status of the equipment and the values of the data being employed in the RM functions are tabulated in the RS function. The RS data are available to the SM and UI functions for crew annunciation and display.

In addition, special functional modules are defined for discrete switch RM, body flap RM, and ADTA RM. The switch RM functional module includes the functions performed by the RMC, SFC, SF, and FD functional modules described but in a more integrated manner. The switch RM interfaces to the RS functional module. The body flap and ADTA RM similarly contain the RMC, SFC, SF, and FD functional modules described but in a more integrated manner. The switch RM interfaces to the RS functional module.

The body flap and ADTA RM similarly contain the RMC, SFC, SF, and FD functional modules and interfaces with the RS. These special functional modules result from hardware peculiarities that dictate special consideration.

The mission-dependent constants are to be easily changeable on a mission-to-mission basis.

2.9 Display and Control Subsystem

Display and control hardware and software provide the crew with manual command, control, and monitoring of GN&C functions. Figure 2.9 is a GN&C displays and controls block diagram that shows the display processor (DP) and its interfaces with elements of GN&C and the displays.

2.10 SRB Separation System Description

The Separation System includes software, release hardware, booster separation motor systems, and subsystem functions uniquely defined by separation requirements. The separation system block diagram is shown in Figure 2-10. The separation sequence is initiated when the chamber pressure in both SRM's is 50 psia, or the time from liftoff has exceeded maximum possible time for any SRM to have reached 50 psia during tailoff.

The SRB/ET attach/release system consist of 1 forward and 3 aft structural fittings per SRB. There are 2 range safety cables and a small ordinance cable across each forward interface and 6 SRB to Orbiter cables and a small ordinance cable across each aft upper strut. In addition, there are small ordinance cables across the separation plane of each of the other aft struts.

The forward and aft structural attach fittings utilize double ended pyrotechnic separation bolts. Disconnect of the electrical cables across the forward and aft upper strut is provided by pull away connectors.

The booster separation motor system consists of two cluster of 4 booster separation motors, BSM's, per SRB, the forward cluster is mounted in the frustrum and the aft cluster is mounted on the aft skirt. These motors are oriented to provide a force to translate the SRB's down from the Orbiter wing and outboard from the ET. BSM ignition is accomplished through redundant initiation of a manifold at each cluster.

2.11 ET Separation System Description

The Separation System includes software, release hardware and subsystem functions uniquely defined by separation requirements. The external tank separation system block diagram is shown in Figure 2.11.

The separation sequence is initiated when SSME MECO has been verified, and all separation pyrotechnics are armed. When SSME pre-valve closure is commanded, the sequence is continued and the feed line disconnect valves are commanded closed. The ET power is commanded off and umbilical carrier plate release and retraction is initiated. Structural release is automatically commanded and a RCS translation maneuver initiated when for NOMINAL, AOA and ATO Separation, the body angular rates are within limits and the feed line disconnect valves closed. RTLS Separation for structural release and RCS translation are initiated when the body angular rates are within limits and the angle-of-attach and sideslip angle are within limits.

The Orbiter/ET attach/release system consists of one forward and two aft structural attach/release fittings and two aft located umbilical clusters which provide the fluid line and electrical interface.

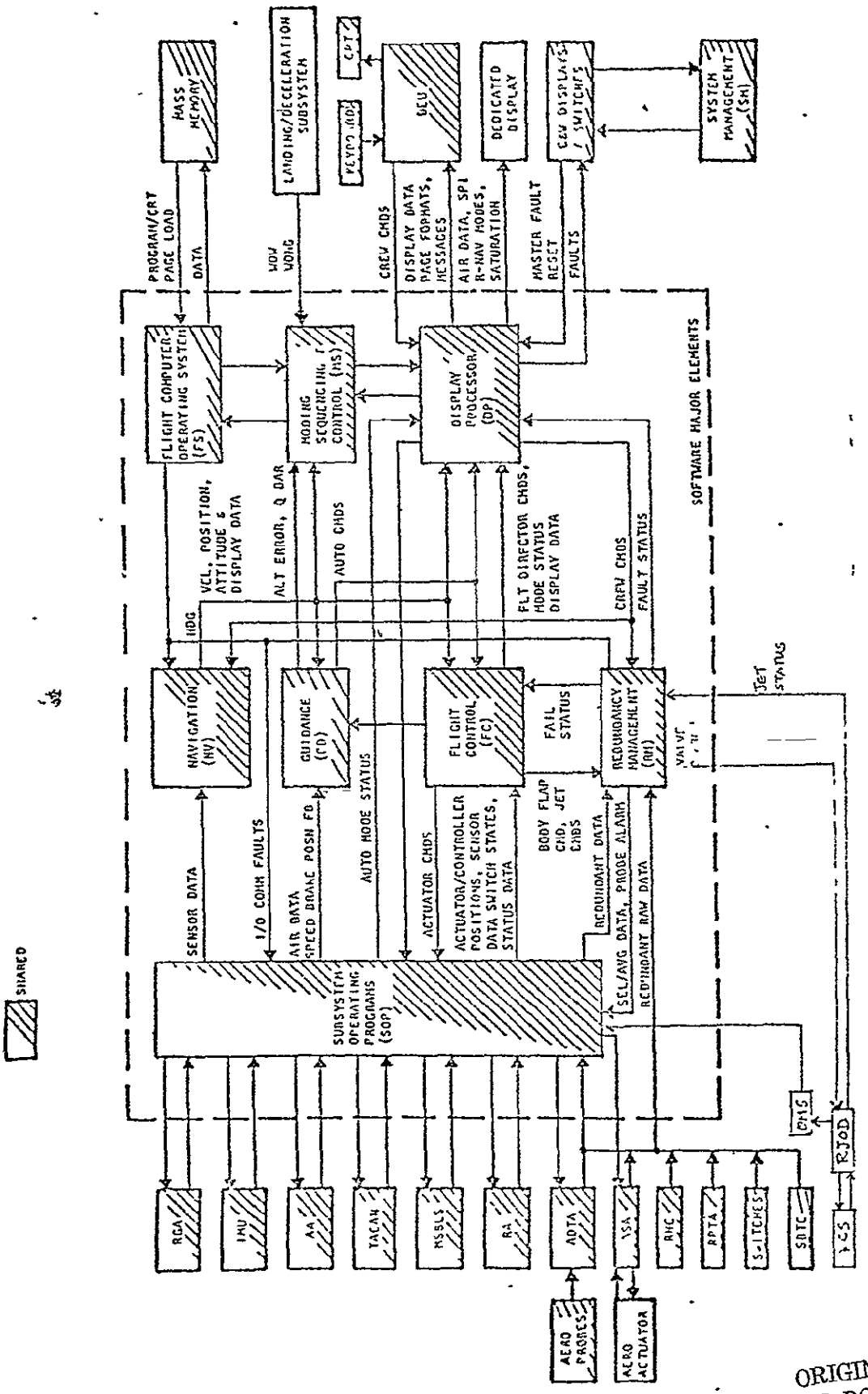


Figure 2-9. CNSC Display and Control Block Diagram Hardware – Software

SRB SEPARATION
SYSTEM BLOCK DIAGRAM

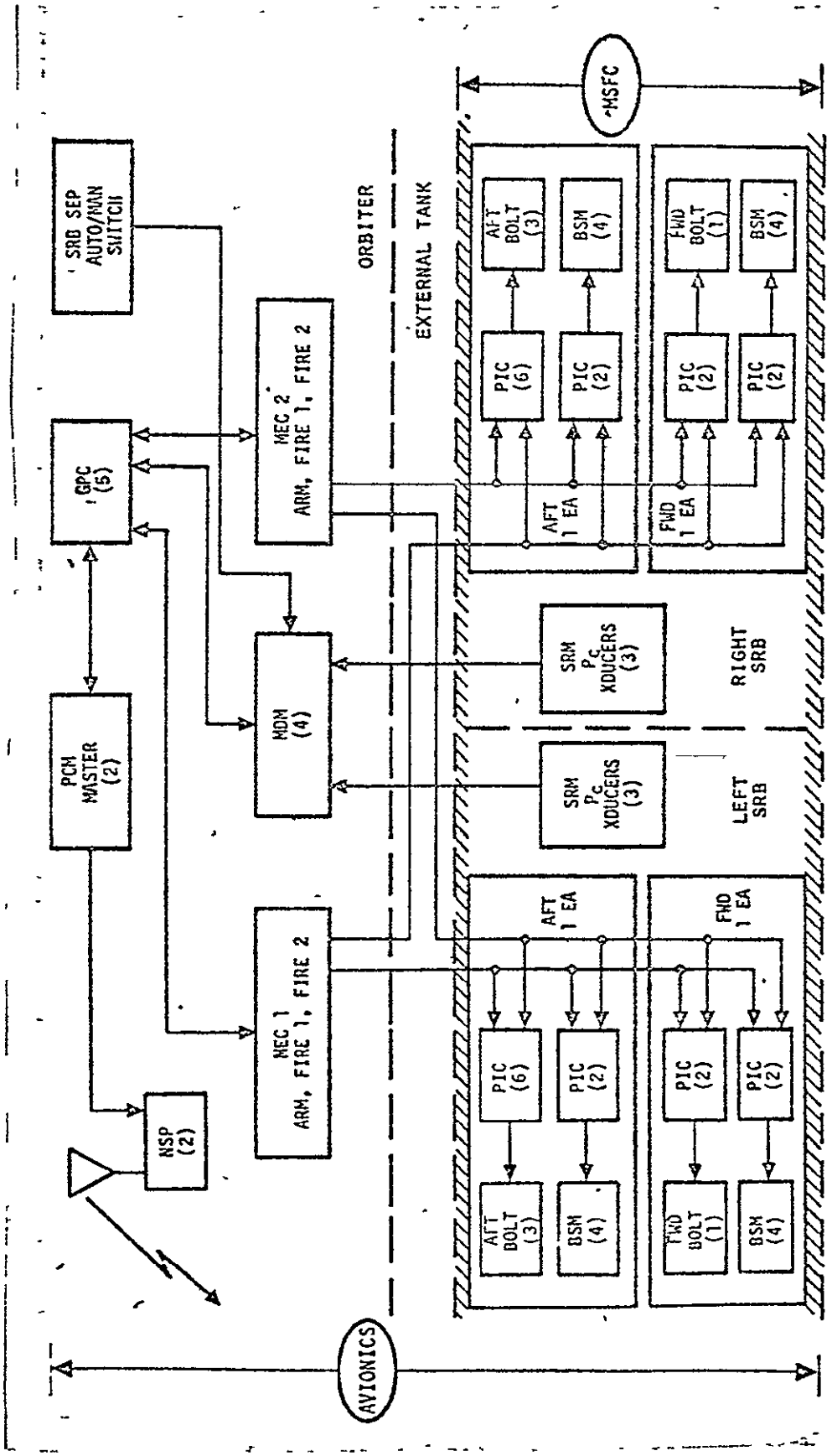


FIGURE 2-10

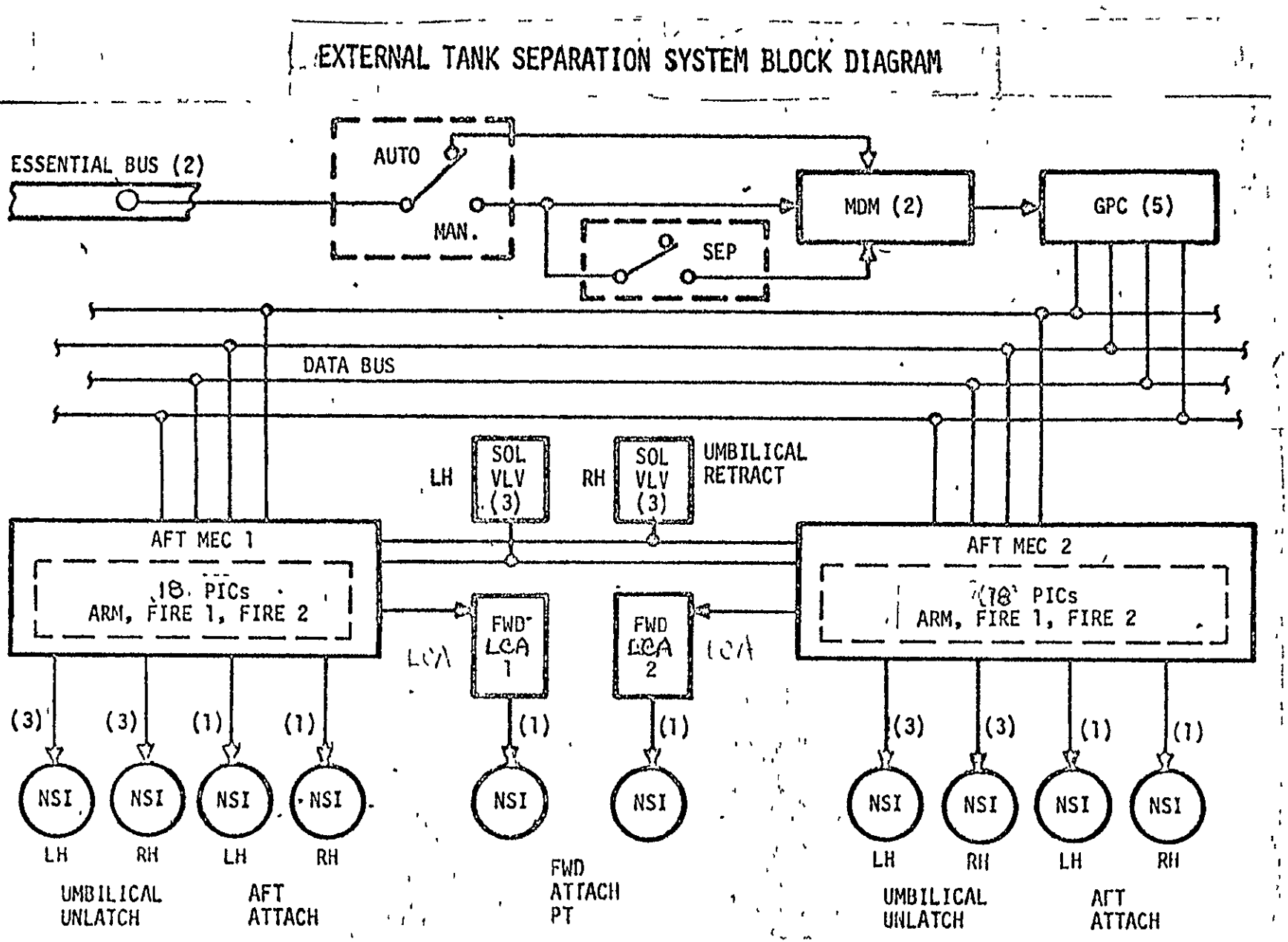


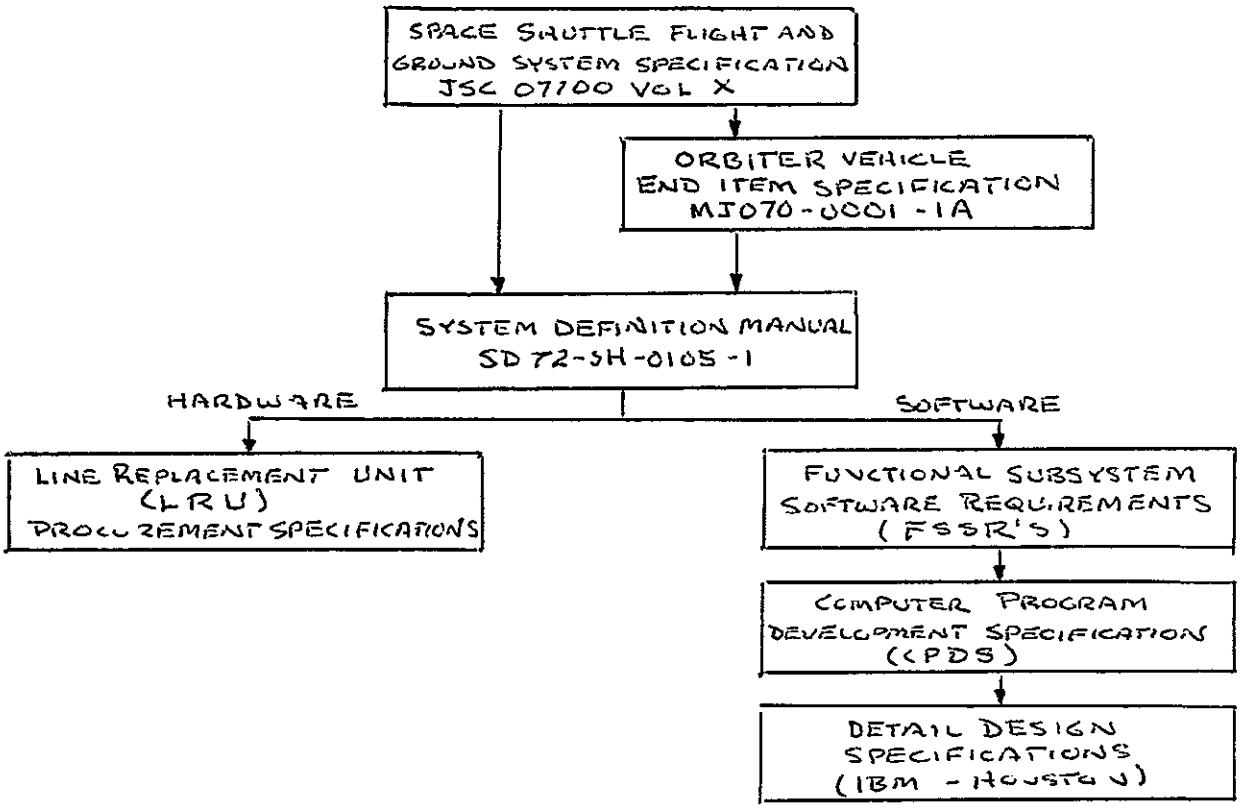
FIGURE 2-11

3. SYSTEM REQUIREMENTS

This section defines the top-level and detailed functional and performance requirements imposed on the ascent integrated GN&C system for the Space Shuttle OFT and operational program. It is important to note that the requirements defined herein are restricted to those requirements that must be verified to demonstrate that the vehicle can fly the powered phases of ascent to orbit insertion or through ET separation in the case of RTLS abort.

3.1 REQUIREMENTS TRACEABILITY

Figure 3-1 defines the GN&C system requirement tree providing traceability from the Space Shuttle Flight and ground system specification down through both the hardware and software specifications. For the integrated GN&C systems verification, the level of requirements to which the system will be verified will be those defined in the Integrated GN&C System Definition Manual (GN&C SDM).



3.2 REQUIREMENTS

The ascent integrated GN&C design requirements from the Space Shuttle Flights and Ground System Specification, Vol. X, are identified in Table 3-1. These requirements and associated Orbiter End Item Specification and other documents GN&C and related Avionics requirements are correlated in the Space Shuttle Avionics Verification Plan for OFT.

TABLE 3-1

SPACE SHUTTLE FLIGHT AND GROUND SYSTEM
SPECIFICATION VOL. X INTEGRATED GN&C REQUIREMENTS

VOL. X	REQUIREMENT DESCRIPTION
3.2.1.1.6	Orbit Insertion Accuracy
3.2.1.1.9	Nominal Ascent Sep IC's and Performance
3.2.1.1.10	Abort Sep IC's and Performance
3.2.1.1.11	Flight Personnel Flight Load Limits
3.2.1.1.17	MECO Targeting for ET Disposal
3.2.1.5.1	Intact Abort and Failures
3.2.1.5.2.3	Manual Initiation of Cont. Abort S/W Modes
3.2.2.1.2	Load Limiting (Throttling, Traj Shaping, Elevon Positioning) Engine Paralleling Modes
3.3.1.2.2.1	Limit SSME Gimbal Excursions
3.3.1.2.3.1.2	Avionics/GN&C Redundancy
3.3.1.2.3.3	Provide GN&C for all Phases (Auto/Manual)
3.3.1.2.3.4	GN&C/Displays & Controls/Crew Interfaces
3.3.1.2.3.4.1	Abort Commands
3.3.1.2.3.5	GN&C Software and Data Processing
3.3.1.3.2.1	GN&C Sources

A detailed listing of Ascent GN&C requirements to be verified are given in Table 3-2. The correlation of these requirements to the various requirement document paragraphs will be supplied in subsequent revision of this plan.

TABLE 3-2 ASCENT GN&C REQUIREMENTS

REF. NO.	REQUIREMENTS
1.1.1(a)	The GN&C shall provide a digitally-processed manual control capability for all flight control functions for all Orbiter-alone flight phases. During launch and ascent of the mated vehicle (ORB/ET/SRB and ORB/ET) the capability to digitally process manual main engine throttle commands shall be provided. Manual guidance (substitution of stick command for auto guidance command) capability shall be provided during mated vehicle flight phases for contingency situations. This manual guidance capability shall be provided only in the abort software operational sequences, and will not be provided in the nominal mission software major modes. If manual guidance is selected, there is no requirement for return to automatic operations during ascent.
1.1.1(b)	The GN&C shall provide vehicle stabilization and control throughout ascent, orbital, entry, and landing flight regimes for both automatic and manual control modes, and combinations of each for those missions where both automatic and manual modes are provided.
1.1.1(c)	The GN&C shall provide an on-board attitude reference that provides continuous attitude information required for guidance, navigation, and display functions with no attitude limitations.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.1.1(d)	GN&C shall provide the capability of accepting state vector updates and other mission and vehicle related GN&C data from external sources through data link communications.
1.1.1(e)	GN&C shall supply GN&C subsystem data to the instrumentation subsystem and performance monitor function for telemetry, recording and configuration/health status reporting.
1.1.1(f)	GN&C shall provide a means for transferring control authority from the Auto Mode to the manual mode and from manual to Auto Mode with acceptable transients for those mission phases where both automatic and manual modes are available.
1.1.1(g)	GN&C shall provide current abort-mode solutions after abort mode selection and initiation by the crew.
1.1.1(h)	GN&C shall provide coarse alignment and the means to fine align the attitude references automatically.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.1.1(r)	GN&C shall provide on-board automatic reconfiguration with manual reconfiguration override capability as required by time-critical failure modes to working GN&C system upon any time-critical failures.
1.1.1(j)	GN&C shall provide automatic calibration and compensation of inertial sensors or sensor data, when required.
1.1.1(k)	GN&C shall supply data to the control and display subsystems required to monitor GN&C subsystem performance, monitor GN&C function execution, and perform vehicle manual control.
1.1.1(l)	GN&C shall provide attitude control stability of the rigid aerodynamic modes, aeroelastic modes, and fluid slosh modes, including the effects of "tail-wags-dog" dynamics.
1.1.1(n)	GN&C shall supply an automatic sequence and command for mission sequences, and manual override/verification capability.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.1.1(o)	GN&C shall provide, when practical, the capability to check out interfacing systems, including end-to-end items.
1.1.1(p)	GN&C shall provide signals to the C&T subsystem for proper antenna selection.
1.1.1(r)	GN&C shall provide capability for inhibiting jet commands and disabling jets.
1.2(a)	GN&C shall initiate lift-off sequence.
1.2(b)	GN&C shall provide guidance and control for tower clearance as specified in 3.2.3.1.2.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.2(c)	GN&C shall control the orbiter/ET/SRB in the presence of: 1. SRB dynamic thrust vector and attach misalignments of TBD. 2. Differential thrust between the two SRB's on the Shuttle vehicle which does not exceed the thrust versus time profile defined in Figure 3.3.5.1.2 of the OVEI spec. 3. Misalignment between MPS thrust vector and engine centerline or 0.5 degree maximum half-cone angle. 4. Mechanical installation misalignment of the actuator on the engine of 0.25 degree maximum with respect to the vehicle centerline as it exists during installation of the engine. 5. MPS snubbing uncertainty of 1.0 degree. 6. MPS thrust mismatch of 12,000 pounds maximum plus the mismatch produced by differential throttling of the engines by the avionics, which shall not exceed 2 percent of commanded thrust.
1.2(d)	GN&C shall provide main engine commands per Table 8.3 of ICD 13M15000 and start commands to the SRB.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.2(e)	GN&C shall provide capability for automatic signals to the MPS and SRB's for control authority in pitch, yaw, and roll. Capability shall also be provided to program orbiter elevon deflections to relieve wing and elevon loads. Hardware and software provisions shall be made for a closed loop load relief elevon control using actuator load pressure signals. Yaw steering capability shall be provided in accordance with 3.2.3.1.3 of OVEI.
1.2(f)	The GN&C computer shall monitor ascent g's and provide signals for throttling MPS to limit resultant rigid body longitudinal acceleration to the g levels stated in 3.2.2.1.5 of OVEI.
1.2(j)	Control angular rates and acceleration to those specified in 3.2.3.1.3 of OVEI.
1.3	GN&C shall sense and determine the time when the chamber pressure of both SRB's decayed to 50 ± 15 psia.
1.3(b)	GN&C shall command SRB (two) separation.
1.3(c)	GN&C shall provide control so that the orbiter/SRB/ET shall have angular rates less than those specified in 3.2.3.2a of OVEI.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.3(d)	GN&C shall provide control so that the orbiter/ET shall not deviate from its orientation at SRB separation initiation by more than the values stated in 3.2.3.2d of OVEI.
1.4(a)	GN&C shall provide guidance commands that permit insertion into both circular and elliptical orbits for all credible orbit inclinations,.
1.4(b)	GN&C shall provide main engine commands per Table 8.3 of ICD 13M15000; provide control signals to the main engine TVC actuators to provide ascent control authority in pitch, roll and yaw as specified in 3.2.3.1.3; and receive electrical signals from SSME TVC actuators and provide failure detection, isolation and recovery (FDIR) and annunciation functions.
1.4(c)	GN&C shall provide the necessary guidance and navigational accuracy for insertion into the required orbit in the presence of design-level off-nominal performance of the MPS, SRB's, and other pertinent subsystems without requiring a flight performance reserve (FPR) exceeding 0.85 percent of total ascent characteristic velocity. This FPR shall be independent of the OMS delta V capability.
1.4(d)	GN&C shall determine ME cutoff time and command throttle to 50 percent prior to shutdown then command ME shutdown.
1.4.1(a)	GN&C shall determine the required ET separation-initiation time.
1.4.1(b)	The angular rate at ET mechanical release shall be as specified in 3.2.3.4a of OVEI.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.10.1	All Mission Abort Phases. The following exceptions apply (ref. 3.3.5.1.1.1 of OVEI): a. Subphase sequential time intervals of 3.2.3.6 of OVEI (on-orbit requirements) do not apply to abort flight. b. Abort mode solutions (ref. 3.3.5.1.1.1.g of OVEI) are not required subsequent to selecting an abort mode.
1.10.2	Orbiter/ET/SRB Mated Ascent. The following exceptions and additions apply (ref. 3.3.5.1.2 of OVEI). a. "Heads down" orientation for ascent (ref. 3.3.5.1.2.g of OVEI) is not a requirement during an abort mode. b. Control of angular rates and acceleration within the limits specified in 3.2.3.1.3 of OVEI (ref. 3.3.5.1.2.j) is not a requirement during the brief period of a failure transient. c. The SRB's and SSME's shall be monitored for those failures which are classified as intact aborts in 3.2.3.13.1.3 of OVEI. Indication of failure occurrence shall be provided to the crew, together with display for failure evaluation. d. Provide automatic sequence for the time critical abort functions beyond crew response capability.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.10.3	Orbiter/ET Ascent. The following additions and exception apply (ref. 3.3.5.1.4 of OVEI). a. Provide guidance commands that permit attainment of intact abort MECO target conditions for RTLS, AOA, ATO (abort to orbit) and mission continuation type of aborts. b. Provide the necessary guidance and navigation accuracy for MECO target attainment in the presence of design-level off nominal performance of the remaining operating systems and subsystems within the normal mission flight performance reserves. c. Provide the necessary commands and sequencing for depletion of aft RCS and OMS propellants to the various abort mode subphase propellant remaining redlines including the interconnect of the aft RCS engines to the OMS tanks when necessary. d. Provide OMS engine commands and signals to position OMS gimbals for burn simultaneous with the SSME's for RTLS, AOA and ATO aborts. f. For RTLS abort, main engines will not be throttled to 50 percent percent prior to shutdown (ref. 3.3.5.1.4d of OVEI).

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.11.2	Transfer and Install Shuttle on Pad. The GN&C shall be capable of supporting the 24-hour launch requirement specified in 3.2.3.14.4 of OVEI.
1.11.3	Launch Readiness Checkout. a. The subsystem shall have the capability for checkout of all GN&C functional paths. The capability to perform checkout with interfacing systems shall be provided. Verification of system readiness shall be made through the on-board display system: no GSE shall be required for this capability. b. The GN&C shall be capable of verification between T-10 hours and T-2 hours prior to launch. c. Inertial sensors shall be calibrated at prelaunch with the accuracy required to meet mission requirements. Capability shall be provided for calibration with the vehicle in the vertical or horizontal attitude without leveling the vehicle and without determing azimuth from an external source.
1.11.3.1	Launch From Standby. The subsystem shall have the capability to support the launch from standby requirement specified in 3.2.3.14.5 of OVEI.
1.11.5	Launch Countdown. The GN&C subsystem shall have the capability to retarget as specified in 3.2.3.14.13 of OVEI. The subsystem shall have variable launch capability to satisfy the acceptable launch-to-insertion azimuths from both KSC and VAFB.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.10.4	ET Separation. The following additions apply (ref. 3.3.5.1.4 of OVEI): a. For RTLS aborts, determine the required ET separation initiation time. b. Control angular rate at ET mechanical release to the following limits: 1. For RTLS, within ±0.2 degrees per second of commanded rate. 2. For AOA, ATO and mission continuation, equal to or less than 0.1 degrees per second.
1.10.5	Insertion. The following additions apply (ref. 3.3.5.1.4.2 of OVEI): a. Provide guidance capability for direct ascent to a free-return elliptical orbit which allows entry and landing at the launch site within one revolution for AOA mode. b. Provide guidance capability for direct ascent to a safe elliptical orbit for the ATO mode.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
1.4.1(c)	Gn&C shall initiate and control separation sequence.
1.4.2(a)	GN&C shall provide guidance capability for direct ascent to all circular or elliptic orbits that are compatible with launch site and propulsive capability.
1.4.2(c)	GN&C shall maintain angular rates as specified in 3.2.3.5.3 of OVEI
1.4.2(d)	GN&C shall determine OMS start and cutoff time and command OMS ignition and shutdown.
1.4.2(e)	GN&C shall provide output to the cockpit displays of residual velocity vectors after termination of the OMS burn.
1.4.2(f)	GN&C shall permit insertion errors no greater than those described in Section 3.2.3.5 of OVEI.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
5.2.1	GN&C Computer Program. The GN&C computer program, in conjunction with the GN&C data processing equipment, shall provide the data processing capabilities necessary to perform the guidance navigation, control, GN&C performance monitoring, and input sensor redundancy management functions in support of the GN&C performance requirements.
5.2.1.4	Guidance Functional Element. The guidance functional element will provide the outer loop attitude steering commands to flight control to guide the Orbiter on the desired flight trajectory. The guidance commands will be computed from navigation inputs and based upon the specific objectives of the particular mission phase in which the Orbiter is operating. Guidance will perform the required targeting computations, mission planning functions, schedule engine start and stop time and compute thrust level values for all applicable mission phases.

TABLE 3-2 ASCENT GN&C REQUIREMENTS (CONT.)

REF. NO.	REQUIREMENTS
5.2.1.5	Navigation Functional Element. The navigation functional element shall be capable of establishing and maintaining state vector and attitude data based on data received from the GN&C navigation sensors and appropriate force models (except that one-way-doppler data will not be utilized for the first TBD OFT flights during which ground supplied state vector updates will be used). It shall also be capable of providing the GN&C Sensor Management functions with necessary information for computing sensor orientation commands, tracking angle designates, and search area information, and of providing systems management major function state vector and attitude data for purposes of calculating communication antenna pointing information.
5.2.1.6	Control Functional Elements. The control functional element shall be capable of generating outer loop control commands, based on attitude and guidance steering data, and inner loop control commands, based on air data and rate sensors. It shall provide the capability of generating commands for aerosurface control thrust vector control, main engine throttle control, RCS control and sequencing controls required by the mission.
5.2.1.7	GN&C Performance Monitor Functional Elements. The GN&C performance monitor functional element shall provide the capability to periodically monitor the status of GN&C subsystem data other than that used in GN&C computations. The crew shall be notified of out-of-tolerance conditions.

4.0 VERIFICATION METHODS

The verification of integrated GN&C is accomplished by analysis and test. Analyses include studies performed in non-real time sucy as point stability six-degree-of-freedom non-real-time trajectory/stability studies and man-in-loop (MIL) real-time studies. Check solutions are generated by Draper Labs. SSFS, Rockwell real and non-real-time simulation activities and are used as a data base for comparison of test results from the major test facilities FSL, SDL, SAIL) and vehicle level testing. Figure 4.0-1 presents a functional flow of the verification process starting with the basic flight software requirements and hardware models and concluding with integrated system checkout at the vehicle level. As indicated, the primary facilities for verification of OFT is the FSL and SAIL supported by the various man-in-loop simulations and offline analyses. In general, the SAIL facility will support the ascent and on-orbit flight phases and the FSL will support the descent flight phase of OFT.

Software is government-furnished equipment (GFE) and as such will be verified by a configuration inspection (CI) demonstration that the software as coded meets the requirements specified.

4.1 Verification by Analyses

The performance of ascent integrated GN&C system is verified by digital simulation as described below.

4.1.1 Digital Simulation

The digital simulations verify open and closed loop performance of ascent integrated GN&C with six-degrees-of-freedom math models of the vehicle dynamics and appropriate math models of the GN&C software, sensors, earth's gravitational and atmospheric environment, and effectors. These simulations establish sensitivity of the system performance to the natural environment and system design parameters. Rockwell and JSC will utilize 6 DOF trajectory performance studies that functionally models the ascent integrated GN&C software. Man-in-the-loop real time simula tion conducted on the SPS are part of the verification by analysis.

SLS (statement level simulator) is a Draper Laboratory 6-DOF simulator that programs the GN&C requirements in HAL and the environment in MAC. By using the HAL language, the requirements are modeled to the statement level rather than just functionally. This simulation tool is used to verify the ascent integrated GN&C software requirements and to generate check solutions for laboratory tests.

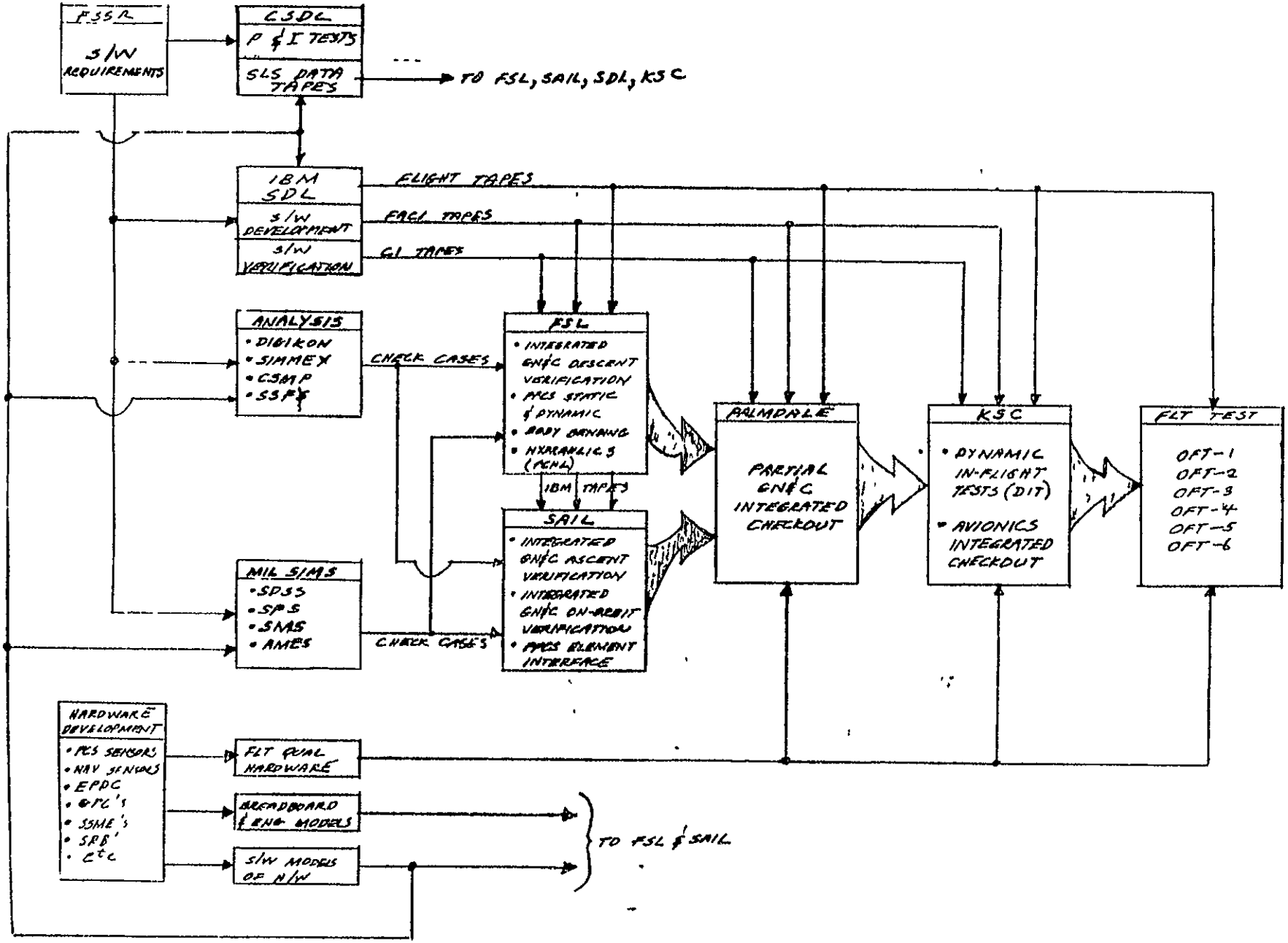


FIGURE 4.0-1 GN&C VERIFICATION BY ANALYSIS/TEST

4.2 Software Specific Testing

The software specific testing consists of two parallel and essentially independent test efforts, as shown in Figure 4.2-1. There is requirements testing, which are tests done on other than the flight software via P&I tests and SLS end-to-end tests. The other is implementation testing via the IBM test program, and the SAIL and the flight test programs. These efforts derive from the same requirements (CPDS) and evolve toward the same goal, avionics GN&C software verification. The horizontal lines represent the interrelationship of these two methods.

