Space Flight Operations Contract

Shuttle Orbiter/Mightysat Cargo Element Interfaces

ICD-A-21358

Prepared by Boeing North American, Inc.
Reusable Space Systems

Under Subcontract 1970483303, PDRD P1226

May 25, 1997

DRD-1.2.2.6

Contract NAS9-20000

United Space Alliance

STS
INTERFACE CONTROL DOCUMENT

THIS DOCUMENT SHALL NOT BE USED FOR MANUFACTURING, PROCUREMENT OF HARDWARE, INSPECTION OF MANUFACTURED ITEMS OR ASSEMBLY BUT SHALL GOVERN PERTINENT DESIGN DOCUMENTATION (FORM I & II DRAWINGS, ETC.). REVISIONS TO THIS DOCUMENT OR THE PROPERLY IDENTIFIED PERTINENT DESIGN DOCUMENTATION CAN ONLY BE MADE WITH APPROVAL OF THE RESPONSIBLE INTERFACE AUTHORITY.

/s/ Larry M. Lettow

/s/ Ronny H. Moore	/s/ Cgris Dunker
RONNY H. MOORE MANAGER ENGINEERING PRODUCTS OFFICE, MS3	CHRIS DUNKER MIGHTYSAT 1 MISSION MANAGER
THIS DOCUMENT IS ISSUED BY BOEING NORTH AMERICAN, INC.	BOEING NORTH AMERICAN, INC, IS NOT AFFILIATED WITH ROCKWELL INTERNATIONAL CORPORATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHNSON SPACE CENTER
HOUSTON, TEXAS, 77058

ROCKWELL INTERNATIONAL CORPORATION
SPACE SYSTEMS DIVISION
12214 LAKEWOOD BOULEVARD, DOWNEY, CALIFORNIA 90241

DRAWN BY /s/ Yunan Lees, BNA 20-Apr-97	TITLE
APPROVAL /s/ Rafael E. Gatica, BNA 9-May-97	
APPROVAL C. Mac Jones Jeri L Brown	SHUTTLE ORBITER / MIGHTYSAT 1 CARGO ELEMENT INTERFACES
C. Mac Jones Johnson Space Center Mail Code MS3 (281) 483-5086	

PRCBD NO.	SIZE	ICD NO.	REV	SHEET 1
	A	ICD-A-21358	A	0F

DOCUMENT CHANGE LOG

Document Baseline/Revision Date: 25-MAY-97 (Directive: A03448)

Chg Pkg Number	Change Date	Directive	IRN Number	Item(s) Affected
1	24-NOV-97	A03690	3	(F)3.0.1.3-1
2	07-JAN-98	A03720	4	(P)10.0.2
				(P)10.0.2.1
				(P)10.0.2.1.1
				(T)10.0.2.1.1-1
				(P)10.0.2.1.2
				(F)10.0.2.1.2-1
				(P)10.0.2.1.3
				(F)10.0.2.1.3-1
				(P)10.0.2.1.4
				(F)10.0.2.1.4-1
				(F)10.0.2.1.4-2
3	17-MAR-98	A03760	5	(F)3.0.1.3-1
				(F)6.0.1.2-1
4	15-APR-98	A03788	6	(P)2.2
				(P)4.0.1.2
4	26-APR-98	A03801	7	(P)1.2
				(P)3.0.1.3
				(F)3.0.1.3-1
				(P)3.0.2.1.1
				(F)3.0.2.1.1-2
				(P)3.0.4.2.1.1
				(P)4.0.1.2.1
				(P)4.0.4.2.6.1.1
				(F)6.0.1.2-1
				(T)6.0.1.2-1
				(T)7.0.3.1.1-1
4	14-OCT-98	A03909	8	(P)4.0.1.2.1
5	11-NOV-98	A03947	9	(P)3.0.2.1.3
				(F)3.0.2.1.3-1
				(P)6.0.3
				(P)6.0.4.3
				(F)6.0.4.3-1
				(T)6.0.4.3-1
				(T)10.0.2.1.1-1

SECTION CHANGE LOG

Document Section	Change Date	Change
1A	26-APR-98	IRN-7
2A	15-APR-98	IRN-6
3A	11-NOV-98	IRN-9
3B	25-MAY-97	REV A
4A	14-OCT-98	IRN-8
4B	25-MAY-97	REV A
5A	25-MAY-97	REV A
6A	11-NOV-98	IRN-9
6B	25-MAY-97	REV A
6C	25-MAY-97	REV A
6D	25-MAY-97	REV A
7A	26-APR-98	IRN-7
7B	25-MAY-97	REV A
8A	25-MAY-97	REV A
8B	25-MAY-97	REV A
8C	25-MAY-97	REV A
8D	25-MAY-97	REV A
8E	25-MAY-97	REV A
9A	25-MAY-97	REV A
9B	25-MAY-97	REV A
10A	11-NOV-98	IRN-9
10B	25-MAY-97	REV A
10C	25-MAY-97	REV A
10D	25-MAY-97	REV A
10E	25-MAY-97	REV A
10F	25-MAY-97	REV A
11A	25-MAY-97	REV A
11B	25-MAY-97	REV A
12A	25-MAY-97	REV A
13A	25-MAY-97	REV A
13B	25-MAY-97	REV A
14A	25-MAY-97	REV A
20A	25-MAY-97	REV A
A	25-MAY-97	REV A
B	25-MAY-97	REV A
C	25-MAY-97	REV A
E	25-MAY-97	REV A
I	25-MAY-97	REV A
X	25-MAY-97	REV A

1.0 SCOPE

1.1 PURPOSE

This Interface Control Document/Drawing (ICD) defines and controls the design of interfaces between the Shuttle Orbiter and the cargo element.

1.2 DEFINITION

For the purposes of this document the cargo element includes the cargo bay assembly. The cargo bay assembly includes two major elements which are (1) MightySat 1 satellite (2) Satelite de Aplicaciones/Cientifico - A (SAC-A satellite) The MightySat 1 satellite is integrated with Hitchhiker (HH) Ejection System, then mounted inside a lidless canister with a HH avionics box which is mounted on a HH adapter beam assembly on bay 6 port side. The SAC-A satellite is installed in an HH canister equipped with a HH ejection system and a HH motorized door assembly (HMDA) which is mounted on a forward side of HH adapter beam assembly on bay 2 port side. The collective name for this payload is called MightySat. The MightySat cargo element and Cargo Element or Payload are synonymous.

1.3 EFFECTIVITY

This document is applicable to all Shuttle Orbiter/Cargo Element configurations unless otherwise specified.

1.4 CONFIGURATION CONTROL

Configuration control will be initiated upon signature approval and maintained in accordance with NSTS 07700, Vol IV.

1.5 DOCUMENTATION

1.5.1 Payload Unique

As a payload unique ICD, this document defines and controls specific payload requirements as well as Shuttle Orbiter provisions. The payload specific requirements reside at the beginning of Sections 3.0 through 14.0.

Paragraph X.0.1 (i.e., 3.0.1, 8.0.1, etc.) is used to define the payload and to document its interface requirements in terms of selectable standard Orbiter capabilities and requirements in accordance with payload requirements as agreed to in the specific Payload Integration Plan (PIP).

Section X.0.2 (i.e., 3.0.2, 8.0.2, etc.) provides mission unique interface definitions in payload unique ICD’s.

Paragraph X.0.3 (i.e., 3.0.3, 8.0.3 etc.) documents these requirements which can be considered "standard" for the generic payload.

Paragraph X.0.4 (i.e., 3.0.4, 8.0.4, etc.) provides interface definition of special Orbiter accommodations not documented in the Shuttle/Orbiter Standard Interfaces.

Standard Shuttle Orbiter provisions as defined in Sections 3.0 through 14.0 are derived directly from the Shuttle Payload Interface Definition Document for Small Payload Accommodations, NSTS-21000-IDD-SML, which in turn is derived from the Shuttle Orbiter Standard Interfaces, ICD-2-19001, and are selectively dispositioned to reflect the requirements established in Paragraph X.0.1 and the specific Payload Integration Plan (PIP).

The following format shall be followed in establishing the payload specific ICD requirements:

- Applicable: Sections' Paragraph Text, Tables and Figures are shown in full, with associated subparagraphs.

- Not Applicable: Sections' Paragraph Text, Tables and Figures are deleted in their entirety except for paragraph's number and title which shall be shown as "Not Applicable". Subparagraphs will automatically be deleted when leading paragraph is "Not Applicable".

- Title Only: A lead-in paragraph is shown by title and number only. This condition allows disposition of the subparagraphs without carrying the lead-in paragraph (text, tables, and/or figures) when its content does not add to the Interface Control Definition.

- Exception: An exception is taken to the Shuttle Payload Interface Definition Document for Small Payload (IDD) paragraph. The exception paragraph shall use less than the total Orbiter capability identified in the IDD. Exceptions can currently only be written against the text of a paragraph. Any exception to tables and figures shall be included in the paragraph text.

1.5.2 Relationship to Payload Integration Plan (PIP)

The PIP represents the cargo element to STS agreement on the responsibilities and tasks which directly relate to the integration of the Cargo Element into the STS, and includes the definition of tasks which the STS considers optional services. The payload unique ICD provides specific design data and defines the engineering parameters applicable to the Orbiter/Cargo Element interfaces and optional services identified in the PIP. In the event of conflict between the payload unique ICD and one or both PIPs, the PIPs will take precedence. This ICD documents and controls applicable interfaces and optional services as identified in PIP NSTS-21358 (MightySat) and PIP NSTS-21372 (SAC-A) for an integrated payload configuration.

1.5.3 ICD Waivers; Deviations; and Exceedances

ICD agreements with payloads are based on NSTS allowed payload services and provisions are identified in this document. All Orbiter/STS design-to requirements for payloads are controlled at Level II. The unique payload ICD does not require NSTS Orbiter Project approval if it remains within the Orbiter vehicle interface design parameters. Limits of this ICD are established in a conservative manner to minimize individual payload and mixed cargo analyses. Any exceedance or deviation in payload capabilities or services shall be documented in the payload unique ICD's, Section 20, and evaluated to assure that the stated condition is controlled in a manner to guarantee acceptable conditions to eliminate any added risk to the vehicle or crew.

DEFINITIONS:

EXCEEDANCE: Documentation of a condition that does not comply with stated requirements but does not add any risk due to intended usage or configuration and can be shown acceptable without special analysis or controls.

DEVIATION: A non-compliance that requires additional analysis or control to eliminate risk and is acceptable when properly documented.

WAIVER: A condition that does not comply with the requirements of this ICD could add risk and requires special controls/analysis to assure adequate flight margins.

1.5.4 Avionics Control Drawing

Orbiter-to-Payload electrical interfaces shall be as specified in Section 13.0. Refer to Avionics Control Drawing VS72-270122 (schematic) for overall Orbiter-to-Payload proposed electrical wiring implementation.

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of this document to the extent specified herein. In the event of conflict between the documents referenced and the content of this document the contents of this document shall be considered a superseding requirement. Documents invoked herein shall be cross-referenced to the appropriate paragraphs, tables and/or figures of this ICD.

Federal

Military

MIL-B-5087B August 31, 1970	Bonding, Electrical and Lightning Protection for Aerospace Systems (Ref. Para. 10.7.4.2, 10.7.4.2.1, 10.7.4.2.3.5, and Fig 3.0.2.1.1-1, 3.0.2.1.1-2)
MIL-C-5541 Amendment 2 November 30, 1972	Chemical Conversion Coatings on Aluminum and Aluminum Alloys (Ref. Para. 10.7.4.2)
MIL-W-5088H July 20, 1979	Wiring Aerospace Vehicle (Ref. Para. 3.3.2.2.1, 3.0.2.1.2.1)

NASA (National Aeronautics and Space Administration)

ES3-76-1 July 1983	Orbiter Midsection/Payload Bay Thermal Math Model Description (Ref. Para. 6.1.2.1)
ES3-77-3 September 1983	"390 Node" Atmospheric Orbiter Mid-section/ Payload Bay Thermal Math Model Description (Ref. Para. 6.1.2.1)
JSC 08220 Date TBD	Space Shuttle Master Measurement List (Ref. Table 8.2.1.1-1)
JSC-19540 March 1984	Open Door Simplified Orbiter Thermal Simulator Description (Ref. Para. 6.1.2.1, 6.1.4.3)
JSC-19692 May 1984	Closed Door Simplified Orbiter Thermal Simulator Description (Ref. Para. 6.1.2.1)
NSTS-08060 Rev. D January 28, 1983	Space Shuttle System Pyrotechnic Specification (Ref. Para. 10.7.4.1.2.1.3)
NSTS 14046 Rev. B	Payload Verification Requirements

March 1989	(Ref. Para. 4.3.1)
NSTS 1700.7B December 1980	Safety Policy and Requirements for Payloads using the Space Transportation System (STS) (Ref. Para. 10.7.4.1.2.1.3, 11.1.1)
NSTS-18798 Rev. A April 1, 1989	Interpretations of NSTS Payload Safety Requirements (Ref. Para. 7.3.1.4)
SN-C-0005 (Current Issue)	National Space Transportation System Specification, Contamination Control Requirements (Ref. Para. 10.6.2.4, 10.6.2.1.1,)
SP-R-0022 Rev. A September 1974	Vacuum Stability Requirements of Polymeric Material for Spacecraft Applications, Specifications for (Ref. Para. 10.6.2.2)
40M38277 December 15, 1973	Connectors, Electrical, Circular Miniature High Density Environment Resisting, Specifications for (Ref. Para. 13.2.2)
40M38298 (Current Issue)	Specification, Connector, Electrical, Special Miniature Circular Environment Resisting 200RC (Ref. Para. 13.2.2)
40M39569 December 15, 1973	Connectors, Electrical Miniature Circular, Environment Resisting 200RC, Specification for (Ref. Para. 13.2.2)
Rockwell International MC414-0614 (Current Issue)	Specification, Connector RF, SMA Series Ref. Para. 13.2.2
ME414-0234 (Current Issue)	Specification, Connector, Receptacle, Electric Wall Mounting (Ref. Para. 13.2.2)
ME414-0235 (Current Issue)	Specification, Connector, Plug, Electric Straight (Ref. Para. 13.2.2)
ME414-0247 (Current Issue)	Specification, Connector, TNC Bulkhead Cable Jack (Ref. Para. 13.2.2)
ME414-0250 (Current Issue)	Specification, Connector, TNC Cable Plug (Ref. Para. 13.2.2)

ME414-0610 (Current Issue)	Specification, Cable Adapter, Connector Plug, Electric (Ref. Para. 13.2.2)
ME414-0611 (Current Issue)	Specification, Connector, Hermetic Jam Nut, Electric (Ref. Para. 13.2.2)
ME414-0612 (Current Issue)	Specification, Connector, Hermetic Flange Mount, Electric (Ref. Para. 13.2.2)
ME418-0031 (Current Issue)	Specification, Contact, Socket Crimp, Clip Retained (Ref. Para. 13.2.2)
ME418-0032 (Current Issue)	Specification, Contact, Pin Crimp, Clip Retained (Ref. Para. 13.2.2)
MP572-0328-0002 August 1979	Cable, Electrical, Special Purpose, TFE Insul., 2 Cond., Shielded and Jacketed (Ref. Table 8.2.1.3.1-1, 8.2.10.1.3-1, 8.2.5.1-1, 8.2.10.1.3-1)
SD73-SH-0226 Vol. 1E Book V Sept. 1985	Space Shuttle Program Thermodynamic Design Data Book Thermal Control System Constraints (Ref. Table 6.1.1.2.1-1)
IRD-21358 Current Issue	Installation Requirement Document (Ref. 3.0.2.1.2.1)

2.2 PAYLOAD UNIQUE/APPLICABLE DOCUMENTS

The following documents form a part of this ICD to the extent specified herein. In the event of conflict between this ICD and any other documents invoked herein, the contents of this ICD shall govern.

STS81-0641F July 1988	STS Dynamic Math Models (M6.0ZA) For Payload Load Analysis (Ref. Para. 4.0.1.1)
STS88-0609 April 1988	Liftoff Forcing Functions (LR2000 Series) For Payload Loads Analysis (Ref. Para. 4.0.1.1)
STS86-0020A February 1988	Landing Forcing Functions 7000 Series Data Base (Ref. Para. 4.0.1.1)
SAI-TM-794	Mightysat 1 Stress Analysis and Structural Model (Ref. Para. 4.0.1.2)
SAI-RPT-0140	Hitchhiker MightySat; SAC-A; AMTEC/AWCS RTM Report (Ref. Para. 6.0.1.1)

2.3 REFERENCE DOCUMENTS

NSTS 21358 (Date)	Payload Integration Plan, MightySat

	(Ref. Para. 1.5.1)
NSTS 21372 (Date)	Payload Integration Plan, SAC-A (Ref. Para. 1.5.1)
NSTS 07700, Vol IV (Current Issue)	Mission Integration Control Board Configuration Management Procedures (Appendix H) (Ref. Para. 1.4)
VS72-270122	Cargo Element Avionics Control Schematic (Ref. Para. 1.5.4)
STS89-0770 (Current Issue)	APC Generic Payload Allowable Weights (Ref. Para. 4.0.4.2.6.2)
STS89-390 (Current Issue)	ICAPC Generic Payload Allowable Weights (Ref. Para. 4.0.4.2.6.3)
ICD-A-21202	Shuttle Orbiter/GET-AWAY SPECIAL 13. (Ref. Fifure 3.0.1.3-1)

THIS PAGE INTENTIONALLY LEFT BLANK

3.0 PHYSICAL INTERFACES

3.0.1 Payload Definition

3.0.1.1 (Reserved)

3.0.1.2 (Reserved)

3.0.1.3 Sidewall-Mounted Payloads Physical Definition

The payload shall be mounted as follows: (1) MightySat 1 in bay 6 port side (2) SAC-A in bay 2 forward port side. Physical definition, thermal and dynamic envelope as well as mechanical interface definition shall be as shown in Figure 3.0.1.3-1.

3.0.1.4 (Reserved)

3.0.2 UNIQUE MISSION SPECIFIC REQUIREMENTS

3.0.2.1 PAYLOAD UNIQUE DEFINITION

3.0.2.1.1 Payload Mounting Provisions

The MightySat 1 canister, and Hitchhiker avionics box on a Light weight Avionics Plate (LAP) shall be mounted on a GSFC-supplied Hitchhiker adapter beam which shall be attached to the Orbiter. The SAC-A shall be mounted on a GSFC-supplied Hitchhiker adapter beam which shall be attached to the Orbiter. The mechanical interfaces for the GSFC-supplied Hitchhiker adapter beam to Orbiter are defined in Figure 3.0.2.1.1-1. The Hitchhiker adapter beam shall attach to the sill longeron, main and stub frames and shall utilize standard STS-GAS adapter beam mounting hardware. Table 3.0.2.1.1-1 identifies the adapter beam mounting hardware. The sub assembly installation of payload-to-payload and payload-to-GSFC HH adapter beam shall be defined in IRD-21358.

3.0.2.1.2 STS-to-Cargo Element Interfaces

All cargo element connectors shall consist of socket (female) contacts for interfacing with the cable connectors. The cargo element shall provide cable support, as required, such that there shall be no unsupported lengths of cables greater than 18 inches with adequate allowance for mating and demating of connectors. The payload cable departure points shall be defined in Figure 3.0.2.1.2-1. The payload shall supply harnesses from the unique interface panel(UIP) interface to the payload avionics box. The payload cable length from Mightysat 1 connectors J006, J007, and J008 to the UIP are 96.00 +3/-0, inches for Mightysat 1 element mounted in bay 6 port side.

3.0.2.1.2.1 Wire Harness Installation

Cargo element supplied wire harness shall be installed in accordance with MIL-W-5088 and IRD-21358. Wire harness installation and routing from the cargo element to the UIP interface panels shall be a STS function. The physical characteristics of the unique electrical interface in the cargo bay are defined in Figure 3.0.2.1.2.1-1. The payload shall provide cable support provisions such that the cables can be clamped within 6 inches of the connectors. The cable support provisions shall be either a No. 10 (0.1900)-32 UNF self- locking threaded receptacle or a tie strap retention device which will accommodates STS provided tie straps (Part No. ME127-0074-0001).

3.0.2.1.3 EVA Slidewire Tether Installation
Installation of EVA slidewire tether on SAC-A GAS beam is shown in Figure 3.0.2.1.3-1.

3.0.3 SMALL PAYLOAD UNIQUE INTERFACES NOT APPLICABLE

3.0.4 ORBITER-TO-PAYLOAD DEDICATED ACCOMMODATIONS

3.0.4.1 (Reserved)

3.0.4.2 LONGERON/ADAPTER MOUNTED PAYLOADS

3.0.4.2.1 (Reserved)

3.0.4.2.2 (Reserved)

3.0.4.2.3 Payload Connector Location and Cable Clamping
The Payload electrical interface location is defined to be at the payload avionics box. The UIP interfaces of connectors J103, J107, J108 are defined in Paragraph 3.0.2.1.2. The payload interface shall be on the outer perimeter of the payload with the connectors facing forward, aft or down in Bays 2 through 8 and forward or downward in Bay 13. Figure 3.0.4.2.3-1 defines the allowable zone. The payload shall provide cable support provisions such that the cables can be clamped within 6 inches of the connectors. The cable support provisions shall be either a No. 10 (0.1900)-32 UNF self- locking threaded receptacle or a tie strap retention device which will accommodate STS provided tie straps (Part No. ME127-0074-0001).

3.0.4.2.4 Payload-to-Orbiter Electrical Bond
Each payload shall provide a Payload-to-Orbiter electrical bond in accordance with Paragraph 3.0.4.2.4.1, 3.0.4.2.4.2 and/or 3.0.4.2.4.3 unless otherwise determined by payload unique requirements. All electrical bond interfaces shall conform to requirements specified in Paragraph 10.7.4.2.

3.0.4.2.4.1 FAULT-CURRENT BOND

3.0.4.2.4.1.1 Bus Connector Bond
The bus connector bond is defined to be the main Orbiter-to-Cargo power interface and shall be accomplished by a single wire in each power connector, as specified in Paragraph 10.7.4.2.2.1.1.

3.0.4.2.4.1.2 (Reserved)

3.0.4.2.4.2 RF BOND

3.0.4.2.4.2.1 Cargo-to-Orbiter RF Bond Strap
The Cargo-to-Orbiter RF bond strap shall be STS-provided and shall be connected between Orbiter structure and payload ground point provisions as defined in Figure 3.0.1.3-1. This bond shall meet bonding requirements specified in Paragraph 10.7.4.2.

3.0.4.2.4.3 (Reserved)

3.0.4.2.5 (Reserved)

3.0.4.2.6 Ground Handling at KSC

Sidewall mounted payloads shall be installed while the Orbiter is in a horizontal position.

TABLE 3.0.2.1.1-1 HH ADAPTER BEAM ASSEMBLIES

BAY	BEAM ASSEMBLY NUMBER	SHEAR PLATE LOCATION							
		NONE		FWD		AFT		FWD AND AFT	
		PORT	STBD	PORT	STBD	PORT	STBD	PORT	STBD
2	GE1507106	NA	NA	-1-32	NA	NA	NA	NA	NA
3	GE1507106	NA	NA	NA	NA	NA	NA	NA	NA
4	GE1507106	NA	NA	NA	NA	NA	NA	NA	NA
5	GE1507106	NA	NA	NA	NA	NA	NA	NA	NA
6	GE1507106	NA	NA	-7-32	NA	NA	NA	NA	NA
7	GE1507106	NA	NA	NA	NA	NA	NA	NA	NA
8	GE1507106	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1. The 5 cubic foot canister shall require use of shear pins and the associated load bearing adapter plates.

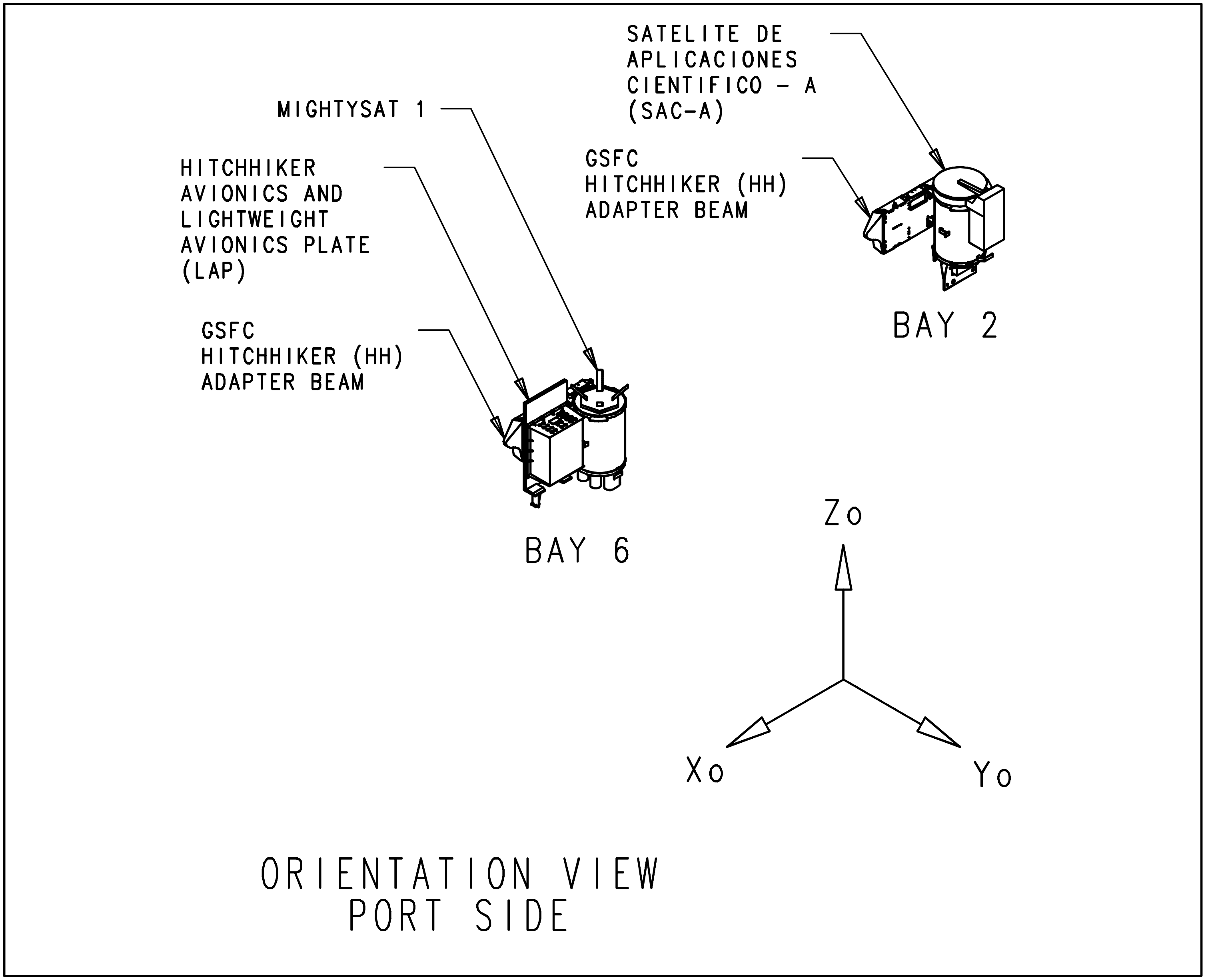


FIGURE 3.0.1.3-1 PAYLOAD PHYSICAL DEFINITION AND THERMAL AND DYNAMIC ENVELOPE
(SHEET 1 OF 4)

FIGURE 3.0.1.3-1 PAYLOAD PHYSICAL DEFINITION AND THERMAL AND DYNAMIC ENVELOPE
(SAC-1)
(SHEET 2 OF 4)

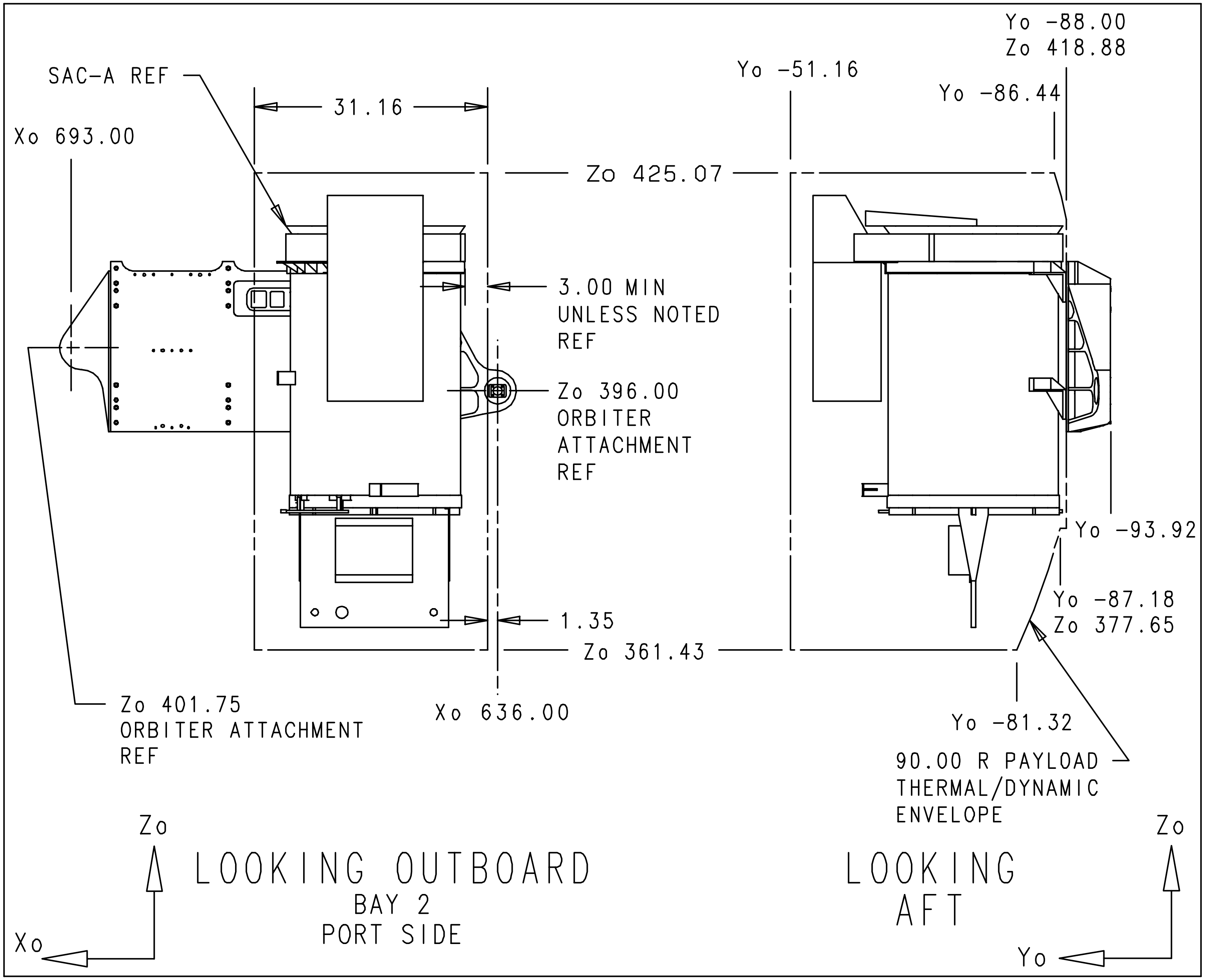
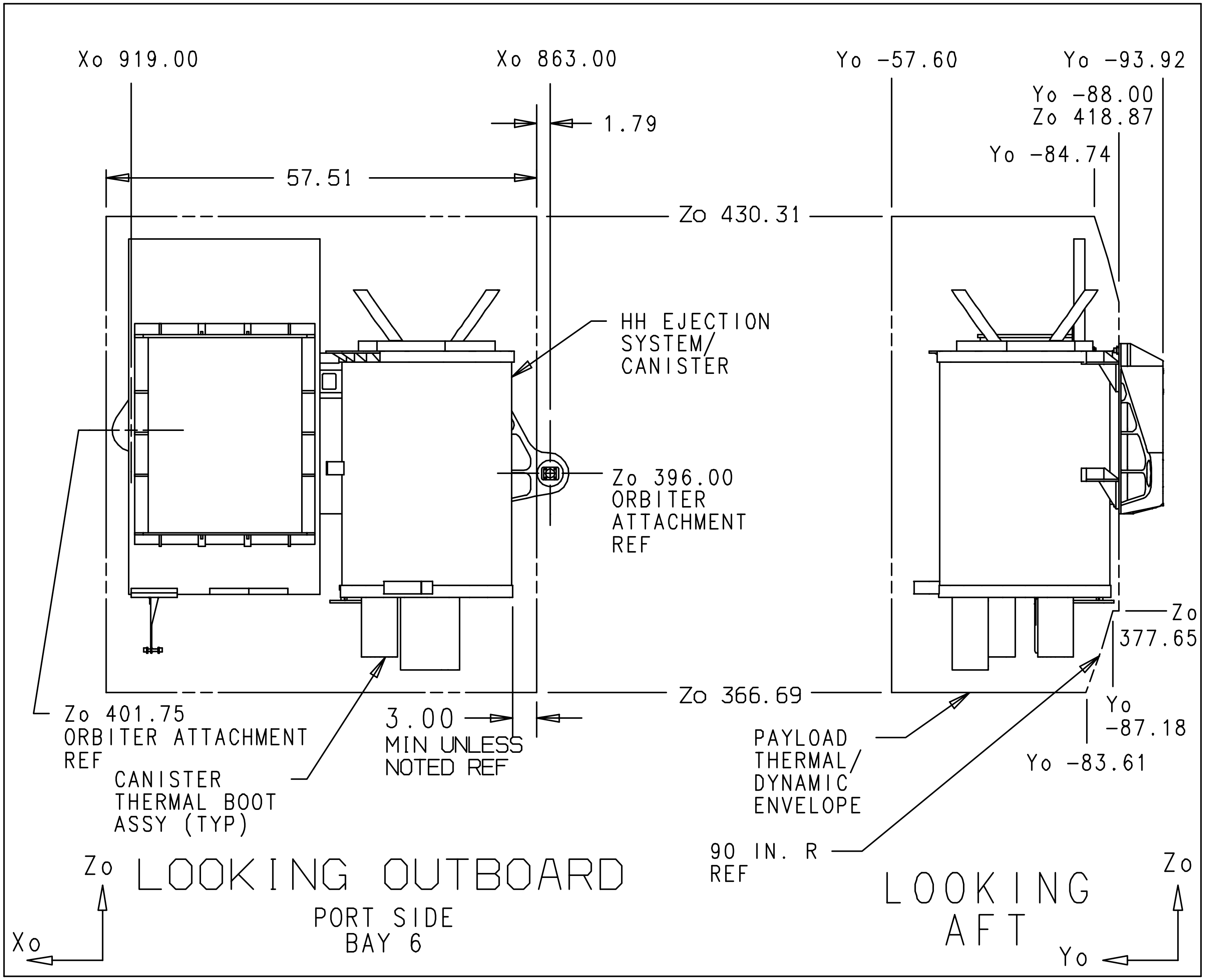


FIGURE 3.0.1.3-1 PAYLOAD PHYSICAL DEFINITION AND THERMAL AND DYNAMIC ENVELOPE
(MIGHTYSAT 1)
(SHEET 3 OF 4)



NOTES:

1. FOR ALL PORT SIDE CONFIGURATIONS: MPM'S MUST BE DEPLOYED PRIOR TO THE PAYLOAD'S EJECTION FROM ITS CANISTER

FIGURE 3.0.1.3-1 PAYLOAD PHYSICAL DEFINITION AND THERMAL AND DYNAMIC ENVELOPE
(SHEET 4 OF 4)

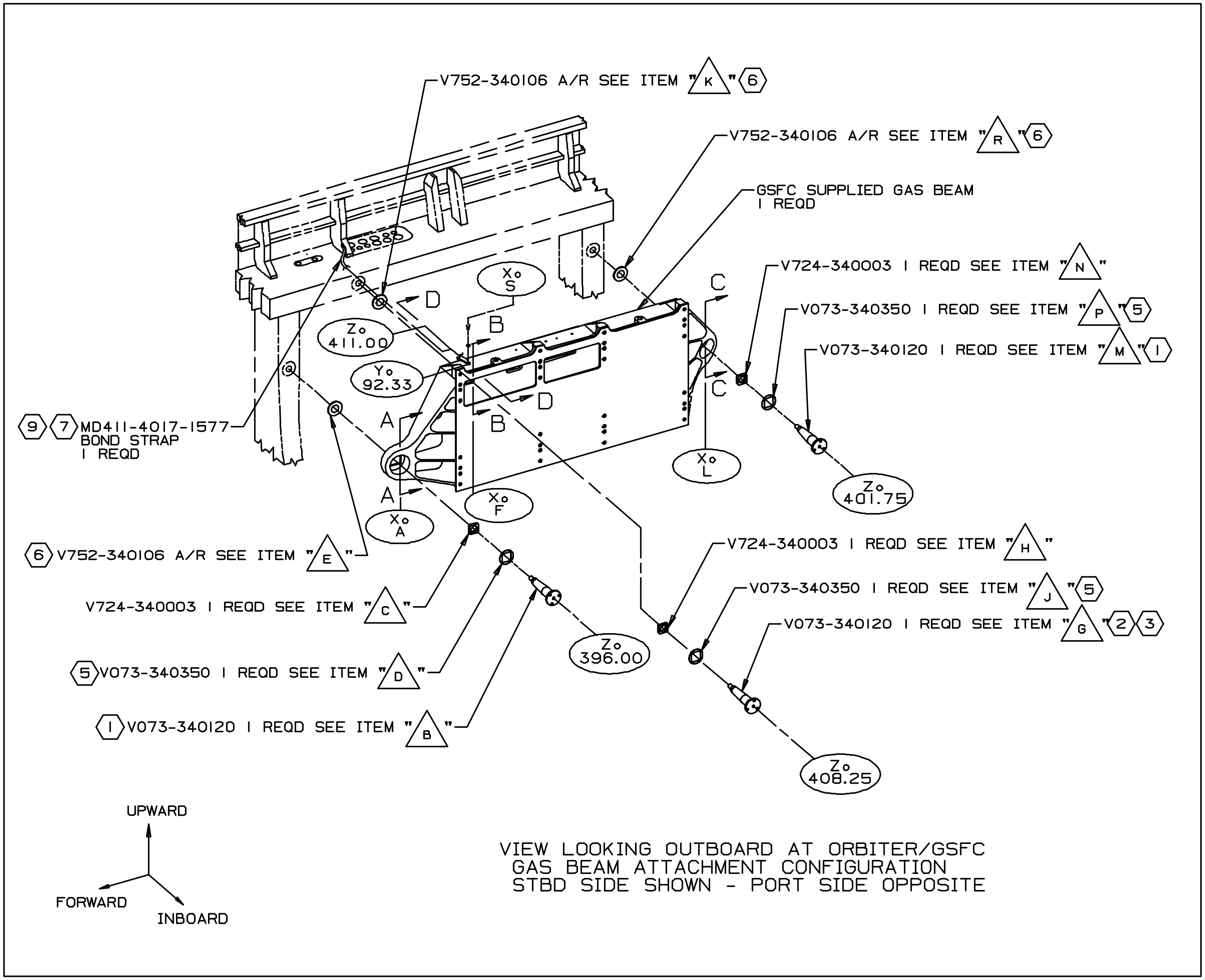


FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS
(SHEET 1 OF 7)

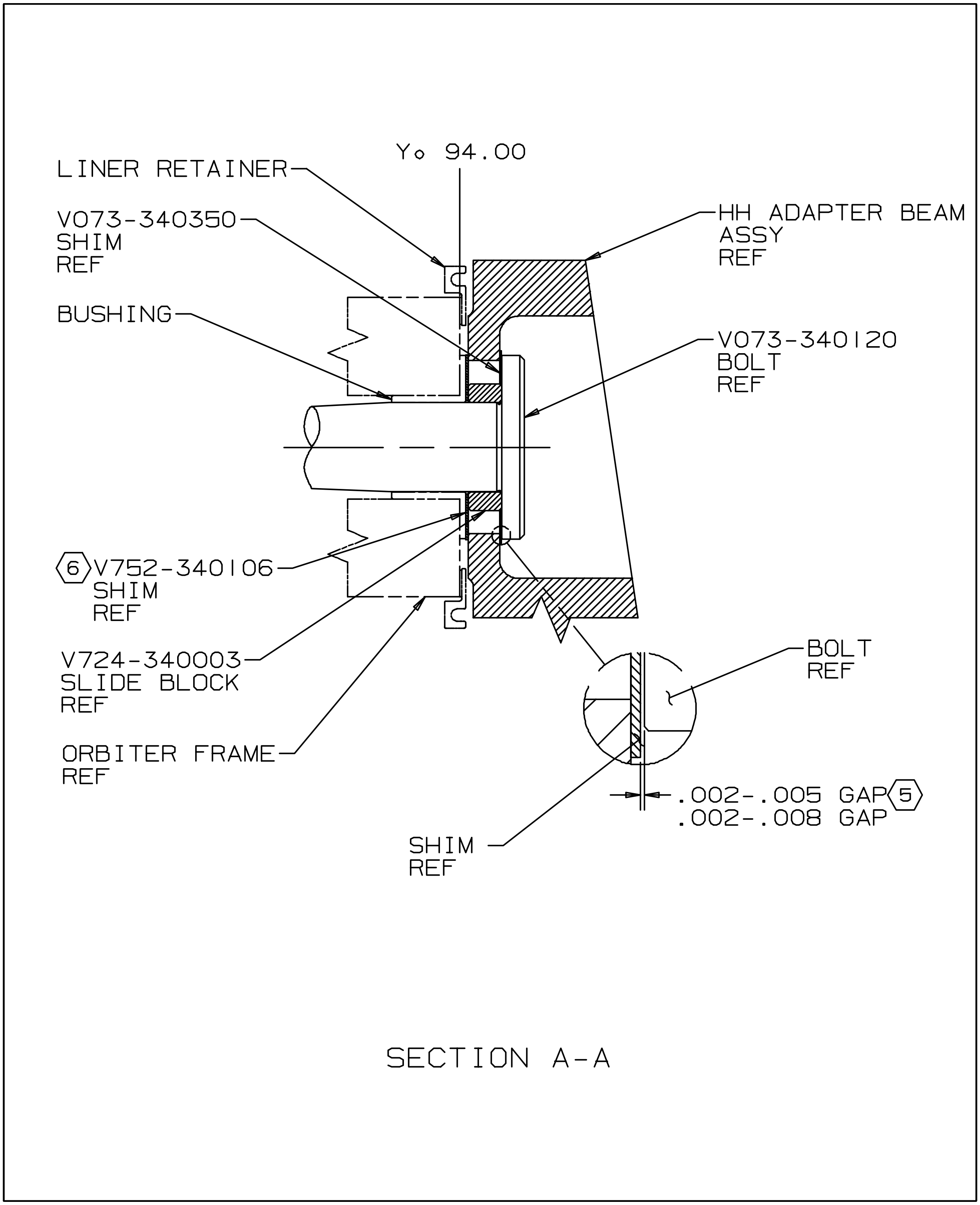


FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS
(SHEET 2 OF 7)

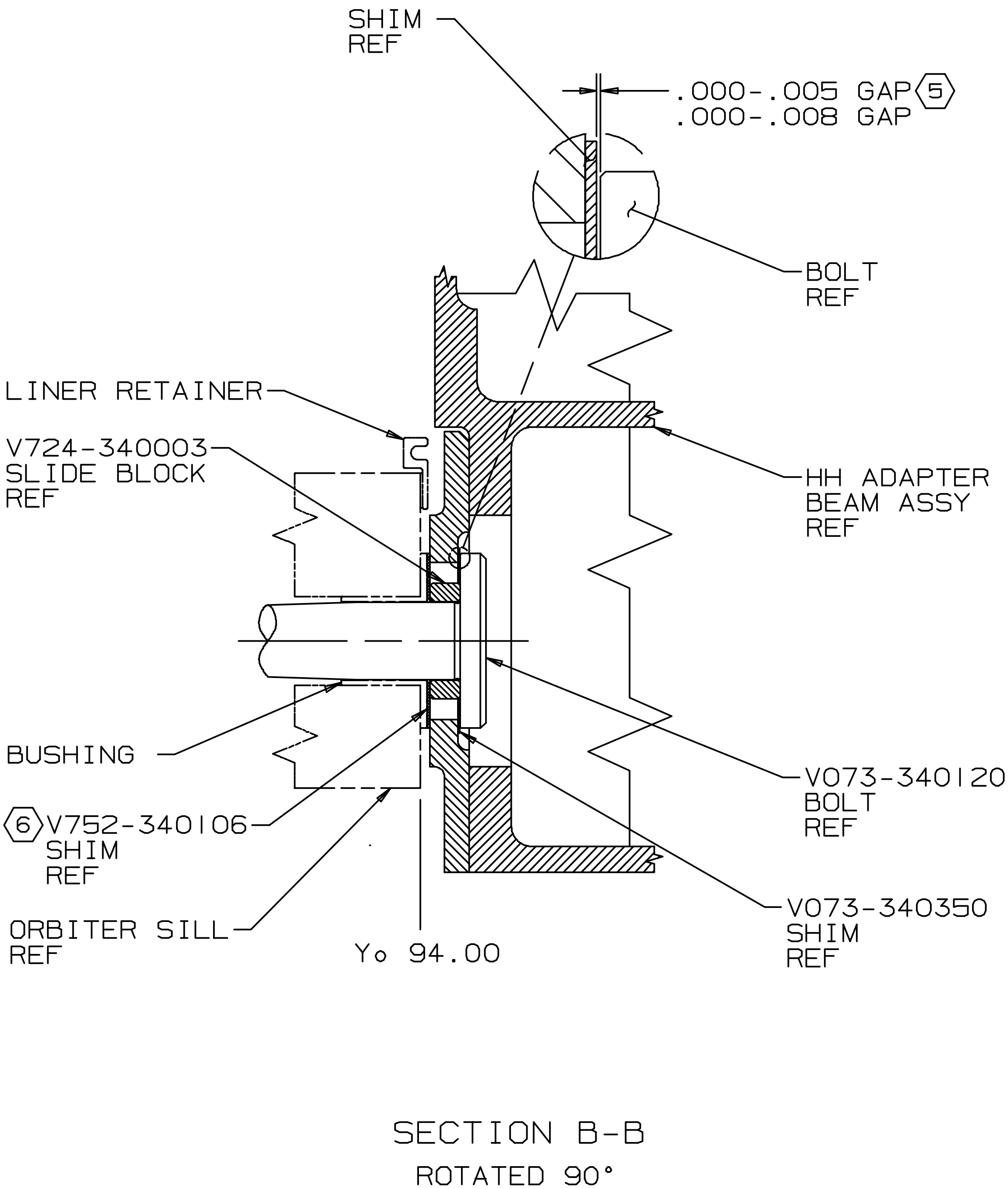


FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS
(SHEET 3 OF 7)

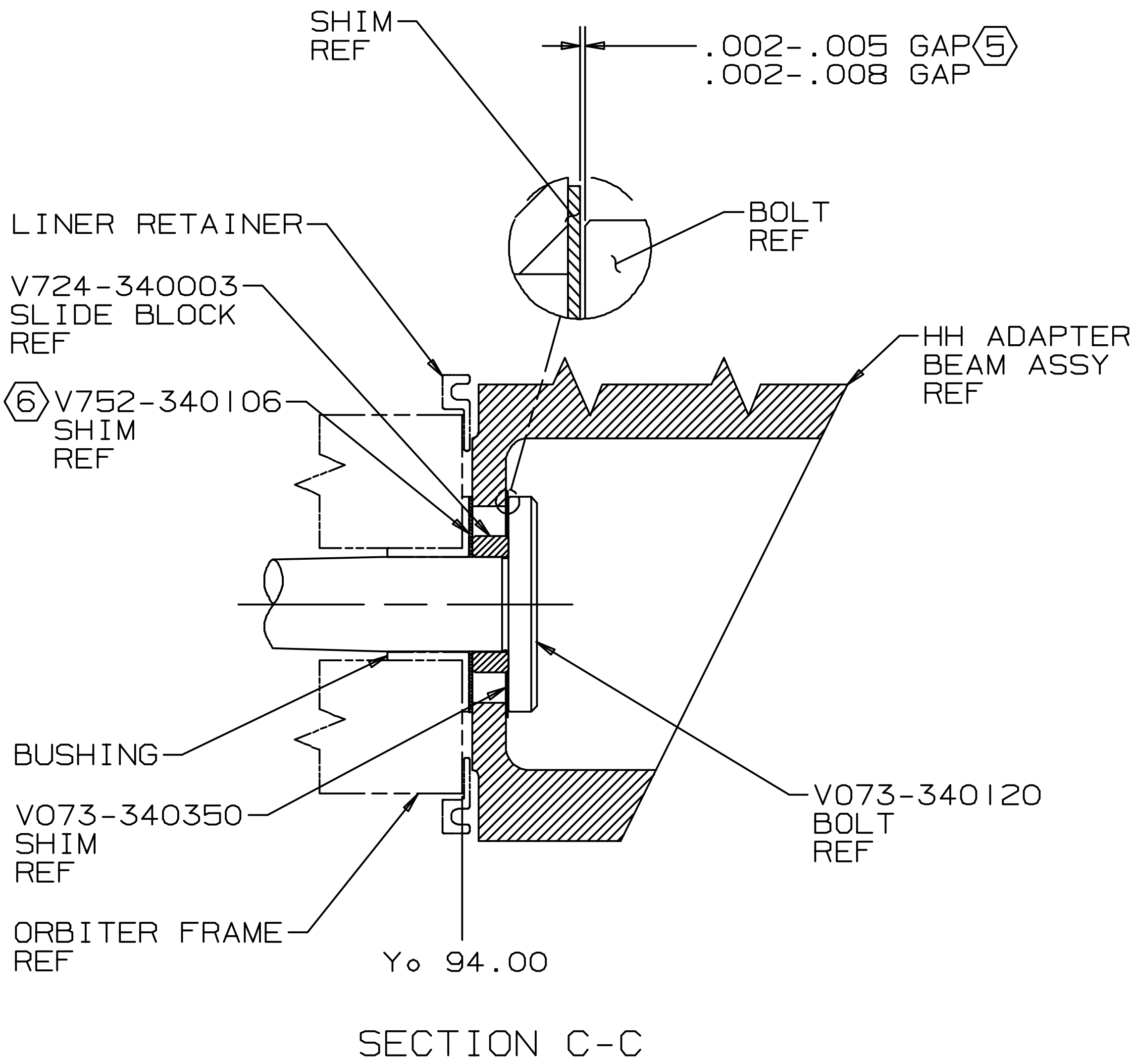


FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS
(SHEET 4 OF 7)

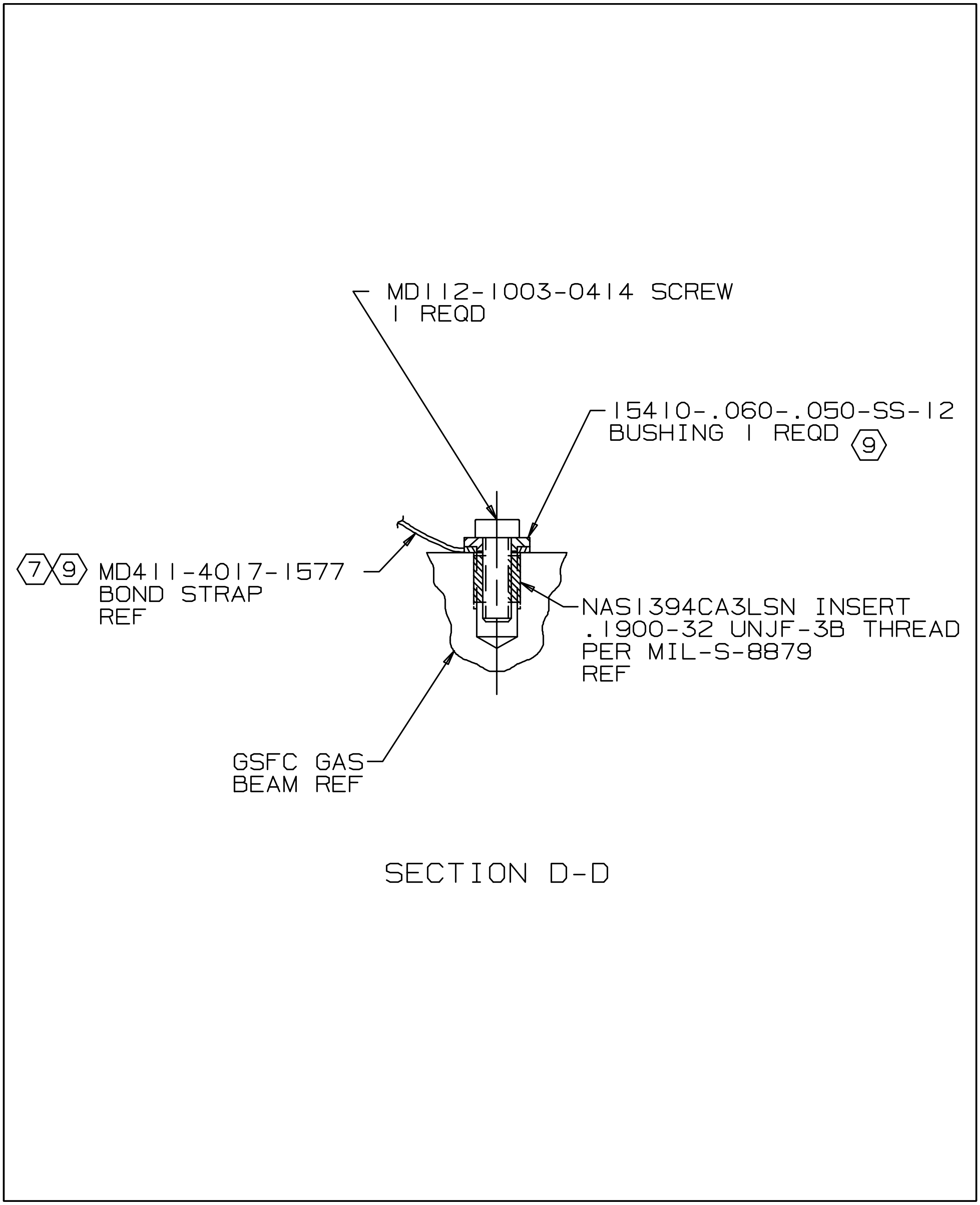


FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS
(SHEET 5 OF 7)

GAS BEAM ASSEMBLY INSTALLATION MATRIX

FWD FRAME HOLE					
BAY	Xo A	BOLT V073-340120 △B	SLIDE BLOCK V724-340003 △C	SHIM V073-340350 △D	SHIM V752-340106 △E
2	636.00	-012	-001	-001	-005
3	693.00	-012	-001	-001	-005
4	750.00	-012	-001	-001	-005
5	807.00	-011	-002	-001	-003
6	863.00	-011	-002	-001	-003
7	919.00	-012	-001	-001	-005
8	979.50	-012	-001	-001	-005

SILL LONGN HOLE					
BAY	Xo F	BOLT V073-340120 △G	SLIDE BLOCK V724-340003 △H	SHIM V073-340350 △J	SHIM V752-340106 △K
2	649.00	-016	-003	-005	-006
3	715.00	-016	-003	-005	-006
4	776.90	-017	-004	-011	-004
5	833.00	-017	-004	-011	-004
6	892.50	-017	-005	-012	-004
7	951.00	-013	-006	-013	-008
8	1011.40	-013	-006	-013	-008

AFT FRAME HOLE						BOND JUMPER	
BAY	Xo L	BOLT V073-340120 △M	SLIDE BLOCK V724-340003 △N	SHIM V073-340350 △P	SHIM V752-340106 △R	BEAM Xo S	
2	693.00	-019	-007	-007	-007	649.00	
3	750.00	-019	-007	-007	-007	715.00	
4	807.00	-019	-007	-007	-007	772.00	
5	863.00	-012	-001	-001	-005	829.00	
6	919.00	-011	-002	-001	-003	876.00	
7	979.50	-011	-002	-001	-003	948.65	
8	1040.00	-012	-001	-001	-005	992.50	

FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS
(SHEET 6 OF 7)

NOTES:

1. TORQUE FROM 300-425 IN-LBS PER MA0101-301.

2. TORQUE FROM 525-840 IN-LBS PER MA0101-301 IN BAYS 2-6 ONLY.

3. TORQUE FROM 1000-1725 IN-LBS PER MA0101-301 IN BAYS 7 & 8 ONLY.

4. TORQUE ALL BOLTS TO CLASS 1 PER MA0101-301 UNLESS OTHERWISE SPECIFIED.

5. PEEL SHIM FOR CLEARANCE AS SHOWN BETWEEN BOLT HEAD AND SHIM. GAP REQUIREMENTS AROUND THE PERIMETER OF THE SILL & MAIN FRAME ATTACH POINTS SHALL BE .002 TO .005 IN AT LEAST ONE LOCATION AND .002 TO .008 IN ALL OTHER ACCESSIBLE LOCATIONS. GAP REQUIREMENT AROUND THE PERIMETER OF THE LONGERON SILL ATTACH POINT SHALL BE .000 TO .005 IN AT LEAST ONE LOCATION AND .000 TO .008 IN ALL OTHER ACCESSIBLE LOCATION.

6. SHIM AS REQUIRED TO CLEAR PAYLOAD BAY LINER RETAINERS.

7. ELECTRICAL BOND AND TEST PER ROCKWELL SPECIFICATION MA0113-306, CLASS R, TYPE I. MAXIMUM RESISTANCE NOT TO EXCEED 2.5 MILLI-OHMS (REF: MIL-B-5087B).

8. ALL HARDWARE SSP-SUPPLIED EXCEPT THE GODDARD GAS BEAM AND PAYLOAD.

9. V073-340296-002 BOND JUMPER AND MD153-0018-0003 WASHER ARE INTERCHANGEABLE WITH MD411-4017-1577 BOND STRAP AND 15410-.060-.050-SS-12 BUSHING.

FIGURE 3.0.2.1.1-1 SHUTTLE ORBITER/HH ADAPTER BEAM MOUNTING PROVISIONS (SHEET 7 OF 7)

FIGURE 3.0.2.1.2-1 WIRE HARNESS LAST POINT OF ATTACHMENT AND HARNESS LENGTH
(Mightysat 1)
(SHEET 1 OF 2)

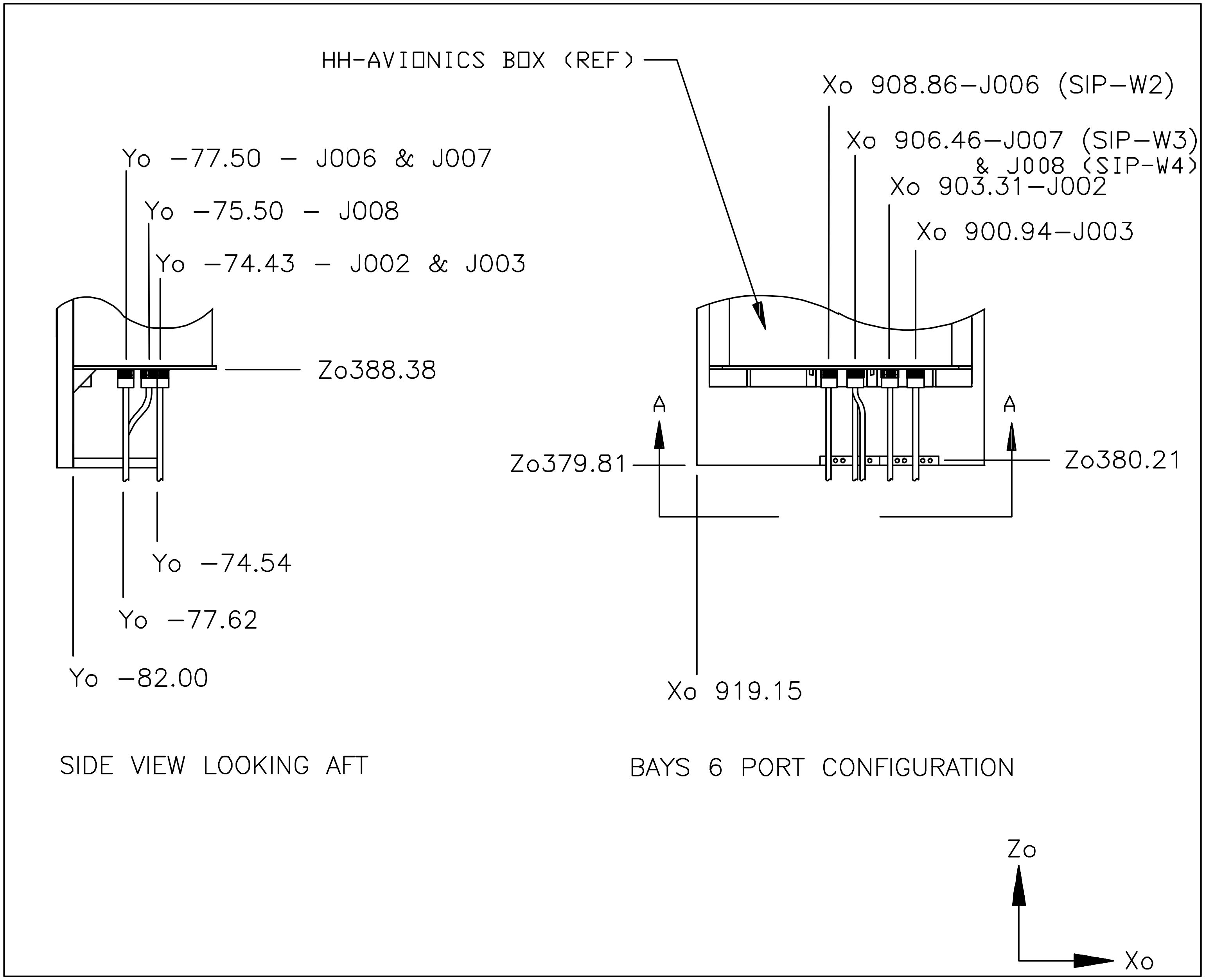
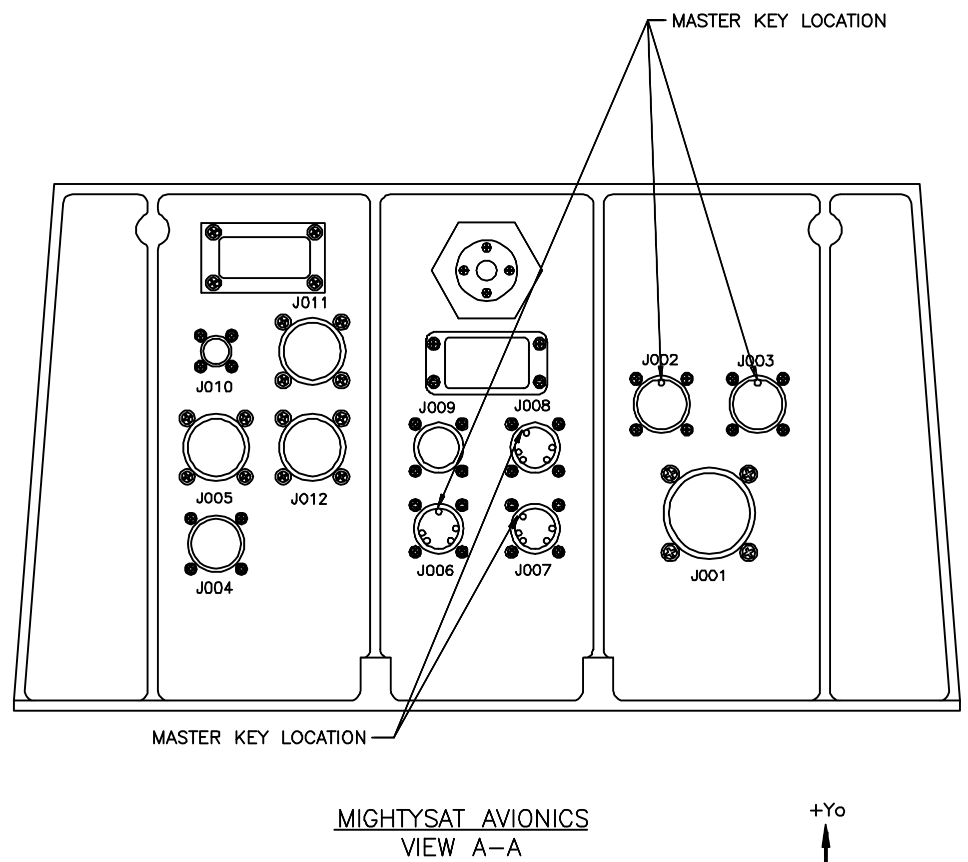


FIGURE 3.0.2.1.2-1 WIRE HARNESS LAST POINT OF ATTACHMENT AND HARNESS LENGTH
(SHEET 2 OF 2)



NOTES:
1. "o" DESIGNATES MASTER KEYWAY LOCATIONS.
2. ALIGN MATING CONNECTORS WITH MASTER KEYWAY LOCATIONS AND ROTATE CONNECTOR COUPLING NUT CLOCKWISE(CW).

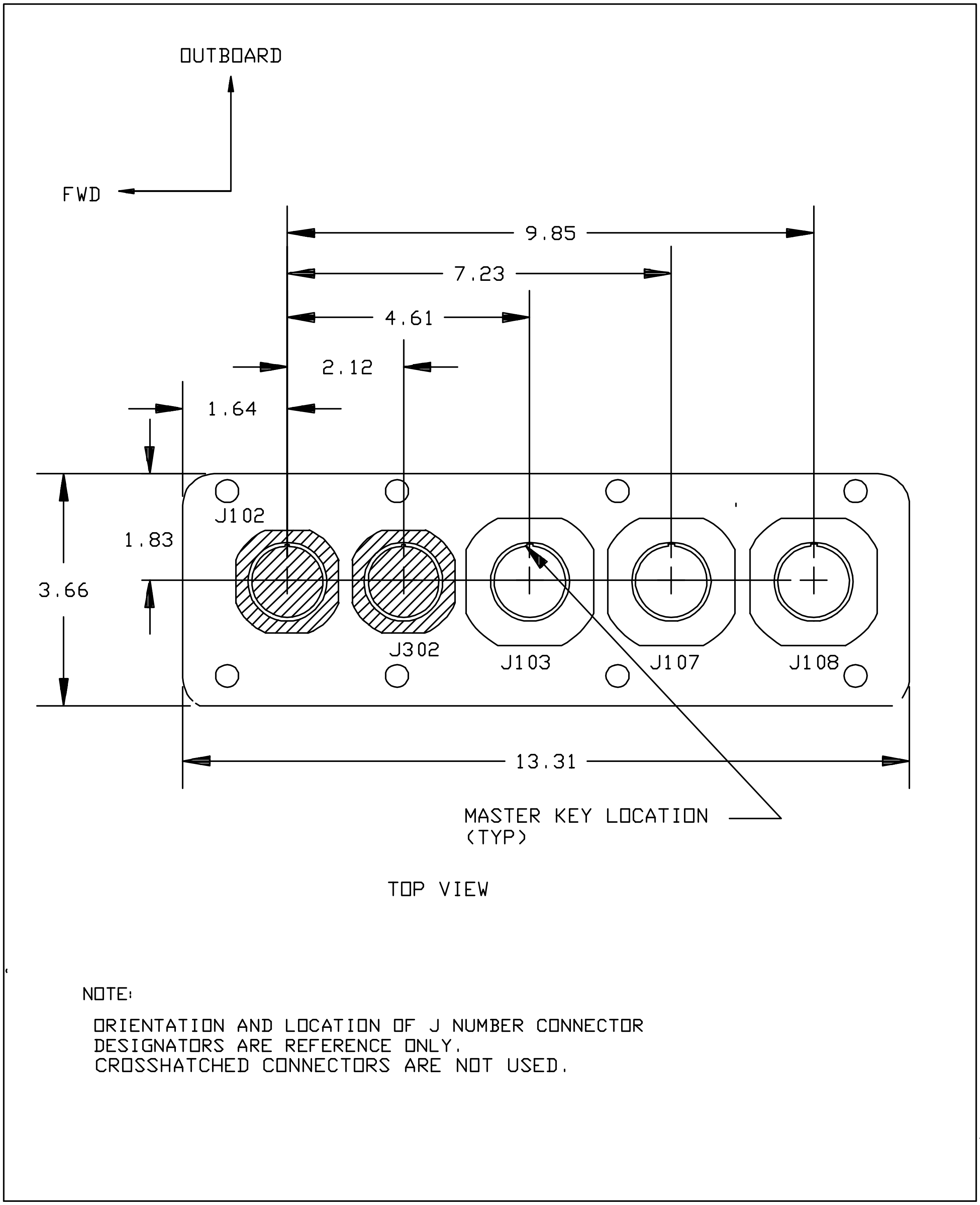


FIGURE 3.0.2.1.2.1-1 UNIQUE SMCH-IP ELECTRICAL INTERFACES

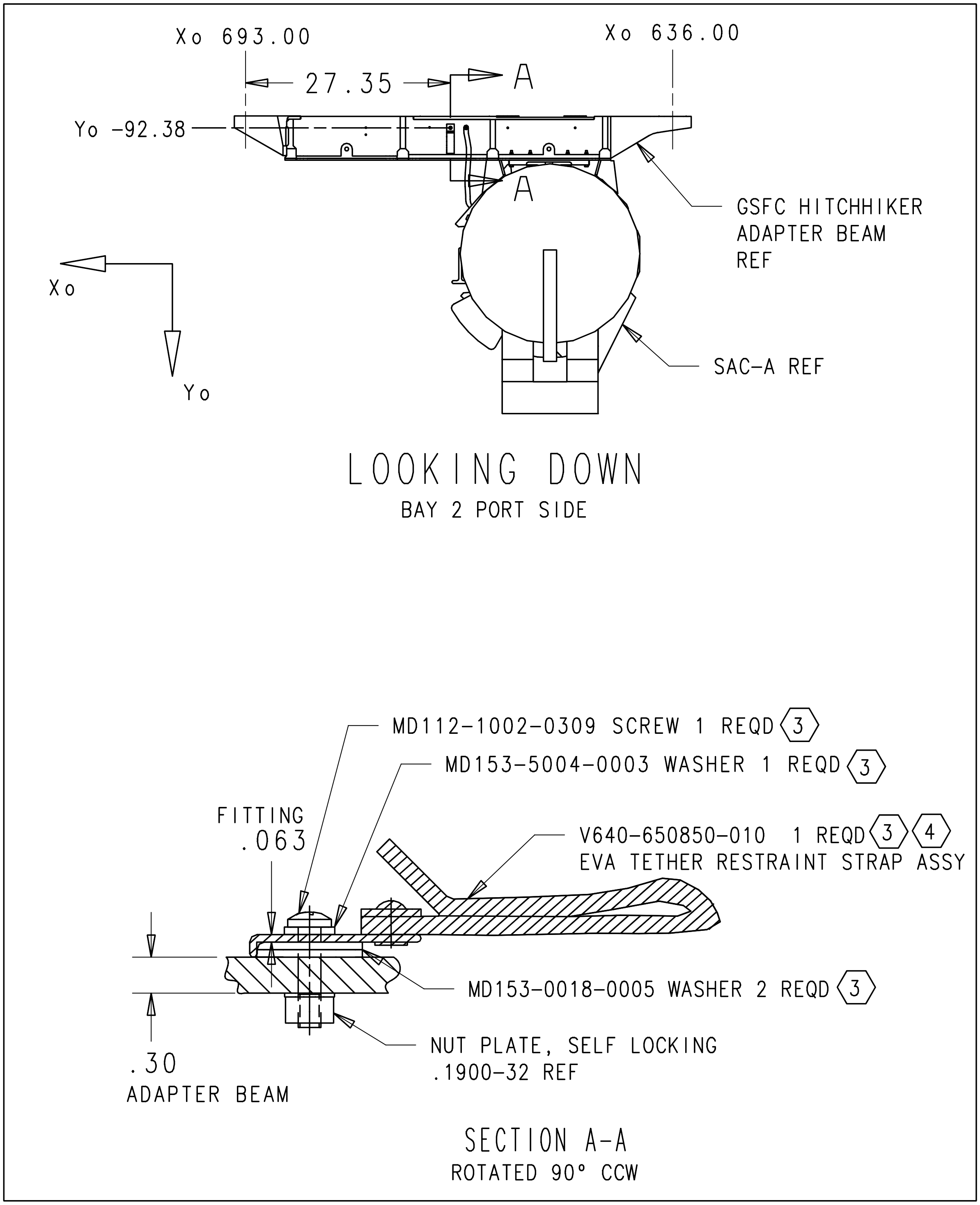


FIGURE 3.0.2.1.3-1 EVA SLIDEWIRE TETHER INSTALLATION
(SHEET 1 OF 2)

NOTES:

1. ALL HARDWARE SUPPLIED BY PAYLOAD CONTRACTOR UNLESS OTHERWISE SPECIFIED.

2. INSTALL THREADED FASTENERS PER MA0101-301 AND TORQUE VALUE 20-30 IN-LBS.

3. STS HARDWARE.

4. EVA TETHER RESTRAINT STRAP ASSEMBLY INSTALLATION REQUIREMENT IS A MISSION SPECIFIC APPLICATION ONLY AND IT IS NOT PART OF PAYLOAD APPLICATION.

