Propulsion Module Arrangement Trade

3-P-006

Design Data Book

Volume 3 Hybrid Propulsion Module Configuration

December 17, 1991

Boeing Defense & Space Group

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1.0 Introduction

The objective of the Propulsion Module Arrangement trade is to compare alternative propulsion module concepts for the NLS common core stage and select the configuration that best satisfies program requirements and goals. The selected configuration will be recommended as an update to the reference vehicle configuration for incorporation in the cycle 1 definition. The major issues that are being addressed by this trade are:

- Propulsion module commonality between 50 k and HLLV (DDT&E cost)
- Impact of propulsion module configuration on:
- Weight and performance
- Operations cost
- Manufacturing / launch processing efficiency and flexibility
- System dependability (launch on schedule)
- Suitability of propulsion module for growth vehicles
- Adaptability of propulsion module concept to recovery

The purpose of this trade is to establish the top level configuration for the propulsion module. Subsequent trades and analyses will determine the lower level requirements and design. The design features and characteristics that will be established by this trade are:

- Engine arrangement, spacing, clocking
- Feed system configuration, gimballing concept
- Primary structure configuration
- Engine and TVC
- Holdown concept/location
- Staging concept
- Subsystem location/installation
- Umbilical concept/location
- MLP interface
- Design features for evolution to recovery

The approach we have taken in accomplishing this trade was to identify candidate propulsion module configuration concepts based on the scope and issues being addressed by this trade. Each concept

was formulated from a winning strategy that hypothesized how it might be superior to the reference concept. Previous definition and analysis of vehicle concepts has identified the characteristics that are most important in developing a system that can provide the low cost, high reliability, and improved operability specified for NLS. The winning strategies were developed with these key characteristics in mind. These concepts were defined and analyzed in sufficient depth to address the technical discriminators that were identified as the basis for comparison. In addition to the alternate concepts we have also defined the reference configuration using the same groundrules and methodology to ensure an accurate comparison. The primary focus of the design definition was to determine weight, performance, and cost differences between the concepts. In addition, operations timelines and manpower requirements, and facilities were defined to provide operations costs comparisons.

The results of the definition and analyses of the candidate propulsion module concepts are documented in this data book. The data book is divided into 4 volumes, one for each concept:

Volume 1	Reference Propulsion Module Configuration
Volume 2	Modular Propulsion Module Configuration
Volume 3	Hybrid Propulsion Module Configuration
Volume 4	Reference Configuration / Modular MPS

A set of discriminators was developed by the MSFC propulsion panel for the purposes of evaluating the candidate propulsion module concepts. These discriminators were derived from the overall NLS program goals and requirements and reflect the trade study evaluation criteria developed by level II. The discriminators are:

Cost/Flight

1. Final Assembly, Stacking, & Checkout Cost
2. Maintenance Cost
3. Loading & Launch Cost
4. Manufacturing Cost
5. Assembly Cost

6. Acceptance Testing

Non-Recurring Cost

7. Vehicle Design & Development Engineering
8. Development Testing
9. Verification Testing
10. Handling Equipment
11. Manufacturing Development

Construction of Facilities

12. Launch Facilities
13. Test Facilities

Design Capability

14. Weight
15. Aerodynamic Drag
16. Useable Propellant

Mission Reliability

17. System/Subsystem Complexity
18. Confidence Level

Dependability

19. Maintainability
20. Launch Schedule Reliability

We have attempted to quantify the evaluation of the discriminators in common units to the maximum extent possible. All discriminators under cost / flight have been taken in to account in estimating the cost per flight. Similarly the estimate of non recurring costs includes all the its discriminators. The design capability discriminators have been addressed by estimating vehicle weights and aerodynamic drag, and then using a trajectory simulation to determine resulting payload capability. Based on our analyses of the propulsion module concepts these two categories contain the primary measurable differences between concepts

Each volume in this data book follows the same outline and is divided into the following sections:

1.0 Introduction
2.0 Configuration

2.0 Configuration

3.0 Ascent performance
4.0 Loads
5.0 Structure design
6.0 Structural analysis
7.0 Main propulsion system design
8.0 Weights
9.0 Cost
10.0 Operations
11.0 Reliability

Figure 1-1 provides a cross reference showing which sections address which discriminators. In general all costs are reported in the cost section. However the description of the designs with their producibility and maintainability features that impact costs are contained in the configuration, structures design, and main propulsion system design sections. Similarly the operations flows that provide the basis for the operations cost estimates are described in the operations section.

2.1 Configuration Description

2.1 Hybrid Propulsion Module Arrangement Configuration Description

The hybrid propulsion module arrangement option represents a comprimise position between the reference and modular options. It combines the commonality attributes of two-engine booster propulsion modules with the lightweight, simple design features of the two-engine core stage sustainer section, thereby providing a good performing, cost-effective alternative. The 1&1/2-stage vehicle configuration is comprised of two, two-engine booster propulsion modules located 180 degrees apart on the periphery at the base of the vehicle aft skirt section, and, the two-engine core sustainer section. During a mission, the two booster propulsion modules are first sequentially staged, and then, a section of the aft skirt is staged. The two-engine sustainer section with its own independent conic thrust structure continues to propel the core stage to orbit.

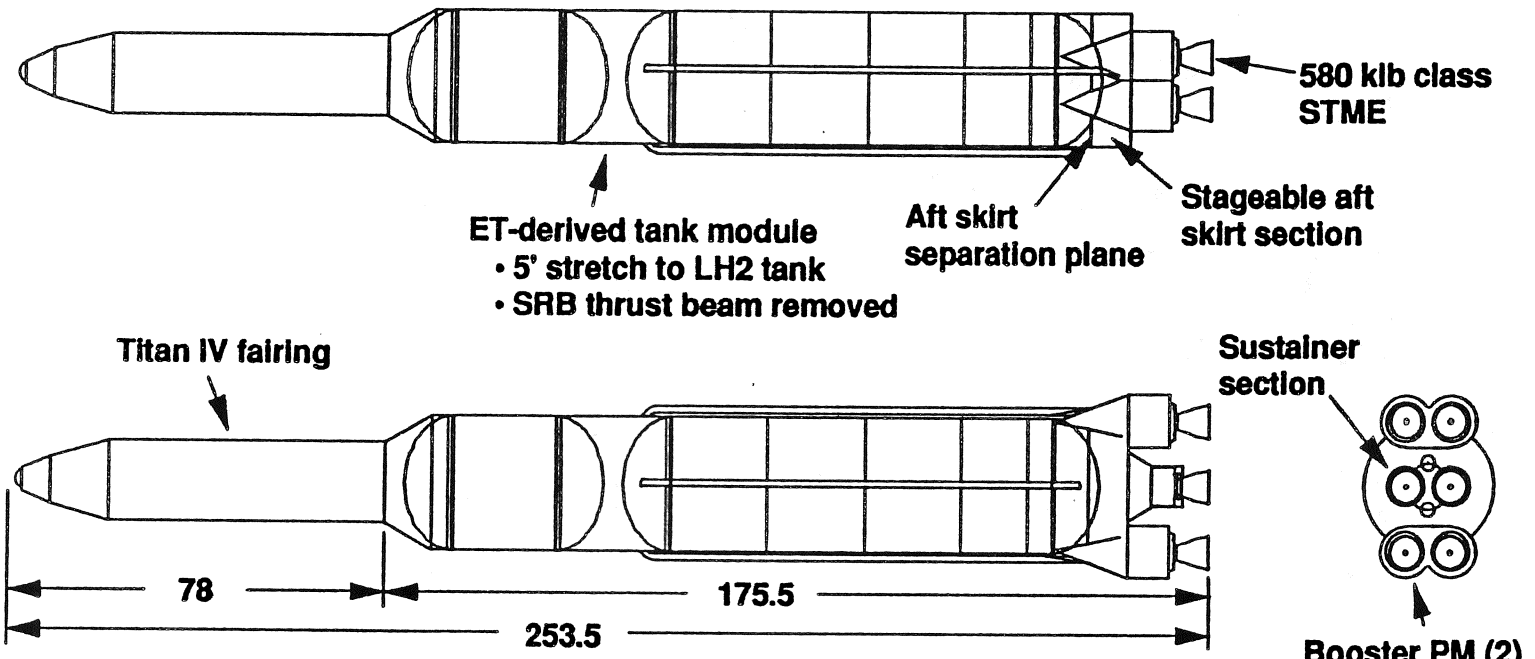
As configured with the reference five feet stretch to the ET liquid hydrogen tank, the 1&1/2-stage vehicle with the hybrid propulsion module arrangement achieves a payload capability of 51,300 pounds to low earth orbit.

For the heavy lift launch vehicle (HLLV) member of the NLS family, two of the modules, configured 180 degrees apart, are used for core stage main propulsion.

The independently integrated design features of the two-engine booster modules allows for parallel processing of the modules and the tank, along with full test and check-out of the modules prior to integration with the rest of the core stage, thereby decreasing serial flow time during ground processing.

The hybrid approach, like the modular arrangement, exhibits a direct path to dry, protected recovery of the engines, avionics, and additional high cost elements within the booster modules, lending the potential for substantial cost per flight reduction.

Hybrid PM Arrangement 50k Vehicle Configuration



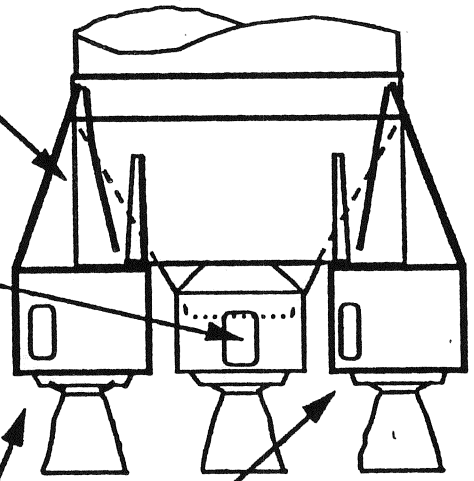
GLOW	1,943,200
Propellant	1,657,600
Core inert	146,000
Booster inert	83,200
Lift capability	56,400
Payload	51,300
Margin	5,100

6 STME
- 583.4 klbf STME
- (2) 2-engine booster PM's
- 2-engine sustainer

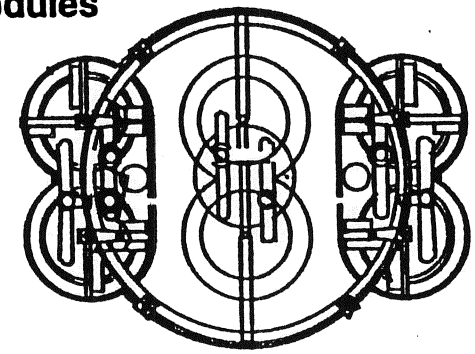
Hybrid Propulsion Module Concept
Modular Booster, Non Modular Core

Aft skirt
- Staged after booster module separation

Sustainer section
- 2 STME's
- Common MPS with booster modules
- Core avionics



Common booster modules
- Independant staging
- 2 STME's
- Fully integrated
- MPS & TVC
- Avionics
- LRU

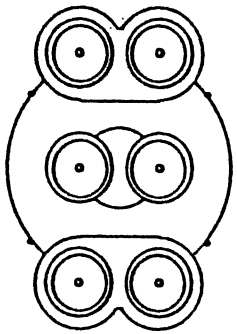


- Increased commonality - reduced DDT&E cost
- Simplified test program
- Parallel processing of booster modules
- Full checkout of booster modules prior to integration with tank
- Sequential staging of booster modules for improved performance, reduced G's
- Direct path to booster dry, protected recovery - lowest cost/flt, least risk approach
- For HLLV only booster modules used
- Sustainer section similar to reference concept for lightest weight
- Increased booster section weight
- More complex separation system

2.3 Evolution to Recovery

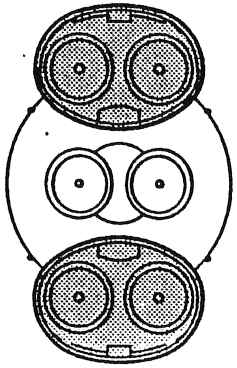
Hybrid Propulsion Module Configuration Evolution to Recovery

Expendable Vehicles



(2) - 2-Engine boost modules
2-Engine sustainer

Recoverable Version



- Dry, protected recovery of booster propulsion modules

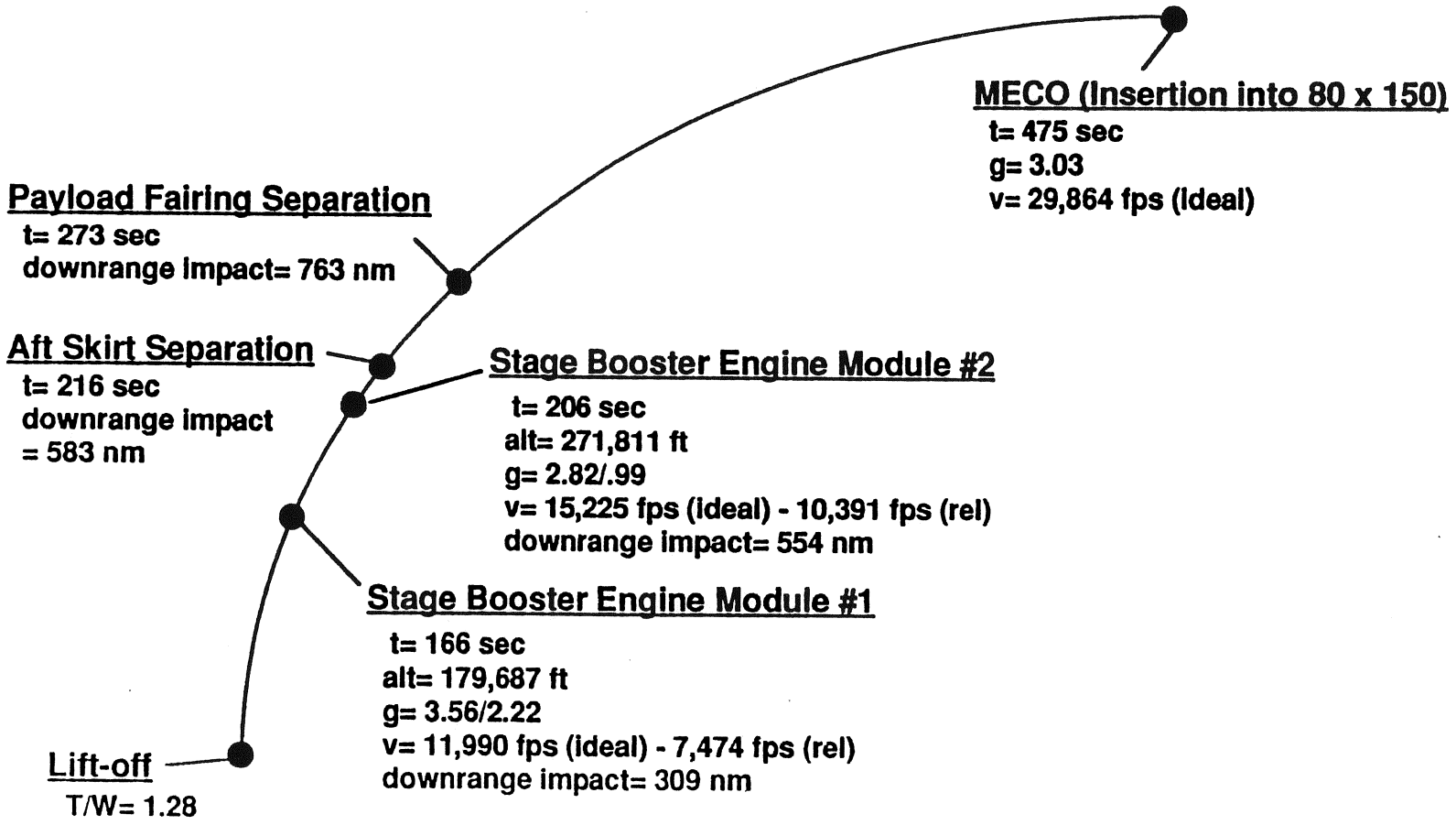
3.0 Ascent Performance

3.0 Ascent Performance

The following charts present results of a trajectory/performance optimization analysis for this propulsion module arrangement option on a 1&1/2-stage vehicle configuration. The first chart describes the mission profile parameters for the configuration, and, the second chart presents raw output data from the trajectory optimization analysis.

3.1 Mission Profile

Hybrid 50k Launch Vehicle Flight Profile



3.2 Ascent Trajectory / Payload Capability

NLS 1.5 Stage	expendable hybrid core engine out at liftoff 28.5° LEO max payload status 11/1/91 weights
date	12/16/91 MM
filename	a520
source	BC...12/16
launch location	ETR
burnout conditions	80nm, 80x150 nm, 28.5°
EARTH	fisher
ATMOSPHERE	patrick 1963
WIND	KSC annual mean
MOMENT BALANCED	no
AERODYNAMICS ref area (ft^2), drag factor	L15S3PA (side-by-side) SF...2/11/91 598 (27.6 ft dia)
PROPULSION	
BOOST	4/4 -> 2/2 STME's
vacuum thrust (lbs)	4-> 2 @ 583400
exit area (ft^2)	4-> 2 @ 41.146
vacuum isp (sec)	430.50
CORE	1/2 STME's
vacuum thrust (lbs)	1 @ 583400
exit area (ft^2)	1 @ 41.146
vacuum isp (sec)	430.50
WEIGHTS (lbs)	
liftoff weight	1943217
core prop @ liftoff	1657621
booster jettisoned	2 @ 32693
aft skirt jettisoned	17773
shroud jettisoned	14016
core inert	131998
core prop @ insertion	4107 (1% ΔV)
payload	51293 (maximized)
payload margin	5129
insertion weight	192527
LOADS	
max Q (psf)	672
max Q-Alpha (psf-deg)	1582
max axial accel (g)	3.56
FLIGHT PARAMETERS	
LIFTOFF	
axial accel (g)	1.28
BOOSTER SEPARATION	
time (sec)	166, 206
altitude (ft)	179687, 271811
velocity (fps)	7474, 10391
axial accel before (g)	3.56, 2.82
axial accel after (g)	2.22, .99
ideal velocity (fps)	11990, 15225
downrange impact (nm)	309, 554
AFT SKIRT SEPARATION	
time (sec)	216
downrange impact (nm)	583
SHROUD SEPARATION	
time (sec)	273
downrange impact (nm)	763
INSERTION	
time (sec)	475
axial accel (g)	3.03
ideal velocity (fps)	29864

NLS Propulsion Module Structure
Hybrid Concept

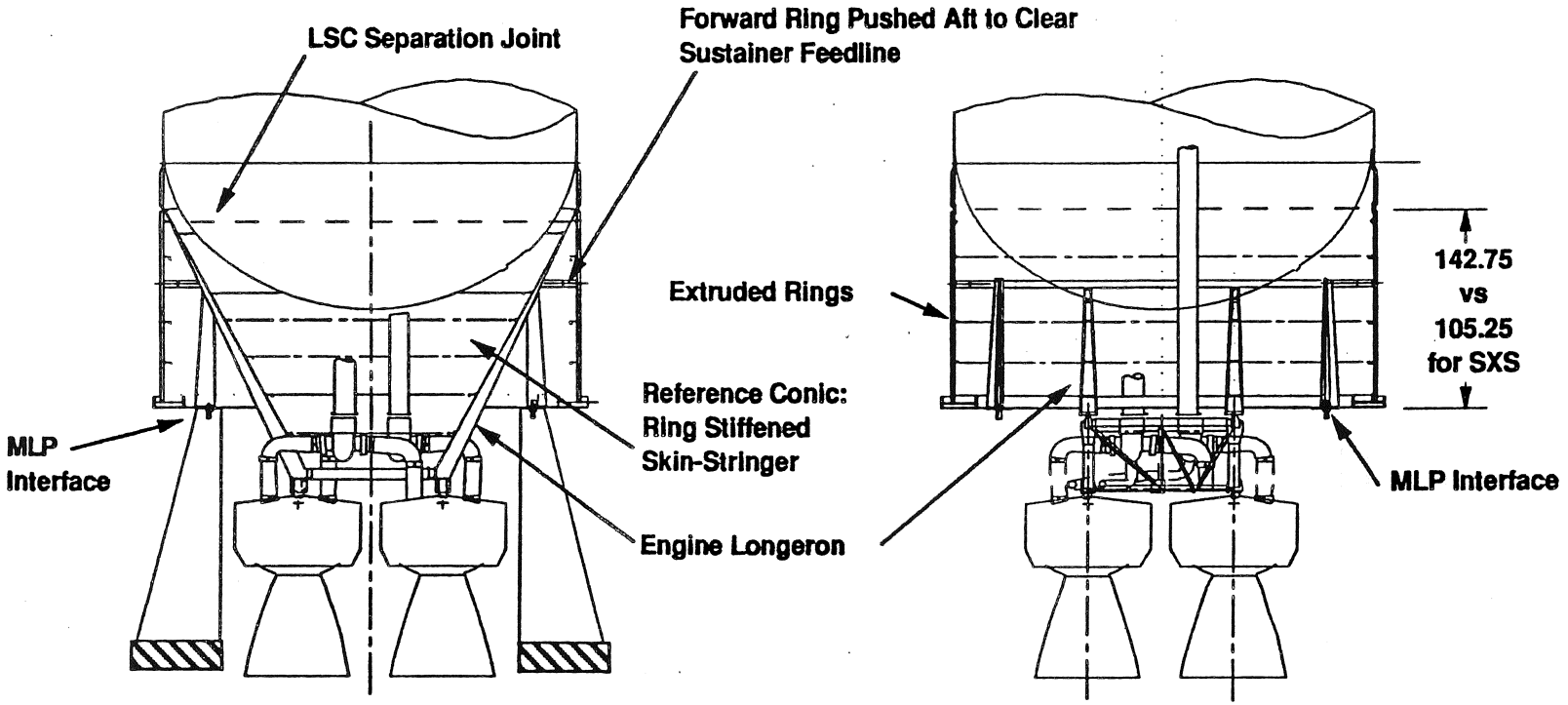
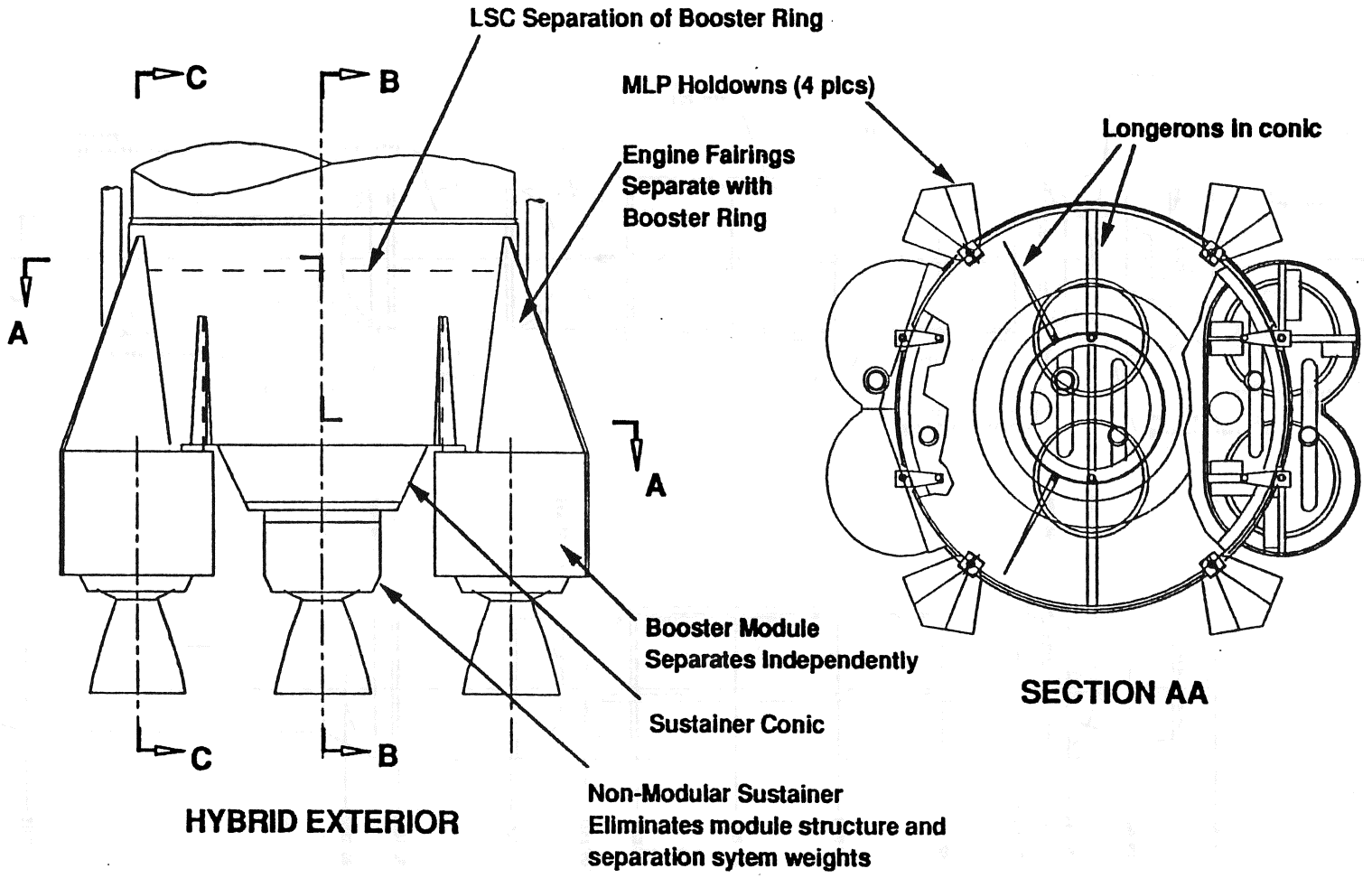


FIGURE 5.3

NLS Propulsion Module Structure
Hybrid Concept



5.0-3

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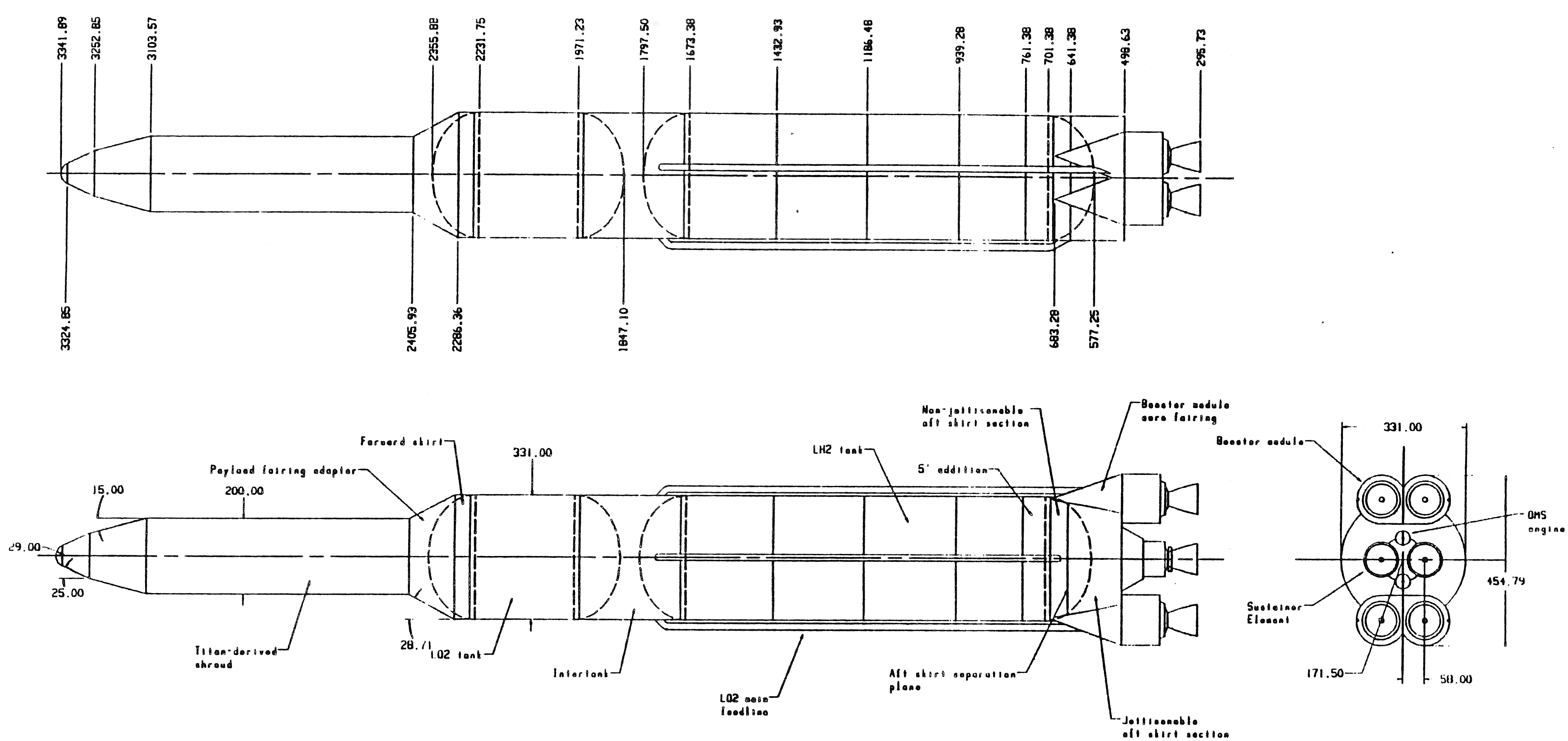
FIGURE 5.2



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dataset name:
contact:
dwg only by:

prepared in accordance with dod std 100

see ________ for parts list, application data, and notes

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Hybrid Propulsion Module
Expendable 1&1/2-Stage
Configuration

size E

4-1-4

6.0 Structural Analysis

Preliminary design structural analyses were used to size the major structural components of the propulsion module. The goal was to perform analysis in sufficient depth to define significant configuration diffrrences with a consistent approach that produces reasonable structural weights. The analysis was based on fundamental structural behaviour (stiffened panel buckling, material properties, structural geometry, etc.).

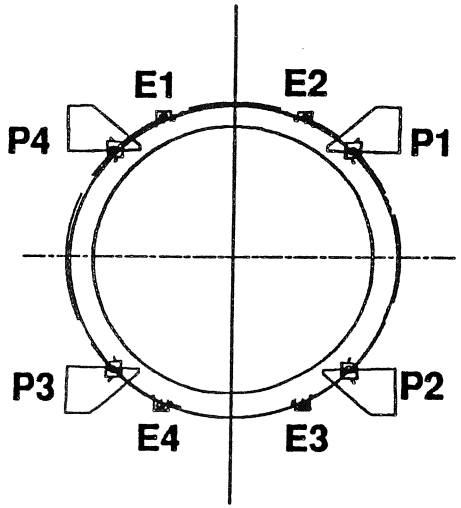
The design loads of section 4 were reviewed and the critical design conditions determined. Figure 6.0-1 indicates the critical design loads for the structure. The pad support loads, critical for the ground wind (fueled) condition, were determined by placing the wind vector so as to maxmize the loading for each support point. The indicated loads are therefore a summary of maximums for each point and not an equilibrium condition.

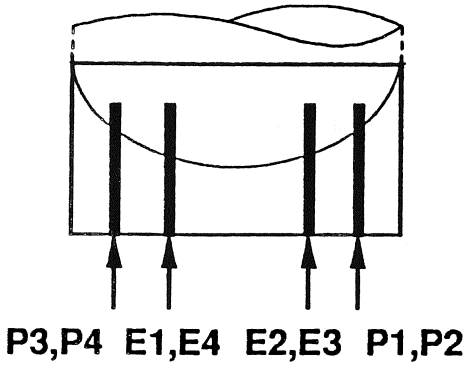
The fundamental design approach of this concept is the distribution of concentrated forces, from engines or pad supports, into a cylindrical shell structure by shear out thru tapered longerons. The shear out is intended to be accomplished without introducing weight penalties in the LH2 tank due to excessive load non-uniformity. For comparative analysis purposes, the skirt shell structure was sized as a "hat" stiffened skin shell using a balanced design which adjusted stiffener size and spacing to maintain efficient stress levels. Ring frames were considered at 30" spacing to stabilize the stiffened shell. Material properties for structural sizing were based on 7075 -T6 sheet and 7075-T73 extruded shapes. These properties are considered adequate for preliminary design as both type of construction and material will be extensivly worked during design development.

The base ring was sized to distribute the concentrated lateral shear forces from engine or pad supports into the skirt skin. At the upper end of the longerons a ring was sized to react the kick loads caused by the longeron load offsets from the skin line.

Figure 6.0-2 summarizes the analysis method used to approximate the weight penality associated with the shear out of concentrated loads into a shell structure. An accurate analysis of this problem can be accomplished with finite element techniques or sets of strain compatability equations, both of which are out of the scope of this study. The illustrated method assumes a 25° shear out angle and sizes the stiffened skin for the line load at the end of the longeron. This increased thickness is then allocated to the longeron shear out area and extended forward to the end of the skirt. The remainder of the skirt is sized by the uniform line loads from the body loads of section 4 as indicated on the left.