The basic software test accountability is the IBM test program. That verification activity, VTS and VTP, must reflect sufficient testing to verify that the IBM implementation of the flight code satisfies the requirements of the CPDS. However, SAIL must perform additional tests on Guidance and integrated GN&C some of which may be common with the VTS, which are necessary to validate the avionics system operation. Software specific testing by SAIL will be limited to these necessary tests and consist of a limited "audit" of the IBM code to allow system validation.

Although software verification in SDL is not specifically integrated GN&C verification, this plan defines test objectives and requirements which should be adopted by IBM in the VTS and VTP for integrated software verification.

The SAIL software specific testing approach, in summary, is primarily one of top down with selective lower-level tests to troubleshoot problems. That is, the software will be tested primarily as a complete LRU and not dissected into its component parts unless problems warrant such an investigation. The objective of the majority of the te testing will be to duplicate similar tests, such as the common facility tests, in the SDL.

4.3 Verification by Simulation/Test

In general, verification by simulation/test is the method by which the GN&C hardware and software is integrated in test facilities to demonstrate overall compliance with the system design requirements. Specifically, the purpose is to demonstrate by open-and closed-loop tests that the GN&C system (when integrated with man/machine/environment) will perform satisfactorily and accomplish all of the flight test requirements (FTR's) for OFT. Tests will begin with functional path, step response, and frequency response checks to assure proper coding of software, and demonstrate satisfactory integration of hardware/software. Next, common facility tests will be conducted at each major facility to assure compatibility of results. Finally closed-loop (real time six-degree-of-freedom) tests with man-in-loop will be conducted to assess the basix OFT trajectories, effects of aerodynamic tolerances, effects of winds/gusts effects of sensor errors/ drift, and effects of failure.

4.4 Common Facility Tests

Four Common Facility Tests (CDT's) are planned for SAIL. These tests are to be similar to the CDT's to be conducted at both the IBM SDL and the MPAD SVDS facilities. A summary of the planned tests is given below:

(a) Test #S-33: nominal ascent trajectory initialized 20 seconds prior to liftoff and terminated subsequent to the first OMS burn

(b) Test #S-34: earliest AOA with -3 sigma thrust on all SSME, 3 sigma SRM tailoff, fail SSME #2 in MM 103 at mode boundary, select AOA, terminate at the MM 104 OMS burn

(c) Test #S-35: nominal ascent, introduce bias in pitch RGA at ET separation, manual ET separation, ET separation delay of 3 minutes, cross range state update during MM 104, Navigation uplink in MM 104, OMS-1 burn TIG delay (2 minutes), terminate run at end of OMS-1 burn

(d) Test #S-36 nominal ascent, maximum design SRB thrust mismatch, 95 percentile design crosswind/shear/gust, terminate run at end of OMS-1 burn.

Check solutions for the above CFT's will be generated under Track Task by CSDL.

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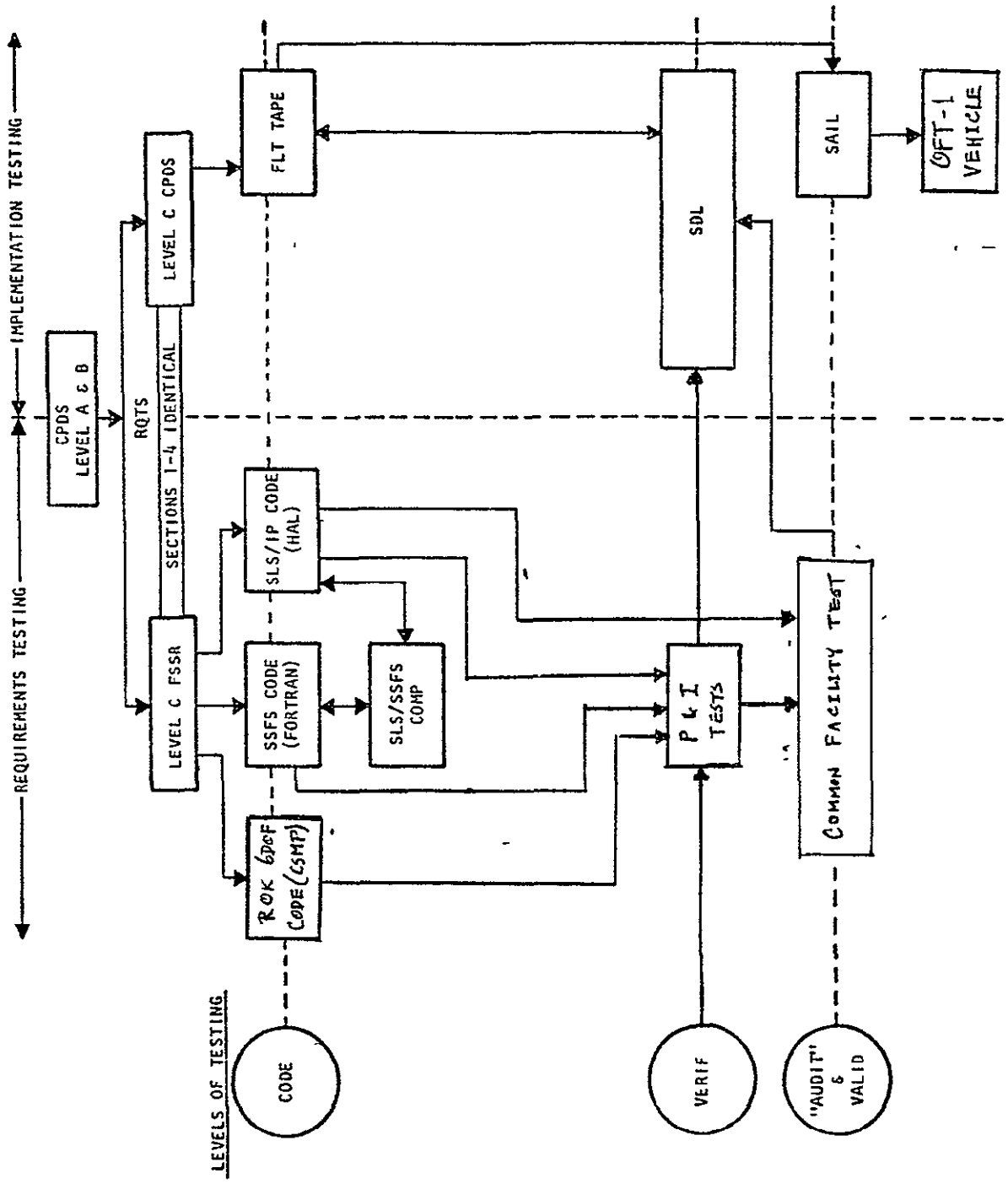

FIGURE 4.2-1 RELATIONSHIPS AMONG ASCENT INTEGRATED GN&C SOFTWARE TESTS

4.4 Common Facility Tests

Four Common Facility Tests (CDT's) are planned for SAIL. These tests are to be similar to the CDT's to be conducted at both the IBM SDL and the MPAD SVDS facilities. A summary of the planned tests is given below:

(a) Test #S-33: nominal ascent trajectory initialized 20 seconds prior to liftoff and terminated subsequent to the first OMS burn

(b) Test #S-34: earliest AOA with -3 sigma thrust on all SSME, 3 sigma SRM tailoff, fail SSME #2 in MM 103 at mode boundary, select AOA, terminate at the MM 104 OMS burn

(c) Test #S-35: nominal ascent, introduce bias in pitch RGA at ET separation, manual ET separation, ET separation delay of 3 minutes, cross range state update during MM 104, Navigation uplink in MM 104, OMS-1 burn TIG delay (2 minutes), terminate run at end of OMS-1 burn

(d) Test #S-36: nominal ascent, maximum design SRB thrust mismatch, 95 percentile design crosswind/shear/gust, terminate run at end of OMS-1 burn.

Check solutions for the above CFT's will be generated under Track Task by CSDL.

5.0 ASCENT GN&C VERIFICATION REQUIREMENTS

In deriving the verification requirements for the Ascent Guidance and the Ascent Integrated GN&C, it is assumed that the line replaceable units (LRU's) have been thoroughly tested to their own specification. Furthermore, it is assumed that each subsystem has also been tested to its own requirements. The Avionics subsystem so tested include:

1. Flight Control
2. Navigation
3. Communications and Tracking
4. Displays and Controls
5. Software
6. Electrical Power Distribution and Control
7. Instrumentation
8. Data Processing
9. Performance Monitoring/System Management

5.1 Ascent GN&C Verification Requirement Matrices

The ascent Guidance and Integrated GN&C will be verified by analysis including MIL simulation and tests in SAIL, vehicle checkout and flight tests. An analysis/test matrix is summarized in Table 5.1-1 which presents the verification objective, method of verification and responsible organization/facility.

TABLE 5.1-1 ASCENT GUIDANCE AND INTEGRATED GN&C VERIFICATION ANALYSIS/TEST MATRIX

DESIGN REQUIREMENTS IDENTIFICATION NUMBER	TITLE	OBJECTIVE	METHOD AND RESPONSIBILITY
TBS	TBS	TBS	TBS

6.0 VERIFICATION TEST REQUIREMENTS

This section presents the Ascent Guidance Interface, Attitude Processor Interface, Integrated GN&C and GN&C OPS Transition verification test requirements. The Pass/Fail criteria for SAIL tests are also presented. The Ascent GN&C software is verified as an LRU by IBM (SDL). Level 7 SDL test requirements are presented here for reference information only.

6.1 GN&C SOFTWARE LEVEL 7 TEST REQUIREMENTS

Table 6.1-1 is an excerpt from the IBM test specification document for Level 7 tests to support Configuration Inspection (CI). These tests have been reviewed by Rockwell and are included for information only. It is noted that the Level 7 tests reflect a selected set from their Level 6 verification test program.

TABLE 6.1-1 ASCENT PERFORMANCE TEST MATRIX

CASE IDENTIFIER	PRELIFT OFF (101)	FIRST STAGE (102)	SEPARATION (102)	SECOND STAGE (103)	ET SEP (103)	COAST (104)	OMS-1 (104)	COAST (104/105)	OMS-2 (105)	COAST (105/106)
AHM-1										Termination OPS2, MM 201
AGD-1		• 95% Crosswind/ Shear/Gust		• Fail SSME #3 After Earliest ATO • Select ATO	• Fail Two RCS Pitch Jets			Termination	N/A	N/A
AGD-2	• -3σ Thrust All SSME		• 3σ SRM Tailoff	• Fail SSME #2 At Mode Boundary • Select AOA				Termination OPS3, MM 301	N/A	N/A
AGD-3		• Measured Crosswind • Fail ORB APU #2 During Throttling		• Select AOA			• Fail Left OMS Engine At IGN	Termination OPS3, MM 301	N/A	N/A
AGD-4	• + Vehicle Weight (20000 LB)	• Hot Atmosphere • +3σ Aero		• +3σ Aero		• State Update • NAV Uplink • MECO Overspeed		Termination	N/A	N/A
AGD-5	N/A	N/A	N/A	• EIU/SSME #2 Fail • Select ATO				Termination	N/A	N/A
AGD-6	N/A	N/A	N/A	• Fail SSME #1 After Position Constraint Release				Termination	N/A	N/A

TABLE 6.1-1 ASCENT PERFORMANCE TEST MATRIX

(Continued)

CASE IDENTIFIER	PRELIFT OFF (101)	FIRST STAGE (102)	SEPARATION (102)	SECOND STAGE (103)	FT SEP (103)	COAST (104)	OMS-1 (104)	COAST (104/105)	OMS-2 (105)	COAST (105/106)
AGD-7	N/A	N/A	N/A	• Fail SSME #3 After Fine Countdown				Termination	N/A	N/A
AGD-8	• $+3\sigma$ Thrust All SSME	• 95% Crosswind/ Shear/Gust				• State Update • NAV Uplink • MECO Under-speed	• Fail Right OMS (Early In Burn)	Termination	N/A	N/A
AGD-9	N/A	N/A	N/A	N/A	• Bias ORB Pitch RGA • Manual ET SEP • FT SEP - Delay (3 MIN)	• State Update (Cross-range) • NAV Uplink	• OMS TIG Delay (2 MIN)			Termination
AGD-10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	• Select Right OMS • Select ATO		Termination
ASN-1	• 3σ Mis-alignment IMU #2 • AA Biases #1 - None #2 - 3σ #3 - 1σ #4 - 2σ	• SRB RGA Hard-Over #1 - Pitch #2 - Yaw • AA Hard-Over #2 - All Axes #4 - Lateral Axis		• ORB RGA Hard-Over #2, #3 (All Axes)			• Fail IMU #1	• NAV Uplink • IMU Deselect Termination	N/A	N/A

TABLE 6.1-1 ASCENT PERFORMANCE TEST MATRIX

(Continued)

CASE IDENTIFIER	PRELIFT OFF (101)	FIRST STAGE (102)	SEPARATION (102)	SECOND STAGE (103)	ET SEP (103)	COAST (104)	OMS-1 (104)	COAST (104/105)	OMS-2 (105)	COAST (105/106)
AFC-1		• Max Design Performance Differential SRM • 95% Crosswind/ Shear/Gust						Termination	N/A	N/A
AFC-2		• -3σ WEB SRM (Both) • 95% Headwind/ Shear/Gust	• Fail SRB CPT (High) • SRB SEP CUE-Timer				• Right OMS Pitch Actuator Hard-Over	Termination	N/A	N/A
AFC-3		• +3σ WEB SRM (Both) • 95% Tailwind/ Shear/Gust		• ORB APU #2 Failed Prior 3g Throttle • ORB APU #1 Failed During 3g Throttle • Manual Shutdown SSME #2				Termination	N/A	N/A
AFC-4		• Measured Wind • +3σ Aero • FCS Gain Downmode - (1) L 0 - L 0 + 10 SEC (2) L.O + 60 SEC - L 0 + 70 SEC (3) Prior WEB To SEP + 2 SEC	• Downmoded Gains	• +3σ Aero • FCS Gain Downmode - 10 SFC Prior To Abort Boundary - MECO		• Select External Delta Velocity Guidance (PEG 7)	• PEG 7	Termination	N/A	N/A

TABLE 6.1-1 ASCENT PERFORMANCE TEST MATRIX

(Continued)

CASE IDENTIFIER	PRELIFT OFF (101)	FIRST STAGE (102)	SEPARATION (102)	SECOND STAGE (103)	ET SEP (103)	COAST (104)	OMS-1 (104)	COAST (104/105)	OMS-2 (105)	COAST (105/106)
AFC-5	• Open-loop Simulation (Reference Trajectory)	• Manual RHC Commands		• Manual RHC Commands			• Manual RHC Commands	Termination	N/A	N/A
AFC-6	N/A	N/A	N/A	N/A	• Manual ET SEP • Manual -Z Mnvr (THC Commands)		• Manual Steering With Moding To AUTO	Termination	N/A	N/A
AFC-7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	• Fail Left OMS At TGO 50 SEC	Termination
AFC-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	• Fail Left OMS • Fail Right OMS • +λ RCS Jets (THC) • Ramp In RHC Commands • Shutdown +X RCS	Termination
AFC-9		• Measured Wind • +3σ Aero • Fail SSME #1 (Pitch/Roll Mnvr)	• Phase To MM 601 Termination	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 6.1-1 ASCENT PERFORMANCE TEST MATRIX

(Continued)

CASF IDENTIFIER	PRELIFT OFF (101)	FIRST STAGE (102)	SEPARATION (102)	SECOND STAGE (103)	ET SEP (103)	COAST (104)	OMS-1 (104)	COAST (104/105)	OMS-2 (105)	COAST (105/106)
AFC-10		• 95% Crosswind/ Shear/Gust • Fail SSME #3 (Max $\bar{q}$ Region)	• Phase To MM 601 Termination	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AFC-11		• Fail SSME #2 After WEB Time	• 3σ SRM Tailoff Uncertainty	• Phase To MM 601 Termination	N/A	N/A	N/A	N/A	N/A	N/A
ASQ-1	• FRF ILOADs • 100% Thrust All SSME	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ASQ-2	• Launch Hold At T-9 ML Start • Countdown Recycle • GMTLO Update • NAV State Uplink							Termination	N/A	N/A

6.2 Guidance Interface Verification Testing

These tests are included in the verification test planning to assure that guidance commands to the SSME's, OMS and RCS engines and D&C panel lights cause the desired response by the hardware; and that hardware generated stimuli (engine and gimbal status flags, manual throttling inputs, etc) reach the guidance SW.

The tests described here are intended to complement the internal guidance SW verification testing by IBM in the SDL, and the integrated GN&C SW testing in the SAIL.

Each test will require generation of a SW or HW signal, and verification that the appropriate HW or SW response occurs. Table 6.2-3 lists the required tests of SW to HW interface signals, and table 6.2-2 lists the HW to SW interface signal tests. These tests may be performed independently or be incorporated into the integrated GN&C verification test schedule.

TABLE 6.2-1 GUIDANCE SOFTWARE TO HARDWARE SIGNAL VERIFICATION TESTS

SOURCE PRINCIPAL FUNCTION(s)	SW SIGNAL DESCRIPTION (HAL NAME)	GENERATE SIGNAL BY	TEST OBJECTIVE: VERIFY THAT
AS 1STG GUID AS 2STG GUID PW RTLS GUID	SSME THROTTLE Command (K_CMD)	GUID SW execution during 1st stage or g limiting RTLS flyback.	Throttle cmd. is received by each SSME in mainstage
SBTC SOP	SSME Throttle Command (K_CMD)	PLT manual throttle To (if man. throt. is implemented).	Throttle cmd. is received by each SSME in mainstage
AS 2STG GUID	MECO time set discrete (S_TMECO) and MECO time (T_MECO)	GUID SW execution in MM103 or 601 FCD auto FCS.	Shutdown cmd. is sent to each SSME within ± 40 ms of T_MECO.
SBTC SOP	SBTC auto/manual discretes (LH/RM_SBDBK_AUTO(2), RH_SPDBK_MANUAL	PLT man. throt TO. Man-auto throttle match Either (RH, LH) glareshield SBTC PBI pushed.	Glareshield SBTC PBI lights correctly indicate throttle control mode; LH & RH auto lights off RH MAN light on LH & RH auto lights on, RH MAN light off.
AS MNVR DIP	OMS burn enable flag (BURN_ENABLE) and propulsion system indicator flag (PROP_FLAG_OPS)	Execute PF's 4.3 & 4.210. Push KYBD EXEC button on flashing EXEC display	Engine ignition cmds are received; both OMS if PROP_FLAG_OPS 1, L OMS if P_F_027, R OMS if P_)=3, 4 + X RCS if P_F_0=4.
ORB INS GUID	OMS cutoff alert discrete (S_OMSCO) and desired cutoff time (T_CUTOFF)	Execute P.F. 4.3 during OMS burn	OMS cutoff occurs within 40 ms. of T_CUTOFF

TABLE 6.2-2 HARDWARE TO GUIDANCE SOFTWARE SIGNAL VERIFICATION TESTS

SOURCE PRINCIPAL	HW TO SW SIGNAL DESCRIPTION	GENERATE SIGNAL BY	GUIDANCE INPUT SIGNAL	DESTINATION PRINCIPAL FUNCTIONS
SSME-1 SSME-2 SSME-3	Engine status word indicating SSME failure	Simulated ME failure	S_EO_E1 S_EO_E2 S_EO_E3	AS 1STG GUID AS 2STG GUID PW RTLS GUID
LH/RH SBTC AUTO/MAN PBI(2)	Return to auto throttle cmd.	Push either SBTC PBI	S_MAN_THROT	AS 1STG GUID AS 2STG GUID PW RTLS GUID
RH SBTC to PB	Man. throttle to	Push RH to PB	S_MAN_THROT	AS 1STG GUID AS 2STG GUID
RH SBTC Controller	Controller position	Move SBTC controller	K_CMD	PW RTLS GUID AS 1STG GUID AS 2STG GUID
Abort SEL SW Abort SEL PB	Abort mode selected Initiate abort	Rotate SEL SW to AOA or ATO Push abort SEL PB	S_AOA S_ATO	PW RTLS GUID AOA/ATO TGT ORB INS GUID AS MNVR DIP

6.3 Attitude Processor Interface Testing

The basic intent of this test is to verify the dynamic operation of the attitude processor when it is interfaced with a single string hardware IMU and RGA. A tilt table would be used to simulate various attitude angles and inputs such as ramps and/or sinusoids would be utilized to check the dynamic aspects of the processor. These tests would verify the attitude processor operation with a combination of low frequency sampled data (1.04 hz) from the IMU and high frequency sampled data (25 hz) from the RGA. The test set-up is shown in Figure 6.3-1.

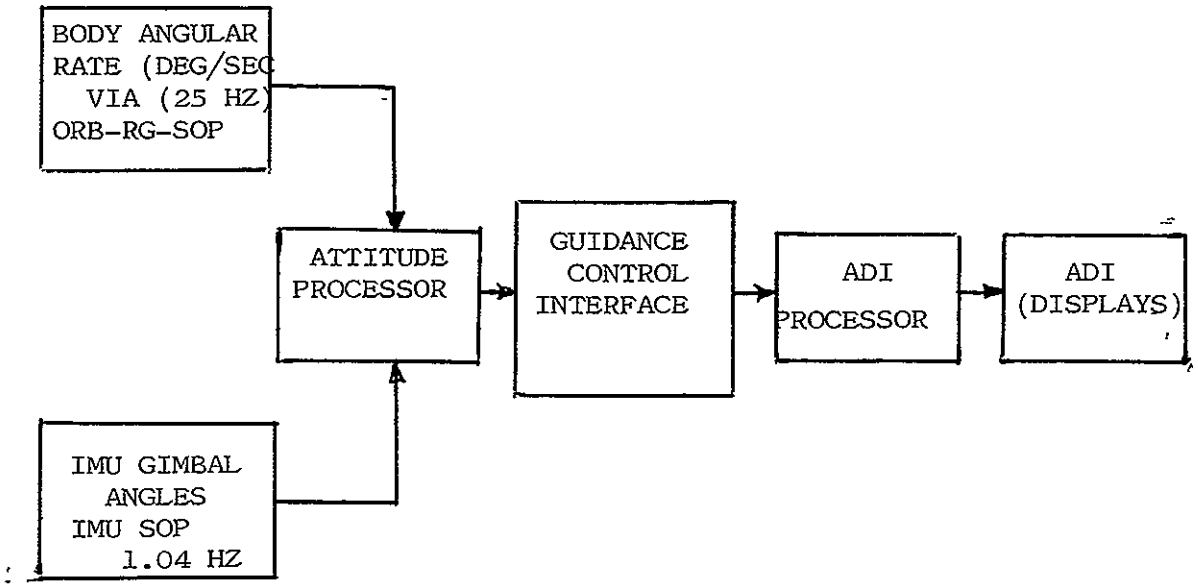

FIGURE 6.3-1

6.4 INTEGRATED SYSTEM TESTING

6.4.1 Site/System Acceptance

A formal acceptance of both the facility and the integrated GN&C system is performed prior to the start of verification tests. Facility acceptance tests are structured to demonstrate that various elements of simulation hardware and software plus elements of flight hardware and software perform in accordance with off-line solutions within a given acceptability bandwidth. Acceptance of system level performance is accomplished via closed loop trajectories with results checked against common facility tests generated by CSDL. A recommended set of acceptance testing across all facilities to be used in the verification process is given in Table 6.4-1. At the SAIL facility, a Test Start Approval form must be signed by participating NASA, Rockwell/Houston, and Rockwell/Downey personnel.

The SAIL site acceptance tests outlined in Table 6.4-2 are structured to verify those elements of the facility and system not previously demonstrated either on the ALT program or in the buildup and development phase of OFT. Each site acceptance test must either pass the acceptance criteria or be waivered and indicated as such as on the Test Start Approval form.

6.4.1.2 IMU/Navigation Tests

The initial test is designed to verify that hardware IMU's and corresponding system software will perform a hangar A calibration and gyrocompass alignment within specified criteria. Because of the problems associated with reading the platform alignment directly (resolver and nav base readout errors), the azimuth and tilt errors will be derived indirectly from the amplitude of the Schuler period. This will require moding to MM 603 and performing benchmark navigation for a time period of 84 minutes. For this test, stabilization of the vertical axis is required. This is accomplished by accepting baro updates in the navigation system. Acceptance criteria for test test is 180 arc seconds in both azimuth and tilt. As shown in Figure 6.4.1-3, this equates to approximately 36,000 feet of drift in the lateral and longitudinal axes. A second IMU/navigation test will be similar to the above. This test will require software models of 3 IMU's and 4 GPC's. Benchmark navigation is accomplished in MM 603. With S/W IMU models the navigation base can be determined precisely, consequently, azimuth and tilt errors are to be determined with off-line calculations. For this case, no navigation updates are to be performed. Vertical drift will be related to g error as shown in Figure 6.4.1-4. Acceptance criteria for this test is 30 arc seconds in azimuth and tilt and 50 micro g's in sensed acceleration.

TABLE 6.4.1-1 SITE/FACILITY ACCEPTANCE TESTS - ASCENT

TASK DESCRIPTION	FACILITY					
	FSL	SAIL	SMS	SLS	SPS	SDL
o Actuator Frequency Response (No Load) (SRB, SSME, Elevator)		X	X		X	
o Navigation Drift		X	X	X	X	
o Propulsion System Characteristics (RCS, SSME, SRB, OMS)		X	X		X	
o Open Loop Frequency Response		X	X		X	
o ORB & SRB & Tank (SRB & SSME Thrusting)						
o ORB & Tank (SSME Thrusting)						
o Closed Loop Step Response		X	X	X	X	
o Closed Loop Gain Margin		X	X		X	
o Open Loop Step Response		X	X	X	X	
o Closed Loop Freq Response (OMS) (Transition DAP)		X	X		X	
o Attitude Control Phase Plane (RCS) (Transition DAP)		X	X	X	X	
o Common Facility Test (Auto) (Nominal, Low and High Energy)		X	X	X	X	X

TABLE 6.4-2. SAIL SITE ACCEPTANCE TESTS - ASCENT

TEST NO.	FLIGHT PHASE	TEST DESCRIPTION	COMMENTS
S-1	Pre-Launch	IMU Hangar "A" Cal/Gyrocompass & Align	2 or 3 H/W IMU's & 4 GPC's
S-2	Pre-Launch	Gyrocompass & Align + Benchmark Nav w/o Nav Updates	S/W IMU's and 4 GPC's
S-3	1st Stage	Open Loop Frequency Response at Max $\bar{q}$ (Pitch)	Tested at 8 frequencies & 1 or 2 Amplitudes/Freq.
S-4	2nd Stage	Open Loop Frequency Response at Max g (Pitch)	Tested at 8 frequencies & 1 or 2 Amplitudes/Freq.
S-5	1st Stage	Open Loop Frequency Response at Max $\bar{q}$ (Roll)	Tested at 8 frequencies & 1 or 2 Amplitudes/Freq.
S-6	2nd Stage	Open Loop Frequency Response at Max g (Roll)	Tested at 8 frequencies & 1 or 2 Amplitudes/Freq.
S-7	1st Stage	Open Loop Frequency Response at Max $\bar{q}$ (Yaw)	Tested at 8 frequencies & 1 or 2 Amplitudes/Freq.
S-8	2nd Stage	Open Loop Frequency Response at Max g (Yaw)	Tested at 8 frequencies & 1 or 2 Amplitudes/Freq.
S-9	1st Stage	C/L Transient Response at Max $\bar{q}$ (Pitch)	Latch Lat/Directional Axes
S-10	1st Stage	C/L Gain Margin at Max $\bar{q}$ (Pitch)	Latch Lat/Directional Axes
S-11	2nd Stage	C/L Transient Response at Max g (Pitch)	Latch Lat/Directional Axes
S-12	2nd Stage	C/L Gain Margin at Max g (Pitch)	Latch Lat/Directional Axes
S-13	1st Stage	C/L Transient Response at Max $\bar{q}$ (Roll)	Latch Pitch Axis
S-14	1st Stage	C/L Gain Margin at Max $\bar{q}$ (Roll)	Latch Pitch Axis
S-15	2nd Stage	C/L Transient Response at Max g (Roll)	Latch Pitch Axis
S-16	2nd Stage	C/L Gain Margin at Max g (Roll)	Latch Pitch Axis
S-17	1st Stage	C/L Transient Response at Max $\bar{q}$ (Yaw)	Latch Pitch Axis
S-18	1st Stage	C/L Gain Margin at Max $\bar{q}$ (Yaw)	Latch Pitch Axis
S-19	2nd Stage	C/L Transient Response at Max g (Yaw)	Latch Pitch Axis
S-20	2nd Stage	C/L Gain Margin at Max g (Yaw)	Latch Pitch Axis
S-21	N/A	SRB Engine Ignition & Shutdown	Measure T, I_{sp}, $\dot{W}$, W, and Mass Property Changes vs. t
S-22	N/A	SSME Engine Ignition & Shutdown	Measure T, I_{sp}, $\dot{W}$, W, and Mass Property Changes vs. t

TABLE 6.4-2. SAIL SITE ACCEPTANCE TESTS - ASCENT (Continued)

TEST NO.	FLIGHT PHASE	TEST DESCRIPTION	COMMENTS
S-23	N/A	RCS Jet Thrust Buildup & Decay Characteristics	Measure T, I_{sp}, $\dot{W}$, and W Vs. Time
S-24	N/A	OMS Actuator Step/Ramp Response	Data (TBS)
S-25	Transition DAP	C/L Transient Response (Pitch)	OMS Engine On, I.C. Att Cmd
S-26	Transition DAP	C/L Gain Margin (Pitch)	OMS Engine On, Rate I.C., S/W "I" Load Gain Change
S-27	Transition DAP	C/L Transient Response (Yaw)	OMS Engine On, I.C. Att Cmd
S-28	Transition DAP	C/L Gain Margin (Yaw)	OMS Engine On, Rate I.C., S.W."I" Load Gain Change
S-29	Transition DAP	Attitude Control Phase Plane (Pitch)	RCS Control (no OMS)-I.C.With 20 deg Att Error
S-30	Transition DAP	Attitude Control Phase Plane (Roll)	RCS Control (no OMS)-I.C. with 20 deg Att Error
S-31	Transition DAP	Attitude Control Phase Plane (Yaw)	RCS Control (no OMS)-I.C. with 20 deg Att Error
S-32	N/A	Bring Up BFS GPC, Load, Dump	Confirm Shutdown Has No Effect on Primary
S-33	N/A	Demonstrate capability to Load BFS in Alternate GPC	Half GPC #5 & Load BFS in GPC #4
S-34	Nom Ascent	Run Common Facility Test Case #1	Case (TBS)
S-35	Nom Ascent	Run Common Facility Test Case #2	Case (TBS)
S-36	Nom Ascent	Run Common Facility Test Case #3	Case (TBS)
S-37	Nom Ascent	Run Common Facility Test Case #4	Case (TBS)

6.4.1.3 Propulsion System Characteristics

Prior to starting verification tests, the thrust buildup and decay characteristics for the SRB, SSME, OMS, and RCS jets will be demonstrated. In addition, propellant flow rate, engine specific impulse, and mass property changes are to be compared with theoretical values.

6.4.1.4 Open Loop Frequency Response

In this test the loop is broken at the input to the MMES. A BAFCO unit provides sine wave inputs into the ATVC electronics at selected frequencies and amplitudes. The return signal to the BAFCO shall be a single SSME DAP output. Attenuation and phase lag are computed and displayed on the BAFCO. The results are compared to theoretical solutions generated off-line. A functional diagram for the open loop frequency response test set-up is shown in appendix A along with input frequencies and amplitudes with acceptance criteria.

6.4.1.5 Closed Loop Gain Margin Tests

This test will require a software "I Load" change. The DAP forward loop gain will be adjusted until neutral vehicle stability is observed. The increase in gain will be compared with the theoretical gain margin. The pitch axis is to be latched when assessing the lateral/direction characteristics and vice versa.

6.4.1.6 Closed Loop Transient Response

Off-line results of transient response characteristics to attitude commands will be provided for one flight condition for both 1st and 2nd stage ascent. Each plot will specify acceptance criteria. The test set-up will require freezing the environment at a constant dynamic pressure and Mach number as well as latching the quiescent axis. Transient responses in roll, pitch, and yaw are required for each flight condition.