FIGURE 3.0.2.1.3-1 EVA SLIDEWIRE TETHER INSTALLATION
(SHEET 2 OF 2)

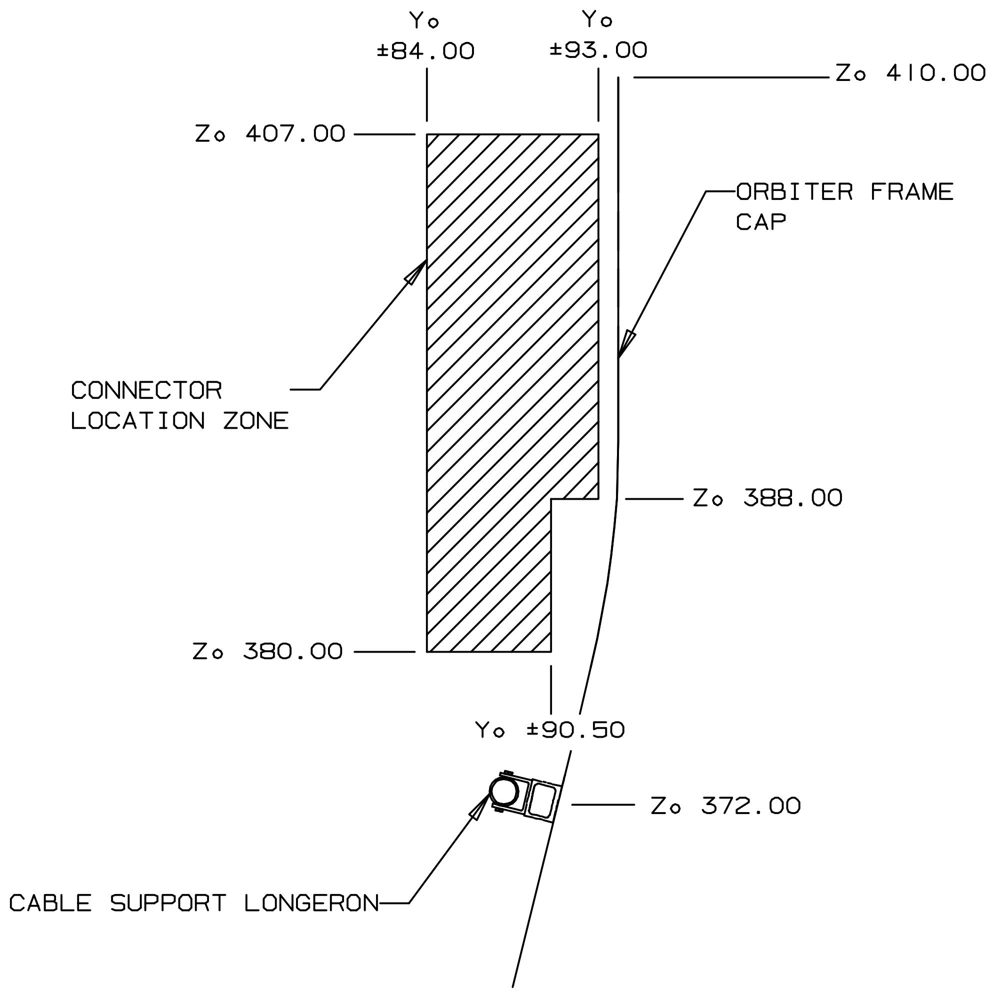


FIGURE 3.0.4.2.3-1 PAYLOAD CONNECTOR LOCATION AND CABLE CLAMPING

THIS PAGE INTENTIONALLY LEFT BLANK

3.1 GEOMETRIC RELATIONSHIPS

3.1.1 Coordinate Systems

3.1.1.1 Orbiter

The Orbiter coordinate system shall be in conformance with Figure 3.1.1.1-1.

3.1.1.2 (Reserved)

3.1.1.3 (Reserved)

3.1.1.4 (Reserved)

3.1.1.5 (Reserved)

3.1.1.6 (DELETED)

3.1.2 (Reserved)

3.1.3 Visual Interfaces

3.1.3.1 Lateral Field of View

The Orbiter shall provide the capability of exposing the entire length and full width of the cargo bay as defined in Figure 3.1.3.1-1. With the cargo bay doors and radiators open, the Orbiter shall provide an unobstructed 180-degree lateral field of view for any point along the line Yo=0, Zo=429.5 between Xo=582 and Xo=1302 (as shown in Figure 3.1.3.1-1) without such mechanisms as the docking module, manipulator arm, rendezvous sensor, payload retention guides, the TV/light, bracket and EDO pallet installed.

3.1.3.2 Cargo Bay Lighting

The Orbiter shall provide lighting within the cargo bay to support Orbiter/payload operations both internal and external to the cargo bay, including the modes of payload operations that are supported by the Remote Manipulator System (RMS). The cargo bay lighting shall consist of sources of illumination within the cargo bay, nominally located as shown in Figure 3.1.3.2-1.

3.1.3.3 Television Viewing

The Orbiter shall provide closed circuit television viewing. Up to four cameras shall be mounted on the forward and aft cargo bay bulkheads (2 each) in positions identified in Figure 3.1.3.2-1, and two cameras (operated one at a time) can be installed on the RMS. Additionally, one camera may be installed along the keel on a given flight. The cameras require a space 22 inches in length and, when installed, can protrude into the cargo dynamic envelope. The view of the aft bulkhead cameras is restricted when EDO pallet is utilized, however.

Up to two cameras can be displayed in the Orbiter crew compartment (up to four if split screen). One camera (two if split screen) can be recorded for subsequent play back to the ground, and one camera (two if split screen) can be transmitted to the ground in real time (when not playing back recorded data to the ground).

3.2 INTERFACE LOCATION AND DIMENSIONING

3.2.1 (Reserved)

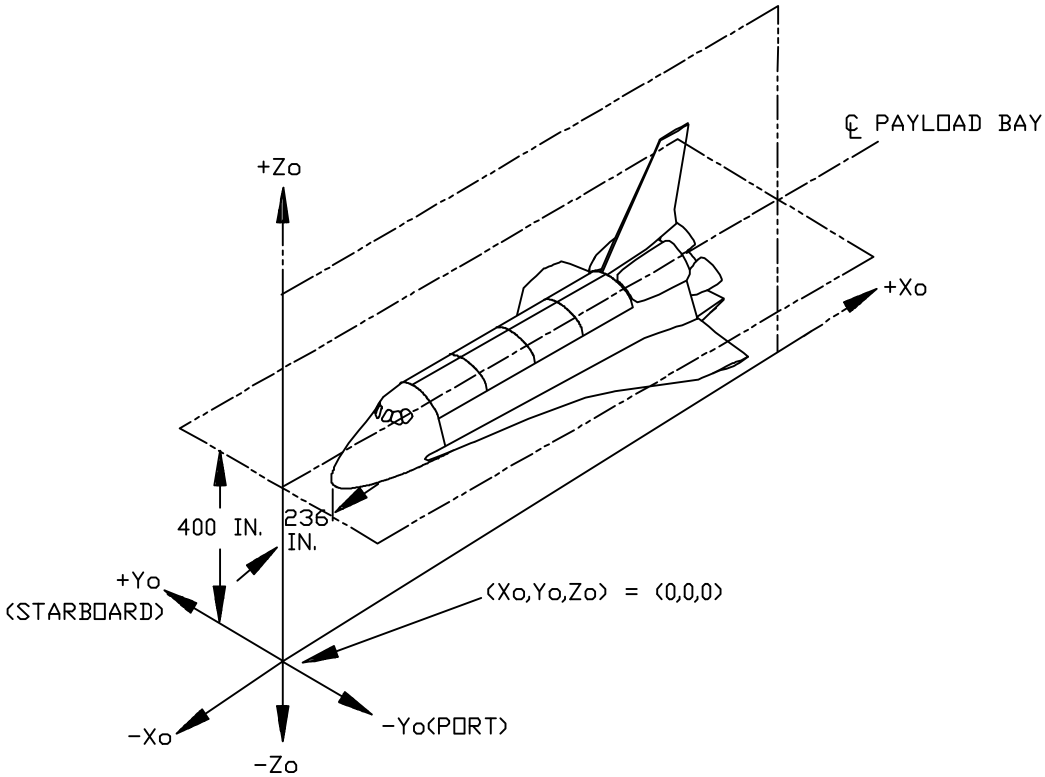
3.2.2 Dimensions and Tolerances

Unless otherwise specified, all linear dimensions are in inches, all angular dimensions are in degrees, and the tolerances for these are as follows:

Decimal:	X.X =	± 0.1
	X.XX =	± 0.03
	X.XXX =	± 0.010
Fractions:		± 1/16
Angles:		± 0°30′

3.3 PAYLOAD BAY NOT APPLICABLE

3.4 (Reserved)



ORIGIN:	IN THE ORBITER PLANE OF SYMMETRY, 400 INCHES BELOW THE CENTERLINE OF THE PAYLOAD BAY AND AT ORBITER X STATION = 0.
ORIENTATION:	THE Xo AXIS IS THE VEHICLE PLANE OF SYMMETRY, PARALLEL TO AND 400 INCHES BELOW THE PAYLOAD BAY CENTERLINE. POSITIVE SENSE IS FROM THE NOSE OF THE VEHICLE TOWARD THE TAIL. THE Zo AXIS IS IN THE VEHICLE PLANE OF SYMMETRY, PERPENDICULAR TO THE Xo AXIS, AND POSITIVE UPWARD IN THE LANDING ATTITUDE. THE Yo AXIS COMPLETES A RIGHT-HANDED SYSTEM.
CHARACTERISTICS:	RIGHT-HANDED CARTESIAN COORDINATE SYSTEM. THE STANDARD COORDINATE DESIGNATION IS o (E.G., Xo, Yo, Zo).

FIGURE 3.1.1.1-1 ORBITER COORDINATE SYSTEM

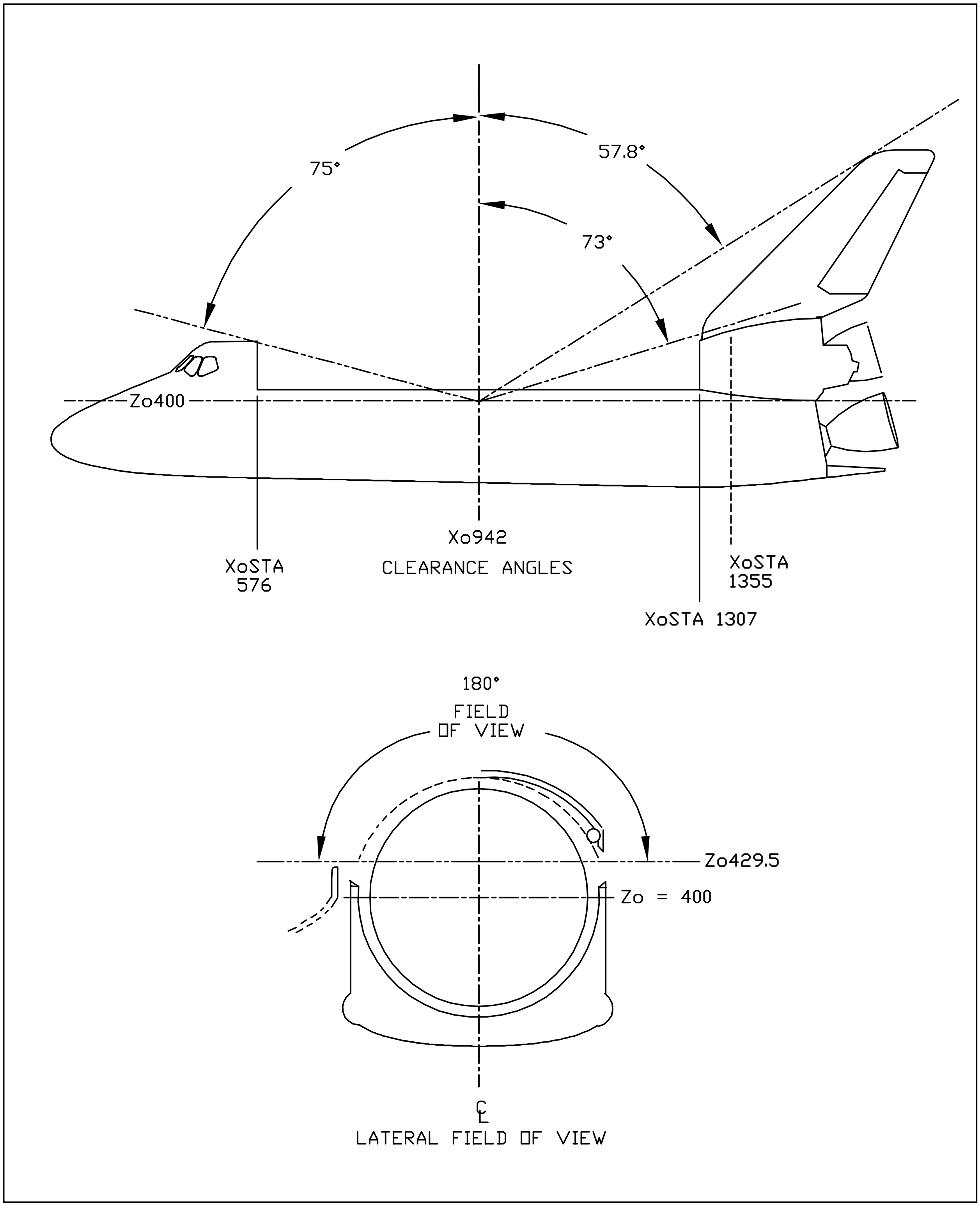
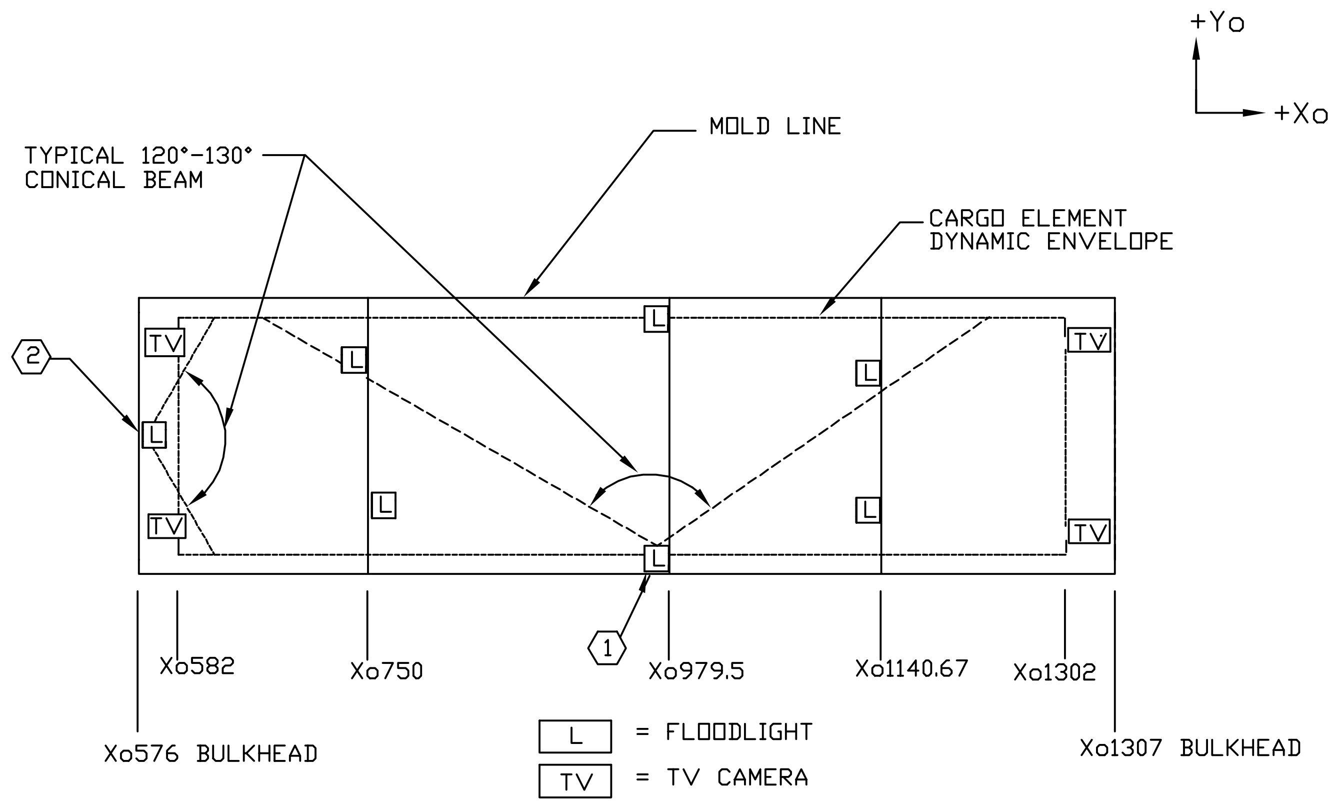


FIGURE 3.1.3.1-1 CARGO ELEMENT FIELD OF VIEW

FIGURE 3.1.3.2-1 CARGO BAY LIGHTING AND TV CAMERA LOCATIONS (SHEET 1 OF 3)



NOTES:

1. SIX LIGHTS MOUNTED OUTSIDE CARGO ELEMENT DYNAMIC ENVELOPE. (120° MINIMUM CONICAL BEAM POINTED WITHIN APPROX 5° OF NORMAL TO CARGO BAY CENTERLINE)
2. FORWARD BULKHEAD FLOODLIGHT. (120° CONICAL BEAM POINTED IN +X DIRECTION PENETRATES 0.14x5.70 DIA INTO THE CARGO ELEMENT DYNAMIC ENVELOPE)
3. LIGHTING CHARACTERISTICS ARE SPECIFIED IN PARAGRAPH 10.9.1
4. CCTV CAMERAS ARE KITTABLE AND MAY BE REMOVED WHEN REQUIRED TO ACCOMMODATE MAXIMUM ENVELOPE CARGO ELEMENT
5. FIGURE NOT TO SCALE

LOCATION OF LIGHTS (**)	ATTACHMENT LOCATION		FIXTURE CENTERLINE	
	X_o	SIDE	Y_o	Z_o
	576	Aft	0	484.2
	750	Forward	56	325.2
	750	Aft	-48	320.0
	979.5	Forward	54.3	323.9
	979.5	Forward	-54.3	323.9
	1140.67	Forward	56	324.9
	1140.67	Forward	-56	324.9

BULKHEAD TV CAMERA LOCATIONS (**)	ATTACHMENT BULKHEAD X_o	LENS EXTREME POSITION X_o	CAMERA CENTERLINE	
			Y_o	Z_o
	576	598	71.5	446
	576	598	-71.5	446
	1307	1285	87	446
	1307	1285	-87	446

KEEL CAMERA LOCATIONS (**) (***)				
BAY	NO. OF LOCATIONS IN BAY	Xo CENTERLINE OF CAMERA (AT 3.93 INCREMENTS)	Yo CENTERLINE OF CAMERA	Zo CAMERA LENS (EXTENDED)
1	2	616.67 TO 620.60	-1.40	316.14
2	8	648.13 TO 675.67	-1.40	316.14
3	7	711.07 TO 734.67	-1.40	316.14
4	7	770.07 TO 793.67	-1.40	316.14
5	7	825.13 TO 848.73	-1.40	316.14
6	7	880.20 TO 903.80	-1.40	316.14
6	1	892.00	-4.00	317.19
7	8	935.27 TO 962.80	-1.40	316.14
8	8	998.20 TO 1025.73	-1.40	316.14
9	6	1057.20 TO 1076.87	-1.40	316.14
10	6	1108.33 TO 1128.00	-1.40	316.14
10	1	1104.40	-2.80	317.19
11	5	1159.47 TO 1175.20	-1.40	316.14
	73 TOTAL LOCATIONS			

(**) REPRESENTS STATIC POSITION ONLY.

(***) SELECTED LOCATION (S) WILL BE AFFECTED BY MISSION UNIQUE THERMAL CHARACTERISTICS AND WILL BE NEGOTIATED IN THE PIP.

FIGURE 3.1.3.2-1 CARGO BAY LIGHTING AND TV CAMERA LOCATIONS
(SHEET 2 OF 3)

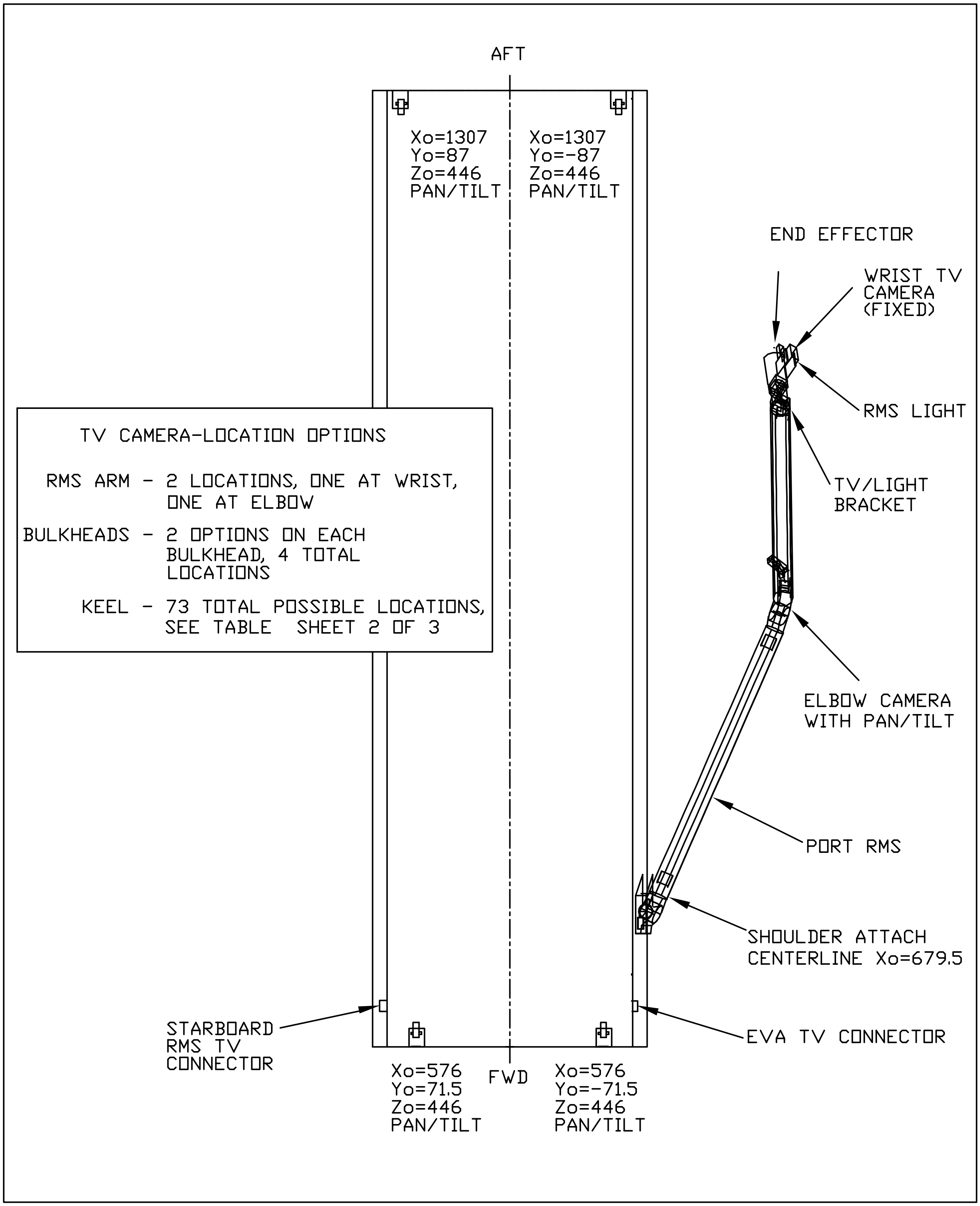


FIGURE 3.1.3.2-1 CARGO BAY LIGHTING AND TV CAMERA LOCATIONS
(SHEET 3 OF 3)

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 STRUCTURAL INTERFACES

4.0.1 Payload Definition

4.0.1.1 Interface Loads and Relative Deflections

Interface loads and relative deflections for the combined Shuttle Orbiter and Cargo Element are determined by coupled dynamic analysis for Shuttle lift-off, landing, and by coupled static analysis for quasi-static conditions. Effects due to the random vibration environment need to be considered. The payload unique Shuttle static and dynamic models are based upon STS81-0641F. Shuttle liftoff and landing forcing functions are defined in STS88-0609 and STS86-0020A, respectively.

The Shuttle static and dynamic models and forcing functions, in conjunction with the cargo element math models, shall be the controlling factors for assessing changes in interface loads and relative deflections. Alternate design limit load factors should be coordinated with the SSP Structural/Mechanical Working Group.

4.0.1.2 Sidewall Mounted Payload

The interface load limitations for the longeron/adapter mounted payloads are governed by weight and C.G of the payload, the adapter beam design and mounting provisions, and the Orbiter longeron and frame structural capabilities. The payload structural model and stress analysis are documented in SAI-TM-794.

4.0.1.2.1 Mass Properties

The weight, center of gravity (C. G.), and mass moments of inertia (I) of the cargo element depends upon the mounting locations. See the details as follows:

Assembly	Weight (lbs)	C.G (Inches)	Moments of Inertia (Slug*ft**2)	Moments of Inertia (Slug*ft**2)
Mightysat 1:				
Bay 6	677.0	Xp=27.9	Ixx=22.5	Ixy=3.81
(PORT side)		Yp=13.0	Iyy=44.5	Iyz=2.16
Launch		Zp=3.6	Izz=40.6	Izx=-4.65
Bay 6	541.0	Xp=30.8	Ixx=19.3	Ixy=1.66
(PORT side)		Yp=11.7	Iyy=37.7	Iyz=3.13
landing		Zp=2.6	Izz=33.4	Izx=-6.13

Mightysat payload weight	136.0 lbs
GSFC beam & Carrier HW included	541.0 lbs
Total	677.0 lbs

The origin of the payload axes is defined as follows:
(At Port side Bay 6)

Xp 0.00 =Xo 863.00

Yp 0.00 =Yo -94.0 (Port)

Zp 0.00 =Zo 396.0

and Xp, Yp, and Zp are parallel to the Orbiter Xo, Yo, and Zo axes.

SAC-A:

Assembly	Weight (lbs)	C.G (inches)	Moments of Inertia (Slug*ft**2)	Moments of Intertia (Slug*ft*2)
Bay 2 (Port side) Launch	583.0	Xp=20.6 Yp=14.6 Zp= 2.9	Ixx=29.6 Iyy=32.1 Izz=29.8	Ixy= 5.88 Iyz= 1.32 Izx=-1.56
Bay 2 (Port side) Landing	438.0	Xp=22.0 Yp=12.8 Zp= 3.4	Ixx=28.3 Iyy=31.3 Izz=27.9	Ixy= 4.96 Iyz= 0.99 Izx=-1.32

SAC-A Payload weight	145.0 lbs
GSFC beam & Carrier HW included	438.0 lbs
Total	583.0 lbs

The origin of the payload axes is defined as follows:

Xp 0.00=Xo 636.0
Yp 0.00=Yo -94.0
Zp 0.00=Zo 396.0

4.0.1.3 (Reserved)

4.0.2 UNIQUE MISSION SPECIFIC REQUIREMENTS

4.0.2.1 Payload Induced Pyrotechnic Shock

The payload generated pyrotechnic shock detected on the trunnion at the payload to Orbiter interface shall not exceed the shock response spectrum shown in Figure 4.0.2.1-1. Payload generated pyrotechnic shock is not acceptable in the midddeck or the aft flight deck.

4.0.3 (Reserved)

4.0.4 ORBITER-TO-PAYLOAD DEDICATED ACCOMMODATIONS

4.0.4.1 (Reserved)

4.0.4.2 SIDEWALL MOUNTED PAYLOADS - STRUCTURAL DESIGN

4.0.4.2.1 (Reserved)

4.0.4.2.2 (Reserved)

4.0.4.2.3 Acoustics

The acoustics levels in an empty payload bay that are defined in Table 4.0.4.2.3-1 represent the minimum level to which a payload must be considered safe to fly on the STS. Table 4.0.4.2.3-1 represents the acoustic environment of the sidewall mounted payloads at or near Zo400.

The acoustic levels during orbit, entry, and landing are significantly below the ascent levels and shall be assumed negligible.

Acoustic levels for specific payloads are dependent on payload geometry, surface area and acoustic absorption characteristics and will differ from those of the empty payload bay.

4.0.4.2.4 Limit Load Factors

Sidewall mounted payloads that have a minimum natural frequency of 35 Hz with respect to the adapter interface may use the load factors specified in Table 4.0.4.2.4-1 (Bay 2 to 8 only) in lieu of the coupled loads analysis specified in paragraph 4.0.1.1. The load factors encompass the maximized transient responses at liftoff and landing, and the random vibration responses during liftoff. The loads associated with the quasi-static flight events after liftoff and before landing are relatively lower. Therefore, the limit load factors given in Table 4.0.4.2.4-1 may be used for the design of the payload, at all applicable locations in the payload bay, provided payloads have the minimum frequency requirement.

4.0.4.2.5 (Reserved)

4.0.4.2.6 Interface Loads

Interface load limitations for the sidewall mounted payloads are governed by the weight and C.G. of the payload, the adapter beam design and mounting provisions, and the orbiter longeron and frame structural capabilities. The allowables are specified in the following paragraphs for each of the unique sidewall carriers.

4.0.4.2.6.1 (Reserved)

4.0.4.2.6.2 (Reserved)

4.0.4.2.6.3 (Reserved)

TABLE 4.0.4.2.3-1 ORBITER PAYLOAD BAY SIDEWALL ACOUSTIC ENVIRONMENT

1/3 Octave Band Center Frequency (Hz)	Sound Pressure Level (dB) Ref. $2x10^{-5}$ N/m^2	
	Lift-Off	Aeronoise
	5 Seconds/Flight*	10 Seconds/Flight*
31.5	124.0	112.0
40.0	126.0	114.0
50.0	128.5	116.0
63.0	131.0	118.0
80.0	133.0	120.0
100.0	133.0	121.0
125.0	132.0	122.5
160.0	131.0	123.5
200.0	130.0	124.5
250.0	129.0	125.0**
315.0	128.0	125.0**
400.0	126.5	124.0**
500.0	125.0	121.5
630.0	123.0	119.5
800.0	121.5	117.5
1000.0	120.0	116.0
1250.0	118.5	114.0
1600.0	117.0	112.5
2000.0	115.5	110.5
2500.0	113.5	108.5
Overall	141.0	133.5

* Time per flight does not include a scatter factor.

** Narrowband discrete noise is radiated from the payload bay vent doors during transonic/low supersonic flight. The noise radiated from any one vent is described below.

This environment is not intended for full payload exposure but only to those areas of the payload adjacent to a cargo bay vent opening.

One-Third Octave Band Center Frequencies, Hz	Sound Power Level dB Ref. 10^{-12} watts
	8 Seconds per Flight
250	128
315	136
400	130

TABLE 4.0.4.2.4-1 ADAPTER BEAM MOUNTED PAYLOAD LIMIT LOAD FACTORS

FLIGHT EVENT	LOAD FACTOR g			ANGULAR ACCELERATION RAD/SEC^2		
	N_X	N_Y	N_Z	$\ddot{\phi}_x$	$\ddot{\theta}_y$	$\ddot{\psi}_z$
LIFT-OFF						
Low Frequency	±7	±7	±6	±75	±20	±55
Vibration	±5.4	±8.0	±5.4			
Combination (RSS on One Axis at a Time) 1	±8.8	±7	±6	±75	±20	±55
2	±7	±10.6	±6	±75	±20	±55
3	±7	±7	±8.1	±75	±20	±55
LANDING	±6	±7	±8	±85	±30	±50

NOTES:

1. This data applies to a system with minimum natural frequency of 35 hertz when cantilevered at the interface with the beam.

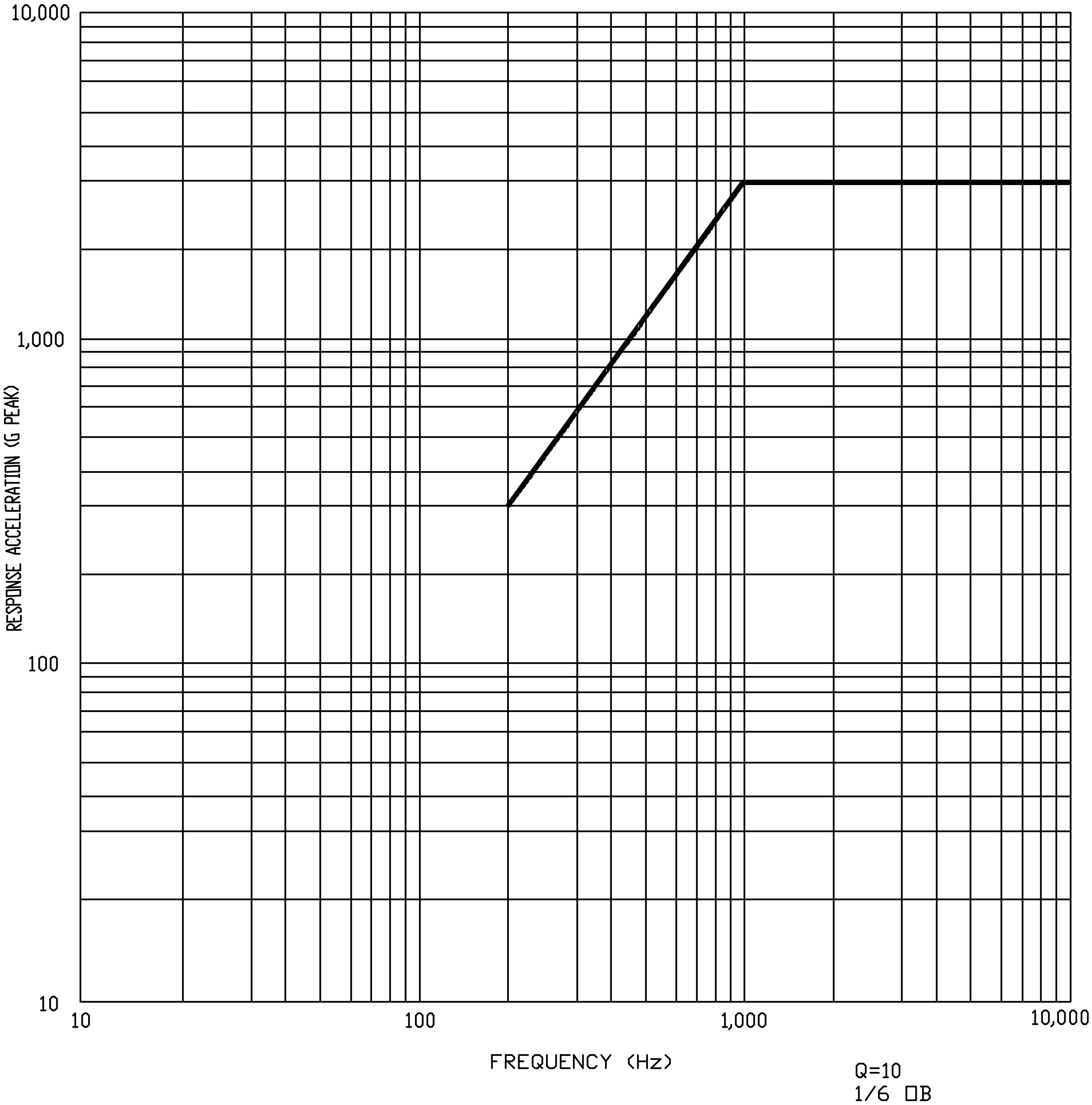


FIGURE 4.0.2.1-1 ORBITER/PAYLOAD INTERFACE SHOCK RESPONSE SPECTRUM PAYLOAD PYROTECHNIC SHOCK

THIS PAGE INTENTIONALLY LEFT BLANK

4.1 CARGO BAY

4.1.1 (Reserved)

4.1.2 (Reserved)

4.1.3 Cargo Limit-Load Factors/Angular Accelerations

The load factors/angular accelerations specified in the following subparagraphs shall be used for preliminary design of cargo and carrier primary structure and for determination of preliminary Orbiter/Cargo interface loads as the guiding criteria only. The center-of-rotation for angular accelerations is at the cargo element center-of-gravity. The load factors for emergency landing condition are defined in Paragraph 4.1.3.5.

Cargo load factor/angular acceleration is defined as the total externally applied force/moment on the cargo or cargo component divided by the corresponding total or component weight/mass moment of inertia and carries the sign of the externally applied force/moment in accordance with the Orbiter coordinate system. (See Figure 4.1.3-1).

4.1.3.1 (Reserved)

4.1.3.2 (Reserved)

4.1.3.3 (Reserved)

4.1.3.4 (Reserved)

4.1.3.5 Emergency Landing Load Factors

The Orbiter Vehicle design considers safe crew egress following emergency landing or water ditching. Hence, the mounting structures for equipment and crew provisions vessels and for the payload attachments, shall be designed to load factors equal to or greater than those shown in Table 4.1.3.5-1. Payload equipment inside the Orbiter crew compartment shall be designed to preclude hazards to the flight personnel after the application of the emergency landing loads defined in the table. The attachment structures (including fittings and fasteners) of the payloads must be designed for emergency landing loads. The attachment structure of payload equipment where failures could result in injury to personnel or prevent egress from the emergency landed vehicle must be designed for this requirement. Payload equipment design shall consider provisions to maximize the probability of safe crew egress following an emergency landing.

4.1.3.6 Factors of Safety for Structural Design

The structural design of all mounting hardware and/or bracketry (or any other structure which could be affected by flight loads) shall assure an ultimate factor of safety $\geq$ 1.4. Pressurized lines and fittings less than 1.5 inch in diameter shall have an ultimate factor of safety $\geq$ 4.0. Those equal to or larger than 1.5 inch in diameter shall have an ultimate factor of safety $\geq$ 1.5.

4.1.3.7 Fracture Control

Structural components, including all pressure vessels, the failure of which could cause destruction of the Orbiter or injury to the crew, shall be analyzed to preclude failures caused by propagation of pre-existing flaws.

4.1.4 (Reserved)

4.1.5 (Reserved)

4.1.6 Vibration

4.1.6.1 (Reserved)

4.1.6.2 Random Vibration

The random vibration environments associated with STS lift-off are specified for sidewall adapter mounted payloads and Orbiter longerons. The environments are applicable at Orbiter interfaces for all axial locations. Payload structure must be certified to vibration criteria that are based on these environments to be considered safe to fly on the STS. The environments may be considered statistically uncorrelated.

4.1.6.2.1 (Reserved)

4.1.6.2.2 Random Vibration for Sidewall/Adapter Mounted Payloads
The random vibration environments for hardware mounted on the Orbiter sidewall through an adapter is given in Table 4.1.6.2.2-1.

4.1.6.2.3 (Reserved)

4.1.6.3 Orbiter-to-Cargo Element Electrical Interface Random Vibration Environment

During launch and ascent, the random vibration environment of Orbiter-to-Cargo Element Electrical Interfaces shall not exceed the following:

20 - 50 Hz	+12 dB/Octave
50 - 85 Hz	0.15 g2/Hz
85 - 100 Hz	+9 dB/Octave
100 - 400 Hz	0.25 g2/Hz
400 - 2000 Hz	-6 dB/Octave

Duration: 20 seconds/axis/mission (in 3 orthogonal axes, including a fatigue scatter factor of 4).

4.1.7 (Reserved)

4.1.8 (Reserved)

4.1.9 Pyrotechnic Shock

4.1.9.1 (Reserved)

4.1.9.2 Pyrotechnic Shock From Other Sources

The maximum level of pyrotechnic shock detected on the sidewall mounted payload to Orbiter interface transmitted from other payloads or Orbiter mounted equipment, such as the RMS or the KU Band Antenna, is shown in Figure 4.1.9.2-1.

4.2 AFT FLIGHT DECK NOT APPLICABLE

4.3 GENERAL ACCELERATIONS

4.3.1 (Reserved)

4.3.2 (Reserved)

4.3.3 (Reserved)

4.3.4 Orbiter Towing Loads

The Orbiter shall not impose total acceleration levels in Cargo elements which exceed ±0.8g laterally, 1±1.3g vertically, and 1g axially.

4.3.5 (Reserved)

4.3.6 Contingency Orbiter Rollback/Rollout

The deceleration and centripetal acceleration that the payload will experience when the SSV is rolled back from the launch pad to the Vertical Assembly Building (VAB), and later returned to the pad for launch are as follows:

- Braking Maneuvers (Deceleration)

  0.0028 g’s along the SSV Z-axis

- Turning Maneuvers (Centripetal Acceleration)

  0.000035 g’s

TABLE 4.1.3.5-1 EMERGENCY LANDING DESIGN LOAD FACTORS

CONDITION	Load Factor 65 klb (29484 kg) Up 32 klb (14515 kg) Down			Load Factor 65 klb (29484 kg) Down		
	X	Y	Z	X	Y	Z
Emergency Landing (Outside Crew Compartment)	+4.5 -1.5	+1.50 -1.50	+4.5 -2.0	+4.50 -0.738	+0.738 -0.738	+2.215 -0.985
Emergency Landing (Inside Crew Compartment)	+20.0 -3.3	+3.3 -3.3	+10.0 -4.4			

Sign convention follows that of the Orbiter coordinate system in Figure 4.1.3-1.

Emergency landing load factors are ultimate. The longitudinal load factors are directed in all aftward azimuths within a cone of 20 degrees half-angle. The specified load factors shall operate separately.

For cargo weight between 32 klb and 65 klb, use a linear interpolation between the load factors given.

TABLE 4.1.6.2.2-1 ORBITER CARGO BAY RANDOM VIBRATION PAYLOAD SIDEWALL ADAPTERS/ORBITER INTERFACE

X Axis (same as longerons)		
	20 - 32 Hz	.003 g^2/Hz
	32 - 100 Hz	+6 dB/Octave
	100 - 500 Hz	.030 g^2/Hz
	500 - 2000 Hz	-4 dB/Octave
	Overall = 5.5 Grms	
Y Axis	20 - 45 Hz	+10 dB/Octave
	45 - 600 Hz	.060 g^2/Hz
	600 - 2000 Hz	-6 dB/Octave
	Overall = 7.7 Grms	
Z Axis (same as longerons)		
	20 - 45 Hz	.009 g^2/Hz
	45 - 70 Hz	+12 dB/Octave
	70 - 600 Hz	.050 g^2/Hz
	600 - 2000 Hz	-6 dB/Octave
	Overall = 7.0 Grms	

The associated time duration is 20 seconds per axis per flight which includes a fatigue scatter factor of 4.

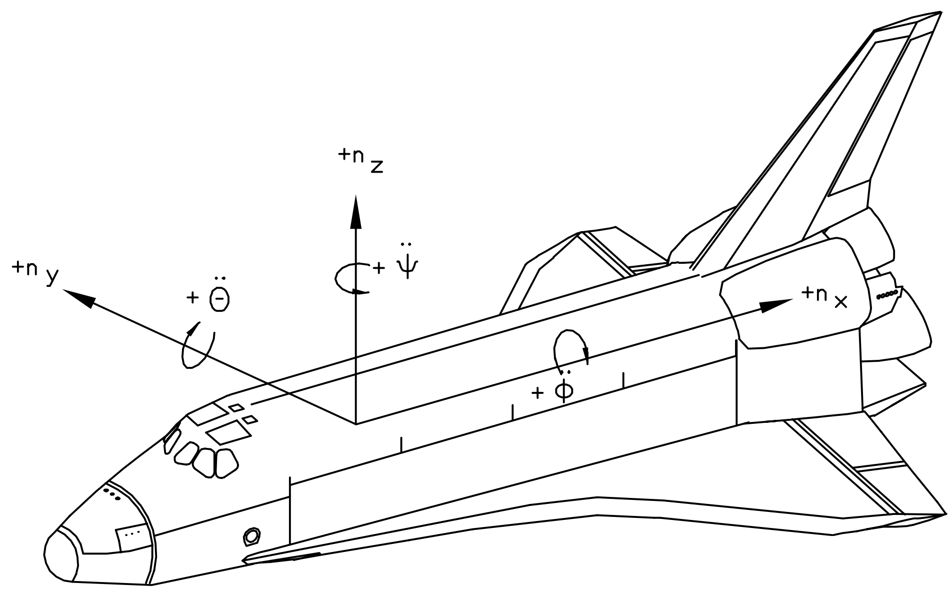


FIGURE 4.1.3-1 SIGN CONVENTION FOR CARGO LIMIT-LOAD FACTORS/ANGULAR ACCELERATIONS

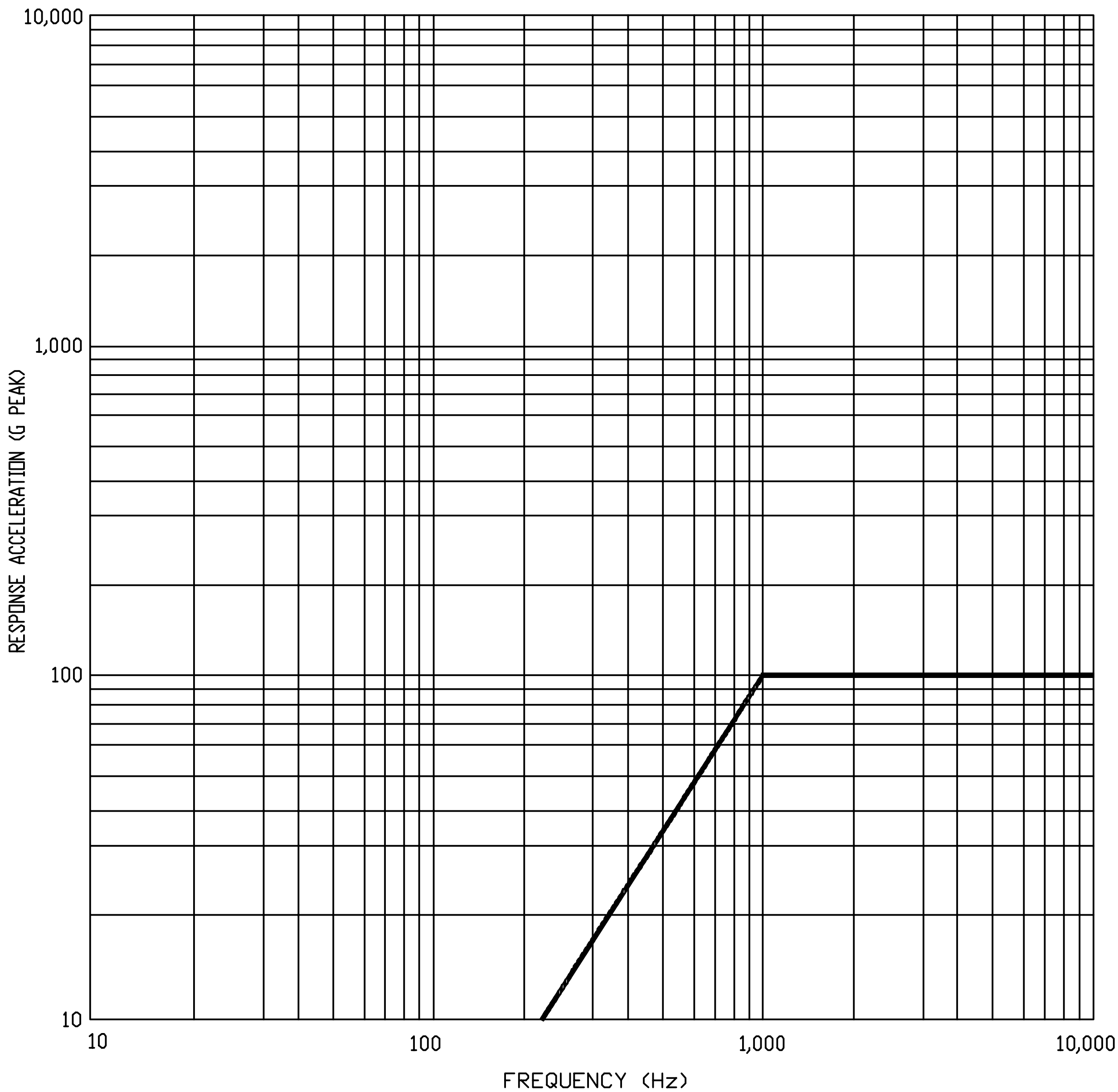


FIGURE 4.1.9.2-1 ORBITER/PAYLOAD INTERFACE SHOCK RESPONSE SPECTRUM ORBITER PYROTECHNIC SHOCK

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 (Reserved)

5.1 (Reserved)

5.2 (Reserved)

5.3 (Reserved)

5.4 (Reserved)

5.5 (Reserved)

5.6 (Reserved)

5.7 (DELETED)

5.8 (Reserved)

5.9 (Reserved)

THIS PAGE INTENTIONALLY LEFT BLANK

6.0 ENVIRONMENTAL CONTROL INTERFACES

6.0.1 Payload Definition

6.0.1.1 Payload Interface Models
Payload thermal models for integrated analysis shall be as defined in SAI-RPT-0140.

6.0.1.2 Payload Coating Surface Properties
For thermal design purposes, the infrared emissions and solar absorptions of those external surfaces shall be as defined in Table 6.0.1.2-1. The breakdown of the Cargo Element surfaces viewed by the Orbiter shall be according to Figure 6.0.1.2-1.

6.0.1.3 (Reserved)

6.0.1.4 (Reserved)

6.0.1.5 (Reserved)

6.0.2 (Reserved)

6.0.3 (Reserved)

6.0.4 ORBITER-TO-PAYLOAD DEDICATED ACCOMMODATIONS

6.0.4.1 (Reserved)

6.0.4.2 Sidewall Mounted Payloads

6.0.4.2.1 Thermal Interfaces
The payload thermal design shall not depend on the Orbiter structure to supply or dissipate heat. The thermal interfaces shall be defined by the interface conductances between the Orbiter structure and the sidewall carrier to which the payload is mounted.

6.0.4.2.1.1 (Reserved)

6.0.4.2.1.2 (Reserved)

6.0.4.2.1.3 (Reserved)

6.0.4.3 Orbiter Docking System Provisions
For thermal design purposes, the infrared emittance (ε) and solar absorptance (α) of the Orbiter Surfaces shall be as defined in Figure 6.0.4.3-1 and Table 6.0.4.3-1.

TABLE 6.0.1.2-1 CARGO ELEMENT COATING SURFACE PROPERTIES

ZONE (Reference Figure 6.0.1.2-1)	SURFACE DESCRIPTION	SURFACE MATERIALS	ALPHA NEW	ALPHA DEGRAD	EPSILON NEW	EPSILON DEGRAD	RHO-DIFFUSE PERCENT	RHO-SPECULAR PERCENT	NOTES
1	HH adapter beam assembly (ABA) Bay 6	White paint Aeroglaze (A276)	0.24	0.36	0.86	0.88	>90	<10	
2	HH adapter beam assembly (ABA) Bay 2	White paint Aeroglaze (A276)	0.24	0.36	0.86	0.88	>90	<10	
3	HH lightweight avionics plate - front	White paint Aeroglaze (A276)	0.24	0.36	0.86	0.88	>90	<10	
3	HH lightweight avionics plate - back and sides	MLI/white beta cloth	0.25	0.32	0.80	0.90	99	1	
4	HH avionics - connector ends	MLI/white beta cloth	0.25	0.32	0.80	0.90	99	1	
4	HH avionics - housing	White paint Aeroglaze (A276)	0.24	0.36	0.86	0.88	>90	<10	
5	Mightysat-1 canister sides	MLI/white beta cloth	0.25	0.32	0.80	0.90	99	1	
5	Mightysat-1 canister lower insulating end cap	MLI/white beta cloth	0.25	0.32	0.80	0.90	99	1	
6	Mightysat-1 top surface (approx. 70%)	Silicon solar cells	0.72	0.72	0.86	0.86	<10	>90	
6	Mightysat-1 top surface (approx. 30%)	Carbon graphite composite	0.93	0.93	0.85	0.85	>90	<10	
6	Mightysat-1 antennas (four)	Chemglaze Z306	0.96	0.96	0.86	0.86	99	1	
7	SAC-A canister sides	MLI/white beta cloth	0.25	0.32	0.80	0.90	99	1	
7	SAC-A canister HMDA (HH motorized door assembly)	MLI/white beta cloth	0.25	0.32	0.80	0.90	99	1	
7	SAC-A canister lower insulating end cap	Silver teflon	0.08	0.14	0.78	0.75	<10	>90	

TABLE 6.0.4.3-1 Thermal-Optical Properties of Orbiter Surfaces

Surface Description	Design Criterion	Surface Material	a New	a Degr.	e New	e Degr.	r Diffuse Percent	r Specular Percent
ODS Trunnions	N/A	Chrome	.30	.40	.10	.90	10	90
ODS Airlock Truss Frame	N/A	Teflon Coated Glass Cloth	.22	.36	.90	.90	99	1
ODS External Airlock	N/A	Teflon Coated Glass Cloth	.22	.36	.90	.90	99	1
ODS Tunnel Adapter	N/A	Teflon Coated Glass Cloth	.22	.36	.90	.90	99	1
Vestible (Internal & External Surfaces)	N/A	Teflon Coated Glass Cloth	.22	.36	.90	.90	99	1
APDS Docking Surface	N/A	Anodized Aluminum	.25 to .45	.45 to .65	.6 to .85	.6 to .85	90	10

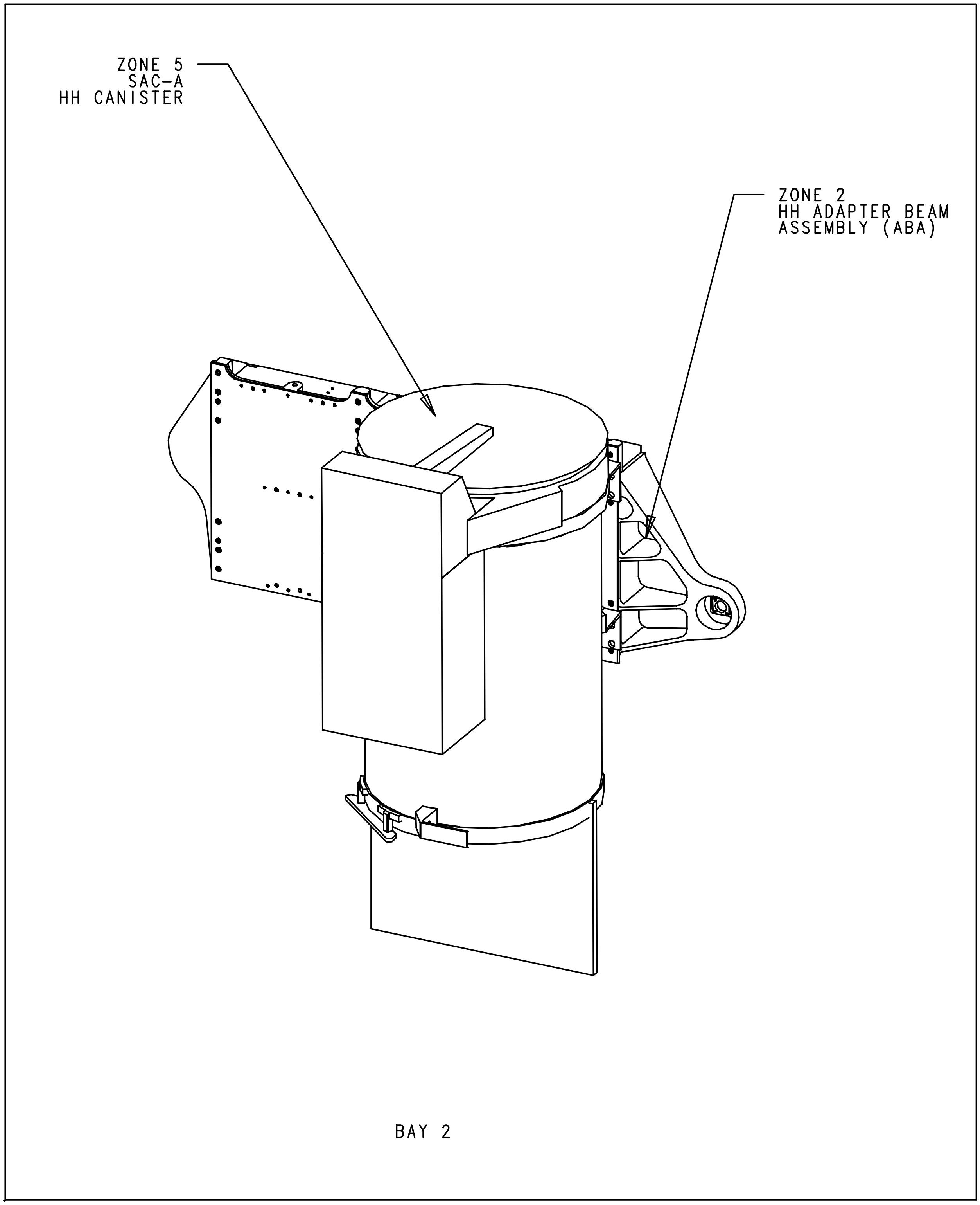


FIGURE 6.0.1.2-1 PAYLOAD SURFACES AFFECTING THERMAL ANALYSIS
(SHEET 1 OF 2)

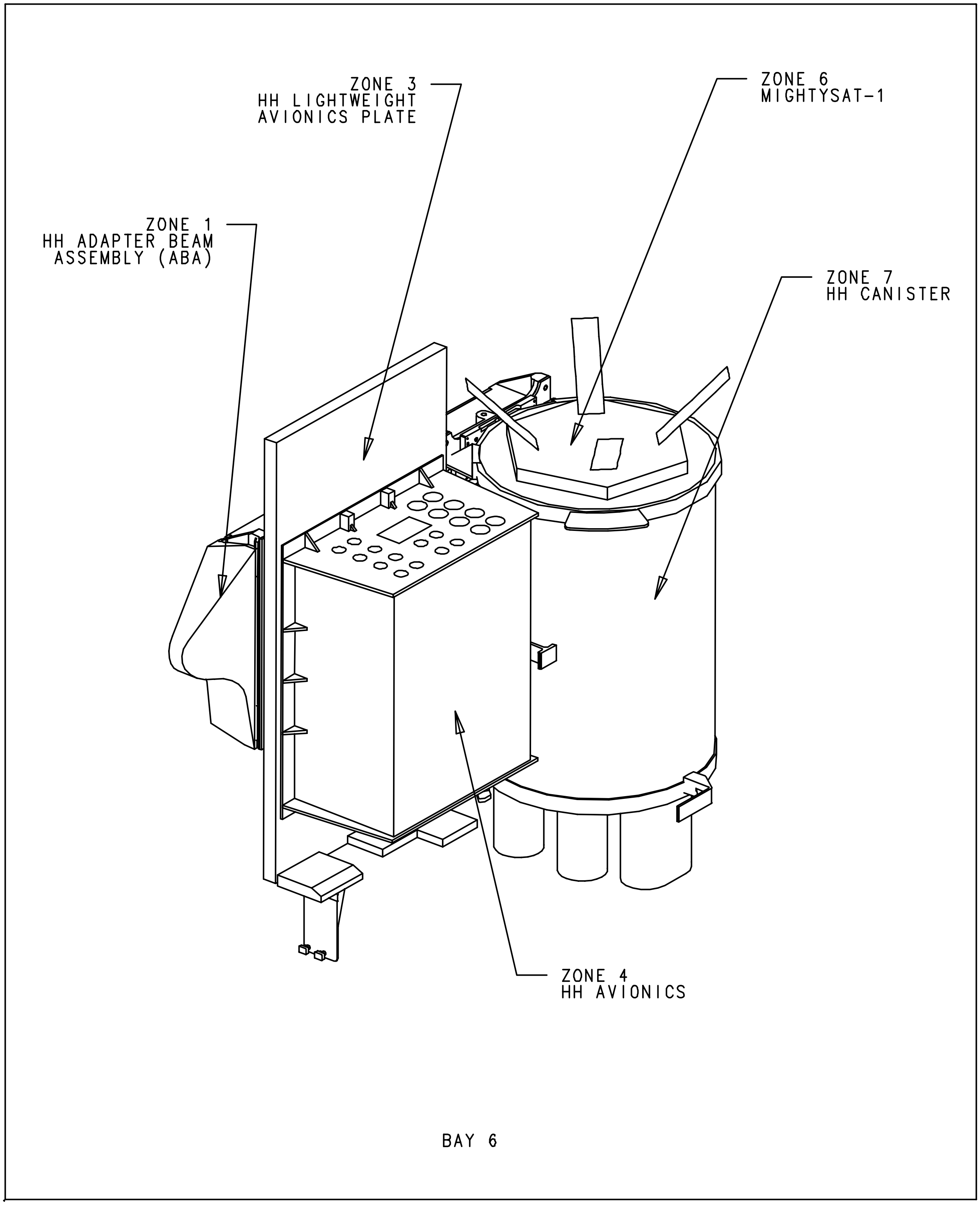


FIGURE 6.0.1.2-1 PAYLOAD SURFACES AFFECTING THERMAL ANALYSIS
(SHEET 2 OF 2)

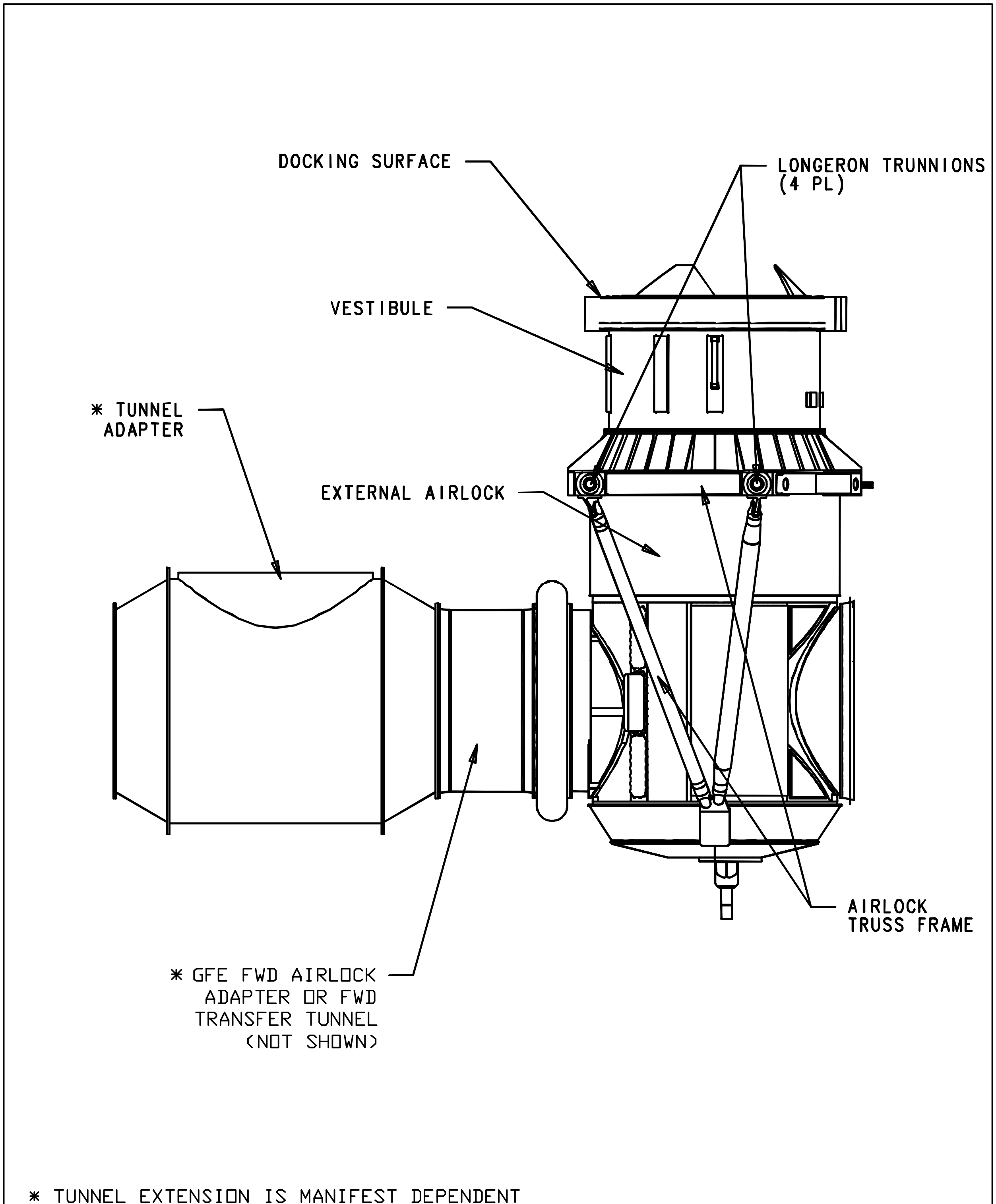


FIGURE 6.0.4.3-1 ORBITER DOCKING SYSTEM (ODS) SURFACES

THIS PAGE INTENTIONALLY LEFT BLANK

6.1 PASSIVE THERMAL CONTROL

6.1.1 Thermal Design Mission

6.1.1.1 (Reserved)

6.1.1.2 Orbiter Vehicle Attitude Constraints

During on-orbit operations, the Orbiter attitude-hold time limits depend on a combination of the following factors:

a. Sun angle to orbital plane (Beta angle)

b. Orbiter altitude

c. Orbiter attitude and attitude history

d. Water management for heat rejection

e. On-orbit thermal conditioning requirements

f. Pre-entry thermal conditioning requirements

Because these factors depend on Orbiter operations in response to payload mission requirements, the Orbiter's attitude-hold capability shall be established in the mission-specific Payload Integration Plans (PIPs) for each payload which requires attitude-hold periods greater than the minimum durations defined in Paragraph 6.1.1.2.1, including the deorbit and entry requirements defined in Paragraph 6.1.1.2.3. The attitude-hold periods presented in this paragraph are composite values based on consideration of a number of Orbiter thermal issues. The durations are referenced from specific initial conditions (passive thermal control (PTC) steady-state conditions at the particular beta angle). The attitude-hold periods are intended only as an initial simplified presentation of Orbiter capabilities for STS users.

Payloads manifested with Extended Duration Orbiter (EDO) pallets shall refer to Appendix E for attitude hold constraints.

6.1.1.2.1 Orbiter Constraints as a Function of Attitude and Sun Angle-to-Orbital Plane (Beta Angle)

Depending on the combination of factors noted in Paragraph 6.1.1.2, the maximum attitude-hold capability for the Orbiter will be limited to the durations and ranges given in Table 6.1.1.2.1-1 for $0^\circ \leq$ beta angle $< 20^\circ$, $20^\circ \leq$ beta angle $< 60^\circ$, and $60^\circ \leq$ beta angle $\leq 90^\circ$. Attitude-hold periods longer than the minimum specified durations may impose constraints on mission variables such as vehicle orientation, orbital parameters, etc. Such extended attitude holds, and the corresponding mission constraints, shall be specified in the applicable mission-specific PIPs as a basis for mission planning. Before the attitude-hold durations can be repeated, the Orbiter must be placed in a preferred attitude for a specific duration to allow the accumulation of fuel cell generated water used for active thermal control and/or passive thermal conditioning, also to be defined in applicable PIPs.

6.1.1.2.2 (Reserved)

6.1.1.2.3 Orbiter Constraints for De-orbit and Entry Preparation

Orbiter pre-entry thermal conditioning attitudes and duration requirements are dependent upon the thermal state of the orbiter and nature (normal or contingency) of the impending entry. The Orbiter pre-entry thermal conditioning time will be established during the mission using real-time temperature measurements. These data will be used to determine the actual required pre-entry thermal conditioning duration within the range defined in the following table.

Beta Angle Range, Degrees	Long Term Orbiter Orientation Prior To Pre-Entry Thermal Conditioning	Thermal Conditioning Time Range, Hours
0° To 90°	Any	0 To 12

The operational objective will be to accomplish pre-entry conditioning required for normal entry by attitude holds compatible with both the Orbiter and payload operational or refurbishment requirements. If mutually compatible requirements cannot be established, pre-entry conditioning will be accomplished by passive thermal conditioning (PTC) by rotating the Orbiter at 2 to 5 revolutions per hour about the X-axis with the orientation of the X-axis within $\pm$20 degrees of the perpendicular to the sun vector.

For an aborted entry resulting from an Orbiter problem, the pre-entry thermal conditioning will be constrained only by the payload flight safety constraints defined in the PIP Annex. However, for an aborted entry, effort will be made to satisfy the pre-entry thermal requirements without violating the payload operational or refurbishment attitude-hold constraints also defined in the cargo element PIP.

6.1.1.2.4 (Reserved)

6.1.1.3 Space Environment

The numerical values of the parameters defining the space environment shall be as follows:

a. Solar Radiation (hot case) — 444 Btu/hr. - ft^2

b. Earth albedo — 30 percent of solar radiation

c. Earth Radiation — 77 Btu/hr. - ft^2

d. Space Sink Temperature — 0°R

6.1.1.4 (DELETED)

6.1.2 Thermal Design Configurations/Models

6.1.2.1 Orbiter Interface Models

Orbiter thermal models for integrated analysis shall be as defined in ES3-76-1, ES3-77-3, JSC-19540 and JSC-19692.

6.1.2.2 Coating Surface Properties

6.1.2.2.1 Orbiter Surfaces

For thermal design purposes, the infrared emittance and solar absorptance of the Orbiter surfaces shall be as defined in Figure 6.1.2.2.1-1 and Table 6.1.2.2.1-1.

