Space Flight Operations Contract

Shuttle Orbiter /Cargo Standard Interfaces

(CORE)

ICD-2-19001, Revision L

Prepared by Boeing North American, Inc.
Reusable Space Systems

Under Subcontract 1970483303, PDRD P1225

January 15, 1998

DRD-1.2.2.5

Contract NAS9-20000

United Space Alliance

NOTICE - WHEN GOVERNMENT DRAWINGS, SPECIFICATIONS, OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE UNITED STATES GOVERNMENT THEREBY INCURS NO RESPONSIBILITY NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON, CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE, OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 SCOPE

1.1 PURPOSE

a. Define and control the interfaces which shall be provided by the baseline Shuttle System, for total cargo use by all members of the payload units.

b. Define and control all constraints which shall be observed by all members of the payload community in using the interfaces so defined.

c. Establish commonalty with respect to analytical approaches, analytical models, technical data and definitions for integrated analyses by all interfacing parties.

1.2 ORGANIZATION OF DOCUMENT

Section 1 (Scope) and Section 2 (Applicable Documents) are standard and self-explanatory.

Section 3 (Physical Interfaces) identifies, codes and locates specifically all of the physical interfaces which are defined and controlled by this document. Included is a figure for each of the bulkheads, connector panels, stations, etc., which (1) identifies individual connectors, fittings, etc., (2) locates each dimensionally within the Shuttle Vehicle, and (3) references other paragraphs herein which provide detail performance/design data for each.

Sections 4 through 8 define, for each subsystem discipline, detail performance/design data necessary to achieve a satisfactory operational interface. When appropriate, the individual sections establish analytic methodologies for integrated analysis efforts. Where such data is voluminous (i.e., electrical connectors), some tables have been moved to the appendices in the rear of this document.

Section 9 (Software Interfaces) defines software detail performance/design data necessary to develop compatible software at the interfaces.

Section 10 (Environmental Interfaces) establishes induced environments for which the total cargo must be designed. When appropriate, it also establishes analytic methodologies for integrated analysis efforts.

Section 11 (Other Interface Constraints and Limitations) defines general constraints which must be observed in order to ensure satisfactory interface performance and design.

Section 12 (Reserved)

Section 13 defines the electrical wiring interfaces. Connector interface definitions and pin functions are given for both standard and non-standard cargo interfaces.

Section 14 defines the payload deployment and retrieval system. Detail performances and design data necessary to achieve a compatible interface are defined along with the analytical methodology involved.

Section 15 refers the user to the sections that cover mandatory requirements imposed upon payload habitable volume.

Appendix A (Abbreviations and Acronyms) and Appendix B (Glossary) are self-explanatory.

Appendix C lists the Channel Frequency Assignments for transmitting.

Appendix E describes the requirements imposed upon payloads when the Extended Duration Orbiter (EDO) pallet is manifested for flights of extended duration.

Appendices D, F through H and J through W   (Reserved)

Appendix I defines the analytical techniques and data to be used to determine the compatibility of payload-induced loads with the Orbiter static limit-load capabilities.

Appendix X defines the length selection criteria and deflection data for alternate trunnion lengths.

1.3 EFFECTIVITY

Unless otherwise specified, the interfaces defined and controlled herein are applicable to the operational configuration of the Shuttle System. The Orbiter Vehicle (OV) effectivity sequence is as follows: OV102 and Subs.

1.4 CHANGE POLICY

1.4.1 Scope

All changes to this document shall be controlled in accordance with the procedures prescribed herein and by NSTS 07700, Volume IV. Dispositioned changes shall reflect program decisions and will record new, changed, and/or deleted requirements.

1.4.2 Change Initiation

Payload community PRCB members may initiate changes following NSTS 07700, Volume IV procedures. All other payload community initiated changes shall be submitted to the Space Shuttle Systems Integration Office at the Space Shuttle Program. The Space Shuttle Systems Integration Office shall review the proposed change for technical adequacy, completeness, and validity. If the Space Shuttle Systems Integration Office review verifies that a change is required, a Change Request shall be submitted in accordance with NSTS 07700, Volume IV. All other initiators shall submit changes in accordance with NSTS 07700, Volume IV.

1.4.3 Change Processing/Disposition

A change may be processed outside the formal change procedure and approved by the PRCB Secretary when both the Space Shuttle Vehicle Engineering Office and the Space Shuttle Systems Integration Office recommend approval and there is no cost, schedule, weight, or performance impact. In this instance, the applicable change shall be coordinated with the Management Systems Office for special processing. Both the Space Shuttle Vehicle Engineering Office and the Space Shuttle Systems Integration Office shall coordinate on the PRCBD prior to authorization signature for those specially processed changes. All other changes shall be processed for review and appropiate disposition action as specified by NSTS 07700, Volume IV.

1.5 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 requirement for payloads is controlled at Level II.

Unique payload ICD's are derivatives of this ICD and do not require Orbiter Project approval if they remain 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. (e.g. 90" radius maximum dynamic envelope allows 3" radius for Orbiter deflection to remain free of potential contact).

Total Orbiter capability for payloads is divided into four sub-sections for mixed cargo flights (e.g. 1.75 kW/Element is equal to this ICD's available power of 7 kW continuous).

Any exceedance or deviation in payload capabilities or services is documented in the payload specific 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: A condition that does not comply with stated requirements but does not add risk to intended usage or configuration and can be shown acceptable without special analysis or controls.

Deviation: A condition that does not comply with stated requirements but does not add risk to intended usage or configuration and can be shown acceptable through additional analysis or controls.

Waiver: A condition that does not comply with stated requirements and could add risk to safety of crew and Orbiter. Requires additional analysis and could require special controls, such as flight rules changes, to assure adequate flight margins

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.

Federal

FED-STD-H28/21B Notice 2 February 8, 1995	Screw Threads, Standard for Federal Services Section 21 Metric Screw Threads (Ref. Fig. 3.3.1.4.1-2)
FED-STD-595B December 14, 1989	Federal Standard Colors (Ref. Fig. 3.4.1.2.1-1, 14.4.6-1)
SPEC-QQ-C-320B-AM1 Class 2 April 1, 1981	Chromium Plating (Electro-Deposited) (Ref. Fig. 3.3.1.2.2.2-1, 3.3.1.2.1-1, 3.3.1.3.1-1, 3.3.1.3.2-1)

Military

MIL-C-5541E Amendment 2 November 30, 1972	Chemical Conversion Coatings on Aluminum and Aluminum Alloys (Ref Para. 10.7.4.2)
MIL-S-7742D Amendment 1 September 2, 1992	Screw Threads, Standard, Optimum Selected Series, General Specification for (Ref. Fig. 3.3.1.4.1-2)
MIL-STD-189 Notice 2 March 14, 1961	Racks, Electrical Equipment, 19 Inch and Associated Panels (Ref. Fig. 3.4.1.1.1-2)
MIL-STD-1572 May 17, 1976	Telemetry Standards (Ref. Para. 8.2.2.5, 8.2.12.1, Table 8.2.12-2, 8.2.2.5.13-2, 8.2.2.5.13-3)
MIL-W-5088L Amendment 1 July 20, 1979	Wiring Aerospace Vehicle (Ref. Para. 3.3.2.2.1)

NASA (National Aeronautics and Space Administration)

ES3-76-1E MAY 1991	Orbiter Midsection/Payload Bay Thermal Math Model Description (Ref. Para. 6.1.2.1)
ES3-77-3E May 1991	"390 Node" Atmospheric Orbiter Midsection/Payload Bay Thermal Math Model Description (Ref. Para. 6.1.2.1)
ES3-76-7D June 1995	Simplified "136 Node" On-Orbit Orbiter Midsection/ Payload Bay Thermal Math Model Description (Ref. Para. 6.1.2.1)
ES3-77-1D June 1995	Simplified "136 Node" Atmospheric Orbiter Midsection/Payload Bay Thermal Math Model Description (Ref. Para. 6.1.2.1)

JSC 27831 April 1997	JSC Frequency Management Measurement Stimuli (Ref. Para. 10.7.3.2.2.2.1.4)
MSFC Handbook 527F/JSC-09604F September 30, 1988	Material Selection List for Space Hardware System (Ref. Para. 10.11.1.1)
NSTS-SE-S-0073 Current Issue	Specification, Space Shuttle Fluid Procurement and Use Control (Ref. Para. 5.8, 6.2.2.2)
NSTS 21000-A04 Current Issue	Standard Integration Plan Annex No. 4 Command and Data Requirements (Ref. Tab. 8.2.1.1-1)
NSTS 37330	Bonding, Electrical and Lightning Specifications (Ref. Para. 10.7.4.2, 10.7.4.2.1, 10.7.4.2.2.2, 10.7.4.2.2.3, 10.7.4.2.2.4, 10.7.4.2.3.5) (Note: for bonding implementation on STS refer to specification MA0113-306, latest revision)
NSTS-08060 Rev. D January 28, 1983	Space Shuttle System Pyrotechnic Specification (Ref. Para. 10.7.4.1.2.1.3)
NSTS-08080-1 January 14, 1994	Acoustic Noise Criteria (Ref. Para. 4.2.2, 7.7.1)
NSTS 16007 Rev. E	Launch Commit Criteria (Ref. Figure 7.3.2.1-1)
NSTS 14046 Rev. E March 3, 2000	Payload Verification Requirements (Ref. Para. 4.1.7.3)
NSTS 1700.7B Changes 1 through 6, July 28, 1999	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-37329 Rev. B Change 3 October 18, 2004	Structural Integration Analyses Responsibility Definition for Space Shuttle Vehicle and Cargo Element Developers (Ref. Para. 4.1.7.4)
NSTS-18798 Rev. B Changes 1 through 4 Oct. 27, 1999	Interpretations of NSTS Payload Safety Requirements (Ref. Para. 7.3.1.4)
SN-C-0005 Rev. C February 15, 1989	National Space Transportation System Specification, Contamination Control Requirements (Ref. Para. 10.6.2.4, 10.6.2.1.1, 10.11.1.2.1)
SP-R-0022 Rev. A Amendment 2 February 24, 1984	Vacuum Stability Requirements of Polymeric Material for Spacecraft Applications, Specifications for (Ref. Para. 10.6.2.2)
40M38277B May 15, 1979	Connectors, Electrical, Circular Miniature High Density Environment Resisting, Specifications for (Ref. Para. 13.2.2, Fig. 3.3.3.1-1, 3.3.3.1-2 3.4.1.4.6.1-1, 3.4.1.4.6.2-2, 3.4.1.4.6.4-1, 3.4.1.4.6.4-2)
40M38298B Notice 6 March 15,1979	Specification, Connector, Electrical, Special Miniature Circular Environment Resisting 200°C (Ref. Para. 13.2.2)

40M39569E May 30, 1983	Connectors, Electrical Miniature Circular, Environment Resisting 200°C, Specification for (Ref. Para. 13.2.2, Fig. 3.3.3-3, 3.3.3-4,3.4.1.2.2-1, 3.4.1.3.2-2, 3.4.1.1.2-1, 3.4.1.4.6.2-1, 3.4.1.4.6.2-2, 3.4.1.4.6.4-2)
NASA STD 5001 June 21, 1996	Structural Design and Test Factors of Safety for Spaceflight Hardware (Ref. Para. 4.1.3.6)
NASA STD 5003 Oct. 7, 1996	Fracture Control Requirements for Payloads Using the Space Shuttle (Ref. Para. 4.1.3.7)
NSTS-07700 Volume XIV	System Description and Design Data (Ref. Para. 3.2.1.5.1)
NSTS-07636 Rev. G April 15, 94	Space Shuttle Lightning Protection, Test and Analysis Requirements

Industry

ANSI Z136.1-1993 February 5, 1993	American National Standard for Safe Use of Lasers (Ref. Para. 10.7.2.3.3)
EIA-STD-RS170 November 1957	Electrical Performance Standard – Monochrome TV Studio Facilities, (Ref. Para. 8.2.8-1, Table 8.2.8.1-1, Table 8.2.8.1-2, Fig. 8.2.8.2-1)
EIA-STD-RS240 Appendix A Current Issue	Electrical Performances Standard for Television Broadcast Transmitters (Ref. Para. 8.2.8.2-1)
EIA-STD-RS330 March 1968	Electrical Performance Standard for Closed Circuit TV Camera 525/60 Interlaced 2:1, (Ref. Para. 8.2.8.1)
SPAR-SG.459/010	Connectors, Electrical, Rectangular Type, Rack to Panel, Environment Resisting, 200RC (Ref. Fig. 14.4.4-1)
SPAR-51140D1897	Connector, Plug-Mod. End Effector (Ref. Fig. 14.4.4-1)
SMD-91-2104 August 6, 1991	Lockheed Engineering & Sciences Company, "Ferry Flight Loads Environment for Returnable Payloads" (Ref. Para. 4.1.11)

Boeing

MAO1O8-307,B July 14, 1977	Corrosion Preventive Finish for Electrical Bonding (Ref. Fig. 3.3.8-1)
MA0109-318C October 6, 1990	Chromium Plating (Electro-Deposited) on Titanium and Titanium Alloys (Ref. Fig. 3.3.1.2.1-1, 3.3.1.2.2.2-1, 3.3.1.3.1-1, 3.3.1.3.2-1)
MA0110-301G Amendment H01 October 28, 1985	Product Cleanliness (Ref. Para. 3.3.4.2)

MBO150-051D September 21, 1977	Cable, Electrical, Two Conductor, Shielded and Jacketed, Special Purpose (Ref. Para. 8.2.2.5.12)
MC276-0045A Amendment B02 May 1, 1989	Payload Fluid Disconnect (Ref. Fig. 3.3.5.2.1-1)
MC409-0019A Amendment 6 May 27, 1977	Amplifier, Data Bus Isolation (Ref. Para. 8.2.12)
MC409-0020A Amendment A01 June 27, 1977	Coupler, Data Bus (Ref. Para. 8.2.12)
MC414-0614A Amendment BO6 April 16, 1975	Specification, Connector RF, SMA Series (Ref. Para. 13.2.2)
MC432-0222C August 18, 1975	Specification, Event Indicator (Ref. Para. 13.4.2)
MC454-0026B June 17, 1977	Circuit Protection and Characteristics, Specification, Circuit Breaker, Thermal (Ref. Para. 13.4.2)
MC615-0010B June 17, 1977	Adapter, Interface, Serial Multiplexer (Ref. Para. 8.2.12)
MC999-0096D October 4, 1974	Materials and Processes Control and Verification System for Space Shuttle Program: Suppliers & Subcontractors (Ref. Para. 10.11.1.1)
ME414-0234P Amendment R07 February 12, 1974	Specification, Connector, Receptacle, Electric Wall Mounting (Ref. Para. 13.2.2)
ME414-0235R Amendment S08 February 2, 1974	Specification, Connector, Plug, Electric Straight (Ref. Para. 13.2.2)
ME414-0247W Amendment Y07 February 12, 1974	Specification, Connector, TNC Bulkhead Cable Jack (Ref. Para. 13.2.2)
ME414-0250Y Amendment Z08 February 12, 1974	Specification, Connector, TNC Cable Plug (Ref. Para. 13.2.2)
ME414-0610 Amendment A03 July 30, 1974	Specification, Cable Adapter, Connector Plug, Electric (Ref. Para. 13.2.2)
ME414-0611 Amendment A05 July 30, 1974	Specification, Connector, Hermetic Jam Nut, Electric (Ref. Para. 13.2.2)
ME414-0612 July 30, 1974	Specification, Connector, Hermetic Flange Mount, Electric (Ref. Para. 13.2.2)

ME414-0630D Amendment E07 May 18, 1994	Specification, Connector, Adapter (Ref. Table 13.5.1-1)
ME418-0031F Amendment G04 March 22, 1974	Specification, Contact, Socket Crimp, Clip Retained (Ref. Para. 13.2.2)
ME418-0032F Amendment G03 March 22, 1974	Specification, Contact, Pin Crimp, Clip Retained (Ref. Para. 13.2.2)
ME451-0018B February 26, 1991	Circuit Protection and Characteristics, Fuse - Subminiature Plug In (Ref. Para. 13.4.2)
ME452-0093K November 2, 1976	Specification, Rotary Switch (Ref. Para. 13.4.3.2)
ME452-0102K May 2, 1984	Specification, Toggle Switch (Ref. Para. 13.4.2, 13.4.3.2)
MP572-0279-002F August 14, 1974	Cable Electrical, Shielded and Jacketed, Special Purpose (Ref. Para. 8.2.12, 8.2.12.2)
MP572-0304-002 December 8, 1975	Wire and Cable, Electrical, Polyimide Insulated, Copper or Copper Allow (Ref. Para. 8.2.12)
MP572-0311-003 December 8, 1975	Cable Electrical, Shielded and Jacketed, Special Purpose (Ref. Table 8.2.2.4-1, 8.2.7.1-1, 8.2.7.1-2, 8.2.7.2-1, 8.2.9.5-1)
MP572-0328-0002C December 8, 1975	Wire and Cable, Electrical, Polyimide Insulated, Copper or Copper Allow (Ref. Table 8.2.1.3.1-1, 8.2.1.3.2-1, 8.2.2.5.13-1, 8.2.3.1.3-1, 8.2.3.2.3-1, 8.2.4.2-1, 8.2.4.3-1, 8.2.4.4-1, 8.2.4.5-1, 8.2.4.5-2, 8.2.5.1-1, 8.2.6.1-1, 8.2.6.2-1, 8.2.6.3-1, 8.2.8.1-1, 8.2.8.1-2 8.2.10.1.3-1, 8.2.10.2.2-1, 8.2.10.2.3-1, 8.2.10.2.4-1, 8.2.10.2.5-1, Para. 8.2.2.5.12)
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 Table E.1.2-1)

2.2 REFERENCE DOCUMENTS

2.2.1 Cargo Ground Interfaces

The Orbiter/cargo ground interface requirements are defined and controlled by the following ICD's:

ICD-2-00003	Flight Vehicle/LPS Computational System Interfaces
ICD-2-1A001	Orbiter/Landing Station
ICD-2-1A002	Orbiter/Processing Facility
ICD-2-0A001	Shuttle System/VAB and MLP

ICD-2-0A002	Shuttle System/Launch Pad and MLP
ICD-2-1D003	Orbiter/Secondary Landing Station Interfaces
ICD 2-14001	Orbiter Vehicle/Solid Rocket Booster (Ref. Para. 7.1.1.1)

2.2.2 Middeck Accommodations

Interface provisions for payloads in the middeck area of the crew compartment are controlled by the following document:

NSTS-21000-IDD-MDK Rev A (Current Issue)	Middeck Interface Definitions Document (Ref. Para. 7.1.1, 7.1.1.2)

2.2.3 Sidewall Accommodations

Interface provisions for payloads that utilizes cargo bay sidewall carriers are controlled by the following document:

NSTS 21000-IDD-SML Rev. C Changes 1 through 4 June, 2000	Shuttle Orbiter/Small Payload Accommodation Interfaces

THIS PAGE INTENTIONALLY LEFT BLANK.

3.0 PHYSICAL INTERFACES

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 Payload

The payload coordinate system shall be in conformance with Figure 3.1.1.2-1.

3.1.1.3 Instrument Pointing

The instrument pointing coordinate system shall be in conformance with Figure 3.1.1.3-1.

3.1.1.4 Orbiter Dynamic Body Coordinate System

The Orbiter Dynamic Body Coordinate System is shown in Figure 3.1.1.4-1.

3.1.1.5 Orbiter Navigation System

3.1.1.5.1 Mean Versus True Systems

The line of intersection of the ecliptic plane (the instantaneous plane of motion of the Earth and Sun) and the celestial equator (mean Earth equator) precesses among the fixed stars with a rate of one revolution in 26,000 years. Additionally, the Earth wobbles slightly on its axis, relative to its mean position, with periods of oscillations of only a few years. The former phenomenon is called precession; the latter is called nutation. A mean system conveys the concept that precession is included when relating that system to another system at a different time, but the nutation phenomenon is not included. A true system, however, conveys the concept that a mean system at any specific instant of time is converted to a true system at the same instant of time by including terms associated with the nutation phenomenon. The coordinate systems are defined below.

3.1.1.5.2 Orbiter GN and C Data (GTOD)

The origin of the GTOD (Greenwich True Of Date) coordinate system is the center of the earth. The Z-axis is directed along the earth's true-of-date rotational axis and is positive toward the north. The X-axis lies in the plane of the earth's true-of-date equator, and its positive direction is toward the prime meridian. The Y-axis completes a right handed system as shown in Figure 3.1.1.5.2-1.

The ordered transformation from GTOD to the Orbiter body is a right handed rotation about the positive GTOD Y-axis (pitch), right handed rotation about the intermediate positive Z-axis (yaw), and a right handed rotation about the positive Orbiter X-axis (roll). A right hand rotation is defined by placing the right hand thumb along the axis of rotation with the fingers curling in the direction of rotation.

Orbiter rotation rates are represented by instantaneous, right-handed rotations about the positive Orbiter Y, Z, and X axis, respectively. These rates represent the instantaneous body fixed rates, and are not the derivatives of the Euler Angles.

3.1.1.5.3 Orbiter GN and C Data (Aries M50)

The origin of the Aries M50 (mean of 1950) coordinate system is the center of the earth. The Z-axis is directed along the earth's mean rotational axis of epoch (the epoch is the beginning of Besselian year 1950) and is positive toward the north. Its positive X-axis is directed toward the mean vernal equinox of epoch. The Y-axis completes a right-handed system as shown in Figure 3.1.1.5.3-1.

Orbiter rotation rates are represented by instantaneous, right-handed rotations about the positive Orbiter Y, Z, and X axis, respectively. These rates represent the instantaneous body fixed rates, and are not the derivatives of the Euler Angles.

The order of parameters within vectors transmitted to payloads is X, Y, Z for position and velocity vectors; and pitch, yaw, and roll for attitude; and Y, Z, and X for body rates.

3.1.1.6 (Deleted)

3.1.2 Limit Envelopes for Cargo-Chargeable Items

3.1.2.1 Cargo Bay

3.1.2.1.1 Cargo Element Thermal and Dynamic Envelope

a. Payload Bay Configuration without Airlock. A 15 foot diameter (4.572 m) and 60 foot long (Xo582 to Xo1302), payload envelope shall be provided in the Orbiter payload bay for cargo installation.

b. Payload Bay Configuration with ISSA Configured External Airlock. A 15 foot diameter (4.572 m) and 49.83 foot long (Xo704 to Xo1302), payload envelope shall be provided in the Orbiter payload bay for cargo installation.

The centerline of these envelopes is located at Yo 0.0 and Zo 400.0. During flight events, this cargo envelope distorts due to Orbiter thermal and dynamic loads. The resulting payload envelope is a 15 foot diameter circle at each Orbiter Xo Station with the center of the circular envelope located at the distorted Orbiter centerline. The distorted Orbiter centerline is defined by displacing the undistorted centerline by the average motion of the right and left Orbiter longerons for each Xo Station. The effects of cargo element manufacturing and installation tolerances shall be included when calculating payload clearance losses with respect to the cargo envelope. Cargo element static(87-inch radius), thermal and dynamic deflections and all payload attach soft structures (i.e. blanket and cloth hand holds/straps, etc.) except the payload attach trunnions shall be contained within this envelope. All cargo element attach blankets and hand holds/straps near the 90-inch thermal and dynamic envelope shall be restrained. Cargo element attachment trunnions mating with the Orbiter attachment fittings and GSE handling trunnions may extend beyond the payload 90 inch thermal and dynamic envelope as shown in Figure 3.3.1.2.1-1 (Non-deployable cargo elements) and Figure 3.3.1.2.2.2-1 (Deployable cargo elements). Umbilicals required to interface the cargo element to the Orbiter or to GSE while the payload is in the cargo bay may also penetrate the envelope.

Compliance with the 15 foot diameter envelope ensures compatibility with KSC ground handling equipment including the payload ground transport canister (reference 79K12170). Payloads manifested with Extended Duration Mission (EDO) pallets shall refer to Appendix E for constraints on payload thermal and dynamic envelope.

3.1.2.1.2 Cargo Bay Clearance

The Orbiter shall provide clearance between the cargo element thermal and dynamic envelope defined in Paragraph 3.1.2.1.1 and the Orbiter vehicle structure and subsystems, except for penetrations defined in Paragraph 3.1.2.1.4. Payloads are constrained to inside the cargo element thermal and dynamic envelope when subjected to the induced environment during the complete flight, beginning with payload installation and ending with payload deployment or removal. Cargo elements shall comply with both the following clearance requirements.

A static clearance of three inches shall be provided between the attached cargo elements and the orbiter structure, including penetrations defined in Paragraph 3.1.2.1.4 and mission kits, when installed.

A minimum dynamic clearance of one inch shall be maintained throughout all flight events between the latched cargo elements and the Orbiter structure, including penetrations defined in Paragraph 3.1.2.1.4 and mission kits, per NSTS 37329.

3.1.2.1.3 On-Orbit Payload Positioning Envelope

The deployment/retrieval envelope (for removing and installing payloads on-orbit) shall be that created by the payload thermal and dynamic envelope being extended in the +Zo direction until the payload 15 feet thermal and dynamic envelope diameter is clear of the Orbiter longeron and the 60 feet thermal and dynamic envelope length is clear of the Orbiter cargo bay forward and aft bulkheads. Lateral and longitudinal movement of the payloads during deployment/ retrieval operations shall be controlled to avoid localized Orbiter structure and subsystems as shown on Figure 3.1.2.1.3-1.

Payloads manifested with Extended Duration Mission (EDO) pallets shall refer to Appendix E for constraints on payload thermal and dynamic envelope.

3.1.2.1.4 Cargo Bay Protuberances

Orbiter protuberances into the cargo thermal and dynamic envelope may occur as a result of Orbiter mission and/or cargo elements requirements. Payloads must consider and avoid interference between these protuberances and the cargo element. Potential protuberances are shown in Figure 3.1.2.1.4-1 for the Forward Bulkhead (Xo576); Figure 3.1.2.1.4-2 for the Aft Bulkhead (Xo1307); Figure 3.1.2.1.4-3 for the Keel Bridge; Figure 3.1.2.1.4-4 for the RMS Elbow Camera; and Figure 3.1.2.1.4-5 for payload bay door centerline latches and radiator intrusions. Additional protuberances are also defined in Figures 3.3.2-1 and 3.3.5.2.1-1. The cargo element shall provide the minimum clearance as specified in Paragraph 3.1.2.1.2 between cargo element hardware and each of the identified Orbiter protuberances.

3.1.2.1.4.1 Cargo Bay Liner

The cargo bay liner is another potential interference with large diameter cargo elements. The cargo bay liner is installed across and attached to the

Orbiter structural frames, conforming to the internal mold lines of the lower cargo bay clearance area approximately from longeron to longeron except where cable trays and cargo attach hardware are located. The liner is attached to the lower side of the longerons at Zo 406 between all structural frames except between Xo 576 to Xo 582, where the upper limits extend to Zo 419. During Orbiter ascent and/or descent the cargo bay liner could penetrate the cargo bay envelope and contact the large diameter cargo element with a pressure of less than 0.1 psi. The pressure differential acting across the liner causes a billowing of the liner to a radius of 87.5 inches from the cargo bay centerline. When required, local special hardware can be provided by the Orbiter to preclude the liner from violating the cargo 90" radius envelope.

3.1.2.1.5 Limit Envelopes for EVA and for Cargo Bay Kits

3.1.2.1.5.1 EVA Envelopes

Envelopes shall be provided within the cargo bay for EVA activities, as required. Cargo elements may be installed within volumes required for EVA but shall be deployed, RMS removed or jettisoned prior to EVA utilization. The forward limit for payload is Xo725.00 (with the external airlock) or Xo632.55 (without external airlock). The following EVA envelopes shall apply:

a. Airlock Ingress/Egress. A 40-inch minimum clearance envelope shall be kept free of obstruction from the external airlock open hatch (aft end, Xo685 through Xo725) at all times.

   Airlock Ingress/Egress. Without external airlock, the first 48 inches aft of EVA boom Xo584.55 shall be clear of cargo elements during EVA access and operation.

b. Translation to Worksites. A 43-inch diameter translation envelope to all EVA worksites in the payload bay with cargo elements installed.

c. Work Envelope. A 48-inch work envelope around elements requiring EVA access for actuation/removal.

d. EVA Glove Clearance. An 8-inch diameter cylinder for gloved hand access to EVA worksites per NSTS 07700, Volume XIV, Appendix 7, paragraph 2.7.

e. Other EVA Criteria. Sharp edge criteria (Reference Para. 11.3), touch temperature limits, and working volume requirements in general shall be in accordance with NSTS 07700, Volume XIV, Appendix 7.

The cargo element shall provide the minimum clearance as specified in Paragraph 3.1.2.1.2 between cargo element hardware and each of the identified Orbiter protuberances.

3.1.2.1.5.2 MMU/CBSA Limit Envelopes

The limit envelopes for the Manned Maneuvering Unit (MMU) and Cargo Bay Stowage Assembly (CBSA) at the sides of the cargo bay, when required, shall be defined as follows:

Xo 582.00 to 636.00

Yo Outboard of Yo 40.00 and Yo -40.00

Zo 341.00 to 414.00

The volumes above these limit envelopes shall be clear of cargo elements during EVA ingress/egress with the MMU/CBSA.

3.1.2.1.5.3 On-Orbit Berthing Provisions

Payloads manifested on flights that involve on-orbit berthing with another vehicle are restricted to locations aft of Xo 725.00 in the cargo bay.

3.1.2.1.5.4 Airlock/Tunnel Adapter

The limit envelope for the airlock/tunnel adapter shall be as shown in Figure 3.1.2.1.5.4-1.

3.1.2.1.5.5 (Deleted)

3.1.2.1.5.6 Overhead Docking Floodlight

The limit envelope for the overhead docking floodlight, when installed, shall be defined as follows:

Xo 581.5 to 586.5

Yo -3 to 3

Zo 486 to 491

3.1.3 Visual Interfaces

3.1.3.1 Lateral Field of View

With the cargo bay doors and radiators open, the Orbiter shall provide a 180 degree lateral field of view for any point along the line Yo=0, Zo=429.5 between Xo=582 and Xo=1302 without such mechanisms as the RMS, rendezvous sensor, payload retention guides or other orbiter hardware 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).

3.1.3.4 Crew Compartment Windows

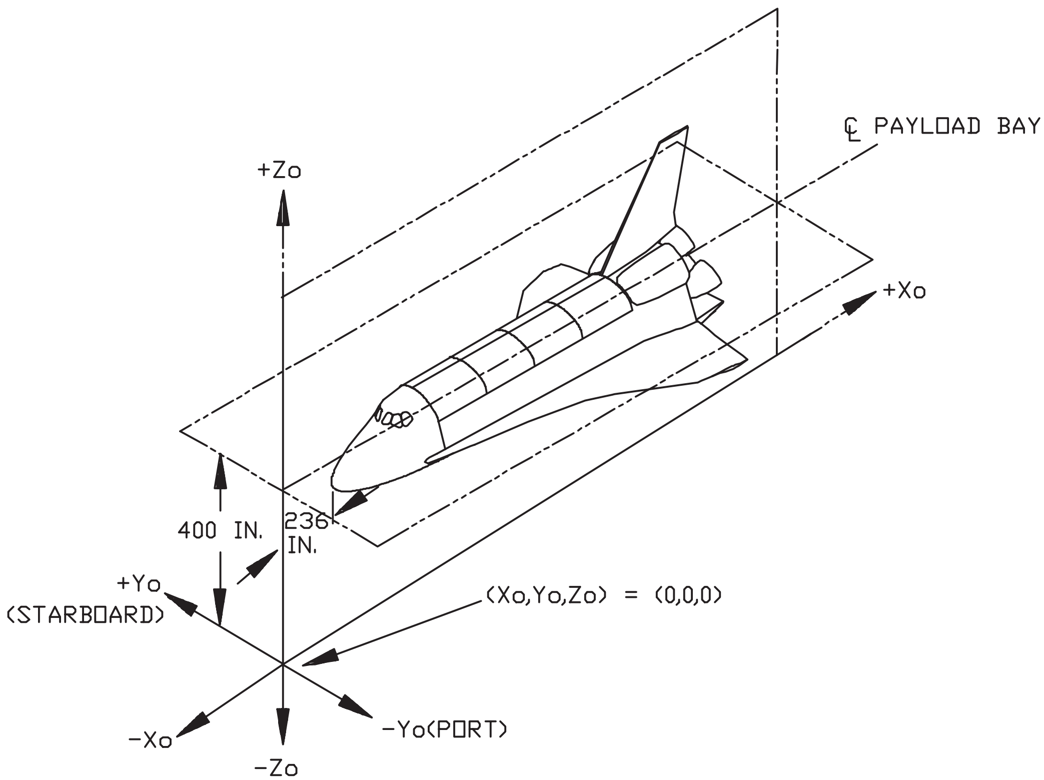
The Orbiter crew compartment windows are located as shown in Figure 3.1.3.4-1.

3.1.3.5 Keel Camera Target for Deployable Cargo Elements

The requirement for a Keel Camera Target is evaluated on a mission specific basis.

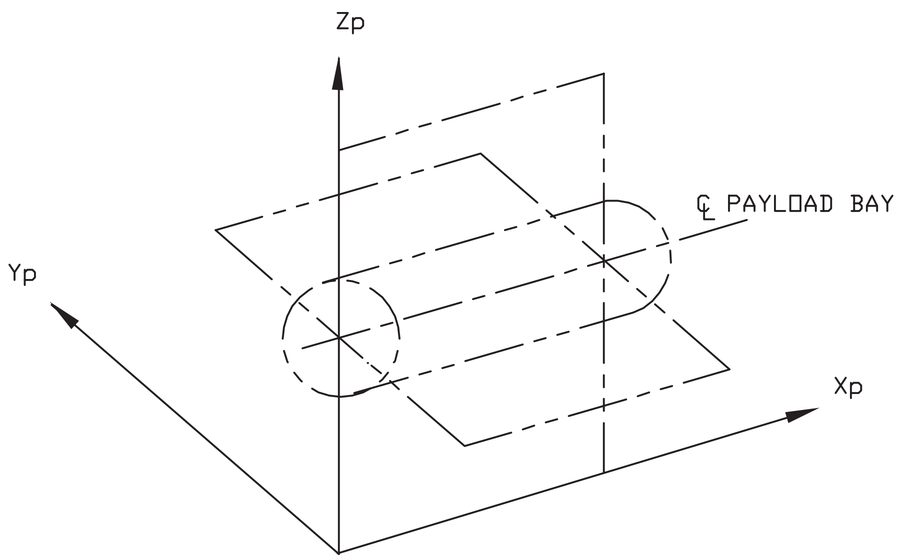
3.1.3.5.1 Keel Camera Target Requirements

The cargo element keel camera target shall be mounted above the Orbiter keel camera without posing potential contact. The keel camera target shall be oriented with its target rod tip pointing to the –Zo axis and must be in-line with the keel camera lens for alignment viewing through closed circuit TV. The keel camera target shall be placed in conformance with paragraph 14.5 and shall conform to the dimensional parameters & clocking as shown in Figure 3.1.3.5-1. Target orientation and visibility adequacy are reviewed in preparation during specific Flight Operation Review planning.



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



TYPE: ROTATING, PAYLOAD REFERENCED

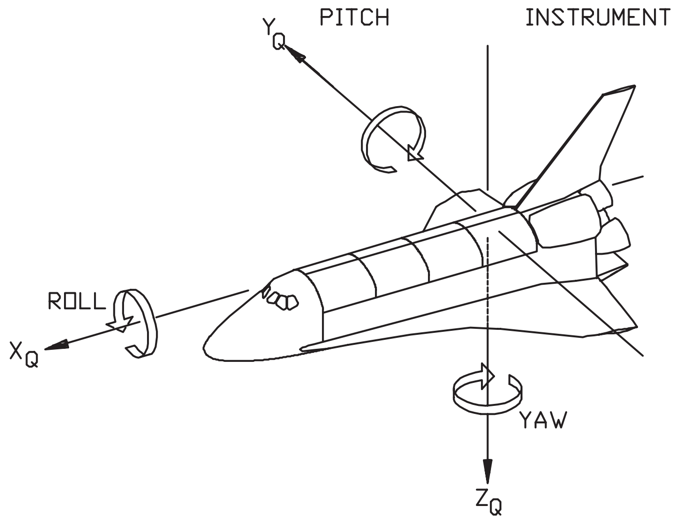
ORIENTATION AND LABELING: Xp AXIS IS NEGATIVE IN THE DIRECTION OF LAUNCH, PARALLEL TO THE ORBITER PAYLOAD BAY CENTERLINE.

Zp AXIS IS POSITIVE UPWARD IN THE ORBITER LANDED POSITION, PARALLEL TO ORBITER Z AXIS.

Yp AXIS COMPLETES THE RIGHT-HANDED SYSTEM.

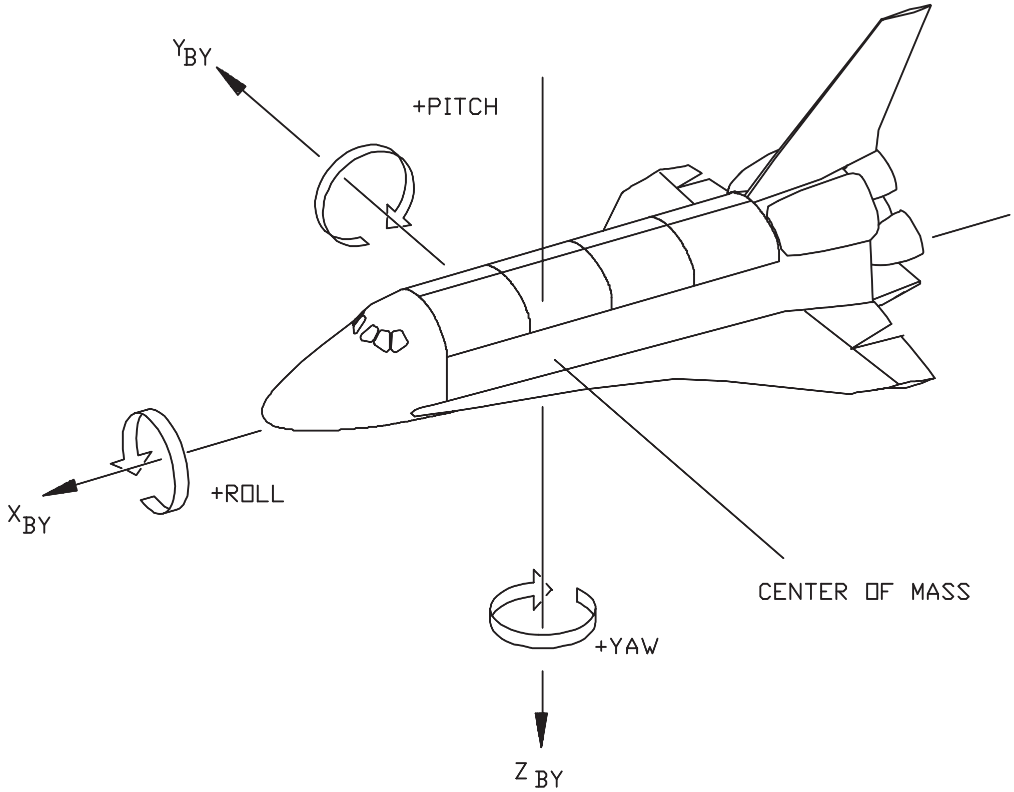
THE STANDARD COORDINATE DESIGNATION IS p (E.G., Xp, Yp, Zp).

FIGURE 3.1.1.2-1 PAYLOAD COORDINATE SYSTEM



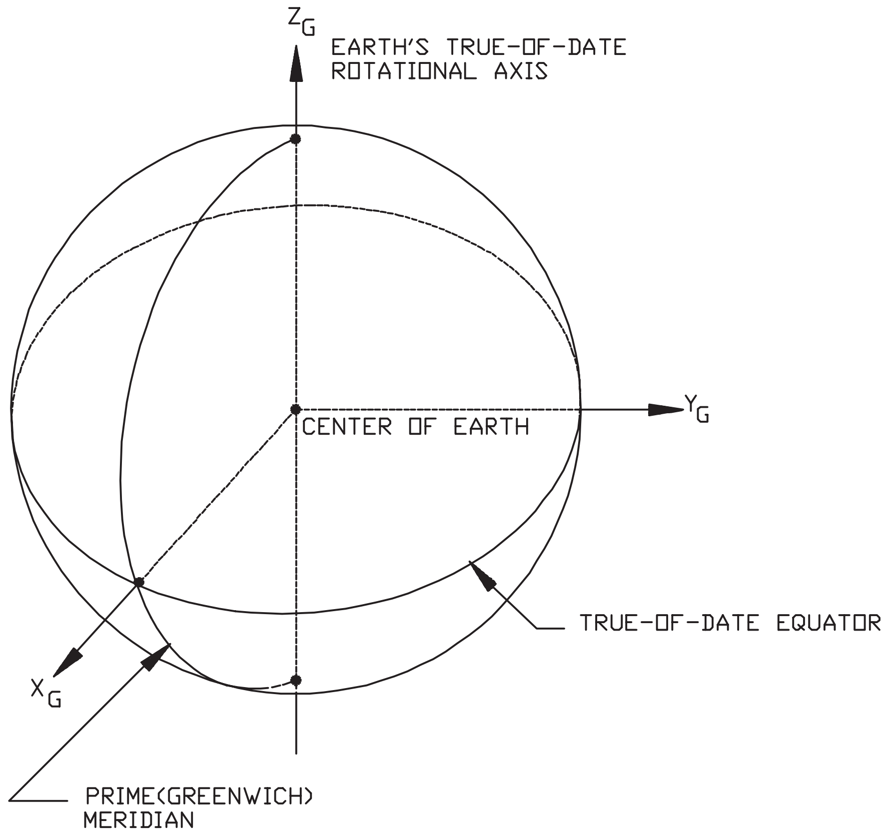
ORIGIN:	INSTRUMENT CENTER OF ROTATION.
ORIENTATION AND LABELING:	THE X_Q AXIS IS PARALLEL TO THE CENTERLINE OF THE CARGO BAY, POSITIVE IN THE DIRECTION OF THE NOSE OF THE ORBITER. THE Z_Q AXIS LIES IN A PLANE PARALLEL TO THE PLANE OF SYMMETRY AND IS PERPENDICULAR TO THE X_Q AXIS AND IS POSITIVE DOWN IN THE LANDING ATTITUDE. THE Y_Q AXIS COMPLETES A RIGHT-HANDED SYSTEM.
CHARACTERISTICS:	ROTATING RIGHT-HANDED SYSTEM. THE STANDARD SUBSCRIPT IS Q (E.G., X_Q, Y_Q, Z_Q).

FIGURE 3.1.1.3-1 INSTRUMENT POINTING COORDINATE SYSTEM



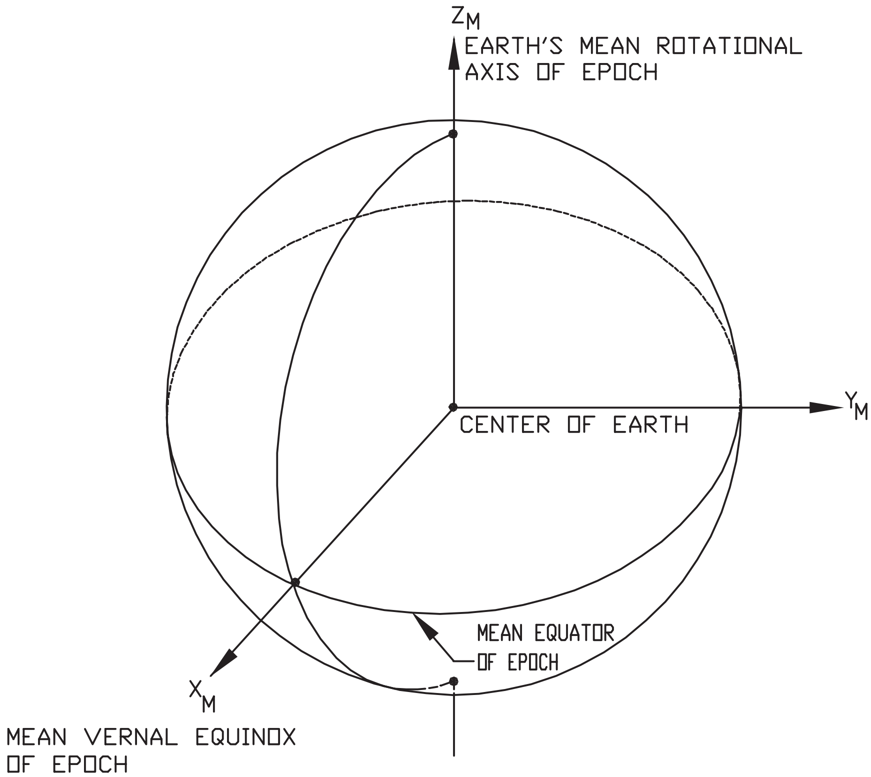
NAME:	ORBITER DYNAMIC BODY COORDINATE SYSTEM
ORIGIN:	CENTER OF MASS
ORIENTATION:	X_{BY} AXIS IS PARALLEL TO THE ORBITER STRUCTURAL BODY Xo AXIS: POSITIVE TOWARD THE NOSE Z_{BY} AXIS IS PARALLEL TO THE ORBITER PLANE OF SYMMETRY AND IS PERPENDICULAR TO X_{BY}, POSITIVE DOWN WITH THE RESPECT TO THE ORBITER FUSELAGE
CHARACTERISTICS:	ROTATING, RIGHT-HANDED ORTHOGONAL SYSTEM THE STANDARD SUBSCRIPT IS BY (E.G., X_{BY})

FIGURE 3.1.1.4-1 ORBITER DYNAMIC BODY COORDINATE SYSTEM



NAME:	GREENWICH TRUE-OF-DATE (GEOGRAPHIC) COORDINATE SYSTEM.
ORIGIN:	THE CENTER OF THE EARTH.
ORIENTATION:	THE X_G-Y_G PLANE IS THE EARTH'S TRUE-OF-DATE EQUATOR..
	THE Z_G AXIS IS DIRECTED ALONG THE EARTH'S TRUE-OF-DATE ROTATIONAL AXIS AND IS POSITIVE NORTH.
	THE $+X_G$ AXIS IS DIRECTED TOWARD THE PRIME MERIDIAN.
	THE Y_G AXIS COMPLETES A RIGHT-HANDED SYSTEM.
CHARACTERISTICS:	ROTATING, RIGHT-HANDED, CARTESIAN COORDINATE SYSTEM. VELOCITY VECTORS EXPRESSED IN THIS SYSTEM ARE RELATIVE TO A ROTATING REFERENCE FRAME FIXED TO THE EARTH.

FIGURE 3.1.1.5.2-1 GREENWICH TRUE OF DATE (GEOGRAPHIC)



NAME:	ARIES-MEAN-OF-1950, CARTESIAN, COORDINATE SYSTEM
ORIGIN:	THE CENTER OF THE EARTH.
ORIENTATION:	THE X_M-Y_M PLANE IS THE MEAN EARTH'S EQUATOR OF EPOCH.
	THE X_M AXIS IS DIRECTED TOWARDS THE MEAN VERNAL EQUINOX OF EPOCH.
	THE Z_M AXIS IS DIRECTED ALONG THE EARTH'S MEAN ROTATIONAL AXIS OF EPOCH AND IS POSITIVE NORTH.
	THE Y_M AXIS COMPLETES A RIGHT-HANDED, CARTESIAN SYSTEM.
CHARACTERISTICS:	INERTIAL, RIGHT-HANDED, CARTESIAN SYSTEM
	ROTATION RATES ARE EXPRESSED RELATIVE TO THE ARIES MEAN OF 1950 SYSTEM

FIGURE 3.1.1.5.3-1 ARIES MEAN OF 1950, CARTESIAN

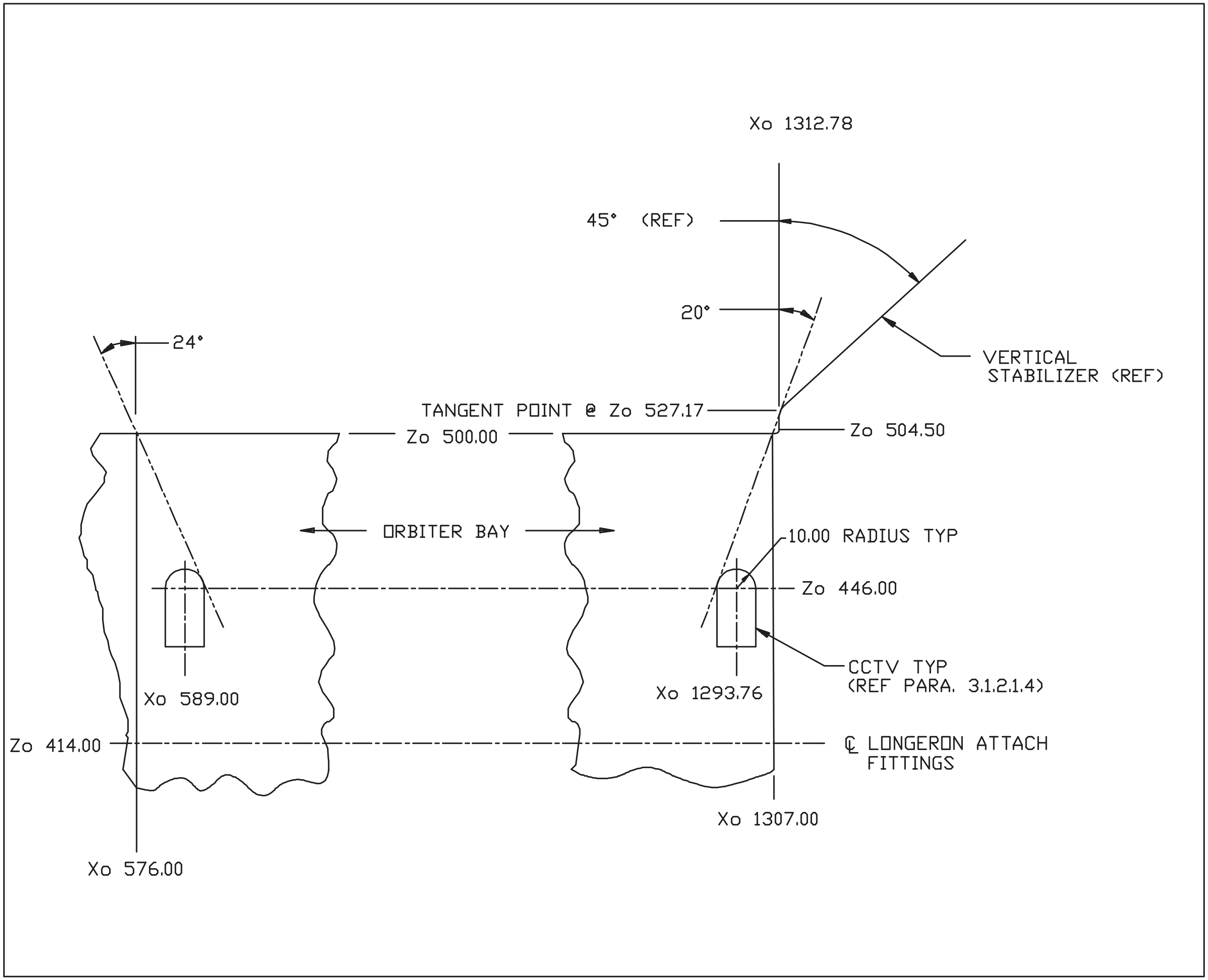


FIGURE 3.1.2.1.3-1 ON-ORBIT DEPLOYMENT/RETRIEVAL CLEARANCES
(SHEET 1 OF 3)

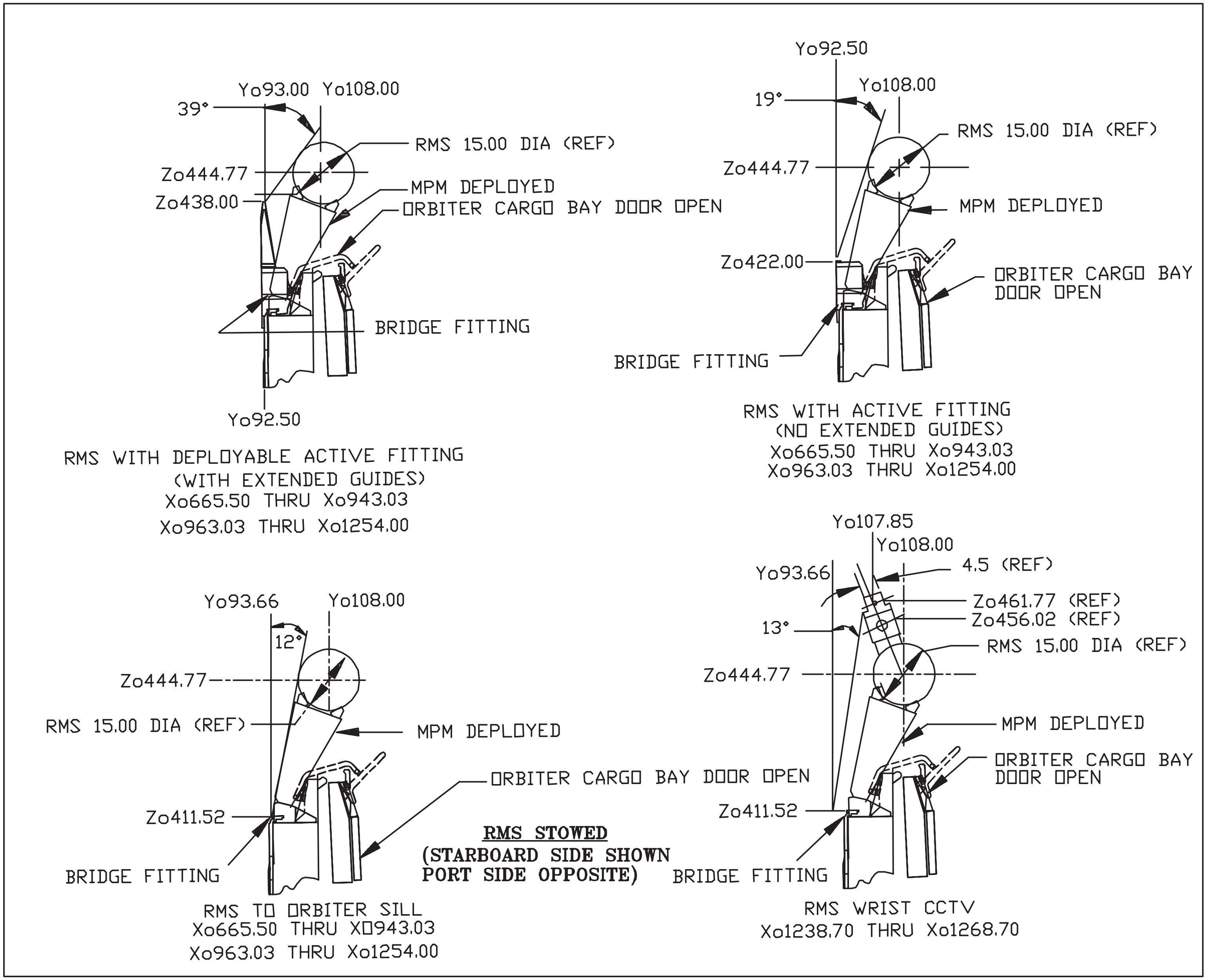


FIGURE 3.1.2.1.3-1 ON-ORBIT DEPLOYMENT/RETRIEVAL CLEARANCES
(SHEET 2 OF 3)

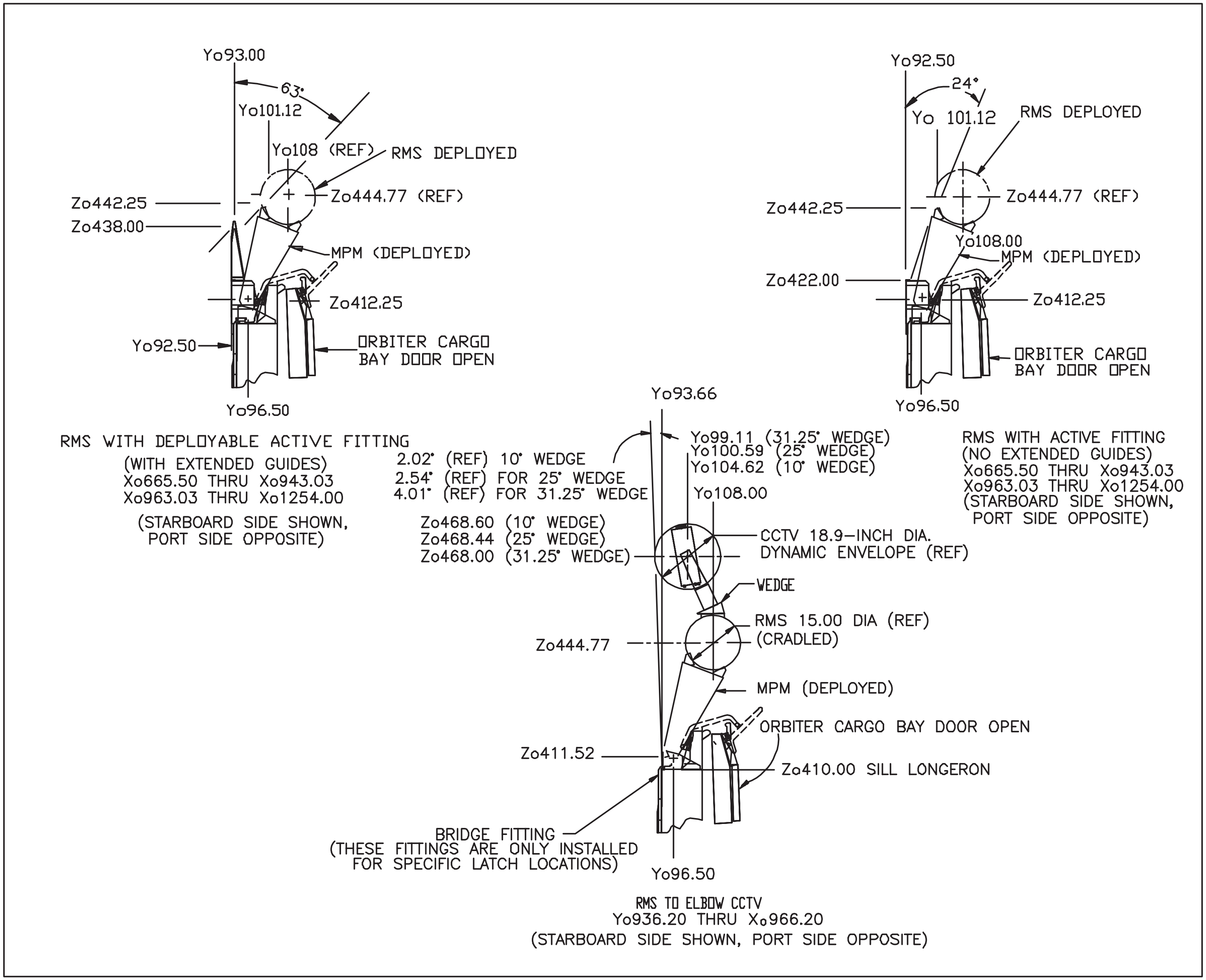


FIGURE 3.1.2.1.3-1 ON-ORBIT DEPLOYMENT/RETRIEVAL CLEARANCES

(SHEET 3 OF 3)

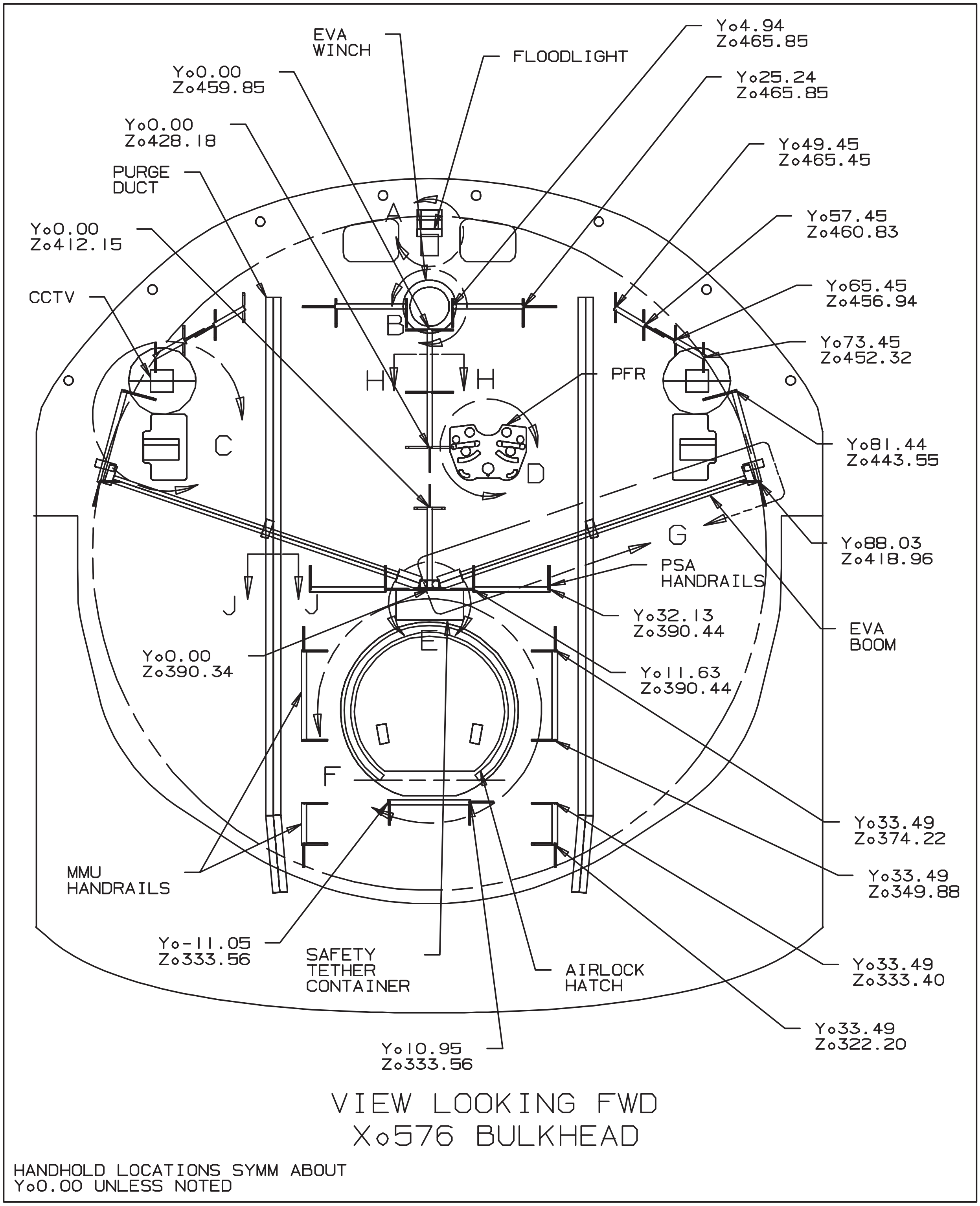


FIGURE 3.1.2.1.4-1 CARGO BAY PROTUBERANCES - FWD BULKHEAD

(SHEET 1 OF 5)

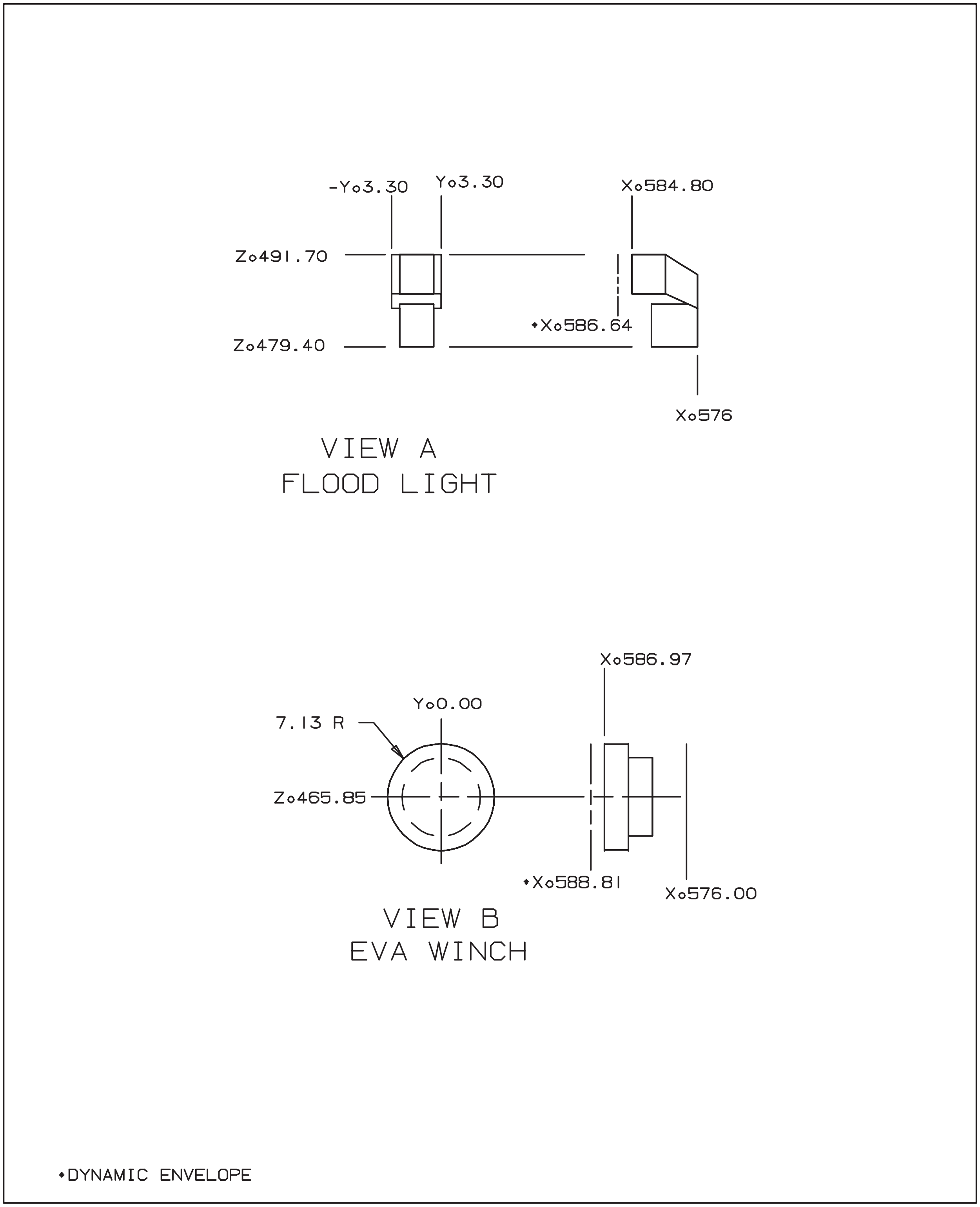


FIGURE 3.1.2.1.4-1 CARGO BAY PROTUBERANCES - FWD BULKHEAD

(SHEET 2 OF 5)

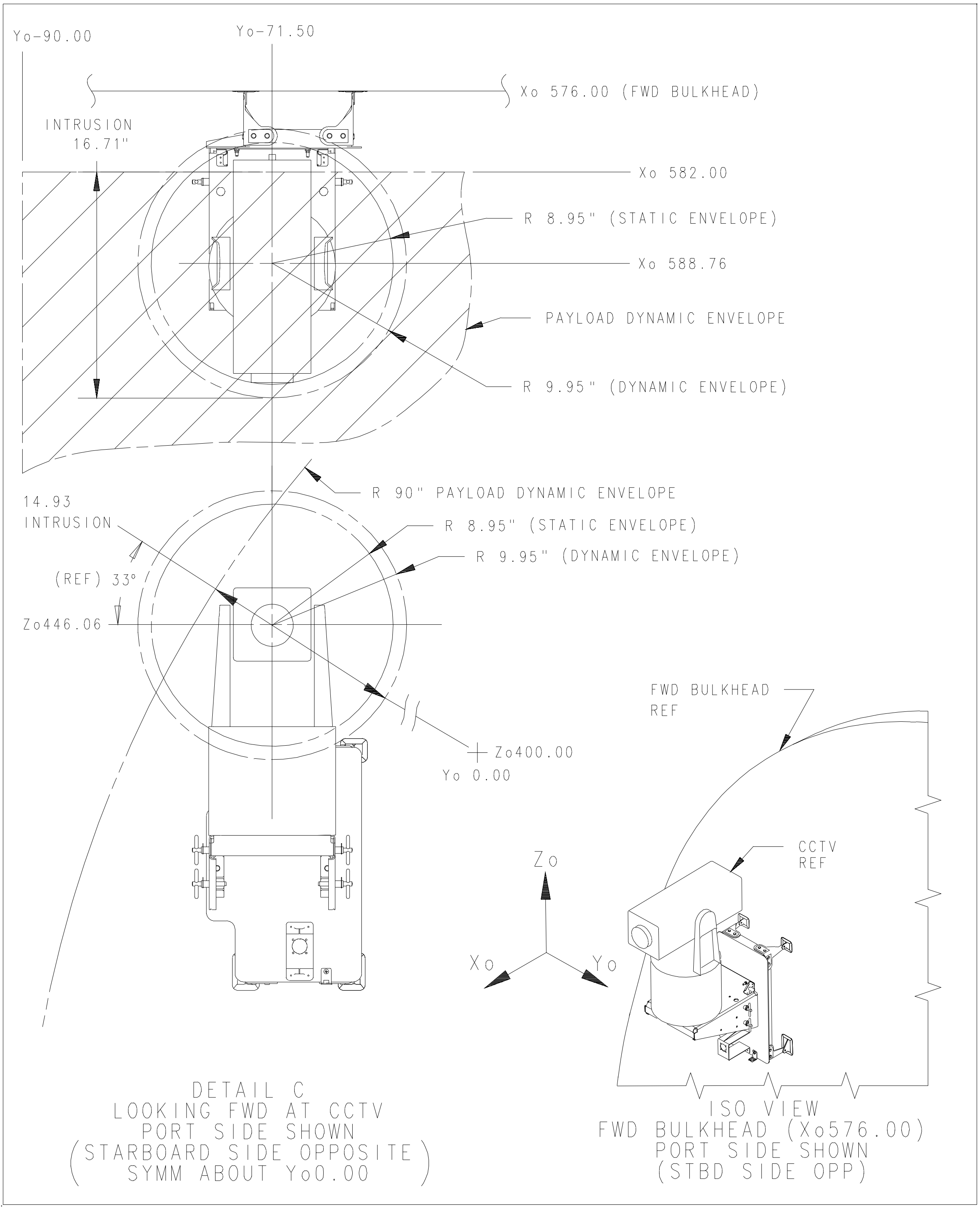


FIGURE 3.1.2.1.4-1 CARGO BAY PROTUBERANCES - FWD BULKHEAD

(SHEET 3 OF 5)

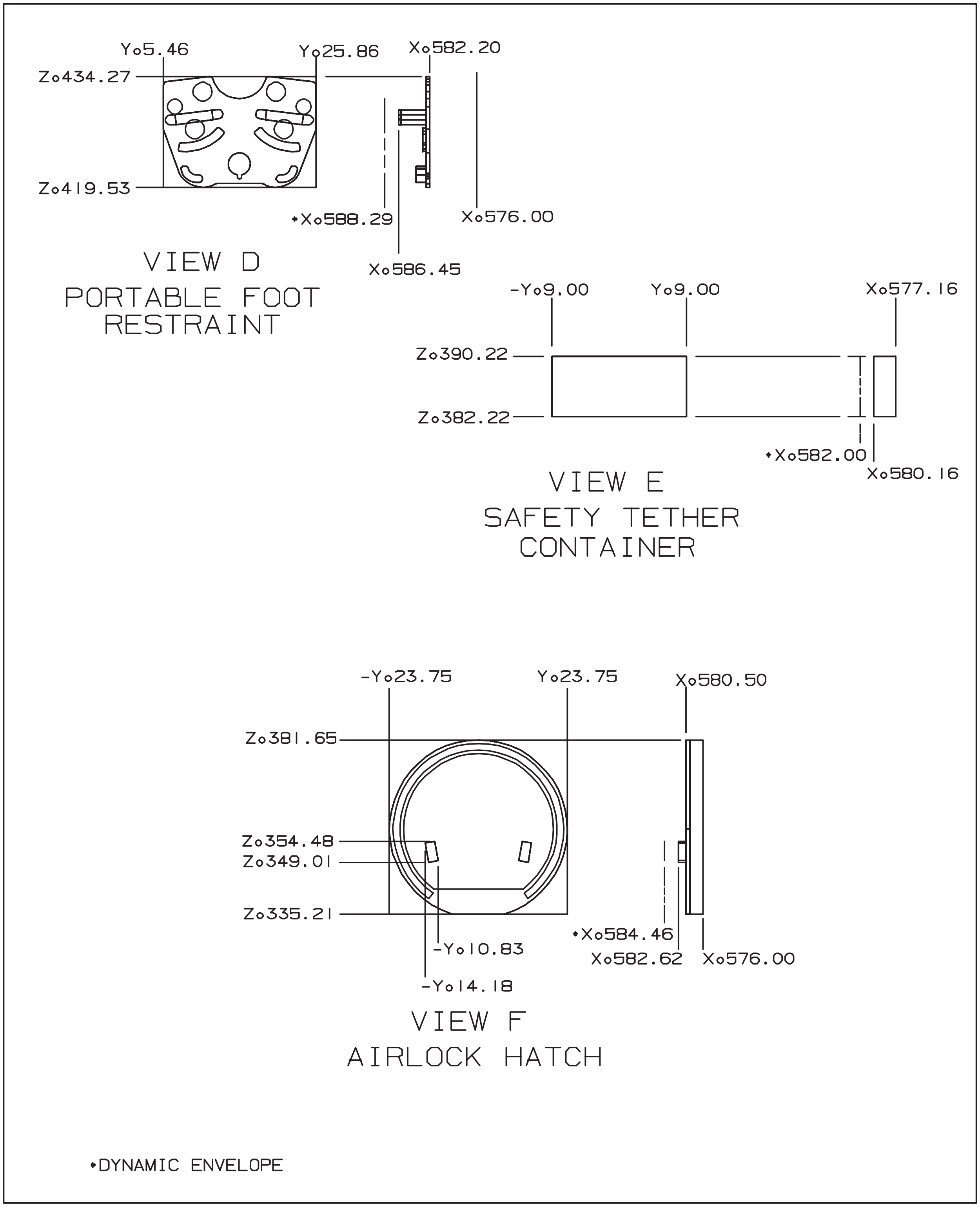


FIGURE 3.1.2.1.4-1 CARGO BAY PROTUBERANCES - FWD BULKHEAD

(SHEET 4 OF 5)

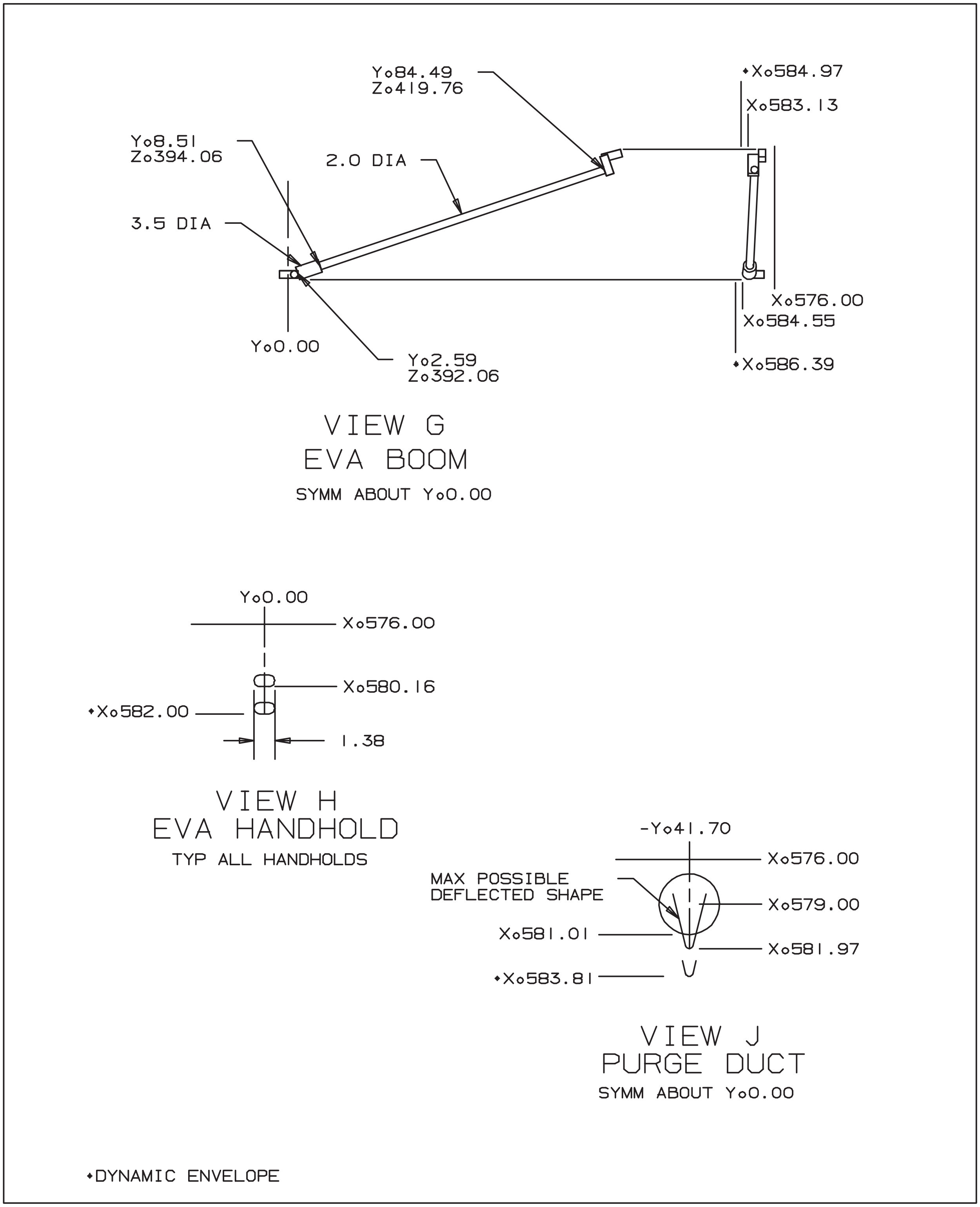


FIGURE 3.1.2.1.4-1 CARGO BAY PROTUBERANCES - FWD BULKHEAD

(SHEET 5 OF 5)

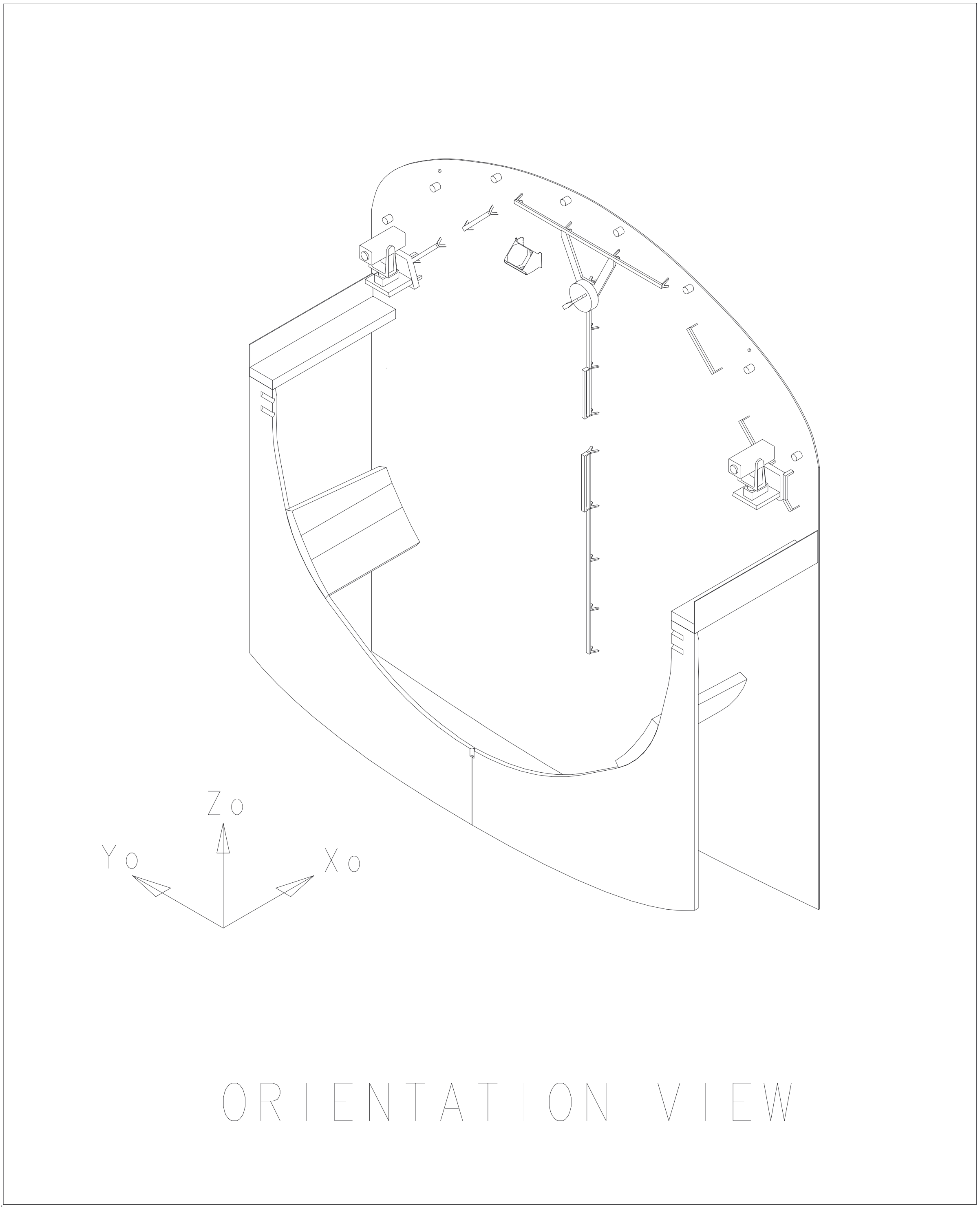


FIGURE 3.1.2.1.4-2 CARGO BAY PROTUBERANCES - AFT BULKHEAD

(SHEET 1 OF 6)

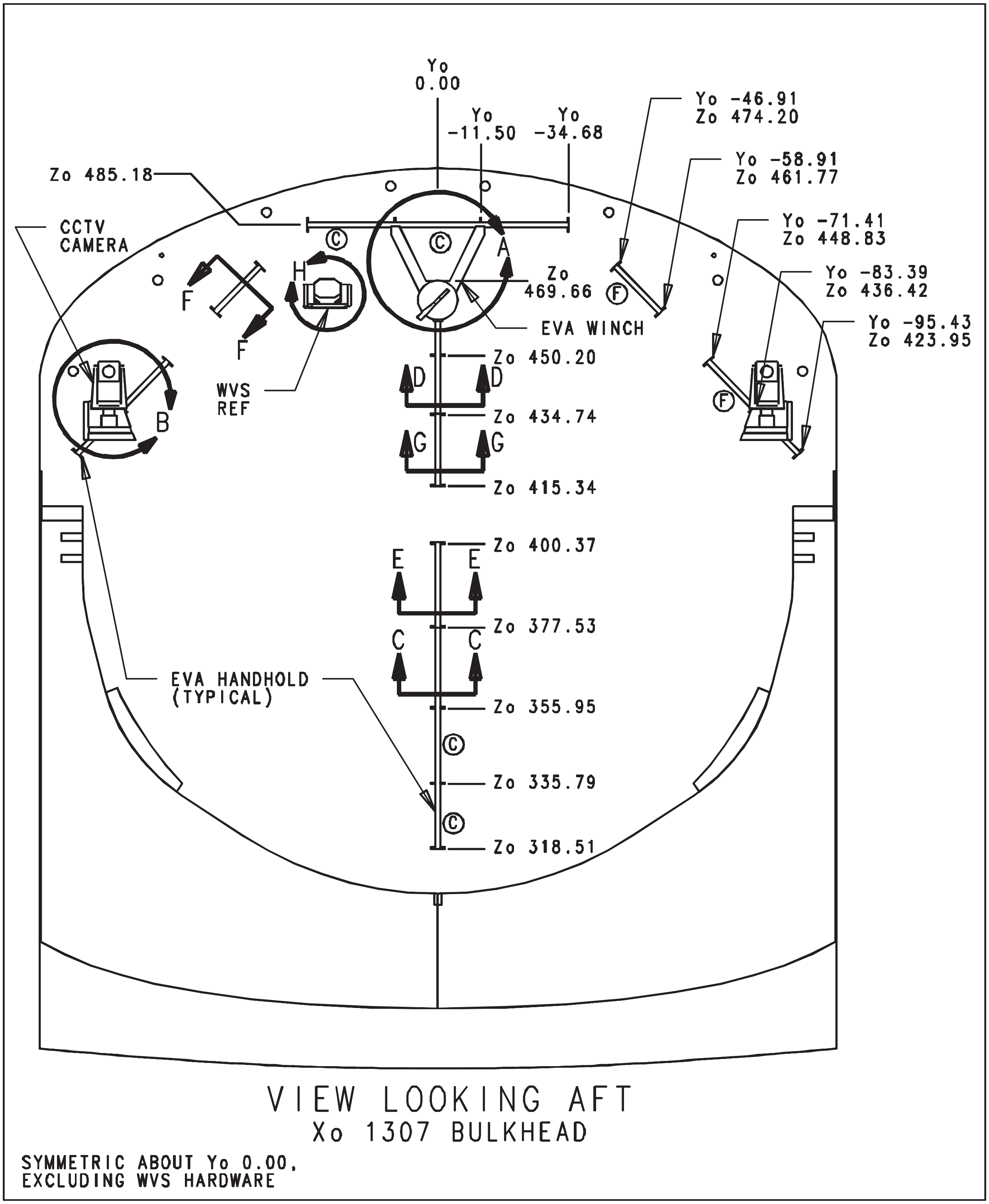


FIGURE 3.1.2.1.4-2 CARGO BAY PROTUBERANCES - AFT BULKHEAD

(SHEET 2 OF 6)

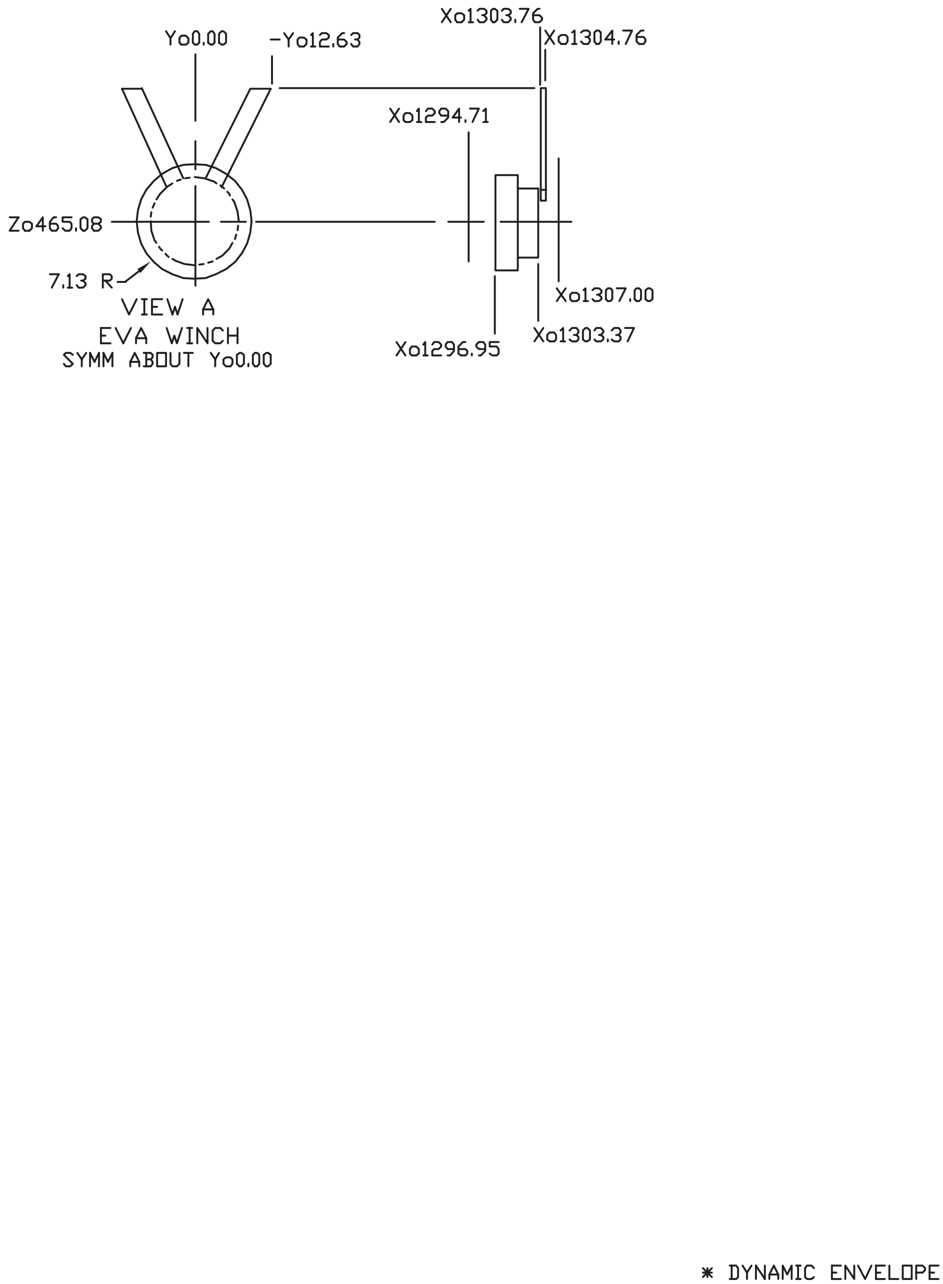


FIGURE 3.1.2.1.4-2 CARGO BAY PROTUBERANCES - AFT BULKHEAD

(SHEET 3 OF 6)

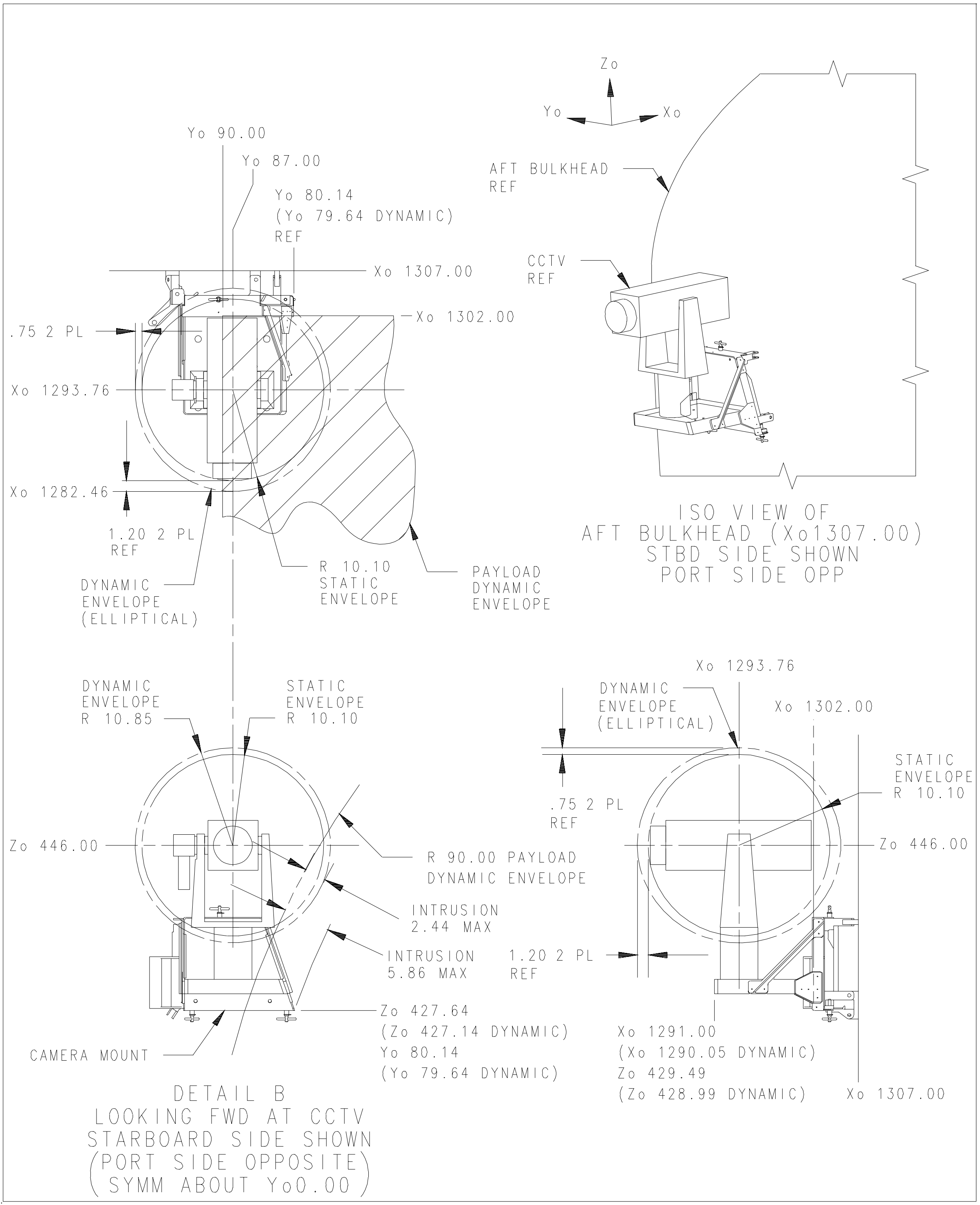


FIGURE 3.1.2.1.4-2 CARGO BAY PROTUBERANCES - AFT BULKHEAD

(SHEET 4 OF 6)

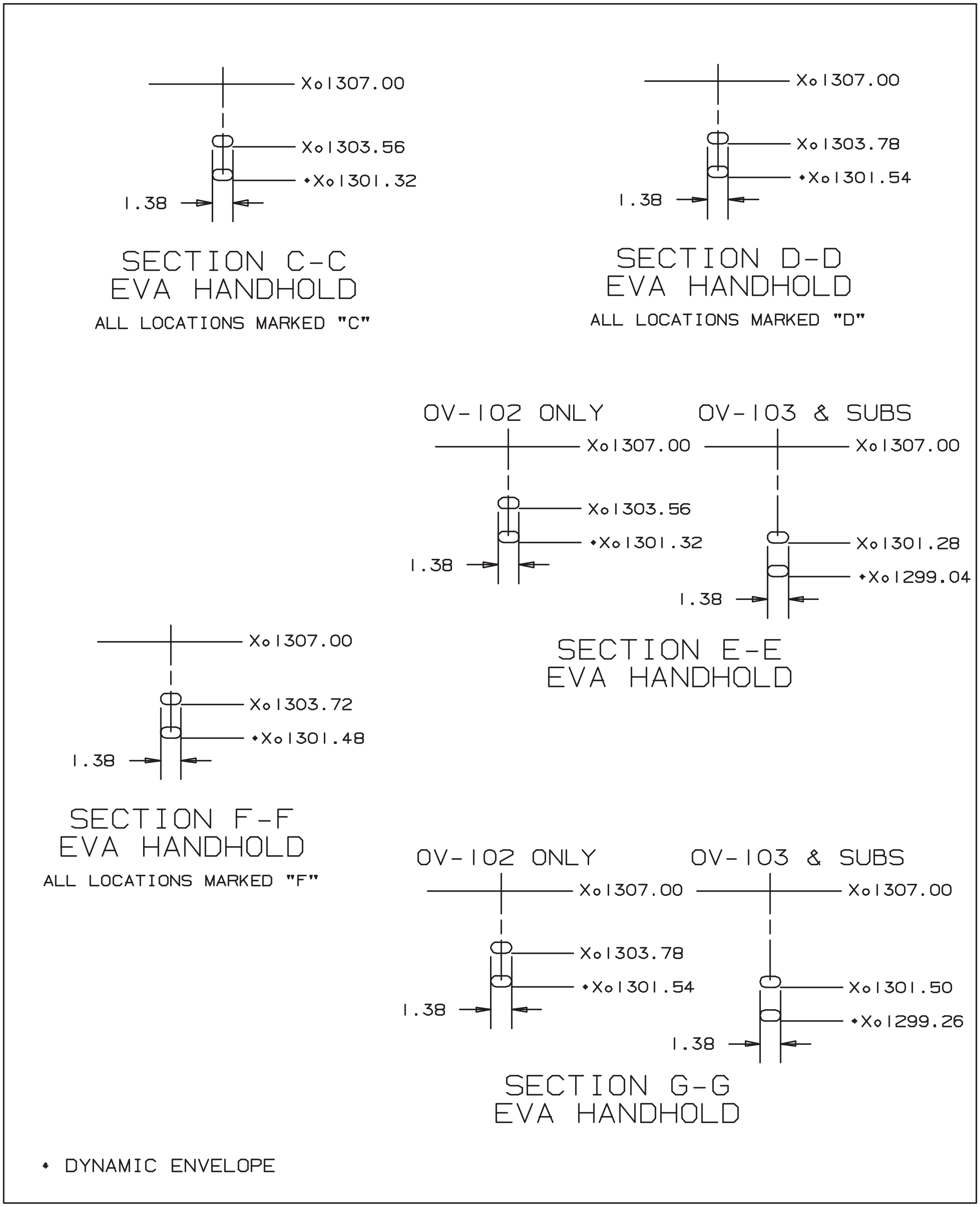


FIGURE 3.1.2.1.4-2 CARGO BAY PROTUBERANCES - AFT BULKHEAD

(SHEET 5 OF 6)

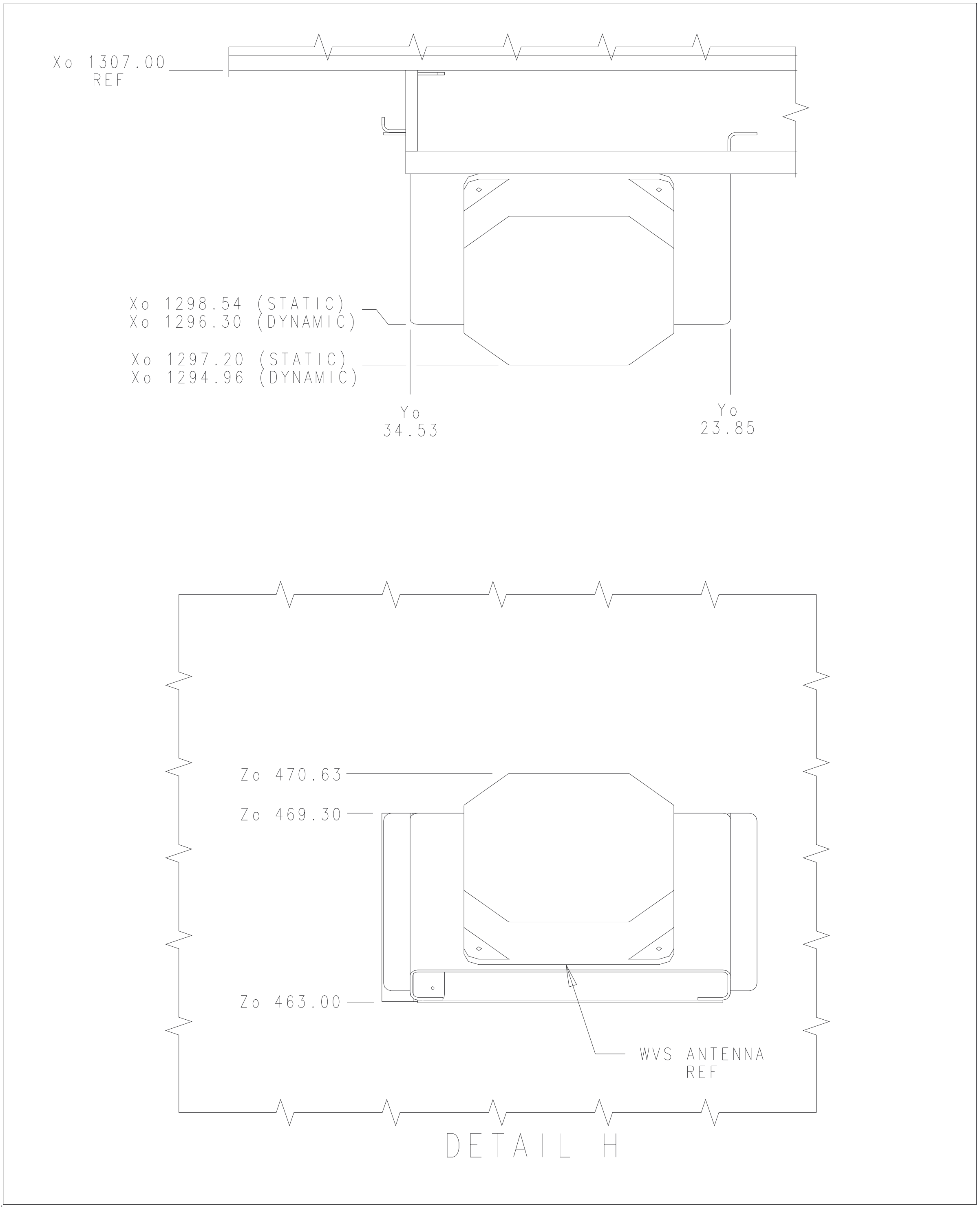


FIGURE 3.1.2.1.4-2 CARGO BAY PROTUBERANCES - AFT BULKHEAD

(SHEET 6 OF 6)

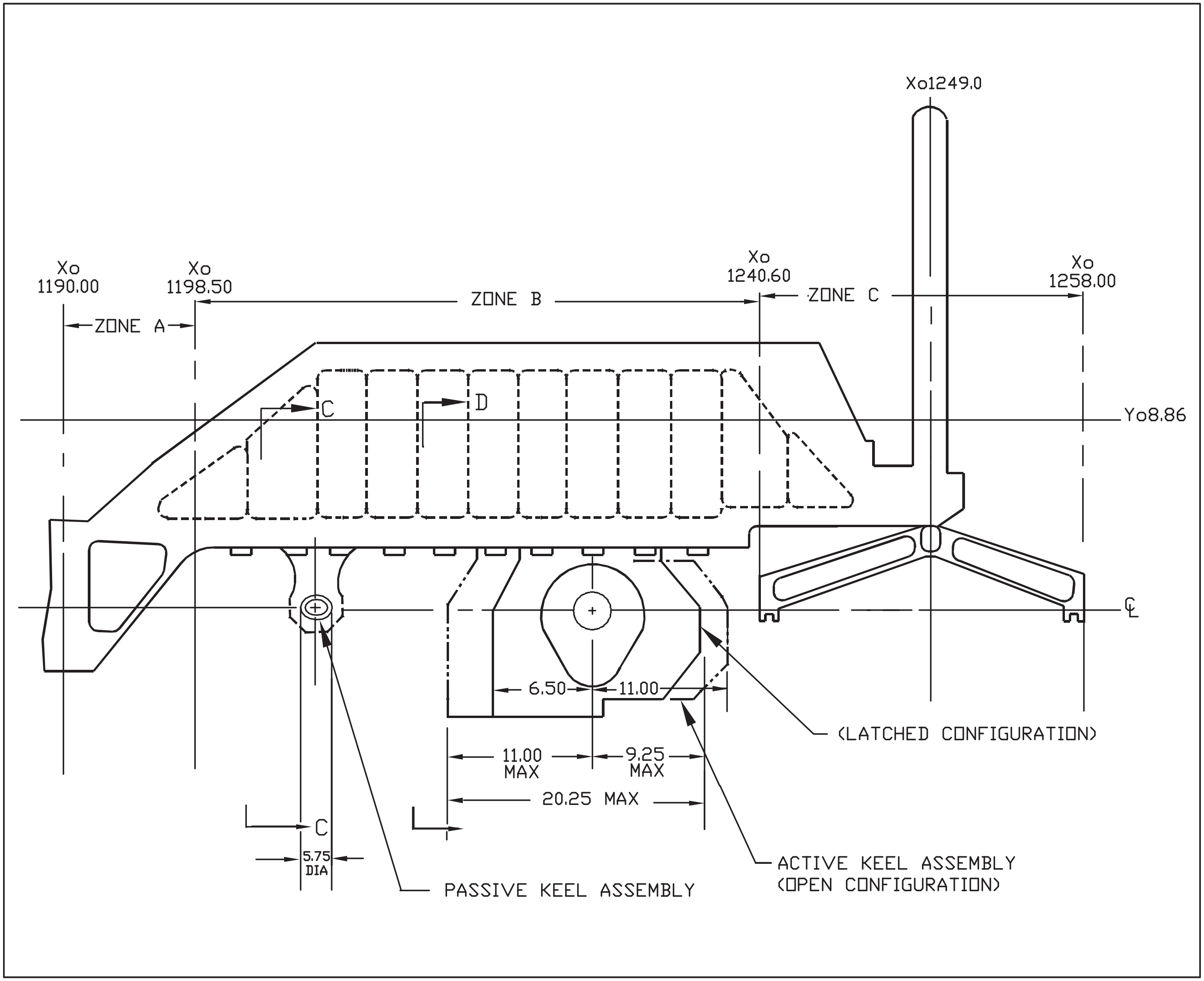


FIGURE 3.1.2.1.4-3 CARGO BAY PROTUBERANCES - KEEL BRIDGE

(SHEET 1 OF 2)

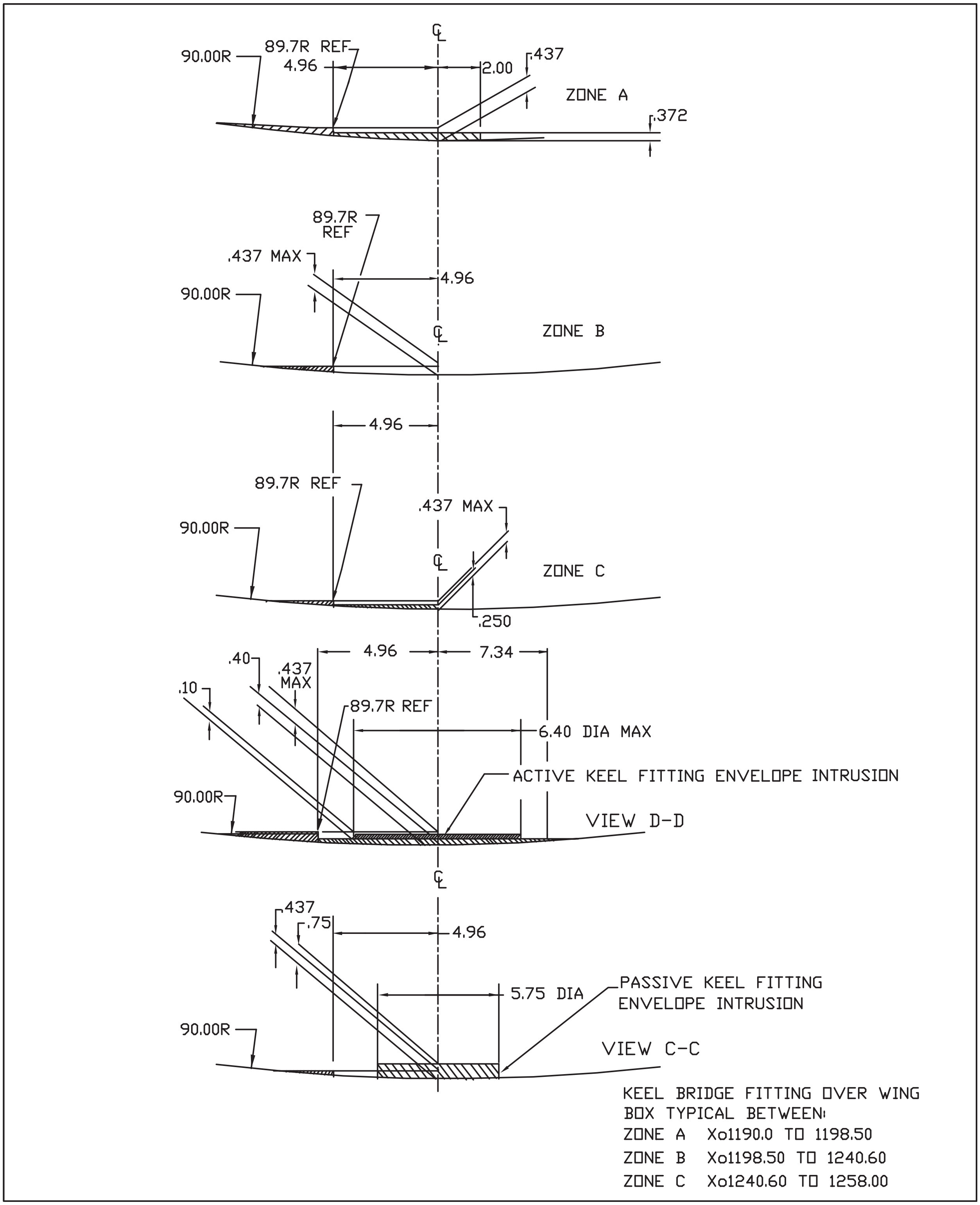
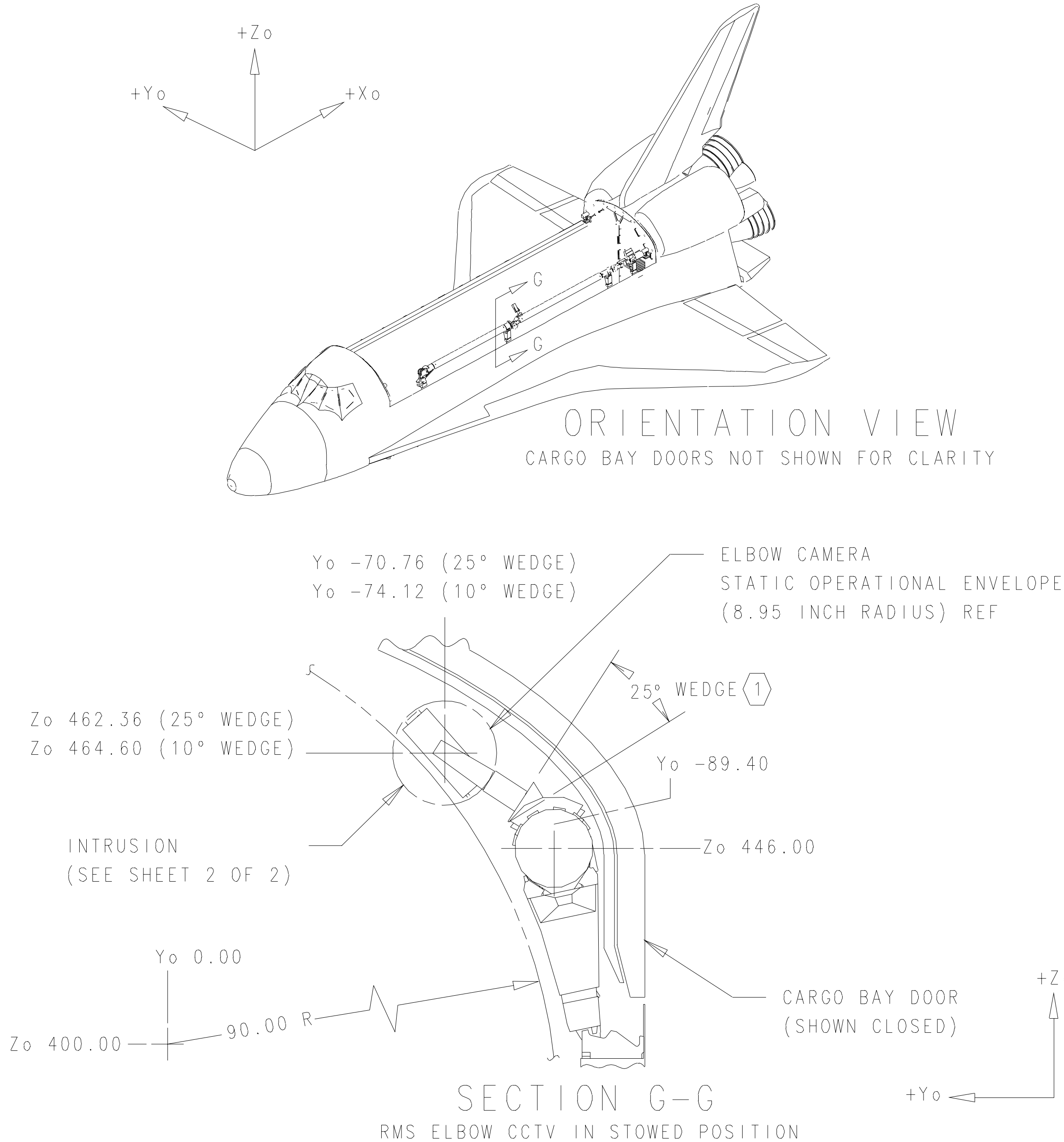


FIGURE 3.1.2.1.4-3 CARGO BAY PROTUBERANCES - KEEL BRIDGE

(SHEET 2 OF 2)



NOTES:

1. RMS ELBOW CAMERA STOWED TANGENT TO THE 90"R (AS SHOWN) FOR LAUNCH & LANDING.
2. RMS ELBOW CAMERA MUST HAVE PAN/TILT OPERATIONAL CONSTRAINT WHEN PAYLOAD IS IN THE CARGO BAY.
3. ⟨1⟩ THE 25° WEDGE WILL BE STANDARD. USE OF THE 10° WEDGE WILL REQUIRE SPECIAL EVALUATION BY NASA/JSC.

FIGURE 3.1.2.1.4-4 CARGO BAY PROTUBERANCES - RMS ELBOW CAMERA

(SHEET 1 OF 2)

CLEARANCE/INTRUSION OF RMS ELBOW CAMERA CCTV WITH MONOCHROME LENS ASSY

	STATIC		DYNAMIC	
	CAMERA TANGENT 90" R ENV.	CAMERA PERPENDICULAR TO 90" R ENV.	CAMERA TANGENT TO 90" R ENV.	CAMERA PERPENDICULAR TO 90" R ENV.
31.25° WEDGE	0.04 (CLEARANCE)	6.11 (INTRUSION)	3.95 (INTRUSION)	10.1 (INTRUSION)
25° WEDGE	1.48 (CLEARANCE)	4.63 (INTRUSION)	2.52 (INTRUSION)	8.63 (INTRUSION)
10° WEDGE	5.52 (CLEARANCE)	0.63 (INTRUSION)	1.54 (CLEARANCE)	4.61 (INTRUSION)

CLEARANCE/INTRUSION OF RMS ELBOW CAMERA CCTV WITH WIDE ANGLE LENS ASSY

	STATIC		DYNAMIC	
	CAMERA TANGENT 90" R ENV.	CAMERA PERPENDICULAR TO 90" R ENV.	CAMERA TANGENT TO 90" R ENV.	CAMERA PERPENDICULAR TO 90" R ENV.
31.25° WEDGE	0.22 (CLEARANCE)	6.37 (INTRUSION)	4.21 (INTRUSION)	10.27 (INTRUSION)
25° WEDGE	1.22 (CLEARANCE)	4.89 (INTRUSION)	2.78 (INTRUSION)	8.89 (INTRUSION)
10° WEDGE	5.26 (CLEARANCE)	0.89 (INTRUSION)	1.28 (CLEARANCE)	4.87 (INTRUSION)

NOTE: THE 25° WEDGE WILL BE STANDARD. USE OF THE 10° AND 31.25° WEDGES WILL REQUIRE SPECIAL EVALUATION BY NASA/JSC.

FIGURE 3.1.2.1.4-4 CARGO BAY PROTUBERANCES - ELBOW CAMERA

(SHEET 2 OF 2)

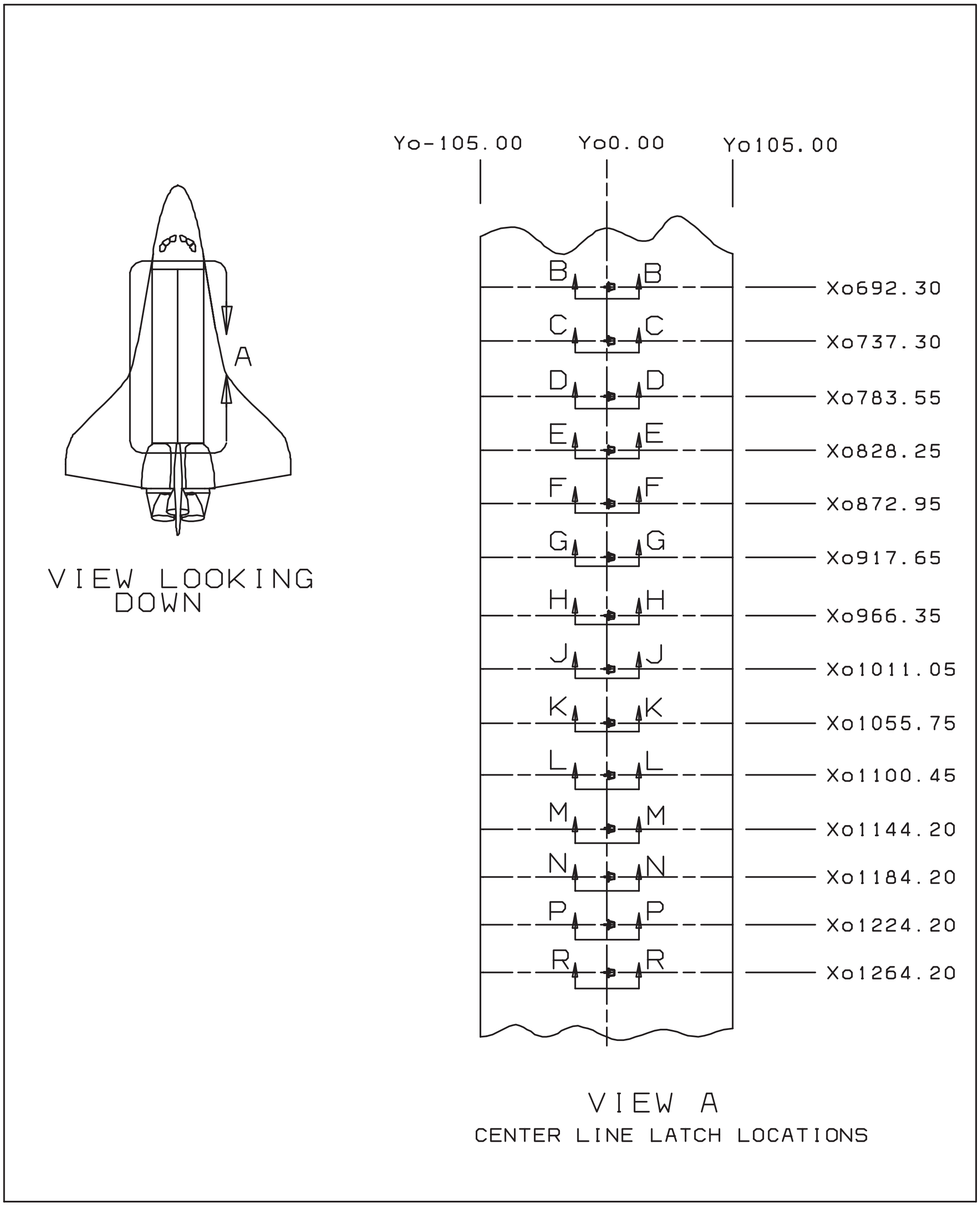
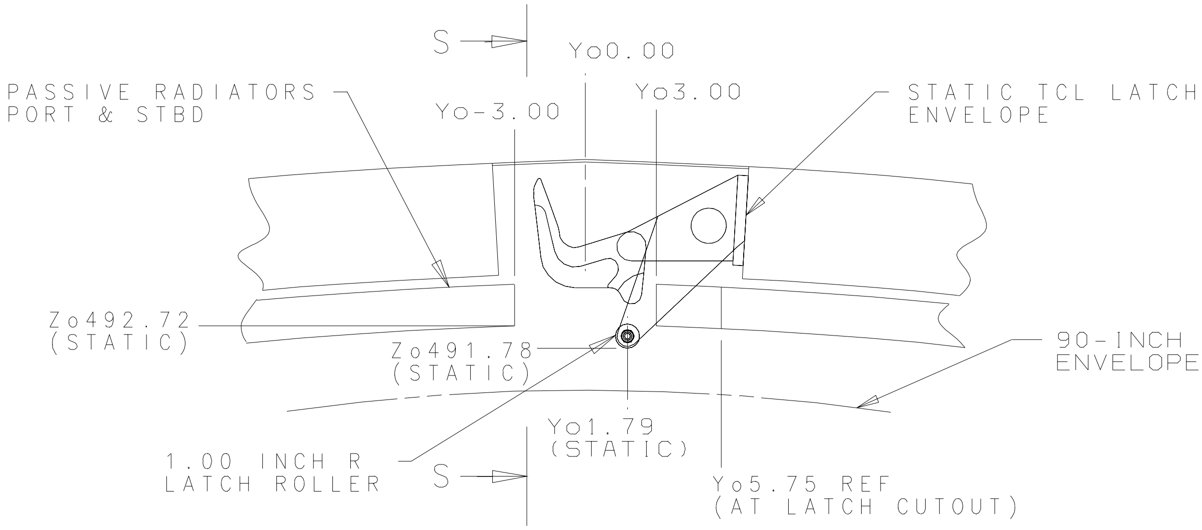


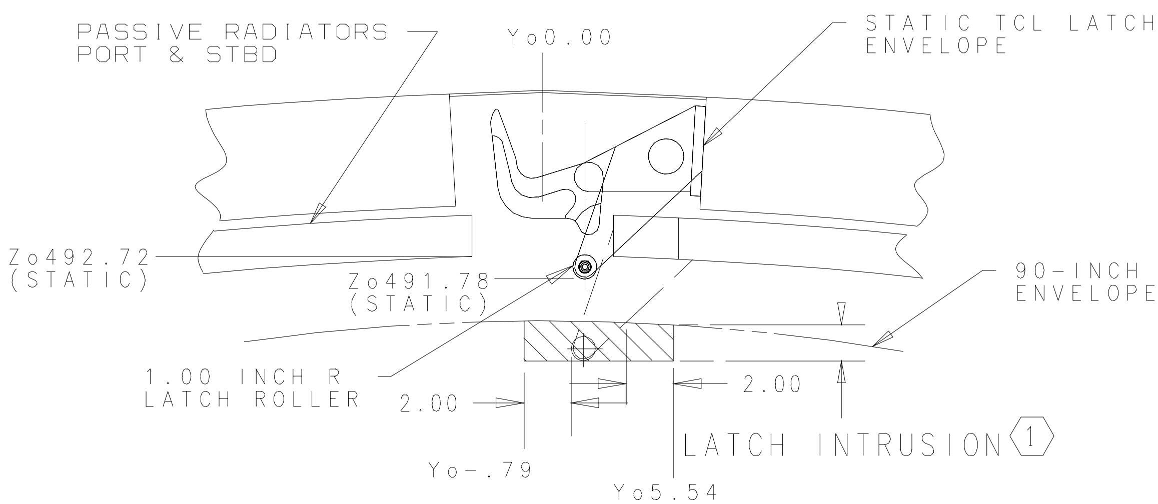
FIGURE 3.1.2.1.4-5 CARGO BAY PROTUBERANCES - PAYLOAD BAY DOOR CENTERLINE LATCHES AND PASSIVE RADIATORS

(SHEET 1 OF 5)



SECTION B-B THRU R-R

LOOKING FWD AT CENTERLINE LATCH
STATIC NOMINAL POSITION
OF TCL LATCH AND PASSIVE RADIATOR



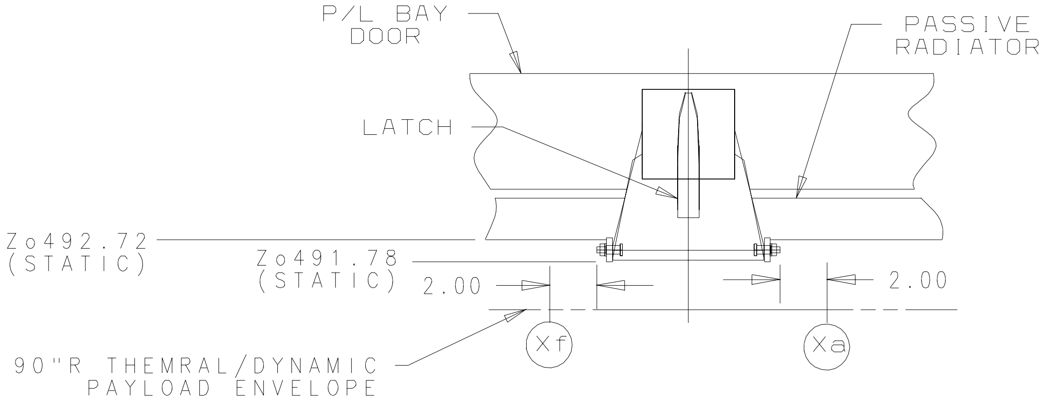
SECTION B-B THRU R-R

LOOKING FWD AT CENTERLINE LATCH
DYNAMIC INTRUSION INTO PAYLOAD THERMAL/DYNAMIC ENVELOPE

DYNAMIC INTRUSION PARAMETERS PRESENTED IN TABLE 1 ⟨1⟩

FIGURE 3.1.2.1.4-5 CARGO BAY PROTUBERANCES - PAYLOAD BAY DOOR CENTERLINE LATCHES AND PASSIVE RADIATORS

(SHEET 2 OF 5)



SECTION S-S
LOOKING STBD AT CENTERLINE LATCH
Xo LOCATION OF LATCHES PRESENTED IN TABLE 1

TABLE 1
TOP CENTERLINE (TCL) LATCH DYNAMIC INTRUSION PARAMETERS

SECTION	Xf (Xo)	Xa (Xo)	INCHES ⟨1⟩
B-B	686.30	698.31	A
C-C	731.30	743.31	C
D-D	777.54	789.56	C
E-E	822.24	834.26	C
F-F	866.94	878.96	B
G-G	911.64	923.66	A
H-H	960.34	972.36	A
J-J	1005.04	1017.06	A
K-K	1049.74	1061.76	A
L-L	1094.44	1106.46	B
M-M	1138.19	1150.21	C
N-N	1178.19	1190.21	A
P-P	1218.19	1230.21	C
R-R	1258.19	1270.21	D

A=.50
B=.73
C=1.12
D=1.69

⟨1⟩ RADIAL DYNAMIC INTRUSION INTO THE 90"R THERMAL/DYNAMIC ENVELOPE

FIGURE 3.1.2.1.4-5 CARGO BAY PROTUBERANCES - PAYLOAD BAY DOOR CENTERLINE LATCHES AND PASSIVE RADIATORS

(SHEET 3 OF 5)

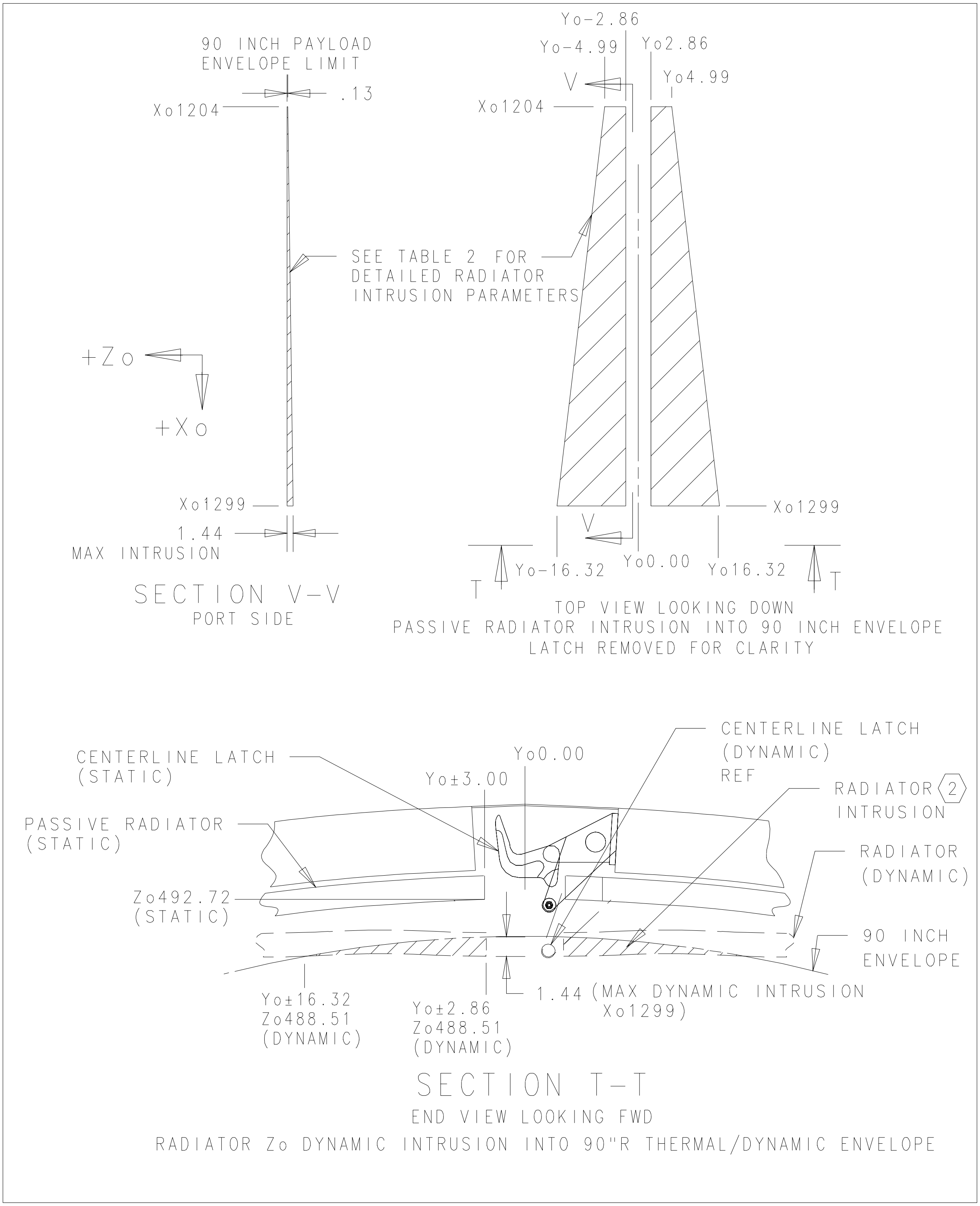


FIGURE 3.1.2.1.4-5 CARGO BAY PROTUBERANCES - PAYLOAD BAY DOOR CENTERLINE LATCHES AND PASSIVE RADIATORS

(SHEET 4 OF 5)

TABLE 2

RADIATOR DYNAMIC INTRUSION PARAMETERS (INCHES) ⟨2⟩

	Xo1204	Xo1224	Xo1244	Xo1264	Xo1284	Xo1299
Yo±2.86	.13	.35	.55	.86	1.20	1.44
Yo±4.99	.05	.20	.44	.71	1.08	1.32
Yo±11.55					.33	.55
Yo±16.32						0.00

⟨2⟩ RADIAL DYNAMIC INTRUSION INTO THE 90"R THERMAL/DYNAMIC ENVELOPE

FIGURE 3.1.2.1.4-5 CARGO BAY PROTUBERANCES - PAYLOAD BAY DOOR CENTERLINE LATCHES AND PASSIVE RADIATORS

(SHEET 5 OF 5)

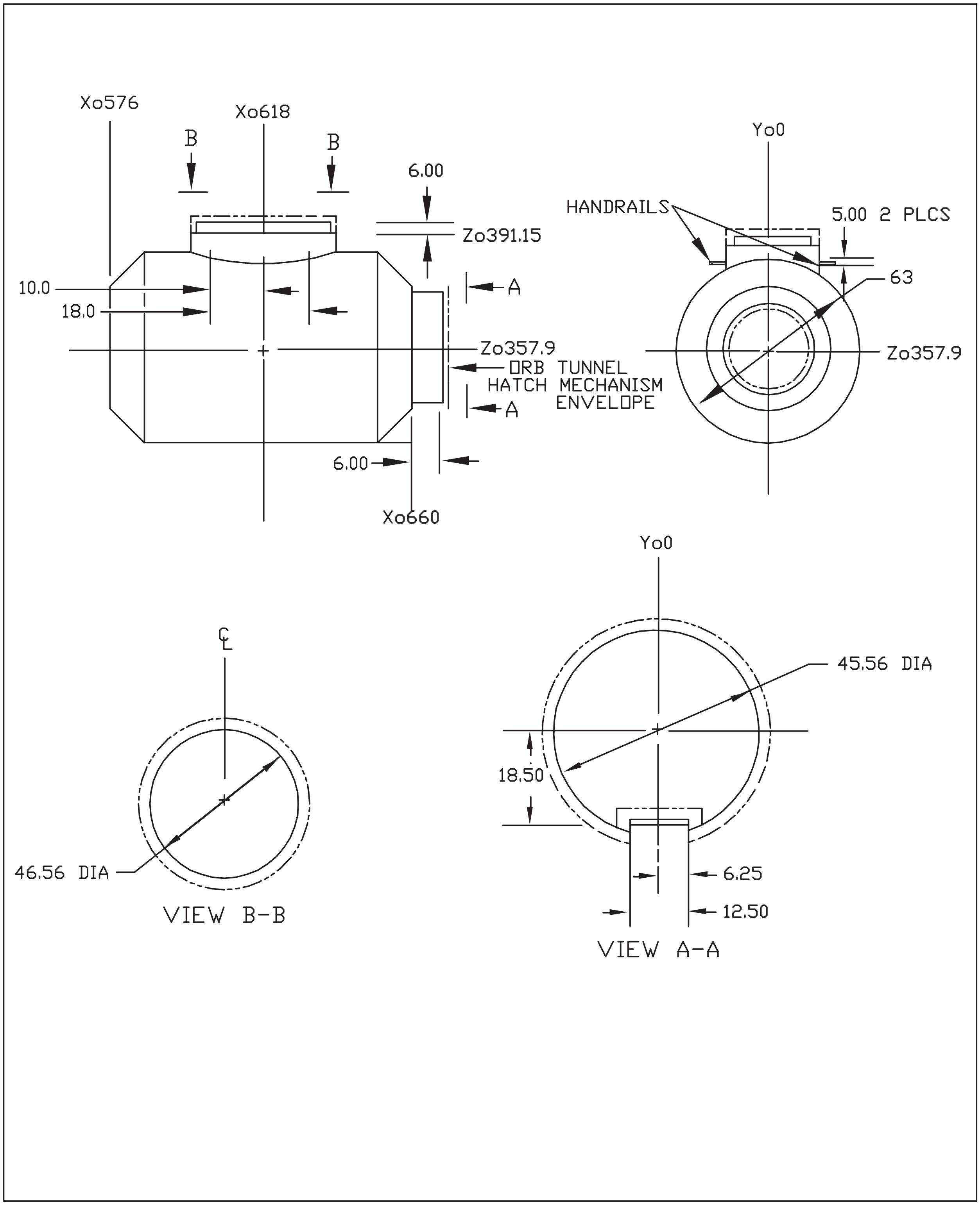


FIGURE 3.1.2.1.5.4-1 AIRLOCK/TUNNEL ADAPTER LIMIT ENVELOPE

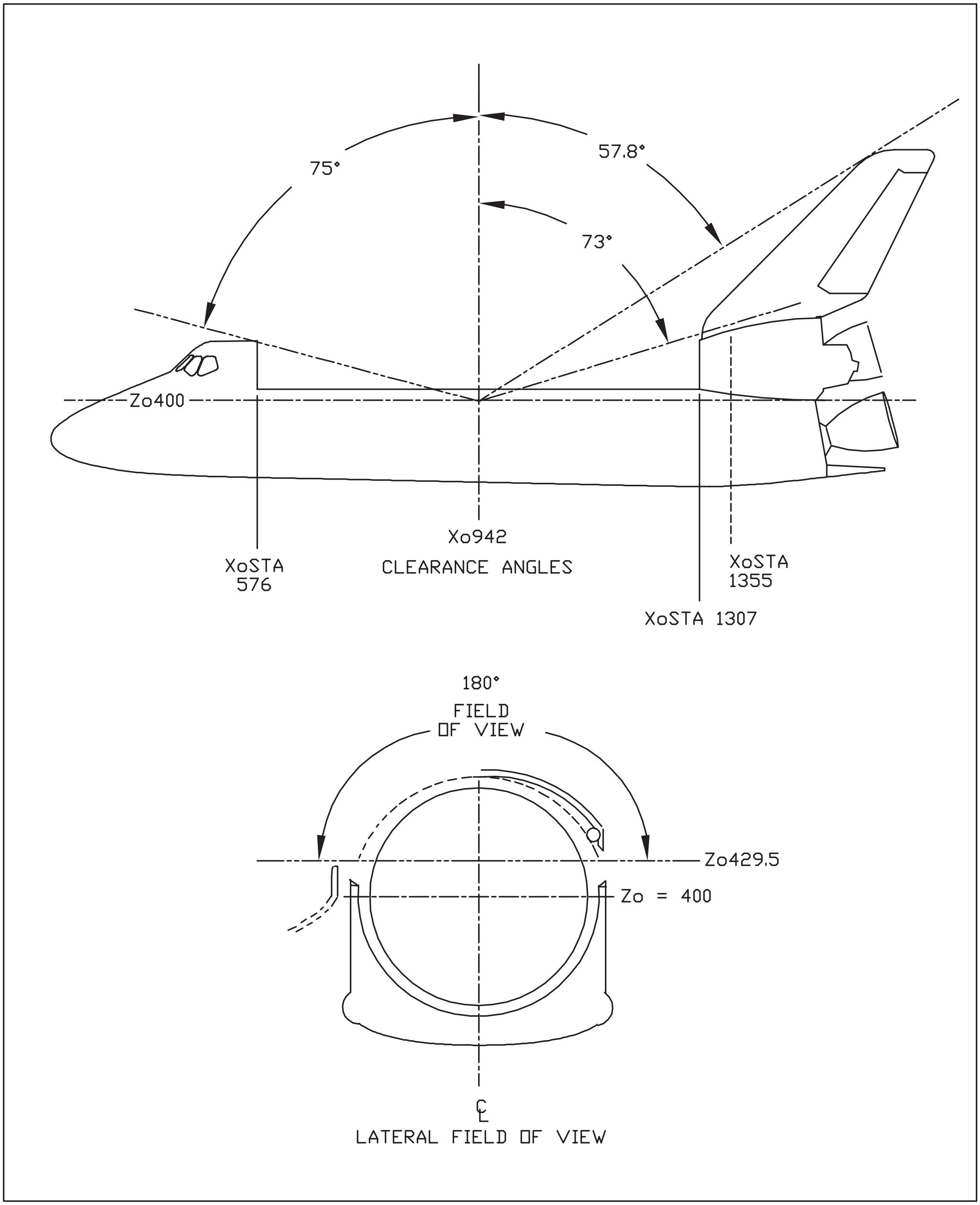
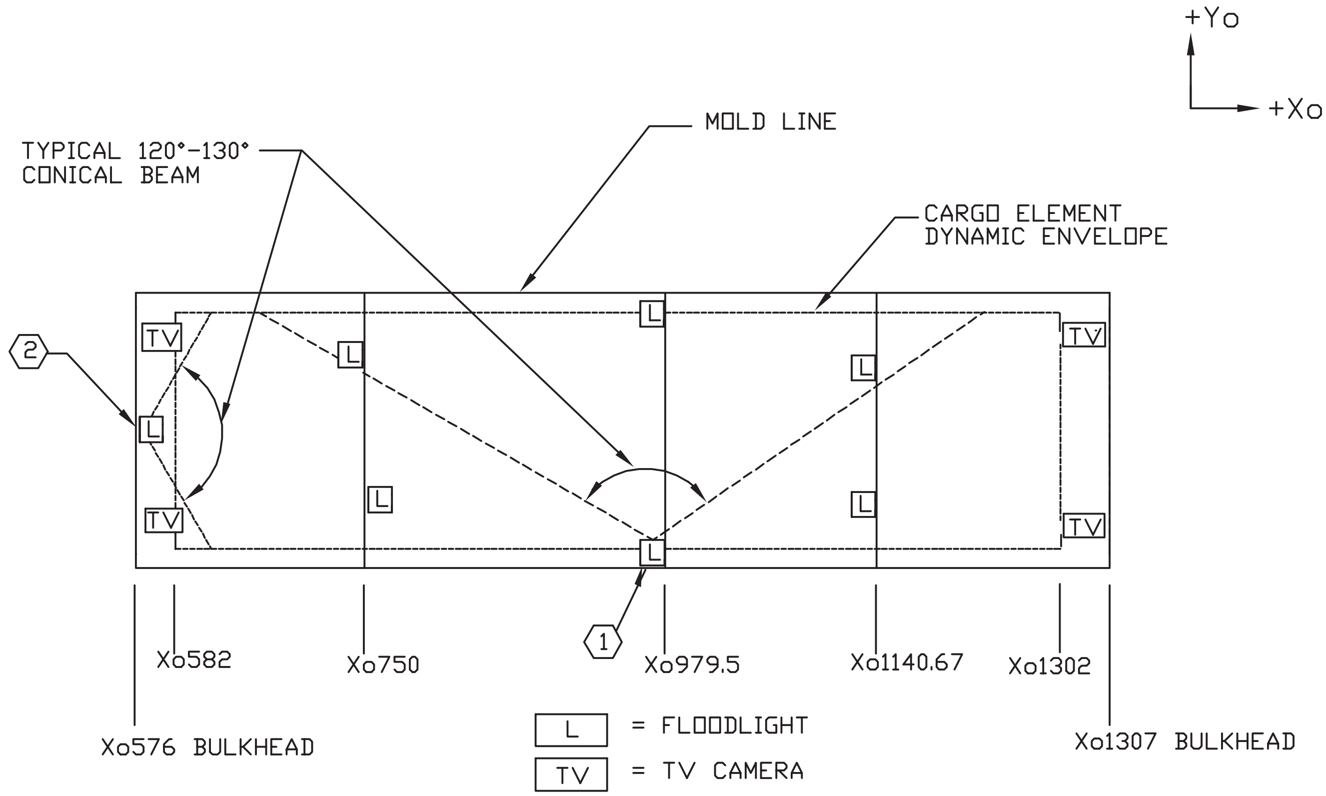


FIGURE 3.1.3.1-1 CARGO ELEMENT FIELD OF VIEW



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

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

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)

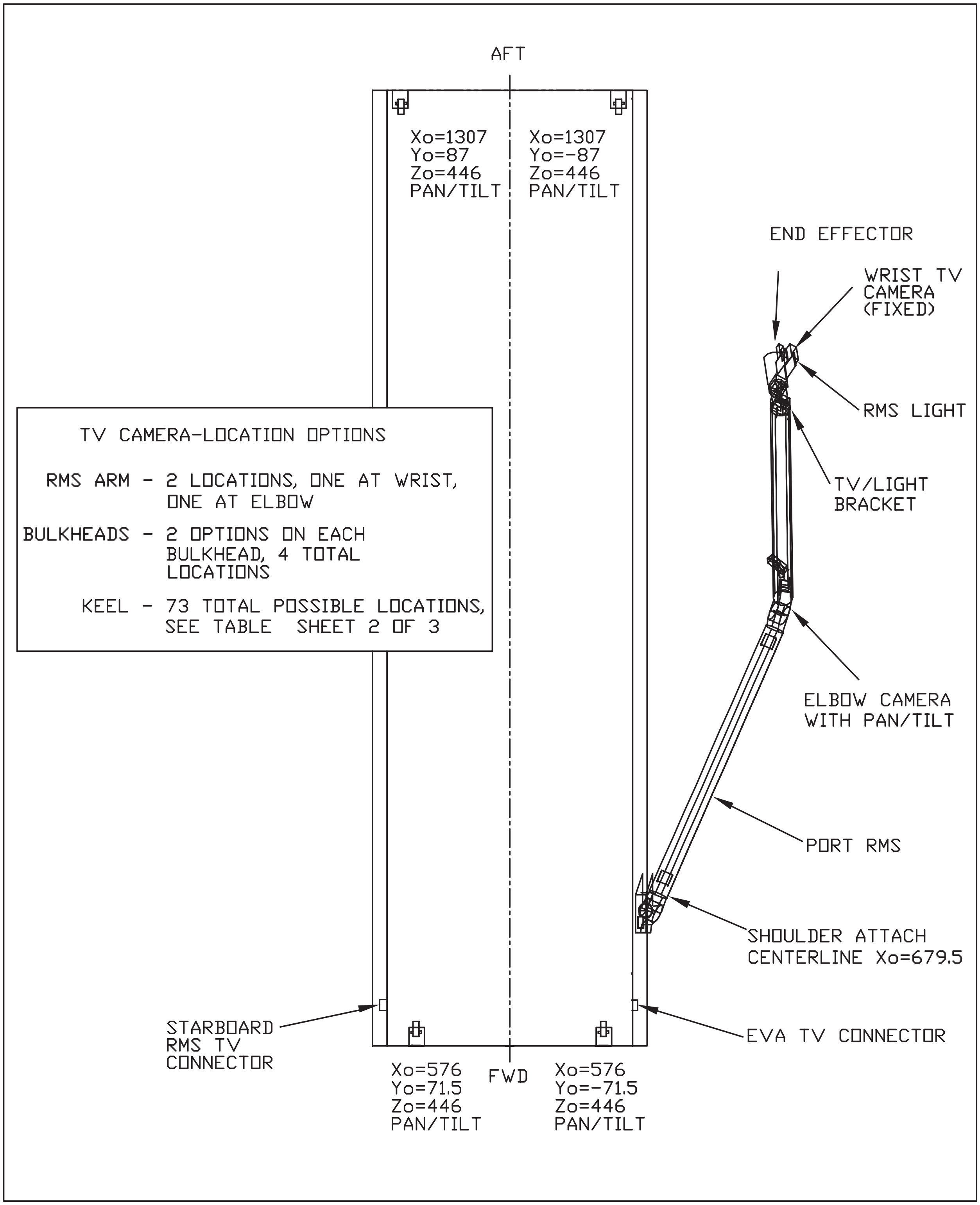


FIGURE 3.1.3.2-1 CARGO BAY LIGHTING AND TV CAMERA LOCATIONS

(SHEET 3 OF 3)

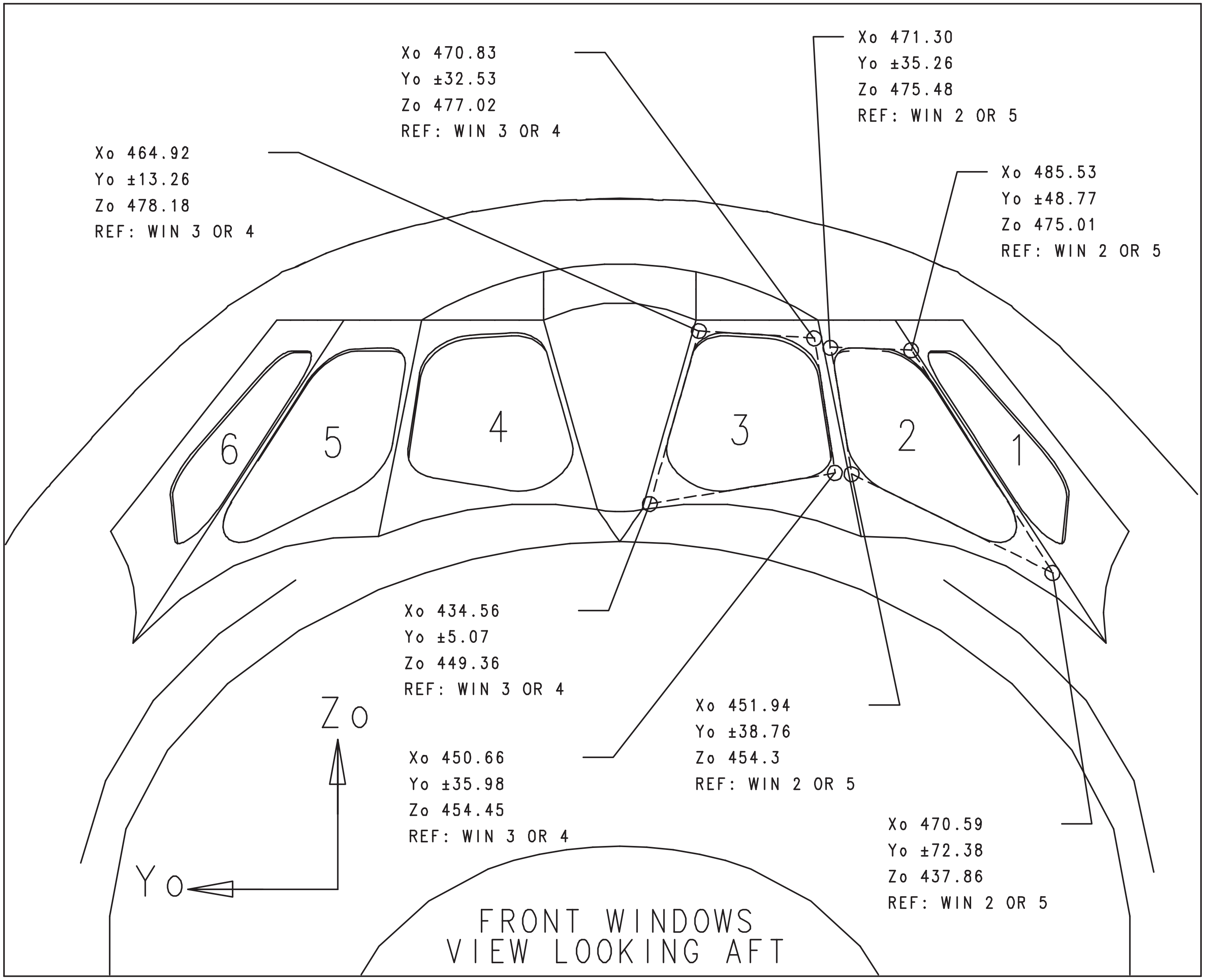


FIGURE 3.1.3.4-1 CREW COMPARTMENT WINDOW LOCATIONS
(SHEET 1 OF 4)

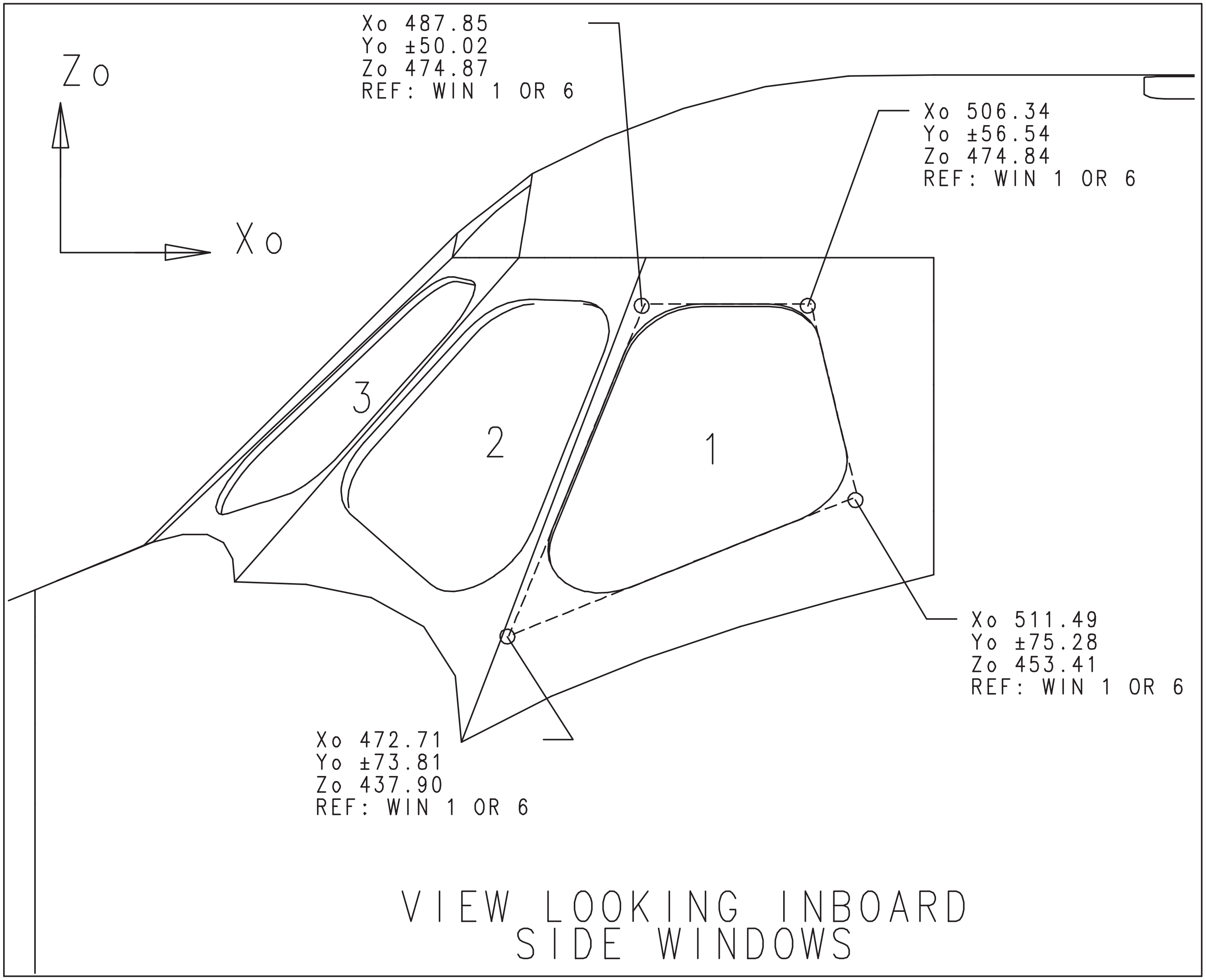


FIGURE 3.1.3.4-1 CREW COMPARTMENT WINDOW LOCATIONS

(SHEET 2 OF 4)

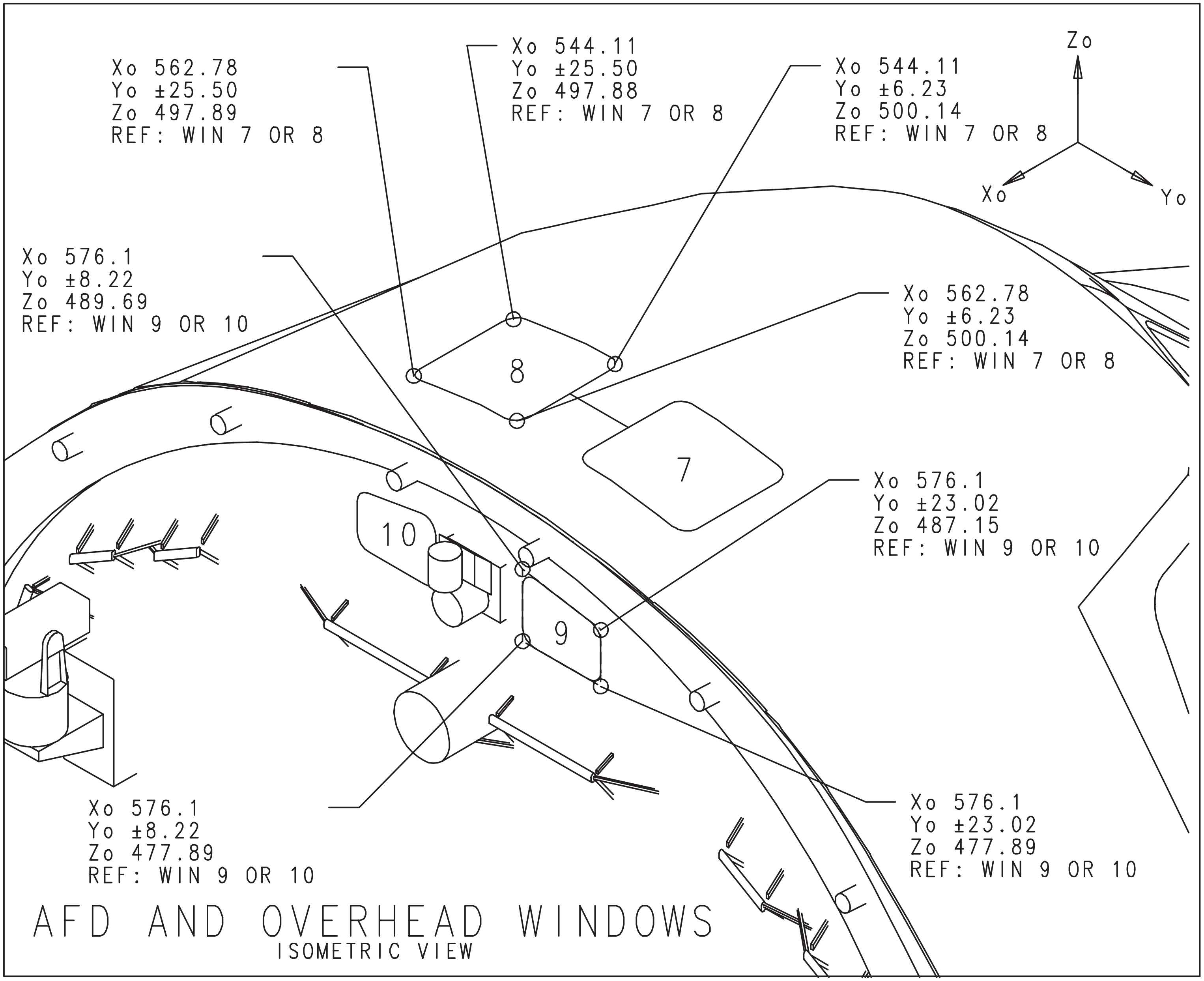


FIGURE 3.1.3.4-1 CREW COMPARTMENT WINDOW LOCATIONS
(SHEET 3 OF 4)

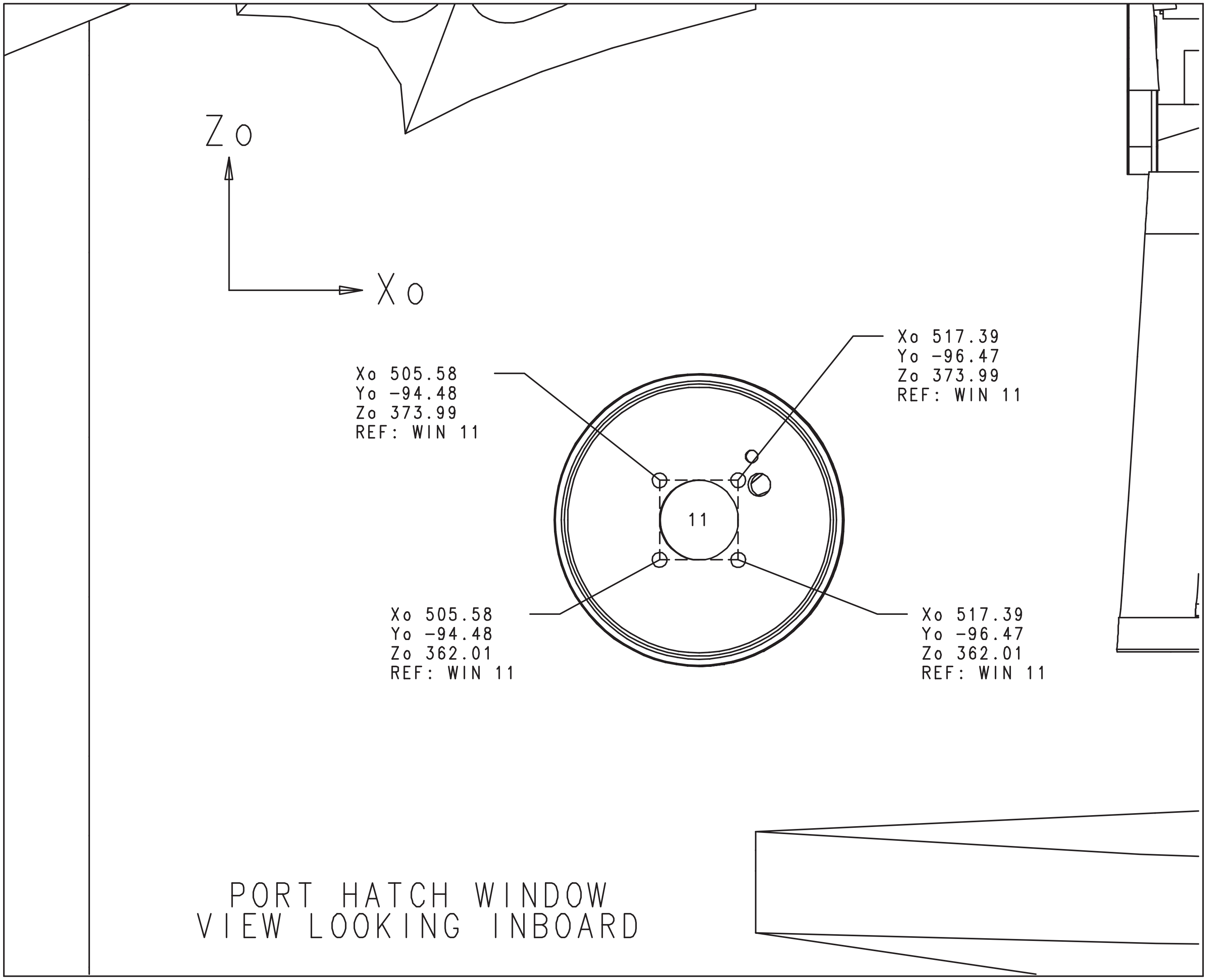


FIGURE 3.1.3.4-1 CREW COMPARTMENT WINDOW LOCATIONS
(SHEET 4 OF 4)

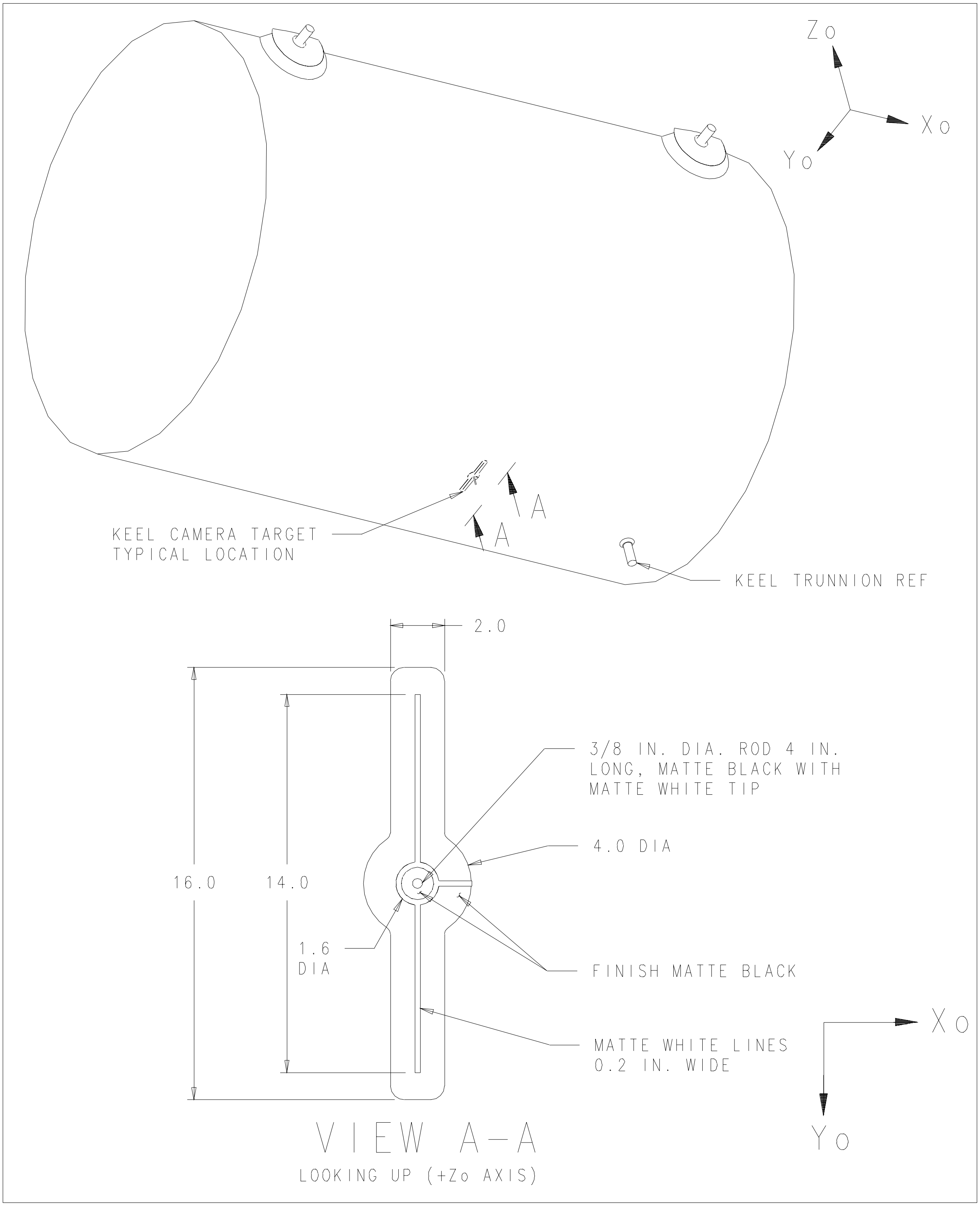


FIGURE 3.1.3.5.1-1 KEEL CAMERA TARGET

THIS PAGE INTENTIONALLY LEFT BLANK.

3.2 INTERFACE LOCATION AND DIMENSIONING

3.2.1 Physical Interface Locations in the Cargo Bay

Shuttle Orbiter/Payload physical interface locations in the cargo bay shall be in accordance with Figure 3.2.1-1. Standard payload electrical interface accommodations are available only at the cargo element end of Standard Mixed Cargo Harness (SMCH) cables in the cargo bay. Some of the electrical interfaces shown in Figure 3.2.1-1 are not directly available and non-standard cables to the cargo element can be provided from these interfaces when agreed to in the Payload Integration Plan (PIP).

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:

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

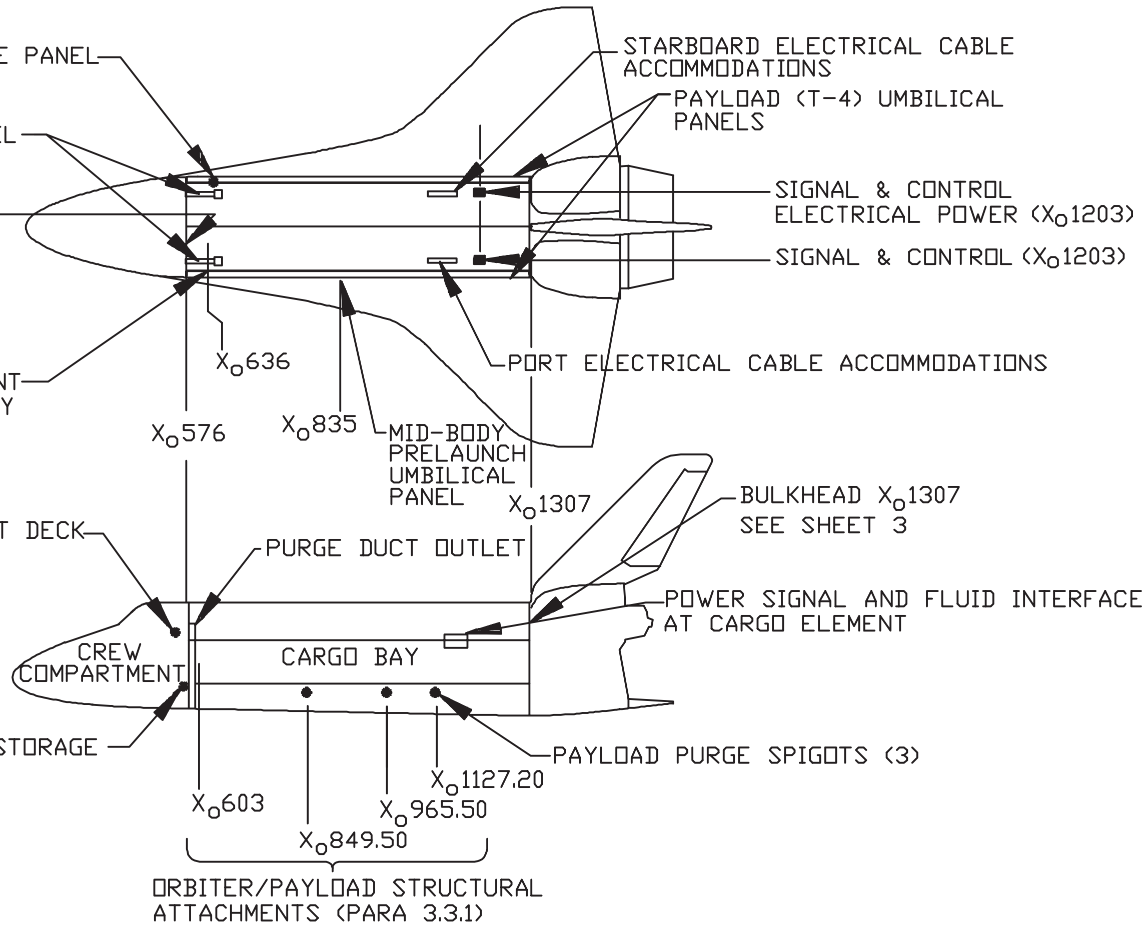


FIGURE 3.2.1-1 SHUTTLE ORBITER PAYLOAD PHYSICAL INTERFACE LOCATIONS

(SHEET 1 OF 3)

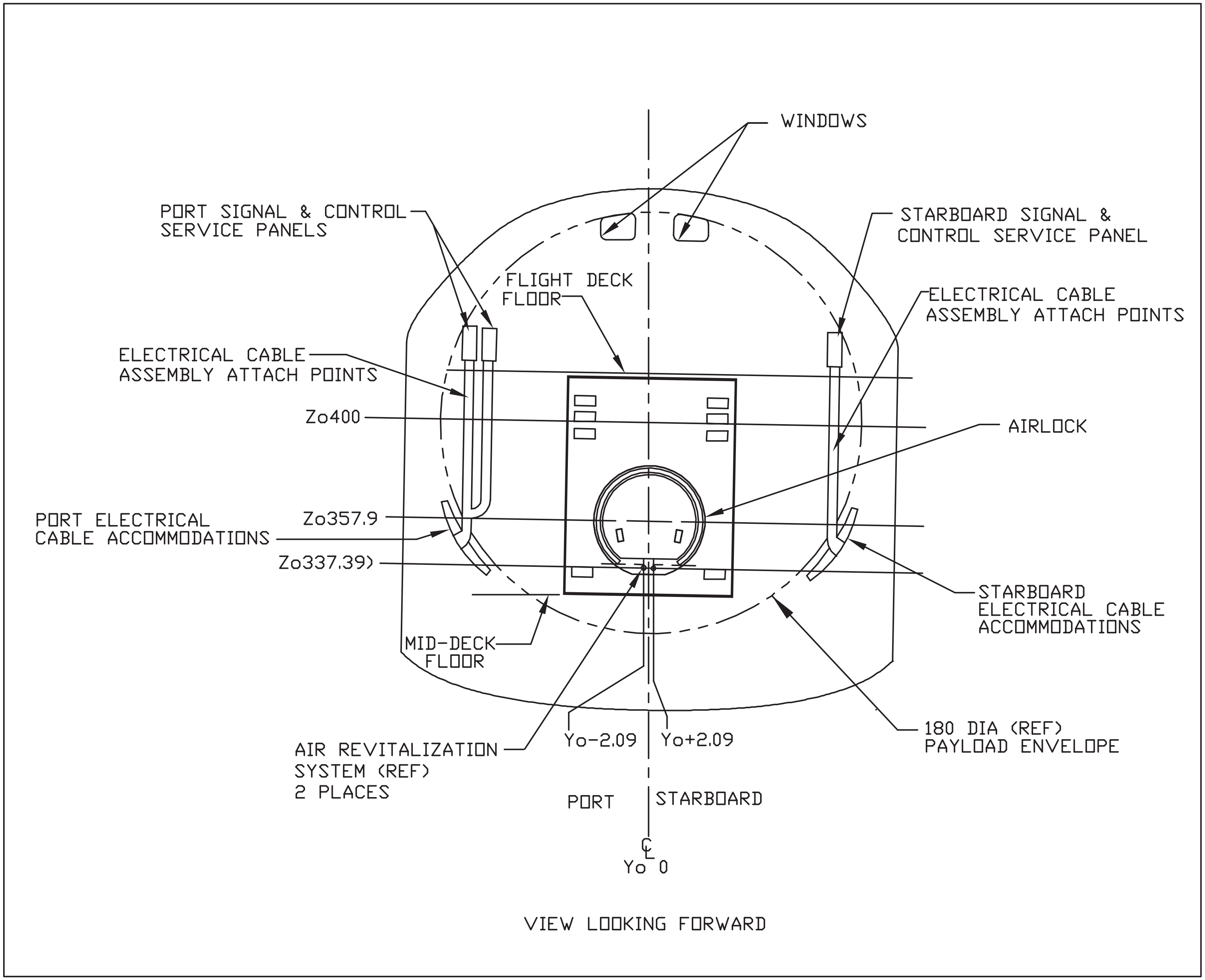


FIGURE 3.2.1-1 SHUTTLE ORBITER PAYLOAD PHYSICAL INTERFACE LOCATIONS - Xo576 BULKHEAD

(SHEET 2 OF 3)

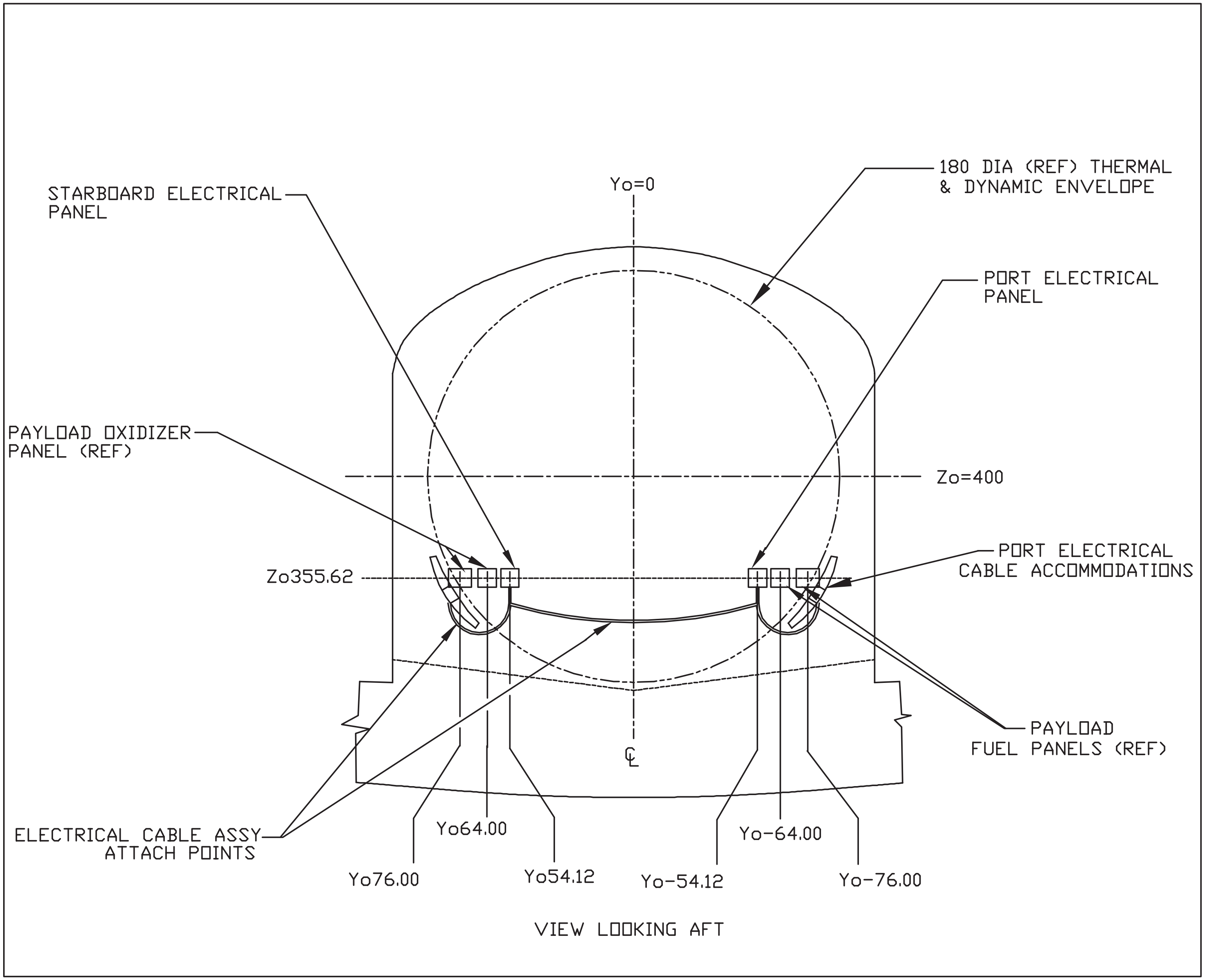


FIGURE 3.2.1-1 SHUTTLE ORBITER PAYLOAD PHYSICAL INTERFACE LOCATIONS - Xo1307
BULKHEAD
(SHEET 3 OF 3)

THIS PAGE INTENTIONALLY LEFT BLANK.

3.3 PAYLOAD BAY

3.3.1 Orbiter/Payload Structural Attachments

Payloads/Payload carriers shall be supported in the cargo bay on payload trunnions extending beyond the payload envelope in the ±Yo directions at Zo=414 and in the minus Zo direction at Yo=0. The trunnions shall be free to slide axially through split self-aligning bearings contained in Orbiter attach fittings defined below, which in turn shall be supported on bridges at the sides of the cargo bay (longerons) and the bottom of the cargo bay (keel). The bridges shall distribute the loads to Orbiter structure. The trunnion/bearing surfaces shall be the interfaces which transmit loads between the Orbiter and the Payload.

The design concept for payload retention at the longeron shall permit Stabilizing Fittings to carry only Z-Z loads by sliding fore and aft on the longeron bridge cap relieving X-X loads, while the payload trunnion is free to slide through the bearing relieving Y-Y loads. Insertion of shear pins between a longeron retention fitting and the bridge converts it to a Primary Fitting, which shall carry X-X loads in addition to Z-Z loads. The keel fitting shall carry only Y-Y loads from the payload keel trunnion which is free to slide in the bearing relieving Z-Z loads; the fitting is free to slide on the keel bridge in the Xo direction, thus relieving X-X loads (Auxiliary Fitting) or can be pinned to the keel bridge to carry X-X loads. Only the payload attachment fittings required for a particular flight will be installed.

3.3.1.1 Attachment Point Locations and Constraints

The Orbiter shall provide the attach points located by nominal Xo, Yo and Zo coordinates as listed in Table 3.3.1.1-1. This table details those longeron attach points which may be used for active and passive longeron fittings and the limitations on their use. It also details those keel attach points which may be used for the active and passive keel fittings, and the limitations on their use. Further limitations on the availability of specific attach points due to limits on trunnion deflections are presented in succeeding paragraphs.

3.3.1.1.1 Attachment Point Locations Tolerances

The Orbiter longeron and keel attachment point location tolerances shall be as defined in Table 3.3.1.1.1-1 and Figure 3.3.1.1.1-1. These attachment tolerances include Orbiter manufacturing and assembly tolerances and the effect of Orbiter structural hysteresis. The tolerances are to be used to calculate preloads induced to the payload attach fittings as specified in Paragraphs 3.3.1.2.1 and 3.3.1.2.2.

The attachment deflections due to Orbiter thermal and mechanical loading are discussed in section 4.1.2.

Points +A and -A are shown at the primary trunnion attach fittings, Point B is at a stabilizer attach fitting, and point C is at the keel attach fitting. Tolerances are shown for both position and form between the points. Tolerances associated with points +A, -A, B and C are applicable to:

(1) Statically determinate or indeterminate cargo element suspension system.
(2) Points B and A assume the primary trunnions are forward of the stabilizer, but the tolerances are applicable for the trunnions reversed.

(3) Keel locations independent of primary/stabilizing fittings. Points A, B and C shall be taken as normal locations. Actual locations of each of these points shall fall within the tolerance envelope specified from its nominal location.

3.3.1.2 Longeron Attachment Interface

The design concept for the longeron attach fitting interface is a nominal 3.245-inch diameter (82.42mm) smooth trunnion on the payload which mates with a split bearing retained in a housing (attach fitting) on the Orbiter longeron. The Payload-to-Orbiter interface will be at the trunnion-to-bearing surface. The attach fitting will be furnished by the Orbiter.

3.3.1.2.1 Attach Fitting and Longeron Trunnion for Non-Deployable Payloads

The longeron trunnion for non-deployable payloads and its attach fitting mechanism on the Orbiter shall be as defined in Figure 3.3.1.2.1-1. This mechanism shall be capable of attaching all statically determinate payloads. It shall also be capable of attaching statically indeterminate payloads which have no longeron trunnion more than 0.412 inch out of the X-Y plane formed by the other three. For such Z redundant payloads, with each trunnion on a separate bridge, the center of the bearing of each longeron attach fitting due to Orbiter manufacturing tolerances shall be within 0.177 inch of the plane through the centers of any other three longeron attach fittings.

For the case of Z redundant payloads with two trunnions on the same longeron bridge (each side of the cargo bay), the out-of-planarity Orbiter tolerance will be within the root-sum-square of 0.030 inch and 0.174 inch times the ratio of the trunnion spacing to the respective bridge span length.

The attach fittings shall be capable of pulling the trunnions in line with the attach fittings. The force applied during installation to bring the trunnions in line with the attach fittings shall be determined by the Root-Sum-Square (RSS) of Orbiter and payload planarity errors due to manufacturing tolerances and by the payload stiffness. This preload shall be combined with the flight loads and assessed against the strength capability of the Orbiter as defined in Appendix I.

The torque imparted to the payload in latching an out-of-plane longeron trunnion will cause the longeron trunnions to deflect in the ±Yo direction and can cause the keel trunnion to deflect in the -Zo direction. See Appendix X for the limits on these deflections.

3.3.1.2.1.1 (Deleted)

3.3.1.2.2 Attach Fitting for Deployable Payloads

The mechanism for deployment and retrieval of payloads shall be as presented in Figure 3.3.1.2.2-1. It shall contain an alignment guide and a payload trunnion latch to secure the payload. The trunnion latch shall be operated by an electromechanical actuator. No more than two latches shall be actuated simultaneously. The mechanism shall be capable of deploying and retrieving statically determinate or indeterminate payloads.

Use of this mechanism for statically indeterminate payloads invokes the following:

a. Ground Installation

1. The planarity error of the Orbiter longeron attach fitting locations due to manufacturing tolerances shall be as specified in Paragraph 3.3.1.1.1. For Z redundant payloads where each longeron trunnion is mounted on a separate bridge, the center of the bearing for each longeron attach fitting due to the Orbiter manufacturing tolerances shall be within 0.177 inch of the plane through the centers of any other three longeron attach fittings.
   For the case of Z redundant payloads with two trunnions on the same longeron bridge (each side of the cargo bay), the out-of-planarity Orbiter tolerance will be within the root-sum-square of 0.030 inch and 0.174 inch times the ratio of the trunnion spacing to the respective bridge span length.

2. The planarity error of the four payload longeron trunnions due to manufacturing tolerances shall be determined by the payload supplier.

3. The trunnion displacement from the Orbiter attach fittings shall be defined as the root-sum-square (RSS) of the two planarity errors defined in 1 and 2 above.

4. The mechanism shall be capable of latching down the trunnions provided that the payload stiffness does not exceed the allowable value given in Figure 3.3.1.2.2-2 for the trunnion displacement determined in 3 above.

5. The force required to pull down the trunnions, a preload, shall be combined with the flight loads and assessed against the strength capability of the Orbiter structure as defined in Appendix I.

b. On-Orbit Retrieval

1. In lieu of an analysis to determine the Orbiter planarity error due to on-orbit thermal deformation for a specific payload longeron attach location, the maximum Orbiter planarity error due to on-orbit thermal deformation shall be 0.30 inch.

2. The payload planarity error due to on-orbit thermal deformation shall be determined by the payload supplier.

3. The trunnion displacement from the Orbiter attach fittings due to on-orbit thermal deformation shall be defined as the root-sum-square (RSS) of the two planarity errors defined in 1 and 2 above.

4. The planarity errors of the Orbiter and payload due to manufacturing tolerances shall be the same as in ground installation.

5. The trunnion displacement from the Orbiter attach fittings to secure the payload shall be defined as the root-sum-square (RSS) of both Orbiter and payload planarity errors due to on-orbit thermal deformation and manufacturing tolerances as shown by the following equation:

$A = (ORBITER^2 + PAYLOAD^2)$ MANUFACTURING TOLERANCES ON ORBIT THERMAL

$B = (ORBITER^2 + PAYLOAD^2)$

TOTAL PLANARITY ERROR = $\sqrt{A + B}$

6. The mechanism shall be capable of latching down the trunnions provided that the payload stiffness does not exceed the allowable value given in Figure 3.3.1.2.2-2 for trunnion displacement determined in 5 above.

7. The force required to pull down the trunnions shall be combined with the flight loads and assessed against the strength capability of the Orbiter structure as defined in Appendix I.

The torque imparted to the payload in latching an out-of-plane longeron trunnion will cause the longeron trunnions to deflect in the ±Y direction and can cause the keel trunnion to deflect in the -Z direction. See Appendix X for the allowable limits on these deflections.

3.3.1.2.2.1 Payload Alignment Guide

The Orbiter active longeron latches provide integral alignment guides to constrain the payload motion during berthing and deployment operations. The integral guides extend 8 inches above the payload attach point centerline. Auxiliary guide extensions are available in lengths of 22 and 24 inches to attach to the latches to increase the height above the payload attach point centerline. The height of the guides are dependent upon payload requirements and location of the selected attach points. The extended guides have both left-handed and right-handed versions for placement of the 24 inch guide on the far side of the trunnion from the cargo bay camera viewing position.

3.3.1.2.2.2 Longeron Trunnion for Deployable Payloads

The longeron trunnion for deployable payloads shall be as defined in Figure 3.3.1.2.2.2-1. The scuff plate shall interface with the inboard surfaces of the alignment guides to restrict motion in the Yo directions and thus preclude inadvertent contact between the cargo element and Orbiter structure during installation, deployment, retrieval or removal from the cargo bay.

3.3.1.2.3 Payload Longeron Trunnion Yo Travel

Maximum and minimum longeron trunnion lengths shall be limited by Orbiter structure and by combined deflections of the Orbiter and the payload as defined in Appendix X. To prevent excessive trunnion deflections in the Yo direction, the payload design shall incorporate features (such as scuff plates) that shall cause initial contact to occur against the inboard surface of the Orbiter longeron latch.

3.3.1.2.4 Longeron Trunnion Spacing

Minimum allowable longeron trunnion spacing for vertical installation/removal of cargo elements shall be in accordance with Figure 3.3.1.2.4-1.

3.3.1.3 Keel Fitting Interface

The Orbiter shall provide either an active or a passive keel fitting for each payload/carrier. The active keel fitting shall be capable of capturing and releasing the payload keel trunnion, both on the ground and in flight; the passive keel fitting shall not have this capability.

3.3.1.3.1 Active Keel Fitting Interface

Payloads using the active keel fitting shall provide a keel trunnion in accordance with Figure 3.3.1.3.1-1. The interface between the active keel fitting and the payload keel trunnion shall be in accordance with Figure 3.3.1.3.1-1.

3.3.1.3.2 Passive Keel Fitting Interface

The passive keel fitting shall be used only with prior SSP approval and for payloads which are installed with the Orbiter in the horizontal position and shall not be used in lieu of the active keel fitting for deployable/retrievable payloads. Payloads using the passive keel fitting shall provide a keel trunnion in accordance with Figure 3.3.1.3.2-1. The interface between the passive keel trunnion and the passive keel fitting shall be as shown on Figure 3.3.1.3.2-2.

3.3.1.4 Ground Handling at KSC

Cargo elements may be installed in the Orbiter with the Orbiter in either a horizontal or vertical attitude. All cargo elements shall be capable of being removed from the Orbiter in a vertical attitude. For two flight longeron payloads, appropriate GSE (such as a ground handling trunnion) shall be provided by the payload to facilitate ground handling for horizontal and vertical installation and removal and shall conform to the constraints of Paragraph 3.1.2.1.1.

3.3.1.4.1 Horizontal Cargo Element Installation and Removal

A clearance envelope at the longeron trunnion interface shall be provided for horizontal cargo element installation/removal operations in accordance with Figure 3.3.1.4.1-1. GSE end caps on longeron trunnions for cargo element horizontal installation/removal operations shall be in accordance with Figure 3.3.1.4.1-2.

3.3.1.4.2 Vertical Cargo Element Installation and Removal

A clearance envelope at the longeron trunnion interface shall be provided for vertical cargo element installation/removal operation in accordance with Figure 3.3.1.4.2-1.

3.3.1.4.3 Payload Segments Cross Connect Criterion

During vertical transfer operations of a payload consisting of two segments, payload segments motion apart (separation) and motion together (approaching) can occur due to PGHM manipulation. The payload shall make design provisions to allow for plus or minus 5.0 inches of segment motion from the nominal position. This motion applies to all payload cross connect equipment-cables, fluid lines, wires, etc. The five inch motion assumes that the cross connect equipment is located at the same Zo elevation and that the minimum trunnion spacing is per Figure 3.3.1.2.4-1.

3.3.1.5 ODS Structural Interface

Physical interface definition for the ODS (when it is installed in the cargo bay) shall be as shown in Figure 3.3.1.5-1.

TABLE 3.3.1.1-1 ATTACHMENT POINT LOCATIONS AND CONSTRAINTS*

Number	Xo	Keel Fitting			Longeron Fitting		
	(Inches)	Active	** Passive	Notes	Active	Passive	Notes
155	612.73		(13)				
156	616.67	x	x		(3,9,15)	(3)	
157	620.60	x	x		(3,9,15)	x	
158	624.53		(11)		(3,9,15)	(9)	
159	628.47				(3,9,15)	x	
160	632.40				(3,9,15)	x	
163	644.20				(3,15)	x	
164	648.13				(3,15)	x	
165	652.07		x		(3,10,15)	(10)	
166	656.00	x	x		(3,10,15)	(10)	
167	659.93	x	x		(3,10,15)	(10)	
168	663.87	x	x				
169	667.80	x	x				
170	671.73	x	x				
171	675.67	x	x				
172	679.60	(1)	(11)				
177	699.27				(3,6)	x	
178	703.20				(6)	x	
179	707.13				(6)	x	
180	711.07	(1)	x		(6)	x	
181	715.00	x	x		x	x	
182	718.93	x	x		(5)	x	
183	722.87	x	x		(5)	x	
184	726.80	x	x		(5)	x	
185	730.73	x	x		(3,5)	(3)	
186	734.67	x	x				
187	738.60		x				
188	742.53					(3)	
189	746.47					x	
192	758.27				(3,5)	x	
193	762.20				(5)	x	
194	766.13		(11)		(5)	x	
195	770.07	x	x		(5)	x	
196	774.00	x	x		x	x	
197	777.93	x	x		x	x	
198	781.87	x	x		(10)	(10)	
199	785.80	x	x		(5,10)	(10)	
200	789.73	x	x		(5)	x	
201	793.67	(1)	x		(5)	x	
202	797.60				(5)	x	
203	801.53				(3,5)	x	
206	813.33				(3)	x	
207	817.27				x	x	
208	821.20		(11)		x	x	
209	825.13	(1)	x		x	x	

TABLE 3.3.1.1-1 ATTACHMENT POINT LOCATIONS AND CONSTRAINTS*
(CONTINUED)

Number	Xo	Keel Fitting			Longeron Fitting		
	(Inches)	Active	** Passive	Notes	Active	Passive	Notes
210	829.07	x	x		x	x	
211	833.00	x	x		x	x	
212	836.93	x	x				
213	840.87	x	x				
214	844.80	x	x		x	x	
215	848.73	x	x		(10)	(10)	
216	852.67		x		(10)	(10)	
217	856.60				(5)	x	
218	860.53				(3,5)	x	
221	872.33				(3)	x	
222	876.27				x	x	
223	880.20	(1)	x		x	x	
224	884.13	(1)	x		x	x	
225	888.07	x	x		x	x	
226	892.00	x	x		x	x	
227	895.93	x	x		(3)	x	
228	899.87	x	x				
229	903.80	x	x				
230	907.73		x				
234	923.47				(3,6)	x	
235	927.40				(6)	x	
236	931.33				(6,10)	(10)	
237	935.27		(11)		(5,10)	(10)	
238	939.20	x	x		(5)	x	
239	943.13	x	x		(5)	x	
240	947.07	x	x		(5)	x	
241	951.00	x	x		x	x	
242	954.93	x	x		(10)	(10)	
243	958.87	x	x		(3,10)	(3,10)	
244	962.80	x	x				
245	966.73		x				
247	974.60					x	
250	986.40				(3)	x	
251	990.33				x	x	
252	994.27		(11)		x	x	
253	998.20	x	x		x	x	
254	1002.13	x	x		x	x	
255	1006.07	x	x		x	x	
256	1010.00	x	x		x	x	
257	1013.93	x	x		(5)	x	
258	1017.87	x	x		(5)	x	
259	1021.80	x	x		(5)	x	
260	1025.73	x	x		(5)	x	
261	1029.67		x		(10)	(10)	

TABLE 3.3.1.1-1 ATTACHMENT POINT LOCATIONS AND CONSTRAINTS*
(CONTINUED)

Number	Xo	Keel Fitting			Longeron Fitting		
	(Inches)	Active	** Passive	Notes	Active	Passive	Notes
262	1033.60				(10)	(10)	
263	1037.53				(3)	x	
266	1049.33				(3)	x	
267	1053.27				x	x	
268	1057.20	(1)	x		x	x	
269	1061.13	x	x		x	x	
270	1065.07	x	x		x	x	
271	1069.00	x	x		x	x	
272	1072.93	x	x		x	x	
273	1076.87	(1)	x		(5)	x	
274	1080.80				(3,5)	x	
277	1092.60				(3,5)	x	
278	1096.53				(10)	(10)	
279	1100.47				(10)	(10)	
280	1104.40				(10)	(10)	
281	1108.33	(1)	x		x	x	
282	1112.27	x	x		(5)	x	
283	1116.20	x	x		(5)	x	
284	1120.13	x	x		(5)	x	
285	1124.07	x	x		(5)	x	
286	1128.00		x		(5)	x	
287	1131.93				(5)	x	
288	1135.87				(3)	x	
292	1151.60				(3)	(3)	
293	1155.53		x		(8)	x	
294	1159.47	x	x		x	x	
295	1163.40	x	x		x	x	
296	1167.33	x	x		x	x	
297	1171.27	x	x		x	x	
298	1175.20	x	x	14	(3)	x	
299	1179.13		x	14		(3)	
304	1198.80					(3)	14
305	1202.73				(3,10)	(10)	14
306	1206.67	x	x	14	(5,10)	(10)	14
307	1210.60	x	x	14	(5)	x	14
308	1214.53	x	x	14	(5)	x	14
309	1218.47	x	x	14	(5,12)	x	14
310	1222.40	x	x	14	(5,12)	x	14
311	1226.33	x	x	14	(12)	x	14
312	1230.27			14	(9)	x	14
313	1234.20				(9)	(9)	14
314	1238.13				(9)	x	14
315	1242.07				(9)	x	14

TABLE 3.3.1.1-1 ATTACHMENT POINT LOCATIONS AND CONSTRAINTS*
(CONTINUED)

Number	**Xo**	**Keel Fitting**			**Longeron Fitting**		
	(Inches)	Active	** Passive	Notes	Active	Passive	Notes
316	1246.00					(3)	14
322	1269.60				(17)	(3)	14
323	1273.53				(3,17)	(17)	14
324	1277.47				(3)	x	14
325	1281.40					x	14

GENERAL NOTES:

* "x" denotes attachment capability. A number in parentheses indicates attachment capability as limited in note.

** Visual observation of the payload keel trunnion/keel attach fitting interface is required during installation of a payload using a passive keel fitting.

A 24 inch high trunnion guide may be used at all available longeron attach points which are not referenced to Note 5, Note 6, Note 7 or Note 8.

Additional trunnion attachment locations that are not referenced in this table must be evaluated on a case-by-case basis by SSP and may require negotiation in the MIP/PIP.

SPECIAL NOTES:

The following restraints are applicable to certain attach points as referenced in the "Notes" column and under attachment type. They do not apply to other attach points.

1. Payload retrieval capability at this location may be marginal and must be evaluated on a case-by-case basis by SSP (keel latch opening not symmetrical about attach point Xo location in open position).

2. Reserved.

3. These longeron attach points may be used only for primary fittings; i.e., the fitting must be pinned to the longeron.

4. Available at port side only.

TABLE 3.3.1.1-1 ATTACHMENT POINT LOCATIONS AND CONSTRAINTS*
(CONTINUED)

SPECIAL NOTES: (Continued)

5. These longeron attach points are available for deployment and retrieval operations with the integral 8 inch high trunnion guides (No extended guides).

6. These longeron attach points are available for deployment and retrieval operations with the integral 8 inch high trunnion guides on the RMS side (port) and unrestricted trunnion guides on the non-RMS side (starboard).

7. When the RMS is installed, these attach points are available for deployment and retrieval operations only with the integral 8 inch high trunnion guide on the RMS side.

8. These longeron attach points are available with the integral 8 inch guide on the stabilizing fitting and a 22 or 24 inch guide on the primary fitting.

9. These longeron attach points may not be available for use when the short EVA slidewire assembly is installed. Use of these locations for longeron attach points is permitted when the long slidewire assembly is installed.

10. Trunnion lengths at these attach points shall be selected to meet the criteria in Appendix X when trunnion spacing in the Xo direction is greater than 100 inches.

11. Passive keel trunnion lengths at these attach points shall be selected to meet the criteria in Appendix X.

12. Utilization of this longeron attach point with the EVA slidewire assembly installed is dependent upon selection of specific latch configuration and orientation.

13. Use requires a special evaluation/analysis by NASA/JSC. This location is normally restricted to a pinned passive fitting.

14. Attach points 298 through 325 are not available for payloads manifested with EDO pallet.

15. Extended guides may not be used on latches on the right hand side due to interference with the KU-Band antenna.

TABLE 3.3.1.1-1 ATTACHMENT POINT LOCATIONS AND CONSTRAINTS*
(CONTINUED)

16. CE installation/retrieval at these locations require maximum longeron trunnion tip dimension of Yo=±96.50.

17. These longeron attach points may not be available for use when the long EVA slidewire assembly is installed. Use of these locations for longeron attach points are permitted when the short EVA slidewire assembly is installed.