FIGURE 6.4.1-3

$X = R \sin\theta \left(1 - \cos\sqrt{\frac{g_0}{R}}\, t\right)$

θ = PLATFORM TILT

R = RADIUS OF EARTH

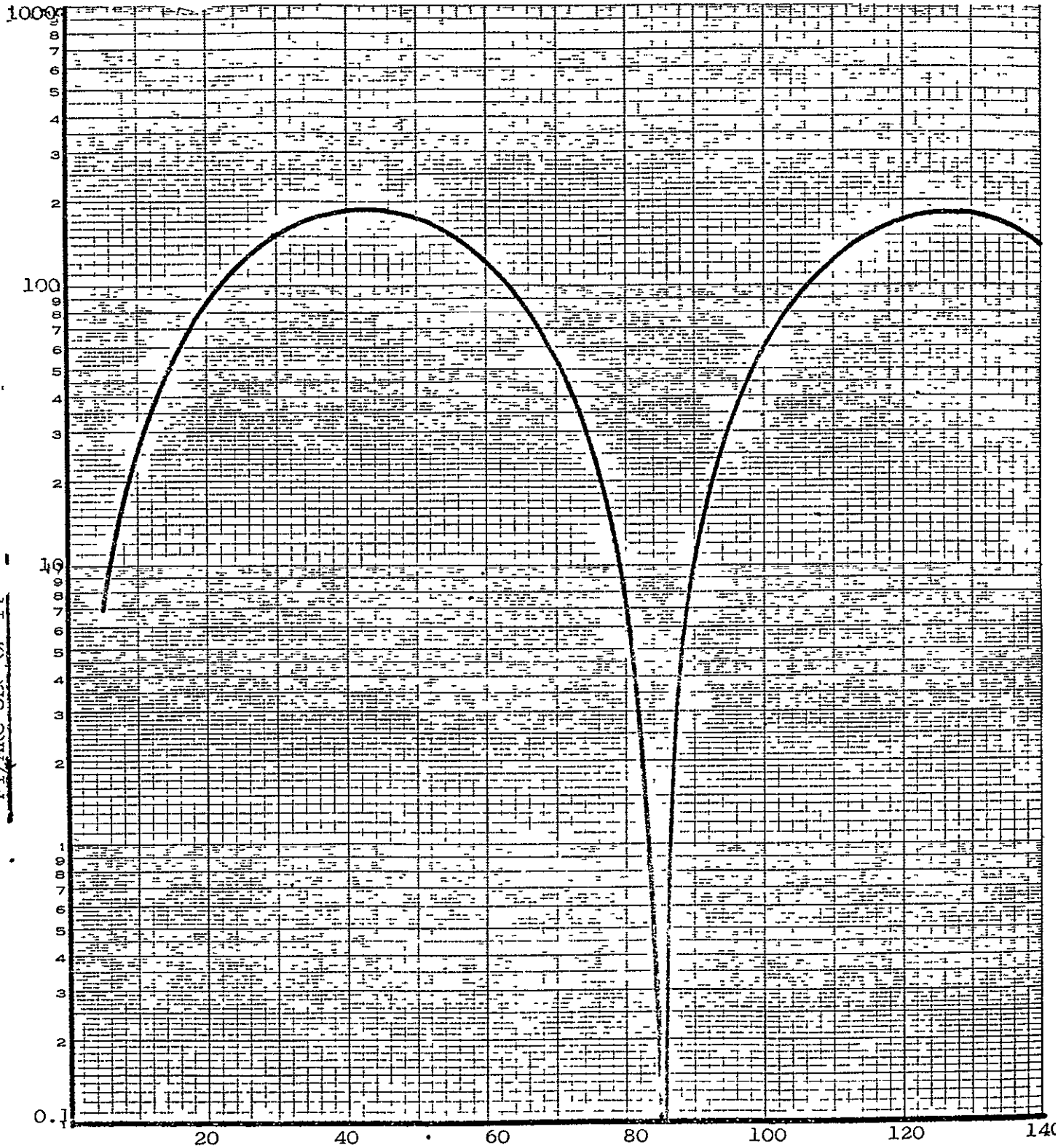

FIGURE 6.4.1-4

$$H = \frac{Ro\ (A_z - g_o)}{2g_o}\left[\cosh\sqrt{\frac{2g_o}{R_o}}\ t - 1\right]$$

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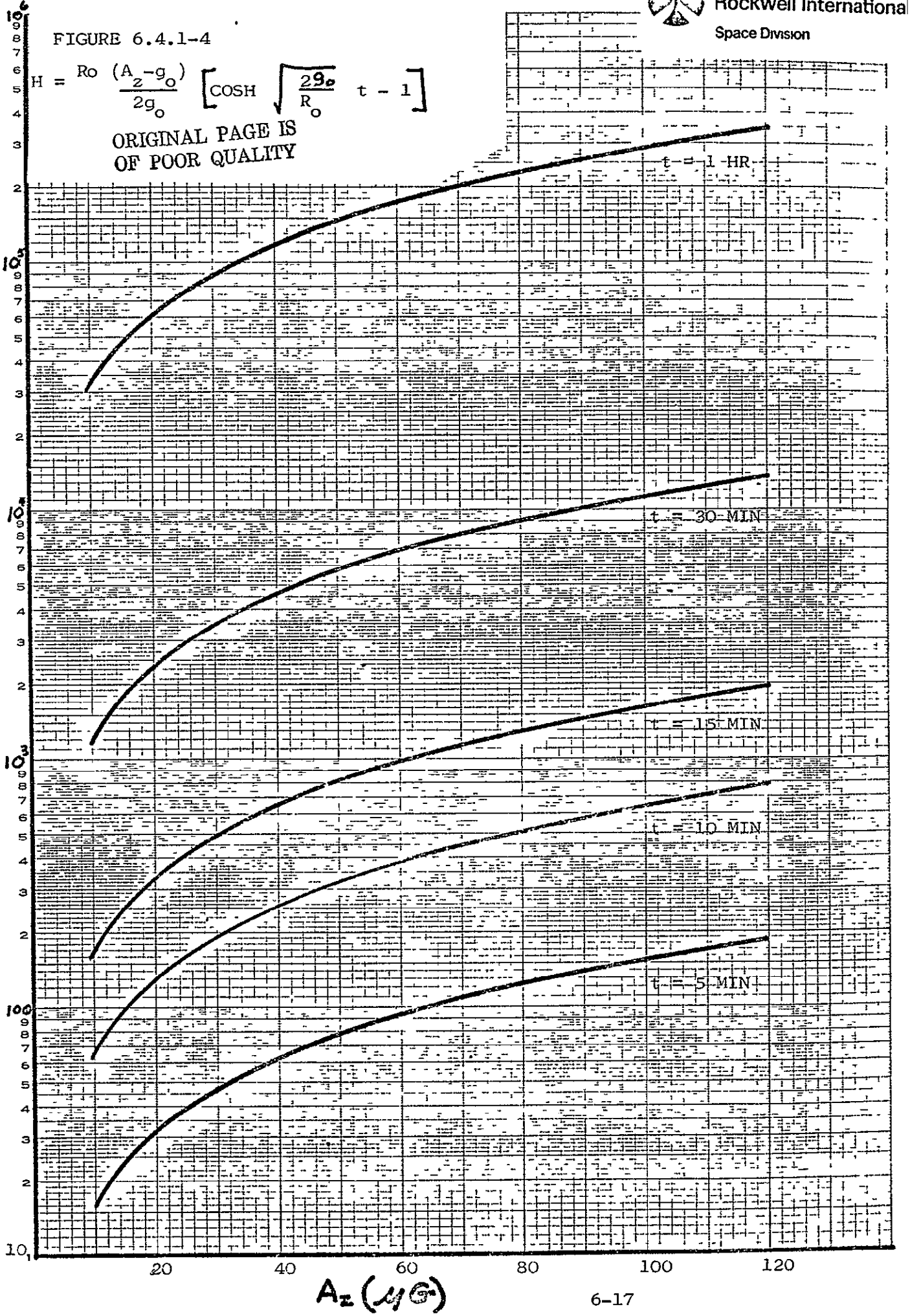

6.4.2 System Performance and Compatibility

The SAIL complex includes two test facilities to be used in the verification of the ascent flight phase. These are (1) the Shuttle Test Station (STS), and (2) the GN&C Test Station (GTS). This report will not specify the particular facility to be employed for a given test. Prior to the start of verification testing, total system performance will be demonstrated. This demonstration will include site acceptance tests, data acquisition, and on-line/off-line data processing.

6.4.2.1 Test Scope

In general, the ascent flight phase will begin approximately 20 seconds prior to liftoff and will terminate subsequent to either the first or second OMS burn depending on the intent of a given test. Parameters to be varied include vehicle environment, aerodynamic characteristics, sensor tolerances, and subsystem malfunctions. Test categories will include nominal ascent, AOA/ATO/and RTLS aborts, and contingency aborts. For the RTLS abort trajectories the test will include approximately 30 seconds of orbiter only glide; this will require implementation of Orbiter alone aerodynamic properties for one Mach number only. Also, for the RTLS abort tests, proximity aerodynamics for ET separation are included. SRB proximity effects are to be included in all test cases. ET and SRB proximity data is to be mechanized as time functions of the six basic force and moment coefficients.

6.4.2-2 Detailed Test Description

As shown in Figure 6.4.2-1 the verification tests at SAIL are categorized into (1) nominal mission, (2) AOA/ATO/RTLS aborts, (3) subsystem malfunctions, (4) contingency aborts, and (5) backup flight system. The separation reference relates to SRB and ET test requirements outlined in Table 6.4.2-2 and 6.4.2-3 while Table 6.4.2-1 lists the wind data.

6.4.2.3 Nominal Mission

Nominal mission evaluation includes non-failure primary GN&C trajectories flown in either automatic or manual guidance modes. The tests are designed to assess the impact of parameter variations on the nominal OFT-1 design ascent trajectory. The parameter variations include standard/hot/cold atmosphere, winds/gusts/shear, IMU alignment and drift errors, aero variations/tolerances, and SRB thrust mismatch.

6.4.2.4 AOA/ATO/RTLS Aborts

The abort mode tests shown in the test matrix reflect a very limited assessment of AOA, ATO, and RTLS aborts. It is anticipated that the IBM Level 6 testing will exercise the remaining software functional paths. As in all tests, should results indicate potential problem areas, the abort boundaries will be further investigated. Test cases for 3 engine RTLS aborts include 3 sigma IMU errors, aerodynamic variations, and combined system errors. One test case is planned for an engine out RTLS abort. The AOA and ATO aborts are to be flown in both 2 engine and 3 engine SSME configurations.

6.4.2.5 Subsystem Malfunctions

The basic intent of the subsystem malfunction tests is to perform a limited audit of the redundancy management subsystem, the impact of electrical power system failures on the GN&C system, and the effect of hydraulic failures on vehicle performance. It is not anticipated that flight control sensor failures will not introduce significant transients. The RM is such that subsequent to a single FCS LRU failure, the fourth LRU is brought on line. Subsequent to the second failure, the remaining FCS LRU's are averaged. It is therefore conceivable that all FCS sensor malfunctions could be accomplished in a single run.

6.4.2.6 Contingency Aborts

Although the capability to perform a contingency abort is not an integrated system design requirement, the test cases in Figure 10.3-1 were included to exercise current software paths. Should the S/W be modified to exclude these functional paths, the indicated contingency abort conditions are to be deleted from the test schedule. It will not be necessary to generate initial conditions for the Flight Simulation Lab (FSL) from the SAIL end conditions for the indicated tests.

6.4.2.7 Backup Flight System

The BFS test cases shown in the test matrix reflect test requirements to be specified under separate cover in the BFS verification plan. Note that a unique set of SRB and ET separation requirements exist for those cases where BFS is selected prior to or during a separation event. Of particular interest is the reinitialization of the separation sequence for SRB and ET separation should the BFS be selected during primary SRB or ET separation.

6.4.2.8 SAIL Run Description Sheet

Appendix B will contain a SAIL Run Description Sheet on each test in Figure 6.4.2-1. An example is shown in Figure 6.4.2-2.

FOLDOUT FRAME 1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

FOLDOUT FRAME 2

TEST	SEAM TEAM REQMT'S REF	FCS MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
1	SRB-1/ET-1 3-6 11-3 12-1 12-2-1	Auto	E-1	STD	T-20 MIN/OMS 2 & 20 SEC	NOMINAL OFT-1 DESIGN TRAJECTORY-PERFORM AUTO STATE VECTOR UPDATE FOLLOWING 1ST OMS BURN-VERIFY DATA ACQUISITION (GN&C-1) CMD/ RESPONSE ON LDB - TRANSITION TO OPS 201
2	SRB-1/ET-5 12-2-5	Auto	E-1	Hot	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - SSME LIMIT SHUTDOWN SW FROM AUTO TO INHIBIT AND BACK TO AUTO - CANNED DELTA STATE VECTOR UPDATE AFTER MECO
3	SRB-1/ET-9 12-2-8 12-2-9 12-2-11 12-2-13	Auto	E-1	Cold	T-12 SEC/OMS 1 + 5 MIN	NOMINAL OFT-1 - MAN STATE VECTOR UPDATE AFTER OMS-1 - SSME 2 DATA PATH FAIL BEFORE MECO CMD (LIMIT S/D SW IN AUTO - SSME 2 DATA PATH FAIL BEFORE MECO CMD (LIMIT S/D SW IN ENABLE) - SSME 2 DATA PATH FAIL AND MECO CMD - LO2 LOW LEVEL SENSORS NO 1&2 DRY BUT DISABLED
4	SRB-1/ET-1 12-2-10 12-2-14	Auto	E-3	STD	T-12 SEC/OMS 2 + 20 SEC	NOMINAL OFT-1 - AUTO STATE VECTOR UPDATE PRIOR TO OMS 2 - SSME 1 DATA PATH FAIL AND MECO CMD - LO2 LOW LEVEL SENSORS 3&4 DRY BUT DISABLED
5	SRB-17/ET-1 12-2-12&15	Auto/ CSS	E-5	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - SWITCH TO CSS AT L/O + 10 SECS - SSME 3 DATA PATH FAIL AND MECO CMD - LH2 LOW LEV SENS 1&2 DRY BUT NOT DISABLED
6	SRB-18/ET-1 12-2-16	Auto/ CSS	E-4	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - SWITCH TO CSS AT SRB SEP - LH2 LOW LEVEL SENSORS 3&4 DRY BUT NOT DISABLED
7	SRB-1/ET-1	Auto	E-2/27	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - WORST CASE AERO TOLERANCES
*8	SRB-1/ET-1	Auto	E-11	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - WORST CASE AERO VARIATIONS
9	SRB-1/ET-1	Auto	E-8	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - 3 SIGMA IMU (AZIMUTH, TILT, SENSED g. DRIFT) AUTO STATE VECTOR UPDATE PRIOR TO OMS 1 BURN
10	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - 3 SIGMA SRB THRUST MISMATCH
11	SRB-1/ET-1	Auto	E-12	STD	T-12 SEC/OMS 1 + 20 SEC	NOMINAL OFT-1 - COMBINED SYSTEM ERRORS - AUTO STATE VECTOR UPDATE PRIOR TO OMS 1 BURN
12	SRB-1/ET-NA 6-1-1	Auto/ CSS	E-2 #102	STD	T-12 SEC/MECO + 10 SEC	CREW SELECT ABORT-TO-ORBIT ON GROUND COMMAND-SWITCH TO CSS MODE AT SRB SEP -3 σ MISMATCH - FAIL SSME #3 AT t + 218 SEC
13	SRB-1/ET-NA 6-1-3	Auto/ CSS	E-2 #112	STD	T-12 SEC/MECO + 10 SEC	CREW SELECT ABORT-ONCE-AROUND ON GROUND COMMAND - SWITCH TO CSS MODE AT APPROX MAX DYNAMIC PRESSURE - TRANSITION TO OPS 301

FIGURE 6.4.2-1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

FOLDOUT FRAME 2

TEST NO	SEAM TEAM RQMT'S REF	REF MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
14	SRB-1/ET-A3 6-1-5	Auto/ CSS	E-10	STD	T-12 SEC/ET SEP + 30 SEC	Crew Select RTLS ABORT ON GROUND COMMAND-SWITCH TO CSS MODE AT LIFTOFF + 10 SECS
15	SRB-8/ET-10 6-1-4 12-2-2	Auto/ CSS	E-2 #128	Hot	T-12 SEC/ET SEP + 30 SEC	CREW SELECT RTLS ABORT ON GROUND COMMAND-FAIL ENGINE #1 AT SRB SEP - MAN SHUTDOWN OF ENG #1 WITH PUSHBUTTON-SWITCH TO CSS MODE AT ENG SHUTDOWN
16	SRB-8/ET-1 6-1-2 12-2-3	Auto/CSS	E-2 #27	Hot	T-12 SEC/ET SEP + 30 SEC	CREW SELECT ABORT-TO-ORBIT ON GROUND COMMAND - MAN SHUTDOWN OF ENG #2 WITH PUSHBUTTON AT t = 210 SECS - SWITCH TO CSS MODE AFTER ENG FAIL
17	SRB-8/ET-A1 6-1-6 12-2-6	Auto	E-2 #102	Hot	T-12 SEC/ET SEP + 30 SEC	FAIL ENGINE #1 AT LIFTOFF - ENG 1 SHUTS DOWN WITH LIMIT S/D SWITCH IN AUTO - SELECT RTLS ABORT ON GROUND COMMAND AT t 230 SECS
18	SRB-8/ET-18 12-2-7	Auto/CSS	E-2 #112	Hot	T-12 SEC/ET SEP + 30 SEC	FAIL ENG #1 AT APPROX MAX DYN PRESSURE - ENG 1 SHUTS DOWN WITH LIMIT S/D SWITCH IN ENABLE - SWITCH TO CSS MODE - SELECT RTLS ABORT ON GROUND COMMAND ≈ SRB STAGING
19	SRB-1 ET-A8/ET-A5	Auto	E-8	STD	T-12 SEC/ET SEP + 30 SEC	SELECT RTLS ABORT AT SRB SEPARATION - COMBINED SYSTEM ERRORS (TBS) - SSME STUCK THROTTLE AT MAX DYN PRESS - FAIL 2 HILIUM REGULATORS IN FWD RCS MODULE
20	SRB-1 ET-A9	Auto	E-3	STD	T-12 SEC/ET SEP + 30 SEC	3 SIGMA IMU ERRORS (AZIMUTH/TILT/SENSED g) - SELECT RTLS ABORT AT SRB SEP + 10 SEC - #2 SSME OUT AT SRB SEP
21	SRB-1 ET-6	Auto	E-11	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL GPC #1 AT STRUCTURAL SEPARATION & SRB PITCH RATE GYRO #2 H/O AT LIFTOFF + 45 SEC - SET + 3σ SIGMA BIAS ON SRB PITCH RATE GYRO #3 AT START OF TEST
22	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/MECO +10 SEC	FAIL AFT MDM #2 AT L/O + 10 SEC - SRB YAW RATE GYRO #1 H/O AT MAX DYNAMIC PRESSURE - SRB YAW RATE GYRO #3 (3 SIGMA BIAS AT L/O)
23	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/MECO +10 SEC	FAIL AFT MDM #3 AT L/O - FAIL ROLL RATE GYRO #2 H/O AT MAX DYNAMIC PRESSURE - SET + 3σ BIAS ON ROLL RATE GYRO NO. 1
24	SRB-7/ET-1	Auto	E-1	STD	T-12 SEC/MECO + 10 SEC	GPC #1 FAIL AT MAX DYN PRESS - GPC #2 FAIL DURING SRB SEP SEQUENCE.
25	SRB-1/ET-7	AUTO	E-1	STD	T-12 SEC/OMS-1 + 1 MIN	TWO PITCH RCS JETS FAILED H/O (ONE AT MECO AND ONE AT FIRST OMS BURN)

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FIGURE 6.4.2-1

FOLDOUT FRAME 1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

FOLDOUT FRAME 2

TEST NO	SEAM TEAM RQMT'S REF	REF MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
26	SRB-1/ET07	Auto	E-12	STD	T-12 SEC/OMS-1 + 20 SEC	ONE ROLL JET FAILED H/O & ONE FORWARD -Z JET H/O AT EXTERNAL TANK SEPARATION
27	SRB-1/ET-1	Auto	E-13	STD	T-12 SEC/OMS-1 + 2 MIN	FAIL ONE OMS ENGINE AT FIRST OMS BURN
28	SRB-1/ET-1	Auto	E-14	STD		ORB PITCH RATE GYRO #2 (5 DEG BIAS AT L/O) - ORB PITCH RATE GYRO #3 H/O AT MAX DYNAMIC PRESSURE - ORB PITCH RATE GYRO #4 (3 SIGMA BIAS AT L/O)
29	SRB-1/ET-1	Auto	E-11	STD	T-12 SEC/MECO + 10 SEC	ORB YAW RATE GYRO #2 (5 DEG BIAS) AT SRB SEP - ORB YAW RATE GYRO #3 H/O AT ET SEP - ORB YAW RATE GYRO #1 (3 SIGMA BIAS AT L/O)
30	SRB-20/ET-1	Auto	E-2	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL FWD MDM #1 AT L/O AND ACCEL #2 FAIL H/O AT MAX DYNAMIC PRESSURE
31	SRB-21/ET-1	Auto	E-2	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL FWD MDM #1 @ L/O & Y AXIS ACCEL #2 AT MAX DYNAMIC PRESSURE
32	SRB-1/ET-1	Auto	E-2	STD	T-12 SEC/OMS-1 + 5 MIN	FAIL FUEL CELL #1 AT LIFTOFF - PERFORM AUTO STATE VECTOR UPDATE POST MECO
33	SRB-1/ET-1	Auto	E-2	STD	T-12 SEC/OMS-1 + 5 MIN	FAIL FUEL CELL #2 AT MAX DYNAMIC PRESSURE - PERFORM AUTO STATE VECTOR UPDATE POST MECO
34	SRB-1/ET-8	Auto	E-2	STD	T-12 SEC/OMS-1 +5 MIN	FAIL FUEL CELL #3 AT SRB SEP - FAIL FWD -Z JET AT ET SEP - AUTO STATE VECTOR UPDATE POST MECO
35	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL APU #1 AT LIFTOFF
36	SRB-19/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	MEC 1 FAIL AT LIFTOFF (VERIFY NOMINAL SEPARATION SEQUENCE WITH MEC 2)
37	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL ESSENTIAL BUS 1BC AT SRB SEP
38	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL ESSENTIAL BUS 2CA AT SRB SEP
39	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL ESSENTIAL BUS 3AB AT SRB SEP
40	SRB-1/ET-1 4-10-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS AB1 AT LIFTOFF
41	SRB-1/ET-1 4-10-2	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS AB2 AT LIFTOFF

Figure 6.4.2-1

FOLDOUT FRAME 1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

FOLDOUT FRAME 2

TEST NO.	SEAM TEAM RQMT'S REF	REF MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
42	SRB-1/ET-1 4-10-3	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS AB3 AT LIFTOFF
43	SRB-1/ET-1 4-10-4	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS BC1 AT LIFTOFF
44	SRB-1/ET-1 4-10-5	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS BC2 AT LIFTOFF
45	SRB-1/ET-1 4-10-6	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS BC3 AT LIFTOFF
46	SRB-1/ET-1 4-10-7	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS CA1 AT LIFTOFF
47	SRB-1/ET-1 4-10-8	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS CA2 AT LIFTOFF
48	SRB-1/ET-1 4-10-9	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL BUS CA3 AT LIFTOFF
49	SRB-6/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL IMU #1 AT LIFTOFF - FAIL IMU #2 AT SRB SEP - SET 1 SIGMA BIAS ON IMU #3
* 50	SRB-5/ET-1	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	FAIL APU #2 AT LIFTOFF - FAIL APU #3 AT MAXIMUM DYNAMIC PRESSURE
* 51	SRB-18/ET-9 6-1-7	Auto/ CSS	E-1	STD	T-12 SEC/ET SEP	FAIL 2 SSME AT LIFTOFF - SWITCH TO CSS - FLY SINGLE SSME TO MECO - STOP TEST AT ET SEP
* 52	SRB/18/ET-1	Auto/ CSS	E-1	STD	T-12 SEC/ET SEP	FAIL ALL 3 SSME AT LIFTOFF - NO SRB MISMATCH - MAN STEER FOR SRB SEQ - ET SEP AUTO
* 53	SRB-18/ET-A4	Auto/ CSS	E-1	STD	T-12 SEC/ET SEP	FAIL 3 SSME AT LIFTOFF - MANUAL INHIBIT OF ET SEP - MAN SEP CMD AFTER SRB SEP TRANSIENTS DECAY
* 54	SRB-18/ET N/A	Auto/ CSS	E-1	STD	T-12 SEC/MECO	FAIL 2 SSME AT t = 50 SEC - 1 SIGMA SRB THRUST MISMATCH - FLY SINGLE SSME TO MECO
* 55	SRB-NA/ET-3	Auto/ CSS	E-1	STD	T-12 SEC/ET SEP	FAIL 3 SSME AT t = 50 SEC - SWITCH TO MAN STEER - CMD ET SEP IN MM 102 (SRB THRUSTING)
* 56	SRB-1/ET-1	Auto/ CSS	E-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL 2 SSME AT t = 90 SEC - 1 SIGMA SRB THRUST MISMATCH = NO MAN STEER PRIOR TO SRB SEP - FLY SINGLE SSME TO MECO.

FIGURE 6.4.2-1

FOLDOUT FRAME 1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

FOLDOUT FRAME 2

TEST NO.	SBAM TEAM REMT'S REF	REF MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
* 57	SRB-1/ET-1	Auto/ CSS	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH - FAIL 2 SSME AT SRB SEP + 12 SEC - SWITCH TO CSS AND FLY SINGLE SSME
* 58	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH - FAIL 3 SSME AT SRB SEP + 12 SEC - ET SEP AUTO
* 59	SRB-1/ET-3 6-1-8 12-2-4	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH - MAN SHUTDOWN OF SSME 1, 2 & 3 WITH PUSHBUTTONS AT SRB SEP + 12 SEC - ET SEP MANUAL INHIBIT - MAN ET SEP
* 60	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH -2 SSME FAIL AT t = 250 SEC - AUTO ET SEP
* 61	SRB-1/ET-1	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH -2 SSME FAIL AT t = 300 SEC - AUTO ET SEP
* 62	SRB-1/ET-A1	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH - 1 SSME FAIL AT SRB SEP + 12 SEC - RTLS SEL & EXECUTE (MM601) - 2ND SSME FAIL APPROX 40 SEC PRIOR TO MECO - FLY ONE ENG TO POWERED PITCH DN & MECO AUTO RTLS ET SEP
* 63	SRB-1/ET-3	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	3 SIGMA SRB THRUST MISMATCH - NOM 2nd STAGE TO MECO - ET SEP MAN INHIBIT - ET SEP MAN CMD - TRANSITION TO MM 104 AT ET SEP - PRO TO MM 602 PRIOR TO OMS-1 TIG
64	SRB-10/ET-B1 12-2-22	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM OFT-1 - ENGAGE BFS AT L/O + 3 SEC - NOMINAL SSME OPS SEQUENCE
65	SRB-11/ET-B2 12-2-26	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOMINAL WITH FDA - ENGAGE BFS AT L/O + 3 SEC - INSERT FAULTS (TBS)
66	SRB-12/ET-B3 12-2-29 12-2-30 12-2-32	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM OFT-1 - ENGAGE BFS AT TOWER CLEAR (START OF PROGRAMMED TURN - ENG 2 DATA PATH FAIL BEFORE MECO CMD (LIMIT S/D SW IN AUTO) - THEN - ENG 2 DATA PATH FAIL BEFORE MECO CMD (LIMIT S/D SWITCH IN ENABLE)
67	SRB-13/ET-B4 12-2-31	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM - ENGAGE BFS AT MAX DYNAMIC PRESSURE - ENG #1 DATA PATH FAIL AT MECO CMD
68	SRB-22/ET-B6 12-2-33	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM - ENGAGE BFS WITHIN 2.3 SEC OF PC < 50 PSI (CRITICAL PERIOD FOR SEQUENCE RESTART) - ENG #3 DATA PATH FAIL AND MECO CMD
69	SRB-10/ET-B7	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM - ENGAGE BFS DURING ET SEP (CONFIRM RESTART OF SEQUENCE BY BFS)

FIGURE 6.4.2-1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

TEST NO	SEAM TEAM RQMT'S REF	FCS MODE(S)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
70	SRB-1/ET-1	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM - ENGAGE BFS DURING OMS-1 BURN (AUTO TO MAN FLT CONTROL)
71	SRB-1/ET-1	Auto/ BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	NOM - ENGAGE BFS DURING MPS DUMP (CONFIRM SEQUENCE CONTINUED)
72	SRB-1/ET-1	Auto/ BFS	E-1	STD	T-12 SEC/OMS-2 + 20 SEC	NOM - ENGAGE BFS DURING OMS-2 BURN (CONFIRM CORRECT LISTENING BY BFS
73	SRB-14/ET-NA	Auto/ BFS	E-3	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT L/O + 3 SEC
74	SRB-15/ET-NA	Auto/ BFS	E-7	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT TOWER CLEAR
75	SRB-16/ET-NA	Auto-BFS	E-11	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT MAX DYN PRESSURE
76	SRB-10/ET-NA	Auto/ BFS	E-5	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT L/O + 3 SEC
77	SRB-10/ET-NA	Auto/ BFS	E-9	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT TOWER CLEAR
78	SRB-10/ET-NA	Auto/ BFS	E-13	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT MAX DYN PRESSURE
79	SRB-10/ET-NA	Auto/ BFS	E-6	STD	T-12 SEC/MECO +5 SEC	NOM - ENGAGE BFS AT L/O + 3 SEC
80	SRB-10/ET-NA	Auto/ BFS	E-4	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT TOWER CLEAR
81	SRB-10/ET-NA	Auto/ BFS	E-8	STD	T-12 SEC/MECO + 5 SEC	NOM - ENGAGE BFS AT MAX DYN PRESSURE
82	SRB-10/ET-B5 12-2-23	Auto/ BFS	E-1	STD	T-12 SEC/ET SEP + 1 MIN	FAIL ENG #2 AT t = 218 SEC (EARLIEST ATO ABORT) ENGAGE BFS PRIOR TO ENGINE FAILURE - NOMINAL S/D OF ENG #1 WITH PUSHBUTTON
83	SRB-1/ET-1	Auto/ BFS	E-1	STD	T-12 SEC/ET SEP + 1 MIN	ENG #3 FAIL AT t = 218 SEC (EARLIEST ATO ABORT) ENGAGE BFS DURING MPS DUMP - PERFORM OMS - TRANS TO OPS 301
84	SRB-23/ET-B1	Auto/ BFS	E-1	STD	T-12 SEC/ET SEP + 1 MIN	ATO AFTER V ATO MECO - ENGAGE BFS PRIOR TO ENG FAIL - ATO

FOLDOUT FRAME 1

FIGURE 6.4.2-1

FOLDOUT FRAME 2

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

TEST NO	SEAM TEAM REQMT REF	FCS MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
85	SRB-1/ET-1 12-2-24	Auto/ BFS	E-1	STD	T-12 SEC/ET Sep + 1 MIN	ATO AFTER V ATO MECO - ENGAGE BFS DURING MPS DUMP - MAN SHUTDOWN OF ENG #2 WITH PUSHBUTTON
86	SRB-1/ET-B1 12-2-27	Auto/ BFS	E-1	STD	T-12 SEC/ET Sep + 1 MIN	ATO AFTER V LIN- ENG #1 SHUTS DOWN WITH LIMIT S/D SWITCH IN AUTO
87	SRB-1/ET-B7 12-2-28	Auto/ BFS	E-1	STD	T-12 SEC/ET Sep + 1 MIN	ATO AFTER V LIN- ENGAGE BFS DURING ET SEP - ENG #1 SHUTS DOWN WITH LIMIT S/D SWITCH IN ENABLE
88	SRB-2/ET-1	Auto/BFS	E-1	STD	T-12 SEC/OMS -1 + 1 MIN	ATO AFTER V LIN - ENGAGE BFS DURING OM-1 BURN - AUTO STATE UPDATE POST OMS-1 BURN
89	SRB-3/ET-1	Auto/BFS	E-1	STD	T-12 SEC/ET SEP + 2 MIN	ATO AFTER V LIN - FAIL ENG #1 BEFORE V ZERO - ENGAGE BFS BEFORE MPS DUMP
90	SRB-1/ET-1	Auto/BFS	E-1	STD	T-12 SEC/OMS-2 + 20 SEC	ATO AFTER V LIN - ENGAGE BFS AFTER OMS-2 BURN
91	SRB-3/ET-1	Auto/BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	ATO DURING OMS-1 BURN - ENGAGE BFS PRIOR TO ENG FAIL - SELECT ATO
92	SRB-4/ET-2	Auto/BFS	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	ATO DURING OMS-1 BURN - ENGAGE MPS DURING MPS DUMP
93	SRB-1/ET-3	Auto/BFS	E-1	STD	T-12 SEC/OMS-2 + 20 SEC	ENGAGE BFS PRIOR TO ENG FAIL
94	SRB-1/ET-4	Auto/BFS	E-1	STD	T-12 SEC/OMS-2 + 20 SEC	ENGAGE BFS DURING OMS-2 BURN
95	SRB-1/ET-A2/ ET-A5	Auto	E-1	STD	T-12 SEC/ET SEP + 10 SEC	SPECIAL ET SEP REQM'T (SEE ATTACHED)
96	SRB-1/ET A4/ ET A5	Auto	E-1		T-12 SEC/ET SEP + 10 SEC	SPECIAL ET SEP REQM'T (SEE ATTACHED)
97	6-1-9	Auto	NA	NA	MECO + 5 SEC/OMS-2 + 20 SEC	PERFORM OMS-2 BURN WITH RCS (2 OMS OUT)
98	SRB-1/ET-1 12-2-17	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	LO2 LOW LEVEL SENSORS 1 & 2 DRY BUT NOT DISABLED
99	SRB-1/ET-1 12-2-18	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	LO2 LOW LEVEL SENSORS 3 & 4 DRY BUT NOT DISABLED
100	SRB-1/ET-1 12-2-19	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	LH2 LOW LEVEL SENSORS 1&2 DRY BUT NOT DISABLED

FOLDOUT FRAME 1

FIGURE 6.4.2-1

FOLDOUT FRAME 2

FOLDOUT FRAME 1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

FOLDOUT FRAME 2

TEST NO.	SEAM TEAM RQMT'S REF	FCS MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
101	SRB-1/ET-1 12-2-20	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	LH2 LOW LEVEL SENSORS 3&4 DRY BUT NOT DISABLED
102	SRB-1/ET-1 12-2-21	Auto	E-1	STD	T-12 SEC/OMS-1 + 20 SEC	ENG #1 CUTOFF VIA TWO AC POWER SWITCHES
103	12-2-25	Auto/ BFS	E-1	STD	T-12 SEC/ET SEP + 10 SEC	SWITCH TO BFS AT LIFTOFF + 10 SEC - MAN SHUTDOWN OF ENG'S 1, 2, 3 WITH PUSHBUTTONS
104	4-7	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL AC BUS 1 AT L/O - FAIL ESSENTIAL BUS 1BC AT L/O + 20 SEC - FAIL MAN BUS A AT MAX DYN PRESSURE
105	4-8	Auto	E-1	STD	T-12 SEC/ET Sep + 20 Sec	FAIL AC BUS 2 AT L/O - FAIL ESSENTIAL BUS 2CA AT L/O + 20 SEC - FAIL MAIN BUS B AT MAX DYN PRESSURE
106	4-9	Auto	E-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL AC BUS 3 AT L/O - FAIL ESSENTIAL BUS 3AB AT L/O + 20 SEC - FAIL MAIN BUS C AT MAX DYN PRESSURE
107	-	Auto	-	-	MECO/OMS-2 C/O + 5 SEC	FAIL LEFT OMS AT OMS-2 TIG - 1 MIN, VERIFY OMS RECONFIGURATION
108	-	CSS	-	-	MECO/OMS-2 C/O + 5 SEC	FAIL LEFT OMS AT OMS-2 TIG - 1 MIN, VERIFY OMS RECONFIGURATION
109	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	CREW SELECT AOA AT TEST START, RIGHT OMS FAIL AT TIG + 1 MIN, VERIFY TARGET
110	-	CSS	-	-	MECO/OMS-1 C/O + 5 SEC	CREW SELECT AOA AT TEST START, RIGHT OMS FAIL AT TIG + 1 MIN, VERIFY TARGET
111	-	Auto	-	-	MECO/OMS-2 C/O + 5 SEC	CREW SELECT ATO AT TEST START, VERIFY TARGET
112	-	CSS	-	-	MECO/OMS-2 C/O + 5 SEC	CREW SELECT ATO AT TEST START, VERIFY TARGET
113	-	Auto	-	-	MECO/OMS-2 C/O + 5 SEC	CREW SELECT ATO AT TEST START, FAIL LEFT OMS ENGINE AT TGO (OMS-2) = 30 SEC, VERIFY TARGET
114	-	CSS	-	-	MECO/OMS-2 C/O + 5 SEC	CREW SELECT ATO AT TEST START, FAIL LEFT OMS ENGINE AT TGO (OMS-2) = 30 SEC , VERIFY TARGET
115	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	NOM, FAIL RIGHT ENG AT OMS TIG, ARM SWS OFF, RECYCLE
116	-	CSS	-	-	MECO/OMS-1 C/O + 5 SEC	NOM, FAIL RIGHT ENG AT OMS TIG, ARM SWS OFF, RECYCLE

FIGURE 6.4.2-1

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

TEST NO.	SEAM TEAM RQMT'S REF	FCS MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
117	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL RIGHT ENG AT OMS-1 TIG + 30 SEC, NO OMS RECONFIGURATION
118	-	CSS	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL RIGHT ENG AT OMS-1 TIG + 30 SEC, NO OMS RECONFIGURATION
119	-	Auto	-	-	MECO/OMS-2 C/O + 5 SEC	CREW SELECT ATO AT TEST START, FAIL LEFT ENG AT OMS-2 TIG, FAIL RIGHT ENG AT TGO = 45 SEC, COMPLETE BURN WITH RCS
120	-	CSS	-	-	MECO/OMS-2 C/O + 5 SEC	CREW SELECT ATO AT TEST START, FAIL LEFT ENG AT OMS -2 TIG, FAIL RIGHT ENG AT TGO = 45 SEC, COMPLETE BURN WITH RCS
121	-	Auto	-	-	MECO/OMS -2 C/O + 5 SEC	NOM - USE EXTERNAL DELTA-V TARGETS FOR BOTH BURNS
122	-	MAN	-	-	MECO/OMS-2 C/O + 5 SEC	NOM - USE EXTERNAL DELTA-V TARGETS FOR BOTH BURNS
123	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL RIGHT OMS AT TIG + 30 SEC, FAIL LEFT OMS AT RECONFIGURATION
124	-	Man	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL RIGHT OMS AT TIG + 30 SEC, FAIL LEFT OMS AT RECONFIGURATION
125	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL LEFT OMS GIMBAL ACTUATOR AT TIG
126	-	Man	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL LEFT OMS GIMBAL ACTUATOR AT TIG
127	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL ONE OR TWO RCS JETS AT TIG
128	-	Man	-	-	MECO/OMS-1 C/O + 5 SEC	FAIL ONE OR TWO RCS JETS AT TIG
129	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	5 MINUTE TIG DELAY
130	-	Man	-	-	MECO/OMS-1 C/O + 5 SEC	5 MINUTE TIG DELAY
131	-	Auto	-	-	MECO/OMS-1 C/O + 5 SEC	SSME ENG #2 FAIL TO SHUTDOWN
132	-	Man	-	-	MECO/OMS-1 C/O + 5 SEC	SSME ENG #2 FAIL TO SHUTDOWN
133		Auto	E-1	STD	T-12 SEC/MECO + 10 SEC	LATE ATO - FAIL SSME #1 at 505 SEC
134		Auto	E-1	STD	T-12 SEC/MECO + 10 SEC	LATE AOA - FAIL SSME #1 AT 505 SEC