Structural Sizing - Hybrid Configuration





Pad Support Loads, max. (limit)
P1 = 828370 lb
P2 = 828370 lb
P3 = 828370 lb
P4 = 828370 lb

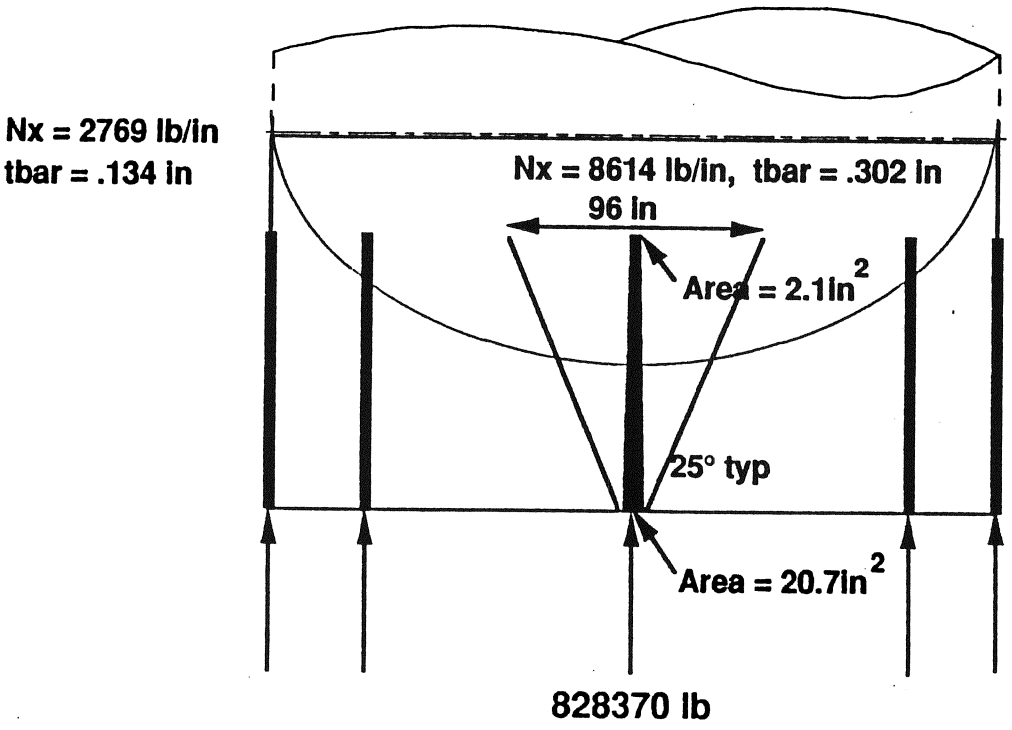
Engine Thrust Loads (limit)
E1 thru E4 = 580000 lb ea.

- **Aft skirt longerons sized for above loads**
- **Base ring assumed same as Ref. configuration**
- **Shell sized by 2769 lb/in ground wind condition**
- **Longerons and engine cone weights based on previous analysis**

Figure 6.0-1

Concentrated Load Assesment - Base Skirt

Hybrid Configuration



- Hat stiffened skin panels designed to maintain efficient stress levels
- Estimates weight penality due to shear out of concentrated loads
- Sensitive to load level, shear out length and number of longerons
- Gives indication of uniformity of sheared out loads
- Thrust cone sized using same approach

Figure 6.0-2

7.0 Main Propulsion System Design

The Hybrid MPS shown, represents our configuration consisting of two ea two engine booster propulsion modules in line with and surrounding a two sustainer engines, designed to meet the specific requirements previously discussed.

7.1 MPS Schematics

MPS schematics have been prepared for both the LOX /He systems and the LH2 systems. Only major components have been shown, with instrumentation not included. The Control Helium System consists of controls required to deliver the proper quality helium gas to the engines for purges and potential valve actuation, as well as to the remainder of the MPS for valve actuation, purges and potential propellant conditioning. Since none of these functions are clearly defined at this time, the details are not available.

The PSS (power supply system) has been conceptually identified as our power system of choice to drive the TVC actuators, and generally consists of three pneumatic motors, driven by hydrogen pressurization gas, each set serving two engines. Again, the details have not been developed, and they are shown as a box.

The LOX subsystem schematic is shown in figure 7.1-1 and the LH2 Subsystem schematic is shown in figure 7.1-2. The Sustainer engine arrangement is shown in figure 7.1-3; the LOX fill booster module is shown in figure 7.1-4; and the LH2 fill booster module is shown in figure 7.1-5

7.2 MPS Layouts

MPS CATIA layouts are not available at this time, and will be delivered immediately upon completion.

7.3 Master Equipment Lists

Preliminary master equipment lists have been prepared for comparative purposes and are shown in figure 7.3-1.

Hybrid NLS MPS LOX & He Systems, Expendable & Recoverable

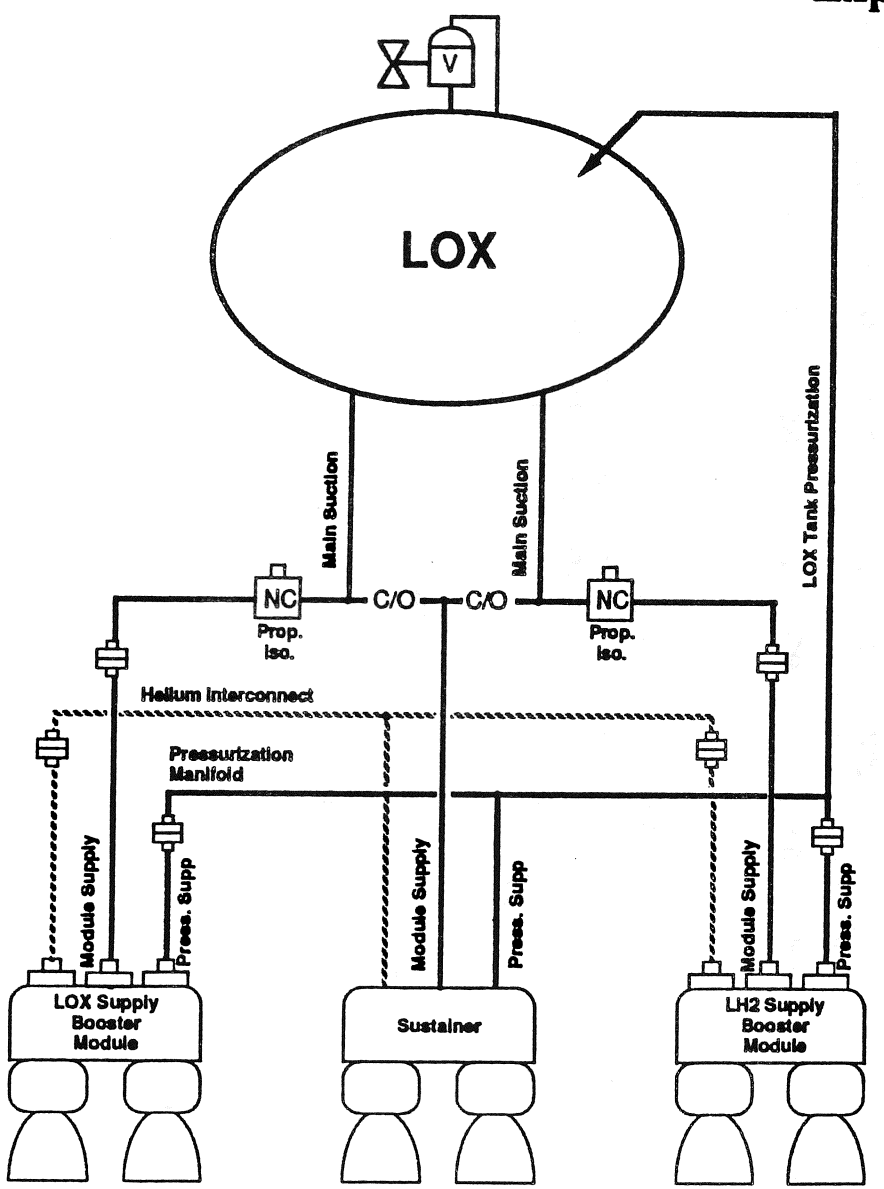


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FIGURE 7.1-1

Hybrid NLS MPS LH2 System, Recoverable & Expendable

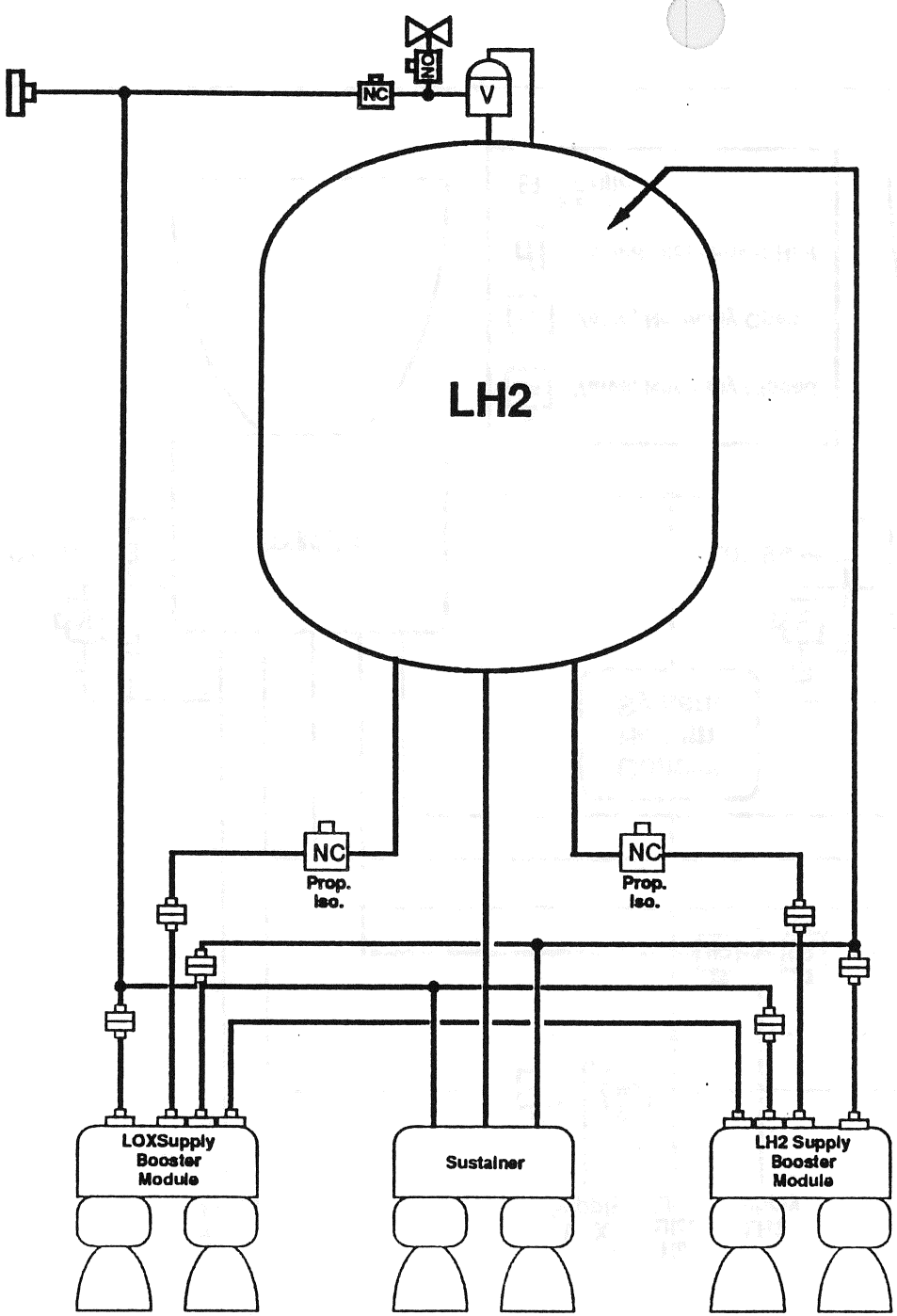

Figure 7.1-2

NLS Hybrid Sustainer

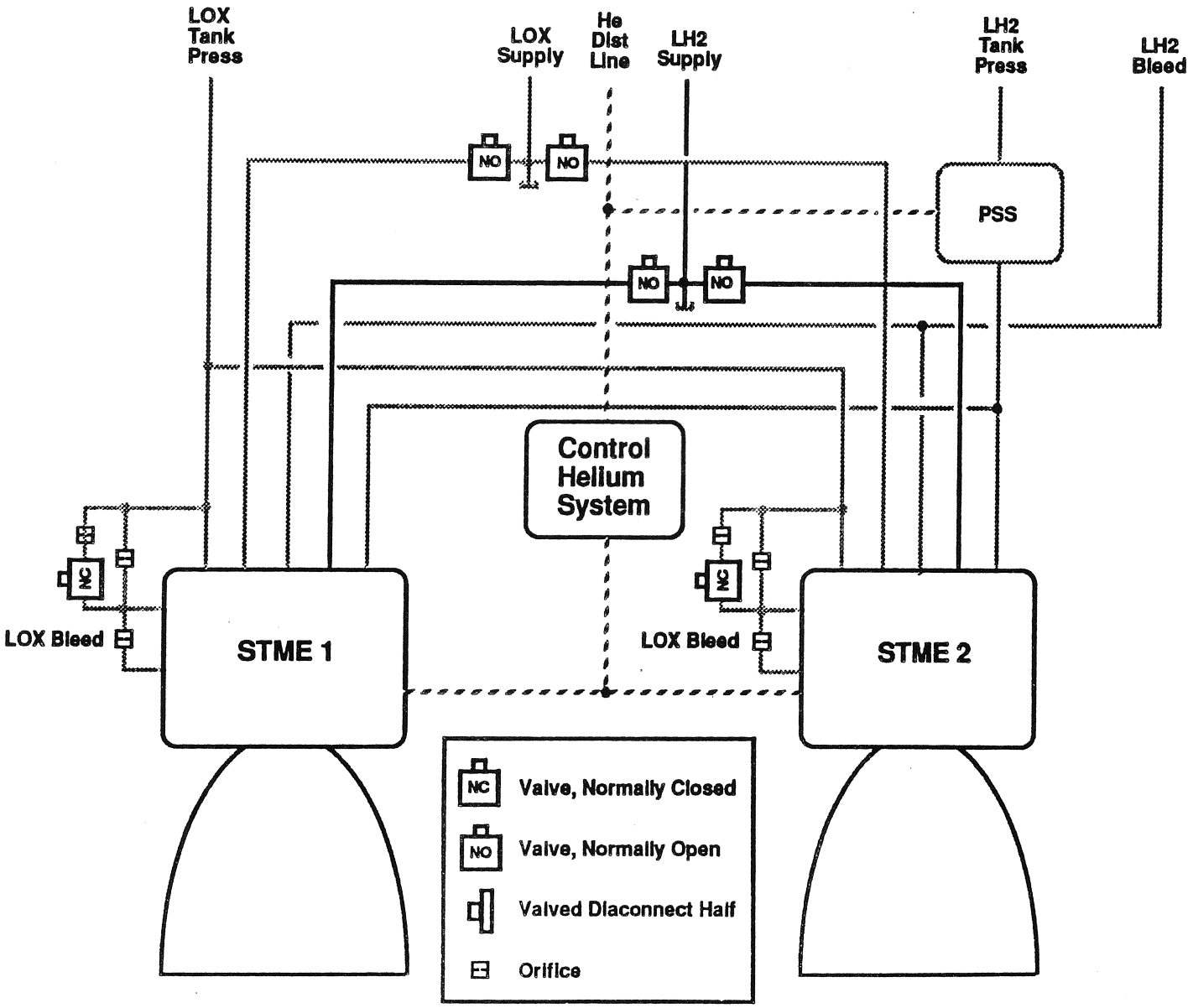

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FIGURE 7.1-3

NLS MPS; Recoverable Module, LOX & He Supply System

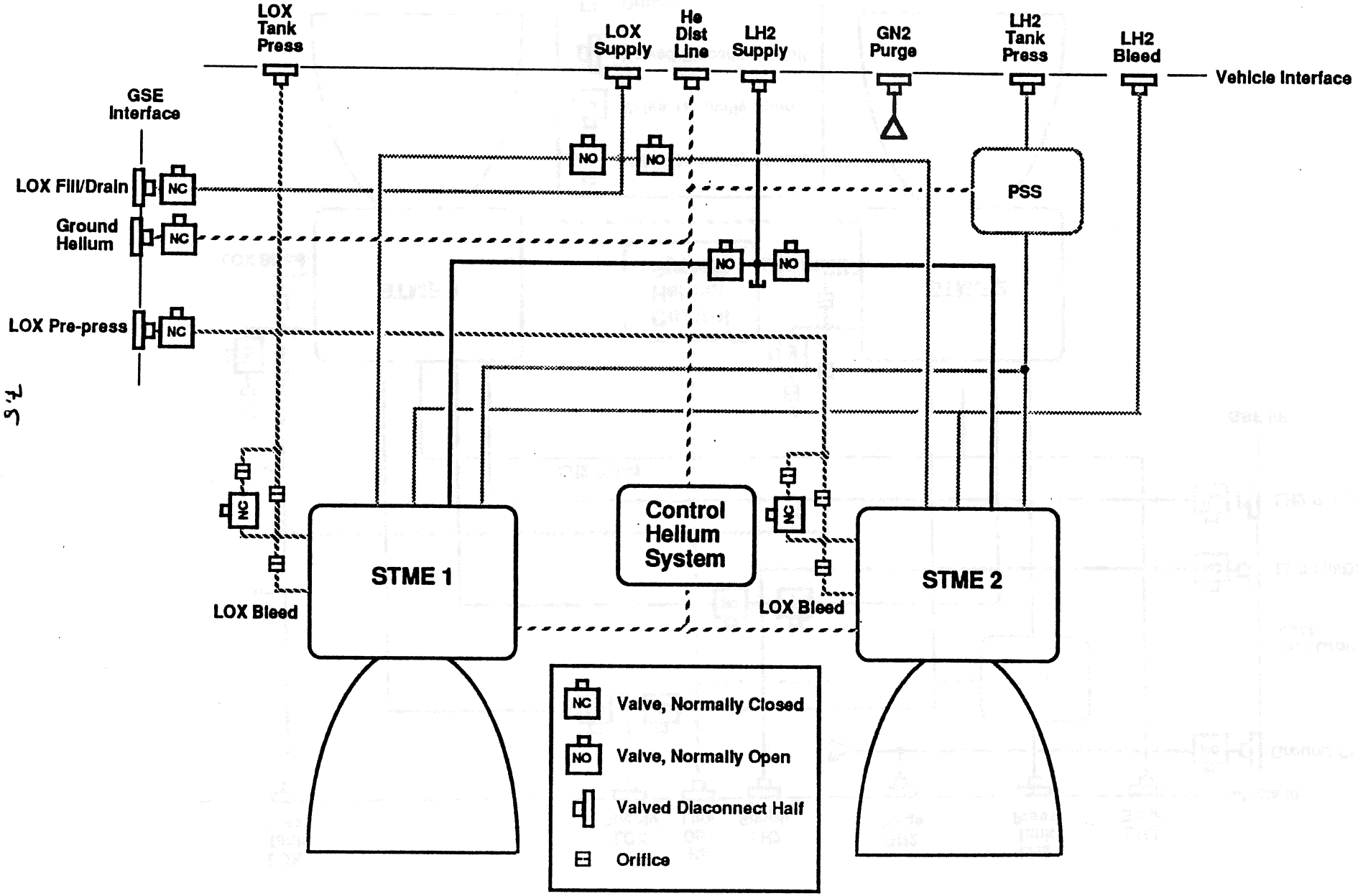

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FIGURE 7.1-4

NLS MPS; Recoverable Module, LH2 & GN2 Supply Systems

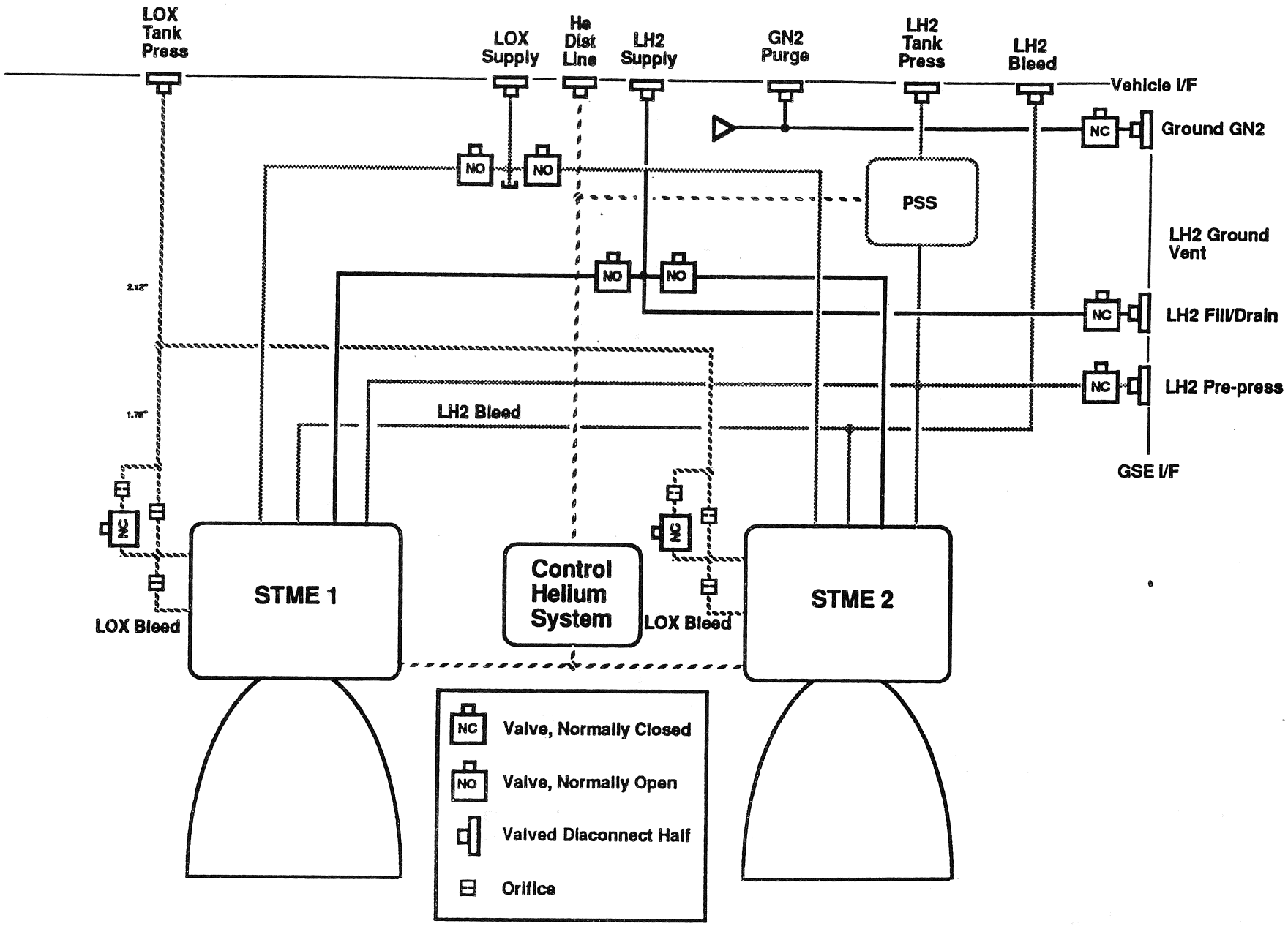


FIGURE 1-5

MPS HYBRID CONFIGURATION	NATIONAL LAUNCH SYSTEM MASTER EQUIPMENT LIST											
INDENTURED EQUIPMENT LIST 1 2 3 4 5 6 7 8 9 ITEM	M/B GFP	TE	DEV	QUAL	FV	SDA	CQ	SIL	LS	MFG	TOTAL NO.	REMARKS
LIQUID PROPELLANT SYSTEM - MAIN PROPULSION			1	1	1						3	
LO2 MAIN FEED, BOOST/SUSTAINER -			2	2	2						6	20.0 IN
DISCONNECT -			1	1	1						3	15.0 IN
VALVE PACKAGE -			1	1	1						3	
ISOLATION VALVE			1	1	1						3	15.0 IN NC
FORWARD FLEXIBLE ELBOW ASSEMBLY -			1	1	1						3	20 IN
BELLOWS ASSY (RESTRAINED)			2	2	2						6	
TUBE SEGMENTS			1	1	1						3	
FLANGES			2	2	2						6	
UPPER ELBOW			1	1	1						3	20 IN DIA, 43.5°
LOWER ELBOW			1	1	1						3	20 IN DIA, 60.0°
FORWARD FLEXIBLE ASSEMBLY -			1	1	1						3	20 IN
BELLOWS ASSY (RESTRAINED)			1	1	1						3	
TUBE SEGMENTS			1	1	1						3	
FLANGES			2	2	2						6	
STRAIGHT SECTION -			5	5	5						15	20 IN
TUBE SEGMENTS			1	1	1						3	
FLANGES			2	2	2						6	
AFT FLEXIBLE ASSEMBLY -			1	1	1						3	20 IN
BELLOWS ASSY (UNRESTRAINED)			2	2	2						6	
TUBE SEGMENTS			3	3	3						9	
FLANGES			2	2	2						6	
TEE-FLANGE (FOR CORE LO2 CROSSOVER LINE)			1	1	1						3	10.0 IN
CROSSOVER LINE			2	2	2						6	10.0 IN
RESTRAINED BELLOWS			3	3	3						9	
TUBE SEGMENTS			3	3	3						9	
ELBOWS 90°			1	1	1						3	
ELBOWS 45°			2	2	2						6	
FLANGES			2	2	2						6	
TRANSITION SECTION -			1	1	1						3	20 IN TO 15 IN
TUBE SEGMENT			1	1	1						3	

FIGURE 7.3-1 (12 PAGES)

FLANGE - FWD			1	1	1						3	
FLANGE - AFT			1	1	1						3	
ASSEMBLY HARDWARE - ITEM TO ITEM			1	1	1						3	
FASTENER AND SEAL SET -			AR	AR	AR							18.0 IN
FASTENER AND SEAL SET -			AR	AR	AR							15.0 IN
INSTALLATION HARDWARE - FEED TO LO2 TANK			1	1	1						3	
FASTENER AND SEAL SET -			1	1	1						3	18.0 IN
LO2 TANK PRESSURIZATION			1	1	1						3	3.0 IN
TUBE SEGMENTS			2	8	8						18	
FLANGES			4	16	16						36	
												7.0 IN
LO2 TANK VENT			1	1	1						3	
VENT VALVE			1	1	1						3	
BELLOWS ASSY (UNRESTRAINED)			2	2	2						6	
TUBE SEGMENT			1	1	1						3	
FLANGES			2	2	2						6	
LH2 MAIN FEED, BOOST -			2	2	2						6	15.0 IN
DISCONNECT -			2	2	2						6	15.0 IN
ISOLATION VALVE -			1	1	1						3	15.0 IN
FLEX ASSEMBLY -			1	1	1						3	15.0 IN
BELLOWS ASSY (UNRESTRAINED)			2	2	2						6	
TUBE SEGMENTS			2	2	2						6	
FLANGES			2	2	2						6	
VACUUM JACKET			1	1	1						3	
ELBOW			1	1	1						3	29.6°
ASSEMBLY HARDWARE - ITEM TO ITEM												
FASTENER AND SEAL SET												
INSTL HDWR - LH2 BOOST FEED TO LH2 TANK			1	1	1						3	
FASTENER AND SEAL SET			AR	AR	AR							
VACUUM JACKET - DISCONNECT			2	2	2						6	
VACUUM JACKET - VALVE PACKAGE			1	1	1						3	
LH2 MAIN FEED, SUSTAINER -			1	1	1						3	15.0 IN

			FLEX ASSEMBLY -						1	1	1						3	15.0 IN
				BELLOWS ASSY (UNRESTRAINED)					2	2	2						6	
				TUBE SEGMENTS					1	1	1						3	
				FLANGES					2	2	2						6	
				VACUUM JACKET					1	1	1						3	
				ELBOW					2	2	2						6	29.6°
			ASSEMBLY HARDWARE - ITEM TO ITEM															
				FASTENER AND SEAL SET														
			INSTL HDWR - LH2 BOOST FEED TO LH2 TANK						1	1	1						3	
				FASTENER AND SEAL SET					AR	AR	AR							
		LH2 TANK PRESSURIZATION							1	1	1						3	3.0 IN
			TUBE SEGMENTS						2	8	8						18	
			FLANGES						4	16	16						36	
		LH2 TANK VENT							1	1	1						3	7.0 IN
			VENT VALVE						1	1	1						3	
			BELLOWS ASSY (UNRESTRAINED)						2	2	2						6	
			TUBE SEGMENT						1	1	1						3	
			FLANGES						2	2	2						6	
			DISCONNECT						1	1	1						3	
		PROPULSION SYSTEM MPS-SUSTAINER							1	1	1						3	
			ANCILLARY EQUIPMENT						1	1	1						3	
				ENGINE GIMBAL SYSTEM					1	1	1						3	
					ACTUATORS				4	4	4						12	
					POWER SOURCE SYSTEM				3	3	3						9	
					GH2 SUPPLY PLUMBING				1	1	1						3	
				ENGINE INSTALLATION PROVISIONS					2	2	2						6	
					GIMBAL ATTACH				1	1	1						3	
					INSULATION				1	1	1						3	
					PANELS & MISC PARTS				1	1	1						3	
				ENGINE HEAT SHIELD INSTALLATION					2	2	2						6	
				ENGINE GN2 GROUND PURGE PROVISIONS					1	1	1						3	
					DISCONNECT & VALVES				1	1	1						3	
					LINES & FITTINGS				1	1	1						3	
					SUPPORTS & MISC PARTS				1	1	1						3	

He PNEUMATIC SYSTEM - PLUMBING	1	1	1	3	
SURGE CHAMBERS	1	1	1	3	
DISCONNECT HALVES	5	5	5	15	
SOLENOID VALVES	12	12	12	36	
CHECK VALVES	8	8	8	24	
REGULATORS	4	4	4	12	
FILTERS	4	4	4	12	
PLUMBING & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
He PNEUMATIC SYSTEM - SPHERICAL BOTTLES	2	2	2	6	
LO2 FEED -	1	1	1	3	15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA
DISCONNECT -	1	1	1	3	15.0 IN DIA, 6.0 IN LENGTH
PREVALVE -	2	2	2	6	10.O IN DIA, 13.0 IN LENGTH
MANIFOLD ASSEMBLY -	2	2	2	6	15.0 IN DIA, 27.0 IN LENGTH
TUBE SEGMENT	1	1	1	3	
TUBE END CLOSEURE, @ F&D INTERFACE	1	1	1	3	
FLANGE AT DISCONNECT INTERFACE -	1	1	1	3	15.0 IN ID
FLANGE AT PREVALVE INTERFACE -	2	2	2	6	10.0 IN ID
FLANGE AT F & D VALVE INTERFACE -	1	1	1	3	8.0 IN ID
LOCAL REINFORCEMENT / SUPPORT TABS SET	1	1	1	3	
FOAM INSULATED COVER	1	1	1	3	
FLEXIBLE ASSEMBLY -	2	2	2	6	10.0 IN
BELLOWS ASSY (RESTRAINED)	3	3	3	9	
TUBE SEGMENTS	2	2	2	6	
FLANGES	2	2	2	6	
FOAM INSULATED COVER	1	1	1	3	
ASSEMBLY HARDWARE	1	1	1	3	
FASTENER AND SEAL SET -	4	4	4	12	10.0 IN DIA
FASTENER AND SEAL SET -	1	1	1	3	15.0 IN DIA
FASTENER AND SEAL SET -	1	1	1	3	8.0 IN DIA
FOAM INSULATED COVER - DISCONNECT	1	1	1	3	
FOAM INSULATED COVER - PREVALVE	2	2	2	6	
SUPPORTS & MISC PARTS SET	1	1	1	3	
LO2 BLEED	1	1	1	3	1.0 IN
VALVE	1	1	1	3	

LINES & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
LO2 TANK PRESSURIZATION	1	1	1	3	2.0 IN
DISCONNECT	1	1	1	3	
VALVE	2	2	2	6	
ORIFICE	4	4	4	12	
LINES & FITTINGS SET	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
LH2 FEED -	1	1	1	3	15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA
DISCONNECT -	1	1	1	3	15.0 IN DIA, 6.0 IN LENGTH
PREVALVE -	1	1	1	3	10.0 IN DIA, 13.0 IN LENGTH
MANIFOLD ASSEMBLY -	1	1	1	3	15.0 IN DIA, 27.0 IN LENGTH
TUBE SEGMENT	1	1	1	3	
TUBE END CLOSEURE, @ F& D INTERFACE	1	1	1	3	
FLANGE AT DISCONNECT INTERFACE -	1	1	1	3	15.0 IN ID
FLANGE AT PREVALVE INTERFACE -	1	1	1	3	10.0 IN ID
FLANGE AT F & D VALVE INTERFACE -	1	1	1	3	8.0 IN ID
LOCAL REINFORCEMENT / SUPPORT TABS SET	1	1	1	3	
VACUUM JACKET	1	1	1	3	
FLEXIBLE ASSEMBLY -	2	2	2	6	10.0 IN DIA
BELLOWS ASSY (RESTRAINED)	3	3	3	9	
TUBE SEGMENTS	2	2	2	6	
FLANGES	2	2	2	6	
VACUUM JACKET SET	1	1	1	3	
ASSEMBLY HARDWARE					
FASTENER AND SEAL SET - 10.0 IN DIA	1	1	1	3	
FASTENER AND SEAL SET - 15.0 IN DIA	1	1	1	3	
FASTENER AND SEAL SET - 8.0 IN DIA	1	1	1	3	
VACUUM JACKET - DISCONNECT	1	1	1	3	
VACUUM JACKET - PREVALVE	1	1	1	3	
SUPPORTS & MISC PARTS SET	1	1	1	3	
H2 PRESTART BLEED	1	1	1	3	1.5 IN
DISCONNECT	2	2	2	6	
LINES & FITTINGS	1	1	1	3	
INSULATION	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	

LH2 TANK PRESSURIZATION	1	1	1	3	2.0 IN
DISCONNECT	1	1	1	3	
FLOW CONTROL VALVES	3	3	3	9	
LINES & FITTINGS SET	1	1	1	3	
ORIFICES	3	3	3	9	
SUPPORTS & MISC PARTS	1	1	1	3	
PROPULSION MODULE MPS-BOOSTER,LOX/He FILL	1	1	1	3	
ANCILLARY EQUIPMENT	1	1	1	3	
ENGINE GIMBAL SYSTEM	1	1	1	3	
ACTUATORS	4	4	4	12	
POWER SOURCE SYSTEM	3	3	3	9	
GH2 SUPPLY PLUMBING	1	1	1	3	
ENGINE INSTALLATION PROVISIONS	2	2	2	6	
GIMBAL ATTACH	1	1	1	3	
INSULATION	1	1	1	3	
PANELS & MISC PARTS	1	1	1	3	
ENGINE HEAT SHIELD INSTALLATION	2	2	2	6	
ENGINE GN2 GROUND PURGE PROVISIONS	1	1	1	3	
DISCONNECT & VALVES	1	1	1	3	
LINES & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
He PNEUMATIC SYSTEM - PLUMBING	1	1	1	3	
SURGE CHAMBERS	1	1	1	3	
DISCONNECT HALVES	5	5	5	15	
SOLENOID VALVES	12	12	12	36	
CHECK VALVES	8	8	8	24	
REGULATORS	4	4	4	12	
FILTERS	4	4	4	12	
PLUMBING & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
He PNEUMATIC SYSTEM - SPHERICAL BOTTLES	2	2	2	6	
LO2 FEED -	1	1	1	3	15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA
DISCONNECT -	1	1	1	3	15.0 IN DIA, 6.0 IN LENGTH
PREVALVE -	2	2	2	6	10.0 IN DIA, 13.0 IN LENGTH