TABLE 3.3.1.1.1-1 PAYLOAD ATTACH POINT LOCATION TOLERANCES

TOLERANCES OF POSITION	**X_o**	**Y_o**	**Z_o**
pt +A relative to pt +A pt -A relative to pt -A pt -A relative to pt -A pt C relative to pt C pt C relative to pt A pt B relative to pt B	±.073 ±.070 N/A	.062 OUTBD .090 INBD +.088 -.127 ±.072 .062 OUTBD .090 INBD	+.090 -.087 ±.136 .163 -.162 ±.090
TOLERANCES OF FORM	**X_o**	**Y_o**	**Z_o**
STRAIGHTNESS			
pt +A relative to pt -A pt B relative to pt A	.103	 .109	.125 .125
PERPENDICULARITY			
pt C relative to pt A	.101	.095 -.115	

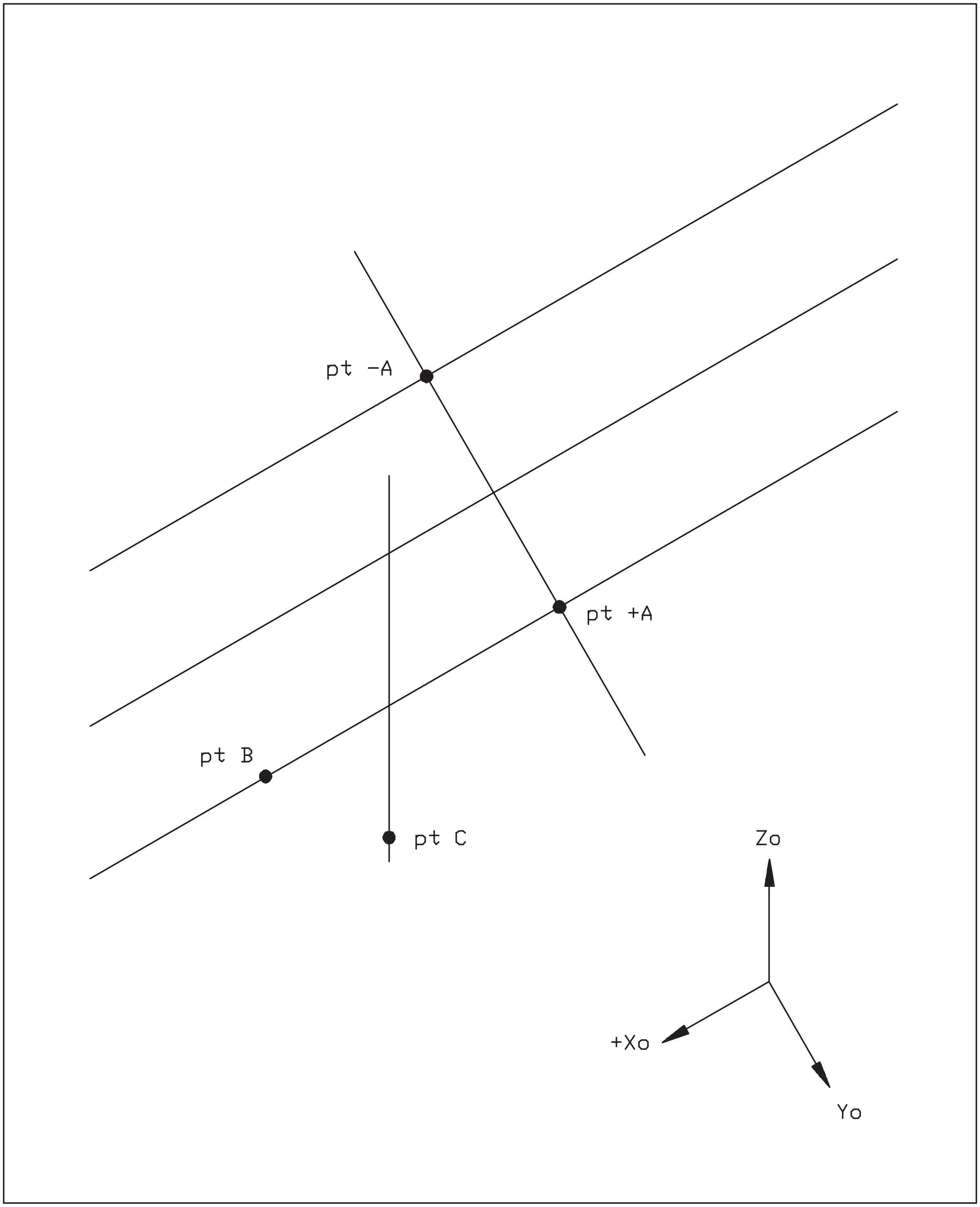


FIGURE 3.3.1.1.1-1 PAYLOAD ATTACH POINT LOCATION TOLERANCES

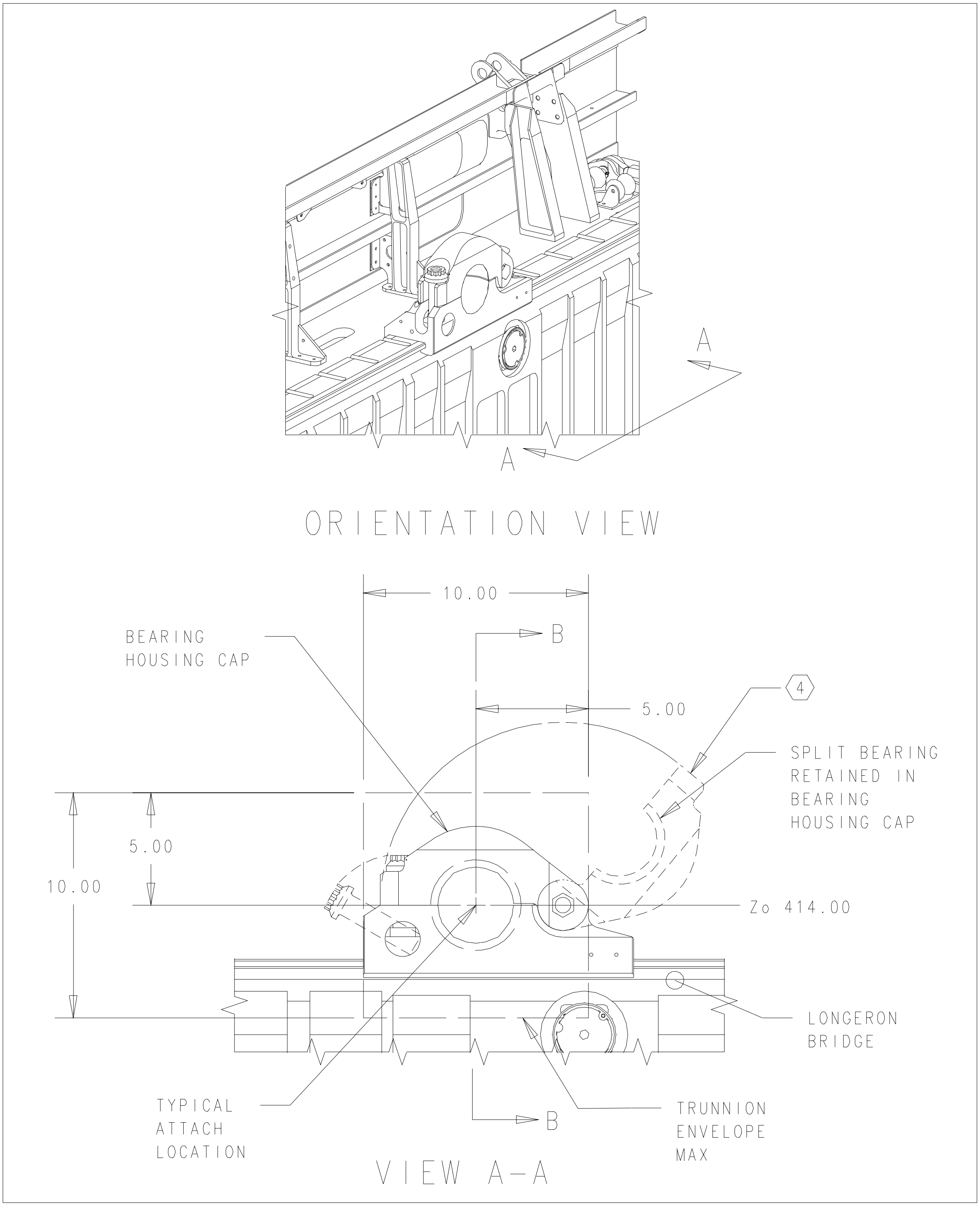
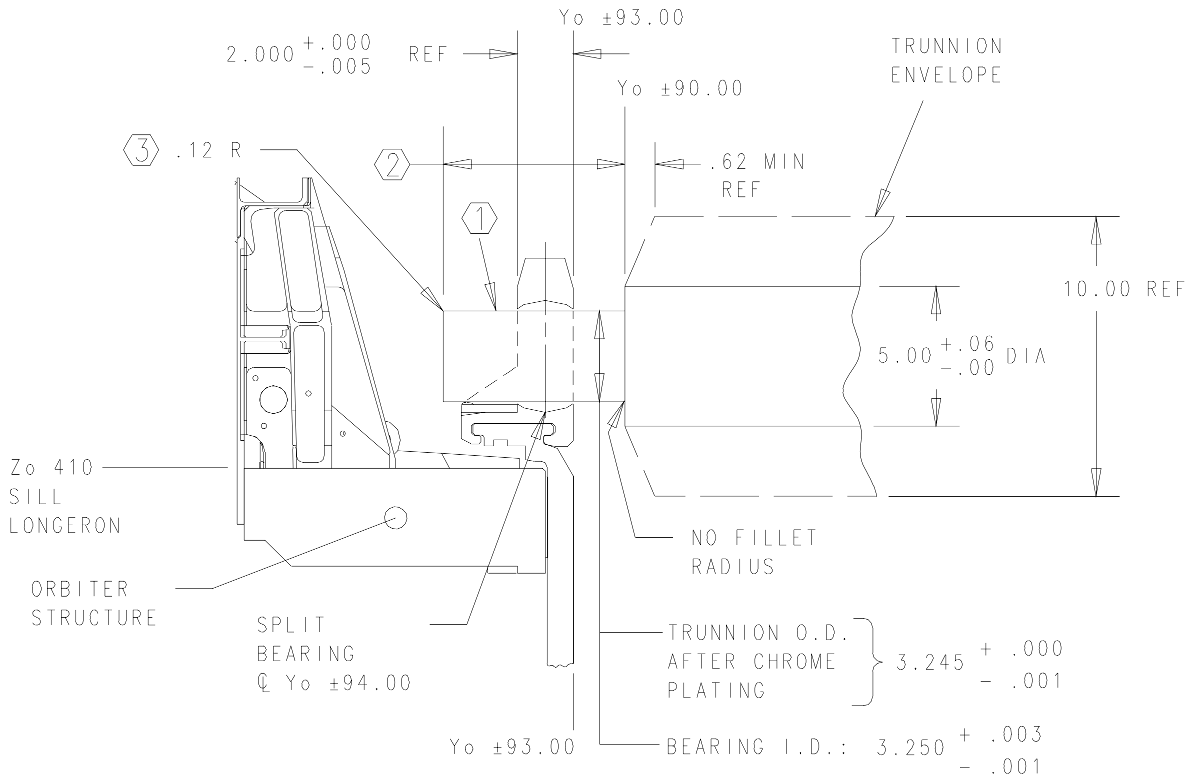


FIGURE 3.3.1.2.1-1 LONGERON ATTACHMENT MECHANISM AND ASSOCIATED PAYLOAD TRUNNION FOR NONDEPLOYABLE CARGO ELEMENTS

(SHEET 1 OF 2)



SECTION B-B

NOTES:

1. TRUNNION SURFACE MATERIAL:
ON NICKEL-BASED ALLOYS (E.G., INCONEL 718) ELECTRO-DEPOSITED CHROME (PER FEDERAL SPEC QQ-C-320B, CLASS 2), THICKNESS 0.0003 IN. (0.008 MM) MINIMUM.
ON TITANIUM: ELECTRO DEPOSITED CHROME (PER ROCKWELL SPEC MA0109-318) THICKNESS 0.002 IN. (0.05 MM) MINIMUM. TRUNNION SURFACE FINISH AFTER CHROME PLATING 8√ (8 RHR, MEASURED IN MICROINCHES - EQUIVALENT TO 0.2 MICRON). SUBSEQUENT TO GRINDING, THE FINAL SURFACE FINISH SHALL BE OBTAINED BY POLISHING, LAPPING, BUFFING, OR SIMILAR METHODS.

2. THE TRUNNION LENGTH SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
FOR TRUNNION SPACING IN THE Xo DIRECTION ≤100 INCHES - LENGTH IS 6.50 INCHES.
FOR TRUNNION SPACING IN THE Xo DIRECTION >100 INCHES - LENGTH IS 7.75 INCHES.
NOTE: FOR SOME LONGERON TRUNNION LOCATIONS (THAT ARE IDENTIFIED IN TABLE 3.3.1.1.1-1), THE TRUNNION LENGTH SHALL COMPLY WITH SECTION 3.3.1.1.2.3 AND APPENDIX X RESTRICTIONS IN LIEU OF THE ABOVE VALUES.

3. THIS RADIUS FAIRED WITH NO MISMATCH TO CYLINDRICAL SURFACE.

4. BEARING HOUSING CAP SHOWN SWINGING AFT. ATTACH FITTINGS ARE INTERCHANGEABLE FROM THE STARBOARD SIDE TO PORT, REVERSING SWING DIRECTION.

FIGURE 3.3.1.2.1-1 LONGERON ATTACHMENT MECHANISM AND ASSOCIATED PAYLOAD TRUNNION FOR NONDEPLOYABLE CARGO ELEMENTS

(SHEET 2 OF 2)

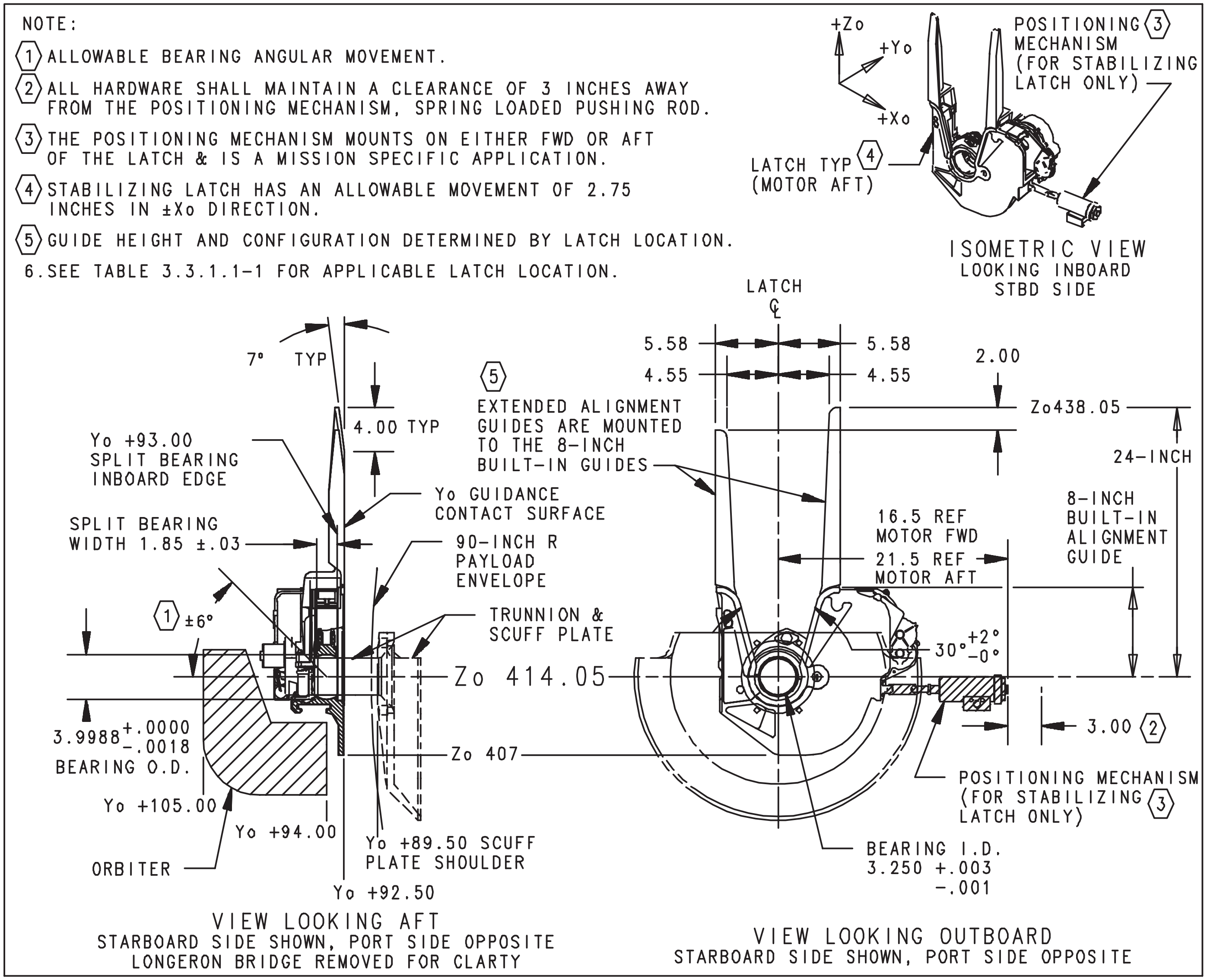


FIGURE 3.3.1.2.2-1 ACTIVE ATTACH FITTING

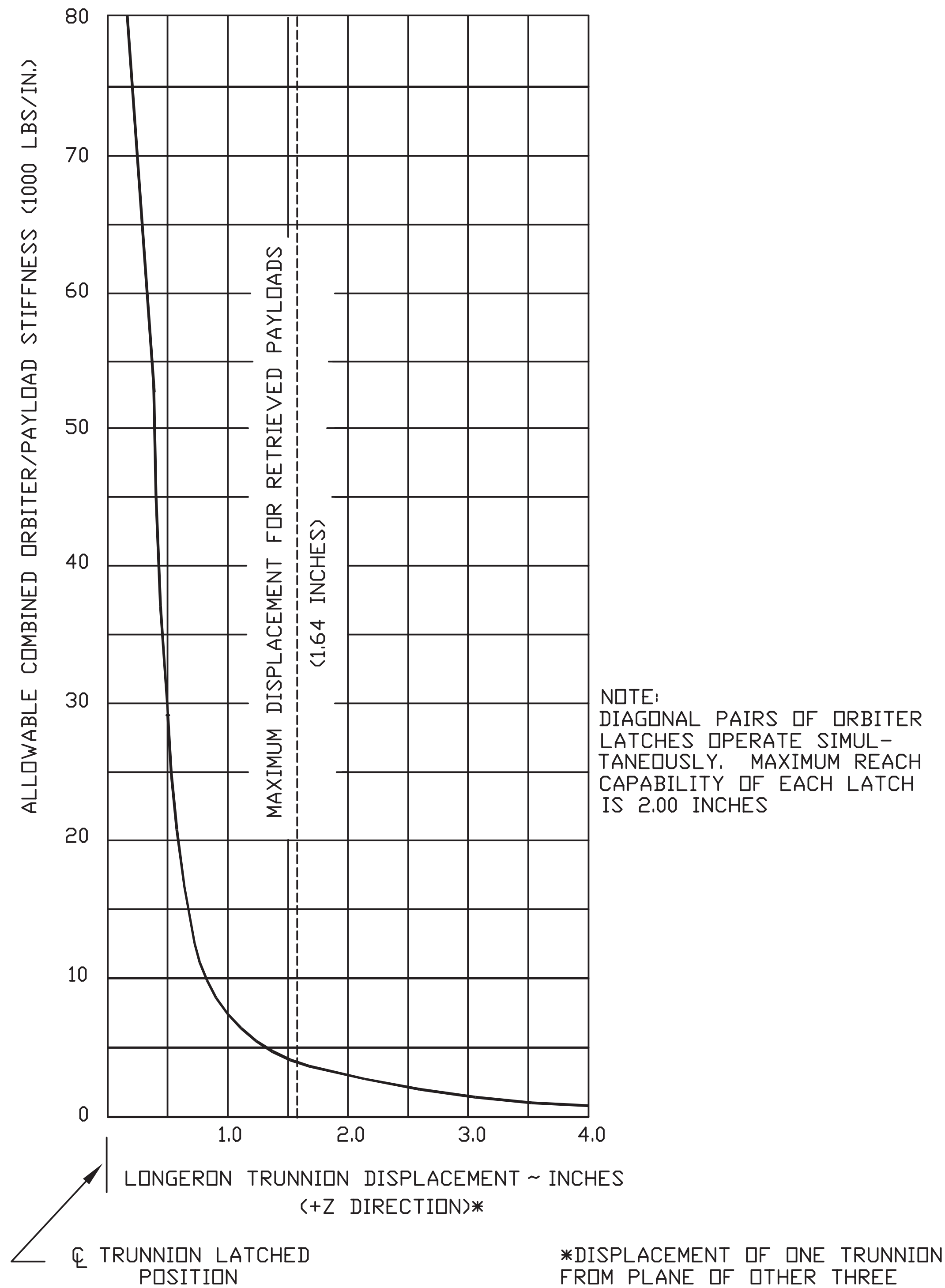
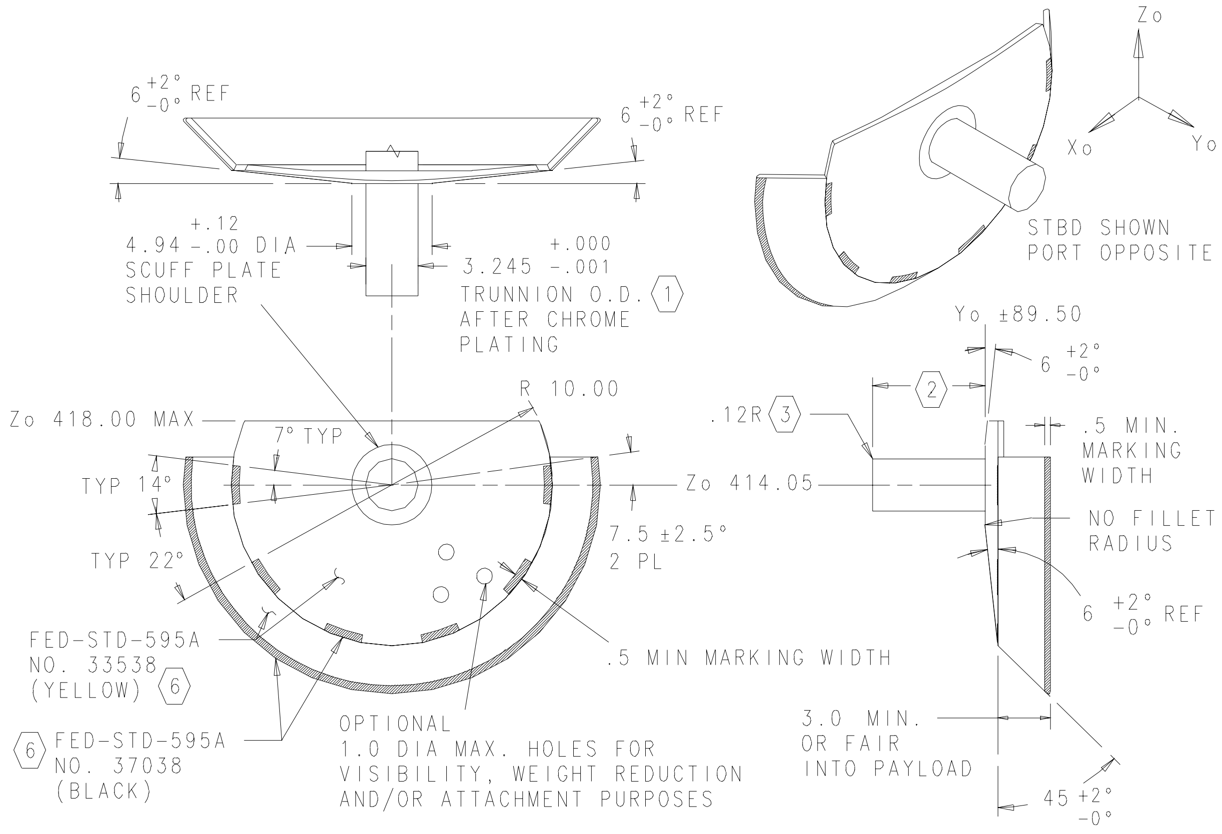


FIGURE 3.3.1.2.2-2 ALLOWABLE COMBINED ORBITER/PAYLOAD STIFFNESS BASED ON ORBITER LATCHING CAPABILITY



NOTES:

1. TRUNNION SURFACE MATERIAL:
ON NICKEL-BASED ALLOYS (e.g. INCONEL 718): ELECTRO-DEPOSITED CHROME (PER FEDERAL SPEC QQ-C-320B, CLASS 2), THICKNESS 0.0003 IN. (0.008 MM) MIN.
ON TITANIUM: ELECTRO-DEPOSITED CHROME (PER ROCKWELL SPEC. MA0109-318), THICKNESS 0.002 IN. (0.05 MM) MIN. TRUNNION SURFACE FINISH AFTER CHROME PLATING 8√ (8 RHR, MEASURED IN MICROINCHES EQUIVALENT TO 0.2 MICRON). SUBSEQUENT TO GRINDING, THE FINAL SURFACE FINISH SHALL BE OBTAINED BY POLISHING, LAPPING, BUFFING, OR SIMILAR METHODS.

2. THE TRUNNION LENGTH SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
FOR TRUNNION SPACING IN THE Xo DIRECTION ≤100 INCHES - LENGTH IS 7.00 INCHES
FOR TRUNNION SPACING IN THE Xo DIRECTION >100 INCHES - LENGTH IS 8.25 INCHES
NOTE: FOR SOME LONGERON TRUNNION LOCATIONS (THAT ARE IDENTIFIED IN TABLE 3.3.1.1.1-1), THE TRUNNION LENGTH SHALL COMPLY WITH SECTION 3.3.1.1.2.3 AND APPENDIX X RESTRICTIONS IN LIEU OF THE ABOVE VALUES.

3. THIS RADIUS FAIRED WITH NO MISMATCH TO CYLINDRICAL SURFACE.

4. AT SUPPLIER'S OPTION, SCUFF PLATE MAY BE A SEPARATE PIECE ATTACHED TO THE TRUNNION OR MAY BE AN INTEGRAL PART OF THE TRUNNION OR CARGO ELEMENT.

5. SCUFF PLATE IMPACT REQUIREMENT: ENERGY EQUIVALENT TO CARGO ELEMENT MASS MOVING AT 0.11 FT/SEC (32K CARGO ELEMENT MAX.).

6. THE BLACK AND YELLOW COLORS ARE NOT REQUIRED FOR ANY CARGO ELEMENT WHICH DOES NOT RETURN WITH THE SAME MISSION ON WHICH IT WAS DEPLOYED.

FIGURE 3.3.1.2.2.2-1 LONGERON TRUNNION AND SCUFF PLATE FOR DEPLOYABLE CARGO ELEMENTS

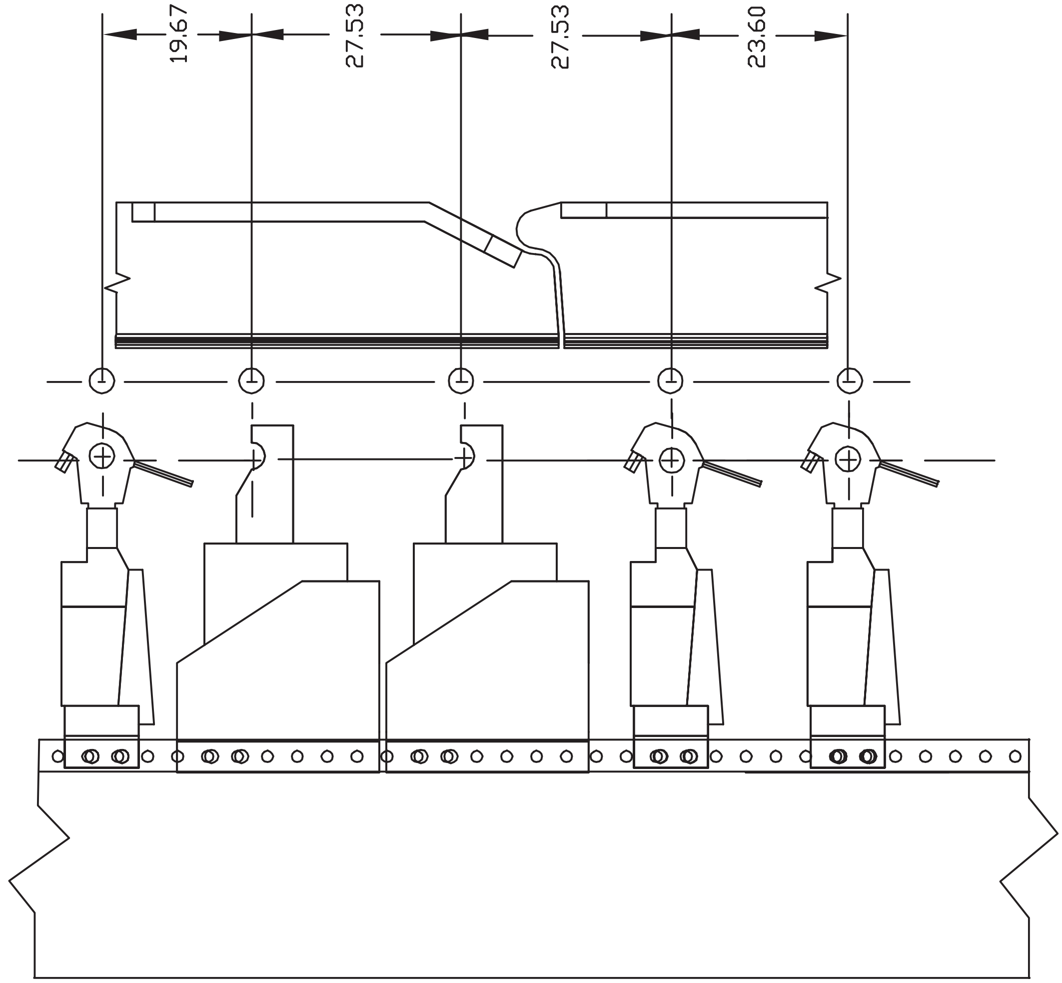
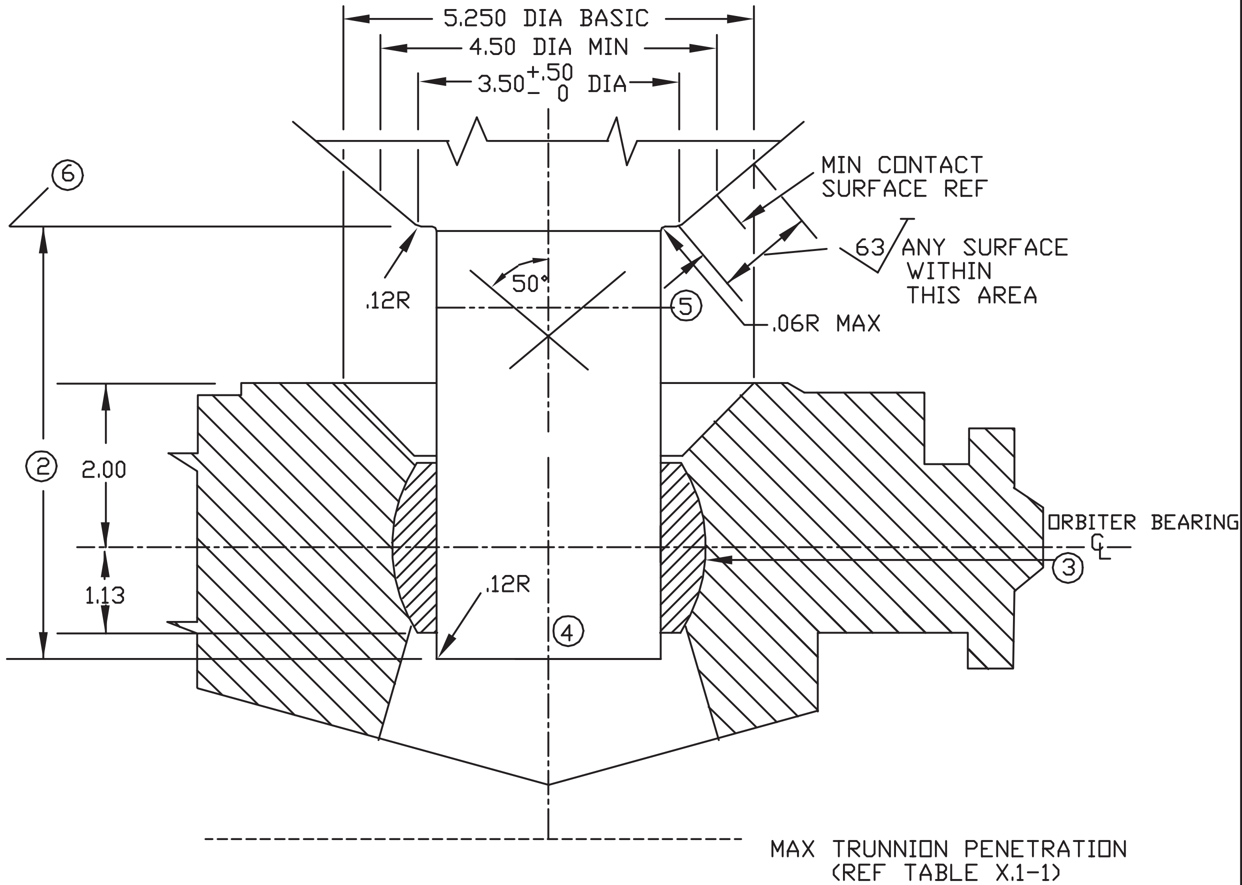


FIGURE 3.3.1.2.4-1 MINIMUM ALLOWABLE LONGERON TRUNNION SPACING FOR VERTICAL INSTALLATION/REMOVAL



NOTES:

1. TRUNNION CYLINDRICAL SURFACE MATERIAL: HARD, DENSE, FINEGRAINED, ELECTRODEPOSITED CHROME TO WITHIN 0.15 INCH OF ROOT. NICKLE-BASED ALLOYS ARE TO BE PLATED PER FED SPEC QQ-C-320B, CLASS 2: THICKNESS SHALL BE 0.0003 INCH MIN. TITANIUM IS TO BE PLATED PER ROCKWELL SPEC MA0109-318: THICKNESS SHALL BE 0.002 INCH MIN. TRUNNION FINISH AFTER PLATING SHALL 8 (8 RHR, MEASURED IN MICROINCHES).

(2) TRUNNION LENGTH SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
FORWARD OF Xo1191.00 - LENGTH IS 8.00 INCHES
AFT OF Xo1191.00 - LENGTH IS 4.82 INCHES

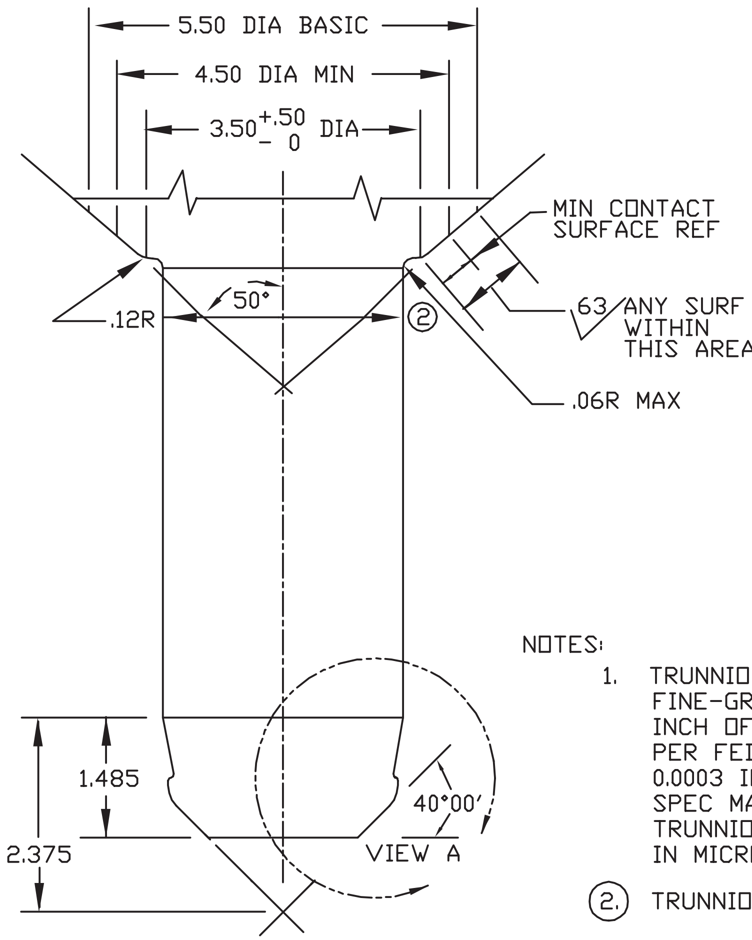
(3) SELF-ALIGNING SPLIT BEARING, INSIDE DIAMETER 3.000 + 0.001, -0.000. BEARING CENTERLINE AT Zo305.025 FORWARD OF Xo1191, AT Zo308.40 AFT OF Xo1191.

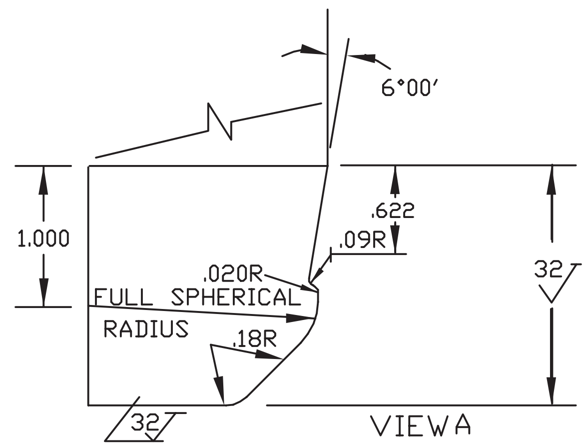
(4) BLEND WITHOUT MISMATCH WITH CYLINDRICAL O.D.

(5) TRUNNION O.D. AFTER CHROME PLATING: $2.9960^{+.0000}_{-.0010}$

(6) TRUNNION STATIC LOCATION AT Zo309.50 FORWARD OF Xo1191, AT Zo311.10 AFT OF Xo1191.

FIGURE 3.3.1.3.1-1 PAYLOAD KEEL TRUNNION FOR ACTIVE KEEL FITTING



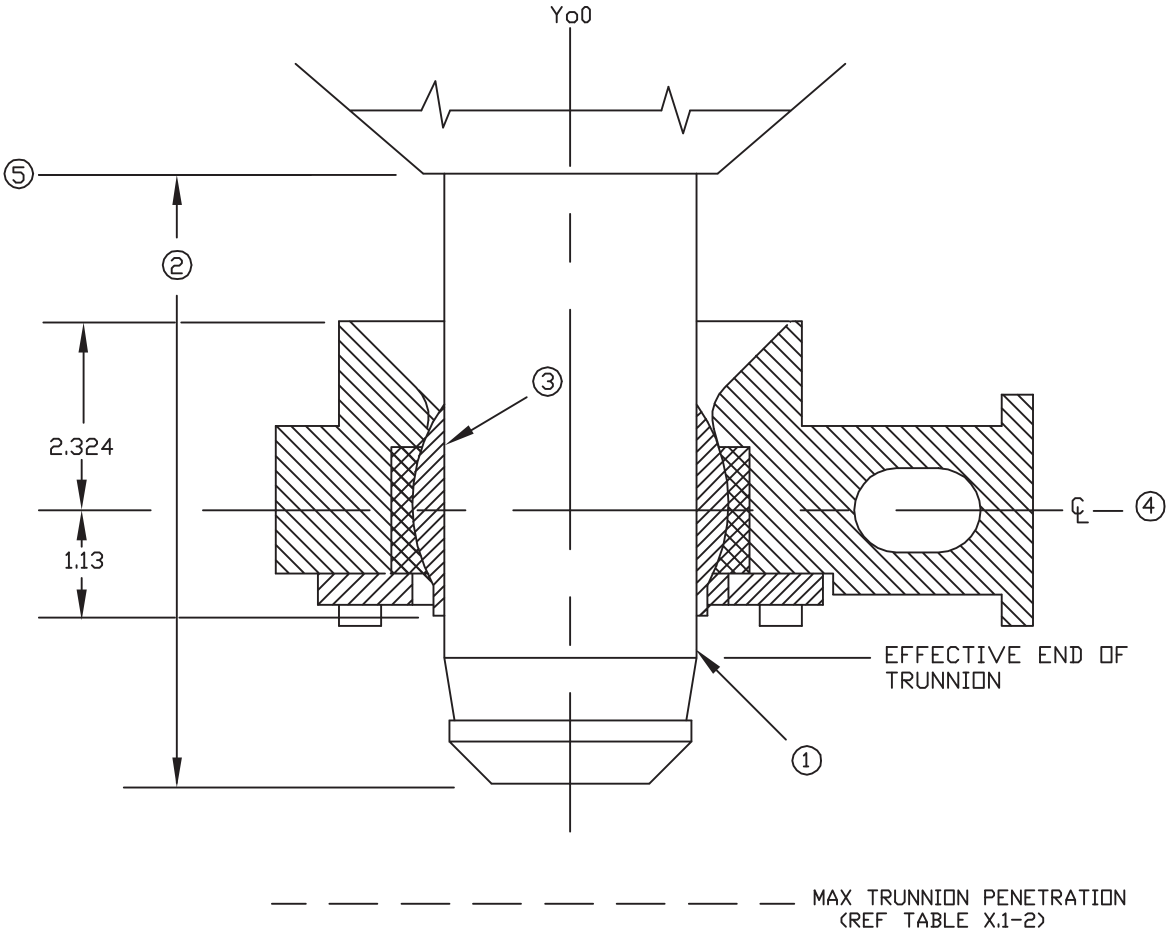


NOTES:

1. TRUNNION CYLINDRICAL SURFACE MATERIAL: HARD, DENSE, FINE-GRAINED, ELECTRODEPOSITED CHROME TO WITHIN 0.25 INCH OF ROOT. NICKEL-BASED ALLOYS ARE TO BE PLATED PER FED SPEC QQ-C-320B, CLASS 2: THICKNESS SHALL BE 0.0003 INCH MIN. TITANIUM IS TO BE PLATED PER ROCKWELL SPEC MA0109-318; THICKNESS SHALL BE 0.002 INCH MIN. TRUNNION FINISH AFTER PLATING SHALL BE 8 (8RHR, MEASURED IN MICROINCHES).

(2.) TRUNNION O.D. AFTER CHROME PLATING 2.9960 +.0000,-.0010

FIGURE 3.3.1.3.2-1 PAYLOAD PASSIVE KEEL TRUNNION DETAILS



NOTES:

1. PASSIVE KEEL TRUNNION - SEE FIGURE 3.3.1.3.2-1
2. TRUNNION LENGTH SHALL BE SUCH THAT THE EFFECTIVE END OF TRUNNION SHALL REMAIN WITHIN THE LIMITS ESTABLISHED IN APPENDIX X UNDER COUPLED ORBITER AND CARGO ELEMENT DEFLECTIONS.
3. SELF-ALIGNING BEARING ASSEMBLY, INSIDE DIAMETER 3.0000+.0010,-0.0000 AND 2.26 INCH LONG
4. BEARING CENTERLINE AT Zo305.025 FORWARD OF Xo1191, AT Zo308.40 AFT OF Xo1191
5. TRUNNION STATIC LOCATION AT Zo309.50 FORWARD OF Xo1191, AT Zo311.10 AFT OF Xo1191

FIGURE 3.3.1.3.2-2 PASSIVE KEEL ATTACHMENT INTERFACE DETAILS

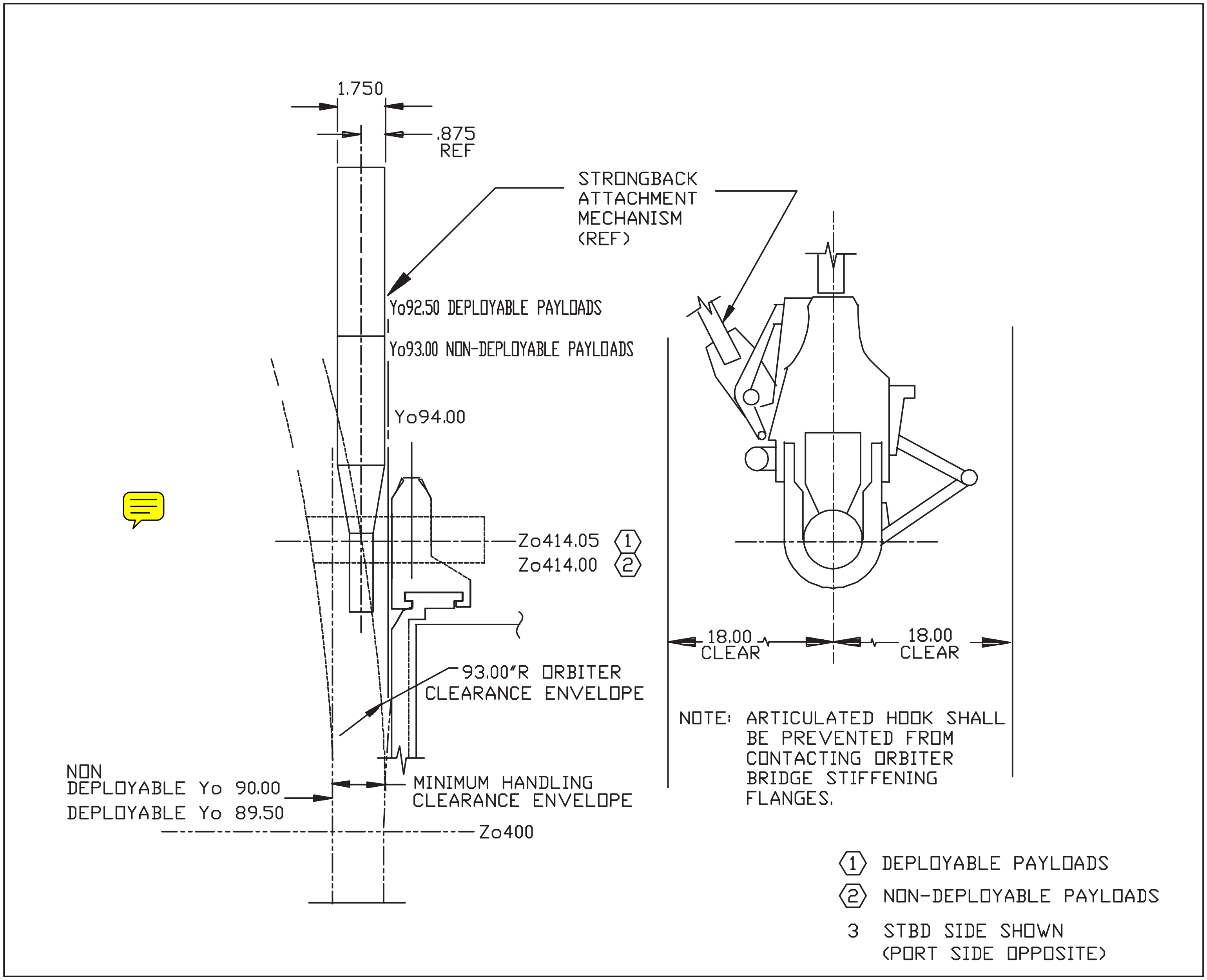


FIGURE 3.3.1.4.1-1 HORIZONTAL GROUND HANDLING ACCESS CLEARANCE ENVELOPE

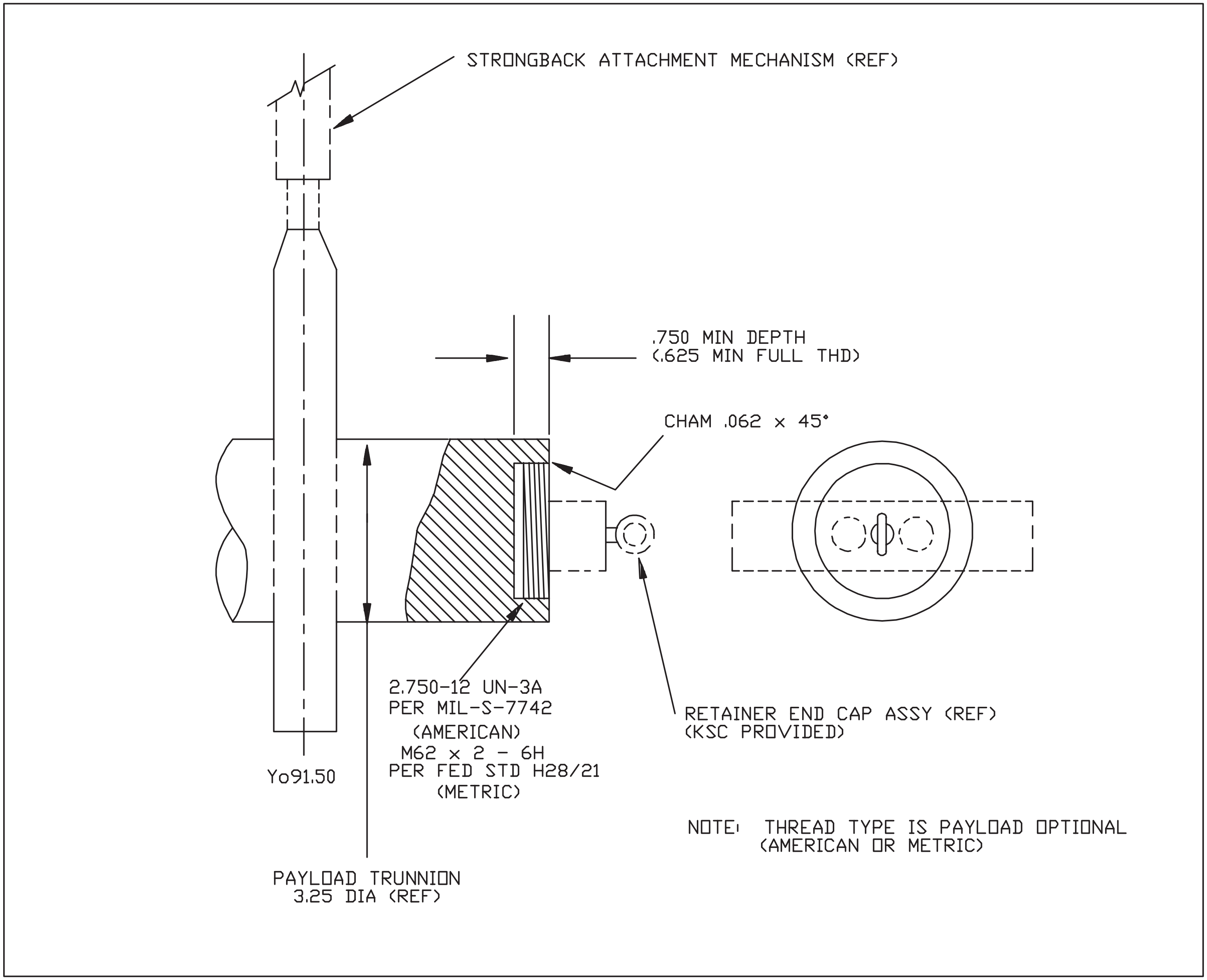


FIGURE 3.3.1.4.1-2 TRUNNION WITH END CAP

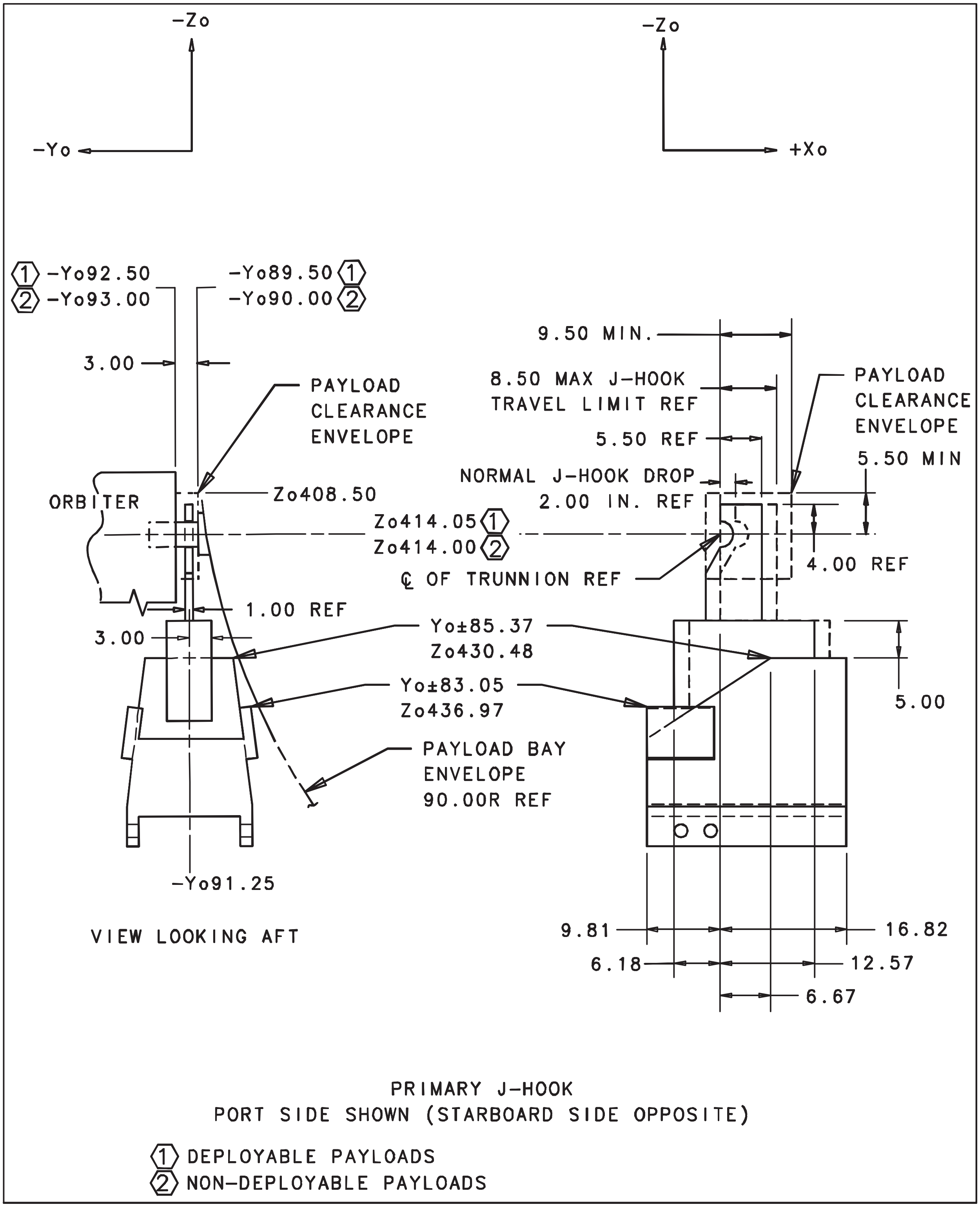


FIGURE 3.3.1.4.2-1 VERTICAL GROUND HANDLING CLEARANCE ENVELOPE FOR J-HOOK FITTING

(SHEET 1 OF 2)

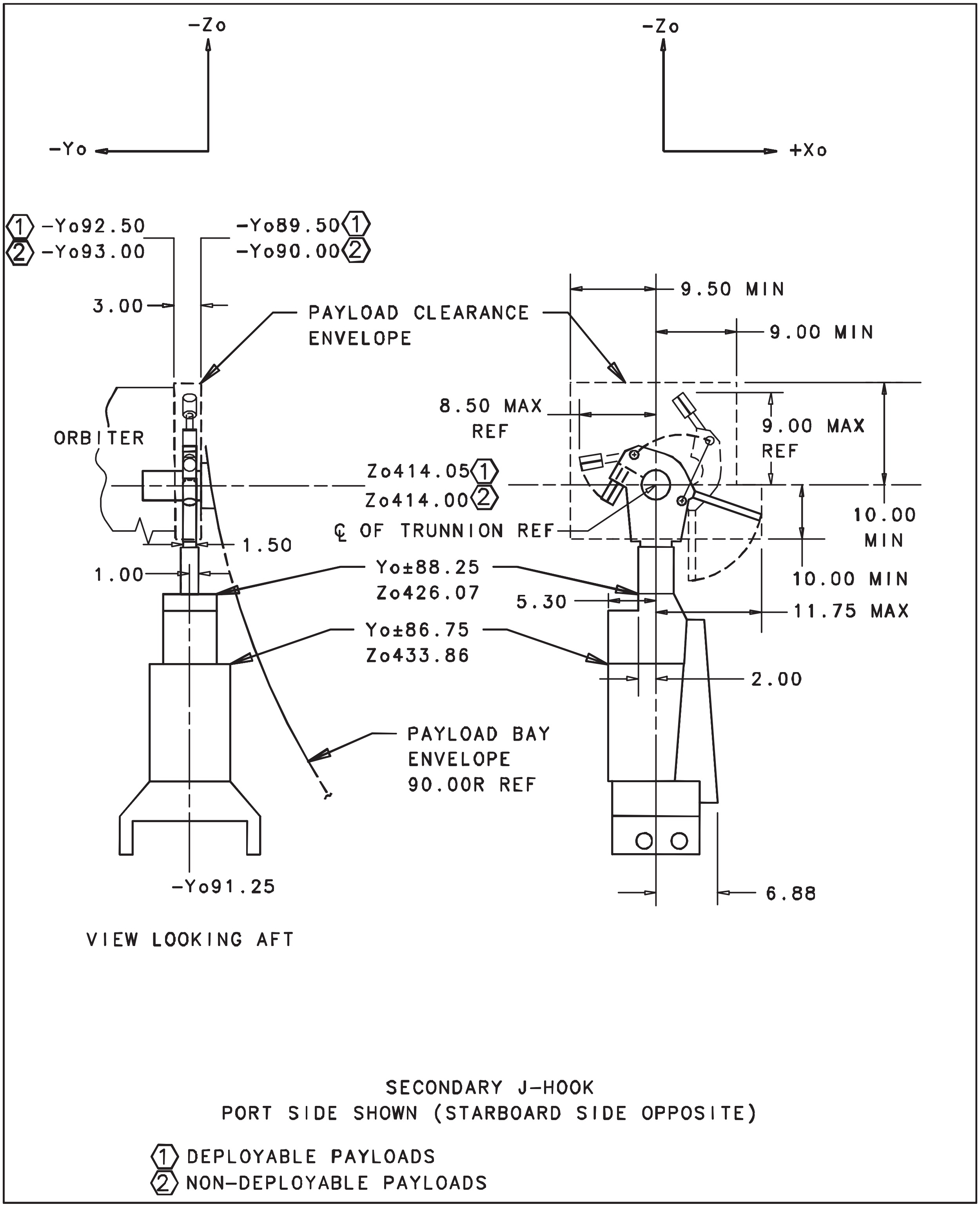


FIGURE 3.3.1.4.2-1 VERTICAL GROUND HANDLING CLEARANCE ENVELOPE FOR J-HOOK FITTING

(SHEET 2 OF 2)

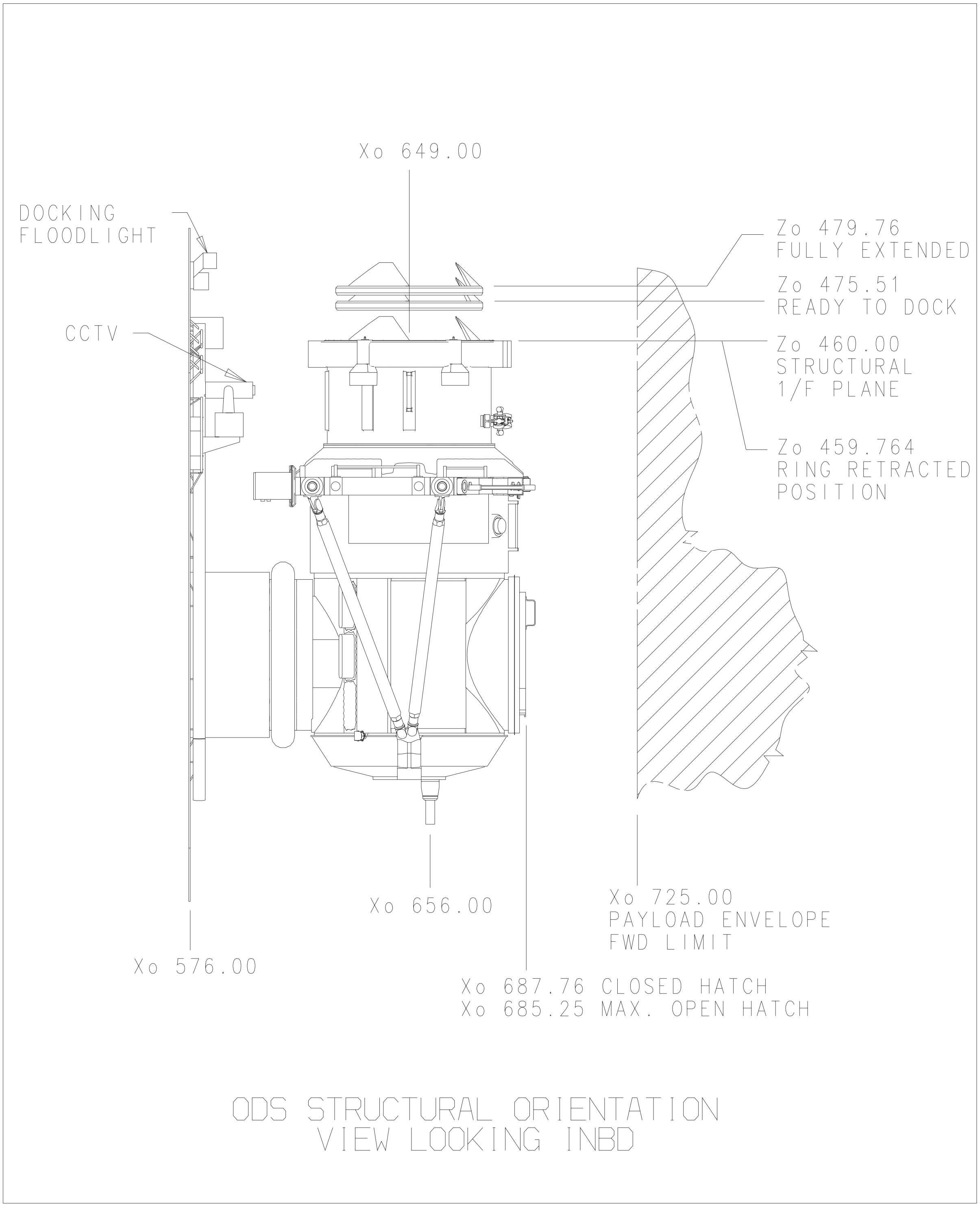


FIGURE 3.3.1.5-1 ODS STRUCTURAL INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

3.3.2 Standard Interface Panel (SIP)

Standard Interface Panels (SIP), located on the port and/or starboard sides of the cargo bay, shall provide interface provisions for the Standard Mixed Cargo Harness (SMCH), add-on black boxes, unique connector panels, structural support and clamps for cables and the Payload Active Cooling Kit (PACK). The relationship of the SIP to the element within the cargo bay shall be as shown in Figure 3.3.2-1 for bridge and Adaptive Payload Carrier (APC) mount configuration. For electrical interface definition refer to Section 13.3. Typical SIP-PACK configuration is as shown in Figure 3.3.5.2.1-1.

3.3.2.1 Standard Mixed Cargo Harness - Standard Interface Panel (SMCH-SIP)

SIP, with a SMCH Interface Panel Installed (SMCH-SIP), shall be the electrical interface between the Orbiter and the Cargo Element.

3.3.2.1.1 Port SMCH-SIP Connector Panel

The port SMCH-SIP connector panel shall be as shown in Figure 3.3.2.1.1-1.

3.3.2.1.2 Starboard SMCH-SIP Connector Panel

The starboard SMCH-SIP connector panel shall be as shown in Figure 3.3.2.1.2-1. The starboard SMCH-SIP connector panel shall provide cut-outs for additional connectors and one spare power connector. Connector cut-outs and a spare power connector are available for cargo element use to accommodate payload unique requirements as agreed to in the Payload Integration Plan (PIP).

3.3.2.2 SMCH-SIP Connectors and Cargo Element Supplied Harness

All SMCH-SIP connectors shall consist of socket (female) contacts for interfacing with the SMCH cables and pin (male) contacts for interfacing with cargo element supplied cables. Cargo element supplied cables shall extend 50.0 ± 2.0 inches beyond their departure from the cargo element structure, and either be hardwired to the cargo element or shall terminate in pin (male) contacts for interfacing with the cargo element. The cargo element shall provide cable support, as required, such that there shall be no unsupported lengths of cables greater than 18 inches. The departure point for the cargo element supplied cables shall be no more than 18 inches from the Orbiter sill. The length of the cable shall provide adequate allowance for routing and a bend radius at the interface for ease of mating and demating of connectors. with adequate allowance for mating and demating of connectors.

3.3.2.2.1 Wire Harness Installation

Cargo element supplied wire harnesses shall be installed in accordance with MIL-W-5088. Wire harness installation and routing from the cargo element to the SMCH-SIP shall be a STS function. Wire harness departure from the cargo element structure shall be in the forward direction and shall be as shown in Figure 3.3.2-1.

3.3.2.3 Payload Retention Latch Actuator (PRLA) Power Interface Panel

The PRLA Power Interface Panel shall be STS supplied as shown in Figure 3.3.2.3-1. It shall be mounted on Standard Interface Panels (SIP). Pin function assignments are as shown in Table 13.6.1.2-7.

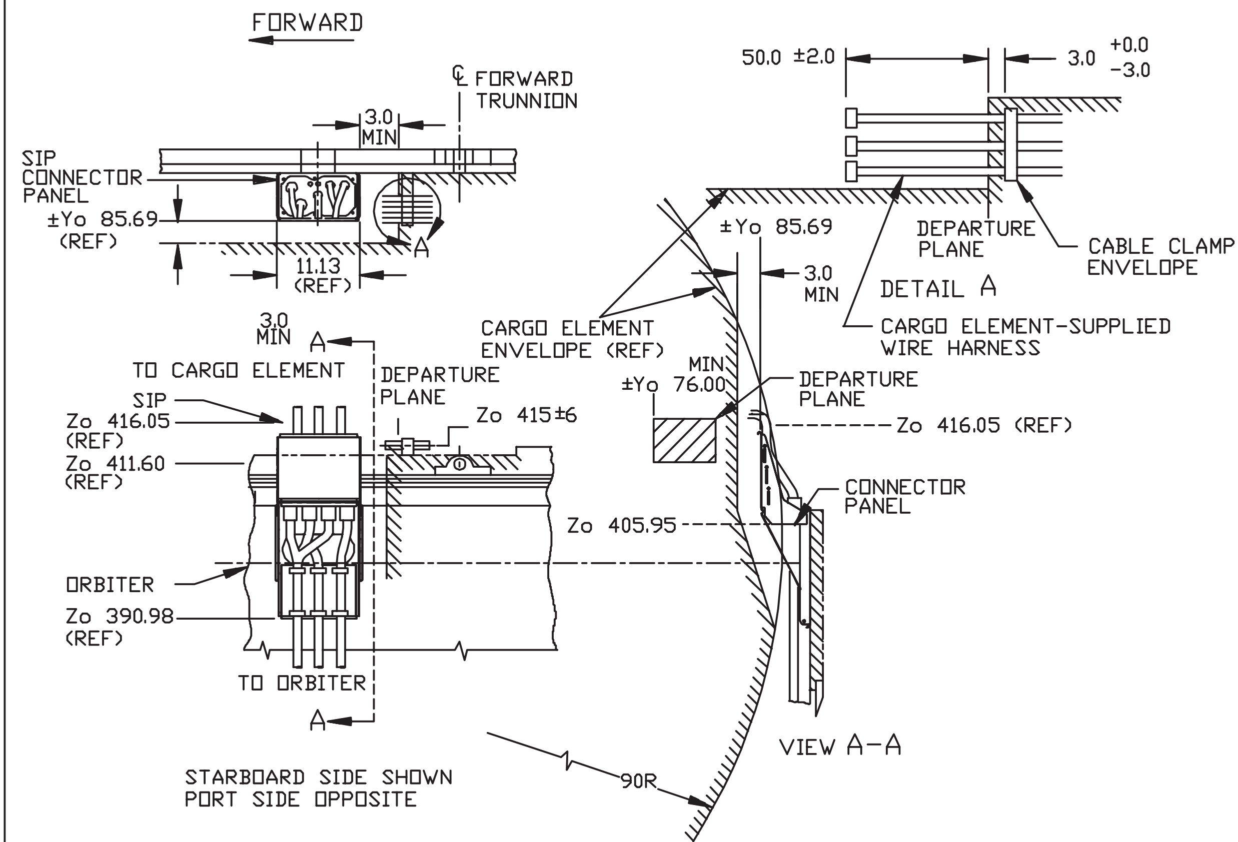


FIGURE 3.3.2-1 SIP LOCATION (BRIDGE-MOUNTED)

(SHEET 1 OF 2)

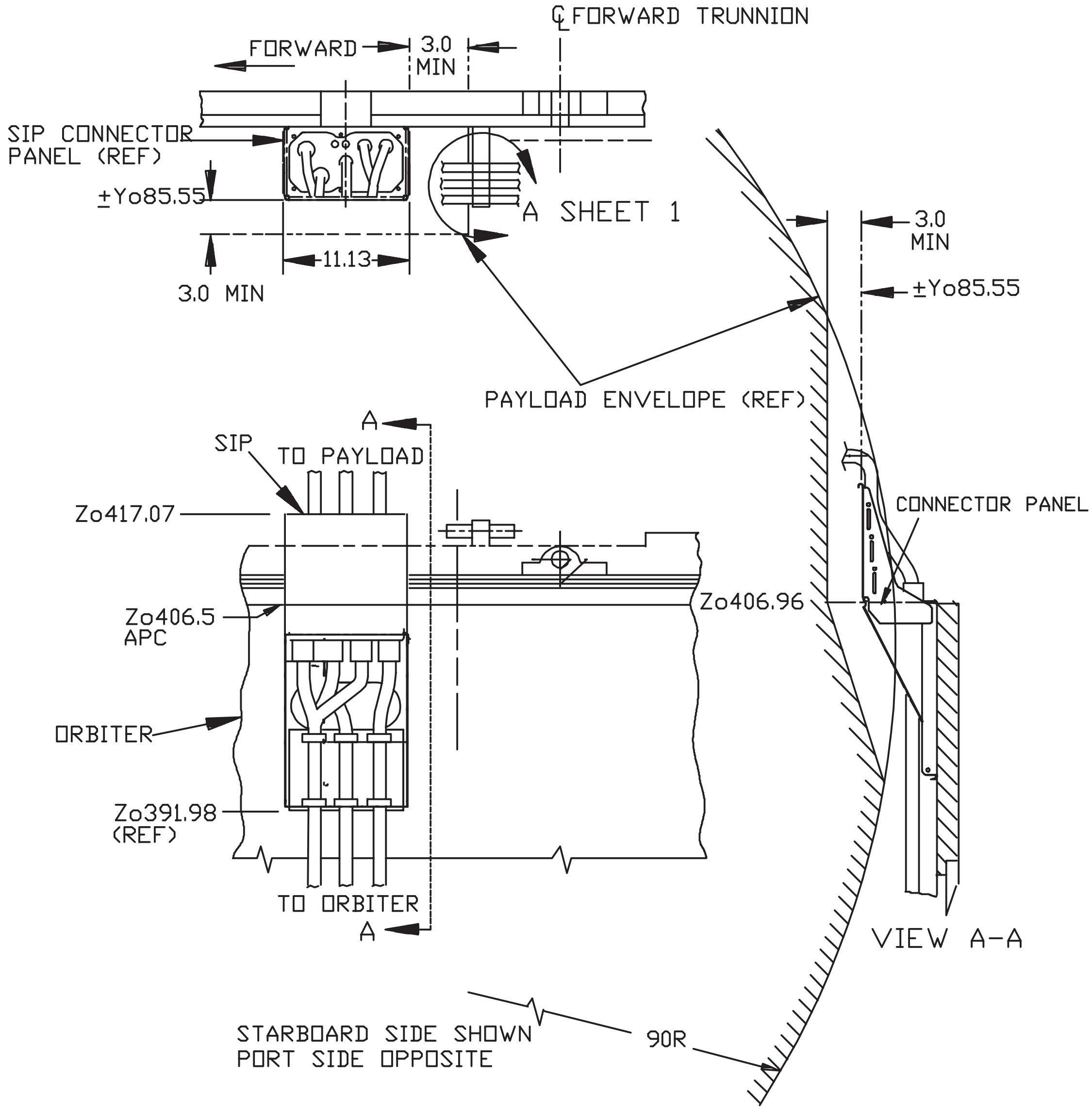


FIGURE 3.3.2-1 SIP LOCATION (APC-MOUNTED)

(SHEET 2 OF 2)

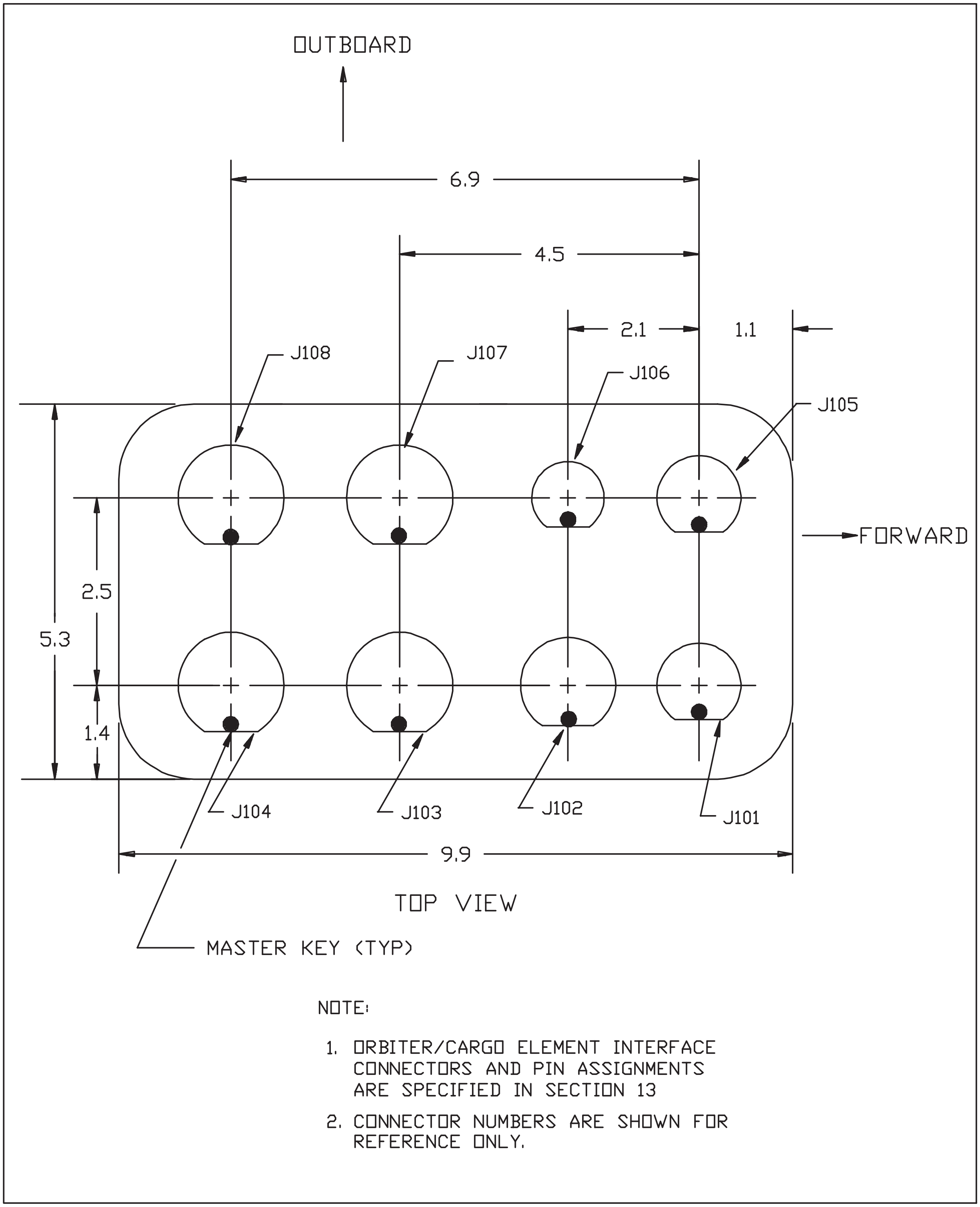
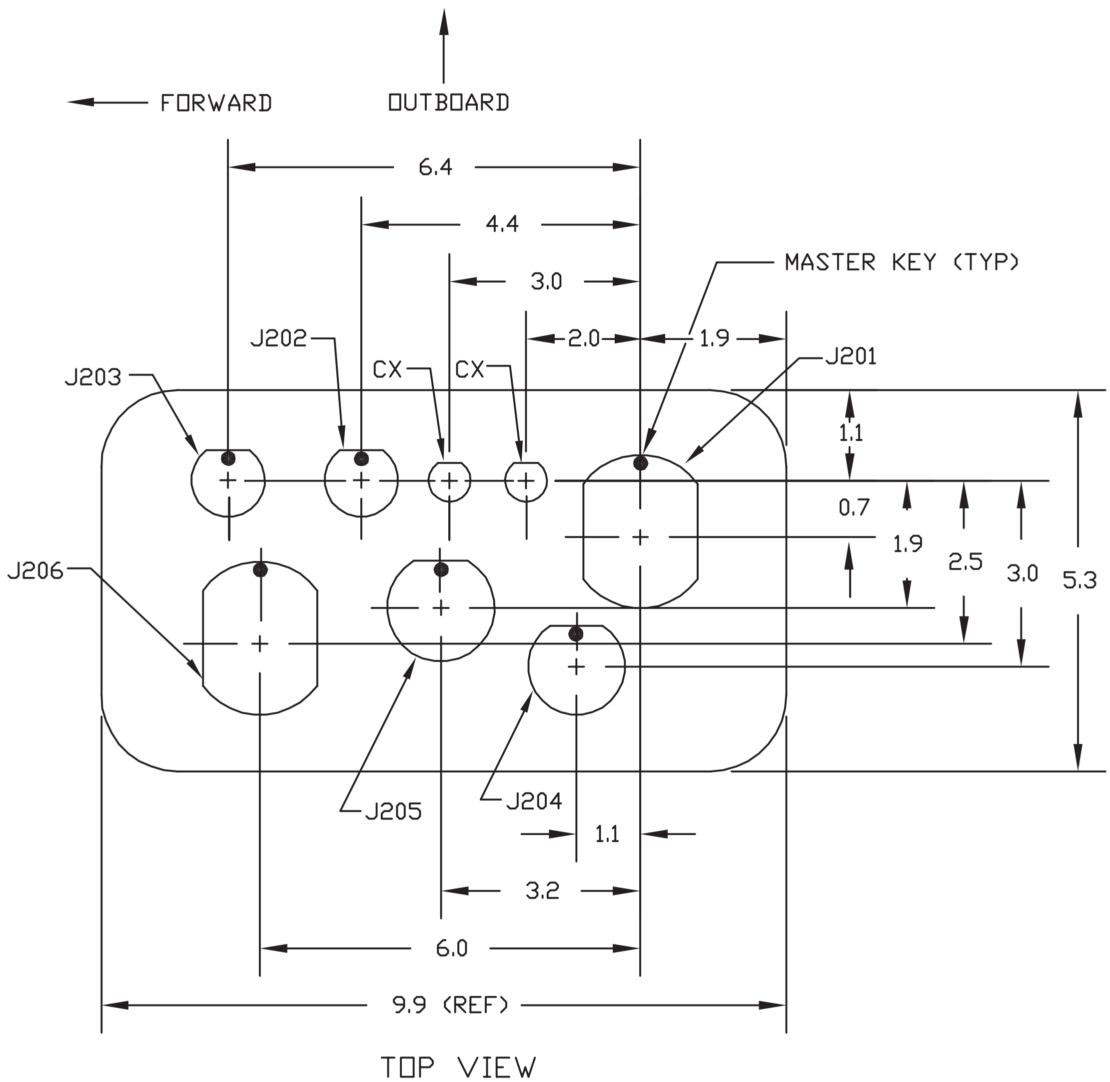


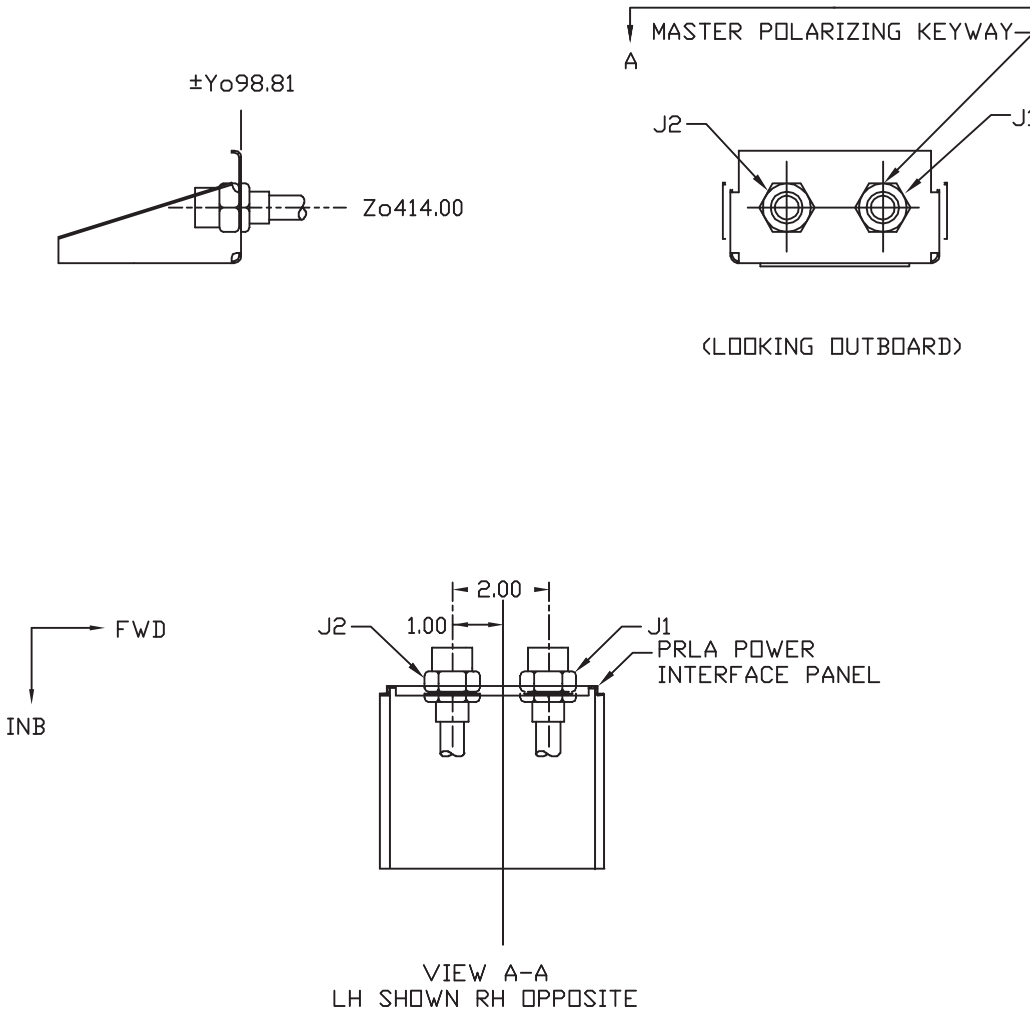
FIGURE 3.3.2.1.1-1 PORT SMCH-SIP ELECTRICAL INTERFACES



NOTE:

1. ORBITER/CARGO ELEMENT INTERFACE CONNECTORS AND PIN ASSIGNMENTS FOR J201, J202 AND J203 ARE SPECIFIED IN SECTION 13.
2. J201 AND J206 ARE IDENTICAL CONNECTORS, J201 SHALL BE USED AS AN AUXILIARY POWER CONNECTOR.
3. CUTOUTS J204, J205 AND CX SHALL BE CAPABLE OF ACCOMMODATING AN 18 SHELL SIZE, A 22 SHELL SIZE AND COAXIAL CONNECTORS RESPECTIVELY.
4. CONNECTOR NUMBERS ARE SHOWN FOR REFERENCE ONLY.

FIGURE 3.3.2.1.2-1 STARBOARD SMCH-SIP ELECTRICAL INTERFACES



NOTES:

1. ORBITER/CARGO ELEMENT PRLA INTERFACE PIN ASSIGNMENTS ARE SPECIFIED IN TABLE 13.6.1.2-7

2. ORIENTATION OF THE PANEL WITH RESPECT TO THE ORBITER IS MISSION SPECIFIC.

FIGURE 3.3.2.3-1 PRLA POWER INTERFACE PANEL

THIS PAGE INTENTIONALLY LEFT BLANK.

3.3.3 Non-Standard Electrical Interfaces (Independent of SMCH)

The electrical interfaces defined under this heading shall not normally be used by a payload except as a non-standard service and as agreed to in the Payload Integration Plan (PIP).

3.3.3.1 Xo576 Connector Panels Interface

The feed-through connector panel on the starboard side of the Orbiter Xo576 bulkhead is shown in Figure 3.3.3.1-1. The port side feed-through connector panel is shown in Figure 3.3.3.1-2.

3.3.3.2 Xo1307 Connector Interfaces

The starboard side connector interfaces at the Orbiter Xo1307 bulkhead are shown in Figure 3.3.3.2-1. The port side connector interfaces are shown in Figure 3.3.3.2-2.

3.3.3.3 Xo603 Connector Interfaces

The starboard side connector interfaces at Xo603 are shown in Figure 3.3.3.3-1. The port side connector interfaces are shown in Figure 3.3.3.3-2.

3.3.3.4 Xo645 Electrical Power Service Interface

Orbiter main DC and aux. power service are at the Xo645, starboard side, power service panel and are shown in Figure 3.3.3.4-1.

3.3.3.5 Xo1203 Signal and Control Panels

Orbiter signal and control panels interface at Xo1203 and are shown in Figure 3.3.3.5-1 for the starboard side and Figure 3.3.3.5-2 for the port side.

3.3.3.6 Retention System Power and GAS Interface

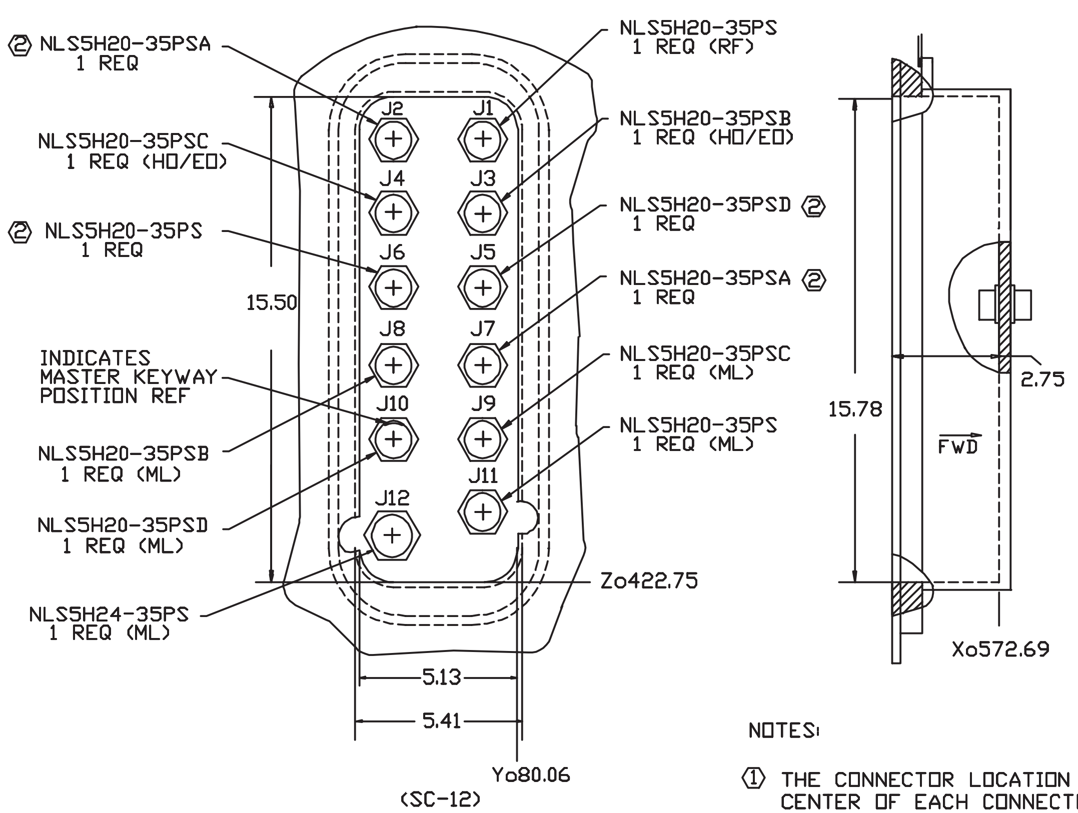
Retention system power connector locations are as shown in Table 3.3.3.6-1, which also notes those connectors with Get-Away-Special wiring provisions.

TABLE 3.3.3.6-1 RETENTION SYSTEM POWER CONNECTORS LOCATIONS

LOCATION NUMBER	PORT (-Yo101.75; Zo410.0)		STARBOARD (-Yo101.75; Zo410.0)		X_o FOR CONN. J1 CENTER LINE	X_o FOR CONN. J2 CENTER LINE	BAY NO.
	J1	J2	J1	J2			
1	J9017	J9019	J9022	J9024	627.24	630.24	1
2	J9021	J9023	J9026	J9028	642.65	645.65	2
3(1)	J9049	J9051	J9048	J9052	708.30	709.65	3
4(1)	J9061	J9063	J9064	J9066	744.51	746.00	3
5(1)	J9073	J9075	J9078	J9082	811.25	814.25	5
6(1)	J9085	J9087	J9094	J9096	885.50	886.74	6
7(1)	J9097	J9099	J9108	J9112	924.75	926.35	7
8(1)	J9101	J9103	J9114	J9116	1003.75	1005.15	8
9	J9111	J9113	J9126	J9128	1050.40	1051.75	9
10	J9121	J9123	J9138	J9142	1106.75	1109.75	10
11	J9133	J9135	J9154	J9156	1160.55	1163.75	11
12	J9143	J9145	J9166	J9168	1229.20	1232.20	12

(1) Connectors J1 at these cargo bay locations (Port/STBD) provide, in addition to retention system power service, electrical interfaces for Get-Away-Special (GAS) payloads.

2. For connector part numbers and pin assignments refer to Section 13.0.



30V70A8
CONNECTOR LOCATION
TABLE (SC-12) ⟨1⟩

DESIG	Yo	Zo
J1	78.688	436.938
J2	76.308	436.938
J3	78.688	434.578
J4	76.308	434.578
J5	78.688	432.208
J6	76.308	432.208
J7	78.688	429.828
J8	76.308	429.828
J9	78.688	427.478
J10	76.308	427.478
J11	78.688	425.108
J12	76.368	424.208

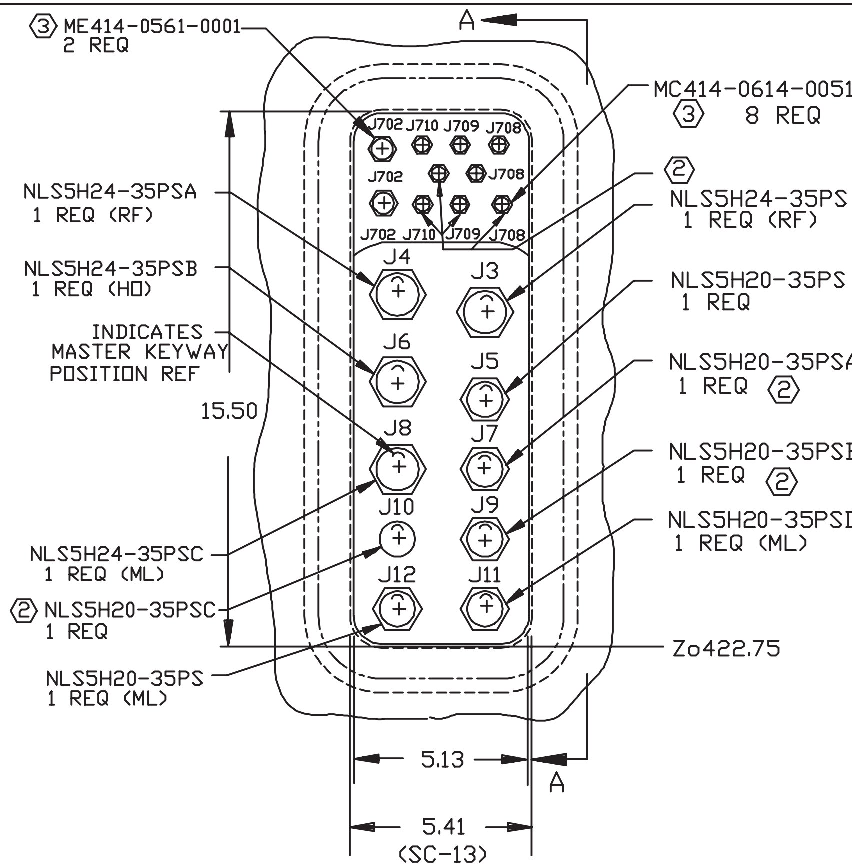
NOTES:

⟨1⟩ THE CONNECTOR LOCATION TABLE LOCATES THE CENTER OF EACH CONNECTOR IN RELATION TO STATION LOCATIONS. ALL CONNECTORS ON THIS PANEL CONFORM TO NASA SPECIFICATION 40M38277.

⟨2⟩ NOT WIRED. NOT AVAILABLE FOR ASSIGNMENT.

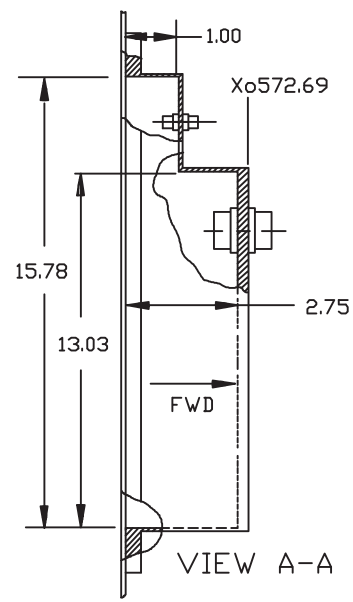
FIGURE 3.3.3.1-1 FEED-THROUGH CONNECTOR PANEL, STARBOARD SIDE BULKHEAD Xo576

FIGURE 3.3.3.1-2 FEED-THROUGH CONNECTOR PANEL, PORT SIDE BULKHEAD Xo 576



30V70A7
CONNECTOR LOCATION TABLE (S0-13) ①

DESIG	Yo	Zo
J701	-79.202	437.359
J702	-79.202	436.329
J703	-75.692	437.449
J704	-76.882	437.449
J705	-78.072	437.449
J706	-76.287	436.859
J707	-77.477	436.859
J708	-75.692	436.269
J709	-76.882	436.269
J710	-78.072	436.269
J3	-76.218	433.398
J4	-78.772	434.208
J5	-76.218	430.998
J6	-78.772	431.408
J7	-76.218	428.698
J8	-78.772	428.698
J9	-76.218	426.188
J10	-78.772	426.188
J11	-76.218	423.858
J12	-78.772	423.858



NOTES:

① THE CONNECTOR LOCATION TABLE LOCATES THE CENTER OF EACH CONNECTOR IN RELATION TO STATION LOCATIONS. EXCEPT AS NOTED IN ③ ALL CONNECTORS ON THESE PANELS CONFORM TO NASA SPECIFICATION 40M38277.

② NOT WIRED. NOT AVAILABLE FOR ASSIGNMENT.

③ INTERIM ROCKWELL PART NUMBER (FOR REFERENCE ONLY) WILL BE CHANGED TO APPROPRIATE GOVERNMENT IDENTIFICATION WHEN SUCH GOVERNMENT SPECIFICATION COVERAGE IS IMPLEMENTED.

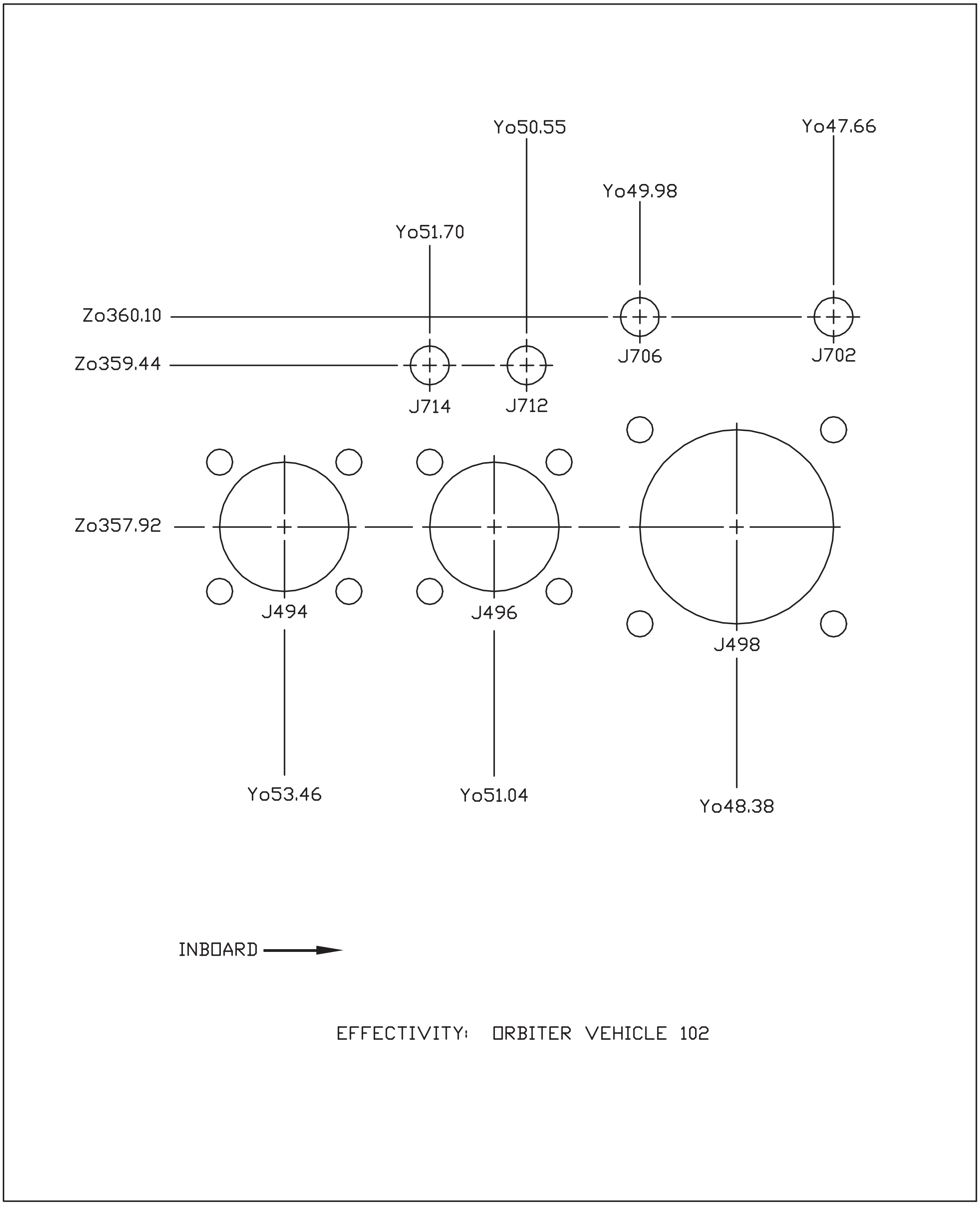


FIGURE 3.3.3.2-1 Xo 1307 STARBOARD ELECTRICAL INTERFACES (LOOKING AFT)
(SHEET 1 OF 2)

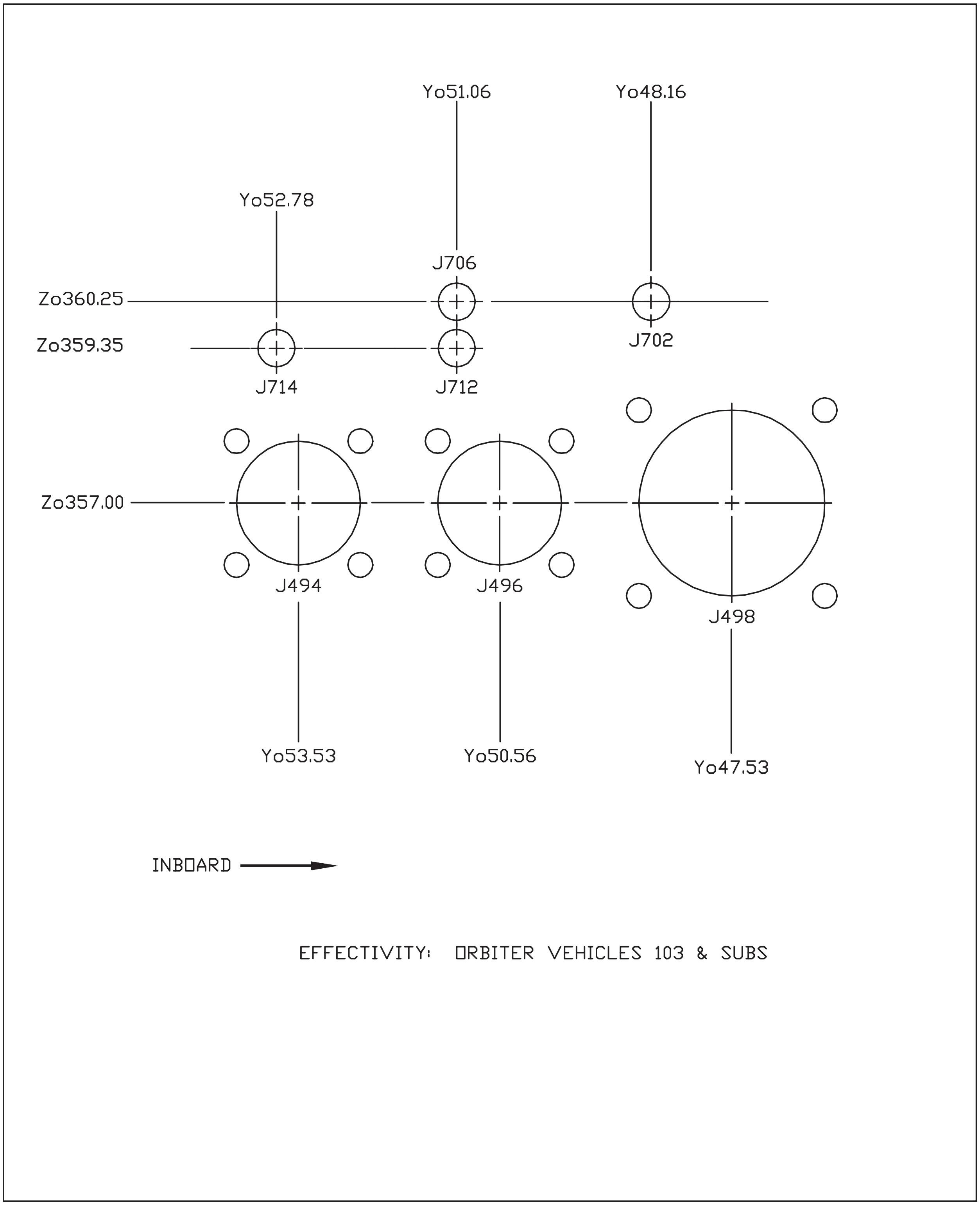


FIGURE 3.3.3.2-1 Xo 1307 STARBOARD ELECTRICAL INTERFACES (LOOKING AFT)
(SHEET 2 OF 2)

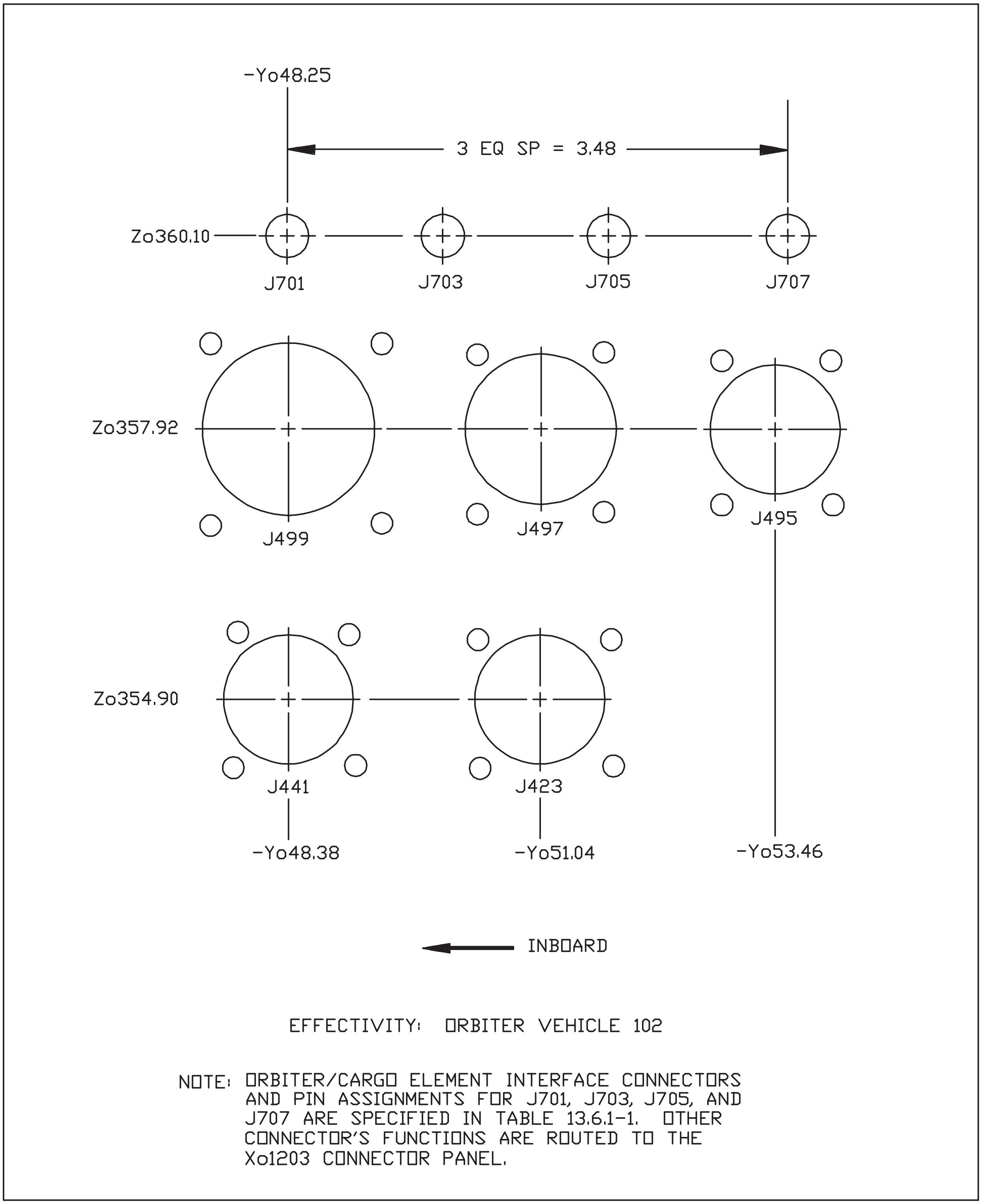
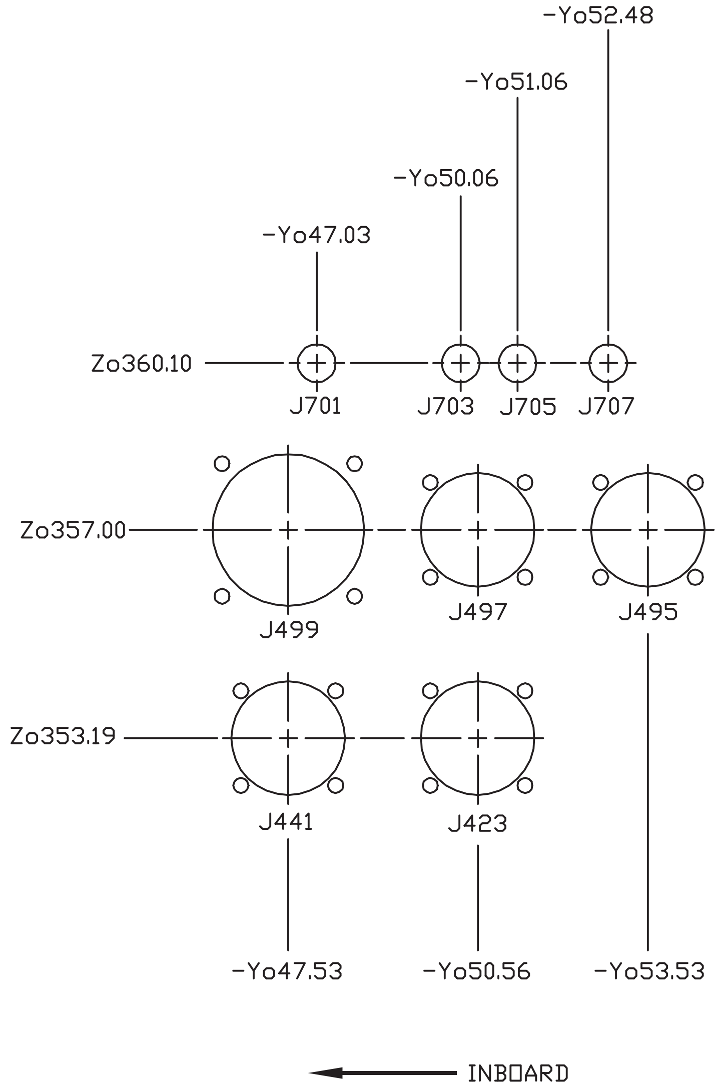


FIGURE 3.3.3.2-2 Xo 1307 PORT ELECTRICAL INTERFACES (LOOKING AFT)

(SHEET 1 OF 2)



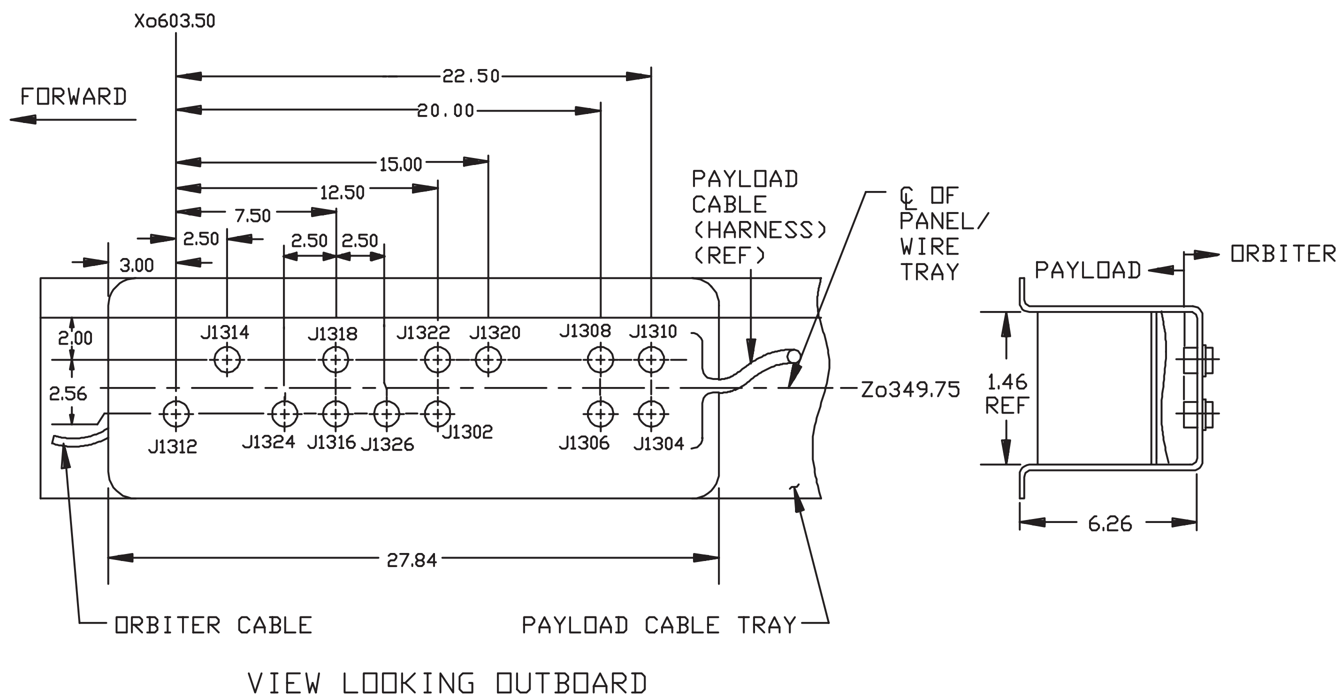
EFFECTIVITY: ORBITER VEHICLES 103 & SUBS

NOTE: ORBITER/CARGO ELEMENT INTERFACE CONNECTORS AND PIN ASSIGNMENTS FOR J701, J703, J705, AND J707 ARE SPECIFIED IN TABLE 13.6.1-1. OTHER CONNECTOR'S FUNCTIONS ARE ROUTED TO THE Xo1203 CONNECTOR PANEL.

FIGURE 3.3.3.2-2 Xo 1307 PORT ELECTRICAL INTERFACES (LOOKING AFT)

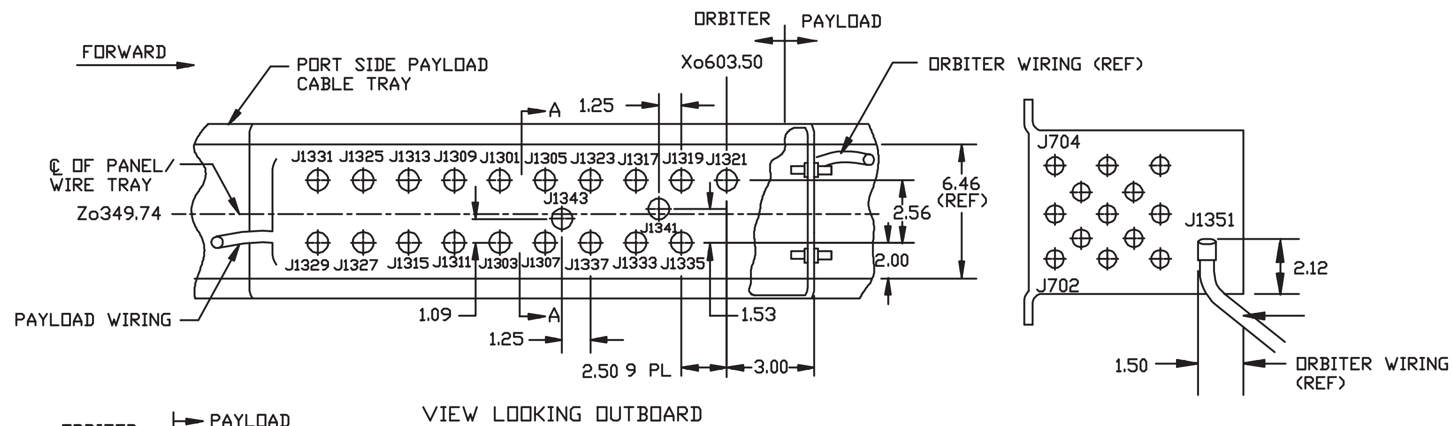
(SHEET 2 OF 2)

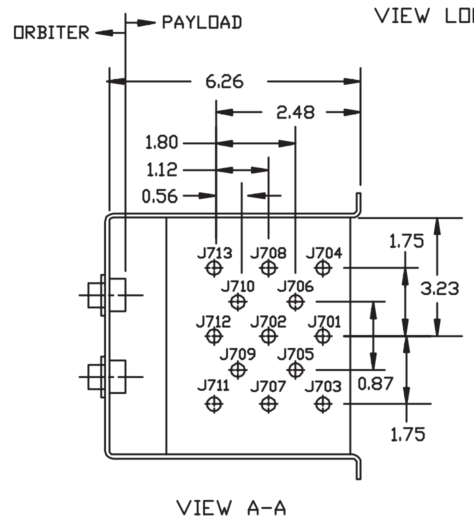
FIGURE 3.3.3.3-1 Xo 603 STARBOARD SIGNAL AND CONTROL PANEL



NOTE:

1. ORBITER/CARGO ELEMENT INTERFACE CONNECTORS AND PIN ASSIGNMENTS FOR J1302, J1304, J1306, J1308, J1310, J1312, J1314, J1316, J1318, J1320, AND J1322 ARE SPECIFIED IN TABLE 13.6.1-1. J1324 AND J1326 ARE SPECIFIED IN TABLE 13.5.2.1-1.

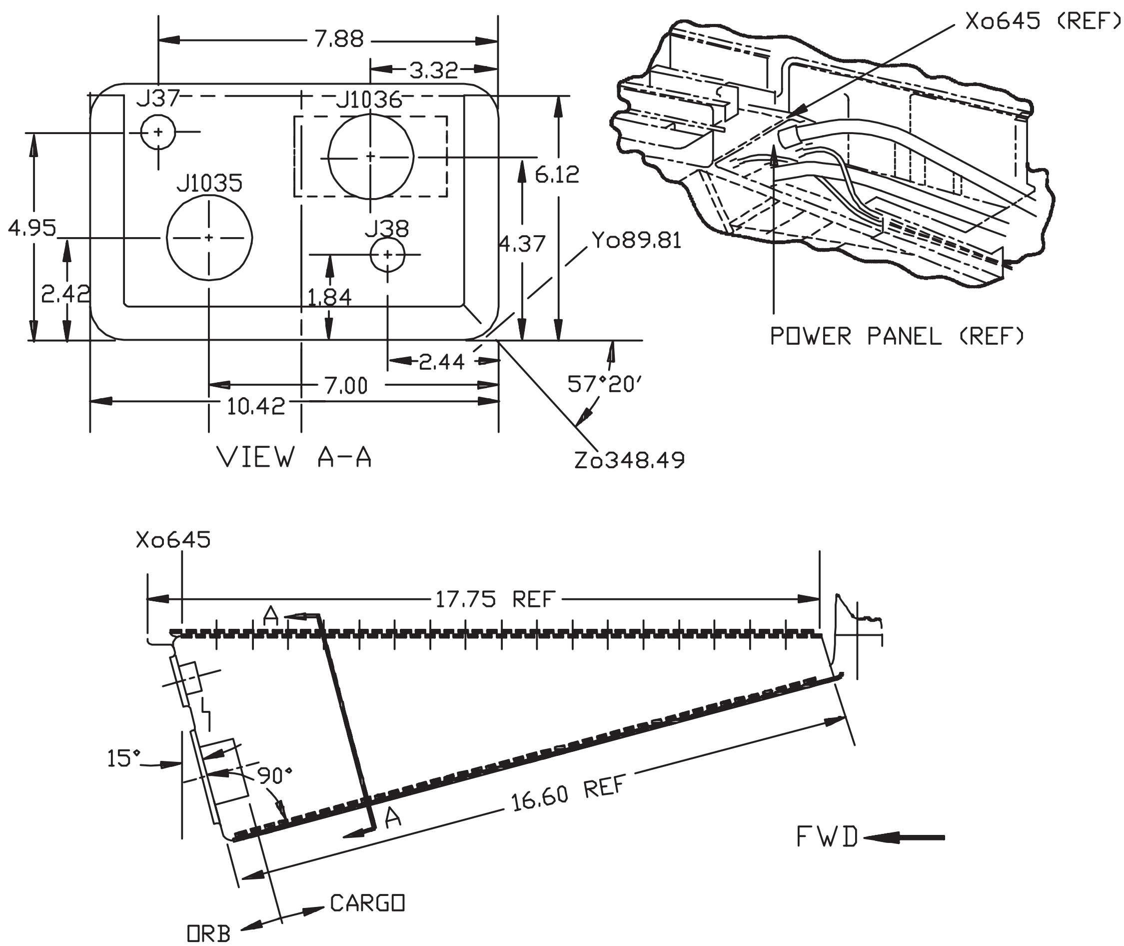




NOTE:

⟨1⟩ ORBITER/CARGO ELEMENT INTERFACE CONNECTOR AND PIN ASSIGNMENTS FOR J1301, J1303, J1305, J1307, J1309, J1311, J1313, J1315, J1325, J1327, J1329, J1331, J1341, J1343, AND J1351 ARE SPECIFIED IN TABLE 13.5.2.1-1. J1317, J1319, J1323, J1333, J1335, J1337 AND COAXIAL CONNECTORS J701 THROUGH J713 ARE SPECIFIED IN TABLE 13.6.1-1.

FIGURE 3.3.3-2 Xo603 PORT SIGNAL AND CONTROL PANEL

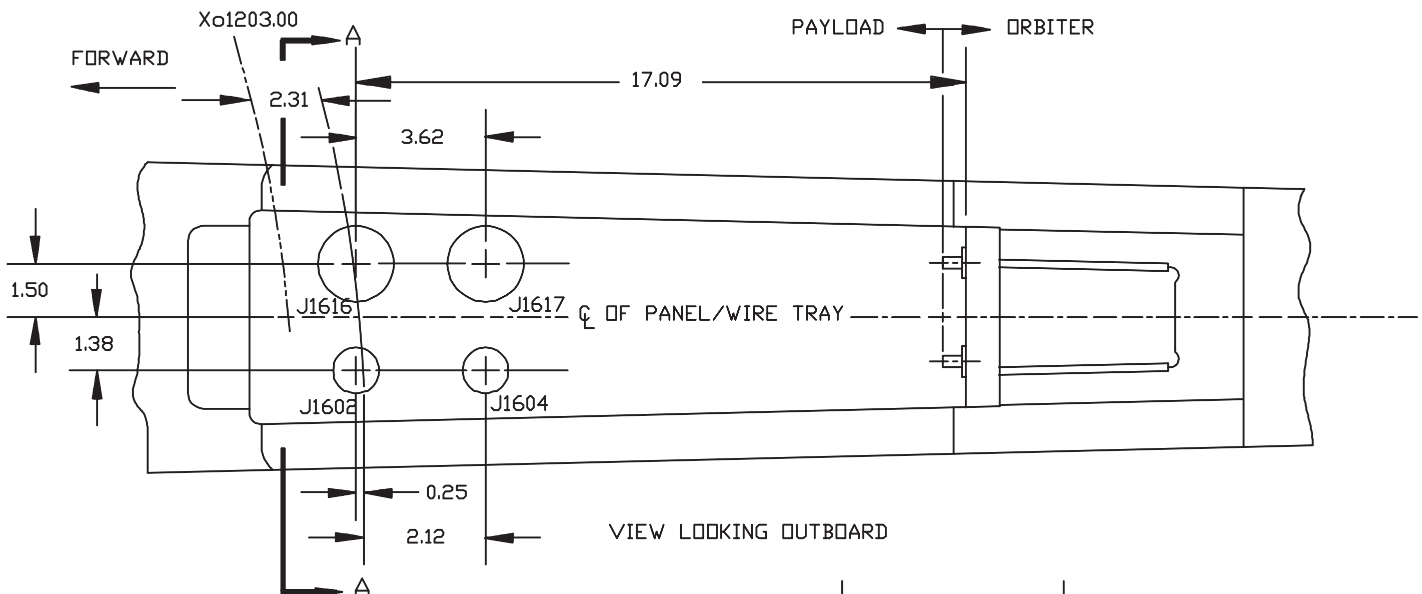


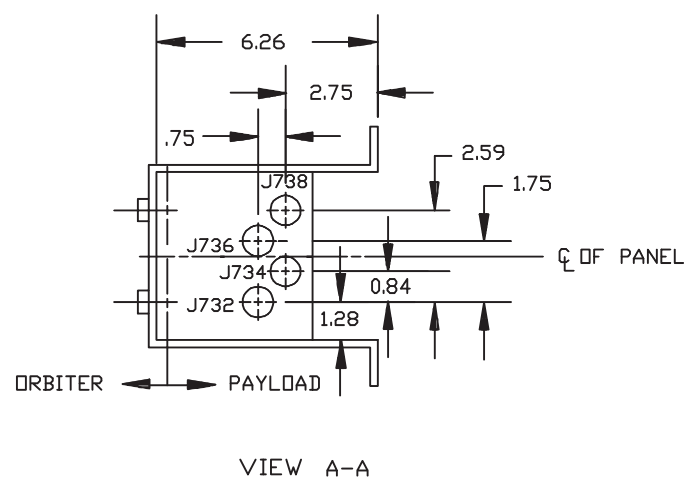
NOTE:

1 ORBITER/CARGO ELEMENT CONNECTORS AND PIN ASSIGNMENTS FOR J1035 AND J1036 ARE SPECIFIED IN TABLE 13.5.2.1-1. J37 AND J38 ARE SPECIFIED IN TABLE 13.6.1-1.

FIGURE 3.3.3.4-1 Xo 645 ELECTRICAL POWER SERVICE PANEL

FIGURE 3.3.3.5-1 Xo 1203 STARBOARD SIGNAL AND CONTROL PANEL



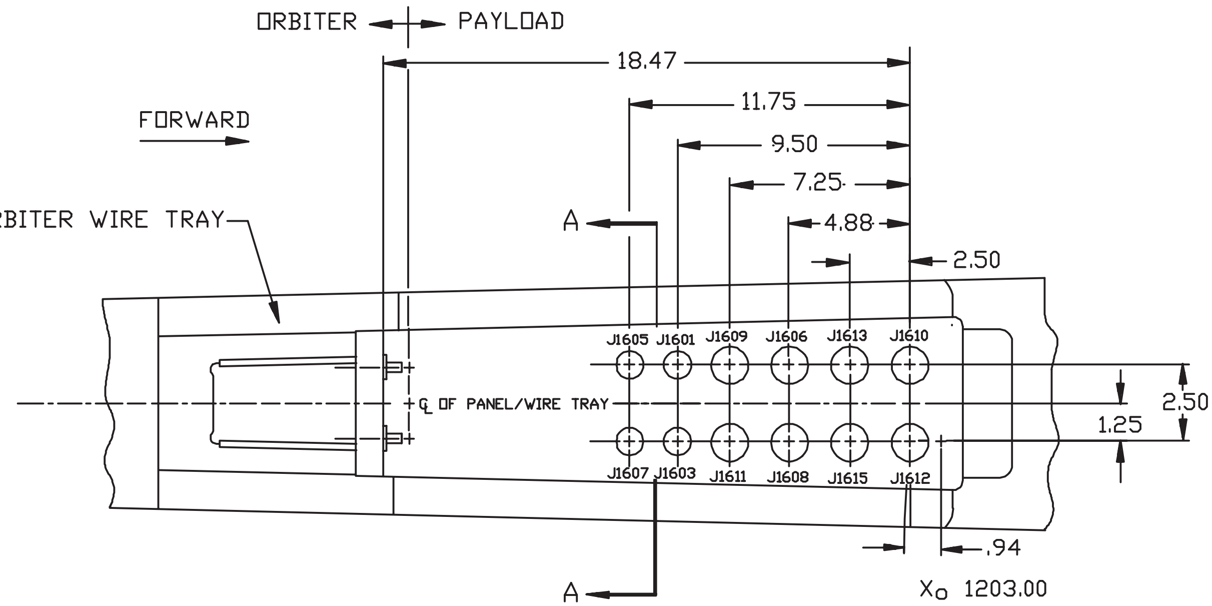


NOTES:

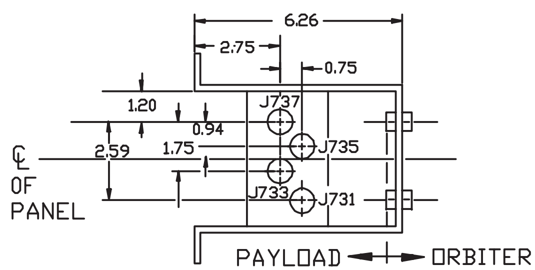
1 ORBITER/CARGO ELEMENT INTERFACE CONNECTORS AND PIN ASSIGNMENT FOR J1602 AND J1604 ARE SPECIFIED IN TABLE 13.5.2.1-1. J732, J734, J736 AND J738 ARE SPECIFIED IN TABLE 13.6.1-1.

2 J1616 AND J1617 NOT WIRED.

FIGURE 3.3.3.5-2 Xo 1203 PORT SIGNAL AND CONTROL PANEL



VIEW LOOKING OUTBOARD



VIEW A-A

NOTES:

1. ORBITER/CARGO ELEMENT INTERFACE CONNECTORS AND PIN ASSIGNMENTS FOR J1601, J1603, J1605, J1606, J1607, J1608, J1609, J1610, J1611, J1612, J1613, AND J1615 ARE SPECIFIED IN TABLE 13.5.2.1-1.

2. J731, J733, J735 AND J737 NOT WIRED.

THIS PAGE INTENTIONALLY LEFT BLANK.

3.3.4 Fluid and Umbilical Panel Interfaces

Cargo element usage of the interfaces, defined under this heading, shall be accomplished by installing cargo element supplied wiring and/or fluid lines with adequate allowances for mating and demating of connectors. There shall be no unsupported lengths of cables or fluid lines greater than 18 inches. These interfaces shall not be normally used by a payload except as a non-standard service and as agreed to in the Payload Integration Plan (PIP).

3.3.4.1 Atmospheric Revitalization Interface

The Orbiter atmospheric revitalization interface is as shown in Figure 3.3.4.1-1.

3.3.4.2 Gaseous Helium; Nitrogen; and Air Purge Interface

The Orbiter provides the capability to transport gaseous nitrogen (GN_2), air, and helium (GHe) from the T-0 umbilical interface to the cargo bay. The payload interface is located as shown in Figures 3.3.4.2-1, 3.3.4.2-2 and 3.3.4.2-3. The purge supply system can supply an air or GN_2 flow rate in excess of 9 lbs/min at the SIP interface. The maximum GHe flow rate through the purge system is 2 lbs/min at the SIP interface.

The flow rate and pressure combinations available at the SIP interface are dependent upon the specific location in the payload bay, the integration hardware configuration, gas temperature and the specific gas being used. The temperature of the purge gas supplied to the T-0 umbilical can not be controlled and varies with the ambient air temperature at the launch pad. The temperature difference between the T-0 umbilical and the SIP is insignificant. Representative values of flow rates, temperatures, and pressure drops are shown in Figures 3.3.4.2-4 for GN_2. Similar figures representing air and GHe are shown in Figures 3.3.4.2-5 and 3.3.4.2-6, respectively. Although the T-0 pressure can be regulated to any value between 65 and 265 psia, a T-0 pressure of 265 psia is assumed in each case. Since the SIP can vary in location, the length of line required to reach the SIP was set to both a minimum of 0 inches (above X_o 1249 panel) and a maximum of 595 inches (forward most SIP location). A unique analysis will be required for applications which deviate from any of the conditions listed in the figures.

Cleanliness of the lines is level 200 per MA0110-301 and fluids used shall meet the requirements of SE-S-0073.

3.3.4.3 Payload Heat Exchanger (Oxygen/Nitrogen Supply Interface)

The payload heat exchanger and O_2/N_2 supply interface panel is as shown in Figure 3.3.4.3-1.

3.3.4.4 Cargo Bay Purge System Interface

The mid-fuselage/cargo bay purge system is as shown in Figure 3.3.4.4-1. Payload purge spigots interface is as shown in Figure 3.3.4.4-2.

3.3.4.5 Pre-launch Umbilical Interfaces

The Orbiter mid-body pre-launch umbilical interface panel, at Yo100.20 port, is as shown in Figure 3.3.4.5-1.

3.3.4.6 (Deleted)

3.3.4.7 (Deleted)

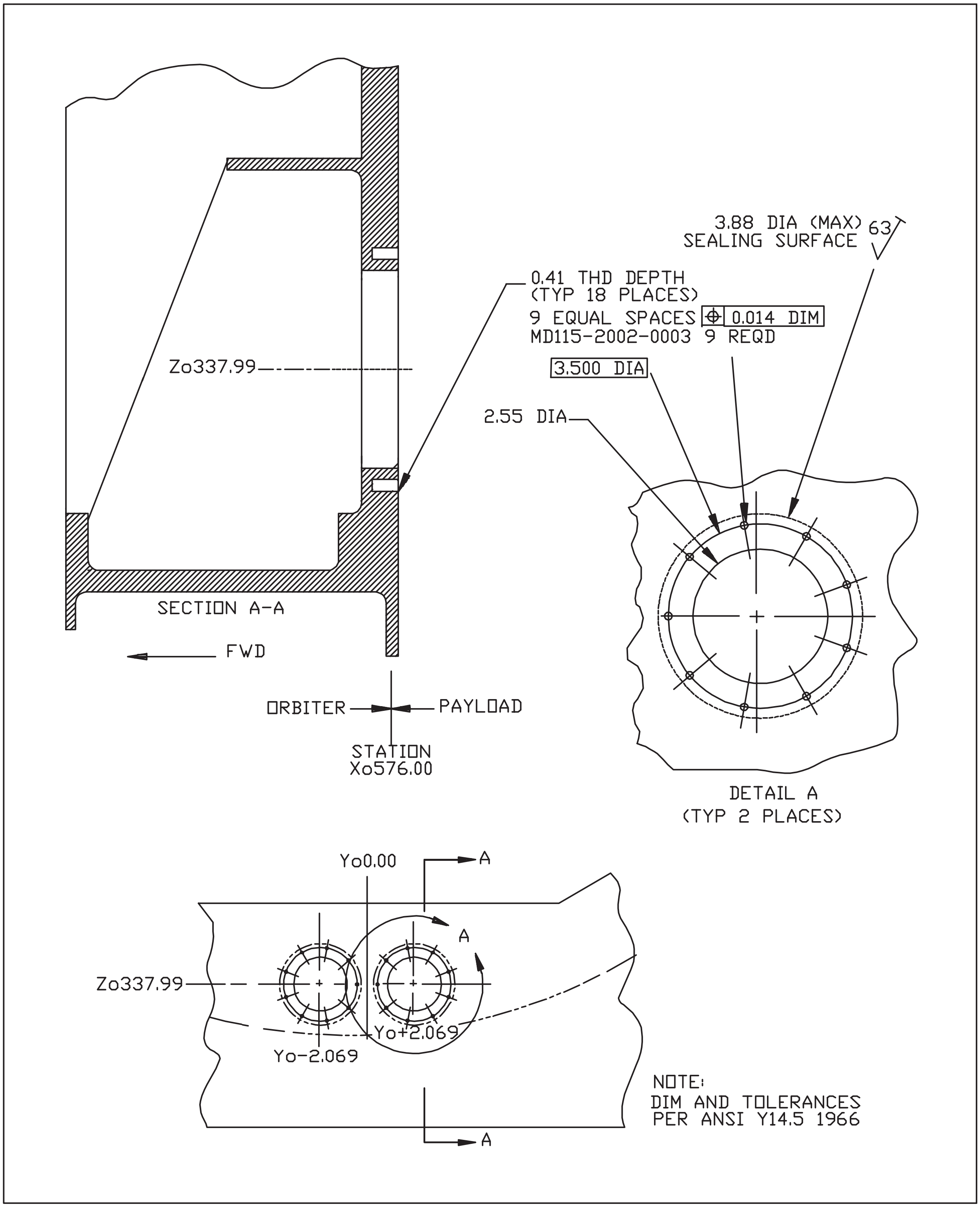


FIGURE 3.3.4.1-1 ATMOSPHERIC REVITALIZATION SYSTEM INTERFACE

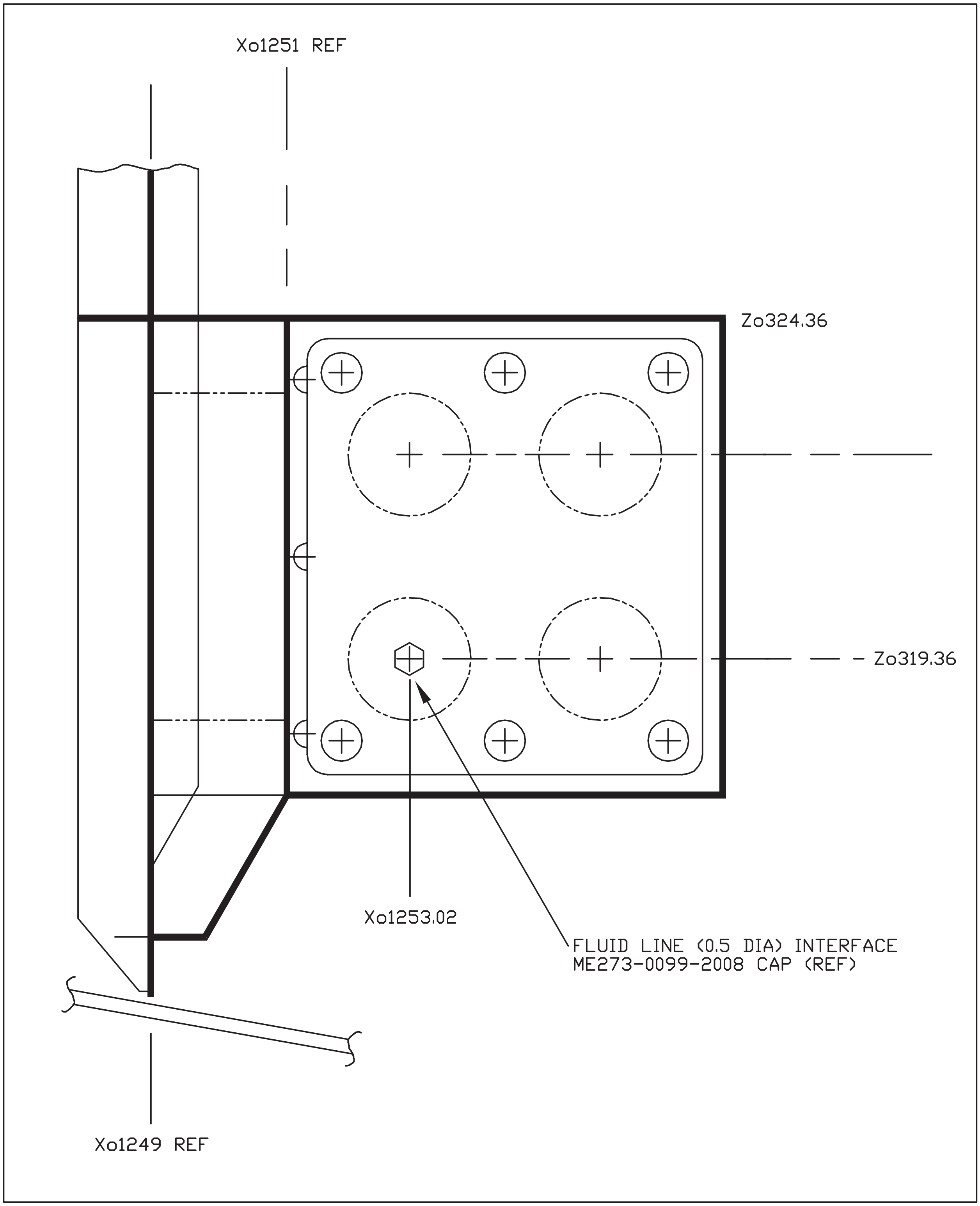


FIGURE 3.3.4.2-1 LOWER STARBOARD INTERFACE PANEL AT Xo 1249

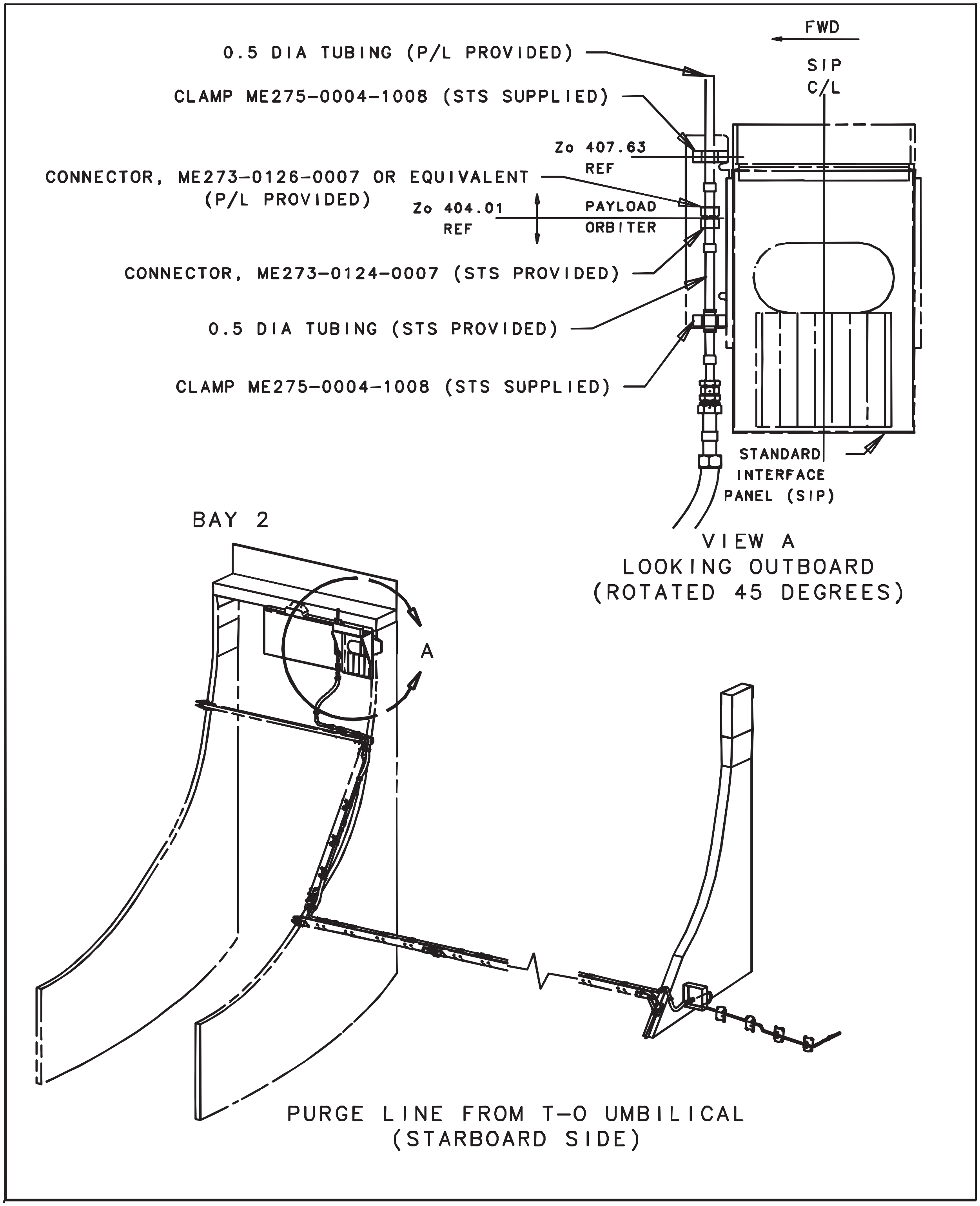


FIGURE 3.3.4.2-2 REPRESENTATIVE INSTL. MAXIMUM FLUID LINE LENGTH: FROM Xo 1249 INTERFACE TO BAY 2 PAYLOAD INTERFACE

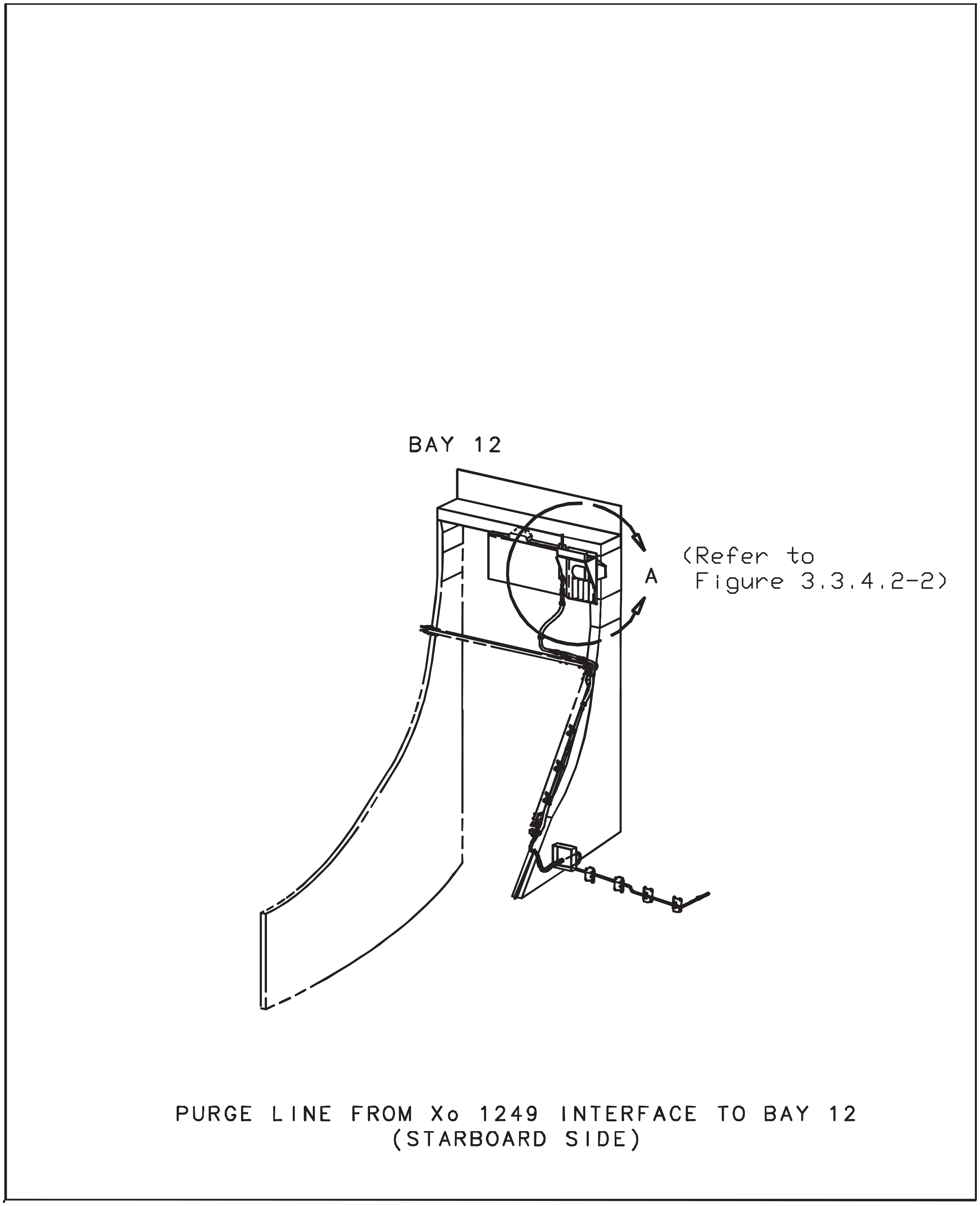


FIGURE 3.3.4.2-3 REPRESENTATIVE INSTL. MINIMUM FLUID LINE LENGTH: FROM Xo 1249 INTERFACE TO BAY 12 PAYLOAD INTERFACE

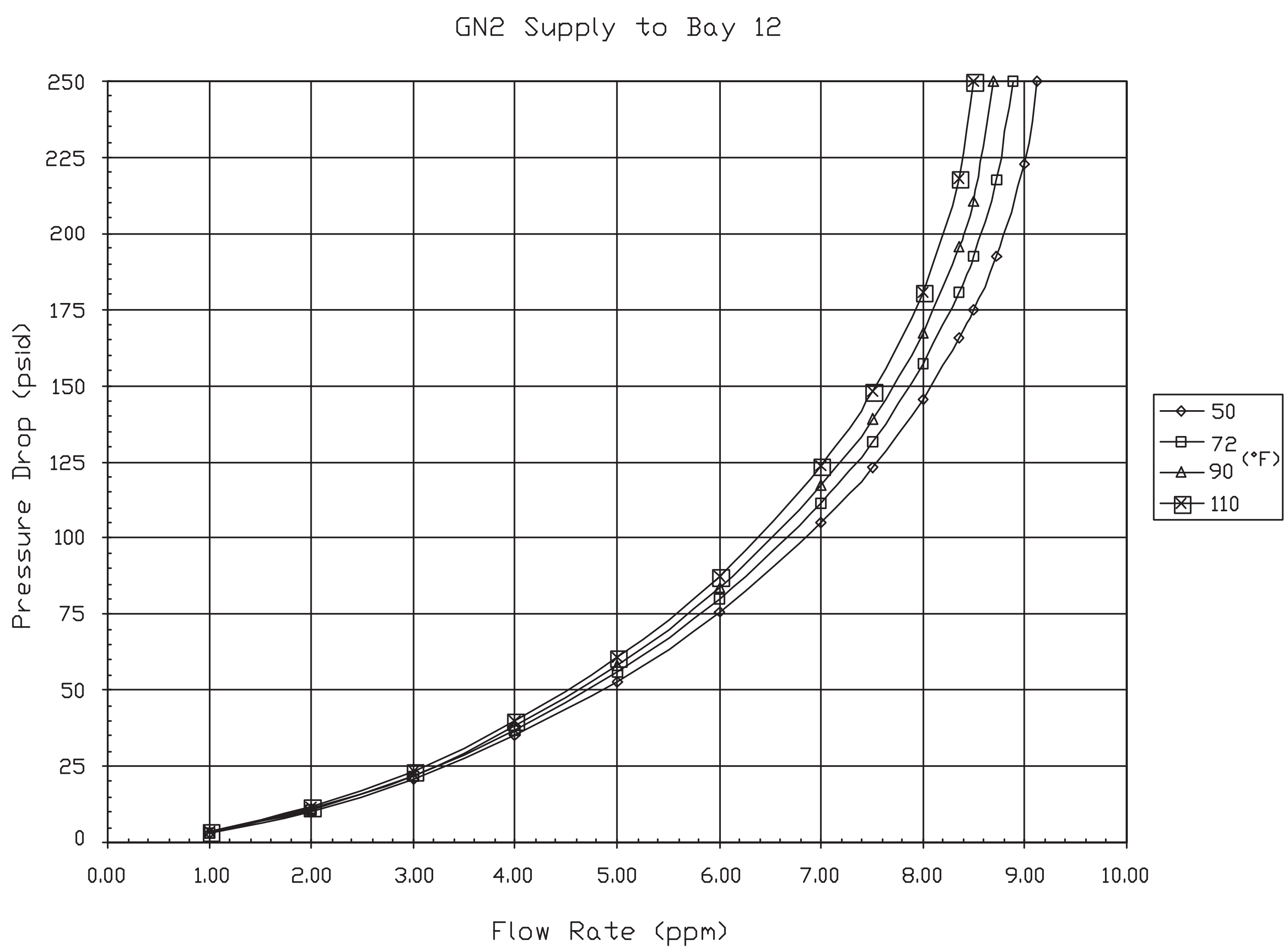
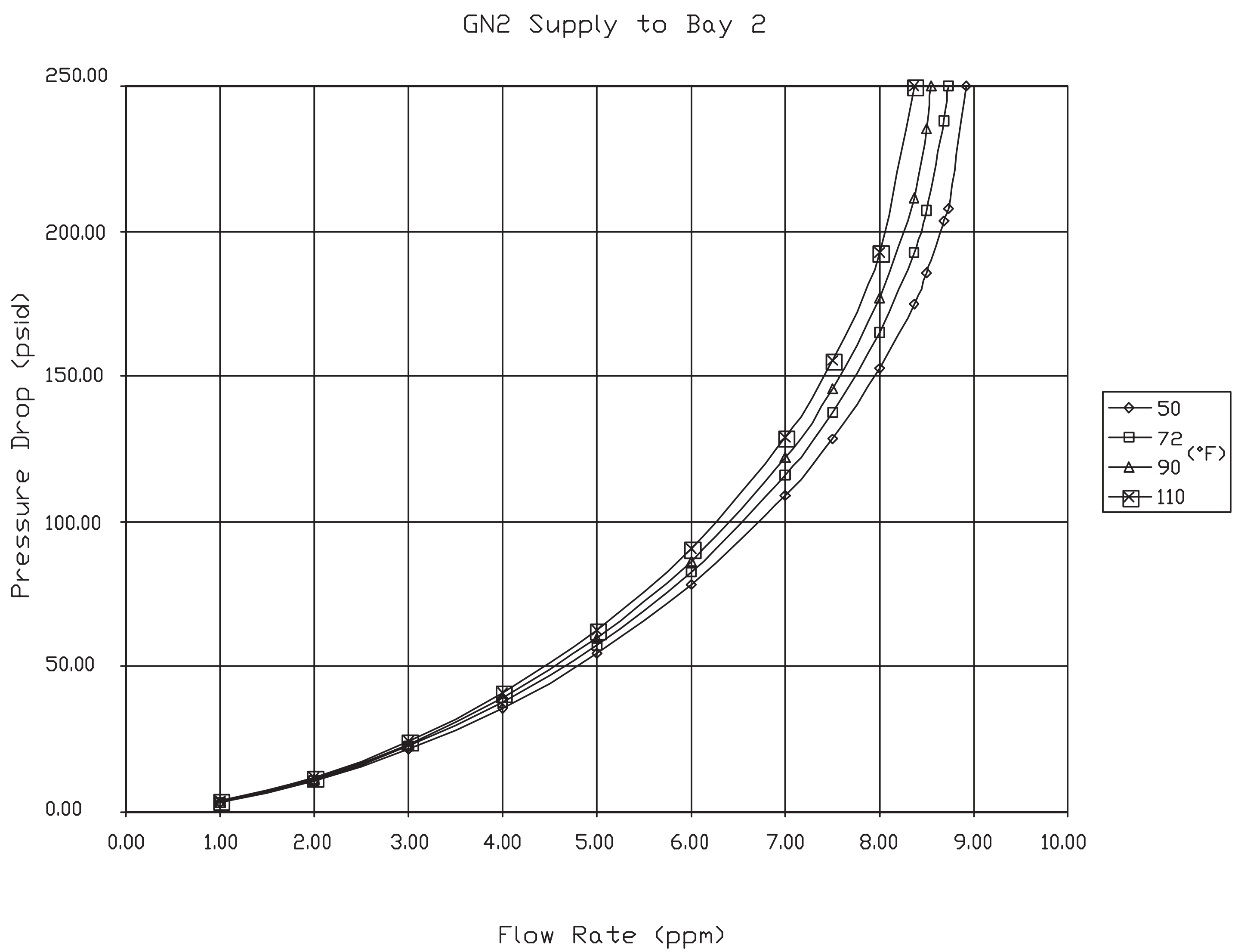


FIGURE 3.3.4.2-4 PRESSURE DROP VS FLOW RATE FOR GN2 SUPPLIED TO BAY 12

(SHEET 1 OF 2)

FIGURE 3.3.4.2-4 PRESSURE DROP VS FLOW RATE FOR GN2 SUPPLIED TO BAY 2

(SHEET 2 OF 2)



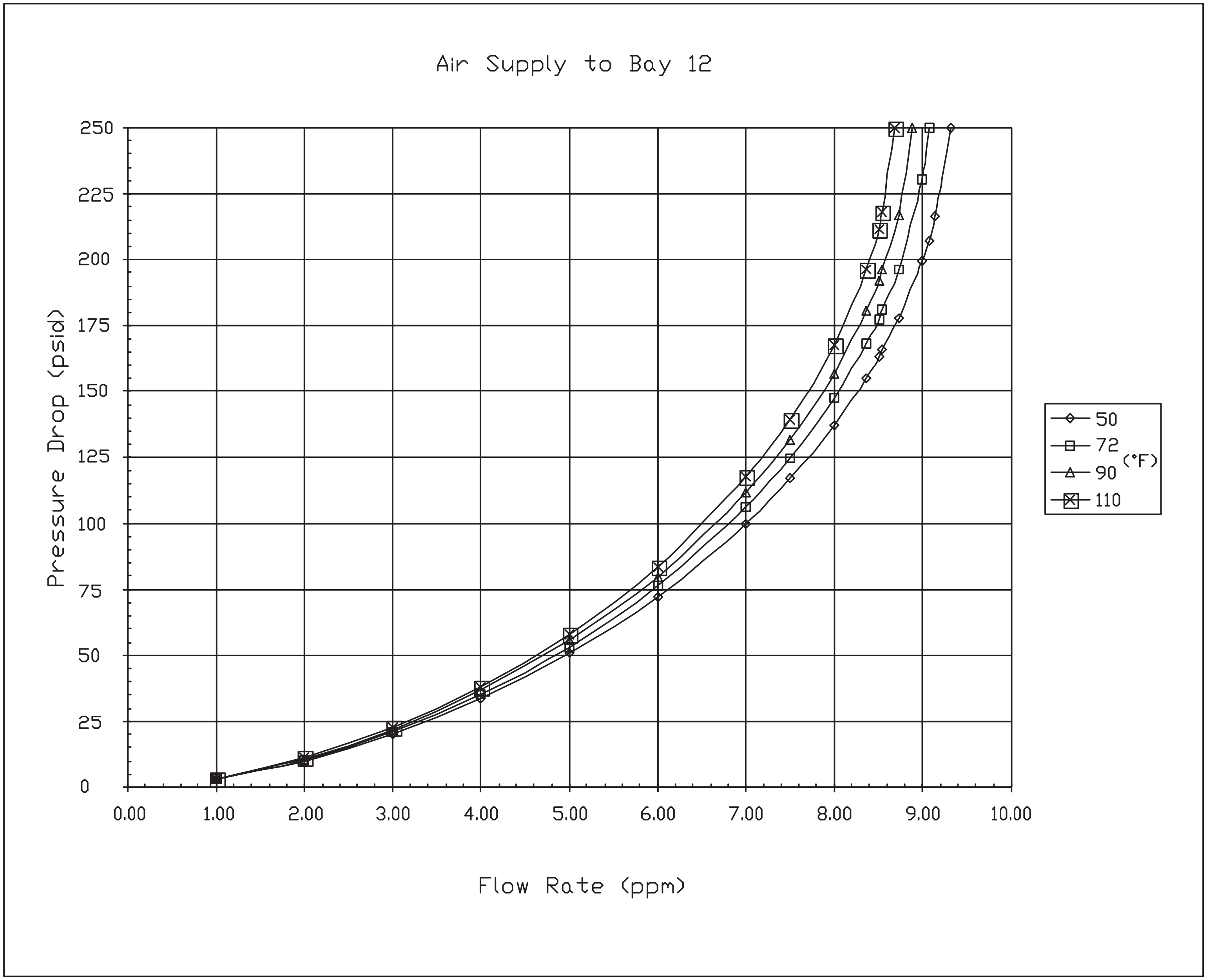


FIGURE 3.3.4.2-5 PRESSURE DROP VS FLOW RATE FOR AIR SUPPLIED TO BAY 12

(SHEET 1 OF 2)

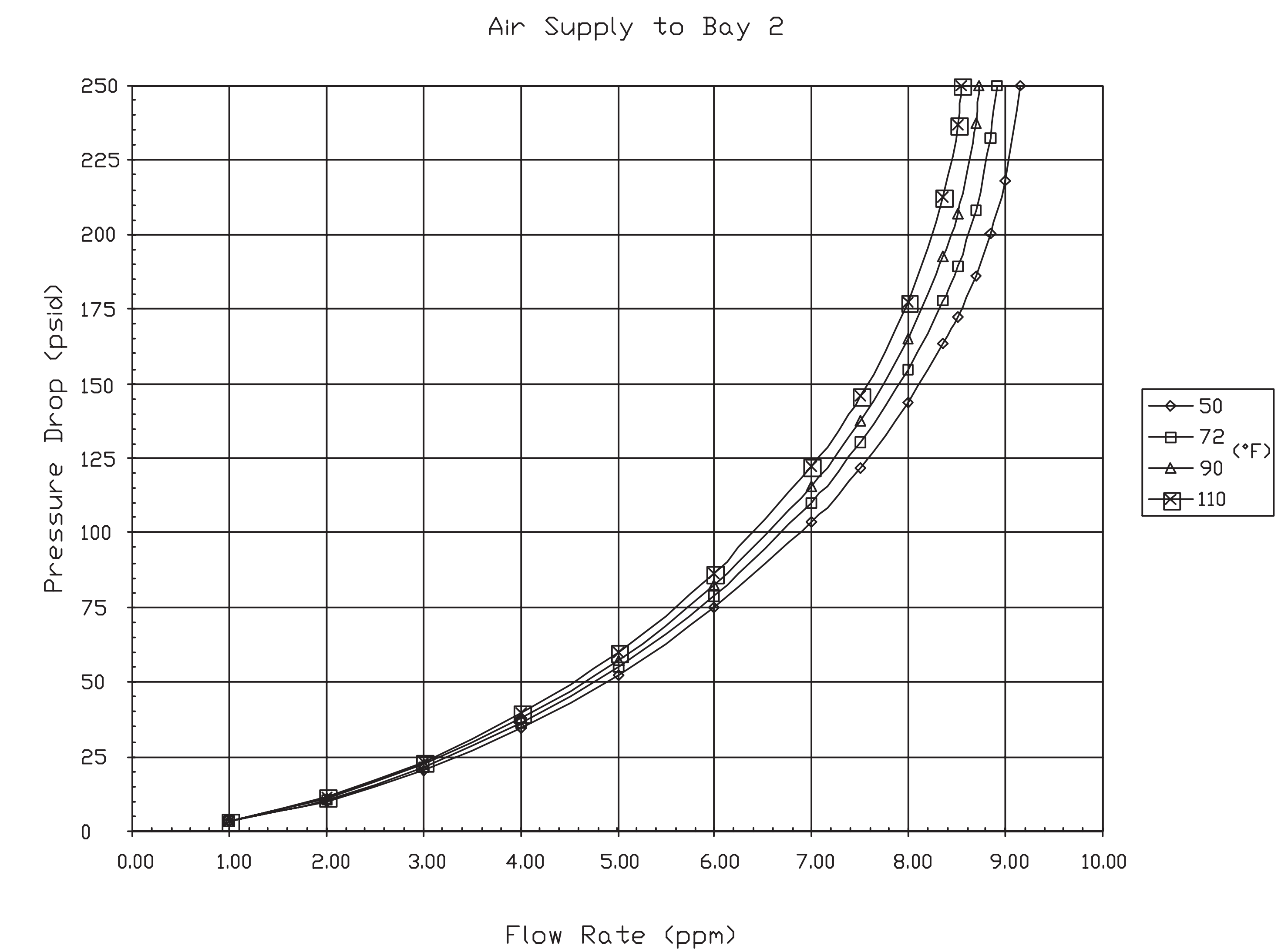


FIGURE 3.3.4.2-5 PRESSURE DROP VS FLOW RATE FOR AIR SUPPLIED TO BAY 2

(SHEET 2 OF 2)

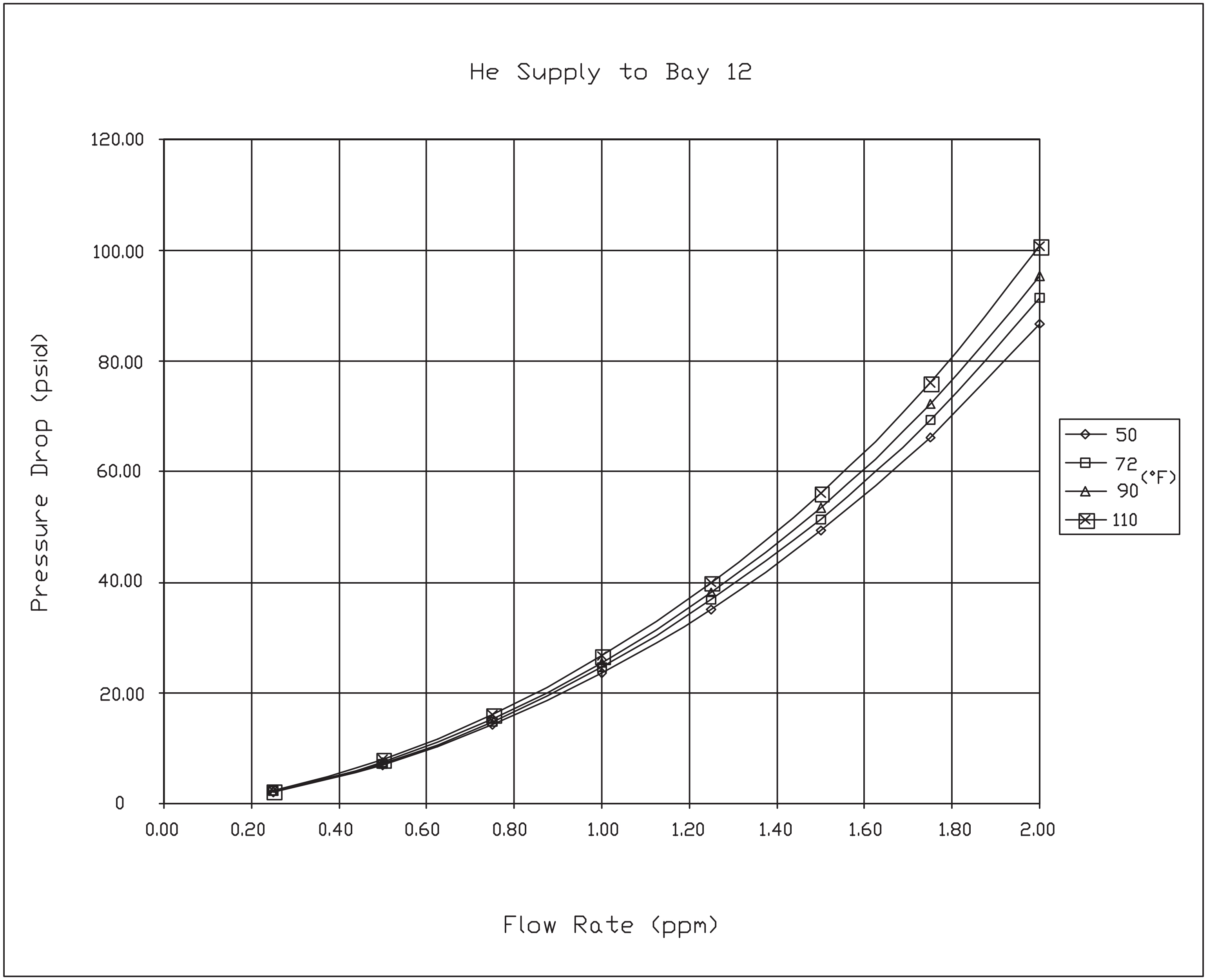
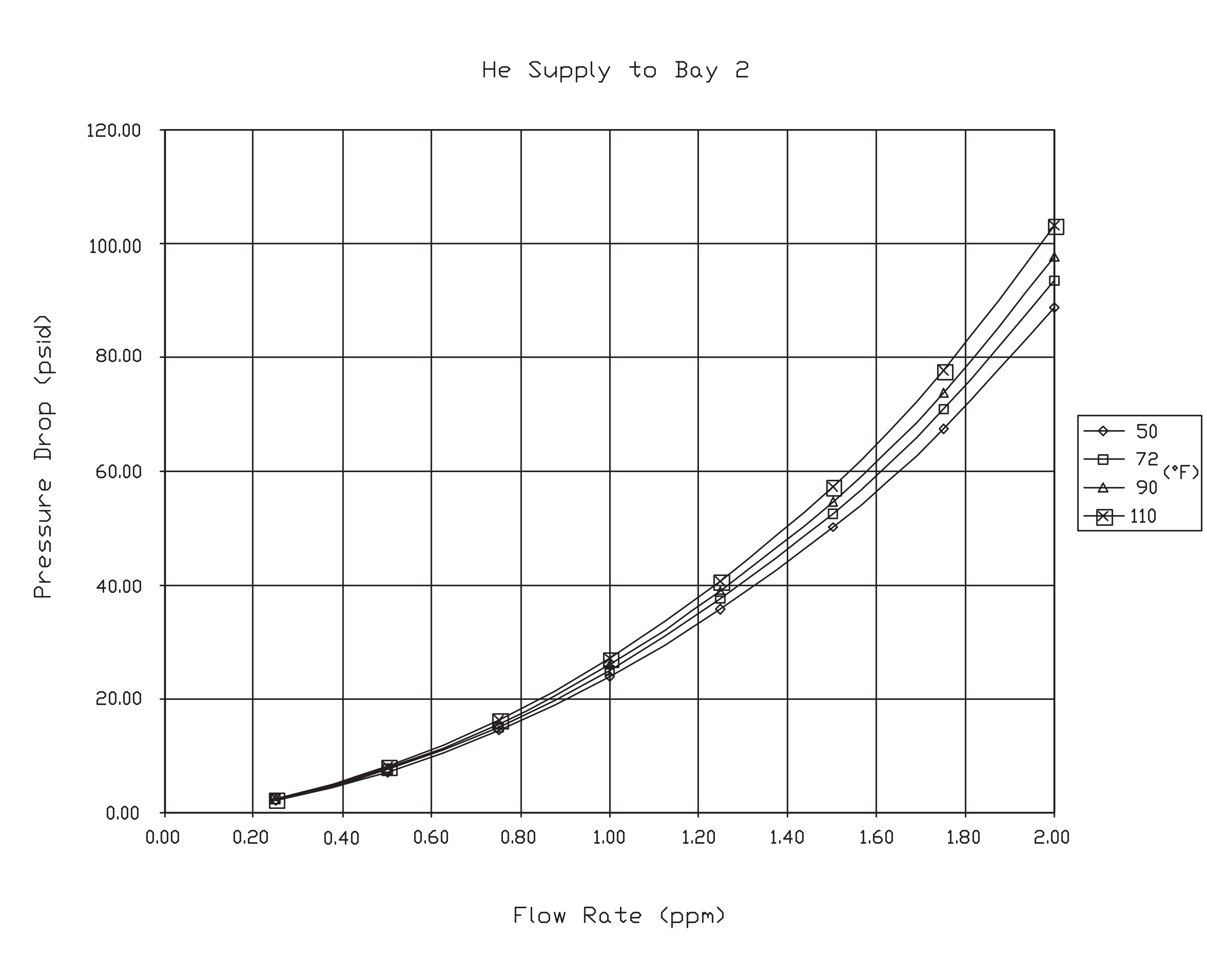


FIGURE 3.3.4.2-6 PRESSURE DROP VS FLOW RATE FOR GHe SUPPLIED TO BAY 12
(SHEET 1 OF 2)

FIGURE 3.3.4.2-6 PRESSURE DROP VS FLOW RATE FOR GHe SUPPLIED TO BAY 2
(SHEET 2 OF 2)



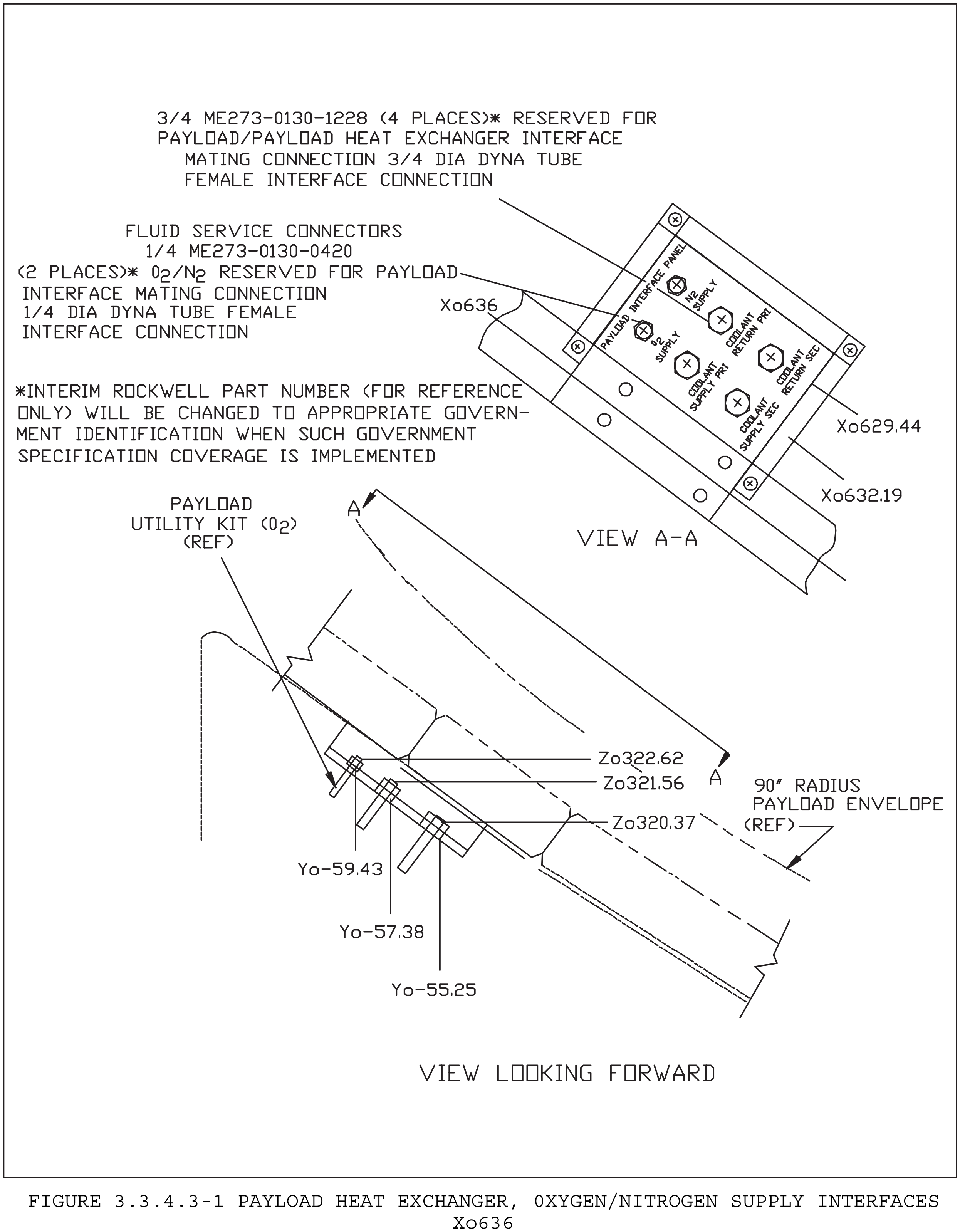
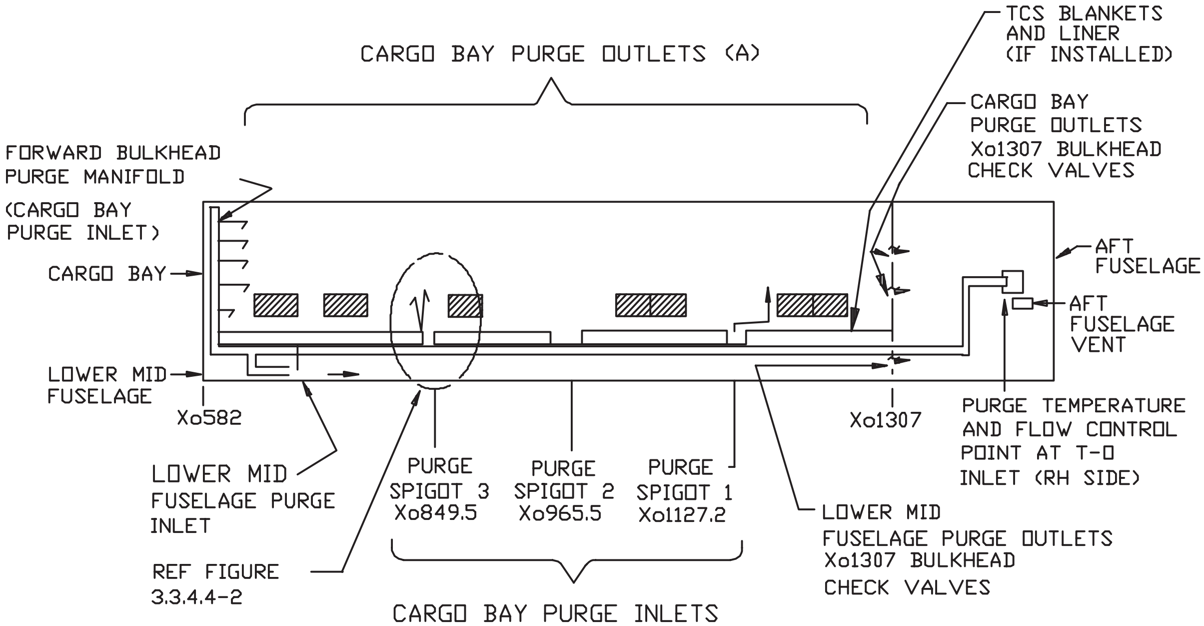


FIGURE 3.3.4.3-1 PAYLOAD HEAT EXCHANGER, 0XYGEN/NITROGEN SUPPLY INTERFACES
Xo636



- o REF TABLE 6.2.1.1-1 CARGO BAY PURGE GAS CHARACTERISTICS
- o PURGE INLET SPIGOTS 1, 2 AND 3 NORMALLY CAPPED OFF UNLESS REQUIRED BY PAYLOAD

NOTE:

(A) COORDINATES LISTED ARE FOR FORWARD EDGE OF FORWARD FILTER AND AFT EDGE OF AFT FILTER

FIGURE 3.3.4.4-1 MID-FUSELAGE/CARGO BAY PURGE SYSTEM

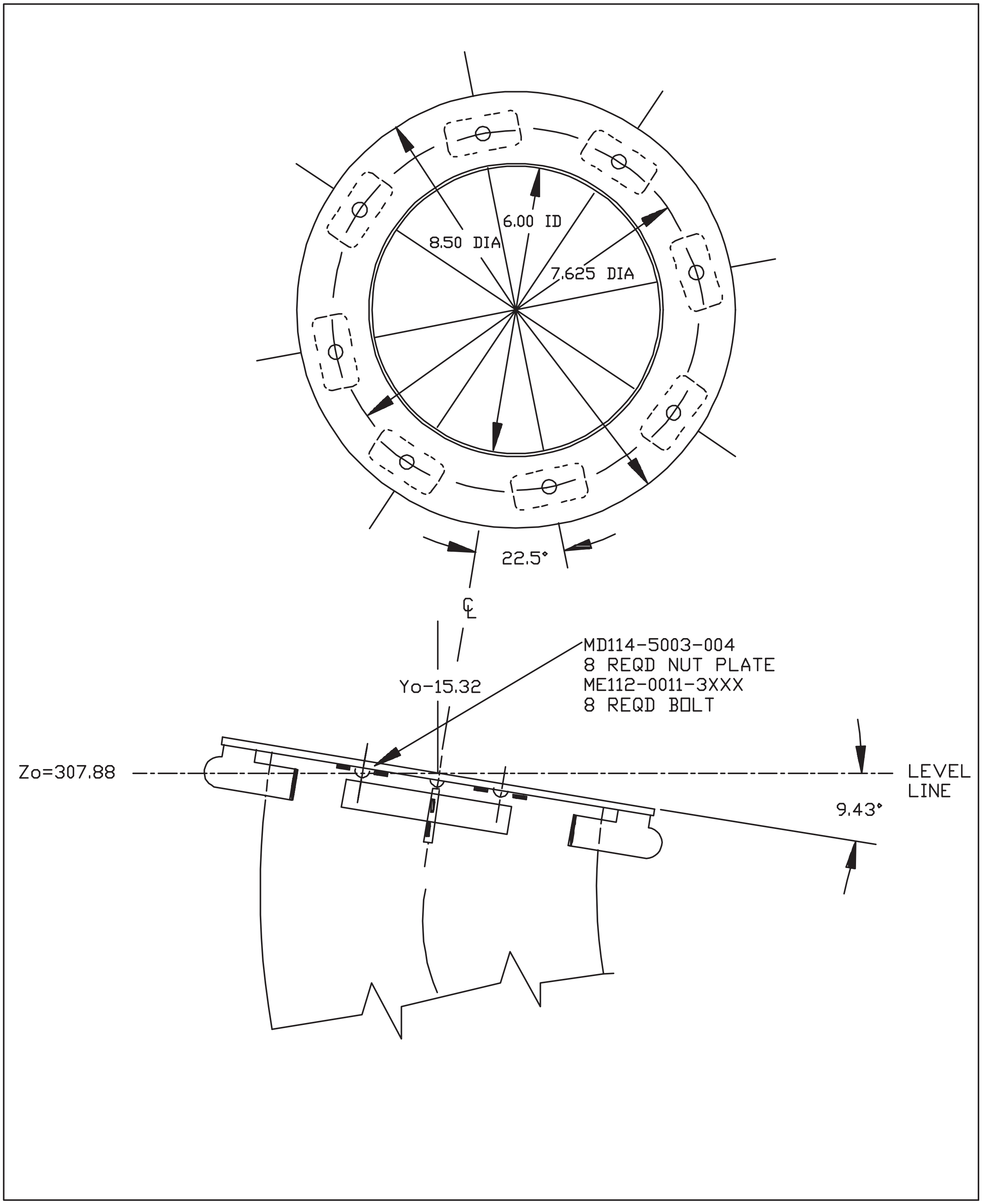


FIGURE 3.3.4.4-2 MID-FUSELAGE/CARGO BAY PURGE INLET SPIGOT

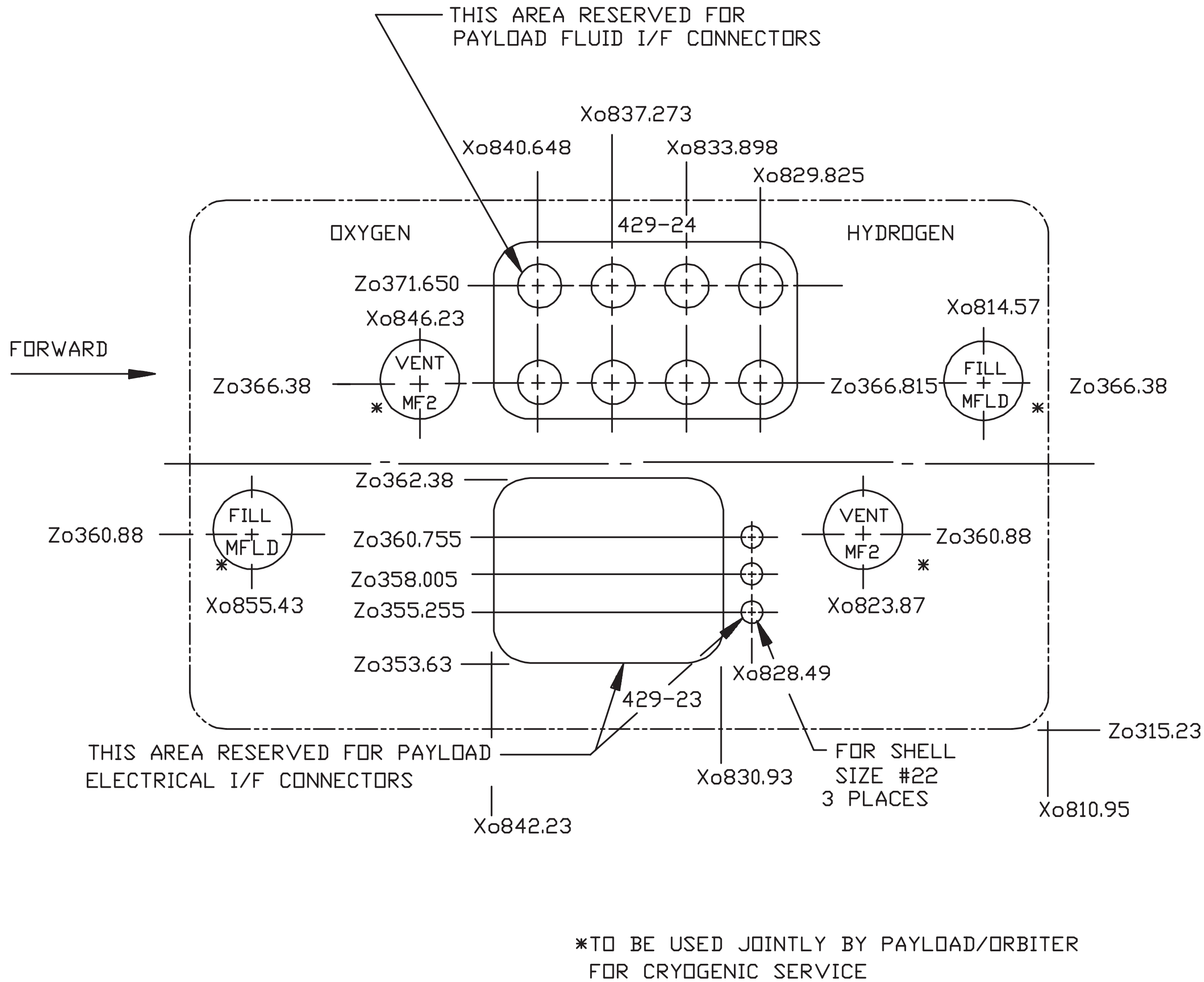


FIGURE 3.3.4.5-1 MID-BODY PRELAUNCH UMBILICAL PANEL (PORT SIDE AT Yo 100.20)

THIS PAGE INTENTIONALLY LEFT BLANK.

3.3.5 Midbody Attachment of Cargo Element Wiring; Fluid Lines and Other Lightweight Airborne Support Equipment (ASE)

3.3.5.1 Electrical Cable Accommodations

The Orbiter shall provide wire trays along the sides of the cargo bay, extending from the connector panels at Xo603 to those at Xo1203, in accordance with Figure 3.3.5.1-1. The Orbiter shall also provide for egress of SMCH and cargo element provided cables from the wire trays, as required, without physical interference with installed cargo elements.

3.3.5.2 Fluid Line Accommodations

3.3.5.2.1 Payload Active Cooling Kit (PACK)

Cargo elements requiring active cooling shall utilize the PACK. This kit provides secondary structure, hardware, insulation, and the generic portion of the coolant supply and return lines between the Payload Heat Exchanger Interface at Station Xo636 and the PACK Interface at the SIP Structure.

The PACK is designed for a wet mate (quick-disconnect interface) and accommodates vertical installation of the cargo elements.

Payloads will provide flex-lines to mate with STS provided quick-disconnects as shown in Figure 3.3.5.2.1-1. The flex-lines shall provide a 0.75 inch OD rigid tubing segment for a minimum of 4.85 inch to accommodate STS provided clamping. Payloads shall provide for support for flex-lines on their side of the departure point with adequate allowance for mating and demating of connectors. Payloads shall provide flex-lines support, as required, such that there shall be no unsupported lengths of flex-lines greater than 18 inches.

3.3.5.3 (Deleted)

3.3.5.4 Midbody Scar

The Orbiter shall provide scar in the midbody for the attachment of cargo element hardware at locations shown in Figure 3.3.5.4-1. Load carrying capability shall be such that a ten pound weight can be carried at each scar location simultaneously. Use of this scar by payloads shall be limited as specified and agreed to in the Payload Integration Plan (PIP).

3.3.6 (Deleted)

3.3.6.1 (Deleted)

3.3.6.2 (Deleted)

3.3.6.3 (Deleted)

3.3.7 (Deleted)

3.3.8 Cargo to Orbiter Electrical Bond

Each payload shall provide a Payload-to-Orbiter electrical bond in accordance with paragraphs 3.3.8.1 or 3.3.8.2 or 3.3.8.3 unless otherwise determined by payload unique requirements. All electrical bond interfaces shall conform to requirements specified in Paragraph 10.7.4.2. Orbiter ground stud provisions are defined in Figure 3.3.8-1.

3.3.8.1 Fault Current Bond

3.3.8.1.1 Bus Connector Bond

The bus connector bond is designed to be routed within 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.

3.3.8.1.2 Cargo-to-Orbiter Bond Strap

In lieu of the power connector bond described in paragraph 10.7.4.2.2.1.1, a Cargo-to-Orbiter bond strap can be STS provided (as an optional service) and shall be connected between Orbiter structure and payload ground point provisions. This bond shall meet bonding requirements specified in Paragraph 10.7.4.2.

3.3.8.2 RF Bond

3.3.8.2.1 Cargo-to-Orbiter RF Bond Strap

The Cargo-to-Orbiter RF bond strap may be STS-provided (as an optional service) and shall be connected between Orbiter structure and payload ground point provisions. This bond shall meet bonding requirements specified in Paragraph 10.7.4.2.

3.3.8.3 Static Bond

3.3.8.3.1 Cargo-to-Orbiter Static Bond

The Cargo-to-Orbiter static bond strap may be STS-provided and shall be connected between Orbiter structure and payload ground point provisions. This bond shall meet bonding requirements specified in Paragraph 10.7.4.2.3.5.

3.3.8.3.2 Cargo-to-Orbiter Static Bonding at the Keel Trunnion

Cargo-to-Orbiter static bonding may be provided through the orbiter keel latch bonding assembly establishing and maintaining contact with the cargo element keel trunnion for deployable/retrievable cross bay cargo elements. Keel bonding characteristics shall be as specified in Paragraph 10.7.4.2.3.5. The keel latch bonding assembly shall be used for static bonding only.

3.3.9 Habitable Payloads

Intravehicle activities between the orbiter crew compartment and the Habitable payload shall be accomplished through a tunnel connecting the crew compartment to the habitable payload. Within the tunnel on the Orbiter side of the interface a tunnel adapter or docking system shall be installed to support the habitable payload and EVA activities.

3.3.9.1 Transfer Tunnel

Habitable payloads shall provide a transfer tunnel located between the Orbiter tunnel adapter or the docking system and the habitable payload. This interface shall be defined in the payload unique ICD.

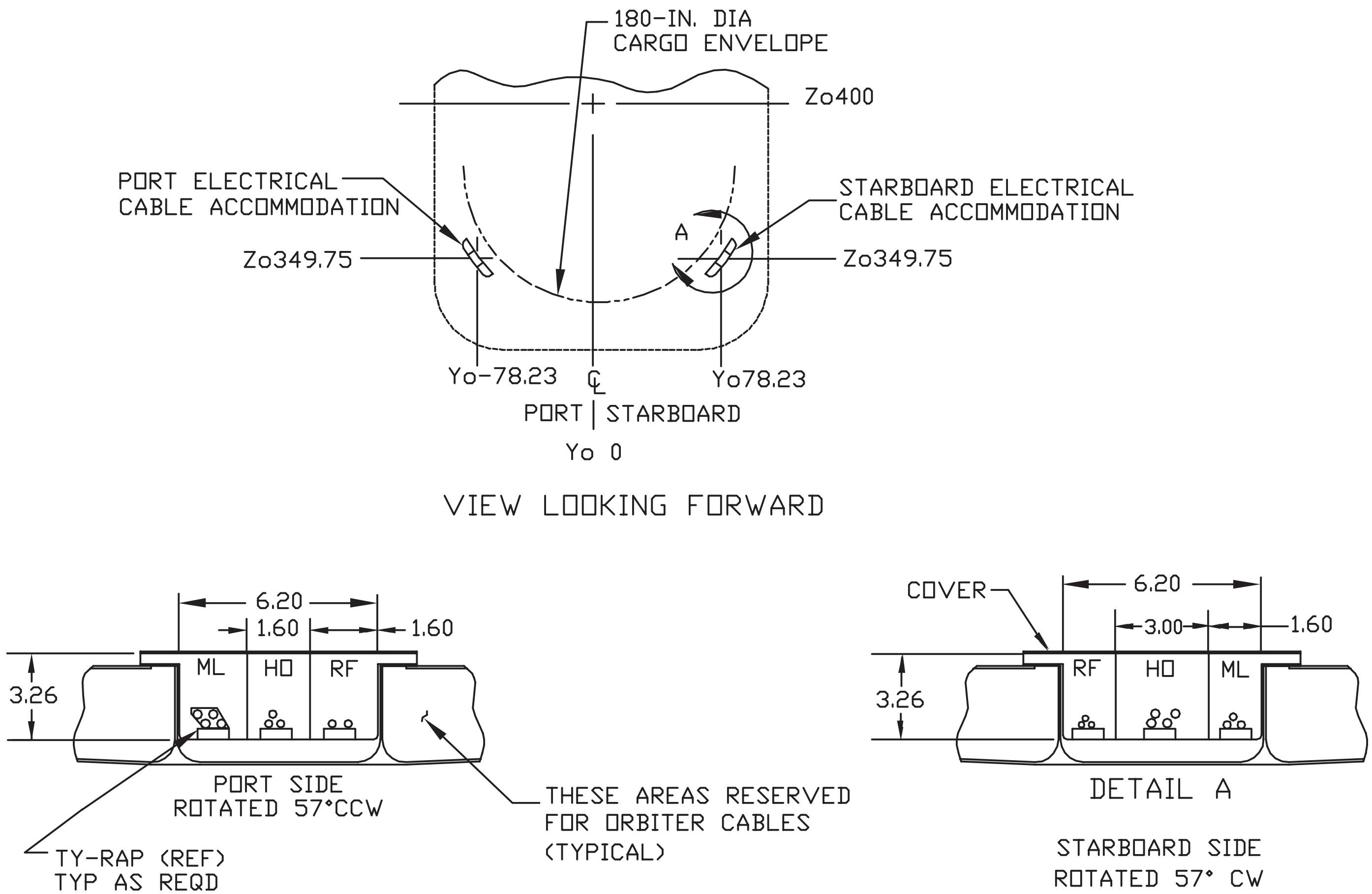
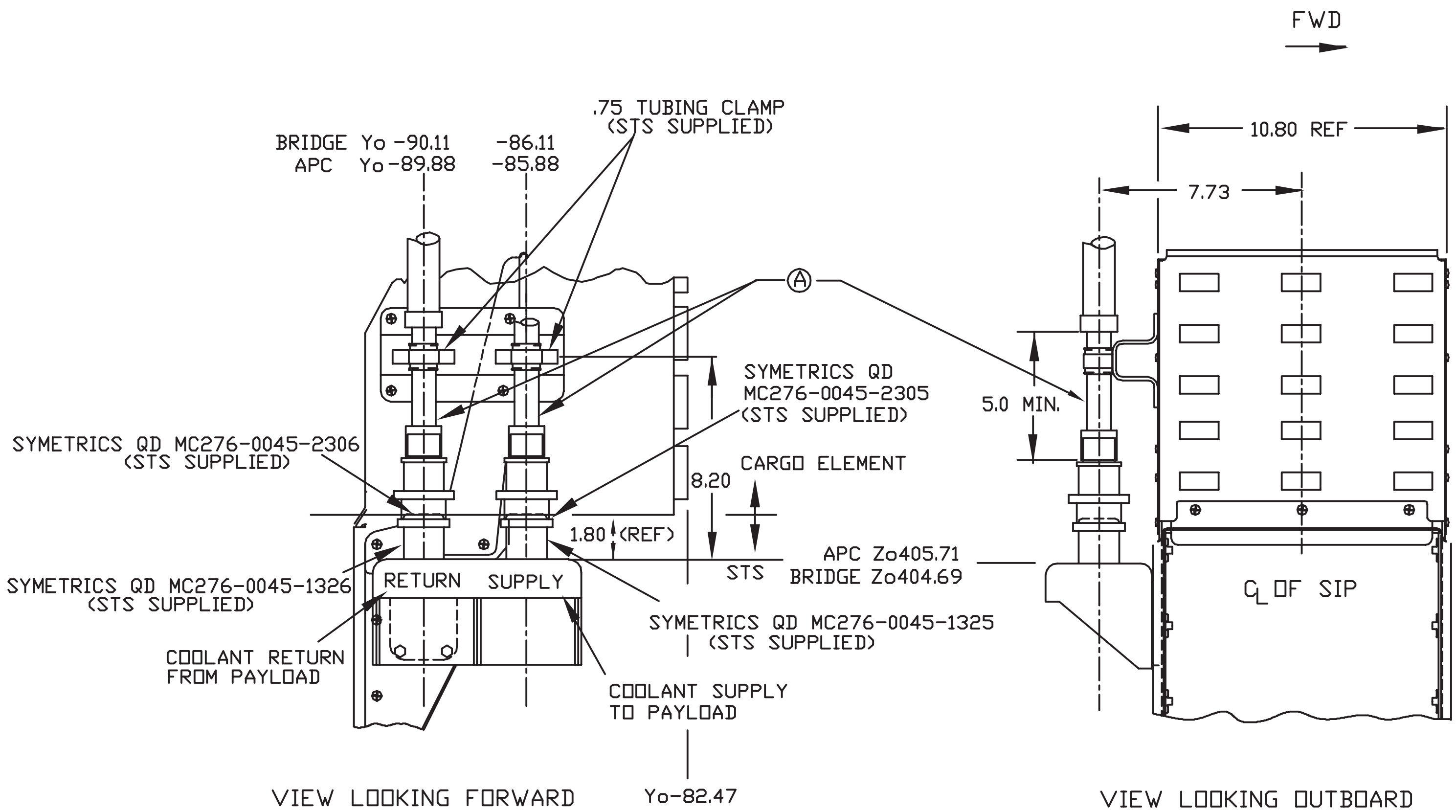
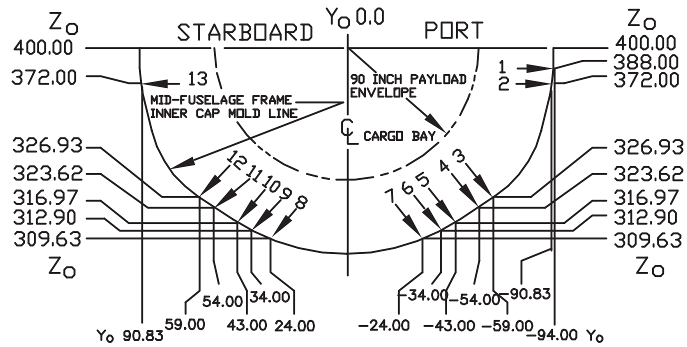


FIGURE 3.3.5.1-1 MID-BODY WIRE TRAYS

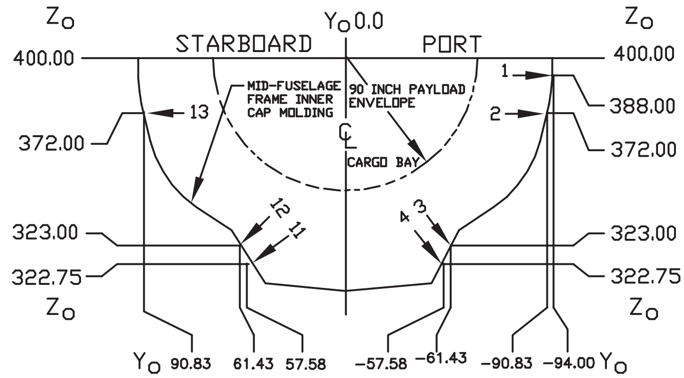


(A) PAYLOAD PROVIDED FLEX LINES WITH 0.75 DIA RIGID TUBING SEGMENT TO MATE TO STS PROVIDED QUICK DISCONNECTS USING MS24385L12 FITTING FLARED TUBE CONNECTION, PRECISION TYPE

FIGURE 3.3.5.2.1-1 PACK FLUID LINES INSTALLATION



LOOKING AFT, FRAMES X_O636.00 TO X_O1191.00 TYPICAL



LOOKING AFT, FRAME X_O1249 ONLY

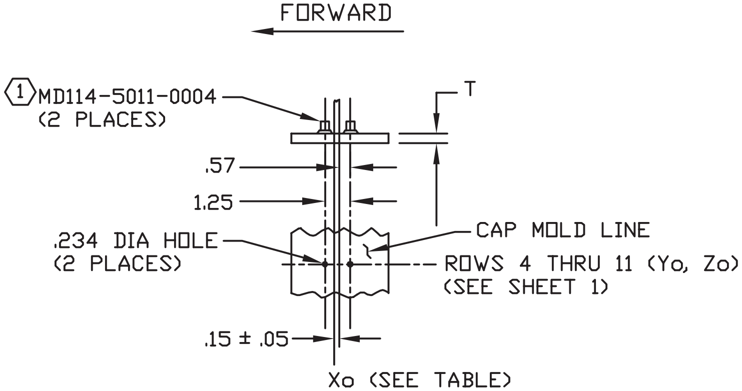
TABLE OF SCAR ATTACHMENT DETAILS*

SCAR ATTACH ROW	X_O FRAMES											
	636.00	693.00	750.00	807.00	843.00	919.00	979.50	1040.00	1090.33	1140.67	1191.00	1249.00
1	**	B	B	B	B	B	B	B	B	B	B	B
2	B	B	C	B	B	C	C	B	B	B	B	B
3	E	B	B	B	B	B	B	B	B	B	E	F
4	A	A	A	A	A	A	A	D	A	A	G	F
5	A	A	A	A	A	A	A	A	A	A	G	**
6	A	A	A	A	A	A	A	A	A	A	G	**
7	A	A	A	A	A	A	A	A	A	A	G	**
8	A	A	A	A	A	A	A	A	A	A	G	**
9	A	A	A	A	A	A	A	A	A	A	G	**
10	A	A	A	A	A	A	A	A	A	A	G	**
11	A	A	A	A	A	A	A	D	A	A	G	F
12	E	B	B	B	B	B	B	B	B	B	E	F
13	B	B	B	B	C	C	C	B	B	B	B	B

*DETAILS A AND B: SHEET 2; DETAILS C, D, E: SHEET 3; DETAILS F AND G: SHEET 4
**NO ATTACHMENT POINTS

FIGURE 3.3.5.4-1 MID-BODY SCAR ATTACHMENT PROVISIONS

(SHEET 1 OF 4)



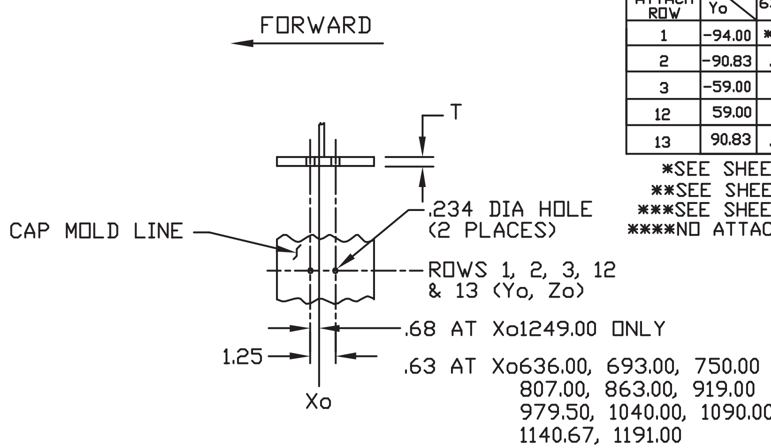
VIEW LOOKING STARBOARD
(PORT OPPOSITE)

T DIMENSION

SCAR ATTACH ROW	Yo \ Xo	636.00	693.00	750.00	807.00	863.00	919.00	979.50	1040.00	1090.33	1140.67
4	-54.00	.150	.135	.135	.135	.135	.149	.150	*	.260	.280
5	-43.00	.150	.135	.135	.135	.135	.144	.150	.170	.260	.280
6	-34.00	.150	.135	.135	.135	.135	.140	.164	.204	.260	.280
7	-24.00	.150	.135	.135	.135	.135	.144	.181	.231	.260	.280
8	24.00	.150	.135	.135	.135	.135	.144	.181	.231	.260	.280
9	34.00	.150	.135	.135	.135	.135	.140	.164	.204	.260	.280
10	43.00	.150	.135	.135	.135	.135	.144	.150	.170	.260	.280
11	54.00	.150	.135	.135	.135	.135	.149	.150	*	.260	.280

*SEE SHEET 3 DETAIL D

DETAIL A



VIEW LOOKING STARBOARD
(PORT OPPOSITE)

T DIMENSION

SCAR ATTACH ROW	Yo \ Xo	636.00	693.00	750.00	807.00	863.00	919.00	979.00	1040.00	1090.33	1140.67	1191.00	1249.00
1	-94.00	****	.350	.310	.310	.340	.260	.300	.371	.350	.600	.880	.780
2	-90.83	.340	.330	*	.279	.330	*	*	.294	.310	.520	.740	.540
3	-59.00	**	.135	.135	.135	.150	.150	.150	.389	.260	.280	**	***
12	59.00	**	.135	.135	.135	.150	.150	.150	.389	.260	.280	**	***
13	90.83	.340	.330	.290	.279	*	*	*	.294	.310	.520	.740	.540

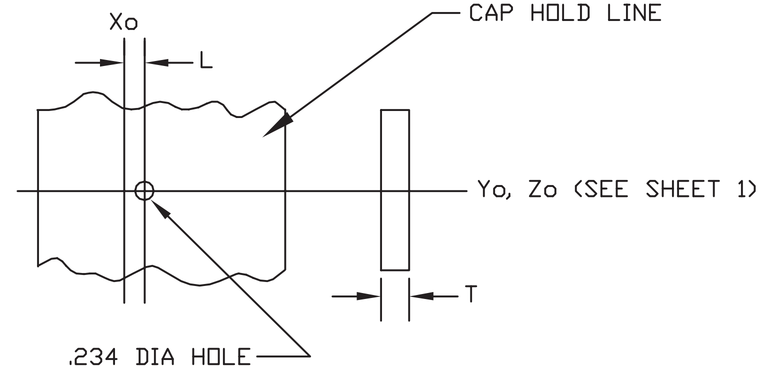
*SEE SHEET 3, DETAIL C
**SEE SHEET 3, DETAIL E
***SEE SHEET 4, DETAIL F
****NO ATTACHMENT POINT

NOTES:
1. INTERIM ROCKWELL PART NUMBER (FOR REFERENCE ONLY) WILL BE CHANGED TO APPROPRIATE GOVERNMENT IDENTIFICATION WHEN SUCH GOVERNMENT SPECIFICATION COVERAGE IS IMPLEMENTED.