FOLDOUT FRAME 1

FIGURE 6.4.2-1

FOLDOUT FRAME 2

GN&C ASCENT/ORBIT INSERTION TEST MATRIX (SAIL)

TEST NO	SEAM TEAM RQMT'S REF	FCS MODE(s)	WINDS	ATMOS	TEST START/STOP	TEST DESCRIPTION
135		Auto	B-1	STD	T-12 SEC/OMS-1 + 5 SEC	MISSION COMPLETION - FAIL SSME #3 AT 230 SECONDS
136		Auto	B-1	STD	F12 SEC/ET SEP + 20 SEC	RTLS ABORT - FAIL ENG #2 AT 260 SECONDS
137		Auto	B-1	STD	T-12 SEC/ET SEP + 20 SEC	RTLS ABORT - FAIL ENG #2 AT MAX DYN PRESSURE
138		Auto	B-1	STD	T-12 SEC/ET SEP + 20 SEC	RTLS ABORT - FAIL ENG #3 AT LIFTOFF
139		Auto	B-1	STD	T-12 SEC/ET SEP + 20 SEC	INITIATE 3 ENG RTLS ABORT BUT FAIL ENG #2 APPROX 60 SECONDS PRIOR TO MECO
140		Auto	B-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL ENG #2 AT 218 SEC - SELECT ATO - SWITCH TO RTLS AT 240 SEC
141		Auto/ CSS	B-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL ENG #2 AT LIFTOFF - SWITCH TO CSS MODE - SELECT RTLS ABORT
142		Auto/ CSS	B-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL ENG #3 AT SRB SEP - SWITCH TO CSS MODE - SELECT RTLS ABORT
143		Auto/ CSS	B-1	STD	T-12 SEC/ET SEP + 20 SEC	FAIL ENG #2 AT SRB SEP - FLY AUTO UNTIL POST TURNAROUND THEN SWITCH TO CSS
144		Auto	B-1	STD	T-12 SEC/MECO + 10 SEC	MAN THROTTLE TAKEOVER AT 3g DURING 2ND STAGE
145		Auto	B-1	STD	T-12 SEC/MECO + 10 SEC	FAIL APU #2 (STUCK THROTTLE) BEFORE t = 30 SEC
146		Auto	B-1	STD	T-12 SEC/MECO + 10 SEC	FAIL APU #1 AT LIFTOFF - FAIL APU #2 AT t = 20 SEC.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

* DESIGN ASSESSMENT FOR INTEGRATED GN&C

FIGURE 6.4.2-1

TABLE 6.4.2-1 WIND TABLE

*WIND CASE	MEAN	MEAS.	SSW PROB.	SSW $\Theta_{W(DEG)}$	* SHEAR	* GUST ONSET ALT(FT)	* GUST THICKNESS FT
E1	April						
E2		April					
E3	April		.95	40	Yes	36,200	984
E4	April		.95	130	Yes	36,200	984
E5	April		.95	220	Yes	36,200	984
E6	April		.95	310	Yes	36,200	984
E7	April		.95	40	Yes	28,150	984
E8	April		.95	130	Yes	28,150	984
E9	April		.95	220	Yes	28,150	984
E10	April		.95	310	Yes	28,150	984
E11	April		.7	40	Yes	36,200	984
E12	April		.7	130	Yes	28,150	984
E13	April		.7	220	Yes	36,200	984
E14	April		.7	310	Yes	28,150	984

* Shear: ϕ_S = 0.0 DEG
Shear Probability = .99
Shear Factor = .85

* Gust: ϕ_G = 0.0 DEG
Gust Factor = .85

* Wind Case: E = ETR, W = WTR

Table 6.4.2-2 SRB/ET Separation Vertification Run Matrix (SAIL)

Test No.		Description
Sep	GN&C	
1	TBD	Nominal SRB/ET separation
2		Two chamber pressures fail high in same SRB (prior to 105 sec MET)
3		Two chamber pressures fail low in same SRB (prior to 105 sec MET)
4		Body rates at SRB sep time (Event 28) exceed inhibit criteria, then return to acceptable state and auto separation
5		Derived dynamic pressure greater than 63 psf at SRB separation time, then becomes less than 63 psf and auto separation
6		Separation inhibit override with manual separation
7		GPC failure during separation sequence (nominal separation)
8		Separation with one SSME out
9		One chamber pressure fails high in left SRB (prior to 105 sec MET)
		One chamber pressure fails low in right SRB (prior to 105 sec MET)
10		SRB/ET separation (BFS) (no failures)
11		SRB/ET separation (BFS) (same as Sep2)
12		SRB/ET separation (BFS) (same as Sep3)
13		SRB/ET separation (BFS) (same as Sep4)
14		SRB/ET separation (BFS) (same as Sep5)
15		SRB/ET separation (BFS) (same as Sep6)
16		SRB/ET separation (BFS) (same as Sep9)
17		SRB/ET separation (primary) with manual control prior to SRB separation
18		SRB/ET separation (primary) with manual control at SRB separation
19		MEC1 failure at lift-off
20		Manual separation with MDM FF1, FF3, or FF4 failure prior to separation
21		Auto separation with MDM FF1, FF3, or FF4 failure prior to separation
22		Auto separation selecting BFS between Event 26 and Event 27
23	TBD	Auto separation selecting BFS immediately after SRB separation (Event 28)

Table 6.4.2-3 Orbiter/ET Separation Verification Run Matrix

Test No.		Descriptions
Sep	GN&C	
		NOM/AOA/ATO
1	TBD ↑	Nominal orbiter/ET separation
2		Vehicle body rates exceed inhibit values at separation—corrected by FCS for auto separation
3		Same as 2—no FCS correction, manual override of inhibit by crew
4		Feed-line disconnect valve fails to close—auto inhibit with crew manual override
5		Crew selects manual inhibit after MECO confirmed. After a delay of Δt seconds crew reselects auto mode
6		Fail (1) GPC at time of structural release
7		Fail (1) forward -Z RCS thruster (check downmoding)
8		Fail bus A or B and Bus C (dual RCS failure)
9		Fail two regulators in forward helium supply to RCS fuel tank (blow-down mode)
10		Induced failure (undefined) which requires manual control prior to MECO cmd and at structural release
		RTLS
A1	↓	Nom RTLS (1 SSME out)
A2		Same condition as Case 2
A3		Vehicle body rates exceed inhibit values. Not corrected by FCS auto inhibit override after 6 seconds
A4		Same condition as Case 3
A5		Same as Case 5
A6	TBD	Same as Case 6

Table 6.4.2-3 Orbiter/ET Separation Verification Run Matrix (Cont)

Test No.		Descriptions
Sep	GN&C	
A7	TBD	Fail Bus C prior to MECO confirmed
A8		Same as Case 10
A9		Maximum rate and attitude dispersions at MECO confirmed
A10		Maximum aero and mass property dispersions (detail cases under study)
BFS—NOM/AOA/ATO		
B1		Same as Case 1
B2		Same as Case 2
B3		Same as Case 3
B4		Same as Case 4
B5		Same as Case 5
B6		Same as Case 7
B7	TBD	Same as Case 1—BFS selected after MECO confirmed

Rockwell International
Space Division

SAIL RUN DESCRIPTION SHEET

IDENTIFICATION: _____

TEST TITLE: _____

OBJECTIVE: _____

TEST CONDITIONS:

MISSION SELECTION	FIRST	
	2 ND	
	OMS 1	
	OMS 2	

MAJOR MODE	INITIAL	
	TERM	

ENVIRONMENT	ATM	
	WIND	

CONTROL MODE/SYSTEM	AUTO		
	MANUAL		
	BFS		

AERO		

UPLINK		

SSME	E/O	E/O TIME	ABORT SELECT TIME

SRB		MISL	MISMATCH
	MAN		
	DIR		

RCS	FAIL	TIME

OMS	FAIL	TIME

SENSORS	

ACTUATOR HYDRAULICS APU	

IMU	

OTHER	

TEST APPROACH: _____

FIGURE 6.4.2-2 C-2

6.5 OPS Transition Tests

A normal ascent mission (OPS 1) following the OMS-1 and OMS-2 burns is terminated by a Transition in the computers to on orbit OPS-2. In case of an Abort Once Around mission the transition is to the Entry OPS-3. In an RTLS the transition to OPS 6 takes place without a memory configuration change in the flight computers.

Tests will be conducted in SAIL to confirm the proper Transition. The SAIL RTLS runs will conform transitions from MM102 to 601 and 103 to 601. The transition from MM 601 to 602 will also be confirmed in SAIL. The OPS transitions will be confirmed as follows:

SAIL TEST CASE	TRANSITION
1 (FIGURE 6.4.2-1)	OPS 1 (MM106) to OPS 2 (Primary)
83 (FIGURE 6.4.2-1)	OPS 1 (MM106) to OPS 3 (BackUp)
13 (FIGURE 6.4.2-1)	OPS 1 (MM104) to OPS 3 (Primary)

6.6 Pass/Fail Criteria

The Ascent Integrated GN&C System is to be verified at SAIL by the simulated mission flight profiles defined in the appropriate data base appendices of SDM SD72-SH-0105. Verification will demonstrate that the Ascent GN&C System performance complies with the pass-fail criteria given in Tables 6.6-1 through 6.6-10 as follows:

First Stage Ascent Verification Requirements, Table 6.6-1
SRB Separation Verification Requirements, Table 6.6-2
Second Stage Ascent Verification Requirements, Table 6.6-3
External Tank Separation Verification Requirements, Table 6.6-4
Orbital Insertion Verification Requirements, Table 6.6-5
Abort-Once-Around Verification Requirements, Table 6.6-6
Abort to Orbit Verification Requirements, Table 6.6-7
RTLS Verification Requirements, Table 6.6-8
Ascent Maneuver DIP Verification Requirements, Table 6.6-9
GPC and I/O Error Log Verification Requirements, Table 6.6-10

The tables are organized by major mode/event sequence and present the pass/fail criteria to be used against the mission profile. The methodology used to resolve any deviations in performance constraints is illustrated in figure 6.6-1.

In addition to the pass/fail constraints specified in Tables 6.6-1 through 6.6-10, a reasonableness check will be performed that consists of visually comparing the baseline trajectories against off-line generated nominal trajectory parameters. The reasonableness check, which will be performed by cognizant designated engineers and crew members, will be exercised only if a probable system anomaly is reported by the crew. The process used to resolve any probable anomaly is shown in figure 6.6-2. Testing will resume on non-critical anomalies after proper documentation.

TABLE 6.6-1 FIRST STAGE ASCENT VERIFICATION REQUIREMENTS
(SOFTWARE/HARDWARE INTERFACE)

TBS

TABLE 6.6-2 SRB SEPARATION VERIFICATION REQUIREMENTS
(SOFTWARE/HARDWARE INTERFACE)

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
102	Verify nominal SRB/ET separation sequence (benign and design environment)	Verify pre-separation sequence initiation (MET < 105 sec):		
		o Major mode code	MMC = 2	V90Q8001c
		o SRB sep inhibit alert	SRB auto inhibit crew alert =0	V90X8340X
		o CRT display	"Ascent Traj 1"	
		o SRB bus voltages	LH op Bus a volt = 28 V ± TBD	B76V1600C
			LH op Bus B volt = 28 V ± TBD	B76V1601C
			RH op Bus A volt = 28 V ± TBD	B76V2600C
			RH op Bus B volt = 28 V ± TBD	B76V2601C
		o SRB sep PIC voltage (sep bolts and BSM's)	LH fwd thr pin PIC cap A volt ≤ 1.5V	B55V1605C
			LH fwd thr pin PIC cap B volt ≤ 1.5V	B55V1606C
			LH aft upr brct PIC cap A volt ≤1.5 V	B55V1608C
			LH aft upr brct PIC cap B volt ≤1.5 V	B55V1608C
			LH aft mid brct PIC cap A volt ≤1.5 V	B55V1609C
			LH aft mid brct PIC cap B volt ≤1.5 V	B55V1610C
			LH aft lwr brct PIC cap A volt ≤1.5 V	B55V1611C
			LH aft lwr brct PIC cap B volt ≤1.5 V	B55V1612C
			LH fwd sep mot PIC cap A volt ≤1.5 V	B55V1613C
			LH fwd sep mot PIC cap B volt ≤1.5 V	B55V1614C
			LH aft sep mot PIC cap A Volt ≤1.5 V	B55V1615C
			LH aft sep mot PIC cap B Volt ≤1.5 V	B55V1616C
			RH fwd thr pin PIC cap A volt ≤1.5 V	B55V2605C

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
			RH fwd thr pin PIC cap B volt ≤1.5 V	B55V2606C
			RH aft upr brct PIC cap A volt ≤1.5 V	B55V2607C
			RH aft upr brct PIC cap B volt ≤1.5 V	B55V2608C
			RH aft mid brct PIC cap A volt ≤1.5 V	B55V2609C
			RH aft mid brct PIC cap B volt ≤1.5 V	B55V2610C
			RH aft lwr brct PIC cap A volt ≤1.5 V	B55V2611C
			RH aft lwr brct PIC cap B volt ≤1.5 V	B55V2612C
			RH fwd sep mot PIC cap A volt ≤1.5 V	B55V2613C
			RH fwd sep mot PIC cap B volt ≤1.5 V	B55V2614C
			RH aft sep mot PIC cap A volt ≤1.5 V	B55V2615C
			RH aft sep mot PIC cap B volt ≤1.5 V	B55V2616C
		o SSME operational status	SSME failure status flag = 0	V90X1763X
			MPS E1 fail flag = 0	V95X1207X
			MPS E2 fail flag = 0	V95X1208X
			MPS E3 fail flag = 0	V95X1209X
		o Manual sep switches/cmds	SRB sep auto cmd = 1	V90X7570X
			SRB sep/man/auto enable cmd = 0	V90X7571X
			SRB sep init cmd = 0	V90X7572X
		o SRB sep seq flags events	SRB sep monitor flag = 0	V90X8193X
			SRB sep initiation flag = 0	V90X8333X
			SRB sep function moding = 0	V90X8330X
			SRB sep cmd flag = 0	V90X8331X
			SRB sep subphase flag = 0	V90X1761X
		o Guid/FCS functions	Guidance ready flag = 0	V90X1965X
			Frz desired body cmd flag = 0	V90X1714X
			Stage 2 steer mode flag = 0	V90X1757X

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
			Steering Mode Flag = 1	V90X1712X
			Manual Mode During Stage 1 Flag = 0	V90X1707X
			Manual Mode During Stage 2 Flag =0	V90X1741X
			Auto Guidance Mode Flag = 1	V90X1710X
			STG1 Guidance Discrete = 1	V90X1713X
			Initiate Stage 2 Guidance = 0	V90X8630X
			PEG Convergence Discrete = 0	V90X1971X
		o SRB RCS ARM Status	LH SRB RSS S&A Armed = 1	B55X1870X
			RH SRB RSS S&A Armed = 1	B55X2870X
		o SRB RSS Safe Status	LH SRB RSS S&A Safed = 0	B55X1869X
			RH SRB RSS S&A Safed = 0	B55X2869X
		Verify SRB sep monitor initiation (Event 25) (MET > 105 sec and no MECO confirmed):	SRB sep monitor flag = 1	V90X8193X
			MECO confirmed flag = 0	V90X8561X
		Verify sep initiation sequence/functions (Event 26):	SRB sep initiation flag = 1	V90X8333X
		o SRB $P_c \leq$ 50 psia	Selected LH SRB $P_c \leq$ 50 TBD psia at T_2	V90P2535C
			Selected RH SRB $P_c \leq$ 50 TBD psia at T_1	V90P2536C
			$\lvert T_2 - T_1 \rvert \simeq$ 4.2 seconds	
			LH SRB P_c A $\leq$ 50 psia	B47P1300C
			LH SRB P_c B $\leq$ 50 psia	B47P1301C
			LH SRB P_c C $\leq$ 50 psia	B47P1302C
			RH SRB P_c A $\leq$ 50 psia	B47P2300C
			RH SRB P_c B $\leq$ 50 psia	B47P2301C
			RH SRB P_c C $\leq$ 50 psia	B47P2302C
		o P_c < 50 psia	LH/RH SRB 50 psia flag = 1 (Displayed on Ascent Traj 1 display	V90X8332X

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		P_c Measurement Accuracy	$\Delta P \leq 10$ PSIA (Note 1)	
		o SRB RSS ARM Status	LH SRB RSS S&A Armed = 0 RH SRB RSS S&A Armed = 0	B55X1870X B55X2870X
		o SRB RSS Safe Status	LH SRB RSS S&A Safed = 1 RH SRB RSS S&A Safed = 1	B55R1869X B55X2869X
		o SRB RSS Power Status	LH RSS decoder A = 0 LH RSS decoder B = 0 LH SRB RSS receiver sig strength A volt = 0 LH SRB RSS receiver sig strength B volt = 0 RH RCS A decoder A = 0 RH RSS B decoder B = 0 RH SRB RSS receiver sig strength A volt = 0 RH SRB RSS receiver sig strength B volt = 0	B55X1871X B55X1872X B55E1100C B55E1101C B55X2871X B55X2872X B55E2100C B55E2101C
		o ET/Orbiter camera on	TBD	
		Verify SRB sep function moding: (Event 27) (Event 26 + 2.3 sec)	Function moding for SRB sep	V90X8330X
		o SRB nozzles nulled	LH pos TVC rock actuator = TBD LH pos TVC tilt actuator = TBD RH pos TVC rock actuator = TBD RH pos TVC tilt actuator = TBD	B58H1150C B58H1151C B58H2150C B58H2151C
			SRB LH Rock Actr A Drvr Out = TBD SRB LH Tilt Actr A Drvr Out SRB LH Rock Actr B Drvr Out SRB LH Tilt Actr B Drvr Out SRB LH Rock Actr C Drvr Out SRB LH Tilt Actr C Drvr Out SRB LH Rock Actr D Drvr Out	V79H2110A V79H2111A V79H2114A V79H2115A V79H2119A V79H2120A V79H2125A

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
102 (Cont)			SRB LH Tilt Actr D Drvr Out	V79H2126A
			SRB RH Rock Actr A Drvr Out	V79H2130A
			SRB RH Tilt Actr A Drvr Out	V79H2131A
			SRB RH Rock Actr B Drvr Out	V79H2135A
			SRB RH Tilt Actr B Drvr Out	V79H2136A
			SRB RH Rock Actr G Drvr Out	V79H2140A
			SRB RH Tilt Actr C Drvr Out	V79H2141A
			SRB RH Rock Actr D Drvr Out	V79H2145A
			SRB RH Tilt Actr D Drvr Out	V79H2146A
		o SRB TVC FDIR terminated	TBD	
		o Transition from SRB to orbiter RGA	TBD	
		o Stage 2 FCS logic enabled	TBD	
		o Arm SRB sep PIC's (sep bolts and BSM's):	LH fwd thr pin PIC cap A volt ≥ 35.7 V	B55V1605C
			LH fwd thr pin PIC cap B volt ≥ 35.7 V	B55V1606C
			LH aft upr brct PIC cap A volt ≥ 35.7 V	B55V1607C
			LH aft upr brct PIC cap B volt ≥ 35.7 V	B55V1608C
			LH aft mid brct PIC cap A volt ≥ 35.7 V	B55V1609C
			LH aft mid brct PIC cap B volt ≥ 35.7 V	B55V1610C
			LH aft lwr brct PIC cap A volt ≥ 35.7 V	B55V1611C
			LH aft lwr brct PIC cap B volt ≥ 35.7 V	B55V1612C
			LH fwd sep motor PIC cap A volt ≥ 35.7 V	B55V1613C
			LH fwd sep motor PIC cap B volt ≥ 35.7	B55V1614C

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
102 (Cont)			LH aft sep motor PIC cap A volt ≥ 35.7 V	B55V1615C
			LH aft sep motor PIC cap B volt ≥ 35.7 V	B55V1616C
			RH fwd thr pin PIC cap A volt ≥ 35.7 V	B55V2605C
			RH fwd thr pin PIC cap B volt ≥ 35.7 V	B55V2606C
			RH aft upr brct PIC cap A volt ≥ 35.7 V	B55V2607C
			RH aft upr brct PIC cap B volt ≥ 35.7 V	B55V2608C
			RH aft mid brct PIC cap A volt ≥ 35.7 V	B55V2609C
			RH aft mid brct PIC cap B volt ≥ 35.7 V	B55V2610C
			RH aft lwr brct PIC cap A volt ≥ 35.7 V	B55V2611C
			RH aft lwr brct PIC cap B volt ≥ 35.7 V	B55V2612C
			RH fwd sep motor PIC cap A volt ≥ 35.7 V	B55V2613C
			RH fwd sep motor PIC cap B volt ≥ 35.7 V	B55V2614C
			RH aft sep motor PIC cap A volt ≥ 35.7 V	B55V2615C
			RH aft sep motor PIC cap B volt ≥ 35.7 V	B55V2616C
		Verify SRB separation (Event 28) (sep initiation + 4.0 sec and no sep inhibit):	SRB sep cmd flag = 1	V90X8331X
		o Monitor sep auto inhibit parameters	Sel RGA roll rate — See rate inhibit criteria (1.2.2.2)	V90R5301C
			Sel RGA pitch rate — See rate inhibit criteria (1.2.2.2)	V90R5321C
			Sel RGA yaw rate — See rate inhibit criteria (1.2.2.2)	V90R5341C
			Derived dynamic press. < 63 psf	V95P0500C
		o Major mode change from 102 to 103	MMC = 103	V90Q8001C

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		o Initiate attitude hold	Body pitch attitude error $\leq 0^{\circ}$ Body yaw attitude error $\leq 0^{\circ}$ Body roll attitude error $\leq 0^{\circ}$ Pitch rate, flight body-inertial $\leq 0^{\circ}$/sec Yaw rate, flight body-inertial $\leq 0^{\circ}$/sec Roll rate, flight body-inertial $\leq 0^{\circ}$/sec	V95H3521C V95H3522C V95H3523C V95H3526C V95H3527C V95H3528C
		o Guidance/FCS Functions	SRB sep subphase flag = 1 Freeze desired body command flag=1 Steering mode flag = 0	V90X1761X V90X1714X V90X1712X
		o Attach & BSM PIC discharge/sep CMD time difference	Special requirement (T $\leq$ 20 ms) (Note 2)*	
		o ATVC SRB 26-V dead face	Special Requirement (Note 3)*	
		o ATVC SRB IVD power off	Special Requirement (Note 4)*	
		o CRT display	Ascent Traj 2	
		o Initiate stage 2 guidance	TBD	
		o Terminate SRB data acquisition	TBD	
		o Terminate stage 1 guidance	TBD	
		o Terminate SRB RG SOP	TBD	
		O Terminate AA SOP	TBD	
		o Terminate SRB monitor PCN	TBD	
		o Terminate ΔP P/B SOP	TBD	

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		o Terminate AA FDIR	TBD	
		o Pitch axis trim change	MPS eng 1 P act. A cmd = TBD	V58K1164C
			MPS eng 2 P act. A cmd = TBD	V58K1264C
			MPS eng 3 P act. A cmd = TBD	V58K1364C
			MPS eng 1 P act. position = TBD	V58H1100A
			MPS eng 2 P act. position = TBD	V58H1200A
			MPS eng 3 P act. position = TBD	V58H1300A
		o PIC voltage discharge (sep bolts and BSM)	LH fwd thr pin PIC cap A volt $\leq$ 1.5 V	B55V1605C
			LH fwd thr pin PIC cap B volt $\leq$ 1.5 V	B55V1606C
			LH aft upr brct PIC cap A volt $\leq$ 1.5 V	B55V1607C
			LH aft upr brct PIC cap B volt $\leq$ 1.5 V	B55V1608C
			LH aft mid brct PIC cap A volt $\leq$ 1.5 V	B55V1609C
			LH aft mid brct PIC cap B volt $\leq$ 1.5 V	B55V1610C
			LH aft lwr brct PIC cap A volt $\leq$ 1.5 V	B55V1611C
			LH aft lwr brct PIC cap B volt $\leq$ 1.5 V	B55V1612C
			LH fwd sep motor PIC cap A volt $\leq$ 1.5 V	B55V1613C
			LH fwd sep motor PIC cap B volt $\leq$ 1.5 V	B55V1614C
			LH-aft sep motor PIC cap A volt $\leq$ 1.5 V	B55V1615C
			LH aft sep motor PIC cap B volt $\leq$ 1.5 V	B55V1616C
			RH fwd thr pin PIC cap a volt $\leq$ 1.5 V	B55V2605C
			RH fwd thr pin PIC cap B volt $\leq$ 1.5 V	B55V2606C
			RH aft upr brct PIC cap A volt $\leq$ 1.5 V	B55V2607C

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
			RH aft upr brct PIC cap B volt ≤ 1.5 V	B55V2608C
			RH aft mid brct PIC cap A volt ≤ 1.5 V	B55V2609C
			RH aft mid brct PIC cap B volt ≤ 1.5 V	B55V2610C
			RH aft lwr brct PIC cap A volt ≤ 1.5 V	B55V2611C
			RH aft lwr brct PIC cap B volt ≤ 1.5 V	B55V2612C
			RH fwd sep motor PIC cap A volt ≤ 1.5 V	B55V2613C
			RH fwd sep motor PIC cap B volt ≤ 1.5 V	B55V2614C
			RH aft sep motor PIC cap A volt ≤ 1.5 V	B55V2615C
			RH aft sep motor PIC cap B volt ≤ 1.5 V	B55V2616C
		o Separation indication	LH voltage oper bus A = 0 volt	B76V1600C
			LH voltage oper bus B = 0 volt	B76V1601C
			RH voltage oper bus A = 0 volt	B76V2600C
			RH voltage oper bus B = 0 volt	B76V2601C
		Verify SRB sep sequence completion (At SRB separation cmd + 4.0 sec)		
		o Sep cmd flag off	SRB sep cmd flag = 0	V90X8331X
		o SRB pwr off (buses A and B)	Special Requirement (Note 5)*	
		o SRB pwr off, Bus C	Special Requirement (Note 6)*	
	---	o ET/orbiter sep camera off	TBD	
		o MEC 1 and 2 reset	TBD	
		o MEC Outputs are Zero	Special Requirement (Note 7)*	

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		Verify guidance initiate (Event 29) (SRB sep cmd + 4 sec and guidance ready)		
		o Guidance/FCS functions	Stage 2 steer mode flag = 1	V90X1757X
			Guidance ready flag = 1	V90X1965X
			Freeze desired body CMD flag = 0	V90X1714X
			SRB sep subphase flag = 0	V90X1761X
			STG 1 Guidance Discrete = 0	V90X1713X
			Initiate Stage 2 Guidance = 1	V90X8630X
			PEG Convergence Discrete = 1	V90X1971X

NOTE #1 SRB P_c Measurement Accuracy

Requirement

At a SRB chamber pressure of 50 ± 20 psia, measure the difference between each simulated SRB P_c transducer pressure provided by the MMES and the corresponding SRB chamber pressure output from the MDMs. Perform test at least three times.

Pass/Fail Criteria

Pressure difference $\leq$ 10 psi

Downlist Requirement

B47P1300C	LH Press A SRM Chamber
B47P1301C	LH Press B SRM Chamber
B47B1302C	LH Press C SRM Chamber
B47B2300C	RH Press A SRM Chamber
B47B2301C	RH Press B SRM Chamber
B47B2302C	RH Press C SRM Chamber

NOTE #2 Attach & BSM PIC Discharge/SEP CMD Time Difference

Requirement

Measure the time difference between the first MEC SEP CMD (Fire 2) crossing the ORB/SRB interface and the discharge of the A&B PIC's to the four attachment NSI simulators and the two BSM ignition system NSI simulators per SRB. Perform test at least three times.

Pass/Fail Criteria

The time difference between the separation command crossing the Orb/SRB interface and the discharge of any PIC shall be $\leq$ 20 milliseconds.

Downlist/Downlink Requirement

None

Special instrumentation is required.

NOTE #3 Verify proper deadface of the ATVC SRB 26 VAC power

Requirement

- Monitor TVC Rock Tilt Secondary ΔP excitation voltage.
- Requires a breakout box installed at the ORB/ET umbilical plate interface to monitor each individual excitation line on AC meter, etc.

Pass/Fail Criteria

LH TVC A Rock/Tilt Sec Δ - P Excit = 0
LH TVC B Rock/Tilt Sec Δ - P Excit = 0
LH TVC C Rock/Tilt Sec Δ - P Excit = 0
LH TVC D Rock/Tilt Sec Δ - P Excit = 0
RH TVC A Rock/Tilt Sec Δ - P Excit = 0
RH TVC B Rock/Tilt Sec Δ - P Excit = 0
RH TVC C Rock/Tilt Sec Δ - P Excit = 0
RH TVC D Rock/Tilt Sec Δ - P Excit = 0

Downlist/Downlink Requirement

None

NOTE #4 Verify proper deadface of the ATVC SRB IVD power off.

Requirement

- Monitor TVC Rock/Tilt Servo Bypass Commands
- Requires a breakout box installed at the ORB/ET umbilical plate interface to monitor each individual command on DC meter, etc.

Pass/Fail Criteria

B58K3521E LH TVC TILT SERVO A BYPASS CMD = 0
B58K3522E LH TVC TILT SERVO B BYPASS CMD = 0
B58K3523E LH TVC TILT SERVO C BYPASS CMD = 0
B58K3524E LH TVC TILT SERVO D BYPASS CMD = 0
B58K3525E LH TVC ROCK SERVO A BYPASS CMD = 0
B58K3526E LH TVC ROCK SERVO B BYPASS CMD = 0
B58K3527E LH TVC ROCK SERVO C BYPASS CMD = 0
B58K3528E LH TVC ROCK SERVO D BYPASS CMD = 0
B58K4521E RH TVC TILT SERVO A BYPASS CMD = 0
B58K4522E RH TVC TILT SERVO B BYPASS CMD = 0
B58K4523E RH TVC TILT SERVO C BYPASS CMD = 0
B58K4524E RH TVC TILT SERVO D BYPASS CMD = 0
B58K4525E RH TVC ROCK SERVO A BYPASS CMD = 0
B58K4526E RH TVC ROCK SERVO B BYPASS CMD = 0
B58K4527E RH TVC ROCK SERVO C BYPASS CMD = 0
B58K4528E RH TVC ROCK SERVO D BYPASS CMD = 0

Downlist/Downlink Requirement

None

NOTE #5 Verify proper deadface of SRB power Buses A & B

Requirement

- Monitor SRB power buses A & B for L&R SRB's
- Requires a breakout box installed at the ORB/ET umbilical plate interface to monitor each power line with DC meter, etc.

Pass/Fail Criteria

LH Operational Bus A Voltage = 0
LH Operational Bus B Voltage = 0
RH Operational Bus A Voltage = 0
RH Operational Bus B Voltage = 0

Downlist/Downlink Requirement

None

NOTE #6 Verify proper deadface of SRB Bus C

Requirement

- Monitor SRB Bus C for L&R SRB's
- Requires a breakout box installed at the ORB/ET umbilical plate interface to monitor each power line with DC meter, etc.

Pass/Fail Criteria

LH SRB OI C Bus Power = 0
RH SRB OI C Bus Power = 0

Downlist/Downlink Requirements

None

NOTE #7 Verify proper deadfacing of MEC outputs.

Requirements

- o Monitor Arm, Fire, and RSS Commands to L&R SRB's
- o Requires a breakout box installed at Orbiter/ET umbilical plate interface to monitor each output with DC meter, etc.