6.1.2.2.2 (DELETED)

6.1.3 (Reserved)

TABLE 6.1.1.2.1-1 ORBITER ATTITUDE-HOLD DURATION LIMITS

Cargo Bay Orientation*	Orbiter Attitude-Hold Duration Limits From PTC Initial Conditions (Hours)+		
	$0^\circ \le \beta < 20^\circ$	$20^\circ \le \beta < 60^\circ$	$60^\circ \le \beta \le 90^\circ$
Three-Axis Inertial			
Solar Viewing (Bay to Sun)	160 (Approx)	160 (Approx)	52 to 160
Other Inertial Attitudes			
- Tail Sun	12	6	5
- Nose Sun	37	35	33
- Side Sun	110	110	98
- Bottom Sun	160	160	14
Local Vertical (LV)**			
Earth Viewing (Bay to Earth)			
- With Nose Toward Sun at Beta Near 90° (Wing on VV)	---	---	7
- With Tail Toward Sun (Wing on VV)	61 to 160	71 to 160	5
- With Either Side Toward Sun (Nose or Tail on VV)	160	37 to 160	16 to 160
Other LV Attitudes			
- Port Side LV with Tail Toward Sun	160	6	5
- Bottom LV with Tail Toward Sun	160	6	5
- Starboard Side LV with Tail Toward Sun	160	7	5
- Bottom LV with Either Side Toward Sun	160	7	7
- Tail LV with Bottom Toward Sun	160	12	7
- Tail LV with Either Side Toward Sun	160	12	7
- Tail LV with Top Toward Sun	160	120	90 to 160
- Nose LV with Top Toward Sun	160	120	71 to 160
- Nose LV with Bottom Toward Sun	160	160	160
- Bottom LV with Nose Toward Sun at Beta 75°	---	---	16

TABLE 6.1.1.2.1-1 ORBITER ATTITUDE-HOLD DURATION LIMITS (CONTINUED)

(Continued) Cargo Bay Orientation*	Orbiter Attitude-Hold Duration Limits From PTC Initial Conditions (Hours)+		
	$0° \le \beta < 20°$	$20° \le \beta < 60°$	$60° \le \beta \le 90°$
- Either Side LV with Nose Toward Sun at Beta > 75°	---	---	23
- Either Side LV with Top Toward Sun at Beta > 75°	---	---	48 to 160
Orbrate (Single-Axis Inertial) ***			
Solar Viewing (Bay to Sun)	160 (Approx)	160(Approx)	63 to 160
Space Viewing (Bay Heating Near Zero)			
- Tail Sun with Top to Space	7	6	5
- Nose Sun with Top to Space	23	7	7
- Nose Sun (But Pitched up -10° with Top to Space)	160	7	
Other Orbrate Attitudes			
- Tail Sun with Star-board Side to Space	7	6	5
- Tail Sun with Port Side to Space	7	7	5
- Tail Sun with Bottom to Space	12	7	5
- Nose Sun with Bottom to Space	25	7	7
- Nose Sun with Either Side to Space	23	23	23
- Side Sun with Top to Space	110	7	7
- Side Sun with Nose to Space	110	7	7
- Side Sun with Bottom to Space	160	43 to 160	18 to 160
- Bottom Sun with Nose to Space	160	7	7
- Bottom Sun with Side to Space	160	7	7
- Bottom Sun with Tail to Space	160	160	160

TABLE 6.1.1.2.1-1 ORBITER ATTITUDE-HOLD DURATION LIMITS (CONCLUDED)

* The orientations shown are generalized attitudes with no intent to include a tolerance. For significant deviations from the general attitude, unique assessment may be required.

** Local vertical attitudes are those with an Orbiter axis (usually a major axis) pointed continually toward the Earth (e.g., top or bay local vertical).

*** Orbrate attitudes are those with a single Orbiter axis (usually a major axis) inertial but with a rotation period about that axis equal to one orbit period. Orbrate orientations can produce the most severe thermal conditions for the Orbiter or payload.

\+ The Orbiter attitude-hold periods shown are based on consideration of both passive and Active Thermal Control System (ATCS) limits. The passive limits included were obtained from "Space Shuttle Program Thermodynamic Design Data Book - Thermal Control System - Constraints" (Rockwell International Document SD73-SH-0226, Volume 1E, Book V, September 1985). The passive thermal limits are referenced from specific initial conditions (PTC steady-state condition at each beta angle). ATCS attitude duration limits are strong functions of the internal heat load added to the Orbiter Freon loops and these heat loads are highly dependent on the specific mission, the payload configuration, and other operational factors. Attitude duration limits for specific payload configurations and missions must be determined by analysis, and these shall be addressed in the mission-specific PIPs. The ATCS duration limits presented here reflect a nominal on-orbit supply water quantity (478 pounds) at the beginning of each attitude hold, a 245 pound minimum on-orbit supply water quantity redline, Orbiter fuel cell power of 22 kilowatts, a constant water production rate of 18 pounds per hour, a 110°F radiator Freon inlet temperature, a seven member crew, a deployed forward radiator panel configuration, and eight radiator panels. The attitude-hold periods shown are intended only as an initial simplified presentation of Orbiter capabilities for STS users.

TABLE 6.1.2.2.1-1 THERMO-OPTICAL PROPERTIES OF ORBITER SURFACES

Surface Description	Design Criterion	Surface Material	α New	α Degr.	ε New	ε Degr.	ρ Diffuse Percent	ρ Specular Percent
Cargo Bay Liner	$\alpha_S/\varepsilon \leq .4$ and $\varepsilon \geq .8$	Teflon Coated Glass Cloth	.22	.36	.9	.9	99	none
Fwd Bulkhead	$\alpha_S/\varepsilon \leq .4$ and $\varepsilon \geq .8$	Teflon Coated Glass Cloth	.22	.36	.9	.9	99	none
Aft Bulkhead	$\alpha_S/\varepsilon \leq .4$ and $\varepsilon \geq .8$	Teflon Coated Glass Cloth	.22	.36	.9	.9	99	none
Radiator Concave Surface	N/A	Silver-Coated Teflon	.08	.11	.8 min	.8	50	50
Radiator Convex Surface	N/A	Silver-Coated Teflon	.08	.11	.8 min	.8	50	50
Cargo Bay Doors Con-cave Surface	Fwd 2 Pnls	Silver-Coated Teflon	.08	.11	.8 min	.8	50	50
	Fourth Pnl (w/o radi-ator) $\alpha_S/\varepsilon \leq .4$ and $\varepsilon \geq .8$	Teflon-Coated Glass Cloth	.22	.36	.9	.9	99	none
Cargo Bay Doors Convex Surface	$\alpha_S/\varepsilon = .2$ to .4 and $\varepsilon \geq .8$	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
		LRSI (2)	.16	.32	≥.8	≥.8	N.A.	N.A.
Fuselage Mid-Section Sides	$\alpha_S/\varepsilon = .2$ to .4 and $\varepsilon \geq .8$	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
		LRSI (2)	.16	.32	≥.8	≥.8		
Wing Upper Surface Surface	$\alpha_S/\varepsilon = .2$ to .4 and $\varepsilon \geq .8$	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
		LRSI (2)	.16	.32	≥.8	≥.8		

TABLE 6.1.2.2.1-1 THERMO-OPTICAL PROPERTIES OF ORBITER SURFACES (CONTINUED)

Surface Description	Design Criterion	Surface Material	α New	α Degr.	ε New	ε Degr.	ρ Diffuse Percent	ρ Specular Percent
Wing Lower Surface	α_S/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	≥.6	.85	.85	N.A.	N.A.
Bottom of Orbiter	α_S/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	≥.6	.85	.85	N.A.	N.A.
Fuselage Fwd Section (Top and Portion of Sides, See Figure 6.1.2.2.1-1)	α_S/ε = .2 to .4 $\varepsilon \geq$ .8	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
		LRSI (2)	.16	.32	≥.8	≥.8	N.A.	N.A.
Fuselage Fwd Section (Nose and Portion of Sides, See Figure 6.1.2.2.1-1)	α_S/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	≥.6	.85	.85	N.A.	N.A.
Fuselage Aft Section Sides	α_S/ε = .2 to .4 $\varepsilon \geq$ .8	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
Vertical Fin	α_S/ε = .2 to .4 $\varepsilon \geq$ .8	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
Base Heat Shield	α_S/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	≥.6	.85	.85	N.A.	N.A.
OMS Pods	α_S/ε = .2 to .4 $\varepsilon \geq$ .8	FRSI (1)	.16	.32	≥.8	≥.8	N.A.	N.A.
		LRSI (2)	.16	.32	≥.8	≥.8	N.A.	N.A.

TABLE 6.1.2.2.1-1 THERMO-OPTICAL PROPERTIES OF ORBITER SURFACES (CONCLUDED)

Surface Description	Design Criterion	Surface Material	α New	α Degr.	ε New	ε Degr.	ρ Diffuse Percent	ρ Specular Percent
Body Flap (Upper and Lower Surfaces)	α_S/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	≥.6	.85	.85	N.A.	N.A.
SSME Nozzles External Surfaces	α_S/ε = 1.0	Inconel 718	.8	.85	.8	.85	N.A.	N.A.
SSME Nozzles Internal Surfaces	α_S/ε = 1.8	A286 Stainless Steel	.55	.55	.3	.3	N.A.	N.A.

NOTES:

(1) Felt reusable surface insulation.

(2) Low-temperature reusable surface insulation.

(3) High-temperature reusable surface insulation.

(4) HRSI coating absorptance is highest when new and decreases with degradation.

(5) Small Orbiter surfaces (e.g. wing and vertical fin leading edges, nose cone, T-0 umbilical, etc.) and minor Orbiter vehicle differences are not shown.

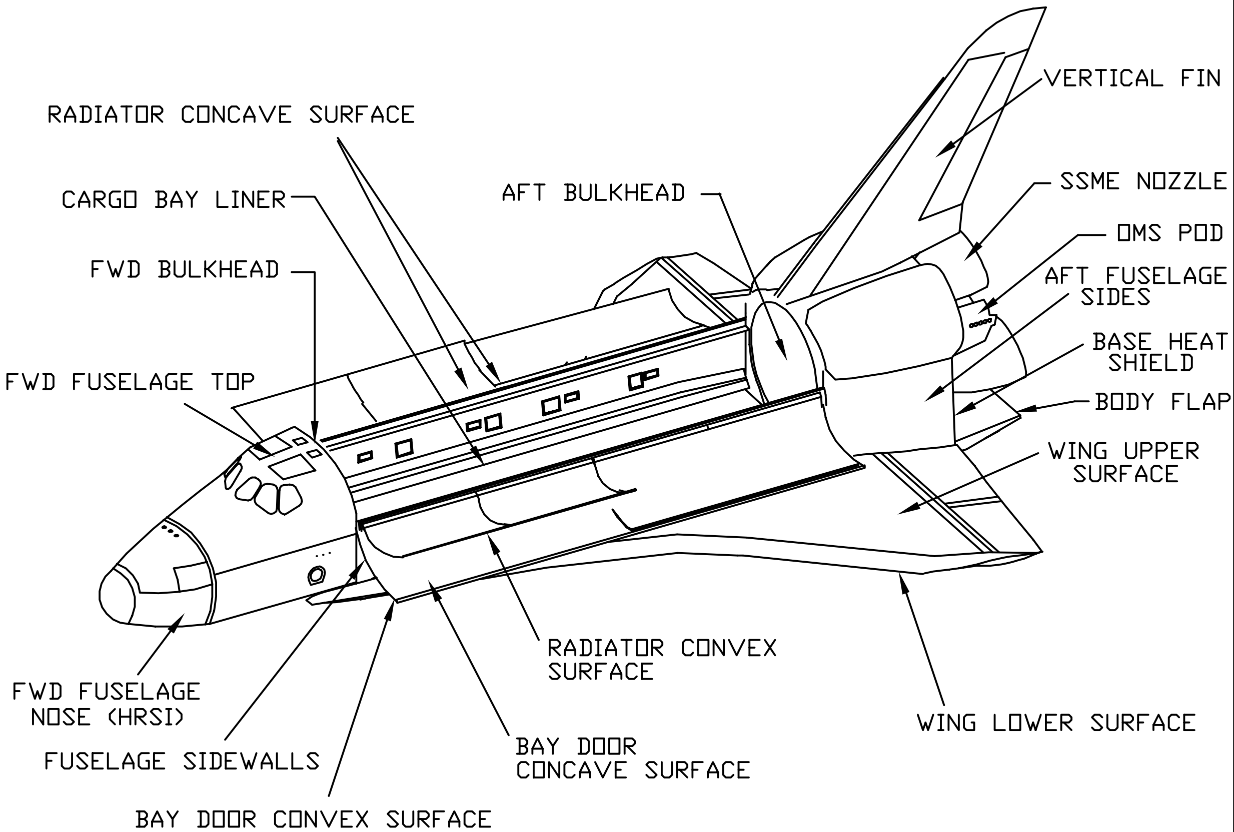


FIGURE 6.1.2.2.1-1 ORBITER SURFACES AFFECTING CARGO ELEMENT THERMAL BALANCE

THIS PAGE INTENTIONALLY LEFT BLANK

6.1.4 THERMAL ENVIRONMENT

6.1.4.1 Cargo Bay Wall Temperature

Typical temperature ranges at the cargo bay walls are defined in Table 6.1.4.1-1. Actual temperatures are dependent upon flight parameters and upon cargo element configuration. The maximum temperature for the radiator panels when the doors are closed shall not exceed 210°F.

6.1.4.2 (DELETED)

6.1.4.2.1 Payload Bay Vent Door Failure Contingency

The payload bay vent doors are normally closed at the start of entry and do not begin to open until after peak aerodynamic heating has occurred. However, the payload is required to make a thermal assessment of the payload and all payload supplied hardware considering a vent failure, wherein any vent fails in the open position and remains in that position throughout entry. The payload shall verify that this condition will not cause the payload to present a hazard to the Orbiter.

6.1.4.2.2 Vent Failure Heating Environment/Analysis Methodology

Failure of a vent in the open position will allow heated air to flow into the payload bay and convectively heat payload components in the path of the plume. The envelope of the ingested air plume increases in diameter with the distance from the vent filter. The heat transfer rate to payload components varies with time, location within the plume, shape, size and component surface temperature. A preliminary safety assessment shall be submitted to STS and shall be made assuming a conservative, worst case condition, wherein the location of the payload is directly in front of the ingested air plume with respect to the Xo direction. If a detailed analysis is required, the STS will determine the exact Xo location to be used based on final flight manifesting. Figure 6.1.4.2.2-1 describes the heating regions of the plume and the dimensions of the filter. The stagnation heating rate varies according to the following:

$$q_s = q_r \times F_c \times F_p \, [0.736 \, T_w^{\,.05} \, (T_A - T_w)/(T_A - 460)]$$

Where:

- q_s = stagnation heating rate, BTU/ft^2-sec
- q_r = reference heating rate, BTU/ft^2-sec
- F_c = factor to account for component configuration and size
- F_p = factor to account for component location in air plume
- T_A = air temperature, ^oR
- T_w = wall (payload component surface) temperature, ^oR

The reference heating rate (q_r) and air temperature (T_A) histories are given in Table 6.1.4.2.2-1. In addition, Table 6.1.4.2.2-1 also lists payload compartment pressure and filter temperature, for analyses requiring this data.

Within Region 1 of Figure 6.1.4.2.2-1, the stagnation heating is independent of component location. Components outside the plume (Region 3) do not experience convective heating from the ingested air. The component location factor (F_p) accounts for plume heating decay effects outside the plume core. F_p, as a function of the location dimensions for the heating regions, is further defined in Figure 6.1.4.2.2-2. For components with surfaces that span more than one region of the plume, the intersection of the Yo and R coordinates shall be used as a conservative approach in establishing the heating distributions.

The configuration factor (F_C) for cylinders, spheres and flat plates are calculated as:

Cylinders: $F_C = D^{-0.5}$
Spheres: $F_C = 1.36D^{-0.5}$
Flat Plates: $F_C = 0.5D^{-0.4} (1 + q_r) (.47 + .53 \sin A)$

Where:

D = component diameter, inches
A = flat plate angle-of-attack to flow direction, degrees, where A = 90^o is for flow normal to the surface.

For configurations of less than one inch in diameter or larger than 48 inches, heating should be calculated using one inch and 48 inches, repectively. For configurations where the heating cannot be synthesized from the generic configuration data or where critical component temperatures would be exceeded, the payload should contact the STS.

6.1.4.3 Reflected Solar Energy

Cargo Elements and Orbiter components which extend above the cargo bay door hinge line (Zo 400.00 ref.), or are deployed transversely over the radiators, may be subjected to locally concentrated solar radiation due to the focusing by the Orbiter reflective radiators. The radiator thermo-optical properties are given in Table 6.1.2.2.1-1 and the radiator configuration and contour equations are provided in JSC-19540. The magnitude of the local solar fluxes will be a function of cargo element or component design, its location in the payload bay and Orbiter orientation relative to the sun.

Payloads which could be subject to this environment shall make an assessment of its effect on the payload. If attitude constraints are indicated by this evaluation, the payload shall notify JSC.

6.1.4.4 Prelaunch and Post-landing Environments

Worst case hot and cold prelaunch and post-landing environments, as well as nominal environments, are defined, and shall be used in verifying Orbiter/cargo elements thermal compatibility. Constant values for environmental extremes are provided, which may be used for calculating conservative thermal predictions. Diurnal data is also provided which may be used for performing more rigorous predictions.

6.1.4.4.1 Solar Flux

The solar constant, which is defined as the heating flux to a surface normal to the incident solar radiation, has a mean value of 429 BTU/hr-ft^2 outside the earth’s atmosphere. Because of attenuation due to atmospheric interference, the solar constant at the earth’s surface varies as a function of time of day.

6.1.4.4.1.1 Solar Flux Diurnal Variation

Figure 6.1.4.4.1.1-1 shows the diurnal variation of the solar constant to be used for normal hot and cold environment cases of prelaunch and post-landing analyses. For prelaunch conditions, it shall be assumed that the Orbiter is in the vertical position on the launch pad with its tail facing south at the Eastern Test Range (ETR). For landings at the ETR the Orbiter is assumed to be generally oriented with the X-axis in a north-south direction.

For hot case analysis, the flux represents the direct flux for a surface normal to the flux. The direct fluxes for the various surfaces of the Orbiter must be corrected for the Angle of Incidence which varies for each surface and with time of day. For cold case analysis, the flux is assumed to represent the diffuse flux for a cloudy day and does not need to be corrected for the Angle of Incidence.

6.1.4.4.1.2 Solar Flux at Contingency Landing Sites

Figure 6.1.4.4.1.2-1 shows the curve to be used for the maximum solar flux at contingency landing sites. The curve was generated assuming a March "noontime" equatorial flux of 396 BTU/hr-ft^2 and the timewise distribution equation shown on Figure 6.1.4.4.1.2-1. Minimum flux at a contingency landing site is assumed to be equal to zero.

6.1.4.4.1.3 Solar Flux Constant Values

For cases where it is desirable to use constant (conservative) values for the solar flux, the following values may be used:

Hot Environment*

Prelaunch and normal post-landing	363 BTU/hr-ft2
Contingency landing	396 BTU/hr-ft2

Cold Environment**

Prelaunch and normal post-landing	70 BTU/hr-ft2
Contingency landing	0 BTU/hr-ft2

* For prelaunch hot conditions with the Orbiter in a vertical position on the pad, assume the sun is in the Orbiter X-Z plane at an angle 38 degrees up from the local horizontal at the ETR. For hot analyses for normal post-landing and contingency landings, assume the sun is directly overhead, Figure 6.1.4.4.1.1-1.

** For cold conditions, assume the flux is diffuse, Figure 6.1.4.4.1.1-1.

6.1.4.4.2 Ambient Air Temperature

The ambient air temperature varies with time of day, season and local weather conditions.

6.1.4.4.2.1 Eastern Test Range (ETR)

Figure 6.1.4.4.2.1-1 shows diurnal air temperatures for the ETR location for cold, hot and nominal days for representative months. The temperatures for hot and cold days represent the maximum and minimum values, respectively, for 95 percent of all measurements while the temperature for a "nominal" day represents the median (50 percentile) of all measurements.

6.1.4.4.2.2 (Reserved)

6.1.4.4.2.3 Air Temperature at Contingency Landing Sites

The diurnal air temperatures for contingency landing sites for missions with inclination of greater than 30° are shown in Figure 6.1.4.4.2.3-1. Diurnal air temperatures for contingency landing sites for missions with inclination of 30° or less are shown in Figure 6.1.4.4.2.3-2. The curves for a hot day were synthesized assuming a maximum temperature of 110°F at noon and a minimum temperature at the ETR in July for a 95 percent hot day. The curve for a cold day for inclination > 30° was synthesized assuming a minimum temperature of 0°F with a 50°F temperature rise and fall in the morning and afternoon, respectively. For inclination ≤ 30°, the curve for a cold day was based on historical data for Moron, Spain.

6.1.4.4.2.4 Ambient Temperature Constant Values

Where it is desired to use constant (conservative) values of ambient temperature, the following values are recommended:

Hot Environment

Prelaunch and normal post-landing	99°F
Contingency landing	110°F

Cold Environment

Prelaunch and normal post-landing	25°F
Contingency landing	0°F

6.1.4.4.3 Ground Surface Temperature

The ground surface temperature is influenced by incident daytime solar radiation, sky/ground radiation interchange, air temperature and velocity, and surface properties. Generally, it is assumed that the ground surface temperature is the same as the air temperature. If desired, the ground temperature may be assumed to be equal to the diurnal air temperature. When constant (conservative) values are appropriate, the following values may be used:

Hot Environment

Prelaunch	99°F (60°F*)
Normal post-landing	99°F
Contingency landing	110°F

Cold Environment

Prelaunch	25°F
Normal post-landing	25°F
Contingency landing	0°F

* When in a vertical position on the launch pad, the bottom of the Orbiter views the external tank which has a temperature of approximately 60°F.

6.1.4.4.4 Sky Temperature

The sky temperature is influenced by climatic conditions such as ambient temperature and cloud cover and time of day. While on the runway the upperbody surfaces of the Orbiter radiate heat primarily to the sky. While on the launch pad in a vertical position, these surfaces radiate approximately one-half to the ground and one-half to the sky. The following constant values are recommended for design purposes:

Hot Environment

Prelaunch	50°F*
Normal post-landing	50°F
Contingency landing	50°F

Cold Environment

Prelaunch	5°F
Normal post-landing	-22°F
Contingency landing	-22°F

* Average radiation temperature viewed by Orbiter top surfaces is 76°F assuming sky temperature of 50°F and ground temperature of 99°F.

6.1.5 (DELETED)

6.1.6 (Reserved)

TABLE 6.1.4.1-1 CARGO BAY WALL TEMPERATURE

CONDITION	TEMPERATURE	
	Minimum	Maximum
1. Prelaunch (1)	+40°F	+120°F
2. Launch (1)	+40°F	+150°F
3. On-Orbit (doors open) (2) (4)	-250°F	+200°F
4. Entry and Post-landing (3) (4)	-50°F	+220°F

NOTES:

(1) Conditions 1 and 2 are for an assumed adiabatic cargo element.

(2) Condition 3 is for an assumed empty cargo bay. The effect on wall temperature which results with a cargo element installed is dependent upon cargo element configuration, cargo element location in the bay, and on-orbit attitude. Under hot case conditions, the effects generated by the cargo element can cause local cargo bay wall insulation temperatures to substanially exceed 200°F.

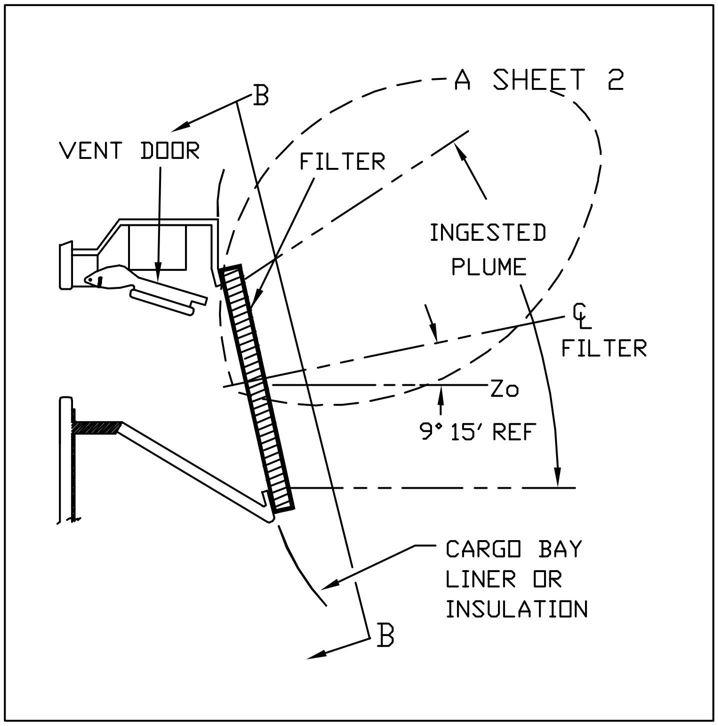
(3) Condition 4, minimum, is for an assumed adiabatic cargo element with an initial -250°F cargo bay wall temperature. Condition 4, maximum, is for an assumed empty cargo bay.

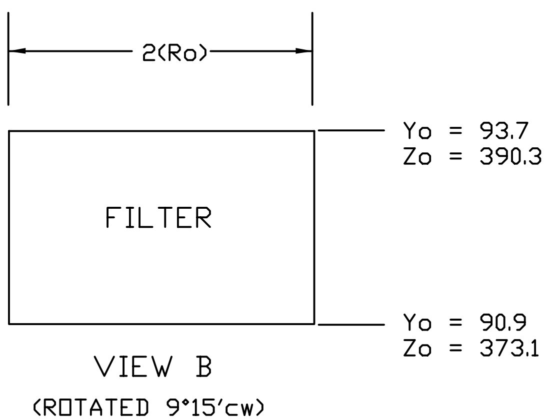
(4) Conditions 3 and 4 should be analyzed using detailed integrated Orbiter/cargo element math models to define cargo element and Orbiter cargo bay temperatures for specific cargo element configurations.

TABLE 6.1.4.2.2-1 REFERENCE HEATING RATE, TEMPERATURES AND PRESSURE

t (sec)	q_r (BTU/ft^2 sec)	T_A (^oR)	T_F (^oR)	P_o (psf)
0	.0000	500	460	4.46E-5
100	.0000	650	470	6.56E-5
200	.0004	850	480	4.44E-4
300	.0050	1040	520	4.44E-3
400	.0156	1350	640	1.30E-2
500	.0277	1470	780	2.33E-2
600	.0416	1530	920	3.54E-2
700	.0600	1660	1000	5.43E-2
800	.0866	1750	1080	8.66E-2
900	.1215	1760	1150	1.60E-1
1000	.2165	2140	1180	3.52E-1
1100	.1367	1830	1160	5.76E-1
1200	.2778	2140	1110	1.138
1300	.3177	1770	1080	2.716
1400	.4644	1380	1050	9.366
1450	.3642	1060	1020	1.680E+1
1475	.3248	660	940	2.287E+1
1500	.2089	560	760	1.738E+1
1550	.1564	520	580	6.244E+1
1650	.0000	500	460	3.362E+1
1700	.0000	500	450	5.865E+1
1750	.0244	500	470	9.547E+2
1800	.0615	530	530	1.459E+3
1850	.0926	530	530	2.029E+3

t = Time from entry interface at 400K ft.
q_r = Reference heating rate (for a 1" D cyl, T_W = 460^oR).
T_A = Reference air temperature (at Yo = 0, ^oR = 0).
T_F = Filter temperature.
P_o = Payload compartment air pressure.





NOTE:

1. FOR CALCULATION PURPOSES, PLUME IS CONSIDERED TO BE CONICAL IN SHAPE

WHERE:

2(Ro)= LARGEST SIDE DIMENSION OF FILTER SCREEN(23.7 FOR CALCULATION PURPOSES)

R = RADIAL DISTANCE FROM CENTERLINE OF PLUME TO OBJECT

Rp = RADIAL DISTANCE FROM CENTERLINE OF PLUME TO OUTERMOST EDGE OF PLUME

FIGURE 6.1.4.2.2-1 AIR PLUME ENVELOPE AND HEATING REGIONS
(SHEET 1 OF 2)

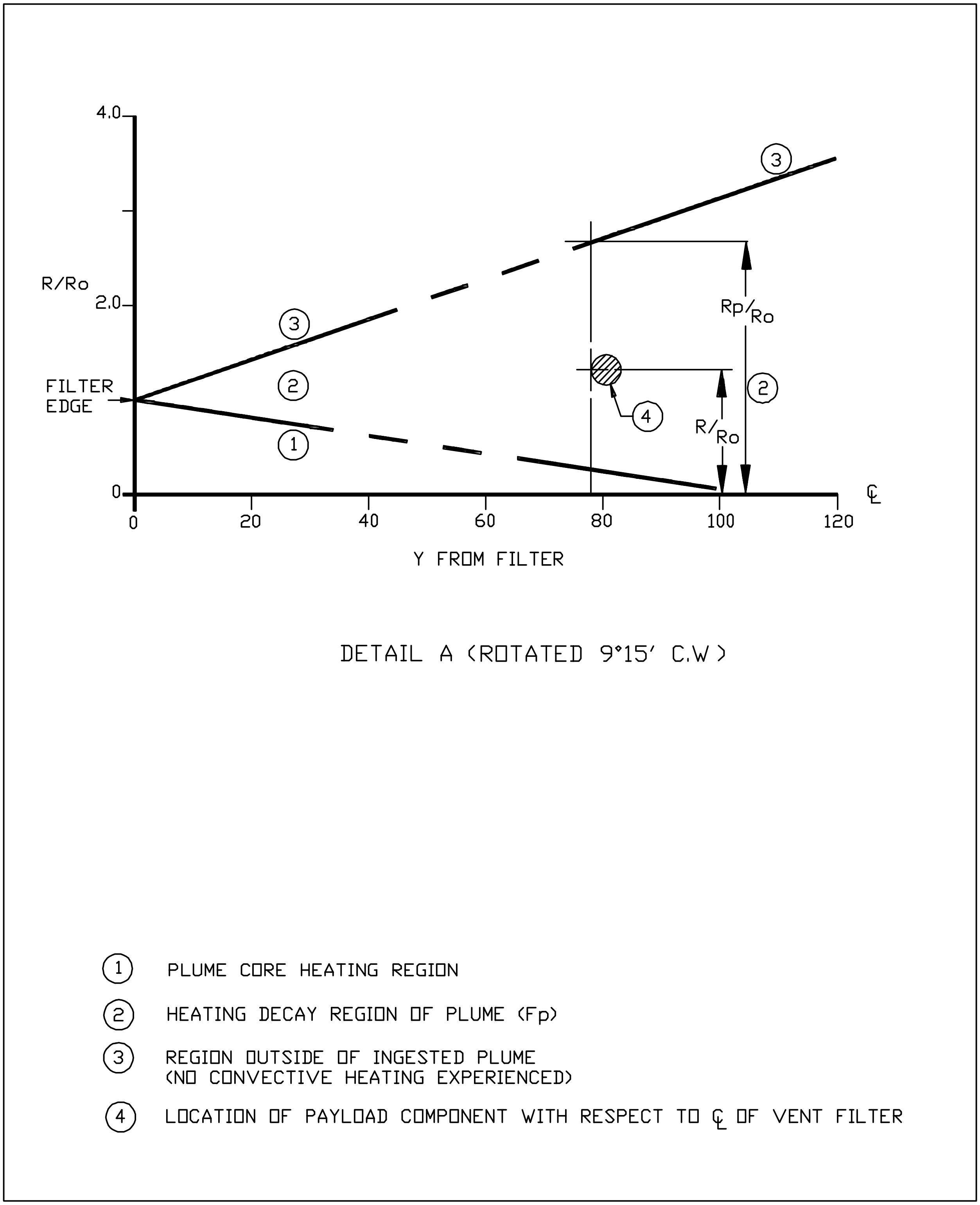


FIGURE 6.1.4.2.2-1 AIR PLUME ENVELOPE AND HEATING REGIONS
(SHEET 2 OF 2)

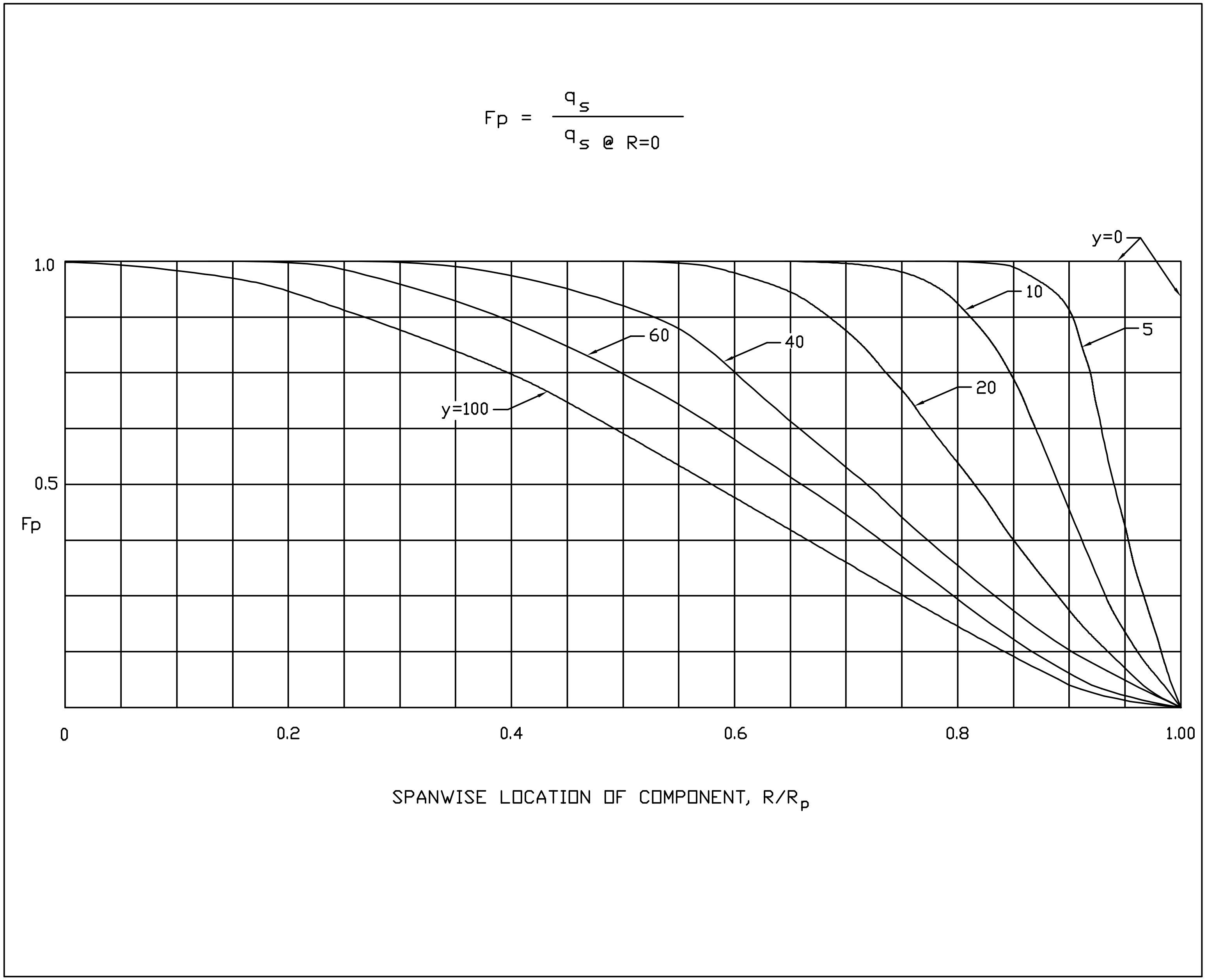


FIGURE 6.1.4.2.2-2 SPANWISE HEATING DISTRIBUTION WITHIN THE PLUME

TIME OF DAY	DESIGN HIGH SOLAR RADIATION		DESIGN LOW SOLAR RADIATION	
HOUR	BTU/FT ^{2}/HR	GM-CAL/CM ^{2}/MIN	BTU/FT ^{2}/HR	GM-CAL/CM ^{2}/MIN
0500	0	0.00	0	0.00
1100	363	1.64	70	0.32
1300			80	0.36
1400	363	1.64		
2000	0	0.00	0	0.00

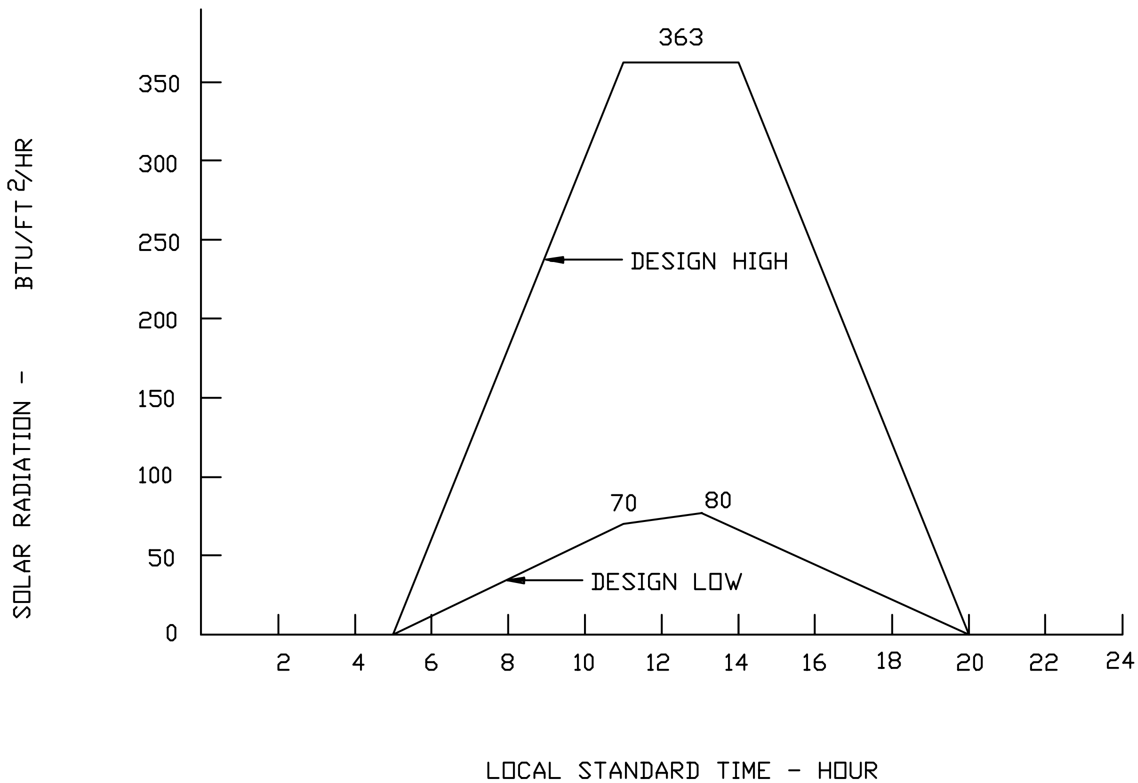


FIGURE 6.1.4.4.1.1-1 DIURNAL VARIATION FOR SOLAR CONSTANT

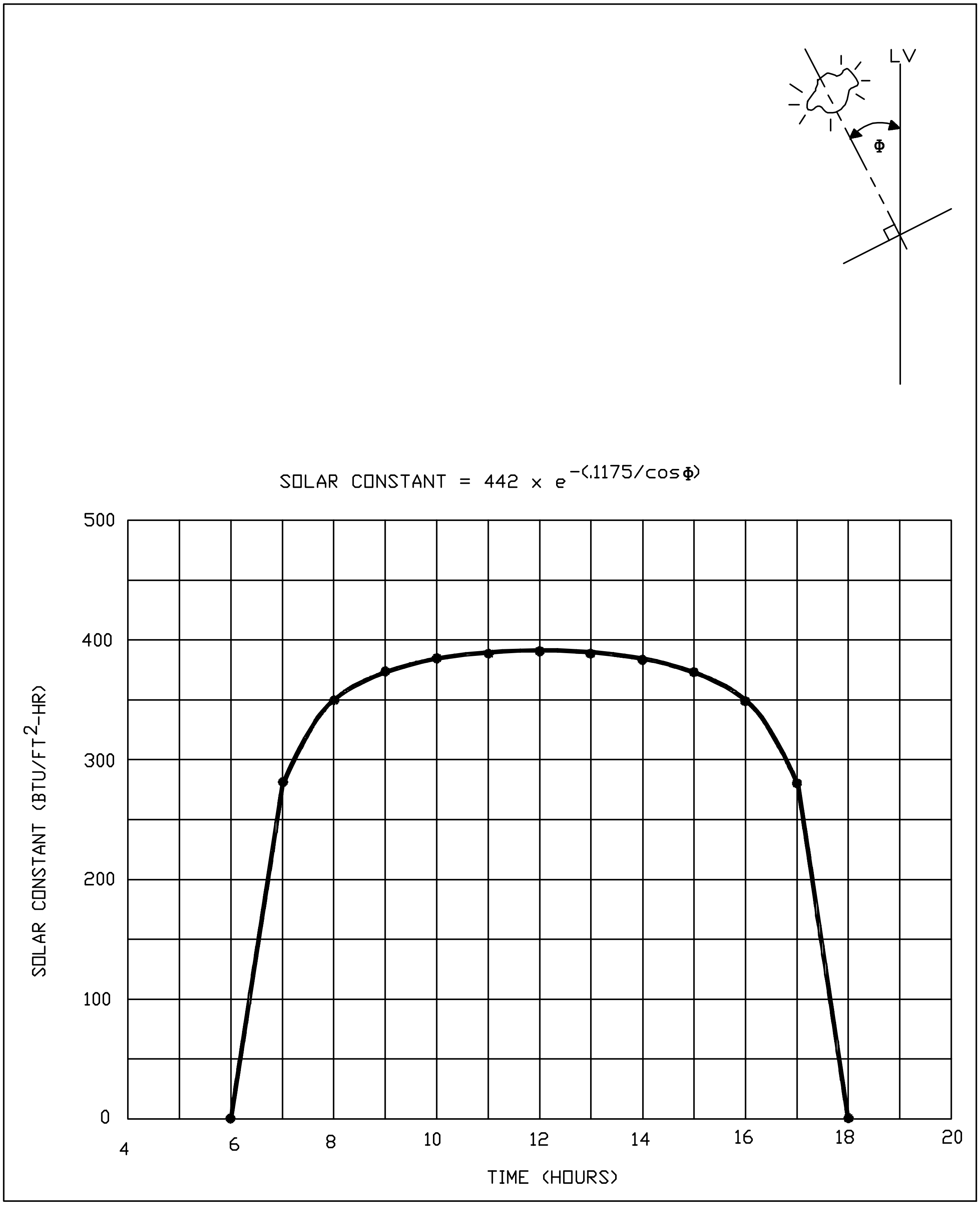


FIGURE 6.1.4.4.1.2-1 EQUATORIAL SOLAR CONSTANT VARIATION AT CONTINGENCY LANDING SITES

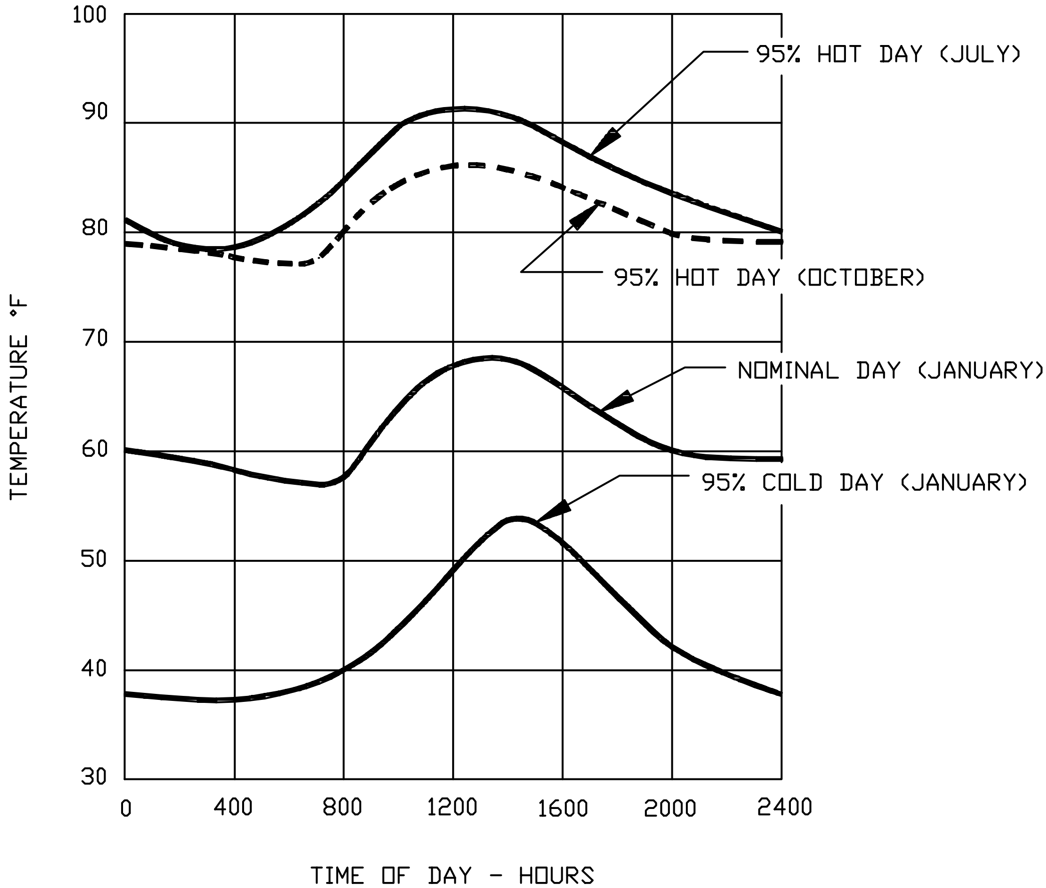


FIGURE 6.1.4.4.2.1-1 EASTERN TEST RANGE (ETR) DIURNAL AIR TEMPERATURE EXPERIENCE

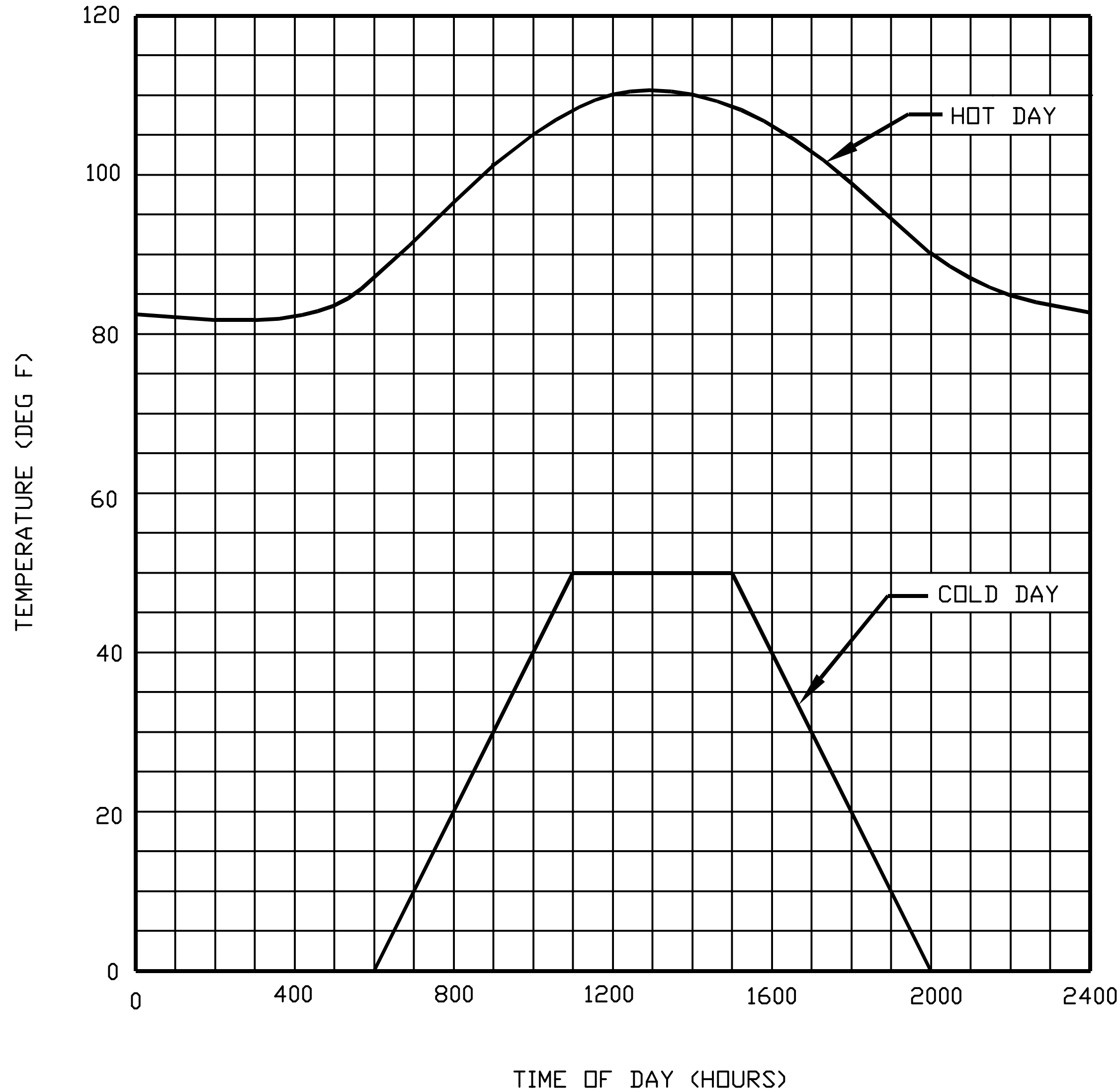


FIGURE 6.1.4.4.2.3-1 WORST CASE DIURNAL AIR TEMPERATURE AT CONTINGENCY LANDING SITES FOR MISSIONS WITH INCLINATION GREATER THAN 30 DEGREES

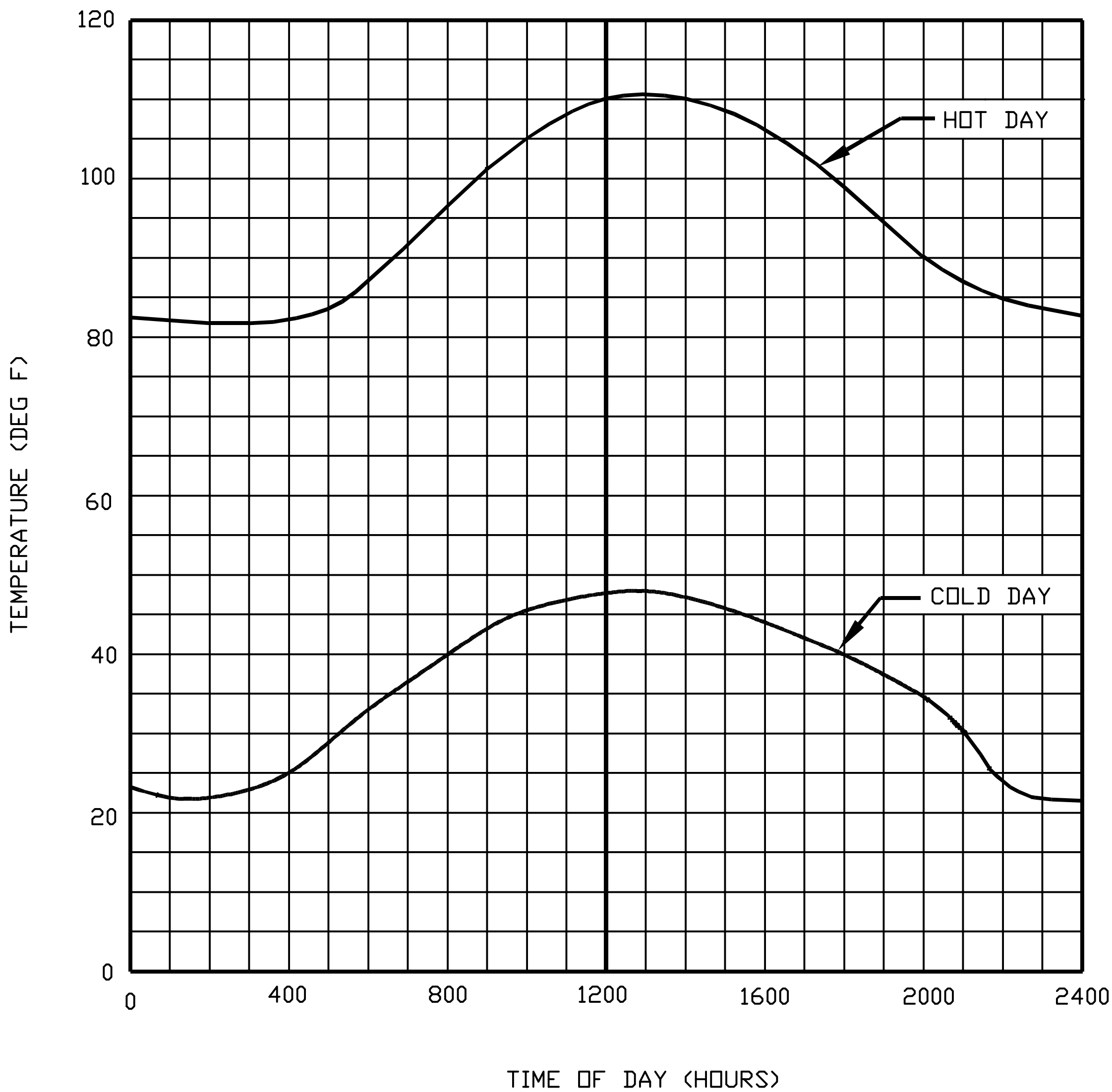


FIGURE 6.1.4.4.2.3-2 WORST CASE DIURNAL AIR TEMPERATURE AT CONTINGENCY LANDING SITES FOR MISSIONS WITH INCLINATION 30 DEGREES OR LESS

THIS PAGE INTENTIONALLY LEFT BLANK

6.2 ACTIVE THERMAL CONTROL

6.2.1 Purge and Vent of Cargo Bay

The Orbiter shall provide a ground purge system which is comprised of a ground-system supplied, on-board duct network which distributes Air/GN_2. A representative purge flow distribution in the cargo bay without spigot flow is shown in Figure 6.2.1-1. As noted, cargo bay purge flow is lost to the lower mid-fuselage at the vent filters due to the slight cargo bay purge positive pressure. The actual flow rate distribution is a function of the manifold and spigot flow rates.

6.2.1.1 Cargo Bay Purge Characteristics

The cargo bay purge gas characteristics provided by the Orbiter to the payload and cargo bay, at the specific prelaunch and post-landing operations phase, shall be as specified in Table 6.2.1.1-1.

6.2.1.2 (DELETED)

6.2.1.3 (Reserved)

6.2.2 (Reserved)

6.3 (Reserved)

6.4 (DELETED)

TABLE 6.2.1.1-1 CARGO BAY PURGE GAS CHARACTERISTICS

Parameter	Pad	Portable Purge UNIT (PPU)	OPF
Gas Type	Air/GN_2(A)(C)	Air (B) (C) (H)	Air (C)
Temperature: (G) deg. C (deg. F) Selectable throughout range	7-37.8(45-100)	7-37.8(45-100)	7-37.8(45-100)
Humidity: grams $H_2$0/Kg (grains $H_2$0/lb) Ground controlled Not selectable Air (I) GN_2	 ≤ 5.29 (≤ 37) ≤ 4.14 (≤ 29) ≤ 0.14 (≤ 1)	 ≤ 5.29 (≤ 37) ------ ------	 ≤ 5.29 (≤ 37) ----- -----
Flow Rate: Spigots Closed: (D) Kg/min (lb/min) Manifold	 50.9 (112) min. 61.8 (136) nom. 109 (240) max.	 50.9 (112) min. 61.8 (136) nom. 100 (220) max.	 50.9 (112) min. 61.8 (136) nom. 109 (240) max.
Flow Rate with Maximum Total Cargo Bay Flow/Spigots Open: (D) Kg/min (lb/min) Manifold Spigots (E) (F)	 54.5 (120) min. 68.2 (150) max.	 50 (110) min. 61.4 (135) max.	 54.5 (120) min. 68.2 (150) max.

NOTES: (Notes 1, 2 and 3 general: Notes A through I apply to specific table locations)

TABLE 6.2.1.1-1 CARGO BAY PURGE GAS CHARACTERISTICS
(CONTINUED)

Notes: (Continued)

1. Flow rates in the table are lower than Vehicle/GSE interface flow rates due to flow distributed to Lower Mid Fuselage. Total Vehicle/GSE Interface flow rates at the Pad and OPF, range from 140 (lb/min) to 300 (lb/min), and all other locations specified in the table, range from 140 (lb/min) to 275 (lb/min).

2. The cargo bay internal pressure shall not exceed .30 PSID above ambient.

3. The cargo bay depressurization rate (on the ground) shall not exceed 0.18 PSI/sec. This dp/dt is associated with the prelaunch vent opening sequence at T-28 sec.

(A) Initiation of GN_2 purge prior to CRYO Tanking for inerting Cargo Bay is defined in ICD-2-0A002 "Shuttle System Launch Pad and MLP".

(B) Purge flow to be initiated within touchdown +45 minutes at primary landing site and touchdown +90 minutes at secondary landing site.

(C) Purge will be provided to all payloads by mobile/facility equipment during closed payload bay door operations except during mobile GSE/facility/mobile GSE transfer, towing, orbiter mate/demate, orbiter test or purge system LRU replacement/test, or GSE periodic maintenance at the OPF, VAB, and Pad. Approximately 3-4 days are required for orbiter mate/demate operations in the VAB after OPF roll-out and 1.5 hours for mobile GSE/facility/mobile GSE transfer at the PAD

(D) Measurement and accuracy of the flow rate is specified and controlled at the Orbiter/Facility interface within ± 5 percent.

Starting no earlier than T-11 minutes, the cargo bay total flow rate (manifold plus spigot) is reduced to between 72.7-81.8 kg/min (160-180 lb/min) should the total flow rate be greater than this range. Spigot and manifold flow rates will decrease proportionally with the cargo bay total flow rate as a result of the flow reduction.

(E) Maximum flow rate out of all three (3) spigots shall not exceed 68.2 kg/min (150 lb/min) or exceed 45.5 kg/min (100 lb/min) out of any single spigot. Nominal flow rate out each spigot is 22.7 kg/min (50 lb/min).

(F) Maximum pressure downstream of purge spigots is 0.50 psig-measured above payload bay pressure.

TABLE 6.2.1.1-1 CARGO BAY PURGE GAS CHARACTERISTICS
(CONCLUDED)

Notes: (Continued)

(G) Temperature is measured at the Orbiter/Facility interface. The nominal set point is 65°F controllable to ± 5°F. Temperature sensitive payloads may request the temperature be controlled to ± 2°F under steady flow conditions with excursions to ± 5°F for up to 1 hour in any 12 hour period. The following exception applies to all payloads:

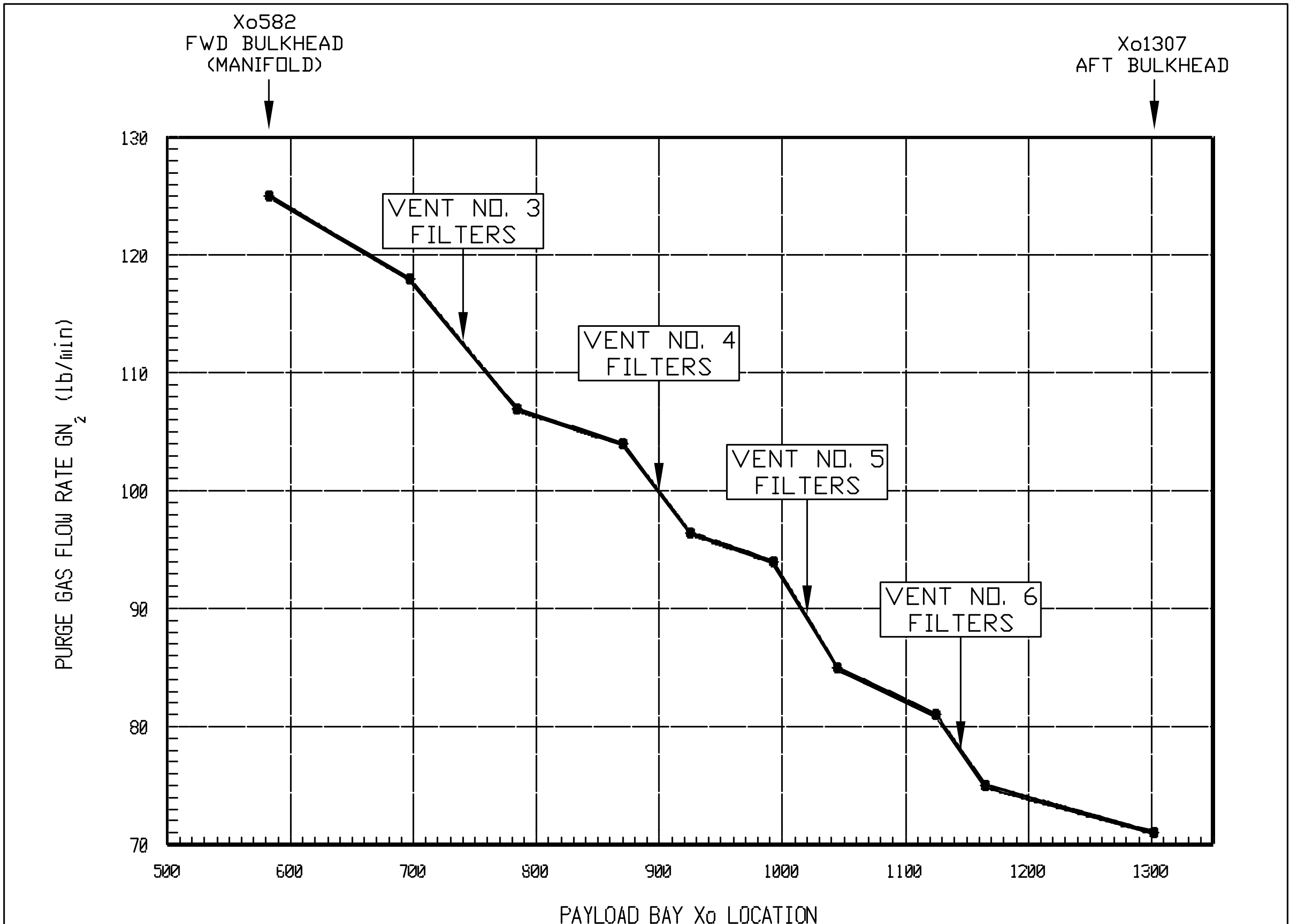
(i) Allowable temperature variations during flowrate adjustment, air to GN_2 or GN_2 to air changeover are ± 15°F for the first 15 minutes after change.

(H) Maximum total flow rate to purge cicuits 1,2, and 3 and the crew module must be limited to 460 lb/min in order to provide full temperature range.

(i) The portable purge unit is used to support operations upon landing, in transit from the runway to the OPF or mate/demate device (MDD), in the VAB, in transit from the VAB to the Pad, and occasionally while the vehicle is in the OPF.

(I) For final Orbiter pyro operations (electrical connect or disconnect) at the pad, the moisture content of the purge air is less than or equal to 37 grains per pound throughout a time period necessary to accommodate each pyro servicing event (approximately 24 hours).

FIGURE 6.2.1-1 CARGO BAY PURGE GAS FLOW DISTRIBUTION (TYPICAL LOW FLOW RATE PURGE, NO SPIGOT FLOW)



NOTES:

(1) VENTS CONSIST OF BOTH MAIN AND LINER FILTERS

(2) CURVE APPLIES ONLY TO VEHICLES WITH ACTIVE VENT NO. 4 FILTERS

THIS PAGE INTENTIONALLY LEFT BLANK

7.0 ELECTRICAL POWER INTERFACES

7.0.1 PAYLOAD DEFINITION

7.0.1.1 (Reserved)

7.0.1.2 Fusing Diagram

STS/Cargo Element electrical power-fusing diagram shall be as shown in Figure 7.0.1.2-1.

7.0.2 UNIQUE MISSION SPECIFIC REQUIREMENTS

7.0.2.1 Pyrotechnic Initiation

Orbiter PRI Pl or Auxiliary PL DC power can be utilized by each payload for pyrotechnic initiation under the following conditions:

a. Payload pyrotechnic initiations, either singly or grouped, shall require no more than 80 amps. (peak) per initiation from the Orbiter PRI power source measured at the interface defined in the cargo element unique-ICD (the initiator(s) should be assumed shorted "0"ohms" for this calculation). Current limiting shall be included in each initiator firing circuit which limits current to 10 amps (peak) per initiator firing circuit. When using the Orbiter Auxiliary PL DC power, the total current limit is 20 amps (peak). When a payload utilizes pyrotechnic initiation via the PRI PL source and one or both Auxiliary buses, the total power utilized per initiation shall not exceed 80 amps (peak) measured at the Orbiter to payload interface.

b. The capability to turn-off firing circuits within 10 seconds after utilization via timer or crew command shall be provided in order to preclude continous draw if the initiator(s) shorts.

c. Figure 7.0.2.1-1 shows the voltage reduction for the firing transient and subsequent "on" time, which shall be applied (subtracted) from the minimum interface voltage levels defined for the PRI PL Bus and Auxiliary PL Busses, in their respective tables.

d. A minimum of 10 seconds shall elapse between pyrotechnic inititaion commands.

e. Power consumption due to pyrotechnic inititaion shall be included as part of the peak power allocated, via the PRI PL Bus or Auxiliary PL DC busses, to the specific payload.

7.0.3 SMALL PAYLOAD UNIQUE INTERFACES

7.0.3.1 ORBITER DC ELECTRICAL POWER DISTRIBUTION FOR SMALL PAYLOADS

7.0.3.1.1 STS/Payload Electrical Power Interfaces

Payload power interface characteristics at STS/Cargo Element Interface shall be as shown in Table 7.0.3.1.1-1.

7.0.3.1.2 (Reserved)

7.0.3.1.3 Cargo Bay Power

Orbiter DC power distribution in the cargo bay is as shown in Figure 7.0.3.1.3-1. The standard electrical power allocation provided by the Orbiter for each mission phase, shall be as specified in Table 7.0.3.1.3-1. The Small Payload electrical interfaces are located at the termination of SPAT extender cables at the STS/Cargo Element interface. On-Orbit voltage level at the payload interface is shown in Figure 7.0.3.1.3-2 for all cargo bay locations except Bay 13 port side. On-Orbit voltage level at the Payload interface for a Bay 13 port side location of a Small Payload is shown in Figure 7.0.3.1.3-3.

7.0.4 (Reserved)

TABLE 7.0.3.1.1-1

CARGO ELEMENT POWER CHARACTERISTICS AT TERMINATION OF SPAT EXTENDER CABLE(S)

ORBITER SERVICE BY FLIGHT PHASE	MAX CONT POWER (W)	PEAK POWER (W)	TIME LIMIT ON PEAK POWER	NOTES
ON-ORBIT STANDBY	175	325	15MIN/3HRS	1
ON-ORBIT OPERATIONS	200	500	15MIN/3HRS	1

TABLE 7.0.3.1.1-1 CARGO ELEMENT POWER CHARACTERISTICS AT TERMINATION OF SPAT EXTENDER CABLE(S)
(CONCLUDED)

Note: (1) Interface voltage requirement is 24 - 32 VDC.

TABLE 7.0.3.1.3-1 POWER ALLOCATION AT THE END OF TWO 8 AWG FEEDERS

MISSION PHASE	VOLTS RANGE (VDC)	POWER (WATTS)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
GROUND OPERATION		250	375	15 min/3 hr	(1)
	(2)	1500	1500	N/A	(3)(4)
ON-ORBIT	(2)	1500	1500	N/A	(4)(5)

NOTES:

(1) Orbiter systems powered to greater than on-orbit levels.

(2) See Figure 7.0.3.1.3-2 or 7.0.3.1.3-3 for voltage levels.

(3) Orbiter systems powered to on-orbit levels.

(4) Power levels shown in table are for the sum of two 8 AWG feeders. Power levels for one 8 AWG feeder shall not exceed 750 watts.

(5) The SPA payload shall be limited to 300 watts peak during on-orbit 1 and 3 (after primary payload operations are complete), reference Table 7.0.3.1.1-1.