DETAIL B

FIGURE 3.3.5.4-1 MID-BODY SCAR ATTACHMENT PROVISIONS
(SHEET 2 OF 4)

FORWARD



SCAR ATTACHMENT ROW 13 SHOWN, STARBOARD
SCAR ATTACHMENT ROW 2, PORT SIDE OPPOSITE

L DIMENSION

SCAR ATTACH ROW	Yo \ Xo	750.00	863.00	919.00	979.50
2	-90.83	.520	*	.520	.720
13	90.83	*	.770	.520	.720

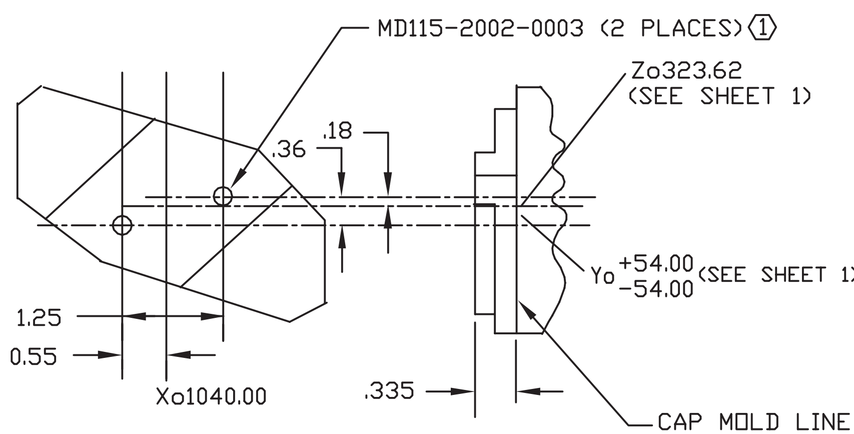
T DIMENSION

SCAR ATTACH ROW	Yo \ Xo	750.00	863.00	919.00	979.50
2	-90.83	.290	*	.250	.270
13	90.83	*	.330	.250	.270

* SEE SHEET 1, DETAIL B

DETAIL C

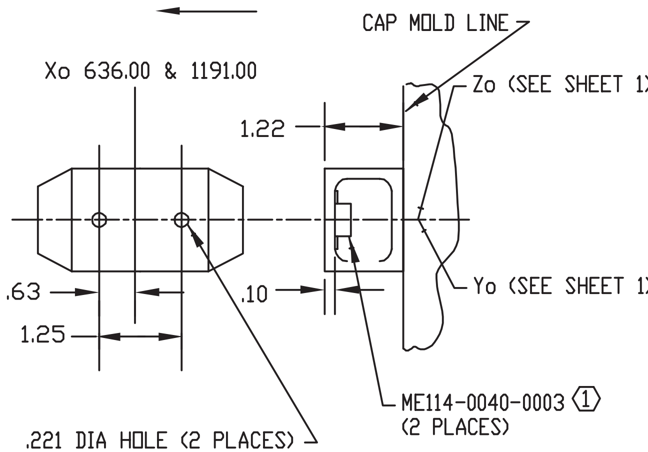
FORWARD



SCAR ATTACHMENT ROW 11 SHOWN, STARBOARD
SCAR ATTACHMENT ROW 4, PORT SIDE OPPOSITE

DETAIL D

FORWARD



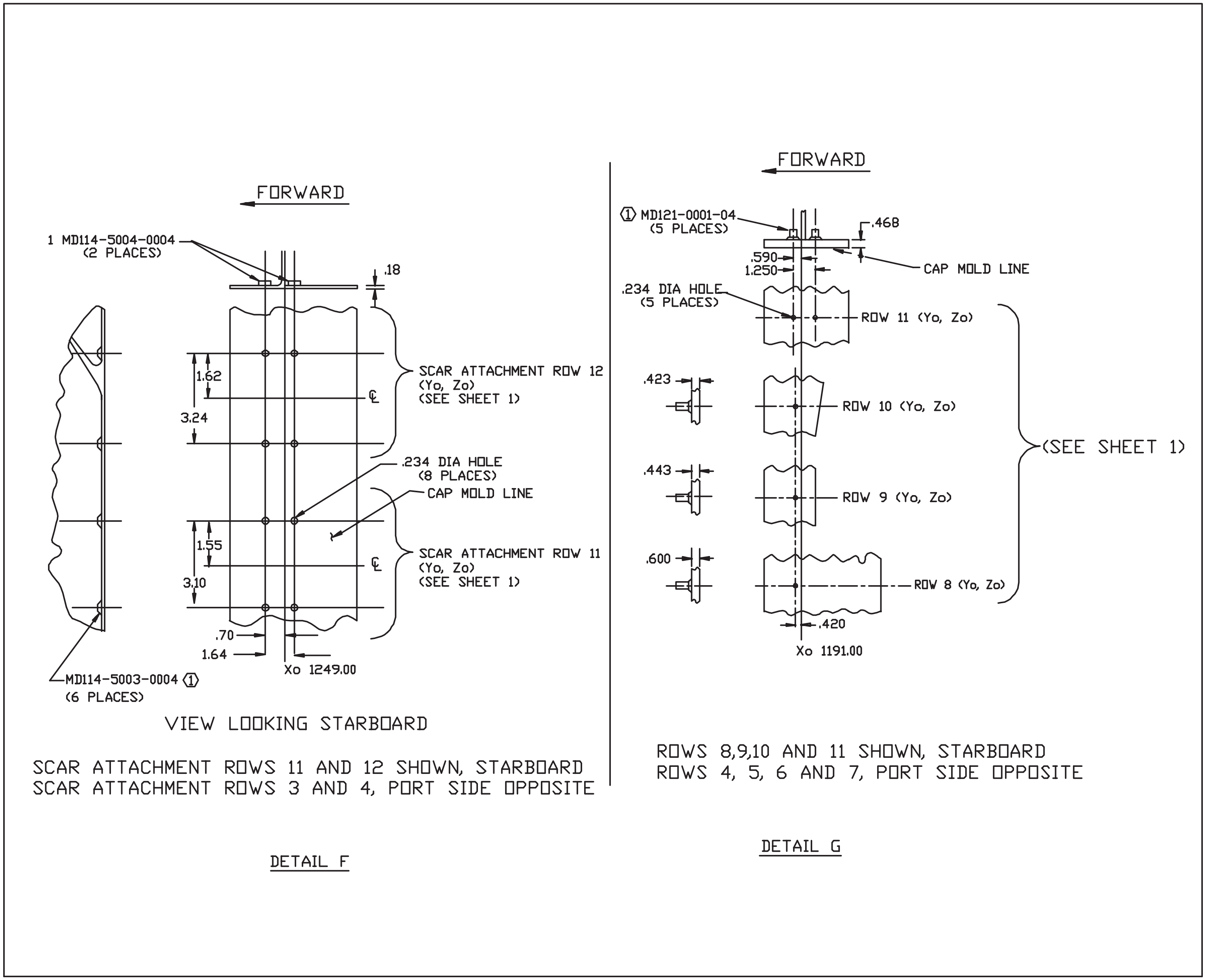
SCAR ATTACHMENT ROW 12 SHOWN, STARBOARD
SCAR ATTACHMENT ROW 3, PORT SIDE OPPOSITE

DETAIL E

FIGURE 3.3.5.4-1 MID-BODY SCAR ATTACHMENT PROVISIONS
(SHEET 3 OF 4)

FIGURE 3.3.5.4-1 MID-BODY SCAR ATTACHMENT PROVISIONS

(SHEET 4 OF 4)



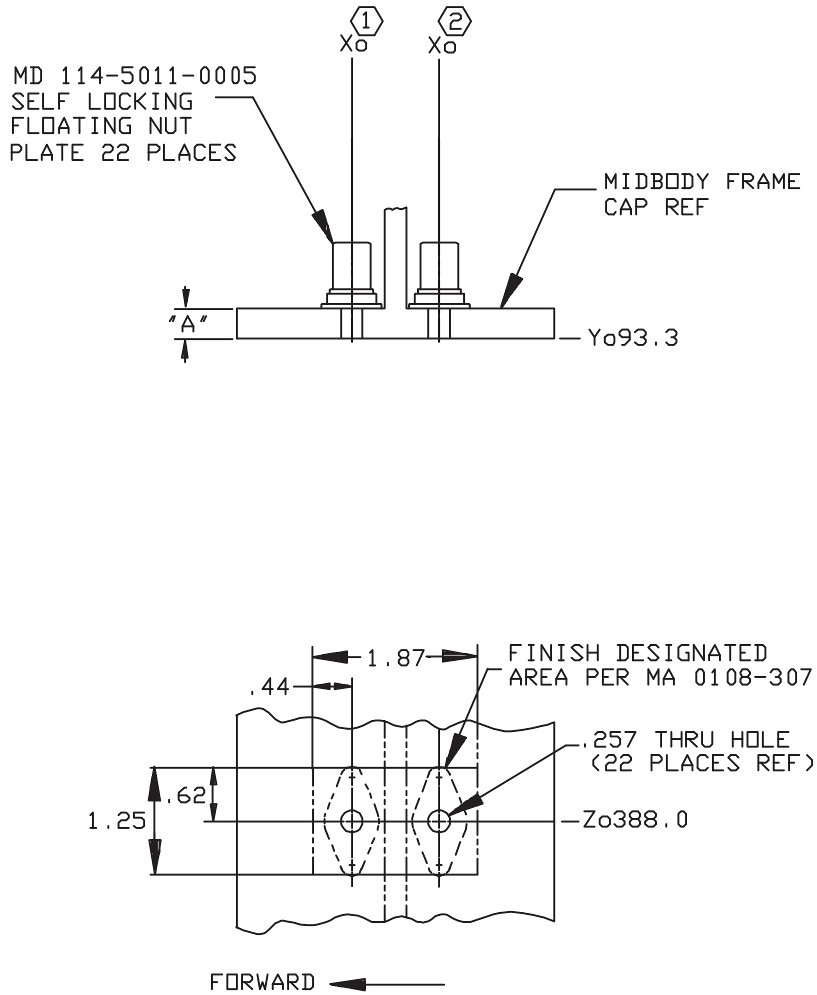


FIGURE 3.3.8-1 MID-BODY CARGO ELEMENT BONDING SCAR

DATA TABLE

Xo ①	Xo ②	"A" ③	"A" ④
692.63	693.57	.413	.350
749.63	750.61	.373	.310
806.63	807.57	.383	.320
862.63	863.57	.403	.340
918.63	919.57	.383	.320
979.13	979.07	.383	.320
1039.63	1040.57	.383	.320
1089.96	1090.90	.413	.350
1140.30	1141.29	.663	.600
1190.63	1191.62	.943	.880
1248.63	1249.62	.843	.780

NOTES:

1. FOR DIM "A", Xo ① AND Xo ② VALUES SEE DATA TABLE
2. ③ INDICATES ORBITER VEHICLE EFFECTIVITY OF S/C 102 ONLY
3. ④ INDICATES ORBITER VEHICLE EFFECTIVITY OF S/C 103 & SUBS

THIS PAGE INTENTIONALLY LEFT BLANK.

3.4 CREW COMPARTMENT

3.4.1 Aft Flight Deck

A general arrangement of the aft flight deck is shown in Figure 3.4.1-1.

3.4.1.1 Payload Equipment Interfaces

3.4.1.1.1 Equipment Consoles

The payload display and control panels and/or equipment shall be installed in Orbiter-provided removable consoles at the Mission Station and Payload Station. The console, used at both stations, is defined in Figure 3.4.1.1.1-1. Each console shall accommodate the electrical equipment rack panels defined in Figure 3.4.1.1.1-2.

The console and attachments are designed to accommodate a total equipment module weight of up to 135 lbs. Cantilever mounted modules are in each case to be bolted to the top frame as shown in Figure 3.4.1.1.1-3. To keep individual module loads within strength limits, the c.g. of each cantilevered module must fall within the limits of Figure 3.4.1.1.1-4. To keep combined module loads within strength limits, the overall c.g. of the modules must fall within the limits of Figure 3.4.1.1.1-5.

Equipment modules which fall outside the limits of Figure 3.4.1.1.1-4 shall have a lower support, in addition to the upper attachment, to provide Y-direction support for the lower end of the module. For structural purposes a single strut running from the lower center of the module to a lower corner of the container is sufficient. Access for attachment is through the front panel.

3.4.1.1.2 Equipment Areas

Payload display and control panel areas shall be provided at the On-Orbit Station. The interface requirement for On-Orbit Station panels is defined in Paragraph 3.4.1.3.

3.4.1.1.3 Panel GSE Hard Points

Accommodations to install and remove cargo-provided panels in the consoles and panel areas shall be provided as required. GSE quick release pin T and U handles are available as GFE and payloads using this service shall provide receptacles in accordance with Figure 3.4.1.1.3-1.

3.4.1.1.4 Fire Protection

Each payload display/control panel shall have adequate provisions for fire protection.

3.4.1.1.4.1 Fire Holes

Each payload display/control panel shall have on its front surface a "fire hole", 0.5 inch in diameter, located so as to allow a fire extinguisher to be inserted for suppressing fire behind the panel. The hole shall be covered by a 0.75 inch diameter GFE decal placed over the fire hole.

3.4.1.1.5 Electrical Short Prevention

A coating shall be required on all exposed wire terminations, component terminals, and other conductive surfaces of electrical and electronic equipment located in the Orbiter Crew Compartment, for protection against electrical shorts due to humidity and debris.

3.4.1.2 Mission Station

3.4.1.2.1 Equipment Console and Display Panel

One equipment console shall be provided in accordance with paragraph 3.4.1.1.1. The panel envelopes for the two possible console installations are defined in Figure 3.4.1.2.1-2. In addition, space and mounting provisions for a display and control panel are defined in Figure 3.4.1.2.1-1.

3.4.1.2.2 Electrical Distribution Panel

The electrical distribution panel interface shall be in accordance with Figure 3.4.1.2.2-1.

3.4.1.2.3 Electrical Harness Supports

The supports for the electrical harnesses shall be in accordance with Figure 3.4.1.2.3-1.

3.4.1.2.4 Equipment Cooling

Orbiter provided ducting for the cooling of cargo element electrical equipment mounted in the Mission Station (MS) console is shown in Figure 3.4.1.2.3-1 and Figure 3.4.1.2.4-1. Cooling air provided at the MS shall be as defined in Paragraph 6.3.

3.4.1.3 On-Orbit Station

3.4.1.3.1 Display and Control Panels

Two areas for display and control panels shall be provided for payload use at the On-Orbit Station. The envelope for each shall be in accordance with Figure 3.4.1.3.1-1.

3.4.1.3.2 Electrical Distribution Panel

The port electrical distribution panel connector interfaces shall be in accordance with Figure 3.4.1.3.2-1. The starboard electrical distribution panel connector interfaces shall be in accordance with Figure 3.4.1.3.2-2.

3.4.1.3.3 Electrical Harness Supports

The electrical harness supports shall be in accordance with Figures 3.4.1.3.3-1 and 3.4.1.3.3-2.

3.4.1.3.4 Retention System Control

The Orbiter shall provide switch controls and talkback indicators for Retention System management. Switches on Panel A6A1, installed at the Aft Flight Deck On-Orbit Station, provide for the activation of a total of fifteen latches in the cargo bay, with no more than two latches being operated simultaneously.

3.4.1.4 Payload Station

3.4.1.4.1 Equipment Consoles

Three equipment consoles shall be provided in accordance with Paragraph 3.4.1.1.1. The panel envelopes for each shall be in accordance with Figure 3.4.1.4.1-1.

3.4.1.4.2 Payload Station Distribution Panel (PSDP)

The Orbiter shall provide electrical interfaces at the PSDP in accordance with Figure 3.4.1.4.2-1.

3.4.1.4.2.1 Electrical Characteristics at the Cargo Element Interface

Electrical interface characteristics are defined by function in Sections 8 and 13.

3.4.1.4.2.2 Standard Interface Cabling

The Orbiter shall provide standard cables, as defined in Paragraph 13.5.2.2 to extend from the PSDP to cargo element equipment installed at the Payload Station.

3.4.1.4.3 Electrical Harness Supports

The supports for the electrical harnesses shall be in accordance with Figure 3.4.1.4.3-1.

3.4.1.4.4 Equipment Cooling

Orbiter provided ducting for the cooling of cargo element electrical equipment mounted in and below the PS console is shown in Figure 3.4.1.4.4-1. Cooling air provided at the Payload Station shall be as defined in Paragraph 6.3.

3.4.1.4.5 Space Allocation

The space below the modules reserved for payloads shall be in accordance with Figure 3.4.1.4.5-1.

3.4.1.4.6 Standard Payload Display and Control Interface Modules

The STS shall provide Standard Payload Display and Control Interface (SPDCI) modules. The SPDCI shall include a Closed-Circuit Television (CCTV) Monitor Panel (TVMP), a Standard Switch Panel (SSP), a Manual Pointing Controller (MPC), a Deployment Pointing Panel (DPP) to which the MPC is attached by an STS-provided umbilical, a Computer Interface Panel (CIP), and a Payload Data Interface Panel (PDIP). Performance characteristics shall be as defined in Paragraph 13.4.

3.4.1.4.6.1 Television Monitor Panel (TVMP)

The TVMP rear panel connector layout, shall be as shown in Figure 3.4.1.4.6.1-1.

3.4.1.4.6.2 Standard Switch Panel (SSP)

The Standard Switch Panel primary location will be in payload dedicated console location L12, with optional locations in L10 or L11 when defined in cargo element-unique ICD’s. Layout of the SSP front panel, including lettering, shall be as shown in Figure 3.4.1.4.6.2-1. The SSP rear panel connector designations and layout shall be as shown in Figure 3.4.1.4.6.2-2.

3.4.1.4.6.3 Manual Pointing Controller (MPC)

The manual pointing controller (MPC) shall be attached by an electrical connection to the DPP by an eight-foot umbilical cable.

3.4.1.4.6.4 Deployment/Pointing Panel (DPP)

Layout of the DPP front panel shall be as shown in Figure 3.4.1.4.6.4-1. The rear panel connector designations and layout shall be as shown in Figure 3.4.1.4.6.4-2.

3.4.1.4.6.5 Payload General Support Computer Interface Panel (CIP)

Layout and connector designations of the CIP front panel shall be as shown in Figure 3.4.1.4.6.5-1. The rear panel connector designations and layout shall be as shown in Figure 3.4.1.4.6.5-2.

3.4.1.4.6.6 Payload Data Interface Panel (PDIP)

Layout and connector designations of the PDIP front panel shall be as shown in Figure 3.4.1.4.6.6-1. The rear panel connector designations and layout shall be as shown in Figure 3.4.1.4.6.6-2.

3.4.1.5 (Reserved)

3.4.1.6 Bonding

All crew-compartment electrical bonding interfaces shall be prepared in accordance with Paragraph 10.7.4.2.

3.4.1.7 Harness/Connector Interface Between Orbiter and Cargo Element

All cables, STS or cargo element supplied, interconnecting the Orbiter and cargo element shall have the following connector configuration at the cargo element termination of the cable:

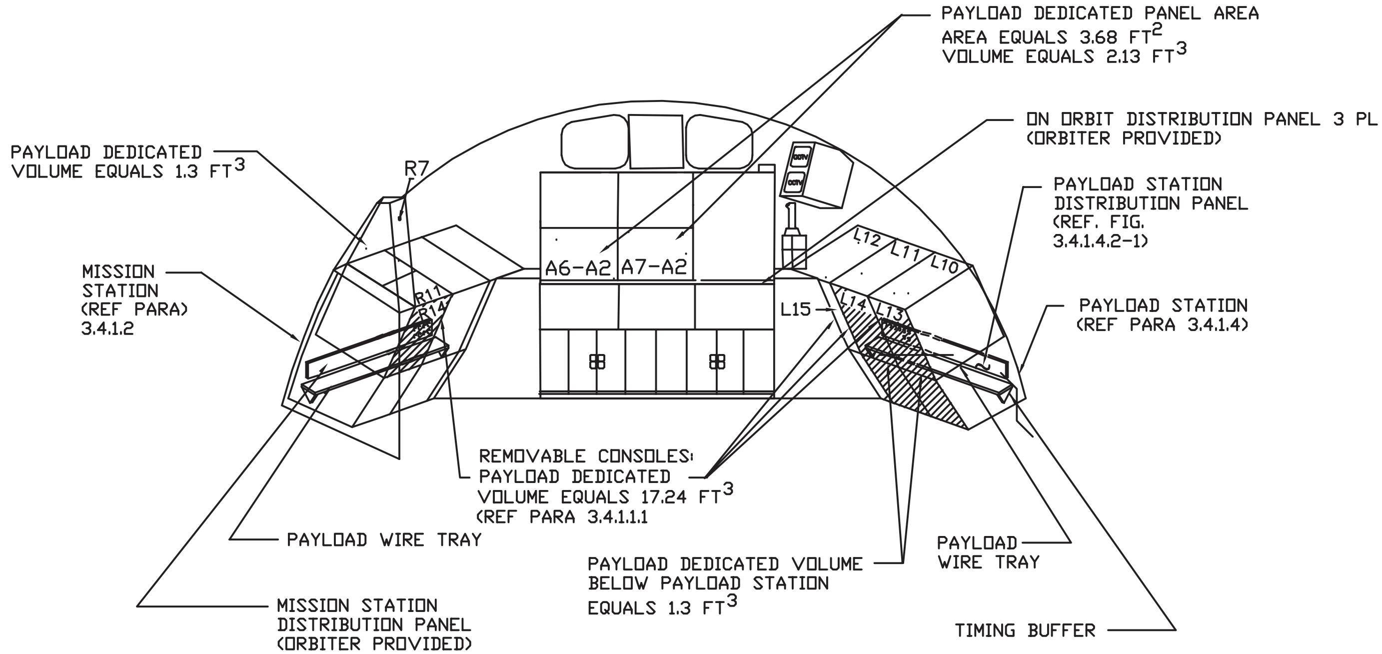
a. All cables shall terminate in connector plugs which consist only of pin (male) contacts for interfacing with cargo element modules, panels, components, etc.

b. All interfacing cargo element modules, panels, components, etc., shall incorporate connector receptacles which consist only of socket (female) contacts for interfacing with cables interconnecting the Orbiter and cargo element.

3.4.2 Middeck

3.4.2.1 Stowage

All of the potential loose-equipment stowage locations and volumes, negotiable on a mission-by-mission basis for Cargo use, are defined and controlled in NSTS-21000-IDD-MDK. A minimum of 42 middeck lockers shall be dedicated to cargo use in each mission, except for EDO missions. For EDO missions refer to Appendix E. The physical dimensions of the middeck locker are shown in Figure 3.4.2.1-1.



1. LEGEND

▭ PAYLOAD DEDICATED PANEL AREA EQUALS 16.85 FT^2.

▨ ADDITIONAL PAYLOAD DEDICATED D&C PANELS ON INBOARD SURFACES OF THREE EQUIPMENT CONSOLES REQUIRE ALLOWANCE OF SIX (6) INCHES DEPTH OF NORMAL PANEL AREA. ALL COMPONENTS ON THESE SURFACES MUST BE FULL RECESSED. ADDITIONAL PANEL SURFACE AREA IS 5.5 FT^2.

2. TOTAL PAYLOAD DEDICATED VOLUME IS 21.64 FT^3.

FIGURE 3.4.1-1 SHUTTLE ORBITER PAYLOAD PHYSICAL INTERFACE LOCATIONS - AFT FLIGHT DECK ARRANGEMENT

NOTES:

1. CONSOLE ACCOMMODATES PANELS UP TO SIZE "M" OR COMBINATION OF PANEL SIZES UP TO SIZE "M" PER FIG. 3.4.1.1.1-2

2. MOUNTING HOLE LOCATION DIMENSIONS ARE REFERENCE ONLY

3. MOUNTING HOLE LOCATIONS CONTROLLED PER ROCKWELL INTERNATIONAL TOOL #T-7135445

4. MAXIMUM WEIGHT OF CARGO ELEMENT COMPONENTS IN CONSOLE SHALL NOT EXCEED 135.0 LBS WITH CONTENT DENSITY OF NOT MORE THAN 30.0 LBS PER CUBIC FOOT

5. COMPONENTS MOUNTED ON PANELS R14, L13, AND L14 SHALL BE RECESSED SO THAT THERE WILL BE NO PROTRUSIONS BEYOND THE SURFACE OF THESE PANELS

6. PANEL KICK/PUSH LOADS PER PARAGRAPH 4.2.3

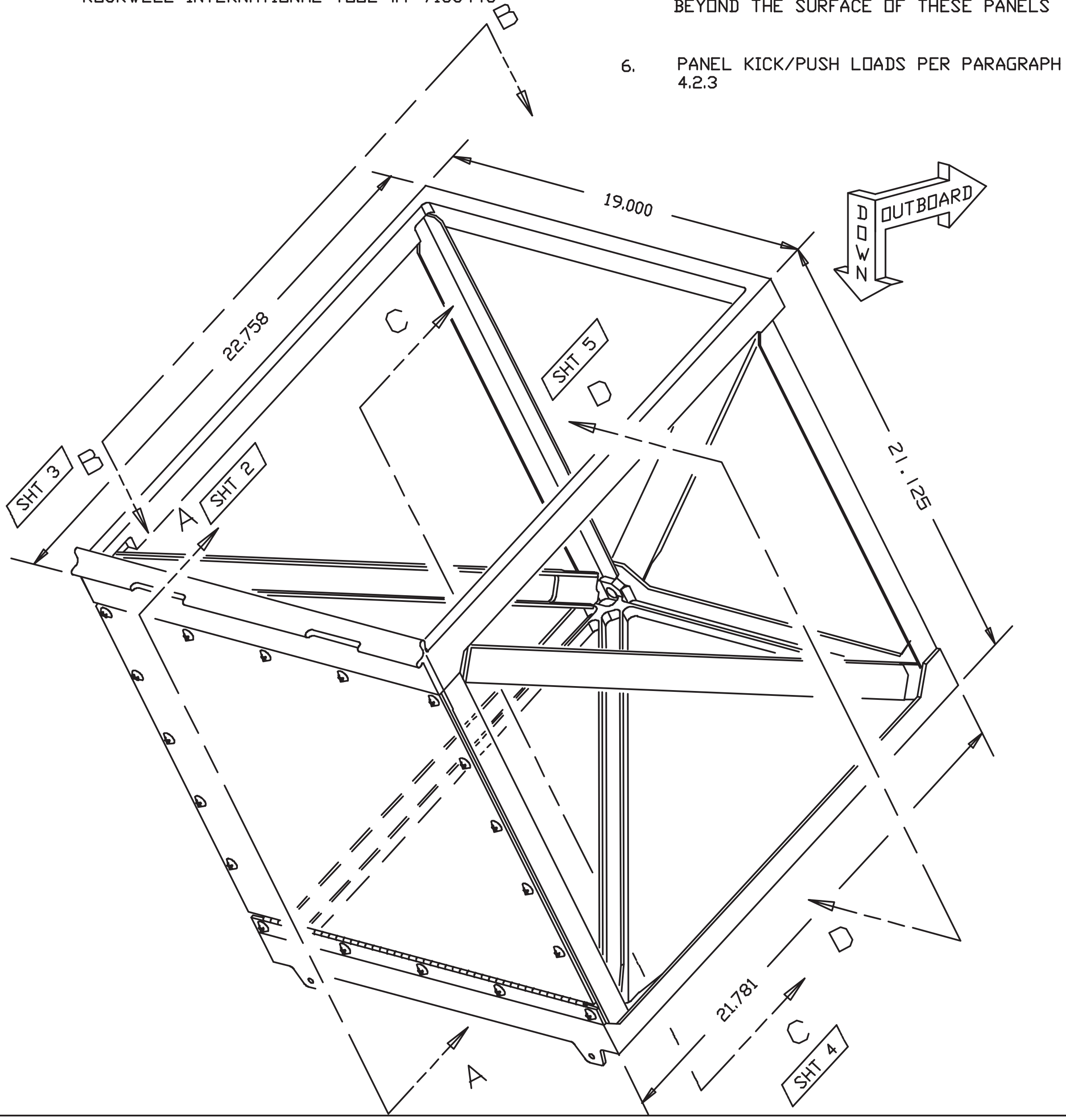


FIGURE 3.4.1.1.1-1 PAYLOAD DEDICATED CONSOLE, TYPICAL FOR L10, L11, L12, L13, L14, R11 OR R14 ON AFT FLIGHT DECK

(SHEET 1 OF 5)

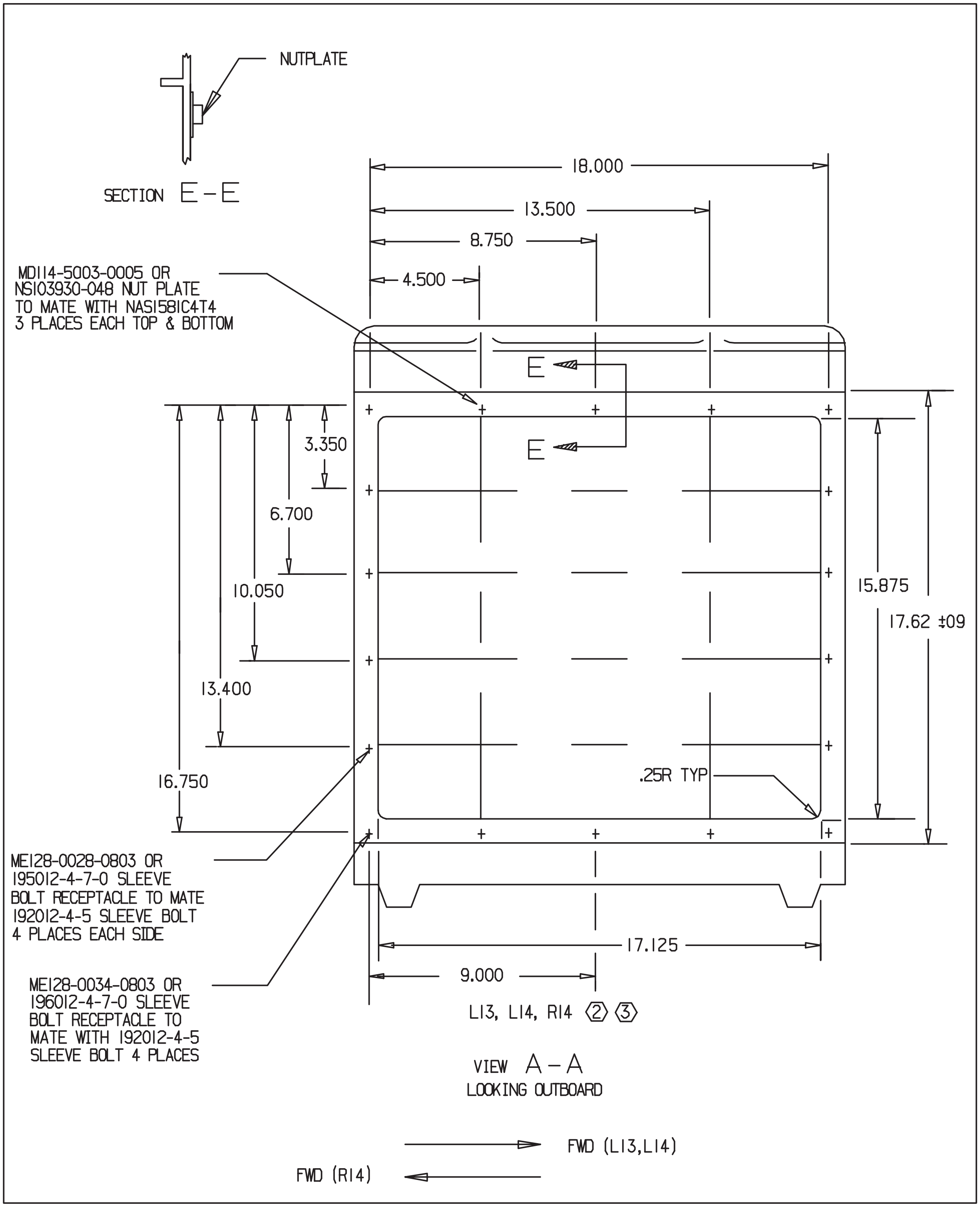


FIGURE 3.4.1.1.1-1 PAYLOAD DEDICATED CONSOLE, TYPICAL FOR L10, L11, L12, L13, L14, R14, R11 OR R12 ON AFT FLIGHT DECK

(SHEET 2 OF 5)

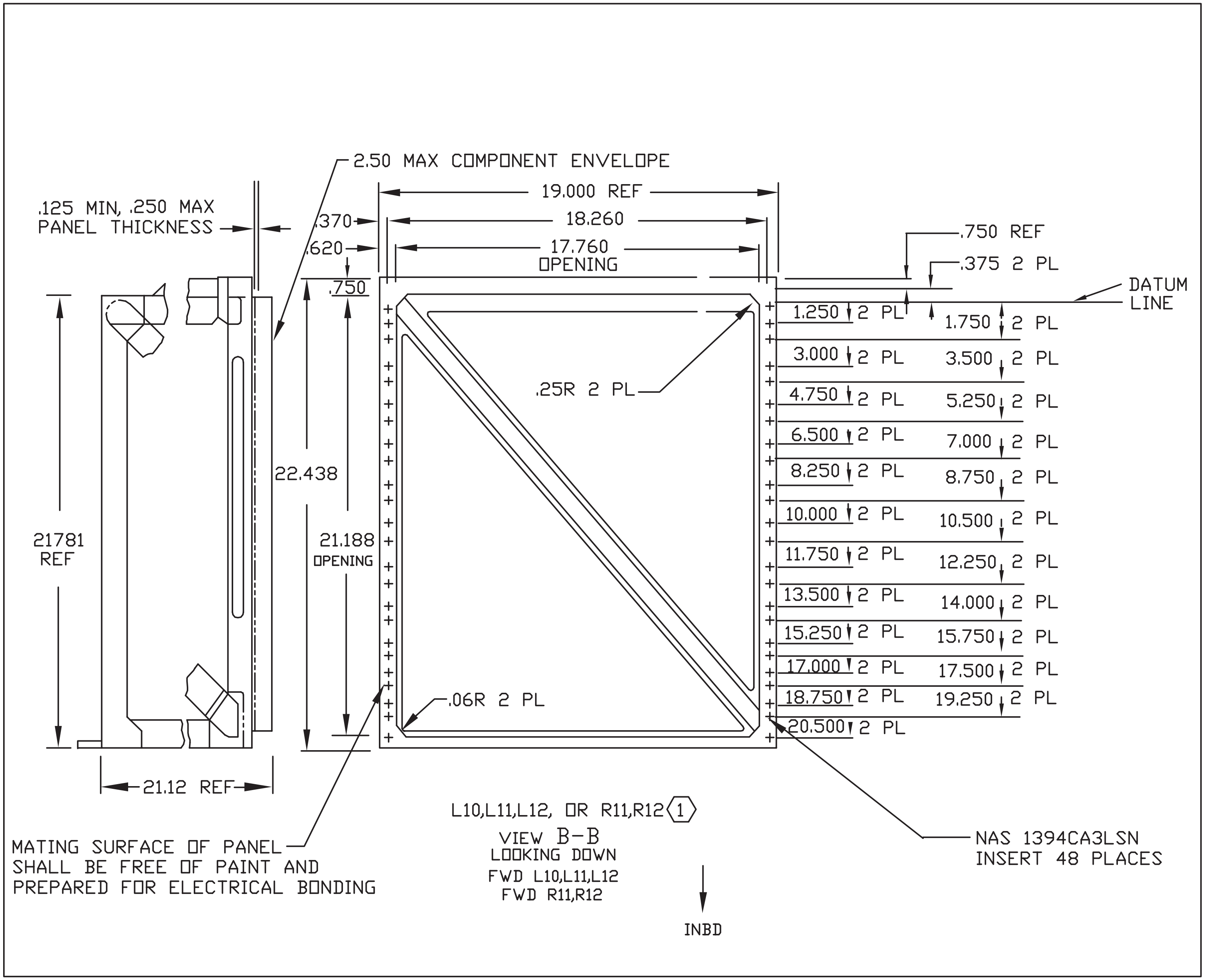


FIGURE 3.4.1.1.1-1 PAYLOAD DEDICATED CONSOLE, TYPICAL FOR L10, L11, L12 OR R11 ON AFT FLIGHT DECK

(SHEET 3 OF 5)

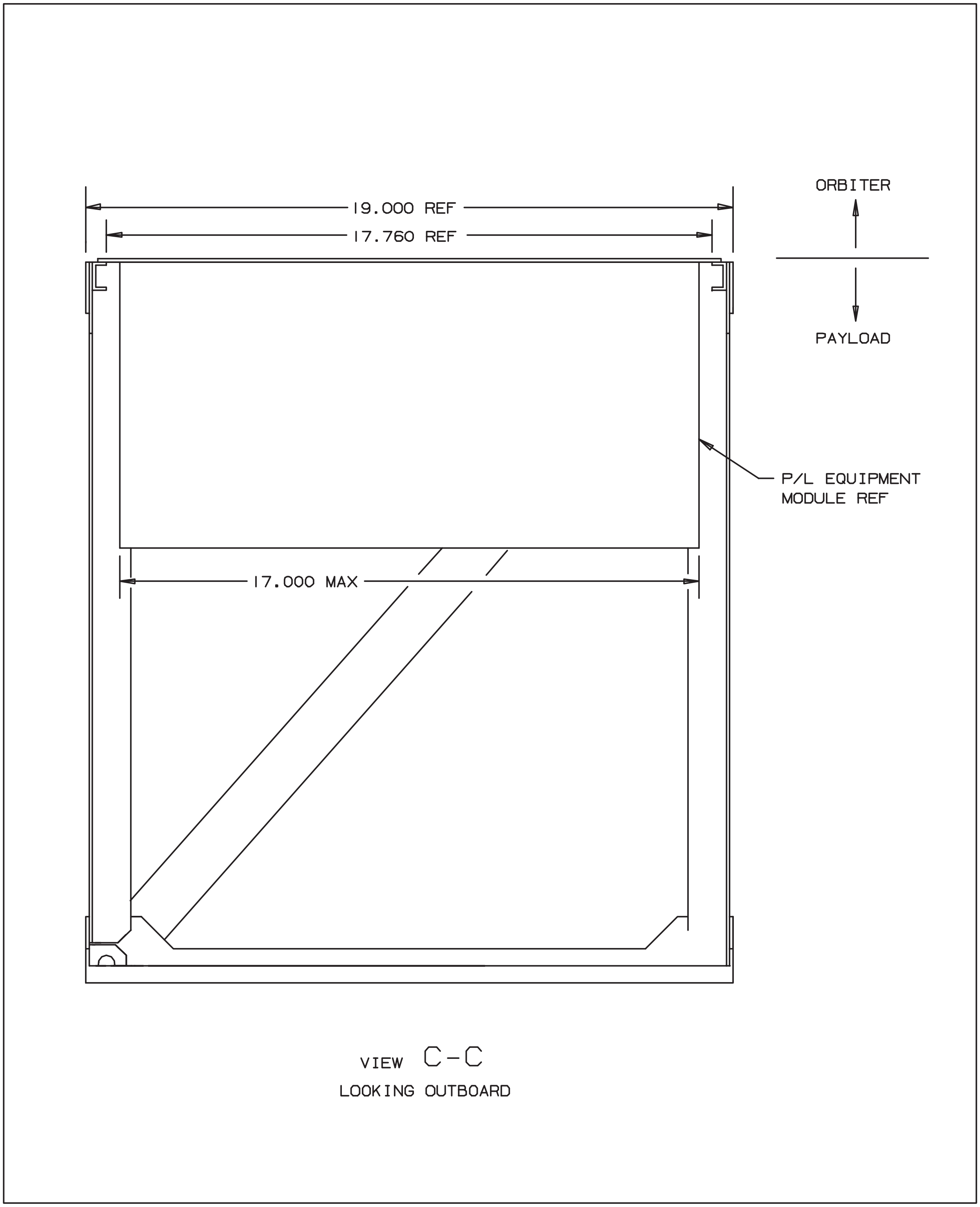


FIGURE 3.4.1.1.1-1 PAYLOAD DEDICATED CONSOLE, TYPICAL FOR L10, L11, L12, L13, L14, R14, R11 OR R12 ON AFT FLIGHT DECK

(SHEET 4 OF 5)

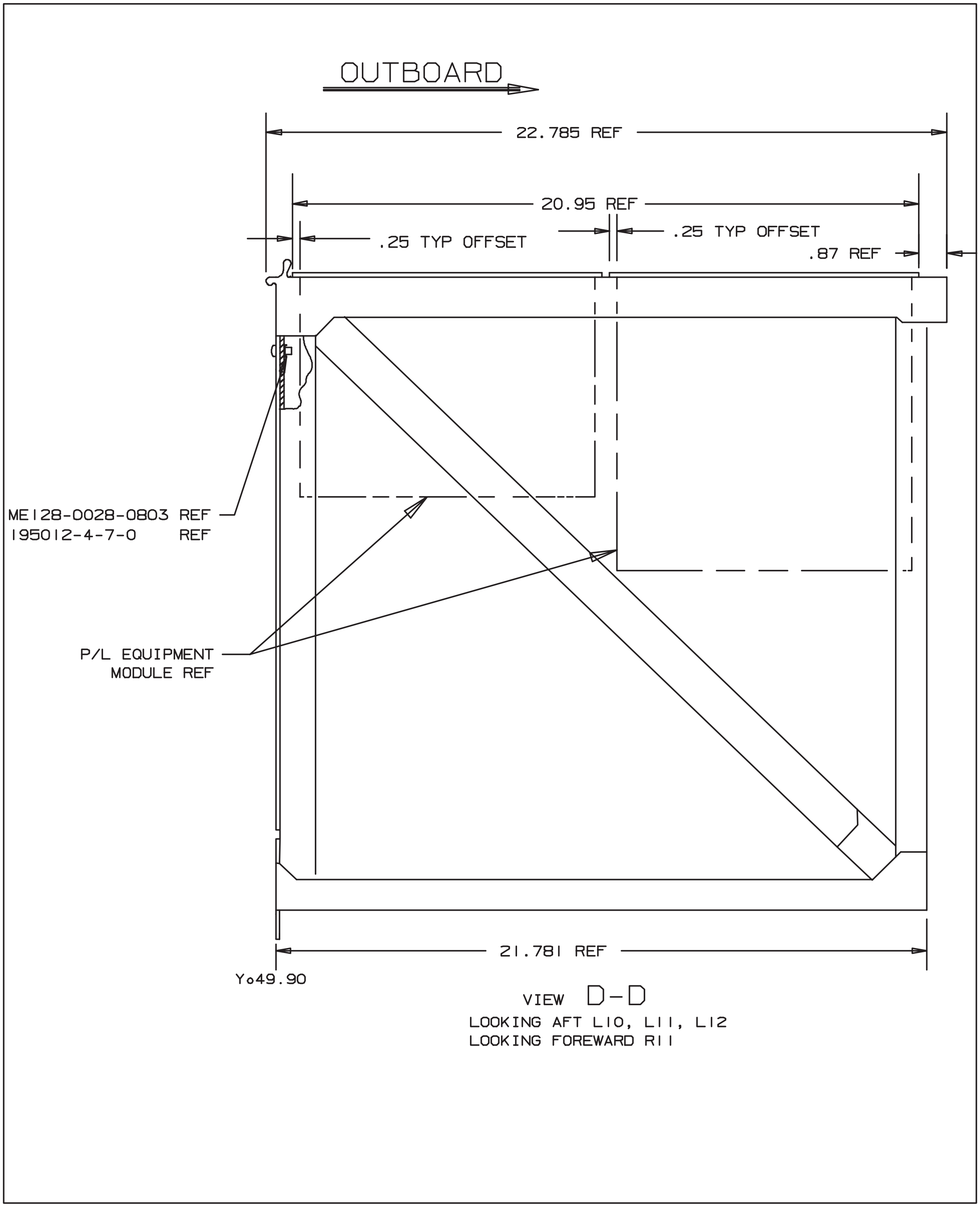
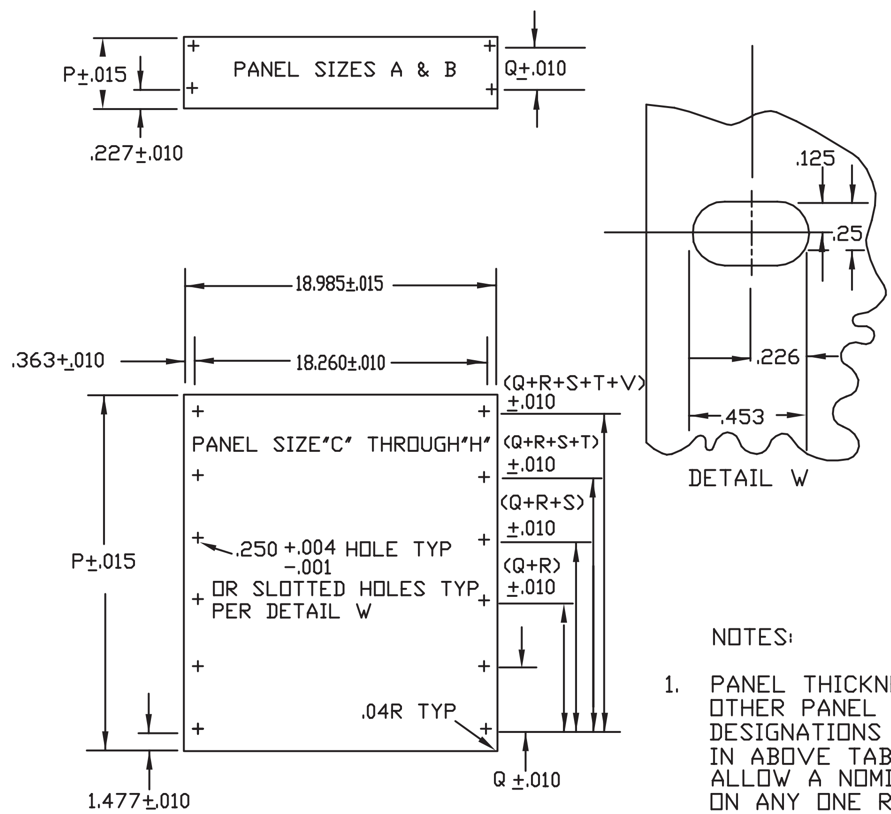


FIGURE 3.4.1.1.1-1 PAYLOAD DEDICATED CONSOLE, TYPICAL FOR L10, L11, L12 OR R11 ON AFT FLIGHT DECK

(SHEET 5 OF 5)

FIGURE 3.4.1.1.1-2 LIMITING DIMENSIONS FOR 19 INCH ELECTRICAL EQUIPMENT RACK PANELS



PANEL DIMENSIONS

PANEL SIZE	P ±.015	Q	R	S	T	V
A	1.704	1.250				
B	3.454	3.000				
C	5.204	2.250				
D	6.954	4.000				
E	8.704	1.750	2.250	1.750		
F	10.454	2.250	3.000	2.250		
G	12.204	1.750	5.750	1.750		
H	13.954	3.500	4.000	3.508		
J	15.704	3.500	5.750	3.500		
K	17.454	3.500	7.500	3.500		
L	19.204	5.250	5.750	5.250		
M	20.954	1.750	5.250	4.000	5.250	1.750

NOTES:

1. PANEL THICKNESS SHALL BE .125,. MINIMUM, .250 MAXIMUM. OTHER PANEL DIMENSIONS IN INCHES WITH THEIR LETTER DESIGNATIONS (A,B,C,& OTHERS) SHALL BE AS SPECIFIED IN ABOVE TABLE. DIMENSIONS HAVE BEEN CHOSEN TO ALLOW A NOMINAL CLEARANCE OF .031 IN. BETWEEN PANELS ON ANY ONE RACK.
2. THIS FIGURE DOES NOT PRECLUDE USE OF FRONT PANELS CONFORMING TO MIL-STD-189 PROVIDED THE TOLERANCES ON DIMENSIONS OF FEATURES NOT SPECIFIED IN MIL-STD-189 ARE IDENTIFIED IN PAYLOAD UNIQUE ICDs.

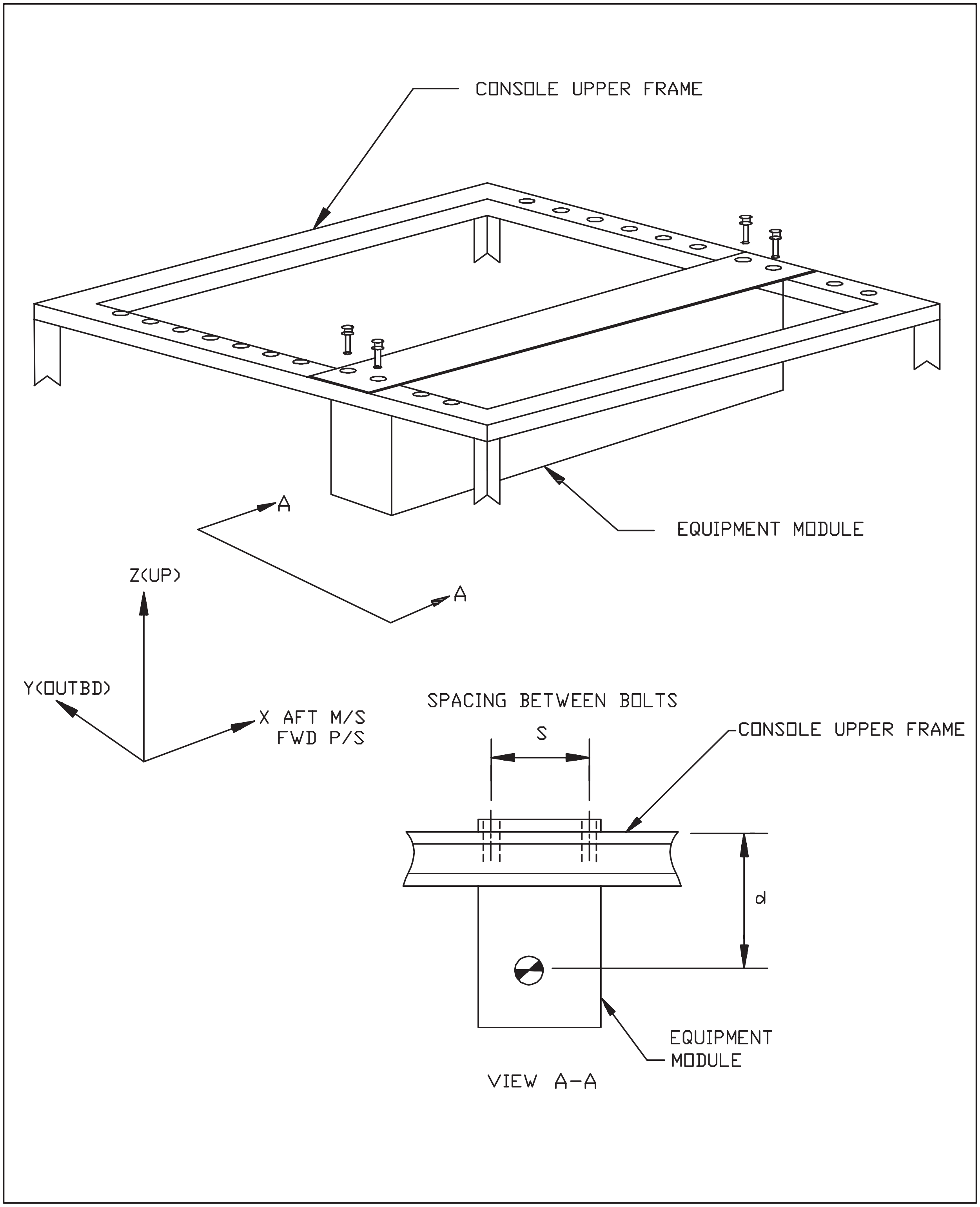


FIGURE 3.4.1.1.1-3 EQUIPMENT ATTACHMENT

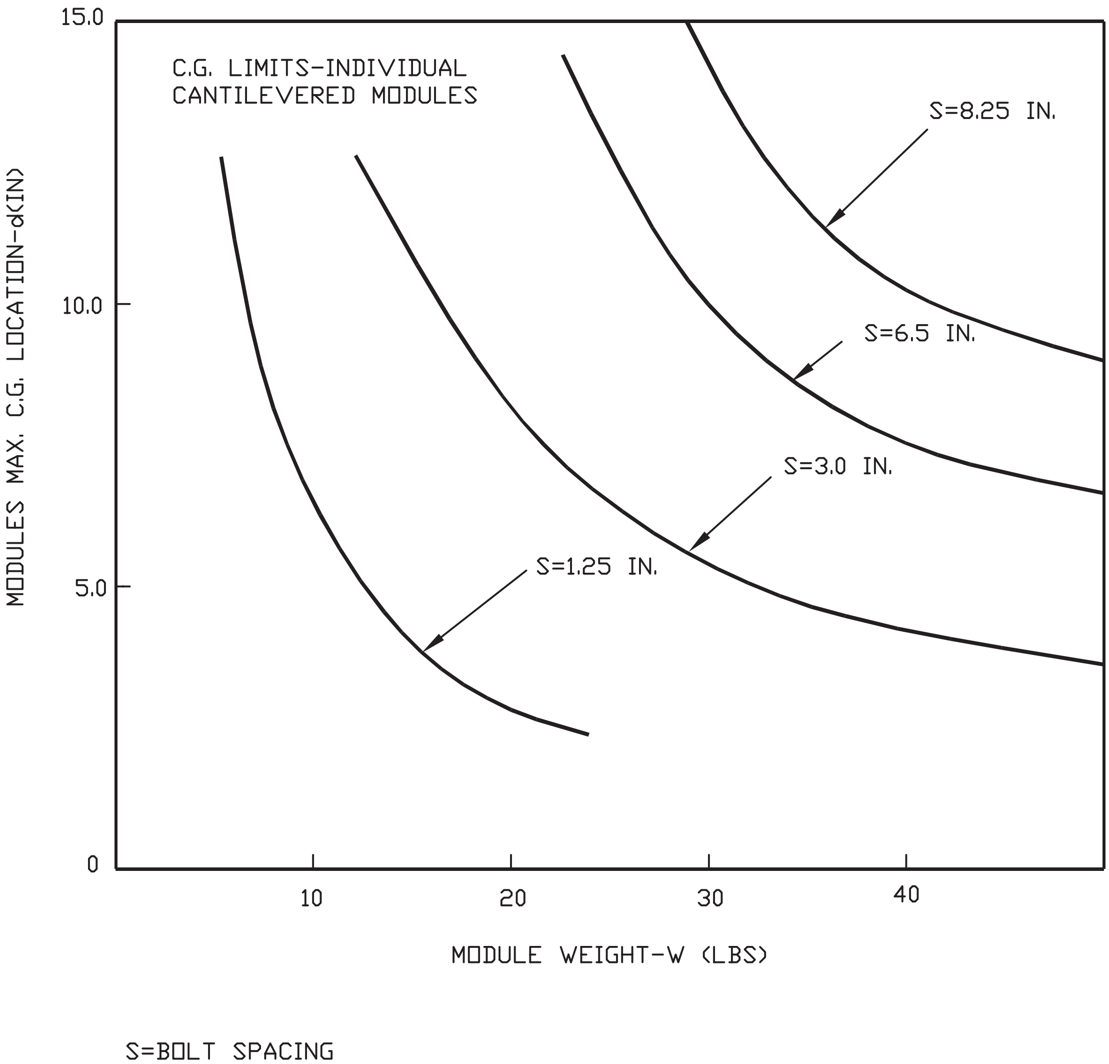


FIGURE 3.4.1.1.1-4 C.G. LIMITS - INDIVIDUAL CANTILEVERED MODULES

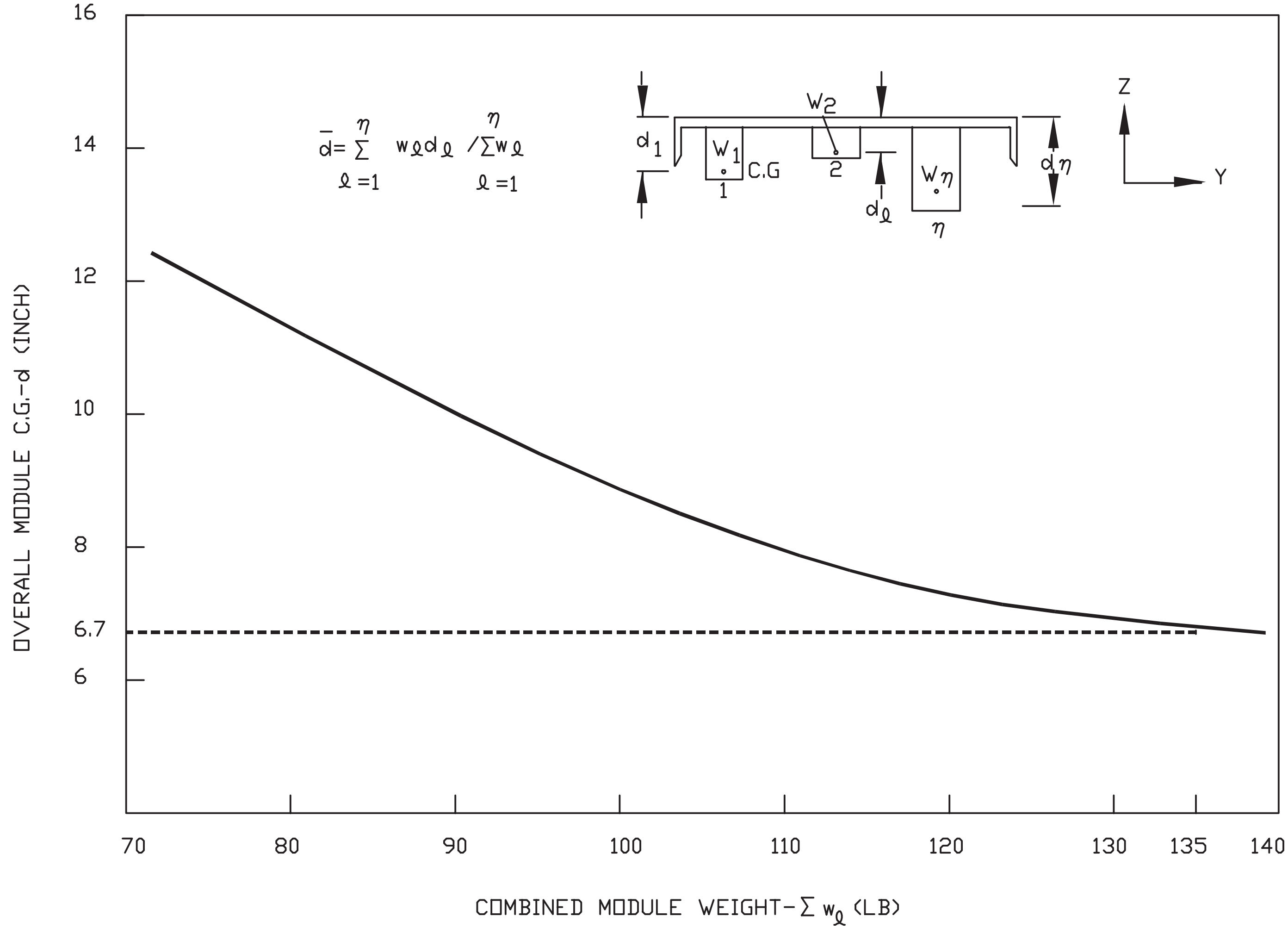
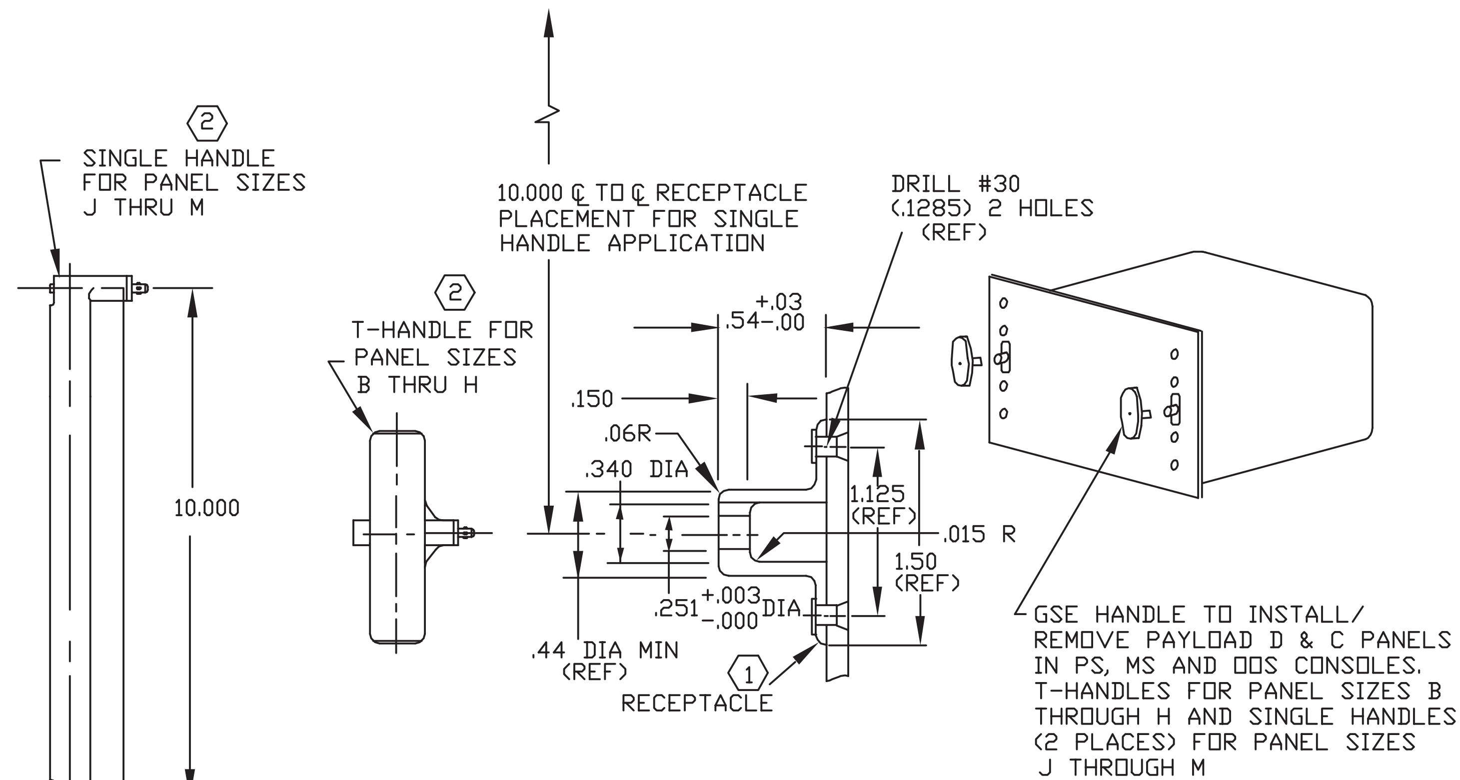


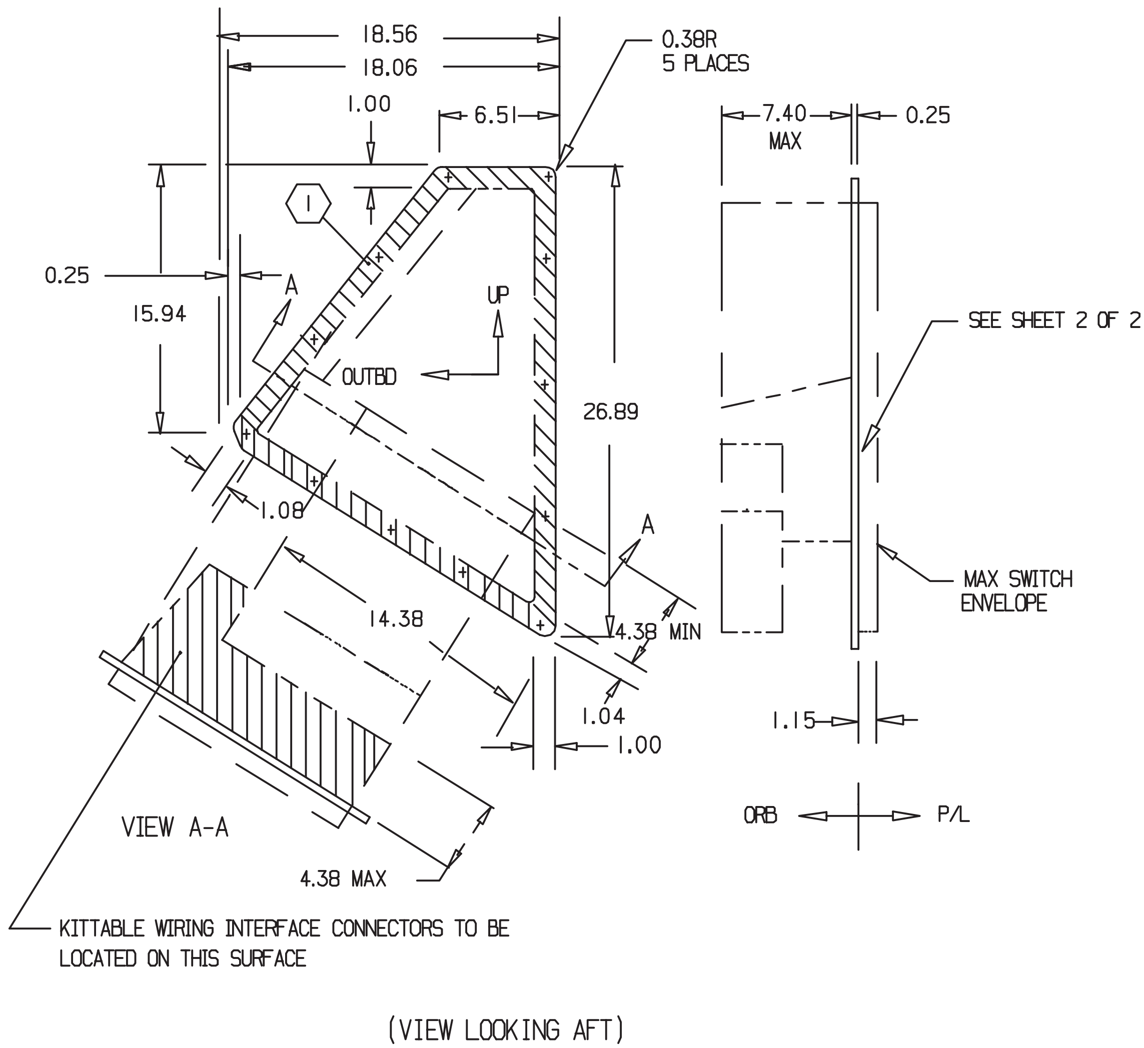
FIGURE 3.4.1.1.1-5 C.G. LIMITS - COMBINED CANTILEVERED MODULES

FIGURE 3.4.1.1.3-1 DISPLAY AND CONTROL PANELS GSE HARD POINTS



NOTES:

1. RECEPTACLE ROCKWELL INTERNATIONAL PART # MD122-0012-0004 OR EQUIV. , PAYLOAD PROVIDED
2. "T" AND SINGLE HANDLES GSE-PROVIDED AS A PART OF ORBITER HANDLING EQUIPMENT MODEL H70-0561
3. MAX PANEL WEIGHT WHEN USING GSE HANDLES IS 50 LBS PER HANDLE
4. RECEPTACLE INSTALLATION SHALL NOT INTERFERE WITH THE INSTALLATION OR REMOVAL OF PANEL TO CONSOLE-ATTACHING HARDWARE



NOTES:

1. SURFACE PREPARED FOR ELECTRICAL BONDING OF PANEL PER PARAGRAPH 10.7.4.2 ALL AROUND MOUNTING FLANGE.
2. FIRE HOLE .50 DIA SHALL BE PROVIDED ON THE PANEL SURFACE TO INTERFACE WITH FIRE EXTINGUISHER NOZZLE. .75 DIA AREA AROUND THE FIRE HOLE ON PANEL SURFACE SHALL BE RED COLOR NO.31136, PER FED-STD-595.
3. PANEL MOUNTING HOLE LOCATIONS CONTROLLED AND MATCHED DRILLED PER ROCKWELL INTERNATIONAL TOOL NC. T-72;0006.
4. MOUNTING HOLE LOCATION DIMENSIONS SHOWN ARE REFERENCE ONLY.
5. CONTENT DENSITY SHALL NOT EXCEED 30.0 LBS PER CUBIC FOOT
6. PANEL KICK/PUSH OFF LOADS PER PARAGRAPH 4.2.3
7. SEE FIGURE 3.4.1-1 FOR ORIENTATION.

FIGURE 3.4.1.2.1-1 R-7 PANEL ENVELOPE

(SHEET 1 OF 2)

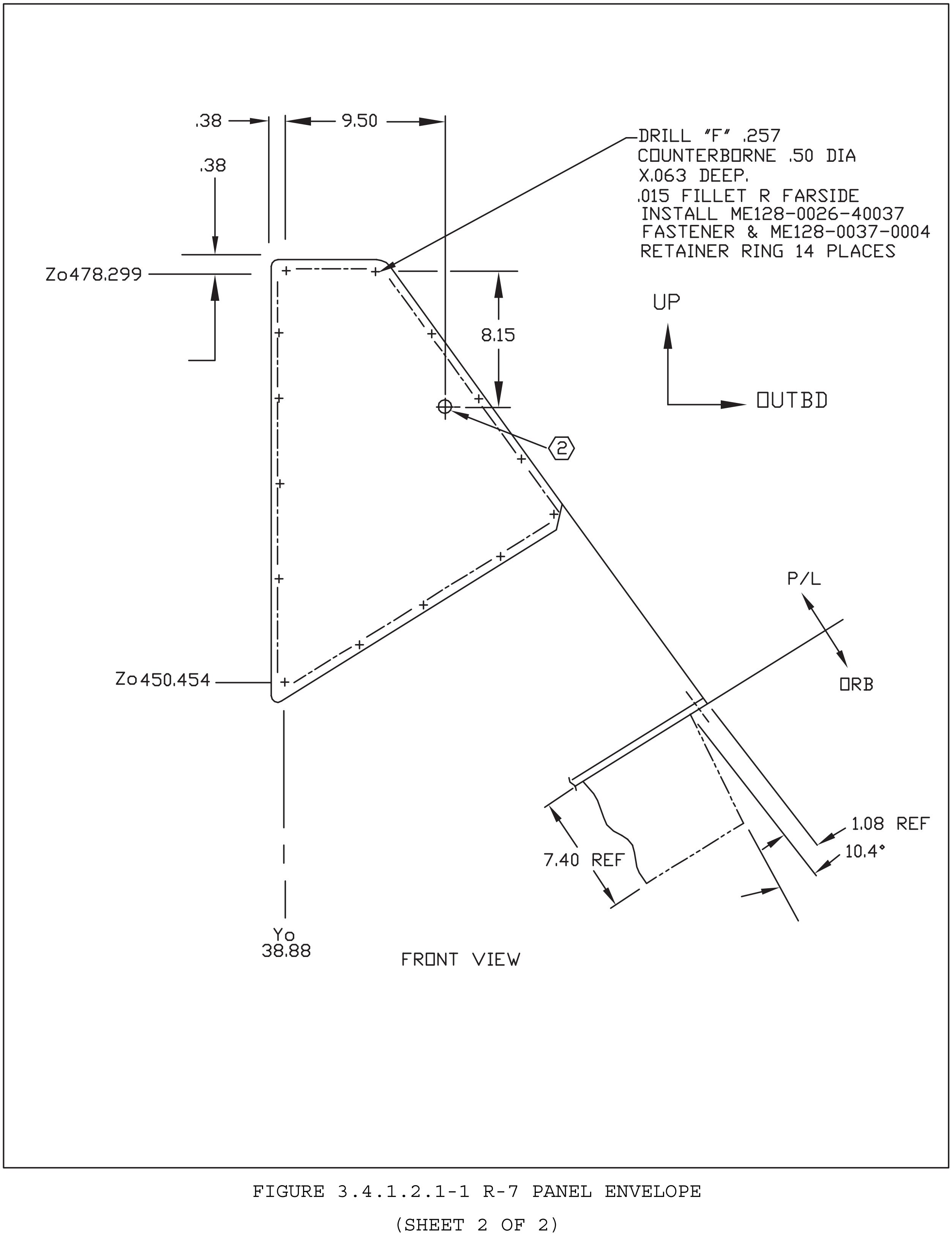
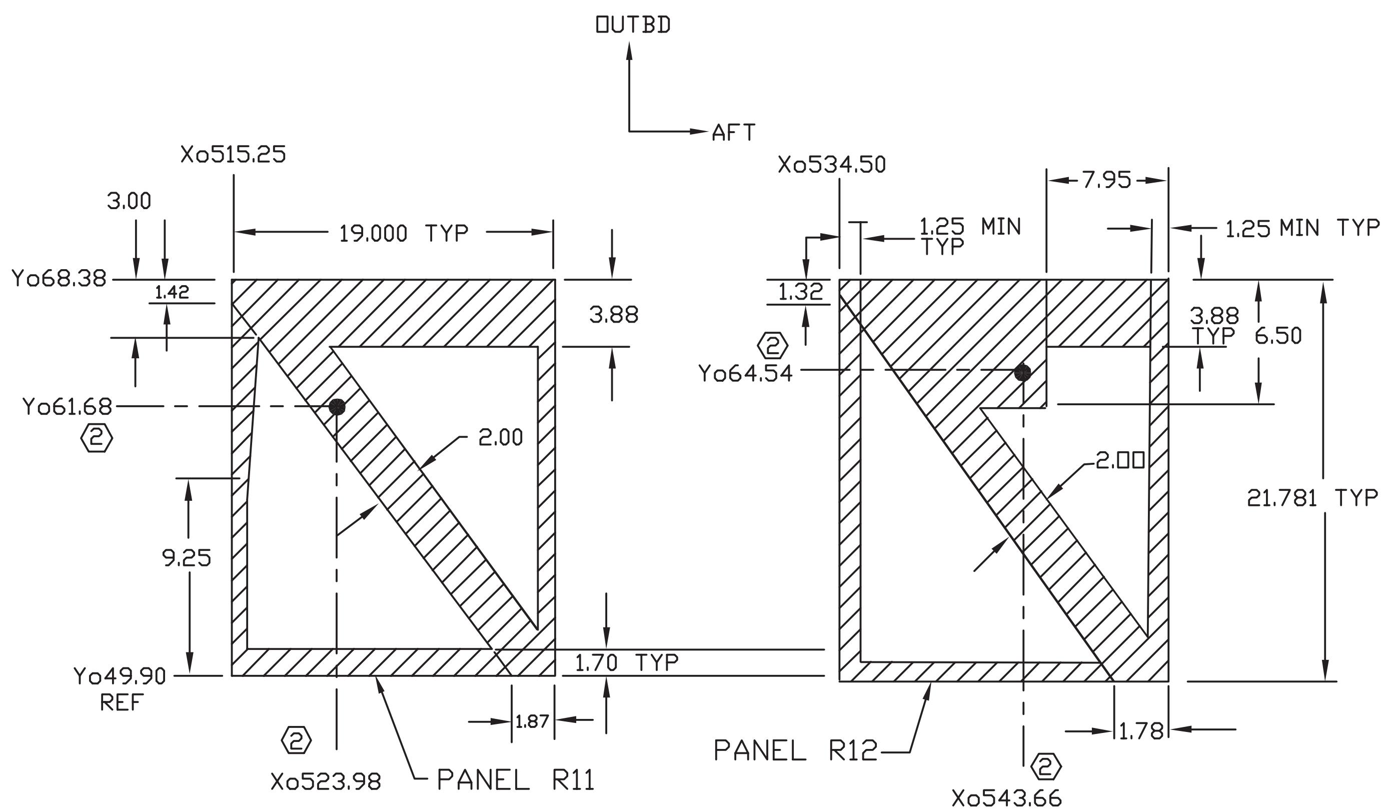


FIGURE 3.4.1.2.1-1 R-7 PANEL ENVELOPE

(SHEET 2 OF 2)



VIEW LOOKING DOWN
MISSION STATION
(IN Zo PLANE AT BOTTOM OF CONSOLE)

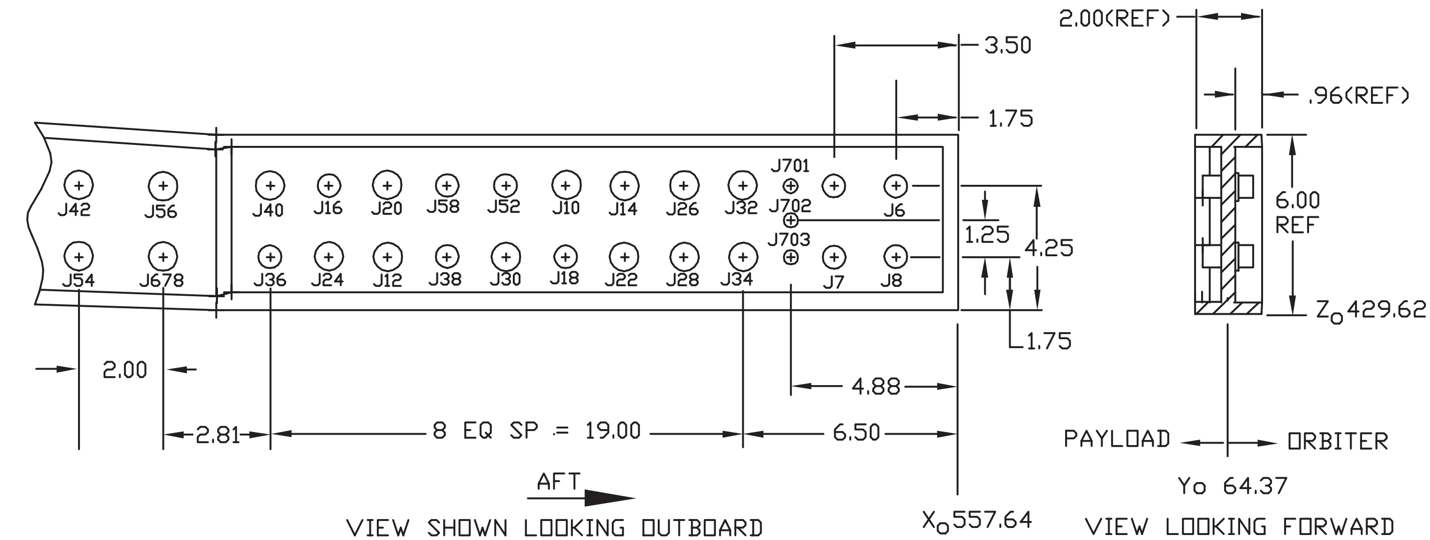
NOTES:

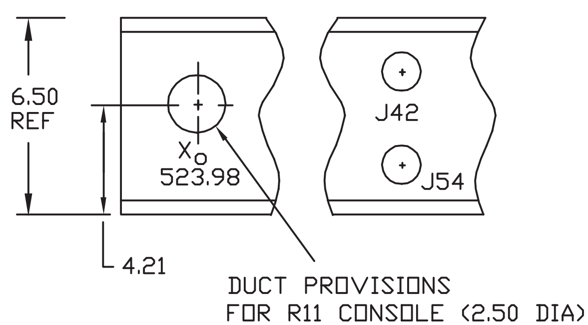
1. SHADED AREAS TO BE FREE OF ELECTRICAL AND COOLING INTERFACES. IF DEPTH OF PANEL ENVELOPE EXCEEDS 16.00 INCHES, SEE FIGURE 3.4.1.2.3-1 FOR DETAILS OF DEPTH ENVELOPE.

(2) CENTER OF COOLING DUCT ORBITER INTERFACE LOCATION.

3. .50 INCH CLEARANCE PROVIDED OVER STRUCTURAL MEMBERS AND COOLING DUCTS.

FIGURE 3.4.1.2.1-2 PANEL ENVELOPE CLEARANCES AND COOLING OUTLETS AT MISSION STATION

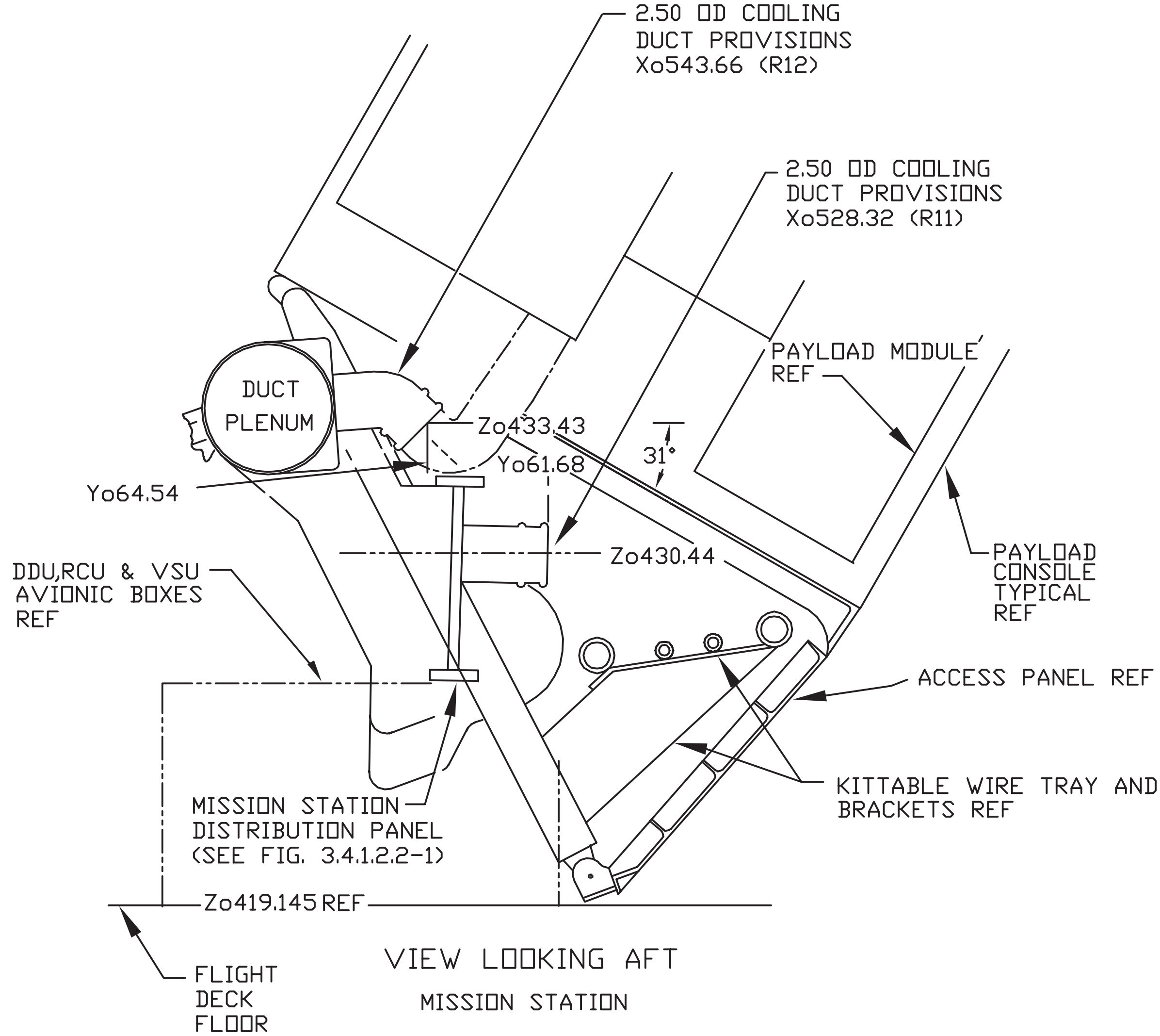




NOTES:

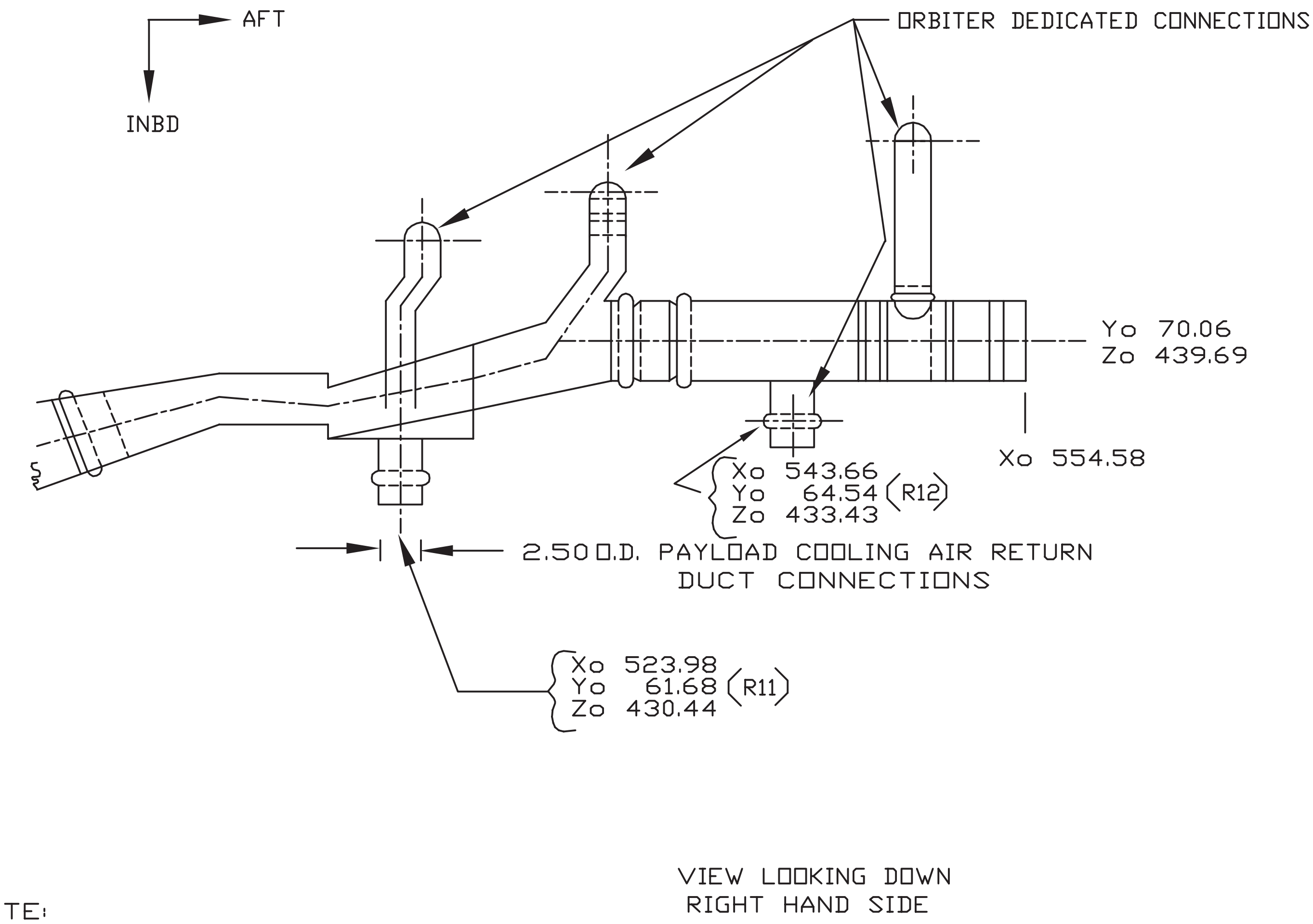
1. ORBITER AND CARGO ELEMENT INTERFACE CONNECTORS SHALL BE AS SPECIFIED IN TABLE 13.6.2.2-1
2. J5, J6, J7, & J8 ARE ORBITER DEDICATED CONNECTORS.
3. CONNECTORS SHALL BE INSTALLED WITH KEYWAY AT TOP.
4. DETAILS OF COOLING AIR DUCT IS PROVIDED IN FIGURE 3.4.1.2.4-1.
5. REFER TO FIGURE 3.4.1-1 FOR ORIENTATION REFERENCE

FIGURE 3.4.1.2.2-1 MISSION STATION DISTRIBUTION PANEL



NOTES:
1. COOLING DUCT PROVISIONS IN ACCORDANCE WITH FIG. 3.4.1.4.4-1
2. SEE FIGURE 3.4.1-1 FOR ORIENTATION REFERENCE.

FIGURE 3.4.1.2.3-1 MISSION STATION DISTRIBUTION PANEL, COOLING DUCT CONNECTIONS AND KITTABLE WIRE TRAY LOCATIONS

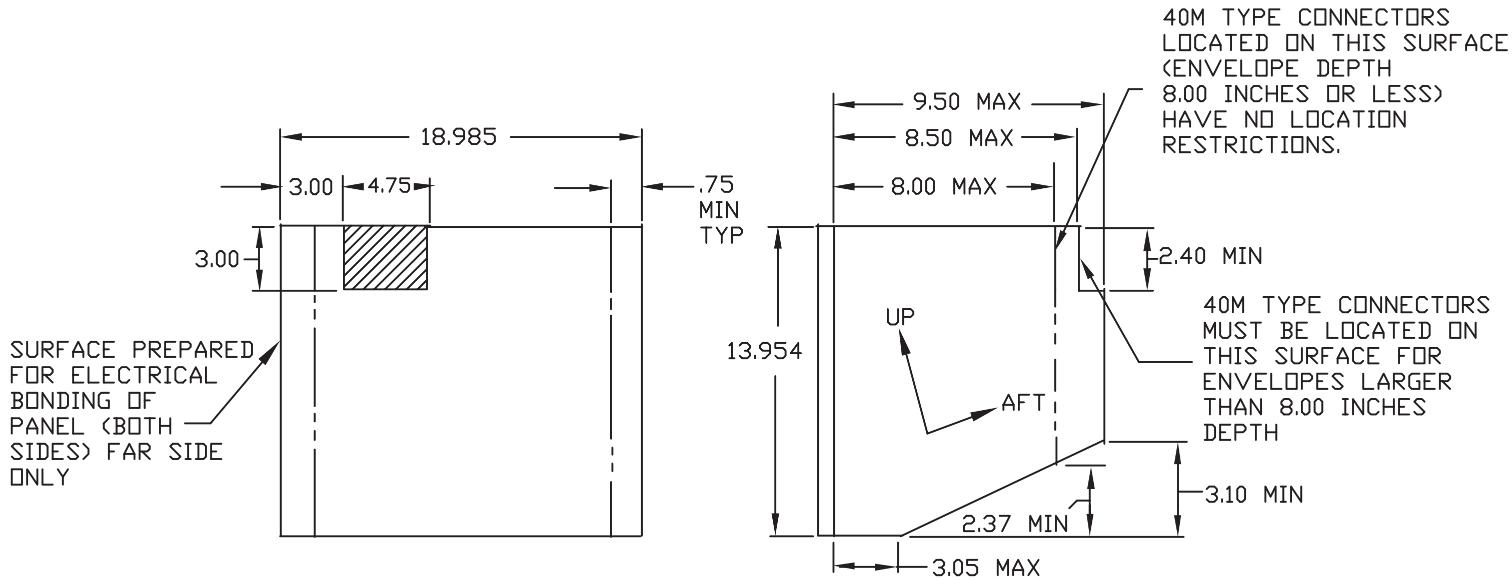


NOTE:

1. COOLING AIR RETURN DUCT CONNECTION FITTING ENDS IN ACCORDANCE WITH FIGURE 3.4.1.4.4-1

FIGURE 3.4.1.2.4-1 COOLING DUCT CONNECTIONS FOR MISSION STATION ON AFT FLIGHT DECK

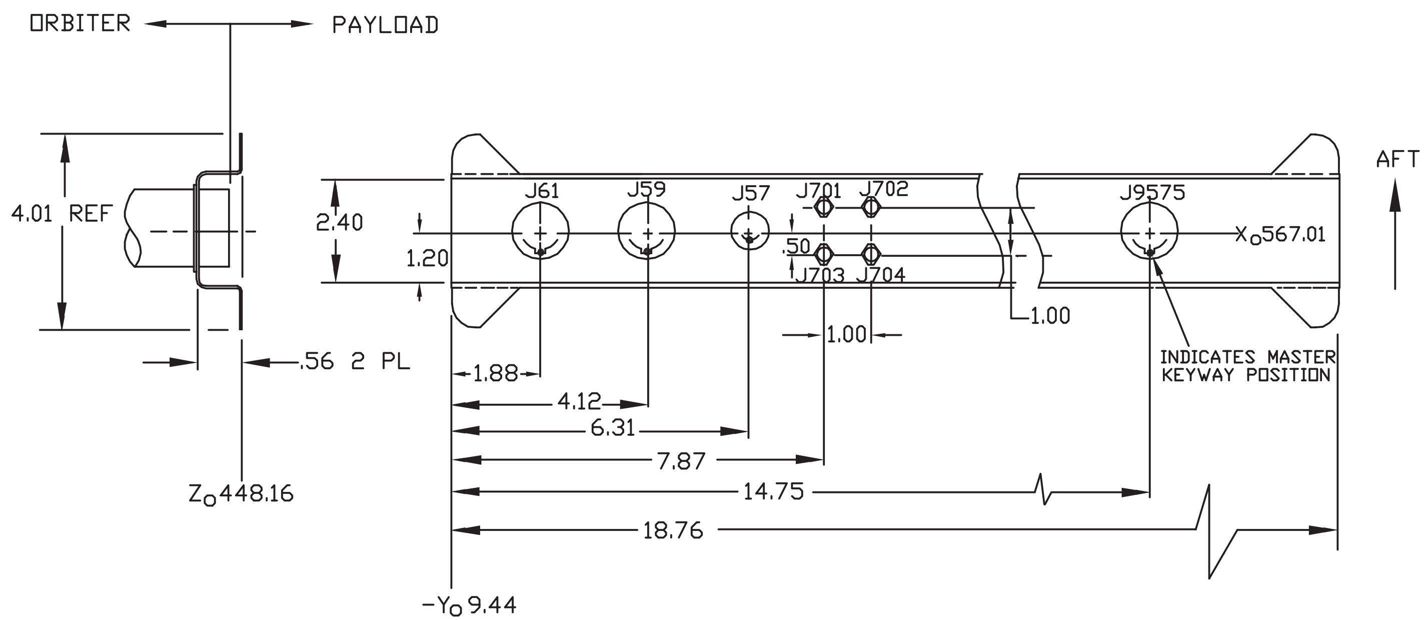
FIGURE 3.4.1.3.1-1 TYPICAL PAYLOAD DEDICATED PANEL ENVELOPE FOR ON-ORBIT STATION LOCATIONS A6-A2 AND A7-A2



NOTES:

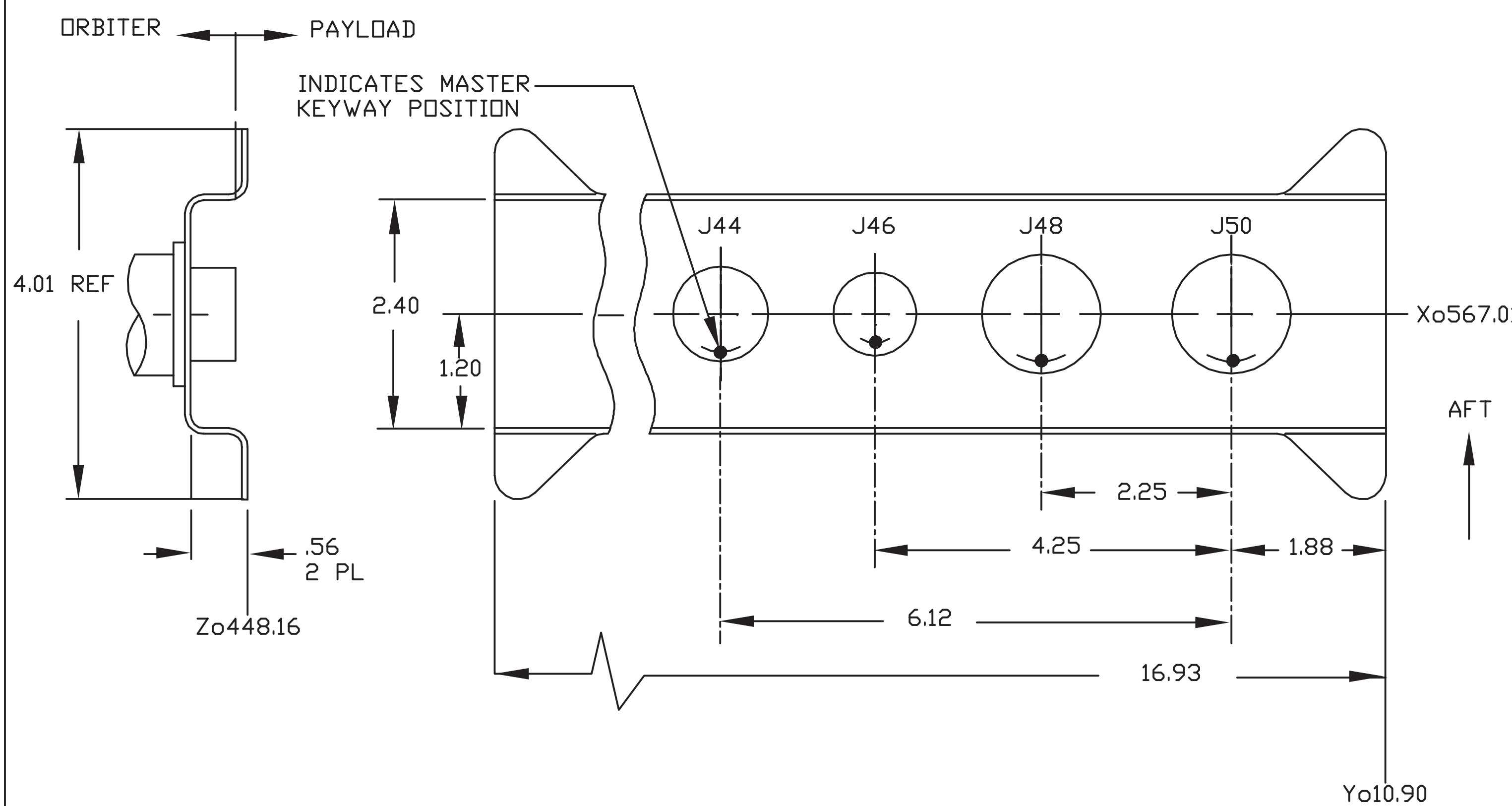
1. SHADED AREA TO BE FREE OF ELECTRICAL INTERFACES ON PANEL A7-A2 ONLY
2. PANEL SIZES "H" OR COMBINATIONS OF PANEL SIZES UP TO SIZE "H" PER FIGURE 3.4.1.1.1.-2
3. FASTENERS ATTACHING PANEL TO MATE WITH MD-115-2002-003 INSERTS
4. PANEL THICKNESS AND FASTENER LENGTH VARIES DEPENDING ON APPLICATION

FIGURE 3.4.1.3.2-1 ON-ORBIT STATION DISTRIBUTION PANEL, PORT SIDE



NOTE:

1. ORBITER/CARGO ELEMENT INTERFACE CONNECTORS & PIN ASSIGNMENTS FOR J57, J59, J61 & J701, J702 J703 J704 AND J9575 ARE SPECIFIED IN TABLE 13.6.2.4-1.



NOTE:

1. ORBITER/CARGO ELEMENT INTERFACE CONNECTORS & PIN ASSIGNMENT FOR J44, J46,S J48 & J50 ARE SPECIFIED IN TABLE 13.6.2.3-1.

FIGURE 3.4.1.3.2-2 ON-ORBIT STATION DISTRIBUTION PANEL, STARBOARD SIDE

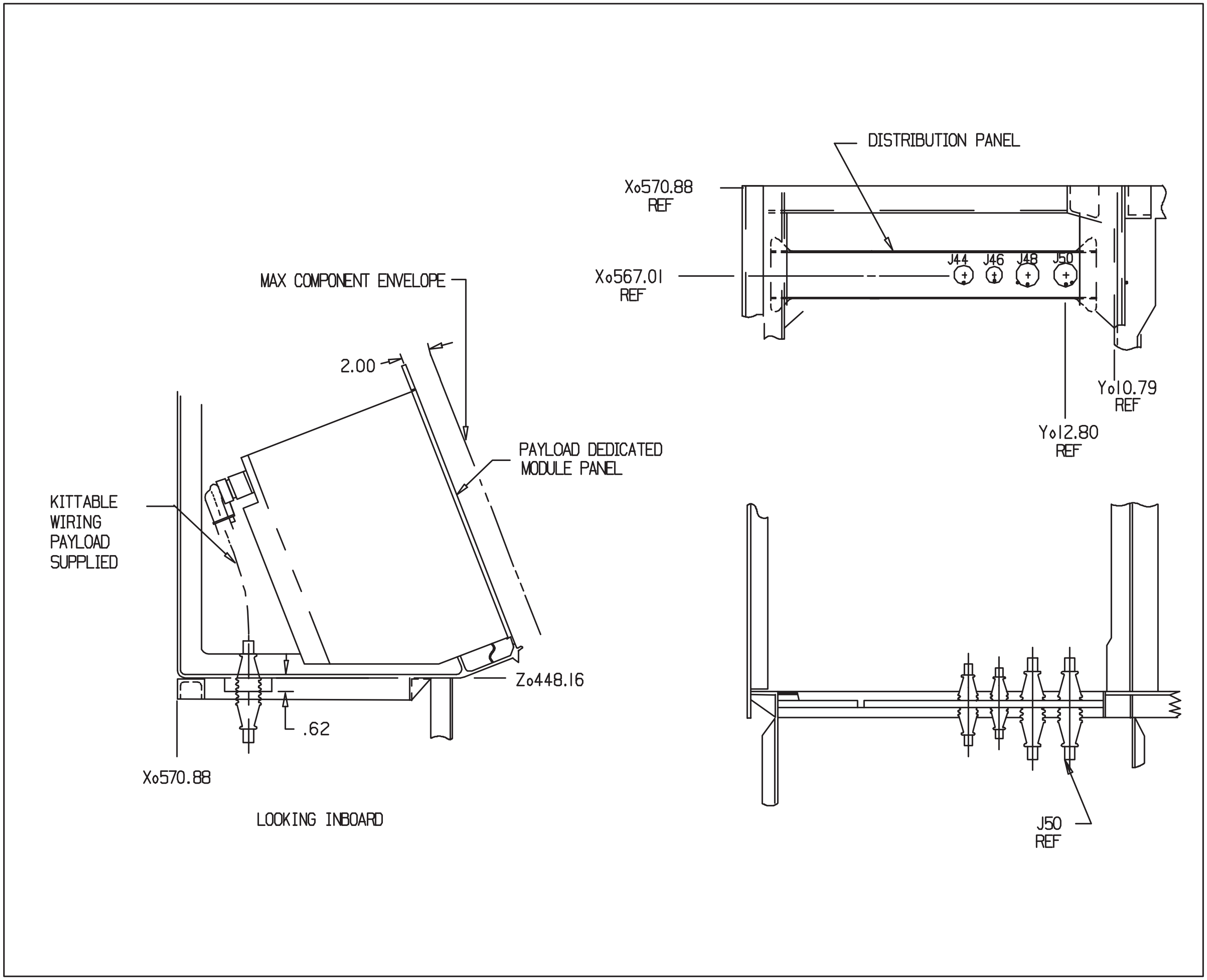


FIGURE 3.4.1.3.3-1 ON-ORBIT STATION LOCATION A6-A2

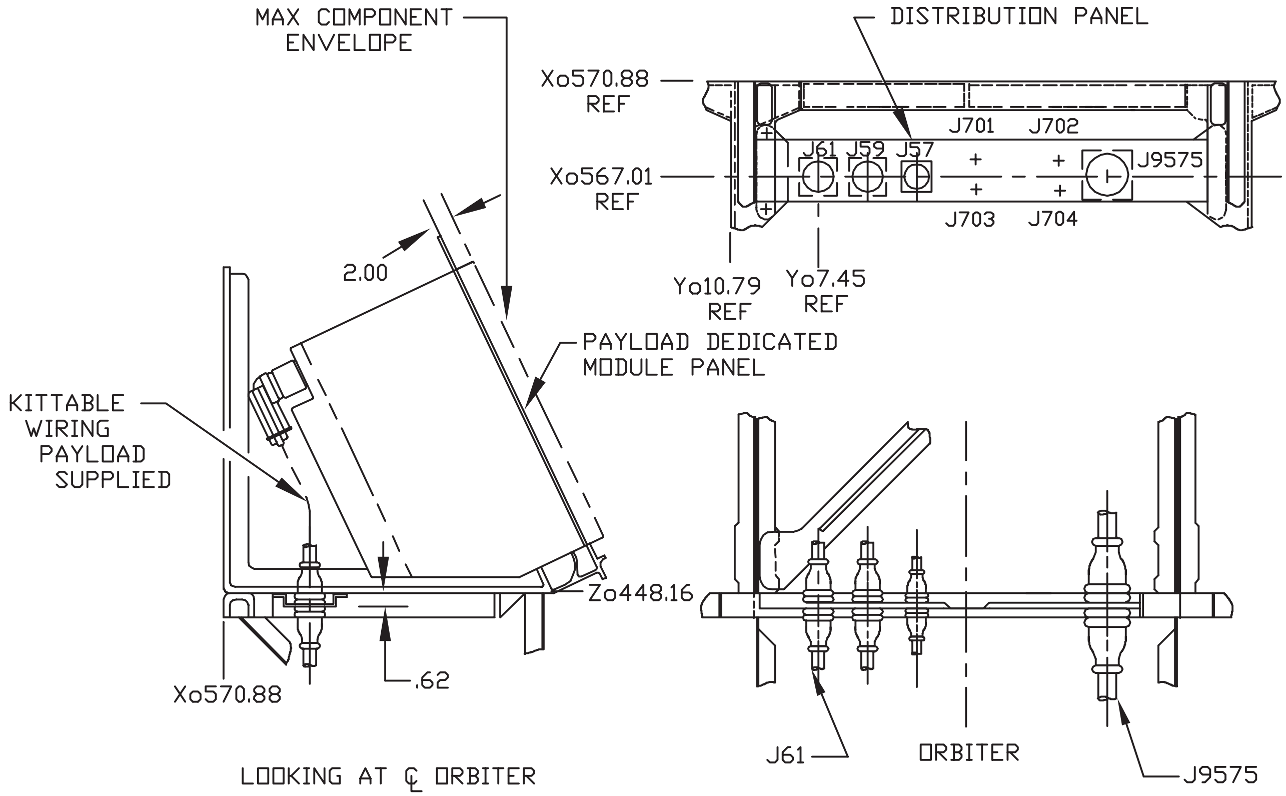
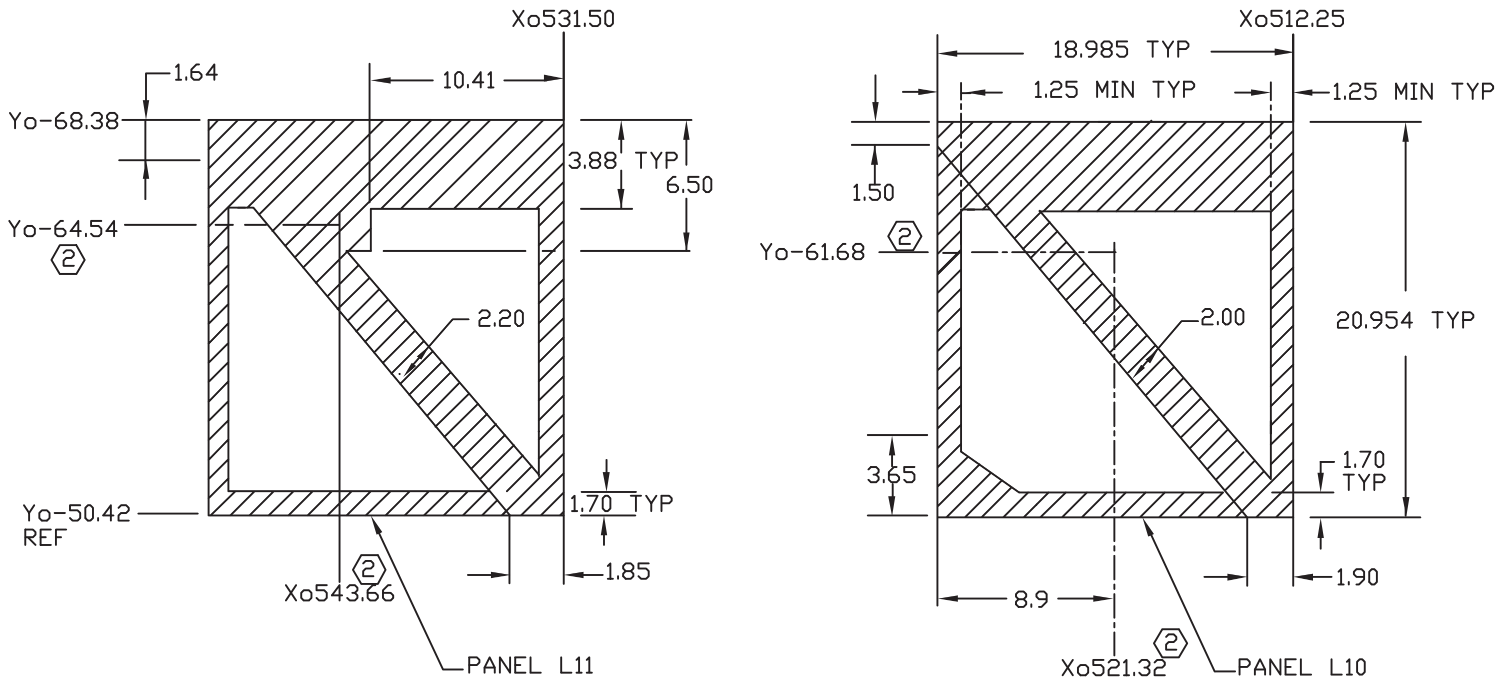


FIGURE 3.4.1.3.3-2 ON-ORBIT STATION LOCATION A7-A2



NOTES:

1. SHADED AREAS TO BE FREE OF ELECTRICAL AND COOLING INTERFACES IF DEPTH OF PANEL ENVELOPE EXCEEDS 16.00 INCHES. FOR DETAILS OF DEPTH ENVELOPE SEE SHEET 2.

(2) CENTER OF COOLING DUCT ORBITER INTERFACE LOCATION.

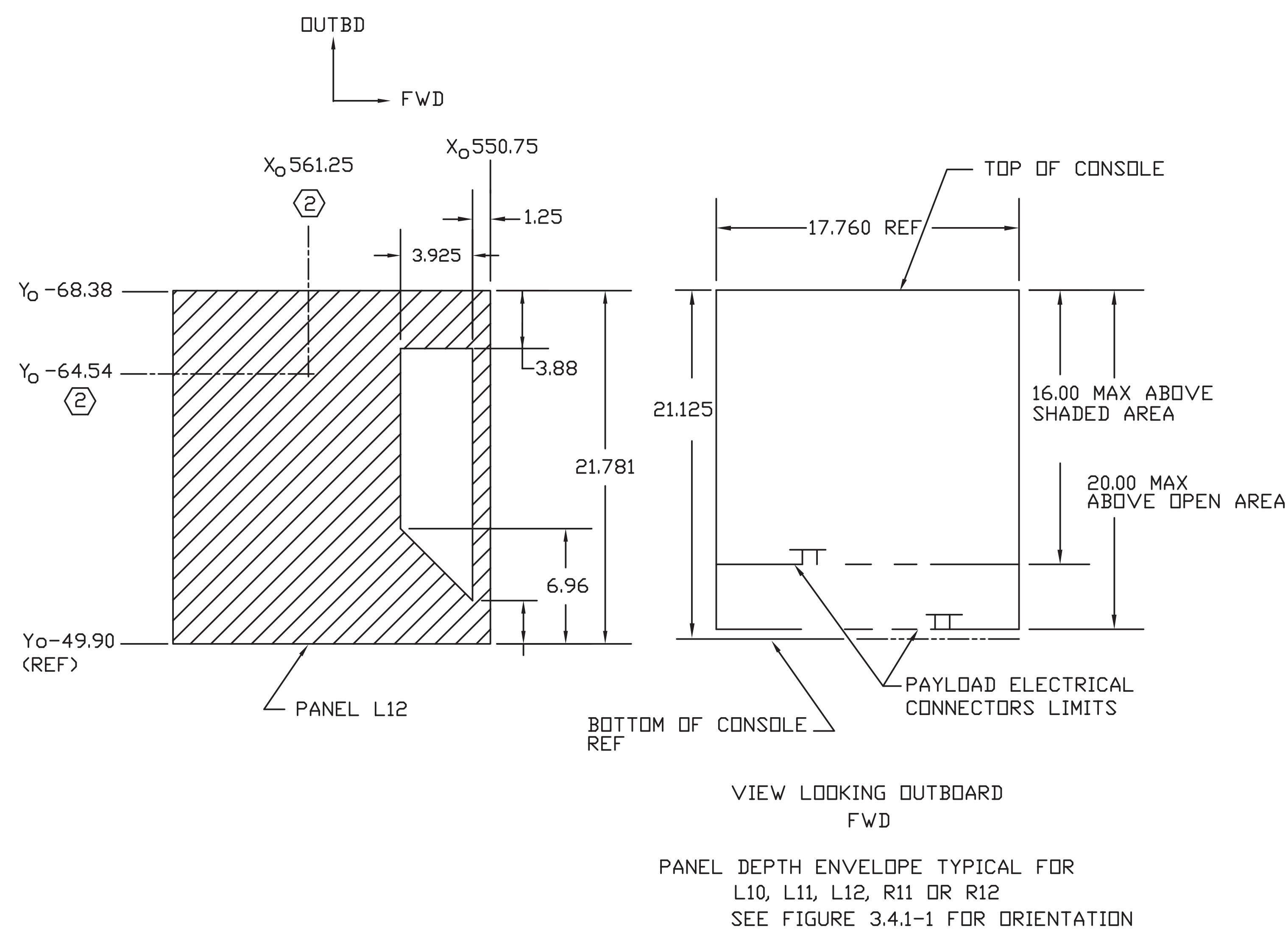
3. .50 INCH CLEARANCE PROVIDED OVER STRUCTURAL MEMBERS.

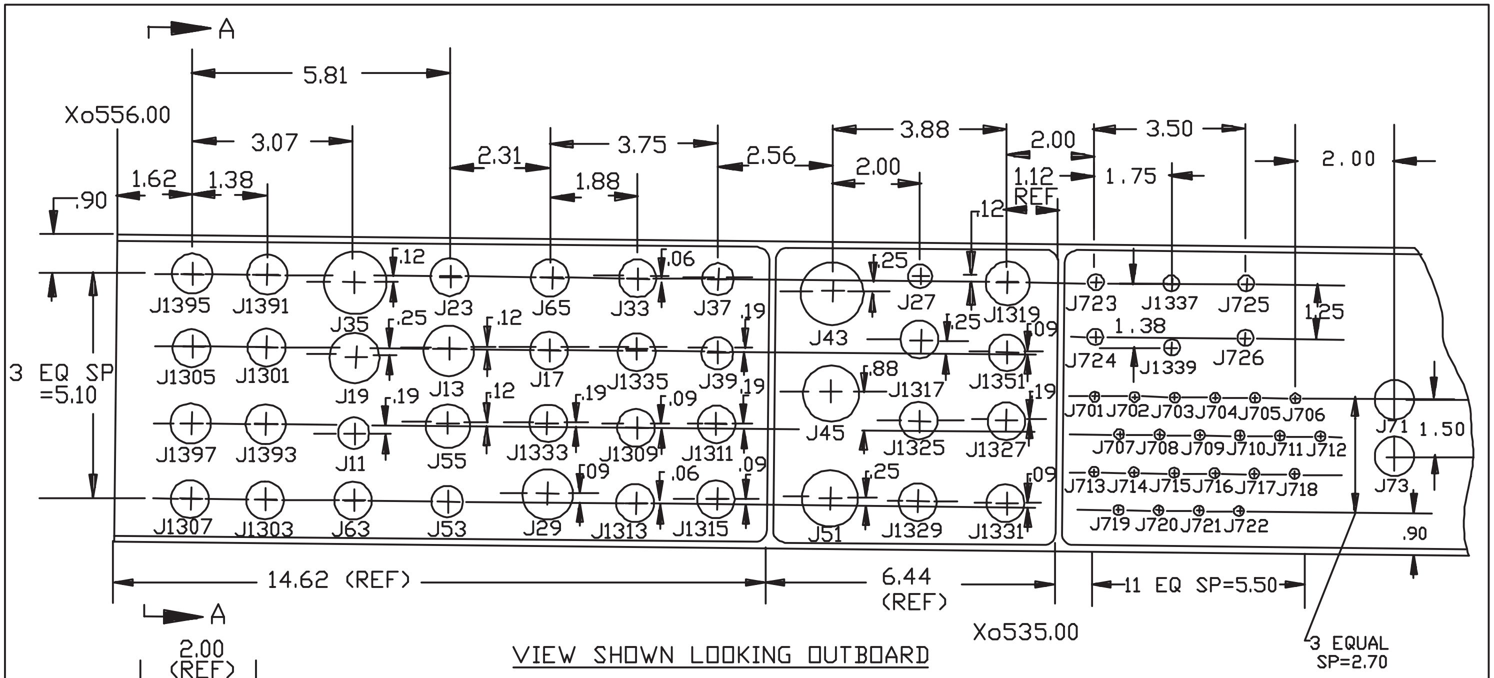
FIGURE 3.4.1.4.1-1 PANEL ENVELOPE CLEARANCES AND COOLING OUTLETS AT PAYLOAD STATION

(SHEET 1 OF 2)

FIGURE 3.4.1.4.1-1 PANEL ENVELOPE CLEARANCES AND COOLING OUTLETS AT PAYLOAD STATION

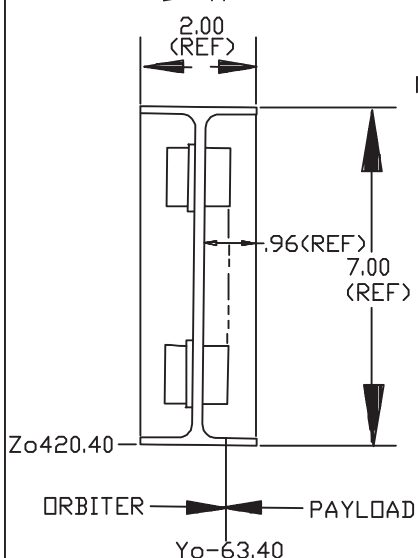
(SHEET 2 OF 2)





VIEW SHOWN LOOKING OUTBOARD

AFT



VIEW A-A

NOTES:

1. CONNECTOR AND PIN ASSIGNMENTS FOR CONNECTORS J1391/93/95/97,J1325/27/29/31,J1309/11/13 15,J1351,J29,J53 AND J63 ARE SPECIFIED IN SECTION 13.5. REMAINING CONNECTORS ARE SPECIFIED IN SECTION 13.6.
2. J711, J712 & J713 CONNECTOR CUTOUTS ARE RESERVED.
3. CONNECTORS SHALL BE INSTALLED WITH KEYWAY AT TOP.
4. DETAILS OF COOLING AIR EXHAUST IS PROVIDED IN FIGURE 3.4.1.4.4-1.
5. REFER TO FIGURE 3.4.1-1 FOR ORIENTATION REFERENCE.

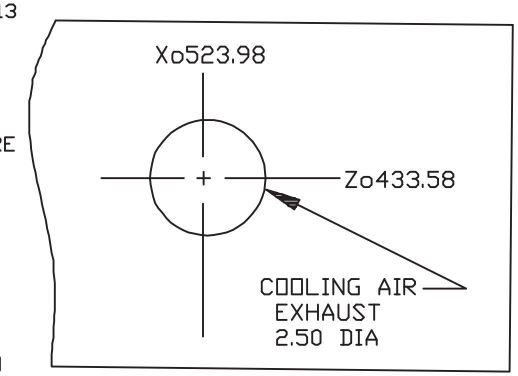


FIGURE 3.4.1.4.2-1 PAYLOAD STATION DISTRIBUTION PANEL
(SHEET 1 OF 2)

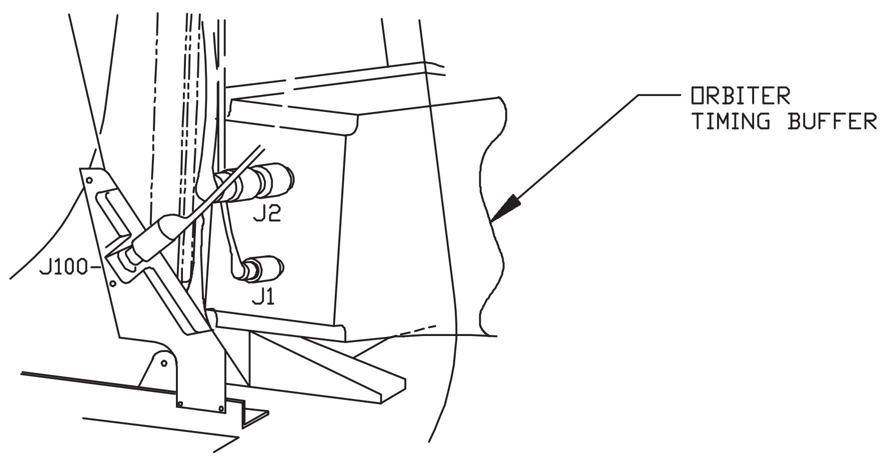


FIGURE 3.4.1.4.2-1 PAYLOAD STATION DISTRIBUTION PANEL CONNECTOR PSDP-J100

(SHEET 2 OF 2)

FIGURE 3.4.1.4.3-1 DISTRIBUTION PANEL AND KITTABLE WIRE TRAY AT PAYLOAD STATION

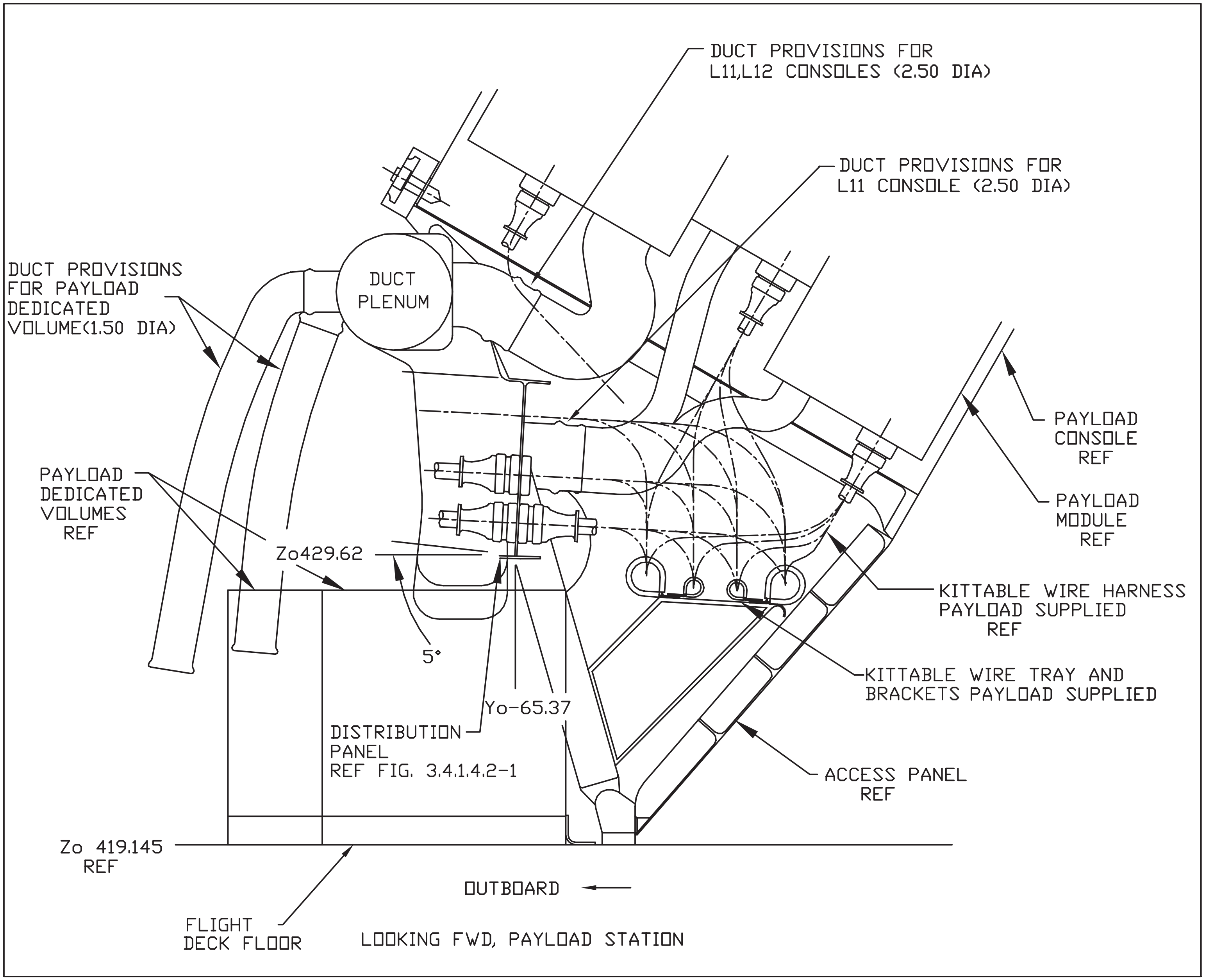


FIGURE 3.4.1.4.4-1 COOLING DUCT CONNECTIONS AT PAYLOAD STATION

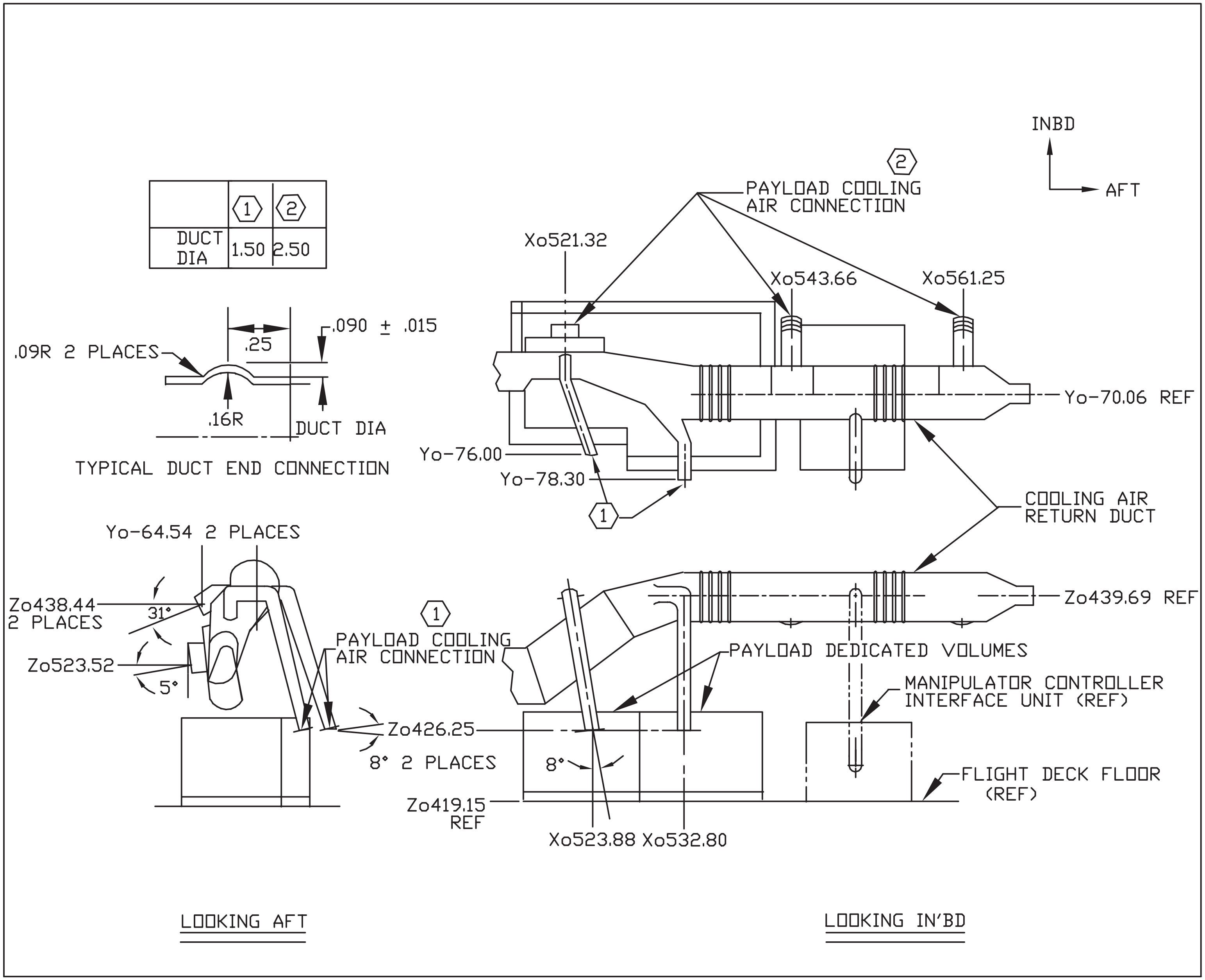
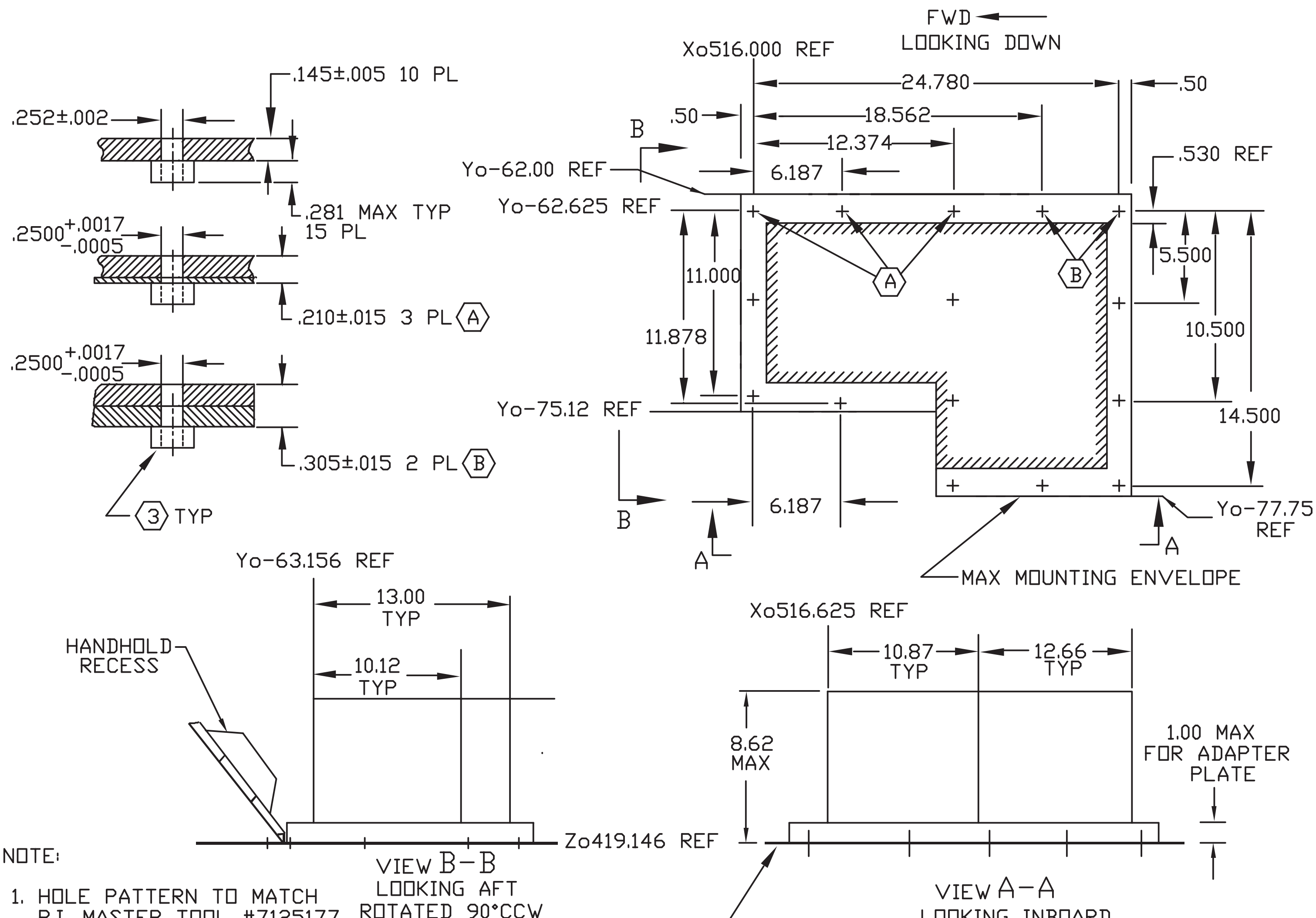


FIGURE 3.4.1.4.5-1 PAYLOAD DEDICATED VOLUME UNDER PAYLOAD STATION



NOTE:

1. HOLE PATTERN TO MATCH R.I. MASTER TOOL #7125177.
2. HOLE LOCATION DIM. REF.
3. (3) FLOATING NUTPLATE .2500-28 UNJF-3B SELF LOCKING THREAD TYP 15 PLACES.
4. P/L VOLUME AVAILABLE. 1.0 CUBIC FEET MAX.
5. SEE FIGURE 3.4.1-1 FOR ORIENTATION.

FIGURE 3.4.1.4.6.1-1 TVMP REAR CONNECTOR PANEL INTERFACE

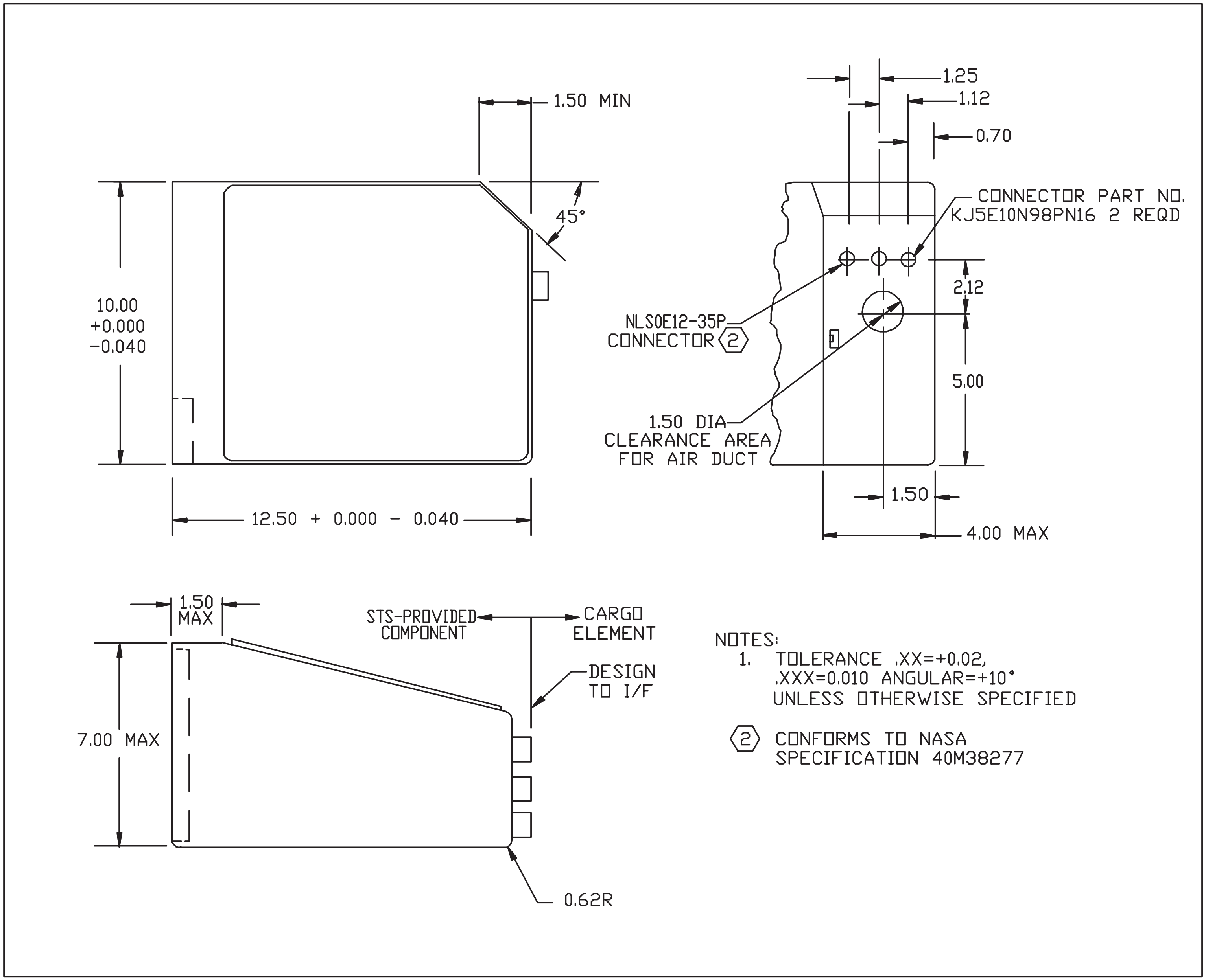
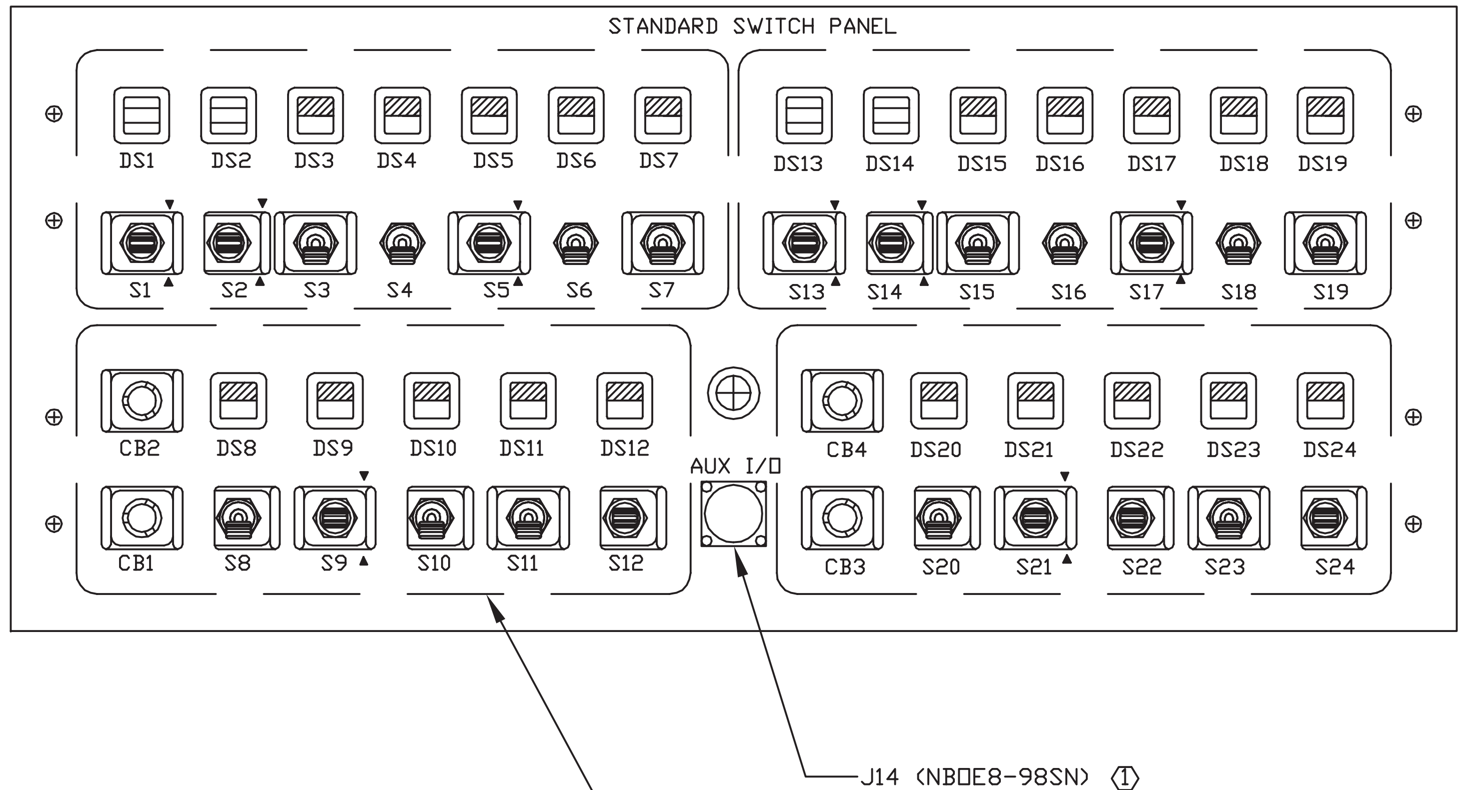


FIGURE 3.4.1.4.6.2-1 STANDARD SWITCH PANEL (SSP) FRONT PANEL LAYOUT

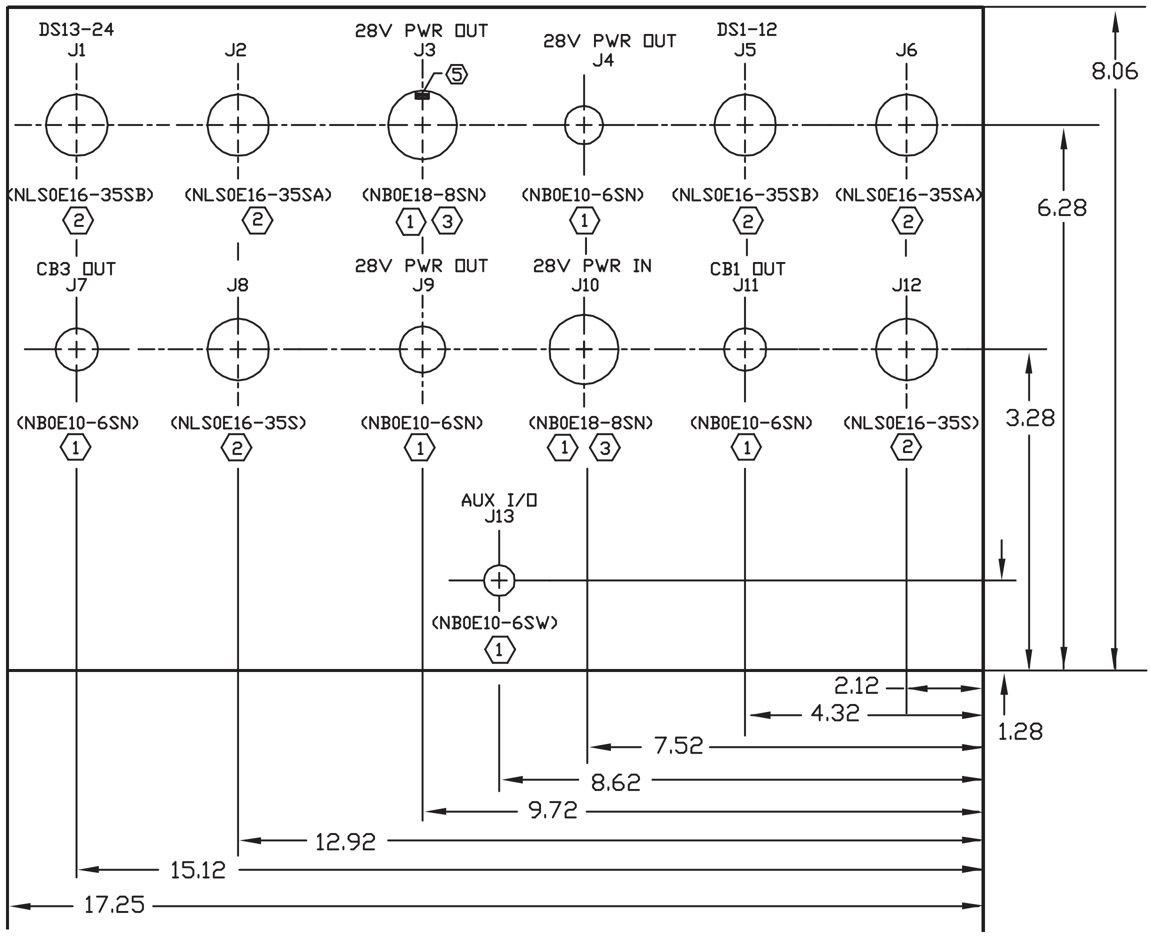


MARKING OF FOUR OVERLAYS TO BE DONE BY JSC PER INDIVIDUAL CARGO ELEMENT REQUIREMENTS (OVERLAY WILL COVER COMPONENT DESIGNATORS)

NOTES:

⟨1⟩ CONFORMS TO NASA SPECIFICATION 40M39569

2. PANEL IS PANEL SIZE E AS DEFINED IN PARAGRAPH 3.4.1.1.1

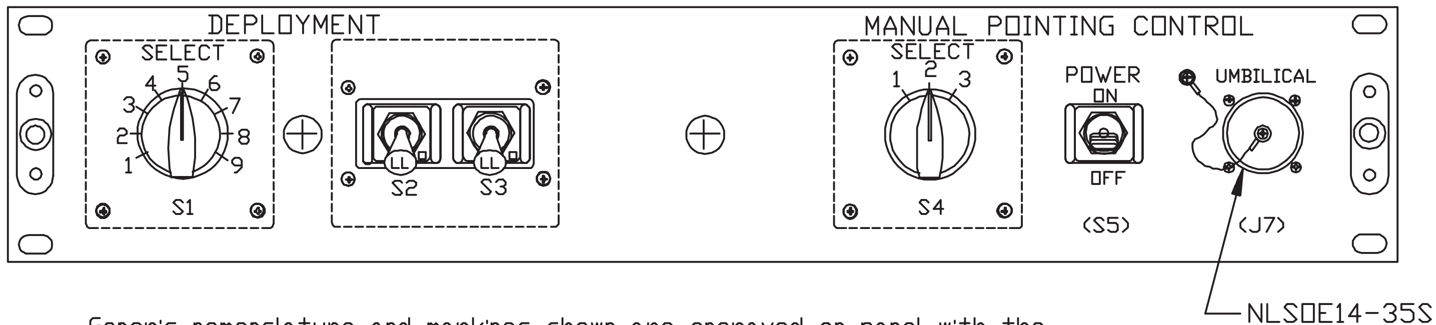


NOTES:

1. CONFORMS TO NASA SPECIFICATION 40M39569.
2. CONFORMS TO NASA SPECIFICATION 40M38277.
3. REQUIRED WIRE SIZE TO PINS IN CONNECTOR IS AWG 12. ALL OTHERS ARE AWG 22.
4. REAR PANEL CONNECTOR FACE IS LOCATED AT A DEPTH OF 8.5 INCHES FROM FACE OF FRONT PANEL IN L10, L11 OR L12 CONSOLE LOCATIONS.
5. CONNECTOR MASTER KEYWAY AT TOP (TYPICAL).

FIGURE 3.4.1.4.6.2-2 STANDARD SWITCH PANEL (SSP) REAR PANEL CONNECTOR LAYOUT

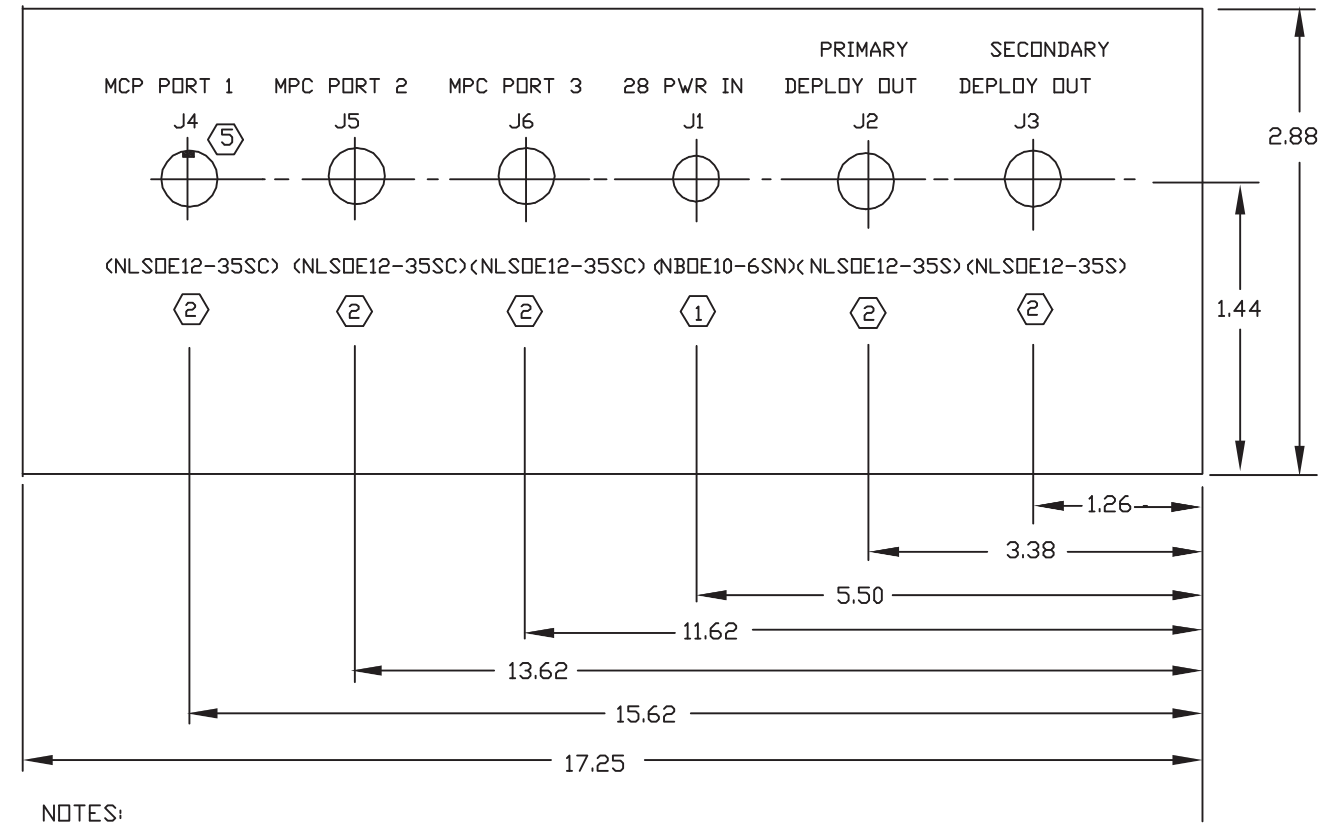
FIGURE 3.4.1.4.6.4-1 DEPLOYMENT/POINTING PANEL (DPP) FRONT PANEL LAYOUT



Generic nomenclature and markings shown are engraved on panel with the exception of two component designators (S5) and (J7). Payload specific overlays will cover generic nomenclature as indicated by dotted outlines. Overlays will be provided by JSC per individual payload requirements with nomenclature and markings as defined by the PIP annex-6.

Notes:

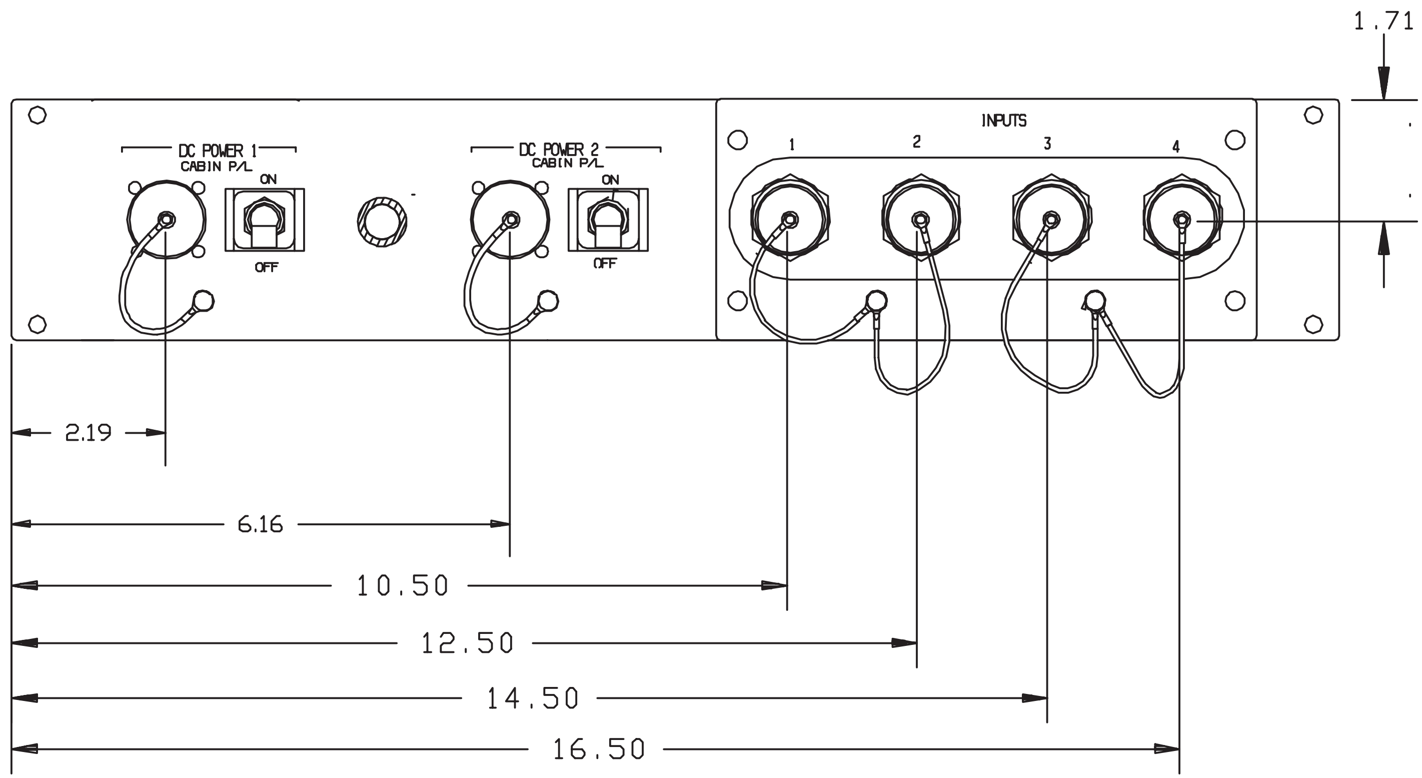
1. Connector J7 conforms to NASA specification 40M38277.
2. Panel is size B as defined in paragraph 3.4.1.1.1.
3. Connector J7 master keyway at top.



NOTES:

1. CONFORMS TO NASA SPECIFICATION 40M39569
2. CONFORMS TO NASA SPECIFICATION 40M38277
3. REQUIRED WIRE SIZE TO PINS IN ALL CONNECTORS IS AWG 22
4. REAR PANEL CONNECTOR FACE SHALL BE LOCATED AT A DEPTH OF 8.5 INCHES FROM FACE OF FRONT PANEL
5. CONNECTOR MASTER KEYWAY AT TOP (TYPICAL)

FIGURE 3.4.1.4.6.4-2 DEPLOYMENT/POINTING PANEL (DPP) REAR PANEL CONNECTOR LAYOUT

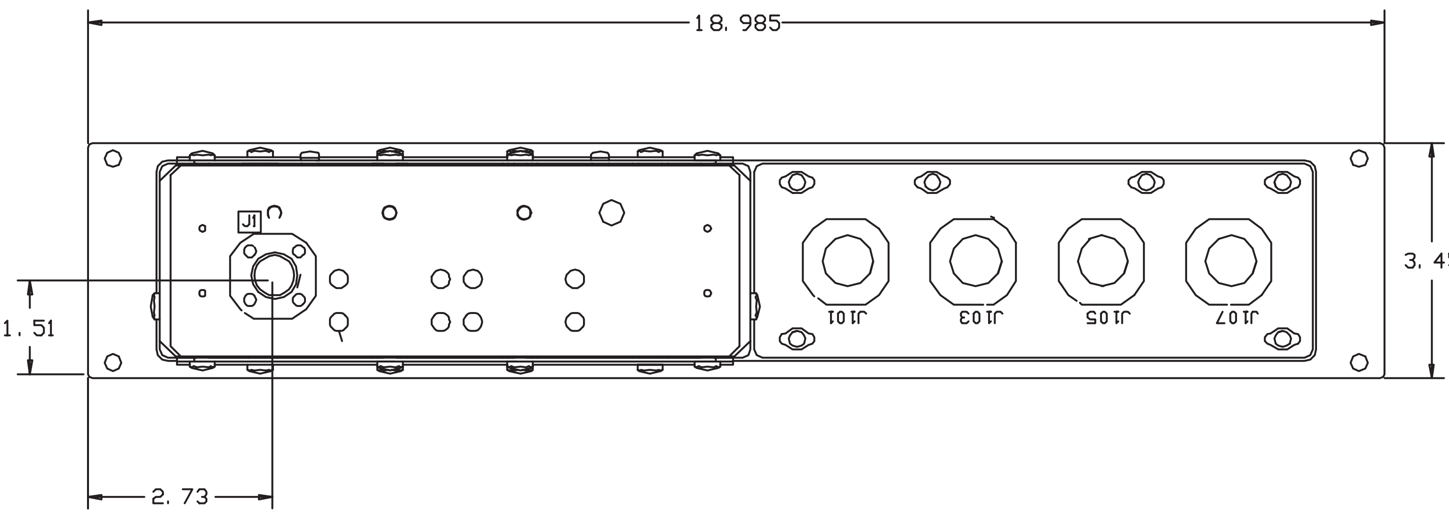


NOTES:

1. INPUT CONNECTORS 1 THROUGH 4 ARE ROCKWELL P/N ME414-0630-4001. MATING CONNECTOR SHALL BE NLS6GT12-35P CONFORMING TO NASA SPECIFICATION 40M38277.
2. DC POWER CONNECTORS ARE NB0E14-12SNT3 AND MATING CONNECTOR SHALL BE NB6GE14-12PNT3 BOTH CONNECTORS SHALL CONFORM TO NASA SPECIFICATION 40M39569.

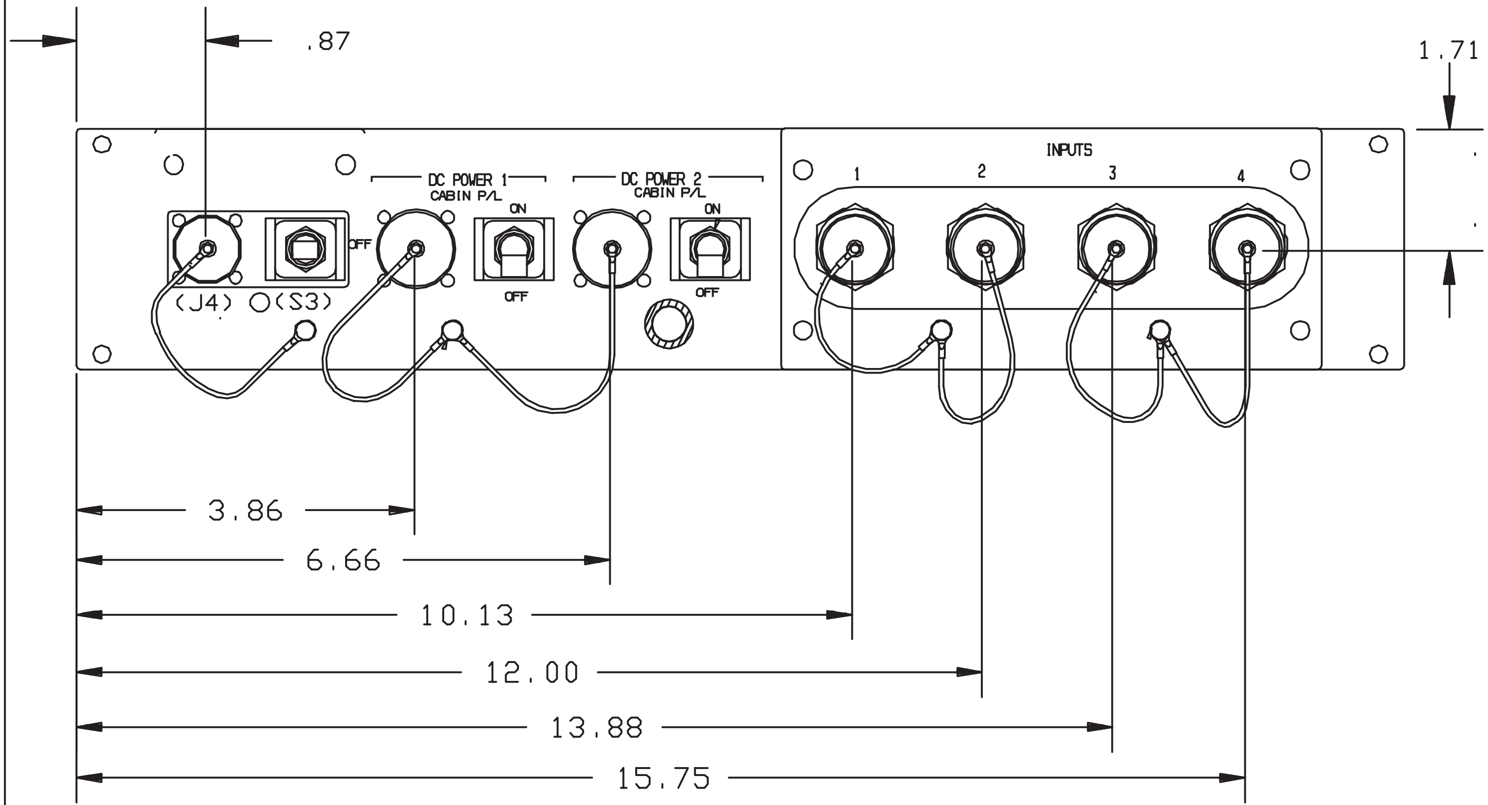
FIGURE 3.4.1.4.6.5-1 COMPUTER INTERFACE PANEL (CIP) FRONT PANEL LAYOUT

FIGURE 3.4.1.4.6.5-2 COMPUTER INTERFACE PANEL (CIP) REAR CONNECTOR PANEL LAYOUT



NOTES:

1. CONNECTOR J1 IS NB0E10-6SNT3 AND MATING CONNECTOR IS NB6GE10-6PNT3 CONFORMING TO NASA SPECIFICATION 40M39569.
2. CONNECTORS J101, J103, J105 AND J107 ARE INPUT CONNECTORS 1, 2, 3 AND 4 RESPECTIVELY. MATING CONNECTOR SHALL BE NLS6GT12-25S CONFORMING TO NASA SPECIFICATION 40M38277.



NOTES:

1. INPUT CONNECTORS 1 THROUGH 4 ARE FEED THROUGH CONNECTORS WITH BOEING P/N ME414-0630-4001. MATING CONNECTOR SHALL BE NLS6GT12-35P CONFORMING TO NASA SPECIFICATION 40M38277.
2. DC POWER CONNECTORS ARE NB0E14-12SNT3 AND MATING CONNECTOR SHALL BE NB6GE14-12PNT3. BOTH CONNECTORS SHALL CONFORM TO NASA SPECIFICATION 40M39569.
3. DATA CONNECTOR J4 IS NLS0T12-35S AND MATING CONNECTOR SHALL BE NLS6GT12-35P. BOTH CONNECTORS SHALL CONFORM TO NASA SPECIFICATION 40M38277.

FIGURE 3.4.1.4.6.6-1 PAYLOAD DATA INTERFACE PANEL (PDIP) FRONT PANEL LAYOUT

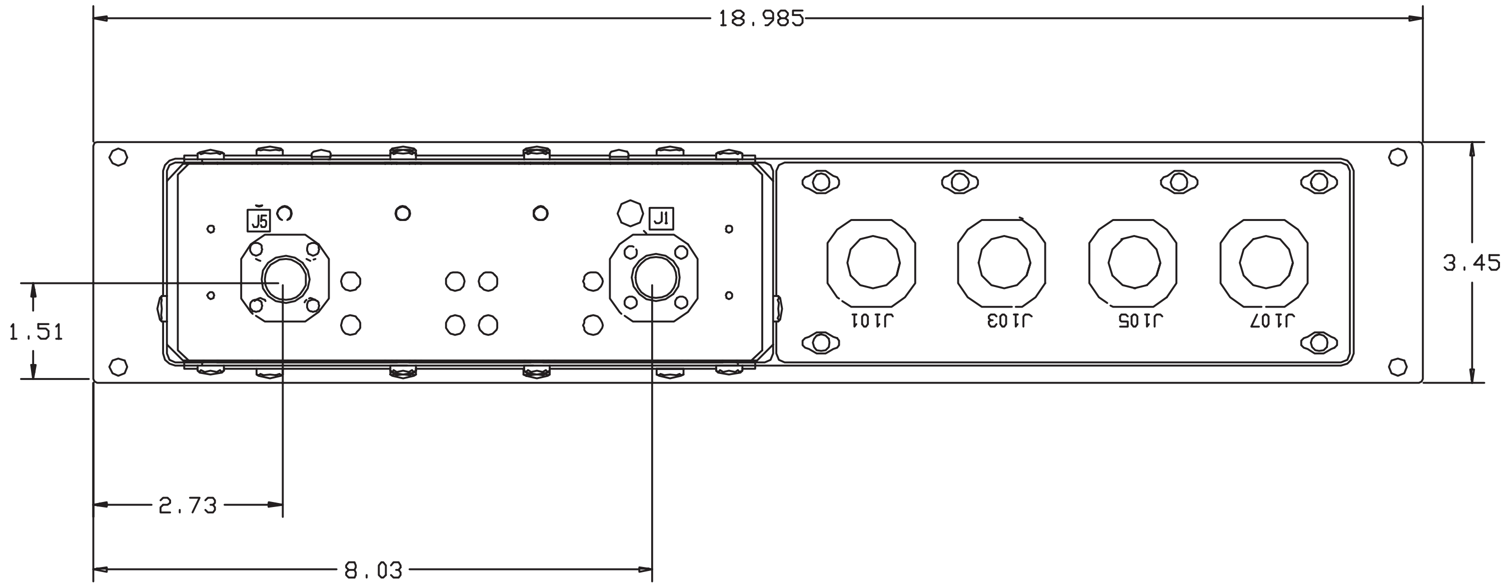
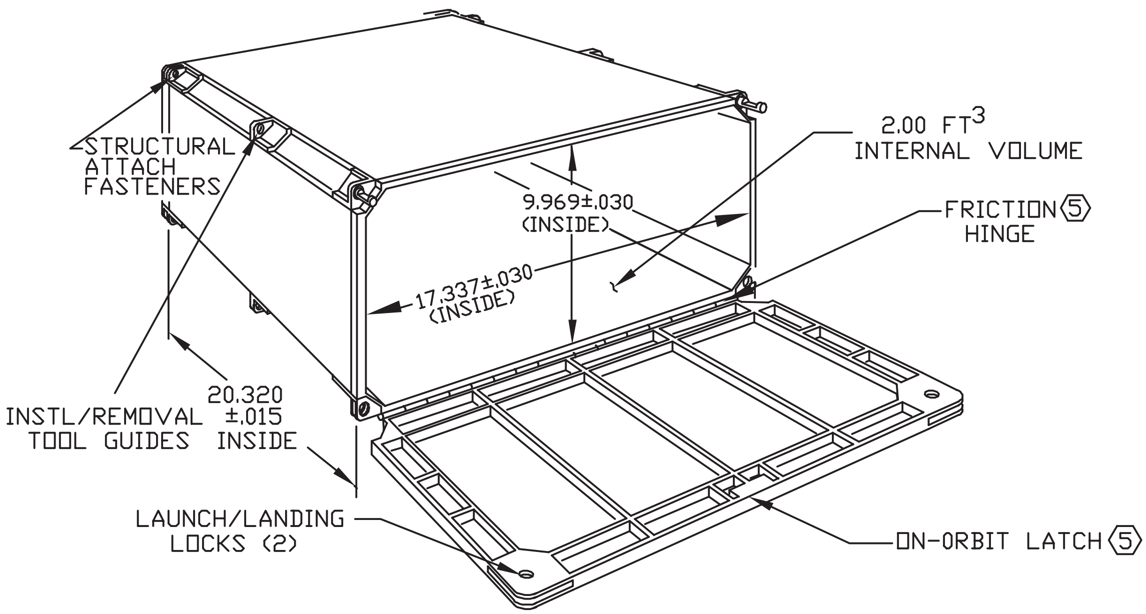


FIGURE 3.4.1.4.6.6-2 PAYLOAD DATA INTERFACE PANEL (PDIP) REAR CONNECTOR PANEL LAYOUT

NOTES:

1. CONNECTOR J1 IS NB0E10-6SNT3 AND MATING CONNECTOR IS NB6GE10-6PNT3 CONFORMING TO NASA SPECIFICATION 40M39569.
2. CONNECTOR J5 IS NLS0T12-35P AND MATING CONNECTOR IS NLS6GT12-35S CONFORMING TO NASA SPECIFICATION 40M38277.
3. CONNECTORS J101, J103, J105 AND J107 ARE FEED THROUGH CONNECTORS RELATING TO INPUT CONNECTORS 1, 2, 3 AND 4 RESPECTIVELY. MATING CONNECTOR SHALL BE NLS6GT12-35S CONFORMING TO NASA SPECIFICATION 40M38277.



NOTES:

1. STOWAGE CONTAINER HAS A DESIGN DENSITY OF 30 LBS/FT^3
2. LOCKER CONTENTS MUST BE PACKAGED TO PREVENT LOAD SHIFTING
3. INTERNAL LOCKER RESTRAINTS WILL NOT BE DESIGNED FOR CRASH CONDITIONS
4. DOOR IS FLUSH WITH BOTTOM OF LOCKER WHEN OPENED 90 DEGREES AND CAN OPEN 180 DEGREES (STRAIGHT DOWN)

5 DOOR HAS FRICTION HINGE FOR ZERO-G OPERATION AND A MAGNETIC LATCH FOR TEMPORARY CLOSURE OF DOOR

FIGURE 3.4.2.1-1 MODULAR STOWAGE

THIS PAGE INTENTIONALLY LEFT BLANK.

4.0 STRUCTURAL INTERFACES

The following sections describe the interfaces between the shuttle Orbiter and Cargo Elements (CEs). For the purpose of structural design, analysis and verification, a CE is defined as the entity that is installed in the Orbiter cargo bay and is either retained with Payload Retention Latch Assemblies (PRLAs) for across-the-bay-mounted structures or attached to the Orbiter sidewall for smaller structures. The term component refers to stand-alone experiments and equipment items that are part of a CE and are treated as an entity for the purposes of structural analysis (such as electronic boxes, batteries, electromechanical devices, payloads, etc.). Components also include Orbital Replacement Units (ORUs) and stowage items.

4.1 CARGO BAY

4.1.1 Interface Force Constraints

Interface forces shall be constrained to the Orbiter attach point limit-load capability defined in Appendix I.

4.1.1.1 Friction-Induced Loads

Design of the Orbiter and Cargo Elements (CEs) shall include the effects of friction induced loads at both longeron and keel interfaces. The coefficient of friction (μ) for X, Y, and Z directions is shown in Figure 4.1.1.1-1 and Figure 4.1.1.1-2. The friction loads shall be combined with normal interface loads for Cargo Element (CE) design.

4.1.2 Attachment Mechanism Deflection Limits

With the exceptions of attachment mechanisms and umbilicals, the CE in the cargo bay shall remain at all times within the CE thermal and dynamic envelope defined in Paragraph 3.1.2.1.1.

CE attach fitting deflection limits used for longeron and keel trunnion length selection are specified in Appendix X. Trunnion lengths for most CE categories are standardized with trunnion length restrictions placed upon certain longeron and keel attach points as specified in Section 3.3. The criteria in Appendix X must be satisfied for CEs requiring non-standard lengths.

The spherical bearings in the longeron and keel attach fittings provide for misalignment and for relative rotational deflection between the CE trunnion and the Orbiter structure. The available alignment cone angles constitute the limits on the relative rotational deflections between the CE trunnions and the Orbiter structure. These limits are apportioned to the CE and to the Orbiter in Table 4.1.2-1 for use in preliminary CE design. The total relative deflection limits for the final CE design shall be verified by coupled dynamic and quasi-static analyses.

4.1.3 Cargo Element Limit-Load Factors/Angular Accelerations

The load factors/angular accelerations specified in the following subparagraphs shall only be used for preliminary design of the Cargo Element (CE) primary structure and for determination of preliminary Orbiter/CE interface loads. Analysis results using these preliminary design load factors/angular accelerations shall be superseded by coupled dynamic and quasi-static analysis results. The center-of-rotation for angular accelerations is at the CE center-of-gravity. The load factors for the emergency landing condition are defined in Paragraph 4.1.3.5.

Load factor/angular acceleration is defined as the total externally applied force/moment on CE component(s), divided by the corresponding CE 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).

These load factors/angular accelerations are valid for any location in the Orbiter cargo bay. The load factors/angular accelerations result from the response of the Shuttle vehicle structure, including cargo, to external forces corresponding to both quasi-static and transient flight events. These external forces are generated by the thrust, aerodynamics, wind shear, prelaunch restraints, entry maneuvers, landing gears impact, etc.

Accelerations at specific points within the CE will depend upon CE design characteristics and mounting methods. Portions of the CE that are cantilevered from their support points, or that have substantial internal flexibility, may experience higher accelerations than those shown in the tables. For the CE preliminary design, all combinations of the load factors/angular accelerations for each flight event shall be considered.

4.1.3.1 Quasi-Static Flight Events

The load factors/angular accelerations associated with the quasi-static flight events are generated by external forces which change slowly with time and for which the vehicle elastic responses are relatively small. Consequently, coupled transient dynamic analyses are not normally required. However, for CEs with redundant Orbiter interfaces, a coupled static analysis of the various quasi-static flight events shall be used for determining deflections and CE interface forces. The Space Shuttle Vehicle (SSV) quasi-static structural math model and deflection data base shall be provided by the SSP in compliance with NSTS 37329 requirements.

Load factors/angular accelerations are specified in Table 4.1.3.1-1 for quasi-static flight events during ascent and descent, for up to a maximum of 65,000 lb (29,484 kg) lift-off CEs and up to a maximum of 32,000 lb (14,515 kg) landing returnable CEs. Non-returnable CEs are required to design for descent conditions associated with an abort event. Descent load factors/angular accelerations for non-returnable CEs up to 65,000 lb (29,484 kg) are specified in Table 4.1.3.1-2. These conditions are normal design conditions for the Orbiter structure.

4.1.3.2 Transient Flight Events

The transient flight events correspond to conditions for which the external forces are highly transient in nature and significant elastic response occurs. Shuttle lift-off and landing are events of this type. The associated CE responses depend on the CE geometry, stiffness, and mass characteristics. Consequently, final design values of CE/Shuttle interface forces and CE design loads shall be determined by coupled dynamic analysis. The SSV dynamic structural math models and forcing functions shall be provided by the SSP in compliance with NSTS 37329 requirements.

4.1.3.2.1 Lift-off Loads

The preliminary design load factors for lift-off are expressed in Table 4.1.3.2.1-1 as a function of CE weight. Linear interpolation should be used to determine load factors for intermediate CE weights. Analysis results using these lift-off load factors shall be superseded by coupled dynamic analysis results.

4.1.3.2.2 Landing Loads

4.1.3.2.2.1 Landing Loads for Returnable Cargoes

Returnable CEs, including empty cradles, shall be designed for 3-sigma Orbiter landing events. The preliminary design load factors for landing of returnable CEs are expressed in Table 4.1.3.2.2.1-1 as a function of CE weight. Linear interpolation should be used to determine load factors for intermediate CE weights. Retunable CEs shall also be designed for contingency Orbiter landing events as specified in Para. 4.1.3.2.2.2. The maximum design landing sink rate for returnable CEs is 9.6 fps (2.93 mps). Analysis results using the landing load factors shall be superseded by coupled dynamic analysis results.

4.1.3.2.2.2 Landing Loads for Non-Returnable CEs

Non-returnable CEs shall be designed for Orbiter intact abort landing events. CEs shall also be designed for contingency Orbiter landing events using the same landing criteria as for Orbiter intact abort landing. A contingency landing event is due to a mission failure (e.g. Orbiter failure on-orbit, CE non-deployment, partial transfer, etc.). The preliminary design load factors for landing of non-returnable CEs are expressed in Table 4.1.3.2.2.2-1 as a function of CE weight. Linear interpolation should be used to determine load factors for intermediate payload weights. The maximum design landing sink rate for non-returnable CEs is 7.2 fps (2.19 mps). Analysis results using these load factors shall be superseded by coupled dynamic analysis results.

4.1.3.3 (Deleted)

4.1.3.3.1 (Deleted)

4.1.3.3.2 (Deleted)

4.1.3.4 (Reserved)

4.1.3.5 Emergency Landing Load Factors

Safe crew egress following emergency landing or water ditching is an Orbiter vehicle design requirement. Hence, the mounting structure for equipment and crew provisions that are stowed in the Orbiter crew cabin and all cargo bay CEs shall be designed to load factors equal to or greater than those shown in Table 4.1.3.5-1 and Figure 4.1.3.5-1. CE 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 CE attachment structures (including fittings and fasteners) shall be designed for emergency landing loads. The attachment structure of CE equipment whose failure could result in injury to personnel or prevent egress from the emergency landed vehicle shall be designed for this requirement. CE 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 CE structural design (including all mounting hardware, bracketry, or other structure which could be affected by flight loads) shall assure an ultimate combined factor of safety greater than or equal to 1.40. The CE structural design and all components shall comply with the factors of safety that are specified (e.g. for materials, components, pressure vessels, pressurized lines and fittings, etc.) in NSTS 14046 and NASA STD 5001. The combined factor of safety shall be calculated per NSTS 37329, Appendix P.

4.1.3.7 Fracture Control

Structural components, including all pressure vessels, the failure of which could cause destructive damage to the Orbiter or injury to the crew, shall be analyzed to preclude failures caused by propagation of pre-existing flaws and shall comply with the requirements specified in NASA STD 5003.

4.1.4 Mass Properties Characteristics of Total Cargo

4.1.4.1 Center-of-Gravity (C.G.) Envelopes for Total Cargo

The Shuttle Vehicle must remain aerodynamically stable during certain phases of a mission. These phases include:

a. Nominal entry through landing

b. MECO through landing for RTLS aborts

c. Entry through landing for all other aborts, including an emergency deorbit

To ensure that aerodynamic stability is maintained, the cargo C.G. shall be constrained. The C.G. constraints for a co-manifested cargo element can only be determined after the mission-unique requirements of all cargo elements are integrated with the Orbiter C.G. For customers with a primary cargo bay element (greater than 20,000 pounds), the Shuttle Program Office will perform a preliminary flight assessment early in the design process. The customer can use the assessment to aid in designing their cargo element such that it can be placed in an acceptable cargo bay attach point location to maintain Orbiter C.G. constraints.

4.1.5 Acoustics

The acoustic levels in the cargo bay that are defined in Table 4.1.5-1 represent the minimum levels to which a CE must be certified to be considered safe to fly on the Shuttle. The acoustic levels during entry and landing are significantly below the ascent levels and for analysis purposes can be assumed to be 20 dB lower than the ascent acoustic environment. Acoustic levels for specific CE local zones/surfaces are dependent on payload geometry, surface area and acoustic absorption characteristics and may differ from those of Table 4.1.5-1.

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 trunnion mounted CEs, sidewall adapter mounted CEs, and Orbiter longerons. The environments are applicable at Orbiter interfaces for all axial (Xo) locations. CE structure must be certified to vibration criteria that are based on these environments to be considered safe to fly on the STS. The environments in each axis may be considered statistically uncorrelated.

4.1.6.2.1 Random Vibration for Trunnion Mounted Cargo Elements(CEs)

The random vibration environments for the longeron trunnion and keel trunnion interfaces are specified in Tables 4.1.6.2.1-1 and 4.1.6.2.1-2. These environments represent vibration responses on the CE trunnions due to both Orbiter and CE primary structure vibration.

4.1.6.2.2 Random Vibration for Sidewall/Adapter Mounted Cargo Elements (CEs)

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 Random Vibration for Orbiter Longerons

The random vibration for hardware mounted to the Orbiter longerons is given in Table 4.1.6.2.3-1.

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	g^2/Hz
85 - 100 Hz	+9	dB/Octave
100 - 400 Hz	0.25	g^2/Hz
400 - 2000 Hz	-6	dB/Octave

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

NOTE: Vibration criteria applies to connector interfaces in the following locations; Mid-Fuselage Cable Trays, Mid-Fuselage Longerons, Mid-Fuselage Payload Adapter-to-Orbiter Interface, Crew Compartment Interior, Crew Stations, IMU, Hull and Airlock, and the Aft Fuselage Xo1307 Bulkhead below Zo409.

4.1.7 Cargo Element Structure/Flight Control System Interaction

4.1.7.1 Applicability

The requirements herein can be used by both the cargo element designer/manufacturer and the mission planner. Individual cargo element and mission cargo manifest acceptability is based on the ascent/entry stability requirements of the Orbiter flight control system. Acceptability in the on-orbit mode with cargo elements extended or otherwise in a changed orientation from the lift-off and landing configuration and the payload bay doors open is not covered in this section.

4.1.7.2 Criteria

The cargo element designer can minimize the interaction between the cargo element and the Orbiter flight control system by designing the cargo element above a minimum stiffness. To minimize cargo element/flight control system interaction, a constrained cargo element shall exhibit a structural modal frequency not less than 5.1 Hz (32.0 radians per second) and a structural modal damping not less than 1% in both the pitch and lateral axes. Structural modes with less than 1,000 pounds of effective weight are not subject to the minimum frequency requirement.

A cargo element that meets the structural modal frequency and damping requirements can be manifested with other cargo elements which satisfy this same criteria provided the combined weight of all cargo elements is less than 45,000 pounds.

4.1.7.3 Constrained Modal Frequency and Effective Weight

The cargo element structural data used for flight control/stability analysis shall be based on the lift-off weight, structural characteristics, and the associated suspension system. Landing configurations shall also be considered if they differ from lift-off. The constrained cargo element modal frequencies and associated effective weights are generated with the cargo element in the stowed position and the supporting equipment restrained at the Orbiter interface degrees-of-freedom. A constrained cargo element modal frequency is defined as a frequency of the cargo element on its Orbiter interface mounts, with the mounts fixed to an infinite mass. Constrained frequencies can be attributed to either the inherent flexible characterisitcs of the cargo element and/or to the suspension characteristics of the rigid cargo element.

4.1.7.4 Flight Control/Stability Analysis Requirements

A flight control/stability analysis shall be required when any of the following conditions exist:

- The cargo element has less than one percent damping for any structural mode
- A mode exists with a modal frequency less than 5.1 Hz with an associated effective weight of more than 1,000 pounds
- The total cargo element manifest weight exceeds 45,000 pounds

For a mixed manifest in which the cargo elements individually comply with the minimum structural damping and frequency requirements but not the total cargo weight, the flight control/stability analysis required by the SSP will not be the responsibility of the cargo element development organizations. Significant Shuttle Orbiter mission kits such as the Orbiter Docking System shall be considered in the total manifest weight. When a flight control/stability analysis is required, the cargo element development organization shall provide the cargo element structural math model data for the stowed configuration to the SSP such that flight control/stability acceptability can be demonstrated for the Cargo Integration Review. When a test-verified cargo element math model becomes available, that math model shall also be provided to the SSP to determine if additional flight control/stability analyses are required. The SSP may also require the cargo element math model for engineering assessments in situations when a flight control/stability analysis is not required by the criteria stated in Paragraph 4.1.7.2. No flight control/stability analysis will be required of the cargo element development organization in these instances. In all cases, the cargo element math models provided to the SSP shall be for the stowed configuration and in the format specified in the current version of NSTS 37329.

4.1.8 Payload Fluid Lines/PACK Interface Structural Limitations

4.1.8.1 Interface Loads

The maximum loads that may be transmitted by the payload coolant lines to the Payload Active Cooling Kit (PACK) are presented in Table 4.1.8.1-1. These loads are based on the analytic capability of the PACK support structure.

4.1.8.2 Deflections

The payload fluid lines shall be designed to accommodate maximum deflections without producing loads that exceed the values given in Table 4.1.8.1-1. Total line deflection shall include maximum Orbiter deflection and relevant payload deflection. Maximum deflections are presented in Table 4.1.8.2-1. These values include Orbiter sidewall movement and permissible trunnion sliding. Relative motion of the payload fluid line clamp point with respect to the longeron trunnion shall be added to the deflections in Table 4.1.8.2-1. The deflections apply for any PACK payload bay location.

4.1.9 Pyrotechnic Shock

4.1.9.1 Cargo Element (CE) Induced Pyrotechnic Shock

The CE generated pyrotechnic shock detected on the trunnion at the CE-to-Orbiter interface shall not exceed the shock response spectrum shown in Figure 4.1.9.1-1.

4.1.9.2 Pyrotechnic Shock From Other Sources

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

4.1.10 Crew Induced Loading Criteria

The Orbiter crew-induced design limit loads criteria is intended to conservatively provide criteria for preliminary design. These load values can be used for designing local EVA attachment and structure hardware without the time history component (i.e. Static load analysis only). The time history component along with the load value is to be used for system level analyses.

The Orbiter crew-induced Extravehicular Activity (EVA) design limit loads are shown in Tables 4.1.10-1 and Figures 4.1.10-1, 4.1.10-2. The Orbiter Intravehicular Activity (IVA) design limit loads are shown in Table 4.1.10-2. In certain cases, coupled dynamic analyses may be required to verify cargo loads and deflections. If such an analysis is required, the Orbiter dynamic model and forcing functions shall be identified by the SSP.

4.1.10.1 Crew Exercise Equipment Locations and force application locations

Crew exercise equipment locations and force application locations shall be defined in Table 4.1.10.1-1 and Figure 4.1.10.1-1, -2.

4.1.11 Ferry Flight Environment

Cargo Elements (CEs) may be transported (ferried) inside the payload bay with the Orbiter mounted on the Boeing 747 Shuttle Carrier Aircraft from a landing site back to KSC. A returnable CE that flies multiple missions could log a significant amount of time being ferried from the Shuttle landing site(s) to KSC, and therefore potential considerations of fatigue life are factors in determining the mission life of the CE. The criteria specified in this section are based on SMD-91-2104.

The criteria presented here represent all flight phases that include takeoff, climb, cruise, descent, and landing. All events, especially gusts and maneuvers, contributing to fatigue loading are included in the criteria development. The criteria is based on the components $N_{mission}$, $N_{percent}$, N_{ferry}, and T_{ferry} which are defined below:

- $N_{mission}$= the number of missions the CE will fly on the shuttle
- $N_{percent}$= percentage of shuttle flights to land in California is forty per cent of the number of CE missions.
- N_{ferry}= the number of ferry flights in the CE life
- T_{ferry}= the total ferry time for the CE in hours. Time per mission does not include a scatter factor.

This environment applies to all Orbiter weight conditions.

4.1.11.1 Load Factors

The load factors for the design of the CE are given in Table 4.1.11.1-1. The loading spectrum resulting from different phases of a single ferry flight is given in Table 4.1.11.1-2. The limit value of the stress is the resulting stress when Table 4.1.11.1-1 load factors are applied simultaneously. For additional cross-country ferry flights, each entry in the second column (Cycles/Ferry Flight) of Table 4.1.11.1-2 should be multiplied by N_{ferry}.

$$N_{ferry} = (N_{mission}) * (N_{percent})$$

The design landing sink rate for determining the load factor is 3.0 fps. The load factors given here have to be transformed to the stress spectrum for use in fatigue analysis.

The load factors are given in the Orbiter structural coordinate system and are considered to be the loads applied to the CE by the Orbiter. The load factors should be applied simultaneously. The load factors are considered to act at the center of gravity (CG) of the Payload. The contribution of the rotational components to the load factors is very minor and has therefore been ignored.

4.1.11.2 Acoutics

The acoustic levels on the CE are defined in Table 4.1.11.2-1. These are the levels to which the CE is exposed during the Ferry Flight. The duration of exposure, (T_{ferry}), is calculated by the equations:

$$N_{ferry} = (N_{mission}) * (N_{percent})$$
$$T_{ferry} = (N_{ferry} * 7.08) + 25.02$$

The duration of exposure is significantly higher than those encountered during liftoff. Acoustic levels for specific local zones/surfaces are dependent on payload geometry, surface area and acoustic absorption characteristics and may differ from Table 4.1.11.2-1.

<u>4.1.11.3 Random Vibration</u>

The random vibration environment at the Orbiter longeron and keel trunnion interfaces during Ferry Flight is specified in Table 4.1.11.3-1. The total associated time of duration of random vibration, (T_{ferry}), is calculated by the equations:

$$N_{ferry} = (N_{mission}) * (N_{percent})$$
$$T_{ferry} = (N_{ferry} * 7.08) + 25.02$$

This environment represents vibration response on the CE trunnion due to both Orbiter and CE primary structure vibration.

TABLE 4.1.2-1 CARGO ELEMENT (CE)/ORBITER ROTATIONAL DEFLECTION LIMITS FOR PRELIMINARY DESIGN

INTERFACE LOCATION	**ROTATIONAL DEFLECTION LIMITS DEGREES**		
	CE*	**ORBITER***	**TOTAL****
DEPLOYABLE LONGERON FITTING	3.0	3.0	6.0
NON-DEPLOYABLE LONGERON FITTING	5.0	3.0	8.0
ACTIVE AND PASSIVE KEEL FITTING	3.0	3.0	6.0

*   For preliminary design use only.
** Total relative rotational deflection.

TABLE 4.1.3.1-1 CE LIMIT-LOAD FACTORS/ANGULAR ACCELERATIONS FOR PRELIMINARY DESIGN (QUASI-STATIC FLIGHT EVENTS)

FLIGHT EVENT	LOAD FACTOR g			ANGULAR ACCELERATION RAD/SEC^2			CE WEIGHT
	N_x	N_y	N_z	$\ddot{\phi}$	$\ddot{\theta}$	$\ddot{\Psi}$	
ASCENT							
HIGH-Q BOOST ENVELOPE	-2.4	±0.40	0.25 -0.50	±0.10	±0.15	±0.15	Up to 65 klb
INTEGRATED VEHICLE BOOST MAX N_x	-2.7	±0.06	-0.20	±0.20	±0.25	±0.25	
POST SRB STAGING	-1.20	±0.18	-0.36	±0.20	±0.10	±0.10	
ORBITER BOOST MAX N_x	-3.17 -3.05	±0.14 ±0.14	-0.60 -0.80	±0.20 ±0.20	±0.05 ±0.05	±0.25 ±0.25	
DESCENT							
TAEM: PITCH MANEUVER	1.00 1.00 1.00	0 0 0	2.50 1.00 -1.00	0 0 0	-0.33 ±0.3 0.2	0 0 0	Up to 32 klb
TAEM: ROLL MANEUVER	1.00 1.00	-0.25 +0.25	2.00 2.00	+1.10 -1.10	0.05 0.05	+0.05 -0.05	
TAEM: YAW MANEUVER	1.00	±0.50	1.25	0	0	±0.05	

TABLE 4.1.3.1-2 CE LIMIT-LOAD FACTORS/ANGULAR ACCELERATIONS FOR PRELIMINARY DESIGN (DESCENT OF NON-RETURNABLE CE)

FLIGHT EVENT	LOAD FACTOR g			ANGULAR ACCELERATION RAD/SEC^2			CE WEIGHT
	N_x	N_y	N_z	$\ddot{\phi}$	$\ddot{\theta}$	$\ddot{\Psi}$	
<u>DESCENT</u>							
TAEM: PITCH MANEUVER	1.00	0	2.50	0	-0.33	0	Up to 32 klb
	1.00	0	1.00	0	±0.3	0	
	1.00	0	-1.00	0	0.2	0	
TAEM: ROLL MANEUVER	1.00	-0.25	2.00	+1.10	0.05	+0.05	
	1.00	+0.25	2.00	-1.10	0.05	-0.05	
TAEM: YAW MANEUVER	1.00	±0.50	1.25	0	0	±0.05	
TAEM: PITCH MANEUVER	0.70	0	2.07	0	-0.24	0	Up to 65 klb
	0.70	0	1.00	0	±0.2	0	
	0.70	0	-0.83	0	0.33	0	
TAEM: ROLL MANEUVER	0.70	-0.20	1.65	+1.0	0.05	+0.05	
	0.70	+0.20	1.65	-1.0	0.05	-0.05	
TAEM: YAW MANEUVER	0.70	±0.50	1.25	0	0	±0.05	

NOTE: Load factors for non-returnable CEs between 32,000 lbs and 65,000 lbs are found by linear interpolation between values given in the table.

TABLE 4.1.3.2.1-1 Liftoff CE Limit Load Factors/Angular Accelerations for Preliminary Design

	ZERO POUNDS	5,000 POUNDS	20,000 POUNDS	50,000 POUNDS	65,000 POUNDS
N_x G's	+3.1 -6.0	+3.1 -6.0	+0.3 -3.2	+0.3 -3.2	+0.3 -3.2
N_y G's	+3.5 -3.0	+1.6 -1.6	+1.6 -1.6	+0.4 -0.4	+0.4 -0.4
N_z G's	+6.4 -6.4	+6.4 -6.4	+3.5 -3.5	+1.5 -1.5	+1.5 -1.5
$\ddot{\phi}$ RAD/SEC^2	+10.0 -10.0	+10.0 -10.0	+8.0 -8.0	+3.0 -3.0	+3.0 -3.0
$\ddot{\theta}$ RAD/SEC^2	+35.0 -35.0	+35.0 -35.0	+8.0 -8.0	+6.0 -6.0	+6.0 -6.0
$\ddot{\Psi}$ RAD/SEC^2	+12.0 -12.0	+12.0 -12.0	+5.0 -5.0	+2.5 -2.5	+2.5 -2.5

TABLE 4.1.3.2.2.1-1 Returnable CE Landing Limit Load Factors/Angular Accelerations for Preliminary Design

	ZERO POUNDS	5,000 POUNDS	12,500 POUNDS	32,000 POUNDS
N_x G's	+6.0 -6.0	+6.0 -6.0	+2.4 -3.2	+1.8 -2.4
N_y G's	+4.0 -4.0	+4.0 -4.0	+1.6 -1.6	+1.6 -1.6
N_z G's	+7.5 -4.2	+7.5 -4.2	+5.0 -1.7	+4.2 -1.5
$\ddot{\phi}$ RAD/SEC^2	+8.5 -8.5	+8.5 -8.5	+8.5 -8.5	+8.5 -8.5
$\ddot{\theta}$ RAD/SEC^2	+55.0 -55.0	+55.0 -55.0	+20.0 -15.0	+7.0 -7.0
$\ddot{\Psi}$ RAD/SEC^2	+14.0 -14.0	+14.0 -14.0	+5.0 -5.0	+5.0 -5.0

TABLE 4.1.3.2.2.2-1 Non Returnable CE Landing Limit Load Factors/Angular Accelerations for Preliminary Design

	ZERO POUNDS	5,000 POUNDS	12,500 POUNDS	50,000 POUNDS	65,000 POUNDS
N_x G's	+5.0 -5.0	+5.0 -5.0	+2.0 -2.0	+1.0 -1.0	+1.0 -1.0
N_y G's	+3.0 -3.0	+3.0 -3.0	+1.0 -1.0	+1.0 -1.0	+1.0 -1.0
N_z G's	+6.5 -4.0	+6.5 -4.0	+3.6 -0.6	+3.6 -0.6	+3.6 -0.6
$\ddot{\phi}$ RAD/SEC^2	+6.0 -6.0	+6.0 -6.0	+5.0 -5.0	+3.0 -3.0	+3.0 -3.0
$\ddot{\theta}$ RAD/SEC^2	+38.0 -38.0	+38.0 -38.0	+9.0 -9.0	+5.0 -5.0	+5.0 -5.0
$\ddot{\Psi}$ RAD/SEC^2	+10.0 -10.0	+10.0 -10.0	+4.0 -4.0	+2.0 -2.0	+2.0 -2.0

TABLE 4.1.3.5-1 EMERGENCY LANDING DESIGN LOAD FACTORS

	Load Factor (g) 65 klb Up 32 klb Down			Load Factor (g) 65 klb Down		
CONDITION	N_x	N_y	N_z	N_x	N_y	N_z
Emergency Landing (Outside Crew Compartment)	+4.500 -1.500	+1.500 -1.500	+4.500 -2.000	+4.500 -0.738	+0.738 -0.738	+2.215 -0.985
Emergency Landing (Inside Crew Compartment)	+20.00 -3.300	+3.300 -3.300	+10.00 -4.400			

Sign convention follows the Orbiter coordinate system as shown in Figure 4.1.3-1.

"Up" refers to an emergency landing due to an ascent event (e.g. launch abort).
"Down" refers to an emergency landing due to a descent event.

Emergency landing load factors are ultimate. Two separate applications shall be considered when utilizing the above load factors:

(1) The above N_x, N_y and N_z load factors shall operate separately, one axis at a time.

(2) The specified longitudinal load factors (N_x) are directed in all aftward azimuths as the resultant within a cone of 20 degrees half angle (reference Figure 4.1.3.5-1). Resolution of the resultant defines specific load conditions (N_x', N_y' and N_z') depending on the azimuth angle ϕ. For these load conditions, the associated load factors shall be considered simultaneously.