Pass/Fail Criteria

B55K3506E	LH SEPN PIC A ARM CMD = 0
B55K3509E	LH SEPN PIC B ARM CMD = 0
B55K4506E	RH SEPN PIC A ARM CMD = 0
B55K4509E	RH SEPN PIC B ARM CMD = 0
B55K3507E	LH SEPN PIC A FIRE 1 CMD = 0
B55K3508E	LH SEPN PIC A FIRE 2 CMD = 0
B55K3510E	LH SEPN PIC B FIRE 1/RCVY PWR ON = 0
B55K3511E	LH SPEN PIC B FIRE 2/RCVY ARM CMD = 0
B55K4507E	RH SEPN PIC A FIRE 1 CMD = 0
B55K4508E	RH SEPN PIC A FIRE 2 CMD = 0
B55K4510E	RH SEPN PIC B FIRE 1/RCVY PWR ON = 0
B55K4511E	RH SEPN PIC B FIRE 2/RCVY ARM CMD = 0
B55K3517E	LH RSS S&A SAFE CMD 1 = 0
B55K3518E	LH RSS S&A SAFE CMD 2 = 0
B55K3515E	LH SRB RSS POWER A OFF CMD = 0
B55K3516E	LH SRB RSS POWER B OFF CMD = 0
B55K4517E	RH RSS S&A SAFE CMD 1 = 0
B55K4518E	RH RSS S&A SAFE CMD 2 = 0
B55K4515E	RH SRB RSS POWER A OFF CMD = 0
B55K4516E	RH SRB RSS POWER B OFF CMD = 0

Downlist/Downlink Requirements

None

TABLE 6.6-3 SECOND STAGE ASCENT VERIFICATION REQUIREMENTS
(SOFTWARE/HARDWARE INTERFACE)

TBS

TABLE 6.6-4 ET SEPARATION VERIFICATION REQUIREMENTS
(SOFTWARE/HARDWARE INTERFACE)

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
103	Verify Nom Orbiter/ ET Separation	Verify ET sep (Event 33)		
		o Major mode code o CRT display	MM=103 "Ascent Traj 2"	V90Q8001C
		o MECO status	MECO confirmed flag = 1	V90X8561X
		o Initiate ET sep seq	TBD	
		o Initiate MEC SOP	TBD	
		o ET sep PIC voltage	MEC 1 PIC 1 cap volt < 1.5 V	V76M7061B
			MEC 1 PIC 2 cap volt < 1.5 V	62B
			MEC 1 PIC 3 cap volt < 1.5 V	65B
			MEC 1 PIC 4 cap volt < 1.5 V	66B
			MEC 1 PIC 5 cap volt < 1.5 V	69B
			MEC 1 PIC 6 cap volt < 1.5 V	70B
			MEC 1 PIC 7 cap volt < 1.5 V	73B
			MEC 1 PIC 8 cap volt < 1.5 V	74B
			MEC 1 PIC 9 cap volt < 1.5 V	77B
			MEC 2 PIC 1 cap volt < 1.5 V	V76M7161B
			MEC 2 PIC 2 cap volt < 1.5 V	62B
			MEC 2 PIC 3 cap volt < 1.5 V	65B
			MEC 2 PIC 4 cap volt < 1.5 V	66B
			MEC 2 PIC 5 cap volt < 1.5 V	69B
			MEC 2 PIC 6 cap volt < 1.5 V	70B
			MEC 2 PIC 7 cap volt < 1.5 V	73B
			MEC 2 PIC 8 cap volt < 1.5 V	74B
			MEC 2 PIC 9 cap volt < 1.5 V	77B
		o Manual sep switches/cmds	ET sep auto cmd = 1	V98X0747X V90X7554X V98X0748X
			ET sep manual enable = 0	V90X7556X V98X0749X
			ET sep initiate = 0	V90X7564X
		o Terminate feed-line relief shut-off valve close cmds	MPS LH_2 feed-line relief shutoff valve close cmd = 0	V41S1447E
			MPS LH_2 feed-line relief shutoff valve closed = 0	V41X1442E

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
			MPS LH_2 feed-line relief shutoff Valve closed = 0	V41X1442E
			MPS LO_2 feed-line relief shutoff valve closed = 0	V41S1547E
			MPS LO_2 feed-line relief shutoff valve closed = 0	V41X1542E
		o Terminate ET umb doors centerline latch lock cmd	ET umb door centerline latch 1 locked indicator 1 = 0	V56X1255X
			ET umb door centerline latch 1 locked indicator 2 = 0	V56X1265X
			ET umb door centerline latch 2 locked indicator 1 = 0	V56X1355X
			ET umb door centerline latch 2 locked indicator 2 = 0	V56X1365X
			All prevalves cmd. close ind	V90X8568X
		o ET umb Dr. Cl Latch Stow Cmd	ET Umb Dr.CL Latch 1 Stow Ind 1 = 1	V56X1205X
			ET Umb Dr.CL Latch 1 Stow Ind 2 = 1	V56X1215X
			ET Umb Dr.CL Latch 2 Stow Ind 1 = 1	V56X1305X
			ET Umb Dr.CL Latch 2 Stow Ind 2 = 1	V56X1315X
		o All pre-valves cmd closed	MPS E-1 LH_2 prevalve close cmd = 1	V41S1122E
			MPS E-1 LO_2 prevalve close cmd = 1	V41S1139E
			MPS E-2 LH_2 prevalve close cmd = 1	V41S1222E
			MPS E-2 LO_2 prevalve close cmd = 1	V41S1239E
			MPS E-3 LH_2 prevalve close cmd = 1	V41S1277E
			MPS E-3 LO_2 prevalve close cmd = 1	V41S1339E
		o ET tumble sys arm	ET tumble sys arm flag = 1	V98X0750X
		o ET tumble sys fire	ET tumble sys fire flag = 1	V98X0751X
		o ET/orbiter camera on	ET/orbiter sep camera on cmd = 1	V56K9000X
		o Terminate feed-line disconnect valve cmd open	MPS LH_2 feedline disc valve open = 0	V41X1428X
			MPS LO_2 feedline disc valve open = 0	V41X1429X

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		o Feedline disc valve cmd close	MPS LH_2 feedline disc valve close A = 1	V41X1430X
			MPS LH_2 feedline disc valve close B = 1	V41X1434X
			MPS LO_2 feedline disc valve close A = 1	V41X1530X
			MPS LO_2 feedline disc valve close B = 1	V41X1534X
		o Set MPS dump gimbal	MPS dump gimbal pos flag = 1	
		o Arm ET/Umb unlatch PIC's	ET/umb unlatch PIC's arm flag = 1	V70X8247X
			MEC 1 PIC 1 cap volt $\geq$ 35.7 V	V76M7061B
			MEC 1 PIC 2 cap volt $\geq$ 35.7 V	62B
			MEC 1 PIC 3 cap volt $\geq$ 35.7 V	65B
			MEC 1 PIC 4 cap volt $\geq$ 35.7 V	66B
			MEC 1 PIC 5 cap volt $\geq$ 35.7 V	69B
			MEC 1 PIC 6 cap volt $\geq$ 35.7 V	70B
			MEC 2 PIC 1 cap volt $\geq$ 35.7 V	V76M7161B
			MEC 2 PIC 2 cap volt $\geq$ 35.7 V	62B
			MEC 2 PIC 3 cap volt $\geq$ 35.7 V	65B
			MEC 2 PIC 4 cap volt $\geq$ 35.7 V	66B
			MEC 2 PIC 5 cap volt $\geq$ 35.7 V	69B
			MEC 2 PIC 6 cap volt $\geq$ 35.7 V	70B
		o Reset ET tumble sys flags	ET tumble sys arm flag = 0	V98X0750X
			ET tumble sys fire flag = 0	V98X0751X
		o Terminate MPS cond pwr cmd	MPS sig cond pwr on cmd = 0	
		o Reset ET DFI pwr on cmd	ET DFI pwr on cmd = 0	
		o Reset ET/umb unlatch arm	ET/umb unlatch arm flag set = 0	V90X8247X
		o ET/umb unlatch fire	ET/umb unlatch fire flag = 1	V98X0755X
			MEC 1 PIC 1 cap volt $<$ 1.5 V	V76M7061B
			MEC 1 PIC 2 cap volt $<$ 1.5 V	62B
			MEC 1 PIC 3 cap volt $<$ 1.5 V	65B
			MEC 1 PIC 4 cap volt $<$ 1.5 V	66B

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
			MEC 1 PIC 5 cap volt < 1.5 V	69B
			MEC 1 PIC 6 cap volt < 1.5 V	70B
			MEC 2 PIC 1 cap volt < 1.5 V	V76M7161B
			MEC 2 PIC 2 cap volt < 1.5 V	62B
			MEC 2 PIC 3 cap volt < 1.5 V	65B
			MEC 2 PIC 4 cap volt < 1.5 V	66B
			MEC 2 PIC 5 cap volt < 1.5 V	69B
			MEC 2 PIC 6 cap volt < 1.5 V	70B
		o ET/umb retract fire	ET/umb retract fire flag = 1	V98X0756X
		o MEC crit cmd set	MEC crit cmd flags = 0	
		o Status inhibit alert	ET auto sep inhibit crew alert reset = 0	V90X8259X
		Verify ET Sep (Event 33B)		
		O Terminate ascent DAP	TBD	
		o Terminate G&C steer	TBD	
		VERIFY ET Sep (Event 33C)		
		O Initiate trans DAP	TBD	
		o Initiate RCS cmd SOP	TBD	
		o Attitude cmd (snapshot)	LH ADI roll rate	V72R0916C
			LH ADI pitch rate	V72R0917C
			LH ADI yaw rate	V72R0918C
			LH ADI roll attitude error	V72H0925C
			LH ADI pitch attitude error	V72H0927C
			LH ADI yaw attitude error	V72H0929C
		Verify ET Sep (Event 34)		

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		o ET/orbiter struct PIC's arm	ET/orbiter struct sep arm flag = 1	V98X0752X
			MEC 1 PIC 7 cap volt ≥ 35.7 V	V76M7073B
			MEC 1 PIC 8 cap volt ≥ 35.7 V	V76M7074B
			MEC 1 PIC 9 cap volt ≥ 35.7 V	V76M7077B
			MEC 2 PIC 7 cap volt ≥ 35.7 V	V76M7173B
			MEC 2 PIC 8 cap volt ≥ 35.7 V	V76M7174B
			MEC 2 PIC 9 cap volt ≥ 35.7 V	V76M7178B
		o Status inhibit crew alert	ET auto sep inhibit crew alert = 0	V90X8259X
			Select RGA roll rate < 0.3 °/s	V90R5301C
			Select RGA pitch rate < 0.3 °/s	V90R5321C
			Select RGA yaw rate < 0.3 °/s	V90R5341C
			MPS LH_2 feedline disc valve close A = 1	V41X1430X
			MPS LH_2 feedline disc valve close B = 1	V41X1434X
			MPS LO_2 feedline disc valve close A = 1	V41X1530X
			MPS LH_2 feedline disc valve close B = 1	V41X1534X
		o Status sep switch	ET sep manual enable = 0	V90X7556X
			ET sep initiate = 0	V90X7564X
		o If inhib occurs Term ET/Orb Sep Camera on cmd	If inhibit occurs - ET/orb Sep Camera On = 0	V56K9000X
		o Set RCS inhibit	ET sep. RCS inhibit flag = 1	V90X8260X
		o ET/orbiter struct sep fire 1&2	ET/orbiter struct sep fire = 1	V98X0753X
			MEC 1 PIC 7 cap volt < 1.5 V	V76M7073B
			MEC 1 PIC 8 cap volt < 1.5 V	V76M7074B
			MEC 1 PIC 9 cap volt < 1.5 V	V76M7077B
			MEC 2 PIC 7 cap volt < 1.5 V	V76M7173B
			MEC 2 PIC 8 cap volt < 1.5 V	V76M7174B
			MEC 2 PIC 9 cap volt < 1.5 V	V76M7177B
		o Reset ET/Orb Sep Com Cmd (if inhib has occurred)	ET/Orb Sep camera on = 1	V56K9000X

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		o Attitude cmd (snapshot)	LH ADI roll rate	V72R0916C
			LH ADI pitch rate	V72R0917C
			LH ADI yaw rate	V72R0918C
			LH ADI roll attitude error	V72H0925C
			LH ADI pitch attitude error	V72H0927C
			LH ADI yaw attitude error	V72H0929C
		o ET sep cmd set	ET sep cmd flag = 1	V90X8250X V98X0754X
		o Enable RCS jets (Initiate -Z trans)	ET sep RCS inhibit flag = 0	V90X8260X
			RJDF 1 jet F1D cmd A = 1	V79K2404X
			RJDF 1 jet F2D cmd A = 1	V79K2408X
			RJDF 2 jet F3D cmd A = 1	V79K2412X
			RJDF 2 jet, F4D cmd A = 1	V79K2414X
			RJDF 1 jet L2D cmd A = 1	V79K2422X
			RJDA 2 jet L3D cmd A = 1	V79K2425X
			RJDA 2 jet L4D cmd A = 1	V79K2428X
			RJDA 1 jet R2D cmd A = 1	V79K2436X
			RJDA 2 jet R3D cmd A = 1	V79K2439X
			RJDA 2 jet R4D cmd A = 1	V79K2442X
			RJDF 1 Jet F1L cmd A = 1	V79K2402X
			RJDF 1 Jet F1U cmd A = 1	03X
			RJDF 1 Jet F2R cmd A = 1	06X
			RJDF 1 Jet F2U cmd A = 1	07X
			RJDF 2 Jet F3L cmd A = 1	10X
			RJDF 2 Jet F3U cmd A = 1	11X
			RJDF 2 Jet F4R cmd A = 1	13X
			RJDA 1 Jet L1L cmd A = 1	18X
			RJDA 1 Jet L1U cmd A = 1	19X
			RJDA 1 Jet L2L cmd A = 1	20X
			RJDA 1 Jet L2U cmd A = 1	21X
			RJDA 2 Jet L3L cmd A = 1	24X
			RJDA 2 Jet L4L cmd A = 1	26X
			RJDA 2 Jet L4U cmd A = 1	27X
			RJDA 1 Jet R1R cmd A = 1	32X
			RJDA 1 Jet R1U cmd A = 1	33X
			RJDA 1 Jet R2U cmd A = 1	35X
			RJDA 2 Jet R3R cmd A = 1	38X
			RJDA 2 Jet R4R cmd A = 1	40X
			RJDA 2 Jet R4U cmd A = 1	41X

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
		o Terminate feed-line disc valve close cmd	MPS LH_2 feedline disc valve close A = 0	V41X1430X
			MPS LH_2 feedline disc valve close B = 0	V41X1434X
			MPS LO_2 feedline disc valve close A = 0	V41X1530X
			MPS LO_2 feedline disc valve close B = 0	V41X1534X
		o Terminate MEC critical cmd	MEC crit cmd flag = 0	
		o Set MEC 1 & 2 master reset	MEC master reset flag = 0	V90X8258X
		o Terminate ET sep seq	TBD	
		o Terminate MEC SOP	TBD	
		Verify Major Modes Transition (Event 36)		
		o Major mode code	MMC 4	V90Q8001C

TABLE 6.6-5 ORBITAL INSERTION VERIFICATION REQUIREMENTS (SOFTWARE/HARDWARE INTERFACE).

TBS

TABLE 6.6-6 ABORT-ONCE-AROUND VERIFICATION REQUIREMENTS (SOFTWARE/HARDWARE INTERFACE)

TBS

TABLE 6.6-7 ABORT TO ORBIT VERIFICATION REQUIREMENTS
(SOFTWARE/HARDWARE INTERFACE)

TBS

TABLE 6.6-8 RTLS VERIFICATION REQUIREMENTS
(SOFTWARE/HARDWARE INTERFACE)

TBS

TABLE 6.6-9 ASCENT MANEUVER DIP VERIFICATION REQUIREMENTS (SOFTWARE/HARDWARE INTERFACE)

TBS

TABLE 6.6-10 GPC AND I/O ERROR LOG VERIFICATION REQUIREMENTS (SOFTWARE/HARDWARE INTERFACE)

Major Mode	Objective	Requirement	Pass/Fail Criteria	Downlist Requirement
All	Verify DPS hardware performance during GN&C system verification	GPC error log verification	Zero ("0") GPC errors determined from GPC error cumulative counters	GPC-1, V92Q6036C GPC-2, V92Q6046C GPC-3, V92Q6056C GPC-4, V92Q6066C GPC-5, V92Q6076C
		GPC I/O error log verification.	Zero ("0") I/O errors detected from GPC I/O error cumulative counter NOTE: Counter to be adjusted to account for hardware (BTU's and LRU's) powered off.	GPC-1, V92Q4770C GPC-2, V92Q4847C GPC-3, V92Q4920C GPC-4, V92Q5007C GPC-5, V92Q4998C
		GPC sum word fail votes (redundant set comparison verification).	Zero ("0") fail votes by any GPC in redundant set.	V91Q2030C through V91Q2049C V91Q20526 through V91Q2056C

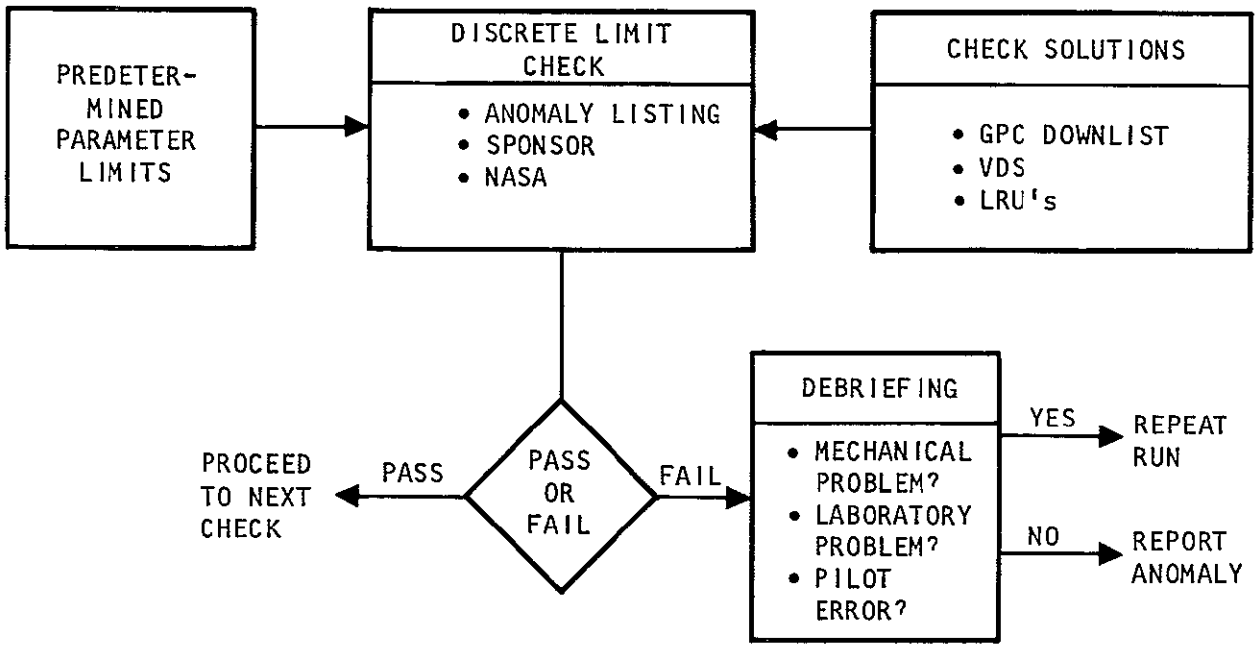


Figure 6.6-1 Discrete Limit Check Functional Flow Diagram

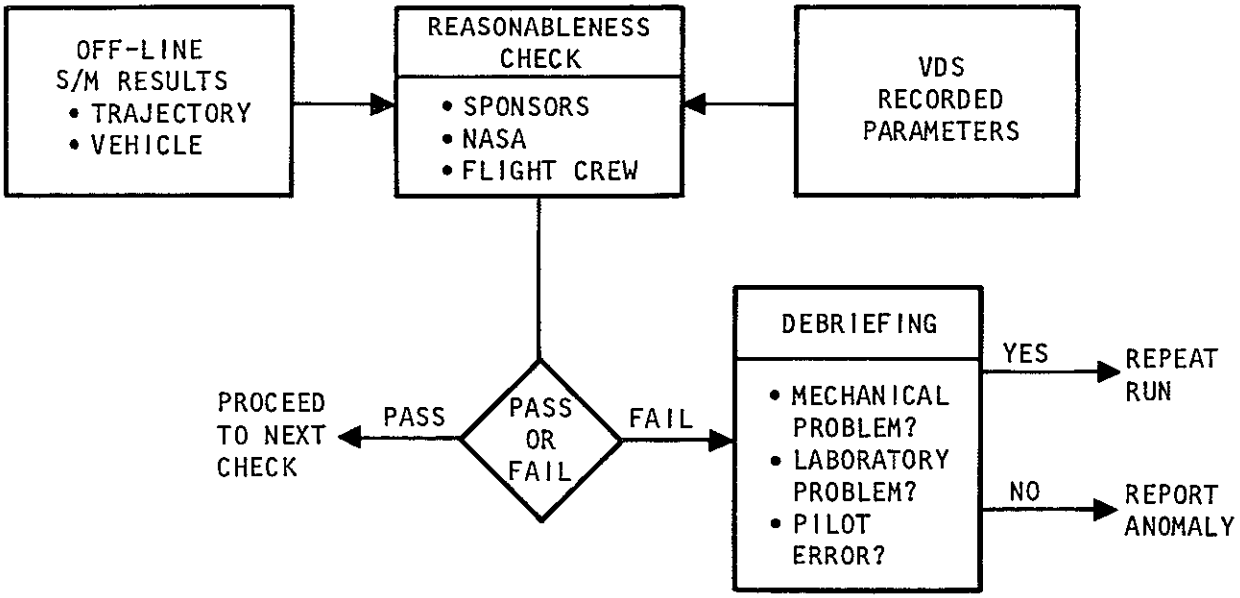


FIGURE 6.6-2 REASONABLENESS CHECK FUNCTIONAL FLOW DIAGRAM

7.0 TEST DATA REQUIREMENTS

The Pass/Fail Criteria presented in Section 6.6 specifies downlist parameters and MML numbers required to satisfy the pass/fail limits. In addition to the downlist parameters, VDS generated parameters are required to demonstrate compliance with the pass/fail constraints, reasonableness checks and post-test analyses.

Data reduction requirements in terms of downlist and VDS parameters with their associated identification numbers are listed in Table 7-1.

SAIL data acquisition will be categorized into quick look data and normal data processing. The quick look data will be used for 1 day reporting based on real time data to support rerun decisions and trouble-shooting. Quick look data will also support a 5 day report. Normal test data processing will be utilized for the Flight Readiness Review and the Test Agency Report.

Real time data processing will consist of analog strip charts, X-Y plots and the TOC application program. The analog strip charts will record VDS parameters, flight system parameters and external box parameters such as MMBS, SAAS, etc. X-Y plots will record $\bar{q}\alpha$ and $\bar{q}\beta$ versus Mach Number and ground tracking parameters. The TOC application program will contain 30 selected parameter discretes and variables from the pass/fail criteria. Capability will exist for end of run hard copies with a summary of minimum-maximum valves, flag of pass/fail violations and a summary of discretes and the corresponding GMT.

The quick look data processing will utilize the VDS printout which will read and store selected parameters at key points along the trajectory and will be printed out after each test. Pass/fail criteria data processed from the TOC application program will be processed on a 24 hour turnaround basis and will be included in the 5 day report. The Quick Look Station will have the capability to process TICM or CDT data and will be able to be utilized for troubleshooting on verification tests.

Normal test data processing will utilize CDT to provide continuous time history plots of VDS and flight system parameters. Multi-plot capability will exist for up to six data parameters as well as microfilm capability of selected parameters. The FR1400 Data Tape will supply a microfilm of all PCM flight system discretes and variables specified in the pass/fail criteria as well as continuous data on an as required basis. A 72 hour turnaround is scheduled.

Figure 7-1 shows the SAIL OFT configuration with its various data processing interfaces.

SAIL Data Processing Requirements along with the parameter characteristics such as scaling, units, time intervals and identification numbers are listed in Appendix C.

ASCENT FIRST STAGE GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFICAT.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER	PF*	SC	CR	XY	DP	SN
		TIME	TIME FROM SRB IGNITION						
		TME	MISSION ELAPSED TIME						
V95L0151C	REL-VEL-MAG		GROUND RELATIVE VELOCITY MAGNITUDE IN M50 SYSTEM						
V95H0185C V95H0186C V95H0187C	R-AVGG		CURRENT M50 POSITION VECTOR						
V95L0190C V95L0191C V95L0192C	V-AVGG		CURRENT M50 VELOCITY VECTOR						
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR						
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR						
	V-RHO-MAG	VRHOMG	MAG. OF REL. VELOCITY IN M50 FRAME						
	V-RHO		REL VELOCITY VECTOR IN M50 FRAME						
V95P3170C	Q-BAR-A		DERIVED ASCENT DYNAMIC PRESSURE						
V95H0175C		H	ALTITUDE, FISCHER ELLIPSOID						
		H	ALTITUDE, FISCHER ELLIPSOID						
		RAD	RADIAL DISTANCE FROM CENTER OF EARTH						
		VREL	RELATIVE VELOCITY						
		VREL	RELATIVE VELOCITY						
		GARD	RELATIVE FLIGHT PATH ANGLE						
		GARD	RELATIVE FLIGHT PATH ANGLE						
		PSRD	GROUND TRACK ANGLE FROM NORTH						
		LAD	EARTH LONGITUDE						
		LYD	EARTH LATITUDE						
V90H1044C	PHI	PHICMD	ROLL ATTITUDE COMMAND						
	THETC	THECMD	PITCH ATTITUDE COMMAND						
	PSI	PSICMD	YAW ATTITUDE COMMAND						
	Q-GCB-I	QGCBI	M50 INERTIAL-TO-COMMANDED BODY QUATERNION						
V90U1948C	K-CMD	THROC	SSME THROTTLE COMMAND						
		THROTL	SSME ACTUAL THROTTLE SETTING						

P/F = PASS/FAIL SC = STRIP CHART CR = CRT XY = XY PLOT DP = DIGITAL PRINTOUT
SN = SNAPSHOT

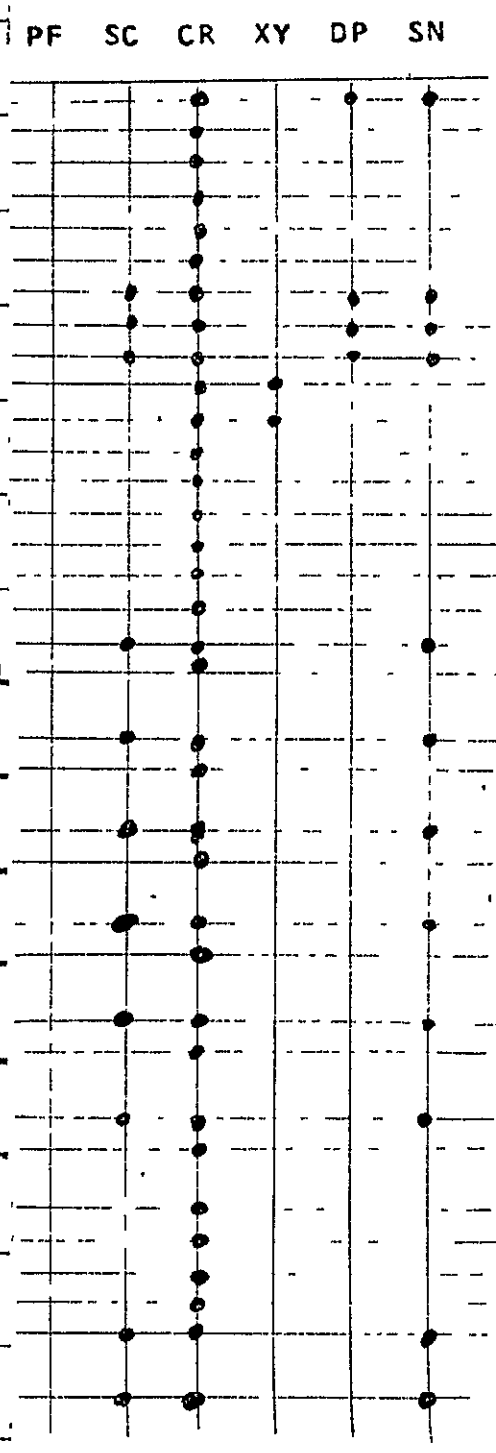
TABLE 7.0-1

				PF	SC	CR	XY	DP	SN
		IXX1	MOMENT OF INERTIA,BODY X-AXIS						
		IYY1	MOMENT OF INERTIA,BODY Y-AXIS						
		IZZ1	MOMENT OF INERTIA,BODY Z-AXIS						
		IXZ1	PRODUCT OF INERTIA,BODY X & Z AXES						
		XCG1	C.G. LOCATION,X-COMP.,ET AXES						
		XCG2	C.G. LOCATION,Y-COMP.,ET AXES						
		XCG3	C.G. LOCATION,Z-COMP.,ET AXES						
V90U1961C	M	MORBET	GUIDANCE ESTIMATED MASS, ORB.+ ET						
V94U3822C	M	MASS	ACTUAL MASS FROM SIMULATOR ENVIRON.						
		THRUS1	ATMOS. THRUST, ORBITER NO. 1						
		THRUS2	ATMOS. THRUST, ORBITER NO. 2						
		THRUS3	ATMOS. THRUST, ORBITER NO. 3						
		THRUS4	ATMOS. THRUST, SRB NO.4						
		THRUS5	ATMOS. THRUST, SRB NO.5						
		THR54	SRB MISMATCH, (THRUS5-THRUS4)						
		WEIGHT	TOTAL VEHICLE WEIGHT						
V90L1947C	V-ME-OUT	VMEOUT	AOA/ATO REFERENCE VELOCITY						
	L	LLL	PITCH/YAW POLYNOMIAL INDEX						
V90U1962C	N-SSME	NSSME	NO. OF ACTIVE SSME'S						
	V-IND	VIND	INDICATED RELATIVE VELOCITY						
V90H2202C	*	PHIO	ROLL ATTITUDE (EULER)						
V90H2217C	*	THETD	PITCH ATTITUDE (EULER)						
V90H2230C	*	PSID	YAW ATTITUDE (EULER)						
		XDR	X-COMP.,POSITION,DOWNRANGE FRAME						
		YLT	Y-COMP.,POSITION,DOWNRANGE FRAME						
		WAZ	WIND ANGLE FROM NORTH						
		WINDL	WIND VELOCITY						
V90L0847C		MACH	MACH NUMBER,NAV DERIVED						
		MACH	MACH NUMBER						
V95H3156C		ALD	ANGLE OF ATTACK						
		ALD	ANGLE OF ATTACK						
V90H2249C		BED	SIDESLIP ANGLE						
		BED	SIDESLIP ANGLE						
V95P3011C		QBR	DYNAMIC PRESSURE (GN&C)						
V95P3170C		QBR	DYNAMIC PRESSURE (NAV. DERIV.)						
		QBR	DYNAMIC PRESSURE						
		QALD	PROD.,DYN. PRESS. X ANGLE OF ATTACK						
		QBED	PROD.,DYN. PRESS. X SIDESLIP ANGLE						
		AX	ACCELERATION, X-COMP.,BODY AXES						
		AY	ACCELERATION, Y-COMP.,BODY AXES						
		AZ	ACCELERATION, Z-COMP.,BODY AXES						

				PF	SC	CR	XY	DP	SN
		NYA	LOAD FACTOR, Y-COMP.,BODY AXES						
		NZA	LOAD FACTOR, Z-COMP.,BODY AXES						
		NYREF	REFERENCE LATERAL ACCELERATION						
		NZREF	REFERENCE NORMAL ACCELERATION						
		NZERR	NORMAL ACCELERATION ERROR						
		NYERR	LATERAL ACCELERATION ERROR						
	PORB	PORB	ROLL RATE,ORBITER RATE GYROS						
	QORB	QORB	PITCH RATE,ORBITER RATE GYROS						
	RORB	RORB	YAW RATE,ORBITER RATE GYROS						
		QSRBLFT	PITCH RATE,LEFT SRB RATE GYROS						
		QSRBRGT	PITCH RATE,RIGHT SRB RATE GYROS						
		RSRBLFT	YAW RATE,LEFT SRB RATE GYROS						
		RSRBRGT	YAW RATE,RIGHT SRB RATE GYROS						
V95H3528C		PD	BODY RATE, X-AXIS						
		PD	BODY RATE, X-AXIS						
V95H3526C		QD	BODY RATE, Y-AXIS						
		QD	BODY RATE, Y-AXIS						
V95H3527C		RD	BODY RATE, Z-AXIS						
		RD	BODY RATE, Z-AXIS						
		DPD	ROTAT. ACCEL. ABOUT BODY X-AXIS						
		DQD	ROTAT. ACCEL. ABOUT BODY Y-AXIS						
		DRD	ROTAT. ACCEL. ABOUT BODY Z-AXIS						
		DLIBPC	ELEV. COMMAND,LEFT INBOARD						
		DLOBPC	ELEV. COMMAND,LEFT OUTBOARD						
		DRIBPC	ELEV. COMMAND,RIGHT INBOARD						
		DROBPC	ELEV. COMMAND,RIGHT OUTBOARD						
		ELV(1)	ELEV. DEFLECT.,LEFT INBOARD						
		ELV(2)	ELEV. DEFLECT.,RIGHT INBOARD						
		ELV(3)	ELEV. DEFLECT.,LEFT OUTBOARD						
		ELV(4)	ELEV. DEFLECT.,RIGHT OUTBOARD						
		DELVI	ELEV. RATE,LEFT INBOARD						
			ELEV. RATE,RIGHT INBOARD						
		DELVO	ELEV. RATE,LEFT OUTBOARD						
			ELEV. RATE,RIGHT OUTBOARD						
		ACTHM(1)	ELEV.ACT. HINGE MOM.,RIGHT OUTBOARD						
		ACTHM(2)	ELEV.ACT. HINGE MOM.,RIGHT INBOARD						
		ACTHM(3)	ELEV.ACT. HINGE MOM.,LEFT OUTBOARD						
		ACTHM(4)	ELEV.ACT. HINGE MOM.,LEFT INBOARD						
V95H3528C	WFBIFB	WFBIFB1	BODY ROLL RATE COMMAND						
V95H3526C		WFBIFB2	BODY PITCH RATE COMMAND						
V95H3527C		WFBIFB3	BODY YAW RATE COMMAND						
V95H3523C		EBFB1	BODY ATTITUDE ERROR,ROLL						
V95H3521C		EBFB2	BODY ATTITUDE ERROR,PITCH						

V95H3522C

	EBFB3	BODY ATTITUDE ERROR,YAW
	QFDBK	PITCH RATE FDBK ERROR
	RFDBK	YAW RATE FDBK ERROR
	DPTVC	ROLL TVC ERROR
	DQTVC	PITCH TVC ERROR
	DRTVC	YAW TVC ERROR
	DPTVCI	ROLL ATT ERROR INTEG
	DQTVCI	PITCH ATT ERROR INTEG
	DRTVCI	YAW ATT ERROR INTEG
	DQMPST	PITCH TVC TRIM,MPS
	DQSRBT	PITCH TVC TRIM,SRB
	DPORB	BODY ROLL ATTITUDE CMD, ORBITER
	DQORB	BODY PITCH ATTITUDE CMD, ORBITER
	DRORB	BODY YAW ATTITUDE CMD, ORBITER
	DPSRB	BODY ROLL ATTITUDE CMD, SRB
	DQSRB	BODY PITCH ATTITUDE CMD, SRB
	DRSRB	BODY YAW ATTITUDE CMD, SRB
	DEY(1)	ENGINE POSITION (PITCH), NO. 1 ENG.
DYC1	DYC1	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 1 ENGINE
	DEY(2)	ENGINE POSITION (PITCH), NO. 2 ENG.
DYC2	DYC2	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 2 ENGINE
	DEY(3)	ENGINE POSITION (PITCH), NO. 3 ENG.
DYC3	DYC3	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 3 ENGINE
	DEZ(1)	ENGINE POSITION (YAW), NO. 1 ENG.
DZC1	DZC1	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE
	DEZ(2)	ENGINE POSITION (YAW), NO. 2 ENG.
DZC2	DZC2	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE
	DEZ(3)	ENGINE POSITION (YAW), NO. 3 ENG.
DZC3	DZC3	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE
	DR4P	ROCK DEFLECTION CMD, SRB NO. 4
	DR5P	ROCK DEFLECTION CMD, SRB NO. 5
	DT4P	TILT DEFLECTION CMD, SRB NO. 4
	DT5P	TILT DEFLECTION CMD, SRB NO. 5
	DEY(4)	ENGINE POSITION (PITCH), NO. 4 ENG. GIMBAL AXES
	DEY(5)	ENGINE POSITION (PITCH), NO. 5 ENG. GIMBAL AXES



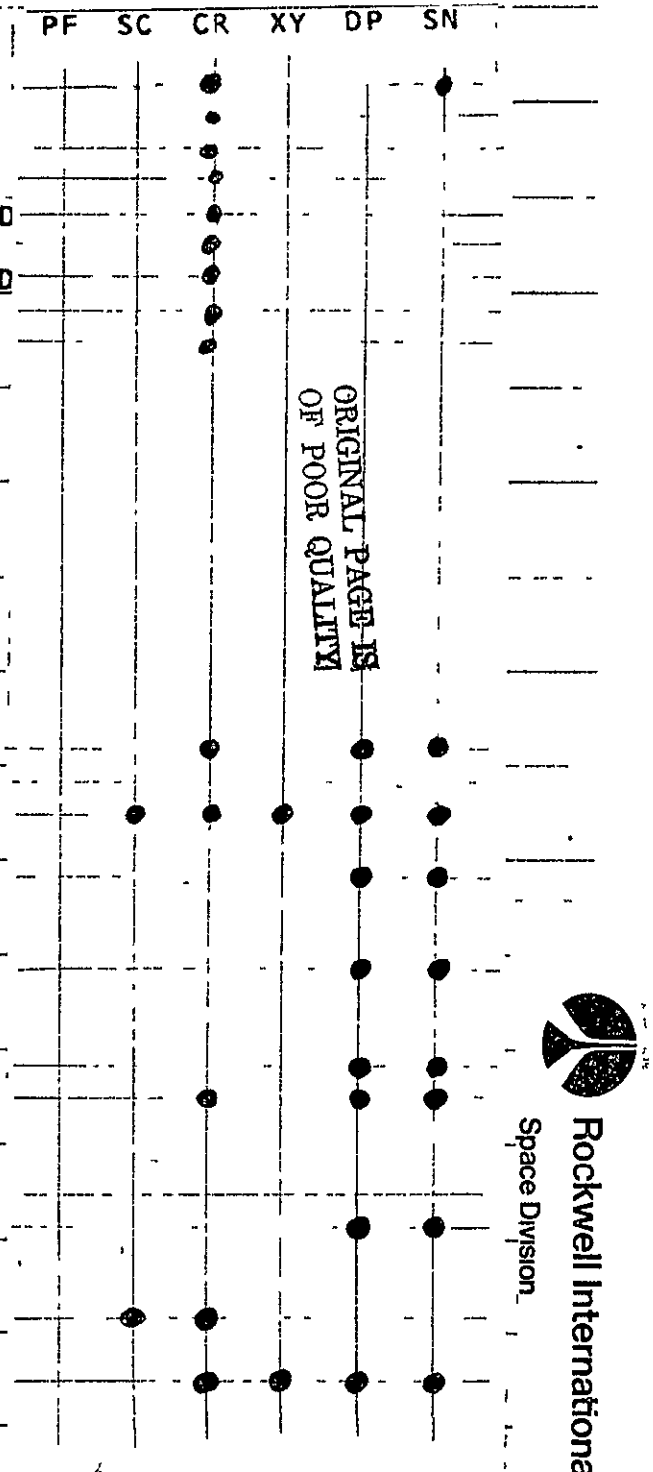
		PF	SC	CR	XY	DP	SN
DEZ(4)	ENGINE POSITION (YAW), NO. 4 ENG. GIMBAL AXES						
DEZ(5)	ENGINE POSITION (YAW), NO. 5 ENG. GIMBAL AXES						
DDEY(1)	ENGINE RATE (PITCH), NO.1 ENGINE						
DDEY(2)	ENGINE RATE (PITCH), NO.2 ENGINE						
DDEY(3)	ENGINE RATE (PITCH), NO.3 ENGINE						
DDEY(4)	ENGINE RATE (PITCH), NO.4 ENGINE GIMBAL AXES						
DDEY(5)	ENGINE RATE (PITCH), NO.5 ENGINE GIMBAL AXES						
DDEZ(1)	ENGINE RATE (YAW), NO.1 ENGINE						
DDEZ(2)	ENGINE RATE (YAW), NO.2 ENGINE						
DDEZ(3)	ENGINE RATE (YAW), NO.3 ENGINE						
DDEZ(4)	ENGINE RATE (YAW), NO.4 ENGINE GIMBAL AXES						
DDEZ(5)	ENGINE RATE (YAW), NO.5 ENGINE GIMBAL AXES						
FYSLSH	TOTAL SLOSH Y FORCE						
FZSLSH	TOTAL SLOSH Z FORCE						
LSLOSH	TOTAL SLOSH ROLLING MOMENT						
MSLOSH	TOTAL SLOSH PITCHING MOMENT						
NSLOSH	TOTAL SLOSH YAWING MOMENT						
ZTALH	LH2 DAMPING RATIO						
ZTALX	LOX DAMPING RATIO						
OMGALH	LH2 SLOSH FREQUENCY						
OMGALX	LOX SLOSH FREQUENCY						
SEOE1	MPS E1 FAIL FLAG						
SEOE2	MPS E2 FAIL FLAG						
SEOE3	MPS E3 FAIL FLAG						
	MAJOR MODE 102 FLAG						
S1G	STAGE 1 GUIDANCE DISCREET						
ATTCMD	STEERING MODE COMMAND						
FRZCMD	FREEZE DESIRED BODY CMD FLAG						
MNL-STG1	MANUAL MODE STAGE 1 FLAG						
SRB-SEP-CMD-FLAG	SRB SEPARATION CMD FLAG						
OPBSEP	SRB SEPARATION SUBPHASE FLAG						
	SSME FAILURE STATUS FLAG						
AFCS-FIRST-PASS	FIRST-TIME ASC-DAP SCHEDULE FLAG						
P-ORB	SELECTED RGA ROLL RATE						
Q-ORB	SELECTED RGA PITCH RATE						