MANIFOLD ASSEMBLY -	2	2	2	6	15.0 IN DIA, 27.0 IN LENGTH
TUBE SEGMENT	1	1	1	3	
TUBE END CLOSEURE, @ F&D INTERFACE	1	1	1	3	
FLANGE AT DISCONNECT INTERFACE -	1	1	1	3	15.0 IN ID
FLANGE AT PREVALVE INTERFACE -	2	2	2	6	10.0 IN ID
FLANGE AT F & D VALVE INTERFACE -	1	1	1	3	8.0 IN ID
LOCAL REINFORCEMENT / SUPPORT TABS SET	1	1	1	3	
FOAM INSULATED COVER	1	1	1	3	
FLEXIBLE ASSEMBLY -	2	2	2	6	10.0 IN
BELLOWS ASSY (RESTRAINED)	3	3	3	9	
TUBE SEGMENTS	2	2	2	6	
FLANGES	2	2	2	6	
FOAM INSULATED COVER	1	1	1	3	
ASSEMBLY HARDWARE	1	1	1	3	
FASTENER AND SEAL SET -	4	4	4	12	10.0 IN DIA
FASTENER AND SEAL SET -	1	1	1	3	15.0 IN DIA
FASTENER AND SEAL SET -	1	1	1	3	8.0 IN DIA
FOAM INSULATED COVER - DISCONNECT	1	1	1	3	
FOAM INSULATED COVER - PREVALVE	2	2	2	6	
SUPPORTS & MISC PARTS SET	1	1	1	3	
LO2 FILL / DRAIN	1	1	1	3	8.0 IN
DISCONNECT	1	1	1	3	
VALVE	1	1	1	3	
DUCT ASSEMBLY	1	1	1	3	
INSULATION	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
LO2 BLEED	1	1	1	3	1.0 IN
VALVE	1	1	1	3	
LINES & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
LO2 TANK PRESSURIZATION	1	1	1	3	2.0 IN
DISCONNECT	1	1	1	3	
VALVE	2	2	2	6	
ORIFICE	4	4	4	12	
LINES & FITTINGS SET	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
LH2 FEED -	1	1	1	3	15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA

					DISCONNECT -			1	1	1						3	15.0 IN DIA, 6.0 IN LENGTH
					PREVALVE -			1	1	1						3	10.0 IN DIA, 13.0 IN LENGTH
					MANIFOLD ASSEMBLY -			1	1	1						3	15.0 IN DIA, 27.0 IN LENGTH
					TUBE SEGMENT			1	1	1						3	
					TUBE END CLOSEURE, @ F& D INTERFACE			1	1	1						3	
					FLANGE AT DISCONNECT INTERFACE -			1	1	1						3	15.0 IN ID
					FLANGE AT PREVALVE INTERFACE -			1	1	1						3	10.0 IN ID
					FLANGE AT F & D VALVE INTERFACE -			1	1	1						3	8.0 IN ID
					LOCAL REINFORCEMENT / SUPPORT TABS SET			1	1	1						3	
					VACUUM JACKET			1	1	1						3	
					FLEXIBLE ASSEMBLY -			2	2	2						6	10.0 IN DIA
					BELLOWS ASSY (RESTRAINED)			3	3	3						9	
					TUBE SEGMENTS			2	2	2						6	
					FLANGES			2	2	2						6	
					VACUUM JACKET SET			1	1	1						3	
					ASSEMBLY HARDWARE														
					FASTENER AND SEAL SET - 10.0 IN DIA			1	1	1						3	
					FASTENER AND SEAL SET - 15.0 IN DIA			1	1	1						3	
					FASTENER AND SEAL SET - 8.0 IN DIA			1	1	1						3	
					VACUUM JACKET - DISCONNECT			1	1	1						3	
					VACUUM JACKET - PREVALVE			1	1	1						3	
					SUPPORTS & MISC PARTS SET			1	1	1						3	
				H2 PRESTART BLEED				1	1	1						3	1.5 IN
				DISCONNECT				2	2	2						6	
				LINES & FITTINGS				1	1	1						3	
				INSULATION				1	1	1						3	
				SUPPORTS & MISC PARTS				1	1	1						3	
				LH2 TANK PRESSURIZATION				1	1	1						3	2.0 IN
				DISCONNECT				1	1	1						3	
				FLOW CONTROL VALVES				3	3	3						9	
				LINES & FITTINGS SET				1	1	1						3	
				ORIFICES				3	3	3						9	
				SUPPORTS & MISC PARTS				1	1	1						3	
		PROPULSION MODULE MPS-LH2 FILL						1	1	1						3	
			ANCILLARY EQUIPMENT					1	1	1						3	

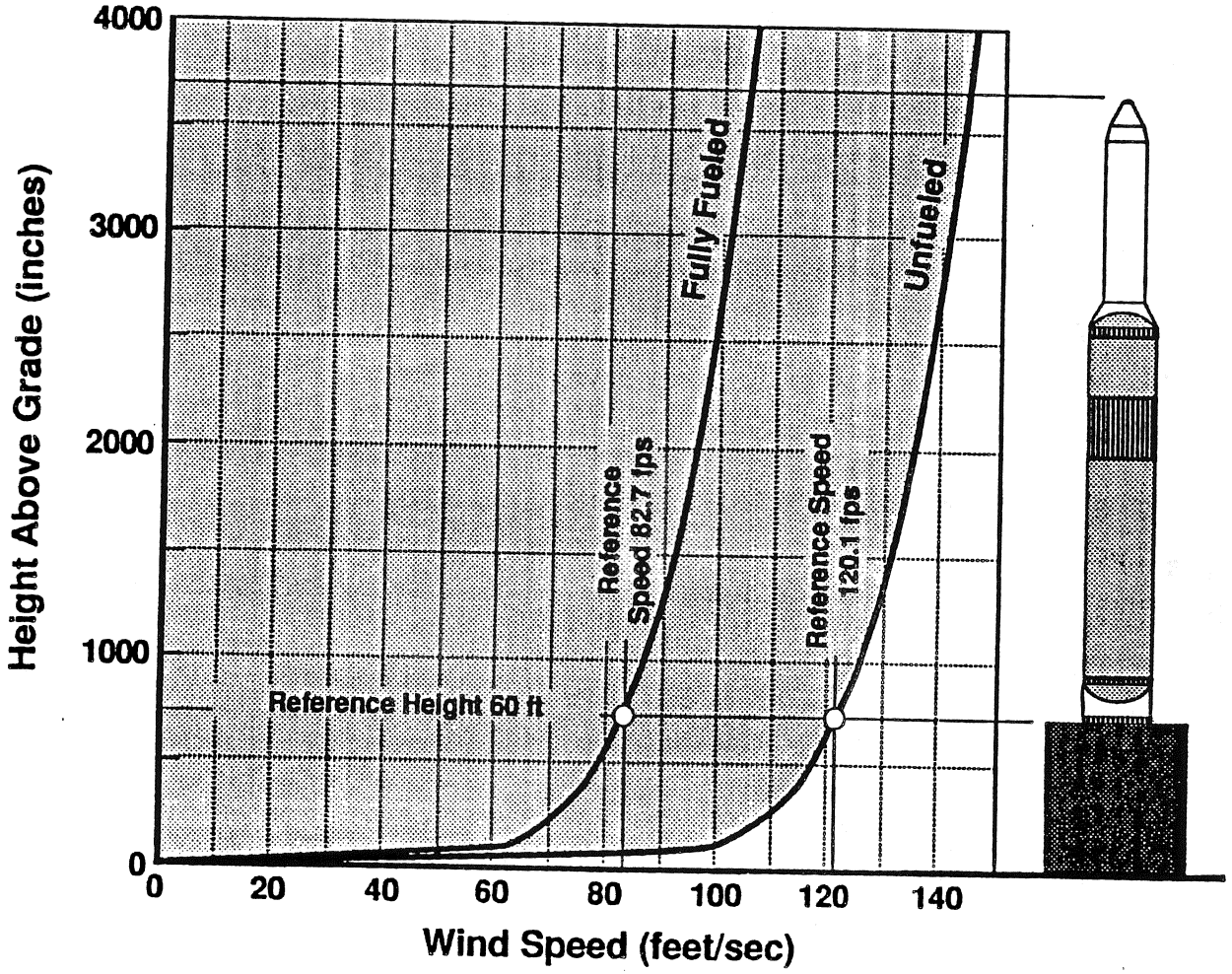
4.0 Loads

Ascent flight loads were based on a rigid body model with the engines gimbaled as required for moment trimming. Vacuum engine thrust was 583K per engine and trajectories were based on engine out capability. The maximum qalpha (resultant) was 5306 psf with a 25 fps gust included. A 95 percentile steady ascent wind profile based on the windiest month of year was combined with a combination 99 percentile shear and gust. A worst case launch azimuth was used and an uncertainty factor of 1.25 was applied to aerodynamic load. The maximum boost acceleration (before separation) is 3.4g.

Figure 4.1 gives a plot of the ground wind velocity profiles used for prelaunch wind and holddown loads. The unfueled design ground winds is based on a 1% risk of exceedance, during the windiest 2 week exposure of the month. Fueled ground winds are based on a 1% risk of exceedance for the windiest day of month exposure. Vortex shedding/dynamic effects approximated by using a preliminary factor of 1.5 on the computed rigid body loads.

Figure 4.2 defines the maximum compressive line loads versus vehicle station which were used to size the structure for the illustrated configuration. These are limit loads and do not include factor of safety or internal pressure effects in the tanks.

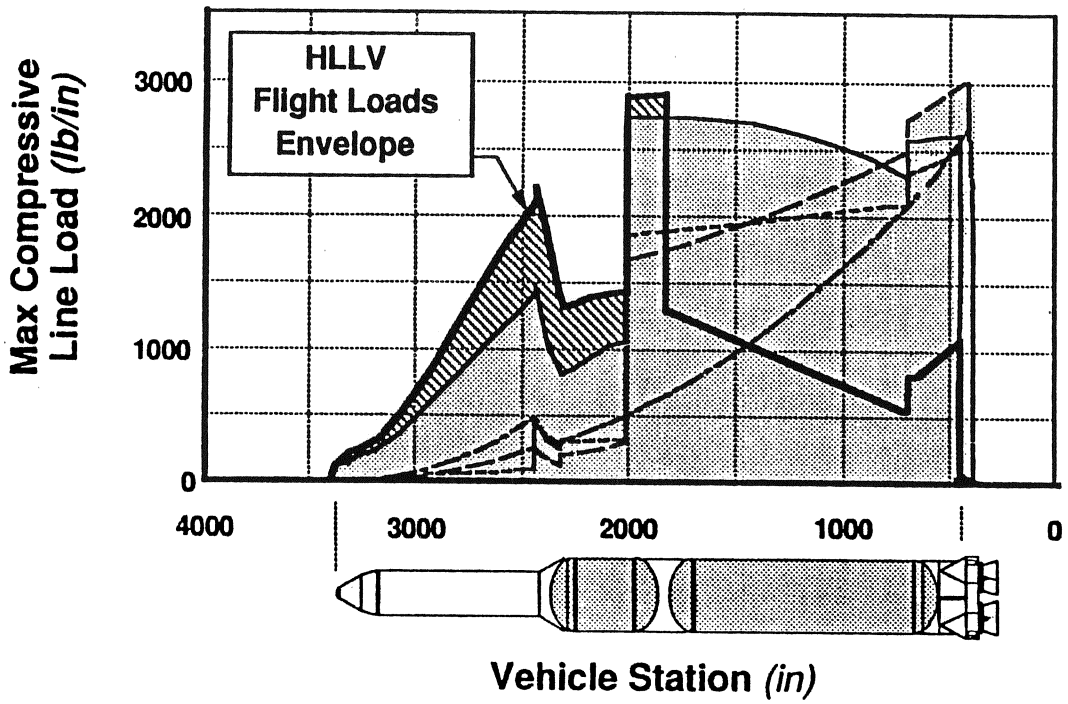
Ground Wind Velocity Profiles



BOEING

Figure 4.1

NLS Design Limit Flight Loads
1.5 Stage Reference & Hybrid



1 and 1/2 Stage Loads	
———	Max qα
- - - - - - -	Max Boost
— — —	Fueled Grd Wind
——-——	Unfueled Grd Wind

Note: These line loads do not include tank pressurization effects

Section 5.0
Hybrid Configuration Structure Design

The Hybrid configuration was developed as another alternate to the reference configuration. The Hybrid uses two booster modules and the non-modular sustainer from the reference (See figure 5.1) Commonality between structure within the vehicle is one feature of this configuration. Each module contains the thrust structure, powerhead shell, engine heat shield, and separation system, among others, for the two enclosed engines. (Refer to the 90° configuration for a chart of the engine module structure). The feed system is modularized like the modular configuration to reduce part count and test requirements. The booster separation system is four shuttle type separation bolts at each module. A linear shaped charge separate the booster ring after module separation.

The system is more complex than the Reference or the 90° Modular due to the two separation systems, and the more complex structure. The benefits of modularity operations have been maintained for the boosters and the core weight to orbit is reduced by separation of the booster skirt.

The structure consists of the basic cylindrical booster skirt aft of the LH2 tank and the interfacing sustainer conic similar to the rerference. The skirt structure is aluminum skin-stringer with extruded rings. Again, honeycomb structure could be studied for improved producibility in the future. Longerons are machined from 7075 Al. Engine kick loads carried by the longerons are transfered to the forward and aft ring in the booster skirt. Producibility of the conic and booster skirt will be similar to the reference. The engine modules contain a simple tube truss supporting a honeycomb fairing to protect the powerheads. The engine heat shield will be mounted on the aft bulkhead.

The MLP holddowns are spaced on the booster skirt (see fig 5.2 & 5.3). Holddowns are stationary, and no retraction or swing away structure is necessary. The attachments are simple liftoff separation bolts or clamp release.

The configuration is compatible with the HLLV and existing ET configurations. The ET will require only minor structural modification, similar to the reference. The HLLV configuration is assembled by omission of the sustainer conic and installation of the ASRB's.

Hybrid Configuration
1.5 Stage Vehicle

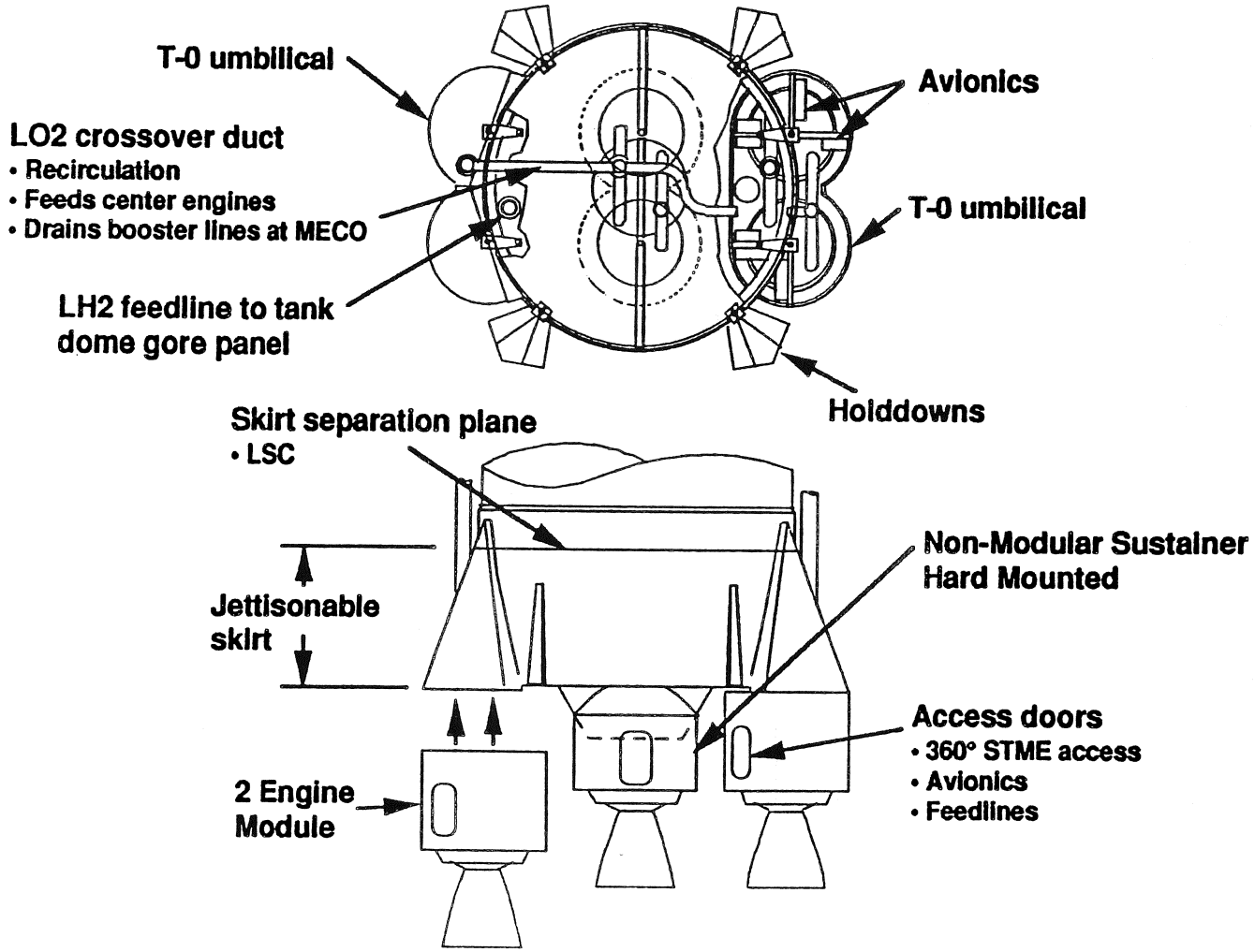


FIGURE 5.1

ENGINE GIMBAL SYSTEM	1	1	1	3	
ACTUATORS	4	4	4	12	
POWER SOURCE SYSTEM	3	3	3	9	
GH2 SUPPLY PLUMBING	1	1	1	3	
ENGINE INSTALLATION PROVISIONS	2	2	2	6	
GIMBAL ATTACH	1	1	1	3	
INSULATION	1	1	1	3	
PANELS & MISC PARTS	1	1	1	3	
ENGINE HEAT SHIELD INSTALLATION	2	2	2	6	
ENGINE GN2 GROUND PURGE PROVISIONS	1	1	1	3	
DISCONNECT & VALVES	1	1	1	3	
LINES & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
He PNEUMATIC SYSTEM - PLUMBING	1	1	1	3	
SURGE CHAMBERS	1	1	1	3	
DISCONNECT HALVES	5	5	5	15	
SOLENOID VALVES	12	12	12	36	
CHECK VALVES	8	8	8	24	
REGULATORS	4	4	4	12	
FILTERS	4	4	4	12	
PLUMBING & FITTINGS	1	1	1	3	
SUPPORTS & MISC PARTS	1	1	1	3	
He PNEUMATIC SYSTEM - SPHERICAL BOTTLES	2	2	2	6	
LO2 FEED -	1	1	1	3	15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA
DISCONNECT -	1	1	1	3	15.0 IN DIA, 6.0 IN LENGTH
PREVALVE -	2	2	2	6	10.O IN DIA, 13.0 IN LENGTH
MANIFOLD ASSEMBLY -	2	2	2	6	15.0 IN DIA, 27.0 IN LENGTH
TUBE SEGMENT	1	1	1	3	
TUBE END CLOSEURE, @ F&D INTERFACE	1	1	1	3	
FLANGE AT DISCONNECT INTERFACE -	1	1	1	3	15.0 IN ID
FLANGE AT PREVALVE INTERFACE -	2	2	2	6	10.0 IN ID
FLANGE AT F & D VALVE INTERFACE -	1	1	1	3	8.0 IN ID
LOCAL REINFORCEMENT / SUPPORT TABS SET	1	1	1	3	
FOAM INSULATED COVER	1	1	1	3	
FLEXIBLE ASSEMBLY -	2	2	2	6	10.0 IN
BELLOWS ASSY (RESTRAINED)	3	3	3	9	

TUBE SEGMENTS			2	2	2						6	
FLANGES			2	2	2						6	
FOAM INSULATED COVER			1	1	1						3	
ASSEMBLY HARDWARE			1	1	1						3	
FASTENER AND SEAL SET -			4	4	4						12	10.0 IN DIA
FASTENER AND SEAL SET -			1	1	1						3	15.0 IN DIA
FASTENER AND SEAL SET -			1	1	1						3	8.0 IN DIA
FOAM INSULATED COVER - DISCONNECT			1	1	1						3	
FOAM INSULATED COVER - PREVALVE			2	2	2						6	
SUPPORTS & MISC PARTS SET			1	1	1						3	
LO2 BLEED			1	1	1						3	1.0 IN
VALVE			1	1	1						3	
LINES & FITTINGS			1	1	1						3	
SUPPORTS & MISC PARTS			1	1	1						3	
LO2 TANK PRESSURIZATION			1	1	1						3	2.0 IN
DISCONNECT			1	1	1						3	
VALVE			2	2	2						6	
ORIFICE			4	4	4						12	
LINES & FITTINGS SET			1	1	1						3	
SUPPORTS & MISC PARTS			1	1	1						3	
LH2 FEED -			1	1	1						3	15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA
DISCONNECT -			1	1	1						3	15.0 IN DIA, 6.0 IN LENGTH
PREVALVE -			1	1	1						3	10.0 IN DIA, 13.0 IN LENGTH
MANIFOLD ASSEMBLY -			1	1	1						3	15.0 IN DIA, 27.0 IN LENGTH
TUBE SEGMENT			1	1	1						3	
TUBE END CLOSEURE, @ F& D INTERFACE			1	1	1						3	
FLANGE AT DISCONNECT INTERFACE -			1	1	1						3	15.0 IN ID
FLANGE AT PREVALVE INTERFACE -			1	1	1						3	10.0 IN ID
FLANGE AT F & D VALVE INTERFACE -			1	1	1						3	8.0 IN ID
LOCAL REINFORCEMENT / SUPPORT TABS SET			1	1	1						3	
VACUUM JACKET			1	1	1						3	
FLEXIBLE ASSEMBLY -			2	2	2						6	10.0 IN DIA
BELLOWS ASSY (RESTRAINED)			3	3	3						9	
TUBE SEGMENTS			2	2	2						6	
FLANGES			2	2	2						6	
VACUUM JACKET SET			1	1	1						3	

ASSEMBLY HARDWARE												
FASTENER AND SEAL SET - 10.0 IN DIA			1	1	1						3	
FASTENER AND SEAL SET - 15.0 IN DIA			1	1	1						3	
FASTENER AND SEAL SET - 8.0 IN DIA			1	1	1						3	
VACUUM JACKET - DISCONNECT			1	1	1						3	
VACUUM JACKET - PREVALVE			1	1	1						3	
SUPPORTS & MISC PARTS SET			1	1	1						3	
LH2 FILL / DRAIN			1	1	1						3	8.0 IN
DISCONNECT			1	1	1						3	
VALVES			1	1	1						3	
DUCT ASSEMBLY			1	1	1						3	
INSULATION			1	1	1						3	
SUPPORTS & MISC PARTS			1	1	1						3	
H2 PRESTART BLEED			1	1	1						3	1.5 IN
DISCONNECT			2	2	2						6	
LINES & FITTINGS			1	1	1						3	
INSULATION			1	1	1						3	
SUPPORTS & MISC PARTS			1	1	1						3	
LH2 TANK PRESSURIZATION			1	1	1						3	2.0 IN
DISCONNECT			1	1	1						3	
FLOW CONTROL VALVES			3	3	3						9	
LINES & FITTINGS SET			1	1	1						3	
ORIFICES			3	3	3						9	
SUPPORTS & MISC PARTS			1	1	1						3	
GN2 GROUND SUPPLY			1	1	1						3	
DISCONNECT			1	1	1						3	
VALVE			1	1	1						3	
DUCT ASSEMBLY			1	1	1						3	
SUPPORY & MISC PARTS			1	1	1						3	

Description. The following is a synopsis of the activities for each of the flow blocks of the manufacturing flow.

Tank Fabrication. Consists of LO2, LH2, intertank, and forward skirt manufacturing, proof testing, and assembly.

Non-jettisonable Skirt Fabrication. Fabricate the structure of the non-jettisonable skirt section.

Conic Structure Fabrication. Fabricate the conic structure onto the non-jettisonable skirt structure.

Assemble Non-jettisonable. Assemble the non-jettisonable skirt and conic to the tank. Install the MPS feedlines, manifolding, avionics, TVC, environmental control, cabling, helium bottles into these sections.

Boost Ring Fabrication. Fabricate the jettisonable ring structure and install feedlines, cabling, etc.

Boost Module Fabrication. Build the ring structure and install the MPS feedlines, manifolding, avionics, TVC, environmental control, cabling, helium bottles.

Test and Checkout. Perform test and checkout of the MPS, helium, avionics, EPS, ECS, and STMEs.

Install Boost Module. Install the boost module to the jettisonable skirt.

8.0 Weights

Weights data provided for the Hybrid Configuration consists of the following:

Mission Weight Summary

Major Elements Inert Weight Summary

Weight Details - Core Tank Module

Weight Details - Fixed 2-Engine Sustainer Propulsion Package

Weight Details - Non-Jettisonable Aft Skirt Package

Weight Details - Jettisonable Aft Skirt Package

Weight Details - Expendable 2-Engine Propulsion Modules

MISSION WEIGHT SUMMARY (ENGINE OUT MISSION) NLS STATUS: 11/1/91

1.5 STAGE VEHICLE - TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE REVISION 1

* (2) LO2/LH2 EXPENDABLE BOOST PROPULSION MODULES
* (1) LO2/LH2 FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE (INCLUDING AVIONICS)
* (1) SUSTAINER ENGINE OUT CAPABILITY (FROM LIFTOFF)
* BOOST ENGINE AND SUSTAINER ENGINE: TVAC=583.4 KLBT, ISP=430.5 SEC, OBMR=6.0:1
* PAYLOAD SIZE (15 FT X 60 FT) X 1
* SHROUD SIZE: 16.67 FT X 80 FT
* LIFT CAPABILITY: 56422 LBS TO 80 X 150 NM, 28.5 DEG INCLINATION

	LAUNCH VEHICLE						SHROUD			LIFT CAPABILITY		
	BOOST MODULE NO. 1	BOOST MODULE NO. 2	CORE				ADAPTER	FAIRING		CARGO		MISSION MARGIN
			AFT SKIRT		SUSTAINER	TANK		NON		RETAINED	DEPLOYED	
			JETTISON	NON-JETT	PACKAGE	MODULE		JETTISON	JETTISON	ASE	PAYLOAD	
STRUCTURE	5299	5299	10993	2618	7484	57734	3133	209	12742			
STAGING/ORDNANCE	187	187	264	72		41						
RECOVERY	0	0										
THERMAL CONTROL	763	763	304	95	2118	2582	101					
LIQUID FUEL SYSTEM - MAIN ENGINES	16008	16008			16008							
- MAIN PROPULSION	4420	4420	2578	1138	5154	5482						
AUX PROP - RCS					131							
- OMS					692							
POWER - ELECTRICAL	794	794	70	20	874	500						
AVIONICS	662	662	0	0	1041	150	30					
DRY WT, LESS GROWTH	28133	28133	14209	3943	33502	66489	3264	209	12742			
WT GROWTH MARGIN	2813	2813	1421	394	3350	5612	326	21	1274			
DRY WEIGHT	30946	30946	15630	4337	36852	72101	3590	230	14016			
THERMAL CNTRL FLUIDS-AVIONICS	0	0	0		0							
MAIN RESIDUAL FLUIDS												
LO2 SYSTEM	1549	1549	2077	673	4562	3055						
LH2 SYSTEM	155	155	66	0	191	1626						
FUEL BIAS (LH2)	0	0	0	0	0	1374						
ENGINE OPERATIONAL CONTINGENCY (LO2)	0	0	0	0	0	0						
ENGINE OPERATIONAL CONTINGENCY (LH2)	0	0	0	0	0	0						
PNEUMATIC SYSTEM He	43	43			90							
RCS FLUIDS					478							
OMS FLUIDS					2839							
INERT WEIGHT	32693	32693	17773	5010	45012	78156	3590	230	14016			
MAIN PROPELLANT												
MAINSTAGE / SHUTDOWN						1653514						
FLIGHT PERFORMANCE RESERVE						4107						
ENGINE OUT RESERVE						0						
WEIGHT AT LIFTOFF	32693	32693	17773	5010	45012	1735777		230	14016	4663	46630	
	65386		1803572				3590	14246		51293		5129
	1868958						17836			56422		
	1943216											
THRUST HOLD PROP (6 ENGINES @ 86.5% RPL, 3.0 SEC)						21100						
THRUST BUILDUP PROP (6 ENGINES TO 86.5% RPL)						5866						
PROPELLANT DRAINBACK PRIOR TO ENGINE START						0						
HELIUM PURGING PRIOR TO ENGINE START	4	4			4	0						
PROPELLANT OFFLOAD - LO2						46192						
PROPELLANT OFFLOAD - LH2						0						

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
MAJOR ELEMENTS INERT WEIGHT SUMMARY (LONG FORM)

STATUS: 11/1/91
REVISION 1

ITEM	TANK MODULE	SUSTAINER PACKAGE	NON-JETT AFT SKIRT	JETTISONABLE AFT SKIRT	BOOST MODULE NO. 2	BOOST MODULE NO. 1	TOTAL
CORE STRUCTURE	57734	7484	2617	10993			78828
FORWARD SKIRT	1124						1124
LO2 TANK	13271						13271
IN INTERTANK	10372						10372
LH2 TANK	31323						31323
CONIC THRUST STRUCTURE		6624					6624
AFT SKIRT / SERARATION RING			2398	8133			10531
AERO FAIRINGS				2088			2088
UMBILICAL PLATES	120		120	480			720
LO2 UMBILICAL PLATES, BOOST			120	240			360
LO2 UMBILICAL PLATES, SUSTAINER							
LH2 UMBILICAL PLATES, BOOST	120			240			360
LH2 UMBILICAL PLATES, SUSTAINER							
EXTERNAL TUNNELS / CONDUIT	670						670
AVIONICS / EQUIPMENT COMPARTMENT		250					250
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT	854	610	99	294			1857
PROPULSION MODULE STRUCTURE					5299	5299	10598
MECHANISMS					10	10	20
SIDE SHELL					1627	1627	3254
FWD BULKHEAD (INCORPORATES LO2 AND LH2 UMBILICALS)					544	544	1088
AFT BULKHEAD					454	454	908
THRUST STRUCTURE					1988	1988	3976
SECONDARY INTERNAL SUPPORTS					175	175	350
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT					501	501	1002
STAGING / ORDNANCE	41		72	264	187	187	751
LO2 / LH2 TANKAGE DESTRUCTION	41						41
LINEAR SHAPED CHARGE - LO2 TANK	4						4
LINEAR SHAPED CHARGE - LH2 TANK	10						10
CONFINED DETONATING FUSE (CDF)	25						25
CDF MANIFOLD	3						3
JETTISONABLE SKIRT SEPARATION			72	76			148
SEP BOLTS, FLUIDS INTERFACE			24	24			48
LINEAR SHAPED CHARGE			35	52			87
CONFINED DETONATING FUSE (CDF)			11				11
CDF MANIFOLD			3				3
LAUNCH PAD SEPARATION				100			100
SEPARATION BOLTS				100			100
BOOST PROPULSION MODULE SEPARATION				88	187	187	462
SEP BOLTS, FLUIDS INTERFACE				24	12	12	48
SEP BOLTS, STRUCTURAL INTERFACE				40	20	20	80
PUSHOFF SPRINGS				24			24
SEPARATION SRMS					155	155	310

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
MAJOR ELEMENTS INERT WEIGHT SUMMARY (LONG FORM)

STATUS: 11/1/91
REVISION 1

ITEM	TANK MODULE	SUSTAINER PACKAGE	NON-JETT AFT SKIRT	JETTISONABLE AFT SKIRT	BOOST MODULE NO. 2	BOOST MODULE NO. 1	TOTAL
CORE THERMAL CONTROL / ECS	2582	2118	94	306			5100
MECHANICAL SYSTEMS	130	130					260
PURGE AND VENT, DRAIN	115	115					230
HAZARDOUS GAS DETECTION	15	15					30
EQUIPMENT HEAT TRANSPORT		257					257
HEAT SINK PLATES		237					237
GROUND COOLING - AIR / GN2		20					20
INSULATION / TPS / THERMAL PAINT	2452	147	94	306			2999
FORWARD SKIRT	18						18
LO2 TANK	271						271
INTERTANK	117						117
LH2 TANK	1168						1168
CONIC THRUST STRUCTURE		111					111
AFT SKIRT / SEPARATION RING			71	173			244
AERO FAIRINGS				83			83
LO2 MAIN FEED, BOOST	172		6	10			188
LO2 MAIN FEED, SUSTAINER	86	13	5				104
LO2 CROSSOVER FEED, BOOST TO SUSTAINER		23					23
LO2 ENGINE FEED, BOOST							
LO2 ENGINE FEED, SUSTAINER							
EXTERNAL TUNNELS / CONDUIT	280						280
MISCELLANEOUS CLOSEOUTS	320		12	40			372
MAIN ENGINE THERMAL ENCLOSURES		1394					1394
ENCLOSURE STRUCTURE		792					792
MOUNTING BASE STRUCTURE		242					242
ENCLOSURE TPS		60					60
ENGINE THERMAL BOOTS		300					300
RCS THRUSTER PLUME SHIELDS		80					80
OMS PROPELLANT LINE INSULATION		10					10
MISCELLANEOUS		100					100
PROPULSION MODULE THERMAL CONTROL / ECS					763	763	1526
MECHANICAL SYSTEMS					110	110	220
PURGE AND VENT, DRAIN					100	100	200
HAZARDOUS GAS DETECTION					10	10	20
EQUIPMENT HEAT TRANSPORT					209	209	418
EQUIPMENT HEAT SINK PLATES					189	189	378
AIR / GN2 GROUND COOLING					20	20	40
INSULATION / TPS					144	144	288
SIDE SHELL					67	67	134
BASE REGION					77	77	154
ENGINE THERMAL BOOTS					300	300	600