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

TABLE 4.1.5-1 ORBITER CARGO BAY INTERNAL ACOUSTIC ENVIRONMENT

1/3 OCT. BAND CENTER Hz	SOUND PRESSURE LEVEL(dB) REF. $2x10^{-5}$ N/m^{2}				SOUND POWER LEVEL (dB) REF. 10^{-12} WATTS	
	MEI/LIFT-OFF			MAX Q/ TRANSONIC	PAYLOAD BAY VENTS**	
	5 SECONDS PER MISSION* PAYLOAD DIAMETER < 160 INCHES	5 SECONDS PER MISSION* PAYLOAD DIAMETER 160-180 INCHES	5 SECONDS PER MISSION* SIDEWALL MOUNTED PAYLOADS	10 Seconds PER MISSION* PAYLOAD DIAMETER ≤ 180 INCHES	LIFT-OFF 5 SECONDS PER MISSION	MAX Q/ TRANSONIC 36 SECONDS PER MISSION
31.5	122.0	125.0	124.0	112.0	119.0	110.0
40	124.0	127.0	126.0	114.0	121.0	114.0
50	125.5	128.5	128.5	116.0	122.0	114.0
63	127.0	130.0	131.0	118.0	126.0	115.0
80	128.0	131.0	133.0	120.0	128.0	118.0
100	128.5	131.5	133.0	121.0	130.0	120.0
125	129.0	132.0	132.0	122.5	126.0	125.0
160	129.0	132.0	131.0	123.5	130.0	130.0
200	128.5	131.5	130.0	124.5	129.0	125.0
250	127.0	130.0	129.0	125.0	132.0	121.0
315	126.0	129.0	128.0	125.0	130.0	124.0
400	125.0	128.0	126.5	124.0	127.0	118.0
500	123.0	126.0	125.5	121.5	130.0	119.0
630	121.5	124.5	123.0	119.5	122.0	117.0
800	120.0	123.0	121.5	117.5	123.0	115.0
1000	117.5	120.5	120.5	116.0	122.0	114.0
1250	116.0	119.0	118.5	114.0	121.0	115.0
1600	114.0	117.0	117.5	112.5	118.0	109.0
2000	112.0	115.0	115.5	110.5	121.0	108.0
2500	110.0	113.0	113.5	108.5	123.0	110.0
OA	138.0	141.0	141.0	133.5	140.0	134.0

* TIME PER MISSION DOES NOT INCLUDE A SCATTER FACTOR

** THE PAYLOAD BAY VENTS ACT AS INDIVIDUAL NOISE SOURCES FOR THE PAYLOAD BAY
THE NOISE RADIATED FROM ANY ONE VENT IS DESCRIBED BELOW

TABLE 4.1.6.2.1-1 ORBITER CARGO BAY RANDOM VIBRATION LONGERON TRUNNION/ORBITER INTERFACE

X Axis	20 - 58 Hz	.0025 g^2/Hz
	58 - 125 Hz	+9 dB/Octave
	125 - 300 Hz	.025 g^2/Hz
	300 - 900 Hz	-9 dB/Octave
	900 - 2000 Hz	.001 g^2/Hz
	Overall = 3.1 Grms	
Y Axis	20 - 68 Hz	.004 g^2/Hz
	68 - 125 Hz	+9 dB/Octave
	125 - 300 Hz	.025 g^2/Hz
	300 - 900 Hz	-9 dB/Octave
	900 - 2000 Hz	.001 g^2/Hz
	Overall = 3.1 Grms	
Z Axis	20 - 45 Hz	.009 g^2/Hz
	45 - 125 Hz	+3 dB/Octave
	125 - 300 Hz	.025 g^2/Hz
	300 - 900 Hz	-9 dB/Octave
	900 - 2000 Hz	.001 g^2/Hz
	Overall = 3.2 Grms	

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

TABLE 4.1.6.2.1-2 ORBITER CARGO BAY RANDOM VIBRATION KEEL TRUNNION/ORBITER INTERFACE

X Axis	20 - 90 Hz	.008 g^2/Hz
	90 - 100 Hz	+9 dB/Octave
	100 - 300 Hz	.01 g^2/Hz
	300 - 650 Hz	-9 dB/Octave
	650 - 2000 Hz	.001 g^2/Hz
	Overall = 2.3 Grms	
Y Axis	20 - 90 Hz	.008 g^2/Hz
	90 - 100 Hz	+9 dB/Octave
	100 - 300 Hz	.01 g^2/Hz
	300 - 650 Hz	-9 dB/Octave
	650 - 2000 Hz	.001 g^2/Hz
	Overall = 2.3 Grms	
Z Axis	20 - 60 Hz	.0023 g^2/Hz
	60 - 100 Hz	+9 dB/Octave
	100 - 300 Hz	.01 g^2/Hz
	300 - 650 Hz	-9 dB/Octave
	650 - 2000 Hz	.001 g^2/Hz
	Overall = 2.2 Grms	

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

TABLE 4.1.6.2.2-1 ORBITER CARGO BAY RANDOM VIBRATION 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.

TABLE 4.1.6.2.3-1 ORBITER CARGO BAY RANDOM VIBRATION ORBITER LONGERONS

X Axis	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 - 50 Hz	+10 dB/Octave
	50 - 120 Hz	.08 g^2/Hz
	120 - 160 Hz	-3 dB/Octave
	160 - 600 Hz	.06 g^2/Hz
	600 - 2000 Hz	-6 dB/Octave
	Overall = 7.8 Grms	
Z Axis	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.

TABLE 4.1.8.1-1 MAXIMUM INTERFACE LOADS PAYLOAD FLUID LINES/PACK INTERFACES

PACK Maximum Allowable Loads Per Fluid Line			
Interface Load		Interface Moment	
Direction	Load (Pounds)	Direction	Moment (In. Pounds)
Xo	±112	MXo	±1032
Yo	±124	MYo	± 612
Zo	± 75	MZo	± 425

TABLE 4.1.8.2-1 MAXIMUM INTERFACE DEFLECTIONS PAYLOAD FLUID LINES/PACK INTERFACE

Motion Together (Inches)			Motion Apart (Inches)		
X	Y	Z	X	Y	Z
0.80	3.00(1)	0.50	0.80	2.75(2)	0.50

(1) Includes 0.93 inch payload motion

(2) Includes 1.99 inches payload motion

TABLE 4.1.10-1 SHUTTLE EXTRAVEHICULAR ACTIVITY LOADING

EVA OPERATION	LOADS REQUIREMENT	LOADS APPLICATION	DYNAMIC CONDITION
Portable Foot Restraint(PFR) Static Loads Criteria	Fxp = 190 lb Fyp = 70 lb Fzp = 185 lb Mxp = 3200 in-lb Myp = 2900 in-lb Mzp = 2000 in-lb	Loads applied simultaneously at PFR base plate. Component directions shown in Figure 4.1.10-1.	Not Applicable
Portable Foot Restraint (PFR) Loads Criteria Case 1	Fxp = 105 lb Fyp = 50 lb Fzp = 60 lb Mxp = 2100 in-lb Myp = 2900 in-lb Mzp = 750 in-lb	Loads applied simultaneously at PFR base plate. Component direction shown in Figure 4.1.10-1.	Forces shall be applied as a 0.8 second half-size wave, ±0.2 second: moments shall be applied as a 1.5 second half-sine wave, ±0.35 second.
Portable Foot Restraint (PFR) Loads Criteria Case 2	Fxp = 190 lb Fyp = 45 lb Fzp = 185 lb Mxp = 900 in-lb Myp = 2300 in-lb Mzp = 550 in-lb	Loads applied simultaneously at PFR base plate. Component directions shown in Figure 4.1.10-1.	Forces shall be applied as a 0.2 second half-sine wave, ±0.05 second: moments shall be applied as a 0.6 second half-sine wave, ±0.15 second.
Portable Foot Restraint (PFR) Loads Criteria Case 3	Fxp = 30 lb Fyp = 45 lb Fzp = 70 lb Mxp = 1900 in-lb Myp = 750 in-lb Mzp = 850 in-lb	Loads applied simultaneously at PFR base plate. Component directions shown in Figure 4.1.10-1.	Forces shall be applied as a 2.5 second half-sine wave, ±1.0 second: moments shall be applied as a 2.5 second half-sine wave, ±1.0 second.
Portable Foot Restraint (PFR) with Load limiter Static Loads Criteria	F = 274 lb M = 4200 in-lb	Loads applied simultaneously at socket to structure interface	Not Applicable
Handrail/ Handhold (Static Loads Criteria)	$F_{resultant}$ =220 lb	Load applied at point of grasp on handrail in any direction.	Not Applicable

TABLE 4.1.10-1 SHUTTLE EXTRAVEHICULAR ACTIVITY LOADING (CONTINUED)

EVA OPERATION	LOADS REQUIREMENT	LOADS APPLICATION	DYNAMIC CONDITION
Handrail/ Handhold translation and stopping	$F_{resultant}$=100 lb $M_{resultant}$=600 in-lb	Force applied in any direction simultaneously with moment. Moment acts perpendicular to axis of handrail, and is applied as a couple of two opposing handhold forces separated by 6 inches.	Apply force as 1.0 second half-sine wave (±0.05 sec), and the moment as a 1.5 second triangular pulse (±0.5 sec).
Push-off (both hands) of tethered crew members	$F_{resultant}$=170 lb	Apply load in any direction at point of application on all applicable hardware.	Apply force as a 0.8 second half-sine wave (±0.2 sec.).
Kick-off force of tethered crew member	$F_{resultant}$=200 lb	Apply load in any direction at point of application on all applicable hardware.	Apply force as a 0.5 second half-sine wave (±0.2 sec.).
Inadvertent kick of tethered crew member	$F_{resultant}$=125 lb	Applied in any direction at the point of application over a 0.5 inch diameter circular area.	Apply force as a 0.8 second half-sine wave (±0.2 sec.).
Crew tether attach	$F_{resultant}$=200 lb	Apply load in any direction at all crew attach points.	Apply force as shown in Figure 4.1.10-2.

TABLE 4.1.10-2 SHUTTLE INTRAVEHICULAR ACTIVITY LOADING

TYPE OF LOAD	LOAD AMPLITUDE	FREQUENCY RANGE	LOAD APPLICATION
IVA Soaring	$F_{resultant}$=125 lb		Apply load in any direction at point of allication on all applicable hardware. Apply force as a 1.0 second half-sine wave (± 0.5 sec)
Cycle Ergometer	$F_x = 45.78 * \sin 2\pi ft$ $F_x = 3.60 * \sin 2\pi ft$ $F_y = 67.32 * \sin 2\pi ft$ $F_z = 54.96 * \sin 2\pi ft$ $F_z = 41.58 * \sin 2\pi ft$	$0.70 \leq f < 2.70$ Hz $2.70 \leq f \leq 10.80$ Hz $0.70 \leq f \leq 10.80$ Hz $0.70 \leq f < 5.40$ Hz $5.40 \leq f \leq 10.80$ Hz	Resultant force in cycle ergometer coordinate; the cycle may be oriented such that: $x=-Y_o; y=-X_o; z=-Z_o$ OR $x=Y_o; y=X_o; z=-Z_o$
Rower Ergometer	$F_x = 4.773 * \sin 2\pi ft$ $F_y = 162.54 * \sin 2\pi ft$ $F_y = 46.70 * \sin 2\pi ft$ $F_z = 30.70 * \sin 2\pi ft$ $F_z = 20.12 * \sin 2\pi ft$	$0.15 \leq f \leq 2.25$ Hz $0.15 \leq f < 0.75$ Hz $0.75 \leq f \leq 2.25$ Hz $0.15 \leq f < 0.75$ Hz $0.75 \leq f \leq 2.25$ Hz	Resultant force in rower ergometer coordinate; the rower may be oriented such that: $x=-Y_o; y=-X_o; z=-Z_o$ OR $x=Y_o; y=X_o; z=-Z_o$
Treadmill Walk	$F_x = 28.81 * \sin 2\pi ft$ $F_x = 12.32 * \sin 2\pi ft$ $F_y = 33.95 * \sin 2\pi ft$ $F_y = 16.20 * \sin 2\pi ft$ $F_z = 97.00 * \sin 2\pi ft$ $F_z = 52.96 * \sin 2\pi ft$	$0.75 \leq f < 1.50$ Hz $1.50 \leq f \leq 6.60$ Hz $0.75 \leq f < 2.25$ Hz $2.25 \leq f \leq 6.60$ Hz $0.75 \leq f < 2.25$ Hz $2.25 \leq f \leq 6.60$ Hz	Resultant force in treadmill coordinate; the treamill may be oriented such that: $x=Y_o; y=X_o; z=-Z_o$
Treadmill Jog	$F_x = 12.38 * \sin 2\pi ft$ $F_x = 8.25 * \sin 2\pi ft$ $F_y = 59.95 * \sin 2\pi ft$ $F_y = 25.35 * \sin 2\pi ft$ $F_z = 285.18 * \sin 2\pi ft$ $F_z = 54.45 * \sin 2\pi ft$	$1.00 \leq f < 3.40$ Hz $3.40 \leq f \leq 10.20$ Hz $1.00 \leq f < 3.40$ Hz $3.40 \leq f \leq 10.20$ Hz $1.00 \leq f < 3.40$ Hz $3.40 \leq f \leq 10.20$ Hz	Resultant force in treadmill coordinate; the treadmill may be oriented such that: $x=Y_o; y=X_o; z=-Z_o$

NOTE: These Values do not include effects due to model, frequency, or amplitude uncertainties. The forces, directions, and orientations are in the exercice coordinate frame, which is related to the Orbiter coordinates frame by the given relations in the Loads Application column.

TABLE 4.1.10.1-1 CREW EXCERCISE EQUIPMENT LOCATIONS

EQUIPMENT TYPE	MID-DECK LOCATION(S)	FLIGHT DECK LOCATION(S)
CYCLE ERGOMOTER	SEAT 6/7 (See FIG. 4.1.10.1-1)	SEAT 3(See FIG. 4.1.10.1-1)
ROWER ERGOMETER	SEAT 5/6/7(See FIG. 4.1.10.1-1)	N/A
TREADMILL	Forward, approximately center about Y of MID-DECK at $X_1$279.00, Y_1-15.56, $X_2$295.00, $Y_2$18.00(See FIG. 4.1.10.1-1) (Crew Module Coordinates)	N/A

TABLE 4.1.11.1-1 LOAD FACTORS FOR FERRY FLIGHT

DOF	Load Factors, g's
N_x	-0.30, +0.40
N_y	-0.30, +0.30
N_z	+0.68, +1.32

Notes:

1. Load factors include a steady state value of +1.0 g for N_z.

TABLE 4.1.11.1-2 FERRY FLIGHT LOAD SPECTRUM

Load Step	**Cycles/Ferry Flight**	**Cycles/ Trans Atlantic Flight**	**Total number of Cycles per load step**	**Cyclic Stress (% limit value)**	
Number			**(N_{ferry}=1)**	**Min.**	**Max.**
1	72	162	234	90	100
2	60	135	195	80	90
3	128	288	416	70	80
4	24	54	78	60	70
5	68	153	221	50	60
6	16	36	52	40	50
Total cycles	368	828	1196		

Notes:

1. The above spectrum does not include the scatter factor of 4.
2. Trans Atlantic Flight is only 1 occurrence per lifetime.

TABLE 4.1.11.2-1 CARGO ELEMENT ACOUSTIC ENVIRONMENT DURING FERRY FLIGHT

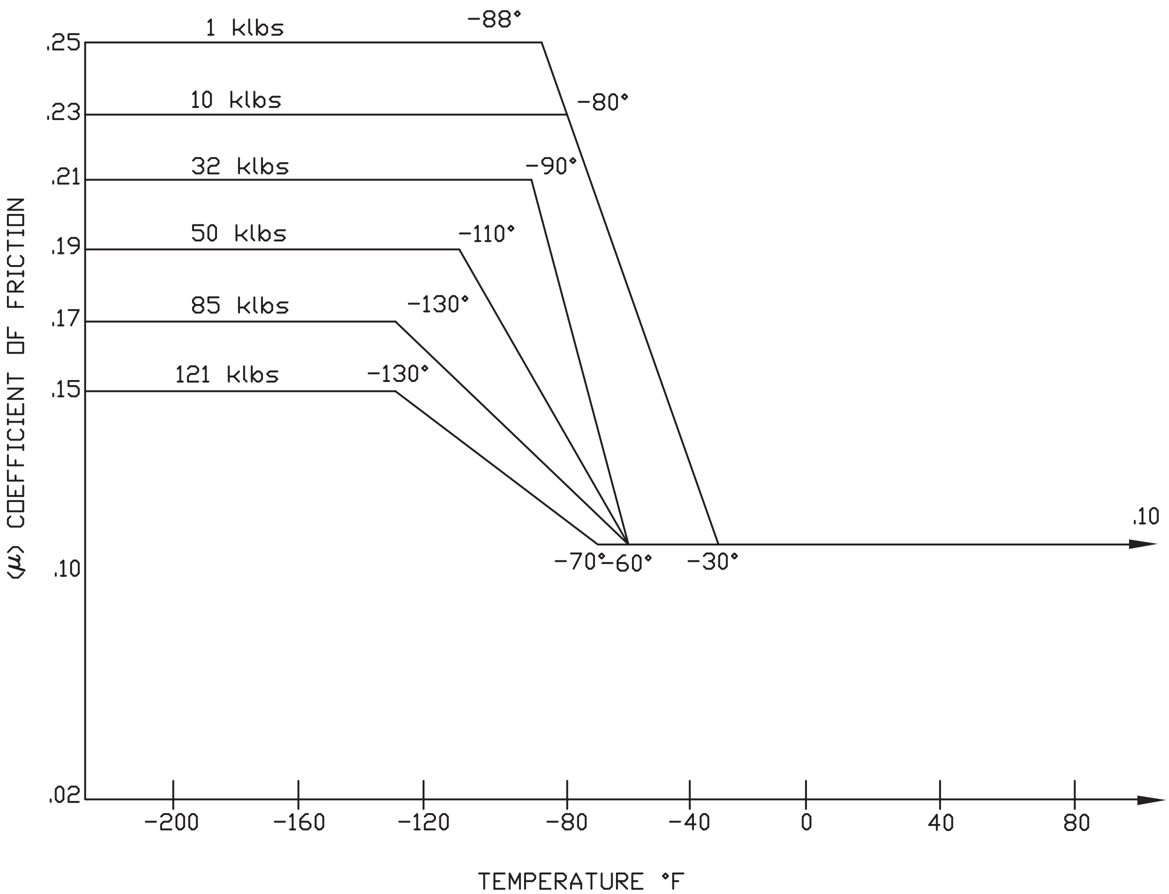
1/3 Octave Band Center Frequency (Hz)	Sound Pressure Levels dB Ref $2x10^{-5}$ N/m^2
31.5	109
40	110.5
50	111.5
63	112
80	112.5
100	113
125	113.5
160	113.5
200	113
250	112
315	111
400	110
500	109
630	107.5
800	105.5
1000	104.5
1250	103
1600	102
2000	100
2500	98
Overall	124

Note: The total associated time duration is (T_{ferry}) hours per axis, as calculated in Paragraph 4.1.11.2. Time per mission does not include a scatter factor.

TABLE 4.1.11.3-1 CARGO ELEMENT RANDOM VIBRATION AT THE ORBITER LONGERON AND KEEL TRUNNION INTERFACE DURING FERRY FLIGHT

Frequency Range	Levels
20 to 60 Hz	90 db/octave slope
60 to 2000 Hz	0.001 g^2/Hz constant

Note: The total associated time of duration is (T_{ferry}) hours per axis, as calculated in Paragraph 4.1.11.3. Time per mission does not include a scatter factor.



TRUNNION INTERFACE ONLY

VALUES TO BE USED FOR:

1. Y-Y LOADS AT LONGERON LATCH

2. Z-Z LOAD AT KEEL LATCH

3. FOR INTERMEDIATE LOAD VALUES, USE NEXT HIGHEST μ VALUES PLOTTED

(NOTE: DO NOT INTERPOLATE)

FIGURE 4.1.1.1-1 ORBITER/PAYLOAD Y AND Z DIRECTION RETENTION SYSTEM COEFFICIENT OF FRICTION FOR FIBRILOID BEARING LINER WITH BRAYCO OIL

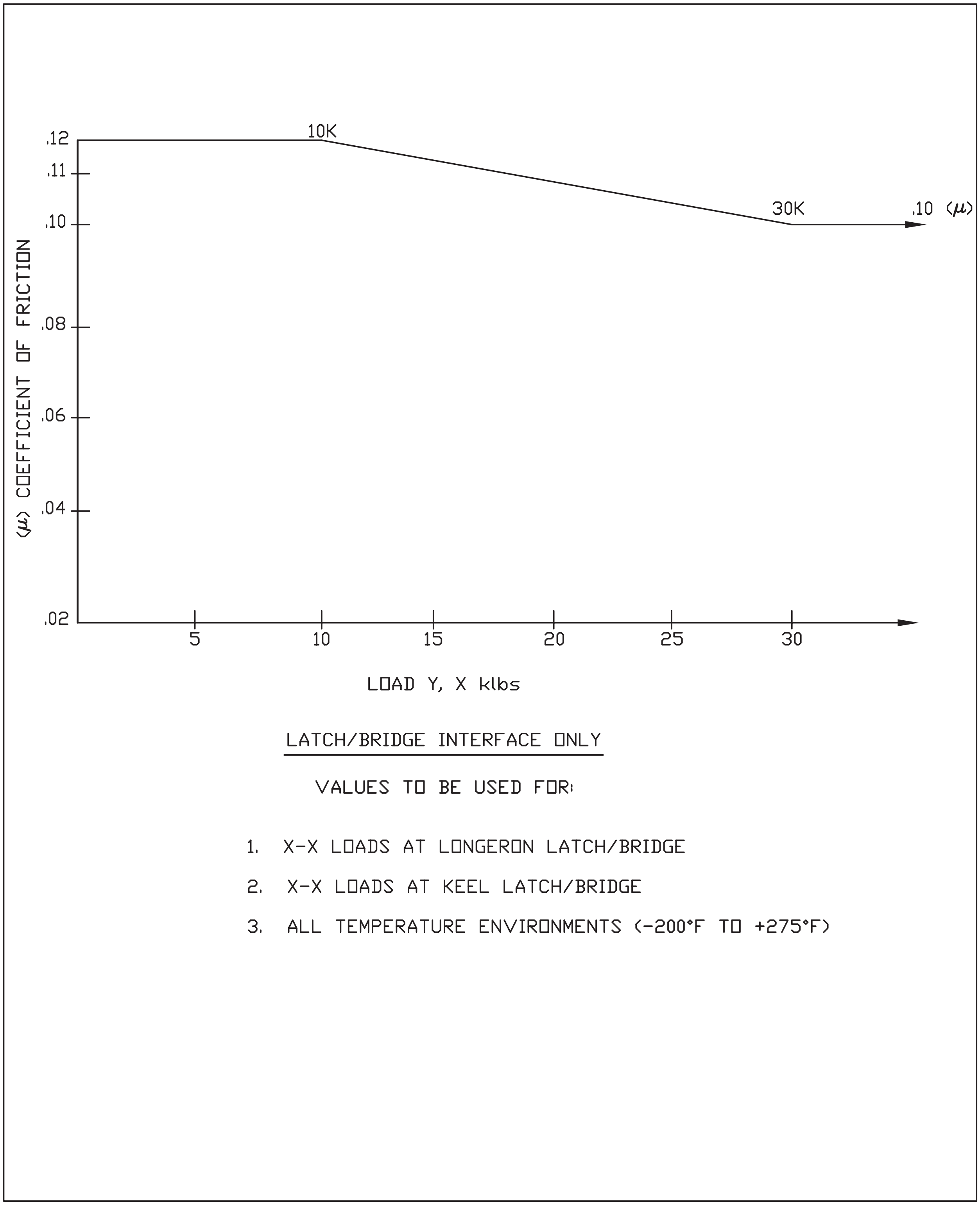


FIGURE 4.1.1.1-2 ORBITER/PAYLOAD X-X DIRECTION RETENTION SYSTEM COEFFICIENT OF FRICTION FOR DRY FILM LUBRICANT LATCH/BRIDGE INTERFACE

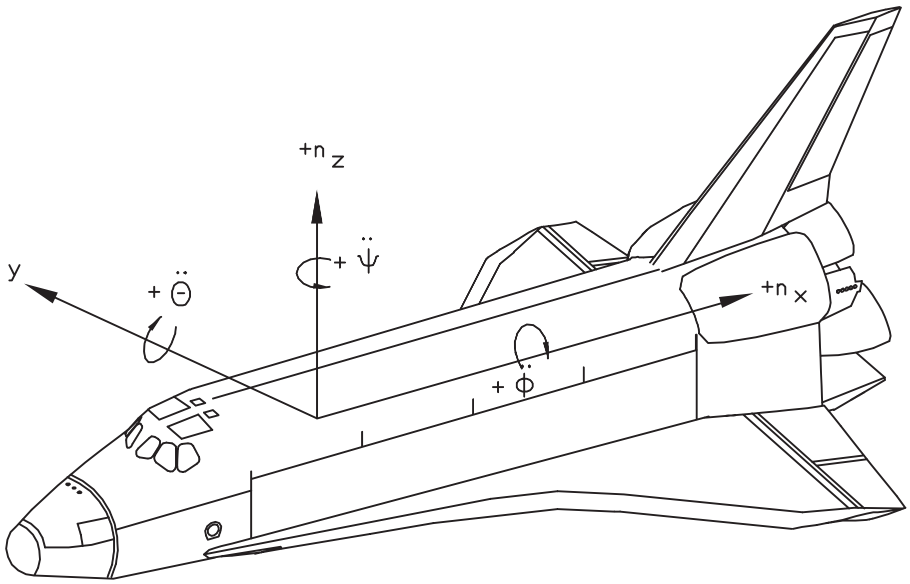


FIGURE 4.1.3-1 SIGN CONVENTION FOR CARGO LIMIT-LOAD FACTORS/ANGULAR ACCELERATIONS

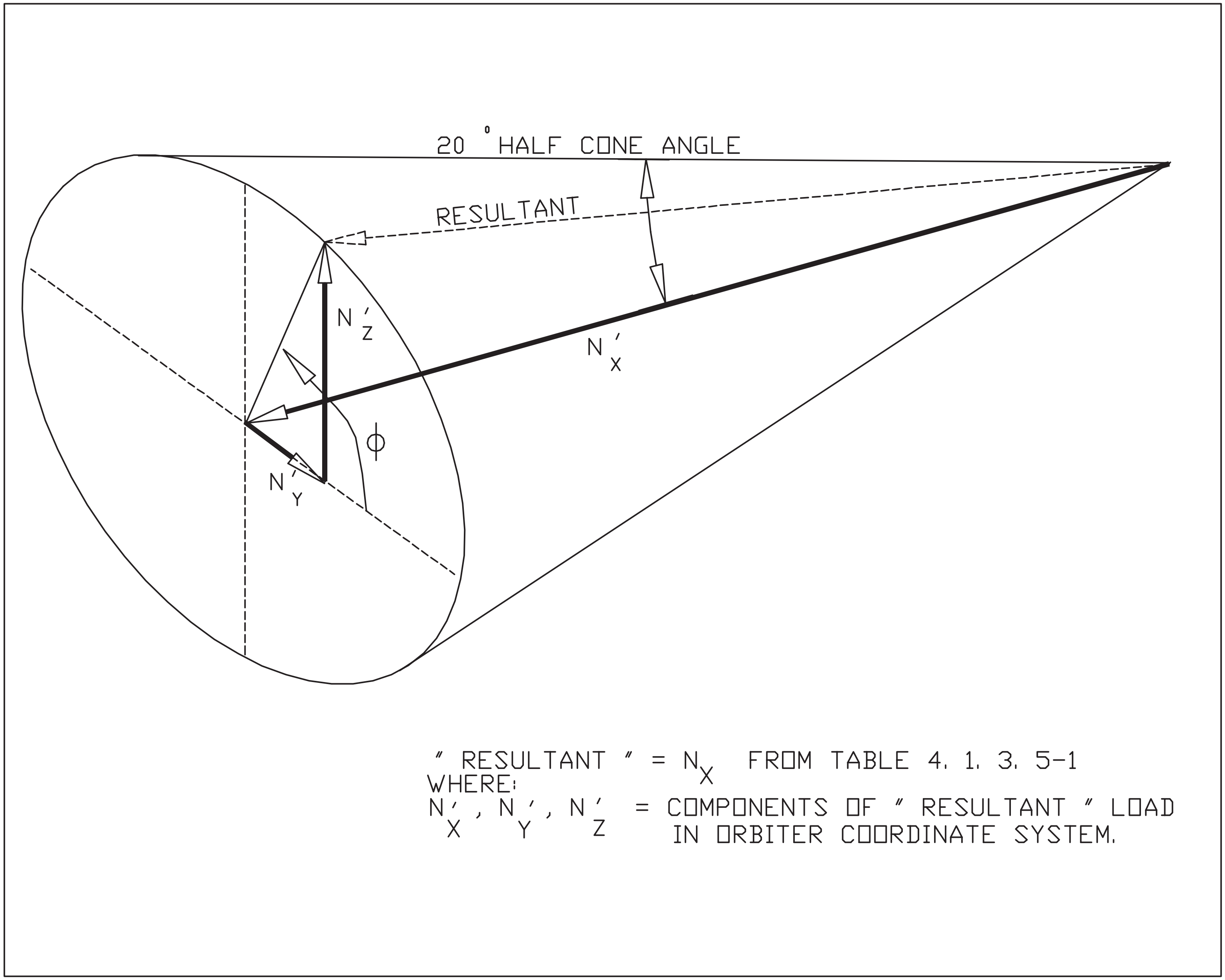


FIGURE 4.1.3.5-1 EMERGENCY LANDING DESIGN LOAD FACTORS

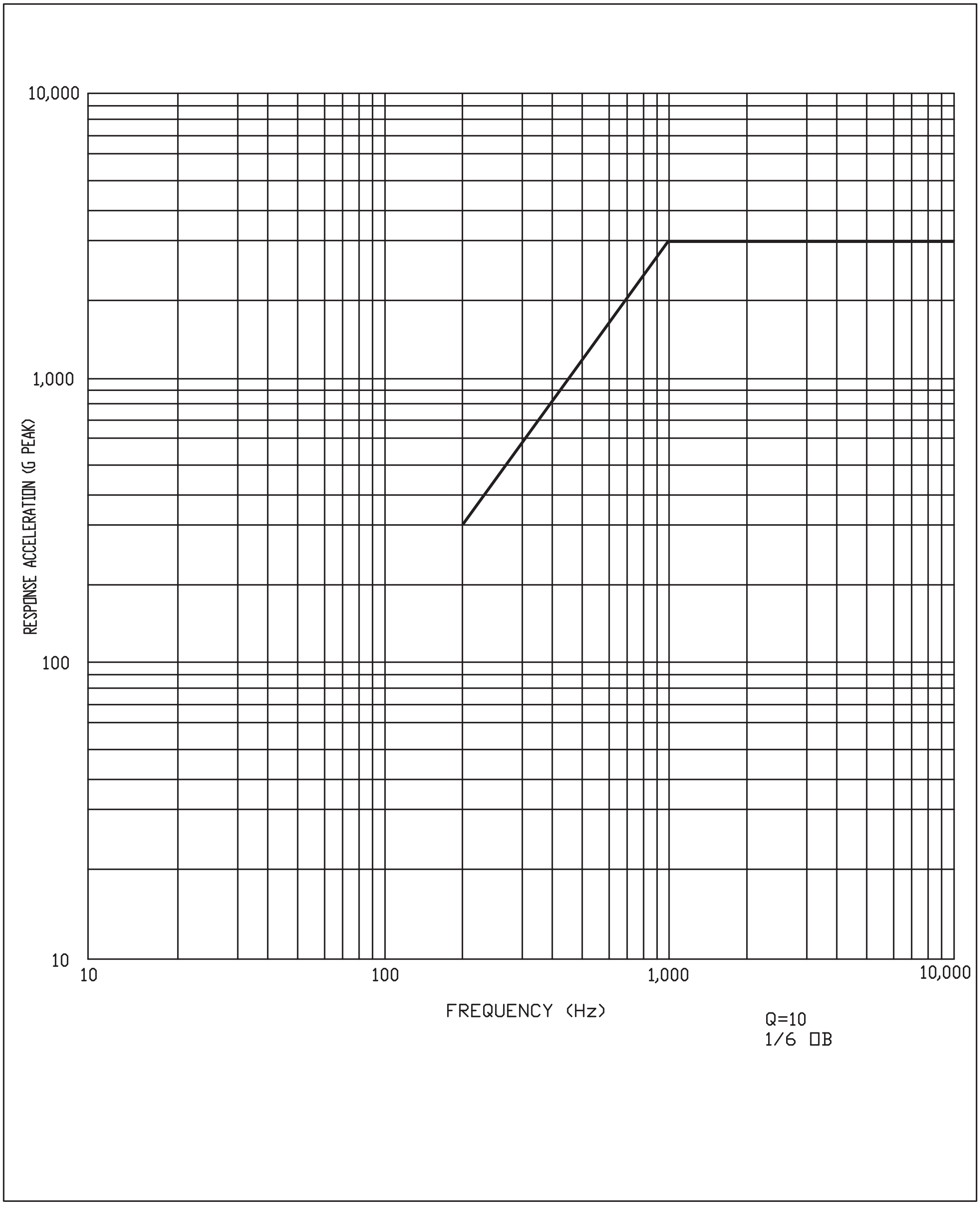


FIGURE 4.1.9.1-1 ORBITER/PAYLOAD INTERFACE SHOCK RESPONSE SPECTRUM PAYLOAD INDUCED PYROTECHNIC SHOCK AT P/L SIDE OF TRUNNION

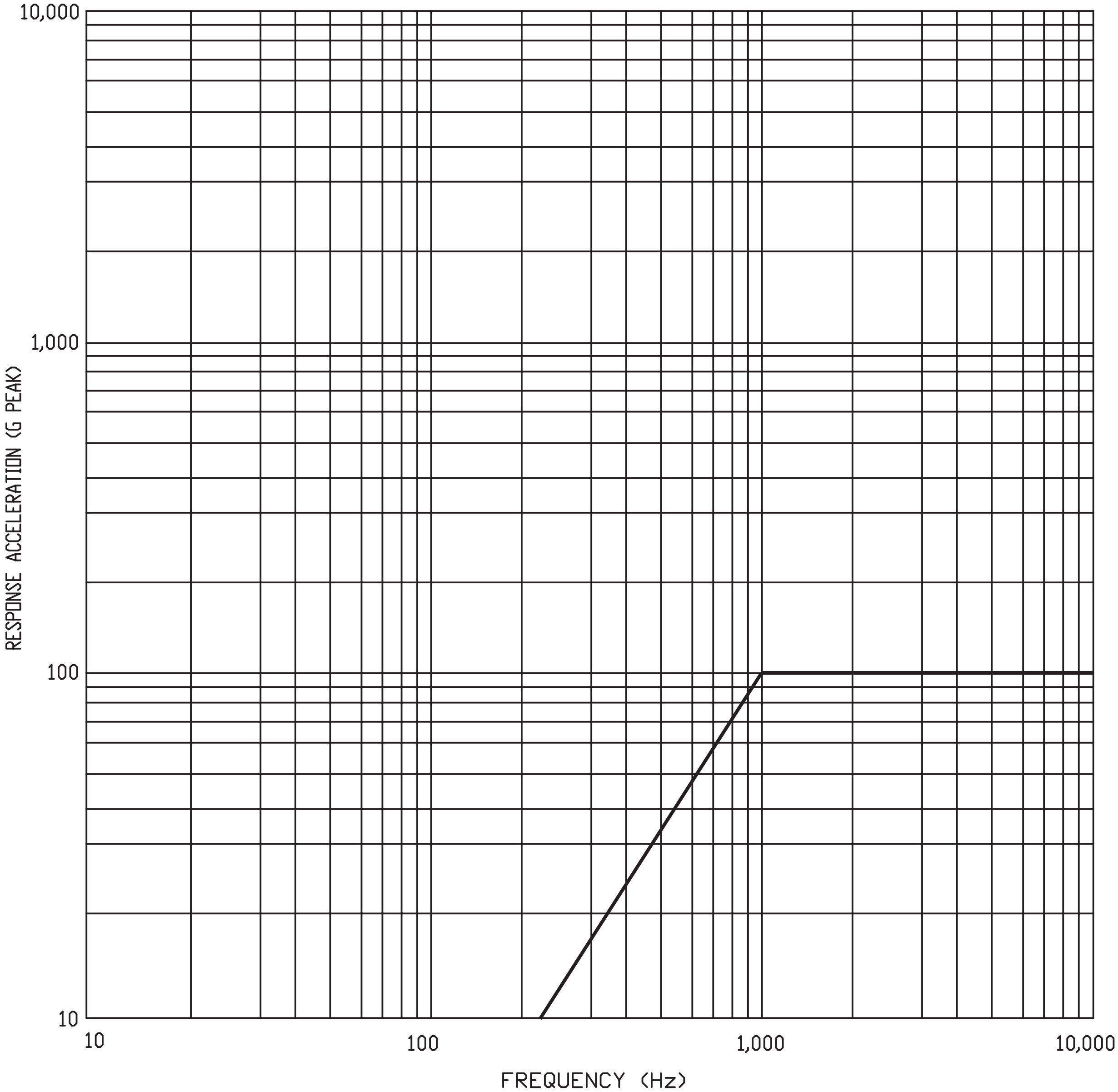


FIGURE 4.1.9.2-1 ORBITER/PAYLOAD INTERFACE SHOCK RESPONSE SPECTRUM ORBITER INDUCED PYROTECHNIC SHOCK AT P/L SIDE OF TRUNNION

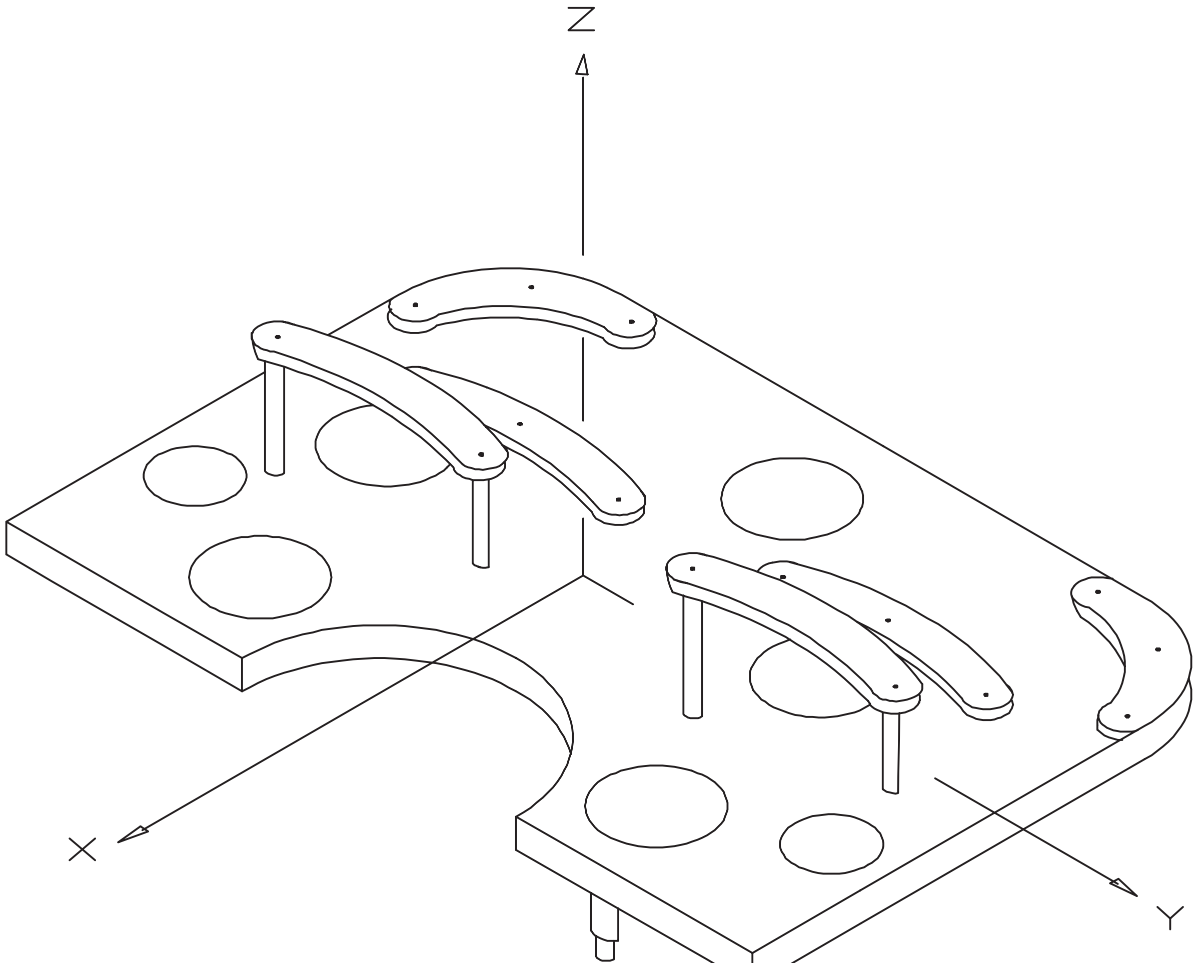


FIGURE 4.1.10-1 PFR COORDINATE SYSTEM AXES

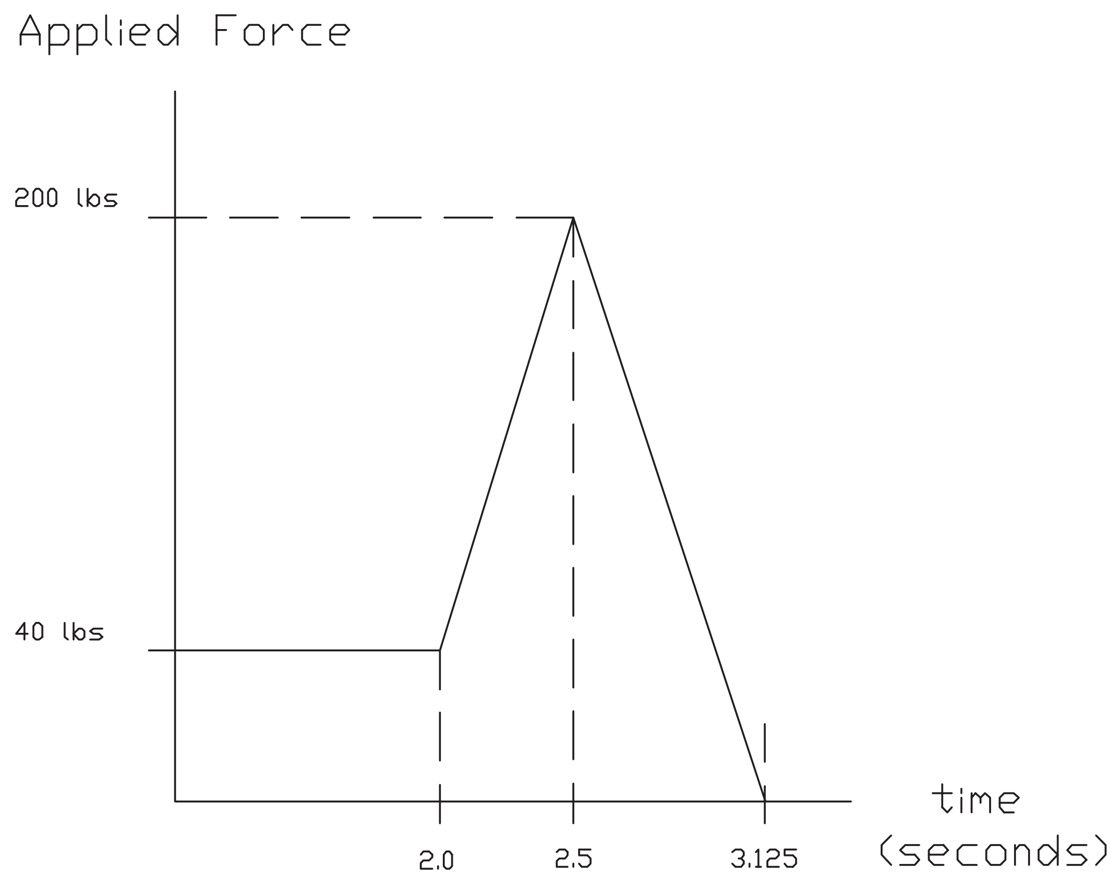


FIGURE 4.1.10-2 EVA TETHER LOADS CRITERIA

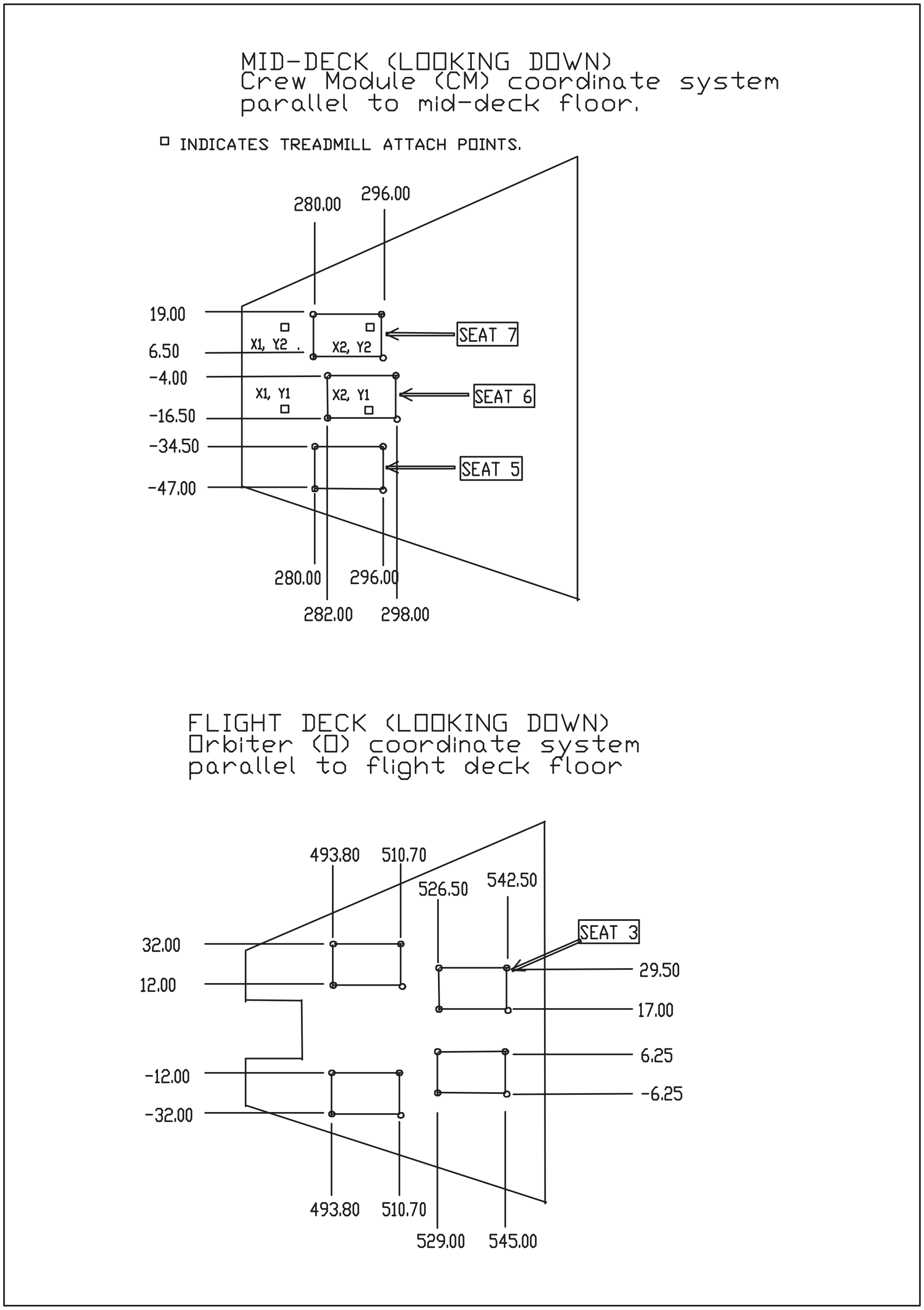


FIGURE 4.1.10.1-1 CREW EXERCISE EQUIPMENT

TREADMILL LOCATION: 10.5 in. from front attach bolts, 8.0 in. from side attach bolts.

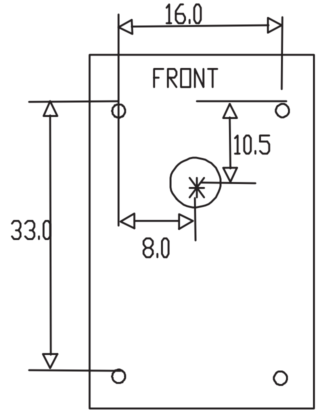
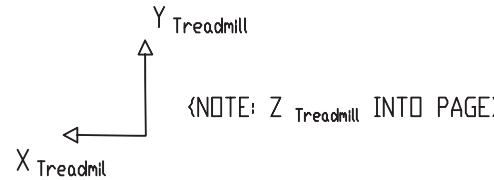


FIGURE TREADMILL FORCE APPLICATION



TREADMILL COORDINATE SYSTEM

ROWER/CYCLE ERGOMETER LOCATION: center point of four attach bolts.

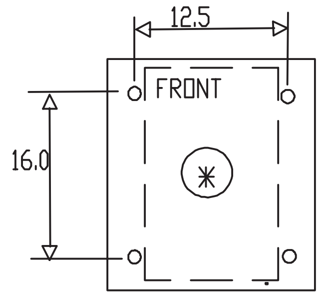
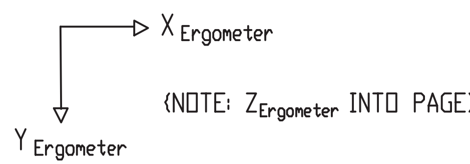


FIGURE ROWER/CYCLE ERGOMETER FORCE APPLICATION



ERGOMETER COORDINATE SYSTEM

ALL DIMENSIONS IN INCHES

FIGURE 4.1.10.1-2 EXERCISE EQUIPMENT FORCE APPLICATION

THIS PAGE INTENTIONALLY LEFT BLANK.

4.2 CREW MODULE AND PAYLOAD HABITABLE VOLUMES

4.2.1 Quasi-Static

4.2.1.1 Limit Load Factors

Cargo load factor 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. (i.e. $+N_x$ in the $+X_o$ direction; $+N_y$ in the $+Y_o$ direction; N_z in the $+Z_o$ direction)

4.2.1.1.1 Operational Inertia Load Factors

Operational inertia load factors shown in Table 4.2.1.1.1-1 shall apply to all secondary structure.

4.2.1.2 Emergency Landing Load Factors

The emergency load factors specified below shall apply to components mounted in the crew compartment. They shall not apply to items whose failure does not result in injury to personnel or prevent egress from the crashed vehicle.

Ultimate Inertia Load Factors		
N_x	N_y	N_z
20.0	3.3	10.0
-3.3	-3.3	-4.4

These load factors shall act independently, and the longitudinal load factors shall be directed within 20° of the longitudinal axis.

4.2.1.3 Vibration

4.2.1.3.1 (Reserved)

4.2.1.3.2 Crew Module Random Vibration

The random vibration environments applicable to components mounted in the Orbiter Crew Module during launch and ascent shall be as follows:

20 - 150 Hz	+6.00 dB/Octave
150 - 1000 Hz	0.03 g^2/Hz
1000 - 2000 Hz	-6.00 dB/Octave Composite = 6.5 g(rms)

Environment exposure duration = 7.2 sec/flight in each of Xo, Yo, and Zo axes.

The exposure duration of 7.2 seconds/flight does not include a fatigue scatter factor. A fatigue scatter factor, appropriate for the materials and method of construction, is required and shall be not less than 4.0.

4.2.1.3.3 Habitable Volume Random Vibration

The random vibration environments applicable to components mounted in the Orbiter Habitable Volumes during launch and ascent is determined by dynamic analysis of the particular habitable volume design/construction.

4.2.2 Acoustics

1. Significant Noise Sources. A significant noise source is any individual piece of equipment, or group of equipment items, which collectively function as operating system, that generates an A-weighted sound pressure level (SPL) equal to or in excess of 55 dBA, measured at a distance of 0.3 meters from the loudest source or radiating surface.

   The loudest source or noise radiation surface shall be determined by measuring the maximum A-weighted SPL reading with the microphone pointed directly at and at 0.3 meter distance from all parts of the equipment.

2. Continuous Noise Source. A significant noise source which exists for more than a cumulative total of eight (8) hours in any twenty-four (24) hour period is considered a continuous noise source.

3. Intermittent Noise Source. A significant noise source which exists for a cumulative total time of eight (8) hours or less in a twenty-four (24) hour period is considered an intermittent noise source.

4. Acoustical Reference. All SPL's are in decibels referenced to 20 micropascals.

5. Shuttle Systems. Shuttle systems are manned habitable volumes such as the Orbiter crew module middeck and flight deck, SPACELAB and other habitable volumes.

6. Equipment. Equipment is defined as those hardware items that produce and emit acoustic noise.

4.2.2.1 Launch Noise

Table 4.2.2.1-1 represents the minimum level to which equipment to be flown in the crew module must be certified to be considered safe to fly on the Shuttle. Equipment to be flown in a Habitable Volume located in the Shuttle cargo bay must be certified for levels which will depend on the noise transmission characteristics of the particular habitable volume structure.

4.2.2.2 On-orbit Habitable Volume Noise/All Systems Operating

The maximum allowable on-orbit continuous SPL in a Shuttle Habitable Volume, produced by all significant continuous noise sources, including subsystems, payloads, and other equipment operating during a mission, shall not exceed the limits defined in Figure 4.2.2.2-1. These levels apply as measured at the following locations: (1) in the Orbiter Crew Module at the center of the middeck, between the Commander and Pilot at ear level on the flight deck and (2) in Habitable Volumes at locations corresponding to living/working areas at ear level and/or the center of the volume. The maximum twenty-four (24) hour crew exposure during on-orbit phases of a mission shall be less than 74 dBA. This level includes both continuous and intermittent noise sources as measured at a distance of 0.3 meters or more from any surface.

4.2.2.3 On-orbit Habitable Volumes Equipment/Subsystem Generated Acoustic Noise

All equipment installed or operated in Shuttle Habitable Volumes shall meet the continuous or intermittent limits provided herein for on-orbit operations. The maximum allowable continuous noise generated by individual noise sources shall not exceed the limits defined in Figure 4.2.2.3-1 as measured 0.3 meters distant from the loudest part of the equipment. The maximum intermittent "A-weighted" SPL emitted by an individual noise source shall not exceed the limits of Table 4.2.2.3-1. These levels shall not be exceeded for any mode of operation and shall be measured at 0.3 meters distant from the loudest part of the equipment.

4.2.2.4 Equipment Generated Continuous Noise Sources with Intermittent Noise Features

Continuous noise sources which exhibit predictable intermittent acoustical noise characteristics must meet both the continuous noise specification and the intermittent limits of paragraph 4.2.2.3 above. The intermittent characteristics must be quantified in terms of (1) when the intermittent sound occurs, (2) duration, and (3) maximum "A-weighted" SPL measured at 0.3 meters distant from the loudest part of the equipment.

4.2.2.5 Shuttle Orbiter Middeck Airlock/Habitable Volume Interface On-orbit Noise

Noise radiating from a Habitable Volume into the Orbiter middeck through the Orbiter airlock will be treated as an equipment noise source mounted in the airlock port and will be subject to the noise limits of Paragraphs 4.2.2.3 and 4.2.2.4.

4.2.3 Panel Kick/Push-Off Loads

In areas where panel deflection could cause equipment damage to payload provided aft flight deck equipment, the panel shall be capable of absorbing a limit 125 pound (56.7 kg) load distributed over a 4 in. x 4 in. (101.6 mm x 101.6 mm) square area.

4.2.4 Pyrotechnic Shock

Payloads located in a Habitable Volumes shall not generate pyrotechnic shock. Orbiter induced pyrotechnic shock is negligible.

TABLE 4.2.1.1.1-1 OPERATIONAL INERTIA LOAD FACTORS

Condition	Limit	Load	Factors
	N_x	N_y	N_z
Lift-Off	-2.55 -2.23 -1.28	0 -.03 .01	.55 1.68 -2.05
High-q Boost	-1.90 -1.60	.04 ±.20	-.20 -.20
Max Boost	-3.20	.09	-.20
Orbiter Max Load Factor	-3.25 -3.01	-.02 0	-.60 -.77
TAEM Maneuvers	1.21 0.53 0.21	0 1.67 -1.39	2.5 1.02 0.90
Landing	3.57 -2.96 -.60	0 0 0	.96 .35 4.9(1)

(1) N_z is 4.9g at the crew module C.G. only. It varies linearly with X from 6.68g at the forward bulkhead to 3.70g at the aft bulkhead.

TABLE 4.2.2.1-1 ORBITER CREW MODULE LAUNCH ACOUSTIC ENVIRONMENT

1/3 Octave Band Center Frequency (Hz)	Sound Pressure Level - dB ref. 2 x 10^{-5} N/m^2	
	Lift-off	Aeronoise
	5 Seconds/Flight*	10 Seconds/Flight*
31.5	107	99
40.0	108	100
50.0	109	100
63.0	109	100
80.0	108	100
100.0	107	100
125.0	106	100
160.0	105	99
200.0	104	99
250.0	103	99
315.0	102	98
400.0	101	98
500.0	100	97
630.0	99	97
800.0	98	96
1000.0	97	95
1250.0	96	94
1600.0	95	93
2000.0	94	92
2500.0	93	91
Overall	117.5	111

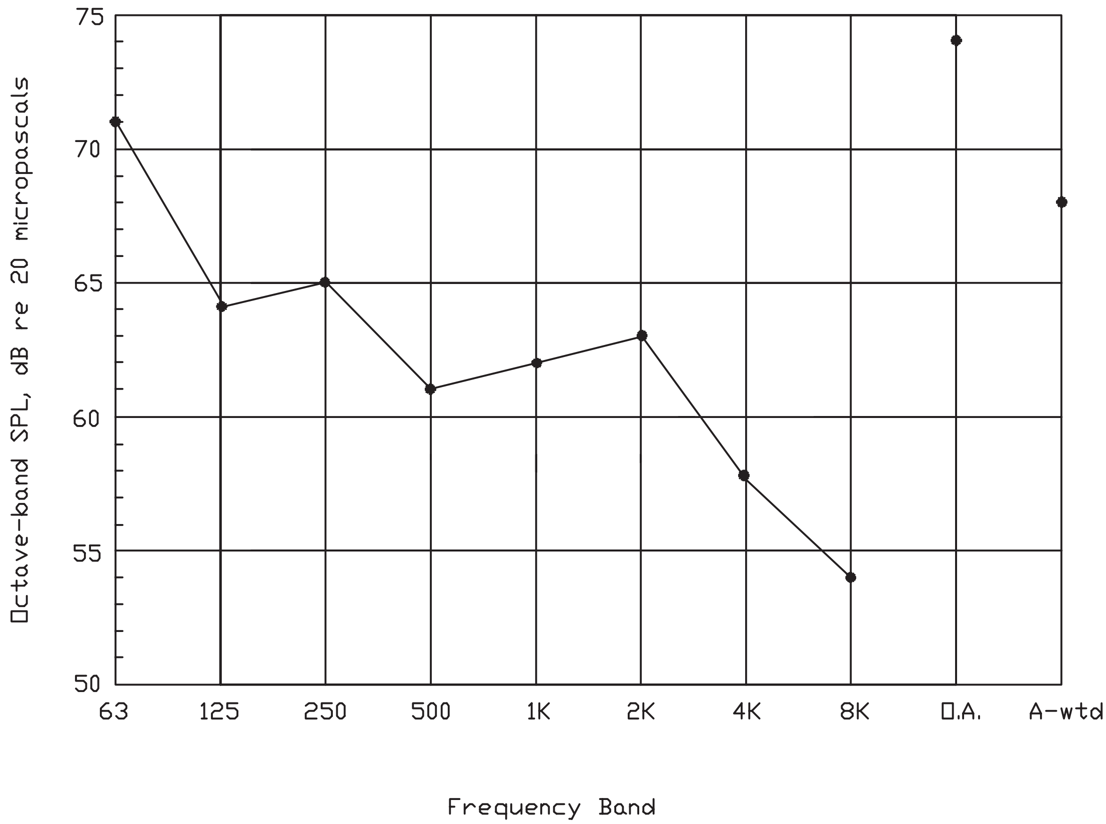
*Time per flight does not include a scatter factor.

TABLE 4.2.2.3-1 INTERMITTENT NOISE LIMITS

A-weighted SPL* (dBA)	Maximum Allowable Duration **
55-60	8 Hours
61-65	4 Hours
66-70	2 Hours
71-75	1 Hour
76-80	5 Minutes
81-85	1 Minute
86 & Above	Not Allowed

* A-weighted Sound Pressure Level, dB re 20 micropascals. Measured at 0.3 meters distance from noisiest surface with equipment operating in the mode or condition that produces the maximum acoustic noise. Round dBA to nearest whole number.

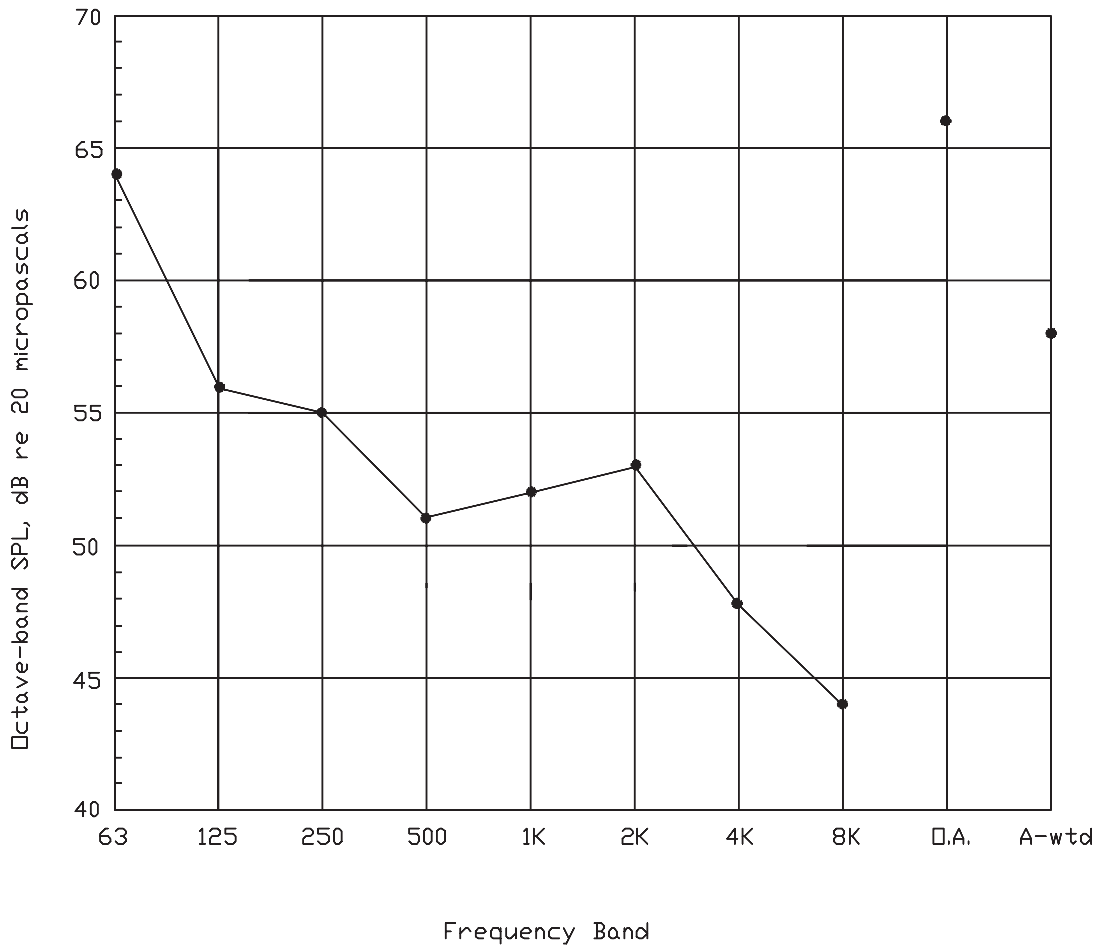
** Per 24-hour period.



FREQ. BAND	63	125	250	500	1000	2000	4000	8000	O.A.	A-wtd
LIMIT	71	64	65	61	62	63	58	54	74	68

Note:
—●— Maximum allowable noise at designated habitable module measurement locations.

FIGURE 4.2.2.2-1 CONTINUOUS ON-ORBIT ACOUSTIC NOISE LIMITS FOR SHUTTLE HABITABLE VOLUMES



FREQ. BAND	63	125	250	500	1000	2000	4000	8000	O.A.	A-wtd
LIMIT	64	56	55	51	52	53	48	44	66	58

Note:
—●— Maximum 30 centimeters from loudest part of equipment

FIGURE 4.2.2.3-1 ACOUSTIC NOISE LIMITS FOR A CONTINUOUS NOISE SOURCE

THIS PAGE INTENTIONALLY LEFT BLANK.

4.3 GENERAL ACCELERATIONS

4.3.1 Reaction Control System Loads

During normal Orbiter attitude control and maneuver activities, thrusting of the Orbiter Reaction Control System (RCS) jets will cause accelerations to be exerted on cargo elements. These accelerations are small compared to those associated with lift-off and landing events; however, they may represent a design condition for cargo elements which change from their launch configuration while on-orbit. Although the Vernier RCS (VRCS) is typically used for Orbiter attitude control, the Primary RCS (PRCS) may be used either because the VRCS is unavailable or to satisfy unique requirements for attitude pointing or translational maneuvers. For this reason, cargo elements shall be designed to withstand loads induced by PRCS thruster firings.

Translational maneuvers using the PRCS thrusters may be required for a variety of reasons including planned orbit adjustments and collision avoidance. The accelerations are small compared to those associated with lift-off and landing events; however, they may represent a design condition for cargo elements (CEs) or components which change from their normal stowed configuration while on-orbit. CEs which require translation manuevers to accomplish their mission requirements must be designed to withstand the induced loads. For CEs which do not require translational maneuvers, an assessment of the load environment should be conducted to support mission operations planning and real time decision making in contingency situations.

The following paragraphs contain RCS-induced limit loads for preliminary design or assessment of the CE structure. The load factors are intended to predict CE internal loads caused by dynamic response to thruster firings as transmitted directly through the Orbiter structure to the CE. The load factors do not account for payload internal loads caused by impingement of the thruster plumes on the CE surfaces. In certain cases, coupled dynamic loads analyses will be required to verify cargo loads and deflections. If such an analysis is required, the Orbiter dynamic model and forcing functions shall be identified by the SSP.

4.3.1.1 RCS Rotational Maneuver Loads

Preliminary design limit load factors and angular accelerations associated with PRCS rotational maneuvers are specified in Table 4.3.1.1-1. The rotational accelerations are to be applied about the Orbiter center of gravity. A reference location of Xo=1107.0", Yo=0.0", Zo=374.0" can be used. Applying the accelerations at this location ensures that the cargo element location with respect to the Orbiter center of gravity is accounted for. The load factors and angular accelerations are to be applied in all axes simultaneously and in all combinations of positive and negative direction.

4.3.1.2 PRCS Translational Maneuver Loads

Limit load factors and angular accelerations associated with PRCS translational maneuvers in each of the Orbiter orthogonal axes are specified in the following paragraph. Propellant and loads considerations will generally determine the decision regarding which is the preferred PRCS firing axis. The loads are consistent with PRCS firings required to produce the following typical velocity changes:

X-axis delta V = 6 fps
Y-axis delta V = 2 fps
Z-axis delta V = 5 fps

Loads experienced during translation burns for higher delta V’s may be larger than those specified here.

The rotational accelerations are to be applied about the Orbiter center of gravity. A reference location of Xo=1107.0", Yo=0.0", Zo=374.0" can be used. Applying the accelerations at this location insures that the cargo element location with respect to the Orbiter center of gravity is accounted for. The load factors and angular accelerations for each maneuver case are to be applied in all axes simultaneously and in all combinations of positive and negative directions.

4.3.1.2.1 PRCS Translational Maneuver Loads (with Simultaneous Attitude Control)

During most long duration PRCS translation maneuvers the Orbiter attitude is maintained by using PRCS thruster firings. These attitude control firings are generally periodic in nature and can induce large CE responses. The limit load factors and angular accelerations associated with PRCS translational maneuvers with simultaneous attitude control firings are specified in Table 4.3.1.2.1-1.

4.3.1.2.2 PRCS Translational Maneuver Loads (without Simultaneous Attitude Control)

For some PRCS translational maneuvers, simultaneous Orbiter attitude control may not be required. Preliminary design limit load factors and angular accelerations associated with PRCS translational maneuvers without attitude control firings are specified in Table 4.3.1.2.2-1.

4.3.2 Prelaunch Accelerations

Limit-load factor/angular accelerations exerted on the cargo during prelaunch from ground wind loads are given in Table 4.3.2-1. This data is based upon the dynamic response of the cargo in a Shuttle vehicle on the launch pad with the cargo doors closed and the Rotating Service Structure (RSS) and all other Shuttle service connections retracted. Wind gusts and vortex shedding effects are taken into account for the ground wind loading. The center-of-rotation for angular accelerations is at the cargo element center-of-gravity. The dynamic response is maximized such that the data may be applied conservatively to cargo elements regardless of their individual weight or location within the cargo bay. Limit-load factor/angular acceleration, including sign convention, is defined in paragraph 4.1.3.

4.3.3 Orbital Maneuvering System Loads

Thrusting of the Orbital Maneuvering System (OMS) engines will cause accelerations to be exerted on cargo elements. The accelerations are small compared to those associated with the lift-off and landing events; however, they may represent a design condition for CEs or components which change from their normal stowed configuration while on-orbit. CEs, which require an OMS firing to accomplish their mission requirements, shall be designed to withstand the induced loads. For CEs which do not require an OMS firing, an assesment of the load environment shall be conducted to support mission operations planning and real time decision making in contingency situations.

Table 4.3.3-1 specifies limit load factors and angular accelerations for preliminary design assessment of both dual engine and single engine OMS firings. The loads are intended to conservatively account for the effects of OMS engine thrust, overshoot, engine misalignment, simultaneous PRCS roll-axis attitude control, and the effects of Orbiter/cargo element dynamics. In certain cases, coupled dynamic loads analyses will be required to verify cargo element loads and deflections. If such an analysis is required, the Orbiter dynamic model and forcing functions shall be identified by the SSP.

The rotational accelerations are to be applied about the Orbiter center of gravity. A reference location of Xo=1107.0", Yo=0.0", Zo=374.0" can be used. Applying the accelerations at this location ensures that the cargo element location with respect to the Orbiter center of gravity is accounted for. The load factors and angular accelerations for each maneuver case are to be applied in all axes simultaneously and in all combinations of positive and negative directions.

4.3.4 Orbiter Towing Loads

The maximum limit load factors exerted on the cargo during towing operations are specified in Table 4.3.4-1.

4.3.5 Non-RMS Payload Deployment/Handling Operations

During non-RMS deployment operations, the CE shall be capable of sustaining loads imposed by the Shuttle as a result of RCS attitude control. The definition of the flight control system for RCS attitude control shall be contained within the appropriate PIP. OMS and RCS translation will not be considered during CE deployment operations involving erection and/or extension.

4.3.6 Orbiter Rollback/Rollout

The deceleration and centripetal acceleration that the CE 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

4.4 (DELETED)

TABLE 4.3.1.1-1 RCS ROTATIONAL MANEUVER LIMIT LOAD FACTORS

LOAD FACTOR (g)			ANGULAR ACCELERATION (RAD/SEC^2)		
N_x	N_y	N_z	$\ddot{\phi}$	$\ddot{\theta}$	$\ddot{\Psi}$
±0.016	±0.058	±0.098	±0.176	±0.159	±0.105

TABLE 4.3.1.2.1-1 LIMIT LOAD FACTORS FOR PRCS TRANSLATIONAL MANEUVERS WITH SIMULTANEOUS ATTITUDE CONTROL

Translation axis	Load Factor (g)			Angular Acceleration (Rad/sec^2)		
	N_x	N_y	N_z	Φ_x	Φ_y	Φ_z
+Xb	± 0.18	± 0.02	± 0.15	± 0.01	± 0.01	± 0.01
-Xb	± 0.18	± 0.001	± 0.15	± 0.09	± 0.09	± 0.09
±Yb	± 0.01	± 0.20	± 0.02	± 0.20	± 0.20	± 0.20
+Zb	± 0.08	± 0.08	± 0.20	± 0.10	± 0.10	± 0.10
-Zb	± 0.15	± 0.10	± 0.25	± 0.20	± 0.20	± 0.20

Note: Maneuver axes are relative to the Orbiter body axis system (+X toward vehicle nose, +Y toward starboard wing, +Z completes right-hand system). Load factors and angular accelerations are relative to the Orbiter structural coordinate system.

TABLE 4.3.1.2.2-1 LIMIT LOAD FACTORS FOR PRCS TRANSLATIONAL MANEUVERS WITHOUT SIMULTANEOUS ATTITUDE CONTROL

Translation Axis	Load Factor (g)			Angular Acceleration (Rad/sec^2)		
	N_x	N_y	N_z	Φ_x	Φ_y	Φ_z
±Xb	± 0.045	± 0.001	± 0.03	± 0.0005	± 0.0005	± 0.0005
±Yb	± 0.01	± 0.13	± 0.02	± 0.002	± 0.002	± 0.002
+Zb	± 0.08	± 0.005	± 0.20	± 0.0005	± 0.0005	± 0.0005
-Zb	± 0.15	± 0.009	± 0.25	± 0.0005	± 0.0005	± 0.0005

Note: Maueuver axes are relative to the Orbiter body axis system (+X toward vehicle nose, +Y toward starboard wing, +Z completes right-hand system). Load factors and angular accelerations are relative to the Orbiter structural coordinate system.

TABLE 4.3.2-1 PRELAUNCH CARGO LIMIT LOAD FACTORS/ANGULAR ACCELERATIONS

Prelaunch Condition	Load Factor			Angular Acceleration Rad/Sec^2		
	N_x	N_y	N_z	$\ddot{\phi}$	$\ddot{\theta}$	$\ddot{\Psi}$
Wind only 74.5 knots (EMPTY-ET)	-1±0.10	±0.07	±0.17	±0.03	±0.29	±0.02
Wind only 47.0 knots (FULL-ET)	-1±0.02	±0.01	±0.02	±0.01	±0.03	±0.01

TABLE 4.3.3-1 LIMIT LOAD FACTORS FOR OMS MANEUVERS

Translation Axis	Load Factor (g)			Angular Acceleration (Rad/Sec^2)		
	N_x	N_y	N_z	Φ_x	Φ_y	Φ_z
Two-engine Burn	$\pm$0.40	$\pm$0.005	$\pm$0.30	$\pm$0.016	$\pm$0.01	$\pm$0.015
Single Engine Burn	$\pm$0.35	$\pm$0.080	$\pm$0.22	$\pm$0.09	$\pm$0.09	$\pm$0.090

Note: Maneuver axes are relative to the Orbiter body axis system (+X toward vehicle nose, +Y toward starboard wing, +Z completes right-hand system). Load factors and angular accelerations are relative to the Orbiter structural coordinate system.

TABLE 4.3.4-1 ORBITER TOWING LIMIT LOAD FACTORS

N_x (g)	N_y (g)	N_z (g)
$\pm$ 1	$\pm$ 0.8	-0.3 to +2.3

THIS PAGE INTENTIONALLY LEFT BLANK.

5.0 FLUID INTERFACES

5.1 UMBILICALS

5.1.1 Mid-Body Prelaunch Umbilical Panel

The physical characteristics of the fluid interfaces are defined in Figure 3.3.4.5-1.

5.1.2 (Deleted)

5.1.3 (Deleted)

5.2 CARGO BAY PURGE AND VENT

(See Paragraph 6.2.1)

5.3 HEAT EXCHANGER INTERFACE

(See Paragraph 6.2.2)

5.4 AIR REVITALIZATION SERVICE

(See Paragraph 6.3.)

5.5 OXYGEN SUPPLY

(See Paragraph 6.3.1)

5.6 PAYLOAD STATION AND MISSION STATION COOLING

(See Paragraph 6.3.2)

5.7 (DELETED)

THIS PAGE INTENTIONALLY LEFT BLANK.

5.8 SPECIFICATION OF FLUIDS

Fluid procurement and use control shall be in accordance with NASA Specification NSTS-SE-S-0073.

5.9 GENERIC VENT CHARACTERISTICS

The generic is intended primarily for venting of gases. Venting of liquids (especially for safety critical functions) will require special evaluation to determine the potential for freezing and plugging of the vent. Utilization of this vent service requires evaluation by the SSP for specific fluids, flow rates, pressure drops, etc., to determine acceptability regarding concerns such as condensation, impact on vehicle dynamics, and wake ingestion of flammable/hazardous gases. Use of the vent service requires negotiation with the SSP and must be specified in the PIP.

The Orbiter installed side of the interface is designed to prevent rain water from entering the system while the Orbiter is in either a vertical or horizontal position.

The Orbiter installed plumbing is designed to withstand a maximum pressure of 450 psig.

THIS PAGE INTENTIONALLY LEFT BLANK.

6.0 ENVIRONMENTAL CONTROL INTERFACES

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 $0° \leq$ beta angle $< 20°$, $20° \leq$ beta angle $< 60°$, and $60° \leq$ beta angle $\leq 90°$. 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 ±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 On-Board Support Equipment

On-Board Support Equipment remaining in the cargo bay after deployment of the payload shall be designed to be compatible with the Orbiter attitude-hold capability defined in Paragraphs 6.1.1.2.1 and 6.1.1.2.3. However, the use of active cooling shall not be required to meet Orbiter compatible attitude-holds.

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, ES3-76-7, and ES3-77-1.

6.1.2.2 Coating Surface Properties

6.1.2.2.1 Orbiter Surfaces

For thermal design purposes, the infrared emittance (ε) and solar absorptance (α) 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 Structural Attachment Thermal Interfaces

The structural attachments for the cargo element/Orbiter configurations shall be as defined in Paragraph 3.3.1. These interfaces shall be defined by the contact conductances between cargo element provided attachment hardware and Orbiter provided attachment hardware. For thermal analysis purposes the contact conductances should be assumed to be either zero or infinite, whichever is the worst thermal design case.

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:

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

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, $^\circ$R
- T_w = wall (payload component surface) temperature, $^\circ$R

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° 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.

Transient analysis are performed for each impacted payload from entry interface to touchdown including plume convective heating and radiation interchange between the payload and vent filter and remaining payload bay environment. Table 6.1.4.2.2-1 provides temperature profiles for filter and typical payload bay environment during entry and values of radiation parameters.

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. For landings 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-ft^2
Contingency landing	396 BTU/hr-ft^2

Cold Environment**

Prelaunch and normal post-landing	70 BTU/hr-ft^2
Contingency landing	0 BTU/hr-ft^2

* 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° up from the local horizontal. 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 (Deleted)

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 $\leq$ 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.

6.1.4.4.5 Radiator Flow

During External Tanking (ET) and Power Reactant Storage Distribution (PRSD) prelaunch operations, freon flow through the orbiter payload bay door radiators is desirable in order to ensure safe conditions in the event of certain failures. During landing, radiator flow is intiated about ten minutes prior to landing and ends with orbiter power down. Since the radiator freon flows from aft to forward and dissipates heat, the temperature in the aft half of the payload bay is also expected to increase. The payload shall evaluate the effect of the increased heat load.

The following table provides worst case radiator panel temperatures for the high heat load activities (ET and PRSD) when radiator flow is activated. The payload shall review the radiator temperatures closest to the payload to determine if the payload has a temperature concern. These temperatures do not indicate temperatures in the payload bay, and shall only be used to determine an upper temperature limit. A payload bay (closed door) thermal analysis may be required using the models defined in section 6.1.2.1 if it is determined that the additional temperature cannot be tolerated. If the payload(s) deems these radiator temperatures unacceptable due to known thermal constraints, the constraint for no rad flow shall be document in the applicable Payload Integration Plan (PIP)

Mission Phase	Start Time	Duration	Radiator inlet	Radiator Temperatures(°F)			
				fwd	mid fwd	mid aft	aft
Prelaunch							
PRSD Loading	L-2 days	12 hrs	85	77	79	81	83
ET Operations	L-18 hrs	10 hrs	100	82	87	93	98
	L-8 hrs	4 hrs	110	86	93	100	104
Postlanding							
	TD-10 min	2 hrs	120	94	101	108	116
	TD+2 hrs	12 hrs	100	82	87	93	98

This table assumes a payload bay temperature of 70 deg F. and a flow rate of 170 lb/min.

6.1.5 (Deleted)

6.1.6 Cargo Bay Floodlight Thermal Characteristics

Depending upon the degree of payload blockage of the cargo bay floodlight's view to space, operation of the lights may be constrained due to payload or floodlight thermal limitations. Thermal configuration and maximum temperatures of the lights are presented in Figure 6.1.6-1 and direct light beam short wavelength (excluding IR) maximum heat flux is presented in Figure 6.1.6-2 for use in payload thermal design analyses. These data are included for use in identifying potential floodlight operational constraints due to payload thermal considerations. If constraints are indicated, a more detailed analysis shall be accomplished to define the required operational constraints. A thermal math model of a typical floodlight is available, if required, for detailed thermal analysis. Specific locations of the cargo bay lights are presented in Figure 3.1.3.2-1, Section 3.0.

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° ≤ β < 20°	20° ≤ β < 60°	60° ≤ β ≤ 90°
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)

Cargo Bay Orientation*	Orbiter Attitude-Hold Duration Limits From PTC Initial Conditions (Hours) +		
	$0° \leq \beta < 20°$	$20° \leq \beta < 60°$	$60° \leq \beta \leq 90°$
- 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 THERMAL-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	$\alpha_s/\varepsilon < .4$	FRSI (1)	.16	.32	$\geq .8$	$\geq .8$	N.A.	N.A.
		AFRSI (6)	.1	.1	f(T)	f(T)	N.A.	N.A.
Fuselage Mid-Section Sides	$\alpha_s/\varepsilon < .4$	FRSI (1)	.16	.32	$\geq .8$	$\geq .8$	N.A.	N.A.
		AFRSI (6)	.1	.1	f(T)	f(T)	N.A.	N.A.
Wing Upper Surface	$\alpha_s/\varepsilon < .4$	FRSI (1)	.16	.32	$\geq .8$	$\geq .8$	N.A.	N.A.
		AFRSI (6)	.1	.1	f(T)	f(T)	N.A.	N.A.

TABLE 6.1.2.2.1-1 THERMAL-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	$\geq$.6	.85	.85	N.A.	N.A.
Bottom of Orbiter	α_s/e = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	$\geq$.6	.85	.85	N.A.	N.A.
Fuselage Fwd Section (Top and Portion of Sides, See Figure 6.1.2.2.1-1)	$\alpha_s/\varepsilon \leq$ .4	FRSI (1)	.16	.32	$\geq$.8	$\geq$.8	N.A.	N.A.
		AFRSI (6)	.1	.1	f(T)	f(T)	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	$\geq$.6	.85	.85	N.A.	N.A.
Fuselage Aft Section Sides	α_s/ε < .4 α_s/ε = .7 to 1.1 $\varepsilon \geq$ .85	FRSI (1) LI900 HRSI (3) (4)	.16 .92	.32 $\geq$.6	$\geq$.8 .85	$\geq$.8 .85	N.A. N.A.	N.A. N.A.
Vertical Fin	α_s/ε < .4	AFRSI (6) LRSI (2)	.1 .16	.1 .32	f(T) $\geq$.8	f(T) $\geq$.8	N.A. N.A.	N.A. N.A.
Base Heat Shield	α_s/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	$\geq$.6	.85	.85	N.A.	N.A.
OMS Pods	α_s/ε = .7 α_s/ε < .4 α_s/ε < .4 α_s/ε < .4	FRCI-12 (7) FRSI (1) AFRSI (6) LRSI (2)	.92 .16 .1 .16	$\geq$.6 .32 .1 .32	.85 $\geq$.8 f(T) $\geq$.8	.85 $\geq$.8 f(T) $\geq$.8	N.A. N.A. N.A. N.A.	N.A. N.A. N.A. N.A.

TABLE 6.1.2.2.1-1 THERMAL-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
Body Flap (Upper and Lower Surfaces)	α_s/ε = .7 to 1.1 $\varepsilon \geq$ .85	LI 900 HRSI(3)(4)	.92	$\geq$.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) Flexible 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.

(6) Advanced flexible reusable surface insulation.

(7) Fibrous refractory composite insulation.

* f(T) : denotes temperature dependent emissivity.

TEMPERATURE (F)	EMISSIVITY
70	0.865
200	0.850
400	0.825
600	0.790
800	0.725
1000	0.660
1200	0.600
1400	0.555
1600	0.515
1800	0.480

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 (°R)	T_F (°R)	P_o (psf)	T_e (°R)
0	.0000	500	460	4.46E-5	546
100	.0000	650	470	6.56E-5	546.5
200	.0004	850	480	4.44E-4	547
300	.0050	1040	520	4.44E-3	547.5
400	.0156	1350	640	1.30E-2	548
500	.0277	1470	780	2.33E-2	548.5
600	.0416	1530	920	3.54E-2	549
700	.0600	1660	1000	5.43E-2	549.5
800	.0866	1750	1080	8.66E-2	551
900	.1215	1760	1150	1.60E-1	552
1000	.2165	2140	1180	3.52E-1	554
1100	.1367	1830	1160	5.76E-1	557
1200	.2778	2140	1110	1.138	561
1300	.3177	1770	1080	2.716	572
1400	.4644	1380	1050	9.366	589
1450	.3642	1060	1020	1.680E+1	601
1475	.3248	660	940	2.287E+1	603
1500	.2089	560	760	1.738E+1	605
1550	.1564	520	580	6.244E+1	609
1650	.0000	500	460	3.362E+1	613
1700	.0000	500	450	5.865E+1	614
1750	.0244	500	470	9.547E+2	615
1800	.0615	530	530	1.459E+3	616
1850	.0926	530	530	2.029E+3	616

t = Time from entry interface at 400K ft.
q_r = Reference heating rate (for a 1" D cyl, T_w = 460°R).
T_A = Reference air temperature (at Yo = 0, °R = 0).
T_F = Filter temperature.
P_o = Payload compartment air pressure.
T_E = Typical payload environment during entry.

Note:
The radiation interchange between the vent filter and the payload should be calculated using the following data:
- -Emissivity of filter = 0.99
- -Areas of filter screen:

Vent	Bay	Coordinates of Filter Center			Area (ft^2)
		Xo	Yo	Zo	
3	4	765.15	92.3	381.7	2.65
5	8	995.55	92.3	381.7	2.86
6	10	1127.85	92.3	381.7	2.09

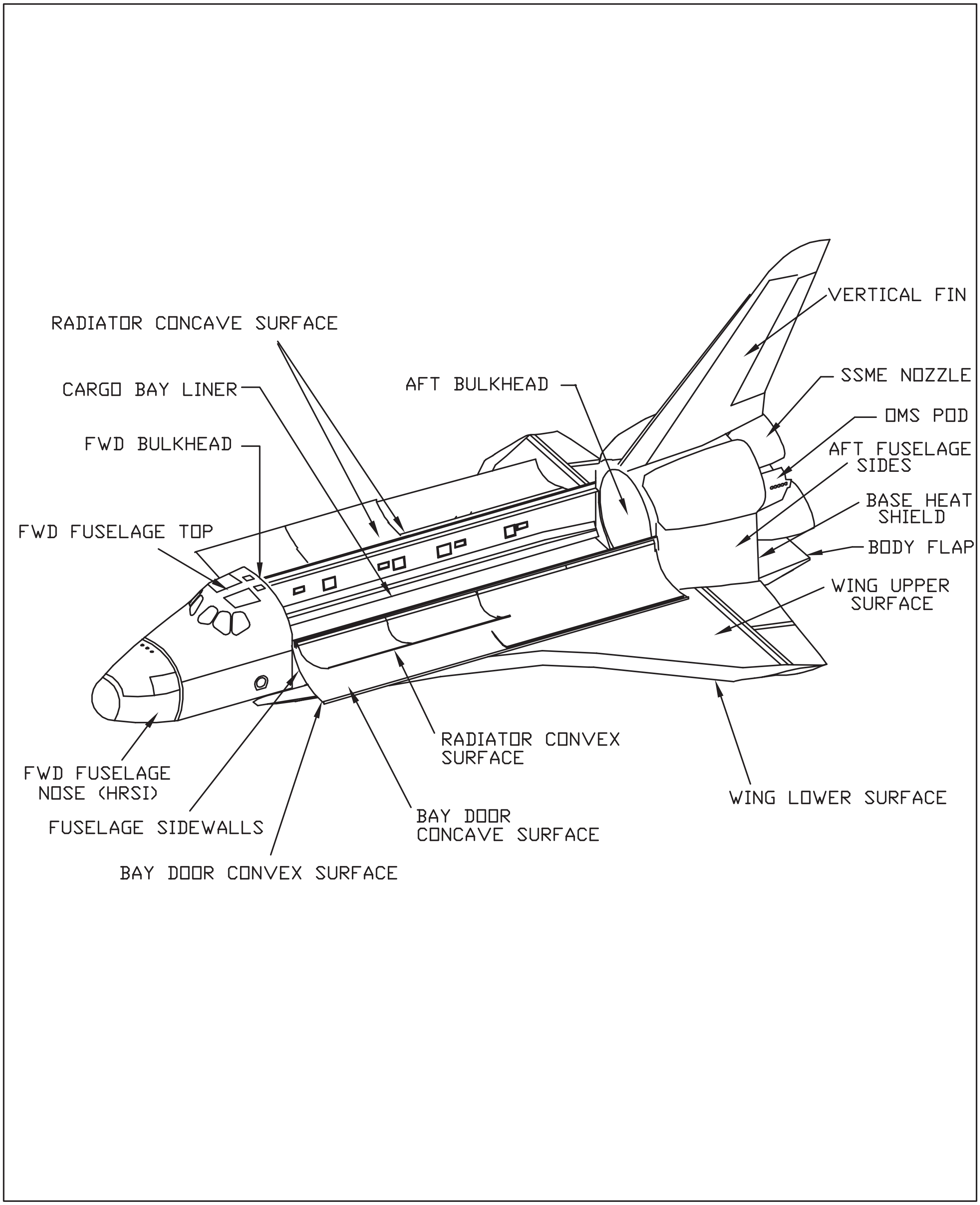


FIGURE 6.1.2.2.1-1 ORBITER SURFACES AFFECTING CARGO ELEMENT THERMAL BALANCE

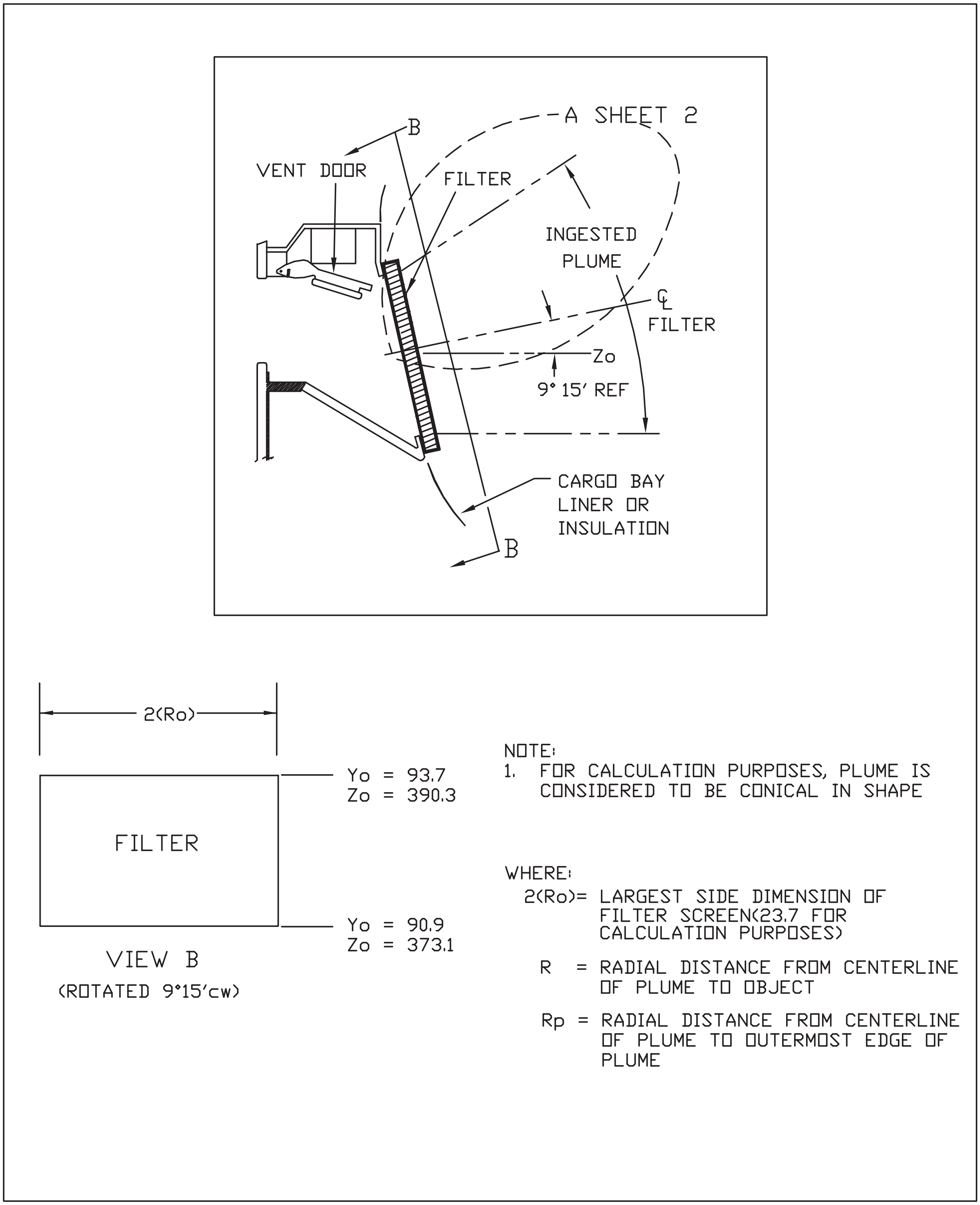
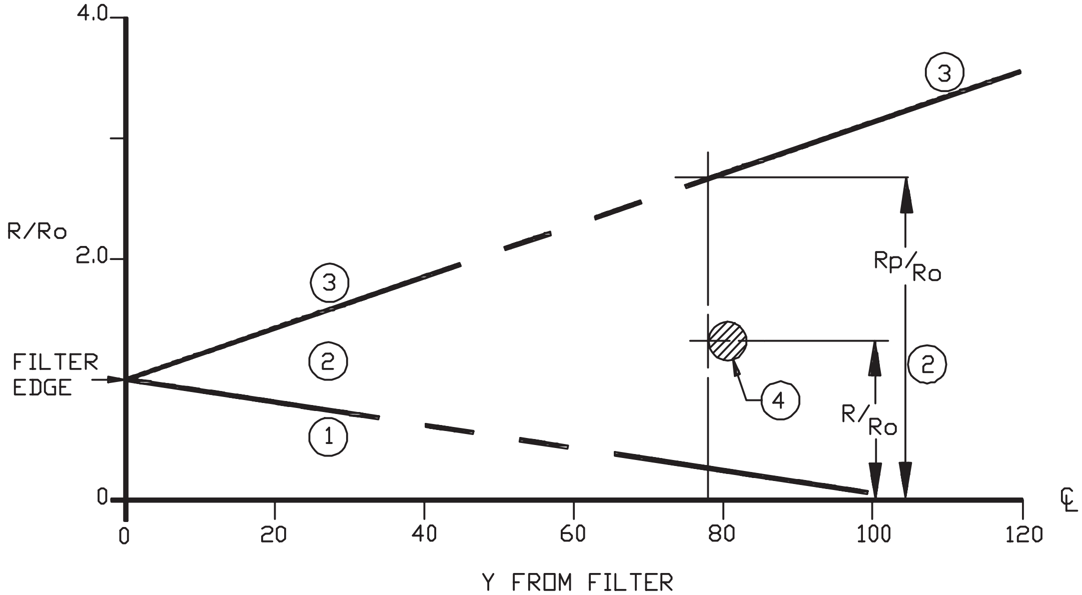


FIGURE 6.1.4.2.2-1 AIR PLUME ENVELOPE AND HEATING REGIONS

(SHEET 1 OF 2)



DETAIL A (ROTATED 9°15′ C.W)

1 PLUME CORE HEATING REGION

2 HEATING DECAY REGION OF PLUME (Fp)

3 REGION OUTSIDE OF INGESTED PLUME
(NO CONVECTIVE HEATING EXPERIENCED)

4 LOCATION OF PAYLOAD COMPONENT WITH RESPECT TO ℄ OF VENT FILTER

FIGURE 6.1.4.2.2-1 AIR PLUME ENVELOPE AND HEATING REGIONS

(SHEET 2 OF 2)

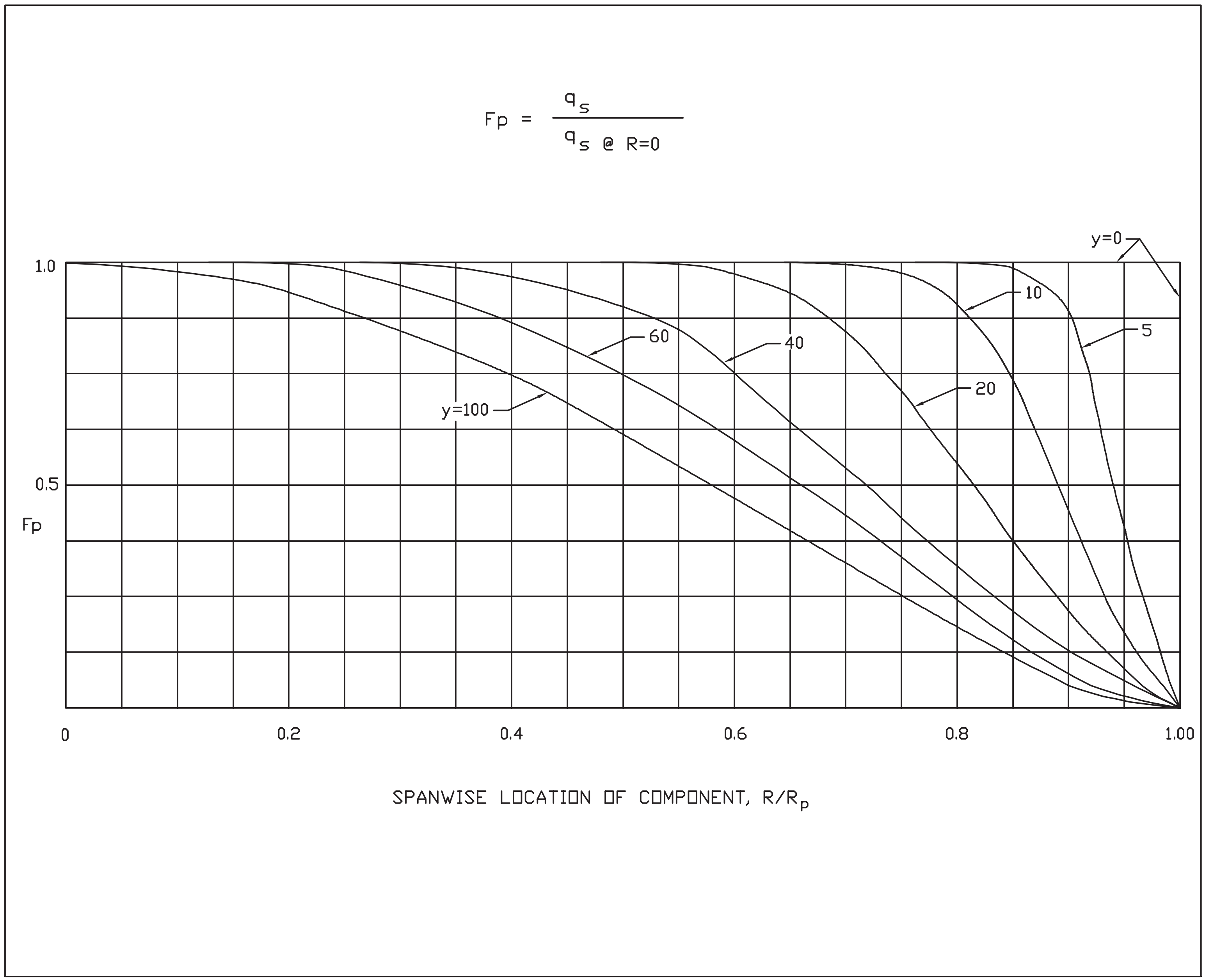


FIGURE 6.1.4.2.2-2 SPANWISE HEATING DISTRIBUTION WITHIN THE PLUME

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

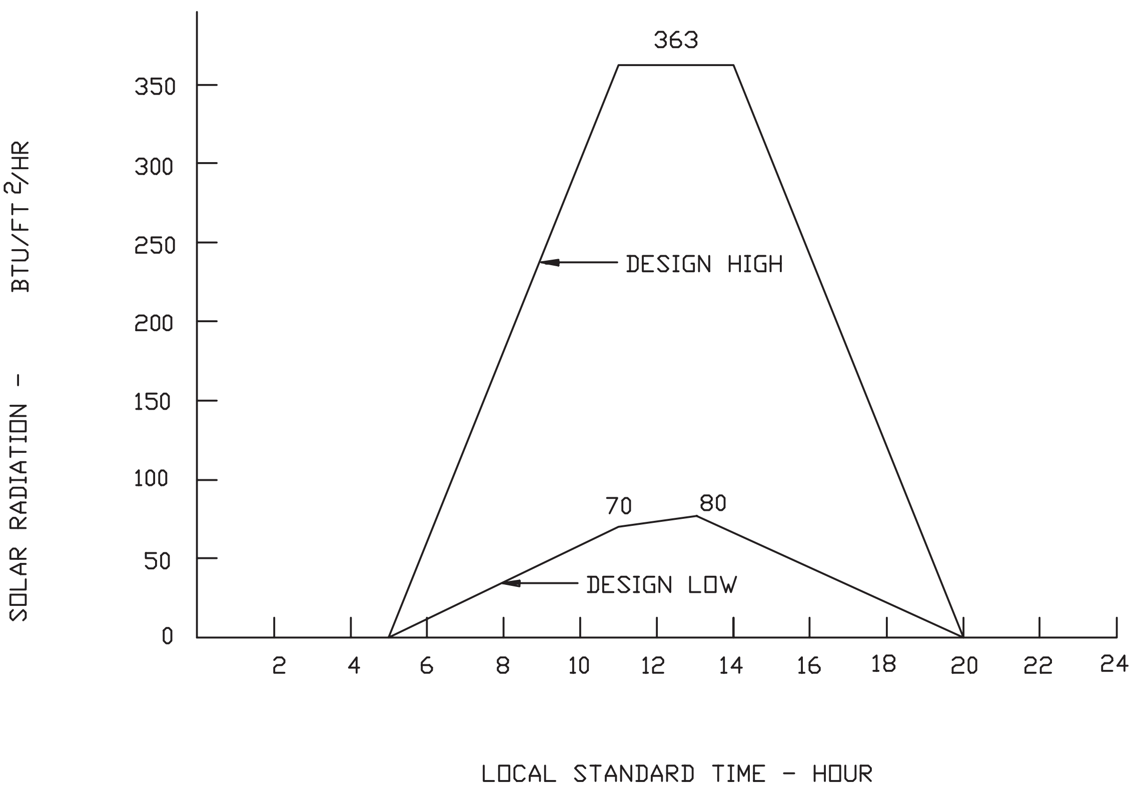


FIGURE 6.1.4.4.1.1-1 DIURNAL VARIATION FOR SOLAR CONSTANT

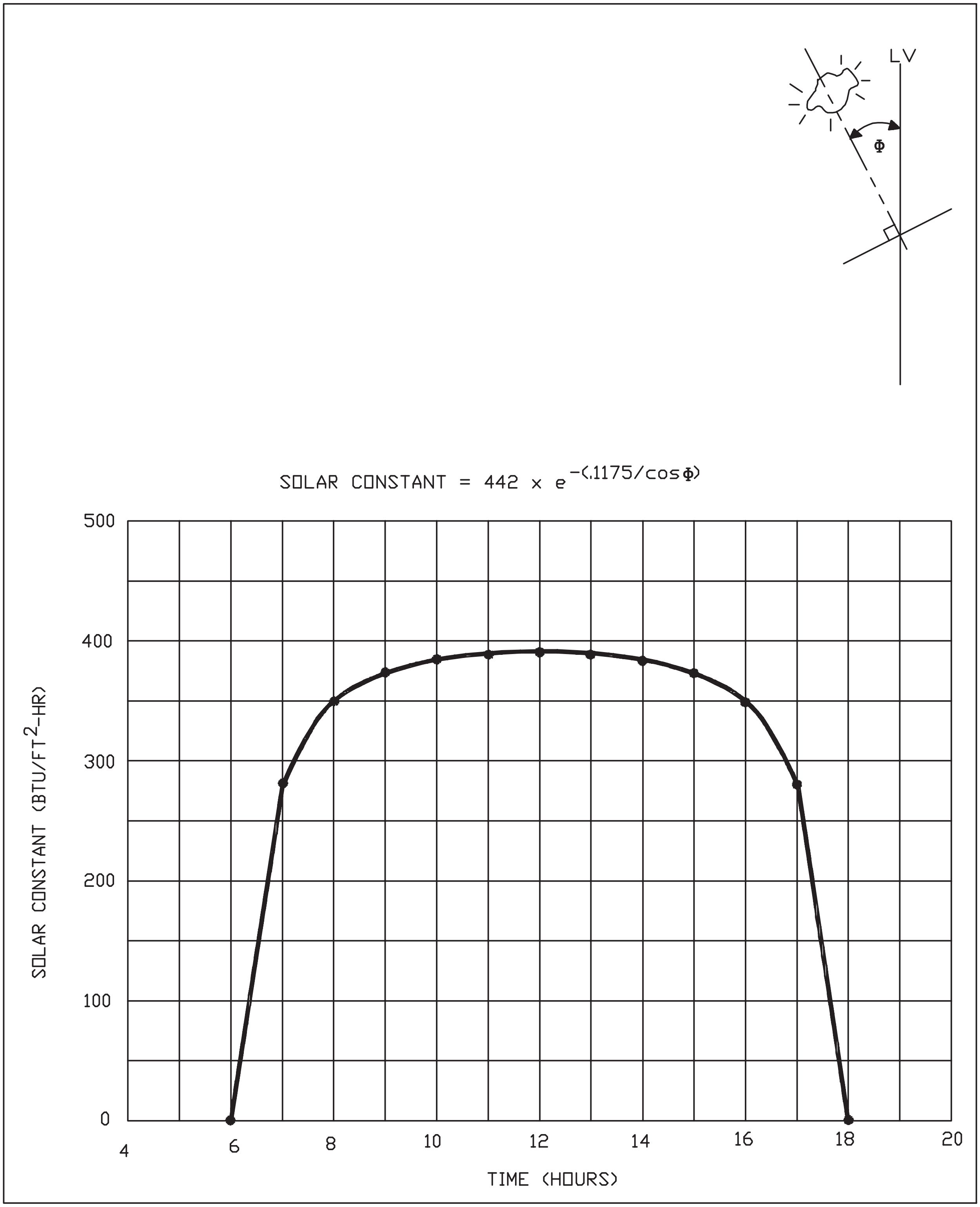


FIGURE 6.1.4.4.1.2-1 EQUATORIAL SOLAR CONSTANT VARIATION AT CONTINGENCY LANDING SITES

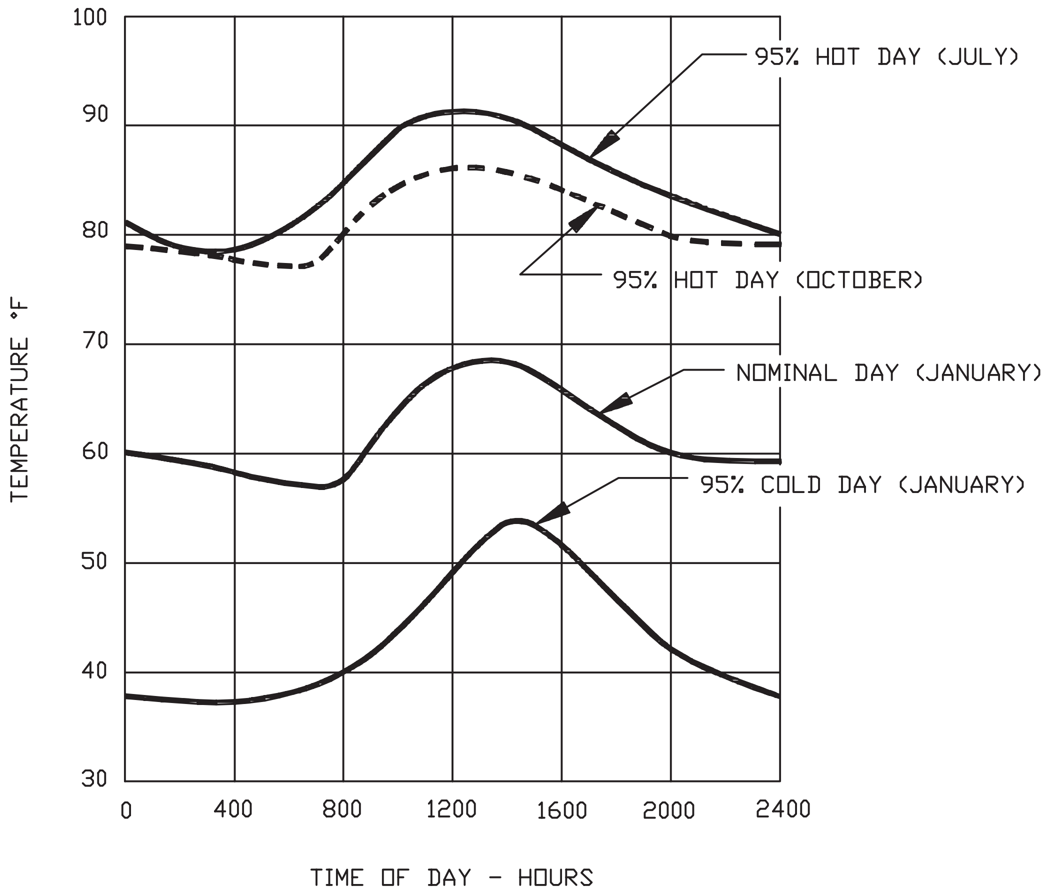


FIGURE 6.1.4.4.2.1-1 EASTERN TEST RANGE (ETR) DIURNAL AIR TEMPERATURE EXPERIENCE

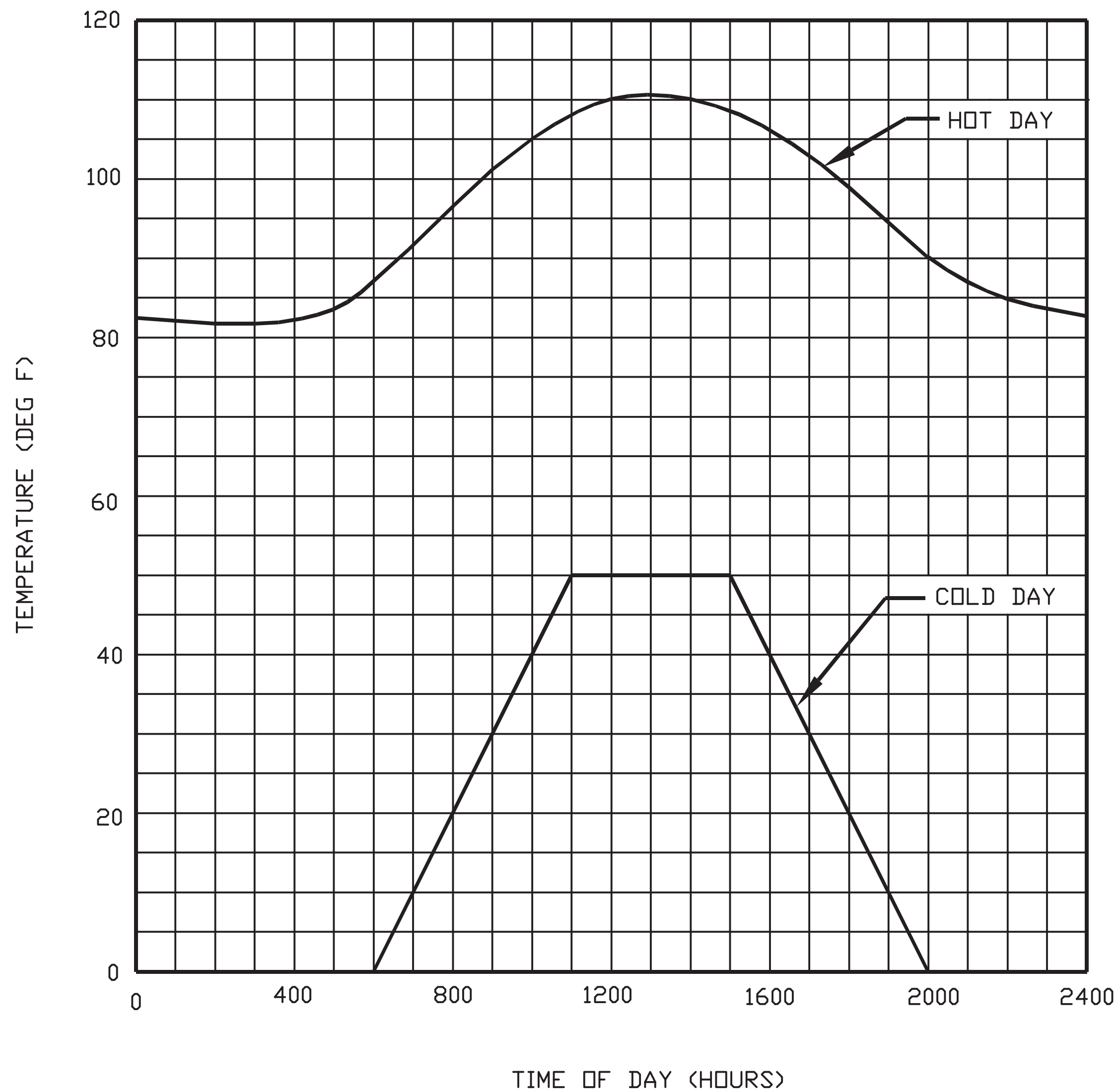


FIGURE 6.1.4.4.2.3-1 WORST CASE DIURNAL AIR TEMPERATURE AT CONTINGENCY LANDING SITES FOR MISSIONS WITH INCLINATION GREATER THAN 30 DEGREES

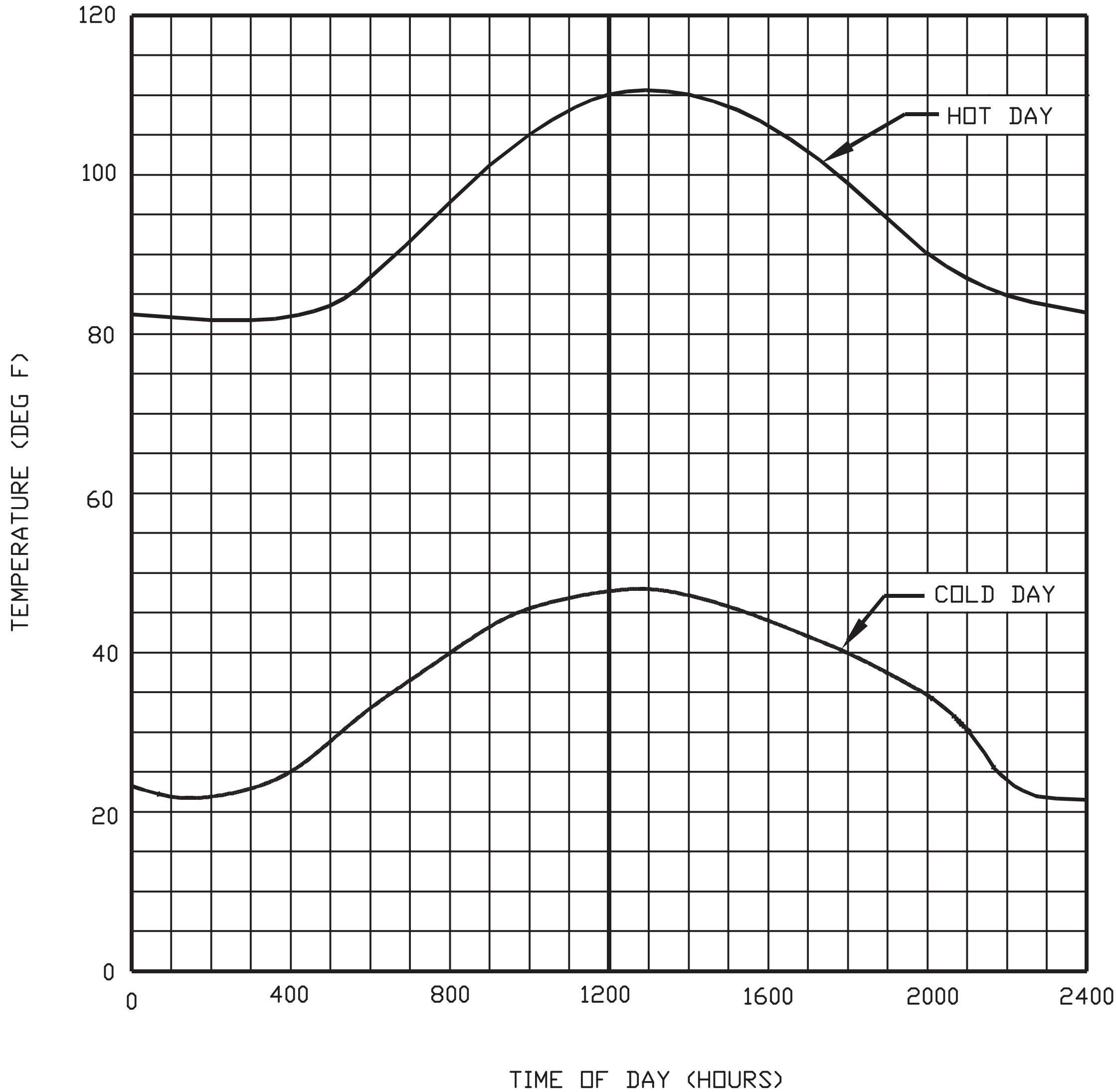


FIGURE 6.1.4.4.2.3-2 WORST CASE DIURNAL AIR TEMPERATURE AT CONTINGENCY LANDING SITES FOR MISSIONS WITH INCLINATION 30 DEGREES OR LESS

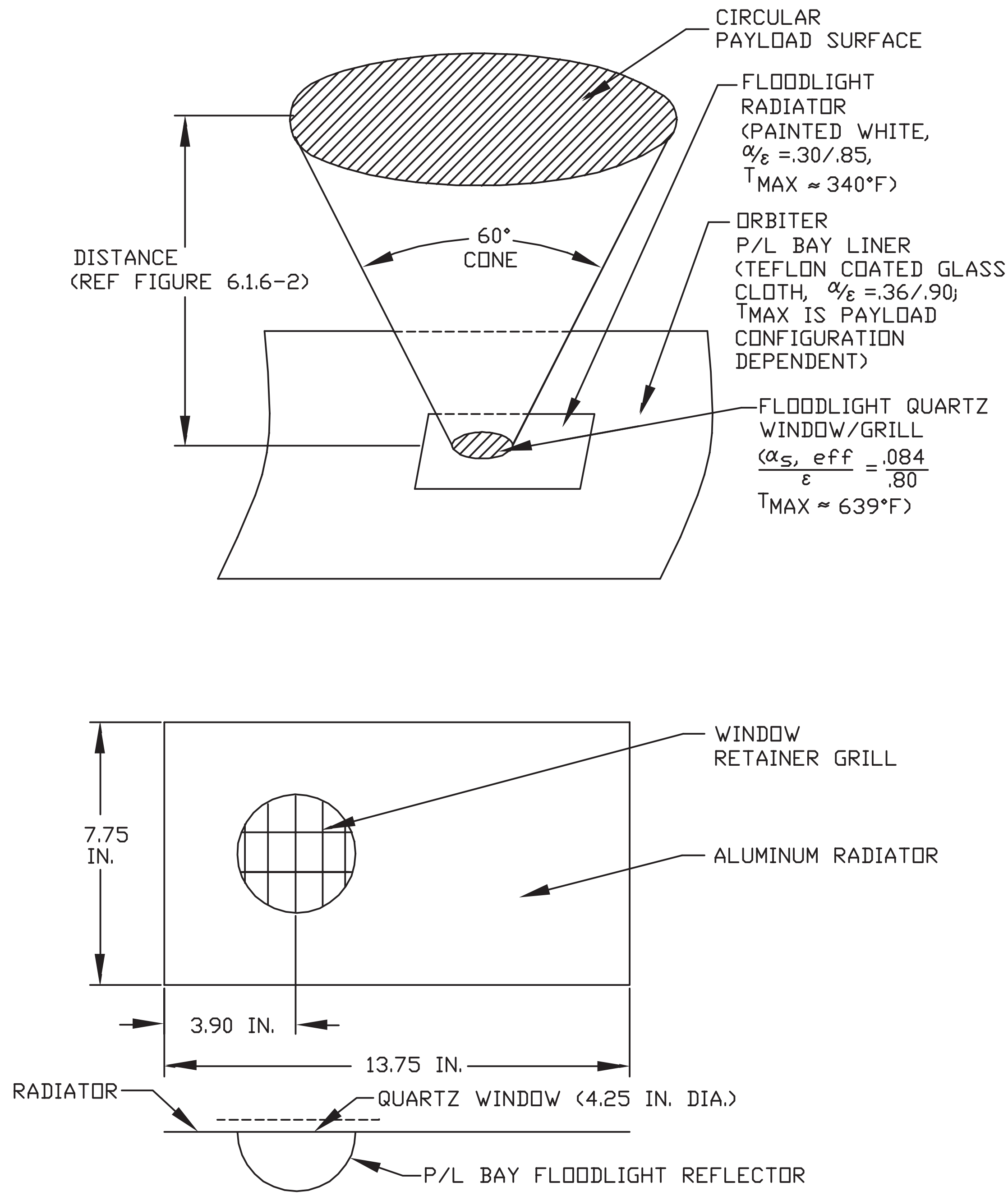


FIGURE 6.1.6-1 P/L BAY FLOODLIGHT THERMAL CONFIGURATION/CHARACTERISTICS

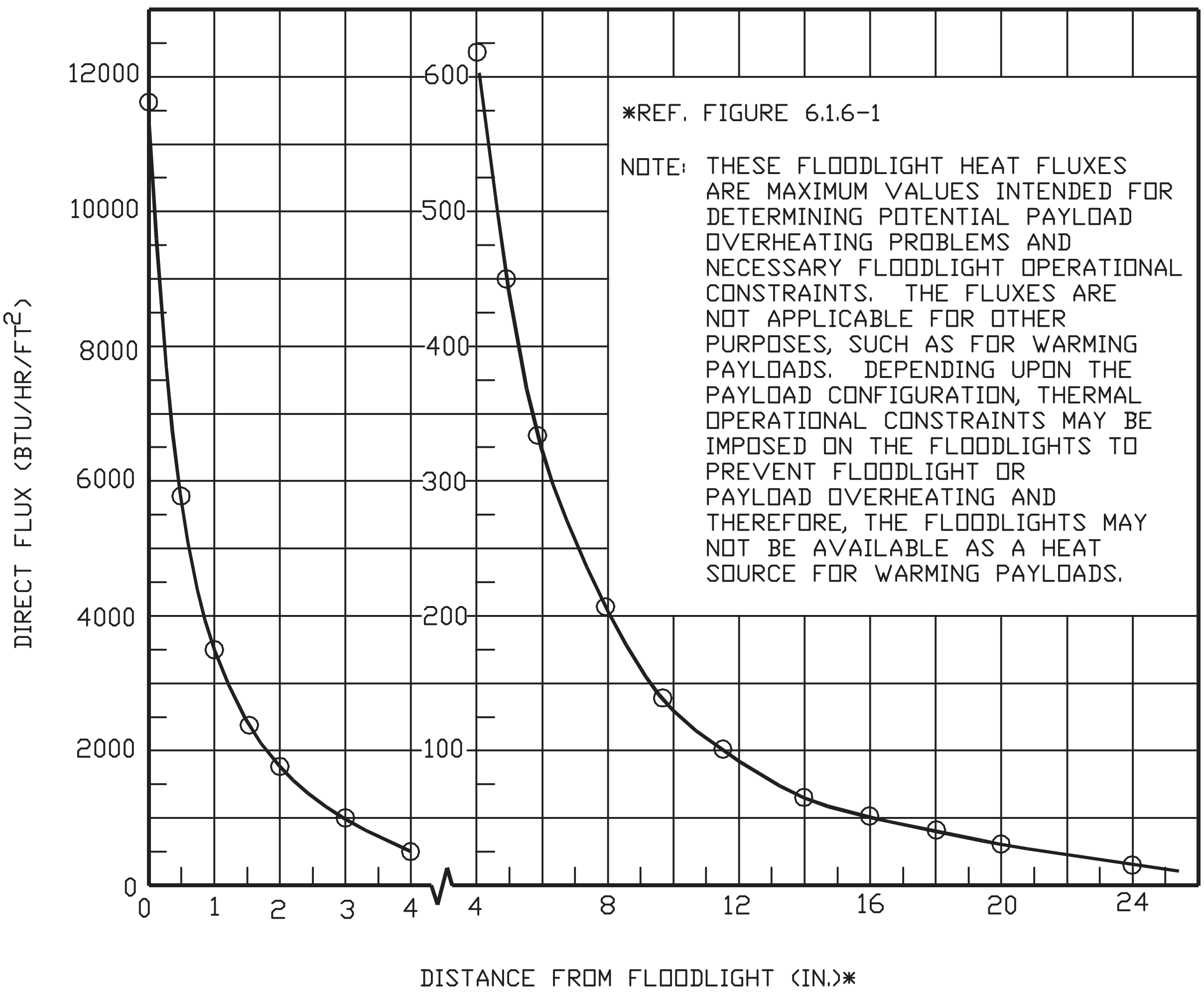


FIGURE 6.1.6-2 DIRECT LIGHT BEAM SHORT WAVELENGTH HEAT FLUX (EXCLUDING IR)
(FLUX FOR 60 DEGREE CONE)

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 TAL and ELS Abort Contingency

Provisions for ground purge after landing shall be made available within 72 hours in the event of TAL or ELS abort. Payload requirements for special services in less than 72 hours shall be addressed in the PIP.

6.2.2 Coolant Interfaces for Active Thermal Control

6.2.2.1 Payload Heat Exchanger

The Payload Heat Exchanger (P/L Hx) within the orbiter provides transfer of heat from a payload coolant loop to the orbiter Active Thermal Control Subsystem (ATCS). The P/L Hx provides two coolant passages for payload utilization. One passage normally supports a payload in the payload bay, while the other passage is plumbed for payload use in the cabin middeck. The payload bay located payloads may use water, Freon 114 or Freon 21, while the middeck located payloads may use only water. The orbiter uses Freon 21 as its ATCS coolant fluid.

The position of two Flow Proportioning Modules (FPMs) regulates the ATCS coolant flow through the P/L Hx. Each individual FPM can be in either the "payload" (P/L) position or "interchanger" (I/C) position. Maximum payload heat rejection is available when both FPMs are in the P/L position and the ATCS is configured for radiator flow. This configuration is available when the orbiter is on-orbit and the paylaod heat rejection is high enough to warrant it. Heat rejection capabilities for other ATCS configurations are extremely different. During the following mission phases the nominal ATCS configuration is both FPMs in the I/C position:

(1) Pre-launch mission phase
(2) Ascent mission phase
(3) Depressed cabin (e.g., 10.2 psia operations)
(4) Descent mission phase
(5) Post-Landing mission phase

It may be allowable, however, as an optional service, to leave one of the FPMs in the P/L position during these mission phases. A mission specific analysis must be completed to determine the payload cooling capability when the ATCS is operating in an "off-nominal" configuration.

Figures 6.2.2.1-1, 6.2.2.1-2, and 6.2.2.1-3 define the thermal performance of the P/L Hx for water, Freon 114, and Freon 21, respectively, as payload coolants. The ATCS supply temperature to the P/L Hx can be up to 4 °F hotter than the output temperature of the controlling orbiter heat sink. Table 6.2.2.1-1 specifies the design payload heat rejection capabilities provided by orbiter during each mission phase. The temperature supplied to the payload is a function of the payload's flow rate and the information provided in Figure 6.2.2.1 and Table 6.2.2.1. The best performance of the P/L Hx is achieved only when using the optimal payload flow rate for a specific orbiter Freon 21 flow rate. Therefore, if a specific supply temperature is required over multiple mission phases, the payload flow rate can not be constant throughout the mission but must change as the orbiter Freon 21 flow rate changes.

A payload coolant loop interfacing with the Payload Heat Exchanger (P/L Hx) shall have a system pressure (system static or dynamic) at the Orbiter to payload interface that is not greater than 200 psia. In the event of a P/L Hx leak, the payload side of the interface could be exposed to Freon 21. A nominal amount of Freon 21 is allowed to leak from the Freon 21 loop to the payload's cooling loop. This allowable leakage is defined as 0.001 cc/hour. Since this leakage is possible, all payload cooling system materials shall be able to maintain system integrity and prevent further leakage when exposed to Freon 21. A payload shall consider the pressure increase due to the Payload Heat Exchanger leak and the static pressure of the payload cooling fluid (water or Freon 114). The maximum local pressure, as a result of the leak, depends on the mission phase, the payload cooling fluid, and the Xo location of the payload. Table 6.2.2.1-3 provides the pressure at the SIP for both water and Freon 114 for ascent and post-landing. The ascent max boost acceleration is based on the values listed in Table 4.1.3.1-1. The static pressure for Xo locations between those listed shall be determined by linear interpolation.

In addition to Freon 21, the payload design shall take into account the materials used in the Orbiter provided portion of the cooling loop when selection of wetted materials and coolant media is made. Wetted materials or fluids which may react to allow galvanic corrosion or the formation of contaminatinng byproducts shall be avoided. Table 6.2.2.1-2 provides a list of materials known to be compatible with the cooling system from which a payload designer could construct a cooling system. Any materials included within the wetted portion of the payloads's coolant loop which do not appear in Table 6.2.2.1-2 shall require a mission specific analysis to be performed to assure overall system compatibility.

It is possible to have both of the payload cooling loops serviced and/or operating at the same time. The heat rejection capability and P/L Hx effectiveness for such a condition must be determined by an analysis performed specifically for that mission's cargo manifest and requirements. It is also possible for a P/L Hx leak to occur between the two independent payload coolant loops. In the event of such a leak, each payload coolant loop must be compatible with both the operating fluid and the pressure existing at the P/L Hx (maximum of 200 psia) in the other payload's coolant loop, as well as with the orbiter ATCS requirements.

6.2.2.2 Payload Active Cooling Kit (PACK)

Cargo elements, located in the cargo bay and requiring active cooling, shall utilize the Payload Active Cooling Kit (PACK). This kit, provided as an optional service by STS, is comprised of the plumbing required to connect to the Payload Heat Exchanger and provides a fluid interface to the payload on a port-side Standard Interface Panel (SIP) (Reference Sections 3.3.2 and 3.3.5.2). The PACK hardware elements are defined in Section 3.3.5.2.1. This interface utilizes quick-disconnects and is designed to be compatible with water, Freon-21, and Freon-114. Freon-114 is recommended. Coolant fluid specifications are defined in NSTS-SE-S-0073.

Flow, pressure control, filtration, and instrumentation are responsibilities of the payload. If water is utilized as a coolant, a minimum continuous flow rate of 200 lbs/hr shall be maintained for all on-orbit periods to prevent local freezing.

Pressure drop vs coolant flow rate is defined in Figure 6.2.2.2-1. These values reflect total STS side pressure drop, including the Payload Heat Exchanger. Predicted heat gain/loss for the PACK is defined in Figure 6.2.2.2-2.

6.2.2.3 Active Liquid Cooling

Any active liquid cooling required by payloads (e.g. Mid-deck/payload bay via the payload heat exchanger) shall be negotiated with the NSTS and specified in the PIP.

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) 18.3-29.4 (65-85) (J)	7-37.8 (45-100)
Humidity: grams H_20/Kg (grains H_20/lb) Ground controlled Not selectable Air (I) GN_2	 $\leq$ 5.29 ($\leq$ 37) $\leq$ 4.14 ($\leq$ 29) $\leq$ 0.14 ($\leq$ 1)	 $\leq$ 5.29 ($\leq$ 37) ---- ----	 $\leq$ 5.29 ($\leq$ 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. 58.2 (128) max. (J) 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)

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".

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

(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.

(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.

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

Notes: (Continued)

(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).

(J) During VAB and PAD transit operations the S83-0804 mini-PPU may be used. Maximum Vehicle/GSE interface flow rate with the mini-PPU is 160 lbs./min. Two mini-PPUs may be used to provide full flow rate range or a full-size S70-0534 cart may be used to obtain the full temperature and flow rate range specified.

TABLE 6.2.2.1-1 PAYLOAD HEAT REJECTION CAPABILITIES PROVIDED BY ORBITER

Mission Phase	Flow Proportion Module (FPM) Position	Design Heat Rejection Btu/hr (kW)	Orbiter Heat Sink Temp. Range* °F(°C)	Maximum Environmental Effect Between Heat Sink and P/L Hx °F(°C)	Orbiter Freon Min. Flow Rate** lb/hr (kg/hr)	Notes
Pre launch	2 in P/L (Prior to L-6 hours)	29,000 (8.5)	33-50 (0.6-10.0)	+4 (+2.2)	2240 (1017)	Requires pre-schedule and coordination with Orbiter Operations
	1 in P/L 1 in I/C (Prior to L-6 hours)	17,000 (4.98)	33-50 (0.6-10.0)	+4 (+2.2)	1270 (577)	Requires pre-schedule and coordination with Orbiter Operations
	2 in I/C	5,200 (1.52)	33-50 (0.6-10.0)	+4 (+2.2)	365 (168)	Normal Operations
Ascent	2 in I/C	5,200 (1.52)	40-95 (4.4-35.0)	+4 (2.2)	365 (168)	Orbiter heat sink temp. will increase up to 95°F/ 35°C from T-15 to T+135 sec.
On-Orbit	2 in I/C	5,200 (1.52)	36-40 (2.2-4.4)	±1 (±0.6)	310 (143)	Cooling limited with cargo bay doors closed-see specific PIP for door operation time
	2 in P/L	29,000 (8.5)	36-40 (2.2-4.4)	±1 (±0.6)	1960 (889)	Requires pre-schedule and coordination with Orbiter Operations
	1 in P/L 1 in I/C	14,000 (4.37)	36-40 (2.2-4.4)	±1 (±0.6)	1125 (513)	Default position with actively cooled payload

TABLE 6.2.2.1-1 PAYLOAD HEAT REJECTION CAPABILITIES PROVIDED BY ORBITER (CONTINUED)

Mission Phase	Flow Proportion Module (FPM) Position	Design Heat Rejection Btu/hr (kW)	Orbiter Heat Sink Temp. Range* °F(°C)	Maximum Environmental Effect Between Heat Sink and P/L Hx °F(°C)	Orbiter Freon Min. Flow Rate** lb/hr (kg/hr)	Notes
Deorbit /Entry	2 in I/C	5,200 (1.52)	36-60 (2.2-15.6)	+4 (+2.2)	365 (168)	
Post landing	2 in I/C	5,200 (1.52)	32-60 (0.6-15.6)	+4 (+2.2)	310 (143)	Available at primary land site with liquid cooling
	2 in P/L 1 in P/L 1 in I/C	29,000 (8.5) 17,000 (4.98)	32-60 (0.6-15.6) 32-60 (0.6-15.6)	+4 (+2.2) +4 (+2.2)	1960 (889) 1270 (577)	Requires pre-schedule and coordination with Orbiter Operations

* Heat sink range dependent upon active heat sink: Radiators, Flash Evaporator Subsystems (FES), Ammonia Boiler Subsystem (ABS), or Ground Support Equipment (GSE).

** Used in Figures 6.2.2.1-1, 6.2.2.1-2 and 6.2.2.1-3 for determining Payload Heat Exchanger Performance.

TABLE 6.2.2.1-2 Materials in Use in the Orbiter Portion of Payload Coolant Loops

Water Cooled Payloads	Freon Cooled Payloads
300 Series CRES alloys	300 Series CRES alloys
CRES A-286	CRES A-286
Inconel Alloys	Inconel Alloys
Nickel 200	Nickel 200
Hastelloy	Hastelloy
Titanium Alloys	Titanium Alloys
Monel	Monel
Rulon J	PTFE
PTFE	Gold
Gold	21-6-9 Stainless Steel
21-6-9 Stainless Steel	
Neoprene	
Silicon Rubber	

TABLE 6.2.2.1-3 Static Pressure and Heat Exchanger Leak Pressure for Freon 114 and Water Cooled Payloads.

Xo	Water during Ascent (psia)	Water during Post-landing (psia)	Freon during Ascent (psia)	Freon during Post-landing (psia)
636	139.4	177.0	140.6	175.5
650	139.9	177.0	141.4	175.5
700	144.7	177.0	148.8	175.5
750	150.3	177.0	157.3	175.5
800	155.9	177.0	165.9	175.5
850	161.6	177.0	174.6	175.5
900	167.3	177.0	183.4	175.5
950	173.0	177.0	192.1	175.5
1000	178.7	177.0	200.8	175.5
1050	184.5	177.0	209.6	175.5
1100	190.2	177.0	218.3	175.5
1150	195.9	177.0	227.1	175.5
1200	201.6	177.0	235.8	175.5
1250	207.3	177.0	244.6	175.5
1307	213.8	177.0	254.5	175.5

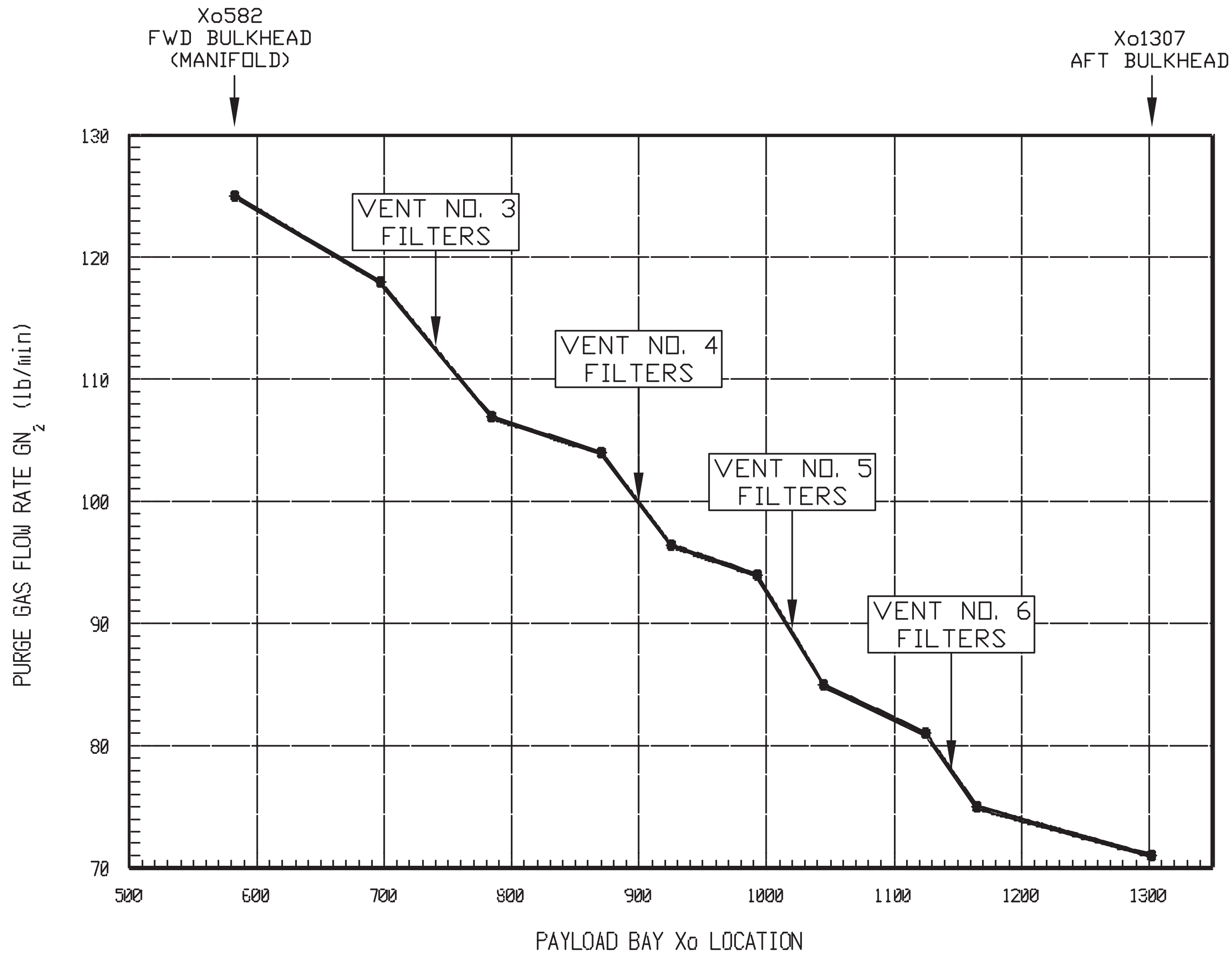


FIGURE 6.2.1-1 CARGO BAY PURGE GAS FLOW DISTRIBUTION (TYPICAL LOW FLOW RATE PURGE, NO SPIGOT FLOW)

NOTES:

(1) VENTS CONSIST OF BOTH MAIN AND LINER FILTERS

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

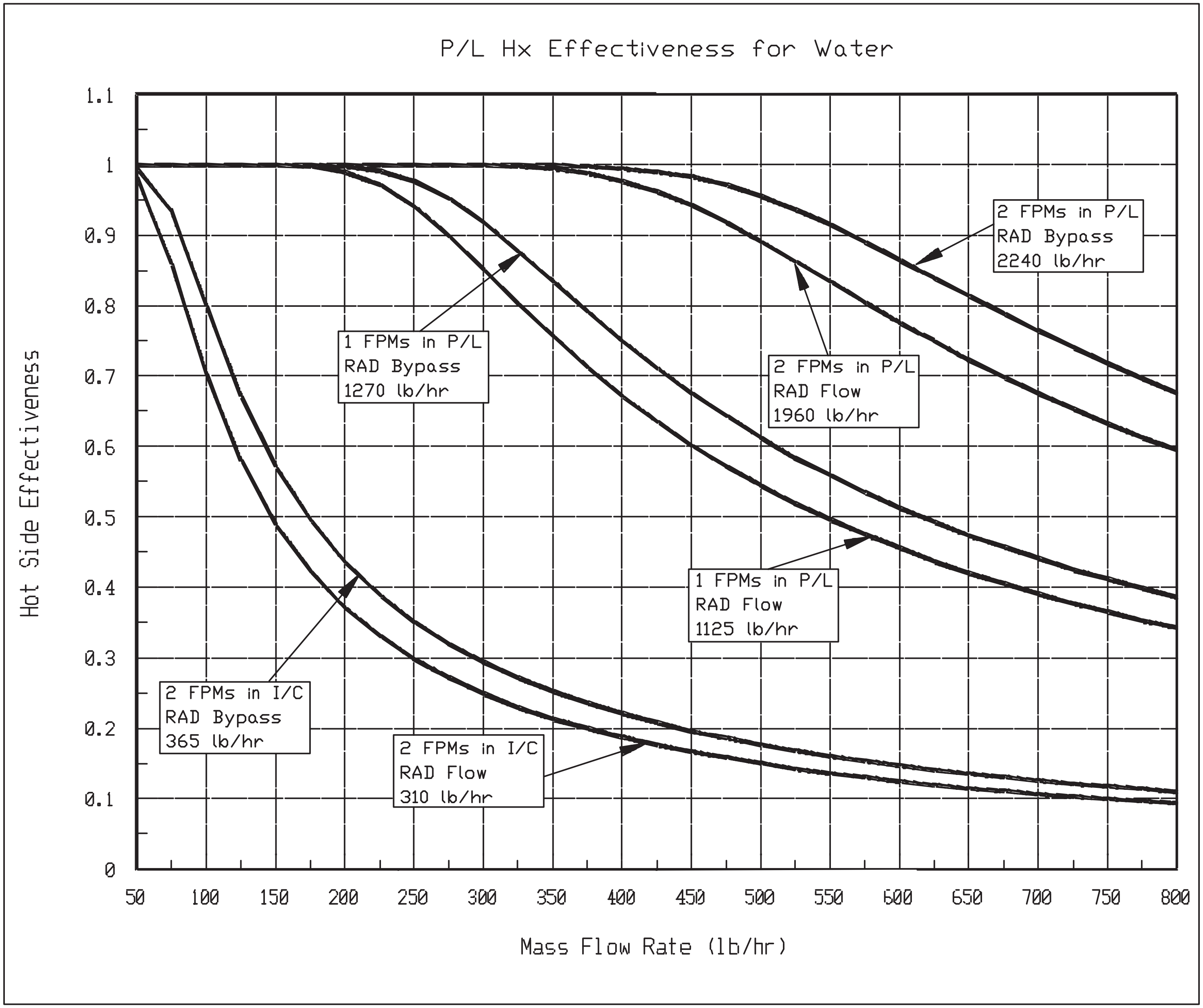


FIGURE 6.2.2.1-1 PAYLOAD HEAT EXCHANGER PERFORMANCE - WATER

(SHEET 1 OF 2)

NOTES:

1. Hot Side Effectiveness, $E_H = \frac{(T_{P/L\,in} - T_{P/L\,out})}{(T_{P/L\,in} - T_{ORBITER\,in})}$

2. $Q(BTU/hr) = E_H C_H (T_{P/L\,in} - T_{ORBITER\,in})$ where $C_H(btu/HR\text{-}°F) = \dot{m}_H c_{P\,H}$

3. Predicted performance based on vendor OV-103 payload heat exchanger test, dated May 1976.

4. Total orbiter Freon 21 flow to payload heat exchanger is based on -3 sigma deviation from actual flight data mean through mission STS-68.

5. Assumes one active payload loop.

6. Counterflow heat exchanger performance
   $UA(BTU/hr\text{-}°F) = 0.234\dot{m}_{ORBITER}^{1.317}$

7. Nominal orbiter heat sink control range

Radiators controlling	38±2°F(33±1.1°C)
Flash Evaporator Subsystem controlling	39±1°F(3.8±0.5°C)
Ammonia Boiler Subsystem controlling	35±3°F(1.7±1.7°C)
Ground Support Equipment controlling	33 to 50°F(1.7 to 10°C)

8. $T_{ORBITER\,in}$ = orbiter heat sink temperature + environmental impact

9. FPM = Flow Proportioning Module located in the orbiter freon loop

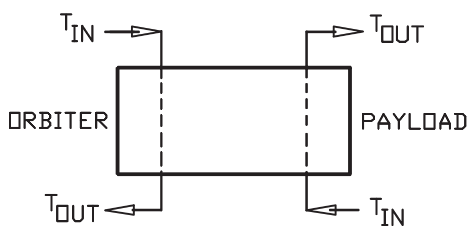


FIGURE 6.2.2.1-1 PAYLOAD HEAT EXCHANGER PERFORMANCE - WATER

(SHEET 2 OF 2)

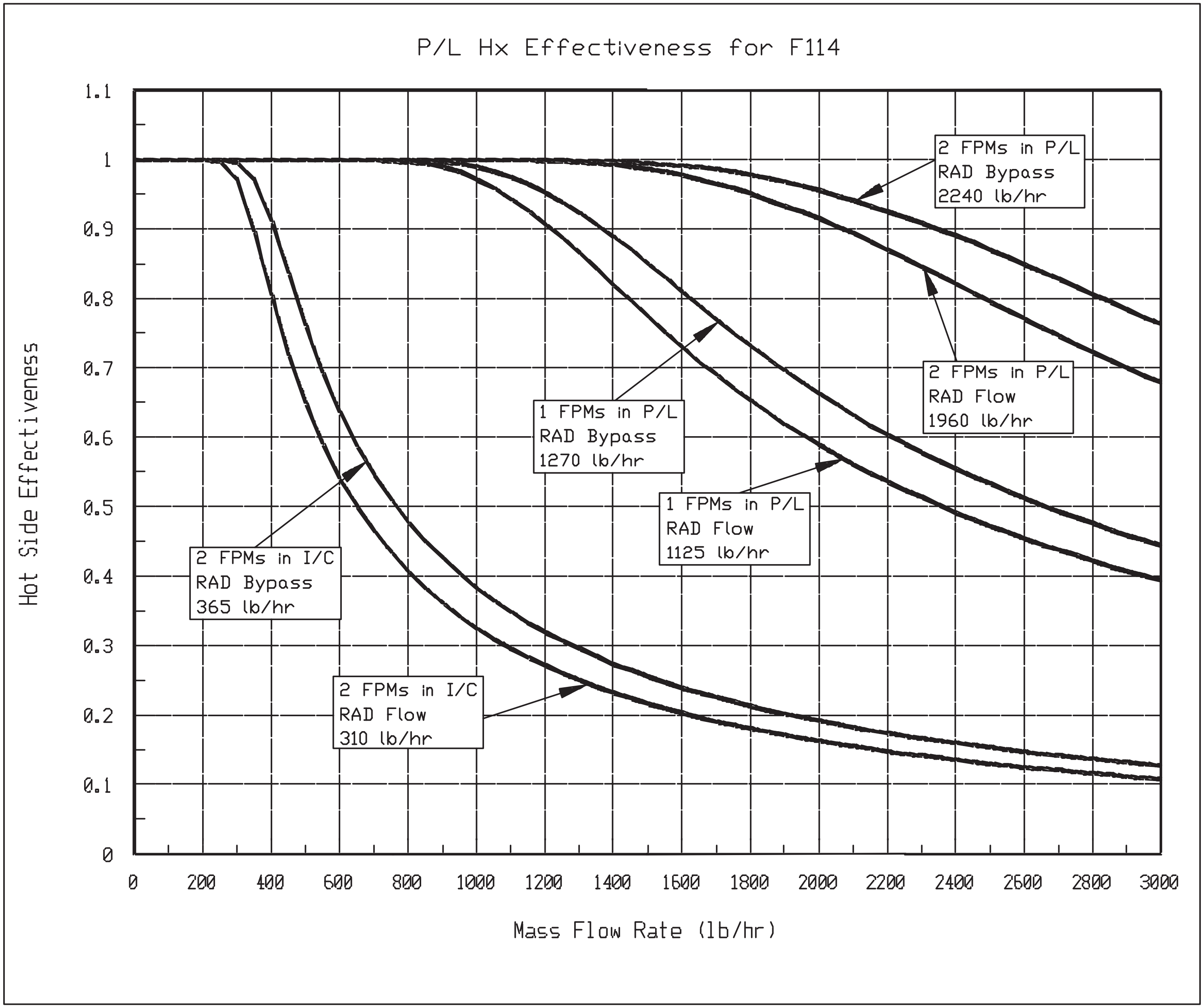


FIGURE 6.2.2.1-2 PAYLOAD HEAT EXCHANGER PERFORMANCE - FREON-114
(SHEET 1 OF 2)

NOTES:

1. Hot Side Effectiveness, $E_H = \frac{(T_{P/L\,in} - T_{P/L\,out})}{(T_{P/L\,in} - T_{ORBITER\,in})}$

2. $Q(BTU/hr) = E_H C_H (T_{P/L\,in} - T_{ORBITER\,in})$ where $C_H(btu/HR\text{-}°F) = \dot{m}_H c_{P\,H}$

3. Predicted performance based on vendor analytical data, dated November 16, 1982.

4. Total orbiter Freon 21 flow to payload heat exchanger is based on -3 sigma deviation from actual flight data mean through mission STS-68.

5. Assumes one active payload loop.

6. Counterflow heat exchanger performance

   $UA(BTU/hr\text{-}°F) = 42.79\dot{m}_{ORBITER}^{0.3372}\dot{m}_{P/L}^{0.2922}$

7. Nominal orbiter heat sink control range

Radiators controlling	38±2°F(33±1.1°C)
Flash Evaporator Subsystem controlling	39±1°F(3.8±0.5°C)
Ammonia Boiler Subsystem controlling	35±3°F(1.7±1.7°C)
Ground Support Equipment controlling	33 to 50°F(1.7 to 10°C)

8. $T_{ORBITER\,in}$ = orbiter heat sink temperature + environmental impact

9. FPM = Flow Proportioning Module located in the orbiter freon loop

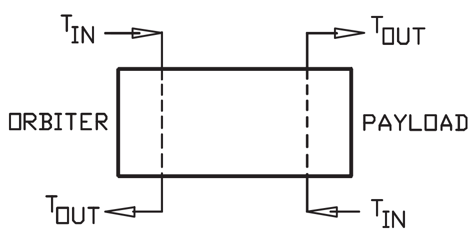


FIGURE 6.2.2.1-2 PAYLOAD HEAT EXCHANGER PERFORMANCE - FREON-114

(SHEET 2 OF 2)

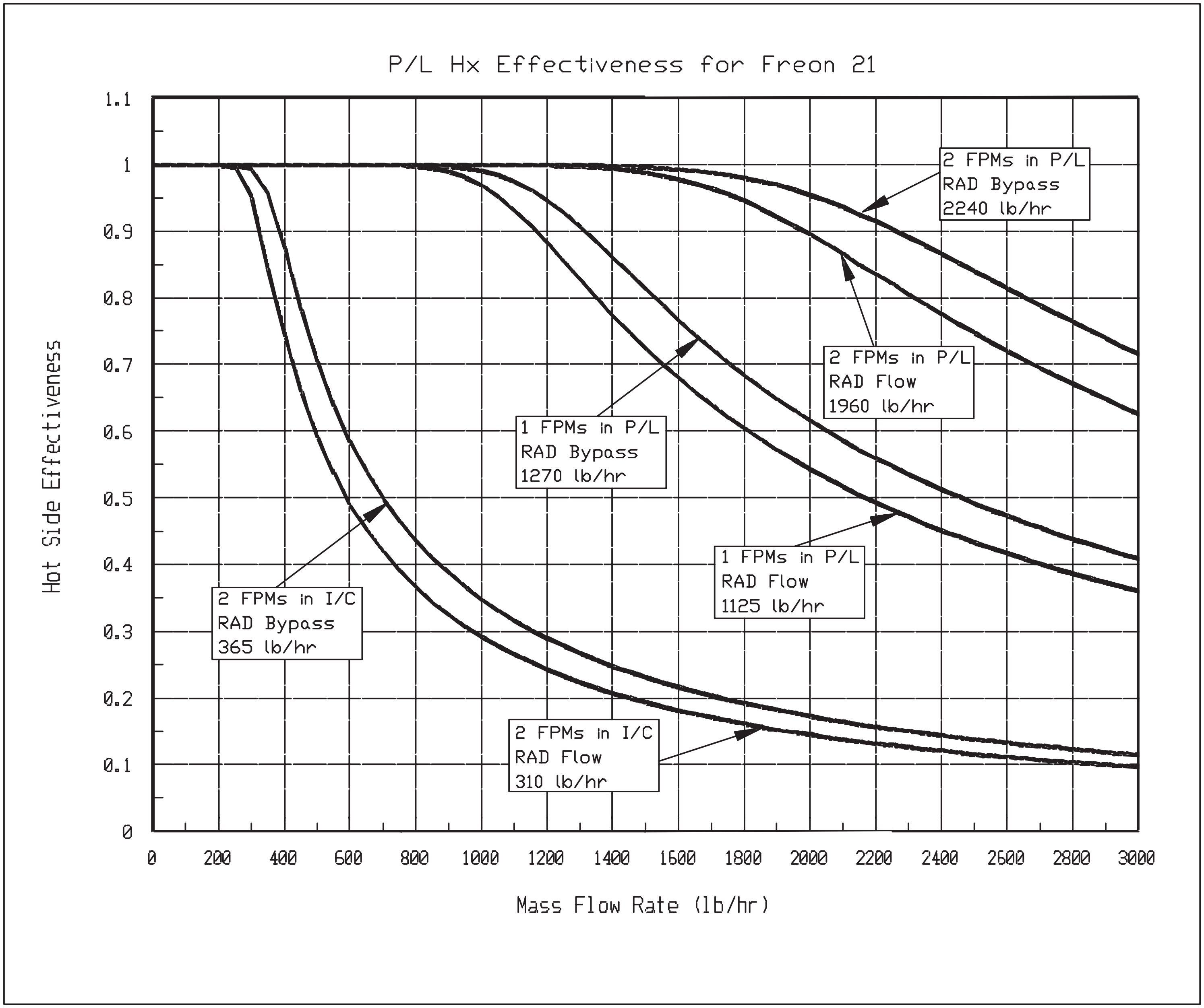


FIGURE 6.2.2.1-3 PAYLOAD HEAT EXCHANGER PERFORMANCE - FREON-21

(SHEET 1 OF 2)

NOTES:

1. Hot Side Effectiveness, $E_H = \dfrac{(T_{P/L\,in} - T_{P/L\,out})}{(T_{P/L\,in} - T_{ORBITER\,in})}$

2. $Q(BTU/hr) = E_H C_H (T_{P/L\,in} - T_{ORBITER\,in})$ where $C_H(btu/HR\text{-}°F) = \dot{m}_H c_{P\,H}$

3. Predicted performance based on vendor OV-103 payload heat exchanger test, dated May 1976.

4. Total orbiter Freon 21 flow to payload heat exchanger is based on -3 sigma deviation from actual flight data mean through mission STS-68.

5. Assumes one active payload loop.

6. Counterflow heat exchanger performance

   $$UA(BTU/hr\text{-}°F) = 29.23\,\dot{m}_{ORBITER}^{0.459}\,\dot{m}_{P/L}^{0.2384}$$

7. Nominal orbiter heat sink control range

Radiators controlling	38±2°F(33±1.1°C)
Flash Evaporator Subsystem controlling	39±1°F(3.8±0.5°C)
Ammonia Boiler Subsystem controlling	35±3°F(1.7±1.7°C)
Ground Support Equipment controlling	33 to 50°F(1.7 to 10°C)

8. $T_{ORBITER\,in}$ = orbiter heat sink temperature + environmental impact

9. FPM = Flow Proportioning Module located in the orbiter freon loop

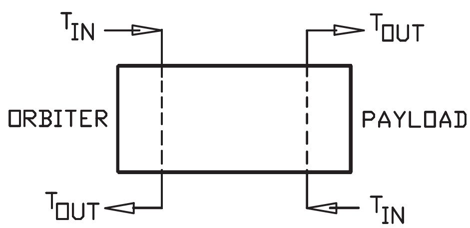


FIGURE 6.2.2.1-3 PAYLOAD HEAT EXCHANGER PERFORMANCE - FREON-21

(SHEET 2 OF 2)

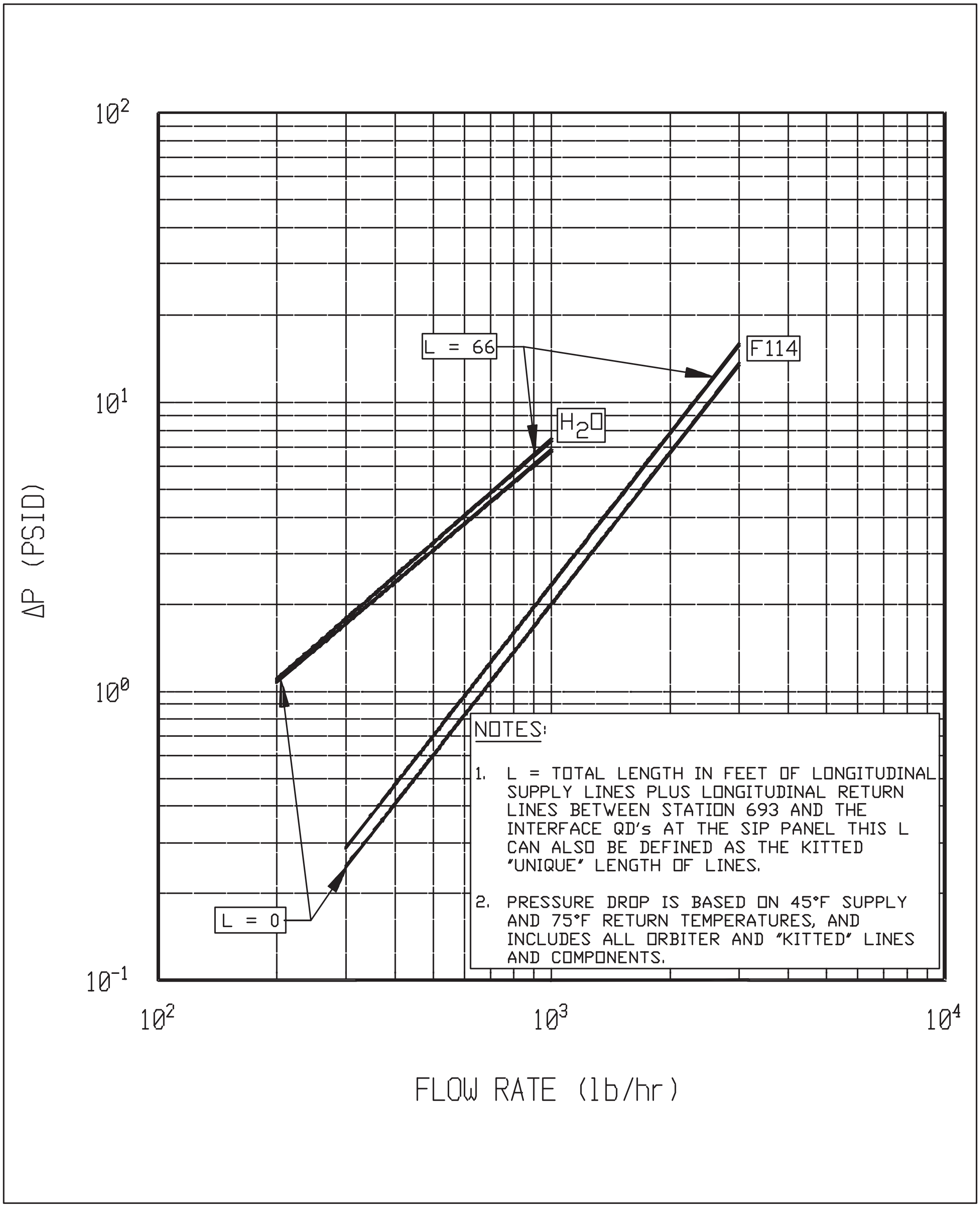


FIGURE 6.2.2.2-1 TOTAL PACK PRESSURE DROP

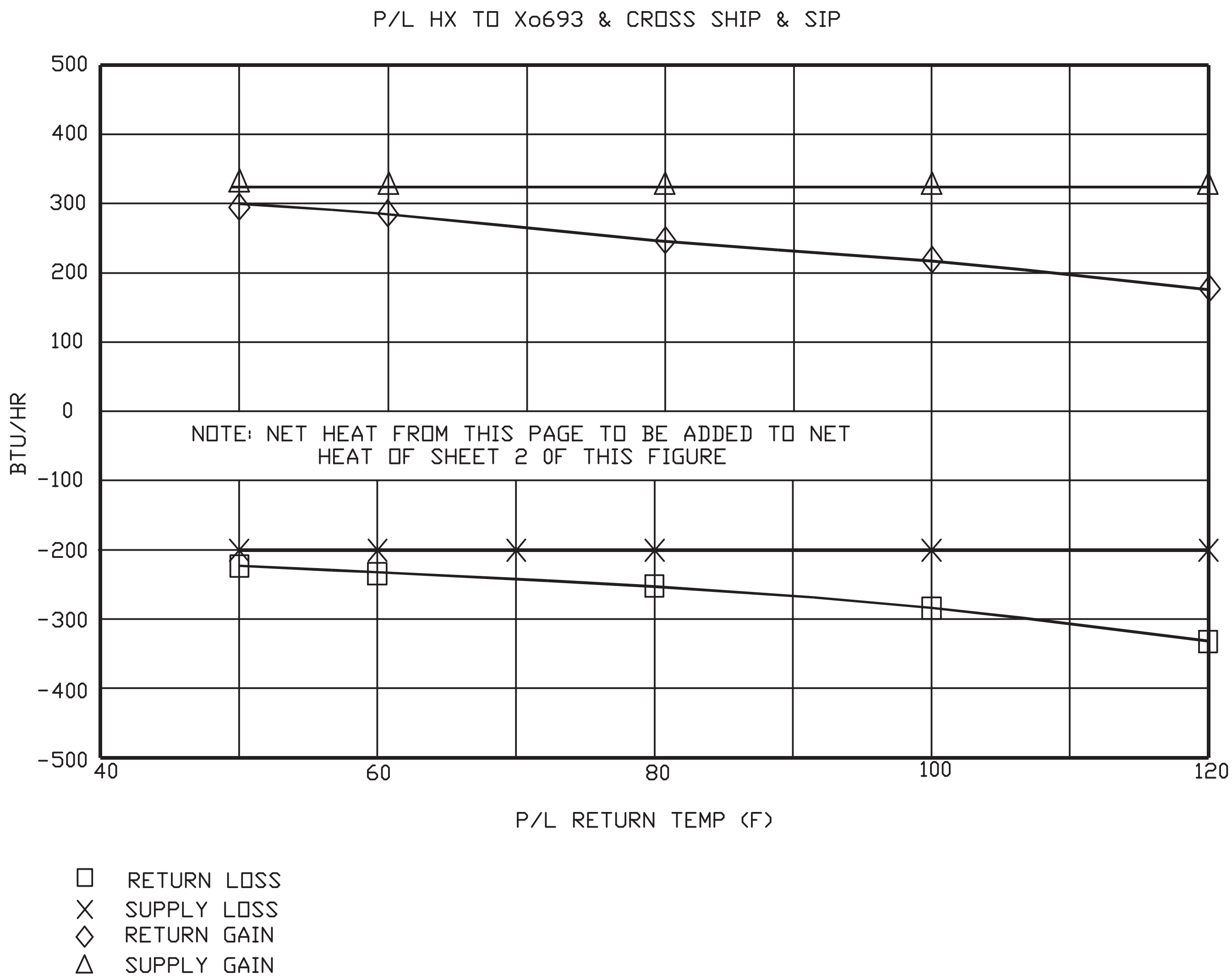


FIGURE 6.2.2.2-2 PREDICTED PACK HEAT GAIN AND LOSS
(SHEET 1 OF 2)

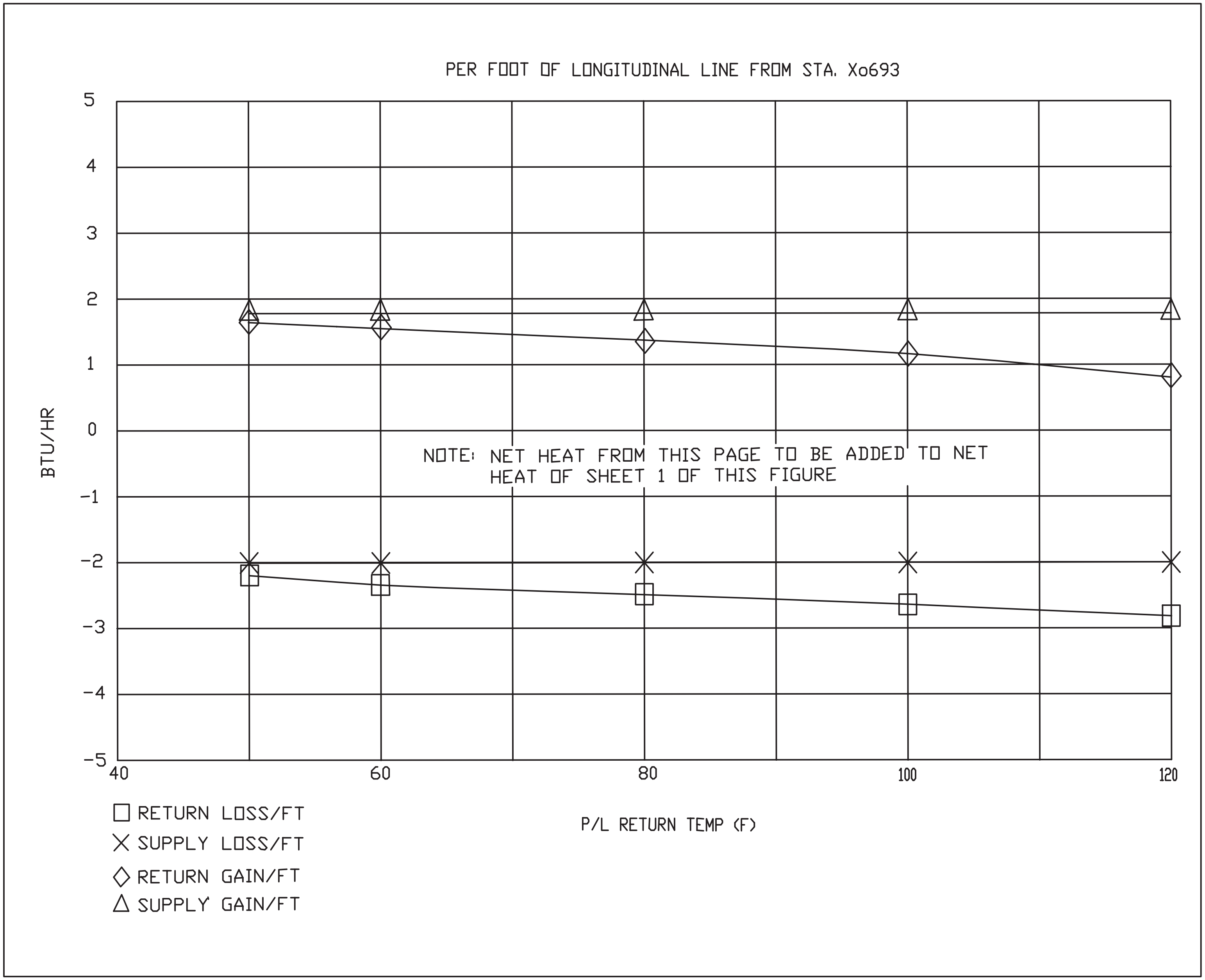


FIGURE 6.2.2.2-2 PREDICTED PACK HEAT GAIN AND LOSS
(SHEET 2 OF 2)

THIS PAGE INTENTIONALLY LEFT BLANK.

6.3 ATMOSPHERIC REVITALIZATION SYSTEM (ARS)

6.3.1 Oxygen Supply to Station Xo 636

The Orbiter shall supply low-pressure oxygen to the interface at the payload heat-exchanger panel per Figure 3.3.4.1-1. The characteristics of the oxygen supply at the payload heat-exchanger panel interface shall be as follows:

a. Pressure: Minimum pressure is a function of the flow demand since a restrictor limits the flow to a maximum of 7 lb/hr per loop. Nominal 114.7+10/-15 psia (5934+517/-776 mm Hg). "No Flow" Max 139.7 psia (7227 mm Hg)

Maximum: (failed regulator) 259.7 psia (13,434 mm Hg)

b. Temperature: +35 to +120°F (1.6 to 48.9°C)

c. Flow: Nominal: 0.46 lb/hr (0.209 kg/hr) (Except during Orbiter airlock operations, EVA suit purges, or 8 psia (414 mm Hg) pressure maintenance.)

Maximum: One regulator operating 7 lb/hr (3.18 kg/hr). Two regulators operating 14 lb/hr (6.35 kg/hr). (Oxygen is flow-limited by a restrictor. Its flow rate shall be limited to 6 to 7 lb/hr with an inlet pressure of 115 psia and 70±10°F).

d. Mass: 56 lbs (25.43 kg) available from each EPS cryo kit added for payload power.

6.3.1.1 CABIN LOCATED PAYLOAD ELEMENT AIR COOLING

6.3.1.1.1 Maximum Allowable Heat Loads

A payload may be cooled with or without payload provided capability to internally circulate cabin air. The total cabin payload heat load will not cause the cabin air temperature to exceed the temperatures given below:

Mission Phase	Max. Cabin Temp	Conditions
pre-launch/ascent	75°F	without TELCG
	75+5°F	with TELCG
on-orbit	80°F	14.7 psi and 10.2 psi cabin pressure
descent/landing, post-landing	75°F	with or without TELCG

TELCG: Thermo-Electric Liquid Cooling Garment (worn by the crew)

The actual amount of payload heat rejection available during pre-launch, ascent, descent/landing, and post-landing is a function of launch time, crew size, on-orbit attitude and configuration, type of crew cooling, etc., and shall be determined by an integrated analysis on a flight-by-flight basis.

Tables 6.3.1.1.1-1, -2, -3 and -4 define the maximum allowable cabin air heat dissipation during the various mission phases. When the AFD active cooling is less than 700 watts, linear interpolation determines the allowable passive heat load.

6.3.1.1.2 Passive Cooling

Payloads relying on dissipation of waste heat by free convective heat transfer only (i.e., without the use of a fan or similar means) shall be constrained to the following heat load:

PAYLOAD CONTAINER	HEAT LOAD
Standard Stowage Locker	60 Watts
Payload Equipment on AFD Panel	15 Watts

The design value for the free convective heat transfer coefficient shall be 0.25 BTU/Hr °F Ft^2 for 14.7 psia and 0.17 BTU/Hr °F Ft^2 for 10.2 psia cabin pressure. Payloads which are required to operate during EVA or EVA pre-breathe periods shall design cooling based on 10.2 psia cabin pressure.

6.3.1.1.3 Forced Air Cooling

When a payload provides an air circulation fan which discharges to the cabin, the maximum air outlet temperature shall not exceed 120°F.

The forced cooling design shall be compatible with ingestion of up to 1 gram of lint-like contamination from the cabin and/or 1.0 in^2 material blockage or provide protection from that contamination (the Orbiter avionics filters are designed to provide a flow area of 1 to 5 in^2/lbm/hr using 50 by 250 micron pleated filter material. Additionally, the cooling system design shall not contribute to further contamination of the cabin.

6.3.1.1.4 External Surface Temperatures

External surface temperatures of payload elements accessible to the crew shall not exceed 113°F, while inaccessible external surfaces shall not exceed 120°F.

6.3.2 Payload Station and Mission Station Support (14.7 psia Cabin Pressure)

The active cooling at these locations shall be provided by drawing air from the cabin through the air cooled payload electronics and into the Orbiter ducting system. Total cooling air flow available to all manifested payload electronics located in the Aft Flight Deck (AFD) stations is dependent on the air flow distribution in each of the payload and mission stations as defined in Figure 6.3.2-1.

Air-cooled-avionics air flow shall be provided at a rate of 0.406 lbs/hr per watt of heat load. This rate is based on a maximum air temperature increase of 35°F (19.5°C) across each equipment item at a cabin environment of 95°F and 14.7 psia. When operating at 10.2 psia an air temperature increase of 50°F (32.4°C), from 80°F to 130°F, is allowable. The resulting flow will provide sufficient cooling at both 10.2 and 14.7 psia operations. Therefore, the 14.7 psia conditions should be used for design.

Air cooling kits are provided by STS and are payload unique. The kits provide the necessary ducting between the Orbiter manifold shown in Figures 3.4.1.2.4-1, 3.4.1.2.3-1, and 3.4.1.4.4-1 and the payload. The pressure drop allocation for the payload is dependent on the payload interface location, the flow requirement, and the ducting size selection. Although interface ducting diameter is normally 1.5 inches, ducting as large as 2.5 inches is compatible with the 2.5 inch ports shown in the figures. Since 1 inch of water is the total pressure drop available for the ducting to the manifold plus the payload, the pressure drop available to the payload will be less than 1 inch of water. The interface definition at the payload and the maximum pressure drops to the payload shall be negotiated with the STS and specified in the PIP.

6.3.2.1 (Deleted)

6.3.2.2 (Deleted)

6.3.3 Cabin Environment

All payload hardware located within the Orbiter crew cabin shall be certified to be safe for the full range of environments specified in the table below:

Parameter	Minimum	Maximum
Crew Accessible Surface Temperature		120° F (49° C)
Crew Inaccessible Surface Temperature		120° F (49° C)
Dew Point	39° F(4°C)	61° F (16° C)
Cabin air temperature	65° F (18° C)	90° F (32° C)
Cabin air temperature (Ferry Flight only)	32° F (0° C)	120° F (49° C)
Atmospheric Pressure	10.0 psia (0.69 bar)	18.1 psia (1.25 bar)
Orbiter cabin rate of pressurization	-9.0 psi/min (-0.62 bar/min)	2.0 psi/minute (0.14 bar/min)
Particulate level	Cabin air	
Cabin O_2 concentration	19.8%	25.9% at 14.7 psia 30% at 10.2 psia 32% at 8 psia

For design or analysis purposes, the mounting structure to which the payload attaches and the average radiant environment within the consoles shall be considered to be 90°F maximum during on-orbit operations, and 120°F during ascent and descent phases. The radiation environment should be considered to be a heat sink at constant temperature, whereas, the mounting structure may be driven above 90°F when power is applied. Rejection of payload heat load to the structure shall not be considered as a means of cooling.

<u>6.3.3.1 Emergency Bailout Requirements</u>

Payloads located within the crew compartment area shall be designed to meet the following depressurization requirements in order to ensure they will not present a hazard to the crew or to the Orbiter which could jeopardize crew survivability or impede crew egress during emergency bailout procedures:

Cabin Pressure Range	Initial (Max)	15.2	PSIA
	Final (Min)	3.95	PSIA
Max Depressurization Rate		0.4	PSI/SEC

<u>6.3.4 Habitable Payload</u>

The Orbiter shall provide conditioned air at a rate of 53 +/- 10 CFM to the habitable payload via an air interchange duct. Air return to the Orbiter shall be via the tunnel. The air interchange shall be available when the Orbiter hatch and the ARS supply duct valves are open. A typical ARS diagram is presented in Figure 6.3.4-1. The Orbiter hatch shall be closed during launch and reentry and shall be equipped with a pressure equalization valve operable from either side of the hatch. The Orbiter and payload atmospheric environment shall each comply with the requirements of 6.3.3 during all phases of a flight.

<u>6.3.4.1 Atmospheric Condition Monitoring</u>

The payload shall provide instrumentation for verification of the atmospheric conditions within the habitable payload, this shall be displayed and verified in the Orbiter AFD prior to hatch opening.

<u>6.3.4.2 Carbon Dioxide Control And Removal</u>

The habitable payload shall have a carbon dioxide removal system capable of limiting the CO_2 partial pressure within the volume to 7.6 mm Hg based on the normal metabolic rate for designed maximum occupancy.

<u>6.3.4.3 Surface Temperatures</u>

Surface temperatures accessible to the crew shall not exceed 113°F, inaccessible surfaces shall not exceed 120°F.

6.4 (DELETED)

TABLE 6.3.1.1.1-1 MAXIMUM LAUNCH COOLING WATTAGE AVAILABLE FOR CABIN LOCATED PAYLOADS (CABIN TEMPERATURE = 80°F)

AFD Active Cooling	Crew Size	Cabin Pressure (psia)	FCL FPM Configuration	Cargo HX Load (kW)											
				0.0			1.0			2.0			3.0		
				Rear-breather Load (W)											
				0	800	1600	0	800	1600	0	800	1600	0	800	1600
0 W	5	14.7	IC/IC	800	700	700	700	600	500	500	400	400	400	300	200
			IC/PL												
			PL/PL												
	6	14.7	IC/IC	700	600	600	600	500	400	400	300	300	300	200	100
			IC/PL												
			PL/PL												
	7	14.7	IC/IC	700	600	600	600	500	400	400	300	300	300	200	100
			IC/PL												
			PL/PL												
700 W	5	14.7	IC/IC	600	500	500	500	400	300	300	200	100	200	100	0
			IC/PL												
			PL/PL												
	6	14.7	IC/IC	500	400	400	400	300	200	200	100	0	100	0	0
			IC/PL												
			PL/PL												
	7	14.7	IC/IC	500	400	400	400	300	200	200	100	0	100	0	
			IC/PL												
			PL/PL												

Parameters:
1. Water coolant loop in manual mode (IC flow rate=850 lbm/hr actual).
2. Linear Interpolation between values provides good estimate for payload capability.
3. Orbiter heat sink outlet = 38.5 °F.
4. Orbiter passive equipment = 186 W.
5. All passive values are based on OV-104 heat loads.

Cabin temperature violation, unacceptable.
Configuration unavailable at this time.

TABLE 6.3.1.1.1-2 MAXIMUM ON-ORBIT COOLING WATTAGE AVAILABLE FOR CABIN LOCATED PAYLOADS (CABIN TEMPERATURE = 80°F)

AFD Active Cooling	Crew Size	Cabin Pressure (psia)	FCL FPM Configuration	Cargo HX Load (kW)											
				0.0			1.0			2.0			3.0		
				Rear-breather Load (W)											
				0	800	1600	0	800	1600	0	800	1600	0	800	1600
0 W	5	14.7	IC/IC	1400	1300	1100	1100	900	800	800	600	400	400	300	200
			IC/PL	1000	700	500									
			PL/PL	200											
		10.2	IC/IC	500	400	300									
	6	14.7	IC/IC	1300	1200	1000	1000	800	700	700	500	300	300	200	100
			IC/PL	900	600	400									
			PL/PL	100											
		10.2	IC/IC	400	300	200									
	7	14.7	IC/IC	1200	1100	900	900	700	600	600	400	200	200	100	0
			IC/PL	800	500	300									
			PL/PL	0											
		10.2	IC/IC	300	200	100									
700 W	5	14.7	IC/IC	1200	1100	900	900	700	500	500	400	200	300	200	100
			IC/PL	600	400	200									
			PL/PL												
		10.2	IC/IC	300	200	100									
	6	14.7	IC/IC	1100	1000	800	800	600	400	400	300	100	200	100	0
			IC/PL	500	300	100									
			PL/PL												
		10.2	IC/IC	200	100	0									
	7	14.7	IC/IC	1000	900	700	700	500	300	300	200	0	100	0	
			IC/PL	400	200	0									
			PL/PL												
		10.2	IC/IC	100	100										

Parameters:
1. Water coolant loop in automatic mode.
2. Linear Interpolation between values provides good estimate for payload capability.
3. Orbiter heat sink outlet = 38.5 °F.
4. Orbiter passive equipment = 758 W.
5. Passive values for 14.2 psia may be obtained by subtracting 100 W from 14.7 IC/IC passive values.
6. All passive values are based on OV-104 heat loads.

(hatched) Cabin temperature violation, unacceptable.
(shaded) Configuration unavailable at this time.

TABLE 6.3.1.1.1-3 MAXIMUM GROUP B (6.5 HOUR POWER-UP) COOLING WATTAGE AVAILABLE FOR CABIN LOCATED PAYLOADS (CABIN TEMPERATURE = 80°F)

AFD Active Cooling	Crew Size	Cabin Pressure (psia)	FCL FPM Configuration	Cargo HX Load (kW)											
				0.0			1.0			2.0			3.0		
				Rear-breather Load (W)											
				0	800	1600	0	800	1600	0	800	1600	0	800	1600
0 W	5	14.7	IC/IC	1200	1100	1000	900	800	600	600	400	300	300	100	0
			IC/PL	600	400	200									
			PL/PL												
		10.2	IC/IC	300	200	0									
	6	14.7	IC/IC	1100	1000	900	800	700	500	500	300	200	200	0	
			IC/PL	500	300	100									
			PL/PL												
		10.2	IC/IC	200	100										
	7	14.7	IC/IC	1000	900	800	700	600	400	400	200	100	100	0	
			IC/PL	400	200	0									
			PL/PL												
		10.2	IC/IC	100	0										
700 W	5	14.7	IC/IC	1000	900	700	700	500	400	400	200	200	100	0	
			IC/PL	300	100	0									
			PL/PL												
		10.2	IC/IC	100	0										
	6	14.7	IC/IC	900	800	600	600	400	300	300	100	100	0		
			IC/PL	200	0										
			PL/PL												
		10.2	IC/IC	0											
	7	14.7	IC/IC	800	700	500	500	300	200	200	0				
			IC/PL	100	0										
			PL/PL												
		10.2	IC/IC												

Parameters:
1. Water coolant loop in automatic mode.
2. Linear Interpolation between values provides good estimate for payload capability.
3. Orbiter heat sink outlet = 38.5 °F.
4. Orbiter passive equipment = 758 W.
5. Passive values for 14.2 psia may be obtained by subtracting 100 W from 14.7 IC/IC passive values.
6. All passive values are based on OV-104 heat loads.

(Hatched) Cabin temperature violation, unacceptable.
(Gray) Configuration unavailable at this time.

TABLE 6.3.1.1.1-4 MAXIMUM ENTRY COOLING WATTAGE AVAILABLE FOR CABIN LOCATED PAYLOADS (CABIN TEMPERATURE = 80°F)

AFD Active Cooling	Crew Size	Cabin Pressure (psia)	FCL FPM Configuration	Cargo HX Load (kW)											
				0.0			1.0			2.0			3.0		
				Rear-breather Load (W)											
				0	800	1600	0	800	1600	0	800	1600	0	800	1600
0 W	5	14.7	IC/IC	600	500	400	400	300	200	300	200	100	100	0	
			IC/PL												
			PL/PL												
	6	14.7	IC/IC	500	400	300	300	200	100	200	100	0	0		
			IC/PL												
			PL/PL												
	7	14.7	IC/IC	400	300	200	200	100	0	100	0				
			IC/PL												
			PL/PL												
700 W	5	14.7	IC/IC	400	300	200	200	100	0	0					
			IC/PL												
			PL/PL												
	6	14.7	IC/IC	300	200	100	100	0							
			IC/PL												
			PL/PL												
	7	14.7	IC/IC	200	100	0	0								
			IC/PL												
			PL/PL												

Parameters:
1. Water coolant loop in manual mode (IC flow rate=850 lbm/hr actual).
2. Linear Interpolation between values provides good estimate for payload capability.
3. Orbiter heat sink outlet = 38.5 °F.
4. Orbiter passive equipment = 186 W.
5. All passive values are based on OV-104 heat loads.

(hatched) Cabin temperature violation, unacceptable.
(shaded) Configuration unavailable at this time.

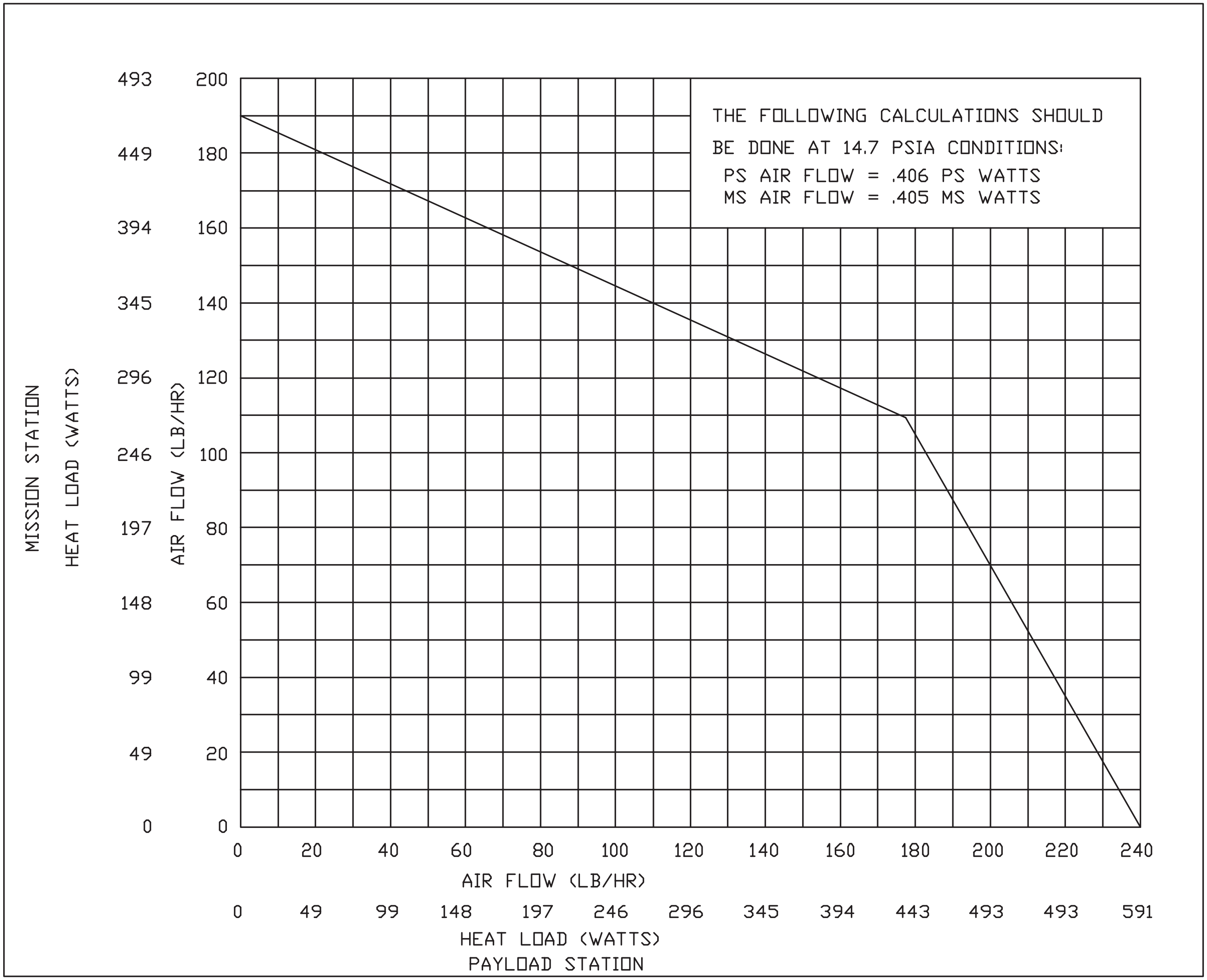


FIGURE 6.3.2-1 AIR FLOW AND HEAT LOAD DISTRIBUTION IN PAYLOAD AND MISSION STATIONS

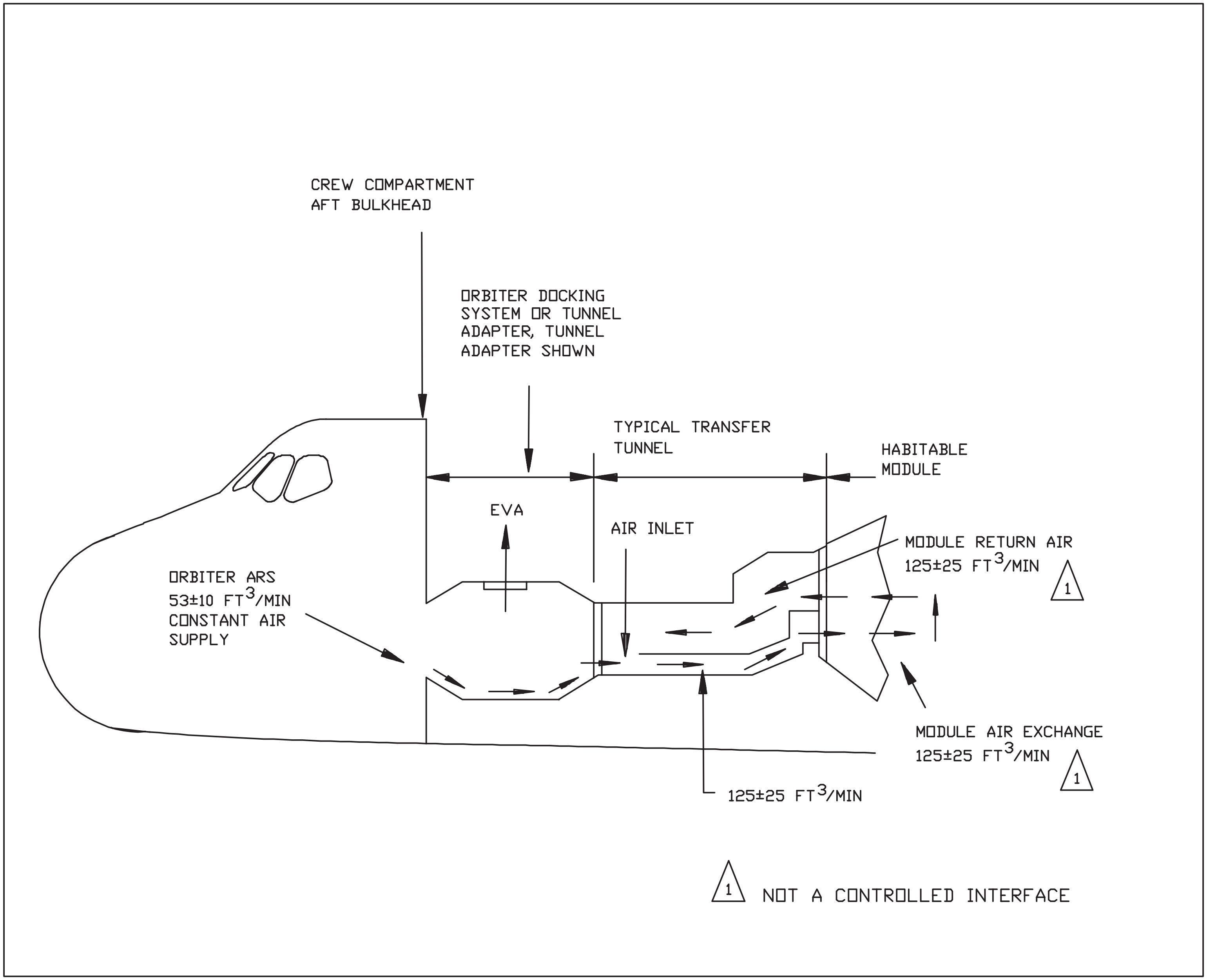


FIGURE 6.3.4-1 TYPICAL HABITABLE MODULE ARS DIAGRAM

THIS PAGE INTENTIONALLY LEFT BLANK.

7.0 ELECTRICAL POWER INTERFACES

7.1 ELECTRICAL POWER ACCOMMODATIONS

7.1.1 Electrical Power Accommodations

Standard DC power accommodations for payloads are divided into four sections, with each section allocated one-fourth of the total DC power. Standard DC power is available in the cargo bay from the Primary PL Bus and in the crew compartment from the Cabin Payload Bus. Additionally, optional DC power accommodations are available from Auxiliary Buses A and B, Aft Payload Buses B and C and the Orbiter utility outlets. AC power, always an optional service, is available in the crew compartment at the PSDP and MSDP as well as from the Orbiter utility outlets. AC power can be made available in the payload bay by jumpering at the MSDP interfaces. In addition, AC power provisions are accessible on an as-available basis via Orbiter longeron connector panels to operate payload ASE latches or other compatible electrical systems.

The capabilities of the power interface allocated to payloads are defined in Paragraphs 7.3 and 7.4. Orbiter utility outlet power accommodations are specified in NSTS-21000-IDD-MDK. The total electrical power available to payloads during each mission phase shall be as defined in the following subparagraphs.

7.1.1.1 Total Electrical Power Allocations (*Prelaunch/Ascent/Descent/Postlanding)

Up to 3200 watts, (DC or DC equivalent) of total power shall be provided to payloads during each of the mission phases from all Orbiter sources in the crew compartment and the payload bay (up to 2600 watts may be used in the cargo bay and up to 600 watts may be used in the crew compartment). The mission-specific available payload power shall be limited to assure compliance with the Orbiter/SRB electrical interface requirements as specified in ICD 2-14001 for all nominal and single power source failure conditions. The amount of crew cabin power used shall also be compatible with the thermal requirements and limitations of paragraph 6.3.1.1. If T-0 power is used in the cargo bay, consideration shall be given to possible thermal impacts.

* Prelaunch is defined as that period from launch-10 hours to liftoff.

7.1.1.2 Total Electrical Ground Operations/On-Orbit Power Allocations

Up to 8000 watts maximum continuous, 12000 watts peak, (DC or DC equivalent) of total power shall be provided to payloads during each of the mission phases from all Orbiter sources in the crew compartment and the payload bay. Of the maximum continuous amount, up to 2100 watts may be used in the crew cabin. The amount of payload power available for use in the crew compartment shall be constrained to a level such that the temperature requirements specified in paragraph 6.3.1.1 are not violated. Vehicle specific power capability for middeck utility outlets are specified in NSTS-21000-IDD-MDK.

7.1.2 GSE Power Allocations

As a standard service, power T-0 umbilical services are divided into four sections with limited GSE power capability. As a non-standard service, GSE power accommodations are available for payload use via starboard T-0 umbilical connector J74. These services are described in Paragraph 7.3.6.

7.1.3 (Deleted)

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.

THIS PAGE INTENTIONALLY LEFT BLANK.

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 AFD DC Power and Cargo Bay Auxiliary Power

Orbiter AFD DC power and cargo bay auxiliary power distribution is as shown in Figure 7.3.1.2-1.

7.3.1.3 Cargo Bay Aft DC Power

Orbiter Aft DC power distribution in the cargo bay is as shown in Figure 7.3.1.3-1.

7.3.1.4 Circuit Protection Criteria

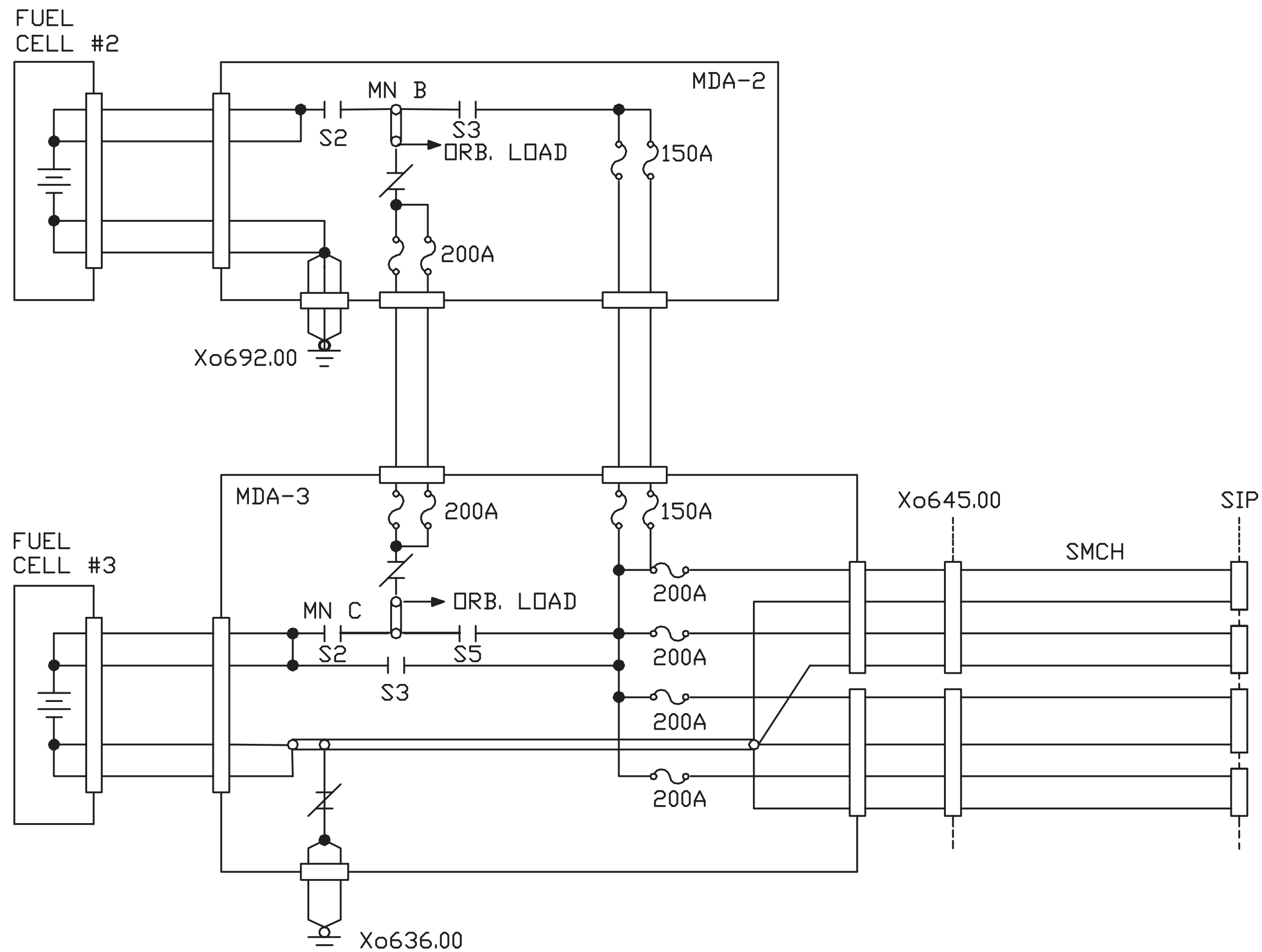
Payload electrical power distribution circuitry shall be designed such that electrical faults do not damage Orbiter wiring nor present a hazard to the Orbiter or crew. Circuit protection devices shall be incorporated into the payload design in compliance with the NASA electrical design criteria for cargo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

Orbiter electrical wiring insulation is rated at 200 degrees Celsius.

7.3.1.5 SSP Current Protection

When powered by the cargo element, Standard Switch Panel wiring shall be protected with a circuit protection device equivalent to a 5 amp fuse or smaller, located on the cargo element side of the interface.