	R-ORB	SELECTED RGA YAW RATE
	NY	SELECTED AA LATERAL ACCELERATION
	NZ	SELECTED AA NORMAL ACCELERATION
		SELECT. ELEV.FEEDBACK,LEFT INBOARD
		SELECT. ELEV.FEEDBACK,LEFT OUTBOARD
		SELECT. ELEV.FEEDBACK,RIGHT INBOARD
		SELECT. ELEV.FEEDBACK,RIGHT OUTBOARD
		SELECTED PRESS.,LEFT SRB CHAMBER
		SELECTED PRESS.,RIGHT SRB CHAMBER

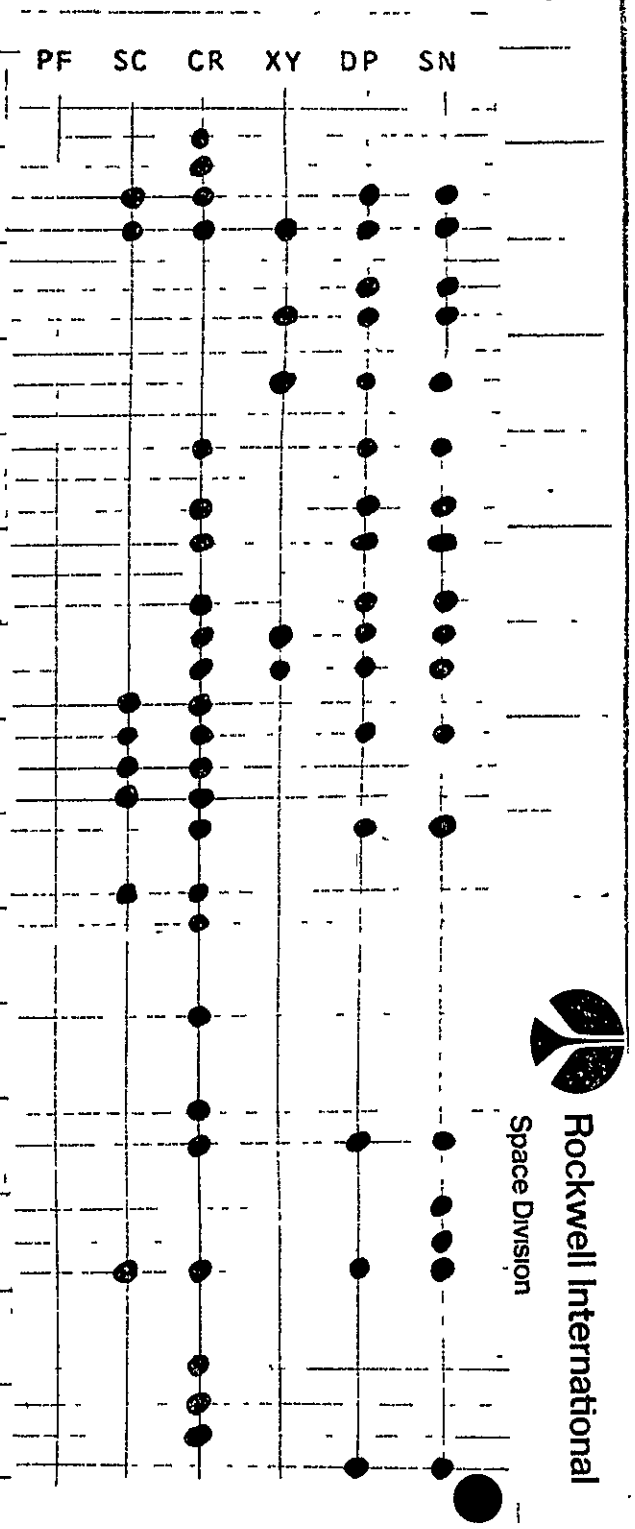
* PHI,THET, AND PSI ARE EULER HALF-ANGLES IN THE FSSR

ASCENT-SECOND STAGE GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFICAT.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER
		TME	TIME FROM SRB IGNITION MISSION ELAPSED TIME
V95L0151C	REL-VEL-MAG		GROUND RELATIVE VELOCITY MAGNITUDE IN M50 SYSTEM
V95H0185C V95H0186C V95H0187C	R-AVGG		CURRENT M50 POSITION VECTOR
V95L0190C V95L0191C V95L0192C	V-AVGG		CURRENT M50 VELOCITY VECTOR
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR
	V-RHO-MAG		MAG. OF REL. VELOCITY IN M50 FRAME
	V-RHO		REL VELOCITY VECTOR IN M50 FRAME
	V-CROSSRANGE		INERTIAL VELOCITY COMPONENT NORMAL TO NOMINAL ORBIT PLANE
	V-INERTIAL-MAG		INERTIAL VELOCITY MAGNITUDE, M50 SYSTEM



		WINDL	WIND SPEED
		WAZ	WIND DIRECTION FROM NORTH
		EVENT	EVENT COUNTER (28,29,30, ETC.)
V95H0175C		H	ALTITUDE,FISCHER ELLIPSOID
		H	ALTITUDE,FISCHER ELLIPSOID
		RAD	MAGNITUDE OF POSITION VECTOR
		VREL	EARTH RELATIVE VELOCITY
		VREL	EARTH RELATIVE VELOCITY
		VITOT	MAG. OF INERTIAL VELOCITY
		VITOT	MAG. OF INERTIAL VELOCITY
		GAMMAI	INERTIAL FLIGHT PATH ANGLE
		GAMMAI	INERTIAL FLIGHT PATH ANGLE
		AZMTHI	INERTIAL FLIGHT AZIMUTH FROM NORTH
		GARD	RELATIVE FLIGHT PATH ANGLE
		GARD	RELATIVE FLIGHT PATH ANGLE
		PSRD	HEADING OF REL VEL VECTOR WRT NORTH
		LYD	GEODETIC LATITUDE OF THE VEHICLE
		LAD	RELATIVE LONGITUDE OF VEHICLE
		DDRAD	RADIAL ACCELERATION,GEOCENTRIC
		DRAD	RADIAL VELOCITY,GEOCENTRIC
V90W1941C	TGO	XTGO	TIME-TO-GO TO MECO
V90U1966C	VGOMAG	VGOMAG	VELOCITY-TO-GO MAGNITUDE
		VELERR	MAG. OF VELOCITY VECTOR ERROR, ENVIRON. MINUS NAV. VALUE
	LAMDMAG	LAMDMG	THRUST TURNING RATE MAGNITUDE
V90U1954C	LAMC	LAMC	COMMANDED THRUST DIRECTION
V90U1955C			
V90U1956C			
V90U1957CA	LAMDC	LAMDC	COMMANDED THRUST TURNING RATE
V90U1958CA			VECTOR
V90U1959CA			
V90W1955C	TLAMC	TLAMC	TIME ASSOCIATED WITH LAMC
		POSERR	MAG. OF POSITION ERROR VECTOR, ENVIRON. MINUS NAV. VALUE
			TARGET POSITION ERROR MAGNITUDE
			TARGET VELOCITY ERROR MAGNITUDE
			THRUST POINTING ERROR VECTOR
	ATR	ATEST	THRUST ACCELERATION ESTIMATE
V90A1973C	AD		DESIRED VEHICLE ACCELERATION
	AT-AVE	ATS	MEASURED VEHICLE ACCELERATION
	S-GLIMIT		G-LIMITING DISCRETE



		THRUST(1)	THRUST OF SSME NO. 1
		THRUST(2)	THRUST OF SSME NO. 2
		THRUST(3)	THRUST OF SSME NO. 3
		TMPS	TOTAL THRUST, SSME ENGINES
		TOMS	TOTAL THRUST OF OMS ENGINES
		TRCS	THRUST OF TX RCS JET
			MPS USEABLE PROPELLANT REMAINING
			OMS USEABLE PROPELLANT REMAINING
			RCS USEABLE PROPELLANT REMAINING
		WEIGHT	TOTAL VEHICLE WEIGHT
V90U1948C	K-CMD	THROC	COMMANDED THROTTLE SETTING
V90J2091C	K		DESIRED THROTTLE SETTING
			MASS DIFFERENCE
V90A2211C			ACTUAL ACCELERATION FROM SIMULATOR ENVIRONMENT
		DRNG	DOWN RANGE,LAUNCH SITE TO VEHICLE
V90H2202C		PHIBD	ROLL ATTITUDE (EULER)
V90H2217C		THEBD	PITCH ATTITUDE (EULER)
V90H2230C		PSIBD	YAW ATTITUDE (EULER)
		EBDBI	BODY ATTITUDE ERROR VECTOR FOR DISPLAY
	WFBIFB	WFBFB1	BODY RATE COMMAND,ROLL
		WFBFB2	BODY RATE COMMAND,PITCH
		WFBFB3	BODY RATE COMMAND,YAW
V95H3528C		PD	ACTUAL BODY RATE, ROLL
		PD	ACTUAL BODY RATE, ROLL
	PORB	PORB	ROLL RATE,ORBITER RATE GYROS
V95H3527C		QD	ACTUAL BODY RATE, PITCH
		QD	ACTUAL BODY RATE, PITCH
	QORB	QORB	PITCH RATE,ORBITER RATE GYROS
V95H3526		RD	ACTUAL BODY RATE, YAW
		RD	ACTUAL BODY RATE, YAW
	RORB	RORB	YAW RATE,ORBITER RATE GYROS
		DPD	ROTAT. ACCEL. ABOUT BODY X-AXIS
		DQD	ROTAT. ACCEL. ABOUT BODY Y-AXIS
		DRD	ROTAT. ACCEL. ABOUT BODY Z-AXIS
V90L0847C		MACH	MACH NUMBER,NAV DERIVED
		MACH	MACH NUMBER
V95P3011C		QBR	DYNAMIC PRESSURE (GN&C)
V95P3170C		QBR	DYNAMIC PRESSURE (NAV. DERIV.)
		QBR	DYNAMIC PRESSURE
V95H3156C		ALD	ANGLE OF ATTACK

PF SC CR XY DP SN

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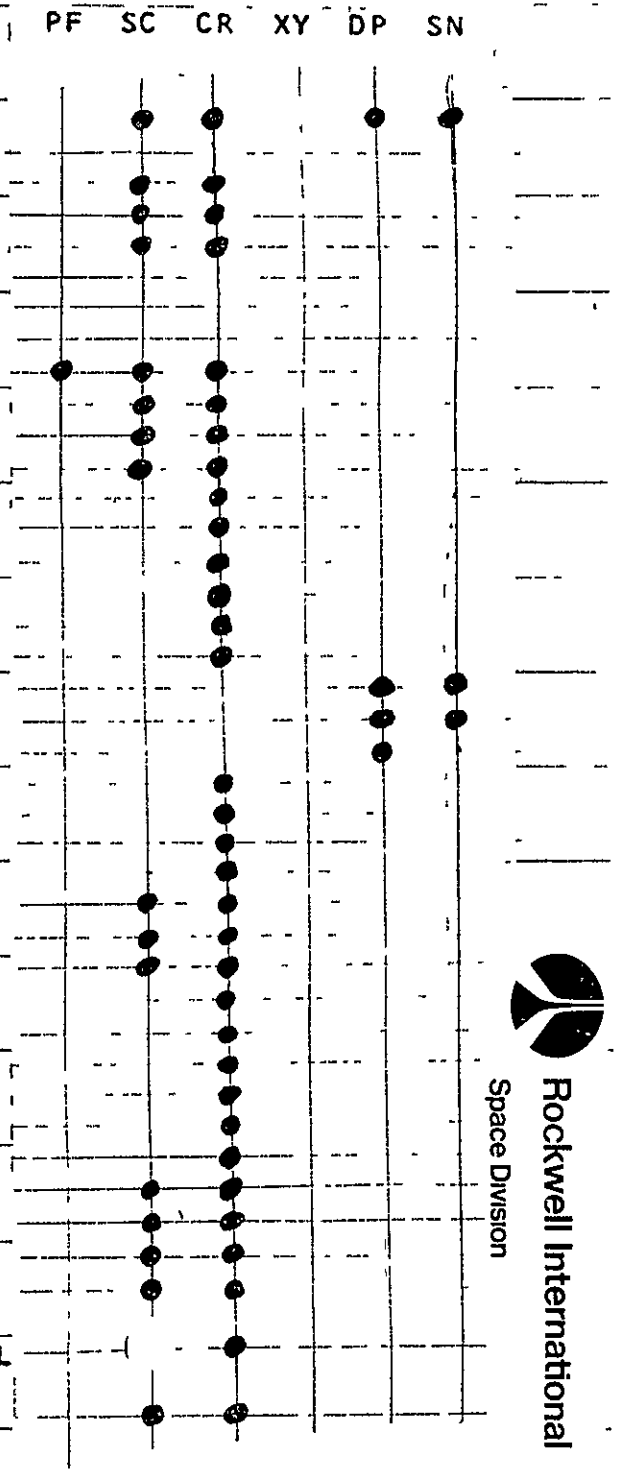
		ALD	ANGLE OF ATTACK
V90H2249C		BED	SIDESLIP ANGLE
		BED	SIDESLIP ANGLE
		AX	ACCELERATION,X-COMP.,BODY AXES
		AY	ACCELERATION,Y-COMP.,BODY AXES
		AZ	ACCELERATION,Z-COMP.,BODY AXES
		NXGS	LOAD FACTOR, X-COMP.,BODY AXES
		NYGS	LOAD FACTOR, Y-COMP.,BODY AXES
		NZGS	LOAD FACTOR, Z-COMP.,BODY AXES
		NTGS	TOTAL LOAD FACTOR
		LSTOT	TOTAL SLOSHING ROLL MOMENT
		MSTOT	TOTAL SLOSHING PITCH MOMENT
		NSTOT	TOTAL SLOSHING YAW MOMENT
		FYS	SLOSH FORCE,Y-COMP.,BODY AXES
		FZS	SLOSH FORCE,Z-COMP.,BODY AXES
		ZTALH	LH2 DAMPING RATIO
		ZTALX	LOX DAMPING RATIO
		OM1LH	LH2 SLOSH MASS NATURAL FREQUENCY
		OM1LOX	LOX SLOSH MASS NATURAL FREQUENCY
			GUIDANCE READY DISCRETE
V90L1947C	V-ME-OUT		AOA/ATO REFERENCE VELOCITY
	V-RTLS-FD		RTLS REFERENCE VELOCITY
		DPTVCI	ROLL TRIM INTEGRATOR
		DQTVCI	PITCH TRIM INTEGRATOR
		DRTVCI	YAW TRIM INTEGRATOR
		DMORBT	ORBITER PITCH TRIM
		DPTVC	ROLL GIMBAL ANGLE COMMAND
		DQTVC	PITCH GIMBAL ANGLE COMMAND
		DRTVC	YAW GIMBAL ANGLE COMMAND
		DDEY(1)	PITCH GIMBAL RATE, NO. 1 ENGINE
		DDEY(2)	PITCH GIMBAL RATE, NO. 2 ENGINE
		DDEY(3)	PITCH GIMBAL RATE, NO. 3 ENGINE
		DDEZ(1)	YAW GIMBAL RATE, NO. 1 ENGINE
		DDEZ(2)	YAW GIMBAL RATE, NO. 2 ENGINE
		DDEZ(3)	YAW GIMBAL RATE, NO. 3 ENGINE
V95H3523C	EBFB	EBFB1	BODY ATTITUDE ERROR,ROLL
V95H3521C		EBFB2	BODY ATTITUDE ERROR,PITCH
V95H3522C		EBFB3	BODY ATTITUDE ERROR,YAW
		DEYA(1)	PITCH GIMBAL ANGLE FROM NULL, NO. 1 ENGINE
	DYC1	DYC1	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 1 ENGINE
		DEYA(2)	PITCH GIMBAL ANGLE FROM NULL,



			PF	SC	CR	XY	DP	SN
		NO. 2 ENGINE						
DYC2	DYC2	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 2 ENGINE			●			
	DEYA(3)	PITCH GIMBAL ANGLE FROM NULL, NO. 3 ENGINE		●	●			
DYC3	DYC3	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 3 ENGINE			●			
	DEZA(1)	YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE		●	●			
DZC1	DZC1	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE			●			
	DEZA(2)	YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE		●	●			
DZC2	DZC2	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE			●			
	DEZA(3)	YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE		●	●			
DZC3	DZC3	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE			●			
	NYAWJA	NO. OF AFT YAW JETS FIRING			●			
	NYAWJF	NO. OF FWD YAW JETS FIRING			●			
	NZRAFT	NO. RT.AFT PLUS/MINUS Z JETS FIRING			●			
	NZLAFT	NO. LT.AFT PLUS/MINUS Z JETS FIRING			●			
	NXJETS	NO. OF PLUS XRCS JETS FIRING			●			
	NZFWD	NO. OF FWD PLUS/MINUS Z JETS FIRING			●			
		SRB SEPARATION COMMAND FLAG					●	●
		GUIDANCE READY FLAG					●	●
		MPS GUIDANCE CUTOFF TASK DISCRETE FLAG					●	●
		MECO COMMANDED FLAG					●	●
		MECO CONFIRMED FLAG					●	●
		AUTO SEP MNVR COMPLETE					●	●
		OPS 104 PRO FLAG					●	●
		BURN ENABLE					●	●
		OMS CUTOFF CONFIRMED					●	●
		OPS 105 PRO FLAG					●	●
		OPS 106 PRO FLAG					●	●
		RTLS ABORT REQUEST FLAG					●	●
		AOA ABORT REQUEST FLAG					●	●
		ATO ABORT REQUEST FLAG					●	●

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ORBITAL INSERTION GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFICAT.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER	PF	SC	CR	XY	DP	SN
			TIME FROM SRB IGNITION			●			
			MISSION ELAPSED TIME						
V95L0151C	REL-VEL-MAG		GROUND RELATIVE VELOCITY MAGNITUDE IN M50 SYSTEM		●	●	●	●	●
V95H0185C	R-AVGG		CURRENT M50 POSITION VECTOR					●	●
V95H0186C									
V95H0187C									
V95L0190C	V-AVGG		CURRENT M50 VELOCITY VECTOR					●	●
V95L0191C									
V95L0192C									
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR					●	●
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR			●		●	●
	V-RHO-MAG		MAG. OF REL. VELOCITY IN M50 FRAME					●	
	V-RHO		REL VELOCITY VECTOR IN M50 FRAME					●	
V95H0175C		H	ALTITUDE,FISCHER ELLIPSOID		●	●	●	●	●
		H	ALTITUDE,FISCHER ELLIPSOID						
		RAD	MAGNITUDE OF POSITION VECTOR					●	●
		VREL	EARTH RELATIVE VELOCITY			●	●	●	●
		VREL	EARTH RELATIVE VELOCITY						
		VITOT	MAG. OF INERTIAL VELOCITY			●	●	●	●
		VITOT	MAG. OF INERTIAL VELOCITY						
		GARD	RELATIVE FLIGHT PATH ANGLE			●		●	●
		GARD	RELATIVE FLIGHT PATH ANGLE						
		GAMMAI	INERTIAL FLIGHT PATH ANGLE			●		●	●
		GAMMAI	INERTIAL FLIGHT PATH ANGLE						
		AZMTHI	INERTIAL FLIGHT AZIMUTH FROM NORTH			●		●	●
		PSRD	HEADING OF REL VEL VECTOR WRT NORTH			●		●	●
		LYD	GEODETIC LATITUDE OF THE VEHICLE				●	●	●
		LAD	RELATIVE LONGITUDE OF VEHICLE				●	●	●
		DRNG	DOWN RANGE,LAUNCH SITE TO VEHICLE			●		●	●
		DDRAD	RADIAL ACCELERATION,GEOCENTRIC		●	●			
		DRAD	RADIAL VELOCITY,GEOCENTRIC		●	●		●	●

				PF	SC	CR	XY	DP	SN
V90W1941C	TGO	XTGO	TIME-TO-GO						
V90U1966C		VGOMAG	MAGNITUDE OF VGO						
			INITIAL MINUS CURRENT PREDICTED CUTOFF TIME						
V90U1954C	LAMC	LAMC	DESIRED THRUST VECTOR						
V90U1955C									
V90U1956C									
V90U1957CA	LAMDC	LAMDC	DESIRED THRUST TURNING RATE VECTOR						
V90U1958CA									
V90U1959CA									
V90W1953C	TLAMC	TLAMC	TIME TAG FOR LAMC AND LAMDC						
		POSERR	MAG. OF POSITION ERROR VECTOR, ENVIRON. MINUS NAV. VALUE						
			VELOCITY-TO-BE-GAINED VECTOR						
			VGO IN LVLH COORDINATES						
			DESIRED THRUST DIRECTION						
			ATP IN LVLH COORDINATES						
		TOMS	TOTAL THRUST OF OMS ENGINES						
		TRCS	THRUST OF TX RCS JET						
			OMS USEABLE PROPELLANT REMAINING						
			RCS USEABLE PROPELLANT REMAINING						
		WEIGHT	TOTAL VEHICLE WEIGHT						
V90U1961C	M		GUIDANCE COMPUTED MASS						
			LVLH PITCH ANGLE (ATP)						
			LVLH YAW ANGLE (ATP)						
V90H2202C		PHIBD	ROLL ATTITUDE (EULER)						
V90H2217C		THEBD	PITCH ATTITUDE (EULER)						
V90H2230C		PSIBD	YAW ATTITUDE (EULER)						
	VGRAV	VGRAV	PREDICTED VELOCITY INCREMENT DUE TO GRAVITY						
	(WFBIFB) OMEGA_B	WFBFB1	BODY RATE COMMAND, ROLL						
		WFBFB2	BODY RATE COMMAND, PITCH						
		WFBFB3	BODY RATE COMMAND, YAW						
V95L0190C		VGD(1)	GUIDANCE COMPUTED VELOCITY, X-COMP.						
V95L0191C		VGD(2)	GUIDANCE COMPUTED VELOCITY, Y-COMP						

				PF	SC	CR	XY	DP	SN
V95L0192C		VGD(3)	GUIDANCE COMPUTED VELOCITY,Z-COMP.						
V95H0185C		RGD(1)	GUID. COMPUTED POSIT. VECTOR, X-COMP						
V95H0186C		RGD(2)	GUID. COMPUTED POSIT. VECTOR, Y-COMP						
V95H0187C		RGD(3)	GUID. COMPUTED POSIT. VECTOR, Z-COMP						
V95H3528C		PD	ACTUAL BODY RATE, ROLL						
		PD	ACTUAL BODY RATE, ROLL						
	PORB	PORB	ROLL RATE,ORBITER RATE GYROS						
V95H3527C		QD	ACTUAL BODY RATE, PITCH						
		QD	ACTUAL BODY RATE, PITCH						
	QORB	QORB	PITCH RATE,ORBITER RATE GYROS						
V95H3526		RD	ACTUAL BODY RATE, YAW						
		RD	ACTUAL BODY RATE, YAW						
	RORB	RORB	YAW RATE,ORBITER RATE GYROS						
			TARGET MINUS ACHIEVED POSITION						
		DPD	ROTAT. ACCEL. ABOUT BODY X-AXIS						
		DQD	ROTAT. ACCEL. ABOUT BODY Y-AXIS						
		DRD	ROTAT. ACCEL. ABOUT BODY Z-AXIS						
			TARGET MINUS ACHIEVED FLIGHT PATH ANGLE						
		AX	ACCELERATION,X-COMP.,BODY AXES						
		AY	ACCELERATION,Y-COMP.,BODY AXES						
		AZ	ACCELERATION,Z-COMP.,BODY AXES						
		NXGS	LOAD FACTOR, X-COMP.,BODY AXES						
		NYGS	LOAD FACTOR, Y-COMP.,BODY AXES						
		NZGS	LOAD FACTOR, Z-COMP.,BODY AXES						
		NTGS	TOTAL LOAD FACTOR						
V90U1976C V90U1977C V90U1978C	IY	IY	UNIT VECTOR NORMAL TO ORBIT PLANE						
		NYAWJA	NO. OF AFT YAW JETS FIRING						
		NYAWJF	NO. OF FWD YAW JETS FIRING						
		NZRAFT	NO. RT.AFT PLUS/MINUS Z JETS FIRING						
		NZLAFT	NO. LT.AFT PLUS/MINUS Z JETS FIRING						
		NXJETS	NO. OF PLUS XRCS JETS FIRING						
		NZFWD	NO. OF FWD PLUS/MINUS Z JETS FIRING						
			TRANS DAP RATE ERRORS						
			TRANS DAP ATTITUDE ERRORS						
			SRB SEPARATION COMMAND FLAG						
			GUIDANCE READY FLAG						
			MPS GUIDANCE CUTOFF TASK DISCRETE FLAG						

			PF	SC	CR	XY	DP	SN
		MECO COMMANDED FLAG						
		MECO CONFIRMED FLAG						
		AUTO SEP MNVR COMPLETE						
		OPS 104 PRO FLAG						
		BURN ENABLE						
		OMS CUTOFF CONFIRMED						
		OPS 105 PRO FLAG						
		OPS 106 PRO FLAG						
		RTLS ABORT REQUEST FLAG						
		AOA ABORT REQUEST FLAG						
		ATO ABORT REQUEST FLAG						

ABORT-ONCE-AROUND GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFIC.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER
			TIME FROM SRB IGNITION
			MISSION ELAPSED TIME
V95L0151C	REL-VEL-MAG		GROUND RELATIVE VELOCITY MAGNITUDE IN M50 SYSTEM
V95H0185C V95H0186C V95H0187C	R-AVGG		CURRENT M50 POSITION VECTOR
V95L0190C V95L0191C V95L0192C	V-AVGG		CURRENT M50 VELOCITY VECTOR
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR
	V-RHO-MAG		MAG. OF REL. VELOCITY IN M50 FRAME
	V-RHO		REL VELOCITY VECTOR IN M50 FRAME
	V-CROSSRANGE		INERTIAL VELOCITY COMPONENT NORMAL TO NOMINAL ORBIT PLANE
	V-INERTIAL-		INERTIAL VELOCITY MAGNITUDE,

				PF	SC	CR	XY	DP	SN
	MAG		M50 SYSTEM						
	MDOT-OMS	MDOMS	OMS FLOW RATE						
	MDOT-RCS	MDRCS	RCS FLOW RATE						
		WINDL	WIND SPEED						
		WAZ	WIND DIRECTION FROM NORTH						
		EVENT	EVENT COUNTER (28,29,30, ETC.)						
V95H0175C		H	ALTITUDE,FISCHER ELLIPSOID						
		H	ALTITUDE,FISCHER ELLIPSOID						
		RAD	MAGNITUDE OF POSITION VECTOR						
		VITOT	INERTIAL VELOCITY						
		VITOT	INERTIAL VELOCITY						
		VREL	EARTH RELATIVE VELOCITY						
		VREL	EARTH RELATIVE VELOCITY						
		GARD	RELATIVE FLIGHT PATH ANGLE						
		GARD	RELATIVE FLIGHT PATH ANGLE						
		DDRAD	RADIAL ACCELERATION,GEOCENTRIC						
		DRAD	RADIAL VELOCITY,GEOCENTRIC						
		GAMMAI	INERTIAL FLIGHT PATH ANGLE						
		GAMMAI	INERTIAL FLIGHT PATH ANGLE						
		AZMIHI	INERTIAL FLIGHT AZIMUTH FROM NORTH						
		PSRD	HEADING OF REL VEL VECTOR WRT NORTH						
		LYD	GEODETIC LATITUDE OF THE VEHICLE						
		LAD	RELATIVE LONGITUDE OF VEHICLE						
7-16	FT	FT	THRUST						
		THRUST(1)	THRUST OF SSME NO. 1						
		THRUST(2)	THRUST OF SSME NO. 2						
		THRUST(3)	THRUST OF SSME NO. 3						
		TMPS	TOTAL THRUST, SSME ENGINES						
		TOMS	TOTAL THRUST OF OMS ENGINES						
		TRCS	THRUST OF TX RCS JET						
			MPS USEABLE PROPELLANT REMAINING						
			OMS USEABLE PROPELLANT REMAINING						
			RCS USEABLE PROPELLANT REMAINING						
		WEIGHT	TOTAL VEHICLE WEIGHT						
V90U2023CA	M	MASS	MASS						
	MDOT	MDOT	MASS FLOW RATE						
			DESIRED MINUS PREDICTED VELOCITY, MAGNITUDE						
V90W1941C		XTGO	TIME-TO-GO						
		VGO	VELOCITY-TO-GO VECTOR						
		VELERR	MAG. OF VELOCITY VECTOR ERROR,						

				PF	SC	CR	XY	DP	SN
			ENVIRON. MINUS NAV. VALUE						
		DRNG	DOWN RANGE,LAUNCH SITE TO VEHICLE						
V90H2202C		PHIBD	ROLL ATTITUDE (EULER)						
V90H2217C		THEBD	PITCH ATTITUDE (EULER)						
V90H2230C		PSIBD	YAW ATTITUDE (EULER)						
V90U1976C	IY	IY	ORBITAL PLANE TARGET						
V90U1977C									
V90U1978C									
	WFBIFB	WFBFB1	BODY RATE COMMAND,ROLL						
		WFBFB2	BODY RATE COMMAND,PITCH						
		WFBFB3	BODY RATE COMMAND,YAW						
			RANGE TO LANDING SITE						
V95P3011C		QER	DYNAMIC PRESSURE (GN&C)						
V95P3170C		QBR	DYNAMIC PRESSURE (NAV. DERIV.)						
		QBR	DYNAMIC PRESSURE						
V90L0847C		MACH	MACH NUMBER,NAV DERIVED						
		MACH	MACH NUMBER						
V95H3156C		ALD	ANGLE OF ATTACK						
		ALD	ANGLE OF ATTACK						
V90H2249C		BED	SIDESLIP ANGLE						
		BED	SIDESLIP ANGLE						
	WFBIFB	WFBFB1	BODY RATE COMMAND,ROLL						
		WFBFB2	BODY RATE COMMAND,PITCH						
		WFBFB3	BODY RATE COMMAND,YAW						
V95H3528C		PD	ACTUAL BODY RATE, ROLL						
		PD	ACTUAL BODY RATE, ROLL						
	PORB	PORB	ROLL RATE,ORBITER RATE GYROS						
V95H3527C		QD	ACTUAL BODY RATE, PITCH						
		QD	ACTUAL BODY RATE, PITCH						
	QORB	QORB	PITCH RATE,ORBITER RATE GYROS						
V95H3526		RD	ACTUAL BODY RATE, YAW						
		RD	ACTUAL BODY RATE, YAW						
	RORB	RORB	YAW RATE,ORBITER RATE GYROS						
		LAM	THRUST DIRECTION,UNIT VECTOR						
		DPD	ROTAT. ACCEL. ABOUT BODY X-AXIS						
		DQD	ROTAT. ACCEL. ABOUT BODY Y-AXIS						
		DRD	ROTAT. ACCEL. ABOUT BODY Z-AXIS						
		SCONC	CONVERGENCE FLAG						
V90U1948C	K-CMD	KCMD	COMMANDED THROTTLE SETTING						
		AX	ACCELERATION,X-COMP.,BODY AXES						

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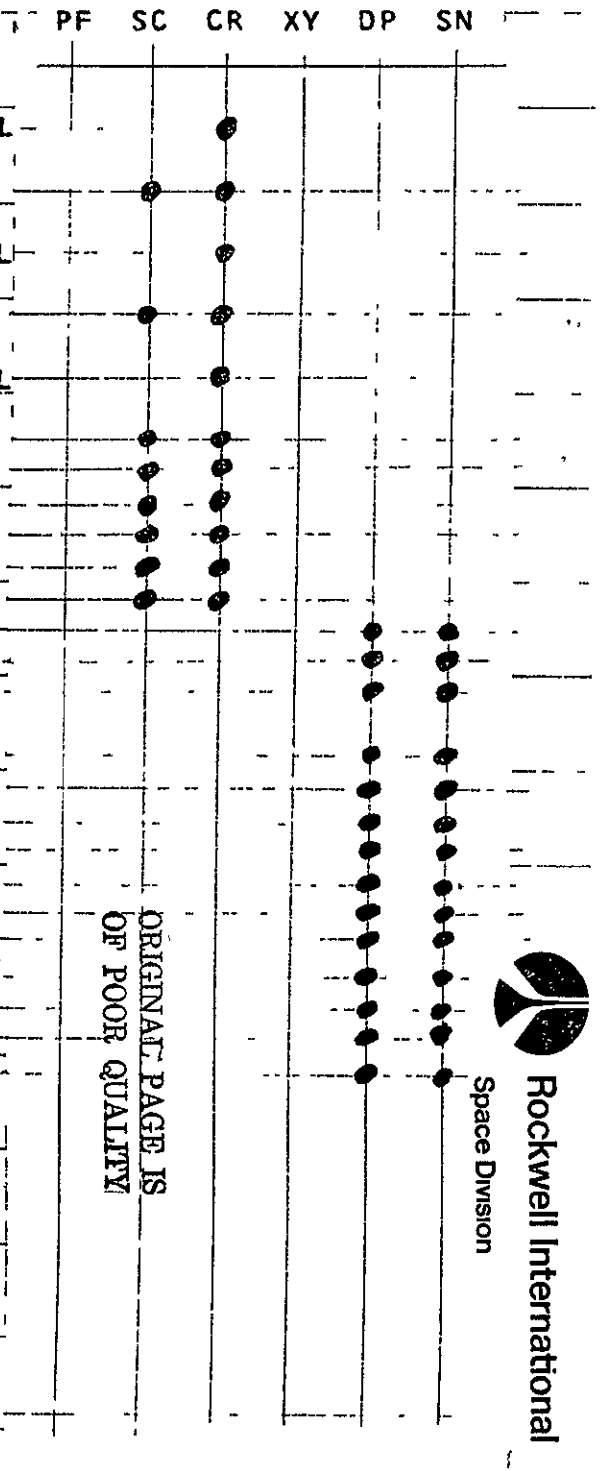
			PF	SC	CR	XY	DP	SN
	AY	ACCELERATION,Y-COMP.,BODY AXES						
	AZ	ACCELERATION,Z-COMP.,BODY AXES						
	NXGS	LOAD FACTOR, X-COMP.,BODY AXES						
	NYGS	LOAD FACTOR, Y-COMP.,BODY AXES						
	NZGS	LOAD FACTOR, Z-COMP.,BODY AXES						
	NTGS	TOTAL LOAD FACTOR						
	LSTOT	TOTAL SLOSHING ROLL MOMENT						
	MSTOT	TOTAL SLOSHING PITCH MOMENT						
	NSTOT	TOTAL SLOSHING YAW MOMENT						
	FYS	SLOSH FORCE,Y-COMP.,BODY AXES						
	FZS	SLOSH FORCE,Z-COMP.,BODY AXES						
	ZTALH	LH2 DAMPING RATIO						
	ZTALX	LOX DAMPING RATIO						
	OMILH	LH2 SLOSH MASS NATURAL FREQUENCY						
	OMILOX	LOX SLOSH MASS NATURAL FREQUENCY						
	PCIO	ROLL TRIM INTEGRATOR						
	QCIO	PITCH TRIM INTEGRATOR						
	RCIO	YAW TRIM INTEGRATOR						
	DPTVC	ROLL GIMBAL ANGLE COMMAND						
	DQTVC	PITCH GIMBAL ANGLE COMMAND						
	DRTVC	YAW GIMBAL ANGLE COMMAND						
	DDEY(1)	PITCH GIMBAL RATE, NO. 1 ENGINE						
	DDEY(2)	PITCH GIMBAL RATE, NO. 2 ENGINE						
	DDEY(3)	PITCH GIMBAL RATE, NO. 3 ENGINE						
	DDEZ(1)	YAW GIMBAL RATE, NO. 1 ENGINE						
	DDEZ(2)	YAW GIMBAL RATE, NO. 2 ENGINE						
	DDEZ(3)	YAW GIMBAL RATE, NO. 3 ENGINE						
V95H3523C	EBFB	EBFB1						
V95H3521C		EBFB2						
V95H3522C		EBFB3						
	DEYA(1)	PITCH GIMBAL ANGLE FROM NULL, NO. 1 ENGINE						
	DYC1	DYC1 COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
	DEYA(2)	PITCH GIMBAL ANGLE FROM NULL, NO. 2 ENGINE						
	DYC2	DYC2 COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
	DEYA(3)	PITCH GIMBAL ANGLE FROM NULL, NO. 3 ENGINE						
	DYC3	DYC3 COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
	DEZA(1)	YAW GIMBAL ANGLE FROM NULL						