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
MAJOR ELEMENTS INERT WEIGHT SUMMARY (LONG FORM)

STATUS: 11/1/91
REVISION 1

ITEM	TANK MODULE	SUSTAINER PACKAGE	NON-JETT AFT SKIRT	JETTISONABLE AFT SKIRT	BOOST MODULE NO. 2	BOOST MODULE NO. 1	TOTAL
LIQUID FUEL SYSTEM - MAIN ENGINES		18006			18006	18006	49024
LIQUID FUEL SYSTEM - MAIN PROPULSION	5482	5153	1138	2578	4420	4420	23191
ANCILLARY EQUIPMENT		2014			1709	1709	5432
ENGINE GIMBAL SYSTEM		970			970	970	2910
ENGINE INSTALLATION PROVISIONS		32			32	32	96
ENGINE GN2 GROUND PURGE PROVISIONS		10			10	10	30
He PNEUMATIC SYSTEM - PLUMBING		391			391	391	1173
He PNEUMATIC SYSTEM - BOTTLES		611			308	308	1223
LO2 SYSTEMS	3461	1882	1138	1233	1250	1250	10214
LO2 MAIN FEED, BOOST	1850		907	1193			3950
LO2 MAIN FEED, SUSTAINER	925	463	211				1599
LO2 CROSSOVER FEED, BOOST TO SUSTAINER		538					538
LO2 ENGINE FEED, BOOST (INCLUDES INSULATED COVER)					853	853	1706
LO2 ENGINE FEED, SUSTAINER (INCLUDES INSULATED COVER)		727					727
LO2 FILL / DRAIN					243	243	486
LO2 OVERBOARD BLEED		45			45	45	135
O2 RELIEF		24			24	24	72
GOX POGO SUPPRESSION		35			35	35	105
LO2 AUTOGENOUS PRESS	591	50	20	40	50	50	801
LO2 TANK VENT	95						95
LH2 SYSTEMS	2021	1257		1345	1461	1461	7545
LH2 MAIN FEED, BOOST (INCLUDES VACUUM JACKETING)	949			1305			2254
LH2 MAIN FEED, SUSTAINER (INCLUDES VACUUM JACKETING)	-	173					173
LH2 ENGINE FEED, BOOST (INCLUDES VACUUM JACKETING)					899	899	1798
LH2 ENGINE FEED, SUSTAINER (INCLUDES VACUUM JACKETING)		773					773
LH2 RECIRCULATION	90						90
LH2 FILL / DRAIN					251	251	502
LH2 PRESTART CONDITIONING		203			203	203	609
H2 RELIEF		23			23	23	69
LH2 DUMP		29			29	29	87
LH2 AUTOGENOUS PRESS	885	58		40	58	58	1093
LH2 TANK VENT	97						97
AUXILIARY PROPULSION - RCS		131					131
THRUSTERS		45					45
PROPELLANT FEED / FILL / DRAIN		56					56
PROPELLANT TANKAGE							
PRESSURIZATION - PLUMBING		30					30
PRESSURIZATION - BOTTLES							
AUXILIARY PROPULSION - OMS		692					692 692
ENGINES		358					358
TVC ACTUATORS		24					24
PROPELLANT FEED / FILL / DRAIN		65					65
PROPELLANT TANKAGE		188					188
PRESSURIZATION - PLUMBING		57					57
PRESSURIZATION - BOTTLES							

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
MAJOR ELEMENTS INERT WEIGHT SUMMARY (LONG FORM)

STATUS: 11/1/91
REVISION 1

ITEM	TANK MODULE	SUSTAINER PACKAGE	NON-JETT AFT SKIRT	JETTISONABLE AFT SKIRT	BOOST MODULE NO. 2	BOOST MODULE NO. 1	TOTAL
POWER - ELECTRICAL	500	874	20	70	784	784	3052
GENERATION AND STORAGE	0	352			352	352	1058
PRIMARY BATTERIES		176			176	176	528
UTILITY BATTERIES		176			176	176	528
DISTRIBUTION AND SEQUENCING	500	522	20	70	442	442	1996
MAIN POWER DISTRIBUTOR ASSEMBLIES		104			104	104	312
POWER SWITCHING UNITS		68			68	68	204
CIRCUITRY	500	350	20	70	270	270	1480
AVIONICS	150	1041			682	682	2515
GUIDANCE AND CONTROL		363			282	282	927
INERTIAL MEASUREMENT UNIT		55					55
ASCENT TVC CONTROLLERS		168			168	168	504
ASCENT TVC POWER SOURCE SYSTEM CONTROLLERS		114			114	114	342
OMS TVC CONTROLLERS		26					26
DATA HANDLING		210			105	105	420
FLIGHT PROCESSOR UNITS		105					105
SIGNAL HANDLING UNITS		105			105	105	315
INSTRUMENTATION	28	280			275	275	858
SENSOR INTERFACE UNITS		35			30	30	95
LASER FIRING UNITS		20			20	20	60
CABLING HARNESS TO INTERFACE UNITS		35			35	35	105
CABLING HARNESS TO SENSORS		140			140	140	420
SENSORS (OPERATIONAL)	28	50			50	50	178
COMMUNICATIONS	18	132					148
S-BAND TRANSPONDERS		28					28
S-BAND POWER AMPLIFIERS		24					24
DIPLEXERS		4					4
C-BAND TRANSPONDERS		20					20
ENCRYPTER / DECRYPTER		10					10
S-BAND ANTENNAS	16	16					32
C-BAND ANTENNAS		4					4
COAX CABLING		28					28
RANGE SAFETY EQUIPMENT	106	56					162
INTREGRATED RECEIVER / DECODER UNITS		12					12
BATTERIES		20					20
LASER FIRING UNITS		20					20
ANTENNAS	16	4					20
ANTENNA GROUND PLANES	36						36
HYBRID COUPLER	2						2
DIRECTIONAL COUPLER	1						1
SAFE & ARM (INCLUDING DETONATORS)	3						3
FAIRING - CABLING / CDF	7						7
CABLING - INTERCONNECTING	41						41
DRY WEIGHT, EXCLUDING WEIGHT GROWTH MARGIN	66489	33501	3941	14211	28133	28133	174408
WEIGHT GROWTH MARGIN	5612	3350	394	1421	2813	2813	16403
DRY WEIGHT	72101	36851	4335	15632	30946	30946	190811

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
MAJOR ELEMENTS INERT WEIGHT SUMMARY (LONG FORM)

STATUS: 11/1/91
REVISION 1

ITEM	TANK MODULE	SUSTAINER PACKAGE	NON-JETT AFT SKIRT	JETTISONABLE AFT SKIRT	BOOST MODULE NO. 2	BOOST MODULE NO. 1	TOTAL
MAIN RESIDUAL FLUIDS - LO2 / LH2	6055	4754	673	2143	1704	1704	17033
LO2 SYSTEM	3055	4563	673	2077	1550	1550	13468
INITIAL ULLAGE VAPOR	302						302
PREPRESS GAS	32						32
INFLIGHT PRESS VAPORIZED PROPELLANT	2721						2721
TRAPPED IN TANK	0						0
TRAPPED IN MAIN FEED, BOOST	0		673	2077			2750
TRAPPED IN MAIN FEED, SUSTAINER	0	1397	0				1397
TRAPPED IN CROSSOVER FEED, BOOST TO SUSTAINER		1616					1616
TRAPPED IN ENGINE FEED, BOOST					923	923	1846
TRAPPED IN ENGINE FEED, SUSTAINER		923					923
TRAPPED IN MAIN ENGINES - ABOVE VALVE		509			509	509	1527
TRAPPED IN MAIN ENGINES - BELOW VALVE		118			118	118	354
LH2 SYSTEM	1628	191		66	154	154	2191
INITIAL ULLAGE VAPOR (GH2)	33						33
PREPRESS GAS (GHe)	27						27
INFLIGHT PRESS VAPORIZED PROPELLANT (GO2)	1108						1108
TRAPPED IN TANK	400						400
TRAPPED IN MAIN FEED, BOOST	58			66			124
TRAPPED IN MAIN FEED , SUSTAINER		36					36
TRAPPED IN ENGINE FEED, BOOST					57	57	114
TRAPPED IN ENGINE FEED, SUSTAINER		57					57
TRAPPED IN MAIN ENGINES - ABOVE VALVE		49			49	49	147
TRAPPED IN MAIN ENGINES - BELOW VALVE		49			48	48	145
FUEL BIAS (LH2) - SUSTAINER ENGINE OUT AT LIFTOFF	1374						1374
PHASE 1 MAINSTAGE (5 ENGINES OPERATING)	716						716
PHASE 2 MAINSTAGE (3 ENGINES OPERATING)	137						137
PHASE 3 MAINSTAGE (1 ENGINE OPERATING)	19						19
PHASE 4 MAINSTAGE (1 ENGINE OPERATING)	109						
PHASE 5 MAINSTAGE (1 ENGINE OPERATING)	393						
ENGINE OPERATIONAL CONTINGENCY	TBD						TBD
LO2	TBD						TBD
LH2	TBD						TBD
PNEUMATIC SYSTEM He		94			47	47	188
NOMINAL USAGE		69.8			31.8	31.8	133.2
MAIN ENGINES SEAL PURGE - PRELIFTOFF		2.5			2.5	2.5	7.5
MAIN ENGINES SEAL PURGE - LIFTOFF TO MECO		48.8			22.7	22.7	94.0
MAIN ENGINES SEAL PURGE - MECO TO MECO+20 SEC		2.1			2.1	2.1	6.3
MAIN PROPULSION SYS FUNCTIONS - PRELIFTOFF		1.5			1.5	1.5	4.5
MAIN PROPULSION SYS FUNCTIONS - LIFTOFF TO MECO		3.0			3.0	3.0	9.0
MAIN PROPULSION SYS FUNCTIONS - MECO TO MECO+20 SEC		0.0			0.0	0.0	0.0
RCS NOMINAL PROPELLANT PRESSURIZATION		1.5					1.5
OMS NOMINAL PROPELLANT PRESSURIZATION		10.4					10.4
RESERVE		7.1			3.2	3.2	13.5
MAIN ENGINES SEAL PURGE		5.3			2.7	2.7	10.7
MAIN PROPULSION SYSTEM FUNCTIONS		0.5			0.5	0.5	1.5
RCS RESERVE PROPELLANT PRESSURIZATION		0.3					0.3
OMS RESERVE PROPELLANT PRESSURIZATION		1.0					1.0
MARGIN - FULL BOTTLES		1.8			4.2	4.2	10.0
RESIDUAL- TRAPPED IN BOTTLES		15.7			7.8	7.8	31.3

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
MAJOR ELEMENTS INERT WEIGHT SUMMARY (LONG FORM)

STATUS: 11/1/91
REVISION 1

ITEM	TANK MODULE	SUSTAINER PACKAGE	NON-JETT AFT SKIRT	JETTISONABLE AFT SKIRT	BOOST MODULE NO. 2	BOOST MODULE NO. 1	TOTAL
RCS PROPELLANT		478					478
NOMINAL USAGE		371					371
TRIM PRIOR TO PAYLOAD SEPARATION		216					216
COLLISION AVOIDANCE AFTER PAYLOAD SEPARATION		155					155
RESERVE		74					74
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		18					18
RESIDUAL PROPELLANT - FEED SYSTEM / THRUSTERS		15					15
OMS PROPELLANT		2839					2839
NOMINAL USAGE		2443					2443
DEORBIT CORE STAGE		2443					2443
RESERVE		244					244
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		107					107
RESIDUAL PROPELLANT - FEED SYSTEM / ENGINES		45					45
REFERENCE INERT WEIGHT	78156	45016	5008	17775	32697	32697	211349
LESS PRELIFTOFF LOSSES		-4			-4	-4	-12
PNEUMATIC SYSTEM He		-4.0			-4.0	-4.0	-12.0
MAIN ENGINES SEAL PURGE		-2.5			-2.5	-2.5	-7.5
MAIN PROPULSION SYSTEM FUNCTIONS		-1.5			-1.5	-1.5	-4.5
INERT WEIGHT AT LIFTOFF	78156	45012	5008	17775	32693	32693	211337

1.5 STAGE VEHICLE

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)

STATUS: 11/1/91

CORE TANK MODULE

DETAIL WEIGHT STATEMENT

ITEM	QTY	WEIGHT - LB			%WG	REMARKS
STRUCTURE				57734	8.2	
LO2 TANK	1		13271		10	2219 WELDED ASSEMBLY / 2024 INTERNAL ELEMENTS
DOME, FWD	1		1387			ELLIPTICAL, R =165.5 IN, H = 124.125 IN (PRIOR TO 15.0 IN TRIM)
BASIC MEMBRANE, APEX TO TP	1	1097				144511 IN2, 0.084 IN (APEX), 0.071 IN (TP), 0.0744 (MEAN)
EDGE TRIM, 15 IN - FWD RING	1	-113				15598 IN2, 0.071 IN
HOLEOUT,45 IN DIA - MANHOLE FITTING	1	-14				1590 IN2, 0.084 IN
WELD LANDS / TOLERANCES / PADS	1	349				36.0%
MANHOLE FITTING (36-IN ACCESS DIAMETER)	1	27				2 X HOLEOUT
MANHOLE COVER / FASTENERS / SEALS	1	41				3 X HOLEOUT
RING, FWD	1		789			WIDTH = 11.05 IN
OUTER CHORD	1	789				ET LO2 TANK AFT RING OUTER CHORD
INNER CHORD / WEB /SPLICES / FASTENERS SEGMENTS	-	-				INCORPORATED INTO SLOSH BAFFLE
STABLIZERS	-	-				NONE REQUIRED. FUNCTION PROVIDED BY SLOSH BAFFLE
BARREL	1		5679			CYLINDER, R = 165.5 IN, H = 268.42 IN
BASIC MEMBRANE	1	4456				279121 IN2, 0.141 IN (FWD TP), 0.172 IN (AFT TP)
INTEGRAL STRINGERS	86	534				A = 0.227 IN2 (EACH), SPACING = 12.0 IN
WELD LANDS / TOLERANCES / PADS	1	399				8.0% (ASSUMES BARREL HAS 4 PANELS)
SRB THRUST BEEFUP INCREMENT	2	290				ET LO2 TANK BEEFUP INCREMENT
RING, AFT	1		789			SAME AS FORWARD RING
OUTER CHORD	1	789				ET LO2 TANK AFT RING OUTER CHORD
INNER CHORD / WEB /SPLICES / FASTENERS SEGMENTS	-	-				INCORPORATED INTO SLOSH BAFFLE
STABLIZERS	-	-				NONE REQUIRED. FUNCTION PROVIDED BY SLOSH BAFFLE
DOME, AFT	1		2470			ELLIPTICAL, R =165.5 IN, H = 124.125 IN (PRIOR TO 15.0 IN TRIM)
BASIC MEMBRANE, APEX TO TP	1	1832				144511 IN2, 0.110 IN (TP), 0.149 IN (APEX), 0.1243 (MEAN)
EDGE TRIM, 15 IN - AFT RING	1	-175				15598 IN2, 0.110 IN
HOLEOUT,48 IN DIA - OUTLET FITTING	3	-83				1810 IN2, 0.149 IN
HOLEOUT,45 IN DIA - MANHOLE FITTING	1	-24				1590 IN2, 0.149 IN
WELD LANDS / TOLERANCES / PADS / BANDS	1	633				36.0% + 75 LBS COMPRESSION BANDS
OUTLET FITTING - 15.0 IN DIA OUTLET	3	165				2 X HOLEOUT
MANHOLE FITTING (36-IN ACCESS DIAMETER)	1	48				2 X HOLEOUT
MANHOLE COVER / FASTENERS / SEALS	1	72				3 X HOLEOUT
VORTEX BAFFLE / SCREEN - 15.0 IN DIA OUTLET	3		70			15.0 IN LINES, 1.23 FT2 LINE AREA / OUTLET, 19 LB/FT2
SLOSH BAFFLE	1		2021			H = 260.5 IN
FWD RING INNER CHORD / WEB / SPLICES / FASTENERS	1	342				ET LO2 TANK FWD RING / SLOSH BAFFLE COMPONENTS
AFT RING INNER CHORD / WEB / SPLICES / FASTENERS	1	342				ET LO2 TANK AFT RING / SLOSH BAFFLE COMPONENTS
INTERMEDIATE BAFFLE SYSTEM - INCL ASSY / INSTL HDW	1	1337				ET LO2 TANK INTERMEDIATE BAFFLE SYSTEM SCALEUP (W = 4.70 LB / IN)
PRIMER - TOTAL EXTERIOR	1		66			S = 903 + 2079 + 903 = 3885 FT2, W/S = 0.017 LB /FT2

1.5 STAGE VEHICLE

STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)

CORE TANK MODULE

DETAIL WEIGHT STATEMENT

ITEM	QTY	WEIGHT - LB		%WG	REMARKS
LH2 TANK	1		31323	10	2219 WELDED ASSEMBLY / 2024 INTERNAL ELEMENTS
DOME, FWD	1	1331			ELLIPTICAL, R =165.5 IN, H = 124.125 IN (PRIOR TO 15.0 IN TRIM)
BASIC MEMBRANE, APEX TO TP	1	1041			144511 IN2, 0.084 IN (APEX), 0.063 IN (TP), 0.0706 IN (MEAN)
EDGE TRIM, 15 IN - FWD RING	1	-100			15598 IN2, 0.063 IN
HOLEOUT,45 IN DIA - MANHOLE FITTING	1	-14			1670 IN2, 0.084 IN
WELD LANDS / TOLERANCES / PADS	1	333			36.0%
MANHOLE FITTING (36-IN ACCESS DIAMETER)	1	29			2 X HOLEOUT
MANHOLE COVER / FASTENERS / SEALS	1	43			3 X HOLEOUT
RING, FWD	1	1129			WIDTH = 12.0 IN
OUTER CHORD	1	731			ET LH2 TANK FORWARD RING OUTER CHORD
INNER CHORD / WEB / SPLICES / FASTENERS SEGMENTS	1	364			ET LH2 TANK FORWARD RING COMPONENTS
STABLIZERS		34			ET LH2 TANK FORWARD RING COMPONENTS
BARREL A	1	5679			CYLINDER, R = 165.5 IN, H = 240.45 IN
BASIC MEMBRANE	1	3213			250036 IN2, 0.126 IN (FWD), 0.126 IN (AFT)
INTEGRAL STRINGERS	172	958			A=0.227 IN2, SPACING = 6.0 IN
WELD LANDS / TOLERANCES / PADS	1	626			15.0%
STAB. RING FRAMES (7) - FRAME SEGMENTS	28	774			A = 1.09 IN2 (EACH), RBAR = 161.4 IN, DEPTH = 5.20 IN
STAB. RING FRAMES (7) - SPLICE PLATE SETS	28	31			4.0%
STAB. RING FRAMES (7) - INSTL CLIPS / FASTENERS	TBD	77			10.0%
RING FRAME, INTERBARREL A - B	1	414			ET LH2 TANK MINIMUM INTERBARREL RING. WIDTH = 6.0 IN
BARREL B	1	5679			CYLINDER, R = 165.5 IN, H = 240.45 IN
BASIC MEMBRANE	1	3213			250036 IN2, 0.126 IN (FWD), 0.126 IN (AFT)
INTEGRAL STRINGERS	172	958			A=0.227 IN2, SPACING = 6.0 IN
WELD LANDS / TOLERANCES / PADS	1	626			15.0%
STAB. RING FRAMES (7) - FRAME SEGMENTS	28	774			A = 1.09 IN2 (EACH), RBAR = 161.4 IN, DEPTH = 5.20 IN
STAB. RING FRAMES (7) - SPLICE PLATE SETS	28	31			4.0%
STAB. RING FRAMES (7) - INSTL CLIPS / FASTENERS	TBD	77			10.0%
RING FRAME, INTERBARREL B - C	1	414			ET LH2 TANK MINIMUM INTERBARREL RING. WIDTH = 6.0 IN
BARREL C	1	5674			CYLINDER, R = 165.5 IN, H = 240.20 IN
BASIC MEMBRANE	1	3210			249776 IN2, 0.126 IN (FWD), 0.126 IN (AFT)
INTEGRAL STRINGERS	172	957			A = 0.227 IN2, SPACING = 6.0 IN
WELD LANDS / TOLERANCES / PADS	1	625			15.0%
STAB. RING FRAMES (7) - FRAME SEGMENTS	28	774			A = 1.09 IN2 (EACH), RBAR = 161.4 IN, DEPTH = 5.20 IN
STAB. RING FRAMES (7) - SPLICE PLATE SETS	28	31			4.0%
STAB. RING FRAMES (7) - INSTL CLIPS / FASTENERS	TBD	77			10.0%

1.5 STAGE VEHICLE — STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)

CORE TANK MODULE

DETAIL WEIGHT STATEMENT

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
LH2 TANK (CONT)				
RING FRAME, INTERBARREL C - D	1	414		ET LH2 TANK MINIMUM INTERBARREL RING. WIDTH = 6.0 IN
BARREL D	1	4099		CYLINDER, R = 165.5 IN, H = 170.4 IN
BASIC MEMBRANE	1	2277		177193 IN2, 0.126 IN (FWD), 0.126 IN (AFT)
INTEGRAL STRINGERS	172	679		A = 0.227 IN2, SPACING = 6.0 IN
WELD LANDS / TOLERANCES / PADS	1	443		15.0%
STAB. RING FRAMES (5) - FRAME SEGMENTS	20	614		A = 1.21 IN2 (EACH), RBAR = 161.4 IN, DEPTH = 5.20 IN
STAB. RING FRAMES (5) - SPLICE PLATE SETS	20	25		4.0% OF FRAME SEGMENTS
STAB. RING FRAMES (5) - INSTL. CLIPS / FASTENERS	TBD	61		10.0% OF FRAME SEGMENTS
RING FRAME, INTERBARREL D - E	1	2480		WIDTH = 11.0 IN
OUTER CHORD	1	891		ET LH2 TANK AFT RING OUTER CHORD (MODIFIED FOR INTERBARREL. NO WT CHANGE)
INNER CHORD / WEB / SPLICES / FASTENERS	1	1472		ET LH2 TANK AFT RING COMPONENTS
STABLIZERS		117		ET LH2 TANK AFT RING COMPONENTS
BARREL E	1	1300		CYLINDER, R = 165.5 IN, H = 57.5 IN
BASIC MEMBRANE	1	768		59792 IN2, 0.126 IN (FWD), 0.126 IN (AFT)
INTEGRAL STRINGERS	172	229		A = 0.227 IN2, SPACING = 6.0 IN
WELD LANDS / TOLERANCES / PADS	1	150		15.0%
STAB. RING FRAME (1) - FRAME SEGMENTS	4	134		A = 1.32 IN2 (EACH), RBAR = 161.4 IN, DEPTH = 5.20 IN
STAB. RING FRAME (1) - SPLICE PLATE SETS	4	5		4.0%
STAB. RING FRAME (1) - INSTL. CLIPS / FASTENERS	TBD	13		10.0%
RING, AFT	1	1129		WIDTH = 12.0 IN
OUTER CHORD	1	731		ET LH2 TANK FORWARD RING OUTER CHORD
INNER CHORD / WEB / SPLICES / FASTENERS SEGMENTS	1	364		ET LH2 TANK FORWARD RING COMPONENTS
STABLIZERS		34		ET LH2 TANK FORWARD RING COMPONENTS
DOME, AFT	1	1358		ELLIPTICAL, R =165.5 IN, H = 124.125 IN (PRIOR TO 15.0 IN TRIM)
BASIC MEMBRANE, APEX TO TP	1	1041		144511 IN2, 0.063 IN (TP), 0.084 IN (APEX), 0.0708 (MEAN)
EDGE TRIM, 15 IN - AFT RING	1	-100		15598 IN2, 0.063 IN
HOLEOUT, 48 IN DIA - OUTLET FITTING	3	-47		1810 IN2, 0.084 IN
HOLEOUT, 45 IN DIA - MANHOLE FITTING	1	-14		1590 IN2, 0.084 IN
WELD LANDS / TOLERANCES / PADS	1	317		36.0%
OUTLET FITTING - 15.0 IN DIA OUTLET	3	93		2 X HOLEOUT
MANHOLE FITTING (36-IN ACCESS DIAMETER)	1	27		2 X HOLEOUT
MANHOLE COVER / FASTENERS / SEALS	1	41		3 X HOLEOUT
VORTEX BAFFLE / SCREEN - 15.0 IN DIA OUTLETS	3	70		15.0 IN LINES, 1.23 FT2 LINE AREA / OUTLET, 19 LB/FT2
PRIMER - TOTAL EXTERIOR	1	153		S = 903 + 7217 + 903 = 9023 FT2, W/S = 0.017 LB / FT2

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)
CORE TANK MODULE
DETAIL WEIGHT STATEMENT

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB		%WG	REMARKS
FORWARD SKIRT (331.0 IN DIA, 40.85 IN LENGTH)	1		1124	10	ALUMINUM SKIN/STRINGER DESIGN, S = 295.0 FT2, W/S = 3.81 LB/FT2
BARREL SKIN PANELS - SKIN/STRINGER	8	592			7075 SKIN/7075 STRINGERS
SKIN	8	323			S =8(130.00 X 38.85)=40404 IN2, T = 080 IN
SKIN DOUBLERS	TBD	65			20% OF SKIN WEIGHT
STRINGERS	208	162			A=0.20 IN2, L=38.85 IN ,SPACING = 5.0 IN
HOLEOUT, 30 IN X 30 IN, ACCESS DOOR	1	-12			900 IN2, 0.136 IN TBAR
HOLEOUT, 5 IN X 14 IN, GO2 PRESS LINE	1	-1			70 IN2, 0.136 IN TBAR
HOLEOUT, CABLING	2	-1			ESTIMATE
EDGE CLOSEOUT, ACCESS DOOR HOLEOUT	1	24			2 X HOLEOUT
EDGE CLOSEOUT, GO2 PRESS LINE HOLEOUT	1	2			2 X HOLEOUT
EDGE CLOSEOUTS, CABLING HOLEOUT	1	2			2 X HOLEOUT
FASTENERS, ASSY	TBD	28			5%
SPLICES, BARREL PANELS	8		17		L = 40.85 - 2(3.00) = 34.85 IN (EACH), W = 0.060 LB/IN
RING FLANGE, FWD - SHROUD INTERFACE	1		163		ALUMINUM
FLANGE SEGMENTS	4	157			A = 1.50 IN2, RBAR = 166.0 IN
SPLICE PLATE SETS	4	6			4.0%
RING FLANGE, AFT - LO2 TANK INTERFACE	1		209		ALUMINUM
FLANGE SEGMENTS	4	209			A = 2.00 IN2, RBAR = 166.0 IN
SPLICE PLATE SETS	-	-			RING FLANGE SEGMENTS NOT JOINED (ET APPROACH)
ACCESS DOOR, 33 IN X 33 IN	1		23		ALUMINUM, 7.6 FT2, 3.0 LB / FT2
AERO FAIRINGS	3		21		ALUMINUM
GO2 PRESS LINE FAIRING	3	21			ET PRESS LINE FAIRING
CABLE TRAY FAIRING	-	-			INCLUDED WITH EXTERNAL TUNNELS / CONDUIT
INTERNAL PRIMER	1		6		S = 1.20 X 295 = 354 FT2 , W/S = 0.017 LB / FT2
INSTALLATION HARDWARE	144		40		STEEL FASTENERS
FASTENERS, FORWARD SKIRT TO SHROUD	-	-			INCLUDED IN SHROUD WEIGHT
FASTENERS, FORWARD SKIRT TO LO2 TANK	144	40			0.28 LB / LOCATION, 144 LOCATIONS
MISCELLANEOUS			54		5%
INTERTANK (331.0 IN DIA, 270.35 IN LENGTH)	1		10372	0	ALUMINUM SKIN/STRINGER DESIGN, S =1952.3 FT2, W/S = 5.31 LB/FT2
BARREL PANELS, MACHINED	2		3685		INCLUDES RING FLANGES (FWD AND AFT)
BARREL PANELS, SKIN/STRINGER	6		4130		INCLUDES RING FLANGES (FWD AND AFT)
SPLICES, BARREL PANELS	8		127		L = 270.35-2(3.0) = 264.35 IN (EACH), W = 0.060 LB/IN
FRAMES, STABILIZING	4		1097		
FRAME, SRB THRUST	1		746		
STABILIZERS, FRAME	20		131		
BEAM, SRB THRUST	-		0		DELETED (1113 LB)
FITTING, SRB THRUST	-		0		DELETED (839 LB)
ACCESS DOOR, 46 IN X 52 IN	1		50		S = 46 IN X 52 IN = 2392 IN2 = 16.6 FT2, W/S = 3.0 LB/FT2
AERO FAIRINGS	6		252		ALUMINUM
LO2 FEED LINE FAIRING	3	231			ET LO2 LINE FAIRING
GH2 PRESS LINE FAIRING	3	21			ET PRESS LINE FAIRING
CABLE TRAY FAIRINGS	-	-			INCLUDED WITH EXTERNAL TUNNELS / CONDUIT
INTERNAL PRIMER	1		50		S = 1.5 X 1952.3 = 2928 FT2, W/S = 0.017 LB / FT2
FASTENERS, TANKAGE INTERFACES	370		104		STEEL FASTENERS
FASTENERS, INTERTANK TO LO2 TANK	192	54			0.28 LB/LOCATION, 192 LOCATIONS
FASTENERS, INTERTANK TO LH2 TANK	178	50			0.28 LB/LOCATION, 178 LOCATIONS
MISCELLANEOUS			0		INCLUDED IN ABOVE WEIGHTS

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE) STATUS: 11/1/91
CORE TANK MODULE
DETAIL WEIGHT STATEMENT

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
UMBILICAL PLATES	2	120	10	
LH2 UMBILICAL PLATES - BOOST FEED	2	120		EACH SUPPORTS (3) DISCONNECTS: LH2 (15 IN DIA), GH2, AND ELECTRICAL
EXTERNAL TUNNELS / CONDUIT	1	670	10	1.05 X ET
SUPPORT / INSTALLATION PROVISIONS		854	10	
UMBILICAL PLATES		30		25%
EXTERNAL TUNNELS / CONDUIT		67		10%
LO2 / LH2 TANKAGE DESTRUCTION		4		10%
PURGE & VENT, DRAIN		32		28%
HAZARDOUS GAS DETECTION		15		100%
LO2 SYSTEMS		346		10%
LH2 SYSTEMS		193		10%
POWER DISTRIBUTION, ELECTRICAL		125		25%
INSTRUMENTATION		28		100%
COMUNICATIONS		3		20%
RANGE SAFETY		11		10%

1.5 STAGE VE
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AS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)
MODULE
GHT STATEMENT

STATUS: 11/1/91

EM	QTY	WEIGHT - LB		%WG	REMARKS	
ING / ORDNANCE			41	10		
LO2 / LH2 TANKAGE DESTRUCTION	1		41	10		
LINEAR SHAPE CHARGE - LO2 TANK	1	4.0			L = 8 FT, W = 0.50 LB/FT	
LINEAR SHAPE CHARGE - LH2 TANK	1	10.0			L = 20 FT, W = 0.50 LB/FT	
CONFINED DETONATING FUSE	7	24.5			L = 408 FT, W = 0.06 LB/FT	
CDF MANIFOLD	2	2.5				
THERMAL CONTROL / ECS			2582	10		
MECHANICAL SYSTEMS			130	10		
PURGE & VENT, DRAIN	1	115			ESTIMATE	
HAZARDOUS GAS DETECTION	1	15			ESTIMATE	
INSULATION / TPS	1		2452	10		
FWD SKIRT	1	18			S = 1.5 X 295.0 SF, W/S = 0.04 PSF	THERMAL PAINT
LO2 TANK	1	271				
FWD DOME	1	75			S = 903 SF, TBAR = 0.50 IN, W/S = 0.083 PSF	BX-250 (2.0 PCF)
SIDES	1	83			S = 2079 SF, W/S = 0.04 PSF	THERMAL PAINT
AFT DOME	1	113			S = 903 SF, TBAR = 0.75 IN, W/S = 0.125 PSF	BX-250 (2.0 PCF)
INTERTANK	1	117			S = 1.5 X 1952.3 SF, W/S = 0.04 PSF	THERMAL PAINT
LH2 TANK	1	1188				
FWD DOME	1	75			S = 903 SF, TBAR = 0.50 IN, W/S = 0.083 PSF	BX-250 (2.0 PCF)
SIDES - GENERAL	1	752			S = 7217 SF, TBAR = 0.50 IN, W/S = 0.104 PSF	CPR-488 (2.5 PCF)
SIDES - LOCAL	1	173			S = 230 SF, TBAR = 0.50 IN, W/S = 0.75 PSF	SLA561 (18 PCF)
AFT DOME	1	188			S = 903 SF, TBAR = 1.00 IN, W/S = 0.208 PSF	CPR-488 (2.5 PCF)
LO2 MAIN FEED LINES, BOOST AND CORE	3	258			S = 413 SF / FEED, TBAR = 1.0 IN, W/S = 0.208 PSF	CPR-488 (2.5 PCF)
LH2 MAIN FEED LINES, BOOST	2	-			VACUUM JACKETING INCLUDED IN FEED WEIGHT	
EXTERNAL TUNNELS / CONDUIT	1	280			S=400 SF, TBAR=1.4 IN, W/S = 0.70 PSF	SLA561/CPR-488 (6.0 PCF)
MISCELLANEOUS CLOSEOUTS	-	320			15%	