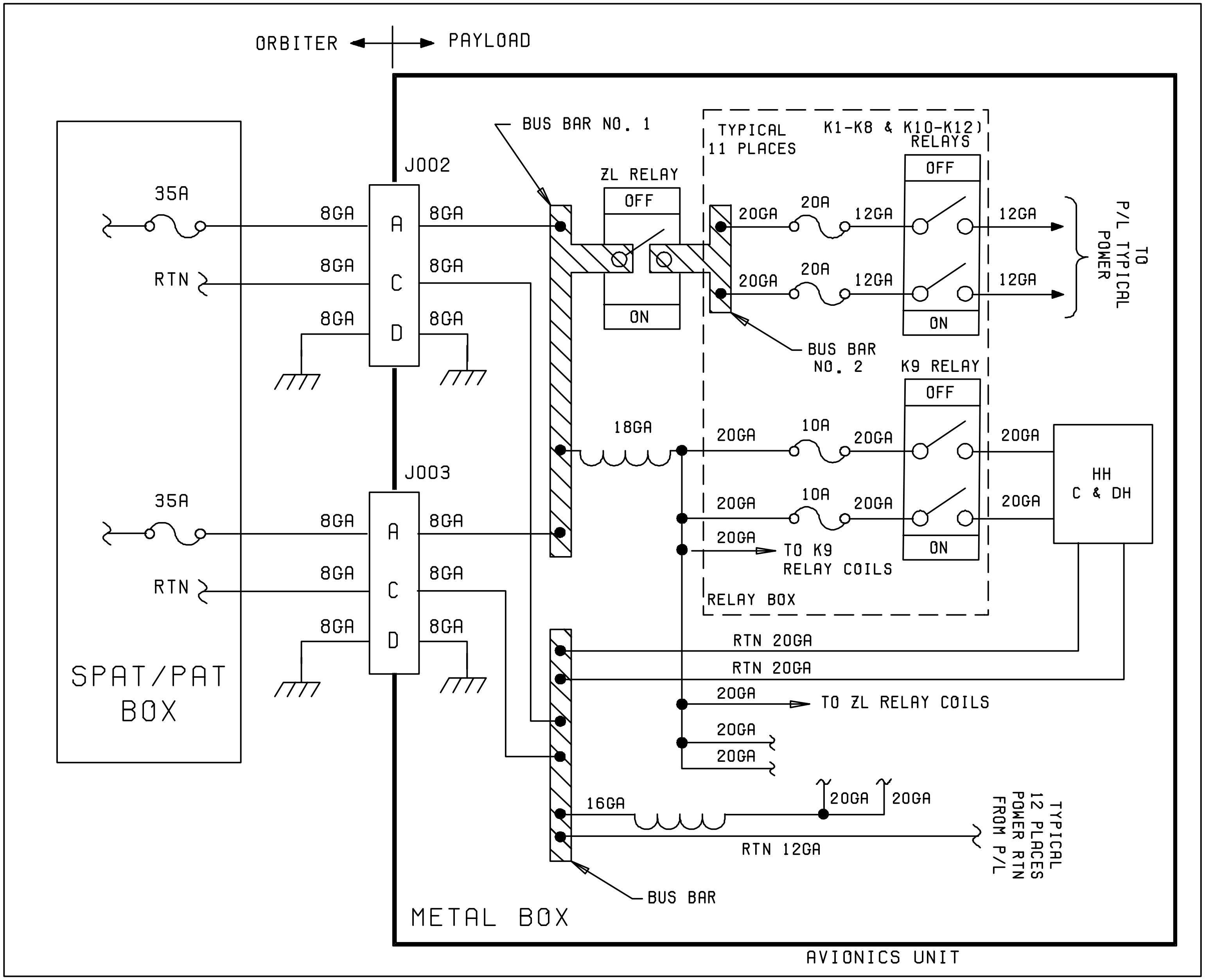


FIGURE 7.0.1.2-1 FUSING DIAGRAM

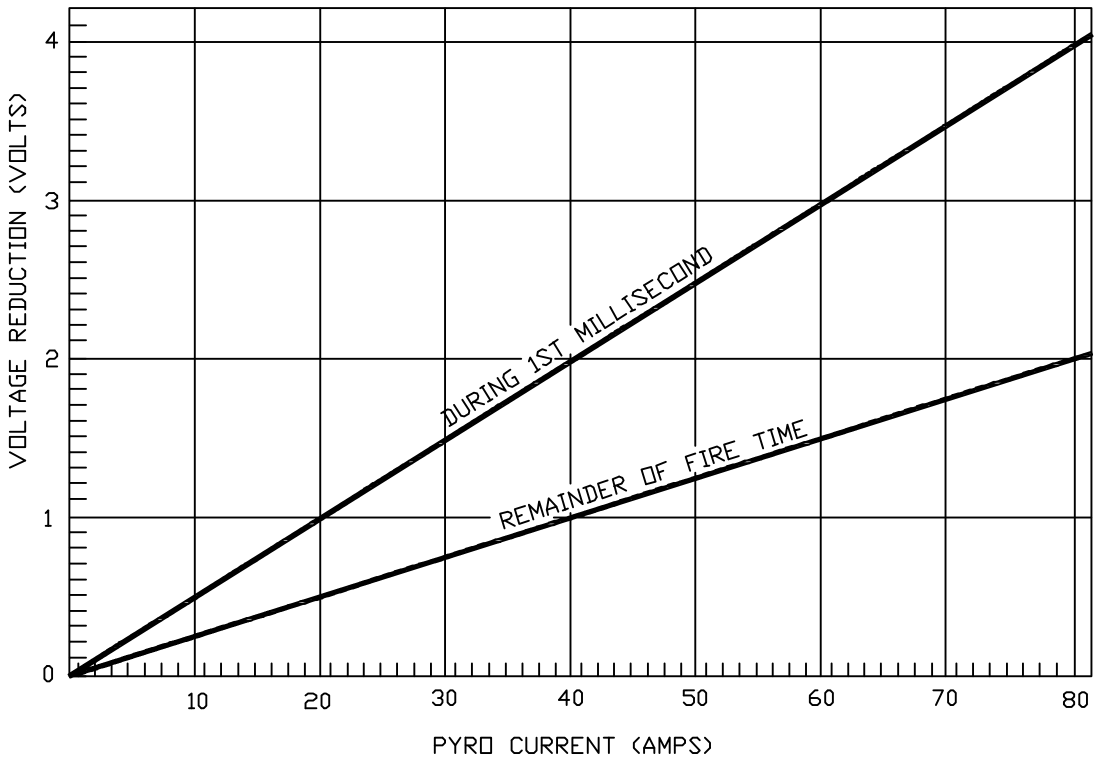


FIGURE 7.0.2.1-1 VOLTAGE REDUCTION DUE TO PYROTECHNIC FIRING

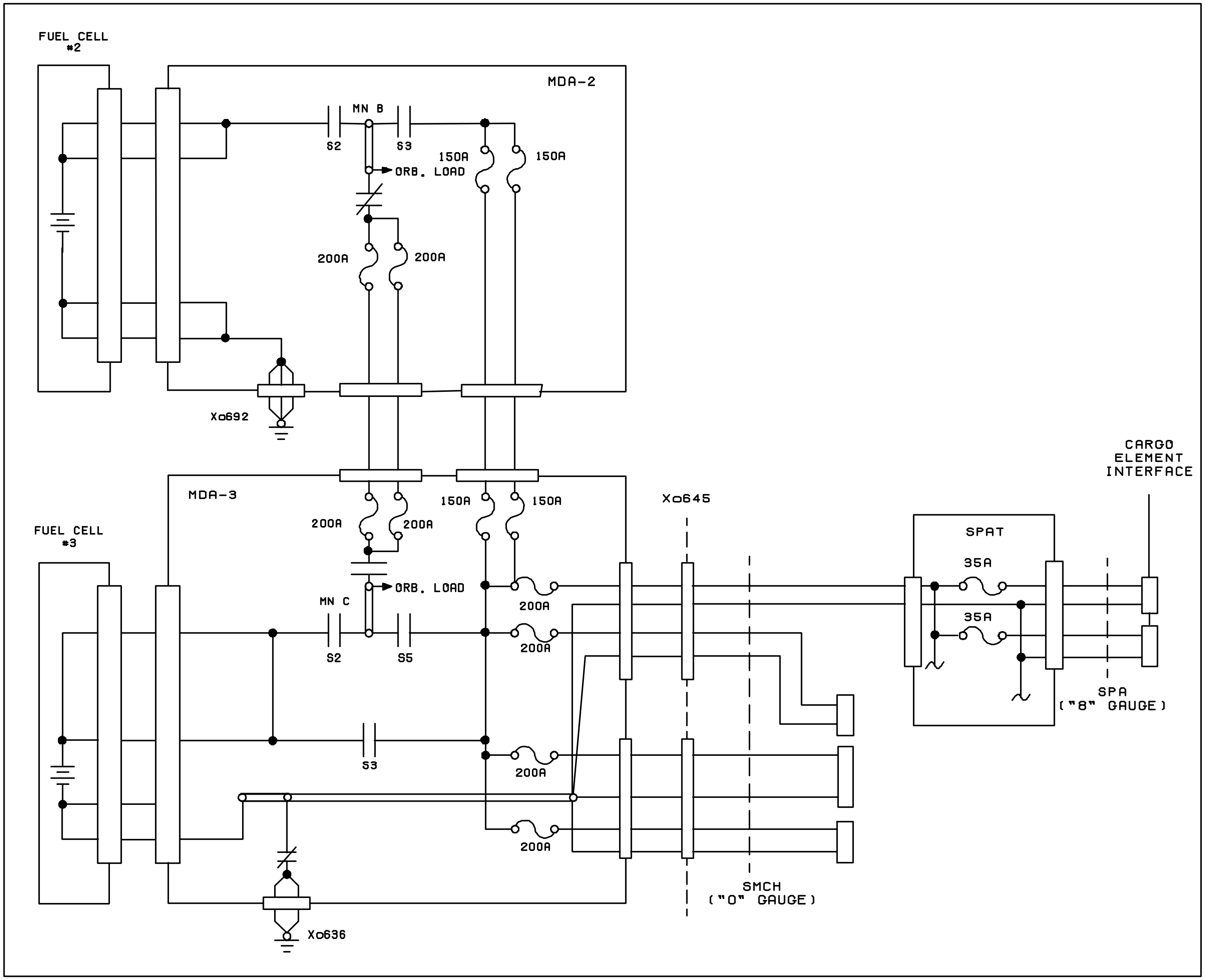
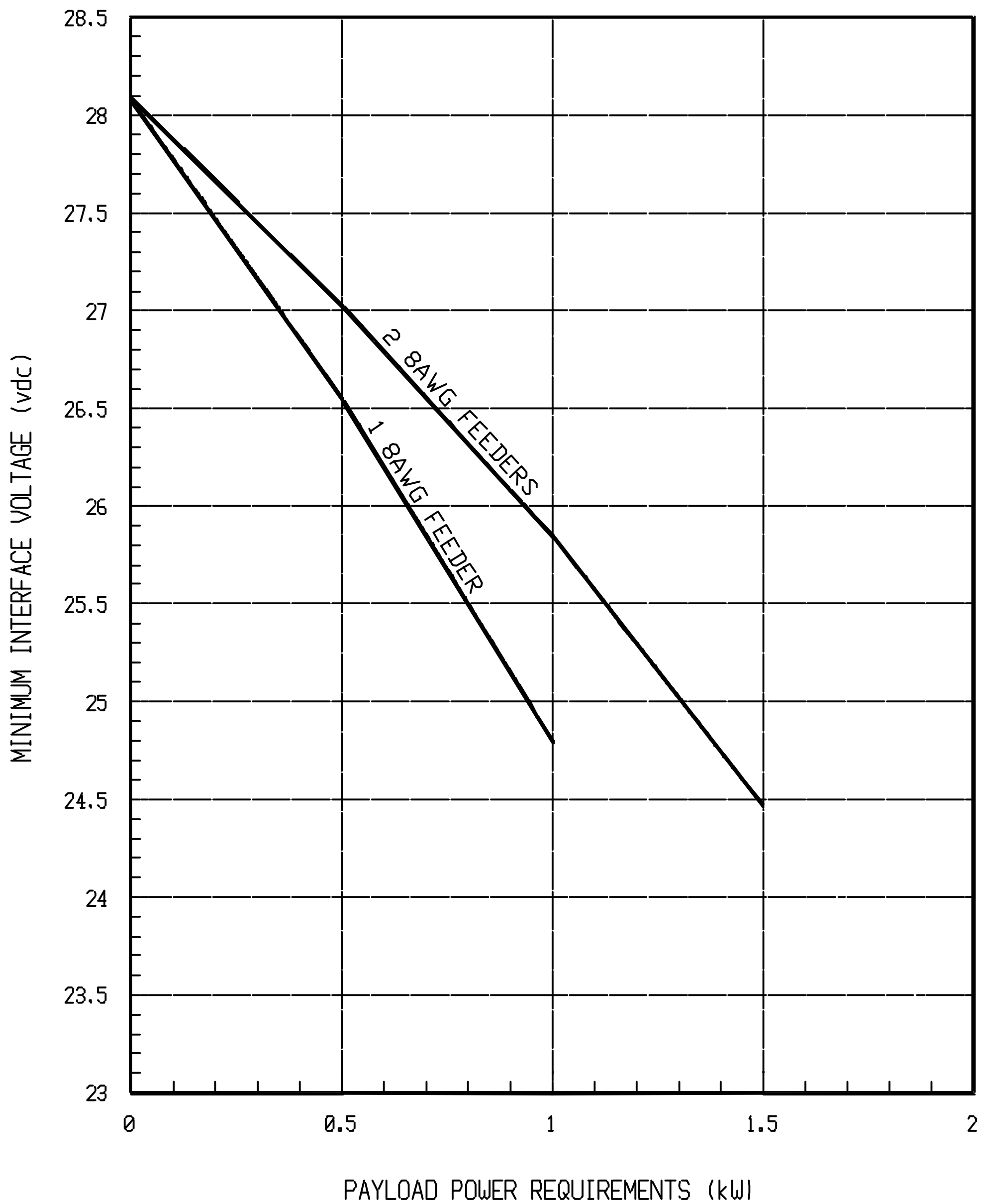


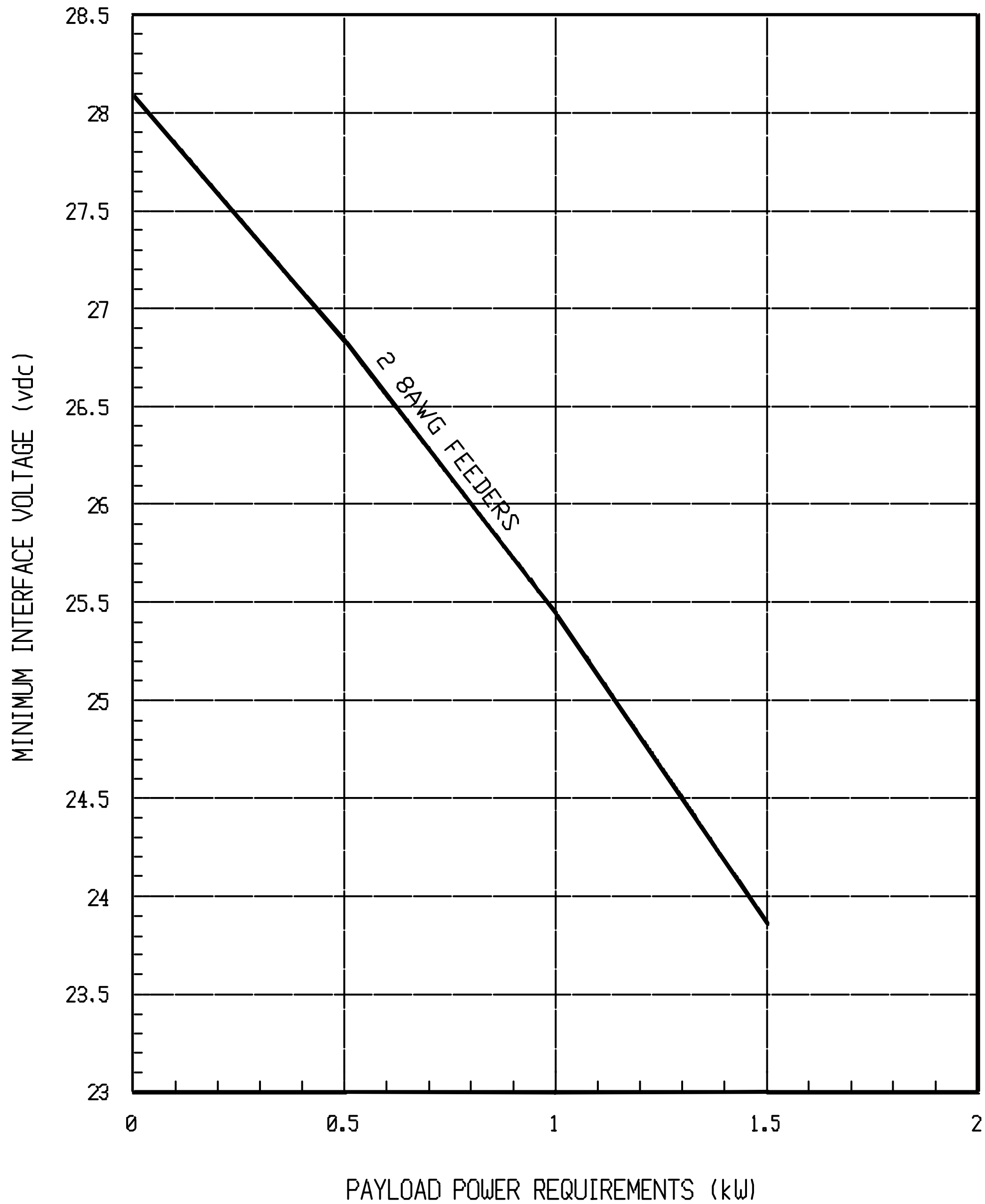
FIGURE 7.0.3.1.3-1 ORBITER DC POWER DISTRIBUTION TO A SMALL PAYLOAD



CURVE CRITERIA:

1. CURVE BASED ON END-OF-LIFE (LCC) FUEL CELL (NSTS 16007, LAUNCH COMMIT CRITERIA, FIG. 25-02 REV. E FUEL CELL POWERPLANT MINIMUM LAUNCH PERFORMANCE LIMITS)
2. ORBITER LOADS = 17.5kW +2kW (HYDRAULIC CIRCULATION PUMP "ON")
3. ASSUME ONE POWER LOAD (PRIMARY PAYLOAD) AT 5kW
4. ASSUME MAIN B AND MAIN C BUS TIED
5. ASSUME VARIED LOAD (0 - 1.5kW SPA PAYLOAD) AT END OF ONE OR TWO 30 FT. 8-AWG SPAT/PAT BOX HARNESSES. SPAT/PAT BOX FED BY 57 FT. SMCH HARNESS

FIGURE 7.0.3.1.3-2 SPA INTERFACE VOLTAGE LEVEL



CURVE CRITERIA:

1. CURVE BASED ON END-OF-LIFE (LCC) FUEL CELL (NSTS 16007, LAUNCH COMMIT CRITERIA, FIG. 25-02 REV. E FUEL CELL POWERPLANT MINIMUM LAUNCH PERFORMANCE LIMITS)
2. ORBITER LOADS = 17.5kW +2kW (HYDRAULIC CIRCULATION PUMP "ON")
3. ASSUME ONE POWER LOAD (PRIMARY PAYLOAD) AT 5kW
4. ASSUME MAIN B AND MAIN C BUS TIED
5. ASSUME VARIED LOAD (0 - 1.5kW SPA PAYLOAD) AT END OF ONE OR TWO 40 FT. 8-AWG SPAT/PAT BOX HARNESSES. SPAT/PAT BOX FED BY 57 FT. SMCH HARNESS

FIGURE 7.0.3.1.3-3 SPA INTERFACE VOLTAGE LEVEL (BAY 13 PORT)

THIS PAGE INTENTIONALLY LEFT BLANK

7.1 (Reserved)

7.2 ELECTRICAL ENERGY

7.2.1 Baseline Energy Allocation

Energy allocation to the individual Cargo Elements shall be defined in the Payload Integration Plan (PIP) for each Cargo Element.

7.3 DC POWER

7.3.1 Orbiter DC Electrical Power System and Distribution

7.3.1.1 Cargo Bay Main DC Power

Orbiter main DC power distribution in the cargo bay is as shown in Figure 7.3.1.1-1.

7.3.1.2 (Reserved)

7.3.1.3 (Reserved)

7.3.1.4 Circuit Protection Criteria

Refer to Section 20 paragraph, 20.2

Note: A non-compliance condition exists between the Orbiter and the MIGHTY. Refer to Section 20 for the definition of the unique interface requirement.

Payload electrical power distribution circuitry shall be designed such that electrical faults do not damage Orbiter wiring nor present a hazard to the Orbiter or crew. Circuit protection devices shall be incorporated into the payload design in compliance with the NASA electrical design criteria for cargo element circuit protection as defined in NSTS 18798.

Orbiter electrical wiring insulation is rated at 200 degrees Celsius.

7.3.1.5 (Reserved)

7.3.2 (Reserved)

7.3.3 (Reserved)

7.3.4 (Reserved)

7.3.5 (Reserved)

7.3.6 (Reserved)

7.3.7 DC Power Ripple and Transient Limits

Ripple and transient limits for electrical power provided by the Orbiter at the indicated interfaces shall not exceed the voltage values specified in the following paragraphs.

During normal equipment operation, for both ground power and fuel cell power, voltage transients of opposite polarity shall not occur simultaneously on the positive and return dc power busses.

7.3.7.1 Inflight DC Power Bus Ripple
Inflight DC power bus ripple at the interface shall not exceed 0.9 volts peak-to-peak narrowband (30 Hz to 7 kHz) falling 10 dB per decade to 0.28 volts peak-to-peak at 70 kHz, thereafter remaining constant to 400 MHz.

The momentary coincidence of 2 or more signals at any one frequency shall not exceed the envelope defined as 1.6 volts peak-to-peak (30 Hz to 7 kHz), falling 10 dB per decade to 0.5 volts peak-to-peak at 70 kHz, thereafter remaining constant to 400 MHz.

Under the conditions of a passive payload (resistive simulation of load), the ripple on the power supplied shall not be greater than 0.8 volts peak-to-peak broadband (DC to 50 MHz); no discrete frequency shall exceed 0.4 volts peak-to-peak. This condition shall apply at the mid-body power interface only.

7.3.7.2 Inflight DC Power Transients
Inflight DC power transients on the Orbiter DC power busses at the cargo element interface measured differential mode (line to line) shall not exceed twice the line voltage relative to the line voltage for either positive or negative transients. A typical positive transient is shown in Figure 7.3.7.2-1.

7.3.7.2.1 (Reserved)

7.3.7.2.2 Hydraulic Circulation Pump and PRI and Cabin and Aux PL Busses
Hydraulic circulation pump produced transient voltages on the PRI PL Bus, Aux PL A, Aux PL B and the Cabin PL Bus, at the payload design interfaces, shall not exceed the voltage envelope of Figure 7.3.7.2.2-1. Payload design shall accommodate sawtooth transient oscillations, having a maximum amplitude of 4 volts peak-to-peak on the PRI PL Bus, Aux PL A, Aux PL B and the Cabin PL Bus, at the cargo element interface. The oscillation has a base frequency between 500 and 700 Hz and contained within the inner envelope shown in Figure 7.3.7.2.2-1. These bus voltage transients (caused by activation of the hydraulic circulation pump connected to that bus) may occur at any time during on-orbit operations, plus activation at touchdown, and shall not be subjected to pre-flight scheduling.

7.3.7.3 Common-Mode Voltage
Common mode voltage, as used here, is defined as the voltage drop across two points of Orbiter structure caused by a current through the impedance between those two points. The common-mode voltage for the longest Cargo Bay dimension (Station Xo585 to Xo1307 bulkhead) shall not exceed 0.3 volts peak-to-peak, when measured in the time domain with an instrument bandwidth of at least 50 MHz (linear function). This is inclusive of the DC component which may exist in the vehicle structural members. Voltages measured at discrete frequencies shall not exceed 0.15 volts peak-to-peak.

Transient excursions shall be limited to $\pm 50 \times 10^{-6}$ volt-seconds with rise and fall rates not greater than 56 volts/microsecond; peak voltage shall not exceed ±2 volts when measured between station Xo585 and Xo1307 bulkhead.

7.3.7.4 Ground DC Power (via Orbiter EPDS) NOT APPLICABLE

7.4 (Reserved)

7.5 LIMITATIONS ON CARGO UTILIZATION OF ELECTRICAL POWER

7.5.1 (DELETED)

7.5.2 (DELETED)

7.5.3 Cargo Element Activation/Deactivation and Isolation

Each cargo element shall be able to disconnect via crew-operated controls all Orbiter power supplied to the cargo element, except for a total amount not to exceed one (1) amp. A maximum of 500 Watts of power shall be latched on, such that if inadvertent power disconnection to the cargo element occurs, all cargo element loads except for a maximum of 500 Watts shall be disconnected.

7.5.4 (Reserved)

7.5.5 Emergency Power Availability

During Orbiter emergency conditions, power will be provided temporarily to payloads as required for payload safing up to the power level agreed to in the Unique Payload PIP.

7.6 (Reserved)

7.7 ELECTRICAL CONNECTORS NOT APPLICABLE

FIGURE 7.3.1.1-1 ORBITER MAIN DC POWER DISTRIBUTION TO THE CARGO BAY

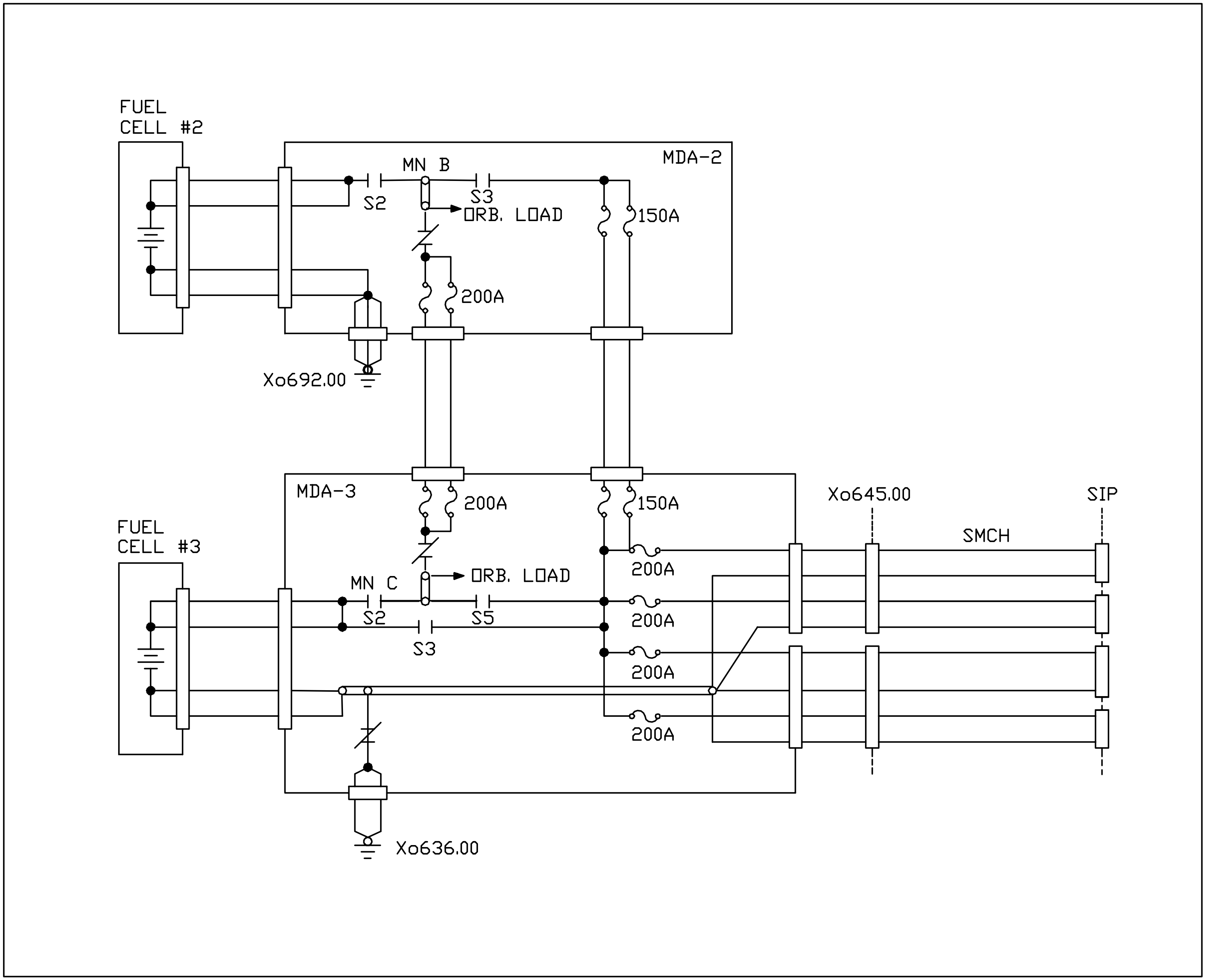
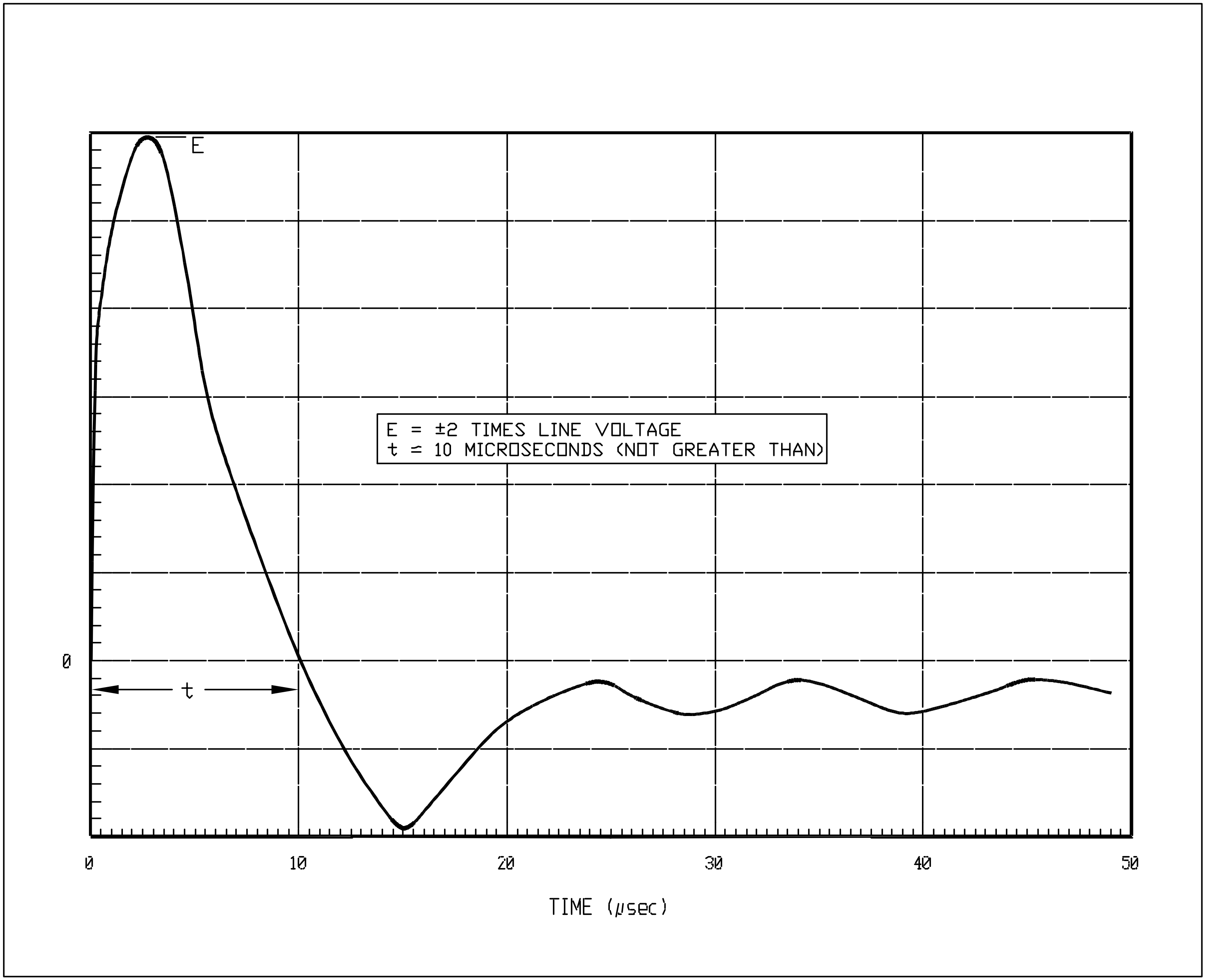


FIGURE 7.3.7.2-1 INFLIGHT DC POWER TRANSIENTS (MEASURED LINE-TO-LINE) AT ALL CARGO ELEMENT DC POWER INTERFACES



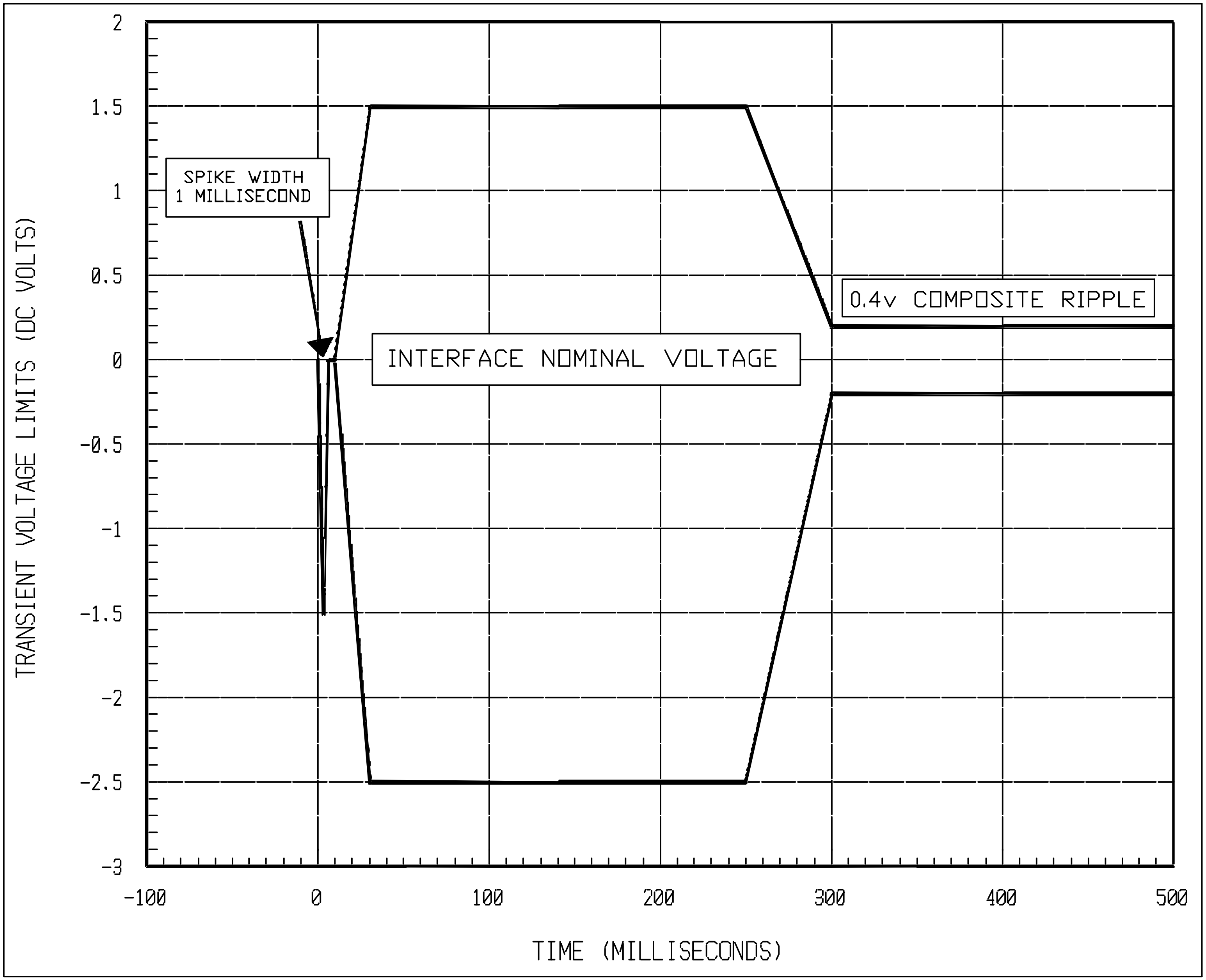


FIGURE 7.3.7.2.2-1 TRANSIENT VOLTAGE ON THE PRI PL BUS, AUX PL A, AUX PL B AND THE CABIN PL BUS AT THE CARGO ELEMENT INTERFACE PRODUCED BY OPERATION OF THE HYDRAULIC CIRCULATION PUMP

THIS PAGE INTENTIONALLY LEFT BLANK

8.0 AVIONICS INTERFACES

8.0.1 PAYLOAD DEFINITION

8.0.1.1 Shuttle Orbiter/Payload Functional Block Diagram and Service Allocation

The Shuttle Orbiter/Cargo Element functional block diagram shall be as shown on Figure 8.0.1.1-1. The Shuttle Orbiter/Payload allocation of interfaces shall be as shown in Table 8.0.1.1-1.

8.0.1.2 STS/Payload PDI Interface

Signal characteristics associated with the Orbiter PDI interface shall be as defined in Table 8.0.1.2-1. Type I, II or III (rather than Block Mode) data is preferred in order to allow ground processing by NSTS. No onboard processing is allowed.

8.0.1.3 (Reserved)

8.0.1.4 STS/Payload PSP Interface

Signal characteristics associated with the Orbiter PSP interface shall be as defined in Table 8.0.1.4-1.

8.0.1.5 (Reserved)

8.0.1.6 STS/Payload Ku-Band Signal Processor NOT APPLICABLE

8.0.1.7 (Reserved)

8.0.1.8 (Reserved)

8.0.2 (Reserved)

8.0.3 (Reserved)

8.0.4 (Reserved)

TABLE 8.0.1.1-1 ORBITER/CARGO ELEMENT AVIONICS INTERFACE ALLOCATION

ORBITER SERVICE	REF PARA	INTERFACE TYPE/ DESCRIPTION	IDD ALLOCATION	P/L USE	NOTES
PAYLOAD DATA INTERLEAVER (PDI)	8.2.1	TELEMETRY INPUTS	1	1	
PAYLOAD SIGNAL PROCESSOR (PSP)	8.2.5	PSP 1	1	1	
PAYLOAD TIMING BUFFER(PTB)	8.2.10.1	MET OUTPUT; MODIFIED IRIG B	1	1	1

TABLE 8.0.1.1-1 ORBITER/CARGO ELEMENT AVIONICS INTERFACE ALLOCATION (CONCLUDED)

NOTE:

1. Orbiter Timing Buffer (OTB) has the same signal characteristics and may replace the PTB.

TABLE 8.0.1.2-1 PAYLOAD DATA INTERLEAVER (REF PARA 8.2.1)

DATA FORMAT	BIT RATE (KBPS)	INPUT SIGNAL CODE	WORD LENGH (BITS)	MASTER FRAME LENGTH (WORDS OR MINOR FRAMES)	MASTER FRAME SYNC LENGTH (BITS)	MINOR FRAME LENGTH (WORDS)	MINOR FRAME SYNC LENGTH (BITS)	PORT ID	STANDARD SAMPLE RATES (SAMPLES/ MASTER FRAME)	NON-STANDARD SAMPLE RATES (SAMPLES/ MASTER FRAME)	NOTES
3	8	BIP-L	8	32	8	64	24		N/A	N/A	1;2;3;4

TABLE 8.0.1.2-1 PAYLOAD DATA INTERLEAVER (REF PARA 8.2.1)
(CONCLUDED)

NOTES:

1 N/A = Not Available

(2) Minor Frame Counter, located in Word 4, 8 bits, in ascending binary count which increments one count for each minor frame. Initial value is 0 incrementing up to 31 and resetting to 0 at the beginning of each Master Frame.

(3) Minor Frame Sync is located in the first three words of each minor frame. Sync pattern is FAF320. Sync pattern FAF320 is in conflict with Note 5 of Table 8.2.1.1-1. This pattern is utilized by the Orbiter by the Orbiter Pulse Coded Modulation (PCM) as a sync pattern. Use of FAF320 Hex by a payload could cause phase lock by ground facilities upon decommutation of the payload data stream. This will cause a real time data loss of 5 minor frames (based on payload telemetry rate of 8 kbps) of all Orbiter/Payload re-estabilishment of correct decommutation lock on the telemetry data stream. The lost data can be recovered through Payload Recorder.

(4) For a Type 3 Data Format, the Master Frame Sync is a 8 bit Minor Frame counter (see Table 8.2.1.1-1)

TABLE 8.0.1.4-1 PAYLOAD SIGNAL PROCESSOR (REF PARA 8.2.5)

DATA RATE (BPS)	DATA TYPE	NOTES
2000	NRZ-L	

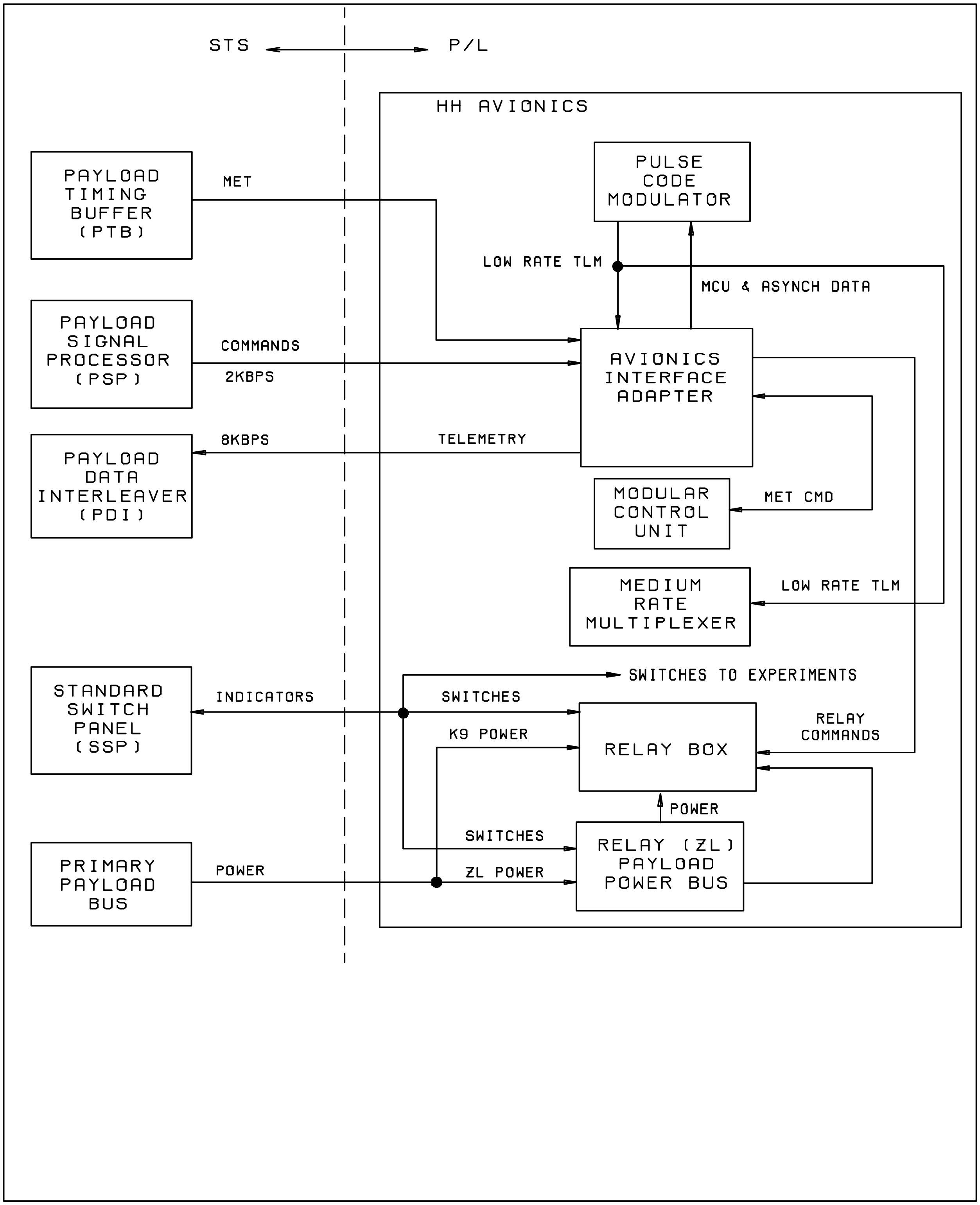


FIGURE 8.0.1.1-1 ORBITER/AVIONICS FUNCTIONAL BLOCK DIAGRAM

THIS PAGE INTENTIONALLY LEFT BLANK

8.1 (Reserved)

8.2 ATTACHED PAYLOADS

8.2.1 Payload Data Interleaver (PDI) Interface

The Orbiter shall provide for the acquisition of asynchronous Payload Pulse Code Modulation (PCM) telemetry data via the PDI. Refer to Figure 8.2.1-1 for PDI data flow.

8.2.1.1 PDI Input Data Characteristics-Shuttle Standard Formats

Refer to Section 20 paragraph, 20.4

Note: A non-compliance condition exists between the Orbiter and the MIGHTY. Refer to Section 20 for the definition of the unique interface requirement.

The Shuttle Orbiter Standard Telemetry Formats for Payloads are three in number, and are designated Format Synchronization Mode Type 1 Format, Type 2 Format, and Type 3 Format. The distinctive characteristic of these three types of Payload PCM Telemetry formats is that their structure enables both the Orbiter's PDI and the Orbiter's GPC software services to process Payload measurement data, and as a group satisfies the requirements of Table 8.2.1.1-1 and Figure 8.2.1.1-1, Figure 8.2.1.1-2, and the figures associated with the three formats defined in the subparagraphs. Each of these three Shuttle Standard Formats also enables the PDI to process Payload Frame data as Time Homogenous Data Sets for inclusion within the Orbiter's PCM Telemetry Downlink.

With respect to the Orbiter's PCM Telemetry Downlink, a Time Homogenous Data Set (THDS) is defined to be those eight bit words decommutated from a Payload frame such that those words from one Payload frame shall never be mixed with those words from any other Payload frame within either the PDI or PCMMU (PCM Master Unit) (refer to Figure 8.2.1.1-3). With respect to Orbiter GPC software services, maintaining the time homogeneity for both individual multiword Payload measurements and Payload measurement word sets cannot be guaranteed.

8.2.1.1.1 Type 1 Format NOT APPLICABLE

8.2.1.1.2 Type 2 Format NOT APPLICABLE

8.2.1.1.3 Type 3 Format

A Type 3 Payload Format is herein defined as a format consisting of Master Frames and Minor Frames as shown in Figure 8.2.1.1.3-1. Every Minor Frame shall be identified by a Minor Frame Sync pattern which occurs once each Minor Frame, and shall be the same sync pattern for all Minor Frames.

A Master Frame, in general, shall contain two or more Minor Frames; otherwise, there is no distinction with a Type 1 Format. Additionally, every Minor Frame shall contain an eight bit Minor Frame Count word. The start of a Master Frame shall be identified as the Minor Frame which contains an initial value of the Minor Frame Count word.

8.2.1.1.3.1 Orbiter PCM TLM Downlink Service

Throughputting Payload data to the ground via the Orbiter's PCM TLM Downlink is implemented via the PDI's Toggle Buffer for individual Minor Frames. Before individual Minor Frames can be transferred to the PDI's Toggle Buffer, recognition by the PDI of two successive valid Minor Frame Sync patterns must first occur. When this has happened, Toggle Buffer storage for each Minor Frame shall proceed as follows:

a. The THDS within the PDI's Toggle Buffer shall, in part, consist of a complete Minor Frame or a subset thereof. The subset may consist of any number of uniquely identifiable contiguous or noncontiguous 8-bit Minor Frame words. The THDS to be downlinked shall be an even number of 8-bit words. If an even number of 8-bit words are not specified, the PDI will add 8-bits of fill data.

b. The remainder of the THDS shall consist of three additional 16 bit Status Words appended to the Minor Frame words by the PDI as shown in Figure 8.2.1.1-3.

8.2.1.1.3.2 Orbiter GPC Software Service NOT APPLICABLE

8.2.1.2 PDI Input Data Characteristics-Shuttle Non Standard Formats NOT APPLICABLE

8.2.1.3 Electrical Interface Characteristics

For Payloads using one of the three Biϕ data codes (Biϕ-L, M or S), the PDI is capable of extracting associated Clock information and determining bit period boundary definition.

For Payloads using one of the three NRZ data codes (NRZ-L, M or S), the PDI requires the Payload to provide a CLOCK interface along with the DATA interface so as to enable the PDI to determine bit period boundary definition.

8.2.1.3.1 PDI Data Input

The PDI Data input electrical interface characteristics at the Orbiter/payload interface shall be as defined in Table 8.2.1.3.1-1 and Figures 8.2.1.3.1-1, 8.2.1.3.1-2 and 8.2.1.3.1-3.

8.2.1.3.2 PDI Clock Input NOT APPLICABLE

8.2.1.4 (Reserved)

8.2.1.5 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.1.5-1.

8.2.2 Multiplexer/Demultiplexer (MDM) Interface NOT APPLICABLE

8.2.3 Orbiter/Payload Recorder (OPR) Interface NOT APPLICABLE

TABLE 8.2.1.1-1 PDI INPUT DATA CHARACTERISTICS-ATTACHED INTERFACE SHUTTLE STANDARD FORMAT

Parameter	Dimension	PDI Tolerance	Data Formats 1	Data Formats 2	Data Formats 3	Notes
Bit rate (center frequency)	bps	10 bps to 8 kbps	x	x	x	(1)
Input Signal Code		NRZ-L NRZ-M NRZ-S Biϕ-L Biϕ-M Biϕ-S	x	x	x	(2)
Word length	Bits	8 or multiples of 8	x	x	x	(3)
Master Frame Length	Words	8 to 1024 (8-bit words)	x			(4)
	or					
	Minor Frames	2 to 256		x	x	(5)
Master Frame Sync	Bits	8, 16, 24 or 32	x			(6)
	Bits	8 bits of unique sync pattern		x		(7)
	Bits	8 bit Minor Frame Counter			x	(8)
Minor Frame Length	Words	8 to 1024 (8-bit words)		x	x	
Minor Frame Sync	Bits	8, 16, 24, or 32		x	x	(9)
Frame Rate	Master Frame/Sec	200 maximum	x			
	Minor Frames Per Sec	200 maximum		x	x	
Formats Sample Rates (Non-standard)	Samples/Master Frame	Limited only by payload input bit rate	x	x	x	(10)

Table 8.2.1.1-1 PDI INPUT DATA CHARACTERISTICS-ATTACHED INTERFACE SHUTTLE STANDARD FORMAT (CONTINUED)

Parameter	Dimension	PDI Tolerance	Data Formats 1	2	3	Notes
Format Sample Rates (Standard)	Samples/Master Frame	Master Frame rate only	x			(11)
		One equal to Minor Frame rate		x	x	(12)(13)
		Six equal to integer submultiple of Minor Frame rate.		x		(12)(13)

Notes:

(1) A maximum of up to 8kbps is allocated for small payload usage.

(2) Refer to Figure 8.2.1.1-1. Bit rate clock is required with NRZ codes.

(3) Bit pattern for the data word in the incoming data stream from the payload in terms of Most Significant Bit (MSB) through Least Significant Bit (LSB), with the following examples, shall be defined by the payload.

(4) Refer to Figure 8.2.1.1.1-1.

(5) Refer to Figures 8.2.1.1.2-1 and 8.2.1.1.3-1.

(6) Any pattern (with exception FAF320 hexadecimal bit pattern shall not be used) of contiguous bit position located in first or last word(s) of every master frame. Utilization of the last word(s) may preclude telemetry data stream processing at KSC.

(7) Any pattern located within the first or last minor frame in any word column, other than the minor frame sync word column(s).

Table 8.2.1.1-1 PDI INPUT DATA CHARACTERISTICS-ATTACHED INTERFACE SHUTTLE STANDARD FORMAT (CONCLUDED)

(8) Ascending or descending binary count which increments or decrements one count each minor frame. Initial count value is programmable. Count pattern shall always be Most Significant Bit (MSB) first and right justified. Location of the minor frame count word within each minor frame can be any word column, other than minor frame Sync word column(s), but has to be the same for every minor frame.

An example of the Minor Frame Counter (MFC) with a Type 3 format with 8 minor frames is as follows:

The initial value of the MFC is 00000000, signifying the start of the master frame. The MFC increments each minor frame to a count of 00000111, signifying end of master frame.

(9) Any pattern of contiguous bit positions located in first or last word(s) of every minor frame. (See Note 6 for KSC limitations.)

(10) For those payloads which require no Orbiter GPC software services (payload data via the PDI toggle buffer only), their PCM telemetry formats can utilize nonstandard sample rates. Any sample rate which is not an integer multiple/submultiple of the payload frame rate is considered a nonstandard rate.

(11) Refer to Figure 8.2.1.1-2. Payloads measurements within the Master Frame (Type 1) whose measurements are at the Master Frame rate can be processed by the PDI only when multiple Measurement Stimulus Identification (MSID) numbers are used to specify each payload measurement.

(12) Format Types 2 or 3 shall contain a maximum of seven sample rates per format. One of the sample rates shall be equal to the number of minor frames per master frame. The remaining six sample rates shall be any submultiple of the minor frame rate as described by Figure 8.2.1.1-2.

(13) Refer to Figure 8.2.1.1-2. Payload measurements within the minor frame whose sample rates are integer multiples of the minor frame rate can be processed by the PDI but only when multiple MSID numbers are used to specify each payload measurement.

Each payload measurement is identified by a unique alphanumeric code (MSID) assigned by NASA/JSC as directed by "Space Shuttle Master Measurement List", document number JSC-08220.

The PDI is not capable of processing payload sample rates which are less than the smallest integer submultiple of the payload minor frame rate (Y) as defined within Figure 8.2.1.1-2.

TABLE 8.2.1.3.1-1 PDI DATA INPUT/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Signal Type		Differential-Balanced	Refer to Figures 8.2.1.3.1-1 and 8.2.1.3.1-2
Amplitude	Volts pk-pk	2.6 Min 9.0 Max	Measured line-to-line
Duty Cycle	Percent	50 ± 5	(1)(2)
Bit-Rate Accuracy	Percent	±3.25	(3)
Stability		≤ 1 part in 10^5 over 60 sec Period	
Waveform Distortion		Overshoot and undershoot less than 20 percent of peak amplitude level	
Noise	Milli-volts	50 pk-pk, differential line-to-line, DC to 100 kHz	Payload transmitting, not transmitting, or failed
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell design standard MP572-0328-0002
Cable impedance Zo	Ohm	70 Min 80 Max	Measured conductor to conductor at 1 MHz
Cable Capacitance (Orbiter)	Pico-farads	3749 Max	(8)
Input Impedance (Orbiter)	Ohm	70 Min 94 Max	DC resistance line-to-line includes cable resistance (8)
Rise/Fall Time		Max: Refer to Differential Phase Skew	(4) RT/FT are independent of bit rate and data code type (Biφ or NRZ).

TABLE 8.2.1.3.1-1 PDI DATA INPUT/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS (Continued)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Skew-Differential Phase	Nano-second to Milli-second depending on payload bit rate		(5) (7)
For Biϕ data:		Max: $Tp - .841Tp - (1x10^{-6}) - 2NTp - .125x10^{-6} -$ $T_{LR}\left[LOG_e\left(\frac{V_{LPK} - 100 \text{ millivolts}}{V_{LPK} - 300 \text{ millivolts}}\right)\right] -$ $T_{TR}\left[LOG_e\left(\frac{V_{TPK} + 300 \text{ millivolts}}{V_{TPK} + 100 \text{ millivolts}}\right)\right]$ Where: N = Payload Duty Cycle Offset $0 \le N \le 0.05$ V_{LPK} = Peak amplitude level of Biϕ waveform leading edge. V_{TPK} = Peak amplitude level of Biϕ waveform trailing edge. Tp = Reciprocal of max. payload bit rate. T_{LR} = Max. rise time of Biϕ waveform leading edge measured between 10 percent and 90 percent points. T_{TR} = Max. fall time of Biϕ waveform trailing edge measured between 10 percent and 90 percent points.	

TABLE 8.2.1.3.1-1 PDI DATA INPUT/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS (Continued)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Skew-Differential Phase (Cont.)			
For NRZ data:		Max: Tp - .691Tp - NTp - $T_{CR}\left[\log_e\left(\frac{V_{CPK} - 100 \text{ millivolts}}{V_{CPK} - 300 \text{ millivolts}}\right)\right]$ - $T_{DR}\left[\log_e\left(\frac{V_{DPK} + 300 \text{ millivolts}}{V_{DPK} + 100 \text{ millivolts}}\right)\right]$ Where: N = Payload Clock Duty Cycle Offset $0 \leq N \leq 0.05$ V_{CPK} = Peak amplitude level of Payload CLOCK signal. V_{DPK} = Peak amplitude level of Payload NRZ DATA signal Tp = Reciprocal of max. payload bit rate (Center Frequency) T_{CR} = Max. transition time (rise or fall time) of payload CLOCK signal measured between 10 percent and 90 percent points. T_{DR} = Maximum transition time (rise or fall time) of payload NRZ DATA signal measured between 10 percent and 90 percent points.	

TABLE 8.2.1.3.1-1 PDI DATA INPUT/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS (Continued)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Common Mode	Volt	Not to exceed ±3, Line to ground	(6) Payload and PDI Connected

(1) Relative position of Biφ-L mid bit transition at interface.

(2) Any bit or clock transition point occurs in time at the 50 percent pk-pk amplitude point.

(3) The PDI shall set an error flag within its BITE Status Register whenever the Payload bit rate exceeds ±3.25 percent of its specified center frequency.

(4) The maximum limit for Payload signal Rise/Fall time is not to be determined independently, but instead is to be determined as part of a tradeoff with other related offsets. In order to make that tradeoff, the appropriate general case equation for Differential Phase Skew shall be utilized.

(5) These two general case equations for Biφ data and NRZ data are an expression of how the Payload bit period is partitioned between the PDI's Bit Lock Range, Payload Duty Cycle Offset, PDI Programmed Bit Rate Offset (for Biφ data only), and Payload maximum Rise and Fall time. The solution for each of these two general case equations indicates that amount of the Payload bit period which remains for partitioning between the payload signal Differential Phase Skew and/or Phase Shift. A solution for either of these two general case equations which produces a negative result indicates that the appropriate Offsets themselves have utilized all the remaining Payload bit period such that none is available for Differential Phase Skew and/or Phase Shift. PDI Bit Lock Range identifies the absolute minimum amount of the Payload bit period required for the PDI's Bit Synchronizer to achieve and maintain bit lock.

Data Type	Bit Lock Range
Biφ	$0.841Tp + (1x10^{-6})$
NRZ	0.691Tp

Payload Signal Differential Phase Skew, as defined here, shall consist of the absolute value of the difference between the Leading Edge Phase Shift and the Trailing Edge Phase Shift (refer to Figure 8.2.1.3.1-3), and is independent of Payload amplitude level.

TABLE 8.2.1.3.1-1 PDI DATA INPUT/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS (Continued)

Payload Signal Phase Shift is the time differential between the 50 percent points of associated amplitude transitions of the two Payload differential inputs.

PDI Programmed Bit Rate Offset shall be 0.125 μsec for all Biϕ data rates from 10 bps to 64 kbps.

(6) Volts over frequency spectrum from DC to 100 KHZ.

(7) The example illustrates how the Biϕ Data general case equation for Differential Phase Skew shall be utilized by a Payload user. The following Payload interface characteristics are utilized as part of the first tradeoff for determining the Payload user's upper limit for each of the Offsets applicable to that Payload.

Bit Rate (Center Frequency):	1600 BPS
Biϕ Data Duty Cycle:	50 ± 5 percent
Biϕ Data Peak Amplitude:	1.25 volts
Maximum Transition Time: (Rise and Fall Time)	5 μsec

For the specified center frequency of 1600 BPS, the corresponding amount of time for one bit period is:

$$Tp = \frac{1}{1600\ BPS} = 625\ \mu seconds.$$

Within each Payload bit period (Tp), the general case equation for Biϕ Data Differential Phase Skew provides for the following amounts to Tp time to be dedicated to:

a) PDI's Bit Lock Range:

$$0.841Tp + (1x10^{-6}) = 0.841(625\ \mu sec) + 1\ \mu sec = 526.625\ \mu sec$$

b) Payload Biϕ Data Duty Cycle Offset: 0.125μsec

$2NTp = 2(0.05)(625\ \mu sec) = 62.50\ \mu sec$ with
N = 0.05 corresponding to a 5 percent Duty Cycle Shift.

c) PDI Programmed Bit Rate Offset: 0.125 μsec

d) Ambiguity in Change of PDI Receiver Output Due to Slow Transition Time of Payload Data Differential Inputs:

$$T_{LR} \left[LOG_e \left(\frac{V_{LPK} - 100\ MV}{V_{LPK} - 300\ MV} \right) \right] + T_{TR} \left[LOG_e \left(\frac{V_{TPK} + 300\ MV}{V_{TPK} + 100\ MV} \right) \right] =$$

TABLE 8.2.1.3.1-1 PDI DATA INPUT/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

$$5\mu\text{sec}\left[\text{LOG}_e\left(\frac{1.25 - 0.10}{1.25 - 0.30}\right)\right] + 5\mu\text{sec}\left[\text{LOG}_e\left(\frac{1.25 + 0.30}{1.25 + 0.10}\right)\right] =$$

$$5\mu\text{sec}\left[\text{LOG}_e\ (1.21)\right] + 5\mu\text{sec}\left[\text{LOG}_e\ (1.15)\right] = 1.64\mu\text{sec}$$

The remaining amount of TP time which is available to the Payload user for partitioning between Payload Biϕ Data Differential Phase Skew and/or Phase Shift is:

Diff. Phase Skew/Phase Shift =
$625\mu\text{sec} - 526.625\mu\text{sec} - 62.5\mu\text{sec} - 0.125\mu\text{sec} - 1.64\mu\text{sec} = 34.11\mu\text{sec}$.

This completes the first tradeoff such that the general case equation for Biϕ Data Differential Phase Skew has enabled the Payload user to dedicate the following amounts of time as upper limits for:

$0 \leq$ Duty Cycle Offset ≤ 62.5 μseconds

$0 \leq$ Transition Time Ambiguity ≤ 1.64 μseconds

$0 \leq$ Diff. Phase Skew/Phase Shift ≤ 34.11 μseconds

If these upper limits are acceptable, then the Payload user shall determine the actual amounts of time to be allocated to each appropriate Offset. If these upper limits are not acceptable, then the Payload user shall have to develop a <u>second tradeoff</u> with an appropriate change in either the Duty Cycle Shift, Maximum Transition Time, or Peak Amplitude. It should be noted that a Payload user can only change PDI Bit Lock Range by choosing a different Payload Bit Rate.

The general case equation for NRZ Data Differential Phase Skew is utilized in a manner identical to its Biϕ Data counterpart with the exception that PDI Programmed Bit Rate Offset is not included.

(8) Calculations based upon 163 feet from PDI to payload interface (end of 30 ft SPAT extender cable).

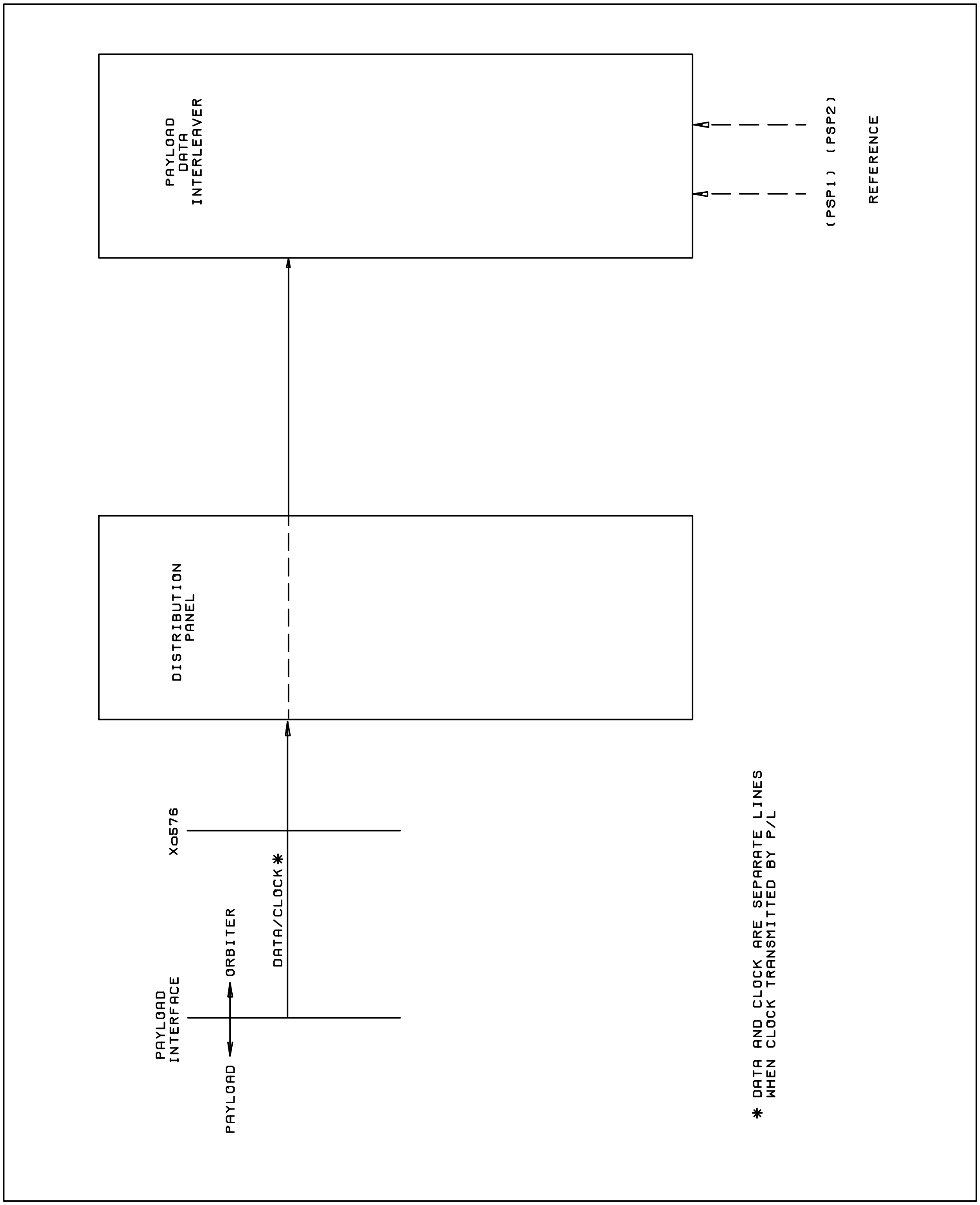
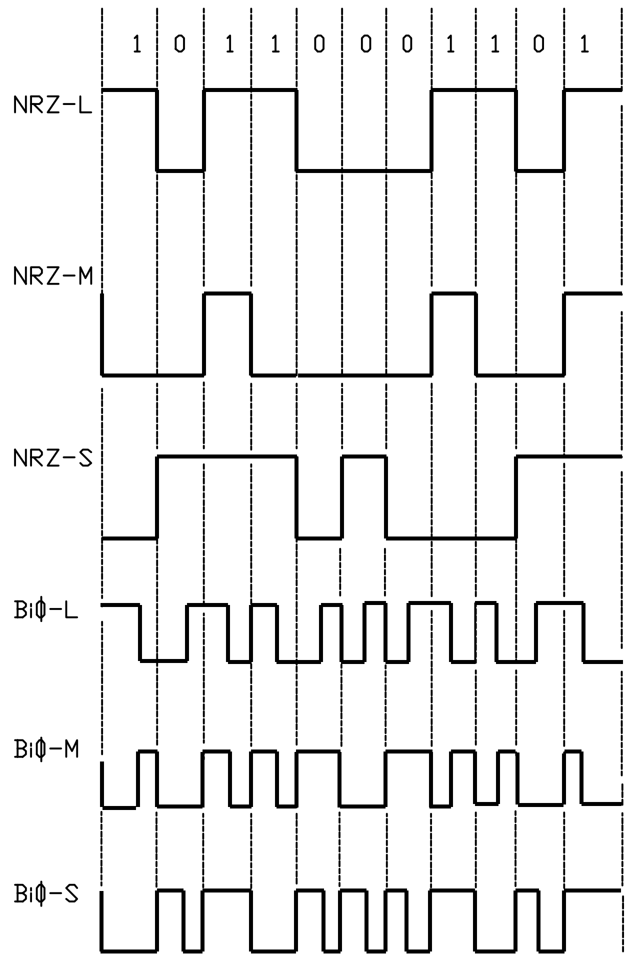


FIGURE 8.2.1-1 PAYLOAD DATA INTERLEAVER DATA FLOW



NRZ-LEVEL (OR NRZ CHANGE):
"ONE" IS REPRESENTED BY ONE LEVEL;
"ZERO" IS REPRESENTED BY THE OTHER LEVEL

NRZ-MARK
"ONE" IS REPRESENTED BY A CHANGE IN LEVEL;
"ZERO" IS REPRESENTED BY NO CHANGE IN LEVEL

NRZ-SPACE
"ONE" IS REPRESENTED BY NO CHANGE IN LEVEL:
"ZERO" IS REPRESENTED BY A CHANGE IN LEVEL

BI-PHASE LEVEL (OR BI-PHASE-CHANGE):
A TRANSITION OCCURS AT CENTER OF EVERY BIT PERIOD;
"ONE" IS REPRESENTED BY A "ONE" LEVEL WITH THE TRANSITION TO THE "ZERO" LEVEL.
"ZERO" IS REPRESENTED BY A "ZERO" LEVEL WITH THE TRANSITION TO THE ONE LEVEL

BI-PHASE-MARK:
A TRANSITION OCCURS AT THE BEGINNING OF EVERY BIT PERIOD;
"ONE" IS REPRESENTED BY A MIDBIT TRANSITION;
"ZERO" IS REPRESENTED BY NO MIDBIT TRANSITION

BI-PHASE SPACE:
A TRANSITION OCCURS AT THE BEGINNING OF EVERY BIT PERIOD;
"ONE" IS REPRESENTED BY NO MIDBIT TRANSITION;
"ZERO" IS REPRESENTED BY A MIDBIT TRANSITION

FIGURE 8.2.1.1-1 PCM INPUT CODES

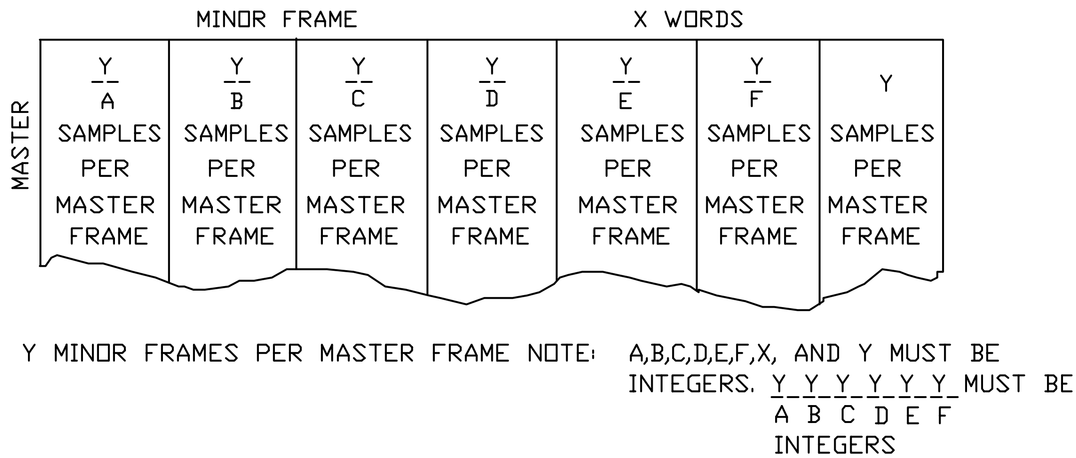
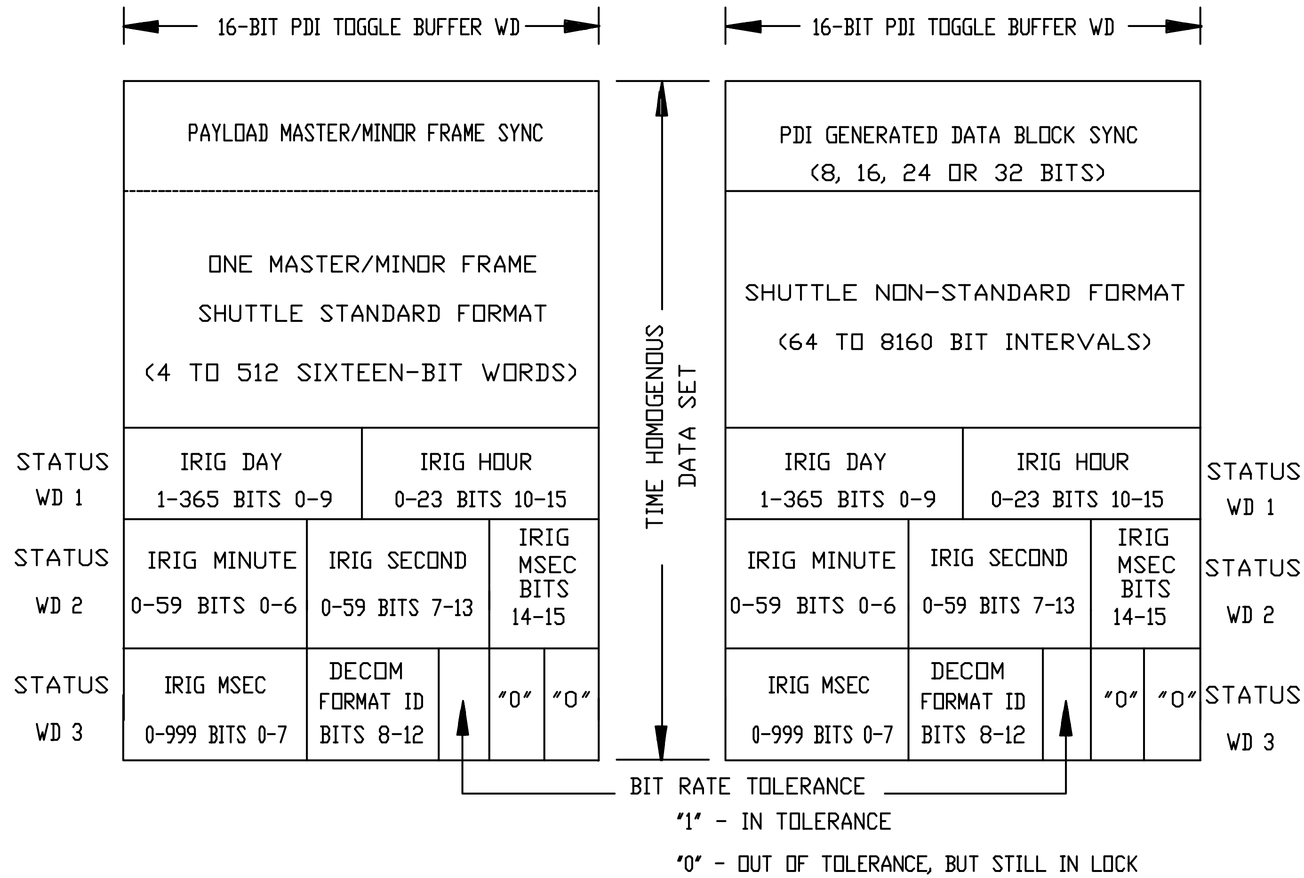