		NO. 1 ENGINE
DZC1	DZC1	COMMANDED YAW GIMBAL ANGLE FROM NULL
		NO. 1 ENGINE
	DEZA(2)	YAW GIMBAL ANGLE FROM NULL
		NO. 2 ENGINE
DZC2	DZC2	COMMANDED YAW GIMBAL ANGLE FROM NULL
		NO. 2 ENGINE
	DEZA(3)	YAW GIMBAL ANGLE FROM NULL
		NO. 3 ENGINE
DZC3	DZC3	COMMANDED YAW GIMBAL ANGLE FROM NULL
		NO. 3 ENGINE
	NYAWJA	NO. OF AFT YAW JETS FIRING
	NYAWJF	NO. OF FWD YAW JETS FIRING
	NZRAFT	NO. RT.AFT PLUS/MINUS Z JETS FIRING
	NZLAFT	NO. LT.AFT PLUS/MINUS Z JETS FIRING
	NXJETS	NO. OF PLUS XRCS JETS FIRING
	NZFWD	NO. OF FWD PLUS/MINUS Z JETS FIRING
		SRB SEPARATION COMMAND FLAG
		GUIDANCE READY FLAG
		MPS GUIDANCE CUTOFF TASK DISCRETE FLAG
		MECO COMMANDED FLAG
		MECO CONFIRMED FLAG
		AUTO SEP MNVR COMPLETE
		OPS 104 PRO FLAG
		BURN ENABLE
		OMS CUTOFF CONFIRMED
		OPS 105 PRO FLAG
		OPS 106 PRO FLAG
		RTLS ABORT REQUEST FLAG
		AOA ABORT REQUEST FLAG
		ATO ABORT REQUEST FLAG

ABORT-TO-ORBIT GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFICAT.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER
			TIME FROM SRB IGNITION



				PF	SC	CR	XY	DP	SN
			MISSION ELAPSED TIME						
V95L0151C	REL-VEL-		GROUND RELATIVE VELOCITY						
	MAG		MAGNITUDE IN M50 SYSTEM						
V95H0185C	R-AVGG		CURRENT M50 POSITION VECTOR						
V95H0186C									
V95H0187C									
V95L0190C	V-AVGG		CURRENT M50 VELOCITY VECTOR						
V95L0191C									
V95L0192C									
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR						
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR						
	V-RHO-MAG		MAG. OF REL. VELOCITY IN M50 FRAME						
	V-RHO		REL VELOCITY VECTOR IN M50 FRAME						
	V-CROSSRANGE		INERTIAL VELOCITY COMPONENT NORMAL TO NOMINAL ORBIT PLANE						
	V-INERTIAL-		INERTIAL VELOCITY MAGNITUDE,						
	MAG		M50 SYSTEM						
	MDOT-OMS	MDOMS	OMS FLOW RATE						
	MDOT-RCS	MDRCS	RCS FLOW RATE						
		WINDL	WIND SPEED						
		WAZ	WIND DIRECTION FROM NORTH						
		EVENT	EVENT COUNTER (28,29,30, ETC.)						
V95H0175C		H	ALTITUDE,FISCHER ELLIPSOID						
		H	ALTITUDE,FISCHER ELLIPSOID						
		RAD	MAGNITUDE OF POSITION VECTOR						
		VITOT	INERTIAL VELOCITY						
		VITOT	INERTIAL VELOCITY						
		VREL	EARTH RELATIVE VELOCITY						
		VREL	EARTH RELATIVE VELOCITY						
		GAMMAI	INERTIAL FLIGHT PATH ANGLE						
		GAMMAI	INERTIAL FLIGHT PATH ANGLE						
		AZMTHI	INERTIAL FLIGHT AZIMUTH FROM NORTH						
		GARD	RELATIVE FLIGHT PATH ANGLE						
		GARD	RELATIVE FLIGHT PATH ANGLE						
		PSRD	HEADING OF REL VEL VECTOR WRT NORTH						
		LYD	GEODETIC LATITUDE OF THE VEHICLE						
		LAD	RELATIVE LONGITUDE OF VEHICLE						
		DRNG	DOWN RANGE,LAUNCH SITE TO VEHICLE						
		DDRAD	RADIAL ACCELERATION,GEOCENTRIC						
		DRAD	RADIAL VELOCITY,GEOCENTRIC						

				PF	SC	CR	XY	DP	SN
		VELERR	MAG. OF VELOCITY VECTOR ERROR, ENVIRON. MINUS NAV. VALUE						
		THRUST(1)	THRUST OF SSME NO. 1						
		THRUST(2)	THRUST OF SSME NO. 2						
		THRUST(3)	THRUST OF SSME NO. 3						
		TMPS	TOTAL THRUST, SSME ENGINES						
		TOMS	TOTAL THRUST OF OMS ENGINES						
		TRCS	THRUST OF TX RCS JET						
			MPS USEABLE PROPELLANT REMAINING						
			OMS USEABLE PROPELLANT REMAINING						
			RCS USEABLE PROPELLANT REMAINING						
		WEIGHT	TOTAL VEHICLE WEIGHT						
V94U3822C	M	MASS	MASS						
	MDOT	MDOT	MASS FLOW RATE						
V90U1976C	IY	IY	ORBITAL PLANE TARGET						
V90U1977C									
V90U1978C									
	K2	K2	PRE-MECO OMS SCALE FACTOR						
V90L0847C		MACH	MACH NUMBER,NAV DERIVED						
		MACH	MACH NUMBER						
V95P3011C		QBR	DYNAMIC PRESSURE (GN&C)						
V95P3170C		QBR	DYNAMIC PRESSURE (NAV. DERIV.)						
		QBR	DYNAMIC PRESSURE						
V95H3156C		ALD	ANGLE OF ATTACK						
		ALD	ANGLE OF ATTACK						
V90H2249C		BED	SIDESLIP ANGLE						
		BED	SIDESLIP ANGLE						
		XTGO	TIME-TO-GO TO MECO						
V90H2202C		PHIBD	ROLL ATTITUDE (EULER)						
V90H2217C		THEBD	PITCH ATTITUDE (EULER)						
V90H2230C		PSIBD	YAW ATTITUDE (EULER)						
		VGO	VELOCITY-TO-GO,VECTOR						
	WFBIFB	WFBFB1	BODY RATE COMMAND,ROLL						
		WFBFB2	BODY RATE COMMAND,PITCH						
		WFBFB3	BODY RATE COMMAND,YAW						
		LAM	THRUST DIRECTION,UNIT VECTOR						
V95H3528C		PD	ACTUAL BODY RATE, ROLL						
		PD	ACTUAL BODY RATE, ROLL						
	PORB	PORB	ROLL RATE,ORBITER RATE GYROS						

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				PF	SC	CR	XY	DP	SN
V95H3527C		QD	ACTUAL BODY RATE, PITCH						
		QD	ACTUAL BODY RATE, PITCH						
	QORB	QORB	PITCH RATE, ORBITER RATE GYROS						
V95H3526		RD	ACTUAL BODY RATE, YAW						
		RD	ACTUAL BODY RATE, YAW						
	RORB	RORB	YAW RATE, ORBITER RATE GYROS						
		LAMDMG	THRUST TURNING RATE						
		DPD	ROTAT. ACCEL. ABOUT BODY X-AXIS						
		DQD	ROTAT. ACCEL. ABOUT BODY Y-AXIS						
		DRD	ROTAT. ACCEL. ABOUT BODY Z-AXIS						
			DESIRED MINUS PREDICTED VELOCITY, MAGNITUDE						
			CONVERGENCE FLAG						
V90U1948C	K-CMD	THROC	COMMANDED THROTTLE SETTING						
		AX	ACCELERATION, X-COMP., BODY AXES						
		AY	ACCELERATION, Y-COMP., BODY AXES						
		AZ	ACCELERATION, Z-COMP., BODY AXES						
		NXGS	LOAD FACTOR, X-COMP., BODY AXES						
		NYGS	LOAD FACTOR, Y-COMP., BODY AXES						
		NZGS	LOAD FACTOR, Z-COMP., BODY AXES						
		NTGS	TOTAL LOAD FACTOR						
		LSTOT	TOTAL SLOSHING ROLL MOMENT						
		MSTOT	TOTAL SLOSHING PITCH MOMENT						
		NSTOT	TOTAL SLOSHING YAW MOMENT						
		FYS	SLOSH FORCE, Y-COMP., BODY AXES						
		FZS	SLOSH FORCE, Z-COMP., BODY AXES						
		ZTALH	LH2 DAMPING RATIO						
		ZTALX	LOX DAMPING RATIO						
		OMILH	LH2 SLOSH MASS NATURAL FREQUENCY						
		OMILOX	LOX SLOSH MASS NATURAL FREQUENCY						
		DPTVC	ROLL GIMBAL ANGLE COMMAND						
		DQTVC	PITCH GIMBAL ANGLE COMMAND						
		DRTVC	YAW GIMBAL ANGLE COMMAND						
		PCIO	ROLL TRIM INTEGRATOR						
		QCIO	PITCH TRIM INTEGRATOR						
		RCIO	YAW TRIM INTEGRATOR						
		DMORBT	ORBITER PITCH TRIM						
		DDEY(1)	PITCH GIMBAL RATE, NO. 1 ENGINE						
		DDEY(2)	PITCH GIMBAL RATE, NO. 2 ENGINE						
		DDEY(3)	PITCH GIMBAL RATE, NO. 3 ENGINE						
		DDEZ(1)	YAW GIMBAL RATE, NO. 1 ENGINE						
		DDEZ(2)	YAW GIMBAL RATE, NO. 2 ENGINE						
		DDEZ(3)	YAW GIMBAL RATE, NO. 3 ENGINE						

				PF	SC	CR	XY	DP	SN
V95H3523C	EBFB	EBFB1	BODY ATTITUDE ERROR,ROLL						
V95H3521C		EBFB2	BODY ATTITUDE ERROR,PITCH						
V95H3522C		EBFB3	BODY ATTITUDE ERROR,YAW						
		DEYA(1)	PITCH GIMBAL ANGLE FROM NULL, NO. 1 ENGINE						
	DYC1	DYC1	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
		DEYA(2)	PITCH GIMBAL ANGLE FROM NULL, NO. 2 ENGINE						
	DYC2	DYC2	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
		DEYA(3)	PITCH GIMBAL ANGLE FROM NULL, NO. 3 ENGINE						
	DYC3	DYC3	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
		DEZA(1)	YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
	DZC1	DZC1	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
		DEZA(2)	YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
	DZC2	DZC2	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
		DEZA(3)	YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
	DZC3	DZC3	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
		NYAWJA	NO. OF AFT YAW JETS FIRING						
		NYAWJF	NO. OF FWD YAW JETS FIRING						
		NZRAFT	NO. RT.AFT PLUS/MINUS Z JETS FIRING						
		NZLAFT	NO. LT.AFT PLUS/MINUS Z JETS FIRING						
		NXJETS	NO. OF PLUS XRCS JETS FIRING						
		NZFWD	NO. OF FWD PLUS/MINUS Z JETS FIRING						
			SRB SEPARATION COMMAND FLAG						
			GUIDANCE READY FLAG						
			MPS GUIDANCE CUTOFF TASK DISCRETE FLAG						
			MECO COMMANDED FLAG						
			MECO CONFIRMED FLAG						
			AUTO SEP MNVR COMPLETE						
			OPS 104 PRO FLAG						
			BURN ENABLE						
			OMS CUTOFF CONFIRMED						

				PF	SC	CR	XY	DP	SN
			OPS 105 PRO FLAG						
			OPS 106 PRO FLAG						
			RTLS ABORT REQUEST FLAG						
			AOA ABORT REQUEST FLAG						
			ATO ABORT REQUEST FLAG						

RTLS GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFICAT.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER	PF	SC	CR	XY	DP	SN
			TIME FROM SRB IGNITION						
			MISSION ELAPSED TIME						
V95L0151C	REL-VEL-MAG		GROUND RELATIVE VELOCITY MAGNITUDE IN M50 SYSTEM						
V95H0185C	R-AVGG		CURRENT M50 POSITION VECTOR						
V95H0186C									
V95H0187C									
V95L0190C	V-AVGG		CURRENT M50 VELOCITY VECTOR						
V95L0191C									
V95L0192C									
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR						
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR						
	V-RHO-MAG		MAG. OF REL. VELOCITY IN M50 FRAME						
	V-RHO		RLL VELOCITY VECTOR IN M50 FRAME						
	V-CROSSRANGE		INERTIAL VELOCITY COMPONENT NORMAL TO NOMINAL ORBIT PLANE						
		WINDL	WIND SPEED						
		WAZ	WIND DIRECTION FROM NORTH						
		EVENT	EVENT COUNTER (28,29,30, ETC.)						
V95H0175C		H	ALTITUDE,FISCHER ELLIPSOID						
		H	ALTITUDE,FISCHER ELLIPSOID						
		RAD	MAGNITUDE OF POSITION VECTOR						
		VREL	EARTH RELATIVE VELOCITY						
		VREL	EARTH RELATIVE VELOCITY						
V90L0847C		MACH	MACH NUMBER,NAV DERIVED						
		MACH	MACH NUMBER						

		VITOT	MAG. OF INERTIAL VELOCITY
		VITOI	MAG. OF INERTIAL VELOCITY
		GAMMAI	INERTIAL FLIGHT PATH ANGLE
		GAMMAI	INERTIAL FLIGHT PATH ANGLE
		AZMTHI	INERTIAL FLIGHT AZIMUTH FROM NORTH
		PSRD	HEADING OF REL VEL VECTOR WRT NORTH
		LYD	GEODETIC LATITUDE OF THE VEHICLE
		LAD	RELATIVE LONGITUDE OF VEHICLE
		DRNG	DOWN RANGE,LAUNCH SITE TO VEHICLE
V90U1954C	LAMC	LAMC	COMMANDED THRUST DIRECTION
V90U1955C			
V90U1956C			
		GARD	RELATIVE FLIGHT PATH ANGLE
		GARD	RELATIVE FLIGHT PATH ANGLE
			INERTIAL FLIGHT PATH ANGLE
			INERTIAL FLIGHT PATH ANGLE
V90U1957CA	LAMDC	LAMDC	COMMANDED THRUST TURNING RATE VECTOR
V90U1958CA			
V90U1959CA			
		DDRAD	RADIAL ACCELERATION,GEOCENTRIC
		DRAD	RADIAL VELOCITY,GEOCENTRIC
		LAMDMG	TURNING RATE MAGNITUDE
V90W1953C	TLAMC	TLAMC	TIME ASSOCIATED WITH LAMC
V90W1941C	TGO	XTGO	TIME-TO-GO
V90W1946C	TMET-MECO	TMMECO	MECO TIME
V90U1966C	VGOMAG	VGOMAG	VELOCITY-TO-GO MAGNITUDE
			VELOCITY MISS VECTOR MAGNITUDE
		EMISS	VELOCITY CONVERGENCE CRITERION
V90U2093C	MF	MF	PREDICTED FINAL MASS
			MASS DIFFERENCE
V90U2092C	DT-TURN		LENGTH OF RTLS TURNAROUND
		GAMD	DESIRED FLIGHT PATH ANGLE
	AT-EST	ATEST	THRUST ACCELERATION
	SCONV		PEG CONVERGENCE DISCRETE&&
V90J2091C	K	K	DESIRED THROTTLE SETTING
			DESIRED CHANGE IN THROTTLE SETTING
V90U1948C	K-CMD	KCMD	COMMANDED SSME THROTTLE SETTING
			ACCELERATION DIFFERENCE
		RMISS	GUIDANCE POSITION CRITERION
			TURNING RATE TEST CRITERION
		TP	PREDICTED GUIDANCE TIME
		THRUST(1)	THRUST OF SSME NO. 1
		THRUST(2)	THRUST OF SSME NO. 2

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			PF	SC	CR	XY	DP	SN
	THRUST(3)	THRUST OF SSME NO. 3						
	TMPS	TOTAL THRUST, SSME ENGINES						
	TOMS	TOTAL THRUST OF OMS ENGINES						
	TRCS	THRUST OF TX RCS JET						
		MPS USEABLE PROPELLANT REMAINING						
		OMS USEABLE PROPELLANT REMAINING						
		RCS USEABLE PROPELLANT REMAINING						
	WEIGHT	TOTAL VEHICLE WEIGHT						
		THRUST POINTING ERROR						
V90U1979C	FTFACT	THRUST SCALING FACTOR						
V90H2202C	PHIBD	ROLL ATTITUDE (EULER)						
V90H2217C	THEBD	PITCH ATTITUDE (EULER)						
V90H2230C	PSIBD	YAW ATTITUDE (EULER)						
V95P3011C	QBR	DYNAMIC PRESSURE (GN&C)						
V95P3170C	QBR	DYNAMIC PRESSURE (NAV. DERIV.)						
	QBR	DYNAMIC PRESSURE						
V95H3156C	ALD	ANGLE OF ATTACK						
	ALD	ANGLE OF ATTACK						
V90H2249C	BED	SIDESLIP ANGLE						
	BED	SIDESLIP ANGLE						
	NXGS	LOAD FACTOR, X-COMP.,BODY AXES						
	NYGS	LOAD FACTOR, Y-COMP.,BODY AXES						
	NZGS	LOAD FACTOR, Z-COMP.,BODY AXES						
	NTGS	TOTAL LOAD FACTOR						
	AX	ACCELERATION,X-COMP.,BODY AXES						
	AY	ACCELERATION,Y-COMP.,BODY AXES						
	AZ	ACCELERATION,Z-COMP.,BODY AXES						
	LSTOT	TOTAL SLOSHING ROLL MOMENT						
	MSTOT	TOTAL SLOSHING PITCH MOMENT						
	NSTOT	TOTAL SLOSHING YAW MOMENT						
	FYS	SLOSH FORCE,Y-COMP.,BODY AXES						
	FZS	SLOSH FORCE,Z-COMP.,BODY AXES						
	ZTALH	LH2 DAMPING RATIO						
	ZTALX	LOX DAMPING RATIO						
	OMILH	LH2 SLOSH MASS NATURAL FREQUENCY						
	OMILOX	LOX SLOSH MASS NATURAL FREQUENCY						
	DDEY(1)	PITCH GIMBAL RATE, NO. 1 ENGINE						
	DDEY(2)	PITCH GIMBAL RATE, NO. 2 ENGINE						
	DDEY(3)	PITCH GIMBAL RATE, NO. 3 ENGINE						
	DDEZ(1)	YAW GIMBAL RATE, NO. 1 ENGINE						
	DDEZ(2)	YAW GIMBAL RATE, NO. 2 ENGINE						
	DDEZ(3)	YAW GIMBAL RATE, NO. 3 ENGINE						
	PCIO	ROLL TRIM INTEGRATOR						

				PF	SC	CR	XY	DP	SN
		QCIO	PITCH TRIM INTEGRATOR						
		RCIO	YAW TRIM INTEGRATOR						
		DMORBT	ORBITER PITCH TRIM						
V95H3523C V95H3521C V95H3522C	EBFB	EBFB1	BODY ATTITUDE ERROR,ROLL						
		EBFB2	BODY ATTITUDE ERROR,PITCH						
		EBFB3	BODY ATTITUDE ERROR,YAW						
		DPTVC	ROLL GIMBAL ANGLE COMMAND						
		DQTVC	PITCH GIMBAL ANGLE COMMAND						
		DRTVC	YAW GIMBAL ANGLE COMMAND						
		DEYA(1)	PITCH GIMBAL ANGLE FROM NULL, NO. 1 ENGINE						
	DYC1	DYC1	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
		DEYA(2)	PITCH GIMBAL ANGLE FROM NULL, NO. 2 ENGINE						
	DYC2	DYC2	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
		DEYA(3)	PITCH GIMBAL ANGLE FROM NULL, NO. 3 ENGINE						
	DYC3	DYC3	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
		DEZA(1)	YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
	DZC1	DZC1	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE						
		DEZA(2)	YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
	DZC2	DZC2	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE						
		DEZA(3)	YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
	DZC3	DZC3	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE						
		NYAWJA	NO. OF AFT YAW JETS FIRING						
		NYAWJF	NO. OF FWD YAW JETS FIRING						
		NZRAFT	NO. RT.AFT PLUS/MINUS Z JETS FIRING						
		NZLAFT	NO. LT.AFT PLUS/MINUS Z JETS FIRING						
		NXJETS	NO. OF PLUS XRCS JETS FIRING						
		NZFWD	NO. OF FWD PLUS/MINUS Z JETS FIRING						
			SRB SEPARATION COMMAND FLAG						
			GUIDANCE READY FLAG						
			MPS GUIDANCE CUTOFF TASK DISCRETE FLAG						

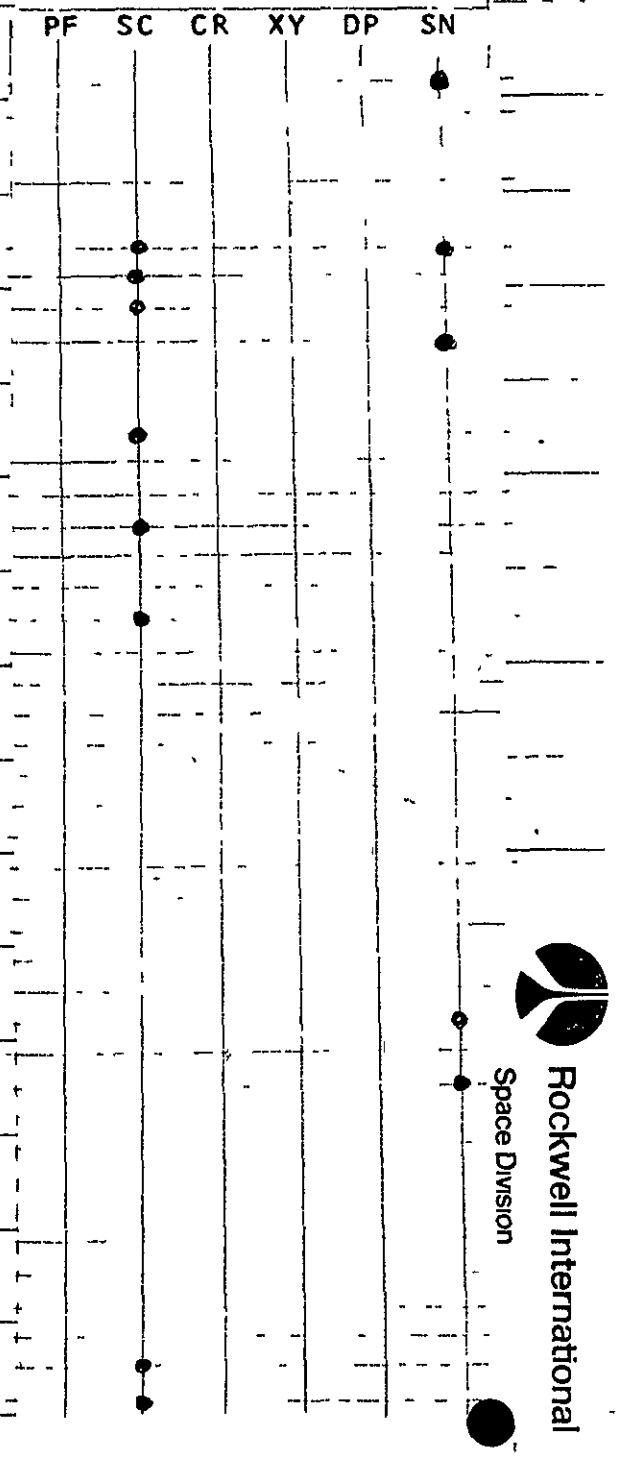
				PF	SC	CR	XY	DP	SN
			MECO COMMANDED FLAG						•
			MECO CONFIRMED FLAG						
			AUTO SEP MNVR COMPLETE						
			OPS 104 PRO FLAG						
			BURN ENABLE						•
			OMS CUTOFF CONFIRMED						•
			OPS 105 PRO FLAG						
			OPS 106 PRO FLAG						
			RTLS ABORT REQUEST FLAG						•
			AOA ABORT REQUEST FLAG						•
			ATO ABORT REQUEST FLAG						•

ASC MNVR DIP GN&C SIMULATION VARIABLES

DOWNLIST OR DUMMY MML IDENTIFICAT.	FSSR SYMBOL	CSMP SYMBOL	PARAMETER						
			TIME FROM SRB IGNITION						
			MISSION ELAPSED TIME						
V95L0151C	REL-VEL-MAG		GROUND RELATIVE VELOCITY MAGNITUDE IN M50 SYSTEM						•
V95H0185C	R-AVGG		CURRENT M50 POSITION VECTOR						
V95H0186C									
V95H0187C									
V95L0190C	V-AVGG		CURRENT M50 VELOCITY VECTOR						
V95L0191C									
V95L0192C									
V95W0200C	T-STATE		TIME TAG FOR CURRENT STATE VECTOR						
	V-IMU-OLD		CURRENT ACCUMULATED IMU VELOCITY VECTOR						
	V-RHO-MAG		MAG. OF REL. VELOCITY IN M50 FRAME						
	V-RHO		REL VELOCITY VECTOR IN M50 FRAME						
	V-CROSSRANGE		INERTIAL VELOCITY COMPONENT NORMAL TO NOMINAL ORBIT PLANE						
V95P3170C	Q-BAR-A		DERIVED ASCENT DYNAMIC PRESSURE						
	V-INERTIAL-MAG		INERTIAL VELOCITY MAGNITUDE, M50 SYSTEM						•
		WINDL	WIND SPEED						
		WAZ	WIND DIRECTION FROM NORTH						

	EVENT	EVENT COUNTER (28,29,30, ETC.)
V95H0175C	H	ALTITUDE,FISCHER ELLIPSOID
	H	ALTITUDE,FISCHER ELLIPSOID
	RAD	MAGNITUDE OF POSITION VECTOR
	VREL	EARTH RELATIVE VELOCITY
	VREL	EARTH RELATIVE VELOCITY
V90L0847C	MACH	MACH NUMBER,NAV DERIVED
	MACH	MACH NUMBER
	VITOT	MAG. OF INERTIAL VELOCITY
	VITOT	MAG. OF INERTIAL VELOCITY
		POSTMANEUVER TARGET MINUS CURRENT APOGEE ALTITUDE
	GARD	RELATIVE FLIGHT PATH ANGLE
	GARD	RELATIVE FLIGHT PATH ANGLE
	GAMMAI	INERTIAL FLIGHT PATH ANGLE
	GAMMAI	INERTIAL FLIGHT PATH ANGLE
	AZMTHI	INERTIAL FLIGHT AZIMUTH FROM NORTH
	PSRD	HEADING OF REL.VEL VECTOR WRT NORTH
	LYD	GEODETIC LATITUDE OF THE VEHICLE
	LAD	RELATIVE LONGITUDE OF VEHICLE
	DDRAD	RADIAL ACCELERATION,GEOCENTRIC
	DRAD	RADIAL VELOCITY,GEOCENTRIC
		MAG. OF VELOCITY VECTOR ERROR, ENVIRON. MINUS NAV. VALUE
		POSTMANEUVER TARGET MINUS CURRENT PERIGEE ALTITUDE
	POSERR	MAG. OF POSITION ERROR VECTOR, ENVIRON. MINUS NAV. VALUE
	THRUST(1)	THRUST OF SSME NO. 1
	THRUST(2)	THRUST OF SSME NO. 2
	THRUST(3)	THRUST OF SSME NO. 3
	TMPS	TOTAL THRUST, SSME ENGINES
	TOMS	TOTAL THRUST OF OMS ENGINES
	TRCS	THRUST OF TX RCS JET
		MPS USEABLE PROPELLANT REMAINING
OMS?		~~RCS~~ USEABLE PROPELLANT REMAINING
	WEIGHT	TOTAL VEHICLE WEIGHT
CUR-HA		CURRENT APOGEE ALTITUDE
CUR-HP		CURRENT PERIGEE ALTITUDE
	DRNG	DOWN RANGE,LAUNCH SITE TO VEHICLE
V90H2202C	PHIBD	ROLL ATTITUDE (EULER)
V90H2217C	THEBD	PITCH ATTITUDE (EULER)
V90H2230C	PSIBD	YAW ATTITUDE (EULER)

	TT-X		TIME-TO-NEXT APSIS
		EBDB1	BODY ATTITUDE ERROR VECTOR FOR DISPLAY
	TTX-FLAG-DISP		NEXT APSIS OR CIRCULAR ORBIT FLAG
	WFBIFB	WFBFB1	BODY RATE COMMAND,ROLL
		WFBFB2	BODY RATE COMMAND,PITCH
		WFBFB3	BODY RATE COMMAND,YAW
V94U3800C	VGO-DISP		VGO IN CURRENT BODY COORDINATES
V94U3801C			
V94U3802C			
V95H3528C		PD	ACTUAL BODY RATE, ROLL
		PD	ACTUAL BODY RATE, ROLL
	PORB	PORB	ROLL RATE,ORBITER RATE GYROS
V95H3527C		QD	ACTUAL BODY RATE, PITCH
		QD	ACTUAL BODY RATE, PITCH
	QORB	QORB	PITCH RATE,ORBITER RATE GYROS
V95H3526		RD	ACTUAL BODY RATE, YAW
		RD	ACTUAL BODY RATE, YAW
	RORB	RORB	YAW RATE,ORBITER RATE GYROS
V90U1966C	DV-TOT		VGO MAGNITUDE
		DPD	ROTAT. ACCEL. ABOUT BODY X-AXIS
		DQD	ROTAT. ACCEL. ABOUT BODY Y-AXIS
		DRD	ROTAT. ACCEL. ABOUT BODY Z-AXIS
V95P3011C		QBR	DYNAMIC PRESSURE (GN&C)
V95P3170C		QBR	DYNAMIC PRESSURE (NAV. DERIV.)
		QBR	DYNAMIC PRESSURE
	VEH-PITCH		PREMANEUVER ATTITUDE,PITCH
	VEH-YAW		PREMANEUVER ATTITUDE,YAW
	VEH-ROLL		PREMANEUVER ATTITUDE,ROLL
V95H3156C		ALD	ANGLE OF ATTACK
		ALD	ANGLE OF ATTACK
V90H2249C		BED	SIDESLIP ANGLE
		BED	SIDESLIP ANGLE
			ACTUAL MINUS PREDICTED VGO
		AX	ACCELERATION,X-COMP.,BODY AXES
		AY	ACCELERATION,Y-COMP.,BODY AXES
		AZ	ACCELERATION,Z-COMP.,BODY AXES
		NXGS	LOAD FACTOR, X-COMP.,BODY AXES
		NYGS	LOAD FACTOR, Y-COMP.,BODY AXES
		NZGS	LOAD FACTOR, Z-COMP.,BODY AXES



		NTGS	TOTAL LOAD FACTOR
V94L3804C			EXT.DELV VECTOR IN M50 COORDINATES
V9413805C			
V94I3806C			
		LSTOT	TOTAL SLOSHING ROLL MOMENT
		MSTOT	TOTAL SLOSHING PITCH MOMENT
		NSTOT	TOTAL SLOSHING YAW MOMENT
		FYS	SLOSH FORCE,Y-COMP.,BODY AXES
		FZS	SLOSH FORCE,Z-COMP.,BODY AXES
		ZTALH	LH2 DAMPING RATIO
		ZTALX	LOX DAMPING RATIO
		OM1LH	LH2 SLOSH MASS NATURAL FREQUENCY
		OM1LOX	LOX SLOSH MASS NATURAL FREQUENCY
	RT	RT	TARGET POSITION VECTOR
	Q-CB-M50		M50 TO COMMANDED BODY QUATERNION
		PCIO	ROLL TRIM INTEGRATOR
		PCIO	ROLL TRIM INTEGRATOR
		QCIO	PITCH TRIM INTEGRATOR
		RCIO	YAW TRIM INTEGRATOR
		DMORBT	ORBITER PITCH TRIM
		DPTVC	ROLL GIMBAL ANGLE COMMAND
		DQTVC	PITCH GIMBAL ANGLE COMMAND
		DRTVC	YAW GIMBAL ANGLE COMMAND
		DDEY(2)	PITCH GIMBAL RATE, NO. 2 ENGINE
		DDEY(3)	PITCH GIMBAL RATE, NO. 3 ENGINE
		DDEZ(1)	YAW GIMBAL RATE, NO. 1 ENGINE
		DDEZ(2)	YAW GIMBAL RATE, NO. 2 ENGINE
		DDEZ(3)	YAW GIMBAL RATE, NO. 3 ENGINE
V95H3523C	EBFB	EBFB1	BODY ATTITUDE ERROR,ROLL
V95H3521C		EBFB2	BODY ATTITUDE ERROR,PITCH
V95H3522C		EBFB3	BODY ATTITUDE ERROR,YAW
		DEYA(1)	PITCH GIMBAL ANGLE FROM NULL, NO. 1 ENGINE
	DYC1	DYC1	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 1 ENGINE
		DEYA(2)	PITCH GIMBAL ANGLE FROM NULL, NO. 2 ENGINE
	DYC2	DYC2	COMMAND PITCH GIMBAL ANGLE FROM NULL

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		NO. 2 ENGINE
	DEYA(3)	PITCH GIMBAL ANGLE FROM NULL, NO. 3 ENGINE
DYC3	DYC3	COMMAND PITCH GIMBAL ANGLE FROM NULL NO. 3 ENGINE
	DEZA(1)	YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE
DZC1	DZC1	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 1 ENGINE
	DEZA(2)	YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE
DZC2	DZC2	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 2 ENGINE
	DEZA(3)	YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE
DZC3	DZC3	COMMANDED YAW GIMBAL ANGLE FROM NULL NO. 3 ENGINE
	NYAWJA	NO. OF AFT YAW JETS FIRING
	NYAWJF	NO. OF FWD YAW JETS FIRING
	NZRAFT	NO. RT.AFT PLUS/MINUS Z JETS FIRING
	NZLAFT	NO. LT.AFT PLUS/MINUS Z JETS FIRING
	NXJETS	NO. OF PLUS XRCS JETS FIRING
	NZFWD	NO. OF FWD PLUS/MINUS Z JETS FIRING
		SRB SEPARATION COMMAND FLAG
		GUIDANCE READY FLAG
		MPS GUIDANCE CUTOFF TASK DISCRETE FLAG
		MECO COMMANDED FLAG
		MECO CONFIRMED FLAG
		AUTO SEP MNVR COMPLETE
		OPS 104 PRO FLAG
		BURN ENABLE
		OMS CUTOFF CONFIRMED
		OPS 105 PRO FLAG
		OPS 106 PRO FLAG
		RTLS ABORT REQUEST FLAG
		AOA ABORT REQUEST FLAG
		ATO ABORT REQUEST FLAG