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



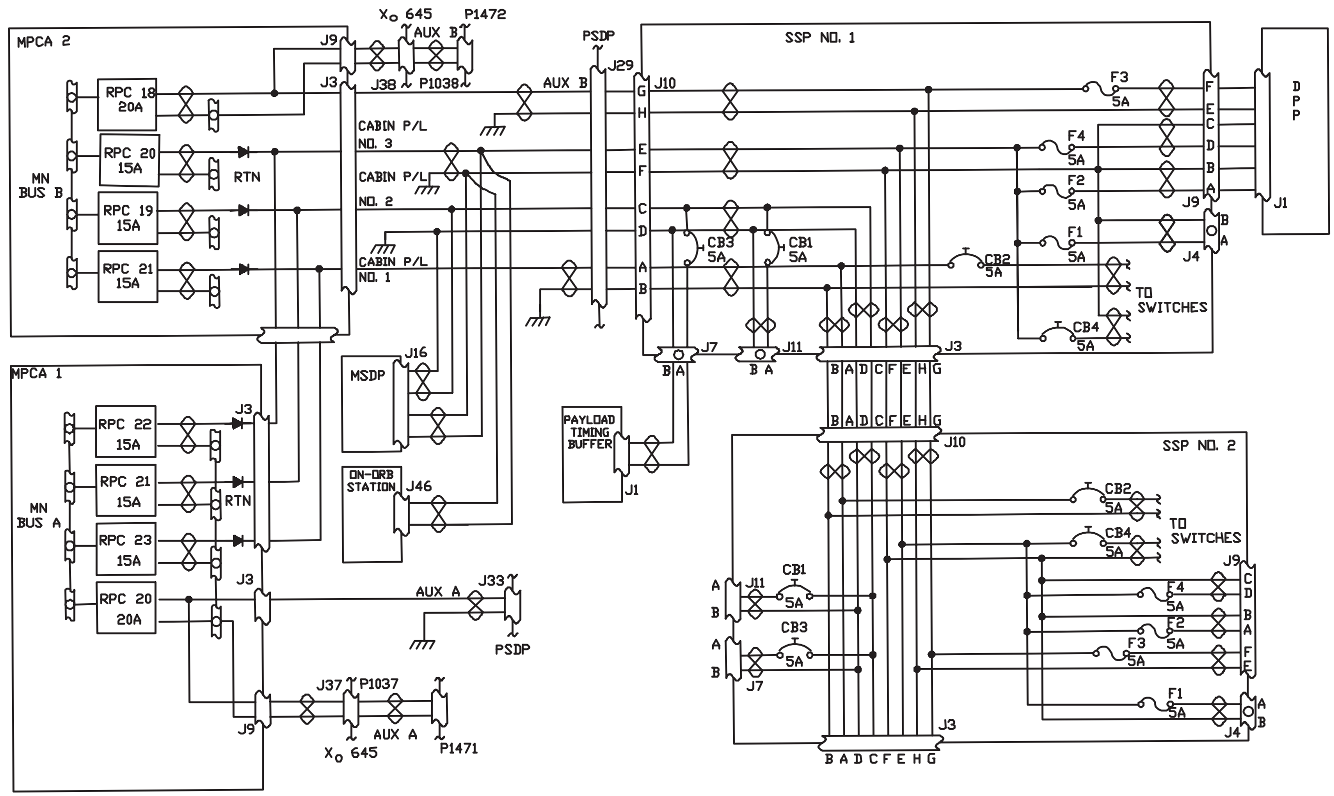


FIGURE 7.3.1.2-1 ORBITER DC POWER DISTRIBUTION TO THE AFT FLIGHT DECK AND CARGO BAY

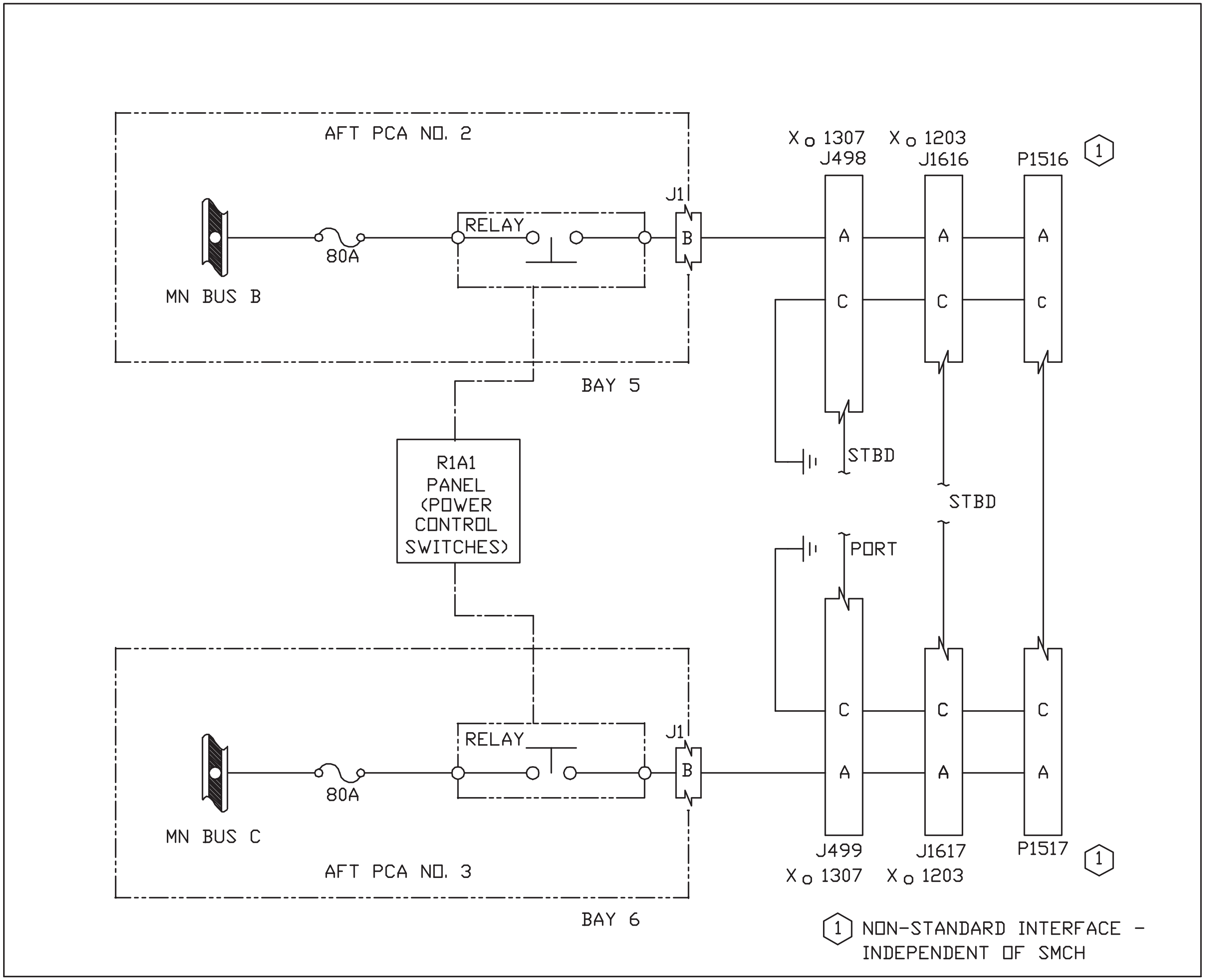


FIGURE 7.3.1.3-1 ORBITER AFT DC POWER DISTRIBUTION TO THE CARGO BAY

THIS PAGE INTENTIONALLY LEFT BLANK.

7.3.2 Cargo Bay Primary PL BUS

7.3.2.1 SMCH-SIP Interface

The standard single section payload allocation for DC electrical power provided by the Primary PL bus is specified in Table 7.3.2.1-1. The payload electrical power interfaces are located at the termination of SMCH-cables at the Standard Interface Panel (SIP). On-orbit voltage level at the SIP is as shown in Figure 7.3.2.1-1.

7.3.2.2 Xo645 Interface

As an alternative to a SMCH-SIP interface, access to the Primary PL BUS can be provided at the Xo645 power interface when specified in the Payload Integration Plan (PIP). The capability of this interface is defined in Table 7.3.2.2-1.

TABLE 7.3.2.1-1 PRIMARY PL BUS/SINGLE-SECTION SMCH (AT END OF SMCH)

MISSION PHASE	VOLTS RANGE (VDC)	POWER (WATTS)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
Ground Operation	27 - 32 (2)	375 1750	375 3000	N/A (5)	(1) (3)(4)
Prelaunch/Ascent/ Descent/Post-Landing	26.5 - 32	650	650	N/A	
On-Orbit	(2)	1750	3000	(5)	(4)

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

(2) See Figure 7.3.2.1-1 for voltage levels.

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

(4) Up to 2000 watts maximum continuous power may be allocated to a payload if there is a corresponding decrease (down to 0 watts) from other possible payload sources.

(5) One or more power peaks in excess of the 2.0 kW maximum continuous value shall be permitted provided:

a. Their maximum value does not exceed 3.0 kW.

b. The total time above the maximum continuous value does not exceed one hour, and

c. Their total excess energy equivalent does not exceed 0.25 kWh.

The preceding shall not occur more often than once in any three hour period.

TABLE 7.3.2.2-1 PRIMARY PL BUS - Xo645 ELECTRICAL POWER PANEL

MISSION PHASE	VOLTS RANGE (VDC)	POWER (KW)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
Ground Operation	27.2-32 27.2-32	1.5 7.0	1.5 12.0	N/A (4)	(1) (2) (3)
Prelaunch/Ascent/ Descent/Post-Landing	27.2-32	2.6	2.6	N/A	
On-Orbit	27.2-32	7.0	12.0	(4)	(3)

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

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

(3) Up to 8000 watts maximum continuous power may be allocated to a payload if there is a corresponding decrease (down to 0 watts) from other possible payload sources.

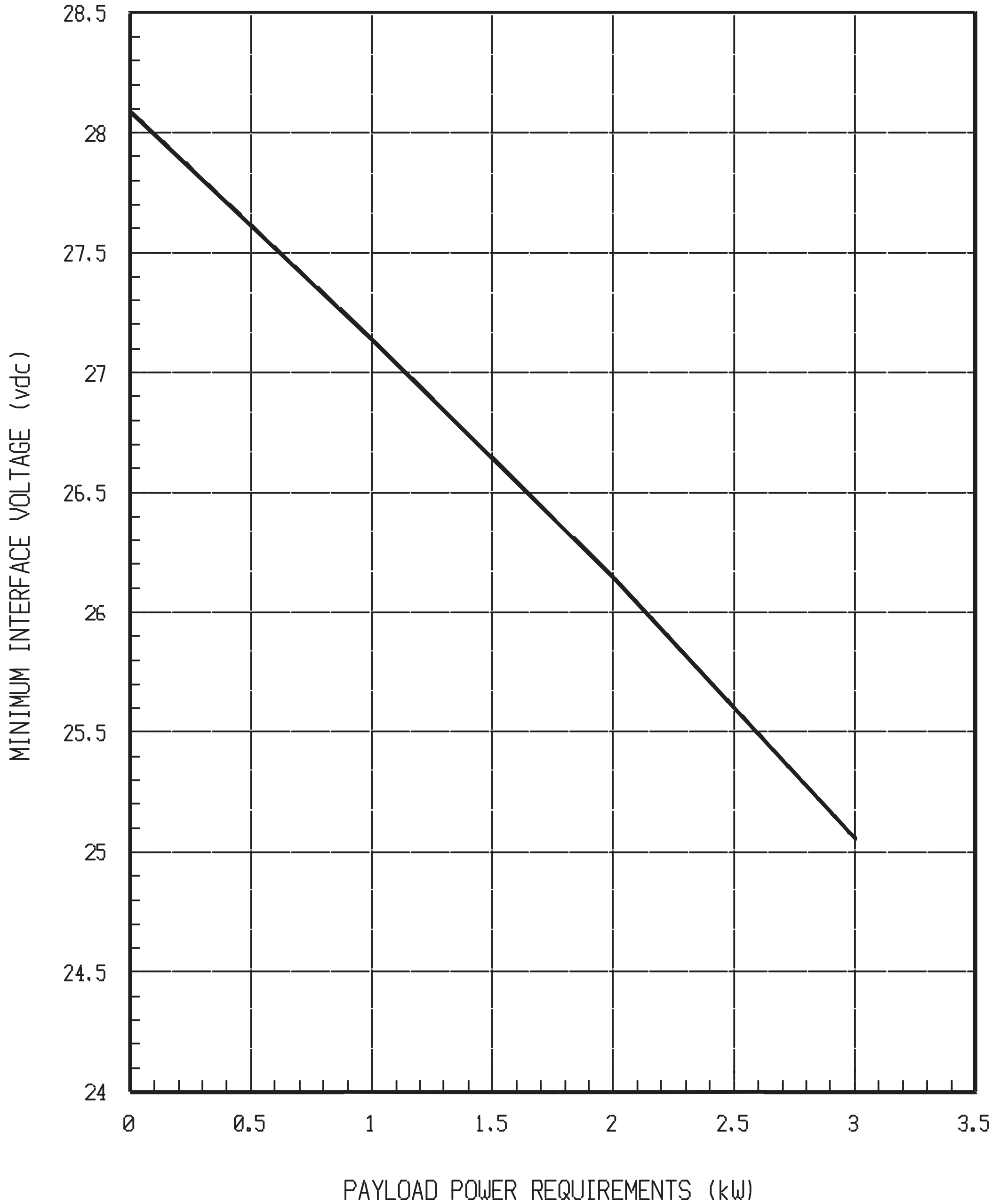
(4) One or more power peaks in excess of the 8.0 kW maximum continuous value shall be permitted provided:

a. Their maximum value does not exceed 12.0 kW.

b. The total time above the maximum continuous value does not exceed one hour, and

c. Their total excess energy equivalent does not exceed 1.0 kWh.

The preceding shall not occur more often than once in any three hour period.



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. ASSUMES INITIAL PRIMARY PAYLOAD BUS LOAD OF 5kW
4. ASSUME MAIN B AND MAIN C BUS TIED
5. ASSUME VARIED LOAD (0 - 3kW PAYLOAD) AT END OF 57 FT. SMCH HARNESS

FIGURE 7.3.2.1-1 SMCH INTERFACE VOLTAGE LEVELS

THIS PAGE INTENTIONALLY LEFT BLANK.

7.3.3 Cabin Payload Bus

DC electrical power provided by the Orbiter to Cabin PL BUS (AFD), for each Cargo Element section by mission phase, shall be as specified in Table 7.3.3-1.

TABLE 7.3.3-1 CABIN PAYLOAD BUS/SINGLE-SECTION SMCH

MISSION PHASE	VOLTS RANGE (VDC)	POWER (WATTS)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
Ground Operation	25.7-32	200	200	N/A	(1)
Ascent/Descent/ Post-Landing	24.2-32	100	100	N/A	
On-Orbit	24.2-32	200	200	N/A	(1)

(1) Actively cooled equipment in the Orbiter Aft Flight Deck shall not draw more than 175 watts, per Figure 6.3.2-1.

THIS PAGE INTENTIONALLY LEFT BLANK.

7.3.4 Aux PL A or Aux PL B

Electrical power is provided by the Aux PL A and/or Aux PL B buses when specified in the Payload Integration Plan (PIP). The capability of these interfaces is defined in Table 7.3.4-1.

The total auxiliary power utilized from both buses shall not exceed twice the allocation specified in Table 7.3.4-1. This table specifies power available at either one of these two buses. Power may be drawn from either one or both simultaneously. The auxiliary buses may be tied together, if diode isolated, but, the total power is limited to that of a single bus in this instance. Aux PL A and Aux PL B are available at separate connectors at Xo645 and at the PSDP.

TABLE 7.3.4-1 AUX PL A OR AUX PL B

MISSION PHASE	VOLTS RANGE (VDC)	POWER (WATTS)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
Any phase (Xo645)	26.1-32	400	400	N/A	(1)
Any phase (AFD)	25.7-32	200	200	N/A	(1)

(1) Total power from both Xo645 and AFD interfaces shall not exceed 400 watts on either AUX BUS A or AUX BUS B.

THIS PAGE INTENTIONALLY LEFT BLANK.

7.3.5 Aft PL B or Aft PL C

Electrical power is provided by the Aft PL B and/or Aft PL C buses, when specified in the Payload Integration Plan (PIP). The capability of these interfaces are defined in Table 7.3.5-1.

The total Aft PL power utilized from both buses shall not exceed twice the allocations specified in Table 7.3.5-1. This table specifies power available at either one of these two buses. Power may be drawn from either one or both simultaneously. Aft PL B and Aft PL C are available at separate connectors on the starboard Xo1203 interface panel.

TABLE 7.3.5-1 AFT PL B OR AFT PL C (Xo1203)

MISSION PHASE	VOLTS RANGE (VDC)	POWER (KW)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
Ground Operation	25.7-32	1.5	1.5	N/A	
Descent/Post-Landing	25.7-32	1.0	1.0	N/A	
On-Orbit	24-32	1.5	1.5	N/A	

THIS PAGE INTENTIONALLY LEFT BLANK.

7.3.6 PL GSE Power

GSE power via the T-0 umbilical is independent of Orbiter power distribution subsystems. Utilization of T-0 wires for commands and signals requires that these functions meet the EMC criteria (including voltage limits) specified in Paragraph 10.7.1. GSE power shall be provided in accordance with the following paragraphs.

7.3.6.1 T-0 Wiring

Payloads shall utilize T-0 wiring for power within the limits specified in Table 7.3.6.1-1. Current limiting shall be provided by the payload for each wire pair utilized, such that the limits of Table 7.3.6.1-1 are not exceeded.

7.3.6.1.1 Port T-0 Wiring

Port side T-0 power accommodations shall be provided to payloads via T-0 connectors J55/J58, J67/J69, and J59 (i.e., SIP connectors J102, J104 amd J106), and in accordance with payload SMCH-section requirements.

7.3.6.1.2 Non-Standard Starboard SIP T-0 Wiring

The entire T-0 power accommodations on the starboard side are provided via T-0 connector J74. Service via T-0 connector J74 shall not be available for cargo use except as agreed to in the Payload Integration Plan (PIP).

7.3.6.2 T-0 Power Source

The power source(s) for T-0 power, whether cargo element or STS provided, shall meet the EMC requirements specified for cargo equipment level (crew compartment) in Figure 10.7.3.1-1.

7.3.6.3 Contingency Orbiter Rollback

Power shall be removed from the Orbiter vehicle 11 hours prior to rollback to the VAB and nominally remains off until return to the Launch Pad. Payload customers must plan on not having power-on capability for up to three days while at VAB. For anticipated stays of more than three days, the required interfaces will be connected and power will be applied to the Orbiter for health status checks only. The payload bus may be powered at this point.

Once the Orbiter vehicle is positioned in the VAB and power is applied to the MLP, payloads that have interface racks in MLP room 10A may be applied to perform some limited functions (e.g., trickle charging through the T-0 umbilical) if local control is available. Landlines to other facilities are not available. Each payload must be evaluated for T-0 capabilities.

TABLE 7.3.6.1-1 T-0 WIRING CHARACTERISTICS

EMC CLASS	SMCH-SIP I/F CONN. (GAGE)	VIA T-0 CONN.	MAXIMUM CURRENT PER WIRE SEGMENTS (AMPS)	MAXIMUM VOLTAGE AT PWR SOURCE (VDC)	MAX. ROUND TRIP DC RESISTANCE (OHMS)				
					SIP/T-0 CONN.	SIP/OPF	SIP RM 10A	SIP RM 220	SIP RM 221
HO	P1502/1504 (12)	J74	22	100	0.90	1.40	1.50	1.80	2.10
HO	J102 (20)	J55 AND J58	6	100	3.00	3.80	7.90	13.80	14.50
HO	J102*	J55 AND J58	6	100	3.00	3.80	4.70	4.90	5.30
ML	J104 (22)	J67 AND J69	1	100	4.20	6.40	9.10	13.00	14.20
RF	J106**	J59	1	100	7.00	12.20	15.90	19.80	20.90

1. (Reserved)

2. Power returns must be twisted with corresponding hot wires.

3. Returns shall be single-point grounded at the payload (flight end) only.

4. When wire bussing is utilized, current limiting (e.g. fusing, etc.) shall be provided for individual wires (hot side) at one end only when two wire pairs are utilized. When wire bussing of three or more wire pairs is utilized, current limiting shall be provided at each end of each wire pair (hot side only).

5. (Reserved)

6. From 30 minutes before launch until launch, the amount of current being transferred through the T-0 umbilical shall be limited to 500 milliamps per circuit (wire pair).

7. When required, a maximum of 125 VAC, 12 Amps may be applied through the associated HO wiring of the J74 T-0 connector.

* See Table 13.5.1.1-4 for low resistance circuit paths.

** OV-102 only: SIP to Xo1307 is 24 gage, Xo1307 to T-0 is 20 gage; for all other vehicles, SIP to T-0 is 24 gage.

THIS PAGE INTENTIONALLY LEFT BLANK.

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 250 kHz.

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 250 kHz.

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 250 kHz); 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 appear at the cargo element interface as measured differential mode (line to line). A typical positive transient is shown in Figure 7.3.7.2-1. A typical negative transient is shown in Figure 7.3.7.2-2.

7.3.7.2.1 Hydraulic Circulation Pump and Aft PL Busses

Hydraulic circulation pump produced transient voltages on the Aft PL B and Aft PL C DC busses, at the payload interfaces, shall not exceed the voltage envelope of Figure 7.3.7.2.1-1. Payload design shall accommodate sawtooth transient oscillations, having a maximum amplitude of 11 volts peak-to-peak on the Aft PL Busses at the payload interface. The oscillation has a base frequency between 500 and 700 Hz and is contained within the inner envelope shown in Figure 7.3.7.2.1-1. 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 planning.

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)

The narrowband ripple voltage at the interface shall not exceed an envelope with limits 1.2 volts peak-to-peak (30 Hz to 7 KHz) falling log-linear to 0.28 volts peak-to-peak at 70 KHz, thereafter remaining constant to 250 kHz.

The momentary coincidence of two or more signals at any one frequency shall not exceed an envelope with limits 2.0 volts peak-to-peak (30 Hz to 7 KHz), falling log-linear to 0.5 volts peak-to-peak at 70 KHz, thereafter remaining constant to 250 kHz.

Ground power transients on the Orbiter D.C. power buses appear at the cargo element interface as measured differential mode (line to line). A typical positive transient is shown in Figure 7.3.7.2-1. A typical negative transient is shown in Figure 7.3.7.2-2.

7.3.7.4.1 Hydraulic Circulation Pump and Ground Power

When the Orbiter is on ground power, hydraulic circulation pump start-up will produce voltage transients on the DC bus connected to the pump and all sub-buses for that bus. The oscillations have a base frequency between 500 and 700 Hertz with a duration of approximately 250 to 300 milliseconds and an amplitude of 14 volts. Only one pump motor shall be turned on at a time.

Hydraulic pump operations is required at the commencement of cryo loading.

7.3.7.5 Susceptibility Testing

7.3.7.5.1 Methodology and Recommended Testing

It is recommended that the techniques and/or test methods of SL-E-0002 be followed when required to demonstrate compatibility with the STS DC power bus environments. The recommended limits and test methods to demonstrate compatibility with the environment are those of CS101 (from 30 Hz and extended to 250 KHz) for power bus ripple and CS106 for power bus transients. For positive transients shown in Figure 7.3.7.2-1, measurements shall be made into a 50-Ohm source.

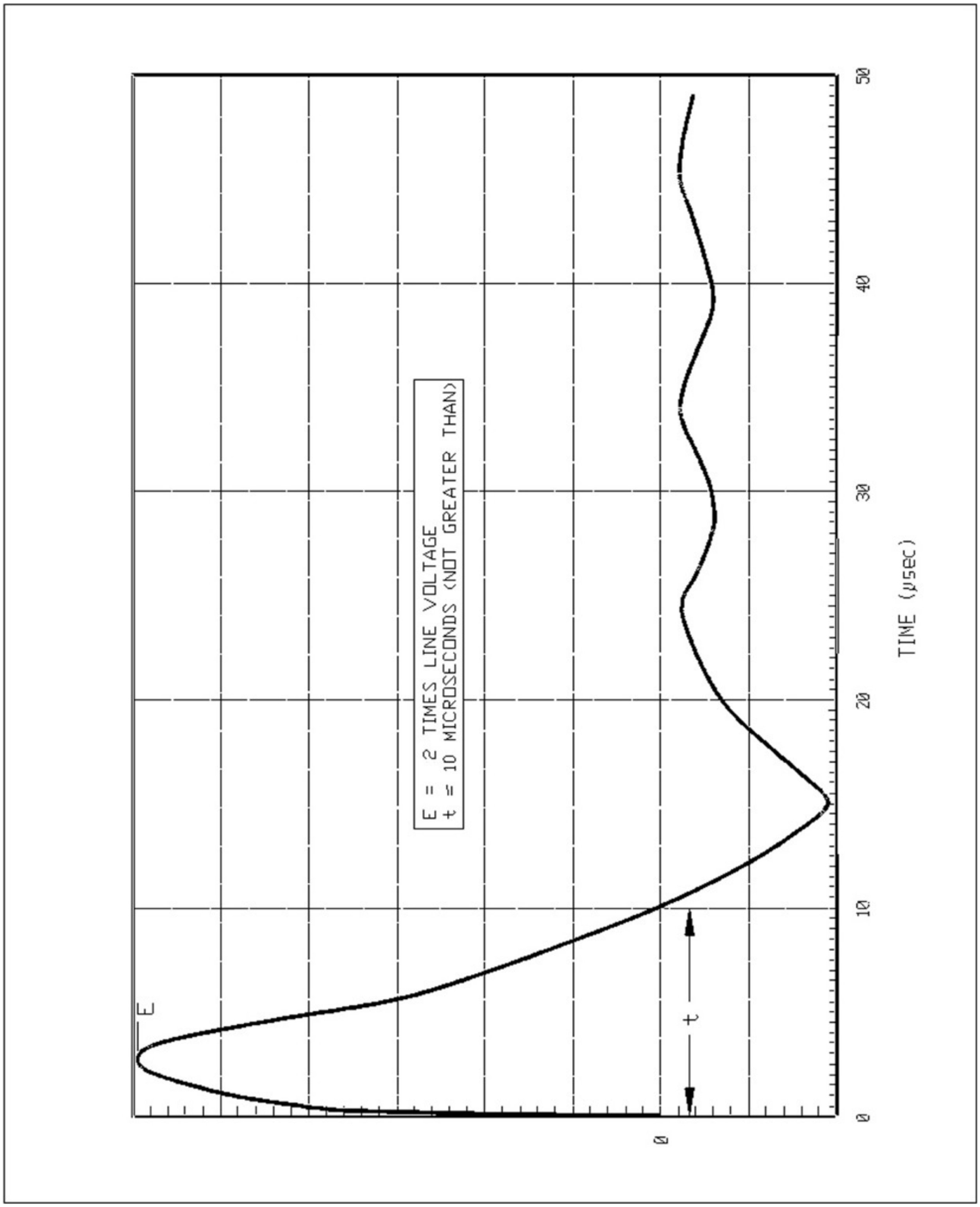


FIGURE 7.3.7.2-1 INFLIGHT AND GROUND DC POWER POSITIVE TRANSIENTS (MEASURED LINE-TO-LINE) AT ALL CARGO ELEMENT DC POWER INTERFACES

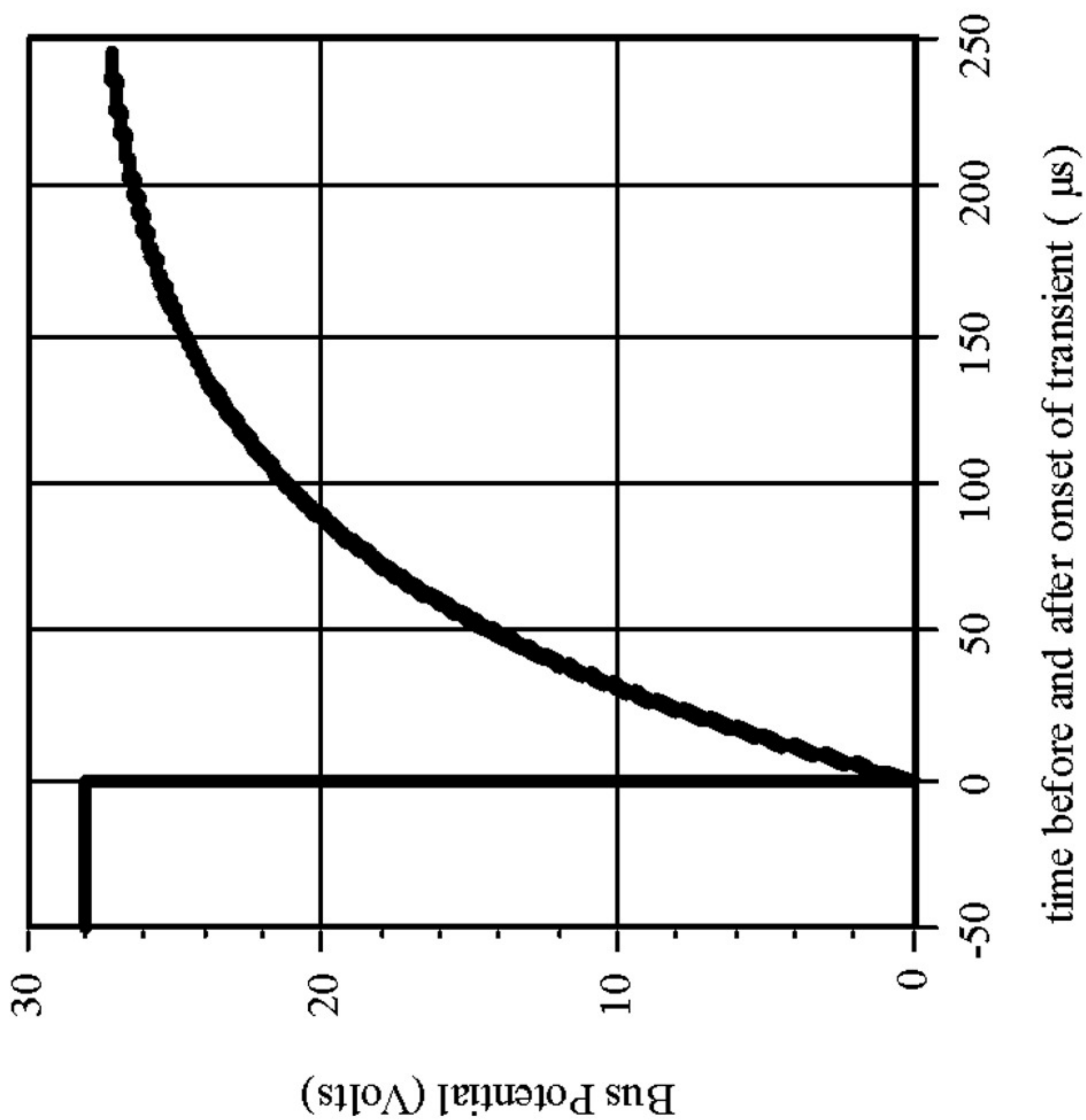


FIGURE 7.3.7.2-2 IN FLIGHT AND GROUND DC POWER NEGATIVE TRANSIENTS AT ALL CARGO ELEMENT DC POWER INTERFACES

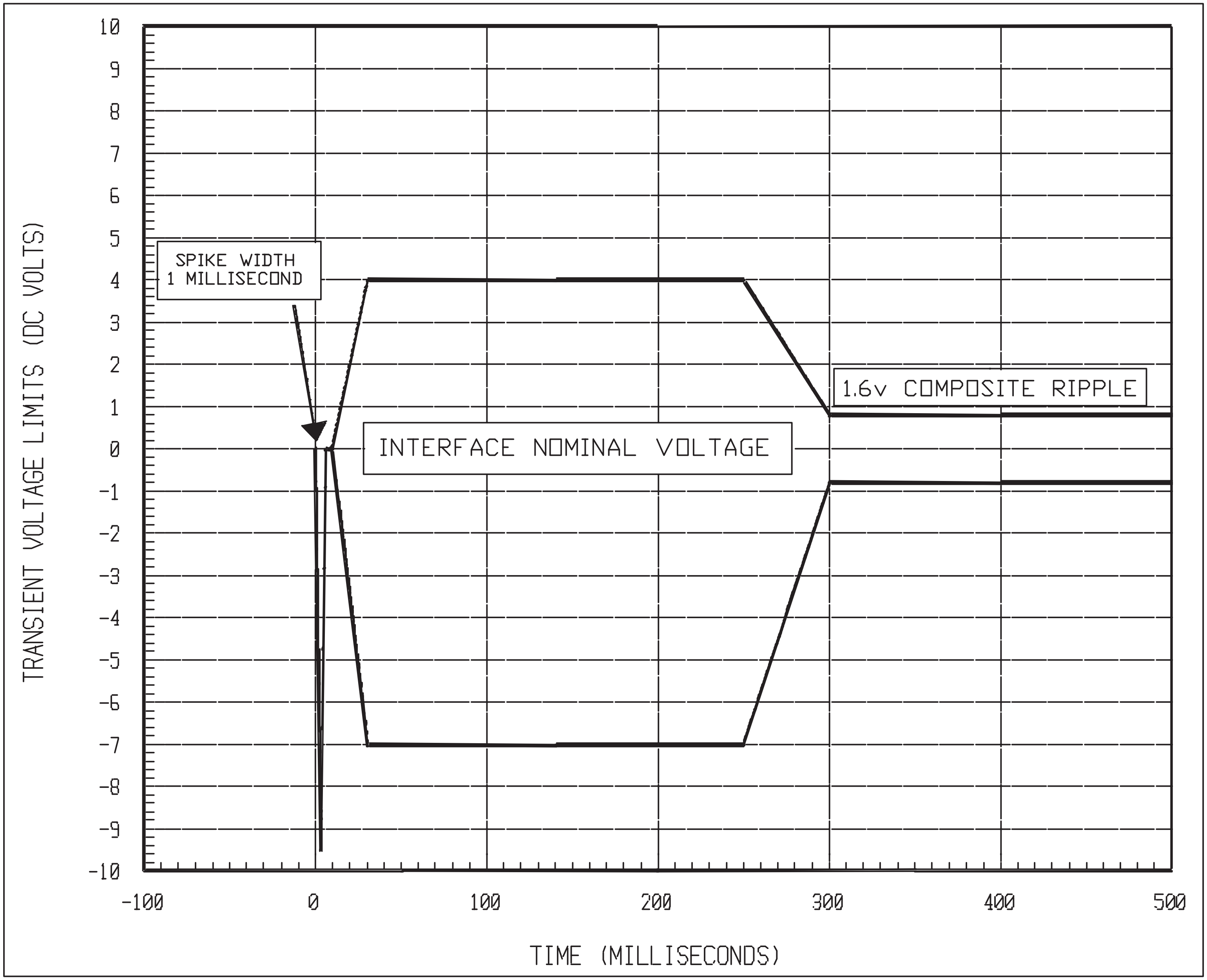


FIGURE 7.3.7.2.1-1 TRANSIENT VOLTAGE ON THE AFT PL B AND C DC BUSSES PRODUCED BY OPERATION OF THE HYDRAULIC CIRCULATION PUMP

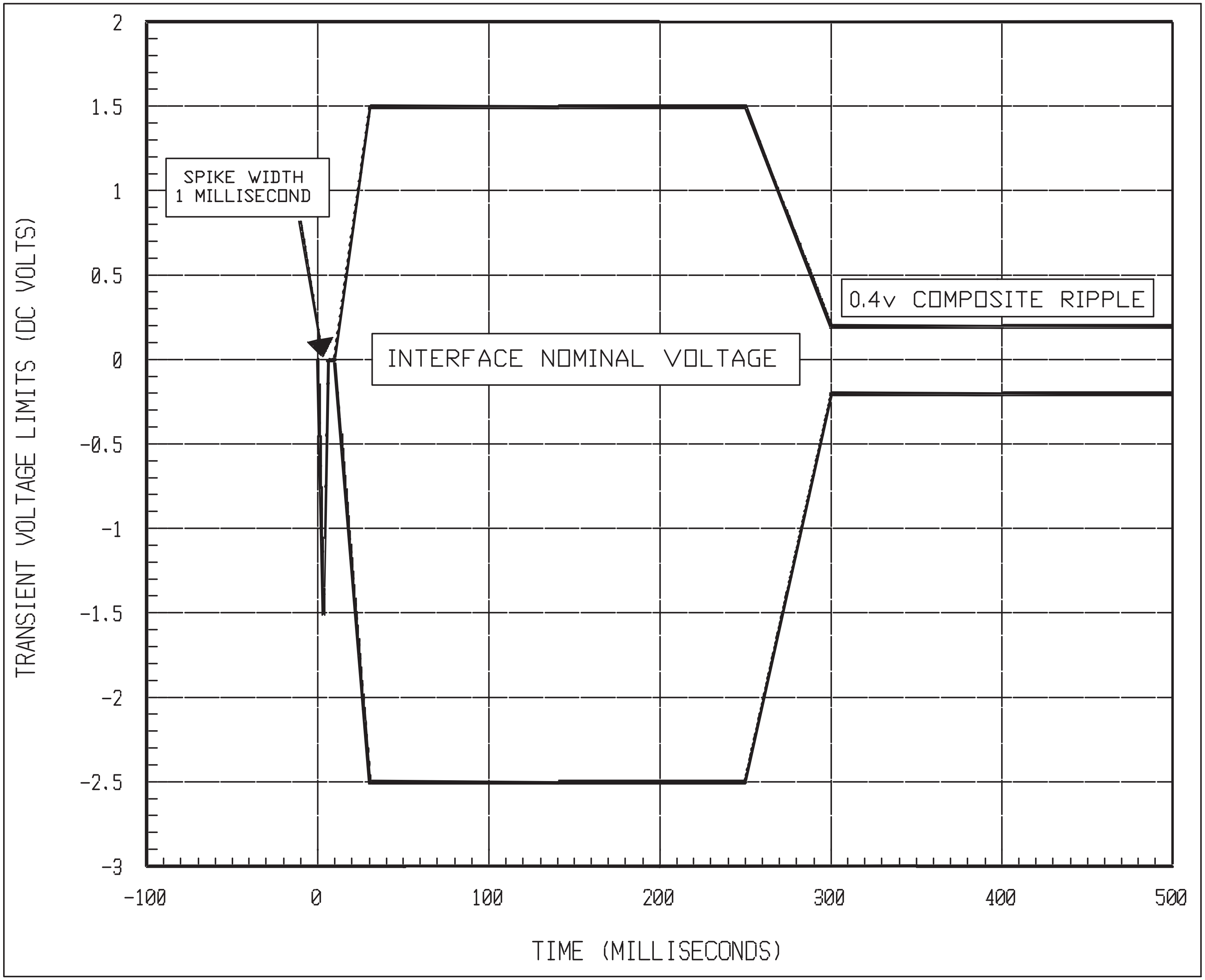


FIGURE 7.3.7.2.2-1 TRANSIENT VOLTAGE ON THE PRI PL BUS, AUX PL A, AUX PL B AND THE CABIN PL BUS AT THE CARGO ELEMENT INTERFACE PRODUCED BY OPERATION OF THE HYDRAULIC CIRCULATION PUMP

THIS PAGE INTENTIONALLY LEFT BLANK.

7.4 AC POWER

7.4.1 AC Power Characteristics

Total AC electrical power shall be provided in the Aft Flight Deck (AFD) for use in the AFD and/or cargo bay (Xo603) for each mission phase as specified in Table 7.4.1-1. This table specifies power available at either or both buses simultaneously.

7.4.2 Voltage Characteristics

Voltage characteristics on each AC power bus shall be as specified below:

Type:	AC, 3-phase, 4-wire, wye.
Voltage:	System: 115/200 volts RMS Steady-state: 115 ±5 volts RMS Modulation: 3.5 volts maximum when measured as the peak-to-valley difference between the maximum and minimum voltages reached on the modulation envelope over a period of at least one second. Transient limits: 115 ±15 volts RMS - with 5 to 10 msec recovery to steady-state limits. Spikes: -600 volts to +600 volts (refer to Paragraph 7.4.2.1)
Frequency:	Limits: 400 ±7 Hz Modulation: ±1 Hz
Waveform:	Sine with crest factor of 1.41 ±0.15 Total harmonic: 5 percent of fundamental (RMS) Individual harmonic: 4 percent of the fundamental RMS when measured with a harmonic analyzer.
Phase:	Sequence: A-B-C Displacement: 120 ±2°
Power Factor:	Equipments shall present as near unity power factor as practicable. The fully loaded equipment loads shall present a power factor on the worst phase within the limits defined in Figure 7.4.2-1

In addition, the average Orbiter inverter efficiency is 76.5 percent. Inverter losses in supplying AC power to the cargo shall be included in calculations of Cargo chargeable energy.

7.4.2.1 AC Power Ripple and Transients

AC power bus ripple shall be limited to 1.5 volts RMS from 30 Hz to 1.5 KHz falling to 0.6 volts RMS at 50 KHz thereafter remaining constant to 250 kHz, except that the ripple shall not exceed 4 percent RMS of the A.C. line voltage at inverter harmonic frequencies. With the AC neutral line grounded to Orbiter structure, the transient spikes measured on the three phases shall not exceed the levels defined in Figure 7.4.2.1-1 for both normal and abnormal AC system operation. The impedance into which the spikes are generated shall be 50 ohms minimum for significant frequency components of the spikes. Figure 7.4.2.1-1 is not intended to represent actual spikes, but rather to define stress levels for design purposes.

Shuttle produced transients less than one millisecond on the AC power busses are not controlled therefore, the use of electronic loads on the orbiter AC power busses is strongly discouraged.

Payloads shall not use AC powered electronic loads to control safety critical functions.

7.4.2.2 Susceptibility

7.4.2.2.1 Methodology and Recommended Testing

It is recommended that the techniques and/or test methods of SL-E-0002 be followed when required to demonstrate compatibility with the STS AC power bus environments. The recommended test method to demonstrate compatibility with the ripple environment is CS101, steady state susceptibility (30 Hz and extended to 250 KHz).

TABLE 7.4.1-1 AC POWER CHARACTERISTICS/AC2 OR AC3 (1)

MISSION PHASE	VOLTS RANGE (VAC RMS)	VOLTS-AMP(VA)		TIME LIMIT ON PEAK POWER	REMARKS
		CONT. MAX.	PEAK		
Ground operation	115 ± 5	690	1000	2 min/3 hr	(2)
Descent/Postlanding	115 ± 5	350	420	2 min/3 hr Phase	(2)
On-orbit	115 ± 5	690	1000	2 min/3 hr	(2)

(1) AC power is not available during prelaunch countdown and ascent phases.

(2) AC loads greater than 100 VA must be balanced three phase loads. Single phase loads are limited to less than 100 VA.

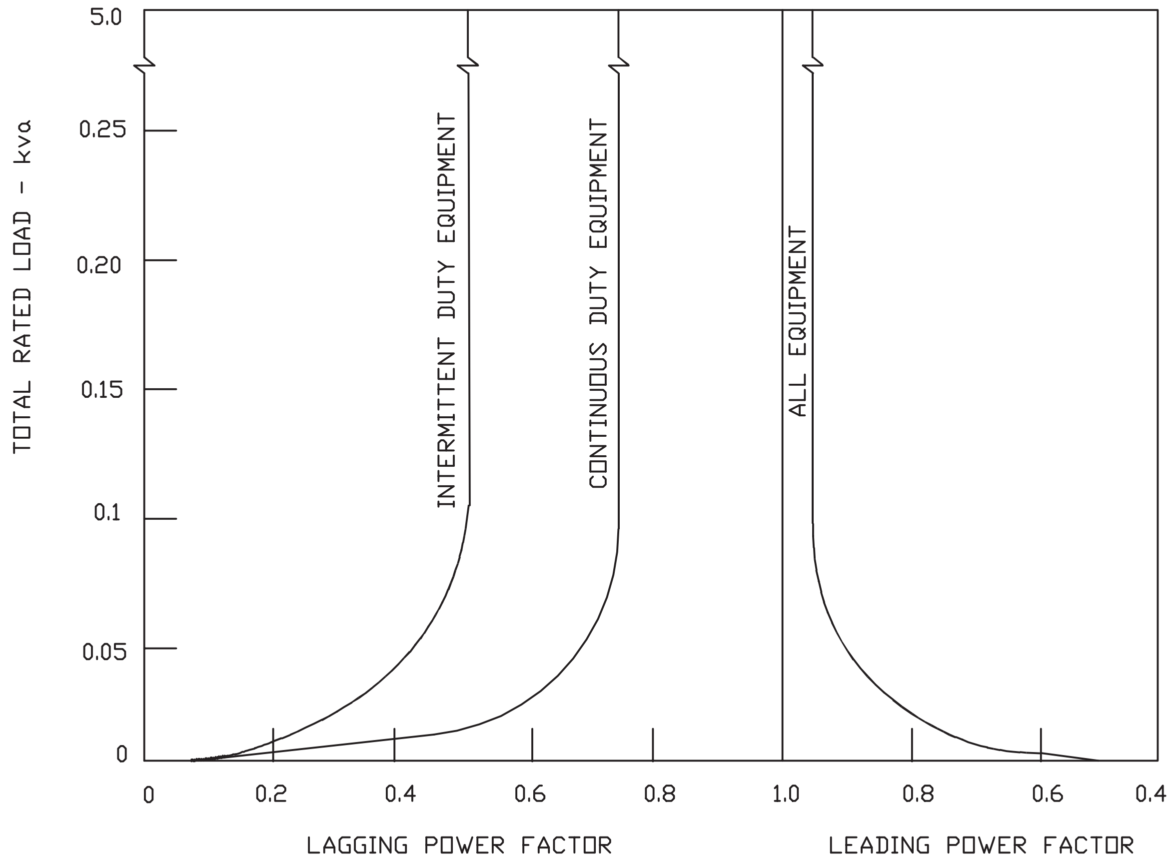


FIGURE 7.4.2-1 POWER FACTOR LIMITS FOR UTILIZATION EQUIPMENT

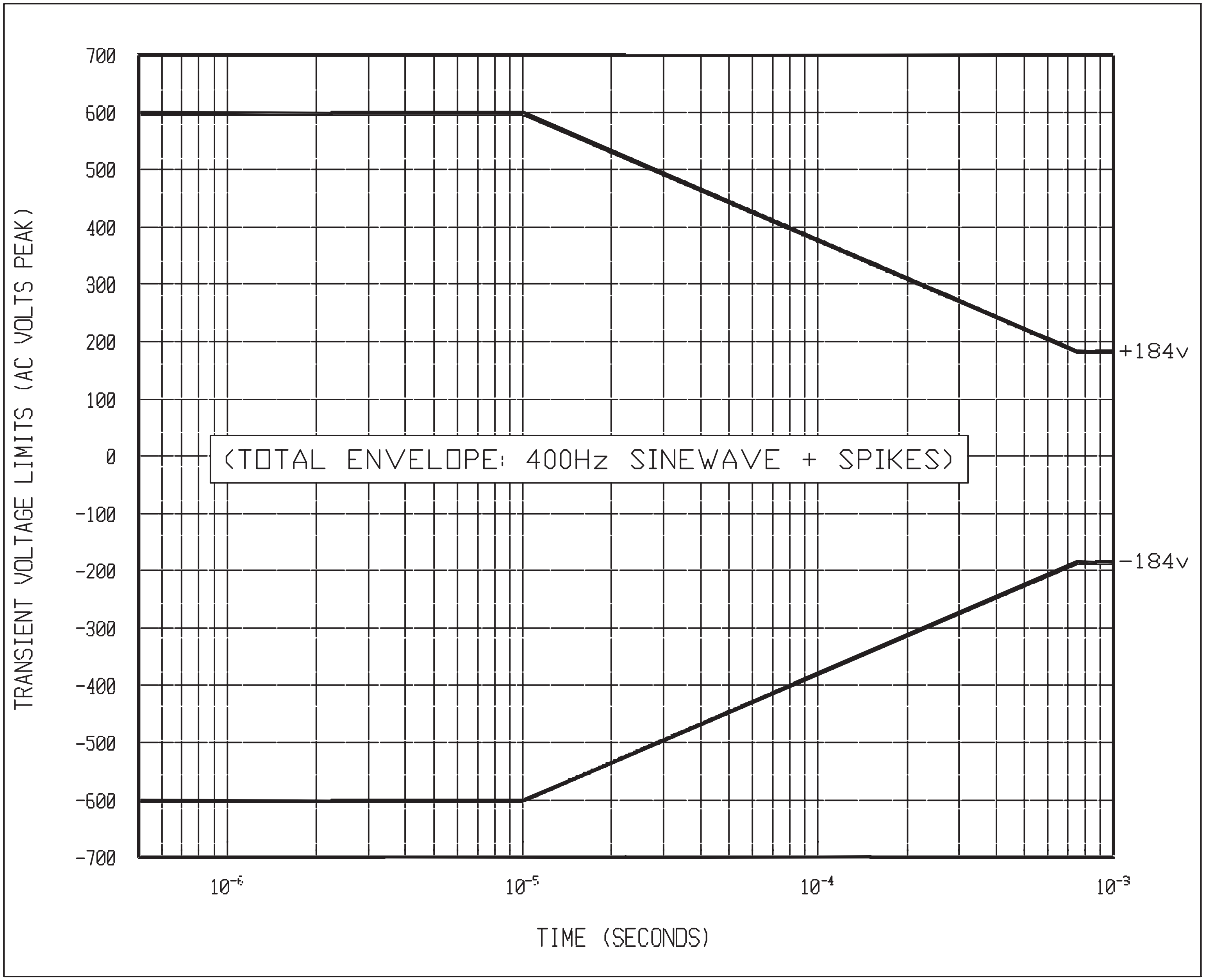


FIGURE 7.4.2.1-1 ENVELOPE OF ORBITER PRODUCED SPIKES ON THE AC POWER BUS

THIS PAGE INTENTIONALLY LEFT BLANK.

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 per single-section payload allocation 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 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 busses, the total power utilized per initiation shall not exceed 80 amps (peak) measured at the interface defined in the cargo element unique ICD.

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 continuous draw if the initiator(s) shorts.

c. Figure 7.5.4-1 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 initiation commands.

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

7.5.5 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.

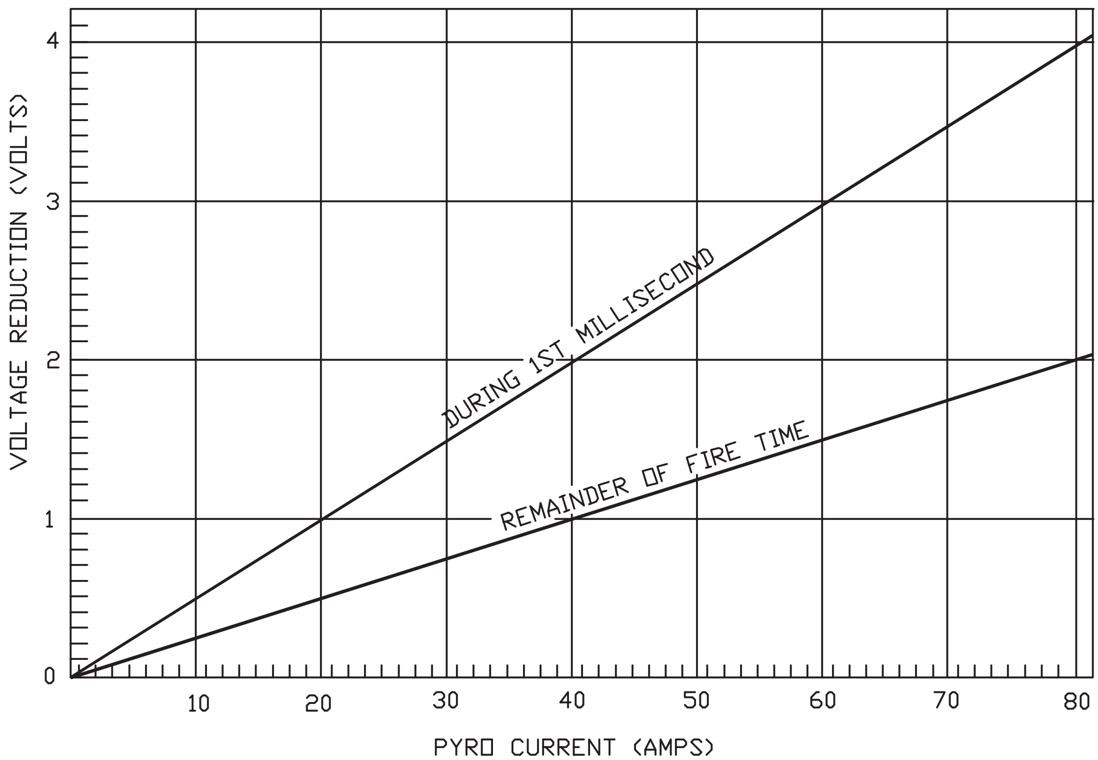


FIGURE 7.5.4-1 VOLTAGE REDUCTION DUE TO PYROTECHNIC FIRING

THIS PAGE INTENTIONALLY LEFT BLANK.

7.6 RETENTION SYSTEM POWER PROVISIONS

7.6.1 Availability to Cargo Elements

Orbiter/Cargo Element retention system power shall be used on an as-available basis to operate latches attaching deployable payloads to cargo element ASE or for other electrically actuated functions compatible with system capability.

7.6.2 Retention System DC Excitation Voltage and Returns

The Orbiter shall provide 28V DC nominal (32V DC maximum) stimulus voltage to the cargo element. This voltage shall be used exclusively for switch closure return to the Orbiter for the purpose of driving indications and stimulating control logic. The Orbiter shall provide current limited outputs for this voltage. The cargo element shall feed back to the Orbiter three 28V DC (nominal) signals. These signals shall be as follows:

a. Ready for Latch Function. Signal indicating payload is mechanically oriented for latching.

b. Latched Indication. Switch closure signal signifying latching system has achieved locked-up position.

c. Released Indication. Switch closure which is activated when latch is in fully open condition.

Function (a) shall be used by the Orbiter to operate crew talkback indicators and telemetry status signals. Indications (b) and (c) shall be used by the Orbiter to inhibit and enable AC latch power as well as provide status signal inputs to telemetry.

7.6.3 AC Power Accommodations

The Orbiter PRLA voltage is 115 + 5, -7 VAC RMS (steady state) with the characteristics specified in Paragraphs 7.4.2 and 7.4.2.1. In addition, the Orbiter AC power shall provide for phase sequencing to reverse motor operation. Maximum latch power requirements are as follows:

170 Watts per motor operating
1.42 Amps per phase per motor operating

315 Watts per motor starting
2.0 Amps per phase motor starting

The Orbiter shall provide three-ampere (derated to 2.85 ampere) circuit breaker/phase protection for this service.

7.7 ELECTRICAL CONNECTORS

7.7.1 Electrical Connector Deadfacing

Electrical deadfacing of interfacing connectors when mating or demating shall comply with NSTS-08080-1, Standard 69, except that connectors which mechanically demate in flight will not require electrical deenergizing of signals prior to demating under the following conditions:

a. The demating connector is in the Orbiter cargo bay.

b. At the time of connector demate, the Orbiter shall be in the "on-orbit" flight phase with the cargo bay doors open.

c. At the time of connector demate, the current on any single circuit shall not exceed 500 milliamperes.

d. The demated connector retained on the Orbiter side shall be mechanically retained.

e. Either the demated connector retained on the Orbiter side shall be the socket (female) side of the connector, or all power shall be removed from the demated connector in the Orbiter bay before the entry phase of the flight.

THIS PAGE INTENTIONALLY LEFT BLANK.

8.0 AVIONICS INTERFACES

8.1 (RESERVED)

8.2 ATTACHED PAYLOADS

THIS PAGE INTENTIONALLY LEFT BLANK.

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. For attached Cargo Elements, the PDI provides five input channels of which four are standard services with the fifth input channel an optional service. For detached Payloads, the PDI provides a single dual redundant input channel via the Orbiter's Payload Interrogator and Payload Signal Processor. The PDI is capable of simultaneously processing up to four Payload PCM telemetry inputs both for inclusion within Orbiter's PCM Telemetry Downlink, and for Orbiter GPC software services. Refer to Figure 8.2.1-1 for PDI data flow.

8.2.1.1 PDI Input Data Characteristics-Shuttle Standard Formats

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.

Frames of telemetry data should be continuous, i.e. the end of a frame should be followed immediately by the start of the next frame, thereby maintaining bit and frame sinc since PDI cannot lock onto data unless continuous. This requirement applies to PDI format types 1, 2 and 3. If not possible to send data continuously, block mode is recommended.

8.2.1.1.1 Type 1 Format

A Type 1 Payload Format is herein defined as a format consisting of Master Frames only, and a Master Frame sync pattern which occurs once every master frame as shown in Figure 8.2.1.1.1-1.

8.2.1.1.1.1 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 Master Frames. Before individual Master Frames can be transferred to the PDI's Toggle Buffer, recognition by the PDI of two successive valid Master Frame Sync patterns must first occur. When this has happened, Toggle Buffer storage of each Master Frame shall proceed as follows:

a. The Time Homogenous Data Set (THDS) within the PDIs Toggle Buffer shall, in part, consist of a complete Payload Master Frame or a subset thereof.

The subset may consist of any number of uniquely identifiable contiguous or noncontiguous 8-bit Master 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 master Frame words by the PDI as shown in Figure 8.2.1.1-3.

8.2.1.1.1.2 Orbiter GPC Software Service

Transferring individual Payload measurements to the Orbiter’s GPC Software Services is implemented via the PDI’s Data RAM. Before individual measurements within the Master Frame can be transferred to the PDI’s Data RAM, recognition of two successive valid Master Frame Sync patterns must first occur. When this has happened, Data RAM storage for each Payload measurement shall proceed as follows:

a. Each Master Frame eight bit word associated with a Payload measurement that is required to be processed by the Orbiter’s GPC Software Services shall be stored within a separate Data RAM byte address.

b. A multiword Payload Measurement shall have its constituent eight bit bytes independently stored within a separate Data RAM byte address whenever its word position within the Master Frame is processed.

c. Maintaining the time homogeneity for both individual multiword Payload measurements and Payload measurement word sets cannot be guaranteed.

8.2.1.1.2 Type 2 Format

A Type 2 Payload Format is herein defined as a format consisting of Master Frames and Minor Frames as shown in Figure 8.2.1.1.2-1. 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. The start of a Master Frame shall be identified by a Master Frame Sync pattern which occurs once per Master Frame.

8.2.1.1.2.1 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 PDIs 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.

8.2.1.1.2.2 Orbiter GPC Software Service

Transferring individual Payload measurements to the Orbiter's GPC Software Services is implemented via the PDI's Data RAM. Before individual measurements within the Minor Frame can be transferred to the PDI's Data RAM, recognition of the second consecutive valid Master Frame Sync pattern with valid Minor Frame Sync patterns in all Minor Frames between the Minor Frames which contain these Master Frame Sync patterns must first occur. When this has happened, Data RAM storage for each Payload measurement shall proceed as follows:

a. Within each Minor Frame word column of a Master Frame, those eight bit words containing data samples for a Payload measurement which is required to be processed by the Orbiter's GPC Software Services shall be stored within the same Data RAM byte address.

b. A multiword Payload measurement shall have its constituent eight bit bytes independently stored within a separate Data RAM byte address whenever its word position within the appropriate Minor Frame is processed.

c. Maintaining the time homogeneity for both individual multiword Payload measurements and Payload measurement word sets cannot be guaranteed.

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

Transferring individual Payload measurements to the Orbiter's GPC Software Services is implemented via the PDI's Data RAM. Before individual measurements within the Minor Frame can be transferred to the PDI's Data RAM, valid recognition of two successive Minor Frame Sync patterns and their corresponding Minor Frame Count patterns must first occur. Data storage starts at the beginning of the 1st master frame following this occurrence. When this has happened, Data RAM storage for each payload measurement shall proceed as follows:

a. Within each Minor Frame word column of a Master Frame, those eight bit words containing data samples for a Payload measurement which is required to be processed by the Orbiter's GPC Software Services shall be stored within the same Data RAM byte address.

b. A multiword payload measurement shall have its constituent eight bit bytes independently stored within a separate Data RAM byte address whenever its word position within the appropriate Minor Frame is processed.

c. Maintaining the time homogeneity for both individual multiword payload measurements and payload measurement word sets cannot be guaranteed.

8.2.1.2 PDI Input Data Characteristics-Shuttle Non Standard Formats

The Shuttle Orbiter Non-Standard Telemetry Format is designated the Block Mode Format. The distinctive characteristic of the Block Mode Format is that the incoming Payload data can only be inserted into the Orbiter's PCM Telemetry Downlink since the PDI is not capable of processing individual Payload measurements for utilization by the Orbiter GPC software services (refer to Table 8.2.1.2-1).

8.2.1.2.1 Block Mode

The PDI does not recognize that the incoming Payload data possesses any format structural properties (e.g. Master Frame, Minor Frame, Word interval, etc.) other than bit intervals, and as such cannot process individual Payload measurements for the Orbiter GPC. The PDI will restructure the incoming Payload bit intervals into Data Blocks appropriate for inclusion within the Orbiter's PCM Telemetry Downlink.

8.2.1.2.1.1 Orbiter PCM TLM Downlink Service

Throughputting block mode Payload data to the ground via the Orbiter's PCM TLM Downlink is implemented via the PDIs Toggle Buffer for individual Data Blocks. Before individual Data Blocks can be transferred to the PDIs Toggle Buffer, establishment by the PDI of valid bit lock with the Payload must first occur. When this has happened, Toggle Buffer storage for each Data Block will proceed as follows:

a. A Data Block Sync Word, generated by the PDI, shall first be transferred to the Toggle Buffer.

b. The sequentially inputted Payload bit intervals shall next be transferred to the Toggle Buffer.

c. Lastly, the PDI shall append three additional 16 bit Status words as delineated within Figure 8.2.1.1-3.

d. The PDI inserted pseudo sync and the three 16 bit status words are removed by the NASA/JSC Mission Control Center (MCC) prior to routing the TLM data stream to payload users.

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

The PDI clock input electrical interface characteristics at the Orbiter/payload interface shall be as defined in Table 8.2.1.3.2-1 and Figure 8.2.1.3.2-1.

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.

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

Parameter	Dimension	PDI Tolerance	Data Formats			Notes
			1	2	3	
Bit rate (center frequency)	bps	10 bps to 64 kbps	x	x	x	
Input Signal Code		NRZ-L NRZ-M NRZ-S Biϕ-L Biϕ-M Biϕ-S	x	x	x	(1)
Word length	Bits	8 or multiples of 8	x	x	x	(2)
Master Frame Length	Words	8 to 1024 (8-bit words)	x			(3)
	or					
	Minor Frames	2 to 256		x	x	(4)
Master Frame Sync	Bits	8, 16, 24 or 32	x			(5)
	Bits	8 bits of unique sync pattern		x		(6)
	Bits	8 bit Minor Frame Counter			x	(7)
Minor Frame Length	Words	8 to 1024 (8-bit words)		x	x	
Minor Frame Sync	Bits	8, 16, 24, or 32		x	x	(8)
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	(9)

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

Parameter	Dimension	PDI Tolerance	Data Formats			Notes
			1	2	3	
Format Sample Rates (Standard)	Samples/Master Frame	Master Frame rate only	x			(10)
		One equal to Minor Frame rate		x	x	(11)(12)
		Six equal to integer submultiple of Minor Frame rate.		x	x	(11)(12)

Notes:

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

(2) 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.

	MSB							Bit Pattern LSB
Bit Number	8	7	6	5	4	3	2	1
	1	2	3	4	5	6	7	8
	7	6	5	4	3	2	1	0
	0	1	2	3	4	5	6	7

The bit pattern is then read by PDI with the MSB as bit-0 and transferred to Orbiter GPC via PCMMU as bit 0 through 7 with bit-0 transmitted first.

Multiword measurements (multiples of 8 bits) shall be structured with the most significant byte first-least significant byte last. Bit packing shall have the measurement's most significant byte located within the most significant word (most significant bit or sign bit first and always left justified as illustrated in the following bit configuration) with unused bits located within the least significant word.

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

Notes: (Continued)

	Most Significant Byte								Least Significant Byte								
Bit No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Bit Weight	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0							(10-bit analog)
Bit Weight	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0					(12-bit analog)

This will allow Orbiter GPC to process the data as an 8-bit parameter by processing the Most Significant Byte of the analog.

(3) Refer to Figure 8.2.1.1.1-1.

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

(5) 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.

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

(7) 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.

(8) Any pattern of contiguous bit positions located in first or last word(s) of every minor frame. (See Note 5 for KSC limitations.)

(9) 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.

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

Notes: (Continued)

(10) Refer to Figure 8.2.1.1-2. Payload 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.

(11) 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.

(12) 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 "Standard Integration Plan Annex No. 4 Command and Data Requirements", document number NSTS 21000-A04.

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 8.2.1.2-1 PDI INPUT DATA CHARACTERISTICS-ATTACHED INTERFACE SHUTTLE NON-STANDARD FORMATS

Parameter	Dimension	PDI Tolerance	Payload Characteristic	Notes
Bit Rate (center frequency)	bps	10 bps to 64 kbps		
Input Signal Code		NRZ-L NRZ-M NRZ-S Biϕ-L Biϕ-M Biϕ-S		Refer to Figure 8.2.1.1-1. Bit rate clock is required with NRZ codes.

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	2.4 Min 9.0 Max	Measured line-to-line
Duty Cycle	Percent	50 ± 5	(1)(2)
Bit-Rate Accuracy	Percent	± 3.25	(3)
Stability		$\leq$ 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	2530 Max	(8)
Input Impedance (Orbiter)	Ohm	74 Min 90 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 $0 \leq N \leq 0.05$ 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 90percent 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:

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

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 μsec) = 62.50 μsec 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)

$$5\mu sec\left[LOG_e\left[\frac{1.25 - 1.00}{1.25 - 0.30}\right]\right] + 5\mu sec\left[LOG_e\left[\frac{1.25 + 1.00}{1.25 + 0.30}\right]\right] =$$

$$5\mu sec\left[LOG_e\left[1.21\right]\right] + 5\mu sec\left[LOG_e\left[1.15\right]\right] = 1.64\mu sec$$

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 =
625μsec - 526.625μsec - 62.5μsec - 0.125μsec - 1.64μsec = 34.11μsec.

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 $\leq$ 62.5 μseconds

$0 \leq$ Transition Time Ambiguity $\leq$ 1.64 μseconds

$0 \leq$ Diff. Phase Skew/Phase Shift $\leq$ 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 second tradeoff 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 110 feet from PDI to payload interface (end of SMCH)

TABLE 8.2.1.3.2-1 PDI CLOCK 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	Min: 2.4 Max: 9	Measured Line-to-line
Duty Cycle	Percent	50 ± 5	NRZ bit rate clock
Skew - Data to clock (NRZ)		Max: ±10 percent of clock period	Bit rate clock to NRZ bit start (1). See Figure 8.2.1.3.2-1.
Stability		≤ 1 part in 10^5 over 60 sec period	
Clock Accuracy	Percent	± 3.25	(2)
Waveform Distortion		Overshoot and undershoot less than 20 percent of peak amplitude level	
Noise	Milli-volts	100 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	Pico-farads	2530	(4)
Input Impedance (Orbiter)	Ohm	74 Min 90 Max	DC resistance line-to-line at interface includes cable resistance (4)

TABLE 8.2.1.3.2-1 PDI CLOCK INPUT/PAYLOAD-TO-ORBITER
ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Rise/Fall Time		Max: Refer to differ- erential phase skew	RT/FT are indepen- dent of bit rate and data code type (Biϕ or NRZ)
Skew Differential Phase	Nanosec to milli- sec depending on bit rate	Maximum value shall be the same as that speci- fied for associated NRZ data	
Common Mode	Volt	Min: -3 pk-pk continuous or -60 pk-pk for 10μsec for damage level Max: +3 pk-pk continuous or +60 pk-pk for 10μsec for damage level	±3V from EMI, neg- ligible from pay- load or PDI (3)

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

(2) 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.

(3) Volts across frequency spectrum from DC to 100 KHz.

(4) Calculation based upon 110 ft from PDI to payload interface (end of SMCH).

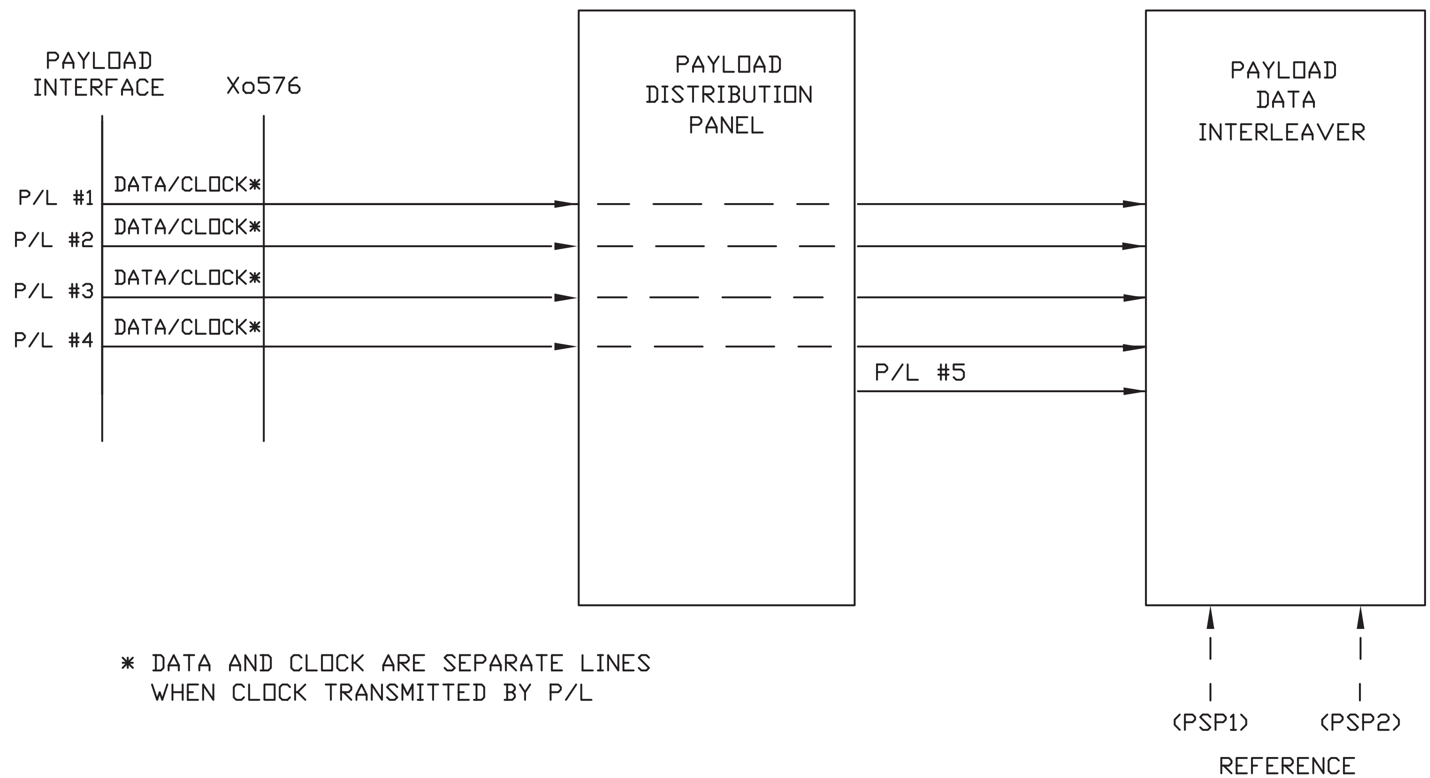
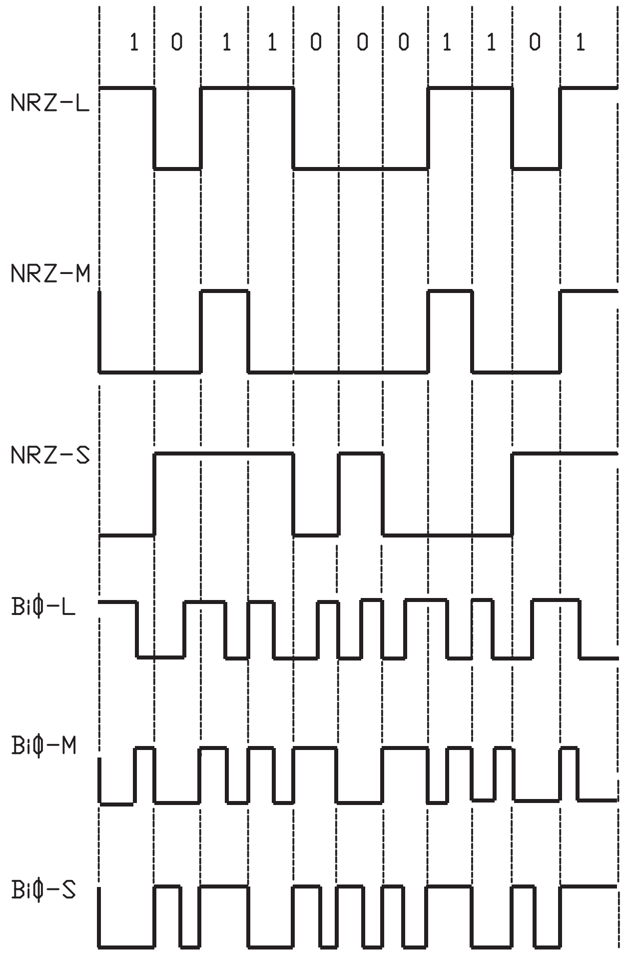


FIGURE 8.2.1-1 PAYLOAD DATA INTERLEAVER DATA FLOW



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

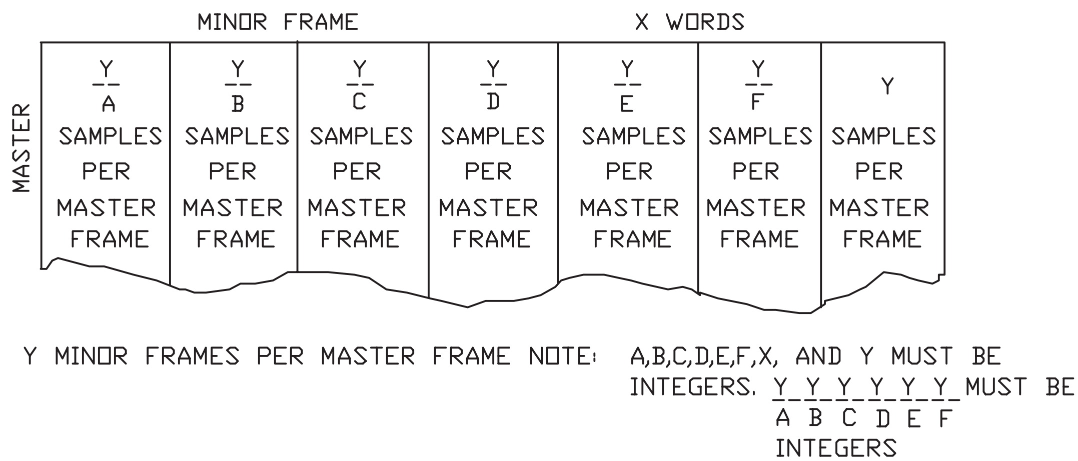
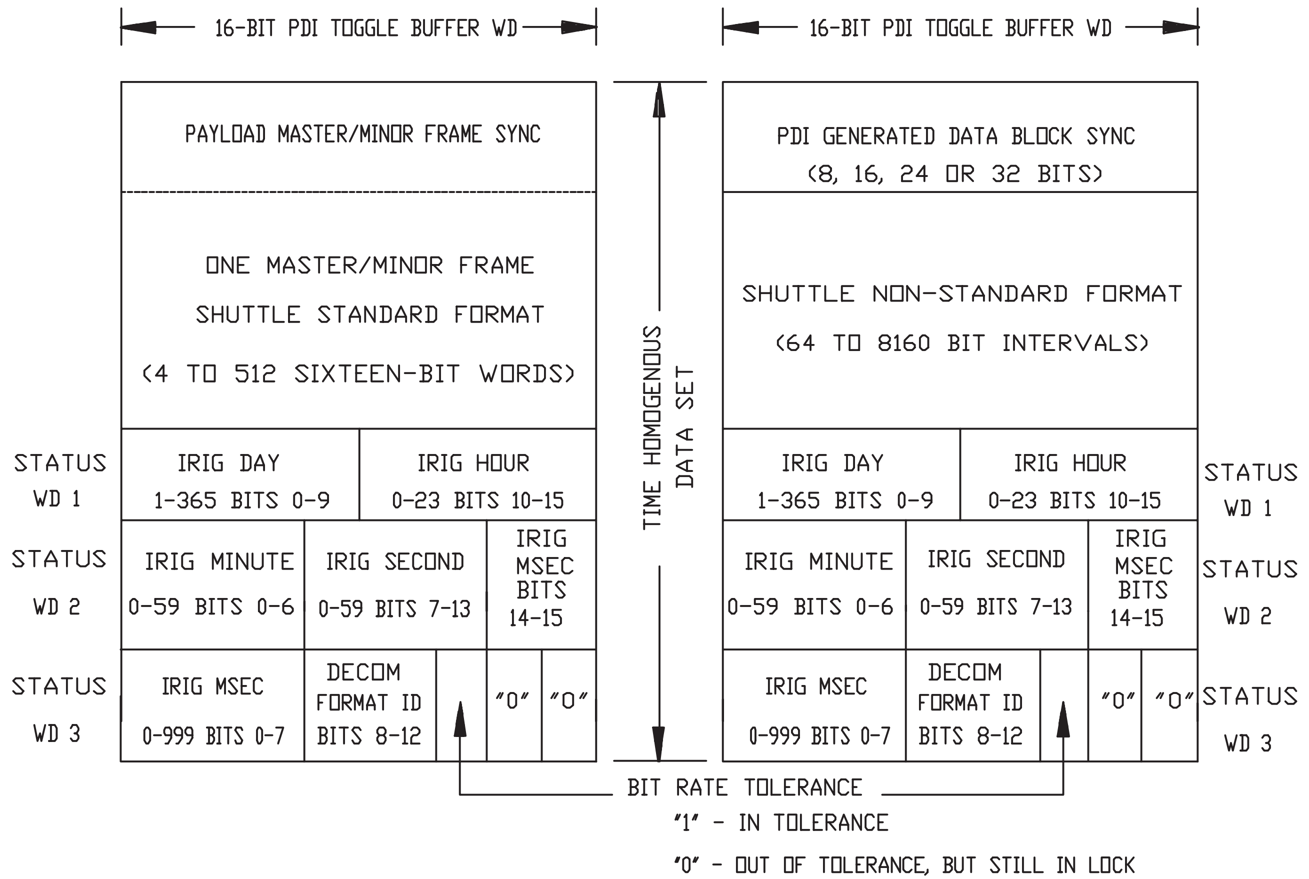


FIGURE 8.2.1.1-2 SHUTTLE STANDARD FORMAT SAMPLE RATES



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

MASTER FRAME ONLY 8-1024 WORDS

MASTER FR. SYNC	MASTER FRAME
"	"
"	"

FIGURE 8.2.1.1.1-1 TYPE 1 SHUTTLE STANDARD FORMAT

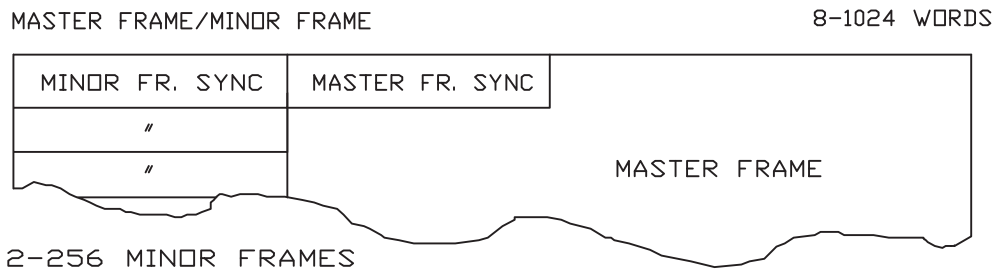


FIGURE 8.2.1.1.2-1 TYPE 2 SHUTTLE STANDARD FORMAT

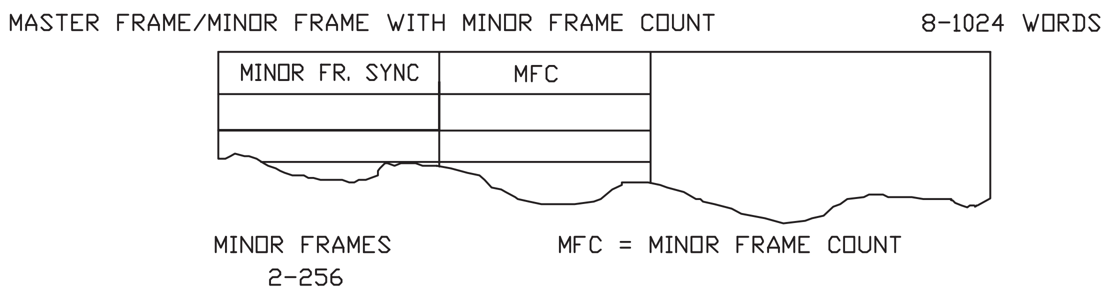
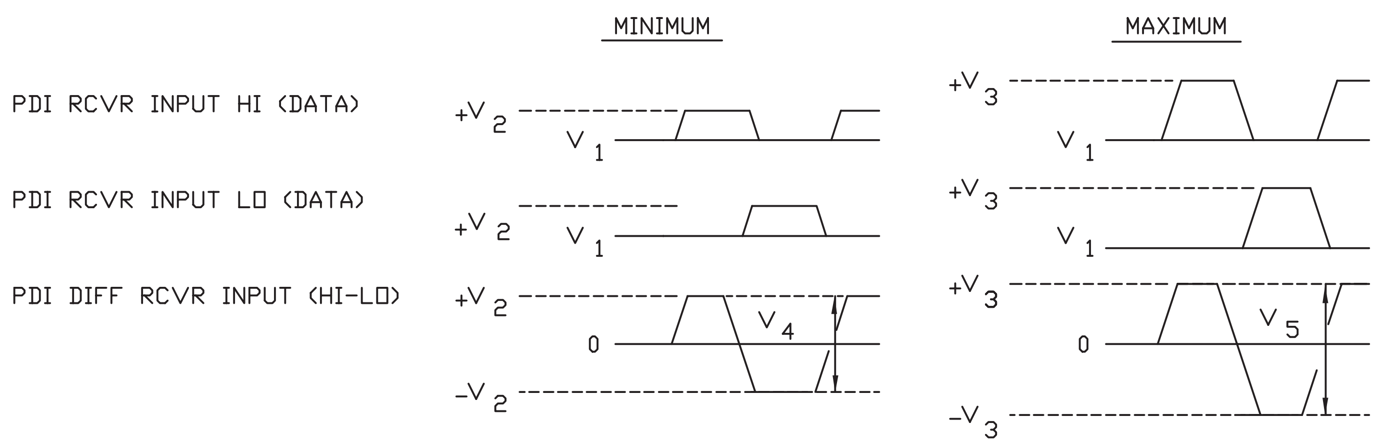


FIGURE 8.2.1.1.3-1 TYPE 3 SHUTTLE STANDARD FORMAT



V_1 = SIGNAL GROUND

V_2 = 1.25 VOLTS LINE TO SIG. GND

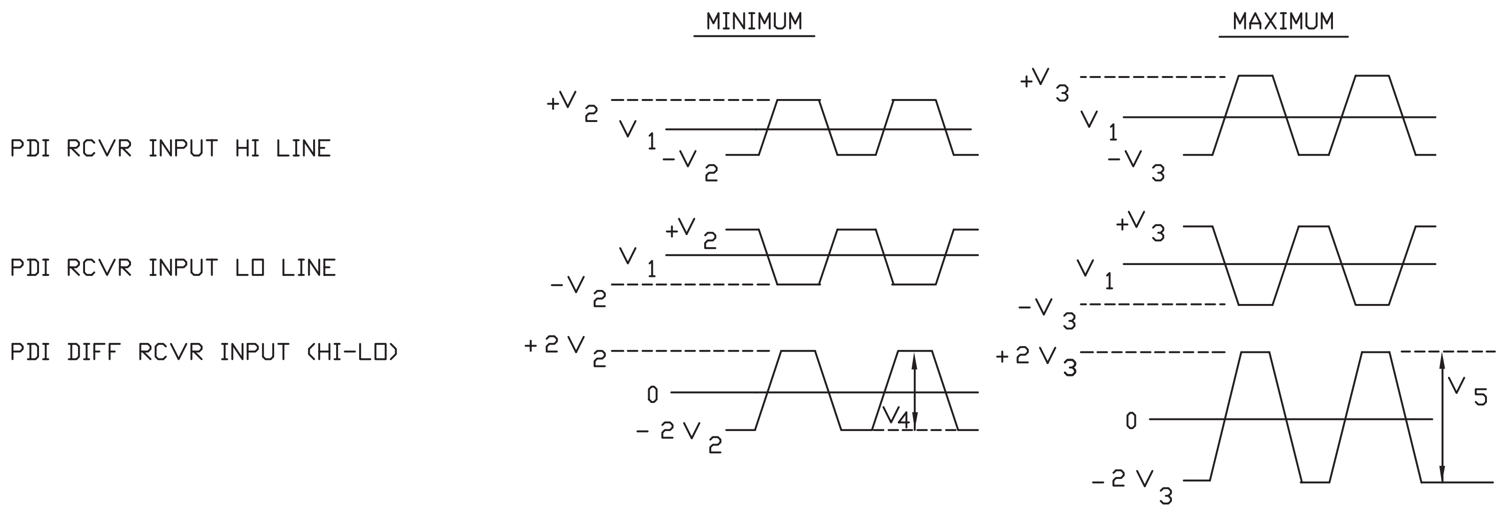
V_3 = 4.5 VOLTS LINE TO SIG. GND

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

FIGURE 8.2.1.3.1-2 BI-POLAR LINES - DIFFERENTIAL TRANSMISSIONS



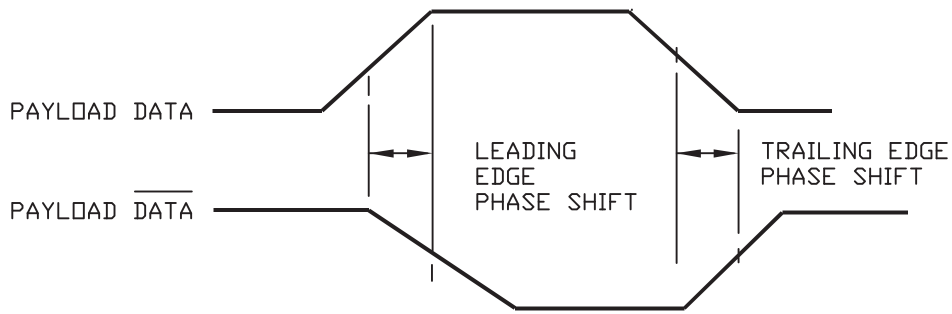
V_1 = SIGNAL GROUND

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

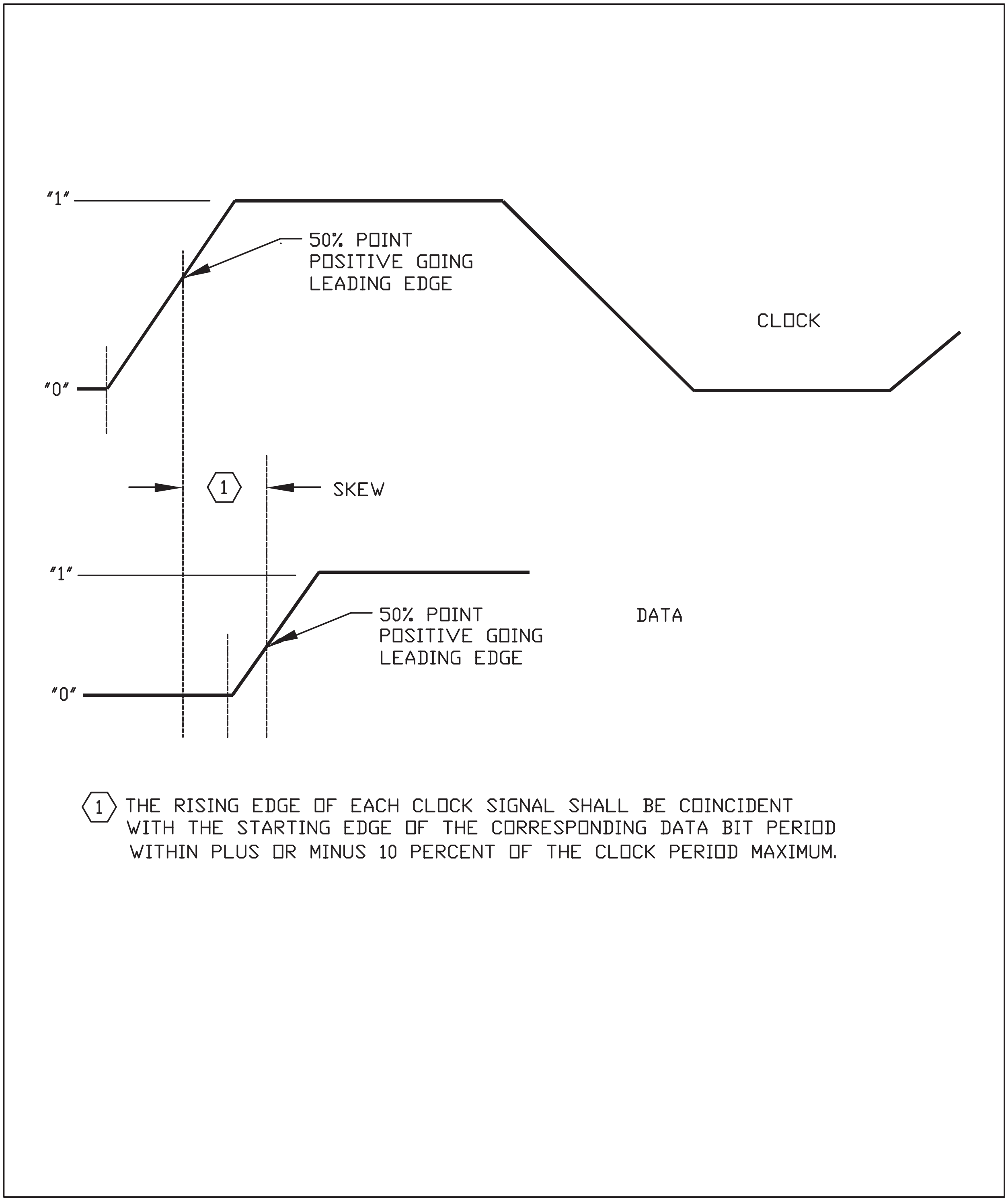


FIGURE 8.2.1.3.2-1 SKEW

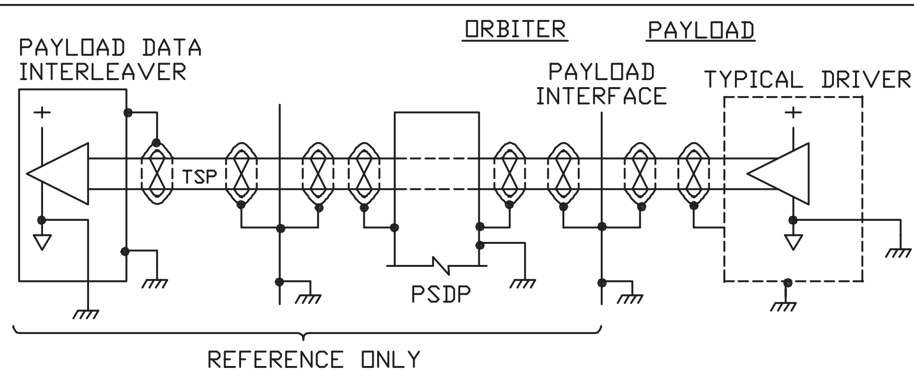
PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.1.3.1 PDI DATA INPUT 8.2.1.3.2 PDI CLOCK INPUT	 NOTE: SYMBOLS DEFINED IN SECTION 10.0

FIGURE 8.2.1.5-1 PAYLOAD DATA INTERLEAVER GROUNDING AND SHIELDING INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.2 Multiplexer/Demultiplexer (MDM) Interface

The Orbiter shall provide data channels for the acquisition and control of attached payloads through MDM's which are under control of the on-board computers. MDM signal transfer capabilities at the Orbiter/payload interfaces are:

a. Low-Level Discrete Outputs (DOL)

b. High-Level Discrete Outputs (DOH)

c. Low-Level Discrete Inputs (DIL)

d. Low-Level Differential Analog Inputs (AID)

e. Serial Input/Output (SIO)

f. High-Level Discrete Inputs (DIH)

The MDM data flow is as shown in Figure 8.2.2-1.

Measurements, Command, and Processing requirements to activate these interfaces shall be pre-flight defined and properly documented with the NSTS.

8.2.2.1 Low Level Discrete Outputs (DOL)

The Electrical Interface characteristics of the MDM low level discrete output Commands at the Orbiter/payload interfaces shall be as shown in Table 8.2.2.1-1.

8.2.2.2 High Level Discrete Outputs (DOH)

The electrical interface characteristics of the MDM high level discrete output commands at the Orbiter/payload interfaces shall be as shown in Table 8.2.2.2-1.

8.2.2.3 Low Level Discrete Inputs (DIL)

The electrical interface characteristics of the MDM low level discrete input signals from the attached payloads, at the Orbiter/payload interfaces, shall be as shown in Table 8.2.2.3-1.

8.2.2.4 Low Level Differential Analog Inputs (AID)

The electrical interface characteristics of the MDM low level differential analog inputs at the Orbiter/payload interfaces shall be as shown in Table 8.2.2.4-1.

8.2.2.5 Serial Input/Output (SIO)

Each serial I/O channel shall be dedicated to a single payload interface and when commanded from the Orbiter General Purpose Computer (GPC), one of two message discretes shall be output to the Payload interface to identify the direction of data transfer on the data line, as shown in Figure 8.2.2.5-1. A third discrete line shall gate each word transferred. Each transaction shall start with Word 1 and shall contain up to 32 words per transaction. Each word shall contain 16 data bits preceded by a Sync pattern and followed by parity as shown in Figure 8.2.2.5-2. Data and parity shall be Manchester II format as defined in MIL-STD-1572 at 1-microsecond per bit.

8.2.2.5.1 Channel Interface

One serial digital I/O channel shall consist of the following paths: (Figure 8.2.2.5-1).

a. Data (half-duplex)

b. Word discrete (MDM-generated).

c. Message out discrete (MDM-generated).

d. Message in discrete (MDM-generated).

The "true" state of message in and out discretes (c and d) shall be mutually exclusive. The cable shall have characteristics as specified in Section 8.2.2.5.12.

8.2.2.5.2 Clock

The transmitting device shall generate data based on its internal clock with an average output bit rate of 1-Mbps, plus or minus 0.1 percent per word. When receiving data, the receiver shall derive the clock from the Manchester II code format as received.

8.2.2.5.3 Word Format

Word sync shall be a non-valid Manchester code, negative pulse followed by a positive pulse as shown in Figure 8.2.2.5.3-1. The transmitting device shall generate the sync and data pulses based on its internal clock. The sync pulse width, measured from break point to break point of the negative pulse, shall be 1.5 microseconds plus or minus 3 percent. The positive half sync pulse measured from break point to break point, of a 01 bit code following sync, shall be 1.5 microseconds plus or minus 3 percent as shown in Figure 8.2.2.5.3-1. A Manchester II/10 code immediately following the data word sync will increase the apparent width of the affected pulse to 2.0 microseconds plus or minus 4.75 percent. Word sync shall be immediately followed by the first data bit. Sixteen data bits shall be followed by one parity bit making the number of true data bits for each word odd. Following the parity bit of the previous word, the sync shall include an uncontrolled region of the negative going pulse that forms the first half of the word sync detail shown on Figure 8.2.2.5.3-1. The word format is shown in Figure 8.2.2.5-2.

8.2.2.5.4 Data Transfer

Serial data transmission shall be under MDM control and shall be as follows:

a. Transmission of word discretes and subsequent data shall be initiated when the message discrete is switched to a logic "1" state, and shall be ended when the message discrete is switched to a logic "0" state. When a multiple word message is transferred, the message discrete shall remain in the logic "1" state during the entire multiple word message.

b. Multiple word transfers shall take place beginning with the first word. The number of words transferred shall be a function of the number of word discretes issued from the MDM while the message discrete is true. A new message-in discrete "True" condition shall cause the Payload to start its response with word one. A new message

- out discrete "True" condition shall cause the Payload to expect an input from the Orbiter, starting with word one.

c. The word discrete shall gate each word transferred between the MDM and Payload.

d. The message-out discrete shall control data transmission from the MDM to the Payload. The message-in discrete shall control data transmission from the Payload to the MDM.

e. The time phasing of the discretes and data words shall be as shown in Figure 8.2.2.5.4-1. The rise and fall times for serial I/O discretes shall be as shown in Figure 8.2.2.5.4-2.

f. Data transfers shall be transmitted MSB first.

8.2.2.5.5 Data Validation by Hardware (Payload or Orbiter)

Logic shall be provided in the data receiver to recognize the following: (1) improperly coded signals received from the data transmitter; (2) data dropouts in the received signals; and (3) excessive noise in the received signals. Each received word shall conform to the following minimum validation criteria.

a. Detection of a valid Manchester II bit rate.

b. Checks shall be made to determine that only 10 or 01 patterns occur and that only the proper number of receiver decision threshold transitions occur within each bit time.

c. The data word shall consist of 20 bits; 3 sync, 16 data and odd parity bit.

d. Parity bit verification. When a word fails to conform to the preceding criteria, the word shall be considered invalid and shall not be accepted by the receiving system. The receiving system shall set the proper bit in the BITE status word to indicate the applicable errors that have been detected; i.e., sync, validity, parity, etc.

8.2.2.5.6 Receiver Performance Characteristics

8.2.2.5.6.1 Payload Serial I/O Receiver Circuit Characteristics

The receiver circuit shall be compatible with the incoming signals specified herein, and shall demonstrate a word error rate performance of less than 2 in 10^6 words. This performance shall be established with a line-to-line signal amplitude of 2.0 volts peak, having a rise and fall time of 250 nanoseconds measured between the break and the opposite threshold and impressed white Gaussian noise of 300 millivolts RMS distributed over the band 1000 Hz to 4.0 MHz. All measurements are made at the appropriate receiver input terminals.

Word Error Rate is defined as:

$$1 - \frac{\text{Total number of correctly received words}}{\text{Total number of words transmitted}}$$

The receiver shall operate with input waveforms varying from a square wave to a sine wave.

8.2.2.5.6.2 MDM Serial I/O Receiver Circuit Characteristics

The receiver circuit shall be compatible with the incoming signals specified herein, and shall demonstrate a word error rate performance of less than 2 in 10^6 words. This performance shall be established with a line-to-line signal amplitude of 2.3 volts peak, having a rise and fall time of 200 nanoseconds measured between 10 and 90 percent of the peak to peak amplitude and impressed white Gaussian noise of 300 millivolts RMS distributed over the band 1000 Hz to 4.0 MHz. All measurements are made at the appropriate receiver input terminals.

Word Error Rate is defined as:

$$1 - \frac{\text{Total number of correctly received words}}{\text{Total number of words transmitted}}$$

The receiver shall operate with input waveforms varying from a square wave to a sine wave.

8.2.2.5.7 Receiver Common-Mode Rejection

The MDM and Payload data receivers shall reject common mode signals for frequencies from dc to 2 MHz. The MDM shall not respond for amplitudes up to 10 volts peak, line-to-shield ground. The Payload shall not respond for amplitudes up to 10 volts peak, line to shield ground. The serial I/O transformers shall tolerate voltages between windings and ground, for up to plus or minus 50 volts dc peak. The Payload discrete receivers shall tolerate up to plus or minus 32 volts on either inputs to signal ground without damage and shall reject common mode voltage from dc to 2 MHz sinusoidal between -10 to +10 volts peak.

8.2.2.5.8 Receiver Input Sensitivity (Data Channel Receiving End)

The data receiver shall respond to an input signal amplitude from plus or minus 8.0 volts peak line-to-line, down to a threshold level of plus or minus 0.6 volts peak, line-to-line. The receiver shall not respond to input signals less than plus or minus 0.4 volt peak. The receiver shall operate with input signal levels from plus or minus 8.0 volts peak, line-to-line, down to plus or minus 1.5 volts peak, line-to-line as measured at the input to the receiver. The input circuit shall reject noise at all frequencies below 1000 Hz and between 5 MHz and 30 MHz for voltages up to 6 volt peak line-to-line with a current limitation on the Payload data receiver of 5 milliamps for frequencies below 1 kHz. The message and word discrete receivers shall recognize a line to line voltage of plus 0.5 volts to plus 5.9 volts as a logic "1" and minus 0.5 volts to minus 5.9 volts as a logic "0".

8.2.2.5.9 Output Waveform Distortion

Distortion of the waveform by the output circuit, including overshoot and ringing shall not exceed 250 millivolts peak-to-peak, line-to-line measured on the receiver input and feedthrough.

8.2.2.5.10 Shield Grounding

The shield on the cable, for data and discrete interfaces, shall be grounded at the MDM and Payload I/O interface. Intermediate ground points shall be permitted by negotiation.

8.2.2.5.11 MDM Power Off

Signal levels due to an unpowered MDM shall be interpreted by the Payload to indicate a failed channel and shall not cause any other degradation to other data processing assembly functions.

8.2.2.5.12 Interface Cable

The interface cable for the SIO channel shall be a two-conductor twisted, shielded, jacketed cable. It shall conform to Specification MBO150-051 and Design Standard MP572-0279-0002 and shall not exceed 150 feet (46 M) in total length between the Orbiter MDM and the Payload I/O unit (up to 125 ft. from the Orbiter MDM to SMCH-SIP interface and 25 ft. from SMCH-SIP interface to Payload I/O unit).

8.2.2.5.13 Electrical Interface Characteristics

The electrical interface Characteristics of the MDM SIO Channel message-in discrete, message out discrete and word discrete shall be as shown in Table 8.2.2.5.13-1. The electrical interface characteristics of the MDM SIO channel data line for the transmission and reception modes shall be as shown in Tables 8.2.2.5.13-2 and 8.2.2.5.13-3, respectively.

8.2.2.6 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.2.6-1.

8.2.2.7 High-Level Discrete Inputs (DIH)

The electrical interface characteristics of the MDM high-level discrete input signals from the attached payloads, at the Orbiter/Payload interfaces, shall be as shown in Table 8.2.2.7-1.

TABLE 8.2.2.1-1 LOW-LEVEL DISCRETE OUTPUT (DOL)/ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Single-Ended Discrete	Load isolated (1)
Code		Step-Level (Software Programmed)	
Analog Range Min Max	 Volt Volt	 N/A	
Discrete- False Min ("0") Max	 Volt Volt	 -0.5 +0.5	 (1) (1)
Discrete- True Min ("1") Max	 Volt Volt	 +4.0 +6.0	 (1) (5)
Ripple and Noise Max	Milli- Volt	 400	
CMV Max	Volt	N/A	
Rise/Fall Time Min (10 to 90 percent) Max	Microsec Microsec	1 20	(2) (2)
Noise Suppression Bandwidth	Hertz	N/A	
Roll-off Rate Min	dB/Octave	N/A	
CMRR	dB	N/A	
Distortion		N/A	
Frequency	Mbps	N/A	
Bit Rate	Mbps	N/A	
Transfer		Direct Coupled	Grounded at Orbiter

TABLE 8.2.2.1-1 LOW-LEVEL DISCRETE OUTPUT (DOL)/ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS (Continued)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Source Impedance Min (Orbiter) Max	Ohm Ohm	30 100	
Load Impedance Min (Payload) Max	Ohm Ohm	600 4K	 (3)
Capacitance Max	Pico-Farad	3500	Payload not to exceed 1500
Pwr. Off Impedance Min	Ohm	10k(+6 Vdc)	Payload shall exceed 600
Current Drive	Milliamp	10 (Logic "1")	
Current Sink	Milliamp	-10 (Logic "0")	±0.5 volts
Overvoltage Protection Max	Volt	±32	(4)
Fault Voltage Emission Max	Volt	±15	(4)
Fault Current Limitation Max	Milliamp	±20	
Power-Ground Isolation	Megohms	10	

NOTES:

0.2 millisecond state uncertainty maximum following power up.

(1) Reference MDM Signal Ground
(2) 400 OHM±5 percent in parallel with 5 nanofarad ±10 percent load
(3) An open input shall not result in an ambiguous logic state
(4) Line-to-line and line to ground
(5) Applies only when no more than 32 of 48 DOL outputs on a given module are set true simultaneously. (If more than 32 outputs are set true simultaneously then all outputs will be set to "0" volts due to power supply overload.)

TABLE 8.2.2.2-1 HIGH-LEVEL DISCRETE OUTPUT(DOH)/ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Single-Ended Discrete	(1)
Code		Step Level	
Min Max Analog Range	Volt Volt	N/A	
Discrete- False Min ("0") Max	Volt Volt	0 3	
Discrete- True Min ("1") Max	Volt Volt	19.5 32	(3)
Ripple and Noise Max	Millivolt	0.9 V Pk-Pk single Freq. 1.6 V Pk-Pk Broadband	(2)
CMV Max	Volt	N/A	
Rise/Fall Time Min Max	Microsec Microsec	10 100	
Noise Suppression Bandwidth	Hertz	N/A	
Roll-off Rate Min	dB/Octave	N/A	
CMRR	dB	N/A	
Distortion		N/A	
Frequency	Hertz	N/A	
Bit Rate	Mbps	N/A	
Transfer		Direct Coupled	
Source Impedance Min (Orbiter) Max	Ohm Ohm	0 450	
Load Impedance Min (Payload) Max	Ohm Ohm	3.2k 10k	
Capacitance Max	Pico-Farad	3500	Payload 1500 Max
Pwr. Off Impedance Min	Ohm	10k (<8 Vdc)	Payload 3k Min
Current Drive	Milliamp	10 (Logic "1")	
Current Sink	Milliamp	N/A	
Overvoltage Protection Max	Volt	±32	

TABLE 8.2.2.2-1 HIGH-LEVEL DISCRETE OUTPUT (DOH)/ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Fault Voltage Emission Max	Volt	±32	
Fault Current Limitation Max	Milliamp	20	

(1) Reference 28-volt power return.

(2) 2.8 k Ohms ±5 percent parallel with 5000 picofarads ±10 percent loads.

(3) Orbiter MDM minimum power voltage is 24 Vdc.

TABLE 8.2.2.3-1 LOW-LEVEL DISCRETE INPUT (DIL)/PAYLOAD-TO-ORBITER ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Single-Ended Discrete	Payload referenced to MDM ground
Code		Threshold Decision	
Analog Range Min Max	Volt Volt	N/A	
Discrete-False Min ("0") Max	Volt Volt	-0.5 +2.0	(1) (1) (2)
Discrete-True Min ("1") Max	Volt Volt	+2.5 +6.5	(1) (1)
Ripple and Noise Max	Milli-Volt	300	
CMV Max	Volt	N/A	
Rise/Fall Time Min Max	Microsec Microsec	N/A	
Noise Suppression Bandwidth Max	Hertz	1K ± 12 percent	
Roll-off Rate Min	dB/Octave	6	
CMRR	dB	N/A	
Distortion		N/A	
Frequency	Hertz	N/A	
Bit Rate	Mbps	N/A	
Transfer		Direct Coupled	
Source Impedance Min (Payload) Max	Ohm Ohm	0 1k	
Load Impedance Min (Orbiter) Max	Ohm Ohm	14k 21k	
Capacitance Max	Pico-Farad	5000	
Pwr-Off Input Min Impedance Max	Ohm Ohm	10k 14k	 (3)
Current Drive	Milliamp	N/A	
Current Sink Max	Milliamp	0.43	At 6.0 volts

TABLE 8.2.2.3-1 LOW-LEVEL DISCRETE INPUT (DIL)/ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Overvoltage Protection Max	Volt	±32	
Fault Voltage Emission Max	Volt	±15V	
Fault Current Limitation Max	Milliamp	2	

(1) Reference return line

(2) Open input interpreted as logic "0"

(3) With ±6.0 volts or less applied.

TABLE 8.2.2.4-1 LOW-LEVEL DIFFERENTIAL ANALOG INPUT (AID), PAYLOAD-TO-ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Differential Analog	
Code		Balanced Input	Line-to-Line
Analog Range Min Max	 Volt Volt	 -5.0 +5.0	(2), (3), (4)
Discrete- False Min Max	 Volt Volt	 N/A N/A	
Discrete- True Min Max	 Volt Volt	 N/A N/A	
Ripple and Noise Max	Milli- Volt	N/A	
Common Mode Voltage Max	 Volt	 ±10	
Rise/Fall Time Min Max	 Microsec Microsec	 N/A	
Noise Sup- pression Bandwidth	Hertz	dc to 40 ±10 percent	
Roll-off Rate Min	 dB/Octave	 6	
CMRR	dB	60 (within BW)	
Accuracy	Percent	±0.5	(1) With 10 Ohms Maximum Unbalance
Frequency	Hertz	See Filter Bandwidth and Sampling Rate	
Bit Rate	Mbps	N/A	
Transfer		Direct Coupled	
Source Impedance Min (Payload) Max	 Ohm Ohm	 0 100	 (1)

TABLE 8.2.2.4-1 LOW-LEVEL DIFFERENTIAL ANALOG INPUT (AID), PAYLOAD-TO-ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS (CONTINUED)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Load Impedance Min (Orbiter) Max	Ohm Ohm	500k N/A	≥100K power off
Capaci- Max tance	Pico-Farad	5000	
Pwr-Off Impedance Min	Ohm	100k	
Current Drive	Milliamp	N/A	
Current Sink	Milliamp	0.024	At 5.0 volts
Overvoltage Protection Max	Volt	±32	
Fault Voltage Emission Max	Volt	±15	
Fault Current Limitation Max	Milliamp	1	
Cable		2 conductor twisted, shielded, jacketed, uncontrolled impedance	Rockwell Design Standard MP572-0311-0003

(1) Source impedance 100 Ohms maximum with 10 Ohms maximum unbalance for 0.5 percent RMS one sigma of F.S. encoding accuracy.

(2) The measurement accuracy shall be within 0.50 percent (1 sigma full scale). The accuracy is directly affected by input noise within the filter passband or signals changing during the AID conversion time.

(3) The maximum voltage measured across terminals line-to-line (differential voltage) will be 5.0 volts absolute (0 to -5.0 Vdc or 0 to +5.0 Vdc).

(4) For additional information refer to Paragraph 9.3.2.1.3 (Ascent/Descent) and/or Paragraph 9.4.3.4 (On-Orbit) for analog input scaling and conversion to GPC binary counts.

TABLE 8.2.2.5.13-1 MDM SERIAL INPUT/OUTPUT (SIO) DISCRETE LINE, ORBITER-TO-PAYLOAD ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Discrete	Complementary Single-Ended Driver
Code		Message-In Message-Out Word Discrete	
Analog Range Min Max	 Volt Volt	 N/A N/A	
Discrete True Min ("1") Max	 Volt Volt	 +2.2 +5.0	(1)(2)
Discrete False Min ("0") Max	 Volt Volt	 -2.2 -5.0	(1)(2)
Ripple and Noise Max	Milli-Volt	±500	
CMV Max	Volt	±10	
Rise/Fall Time Min Max	 Microsec Microsec	See Figure 8.2.2.5.4-2	
Noise Suppression Bandwidth	Hertz	N/A	
Roll-Off Rate Min	dB/Octave	N/A	
CMRR	dB	N/A	
Distortion Max	Volt Pk	±0.25	
Frequency	Hertz	See Figure 8.2.2.5-2	
Bit Rate	Mbps	N/A	
Transfer		Direct Coupled	
Source Impedance Min (Orbiter) Max	 Ohm Ohm	 N/A 100	
Load Impedance Min (Payload) Max	 Ohm Ohm	 See Figure 8.2.2.5.4-2 100	
Capacitance Max	Pico-Farad	Cable length (ft)X 36	See Figure 8.2.2.5.4-2
Pwr Off Impedance Min	Ohm	Diode to ground	

TABLE 8.2.2.5.13-1 MDM SERIAL INPUT/OUTPUT (SIO) DISCRETE LINE, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Current Drive Min	Milliamp	20	
Current Sink	Milliamp	N/A	
Overvoltage Protection Max	Volt	±32 Vdc via 320 ohms	(4)
Fault Voltage Emission Max	Volt	+8	(5)
Fault Current Limitation Max	Milliamp	40	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	3450 max	(2)

(1) Reference Signal Return Line (L-L)
(2) Calculations based upon 150 feet of cable from MDM to payload interface (end of SMCH).
(3) Deleted
(4) This is for over voltage protection of the MDM from a user generated voltage source.
(5) This is for maximum MDM output voltage to a user.

TABLE 8.2.2.5.13-2 MDM SERIAL INPUT/OUTPUT (SIO) DATA LINE MDM TRANSMITTING, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Serial Half Duplex	
Code		MIL-STD-1572 Manchester II Biϕ-L	
Analog Range Min Max	 Volt Volt	 N/A N/A	
Peak Positive Min Level Max	 Volt Volt	 2.5 6.0	
Peak Negative Min Level Max	 Volt Volt	 -2.5 -6.0	
Ripple and Noise Max	 Milli- Volt	 200 rms +350 Pk	Excluding Overshoot and Undershoot
CMV Max	Volt	N/A	
Rise/Fall Time Min (10 to 90 percent) Max	 Microsec Microsec	 0.06 0.25	
Noise Sup- pression Bandwidth	Hertz	Up to 6.0 V rejection below 1 kHz and between 5 and 30 MHz	(1)
Roll-off Rate Min	dB/Octave	N/A	
CMRR	dB	N/A	
Distortion Min Max	 Milli- Volt	 -150 250	(1)
Frequency	Hertz	N/A	
Bit Rate	Mbps	1±0.1 percent (Data)	
Data Transfer		Transformer Coupled	At both ends of line
Source Impedance Min (Orbiter) Max	 Ohm Ohm	 75±10 percent N/A	
Load Impedance Min (Payload) Max	 Ohm Ohm	 75±10 percent N/A	
Quiescent State Recovery		75 mV max from 5 micro-sec after parity until next word sync pattern	

TABLE 8.2.2.5.13-2 MDM SERIAL INPUT/OUTPUT (SIO) DATA LINE MDM TRANSMITTING, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Capacitance Max	Pico-Farad	N/A	
Pwr-Off Impedance Min	Ohm	N/A	
Current Drive	Milliamp	90	At 6.0 volts peak
Current Sink	Milliamp	N/A dc CM	
Overvoltage Protection Max	Volt Pk	±32 DC CM	Line to power, chassis, single gnd
Fault Voltage Emission Max	Volt	±7 ±32 (Line-to-Gnd)	(1)
Fault Current Limitation Max	Milliamp	120	
Word Rate	WPS	See Figures 8.2.2.5-2 and 8.2.2.5.4-1	
Pulse Width Jitter	Nano-Second	40	

Notes:

(1) Reference Return Line (L-L)

Table is based on 150 Feet (45.7m) maximum total Orbiter plus Payload cable length.

Thruput is defined as 1 minus Bit Error Rate (BER) (i.e., valid bits received per bits transmitted). Equivalent word error rate of 1.9×10^{-7} may be used for validation (word thruput=$1-(1.9 \times 10^{-7})$).

TABLE 8.2.2.5.13-3 MDM SERIAL INPUT/OUTPUT (SIO) DATA LINE MDM RECEIVING, PAYLOAD-TO-ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Serial Half Duplex	
Code		MIL-STD-1572 Manchester II Biϕ-L	
Analog Range Min Max	 Volt Volt	 N/A N/A	
Peak Positive Level(2) Min Max	 Volt Volt	 +1.7 +8.0	
Pk Negative Level (1) Min Max	 Volt Volt	 -1.7 -8.0	
Ripple and Noise Max	Milli- Volt	 250 rms	Excluding overshoot and undershoot
CMV Max	Volt	±10V from dc to 2 MHz sine	
Rise/Fall Time Min (10 to 90 percent) Max	 Microsec Microsec	 0.06 0.22	
Noise Suppression Bandwidth	Hertz	Reject up to 6V below 1 kHz and between 5 MHz and 30 MHz	(1)
Roll-off Rate Min	 dB/Octave	 N/A	
CMRR	dB	N/A	
Distortion	Millivolt	±250 Max	(1)
Frequency	Hertz	N/A	
Bit Rate	Mbps	1±0.1 percent (Data)	
Transfer		Transformer Coupled	At both ends of line
Source Impedance Min (Payload) Max	 Ohm Ohm	 75±10 percent N/A	
Load Impedance Min (Orbiter) Max	 Ohm Ohm	 75±10 percent N/A	
Quiescent State Recovery (Pk) (1)		75mV Max from 5microsec. after parity until next sync word	

TABLE 8.2.2.5.13-3 MDM SERIAL INPUT/OUTPUT (SIO) DATA LINE MDM RECEIVING, PAYLOAD-TO-ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Capacitance Payload Cable Max	Pico-Farad	N/A	
Pwr-Off Impedance Min	Ohm	75±10 percent	
Load Current	Milliamp	120 at 8V Pk	
Overvoltage Protection Min Max	Volt Pk	8 Diff. 350 kHz-1.5 MHz ±32 CM	
Fault Voltage Emission Min Max	Volt Volt	±7 ±32 (Line-to-Gnd)	(1)
Fault Current Limitation Max	Milliamp	N/A	
Pulse Width Jitter	Nano-Second	50	
Word Rate	WPS	See Figures 8.2.2.5-2 and 8.2.2.5.4-1	

Note:

(1) Reference Return Line

Table based on 150 Feet (45.7m) maximum total Orbiter plus Payload cable length.

Thruput is defined as 1 minus Bit Error Rate (BER) (i.e., valid bits received per bits transmitted). Equivalent word error rate of $1.9x10^{-7}$ may be used for validation (word thruput = $1-(1.9x10^{-7})$).

TABLE 8.2.2.7-1 HIGH-LEVEL DISCRETE INPUT (DIH)/ORBITER-TO-PAYLOAD ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Type		Single-Ended Discrete	
Code		Threshold Decision	
Analog Min Range Max	Volt Volt	N/A	
Discrete- Min False Max ("0")	Volt Volt	0 6	
Discrete- Min True Max ("1")	Volt Volt	10 32	
Ripple Max and Noise	Millivolt	600	
CMV Max	Volt	N/A	
Rise/Fall Min Time Max	Microsec Microsec	10 100	
Noise Suppression Bandwidth	Hertz	dc--1k ±12 percent	(Low-Pass Filter)
Roll-Off Min Rate	dB/Octave	6	
CMRR	dB	N/A	
Distortion		N/A	
Frequency	Hertz	N/A	
Bit Rate	Mbps	N/A	
Transfer		Direct Coupled	
Source Min Impedance (Payload) Max	Ohm Ohm	0 1k	
Load Min Impedance (Orbiter) Max	Ohm Ohm	245k 357k	
Capaci- Max tance	Pico- Farad	5000	
Pwr-Off Min Input Impedance Max	Ohm Ohm	245k 357k	

TABLE 8.2.2.7-1 HIGH-LEVEL DISCRETE INPUT (DIH)/ORBITER-TO-PAYLOAD ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

Parameter	Dimension	Characteristics Orbiter/Payload Interface	Notes
Current Drive	Milliamp	N/A	
Current Sink Max	Milliamp	0.13	At 32 volts
Over-voltage Protection Max	volt	±32	
Fault Voltage Emission Max	volt	±32	
Fault Current Limitation Max	Microamp	320	
Power-Ground Isolation	Megohms	10	

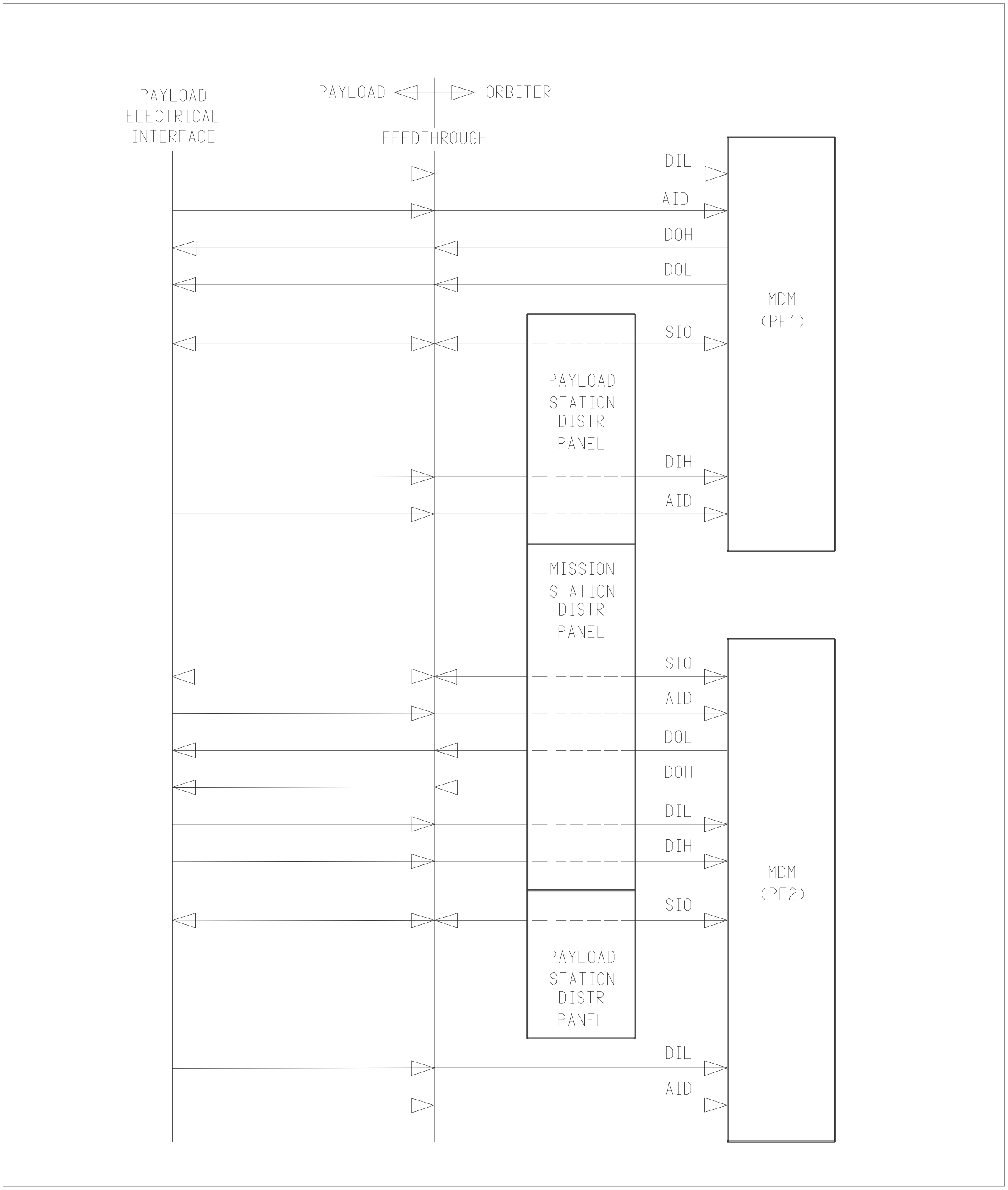


FIGURE 8.2.2-1 MDM DATA FLOW DIAGRAM - INTERFACE

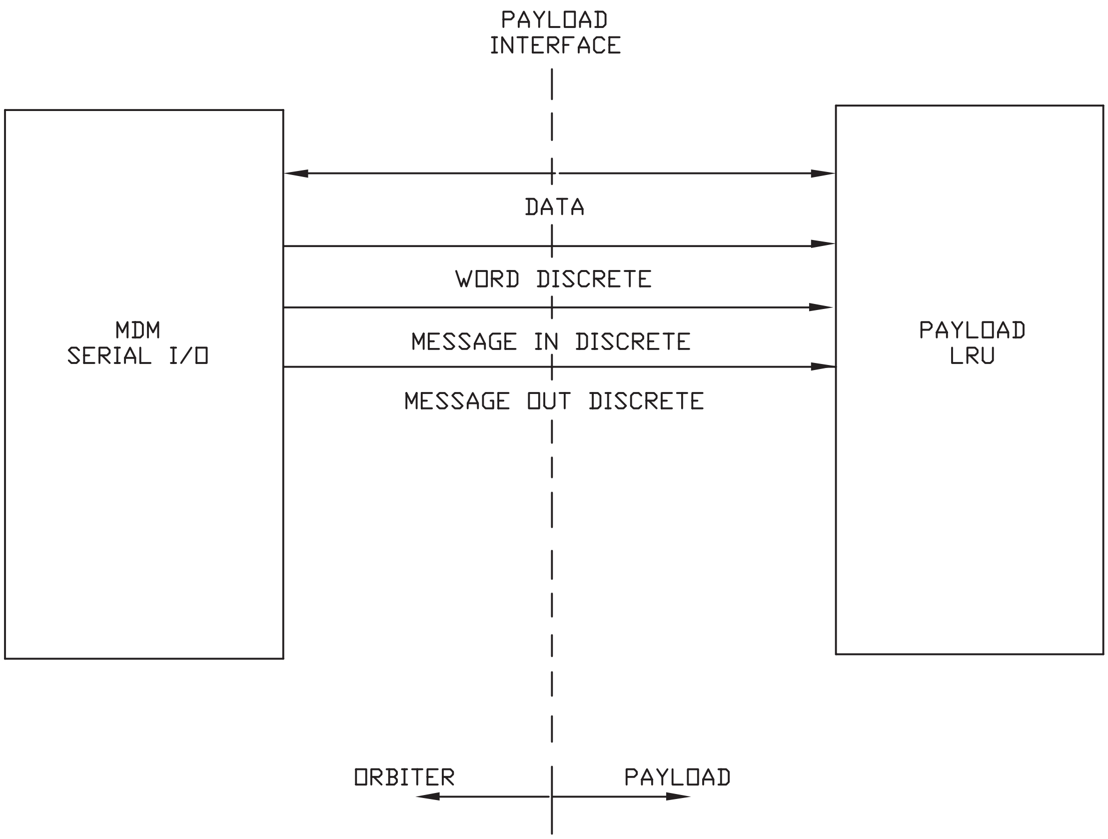


FIGURE 8.2.2.5-1 MDM SERIAL I/O INTERFACE

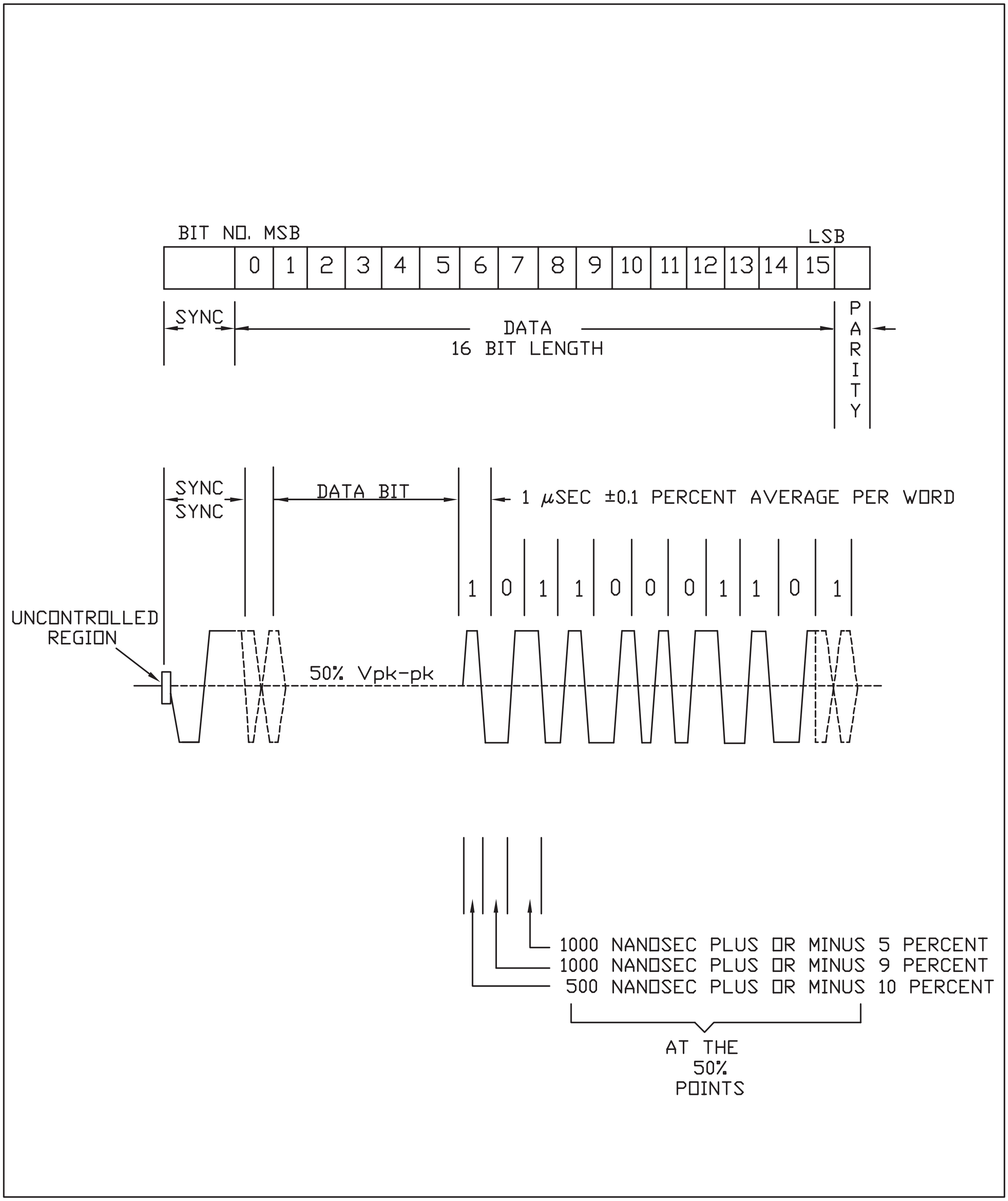


FIGURE 8.2.2.5-2 MDM SERIAL I/O WORD FORMAT

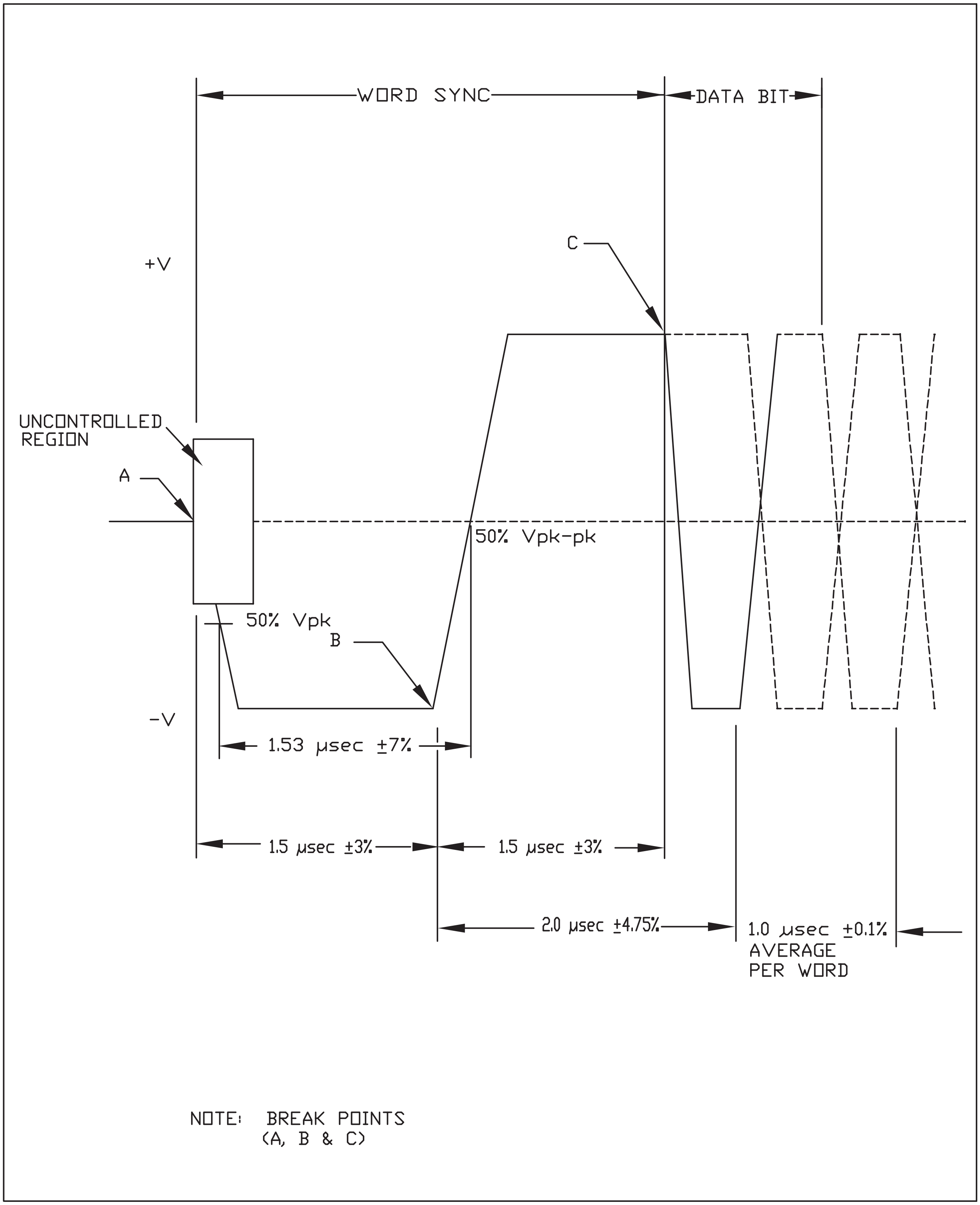
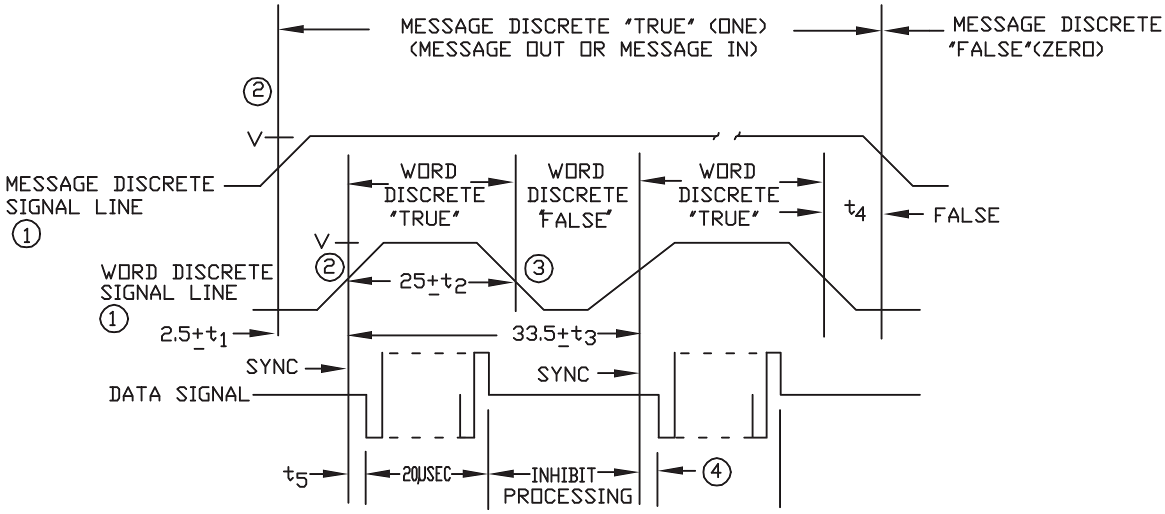


FIGURE 8.2.2.5.3-1 DATA WORD SYNC, NONVALID MANCHESTER CODE

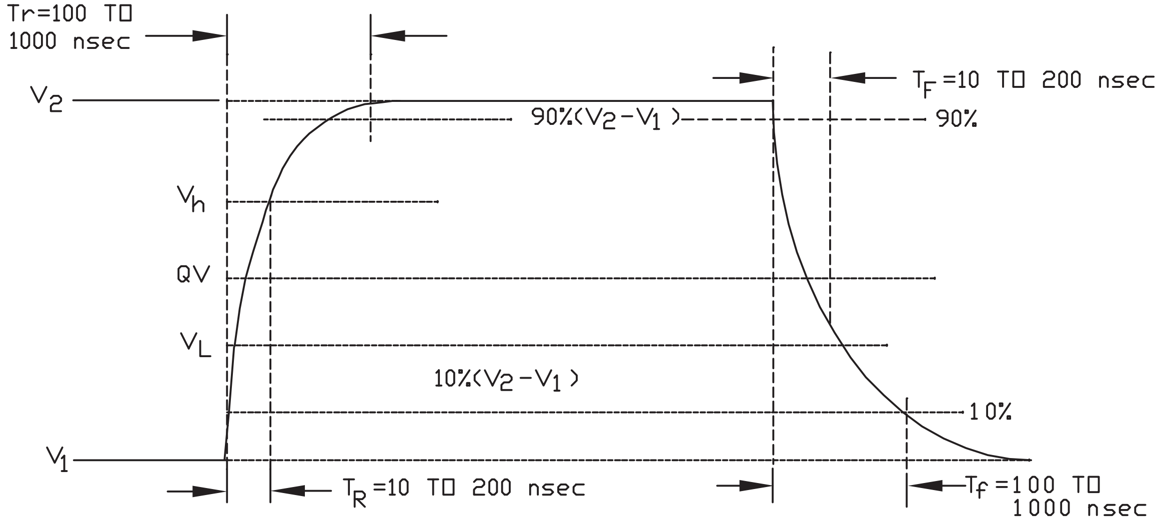


	VOLTAGE LEVELS (V) ②				TIME TOLERANCES (μSEC)					
	DISCRETE TRUE		DISCRETE "FALSE"		t_1	t_2	t_3	t_4		t_5
	SIG/GND	RET/GND	SIG/GND	RET/GND						
I/F DUE TO MDM	VERIFY LINE-TO-LINE PER FIGURE 8.2.2.5.4-2				+0.6	±1.0	±1.5	2 TO 16	XMIT	1.5±0.6
									RCV	1.8±1.0
I/F PAYLOAD REQ	VERIFY LINE-TO-LINE PER FIGURE 8.2.2.5.4-2				+0.7	±1.3	±1.8	2 TO 16	XMIT	1.5±0.6
									RCV	1.5±0.7

NOTES:

① DISCRETE RETURN LINE CARRIES LOGIC COMPLEMENT OF SIGNAL LINE LEVELS.
② VOLTAGE LEVELS ARE SHOWN AND TABULATED WITH REFERENCES TO MDM SIGNAL TO GROUND.
③ ALL TIMING PARAMETERS ARE REFERENCED TO THE MIDPOINT OF LEADING AND TRAILING EDGES.
④ INHIBIT RESPONSES TO NOISE DURING THIS INTERVAL.
5. INTERPRET OPEN RECEIVER INPUT AS LOGIC-0.
6. MAX CABLE LENGTH 150 FEET.
7. VOLTAGE LEVELS SPECIFIED IN TABLE 8.2.2.5.13-1.

FIGURE 8.2.2.5.4-1 MDM SERIAL I/O TIMING



NOTE: WAVE FORM REPRESENTS LINE-TO-LINE VOLTAGE EXCURSION

FIGURE 8.2.2.5.4-2 RISE AND FALL TIMES FOR SERIAL I/O DISCRETES

(SHEET 1 OF 2)

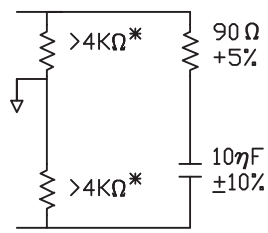
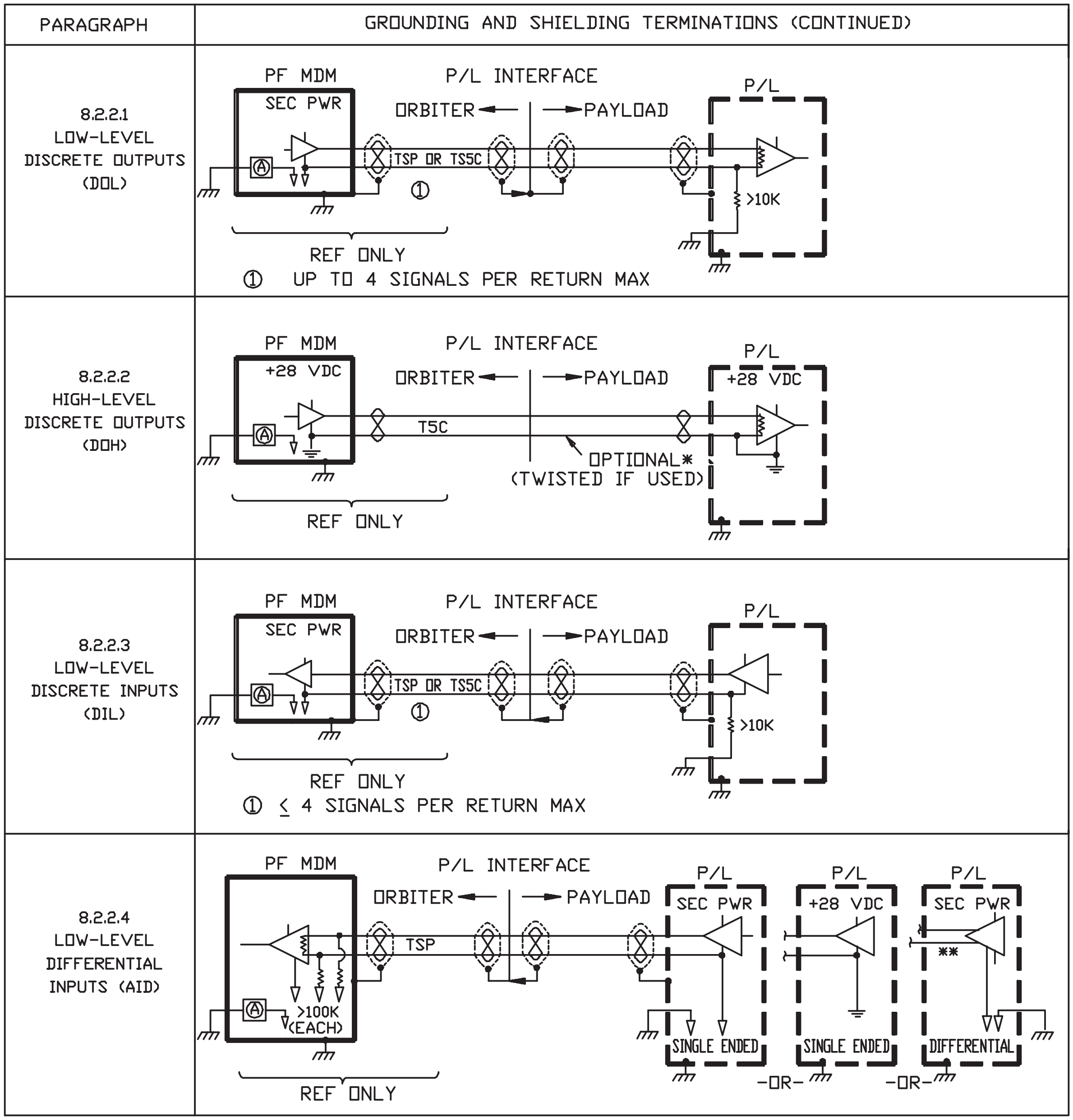
	LINE TERMINATION	V_1 VOLTS	V_2 VOLTS	V_L VOLTS	V_h VOLTS
RECEIVER INTERFACE PAYLOAD	(INSIDE PAYLOAD)  *BALANCED WITHIN 15%				
INTERFACE DUE TO MDM		−2.2 TO −5.0	+2.2 TO +5.0	−2.2	+2.2
INTERFACE LOAD REQUIREMENT		−2.1 TO −5.9	+2.1 TO +5.9	−2.1	+2.1

FIGURE 8.2.2.5.4-2 RISE AND FALL TIMES FOR SERIAL I/O DISCRETES

(SHEET 2 OF 2)

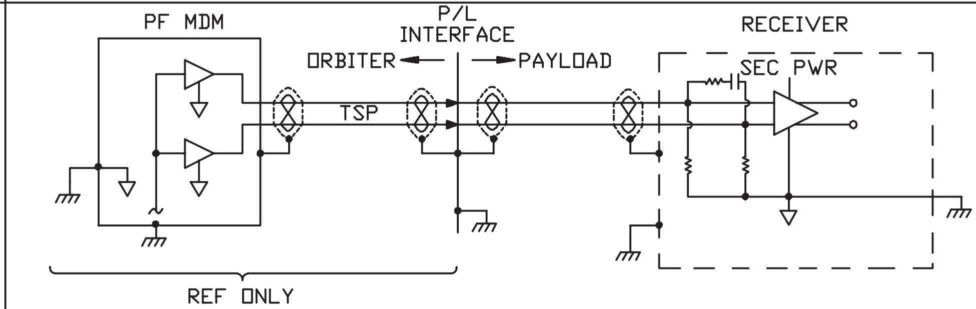
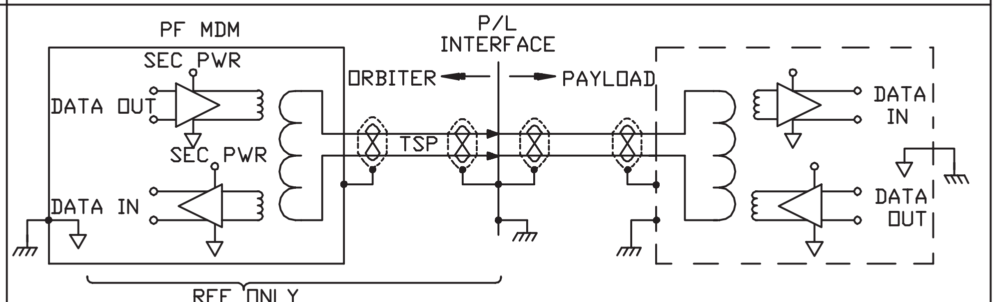
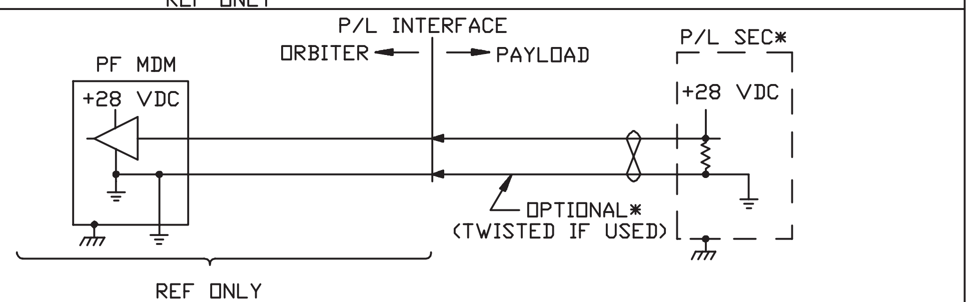


NOTE: SYMBOLS DEFINED IN SECTION 10.0
*SEE LIMITATIONS IN SECTION 10.0
**10V MAXIMUM WITH RESPECT TO MDM (SIGNAL INPUT TO SIGNAL GROUND) IN COMMON MODE NOMINAL SIGNAL INPUT MEASURED ACROSS TERMINALS, LINE TO LINE, SHOULD BE 5 VOLTS ABSOLUTE MAXIMUM (0 TO -5.0 VDC OR 0 TO +5.0 VDC)

Ⓐ EMI FILTER

FIGURE 8.2.2.6-1 MDM INTERFACE GROUNDING AND SHIELDING

(SHEET 1 OF 2)

PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS (CONTINUED)
8.2.2.5.13 MESSAGE-IN, MESSAGE-OUT WORD ENABLE DISCRETE	
8.2.2.5.13 DATA	
8.2.2.7 HIGH-LEVEL DISCRETE INPUTS (DIH)	

NOTE: SYMBOLS DEFINED IN SECTION 10
*SEE LIMITATIONS IN PARAGRAPH 10.7.4

FIGURE 8.2.2.6-1 MDM INTERFACE GROUNDING AND SHIELDING
(SHEET 2 OF 2)

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.3 Modular Memory Unit (MMU1) Interface

The MMU1 shall provide the capability to record Biphase-Level digital data. Orbiter/payload interface inputs to the MMU1 are as shown in Figure 8.2.3-1. Data timing reference shall be supplied by the payload.

8.2.3.1 Digital Data Recording

The MMU1 has two modes of operation when recording paylaod data. In the parallel mode, the MMU1 can be commanded to record simultaneously the three E channels (E1/E2/E3). In the serial mode, the MMU1 can be commanded to record the B channel only.

8.2.3.1.1 Record Rates

The MMU1 shall record with the characteristics of each rate as shown in Table 8.2.3.1.1-1.

8.2.3.1.2 (Deleted)

8.2.3.1.3 Digital Data Electrical Interface Characteristics

The electrical interface characteristics at the Orbiter/payload interface for digital recordings shall be as shown in Table 8.2.3.1.3-1.

8.2.3.2 (Deleted)

8.2.3.2.1 (Deleted)

8.2.3.2.2 (Deleted)

8.2.3.2.3 (Deleted)

8.2.3.3 Grounding and Shielding

Grounding and shielding for the MMU1 interfaces shall be as shown in Figure 8.2.3.3-1.

TABLE 8.2.3.1.1-1 ORBITER MMU1 DIGITAL RECORDING RATE CHARACTERISTICS

CHANNEL	MEMORY SPACE (Kbits)	RECORD RATE (Kbps)	RECORDING TIME (Minimum)
B SERIAL MODE	3,400,000 3,400,000	1000 64	56.67 (Minutes) 885.42 (Minutes)
E1 PARALLEL MODE	216,000 216,000	60 32	60.00 (Minutes) 112.00 (Minutes)
E2 PARALLEL MODE	216,000	60	60.00 (Minutes)
E3 PARALLEL MODE	216,000	60	60.00 (Minutes)

TABLE 8.2.3.1.3-1 DIGITAL DATA RECORDING ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/Payload Interface (2)	Notes
Bit Rate	kbps		
Signal Type		Differential (Biϕ-L)	
Rise and Fall Time	Percent Bit Cell Time(BCT)	10 Max	
Signal Amplitude (MMU1 Output)	V, p-p	Line-To-Line 3.OV to 9V p-p Line-To-Line 1.5V to 4.5V peak	
Jitter and Assymetry	Percent of BCT	±2	
Input Impedance (MMU1)	Ohms, L-L	71±10 percent	
Source Impedance (Payload)	Ohms,L-L	TTL Compatible	(3)
Common-Mode Voltage	Volts	±15	(1)
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Boeing Design Standard MP572-0328-0002
Cable Impedence Zo	Ohms	70 min 80 max	Measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2440 max	(2)
Cable Resistance (Orbiter)	Ohms	6.4 Max	(4) Round Trip

(1) Referenced to Signal Ground
(2) Calculations based upon 106 feet of cable from MMU1 to payload interface (end of SMCH).
(3) TI SN55114, or equivalent driver.
(4) At 68°F maximum.

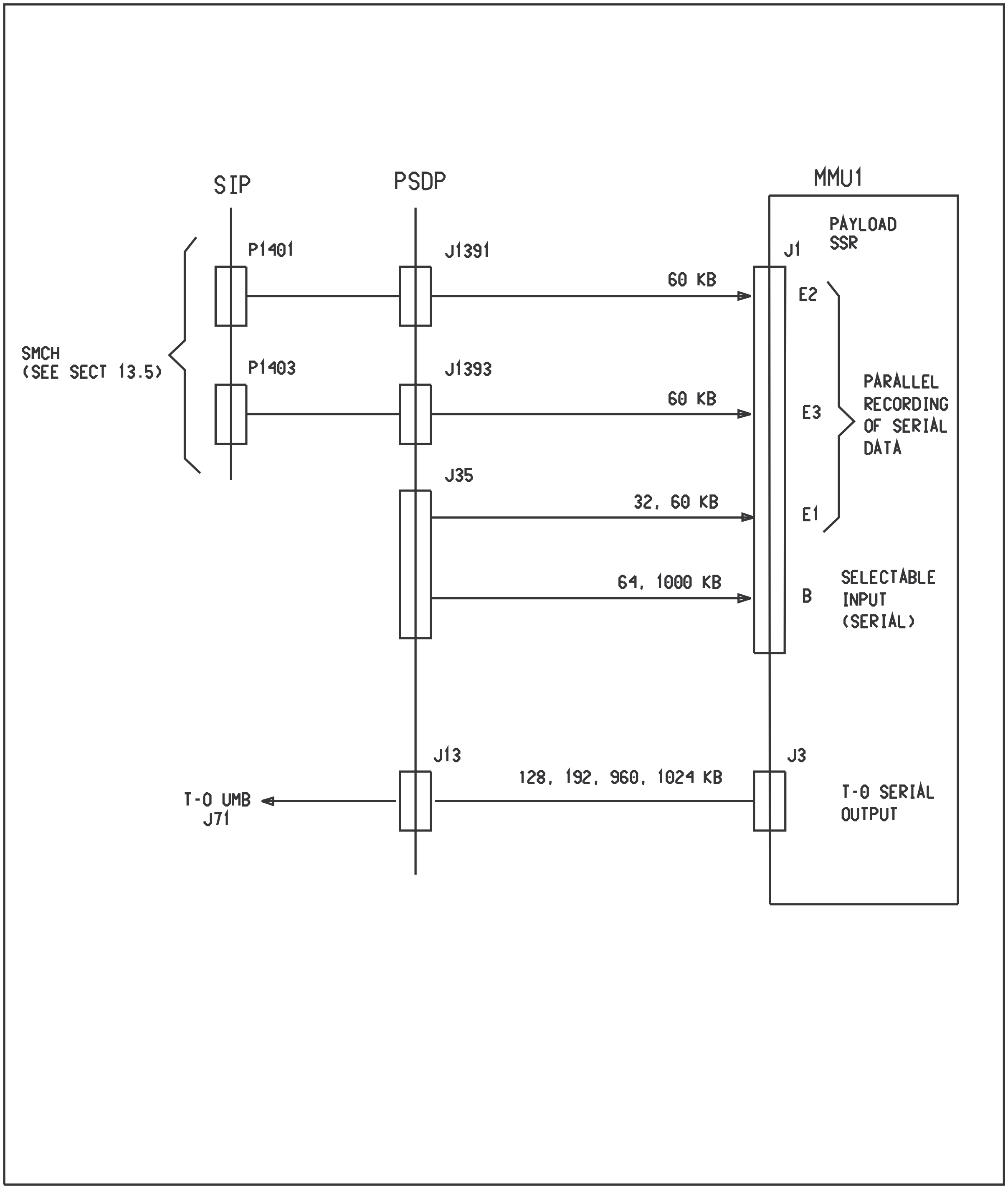
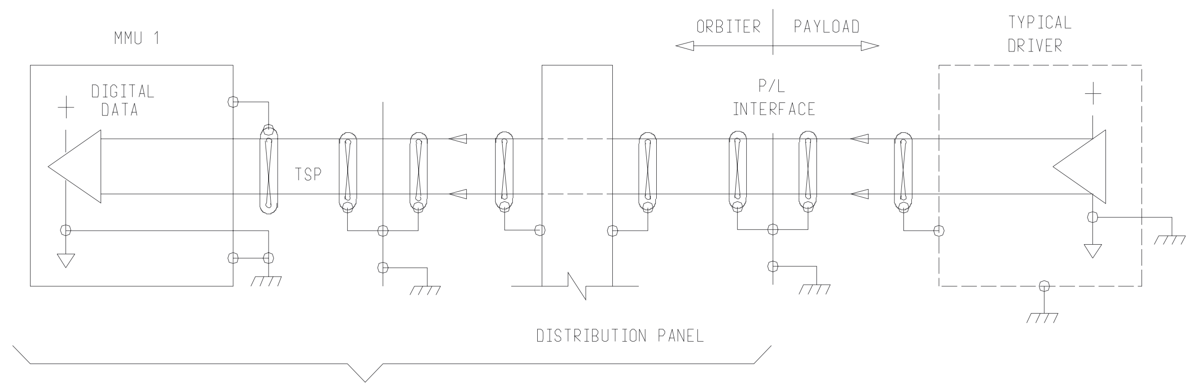


FIGURE 8.2.3-1 ORBITER MMU1 INTERFACE FOR PAYLOAD

FIGURE 8.2.3.3-1 MODULAR MEMORY UNIT GROUNDING AND SHIELDING

PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.3.1 DIGITAL DATA RECORDING (TYPICAL 4 DATA INPUTS)	

NOTE:

SYMBOLS DEFINED IN SECTION 10.0

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.4 KU-Band Signal Processor Interface

The Ku-Band signal processor shall be capable of accepting data from and providing data to attached payloads as shown in Figure 8.2.4-1.

8.2.4.1 High Data Rate Maximum; Digital-Data and Clock Inputs

The 2 to 48-Mbps data and clock signals from the payload shall have the characteristics shown in Tables 8.2.4.1-1 and 8.2.4.1-2, respectively.

8.2.4.2 Low Data Rate; Digital-Data Input

The 16-Kbps to 1.024(Biϕ-L/M/S)/2(NRZ-L/M/S)Mbps data signals from the payload shall have the characteristics shown in Table 8.2.4.2-1.

8.2.4.3 High Data Rate; Digital-Data Input

The 16-kbps to 4-Mbps data signals from the payload shall have the characteristics shown in Table 8.2.4.3-1.

8.2.4.4 Analog-Data Input

The DC to 4.5 MHz analog signals from the payload shall have the characteristics shown in Table 8.2.4.4-1.

8.2.4.5 Forward Link; Data and Clock Outputs

The 128-kbps data and clock signals supplied to the payload shall have the characteristics shown in Table 8.2.4.5-1 and 8.2.4.5-2 respectively. The definition of Forward Link Data-to-Clock offset shall be as shown in Figure 8.2.4.5 -1.

8.2.4.6 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.4.6-1.

TABLE 8.2.4.1-1 2 TO 48 MBPS DATA INPUT ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Rate	Mbps	2 to 48 Mbps	(3)
Data Type		NRZ-L, M or S	
Data Asymmetry	Percent	$\leq$ 16 at 50 Mbps, increasing linearly to 38 at 8.5 Mbps constant at 38, for rates < 8.5 Mbps	
Data Stability	Percent	$\leq$0.01	
Rise/Fall Time	Nanosec	3.5 or 5 percent of bit duration, which ever is greater	(1) From 10 percent to 90 percent of initial to final amplitude-at SIP
Frequency Jitter	Percent rms	±0.01 of the data rate at a rate of 0.01 percent rms of the data rate	
Amplitude	Volts	Logic "1": 4.5 min to 6.5 max. Logic "0": 0 ± 0.5	(1)
Load Impedance	Ohms	50±10 percent	
Source Coupling		Single-ended coaxial	
SNR(RMS)	dB	30 min	Relative to RMS noise at input to Ku SPA - Noise B/W to 200 MHz
Cable Type		RG 142 B/U	50 ohms nominal (2)
Grounding		Figure 8.2.4.6-1	Shield multipoint grounded.

TABLE 8.2.4.1-1 2 TO 48 MBPS DATA INPUT ELECTRICAL INTERFACE CHARACTERISTICS (CONLUDED)

Notes:

(1) Calculations based upon 92 feet of cable from Ku-band signal processor to payload interface (end of SMCH).
(2) The data cable and the associated clock cable shall not differ in the overall length by more than 12 inches. The environment of the data and clock cables shall be uniform and essentially the same for both cables.
(3) The maximum data rate which can be accommodated by the TDRS ground station's statistical multiplexer prior to transmission to the Mission Control Center via domestic satellite is 48 MBPS ± 1 percent.

TABLE 8.2.4.1-2 2 TO 48 MBPS CLOCK, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Clock Rate	Mbps	2 to 48	Same rate as data
Clock Type		Square wave (RZ)	
Clock Asymmetry	Percent of bit period	≤ (10 + Ro/5)	Ro is a number equal to the input clock rate in MHz
Clock Stability	Percent	≤ .01	
Duty Cycle	Percent	50 ± 5 of period	
Data-to-Clock Offset (skew)	Percent of bit period	± 21	
Amplitude	Volts	Logic "1": 4.5 min to 6.5 max. Logic "0": 0 ± 0.5	(1)
SNR RMS	dB	30 min	Relative to RMS noise at input to Ku SPA noise B/W to 200 MHz
Load Impedance	Ohms	50 ± 10 percent	
Source Coupling		Single-ended (coaxial)	
Cable Type		RG142 B/U	50 ohms nominal
Grounding		Refer to Figure 8.2.4.6-1	Shield multipoint grounded
Bit Jitter	Percent	± 2 of bit period	Clock phase jitter relative to data
Frequency Jitter	Percent rms	±0.01 of the input data rate at a rate of 0.01 percent rms of data rate	

(1) Calculations based upon 92 feet of cable from Ku-band signal processor to payload interface (end of SMCH).

TABLE 8.2.4.2-1 LOW DATA RATE, DIGITAL-DATA INPUT ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Rate and Data Type	bps	16 kbps to 1.024 Mbps Biϕ-L, -M, or -S 16 kbps to 2 Mbps, NRZ-L, M or S	
Rise/Fall Time	Nanosec	40 or 4 percent of Bit period whichever is smaller	As measured between the 10 and 90 percent points
Frequency Jitter	Percent rms of data rate	± frequency deviation of 0.01 percent rms of the data rate at a rate of 0.01 percent rms of the data rate	
Amplitude	Volts p-p	2.7 to 5.0, line-to-line	(3)
Load Impedance	Ohms	75 ± 5	(1)
Source Coupling		Balanced differential direct coupled	
SNR (RMS)	dB	35 min	Relative to noise at Ku SPA input
Common Mode Voltage	Volts	DC to 10 kHz ≤ ± 10 10 to 100 kHz Decreasing at 10 dB/decade Above 100 kHz Decreasing at 10 dB/octave	(4)
Data Stability	percent	≤ 0.01	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2093 max	(3)
Grounding		See Figure 8.2.4.6-1	Shield multipoint Grounded

(1) The load impedance shall be a resistive load matched to the line impedance over a 3dB bandwidth of 0 to 2 MHz.

(2) Deleted

(3) Calculations based upon 91 feet of cable from Ku-band signal processor to payload interface (end of SMCH).

(4) Consists of discrete and spectral components to frequency interval four times maximum data rate. Spectral component Gaussian noise with power spectral density of 10-20 watts/Hz. Discrete components randomly distributed over channel bandwidth.

TABLE 8.2.4.3-1 HIGH DATA RATE, DIGITAL-DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Rate	bps	16 kbps to 4 Mbps	
Data Type		NRZ-L, M or S	
Data Stability	Percent	$\leq$ 0.01	
Rise/Fall	Nanosec	40 or 4 percent of bit period whichever is smaller	As measured between the 10 and 90 percent points
Frequency Jitter	Percent rms of data rate	$\pm$ frequency deviation of 0.01 percent rms of the data rate at a rate of 0.01 percent rms of the data rate	
Amplitude	Volts p-p	2.7 to 5.0, line-to-line	(3)
Load Impedance	Ohms	75 $\pm$ 5	(1)
Termination		Balanced differential direct coupled	
SNR (RMS)	dB	35 min	
Common Mode Voltage	Volts	dc to 10kHz $\leq \pm$ 10 10 to 100kHz decreasing at 10 dB/decade. Above 100kHz decreasing at 10 dB/octave.	(4)
Data Stability	Percent	< 0.01	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2093 max	(3)
Grounding		See Figure 8.2.4.6-1	Shield multipoint grounded

Notes:

(1) The load impedance shall be a resistive load matched to the line impedance over a 3dB bandwidth of 0 to 4 MHz.
(2) Deleted
(3) Calculations based upon 91 feet of cable from Ku-band signal processor to payload interface (end of SMCH).
(4) Consist of discrete and spectral components to frequency interval four times maximum data rate. Spectral component Gaussian noise with power spectral density of 10 - 20 watts/Hz. Discrete components randomly distributed over channel bandwidth.

TABLE 8.2.4.4-1 ANALOG-DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Bandwidth	Hz	dc to 4.5 MHz	(3)
Amplitude	Volts p-p	0 to 1.1, line-to-line	Shall not have a dc bias with respect to signal ground (1) (2)
Load Impedance	Ohms	75 ± 5	
Source Impedance	Ohms	75 ± 5	
Source Coupling		Balanced Differential Direct Coupled	
SNR	dB	45 Min	p-p signal to RMS noise
Phase Jitter	Percent	±2 of pulse period for TV synchronizing pulse	
Common Mode Voltage	Volts	DC to 10 kHz ≤ ±10 10 to 100 kHz decreasing at 10 dB/decade. Above 100 kHz decreasing at 10 dB/octave	(4)
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2093 max	(2)
Grounding		See Figure 8.2.4.6-1	Shield multipoint grounded

NOTES:

(1) The load impedance shall be a resistive load matched to the line impedance over a 3 dB bandwidth of 0 to 4 MHz.

(2) Calculations based upon 91 feet of cable from Ku-band signal processor to payload interface (end of SMCH).

(3) Because the frequency response of the MP572-0328-0002 twisted wire pair cable is poor above 2 MHz, the user must provide compensating networks at his line driver.

TABLE 8.2.4.4-1 ANALOG-DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

(4) Consist of discrete and spectral components to frequency interval four times maximum data rate. Spectral component Gaussian noise with power spectral density of 10 - 20 watts/Hz. Discrete components randomly distributed over channel bandwidth.

TABLE 8.2.4.5-1 128 KBPS DATA OUTPUT TO A PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Rate	kbps	128	
Data Type		NRZ-L	
Data Stability	Percent of bit rate	≤0.01	
Data Asymmetry	Percent of bit period	10 max	
Rise/Fall Time	Nanosec	250 max	(1) 10 percent and 90 percent points
Frequency Jitter	Percent RMS	± a frequency deviation of 0.1 percent rms of the data rate at a rate of 0.1 percent rms of the data rate	Determined by ground station
Amplitude	Volts	Logic "1": 1.8 to 3.5 Logic "0": 0 to 0.45	(1) Signal line measured with respect to signal ground
		Logic "1": 0 to 0.45 Logic "0": 1.8 to 3.5	Signal return line measured with respect to signal ground (1)
Load Impedance	Ohms	75±5	
Load Coupling		Balanced differential direct-coupled	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2093 max	(1)
Grounding		See Figure 8.2.4.6-1	Shield multipoint grounded

(1) Calculations based upon 91 feet of cable from Ku-band signal processor to payload interface (end of SMCH).

TABLE 8.2.4.5-2 128 KBPS CLOCK OUTPUT TO PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Clock Rate	kHz	128	
Clock Type	Percent	Square wave	
Asymmetry	Percent of bit period	10 max	
Duty Cycle	Percent of bit period	50 ± 5	
Data-to-Clock Offset (skew)	Nanosec	Leading edge of clock (logic "0" to logic "1") occurs at the middle of the data bit period within 150 nanosec.	
Amplitude	Volts	Logic "1": 1.8 to 3.5 Logic "0": 0 to 0.45	(1) Signal line measured with respect to signal ground
		Logic "1": 0 to 0.45 Logic "0": 1.8 to 3.5	Signal return line measured with respect to signal ground. (1)
Frequency Jitter		± a frequency deviation of 0.1 percent rms of the data rate at a rate of 0.1 percent rms of the data rate	
Phase Jitter	Percent rms of bit period	±2	With respect to data
Load Impedance	Ohms	75±5	
Rise/Fall Times	Nanosec	250 max	Measured at 10 to 90 percent amplitude points
Load Coupling		Balanced differential direct-coupled	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2093 max	(1)
Grounding		See Figure 8.2.4.6-1	Shield multipoint grounded
Data/Clock Jitter	Percent	10 (of bit period)	Clock jitter to data

(1) Calculations based upon 91 feet of cable from Ku-band signal processor to payload interface (end of SMCH).

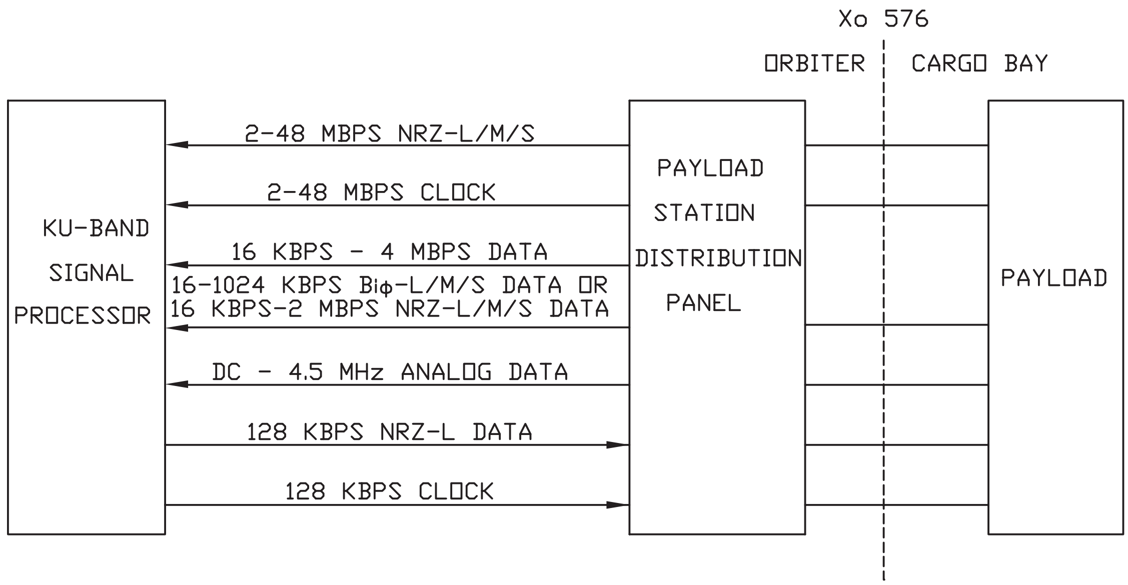


FIGURE 8.2.4-1 KU-BAND SIGNAL PROCESSOR INTERFACE

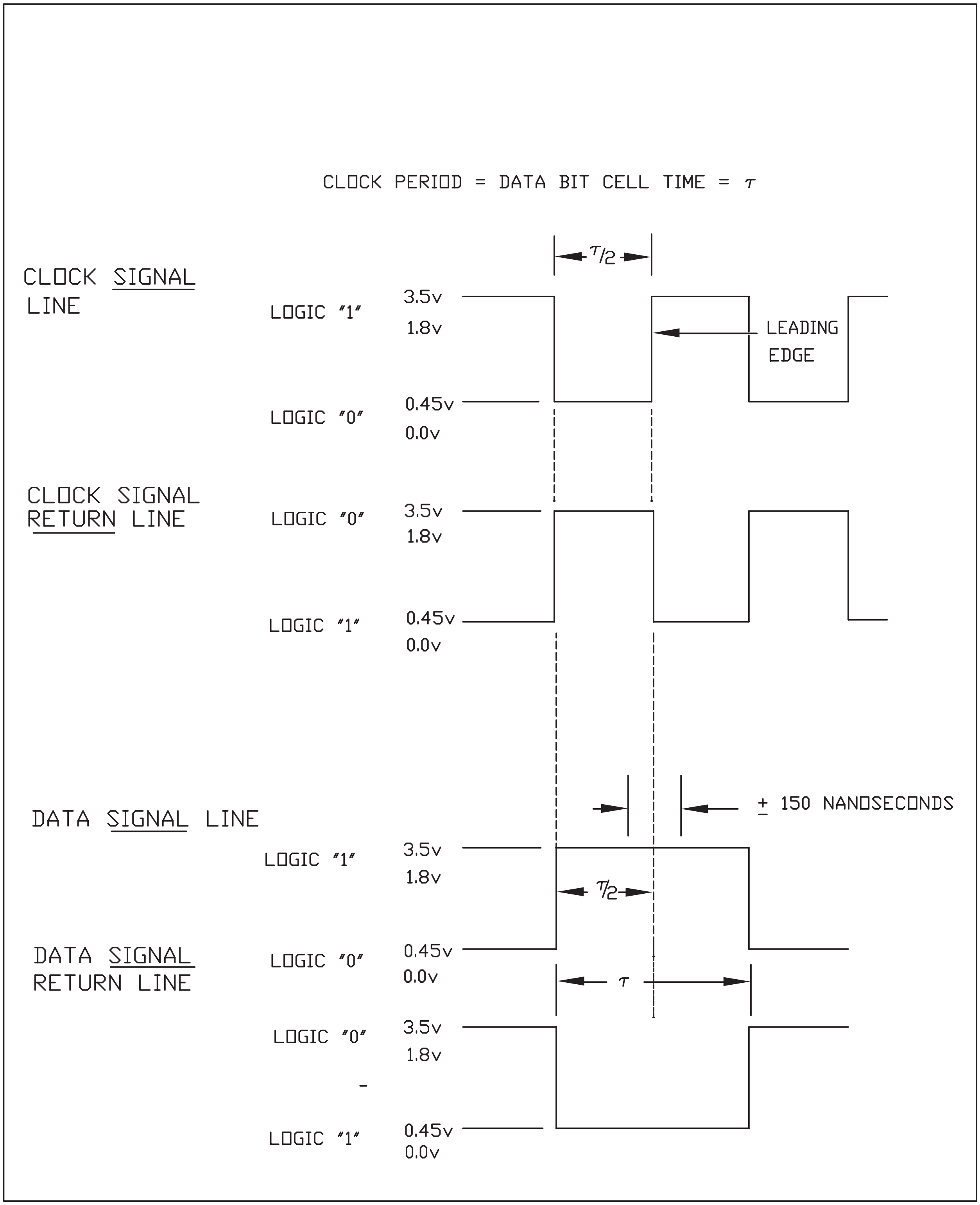


FIGURE 8.2.4.5-1 DEFINITION OF FORWARD LINK DATA-TO-CLOCK OFFSET

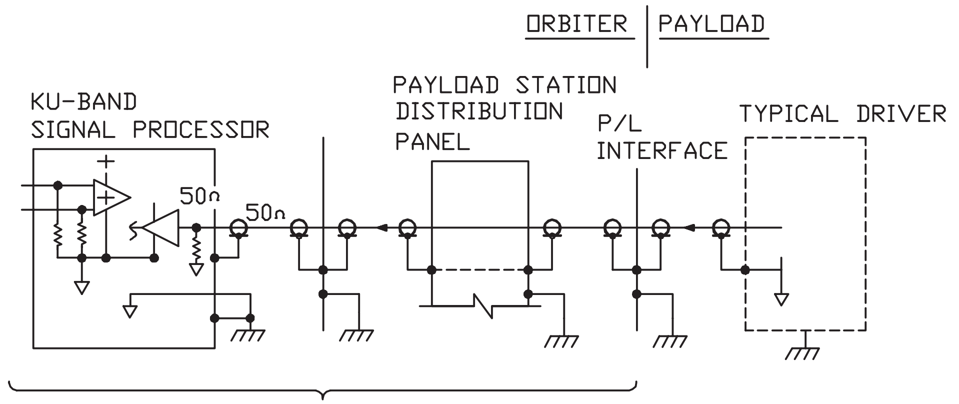
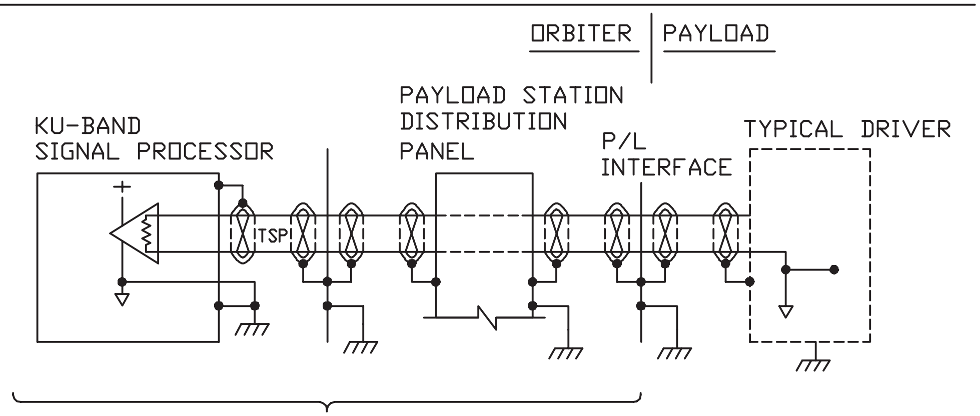
PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.4.1 2 TO 48 MBPS DATA AND CLOCK INPUT	
8.2.4.2 16 KBPS TO 2 MBPS DATA INPUT 8.2.4.3 16 KBPS TO 4 MBPS DATA INPUT 8.2.4.4 DC TO 4.5 MHz ANALOG INPUT	

FIGURE 8.2.4.6-1 KU-BAND GROUNDING AND SHIELDING
(SHEET 1 OF 2)

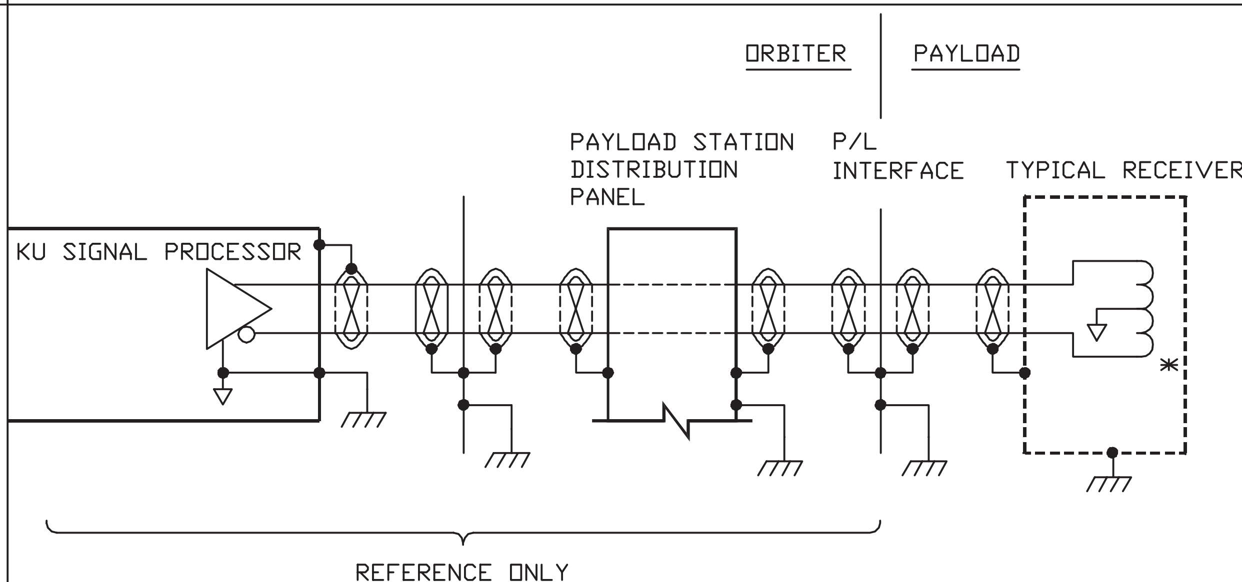
PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.4.5 128 KBPS DATA AND CLOCK OUTPUT	 NOTE: SYMBOLS DEFINED IN PARAGRAPH 10.7.4.2.4 * SEE PARAGRAPH 10.7.4.1.1

FIGURE 8.2.4.6-1 KU-BAND GROUNDING AND SHIELDING
(SHEET 2 OF 2)

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.5 Payload Signal Processor Interface

The Payload Signal Processor (PSP) shall provide command data to up to five attached payloads, while operating in the attached-payload mode, or to one detached payload at a time, via the Payload Interrogator while operating in the detached-payload mode (Reference Paragraph 8.3). It shall also be capable of receiving telemetry data from detached payloads via the Payload Interrogator. (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. This capability applies for both attached and detached payloads. 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)

8.2.5.2.1 (Reserved)

8.2.5.3 Grounding and Shielding

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

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		$\leq 10^{-7}$ 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	3.2 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)
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measure conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2875 max	(2) (3)

(1) Based upon MTU accuracy and stability.
(2) Applicable to attached cargo element interfaces only.
(3) Calculations based upon 125 feet of cable from PSP to payload interface (end of SMCH).

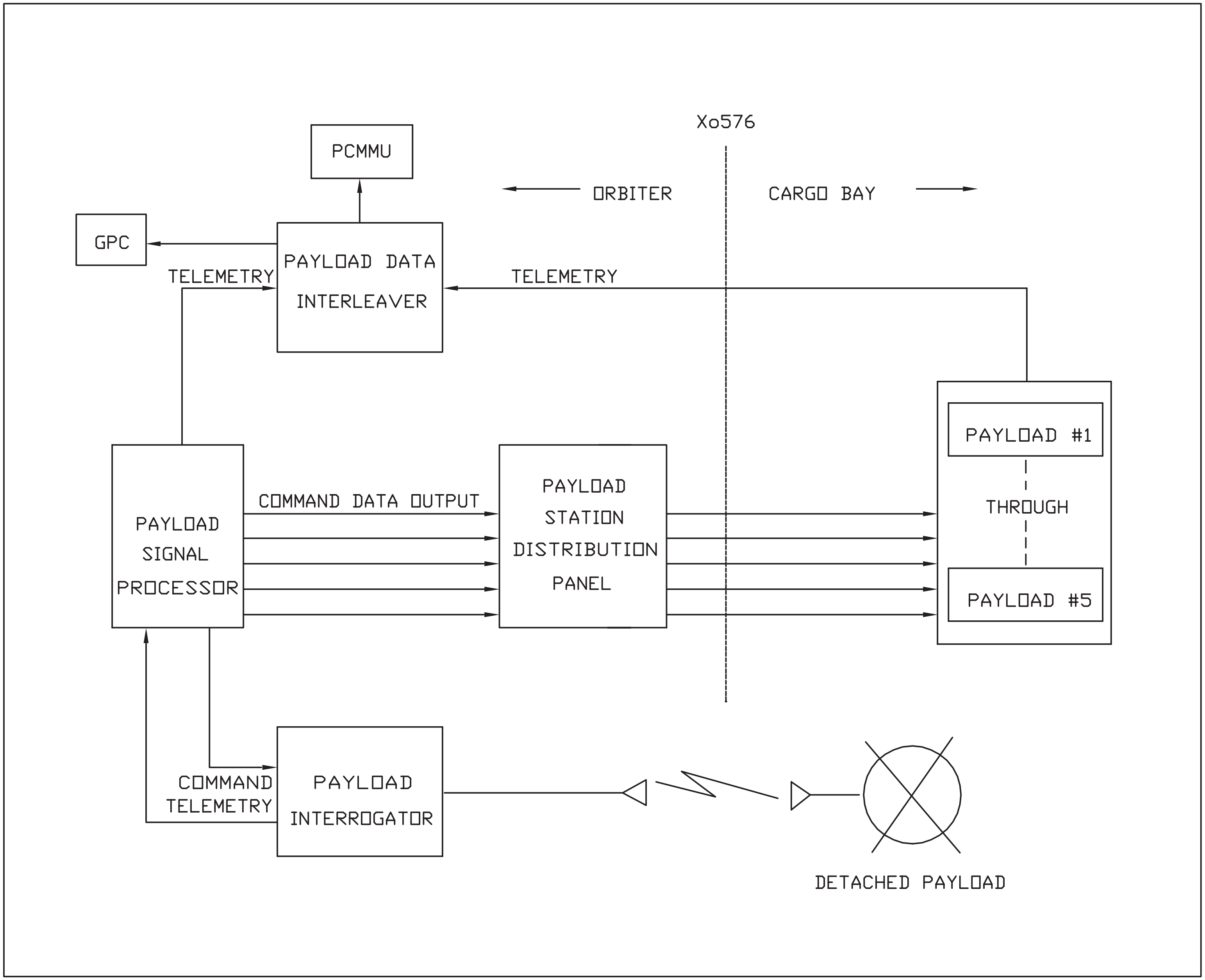
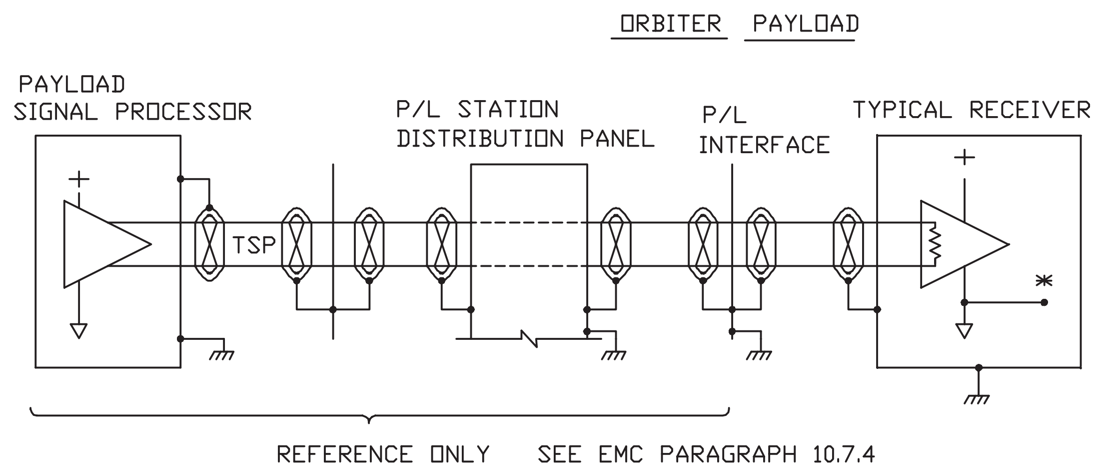


FIGURE 8.2.5-1 PAYLOAD SIGNAL PROCESSOR INTERFACE

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	 NOTE: SYMBOLS DEFINED IN PARAGRAPH 10.7

* SEE PARAGRAPH 10.7.4.1.1

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.6 S-Band FM Signal Processor Interface

The S-Band FM signal processor shall accept data from attached payloads as shown in Figure 8.2.6-1.

8.2.6.1 300 Hz to 4 MHz Analog Data Input

The 300 Hz to 4 MHz analog signals from attached payloads shall have the characteristics shown in Table 8.2.6.1-1.

8.2.6.2 200 bps to 5 Mbps Data Input

The 200-bps to 5 Mbps digital data from attached payloads shall have the characteristics shown in Table 8.2.6.2-1.

8.2.6.3 250 bps to 256 kbps DOD Data Input

The 250 bps to 256 kbps digital data from attached DOD payloads shall have the characteristics shown in Table 8.2.6.3-1.

8.2.6.4 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.6.4-1.

TABLE 8.2.6.1-1 WIDEBAND ANALOG DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Bandwidth	Hz	300 Hz to 4 MHz	
Amplitude	Volts Peak-to-peak, line-to-line	1.38, ±6 percent (V_1)	(1) (2)
Source Coupling		Balanced, Differential	
Load Termination		Balanced, Differential	
Source Impedance (Payload)	Ohms	75 ±10 percent	
Load Impedance (Orbiter)	Ohms	75 ±10 percent	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2440 max	(1)
SNR	dB pk-pk signal to noise	55, for 45 out of Signal Processor (RMS)	dc to 2 MHz
Overvoltage Protection	Volts peak-to-peak	10	

(1) Calculations based on worst case line attenuation, at 4MHz and 106 feet of cable from S-band FM signal processor to payload interface (end of SMCH). Signal amplitude requirements at other operating frequency/frequencies and cable lengths (SMCH harness) are determined by the following generic equation:

$$V_1 = \frac{V2}{1 - \left[\frac{L + 45}{100}\right]\left[.06 + 1/50\sqrt{f/f_1}\right]} \quad \text{Volts, peak - to - peak, line - to - line}$$

Where:

(a) V_1 =Voltage required at the payload interface.
(b) V_2 = Voltage requirement at the LRU (FM Signal Processor).

(c) f_1 = 0.04 MHz reference frequency.

(d) f = operating frequency (MHz)

(e) L = Length (ft) of SMCH cable from Sta 603 to the Orbiter/Payload interface (The cable length from Sta 603 to the FM Signal Processor is 45 feet).

(2) Signal requirement at the S-Band FM Signal Processor (LRU) is 1.0 volt, peak-to-peak, line-to-line ± 10 percent.

TABLE 8.2.6.2-1 WIDEBAND DIGITAL DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Rate	bps	200 bps to 5 Mbps,NRZ-L	
Data Type		200 bps to 2 Mbps,Biϕ-L	
Rise/Fall Time	Micro-seconds	Less than 50 nanoseconds	
Amplitude	Volts Peak-to-peak, line-to-line	6.50, ± 0.3 volts (V_1)	(1) (2)
Source Coupling		Balanced Differential	
Load Termination		Balanced Differential	
Source Impedance (Payload)	Ohms	75 ± 10 percent	
Load Impedance (Orbiter)	Ohms	75 ± 10 percent	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2440 max	(1)
SNR	dB pk-pk sig. to noise	46, for 45 out of Signal Processor (RMS)	dc to 2 MHz
Overvoltage Protection	Volts peak-to-peak	10	

TABLE 8.2.6.2-1 WIDEBAND DIGITAL DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

(1) Calculations based on worst case line attenuation, at 2.5MHz and 106 feet of cable from S-band FM signal processor to payload interface (end of SMCH). Signal amplitude requirements at other operating frequency/frequencies and cable lengths (SMCH harness) are determined by the generic equation defined by note (1) in Table 8.2.6.1-1.

(2) Signal requirement at the S-Band FM Signal Processor (LRU) is 5.0 volts, peak-to-peak, line-to-line ± 0.5 volt.

TABLE 8.2.6.3-1 DOD DIGITAL DATA INPUT, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Data Rate	bps	250 bps to 256 kbps	
Data Type		Biϕ-L or NRZ-L	
Amplitude	Volts peak-to-peak, Line-to-Line	1.13, ±0.4 volts (V_1)	(1) (2)
Rise/Fall Time	Micro-Seconds	Less than 100 nanoseconds	
Source Coupling		Balanced Differential	
Load Termination		Balanced Differential	
Source Impedance (Payload)	Ohms	75 ± 10 percent	
Load Impedance (Orbiter)	Ohms	75 ± 10 percent	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2440 max	(1)
SNR	dB pk-pk sig. to noise	46, for 45 out of Signal Processor (RMS)	dc to 2 MHz
Overvoltage Protection	Volts peak-to-peak	10	

TABLE 8.2.6.3-1 DOD DIGITAL DATA INPUT,
ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

(1) Calculations based on worst case line attenuation, at 256kHz and 106 feet of cable from S-band FM signal processor to payload interface (end of SMCH). Signal amplitude requirements at other operating frequency/frequencies and cable lengths (SMCH harness) are determined by the generic equation defined by note (1) in Table 8.2.6.1-1.

(2) Signal requirement at the S-Band FM Signal Processor (LRU) is 1.0 volt, peak-to-peak, line-to-line ± 0.6 volt.

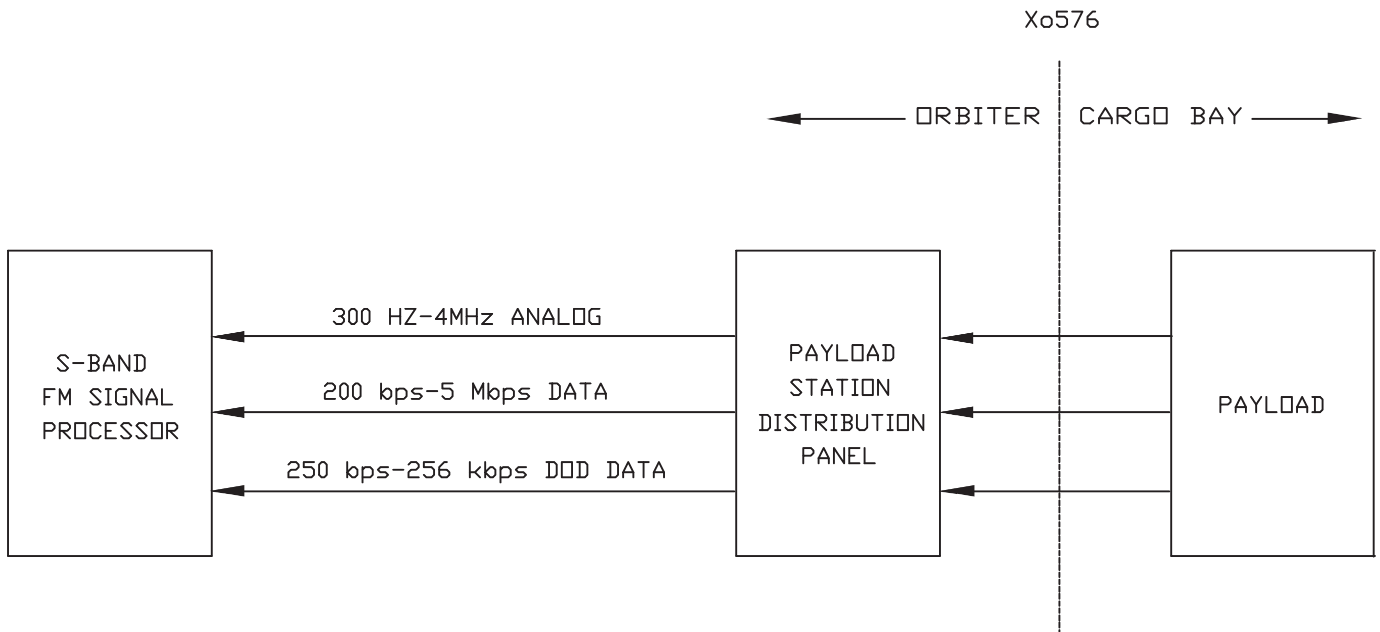
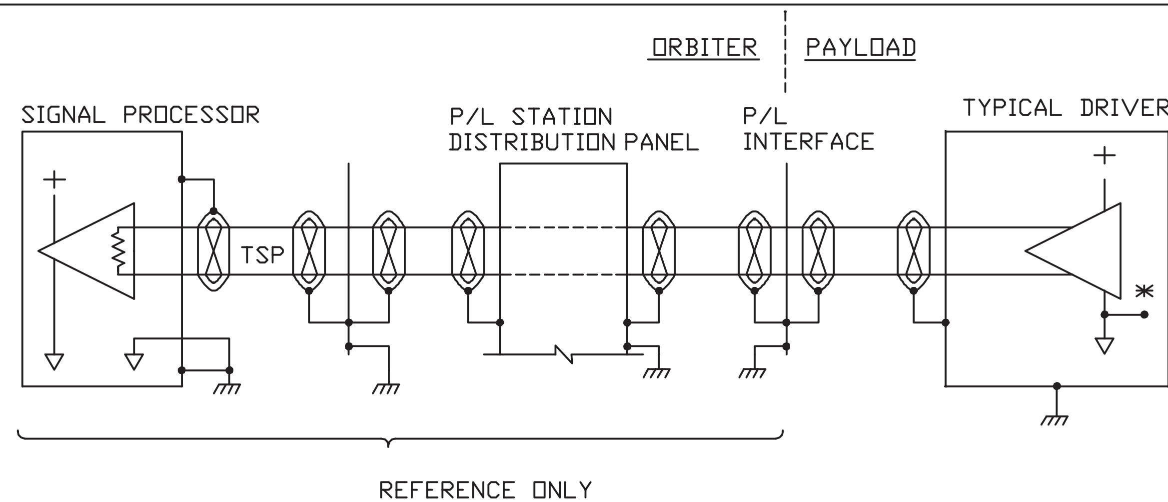


FIGURE 8.2.6-1 S-BAND FM SIGNAL PROCESSOR INTERFACE

FIGURE 8.2.6.4-1 S-BAND FM SIGNAL PROCESSOR GROUNDING AND SHIELDING

PARAGRAPH	GROUNDING AND SHIELDING TERMINATION
8.2.6.1 300 Hz TO 4 MHz ANALOG DATA INPUT 8.2.6.2 200 BPS TO 5 MBPS DATA INPUT 8.2.6.3 250 BPS TO 256 KBPS DOD DATA INPUT	 NOTE: SYMBOLS DEFINED IN SECTION 10.7.4.2.4

*SEE PARAGRAPH 10.7.4.1.1

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.7 Audio Central Control Network Interface

The Orbiter Audio Central Control Network (ACCN) shall provide duplex voice communications, paging, and aural caution and warning to attached manned payloads as shown in Figure 8.2.7-1.

8.2.7.1 Channels

The Orbiter ACCN shall provide the following analog channels with the characteristics defined in Tables 8.2.7.1-1 and 8.2.7.1-2.

Air to Ground 1	AG1
Air to Ground 2	AG2
Intercomm A	I/CA
Intercomm B	I/CB
Air-to-Air	AA
Page	

The page channel audio shall operate at a fixed higher volume level such that all audio stations can hear a page voice regardless of audio on other channels. The Orbiter shall provide the capability for recording the five audio channels.

8.2.7.2 Caution and Warning

The Orbiter ACCN shall distribute caution and warning signals to manned attached payloads with the characteristics shown in Table 8.2.7.2-1.

8.2.7.3 Transmitter Key and Page Key Line

Cargo elements requiring access to the Orbiter ACCN shall provide a switch closure with the characteristics defined in Table 8.2.7.3-1 for keying a simplex transceiver for voice transmission over the AA channel and a switch closure with the characteristics defined in Table 8.2.7.3-2 for keying paging onto the Orbiter operational channels.

8.2.7.4 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.7.4-1.

TABLE 8.2.7.1-1 ACCN ORBITER-TO-PAYLOAD AUDIO CHANNELS, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Bandwidth/ Freq Response	Hz	300 to 2300: ± 3dB 2300 to 3000: +3dB,-6dB	
Filter Rolloff	dB per Octave	18 dB per octave below 300 Hz and above 3kHz	
Signal Level at 1 kHz	dBm	.0dBm ± 3dB	(1)
Crest Factor	dB	3dB (Nominal) Sinewave 6dB (Nominal) Voice	Ratio of peak to rms signal level controlled by voice processing
Nominal Amplitude	Volts, pk-to-pk	2.2 ± 3dB	(1)
Source Coupling	Ohms	Transformer coupled, balanced center tapped	
Load Termination		Transformer coupled, balanced, center tapped	Terminated in 600 Ohms whether in use or not
Cable		2 conductor twisted, shielded, jacketed, uncontrolled impedance	Rockwell Design Standard MP572-0311

(1) Calculations based upon 104 feet of cable from ACCN to payload interface (end of SMCH).

(2) Deleted

TABLE 8.2.7.1-2 ACCN PAYLOAD-TO-ORBITER AUDIO CHANNELS ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Bandwidth/ Freq Response	Hz	300 to 2300: ± 3dB 2300 to 3000: +3dB, -6dB	
Filter Rolloff	dB per Octave	18 dB per octave below 300 Hz and above 3 kHz	
Signal Level at 1 kHz	dBm	.0 dBm ± 3dB	(1)
Crest Factor	dB	3 (Nominal) Sinewave 6 (Nominal) Voice	Ratio of peak to rms signal level controlled by voice processing
Nominal Amplitude	Volts pk-to-pk	2.2 ± 3dB	(1)
Internal Noise	dB	57 dB below nominal 0.0 dBm	
Channel-to-Channel Isolation	dB	Greater than 57 dB	Any channel to any other channel
Crosstalk	dB	More than 50 dB down	Measured from talk-line of one channel to listen-line of another channel
Source Coupling	Ohms	Transformer coupled, balanced center tapped	
Load Termination		Transformer coupled, balanced, center tapped	Terminated in 600 Ohms whether in use or not
Cable		2 conductor twisted, shielded, jacketed, uncontrolled impedance	Rockwell Design Standard MP572-0311

(1) Calculations based upon 104 feet of cable from ACCN to payload interface (end of SMCH).

(2) Deleted

TABLE 8.2.7.2-1 ACCN EMERGENCY, CAUTION AND WARNING, AND SYSTEMS MANAGEMENT AUDIO TONES TO PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Siren: Frequency Cycle	Hz Sec	666 to 1470 5	
Klaxon		2500 Hertz squarewave at a duty cycle of 2.1 milliseconds ON and 1.6 milliseconds OFF, gated by a 270 Hertz square-wave at a duty cycle of 215 milliseconds ON and 70 milliseconds OFF	
Caution and Warning		375 and 1000 (Square) | 2.5 Hz Steps	
System Management		550 (Square) | 1 sec (Nominal)	
Amplitude	Volts pk-to-pk	2.2 ± 3dB	(1)
Noise	dB	-60dBm at 600 Ohms	
Source Impedance	Ohms	600 ± 10 percent	
Load Impedance	Ohms	600 ± 10 percent	
Source Coupling		Balanced, Transformer Coupled	
Load Coupling		Balanced, Transformer Coupled	
Cable		2 conductor twisted, shielded, jacketed, uncontrolled impedance	Rockwell Design Standard MP572-0311

(1) Calculations based upon 104 feet of cable from ACCN to payload interface (end of SMCH).