FIGURE 8.2.1.1-2 SHUTTLE STANDARD FORMAT SAMPLE RATES



IRIG DAY, HOUR, MINUTE, AND SECOND ARE BCD CODED, MSB FIRST

IRIG MSEC IS BINARY CODED, MSB FIRST

FIGURE 8.2.1.1-3 FRAME DATA SET STATUS WORDS

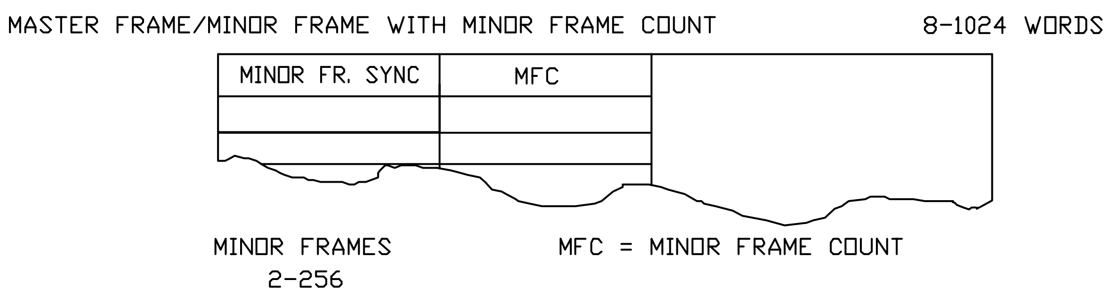
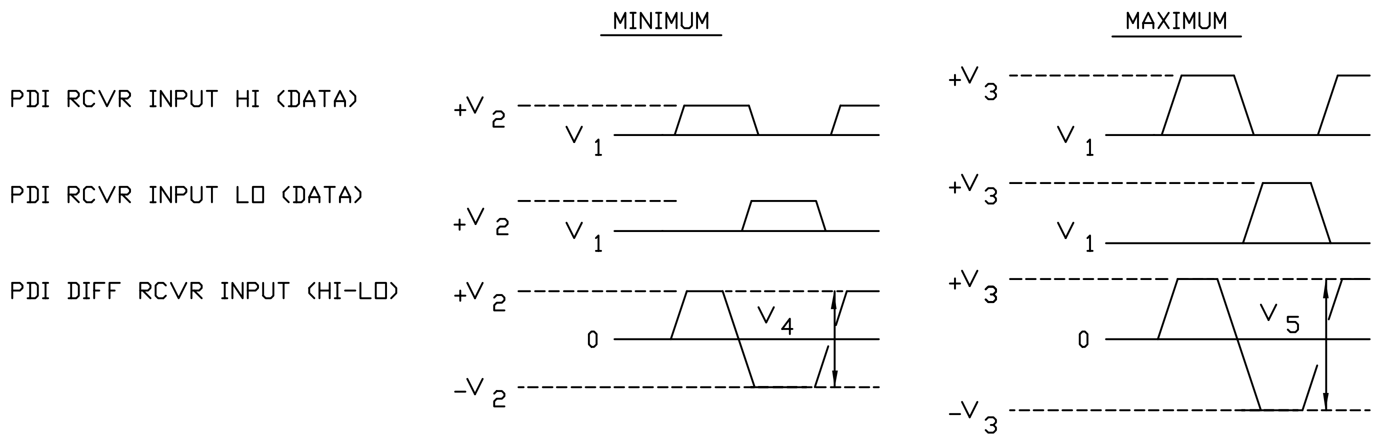


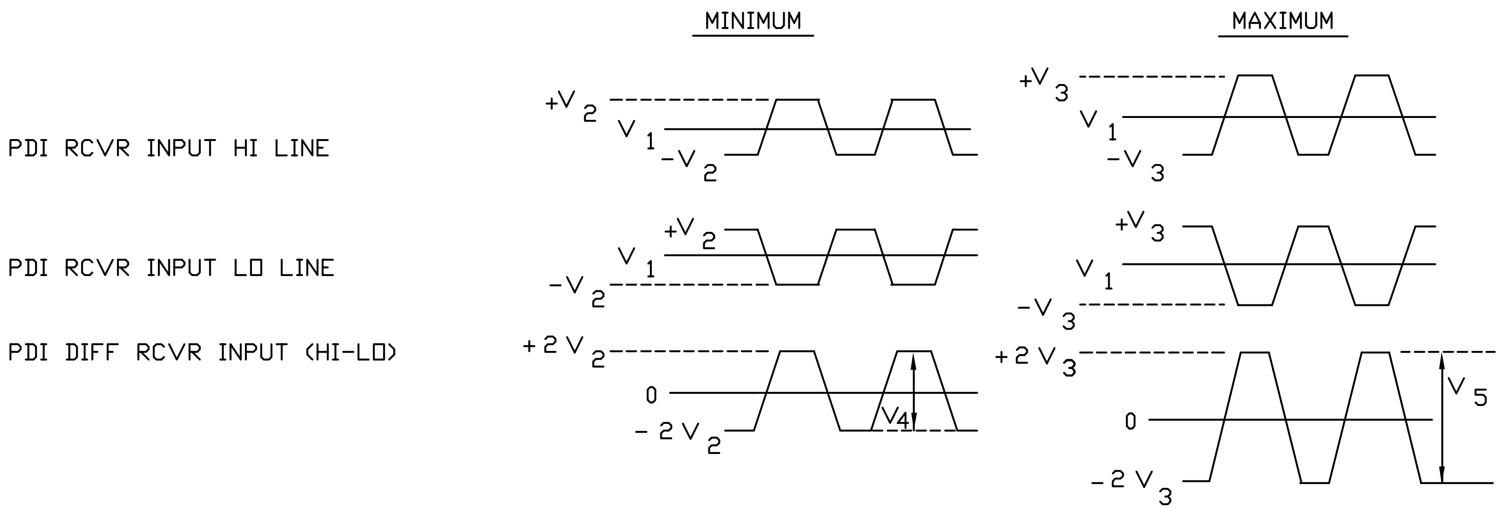
FIGURE 8.2.1.1.3-1 TYPE 3 SHUTTLE STANDARD FORMAT

FIGURE 8.2.1.3.1-1 DATA/DATA (INVERSE) - DIFFERENTIAL TRANSMISSION



- V_1 = SIGNAL GROUND
- V_2 = 1.25 VOLTS LINE TO SIG. GND
- V_3 = 4.5 VOLTS LINE TO SIG. GND
- V_4 = 2.5 VOLTS P-P LINE-TO-LINE DIFFERENTIAL BALANCED
- V_5 = 9.0 VOLTS P-P LINE-TO-LINE DIFFERENTIAL BALANCED

FIGURE 8.2.1.3.1-2 BI-POLAR LINES - DIFFERENTIAL TRANSMISSIONS



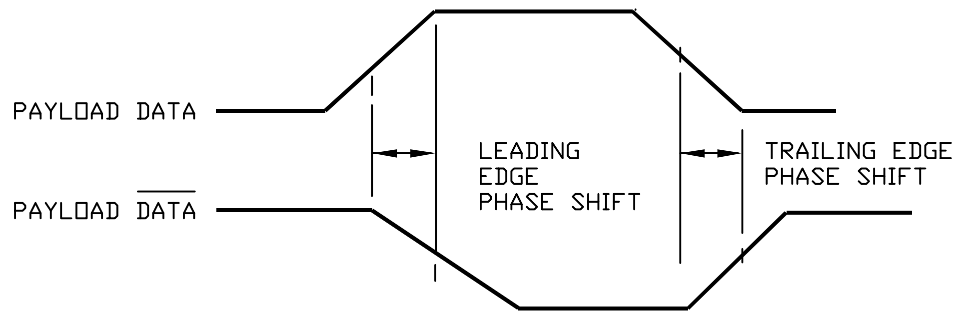
V_1 = SIGNAL GROUND

V_2 = 0.625 VOLTS LINE TO SIG. GND

V_3 = 2.25 VOLTS LINE TO SIG. GND

V_4 = 2.5 VOLTS P-P DIFFERENTIAL LINE-TO-LINE BALANCED

V_5 = 9.0 VOLTS P-P DIFFERENTIAL LINE-TO-LINE BALANCED



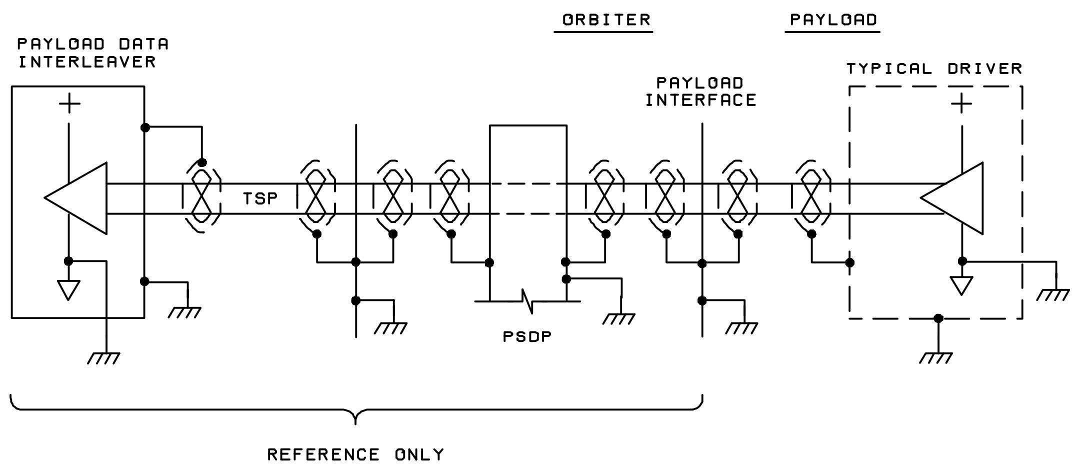
DIFFERENTIAL PHASE SKEW = LEADING EDGE PHASE SHIFT - TRAILING EDGE PHASE SHIFT

WHERE:

LEADING/TRAILING EDGE PHASE SHIFT IS THE TIME DIFFERENTIAL BETWEEN 50% POINTS OF ASSOCIATED AMPLITUDE TRANSITIONS OF THE DIFFERENTIAL INPUTS

FIGURE 8.2.1.3.1-3 DIFFERENTIAL PHASE SKEW

FIGURE 8.2.1.5-1 PAYLOAD DATA INTERLEAVER GROUNDING AND SHIELDING INTERFACE

PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.1.3.1 PDI DATA INPUT 8.2.1.3.2 PDI CLOCK INPUT	 NOTE: CIRCUIT REFERENCE SYMBOLS DEFINED IN SECTION 10.7.4.2.4

THIS PAGE INTENTIONALLY LEFT BLANK

8.2.4 KU-BAND SIGNAL PROCESSOR INTERFACE NOT APPLICABLE

THIS PAGE INTENTIONALLY LEFT BLANK

8.2.5 PAYLOAD SIGNAL PROCESSOR INTERFACE

The Payload Signal Processor (PSP) shall provide command data to the Payload Interface. (Reference Figure 8.2.5-1).

8.2.5.1 PSP Command Data Output

The PSP command data output shall have the characteristics shown in Table 8.2.5.1-1. Commanding shall be limited to a single payload at a time, attached or detached.

8.2.5.1.1 PSP Command Data Formats

The format of the commands to be transmitted to payloads shall be defined in the Paragraph 9.4.2.1.

8.2.5.1.2 Command Bit Idle Pattern

A software selectable idle bit pattern shall be available when actual command bits are not being processed. Utilization of the idle pattern shall be as defined in the software section, Paragraph 9.4.2.2.4 "PSP Idle Pattern".

8.2.5.2 (Reserved)

8.2.5.3 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.5.3-1.

8.2.6 (Reserved)

8.2.7 (Reserved)

8.2.8 (Reserved)

8.2.9 (Reserved)

TABLE 8.2.5.1-1 PSP COMMAND DATA OUTPUT, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Subcarrier Frequency	kHz	16 ± 0.001 percent (Long Term)	Sine Wave
Subcarrier Harmonic Distortion	Percent	Less than 2 percent of the total power in the subcarrier fundamental	Total harmonic distortion
Subcarrier Frequency Stability		≤ 10^{-7} of the sub-carrier frequency over a ten second period (Short Term)	(1)
Subcarrier Modulation		PSK	
Data Rates	bps	2000,1000,500,250,125, 125/2,125/4,125/8,or 125/16 ± 0.001 percent (Long Term)	(1)
Data Rate Stability		10^{-7} over a ten second period. (Short Term)	(1)
Data Types		NRZ-L, -M or -S	
Frequency-to-Bit Rate Ratio		Exact multiple of the allowed data rates	Data waveform shall conform to sub-carrier zero cross-ings within ± 10 degrees
Data Transition		Data shall alter sub-carrier phase by ±90 degrees ±10 percent	
Amplitude	Volts pk-pk	3.1 to 4.4, line-to-line	(2) (3)
Phase Jitter	Percent of bit period	3 max	
Data Asymmetry	Percent of bit period	2 max	

TABLE 8.2.5.1-1 PSP COMMAND DATA OUTPUT, ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

Parameter	Dimension	Value	Notes
Channel-to-Channel Isolation	dB	40 min	(2) Between-channel isolation when each channel is terminated with 75 ohms
Source Impedance	Ohms	<15	(2)
Load Impedance	Ohms	75±10 percent	(2)
Output Type		Differential	(2)
Load Termination		Differential, direct coupled	(2) Controlled by special payload integration provisions
Offset	Volts	0 ± .5, either line-to-signal ground	(2)
Capacitance	Pico-Farads	3841	(2) (3)
Cable Type		Twisted shielded pair RI Spec. MP572-0328-0002	(2) EMI class 'RF' refer to Table 10.7.1-1

(1) Based upon MTU accuracy and stability.
(2) Applicable to attached cargo element interfaces only.
(3) Based on 167-ft cable length, from LRU to P/L interface at end of 30 ft SPAT extender cable.

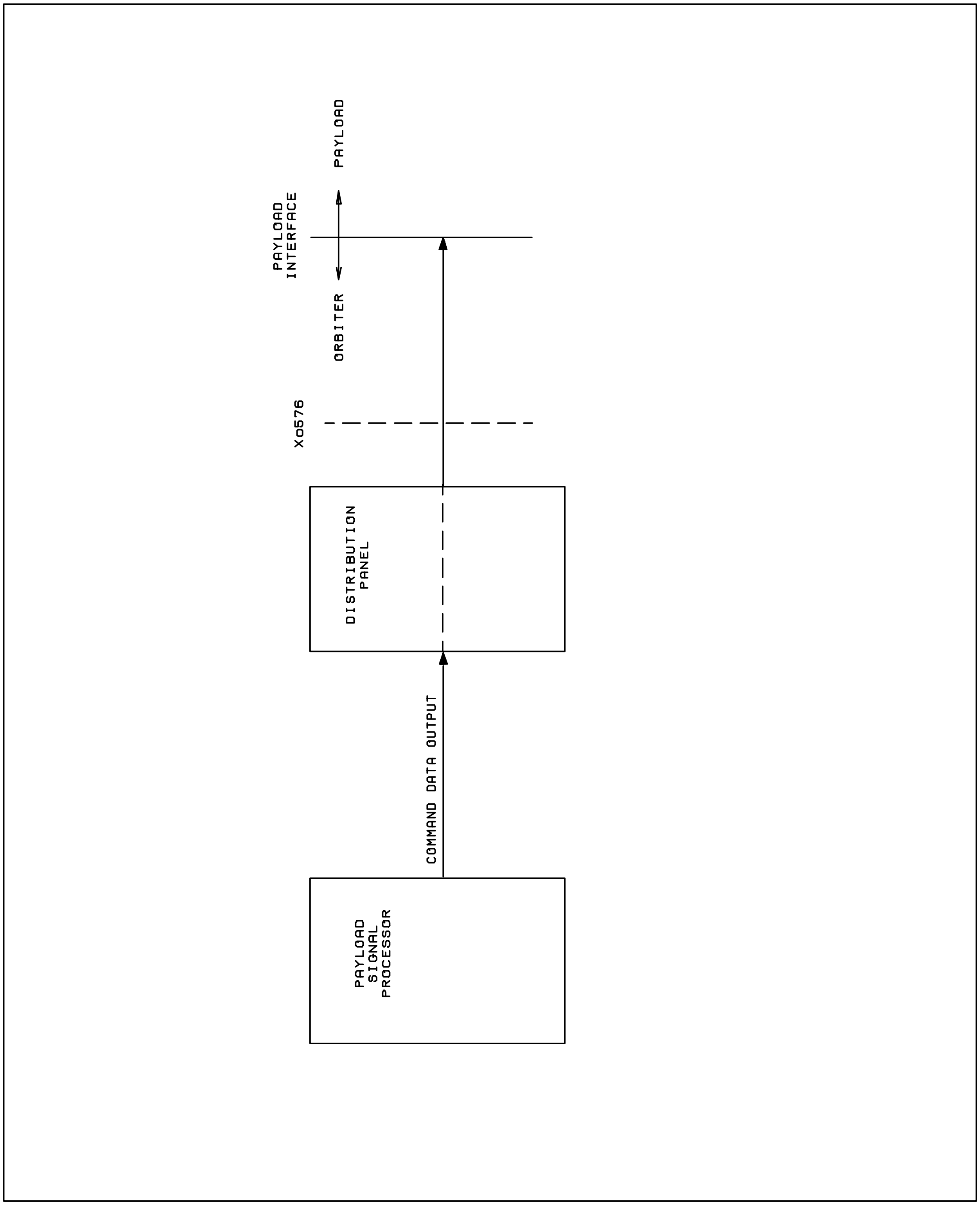
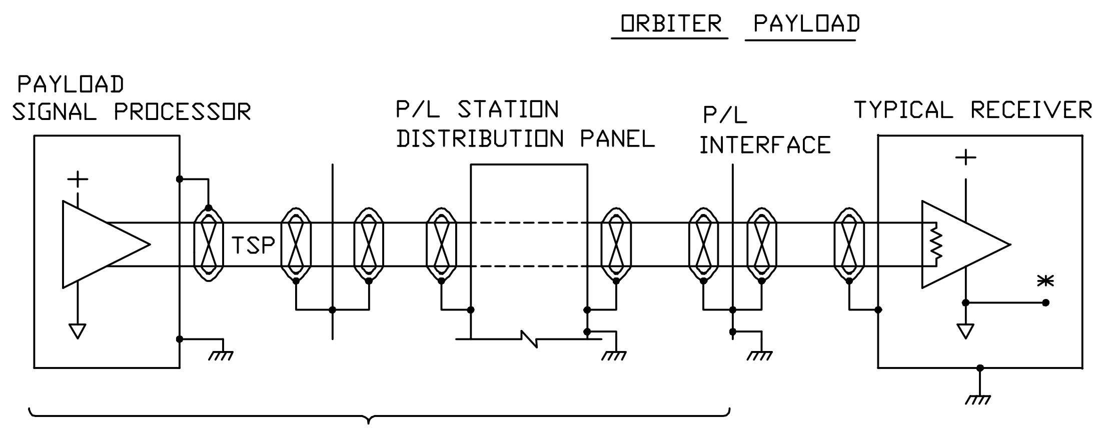


FIGURE 8.2.5-1 PAYLOAD SIGNAL PROCESSOR INTERFACE

FIGURE 8.2.5.3-1 PAYLOAD SIGNAL PROCESSOR GROUNDING AND SHIELDING

PARAGRAPH	GROUNDING AND SHIELDING TERMINATION
8.2.5.1 PSP COMMAND DATA OUTPUT	 REFERENCE ONLY SEE EMC PARAGRAPH 10.7.4 NOTE: SYMBOLS DEFINED IN PARAGRAPH 10.7

* SEE PARAGRAPH 10.7.4.1.1

THIS PAGE INTENTIONALLY LEFT BLANK

8.2.10 MASTER TIMING UNIT (MTU) AND PAYLOAD TIMING BUFFER (PTB) INTERFACES

Small Payloads are allocated the use of the Orbiter Timing Buffer (OTB) or Payload Timing Buffer (PTB). Hereafter, the OTB only shall be described since the PTB characteristics are equivalent to the OTB. Figure 8.2.10-1 shows the OTB interface data flow.

The orbiter timing buffer shall accept single MET input signals from the MTU and provide one isolated MET output timing signal.

8.2.10.1 Time Accumulator Interface

8.2.10.1.1 (Reserved)

8.2.10.1.2 Mission Elapsed Time (MET)

The Mission Elapsed Time shall be reset to zero by the Orbiter at T-0 and shall be synchronized and updated from the ground. MET time error growth rate shall not exceed ±10 milliseconds per 24 hours.

8.2.10.1.3 GMT/MET Electrical Characteristics

The MET output formats shall be a modified IRIG-B as shown in Figure 8.2.10.1.3-1. MET electrical characteristics shall be as shown in Table 8.2.10.1.3-1.

8.2.10.2 (Reserved)

8.2.10.3 Phase Relationship

No fixed phase relationship shall exist between the one second transitions ocurring on the MET outputs.

8.2.10.4 Short-Circuit Protection

The OTB interface output drivers shall withstand indefinite line-to-line or line-to-ground short circuits.

8.2.10.5 Grounding and Shielding

8.2.10.5.1 GMT and MET

Grounding and shielding for MET signals shall be as shown in Figure 8.2.10.5.1-1.

8.2.10.5.2 (Reserved)

8.2.11 (Reserved)

8.2.12 (Reserved)

8.2.13 (DELETED)

8.2.14 (DELETED)

8.3 (Reserved)

TABLE 8.2.10.1.3-1 MTU GREENWICH MEAN TIME/MISSION ELAPSED, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Time Code Format		Modified IRIG-B	See Figure 8.2.10.1.3-1
Type		Digital (Pulse Duration)	
Element Rate	Pulse/Sec	100	See Figure 8.2.10.1.3-1
Time Frame	Sec	1	
Time Accuracy	msec	±10 Max Error Per Day	
Signal Level	V pk-pk	3.4 to 6	(1)
Rise/Fall Time	Micro-Sec	< 50	Measured from 10 to 90 percent Point(1)
Skew	Nano-Sec	<20 at 50 percent Point	
Signal/Noise Ratio		NA	
Max Output Voltage	Volt	10	Under any Failure Condition
Impedance - Source (Orbiter)	OHM	≤ 100	
Impedance - Load (Payload)	OHM	70 to 80	
Impedance - Line	OHM	70 to 80	Per MP572-0328-0002
Capacitance Line	pF	2714	(1)

(1) Based on 118-ft cable length, from PTB to interface at the end of 30 ft SPAT extender cable.

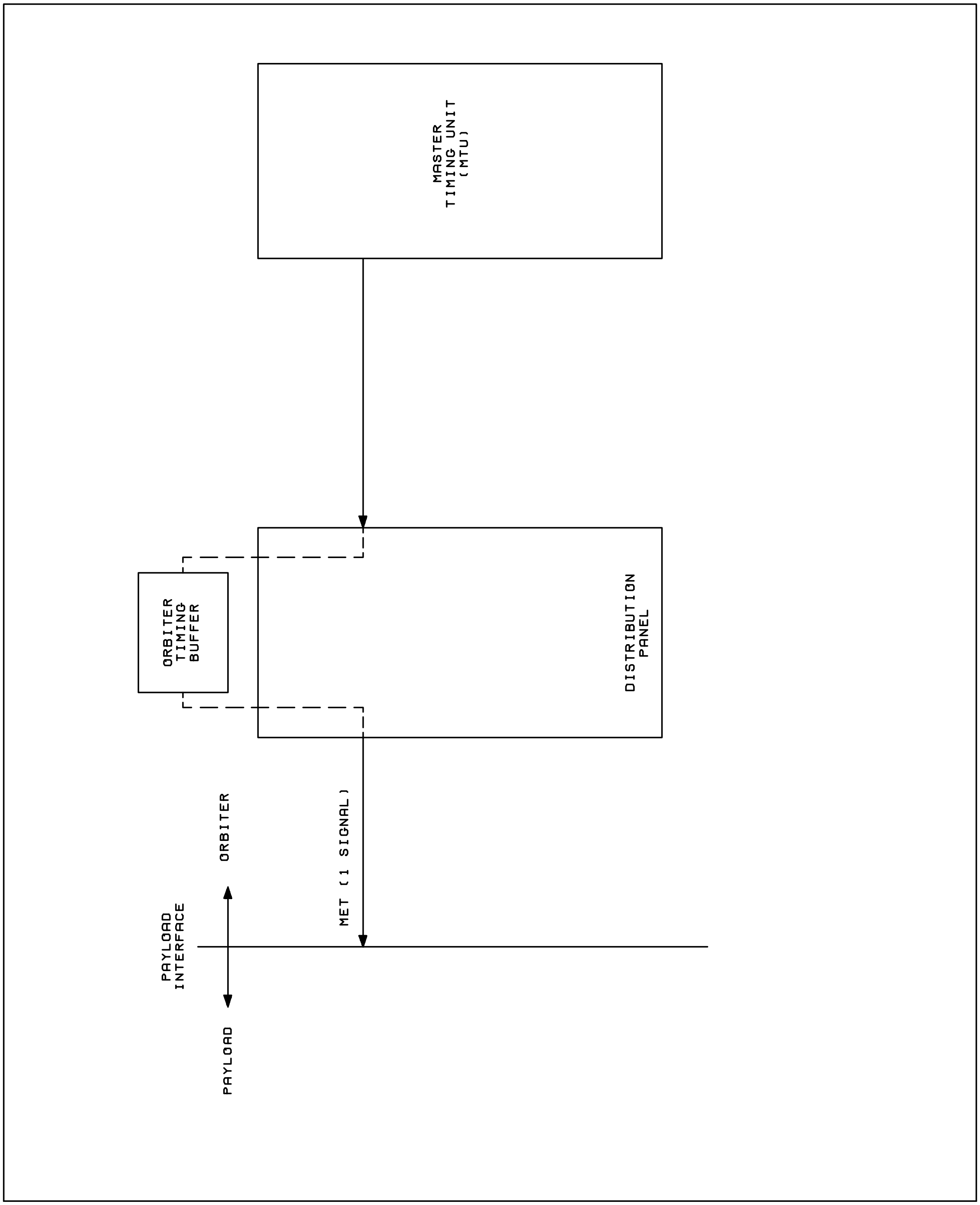
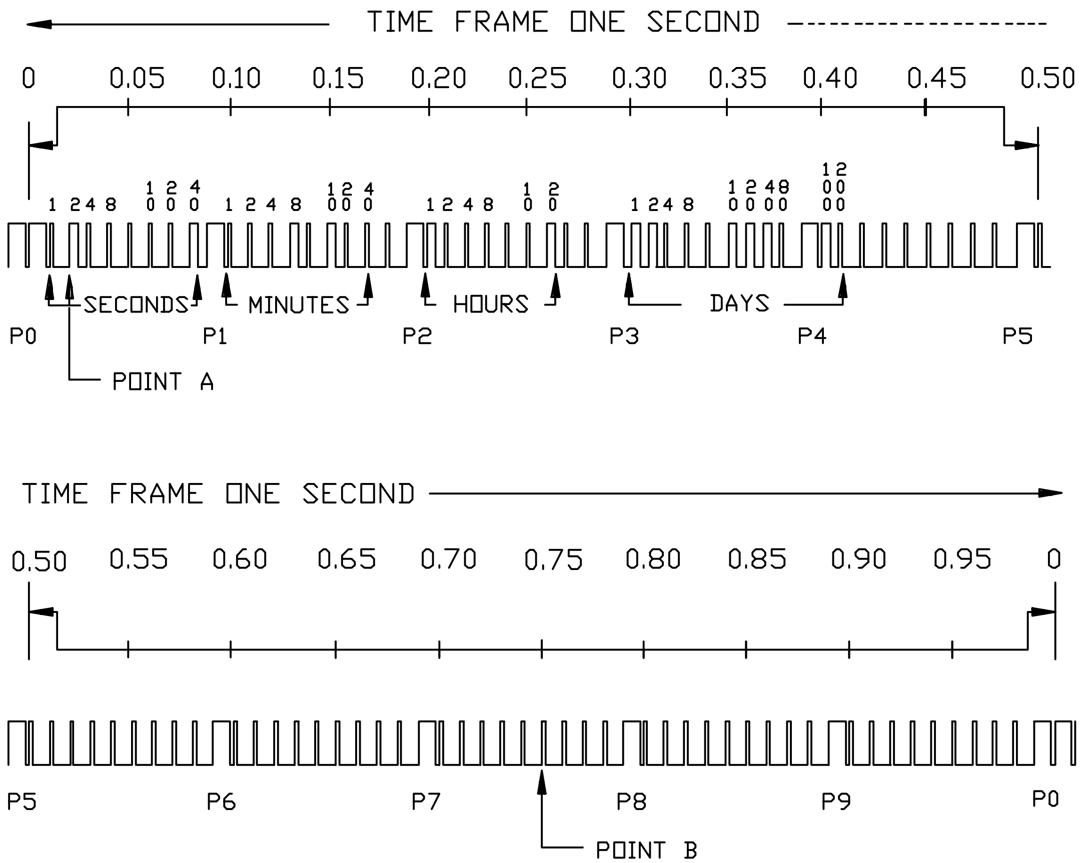


FIGURE 8.2.10-1 TYPICAL MASTER TIMING UNIT AND ORBITER TIMING BUFFER INTERFACE DATA FLOW

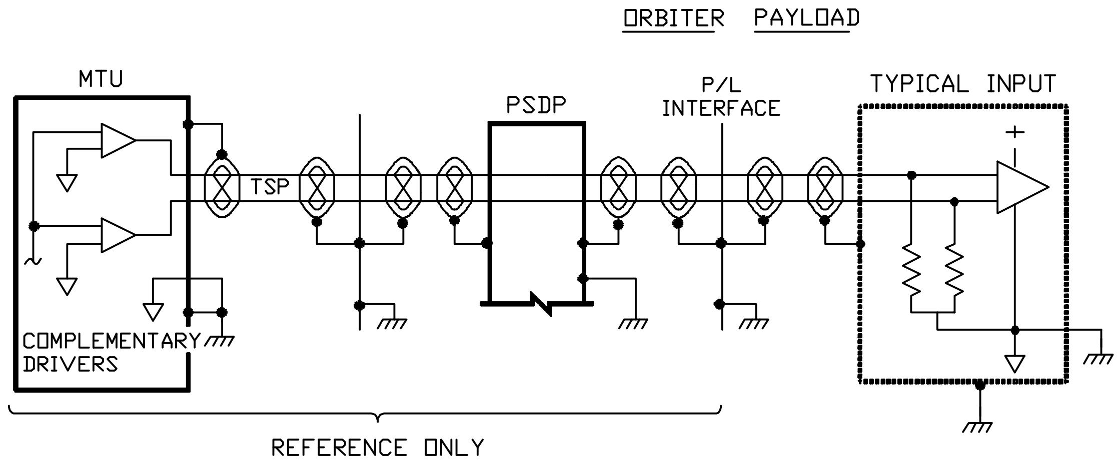


FRAME TIME - 1 SECOND
100 PPS (10 MS BETWEEN PULSES)
BCD
"ON TIME" REF - LEADING EDGE
POSTION IDENTIFIER = 8 MILLISEC DURATION ± 50 MICROSECONDS
BINARY 0 = 2 MILLISEC DURATION ± 50 MICROSECONDS
BINARY 1 = 5 MILLISEC DURATION ± 50 MICROSECONDS
TIME AT POINT A = 173 DAYS, 21 HOURS, 18 MINUTES, 42.02 SECONDS
TIME AT POINT B = 173 DAYS, 21 HOURS, 18 MINUTES, 42.75 SECONDS

NOTE: THE IRIG-B FORMAT IS MODIFIED SUCH THAT THE 1 KHZ MODULATED CARRIER AND THE "STRAIGHT BINARY SECONDS" ARE ELIMINATED. THE TIME SIGNAL IS TRANSMITTED SERIALLY AT 100 PULSES PER SECOND WITH A RESOLUTION OF 10 MILLISECONDS AND WITH THE LEAST SIGNIFICANT BIT BEING TRANSMITTED FIRST.

FIGURE 8.2.10.1.3-1 MASTER TIMING UNIT GMT AND MET OUTPUT FORMATS

FIGURE 8.2.10.5.1-1 MTU: GMT AND MET GROUNDING AND SHIELDING INTERFACE

PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.10.1.2 MISSION ELAPSED TIME	

THIS PAGE INTENTIONALLY LEFT BLANK

9.0 SOFTWARE INTERFACES

9.0.1 Payload Definition

9.0.1.1 Shuttle Orbiter/Payload Software Functional Interfaces

The Shuttle Orbiter/Cargo Element software functional interface shall be as shown in Figure 9.0.1.1-1.

9.0.1.2 (Reserved)

9.0.1.3 Payload Communications

The Payload Signal Processor command message shall be formatted as follows:

```
             BYTE--     0      1        2       3       ....    N-1     N
------------------------------------------------------- .... ----------------
| PSP IDLE PATTERN   |      |      |        |        |        |      |      |
|--------------------|  AA  |  A3  |   12   |        |        |      |      |
| (PARA. 9.4.2.2.4)  |      |      |        |        |  ....  |      |      |
-------------------------------------------------------      ----------------
                     |<--- PAYLOAD SYNC --->|<-----PAYLOAD COMMAND  ------->|
                     |                                                     |
                     |<-----------PAYLOAD  COMMAND  MESSAGE  -------------->|
                                          N (Maximum) = 127
```

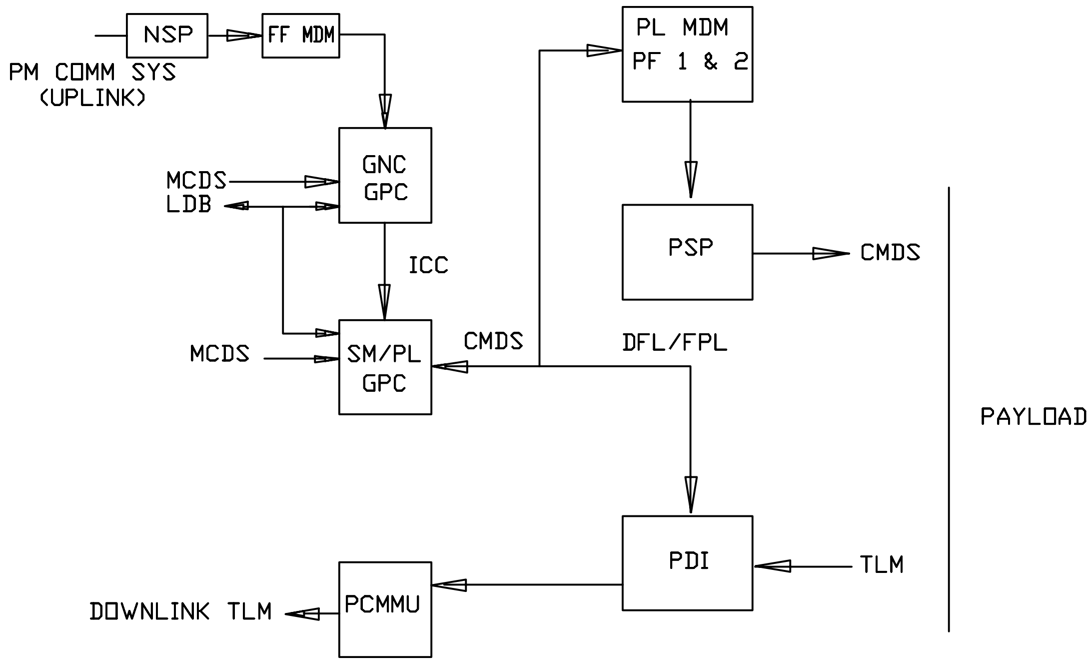
The payload command message shall be preceded by an idle pattern supplied by the Orbiter's PSP. The payload command message shall consist of up to a maximum length of 128 8-bit bytes. The payload command message bytes shall be defined as follows:

Bytes 0-2	AA A3 12 (sync pattern in HEX)
Bytes 3-N	Payload commands (N is an odd integer between 4 and 128)

9.0.2 (Reserved)

9.0.3 (Reserved)

9.0.4 (Reserved)



<u>LEGEND</u>

PF	PAYLOAD FORWARD
PL	PAYLOAD
NSP	NETWORK SIGNAL PROCESSOR
FF	FLIGHT CRITICAL FORWARD
ICC	INTERCOMPUTER CONTROL
DATA ACQ	DATA ACQUISITION
GPC	GENERAL PURPOSE COMPUTER
GNC	GUIDANCE, NAVIGATION AND CONTROL
SM	SYSTEMS MANAGEMENT
MDM	MULTIPLEXER/DEMULTIPLEXER
PCMMU	PULSE CODE MODULATION MASTER UNIT
MCDS	MULTIFUNCTION CRT DISPLAY SYSTEM
CMDS	COMMANDS
LDB	LAUNCH DATA BUS
PSP	PAYLOAD SIGNAL PROCESSOR
PDI	PAYLOAD DATA INTERLEAVER
TLM	TELEMETRY

FIGURE 9.0.1.1-1 PAYLOAD-TO-ORBITER SOFTWARE FUNCTIONAL DIAGRAM

THIS PAGE INTENTIONALLY LEFT BLANK

9.1 SOFTWARE OVERVIEW

9.1.1 Scope

The software system functional interfaces between the Orbiter and the payloads shall be as shown in Figure 9.1.1-1. The interfaces associated with software are the Payload-Orbiter Payload Data Interleaver (PDI) interface and the Orbiter Payload Signal Processor (PSP) interface. The detailed hardware requirements and characteristics of these interfaces are described in Section 8.0. The constraints, formats, and data content that are software dependent for each of these interfaces shall be as defined in the following paragraphs.

9.1.2 Hardware/Software Correlation

Cargo Harness hardware/software correlation is specified in Table 13.5.1.1-1 for the PSP and PDI interfaces. In order to insure hardware/software compatiblity when using Orbiter cargo harness capability, the signal function of the PDI and the PSP should be included as part of the specific command/measurement data in Annex 4 (Command and Data Annex).

9.2 ORBITER GPC SOFTWARE INTERFACE

The Orbiter provides the following software interfaces for use by the payload.

9.2.1 Payload Data Interleaver/PCMMU

Payload data interleaver/PCMMU for data acquisition and monitor for attached payloads.

9.2.2 Payload Signal Processor

Payload Signal Processor for attached payload commands.

9.2.3 (Reserved)

9.2.4 (Reserved)

9.3 FLIGHT PHASE APPLICABILITY

The ability of the GPC software to support the payloads is both flight and flight time (event) dependent.

Timeline. Normally, other than supporting PDI data throughput to the ground, the only GPC software that supports payloads is an on-orbit memory configuration, Systems Management (SM). For a nominal mission SM is available from approximately 77 minutes after lift-off until approximately three hours prior to entry. SM software is also briefly installed during ground processing after payload installation into the Orbiter and before payload bay door closure in order to support agreed-to payload testing.

9.3.1 (Reserved)

9.3.2 (Reserved)

9.3.3 On-Orbit (SM)

The Orbiter software processes acquired payload data and displays to the crew, the health, performance and configuration of payload subsystems. Processing capability includes limit sensing, fault detection and annunciation, display, payload sequencing, payload unique computations and data transferring (downlist) to the Orbiter PCMMU for downlinking. The GPC cannot process subcommutated data. That is, each time a data element is acquired, it will be processed as a different sample of the same payload measurement. The Orbiter software also provides the capability to send commands, either crew initiated or via Orbiter uplink. The constraints, format, and data content that are software dependent for each of these interfaces shall be as defined in Paragraph 9.4.

9.4 SOFTWARE CONSTRAINTS/COMMUNICATION CONVENTIONS

9.4.1 Payload - PDI Interface

Selection of up to four payload asynchronous Pulse Code Modulation (PCM) streams and the required decommutation program (stored in mass memory unit) is provided to the PDI under GPC control. The Orbiter PDI provides two modes of decommutation; format synchronization mode and block mode.

9.4.1.1 Format Synchronization Mode

In the format synchronization mode, the PDI decommutates payload telemetry data into two different data groups for transfer to the PCM master unit. The constraints and format types associated with the two data groups are as defined in Paragragh 8.2.1.1.

9.4.1.1.1 Data Group 1

Data Group 1 includes payload data selected on a telemetry frame basis and transferred via the PDI Toggle Buffer (TB) to the PCMMU solely for interleaving (by the PCMMU) into the operational downlink.

9.4.1.1.2 (Reserved)

9.4.1.2 Block Mode NOT APPLICABLE

9.4.2 PSP/Payload Interface

Hardware characteristics of the PSP/payload interface are as defined in Paragraph 8.2.5. The Orbiter GPC software provides the capability to process command data loads to an attached payload via this link.

9.4.2.1 Data Formats

Each load transferred to the payload via the PSP shall be structured as follows:

9.4.2.1.1 Payload Communications (One or More Commands)

The Orbiter vehicle software limits the maximum message length to the equivalent of 64 x 16 bits (1024) transmitted to the payload without a break in transmission. Each command/data word format shall be preflight-defined.

9.4.2.2 Data Content

The data content of the message transmission shall consist of Orbiter computed data, uplink throughput, or data prestored in the GPC for transmission under crew control. The time interval between command messages could be as long as the time required by the PSP to output the command data from the command output buffers plus 1.5 seconds:

Example: $$tm = \frac{\text{Command Message Length in Bits}}{\text{PSP Command Bit Rate in BPS}} + 1.5 \text{ seconds}$$

Where: tm = Time Minimum
BPS = Bits per Second

9.4.2.2.1 (Reserved)

9.4.2.2.2 (Reserved)

9.4.2.2.3 Uplink Throughput Data Loads

The uplink throughput data load provides the capability to uplink data and/or commands to payloads. The Orbiter GPC software shall not be required to be aware of the data content/format internal to these 16-bit words. Any command sent before transfer completion of the previous command will cause a rejection of the later command. The Orbiter will support the uplink throughput data loads as defined below.

9.4.2.2.3.1 Throughput Command Data Load

The capability is provided to throughput up to 64 sixteen-bit (1024 bits) payload command words per transmission. These words will be downlisted for ground validation/correction before being transferred to the PSP. These words will normally be transferred to the designated PSP channel within two seconds after receipt of a cooperative command to execute the uplink load.

9.4.2.2.3.2 Throughput Command Data Load-Single Stage Processing

The capability is provided to throughput up to 64 sixteen-bit (1024 bits) payload command words per transmission. These words will normally be transferred to the designated PSP channel within two seconds after receipt of the last command word in the uplink load. The Orbiter does not provide validation of these commands and therefore, for critical commands, the payload must provide two-stage execution or other comparable validation systems.

9.4.2.2.3.3 (Reserved)

9.4.2.2.4 PSP Idle Pattern

The capability is provided for the PSP to generate an idle pattern consisting of alternating ones and zeros. The idle pattern is selectable by the Orbiter GPC and shall be generated at a preselected command data rate in NRZ-L, M, or S format as specified.

9.4.2.2.4.1 Payload Commands

Each command message transferred to the payload via the PSP link shall consist of an idle pattern, followed by command word(s). The interval between consecutive command transmissions with no transmission interruption shall be filled by the PSP idle pattern. There shall be no idle pattern between consecutive command words of the same command transmission.

Upon receipt of command data, the idle pattern will terminate with a logic zero and command data will be transmitted. At the completion of command transmission, the idle pattern will again be generated and start with a logic one. If the payload requires a minimum idle pattern, it shall be provided through procedural control.

The idle pattern between consecutive command transmissions, and following the last command to a particular payload, shall begin with a logic one and end with a logic zero. The PSP shall always output command data words in multiples of 16-bits. Command data words less than multiples of 16-bits shall contain fill data. The command data will be transmitted Most Significant Bit (MSB), Most Significant Syllable (MSS) first.

9.4.2.2.4.2 (DELETED)

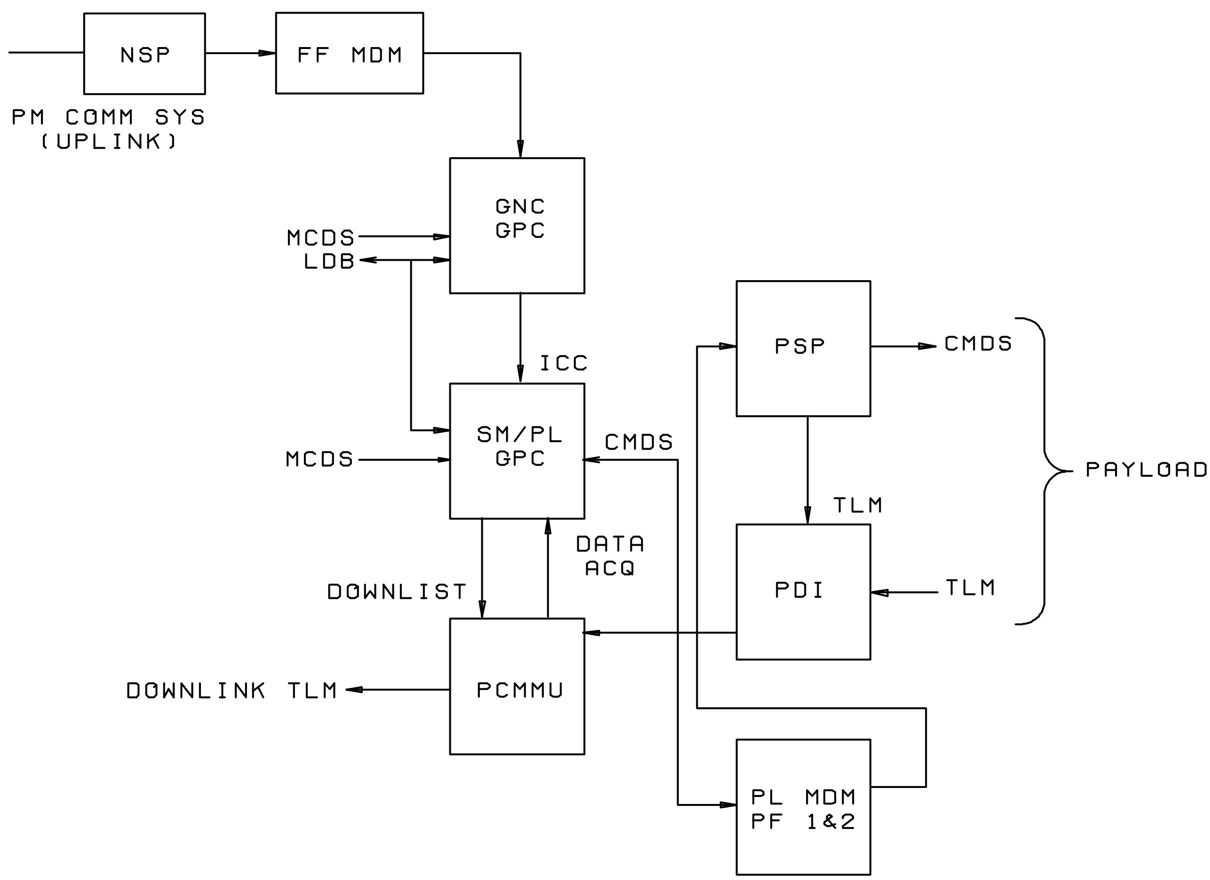
9.4.2.2.5 Non-Standard Idle Pattern NOT APPLICABLE

9.4.2.3 PSP/Payload Telemetry Interface NOT APPLICABLE

9.4.3 (Reserved)

9.4.4 (Reserved)

9.4.5 (Reserved)



LEGEND

PF	PAYLOAD FORWARD
PSP	PAYLOAD SIGNAL PROCESSOR
PDI	PAYLOAD DATA INTERLEAVER
NSP	NETWORK SIGNAL PROCESSOR
PL	PAYLOAD
FF	FLIGHT CRITICAL FORWARD
ICC	INTERCOMPUTER CONTROL
DATA ACQ	DATA ACQUISITION
GPC	GENERAL PURPOSE COMPUTER
GNC	GUIDANCE, NAVIGATION AND CONTROL
SM	SYSTEMS MANAGEMENT
MDM	MULTIPLEXER/DEMULTIPLEXER
PCMMU	PULSE CODE MODULATION MASTER UNIT
MCDS	MULTIFUNCTION CRT DISPLAY SYSTEM
TLM	TELEMETRY
CMDS	COMMANDS
LDB	LAUNCH DATA BUS

FIGURE 9.1.1-1 ORBITER - PAYLOAD SOFTWARE FUNCTIONAL INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK

10.0 INDUCED ENVIRONMENTS

10.0.1 (Reserved)

10.0.2 (Reserved)

10.0.2 UNIQUE MISSION SPECIFIC REQUIREMENTS

10.0.2.1 ORBITER UNIQUE REQUIREMENTS

10.0.2.1.1 Airlock Venting Plume Environment

Atmospheric air shall be vented from the ISS external aiorlock during EVA activities. The payload shall be subjected to pressure loads or moments due to air jet impingement.

A conventional pipe flow outlet with a check valve upstream is used in the external airlock and the Orbiter cabin for overboard venting located as shown in Table 10.0.2.1.1-1.

The data presented herein is specifically applicable only to the Orbiter/External Airlock configuration to be flown on STS-88.

10.0.2.1.2 Air Jet Pressure Environments

The impingement force on a small surface Delta-S can be computed by using the Newtonian impact theory (see Figure 10.0.2.1.2-1). The dynamic pressure defined in the subsequent sections depends on the chamber pressure, the vent size, and the distance of the impingement point from the vent. The moment for the surface can be obtained as the product of the impingement force and the moment arm. Integration of all element surfaces will generate the resultant force and moments for the whole surface.

10.0.2.1.3 Dynamic Pressure for the Pipe Flow

The air flow expands to a near vacuum environment. The source flow model is used to compute the air flow properties that will be used for generating the pressure environments. The air is treated as flowing from an orifice without the effect of the boundary layer on the pipe wall. An assumption is also made that the freezing condition of the fluid particles is set at the maximum Prandtl-Meyer expansion turning angle. These assumptions produce conservative results of the fluid dynamic pressure at high expansion angles. The source flow model, presented herein, provides a spatial distribution of the jet properties that is derived from the conservation of mass and energy, and is based on a series of NASA/JSC Chamber plume tests and the Direct Simulation Monte Carlo (DSMC) computations.

The fundamental assumption of the source flow model is that the fluid properties of a highly under-expanded jet, at a large distance R, can be written as shown in Equation (2) as below.

The source flow model for the dynamic pressure distribution can be derived as shown in Equation (3) as below.

Since the plot variables are non-dimensional, these results are applicable to variable pipe sizes and chamber pressures. In addition , the flow rate is directly proportional to the chamber pressure under a constant chamber temperature, hence the results in Figure 10.0.2.1.3-1 can be linearly extrapolated to other flow rates for practical purposes.

Equation (1) $\Delta F = C_P \, q \, \Delta S \sin^2\alpha$ with $C_p = 2$

where is the angle between the flow direction and the surface normal n and q is the dynamic pressure of the air flow at the point of impingement.

Equation (2) $\rho(R, \theta) = \rho_R(R) \, f(\theta)$

where $\rho(R, \theta)$ is the fluid density and $\rho_R(R)$ depends on R only. The angle θ is measured from the centerline of the pipe exit and $f(\theta)$ depends on θ only.

Equation (3)

$$q(R,\theta) = A_0 \left(\frac{2}{\gamma+1}\right)^{1/(\gamma-1)} \frac{\gamma}{\gamma-1} P_c \left(\frac{R_e}{R}\right)^2 \frac{A_*}{A_e} f(\theta)$$

where

$$A_0 = \frac{\left(\frac{1}{2}\right)\sqrt{\frac{\gamma-1}{\gamma+1}}}{\int_0^{\theta_L} d\theta \, f(\theta) \, \sin\theta}$$

$$f(\theta) = \left[\cos\left(\frac{\pi}{2}\frac{\theta}{\theta_L}\right)\right]^{(\gamma+0.41)/(\gamma-1)} \quad \text{for } \theta < \theta_L \qquad f(\theta) = 0 \quad \text{for } \theta \geq \theta_L$$

where

$$\theta_L = \frac{\pi}{2}\left(\sqrt{\frac{\gamma+1}{\gamma-1}} - 1.0\right)$$

and γ is the specific heat ratio of air. A_e and A_* are the tube exit and throat (minimum cross section) areas, respectively. R is the distance of the impingement point that is measured from the pipe exit centerline and R_e is the pipe exit radius.

The parameter A_0 was derived by the conservation of energy. The angular distribution function $f(\theta)$ is based on cold flow test data correlation and the aforementioned conservative assumptions.

Constant value contours of (q/P_c) are shown in Figure 10.0.2.1.3-1, where R_* is the pipe throat (minimum) radius

10.0.2.1.4 <u>Dynamic Pressure for the Diffuser Nozzle Flow</u>
The flow model for the diffuser nozzle, as shown in Figure 10.0.2.1.4-1, is to simulate the air flowing out from an annular gap with the area that is equivalent to the total area of the small holes. Consequently, the air flow

expands in both the r and x directions. The flow field was calculated by using Computational Fluid Dynamics (CFD) that was based on the Euler formulation.

The dynamic pressure distributions at various distances are shown in Figure 10.0.2.1.4-1. It should be noted that the dynamic pressure increases near the pipe centerline (Ttheta=90 deg.). This is because the flow converges in that region with shock formation.

Unlike the pipe flow in the previous section, results of the diffuser nozzle are only applicable for this specfic configuration.

10.0.3 (Reserved)

10.0.4 (Reserved)

TABLE 10.0.2.1.1-1 VENT CONFIGURATIONS AND FLOW CHARACTERISTICS

Vent	R*	Xo	Yo	Zo	Direction
ISS External Airlock located in					
bay 3 (down)	0.397	714.35	-35.29	329.4	-Z
(up)	0.397	714.35	-35.29	329.4	+Z
Depress valve in position 0					
ISS Docking Base in bay 3					
(system 1)	Note 1	768.34	0	435.59	YZ
(system 2)	Note 1	768.34	0	441.19	YZ

Note:

All dimensions are in inches.
R* = choke radius
Pc = 14.7 psia nominal

1. Exit vent through a 1.88 inches diameter diffuser with 360 X 0.062 inches diameter holes located around perimeter. Exit vent is in radial direction and in YZ plane.

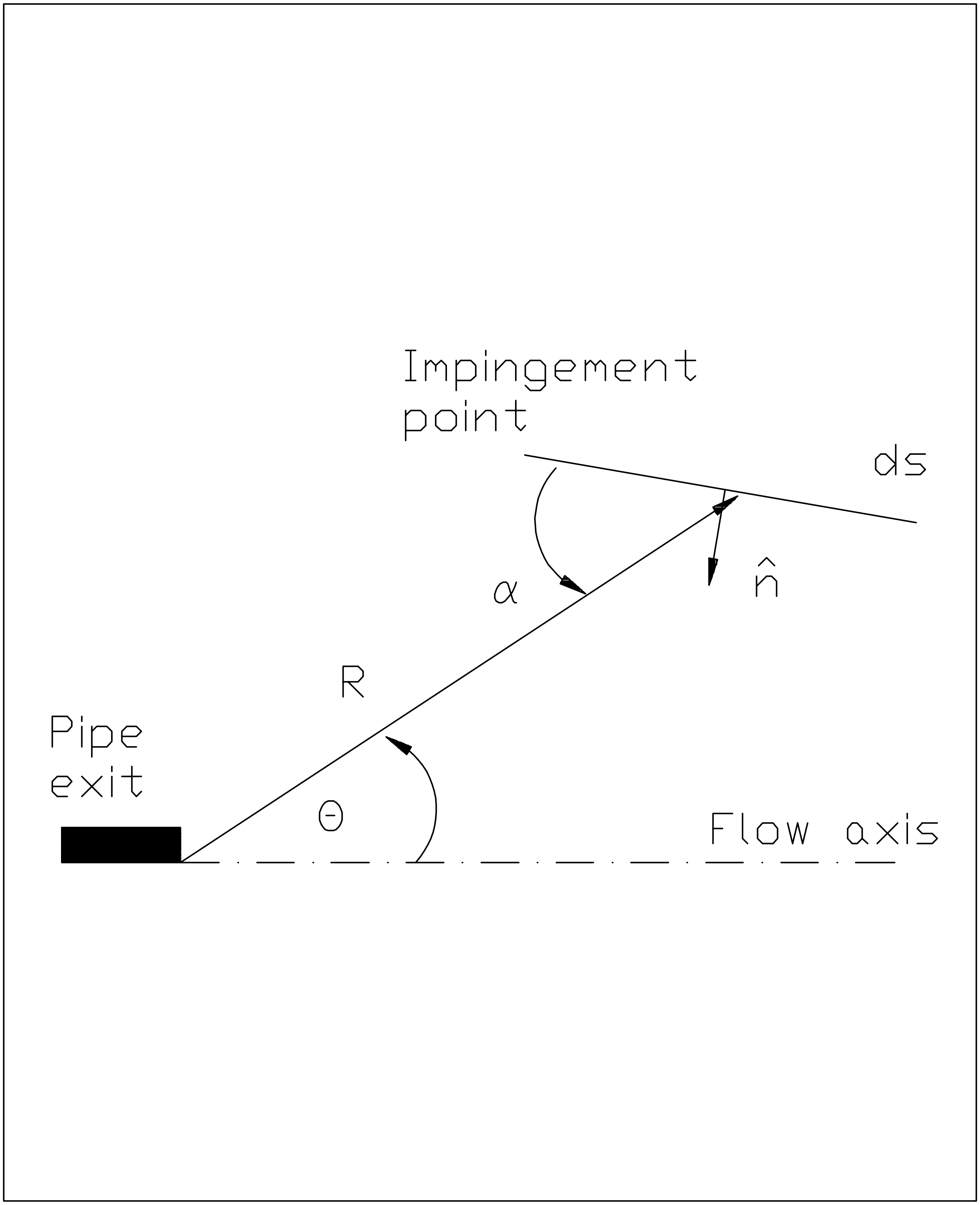


FIGURE 10.0.2.1.2-1 Source Flow Jet Model

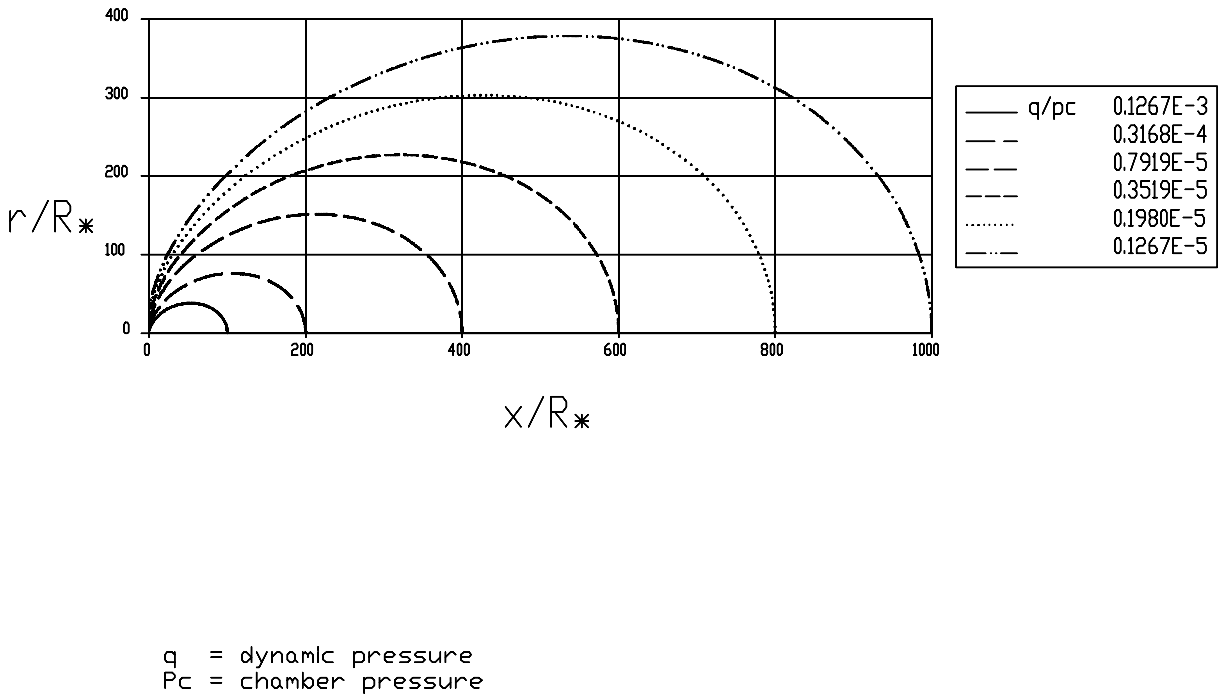


FIGURE 10.0.2.1.3-1 Dynamic Pressure Distribution of Pipe Flow

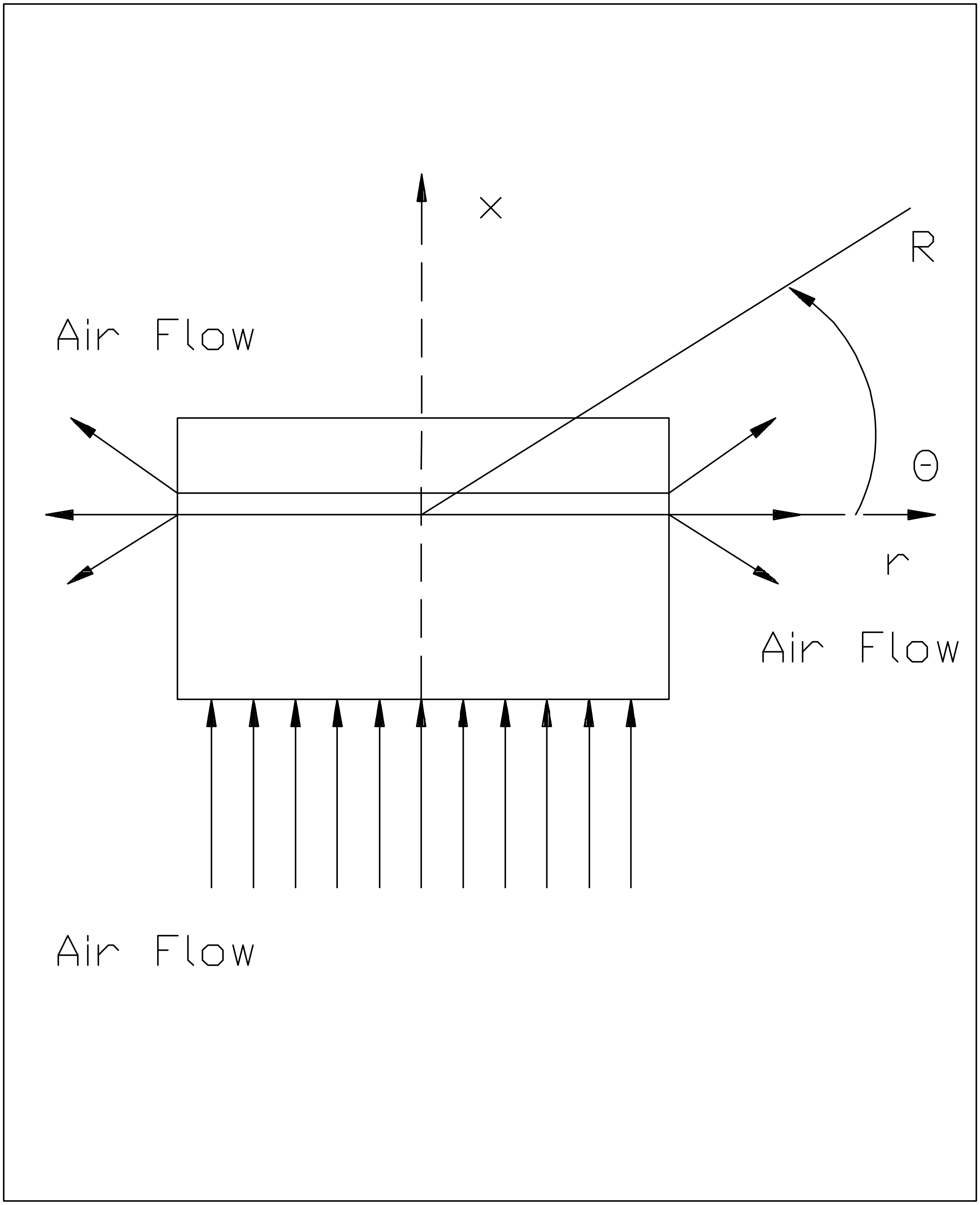


FIGURE 10.0.2.1.4-1 Flow model for Diffuser Nozzle

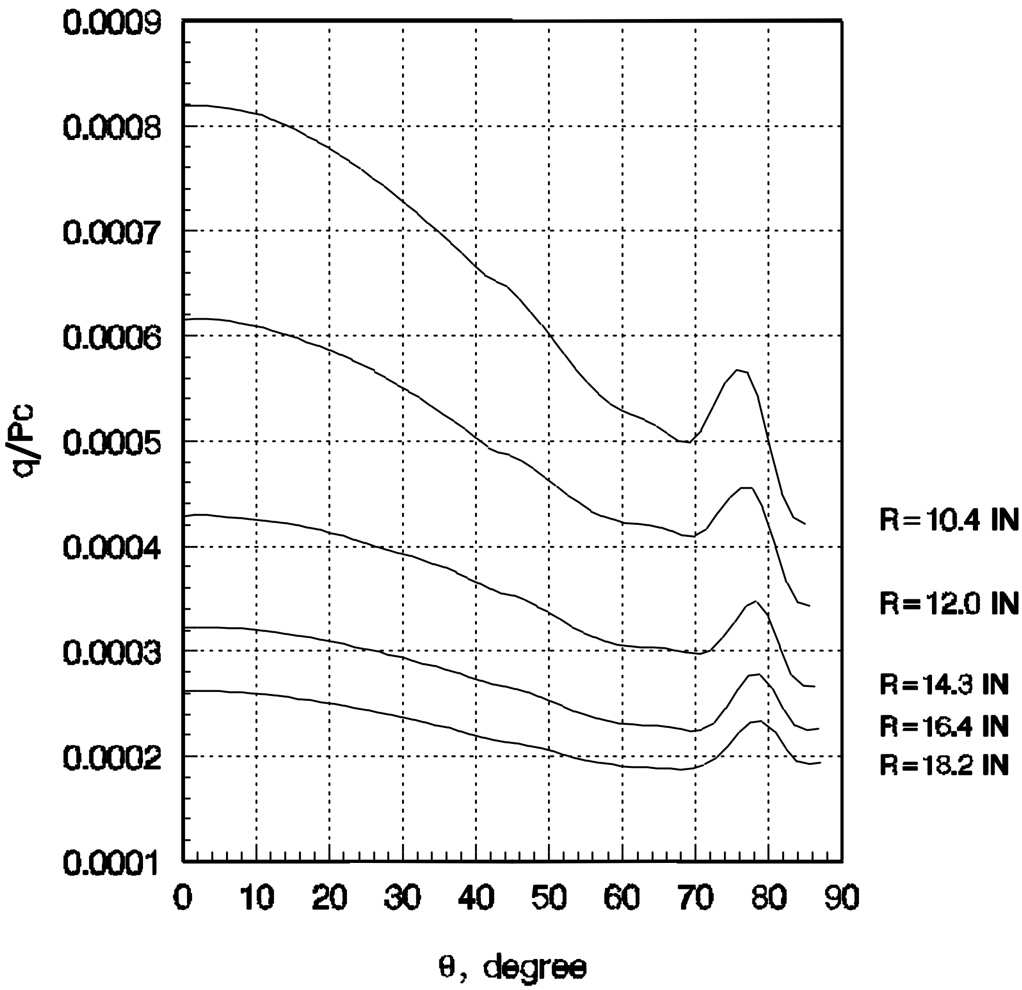


FIGURE 10.0.2.1.4-2 Dynamic Pressure Distribution for Diffuser Nozzle
(SHEET 1 OF 5)

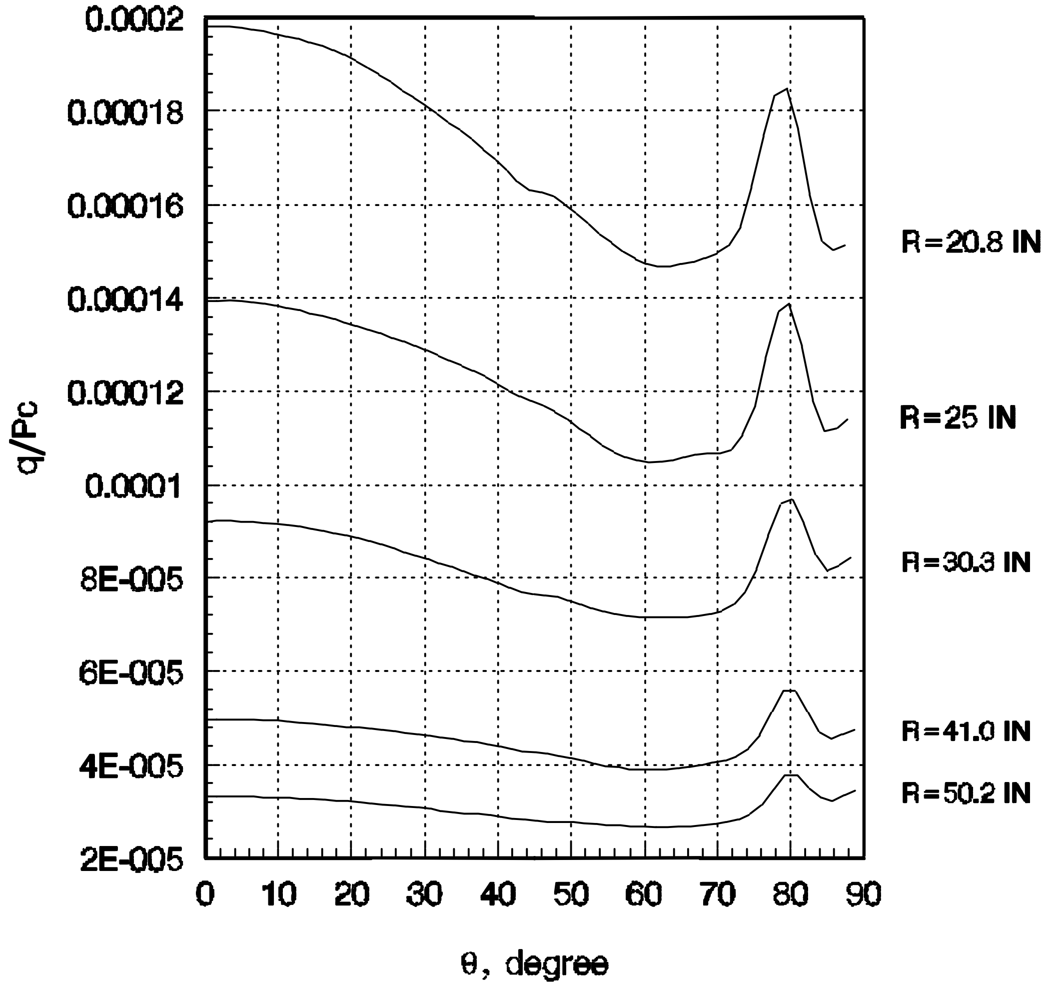


FIGURE 10.0.2.1.4-2 Dynamic Pressure Distribution for Diffuser Nozzle
(SHEET 2 OF 5)