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)
STATUS: 11/1/91
CORE TANK MODULE
DETAIL WEIGHT STATEMENT

ITEM	QTY	WEIGHT - LB			%WG	REMARKS	
LIQUID FUEL SYSTEM - MAIN PROPULSION				5482	10		
LO2 MAIN FEED, BOOST AND CORE - 15.0 IN DIA, 1262.65 IN LENGT	3			2775	10		
FORWARD FLEXIBLE ASSEMBLY - 132.6 IN LENGTH	3		603			PROOF PRESS = 173 PSI	
BELLOWS ASSY (RESTRAINED)	6	300				L = 12.0 IN , W = 50 LB	INCONEL 718
TUBE SEGMENTS	6	215				L = 104.6 IN / FEED, T = 0.050 IN (MIN), DBAR = 15.050 IN	321 STAINLESS
FLANGES	6	87				L = 2.0 IN , DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
FLEXIBLE ELBOW ASSEMBLY - 126.7 IN LENGTH	3		465			PROOF PRESS = 173 PSI	
BELLOWS ASSY (RESTRAINED)	3	150				L = 12.0 IN, W = 50 LB	INCONEL 718
TUBE SEGMENTS	6	228				L = 110.7 IN / FEED, T = 0.050 IN (MIN), DBAR = 15.050 IN	321 STAINLESS
FLANGES	6	87				L = 2.0 IN , DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
STRAIGHT SECTION - 246.0 IN LENGTH	12		1573			PROOF PRESS = 414 PSI	
TUBE SEGMENTS	12	1450				L = 960.0 IN / FEED, T = 0.104 IN, DBAR = 15.104 IN	2219 ALUMINUM
FLANGES	24	123				L = 3.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	2219 ALUMINUM
STRAIGHT SECTION - 19.35 IN LENGTH	3		51			PROOF PRESS = 414 PSI	
TUBE SEGMENTS	3	20				L = 13.35 IN / FEED, T = 0.104 IN, DBAR = 15.104 IN	2219 ALUMINUM
FLANGES	6	31				L = 3.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	2219 ALUMINUM
ASSEMBLY HARDWARE - ITEM TO ITEM	18		72				
FASTENER AND SEAL SET	18	72				4 LB / JOINT	
INSTALLATION HARDWARE - FEED TO LO2 TANK	3		12				
FASTENER AND SEAL SET	3	12				4 LB / JOINT	
LO2 AUTOGENOUS PRESS	3			591	10	3 X ET	
LO2 TANK VENT	1			95	10	SAME AS ET	
LH2 MAIN FEED, BOOST - 15.0 IN DIA, 64.0 IN LENGTH	2			949	10		
RIGID ASSEMBLY - 38.0 IN LENGTH	2		155			PROOF PRESSURE = 126 PSI	
TUBE SEGMENTS	2	47				L = 34.0 IN / FEED, T = 0.050 IN (MIN), DBAR = 15.050 IN	321 STAINLESS
FLANGES - 15.5 IN DIA	4	58				L = 2.0 IN EA, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
VACUUM JACKET	2	50				12.4 SF / ASSY @ 2.0 PSF	
VALVE PACKAGE - 20.0 IN LENGTH	2		400			USING LO2 VALVE PACKAGES	
DISCONNECT - 6.0 IN LENGTH	2		334			USING LO2 DISCONNECTS	
ASSEMBLY HARDWARE - ITEM TO ITEM	4		16				
FASTENER AND SEAL SET	4	16				4 LB / JOINT	
INSTALLATION HARDWARE - FEED TO LH2 TANK	2		8				
FASTENER AND SEAL SET	2	8				4 LB / JOINT	
VACUUM JACKET - DISCONNECT	2		8			2.0 SF / DISCONNECT @ 2.0 PSF	321 STAINLESS
VACUUM JACKET - VALVE PACKAGE	2		28			7.0 SF / VALVE PACKAGE @ 2.0 PSF	321 STAINLESS
LH2 MAIN FEED, CORE - 15.0 IN DIA, 80.0 IN LENGTH	-			0	10	INCLUDED IN CORE SUSTAINER PACKAGE	
H2 RECIRCULATION	2			90	10	3 X ET	
LH2 AUTOGENOUS PRESS	3			885	10	3 X ET	
LH2 TANK VENT	1			97	10	SAME AS ET	

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)
CORE TANK MODULE
DETAIL WEIGHT STATEMENT

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB		%WG	REMARKS
POWER - ELECTRICAL			500	10	
GENERATION AND STORAGE	-		0	10	
DISTRIBUTION AND SEQUENCING	1		500	10	
CIRCUITRY (WIRE HARNESS)	1	500			
AVIONICS			150	10	
GUIDANCE AND CONTROL	-		0	10	
DATA HANDLING	-		0	10	
INSTRUMENTATION	1		28	10	
COMMUNICATIONS	1		16	10	
RANGE SAFETY EQUIPMENT	1		106	10	
HYBRID COUPLER	1	2			
DIRECTIONAL COUPLER	1	1			
SAFE & ARM (INCLUDING DETONATORS)	1	3			
FAIRING - CABLING / CDF	TBD	7			
ANTENNA	2	16			
ANTENNA GROUND PLANE	2	36			
CABLING - INTERCONNECTING	-	41			
DRY WEIGHT, EXCLUDING WEIGHT GROWTH MARGIN			66489	8.4	
WEIGHT GROWTH MARGIN			5612	0.0	10% EXCLUSIVE OF INTERTANK
DRY WEIGHT			72101	7.8	

1.5 STAGE VEHICLE — STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A CORE FIXED 2-ENGINE SUSTAINER PACKAGE)

CORE TANK MODULE

DETAIL WEIGHT STATEMENT

ITEM	QTY	WEIGHT - LB		%WG	REMARKS
MAIN RESIDUAL FLUIDS - LO2 / LH2 SYSTEMS			6055	0	ENGINE OUT MISSION
LO2 SYSTEM	1		3055	0	FROM PROPELLANT INVENTORY
ULLAGE VAPOR @ ESC (GO2)	1	302			
PREPRESS GAS @ ESC (GHe)	1	32			
INFLIGHT PRESS VAPORIZED PROPELLANT (GO2)	1	2721			
TRAPPED IN TANK (LO2)	1	0			
TRAPPED IN BOOST FEEDS (LO2)	3	0			
TRAPPED IN SUSTAINER FEED (LO2)					
LH2 SYSTEM	1		1626	0	FROM PROPELLANT INVENTORY
ULLAGE VAPOR @ ESC (GH2)	1	33			
PREPRESS GAS @ ESC (GHe)	1	27			
INFLIGHT PRESS VAPORIZED PROPELLANT (GH2)	1	1108			
TRAPPED IN TANK (LH2)	1	400			
TRAPPED IN BOOST FEEDS (LH2)	3	58			L = 64 IN, D = 15.0 IN, V = 6.545 FT3 (EACH). FULL
FUEL BIAS (LH2)	1		1374	0	FROM PROPELLANT INVENTORY
PHASE 1 MAINSTAGE (5 ENGINES OPERATING)	1	716			
PHASE 2 MAINSTAGE (3 ENGINES OPERATING)	1	137			
PHASE 3 MAINSTAGE (1 ENGINE OPERATING)	1	19			
PHASE 4 MAINSTAGE (1 ENGINE OPERATING)		109			
PHASE 5 MAINSTAGE (1 ENGINE OPERATING)		393			
ENGINE OPERATIONAL CONTINGENCY	1		0		FROM PROPELLANT INVENTORY
LO2	1	0			
LH2	1	0			
INERT WEIGHT			78155		

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB			%WG	REMARKS
STRUCTURE				7484	10	
CONIC THRUST STRUCTURE (L = 207.85 IN, D = 331.0 IN, d = 106.0 IN)	1		6624		10	ALUMINUM SKIN/STRINGER DESIGN, S = 1104.8 FT2, W/S = 6.00 LB/FT2
CONIC PANELS, SKIN STRINGER	8		2290			7075 SKIN/7075 STRINGERS
SKIN	8	1273				S = 159090 IN2, T = 0.080 IN
SKIN DOUBLERS	TBD	127				10% OF SKIN WEIGHT
STRINGERS - OUTSIDE SHEAROUT REGIONS	TBD	343				S = 64% OF 159090 IN2 = 101818 IN2, TBAR = 0.0337 IN
STRINGERS - WITHIN SHEAROUT REGIONS	TBD	380				S = 36% OF 159090 IN2 = 57272 IN2, TBAR = 0.0664 IN
HOLEOUT, 20 IN X 20 IN, ACCESS DOOR	4	-32				S = 400 IN2 (EACH), TBAR = 0.200 IN
HOLEOUT, 12 IN X 20 IN (OBLONG), CORE LH2 FEED LINE	2	-8				S = 188 IN2 (EACH), TBAR = 0.200 IN
HOLEOUT, 18 IN X 30 IN (OBLONG), BOOST LH2 FEED LINE	2	-17				S = 424 IN2 (EACH), TBAR = 0.200 IN
HOLEOUT, CABLING	1	-1				ESTIMATE
EDGE CLOSEOUT, ACCESS DOOR HOLEOUT	4	64				2 X HOLEOUT
EDGE CLOSEOUT, CORE LH2 FEED LINE HOLEOUT	2	15				2 X HOLEOUT
EDGE CLOSEOUT, BOOST LH2 FEED LINE HOLEOUT	2	34				2 X HOLEOUT
EDGE CLOSEOUT, CABLING HOLEOUT	1	2				2 X HOLEOUT
FASTENERS, ASSEMBLY	TBD	109				5%
SPLICES, CONIC PANELS	8		112			L = 240.0-2(3.0) = 234.0 IN (EACH), W = 0.060 LB/IN
RING, FORWARD	1		2065			
RING SEGMENTS	4	1985				A = 20.0 IN2, RBAR = 158.0 IN
SPLICE PLATE SETS	4	79				4%
RING, AFT	1		196			ONE PIECE RING. A = 6.0 IN2, RBAR = 52.0 IN
FRAMES, STABLIZING	6		645			
FRAME SEGMENTS - FRAME 1	4	183				A = 2.0 IN2, RBAR = 148.35-2.5 = 145.85 IN
SLPICE PLATE SETS - FRAME 1	4	7				4%
FRAME SEGMENTS - FRAME 2	4	146				A = 1.8 IN2, RBAR = 131.20-2.5 = 128.70 IN
SLPICE PLATE SETS - FRAME 2	4	6				4%
FRAME SEGMENTS - FRAME 3	4	112				A = 1.6 IN2, RBAR = 114.05-2.5 = 111.55 IN
SLPICE PLATE SETS - FRAME 3	4	4				4%
FRAME SEGMENTS - FRAME 4	4	83				A = 1.4 IN2, RBAR = 96.90-2.5 = 94.40 IN
SLPICE PLATE SETS - FRAME 4	4	3				4%
FRAME SEGMENTS - FRAME 5	4	58				A = 1.2 IN2, RBAR = 79.75-2.5 = 77.25 IN
SLPICE PLATE SETS - FRAME 5	4	2				4%
FRAME SEGMENTS - FRAME 6	4	38				A = 1.0 IN2, RBAR = 62.60-2.5 = 60.10 IN
SLPICE PLATE SETS - FRAME 6	4	2				4%
STABLIZERS, FRAME	-		-			ASSUME NONE REQUIRED
THRUST POSTS	2		450			
LONGERON - LESS BASE BUILDUP	2	430				ABAR = 1.0(16.30+1.63)/2 = 9.0 IN2, L = 240 IN (EACH)
BASE BUILDUP	2	20				10 LB / LONGERON
THRUST BEAM - ENGINE ATTACH POINTS INTERCONNECT	1		109			ABAR = 12.0 IN2, L = 91 IN
THRUST BEAM STABLIZING BEAMS	4		100			25 LB EACH
ACTUATOR ATTACH FITTINGS	4		240			60 LB EACH
ACCESS DOOR, 20 IN X 20 IN	4		33			S = 20 X 20 = 400 IN2 (EACH) = 2.78 FT2 (EACH), W/S = 3.0 LB/FT2
INTERNAL PRIMER			28			S = 1.5 X 1104.8 FT2 = 1657.2 FT2, W/S = 0.017 LB/FT2
INSTALLATION HARDWARE	TBD		40			STEEL FASTENERS
FASTENERS, THRUST CONE TO BASE SKIRT	TBD	40				ESTIMATE
MISCELLANEOUS			315			5%

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
AVIONICS / EQUIPMENT COMPARTMENT	1	250	10	ESTIMATE
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT		610	10	
PURGE AND VENT, DRAIN		32		28%
HAZARDOUS GAS DETECTION		15		100%
EQUIPMENT HEAT TRANSPORT		21		8%
MAIN ENGINE GIMBAL SYSTEM		49		5%
MAIN ENGINE INSTALLATION		4		12%
MAIN ENGINE GN2 GROUND PURGE		2		20%
HELIUM PNEUMATIC SYSTEM - PLUMBING		20		5%
HELIUM PNEUMATIC SYSTEM - BOTTLES		31		5%
LO2 SYSTEMS		58		5%
LH2 SYSTEMS		24		5%
RCS PROPULSION		13		10%
OMS PROPULSION		69		10%
POWER GENERATION, ELECTRIC		25		7%
POWER DISTRIBUTION, ELECTRIC		131		25%
GUIDANCE AND CONTROL		36		10%
DATA HANDLING		20		10%
INSTRUMENTATION		28		10%
COMMUNICATIONS		26		20%
RANGE SAFETY EQUIPMENT		6		10%

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CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB		%WG	REMARKS
THERMAL CONTROL / ECS			2118	10	
MECHANICAL SYSTEMS	1		130	10	
PURGE AND VENT, DRAIN	1	115			ESTIMATE
HAZARDOUS GAS DETECTION	1	15			ESTIMATE
EQUIPMENT HEAT TRANSPORT	1		257	10	
EQUIP HEAT SINK PLATES / EQUIP SUPPORT	7	237			S= 79 SF(CORE PM) = 63 SF(BOOST PM), @ 3.0 PSF
GROUND COOLING - AIR / GN2	1	20			L= 760 IN, 4 IN DIA @ 0.24 PPF
DUCTING	1	15			
DISCONNECT	1	5			
STRUCTURE TPS			111	10	
CONIC THRUST STRUCTURE	1	111			
EXTERNAL - THERMAL PAINT	1	66			S = 1.5 X 1104.8 = 1657.2 SF, W/S = 0.040 PSF
BASE CLOSEOUT - SUPERALLOY HEAT SHIELD	1	45			S = 15.0 SF (OF 61.3 SF TOTAL), W/S = 3.0 PSF
MPS PROPELLANT FEED TPS			36	10	
LO2 MAIN FEED, SUSTAINER - SPRAY ON FOAM INSULATION	1	13			S = 62.8 SF / FEED, TBAR = 1.0 IN, W/S = 0.208 PSF CPR-488 (2.5 PCF)
LO2 CROSSOVER FEED, BOOST TO SUSTAINER - SPRAY ON FOAM	2	23			S = 54.5 SF, TBAR = 1.0 IN, W/S = 0.208 PSF CPR-488 (2.5 PCF)
LO2 ENGINE FEED, SUSTAINER - FOAM INSULATED COVER	1	-			INSULATED COVER IN FEED WEIGHT
LH2 MAIN FEED, SUSTAINER - VACUUM JACKETING	1	-			VACUUM JACKETING INCLUDED IN FEED WEIGHT
LH2 ENGINE FEED, SUSTAINER - VACUUM JACKETING	1	-			VACUUM JACKETING INCLUDED IN FEED WEIGHT
MAIN ENGINE TPS			1393	10	
ENCLOSURE STRUCTURAL ASSY (CYLINDER, L = 50 IN, D = 112 IN)	2	792			ALUMINUM H/C DESIGN, S = 122.2 SF(EACH), W/S = 3.40 PSF
BASIC SANDWICH PANELS	8	367			S = 122.2 SF / ENCLOSURE, W/S = 1.5 PSF
LONGITUDINAL EDGE MEMBERS	16	80			L = 50 IN (EACH), A = 1.0 IN2
RING, FORWARD - MOUNTING BASE INTERFACE	2	141			A = 2.0 IN2, RBAR = 56.0 IN
RING, AFT - ENGINE THERMAL BOOT INTERFACE	2	167			A = 2.5 IN2, RBAR = 53.0 IN
ASSEMBLY AND INSTALLATION HARDWARE		38			5%
MOUNTING BASE ASSY		242			ALUMINUM
RING	2	141			A = 2.0 IN2, RBAR = 56.0 IN
SUPPORTS STRUTS	6	60			ESTIMATE
STRUT ATTACHMENT BRACKETS	12	30			ESTIMATE
ASSEMBLY AND INSTALLATION HARDWARE		12			5%
ENCLOSURE TPS		60			
SIDES - SPRAY ON FOAM INSULATION	2	31			S = 122.2 SF / ENCLOSURE, T = 0.5 IN, W/S = 0.125 PSF CPR-488(3.0 PCF)
SIDES - FOAM CLOSEOUTS / FILLER	2	3			10% OF FOAM WEIGHT
BASE (AFT RING) - FLEXIBLE BLANKET INSULATION	2	21			S = 13.9 SF / ENCLOSURE, W/S = 0.75 PSF
BASE (AFT RING) - BLANKET ATTACHMENT	2	5			25% OF BLANKET WEIGHT
THERMAL BOOT - MAIN ENGINE	2	300			ESTIMATE150 LB/ENGINE
RCS TPS			80	10	
PLUME SHIELDS	4	80			
OMS TPS			10	10	
INSULATION - PROPELLANT LINES EXTERNAL TO THRUST CONE	2	10			
MISCELLANEOUS			100	10	

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CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
LIQUID FUEL SYSTEM - MAIN ENGINE	2	16008	10	STME X 2 @ 583.4 KLB TVAC EACH
LIQUID FUEL SYSTEM - MAIN PROPULSION		5154	10	
ANCILLARY EQUIPMENT	1	2014	10	NEW DESIGN
ENGINE GIMBAL SYSTEM	2	970		
ACTUATORS	4	860		ALLIED SIGNAL ROM (ELECTRO-HYDROSTATIC)
POWER SOURCE SYSTEM	2	100		ALLIED SIGNAL ROM (GH2 TURBO- GENERATOR)
GH2 SUPPLY PLUMBING	2	10		ESTIMATE
ENGINE INSTALLATION PROVISIONS	2	32		FROM STS (2 ENGINES IN LIEU OF 3)
GIMBAL ATTACH		4		
INSULATION		11		
PANELS & MISC PARTS		17		
ENGINE HEAT SHIELD INSTALLATION	-	-		INCL IN THERMAL CONTROL
ENGINE GN2 GROUND PURGE PROVISIONS	2	10		FROM STS (2 ENGINES IN LIEU OF 3)
DISCONNECT & VALVES		2		
LINES & FITTINGS		6		
SUPPORTS & MISC PARTS		2		
He PNEUMATIC SYSTEM - PLUMBING	1	391		FROM STS (2 ENGINES IN LIEU OF 3)
SURGE CHAMBERS		5		
DISCONNECT & MISC VALVES		13		
SOLENOID VALVES		83		
CHECK VALVES		9		
REGULATORS		17		
FILTERS		14		
PLUMBING & FITTINGS		142		
SUPPORTS & MISC PARTS		108		
He PNEUMATIC SYSTEM - CYLINDRICAL BOTTLES	2	611		650% OF CAPACITY He LOAD OF 47 LB/TANK

1.5 STAGE VEHICLE **STATUS: 11/1/91**

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CORE FIXED 2-ENGINE SUSTAINER PACKAGE

DETAIL WEIGHTS

ITEM	QTY	WEIGHT - LB		%WG	REMARKS	
LO2 MAIN FEED, SUSTAINER - 15.0 IN DIA, 192.0 IN LENGTH	1		463	10	PROOF PRESSURE = 464 PSI	
AFT FLEXIBLE ASSEMBLY, LOWER SECTION - 192.0 IN LENGTH	1	459				
BELLOWS ASSY (RESTRAINED)	2	150			L = 12.0 IN EACH, W = 75 LB EACH	INCONEL 718
TUBE SEGMENTS	3	264			L = 164.0 IN, T = 0.117 IN , DBAR = 15.117 IN	321 STAINLESS
FLANGES	2	29			L = 2.0 IN EACH, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
TEE-FLANGE (FOR CROSSOVER LINE) - 10.0 IN DIA	2	16			L = 4.0 IN EACH, DBAR = 11.0 IN, A = 0.8 IN2	
INSTALLATION HARDWARE - LWR SECTION TO UPR SECTION	1	4				
FASTENER AND SEAL SET	1	4			4 LB / JOINT	
LO2 CROSSOVER FEED, BOOST TO SUSTAINER - 10.0 IN DIA, 250.0 IN LEN	2		538	10	PROOF PRESSURE = 464 PSI	
FLEXIBLE ASSEMBLY - 250.0 IN LENGTH	2	530				
BELLOWS ASSY (RESTRAINED)	6	180			L = 8.0 IN EACH, W = 30 LB EACH	INCONEL 718
TUBE SEGMENTS	8	318			L = 222.0 IN / CROSSOVER, T = 0.078 IN , DBAR = 10.078 IN	321 STAINLESS
FLANGES	4	32			L = 2.0 IN EACH, DBAR = 11.0 IN, A = 0.8 IN2	347 STAINLESS
INSTALLATION HARDWARE - LO2 CROSSOVERS TO LO2 MAIN FEEDS	4	8				
FASTENER AND SEAL SET	4	8			2 LB / JOINT	
LO2 ENGINE FEED, SUSTAINER - 15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA	1		727		FROM BOOST PROPULSION MODULE (BUT WITH DUMMY DISCONNECT	
DUMMY DISCONNECT - 15.0 IN DIA, 6.0 IN LENGTH	1	36				
FLANGES	2	36			L = 3.0 IN EACH, DBAR = 16.0 IN, A = 1.25 IN2	347 STAINLESS
MANIFOLD ASSEMBLY - 15.0 IN DIA, 27.0 IN LENGTH	1	103				
TUBE SEGMENT	1	37			L = 23.0 IN, T = 0.117 IN, DBAR = 15.117 IN	321 STAINLESS
TUBE END CLOSEURE AT F&D INTERFACE	1	4			D = 15.0 IN, d = 8.0 IN, T = 0.117 IN	321 STAINLESS
FLANGE AT DUMMY DISCONNECT INTERFACE - 15.0 IN DIA	1	15			L = 2.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
FLANGE AT PREVALVE INTERFACE - 10.0 IN DIA	2	16			L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	347 STAINLESS
FLANGE AT F & D VALVE INTERFACE - 8.0 IN DIA	1	8			L = 2.0 IN, DBAR = 90 IN, A = 0.7 IN2	347 STAINLESS
LOCAL REINFORCEMENT / SUPPORT TABS / ETC	1	16			20%	
FOAM INSULATION COVER	1	10			10 SF @ 1.0 PSF	
PREVALVES - 10.0 IN DIA, 13.0 IN LENGTH	2	178			SCALED BY SIZE AND PRESSURE TO STS PREVALVES	
FLEXIBLE ASSEMBLY - 10.0 IN DIA, 92.2 IN LENGTH	2	344				
BELLOWS ASSY (RESTRAINED)	6	180			L = 8.0 IN , W = 30.LB	INCONEL 718
TUBE SEGMENTS	4	92			L = 64.2 IN / ASSY, T = 0.078 IN, DBAR = 10.078 IN	321 STAINLESS
FLANGES	4	32			L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	347 STAINLESS
FOAM INSULATION COVER	2	40			20 SF / ASSY @ 1.0 PSF	
ASSEMBLY HARDWARE - ITEM TO ITEM	5	12				
FASTENER AND SEAL SET - 15.0 IN DIA	1	4			4 LB / JOINT	
FASTENER AND SEAL SET - 10.0 IN DIA	4	8			2 LB / JOINT	
INSTALLATION HARDWARE - ENGINE FEED TO MAIN FEED	1	4				
FASTENER AND SEAL SET - 15.0 IN DIA	1	4			4 LB / JOINT	
FOAM INSULATED COVER - DUMMY DISCONNECT	1		2		2 SF @ 1.0 PSF	
FOAM INSULATED COVER - PREVALVE	2		6		3 SF / PREVALVE @ 1.0 PSF	
SUPPORTS AND MISC PARTS			41			

1.5 STAGE VEHICLE

STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)

CORE FIXED 2-ENGINE SUSTAINER PACKAGE

DETAIL WEIGHTS

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
LO2 FILL / DRAIN	-	0	10	SEE BOOST PROPULSION PACKAGE
LO2 OVERBOARD BLEED	1	45	10	FROM STS (NO CHANGE)
DISCONNECT	1	3		
BLEED VALVE	1	3		
CHECK VALVE	6	6		
LINES & FITTINGS		29		
SUPPORTS & MISC PARTS		4		
O2 RELIEF	1	24	10	FROM STS (NO CHANGE)
RELIEF VALVE	1	6		
RELIEF ISOLATION VALVE	1	5		
LINES & FITTINGS		9		
SUPPORTS & MISC PARTS		4		
GOX POGO SUPPRESSION	2	35	10	FROM STS (2 ENGINES IN LIEU OF 3)
VALVE	2	10		
LINES & FITTINGS		22		
SUPPORTS & MISC PARTS		3		
LO2 AUTOGENOUS PRESS	1	50	10	FROM STS (2 ENGINES IN LIEU OF 3)
DISCONNECT	1	7		
FLOW CONTROL VALVE	4	12		
LINES & FITTINGS		25		
SUPPORTS & MISC PARTS		6		

1.5 STAGE VEHICLE

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CORE FIXED 2-ENGINE SUSTAINER PACKAGE

DETAIL WEIGHTS

ITEM	QTY	WEIGHT - LB		%WG	REMARKS	
LH2 MAIN FEED, SUSTAINER - 15.0 IN DIA, 80.0 IN LENGTH	1		173	10	PROOF PRESSURE = 126 PSI	
FLEXIBLE ASSEMBLY - 150 IN DIA, 80.0 IN LENGTH	1	169				
BELLOWS ASSY (UNRESTRAINED)	2	60			L = 12.0 IN EACH, W = 30 LB EACH (USING LO2 FLEX BELLOWS)	INCONEL 718
TUBE SEGMENTS	3	36			L = 52.0 IN / FEED, T = 0.050 IN (MIN), DBAR = 15.050 IN	321 STAINLESS
FLANGES	2	29			L = 2.0 IN EACH, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
VACUUM JACKET	1	45			26.2 SF @ 1.7 PSF	321 STAINLESS
INSTALLATION HARDWARE - FEED TO LH2 TANK	1		4			
FASTENER AND SEAL SET - 15.0 IN DIA	1	4			4 LB / JOINT	
LH2 ENGINE FEED, SUSTAINER - 15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA	1		773		FROM BOOST PROPULSION MODULE (BUT WITH DUMMY DISCONNECT	
DUMMY DISCONNECT - 15.0 IN DIA, 6.0 IN LENGTH	1	36				
FLANGES	2	36			L = 3.0 IN EACH, DBAR = 16.0 IN, A = 1.25 IN2	347 STAINLESS
MANIFOLD ASSEMBLY - 15.0 IN DIA, 27.0 IN LENGTH	1	113				
TUBE SEGMENT	1	37			L = 23.0 IN, T = 0.117 IN, DBAR = 15.117 IN	321 STAINLESS
TUBE END CLOSEURE AT F&D INTERFACE	1	4			D = 15.0 IN, d = 8.0 IN, T = 0.117 IN	321 STAINLESS
FLANGE AT DUMMY DISCONNECT INTERFACE - 15.0 IN DIA	1	15			L = 2.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
FLANGE AT PREVALVE INTERFACE - 10.0 IN DIA	2	16			L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	347 STAINLESS
FLANGE AT F & D VALVE INTERFACE - 8.0 IN DIA	1	6			L = 2.0 IN, DBAR = 90 IN, A = 0.7 IN2	347 STAINLESS
LOCAL REINFORCEMENT / SUPPORT TABS / ETC	1	16			20%	
VACUUM JACKET	1	20			10 SF @ 2.0 PSF	
PREVALVES - 10.0 IN DIA, 13.0 IN LENGTH	2		178		SCALED BY SIZE AND PRESSURE TO STS PREVALVES	
FLEXIBLE ASSEMBLY - 10.0 IN DIA, 92.2 IN LENGTH	2		372			
BELLOWS ASSY (RESTRAINED)	6	180			L = 8.0 IN , W = 30.LB	INCONEL 718
TUBE SEGMENTS	4	92			L = 64.2 IN / ASSY, T = 0.078 IN, DBAR = 10.078 IN	321 STAINLESS
FLANGES	4	32			L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	347 STAINLESS
VACUUM JACKET	2	68			20 SF / ASSY @ 1.7 PSF	
ASSEMBLY HARDWARE - ITEM TO ITEM	5		12			
FASTENER AND SEAL SET - 15.0 IN DIA	1	4			4 LB / JOINT	
FASTENER AND SEAL SET - 10.0 IN DIA	4	8			2 LB / JOINT	
INSTALLATION HARDWARE - ENGINE FEED TO MAIN FEED	1		4			
FASTENER AND SEAL SET - 15.0 IN DIA	1	4			4 LB / JOINT	
VACUUM JACKET - DUMMY DISCONNECT	1		4		2 SF @ 2.0 PSF	
VACUUM JACKET - PREVALVE	2		10		3 SF / PREVALVE @ 1.7 PSF	
SUPPORTS AND MISC PARTS			43			

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CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
LH2 FILL / DRAIN	-	0	10	SEE BOOST PROPULSION PACKAGE
LH2 PRESTART CONDITIONING	1	203	10	FROM STS (2 ENGINES IN LIEU OF 3)
DISCONNECT	1	9		
VALVES		24		
PUMP		20		
LINES & FITTINGS		116		
INSULATION		6		
SUPPORTS & MISC PARTS		28		
H2 RELIEF	1	23	10	FROM STS (NO CHANGE)
RELIEF VALVE	1	6		
RELIEF ISOLATION VALVE	1	5		
LINES & FITTINGS		9		
SUPPORTS & MISC PARTS		3		
INSULATION		1		
SUPPORTS & MISC PARTS		4		
LH2 DUMP	1	29	10	FROM STS (NO CHANGE)
VALVE	1	13		
LINES & FITTINGS		11		
INSULATION		1		
SUPPORTS & MISC PARTS		4		
LH2 AUTOGENOUS PRESS	1	56	10	FROM STS (2 ENGINES IN LIEU OF 3)
DISCONNECT	-	7		
FLOW CONTROL VALVES	4	14		
LINES & FITTINGS		29		
SUPPORTS & MISC PARTS		6		

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CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
AUXILIARY PROPULSION - RCS		131	10	
THRUSTERS - BI-PROP	8	45	10	RS34 THRUSTERS - 70 LBF, 280 SEC ISP
PROPELLANT FEED / FILL / DRAIN	1	56	10	
ISOLATION VALVES (PROPELLANT TANKS) - 1 IN	0	0		
ISOLATION VALVES (THRUSTERS) - 3/8 IN	16	40		
LINES & FITTINGS (DIRECT) - 3/8 IN		0		L= 30-IN EA. NTO, 140-IN EA. MMH @ 0.145 LB/FT
LINES & FITTINGS (MANIFOLD) - 3/8 IN	2	16		L=661-IN EA. @ 0.145 LB/FT
INSTRUMENTATION / CONTROLS		0		INCL IN AVIONICS INSTRUMENTATION
PROPELLANT TANKS	0	0	10	STORED IN OMS YANKAGE
PRESSURIZATION SYSTEM - PLUMBING	0	30	10	ESTIMATE
PRESSURIZATION SYSTEM - BOTTLES	0	0	10	SEE MPS He PNEUMATIC SYSTEM
AUXILIARY PROPULSION - OMS		692	10	
ENGINES	2	358	10	RS41 ENGINES - 2688 LBT, 320 SEC ISP
TVC ACTUATORS	4	24	10	ELECTROMECHANICAL
PROPELLANT FEED / FILL / DRAIN	2	65	10	
ISOLATION VALVES (PROPELLANT TANKS) - 1 IN	4	16		
ISOLATION VALVES (THRUSTERS) - 1 IN	4	16		
VALVES - FILL/DRAIN - 1/2 IN	2	5		
GRND DISCONNECTS - 1/2 IN	2	8		
FILTERS - 1IN	2	5		
LINES & FITTINGS (DIRECT) - 1 IN		0		L= 30-IN EA. NTO, 140-IN EA. MMH @ 1 LB/FT
LINES & FITTINGS (MANIFOLD) - 1 IN	2	15		L=90-IN EA. @ 1 LB/FT
INSTRUMENTATION / CONTROLS		0		INCL IN AVIONICS INSTRUMENTATION
PROPELLANT TANKS	2	188	10	
TANK - N2O4	1	94		3% OF OMS/RCS USABLE PROPELLANT OF 3131 LB
TANK - MMH	1	94		3% OF OMS/RCS USABLE PROPELLANT OF 3131 LB
PRESSURIZATION SYSTEM - PLUMBING	1	57	10	
DISCONNECT	1	2		
LATCHING VALVES - 1/2 IN	4	10		
CHECK VALVES - 1/2 IN	2	6		
REGULATORS - 1/2 IN	2	9		
HP VALVES - 1/4 IN	2	5		
RELIEF VALVES - 1/2 IN	4	12		
FILTERS - 1/2 IN	2	4		
BURST DISCS - 1/ 2 IN	2	4		
LINES & FITTINGS		5		
PRESSURIZATION SYSTEM - BOTTLES	0	0	10	SEE MPS He PNEUMATIC SYSTEM

1.5 STAGE VEHICLE — STATUS: 11/1/91
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

ITEM	QTY	WEIGHT - LB	%WG	REMARKS
POWER - ELECTRICAL		874	10	
GENERATION AND STORAGE		352	10	
PRIMARY BATTERIES	2	176		170 A-HR (AG-ZN)
UTILITY BATTERIES	2	176		170 A-HR (AG-ZN)
DISTRIBUTION AND SEQUENCING		522	10	
MAIN POWER DISTRIBUTOR ASSEMBLIES	2	104		
POWER SWITCHING UNITS	2	68		
CIRCUITRY	1	350		
AVIONICS		1041	10	
GUIDANCE AND CONTROL		363	10	
INERTIAL MEASUREMENT UNIT (IMU)	1	55		HONEYWELL DATA
ASCENT TVC CONTROLLER	4	168		
OMS TVC CONTROLLERS	2	28		
MAIN ENGINE CONTROLLERS	2	0		INCLUDED IN ENGINE WEIGHT
PSS (PWR SOURCE SYS) CONTROLLERS/CABLES	2	114		
DATA HANDLING		210	10	
FLIGHT PROCESSOR UNITS	3	105		
SIGNAL HANDLING UNITS	3	105		
INSTRUMENTATION		280	10	
SENSOR INTERFACE UNITS	2	35		
LASER FIRING UNIT (STAGING, RECOVERY SYSTEMS)	2	20		
CABLING HARNESS TO INTERFACE UNITS	7	35		
CABLING HARNESSES TO SENSORS	70	140		
SENSORS, OPERATIONAL	100	50		ESTIMATE
COMMUNICATIONS		132	10	
S-BAND TRANSPONDERS	2	28		STDN/TDRS
S-BAND POWER AMPLIFIERS	2	24		
DIPLEXERS	2	4		
C-BAND TRANSPONDERS	2	20		
ENCRYPTER / DECRYPTER	2	10		
ANTENNAS, S-BAND	2	16		
ANTENNAS, C-BAND	2	4		
COAX CABLE SETS	4	26		
RANGE SAFETY EQUIPMENT		56	10	
INTREGRATED RECEIVER / DECODER UNITS	2	12		
BATTERIES	2	20		
LASER FIRING UNIT	2	20		
ANTENNA	2	4		
DRY WEIGHT, EXCLUDING WEIGHT GROWTH MARGIN		33502		