(2) Deleted

TABLE 8.2.7.3-1 TRANSMITTER KEY LINE CHARACTERISTICS, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Closed Circuit Impedance	Ohms	Less than 25	
Open Circuit Impedance	Ohms	Greater than 100k	
Closed Circuit Current	milli-amperes	Less than 150	
Open Circuit Voltage	Volts, dc	28	
Closed Circuit Voltage Drop	Volts	Less than 3	
Power/Ground Isolation	Ohms	Greater than 1 Meg	

TABLE 8.2.7.3-2 PAGE KEY LINE CHARACTERISTICS, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
Closed Circuit Impedance	Ohms	Less than 100	
Open Circuit Impedance	Ohms	Greater than 1 Meg ohm	
Closed Circuit Current	Milli-amperes	0.06	
Open Circuit Voltage	Volts	6 Vdc	
Power/Ground Isolation	Ohms	Greater than 1 Meg ohm	

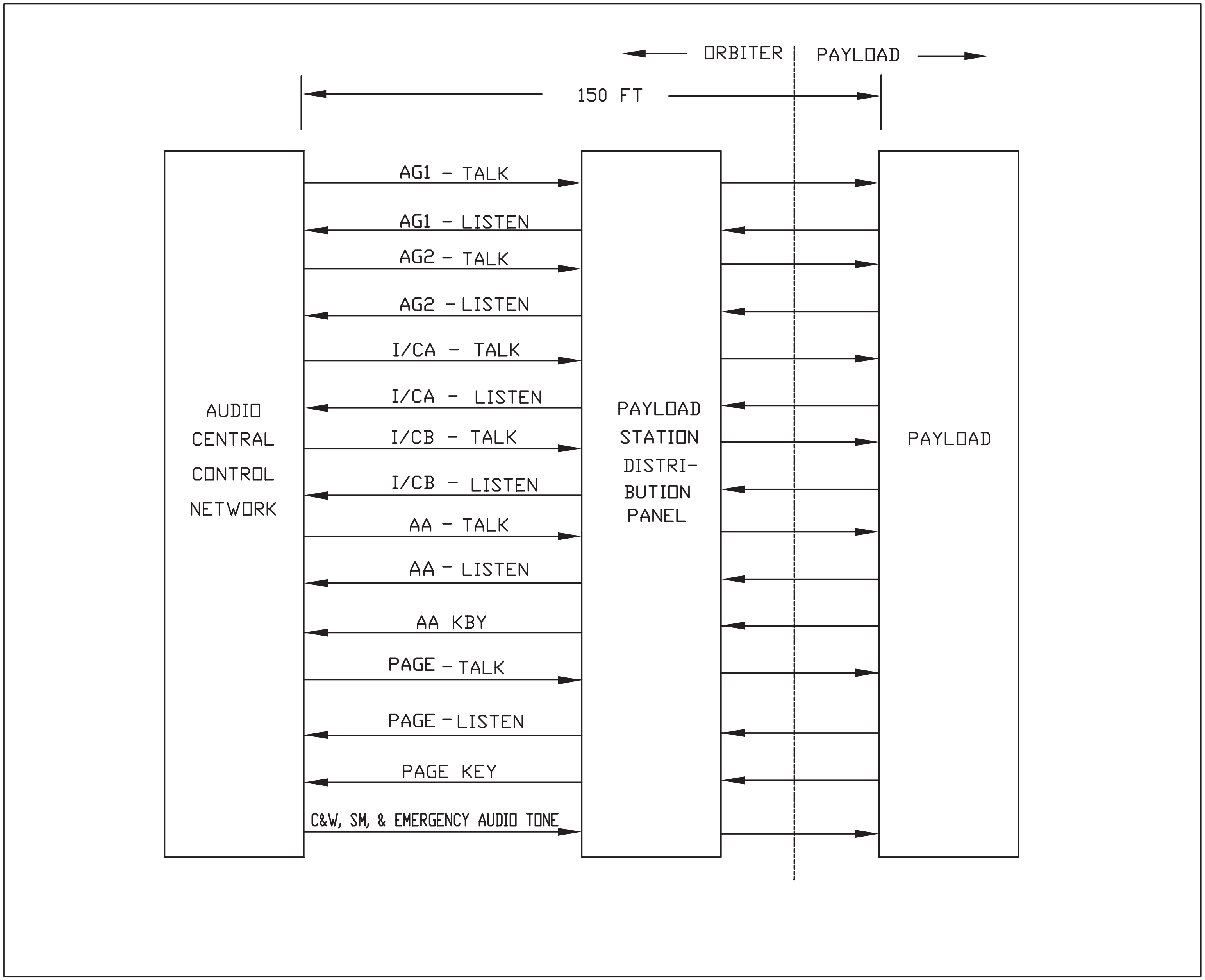
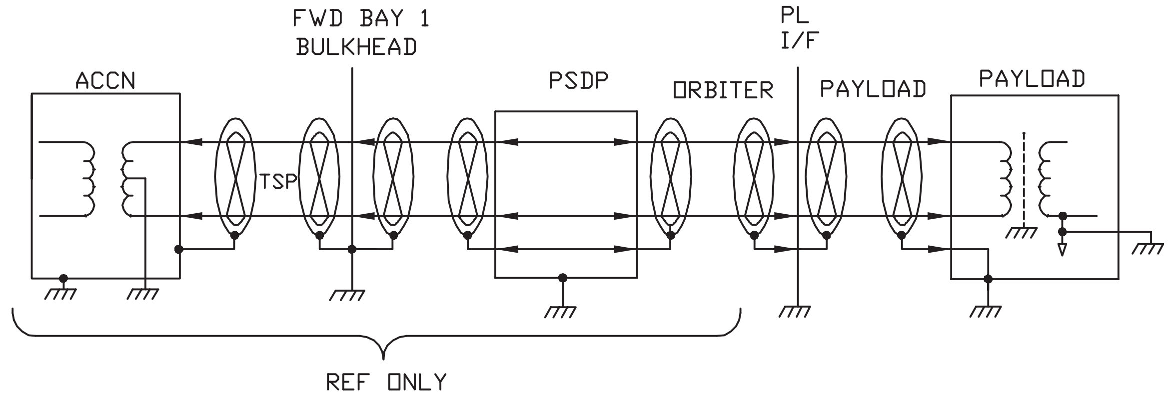
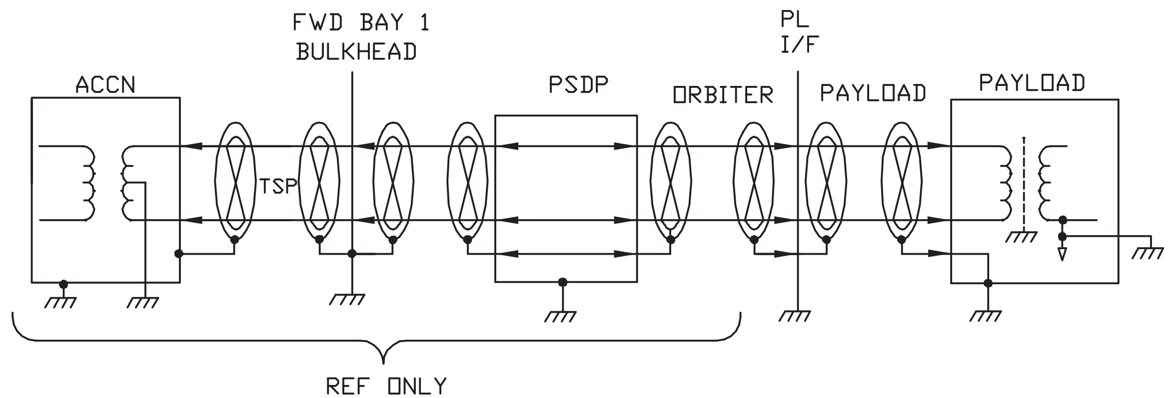


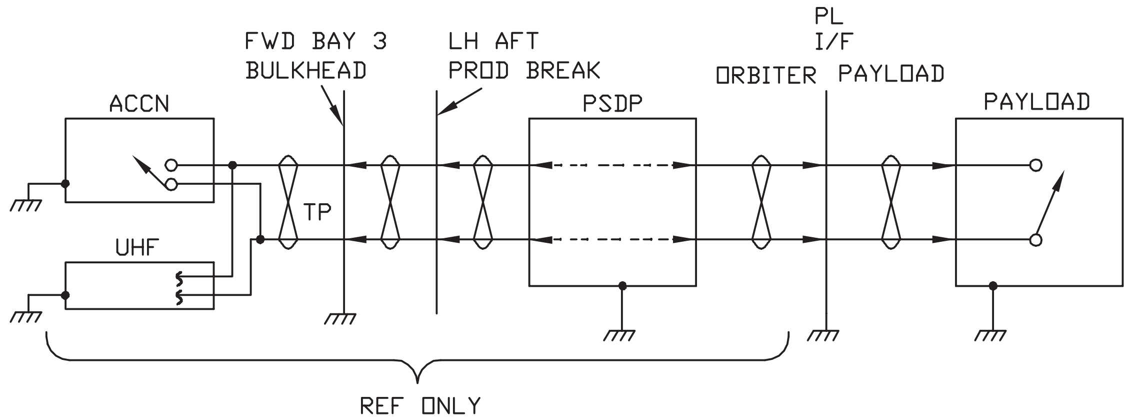
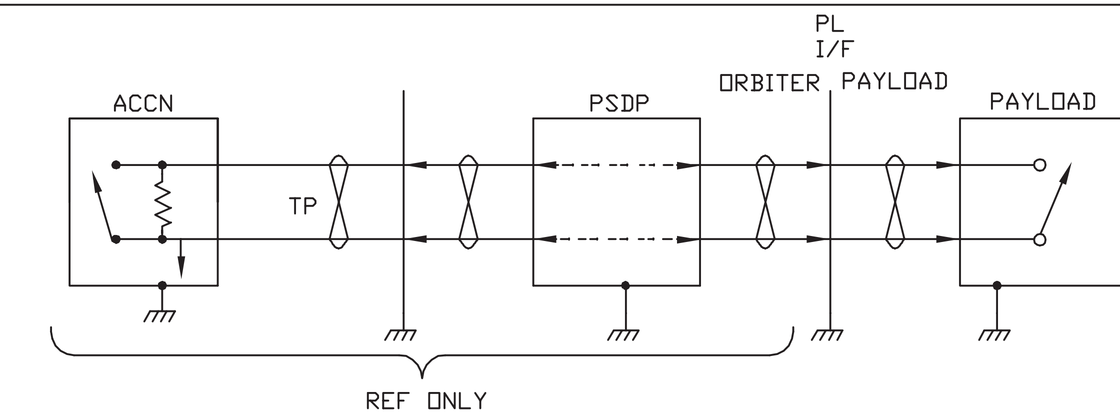
FIGURE 8.2.7-1 AUDIO CENTRAL CONTROL NETWORK INTERFACE

FIGURE 8.2.7.4-1 AUDIO CENTRAL CONTROL NETWORK GROUDING AND SHIELDING

(SHEET 1 OF 2)

PARAGRAPH	GROUNDING AND SHIELDING TERMINATION
8.2.7.1 AUDIO CHANNEL (TALK AND LISTEN)	
8.2.7.2 CAUTION AND WARNING KEY LINES	

NOTE:
SYMBOLS DEFINED IN
SECTION 10.7

PARAGRAPH	GROUNDING AND SHIELDING TERMINATION (CONTINUED)
8.2.7.3 ORBITER TRANSMITTER KEY LINES	
8.2.7.3 PAGE KEY LINES	

NOTE:
SYMBOLS DEFINED IN
SECTION 10.7

FIGURE 8.2.7.4-1 AUDIO CENTRAL CONTROL NETWORK GROUNDING AND SHIELDING
(SHEET 2 OF 2)

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.8 CCTV Video Control Unit Interface

The CCTV video control unit shall provide and accept the video to/from a Cargo Element as shown in Figure 8.2.8-1. The Orbiter shall transmit, on a time-available basis, selected Cargo Element video signals to ground facilities over S-band FM or Ku-band links. Ground commanding of the CCTV system via MDM is as defined in Tables 8.2.8-1, 8.2.8-2, 8.2.8-3 and 8.2.8-4. Additional specific commands for the Color Television Camera (CTVC) are as defined in Table 8.2.8-5.

8.2.8.1 Video Signal Characteristics

All television video signals to/from attached cargo elements shall conform with EIA specifications RS170A as modified in Tables 8.2.8.1-1 and 8.2.8.1-2.

All television video signals to/from attached cargo elements located within the Aft Flight Deck or the Cargo Bay shall conform with EIA specification RS170A as modified in Tables 8.2.8.1-3 and 8.2.8.1-4. The format and control signal provided to an attached payload located within the Aft Flight Deck or the Cargo Bay shall be as specified in Figure 8.2.8.1-1.

8.2.8.2 Sync and Control Signal Output

The format of the sync and control signal provided to an attached payload shall be as shown in Figure 8.2.8.2-1.

8.2.8.3 Composite Video Waveform

All television video signals to/from attached payloads shall conform to the waveforms shown in Figure 8.2.8.3-1.

8.2.8.4 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.8.4-1.

TABLE 8.2.8-1 CCTV 14 Bit Uplink Command Format

1	2	3				7	8	9	10				14
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
0	1												
SYSTEM CODE		ADDRESS CODE					COMMAND ASSIGNMENT		FUNCTION CODE				

BIT POSITION

1-2	System Code: Identify specific system (CCTV A_0=0, A_1=1)
3-7	Address Code: Identifies camera location or other video source
8-9	Command Assignment: Defines camera control command (01) or VSU-RCU commands (00) video output select VSU-RCU Mode, camera power and camera STOP-MOTION commands.
10-14	Function Code: Identifies end effect (control command, power command or video output select command).

TABLE 8.2.8-2 CCTV Uplink Format Address Code for Video Source

VIDEO INPUT	ADDRESS CODE A2	A3	A4	A5	A6	A7	A8	TV MONITOR DISPLAY CODE
CABIN CAMERA 1 (FLT DECK)	0	0	0	0	0			C1
FORWARD BAY CAMERA ("A" POSITION)	0	0	0	0	1			FB
AFT BAY CAMERA ("C" POSITION)	0	0	0	1	0			AB
SPARE (VTR)	0	0	0	1	1			VT
CABIN CAMERA 3	0	0	1	0	0			C3
KEEL CAMERA ("B" POSITION)	0	0	1	0	1			KB
PORT RMS CAMERA	0	0	1	1	0	0 0		RP
STARBOARD RMS CAMERA ("D" POSITION)	0	0	1	1	1	OR		RS
CABIN CAMERA 2 (MID-DECK)	0	1	0	0	0	0 1		C2
VIDEO TEST SIGNAL	0	1	0	0	1	ONLY		TS
SPLIT SCREEN A	0	1	0	1	0			(N/A)
SPLIT SCREEN B	0	1	0	1	1			(N/A)
CABIN CAMERA 4	0	1	1	0	0			C4
PAYLOAD 1	0	1	1	0	1			P1
PAYLOAD 2	0	1	1	1	0			P2
PAYLOAD 3	0	1	1	1	1			P3

TABLE 8.2.8-3 CCTV RCS-VSU Uplink Command Function Codes

COMMAND DESCRIPTION	FUNCTION CODE A_2	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}
This code solely used to initialize new command	X	0	0	0	0	0	0	0
No-Op	1	0	0	0	0	X	X	X
No-Op	1	0	0	0	1	X	X	X
No-Op	1	0	0	1	0	X	X	X
VIDEO SWITCHING COMMANDS								
	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	1	0
DOWNLINK SELECT	0	0	0	0	0	0	1	1
PAYLOAD SELECT	0	0	0	0	0	1	0	0
SPARE (VTR) SELECT	0	0	0	0	0	1	0	1
SPARE 1 SELECT	0	0	0	0	0	1	1	0
SPARE 2 SELECT	0	0	0	0	0	1	1	1
SPLIT-SCREEN A LEFT SELECT	0	0	0	0	1	0	0	0
SPLIT-SCREEN A RIGHT SELECT	0	0	0	0	1	0	0	1
SPLIT-SCREEN B LEFT SELECT	0	0	0	0	1	0	1	0
SPLIT-SCREEN B RIGHT SELECT	0	0	0	0	1	0	1	1
(Not Assigned)	0	0	0	0	1	1	0	0
(Not Assigned)	0	0	0	0	1	1	0	1
(Not Assigned)	0	0	0	0	1	1	1	0
RESERVED (OPEN VIDEO OUTPUTS)	0	0	0	0	1	1	1	1
VCU AND CAMERA-POWER COMMANDS								
CAMERA POWER ON	0	0	0	1	0	0	0	0
CAMERA POWER OFF	0	0	0	1	0	0	0	1
ASYNCHRONOUS VIDEO OFF	0	0	0	1	0	0	1	0
ASYNCHRONOUS VIDEO ON	0	0	0	1	0	0	1	1
AUDIO INTERLEAVE OFF	0	0	0	1	0	1	0	0
AUDIO A INTERLEAVE ON	0	0	0	1	0	1	0	1
AUDIO B INTERLEAVE ON	0	0	0	1	0	1	1	0
AUDIO A AND B INTERLEAVE ON	0	0	0	1	0	1	1	1
STOP MOTION COMMANDS								
PAN STOP	X	0	0	1	1	0	0	0
TILT STOP	X	0	0	1	1	0	0	1
	X	0	0	1	1	0	1	0
	X	0	0	1	1	0	1	1
IRIS STOP	X	0	0	1	1	1	0	0
FOCUS STOP	X	0	0	1	1	1	0	1
ZOOM STOP	X	0	0	1	1	1	1	0
SPARE 2 STOP	X	0	0	1	1	1	1	1

NOTE: X: is either 1 or 0.

TABLE 8.2.8-4 CCTV Camera Control Uplink Command Function Codes

COMMAND DESCRIPTION	FUNCTION CODE						
	A_2	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}
SPARE 1A	X	0	1	0	0	0	0	0
SPARE 1B	X	0	1	0	0	0	0	1
SPARE 1C	X	0	1	0	0	0	1	0
SPARE 1D	X	0	1	0	0	0	1	1
SPARE 1E	X	0	1	0	0	1	0	0
SPARE 1F	X	0	1	0	0	1	0	1
SPARE 1G	X	0	1	0	0	1	1	0
SPARE 1H	X	0	1	0	0	1	1	1
ALC PEAK	X	0	1	0	1	0	0	0
ALC MID	X	0	1	0	1	0	0	1
ALC AVG	X	0	1	0	1	0	1	0
GAMMA WHITE STRETCH	X	0	1	0	1	0	1	1
GAMMA NORMAL	X	0	1	0	1	1	0	0
GAMMA BLACK STRETCH	X	0	1	0	1	1	0	1
AUX OFF	X	0	1	0	1	1	1	0
AUX ON	X	0	1	0	1	1	1	1
SPARE 3	X	0	1	1	0	0	0	0
PAN-TILT RESET	X	0	1	1	0	0	0	1
PAN-TILT SLOW	X	0	1	1	0	0	1	0
PAN-TILT FAST	X	0	1	1	0	0	1	1
PAN RIGHT	X	0	1	1	0	1	0	0
PAN LEFT	X	0	1	1	0	1	0	1
TILT UP	X	0	1	1	0	1	1	0
TILT DOWN	X	0	1	1	0	1	1	1
IRIS CLOSE	X	0	1	1	1	0	0	0
IRIS OPEN	X	0	1	1	1	0	0	1
FOCUS FAR	X	0	1	1	1	0	1	0
FOCUS NEAR	X	0	1	1	1	0	1	1
ZOOM OUT	X	0	1	1	1	1	0	0
ZOOM IN	X	0	1	1	1	1	0	1
SPARE 2A	X	0	1	1	1	1	1	0
SPARE 2B	X	0	1	1	1	1	1	1

NOTE: X is either 1 or 0

TABLE 8.2.8-5 CCTV CTVC Specific Uplink Command Function Codes

COMMAND DESCRIPTION	FUNCTION CODE				
	A_9	A_{10}	A_{11}	A_{12}	A_{13}
ALL OFF MENU SELECT (FOLLOWING CTVC POWER ON)	0	1	0	0	1
MODE SELECTIONS WITHIN MENU					
SHUTTER ON	0	1	0	1	1
SHUTTER OFF	0	1	0	1	1
BARS ON	0	1	1	0	0
BARS OFF	0	1	1	0	0
GAMMA LINEAR	0	1	1	0	1
GAMMA BLACK STRETCH	0	1	1	0	1

BELOW COMMANDS ARE VALID AFTER THE CTVC IS COMMANDED TO THE ALL OFF MENU:

COMMAND DESCRIPTION	A_9	A_{10}	A_{11}	A_{12}	A_{13}
ALC MENU SELECT	0	1	0	0	0
MODE SELECTIONS WITHIN THE MENU					
ALC PEAK	0	1	0	1	1
ALC NORMAL	0	1	1	0	0
ALC AVERAGE	0	1	1	0	1
RETURN TO (ALL OFF) MENU	0	1	0	0	0
MANUAL GAIN MENU SELECT	0	1	0	0	1
MODE SELECTIONS WITHIN THE MENU					
0 dB GAIN	0	1	0	1	1
+12 dB GAIN	0	1	1	0	0
+24 dB GAIN	0	1	1	0	1
RETURN TO (ALL OFF) MENU	0	1	0	0	1
WHITE BALANCE MENU SELECT	0	1	0	1	0
MODE SELECTIONS WITHIN MENU					
BAY	0	1	0	1	1
CABIN	0	1	1	0	0
SUN	0	1	1	0	1
RETURN TO (ALL OFF) MENU	0	1	0	1	0

TABLE 8.2.8.1-1 CCTV Video Electrical Interface Characteristics From The Orbiter To Cargo Elements

Parameter	Dimension	Value	Notes
Frame Rate	frames/ sec	29.97	
Lines per Frame	inter- laced lines/ frame	525	
Fields	Inter- laced fields/ sec	59.9	
Aspect Ratio		4/3	
Horizontal Scanning Frequency	Hz	15,734.264 ± 0.044	
Horizontal Frequency Drift	Hz/sec	0.00044	
Vertical Scanning Frequency	Hz	Horiz freq/262.5	
Composite Video Bandwidth	MHz	4.5	Orbiter Communi- cations system limits video to 4.5 MHz.
Composite Video Amplitude	volts pk-to-pk	0.83 ± 10 percent	(2)
Sync Tip Amplitude	Volts pk	0.00 ± 0.05	Differentially, line-to-line.
Polarity		White positive Black negative	The white signal level shall be 1.20 ± 10 percent volts pk-to-pk, dif- ferentially, line- to-line.

TABLE 8.2.8.1-1 CCTV VIDEO ELECTRICAL INTERFACE CHARACTERISTICS FROM THE ORBITER TO CARGO ELEMENTS (CONTINUED)

Parameter	Dimension	Value	Notes
Video Character-istics	dB		Pk-pk signal (1 volt) to RMS noise. (1)
Crosstalk	dB	-40 or less	Channel-to-channel
Source Coupling		Direct coupled	
Load Coupling		Direct coupled	
Source Impedance (Orbiter)	ohms	75 ± 5 percent	0 to 4.5 MHz differentially, line-to-line.
Load Impedance (Cargo Element)	ohms	75 ± 5 percent	0 to 4.5 MHz differentially, line-to-line.
Signal/ Ground Isolation		Video and sync signal shall be isolated from power ground by at least 1.0 Meg ohm in the payload	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Boeing Design Standard MP572-0328-0002
Cable Impedance Zo	ohms	70 min 80 max	measured conductor to conductor at 1 MHz
Cable Capacitance (Orbiter)	Pico-farads	1978 max	(2)
Grounding		See Figure 8.2.8.4-1	Shield multipoint grounded

TABLE 8.2.8.1-1 CCTV VIDEO ELECTRICAL INTERFACE CHARACTERISTICS FROM THE ORBITER TO CARGO ELEMENTS (CONCLUDED)

(1) Video should meet RS-170A characteristics for amplitude, timing, and SNR requirements applied to a balanced, differential drive signal with exceptions as noted below:

a) The horizontal line frequency is equal to 15,734.264 ± 0.044 Hz. The vertical field frequency is equal to 2/525 times the horizontal line frequency.

b) The synchronization signal, as measured from blanking level to sync tip will be minus 0.286 ± 0.03 volts (nominally 40 IRE units). The sync tip will be 0.0 volts DC.

c) The blanked picture signal, as measured from blanking level to reference white level, will be plus 0.714 ± 0.07 volts (nominally 100 IRE units).

(2) Calculations are based on 86 feet of cable from the VSU to the Cargo Element interface.

(3) Voltage required at the Xo576 A8J1 connector is 1.0 volt ± 10 percent. Worst case used for calculation is 1.62 dB attenuation at 4.5 MHz.

TABLE 8.2.8.1-2 CCTV Video Electrical Interface Characteristics From Cargo Elements To Orbiter

Parameter	Dimension	Value	Notes
Frame Rate	frames/ sec	29.97	
Lines per Frame	inter- laced lines/ frame	525	
Fields	Inter- laced fields/ sec	59.9	
Aspect Ratio		4/3	
Horizontal Scanning Frequency	Hz	15,734.264 ± 0.044	
Horizontal Frequency Drift	Hz/sec	0.00044	
Vertical Scanning Frequency	Hz	Horiz Freq/262.5	
Composite Video Amplitude vs. Frequency	MHz	4.5	Orbiter Communi- cations System limits video to 4.5 MHz.
Composite Video Amplitude	volts, pk-to-pk	1.20 ± 10 percent	(2)
Sync Tip Amplitude	Volts pk	0.00 ± 0.05	Differentially, line-to-line.
Polarity		White positive Black negative	The white signal level shall be 1.20 ± 10 percent, volts pk-to-pk, dif- ferentially, line- to-line.

TABLE 8.2.8.1-2 CCTV VIDEO ELECTRICAL INTERFACE CHARACTERISTICS FROM CARGO ELEMENTS TO ORBITER (CONTINUED)

Parameter	Dimension	Value	Notes
Video Charac-teristics	dB		pk-to-pk signal (1 volt) to RMS noise. (1)
Crosstalk	dB	-40 or less	Channel-to-channel
Source Coupling		Direct coupled	
Load Coupling		Direct coupled	
Source Impedance (Orbiter)	ohms	75 ± 5 percent	0 to 4.5 MHz differentially line-to-line.
Load Impedance (Payload)	ohms	75 ± 5 percent	0 to 4.5 MHz differentially line-to-line.
Signal/Ground Isolation		Video signal shall be isolated from power ground by at least 1.0 Meg ohm in the Payload.	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	MP572-0328-0002
Cable Impedance Zo	ohms	70 min 80 max	measure conductor to conductor at 1 MHz
Cable Capacitance (Orbiter)	Pico-farads	1978 max	(2)
Grounding		See Figure 8.2.8.4-1	Shield multipoint grounded

TABLE 8.2.8.1-2 CCTV VIDEO ELECTRICAL INTERFACE CHARACTERISTICS FROM CARGO ELEMENTS TO ORBITER (CONCLUDEDD)

(1) Video should meet RS-170 characteristics for amplitude, timing, and SNR requirements applied to a balanced, differential drive signal with exceptions as noted below:

a) The horizontal line frequency is equal to 15,734.264 ± 0.044 Hz. The vertical field frequency is equal to 2/525 times the horizontal line frequency.

b) The blanked picture signal, as measured from blanking level to reference white level, will be plus 0.714 ± 0.07 volts (nominally 100 IRE units).

(2) Calculations based upon 86 feet of cable from VSU to Cargo Element interface.

(3) Voltage required at the Xo576 A8J1 connector is 1.0 volt ± 10 percent. Worst case used for calculation is 1.62 dB attenuation at 4.5 MHz.

TABLE 8.2.8.1-3 CCTV Video Characteristics From Orbiter To Cargo Elements Attached Within the Cargo Bay or Aft Flight Deck

PARAMETER	DIMENSION	VALUE	NOTES
Frame Rate	frames/sec	29.97	
Lines per frame	interlaced lines/ frame	525	
Fields	interlaced fields/ sec	59.9	
Aspect Ratio		4/3	
Horizontal Scanning Frequency	Hz	15,734.264 ± 0.044	
Horizontal Frequency Drift	Hz/sec	0.00044	
Vertical Scanning Frequency	Hz	Horiz freq/262.5	
Composite Video Bandwidth	mHz	4.5	Orbiter Communications system limits video to 4.5 mHz
Composite Video Amplitude	volts pk-to-pk	0.83 ± 10 percent	(1) (3)
Sync Tip Amplitude	Volts pk	0.00 ± 0.05	Differentially, line-to-line
Polarity		White positive Black negative	The white signal level shall be .83 ± 10 percent volts, pk-to-pk, differ- entially, line- to-line

TABLE 8.2.8.1-3 CCTV VIDEO CHARACTERISTICS FROM THE ORBITER TO CARGO ELEMENTS ATTACHED WITHIN THE CARGO BAY OR AFT FLIGHT DECK (CONTINUED)

PARAMETER	DIMENSION	VALUE	NOTES
Video Character-istics	dB		Pk-pk signal (1 volt) to RMS noise. (2)
Crosstalk	dB	-40 or less	Channel-to-channel
Source Coupling		Direct Coupled	
Load Coupling		Direct Coupled	
Source Impedance (Orbiter)	ohms	75 ± 5 percent	0 to 4.5 mHz differentially, line-to-line.
Load Impedance (Cargo Element)	ohms	75 ± 5 percent	0 to 4.5 mHz differentially, line-to-line.
Signal/ground Isolation		Video signal shall be isolated from power ground by at least 1.0 Meg ohm in the payload	
Cable		2 conductor twisted, shielded, jacketed, controlled impedence	Boeing Design Standard MP572-0238-0002
Cable Impedance Zo	ohms	70 min 80 max	measured conductor to conductor at 1 mHz
Cable Capacitance (Orbiter)	Pico-farads	1978 max	(3)
Grounding		See Figures 8.2.8.4-1	Shield multipoint grounded

Table 8.2.8.1-3 CCTV Video Characteristics From the Orbiter to Cargo Elements Attached Within the Cargo Bay or Aft Flight Deck (Concluded)

(1) Voltage required at the Xo576 A8J1 connector is 1.0 volt ± 10 percent. Worst case used for calculation is 1.62 dB attenuation at 4.5 mHz.

(2) Video should meet RS-170A characteristics for amplitude, timing, and SNR requirements applied to a balanced, differential drive signal with exceptions as noted below:)

a) The Horizonntal line frequency is equal to 15,734.264 ± 0.044 Hz. The vertical field frequency is equal to 2/525 times the horizontal line frequency.

b) The synchronizing signal, as measured from blanking level to sync tip, will be minus 0.286 ± 0.03 volts (nominally 40 IRE units). The sync tip will be 0.0 volts DC.

c) The blanked picture signal, as measured from blanking level to reference white level, will be + 0.714 ± 0.07 volts (nominally 100 IRE units).

(3) Calculations based upon a 86 feet of cable length from VSU to the cargo element interface.

TABLE 8.2.8.1-4 CCTV Video Characteristics From Cargo Elements Attached Within the Cargo Bay or Aft Flight Deck to the Orbiter

PARAMETER	DIMENSION	VALUE	NOTES
Frame Rate	frames/sec	29.97	
Lines per frame	interlaced lines/ frame	525	
Fields	interlaced fields/ sec	59.9	
Aspect Ratio		4/3	
Horizontal Scanning Frequency	Hz	15,734.264 ± 0.044	
Horizontal Frequency Drift	Hz/sec	0.00044	
Vertical Scanning Frequency	Hz	Horiz freq/262.5	
Composite Video Bandwidth	mHz	4.5	Orbiter Communications system limits video to 4.5 mHz
Composite Video Amplitude	volts pk-to-pk	1.20 ± 10 percent	(1) (3)
Sync Tip Amplitude	Volts pk	0.00 ± 0.05	Differentially, line-to-line
Polarity		White positive Black negative	The white signal level shall be 1.20 ± 10 percent volts, pk-to-pk, differ- entially, line- to-line

TABLE 8.2.8.1-4 CCTV VIDEO CHARACTERISTICS FROM CARGO ELEMENTS ATTACHED WITHIN THE CARGO BAY OR AFT FLIGHT DECK TO THE ORBITER (CONTINUED)

PARAMETER	DIMENSION	VALUE	NOTES
Video Character-istics	dB		Pk-pk signal (1 volt) to RMS noise. (2)
Crosstalk	dB	-40 or less	Channel-to-channel
Source Coupling		Direct Coupled	
Load Coupling		Direct Coupled	
Source Impedance (Orbiter)	ohms	75 ± 5 percent	0 to 4.5 mHz differentially, line-to-line.
Load Impedance (Cargo Element)	ohms	75 ± 5 percent	0 to 4.5 mHz differentially,line-to-line.
Signal/Ground Isolation		Video signal shall be isolated from power ground by at least 1.0 Meg ohm in the payload	
Cable		2 conductor twisted, shielded, jacketed, controlled impedence	Boeing Design Standard MP572-0328-0002
Cable Impedance Zo	ohms	70 min 80 max	measured conductor to conductor at 1 mHz
Cable Capacitance (Orbiter)	Pico-farads	1978 max	(3)
Grounding		See Figures 8.2.8.4-1	Shield multipoint grounded

TABLE 8.2.8.1-4 CCTV VIDEO CHARACTERISTICS FROM CARGO ELEMENTS ATTACHED WITHIN THE CARGO BAY OR AFT FLIGHT DECK TO THE ORBITER (CONCLUDED)

(1) Voltage required at the Xo576 A8J1 connector is 1.0 volt ± 10 percent. Worst case used for calculation is 1.62 dB attenuation at 4.5 mHz.

(2) Video should meet RS-170A characteristics for amplitude, timing, and SNR requirements applied to a balanced, differential drive signal with exceptions as noted below:

a) The Horizonntal line frequency is equal to 15,734.264 ± 0.044 Hz. The vertical field frequency is equal to 2/252 times the horizontal line frequency.

b) The synchronizing signal, as measured from blanking level to sync tip, will be minus 0.286 ± 0.03 volts (nominally 40 IRE units). The sync tip will be 0.0 volts DC.

c) The blanked picture signal, as measured from blanking level to reference white level, will be + 0.714 ± 0.07 volts (nominally 100 IRE units).

(3) Calculations based on a 86 feet of cable length from VSU to the cargo element interface.

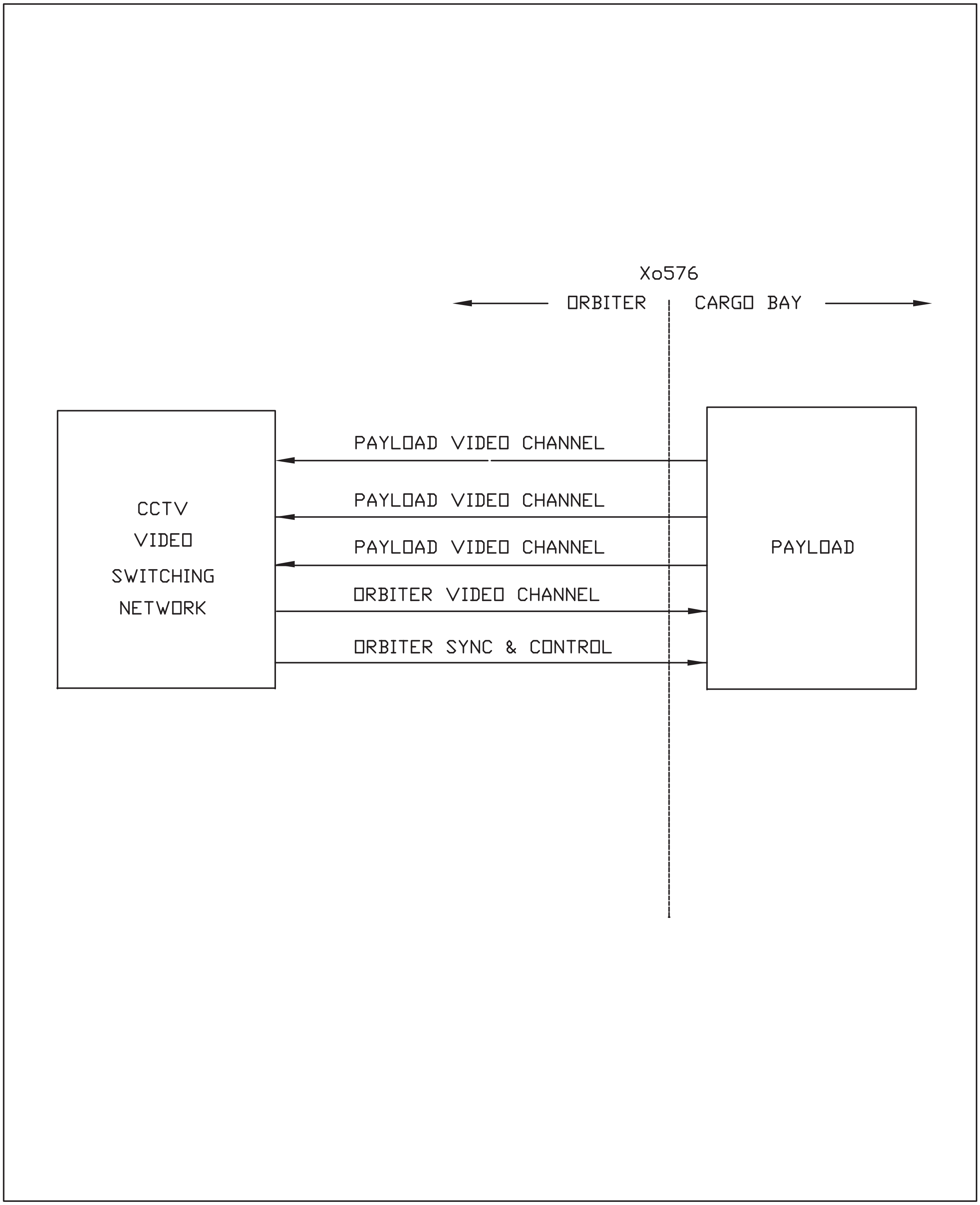
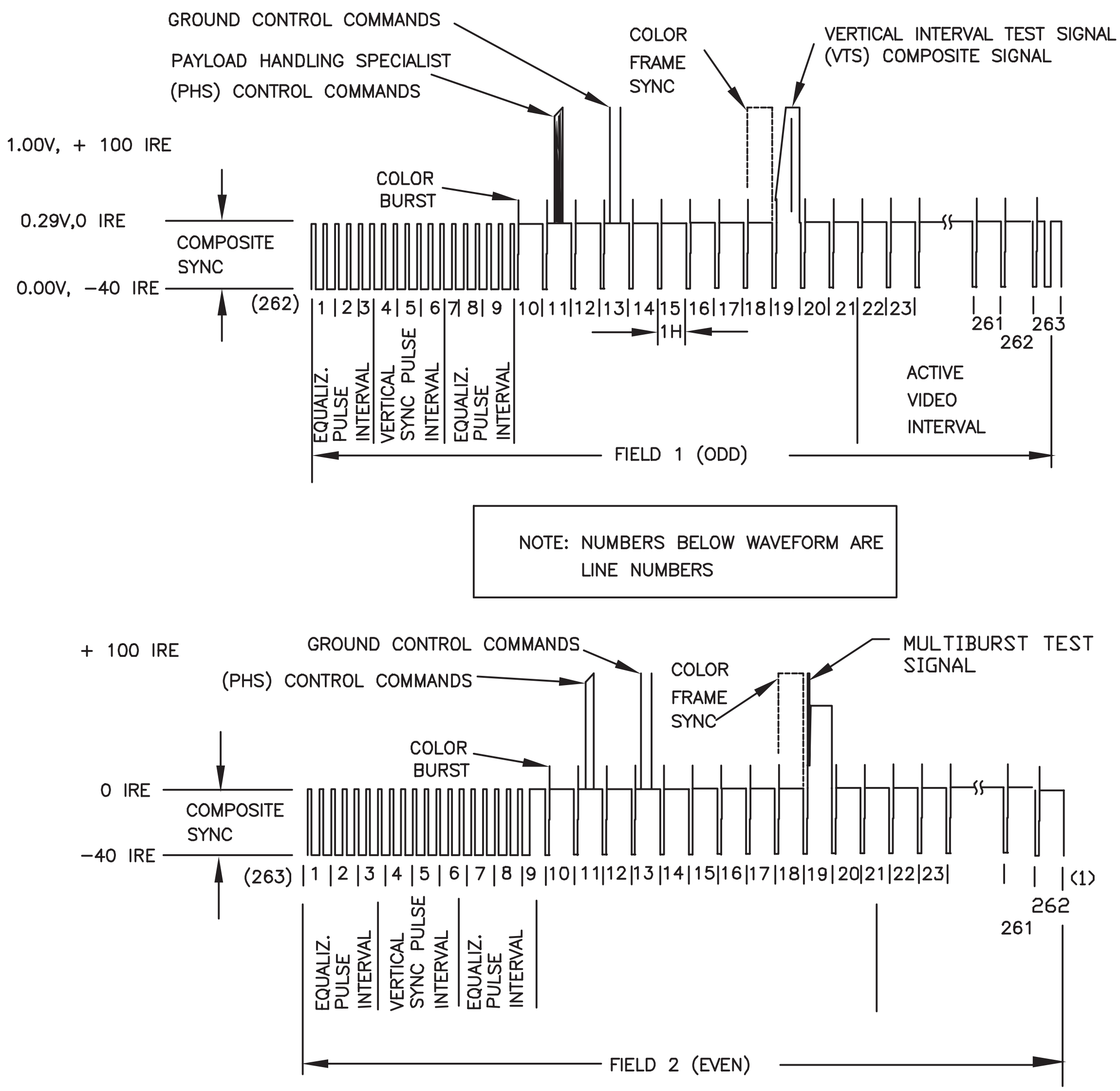


FIGURE 8.2.8-1 CCTV VIDEO SWITCHING NETWORK INTERFACE



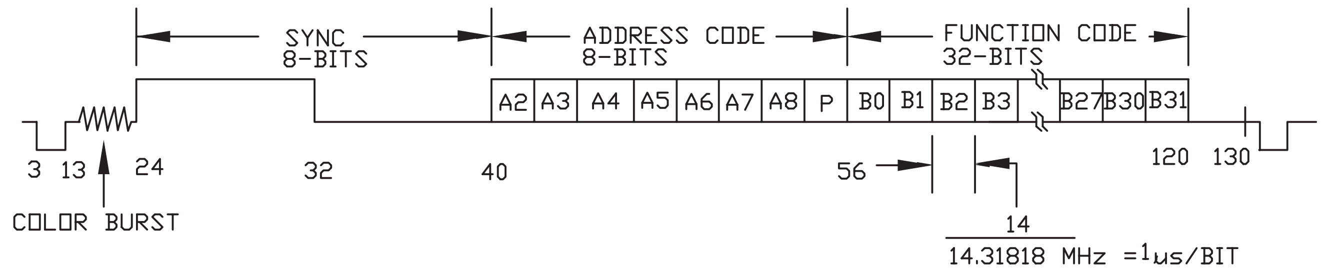
NOTES:

1. COMPOSITE SYNC TIMING IS DEFINED BY EIA STANDARD RS 170.
2. THE HORIZONTAL FREQUENCY IS 15,734.264 Hz
3. COLOR FRAME SYNC IS TRANSMITTED EVERY THIRD FIELD.
4. COLOR BURST IS DEFINED BY EIA STANDARD RS−240, APPENDIX "A"

FIGURE 8.2.8.2-1 SYNC AND CONTROL SIGNAL FORMAT

(SHEET 1 OF 6)

CCTV SYNC LINE-COMMAND FORMAT



SYNC

1110000 AN 8-BIT CODE SYNC EXISTS, EVEN IF NO COMMAND IS BEING TRANSMITTED

ADDRESS CODES

BITS A2 THROUGH A8: THESE ARE THE SAME CODES DEFINED IN FIGURE 1. HOWEVER, UPLINK VCU COMMANDS DENOTED BY A7, A8 = 00 WILL NOT APPEAR ON THE SYNC LINE. AN ALL 0s CODE MEANS A COMMAND IS NOT PRESENT

BIT P: A PARITY BIT. TO MAKE THE 8-BIT ADDRESS CODE ODD PARITY. (WHEN A COMMAND IS NOT PRESENT, THE PARITY BIT MAY BE "0" OR "1")

BITS B0 THROUGH B31: A 32-BIT COMMAND FIELD. COMMAND ASSIGNMENT FOR CAMERA IS GIVEN IN FIGURE 2. A UNIT SHALL NOT RESPOND TO THE FUNCTION CODE UNLESS THE ADDRESS CODE MATCHES ITS OWN LOCATION ADDRESS

NOTES: 1) NUMBERS BELOW WAVEFORM ARE THE "2.045" MHz HORIZONTAL LINE COUNT

2) FIGURES NOT-TO-SCALE

3) COMMANDS MAY APPEAR ON VIDEO LINE 11 AND/OR LINE 13 OF BOTH ODD & EVEN FIELDS. HOWEVER, IF COMMANDS APPEAR ON BOTH LINES IN A FIELD, THE ADDRESS CODE WILL NEVER BE IDENTICAL

FIGURE 8.2.8.2-1 SYNC AND CONTROL SIGNAL FORMAT
(SHEET 2 OF 6)

CCTV VIDEO INPUT ADDRESS ASSIGNMENTS

ADDRESS	SYNC ADDRESS CODE (A2 A3 A4 A5 A6 A7 A8)		VIDEO INPUT	TV MONITOR DISPLAY CODE
0	0 0 0 0 0	0 1 ONLY SEE NOTES	CABIN CAMERA 1 (FLT DECK)	C1
1	0 0 0 0 1		FORWARD BAY CAMERA	FB
2	0 0 0 1 0		AFT BAY CAMERA	AB
3	0 0 0 1 1		SPARE (VTR)	VT
4	0 0 1 0 0		CABIN CAMERA 3	C3
5	0 0 1 0 1		KEEL CAMERA	KB
6	0 0 1 1 0		PORT RMS CAMERA	RP
7	0 0 1 1 1		STARBOARD RMS CAMERA	RS
8	0 1 0 0 0		CABIN CAMERA 2 (MID-DECK)	C2
9	0 1 0 0 1		VIDEO TEST SIGNAL	TS
10	0 1 0 1 0		SPLIT SCREEN A	(N/A)
11	0 1 0 1 1		SPLIT SCREEN B	(N/A)
12	0 1 1 0 0		CABIN CAMERA 4	C4
13	0 1 1 0 1		PAYLOAD 1	P1
14	0 1 1 1 0		PAYLOAD 2	P2
15	0 1 1 1 1		PAYLOAD 3	P3

NOTES:
1) THESE ADDRESS ASSIGNMENTS VALID ONLY FOR THE A2, A7, A8 BIT CODES SHOWN

2) A7, A8 = 01 - DEFINES CAMERA CONTROL COMMAND - THE ASSOCIATED COMMAND IS OUTPUT ON THE SYNC SIGNAL INCLUDING COMMANDS TO ADDRESSES 9, 10 & 11

3) A7, A8 = 00 - DEFINES VCU COMMAND (VIDEO OUTPUT SELECT, VCU MODE, CAMERA POWER & CAMERA STOP-MOTION COMMANDS) THESE COMMANDS NOT OUTPUT ON SYNC SIGNAL

4) ADDRESSES WITH A2 = 1 & ADDRESSES WITH A7, A8 = 10 OR 11 ARE CURRENTLY UNASSIGNED

FIGURE 8.2.8.2-1 SYNC AND CONTROL SIGNAL FORMAT

(SHEET 3 OF 6)

COMMAND ASSIGNMENT

COMMAND ASSIGNMENT (FOR A7, A8 = 01 ONLY)	SYNC SIGNAL BIT POSITION
SPARE 1A	B0
SPARE 1B	B1
SPARE 1C	B2
SPARE 1D	B3
SPARE 1E	B4
SPARE 1F	B5
SPARE 1G	B6
SPARE 1H	B7
ALC PEAK	B8
ALC MID	B9
ALC AVG	B10
GAMMA WHITE STRETCH	B11
GAMMA NORMAL	B12
GAMMA BLACK STRETCH	B13
AUX OFF	B14
AUX ON	B15
SPARE 3	B16
PAN-TILT RESET	B17
PAN-TILT SLOW	B18
PAN-TILT FAST	B19
PAN-RIGHT	B20
PAN-LEFT	B21
TILT UP	B22
TILT DOWN	B23
IRIS CLOSE	B24
IRIS OPEN	B25
FOCUS FAR	B26
FOCUS NEAR	B27
ZOOM OUT	B28
ZOOM IN	B29
SPARE 2A	B30
SPARE 2B	B31

NOTE:

1. PRESENCE OF A COMMAND ON THE SYNC SIGNAL IS DENOTED BY A DATA "1" IN THE BIT POSITION
2. COMMANDS B20 THROUGH B31 ARE REPEATED EVERY FIELD UNTIL CANCELLED BY AN UPLINK STOP MOTION COMMAND
3. BIT B18 OR B19 IS A "1" WHENEVER A PAN OR TILT COMMAND IS PRESENT
4. ALL OTHER COMMANDS ARE INSERTED ON THE SYNC SIGNAL FOR ONE FIELD ONLY AND MUST BE LATCHED IN THE LRU AS NEEDED

FIGURE 8.2.8.2-1 SYNC AND CONTROL SIGNAL FORMAT

(SHEET 4 OF 6)

COLOR FRAME SYNC SIGNAL

NOTE:

1. COLOR FRAME SYNC ON LINE 18
2. COLOR FRAME SYNC IS TRANSMITTED EVERY THIRD FIELD

FIGURE 8.2.8.2-1 SYNC AND CONTROL SIGNAL FORMAT

(SHEET 5 OF 6)

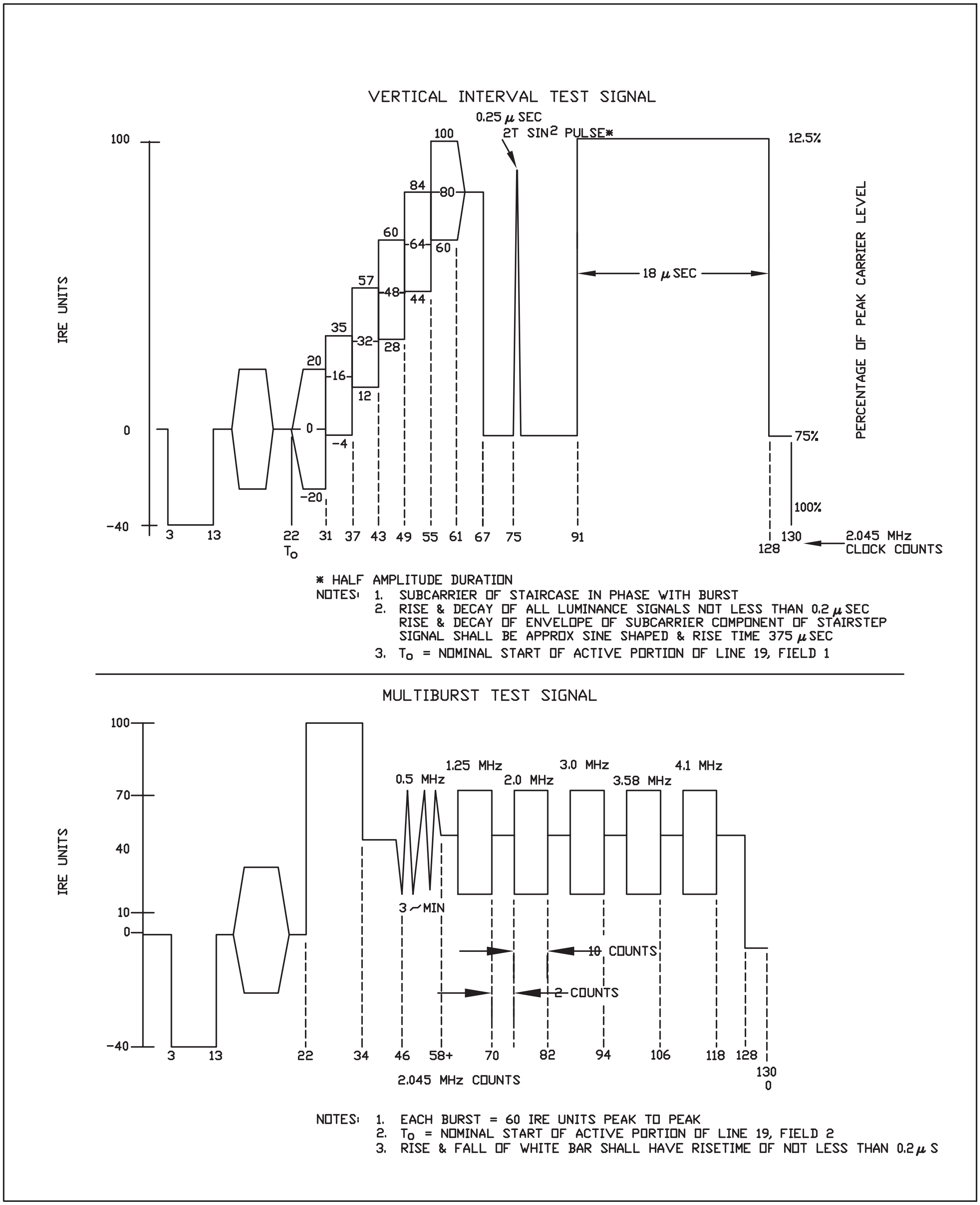


FIGURE 8.2.8.2-1 SYNC AND CONTROL SIGNAL FORMAT

(SHEET 6 OF 6)

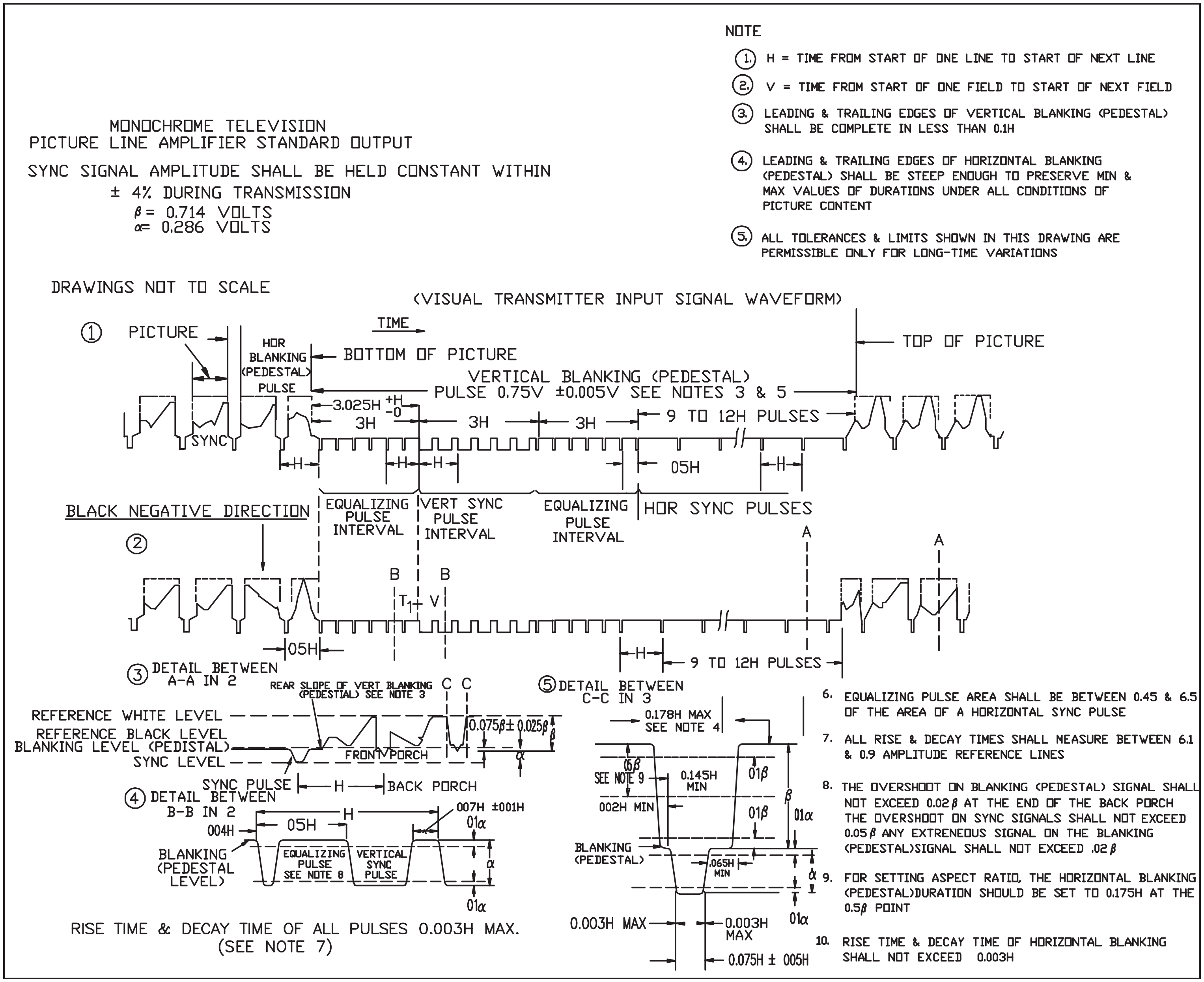


FIGURE 8.2.8.3-1 COMPOSITE VIDEO WAVEFORM

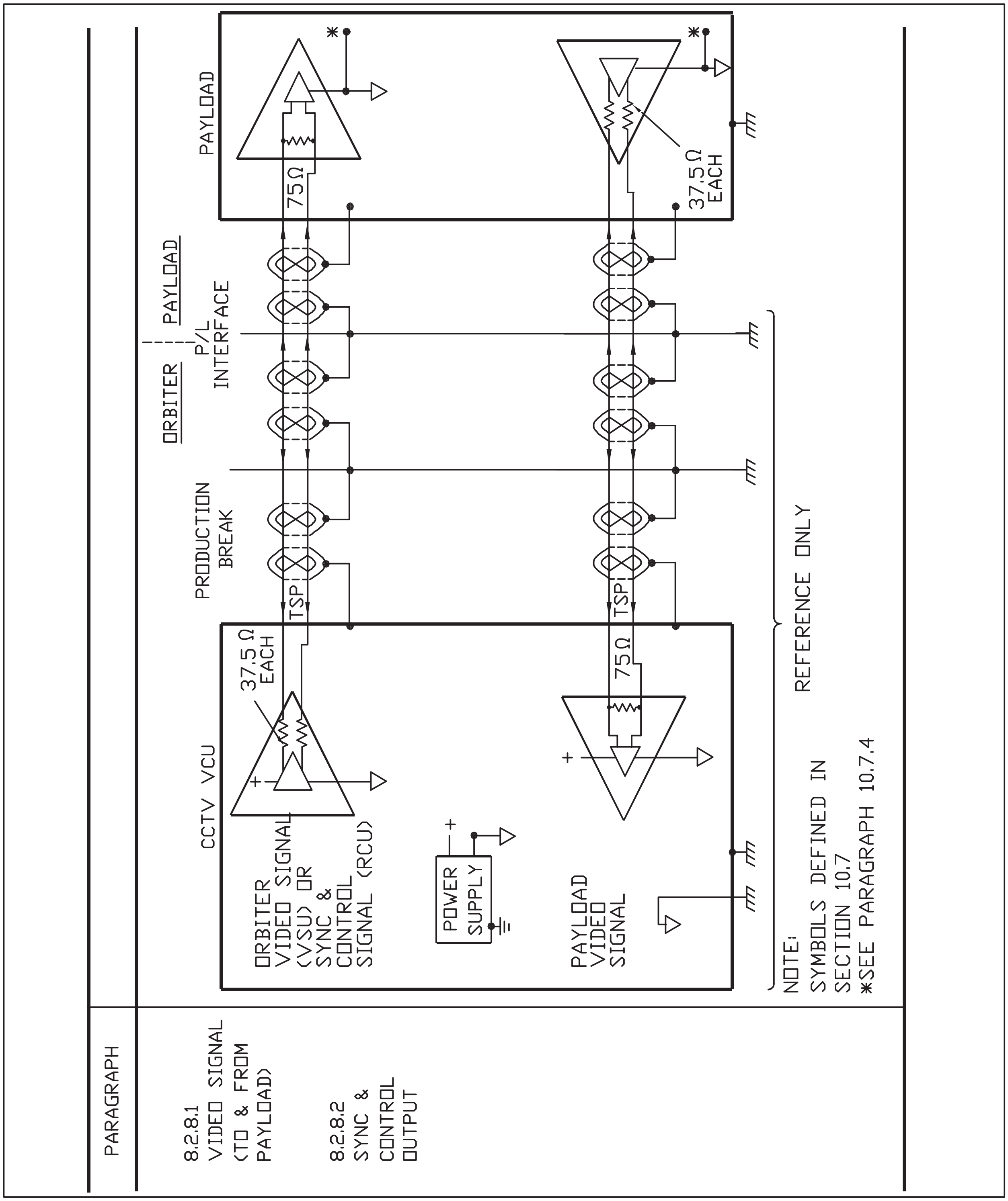


FIGURE 8.2.8.4-1 CCTV VIDEO CONTROL UNIT GROUNDING AND SHIELDING INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.9 Caution and Warning Electronics Assembly (CWEA) Interface

The hardwired interfaces to the CWEA available for payload use are shown in Figure 8.2.9-1. Classified under emergency signals for habitable payloads are the two Fire/Smoke inputs (discrete signals) to the CWEA. In addition, for both habitable and non-habitable payloads, five warning parameter direct inputs are available at the interface. A relay switch closure for actuation of a Master Alarm Light for a habitable payload is also provided.

In addition, Payload Caution and Warning parameters, either analog or discrete, may be hardwired to MDM inputs as defined in Paragraph 8.2.2. Use of this interface requires Orbiter Computer Software Support, as defined in Section 9.0. Annunciation is provided via the Caution/Warning MDM interface.

8.2.9.1 Fire/Smoke Input

The electrical interface characteristics for the Fire/Smoke emergency inputs at the Orbiter/payload interface are defined in Table 8.2.9.1-1.

8.2.9.2 (Reserved)

8.2.9.3 Caution and Warning Discrete Inputs

The electrical interface characteristics for the Caution and Warning discrete inputs at the Orbiter/payload interface shall be as shown in Table 8.2.9.3-1.

8.2.9.4 Caution and Warning Analog Inputs

The electrical interface characteristics for the Caution and Warning analog inputs at the Orbiter/payload interface shall be as shown in Table 8.2.9.4-1.

8.2.9.5 Payload Master Alarm Light

The Orbiter shall provide a switch closure to activate a master alarm light in habitable payload modules. The switch closure shall activate on all emergency, warning or caution signals.

The electrical interface characteristics for the Payload Master Alarm Light output at the Orbiter/payload interface shall be as shown in Table 8.2.9.5-1.

8.2.9.6 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.9.6-1.

TABLE 8.2.9.1-1 FIRE/SMOKE INPUT-ALARM, PAYLOAD TO ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Single-ended	(1)
Discrete- Min False Max	Volts Volts	0 4	
Discrete- Min True Max	Volts Volts	21 32	
Transfer		DC Coupled	
Load Min Impedance (Orbiter) Max	kohms kohms	4.88 15.92 14.95	 (2)
Pwr-Off Min Impedance	kohms	4.88	
Drive Min Capability	milliamps	150	
Load Max Current	milliamps	6.6	(3)
Over- Max voltage Protection	Volts	37.5	
Fault Max Voltage Emission	Volts	±15.0	
Fault Max Current Limitation	milliamps	10	

(1) Orbiter common hardware
(2) If signal source referenced to structure.
(3) At 32 volts

TABLE 8.2.9.3-1 CAUTION AND WARNING DISCRETE-INPUT HARDWIRE, PAYLOAD TO ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type(Orbiter)		Discrete Input	
Discrete-False	Volt	0 ± 0.5	(1), (2)
Discrete-True	Volt	4 to 28	(1), (2)
Ripple and Noise (Orbiter) Max	Millivolt	25	(3)
CMV Max	Volt	5	
Rise/Fall Time Min Max	Microsec Microsec	N/A	
Noise Suppression Bandwidth		N/A	
CMR	dB	40	(4)
Transfer		DC Coupled	
Source Impedance Max (Payload)	ohm	100 or Less	(7)
Load Impedance (Orbiter) Min	Kilohms	200	5 VDC discrete (5)
Pwr-Off Impedance Min	kOhms	22	5 VDC discrete
Load Current (Orbiter) Max	microamps	25	5 VDC discrete (6)
Over-Voltage Protection Max	Volts	±37.5	
Fault Voltage Emission Max	Volts	± 15	
Fault Current Limitation Max	milliamp	1.28	

TABLE 8.2.9.3-1 CAUTION AND WARNING DISCRETE-INPUT HARDWIRE, PAYLOAD TO ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS (CONCLUDED)

NOTES:
(1) Payload input shall be maintained between 0 and 2.5 volts or master alarm will be generated. C and W payload discrete inputs have been set for 2.5 volts high trip. High alarm level adjustable.
(2) 100 msec minimum pulse duration.
(3) As determined using a 50-MHz bandwidth measuring device.
(4) For 5 Vdc discrete with ±5 volts peak common-mode signal over a frequency range of DC to 1.0kHz. For 28 VDC discrete inputs, the presence of ±5 volts peak common-mode signal over a frequency range of DC to 1.0kHz shall not cause the input to be misinterpreted.
(5) Load impedance (Orbiter) is 2.8 kilohms minimum for 28 VDC discrete input signals.
(6) Load current is 10 milliamperes maximum for 28 VDC discrete input signals. 28 volt discretes are internally Zener limited to 12 volts.
(7) 5 volt and 28 volt discretes capable of sinking or supplying 10mA max.
(8) Calculations based upon 97 feet of cable from CWEA to payload interface (end of SMCH).

TABLE 8.2.9.4-1 CAUTION AND WARNING ANALOG INPUT HARDWIRE, PAYLOAD TO ORBITER, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter Type (Orbiter)	Dimension	Characteristics Orbiter/ Payload Interface Differential Analog	Notes
Analog Range	Volts	0 to 5	(1)
Ripple Max and Noise (Orbiter)	Millivolt	25	(2)
CMV Max	Volts	5	
Rise/Fall Min Time Max	Microsec Microsec	N/A	
Noise Suppression Bandwidth		N/A	
CMR	dB	40	(3)
Transfer		DC Coupled	
Source Impedance Max (Payload)	Ohms	100 or Less	
Load Min Impedance (Orbiter)	Kilohms	200	
Pwr-Off Min Impedance	Kilohm	N/A	
Load Max Current (Orbiter)	Microamps	25	
Over- Max Voltage Protection	Volts	±37.5	
Fault Voltage Emission Max	Volts	± 15	
Fault Current Limitation Max	Milliamp	1.28	

NOTES: (1) Payload input shall be maintained between 0 and 2.5 volts or master alarm will be generated. C and W payload analog inputs have been set for 2.5 volts high trip. High alarm level adjustable.

(2) As determined using a 50-MHz bandwidth measuring device.

(3) For 0 to 5 volt analog signals, with ±5 volts peak common-mode signal over a frequency range of dc to 1.0kHz.

(4) Calculations based upon 97 feet of cable from CWEA to payload interface (end of SMCH).

TABLE 8.2.9.5-1 PAYLOAD MASTER ALARM LIGHT OUTPUT, ORBITER TO PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Discrete	Isolated relay contact closure
Discrete-False		Relay Contacts Open	
Discrete-True		Relay Contacts-Closed	
Rise/Fall Time		N/A	Contact closure
Transfer		DC Coupled	
Source Impedance (Orbiter)	Ohms	0.1 Contact Closed Max	
Cable Resistance	Ohms	3.4	Round-trip resistance between Cargo element interface and Orbiter switch (1) (2)
Cable		2 conductor twisted, shielded, jacketed, uncontrolled impedance	Rockwell Design Standard MP572-0311-0003
Drive Max Capability Load Current	Amps	1	

(1) At a maximum temperature of 200°F.
(2) Calculations based upon 80.25 feet of cable from D&C panel R13A1 to payload interface (end of SMCH).

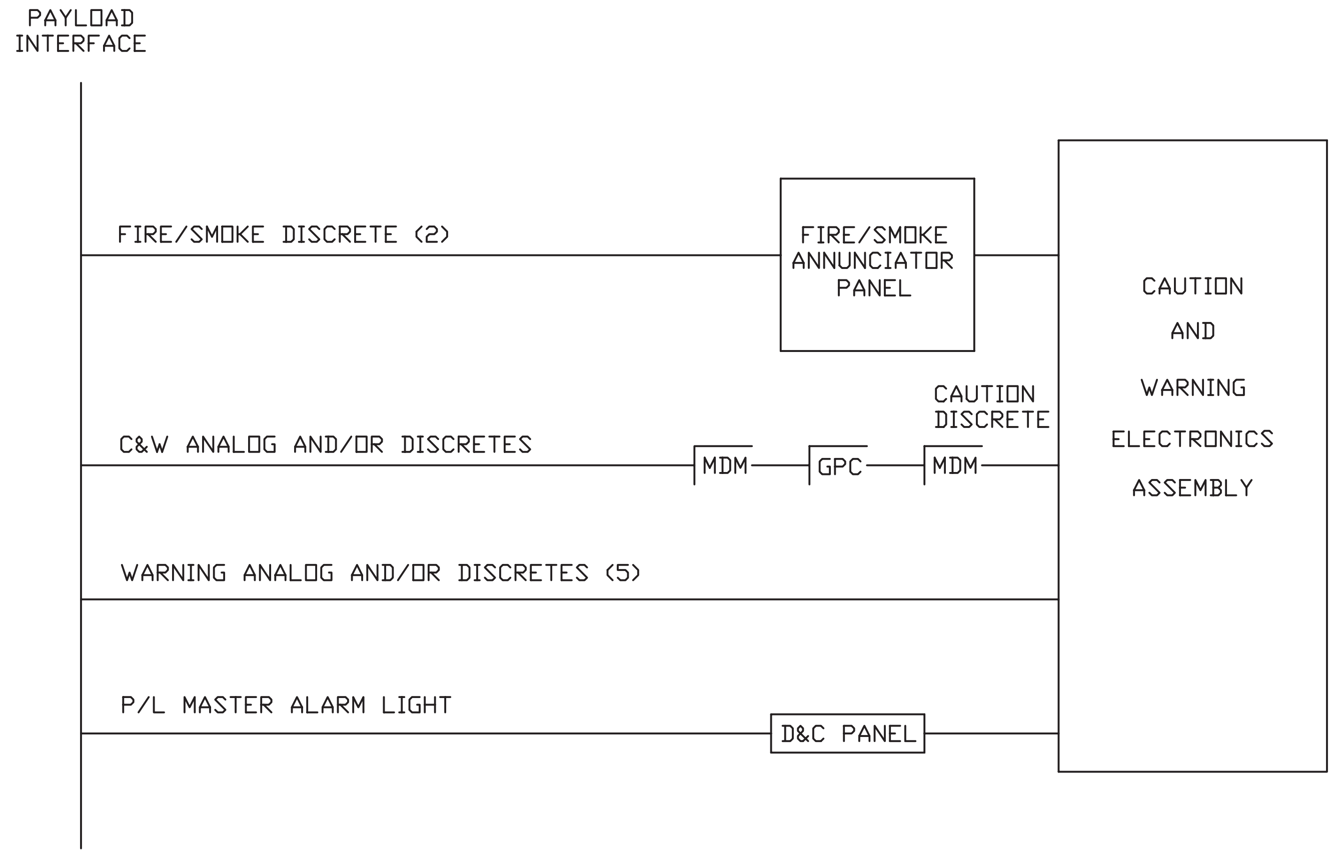
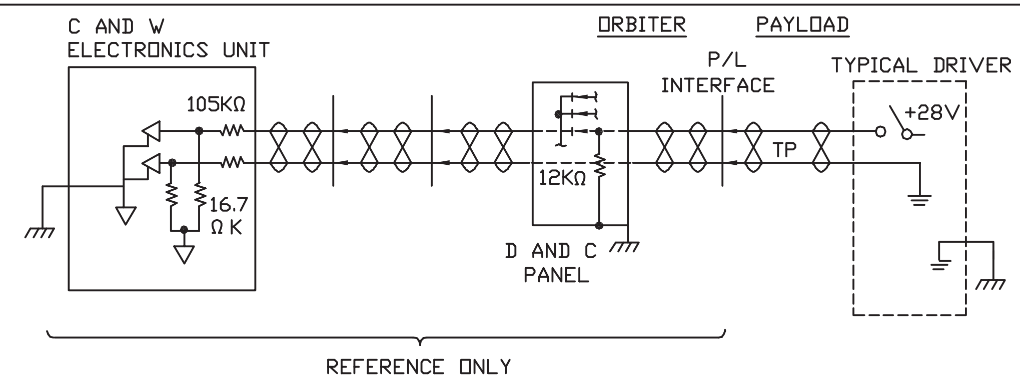
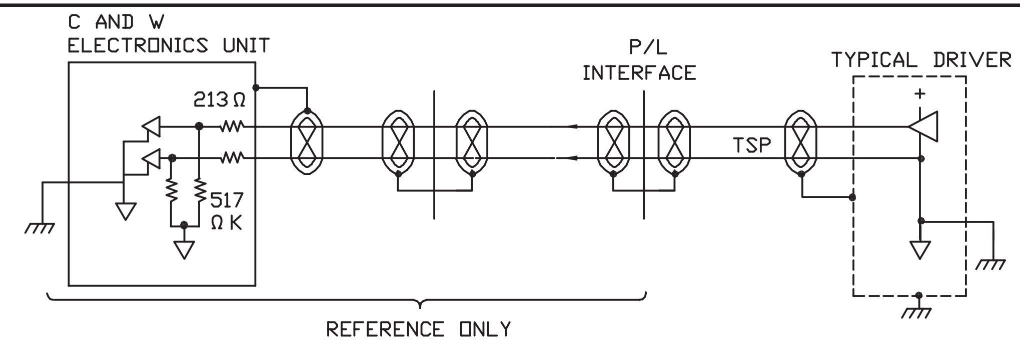
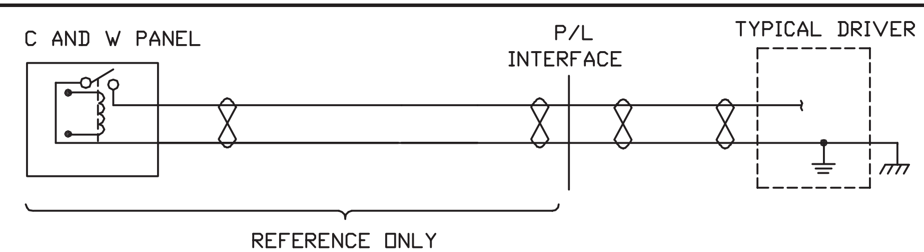


FIGURE 8.2.9-1 CAUTION AND WARNING SIGNAL FLOW

PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.9.1 FIRE/ SMOKE INPUT	
8.2.9.3 C AND W DISCRETE INPUT 8.2.9.4 C AND W ANALOG INPUT	
8.2.9.5 PAYLOAD MASTER ALARM LIGHT	

NOTE:
SYMBOLS DEFINED IN
SECTION 10.7

FIGURE 8.2.9.6-1 CWEA GROUNDING AND SHIELDING INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.10 Master Timing Unit (MTU) and Payload Timing Buffer (PTB) Interfaces

The MTU has the following Payload dedicated outputs:

a. Greenwich Mean Time (GMT)

b. Mission Elapsed Time (MET)

c. 4.608 MHz Reference Square-Wave Frequency

d. 1.024 MHz Reference Square-Wave Frequency

e. 1 KHz Reference Square-Wave Frequency

f. 100 Hz Reference Square-Wave Frequency

g. 10 Hz Reference Square-Wave Frequency

The payload timing buffer shall accept single GMT and MET input signals from the MTU and provide to Cargo elements eight isolated GMT output timing signals and four isolated MET output timing signals. Figure 8.2.10-1 shows MTU and PTB interfaces data flow.

8.2.10.1 Time Accumulator Interface

8.2.10.1.1 Greenwich Mean Time (GMT)

The absolute time data, at any time during a seven day mission, shall not deviate by more than ± 10 milliseconds from the ground station GMT Reference Time Standard and shall be synchronized with the ground GMT at certain times during a mission, subject to mission procedural constraints to prevent unacceptable time base perturbations. The accuracy of these time updates shall be ± 5 milliseconds. The MTU frequency offset and drift rates shall constrain the time error growth rate to a maximum of ± 10 milliseconds per 24 hours.

GMT time is measured beginning with day count 001 on January 1st of each year. If lift-off occurs in one year and landing in the next, GPC time continues to increment across year end with an equivalent day count greater than 365. The MTU generated GMT, however, automatically resets to Day 001 following Day 365. The MTU day count will normally be maintained in agreement with the GPC equivalent day count via a GPC software Specialist Function, Item Entry. Once an update is initiated, the MTU and GPC times will differ for approximately 2 minutes due to a time out requirement which is part of the MTU update mechanization. Updating of the MTU clock, in order to maintain its day count equivalency with the GPC is required following days 365, 366, 375, and 376. Following the last update to Day 377 the MTU will increment to a maximum day count of 399.

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

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

8.2.10.2 Square-Wave Reference Frequencies

The clock frequencies shall be derived from a single divider chain in the MTU. No permanent phase relationship shall exist between the various clock frequencies. Short term timing relationships (during a single power-up period) fall within the limits of the individual jitter specifications. The clock signals shall not have a fixed phase relationship with respect to the one second transition mark in the IRIG-B time code outputs and the frequency accuracy shall be determined by the MTU Master oscillator. For a stabilized MTU (16 hours after power-on) the offset shall not exceed 10 pp 10^8 from center frequency and the drift rate shall be ± 1 pp 10^9 per 24 hours maximum.

8.2.10.2.1 4.608 MHz Square-Wave Reference Frequency

The 4.608 MHz square-wave reference frequency electrical interface characteristics at the Orbiter/payload interface shall be as shown in Table 8.2.10.2.1-1.

8.2.10.2.2 1.024 MHz Square-Wave Reference Frequency

The 1.024 MHz square-wave reference frequency electrical interface characteristics at the Orbiter/payload interface shall be as shown in Table 8.2.10.2.2-1.

8.2.10.2.3 1 kHz Square-Wave Reference Frequency

The 1 kHz square-wave reference frequency electrical interface characteristics at the Orbiter/payload interface shall be as shown in Table 8.2.10.2.3-1.

8.2.10.2.4 100 Hz Square-Wave Reference Frequency

The 100 Hz square-wave reference frequency electrical interface characteristics at the Orbiter/payload interface shall be as shown in Table 8.2.10.2.4-1.

8.2.10.2.5 10 Hz Square-Wave Reference Frequency

The 10 Hz, square-wave, reference frequency, electrical interface characteristics at the Orbiter/payload interface shall be as shown in Table 8.2.10.2.5-1.

8.2.10.2.6 Unused Output Termination

All frequency output interface connectors shall be capped when not used. Any extension from the interface shall be executed with multiple grounded TSP cable. Load impedance termination shall not be required when these constraints are met.

8.2.10.3 Phase Relationship

a. No fixed phase relationship shall exist between the one-second transitions occurring on the GMT and MET Time outputs.

b. No fixed phase relationship shall exist between the 1024 kHz and MET time outputs.

c. No fixed phase relationship shall exist between the 1024 kHz and GMT time outputs.

8.2.10.4 Short-Circuit Protection

All MTU and PTB 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 GMT and MET signals shall be as shown in Figure 8.2.10.5.1-1.

8.2.10.5.2 Square-Wave Reference Frequencies

Grounding and shielding for square-wave reference frequency signals shall be as shown in Figure 8.2.10.5.2-1.

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	3.6 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	
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	1886 max	(1)

(1) Calculations based upon 82 feet of cable from PTB to payload interface (end of SMCH).

TABLE 8.2.10.2.1-1 MTU 4.608 MHz SQUARE-WAVE REFERENCE FREQUENCY, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Digital (Square-Wave)	
Duty Cycle	Percent	50 ± 3	
Signal Level	V pk-pk	2.5 to 5.4	(1)
DC Offset	Vdc	≤ 0.5 Line-to-Gnd	
Rise/Fall Time	Nano-Sec	<100	Measured from 10 to 90 percent point(1)
Skew	Nano-Sec	<20 at 50 percent point	
Jitter	Percent	1	
Overshoot	V pk-pk	<6 Signal Plus Overshoot	
Max Output Voltage	Vdc	10	Under any failure condition
Long Term Stability		1 part in 10^9 per day	
Source Impedance (Orbiter)	Ohm	≤100	
Load Impedance (Payload)	Ohm	70-80	
Line Impedance	Ohm	75 ± 10 percent	Coax Hs 179B
Common Mode Output Voltage	Volt	<10	Under normal Operation
Capacitance (Line)	pF	1794 Nominal	(1)

(1) Based on 92-ft cable length, from MTU to the STS/Payload interface.

TABLE 8.2.10.2.2-1 MTU 1.024 MHz SQUARE-WAVE REFERENCE FREQUENCY, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Digital (Square-Wave)	
Duty Cycle	Percent	50 ± 5	
Signal Level	V pk-pk	3.2 to 6	(1)
DC Offset	Vdc	≤ 0.5 Line-to-Gnd	
Rise/Fall Time	Nano-sec	≤300	Measured from 10 to 90 percent point(1)
Skew	Nano-sec	20	
Jitter	Percent	1.0	
Overshoot	V pk-pk	<6 Signal Plus Overshoot	
Max Output Voltage	Vdc	10	Under any failure condition
Long Term Stability		1 part in 10^9 per day	
Source Impedance (Orbiter)	Ohm	≤100	
Load Impedance (Payload)	Ohm	70-80	
Common Mode Output Voltage	Volt	<10	Under normal operation
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2116 max	(1)

(1) Calculations based upon 92 feet of cable from MTU to payload interface (end of SMCH).

TABLE 8.2.10.2.3-1 MTU 1 kHz SQUARE-WAVE REFERENCE FREQUENCY, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Digital (Square-Wave)	
Duty Cycle	Percent	50 ± 10	
Signal Level	V pk-pk	3.5 to 6	(1)
DC Offset	Vdc	≤ 0.5 Line-to-Gnd	
Rise/Fall Time	Nano-sec	≤300	Measured from 10 to 90 percent point(1)
Skew	Nano-sec	20	
Jitter	Percent	0.5	
Overshoot	V pk-pk	<6 Signal Plus Overshoot	
Max Output Voltage	Vdc	10	Under any failure condition
Long Term Stability		1 part in 10^9 per day	
Source Impedance (Orbiter)	Ohm	≤100	
Load Impedance (Payload)	Ohm	70-80	
Common Mode Output Voltage	Volt	<10	Under normal operation
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2116 max	(1)

(1) Calculations based upon 92 feet of cable from MTU to payload interface (end of SMCH).

TABLE 8.2.10.2.4-1 MTU 100 Hz SQUARE-WAVE REFERENCE FREQUENCY, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Digital (Square-Wave)	
Duty Cycle	Percent	50 ± 10	
Signal Level	V pk-pk	3.5 to 6	(1)
DC Offset	Vdc	≤ 0.5 Iine-to-Gnd	
Rise/Fall Time	Nano-sec	≤700	Measured from 10 to 90 percent point(1)
Skew	Nano-sec	20	
Jitter	Percent	0.5	
Overshoot	V pk-pk	<6 Signal Plus Overshoot	
Max Output Voltage	Vdc	10	Under any failure condition
Long Term Stability		1 part in 10^9 per day	
Source Impedance (Orbiter)	Ohm	≤100	
Load Impedance (Payload)	Ohm	70-80	
Common Mode Output Voltage	Volt	<10	Under normal operation
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2116 max	(1)

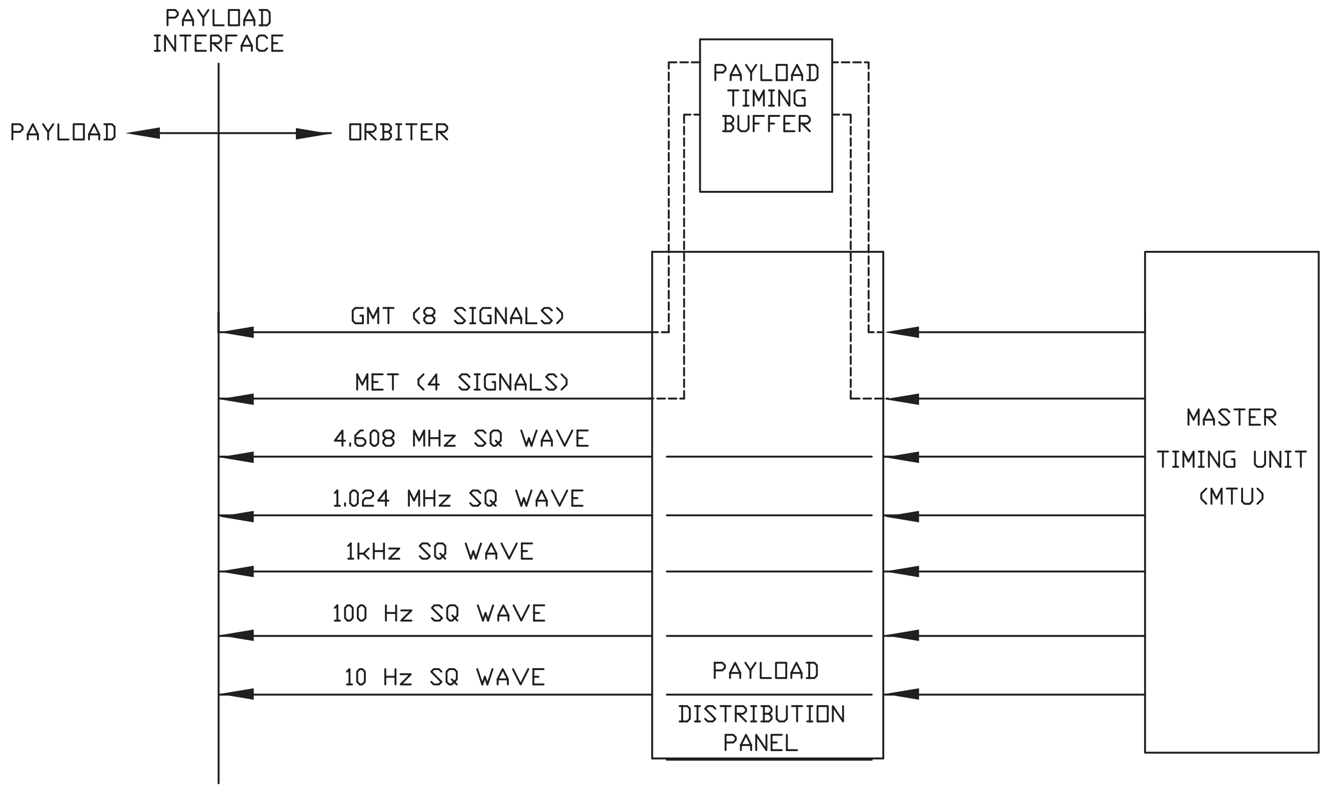
(1) Calculations based upon 92 feet of cable from MTU to payload interface (end of SMCH).

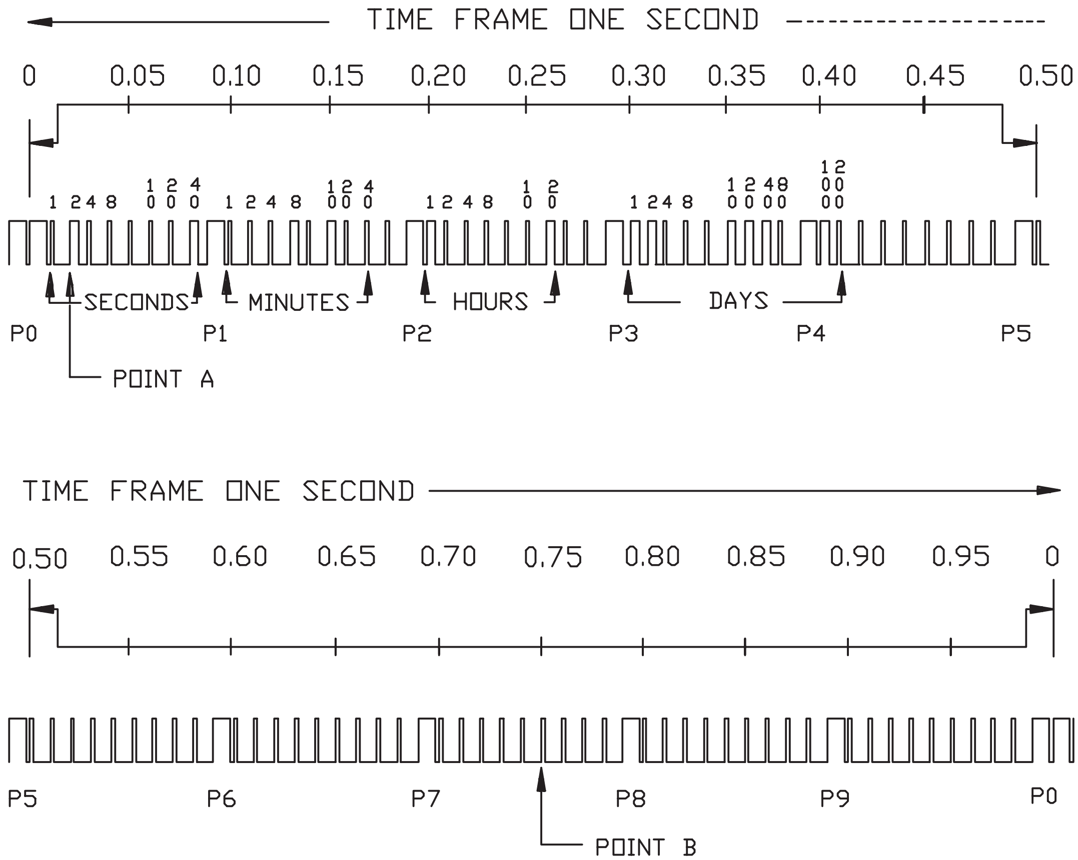
TABLE 8.2.10.2.5-1 MTU 10 Hz SQUARE-WAVE REFERENCE FREQUENCY, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Digital (Square-Wave)	
Duty Cycle	Percent	50±10	
Signal Level	V pk-pk	3.5 to 6	(1)
DC Offset	Vdc	≤0.5 Line to Gnd	
Rise/Fall	Nanosec	<700	Measured from 10 to
Time			90 percent Point(1)
Skew	Nanosec	<20	Measured at 50 percent Point
Jitter	Percent	0.5	
Overshoot	V pk-pk	<6 Signal Plus Overshoot	
Max Output Voltage	Vdc	10	Under any failure Condition
Long Term Stability		1 Part in 10^9 per day	
Source Imped-ance (Orbiter)	Ohm	≤100	
Load Imped-ance (Payload)	Ohm	70-80	
Common Mode Output Voltage	Volt	<10	Under normal operation
Cable		2 conductor twisted, shielded, jacketed, controlled impedance	Rockwell Design Standard MP572-0328-0002
Cable Impedance Zo	Ohms	70 min 80 max	measured conductor to conductor at 1MHz
Cable Capacitance (Orbiter)	Pico-farads	2116 max	(1)

(1) Calculations based upon 92 feet of cable from MTU to payload interface (end of SMCH).

FIGURE 8.2.10-1 TYPICAL MASTER TIMING UNIT AND PAYLOAD TIMING BUFFER INTERFACES DATA FLOW



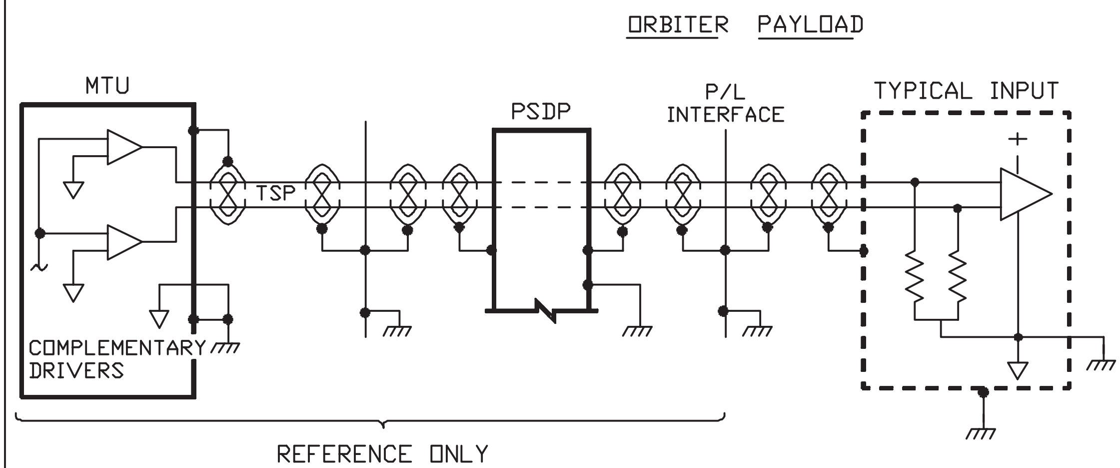


FRAME TIME - 1 SECOND
100 PPS (10 MS BETWEEN PULSES)
BCD
"ON TIME" REF - LEADING EDGE
POSTION IDENTIFIER = 8 MILLISEC DURATION ± 50 MICROSECONDS
BINARY 0 = 2 MILLISEC DURATION ± 50 MICROSECONDS
BINARY 1 = 5 MILLISEC DURATION ± 50 MICROSECONDS
TIME AT POINT A = 173 DAYS, 21 HOURS, 18 MINUTES, 42.02 SECONDS
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
8.2.10.1.1 GREENWICH MEAN TIME 8.2.10.1.2 MISSION ELAPSED TIME	

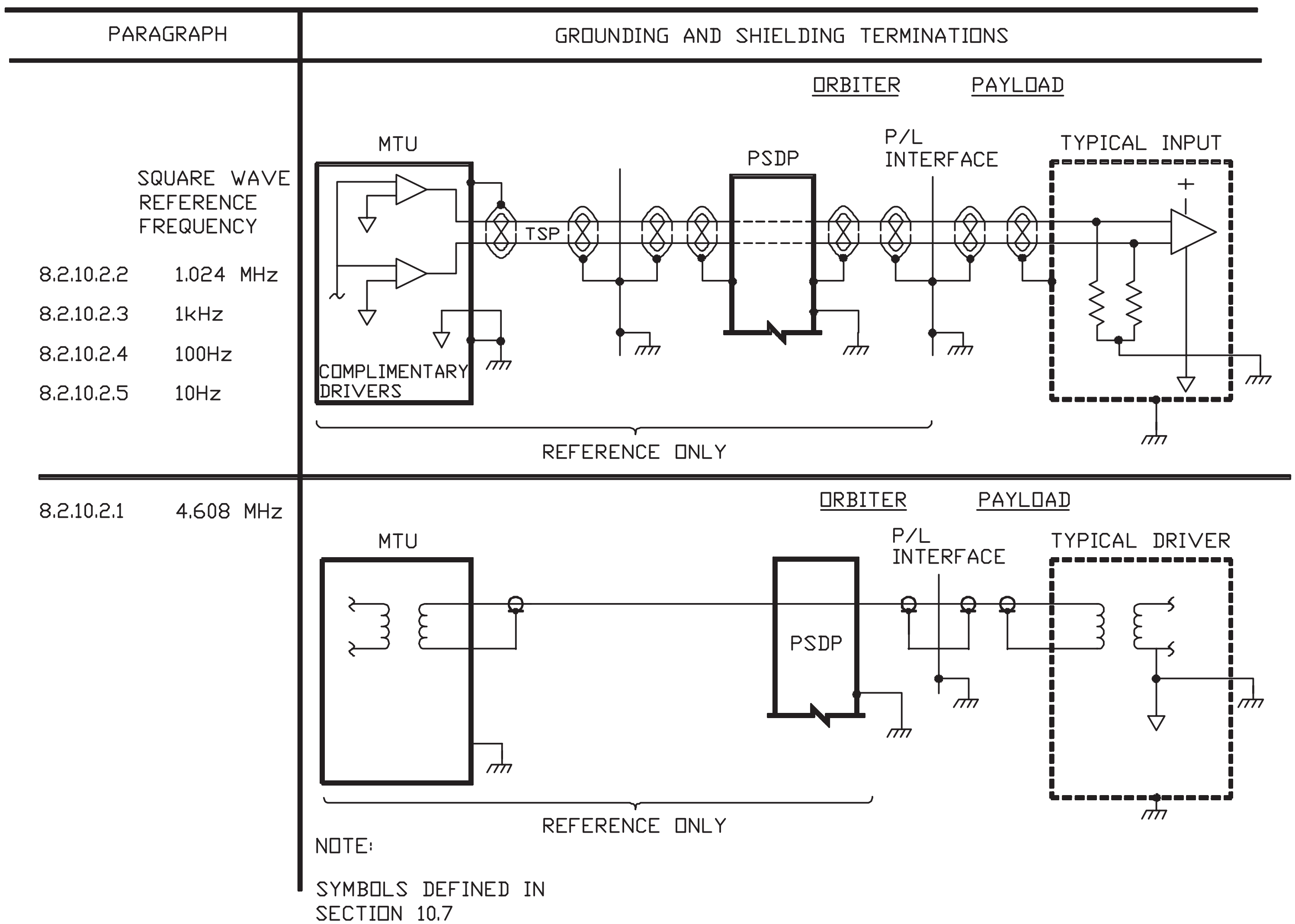


FIGURE 8.2.10.5.2-1 MTU: SQUARE-WAVE REFERENCE FREQUENCIES GROUNDING AND SHIELDING INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.11 Payload Safing-Command Interface

The hardwired interfaces available for Payload Safing commands are as shown in Figure 8.2.11-1. Five switches from the Center Console Panel (C3A5) on the Flight Deck provide redundant ACTIVE/SAFE functions.

8.2.11.1 Commands

The electrical interface characteristics for the Payload Safing ACTIVE/SAFE functions are as defined in Table 8.2.11.1-1.

8.2.11.2 Grounding and Shielding

Grounding and shielding shall be as shown in Figure 8.2.11.2-1.

TABLE 8.2.11.1-1 PAYLOAD SAFING COMMAND-HARDWIRE, ORBITER-TO-PAYLOAD, ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Characteristics Orbiter/ Payload Interface	Notes
Type		Switch Contact	
Input Voltage to Orbiter Max	Volts dc	32	
Transfer		Direct	
Input Max Current to Orbiter	Amperes	8.5	Closed contacts
Circuit Max Resistance	Ohms	4.2	(1)

(1) Round trip distance between cargo element interface at end of SMCH and the Orbiter switch is 211 ft. Resistance value calculated at a maximum temperature of 200°F in the cargo bay. (Note: Round-trip resistance from Xo603 interface to Orbiter switch measured 1.84 ohms at ambient). If SMCH not utilized, new calculation must be performed.

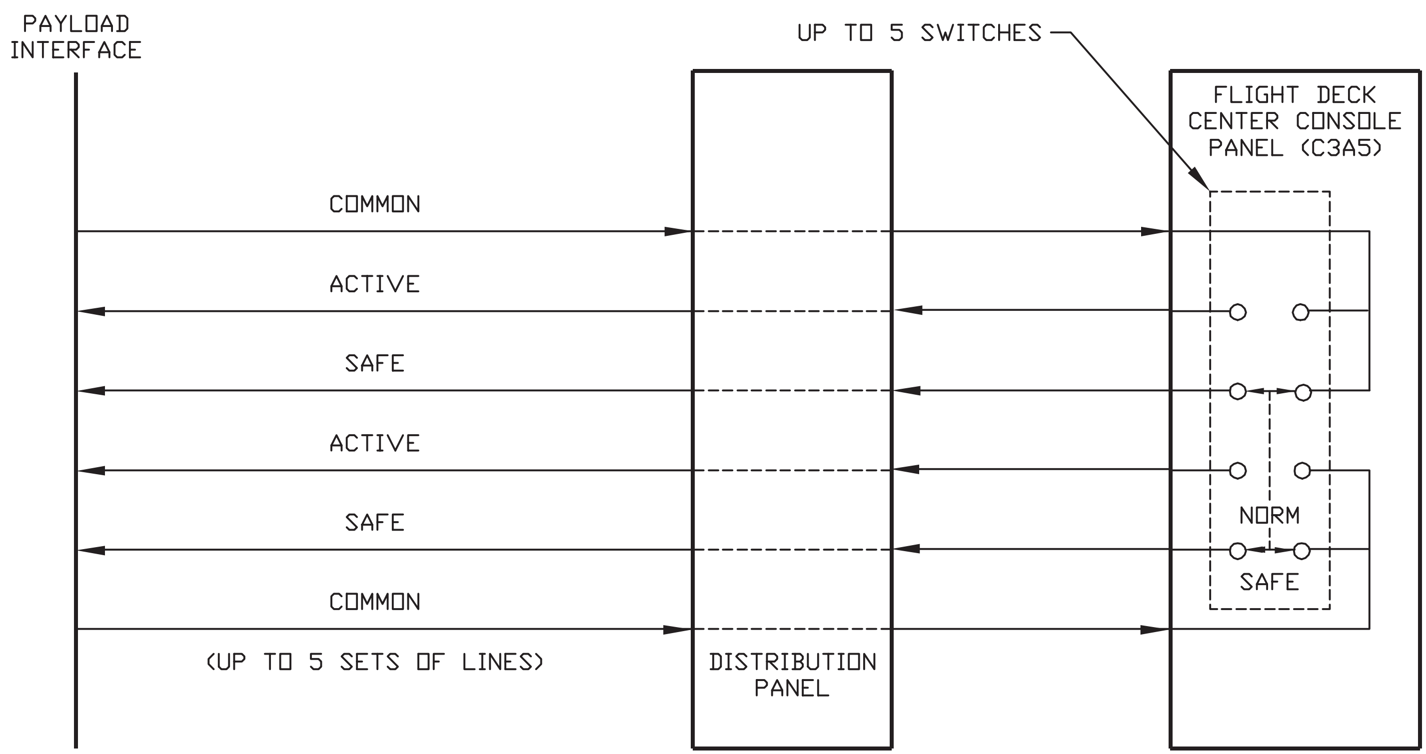
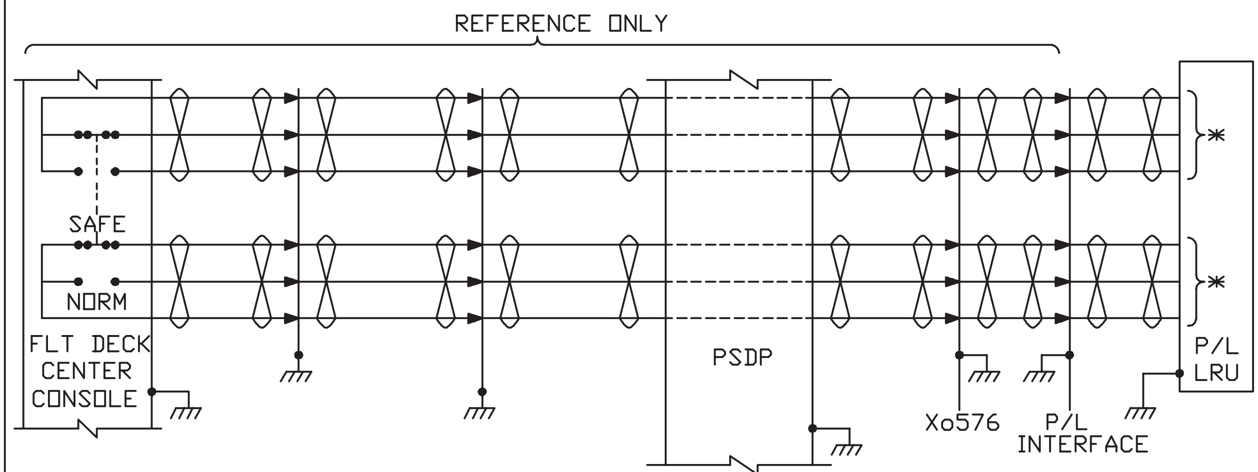


FIGURE 8.2.11-1 PAYLOAD SAFING COMMAND SIGNAL FLOW

FIGURE 8.2.11.2-1 PAYLOAD SAFING COMMAND GROUNDING AND SHIELDING

PARAGRAPH	GROUNDING AND SHIELDING TERMINATIONS
8.2.11.1	 * OPTIONAL PROVIDING ALL ISOLATION REQUIREMENTS ARE MET

THIS PAGE INTENTIONALLY LEFT BLANK.

8.2.12 Orbiter to Cargo Element Data Bus System (DBS) Interfaces

The Orbiter shall provide data bus interfaces to accommodate cargo servicing by the Orbiter data processing equipment. A data bus cable shall interconnect the cargo element to support the flight manifest as shown in Figure 8.2.12-1. Each DBS provided, (PL Bus 1, PL Bus 2, Launch Bus 1, Launch Bus 2), shall be terminated within the cargo bay at the end of the Bus. (See Figures 8.2.12-1 and 8.2.12-2.) The DBS shall conform to Orbiter standards for parts, interfaces, matching, isolation and fault protection to allow the Orbiter GPC, Orbiter Bus Terminal Units (BTU), and cargo BTUs to operate as a digital transmission system. The following notes provide the necessary requirements to meet this objective:

Notes:

a. All cargo BTUs shall interface with the DBS via a dedicated DBC (Data Bus Coupler, Rockwell Specification MC409-0020-0001), and cable stub as shown in Figures 8.2.12-1, 8.2.12-2, 8.2.12-3 and 8.2.12-4. The data bus interface characteristics shall be as shown in Table 8.2.12-1 for Orbiter transmission and in Table 8.2.12-2 for cargo element transmission.

   The vehicle data bus (designated as safety critical by the Orbiter) shall not be interrupted throughout flight. The stub cable may be interrupted due to separations, but only to an open state. Bus routing and pin assignments shall be as shown in Figures 8.2.12-1, 8.2.12-2, 8.2.12-3 and 8.2.12-4 and in Paragraph 13.5.1.3. Depending upon flight requirements, the two alternate DBC connections shall be as shown in Figure 8.2.12-2, view (B) for continuing and view (A) for terminating the data bus. Bus termination lengths greater than 6 cm shall use MP572-0279-0002 cable. Shorter unshielded lengths shall meet the requirements of Rockwell Specification MP572-0304-0002. Rockwell Specification MP572-0279-0002, shall be used for the data bus stub and bus termination jumper.

b. All Orbiter BTUs utilize a common data bus transceiver/decoder to interface with the data bus. This module is referred to as a Multiplexer Interface Adapter (MIA) and is packaged within the BTU. This unit is required for cargo equipment interfacing with the data bus and can be procured to Rockwell Specification MC615-0010 from the manufacturer, Singer/Kearfott Division, Little Falls, New Jersey. Rockwell Specification MC615-0010 is being invoked on an interim basis and will be replaced by applicable government specifications when such coverage is implemented.

c. Any BTU which separates from the DBS during flight shall be connected to the DBS via a Data Bus Isolation Amplifier (DBIA), Rockwell Specification MC409-0019-0002. The DBIA is required to protect the DBS against any significant impedance changes. The DBIA is not an STS standard service. The DBIA shall be connected to the Orbiter DBS in a manner similar to any BTU. The other side of the DBIA shall provide a data bus extension. (See Figure 8.2.12-4.) The bus extension shall interface with the cargo element BTUs in accordance with the same requirements and constraints as the Orbiter DBS and as per the following:

(1) The bus extension shall be hardwired to the DBIA.

(2) The bus extension shall be terminated on both ends; the DBIA end per Figure 8.2.12-4 and the other end per Figures 8.2.12-1 and 8.2.12-2.

(3) There shall be a maximum time delay of 5.25 microseconds for signal transfer through the DBIA in both directions.

d. The interface connector plate at the Orbiter/Cargo interfaces defined in Figures 8.2.12-1 and 8.2.12-2 shall be the SMCH-SIP connector unless otherwise agreed to with the NSTS. Connectors at the Orbiter/Cargo interfaces shall be as shown in Paragraph 13.5.1.3.

e. All data bus and stub cable shields shall be terminated at both ends of the cable within 3 cm of the connector grommet and individually grounded to the backshell tag ring.

f. DBC and DBIA thermal environments shall be maintained within -65°F to +165°F under operating and non-operating conditions.

g. Cable bend radii shall be greater than or equal to 10 times the data bus cable diameter to preclude changes in cable impedances.

h. MDM or FMDM addressing shall be accomplished by jumpering within the connector backshell. A valid address code listed in Table 8.2.12.6.1.1-1, and shall be assigned by the payload integrator. The code wires shall be 26 ga., less than 3 cm long, and jumpered in back of the plug and inside the backshell.

i. The maximum cargo BTUs allowable on the data bus shall be no more than four BTUs.

j. Orbiter data bus cable length requirements are as follows: (Ref. Figure 8.2.12-3)

   1. Total bus cable length shall not exceed 350 feet between end BTU couplers.

   2. 100 feet of each data bus is permanent Orbiter scar. The remaining 250 feet length limit is established by each manifest.

   3. The cable length from the end BTU coupler to the termination resistor shall not exceed 65 feet.

   4. As a design guideline, the cable length shall be held to a minimum to avoid data bus signal degradation.

k. Cargo element data bus cable length requirements are as follows: (Ref. Figures 8.2.12-1 and 8.2.12-3)

   1. The maximum length of the data bus within a payload, from the payload interface to the coupler(s) and back to the interface, shall not exceed 40 feet.

   2. The maximum length of the data bus termination circuit within a payload, from the cargo BTU to the payload interface and back to the BTU termination resistor, shall not exceed 40 feet.

NOTE: The data bus may be terminated on the cargo element side of the interface in order to satisfy Paragraph 8.2.12 (j) (3).

3. As a design guideline, cable lengths shall be held to a minimum to avoid data bus signal degradation.

8.2.12.1 Data Bus Transfer

All communications on a particular data bus shall be initiated by command words from the Orbiter bus control unit in control of that bus. The command words will identify the cargo BTU for which the command is intended and indicate the function to be performed. Data transfer will be in the form of messages. A message will consist of a command word transmitted by the bus controller followed by either command data words from the bus controllers or by response data words transmitted by a BTU. BTUs will neither transmit nor respond on a bus unless commanded to do so by the Orbiter unit in control of that data bus. The information shall be transferred over the half duplex data bus in serial/digital pulse code modulation form and shall be Bi-Phase Level as defined in MIL-STD-1572 and as shown in Figure 8.2.12.1-1. A logic "1" shall be transmitted as a bipolar coded signal 10 (a positive pulse followed by a negative pulse). A logic "0" shall be a bipolar coded signal 01 (a negative pulse followed by a positive pulse). Data shall be transferred at a 1.0 Mbps ± 0.1 percent data rate and when receiving data, the cargo BTU I/O shall derive clocking as necessary to decode the received data message. The command and data words shall consist of 24 data bits plus sync and parity. Each response message shall be in a form of data words, each word of which shall consist of 24 data bits, plus sync and parity.

The command word/data word sync patterns shall be non-valid Bi-Phase Level codes as shown in Figure 8.2.12.1-2. The width of the positive and negative going pulses that form a message sync pattern shall be 1.58 microseconds ±5 percent for the first half cycle and 1.5 microseconds ±3 percent for the second half cycle at the zero crossover, measured at the transmitter output, when terminated into a 70 ohm ± 5 percent resistive load (on the stub). Note that a Bi-Phase Level 01 code immediately following the command sync will increase the apparent width of the affected pulse to 2.0 microseconds plus or minus 4.75 percent. Also, the Bi-Phase Level 10 code immediately following the data sync will increase the apparent width of the affected pulse to 2.0 microseconds plus or minus 4.75 percent.

Each word shall contain a parity bit which shall be assigned a value such that the total number of "ones", including the parity bit in the word, is odd. During the reception, the parity shall be checked by determining whether or not the received word contains an odd number of "ones". The sync field shall not be included in parity generation/validation. Consecutive words transmitted onto the data bus by the bus controller or BTUs shall be separated by a 5.5 ± 0.5 microsecond gap time.

8.2.12.2 Data Bus Transmission Line

The data bus transmission line shall be a two conductor twisted, shielded, jacketed cable. The stub shall be the same cable type as the data bus and shall not exceed 8 ft (2.43 m) in length. The cables in the Cargo which extend and interface with the data bus shall be procured under Rockwell Design Standard MP572-0279-0002. This Rockwell document is being invoked on an interim basis and will be replaced by applicable government documents when such coverage is implemented. The data bus phasing (Hi/Lo) shall be carefully preserved throughout any single bus, stubs, terminations, and BTU connections.

8.2.12.3 Output Circuit Characteristics

The signal output voltage shall be between 12 and 15 volts peak line-to-line, as measured at the output of the Orbiter data bus controller or Cargo BTU transmitter on the stub, when driving a resistive load (on the stub) of 70 ohms plus or minus 5 percent. The waveform seen at the output of the Orbiter or cargo BTU data bus transmitter shall be a bipolar signal with characteristics as shown in Table 8.2.12-1. The rise and fall times of this signal, for positive or negative values, shall be 150 plus or minus 50 nanoseconds (as measured between 10 percent and 90 percent of the plus or minus voltage limits) during transmission when driving a resistive load of 70 ohms plus or minus 5 percent. For a load resistance between 66.5 ohms and 63.5 ohms (faulted conditions), the minimum output voltage shall be 9 volts peak line-to-line.

Line-to-line distortion of the waveform (within a 1.0 microsecond time period) by the output circuit, including ringing, shall not exceed 1.5 volts of overshoot or exceed 125 millivolts of undershoot at the plus and minus 15-volt levels, as shown in Figure 8.2.12.3-1, when driving a resistive load of 70 ohms plus or minus 5 percent.

In the non-transmitting state, transmitter output noise shall be no greater than 50 millivolts peak-to-peak. When signals are not being transmitted or when power is removed, the input impedance to the data bus terminals shall be a minimum of 6000 ohms in parallel with a maximum capacitance of 75 pF line-to-line from 330 KHz to 1.5 MHz.

8.2.12.4 Orbiter Bus Controller/Cargo Bus Terminal Unit Receiver Circuit Characteristics

The receiver circuit shall be compatible with the incoming signals specified herein and shall demonstrate a word error rate performance of less than 3 in 10^7 words. This performance shall be established with a line-to-line signal amplitude of 2.0 volts peak, having a rise and fall time of 250 nanoseconds measured between 10 and 90 percent of the peak to peak amplitude and impressed white Gaussian noise of 300 millivolts RMS distributed over the band 1000 Hz to 4.0 MHz. All measurements are made at the appropriate receiver input terminals.

Word Error Rate is defined as:

$$1 - \frac{\text{Total number of correctly received words}}{\text{Total number of words transmitted}}$$

The receiver shall operate with input waveforms varying from a square wave to a sine wave.

8.2.12.4.1 Input Sensitivity

The receiver shall respond with an input signal amplitude from plus or minus 15.0 volts peak, line-to-line, down to threshold level of $\pm$ 0.6 volt peak, line-to-line.

The receiver shall not respond to input signals of 0.0 volts to $\pm$ 0.4 volts peak, line-to-line. The receiver shall operate as specified in Section 8.2.12.4 with an input signal level of $\pm$ 15.0 volts peak, line-to-line, down to $\pm$ 2.0 volts peak, line-to-line, measured at the Orbiter bus controller/Cargo BTU input terminals.

Input circuit impedance of the receiver with the transmitter not operating or with the power removed shall be a minimum of 6000 ohms in parallel with maximum capacitance of 75 pf line- to-line between 330 KHz and 1.5 MHz.

The input circuit shall reject noise at all frequencies below 1000 Hz and between 5.0 MHz and 30 MHz for voltages up to 10 volts peak, line-to-line.

Signals from DC to 2.0 MHz with amplitudes up to plus or minus 32 volts peak, line-to-ground, applied to both the BTU receiver input circuit terminals, shall not cause the receiver to operate.

8.2.12.5 Orbiter Bus Controller/Cargo Bus Terminal Unit Receiver Data Validation

The cargo BTU I/O coupler or the MIA shall output an error indication to the host LRU for invalid messages received from the data bus. The validation criteria shall be as follows:

a. The word begins with a valid sync pattern.

b. The bit orientation in the received waveform reflects a valid Bi-Phase Level code. Checks shall be made to determine that only a "10" or "01" pattern occurs and that only the proper number of receiver threshold transitions occur within each bit time.

c. The word contains 25 data bits including the parity bit.

d. Parity bit verification.

8.2.12.6 BTU-GPC Command/Response Protocol

a. GPC-to-BTU Data Transfer. The message sequence for the transfer of data to the BTU from the GPC consists of one command word (CW) followed by up to 32 command data words, for a standard command. If a command word is not accepted by a BTU, the BTU does not respond to the subsequent command data words in that message. Figure 8.2.12.6-1 shows the message sequence for GPC-to-BTU data transfers.

b. BTU-to-GPC Data Transfer. The message sequence from the transfer of data to the GPC from the BTU consists of one command word followed by 1 to 32 response data words (RDW) for a response to a standard command. Exceptions are defined in Paragraphs 8.2.12.6.2.7(c), 8.2.12.6.2.12(c3) and 8.2.12.6.2.12(c5). Figure 8.2.12.6-2 shows the message sequence for BTU-to-GPC data transfers.

8.2.12.6.1 Data Bus Word Formats

8.2.12.6.1.1 Command Word Format

The BTU command word format consists of a standard command format, a PROM sequence command format, or a BITE Test command format.

(1) Standard or Direct Command Format.

1 3	4 8	9 13	14 17	18 22	23 27	28
Cmd Sync (3)	MIA Address (5)	Mode Control (5)	Module Address (4)	Channel Address (5)	Number Of Words (5)	P (1)

The definition of contents of the standard command word is:

Bit
Position

1-3 Command Sync. Three-bit non-valid Manchester code for a command data sync.

4-8 MIA Address. Five-bit code defined in Table 8.2.12.6.1.1-1 that identifies the BTU that will respond to a given command word. Address zero (00) is a non-valid address, and a BTU will not respond to it.

9-13 Mode Control Field. Five-bit code used for determining the operational mode of the BTU.

Bit
Position

9 10 11 12 13

0 1 0 0 0 Receive Command. Commands the BTU to receive command data.

0 1 0 0 1 Transmit Command. Commands the BTU to transmit response data.

0 1 0 1 0 BITE Status Request (BSR). Commands the BTU to transmit the contents of the BITE status register and to then reset the BITE status register.

0 1 0 1 1 Master Reset. Commands the BTU to reset all registers.

0 1 1 0 0 Return Command Word. Commands the BTU to return the received word.

0 1 1 0 1 Spare.

0 1 1 1 0 Load BITE. Commands the BTU to load the BITE status register with the contents of the command data words.

0 1 1 1 1 Spare.

14-17 Module Address. A four-bit code (decimal 0 to 15) which identifies the I/O module where the selected channels are located.

18-22 Channel Address. Five-bit code (decimal 0 to 31) that identifies one out of a maximum of 32 channels on the I/O module. This code also identifies a starting channel address for a multiple-word data transfer. The channel addresses available for the corresponding I/O module are:

IOM Type	Number of Channels	Channel Addresses
DIL, DIH, DOL, DOH, P0H	3	0 to 2
SIO	4	0 to 3
AOD	16	0 to 15
AID	32	0 to 31

The following different coding of these channel address bits is used during discrete output control.

Bit Position

18 Logical 1 indicates SET, logical 0 indicates RESET.

19-20 Spare

21-22 Selects one of three discrete channels.

21	22	
0	0	Channel 0
0	1	Channel 1
1	0	Channel 2
1	1	Illegal Code

23-27 Number of Words. Five-bit code that identifies the number of data words to be transmitted or received. The number of words shall be equal to the contents of the "Number of Words" field plus one (00000 = 1 word, ..., 11111 = 32 words). The BTU shall transmit/receive words from/to a channel address increasing monotonically starting at the channel address specified in bits 18-22. If the initial channel address is a serial channel, the "number of words" field shall be interpreted to be the number of words transmitted/received on the serial channel.

28 Parity. Odd parity.

(2) PROM or Indirect Command Format.

1 3	4 8	9 13	14 22	23 27	28
Cmd Sync (3)	MIA Address (5)	Mode Control (5)	Starting From Address (9)	Number of Instructions to Execute (5)	P (1)

The definition of the contents of the PROM Sequence command word is:

Bit Position

1-8 Command Sync and MIA Address. Same as Standard command format.

9-13 Mode Control Field. Five-bit code used for determining the operational mode of the BTU.

Bit
Position

9 10 11 12 13

0 0 0 0 0 Spare.

0 0 0 0 1 Return PROM Address Word. Commands the BTU to return the word at the specified PROM address.

0 0 0 1 0 Execute Command. Commands the BTU to execute the PROM command at the specified PROM address.

0 0 0 1 1 Spare.

14-22 PROM Starting Address. Nine-bit code that identifies the first PROM instruction to be executed.

23-27 Number of Instructions. Five-bit code that identifies the number of PROM instruction to be executed by the BTU. The number of instructions shall be equal to the contents of the "Number of Words" field plus one.

28 Parity. Odd parity.

(3) BITE Test Command Format. When the BTU receives the BITE Test format, it sets bits in the BITE status register, as described in Paragraph 8.2.12.6.2.3(c), and waits for a new command word.

1 3	4 8	9 13	14 17	18 22	23 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Channels	P
(3)	(5)	(5)	(4)	(5)	(5)	(1)

The definition of the contents of the BITE Test command word is:

Bit
Position

1-8 Command Sync and MIA Address. Same as Standard command format.

9-13 Mode Control Field. Five-bit code used for determining the operational mode of the BTU.

Bit
Position

9 10 11 12 13

0 0 1 0 0 BITE Test 1 Command. Commands the BTU to execute BITE Test 1 (SCU Test).

0 0 1 0 1 BITE Test 2 Command. Commands the BTU to execute BITE Test 2 (A/D Test).

0 0 1 1 0 BITE Test 3 Command. Commands the BTU to execute BITE Test 3 (PS Test).

0 0 1 1 1 BITE Test 4 Command. Commands the BTU to execute BITE Test 4 (ICM Test).

14-17 Module Address. A four-bit code (decimal 0 to 15) which identifies the I/O module where the selected channels are located.

18-22 Channel Address. Five-bit code (decimal 0 to 31) that identifies one out of a maximum of 32 channels on the I/O module. This code also identifies a starting channel address for a multiple-word data transfer. The channel addresses available for the corresponding I/O Module are the same as for the Standard or Direct Command Format, format (1) above.

23-27 Number of channels. Five-bit code that identifies the number of channels to test.

28 Parity. Odd parity.

8.2.12.6.1.2 Command Data Word Format

The command data word format is as follows:

1 - 3	4 - 8	9 - 24	25 - 27	28
Data Sync	MIA Address	Data	Pattern Check 1 0 1	P
(3)	(5)	(16)	(3)	(1)

The definition of the contents of the command data word is:

Bit
Position

1-3 Data Sync. Three-bit non-valid Manchester code for a command data sync.

4-8 MIA Address. Five-bit code that identifies the BTU that shall accept the command data word.

9-24 Data. Contains the data to be transferred from the GPC to the subsystem.

25-27 Pattern Check. Three-bit pattern, "101" for message validity test.

28 Parity. Odd parity.

8.2.12.6.1.3 Response Data Word Format

The response data word format is as follows:

1 - 3	4 - 8	9 - 24	25	26	27	28
Data Sync	MIA Address	Data	S	E	V	P

(3)	(5)	(16)	(1)	(1)	(1)	(1)

The definition of the contents of the response data word is:

Bit
Position

1-3 Data Sync. Three-bit non-valid Manchester code for a response data sync.

4-8 MIA Address. Five-bit code that identifies the BTU responding to the command word.

9-24 Data. Contains the requested subsystem or BITE data.

25 Power Transient Flag. Logical 1 in bit 25 indicates normal operation. Logical 0 in bit 25 indicates the occurrence of a power down/power up sequence since the transmission of the last message.

26 Error Flag. Logical 1 in bit 26 indicates a subsystem serial channel error occurred during transmission of this word. The GPC may request BITE status information after the message transmission to determine the type of error.

27 Validity Flag. Logical 1 in bit 27 indicates normal operation. Logical 0 in bit 27 indicates an internal BTU error has occurred. The computer may request BITE status at the end of the message transmission.

28 Parity. Odd parity.

SEV bit shall be forced to "101" for transmitting BSR data word response.

8.2.12.6.2 BTU Modes

8.2.12.6.2.1 Receive Command

Commands the BTU to receive command data words.

a. Command to BTU.

1 — 3	4 — 8	9 — 13	14 — 17	18 — 22	23 — 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 1 0 0 0	X X X X	X X X X X	X X X X X	
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. As appropriate.

c. Response Data from BTU. None

8.2.12.6.2.2 Transmit Command

Commands the BTU to transmit response data words.

a. Command to BTU.

1 3	4 8	9 13	14 17	18 22	23 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 1 0 0 1	X X X X	X X X X X	X X X X X	(1)
(3)	(5)	(5)	(4)	(5)	(5)	

b. Command Data to BTU. None

c. Response Data from BTU. As appropriate.

8.2.12.6.2.3 BITE Status Request

Commands the BTU to transmit the contents of the BITE status register and then reset the BITE status register. The BTU BITE status register is used to report BTU monitored conditions and BITE results to the GPC. All monitored fault conditions, except for power applied/interrupt, set the validity bit (bit 27) in a response data word to a zero state indicating to the GPC that the BITE status register should be interrogated. The BITE status register is reset after a BITE status command, or a Master Reset Command.

a. Command to BTU.

1 3	4 8	9 13	14 17	18 22	23 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 1 0 1 0				
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. None

c. Response Data from BTU.

(1) Normal BSR, i.e. No BTU BITE Command Transmitted.

GPC Bit	BTU Bit	
0	1	Power to the BTU has been applied, or interrupted.
1	2	The BTU has detected an error in the incoming data from the GPC.
2	3	The BTU has been requested to access a non-existent channel.
3	4	The BTU is unable to transfer data to/from a subsystem.
4	5	The BTU received too many words from the GPC in the last message.
5	6	The last command received from the GPC by the BTU was not completed.
6	7	Simultaneous execution on the primary and backup data buses has occurred.
7	8	An illegal mode has been commanded.

8	9	An internal BTU error has been detected.
9	10	A gap-time error has been detected.
10	11	BITE test has been successfully completed.
11-15	12-16	BITE sub-test number that failed.

(2) BSR After BITE Test 1 (Reference Paragraph 8.2.12.6.2.9). As a result of the BITE Test 1 command, one of the following 7 conditions will be loaded into the BSR, and may be accessed by the GPC 1.1 msec after the BITE Test 1 command:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
0 0 1 0 1 1 0 1 0 0 0 0 0 0 0 1	Output of sequence memory parity network always indicates odd parity.
0 0 1 1 1 1 0 1 0 0 0 0 0 0 0 1	Command Data Word Check pattern checker recognizes bad check pattern as good.
0 0 1 1 1 1 0 1 1 0 0 0 0 0 0 1	Command Data Word check pattern checker does not recognize good check pattern.
0 0 1 1 1 1 0 1 0 0 0 0 0 0 1 0	Sequence memory parity tree failure.
0 1 1 1 1 1 0 1 1 1 0 0 0 0 1 1	Register file failure: a. Read/Write error b. Addressing error
0 1 1 1 1 1 0 1 1 1 0 0 0 0 0 0	Module Interface Test: a. Addressed module responds to bad checkbits, or b. Addressed module reply line always asserted, or c. Addressed module not powered. Note: If SCU BITE is repeated without cycling BTU power, bits 3 and 4 will not be set for error conditions b. and c. above. Bits 12 through 15 contain the binary address of the failed module.
0 1 1 1 1 1 0 1 1 1 1 1 0 0 1 1	Successful SCU BITE completion.

(3) BSR after BITE Test No. 2 (Reference Paragraph 8.2.12.6.2.10). As a result of the BITE Test 2 command, one of the following 7 conditions will be loaded into the BSR, and may be accessed by the GPC:

1 1 1 1 1 1

0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	First A/D Bite value transferred.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	Second A/D Bite value transferred.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	Third A/D Bite value transferred.
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	Fourth A/D Bite value transferred.
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	Fifth A/D Bite value transferred.
0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	A/D Reply line always asserted.
0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	Successful A/D Bite completion.

Note: Bit 4 set during any of the above is an additional failure condition. It indicates the A/D reply line was asserted at the wrong time, or was never asserted. This condition will affect the V bit of the Response Data Words.

(4) BSR After BITE Test No. 3 (Reference Paragraph 8.2.12.6.2.11). As a result of the BITE Test 3 command, one of the following 4 conditions will be loaded into the BSR, and may be accessed by the GPC 43 msec. After the BITE Test 3 command:

										1	1	1	1	1	1	
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	Power supply BITE reply line always indicates test pass.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	First half of power supply BITE failed.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	Second half of power supply BITE failed. (Redundant BTU only).
0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	Successful power supply BITE completion.

8.2.12.6.2.4 Master Reset

Commands the BTU to reset all registers.

a. Command to BTU.

1 – 3	4 – 8	9 – 13	14 – 17	18 – 22	23 – 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 1 0 1 1				
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. None

c. Response Data from BTU. None

8.2.12.6.2.5 Return Command Word

Commands the BTU to return the received command word.

a. Command to BTU.

1 - 3	4 - 8	9 - 13	14 - 17	18 - 22	23 - 27	28
Cmd Sync	MIA Address	Mode Control 0 1 1 0 0	Module Address	Channel Address	Number Of Words	P
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. None

c. Response Data from BTU. One word containing the contents of the received command word. The BTU shall transmit 14 bits of the command word starting with bit 14 and ending with bit 27. Bits 14-27 of the command word are inserted into bits 9-22 of the response word. Bits 23 and 24 of the response word are loaded with "ZEROS".

8.2.12.6.2.6 Load BITE

Commands the BTU to load the BITE status register.

a. Command to BTU.

1 - 3	4 - 8	9 - 13	14 - 17	18 - 22	23 - 27	28
Cmd Sync	MIA Address	Mode Control 0 1 1 1 0	Module Address	Channel Address	Number Of Words	P
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. One word with the same format as the BSR.

c. Response Data from BTU. None

8.2.12.6.2.7 Return the Word at the PROM Address

Commands the BTU to return the word at the specified PROM address.

a. Command to BTU.

1 - 3	4 - 8	9 - 13	14 - 22	23 - 27	28
Cmd Sync	MIA Address	Mode Control 0 0 0 0 1	Starting Prom Address X X X X X X X X X	Number of Instruction to Execute X X X X X	P
(3)	(5)	(5)	(9)	(5)	(1)

b. Command Data to BTU. None

c. Response Data from BTU. For a PROM sequence command, the message consists of up to 512 response data words.

8.2.12.6.2.8 Execute Command

Commands the BTU to execute the PROM command(s) starting at the specified PROM address.

a. Command to BTU.

1 3	4 8	9 13	14 22	23 27	28
Cmd Sync	MIA Address	Mode Control	Starting Prom Address	Number of Instruction to Execute	P
		0 0 0 1 0	X X X X X X X X X	X X X X X	
(3)	(5)	(5)	(9)	(5)	(1)

b. Command Data to BTU. As appropriate.

c. Response Data from BTU. As appropriate.

8.2.12.6.2.9 BITE Test 1

Commands the BTU to execute BITE Test 1 Sequence Controller Unit (SCU) test.

a. Command to BTU.

1 3	4 8	9 13	14 17	18 22	23 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 0 1 0 0				
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. None.

c. Response Data from BTU. None.

d. SCU Test Description. the following tests are initiated internal to the BTU during the SCU test.

(1) BTU receiver addressing is checked to insure response to only 1 of 32 addresses by internally forcing all possible receiver addresses and verifying only one result in the BTU selected.

(2) Data word pattern checking is verified by internally generating incorrect check patterns and verifying an error can be detected.

(3) All counters are checked against one another by loading and monitoring simultaneous overflow.

(4) PROM odd parity checking is verified by forcing bad parity.

(5) PROM cyclic checking is verified by executing a sequence with an incorrect cyclic check.

(6) SCU OUT BUS, SCU IN BUS and ICM interfaces are verified by selecting and communicating with each ICM, and monitoring for the correct response. The ability of the IOMs and SCU to recognize bad check bits on the SCU OUT BUS and SCU IN BUS will also be verified at this time.

The above tests are further subdivided into up to 32 subtests. The number of the failed subtest is loaded into the BSR. Any detected failure while testing the SCU will stop the test with the BITE subtest failed number in the BSR. The GPC, after allowing time (1.1

milliseconds) for the BTU to perform its BITE test, may interrogate the BSR status.

8.2.12.6.2.10 BITE Test 2

Commands the BTU to execute BITE Test 2, Analog to Digital Converter (A/D) Test. The A/D converter is tested with a GPC command to execute the A/D test. Five references are converted and sent to the GPC for evaluation. The GPC should evaluate these references against programmed constants. The constants and sequence are as shown in the Response Data.

a. Command to BTU.

1 – 3	4 – 8	9 – 13	14 – 17	18 – 22	23 – 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 0 1 0 1				
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. None

c. Response Data from BTU.

Correct Bit Pattern (16 Bits)

WORD 5	0111111111000000	+Full Scale
WORD 1	1000000000000000	-Full Scale
WORD 2	1011010XXX000000	-Reference
WORD 4	0100101XXX000000	+Reference
WORD 3	0000000XXX000000	Null
or WORD 3	1111110XXX000000	Null

8.2.12.6.2.11 BITE Test 3

Commands the BTU to execute BITE Test 3, Power Supply (PS) Test. During the PS Test, the associated core power-supply regulators are placed in a slight offset condition and monitored for back-up takeover. Primary, secondary, and 28V sources are verified.

Any detected failure while testing the PS will stop the test with the BITE subtest failed number in the BSR. The GPC, after allowing time for the MDM to perform the test (43 msec), may interrogate the BSR status.

a. Command to BTU.

1 – 3	4 – 8	9 – 13	14 – 17	18 – 22	23 – 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 0 1 1 0				
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. None

c. Response Data from BTU. None

8.2.12.6.2.12 BITE Test 4

Commands the BTU to execute BITE Test 4, Input Output Module (IOM) Test. A command may test a module sequentially or on a single channel basis using the normal module address, channel number, and number of words fields in the command word.

a. Command to BTU.

1 3	4 8	9 13	14 17	18 22	23 27	28
Cmd Sync	MIA Address	Mode Control	Module Address	Channel Address	Number Of Words	P
		0 0 1 1 1	X X X X	X X X X X	X X X X X	
(3)	(5)	(5)	(4)	(5)	(5)	(1)

b. Command Data to BTU. See a through e.

c. Response Data from BTU. See a through e.

(1) AOD Module Type. Test of the AOD modules will result in one response data word per channel. The AOD test response should be compared by the GPC with the Programmed output. During AOD test, the GPC must account for output settling before testing. When testing an AOD module the GPC should compare the programmed output with the BITE reply by subtracting the two. The difference should be less than a predetermined value as given by the following equation.

(Programmed output) - (BITE Reply)

= 000000XXXX000000

or

= 111111XXXX000000

(2) DOH, DOL, and POH Module Type. Test of the these modules will result in one response data word per channel. The value of the responses data word(s) will be the state of the actual command discrete output signals.

(3) DIH and DIL Module Type. Test of DIH or DIL modules will result in two response words per channel, not to exceed 64 response data words. The two input IOM test response words should be compared by the GPC against each other. These test words will consist of predetermined complement bit patterns, independent of subsystem inputs. The GPC should verify that the two test words are complement bit patterns of the correct form. The bit patterns for each channel are:

Channel	Word	Bit Pattern
0	1	0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0
0	2	1 1 1 1 0 0 0 0 0 0 0 0 1 1 1 1
1	1	0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1
1	2	1 1 1 1 0 0 0 0 1 1 1 1 0 0 0 0
2	1	1 1 1 1 0 0 0 0 1 1 1 1 0 0 0 0
2	2	0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1

(4) SIO Module Type. The bit pattern will be alternate ones and zeros starting with a one in the first bit.

	Bit Pattern
WORD 1	1010101010101010
WORD 2	0101010101010101

(5) AID Module Type. Test of the AID module will result in two response data words per channel, not to exceed 64 response data words.

The first word will consist of the actual analog input modified by a gain change and constant. The second word will be the actual analog input. The GPC should unmodify the first word using a programmed gain change and constant and compare it against the second word. The equation which the GPC should implement is as follows, where BIT RESPONSE is the first response word and ACTUAL RESPONSE is the second:

(BIT RESPONSE) - (ACTUAL RESPONSE)/2 = CONSTANT

The value of the CONSTANT is either positive or negative depending on the channel number and the bit patterns should be as given below.

	Bit Pattern
CONSTANT (+)	0 0 1 1 0 X X X X X 0 0 0 0 0 0
CONSTANT (-)	1 1 0 0 1 X X X X X 0 0 0 0 0 0

The channel number and sign are as follows:

CHANNEL	SIGN	CHANNEL	SIGN	CHANNEL	SIGN	CHANNEL	SIGN
0	+	8	-	16	-	24	+
1	-	9	+	17	+	25	-
2	-	10	+	18	+	26	-
3	+	11	-	19	-	27	+
4	-	12	+	20	+	28	-
5	+	13	-	21	-	29	+
6	+	14	-	22	-	30	+
7	-	15	+	23	+	31	-

8.2.12.6.3 BTU Data Characteristics

The Data Conventions and Scaling Requirements are defined in Section 9.0, Software Interfaces, Paragraph 9.4.4, Orbiter Data Bus System Interface.

8.2.12.6.3.1 (Deleted)

8.2.12.6.3.2 (Deleted)

8.2.12.6.3.3 (Deleted)

8.2.12.6.3.4 (Deleted)

8.2.12.6.3.5 (Deleted)

8.2.12.6.3.6 (Deleted)

8.2.12.7 Cargo Terminal Address Codes

Cargo terminal (BTU) address codes are allocated according to Table 8.2.12.6.1.1-1. Only these addresses shall be used for the Orbiter/Payload (BTU) communications.

Orbiter bus controller support for multiple BTU's is defined in Section 9.0. Cargo elements shall make accommodations to change cargo terminal address codes on a mission basis. These addresses will be assigned when the cargo element is manifested for each flight.

8.2.12.8 Cargo Bus Terminal Unit Error Handling

The address field of all command and command data words shall be decoded and checked within the BTU. When a command word is received by a BTU which does not have that BTU's address the BTU shall not respond to the command word nor the following command data words in any way. If a command word which contains a BTU's address is received by that BTU, but the word is otherwise invalid, the BTU shall not use that command word, shall not respond to any following command data words in that message, and shall set a bit in the BITE status register in the BTU.

When a command data word is received by a BTU that does not have that BTU's address, but has been preceded by a valid command word addressed to that BTU, the command data word shall be considered invalid by the BTU, and a bit shall be set in the BTU BITE status register. Logic shall be provided in the BTU to detect an invalid check bit pattern in the command data word. When a BTU receives a command data word with an invalid check bit pattern or data validation errors as defined in paragraph 8.2.12.5, the command data word shall be considered invalid by the BTU, and a bit shall be set in the BTU BITE status register.

The BTU shall also contain logic to count the words in a message and compare it to the number of words indicated in the command word. All BTUs shall check to insure that a word has not been missed in a message as the result of an inter-word gap time-out. This time-out shall be between 8 and 35 microseconds. When a BTU detects a time-out it does not respond to any of the command data words following the time-out, it shall set a bit in the BTU BITE status register, and it shall disregard the entire message which was not completed.

8.2.12.9 Orbiter Bus Controller Error Handling

The bus controller shall be capable of detecting errors, generating error status information, and processing error status information. Upon detection of one or more errors, a status word shall be generated which indicates error condition detected.

8.2.12.9.1 Error Detection

8.2.12.9.1.1 Address Check

The address or outgoing command words shall be saved and compared with the address on the returned response data word. If an invalid address is detected in the response word, the word shall be considered invalid.

8.2.12.9.1.2 Pattern Check

If a response data word is received with a pattern other than "101" in bit locations 25-27, the data word shall be considered invalid.

8.2.12.9.1.3 Data Validation Errors

If a response data word is received with a data validation error, as defined in paragraph 8.2.12.5, the data word shall be considered invalid.

8.2.12.9.1.4 Missing Word

The bus controller shall detect missing words within a data stream received on a data bus.

8.2.12.9.1.5 Turnaround Time

The Orbiter bus controller shall perform a check to insure that the maximum turnaround time is not exceeded. The turnaround time is the time between the last bit of the command word transmitted and the first bit of the received response word. This time will depend on the particular bus terminal unit being addressed. If the maximum turnaround time is exceeded, an error condition will be presumed to exist and the data shall be considered invalid. The cargo BTU turnaround time shall be 5 to 23 microseconds.

8.2.12.10 Failure Detection and Isolation

The Orbiter bus controller shall be capable of utilizing the information derived from error checking and BITE status failure detection and fault isolation.

8.2.12.11 Grounding and Shielding

Grounding and Shielding shall be as shown in Figure 8.2.12-2.

8.2.13 (Deleted)

8.2.14 (Deleted)

8.2.14.1 (Deleted)

8.2.14.2 (Deleted)

TABLE 8.2.12-1 ORBITER/CARGO DATA BUS (ORBITER TRANSMITTING) ORBITER TRANSMITTING-CARGO BTU RECEIVING ELECTRICAL INTERFACE CHARACTERISTICS

PARAMETER		DIMENSION	ICD INTERFACE (5)	
			DUE TO SOURCE	LOAD REQUIREMENTS
Type			Serial Burst (See Figure 8.2.12.6-2)	Serial Burst (See Figure 8.2.12.6-2)
Code			MIL-STD-1572 Bi-Phase L	MIL-STD-1572 Bi-Phase L
Analog Range	Min	Volt	N/A	N/A
	Max	Volt	N/A	N/A
Positive Signal Peak	Max	Volt	N/A	+0.56 (NO RESPONSE)
	Min	Volt	+2.5 (4)	+1.0 (MUST RESPOND)
	Max	Volt	+5.9	+7.9
	Min	Volt	+2.6	+2.5 (Ref. Paragraph 8.2.12.4.1)
Negative Signal Peak	Max	Volt	N/A	-0.56 (NO RESPONSE)
	Min	Volt	-2.5 (4)	-1.0 (MUST RESPOND)
	Max	Volt	-5.9	-7.9
	Min	Volt	-2.6	-2.5 (Ref. Paragraph 8.2.12.4.1)
Ripple and Noise (Excluding overshoot and undershoot)	Max	Millivolt	300 rms	300 rms
CMV	Max	Volt	±10V Peak from dc to 2 MHz sine Ref shield	No Response to ±32 V Peak from dc to 2 MHz sine Ref shield
Rise/Fall Time (10 to 90 percent)	Min	Microsec	0.10	0.10
	Max		0.26 (3)	0.26 (3)
Noise Supp Bandwidth		Hertz	N/A	Reject up to ±14 V Peak below 1kHz and between 5MHz and 30 MHz
CMRR		dB	N/A	Reject CMV

TABLE 8.2.12-1 ORBITER/CARGO DATA BUS (ORBITER TRANSMITTING) ORBITER TRANSMITTING - CARGO BTU RECEIVING ELECTRICAL INTERFACE CHARACTERISTICS (Concluded)

PARAMETER		DIMENSION	ICD INTERFACE (5)	
			DUE TO SOURCE	LOAD REQUIREMENTS
Distortion	Max	Volts	10 percent overshoot to 1 percent undershoot (Ref signal Peak)	10 percent overshoot to 1 percent undershoot (Ref signal peak)
Frequency Bit Rate		Mbps	1 ± 0.1 percent (See Figure 8.2.12.1-1)	1 ± 0.1 percent (See Figure 8.2.12.1-1)
Transfer			Direct Coupled Balanced	Direct Coupled Balanced
Impedance	Min	Ohm	70	70
	Max	Ohm	80	80
Pwr-Off Imp Per Stub		Ohm	N/A	N/A
Drive Capability		Milliamps	85 Peak at 5.9V	N/A
Load Current	Max	Milliamps	N/A	101 Peak at 7.9V
Overvoltage Protection	Max	Volt	N/A ±8 Diff (1)	32 Vdc CM ±8 Diff (1)
Fault Voltage Emission	Max	Volt	±8 Diff (1) N/A (2)	±8 Diff (1) N/A (2)
Fault Current Limitation (Estimate)	Max	Milliamps	200	200

(1) Within the signal bandwidth of 330 kHz - 1.5 MHz.
(2) Single point fault voltage cannot draw current on unreferenced, transformer isolated lines.
(3) Operational Boundaries.
(4) Faulted condition.
(5) Main data bus parameters.

TABLE 8.2.12-2 ORBITER/CARGO DATA BUS (CARGO BTU TRANSMITTING) CARGO BTU TRANSMITTING-ORBITER RECEIVING ELECTRICAL INTERFACE CHARACTERISTICS

PARAMETER		DIMENSION	ICD INTERFACE (5) DUE TO SOURCE	ICD INTERFACE (5) LOAD REQUIREMENTS
Type			Serial Burst (See Figure 8.2.12.6-2)	Serial Burst (See Figure 8.2.12.6-2)
Code			MIL-STD-1572 Bi-Phase L	MIL-STD-1572 Bi-Phase L
Analog Range	Min	Volt	N/A	N/A
	Max	Volt	N/A	N/A
Positive Signal Peak (1)	Min	Volt	+2.5 (4)	+1.0 (MUST RESPOND)
	Min	Volt	+2.6	+2.5
	Max	Volt	+5.9	+7.9 (Ref.Paragraph 8.2.12.4.1)
	Max	Volt	N/A	+0.56 (NO RESPONSE)
Negative Signal (1) Peak	Min	Volt	-2.5 (4)	-1.0 (MUST RESPOND)
	Min	Volt	-2.6	-2.5
	Max	Volt	-5.9	-7.9 (Ref.Paragraph 8.2.12.4.1)
	Max	Volt	N/A	-0.56 (NO RESPONSE)
Ripple and Noise (Excluding overshoot and undershoot)	Max	Millivolt	300 rms	300 rms
CMV	Max	Volt	±10V Peak from dc to 2 MHz sine Ref. shield	No Response to ±32 Volts Peak from dc to 2 MHz sine Ref. shield
Rise/Fall Time (10 percent to 90 percent)	Min	Microsec	0.10	0.10
	Max	Microsec	0.25(3)	0.26(3)
Noise Supp Bandwidth		Hertz	N/A	Reject up to ±14 V Peak Below 1kHz and between 5 MHz and 30 MHz

TABLE 8.2.12-2 ORBITER/CARGO DATABUS (CARGO BTU TRANSMITTING) CARGO BTU TRANSMITTING - ORBITER RECEIVING ELECTRICAL INTERFACE CHARACTERISTICS (Continued)

PARAMETER		DIMENSION	ICD INTERFACE (5)	
			DUE TO SOURCE	LOAD REQUIREMENTS
CMRR		dB	N/A	Reject CMV
Distortion	Max	Volts	10 percent overshoot to 1 percent undershoot (Ref Peak Sig.)	10 percent overshoot to 1 percent undershoot (Ref Peak Sig.)
Frequency Bit Rate		Hertz Mbps	N/A 1 ± 0.1 per-cent (See Figure 8.2.12.1-1)	N/A 1 ± 0.1 per-cent (See Figure 8.2.12.1-1)
Transfer			Direct Coupled Balanced	Direct Coupled Balanced
Impedance	Min	Ohm	70	70
	Max	Ohm	80	80
Pwr-Off Imp		Ohm	N/A	N/A
Drive Capability	Max	Milliamps	85 Peak at 5.9V	N/A
Load Current	Max	Milliamps	N/A	101 Peak at 7.9 V
Overvoltage Protection	Max	Volt(pk)	N/A ±8 Diff (1)	±32V dc CM ±8 Diff (1)
Fault Voltage Emission	Max	Volt(pk)	N/A (2) ±8 Diff	N/A (2) ±8 Diff
Fault Current Limitation	Max	Milliamps	200	200

Notes:
(1) Within the signal bandwidth of 330 kHz - 1.5 MHz.
(2) Single point fault voltage cannot draw current on unreferenced, transformer isolated lines.
(3) Operational Boundaries.
(4) Faulted condition.
(5) Main data bus parameters.

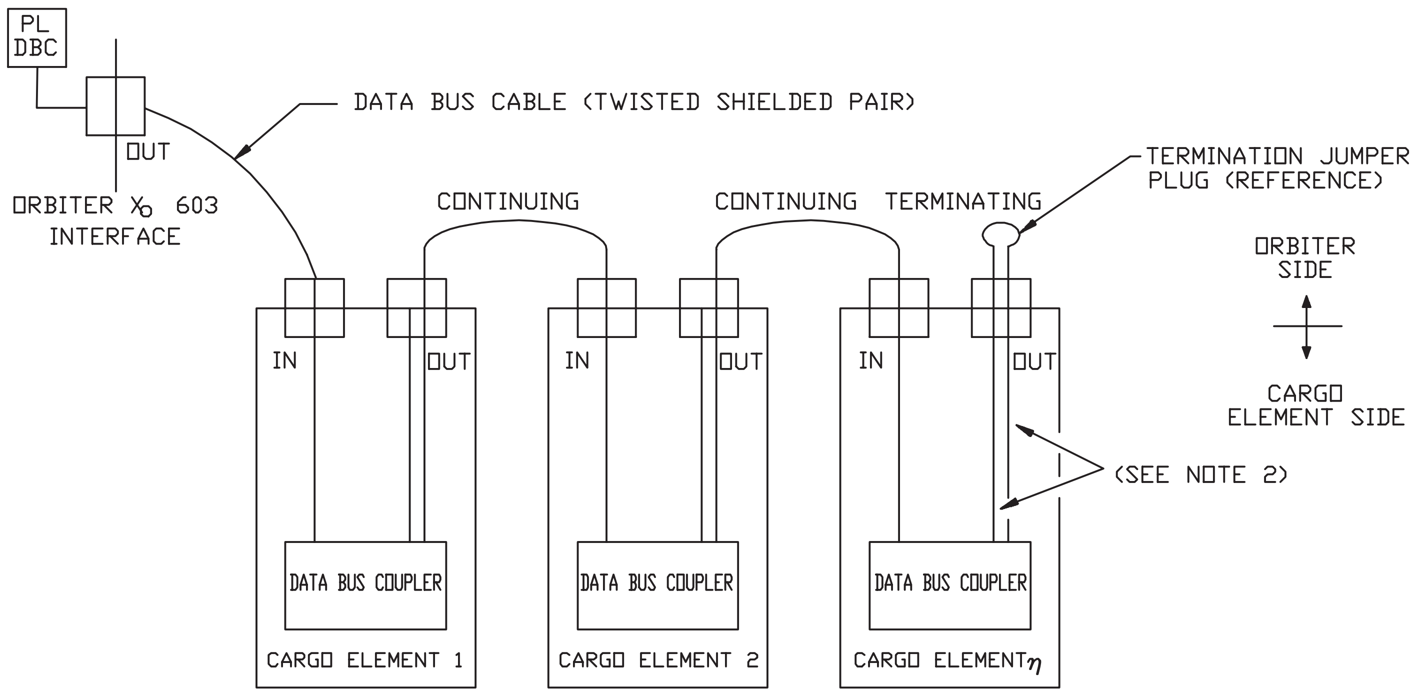
TABLE 8.2.12.6.1.1-1 CARGO TERMINAL ADDRESS CODES

PAYLOADS BTU / DATA BUS	BTU 1	BTU 2	BTU 3	BTU 4	BTU 5
PL1 (P)	6	9	15	29	30
PL2 (S)	6	9	15	29	30

(P) - PRIMARY PORT
(S) - SECONDARY PORT

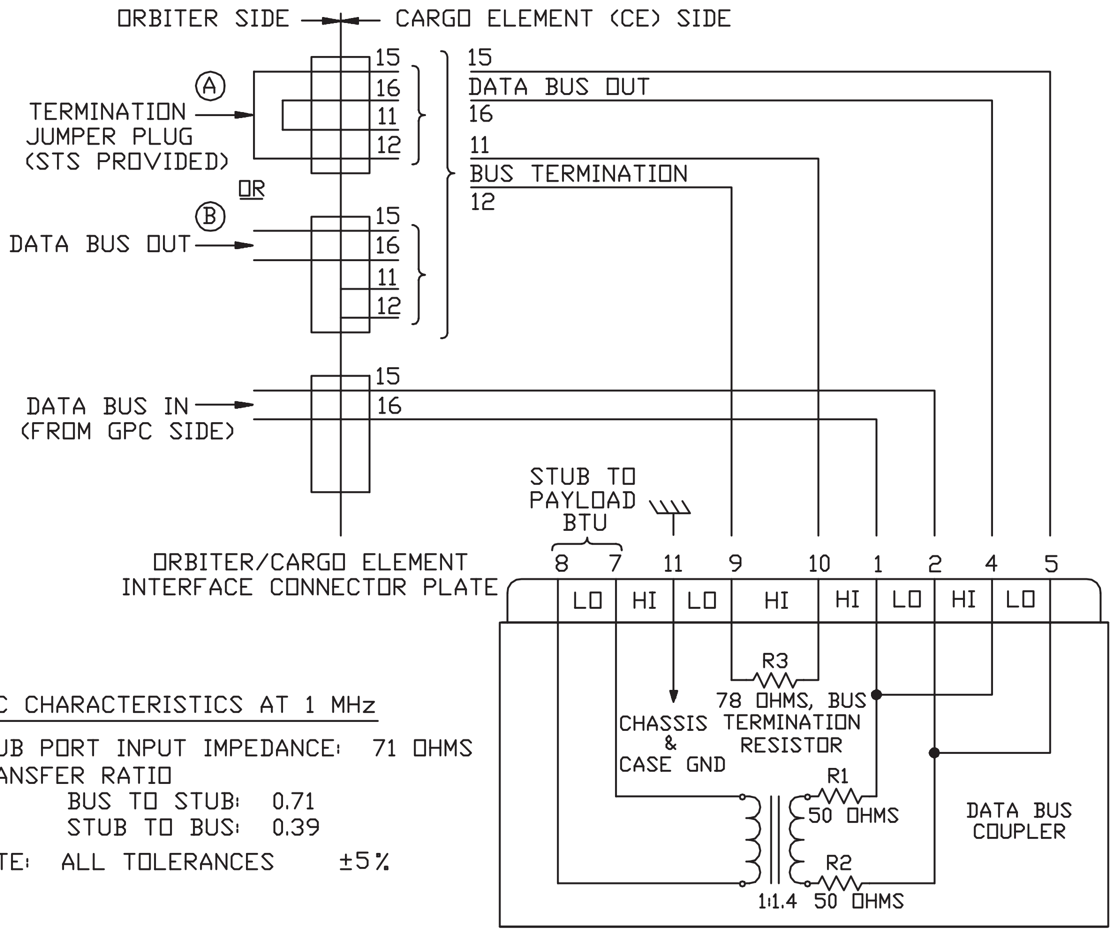
NOTE: On the Orbiter/Payload Data Bus System there are 5 BTU addresses available to support a maximum of four cargo BTUs.

FIGURE 8.2.12-1 CARGO ELEMENT DATA BUS CABLE CONFIGURATION, GENERAL SCHEMATIC



NOTES:

1. FOR DETAILS SEE PARAGRAPH 8.2.12.
2. MAXIMUM TERMINATION CABLE LENGTH FROM TERMINATION COUPLER TO PAYLOAD INTERFACE AND BACK TO THE COUPLER'S TERMINATION RESISTOR SHALL NOT EXCEED 40 FT. IN TOTAL LENGTH.



DBC CHARACTERISTICS AT 1 MHz

STUB PORT INPUT IMPEDANCE: 71 OHMS
TRANSFER RATIO
BUS TO STUB: 0.71
STUB TO BUS: 0.39
NOTE: ALL TOLERANCES ±5%

NOTES:

1. INTERFACE SHOWN IS TYPICAL
2. MOUNT DBC TO METAL STRUCTURE WHEN POSSIBLE

FIGURE 8.2.12-2 DATA BUS INTERFACE AND COUPLER SCHEMATIC

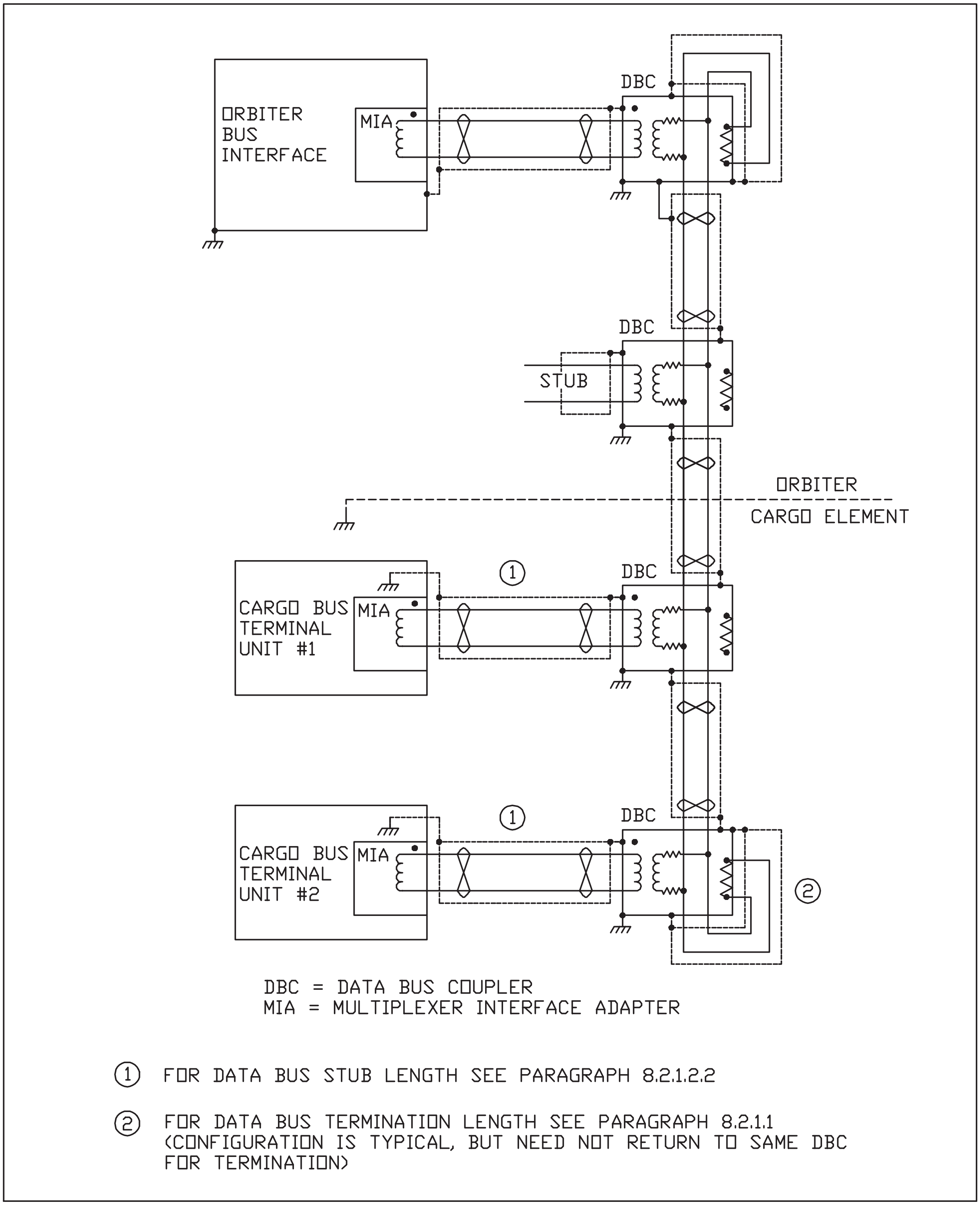


FIGURE 8.2.12-3 ORBITER/CARGO BTU INTERFACE

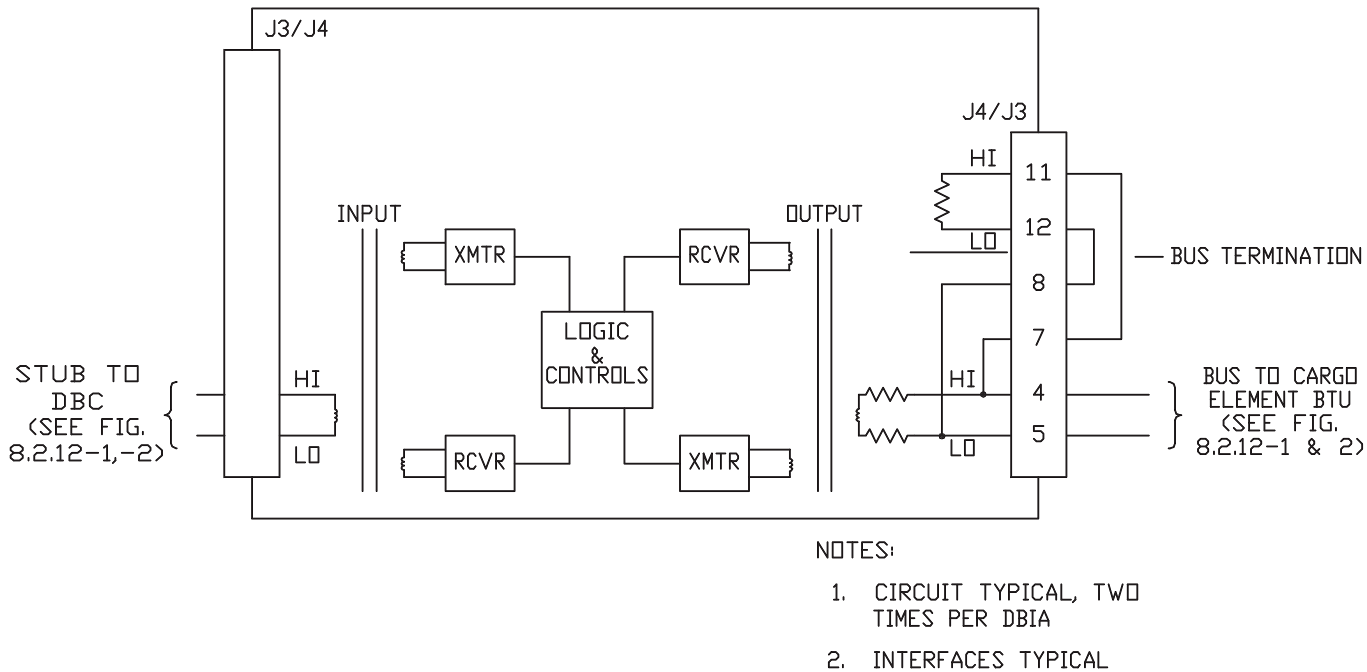


FIGURE 8.2.12-4 DBIA INTERFACE

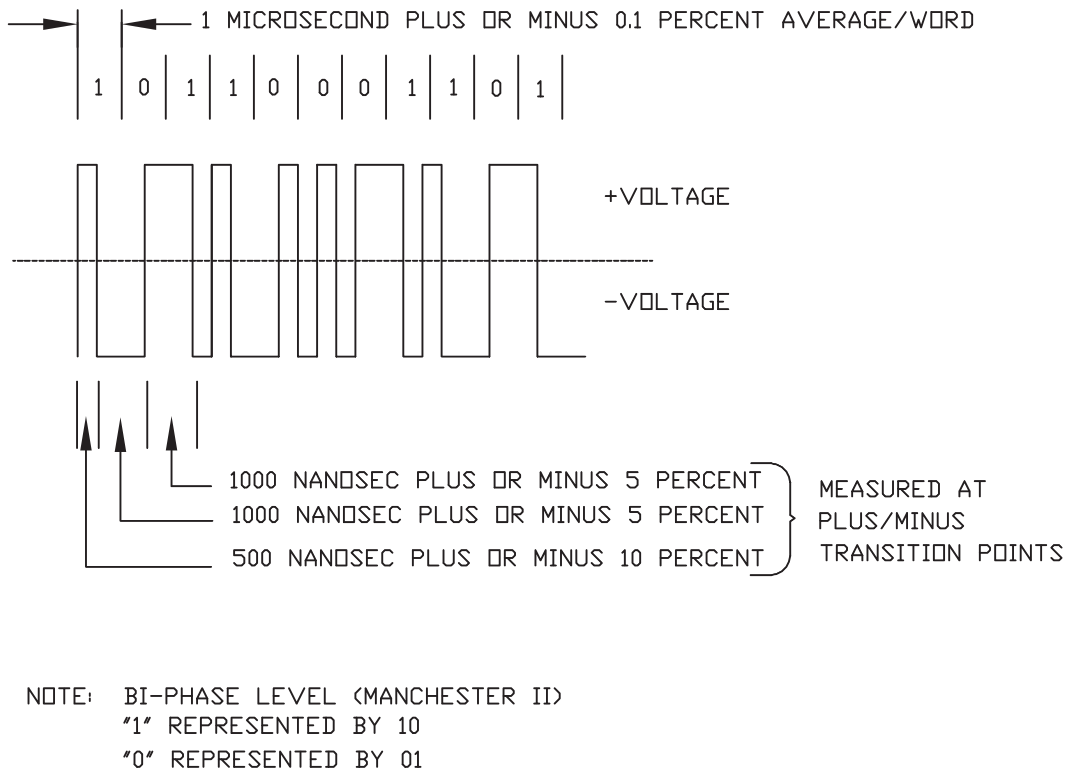


FIGURE 8.2.12.1-1 DATA CODE

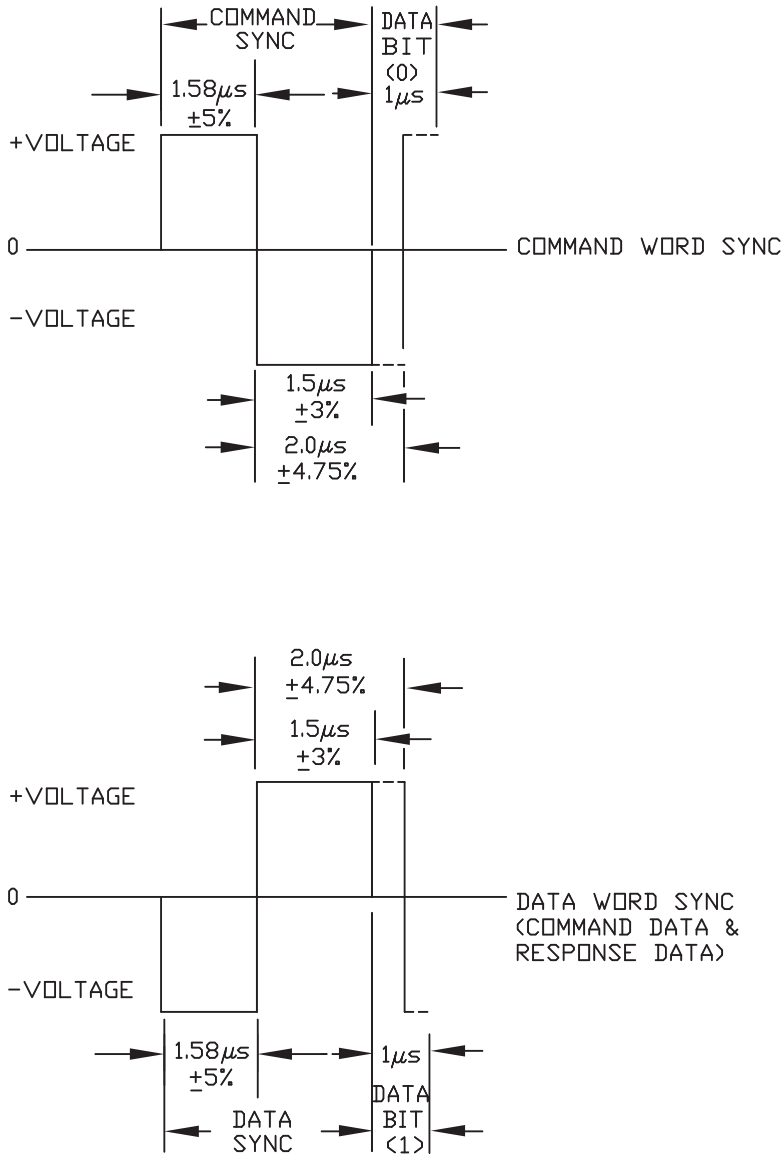


FIGURE 8.2.12.1-2 WORD SYNCS, NONVALID MANCHESTER CODE

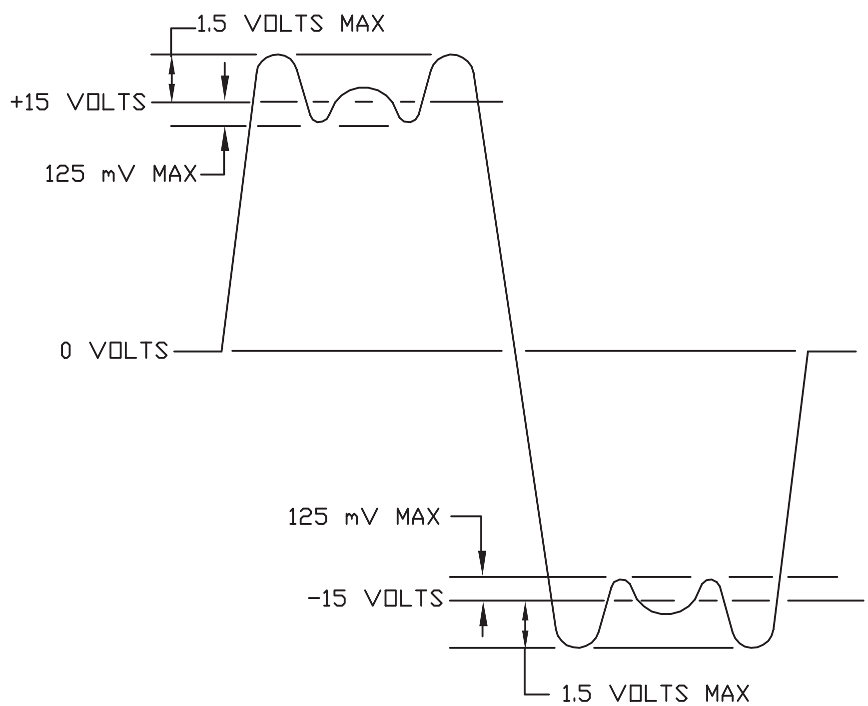


FIGURE 8.2.12.3-1 TRANSMITTER OUTPUT WAVEFORM DISTORTION

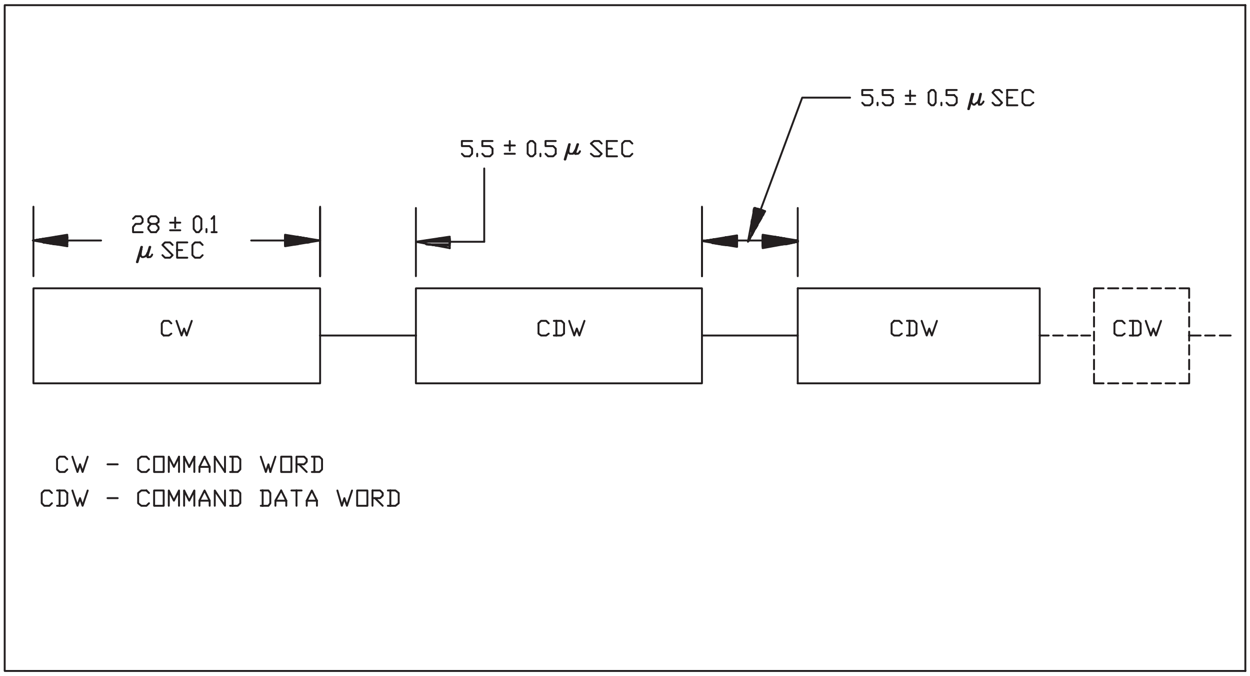


FIGURE 8.2.12.6-1 DATA TRANSFER FROM GPC TO INTERFACE UNITS

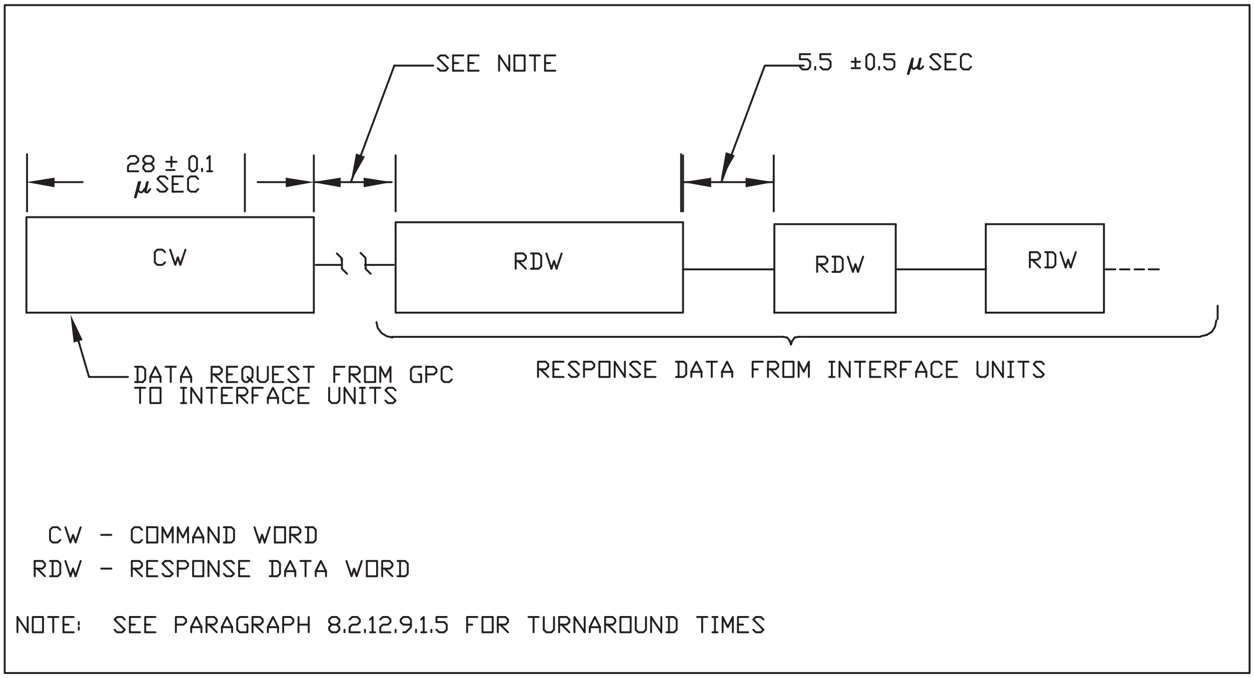


FIGURE 8.2.12.6-2 DATA TRANSFER FROM INTERFACE UNITS TO GPC

THIS PAGE INTENTIONALLY LEFT BLANK.

8.3 DETACHED PAYLOADS

In the following paragraphs, "characteristics" refers to those Orbiter avionics characteristics of which the payload must be cognizant, and "requirements" refers to specifications placed upon payload communication equipment.

8.3.1 Payload Interrogator (PI) Interface Characteristics

The Payload Interrogator shall provide full duplex RF communication between the Orbiter and detached payloads. This capability shall include transmission of commands to, and the reception of telemetry data from, such payloads. Both NASA (STDN and DSN) and DOD (SGLS) transmit/receive frequency pairs shall be available. See Appendix C for specific selectable channels.

8.3.1.1 Transmitter Characteristics

The principal transmitter characteristics shall be as listed in Table 8.3.1.1-1.

8.3.1.2 Receiver Characteristics

The principal receiver characteristics shall be as listed in Table 8.3.1.2-1.

8.3.1.3 Antenna Characteristics

The PI/Payload link shall utilize a single beam antenna for both transmission and reception. The antenna shall have a beam width bounded by an 80° cone aligned with the +Z axis. Polarization, either RHCP or LHCP, shall be switch selectable in the Orbiter.

8.3.2 PI Data Interfaces

Data interfaces provided for detached payload use are classed as standard or non-standard. Standard interfaces are prewired interfaces provided by the baseline Orbiter employing pre-established data handling methods. Non-standard interfaces are those requiring payload-provided unique wiring and processing equipment to be installed at the AFD. Input/output data interfaces shall be available at the PSDP for access to and from the PI. Figure 8.3.2-1 presents a block diagram of the signal routing for both standard and non-standard operation.

8.3.2.1 Standard Payloads

8.3.2.1.1 Commands

Command data shall be accepted by the Payload Signal Processor from the GPC. This data shall be modulated onto a 16 kHz subcarrier and handed off to the PI for RF transmission to detached payloads. Refer to Para. 8.2.5 and Table 8.2.5.1-1 for command structure and subcarrier performance characteristics.

8.3.2.1.2 Telemetry

Telemetry data in standard operation shall be modulated onto a 1.024 MHz subcarrier by the payload. The PI receiver shall strip the RF carrier and hand off the subcarrier signal to the PSP. A single form of telemetry signal shall be allowed with summary requirements as listed in Table 8.3.2.1.2-1.

8.3.2.2 Non-Standard Payloads

8.3.2.2.1 Commands

A payload selectable input port to the PI transmitter shall exist at the payload station distribution panel (PSDP) (Ref. Para. 8.3.2.2.3). This port shall allow non-standard command signals to directly modulate the PI transmitter. Such signals shall comply with the requirements shown in Table 8.3.2.2.1-1.

8.3.2.2.2 Telemetry

An output port from the PI receiver shall exist at the PSDP. The interface characteristics for demodulated RF signals from the PI shall be as defined in Table 8.3.2.2.2-1.

8.3.2.2.2.1 Telemetry Modulation Criteria

Phase modulation (PM) of the payload transmitter carrier shall be the only allowable type. (Quadriphase modulation shall not be allowed). When employed, subcarriers shall be either phase or frequency modulated. Further restrictions on the use of subcarriers will follow. Direct carrier modulation by analog signals shall not be allowed. However, direct modulation by digital signals shall be allowed subject to restrictions to follow. Carrier modulation by periodic signals having fundamental frequencies less than 250 kHz shall not be permitted. No incidental and/or spurious discrete frequency component sideband levels shall be greater than 29 dB below the unmodulated carrier within a frequency range of 250 kHz about the carrier.

8.3.2.2.2.1.1 Frequency Modulated Subcarriers

a. Analog Modulations. The subcarrier frequency shall be greater than 250 kHz and the analog modulation shall satisfy the inequality:

$$fm\Delta f > 4.6 \times 10^{5}$$

where fm is the bandwidth or maximum frequency of the baseband analog signal in Hz and Δf is the peak frequency deviation of the subcarrier in Hz. Provided the above inequality is satisfied, the maximum allowable carrier phase modulation index, β, by the frequency modulated sinusoidal subcarrier shall be the lessor of 1.85 radians (106°) or the β which satisfies the relationship:

$$J_1(\beta)/J_0(\beta) = 2.0 \times 10^{-7} fm\Delta f$$

b. Digital Modulations. The subcarrier frequency shall be greater than 250 kHz and the data bit rate (R_b) of the frequency shift keyed (FSK) modulation shall be greater than 2 kbps. Provided R_b is greater than 2 kbps, the maximum allowable carrier phase modulation index, β, by the FSK modulated sinusoidal subcarrier shall be the lessor of 1.85 radians (106°) or the β which satisfies the relationship:

$$J_1(\beta)/J_0(\beta) \geq 1.25 \times 10^{-9} (R_b)^2$$

8.3.2.2.2.1.2 Phase Modulated Subcarriers

a. Analog Modulations. Phase modulation of subcarriers by analog baseband signals shall not be allowed.

b. Digital Modulations. The subcarrier frequency shall be greater than 250 kHz and R_b of the phase shift keyed (PSK) modulation shall be greater than 2 kbps. Provided R_b is greater than 2 kbps the maximum allowable carrier phase modulation index, β, by the PSK modulated sinusoidal subcarrier, shall be the lessor of 1.85 radians (106°) or the β which satisfies the relationship:

$$J_1(\beta)/J_0(\beta) \le 1.25 \times 10^{-9}(R_b)^2$$

8.3.2.2.2.1.3 Direct Carrier Modulation

a. Analog Modulations. Direct phase modulation of the carrier by an analog baseband signal shall not be allowed.

b. Digital Modulations. The allowable NRZ bit rate must satisfy the following inequality:

$$R_b > 9.2 \times 10^4 (\tan^2\beta)^{1/2}$$

The maximum number of such bits without transition shall be less than $1.0 \times 10^{-4} R_b$. The minimum Biϕ-L bit rate allowed shall be the larger bit rate calculated from:

$$R_b = 1.23 \times 10^3 \tan^2\beta, \text{ or}$$

$$R_b = 2.83 \times 10^4 \sqrt{\tan \beta}$$

The modulation index β for all digital modulations shall not exceed 71.5° or 1.25 radians.

8.3.2.2.3 PI/PS Control Discrete

A control discrete shall be provided via the PSDP to the PI to enable the Payload Station (PS) input and output ports and disable the PSP input and output ports to/from the PI. The characteristics of the control discrete shall be as follows:

True State (PS ports to/from PI enabled)	18 to 32 Vdc
False State (PSP ports to/from PI enabled)	0 to 3 Vdc
Termination	Single ended return to pwr grnd
True State Current	10 milliamps maximum
Power Off Impedance	10 k ohms minimum
Load Impedance	3.2 k ohms minimum

Cargo element signal processors installed in the PS shall utilize an indication of which PI has been selected for use to direct command data and the PS control discrete to the correct interrogator. One of two circuits from the forward load control assemblies (LCA No.2 and No. 3) shall contain a 28 Vdc signal indicating which of the two interrogators has been powered on. Interfaces with these circuits at the PSDP shall be used to provide limited control power, as required, for the PI. The characteristics of the two circuits shall be as follows:

Logic '1' State (PI on)	24 to 32 Vdc
Logic '0' State (PI off	0 plus 2.5, minus 0 Vdc
Maximum Current	125 milliamps
Termination	Single ended return to power ground

Circuit protection shall be provided in the cargo element user unit such that overloads shall not fault the fusing in the LCA's.

If a power return line is required in the Cargo element user unit, power return for Bus A, B or C shall be used.

8.3.2.3 Payload Interrogator Receiver Status Data

The Orbiter acquires and displays the Payload Interrogator's (PI) configuration status. The Orbiter GPC processes and displays the following PI receiver parameters:

a. Phase Lock - Determine if Phase Lock has occurred and indicated YES or NO.

b. Phase Error - +85 kHz to -85 kHz.

c. Payload Signal Strength - Indicates the relative signal strength of the received cargo element telemetry data stream - displays 0 to 5 Volts (-102 dBm to -20 dBm). Voltage presentation is relative (but not proportional) to the measured signal strength received.

In addition to the above a dedicated AGC (received signal strength) meter is provided at the Flight Station.

8.3.3 Bent Pipe Modes for Detached Payloads

The Orbiter Payload Interrogator shall provide a 'bent-pipe' mode for detached payloads to permit the remodulation of received S-Band signals onto the Ku-band return link carrier. The Ku-band signal processor shall accept the demodulated signal from the payload interrogator and, as a function of its frequency content, route the signal, in response to external commands, to either the narrowband channel (Channel 2, mode 1 or mode 2) or the wideband channel (Channel 3, mode 2). Received data modulated on a single subcarrier and having its highest frequency component less than 2 MHz, shall be routed to the narrowband channel. Data modulated on more than one subcarrier and/or having frequency components between 2 MHz and 4.5 MHz, shall be routed to the wideband channel.

NOTE: The bent-pipe mode shall be selected only after the detached payload communications have been established with the PI. The bent-pipe operations shall be terminated when the detached payload signal strength decreases to a marginal level (below - 111.3 dBm). This operational precaution will prevent the degradation and/or loss of the Ku-band return link when PI noise becomes the predominant "Signal" in the absence of a detached payload signal.

8.3.4 Ku-Band Rendezvous Radar Interfaces

8.3.4.1 Interface Characteristics

The rendezvous radar shall have the interface characteristics defined in Table 8.3.4.1-1.

8.3.4.2 (Deleted)

8.3.4.3 (Deleted)

TABLE 8.3.1.1-1 PRINCIPAL PI TRANSMITTER CHARACTERISTICS*

PARAMETER	VALUE	UNITS	NOTES
DOD/S-Band Frequency Range (SGLS) NASA/S-Band Frequency Range: STDN DSN	1763.721 to 1839.795 2025.833400 to 2117.916600 2110.243056 to 2119.792438	MHz MHz MHz	See Appendix C for individual channel freq selections
Carrier Frequency Stability	±0.0012	Percent	
Carrier Phase Noise	≤ 10	Degrees rms	(1)
Carrier Spurs	≤ - 55**	dBc	
Carrier Sweep Range NASA (Wide) DOD (Wide) NASA/DOD (Narrow)	 ±75±5 ±55±5 ±33±3	 kHz kHz kHz	
Carrier Sweep Rates 75 kHz Range (Nominal) 55 kHz Range (Nominal) 33 kHz Range (Nominal)	 10±3 10±3 250±75	 kHz/sec kHz/sec Hz/sec	
EIRP-- High Medium Low	+31.4 +21.4 -2.6	dBm dBm dBm	Three selectable levels at antenna interface.(2)

* at Orbiter interface.
** 0.2 MHz to 16 GHz from carrier

(1) Steady state error for a 100 Hz (Nominal) tracking loop bandwidth.

(2) Specified for 80 deg. cone

TABLE 8.3.1.2-1 PRINCIPAL PI RECEIVER CHARACTERISTICS*

PARAMETER	VALUE	UNITS	NOTES
DOD/S-Band Frequency Range (SGLS) NASA/S-Band Frequency Range: STDN DSN	2202.500 to 2297.500 2200.000 to 2300.000 2290.185185 to 2299.814815	MHz MHz MHz	See Appendix C for individual channel freq selections
Noise Figure (Max)	6.0 max.	dB	***
Carrier Acquisition Sweep Range (Min)	± 80	kHz	
Carrier Phase Lock Time	≤ 3	Sec	0.9 probability
Carrier Sweep Range Minimum Maximum	 ±112 ±132	 kHz kHz	
Modulation Index	1.0±10 percent		
False Lock Immunity Sideband Components Signal Levels	**		
Output Frequency Response	.003 to 4.3	MHz	-3db Point, 1 side
Flux Density at Orb. I/F Acquisition Tracking: Threshold InLock (Min) InLock (Max) Max. Level w/o Damage	 $3.63x10^{-12}$ $1.44x10^{-12}$ $9.12x10^{-12}$ 1.34 (1) $2.69x10^{2}$	 W/m^2 W/m^2 W/m^2 W/m^2 W/m^2	80° antenna cone at 2200 MHz
G/T (Gain/Temp)	-36.2	dB/degree K	
Input Phase Noise (Max.)	8	degrees rms	100Hz to 5.5MHz
Freq. Shift Rate Freq. Shift	<17 <87	kHz/Sec kHz	
Carrier Suppression	<10	dB	
Modulation Types Carrier Subcarriers	 PM PM(PSK) or FM(FSK)		
Bent Pipe Limiting Ratio	2.9 to 4.4	V-P/V-rms	****

TABLE 8.3.1.2-1PRINCIPAL PI RECEIVER CHARACTERISTICS*

* At Orbiter interface.
** To preclude false lock no periodic modulation components greater than -29 dBc shall be allowed within 250 kHz of the carrier frequency.
*** Referenced to the RF PI input/output port.
**** 2.0 Volts rms ± 0.4 Volts line-to-line, with 7 Volts peak-to-peak, maximum.
(1) Will not lock or track above this level.

TABLE 8.3.2.1.2-1 STANDARD TELEMETRY SIGNAL REQUIREMENTS

PARAMETER	VALUE	UNITS	NOTES
Waveform	Sinusoidal	-	(1)
Modulation	PSK, ±90	Degrees	
Subcarrier Frequency	1.024 ±0.01 percent	MHz	(2)
Subcarrier Harmonic Distortion (Max)	≤1.0	Percent	
Subcarrier Frequency Stability over a 10 second period	<0.001	Percent	(2)
P/L Modulation Index	1.0 ± 0.1	Radians	
Bit Rate	16,8,4,2,1	kbps	
Bit Rate Accuracy	within ± 0.04	Percent	
Input Signal Code	NRZ-L,M or S, or Biϕ-L, M, or S	-	
Data Asymmetry	≤2	Percent	
Bit Rate Stability over a 10 second period	<0.01	Percent	
Data Formatting Reqts.	See Paragraph 8.2.1.1		
Transition Density	≥64 transitions in 512 bits ≤64 consecutive bits w/o transition		

NOTES:

(1) The data bits and subcarrier phase may be asynchronous or, if synchronous, no specific relationship is required.

(2) The combination of subcarrier frequency stability and accuracy shall not exceed ± 0.01 percent.

TABLE 8.3.2.2.1-1 PSDP TO PI DATA INPUT ELECTRICAL INTERFACE REQUIREMENTS

PARAMETER	VALUE	UNITS	NOTES
Carrier Modulation	PM/FSK		
Modulator Type	Linear		
Modulator Input Bandwidth	1 to 200	kHz	3dB, One-Sided
Signal Level		Volts	(1)
Load Impedance	75 ± 5	Ohms	
Load Termination	Differential, balanced direct coupled		

(1) 1.0 to 8.0 ± 10 percent peak-to-peak line-to-line ($0.2 \leq \beta \leq 2.5$). The phase deviation shall be directly proportional to the amplitude of the input signal. The linearity of the phase modulator shall be maintained to within 10 percent from 0.2 radians to 2.5 radians when measured from best straight line. (1.0 ± 0.1 Volts pk-pk, L-L, is equivalent to 0.3 radians; 8.0 ± 0.8 Volts, pk-pk, L-L, is equivalent to 2.4 radians.)

TABLE 8.3.2.2.2-1 PI TO PSDP DATA OUTPUT ELECTRICAL INTERFACE CHARACTERISTICS

PARAMETER	VALUE	UNITS	NOTES
Output Frequency Response	.001 to 4.5	MHz	one sided, 3 dB
Output Signal Level	2.0+0.4 -0.6	VRMS	Not to exceed 8 volts pk-pk, L-L.
Load Impedance	75±5	Ohms	
Load Termination	Differen- tial, balanced direct coupled		

TABLE 8.3.4.1-1 RADAR PASSIVE MODE ELECTRICAL INTERFACE CHARACTERISTICS

Parameter	Dimension	Value	Notes
1. Target Type			
Size	$Meter^2$	1.0 Minimum	(1)
Scintillation Characteristics		Swirling Case I target	Target stabilized in 3 axes to an angular rate of TBD deg/sec.
2. Radar			
Operating Frequency	GHz	Nominal Minimum at 13.779	(2)
3. Antenna Characteristics			
Sidelobe	dB relative to mainbeam	20 minimum	
4. Transmitter Power			
EIRP	dBW	52 peak	At 13.779GHz (3)
PRF	pulses/ sec	nominal 7000 and 3000	PRF varies with range
5. Receiver			
Noise Figure	dB	5	

(1) Radar system is designed to detect a 1 m^2 scintillating target at 12 NM with a probability of detection of 0.99. Angular searchfield varies with range from a 20 degree half angle cone at 12 NM to a maximum of a 30 degree half angle cone at 8 NM or less.

(2) 5 frequency, 4 step frequency diversity - 52 MHz per step during search, acquisition and tracking.

(3) Peak and average power vary with range and duty cycle. Duty cycle varies with range from approximately 0.001 to 0.3. Peak power selectable - medium and low power selections provide nominal reductions of 12 or 24 dB respectively. Automatic switch to TWT bypass (approx. 40 dB reduction in transmitted power) at short ranges.

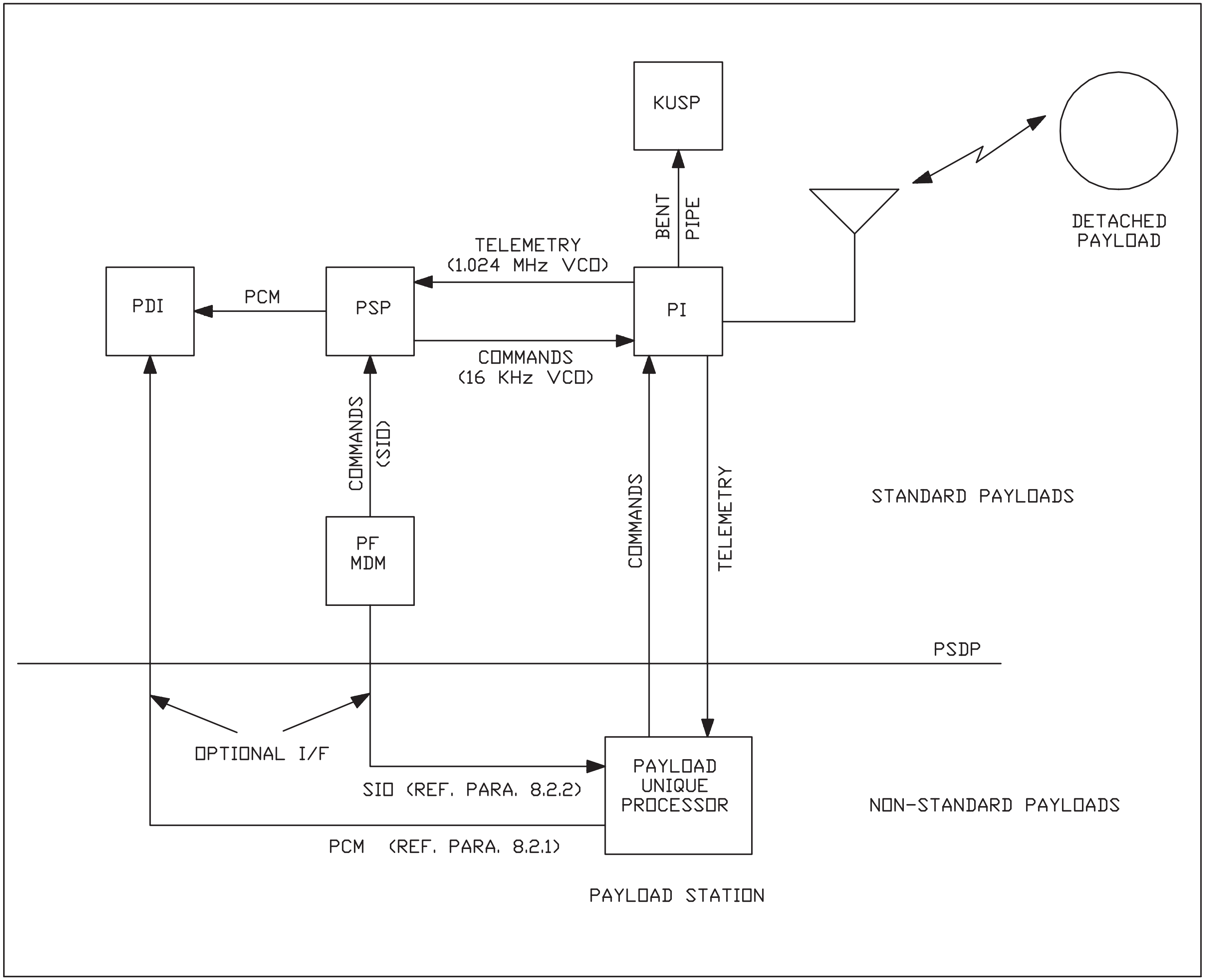


FIGURE 8.3.2-1 DETACHED PAYLOAD COMMUNICATION FLOW

THIS PAGE INTENTIONALLY LEFT BLANK.

9.0 SOFTWARE INTERFACES

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, the Orbiter Payload Signal Processor (PSP) interface, the Orbiter MDM interface, and the Orbiter data bus 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

SMCH (Standard Mixed Cargo Harness) hardware/software correlation is specified in Table 13.5.1.1-1 for the PSP and PDI interfaces and in Tables 13.5.1.1-2 and 13.5.1.1-3 for the Orbiter MDM interface. In order to insure hardware/software compatibility when using Orbiter MDM SMCH capability the signal function (DOL 1, DOL 2 . . ., DIL 1, DIL 2 . . ., etc.) should be included as part of the specific command/measurement nomenclature 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 or detached payloads.

9.2.2 Payload Signal Processor

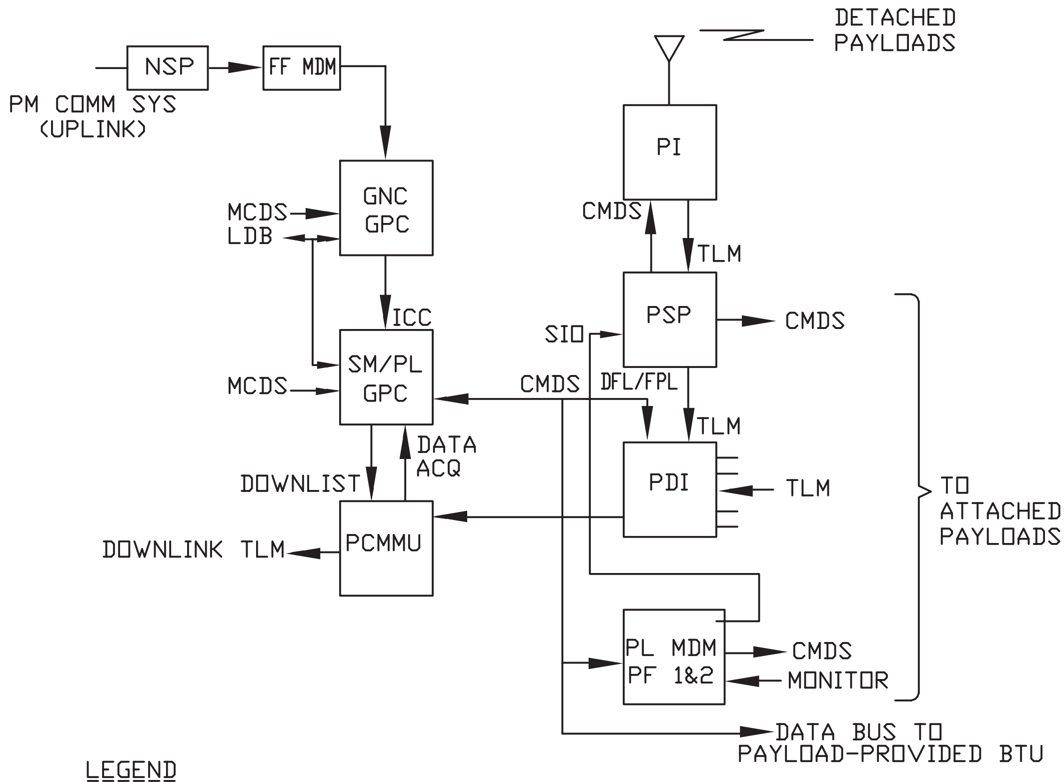
Payload Signal Processor for attached or detached payloads (commands to attached/detached and telemetry for detached).

9.2.3 Payload MDM

Payload MDM for data monitoring and command for attached payloads.

9.2.4 Data Bus

Data bus interface with payload provided BTUs for data monitor and commands for attached payloads.



LEGEND

PF	PAYLOAD FORWARD
PI	PAYLOAD INTERROGATOR
PSP	PAYLOAD SIGNAL PROCESSOR
PDI	PAYLOAD DATA INTERLEAVER
DFL	DATA FORMAT LOAD
BTU	BUS TERMINAL UNIT
NSP	NETWORK SIGNAL PROCESSOR
PL	PAYLOAD
FF	FLIGHT CRITICAL FORWARD
ICC	INTERCOMPUTER CONTROL
DATA ACQ	DATA ACQUISITION
FPL	FETCH POINTER LOAD
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
SIO	SERIAL INPUT/OUTPUT

FIGURE 9.1.1-1 ORBITER - PAYLOAD SOFTWARE FUNCTIONAL INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

9.3 FLIGHT PHASE APPLICABILITY

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

Time line. 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.

There are two other memory configurations, BFS and VU/G9, containing very limited payload services that are only available when specifically agreed to in the PIP. BFS is used during ascent/descent. It is installed from approximately L-20 minutes until on-orbit when SM is loaded and from approximately three hours prior to descent through landing. VU/G9 is used during other Orbiter prelaunch operations. Paragraph 9.3.1 describes the prelaunch (post and pre-payload bay door closure) payload software support restrictions.