SRB SEPARATION, OPERATIONAL MEASUREMENTS

DOWNLIST OR DOWNLINK	DOWNLIST OR DOWNLINK	PARAMETER

PF SC CR XY DP SN

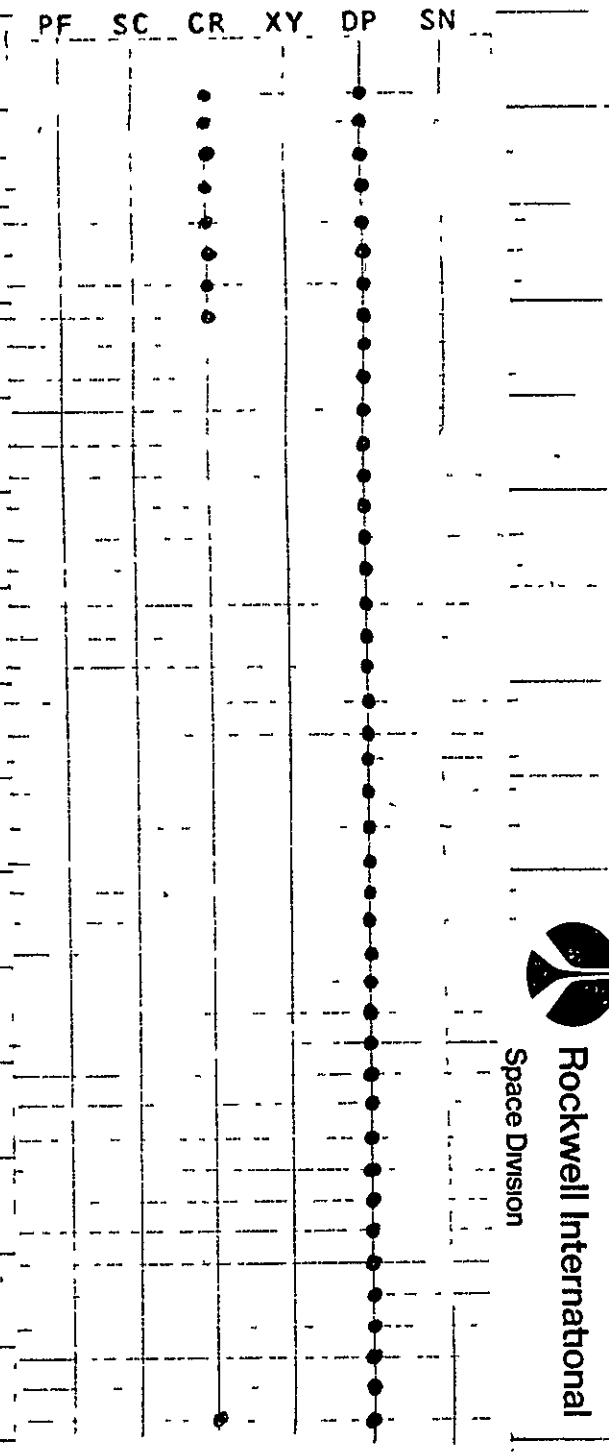
IDENTIFICAT LEFT SRB	IDENTIFICAT. RIGHT SRB	
B55E1100C	B55E2100C	POWER, RSS RCVR SIG STRENGTH A
B55E1101C	B55E2101C	POWER, RSS RCVR SIG STRENGTH B
B58H1150C	B58H2150C	POSITION, TVC ROCK ACTUATOR
B58H1151C	B58H2151C	POSITION, TVC TILT ACTUATOR
B47P1300C	B47P2300C	PRESSURE A, SRM CHAMBER
B47P1301C	B47P2301C	PRESSURE B, SRM CHAMBER
B47P1302C	B47P2302C	PRESSURE C, SRM CHAMBER
B76V1600C	B76V2600C	VOLTAGE, OPERATIONAL BUS A
B76V1601C	B76V2601C	VOLTAGE, OPERATIONAL BUS B
B55V1605C	B55V2605C	VOLTAGE, FWD THRUST PIN PIC CAP A
B55V1606C	B55V2606C	VOLTAGE, FWD THRUST PIN PIC CAP B
B55V1607C	B55V2607C	VOLTAGE, AFT UPPER BRACE PIC CAP A
B55V1608C	B55V2608C	VOLTAGE, AFT UPPER BRACE PIC CAP B
B55V1609C	B55V2609C	VOLTAGE, AFT MIDDLE BRACE PIC CAP A
B55V1610C	B55V2610C	VOLTAGE, AFT MIDDLE BRACE PIC CAP B
B55V1611C	B55V2611C	VOLTAGE, AFT LOWER BRACE PIC CAP A
B55V1612C	B55V2612C	VOLTAGE, AFT LOWER BRACE PIC CAP B
B55V1613C	B55V2613C	VOLTAGE, FWD SEPN MOTORS PIC CAP A
B55V1614C	B55V2614C	VOLTAGE, FWD SEPN MOTORS PIC CAP B
B55V1615C	B55V2615C	VOLTAGE, AFT SEPN MOTORS PIC CAP A
B55V1616C	B55V2616C	VOLTAGE, AFT SEPN MOTORS PIC CAP B
B55X1869X	B55X2869X	EVENT, RSS S&A DEVICE SAFED
B55X1871X	B55X2871X	EVENT, RSS DECODER A ON/CHK TONEOFF
B55X1872X	B55X2872X	EVENT, RSS DECODER B ON/CHK TONEOFF
B58K3750C	B58K4750C	TVC ROCK ACTUATOR CONTROL A CMD
B58K3754C	B58K4754C	TVC TILT ACTUATOR CONTROL A CMD
B58P1311A	B58P2311A	DELTA PRESS SECONDARY A ROCK
B58P1315A	B58P2315A	DELTA PRESS SECONDARY A TILT

SRB SEPARATION, ORBITER/SRB INSTRUMENTATION

DOWNLIST OR DOWNLINK IDENTIFICAT	PARAMETER
V90P2535C	SELECTED LEFT PRESS SRB CHAMBER
V90P2536C	SELECTED RIGHT PRESS SRB CHAMBER
V90R2525C	SELECTED LEFT SRB PITCH RATE

PF SC CR XY DP SN

V90R2526C	SELECTED LEFT SRB YAW RATE
V90R2527C	SELECTED RIGHT SRB PITCH RATE
V90R2528C	SELECTED RIGHT SRB YAW RATE
V90R5301C	SELECTED RGA ROLL RATE
V90R5321C	SELECTED RGA PITCH RATE
V90R5341C	SELECTED RGA YAW RATE
V90A5361C	SELECTED AA LATERAL ACCELERATION
V90A5381C	SELECTED AA NORMAL ACCELERATION
V58H1100A	MPS ENG 1 P ACTUATOR POSITION
V58H1150A	MPS ENG 1 Y ACTUATOR POSITION
V58H1200A	MPS ENG 2 P ACTUATOR POSITION
V58H1250A	MPS ENG 2 Y ACTUATOR POSITION
V58H1300A	MPS ENG 3 P ACTUATOR POSITION
V58H1350A	MPS ENG 3 Y ACTUATOR POSITION
V90X8193X	SRB SEP MONITOR FLAG
V90X8330X	FUNCTION MODING FOR SRB SEP
V90X8331X	SRB SEPARATION COMMAND FLAG
V90X8333X	SRB SEPARATION INITIATION FLAG
V90X1761X	SRB SEPARATION SUBPHASE FLAG
V90X8340X	SRB AUTO INHIBIT CREW ALERT
V90X8332X	LH/RH SRB PC 50 PSIA FLAG
V90X1713X	STG1 GUID. DISCRETE
V90X1757X	S2G STEERING MODE FLAG
V90X8630X	INITIATE STAGE 2 GUIDANCE
V90Q8001C	MAJOR MODE CODE
V90X1714X	FREEZE DESIRED BODY COMMAND FLAG
V90X1743X	SRB TVC FDIR BYPASS PERMITTED
V90X8561X	MECO CONFIRMED FLAG
V90X1965X	GUIDANCE READY FLAG
V90X1763X	SSME FAILURE STATUS FLAG
V95X1207X	MPS E1 FAIL FLAG
V95X1208X	MPS E2 FAIL FLAG
V95X1209X	MPS E3 FAIL FLAG
V90X7570X	SEL SRB SEPARATION AUTO COMMAND
V90X7471X	SEL SRB SEPN MNL/AUTO ENABLE COMMAND
V90X7572X	SEL SRB SEPARATION INITIATE COMMAND
V58K1164C	MPS ENG 1 P ACTUATOR A COMMAND
V58K1168C	MPS ENG 1 Y ACTUATOR A COMMAND
V58K1264C	MPS ENG 2 P ACTUATOR A COMMAND
V58K1268C	MPS ENG 2 Y ACTUATOR A COMMAND
V58K1364C	MPS ENG 3 P ACTUATOR A COMMAND
V58K1368C	MPS ENG 3 Y ACTUATOR A COMMAND
V95H3521C	BODY PITCH ATTITUDE ERROR



		PF	SC	CR	XY	DP	SN
V95H3522C	BODY YAW ATTITUDE ERROR						
V95H3523C	BODY ROLL ATTITUDE ERROR						
V72H0925C	LH ADI ROLL ATTITUDE ERROR						
V72H0927C	LH ADI PITCH ATTITUDE ERROR						
V72H0929C	LH ADI YAW ATTITUDE ERROR						
V72K8504X	LH ADI ERROR SCALE - HIGH						
V72K8505X	LH ADI ERROR SCALE - MED						
V72K8506X	LH ADI ERROR SCALE - LOW						
V95P0500C	DERIVED ASCENT DYNAMIC PRESSURE						
V95H3526C	PITCH RATE, FLIGHT BODY-INERTIAL						
V95H3527C	YAW RATE, FLIGHT BODY-INERTIAL						
V95H3528C	ROLL RATE, FLIGHT BODY-INERTIAL						
V79H2150A	MPS ENG 1 PITCH ACTUATOR A DRIVER OUT						
V79H2165A	MPS ENG 2 PITCH ACTUATOR A DRIVER OUT						
V79H2180A	MPS ENG 3 PITCH ACTUATOR A DRIVER OUT						
V79H2151A	MPS ENG 1 YAW ACTUATOR A DRIVER OUT						
V79H2166A	MPS ENG 2 YAW ACTUATOR A DRIVER OUT						
V79H2181A	MPS ENG 3 YAW ACTUATOR A DRIVER OUT						
V79H2110A	SRB LH ROCK ACTUATOR A DRIVER OUT						
V79H2111A	SRB LH TILT ACTUATOR A DRIVER OUT						
V79H2130A	SRB RH ROCK ACTUATOR A DRIVER OUT						
V79H2131A	SRB RH TILT ACTUATOR A DRIVER OUT						
V71L4240B	IMU2 ACCUMULATED VZ						

SRB SEPARATION, ORBITER/SRB INSTRUMENTATION, BFS

DOWNLIST OR DOWNLINK IDENTIFICAT	PARAMETER	PF	SC	CR	XY	DP	SN
V98M0740P	SM DISCRETE WORD 3 (ASCENT)						
V98X0482X	SRB SEPARATION						
V98X0483X	SRB SEPARATION MONITOR						
V98X0484X	SRB SEPARATION COMMAND						
V98X0732X	SRB SEPARATION INITIATE FLAG						
V98X0731X	SRB SEPARATION COMMAND FLAG						
V98X0741X	SRB SEPARATION AUTO						
V98X0742X	SRB SEPARATION AUTO/MAN						
V98X0743X	SRB SEPARATION MANUAL OVERRIDE						
V98X0744X	SRB SEPARATION ARM COMMAND						
V98X0745X	SRB SEPARATION FIRE COMMAND						
V98X0746X	FUNCTION MODING FOR SRB SEPARATION						

		PF	SC	CR	XY	DP	SN
V98R1550C	ROLL RATE						
V98R1551C	PITCH RATE						
V98R1552C	YAW RATE						
V98H1565C	ROLL ATTITUDE ERROR						
V98H1566C	PITCH ATTITUDE ERROR						
V98H1567C	YAW ATTITUDE ERROR						
V98A1580C	NORMAL ACCELERATION						
V98A1581C	LATERAL ACCELERATION						
V98R1701C	LEFT SRB PITCH RATE GYRO						
V98R1702C	LEFT SRB YAW RATE GYRO						
V98R1706C	RIGHT SRB PITCH RATE GYRO						
V98R1707C	RIGHT SRB YAW RATE GYRO						
V98H1720C	LEFT SRB ROCK						
V98H1721C	LEFT SRB TILT						
V98H1730C	RIGHT SRB ROCK						
V98H1731C	RIGHT SRB TILT						
V98P1740C	LEFT SRB CHAMBER PRESSURE						
V98P1741C	RIGHT SRB CHAMBER PRESSURE						
V98H1750C	SSME 1 PITCH COMMAND						
V98H1751C	SSME 1 YAW COMMAND						
V98H1760C	SSME 2 PITCH COMMAND						
V98H1761C	SSME 2 YAW COMMAND						
V98H1770C	SSME 3 PITCH COMMAND						
V98H1771C	SSME 3 YAW COMMAND						
V98U1901C	MM 102 EVENT WORD						
V98U1902C	MM 103 EVENT WORD						
V98X0456X	GUIDANCE INITIATE						
V98M0560P	BFS SYSTEM STATUS WORD 1						
V98U0567C	OPS-MAJOR MODE						
V98H3019C	ROLL COMMAND						
V98H3020C	PITCH RATE COMMAND						
V98H3021C	YAW COMMAND						

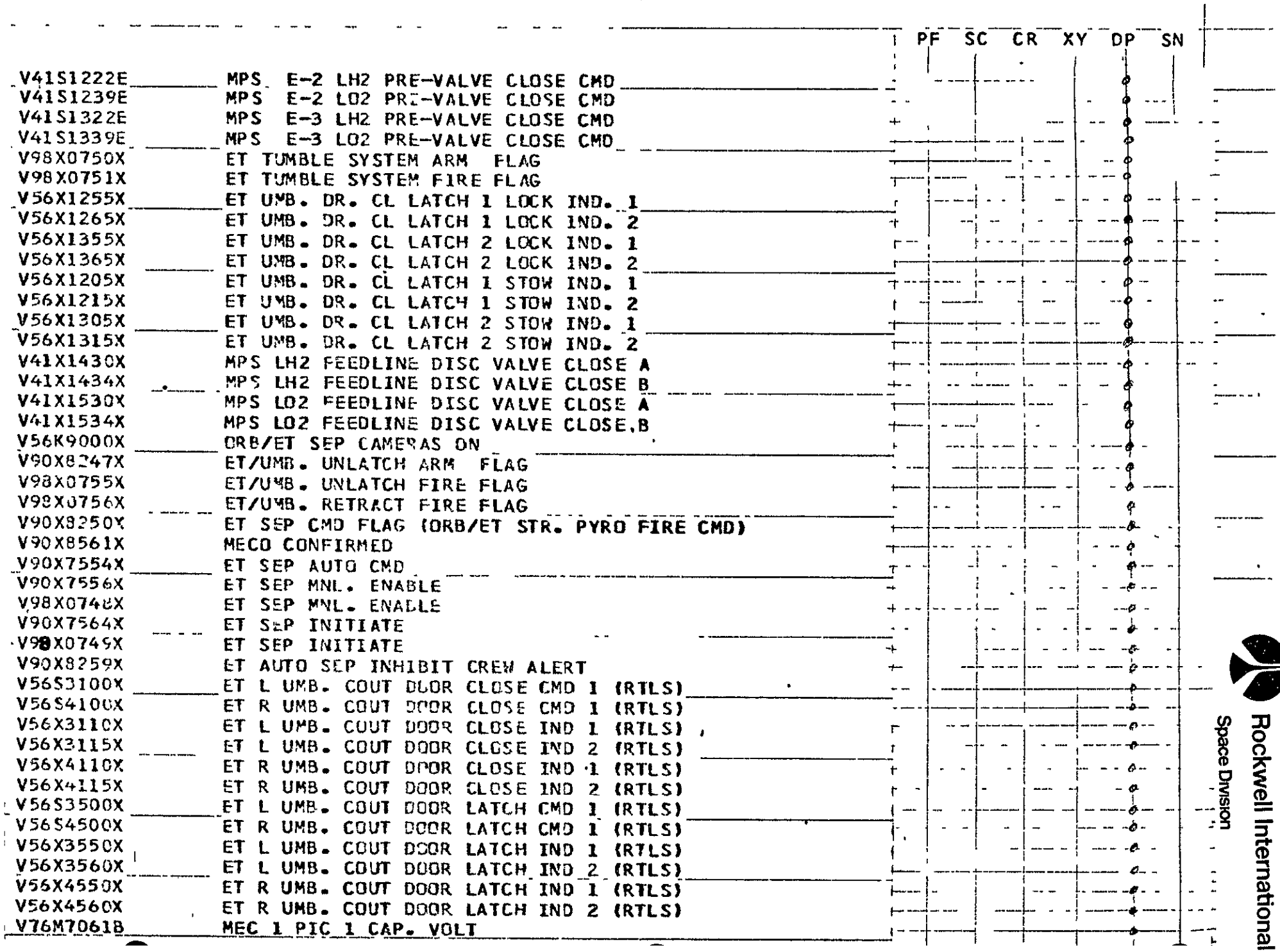
C

ET SEPARATION, SAIL DNLT/KNLK MEASUREMENT LIST REQUIREMENTS

DOWNLIST DOWNLINK OR DUMMY MML IDENTIFICAT	NOMENCLATURE	PF	SC	CR	XY	DP	SN
V90R5301C	SEL. RGA ROLL RATE						

Rockwell International
Space Division

		PF	SC	CR	XY	DP	SN
V90R5321C	SEL. RGA PITCH RATE						
V90R5341C	SEL. RGA YAW RATE						
V72H0925C	LH ADI ROLL ATTITUDE ERROR						
V72H0927C	LH ADI PITCH ATTITUDE ERROR						
V72H0929C	LH ADI YAW ATTITUDE ERROR						
V79K2402X	RJDF 1 JET F1L CMD A						
V79K2403X	RJDF 1 JET F1U CMD A						
V79K2404X	RJDF 1 JET F1D CMD A						
V79K2406X	RJDF 1 JET F2R CMD A						
V79K2407X	RJDF 1 JET F2U CMD A						
V79K2408X	RJDF 1 JET F2D CMD A						
V79K2410X	RJDF 2 JET F3L CMD A						
V79K2411X	RJDF 2 JET F3U CMD A						
V79K2412X	RJDF 2 JET F3D CMD A						
V79K2413X	RJDF 2 JET F4R CMD A						
V79K2414X	RJDF 2 JET F4D CMD A						
V79K2416X	RJDA 1 JET L1L CMD A						
V79K2419X	RJDA 1 JET L1U CMD A						
V79K2420X	RJDA 1 JET L2L CMD A						
V79K2421X	RJDA 1 JET L2U CMD A						
V79K2422X	RJDA 1 JET L2D CMD A						
V79K2424X	RJDA 2 JET L3L CMD A						
V79K2425X	RJDA 2 JET L3D CMD A						
V79K2426X	RJDA 2 JET L4L CMD A						
V79K2427X	RJDA 2 JET L4U CMD A						
V79K2428X	RJDA 2 JET L4D CMD A						
V79K2432X	RJDA 1 JET R1R CMD A						
V79K2433X	RJDA 1 JET R1U CMD A						
V79K2434X	RJDA 1 JET R2R CMD A						
V79K2435X	RJDA 1 JET R2U CMD A						
V79K2436X	RJDA 1 JET R2D CMD A						
V79K2438X	RJDA 2 JET R3R CMD A						
V79K2439X	RJDA 2 JET R3D CMD A						
V79K2440X	RJDA 2 JET R4R CMD A						
V79K2441X	RJDA 2 JET R4U CMD A						
V79K2442X	RJDA 2 JET R4D CMD A						
V41S1447E	MPS LH2 FEEDLINE RELIEF S/O VALVE CLOSE CMD						
V41X1442E	MPS LH2 FEEDLINE RELIEF S/O VALVE CLOSED						
V41S1547E	MPS LO2 FEEDLINE RELIEF S/O VALVE CLOSE CMD						
V41X1542E	MPS LO2 FEEDLINE RELIEF S/O VALVE CLOSED						
V90X8560X	ALL PRE-VALVES CMD CLOSE IND.						
V41S1122E	MPS E-1 LH2 PRE-VALVE CLOSE CMD						
V41S1139E	MPS E-1 LO2 PRE-VALVE CLOSE CMD						



Rockwell International
Space Division

		PF	SC	CR	XY	DP	SN
V76M7062B	MEC 1 PIC 2 CAP. VOLT						
V76M7065B	MEC 1 PIC 3 CAP. VOLT						
V76M7066B	MEC 1 PIC 4 CAP. VOLT						
V76M7069B	MEC 1 PIC 5 CAP. VOLT						
V76M7070B	MEC 1 PIC 6 CAP. VOLT						
V76M7073B	MEC 1 PIC 7 CAP. VOLT						
V76M7074B	MEC 1 PIC 8 CAP. VOLT						
V76M7077B	MEC 1 PIC 9 CAP. VOLT						
V76M7161B	MEC 2 PIC 1 CAP. VOLT						
V76M7162B	MEC 2 PIC 2 CAP. VOLT						
V76M7165B	MEC 2 PIC 3 CAP. VOLT						
V76M7166B	MEC 2 PIC 4 CAP. VOLT						
V76M7169B	MEC 2 PIC 5 CAP. VOLT						
V76M7170B	MEC 2 PIC 6 CAP. VOLT						
V76M7173B	MEC 2 PIC 7 CAP. VOLT						
V76M7174B	MEC 2 PIC 8 CAP. VOLT						
V76M7177B	MEC 2 PIC 9 CAP. VOLT						
V90Q8001C	MAJOR MODE CODE						
	CRT DISPLAY, SEP						
	ET SEP SEQUENCE - INITIATION AND TERMINATION						
	MEC SOP - INITIATION AND TERMINATION						
	MPS SIGNAL COND. POWER - ON-OFF						
V90X8255X	ET DFI POWER RESET - ON-OFF						
	MEC CRITICAL COMMAND INITIATION & TERMINATION						
	ASCENT DAP - TERMINATION						
	G&C STEER -TERMINATION						
	TRANS DAP - INITIATION						
	RCS CMD SOP -INITIATION						
V90X8258X	MEC 1 & 2 MASTER RESET						
V90H2246C	NAV. DERIVED ANGLE OF ATTACK (RTLS)						
V90H2249C	INERTIAL SIDESLIP ANGLE (RTLS)						
V74M1801P	RADAR ALTIMITER #1 PARENT WORD						
V74X1804B	RADAR ALTIMETER #1 ALTITUDE DATA						
V74M1851P	RADAR ALTIMETER #2 PARENT WORD						
V74M1854B	RADAR ALTIMETER #2 ALTITUDE DATA						
V41X1429X	MPS LH2 FEEDLINE DISC VALVE OPEN						
V41X1529X	MPS LO2 FEEDLINE DISC VALVE OPEN						
V90X8253X	MPS DUMP GIMBAL POS. FLAG						
V90X8254X	ENTRY STOW GIMBAL POS. FLAG						
V56K1250X	ET UMB. DOOR CENTERLINE LATCH 1 LOCK CMD 1A						
V56K1260X	ET UMB. DOOR CENTERLINE LATCH 1 LOCK CMD 2A						
V56K1350X	ET UMB. DOOR CENTERLINE LATCH 2 LOCK CMD 1A						
V56K1360X	ET UMB. DOOR CENTERLINE LATCH 2 LOCK CMD 2A						

		PF	SC	CR	XY	DP	SN
V56K1200X	ET UMB. DOOR CENTERLINE LATCH 1 STOW CMD 1A						
V56K1210X	ET UMB. DOOR CENTERLINE LATCH 1 STOW CMD 2A						
V56K1300X	ET UMB. DOOR CENTERLINE LATCH 2 STOW CMD 1A						
V56K1310X	ET UMB. DOOR CENTERLINE LATCH 2 STOW CMD 2A						
V90X7538X	SELECTED RTLS ABORT REQUEST SIGNAL						

8.0 VERIFICATION ANALYSIS REQUIREMENTS

Verification by analysis is required to augment tests conducted in SAIL or on the vehicle. Analysis is used when the results can be considered as valid representations of the actual flight hardware and software performance and where separate tests on SAIL or the vehicle cannot be provided for. Requirements partially or completely verified by analysis are identified in the Verification Requirements Section 5.0. In addition, the specification of required analyses for verification is given in the Master Verification Plan for the Combined Elements (JSC 07700-10-MVP-02) which defines the analysis requirements and controls the documentation of verification completion. The verification by analysis includes the non-real-time, performance and integration, and man-in-the-loop simulations discussed below.

8.1 Non-Real-Time Analysis Requirements

To the maximum extent possible, the Ascent GN&C Verification is performed by hardware/software tests in the SAIL facility. These tests verify system performance under a spectrum of mission and failure conditions. Similar analyses are also performed on analytically developed non-real-time computer simulations. These simulations model the vehicle dynamics and environment in the same manner as SAIL. In addition, the software and hardware which are utilized in SAIL are modeled mathematically in these non-real-time simulations.

The non-real-time simulations (RI CSMP, SSFS and SVDS) are utilized to analyze environmental and system tolerance effects where extensive sets of data are required. These simulations also produce the flight conditions used by structures, aerodynamics thermodynamics, hydraulics and propulsion functions as input data to the verification of subsystems and with launch facilities design to verify adequate clearance and acceptable environments during liftoff.

Correlation between the non-real-time simulations and the SAIL simulations will be demonstrated by comparison of the four test cases (TBS).

8.2 CSDL PERFORMANCE AND INTEGRATION ANALYSIS REQUIREMENTS

Performance and Integration (P&I) testing performed by Draper Laboratory (CSDL) is part of verification by analysis. The test requirements are defined in this plan and the tests serve as checks against SAIL tests and six degree of freedom analysis. The P&I test requirements defined in Table 8.2-1 are for ascent from liftoff through MECO and those defined in Table 8.2-2 are for ascent post MECO through orbit insertion. Table 8.2-3 presents initial conditions to be used as a planning reference for orbit insertion testing. The initial conditions are subject to change and the appropriate data base initial conditions from the Ascent Integrated GN&C SDM should be used. The tests identified with an asterisk in both Tables 8.2-1 and 8.2-2 are the comparison test cases common to other facility tests.

8.3 Man-In-The-Loop Analysis Requirements

Man-in-the-loop (MIL) simulations for Shuttle Ascent flight phase are conducted in the Shuttle Procedures Simulation (SPS). The purpose of these simulations is to evaluate baseline software/hardware requirements and to develop requirements changes for Ascent Manual GN&C capability. The general test plan is documented in IGNCV/77-1095, SPS Ascent MIL Simulation General Test Plan, dated 11 October 1977. This document defines test objectives and controls the subsequent definition of detail test plans which are published three weeks prior to start of production runs and test analysis reports.

TABLE 8.2-1 P&I TEST MATRIX FOR LIFTOFF THROUGH MECO

NO	TYPE	MODE	ATM	WIND		DISPERSIONS	FAILURES	
				DIR	GUST		ENGINE	OTHER
1*	NOM	AUTO	STD	MEAN	-	NONE	NONE	NONE
2	NOM	AUTO	STD	MEAN	-	THRUST MISMATCH SRB 4 HI, THRUST MISALIGNMENT	#1 AT T_{GO} = 10 SEC	SRB P_C #1& #2 HIGH
3	NOM	MANUAL	STD	MEAN	-	THRUST MISMATCH SRB 4 HI, THRUST MISALIGNMENT	NONE	NONE
4	ATO	AUTO	STD	MEAN	-	NONE	#3 AT 243 SEC	NONE
5	ATO	AUTO	STD	MEAN	-	NONE	#1 AT 218 SEC	NONE
6	ATO	MANUAL	STD	MEAN	-	NONE	#3 AT 218SEC	NONE
7	ATO	AUTO	STD	125°	M=1.25	NONE	#3 AT 218SEC	NONE
8	AOA	AUTO	STD	MEAN	-	NONE	#3 at 213 SEC	NONE
9	AOA	AUTO	STD	36°	M=1.25	NONE	NONE	NONE
10	AOA	MANUAL	STD	305	M=1.25	NONE	#3 AT 213 SEC	NONE
11	AOA	AUTO	STD	305	M=1.25	NONE	#1 AT SEC	NONE
12*	AOA	AUTO	STD	MEAN	-	ALL 3 SSME'S AT -3 σ THRUST	#2 AT TARGET-CNG (210SEC)	NONE
13	RTLS	AUTO	STD	125°	M=1.25	NONE	#3 AT T = 0	NONE
14	RTLS	AUTO	STD	125°	M=1.25	THRUST MISMATCH SRB 4 HI, THRUST MISALIGNMENT	#3 AT t =130	NONE
15	RTLS	AUTO	STD	220°	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT	#3 at t =210	NONE

* COMMON FACILITY CHECK CASE

TABLE 8.2-1 P&I TEST MATRIX FOR LIFTOFF THROUGH MECO (Continued)

NO	TYPE	MODE	ATM	WIND		DISPERSIONS	FAILURES	
				DIR	GUST		ENG	OTHER
16	RTLS	AUTO	STD	125	M=1.25	THRUST MISMATCH SRB 4 HI, THRUST MISALIGNMENT	#1 AT t = 0	NONE
17	RTLS	AUTO	STD	220	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT	NONE	NONE
18	RTLS	MANUAL L	STD	220	M=1.25	NONE	NONE	#1 ACCEL HARDOVER AT t = 45
19	RTLS	MANUAL	STD	305	M=1.25	NONE	#3 AT t = 0	GYRO #1 HARDOVER AT t = 130
20	RTLS	MANUAL	STD	305	M=1.25	NONE	#3 AT t =130	ACT #1 CHANNEL t = 40
21	RTLS	AUTO	STD	305	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT	#1 5 SEC BEF GUST	NONE
22	RTLS	AUTO	STD	220	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT	#3 5 SEC BEF GUST	NONE
23	NOM	AUTO	STD	MEAN	-	TEMP SRB = +	NONE	APU #1 OUT t = 260
24	NOM	AUTO	STD	MEAN	-	TEMP SRB = -	NONE	APU #1 OUT t = 130
25	NOM	AUTO	HOT	MEAN	-	NONE	NONE	NONE
26	NOM	AUTO	HOT	220	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT	NONE	NONE
27	NOM	AUTO	COLD	MEAN	-	NONE	NONE	NONE

* COMMON FACILITY CHECK CASE

TABLE 8.2-1 OFT-1 P&I TEST MATRIX FOR LIFTOFF THROUGH MECO (Continued)

NO	TYPE	MODE	ATM	WIND		DISPERSIONS	FAILURES	
				DIR	GUST		ENG	OTHER
28	NOM	AUTO	COLD	220	M=1.25	NONE	NONE	NONE
29*	NOM	AUTO	STD	125°	M=1.25	NONE	NONE	NONE
30	NOM	AUTO	STD	MEAN		NONE	NONE	NONE
31	NOM	AUTO	STD	305	M=1.25	AERO FORCES + AERO MOMENTS +	NONE	IMU #1 t = 40
32*	ATO	AUTO	STD	220	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT ACCELEROMETER + BIAS, + NOISE	#3 AT EATO (218 SEC)	NONE
33	ATO	AUTO	STD	220	M=1.25	THRUST MISMATCH SRB 5 HI, THRUST MISALIGNMENT IMU + BIAS	#1 AT EATO (218 SEC)	NONE
34	NOM	AUTO	STD	220	M=1.25	THRUST MISMATCH SRB 4 HI THRUST MISALIGNMENT	NONE	#1 Pc & #2 P_c At t=50
35	RTLS	AUTO	STD	125	M=.9	THRUST MISMATCH SRB 4 HI THRUST MISALIGNMENT	NONE	APU #1 At t=0
36	RTLS	AUTO	STD	305	M=.9	THRUST MISMATCH SRB 4 HI THRUST MISALIGNMENT	NONE	APU #1 AND APU #2 t = 0
37	RTLS	MANUAL	STD	305	M=.9	NONE	NONE	APU #1 AND t = 120 APU #2 t = 260

* COMMON FACILITY CHECK CASE

TABLE 8.2-2 P&I TEST MATRIX FOR ORBIT INSERTION

TEST SERIES	MISSION PHASE	TEST RUN	OBJECTIVE	TEST CONSTRAINTS	IC'S
I	MECO/OI	1 2	Verify Orbit Insertion Compliance for Normal (Error Free) Conditions and for Nominal (All Parameters Having 1 Values) Conditions.	Conduct Test using Error-Free Parameter Values from MECO to Orbit Insertion.	2
II	MECO/OI	3	Verify Orbit Insertion Accuracy as Function of OMS Thrust Deviation	Conduct Orbit Insertion Test Using One OMS Engine with Maximum Thrust & Long Cutoff Impulse and Other OMS Engine with Minimum Thrust & Short Cutoff Impulse	2
III	MECO/OI	4	Verify Orbit Insertion Parameters using Maximum IMU Alignment Deviation & Maximum IMU Errors.	Perform Orbit Insertion Maneuver using + 3 Alignment Error.	2
		5		Same as Test Run 4 with -3 Alignment Error	2
		6		Same as Test Run 4 Using Worst Case Condition of Runs 4 & 5 Combined with Maximum IMU System Errors.	2
IV	MECO/OI	7	Verify Orbit Insertion Parameters with Maximum Combined Effects of OMS Thrust Deviation, OMS Cutoff Impulse Variation and IMU Alignment and IMU Error Constraints.	Perform Orbit Insertion Maneuver using Conditions of Test Run 6 (Worst Case IMU Alignment and MAX IMU Errors) Combined with OMS Thrust Deviation Conditions Outlined in Test 3.	2
V	OMS 2	8,9, 10	Verify Orbit Insertion Parameters with a Single OMS Failure & RCS Augmentation	Conduct Test Run using Worst Case from Test Series IV Combined with an OMS Engine Failure at Three Selected Critical Times of (1) TIG (2) TIG + 30 (3) TGO = 30 SEC	3

TABLE 8.2-2 P&I TEST MATRIX FOR ORBIT INSERTION
(Continued)

VI	OMS-2	II	Verify Orbit Insertion Parameters with Single OMS Failure & RCS Augmentation Plus Component Failures Requiring Redundancy Management Implementation.	Conduct Test Run using Worst Case Condition from Test Series V Combined with Critical/ Component Failures of an IMU Accelerometer, Inertial Gyro, Rate Gyro & TVC System	3
VII	2nd Stage Through ATO	12	Verify Orbit Insertion Parameters for Selected ATO Abort Modes using Various Combination of OMS/RCS Burns with SSME or OMS Engine Failures.	Burn Duration for Post-MECO (initiated at OMS-1 Ignition) Burn of the Four +X RCS Jets Depleting AFT RCS Propellents with OMS Engine Failure at T = TIG secs.	2
		13		Maximum Pre-MECO Burn Duration for 2 OMS Engines Depleting OMS Propellents after Failure of SSME at T = 218.	1
		14		Maximum Pre-MECO Burn Duration for 2 OMS Engines and Four +X RCS JETS Depleting OMS Propellent after Failure of SSME at T = 218	1
		15		Burn Duration for Pre-MECO Burn of Four +X RCS Jets Depleting AFT RCS Propellents After SSME Failure at T = TBS	1
		16		Burn Duration for Pre-MECO Burn of Fourteen RCS Null Jets Depleting OMS Propellents After SSME Failure at T = TBS	1
		17		Burn Duration for Pre-MECO Burn of 8 RCS Null Jets Depleting AFT RCS Propellents After Single SSME Failure at T = TBS.	1

TABLE 8.1-3 P&I ORBIT INSERTION TEST IC'S

SET 1	SET 2	
Nominal SRB Staging Reset Point at GET=122.684 secs. (SRB's Jettisoned):	Nominal MECO Reset Point at GET=524.02 secs.	Nominal OMS 2 Ignition - 203.0 sec. Reset Point, GET=2341.2 secs.
A. M50 Position Vector (feet) $X_{m50} = 7.7075332 \times 10^6$ $Y_{m50} = -1.6796929 \times 10^7$ $Z_{m50} = 1.0097365 \times 10^7$	A. M50 Position Vector (feet) $X_{m50} = 1.0844748 \times 10^7$ $Y_{m50} = -1.3719811 \times 10^7$ $Z_{m50} = 1.2142303 \times 10^7$	A. M50 Position Vector (feet) $X_{m50} = 5.8590223 \times 10^6$ $Y_{m50} = 2.0839909 \times 10^7$ $Z_{m50} = -2.7122143 \times 10^6$
B. M50 Velocity Vector (fps) $VX_{m50} = 3.2974953 \times 10^3$ $VY_{m50} = 5.1073900 \times 10^2$ $VZ_{m50} = 3.4327863 \times 10^3$	B. M50 Velocity Vector (fps) $VX_{m50} = 1.6968414 \times 10^4$ $VY_{m50} = 1.8320777 \times 10^4$ $VZ_{m50} = 5.9396348 \times 10^3$	B. M50 Velocity Vector (fps) $VX_{m50} = -1.9809988 \times 10^4$ $VY_{m50} = 3.7573551 \times 10^3$ $VZ_{m50} = -1.5188278 \times 10^4$
C. Body Attitude (deg.) OGA = -163.50556 MGA = -21.185878 IGA = -51.715558	C. Vehicle Body Attitude (deg) OGA = -157.59131 MGA = 15.634643 IGA = -106.75062	C. Vehicle Body Attitude (deg) OGA = -158.97659 MGA = -6.0329699 IGA = -136.05697
D. Total Vehicle Weight, (lbs) 1.5116185×10^6	D. Total Vehicle Weight (lb) 3.0600980×10^5	D. Total Vehicle Weight (lb) 1.9893445×10^5

9.0 VERIFICATION REPORTING

Verification reporting of analysis and tests will be accomplished through reports included in Appendices to the Ascent Integrated GN&C SDM, Test Agency Reports for SAIL and a Verification Completion Notice all with appropriate cross references.

9.1 Test Documentation

Three reports are to be published with regards to SAIL verification tests. These are (1) a quick look report, (2) a 5 day report, and (3) the study analysis report. The quick look and 5 day reports are to be published by the on-site certification team members. The study analysis report will be published by RI/Downey within 60 days of study completion and incorporated in the Ascent Integrated GN&C SDM appendices.

The quick-look report is to be published daily and will be a summary of tests conducted on 1st and 2nd shifts the previous day. This report includes pilot comments, sponsor comments, anomaly log, TOC application program summary sheet, and VDS/GDS data snapshots.

The 5 day report, in addition to the above data, will include a cursory analysis of test results. Also included will be apprintout of results from the pass/fail criteria program and, where applicable, selected continuous form plots.

The Study Analysis Report (SAR) will reflect detailed analyses of all data recorded during a given mission evaluation. The SAR document, to be published on a per mission basis, will address only the performance of the primary GN&C system. Avionics systems other than GN&C are to be documented under separate cover.

9.2 Verification Completion Notice

The Verification Completion Notice (VCN) provides evidence that verification requirements have been satisfied to the extent documented in the VCN. Detailed descriptions of the VCN and corresponding format is given in the Space Shuttle Avionics Verification Plan (SD76-SH-0160). The Ascent Integrated GN&C VCN and supporting system VCN's are indicated in the Section 1.0 verification tree.