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB			%WG	REMARKS
WEIGHT GROWTH MARGIN				3350	0	10%
DRY WEIGHT				36852		
MAIN RESIDUAL FLUIDS - LO2 / LH2				4753		
LO2 SYSTEM	1		4562			
TRAPPED IN MAIN FEED	1	1397				D = 15.0 IN, L = 192.0 IN, V = 19.635 FT3. FULL
TRAPPED IN CROSSOVER FEEDS	2	1616				D = 10.0 IN, L = 250.0 IN / CROSSOVER, V = 11.363 FT3 / CROSSOVER. FULL
TRAPPED IN ENGINE FEED	1	923				V = 12.974 FT3. FULL
TRAPPED IN ENGINES	2	626				SCALED GG CYCLE ENGINE DATA
ABOVE VALVE	2	509				254.3 LB/ENGINE
BELOW VALVE	2	118				58.8 LB/ENGINE
LH2 SYSTEM	1		191			
TRAPPED IN MAIN FEED	1	36				D = 15.0 IN, L = 80.0 IN, V = 8.181 FT3 / FEED. FULL
TRAPPED IN ENGINE FEED	1	57				V = 12.974 FT3. FULL
TRAPPED IN ENGINES	2	98				SCALED GG CYCLE ENGINE DATA
ABOVE VALVE	2	49				24.6 LB/ENGINE
BELOW VALVE	2	49				24.3 LB/ENGINE
MAIN RESIDUAL FLUIDS - PNEUMATIC SYSTEM He				94.0		
NOMINAL USAGE			69.0			
MAIN ENGINES SEAL PURGE		53.3				SCALED SSME DATA
PRE LIFTOFF		2.5				0.075 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 13 SEC
LIFTOFF TO MECO		48.7				0.040 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 467 SEC
MECO TO MECO+20 SECONDS		2.1				0.040 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 20 SEC
MAINPROPULSION SYSTEM FUNCTIONS		4.5				
PRE LIFTOFF		1.5				ESTIMATE
LIFTOFF TO MECO		3.0				ESTIMATE
MECO TO MECO+20 SECONDS		0.0				(ASSUMES NO DUMPING OF PROPELLANTS)
RCS NOMINAL PROPELLANT PRESSURIZATION		1.5				0.4% OF RCS NOMINAL PROPELLANT USAGE
OMS NOMINAL PROPELLANT PRESSURIZATION		9.8				0.4% OF OMS NOMINAL PROPELLANT USAGE
RESERVE			7.1			
MAIN ENGINES SEAL PURGE		5.3				10% OF NOMINAL USAGE
MAINPROPULSION SYSTEM FUNCTIONS		0.5				10% OF NOMINAL USAGE
RCS RESERVE PROPELLANT PRESSURIZATION		0.3				0.4% OF RCS RESERVE PROPELLANT
OMS RESERVE PROPELLANT PRESSURIZATION		1.0				0.4% OF OMS RESERVE PROPELLANT
MARGIN - FULL BOTTLES			2.3			IDENTICAL BOTTLES (47.0 LB He CAPACITY EACH)
RESIDUAL- TRAPPED IN BOTTLES			15.7			20% OF USABLE

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
CORE FIXED 2-ENGINE SUSTAINER PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	QTY	WEIGHT - LB		%WG	REMARKS
RCS FLUIDS			478		
NOMINAL USAGE		371			
TRIM PRIOR TO PAYLOAD SEPARATION		216			FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 10 FPS)
COLLISION AVOIDANCE AFTER PAYLOAD SEPARATION		155			FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 10 FPS)
RESERVE		74			20% OF NOMINAL USAGE
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		18			4% OF USABLE PROPELLANT
RESIDUAL PROPELLANT - FEED SYS / THRUSTERS		15			ESTIMATE
OMS FLUIDS			2839		
NOMINAL USAGE		2442			
DEORBIT CORE STAGE		2442			FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 181 FPS)
RESERVE		244			10% OF NOMINAL USAGE
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		107			4% OF USABLE PROPELLANT
RESIDUAL PROPELLANT - FEED SYS / THRUSTERS		45			ESTIMATE
INERT WT (PRIOR TO MISSION OFFLOADS, ONLOADS, AND PRE-LIFTOFF USAGE)			45015		
PRE-LIFTOFF USAGE			-4		
PNEUMATIC SYSTEM He		-4			
He - MAIN ENGINES SEAL PURGE		-2.5			
He - MAIN PROPULSION SYSTEM FUNCTIONS		-1.5			
INERT WEIGHT AT LIFTOFF			45011		

1.5 STAGE VEHICLE - HYBRID CONCEPT
TVAC = 583400 LBF / ENGINE
NON JETTISONABLE AFT SKIRT PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91
REVISION 1

ITEM	QTY	WEIGHT - LB			%WG	REMARKS
STRUCTURE				2618	10	
AFT SKIRT, UPPER SECTION (331.0 IN DIA, 42.75 IN LENGTH)	1		2032		10	ALUMINUM SKIN/STRINGER DESIGN, S= 308.8 FT2, W/S = 6.58 LB/FT2
BARREL PANELS, SKIN / STRINGER	10	1280				7075 SKIN/7075 STRINGERS
SKIN - REGIONS 1	4	333				S = 17832 IN2, T = 0.187 IN
SKIN - REGIONS 2	4	234				S = 17832 IN2, T = 0.131 IN
SKIN - REGIONS 3	TBD	70				S = 8796 IN2, T = 0.080 IN
SKIN DOUBLERS	TBD	64				10% OF SKIN WEIGHT
STRINGERS - REGIONS 1	TBD	205				S = 17832 IN2, TBAR = 0.115 IN
STRINGERS - REGIONS 2	TBD	205				S = 17832 IN2, TBAR = 0.115 IN
STRINGERS - REGIONS 3	TBD	47				S = 8796 IN2, TBAR = 0.054 IN
HOLEOUT, 20 IN X 20 IN, ACCESS DOOR	4	-39				S = 400 IN2 (EACH), TBAR = 0.131 + 0.115 = 0.246 IN
HOLEOUT, 20 IN DIA, LO2 FEED LINE	1	-8				S = 314 IN2, TBAR = 0.246 IN
HOLEOUT, 15 IN DIA, LO2 CROSSOVER LINE	2	-9				S = 177 IN2 (EACH), TBAR = 0.246 IN
HOLEOUT, 5 IN X 14 IN, GO2 AND GH2 PRESS LINES	2	-3				S = 70 IN2 (EACH), TBAR = 0.246 IN
HOLEOUT, CABLING	1	-1				ESTIMATE
EDGE CLOSEOUT, ACCESS DOOR HOLEOUT	4	79				2 X HOLEOUT
EDGE CLOSEOUT, LO2 FEED LINE HOLEOUT	1	15				2 X HOLEOUT
EDGE CLOSEOUT, LO2 CROSSOVER LINE HOLEOUT	2	17				2 X HOLEOUT
EDGE CLOSEOUT, GO2 AND LH2 PRESS LINE HOLEOUTS	2	7				2 X HOLEOUT
EDGE CLOSEOUTS, CABLING HOLEOUT	1	2				2 X HOLEOUT
FASTENERS, ASSY	TBD	61				5.0%
SPLICES, BARREL PANELS	10		22			L = 42.75 - 2(3.0) = 36.75 IN (EACH), W = 0.060 LB/IN
RING FLANGE, FORWARD - LH2 TANK INTERFACE	1		271			
FLANGE SEGMENTS	8	271				A = 2.60 IN2, RBAR = 166.0 IN
SPLICE PLATE SETS	-	-				RING FLANGE SEGMENTS NOT JOINED (ET APPROACH)
RING FRAME - CONIC THRUST STRUCTURE INTERFACE	-		-			INCLUDED WITH CONIC THRUST STRUCTURE
RING FLANGE, AFT- SEPARATION RING INTERFACE	1		282			
FLANGE SEGMENTS	4	271				A = 2.60 IN2, RBAR = 166.0 IN
SPLICE PLATE SETS	4	11				4.0%
ACCESS DOOR, 20 IN X 20 IN	4		33			S = 20 IN X 20 IN = 400 IN2 (EACH) = 2.78 FT2 (EACH), W/S = 3.0 LB/FT2
INTERNAL PRIMER	1		7			S = 1.25 X 308.8 = 386.0 FT2, W/S = 0.017 LB/FT2
INSTALLATION HARDWARE	288		40			STEEL FASTENERS
FASTENERS, BASE SKIRT TO LH2 TANK	144	40				0.28 LB / LOCATION, 144 LOCATIONS
MISCELLANEOUS			97			5%
SEPARATION RING, UPPER HALF (331 IN DIA, 3.5 IN LENGTH)				366	10	ALUMINUM C-SECTION DESIGN, S = 25.3 FT2, W/S = 14.47 PSF
RING - UPPER HALF (EXCLUDES ORDNANCE)	1		325			
RING SEGMENTS	4	313				A = 3.0 IN2, RBAR = 166.0 IN
SPLICE PLATE SETS	4	13				4.0%
INSTALLATION HARDWARE	144		40			STEEL FASTENERS
FASTENERS, SEPARATION RING TO BASE SKIRT	144					0.28 LB / LOCATION, 144 LOCATIONS
INTERNAL PRIMER			1			S = 1.5 X 25.3 = 38.0 SF, W/S = 0.017 PSF

1.5 STAGE VEHICLE - HYBRID CONCEPT
TVAC = 583400 LBF / ENGINE
NON JETTISONABLE AFT SKIRT PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91
REVISION 1

ITEM	QTY	WEIGHT - LB		%WG	REMARKS	
UMBILICAL PLATES	2		120	10		
LO2 UMBILICAL PLATES - BOOST FEED	2	120			EACH SUPPORTS (3) DISCONNECTS: LO2 (15 IN), GO2, AND ELECTRICAL	
SUPPORT / INSTALLATION PROVISIONS			99	10		
UMBILICAL PLATES		30			25%	
JETTISONABLE SKIRT SEPARATION		7			10%	
LO2 SYSTEMS		57			5%	
POWER DISTRIBUTION, ELECTRICAL		5			25%	
STAGING / ORDNANCE			72	10		
JETTISONABLE SKIRT SEPARATION	1		72	10		
SEP BOLTS, FLUIDS I / F	12	24.0				
LINEAR SHAPE CHARGE	1	35.0			L = 87.5 FT, W = 0.40 LB/FT (40% OF TOTAL)	
CONFINED DETONATING FUSE	5	10.5				
CDF MANIFOLD	2	2.5				
THERMAL CONTROL / ECS			95	10		
INSULATION / TPS	1		95	10		
BASE SKIRT	1	66				
EXTERNAL		47			S = 1.5 X 303.8 = 455.7 SF, TBAR = 0.50 IN, W/S = 0.104 PSF	CPR-488 (2.5 PCF)
INTERNAL		18			S = 1.5 X 303.8 = 455.7 SF, W/S = 0.040 PSF	THERMAL PAINT
SEPARATION RING - LOWER HALF		5				
EXTERNAL		4			S = 1.5 X 25.2 = 37.8 SF, TBAR = 0.50 IN, W/S = 0.104 PSF	CPR-488 (2.5 PCF)
INTERNAL		1			S = 1.0 X 25.2 = 25.2 SF, W/S = 0.040 PSF	THERMAL PAINT
LO2 MAIN FEED, BOOST	2	6			S = 15.2 SF / FEED, TBAR = 1.0 IN, W/S = 0.208 PSF	CPR-488 (2.5 PCF)
LO2 MAIN FEED, SUSTAINER	1	5			S = 26.2 SF / FEED, TBAR = 1.0 IN, W/S = 0.208 PSF	CPR-488 (2.5 PCF)
MISCELLANEOUS CLOSEOUTS	-	12			15%	

1.5 STAGE VEHICLE - HYBRID CONCEPT
TVAC = 583400 LBF / ENGINE
JETTISONABLE AFT SKIRT PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91
REVISION 1

ITEM	QTY	WEIGHT - LB		%WG	REMARKS	
AERO FAIRINGS (180 IN LENGTH)	4		2086	10	OVERLAPS NON JETT SKIRT BY 37.25 IN. S = 165 SF EACH. W/S = 3.16 PSF	
UMBILICAL PLATES	8		480	10		
LO2 UMBILICAL PLATES - BOOST FEED	4	240			EACH SUPPORTS (3) DISCONNECTS: LO2 (15 IN DIA), GO2, AND ELECTRICAL	
LH2 UMBILICAL PLATES - BOOST FEED	4	240			EACH SUPPORTS (3) DISCONNECTS: LH2 (15 IN DIA), GH2, AND ELECTRICAL	
SUPPORT / INSTALLATION PROVISIONS			294	10		
UMBILICAL PLATES		120			25%	
LAUNCH PAD SEPARATION		10			10%	
BOOST PROPULSION MODULE SEPARATION		9			10%	
JETTISONABLE SKIRT SEPARATION		8			10%	
LO2 SYSTEMS		62			5%	
LH2 SYSTEMS		67			5%	
POWER DISTRIBUTION, ELECTRIC		18			25%	
STAGING / ORDNANCE			264	10		
LAUNCH PAD SEPARATION			100	10		
SEPARATION BOLTS	4	100				
BOOST PROPULSION MODULE SEPARATION	2		88	10		
SEP BOLTS, FLUIDS I / F	12	24				
SEP BOLTS, STRUCT I / F	8	40				
PUSHOFF SPRINGS	8	24				
JETTISONABLE SKIRT SEPARATION	1		76	10		
SEP BOLTS, FLUIDS I / F	12	24				
LINEAR SHAPE CHARGE	1	52				
SEPARATION SRMS	-	-			L = 87 FT, W = 0.60 LB/FT (60% OF TOTAL)	
THERMAL CONTROL / ECS			304	10		
INSULATION / TPS			304	10		
SEPARATION RING LOWER HALF		5				
EXTERNAL	1	3			S = 1.5 X (25.2 - 4(0.7)) =33.6 SF, TBAR = 0.50 IN , W/S = 0.104 PSF	CPR-488(2.5 PCF)
INTERNAL	1	1			S = 1.0 X 25.2 =25.2 SF, W/S = 0.040 PSF	THERMAL PAINT
THRUST SKIRT	1	168				
EXTERNAL	1	108			S = 1.5 X (1005.7 - 4(79.3)) =1032.8 SF, TBAR = 0.50 IN , W/S = 0.104 PS	CPR-488(2.5 PCF)
INTERNAL	1	60			S = 1.5 X 1005.7 =1508.6 SF, W/S = 0.040 PSF	THERMAL PAINT
AERO FAIRINGS	4	83			S = 165.0 SF (EACH), TBAR = 0.50 IN , W/S = 0.125 PSF	CPR-488(3.0 PCF)
LO2 MAIN FEED, BOOST	2	10			S = 46.7 SF / ASSY, TBAR = 0.50 IN , W/S = 0.104 PSF	CPR-488(2.5 PCF)
LH2 MAIN FEED, BOOST	2	-			VACUUM JACKETING INCLUDED IN FEED WEIGHT	
MISCELLANEOUS CLOSEOUTS	-	40			15%	

1.5 STAGE VEHICLE - HYBRID CONCEPT
TVAC = 583400 LBF / ENGINE
JETTISONABLE AFT SKIRT PACKAGE
DETAIL WEIGHTS

STATUS: 11/1/91
REVISION 1

ITEM	QTY	WEIGHT - LB			%WG	REMARKS	
LIQUID FUEL SYSTEM - MAIN PROPULSION				2578	10		
LO2 MAIN FEED, BOOST - 15.0 IN DIA, 142.75 IN LENGTH	2		1193		10	PROOF PRESSURE = 464 PSI	
DISCONNECTS - 15.0 IN DIA, 6.0 IN LENGTH	4	668				SCALED BY SIZE AND PRESSURE TO STS DISCONNECTS	
FLEXIBLE ASSEMBLY - 15.0 IN DIA, 130.75 IN LENGTH	2	509					
BELLOWS ASSY (UNRESTRAINED)	4	120				L = 12.0 IN , W = 30 LB	INCONEL 718
TUBE SEGMENTS	2	331				L = 102.75 IN/ ASSY, T = 0.117 IN, DBAR = 15.117 IN	321 STAINLESS
FLANGES	4	58				L = 2.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
ASSEMBLY HARDWARE - ITEM TO ITEM	4	16					
FASTENER AND SEAL SET	4	16				4 LB / JOINT	
LO2 AUTOGENOUS PRESS	2		40		10		
DISCONNECTS	4	28					
LINES & FITTINGS	2	12					
LH2 MAIN FEED, BOOST - 15.0 IN DIA, 73.0 IN LENGTH	2		1305		10	PROOF PRESSURE = 126 PSI	
DISCONNECT - 15.0 IN DIA, 6.0 IN LENGTH	4	668				USING LO2 DISCONNECTS	
FLEXIBLE ASSEMBLY - 15.0 IN DIA, 61.0 IN LENGTH	2	605					
BELLOWS ASSY (RESTRAINED)	6	450				L = 12.0 IN , W = 75 LB (USING LO2 BELLOWS)	INCONEL 718
TUBE SEGMENTS	4	29				L = 21.0 IN / ASSY, T = 0.050 IN (MIN), DBAR = 15.050 IN	321 STAINLESS
FLANGES	4	58				L = 2.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	347 STAINLESS
VACUUM JACKET	2	68				20.0 SF EA @ 1.7 PSF	321 STAINLESS
ASSEMBLY HARDWARE	4	16					
FASTENER AND SEAL SET	4	16				4 LB / JOINT	
VACUUM JACKET - DISCONNECT	4	16				2 SF EA @ 2.0 PSF	321 STAINLESS
LH2 AUTOGENOUS PRESS	2		40		10		
DISCONNECT	4	28					
LINES & FITTINGS	2	12					
POWER - ELECTRICAL				70	10		
DISTRIBUTION AND SEQUENCING	2		70		10		
CIRCUITRY	2	70					
AVIONICS				0	10		
DRY WEIGHT, EXCLUDING WEIGHT GROWTH MARGIN				14210	10		
WEIGHT GROWTH MARGIN				1421	0	10%	
DRY WEIGHT				15631			
MAIN RESIDUAL FLUIDS - LO2 / LH2				2142			
LO2 SYSTEM	1		2077				
TRAPPED IN BOOST FEED	2	2077				L = 142.75 IN, D = 15.0 IN, V = 14.598 FT3 / FEED. FULL	
LH2 SYSTEM	1		68				
TRAPPED IN BOOST FEED	2	66				L = 73.0 IN, D = 15.0 IN, V = 7.465 FT3 / FEED. FULL	
INERT WEIGHT				17773			

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB		BOOST MODULE Qty	BOOST MODULE WEIGHT - LB		REMARKS	%MR
STRUCTURE			6182			5299		10
MECHANISMS	2		10	2		10		
MECHANISMS, BODY VENT DOOR	2	10		2	10			10
FORWARD AERO FAIRINGS	-		-	-		-	SEE TANK MODULE AFT SKIRT	
SIDE SHELL ASSEMBLY	1		1627	1		1627		
BASIC SANDWICH PANEL, EXCLUDING HOLEOUTS	1	916		1	916		463 SF @ 3.51 PSF (ALLUM H/C DESIGN)	10
FACE SKIN - OUTER	1	267		1	267		463 SF @ 1.98 PSF	
FACE SKIN - INNER	1	267		1	267		S = 463 SF, T = 0.040 IN	
CORE	1	232		1	232		S = 463 SF, T = 0.040 IN	
ADHESIVE	2	69		2	69		S = 463 SF, H = 2.0 IN, DENSITY = 3.0 PCF	
MISCELLANEOUS		83			83		S = 463 SF / FACE @ 0.075 PSF	
HOLEOUTS	3	-113		3	-113		10%	
HOLEOUT, ACCESS (48 X 60)	2	-79		2	-79		57.2 SF @ 1.98 PSF	
HOLEOUT, T-O UMBILICAL (40 X 62)	1	-34		1	-34		S = 20.0 SF EA @ 1.98 PSF	
HOLEOUT FRAMES	3	170		3	170		S = 17.2 SF @ 1.98 PSF	
FRAME, ACCESS HOLEOUT (48 X 60)	2	130		2	130			
FRAME, T-O UMBILICAL HOLEOUT (40 X 62)	1	41		1	41		L = 216 IN EA, A = 3.0 IN	
INTERMEDIATE STIFFENING FRAMES	3	200		3	200		L=204 IN, A=2.0 IN2	
FORWARD EDGE MEMBER	1	100		1	100		L = 667 IN EA, A = 1.0 IN2	
AFT EDGE MEMBER	1	100		1	100		L = 667 IN , A =1.5 IN2	
DOORS AND PANELS	3	252		3	252		L = 667 IN, A = 1.5 IN2	
PANEL, ACCESS (48 X 60)	2	200		2	200			
PANEL, T-O UMBILICAL (40 X 62)	1	52		1	52		S = 20.0 SF EA @ 5.0 PSF	
MISCELLANEOUS		81			81		S = 17.2 SF @ 3.0 PSF	
FORWARD BULKHEAD ASSEMBLY	1		544	1		544	5%	
BULKHEAD EXCLUDING HOLEOUTS	1	559		1	559		194 SF @ 2.80 PSF (ALLUM MACHINED DESIGN)	10
HOLEOUTS	10	-15		10	-15		194 SF @ 2.88 PSF (TBAR = 0.20 IN)	
HOLEOUT, STRUCTURAL INTERFACE (5 IN DIA)	4	-1.6		4	-1.6		5.256 SF @ 2.88 PSF	
HOLEOUT, LH2 MAIN FEEDLINE (20 IN DIA)	1	-6.3		1	-6.3		S = 0.136 SF EA @ 2.88 PSF	
HOLEOUT, LO2 MAIN FEEDLINE (20 IN DIA)	1	-6.3		1	-6.3		S = 2.182 SF @ 2.88 PSF	
HOLEOUT, GH2 PRESS LINE (4 IN DIA)	1	-0.3		1	-0.3		S = 2.182 SF @ 2.88 PSF	
HOLEOUT, GO2 PRESS LINE (4 IN DIA)	1	-0.3		1	-0.3		S = 0.087 SF @ 2.88 PSF	
HOLEOUT, CABLING (4 IN DIA)	2	-0.5		2	-0.5		S = 0.087 SF @ 2.88 PSF	
							S = 0.087 SF EA @ 2.88 PSF	
AFT BULKHEAD ASSEMBLY	1		454	1		454		
BASIC SANDWICH PANEL, EXCLUDING HOLEOUTS	1	358		1	358		S = 194 SF @ 2.34 PSF (ALLUM H/C DESIGN)	10
FACE SKIN - OUTER	1	112		1	112		S = 194 SF @ 1.85 PSF	
FACE SKIN - INNER	1	112		1	112		S = 194 SF, T = 0.040 IN	
CORE	1	73		1	73		S = 194 SF, T = 0.040 IN	
ADHESIVE	2	29		2	29		S = 194 SF, H = 1.5 IN, DENSITY = 3.0 PCF	
MISCELLANEOUS		33			33		S = 194 SF / FACE @ 0.075 PSF	
HOLEOUTS	4	-207		4	-207		10%	
HOLEOUT, MAIN ENGINE (100 IN DIA)	2	-202		2	-202		S = 111.8 SF @ 1.85 PSF	
HOLEOUT, BODY VENT (14 X 14)	2	-5		2	-5		S = 54.5 SF EA @ 1.85 PSF	
HOLEOUT FRAMES	4	168		4	168		S = 1.4 SF EA @ 1.85 PSF	
FRAME, MAIN ENGINE HOLEOUT (100 IN DIA)	2	157		2	157			
FRAME, BODY VENT HOLEOUT (14 X 14)	2	9		2	9		L = 314 IN EA, A = 2.5 IN2	
STIFFENING FRAME	1	10		1	10		L = 56 IN EA, A = 0.8 IN2	
OUTER EDGE MEMBER	1	100		1	100		L = 100 IN, A = 1.0 IN2	
DOORS AND PANELS	2	6		2	6		L = 667 IN, A = 1.5 IN2	
DOOR, BODY VENT (14 X 14)	2	6		2	6			
MISCELLANEOUS		22			22		S = 1.4 SF EA @ 3.0 PSF	
							5%	

1.5 STAGE VEHICLE

STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)

2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)

DETAIL WEIGHTS

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	CWN
THRUST STRUCTURE ASSEMBLY - MAIN ENGINES	1	1988	1	1988		10
PRIMARY STRUTS	21	518	21	518	ALUMINUM	
STRUTS CO,EF	2	209	2	209	L = 48.0 IN (PIN-TO-PIN), A = 14.5 IN2, STRUT END FITTINGS @ 50%	
STRUTS DO, FO	2	35	2	35	L = 58.0 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS CM, EN	2	19	2	19	L = 31.5 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUT MN	1	18	1	18	L = 53.0 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS DM, FN	2	34	2	34	L = 57.4 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS OM, ON	2	33	2	33	L = 54.8 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS QC,PD,SE,RF,LE	5	47	5	47	L = 31.5 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS QD,PC,SF,LF	4	103	4	103	L = 57.4 IN (PIN-TO-PIN), A = 3.0 IN2, STRUT END FITTINGS @ 50%	
STRUT SR	1	22	1	22	L = 48.0 IN (PIN-TO-PIN), A = 3.0 IN2, STRUT END FITTINGS @ 50%	
PRIMARY FITTINGS	12	1009	12	1009	STEEL	
FITTING C (ENGINE INTERFACE)	1	163	1	163	43 LB BASIC + 120 LB ENGINE INTERFACE	
FITTING E (ENGINE INTERFACE)	1	161	1	161	41 LB BASIC + 120 LB ENGINE INTERFACE	
FITTING D (PRIMARY TANK MODULE INTERFACE)	1	168	1	168	48 LB BASIC + 120 LB PRIMARY TANK MODULE INTERFACE	
FITTING F (PRIMARY TANK MODULE INTERFACE)	1	173	1	173	53 LB BASIC + 120 LB PRIMARY TANK MODULE INTERFACE	
FITTING L (ACTUATOR INTERFACE)	1	40	1	40	10 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING M (ACTUATOR INTERFACE)	1	48	1	48	18 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING Q (ACTUATOR INTERFACE)	1	40	1	40	10 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING S (ACTUATOR INTERFACE)	1	48	1	48	18 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING P (SECONDARY TANK MODULE INTERFACE)	1	70	1	70	10 LB BASIC + 60 LB SECONDARY TANK MODULE INTERFACE	
FITTING R (SECONDARY TANK MODULE INTERFACE)	1	70	1	70	10 LB BASIC + 60 LB SECONDARY TANK MODULE INTERFACE	
FITTING N	1	16	1	16	16 LB BASIC	
FITTING O	1	16	1	16	16 LB BASIC	
PRIMARY ASSEMBLY HARDWARE		202		202	STEEL	
BOLTS, NUTS, WASHERS, ETC		202		202	20% OF PRIMARY FITTING WEIGHT	
SECONDARY BRACING		259		259	15% OF PRIMARY TRUSS WEIGHT	
SECONDARY INTERNAL SUPPORTS		175		175		10
SIDE SHELL ASSY TO THRUST STRUCTURE ASSY		120		120		
BASE BULKHEAD ASSY TO THRUST STRUCTURE ASSY		20		20		
MISCELLANEOUS		35		35		
UMBILICAL PLATES - PROPELLANT FEED	0	0	0	0	INCORPORATED INTO FORWARD BULKHEAD	10
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT		575		501		10
UMBILICAL PLATES - PROPELLANT FEED		0		0	25%	
P/A MODULE SEPARATION		3		19	10%	
PURGE AND VENT, DRAIN		28		28	28%	
HAZARDOUS GAS DETECTION		10		10	100%	
EQUIPMENT HEAT TRANSPORT		21		17	8%	
MAIN ENGINE GIMBAL SYSTEM		49		49	5%	
MAIN ENGINE INSTALLATION		4		4	12%	
MAIN ENGINE GN2 GROUND PURGE		2		2	20%	
HELIUM PNEUMATIC SYSTEM - PLUMBING		20		20	5%	
HELIUM PNEUMATIC SYSTEM - BOTTLES		31		15	5%	
LO2 SYSTEMS		62		62	5%	
LH2 SYSTEMS		73		73	5%	
POWER GENERATION, ELECTRIC		25		25	7%	
POWER DISTRIBUTION, ELECTRIC		131		111	25%	
GUIDANCE AND CONTROL		38		28	10%	
DATA HANDLING		20		10	10%	
INSTRUMENTATION		28		28	10%	
COMMUNICATIONS		28		0	20%	
RANGE SAFETY EQUIPMENT		8		0	10%	

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
OMS / RCS ENCLOSURE ASSEMBLY	1	810	0	0	303.7 SF @ 2.67 PSF (ALUM H/C DESIGN)	10
BASIC SANDWICH PANELS, EXCLUDING HOLEOUTS	5	415			303.7 SF @ 1.37 PSF	
FRONT	1	49			S = 26.6 SF @ 1.85 PSF	
SIDES	2	127			S = 34.2 SF EA @ 1.85 PSF	
TOP	1	151			S = 81.4 SF @ 1.85 PSF	
BOTTOM (AFT OVERHANG REGION)	1	40			S = 21.7 SF @ 1.85 PSF	
BOTTOM (INTERFACE REGION WITH PM)	-	0			S = 79.2 SF @ 0 PSF	
BASE	1	49			S = 26.6 SF @ 1.85 PSF	
HOLEOUTS	4	-31			S = 16.86 SF @ 1.85 PSF	
HOLEOUT, TOP PANEL, ACCESS (30 X 30)	2	-23			S = 6.25 SF EA @ 1.85 PSF	
HOLEOUT, BASE PANEL, OMS ENGINE (20 IN DIA)	2	-8			S = 2.16 SF EA @ 1.85 PSF	
HOLEOUT FRAMES	4	61				
FRAME, TOP PANEL, ACCESS HOLEOUT (30 X 30)	2	48			L = 120 IN EA, A = 2.0 IN2	
FRAME, BASE PANEL, OMS ENGINE HOLEOUT (20 IN DIA)	2	13			L = 63 IN EA, A = 1.0 IN2	
INTERMEDIATE STIFFENING FRAMES	4	140			L = 350 IN EA, A = 1.0 IN2	
INTERNAL LOAD DISTRIBUTION MEMBERS	TBD	50			ESTIMATE	
EXTERNAL ATTACH MEMBERS	2	50			L = 100 IN EA, A = 2.5 IN2	
RCS RACEWAY	2	40			S=20 SF EA @ 1 PSF	
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT		85				
OMS/RCS TANKAGE DESTRUCTION		2			10%	
RCS PROPULSION		13			10%	
OMS PROPULSION		70			10%	

1.5 STAGE VEHICLE
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2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB		BOOST MODULE Qty	BOOST MODULE WEIGHT - LB		REMARKS	SWBS
STAGING / ORDNANCE			48			187		10
PROPULSION MODULE SEPARATION	1		32	1		187	CORE PROPULSION MODULE NOT SEPARATED	10
SEP BOLTS, FLUIDS I / F	6	12		6	12			
SEP BOLTS, STRUCTURAL I / F	4	20		4	20			
SEPARATION SRMS				1	155			
OMS / RCS TANKAGE DESTRUCTION	2		16			-		10
RECOVERY	0		0	0		0		10
THERMAL CONTROL / ECS			1009			763		10
MECHANICAL SYSTEMS	1		110	1		110		10
PURGE & VENT, DRAIN	1	100		1	100			
HAZARDOUS GAS DETECTION	1	10		1	10			
EQUIPMENT HEAT TRANSPORT	1		257	1		209		10
EQUIP HEAT SINK PLATES / EQUIP SUPPORT	7	237		6	189		S= 79 SF(CORE PM) + 63 SF(BOOST PM), @ 3.0 PSF	
AIR / GN2 GROUND COOLING	1	20		1	20		L= 760 IN, 4 IN DIA @ 0.24 PPF	
DUCTING	1	15		1	15			
DISCONNECT	1	5		1	5			
FORWARD AERO FAIRINGS TPS	-		-	-		-	SEE TANK MODULE AFT SKIRT	
SIDE SHELL TPS	1		55	1		67		10
SPRAY ON FOAM INSULATION	1	50		1	61		S = 383.8 SF / 463 SF, T = 0.50 IN, CPR-488 (3.0 PCF)	
FOAM CLOSEOUTS / FILLER		5			6		10%	
BASE REGION TPS	1		77	1		77		10
FLEXIBLE BLANKET INSULATION	1	62		1	62		S=82.2 SF @ 0.75 PSF	
BLANKET ATTACHMENT		15			15		25%	
THERMAL BOOTS - MAIN ENGINES	2		300	2		300		10
OMS / RCS ENCLOSEURE TPS	1		210	0		0		10
EXTERIOR EXCLUDING BASE REGION	1	27						
SPRAY ON FOAM INSULATION	1	25					S = 196.0 SF, T = 0.50 IN, CPR-488 (3.0 PCF)	
FOAM CLOSEOUTS / FILLER	1	2					10%	
BASE REGION	1	23						
FLEXIBLE BLANKET INSULATION	1	18					S=24.32 SF @ 0.75 PSF	
BLANKET ATTACHMENT	1	5					25%	
PLUME SHIELD - RCS THRUSTERS	4	80						
RACEWAY SHIELD - RCS PROPELLANT LINES	2	30						
THERMAL BOOT - OMS ENGINE	2	50						

1.5 STAGE VEHICLE

STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)

2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)