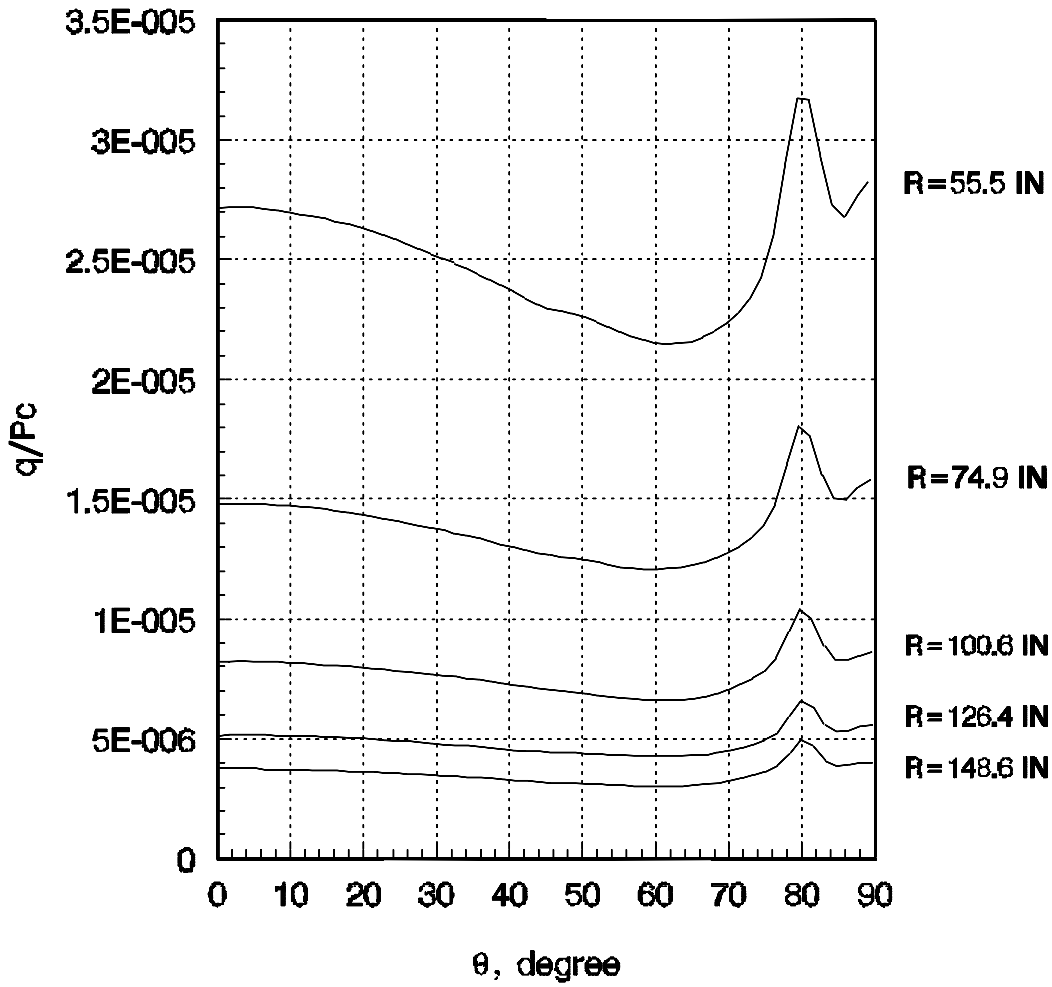


FIGURE 10.0.2.1.4-2 Dynamic Pressure Distribution for Diffuser Nozzle
(SHEET 3 OF 5)

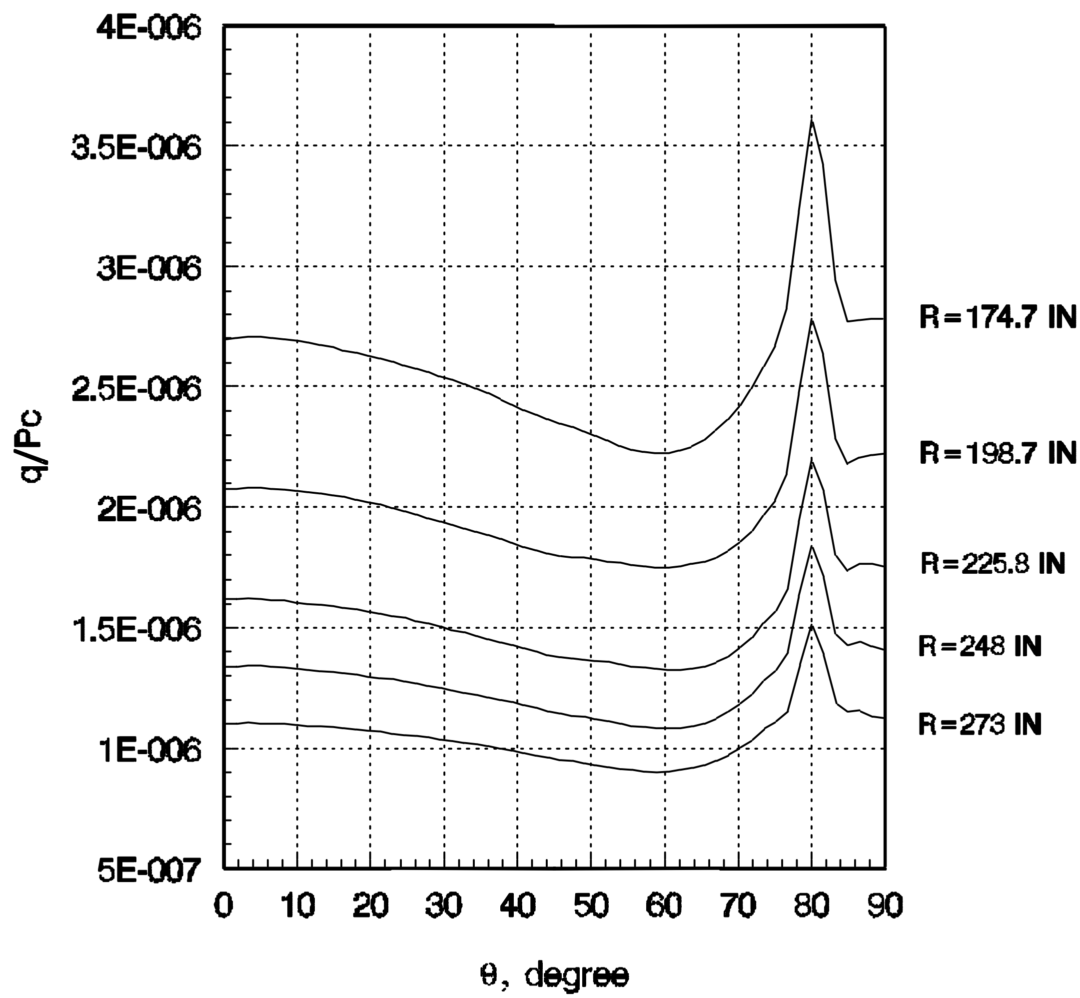


FIGURE 10.0.2.1.4-2 Dynamic Pressure Distribution for Diffuser Nozzle
(SHEET 4 OF 5)

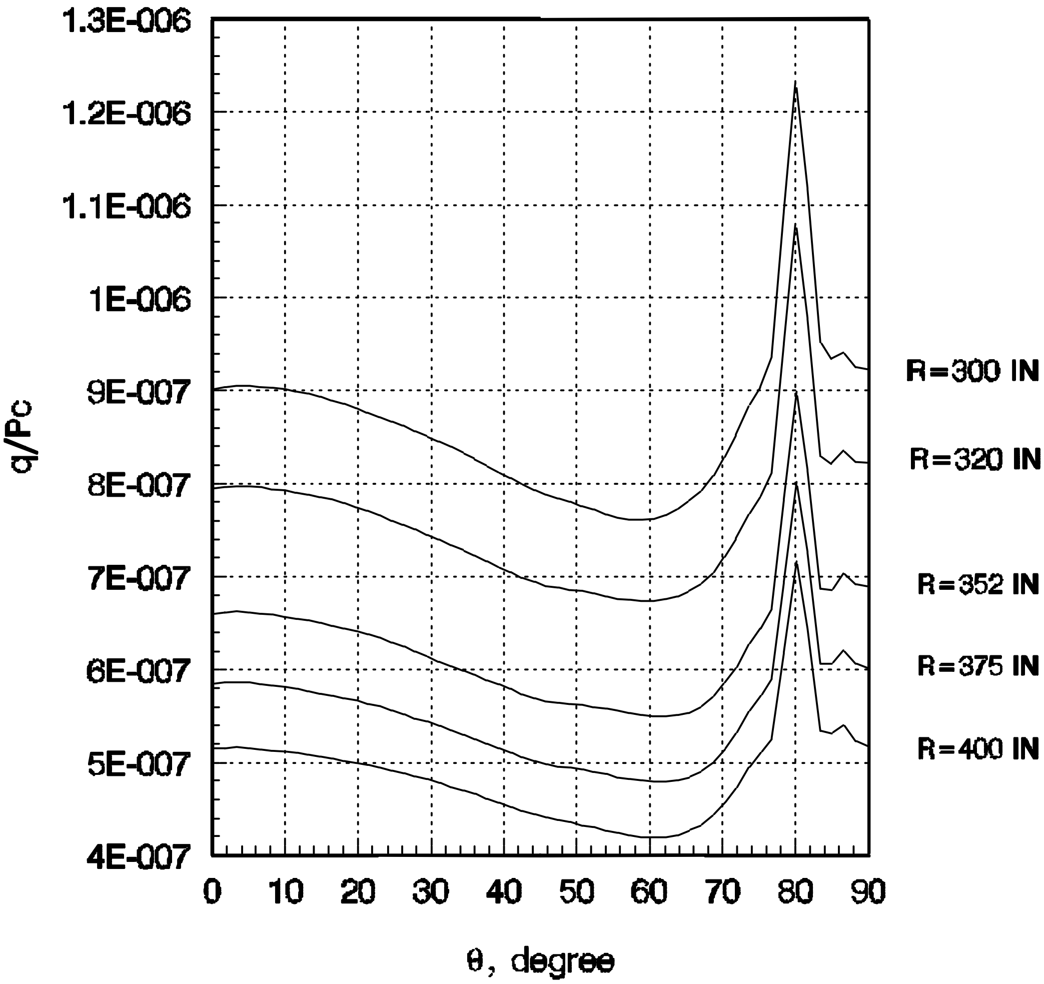


FIGURE 10.0.2.1.4-2 Dynamic Pressure Distribution for Diffuser Nozzle
(SHEET 5 OF 5)

THIS PAGE INTENTIONALLY LEFT BLANK

10.1 (Reserved)

10.2 (Reserved)

10.3 (Reserved)

10.4 (Reserved)

10.5 (Reserved)

10.6 ORBITER/CARGO BAY PARTICULATES AND GASES ENVIRONMENT

10.6.1 Purge Gas in the Cargo Bay

10.6.1.1 Ground Operations With Closed Cargo Bay

Conditioned gas (air or GN_2) which has been HEPA filtered, Class 5000, and containing 15 PPM or less hydrocarbons based on methane equivalent, shall be used to purge the cargo bay as specified in Tables 6.2.1.1-1. The cargo shall have been installed, the cargo bay doors closed, and the Shuttle Vehicle fully mated before purge is started.

10.6.1.2 Lift-off Through Orbit Insertion

The cargo bay gas shall be the residue remaining from the Orbiter ground purge conducted prior to lift-off. The nominal cargo bay pressure during ascent shall be within the curves shown in Figure 10.6.1.2-1. The maximum cargo bay ascent pressure decay rate (i.e., dP/dt) is shown in Figure 10.6.1.2-2 with a maximum value of 0.76 psi/second. Table 10.6.1.2-1 presents values for the data plotted in Figures 10.6.1.2-1 and 10.6.1.2-2.

10.6.1.3 Entry and Descent

Atmospheric air filtered through 35-micron glass-bead-rating filters shall be used to repressurize the cargo bay. Figure 10.6.1.3-1, the Orbiter Cargo Bay internal pressure history, is to be used by payloads for design and venting analysis. Orbiter Cargo Bay vent door opening shall occur at altitudes between 70,000 ft (21,336 m) and 94,000 ft (28,651 m). The repressurization rate (i.e., dP/dt) of the Cargo Bay shall not exceed 0.3 psi/sec during descent. Figure 10.6.1.3-1 (Sheet 2 of 2) presents values for the data plotted in Figure 10.6.1.3-1 (Sheet 1 of 2).

10.6.2 Contamination

10.6.2.1 Accessibility for Cleaning

Interior surfaces of the Cargo Bay and exterior surfaces of the Cargo shall be designed to provide accessibility for cleaning purposes.

10.6.2.1.1 Cargo Bay and Cargo Element Cleaning Condition

Internal Cargo Bay surfaces and external Cargo element surfaces shall be maintained to a visibly clean level, as defined in NSTS Specification SN-C-0005, both prior to and following, Cargo element installation in the Cargo Bay.

10.6.2.2 Cargo Effluents

The formation or transfer, within the cargo bay, of any cargo effluents which can result in payload cross-contamination or jeopardize the performance of Orbiter systems (i.e., radiators, windows, optics, etc.) shall be precluded.

The Cargo shall provide cleanable exterior surfaces. All nonmetallic materials exposed to the cargo bay shall be selected for low outgassing characteristics. Material selection criteria of 1 percent, or less, total mass loss and 0.1 percent, or less, volatile condensible material (VCM) as defined in NASA/JSC Specification SP-R-0022, or its equivalent, shall be used.

10.6.2.3 Gases and Liquids Vented Overboard

Fluids vented overboard shall limit contamination of the cargo, cargo bay, Orbiter windows, optical surfaces, and/or Orbiter thermal protection system surfaces to a level which does not jeopardize mission objectives. Dump design shall be time-selectable in order to program occurrences to be compatible with other flight operations. No payload shall dump or vent any fluids into the Cargo Bay during ascent or descent (including aborts). On-orbit dumps of non-hazardous fluids shall be performed only with the Cargo Bay doors open. Venting or dumping, as used in this paragraph, shall not include the release of non-hazardous gases in internal unpressurized volumes at atmospheric pressure at liftoff which are continuously vented during ascent and continuously repressurized during entry. All other payload venting requirements shall be agreed to in the Payload Integration Plan (PIP).

10.6.2.4 Cargo Bay Liner

The Orbiter shall provide a cargo bay liner, as required, to isolate cargo element surfaces which are sensitive to particulate contamination effects from the Orbiter lower mid-fuselage. The liner shall prevent the transfer of particulates greater than 35 microns GBR (nominal max. particle size 87 microns in length) from the lower mid-fuselage to the cargo bay. All cargo bay surfaces, including the cargo bay liner, shall be cleaned to a visibly clean level as defined in NSTS specification SN-C-0005.

10.6.2.5 Orbiter Sources of Contamination

Number column density and return flux predictions for outgassing, flash evaporator, leakage, and RCS effluents for various lines-of-sight and altitudes are shown in Table 10.6.2.5-1.

10.6.3 (Reserved)

10.6.4 Cargo Bay Venting Velocity and Pressure Environments for Payloads

The Orbiter cargo bay is vented through vent openings on both the port and starboard sides of the vehicle during ascent and entry in order to equalize the internal/external pressure environment. The airflow during this venting process can have an adverse effect upon payloads or payload components. In addition, excessive blockage of the vents by a payload can result in damage to the Orbiter. Therefore, the payload is required to make an assessment of the effects of this induced environment upon their payload and/or its components.

For assessment purposes, the payload shall be assumed to be located directly in front of a vent. Should this assessment indicate a hazardous condition or an adverse effect upon the payload or the orbiter (due to excessive blockage), the payload shall notify the SSP.

Approximate vent locations are shown in Figure 3.3.4.4-1.

10.6.4.1 Vent Flow Environment/Analysis Methodology

During inflow venting, a jet of air flows into the payload bay through the down stream portion (in the Xo direction) of the vent filter as described in

Figure 10.6.4.1-1. The inflow through the upstream portion of the filter is low compared with the flow within the jet. Within the core of the jet, the inflow velocity remains constant. Beyond the core, the centerline velocity gradually decays with increasing distance from the vent filter. However, the total force acting upon any payload component located within the jet impingement region remains constant for all distances from the filter, so long as the component continues to capture the entire jet.

Depending upon its size and location in the payload bay, a payload can be exposed to both an inflow condition at one vent and an outflow condition from another vent at the same time.

During outflow venting, flow-velocity is essentially uniform across the entire area of the vent filter. In addition, the velocity and pressure of the vent flow is affected by the size of the payload component.

For purposes of payload size definition, large components are those that do not meet the definition of a small component. Small payload components are defined as follows:

$$A \leq 0.24\,(Y + 14)^2$$

where A = area of the payload component projected onto the filter, $in.^2$

Y = distance from the filter to the closest point on the payload, in.

10.6.4.1.1 Ascent Vent Flow Environment

Maximum inflow velocity and dynamic pressure during ascent are as shown in Figure 10.6.4.1.1-1. Maximum outflow velocity and dynamic pressure are shown in Figure 10.6.4.1.1-2 for small payload components and in Figure 10.6.4.1.1-3 for larger payload components.

10.6.4.1.2 Entry Vent Flow Environment

Maximum inflow velocity and dynamic pressure during entry are shown in Figure 10.6.4.1.2-1. Maximum outflow velocity and dynamic pressure are shown in Figure 10.6.4.1.2-2 for small payload components and in Figure 10.6.4.1.2-3 for larger payload components.

TABLE 10.6.1.2-1 ASCENT CARGO BAY PRESSURE AND DECAY RATE

TIME	MAXIMUM CARGO BAY PRESSURE	MINIMUM CARGO BAY PRESSURE	MAXIMUM RATE OF DEPRESSURIZATION
10	14.45	14.20	0.155
20	13.20	12.50	0.255
30	11.25	10.00	0.360
35	10.05	8.90	0.510
38	9.40	8.20	0.735
39	9.15	7.60	0.760
40	8.95	7.20	0.760
41	8.70	6.80	0.760
45	7.75	5.70	0.640
48	7.20	5.10	0.570
49	7.05	4.90	0.575
50	6.90	4.70	0.550
51	6.60	4.50	0.520
52	6.10	4.30	0.455
55	5.35	3.65	0.355
60	4.30	2.70	0.273
65	3.50	2.00	0.255
70	2.70	1.40	0.195
80	1.30	0.60	0.150
90	0.60	0.20	0.115
100	0.25	0.10	0.075

NOTE:

(1) PRESSURE IN PSIA

(2) RATE OF DEPRESSURIZATION IN PSI/SECOND

(3) TIME IN SECONDS FROM LIFT-OFF

TABLE 10.6.2.5-1 PREDICTED NUMBER COLUMN DENSITY AND RETURN FLUX CONTRIBUTIONS FROM SHUTTLE ORBITER SOURCES OF CONTAMINATION

Source	Parameter	Number Column Density (Molecules/cm^2)	Return Flux (RF) (Molecules/cm^2/sec) 300 Km	400 Km	700 Km
Outgassing	LOS 1	2.1 x10^{10}	5.2x10^{10}	1.1x10^{10}	2.5x10^{8}
	3	3.1 x10^{10}	2.9x10^{10}	6.2x10^{9}	1.4x10^{8}
	7	2.7 x10^{10}	2.5x10^{10}	5.3x10^{9}	1.2x10^{8}
FES	LOS 1	6.7 x10^{13}	3.0x10^{12}	6.3x10^{11}	1.4x10^{10}
	7	3.3 x10^{14}	1.6x10^{12}	3.4x10^{11}	7.9x10^{9}
VRCS AFT -Z Right Side	LOS 1	2.8x10^{14}	1.4x10^{13}	2.9x10^{12}	6.6x10^{10}
	7	6.8x10^{14}	3.4x10^{12}	7.2x10^{11}	1.7x10^{10}
VRCS AFT +Y	LOS 1	1.6x10^{14}	8.1x10^{12}	1.7x10^{12}	4.0x10^{10}
	7	8.7x10^{14}	3.7x10^{12}	7.9x10^{11}	1.8x10^{10}
PRCS AFT -Z	LOS 1	8.9x10^{15}	5.4x10^{13}	1.1x10^{13}	2.6x10^{11}
	7	3.6x10^{16}	5.4x10^{12}	1.1x10^{12}	2.6x10^{10}
PRCS AFT +Y	LOS 1	8.6x10^{15}	6.0x10^{13}	1.3x10^{13}	3.0x10^{11}
	7	2.9x10^{16}	5.4x10^{12}	1.1x10^{12}	2.6x10^{10}

NOTES:

(1) Ambient velocity direction: -Z, Field of view: 10°, medium density atmosphere.

(2) Maximum temperature, after 100 hours.

(3) LOS 1, zero degree line-of-sight (in the +Zo direction) originating at Xo = 1107, Yo = 0, Zo = 507.
LOS 3, 60° off of +Z towards + Xo (backward) originating at Xo = 1107, Yo = 0, Zo = 507.
LOS 7, 60° off of +Z towards +Yo (right) originating at Xo = 1107, Yo = 0, Zo = 507.

(4) Elevon is in nominal position, maximum flow.

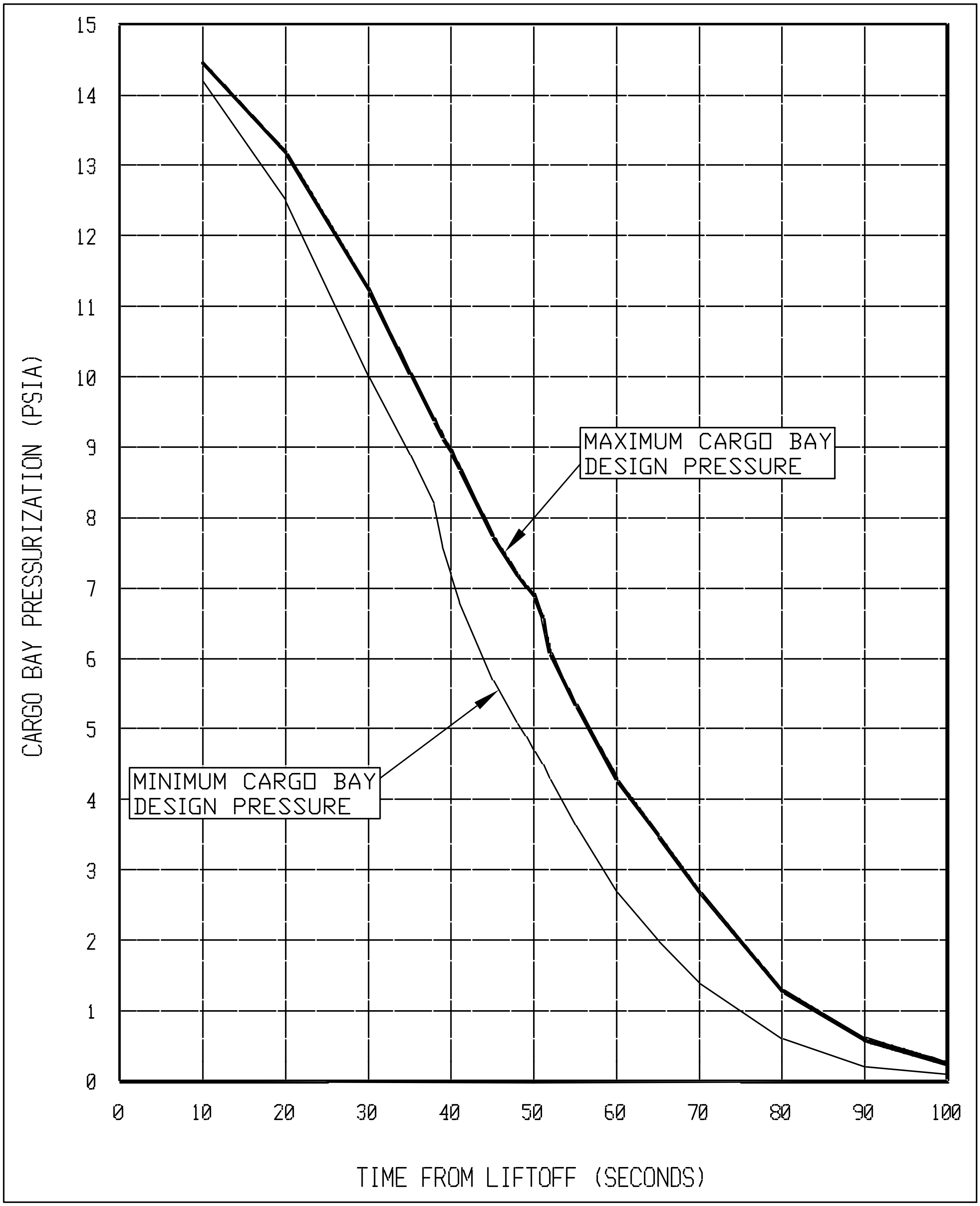


FIGURE 10.6.1.2-1 ORBITER CARGO ELEMENT INTERNAL PRESSURE HISTORY DURING ASCENT

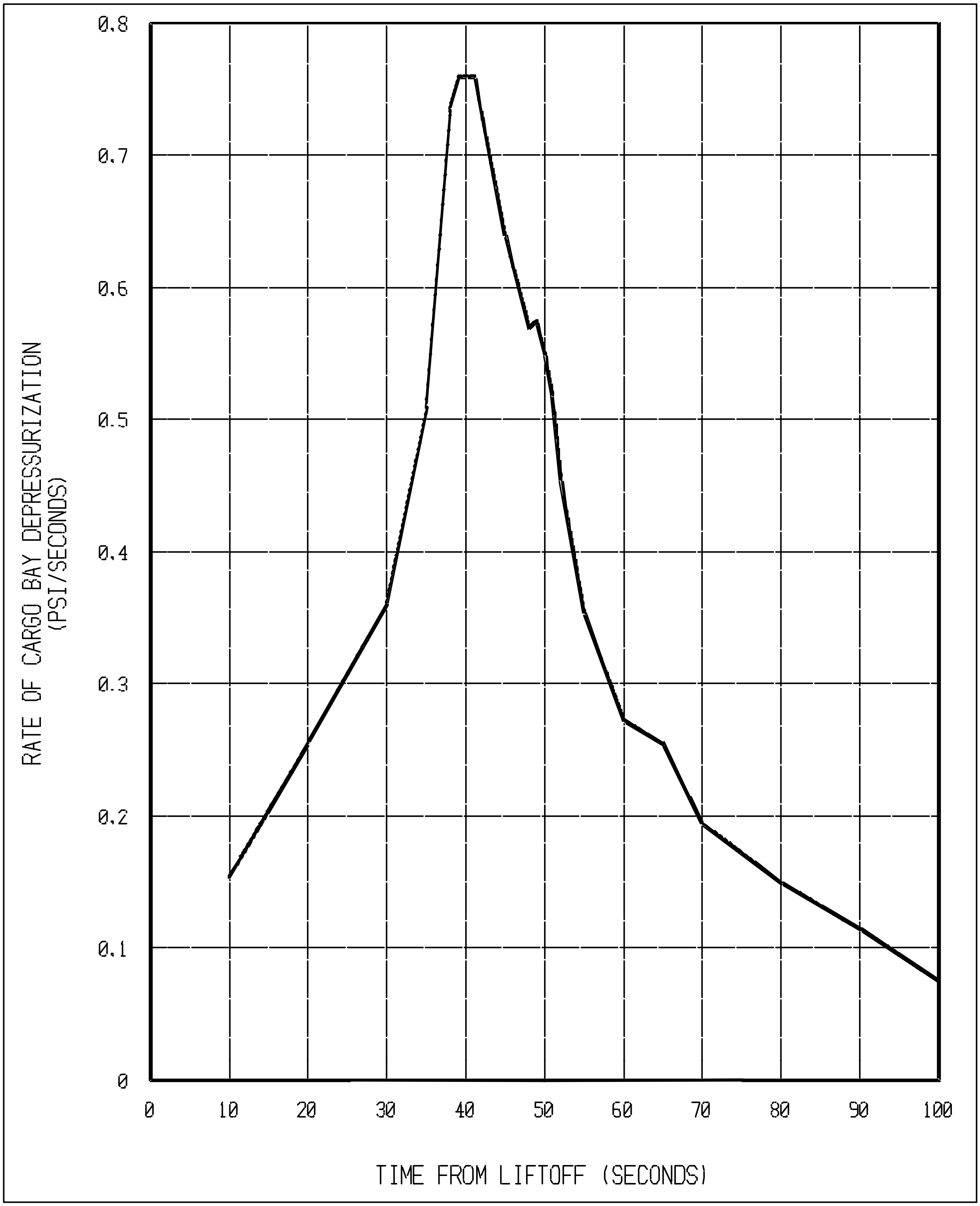


FIGURE 10.6.1.2-2 MAXIMUM CARGO BAY PRESSURE DECAY RATE DURING ASCENT

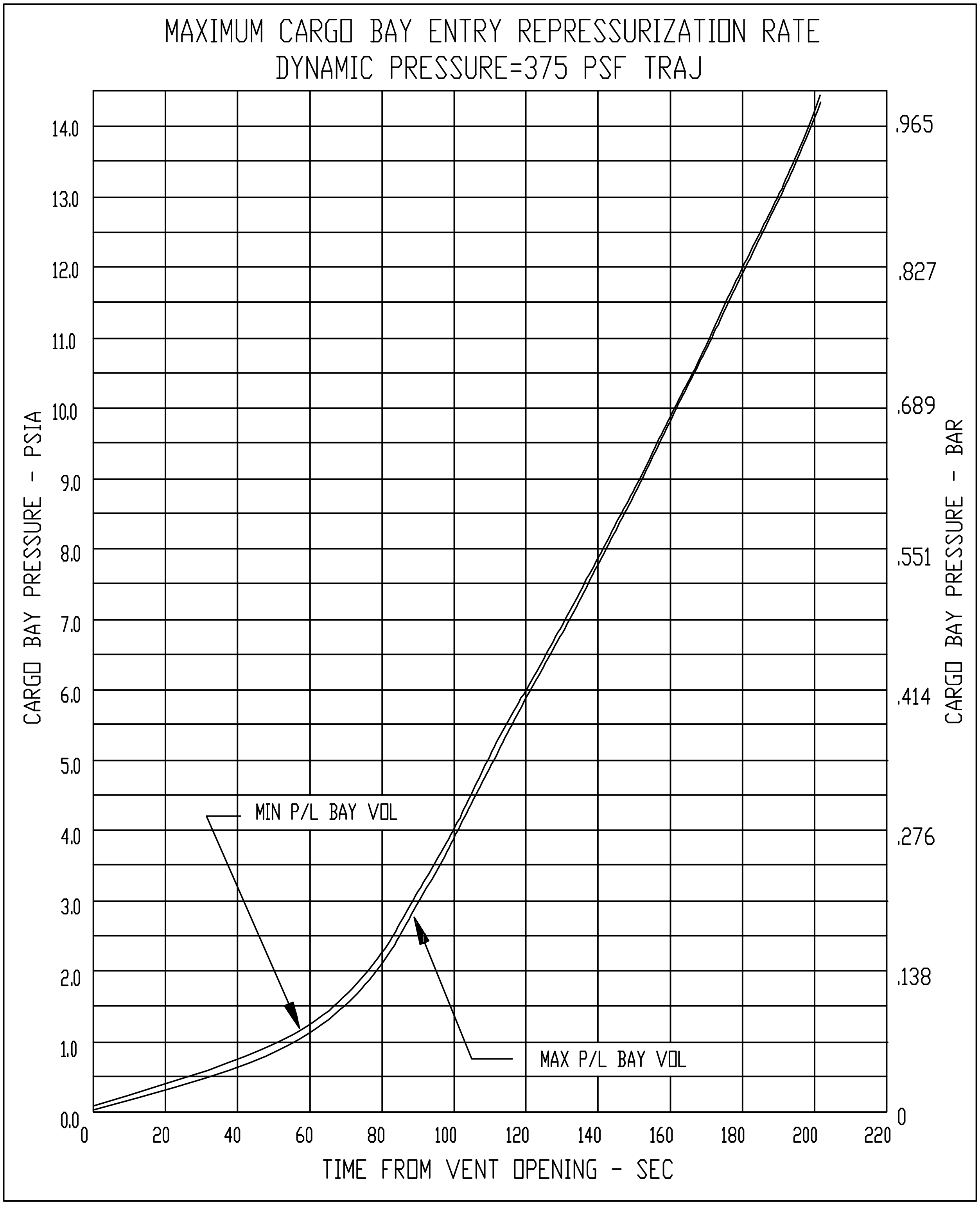


FIGURE 10.6.1.3-1 ENTRY PHASE CARGO BAY INTERNAL PRESSURE HISTORY, TO BE USED FOR PAYLOAD DESIGN
(SHEET 1 OF 2)

Time From Vent Opening (Sec)	Cargo Bay Pressure (psia) Max. P/L Bay Volume	Cargo Bay Pressure (psia) Min. P/L Bay Volume
0.45	0.11	0.17
5.57	0.13	0.21
10.70	0.20	0.31
15.82	0.27	0.41
20.95	0.35	0.49
26.07	0.44	0.57
31.20	0.52	0.64
36.32	0.61	0.71
41.45	0.69	0.79
46.57	0.79	0.89
51.70	0.90	1.01
56.82	1.03	1.14
61.95	1.19	1.31
67.07	1.41	1.54
72.20	1.66	1.80
77.32	1.94	2.09
82.45	2.29	2.44
87.57	2.74	2.92
92.70	3.23	3.39
97.82	3.66	3.79
102.95	4.18	4.32
108.07	4.69	4.82
113.20	5.19	5.36
118.32	5.71	5.84
123.45	6.16	6.26
128.57	6.64	6.73
133.70	7.12	7.21
138.82	7.61	7.70
143.95	8.11	8.19
149.07	8.62	8.70
154.20	9.13	9.21
159.32	9.66	9.73
164.45	10.18	10.25
169.57	10.69	10.76
174.70	11.23	11.31
179.82	11.78	11.86
184.95	12.31	12.38
190.07	12.82	12.89
195.20	13.37	13.44
200.32	14.00	14.08

FIGURE 10.6.1.3-1 ENTRY PHASE CARGO BAY INTERNAL PRESSURE HISTORY, TO BE USED FOR PAYLOAD DESIGN
(SHEET 2 OF 2)

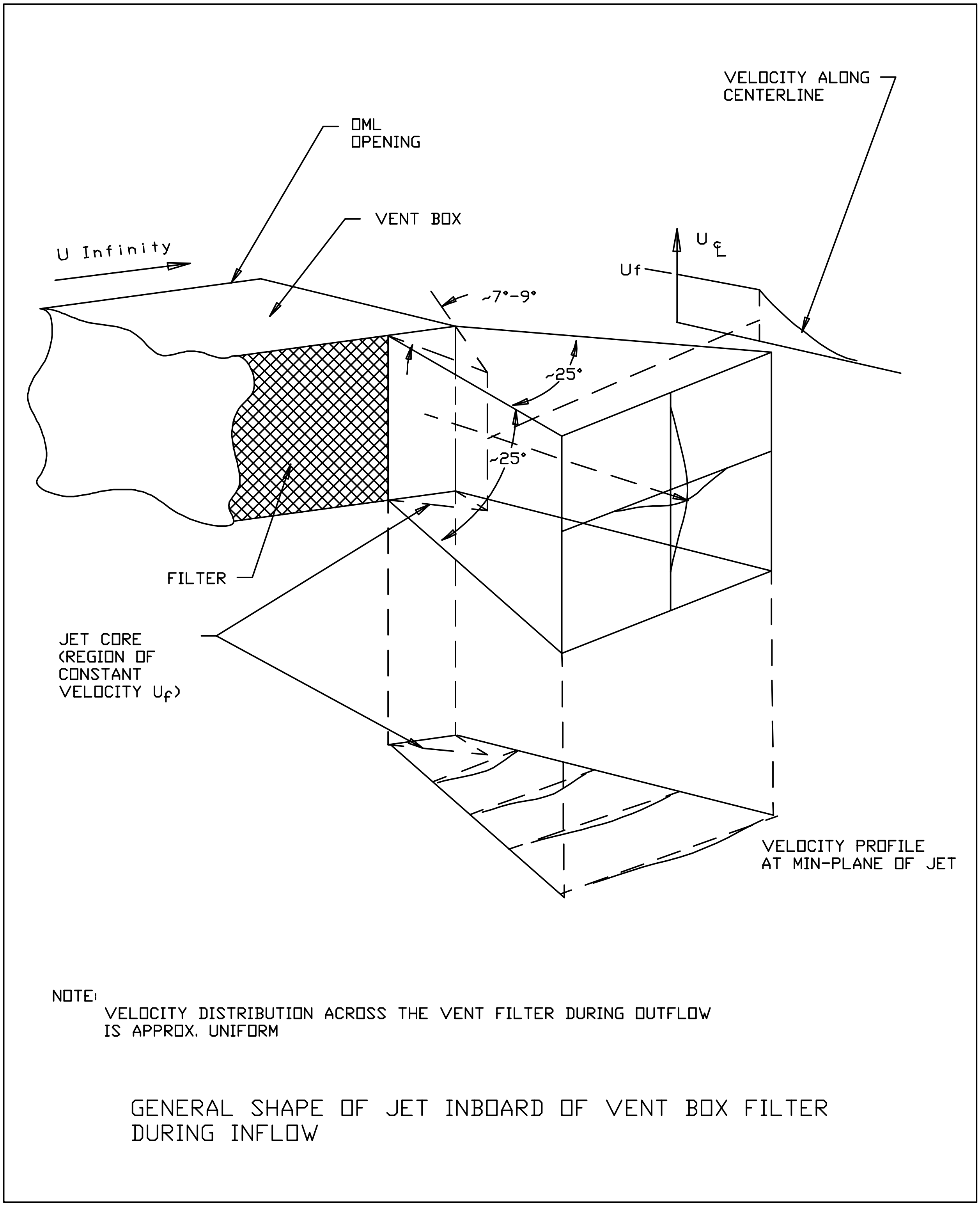
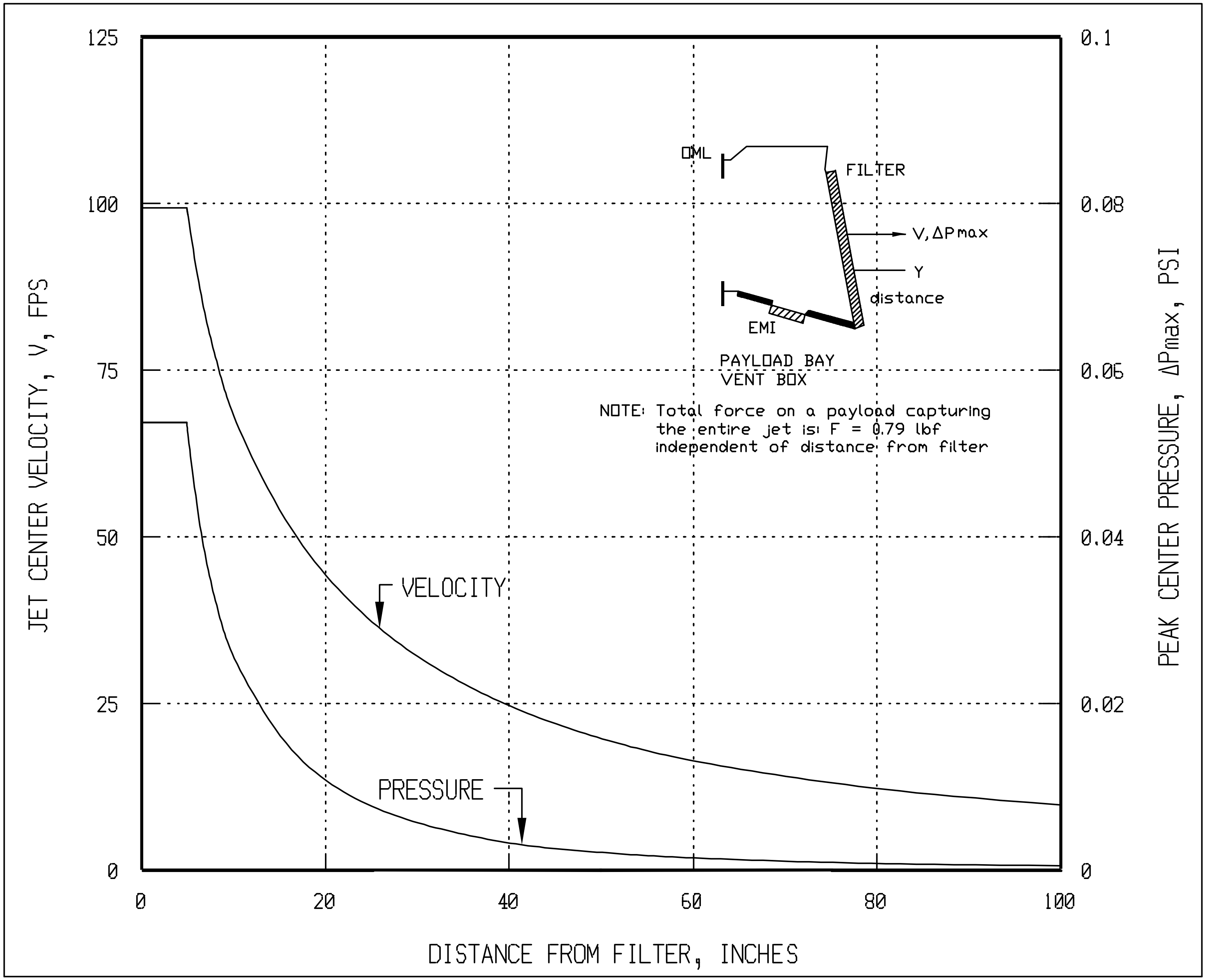


FIGURE 10.6.4.1-1 VENT FLOW CHARACTERISTICS

FIGURE 10.6.4.1.1-1 MAXIMUM VENT INFLOW CHARACTERISTICS DURING ASCENT



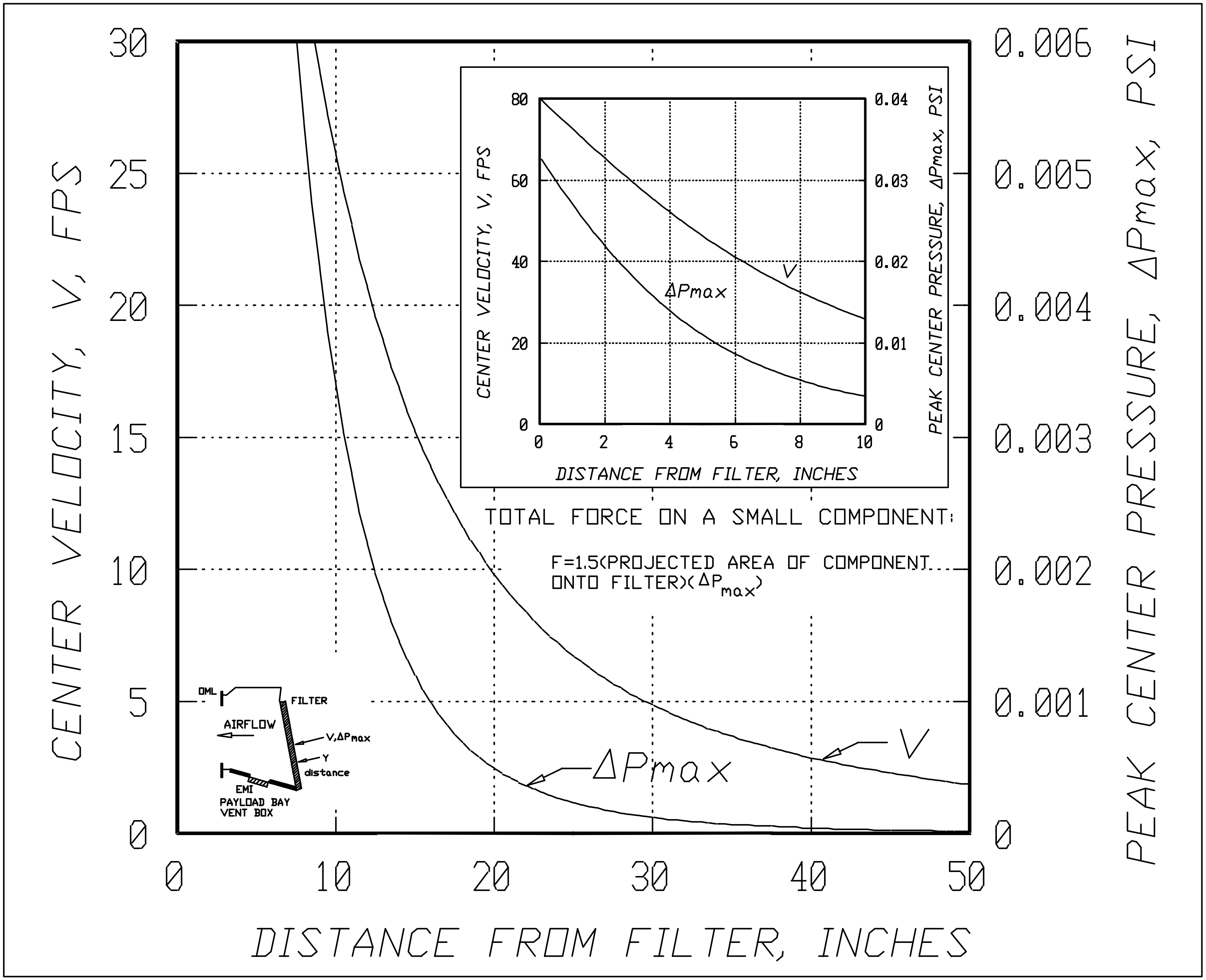


FIGURE 10.6.4.1.1-2 MAXIMUM VENT OUTFLOW CHARACTERISTICS DURING ASCENT FOR SMALL PAYLOAD COMPONENTS

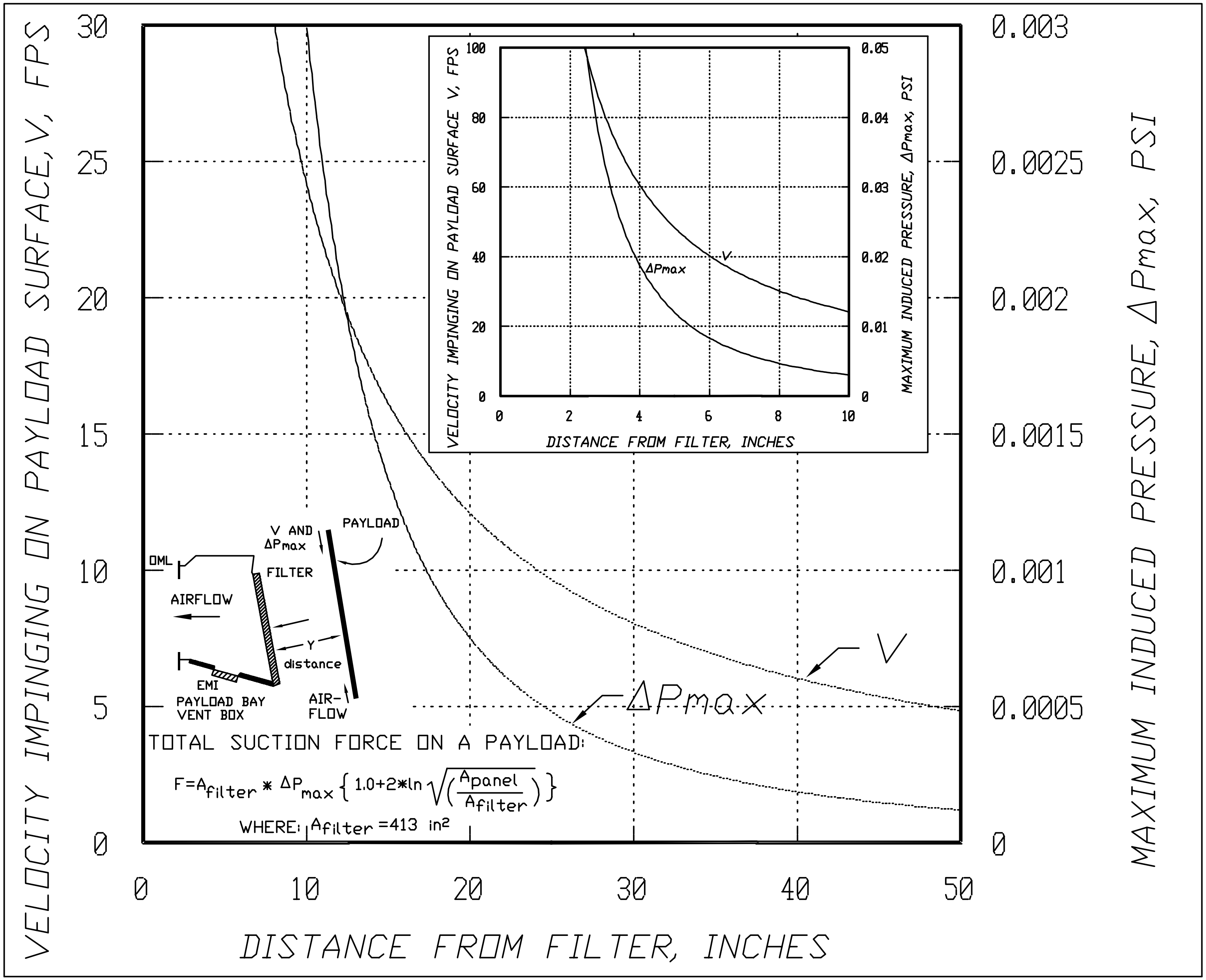


FIGURE 10.6.4.1.1-3 MAXIMUM VENT OUTFLOW CHARACTERISTICS DURING ASCENT FOR LARGE PAYLOAD COMPONENTS

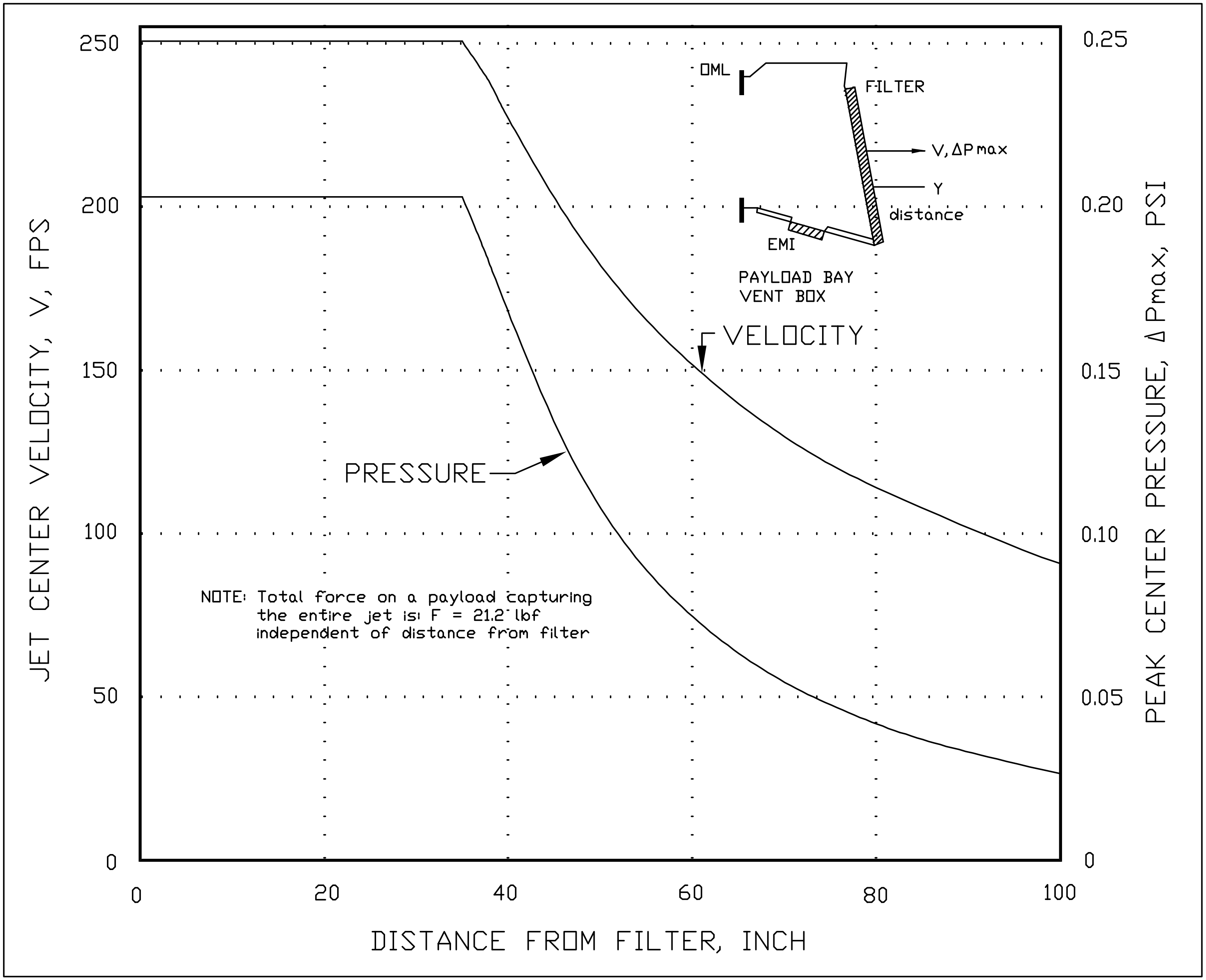
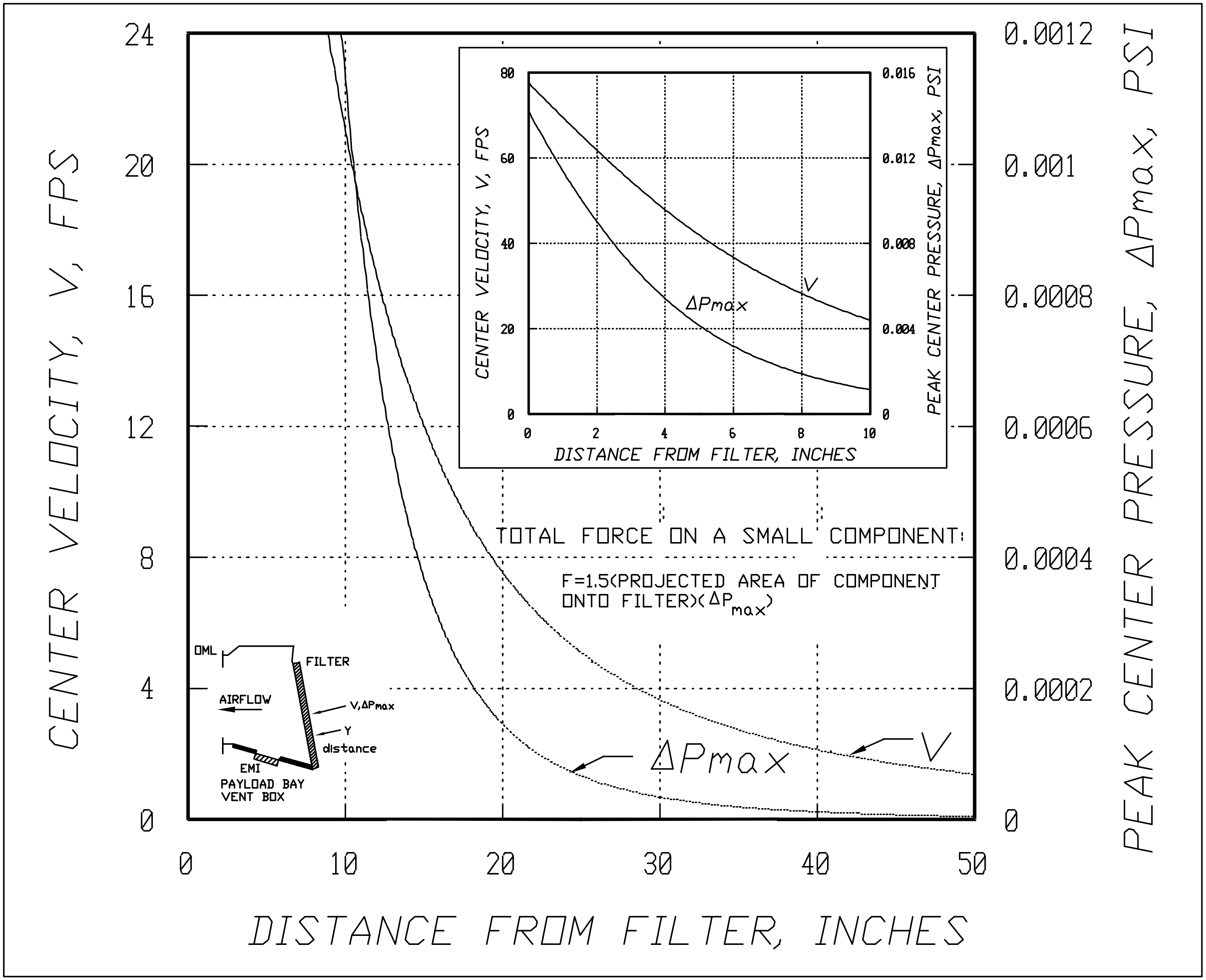


FIGURE 10.6.4.1.2-1 MAXIMUM VENT INFLOW CHARACTERISTICS DURING ENTRY

FIGURE 10.6.4.1.2-2 MAXIMUM VENT OUTFLOW CHARACTERISTICS DURING ENTRY FOR SMALL PAYLOAD COMPONENTS



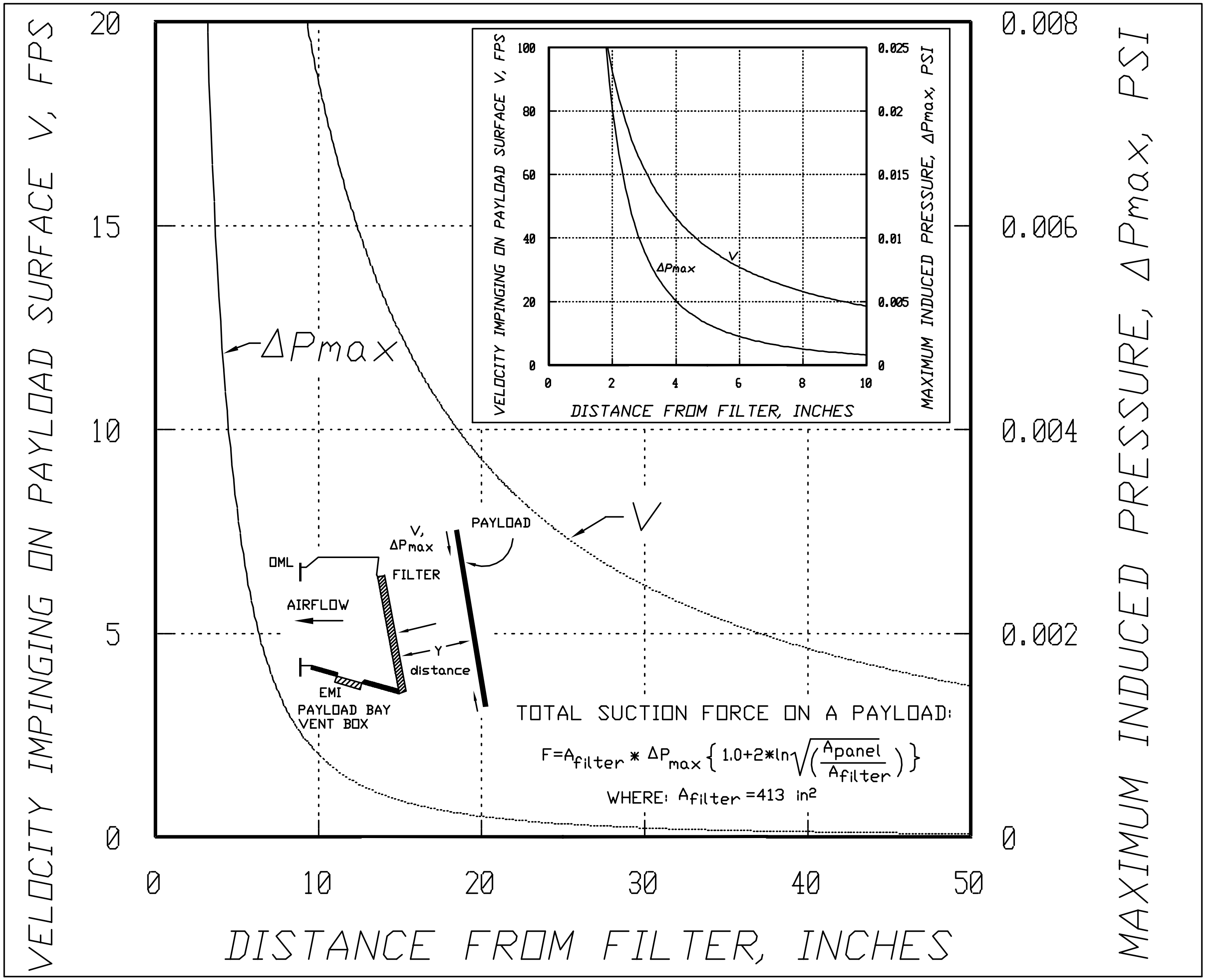


FIGURE 10.6.4.1.2-3 MAXIMUM VENT OUTFLOW CHARACTERISTICS DURING ENTRY FOR LARGE PAYLOAD COMPONENTS

THIS PAGE INTENTIONALLY LEFT BLANK

10.7 ELECTROMAGNETIC COMPATIBILITY (EMC)

10.7.1 Circuit EMEC Classification

Circuit EMEC Classifications are as defined in Table 10.7.1-1. As a design goal, orbiter to payload wiring shall meet the requirements of Table 10.7.1-2 or utilize equivalent shielding.

10.7.2 Shuttle-Produced Interference Environment

10.7.2.1 Conducted Interference

(See Paragraph 7.3.7).

10.7.2.2 Radiated Interference

The Shuttle-produced radiated field environment shall be limited as specified in the following subparagraphs.

10.7.2.2.1 Magnetic Fields

10.7.2.2.1.1 Power Bus-Produced

The magnetic flux density (i.e. field intensity) values are reduced in accordance with the following equation for separation from the power busses in the Y-Z plane.

The formula for decibel reduction is $dB = 20 \log_{10} (57R^2)$; where R (meters) = radial separation in the Y-Z plane from the nearest port or starboard power bus as described by the following location coordinates.

For locations within 2.5 meters of the 576 or 1307 Xo locations, the value of R in the equation should be the separation from the Xo = 576 or Xo = 1307 locations in meters.

10.7.2.2.1.1.1 AC Magnetic Fields

The worst case value for AC magnetic fields is at locations near the Orbiter power buses at Yo=±79, Zo=349, Xo any value in the cargo bay. AC magnetic fields shall be limited to less than 140 dB above 1 picotesla (30 Hz to 2 kHz), falling 40 dB per decade to 50 kHz.

10.7.2.2.1.1.2 DC Magnetic Fields

The worst case value for DC magnetic fields is at locations near the Orbiter power buses at Yo=±79, Zo=349, Xo any value in the cargo bay. DC magnetic fields shall be less than 170 dB above 1 picotesla.

10.7.2.2.1.2 Lightning Produced

Lightning produced magnetic fields in the Payload Bay for vehicles in flight shall not exceed a peak level of 20 amperes/meter; for vehicles on the ground protected by facility or other structures the peak level shall not exceed 40 amperes/meter; and for vehicles on the ground not protected by facility or other structures the peak level shall not exceed 75 amperes/meter. The lightning produced magnetic fields in the Crew compartment for vehicles in flight shall not exceed a peak level of 3 amperes/meter; for vehicles on the ground protected by facility or other structures the peak level shall not exceed 5 amperes/meter; and for vehicles on the ground not protected by facility or other structures the peak level shall not exceed 10 amperes/meter. The rise to peak value is 2 microseconds and the fall to zero value is 100 microseconds. The payload shall be designed so that a failure due to a lightning strike shall not propogate to the Shuttle.

10.7.2.2.2 Electric Fields

Electric fields along the cargo bay center line under normal operating modes are defined in Figures 10.7.2.2.2-1 and 10.7.2.2.2-2 for unintentional emissions. These levels should be considered when evaluating the possibility of operating radio frequency receiving equipment or electric field sensing instruments in the cargo bay.

The values defined in Figure 10.7.2.2.2-3 are the maximum field intensities on the upper spherical wedges (+Xo, +Zo, +Yo) and (+Xo, +Zo, -Yo) of the payload bay envelope with the doors open.

Table 10.7.2.2.2-1 gives the frequency range and modulation type associated with the transmitter field strengths in Figure 10.7.2.2.2-3.

10.7.2.2.2.1 S-Band System

The worst case electric field intensities produced by Orbiter-installed S-Band transmitters are defined for the cargo bay and for the volume above the cargo bay/cabin.

10.7.2.2.2.1.1 Pre-Deployment/Non-Deployment

The S-Band electric field levels, in the payload bay envelope are defined by Figure 10.7.2.2.2-3.

10.7.2.2.2.1.2 Post-Deployment/Retrieval

The values defined in Figures 10.7.2.2.2.1.2-1, 10.7.2.2.2.1.2-2, 10.7.2.2.2.1.2-3 and 10.7.2.2.2.1.2-4 are the maximum field intensities that may impinge on payloads in the +Zo hemisphere above the Orbiter (antenna) during deployment and retrieval operations.

10.7.2.2.2.1.3 Extended Range Payload Communications Link (ERPCL) Produced Electric Field Intensities

Payloads manifested on flights where the ERPCL is installed may be exposed to electric field intensities in the +Zo hemisphere above the Orbiter during deployment and retrieval operations in addition to the field intensities listed in Paragraph 10.7.2.2.2.1.2. The maximum field intensities produced by the ERPCL that may impinge upon payloads are shown in Figure 10.7.2.2.2.1.3-1.

10.7.2.2.2.2 Ku-Band System

The Ku-Band electric field levels are defined in the following subparagraphs.

10.7.2.2.2.2.1 Pre-Deployment/Non-Deployment

The Ku-Band levels are greater along a line defined by the +Yo=90 and +Zo=444. Reduced levels can be expected in the -Y and lower Z areas of the cargo bay, however, the levels are payload geometry dependent and are defined by Figure 10.7.2.2.2-3.

10.7.2.2.2.2.2 Post Deployment/Retrieval

See Figure 10.7.2.2.2.2.2-1 for electrical field intensities when operating in the communications mode and Figure 10.7.2.2.2.2.2-2 when operating in the radar mode. When operating the Ku-Band system in the radar mode, the field may be attenuated in accordance with Paragraph 8.3.4.1.

For equipment that can be in the main beam of the Ku-Band Antenna, the field level can be approximated by:

$$E = \frac{2500}{R} \qquad (R = METERS)$$

10.7.2.2.2.3 Electrostatic Discharges

The design of the cargo bay and cargo bay doors preclude any electrostatic discharges.

10.7.2.2.2.4 EVA Transmitter Characteristics

The maximum field intensities associated with the transmitters supporting an EVA crewman are 6.5 volts per meter at one meter from the TV antenna of the EMU and 3.8 volts per meter at one meter from the EMU EVA voice antenna. Transmitter characteristics associated with EVA activities are given in Table 10.7.2.2.2.4-1. Payloads shall be designed to meet these induced environments.

10.7.2.2.2.5 (Reserved)

10.7.2.3 OPTICAL/LASER RADIATION (INFRARED; OPTICAL; ULTRAVIOLET)

10.7.2.3.1 Shuttle Produced Optical/LASER Radiation

During Shuttle/Payload rendezvous and docked operations, the emitted shuttle optical radiations to be considered are: 1) The Trajectory Control Sensor (TCS) System, and 2) The Handheld - Lidar Ranging (HHL). The properties of the emissions from these two items are as follows:

Trajectory Control Sensor (TCS) System

Quantity	two
Range	CW 2 - 1500 meters (with retroreflector) Pulse 15 - 1500 meters (with retroreflector)
Location	Payload Bay
Pointing	+Zo
Control/Monitor	Aft Flight Deck
Scanning Angle	±25°
Scan Rate	X - ≤30 Hz Y - ≤1 Hz
Output Power:	
CW	40 milliwatts peak at 850±10 nanometers at exit aperture 20 milliwatts average at exit aperture
Pulse	12 watts peak at 850±10 nanometers at exit aperture 2.5 milliwatts average at exit aperture
Aperture	Max. Beam diameter - 16 millimeters (CW and Pulse) at exit aperture
Beam Divergence:	
CW	Min. Beam divergence 0.1745 milliradians for half angle
Pulse	Min. Beam divergence 1.9 milliradians for half angle Max. Beam width 23 milliradians for half angle (Pulse & CW)

Pulse Width	30 nanoseconds (Pulse)
Pulse Repetition Frequency	7 kilohertz (Pulse)
Wavelength - nm:	
CW	850±10
Pulse	850±10

Handheld Lidar (HHL) Equipment

Quantity	two
Range	≤12≥1500 ft (30% diffuse target) (3.7 - 457 meters) ≤12≥4500 ft (2.5 inch diameter retroreflector) (3.7 - 1372 meters)
Accuracy	±0.5 ft (0.15 meters)
Location	Aft Flight Deck
Pointing	any (by procedure)
Control/Monitor	Aft Flight Deck
Scanning Angle	N/A
Output Power:	
Average	32.3 microwatts at 775 nanometers
Peak	17.7 watts at 775 nanometers
Beam Divergence	1.7 milliradians (horizontal axis) 2.2 milliradians (vertical axis)
Aperture	Beam Diameter - 48 millimeters (horizontal), 32 millimeters (vertical) at exit aperture
Range Rate	0 - ≥10 ft/sec (0 - 3.05 meters/sec)
Accuracy	0.5 second average - 0.2 ft/sec at 1 Standard Deviation (S.D.) 1.0 second average - 0.1 ft/sec at 1 S.D. 2.0 second average - 0.05 ft/sec at 1 S.D. 5.0 second average - 0.02 ft/sec at 1 S.D. (0.6 - 0.006 meters/sec)
Pulse Repetition Frequency	150 Hz
Pulse Width	12 nanoseconds

10.7.2.3.2 Shuttle Equipments Sensitive to LASER Radiation

During Shuttle/payload rendezvous/dock missions, the only Orbiter equipment that is sensitive/susceptible to optical/Laser radiation are several cameras mounted in the payload bay, on the Remote Manipulator System (RMS) and the Star Trackers. These cameras are of three types, Silicon Charged-Coupled Device (CCD), Color Television Cameras (CCTV System) and the Silicon Intensified Target Vidicon with Monochrome Lens Array (SIT/MLA) used for viewing primarily during low light level conditions. The optical sensitivity and susceptibility of those items are listed in Table 10.7.2.3.2-1.