9.3.1 Prelaunch (VU/G9)

The Orbiter software (vehicle utility) in conjunction with ground software provides the services in this section periodically during the prelaunch phase of the flight for critical payload command and monitoring functions. The availability of these services during prelaunch depends on the Orbiter schedule. Table 9.3.1-1 describes the prelaunch (post and pre-payload bay door closure) payload software support restrictions.

9.3.1.1 Payload Control and Monitoring

The Orbiter software provides the ground complex the capability to communicate with the payload subsystems utilizing the launch data bus interface. This capability allows the ground to send individual requests to the Orbiter GPC for execution. The capability also exists to specify that a resulting response be transmitted to the ground via the launch data bus.

9.3.1.1.1 Data Acquisition

The Orbiter GPC provides the capability to acquire data from the PCMMU/PDI interface, Orbiter payload MDM interface, and payload BTUs attached to the payload buses. The legal BTU modes for the payload MDMs and payload BTUs attached to the payload buses are defined in Paragraph 8.2.12.6.2. The data bus configuration for payload BTUs attached to the payload data buses shall be as defined in Section 9.4.4.1. The capabilities supported via the payload PDI interface are defined in Section 9.4.1.

9.3.1.1.2 Data Output

The Orbiter GPC provides the capability to output data to the Orbiter payload MDM interface, and to payload BTUs attached to the payload buses. Up to 64 sixteen-bit data words can be output to the PSP, but only through the Launch Data Bus Interface. Depending on the I0 module, up to 32 sixteen-bit words can be output to Orbiter payload MDMs and payload BTUs (refer to Paragraph 8.2.12.6.1.1).

9.3.1.2 Payload Data Acquisition for Downlink

The Orbiter GPC provides the capability to acquire data at 1 Hz from the Orbiter payload MDMs and payload BTUs attached to the payload buses. This data is made available to the ground via the Orbiter downlink. The only BTU mode supported via this service is transmit command (mode 01001, refer to Paragraph 8.2.12.6.1.1). The data types acquired are defined in Paragraph 9.4.3.1.4, 9.4.3.3, 9.4.3.4, 9.4.4.3.4, 9.4.4.6 and 9.4.4.7. The GPC shall acquire data from a maximum of fourteen data acquisition elements per payload BTU or per Orbiter payload MDM. The following are data acquisition elements:

a. An Analog Input Module. One to 32 ten-bit analogs may be acquired from this element. For hardware implementation see Section 8.2.2.4

b. A Discrete Input Module. One to 3 sixteen-bit packed discrete words may be acquired from this element.

c. A Serial I/O Channel. One to 32 sixteen-bit data words containing any of the data types specified in Paragraphs 9.4.4.3.4 or 9.4.3.1.4 may be acquired from this element.

9.3.2 Ascent/Descent (BFS)

The data available for payload support during critical flight phases (ascent, abort, descent) shall be limited. This support includes acquisition, first order scaling, limit sensing, fault detection and annunciation, display and downlist. PDI/PCMMU data as defined in Paragraph 8.2.1 is available when specified in the PIP.

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 software system functional interfaces between the Orbiter and the payload shall be as shown in Figure 9.3.2-1. The interfaces associated with software are the Orbiter MDM interfaces and the Orbiter data bus interface, and the Orbiter pulse code modulation master unit (PCMMU). The constraints, formats, and data content that are software dependent for each of these interfaces shall be as defined in the following paragraphs.

9.3.2.1 Payload MDM Interface

Data shall be input/output from Orbiter GPC to/from the payload via the payload MDMs. The types of input/output shall be analog and discretes. The only capability to output commands shall be via Orbiter uplink. The Orbiter software provides the capability to acquire a maximum of 50 payload parameters, including those defined in Paragraphs 9.3.2.2 and 9.3.2.3. The hardware characteristics associated with the various payload MDM data input/outputs shall be as defined in Paragraph 8.2.2.

9.3.2.1.1 Uplink Discrete Commands

The Orbiter GPC provides the capability to throughput uplink commands to payloads. These uplink commands shall be limited to Low/High-level Discrete Outputs (DOL/DOH).

9.3.2.1.1.1 Single Stage Discrete Commands

The single stage discrete command consists of a reset command and a set command. These commands do not require preview by the ground. The Orbiter GPC software provides at least 150 microseconds between the reset and set command.

9.3.2.1.1.2 Two-Stage Discrete Commands

The two-stage discrete command consists of a reset command followed by a set command. These commands will normally be transferred to the designated channel within 2 seconds of validation/correction by the sender and receipt of a cooperative command to execute the uplink load. The Orbiter software provides at least 150 microseconds between the reset command and the set command.

9.3.2.1.1.2.1 Multiple Discrete Commands

The multiple discrete command consists of up to ten pairs of reset and set commands (two-stage discrete commands). The number of groups of reset/set commands to discrete commands, within a multiple command group, shall be limited to a maximum of 10.

9.3.2.1.1.3 Payload Multiple Stored Program Commands (SPCs)

Payload Multiple Stored Program Commands (SPCs) have an execution time associated with them. SPCs via the MDM discrete channel consists of up to 10 discrete command groups. Normally the SPC shall be transferred to MDM discrete channels within 2 seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when the load is received, the SPC shall normally be output within 2 seconds of receipt. The GPC storage is limited to a maximum of 25 at any given time in the mission.

9.3.2.1.2 Discrete Inputs

The Orbiter GPC software provides the capability to acquire discrete parameters under GPC control. The payload acquisition rate shall be at 1.04 Hz. These discrete inputs shall be limited to Low/High-level Discrete Inputs (DIL/DIH).

9.3.2.1.3 Analog Inputs

The Orbiter GPC software provides the capability to acquire analog parameters from the MDMs under GPC control. The analog parameter acquisition rate shall be at 1.04 Hz. These analog inputs shall be limited to the Low-level Differential Analog Inputs (AID). The analogs are converted for GPC processing to 10-bit two's complement binary by the MDM. The Orbiter GPC will provide the capability to acquire analog data which is in the format defined below. The bit numbers refer to the serial GPC/MDM data bus format.

Signed Ten-Bit Analog. Each analog parameter shall be a signed parameter (bits 9 through 18 of the command data word) with the MSB (bit 9) representing polarity. Positive values are indicated when bit 9 is equal to binary zero. Negative values are in the form of binary two's complement when bit 9 is equal to binary one. The analog-to-digital conversion convention for analog parameters is defined as follows:

Volts	Binary value (MSB (sign bit) ... LSB)	Decimal value	
+5.11 VDC	=0 1 1 1 1 1 1 1 1 1=	511	Maximum positive value PCM count
+0.01 VDC	=0 0 0 0 0 0 0 0 0 1=	1	Minimum positive value PCM count
0.00 VDC	=0 0 0 0 0 0 0 0 0 0=	0	zero
-0.01 VDC	=1 1 1 1 1 1 1 1 1 1=	-1	Maximum negative value PCM count

-5.12 VDC =1 0 0 0 0 0 0 0 0 0=-512 Minimum negative value PCM count

Bit No.   9 10 11 12 13 14 15 16 17 18

Bits 19 through 24 shall contain fill zeros.

9.3.2.1.3.1 Analog Input Scaling

Analog parameters (10-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. The scaling is accomplished using a linear polynomial equation as follows:

$EU = A_o + A_1 X$

Where: EU = the engineering unit value desired for display

X = the decimal value of the PCM count

A_o, A_1 = the polynomial coefficient

9.3.2.1.4 Downlist

The Orbiter GPC provides the capability to acquire data at 1.04 Hz in the Orbiter high data rate payload MDMs. The data is made available to the ground in the Orbiter high data rate downlink. There are 25 16-bit words assigned for payload downlist, including those defined in paragraph 9.3.2.2.5.

Twenty-five analog parameters, or 50 discrete parameters, or a combination of both, ranging from 49 discretes and 1 analog, to 24 analogs and 1-16 discretes, can be downlisted. Since all payload parameters, with the exception of PDI data, processed are required to be downlisted, their quantity and data type mixture are constrained by these downlist processing requirements.

Downlist processing is not affected by invalid or mission data.

9.3.2.2 Orbiter Data Bus System Interface

The Orbiter GPC shall provide for the acquisition/output of data to a unique payload BTU via the Orbiter data bus system. The data bus interface shall be a demand response system under Orbiter GPC control. The interface constraints, formats, and data convention are defined in the following paragraphs.

9.3.2.2.1 Data Bus Interface Configuration

The Orbiter GPC shall provide unique address codes for payload BTUs interfacing with the data bus system (refer to Paragraph 8.2.12.6.1.1). The assigned address codes shall be used by the GPC when communicating with payloads via data bus PL 1 or PL 2 (refer to Paragraph 8.2.12.7, Cargo Terminal Address Codes).

The Orbiter GPC shall communicate with one of a maximum of five different BTU address codes per flight.

Each address code may be supported via one bus only (single port BTUs) or via both buses (dual port BTU which is either a single BTU with a redundant port or two redundant single port BTUs). The Orbiter shall provide the BTU address and bus assignment at the cargo integration review for each flight. For a dual port payload BTU interfacing with the Orbiter data bus system, one BTU port will interface with PL 1 and the other with PL 2. The two BTU ports shall have identical channelization and shall appear to the GPC as identical systems. This interface design shall not preclude the GPC from addressing other BTUs on both PL 1 and PL 2 at any time. The GPC shall communicate with the dual port BTU via only one bus at a time in accordance with the PL bus mode (primary or secondary) selected by the crew.

A maximum of three BTUs can be accessed on each PL bus in either the primary or secondary mode. BTUs which are supported via both buses will be assigned a primary bus and a secondary bus (by the Orbiter software contractor). Figure 9.4.4.1-1 defines the types of BTUs which may be attached to the payload buses. Payload BTUs shall be designed such that their function is not affected by data bus transmission to other address codes.

9.3.2.2.2 Data Bus Interface Communication Conventions

The message sequence for transfer of data to/from the payload via the data bus interface shall be as defined in Paragraph 8.2.12.6. GPC support for data bus word formats and BTU modes shall be as defined in Paragraph 8.2.12.6.1, Data Bus Formats, and Paragraph 8.2.12.6.2 BTU Modes, to the extent specified below.

9.3.2.2.2.1 Command Word Formats

The GPC supports the direct command word format. The GPC support of control modes is specified in Paragraph 9.3.2.2.3, BTU Control Modes.

9.3.2.2.2.2 Data Word Formats

The GPC shall support the response data word format defined in Paragraph 8.2.12.6.1.3 and the command data word format defined in paragraph 8.2.12.6.1.2.

9.3.2.2.3 Command Word Mode Control (BTU Mode)

The control modes supported by the GPC are defined below.

9.3.2.2.3.1 Receive Command

The receive command control mode (01000) shall be used to transmit commands to the payload via the Orbiter data bus system. The sequence of transmission from the GPC is defined in Paragraph 8.2.12.6.2.1, Receive Command. Commands must be uplinked and throughput by the GPC (no crew initiated commands onboard).

9.3.2.2.3.2 Transmit Command

The transmit command control mode (01001) shall be used to acquire data from the payload via the data bus system. The sequence to acquire data to the GPC is defined in Paragraph 8.2.12.6.2.2.

9.3.2.2.4 Flex MDM (or MDM BTU)

The Orbiter GPC provides the capability to transmit or receive data via the data bus system to and from a payload-supplied MDM. The types of input/output shall be analog and discretes. The only capability to output commands shall be via Orbiter Uplink. The Orbiter software provides the capability to acquire a maximum of 50 payload parameters including those defined in paragraph 9.3.2.1 and 9.3.2.3.

9.3.2.2.4.1 Uplink Discrete Commands

The Orbiter GPC provides the capability to throughput uplink commands to payloads. These uplink commands shall be limited to discrete commands as defined in Paragraph 8.2.2.1 and 8.2.2.2.

9.3.2.2.4.1.1 Single Stage Discrete Commands

The single stage discrete command consists of a reset command and a set command. These commands do not require preview by the ground. The Orbiter GPC software provides at least 150 microseconds between the reset and set command.

9.3.2.2.4.1.2 Multiple Discrete Commands

The multiple discrete command consists of a reset command followed by a set command. These commands will normally be transferred to the designated channel within 2 seconds of validation/correction by the sender and receipt of a cooperative command to execute the uplink load. The Orbiter software provides at least 150 microseconds between the reset command and the set command. The number of groups of reset/set commands to MDM discrete channels within a multiple command group shall be limited to a maximum of 10.

9.3.2.2.4.1.3 Payload Multiple Stored Program Commands (SPCs)

Payload Multiple Stored Program Commands (SPCs) has an execution time associated with it. SPCs via the BTU discrete channel consists of up to 10 discrete command groups. Normally the SPC shall be transferred to BTU discrete channels within 2 seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when the load is received, the SPC shall normally be output within 2 seconds after GMT time of execution has occurred. The GPC storage is limited to a maximum of 25 at any given time in the mission.

9.3.2.2.4.2 Discrete Inputs

The Orbiter GPC software provides the capability to acquire discrete parameters from BTUs under GPC control. The payload parameter acquisition rate shall be at 1.04 Hz. The data bus characterisitics of Discrete Input Low/High (DIL/DIH) are defined in Paragraphs 8.2.12.6.1.1 (1) mode 01001, 8.2.12.6.1.3, (response data word format) and 8.2.12.6.2.2 (transmit command).

9.3.2.2.4.3 Analog Input

The Orbiter GPC software provides the capability to acquire analog parameters from BTUs under GPC control. The analog parameter acquisition rate shall be at 1.04 Hz. The data characteristics of analog input are as defined in Paragraphs 8.2.12.6.1.1 (1) and 8.2.12.6.1.3. The analogs shall be 10-bit two's complement binary format defined below. The bit numbers refer to the serial GPC/BTU data bus format.

Signed Ten-Bit Analog. Each analog parameter shall be a signed parameter (bits 9 through 18 of the command data word) with the MSB (bit 9) representing polarity. Positive values are indicated when bit 9 is equal to binary zero. Negative values are in the form of binary two's complement when bit 9 is equal to binary one. The analog-to-digital conversion convention for analog parameters is defined as follows:

Volts	Binary value MSB (sign bit)									Binary value LSB	Decimal value
+5.11 VDC =	0	1	1	1	1	1	1	1	1	1	= 511 Maximum positive value PCM count

+0.01 VDC =	0	0	0	0	0	0	0	0	0	1= 1	Minimum positive value PCM count
0.00 VDC =	0	0	0	0	0	0	0	0	0	0= 0	zero
-0.01 VDC =	1	1	1	1	1	1	1	1	1	1= -1	Maximum negative value PCM count
-5.12 VDC =	1	0	0	0	0	0	0	0	0	0=-512	Minimum negative value PCM count
Bit No.	9	10	11	12	13	14	15	16	17	18	

Bits 19 through 24 shall contain fill zeros.

9.3.2.2.4.3.1 Analog Input Scaling

Analog parameters (10-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. The scaling is accomplished using a linear polynomial equation as follows.

$$EU = A_o + A_1 X$$

Where: EU = the engineering unit value desired for display

X = the decimal value of the PCM count

A_o, A_1 = the polynomial coefficients

9.3.2.2.5 Downlist

The Orbiter GPC provides the capability to acquire data at 1.04 Hz from the Orbiter payload flex MDMs. The data is made available to the ground in the Orbiter high data rate downlink. There are 25 16-bit words assigned for payload downlist, including those defined in paragraph 9.3.2.1.4.

Twenty-five analog parameters, or 50 discrete parameters, or a combination of both, ranging from 49 discretes and 1 analog, to 24 analogs and 1-16 discretes, can be downlisted. Since all payload parameters, with the exception of PDI data, processed are required to be downlisted, their quantity and data type mixture are constrained by these downlist processing requirements.

Downlist processing is not affected by invalid or missing data.

9.3.2.3 Payload-PDI Interface

The orbiter GPC software provides the capability to access PDI data from the PCMMU during ascent and descent. The Orbiter software provides the capability to acquire a maximum of 50 payload parameters, including those defined in Paragraphs 9.3.2.1 and 9.3.2.2.4.

9.3.2.3.1 Data Acquisition

Data is acquired on a parameter basis and transferred to the PCMMU for acquisition by the GPC. The parameter, its word location within a minor frame, the first minor frame in which it appears, and its sample rate will be specified as part of the decommutation program.

The PDI will select the parameter each time it appears in the payload TLM stream and store same for access by the Orbiter GPC via the PCMMU. The constraints and format types supported are defined in paragraph 8.2.1.1.

The Orbiter GPC software provides the capability to process 8-bit analog parameters and 8-bit discrete words via the PDI interface with Bit-0 being the Most Significant Bit (MSB) for analog and being left justified for discrete. Bit-0 is transmitted first from the PDI/PCMMU telemetry data stream in the following bit configuration:

	MSB							LSB
Bit No.	0	1	2	3	4	5	6	7
Bit Weight	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

The allowable process rates for data acquired by the GPC shall be limited to 1.04 Hz. For GPC processing, the PDI is not capable of processing payload sample rates which are less than the smallest integer submultiple (Y/A,Y/B, Y/C, Y/D, Y/E, Y/F) of the payload minor frame rate delineated within Figure 8.2.1.1-5 and Table 8.2.1.1-1. Maintaining the time homogeneity of individual measurements with the length greater than 8-bits or payload measurement word sets cannot be guaranteed.

9.3.2.3.1.1 Data Types

The following are the only data types recognized by the Orbiter GPC software via the PDI interface.

9.3.2.3.1.1.1 Analogs

The following type of analogs will be recognized by the Orbiter GPC. For all analogs the most significant bit (MSB) is bit 0 and is transmitted first.

9.3.2.3.1.1.1.1 Signed 8-Bit

Each analog parameter shall be a signed parameter with the sign in bit 0 and the least significant bit in bit 7. Positive values are indicated when the sign bit is equal to binary 0. Negative values are in the form of binary 2's complement when the sign bit is equal to binary 1. The analog-to-digital conversion convention shall be as follows:

	Binary value								Decimal value	
	MSB (sign bit)							LSB		
	0	1	1	1	1	1	1	1	= 127	Maximum positive value PCM count
	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0	= 0	Zero
	1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
	1	0	0	0	0	0	0	0	=-128	Minimum negative value PCM count
Bit No.	0	1	2	3	4	5	6	7		

9.3.2.3.1.1.1.2 Unsigned 8-Bit

Each analog will be unsigned, 8-bit, positive number with the most significant bit in the bit 0 and the least significant bit in the bit 7. The analog-to-digital conversion convention shall be as follows:

Binary value Decimal value

MSB LSB

	1	1	1	1	1	1	1	1 = 255	Maximum positive value PCM count
	0	0	0	0	0	0	0	1 = 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0 = 0	Zero
Bit No.	0	1	2	3	4	5	6	7	

9.3.2.3.1.1.1.3 Analog Input Scaling

Analog parameters (8-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. The scaling is accomplished using a first order polynomial equation as follows:

$$EU = A_o + A_1 X$$

Where EU = The engineering units value desired for display.
X = The decimal value of the PCM count.
A_o , A_1 = The polynomial coefficients.

9.3.2.3.1.1.2 (Deleted)

9.3.2.3.1.1.3 (Deleted)

9.3.2.3.2 Discretes

Discrete parameters are packed with a maximum of 8 bits per word (bits 0 through 7).

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.

TABLE 9.3.1-1 LAUNCH PROCESSING SYSTEM (LPS) PRELAUNCH SUPPORT FOR PAYLOADS

Function	Mate To PLBD Close	PLBD Close To T-20 Min.	T-20 Min. To T-0
LDB (Control and Monitor)	(1) (2)	(3)	N/A
Uplink Commands	(1)	(6)	N/A
128/64 kBPS Downlink Telemtry Via:			
1. P/L MDM I/F and P/L BTUs Attached To P/L Busses	(1) (4)	(4)	(4)
2. PCMMU/PDI I/F	(1)	(5)	(5)

N/A = Not Applicable

Notes:

(1) Command and/or telemetry support is provided for payloads during the following:

a. Interface Verification Test (IVT)

b. End-to-End

c. Payload specific testing agreed to in the PIP

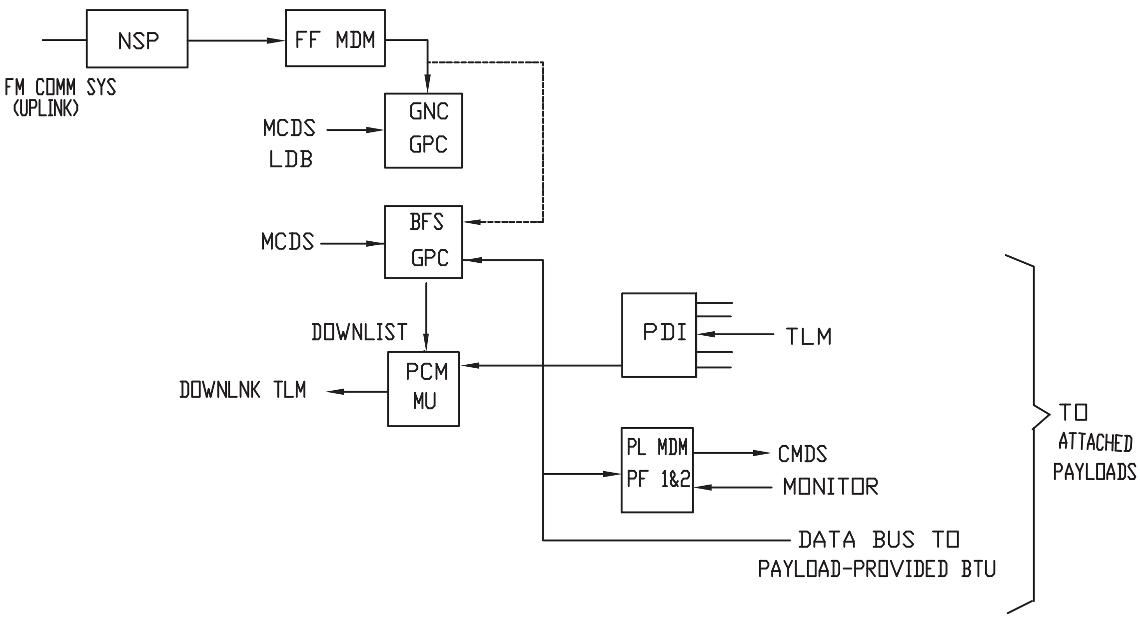
(2) Launch Data Bus commanding/data acquisition support is provided for by the LPS but must be procedurally coordinated with the Orbiter test team.

(3) Launch Data Bus commanding/data acquisition support is severely restricted because of the Orbiter configurations and operations.

(4) Data acquisition via GPC polling of P/L MDM's and BTU's is restricted by GPC memory configuration. This data is included in the downlist which is part of the 128/64 Orbiter downlink.

(5) Data acquisition is restricted by Telemetry Format Load (TFL) configuration. Change in TFL configuration must be procedurally coordinated with Orbiter operations.

(6) Uplink commands sent hardline via the LPS are restricted by GPC memory configuration and Orbiter operations.



LEGEND

PF	PAYLOAD FORWARD	PCMMU	PULSE CODE MODULATION MASTER UNIT
PDI	PAYLOAD DATA INTERLEAVER	MCDS	MUTIFUNCTIONAL CRT DISPLAY SYSTEM
BTU	BUS TERMINAL UNIT	TLM	TELEMETRY
NSP	NETWORK SIGNAL PROCESSOR	CMDS	COMMANDS
PL	PAYLOADS	BFS	BACKUP FLIGHT SYSTEM
FF	FLIGHT CRITICAL FORWARD	LDB	LAUNCH DATA BUS
GPC	GENERAL PURPOSE COMPUTER	PM	PHASE MODULATION
GNC	GUIDANCE,NAVIGATION AND CONTROL	COMM	COMMUNICATIONS
MDM	MULTIPLEXER/DEMULTIPLEXER	SYS	SYSTEM

FIGURE 9.3.2-1 BFS-PAYLOAD SOFTWARE FUNCTION INTERFACE

THIS PAGE INTENTIONALLY LEFT BLANK.

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 Data Group 2

Data Group 2 is selected on a parameter basis and transferred to the PCMMU for acquisition by the GPC. For data Group 2, a parameter, its word location within a minor frame, the first minor frame in which it appears, and its sample rate will be specified as part of the decommutation program.

The PDI will select the parameter each time it appears in the payload TLM stream and store same for access by the Orbiter GPC via the PCMMU.

The Orbiter GPC software provides the capability to recognize and process only eight-bit analog parameters and eight-bit discrete words via the PDI interface with Bit-0 being the Most Significant Bit (MSB) for analog and being left justified for discrete. Bit-0 is transmitted first from the PDI/PCMMU telemetry data stream in the following bit configuration:

	MSB							LSB
Bit No.	0	1	2	3	4	5	6	7
Bit Weight	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

The allowable process rates for data acquired by the GPC shall be limited to 0.52 or 1.04 Hz. For GPC processing, the PDI is not capable of processing payload sample rates which are less than the smallest integer submultiple (Y/A, Y/B, Y/C, Y/D, Y/E, Y/F) of the payload minor frame rate delineated within Figure 8.2.1.1-5 and Table 8.2.1.1-1. Maintaining the time homogeneity of individual measurements with length greater than 8 bits or payload measurement word sets cannot be guaranteed.

9.4.1.1.2.1 Data Types

The following are the only data types recognized by the Orbiter GPC software via the PDI interface.

9.4.1.1.2.1.1 Analogs

The following type of analogs will be recognized by the Orbiter GPC. For all analogs the Most Significant Bit (MSB) is bit 0 and is transmitted first.

9.4.1.1.2.1.1.1 Signed Eight-Bit

Each analog parameter shall be a signed parameter with the sign in bit 0 and the least significant bit in bit 7. Positive values are indicated when the sign bit is equal to binary zero. Negative values are in the form of binary two's complement when the sign bit is equal to binary one. The analog-to-digital conversion convention shall be as follows:

Binary value MSB (sign bit) … LSB									Decimal value
0	1	1	1	1	1	1	1	= 127	Maximum positive value PCM count
0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
0	0	0	0	0	0	0	0	= 0	zero
1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
1	0	0	0	0	0	0	0	= -128	Minimum negative value PCM count
Bit No. 0	1	2	3	4	5	6	7		

9.4.1.1.2.1.1.2 Unsigned Eight-Bit

Each analog will be unsigned, eight-bit, positive number with most significant bit in bit 0 and the least significant bit in bit 7. The analog-to-digital conversion convention shall be as follows:

Binary value MSB … LSB									Decimal value
1	1	1	1	1	1	1	1	= 255	Maximum positive value PCM count
0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
0	0	0	0	0	0	0	0	= 0	zero
Bit No. 0	1	2	3	4	5	6	7		

9.4.1.1.2.1.1.3 Signed Parameter Plus Magnitude Eight-Bit

Each analog parameter shall be a signed parameter plus magnitude with the sign bit in bit 0 and the least significant bit in bit 7. Positive values are indicated when the sign bit is equal to binary zero. Negative values are indicated when the sign bit is equal to binary one. The analog-to-digital conversion convention shall be as follows:

Binary value MSB (sign bit) … LSB									Decimal value
0	1	1	1	1	1	1	1	= 127	Maximum positive value PCM count
0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
0	0	0	0	0	0	0	0	= 0	zero
1	0	0	0	0	0	0	1	= -1	Maximum negative value PCM count
1	1	1	1	1	1	1	1	= -127	Minimum negative value PCM count

Bit No. 0 1 2 3 4 5 6 7

9.4.1.1.2.1.1.4 Analog Input Scaling

Analog parameters (8-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. The scaling is accomplished using a third order polynomial equation as follows:

$$EU = A_0 + A_1X + A_2X^2 + A_3X^3$$

Where EU = The engineering units value desired for display.
X = The decimal value of the PCM count.
A_o, A_1, A_2, A_3 = The polynomial coefficients.

9.4.1.1.2.1.2 Discretes

Discrete parameters are packed with a maximum of eight bits per word (bits 0 through 7).

9.4.1.2 Block Mode

Block mode allows the PDI to throughput payload nonstandard telemetry formats into the Orbiter operational telemetry downlink. Since the PDI cannot decommutate this non- standard data, data cannot be acquired or processed by the GPC. For details on the block mode, see Paragraph 8.2.1.2.

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 or detached 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 Orbiter State Vector/Attitude

The Orbiter state vector/attitude message shall be transmitted to the payload on demand, utilizing Orbiter keyboard entry. The Orbiter state vector/attitude data sets for payloads are defined in Paragraph 9.4.5.1.

9.4.2.2.2 On-Board Command Data Loads

The Orbiter software provides the capability to execute prestored command/data loads to the PSP utilizing CRT/keyboard entry. The PSP command load is executed by accessing a prestored command load and a payload dependent configuration message and transmitting of both to the PSP. The Orbiter GPC provides the capability to prestore command/data loads. The prestored command/data load for any single load may consist of up to 64 sixteen-bit payload command words.

The total storage required for the sixteen-bit payload command words (including those defined in Paragraph 9.4.3.1.6.2 and 9.4.4.3.6.2) shall not exceed 2000 sixteen-bit words for all payloads manifested per flight.

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 Time Executed Commands (TEC)

TECs via the PSP consist of a configuration ID, and up to the 63 sixteen-bit payload command data words per transmission. Normally, the TEC shall be transferred to the PSP within two seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when the load is received, the TEC shall normally be output within 2 seconds of receipt. The GPC storage of TEC (including those defined in Paragraphs 9.4.3.1.6.3.3 and 9.4.4.3.6.3.3) is limited to a maximum of 25 TECs at any given time during the mission. If more than one command has the same GMT time of execution or if more than one command GMT time of execution has already occurred, they may be executed in any order.

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

Payloads requiring preamble or postscript idle patterns other than alternating ones and zeros shall include their unique idle pattern as part of the prestored command data. The command data, including idle pattern, is limited to the equivalent of 64 X 16 bits per command transmission. The total prestored command data load shall not exceed the limits set in paragraph 9.4.2.2.2.

9.4.2.3 PSP/Payload Telemetry Interface

The Orbiter provides the capability to acquire RF telemetry in the format synchronization mode from the payloads in NRZ-L, S, M or Biϕ-L, S, M. The RF telemetry link to the Orbiter shall be via the PI/PSP to the PDI. The PSP shall demodulate the PCM from its carrier and output the PCM data to the PDI in NRZ-L format with clock. The capability supported via this link shall be as defined in Paragraph 9.4.1.1.

9.4.3 Payload MDM Interface

Data shall be input/output from the GPC to/from the payload via the payload MDMs. The types of inputs/outputs shall be analog, discrete, and digital (SIO) data. The hardware characteristics associated with these types of MDMs inputs/outputs are defined in Paragraph 8.2.2. The GPC shall normally acquire data at 1.04 Hz from a maximum of fourteen data acquisition elements per payload MDM. The following are data acquisition elements.

a. An Analog Input Module. One to 16 ten-bit analogs may be acquired from this element. For hardware implementation see Section 8.2.2.4.

b. A Discrete Input Module. One to three 16-bit packed discrete words may be acquired from this element.

c. A Serial I/O Channel. One to 32 16-bit data words containing any of the data types specified in Paragraph 9.4.3.1.4 may be acquired from this element.

9.4.3.1 Serial Input/Output

The Orbiter GPC provides the capability to transmit or receive data via the MDM serial input/output (SIO) channel. Data transmissions between the MDM to/from the payload shall be under GPC control. Up to eight Standard Serial Interfaces (SSI) shall be supported per mission (including those defined in Paragraph 9.4.4.3). Procedurally there shall be no more than four simultaneously active serial interfaces. Two basic standard serial interface configuration exists; single channel and dual channel.

9.4.3.1.1 Single Channel Standard Serial Interface

Single channel Standard Serial Interface (SSI) will be assigned a single MDM module and channel address to be used for both commanding and data aquisition.

9.4.3.1.2 Dual Channel Standard Serial Interface

A dual channel SSI will be assigned a single MDM address and a single module address 15 (01111 binary format) and up to to two channel addresses 0 and 1 (00000, 00001 in binary format). Data shall be acquired from two channels and output to one. Output commands may consist of up to 32 sixteen-bit words. Data shall be acquired from up to 32 sixteen-bit words for each of the SIO channels. The read request (acquisition) of data from the two SIO channels shall be output from the GPC within 5 milliseconds of each other. The time from the last word of the first read request to the start of the second read request shall be at least 300 microseconds.

9.4.3.1.3 Input Data Processing

Each SSI will have the capability to acquire up to 32 sixteen-bit data words from each of its assigned channel(s) at a cyclic rate of 1.04 Hz while the SSI is enabled. The activation of the SSI data acquisition will be initiated by the crew.

9.4.3.1.4 Data Types

The data types recognized by the Orbiter GPC via the MDM SIO channel are defined below (bit numbers refer to the specific bits in the serial data format defined in Paragraph 8.2.2.5). Capability is provided to access any of the 8-bit analog parameter types defined below and an 8-bit discrete word from the same 16-bit word (data bit 0 through 15, reference Figure 8.2.2.5-2). When this occurs, the analog will start in either bit 0 or 8.

9.4.3.1.4.1 Analogs

The following type analogs will be recognized by the Orbiter GPC. For all analogs the Most Significant Bit (MSB) is bit 0 and is transmitted first.

9.4.3.1.4.1.1 Signed Ten-Bit Analog

Each analog parameter shall be a signed parameter with the sign bit in bit 0 and the least significant bit in bit 9. Positive values are indicated when bit 0 is equal to binary zero. Negative values are in the form of binary two’s complement when bit 0 is equal to binary one. The analog-to-digital conversion convention for analog parameters is defined as follows:

Binary value: MSB (sign bit) … LSB	Decimal value
0 1 1 1 1 1 1 1 1 1 = 511	Maximum positive value PCM count

	0	0	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0	0	0	= 0	zero
	1	1	1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
	1	0	0	0	0	0	0	0	0	0	=-512	Minimum negative value PCM count
Bit No.	0	1	2	3	4	5	6	7	8	9		

Bits 10 through 15 shall contain fill zeros.

9.4.3.1.4.1.2 Signed Eight-Bit Analog

One or two eight-bit analog parameters per 16-bit word. Each analog parameter shall be a signed parameter with sign in bits 0 and 8, respectively, and least significant bit in bits 7 and 15, respectively. Positive values are indicated when the sign bit is equal to binary zero. Negative values are in the form of binary two's complement when the sign bit is equal to binary one. The analog-to-digital conversion convention for analog parameters is as follows:

	Binary value MSB (sign bit)							LSB		Decimal value
	0	1	1	1	1	1	1	1	= 127	Maximum positive value PCM count
	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0	= 0	zero
	1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
	1	0	0	0	0	0	0	0	=-128	Minimum negative value PCM count
Bit No.	0	1	2	3	4	5	6	7		(1st-half of 16-bit data word)
Bit No.	8	9	10	11	12	13	14	15		(2nd-half of 16-bit data word)

9.4.3.1.4.1.3 Unsigned Eight-Bit Analog

One or two eight-bit analog parameters per sixteen-bit word. Each analog will be an unsigned eight-bit positive number with the most significant bit in bits 0 and 8, respectively, and least significant bits in bits 7 and 15, respectively. The analog-to-digital conversion convention for these parameters is as follows:

	Binary value MSB (sign bit)							LSB		Decimal value
	1	1	1	1	1	1	1	1	= 255	Maximum positive value PCM count
	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0	= 0	zero

Bit No.	0 1 2 3 4 5 6 7	(1st-half of 16-bit data word)
Bit No.	8 9 10 11 12 13 14 15	(2nd-half of 16-bit data word)

9.4.3.1.4.1.4 Sign Plus Magnitude Eight-Bit Analog

One or two eight-bit analog parameters per sixteen-bit word. Each analog parameter shall be a signed parameter plus magnitude with the sign bit in bits 0 and 8, respectively, and the least significant bit in bits 7 and 15, respectively. Positive values are indicated when the sign bit is equal to binary zero. Negative values are indicated when the sign bit is equal to binary one. The analog-to-digital conversion convention for these parameters is as follows:

	Binary value MSB (sign bit) … LSB		Decimal value
	0 1 1 1 1 1 1 1	= 127	Maximum positive value PCM count
	0 0 0 0 0 0 0 1	= 1	Minimum positive value PCM count
	0 0 0 0 0 0 0 0	= 0	zero
	1 0 0 0 0 0 0 1	= -1	Maximum negative value PCM count
	1 1 1 1 1 1 1 1	=-127	Minimum negative value PCM count
Bit No.	0 1 2 3 4 5 6 7		(1st-half of 16-bit data word)
Bit No.	8 9 10 11 12 13 14 15		(2nd-half of 16-bit data word)

9.4.3.1.4.1.5 Analog Input Scaling

Analog parameters (8 or 10-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. The scaling is accomplished using a third order polynomial equation as follows:

$$EU = A_o + A_1X + A_2X^2 + A_3X^3$$

WHERE EU = The engineering units value desired for display.
X = The decimal value of the PCM count.

A_o, A_1, A_2, A_3 = The polynomial coefficients.

9.4.3.1.4.2 Discretes

Packed with a maximum of 16-bits per word (bits 0 through 15 with bit 0 being transmitted first).

9.4.3.1.5 Command Data Formats

The Orbiter GPC software provides the capability to process command data loads to an attached payload via this link. Each load transferred to the payload via the MDM SIO channel shall be structured as follows.

9.4.3.1.5.1 Payload Command Communication (One or More Commands)

The Orbiter GPC software limits the maximum message length to 32 sixteen-bit words per transmission. Each command/data word format shall be preflight-defined. Payload command communication via an MDM serial channel (either single or dual) will be assigned a single MDM module and channel address per standard serial interface.

9.4.3.1.6 Data Content

The data content of the message transmission may consist of Orbiter computed data, uplink throughput, or data prestored in the GPC for transmission under crew control.

9.4.3.1.6.1 Orbiter State Vector/Attitude

The Orbiter state vector/attitude message shall be transmitted to the payload on demand utilizing Orbiter keyboard entry or cyclically at 0.52 Hz, also initiated/terminated via the keyboard. The Orbiter state vector/attitude data sets for payloads are defined in Paragraph 9.4.5.1.

9.4.3.1.6.2 On-board Command Data Loads

The Orbiter GPC software provides the capability to execute prestored command/data to the MDM SIO channel utilizing CRT/keyboard entry.

The prestored command/data load for any single load may consist of up to 32 sixteen-bit payload command words.

The total storage required for the sixteen-bit payload command words (including those defined in Paragraphs 9.4.2.2.2 and 9.4.4.3) shall not exceed 2000 sixteen-bit words per flight.

9.4.3.1.6.3 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 supports the uplink throughput as defined below.

9.4.3.1.6.3.1 Throughput Command Data Load-Two Stage Processing

The capability is provided to throughput up to 32 sixteen-bit words of data received via uplink to a payload via MDM SIO channel. These words will be downlisted for ground validation/correction before being transferred. These words will normally be transferred to the designated SIO channel within two seconds after receipt of a cooperative command to execute the uplink load.

9.4.3.1.6.3.2 Throughput Command Data Load-Single Stage Processing

The capability is provided to throughput up to 32 sixteen-bit (512 bits) payload command words per transmission. These words will normally be transferred to the designated SIO 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.

9.4.3.1.6.3.3 Time Executed Commands

TECs via the MDM SIO consist of up to 32 sixteen-bit payload command data words per transmission. Normally, the TEC shall be transferred to the SIO channel within two seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when the load is received, the TEC shall normally be output within 2 seconds of receipt. The GPC storage (including those defined in Paragraph 9.4.2.2.3.3) of TEC’s is limited to a maximum of 25 TECs at any given time during the mission. If more than one command has the same GMT time of execution or more than one command GMT time of execution has already occurred, they may be executed in any order.

9.4.3.2 Discrete Output

Discrete command outputs shall be "crew-initiated" or via uplink. Discrete commands are comprised of a command word and a command data word. The two types of discrete command outputs available are Discrete Output Low (DOL) and Discrete Output High (DOH). MDM discrete output logic levels are controlled by the reset and set masks, reference Paragraph 8.2.12.6.1.1 (1). When bit 18 of the command word is a logic one, the command data word (8.2.12.6.1.2) following will be a set mask. Conversely, when bit 18 of the command word is a logic zero, the command data word following will be a reset mask.

The command data word format (8.2.12.6.1.2) contains 16 data bits, bit 9 through 24. For the reset mask, when any of the 16 data bits (bit 9 through 24) are a logic one, the corresponding MDM discrete output bit will be set to a logic zero. For a set mask, when any of the 16 data bits (bit 9 through 24) are set to a logic one, the corresponding MDM discrete output bits are set to a logic one. The command data word's bit 9 through 24 corresponds to the MDM discrete outputs bit 0 through 15 respectively. Discretes either reset or set are accomplished 16 bits at a time. The Orbiter GPC support for discrete output command is defined below.

9.4.3.2.1 MDM Discrete Commands

The Orbiter GPC provides for a request via crew initiation to output reset and set commands to a Discrete Output Low (DOL) or Discrete Output High (DOH) channel on the payload MDM. When the command is initiated by the crew, the reset mask will be sent to the specified channel followed by the set mask.

The current set/reset status of each discrete channel commanded by an MDM discrete command is available on request for display and/or downlist. This is accomplished by means of MDM Bite Test 4 which allows the current status of the discrete output channel to be read by the Orbiter GPC.

The time interval between the reset command and the set command shall be from 300 microseconds to 1.0 second.

The time interval between the set command and the MDM Bite Test 4 shall be from 300 microseconds to 1.0 second.

9.4.3.2.2 Pulsed MDM Discrete Commands

The Orbiter GPC provides for request, via crew initiation, for pulsed output to a discrete channel on the payload MDM. When the command is initiated by the crew, the set mask shall be sent to the specified channel. Between 35 milliseconds and two-seconds later the same mask shall be sent as a reset command.

9.4.3.2.3 Uplink Discrete Command

The Orbiter provides the capability to throughput uplink discrete commands to payloads. These uplink discrete commands shall be limited to Low/High-level Discrete Outputs (DOL/DOH).

9.4.3.2.3.1 Single Stage Discrete Commands

The single stage discrete command consists of a reset command and a set command. These commands will normally be transferred to the designated channel within two seconds of receipt. The Orbiter software provides from 300 microseconds to 200 milliseconds between the reset and the set command.

9.4.3.2.3.2 Two-Stage Discrete Commands

The two-stage discrete commands consist of a reset command followed by a set command. These commands will normally be transferred to the designated channel within two seconds of validation/corrections by the sender and receipt of a cooperative command to execute the uplink load. The Orbiter software provides from 300 microseconds to 200 milliseconds between the reset and set command.

9.4.3.2.3.2.1 Multiple Discrete Commands

The multiple discrete command consists of up to ten pairs of reset and set commands (two-stage discrete commands). The number of groups of reset/set commands to MDM discrete channels within a multiple command group shall be limited to a maximum of 10.

9.4.3.2.3.3 Payload Multiple Stored Program Commands (SPCs)

Payload Multiple Stored Program Commands (SPCs) have an execution time associated with them. SPCs via the MDM discrete channel consists of up to 10 discrete command groups. Normally the SPC shall be transferred to MDM discrete channels within 2 seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when the load is received, the SPC shall normally be output within 2 seconds of receipt. The GPC storage is limited to a maximum of 25 at any given time in the mission.

9.4.3.3 Discrete Inputs

The Orbiter GPC software provides the capability to acquire discrete parameters from MDMs under GPC control. The parameter acquisition rate shall be 1.04 Hz. These discrete inputs shall be limited to Low/High-level Discrete Inputs (DIL/DIH).

9.4.3.4 Analog Input

The Orbiter GPC software provides the capability to acquire analog parameters from MDM's under GPC control. The analog parameter acquisition rate shall be 1.04 Hz. These analog inputs shall be limited to Low-level Differential Analog Inputs (AID). The analogs are converted for GPC processing to 10 bit two's complement binary by the MDM. The Orbiter GPC will provide the capability to acquire analog data which is in the format defined below. The bit numbers refer to the serial GPC/MDM data bus Response Data Word format defined in paragraph 8.2.12.6.1.3 with bit-1 transmitted first.

Signed ten-bit analog. Each analog parameter shall be a signed parameter (bits 9 through 18 of the command data word) with the MSB (bit 9) representing polarity. Positive values are indicated when bit 9 is equal to binary zero. Negative values are in the form of binary two's complement when bit 9 is equal to binary one. The analog-to-digital conversion convention for analog parameters is defined as follows:

Volts	MSB (sign bit)									LSB	Decimal value	
+5.11 VDC =	0	1	1	1	1	1	1	1	1	1	= 511	Maximum positive value PCM count
+0.01 VDC =	0	0	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
0.00 VDC =	0	0	0	0	0	0	0	0	0	0	= 0	zero
-0.01 VDC =	1	1	1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
-5.12 VDC =	1	0	0	0	0	0	0	0	0	0	=-512	Minimum negative value PCM count
Bit No.	9	10	11	12	13	14	15	16	17	18		

(Header "Binary value" spans the bit columns.)

Bits 19 through 24 shall contain fill zeros.

9.4.3.4.1 Analog Input Scaling

Analog parameters (10-bit) acquired by the GPC are scaled from PCM counts to engineering units value for display and limit sensing. The scaling is accomplished using a third order polynomial equation as follows:

$$EU = A_o + A_1X + A_2X^2 + A_3X^3$$

Where EU = The engineering units value desired for display.

X = The decimal value of the PCM count.

A_o, A_1, A_2, A_3 = The polynomial coefficients.

9.4.4 Orbiter Data Bus System Interface

The Orbiter shall provide for the acquisition/output of data to a unique payload BTU via the Orbiter data bus system. The physical characteristics for interfacing a unique payload BTU to the Orbiter data bus shall be as defined in Paragraph 8.2.12. The data bus interface shall be a demand response system under Orbiter GPC control. The interface constraints, formats, and data conventions are defined in the following paragraphs.

9.4.4.1 Data Bus Interface Configuration

The Orbiter shall provide unique address codes for payload BTUs interfacing with the data bus system (refer to Paragraph 8.2.12.6.1.1). The assigned address codes shall be used by the GPC when communicating with payloads via data bus PL 1 or PL 2 (refer to Paragraph 8.2.12.7, Cargo Terminal Address Codes).

The GPC shall communicate with a maximum of five different BTU addresses codes per flight.

Each address code may be supported via one bus only (single port BTUs) or via both buses (dual port BTU which is either a single BTU with redundant ports or two redundant single port BTUs).

The Orbiter shall provide the BTU address and bus assignment at the cargo integration review for each flight. For a dual port payload BTU interfacing with the Orbiter data bus system, one BTU port will interface with PL 1 and the other with PL 2. The two BTU ports shall have identical channelization and shall appear to the GPC as identical systems. This interface design shall not preclude the GPC from addressing other BTUs on both PL 1 and PL 2 at any time. The GPC shall communicate with the dual port BTU via only one bus at a time in accordance with the PL bus mode (primary or secondary) selected by the crew.

A maximum of three BTUs can be accessed on each PL Bus in either the primary or secondary mode. BTUs which are supported via both buses will be assigned a primary bus and a secondary bus (by the Orbiter software contractor). Figure 9.4.4.1-1 defines the types of BTUs which may be attached to the payload buses.

9.4.4.1.1 Payload BTU Design Contraints

Payload BTUs shall be designed such that their function is not affected by data bus transmission to other address codes.

Payload BTUs shall be designed such that module address codes 0, 2, 7 are not used for command data transmission (receive data BTU mode) from the GPC to the payload BTU. These module addresses correspond to output cards on Orbiter payload MDMs. Any receive command from the GPC with an incorrect output module address shall be rejected by the BTU.

When payloads have multiple payload BTUs connected to the same data bus, output cards should not be assigned to the same module address on different BTUs. In addition the same module address in a given BTU should not be used for input and output data transmission. The intent of these constraints is to prevent inadvertent commanding of a payload BTU due to address decoder failures.

9.4.4.1.2 Payload Unique Data Bus Interface Configuration

The data bus interface configuration for each payload shall be preflight-defined. Use of bus address code 15 may preclude payload support at the KSC Cargo Integrated Test Equipment (CITE) for payload checkout.

9.4.4.2 Data Bus Interface Communication Conventions

The message sequence for transfer of data to/from the payload via the data bus interface shall be as defined in Paragraph 8.2.12.6. GPC support for data bus word formats and BTU modes shall be as defined in Paragraph 8.2.12.6.1, Data Bus Word Formats, and Paragraph 8.2.12.6.2, BTU Modes, to the extent specified below.

9.4.4.2.1 Command Word Formats

The GPC supports the direct command word format and the BITE test command word format. The GPC support of special control modes is specified in Paragraph 9.4.4.2.3, BTU Control Modes. There will be 300 microseconds minimum between the end of the one command transmission and the initiation of the next command transmission.

9.4.4.2.2 Data Word Formats

The GPC shall support the response data word format defined in Paragraph 8.2.12.6.1.3 and the command data word format defined in Paragraph 8.2.12.6.1.2.

9.4.4.2.3 Command Word Mode Control (BTU Mode)

The control modes supported by the GPC on-orbit are defined below:

9.4.4.2.3.1 Receive Command

The receive command control mode (01000) shall be used to transmit commands to the payload via the Orbiter data bus system. The sequence of transmission from the GPC is defined in Paragraph 8.2.12.6.2.1, Receive Command. Commands may be either prestored in the GPC, and initiated by the GPC, or uplinked and throughput by the GPC, as defined in Paragraph 9.4.4.3.6.2 and 9.4.4.3.6.3.

Any received commands from the GPC without a legal module address shall be rejected.

9.4.4.2.3.2 Transmit Command

The transmit command control mode (01001) shall be used to acquire data from the payload via the data bus system. The sequence to acquire data from the GPC is defined in Paragraph 8.2.12.6.2.2. The GPC shall normally acquire data at 1.04 Hz from a maximum of fourteen data acquisition elements per payload BTU. The following are data acquisition elements.

a. An Analog Input Module. One to 32 ten-bit analogs may be acquired from this element.

b. A Discrete Input Module. One to three 16-bit packed discrete words may be acquired from this element.

c. A Serial I/O Channel. One to 32 sixteen-bit data words containing any of the data types specified in Paragraph 9.4.4.4 may be acquired from this element.

9.4.4.2.3.3 Bite Test 4

The BITE test and command control mode (00111) is used in conjunction with discrete output command (refer to Paragraph 9.4.4.4.1). The sequence of command transmission and data acquisition is defined in Paragraph 8.2.12.6.2.12 (a), (b), (c)(2) (excluding pulse commands reference Paragraphs 9.4.4.4.2 and 9.4.4.4.3).

9.4.4.3 Serial Input/Output

The Orbiter GPC provides the capability to transmit or receive data via the data bus system. Data transmission between the data bus system to/from the payload shall be under GPC control.

Up to eight Standard Serial Interfaces (SSI) shall be supported per mission (including those defined in Paragraph 9.4.3.1). Procedurally there shall be no more than four simultaneously active serial interfaces. Two basic standard serial interface configurations exists; single channel and dual channel.

9.4.4.3.1 Single Channel Standard Serial Interface

Single channel Standard Serial Interface (SSI) will be assigned a single BTU address and a single BTU module address to be used for both commanding and data acquisition.

9.4.4.3.2 Dual Channel Standard Interface

A dual channel SSI will be assigned a single BTU address and up to three module and channel address combinations. Data shall be acquired from two module/channel addresses and output to one module/channel address. Output commands may consist of up to 32 16-bit words from each of the SIO channels. The read request (acquisition) of the data from the two SIO channels shall be output from the GPC within 5 milliseconds of each other. The time from the last word of the first read request to the start of the second read request shall be at least 300 microseconds.

9.4.4.3.3 Input Data Processing

Each SSI will have the capability to acquire up to 32 sixteen-bit data words from each of its assigned channel(s) at a cycle rate of 1.04 Hz while the SSI is enabled. The activation of the SSI data acquisition will be initiated by the crew.

9.4.4.3.4 Data Types

The data types recognized by the Orbiter GPC via the MDM SIO channel are defined below (bit numbers refer to the specific bits in the serial format defined in Paragraph 8.2.2.5). Capability is provided to access any of the 8-bit analog parameter types defined below and an 8-bit discrete word from the same 16-bit data word (data bits 0 through 15, reference Figure 8.2.2.5-2). When this occurs, the 8-bit analog shall start in either bit 0 or 8.

9.4.4.3.4.1 Analog Input Data

The GPC shall provide the capability to acquire analog data at 1.04 Hz. The analog data shall conform to the following format for the GPC analog conversion algorithm. For all analogs the most significant bit (MSB) is bit zero and is transmitted first.

9.4.4.3.4.1.1 Signed Ten-Bit Analog

Signed ten-bit analog words include bits 9 through 18 of the response data word, with the MSB (bit 9) representing polarity. Positive values are indicated when bit 9 is equal to binary zero. Negative values are in the form of binary two’s complement when bit 9 is equal to binary one. The analog-to-digital conversion convention for analog parameters is defined as follows:

Binary value MSB (sign bit)									Binary value LSB		Decimal value	
0	1	1	1	1	1	1	1	1	1	=	511	Maximum positive value PCM count
0	0	0	0	0	0	0	0	0	1	=	1	Minimum positive value PCM count
0	0	0	0	0	0	0	0	0	0	=	0	zero
1	1	1	1	1	1	1	1	1	1	=	-1	Maximum negative value PCM count
1	0	0	0	0	0	0	0	0	0	=	-512	Minimum negative value PCM count

Bit No. 9 10 11 12 13 14 15 16 17 18

Bits 19 through 24 shall contain fill zeros.

9.4.4.3.4.1.2 Signed Eight-Bit Analog

One or two eight-bit analog parameters per sixteen-bit word. Each analog parameter shall be a signed parameter with sign in bits 9 and 17, respectively, and least significant bits in bits 16 and 24, respectively. Positive values are indicated when the sign bit is equal to binary zero. Negative values are in the form of binary two's complement when the sign bit is equal to binary one. The analog-to-digital conversion convention for analog parameters is as follows:

Binary value MSB (sign bit)							LSB		Decimal value
0	1	1	1	1	1	1	1	= 127	Maximum positive value PCM count
0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
0	0	0	0	0	0	0	0	= 0	zero
1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
1	0	0	0	0	0	0	0	=-128	Minimum negative value PCM count
Bit No. 9	10	11	12	13	14	15	16		(1st-half of 16-bit data word)
Bit No. 17	18	19	20	21	22	23	24		(2nd-half of 16-bit data word)

9.4.4.3.4.1.3 Unsigned Eight-Bit Analog

One or two eight-bit analog parameters per 16-bit word. Each analog shall be an unsigned eight-bit positive number with the most significant bit in bits 9 and 17, respectively, and the least significant bit in bits 16 and 24, respectively. The analog-to-digital conversion convention for these parameters is as follows:

Binary value MSB							LSB		Decimal value
1	1	1	1	1	1	1	1	= 255	Maximum positive value PCM count
0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
0	0	0	0	0	0	0	0	= 0	zero
Bit No. 9	10	11	12	13	14	15	16		(1st-half of 16-bit data word)
Bit No. 17	18	19	20	21	22	23	24		(2nd-half of 16-bit data word)

9.4.4.3.4.1.4 Sign Plus Magnitude Eight-Bit Analog

One or two eight-bit analog parameters per sixteen-bit word. Each analog parameter shall be a signed parameter plus magnitude with the sign bit in bits

9 and 17, respectively, and the least significant bit in bits 16 and 24, respectively. Positive values are indicated when the sign bit is equal to binary zero. Negative values are indicated when the sign bit is equal to binary one. The analog-to-digital conversion convention for these parameters is as follows:

	Binary value MSB (sign bit)							LSB		Decimal value
	0	1	1	1	1	1	1	1	= 127	Maximum positive value PCM count
	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0	= 0	zero
	1	0	0	0	0	0	0	1	= -1	Maximum negative value PCM count
	1	1	1	1	1	1	1	1	=-127	Minimum negative value PCM count
Bit No.	9	10	11	12	13	14	15	16		
Bit No.	17	18	19	20	21	22	23	24		

9.4.4.3.4.1.5 Analog Input Scaling

Analog parameters (8 or 10-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. The scaling is accomplished using a third order polynomial equation as follows:

$$EU = A_0 + A_1X + A_2X^2 + A_3X^3$$

WHERE EU = The engineering units value desired for display.
X = The decimal value of the PCM count.
A_o, A_1, A_2, A_3 = The polynomial coefficients.

9.4.4.3.4.2 Discretes

Packed with a maximum of 16 bits per word (bits 9 through 24 of the response data word). The discrete parameter acquisition rate shall be at 1.04 Hz.

9.4.4.3.5 Command Data Formats

The Orbiter GPC software provides the capability to process command data loads to an attached payload via this link. Each load transferred to the payload via the payload BTU SIO channel shall be structured as follows.

9.4.4.3.5.1 Payload Command Communication (one or more commands)

The Shuttle vehicle software limits the maximum message length to 32 sixteen-bit words per transmission. Each command/data word format shall be preflight-defined. Payload communication via a BTU serial channel will be assigned a single BTU module and channel address per standard serial interface.

9.4.4.3.6 Data Content

The data content of the message transmission may consist of Orbiter computed data, uplink throughput, or data prestored in the GPC for transmission under crew control.

9.4.4.3.6.1 Orbiter State Vector/Attitude

The Orbiter state vector/attitude message shall be transmitted to the payload on demand utilizing Orbiter keyboard entry or cyclically at 0.52 Hz, also initiated/terminated via the keyboard. The Orbiter state vector/attitude data sets for payloads are defined in Paragraph 9.4.5.1.

9.4.4.3.6.2 On-board Command Data Loads

The Orbiter GPC software provides the capability to execute prestored command/data to the BTU SIO channel utilizing CRT/keyboard entry.

The pre-stored command/data load for any single load may consist of up to 32 sixteen-bit payload command words.

The total storage required for the sixteen-bit payload command words (including those defined in Paragraphs 9.4.2.2.2 and 9.4.3.1.6.2) shall not exceed 2000 sixteen-bit words per flight.

9.4.4.3.6.3 Uplink Throughput Data Loads

The uplink throughput data loads 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 latter command. The Orbiter supports the uplink throughput as defined below.

9.4.4.3.6.3.1 Throughput Command Data Load-Two Stage Processing

The capability is provided to throughput up to 32 sixteen-bit words of data received via uplink to a payload via BTU SIO channel. These words will be downlisted for ground validation/correction before being transferred. These words will normally be transferred to the designated SIO channel within two seconds after receipt of a cooperative command to execute the uplink load.

9.4.4.3.6.3.2 Throughput Command Data Load-Single Stage Processing

The capability is provided to throughput up to 32 sixteen-bit (512 bits) payload command words per transmission. These words will normally be transferred to the designated SIO 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.

9.4.4.3.6.3.3 Time Executed Commands (TEC)

TECs via the data bus SIO consist of up to 32 sixteen-bit payload command data words per transmission. Normally, the TEC shall be transferred to the BTU SIO channel within two seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when load is received, the TEC shall normally be output within 2 seconds of receipt. The GPC storage (including those defined in Paragraphs 9.4.2.2.3.3 and 9.4.3.1.6.3.3) is limited to a maximum of 25 TECs at any given time during the mission. If more than one command has the same GMT time of execution or more than one command GMT time of execution has already occurred, they may be executed in any order.

9.4.4.4 Discrete Output

Discrete command outputs shall be crew initiated or via uplink. Discrete commands are comprised of a command word and a command data word. The two types of discrete command outputs available are Discrete Output Low (DOL) and

Discrete Output High (DOH). The hardware characteristic of the discrete outputs are defined in Paragraphs 8.2.2.1 and 8.2.2 respectively. MDM discrete output logic levels are controlled by the reset and set masks, reference Paragraph 8.2.12.6.1.1 (1). When bit 18 of the command word is a logic one, the command data word (8.2.12.6.1.2) following will be a set mask. Conversely, when bit 18 of the command word is a logic zero, the command data word following will be a reset mask.

The command data word format (8.2.12.6.1.2) contains 16 data bits, bit 9 through 24. For the reset mask, when any of the 16 data bits (bit 9 through 24) are a logic one, the corresponding MDM discrete output bit will be set to a logic zero. For a set mask, when any of the 16 data bits (bit 9 through 24) are set to a logic one, the corresponding MDM discrete output bits are set to a logic one. The command data word's bit 9 through 24 corresponds to the MDM discrete output bit 0 through 15 respectively. Discretes, either reset or set, are accomplished 16 bits at a time. The Orbiter GPC support for discrete output command is defined below.

9.4.4.4.1 BTU Discrete Commands

The Orbiter GPC provides for a request via crew initiation to output reset and set commands to a Discrete Output Low (DOL) or Discrete Output High (DOH) channel on the payload BTU. When the command is initiated by the crew, the reset mask will be set to the specified channel followed by the set mask.

The current set/reset status of each discrete channel commanded by a BTU discrete command is available on request for display and/or downlist. This is accomplished by means of BTU Bite Test 4 which allows the current status of the discrete output channel to be read by the Orbiter GPC.

The time interval between the reset command and the set command shall be from 300 microseconds to 1.0 second.

The time interval between the set command and MDM Bite Test 4 shall be from 300 microseconds to 1.0 seconds.

9.4.4.4.2 Pulsed BTU Discrete Commands

The Orbiter GPC provides for request via crew initiation for pulsed output to a discrete channel on the payload BTU. When the command is initiated by the crew, the set mask shall be sent to the specified channel. Between 35 milliseconds and two-seconds later the same mask shall be sent as a reset command.

9.4.4.4.3 Data Bus Discrete Commands to Hardware Pulsed Channels

The Orbiter GPC provides for a request via crew initiation to output a set command to a Pulsed Output High (POH) channel on a payload BTU. When the command is initiated by the crew, the set mask will be sent to the specified channel. The POH discretes will be automatically reset by the BTU.

9.4.4.4.4 Uplink Discrete Command

The Orbiter provides the capability to uplink discrete commands to payloads.

9.4.4.4.4.1 Single Stage Discrete Commands

Single stage discrete commands consist of a reset command and a set command. The commands will normally be transferred to the designated channel within two seconds of receipt. The Orbiter software provides from 300 microseconds to 200 milliseconds between the reset and the set command.

9.4.4.4.4.2 Two-Stage Discrete Commands

The two-stage discrete commands consist of a reset command followed by a set command. These commands will normally be transferred to the designed channel within two seconds of validation/corrections by the sender and receipt of a cooperative command to execute the uplink load. The Orbiter software provides from 300 microseconds to 200 milliseconds between the reset and set command.

9.4.4.4.4.2.1 Multiple Discrete Commands

The multiple discrete command consists of up to ten pairs of reset and set commands (two-stage discrete commands). The number of groups of reset/set commands to discretes, within a mulitple command group, shall be limited to a maximum of 10.

9.4.4.4.4.3 Payload Multiple Stored Program Commands

Payload Multiple Stored Program Commands (SPCs) has an execution time associated with it. SPCs via the BTU discrete channel consists of up to 10 discrete command groups. Normally the SPC shall be transferred to BTU discrete channels within 2 seconds after GMT time of execution has occurred. If the GMT time of execution has already occurred when the load is received, the SPC shall normally be output within 2 seconds after GMT time of execution has occurred. The GPC storage is limited to a maximum of 25 at any given time in the mission.

9.4.4.5 Analog Outputs

The GPC shall provide the capability to transmit analog data on demand via keyboard entry. Command data for an analog shall consist of a single sixteen-bit word containing a ten bit analog value. The command data for an analog channel (non-SIO) shall be computed from the desired Engineering Unit (EU) value, entered via keyboard.

Analog Output Scaling. Analog values are output by the GPC in the form of signed 10-bit two's complement parameters as described below. The PCM count output is derived from the computed value in engineering units using a linear polynomial as follows:

$$EU = A_o + A_1 X \qquad X = \frac{EU - A_o}{A_1}$$

WHERE EU = The engineering units value used in the computation.
X = The decimal value of the PCM count output.

A_o, A_1 = The polynomial coefficients.

The analog command data shall conform to the following format for GPC analog conversion algorithm.

Analog Signed Ten-Bit. Ten-bit words (bits 9 through 18 of the command data word) with the MSB (bit 9) representing polarity. Positive values are indicated when bit 9 is equal to binary zero. Negative values are in the form of binary two's complement when bit 9 is equal to binary one. The digital to analog conversion convention for analog parameters is defined as follows:

Binary value											Decimal value	
	MSB (sign bit)								LSB			
	0	1	1	1	1	1	1	1	1	1	= 511	Maximum positive value PCM count
	0	0	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count
	0	0	0	0	0	0	0	0	0	0	= 0	zero
	1	1	1	1	1	1	1	1	1	1	= -1	Maximum negative value PCM count
	1	0	0	0	0	0	0	0	0	0	=-512	Minimum negative value PCM count
Bit No.	9	10	11	12	13	14	15	16	17	18		

Bits 19 through 24 shall contain fill zeros.

9.4.4.6 Discrete Inputs

The Orbiter GPC provides the capability to acquire discrete parameters from BTUs under GPC control. The payload parameter acquisition rate shall be 1.04 Hz. The data bus characteristics of Discrete Input Low/High (DIL/DIH) are as defined in Paragraphs 8.2.12.6.1.1 (1) and 8.2.12.6.1.3, respectively. GPC data acquisition does not imply that the data are acquired and downlisted in a fixed time interval. The time interval between data acquisition samples will nominally be one second divided by the sample rate ±55 ms. The variable time interval between data and the fact that data acquisition and downlist processing are asynchronous to each other might cause some data samples to be double downlisted or skipped.

9.4.4.7 Analog Input

The Orbiter GPC provides the capability to acquire analog parameters from BTUs under GPC control. The analog parameter acquisition rate shall be 1.04 Hz. The data bus characteristics of analog inputs are as defined in Paragraphs 8.2.12.6.1.1 (1) and 8.2.12.6.1.3. The analogs shall be 10-bit two’s complement binary in the format defined below. The bit numbers refer to the serial GPC/BTU data bus format. GPC data acquisition does not imply that the data are acquired and downlisted in a fixed time interval. The time interval between data acquisition samples will nominally be one second divided by the sample rate ± 55 ms. The variable time interval between data and the fact that data acquisition and downlist processing are asynchronous to each other might cause some data samples to be double downlisted or skipped.

Signed Ten-bit analog. Each analog parameter shall be signed parameter (bits 9 through 18) with the MSB (bit 9) representing polarity. Positive values are indicated when bit 9 is equal to binary zero. Negative values are in the form of binary two’s complement when bit 9 is equal to binary one. The analog-to-digital conversion convention for analog parameters is defined as follows:

Binary value										Decimal value	
MSB (sign bit)									LSB		
0	1	1	1	1	1	1	1	1	1	= 511	Maximum positive value PCM count
0	0	0	0	0	0	0	0	0	1	= 1	Minimum positive value PCM count

	0	0	0	0	0	0	0	0	0	0 = 0	zero
	1	1	1	1	1	1	1	1	1	1 = -1	Maximum negative value PCM count
	1	0	0	0	0	0	0	0	0	0 =-512	Minimum negative value PCM count
Bit No.	9	10	11	12	13	14	15	16	17	18	

Bits 19 through 24 shall contain fill zeros.

9.4.4.7.1 Analog Input Scaling

Analog parameters (10-bit) acquired by the GPC are scaled from PCM counts to engineering units for display and limit sensing. This scaling is accomplished using a third order polynomial equation as follows:

$$EU = A_o + A_1X + A_2X^2 + A_3X^3$$

WHERE EU = The engineering units value desired for display.
X = The decimal value of the PCM count.

A_o, A_1, A_2, A_3 = The polynomial coefficients.

9.4.5 Orbiter Computed Data

The capability exists to transfer the output of payload related Orbiter processes to the payload. The Orbiter computed data and Orbiter/payload related processes available to support payloads are defined in the following paragraphs.

9.4.5.1 Orbiter State Vector/Attitude Data

The capability is provided to transfer Orbiter State vector/attitude data to payloads. The data to be transferred consists of the Orbiter State vector and attitude relative to Greenwich true of date Cartesian coordinate system or Aries mean of 1950 Cartesian coordinate system and Orbiter attitude rates about the Orbiter body axes (Reference Paragraph 3.1.1.5.2 and 3.1.1.5.3).

9.4.5.1.1 Guidance Navigation Parameters

The Orbiter software shall provide parameters listed in the following paragraphs as time-homogeneous data sets. State vector data shall be homogeneous with respect to itself and its timetag. Attitude data shall be homogeneous with respect to itself and its timetag; however, since the source of on-orbit attitude rate is from an estimator and not a sampled rate sensor, there can be a small time skewness between attitude and attitude rate data, i.e., less than 100 milliseconds (error introduced by this skewness is negligible because constant rates are assumed in the Orbiter attitude correction schemes). Homogeneity of a data set shall be maintained during transfer of the data to the payload via the PSP, Orbiter payload MDM serial input/output channel or data bus interface. However, time homogeneity shall not exist between data sets.

9.4.5.1.2 Guidance Navigation Data Transfer

The data transfer contains the GMT time tag of the transferred parameters. The GMT time tag other than for PSP shall be in one double-precision floating-point word. The GMT time tag of the Orbiter state vector shall be as measured from the beginning of the year the mission started. The initial value of this time on January 1, of the year in which the mission started, is the equivalent of one day, zero hours, zero minutes, zero seconds. If lift-off occurs in one year and landing occurs in the following year this time tag will not reset to one day at midnight of December 31 of the lift-off year. Instead it will continue to monotonically increment across the end of the year (Refer to Para. 8.2.10.1.1).

Time Tag Accuracy. Under error-free on-orbit conditions, the GMT shall be within plus or minus five milliseconds of the time at which the state vector or attitude is calculated.

Transport Lag. The Orbiter state vector/attitude message shall be output from the GPC no later than five seconds past the GMT time tag of the data. However, errors occurring in the Orbiter Data Processing System (DPS) and GN&C sensors may cause occasional degradation of this interface.

The specific data set content and sequence of transfer of Orbiter state vector, attitude, and attitude rate shall be as defined in the following paragraph.

Data defined below shall be transmitted Most Significant Bit (MSB), Most Significant Syllable (MSS) first.

9.4.5.1.2.1 (Deleted)

9.4.5.1.2.2 (Deleted)

9.4.5.1.2.3 (Deleted)

9.4.5.1.2.4 (Deleted)

9.4.5.1.3 Orbiter State Vector and Attitude/Attitude Rate Data Transfer via MDM or Data Bus Interface

The Orbiter state vector and attitude/attitude rate message shall be transmitted via Orbiter payload MDM serial input/output channel or data bus interface in the modes defined in Paragraph 9.4.5.1.3.5. These parameters are single-precision floating-point (SP) (Refer to Paragraph 9.4.5.2.1) except for the time tags and Orbiter position, which are double-precision floating-point (DP) (Refer to Paragraph 9.4.5.2.2) parameters, and the header word, which is an integer. The state vector and attitude/attitude rate data set for payloads is defined in the following sub-paragraphs.

9.4.5.1.3.1 Data Set 1 Greenwich True of Date (TOD) State Vector

Data Word	Name	Type	Units
DW1	Header (AAAA)	N/A	hex
DW2-DW5	GMT time tag of state vector	DP	sec
DW6-DW9	Orbiter X position (TOD)	DP	ft
DW10-DW13	Orbiter Y position (TOD)	DP	ft
DW14-DW17	Orbiter Z position (TOD)	DP	ft
DW18-DW19	Orbiter X velocity vector (TOD)	SP	fps

DW20-DW21	Orbiter Y velocity vector (TOD)	SP	fps
DW22-DW23	Orbiter Z velocity vector (TOD)	SP	fps

9.4.5.1.3.2 Data Set 2 Greenwich True of Date (TOD) Attitude/Attitude Rate

Data Word	Name	Type	Units
DW1	Header (5555)	N/A	hex
DW2-DW5	GMT time tag of attitude/attitude rate	DP	sec
DW6-DW7	Orbiter earth relative pitch angle	SP	rad
DW8-DW9	Orbiter earth relative yaw angle	SP	rad
DW10-DW11	Orbiter earth relative roll angle	SP	rad
DW12-DW13	Orbiter pitch rate	SP	rad/sec
DW14-DW15	Orbiter yaw rate	SP	rad/sec
DW16-DW17	Orbiter roll rate	SP	rad/sec

9.4.5.1.3.3 Data Set 3 Aries Mean of 1950 (M50) State Vector

Data Word	Name	Type	Units
DW1	Header (A5A5)	N/A	hex
DW2-DW5	M50 state vector time tag (GMT)	DP	sec
DW6-DW9	Orbiter X position (M50)	DP	ft
DW10-DW13	Orbiter Y position (M50)	DP	ft
DW14-DW17	Orbiter Z position (M50)	DP	ft
DW18-DW19	Orbiter X velocity vector (M50)	SP	fps
DW20-DW21	Orbiter Y velocity vector (M50)	SP	fps
DW22-DW23	Orbiter Z velocity vector (M50)	SP	fps

9.4.5.1.3.4 Data Set 4 Aries Mean of 1950 (M50) Attitude/Attitude Rate

Data Word	Name	Type	Units
DW1	Header (5A5A)	N/A	hex
DW2-DW5	M50 attitude data time tag (GMT)	DP	sec
DW6-DW7	Orbiter Body to M50 Quaternion* Element One	SP	-

DW8-DW9	Orbiter Body to M50 Quaternion* Element Two	SP	-
DW10-DW11	Orbiter Body to M50 Quaternion* Element Three	SP	-
DW12-DW13	Orbiter Body to M50 Quaternion* Element Four	SP	-
DW14-DW15	Orbiter pitch rate	SP	rad/sec
DW16-DW17	Orbiter yaw rate	SP	rad/sec
DW18-DW19	Orbiter roll rate	SP	rad/sec

* The quaternion for the transformation from Orbiter body coordinates to Aries-Mean of 1950, inertial Cartesian, coordinate system is defined below:

Cos α, Cos β, Cos γ are the direction cosines of the eigen axis for the transformation with respect to the x, y, and z axes, respectively, of either coordinate system.

θ is the magnitude of the right handed rotation about the eigen axis required to carry out the transformation.

The elements of the quaternion are defined by:

Element One = Cos $\theta/2$
Element Two = Sin $\theta/2$ Cos α
Element Three = Sin $\theta/2$ Cos β
Element Four = Sin $\theta/2$ Cos γ

The parameters in each data set shall be transmitted in 16-bit words in the parameter order defined. Each parameter shall be transmitted with the most significant bit and most significant syllable first. The time homogeneity of each data set shall be maintained.

9.4.5.1.3.5 GN&C Data Transfer Sequence

Crew keyboard entries are used to transfer GN&C data. GN&C state vector and/or attitude and attitude rate shall be transferred to the payload in the following modes.

a. Single Shot Mode. A single state vector data set or a single attitude/attitude rate data set is transferred when initiated by keyboard command.

b. Cyclic Mode. (Data bus and MDM SIO Interfaces Only). State vector and/or attitude and attitude rate data set are transferred repeatedly when initiated by keyboard command until terminated by keyboard command.Either Greenwich True of Date data sets (1 and/or 2) or Aries Mean 1950 data sets (3 and/or 4) may be selected for transfer and specified by the payload. When state vector and attitude/attitude rate are the data set selected for transfer, the time between state vector and attitude/attitude rate may be as great as 960 milliseconds or as short as 300 microseconds. Upon execution, a data set is transferred repeatedly once every 1.92 seconds until termination.

9.4.5.1.4 PSP Unique Orbiter State Vector/Attitude Data

The Orbiter state vector/attitude message shall be transmitted via the PSP to the payload on demand utilizing Orbiter keyboard entry. The state vector/attitude data set for payloads is defined in the following paragraphs.

9.4.5.1.4.1 Payload Communications

Each state vector/attitude message transferred to the payload via the PSP link will be structured as follows:

```
---------------------          ---------------------
| PREAMBLE |   CMD 1  |  . . . |  CMD N  | POSTAMBLE |
 ---------------------          ---------------------
```

1. The command message preamble shall consist of alternating ones and zeros followed by command word(s), and ending with a postamble consisting of alternating ones and zeros. The preamble and postamble begin with a one and end with a zero.

   The interval between consecutive command message transmissions shall be procedurally controlled such that the minimum preamble/postamble may be satisfied by the PSP IDLE pattern.

2. Each command word is 40 bits. Command words shall be formatted as follows:

BITS	DESCRIPTION
1-8	Ambiguity Word - Fixed 8-bit (11110010) sequence used to resolve subcarrier phase ambiguity, fixed for all missions.
9-15	Address - 7-bit address code (1110000), fixed for all missions.
16-18	Identification - 3-bit identification code, bit 16 message control. Zero State = start of command (data word one). One State = continuation word.

Bit Position

16	17	18	
0	0	0	First word of command (header word).
1	0	0	Data words for multi-word commands.

BITS	DESCRIPTION
19-26	Byte 1 - 8-bit command data.
27-34	Byte 2 - 8-bit command data.
35	Odd parity such that bit 16-35 contain an odd number of one’s.
36-40	Fill - Fixed bit pattern 01010.

9.4.5.1.4.2 Orbiter State Vector

The Orbiter state vector data messages shall contain the following:

The Orbiter state vector data (See Note) shall be a time homogeneous data set. The data content and sequence of data transmission shall be as follows:

DW1	Command Header - 1101000000000000
DW2-DW3	GMT time tag of the Orbiter state vector.
DW4-DW5	Orbiter X position in the Aries Mean of 1950, Inertial Cartesian, coordinate system.
DW6-DW7	Orbiter Y position in the Aries Mean of 1950, Inertial Cartesian, coordinate system.
DW8-DW9	Orbiter Z position in the Aries Mean of 1950, Inertial Cartesian, coordinate system.
DW10-DW11	Orbiter X velocity vector element in the Aries Mean of 1950, Inertial Cartesian, coordinate system.
DW12-DW13	Orbiter Y velocity vector element in the Aries Mean of 1950, Inertial Cartesian, coordinate system.
DW14-DW15	Orbiter Z velocity vector element in the Aries Mean of 1950, Inertial Cartesian, coordinate system.

Data items contained in DW2 through DW15 shall be double precision 32-bit fixed point integers as defined in Paragraph 9.4.5.2.3. The binary point shall be to the right of the LSB.

The data defined above shall be transmitted MSB, Most Significant Syllable (MSS) first. Each data word defined above (DW1-DW15) shall be transferred in bits 19 through 34. While the payload is attached to or detached from the Orbiter, this data shall be transmitted to the payload on demand via crew initiation.

Note: The Orbiter SM/PL software converts the format for state vector data received from the GN&C GPC to 32-bit double precision fixed point integers. The converted state vector data shall have Transformation/Resolution requirements as follows:

State Vector Time Tag (GMT)	LSB = 0.01 sec
Orbiter Position	LSB = 1.0 ft
Orbiter Velocity	LSB = 0.1 ft/sec

The payload must increase the received converted GMT time by the constant 2,147,483,647 (two to the 31st power minus one) to obtain the real GMT time.

9.4.5.1.4.3 Orbiter Attitude

The Orbiter attitude shall be a time homogeneous data set. The Orbiter attitude data (See Note 1) content and sequence of data transmission shall be as follows:

DW1	Header - 1101100000000000
DW2-DW3	Element one of the quaternion representing the transformation from Orbiter body coordinates to the Aries Mean of 1950, Inertial Cartesian, coordinate system. (See Note 2)
DW4-DW5	Element 2 of the quaternion described for DW2-DW3.
DW6-DW7	Element 3 of the quaternion described for DW2-DW3.
DW8-DW9	Element 4 of the quaternion described for DW2-DW3.

Data items contained in DW2 through DW9 shall be double precision 32-bit fixed point integers as defined in paragraph 9.4.5.2.3. The binary point shall be to the right of the LSB. Each data word defined above (DW1-DW9) shall be transferred in bits 19 through 34 of the respective command word, refer to Paragraph 9.4.5.2.3. While the payload is attached to the Orbiter, this data shall be transmitted to the payload on demand via crew initiation.

Note 1: The Orbiter SM/PL software converts the format for attitude data received from the GN&C GPC to double precision fixed point integers. The converted attitude data shall have Transformation/Resolution requirements as follows:

Orbiter Attitude Quaternion LSB = 2^{-31}

Note 2: The quaternion for the transformation from Orbiter body coordinates to the Aries Mean of 1950, Inertial Cartesian Coordinate System is defined as follows:

Cos α, Cos β, Cos γ are the direction cosines of the eigen axis for the transformation with respect to the x, y, and z axes, respectively, of either coordinate system.

θ is the magnitude of the right handed rotation about the eigen axis required to carry out the transformation.

The elements of the quaternion are defined by:

Element One = Cos $\theta/2$
Element Two = Sin $\theta/2$ Cos α
Element Three = Sin $\theta/2$ Cos β
Element Four = Sin $\theta/2$ Cos γ

9.4.5.1.4.4 PSP Orbiter State Vector/Attitude Transfer

The PSP state vector/attitude command load is executed by accessing the state vector or attitude data and a payload dependent configuration message and transmission of both to the PSP.

The command load provides data sets consisting of fifteen 40-bit command words (state vector set) or nine 40-bit command data words (attitude set). An 8-bit pattern of 10101010 is added to the data set after the last command word.

The configuration message format (1-5) to be used shall be the same for either load and shall be a single premission defined format. The Orbiter uplink process provides the capability to change the premission defined format to support multiple payloads.

9.4.5.2 Data Conventions

The GN&C data transferred by the Orbiter GPC software via output to the PSP, payload MDM serial input/output, and data bus input/output to a payload BTU shall be as defined below.

9.4.5.2.1 Single-Precision Floating-Point (SP)

The SP shall consist of a number, X, in hexadecimal format and transmitted as two 16-bit data words in the order DW1, then DW2 (the bit sequence is S, C_1 --- M_8, then M_9, M_{10} ---- M_{24}).

```
          0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
          -------------------------------------
         | |C|C|       |C|M|M|              |M |
     DW1 |S| | |-------| | | |--------------|  |
         | |1|2|       |7|1|2|              | 8|
          -------------------------------------

          0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
          -------------------------------------
         |M|M| |                            |M |
     DW2 | |1| |----------------------------|2 |
         |9|0| |                            | 4|
          -------------------------------------
```

S - Sign of Mantissa: 1 = Negative

0 = Positive

C_1 - C_7 - Characteristics: Coded Hex EXCESSIVE 40_{16}

M_1 - M_{24} - Mantissa (M): Normalized by HEX digits to the range $(16^{-1}, 1-16^{-14})$

$$x = (Sign)(16^{V})(M)$$

$$\text{Where } V = (C_{16} - 40_{16})$$

9.4.5.2.2 Double-Precision Floating-Point (DP)

The DP shall consist of a number, X, in hexadecimal format and transmitted as four 16-bit data words in the order DW1, DW2, DW3, then DW4 (the bit sequence is S, C_1 ---- M_8, then M_9, M_{10} ---- M_{24}, etc.).

```
             0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
             -------------------------------------
            | |C|C|       |C|M|M|              |M |
    DW1     |S| | |-------| | | |--------------|  |
            | |1|2|       |7|1|2|              | 8|
             -------------------------------------

             0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
             -------------------------------------
            |M|                                |M |
    DW2     | |--------------------------------|2 |
            |9|                                | 4|
             -------------------------------------

             0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
             -------------------------------------
            |M|                                |M |
    DW3     |2|--------------------------------|4 |
            |5|                                | 0|
             -------------------------------------

             0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
             -------------------------------------
            |M|                                |M |
    DW4     |4|--------------------------------|5 |
            |1|                                | 6|
             -------------------------------------
```

S - Sign of Mantissa: 1 = Negative
0 = Positive

C_1 - C_7 - Characteristics (C): Coded HEX EXCESSIVE 40_{16}

M_1 - M_{56} - Mantissa (M): Normalized by HEX digits to the range $(16^{-1}, 1\text{-}16^{-14})$

$$x = (\text{Sign})(16^{V})(M)$$

$$\text{Where } V = (C_{16} - 40_{16})$$

9.4.5.2.3 Double Precision Fixed Point

The data transferred to the S/C shall consist of the following data type.

Double Precision Fixed Points:

```
     0   1   2   3   4   5   6   7   8   9   10   11   12   13   14   15
     ----------------------------------------------------------------
    |   |M |                                                         |
    |S  |S |                      VALUE                              |
    |   |B |                                                         |
     ----------------------------------------------------------------
```

```
 0  1  2  3  4  5  6  7  8  9  10  11  12  13  14  15
 ----------------------------------------------------
|                                                 |L |
|                        VALUE                    |S |
|                                                 |B |
 ----------------------------------------------------
```

Fixed point values consist of 32 bits contained in two 16-bit data words. Positive values are indicated when bit zero of data word one is equal to a binary zero; negative values are in the form of binary two's complement when bit zero of data word one is equal to binary one.

9.4.5.3 Payload Sequencing/Payload Unique Computations

The Orbiter software provides services which can be used to perform payload unique computations for crew display and/or payload sequencing. The basic Input/Output (I/O) services are described in paragraphs 9.4.5.3.1 and 9.4.5.3.2. The minimum computational operations provided with these services include addition, subtraction, multiplication, division and logical "and", "or", and "exclusive or". These services also include the capability for the crew to control and monitor the computations via the keyboard and display.

The availability and definition of these services will be negotiated on an individual payload basis.

9.4.5.3.1 Data Acquisition

The capability is provided to acquire data (of the types defined in the referenced paragraphs) from the PCMMU/PDI (refer to Paragraph 9.4.1.1.2.1), payload MDM interface (refer to Paragraphs 9.4.3.1.4, 9.4.3.3 and 9.4.3.4), and Orbiter data bus system interface (refer to Paragraphs 9.4.4.3.4, 9.4.4.6, and 9.4.4.7).

9.4.5.3.2 Output Data Processing

The capability is provided to output data to payload MDM's and payload BTUs on the Orbiter data bus system. The only mode that shall be supported is receive command data (mode "01000"). Output shall be at a 1.04 Hz rate to up to 16 contiguous channels on an analog module or up to three contiguous channels on a discrete module. The total command data output to these channels is limited to fifty sixteen-bit words per flight.

The capability is also provided to output up to 32 16-bit data words via a standard serial interface (refer to Paragraphs 9.4.3.1 and 9.4.4.1).

The capability is provided to output up to 64 16-bit data words via the PSP interface (refer to Paragraph 9.4.2).

Data values to be output via the above services shall be calculated by the payload unique computations.

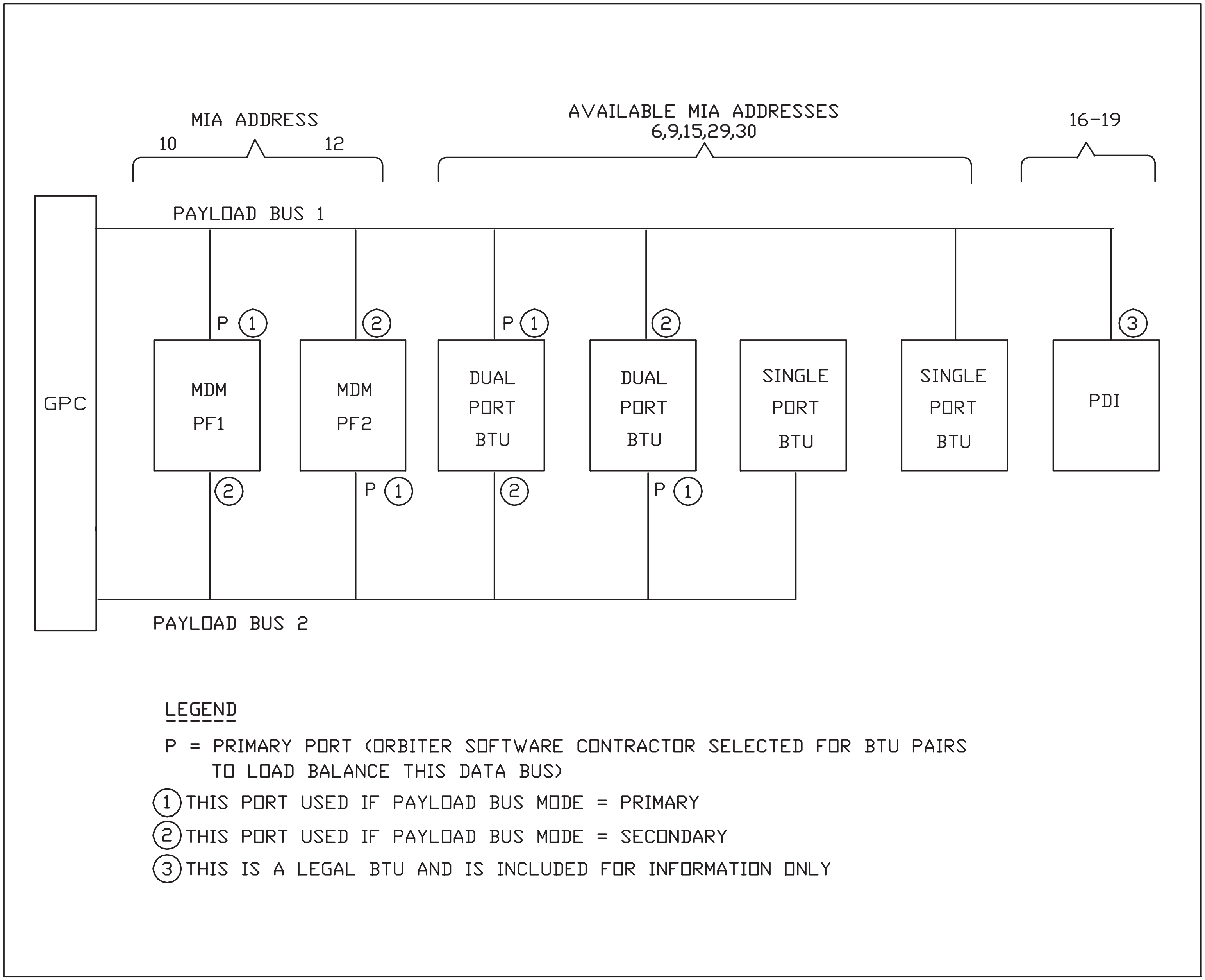


FIGURE 9.4.4.1-1 PAYLOAD BUS CONFIGURATION/LEGAL PAYLOAD BTU TYPES

THIS PAGE INTENTIONALLY LEFT BLANK.

10.0 INDUCED ENVIRONMENTS

10.1 VIBRATION

Orbiter induced vibration environments are defined in Paragraph 4.1.6 and 4.1.11.3 for payloads in the cargo bay for flight and ferry flight, respectively. Paragraph 4.2.1.3 defines Orbiter induced vibration environments for payloads in the Crew Module and equipment installed in Shuttle Habitable Volumes.

10.2 ACOUSTICS

Orbiter induced acoustic environments are defined in Paragraph 4.1.5 and 4.1.11.2 for payloads in the cargo bay for flight and ferry flight, respectively. Paragraph 4.2.2 defines Orbiter induced acoustic environments for payloads in the Crew Module and equipment installed in Shuttle Habitable Volumes.

10.3 SHOCK

Orbiter and payload induced pyrotechnic shock environments are defined in Paragraph 4.1.9.1 for payloads in the cargo bay, and in Paragraph 4.2.4 for payloads in the Crew Module and Shuttle Habitable Volumes.

10.4 LOAD FACTORS

Load factors associated with payloads in the cargo bay are defined in Paragraph 4.1.3 and 4.1.11.1 for flight and ferry flight, respectively. Paragraph 4.2.1 defines load factors associated with payloads in the Aft Flight Deck.

10.5 TEMPERATURE

Thermal conductance between Orbiter-to-payload structural attachments shall be as defined in Paragraph 6.1.3. Overall thermal environments are as given in Paragraph 6.1.4.

THIS PAGE INTENTIONALLY LEFT BLANK.

10.7 ELECTROMAGNETIC COMPATIBILITY (EMC)

Sections 10.7 through 10.7.3 define Orbiter produced electromagnetic environments as well as limitations of Payload produced electromagnetic environments. The recommended test methodologies may be found in SL-E-0002, SSP 30238 and/or NSTS 07636, for example.

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.

TABLE 10.7.1-1 CIRCUIT EMEC CLASSIFICATIONS

Frequency or Rise/Fall Time	Source Impedance (ohms)	Load Impedance (ohms)	Voltage	Circuit Class	Wire Type	Shield Grounding
Analog Alternating or Direct Current	< 100	100-600k	>100 mV to ≤ 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			TWS+	SPG
	< 100	≥ 200	> 100mV to ≤ 6V	ML	TWS	SPG
		≥ 200	> 6V to ≤ 40V	HO	TW	NONE
		≥ 200	> 40V	EO	TW	NONE
≤ 50 kHz or Rise & Fall Time >10 µs	< 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			TWS+	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 µs	ALL	ALL	≤ 100mV	RF	TWS*+	MPG
			> 100mV to ≤ 6V	RF	TWS*	MPG
		< 1000	> 6V	RF	TWS*	MPG
		≥ 1000			TWS+	MPG
≥1.024 MHz	ALL	ALL	ALL	RF	COAX	MPG
Video	ALL	ALL	ALL	RF	TWS*	MPG

NOTE: This table does not describe those wire types that are permitted to use structure for the circuit return.

* If the capacitance per foot is critical, controlled impedance wiring should be used.

** If the circuit is balanced by transformer, differential, or optical isolation, the shield shall be multipoint grounded to structure.

\+ TWDS may be utilized as required.

Symbols Used:

SPG	Single Point Ground	<	Less than
MPG	Multiple Point Ground	≤	Less than or equal to
TW	Twisted	>	Greater than
TWS	Twisted Shielded	≥	Greater than or equal to
TWDS	Twisted Double Shielded	kHz	kilohertz
EO	Extremely high voltage	mV	millivolts
HO	High voltage		
ML	Medium or Low voltage		
RF	Radio Frequency		

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])			
		$1 > D$	$1 \le D < 3$	$3 \le D < 5$	$D \ge 5$
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

THIS PAGE INTENTIONALLY LEFT BLANK.

10.7.3 Allowable Cargo-Produced Interference Environment

10.7.3.1 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 in the frequency domain shall be limited to the levels indicated in Figure 10.7.3.1.1-1. The Cargo-Generated Transients produced on DC power lines by switching or other operations, shall not exceed the limits defined in Figure 10.7.3.1.1-2 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 DC power supplies). Each non-overlapping transient is considered independent of prior or post transients. The Steady State Ripple voltage in the time domain shall not exceed +/- 0.45 volts line-to-line, starting at approximately one second after the transient.

10.7.3.1.2 AC Power

The AC power line conducted emissions shall be limited to the levels indicated in figure 10.7.3.1.1-1.

Shuttle produced transients less than one millisecond on the AC power busses are not controlled therefore, the use of electronic loads on the orbiter AC power busses is strongly discouraged.

Payloads shall not use AC powered electronic loads to control safety critical functions.

All payloads operating on AC power shall comply with the requirements of Figure 10.7.3.1.2-1.

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 7 cm from any payload equipment) shall not exceed 140 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 7 cm from 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 Emissions

10.7.3.2.2.1.1 Internal Equipment Installation Limits

Equipment located internal to the SSV shall meet the limit depicted in Figure 10.7.3.2.2.1.1-1. Equipment that meets all of the following criteria may use the limit depicted in Figure 10.7.3.2.2.1.1-2.

a. The equipment is located internal to the SSV.

b. The equipment is designated as Criticality 3 or non-critical allowing it to be turned off if interference arises from its operation.

c. The equipment is not operated on the flight deck during launch and entry operational phases.

d. The equipment is not permanently manifested.

10.7.3.2.2.1.2 External Equipment Installation Limits

Equipment installed externally to the crew compartments shall meet the limit depicted in Figure 10.7.3.2.2.1.2-1.

10.7.3.2.2.2 Intentional Radiated Electric Fields

10.7.3.2.2.2.1 Payload Transmitter Antenna System Radiation

Allowable levels of radiation from payload transmitter antenna systems are defined in the following subparagraphs. Payloads intentionally producing radiated fields prior to deployment shall include remote turn on/off capability, from either ground stations or from the aft flight deck, for implementation in the event of an unanticipated RF interference problem. A maximum of 0.5 V/m payload intentional radiated field levels are allowed with the payload doors closed during on-orbit operations only.

The following subparagraphs are applicable to payload produced radiation with the cargo bay doors open.

10.7.3.2.2.2.1.1 Payload-To-Payload Limit

The allowable Payload-to-Payload (cargo element-to-cargo element) limit is defined as the radiation impinging upon imaginary planes (Orbiter Y, Z) located at the smallest and largest Xo allocated to the radiating payload, or upon the imaginary planes (Orbiter X, Z) located at the smallest and largest Yo allocated to the radiating payload. The Payload-to-Payload radiation limit is defined in Figure 10.7.3.2.2.2.1.1-1. The limit has been established to permit flexibility in manifesting payloads. (Payload contractors required to demonstrate performance margins when their payloads are exposed to these limits, are advised to raise the test emissions levels proportionately in their radiated susceptibility procedures.)

10.7.3.2.2.2.1.2 Payload-To-Orbiter Limit

The allowable Payload-to-Orbiter limit is defined as the radiation impinging upon an imaginary surface three inches beyond the payload allowable envelope of less than or equal to a Zo of 410. The Payload-to-Orbiter radiation limit is defined in Figure 10.7.3.2.2.2.1.2-1. This does not limit radiation at higher levels with a directional antenna through open cargo bay doors (Zo > 410).

10.7.3.2.2.2.1.3 Payload-To-RMS Limit

The allowable Payload-to-Remote Manipulator System (RMS) limit for payloads attached to the RMS is defined as the radiation impinging upon an imaginary plane containing the RMS wrist roll joint end face, which is the mating interface for the Standard End Effector to the RMS. The Payload-to-RMS radiation limit is defined in Figure 10.7.3.2.2.2.1.3-1.

The allowable Payload-to-RMS limit for payloads intentionally producing radiated fields while mounted in the cargo bay is defined as the radiation impinging on an imaginary surface three inches beyond the envelope of the actual surface of the payload during RMS operation.

10.7.3.2.2.2.1.4 Payload-to-EVA Crew Limit

The allowable Payload-to-EVA crew limits of intentional radiated emissions for a payload mounted in the cargo bay are shown in Figure 10.7.3.2.2.2.1.4-1. Payload Intentional Transmitters expecting to operate in the 399-435 MHz frequency passband must be compliant with JSC 27831 in order to ensure that interference does not occur with the Orbiter Space to Space Communications System (SSCS).

10.7.3.2.2.2.1.5 Payload to Orbiter Ku-Band Radiation Limits

The Orbiter Ku-Band antenna aperture shall not be subjected along its boresight to levels greater than the following levels, either via direct radiation from another Ku-Band frequency source, or via reflected radiation from a flat surface (e.g. solar arrays):

From 13.7-15.2 GHz limit levels to 47.4 V/m for LHCP
From 13.7-15.2 GHz limit levels to 47.4 V/m for RHCP

(LHCP - Left hand circular polarized transmission)
(RHCP - Right hand circular polarized transmission)

2dB shall be used as the loss due to reflection from a solar array. Note that the polarization of a reflected circular polarized signal is reversed from that of the directly transmitted RF signal (e.g. a transmitted RHCP signal will be reflected as a LHCP signal). All limits are specified in Root Mean Square (RMS) values, unless stated otherwise.

10.7.3.2.2.2.1.6 Payload-to-ODS Intentional Radiation Limits

The allowable payload-to-ODS intentional radiation limits for a payload mounted in the cargo bay shall be as shown in Figure 10.7.3.2.2.2.1.6-1

10.7.3.2.2.2.2 Crew Cabin Payload/Experiment Transmitter Radiation

Allowable levels of radiation from cabin payload or experiment transmitter systems are shown in Figure 10.7.3.2.2.2.2-1. These limits apply at 1 meter from window mounted antennas. Other antenna mounted locations shall be negotiated with the STS.

10.7.3.2.2.3 Electrostatic Discharges

Electrostatic discharges shall not occur within the cargo unless they are isolated from the AFD and 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.

10.7.3.3 Cargo Produced LASER Radiation Emissions

10.7.3.3.1 Cargo Produced Optical/LASER Radiation (0.18- to 1000- Micrometer Wavelength)

In general, LASERs that emit visible (0.4 - 0.7 μm wavelength) and near infrared (0.7 - 1.4 μm wavelength) radiation that can be concentrated by optical aids such as binoculars and telescopes to average power densities exceeding about 2.5 mW/cm^2, when averaged over a 7mm diameter aperture, may pose ocular hazards to the crew. A LASER that emits above and below these wavelength ranges may pose a hazard to the unaided eye, and additionally, the LASERs may pass through normal optical aids and present an increased ocular hazard. In addition to direct ocular hazards, lower-level effects such as flash blindness, glare, and startle, which can affect critical crew operations and therefore be deemed hazardous, shall be addressed in the overall hazard assessment.

For purposes of evaluating these potential hazards, the most current American National Standard for Safe Use of Lasers shall be used. The analyses performed in accordance with this standard must show that potential hazards are sufficiently mitigated so as to pose no hazard to crew during operation of the LASER system.

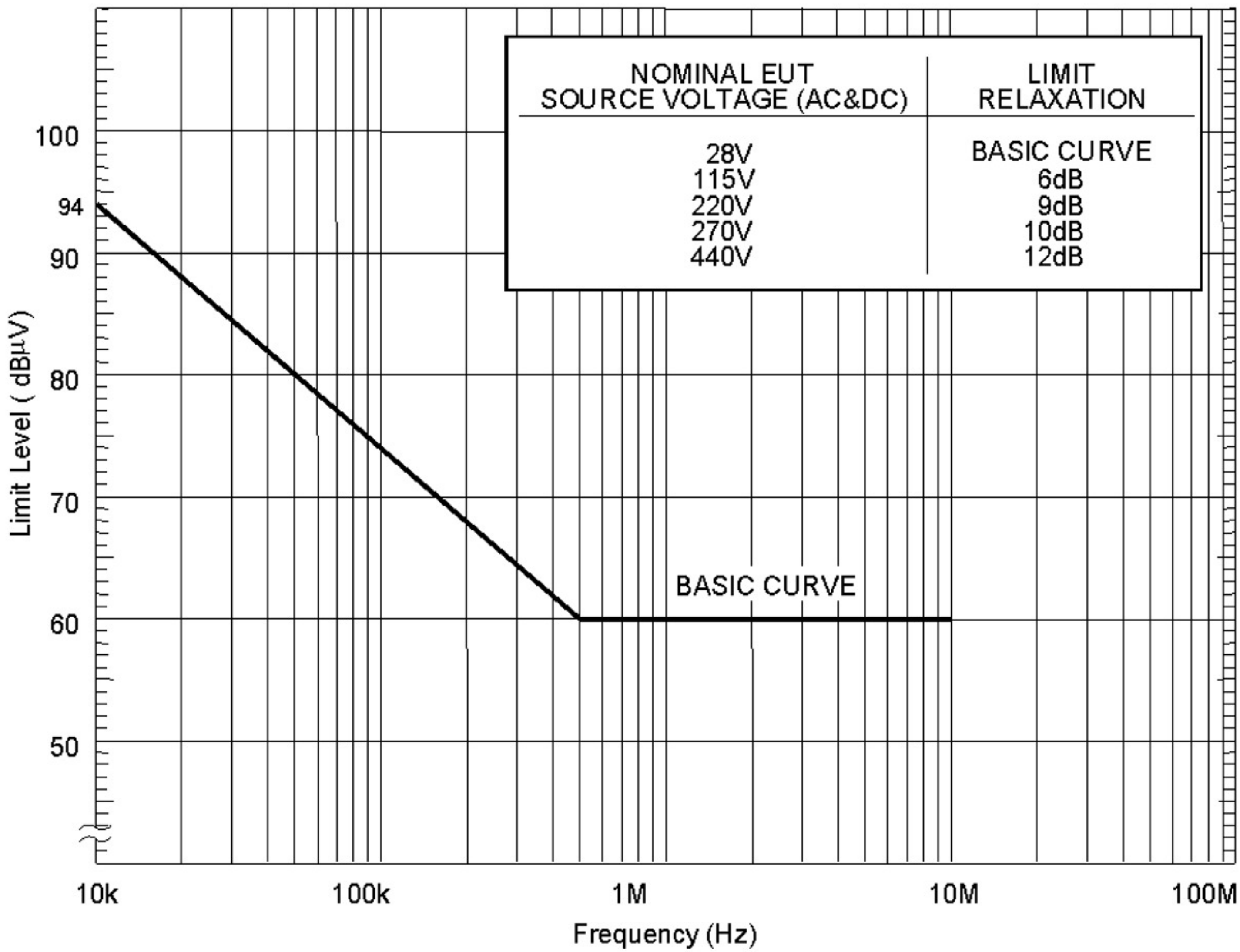


FIGURE 10.7.3.1.1-1 CARGO ALLOWABLE CONDUCTED EMISSIONS

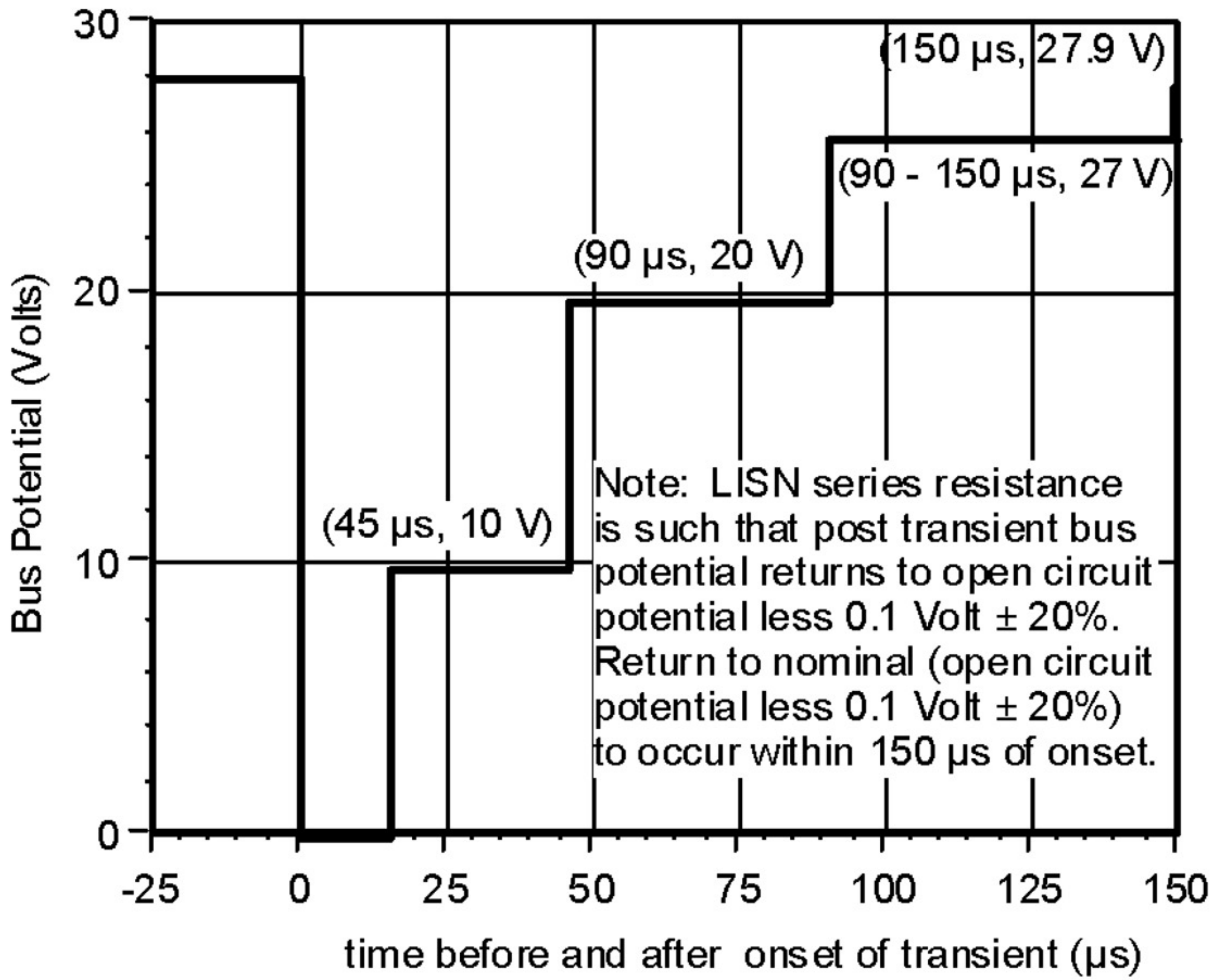


FIGURE 10.7.3.1.1-2 ALLOWABLE CARGO GENERATED DC POWER TRANSIENT LIMITS

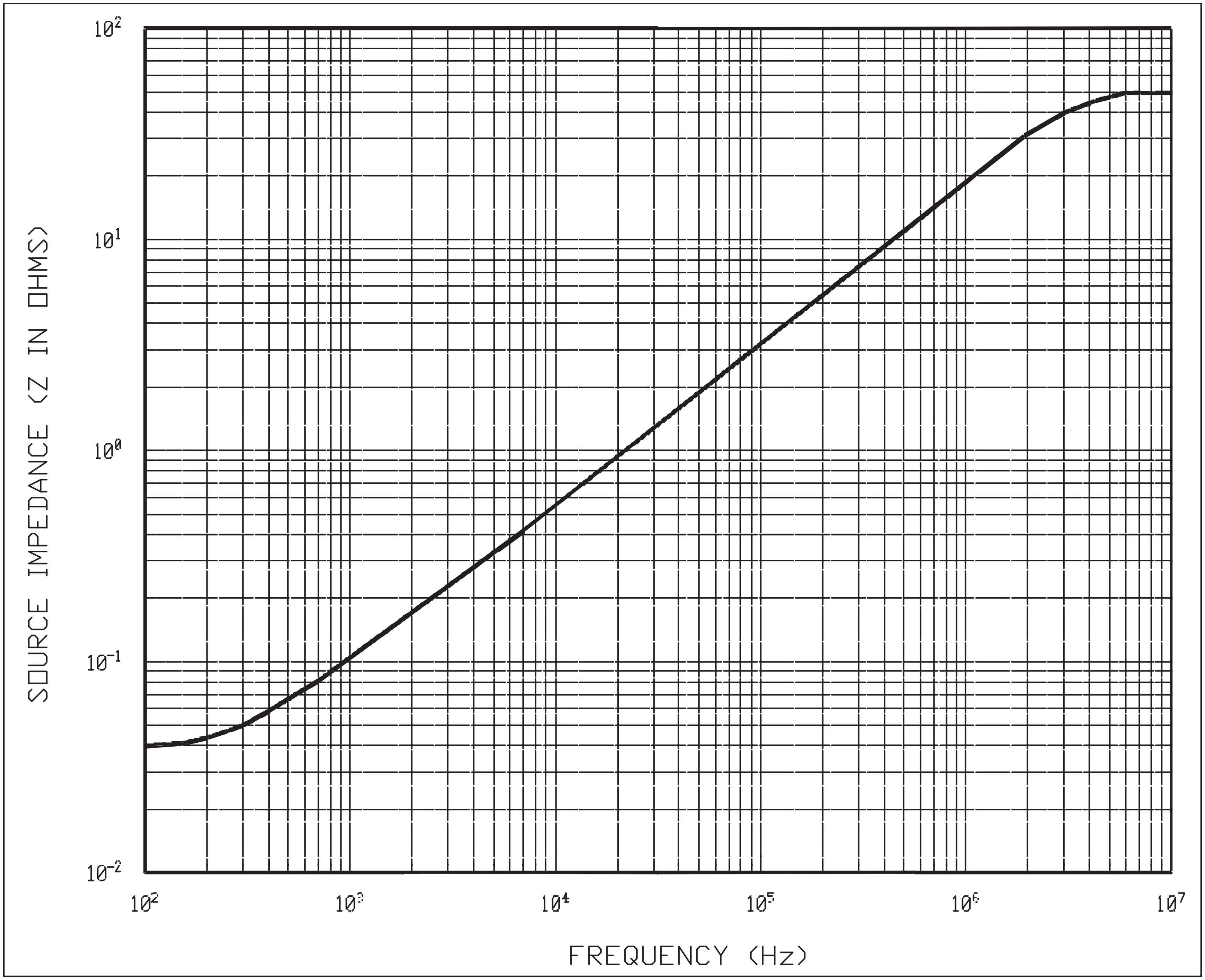
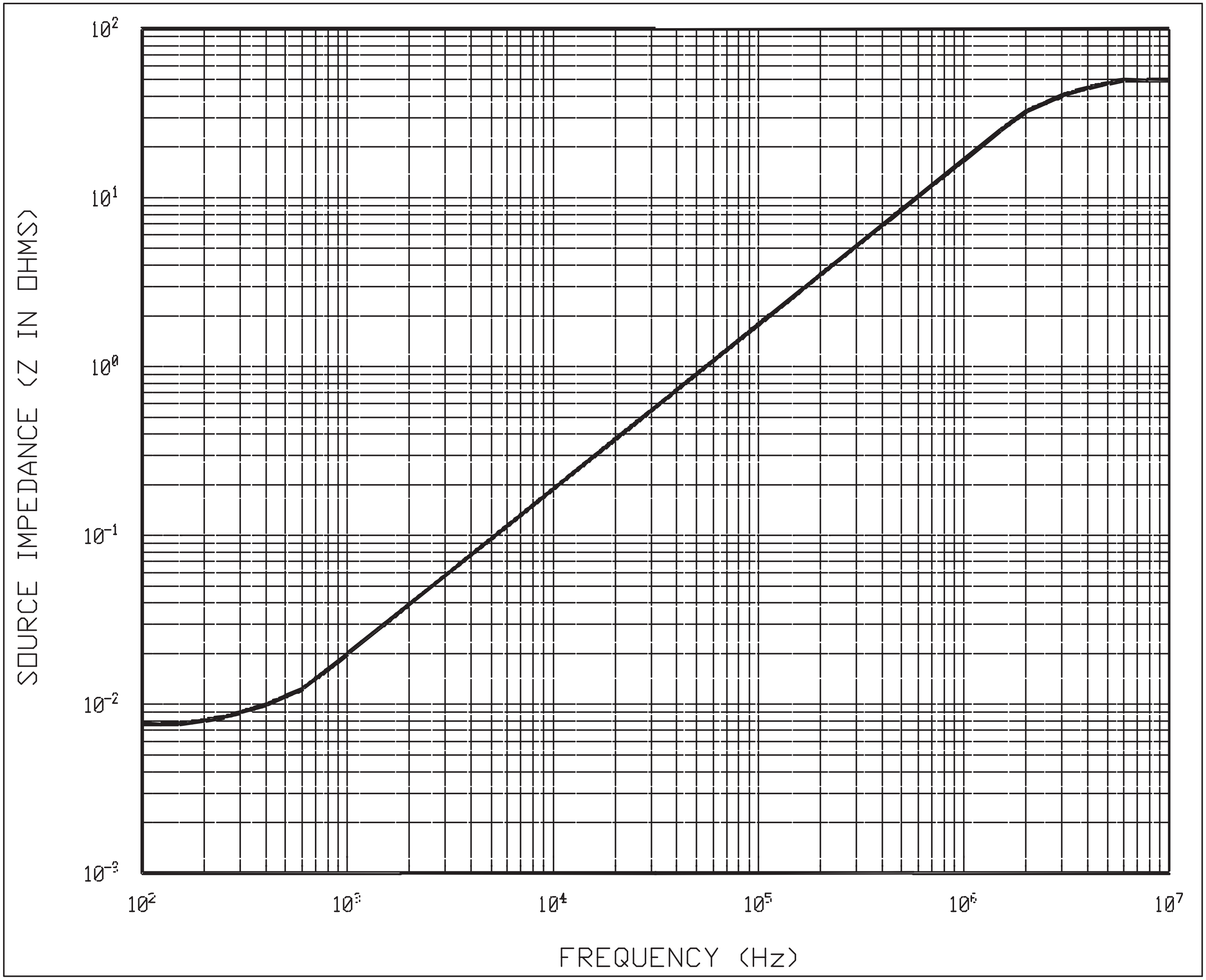


FIGURE 10.7.3.1.1-3 ORBITER DC POWER SOURCE IMPEDANCE (GROUND POWER)

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



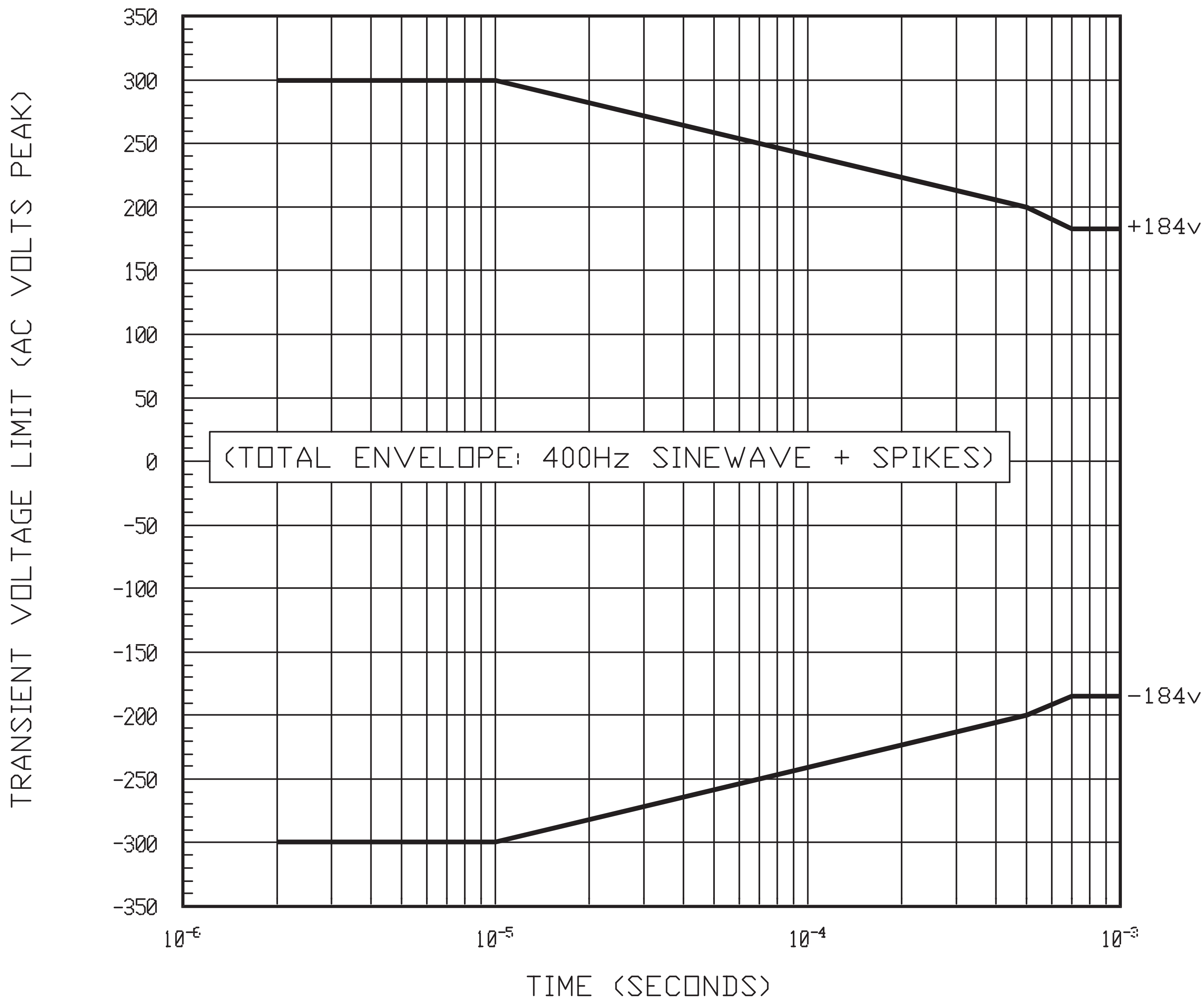


FIGURE 10.7.3.1.2-1 LIMIT ENVELOPE OF CARGO ALLOWED SPIKES ON AC POWER BUSSES

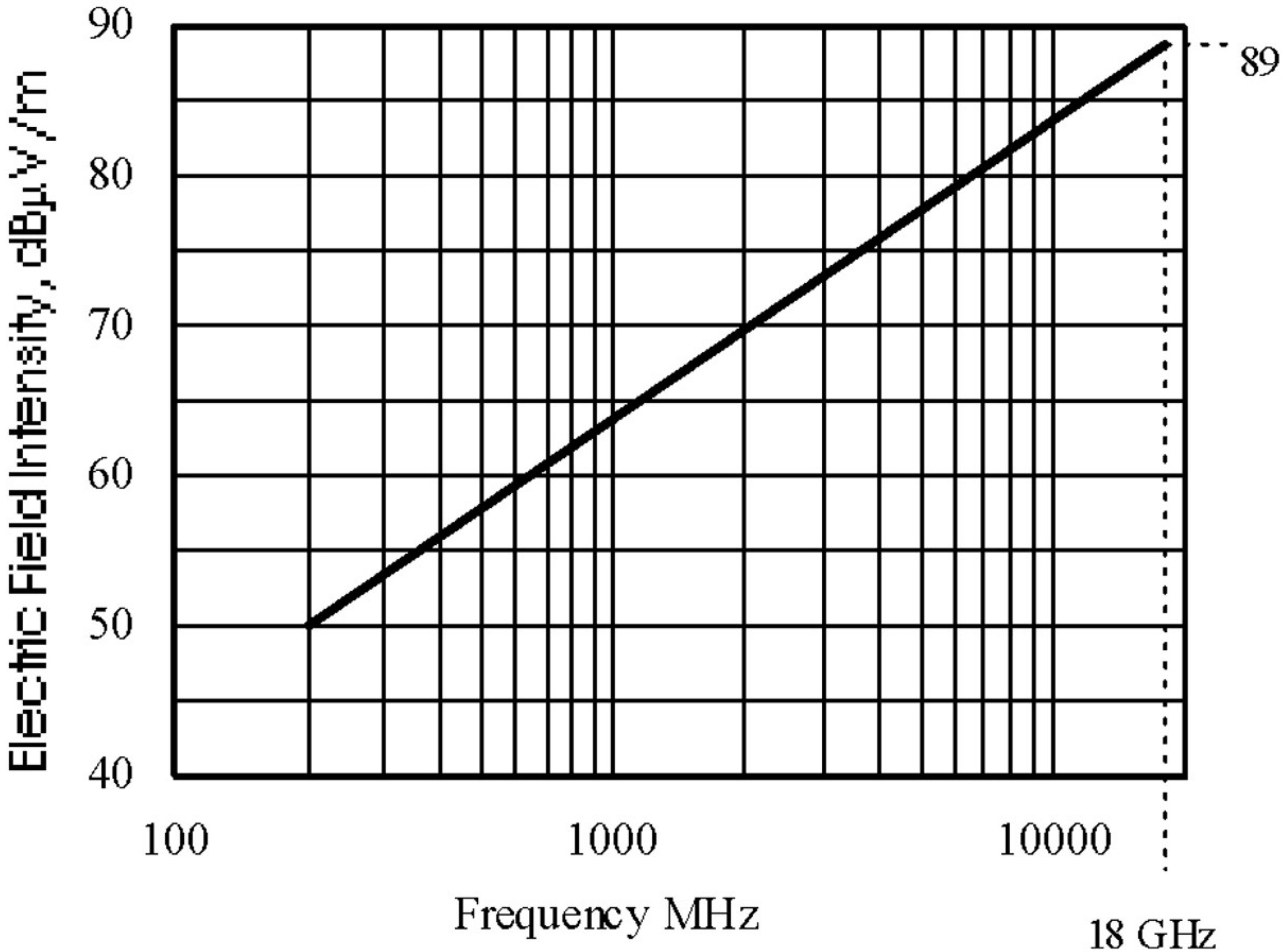


FIGURE 10.7.3.2.2.1.1-1 INTERNAL RADIATED EMISSION LIMITS

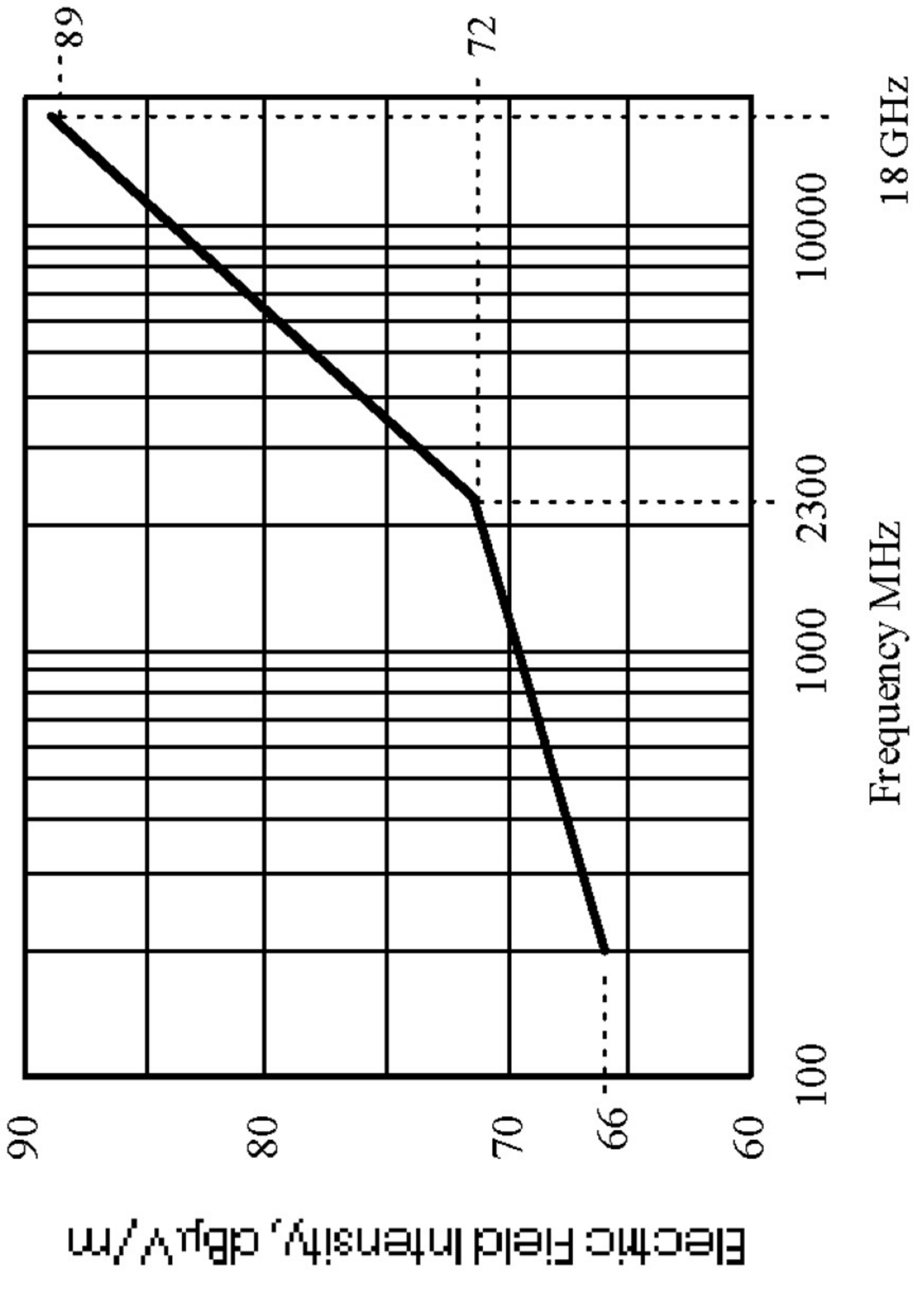


FIGURE 10.7.3.2.2.1.1-2 INTERNAL RADIATED EMISSION LIMITS THAT COMPLIES WITH ALL CRITERIA

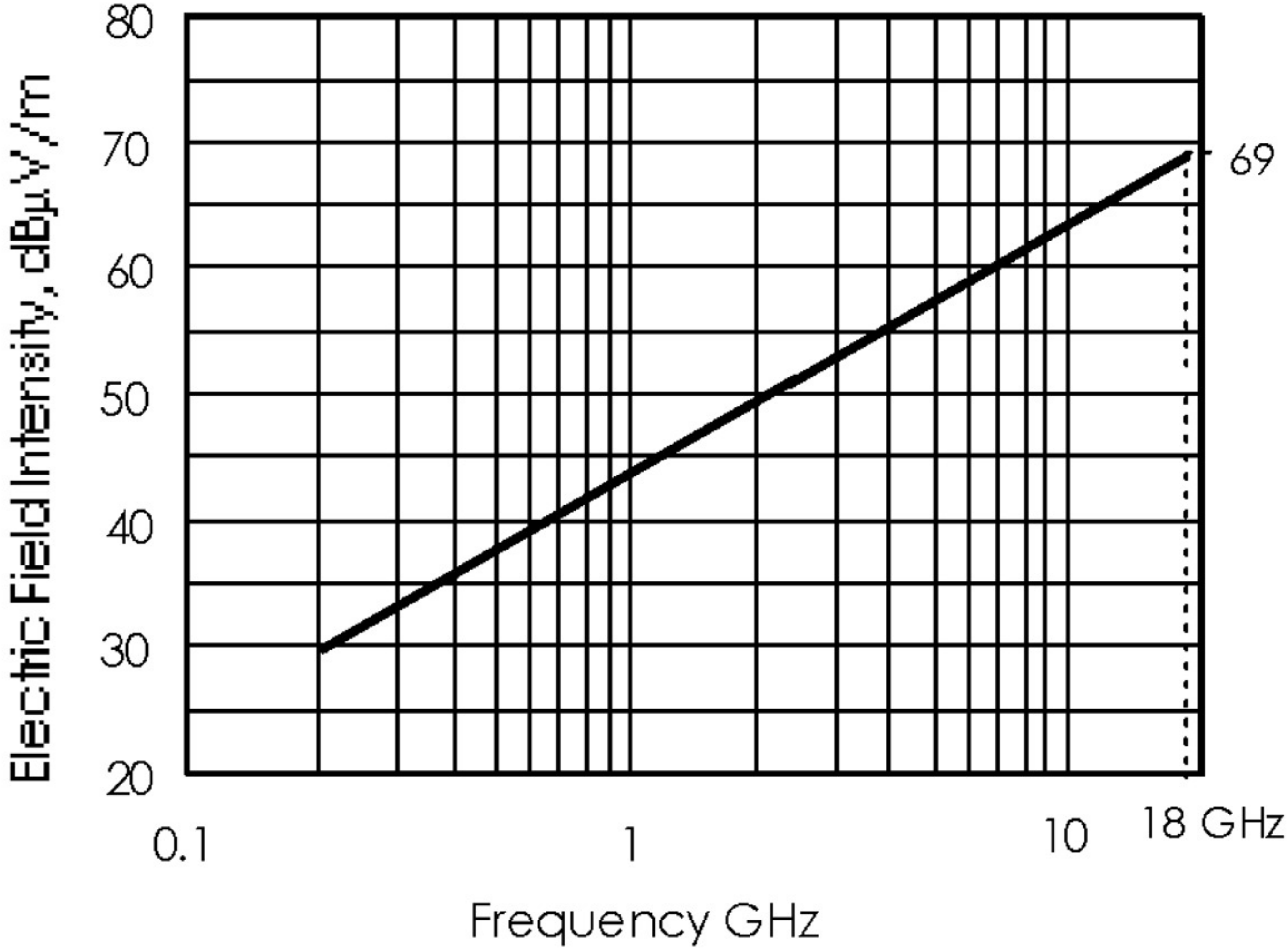


FIGURE 10.7.3.2.2.1.2-1 EXTERNAL RADIATED EMISSION LIMITS

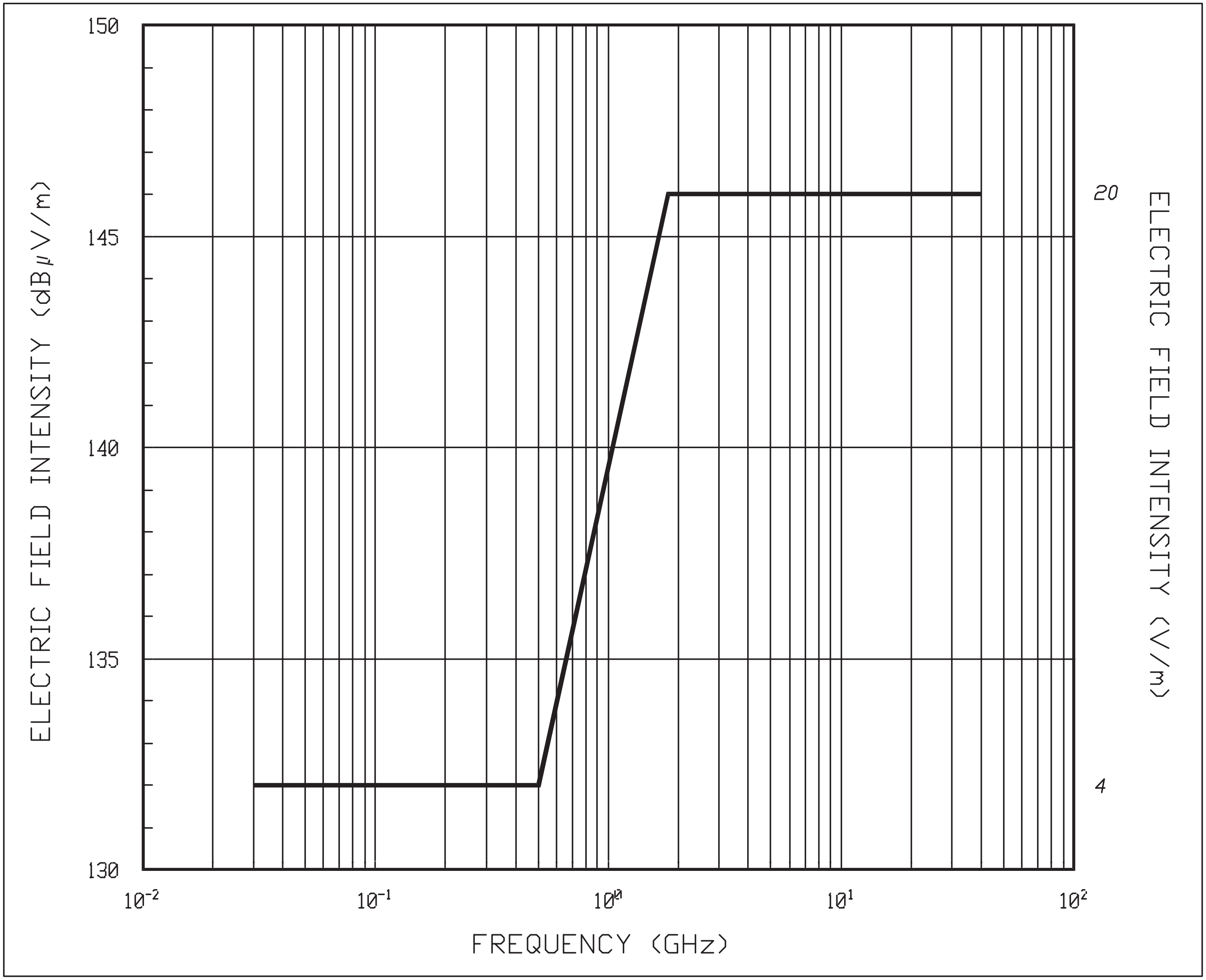


FIGURE 10.7.3.2.2.2.1.1-1 ALLOWABLE PAYLOAD TO PAYLOAD INTENTIONAL ELECTRIC FIELD INTENSITY IN THE CARGO BAY

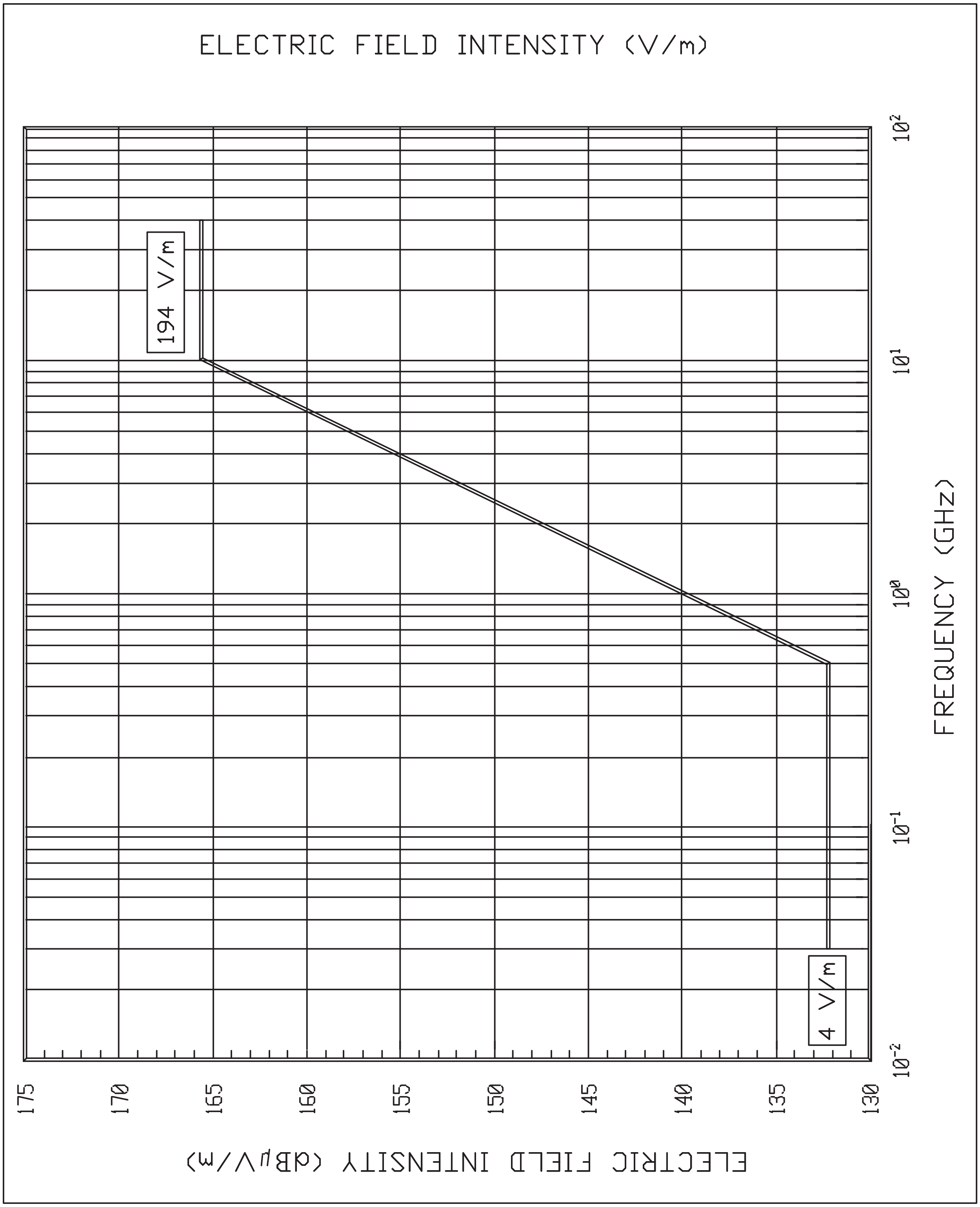


FIGURE 10.7.3.2.2.2.1.2-1 ALLOWABLE PAYLOAD-TO-ORBITER INTENTIONAL ELECTRIC FIELD INTENSITY IN THE CARGO BAY AND AT CREW CABIN WINDOWS

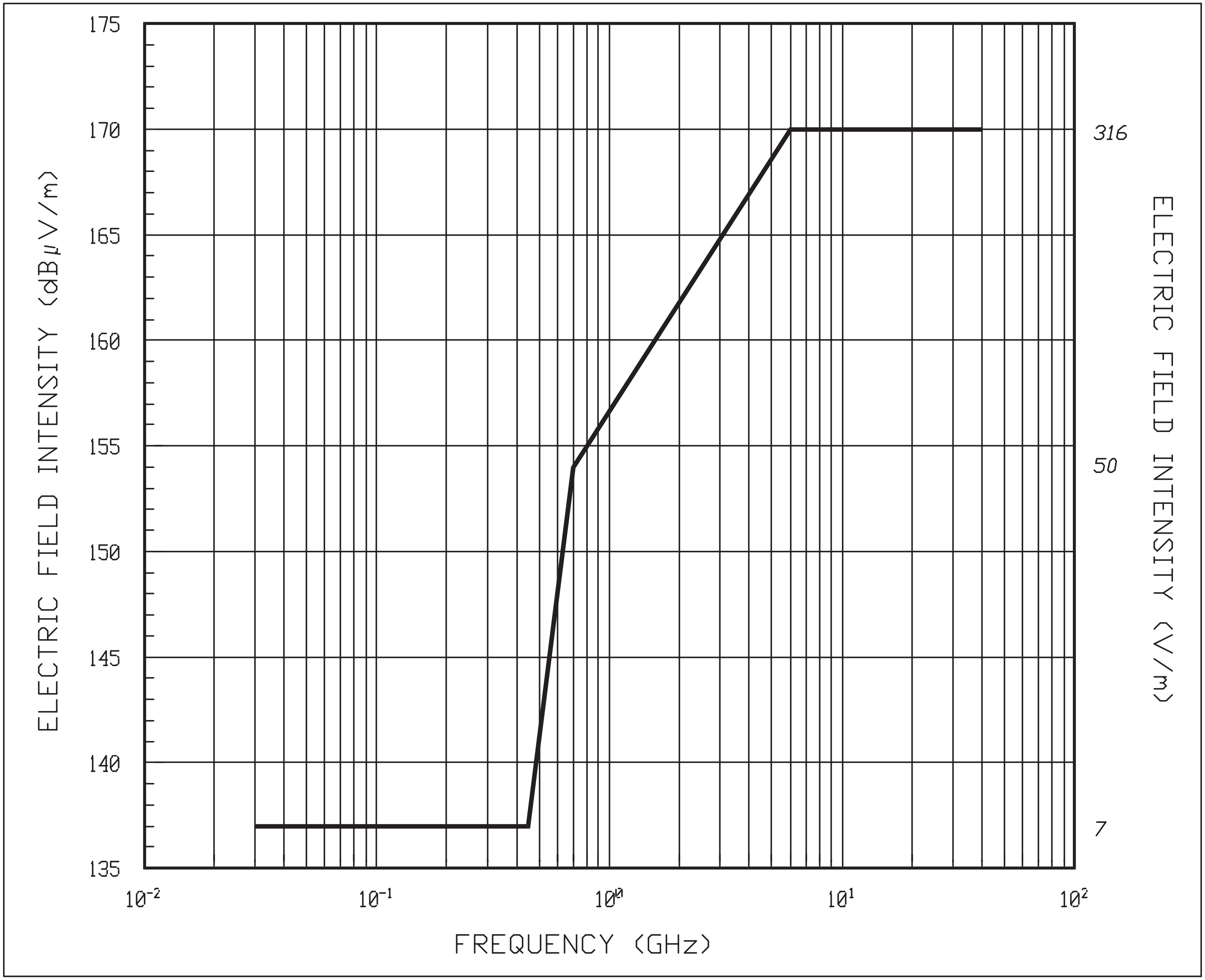


FIGURE 10.7.3.2.2.1.3-1 ALLOWABLE PAYLOAD TO RMS INTENTIONAL ELECTRIC FIELD INTENSITY IN THE CARGO BAY

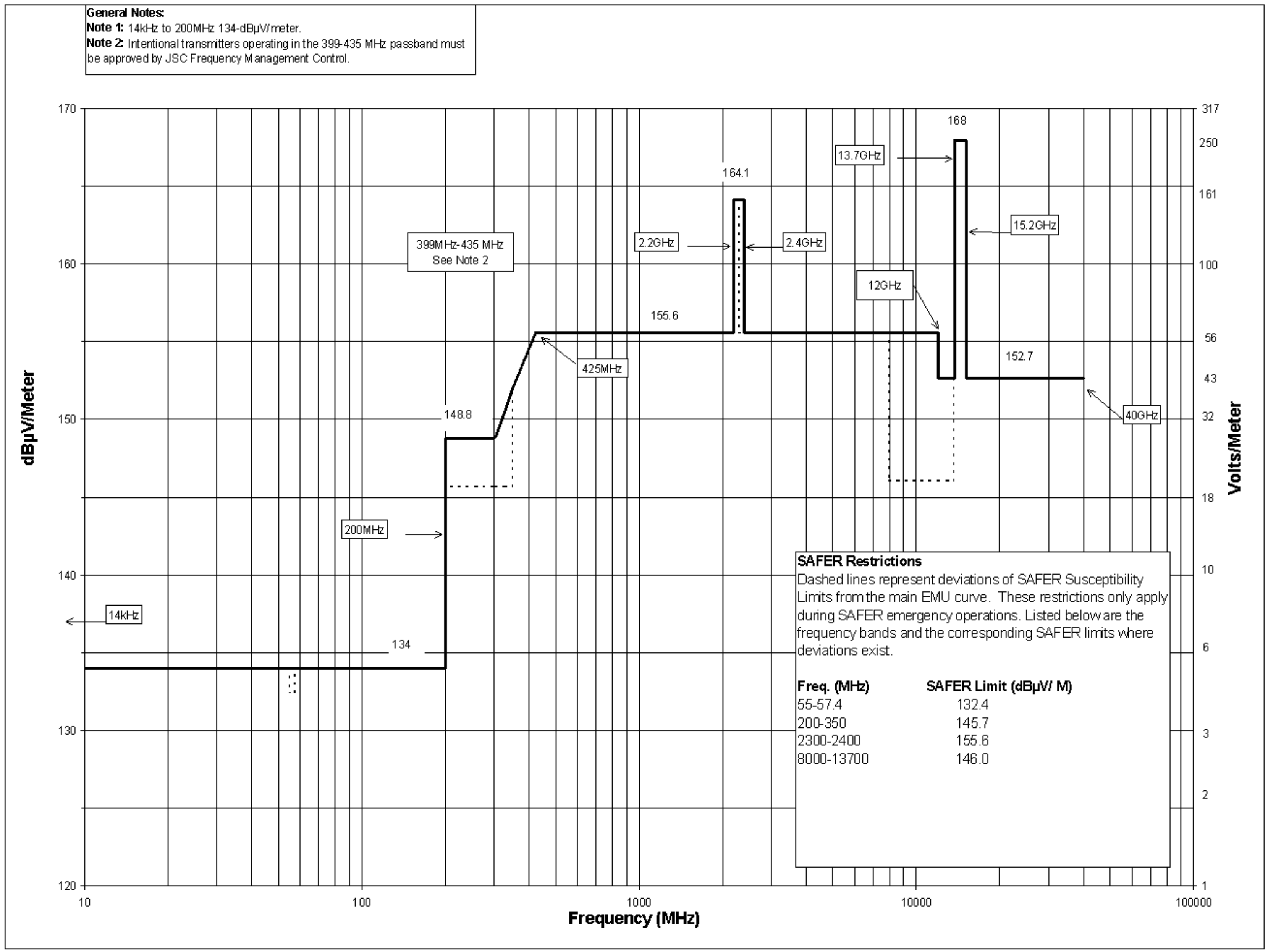
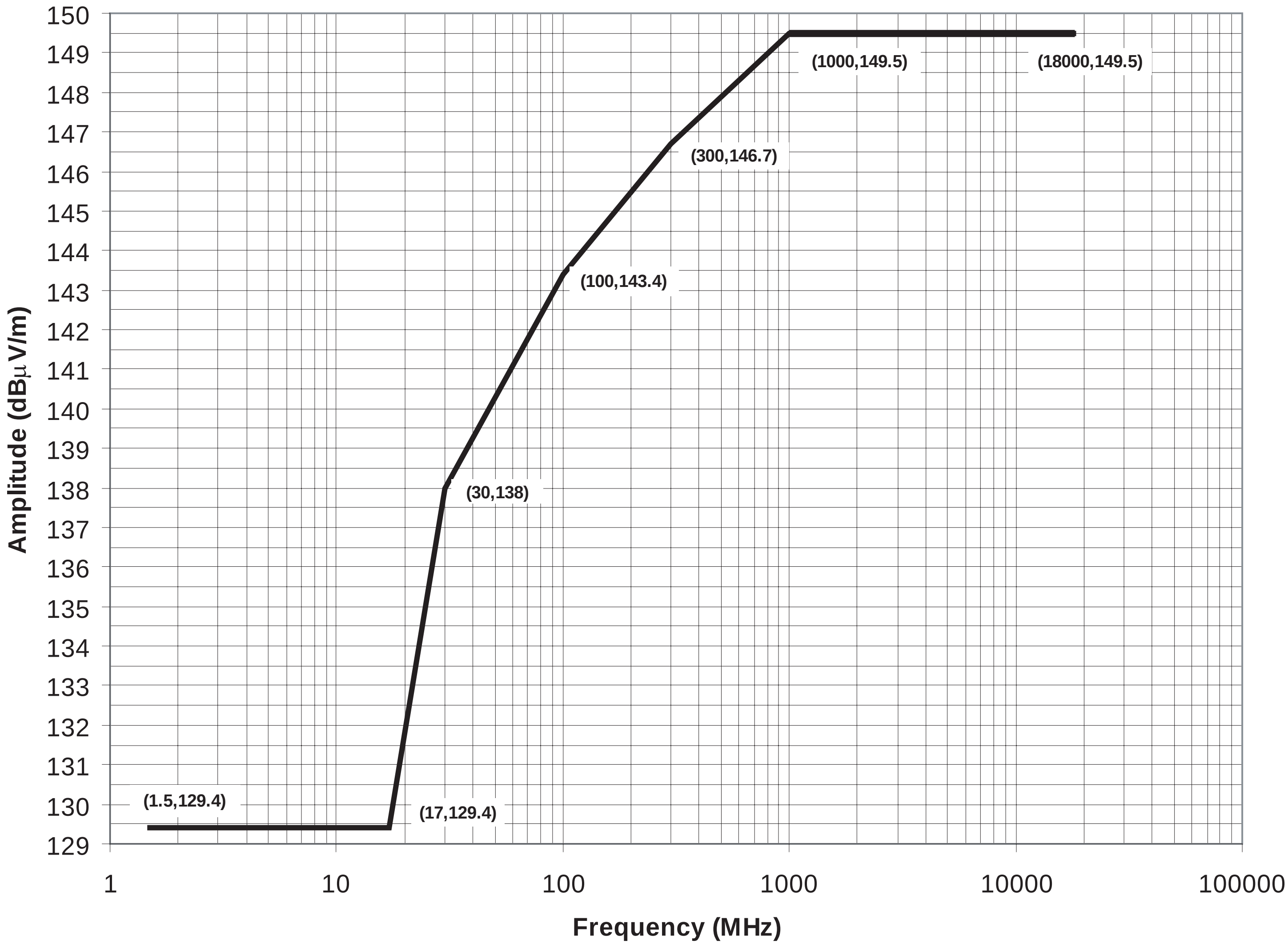


FIGURE 10.7.3.2.2.2.1.4-1 ALLOWABLE PAYLOAD TO EVA INTENTIONAL ELECTRIC FIELD INTENSITY

FIGURE 10.7.3.2.2.1.6-1 ALLOWABLE PAYLOAD-TO-ODS INTENTIONAL ELECTRIC FIELD INTENSITY IN THE CARGO BAY



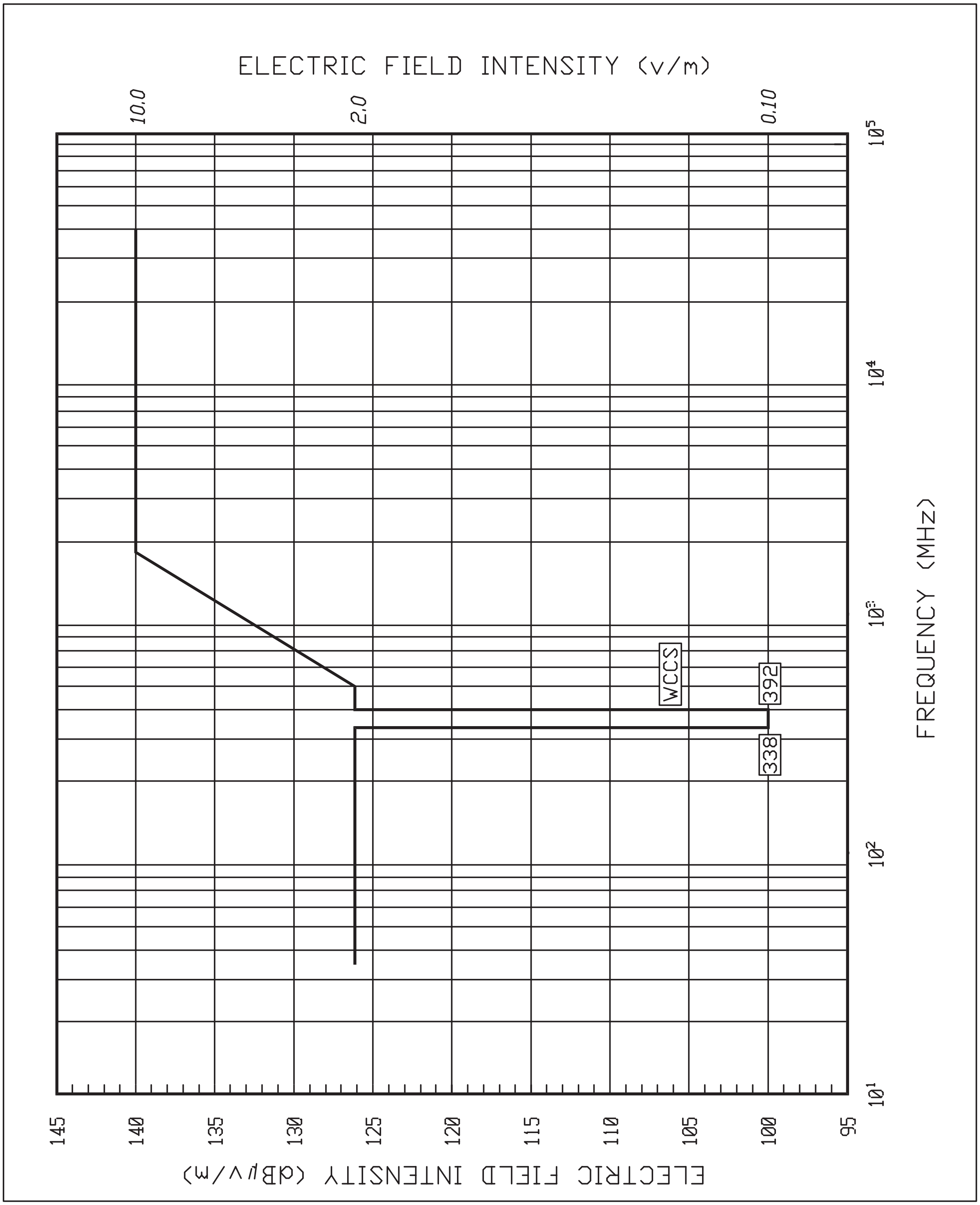


FIGURE 10.7.3.2.2.2.2-1 ALLOWABLE INTENTIONAL ELECTRIC FIELD INTENSITY IN THE CREW COMPARTMENT

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 ILLUMINATION

10.9.1 Cargo Bay Lighting

The lights provided to illuminate the Cargo Bay shall be as specified in Table 10.9.1-1.

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.

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

Temperature shall be as follows:

Surface - Uncontrolled: *	+10°F to +125°F
Surface - Conditioned: **	+48°F to +100°F at 165 lb/min.
Altitude- Starting from uncontrolled surface condition:	+10°F to +125°F
Altitude- Starting from controlled surface condition minimum controlled of +50°F and maximum of +80°F: ***	+35°F to +80°F

* The temperature extremes apply only for ferry flights between primary or secondary landing sites and are the stop over site 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. The conditioned purge, if required, will be terminated 3 hours before the SCA take off and will not be connected until 4 hours after landing at the stop over site if required. Since the purge cannot be connected continually to the payload bay on the ground the payload bay will be exposed to local ambient air conditions until the purge air cart is connected (if negotiated).

*** 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 are described in section 4.1.11. For Shuttle carrier aircraft landings at higher sink rates (normal sink rate is 3 feet per second), the payload components being ferried may experience load factors on the same order as Shuttle flight landing. If such a "hard landing" occurs, the STS will conduct analyses to determine the severity of the loading environment.

10.11 PAYLOAD HABITABLE VOLUME PARTICULATES AND GASES ENVIRONMENT

10.11.1 Materials and Processes (M&P) Requirements for the Space Shuttle Orbiter Habitable Payloads

10.11.1.1 General

The materials and processes used in the fabrication and testing of the habitable payloads shall be in accordance with MC999-0096 with the exception of the Ground Support Equipment (GSE) Section 3.6 and Appendices I & II. Material selection list shall be per MSFC Handbook 527F/JSC-09604F.

10.11.1.2 Contamination Control

10.11.1.2.1 Accessibility for Cleaning and Cleaning Condition

Exterior surfaces of payload equipment within the payload habitable volume shall be designed to provide accessibility for cleaning purposes.

Payload equipment surfaces shall be maintained to a Visibly Clean (standard) level, as defined in NSTS Specification SN-C-0005, both prior to and following cargo element installation in the Cargo Bay.

10.11.1.2.2 Effluents

The habitable payload shall not dump materials in liquid or solid form in a mode that will allow them to impinge on any part of the Orbiter Vehicle. When dumps occur they shall be scheduled by the STS to be compatible with other flight operations.

TABLE 10.9.1-1 CARGO BAY LIGHTING AND ILLUMINATION

Component Performance	Orbiter Baseline
Payload Bay Floodlights	
Watts	200 (a)
Lumens/Watt	40 Minimum
Type	Arc Discharge
Beam	135° x 135°
Docking Floodlight	
Watts	200
Lumens/Watt	40 Minimum
Beam	120° x 120°
Overhead/Docking Light	
Watts	130
Lumens/Watt	12 Minimum
Beam	120° x 120°
RMS Light	
Watts	150
Lumens/Watt	12 Minimum
Beam	80°

(a) Includes 40 watts in cold-plated ballast

THIS PAGE INTENTIONALLY LEFT BLANK.

11.2.2 RCS Engines

Nominal locations, nomenclature and orientations of the thirty-eight RCS engines and plumes are shown in Figure 11.2.2-1. Nominal engine characteristics affecting definition of RCS plume flowfields are shown in Table 11.2.1-1. The engine plume characteristics described in the following figures corresponds to the effective engine thrust vector, rather than the engine/nozzle centerline due to the effects of nozzle scarfing to conform to the Orbiter outer moldline. Typical, plume, constant-density contours generated by a single engine operating in a vacuum are shown in Figure 11.2.2-2. Figure 11.2.2-3 shows typical, contaminants (liquid/solid phase), constant mass-flux-rate contours throughout the plume shown in Figure 11.2.2- 2. With the nominal RCS nozzle configuration (ε, defined in Table 11.2.1-1) and the computed non-gas (liquid/solid) phase flow rate, the contaminants plume has the maximum angular displacement (ϕ_M) defined in Table 11.2.1-1, and it lies entirely within the gas-phase envelope. The distribution of contaminants in this plume is such that the largest mass particles are contained within a cone defined by the effective nozzle expansion angle (ϕ_N). Composition of the contaminants is defined in Paragraph 10.6.3. Figure 11.2.2-4 shows the nominal gas static temperature, as a function of the density constant $K\rho$, throughout the plume shown in Figure 11.2.2-2. Figure 11.2.2-5 shows the nominal plume gas Mach number, as a function of the density constant $K\rho$, throughout the plume shown in Figure 11.2.2-2. Figure111.2.2-6 shows the nominal relationship between gas static pressure and impingement force on a normal flat plate (computed by means of the Diffuse Newtonian Gas Dynamic Interaction Model), both as functions of the density constant $K\rho$, throughout the plume shown in Figure 11.2.2-2. The referenced figures were generated by source flow analysis, represent single engine only (multiple engine effects not considered), valid for continuum flow only, free molecular flow not considered, and are presented for preliminary assessment purposes only.

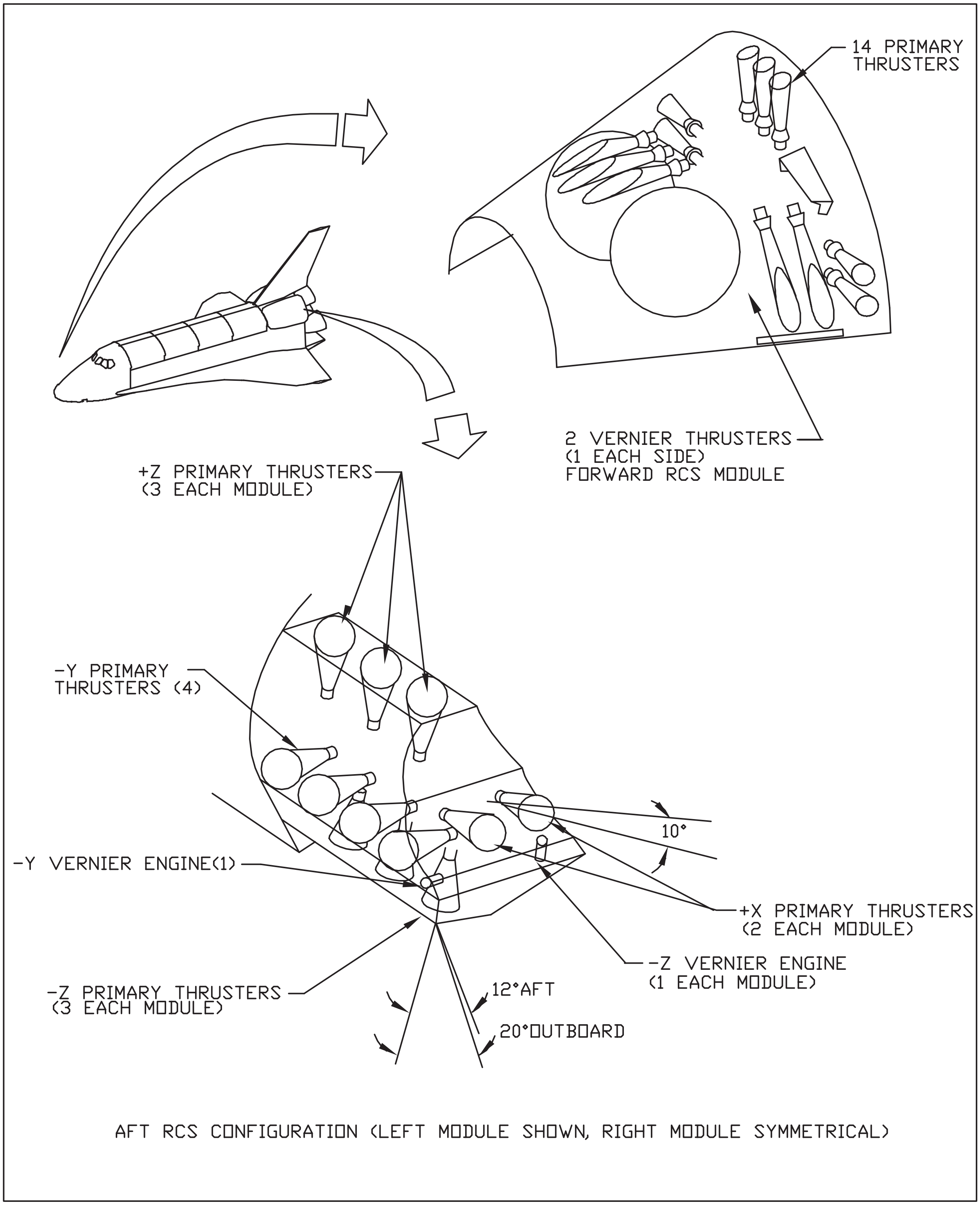


FIGURE 11.2.2-1 RCS/VRCS THRUSTER LOCATIONS AND ORIENTATIONS

(SHEET 1 OF 4)

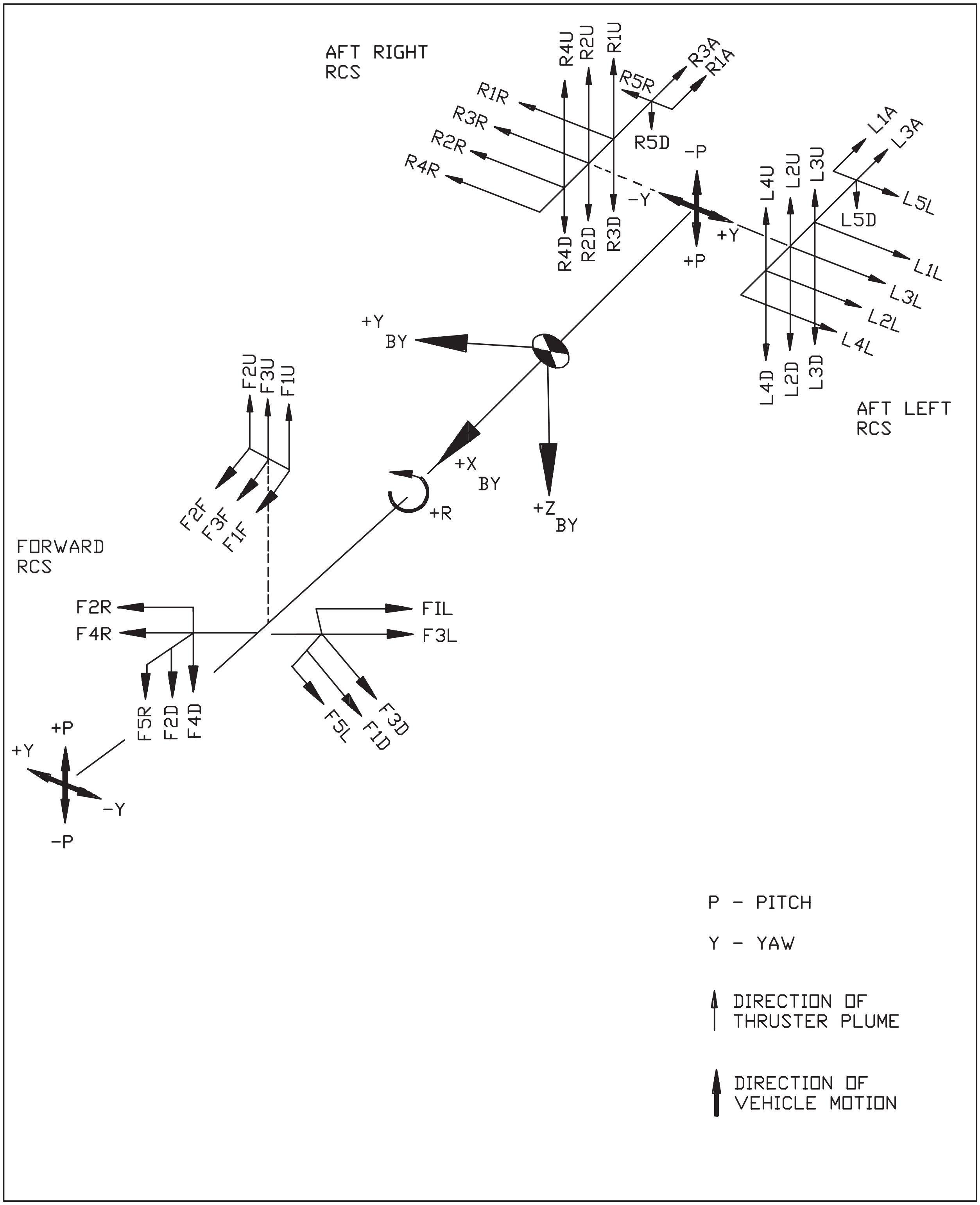


FIGURE 11.2.2-1 RCS/VRCS THRUSTER LOCATIONS AND ORIENTATIONS

(SHEET 2 OF 4)

NOMINAL DIRECTION (1)	THRUSTER ID	THRUST COMPONENTS, LB			RESULTANT THRUST, LB	THRUST APPLICATION LOCATION (2)		
		FX_B	FY_B	FZ_B		X_O	Y_O	Z_O
+X	R3A	856.8	0.0	151.1	870.0	1555.29	137.00	473.06
	R1A	856.8	0.0	151.1	870.0	1555.29	124.00	473.06
	L3A	856.8	0.0	151.1	870.0	1555.29	−137.00	473.06
	L1A	856.8	0.0	151.1	870.0	1555.29	−124.00	473.06
+Y	L4L	0.0	870.5	− 22.4	870.8	1516.00	−149.87	459.00
	L2L	0.0	870.5	− 22.4	870.8	1529.00	−149.87	459.00
	L3L	0.0	870.5	− 22.4	870.8	1542.00	−149.87	459.00
	L1L	0.0	870.5	− 22.4	870.8	1555.00	−149.87	459.00
−Y	R4R	0.0	−870.5	− 22.4	870.8	1516.00	149.87	459.00
	R2R	0.0	−870.5	− 22.4	870.8	1529.00	149.87	459.00
	R3R	0.0	−870.5	− 22.4	870.8	1542.00	149.87	459.00
	R1R	0.0	−870.5	− 22.4	870.8	1555.00	149.87	459.00
+Z	L4U	0.0	0.0	870.0	870.0	1516.00	−132.00	480.50
	L2U	0.0	0.0	870.0	870.0	1529.00	−132.00	480.50
	L1U	0.0	0.0	870.0	870.0	1542.00	−132.00	480.50
	R4U	0.0	0.0	870.0	870.0	1516.00	132.00	480.50
	R2U	0.0	0.0	870.0	870.0	1529.00	132.00	480.50
	R1U	0.0	0.0	870.0	870.0	1542.00	132.00	480.50
−Z	L4D	170.4	291.8	−801.7	870.0	1516.00	−111.95	437.40
	L2D	170.4	291.8	−801.7	870.0	1529.00	−111.00	440.00
	L3D	170.4	291.8	−801.7	870.0	1542.00	−110.06	442.60
	R4D	170.4	−291.8	−801.7	870.0	1516.00	111.95	437.40
	R2D	170.4	−291.8	−801.7	870.0	1529.00	111.00	440.00
	R3D	170.4	−291.8	−801.7	870.0	1542.00	110.06	442.60
−Z(VERNIER)	L5D	0.0	0.0	− 24.0	24.0	1565.00	−118.00	455.44
	R5D	0.0	0.0	− 24.0	24.0	1565.00	118.00	455.44
+Y(VERNIER)	L5L	0.0	24.0	− 0.6	24.0	1565.00	−149.87	459.00
−Y(VERNIER)	R5R	0.0	− 24.0	− 0.6	24.0	1565.00	149.87	459.00

FIGURE 11.2.2-1 RCS/VRCS THRUSTER LOCATIONS AND ORIENTATIONS

(SHEET 3 OF 4)

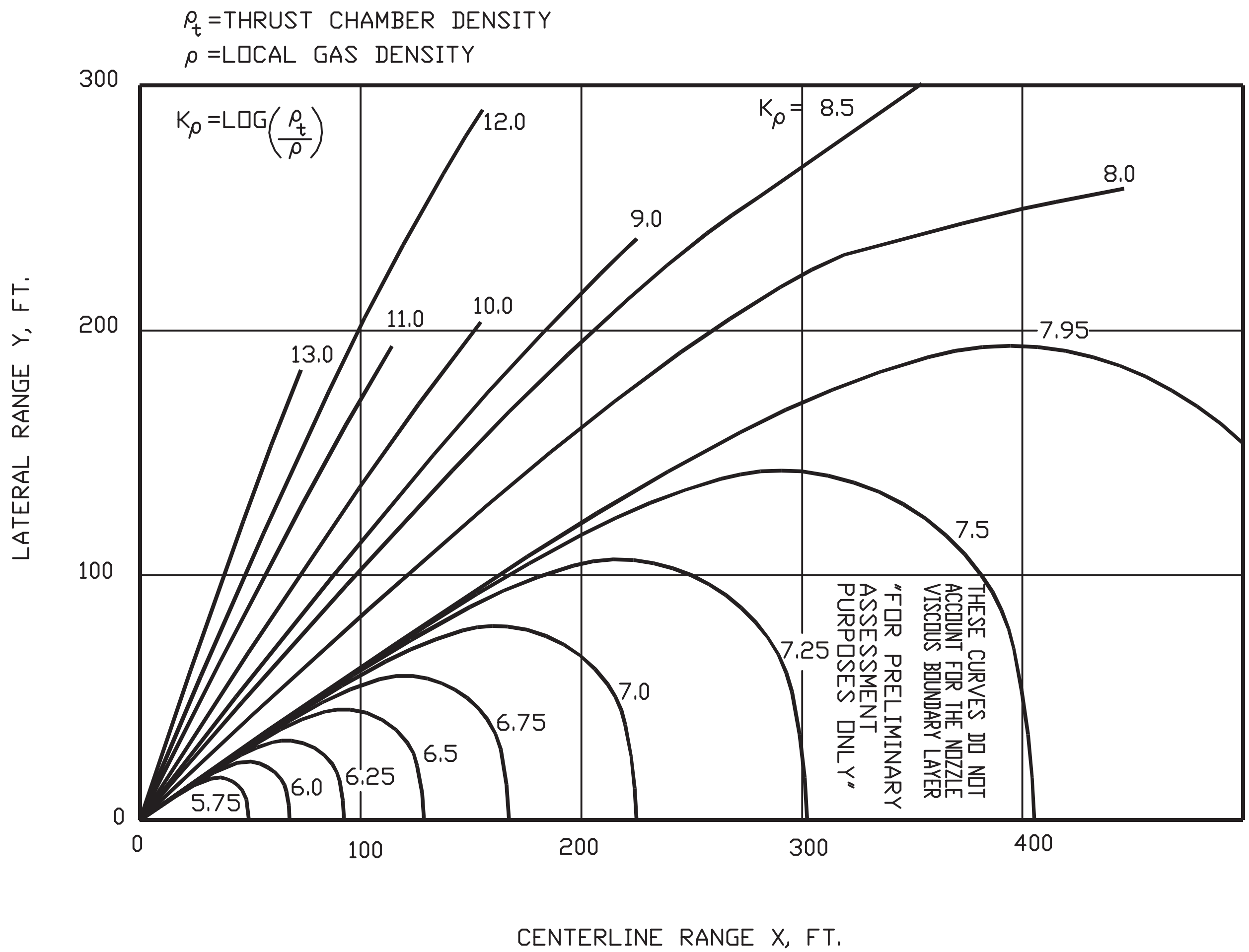
NOMINAL DIRECTION (1)	THRUSTER ID	THRUST COMPONENTS, LB			RESULTANT	THRUST APPLICATION LOCATION (2)		
		FX_B	FY_B	FZ_B	THRUST, LB	X_O	Y_O	Z_O
-X	F2F	-875.1	- 26.2	148.0	887.9	306.72	14.65	392.96
	F3F	-875.1	0.0	150.9	888.0	306.72	0.0	394.45
	F1F	-875.1	26.2	148.0	887.9	306.72	- 14.65	392.96
+Y	F1L	- 26.3	873.6	18.2	874.2	362.67	- 69.50	373.73
	F3L	- 21.0	870.3	0.5	870.6	364.71	- 71.65	359.25
-Y	F2R	- 26.3	-873.6	18.2	874.2	362.67	69.50	373.73
	F4R	- 21.0	-870.3	0.5	870.6	364.71	71.65	359.25
+Z	F2U	- 32.3	-11.7	874.4	875.1	350.93	14.39	413.46
	F3U	- 31.9	0.0	873.5	874.1	350.92	0.0	414.53
	F1U	- 32.3	11.7	874.4	875.1	350.93	- 14.39	413.46
-Z	F2D	- 28.0	-616.4	-639.5	888.6	333.84	61.42	356.95
	F1D	- 28.0	616.4	-639.5	888.6	333.84	- 61.42	356.95
	F4D	- 24.8	-612.6	-639.4	885.9	348.44	66.23	358.44
	F3D	- 24.8	612.6	-639.4	885.9	348.44	- 66.23	358.44
-Z	F5R	- 0.8	- 17.0	- 17.6	24.5	324.35	59.70	350.12
(Vernier)	F5L	- 0.8	17.0	- 17.6	24.5	324.35	- 59.70	350.12

(1) MOTION COORDINATES BODY AXIS COORDINATE SYSTEM, SEE FIGURE 3.1.1.4-1

(2) STATION COORDINATES ORBITER STRUCTURAL COORDINATE SYSTEM, SEE FIGURE 3.1.1.1-1.

FIGURE 11.2.2-1 RCS/VRCS THRUSTER LOCATIONS AND ORIENTATIONS
(SHEET 4 OF 4)

FIGURE 11.2.2-2 RCS PLUME CONSTANT DENSITY CONTOURS - K/RHO



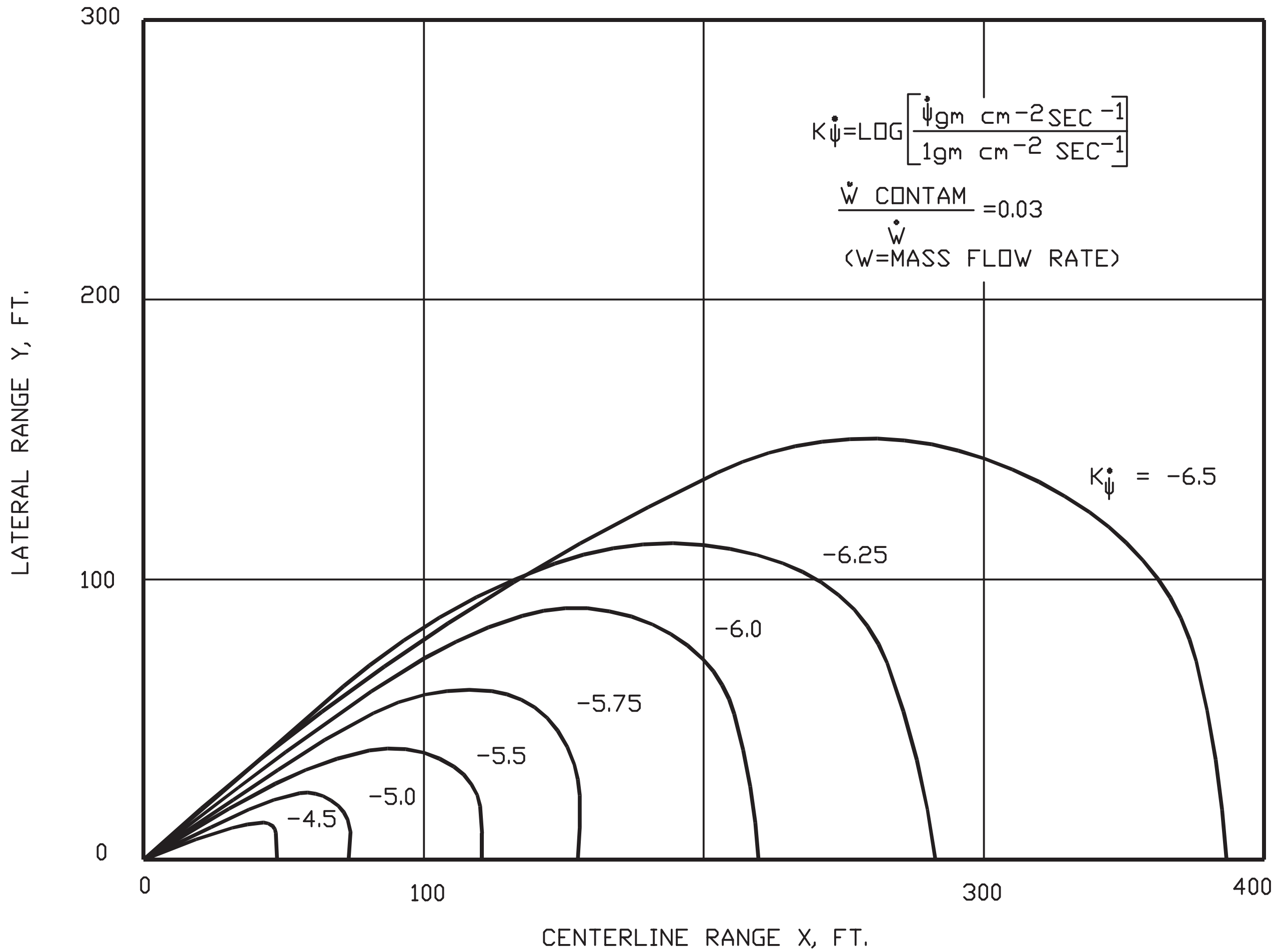


FIGURE 11.2.2-3 RCS CONTAMINANTS CONSTANT MASS-FLUX-RATE CONTOURS

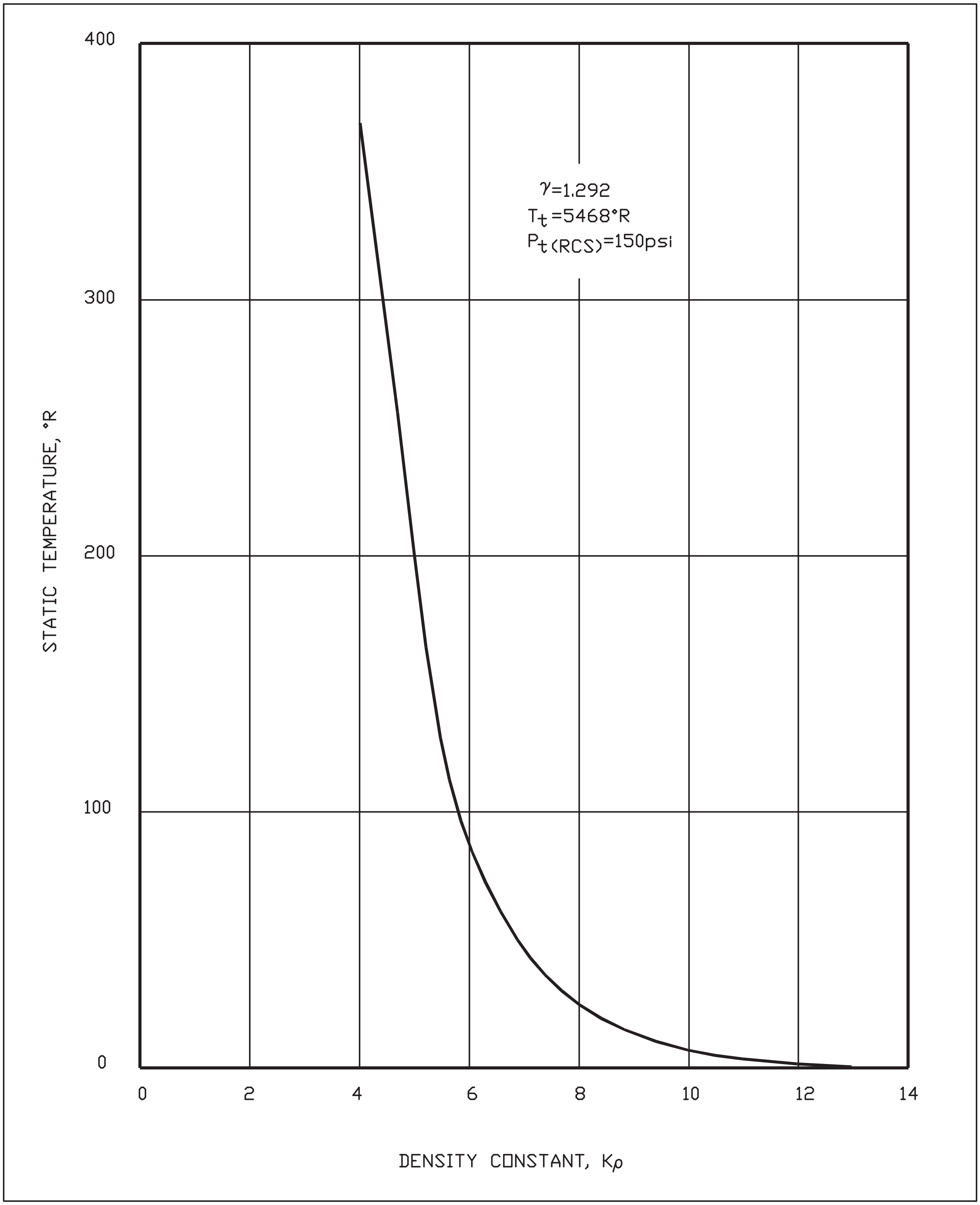


FIGURE 11.2.2-4 RCS PLUME STATIC TEMPERATURE (DEGREES-R) AS A FUNCTION OF DENSITY CONSTANT, K/RHO

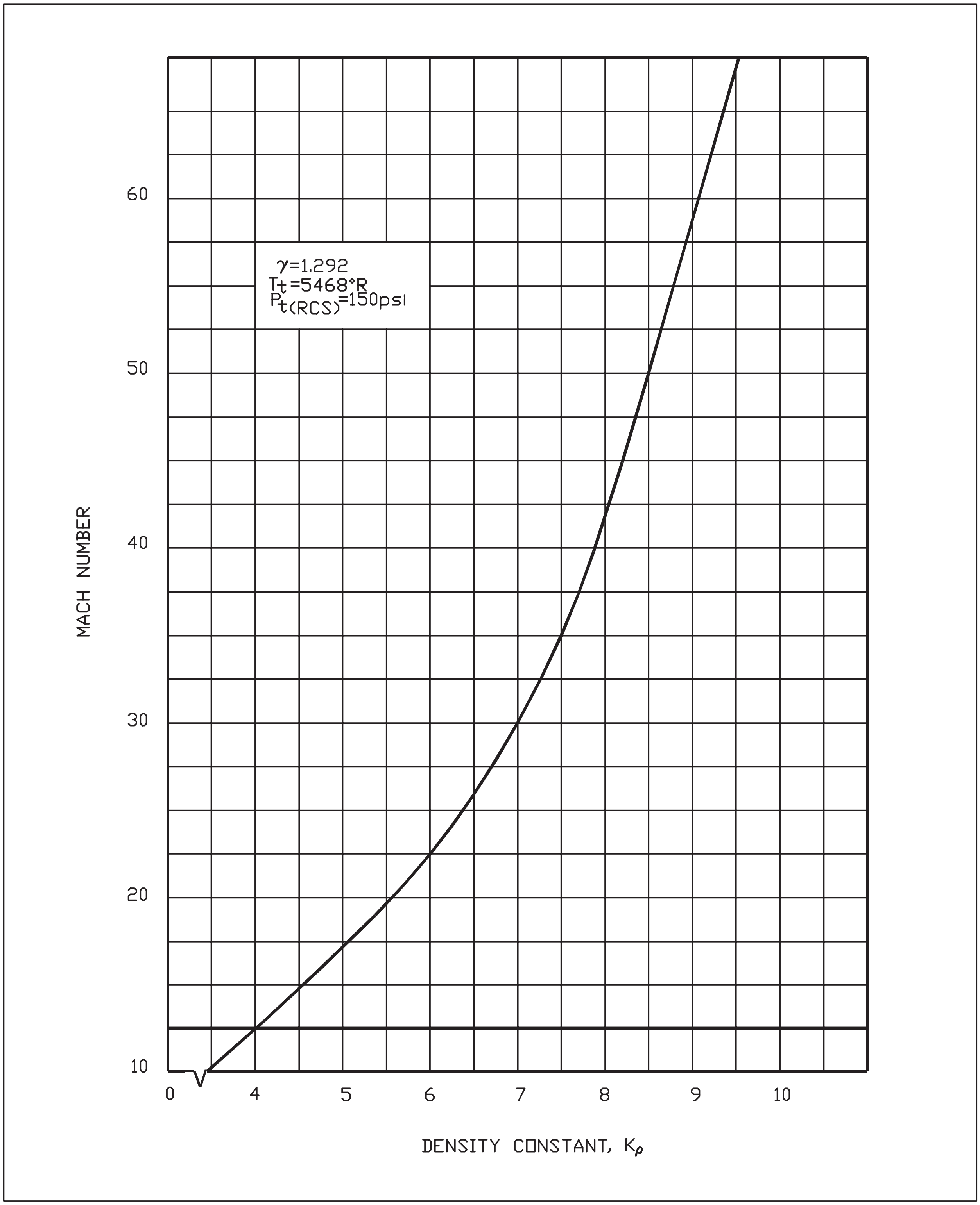


FIGURE 11.2.2-5 RCS PLUME MACH NUMBER AS A FUNCTION OF DENSITY CONSTANT, K/RHO

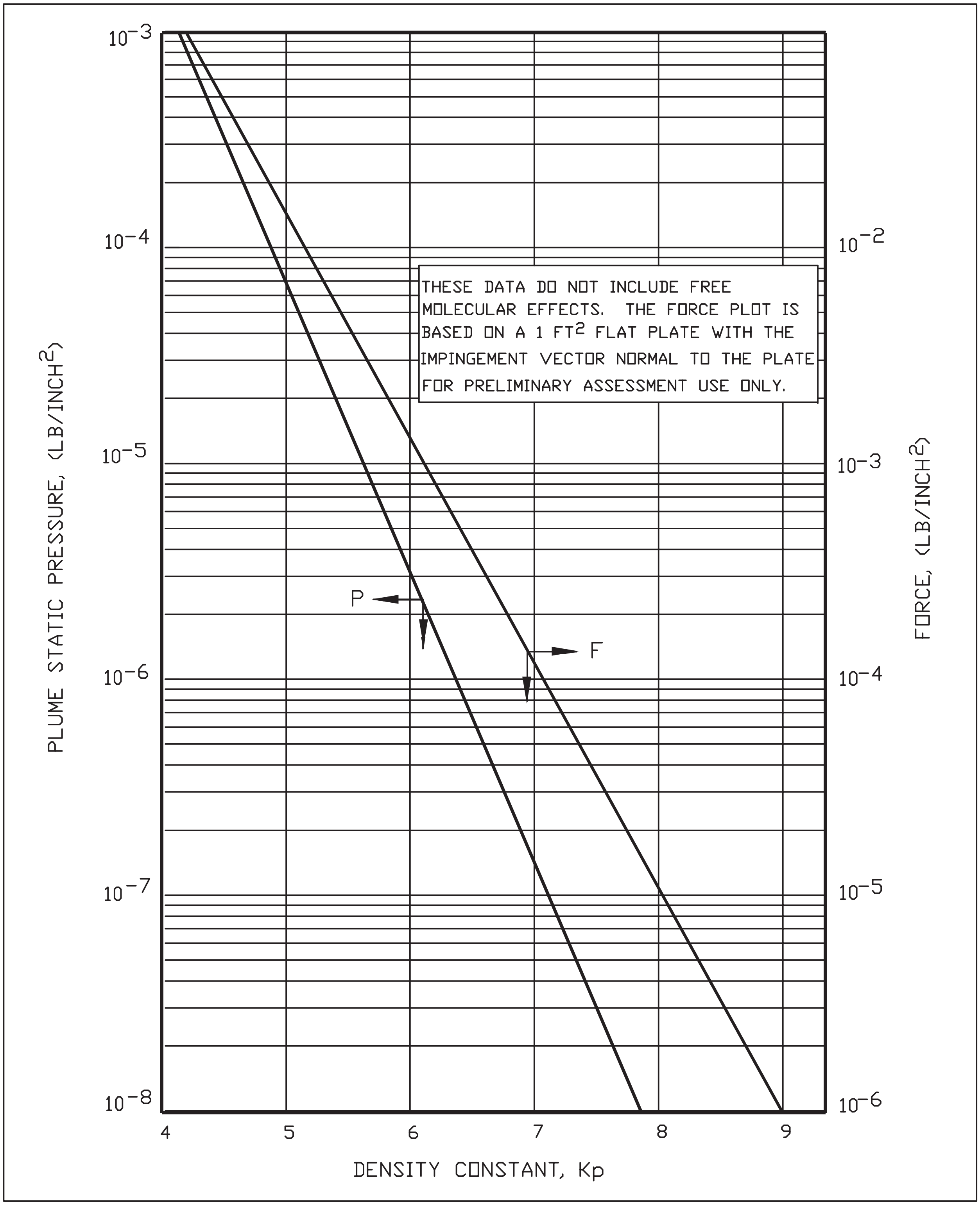


FIGURE 11.2.2-6 RCS PLUME STATIC PRESSURE AND IMPINGEMENT FORCE AS A FUNCTION OF DENSITY CONSTANT, K/RHO

THIS PAGE INTENTIONALLY LEFT BLANK.

12.0 (RESERVED)

THIS PAGE INTENTIONALLY LEFT BLANK.

13.2.3 Substitution of Cargo-Unique Items for Standard Service Items

13.2.3.1 Cables to Cargo Bay Panels (other than Bulkheads Xo576/Xo1307) for SMCH

Substitution of cargo-unique cables for SMCH cables shall be possible on a cable-by-cable basis.

13.2.3.2 Payload-Unique Panel for Standard Switch Panel

The substituted payload-unique panel shall provide connector interfaces identical to those in the SSP (1) for the SMCH cables leading to the Cargo, and (2) for any services provided to the Orbiter by the SSP.