DETAIL WEIGHTS

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB		BOOST MODULE Qty	BOOST MODULE WEIGHT - LB		REMARKS	TWG
LIQUID FUEL SYSTEM - MAIN ENGINE			16008			16008	STME X 2 @ 583.4 KLB TVAC EACH	10
LIQUID FUEL SYSTEM - MAIN PROPULSION			4725			4420		10
ANCILLARY EQUIPMENT	1		2014	1		1709	NEW DESIGN	10
ENGINE GIMBAL SYSTEM	2	970		2	970			
ACTUATORS	4	860		4	860		ALLIED SIGNAL ROM (ELECTRO-HYDROSTATIC)	
POWER SOURCE SYSTEM	2	100		2	100		ALLIED SIGNAL ROM (GH2 TURBO-GENERATOR)	
GH2 SUPPLY PLUMBING	2	10		2	10		ESTIMATE	
ENGINE INSTALLATION PROVISIONS	2	32		2	32		FROM STS (2 ENGINES IN LIEU OF 3)	
GIMBAL ATTACH		4			4			
INSULATION		11			11			
PANELS & MISC PARTS		17			17			
ENGINE HEAT SHIELD INSTALLATION	2	-		2	-		SEE THERMAL CONTROL	
ENGINE GN2 GROUND PURGE PROVISIONS	2	10		2	10		FROM STS (2 ENGINES IN LIEU OF 3)	
DISCONNECT & VALVES		2			2			
LINES & FITTINGS		6			6			
SUPPORTS & MISC PARTS		2			2			
He PNEUMATIC SYSTEM - PLUMBING	1	391		1	391		FROM STS (2 ENGINES IN LIEU OF 3)	
SURGE CHAMBERS		5			5			
DISCONNECT & MISC VALVES		13			13			
SOLENOID VALVES		83			83			
CHECK VALVES		9			9			
REGULATORS		17			17			
FILTERS		14			14			
PLUMBING & FITTINGS		142			142			
SUPPORTS & MISC PARTS		108			108			
He PNEUMATIC SYSTEM - CYLINDRICAL BOTTLES	2	611		1	306		650% OF CAPACITY He LOAD OF 47 LB/BOTTLE	

STATUS: 11/1/91

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
LO2 ENGINE FEED - 15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA	1	853	1	853	PROOF PRESSURE = 464 PSI	10
DISCONNECT - 15.0 IN DIA, 6.0 IN LENGTH	1	167	1	167	SCALED BY SIZE AND PRESSURE TO STS DISCONNECT	
PREVALVE - 10.0 IN DIA, 13.0 IN LENGTH	2	178	2	178	SCALED BY SIZE AND PRESSURE TO STS PREVALVES	
MANIFOLD ASSEMBLY - 15.0 IN DIA, 27.0 IN LENGTH	1	103	1	103		
TUBE SEGMENT	1	37	1	37	L = 23.0 IN, T = 0.117 IN, DBAR = 15.117 IN	
TUBE END CLOSEURE @ F&D INTERFACE	1	4	1	4	D = 15.0 IN, d = 8.0 IN, T = 0.117 IN	
FLANGE AT DISCONNECT INTERFACE - 15.0 IN ID	1	15	1	15	L = 2.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	
FLANGE AT PREVALVE INTERFACE - 10.0 IN ID	2	16	2	16	L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	
FLANGE AT F & D VALVE INTERFACE - 8.0 IN ID	1	8	1	8	L = 2.0 IN, DBAR = 9.0 IN, A = 0.7 IN2	
LOCAL REINFORCEMENT / SUPPORT TABS / ETC	1	16	1	16	20%	
FOAM INSULATED COVER	1	10	1	10	10 SF @ 1.0 PSF	
FLEXIBLE ASSEMBLY - 10.0 IN DIA, 92.2 IN LENGTH	2	344	2	344		
BELLOWS ASSY (RESTRAINED)	6	180	6	180	L = 6.0 IN EA, W = 30 LB EA	
TUBE SEGMENTS	6	92	2	92	L = 64.2 IN / ASSY, T = 0.078 IN, DBAR = 10.078	
FLANGES	4	32	4	32	L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	
FOAM INSULATED COVER	2	40	2	40	20 SF EA @ 1.0 PSF	
ASSEMBLY HARDWARE	5	12	5	12		
FASTENER AND SEAL SET - 10.0 IN DIA	4	8	4	8	2 LB / JOINT	
FASTENER AND SEAL SET - 15.0 IN DIA	1	4	1	4	4 LB / JOINT	
FOAM INSULATED COVER - DISCONNECT	1	2	1	2	2 SF @ 1.0 PSF	
FOAM INSULATED COVER - PREVALVE	2	6	2	6	3 SF EA @ 1.0 PSF	
SUPPORTS & MISC PARTS		41		41	5%	
LO2 FILL / DRAIN	1	243	1	243	FROM STS (NO CHANGE)	10
DISCONNECT	1	13	1	13		
VALVE	2	94	2	94		
DUCT ASSEMBLY	1	112	1	112		
INSULATION		5		5		
SUPPORTS & MISC PARTS		19		19		
LO2 OVERBOARD BLEED	1	45	1	45	FROM STS (NO CHANGE)	10
DISCONNECT	1	3	1	3		
BLEED VALVE	1	3	1	3		
CHECK VALVE	6	6	6	6		
LINES & FITTINGS		29		29		
SUPPORTS & MISC PARTS		4		4		
O2 RELIEF	1	24	1	24	FROM STS (NO CHANGE)	10
RELIEF VALVE	1	6	1	6		
RELIEF ISOLATION VALVE	1	5	1	5		
LINES & FITTINGS		9		9		
SUPPORTS & MISC PARTS		4		4		
GOX POGO SUPPRESSION	2	35	2	35	FROM STS (2 ENGINES IN LIEU OF 3)	10
VALVE	2	10	2	10		
LINES & FITTINGS		22		22		
SUPPORTS & MISC PARTS		3		3		
LO2 AUTOGENOUS PRESS	1	50	1	50	FROM STS (2 ENGINES IN LIEU OF 3)	10
DISCONNECT	1	7	1	7		
FLOW CONTROL VALVE	4	12	4	12		
LINES & FITTINGS		25		25		
SUPPORTS & MISC PARTS		6		6		

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB		BOOST MODULE Qty	BOOST MODULE WEIGHT - LB		REMARKS	%WG
LH2 ENGINE FEED - 15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA	1		899	1		899	USING LO2 FEED WITH VACUUM JACKETING	10
DISCONNECT - 15.5 IN DIA, 8.0 IN LENGTH	1	167		1	167			
PREVALVE - 10.0 IN DIA, 13.0 IN LENGTH	2	178		2	178			
MANIFOLD ASSEMBLY - 15.5 IN DIA, 27.0 IN LENGTH	1	113		1	113			
TUBE SEGMENT	1	37		1	37			
TUBE END CLOSEURE, @ F& D INTERFACE	1	4		1	4			
FLANGE AT DISCONNECT INTERFACE - 15.0 IN ID	1	15		1	15			
FLANGE AT PREVALVE INTERFACE - 10.0 IN ID	2	16		2	16			
FLANGE AT F & D VALVE INTERFACE - 8.0 IN ID	1	8		1	8			
LOCAL REINFORCEMENT / SUPPORT TABS / ETC	1	16		1	16			
VACUUM JACKET	1	20		1	20		10 SF @ 2.0 PSF	
FLEXIBLE ASSEMBLY - 10.0 IN DIA, 92.2 IN LENGTH	2	372		2	372			
BELLOWS ASSY (RESTRAINED)	6	180		6	180			
TUBE SEGMENTS	6	92		6	92			
FLANGES	4	32		4	32			
VACUUM JACKET	2	68		2	68		20 SF EA @ 1.7 PSF	
ASSEMBLY HARDWARE	5	12		5	12			
FASTENER AND SEAL SET - 10.0 IN DIA	4	8		4	8			
FASTENER AND SEAL SET - 15.0 IN DIA	1	4		2	4			
VACUUM JACKET - DISCONNECT	1	4		1	4		2 SF @ 2.0 PSF	
VACUUM JACKET - PREVALVE	2	10		2	10		3 SF EA @ 1.7 PSF	
SUPPORTS & MISC PARTS		43			43		5%	
LH2 FILL / DRAIN	1		251	1		251	FROM STS (NO CHANGE)	10
DISCONNECT	1	13		1	13			
VALVES	2	93		2	93			
DUCT ASSEMBLY	1	121		1	121			
INSULATION		7			7			
SUPPORTS & MISC PARTS		17			17			
LH2 PRESTART CONDITIONING	1		203	1		203	FROM STS (2 ENGINES IN LIEU OF 3)	10
DISCONNECT	1	9		1	9			
VALVES		24			24			
PUMP		20			20			
LINES & FITTINGS		116			116			
INSULATION		6			6			
SUPPORTS & MISC PARTS		28			28			
H2 RELIEF	1		23	1		23	FROM STS (NO CHANGE)	10
RELIEF VALVE	1	6		1	6			
RELIEF ISOLATION VALVE	1	5		1	5			
LINES & FITTINGS		9			9			
SUPPORTS & MISC PARTS		3			3			
LH2 DUMP	1		29	1		29	FROM STS (NO CHANGE)	10
VALVE	1	13		1	13			
LINES & FITTINGS		11			11			
INSULATION		1			1			
SUPPORTS & MISC PARTS		4			4			
LH2 AUTOGENOUS PRESS	1		58	1		58	FROM STS (2 ENGINES IN LIEU OF 3)	10
DISCONNECT	1	7		1	7			
FLOW CONTROL VALVES	4	14		4	14			
LINES & FITTINGS		29			29			
SUPPORTS & MISC PARTS		8			8			

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2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
AUXILIARY PROPULSION - RCS		131		0		10
THRUSTERS - BI-PROP	8	45			RS34 THRUSTERS (70 LBF, 280 SEC ISP)	10
PROPELLANT FEED / FILL / DRAIN	1	56				10
ISOLATION VALVES (PROPELLANT TANKS) - 1 IN	0	0				
ISOLATION VALVES (THRUSTERS) - 3/8 IN	16	40				
LINES & FITTINGS (DIRECT) - 3/8 IN		0				
LINES & FITTINGS (MANIFOLD) - 3/8 IN	2	16			L= 30-IN EA. NTO, 140-IN EA. MMH @ 0.145 LB/FT	
INSTRUMENTATION / CONTROLS		0			L=661-IN EA. @ 0.145 LB/FT INCL IN AVIONICS INSTRUMENTATION	
PROPELLANT TANKS	0	0			STORED IN OMS TANKAGE	
PRESSURIZATION SYSTEM - PLUMBING	0	30			ESTIMATE	10
PRESSURIZATION SYSTEM - BOTTLES	0	0			SEE MPS He PNEUMATIC SYSTEM	10
AUXILIARY PROPULSION - OMS		703		0		10
ENGINES	2	358			RS41 ENGINES (2868 LBT, 320 SEC ISP)	10
TVC ACTUATORS	4	24			ELECTROMECHANICAL	10
PROPELLANT FEED / FILL / DRAIN	2	65				10
ISOLATION VALVES (PROPELLANT TANKS) - 1 IN	4	16				
ISOLATION VALVES (THRUSTERS) - 1 IN	4	16				
VALVES - FILL/DRAIN - 1/2 IN	2	5				
GRND DISCONNECTS - 1/2 IN	2	8				
FILTERS - 1 IN	2	5				
LINES & FITTINGS (DIRECT) - 1 IN		0				
LINES & FITTINGS (MANIFOLD) - 1 IN	2	15			L= 30-IN EA. NTO, 140-IN EA. MMH @ 1 LB/FT	
INSTRUMENTATION / CONTROLS		0			L=90-IN EA. @ 1 LB/FT INCL IN AVIONICS INSTRUMENTATION	
PROPELLANT TANKS	2	199				10
TANK - N2O4	1	100			3% OF OMS / RCS USABLE PROP OF 3328 LB	
TANK - MMH	1	100			3% OF OMS / RCS USABLE PROP OF 3328 LB	
PRESSURIZATION SYSTEM - PLUMBING	1	57				10
DISCONNECT	1	2				
LATCHING VALVES - 1/2 IN	4	10				
CHECK VALVES - 1/2 IN	2	6				
REGULATORS - 1/2 IN	2	9				
HP VALVES - 1/4 IN	2	5				
RELIEF VALVES - 1/2 IN	4	12				
FILTERS - 1/2 IN	2	4				
BURST DISCS - 1/ 2 IN	2	4				
LINES & FITTINGS		5				
PRESSURIZATION SYSTEM - BOTTLES	0	0			SEE MPS He PNEUMATIC SYSTEM	

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2 ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	SWM
POWER - ELECTRICAL		874		794		10
GENERATION AND STORAGE		352		352		10
PRIMARY BATTERIES	2	176	2	176	170 A-HR (AG-ZN)	
UTILITY BATTERIES	2	176	2	176	170 A-HR (AG-ZN)	
DISTRIBUTION AND SEQUENCING		522		442		10
MAIN POWER DISTRIBUTOR ASSEMBLIES	2	104	2	104		
POWER SWITCHING UNITS	2	68	2	68		
CIRCUITRY	1	350	1	270		
AVIONICS		1041		662		10
GUIDANCE AND CONTROL		363		282		10
INERTIAL MEASUREMENT UNIT (IMU)	1	55		0	HONEYWELL DATA	
ASCENT TVC CONTROLLER	4	168	4	168		
OMS TVC CONTROLLERS	2	26		0		
MAIN ENGINE CONTROLLERS	2	0	2	0	INCLUDED IN ENGINE WEIGHT	
PSS (PWR SOURCE SYS) CONTROLLERS/CABLES	2	114	2	114		
DATA HANDLING		210		105		10
FLIGHT PROCESSOR UNITS	3	105	0	0		
SIGNAL HANDLING UNITS	3	105	3	105		
INSTRUMENTATION		280		275		10
SENSOR INTERFACE UNITS	2	35	2	30		
LASER FIRING UNIT (STAGING, RECOVERY SYSTEMS)	2	20	2	20		
CABLING HARNESS TO INTERFACE UNITS	7	35	7	35		
CABLING HARNESSES TO SENSORS	70	140	70	140		
SENSORS, OPERATIONAL	100	50	100	50	ESTIMATE	
COMMUNICATIONS		132		0		10
S-BAND TRANSPONDERS	2	28			STDN/TDRS	
S-BAND POWER AMPLIFIERS	2	24				
DIPLEXERS	2	4				
C-BAND TRANSPONDERS	2	20				
ENCRYPTER / DECRYPTER	2	10				
ANTENNAS, S-BAND	2	16				
ANTENNAS, C-BAND	2	4				
COAX CABLE SETS	4	28				
RANGE SAFETY EQUIPMENT		56		0		10
INTREGRATED RECEIVER / DECODER UNITS	2	12				
BATTERIES	2	20				
LASER FIRING UNIT	2	20				
ANTENNA	2	4				
DRY WEIGHT, EXCLUDING WEIGHT GROWTH MARGIN		30722		28132		
WEIGHT GROWTH MARGIN		3072		2813	10%	0
DRY WEIGHT		33794		30945		

1.5 STAGE VEHICLE
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2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	% WT
MAIN RESIDUAL FLUIDS - LO2 / LH2		170.4		170.4		
LO2 SYSTEM		154.9		154.9		
TRAPPED IN ENGINE FEED		92.3		92.3	12.974 FT3. FULL	
TRAPPED IN ENGINES		62.6		62.6	SCALED GG CYCLE ENGINE DATA	
ABOVE VALVE	509		509		254.3 LB/ENGINE	
BELOW VALVE	118		118		59.8 LB/ENGINE	
LH2 SYSTEM		15.5		15.5		
TRAPPED IN ENGINE FEED		5.7		5.7	12.974 FT3. FULL	
TRAPPED IN ENGINES		9.7		9.7	SCALED GG CYCLE ENGINE DATA	
ABOVE VALVE	49		49		24.8 LB/ENGINE	
BELOW VALVE	48		48		24.3 LB/ENGINE	
PNEUMATIC SYSTEM He		94.0		47.0		
NOMINAL USAGE		69.6		31.8		
MAIN ENGINES SEAL PURGE		53.2		27.3	SCALED SSME DATA	
PRE LIFTOFF	2.5		2.5		0.075 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 13 SEC (13 SEC)	
LIFTOFF TO MECO	48.6		22.7		0.040 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 467 SEC (218 SEC)	
MECO TO MECO+20 SECONDS	2.1		2.1		0.040 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 20 SEC (20 SEC)	
MAIN PROPULSION SYSTEM FUNCTIONS		4.5		4.5		
PRE LIFTOFF	1.5		1.5		ESTIMATE	
LIFTOFF TO MECO	3.0		3.0		ESTIMATE	
MECO TO MECO+20 SECONDS	0.0		0.0		ESTIMATE (ASSUMES NO DUMPING OF PROPELLANTS)	
RCS NOMINAL PROPELLANT PRESSURIZATION		1.5		0.0	0.4% OF RCS NOMINAL PROPELLANT USAGE	
OMS NOMINAL PROPELLANT PRESSURIZATION		10.4		0.0	0.4% OF OMS NOMINAL PROPELLANT USAGE	
RESERVE		7.1		3.2		
MAIN ENGINES SEAL PURGE		5.3		2.7	10% OF NOMINAL USAGE	
MAIN PROPULSION SYSTEM FUNCTIONS		0.5		0.5	10% OF NOMINAL USAGE	
RCS RESERVE PROPELLANT PRESSURIZATION		0.3		0.0	0.4% OF RCS RESERVE PROPELLANT	
OMS RESERVE PROPELLANT PRESSURIZATION		1.0		0.0	0.4% OF OMS RESERVE PROPELLANT	
MARGIN - FULL BOTTLES (2/CORE PM, 1/BOOST PM)		1.6		4.2	IDENTICAL BOTTLES (47.0 LB He CAPACITY EACH)	
RESIDUAL- TRAPPED IN BOTTLES		15.7		7.8	20% OF USABLE	
RCS PROPELLANT		483		0		
NOMINAL USAGE		383				
TRIM PRIOR TO PAYLOAD SEPARATION	217				FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 10 FPS)	
COLLISION AVOIDANCE AFTER PAYLOAD SEPARATION	168				FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 10 FPS)	
RESERVE		77			20% OF NOMINAL USAGE	
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		18			4% OF USABLE PROPELLANT	
RESIDUAL PROPELLANT - FEED SYSTEM / THRUSTERS		15			ESTIMATE	
OMS PROPELLANT		3027		0		
NOMINAL USAGE		2607				
DEORBIT CORE STAGE	2607				FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 181FPS)	
RESERVE		281			10% OF NOMINAL USAGE	
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		115			4% OF USABLE PROPELLANT	
RESIDUAL PROPELLANT - FEED SYSTEM / ENGINES		45			ESTIMATE	
REFERENCE INERT WT (PRIOR TO MISSION OFFLOADS, ONLOADS, AND PRE-LIFTOFF USAGE)		39112		32986		

1.5 STAGE VEHICLE
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2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

ITEM	SUSTAINER MODULE		BOOST MODULE		REMARKS	%WO
	Qty	WEIGHT - LB	Qty	WEIGHT - LB		
PRE-LIFTOFF USAGE		-4		-4		
PNEUMATIC SYSTEM He		-4		-4		
He - MAIN ENGINES SEAL PURGE		-2.5		-2.5		
He - MAIN PROPULSION SYSTEM FUNCTIONS		-1.5		-1.5		
INERT WEIGHT AT LIFTOFF		**39108**		**32892**		

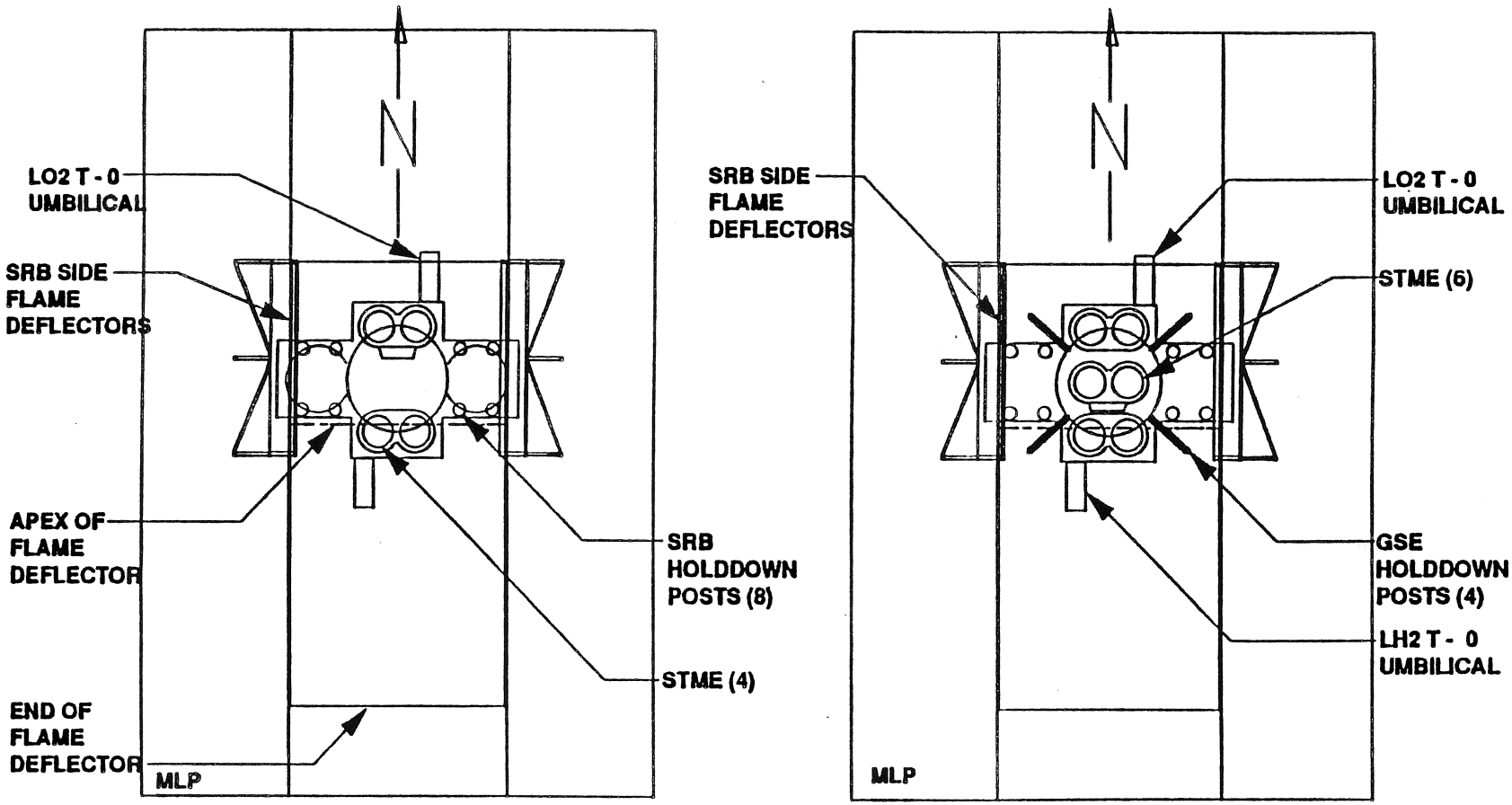
10.0 Operations

10.0 Operations

10.1 MLP INTERFACE

Hybrid Vehicle Concept is shown in Figures 10.1.4 & 10.1.6. These three views show that most of the flow will exit in the North flame trench however the nozzle center lines of the 2 southside STME's are located south of the apex and a greater portion of their exhaust plume will exit using the south flame trench.

Mobile Launch Platform
Modular Side-By-Side Option
(HYBRID)



BOEING

FIGURE 10.1-6

10.2 Maintainability Features

LRU access, placement

LRU Location: The LRUs consist of:

Item	#/Boattail	Weight	lb/box
Batteries	2	318	159
PDU	2	216	108
Rate Gyros	3	48	16
Remote Voter	6	227	38
MDU/RDU	2	27	14
Engine I/F	4	86	22
TVC Batteries	24	3540	148

Except for the TVC batteries the quantities are for the 4 engine ring. Quantities for the sustainer section are unknown. The TVC battery quantity appears to be for both the boost and sustainer sections.

The batteries and PDUs require a two person lift and can be lifted 2 ft off the floor per MIL-STD-1472. This requires these boxes be located close to the floor level and requires access hatches large enough to carry these boxes through. The other boxes can be located up to 5 feet from the floor. In general the objective is to locate the equipment in two equipment bays with access doors to the bays. The equipment would be located on the truss structure which provides a low vibration environment. The aft bulkhead of the module would provide the access platform for installation and removal. The truss structure, however, starts about 4 feet from the aft bulkhead which is a problem for installation for the 150 lb boxes. For this configuration the 150 lb batteris and 100 lb PDUs should be segmented into half batteries sized for a two person lift to the structure (<70 lbs) otherwise the boxes would have to be installed using a mechanical aid.

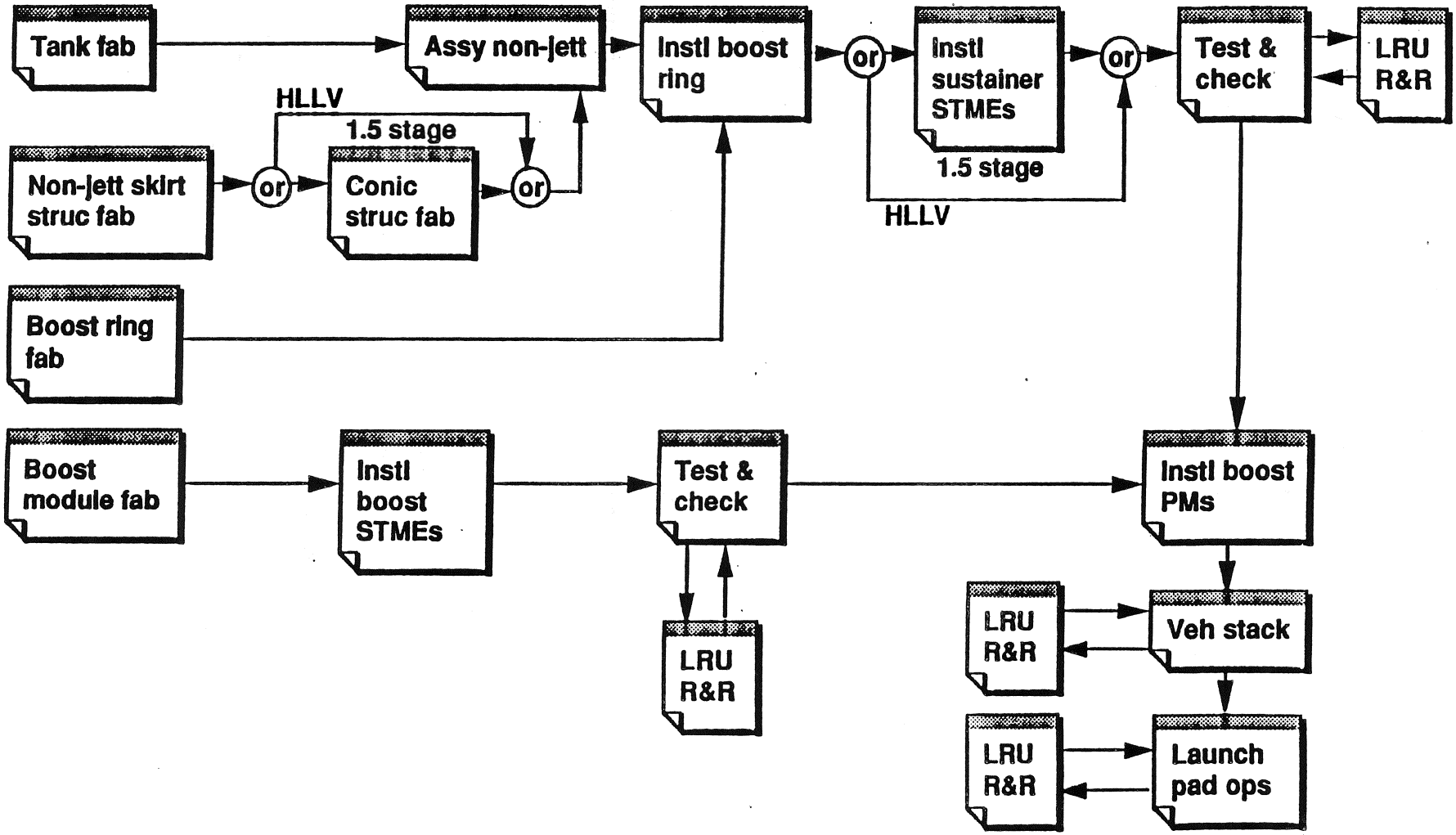
On the sustainer section, equipment is mounted inside the conic structure. Mounting inside protects the boxes from the thermal environment. Access is via a hatch in the side of the conic and the bottom of the conic requires a bulkhead to walk on.

Access to the engines is via the aft bulkhead and equipment access doors. The shell around the engines is sized to allow 360° access to the engine power head.

10.3 Operations Flows

Key Conclusions. The manufacturing plan for the hybrid vehicle is based upon the following assumptions: 1) Assembly of the non-jettisoned skirt and sustainer conic is done attached to the tank because the tank is an integral part of the structural support for the feedlines, and 2) the 2 engine boost module can be installed after STME installation on the sustainer section. The boost modules are parallel processed with the core including test and checkout. This provides a higher level of parallel processing than the reference vehicle and also allows test and checkout to be performed in a test and checkout cell tailored for best access to each of the modules being tested.

Hybrid Vehicle Manufacturing Plan



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2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
THRUST STRUCTURE ASSEMBLY - MAIN ENGINES	1	1988	1	1988		
PRIMARY STRUTS	21	518	21	518		10
STRUTS CD,EF	2	209	2	209	ALUMINUM	
STRUTS DO, FO	2	35	2	35	L = 48.0 IN (PIN-TO-PIN), A = 14.5 IN2, STRUT END FITTINGS @ 50%	
STRUTS CM, EN	2	19	2	19	L = 58.0 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUT MN	1	18	1	18	L = 31.5 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS DM, FN	2	34	2	34	L = 53.0 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS OM, ON	2	33	2	33	L = 57.4 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS QC,PD,SE,RF,LE	5	47	5	47	L = 54.8 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUTS QD,PC,SF,LF	4	103	4	103	L = 31.5 IN (PIN-TO-PIN), A = 2.0 IN2, STRUT END FITTINGS @ 50%	
STRUT SR	1	22	1	22	L = 57.4 IN (PIN-TO-PIN), A = 3.0 IN2, STRUT END FITTINGS @ 50%	
PRIMARY FITTINGS	12	1009	12	1009	L = 48.0 IN (PIN-TO-PIN), A = 3.0 IN2, STRUT END FITTINGS @ 50%	
FITTING C (ENGINE INTERFACE)	1	163	1	163	STEEL	
FITTING E (ENGINE INTERFACE)	1	161	1	161	43 LB BASIC + 120 LB ENGINE INTERFACE	
FITTING D (PRIMARY TANK MODULE INTERFACE)	1	168	1	168	41 LB BASIC + 120 LB ENGINE INTERFACE	
FITTING F (PRIMARY TANK MODULE INTERFACE)	1	173	1	173	48 LB BASIC + 120 LB PRIMARY TANK MODULE INTERFACE	
FITTING L (ACTUATOR INTERFACE)	1	40	1	40	53 LB BASIC + 120 LB PRIMARY TANK MODULE INTERFACE	
FITTING M (ACTUATOR INTERFACE)	1	46	1	46	10 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING Q (ACTUATOR INTERFACE)	1	40	1	40	16 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING S (ACTUATOR INTERFACE)	1	46	1	46	10 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING P (SECONDARY TANK MODULE INTERFACE)	1	70	1	70	16 LB BASIC + 30 LB ACTUATOR INTERFACE	
FITTING R (SECONDARY TANK MODULE INTERFACE)	1	70	1	70	10 LB BASIC + 60 LB SECONDARY TANK MODULE INTERFACE	
FITTING N	1	16	1	16	10 LB BASIC + 60 LB SECONDARY TANK MODULE INTERFACE	
FITTING O	1	16	1	16	16 LB BASIC	
PRIMARY ASSEMBLY HARDWARE		202		202	16 LB BASIC	
BOLTS, NUTS, WASHERS, ETC		202		202	STEEL	
SECONDARY BRACING		259		259	20% OF PRIMARY FITTING WEIGHT	
					15% OF PRIMARY TRUSS WEIGHT	
SECONDARY INTERNAL SUPPORTS		175		175		
SIDE SHELL ASSY TO THRUST STRUCTURE ASSY		120		120		10
BASE BULKHEAD ASSY TO THRUST STRUCTURE ASSY		20		20		
MISCELLANEOUS		35		35		
UMBILICAL PLATES - PROPELLANT FEED	0	0	0	0	INCORPORATED INTO FORWARD BULKHEAD	10
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT		575		501		
UMBILICAL PLATES - PROPELLANT FEED		0		0		10
P/A MODULE SEPARATION		3		19	25%	
PURGE AND VENT, DRAIN		28		28	10%	
HAZARDOUS GAS DETECTION		10		10	28%	
EQUIPMENT HEAT TRANSPORT		21		17	100%	
MAIN ENGINE GIMBAL SYSTEM		49		49	8%	
MAIN ENGINE INSTALLATION		4		4	5%	
MAIN ENGINE GN2 GROUND PURGE		2		2	12%	
HELIUM PNEUMATIC SYSTEM - PLUMBING		20		20	20%	
HELIUM PNEUMATIC SYSTEM - BOTTLES		31		15	5%	
LO2 SYSTEMS		62		62	5%	
LH2 SYSTEMS		73		73	5%	
POWER GENERATION, ELECTRIC		25		25	5%	
POWER DISTRIBUTION, ELECTRIC		131		111	7%	
GUIDANCE AND CONTROL		36		28	25%	
DATA HANDLING		20		10	10%	
INSTRUMENTATION		28		28	10%	
COMMUNICATIONS		26		0	20%	
RANGE SAFETY EQUIPMENT		6		0	10%	