TABLE 10.7.1-1 CIRCUIT EMEC CLASSIFICATIONS

Freq. or Rise/Fall Time	Source Impedance (ohms)	Load Impedance (ohms)	Voltage or Sensitivity	Circuit Classification	Wire Type Reqd	Shield Grounding Reqmts
Analog, Alternating or Direct Current	<100	100-600k	>100mv to ≤6v	ML	TWS	SPG**
		0-200	>6v to ≤40v	HO	TW	None
		0-200	>40v	EO	TW	None
	≤2.5k	100-600k	≤100 mv	ML	TWS	SPG
		>600k			TWDS	SPG
	<100	≥200	>100mv to ≤6v	ML	TWS	SPG
		≥200	>6v to ≤40v	HO	TW	None
		≥200	>40v	EO	TW	None
≤50 KHz and Rise and Fall Time ≥10 Micro Seconds	<100	≥10k	≤6v	ML	TWS	SPG
		0-200	>6v to ≤40v	HO	TW	None
		0-200	>40v	EO	TW	None
	<2.5k	100-600k	≤100mv	ML	TWS	SPG
		>600k			TWDS	SPG
	≥200	>200	>100mv to ≤6v	ML	TWS	SPG**
		>200	>6v to ≤40v	HO	TW	None
		>200	>40v	EO	TW	None
>50 KHz and ≤1.024 MHz or Rise/Fall Time ≤10 Micro Seconds	All	All	≤100mv	RF	TWDS*	MPG
		All	>100mv to ≤6v	RF	TWS*	MPG
	All	<1000	>6v	RF	TWS*	MPG
		≥1000			TWDS	MPG
>1.024 MHz	All	All	All	RF	COAX	MPG
TV Video				RF	TWS	MPG***

Symbols Used

KHz	- Kilohertz	RF	- Radio Frequency	<	- less than
MHz	- Megahertz	TWS	- Twisted Shielded	≤	- less than or equal to
SPG	- Single Point Ground	mv	- Millivolts		
MPG	- Multiple Point Ground	v	- volts	>	- greater than
TW	- Twisted	coax	- coaxial	≥	- greater than or equal to
TWDS	- Twisted Double Shielded	k	- Kilo		

* If the capacitance per foot is critical, controlled-impedance wiring, special shielded-twisted-pair cables (nominal 75 ohms), should be used.

** If circuit is balanced by transformer, differential or optical, the shield shall be multi-point grounded to structure.

*** Distance between shield grounds shall not exceed 18 meters.

TABLE 10.7.1-2 CARGO WIRE BUNDLE EDGE-TO-EDGE SEPARATION

Bundle	Routed Parallel To Bundle	Separation (in inches for parallel runs of D [feet])			
		1 > D	1 ≤ D < 3	3 ≤ D < 5	D ≥ 5
ML	H0	0	1.0	2.0	4.0
	E0	0	1.5	3.0	6.0
	RF	0	2.5	5.0	10.0
H0	E0	0	0.5	1.0	2.0
	RF	0	1.5	3.0	6.0
E0	RF	0	1.0	2.0	4.0

TABLE 10.7.2.2.2-1 ORBITER TRANSMITTER CHARACTERISTICS

TRANSMITTER	ANTENNA (1)	CARRIER FREQ(fc)	MODULATION
S-BAND FM	S-BAND HEMI	2250.0 MHz	FM
S-BAND PM (NETWORK TRANSPONDER)	S-BAND QUAD	2217.5 OR 2287.5 MHz	PSK, PM
PAYLOAD INTERROGATOR			
STDN (NASA) (2)	S-BAND PAYLOAD	2025.8334 TO 2117.9166 MHz	PM
DSN (NASA) (3)	S-BAND PAYLOAD	2110.2431 TO 2119.7924 MHz	PM
SGLS (DOD) (4)	S-BAND PAYLOAD	1763.721 TO 1839.795 MHz	PM
KU-BAND	KU-BAND		
	RETURN LINK	15.0034 GHz	QPSK, FM
	RADAR RANGING	13.883 GHz (5)	PULSED CARRIER PULSE RATES: 268, 3000, 7000 PPS PULSE WIDTH - 66.4 μs max. 122.0 ηs min.

NOTES:
1) Cargo bay radiation levels defined in Figure 10.7.2.2.2-3.
2) 801 Selectable channels over indicated frequency range. (See Appendix C)
3) 29 Selectable channels over indicated frequency range. (See Appendix C)
4) 20 Selectable channels over indicated frequency range. (See Appendix C)
5) Passive tracking uses frequency diversity technique employing center frequencies of 13.779, 13.831, 13.883, 13.935 and 13.987 GHz.

TABLE 10.7.2.2.2.4-1 EVA TRANSMITTER CHARACTERISTICS

TRANSMITTER	ANTENNA	CARRIER FREQ(fc)	MODULATION
EVA/ATC ATC AIR-TO-GROUND	UHF (10 WATTS)	259.7 MHz 296.8 MHz 243.0 MHz (GUARD BAND)	AM 90% VOICE
EVA (ORBITER-TO-EVA) DUPLEX	UHF (0.25 WATTS)	296.8 MHz NORMAL 259.7 MHz BACK-UP (SIMPLEX)	AM 90% VOICE
EVA (EVA-TO-ORBITER)	UHF (0.25 WATTS)		AM 90% VOICE PLUS BIOMED DATA ON 5.4 KHz SUBCARRIER
EVA-1			
A MODE		259.7 MHz	
B MODE		279.0 MHz	
EVA-2			
A MODE		279.0 MHz	
B MODE		259.7 MHZ	
SIMPLEX (BACKUP)		259.7 MHz	NO BIOMED DATA

TABLE 10.7.2.3.2-1 Optical Sensitivity and Susceptibility of Cameras

	CCTV	SIT/MLA	ST
Location	Payload Bay#	Payload Bay#	Shuttle Orbiter Nose##
Field of View in degrees	11 - 17 (Variable)*	6.5 - 38 (Variable)*	10
Recieve Aperture in millimeters	100	80	33
Active Protection/Response Time	auto iris (3 sec)	auto iris (7 sec)	shutter (50 msecs)
Passive Protections	(0.85 mm) CM-500 filter	(2 mm) HA-11 filter	none
Damage Thresholds** in Joule/cm^2	unknown	16E-3	5E-9
Pointing	any (by procedure)	any (by procedure)	###

Legends:

* Horizontal Field of View (FOV); vertical FOV is 3/4 of horizontal FOV

** For point sources of 0.55 microns (micro meters) wavelength

# Xo=589.000, Yo=-71.500, Zo=446.0, for Camera A
Xo=1294.0, Yo=-87.000, Zo=446.0, for Camera B
Xo=1294.0, Yo=+87.500, Zo=446.0, for Camera C
Xo=589.000, Yo=+71.500, Zo=446.0, for Camera D
Xo=953.030, Yo=-70.760, Zo=462.36, for Elbow Camera in stowed position

Keel Camera Mounted Locations:

Xo=709.000, Yo=-4.000, Zo=Liner Level, for mount no: 1
Xo=902.000, Yo=-4.000, Zo=Liner level, for mount no: 2
Xo=1102.300, Yo=-4.000, Zo=Liner Level, for mount no: 3
Xo=1134.000, Yo=-4.000, Zo=Liner Level, for mount no: 4

Xo=423.6711, Yo=-54.4271, Zo=408.375, for Vertical Star Tracker
Xo=425.0043, Yo=-35.9998, Zo=418.0184, for Y-axis Star Tracker

Optical axis of the Vertical Star Tracker is inclined 3° in a plane rotated 41° from the +X axis toward the -Y axis. Optical axis of the Y Axis Star Tracker is in the X-Y plane and is rotated 10.567° away from the -Y axis toward the +X axis.

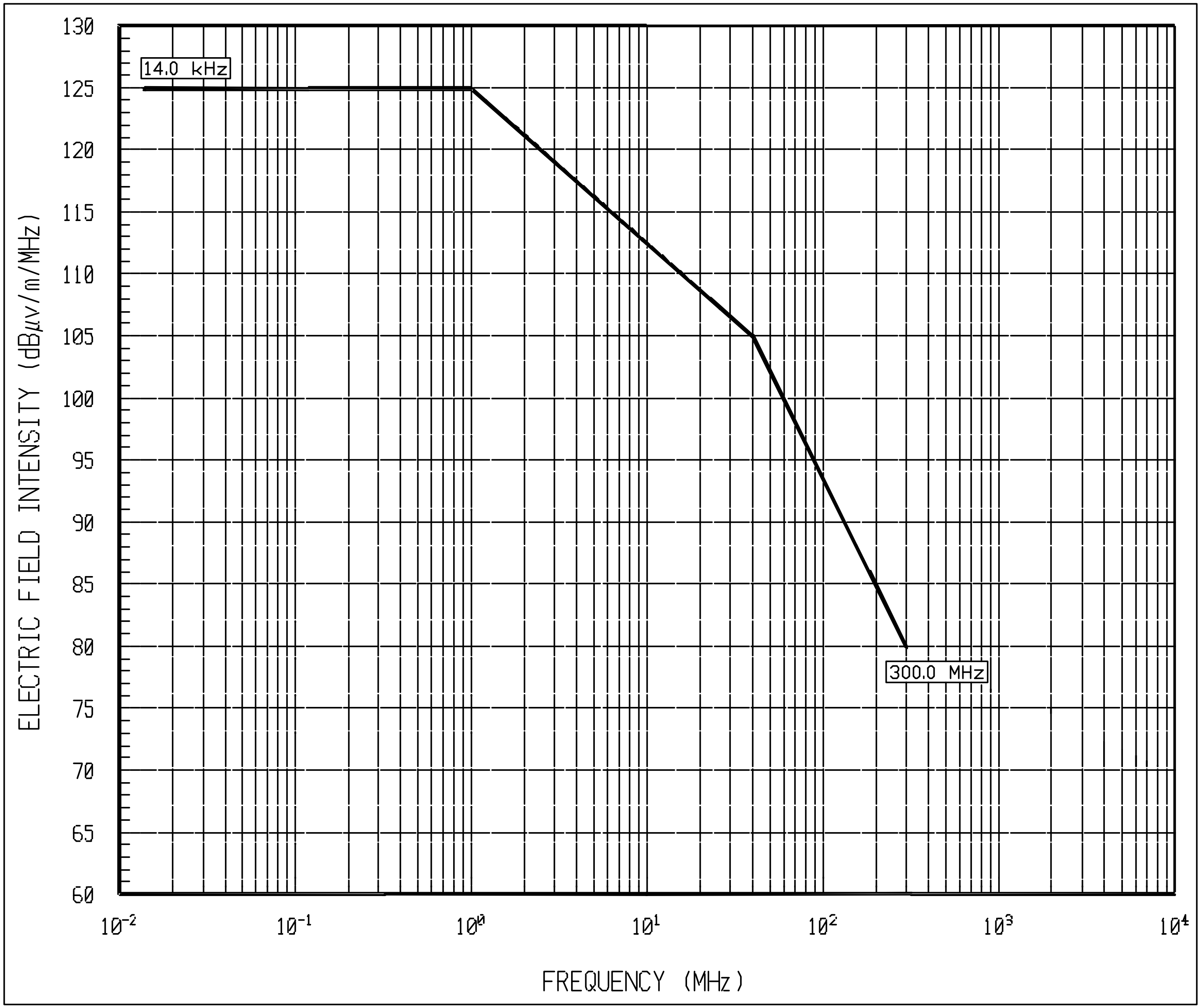
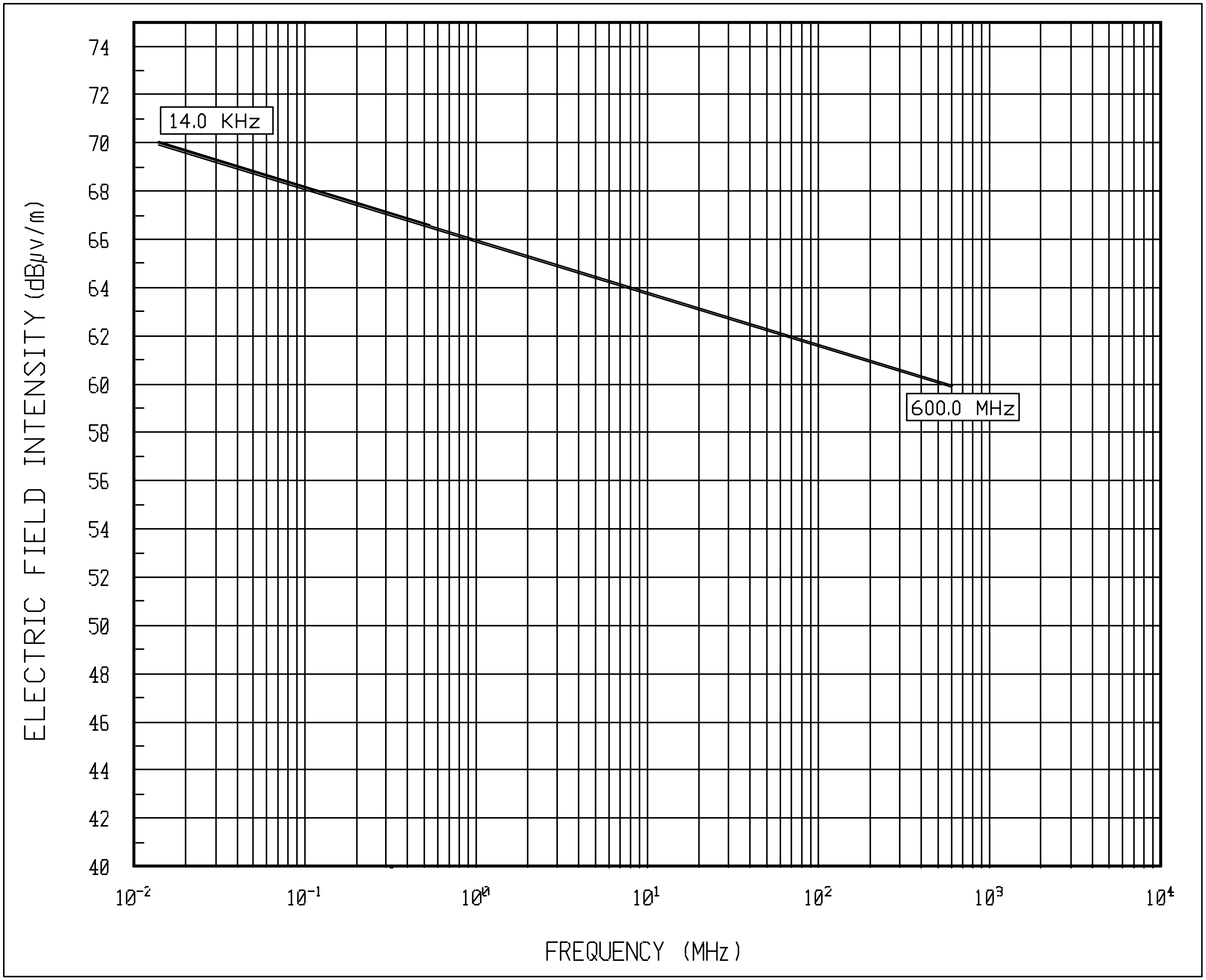


FIGURE 10.7.2.2.2-1 SHUTTLE-PRODUCED CARGO BAY RADIATED BROADBAND EMISSION LIMIT

FIGURE 10.7.2.2.2-2 SHUTTLE-PRODUCED CARGO BAY RADIATED NARROWBAND EMISSION LIMIT



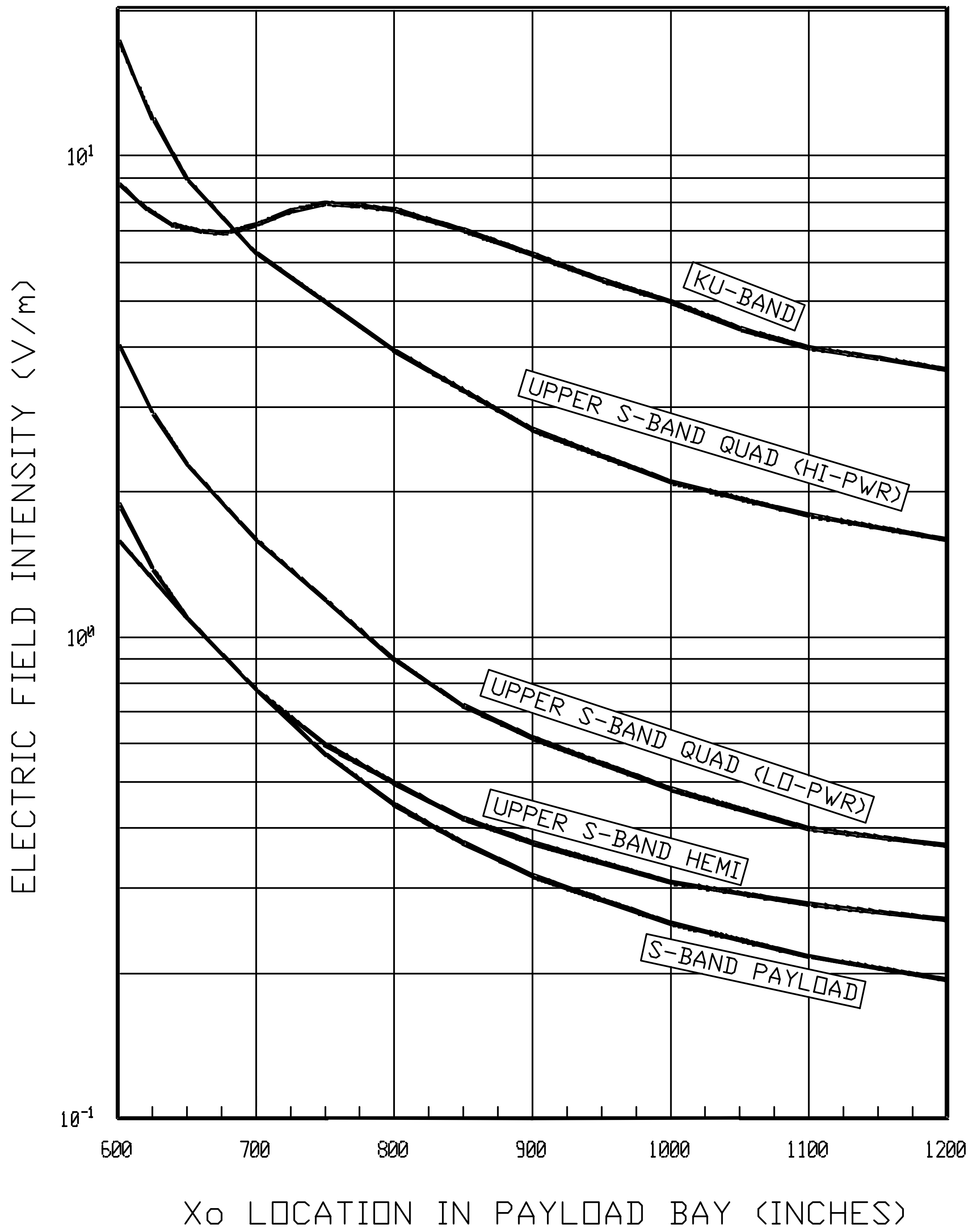
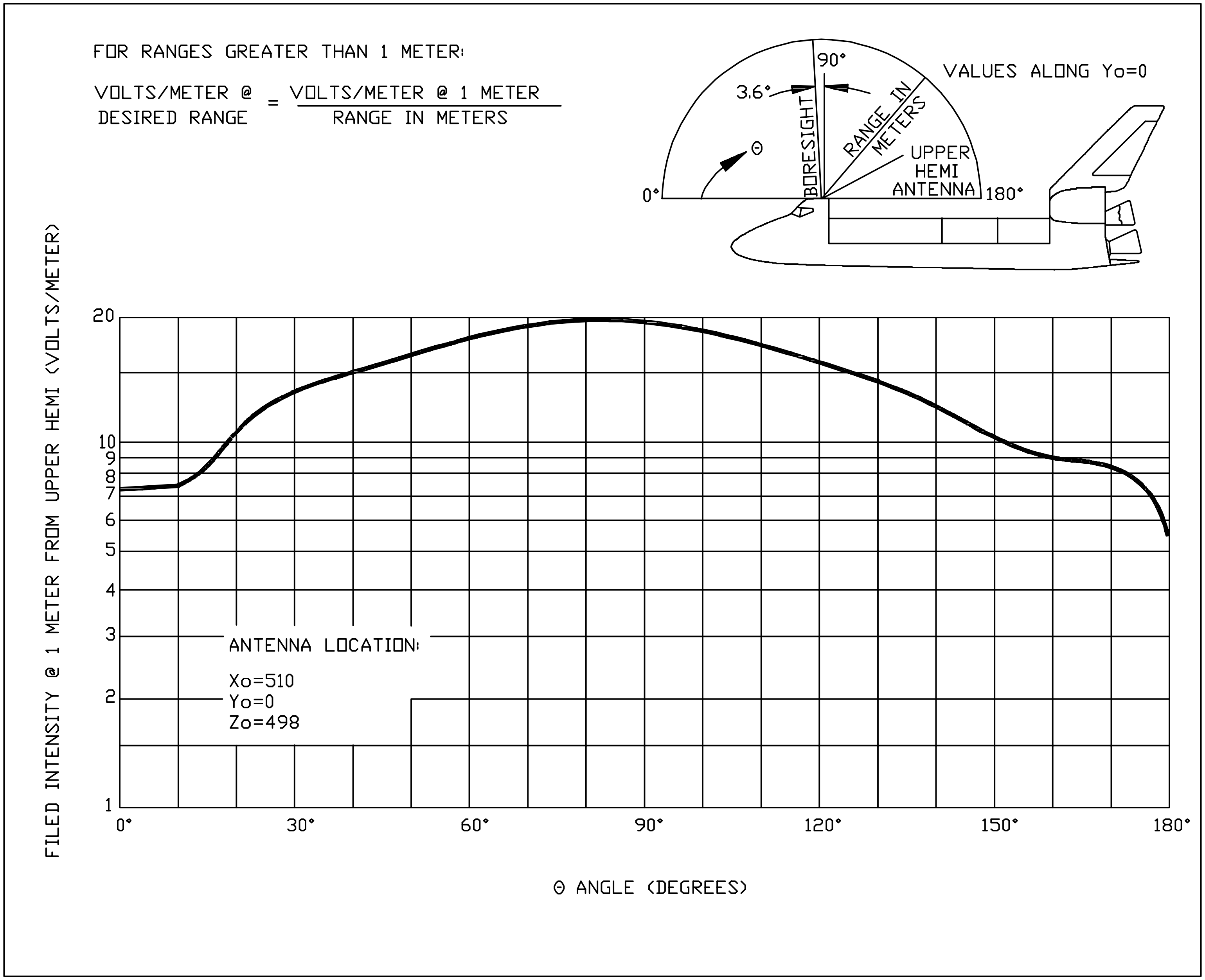


FIGURE 10.7.2.2.2-3 MAXIMUM ELECTRIC FIELD INTENSITIES ON PAYLOAD BAY ENVELOPE

FIGURE 10.7.2.2.2.1.2-1 S-BAND FM TRANSMITTER (UPPER HEMI ANTENNA) MAXIMUM ELECTRIC FIELD INTENSITIES



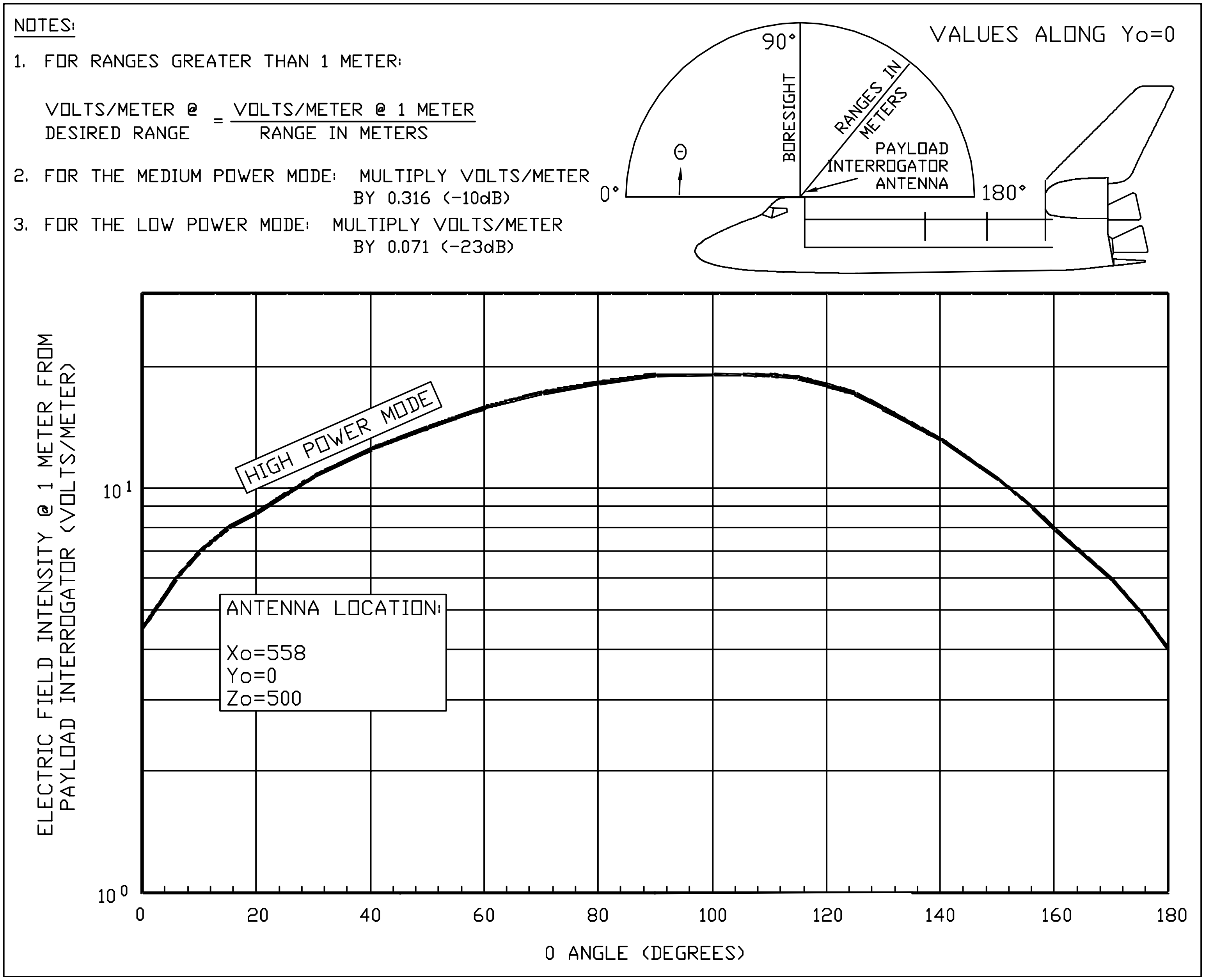
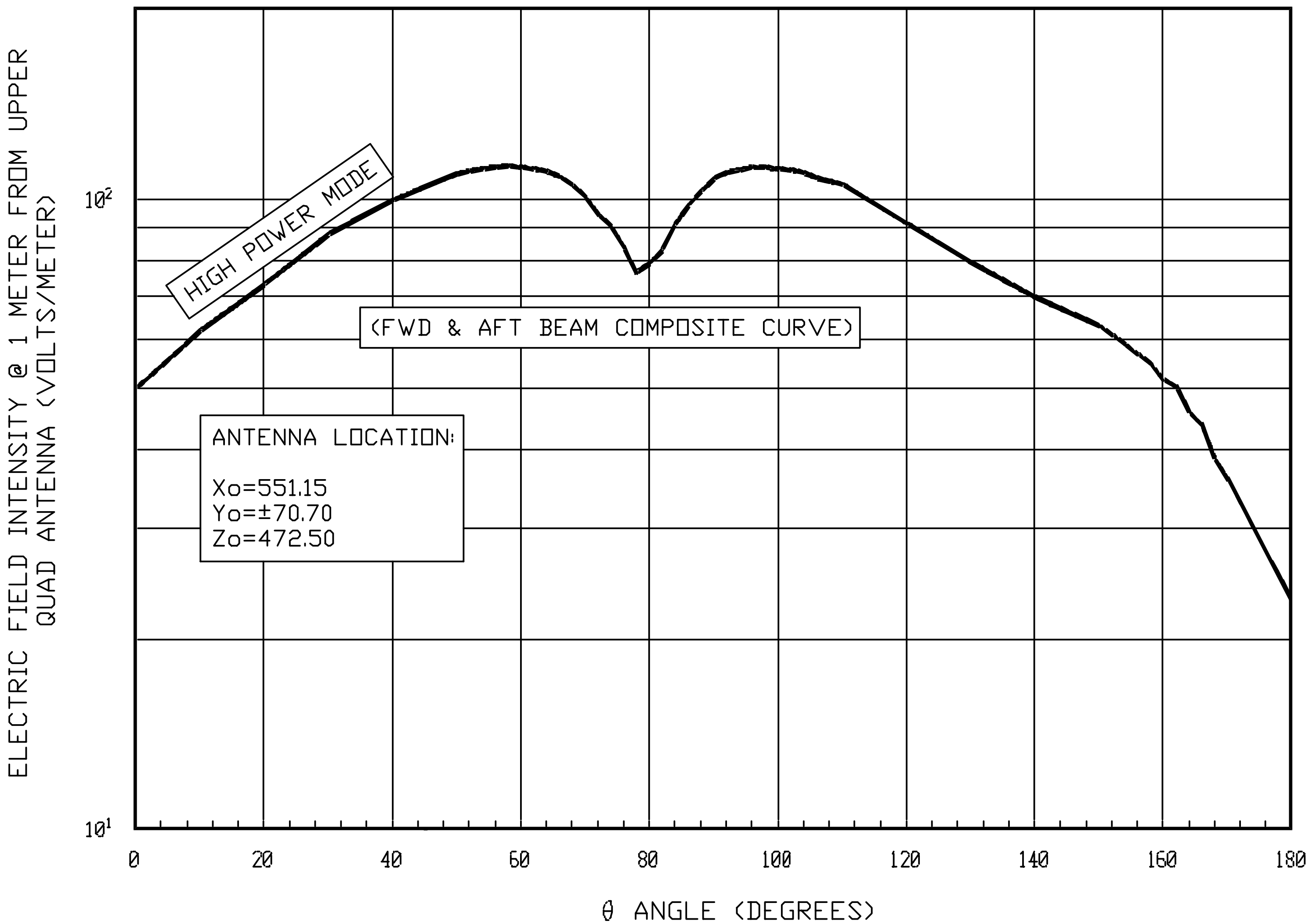


FIGURE 10.7.2.2.2.1.2-2 S-BAND (PAYLOAD INTERROGATOR) MAXIMUM ELECTRIC FIELD INTENSITIES

FIGURE 10.7.2.2.2.1.2-3 S-BAND NETWORK TRANSPONDER (UPPER QUAD ANTENNAS)
MAXIMUM ELECTRIC FIELD INTENSITIES

FOR RANGES GREATER THAN 1 METER: VOLTS/METER @ DESIRED RANGE = $\frac{\text{VOLTS/METER @ METER}}{\text{RANGE IN METERS}}$

FOR THE LOW POWER MODE: MULTIPLY VOLTS/METER BY 0.158(-16dB)



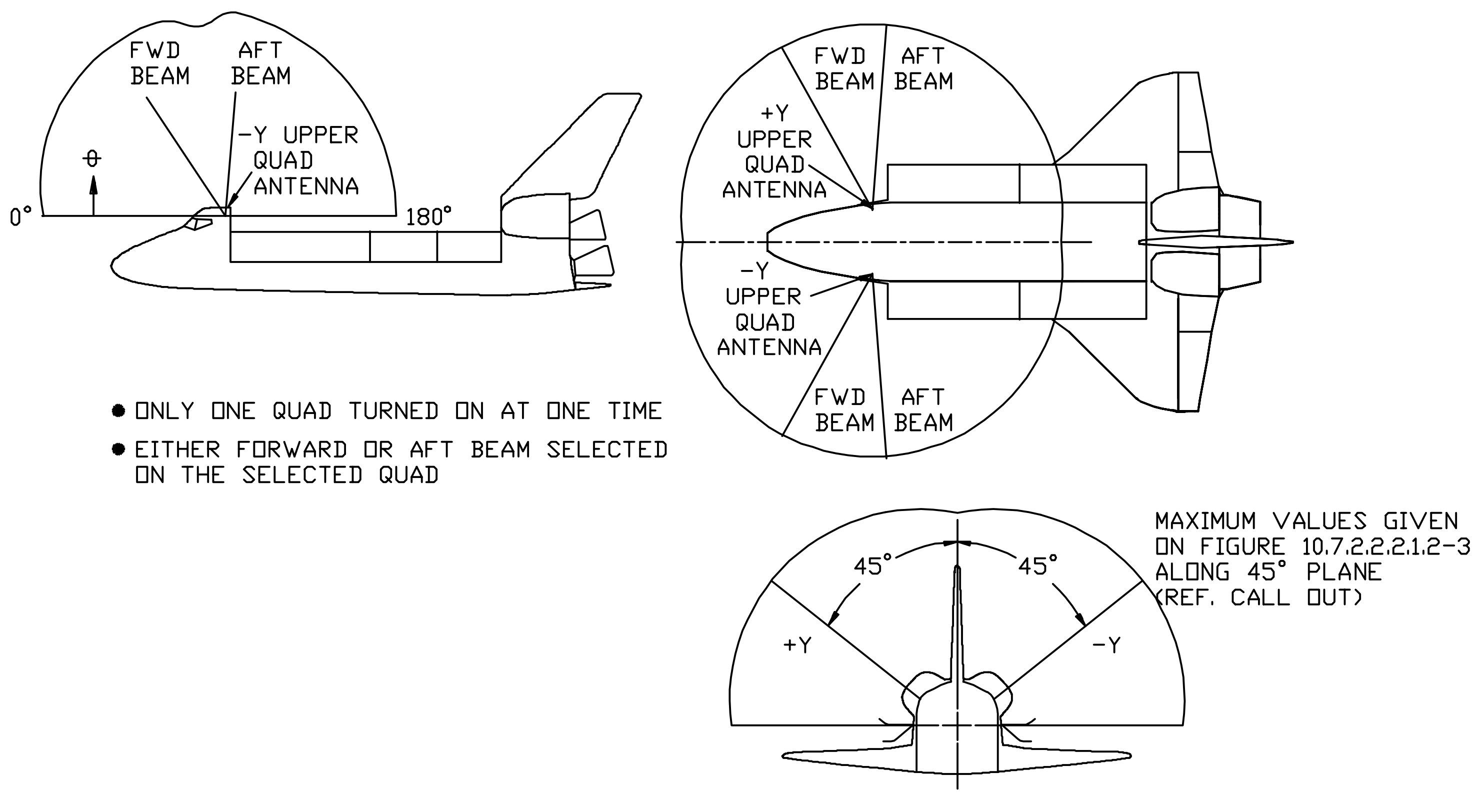


FIGURE 10.7.2.2.2.1.2-4 S-BAND NETWORK TRANSPONDER (UPPER QUAD ANTENNAS) BEAM CONFIGURATION

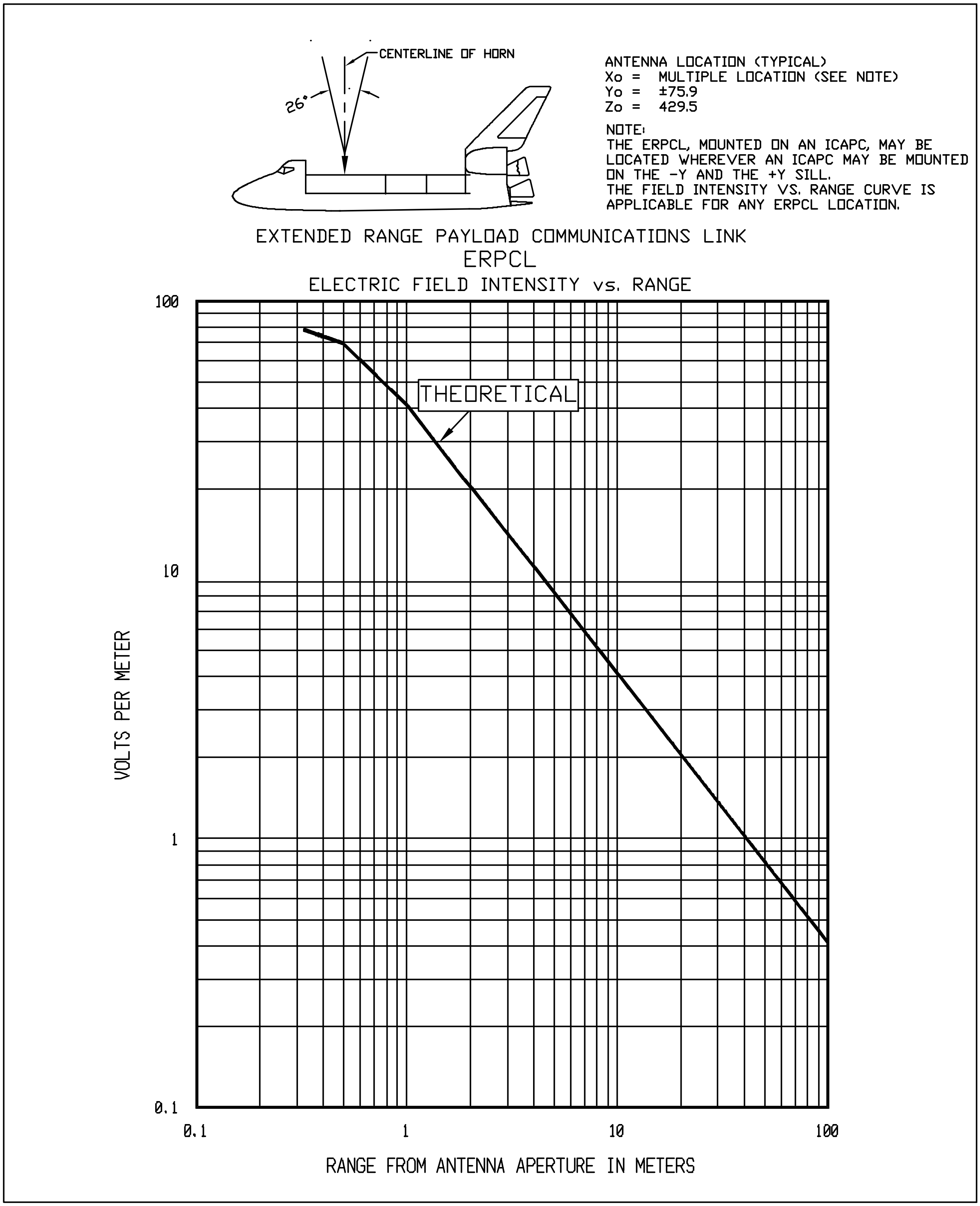


FIGURE 10.7.2.2.2.1.3-1 S-BAND EXTENDED RANGE PAYLOAD COMMUNICATIONS LINK (ERPCL) PRODUCED ELECTRIC FIELD INTENSITIES

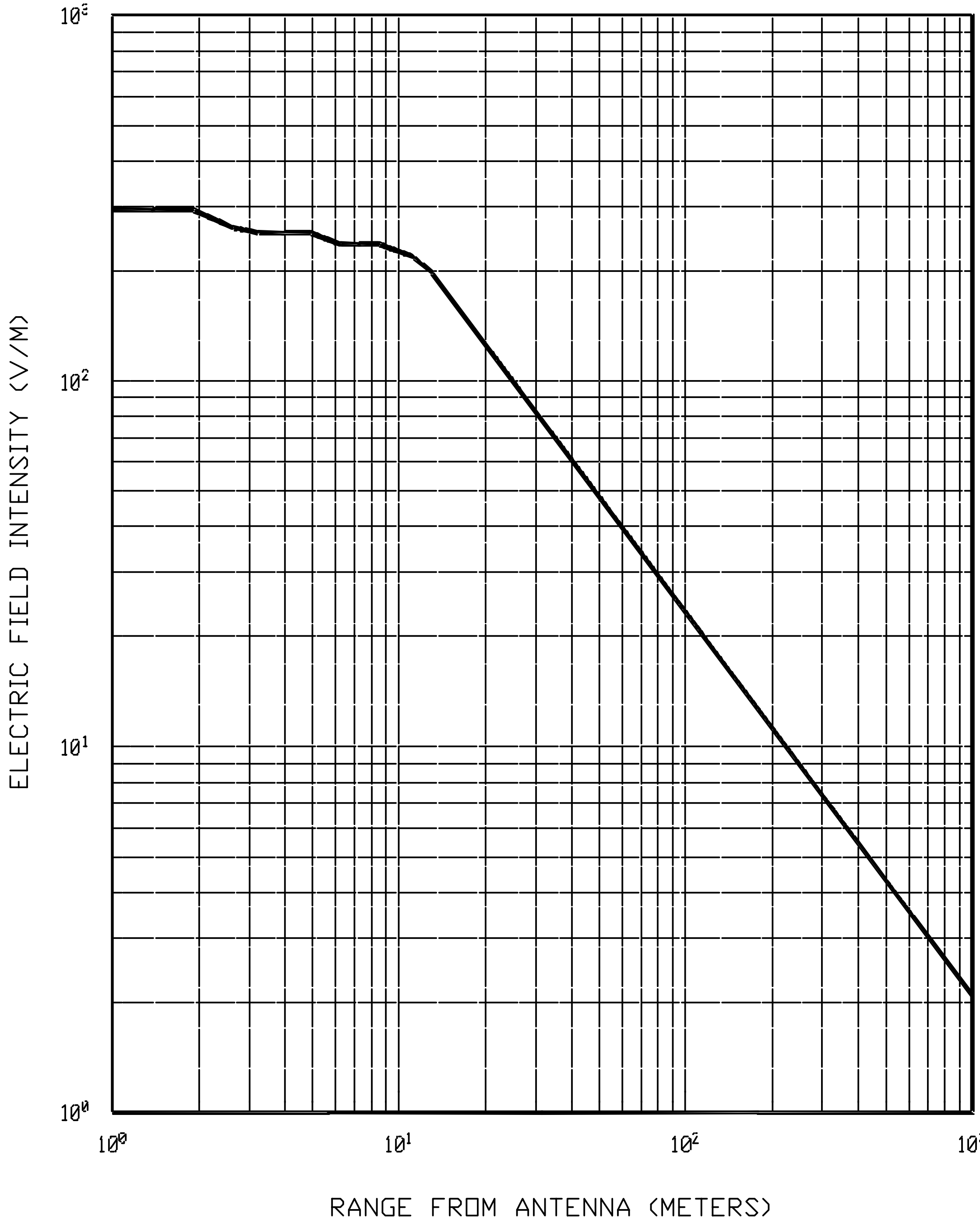


FIGURE 10.7.2.2.2.2.2-1 ORBITER KU-BAND SYSTEM: COMMUNICATION MODE ELECTRIC FIELD INTENSITY VS RANGE FROM ANTENNA

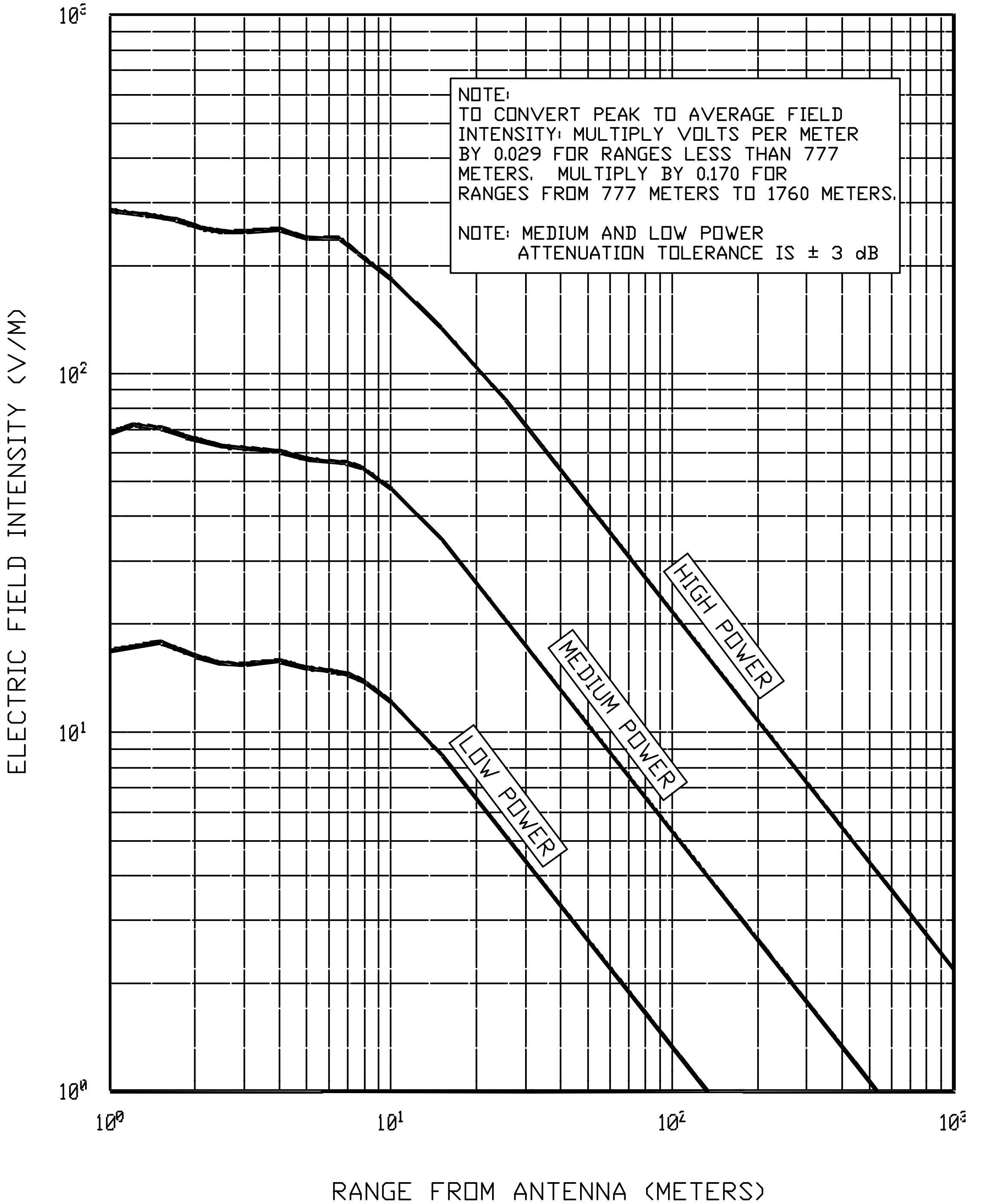


FIGURE 10.7.2.2.2.2.2-2 ORBITER KU-BAND SYSTEM: RADAR MODE PEAK ELECTRIC FIELD INTENSITY VS RANGE FROM ANTENNA

THIS PAGE INTENTIONALLY LEFT BLANK

10.7.3 CARGO-PRODUCED INTERFERENCE ENVIRONMENT

10.7.3.1 Cargo-Produced Conducted Noise

The Cargo-generated conducted emission limits, applicable to all DC and AC power interfaces, shall be as follows in the subparagraphs below.

10.7.3.1.1 DC Power

The DC power line conducted emissions shall be limited to the levels indicated in Figure 10.7.3.1.1-1. The cargo-generated transients produced on D.C. power lines by switching or other operations shall not exceed +/-30 volts peak as referenced to the line voltage, when fed from a source impedance close to but not less than the values defined in figures 10.7.3.1.1-3 and 10.7.3.1.1-4. (The use of a battery cart is preferable to regulated D.C. power supplies). Rise and fall times shall be greater than 1.0 microsecond.

10.7.3.1.2 (Reserved)

10.7.3.2 Cargo-Produced Radiated Fields

10.7.3.2.1 Magnetic Fields

10.7.3.2.1.1 AC Magnetic Fields

The generated AC magnetic fields (applicable at a distance of 1 meter from any payload equipment) shall not exceed 130 dB above 1 picotesla (30 Hz to 2 kHz) falling 40 dB per decade to 50 kHz.

10.7.3.2.1.2 DC Magnetic Fields

The generated DC magnetic fields shall not exceed 170 dBpT at the payload envelope. This limit applies to electromagnetic and permanent magnetic devices.

10.7.3.2.2 Electric Fields

10.7.3.2.2.1 Unintentional Radiated Electric Fields

The unintentional radiated electric fields shall not exceed the levels defined in Figures 10.7.3.2.2.1-1 and 10.7.3.2.2.1-2 except that the broadband emissions for cargo equipment in the cargo bay shall be limited to 70 dB above 1 microvolt/meter/MHz in the frequency range of 1770 MHz to 2300 MHz. Narrowband emissions shall be limited to 35 dB above 1 microvolt/meter from 1770 MHz to 2300 MHz, excluding any payload intentional transmitters.

10.7.3.2.2.2 Intentional Radiated Electric Fields NOT APPLICABLE

10.7.3.2.2.3 Electrostatic Discharges

Electrostatic discharges shall not occur within the cargo unless they are isolated from the cargo bay gaseous environment (hydrogen-oxygen mixture) and are shielded by the Cargo to satisfy the requirements of Paragraphs 10.7.3.2.1.1, 10.7.3.2.1.2 and 10.7.3.2.2.1.

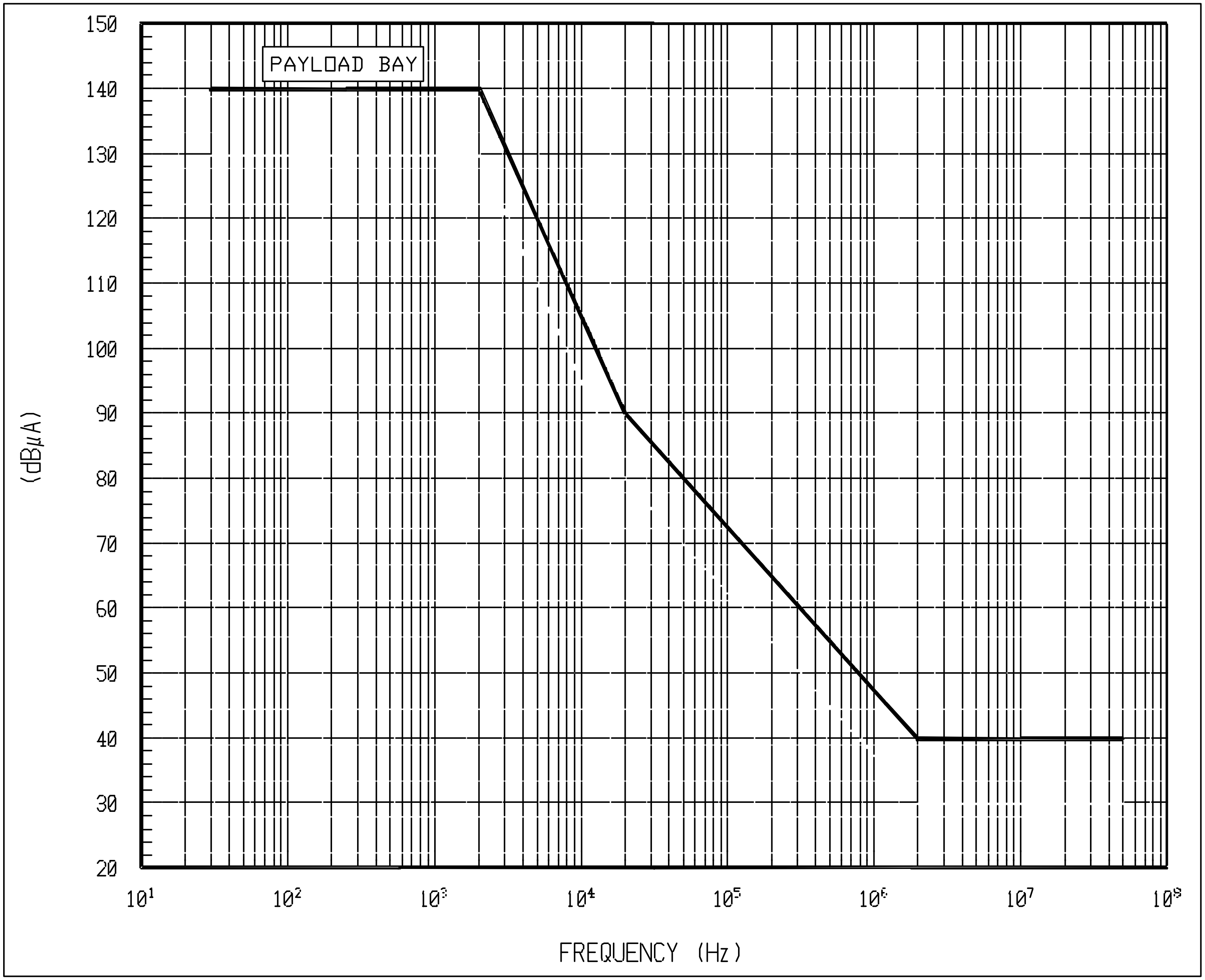


FIGURE 10.7.3.1.1-1 CARGO ALLOWABLE CONDUCTED NARROWBAND EMISSION LIMIT

THIS FIGURE INTENTIONALLY LEFT BLANK

FIGURE 10.7.3.1.1-2 LIMIT ENVELOPE OF CARGO GENERATED TRANSIENTS (LINE-TO-LINE) ON DC POWER BUSSES FOR NORMAL ELECTRICAL SYSTEM

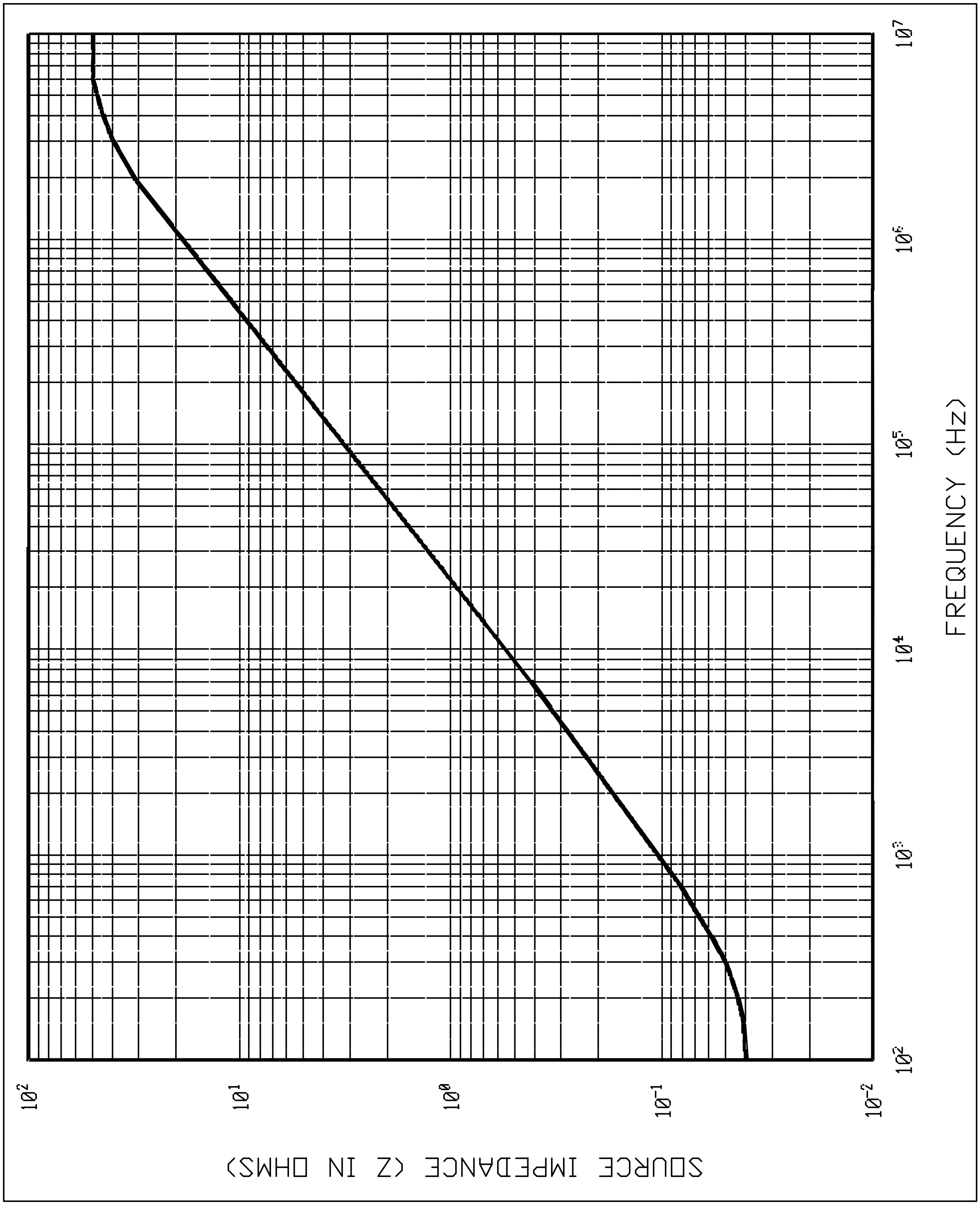


FIGURE 10.7.3.1.1-3 ORBITER DC POWER SOURCE IMPEDANCE (GROUND POWER)

FIGURE 10.7.3.1.1-4 ORBITER DC POWER SOURCE IMPEDANCE (IN FLIGHT)

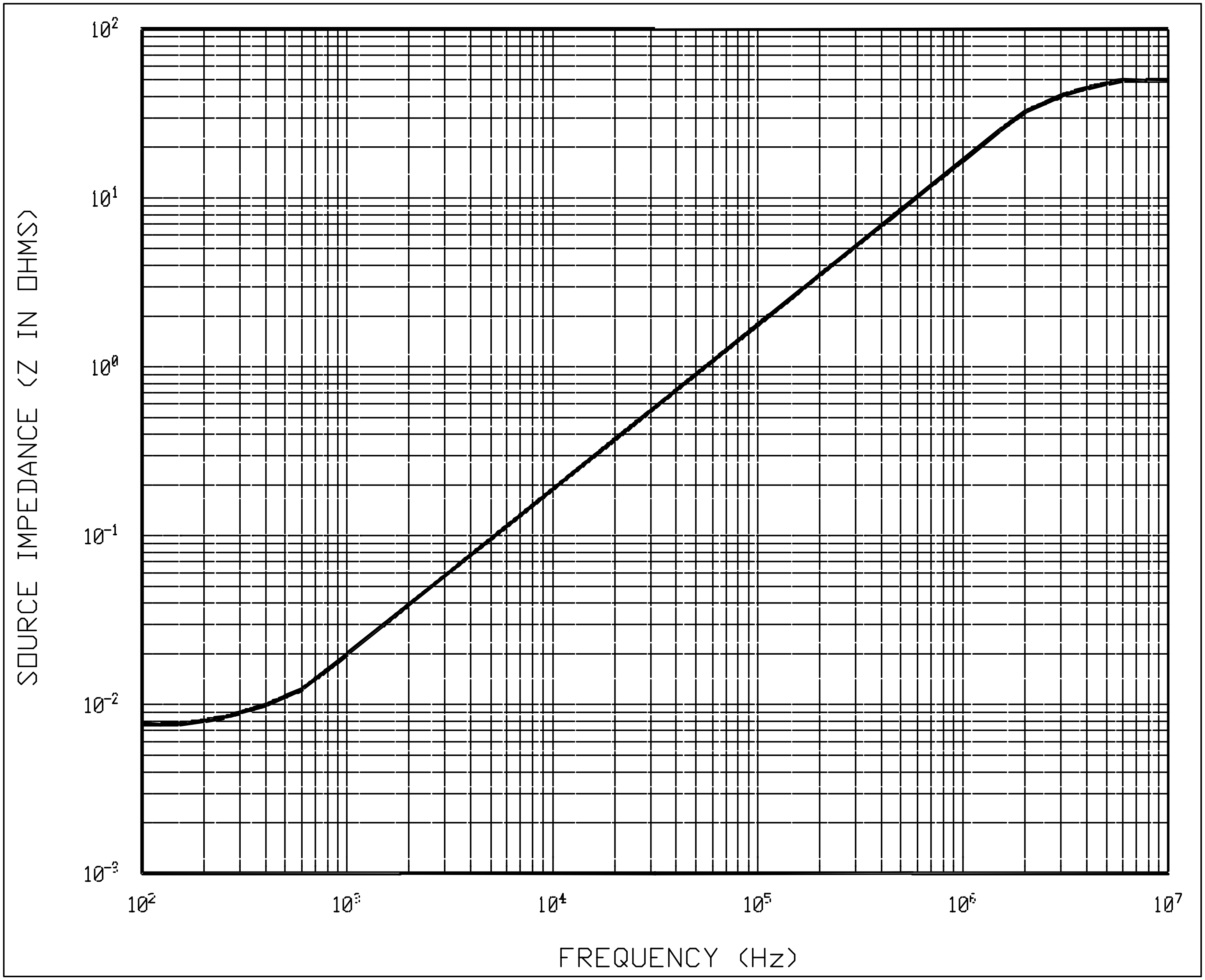


FIGURE 10.7.3.2.2.1-1 CARGO ALLOWABLE UNINTENTIONAL RADIATED BROADBAND EMISSIONS LIMIT

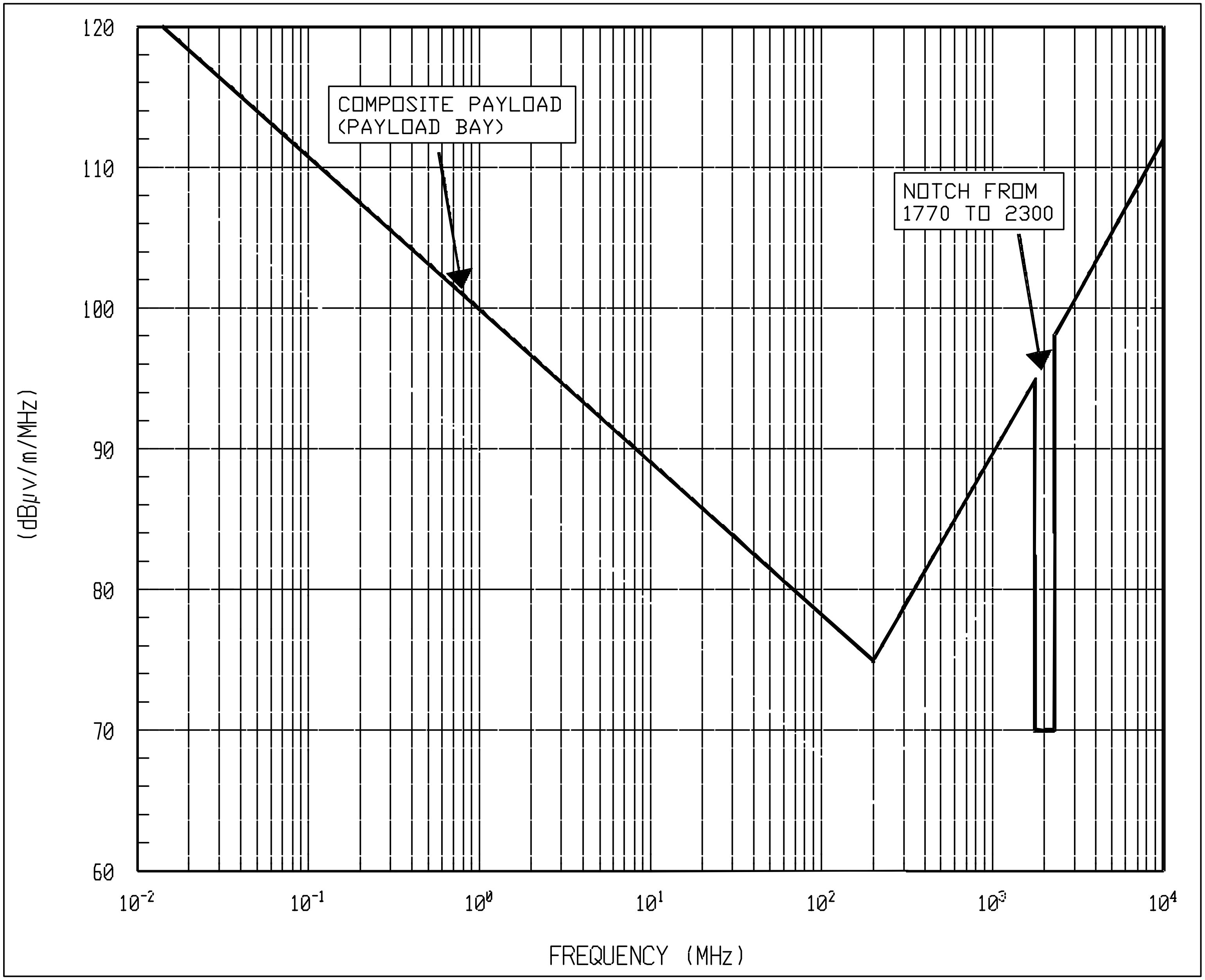
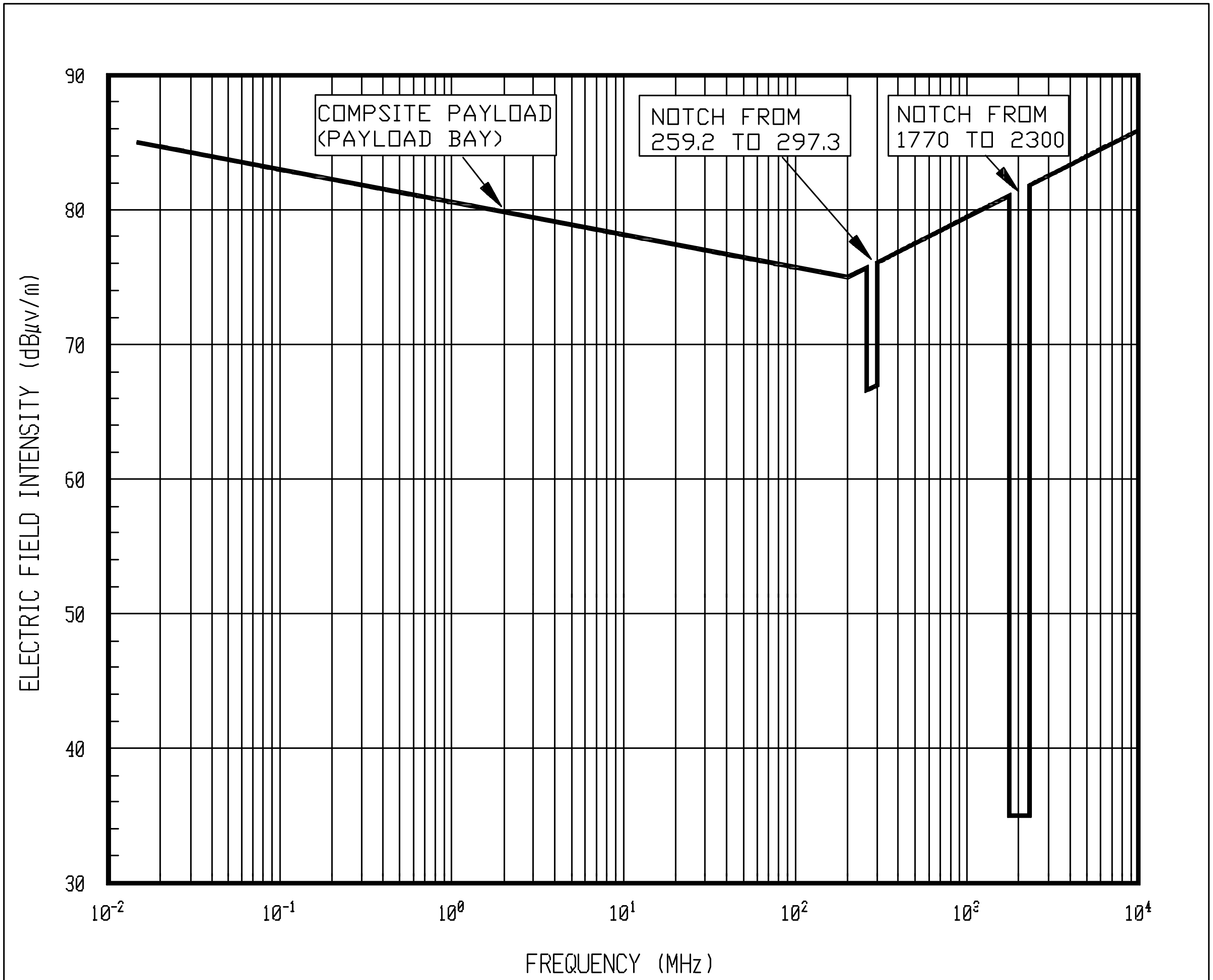


FIGURE 10.7.3.2.2.1-2 CARGO ALLOWABLE UNINTENTIONAL RADIATED NARROWBAND EMISSIONS LIMIT



THIS PAGE INTENTIONALLY LEFT BLANK

10.7.4 AVIONICS ELECTRICAL COMPATIBILITY
Circuit returns, isolation of circuit returns for DC signal circuits, and the handling of shield grounds, shall be as follows in the subparagraphs below.

10.7.4.1 Cargo Element Power and Signal Returns Isolation
The basic ground reference isolation requirement for cargo elements is: A minimum of one megohm (Mohm) D.C. isolation between each of the following: Orbiter primary D.C. returns, Orbiter primary A.C. returns, Orbiter secondary power/signal references, and the structure ground as measured in the cargo element. The structure reference shall be provided in the Orbiter. Primary power return isolation requirements are more completely specified in Paragraph 10.7.4.3. When an exception to this basic requirement occurs with any payload, the payload shall restrict the level of 28V D.C. current through structure to less than 10 amperes peak including transients.

10.7.4.1.1 Payload with Power Referenced to Structure

For payloads using a single point ground reference to structure for power and signal interfaces, the payload shall restrict the level of 28 VDC current through structure to less than 10 amperes peak including transients. The heavier load currents shall be returned to the Orbiter via wire only. Hardwire

return for the light current loads grounded to cargo element structure shall be provided by dioding between the heavy load and the light load returns so that current flows from the light load return to the heavy load return. The circuit shall be equivalent to that shown in the Figure 10.7.4.1.1-1.
The following subparagraphs are also acceptable techniques by which the 28V D.C. power return structure ground in the cargo element may be made compatible with the Orbiter.

10.7.4.1.1.1 (Reserved)

10.7.4.1.1.2 (Reserved)

10.7.4.1.1.3 (DELETED)

10.7.4.1.1.4 (DELETED)

10.7.4.1.1.5 (DELETED)

10.7.4.1.1.6 (DELETED)

10.7.4.1.1.7 (DELETED)

10.7.4.1.2 Circuit Return Referencing Criteria
The following subparagraphs contain criteria for the referencing of typical circuit returns used in the Shuttle.

10.7.4.1.2.1 Orbiter Signal Interfaces

10.7.4.1.2.1.1 Non-Coaxial Interfaces

All cargo element signal interfaces to Orbiter avionics equipment that do not utilize coaxial cabling shall be differential and isolated from structure by at least 10 kohms.

10.7.4.1.2.1.1.1 (Reserved)

10.7.4.1.2.1.1.2 (Reserved)

10.7.4.1.2.1.1.3 (Reserved)

10.7.4.1.2.1.1.4 (Reserved)

10.7.4.1.2.1.1.5 (Reserved)

10.7.4.1.2.1.1.6 (Reserved)

10.7.4.1.2.1.1.7 (Reserved)

10.7.4.1.2.1.2 Controlled Impedance Signals

10.7.4.1.2.1.2.1 (Reserved)

10.7.4.1.2.1.2.2 RF Signals

All pulse or clock interface circuits having a pulse repetition rate of greater than 50 kPPS or signals with fundamental frequencies greater than 50 kHz or circuits processing pulse rise/fall times equal to or less than 10 microseconds shall carry an RF classification. The distribution shall be via shielded-twisted-pair cabling. The method of shield termination shall be via wire pigtails to the connector backshell. No RF circuit shield shall be broken out such that more than 2.0 inches of wiring is exposed within the connector metal backshield. RFI backshells with individual shield grounding provisions are required for multiple RF shield terminations.

10.7.4.1.2.1.3 Electrical Explosive Device (EED) Firing Circuitry

EED firing circuits, if utilized, shall be isolated from other electrical circuits and each other. Each firing circuit shall be routed as a shielded, twisted pair and the shield shall be multipoint grounded. Each EED circuit conductor shall be connected to structure at one point only by a bleeder resistor. EED's and Firing Circuits shall comply with the requirements of specification NSTS 08060 and/or NSTS 1700.7, Paragraph 210. Further requirements are specified in Paragraph 7.5.4, if Orbiter power is utilized. The EED firing circuit is defined as the circuit between the Pyro Initiator Control Function and the pyro.

10.7.4.1.2.1.4 Wire Shield Reference

See grounding and shielding diagrams for individual avionics subsystems in Section 8.

10.7.4.1.2.1.4.1 (Reserved)

10.7.4.1.2.1.4.2 (Reserved)

10.7.4.1.2.1.4.3 RF Circuits

All digital data, pulse and high frequency circuits with a basic frequency greater than 50 kHz or having a rise or fall time less than 10 microseconds shall be considered RF circuits. The shields of RF circuits shall be referenced to structure at the source and load and at all intermediate breakpoints.

10.7.4.1.2.1.4.4 (Reserved)

10.7.4.2 Electrical Bonding

The Orbiter-to-Cargo electrical bonding interface shall be electrically bonded to provide homogeneous electrical characteristics. All electrical and mechanical elements shall be securely bonded to structure in compliance with MIL-B-5087. All aluminum surfaces used for bonding shall be originally cleaned to bare metal and then chemical filmed per MIL-C-5541, Class 3 (gold alodine 1200LN9368, or equivalent). Three classes of bonds per MIL-B-5087 are applicable: Class S, C, and R. These bond classes are defined in the next three subparagraphs.

a. Static Bond-Class S. Refer to Paragraph 10.7.4.2.3.5.

b. Fault-Current Bond-Class C. All cargo elements using Orbiter power shall have mechanically secure electrical connection to the Orbiter structure capable of carrying the maximum trip return current.

c. RF Potentials Bond-Class R. Cargo elements containing electrical circuits which generate radio frequencies or circuits which are susceptible to radio frequency interference may require a low-impedance path to structure in order to meet the EMC requirements of Paragraph 10.7.2.2 or 10.7.3.2. The DC resistance of a Class R bond shall be less than 2.5 milliohms.

10.7.4.2.1 Electrical Bonding of Equipment

Equipment containing electrical circuits which may generate radio frequencies or circuits which are susceptible to radio frequency, shall be so installed that there will be a continuous, low-impedance path from the equipment enclosure to structure. The metallic shells of all equipment electrical connectors shall be electrically bonded to the equipment case or the bulkhead mount with a DC resistance of less than 2.5 milliohms. Procurement specifications require that the DC resistance between the mated halves of the connectors shall not exceed 50 milliohms.

Wire harness shields external to equipment, requiring grounding at the equipment, shall have provisions for grounding the shields to the equipment through the harness connector backshell, or for carrying single point grounded shields through the connector pins.

All equipment electrical bonds and their respective interfaces shall comply with MIL-B-5087.

10.7.4.2.2 Electrical Bonding of Structures

10.7.4.2.2.1 Cargo-to-Orbiter Main Bond

10.7.4.2.2.1.1 Primary PL Bus Connector Bond

Payloads shall utilize one of the wires in each power connector as the principle Orbiter/Cargo electrical bond.

This bond shall meet the appropriate bond class requirements of paragraph 10.7.4.2.

10.7.4.2.2.1.2 Cargo-to-Orbiter Bond Strap

The cargo-to-orbiter bond strap shall be connected between Orbiter structure and cargo ground stud provisions. This bond shall meet the appropriate bond class requirements of paragraph 10.7.4.2.

10.7.4.2.2.2 (Reserved)

10.7.4.2.2.3 (Reserved)

10.7.4.2.2.4 (Reserved)

10.7.4.2.2.5 Bonding for Deployable/Retrievable Cargo Element
All cargo elements which are deployable and/or retrievable shall be electrically bonded when in the cargo bay. A provision shall be made to provide a Class-S electrical bond to Orbiter structure.

Cargo elements which utilize Orbiter power shall be required to provide a Class-C electrical bond to Orbiter structure when electrically mated to the Orbiter.

Cargo elements which utilize Orbiter command signal or data interfaces may be required to provide a Class-R electrical bond to meet the EMC requirements of paragraph 10.7.2.2 & 10.7.3.2.

RMS users are an exception as defined in Paragraph 14.4.2.

10.7.4.2.3 Electrical Bonding for Static Protection
All Orbiter and cargo interfaces shall comply with Paragraph 10.7.4.2.

10.7.4.2.3.1 (Reserved)

10.7.4.2.3.2 (Reserved)

10.7.4.2.3.3 (Reserved)

10.7.4.2.3.4 (Reserved)

10.7.4.2.3.5 Static Electricity Protection

All cargo hardware elements shall comply with the Class S bond requirements of MIL-B-5087. All conducting items subject to triboelectric (frictional) or any other charging mechanism shall have a mechanically secure electrical connection to the cargo element structure. The resistance of the connection shall be less than one (1) ohm.

10.7.4.2.3.5.1 Bonding of Thermal Blankets
Thermal blankets of metalized multilayer construction and metalized surfaces shall be bonded as follows:

- Blanket bond tab to structure - D.C. resistance shall be less than 10.0 Ohms.

- Blanket test tab to test tab - D.C. resistance shall be less than 1000 Ohms prior to connecting a bond tab to structure.

The number of bond tabs and associated bond straps (or wires) shall be determined by the blanket area as defined in the following table:

BLANKET AREA (SQ. CM)	NO. OF REQ. BOND STRAPS (OR WIRES)
0 TO 100.0	0
100.0 TO 1000.0	1
1000.0 TO 40000.0	2
>40000.0	ADD 1 STRAP (OR WIRE) FOR EACH ADDITIONAL 40000 SQ. CM.

All tabs should be located on blanket edges and spaced such that the maximum distance from any one point on the blanket to the nearest BOND or TEST TAB is less than 1.0 meter.

TEST TABS function as resistance (continuity) test points between different areas of a blanket, or between different areas of any two adjacently connected blankets. BOND TABS function as connection points for static electrical bonding to cargo structure as well as test tabs for continuity checks between different areas of a blanket, or between different areas of any two adjacently connected blankets.

If a thermal blanket is fabricated of two or more sections, and these sections are electrically bonded to each other, then the entire electrically common blanket shall be considered to be one blanket for determination of the number and placement of bond tabs and test tabs.

10.7.4.2.3.5.2 High Volume Resistivity Materials
Cargo elements using high volume resistivity materials (greater than 10^9 OHM CM) shall be designed to prevent differential charging between cargo element parts and the Orbiter. The specific requirements and design methods employed shall be negotiated with STS.

10.7.4.2.4 Circuit Reference Symbols
The circuit reference symbols for use on the Space Shuttle program shall be as shown in Figure 10.7.4.2.4-1.

10.7.4.3 Power Circuit Isolation and Grounding

10.7.4.3.1 (Reserved)

10.7.4.3.2 DC Power Ground Reference
Refer to Section 20 paragraph, 20.3

Note: A non-compliance condition exists between the Orbiter and the MIGHTY. Refer to Section 20 for the definition of the unique interface requirement.

The Orbiter D.C. power return from a Cargo element shall be structure referenced in the Orbiter and D.C. isolated from structure ground in the Cargo element by a minimum of 1 megohm except as specified in Paragraph 10.7.4.1. The Orbiter D.C. power return system shall be a combination of a hardwired return system and a structure-return system, with the use of the wire return restricted to specific load-sensitive areas as shown in Figure 10.7.4.3.2-1.

10.7.4.3.3 (Reserved)

10.7.4.3.4 (Reserved)

10.7.4.3.5 Cargo Bay Power-Circuit Returns

When Orbiter power is supplied to the Cargo Bay, the returns shall be referenced to structure in the Orbiter only, except as specified in Paragraph 10.7.4.1 and during Orbiter power to payload internal power changeover switching (switch-over time duration greater than 200 milliseconds shall be reported to STS for review).

10.7.4.3.6 Signal-Circuit Returns

Cargo equipment may have primary power returns connected to signal returns if treated per Paragraph 10.7.4.1.

10.7.4.3.7 Ground Support Equipment Isolation and Grounding

GSE interfacing with payloads shall be isolated from payload circuits (power and signal return lines) by a minimum of 1 megohm, except where balanced differential circuits are used. In the case of balanced differential circuits, each side of the circuit shall be balanced to ground by no less than 4000 ohms. Coax cables, with their inherent grounding of the signal return to structure, are permitted, providing their interface with other LRU’s or systems does not propagate that ground to circuits which are already referenced to ground at some other point.

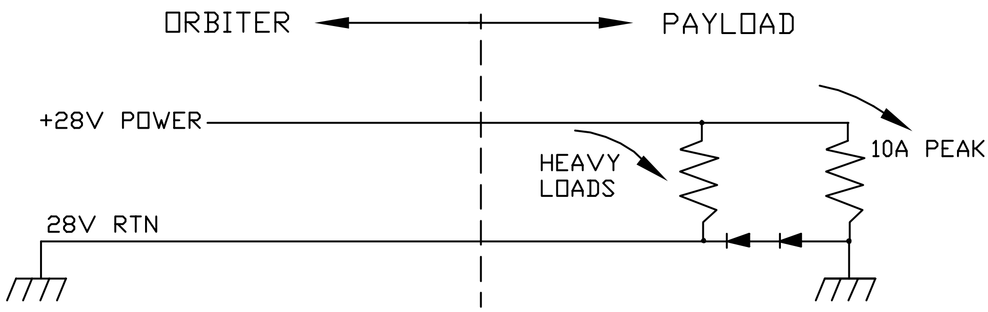


FIGURE 10.7.4.1.1-1 TYPICAL PAYLOAD BASIC GROUND ISOLATION DIAGRAM

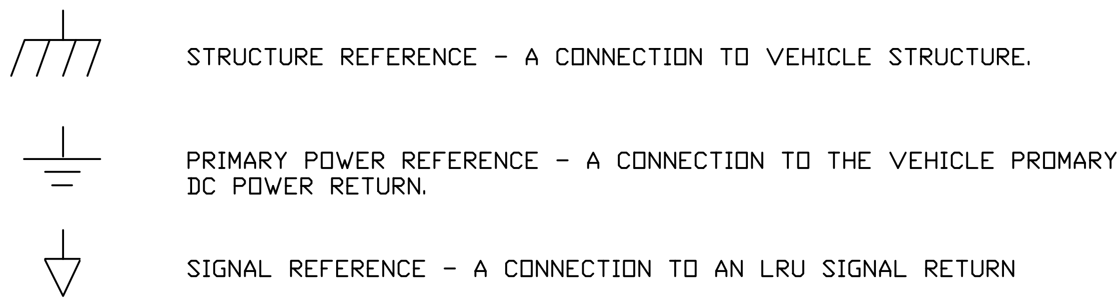


FIGURE 10.7.4.2.4-1 CIRCUIT REFERENCE SYMBOLS

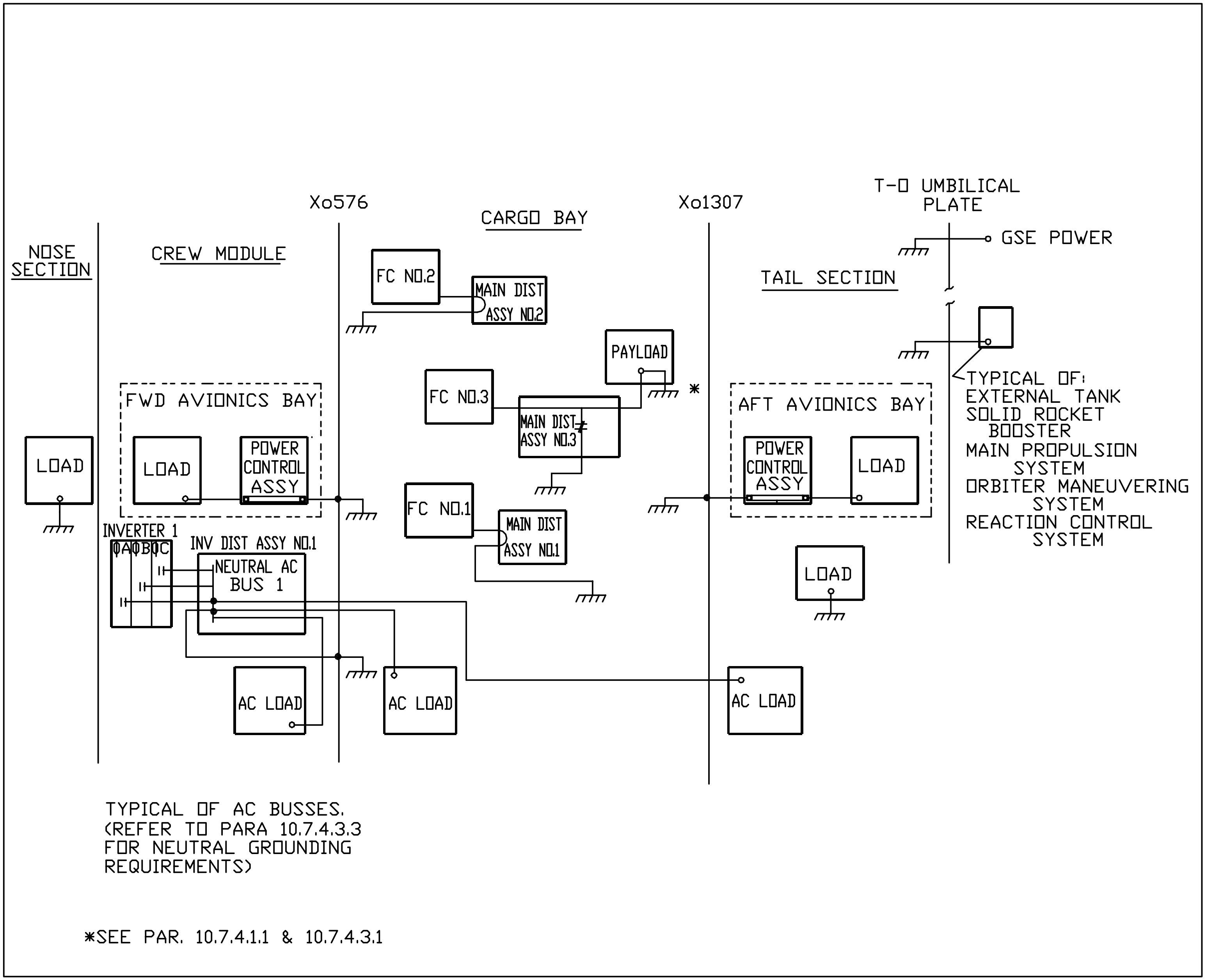


FIGURE 10.7.4.3.2-1 SHUTTLE PRIMARY AC AND DC POWER GROUNDING SYSTEMS

THIS PAGE INTENTIONALLY LEFT BLANK

10.8 NUCLEAR RADIATION

Materials containing natural or man-made radioisotopes (in any quantity, including trace amounts), shall not be used in any Orbiter or payload subsystem, unless prior approval is received from NASA-JSC.

10.9 (Reserved)

10.10 CARGO BAY FERRY FLIGHT ENVIRONMENTS

During Ferry Flight Operations, the payload within the cargo bay will be exposed to ambient conditions which will not be controlled or monitored. Payloads normally will not be powered nor any heating or cooling systems activated. The following Ferry Flight Environment conditions within the cargo bay shall be generally considered as extreme conditions to which a payload may be exposed. For payloads which require a conditioned environment during surface operations, purge cooling/heating can be made available at selected sites. Payloads having special thermal requirements for either surface or flight operations shall specify such requirements in the applicable PIP.

The maximum number of Shuttle Carrier Aircraft (SCA) landings that the payload can experience is 10.

10.10.1 Pressure

Pressure shall be as follows:

Surface	12.36 to 15.23 psia
16,000 Feet Pressure Altitude	8.00 psia minimum

10.10.2 Temperature

Temperatures shall be as follows:

Surface - Uncontrolled: *	+10^{o}F to +125^{o}F
Surface - Conditioned: **	+48^{o}F to +100^{o}F at 165 lb/min. flow
Altitude: ***	+35^{o}F to +80^{o}F

* The temperature extremes apply only for ferry flights between primary or secondary landing sites and are the extremes of the diurnal variations for cold and hot conditions, respectively.

** Conditioned purge air at the specified temperature range and flow can be made available at selected sites. The temperature range to be provided shall be negotiated, based on shared cargo considerations.

*** Obtained by altitude adjustment. Maximum duration of any flight segment is 4 hours.

10.10.3 Humidity

The relative humidity for both surface and altitude conditions may range between 2 percent and 98 percent.

10.10.4 Dynamic Induced Environments

Dynamic loads, acoustic noise, and vibration induced environments for ferry flight conditions other than carrier aircraft landings are less critical as compared to the Shuttle launch and landing. For carrier aircraft landings at high sink rates, the payload components being ferried may experience load factors on the same order as launch and landing. If such a "hard landing" occurs the STS will conduct analyses to determine the severity of the loading environment.

THIS PAGE INTENTIONALLY LEFT BLANK

11.0 OTHER INTERFACE CONSTRAINTS AND LIMITATIONS

11.0.1 PAYLOAD DEFINITION

11.0.1.1 Safety Critical Interfaces

Payload safety critical circuits are identified in Section 13.0, Connector Pin Assignment tables.

11.0.2 (Reserved)

11.0.3 (Reserved)

11.0.4 (Reserved)

THIS PAGE INTENTIONALLY LEFT BLANK

11.1 SAFETY CRITICAL INTERFACES

11.1.1 Interface Identification

NSTS to payload interfaces which are associated with failure tolerance requirements of NSTS 1700.7 shall be identified to the NSTS by the payload.

11.1.1.1 Electrical Interfaces

The NSTS to payload electrical interfaces which are associated with the above requirements shall be identified in Section 13. This table shall correlate specific hazard events with the electrical circuits associated with the control and monitoring of these hazards to ensure that adequate protection and separation (i.e., redundancy separation, inhibit separation, etc.) is provided for these circuits to control the payload’s hazards.

11.1.1.2 Mechanical Interfaces

The NSTS to payload mechanical interfaces which are associated with the above requirements shall be identified in Section 3.

11.1.1.3 (Reserved)

11.2 (Reserved)

THIS PAGE INTENTIONALLY LEFT BLANK

12.0 (Reserved)

THIS PAGE INTENTIONALLY LEFT BLANK

13.0 ELECTRICAL WIRING INTERFACES

13.0.1 PAYLOAD DEFINITION

13.0.1.1 STS-To-Payload Cable Interface Diagram

The STS-To-Cargo Element cable interface diagram shall be as shown in Figure 13.0.1.1-1.

13.0.1.2 (Reserved)

13.0.1.3 (Reserved)

13.0.1.4 Voltage Characteristics for SSP NOT APPLICABLE

13.0.1.5 Pin Assignment Tables Terminology

ENTRY TERMINOLOGY FOR PIN ASSIGNMENTS TABLES

CONDITION

```
                                                WIRE PATH EXPLANATION
                                             STS             |                PAYLOAD
                                                             |
I/F WIRING CLASSIFICATION   ORB  ORB PROD.   ---------  P/L PROD.        P/L
                           SIGNAL  BREAK    |INTERFACE|  BREAK    UNIT   SIGNAL
                             |       |       ---------    |        |       |
                             |       |           |        |        |       |
1. WIRED ON BOTH SIDES OF I/F|<--------FUNCTION |FUNCTION------------------->|
                             |<--------FUNCTION |SPARE---->|
                                     |<----SPARE |SPARE---->|
                                     |<----SPARE |SPARE------------->|
                             |<--------FUNCTION |SPARE------------->|
                                     |<----SPARE |FUNCTION (GSE SUPPORT)--->|
                                                 |
2. WIRED ON ORBITER SIDE OF  |<----FUNCTION---->|NOT WIRED|
   I/F                               |<--SPARE-->|NOT WIRED|
                                                 |
3. WIRED ON P/L SIDE OF I/F          | NOT WIRED |<FUNCTION (GSE SUPPORT)->|
                                     | NOT WIRED |<-SPARE->|
                                     | NOT WIRED |<----SPARE-------->|
                                                 |
4. NOT WIRED ON EITHER SIDE          | NOT WIRED |NOT WIRED|
   OF I/F
```

DEFINITION:

- o FUNCTION - WIRE TERMINATES AT A UNIT CAPABLE OF GENERATING OR RECEIVING A SIGNAL.
- o SPARE - WIRE TERMINATES AT A PRODUCTION BREAK OR A UNIT BUT IS PHYSICALLY INCAPABLE OF GENERATING OR RECEIVING A SIGNAL.
- o NOT WIRED - NO CONDUCTING PATH.

NOTE:

- o PAYLOAD FUNCTIONS WHICH ARE NOT REQUIRED TO SUPPORT A SPECIFIC MISSION SHALL BE IDENTIFIED WITH THE NOTE "NO MATED OPERATIONAL REQUIREMENT".

- o PAYLOAD FUNCTIONS WHICH SUPPORT OFFLINE CHECKOUT SHALL BE IDENTIFIED AS "GSE SUPPORT" AND SHALL INTERFACE WITH ORBITER SPARE OR NOT WIRED.

- o PAYLOAD SHALL BE RESPONSIBLE TO ASSURE THAT THE INADVERTENT ACTIVATION OF A NON-OPERATIONAL FUNCTION SHALL HAVE NO ADVERSE IMPACT ON THE ORBITER OR CREW.

13.0.1.6 Cargo Element Safety Critical Circuit to Hazard Event Correlation
The NSTS-to-payload electrical interfaces which are associated with payload hazard events shall be identified as safety critical and listed in Table 13.0.1.6-1.

13.0.2 UNIQUE MISSION SPECIFIC REQUIREMENTS

13.0.2.1 PAYLOAD UNIQUE DEFINITION

13.0.2.1.1 STS to Payload SSP Interfaces
The standard Payload Display and Control service and cable interface allocations for Cargo Element shall be as shown in Table 13.0.2.1.1-1.

13.0.2.1.2 STS-To- Payload Connector Pin Assignments

13.0.2.1.2.1 STS-To-Payload RF Interface
Connector interface definition shall be as shown in Table 13.0.2.1.2.1-1. This connector interface provides PDI,Orbiter Payload Recorder, PSP and Payload Timing Buffer services.

13.0.2.1.2.2 STS-T0-Payload SSP Indicators
Connector interface definition shall be shown in Table 13.0.2.1.2.2-1.

13.0.2.1.2.3 STS-To-Payload SSP Switches and MDM (DOH) Interfaces
Connector interface definition shall be as shown in Table 13.0.2.1.2.3-1.

13.0.2.1.2.4 Voltage Characteristics for SSP
For voltages originating in the Aft Flight Deck (AFD), voltage characteristics are specified at the SIP as follows:

Voltage Range
23.8 - 32.0 VDC

Voltage/power values stated are for a single switch/contact pair. Total continuous power drawn from the SSP power source shall not exceed 15 watts.

13.0.2.1.4 SSP Interface Schematic
SSP switching shall be as shown in Figure 3.0.2.1.4-1.

13.0.3 SMALL PAYLOAD UNIQUE INTERFACES

13.0.3.1 STS-To-Payload Electrical Wiring Interfaces NOT APPLICABLE

13.0.3.2 STS-To-Payload RF and SPASP (HO) Interface NOT APPLICABLE

13.0.3.3 STS-To-Payload Main DC Power Interface
Connector interface definition shall be as shown in Tables 13.0.3.3-1 and 13.0.3.3-2.

13.0.3.4 Small Payload Accommodations Switch Panel (SPASP) NOT APPLICABLE

13.0.3.5 Small Payload Accommodations Terminal (SPAT)
The interfaces and the internal circuitry of the Small Payload Accommodations Terminal are as shown in Figure 13.0.3.5-1.

13.0.3.6 Cable Schematics NOT APPLICABLE

13.0.4 (Reserved)

TABLE 13.0.1.6-1 PAYLOAD HAZARD EVENT TABLE

HAZARDOUS EVENT	SYSTEM	PAYLOAD INTERFACE CONNECTOR	PIN NUMBER	PAYLOAD FUNCTION NOMENCLATURE	(C)COMMAND/ (M)MONITOR/ (P)POWER	NOTES
1	A	J103	28	HESE PRE-ARM A	C	
1	A	J103	29	HESE PRE-ARM B	C	
1	A	J108	52	HESE PRE-ARM STATUS	M	
1	A	J108	53	HESE PRE-ARM STATUS RTN	M	
1	B	J103	31	HESE ARM A	C	
1	B	J103	32	HESE ARM B	C	
1	B	J108	43	HESE ARM STATUS	M	
1	B	J108	44	HESE ARM STATUS RTN	M	
1	C	J103	34	HESE FIRE A	C	
1	C	J103	35	HESE FIRE B	C	
1	C	J108	41	HESE PUSH PLT MON RTN	M	
1	C	J108	40	HESE PUSH PLT MON	M	
2	A	J103	58	SAC-A DOOR OP/CLS	C	
2	A	J108	58	SAC-A HMDA LISA MON	M	
2	A	J108	59	SAC-A HMDA LISA MON RTN	M	
2	B	J103	44	SAC-A PRE-ARM A	C	
2	B	J103	70	SAC-A PRE-ARM B	C	
2	B	J108	55	SAC-A PRE-ARM STATUS	M	
2	B	J108	56	SAC-A PRE-ARM STATUS RTN	M	
2	C	J103	47	SAC-A ARM A	C	
2	C	J108	68	SAC-A ARM STATUS RTN	M	
2	C	J103	61	SAC-A ARM B	C	
2	C	J108	67	SAC-A ARM STATUS	M	
2	D	J103	40	SAC-A FIRE A	C	
2	D	J103	68	SAC-A FIRE B	C	
2	D	J108	49	SAC-A FIRE STATUS	M	
2	D	J108	50	SAC-A FIRE STATUS RTN	M	

TABLE 13.0.1.6-1 PAYLOAD HAZARD EVENT TABLE
(CONCLUDED)

Notes: HAZARD EVENT

1. INADVERTANT OPERATION/DEPLOYMENT OF MIGHTYSAT 1
   (REF. HAZARD REPORT NO. HH-F-08)

2. INADVERTANT OPERATION/DEPLOYMENT OF SAC-A
   (REF. HAZARD REPORT NO. HH-F-08)

TABLE 13.0.2.1.1-1 STS/PAYLOAD STANDARD INTERFACE ALLOCATION

ORBITER SERVICE	REF PARA	ORBITER CAPABILITY	IDD ALLOCATION	PAYLOAD USE
STANDARD SWITCH PANEL(AFD SECTION)	13.4.2	4 SECTIONS	0	1
PORT SIP RF(PDI/PSP/OPR/PTB)	13.0.2.1.2.1	4 CONCTRS	0	1
PORT SIP ML(SSP INDICATORS/PF01)	13.0.2.1.2.2	4 CONCTRS	0	1
PORT SIP HO(SSP SWITCHES/PF01)	13.0.2.1.2.3	4 CONCTRS	0	1
STBD SIP MAIN DC POWER	13.0.3.3	4 CONCTRS	0	1 *

* Main DC power provided via small payload accommodations (2-8 GA feeds from SPAT box to Hitchhiker interface)

TABLE 13.0.2.1.2.1-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT RF (PDI/PSP/OPR/PTB)

STS CONN ID/SMCH ID: J107
STS CONN PART NO: ME414-0630-4002
P/L CONN IDENT: P107
P/L CONN PART NO: NLS6GT20-35S
P/L CABLE NO: SIP-W2
P/L CABLE DIA (IN): 0.65

EMC CLASS	PIN FUNCT	CABLE CODES	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
			1	NOT WIRED	NOT WIRED		
			2	NOT WIRED	NOT WIRED		
			3	NOT WIRED	NOT WIRED		
			4	NOT WIRED	NOT WIRED		
			5	NOT WIRED	NOT WIRED		
			6	NOT WIRED	NOT WIRED		
			7	NOT WIRED	NOT WIRED		
			8	NOT WIRED	NOT WIRED		
			9	NOT WIRED	NOT WIRED		
RF	SIG	2S22	10	SPARE	NOT WIRED	3	
RF	RTN	2S22	11	SPARE	NOT WIRED	3	
			12	NOT WIRED	NOT WIRED		
RF	SIG	2S23	13	SPARE	NOT WIRED	2	
RF	RTN	2S23	14	SPARE	NOT WIRED	2	
			15	NOT WIRED	NOT WIRED		
RF	SIG	2S1	16	SPARE	NOT WIRED	1	
RF	RTN	2S1	17	SPARE	NOT WIRED	1	
			18	NOT WIRED	NOT WIRED		
RF	SIG	2S2	19	SPARE	NOT WIRED		
RF	RTN	2S2	20	SPARE	NOT WIRED		
			21	NOT WIRED	NOT WIRED		
RF	SIG	2S3	22	SPARE	NOT WIRED		
RF	RTN	2S3	23	SPARE	NOT WIRED		
			24	NOT WIRED	NOT WIRED		
RF	SIG	2S4	25	SPARE	NOT WIRED		
RF	RTN	2S4	26	SPARE	NOT WIRED		
			27	NOT WIRED	NOT WIRED		
RF	SIG	2S5	28	SPARE	NOT WIRED		
RF	RTN	2S5	29	SPARE	NOT WIRED		
			30	NOT WIRED	NOT WIRED		
RF	SIG	2S6	31	SPARE	NOT WIRED		
RF	RTN	2S6	32	SPARE	NOT WIRED		
			33	NOT WIRED	NOT WIRED		
RF	SIG	2S7	34	SPARE	NOT WIRED		
RF	RTN	2S7	35	SPARE	NOT WIRED		
			36	NOT WIRED	NOT WIRED		
RF	SIG	2S8	37	SPARE	NOT WIRED		
RF	RTN	2S8	38	SPARE	NOT WIRED		
			39	NOT WIRED	NOT WIRED		
RF	SIG	2S9	40	SPARE	NOT WIRED		
RF	RTN	2S9	41	SPARE	NOT WIRED		
			42	NOT WIRED	NOT WIRED		
RF	SIG	2S10	43	SPARE	NOT WIRED		
RF	RTN	2S10	44	SPARE	NOT WIRED		
			45	NOT WIRED	NOT WIRED		
RF	SIG	2S11	46	SPARE	NOT WIRED		
RF	RTN	2S11	47	SPARE	NOT WIRED		
			48	NOT WIRED	NOT WIRED		
RF	SIG	2S12	49	P/L RCDR ANAL	NOT WIRED	4	8.2.3
RF	RTN	2S12	50	P/L RCDR ANAL RTN	NOT WIRED	4	8.2.3
			51	NOT WIRED	NOT WIRED		
RF	SIG	2S13	52	P/L RCDR DIG	NOT WIRED	4	8.2.3

TABLE 13.0.2.1.2.1-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT RF (PDI/PSP/OPR/PTB) (CONTINUED)

EMC CLASS	PIN FUNCT	CABLE DESC	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
RF	RTN	2S13	53	P/L RCDR DIG RTN	NOT WIRED	4	8.2.3
			54	NOT WIRED	NOT WIRED		
RF	SIG	2S14	55	P/L RCDR DIG	NOT WIRED	4	8.2.3
RF	RTN	2S14	56	P/L RCDR DIG RTN	NOT WIRED	4	8.2.3
			57	NOT WIRED	NOT WIRED		
RF	SIG	2S15	58	PDI INPUT TLM	LOW RATE DATA +		8.2.1
RF	RTN	2S15	59	PDI INPUT TLM RTN	LOW RATE DATA -		8.2.1
			60	NOT WIRED	NOT WIRED		
RF	SIG	2S16	61	PDI INPUT CLK	NOT WIRED		8.2.1
RF	RTN	2S16	62	PDI INPUT CLK RTN	NOT WIRED		8.2.1
			63	NOT WIRED	NOT WIRED		
RF	SIG	2S17	64	PSP NO. 1 OUTPUT	COMMAND DATA +		8.2.5
RF	RTN	2S17	65	PSP NO. 1 OUTPUT RTN	COMMAND DATA -		8.2.5
			66	NOT WIRED	NOT WIRED		
RF	SIG	2S18	67	PSP NO. 2 OUTPUT	NOT WIRED		8.2.5
RF	RTN	2S18	68	PSP NO. 2 OUTPUT RTN	NOT WIRED		8.2.5
			69	NOT WIRED	NOT WIRED		
RF	SIG	2S19	70	PAYLOAD TIMING BUFFER GMT	NOT WIRED		8.2.10
RF	RTN	2S19	71	PAYLOAD TIMING BUFFER GMT RTN	NOT WIRED		8.2.10
			72	NOT WIRED	NOT WIRED		
RF	SIG	2S20	73	PAYLOAD TIMING BUFFER GMT	NOT WIRED		8.2.10
RF	RTN	2S20	74	PAYLOAD TIMING BUFFER GMT RTN	NOT WIRED		8.2.18
			75	NOT WIRED	NOT WIRED		
RF	SIG	2S21	76	PAYLOAD TIMING BUFFER MET	MET +		8.2.10
RF	RTN	2S21	77	PAYLOAD TIMING BUFFER MET RTN	MET -		8.2.10
			78	NOT WIRED	NOT WIRED		
			79	NOT WIRED	NOT WIRED		

TABLE 13.0.2.1.2.1-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT RF (PDI/PSP/OPR/PTB) (CONCLUDED)

Notes:

(1) Wired to PSDP for SMCH connectors P1401, P1403 and P1405. Wired to Xo603 for SMCH connector P1407.

(2) Wired to Xo603.

(3) Wired to Xo603 for SMCH connectors P1401 and P1403. Not wired for SMCH connectors P1405 and P1407.

(4) If P/L recorder is not installed, Orbiter function nomenclature shall be spare.

TABLE 13.0.2.1.2.2-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT ML (SSP IND/PF01)

STS CONN ID/SMCH ID: J108
STS CONN PART NO: ME414-0630-4004
P/L CONN IDENT: P108
P/L CONN PART NO: NLS6GT20-35SB
P/L CABLE NO: SIP-W3
P/L CABLE DIA (IN): 0.50

EMCS CLASS	PIN FUNCT	CABLE CODE	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
ML	SIG	5S3	1	SPARE	NOT WIRED	1	
ML	SIG	5S3	2	SPARE	NOT WIRED	1	
ML	SIG	5S3	3	SPARE	NOT WIRED	1	
ML	SIG	5S3	4	SPARE	NOT WIRED	1	
ML	RTN	5S3	5	SPARE	NOT WIRED	1	
ML	SHD	5S3	6	TERMINATE	NOT WIRED	1	
ML	SIG	2S16	7	SPARE	NOT WIRED	1	
ML	RTN	2S16	8	SPARE	NOT WIRED	1	
ML	SHD	2S16	9	TERMINATE	NOT WIRED	1	
ML	SIG	5S1	10	P/L COMMAND (DOL 01)	NOT WIRED		8.2.2.1
ML	SIG	5S1	11	P/L COMMAND (DOL 02)	NOT WIRED		8.2.2.1
ML	SIG	5S1	12	P/L COMMAND (DOL 03)	NOT WIRED		8.2.2.1
ML	SIG	5S1	13	P/L COMMAND (DOL 04)	NOT WIRED		8.2.2.1
ML	RTN	5S1	14	DOL 01-04 RETURN	NOT WIRED		8.2.2.1
ML	SHD	5S1	15	TERMINATE	NOT WIRED		
ML	SIG	5S2	16	P/L COMMAND (DOL 05)	NOT WIRED		8.2.2.1
ML	SIG	5S2	17	P/L COMMAND (DOL 06)	NOT WIRED		8.2.2.1
ML	SIG	5S2	18	P/L COMMAND (DOL 07)	NOT WIRED		8.2.2.1
ML	SIG	5S2	19	P/L COMMAND (DOL 08)	NOT WIRED		8.2.2.1
ML	RTN	5S2	20	DOL 05-08 RETURN	NOT WIRED		8.2.2.1
ML	SHD	5S2	21	TERMINATE	NOT WIRED		
ML	SIG	5S4	22	P/L MONITOR (DIL 01)	NOT WIRED		8.2.2.3
ML	SIG	5S4	23	P/L MONITOR (DIL 02)	NOT WIRED		8.2.2.3
ML	SIG	5S4	24	P/L MONITOR (DIL 03)	NOT WIRED		8.2.2.3
ML	SIG	5S4	25	P/L MONITOR (DIL 04)	NOT WIRED		8.2.2.3
ML	RTN	5S4	26	DIL 01-04 RETURN	NOT WIRED		8.2.2.3
ML	SHD	5S4	27	TERMINATE	NOT WIRED		
ML	SIG	5S5	28	P/L MONITOR (DIL 05)	NOT WIRED		8.2.2.3
ML	SIG	5S5	29	P/L MONITOR (DIL 06)	NOT WIRED		8.2.2.3
ML	SIG	5S5	30	P/L MONITOR (DIL 07)	NOT WIRED		8.2.2.3
ML	SIG	5S5	31	P/L MONITOR (DIL 08)	NOT WIRED		8.2.2.3
ML	RTN	5S5	32	DIL 05-08 RETURN	NOT WIRED		8.2.2.3
ML	SHD	5S5	33	TERMINATE	NOT WIRED		
ML	SIG	2S1	34	P/L MONITOR (AID 01)	NOT WIRED		8.2.2.4
ML	RTN	2S1	35	AID 01 RETURN	NOT WIRED		8.2.2.4
ML	SHD	2S1	36	TERMINATE	NOT WIRED		
ML	SIG	2S2	37	P/L MONITOR (AID 02)	NOT WIRED		8.2.2.4
ML	RTN	2S2	38	AID 02 RETURN	NOT WIRED		8.2.2.4
ML	SHD	2S2	39	TERMINATE	NOT WIRED		
ML	SIG	2S15	40	DS24/12	HESE PUSH PLT MON		13.4.2
ML	RTN	2S15	41	DS24/12 RETURN	HESE PUSH PLT MON RTN		13.4.2
ML	SHD	2S15	42	TERMINATE	SHIELD		
ML	SIG	2S14	43	DS23/11	HESE ARM STATUS		13.4.2
ML	RTN	2S14	44	DS23/11 RETURN	HESE ARM STATUS RTN		13.4.2
ML	SHD	2S14	45	TERMINATE	SHIELD		
ML	SIG	2S13	46	DS22/10	NOT WIRED		13.4.2
ML	RTN	2S13	47	DS22/10 RETURN	NOT WIRED		13.4.2
ML	SHD	2S13	48	TERMINATE	NOT WIRED		
ML	SIG	2S12	49	DS21/9	SAC-A FIRE STATUS		13.4.2
ML	RTN	2S12	50	DS21/9 RETURN	SAC-A FIRE STATUS RTN		13.4.2
ML	SHD	2S12	51	TERMINATE	SHIELD		
ML	SIG	2S11	52	DS20/8	HESE PRE-ARM STATUS		13.4.2

TABLE 13.0.2.1.2.2-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT ML (SSP IND/PF01)
(CONTINUED)

EMC CLASS	PIN FUNCT	CABLE CODES	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
ML	RTN	2S11	53	DS20/8 RETURN	HESE PRE-ARM STATUS RTN		13.4.2
ML	SHD	2S11	54	TERMINATE	SHIELD		
ML	SIG	2S10	55	DS19/7	SAC-A PRE-ARM STATUS		13.4.2
ML	RTN	2S10	56	DS19/7 RETURN	SAC-A PRE-ARM STATUS RTN		13.4.2
ML	SHD	2S10	57	TERMINATE	SHIELD		
ML	SIG	2S9	58	DS18/6	SAC-A HMDA LISA MON		13.4.2
ML	RTN	2S9	59	DS18/6 RETURN	SAC-A HMDA LISA MON RTN		13.4.2
ML	SHD	2S9	60	TERMINATE	SHIELD		
ML	SIG	2S8	61	DS17/5	NOT WIRED		13.4.2
ML	RTN	2S8	62	DS17/5 RETURN	NOT WIRED		13.4.2
ML	SHD	2S8	63	TERMINATE	NOT WIRED		
ML	SIG	2S7	64	DS16/4	NOT WIRED		13.4.2
ML	RTN	2S7	65	DS16/4 RETURN	NOT WIRED		13.4.2
ML	SHD	2S7	66	TERMINATE	NOT WIRED		
ML	SIG	2S6	67	DS15/3	SAC-A ARM STATUS		13.4.2
ML	RTN	2S6	68	DS15/3 RETURN	SAC-A ARM STATUS RTN		13.4.2
ML	SHD	2S6	69	TERMINATE	SHIELD		
ML	RTN	2S5	70	DS14/2 RETURN	EXP POWER BUS STATUS RTN		13.4.2
ML	SIG	2S5	71	DS14/2	SPARE		13.4.2
ML	SHD	2S5	72	TERMINATE	SHIELD		
ML	SIG	2S4	73	DS13/1	SPARE		13.4.2
ML	SIG	2S4	74	DS14/2	EXP POWER BUS STATUS		13.4.2
ML	SHD	2S4	75	TERMINATE	SHIELD		
ML	SIG	2S3	76	DS13/1	AVIONICS POWER STATUS		13.4.2
ML	RTN	2S3	77	DS13/1 RETURN	AVIONICS POWER STATUS RTN		13.4.2
ML	SHD	2S3	78	TERMINATE	SHIELD		
			79	NOT WIRED	NOT WIRED		

TABLE 13.0.2.1.2.2-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT ML (SSP IND/PF01)
(CONCLUDED)

Note: (1) Wired to Xo603.

TABLE 13.0.2.1.2.3-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT HO (SSP SWITCHES/PF01)

STS CONN ID/SMCH ID: J103
STS CONN PART NO: ME414-0630-4003
P/L CONN IDENT: P103
P/L CONN PART NO: NLS6GT20-35SA
P/L CABLE NO: SIP-W4
P/L CABLE DIA (IN): 0.50

EMCS CLASS	PIN FUNCT	CABLE CODES	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
			1	NOT WIRED	NOT WIRED		
			2	NOT WIRED	NOT WIRED		
			3	NOT WIRED	NOT WIRED		
			4	NOT WIRED	NOT WIRED		
			5	NOT WIRED	NOT WIRED		
			6	NOT WIRED	NOT WIRED		
			7	NOT WIRED	NOT WIRED		
			8	NOT WIRED	NOT WIRED		
			9	NOT WIRED	NOT WIRED		
			10	NOT WIRED	NOT WIRED		
			11	NOT WIRED	NOT WIRED		
			12	NOT WIRED	NOT WIRED		
HO	SIG	2T1	13	S13/1	HH 28V RTN		13.4.2
HO	SIG	2T1	14	S13/1	HH 28V RTN		13.4.2
			15	NOT WIRED	NOT WIRED		
HO	SIG	2T2	16	S13/1	AVIONICS ON (K9)		13.4.2
HO	SIG	2T2	17	S13/1	AVIONICS ON (K9)		13.4.2
			18	NOT WIRED	NOT WIRED		
HO	SIG	2T3	19	S13/1	AVIONICS OFF (K9)		13.4.2
HO	SIG	2T3	20	S13/1	AVIONICS OFF (K9)		13.4.2
			21	NOT WIRED	NOT WIRED		
HO	SIG	2T4	22	S14/2	EXP POWER BUS ON (ZL)		13.4.2
HO	SIG	2T4	23	S14/2	EXP POWER BUS ON (ZL)		13.4.2
			24	NOT WIRED	NOT WIRED		
HO	SIG	2T5	25	S14/2	EXP POWER BUS OFF (ZL)		13.4.2
HO	SIG	2T5	26	S14/2	EXP POWER BUS OFF (ZL)		13.4.2
			27	NOT WIRED	NOT WIRED		
HO	SIG	2T6	28	S20/8	HESE PRE-ARM A		13.4.2
HO	SIG	2T6	29	S20/8	HESE PRE-ARM B		13.4.2
			30	NOT WIRED	NOT WIRED		
HO	SIG	2T7	31	S23/11	HESE ARM A		13.4.2
HO	SIG	2T7	32	S23/11	HESE ARM B		13.4.2
			33	NOT WIRED	NOT WIRED		
HO	SIG	2T8	34	S24/12	HESE FIRE A		13.4.2
HO	SIG	2T8	35	S24/12	HESE FIRE B		13.4.2
			36	NOT WIRED	NOT WIRED		
			37	NOT WIRED	SPARE		
			38	NOT WIRED	SPARE		
			39	NOT WIRED	NOT WIRED		
HO	SIG	2T9	40	S21/9	SAC-A FIRE A		13.4.2
			41	NOT WIRED	SPARE		
HO	SIG	2T14	42	MDM-PF1 (DIL)	NOT WIRED		
HO	RTN	2T14	43	MDM-PF1 (DIL RTN)	SPARE		
HO	SIG	2T10	44	S19/7	SAC-A PRE-ARM A		13.4.2
			45	NOT WIRED	NOT WIRED		
			46	NOT WIRED	NOT WIRED		
HO	SIG	2T11	47	S15/3	SAC-A ARM A		13.4.2
			48	NOT WIRED	NOT WIRED		
			49	NOT WIRED	NOT WIRED		
HO	SIG	2T17	50	S16/4	SPARE		
			51	NOT WIRED	NOT WIRED		
HO	SIG	2T13	52	MDM-PF1 (AID)	SPARE		

TABLE 13.0.2.1.2.3-1 PIN ASSIGNMENTS FOR CONNECTOR: PORT HO (SSP SWITCHES/PF01) (CONTINUED)

EMCSS	CLASS	PIN FUNCT	CABLE	DESC	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
HO		RTN	2T13		53	MDM-PF1 (AID RTN)	SPARE		
					54	NOT WIRED	NOT WIRED		
HO		SIG	2T12		55	28 VDC (CB2/CB4)	ZL CONTIN PWR/HES IND PWR		13.4.2
HO		RTN	2T12		56	28 VDC RETURN	SPARE		13.4.2
					57	NOT WIRED	NOT WIRED		
HO		SIG	2T17		58	S18/6	SAC-A DOOR OP/CLS		13.4.2
					59	NOT WIRED	NOT WIRED		
					60	NOT WIRED	NOT WIRED		
HO		SIG	2T11		61	S15/3	SAC-A ARM B		13.4.2
HO		SIG	2T16		62	MDM-PF1 (DIL)	SPARE		
HO		RTN	SC		63	MDM-PF1 (DIL RTN)	NOT WIRED		
HO		SIG	2T15		64	MDM-PF1 (DIL)	SPARE		
HO		SIG	2T15		65	MDM-PF1 (DIL)	SPARE		
HO		SIG	2T16		66	MDM-PF1 (DIL)	NOT WIRED		
					67	NOT WIRED	SPARE		
HO		SIG	2T9		68	S21/9	SAC-A FIRE B		13.4.2
					69	NOT WIRED	NOT WIRED		
HO		SIG	2T10		70	S19/7	SAC-A PRE-ARM B		13.4.2
					71	NOT WIRED	NOT WIRED		
					72	NOT WIRED	NOT WIRED		
					73	NOT WIRED	NOT WIRED		
					74	NOT WIRED	NOT WIRED		
					75	NOT WIRED	NOT WIRED		
					76	NOT WIRED	NOT WIRED		
					77	NOT WIRED	NOT WIRED		
					78	NOT WIRED	NOT WIRED		
					79	NOT WIRED	NOT WIRED		

TABLE 13.0.3.3-1 PIN ASSIGNMENTS FOR CONNECTOR: MAIN DC POWER

STS CONN ID/SMCH ID: P40/P60/P70
STS CONN PART NO: ME414-0235-7247
P/L CONN IDENT: J002
P/L CONN PART NO: CVA0R22-22SN16
P/L CABLE NO: N/A
P/L CABLE DIA (IN): N/A

EMC CLASS	PIN FUNCT	CABLE DESC	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
HO	PWR	2T1	A	MAIN DC POWER	+28 VDC POWER		7.0.3.1.3
			B	NOT WIRED	NOT WIRED		
HO	RTN	2T1	C	MAIN DC POWER RETURN	RETURN		7.0.3.1.3
HO	GND	1SC	D	FAULT BOND	FAULT BOND		10.7.4.2

TABLE 13.0.3.3-1 PIN ASSIGNMENTS FOR CONNECTOR: MAIN DC POWER (CONCLUDED)

NOTES:

1. No safety critical circuits.

TABLE 13.0.3.3-2 PIN ASSIGNMENTS FOR CONNECTOR: MAIN DC POWER

STS CONN ID/SMCH ID: P40/P60/P70
STS CONN PART NO: ME414-0235-7247
P/L CONN IDENT: J003
P/L CONN PART NO: CVA0R22-22SN16
P/L CABLE NO: N/A
P/L CABLE DIA (IN): N/A

EMC CLASS	PIN FUNCT	CABLE DESC	PIN NO	ORBITER FUNCTION	PAYLOAD FUNCTION	NOTES	ORBITER REQUIREMENT REFERENCE
HO	PWR	2T1	A	MAIN DC POWER	+28 VDC POWER		7.0.3.1.3
			B	NOT WIRED	NOT WIRED		
HO	RTN	2T1	C	MAIN DC POWER RETURN	RETURN		7.0.3.1.3
HO	GND	1SC	D	FAULT BOND	FAULT BOND		10.7.4.2

TABLE 13.0.3.3-2 PIN ASSIGNMENTS FOR CONNECTOR: MAIN DC POWER (CONCLUDED)

NOTES:

1. No safety critical circuits.

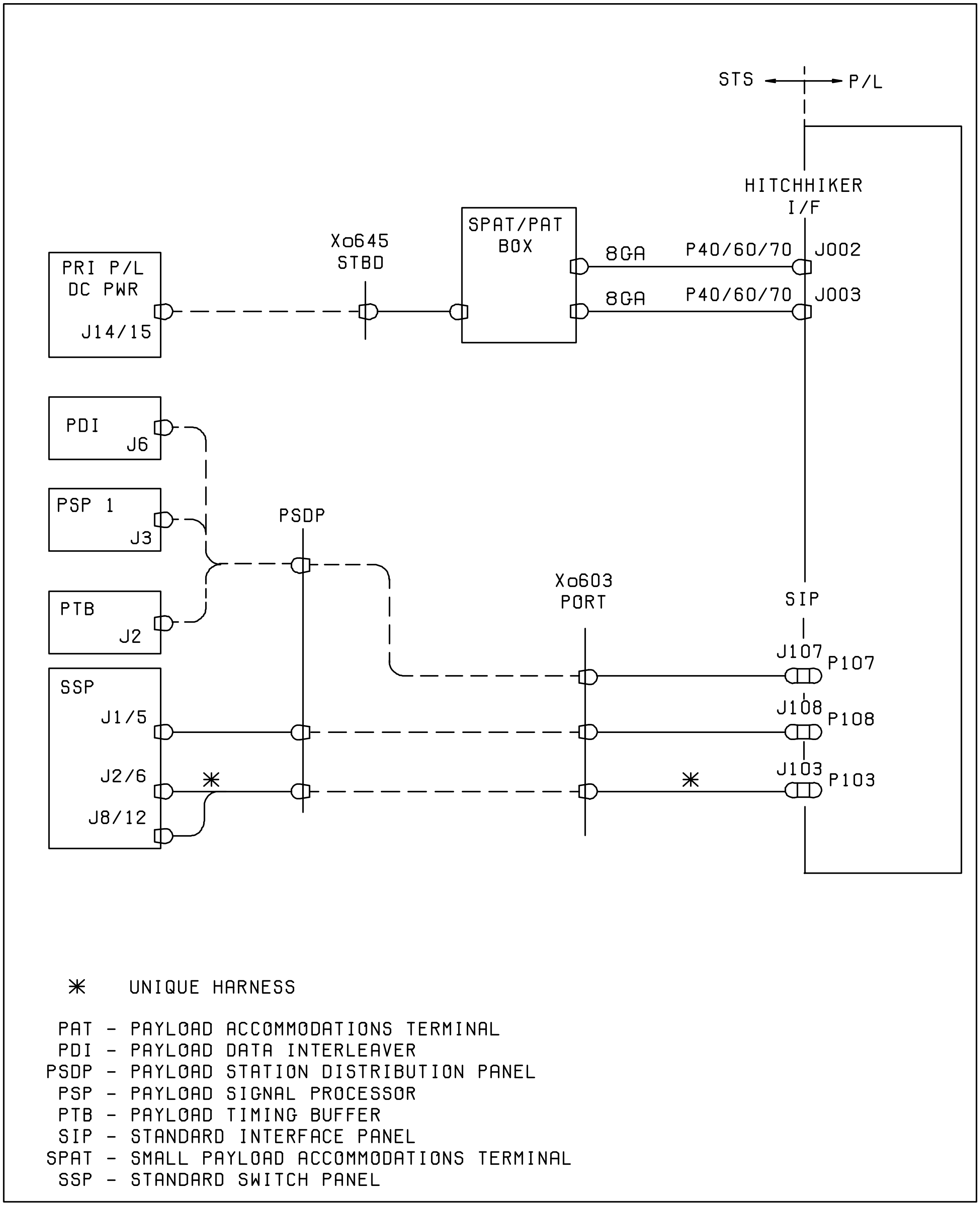


FIGURE 13.0.1.1-1 STS-TO-PAYLOAD CABLE INTERFACE DIAGRAM

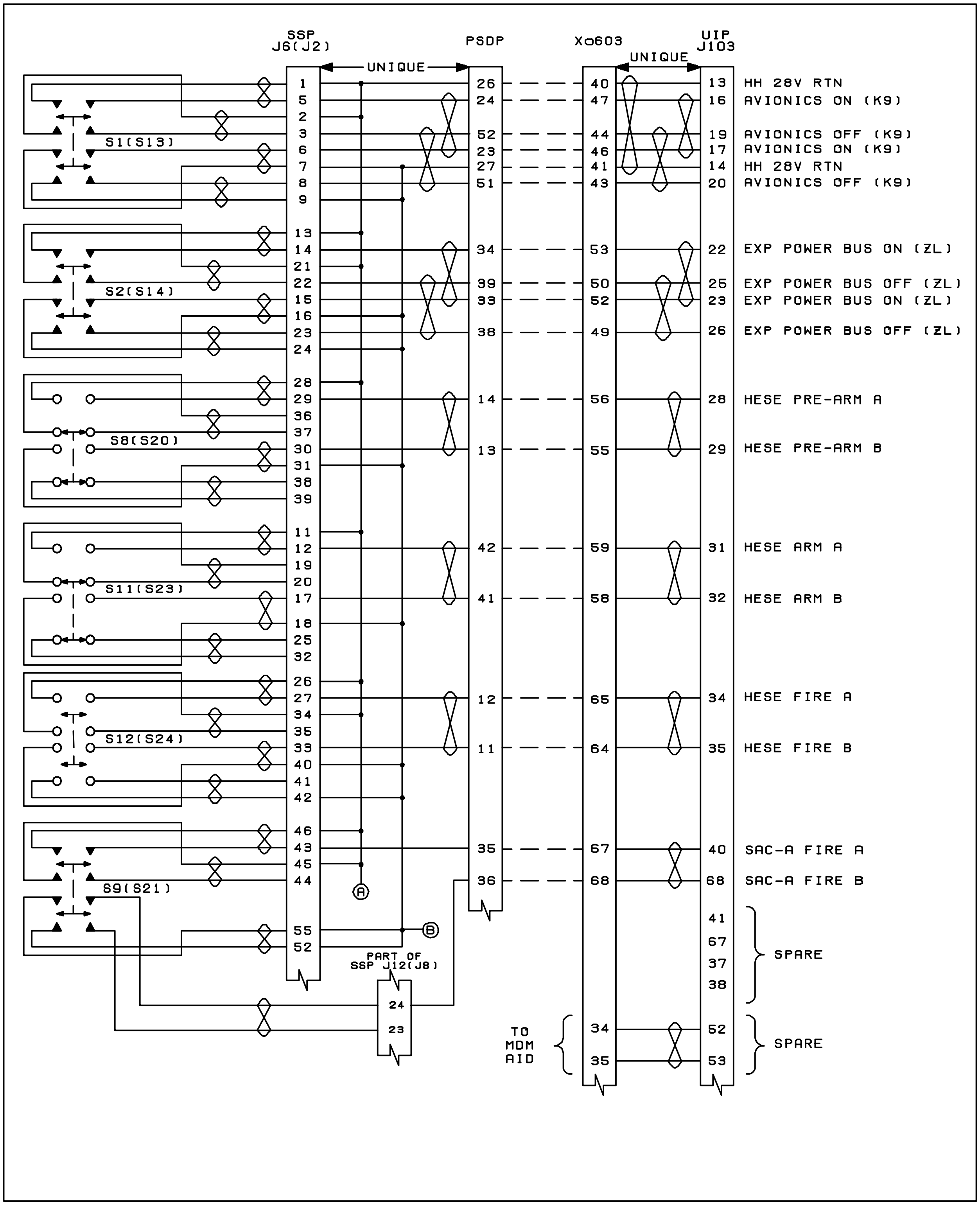


FIGURE 13.0.2.1.4-1 SSP INTERFACE SCHEMATIC
(SHEET 1 OF 2)

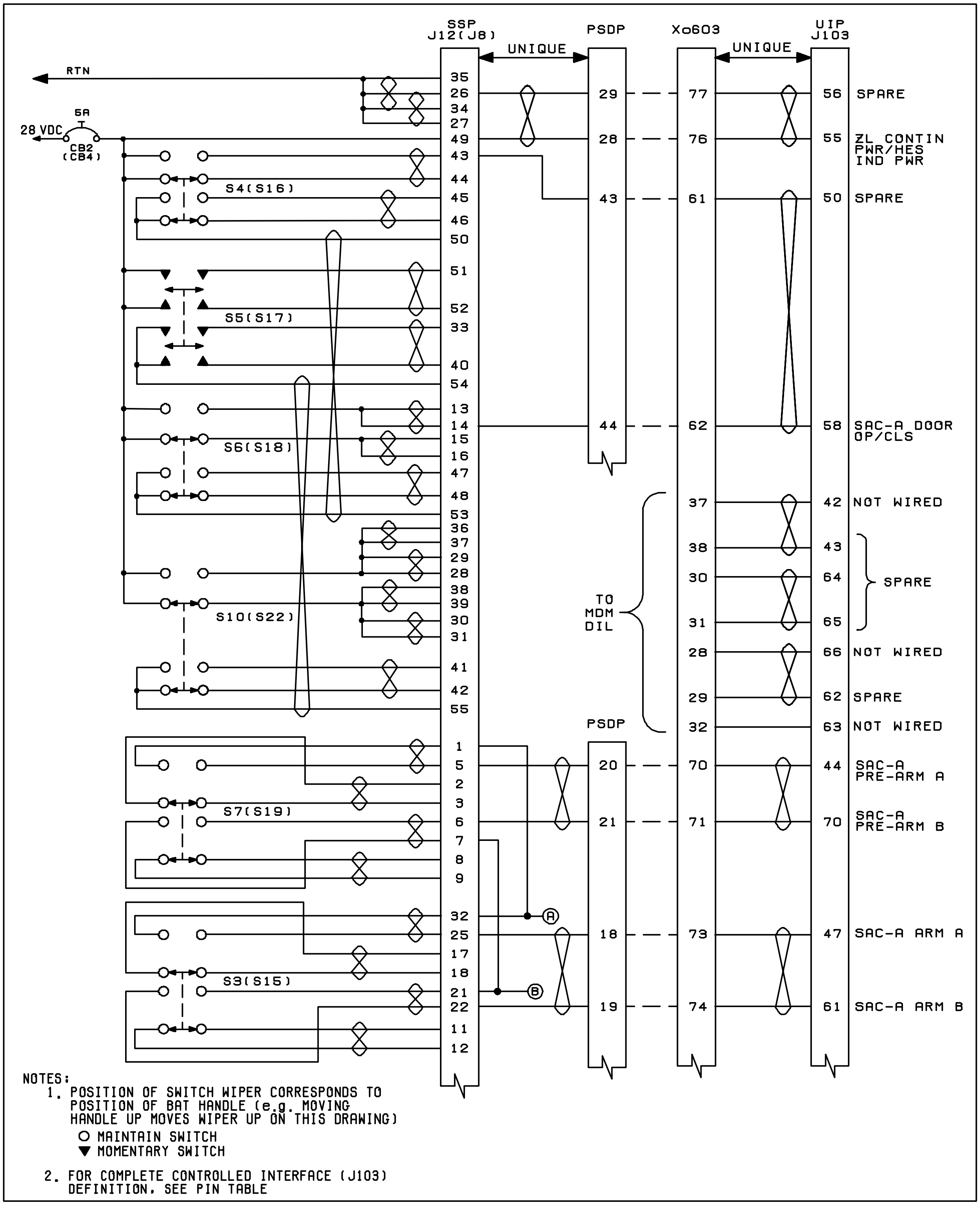


FIGURE 13.0.2.1.4-1 SSP INTERFACE SCHEMATIC
(SHEET 2 OF 2)

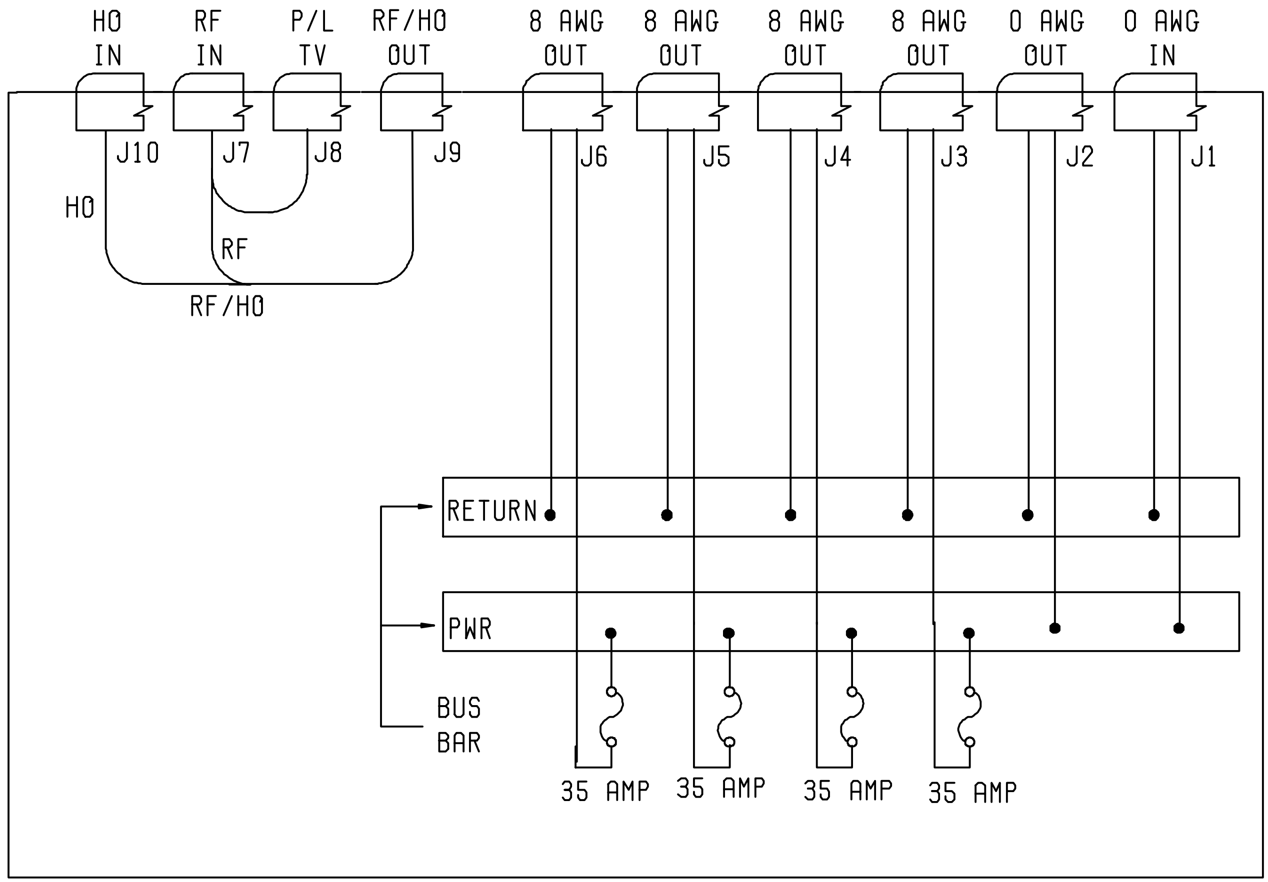


FIGURE 13.0.3.5-1 SMALL PAYLOAD ACCOMMODATION TERMINAL (SPAT) FUNCTIONAL DIAGRAM

THIS PAGE INTENTIONALLY LEFT BLANK

13.1 INTERFACE ALLOCATION

13.2 GENERAL

13.2.1 (Reserved)

13.2.2 Approved Connectors for Cargo Element Use

All cargo element electrical connectors and connector contacts that interface with the Orbiter shall be selected from the following NASA and Rockwell International specifications, as applicable.

NASA

- 40M38277
- 40M39569
- 40M38298

Rockwell International

- ME414-0234
- ME414-0235
- ME414-0610
- ME414-0611
- ME414-0612
- ME414-0247
- ME414-0250
- MC414-0614
- ME418-0031
- ME418-0032

13.2.3 (Reserved)

13.2.4 Coding Used in Tables

In the detail connector/pin assignment tables under the column headed "CABLE DESC", the following coding has been used:

```
 ------------- NO. OF WIRES COMPRISING WIRE CABLE
|    --------- TYPE OF WIRE CABLE (S = twisted,
|   |                                  shielded.
|   |                             T = twisted
|   |                             C = conductor
|   |
|   |    --- WIRE SEQUENCE IN CONNECTOR (1 or
|   |   |                                  2 digit no.)
|   |   |
X   XX  X
```

(e.g., 2S1 is the first shielded pair at the subject connector.)

13.3 (Reserved)

13.4 (Reserved)

13.5 (Reserved)

13.6 (Reserved)

THIS PAGE INTENTIONALLY LEFT BLANK

14.0 (Reserved)

14.1 (Reserved)

14.2 (Reserved)

14.3 (Reserved)

14.4 (Reserved)

14.5 (Reserved)

14.6 (Reserved)

14.7 (Reserved)

14.8 (Reserved)

14.9 (Reserved)

THIS PAGE INTENTIONALLY LEFT BLANK

20.0 WAIVERS; DEVIATIONS; AND EXCEEDANCES

20.2 FUSING CRITERIA
(Ref. Para. 7.3.1.4 and Figure 7.0.1.2-1)

Requirement: The cargo element is required to provide circuit protection in the form of fuses, resistors, or other current limiting devices on its side of the interface in order to protect cargo element and Orbiter wiring.

Exceedance The following potential violations exist (see schematic shown in Figure 7.0.1.2-1):

1. Un-insulated 20 AWG wires connected to the second brass bus bar in the relay box.

2. No fusing between the 18 AWG wire connected to the first brass bus bar before it splices into 20 AWG wires.

Rationale:

1. The lengths of the un-insulated 20 AWG wires from the bus bar # 2 to the 20 amp fuses are no greater 1/8-inch. In addition, it has been inspected to ensure it is physically separated from nearby conducting surfaces.

2. The following eight (8) insulated 20 AWG wires are routed such that they are protected from abrasion due to contact with sharp edges:
   A. The two 23-inch wire segments are used to provide power to the SPA switch panel I/F box. For all Hitchhiker (HH) missions that use the Standard Switch Panel,(SSP)(i.e. MightySat, these wires do not conduct any current. For all HH missions that use the Small Payload Accommodation Switch Panel (SPASP), these wires conduct approximately 100 milliamps.

   B. The two 8-inch wire segments are attached to the hot side of the K9 relay coil, the 16-inch wire segment is attached to the Y+ZL relay coil and the 22-inch wire segment is attached to the X+ZL relay coil.

      These wires only draw current when:
      1) The coils are pulsed from the SSP or

      2) Commanded from the SPASP via the SPA switch panel I/F box in the HH avionics unit.

   C. The two 21-inch fused wire segments are used to provide power to the HH avionics.

   D. The length of the 18 AWG (insulated) and 20 AWG wires involved are short and in a sealed aluminum box located in the cargo bay operated only while in orbit.

E. The payload provided 18 AWG and 20 AWG power circuits are not safety critical.

Authority: CR/DIR A03357

Effectivity: All MightySat missions

20.3 DC POWER GROUND REFERENCE
(Ref. Paragraph 10.7.4.3.2)

Requirement: Orbiter DC power supplied to a cargo element shall be structure referenced in the Orbiter and DC isolated from structure ground at the Cargo Element by 1 megohm except as specified in Paragraph 10.7.4.1.

Exceedance: The Hitchhiker Avionics with MightySat experiment integrated has a DC isolation of 5.0 kilohms from main DC return to structure ground.

Rationale: Isolation of at least 5.0 kilohms will be maintained. This could add noise to the MightySat payload, but it will not impose noise onto the Orbiter or other payloads. Per letter from M. Wright (NASA/GSFC), when an all-up functional test with all experiments activated was performed, all of the experiments (including the Hitchhiker Avionics) functioned normally. All Orbiter/Hitchhiker signal interface isolation requirements will be applicable.

Authority: CR/DIR A03357

Effectivity: All MightySat missions.

20.4 PDI INPUT DATA CHRARCTERISTICS - ATTACHED INTERFACE SHUTTLE STANDARD FORMAT
(Ref. Para. 8.2.1.1 and Table 8.0.1.2-1)
Requirement : Table 8.2.1.1 notes (5) and (8) require that any pattern of contiguous bit positions located in first or last word(s) of every minor frame (with exception of FAF320 Hex bit pattern) shall be used. Utilization of the last word(s) may preclude telemetry data streams processing at KSC.

Exceedance : Table 8.0.1.2-1 Note (2) requires sync pattern FAF320 in Hex to be used.

Rationale : The Orbiter Pulse Code Modulator (PCM) sync pattern id FAF320 Hex. The use of the same sync pattern by a payload could cause a false lock by ground facilities upon decommutation of the payload data stream. This occurs when re-establishing the telemetry data stream, which will cause a loss 5 minor frames(based on a payload telemetry rate of 8 kbps) of all Orbiter/payload data out of 100 minor frames/second. The lost data can be acquired during recorded playback.

Authority   : CR/DIR A03357

Effectivity : All MightySat missions.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A - ABBREVIATIONS AND ACRONYMS NOT APPLICABLE

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B - GLOSSARY NOT APPLICABLE

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E - EXTENDED DURATION ORBITER MISSIONS NOT APPLICABLE

THIS PAGE INTENTIONALLY LEFT BLANK