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
OMS / RCS ENCLOSURE ASSEMBLY	1	810	0	0	303.7 SF @ 2.67 PSF (ALUM H/C DESIGN)	10
BASIC SANDWICH PANELS, EXCLUDING HOLEOUTS	5	415			303.7 SF @ 1.37 PSF	
FRONT	1	49			S = 26.5 SF @ 1.85 PSF	
SIDES	2	127			S = 34.2 SF EA @ 1.85 PSF	
TOP	1	151			S = 81.4 SF @ 1.85 PSF	
BOTTOM (AFT OVERHANG REGION)	1	40			S = 21.7 SF @ 1.85 PSF	
BOTTOM (INTERFACE REGION WITH PM)	-	0			S = 79.2 SF @ 0 PSF	
BASE	1	49			S = 26.5 SF @ 1.85 PSF	
HOLEOUTS	4	-31			S = 16.88 SF @ 1.85 PSF	
HOLEOUT, TOP PANEL, ACCESS (30 X 30)	2	-23			S = 6.25 SF EA @ 1.85 PSF	
HOLEOUT, BASE PANEL, OMS ENGINE (20 IN DIA)	2	-8			S = 2.18 SF EA @ 1.85 PSF	
HOLEOUT FRAMES	4	61				
FRAME, TOP PANEL, ACCESS HOLEOUT (30 X 30)	2	48			L = 120 IN EA, A = 2.0 IN2	
FRAME, BASE PANEL, OMS ENGINE HOLEOUT (20 IN DIA)	2	13			L = 63 IN EA, A = 1.0 IN2	
INTERMEDIATE STIFFENING FRAMES	4	140			L = 350 IN EA, A = 1.0 IN2	
INTERNAL LOAD DISTRIBUTION MEMBERS	TBD	50			ESTIMATE	
EXTERNAL ATTACH MEMBERS	2	50			L = 100 IN EA, A = 2.5 IN2	
RCS RACEWAY	2	40			S=20 SF EA @ 1 PSF	
SUPPORT / INSTALLATION PROVISIONS - AVIONICS / EQUIPMENT		85				
OMS/RCS TANKAGE DESTRUCTION		2			10%	
RCS PROPULSION		13			10%	
OMS PROPULSION		70			10%	

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DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
STAGING / ORDNANCE		48		187		10
PROPULSION MODULE SEPARATION	1	32	1	187	CORE PROPULSION MODULE NOT SEPARATED	10
SEP BOLTS, FLUIDS I/F	6	12	6	12		
SEP BOLTS, STRUCTURAL I/F	4	20	4	20		
SEPARATION SRMS			1	155		
OMS / RCS TANKAGE DESTRUCTION	2	16		-		10
RECOVERY	0	0	0	0		10
THERMAL CONTROL / ECS		1009		763		10
MECHANICAL SYSTEMS	1	110	1	110		10
PURGE & VENT, DRAIN	1	100	1	100		
HAZARDOUS GAS DETECTION	1	10	1	10		
EQUIPMENT HEAT TRANSPORT	1	257	1	209		10
EQUIP HEAT SINK PLATES / EQUIP SUPPORT	7	237	6	189	S= 79 SF(CORE PM) + 63 SF(BOOST PM), @ 3.0 PSF	
AIR / GN2 GROUND COOLING	1	20	1	20	L= 760 IN, 4 IN DIA @ 0.24 PPF	
DUCTING	1	15	1	15		
DISCONNECT	1	5	1	5		
FORWARD AERO FAIRINGS TPS	-	-	-	-	SEE TANK MODULE AFT SKIRT	
SIDE SHELL TPS	1	55	1	67		10
SPRAY ON FOAM INSULATION	1	50	1	61	S = 383.8 SF / 463 SF, T = 0.50 IN, CPR-488 (3.0 PCF)	
FOAM CLOSEOUTS / FILLER		5		6	10%	
BASE REGION TPS	1	77	1	77		10
FLEXIBLE BLANKET INSULATION	1	62	1	62	S=82.2 SF @ 0.75 PSF	
BLANKET ATTACHMENT		15		15	25%	
THERMAL BOOTS - MAIN ENGINES	2	300	2	300		10
OMS / RCS ENCLOSEURE TPS	1	210	0	0		10
EXTERIOR EXCLUDING BASE REGION	1	27				
SPRAY ON FOAM INSULATION	1	25			S = 198.0 SF, T = 0.50 IN, CPR-488 (3.0 PCF)	
FOAM CLOSEOUTS / FILLER	1	2			10%	
BASE REGION	1	23				
FLEXIBLE BLANKET INSULATION	1	18			S=24.32 SF @ 0.75 PSF	
BLANKET ATTACHMENT	1	5			25%	
PLUME SHIELD - RCS THRUSTERS	4	80				
RACEWAY SHIELD - RCS PROPELLANT LINES	2	30				
THERMAL BOOT - OMS ENGINE	2	50				

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2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
LIQUID FUEL SYSTEM - MAIN ENGINE		16008		16008	STME X 2 @ 583.4 KLB TVAC EACH	10
LIQUID FUEL SYSTEM - MAIN PROPULSION		4725		4420		10
ANCILLARY EQUIPMENT	1	2014	1	1709	NEW DESIGN	10
ENGINE GIMBAL SYSTEM	2	970	2	970		
ACTUATORS	4	860	4	860	ALLIED SIGNAL ROM (ELECTRO-HYDROSTATIC)	
POWER SOURCE SYSTEM	2	100	2	100	ALLIED SIGNAL ROM (GH2 TURBO-GENERATOR)	
GH2 SUPPLY PLUMBING	2	10	2	10	ESTIMATE	
ENGINE INSTALLATION PROVISIONS	2	32	2	32	FROM STS (2 ENGINES IN LIEU OF 3)	
GIMBAL ATTACH		4		4		
INSULATION		11		11		
PANELS & MISC PARTS		17		17		
ENGINE HEAT SHIELD INSTALLATION	2	-	2	-	SEE THERMAL CONTROL	
ENGINE GN2 GROUND PURGE PROVISIONS	2	10	2	10	FROM STS (2 ENGINES IN LIEU OF 3)	
DISCONNECT & VALVES		2		2		
LINES & FITTINGS		6		6		
SUPPORTS & MISC PARTS		2		2		
He PNEUMATIC SYSTEM - PLUMBING	1	391	1	391	FROM STS (2 ENGINES IN LIEU OF 3)	
SURGE CHAMBERS		5		5		
DISCONNECT & MISC VALVES		13		13		
SOLENOID VALVES		83		83		
CHECK VALVES		9		9		
REGULATORS		17		17		
FILTERS		14		14		
PLUMBING & FITTINGS		142		142		
SUPPORTS & MISC PARTS		108		108		
He PNEUMATIC SYSTEM - CYLINDRICAL BOTTLES	2	611	1	308	650% OF CAPACITY He LOAD OF 47 LB/BOTTLE	

1.5 STAGE VEHICLE

STATUS: 11/1/91

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)

2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)

DETAIL WEIGHTS

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB		BOOST MODULE Qty	BOOST MODULE WEIGHT - LB		REMARKS	%WG
LO2 ENGINE FEED - 15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA	1		853	1		853	PROOF PRESSURE = 464 PSI	10
DISCONNECT - 15.0 IN DIA, 6.0 IN LENGTH	1	167		1	167		SCALED BY SIZE AND PRESSURE TO STS DISCONNECT	
PREVALVE - 10.0 IN DIA, 13.0 IN LENGTH	2	178		2	178		SCALED BY SIZE AND PRESSURE TO STS PREVALVES	
MANIFOLD ASSEMBLY - 15.0 IN DIA, 27.0 IN LENGTH	1	103		1	103			
TUBE SEGMENT	1	37		1	37		L = 23.0 IN, T = 0.117 IN, DBAR = 15.117 IN	
TUBE END CLOSEURE, @ F&D INTERFACE	1	4		1	4		D = 15.0 IN, d = 8.0 IN, T = 0.117 IN	
FLANGE AT DISCONNECT INTERFACE - 15.0 IN ID	1	15		1	15		L = 2.0 IN, DBAR = 16.0 IN, A = 1.0 IN2	
FLANGE AT PREVALVE INTERFACE - 10.0 IN ID	2	16		2	16		L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	
FLANGE AT F & D VALVE INTERFACE - 8.0 IN ID	1	6		1	6		L = 2.0 IN, DBAR = 9.0 IN, A = 0.7 IN2	
LOCAL REINFORCEMENT / SUPPORT TABS / ETC	1	16		1	16		20%	
FOAM INSULATED COVER	1	10		1	10		10 SF @ 1.0 PSF	
FLEXIBLE ASSEMBLY - 10.0 IN DIA, 92.2 IN LENGTH	2	344		2	344			
BELLOWS ASSY (RESTRAINED)	6	180		6	180		L = 8.0 IN EA, W = 30 LB EA	
TUBE SEGMENTS	6	92		2	92		L = 64.2 IN / ASSY, T = 0.078 IN, DBAR = 10.078	
FLANGES	4	32		4	32		L = 2.0 IN, DBAR = 11.0 IN, A = 0.8 IN2	
FOAM INSULATED COVER	2	40		2	40		20 SF EA @ 1.0 PSF	
ASSEMBLY HARDWARE	5	12		5	12			
FASTENER AND SEAL SET - 10.0 IN DIA	4	8		4	8		2 LB / JOINT	
FASTENER AND SEAL SET - 15.0 IN DIA	1	4		1	4		4 LB / JOINT	
FOAM INSULATED COVER - DISCONNECT	1	2		1	2		2 SF @ 1.0 PSF	
FOAM INSULATED COVER - PREVALVE	2	6		2	6		3 SF EA @ 1.0 PSF	
SUPPORTS & MISC PARTS		41			41		5%	
LO2 FILL / DRAIN	1		243	1		243	FROM STS (NO CHANGE)	10
DISCONNECT	1	13		1	13			
VALVE	2	94		2	94			
DUCT ASSEMBLY	1	112		1	112			
INSULATION		5			5			
SUPPORTS & MISC PARTS		19			19			
LO2 OVERBOARD BLEED	1		45	1		45	FROM STS (NO CHANGE)	10
DISCONNECT	1	3		1	3			
BLEED VALVE	1	3		1	3			
CHECK VALVE	6	6		6	6			
LINES & FITTINGS		29			29			
SUPPORTS & MISC PARTS		4			4			
O2 RELIEF	1		24	1		24	FROM STS (NO CHANGE)	10
RELIEF VALVE	1	6		1	6			
RELIEF ISOLATION VALVE	1	5		1	5			
LINES & FITTINGS		9			9			
SUPPORTS & MISC PARTS		4			4			
GOX POGO SUPPRESSION	2		35	2		35	FROM STS (2 ENGINES IN LIEU OF 3)	10
VALVE	2	10		2	10			
LINES & FITTINGS		22			22			
SUPPORTS & MISC PARTS		3			3			
LO2 AUTOGENOUS PRESS	1		50	1		50	FROM STS (2 ENGINES IN LIEU OF 3)	10
DISCONNECT	1	7		1	7			
FLOW CONTROL VALVE	4	12		4	12			
LINES & FITTINGS		25			25			
SUPPORTS & MISC PARTS		6			6			

1.5 STAGE VEHICLE **STATUS: 11/1/91**

(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)

2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)

DETAIL WEIGHTS

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
LH2 ENGINE FEED - 15.0 IN DIA SPLITTING TO (2) 10.0 IN DIA	1	899	1	899	USING LO2 FEED WITH VACUUM JACKETING	10
DISCONNECT - 15.5 IN DIA, 6.0 IN LENGTH	1	167	1	167		
PREVALVE - 10.0 IN DIA, 13.0 IN LENGTH	2	178	2	178		
MANIFOLD ASSEMBLY - 15.5 IN DIA, 27.0 IN LENGTH	1	113	1	113		
TUBE SEGMENT	1	37	1	37		
TUBE END CLOSEURE, @ F& D INTERFACE	1	4	1	4		
FLANGE AT DISCONNECT INTERFACE - 15.0 IN ID	1	15	1	15		
FLANGE AT PREVALVE INTERFACE - 10.0 IN ID	2	16	2	16		
FLANGE AT F & D VALVE INTERFACE - 8.0 IN ID	1	8	1	8		
LOCAL REINFORCEMENT / SUPPORT TABS / ETC	1	16	1	16		
VACUUM JACKET	1	20	1	20	10 SF @ 2.0 PSF	
FLEXIBLE ASSEMBLY - 10.0 IN DIA, 92.2 IN LENGTH	2	372	2	372		
BELLOWS ASSY (RESTRAINED)	8	180	8	180		
TUBE SEGMENTS	8	92	8	92		
FLANGES	4	32	4	32		
VACUUM JACKET	2	68	2	68	20 SF EA @ 1.7 PSF	
ASSEMBLY HARDWARE	5	12	5	12		
FASTENER AND SEAL SET - 10.0 IN DIA	4	8	4	8		
FASTENER AND SEAL SET - 15.0 IN DIA	1	4	2	4		
VACUUM JACKET - DISCONNECT	1	4	1	4	2 SF @ 2.0 PSF	
VACUUM JACKET - PREVALVE	2	10	2	10	3 SF EA @ 1.7 PSF	
SUPPORTS & MISC PARTS		43		43	5%	
LH2 FILL / DRAIN	1	251	1	251	FROM STS (NO CHANGE)	10
DISCONNECT	1	13	1	13		
VALVES	2	93	2	93		
DUCT ASSEMBLY	1	121	1	121		
INSULATION		7		7		
SUPPORTS & MISC PARTS		17		17		
LH2 PRESTART CONDITIONING	1	203	1	203	FROM STS (2 ENGINES IN LIEU OF 3)	10
DISCONNECT	1	9	1	9		
VALVES		24		24		
PUMP		20		20		
LINES & FITTINGS		116		116		
INSULATION		6		6		
SUPPORTS & MISC PARTS		28		28		
H2 RELIEF	1	23	1	23	FROM STS (NO CHANGE)	10
RELIEF VALVE	1	6	1	6		
RELIEF ISOLATION VALVE	1	5	1	5		
LINES & FITTINGS		9		9		
SUPPORTS & MISC PARTS		3		3		
LH2 DUMP	1	29	1	29	FROM STS (NO CHANGE)	10
VALVE	1	13	1	13		
LINES & FITTINGS		11		11		
INSULATION		1		1		
SUPPORTS & MISC PARTS		4		4		
LH2 AUTOGENOUS PRESS	1	58	1	58	FROM STS (2 ENGINES IN LIEU OF 3)	10
DISCONNECT	1	7	1	7		
FLOW CONTROL VALVES	4	14	4	14		
LINES & FITTINGS		29		29		
SUPPORTS & MISC PARTS		8		8		

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
AUXILIARY PROPULSION - RCS		131		0		
THRUSTERS - BI-PROP	8	45			RS34 THRUSTERS (70 LBF, 280 SEC ISP)	10
PROPELLANT FEED / FILL / DRAIN	1	56				10
ISOLATION VALVES (PROPELLANT TANKS) - 1 IN	0	0				10
ISOLATION VALVES (THRUSTERS) - 3/8 IN	16	40				
LINES & FITTINGS (DIRECT) - 3/8 IN		0				
LINES & FITTINGS (MANIFOLD) - 3/8 IN	2	16			L= 30-IN EA. NTO, 140-IN EA. MMH @ 0.145 LB/FT	
INSTRUMENTATION / CONTROLS		0			L=681-IN EA. @ 0.145 LB/FT INCL IN AVIONICS INSTRUMENTATION	
PROPELLANT TANKS	0	0			STORED IN OMS TANKAGE	
PRESSURIZATION SYSTEM - PLUMBING	0	30			ESTIMATE	10
PRESSURIZATION SYSTEM - BOTTLES	0	0			SEE MPS He PNEUMATIC SYSTEM	10
AUXILIARY PROPULSION - OMS		703		0		10
ENGINES	2	358			RS41 ENGINES (2666 LBT, 320 SEC ISP)	10
TVC ACTUATORS	4	24			ELECTROMECHANICAL	10
PROPELLANT FEED / FILL / DRAIN	2	65				10
ISOLATION VALVES (PROPELLANT TANKS) - 1 IN	4	16				
ISOLATION VALVES (THRUSTERS) - 1 IN	4	16				
VALVES - FILL/DRAIN - 1/2 IN	2	5				
GRND DISCONNECTS - 1/2 IN	2	8				
FILTERS - 1IN	2	5				
LINES & FITTINGS (DIRECT) - 1 IN		0				
LINES & FITTINGS (MANIFOLD) - 1 IN	2	15			L= 30-IN EA. NTO, 140-IN EA. MMH @ 1 LB/FT	
INSTRUMENTATION / CONTROLS		0			L=90-IN EA. @ 1 LB/FT INCL IN AVIONICS INSTRUMENTATION	
PROPELLANT TANKS	2	199				
TANK - N2O4	1	100			3% OF OMS / RCS USABLE PROP OF 3328 LB	10
TANK - MMH	1	100			3% OF OMS / RCS USABLE PROP OF 3328 LB	
PRESSURIZATION SYSTEM - PLUMBING	1	57				
DISCONNECT	1	2				10
LATCHING VALVES - 1/2 IN	4	10				
CHECK VALVES - 1/2 IN	2	6				
REGULATORS - 1/2 IN	2	9				
HP VALVES - 1/4 IN	2	5				
RELIEF VALVES - 1/2 IN	4	12				
FILTERS - 1/2 IN	2	4				
BURST DISCS - 1/ 2 IN	2	4				
LINES & FITTINGS		5				
PRESSURIZATION SYSTEM - BOTTLES	0	0			SEE MPS He PNEUMATIC SYSTEM	

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
POWER - ELECTRICAL		874		794		10
GENERATION AND STORAGE		352		352		10
PRIMARY BATTERIES	2	176	2	176	170 A-HR (AG-ZN)	
UTILITY BATTERIES	2	176	2	176	170 A-HR (AG-ZN)	
DISTRIBUTION AND SEQUENCING		522		442		10
MAIN POWER DISTRIBUTOR ASSEMBLIES	2	104	2	104		
POWER SWITCHING UNITS	2	68	2	68		
CIRCUITRY	1	350	1	270		
AVIONICS		1041		662		10
GUIDANCE AND CONTROL		363		282		10
INERTIAL MEASUREMENT UNIT (IMU)	1	55		0	HONEYWELL DATA	
ASCENT TVC CONTROLLER	4	168	4	168		
OMS TVC CONTROLLERS	2	28		0		
MAIN ENGINE CONTROLLERS	2	0	2	0	INCLUDED IN ENGINE WEIGHT	
PSS (PWR SOURCE SYS) CONTROLLERS/CABLES	2	114	2	114		
DATA HANDLING		210		105		10
FLIGHT PROCESSOR UNITS	3	105	0	0		
SIGNAL HANDLING UNITS	3	105	3	105		
INSTRUMENTATION		280		275		10
SENSOR INTERFACE UNITS	2	35	2	30		
LASER FIRING UNIT (STAGING, RECOVERY SYSTEMS)	2	20	2	20		
CABLING HARNESS TO INTERFACE UNITS	7	35	7	35		
CABLING HARNESSES TO SENSORS	70	140	70	140		
SENSORS, OPERATIONAL	100	50	100	50	ESTIMATE	
COMMUNICATIONS		132		0		10
S-BAND TRANSPONDERS	2	28			STDN/TDRS	
S-BAND POWER AMPLIFIERS	2	24				
DIPLEXERS	2	4				
C-BAND TRANSPONDERS	2	20				
ENCRYPTER / DECRYPTER	2	10				
ANTENNAS, S-BAND	2	18				
ANTENNAS, C-BAND	2	4				
COAX CABLE SETS	4	28				
RANGE SAFETY EQUIPMENT		58		0		10
INTREGRATED RECEIVER / DECODER UNITS	2	12				
BATTERIES	2	20				
LASER FIRING UNIT	2	20				
ANTENNA	2	4				
DRY WEIGHT, EXCLUDING WEIGHT GROWTH MARGIN		30722		28132		
WEIGHT GROWTH MARGIN		3072		2813	10%	0
DRY WEIGHT		33794		30945		

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
MAIN RESIDUAL FLUIDS - LO2 / LH2		1704		1704		
LO2 SYSTEM		1549		1549		
TRAPPED IN ENGINE FEED		923		923		
TRAPPED IN ENGINES		626		626	12.974 FT3. FULL	
ABOVE VALVE		509		509	SCALED GG CYCLE ENGINE DATA	
BELOW VALVE		118		118	254.3 LB/ENGINE 58.8 LB/ENGINE	
LH2 SYSTEM		155		155		
TRAPPED IN ENGINE FEED		57		57		
TRAPPED IN ENGINES		97		97	12.974 FT3. FULL	
ABOVE VALVE		49		49	SCALED GG CYCLE ENGINE DATA	
BELOW VALVE		48		48	24.6 LB/ENGINE 24.3 LB/ENGINE	
PNEUMATIC SYSTEM He		94.0		47.0		
NOMINAL USAGE		69.6		31.8		
MAIN ENGINES SEAL PURGE		53.2		27.3	SCALED SSME DATA	
PRE LIFTOFF		2.5		2.5	0.075 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 13 SEC (13 SEC)	
LIFTOFF TO MECO		48.6		22.7	0.040 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 467 SEC (218 SEC)	
MECO TO MECO+20 SECONDS		2.1		2.1	0.040 LB/SEC/ENGINE X WPDOT RATIO OF1.3 X 20 SEC (20 SEC)	
MAIN PROPULSION SYSTEM FUNCTIONS		4.5		4.5		
PRE LIFTOFF		1.5		1.5	ESTIMATE	
LIFTOFF TO MECO		3.0		3.0	ESTIMATE	
MECO TO MECO+20 SECONDS		0.0		0.0	ESTIMATE (ASSUMES NO DUMPING OF PROPELLANTS)	
RCS NOMINAL PROPELLANT PRESSURIZATION		1.5		0.0	0.4% OF RCS NOMINAL PROPELLANT USAGE	
OMS NOMINAL PROPELLANT PRESSURIZATION		10.4		0.0	0.4% OF OMS NOMINAL PROPELLANT USAGE	
RESERVE		7.1		3.2		
MAIN ENGINES SEAL PURGE		5.3		2.7	10% OF NOMINAL USAGE	
MAIN PROPULSION SYSTEM FUNCTIONS		0.5		0.5	10% OF NOMINAL USAGE	
RCS RESERVE PROPELLANT PRESSURIZATION		0.3		0.0	0.4% OF RCS RESERVE PROPELLANT	
OMS RESERVE PROPELLANT PRESSURIZATION		1.0		0.0	0.4% OF OMS RESERVE PROPELLANT	
MARGIN - FULL BOTTLES (2/CORE PM, 1/BOOST PM)		1.8		4.2	IDENTICAL BOTTLES (47.0 LB He CAPACITY EACH)	
RESIDUAL- TRAPPED IN BOTTLES		15.7		7.8	20% OF USABLE	
RCS PROPELLANT		483		0		
NOMINAL USAGE		383				
TRIM PRIOR TO PAYLOAD SEPARATION		217			FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 10 FPS)	
COLLISION AVOIDANCE AFTER PAYLOAD SEPARATION		166			FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 10 FPS)	
RESERVE		77			20% OF NOMINAL USAGE	
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		18			4% OF USABLE PROPELLANT	
RESIDUAL PROPELLANT - FEED SYSTEM / THRUSTERS		15			ESTIMATE	
OMS PROPELLANT		3027		0		
NOMINAL USAGE		2607				
DEORTBIT CORE STAGE		2607			FROM CORE SECONDARY FLUIDS (FOR DELTA-V = 181FPS)	
RESERVE		281			10% OF NOMINAL USAGE	
RESIDUAL PROPELLANT - TRAPPED IN TANKAGE		115			4% OF USABLE PROPELLANT	
RESIDUAL PROPELLANT - FEED SYSTEM / ENGINES		45			ESTIMATE	
REFERENCE INERT WT (PRIOR TO MISSION OFFLOADS, ONLOADS, AND PRE-LIFTOFF USAGE)		39112		32896		

1.5 STAGE VEHICLE
(VEHICLE HAS TWO 2-ENGINE EXPENDABLE BOOST PROPULSION MODULES, A JETTISONABLE AFT SKIRT PACKAGE, AND A FIXED 2-ENGINE SUSTAINER PROPULSION PACKAGE)
2-ENGINE EXPENDABLE PROPULSION MODULES (WITHOUT FORWARD AERO FAIRINGS)
DETAIL WEIGHTS

STATUS: 11/1/91

ITEM	SUSTAINER MODULE Qty	SUSTAINER MODULE WEIGHT - LB	BOOST MODULE Qty	BOOST MODULE WEIGHT - LB	REMARKS	%WG
PRE-LIFTOFF USAGE		-4		-4		
PNEUMATIC SYSTEM He		-4		-4		
He - MAIN ENGINES SEAL PURGE		-2.5		-2.5		
He - MAIN PROPULSION SYSTEM FUNCTIONS		-1.5		-1.5		
INERT WEIGHT AT LIFTOFF		39108		32892		

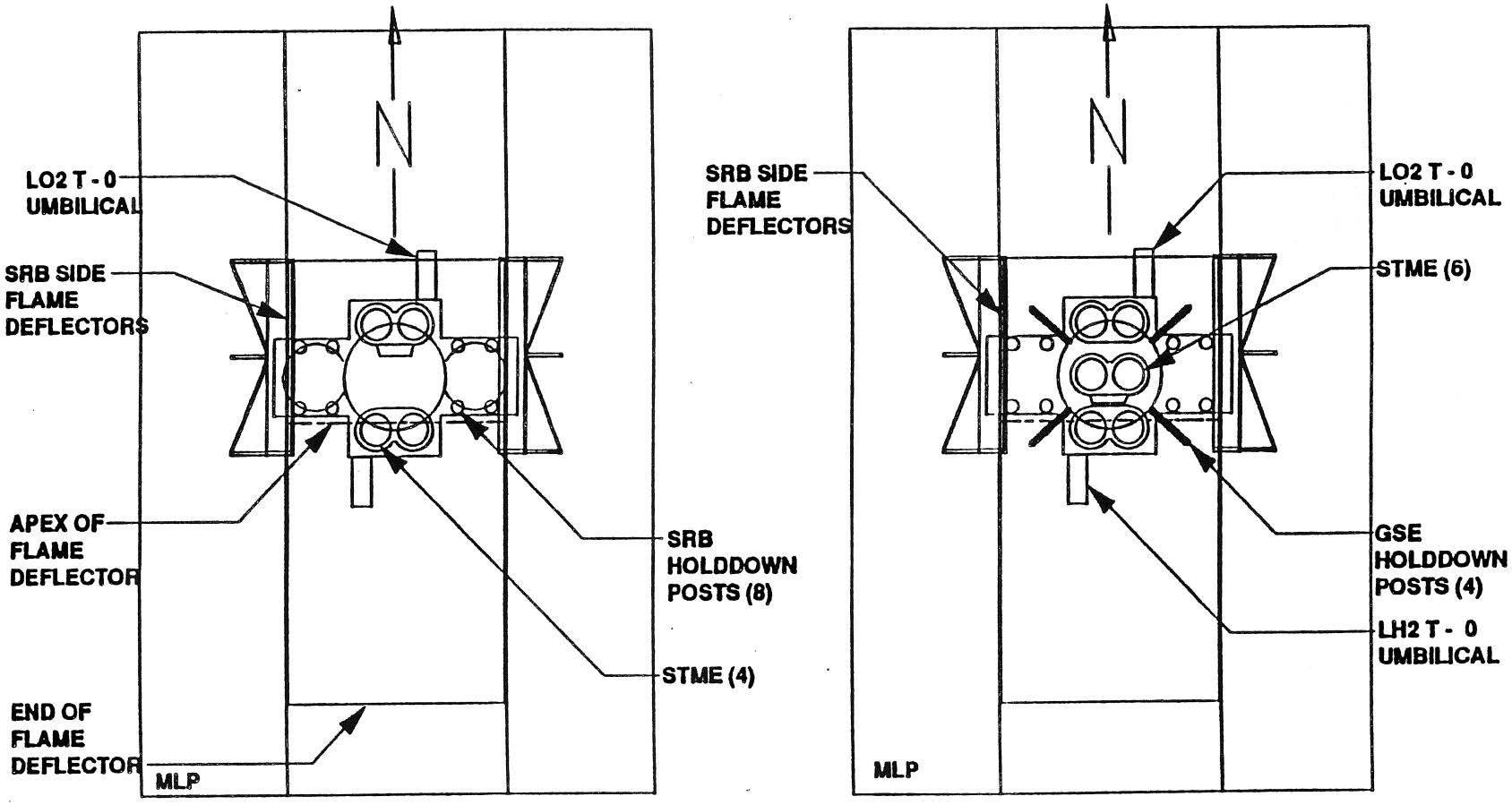
10.0 Operations

10.0 Operations

10.1 MLP INTERFACE

Hybrid Vehicle Concept is shown in Figures 10.1.4 & 10.1.6. These three views show that most of the flow will exit in the North flame trench however the nozzle center lines of the 2 southside STME's are located south of the apex and a greater portion of their exhaust plume will exit using the south flame trench.

Mobile Launch Platform
Modular Side-By-Side Option
(HYBRID)



BOEING

FIGURE 10.1-6

10.2 Maintainability Features

LRU access, placement

LRU Location: The LRUs consist of:

Item	#/Boattail	Weight	lb/box
Batteries	2	318	159
PDU	2	216	108
Rate Gyros	3	48	16
Remote Voter	6	227	38
MDU/RDU	2	27	14
Engine I/F	4	86	22
TVC Batteries	24	3540	148

Except for the TVC batteries the quantities are for the 4 engine ring. Quantities for the sustainer section are unknown. The TVC battery quantity appears to be for both the boost and sustainer sections.

The batteries and PDUs require a two person lift and can be lifted 2 ft off the floor per MIL-STD-1472. This requires these boxes be located close to the floor level and requires access hatches large enough to carry these boxes through. The other boxes can be located up to 5 feet from the floor. In general the objective is to locate the equipment in two equipment bays with access doors to the bays. The equipment would be located on the truss structure which provides a low vibration environment. The aft bulkhead of the module would provide the access platform for installation and removal. The truss structure, however, starts about 4 feet from the aft bulkhead which is a problem for installation for the 150 lb boxes. For this configuration the 150 lb batteris and 100 lb PDUs should be segmented into half batteries sized for a two person lift to the structure (<70 lbs) otherwise the boxes would have to be installed using a mechanical aid.

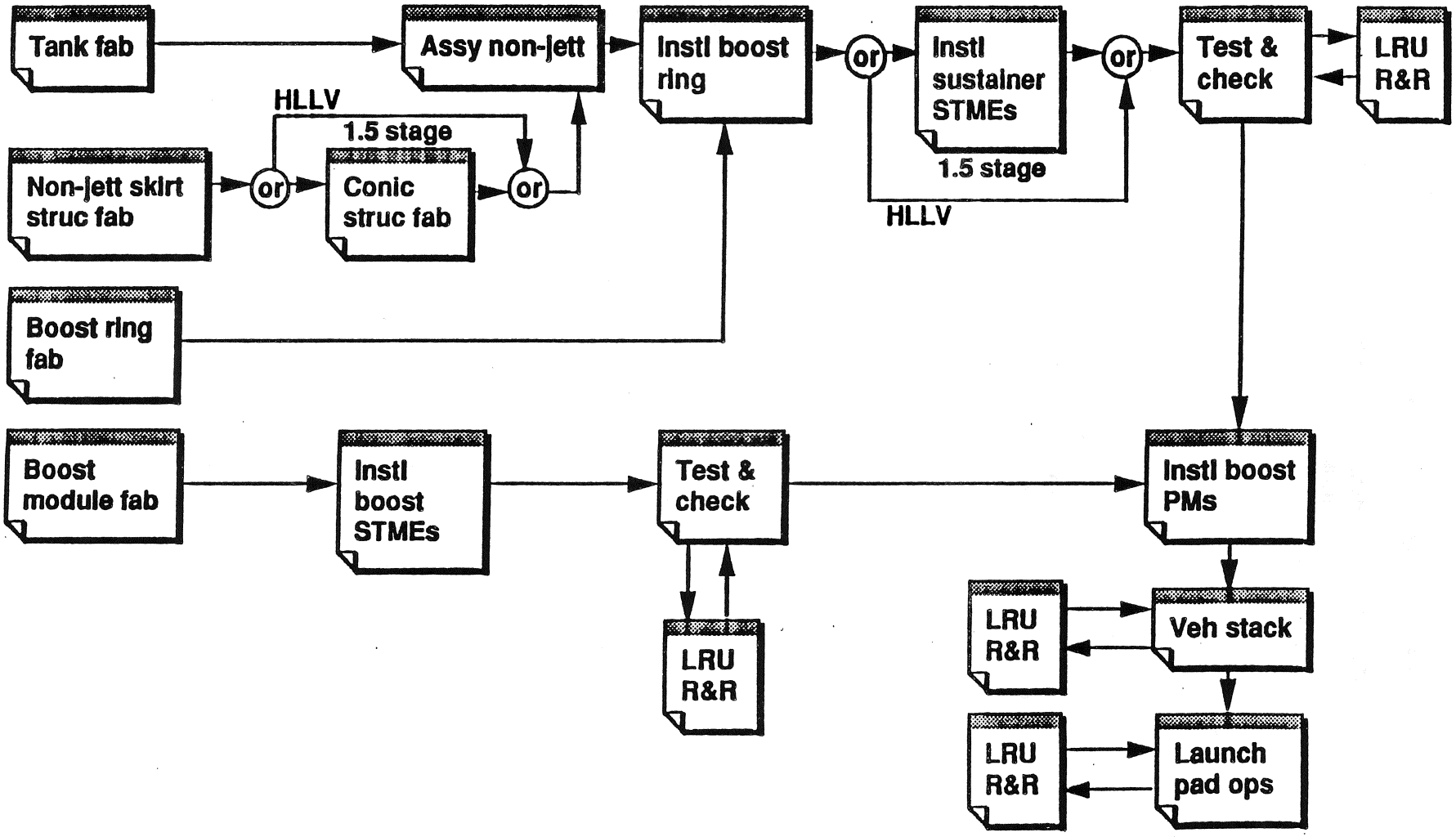
On the sustainer section, equipment is mounted inside the conic structure. Mounting inside protects the boxes from the thermal environment. Access is via a hatch in the side of the conic and the bottom of the conic requires a bulkhead to walk on.

Access to the engines is via the aft bulkhead and equipment access doors. The shell around the engines is sized to allow 360° access to the engine power head.

10.3 Operations Flows

Key Conclusions. The manufacturing plan for the hybrid vehicle is based upon the following assumptions: 1) Assembly of the non-jettisoned skirt and sustainer conic is done attached to the tank because the tank is an integral part of the structural support for the feedlines, and 2) the 2 engine boost module can be installed after STME installation on the sustainer section. The boost modules are parallel processed with the core including test and checkout. This provides a higher level of parallel processing than the reference vehicle and also allows test and checkout to be performed in a test and checkout cell tailored for best access to each of the modules being tested.

Hybrid Vehicle Manufacturing Plan



BOEING