13.2.4 Coding Used in Tables

In the connector summary tables under the column headed "WIRE TYPE", the following coding has been used:

COAX	coaxial
SC	single conductor
TXC	X-conductors, twisted[*]
TP	twisted pair
TSXC	X-conductors, twisted, shielded[*]
TSP	twisted shielded pair

[*]X = number of conductors

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)
 │    │      ┌─── CABLE NO. IN CONNECTOR (1 or 2 digit no.)
 X    X     XX
```

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

13.3 CABLE SCHEMATICS

13.3.1 Signal and Control

13.3.1.1 RF

RF signal and data cable interfaces and routing are shown, for information purposes, in Figure 13.3.1.1-1.

13.3.1.2 ML

ML signal cable interfaces and routing are shown, for information purposes, in Figure 13.3.1.2-1.

13.3.1.3 HO

HO signal and control cable interfaces and routing are shown, for information purposes, in Figure 13.3.1.3-1.

13.3.1.4 Get-Away-Special (GAS)

Get-Away-Special(GAS) ML signal cable interfaces and routing to accommodate the Get-Away-Special containers are shown, for information purposes, in Figure 13.3.1.4-1.

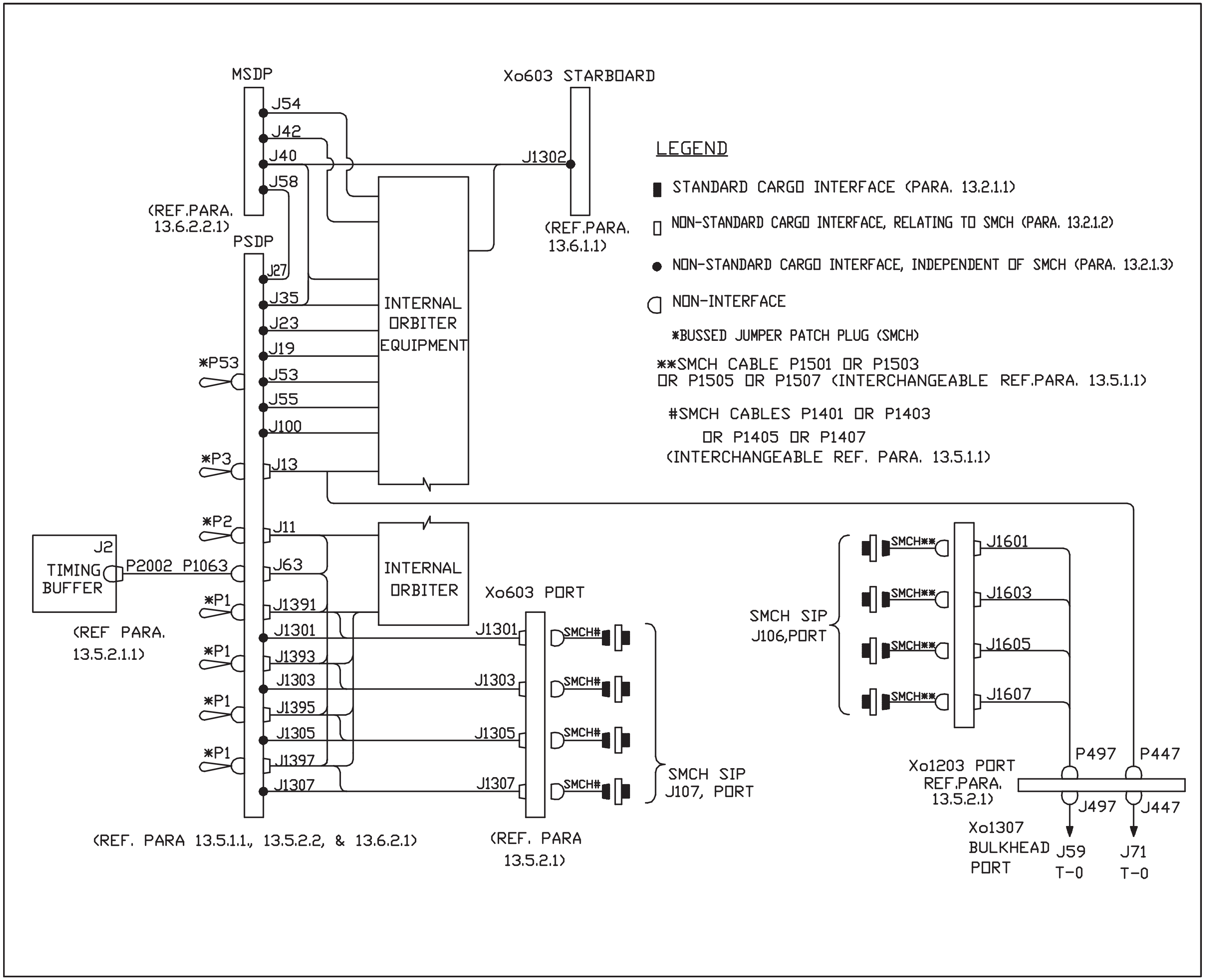


FIGURE 13.3.1.1-1 INTERFACE SCHEMATIC FOR RF CONNECTORS

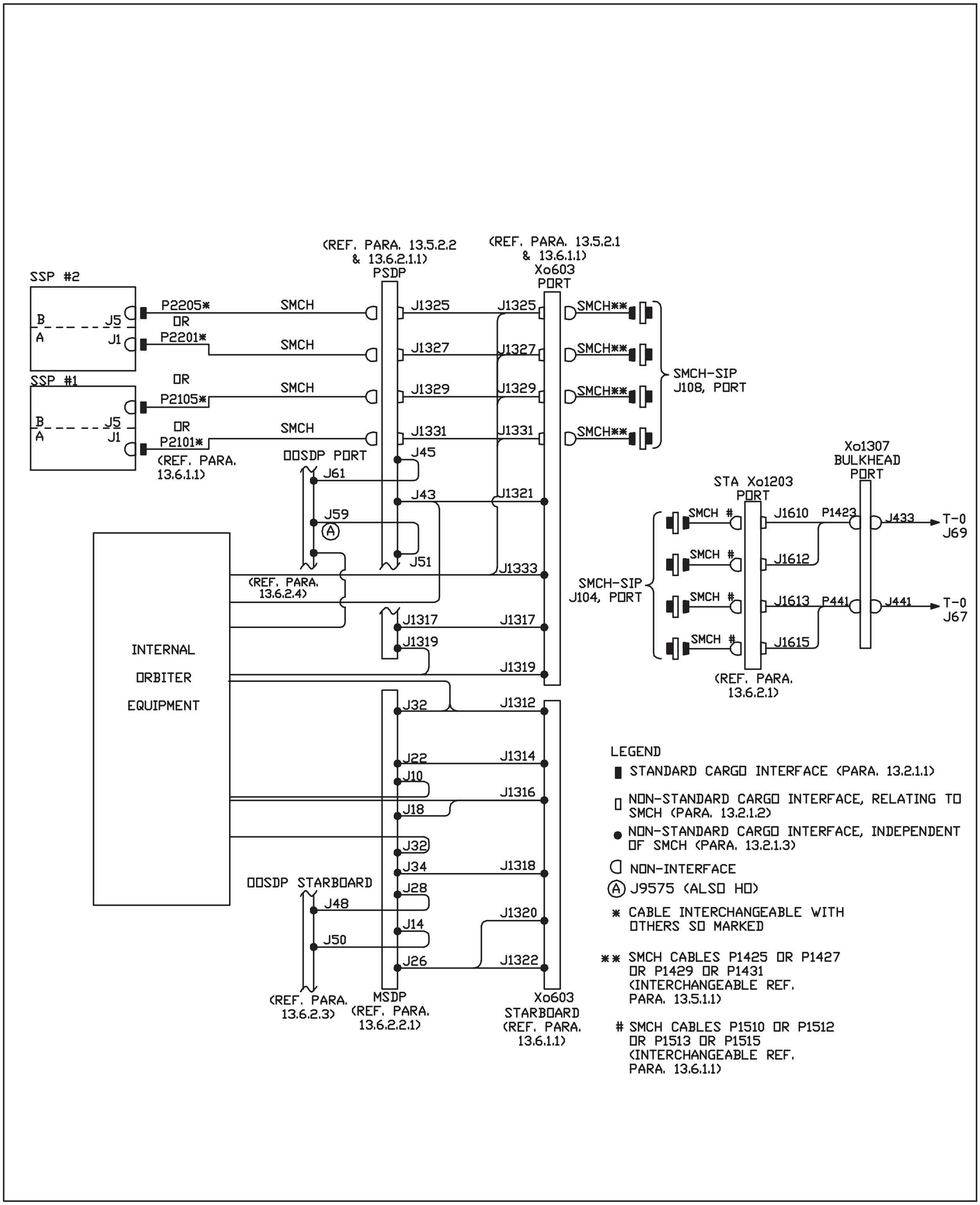


FIGURE 13.3.1.2-1 INTERFACE SCHEMATIC FOR ML CONNECTORS

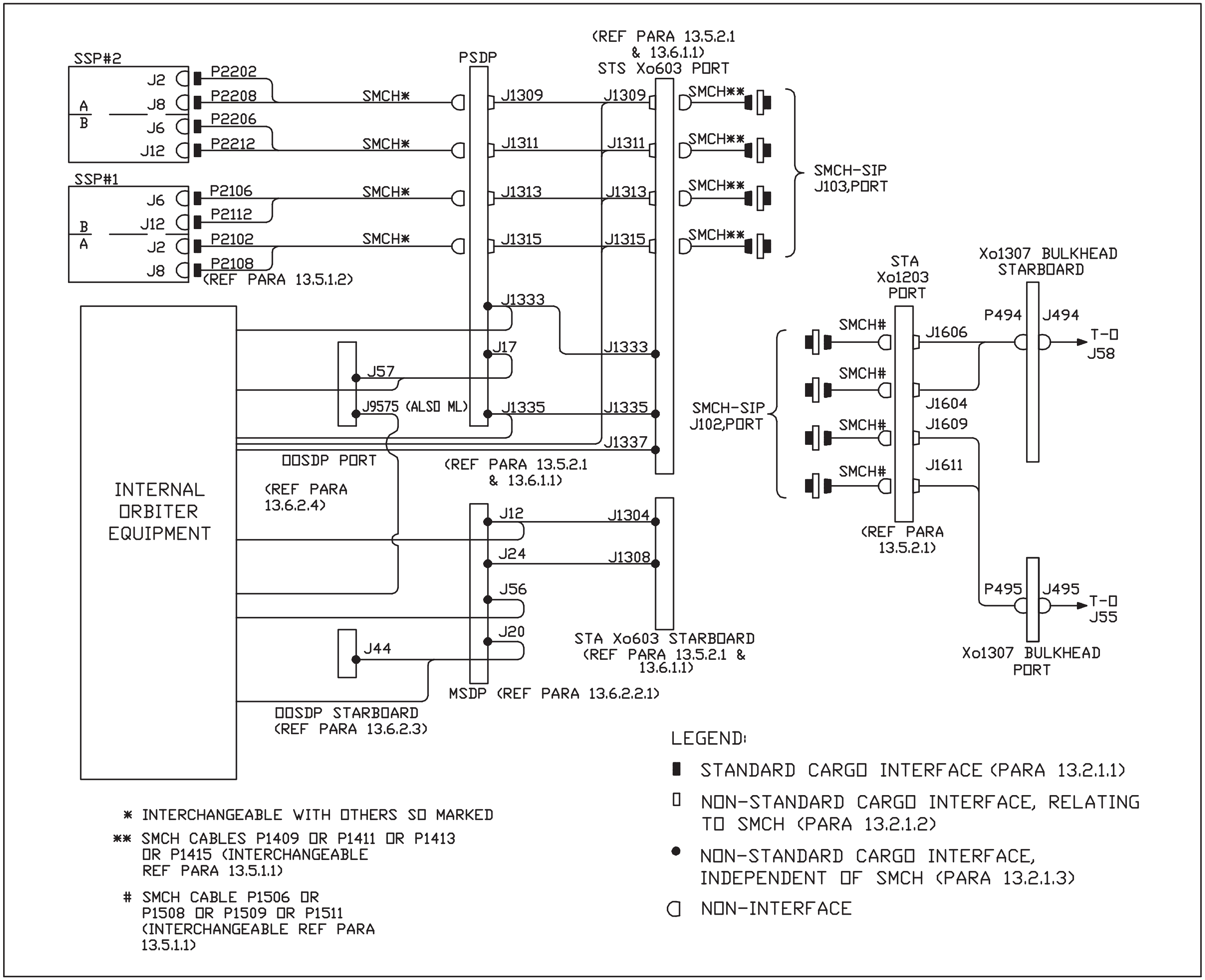


FIGURE 13.3.1.3-1 INTERFACE SCHEMATIC FOR HO CONNECTORS

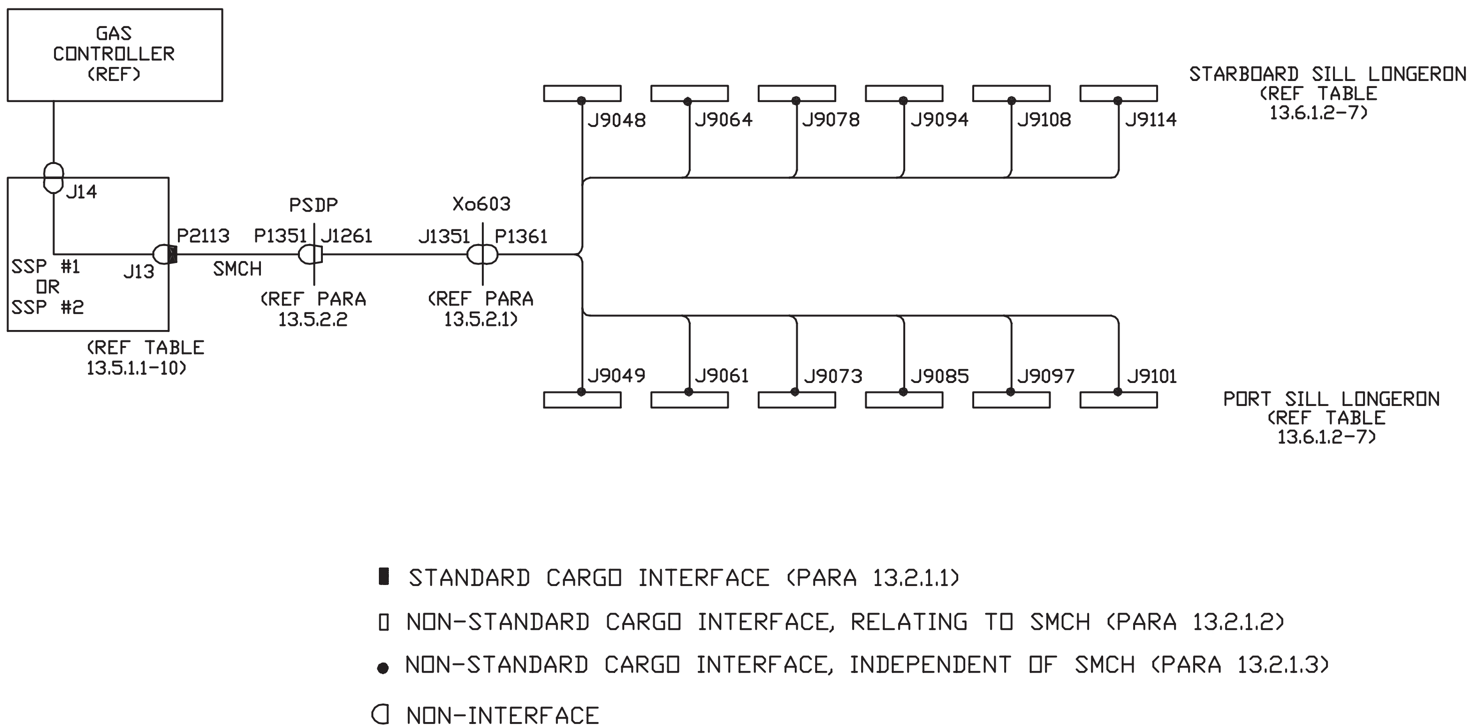


FIGURE 13.3.1.4-1 INTERFACE SCHEMATIC FOR GAS CONNECTORS

THIS PAGE INTENTIONALLY LEFT BLANK.

13.4 STANDARD PAYLOAD DISPLAY AND CONTROL INTERFACE (SPDCI)

13.4.1 CCTV Monitoring

The SPDCI shall provide monitoring of Closed Circuit TV (CCTV) for cargo element use. Performance characteristics of the CCTV monitor (number 3), mounted on the Television Monitor Panel (TVMP), are defined in Paragraph 8.2.8.

13.4.2 Standard Switch Panel (SSP)

The SPDCI shall provide two Standard Switch Panels (SSP) for cargo element use. Each SSP shall provide switching, circuit breaking, fusing and statusing for cargo element use, as well as a limited capability for controlling the conduct of experiments, and power control for pallets. SSP payload switching and statusing interface schematics are shown in Figures 13.4.2-1 and 13.4.2-2, respectively. The SSP circuit protection and power distribution is as shown in Figure 13.4.2-3. Also identified, for reference purposes, are the connector/pin terminations at the cargo end of the standard mixed cargo harness in the AFD. The round-trip circuit resistance between the SSP and the cargo element interface shall not exceed 4.0 ohms (1.0 ohm when four parallel wires are used). All wire within the SSP is 22AWG unless otherwise noted. SSP circuit protection and power distribution is shown in Figure 13.4.2-3. SSP component characteristics shall be as shown in Table 13.4.2-1 and Table 13.4.2-2 and the following specifications:

Toggle Switch	ME452-0102
Circuit Breaker	MC454-0026
Fuse	ME451-0018
Event Indication	MC432-0222

13.4.3 Cargo Element Deployment and Pointing

The SPDCI shall provide for cargo element deployment and cargo element manual pointing by means of a Deployment Panel and an attached Manual Pointing Controller (MPC) which operates in conjunction with it. The cargo element interface schematic is shown in Figure 13.4.3-1.

13.4.3.1 Manual Pointing Controller (MPC)

A portable hand-held MPC shall be available to crew members in various AFD locations for initiating pointing commands to an Orbiter cargo element. The MPC shall provide an LED Power ON-OFF indication capability, toggle switches for varying control characteristics, a two-axis, force-operated joystick which produces continuously variable outputs and two push-button switches for roll access control.

13.4.3.2 Deployment/Pointing Panel (DPP)

The Deployment/Pointing Panel shall provide (1) selection, arming and firing switch functions for pyrotechnic devices, and (2) signal conditioning interfaces between the attached MPC and Orbiter circuits. The characteristics of the rotary switches and the toggle switches shall be as specified in specifications ME452-0093 and ME452-0102, respectively. Signal characteristics of the pointing output functions are defined in Table 13.4.3.2-1.

13.4.4 Computer Interface Panel (CIP)

The CIP shall provide an interface panel for the Payload General Support Computer (PGSC). The panel will make available two switchable power output connectors and four feed through connectors for PGSC access to payload bay payload elements. The power toggle swith characteristics shall be as specified in specification ME452-0102. The CIP schematic is shown in Figure 13.4.4-1.

13.4.5 Payload Data Interface Panel (PDIP)

The PDIP shall provide an interface panel for the Payload General Support Computer (PGSC), as well as generic data switching capability. The panel will make available two switchable power output connectors, four feed through connectors for PGSC access to payload bay payload elements and a three position switch for relay control of 5 inputs and three outputs located on 2 connectors. The toggle switch and relay characteristics shall be as specified in specifications ME452-0102 and MC455-0129, respectively. The PDIP input/output matrix is shown in Table 13.4.5-1. The PDIP switch functionality matrix for S3 is shown in Table 13.4.5-2. The PDIP schematic is shown in Figure 13.4.5-1.

TABLE 13.4.2-1 SSP TOGGLE SWITCH CHARACTERISTICS

Switch Ident.	No. of Poles	No. of Pos.	Operations	Volt Rating	Amp Rating
S1,S2,S5,S9,S13 S14,S17,S21	2	3	momentary ON maintained OFF momentary ON	32 VDC	5
S10,S22	2	2	maintained ON maintained ON	32 VDC	5 (10*)
S3,S4,S6,S7,S8, S11,S15,S16,S18, S19,S20,S23	2	2	maintained ON maintained ON	32 VDC	5
S12,S24	2	3	maintained ON maintained OFF maintained ON	32 VDC	5

* Up to 10 amperes for 2 seconds maximum with unique harness required

Ref. Figure 13.4.2-1

TABLE 13.4.2-2 SSP PAYLOAD STATUS INDICATOR CHARACTERISTICS

Indicator Identification	Type	VDC	Input Impedance Kilohms
DS1, DS2, DS13, DS14	3 position(1)	28 VDC	35.3±3.3
DS3 to DS12, DS15 to DS24	2 Position(2)	28 VDC	28±3

Ref. Figure 13.4.2-2

(1) Full ON indication given (up or down) for greater than 18 VDC applied.
Full OFF indication given (center position) for zero volts applied.

(2) Full ON indication given for greater than 18 VDC applied.
Full OFF indication given for less than 5 VDC applied.

TABLE 13.4.3.2-1 SIGNAL CHARACTERISTICS OF POINTING CONTROLLER OUTPUT FUNCTIONS

Parameter	Dimension	Characteristics	Notes
Roll	Volts DC (discrete)	HI: +5 ± 1.0 LO: 0 ± 0.5	Compatible with MDM
Mode			
Gain			
MPC On			
Pitch	Volts DC (analog)	Balanced Differential +5.11 to -5.12	
Yaw			

TABLE 13.4.5-1 PDIP Input/Output Matrix

	CONNECTOR NUMBER	PIN NUMBERS SIGNAL, RETURN
INPUT 1	J4	17, 22
INPUT 2	J4	15, 16
INPUT 3	J5	19, 20
INPUT 4	J5	21, 22
INPUT 5	J5	5, 6
OUTPUT 1	J5	15, 16
OUTPUT 2	J5	17, 18
OUTPUT 3	J5	13, 14

TABLE 13.4.5-2 PDIP Switch Functionality Matrix for S3

SWITCH POSITION	INPUTS 1	2	3	4	5
LOW	-	OUTPUT 2	-	OUTPUT 1	OUTPUT 3
CENTER	-	-	OUTPUT 2	OUTPUT 1	OUTPUT 3
HIGH	OUTPUT 3	OUTPUT 1	OUTPUT 2	-	-

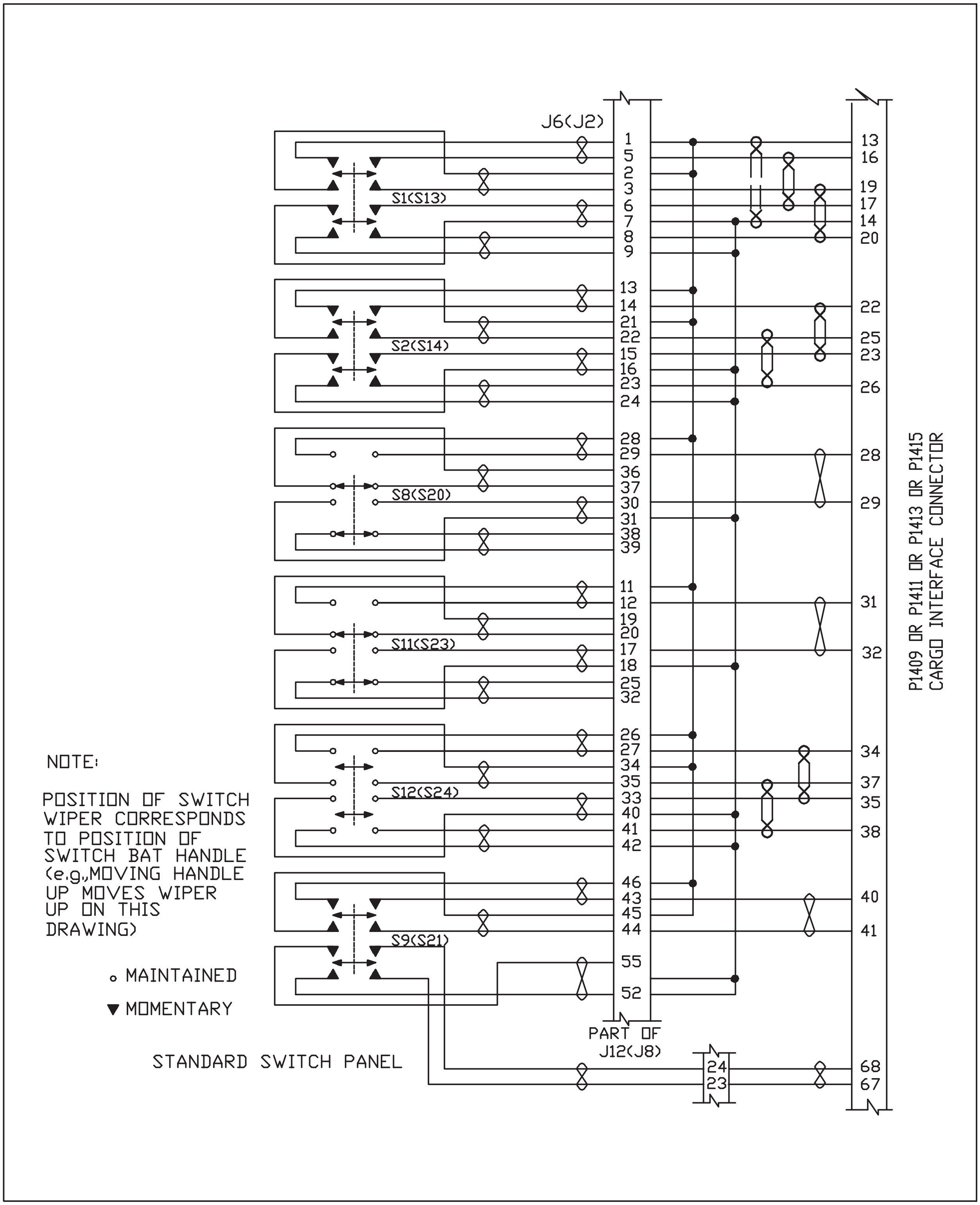


FIGURE 13.4.2-1 SSP CARGO ELEMENT SWITCHING AND FUSING INTERFACE SCHEMATIC
(SHEET 1 OF 2)

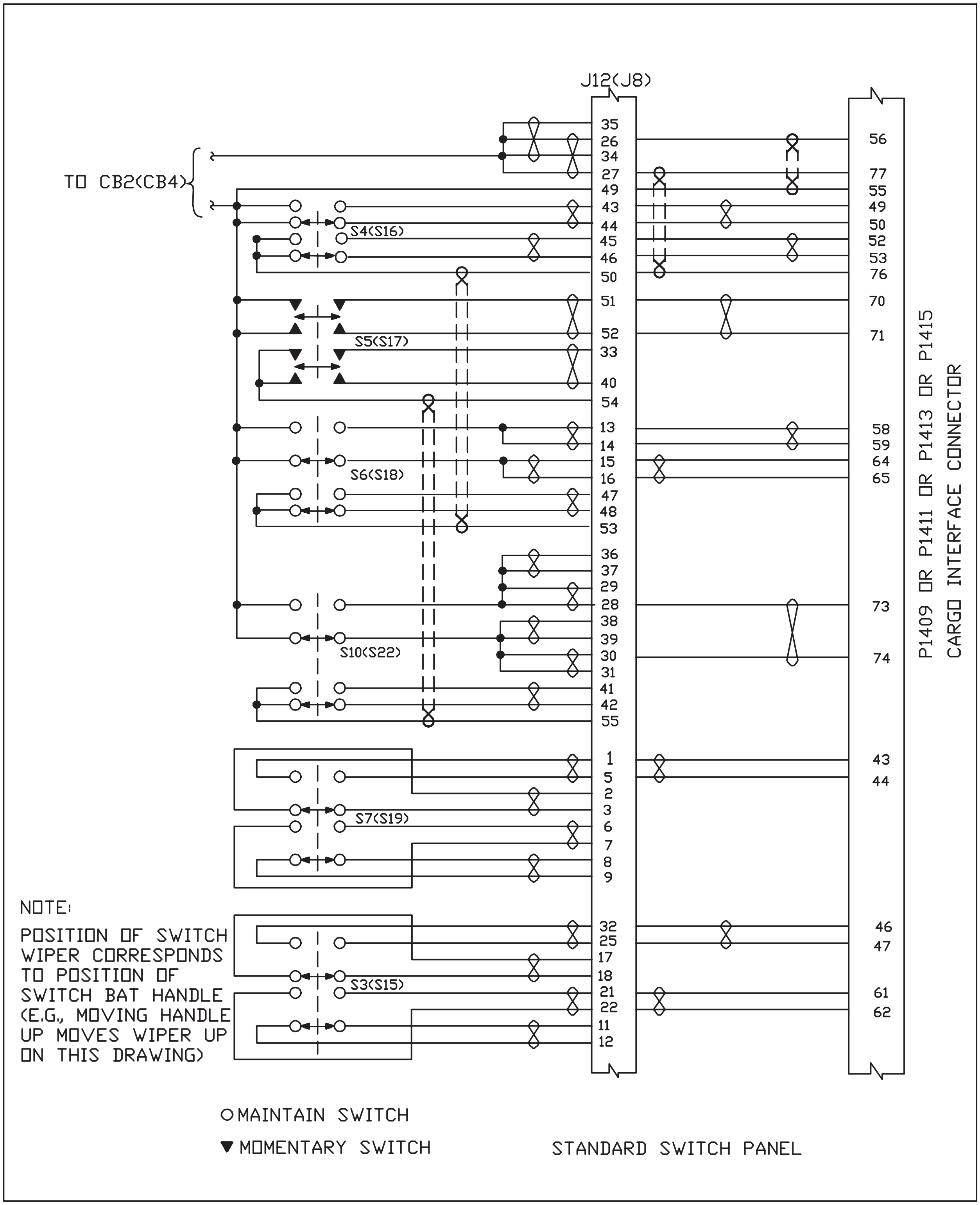


FIGURE 13.4.2-1 SSP CARGO ELEMENT SWITCHING AND FUSING INTERFACE SCHEMATIC
(SHEET 2 OF 2)

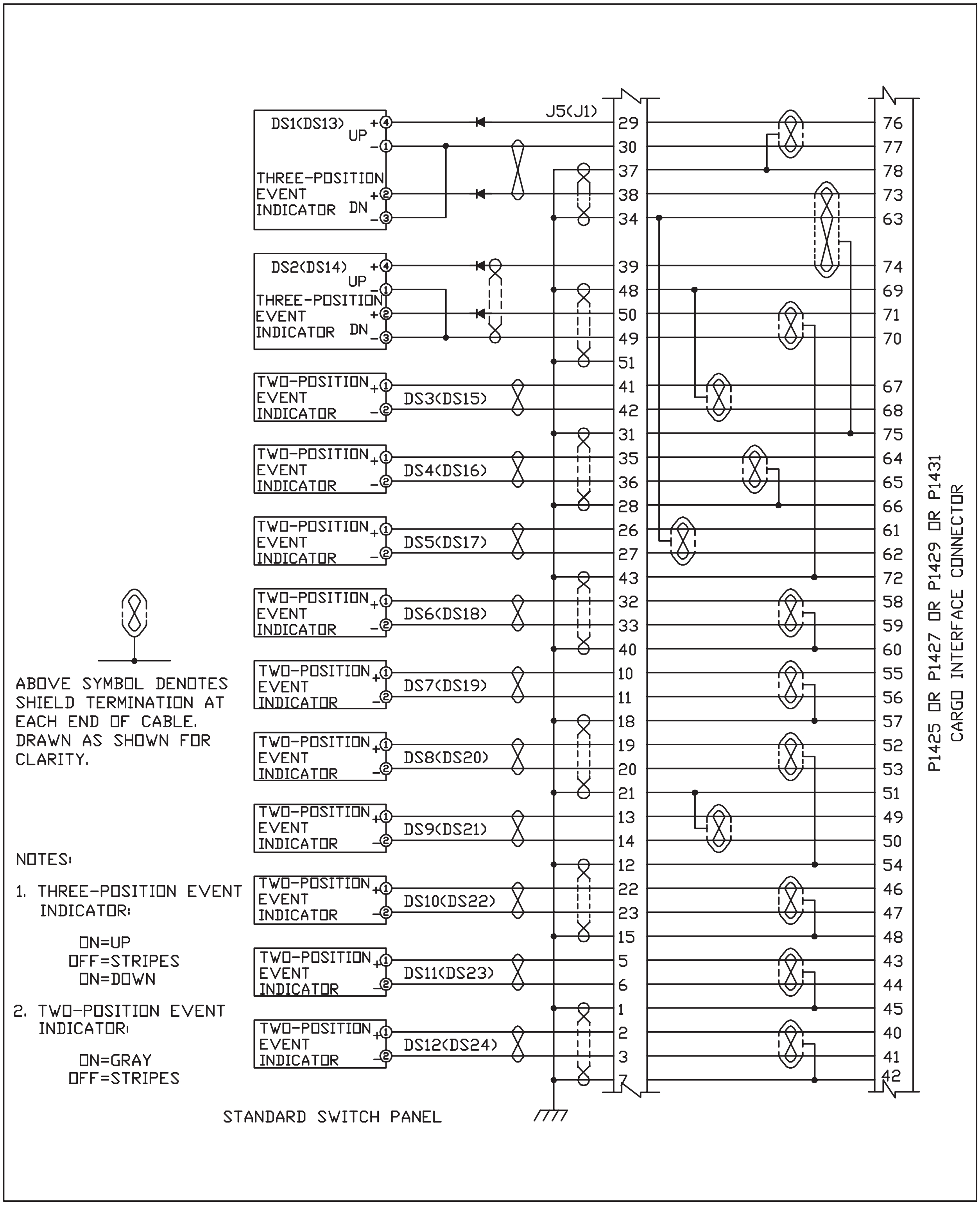


FIGURE 13.4.2-2 SSP CARGO ELEMENT INDICATOR INTERFACE SCHEMATIC

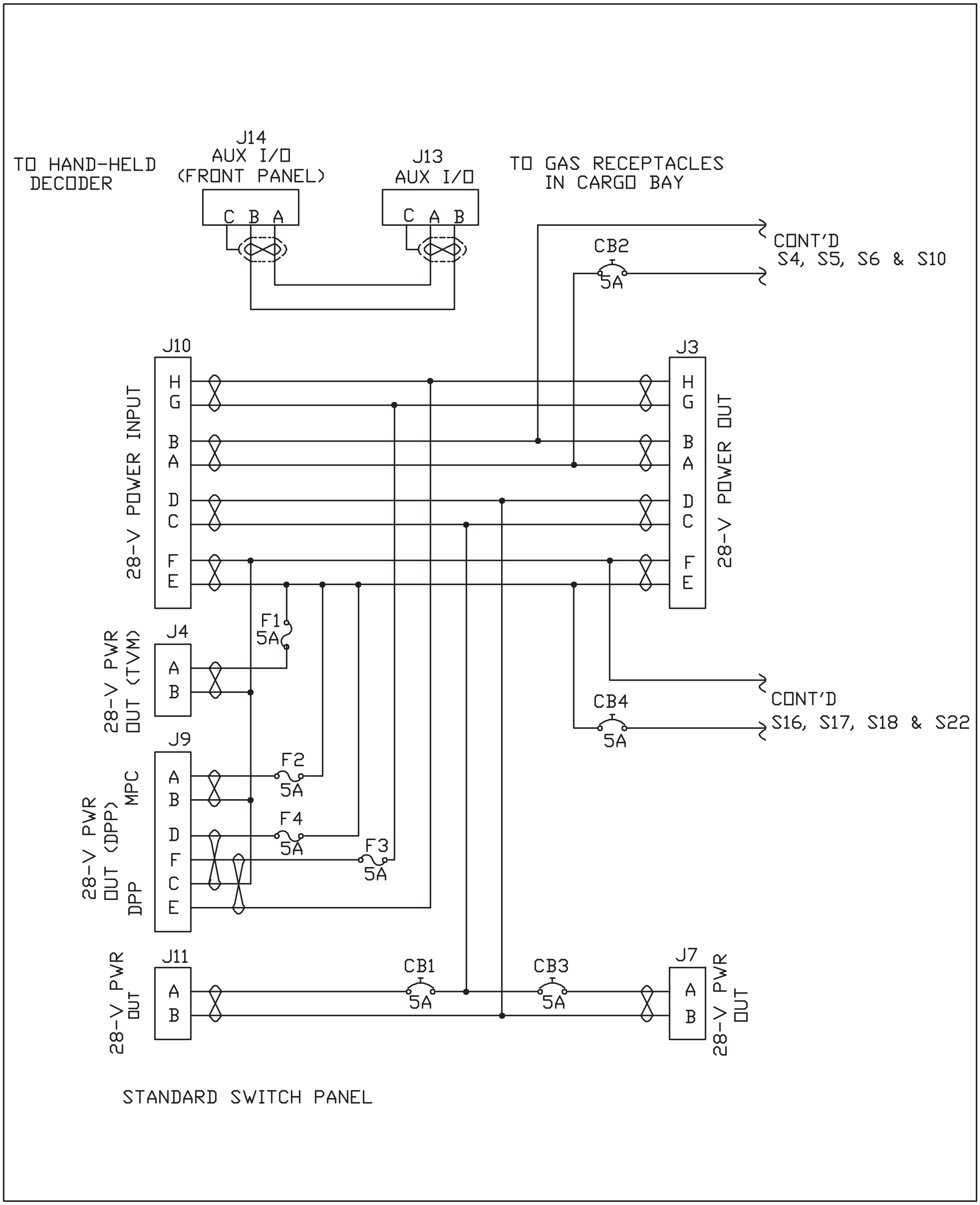


FIGURE 13.4.2-3 SSP POWER AND AUXILIARY I/O INTERFACES

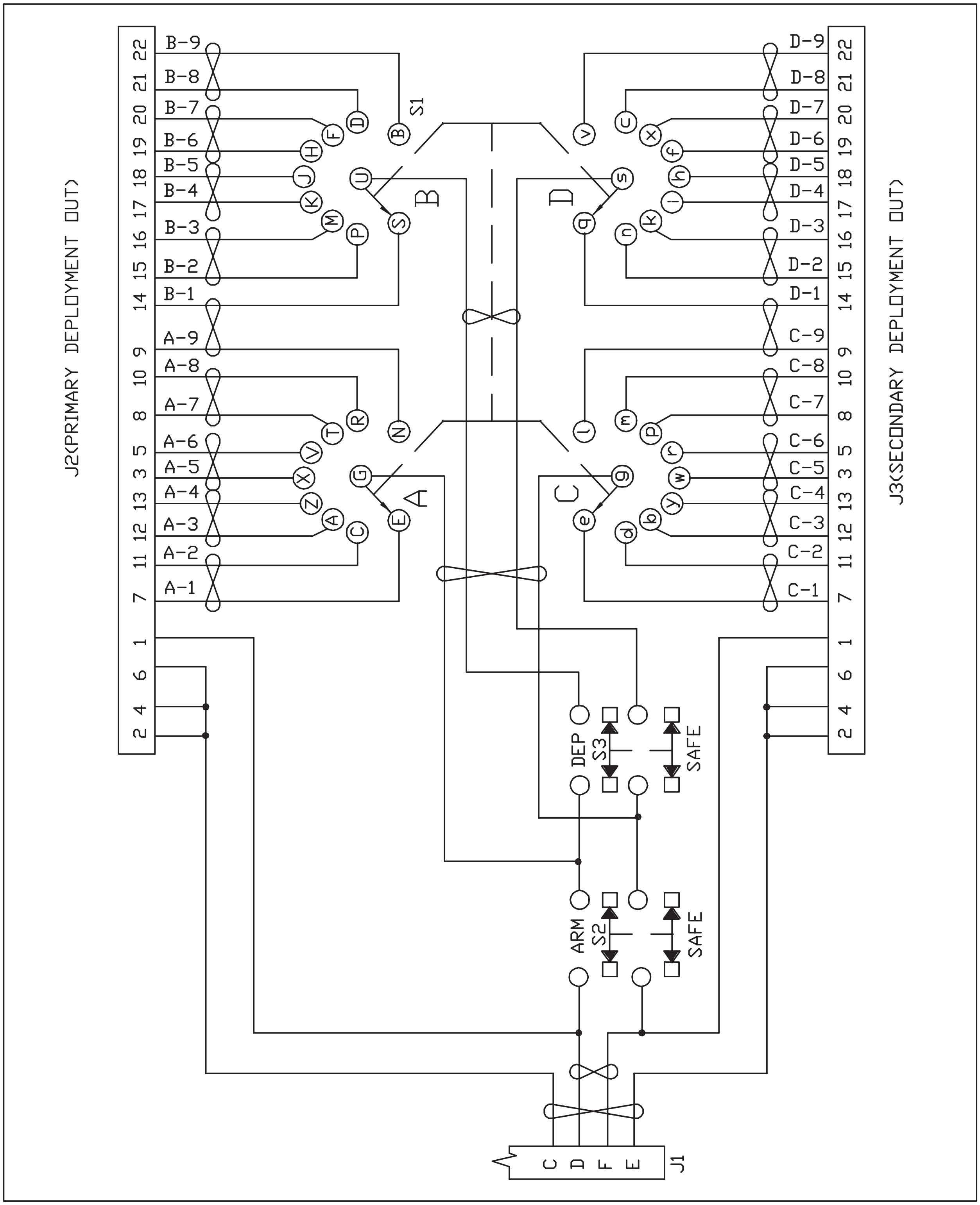


FIGURE 13.4.3-1 DEPLOYMENT/POINTING PANEL INTERFACE SCHEMATIC

(SHEET 1 OF 3)

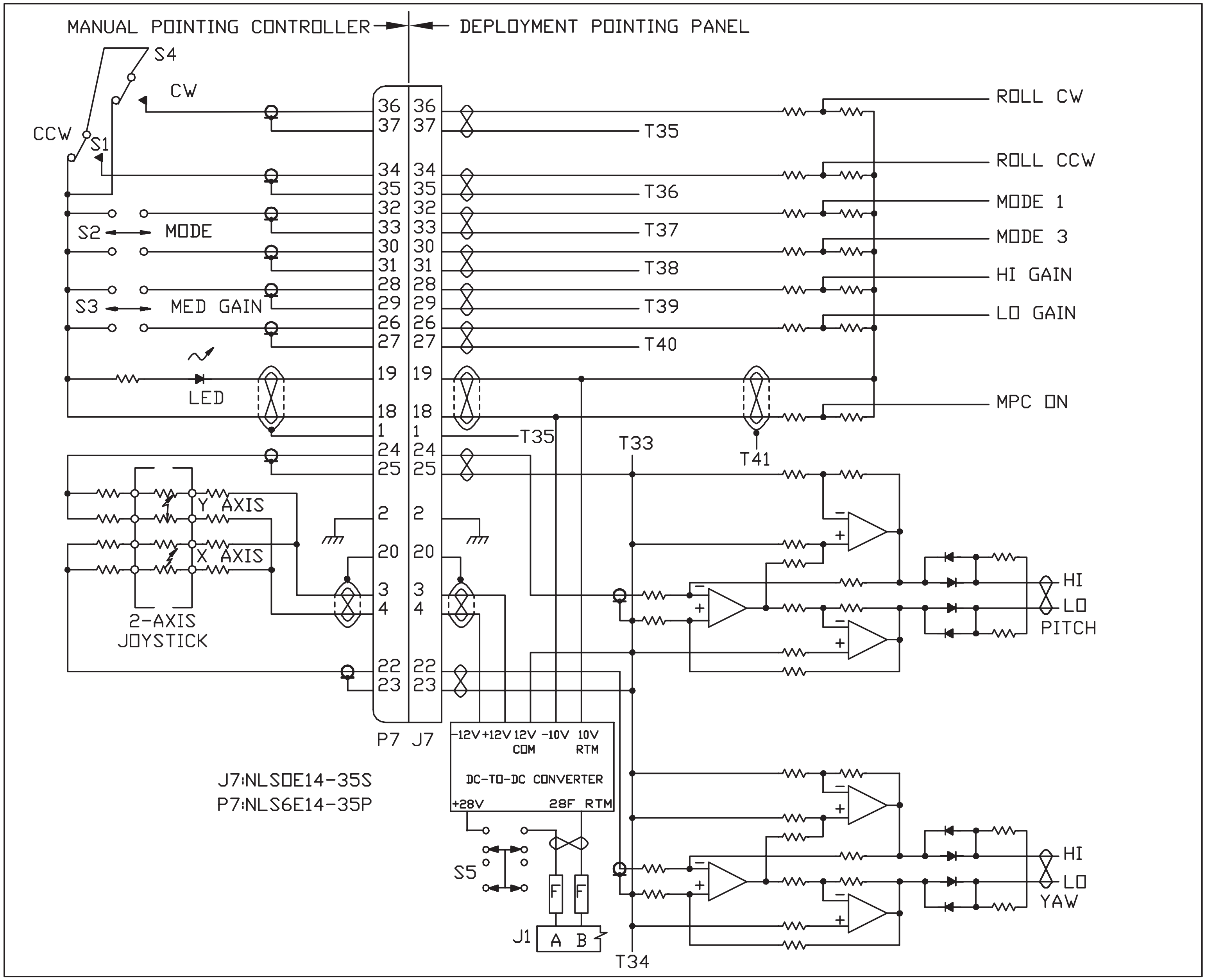


FIGURE 13.4.3-1 DEPLOYMENT/POINTING PANEL INTERFACE SCHEMATIC

(SHEET 2 OF 3)

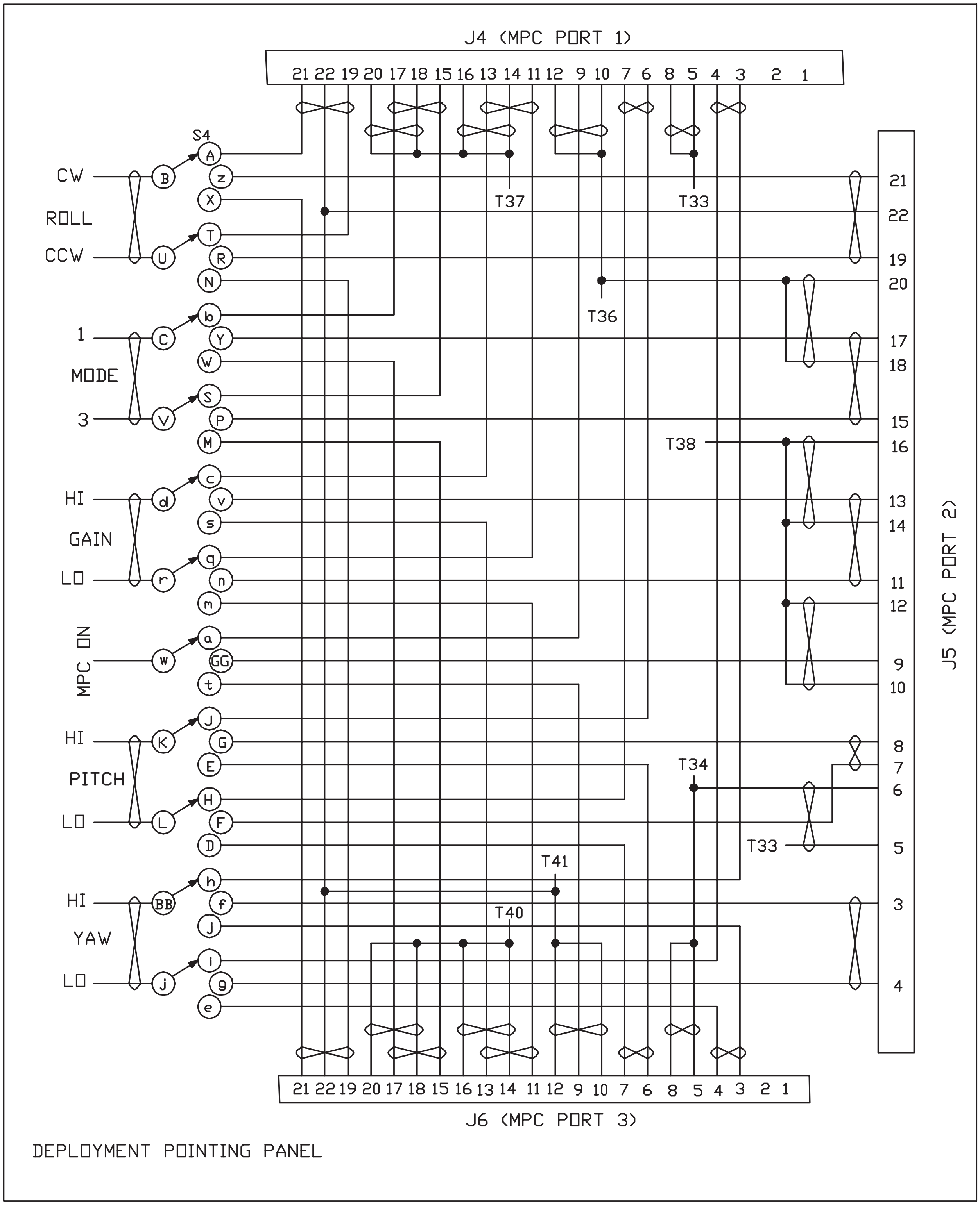


FIGURE 13.4.3-1 DEPLOYMENT/POINTING PANEL INTERFACE SCHEMATIC

(SHEET 3 OF 3)

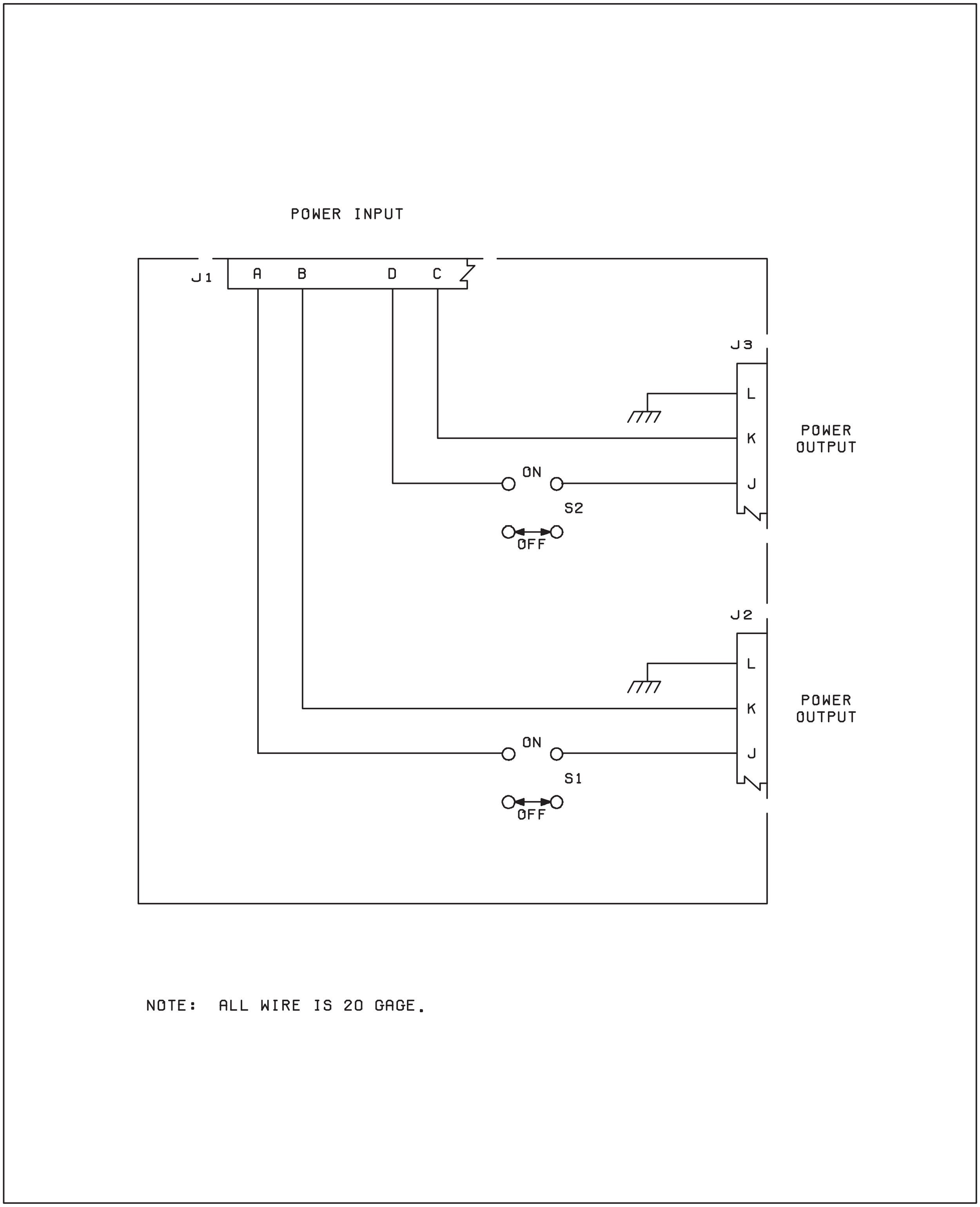


FIGURE 13.4.4-1 COMPUTER INTERFACE PANEL (CIP) SCHEMATIC

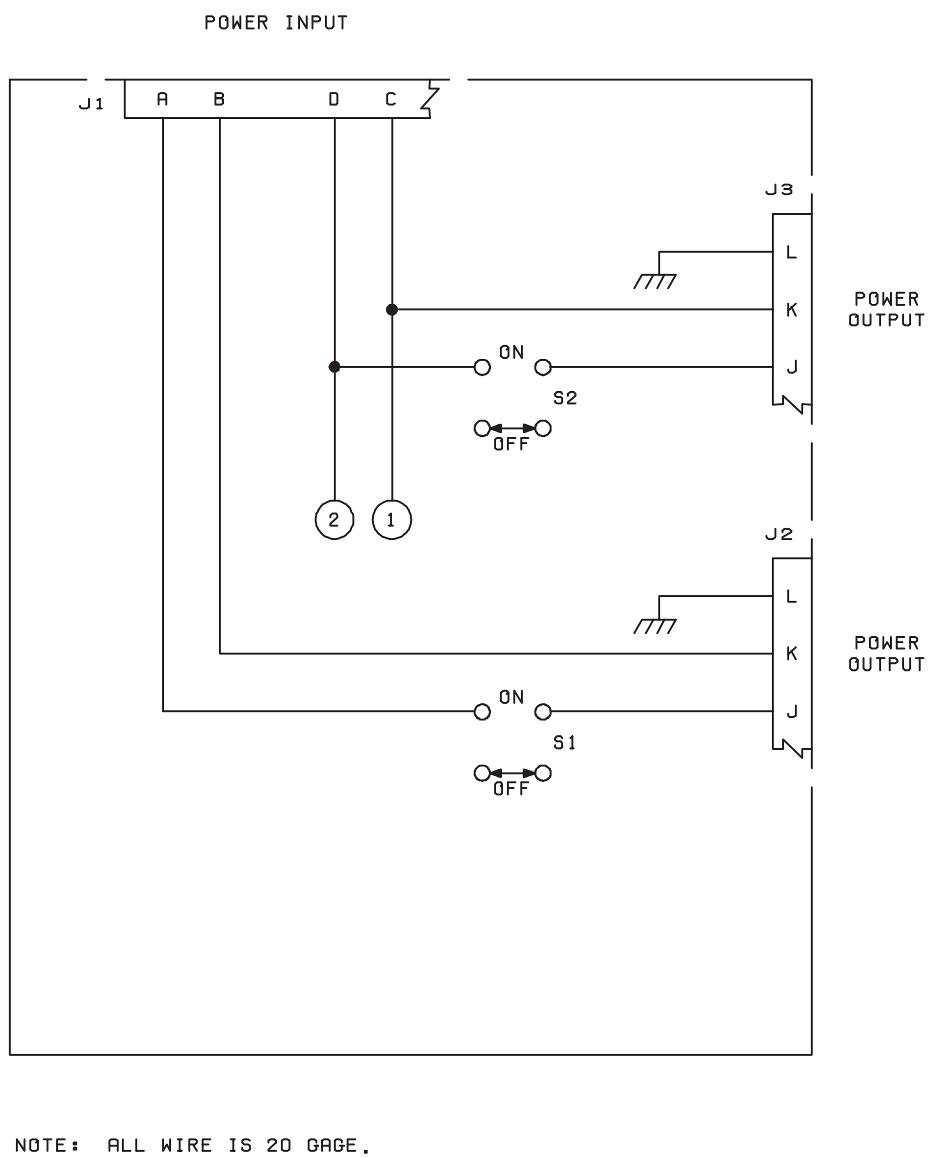


FIGURE 13.4.5-1 PAYLOAD DATA INTERFACE PANEL (PDIP) SCHEMATIC
(SHEET 1 OF 2)

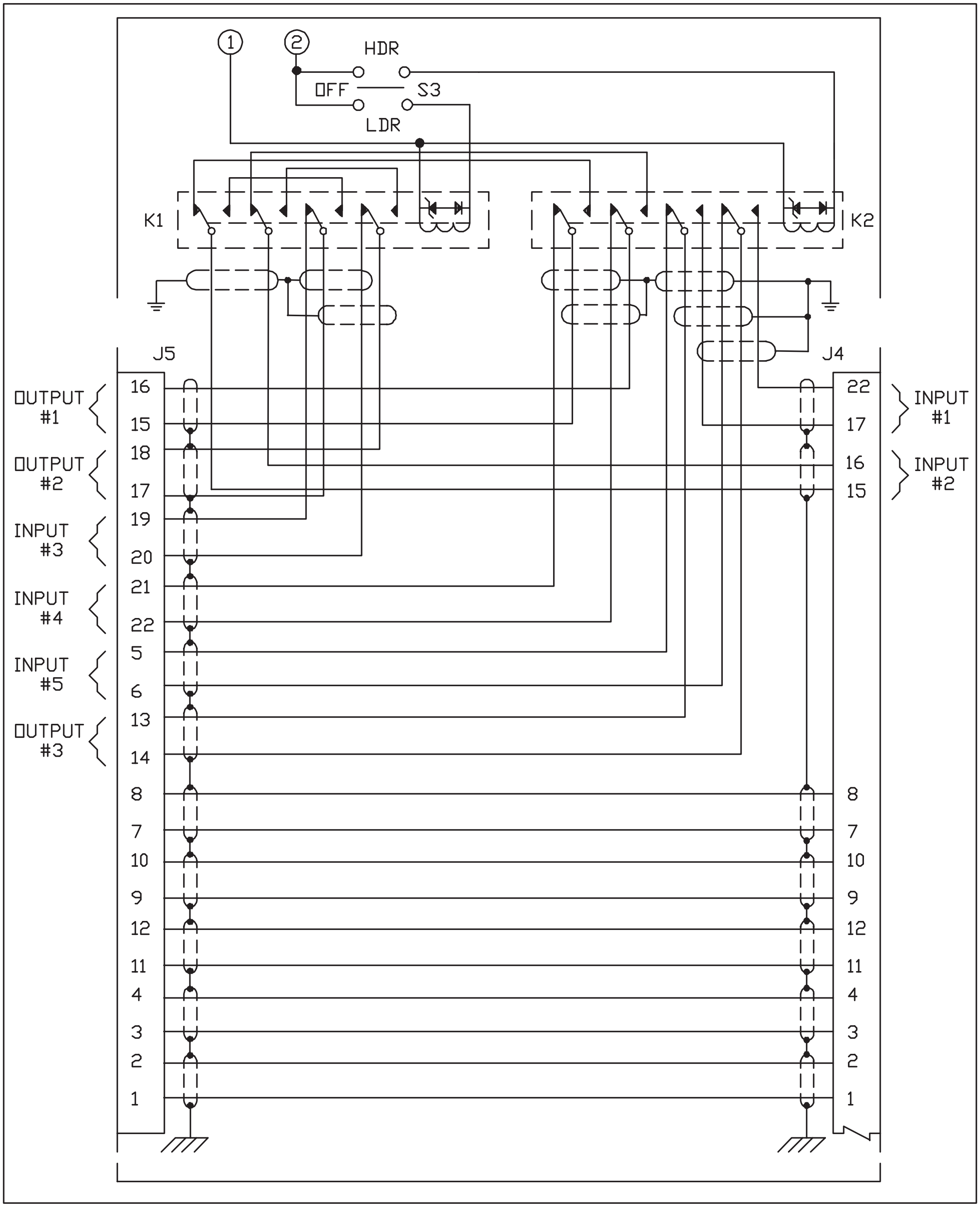


FIGURE 13.4.5-1 PAYLOAD DATA INTERFACE PANEL (PDIP) SCHEMATIC

(SHEET 2 OF 2)

THIS PAGE INTENTIONALLY LEFT BLANK.

13.6 NON-STANDARD CARGO INTERFACES (INDEPENDENT OF SMCH)

13.6.1 Connectors in Cargo Bay

The non-standard cargo electrical interfaces (independent of SMCH) in the Cargo Bay are summarized in Table 13.6.1-1. Also included is the indication of the table in which pin assignments for each connector are defined.

13.6.1.1 Signal and Control

Signal and control connector/pin assignments are defined in Tables 13.6.1.1-1 through 13.6.1.1-9 (starboard side) and Tables 13.6.1.1-10 through 13.6.1.1-16 (port side).

13.6.1.2 Electrical Power

Electrical power connector/pin assignments are defined in Tables 13.6.1.2-1 through 13.6.1.2-7.

13.6.1.3 Coaxial

Coaxial connectors are defined in Table 13.6.1-1.

13.6.1.4 RMS End Effector

Pin assignments for RMS end effector/cargo element interface are defined in Table 13.6.1.4-1.

13.6.1.5 Get-Away-Special (GAS)

Connector and pin assignments for GAS interfaces in the cargo bay are defined in Table 13.6.1.2-7.

13.6.2 Connectors in Aft Flight Deck

13.6.2.1 Connectors on Payload Station Distribution Panel (PSDP)

Non-standard cargo electrical interfaces (independent of SMCH) of the connectors on the PSDP are summarized in Table 13.6.2.1-1. Also included is the indication of the table in which the remaining pin assignments for each connector are defined. Each table includes only those pin assignments which have not already been defined in Paragraph 13.5.1, and its sub-paragraphs, or in Paragraph 13.6.1, and its sub-paragraphs.

13.6.2.1.1 Signal and Control

PSDP signal and control connector/pin assignments are defined in Tables 13.6.2.1.1-2 through 13.6.2.1.1-21.

13.6.2.1.2 Electrical Power

PSDP electrical power connector/pin assignments are defined in Tables 13.6.2.1.2-2 through 13.6.2.1.2-4.

13.6.2.1.3 Coaxial

PSDP coaxial connectors are identified in Table 13.6.2.1-1. Pin assignment tables are not required.

13.6.2.1.4 Timing Buffer

PSDP connector/pin assignments are defined in Table 13.6.2.1.4-1.

13.6.2.1.5 Get-Away-Special

Connector and pin assignments for Aft Flight Deck GAS interfaces on the SSP are defined in Figure 13.4.2-3.

13.6.2.2 Connectors on Mission Station Distribution Panel (MSDP)

The non-standard cargo electrical interfaces (independent of SMCH) of the connectors on the MSDP are summarized in Table 13.6.2.2-1. Also included is the indication of the table in which the remaining pin assignments for each connector are defined. Each table includes only those pin assignments which have not already been defined in Paragraph 13.5.1, and its sub paragraphs, or Paragraph 13.6.1, and its sub-paragraphs, or Paragraph 13.6.2.1, and its sub paragraphs.

13.6.2.2.1 Signal and Control

MSDP signal and control connector/pin assignments are defined in Tables 13.6.2.2.1-1 through 13.6.2.2.1-15.

13.6.2.2.2 Electrical Power

MSDP electrical power connector/pin assignments are defined in Tables 13.6.2.2.2-1 through 13.6.2.2.2-3.

13.6.2.2.3 Coaxial

MSDP Coaxial connectors are identified in Table 13.6.2.2-1. Pin assignment tables are not required.

13.6.2.3 Connectors on Starboard On-Orbit Station Distribution Panel (OOSDP)

The non-standard cargo electrical interfaces (independent of SMCH) of the connectors on the starboard OOSDP are summarized in Table 13.6.2.3-1 and defined in Tables 13.6.2.3-2 through 13.6.2.3-5. Also included is the indication of the table in which the remaining pin assignments for each connector are defined. Each table includes only those pin assignments which have not already been defined in Paragraphs 13.5.1, and its sub-paragraphs, or 13.6.2.1, and its sub-paragraphs, or 13.6.2.2, and its sub-paragraphs.

13.6.2.4 Connectors on Port On-Orbit Station Distribution Panel

The non-standard cargo electrical interfaces (independent of SMCH) of the connectors on the port OOSDP are summarized in Table 13.6.2.4-1 and defined in Tables 13.6.2.4-2 through 13.6.2.4-5. Also included is the indication of the Table in which the remaining pin assignments for each connector are defined. Each table includes only those pin assignments which have not already been defined in Paragraphs 13.5.1, and its sub-paragraphs, or 13.6.2.1, and its sub-paragraphs, or 13.6.2.2, and its sub-paragraphs.

TABLE 13.6.1-1 SUMMARY OF CONNECTORS AVAILABLE AS NON-STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE CARGO BAY

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO.	PANEL LOCATION
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS				
J1/GAS	1	TQ	EO	12	13.6.1.2-7	NLS0T12-35S	NLS6GT12-35P	SEE TABLE 3.3.3-1
	1	TP	ML					
	4	SC	HO					
J2	1	TQ	EO	14	13.6.1.2-7	NLS0T12-35SA	NLS6GT12-35PA	SEE TABLE 3.3.3-1
	4	SC	HO					
J37	1	TP	HO	1	13.6.1.2-1	ME414-0234-7106	ME414-0235-7101	STA Xo 645, STBD
	1	SC	HO					
J38	1	TP	HO	2	13.6.1.2-2	ME414-0234-7106	ME414-0235-7101	STA Xo 645, STBD
J411	2	TP	HO	26	13.6.1.4-1	5114001897-1	SG459/010-102	(2)
	2	TSP	ML					
	1	T4C	HO					
	1	TS4C	ML					
	6	SC	HO					
J701	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	STA Xo 603, PORT
J701	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	BKHD Xo 1307, PORT
J702	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	STA Xo 603, PORT
J703	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J703	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	BKHD Xo 1307, PORT
J704	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J705	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J705	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	BKHD Xo 1307, PORT
J706	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J707	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J707	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	BKHD Xo 1307, PORT
J708	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J709	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J710	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J711	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J712	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J713	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011	STA Xo 603, PORT
J732	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	STA Xo 1203, STBD
J734	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	STA Xo 1203, STBD
J736	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	STA Xo 1203, STBD
J738	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306	STA Xo 1203, STBD
J1302	21	TSP	RF	37	13.6.1.1-1	NLS0T20-35S	NLS6GT20-35P	STA Xo 603, STBD
J1304	16	TP	HO	47	13.6.1.1-8	NLS0T20-35SA	NLS6GT20-35PA	STA Xo 603, STBD
J1306	1	TQ	EO	15	13.6.1.2-5	NB0E14-19SNT3	NB6GE14-19PNT3	STA Xo 603, STBD
J1308	16	TP	HO	22	13.6.1.1-9	NLS0T20-35SA	NLS6GT20-35PA	STA Xo 603, STBD
	5	T5C	HO					
J1310	1	TQ	EO	15	13.6.1.2-6	NB0E14-19SNT3	NB6GE14-19PNT3	STA Xo 603, STBD

TABLE 13.6.1-1 SUMMARY OF CONNECTORS AVAILABLE AS NON-STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE CARGO BAY

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO.	PANEL LOCATION
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS				
J1312	13	TSP	ML	22	13.6.1.1-2	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, STBD
	3	TS5C	ML					
J1314	20	TSP	ML	19	13.6.1.1-3	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, STBD
J1316	21	TSP	ML	16	13.6.1.1-4	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, STBD
J1317	13	TSP	ML	40	13.6.1.1-10	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, PORT
J1318	21	TSP	ML	16	13.6.1.1-5	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, STBD
J1319	15	TSP	ML	28	13.6.1.1-11	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, PORT
	1	TS5C	ML					
J1320	6	TS5C	ML	43	13.6.1.1-6	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, STBD
J1321	13	TSP	ML	40	13.6.1.1-12	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, PORT
J1322	8	TS5C	ML	31	13.6.1.1-7	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, STBD
J1323	5	TSP	ML	64	13.6.1.1-13	NLS0T20-35SB	NLS6GT20-35PB	STA Xo 603, PORT
J1333	5	T3C	HO	64	13.6.1.1-14	NLS0T20-35SA	NLS6GT20-35PA	STA Xo 603, PORT
J1335	5	T3C	HO	64	13.6.1.1-15	NLS0T20-35SA	NLS6GT20-35PA	STA Xo 603, PORT
J1337	5	T5C	HO	54	13.6.1.1-16	NLS0T20-35SA	NLS6GT20-35PA	STA Xo 603, PORT
J1616	1	TP	HO	2	13.6.1.2-3	ME414-0234-7240	ME414-0235-7244	STA Xo 1203, STBD
J1617	1	TP	HO	2	13.6.1.2-4	ME414-0234-7240	ME414-0235-7244	STA Xo 1203, STBD

(1) SIGNAL IS CARRIED CONVENTIONALLY ON CENTER CONDUCTOR FOR ALL ORBITER COAX CABLES. NO PIN ASSIGNMENT TABLES ARE REQUIRED. CIRCUIT TERMINATIONS ARE SHOWN IN FIGURE 13.3.3-1

(2) CONNECTOR IS LOCATED ON THE END EFFECTOR OF THE RMS.

TABLE 13.6.1.1-1 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1302

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
RF	SIG	2S5	16	MSDP J40 - 26		
RF	RTN	2S5	17	MSDP J40 - 25		
			18			NOT WIRED
RF	SIG	2S6	19	MSDP J40 - 28		
RF	RTN	2S6	20	MSDP J40 - 27		
			21			NOT WIRED
RF	SIG	2S7	22	MSDP J40 - 30		
RF	RTN	2S7	23	MSDP J40 - 29		
			24			NOT WIRED
RF	SIG	2S8	25	MSDP J40 - 32		
RF	RTN	2S8	26	MSDP J40 - 31		
			27			NOT WIRED
RF	SIG	2S9	28	MSDP J40 - 35		
RF	RTN	2S9	29	MSDP J40 - 34		
			30			NOT WIRED
RF	SIG	2S10	31	MSDP J40 - 37		
RF	RTN	2S10	32	MSDP J40 - 36		
			33			NOT WIRED
RF	SIG	2S11	34	MSDP J40 - 39		
RF	RTN	2S11	35	MSDP J40 - 38		
			36			NOT WIRED
RF	SIG	2S12	37	MSDP J40 - 41		
RF	RTN	2S12	38	MSDP J40 - 40		
			39			NOT WIRED
RF	SIG	2S1	40	MSDP J40 - 65		
RF	RTN	2S1	41	MSDP J40 - 64		
			42			NOT WIRED
RF	SIG	2S2	43	MSDP J40 - 66		
RF	RTN	2S2	44	MSDP J40 - 62		
			45			NOT WIRED

TABLE 13.6.1.1-1 PIN ASSIGNMENTS FOR STARBOARD Xo 603
CONNECTOR J1302

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	SIG	2S3	46	MSDP J40 - 61		
RF	RTN	2S3	47	MSDP J40 - 60		
			48			NOT WIRED
RF	SIG	2S4	49	MSDP J40 - 63		
RF	RTN	2S4	50	MSDP J40 - 57		
			51			NOT WIRED
RF	RTN	2S13	52	MSDP J40 - 21		
RF	SIG	2S13	53	MSDP J40 - 22		
			54			NOT WIRED
RF	RTN	2S14	55	MSDP J40 - 19		
RF	SIG	2S14	56	MSDP J40 - 20		
			57			NOT WIRED
RF	RTN	2S15	58	MSDP J40 - 17		
RF	SIG	2S15	59	MSDP J40 - 18		
			60			NOT WIRED
RF	RTN	2S16	61	MSDP J40 - 15		
RF	SIG	2S16	62	MSDP J40 - 16		
			63			NOT WIRED
RF	SIG	2S17	64	SYNCHRONIZE	8.2.8	REMOTE CONTROL UNIT
RF	RTN	2S17	65	SYNCHRONIZE RETURN		
			66			NOT WIRED
RF	SIG	2S18	67	ORBITER TV	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S18	68	ORBITER TV RETURN		
			69			NOT WIRED
RF	SIG	2S19	70	PAYLOAD TV 3	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S19	71	PAYLOAD TV 3 RETURN		
			72			NOT WIRED
RF	SIG	2S20	73	PAYLOAD TV 1	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S20	74	PAYLOAD TV 1 RETURN		
			75			NOT WIRED
RF	SIG	2S21	76	PAYLOAD TV 2	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S21	77	PAYLOAD TV 2 RETURN		
			78			NOT WIRED
			79			NOT WIRED

TABLE 13.6.1.1-2 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1312

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
ML	SIG	2S1	22	MSDP J32 - 43		
ML	RTN	2S1	23	MSDP J32 - 42		
ML	SHD	2S1	24	MSDP J32 - 41		TERMINATE
ML	SIG	2S2	25	MSDP J32 - 46		
ML	RTN	2S2	26	MSDP J32 - 45		
ML	SHD	2S2	27	MSDP J32 - 44		TERMINATE
ML	SIG	2S3	28	MSDP J32 - 49		
ML	RTN	2S3	29	MSDP J32 - 48		
ML	SHD	2S3	30	MSDP J32 - 47		TERMINATE
ML	SIG	2S4	31	MSDP J32 - 52		
ML	RTN	2S4	32	MSDP J32 - 51		
ML	SHD	2S4	33	MSDP J32 - 50		TERMINATE
ML	SIG	2S5	34	MSDP J32 - 55		
ML	RTN	2S5	35	MSDP J32 - 54		
ML	SHD	2S5	36	MSDP J32 - 53		TERMINATE
ML	SIG	2S6	37	MSDP J32 - 58		
ML	RTN	2S6	38	MSDP J32 - 57		
ML	SHD	2S6	39	MSDP J32 - 56		TERMINATE
ML	SIG	2S7	40	MSDP J32 - 61		
ML	RTN	2S7	41	MSDP J32 - 60		
ML	SHD	2S7	42	MSDP J32 - 59		TERMINATE
ML	SIG	2S8	43	MSDP J32 - 64		
ML	RTN	2S8	44	MSDP J32 - 63		
ML	SHD	2S8	45	MSDP J32 - 62		TERMINATE

TABLE 13.6.1.1-2 PIN ASSIGNMENTS FOR STARBOARD Xo 603 CONNECTOR J1312

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S9	46	MSDP J32 - 67		
ML	RTN	2S9	47	MSDP J32 - 66		
ML	SHD	2S9	48	MSDP J32 - 65		TERMINATE
ML	SIG	2S10	49	MSDP J32 - 70		
ML	RTN	2S10	50	MSDP J32 - 69		
ML	SHD	2S10	51	MSDP J32 - 68		TERMINATE
ML	SIG	2S11	52	MSDP J32 - 73		
ML	RTN	2S11	53	MSDP J32 - 72		
ML	SHD	2S11	54	MSDP J32 - 71		TERMINATE
ML	SIG	2S12	55	MSDP J32 - 76		
ML	RTN	2S12	56	MSDP J32 - 75		
ML	SHD	2S12	57	MSDP J32 - 74		TERMINATE
ML	SIG	2S13	58	MSDP J32 - 79		
ML	RTN	2S13	59	MSDP J32 - 78		
ML	SHD	2S13	60	MSDP J32 - 77		TERMINATE
ML	SIG	5S3	61	P01X5226Y DIL 26	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S3	62	P01X5227Y DIL 27	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S3	63	P01X5228Y DIL 28	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S3	64	P01X5229Y DIL 29	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	RTN	5S3	65	RETURN		
ML	SHD	5S3	66			TERMINATE
ML	SIG	5S2	67	P01X5230Y DIL 30	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S2	68	P01X5231Y DIL 31	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S2	69	P01X5232Y DIL 32	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S2	70	P01X5233Y DIL 33	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	RTN	5S2	71	RETURN		
ML	SHD	5S2	72			TERMINATE
ML	SIG	5S1	73	P01X5234Y DIL 34	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S1	74	P01X5235Y DIL 35	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S1	75	P01X5236Y DIL 36	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	SIG	5S1	76	P01X5237Y DIL 37	8.2.2.3	MDM-PF2 PAYLOAD CAUTION & WARNING
ML	RTN	5S1	77	RETURN		
ML	SHD	5S1	78			TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-3 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1314

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
ML	SIG	2S8	19	MSDP J22 - 70		
ML	RTN	2S8	20	MSDP J22 - 69		
ML	SHD	2S8	21	MSDP J22 - 68		TERMINATE
ML	SIG	2S9	22	MSDP J22 - 67		
ML	RTN	2S9	23	MSDP J22 - 66		
ML	SHD	2S9	24	MSDP J22 - 65		TERMINATE
ML	SIG	2S10	25	MSDP J22 - 64		
ML	RTN	2S10	26	MSDP J22 - 63		
ML	SHD	2S10	27	MSDP J22 - 62		TERMINATE
ML	SIG	2S11	28	MSDP J22 - 61		
ML	RTN	2S11	29	MSDP J22 - 60		
ML	SHD	2S11	30	MSDP J22 - 59		TERMINATE
ML	SIG	2S12	31	MSDP J22 - 58		
ML	RTN	2S12	32	MSDP J22 - 57		
ML	SHD	2S12	33	MSDP J22 - 56		TERMINATE
ML	SIG	2S13	34	MSDP J22 - 55		
ML	RTN	2S13	35	MSDP J22 - 54		
ML	SHD	2S13	36	MSDP J22 - 53		TERMINATE
ML	SIG	2S14	37	MSDP J22 - 52		
ML	RTN	2S14	38	MSDP J22 - 51		
ML	SHD	2S14	39	MSDP J22 - 50		TERMINATE
ML	SIG	2S15	40	MSDP J22 - 49		
ML	RTN	2S15	41	MSDP J22 - 48		
ML	SHD	2S15	42	MSDP J22 - 47		TERMINATE
ML	SIG	2S16	43	MSDP J22 - 46		
ML	RTN	2S16	44	MSDP J22 - 45		
ML	SHD	2S16	45	MSDP J22 - 44		TERMINATE

TABLE 13.6.1.1-3 PIN ASSIGNMENTS FOR STARBOARD Xo 603
CONNECTOR J1314

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S17	46	MSDP J22 - 43		
ML	RTN	2S17	47	MSDP J22 - 42		
ML	SHD	2S17	48	MSDP J22 - 41		TERMINATE
ML	SIG	2S18	49	MSDP J22 - 73		
ML	RTN	2S18	50	MSDP J22 - 72		
ML	SHD	2S18	51	MSDP J22 - 71		TERMINATE
ML	SIG	2S19	52	MSDP J22 - 76		
ML	RTN	2S19	53	MSDP J22 - 75		
ML	SHD	2S19	54	MSDP J22 - 74		TERMINATE
ML	SIG	2S20	55	MSDP J22 - 77		
ML	RTN	2S20	56	MSDP J22 - 78		
ML	SHD	2S20	57	MSDP J22 - 79		TERMINATE
ML	SIG	2S1	58	MSDP J22 - 22		
ML	RTN	2S1	59	MSDP J22 - 21		
ML	SHD	2S1	60	MSDP J22 - 20		TERMINATE
ML	SIG	2S2	61	MSDP J22 - 25		
ML	RTN	2S2	62	MSDP J22 - 24		
ML	SHD	2S2	63	MSDP J22 - 23		TERMINATE
ML	SIG	2S3	64	MSDP J22 - 28		
ML	RTN	2S3	65	MSDP J22 - 27		
ML	SHD	2S3	66	MSDP J22 - 26		TERMINATE
ML	SIG	2S4	67	MSDP J22 - 31		
ML	RTN	2S4	68	MSDP J22 - 30		
ML	SHD	2S4	69	MSDP J22 - 29		TERMINATE
ML	SIG	2S5	70	MSDP J22 - 34		
ML	RTN	2S5	71	MSDP J22 - 33		
ML	SHD	2S5	72	MSDP J22 - 32		TERMINATE
ML	SIG	2S6	73	MSDP J22 - 37		
ML	RTN	2S6	74	MSDP J22 - 36		
ML	SHD	2S6	75	MSDP J22 - 35		TERMINATE
ML	SIG	2S7	76	MSDP J22 - 40		
ML	RTN	2S7	77	MSDP J22 - 39		
ML	SHD	2S7	78	MSDP J22 - 38		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-4 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1316

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
ML	SIG	2S13	16	PAYLOAD MASTER ALARM LIGHT	8.2.9.5	PANEL R13A1
ML	RTN	2S13	17	MASTER ALARM LIGHT RETURN		
ML	SHD	2S13	18			TERMINATE
ML	SIG	2S14	19	dP / dT EMERGENCY	8.2.9.5	PANEL R13A1
ML	RTN	2S14	20	dP / dT EMERGENCY RETURN		
ML	SHD	2S14	21			TERMINATE
ML	SIG	2S3	22	MSDP J18 - 47		
ML	RTN	2S3	23	MSDP J18 - 40		
ML	SHD	2S3	24	MSDP J18 - 41		TERMINATE
ML	SIG	2S2	25	MSDP J18 - 53		
ML	RTN	2S2	26	MSDP J18 - 49		
ML	SHD	2S2	27	MSDP J18 - 48		TERMINATE
ML	SIG	2S1	28	MSDP J18 - 54		
ML	RTN	2S1	29	MSDP J18 - 50		
ML	SHD	2S1	30	MSDP J18 - 55		TERMINATE
ML	SIG	2S4	31	MSDP J18 - 26		
ML	RTN	2S4	32	MSDP J18 - 19		
ML	SHD	2S4	33	MSDP J18 - 18		TERMINATE
ML	SIG	2S19	34	P01U6153V AID 53	8.2.2.4	MDM-PF2
ML	RTN	2S19	35	AID 53 RETURN		
ML	SHD	2S19	36			TERMINATE
ML	SIG	2S20	37	P01U6154V AID 54	8.2.2.4	MDM-PF2
ML	RTN	2S20	38	AID 54 RETURN		
ML	SHD	2S20	39			TERMINATE
ML	SIG	2S21	40	P01U6155V AID 55	8.2.2.4	MDM-PF2
ML	RTN	2S21	41	AID 55 RETURN		
ML	SHD	2S21	42			TERMINATE
ML	SIG	2S17	43	P01U6151V AID 51	8.2.2.4	MDM-PF2
ML	RTN	2S17	44	AID 51 RETURN		
ML	SHD	2S17	45			TERMINATE

TABLE 13.6.1.1-4 PIN ASSIGNMENTS FOR STARBOARD Xo 603 CONNECTOR J1316

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S16	46	P01U6150V AID 50	8.2.2.4	MDM-PF2
ML	RTN	2S16	47	AID 50 RETURN		
ML	SHD	2S16	48			TERMINATE
ML	SIG	2S15	49	P01U6149V AID 49	8.2.2.4	MDM-PF2
ML	RTN	2S15	50	AID 49 RETURN		
ML	SHD	2S15	51			TERMINATE
ML	SIG	2S18	52	P01U6152V AID 52	8.2.2.4	MDM-PF2
ML	RTN	2S18	53	AID 52 RETURN		
ML	SHD	2S18	54			TERMINATE
ML	SIG	2S5	55	MSDP J18 - 27		
ML	RTN	2S5	56	MSDP J18 - 20		
ML	SHD	2S5	57	MSDP J18 - 28		TERMINATE
ML	SIG	2S6	58	MSDP J18 - 13		
ML	RTN	2S6	59	MSDP J18 - 14		
ML	SHD	2S6	60	MSDP J18 - 21		TERMINATE
ML	SIG	2S7	61	MSDP J18 - 23		
ML	RTN	2S7	62	MSDP J18 - 15		
ML	SHD	2S7	63	MSDP J18 - 22		TERMINATE
ML	SIG	2S8	64	MSDP J18 - 37		
ML	RTN	2S8	65	MSDP J18 - 30		
ML	SHD	2S8	66	MSDP J18 - 29		TERMINATE
ML	SIG	2S9	67	MSDP J18 - 46		
ML	RTN	2S9	68	MSDP J18 - 39		
ML	SHD	2S9	69	MSDP J18 - 38		TERMINATE
ML	SIG	2S10	70	MSDP J18 - 51		
ML	RTN	2S10	71	MSDP J18 - 45		
ML	SHD	2S10	72	MSDP J18 - 52		TERMINATE
ML	SIG	2S11	73	MSDP J18 - 43		
ML	RTN	2S11	74	MSDP J18 - 44		
ML	SHD	2S11	75	MSDP J18 - 36		TERMINATE
ML	SIG	2S12	76	MSDP J18 - 42		
ML	RTN	2S12	77	MSDP J18 - 34		
ML	SHD	2S12	78	MSDP J18 - 35		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-5 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1318

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
ML	SIG	2S21	16	MSDP J34 - 19		
ML	RTN	2S21	17	MSDP J34 - 18		
ML	SHD	2S21	18	MSDP J34 - 17		TERMINATE
ML	SIG	2S20	19	MSDP J34 - 22		
ML	RTN	2S20	20	MSDP J34 - 21		
ML	SHD	2S20	21	MSDP J34 - 20		TERMINATE
ML	SIG	2S19	22	MSDP J34 - 25		
ML	RTN	2S19	23	MSDP J34 - 24		
ML	SHD	2S19	24	MSDP J34 - 23		TERMINATE
ML	SIG	2S18	25	MSDP J34 - 28		
ML	RTN	2S18	26	MSDP J34 - 27		
ML	SHD	2S18	27	MSDP J34 - 26		TERMINATE
ML	SIG	2S17	28	MSDP J34 - 31		
ML	RTN	2S17	29	MSDP J34 - 30		
ML	SHD	2S17	30	MSDP J34 - 29		TERMINATE
ML	SIG	2S16	31	MSDP J34 - 34		
ML	RTN	2S16	32	MSDP J34 - 33		
ML	SHD	2S16	33	MSDP J34 - 32		TERMINATE
ML	SIG	2S15	34	MSDP J34 - 37		
ML	RTN	2S15	35	MSDP J34 - 36		
ML	SHD	2S15	36	MSDP J34 - 35		TERMINATE
ML	SIG	2S14	37	MSDP J34 - 40		
ML	RTN	2S14	38	MSDP J34 - 39		
ML	SHD	2S14	39	MSDP J34 - 38		TERMINATE
ML	SIG	2S13	40	MSDP J34 - 43		
ML	RTN	2S13	41	MSDP J34 - 42		
ML	SHD	2S13	42	MSDP J34 - 41		TERMINATE
ML	SIG	2S12	43	MSDP J34 - 46		
ML	RTN	2S12	44	MSDP J34 - 45		
ML	SHD	2S12	45	MSDP J34 - 44		TERMINATE

TABLE 13.6.1.1-5 PIN ASSIGNMENTS FOR STARBOARD Xo 603
CONNECTOR J1318

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S11	46	MSDP J34 - 49		
ML	RTN	2S11	47	MSDP J34 - 48		
ML	SHD	2S11	48	MSDP J34 - 47		TERMINATE
ML	SIG	2S10	49	MSDP J34 - 52		
ML	RTN	2S10	50	MSDP J34 - 51		
ML	SHD	2S10	51	MSDP J34 - 50		TERMINATE
ML	SIG	2S9	52	MSDP J34 - 55		
ML	RTN	2S9	53	MSDP J34 - 54		
ML	SHD	2S9	54	MSDP J34 - 53		TERMINATE
ML	SIG	2S8	55	MSDP J34 - 58		
ML	RTN	2S8	56	MSDP J34 - 57		
ML	SHD	2S8	57	MSDP J34 - 56		TERMINATE
ML	SIG	2S7	58	MSDP J34 - 61		
ML	RTN	2S7	59	MSDP J34 - 60		
ML	SHD	2S7	60	MSDP J34 - 59		TERMINATE
ML	SIG	2S6	61	MSDP J34 - 64		
ML	RTN	2S6	62	MSDP J34 - 63		
ML	SHD	2S6	63	MSDP J34 - 62		TERMINATE
ML	SIG	2S5	64	MSDP J34 - 67		
ML	RTN	2S5	65	MSDP J34 - 66		
ML	SHD	2S5	66	MSDP J34 - 65		TERMINATE
ML	SIG	2S4	67	MSDP J34 - 70		
ML	RTN	2S4	68	MSDP J34 - 69		
ML	SHD	2S4	69	MSDP J34 - 68		TERMINATE
ML	SIG	2S3	70	MSDP J34 - 73		
ML	RTN	2S3	71	MSDP J34 - 72		
ML	SHD	2S3	72	MSDP J34 - 71		TERMINATE
ML	SIG	2S2	73	MSDP J34 - 76		
ML	RTN	2S2	74	MSDP J34 - 75		
ML	SHD	2S2	75	MSDP J34 - 74		TERMINATE
ML	SIG	2S1	76	MSDP J34 - 79		
ML	RTN	2S1	77	MSDP J34 - 78		
ML	SHD	2S1	78	MSDP J34 - 77		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-6 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1320

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-42 NOT WIRED
			.			.
			.			.
			42			PINS 1-42 NOT WIRED
ML	SIG	5S5	43	MSDP J26 - 21		
ML	SIG	5S5	44	MSDP J26 - 30		
ML	SIG	5S5	45	MSDP J26 - 19		
ML	SIG	5S5	46	MSDP J26 - 20		
ML	RTN	5S5	47	MSDP J26 - 29		
ML	SHD	5S5	48	MSDP J26 - 40		TERMINATE
ML	SIG	5S6	49	MSDP J26 - 43		
ML	SIG	5S6	50	MSDP J26 - 42		
ML	SIG	5S6	51	MSDP J26 - 22		
ML	SIG	5S6	52	MSDP J26 - 32		
ML	RTN	5S6	53	MSDP J26 - 31		
ML	SHD	5S6	54	MSDP J26 - 41		TERMINATE
ML	SIG	5S1	55	MSDP J26 - 48		
ML	SIG	5S1	56	MSDP J26 - 38		
ML	SIG	5S1	57	MSDP J26 - 28		
ML	SIG	5S1	58	MSDP J26 - 39		
ML	RTN	5S1	59	MSDP J26 - 49		
ML	SHD	5S1	60	MSDP J26 - 50		TERMINATE
ML	SIG	5S2	61	MSDP J26 - 58		
ML	SIG	5S2	62	MSDP J26 - 59		
ML	SIG	5S2	63	MSDP J26 - 79		
ML	SIG	5S2	64	MSDP J26 - 69		
ML	RTN	5S2	65	MSDP J26 - 70		
ML	SHD	5S2	66	MSDP J26 - 60		TERMINATE
ML	SIG	5S3	67	MSDP J26 - 80		
ML	SIG	5S3	68	MSDP J26 - 71		
ML	SIG	5S3	69	MSDP J26 - 82		
ML	SIG	5S3	70	MSDP J26 - 81		
ML	RTN	5S3	71	MSDP J26 - 72		
ML	SHD	5S3	72	MSDP J26 - 61		TERMINATE
ML	SIG	5S4	73	MSDP J26 - 73		
ML	SIG	5S4	74	MSDP J26 - 62		
ML	SIG	5S4	75	MSDP J26 - 53		
ML	SIG	5S4	76	MSDP J26 - 63		
ML	RTN	5S4	77	MSDP J26 - 52		
ML	SHD	5S4	78	MSDP J26 - 51		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-7 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1322

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
			28			NOT WIRED
			29			NOT WIRED
			30			NOT WIRED
ML	SIG	5S1	31	MSDP J26 - 4		
ML	SIG	5S1	32	MSDP J26 - 3		
ML	SIG	5S1	33	MSDP J26 - 2		
ML	SIG	5S1	34	MSDP J26 - 1		
ML	RTN	5S1	35	MSDP J26 - 5		
ML	SHD	5S1	36	MSDP J26 - 6		TERMINATE
ML	SIG	5S2	37	MSDP J26 - 11		
ML	SIG	5S2	38	MSDP J26 - 10		
ML	SIG	5S2	39	MSDP J26 - 9		
ML	SIG	5S2	40	MSDP J26 - 8		
ML	RTN	5S2	41	MSDP J26 - 12		
ML	SHD	5S2	42	MSDP J26 - 13		TERMINATE
ML	SIG	5S3	43	MSDP J26 - 14		
ML	SIG	5S3	44	MSDP J26 - 7		
ML	SIG	5S3	45	MSDP J26 - 15		

TABLE 13.6.1.1-7 PIN ASSIGNMENTS FOR STARBOARD Xo 603
CONNECTOR J1322

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	5S3	46	MSDP J26 - 24		
ML	RTN	5S3	47	MSDP J26 - 23		
ML	SHD	5S3	48	MSDP J26 - 33		TERMINATE
ML	SIG	5S4	49	MSDP J26 - 25		
ML	SIG	5S4	50	MSDP J26 - 16		
ML	SIG	5S4	51	MSDP J26 - 17		
ML	SIG	5S4	52	MSDP J26 - 18		
ML	RTN	5S4	53	MSDP J26 - 26		
ML	SHD	5S4	54	MSDP J26 - 27		TERMINATE
ML	SIG	5S5	55	MSDP J26 - 47		
ML	SIG	5S5	56	MSDP J26 - 37		
ML	SIG	5S5	57	MSDP J26 - 36		
ML	SIG	5S5	58	MSDP J26 - 35		
ML	RTN	5S5	59	MSDP J26 - 46		
ML	SHD	5S5	60	MSDP J26 - 56		TERMINATE
ML	SIG	5S6	61	MSDP J26 - 68		
ML	SIG	5S6	62	MSDP J26 - 57		
ML	SIG	5S6	63	MSDP J26 - 67		
ML	SIG	5S6	64	MSDP J26 - 77		
ML	RTN	5S6	65	MSDP J26 - 78		
ML	SHD	5S6	66	MSDP J26 - 86		TERMINATE
ML	SIG	5S7	67	MSDP J26 - 90		
ML	SIG	5S7	68	MSDP J26 - 89		
ML	SIG	5S7	69	MSDP J26 - 88		
ML	SIG	5S7	70	MSDP J26 - 87		
ML	RTN	5S7	71	MSDP J26 - 91		
ML	SHD	5S7	72	MSDP J26 - 92		TERMINATE
ML	SIG	5S8	73	MSDP J26 - 97		
ML	SIG	5S8	74	MSDP J26 - 96		
ML	SIG	5S8	75	MSDP J26 - 95		
ML	SIG	5S8	76	MSDP J26 - 94		
ML	RTN	5S8	77	MSDP J26 - 98		
ML	SHD	5S8	78	MSDP J26 - 99		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-8 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1304

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
			28			NOT WIRED
			29			NOT WIRED
			30			NOT WIRED
HO	SIG	2T16	31	MSDP J12 - 78		
HO	RTN	2T16	32	MSDP J12 - 79		
			33			NOT WIRED
HO	SIG	2T15	34	MSDP J12 - 49		
HO	RTN	2T15	35	MSDP J12 - 48		
			36			NOT WIRED
HO	SIG	2T14	37	MSDP J12 - 51		
HO	RTN	2T14	38	MSDP J12 - 50		
			39			NOT WIRED
HO	SIG	2T13	40	MSDP J12 - 53		
HO	RTN	2T13	41	MSDP J12 - 52		
			42			NOT WIRED
HO	SIG	2T12	43	MSDP J12 - 55		
HO	RTN	2T12	44	MSDP J12 - 54		
			45			NOT WIRED

TABLE 13.6.1.1-8 PIN ASSIGNMENTS FOR STARBOARD Xo 603
CONNECTOR J1304

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	2T11	46	MSDP J12 - 57		
HO	RTN	2T11	47	MSDP J12 - 56		
			48			NOT WIRED
HO	SIG	2T10	49	MSDP J12 - 59		
HO	RTN	2T10	50	MSDP J12 - 58		
			51			NOT WIRED
HO	SIG	2T9	52	MSDP J12 - 61		
HO	RTN	2T9	53	MSDP J12 - 60		
			54			NOT WIRED
HO	SIG	2T8	55	MSDP J12 - 63		
HO	RTN	2T8	56	MSDP J12 - 62		
			57			NOT WIRED
HO	SIG	2T7	58	MSDP J12 - 65		
HO	RTN	2T7	59	MSDP J12 - 64		
			60			NOT WIRED
HO	SIG	2T6	61	MSDP J12 - 67		
HO	RTN	2T6	62	MSDP J12 - 66		
			63			NOT WIRED
HO	SIG	2T5	64	MSDP J12 - 69		
HO	RTN	2T5	65	MSDP J12 - 68		
			66			NOT WIRED
HO	SIG	2T4	67	MSDP J12 - 71		
HO	RTN	2T4	68	MSDP J12 - 70		
			69			NOT WIRED
HO	SIG	2T3	70	MSDP J12 - 73		
HO	RTN	2T3	71	MSDP J12 - 72		
			72			NOT WIRED
HO	SIG	2T2	73	MSDP J12 - 75		
HO	RTN	2T2	74	MSDP J12 - 74		
			75			NOT WIRED
HO	SIG	2T1	76	MSDP J12 - 77		
HO	RTN	2T1	77	MSDP J12 - 76		
			78			NOT WIRED
			79			NOT WIRED

TABLE 13.6.1.1-9 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1308

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	2T16	1	MSDP J24 - 34		
HO	RTN	2T16	2	MSDP J24 - 56		
			3			NOT WIRED
HO	SIG	2T15	4	MSDP J24 - 63		
HO	RTN	2T15	5	MSDP J24 - 62		
			6			NOT WIRED
HO	SIG	2T14	7	MSDP J24 - 65		
HO	RTN	2T14	8	MSDP J24 - 64		
			9			NOT WIRED
HO	SIG	2T13	10	MSDP J24 - 67		
HO	RTN	2T13	11	MSDP J24 - 66		
			12			NOT WIRED
HO	SIG	2T12	13	MSDP J24 - 69		
HO	RTN	2T12	14	MSDP J24 - 68		
			15			NOT WIRED
HO	SIG	2T11	16	MSDP J24 - 71		
HO	RTN	2T11	17	MSDP J24 - 70		
			18			NOT WIRED
HO	SIG	2T10	19	MSDP J24 - 73		
HO	RTN	2T10	20	MSDP J24 - 72		
			21			NOT WIRED
HO	SIG	2T9	22	MSDP J24 - 75		
HO	RTN	2T9	23	MSDP J24 - 74		
			24			NOT WIRED
HO	SIG	2T8	25	MSDP J24 - 77		
HO	RTN	2T8	26	MSDP J24 - 76		
			27			NOT WIRED
HO	SIG	2T7	28	MSDP J24 - 79		
HO	RTN	2T7	29	MSDP J24 - 78		
			30			NOT WIRED
HO	SIG	2T6	31	MSDP J24 - 51		
HO	RTN	2T6	32	MSDP J24 - 50		
			33			NOT WIRED
HO	SIG	2T5	34	MSDP J24 - 53		
HO	RTN	2T5	35	MSDP J24 - 52		
			36			NOT WIRED
HO	SIG	2T4	37	MSDP J24 - 55		
HO	RTN	2T4	38	MSDP J24 - 54		
			39			NOT WIRED
HO	SIG	2T3	40	MSDP J24 - 29		
HO	RTN	2T3	41	MSDP J24 - 28		
			42			NOT WIRED
HO	SIG	2T2	43	MSDP J24 - 31		
HO	RTN	2T2	44	MSDP J24 - 30		
			45			NOT WIRED

TABLE 13.6.1.1-9 PIN ASSIGNMENTS FOR STARBOARD Xo 603
CONNECTOR J1308

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	2T1	46	MSDP J24 - 2		
HO	RTN	2T1	47	MSDP J24 - 1		
			48			NOT WIRED
HO	SIG	5T1	49	MSDP J24 - 33		
HO	SIG	5T1	50	MSDP J24 - 6		
HO	SIG	5T1	51	MSDP J24 - 5		
HO	SIG	5T1	52	MSDP J24 - 4		
HO	RTN	5T1	53	MSDP J24 - 32		
			54			NOT WIRED
HO	SIG	5T2	55	MSDP J24 - 36		
HO	SIG	5T2	56	MSDP J24 - 9		
HO	SIG	5T2	57	MSDP J24 - 8		
HO	SIG	5T2	58	MSDP J24 - 7		
HO	RTN	5T2	59	MSDP J24 - 35		
			60			NOT WIRED
HO	SIG	5T3	61	MSDP J24 - 12		
HO	SIG	5T3	62	MSDP J24 - 11		
HO	SIG	5T3	63	MSDP J24 - 10		
HO	SIG	5T3	64	MSDP J24 - 37		
HO	RTN	5T3	65	MSDP J24 - 38		
			66			NOT WIRED
HO	SIG	5T4	67	MSDP J24 - 15		
HO	SIG	5T4	68	MSDP J24 - 14		
HO	SIG	5T4	69	MSDP J24 - 13		
HO	SIG	5T4	70	MSDP J24 - 39		
HO	RTN	5T4	71	MSDP J24 - 40		
			72			NOT WIRED
HO	SIG	5T5	73	MSDP J24 - 18		
HO	SIG	5T5	74	MSDP J24 - 17		
HO	SIG	5T5	75	MSDP J24 - 16		
HO	SIG	5T5	76	MSDP J24 - 41		
HO	RTN	5T5	77	MSDP J24 - 42		
			78			NOT WIRED
			79			NOT WIRED

TABLE 13.6.1.1-10 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1317

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-39 NOT WIRED
			.			.
			.			.
			39			PINS 1-39 NOT WIRED
ML	SIG	2S1	40	PSDP J1317 - 26		
ML	RTN	2S1	41	PSDP J1317 - 27		
ML	SHD	2S1	42	PSDP J1317 - 25		TERMINATE
ML	SIG	2S2	43	PSDP J1317 - 51		
ML	RTN	2S2	44	PSDP J1317 - 52		
ML	SHD	2S2	45	PSDP J1317 - 46		TERMINATE
ML	SIG	2S3	46	PSDP J1317 - 23		
ML	RTN	2S3	47	PSDP J1317 - 24		
ML	SHD	2S3	48	PSDP J1317 - 16		TERMINATE
ML	SIG	2S4	49	PSDP J1317 - 38		
ML	RTN	2S4	50	PSDP J1317 - 39		
ML	SHD	2S4	51	PSDP J1317 - 31		TERMINATE
ML	SIG	2S5	52	PSDP J1317 - 33		
ML	RTN	2S5	53	PSDP J1317 - 34		
ML	SHD	2S5	54	PSDP J1317 - 32		TERMINATE
ML	SIG	2S6	55	PSDP J1317 - 13		
ML	RTN	2S6	56	PSDP J1317 - 14		
ML	SHD	2S6	57	PSDP J1317 - 15		TERMINATE
ML	SIG	2S7	58	PSDP J1317 - 41		
ML	RTN	2S7	59	PSDP J1317 - 42		
ML	SHD	2S7	60	PSDP J1317 - 40		TERMINATE
ML	SIG	2S8	61	PSDP J1317 - 43		
ML	RTN	2S8	62	PSDP J1317 - 44		
ML	SHD	2S8	63	PSDP J1317 - 45		TERMINATE
ML	SIG	2S9	64	PSDP J1317 - 11		
ML	RTN	2S9	65	PSDP J1317 - 12		
ML	SHD	2S9	66	PSDP J1317 - 10		TERMINATE
ML	SIG	2S10	67	PSDP J1317 - 35		
ML	RTN	2S10	68	PSDP J1317 - 36		
ML	SHD	2S10	69	PSDP J1317 - 37		TERMINATE
ML	SIG	2S11	70	PSDP J1317 - 20		
ML	RTN	2S11	71	PSDP J1317 - 21		
ML	SHD	2S11	72	PSDP J1317 - 22		TERMINATE
ML	SIG	2S12	73	PSDP J1317 - 18		
ML	RTN	2S12	74	PSDP J1317 - 19		
ML	SHD	2S12	75	PSDP J1317 - 17		TERMINATE
ML	SIG	2S13	76	PSDP J1317 - 28		
ML	RTN	2S13	77	PSDP J1317 - 29		
ML	SHD	2S13	78	PSDP J1317 - 30		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-11 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1319

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
ML	SIG	5S1	28	P01X5246Y DIL 46	8.2.2.3	MDM-PF1
ML	SIG	5S1	29	P01X5247Y DIL 47	8.2.2.3	MDM-PF1
ML	SIG	5S1	30	P01X5248Y DIL 48	8.2.2.3	MDM-PF1
ML	SIG	5S1	31	P01X5249Y DIL 49	8.2.2.3	MDM-PF1
ML	RTN	5S1	32	DIL 46-49 RETURN		
ML	SHD	5S1	33			TERMINATE
ML	SIG	2S2	34	P01U6164V AID 64	8.2.2.4	MDM-PF1
ML	RTN	2S2	35	AID 64 RETURN		
ML	SHD	2S2	36			TERMINATE
ML	SIG	2S1	37	P01X5250Y DIL 50	8.2.2.3	MDM-PF1
ML	RTN	2S1	38	DIL 50 RETURN		
ML	SHD	2S1	39			TERMINATE
ML	SIG	2S15	40	PSDP J1319 - 26		
ML	RTN	2S15	41	PSDP J1319 - 27		
ML	SHD	2S15	42	PSDP J1319 - 25		TERMINATE
ML	SIG	2S14	43	PSDP J1319 - 51		
ML	RTN	2S14	44	PSDP J1319 - 52		
ML	SHD	2S14	45	PSDP J1319 - 46		TERMINATE

TABLE 13.6.1.1-11 PIN ASSIGNMENTS FOR PORT Xo 603
CONNECTOR J1319

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S13	46	PSDP J1319 - 23		
ML	RTN	2S13	47	PSDP J1319 - 24		
ML	SHD	2S13	48	PSDP J1319 - 16		TERMINATE
ML	SIG	2S12	49	PSDP J1319 - 38		
ML	RTN	2S12	50	PSDP J1319 - 39		
ML	SHD	2S12	51	PSDP J1319 - 31		TERMINATE
ML	SIG	2S11	52	PSDP J1319 - 33		
ML	RTN	2S11	53	PSDP J1319 - 34		
ML	SHD	2S11	54	PSDP J1319 - 32		TERMINATE
ML	SIG	2S10	55	PSDP J1319 - 13		
ML	RTN	2S10	56	PSDP J1319 - 14		
ML	SHD	2S10	57	PSDP J1319 - 15		TERMINATE
ML	SIG	2S9	58	PSDP J1319 - 41		
ML	RTN	2S9	59	PSDP J1319 - 42		
ML	SHD	2S9	60	PSDP J1319 - 40		TERMINATE
ML	SIG	2S8	61	PSDP J1319 - 43		
ML	RTN	2S8	62	PSDP J1319 - 44		
ML	SHD	2S8	63	PSDP J1319 - 45		TERMINATE
ML	SIG	2S7	64	PSDP J1319 - 11		
ML	RTN	2S7	65	PSDP J1319 - 12		
ML	SHD	2S7	66	PSDP J1319 - 10		TERMINATE
ML	SIG	2S6	67	PSDP J1319 - 35		
ML	RTN	2S6	68	PSDP J1319 - 36		
ML	SHD	2S6	69	PSDP J1319 - 37		TERMINATE
ML	SIG	2S5	70	PSDP J1319 - 20		
ML	RTN	2S5	71	PSDP J1319 - 21		
ML	SHD	2S5	72	PSDP J1319 - 22		TERMINATE
ML	SIG	2S4	73	PSDP J1319 - 18		
ML	RTN	2S4	74	PSDP J1319 - 19		
ML	SHD	2S4	75	PSDP J1319 - 17		TERMINATE
ML	SIG	2S3	76	PSDP J1319 - 28		
ML	RTN	2S3	77	PSDP J1319 - 29		
ML	SHD	2S3	78	PSDP J1319 - 30		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-12 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1321

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-39 NOT WIRED
			.			.
			.			.
			39			PINS 1-39 NOT WIRED
ML	SIG	2S10	40	PSDP J43 - 56		
ML	RTN	2S10	41	PSDP J43 - 57		
ML	SHD	2S10	42	PSDP J43 - 58		TERMINATE
ML	SIG	2S9	43	PSDP J43 - 59		
ML	RTN	2S9	44	PSDP J43 - 60		
ML	SHD	2S9	45	PSDP J43 - 61		TERMINATE
ML	SIG	2S13	46	PSDP J43 - 46		
ML	RTN	2S13	47	PSDP J43 - 47		
ML	SHD	2S13	48	PSDP J43 - 48		TERMINATE
ML	SIG	2S12	49	PSDP J43 - 49		
ML	RTN	2S12	50	PSDP J43 - 50		
ML	SHD	2S12	51	PSDP J43 - 51		TERMINATE
ML	SIG	2S11	52	PSDP J43 - 52		
ML	RTN	2S11	53	PSDP J43 - 53		
ML	SHD	2S11	54	PSDP J43 - 54		TERMINATE
ML	SIG	2S8	55	PSDP J43 - 62		
ML	RTN	2S8	56	PSDP J43 - 63		
ML	SHD	2S8	57	PSDP J43 - 64		TERMINATE
ML	SIG	2S7	58	PSDP J43 - 65		
ML	RTN	2S7	59	PSDP J43 - 66		
ML	SHD	2S7	60	PSDP J43 - 55		TERMINATE
ML	SIG	2S6	61	PSDP J43 - 67		
ML	RTN	2S6	62	PSDP J43 - 68		
ML	SHD	2S6	63	PSDP J43 - 69		TERMINATE
ML	SIG	2S2	64	PSDP J43 - 80		
ML	RTN	2S2	65	PSDP J43 - 81		
ML	SHD	2S2	66	PSDP J43 - 82		TERMINATE
ML	SIG	2S1	67	PSDP J43 - 83		
ML	RTN	2S1	68	PSDP J43 - 84		
ML	SHD	2S1	69	PSDP J43 - 92		TERMINATE
ML	SIG	2S5	70	PSDP J43 - 70		
ML	RTN	2S5	71	PSDP J43 - 71		
ML	SHD	2S5	72	PSDP J43 - 72		TERMINATE
ML	SIG	2S4	73	PSDP J43 - 73		
ML	RTN	2S4	74	PSDP J43 - 74		
ML	SHD	2S4	75	PSDP J43 - 75		TERMINATE
ML	SIG	2S3	76	PSDP J43 - 76		
ML	RTN	2S3	77	PSDP J43 - 85		
ML	SHD	2S3	78	PSDP J43 - 93		TERMINATE
			79			NOT WIRED

TABLE 13.6.1.1-13 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1323

EMC CLASS .	PIN FUNCT.	CABLE DESCR .	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-51 NOT WIRED
			.			.
			.			.
			51			PINS 1-51 NOT WIRED
ML	SIG	2S2	52	PAYLOAD WARNING (A), PARAM 55	8.2.9	CAUTION & WARNING ELECTRONICS ASSEMBLY (1)
ML	RTN	2S2	53	PARAMETER 55 RETURN		
ML	SHD	2S2	54			TERMINATE
			55			NOT WIRED
			56			NOT WIRED
			57			NOT WIRED
ML	SIG	2S5	58	PAYLOAD WARNING (B), PARAM 65	8.2.9	CAUTION & WARNING ELECTRONICS ASSEMBLY (1)
ML	RTN	2S5	59	PARAMETER 65 RETURN		
ML	SHD	2S5	60			TERMINATE
			61			NOT WIRED
			62			NOT WIRED
			63			NOT WIRED
ML	SIG	2S4	64	PAYLOAD WARNING (C), PARAM 75	8.2.9	CAUTION & WARNING ELECTRONICS ASSEMBLY (1)
ML	RTN	2S4	65	PARAMETER 75 RETURN		
ML	SHD	2S4	66			TERMINATE
			67			NOT WIRED
			68			NOT WIRED
			69			NOT WIRED
ML	SIG	2S3	70	PAYLOAD WARNING (D), PARAM 85	8.2.9	CAUTION & WARNING ELECTRONICS ASSEMBLY (1)
ML	RTN	2S3	71	PARAMETER 85 RETURN		
ML	SHD	2S3	72			TERMINATE
			73			NOT WIRED
			74			NOT WIRED
			75			NOT WIRED
ML	SIG	2S1	76	PAYLOAD WARNING (E), PARAM 95	8.2.9	CAUTION & WARNING ELECTRONICS ASSEMBLY (1)
ML	RTN	2S1	77	PARAMETER 95 RETURN		
ML	SHD	2S1	78			TERMINATE
			79			NOT WIRED

(1) FUNCTION TO BE SIG/RTN JUMPERED WHEN NOT IN USE.

TABLE 13.6.1.1-14 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1333

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-51 NOT WIRED
			.			.
			.			.
			51			PINS 1-51 NOT WIRED
HO	SIG	3T1	52	PSDP J1333 - 20		
HO	SIG	3T1	53	PSDP J1333 - 21		
HO	RTN	3T1	54	PSDP J1333 - 22		
			55			NOT WIRED
			56			NOT WIRED
			57			NOT WIRED
HO	SIG	3T2	58	PSDP J1333 - 17		
HO	SIG	3T2	59	PSDP J1333 - 18		
HO	RTN	3T2	60	PSDP J1333 - 19		
			61			NOT WIRED
			62			NOT WIRED
			63			NOT WIRED
HO	SIG	3T3	64	PSDP J1333 - 14		
HO	SIG	3T3	65	PSDP J1333 - 15		
HO	RTN	3T3	66	PSDP J1333 - 16		
			67			NOT WIRED
			68			NOT WIRED
			69			NOT WIRED
HO	SIG	3T4	70	PSDP J1333 - 11		
HO	SIG	3T4	71	PSDP J1333 - 12		
HO	RTN	3T4	72	PSDP J1333 - 13		
			73			NOT WIRED
			74			NOT WIRED
			75			NOT WIRED
HO	SIG	3T5	76	PSDP J1333 - 40		
HO	SIG	3T5	77	PSDP J1333 - 41		
HO	RTN	3T5	78	PSDP J1333 - 42		
			79			NOT WIRED

TABLE 13.6.1.1-15 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1335

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-51 NOT WIRED
			.			.
			.			.
			51			PINS 1-51 NOT WIRED
HO	SIG	3T1	52	PSDP J1335 - 20		
HO	SIG	3T1	53	PSDP J1335 - 21		
HO	RTN	3T1	54	PSDP J1335 - 22		
			55			NOT WIRED
			56			NOT WIRED
			57			NOT WIRED
HO	SIG	3T2	58	PSDP J1335 - 17		
HO	SIG	3T2	59	PSDP J1335 - 18		
HO	RTN	3T2	60	PSDP J1335 - 19		
			61			NOT WIRED
			62			NOT WIRED
			63			NOT WIRED
HO	SIG	3T3	64	PSDP J1335 - 14		
HO	SIG	3T3	65	PSDP J1335 - 15		
HO	RTN	3T3	66	PSDP J1335 - 16		
			67			NOT WIRED
			68			NOT WIRED
			69			NOT WIRED
HO	SIG	3T4	70	PSDP J1335 - 11		
HO	SIG	3T4	71	PSDP J1335 - 12		
HO	RTN	3T4	72	PSDP J1335 - 13		
			73			NOT WIRED
			74			NOT WIRED
			75			NOT WIRED
			76			NOT WIRED
HO	SIG	3T5	77	PSDP J1335 - 40		
HO	SIG	3T5	78	PSDP J1335 - 41		
HO	RTN	3T5	79	PSDP J1335 - 42		

TABLE 13.6.1.1-16 PIN ASSIGNMENTS FOR PORT Xo603 CONNECTOR J1337

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			PINS 1-48 NOT WIRED
			.			.
			.			.
			48			PINS 1-48 NOT WIRED
HO	SIG	5T2	49	P01K4122Y DOH 22	8.2.2.2	MDM-PF1
HO	SIG	5T2	50	P01K4120Y DOH 20		MDM-PF1
HO	SIG	5T2	51	P01K4119Y DOH 19		MDM-PF1
HO	SIG	5T2	52	P01K4121Y DOH 21		MDM-PF1
HO	RTN	5T2	53	DOH 19-22 RETURN		
			54			NOT WIRED
HO	SIG	5T3	55	P01K4126Y DOH 26	8.2.2.2	MDM-PF1
HO	SIG	5T3	56	P01K4124Y DOH 24		MDM-PF1
HO	SIG	5T3	57	P01K4123Y DOH 23		MDM-PF1
HO	SIG	5T3	58	P01K4125Y DOH 25		MDM-PF1
HO	RTN	5T3	59	DOH 23-26 RETURN		
			60			NOT WIRED
HO	SIG	5T4	61	P01K4130Y DOH 30	8.2.2.2	MDM-PF1
HO	SIG	5T4	62	P01K4128Y DOH 28		MDM-PF1
HO	SIG	5T4	63	P01K4127Y DOH 27		MDM-PF1
HO	SIG	5T4	64	P01K4129Y DOH 29		MDM-PF1
HO	RTN	5T4	65	DOH 27-30 RETURN		
			66			NOT WIRED
HO	SIG	5T5	67	P01K4134Y DOH 34	8.2.2.2	MDM-PF1
HO	SIG	5T5	68	P01K4132Y DOH 32		MDM-PF1
HO	SIG	5T5	69	P01K4131Y DOH 31		MDM-PF1
HO	SIG	5T5	70	P01K4133Y DOH 33		MDM-PF1
HO	RTN	5T5	71	DOH 31-34 RETURN		
			72			NOT WIRED
HO	SIG	5T1	73	P01K4138Y DOH 38	8.2.2.2	MDM-PF1
HO	SIG	5T1	74	P01K4137Y DOH 37		MDM-PF1
HO	SIG	5T1	75	P01K4135Y DOH 35		MDM-PF1
HO	SIG	5T1	76	P01K4136Y DOH 36		MDM-PF1
HO	RTN	5T1	77	DOH 35-38 RETURN		
			78			NOT WIRED
			79			NOT WIRED

NOTE :

1) WIRES ARE HO TYPE AT Xo 603, ML TYPE AT Xo 576

2) PINS 49-72 ARE ALSO SPLICED TO SMCH P1409/11/13/15

TABLE 13.6.1.2-1 PIN ASSIGNMENTS FOR STARBOARD Xo645 CONNECTOR J37

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	1SC	A	KILL POWER	7.3.4	MPCA # 2 AND # 3
HO	RTN	2T1	B	AUX BUS A RETURN		
			C			NOT WIRED
HO	PWR	2T1	D	AUX BUS A	7.3.4	MPCA - 1

TABLE 13.6.1.2-2 PIN ASSIGNMENTS FOR STARBOARD Xo645 CONNECTOR J38

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			A			NOT WIRED
HO	RTN	2T1	B	AUX BUS B RETURN	7.3.4	
			C			NOT WIRED
HO	PWR	2T1	D	AUX BUS B	7.3.4	MPCA - 2

TABLE 13.6.1.2-3 PIN ASSIGNMENTS FOR STARBOARD Xo1203 CONNECTOR J1616

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	PWR	2T1	A	AFT PAYLOAD BUS B	7.3.5	AFT PCA # 2 (CONTROLLED BY PANEL R1A1)
			B			NOT WIRED
HO	RTN	2T1	C	AFT PAYLOAD BUS B RETURN		GROUND
			D			NOT WIRED

TABLE 13.6.1.2-4 PIN ASSIGNMENTS FOR STARBOARD Xo1203 CONNECTOR 46J1617

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	PWR	2T1	A	AFT PAYLOAD BUS C	7.3.5	AFT PCA # 3 (CONTROLLED BY PANEL R1A1)
			B			NOT WIRED
HO	RTN	2T1	C	AFT PAYLOAD BUS C RETURN		GROUND
			D			NOT WIRED

TABLE 13.6.1.2-5 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1306

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			A			NOT WIRED
			B			NOT WIRED
			C			NOT WIRED
			D			NOT WIRED
			E			NOT WIRED
			F			NOT WIRED
			G			NOT WIRED
			H			NOT WIRED
			J			NOT WIRED
			K			NOT WIRED
			L			NOT WIRED
			M			NOT WIRED
			N			NOT WIRED
			P			NOT WIRED
			R			NOT WIRED
EO	SIG	4T1	S	MSDP J36 - F		
EO	SIG	4T1	T	MSDP J36 - G		
EO	SIG	4T1	U	MSDP J36 - H		
EO	NTL	4T1	V	MSDP J36 - K		

TABLE 13.6.1.2-6 PIN ASSIGNMENTS FOR STARBOARD Xo603 CONNECTOR J1310

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMIANTION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			A			NOT WIRED
			B			NOT WIRED
			C			NOT WIRED
			D			NOT WIRED
			E			NOT WIRED
			F			NOT WIRED
			G			NOT WIRED
			H			NOT WIRED
			J			NOT WIRED
			K			NOT WIRED
			L			NOT WIRED
			M			NOT WIRED
			N			NOT WIRED
			P			NOT WIRED
			R			NOT WIRED
EO	SIG	4T1	S	MSDP J38 - F		
EO	SIG	4T1	T	MSDP J38 - G		
EO	SIG	4T1	U	MSDP J38 - H		
EO	NTL	4T1	V	MSDP J38 - K		

TABLE 13.6.1.2-7 PIN ASSIGNMENTS FOR PORT & STARBOARD SILL LONGERON RETENTION SYSTEM POWER CONNECTORS (1)

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
EO	SIG	4T1	1	AC PHASE A	7.6.3	(2)
EO	SIG	4T1	2	AC PHASE B	7.6.3	(2)
EO	SIG	4T1	3	AC PHASE C	7.6.3	(2)
EO	NTL	4T1	4	AC NEUTRAL	7.6.3	(2)
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
HO	SIG	SC	8	PRLA LATCHED	7.6.2	
HO	SIG	SC	9	PRLA RELEASED	7.6.2	
HO	SIG	SC	10	28 VOLTS	7.6.2	COMMON TO WIPERS OF PINS 8, 9, & 12
			11			NOT WIRED
HO	SIG	SC	12	PRLA READY TO LATCH	7.6.2	
ML	SIG	2S1	13	GAS CAN CONTROL	3.3.3	SSP 1 OR SSP 2, SMCH P2113 OR P1113 (3)(4)
ML	RTN	2S1	14	GAS CAN CONTROL RETURN		SSP 1 OR SSP 2, SMCH P2113 OR P1113 (3)(4)
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED

NOTES :

(1) SEE TABLE 3.3.3-1 FOR COMPLETE LIST OF RETENTION SYSTEM POWER CONNECTORS

(2) AC BUS 1 APPLICABLE TO SYSTEM 1, AC BUS 2 APPLICABLE TO SYSTEM 2

(3) THIS PIN IS NORMALLY ASSIGNED TO A GET AWAY SPECIAL INTERFACE AND ITS WIRING IS LIMITED TO THE RETENTION SYSTEM POWER CONNECTORS SHOWN IN FIGURE 13.3.1.4-1.

(4) SHIELD IS GROUNDED AT THE CONNECTOR BACKSHELL.

TABLE 13.6.1.4-1 PIN ASSIGNMENTS FOR SPECIAL PURPOSE END EFFECTOR CONNECTOR J411 (2)

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	MAX (1) AMPS	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1				NOT WIRED
			2				NOT WIRED
HO	PWR	2T1	3	28 VOLTS SPEE POWER	5.6	13.6.1.4	
HO	RTN	2T1	4	SPEE POWER RETURN	5.6		
HO	PWR	2T2	5	28 VOLTS SPEE POWER	5.6	13.6.1.4	
ML	SHD	2S1	6				TERMINATE
ML	SIG	2S1	7	SPEE # 5	1.5	13.6.1.4	
			8				NOT WIRED
			9				NOT WIRED
			10				NOT WIRED
			11				NOT WIRED
HO	PWR	4T1	12	SPEE # 3 HEATER POWER	3.7	13.6.1.4	
HO	PWR	4T1	13	SPEE # 2 HEATER POWER	3.7	13.6.1.4	
HO	RTN	2T2	14	SPEE POWER RETURN	5.6		
	GND	1SC	15	STRUCTURE GROUND			
ML	SIG	4S1	16	SPEE # 9	1.5	13.6.1.4	
ML	SIG	2S1	17	SPEE # 6	1.5	13.6.1.4	
			18				NOT WIRED
			19				NOT WIRED
			20				NOT WIRED
			21				NOT WIRED
			22				NOT WIRED
HO	RTN	4T1	23	SPEE # 4 HEATER POWER	3.7		
HO	RTN	4T1	24	SPEE # 1 HEATER POWER	3.7		
	GND	1SC	25	STRUCTURE GROUND			
ML	SIG	4S1	26	SPEE # 10	1.5	13.6.1.4	
ML	SIG	4S1	27	SPEE # 11	1.5	13.6.1.4	
			28				NOT WIRED
			29				NOT WIRED
			30				NOT WIRED
			31				NOT WIRED
			32				NOT WIRED
HO	SIG	1SC	33	SPEE # 13	1.5	13.6.1.4	
			34				NOT WIRED
			35				NOT WIRED
ML	SHD	4S1	36				TERMINATE
ML	SIG	4S1	37	SPEE # 12	1.5	13.6.1.4	
ML	SIG	2S2	38	SPEE # 7	1.5	13.6.1.4	
			39				NOT WIRED
			40				NOT WIRED
			41				NOT WIRED
			42				NOT WIRED
			43				NOT WIRED
HO	SIG	1SC	44	SPEE # 14	1.5	13.6.1.4	
HO	SIG	1SC	45	SPEE # 15	1.5	13.6.1.4	

TABLE 13.6.1.4-1 PIN ASSIGNMENTS FOR SPECIAL PURPOSE END EFFECTOR CONNECTOR J411 (2)

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	MAX (1) AMPS	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	1SC	46	SPEE # 16	1.5	13.6.1.4	
ML	SHD	2S2	47				TERMINATE
ML	SIG	2S2	48	SPEE # 8	1.5	13.6.1.4	
			49				NOT WIRED
			50				NOT WIRED
			51				NOT WIRED
			52				NOT WIRED
			53				NOT WIRED
			54				NOT WIRED
			55				NOT WIRED

NOTES :

(1) MAXIMUM AMPS IMPOSED ON ORBITER WIRING

TABLE 13.6.2.1-1 SUMMARY OF PSDP CONNECTORS AVAILABLE AS NON STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE AFD

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO.
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS			
PSDP-J17	15	TSP	HO	3	13.6.2.1.1-10	NLS0T14-35SC	NLS6GT14-35PC
	2	TP	HO				
PSDP-J19	20	TSP	RF	15	13.6.2.1.1-2	NLS0T16-35SA	NLS6GT16-35PA
PSDP-J23	10	TSP	RF	2	13.6.2.1.1-3	NLS0T12-35S	NLS6GT12-35P
PSDP-J27	10	TSP	RF	2	13.6.2.1.1-20	NLS0T12-35P	NLS6GT12-35S
PSDP-J33	1	TP	HO	2	13.6.2.1.2-2	NB0E14-4SNT	NB6GE14-4PNT
PSDP-J35	34	TSP	RF	11	13.6.2.1.1-4	NLS0T20-35S	NLS6GT20-35P
PSDP-J37	1	TQ	EO	6	13.6.2.1.2-3	NB0E12-10SNT2	NB6GE12-10PNT3
PSDP-J39	1	TQ	EO	6	13.6.2.1.2-4	NB0E12-10SWT2	NB6GE12-10PWT3
PSDP-J43	26	TSP	ML	22	13.6.2.1.1-7	NLS0T22-35S	NLS6GT22-35P
PSDP-J45	21	TSP	ML	16	13.6.2.1.1-8	NLS0T20-35PA	NLS6GT20-35SA
PSDP-J51	22	TSP	ML	13	13.6.2.1.1-9	NLS0T20-35P	NLS6GT20-35S
PSDP-J55	3	TSP	RF	28	13.6.2.1.1-21	NLS0T14-35P	NLS6GT14-35S
	1	T3C	HO				
PSDP-J71	8	TSP	RF	6	13.6.2.1.1-22	NLS0T12-35S	NLS6GT12-35P
PSDP-J73	8	TSP	RF	6	13.6.2.1.1-23	NLS0T12-35S	NLS6GT12-35P
PSDP-J100	1	TSP	RF	20	13.6.2.1.4-1	NLS0T12-35S	NLS6GT12-35P
PSDP-J701	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J702	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J703	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J704	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J705	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J706	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J707	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J708	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J709	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J710	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J714	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J715	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J716	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J717	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J718	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J719	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J720	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J721	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J722	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
PSDP-J723	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306
PSDP-J724	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306
PSDP-J725	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306
PSDP-J726	1	COAX	RF	0	(1)	ME414-0247-0306	ME414-0250-0306
PSDP-J1301	11	TSP	RF	15	13.6.2.1.1-14	NLS0T14-35S	NLS6GT14-35P
PSDP-J1303	11	TSP	RF	15	13.6.2.1.1-15	NLS0T14-35S	NLS6GT14-35P

TABLE 13.6.2.1-1 SUMMARY OF PSDP CONNECTORS AVAILABLE AS NON STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE AFD

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO.
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS			
PSDP-J1305	11	TSP	RF	15	13.6.2.1.1-16	NLS0T14-35S	NLS6GT14-35P
PSDP-J1307	10	TSP	RF	17	13.6.2.1.1-17	NLS0T14-35S	NLS6GT14-35P
PSDP-J1317	13	TSP	ML	16	13.6.2.1.1-18	NLS0T16-35SD	NLS6GT16-35PD
PSDP-J1319	13	TSP	ML	16	13.6.2.1.1-19	NLS0T16-35SC	NLS6GT16-35PC
PSDP-J1333	10	T3C	HO	16	13.6.2.1.1-11	NLS0T16-35S	NLS6GT16-35P
	2	TSP	ML				
	5	SC	HO				
PSDP-J1335	10	T3C	HO	16	13.6.2.1.1-12	NLS0T16-35S	NLS6GT16-35P
	1	TSP	HO				
	7	SC	HO				

(1) SIGNAL IS CARRIED CONVENTIONALLY ON CENTER CONDUCTOR FOR ALL ORBITER COAX CABLES. NO PIN ASSIGNMENT TABLES ARE REQUIRED. CIRCUIT TERMINATIONS ARE SHOWN IN FIGURE 13.3.3-1.

TABLE 13.6.2.1.1-2 PIN ASSIGNMENTS FOR PSDP - J19

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
RF	SIG	2S20	5	DATA BUS HI	8.2.12	DATA BUS COUPLER - PI1
RF	RTN	2S20	6	DATA BUS LO		
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
RF	SIG	2S1	11	TIMING 1024 KHZ	8.2.10.2.2	MASTER TIMING UNIT
RF	RTN	2S1	12	TIMING 1024 KHZ RETURN		
RF	SIG	2S2	13	TIMING 1 KHZ	8.2.10.2.3	MASTER TIMING UNIT
RF	RTN	2S2	14	TIMING 1 KHZ RETURN		
RF	SIG	2S3	15	TIMING 100 HZ	8.2.10.2.4	MASTER TIMING UNIT
RF	RTN	2S3	16	TIMING 100 HZ RETURN		
RF	SIG	2S4	17	NSP 2 OUT		NETWORK SIGNAL PROCESSOR 2
RF	RTN	2S4	18	NSP 2 OUT RETURN		
RF	SIG	2S5	19	NSP 2 OUT CLOCK		NETWORK SIGNAL PROCESSOR 2
RF	RTN	2S5	20	NSP 2 OUT CLOCK RETURN		
RF	SIG	2S6	21	NSP 2 IN		NETWORK SIGNAL PROCESSOR 2
RF	RTN	2S6	22	NSP 2 IN RETURN		
RF	SIG	2S7	23	NSP # 2 PSS TIMING		NETWORK SIGNAL PROCESSOR 2
RF	RTN	2S7	24	NSP # 2 PSS TIMING RETURN		
			25			NOT WIRED
RF	SIG	2S8	26	DOD CMDS FSK AM TERNARY TONES	8.3.1	PAYLOAD INTERROGATOR 2
RF	RTN	2S8	27	DOD CMDS RETURN		
RF	SIG	2S9	28	16 KHZ COMMAND OUT 5	8.2.5	PAYLOAD SIGNAL PROCESSOR 2
RF	RTN	2S9	29	16 KHZ COMMAND OUT 5 RETURN		
RF	SIG	2S10	30	NSP 2 IN CLOCK		NETWORK SIGNAL PROCESSOR 2
RF	RTN	2S10	31	NSP 2 IN CLOCK RETURN		
RF	SIG	2S11	32	NSP 1 OUT		NETWORK SIGNAL PROCESSOR 1
RF	RTN	2S11	33	NSP 1 OUT RETURN		
RF	SIG	2S12	34	DOD DATA (1.024 &/OR 1.7 MHZ)	8.3.1	PAYLOAD INTERROGATOR 2
RF	RTN	2S12	35	DOD DATA RETURN		
RF	SIG	2S13	36	PDI TELEMETRY 5	8.2.1	PAYLOAD DATA INTERLEAVER
RF	RTN	2S13	37	PDI TELEMETRY 5 RETURN		
RF	SIG	2S14	38	NSP # 1 PSS TIMING		NETWORK SIGNAL PROCESSOR 1
RF	RTN	2S14	39	NSP # 1 PSS TIMING RETURN		
RF	SIG	2S15	40	NSP 1 OUT CLOCK		NETWORK SIGNAL PROCESSOR 1
RF	SIG	2S16	41	NSP 1 IN		NETWORK SIGNAL PROCESSOR 1
RF	RTN	2S16	42	NSP 1 IN RETURN		
RF	SIG	2S17	43	NSP 1 IN CLOCK		NETWORK SIGNAL PROCESSOR 1
RF	RTN	2S17	44	NSP 1 IN CLOCK RETURN		
RF	SIG	2S18	45	TIMING 10 HZ	8.2.10.2.5	MASTER TIMING UNIT

TABLE 13.6.2.1.1-2 PIN ASSIGNMENTS FOR PSDP - J19

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	RTN	2S18	46	TIMING 10 HZ RETURN		
RF	RTN	2S15	47	NSP 1 OUT CLOCK RETURN		
RF	SIG	2S19	48	PDI CLOCK 5	8.2.1	PAYLOAD DATA INTERLEAVER
RF	RTN	2S19	49	PDI CLOCK 5 RETURN		
			50			NOT WIRED
			51			NOT WIRED
			52			NOT WIRED
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

TABLE 13.6.2.1.1-3 PIN ASSIGNMENTS FOR PSDP - J23

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
RF	SIG	2S10	3	DATA BUS PI2 HI	8.2.12	DATA BUS COUPLER - PI2
RF	RTN	2S10	4	DATA BUS PI2 LO		
RF	SIG	2S11	5	DATA BUS DK2 HI	8.2.12	DATA BUS COUPLER - DK2
RF	RTN	2S11	6	DATA BUS DK2 LO		
RF	SIG	2S4	7	CLOCK 128 KBPS	8.2.4.1	KU-BAND SIGNAL PROCESSOR
RF	RTN	2S4	8	CLOCK 128 KBPS RETURN		
RF	SIG	2S3	9	FWD DATA LINK 128 KBPS	8.2.4.5	KU-BAND SIGNAL PROCESSOR
RF	RTN	2S3	10	FWD DATA LINK 128 KBPS RETURN		
RF	SIG	2S6	11	HDR P/L DIGITAL DATA	8.2.4.3	KU-BAND SIGNAL PROCESSOR
RF	RTN	2S6	12	HDR P/L DIGITAL DATA RETURN		
RF	SIG	2S5	13	HDR P/L ANALOG DATA	8.2.4.4	KU-BAND SIGNAL PROCESSOR
RF	RTN	2S5	14	HDR P/L ANALOG DATA RETURN		
RF	SIG	2S9	15	LDR P/L DIGITAL DATA	8.2.4.2	KU-BAND SIGNAL PROCESSOR
RF	RTN	2S9	16	LDR P/L DIGITAL DATA RETURN		
RF	SIG	2S2	17	DIGITAL P/L DATA ENCR	8.2.6.3	S-BAND FM SIGNAL PROCESSOR
RF	RTN	2S2	18	DIGITAL P/L DATA ENCR RETURN		
RF	SIG	2S8	19	W/B DIGITAL SIGNAL	8.2.6.2	S-BAND FM SIGNAL PROCESSOR
RF	RTN	2S8	20	W/B DIGITAL SIGNAL RETURN		
RF	SIG	2S7	21	W/B ANALOG SIGNAL	8.2.6.1	S-BAND FM SIGNAL PROCESSOR
RF	RTN	2S7	22	W/B ANALOG SIGNAL RETURN		

TABLE 13.6.2.1.1-4 PIN ASSIGNMENTS FOR PSDP - J35

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
RF	SIG	2S42	12	WORD ENBL DISCRETE	8.2.2.5	MDM-PF1 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S42	13	WORD ENBL DISCRETE RETURN		
RF	SIG	2S43	14	MSDP J40 - 7		
RF	RTN	2S43	15	MSDP J40 - 6		
RF	SIG	2S44	16	MSDP J40 - 9		
RF	RTN	2S44	17	MSDP J40 - 8		
RF	SIG	2S45	18	MSDP J40 - 11		
RF	RTN	2S45	19	MSDP J40 - 10		
RF	SIG	2S46	20	MSDP J40 - 13		
RF	RTN	2S46	21	MSDP J40 - 12		
RF	SIG	2S34	22	1.024 &/OR 1.7 MHZ DATA SCO	8.3.1	PAYLOAD INTERROGATOR 1
RF	RTN	2S34	23	1.024 &/OR 1.7 MHZ DATA RTN		
RF	SIG	2S33	24	DOD CMDS FSK AM TERNARY TONES	8.3.1	PAYLOAD INTERROGATOR 1
RF	RTN	2S33	25	DOD CMDS FSK AM TERNARY RETURN		
RF	SIG	2S51	26	16 KHZ CMD OUT NO. 5	8.2.5	PAYLOAD SIGNAL PROCESSOR 1
RF	RTN	2S51	27	16 KHZ CMD OUT NO. 5 RETURN		
RF	SIG	2S41	28	MSG OUT DISCRETE	8.2.2.5	MDM-PF1 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S41	29	MSG OUT DISCRETE RETURN		
RF	SIG	2S40	30	MSG IN DISCRETE	8.2.2.5	MDM-PF1 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S40	31	MSG IN DISCRETE RETURN		
RF	SIG	2S39	32	PO1M1120J SIO 20	8.2.2.5	MDM-PF1 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S39	33	SIO 20 RETURN		
RF	SIG	2S38	34	WORD ENBL DISCRETE	8.2.2.5	MDM-PF1 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S38	35	WORD ENBL DISCRETE RETURN		
RF	SIG	2S37	36	MSG OUT DISCRETE	8.2.2.5	MDM-PF1 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S37	37	MSG OUT DISCRETE RETURN		
RF	SIG	2S36	38	MSG IN DISCRETE	8.2.2.5	MDM-PF1 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S36	39	MSG IN DISCRETE RETURN		
RF	SIG	2S35	40	PO1M1100J SIO 00	8.2.2.5	MDM-PF1 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S35	41	SIO 00 RETURN		
RF	SIG	2S2	42	E1 INPUT	8.2.3	MMU1 E1 INPUT
RF	RTN	2S2	43	E1 RTN	8.2.3	MMU1 E1 RTN
RF	SIG	2S1	44	B INPUT	8.2.3	MMU1 B INPUT
RF	RTN	2S1	45	B RTN	8.2.3	MMU1 B RTN

TABLE 13.6.2.1.1-4 PIN ASSIGNMENTS FOR PSDP - J35

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	SIG	2S17	46	SPARE	8.2.3	30P565
RF	RTN	2S17	47	SPARE		30P565
RF	SIG	2S16	48	SPARE	8.2.3	30P565
RF	RTN	2S16	49	SPARE		30P565
RF	SIG	2S15	50	SPARE	8.2.3	30P565
RF	RTN	2S15	51	SPARE		30P565
RF	SIG	2S14	52	SPARE	8.2.3	30P565
RF	RTN	2S14	53	SPARE		30P565
RF	SIG	2S13	54	SPARE	8.2.3	30P565
RF	RTN	2S13	55	SPARE		30P565
RF	SIG	2S12	56	SPARE	8.2.3	30P565
RF	RTN	2S12	57	SPARE		30P565
RF	SIG	2S11	58	SPARE	8.2.3	30P565
RF	RTN	2S11	59	SPARE		30P565
RF	SIG	2S31	60	SPARE	8.2.3	30P565
RF	RTN	2S31	61	SPARE		30P565
RF	SIG	2S30	62	SPARE	8.2.3	30P565
RF	RTN	2S30	63	SPARE		30P565
RF	SIG	2S29	64	SPARE	8.2.3	30P565
RF	RTN	2S29	65	SPARE		30P565
RF	SIG	2S28	66	SPARE	8.2.3	30P565
RF	RTN	2S28	67	SPARE		30P565
RF	SIG	2S27	68	SPARE	8.2.3	30P565
RF	RTN	2S27	69	SPARE		30P565
RF	SIG	2S26	70	SPARE	8.2.3	30P565
RF	RTN	2S26	71	SPARE		30P565
RF	SIG	2S25	72	SPARE	8.2.3	30P565
RF	RTN	2S25	73	SPARE		30P565
RF	SIG	2S24	74	SPARE	8.2.3	30P565
RF	RTN	2S24	75	SPARE		30P565
RF	SIG	2S23	76	SPARE	8.2.3	30P565
RF	RTN	2S23	77	SPARE		30P565
RF	SIG	2S22	78	SPARE	8.2.3	30P565
RF	RTN	2S22	79	SPARE		30P565

TABLE 13.6.2.1.1-7 PIN ASSIGNMENTS FOR PSDP - J43

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S24	1		8.2.7	TERMINATE
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
ML	SIG	2S24	8	AUDIO OUT EIC HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S24	9	AUDIO OUT EIC LO		
ML	SHD	2S25	10			TERMINATE
ML	SIG	2S25	11	AUDIO OUT PAGE HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S25	12	AUDIO OUT PAGE LO		
ML	SHD	2S26	13			TERMINATE
ML	SIG	2S26	14	P/L C/W TONE	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S26	15	P/L C/W TONE RETURN		
ML	SIG	2S21	16	AUDIO OUT AG2 HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S21	17	AUDIO OUT AG2 LO		
ML	SHD	2S21	18			TERMINATE
ML	SIG	2S22	19	AUDIO OUT AA HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S22	20	AUDIO OUT AA LO		
ML	SHD	2S22	21			TERMINATE
ML	SIG	2S23	22	AUDIO OUT OIC HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S23	23	AUDIO OUT OIC LO		
ML	SHD	2S23	24			TERMINATE
ML	SHD	2S18	25			TERMINATE
ML	SIG	2S18	26	AUDIO IN EIC HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S18	27	AUDIO IN EIC LO		
ML	SHD	2S19	28			TERMINATE
ML	SIG	2S19	29	AUDIO IN PAGE HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S19	30	AUDIO IN PAGE LO		
ML	SHD	2S20	31			TERMINATE
ML	SIG	2S20	32	AUDIO OUT AG1 HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S20	33	AUDIO OUT AG1 LO		
ML	SHD	2S17	34			TERMINATE
ML	SIG	2S14	35	AUDIO IN AG1 HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S14	36	AUDIO IN AG1 LO		
ML	SHD	2S14	37			TERMINATE
ML	SIG	2S15	38	AUDIO IN AG2 HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S15	39	AUDIO IN AG2 LO		
ML	SHD	2S15	40			TERMINATE
ML	SIG	2S16	41	AUDIO IN AA HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S16	42	AUDIO IN AA LO		
ML	SHD	2S16	43			TERMINATE
ML	SIG	2S17	44	AUDIO IN OIC HI	8.2.7	AUDIO CENTRAL CONTROL UNIT
ML	RTN	2S17	45	AUDIO IN OIC LO		

TABLE 13.6.2.1.1-7 PIN ASSIGNMENTS FOR PSDP - J43

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S13	46	Xo 603 J1321 - 46		
ML	RTN	2S13	47	Xo 603 J1321 - 47		
ML	SHD	2S13	48	Xo 603 J1321 - 48		TERMINATE
ML	SIG	2S12	49	Xo 603 J1321 - 49		
ML	RTN	2S12	50	Xo 603 J1321 - 50		
ML	SHD	2S12	51	Xo 603 J1321 - 51		TERMINATE
ML	SIG	2S11	52	Xo 603 J1321 - 52		
ML	RTN	2S11	53	Xo 603 J1321 - 53		
ML	SHD	2S11	54	Xo 603 J1321 - 54		TERMINATE
ML	SHD	2S7	55	Xo 603 J1321 - 60		TERMINATE
ML	SIG	2S10	56	Xo 603 J1321 - 40		
ML	RTN	2S10	57	Xo 603 J1321 - 41		
ML	SHD	2S10	58	Xo 603 J1321 - 42		TERMINATE
ML	SIG	2S9	59	Xo 603 J1321 - 43		
ML	RTN	2S9	60	Xo 603 J1321 - 44		
ML	SHD	2S9	61	Xo 603 J1321 - 45		TERMINATE
ML	SIG	2S8	62	Xo 603 J1321 - 55		
ML	RTN	2S8	63	Xo 603 J1321 - 56		
ML	SHD	2S8	64	Xo 603 J1321 - 57		TERMINATE
ML	SIG	2S7	65	Xo 603 J1321 - 58		
ML	RTN	2S7	66	Xo 603 J1321 - 59		
ML	SIG	2S6	67	Xo 603 J1321 - 61		
ML	RTN	2S6	68	Xo 603 J1321 - 62		
ML	SHD	2S6	69	Xo 603 J1321 - 63		TERMINATE
ML	SIG	2S5	70	Xo 603 J1321 - 70		
ML	RTN	2S5	71	Xo 603 J1321 - 71		
ML	SHD	2S5	72	Xo 603 J1321 - 72		TERMINATE
ML	SIG	2S4	73	Xo 603 J1321 - 73		
ML	RTN	2S4	74	Xo 603 J1321 - 74		
ML	SHD	2S4	75	Xo 603 J1321 - 75		TERMINATE
ML	SIG	2S3	76	Xo 603 J1321 - 76		
			77			NOT WIRED
			78			NOT WIRED
			79			NOT WIRED
ML	SIG	2S2	80	Xo 603 J1321 - 64		
ML	RTN	2S2	81	Xo 603 J1321 - 65		
ML	SHD	2S2	82	Xo 603 J1321 - 66		TERMINATE
ML	SIG	2S1	83	Xo 603 J1321 - 67		
ML	RTN	2S1	84	Xo 603 J1321 - 68		
ML	RTN	2S3	85	Xo 603 J1321 - 77		
			86			NOT WIRED
			87			NOT WIRED
			88			NOT WIRED
			89			NOT WIRED
			90			NOT WIRED

TABLE 13.6.2.1.1-7 PIN ASSIGNMENTS FOR PSDP - J43

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			91			NOT WIRED
ML	SHD	2S1	92	Xo 603 J1321 - 69		TERMINATE
ML	SHD	2S3	93	Xo 603 J1321 - 78		TERMINATE
			94			NOT WIRED
			95			NOT WIRED
			96			NOT WIRED
			97			NOT WIRED
			98			NOT WIRED
			99			NOT WIRED
			100			NOT WIRED

TABLE 13.6.2.1.1-8 PIN ASSIGNMENTS FOR PSDP - J45

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S9	1	OOSDP J61 - 54		TERMINATE
ML	SHD	2S16	2	OOSDP J61 - 57		TERMINATE
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
ML	SIG	2S12	8	OOSDP J61 - 4		
ML	RTN	2S12	9	OOSDP J61 - 32		
ML	SHD	2S12	10	OOSDP J61 - 5		TERMINATE
ML	SIG	2S14	11	OOSDP J61 - 6		
ML	RTN	2S14	12	OOSDP J61 - 7		
ML	SIG	2S15	13	OOSDP J61 - 35		
ML	RTN	2S15	14	OOSDP J61 - 36		
ML	SHD	2S15	15	OOSDP J61 - 56		TERMINATE
			16			NOT WIRED
			17			NOT WIRED
ML	RTN	2S13	18	OOSDP J61 - 34		
ML	SHD	2S13	19	OOSDP J61 - 33		
ML	SHD	2S13	20	OOSDP J61 - 55		TERMINATE
ML	SHD	2S19	21	OOSDP J61 - 12		TERMINATE
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
ML	SHD	2S8	25	OOSDP J61 - 52		TERMINATE
ML	SIG	2S8	26	OOSDP J61 - 31		
ML	RTN	2S8	27	OOSDP J61 - 53		
ML	SIG	2S9	28	OOSDP J61 - 69		TERMINATE
ML	RTN	2S9	29	OOSDP J61 - 70		
ML	SIG	2S16	30	OOSDP J61 - 71		
ML	RTN	2S16	31	OOSDP J61 - 58		
ML	SIG	2S17	32	OOSDP J61 - 9		
ML	RTN	2S17	33	OOSDP J61 - 10		
ML	SHD	2S17	34	OOSDP J61 - 11		TERMINATE
ML	RTN	2S1	35	OOSDP J61 - 1		
ML	SIG	2S1	36	OOSDP J61 - 2		
ML	SHD	2S1	37	OOSDP J61 - 3		TERMINATE
ML	SHD	2S14	38	OOSDP J61 - 8		TERMINATE
			39			NOT WIRED
			40			NOT WIRED
ML	RTN	2S9	41	OOSDP J61 - 72		
ML	SIG	2S16	42	OOSDP J61 - 59		
ML	RTN	2S16	43	OOSDP J61 - 73		TERMINATE
ML	SIG	2S17	44	OOSDP J61 - 37		
ML	RTN	2S17	45	OOSDP J61 - 38		

TABLE 13.6.2.1.1-8 PIN ASSIGNMENTS FOR PSDP - J45

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S2	46	OOSDP J61 - 29		
ML	RTN	2S2	47	OOSDP J61 - 28		
ML	SIG	2S5	48	OOSDP J61 - 51		
ML	RTN	2S5	49	OOSDP J61 - 67		
ML	SIG	2S10	50	OOSDP J61 - 77		
ML	RTN	2S10	51	OOSDP J61 - 79		
ML	SHD	2S10	52	OOSDP J61 - 78		TERMINATE
ML	SIG	2S20	53	OOSDP J61 - 61		
ML	RTN	2S20	54	OOSDP J61 - 62		
ML	SHD	2S20	55	OOSDP J61 - 44		TERMINATE
ML	SIG	2S3	56	OOSDP J61 - 50		
ML	RTN	2S3	57	OOSDP J61 - 27		
ML	SHD	2S3	58	OOSDP J61 - 26		TERMINATE
ML	SIG	2S6	59	OOSDP J61 - 65		
ML	RTN	2S6	60	OOSDP J61 - 64		
ML	SHD	2S6	61	OOSDP J61 - 47		TERMINATE
ML	SIG	2S11	62	OOSDP J61 - 75		
ML	RTN	2S11	63	OOSDP J61 - 74		
ML	SHD	2S11	64	OOSDP J61 - 76		TERMINATE
ML	SHD	2S2	65	OOSDP J61 - 30		TERMINATE
ML	SHD	2S5	66	OOSDP J61 - 68		TERMINATE
			67			NOT WIRED
ML	SIG	2S4	68	OOSDP J61 - 49		
ML	RTN	2S4	69	OOSDP J61 - 48		
ML	SHD	2S4	70	OOSDP J61 - 66		TERMINATE
ML	SIG	2S7	71	OOSDP J61 - 46		
ML	RTN	2S7	72	OOSDP J61 - 45		
ML	SHD	2S7	73	OOSDP J61 - 63		TERMINATE
ML	SIG	2S21	74	OOSDP J61 - 42		
ML	RTN	2S21	75	OOSDP J61 - 43		
ML	SHD	2S21	76	OOSDP J61 - 60		TERMINATE
			77			NOT WIRED
			78			NOT WIRED
			79			NOT WIRED

TABLE 13.6.2.1.1-9 PIN ASSIGNMENTS FOR PSDP - J51

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
ML	SIG	2S2	14	OOSDP J59 - 14		
ML	RTN	2S2	15	OOSDP J59 - 15		
ML	SHD	2S2	16	OOSDP J59 - 16		TERMINATE
ML	SIG	2S1	17	OOSDP J59 - 17		
ML	RTN	2S1	18	OOSDP J59 - 18		
ML	SHD	2S1	19	OOSDP J59 - 19		TERMINATE
ML	SIG	2S9	20	OOSDP J59 - 20		
ML	RTN	2S9	21	OOSDP J59 - 21		
ML	SHD	2S9	22	OOSDP J59 - 22		TERMINATE
ML	SIG	2S12	23	OOSDP J59 - 23		
ML	RTN	2S12	24	OOSDP J59 - 24		
ML	SHD	2S12	25	OOSDP J59 - 25		TERMINATE
ML	SIG	2S14	26	OOSDP J59 - 26		
ML	RTN	2S14	27	OOSDP J59 - 27		
ML	SHD	2S14	28	OOSDP J59 - 28		TERMINATE
ML	SIG	2S15	29	OOSDP J59 - 29		
ML	RTN	2S15	30	OOSDP J59 - 30		
ML	SHD	2S15	31	OOSDP J59 - 31		TERMINATE
ML	SIG	2S8	32	OOSDP J59 - 32		
ML	RTN	2S8	33	OOSDP J59 - 33		
ML	SHD	2S8	34	OOSDP J59 - 34		TERMINATE
ML	SIG	2S7	35	OOSDP J59 - 35		
ML	RTN	2S7	36	OOSDP J59 - 36		
ML	SHD	2S7	37	OOSDP J59 - 37		TERMINATE
ML	SIG	2S4	38	OOSDP J59 - 38		
ML	RTN	2S4	39	OOSDP J59 - 39		
ML	SHD	2S4	40	OOSDP J59 - 40		TERMINATE
ML	SIG	2S3	41	OOSDP J59 - 41		
ML	RTN	2S3	42	OOSDP J59 - 42		
ML	SHD	2S3	43	OOSDP J59 - 43		TERMINATE
ML	SIG	2S10	44	OOSDP J59 - 44		
ML	RTN	2S10	45	OOSDP J59 - 45		

TABLE 13.6.2.1.1-9 PIN ASSIGNMENTS FOR PSDP - J51

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S10	46	OOSDP J59 - 46		TERMINATE
ML	RTN	2S13	47	OOSDP J59 - 47		
ML	SIG	2S13	48	OOSDP J59 - 48		
ML	SHD	2S13	49	OOSDP J59 - 49		TERMINATE
ML	RTN	2S17	50	OOSDP J59 - 50		
ML	SIG	2S17	51	OOSDP J59 - 51		
ML	SHD	2S17	52	OOSDP J59 - 52		TERMINATE
ML	RTN	2S16	53	OOSDP J59 - 53		
ML	SIG	2S16	54	OOSDP J59 - 54		
ML	SHD	2S16	55	OOSDP J59 - 55		TERMINATE
ML	SIG	2S6	56	OOSDP J59 - 56		
ML	RTN	2S6	57	OOSDP J59 - 57		
ML	SHD	2S6	58	OOSDP J59 - 58		TERMINATE
ML	SIG	2S5	59	OOSDP J59 - 59		
ML	RTN	2S5	60	OOSDP J59 - 60		
ML	SHD	2S5	61	OOSDP J59 - 61		TERMINATE
ML	SIG	2S11	62	OOSDP J59 - 62		
ML	RTN	2S11	63	OOSDP J59 - 63		
ML	SHD	2S11	64	OOSDP J59 - 64		TERMINATE
ML	RTN	2S18	65	OOSDP J59 - 65		
ML	SIG	2S18	66	OOSDP J59 - 66		
ML	SHD	2S18	67	OOSDP J59 - 67		TERMINATE
ML	RTN	2S21	68	OOSDP J59 - 68		
ML	SIG	2S21	69	OOSDP J59 - 69		
ML	SHD	2S21	70	OOSDP J59 - 70		TERMINATE
ML	SIG	2S19	71	OOSDP J59 - 71		
ML	RTN	2S19	72	OOSDP J59 - 72		
ML	SHD	2S19	73	OOSDP J59 - 73		TERMINATE
ML	SIG	2S20	74	OOSDP J59 - 74		
ML	RTN	2S20	75	OOSDP J59 - 75		
ML	SHD	2S20	76	OOSDP J59 - 76		TERMINATE
ML	RTN	2S22	77	OOSDP J59 - 77		
ML	SIG	2S22	78	OOSDP J59 - 78		
ML	SHD	2S22	79	OOSDP J59 - 79		TERMINATE

TABLE 13.6.2.1.1-10 PIN ASSIGNMENTS FOR PSDP - J17

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
HO	SIG	2T39	4	PAGE KEY	8.2.7	AUDIO CENTRAL CONTROL UNIT
HO	RTN	2T39	5	PAGE KEY RETURN		
HO	SIG	2T40	6	PTT OUT HI EVA	8.2.7	SPLICED TO ACCU & UHF EVA/ATC XCVR
HO	RTN	2T40	7	PTT OUT LO EVA		
HO	RTN	2T22	8	OOSDP J57 - 23		
HO	RTN	2T22	9	OOSDP J57 - 24		
HO	SIG	2T21	10	OOSDP J57 - 21		
HO	RTN	2T21	11	OOSDP J57 - 22		
HO	SIG	2T20	12	OOSDP J57 - 19		
HO	RTN	2T20	13	OOSDP J57 - 20		
HO	SIG	2T19	14	OOSDP J57 - 17		
HO	RTN	2T19	15	OOSDP J57 - 18		
HO	SIG	2T18	16	OOSDP J57 - 45		
HO	RTN	2T18	17	OOSDP J57 - 46		
HO	SIG	2T17	18	OOSDP J57 - 43		
HO	RTN	2T17	19	OOSDP J57 - 44		
HO	SIG	2T16	20	OOSDP J57 - 41		
HO	RTN	2T16	21	OOSDP J57 - 42		
HO	SIG	2T15	22	OOSDP J57 - 38		
HO	RTN	2T15	23	OOSDP J57 - 39		
HO	SIG	2T14	24	OOSDP J57 - 36		
HO	RTN	2T14	25	OOSDP J57 - 37		
HO	SIG	2T13	26	OOSDP J57 - 34		
HO	RTN	2T13	27	OOSDP J57 - 35		
HO	SIG	2T12	28	OOSDP J57 - 40		
HO	RTN	2T12	29	OOSDP J57 - 33		
HO	SIG	2T11	30	OOSDP J57 - 30		
HO	RTN	2T11	31	OOSDP J57 - 31		
HO	SIG	2T10	32	OOSDP J57 - 28		
HO	RTN	2T10	33	OOSDP J57 - 29		
HO	SIG	2T9	34	OOSDP J57 - 26		
HO	RTN	2T9	35	OOSDP J57 - 27		
HO	SIG	2T8	36	OOSDP J57 - 32		
HO	RTN	2T8	37	OOSDP J57 - 25		

TABLE 13.6.2.1.1-11 PIN ASSIGNMENTS FOR PSDP - J1333

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
HO	SIG	SC	3	ACCU VOICE ENABLE		NETWORK SIGNAL PROCESSOR # 1 (1) *
HO	SIG	SC	4	PS VOICE ENABLE		NETWORK SIGNAL PROCESSOR # 1 (1) *
HO	SIG	SC	5	VOICE ENABLE STIMULUS (28VDC)		PANEL A1A3 (1) *
HO	SIG	SC	6	28 VDC MAIN BUS B		FORWARD LCA # 2
HO	SIG	SC	7	DOD ENABLE		PAYLOAD INTERROGATOR # 1
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
HO	SIG	3T4	11	Xo 603 J1333 - 70		
HO	SIG	3T4	12	Xo 603 J1333 - 71		
HO	RTN	3T4	13	Xo 603 J1333 - 72		
HO	SIG	3T3	14	Xo 603 J1333 - 64		
HO	SIG	3T3	15	Xo 603 J1333 - 65		
HO	RTN	3T3	16	Xo 603 J1333 - 66		
HO	SIG	3T2	17	Xo 603 J1333 - 58		
HO	SIG	3T2	18	Xo 603 J1333 - 59		
HO	RTN	3T2	19	Xo 603 J1333 - 60		
HO	SIG	3T1	20	Xo 603 J1333 - 52		
HO	SIG	3T1	21	Xo 603 J1333 - 53		
HO	RTN	3T1	22	Xo 603 J1333 - 54		
			23			NOT WIRED
ML	SIG	2S2	24	ENCRYPTOR ZEROIZE	8.2.14	KGX-60 COMSEC (2)
ML	RTN	2S2	25	ENCRYPTOR ZEROIZE RETURN		(2)
HO	SIG	3T8	26	ACTIVE 2A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T8	27	COM 2A		
HO	SIG	3T8	28	SAFE 2A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	SIG	3T9	29	ACTIVE 3A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T9	30	COM 3A		
HO	SIG	3T9	31	SAFE 3A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	SIG	3T10	32	ACTIVE 4A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T10	33	COM 4A		
HO	SIG	3T10	34	SAFE 4A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	SIG	3T6	35	ACTIVE 5A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T6	36	COM 5A		
HO	SIG	3T6	37	SAFE 5A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
ML	SIG	2S1	38	ENCRYPTOR ZEROIZE	8.2.14	PANEL R12A2 (2)
ML	RTN	2S1	39	ENCRYPTOR ZEROIZE RETURN		(2)
HO	SIG	3T5	40	Xo 603 J1333 - 76		
HO	SIG	3T5	41	Xo 603 J1333 - 77		
HO	RTN	3T5	42	Xo 603 J1333 - 78		
HO	SIG	3T7	43	SAFE 1A	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T7	44	ACTIVE 1A		
HO	SIG	3T7	45	COM 1A	8.2.9	PANEL C3A5 - PAYLOAD SAFING

* USE OF THIS INTERFACE REQUIRES THAT IT BE IDENTIFIED AS A SAFETY CRITICAL CIRCUIT.

TABLE 13.6.2.1.1-11 PIN ASSIGNMENTS FOR PSDP - J1333

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML			46			NOT WIRED
ML			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
			50			NOT WIRED
			51			NOT WIRED
			52			NOT WIRED
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

(1) JUMPER REQUIRED FROM PIN 5 TO EITHER PIN 3 OR 4 FOR DOWNLINK VOICE SELECT.

(2) JUMPERS ARE REQUIRED FROM PIN 25 TO 39 AND 24 TO 38 UNLESS OTHERWISE SPECIFIED IN MISSION UNIQUE ICD.

TABLE 13.6.2.1.1-12 PIN ASSIGNMENTS FOR PSDP - J1335

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	SC	1	PS VOICE ENABLE		NETWORK SIGNAL PROCESSOR # 2 (1) *
HO	SIG	SC	2	ACCU VOICE ENABLE		NETWORK SIGNAL PROCESSOR # 2 (1) *
HO	SIG	SC	3	POWER ON DISCRETE FOR CRT 5		D&C PANEL C2A2
HO	SIG	SC	4	NSP # 1 VOICE ENABLE		MDM OF 4
HO	SIG	SC	5	VOICE ENABLE STIMULUS (28VDC)		PANEL A1A3 (1) *
HO	SIG	SC	6	28 VDC MAIN BUS C		FORWARD LCA # 3
HO	SIG	SC	7	DOD ENABLE		PAYLOAD INTERROGATOR # 2
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
HO	SIG	3T4	11	Xo 603 J1335 - 70		
HO	SIG	3T4	12	Xo 603 J1335 - 71		
HO	RTN	3T4	13	Xo 603 J1335 - 72		
HO	SIG	3T3	14	Xo 603 J1335 - 64		
HO	SIG	3T3	15	Xo 603 J1335 - 65		
HO	RTN	3T3	16	Xo 603 J1335 - 66		
HO	SIG	3T2	17	Xo 603 J1335 - 58		
HO	SIG	3T2	18	Xo 603 J1335 - 59		
HO	RTN	3T2	19	Xo 603 J1335 - 60		
HO	SIG	3T1	20	Xo 603 J1335 - 52		
HO	SIG	3T1	21	Xo 603 J1335 - 53		
HO	RTN	3T1	22	Xo 603 J1335 - 54		
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
HO	SIG	3T8	26	SAFE 2B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T8	27	COM 2B		
HO	SIG	3T8	28	ACTIVE 2B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	SIG	3T9	29	SAFE 3B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T9	30	COM 3B		
HO	SIG	3T9	31	ACTIVE 3B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	SIG	3T10	32	SAFE 4B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T10	33	COM 4B		
HO	SIG	3T10	34	ACTIVE 4B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	SIG	3T6	35	SAFE 5B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T6	36	COM 5B		
HO	SIG	3T6	37	ACTIVE 5B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
ML	RTN	2S1	38	ENCRYPTOR ZEROIZE RETURN		
ML	SIG	2S1	39	ENCRYPTOR ZEROIZE		PANEL R12A2
HO	SIG	3T5	40	Xo 603 J1335 - 77		
HO	SIG	3T5	41	Xo 603 J1335 - 78		
HO	RTN	3T5	42	Xo 603 J1335 - 79		
HO	SIG	3T7	43	SAFE 1B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
HO	RTN	3T7	44	ACTIVE 1B		
HO	SIG	3T7	45	COM 1B	8.2.9	PANEL C3A5 - PAYLOAD SAFING
			46			NOT WIRED

* USE OF THIS INTERFACE REQUIRES THAT IT BE IDENTIFIED AS A SAFETY CRITICAL CIRCUIT.

TABLE 13.6.2.1.1-12 PIN ASSIGNMENTS FOR PSDP - J1335

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
			50			NOT WIRED
			51			NOT WIRED
			52			NOT WIRED
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

(1) JUMPER REQUIRED FROM PIN 5 TO EITHER PIN 1 OR PIN 2 FOR DOWNLINK VOICE SELECT.

TABLE 13.6.2.1.1-14 PIN ASSIGNMENTS FOR PSDP - J1301

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
RF	SIG	2S11	16	P1401 - 46		SPARE
RF	RTN	2S11	17	P1401 - 47		SPARE
RF	SIG	2S10	18	P1401 - 43		SPARE
RF	RTN	2S10	19	P1401 - 44		SPARE
RF	SIG	2S9	20	P1401 - 40		SPARE
RF	RTN	2S9	21	P1401 - 41		SPARE
RF	SIG	2S8	22	P1401 - 37		SPARE
RF	RTN	2S8	23	P1401 - 38		SPARE
RF	SIG	2S7	24	P1401 - 34		SPARE
RF	RTN	2S7	25	P1401 - 35		SPARE
RF	SIG	2S6	26	P1401 - 31		SPARE
RF	RTN	2S6	27	P1401 - 32		SPARE
RF	SIG	2S5	28	P1401 - 28		SPARE
RF	RTN	2S5	29	P1401 - 29		SPARE
RF	SIG	2S4	30	P1401 - 25		SPARE
RF	RTN	2S4	31	P1401 - 26		SPARE
RF	SIG	2S3	32	P1401 - 22		SPARE
RF	RTN	2S3	33	P1401 - 23		SPARE
RF	SIG	2S2	34	P1401 - 19		SPARE
RF	RTN	2S2	35	P1401 - 20		SPARE
RF	SIG	2S1	36	P1401 - 16		SPARE
RF	RTN	2S1	37	P1401 - 17		SPARE

TABLE 13.6.2.1.1-15 PIN ASSIGNMENTS FOR PSDP - J1303

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
RF	SIG	2S11	16	P1403 - 46		SPARE
RF	RTN	2S11	17	P1403 - 47		SPARE
RF	SIG	2S10	18	P1403 - 43		SPARE
RF	RTN	2S10	19	P1403 - 44		SPARE
RF	SIG	2S9	20	P1403 - 40		SPARE
RF	RTN	2S9	21	P1403 - 41		SPARE
RF	SIG	2S8	22	P1403 - 37		SPARE
RF	RTN	2S8	23	P1403 - 38		SPARE
RF	SIG	2S7	24	P1403 - 34		SPARE
RF	RTN	2S7	25	P1403 - 35		SPARE
RF	SIG	2S6	26	P1403 - 31		SPARE
RF	RTN	2S6	27	P1403 - 32		SPARE
RF	SIG	2S5	28	P1403 - 28		SPARE
RF	RTN	2S5	29	P1403 - 29		SPARE
RF	SIG	2S4	30	P1403 - 25		SPARE
RF	RTN	2S4	31	P1403 - 26		SPARE
RF	SIG	2S3	32	P1403 - 22		SPARE
RF	RTN	2S3	33	P1403 - 23		SPARE
RF	SIG	2S2	34	P1403 - 19		SPARE
RF	RTN	2S2	35	P1403 - 20		SPARE
RF	SIG	2S1	36	P1403 - 16		SPARE
RF	RTN	2S1	37	P1403 - 17		SPARE

TABLE 13.6.2.1.1-16 PIN ASSIGNMENTS FOR PSDP - J1305

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
RF	SIG	2S11	16	P1405 - 46		SPARE
RF	RTN	2S11	17	P1405 - 47		SPARE
RF	SIG	2S10	18	P1405 - 43		SPARE
RF	RTN	2S10	19	P1405 - 44		SPARE
RF	SIG	2S9	20	P1405 - 40		SPARE
RF	RTN	2S9	21	P1405 - 41		SPARE
RF	SIG	2S8	22	P1405 - 37		SPARE
RF	RTN	2S8	23	P1405 - 38		SPARE
RF	SIG	2S7	24	P1405 - 34		SPARE
RF	RTN	2S7	25	P1405 - 35		SPARE
RF	SIG	2S6	26	P1405 - 31		SPARE
RF	RTN	2S6	27	P1405 - 32		SPARE
RF	SIG	2S5	28	P1405 - 28		SPARE
RF	RTN	2S5	29	P1405 - 29		SPARE
RF	SIG	2S4	30	P1405 - 25		SPARE
RF	RTN	2S4	31	P1405 - 26		SPARE
RF	SIG	2S3	32	P1405 - 22		SPARE
RF	RTN	2S3	33	P1405 - 23		SPARE
RF	SIG	2S2	34	P1405 - 19		SPARE
RF	RTN	2S2	35	P1405 - 20		SPARE
RF	SIG	2S1	36	P1405 - 16		SPARE
RF	RTN	2S1	37	P1405 - 17		SPARE

TABLE 13.6.2.1.1-17 PIN ASSIGNMENTS FOR PSDP - J1307

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
RF	SIG	2S11	16	P1407 - 46		SPARE
RF	RTN	2S11	17	P1407 - 47		SPARE
RF	SIG	2S10	18	P1407 - 43		SPARE
RF	RTN	2S10	19	P1407 - 44		SPARE
RF	SIG	2S9	20	P1407 - 40		SPARE
RF	RTN	2S9	21	P1407 - 41		SPARE
RF	SIG	2S8	22	P1407 - 37		SPARE
RF	RTN	2S8	23	P1407 - 38		SPARE
RF	SIG	2S7	24	P1407 - 34		SPARE
RF	RTN	2S7	25	P1407 - 35		SPARE
RF	SIG	2S6	26	P1407 - 31		SPARE
RF	RTN	2S6	27	P1407 - 32		SPARE
RF	SIG	2S5	28	P1407 - 28		SPARE
RF	RTN	2S5	29	P1407 - 29		SPARE
RF	SIG	2S4	30	P1407 - 25		SPARE
RF	RTN	2S4	31	P1407 - 26		SPARE
RF	SIG	2S3	32	P1407 - 22		SPARE
RF	RTN	2S3	33	P1407 - 23		SPARE
RF	SIG	2S2	34	P1407 - 19		SPARE
RF	RTN	2S2	35	P1407 - 20		SPARE
			36			NOT WIRED
			37			NOT WIRED

TABLE 13.6.2.1.1-18 PIN ASSIGNMENTS FOR PSDP - J1317

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
ML	SHD	2S9	10	Xo 603 J1317 - 66		TERMINATE
ML	SIG	2S9	11	Xo 603 J1317 - 64		
ML	RTN	2S9	12	Xo 603 J1317 - 65		
ML	SIG	2S6	13	Xo 603 J1317 - 55		
ML	RTN	2S6	14	Xo 603 J1317 - 56		
ML	SHD	2S6	15	Xo 603 J1317 - 57		TERMINATE
ML	SHD	2S3	16	Xo 603 J1317 - 48		TERMINATE
ML	SHD	2S12	17	Xo 603 J1317 - 75		TERMINATE
ML	SIG	2S12	18	Xo 603 J1317 - 73		
ML	RTN	2S12	19	Xo 603 J1317 - 74		
ML	SIG	2S11	20	Xo 603 J1317 - 70		
ML	RTN	2S11	21	Xo 603 J1317 - 71		
ML	SHD	2S11	22	Xo 603 J1317 - 72		TERMINATE
ML	SIG	2S3	23	Xo 603 J1317 - 46		
ML	RTN	2S3	24	Xo 603 J1317 - 47		
ML	SHD	2S1	25	Xo 603 J1317 - 42		TERMINATE
ML	SIG	2S1	26	Xo 603 J1317 - 40		
ML	RTN	2S1	27	Xo 603 J1317 - 41		
ML	SIG	2S13	28	Xo 603 J1317 - 76		
ML	RTN	2S13	29	Xo 603 J1317 - 77		
ML	SIG	2S13	30	Xo 603 J1317 - 78		
ML	SHD	2S4	31	Xo 603 J1317 - 51		TERMINATE
ML	SHD	2S5	32	Xo 603 J1317 - 54		TERMINATE
ML	SIG	2S5	33	Xo 603 J1317 - 52		
ML	RTN	2S5	34	Xo 603 J1317 - 53		
ML	SIG	2S10	35	Xo 603 J1317 - 67		
ML	RTN	2S10	36	Xo 603 J1317 - 68		
ML	SHD	2S10	37	Xo 603 J1317 - 69		TERMINATE
ML	SIG	2S4	38	Xo 603 J1317 - 49		
ML	RTN	2S4	39	Xo 603 J1317 - 50		
ML	SHD	2S7	40	Xo 603 J1317 - 60		TERMINATE
ML	SIG	2S7	41	Xo 603 J1317 - 58		
ML	RTN	2S7	42	Xo 603 J1317 - 59		
ML	SIG	2S8	43	Xo 603 J1317 - 61		
ML	RTN	2S8	44	Xo 603 J1317 - 62		
ML	SHD	2S8	45	Xo 603 J1317 - 63		TERMINATE

TABLE 13.6.2.1.1-18 PIN ASSIGNMENTS FOR PSDP - J1317

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S2	46	Xo 603 J1317 - 45		TERMINATE
			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
			50			NOT WIRED
ML	SIG	2S2	51	Xo 603 J1317 - 43		
ML	RTN	2S2	52	Xo 603 J1317 - 44		
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

TABLE 13.6.2.1.1-19 PIN ASSIGNMENTS FOR PSDP - J1319

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
ML	SHD	2S7	10	Xo 603 J1319 - 66		TERMINATE
ML	SIG	2S7	11	Xo 603 J1319 - 64		
ML	RTN	2S7	12	Xo 603 J1319 - 65		
ML	SIG	2S10	13	Xo 603 J1319 - 55		
ML	RTN	2S10	14	Xo 603 J1319 - 56		
ML	SHD	2S10	15	Xo 603 J1319 - 57		TERMINATE
ML	SHD	2S13	16	Xo 603 J1319 - 48		TERMINATE
ML	SHD	2S4	17	Xo 603 J1319 - 75		TERMINATE
ML	SIG	2S4	18	Xo 603 J1319 - 73		
ML	RTN	2S4	19	Xo 603 J1319 - 74		
ML	SIG	2S5	20	Xo 603 J1319 - 70		
ML	RTN	2S5	21	Xo 603 J1319 - 71		
ML	SHD	2S5	22	Xo 603 J1319 - 72		TERMINATE
ML	SIG	2S13	23	Xo 603 J1319 - 46		
ML	RTN	2S13	24	Xo 603 J1319 - 47		
ML	SHD	2S15	25	Xo 603 J1319 - 42		TERMINATE
ML	SIG	2S15	26	Xo 603 J1319 - 40		
ML	RTN	2S15	27	Xo 603 J1319 - 41		
ML	SIG	2S3	28	Xo 603 J1319 - 76		
ML	RTN	2S3	29	Xo 603 J1319 - 77		
ML	SHD	2S3	30	Xo 603 J1319 - 78		TERMINATE
ML	SHD	2S12	31	Xo 603 J1319 - 51		TERMINATE
ML	SHD	2S11	32	Xo 603 J1319 - 54		TERMINATE
ML	SIG	2S11	33	Xo 603 J1319 - 52		
ML	RTN	2S11	34	Xo 603 J1319 - 53		
ML	SIG	2S6	35	Xo 603 J1319 - 67		
ML	RTN	2S6	36	Xo 603 J1319 - 68		
ML	SHD	2S6	37	Xo 603 J1319 - 69		TERMINATE
ML	SIG	2S12	38	Xo 603 J1319 - 49		
ML	RTN	2S12	39	Xo 603 J1319 - 50		
ML	SHD	2S9	40	Xo 603 J1319 - 60		TERMINATE
ML	SIG	2S9	41	Xo 603 J1319 - 58		
ML	RTN	2S9	42	Xo 603 J1319 - 59		
ML	SIG	2S8	43	Xo 603 J1319 - 61		
ML	RTN	2S8	44	Xo 603 J1319 - 62		
ML	SHD	2S8	45	Xo 603 J1319 - 63		TERMINATE

TABLE 13.6.2.1.1-19 PIN ASSIGNMENTS FOR PSDP - J1319

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S14	46	Xo 603 J1319 - 45		TERMINATE
			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
			50			NOT WIRED
ML	SIG	2S14	51	Xo 603 J1319 - 43		
ML	RTN	2S14	52	Xo 603 J1319 - 44		
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

TABLE 13.6.2.1.1-20 PIN ASSIGNMENTS FOR PSDP - J27

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
RF	SIG	2S1	3	MSDP J58 - 17		
RF	RTN	2S1	4	MSDP J58 - 18		
RF	SIG	2S2	5	MSDP J58 - 19		
RF	RTN	2S2	6	MSDP J58 - 21		
RF	SIG	2S3	7	MSDP J58 - 22		
RF	RTN	2S3	8	MSDP J58 - 23		
RF	SIG	2S4	9	MSDP J58 - 24		
RF	RTN	2S4	10	MSDP J58 - 25		
RF	SIG	2S5	11	MSDP J58 - 26		
RF	RTN	2S5	12	MSDP J58 - 27		
RF	SIG	2S6	13	MSDP J58 - 28		
RF	RTN	2S6	14	MSDP J58 - 29		
RF	SIG	2S7	15	MSDP J58 - 30		
RF	RTN	2S7	16	MSDP J58 - 31		
RF	SIG	2S8	17	MSDP J58 - 32		
RF	RTN	2S8	18	MSDP J58 - 33		
RF	SIG	2S9	19	MSDP J58 - 34		
RF	RTN	2S9	20	MSDP J58 - 35		
RF	SIG	2S10	21	MSDP J58 - 36		
RF	RTN	2S10	22	MSDP J58 - 37		

TABLE 13.6.2.1.1-21 PIN ASSIGNMENTS FOR PSDP - J55

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	3T1	1	CROSSHAIR DISABLE	8.2.8	VIDEO SWITCHING NETWORK
HO	SIG	3T1	2	DATA DISABLE	8.2.8	VIDEO SWITCHING NETWORK
HO	RTN	3T1	3	DATA DISABLE RETURN		
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
			28			NOT WIRED
			29			NOT WIRED
RF	SIG	2S7	30	VIDEO A+	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S7	31	VIDEO A-		
RF	SIG	2S2	32	VIDEO B+	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S2	33	VIDEO B-		
RF	SIG	2S3	34	SYNC TO MONITOR 3 POSITIVE	8.2.8	REMOTE CONTROL UNIT
RF	RTN	2S3	35	SYNC TO MONITOR 3 NEGATIVE		
			36			NOT WIRED
			37			NOT WIRED

TABLE 13.6.2.1.1-22 PIN ASSIGNMENTS FOR PSDP - J71

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	RTN	2S1	1	MSG OUT DISCRETE RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S1	2	MSG OUT DISCRETE	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S2	3	DATA RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S2	4	DATA	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S3	5	MSG IN DISCRETE RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S3	6	MSG IN DISCRETE	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S4	7	WORD ENBL DISCRETE RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S4	8	WORD ENBL DISCRETE	8.2.2.5	MDM-PF2 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S5	9	MSG OUT DISCRETE RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S5	10	MSG OUT DISCRETE	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	RTN	2S6	11	DATA RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S6	12	DATA	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	RTN	2S7	13	MSG IN DISCRETE RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S7	14	MSG IN DISCRETE	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	RTN	2S8	15	WORD ENBL DISCRETE RETURN	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S8	16	WORD ENBL DISCRETE	8.2.2.5	MDM-PF2 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED

TABLE 13.6.2.1.1-23 PIN ASSIGNMENTS FOR PSDP - J73

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	RTN	2S1	1	MSG OUT DISCRETE RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S1	2	MSG OUT DISCRETE	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S2	3	DATA RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S2	4	DATA	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S3	5	MSG IN DISCRETE RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S3	6	MSG IN DISCRETE	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S4	7	WORD ENBL DISCRETE RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	SIG	2S4	8	WORD ENBL DISCRETE	8.2.2.5	MDM-PF1 SIO CH 03, CARD 08 (PAYLOAD SENSOR)
RF	RTN	2S5	9	MSG OUT DISCRETE RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S5	10	MSG OUT DISCRETE	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	RTN	2S6	11	DATA RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S6	12	DATA	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	RTN	2S7	13	MSG IN DISCRETE RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S7	14	MSG IN DISCRETE	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	RTN	2S8	15	WORD ENBL DISCRETE RETURN	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
RF	SIG	2S8	16	WORD ENBL DISCRETE	8.2.2.5	MDM-PF1 SIO CH 03, CARD 15 (PAYLOAD GN&C UPDATE)
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED

TABLE 13.6.2.1.2-2 PIN ASSIGNMENTS FOR PSDP - J33

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	SIG	2T1	A	AUX DC POWER BUS A	7.3.4	M-PCA 1
			B			NOT WIRED
RF	RTN	2T1	C	AUX DC POWER BUS A RETURN		GROUND
			D			NOT WIRED

TABLE 13.6.2.1.2-3 PIN ASSIGNMENTS FOR PSDP - J37

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
EO	SIG	4T1	A	AC BUS 2 PH A	7.4	PANEL MA73C
EO	SIG	4T1	B	AC BUS 2 PH B	7.4	PANEL MA73C
EO	SIG	4T1	C	AC BUS 2 PH C	7.4	PANEL MA73C
			D			NOT WIRED
			E			NOT WIRED
			F			NOT WIRED
			G			NOT WIRED
			H			NOT WIRED
EO	NTL	4T1	J	AC BUS 2		PANEL MA73C
			K			NOT WIRED

TABLE 13.6.2.1.2-4 PIN ASSIGNMENTS FOR PSDP - J39

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
EO	SIG	4T1	A	AC BUS 3 PH A	7.4	PANEL MA73C
EO	SIG	4T1	B	AC BUS 3 PH B	7.4	PANEL MA73C
EO	SIG	4T1	C	AC BUS 3 PH C	7.4	PANEL MA73C
			D			NOT WIRED
			E			NOT WIRED
			F			NOT WIRED
			G			NOT WIRED
			H			NOT WIRED
EO	NTL	4T1	J	AC BUS 3		PANEL MA73C
			K			NOT WIRED

TABLE 13.6.2.1.4-1 PIN ASSIGNMENTS FOR PSDP - J100

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
RF	SIG	2S3	7	MET 2 HI	13.6.2.1.4	ORBITER TIMING BUFFER
RF	RTN	2S3	8	MET 2 LO		
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED

TABLE 13.6.2.2-1 SUMMARY OF MSDP CONNECTORS AS NON-STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE AFD

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO.
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS			
MSDP-J10	9	TS5C	ML	10	13.6.2.2.1-2	NLS0T22-35PA	NLS6GT22-35SA
	12	TSP	ML				
MSDP-J12	17	TP	HO	45	13.6.2.2.1-9	NLS0T20-35PA	NLS6GT20-35SA
MSDP-J14	21	TSP	ML	16	13.6.2.2.1-3	NLS0T20-35P	NLS6GT20-35S
MSDP-J16	2	TP	HO	0	13.6.2.2.2-1	NB0E14-4SNT2	NB6GE14-4PNT2
MSDP-J18	12	TSP	ML	13	13.6.2.2.1-4	NLS0T16-35P	NLS6GT16-35S
	1	TS5C	ML				
MSDP-J20	16	TP	HO	17	13.6.2.2.1-10	NLS0T20-35P	NLS6GT20-35S
	5	TS5C	HO				
MSDP-J22	20	TSP	ML	19	13.6.2.2.1-11	NLS0T20-35PB	NLS6GT20-35SB
MSDP-J24	16	TP	HO	17	13.6.2.2.1-12	NLS0T20-35PC	NLS6GT20-35SC
	5	T5C	HO				
MSDP-J26	14	TS5C	ML	16	13.6.2.2.1-13	NLS0T22-35PB	NLS6GT22-35SB
MSDP-J28	22	TSP	ML	13	13.6.2.2.1-5	NLS0T20-35PC	NLS6GT20-35SC
MSDP-J30	14	TSP	ML	16	13.6.2.2.1-6	NLS0T22-35P	NLS6GT22-35S
	7	TS5C	ML				
MSDP-J32	13	TSP	ML	34	13.6.2.2.1-7	NLS0T20-35PA	NLS6GT20-35SA
	1	TS5C	ML				
MSDP-J34	21	TSP	ML	16	13.6.2.2.1-14	NLS0T20-35PD	NLS6GT20-35SD
MSDP-J36	2	TQ	EO	2	13.6.2.2.2-2	NB0E12-10SNT2	NB6GE12-10PNT2
MSDP-J38	2	TQ	EO	2	13.6.2.2.2-3	NB0E12-10SWT2	NB6GE12-10PWT2
MSDP-J40	32	TSP	RF	2	13.6.2.2.1-1	NLS0T18-35P	NLS6GT18-35S
MSDP-J42	2	TSP	RF	18	13.6.2.2.2-4	NLS0T10-35S	NLS6GT10-35P
MSDP-J52	1	TSP	ML	10	13.6.2.2.1-8	NLS0T10-35P	NLS6GT10-35S
MSDP-J54	4	TSP	RF	14	13.6.2.2.2-5	NLS0T12-35S	NLS6GT12-35P
MSDP-J56	2	TSP	HO	31	13.6.2.2.2-6	NLS0T14-35S	NLS6GT14-35P
	2	SC	HO				
MSDP-J58	10	TSP	RF	17	13.6.2.2.1-15	NLS0T14-35P	NLS6GT14-35S
MSDP-J701	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
MSDP-J702	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
MSDP-J703	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011

(1) SIGNAL IS CARRIED CONVENTIONALLY ON CENTER CONDUCTOR FOR ALL ORBITER COAX CABLES. NO PIN ASSIGNMENT TABLES ARE REQUIRED. CIRCUIT TERMINATIONS ARE SHOWN IN FIGURE 13.3.3-1.

TABLE 13.6.2.2.1-1 PIN ASSIGNMENTS FOR MSDP CONNECTOR J40

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	SIG	2S25	1	P01M1140B HI DATA	8.2.2.5	MDM-FF1 (NOT AVAILABLE FOR PAYLOAD USE)
RF	RTN	2S25	2	LO DATA		
			3			NOT WIRED
RF	SIG	2S25	4	MESSAGE IN HI	8.2.2.5	MDM-FF1 (NOT AVAILABLE FOR PAYLOAD USE)
RF	RTN	2S25	5	MESSAGE IN LO		
RF	RTN	2S43	6	PSDP J35 - 15		
RF	SIG	2S43	7	PSDP J35 - 14		
RF	RTN	2S44	8	PSDP J35 - 17		
RF	SIG	2S44	9	PSDP J35 - 16		
RF	RTN	2S45	10	PSDP J35 - 19		
RF	SIG	2S45	11	PSDP J35 - 18		
RF	RTN	2S46	12	PSDP J35 - 21		
RF	SIG	2S46	13	PSDP J35 - 20		
			14			NOT WIRED
RF	RTN	2S16	15	Xo 603 J1302 - 61		
RF	SIG	2S16	16	Xo 603 J1302 - 62		
RF	RTN	2S15	17	Xo 603 J1302 - 58		
RF	SIG	2S15	18	Xo 603 J1302 - 59		
RF	RTN	2S14	19	Xo 603 J1302 - 55		
RF	SIG	2S14	20	Xo 603 J1302 - 56		
RF	RTN	2S13	21	Xo 603 J1302 - 52		
RF	SIG	2S13	22	Xo 603 J1302 - 53		
RF	SIG	2S27	23	MESSAGE OUT HI	8.2.2.5	MDM-FF1 (NOT AVAILABLE FOR PAYLOAD USE)
RF	RTN	2S27	24	MESSAGE OUT LO		
RF	SIG	2S5	25	Xo 603 J1302 - 17		
RF	RTN	2S5	26	Xo 603 J1302 - 16		
RF	SIG	2S6	27	Xo 603 J1302 - 20		
RF	RTN	2S6	28	Xo 603 J1302 - 19		
RF	SIG	2S7	29	Xo 603 J1302 - 23		
RF	RTN	2S7	30	Xo 603 J1302 - 22		
RF	SIG	2S8	31	Xo 603 J1302 - 26		
RF	RTN	2S8	32	Xo 603 J1302 - 25		
RF	SIG	2S28	33	WORD DISCRETE HI	8.2.2.5	MDM-FF1 (NOT AVAILABLE FOR PAYLOAD USE)
RF	RTN	2S9	34	Xo 603 J1302 - 29		
RF	SIG	2S9	35	Xo 603 J1302 - 28		
RF	RTN	2S10	36	Xo 603 J1302 - 32		
RF	SIG	2S10	37	Xo 603 J1302 - 31		
RF	RTN	2S11	38	Xo 603 J1302 - 35		
RF	SIG	2S11	39	Xo 603 J1302 - 34		
RF	RTN	2S12	40	Xo 603 J1302 - 38		
RF	SIG	2S12	41	Xo 603 J1302 - 37		
RF	RTN	2S28	42	WORD DISCRETE LO		
RF	RTN	2S17	43	SIO 10 RETURN		
RF	SIG	2S17	44	P01M110J SIO 10		MDM-PF2 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S18	45	MESSAGE IN DISCRETE RETURN		

TABLE 13.6.2.2.1-1 PIN ASSIGNMENTS MSDP CONNECTOR J40

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
RF	SIG	2S18	46	MESSAGE IN DISCRETE	8.2.2.5	MDM-PF2 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S19	47	MESSAGE OUT DISCRETE RETURN		
RF	SIG	2S19	48	MESSAGE OUT DISCRETE	8.2.2.5	MDM-PF2 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S20	49	WORD ENABLE DISCRETE RETURN		
RF	SIG	2S20	50	WORD ENABLE DISCRETE	8.2.2.5	MDM-PF2 SIO CH 00 (PAYLOAD GN&C UPDATE)
RF	RTN	2S21	51	SIO 30 RETURN		
RF	SIG	2S21	52	P01M1130J SIO 30	8.2.2.5	MDM-PF2 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S22	53	MESSAGE IN DISCRETE RETURN		
RF	SIG	2S22	54	MESSAGE IN DISCRETE	8.2.2.5	MDM-PF2 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S23	55	MESSAGE OUT DISCRETE RETURN		
RF	SIG	2S23	56	MESSAGE OUT DISCRETE	8.2.2.5	MDM-PF2 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S4	57	Xo 603 J1302 - 50		
RF	RTN	2S24	58	WORD ENABLE DISCRETE RETURN		
RF	SIG	2S24	59	WORD ENABLE DISCRETE	8.2.2.5	MDM-PF2 SIO CH 01 (PAYLOAD SENSOR)
RF	RTN	2S3	60	Xo 603 J1302 - 47		
RF	SIG	2S3	61	Xo 603 J1302 - 46		
RF	RTN	2S2	62	Xo 603 J1302 - 44		
RF	SIG	2S4	63	Xo 603 J1302 - 49		
RF	RTN	2S1	64	Xo 603 J1302 - 41		
RF	SIG	2S1	65	Xo 603 J1302 - 40		
RF	SIG	2S2	66	Xo 603 J1302 - 43		

TABLE 13.6.2.2.1-2 PIN ASSIGNMENTS FOR MSDP CONNECTOR J10

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S3	1			TERMINATE
ML	SIG	2S4	2	PO1U5212V AID 12	8.2.2.4	MDM-PF2
ML	RTN	5S4	3	AID 12 RETURN		
ML	SHD	5S4	4			TERMINATE
ML	SIG	5S5	5	PO1U5211V AID 11	8.2.2.4	MDM-PF2
ML	RTN	5S5	6	AID 11 RETURN		
ML	SHD	5S5	7			TERMINATE
ML	SHD	5S1	8			TERMINATE
ML	SIG	2S3	9	PO1U5203V AID 03	8.2.2.4	MDM-PF2
ML	RTN	2S3	10	AID 03 RETURN		
ML	SIG	2S5	11	PO1K4517Y DOL 17	8.2.2.1	MDM-PF2
ML	SIG	2S5	12	P01K4518Y DOL 18	8.2.2.1	MDM-PF2
ML	SIG	5S5	13	P01K4519Y DOL 19	8.2.2.1	MDM-PF2
ML	SIG	5S6	14	P01K5210V DOL 10	8.2.2.4	MDM-PF2
ML	RTN	5S6	15	AID 10 RETURN		
ML	SHD	5S2	16			TERMINATE
ML	RTN	5S1	17	DOL 01-04 RETURN		
ML	SIG	5S1	18	PO1K4501Y DOL 01	8.2.2.1	MDM-PF2
ML	SIG	5S3	19	P01K4511Y DOL 11	8.2.2.1	MDM-PF2
ML	RTN	2S5	20	DOL 17-20 RETURN		
ML	SIG	2S5	21	PO1K4520Y DOL 20	8.2.2.1	MDM-PF2
ML	RTN	2S6	22			TERMINATE
ML	SIG	5S7	23	PO1U5209V AID 09	8.2.2.4	MDM-PF2
ML	SHD	5S7	24			TERMINATE
ML	SIG	5S2	25	P01U5202V AID 02	8.2.2.4	MDM-PF2
ML	SIG	5S1	26	P01K4504Y DOL 04	8.2.2.1	MDM-PF2
ML	SIG	5S1	27	PO1K4502Y DOL 02	8.2.2.1	MDM-PF2
ML	SIG	5S3	28	P01K4510Y DOL 10	8.2.2.1	MDM-PF2
ML	SIG	5S3	29	P01K4512Y DOL 12	8.2.2.1	MDM-PF2
ML	SHD	2S5	30			TERMINATE
ML	SIG	2S7	31	PO1K4525Y DOL 25	8.2.2.1	MDM-PF2
ML	RTN	5S7	32	AID 09 RETURN		
ML	SIG	5S8	33	P01U5208V AID 08	8.2.2.4	MDM-PF2
ML	RTN	5S8	34	AID 08 RETURN		
ML	SHD	5S1	35			TERMINATE
ML	RTN	5S2	36	AID 02 RETURN		
ML	SIG	5S1	37	P01K4503Y DOL 03	8.2.2.1	MDM-PF2
ML	SIG	5S3	38	P01K4509Y DOL 09	8.2.2.1	MDM-PF2
ML	RTN	5S3	39	DOL 09-12 RETURN		
ML	SHD	5S3	40			TERMINATE
ML	RTN	5S7	41	DOL 25-28 RETURN		
ML	SIG	5S7	42	P01K4526Y DOL 26	8.2.2.1	MDM-PF2
ML	SHD	5S8	43			TERMINATE
ML	SIG	5S9	44	P01U5207V AID 07	8.2.2.4	MDM-PF2
ML	SHD	5S7	45			TERMINATE

TABLE 13.6.2.2.1-2 PIN ASSIGNMENTS FOR MSDP CONNECTOR J10

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S1	46	P01U5201V AID 01	8.2.2.4	MDM-PF2
ML	RTN	2S1	47	AID 01 RETURN		
ML	SIG	5S4	48	P01K4515Y DOL 15	8.2.2.1	MDM-PF2
ML	SIG	5S4	49	P01K4516Y DOL 16	8.2.2.1	MDM-PF2
ML	SHD	5S4	50			TERMINATE
ML	SHD	5S7	51			TERMINATE
ML	SIG	5S7	52	PO1K4528Y DOL 28	8.2.2.1	MDM-PF2
ML	SIG	5S7	53	PO1K4527Y DOL 27	8.2.2.1	MDM-PF2
ML	RTN	2S9	54	AID 07 RETURN		
ML	SIG	2S10	55	P01U5206V AID 06	8.2.2.4	MDM-PF2
ML	SHD	2S12	56			TERMINATE
ML	SIG	2S12	57	P01U5204V AID 04	8.2.2.4	MDM-PF2
ML	SIG	5S2	58	P01K4505Y DOL 05	8.2.2.1	MDM-PF2
ML	SIG	5S4	59	P01K4514Y DOL 14	8.2.2.1	MDM-PF2
ML	RTN	5S4	60	DOL 13-16 RETURN		
ML	SHD	5S6	61			TERMINATE
ML	SHD	5S8	62			TERMINATE
ML	RTN	5S8	63	DOL 29-32 RETURN		
ML	SIG	5S8	64	P01K4529Y DOL 29	8.2.2.1	MDM-PF2
ML	RTN	2S10	65	AID 06 RETURN		
ML	SHD	2S10	66			TERMINATE
ML	RTN	2S12	67	AID 04 RETURN		
ML	RTN	5S2	68	DOL 05-08 RETURN		
ML	SIG	5S2	69	P01K4506Y DOL 06	8.2.2.1	MDM-PF2
ML	SIG	5S4	70	P01K4513Y DOL 13	8.2.2.1	MDM-PF2
ML	SIG	5S6	71	P01K4524Y DOL 24	8.2.2.1	MDM-PF2
ML	RTN	5S6	72	DOL 21-24 RETURN		
ML	SIG	5S8	73	P01K4532Y DOL 32	8.2.2.1	MDM-PF2
ML	SIG	5S8	74	P01K4530Y DOL 30	8.2.2.1	MDM-PF2
ML	SIG	2S11	75	P01U5205V AID 05	8.2.2.4	MDM-PF2
ML	RTN	2S11	76	AID 05 RETURN		
ML	SHD	5S2	77			TERMINATE
ML	SIG	5S2	78	P01K4508Y DOL 08	8.2.2.1	MDM-PF2
ML	SIG	5S2	79	P01K4507Y DOL 07	8.2.2.1	MDM-PF2
ML	SIG	5S6	80	P01K4522Y DOL 22	8.2.2.1	MDM-PF2
ML	SIG	5S6	81	P01K4523Y DOL 23	8.2.2.1	MDM-PF2
ML	SIG	5S6	82	P01K4521Y DOL 21	8.2.2.1	MDM-PF2
ML	SIG	5S8	83	P01K4531Y DOL 31	8.2.2.1	MDM-PF2
			84			NOT WIRED
ML	SHD	2S11	85			TERMINATE
ML	SIG	5S9	86	P01X5113Y DIH 13	8.2.2.7	MDM-PF2
ML	SIG	5S9	87	P01X5114Y DIH 14	8.2.2.7	MDM-PF2
ML	SIG	5S9	88	P01X5115Y DIH 15	8.2.2.7	MDM-PF2
ML	SIG	5S9	89	P01X5116Y DIH 16	8.2.2.7	MDM-PF2
ML	RTN	5S9	90	DIH 13-16 RETURN		
ML	SHD	5S9	91			TERMINATE

TABLE 13.6.2.2.1-2 PIN ASSIGNMENTS FOR MSDP CONNECTOR J10

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			92			NOT WIRED
			93			NOT WIRED
			94			NOT WIRED
			95			NOT WIRED
			96			NOT WIRED
			97			NOT WIRED
			98			NOT WIRED
			99			NOT WIRED
			100			NOT WIRED

TABLE 13.6.2.2.1-3 PIN ASSIGNMENTS FOR MSDP CONNECTOR J14

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
ML	SIG	2S1	17	OOSDP J50 - 17		
ML	RTN	2S1	18	OOSDP J50 - 18		
ML	SHD	2S1	19	OOSDP J50 - 19		TERMINATE
ML	RTN	2S2	20	OOSDP J50 - 20		
ML	SIG	2S2	21	OOSDP J50 - 21		
ML	SHD	2S2	22	OOSDP J50 - 22		TERMINATE
ML	RTN	2S3	23	OOSDP J50 - 23		
ML	SIG	2S3	24	OOSDP J50 - 24		
ML	SHD	2S3	25	OOSDP J50 - 25		TERMINATE
ML	RTN	2S4	26	OOSDP J50 - 26		
ML	SIG	2S4	27	OOSDP J50 - 27		
ML	SHD	2S4	28	OOSDP J50 - 28		TERMINATE
ML	RTN	2S5	29	OOSDP J50 - 29		
ML	SIG	2S5	30	OOSDP J50 - 30		
ML	SHD	2S5	31	OOSDP J50 - 31		TERMINATE
ML	RTN	2S6	32	OOSDP J50 - 32		
ML	SIG	2S6	33	OOSDP J50 - 33		
ML	SHD	2S6	34	OOSDP J50 - 34		TERMINATE
ML	SIG	2S7	35	OOSDP J50 - 35		
ML	RTN	2S7	36	OOSDP J50 - 36		
ML	SHD	2S7	37	OOSDP J50 - 37		TERMINATE
ML	SIG	2S8	38	OOSDP J50 - 38		
ML	RTN	2S8	39	OOSDP J50 - 39		
ML	SHD	2S8	40	OOSDP J50 - 40		TERMINATE
ML	SIG	2S9	41	OOSDP J50 - 41		
ML	RTN	2S9	42	OOSDP J50 - 42		
ML	SHD	2S9	43	OOSDP J50 - 43		TERMINATE
ML	SIG	2S10	44	OOSDP J50 - 44		
ML	RTN	2S10	45	OOSDP J50 - 45		

TABLE 13.6.2.2.1-3 PIN ASSIGNMENTS FOR MSDP CONNECTOR J14

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S10	46	OOSDP J50 - 46		TERMINATE
ML	RTN	2S11	47	OOSDP J50 - 47		
ML	SIG	2S11	48	OOSDP J50 - 48		
ML	SHD	2S11	49	OOSDP J50 - 49		TERMINATE
ML	RTN	2S12	50	OOSDP J50 - 50		
ML	SIG	2S12	51	OOSDP J50 - 51		
ML	SHD	2S12	52	OOSDP J50 - 52		TERMINATE
ML	RTN	2S13	53	OOSDP J50 - 53		
ML	SIG	2S13	54	OOSDP J50 - 54		
ML	SHD	2S13	55	OOSDP J50 - 55		TERMINATE
ML	SIG	2S14	56	OOSDP J50 - 56		
ML	RTN	2S14	57	OOSDP J50 - 57		
ML	SHD	2S14	58	OOSDP J50 - 58		TERMINATE
ML	SIG	2S15	59	OOSDP J50 - 59		
ML	RTN	2S15	60	OOSDP J50 - 60		
ML	SHD	2S15	61	OOSDP J50 - 61		TERMINATE
ML	SIG	2S16	62	OOSDP J50 - 62		
ML	RTN	2S16	63	OOSDP J50 - 63		
ML	SHD	2S16	64	OOSDP J50 - 64		TERMINATE
ML	RTN	2S17	65	OOSDP J50 - 65		
ML	SIG	2S17	66	OOSDP J50 - 66		
ML	SHD	2S17	67	OOSDP J50 - 67		TERMINATE
ML	RTN	2S18	68	OOSDP J50 - 68		
ML	SIG	2S18	69	OOSDP J50 - 69		
ML	SHD	2S18	70	OOSDP J50 - 70		TERMINATE
ML	SIG	2S19	71	OOSDP J50 - 71		
ML	RTN	2S19	72	OOSDP J50 - 72		
ML	SHD	2S19	73	OOSDP J50 - 73		TERMINATE
ML	SIG	2S20	74	OOSDP J50 - 74		
ML	RTN	2S20	75	OOSDP J50 - 75		
ML	SHD	2S20	76	OOSDP J50 - 76		TERMINATE
ML	RTN	2S22	77	OOSDP J50 - 77		
ML	SIG	2S22	78	OOSDP J50 - 78		
ML	SHD	2S22	79	OOSDP J50 - 79		TERMINATE

TABLE 13.6.2.2.1-4 PIN ASSIGNMENTS FOR MSDP CONNECTOR J18

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
ML	SIG	5S1	4	P01X5112Y DIH 12	8.2.2.7	MDM-PF2
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
ML	SIG	5S1	10	P01X5111Y DIH 11	8.2.2.7	MDM-PF2
ML	SHD	5S1	11			TERMINATE
			12			NOT WIRED
ML	SIG	2S6	13	Xo 603 J1316 - 58		
ML	RTN	2S6	14	Xo 603 J1316 - 59		
ML	RTN	2S7	15	Xo 603 J1316 - 62		
			16			NOT WIRED
ML	SIG	5S1	17	P01X5110Y DIH 10	8.2.2.7	MDM-PF2
ML	SHD	2S4	18	Xo 603 J1316 - 33		TERMINATE
ML	RTN	2S4	19	Xo 603 J1316 - 32		
ML	RTN	2S5	20	Xo 603 J1316 - 56		
ML	SHD	2S6	21	Xo 603 J1316 - 60		TERMINATE
ML	SHD	2S7	22	Xo 603 J1316 - 63		TERMINATE
ML	SIG	2S7	23	Xo 603 J1316 - 61		
			24			NOT WIRED
ML	SIG	5S1	25	P01X5109Y DIH 09	8.2.2.7	MDM-PF2
ML	SIG	2S4	26	Xo 603 J1316 - 31		
ML	SIG	2S5	27	Xo 603 J1316 - 55		
ML	SHD	2S5	28	Xo 603 J1316 - 57		TERMINATE
ML	SHD	2S8	29	Xo 603 J1316 - 66		TERMINATE
ML	RTN	2S8	30	Xo 603 J1316 - 65		
			31			NOT WIRED
ML	RTN	5S1	32	DIH 09-12 RETURN		
			33			NOT WIRED
ML	RTN	2S12	34	Xo 603 J1316 - 77		
ML	SHD	2S12	35	Xo 603 J1316 - 78		TERMINATE
ML	SHD	2S11	36	Xo 603 J1316 - 75		TERMINATE
ML	SIG	2S8	37	Xo 603 J1316 - 64		
ML	SHD	2S9	38	Xo 603 J1316 - 69		TERMINATE
ML	RTN	2S9	39	Xo 603 J1316 - 68		
ML	RTN	2S3	40	Xo 603 J1316 - 23		
ML	SHD	2S3	41	Xo 603 J1316 - 24		TERMINATE
ML	SIG	2S12	42	Xo 603 J1316 - 76		
ML	SIG	2S11	43	Xo 603 J1316 - 73		
ML	RTN	2S11	44	Xo 603 J1316 - 74		
ML	RTN	2S10	45	Xo 603 J1316 - 71		

TABLE 13.6.2.2.1-4 PIN ASSIGNMENTS FOR MSDP CONNECTOR J18

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S9	46	Xo 603 J1316 - 67		
ML	SIG	2S3	47	Xo 603 J1316 - 22		
ML	SHD	2S2	48	Xo 603 J1316 - 27		TERMINATE
ML	RTN	2S2	49	Xo 603 J1316 - 26		
ML	RTN	2S1	50	Xo 603 J1316 - 29		
ML	SIG	2S10	51	Xo 603 J1316 - 70		
ML	SHD	2S10	52	Xo 603 J1316 - 72		TERMINATE
ML	SIG	2S2	53	Xo 603 J1316 - 25		
ML	SIG	2S1	54	Xo 603 J1316 - 28		
ML	SHD	2S1	55	Xo 603 J1316 - 30		TERMINATE

TABLE 13.6.2.2.1-5 PIN ASSIGNMENTS FOR MSDP CONNECTOR J28

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
ML	SIG	2S1	14	OOSDP J48 - 14		
ML	RTN	2S1	15	OOSDP J48 - 15		
ML	SHD	2S1	16	OOSDP J48 - 16		TERMINATE
ML	SIG	2S2	17	OOSDP J48 - 17		
ML	RTN	2S2	18	OOSDP J48 - 18		
ML	SHD	2S2	19	OOSDP J48 - 19		TERMINATE
ML	SIG	2S3	20	OOSDP J48 - 20		
ML	RTN	2S3	21	OOSDP J48 - 21		
ML	SHD	2S3	22	OOSDP J48 - 22		TERMINATE
ML	RTN	2S4	23	OOSDP J48 - 23		
ML	SIG	2S4	24	OOSDP J48 - 24		
ML	SHD	2S4	25	OOSDP J48 - 25		TERMINATE
ML	RTN	2S5	26	OOSDP J48 - 26		
ML	SIG	2S5	27	OOSDP J48 - 27		
ML	SHD	2S5	28	OOSDP J48 - 28		TERMINATE
ML	RTN	2S6	29	OOSDP J48 - 29		
ML	SIG	2S6	30	OOSDP J48 - 30		
ML	SHD	2S6	31	OOSDP J48 - 31		TERMINATE
ML	RTN	2S7	32	OOSDP J48 - 32		
ML	SIG	2S7	33	OOSDP J48 - 33		
ML	SHD	2S7	34	OOSDP J48 - 34		TERMINATE
ML	SIG	2S8	35	OOSDP J48 - 35		
ML	RTN	2S8	36	OOSDP J48 - 36		
ML	SHD	2S8	37	OOSDP J48 - 37		TERMINATE
ML	SIG	2S9	38	OOSDP J48 - 38		
ML	RTN	2S9	39	OOSDP J48 - 39		
ML	SHD	2S9	40	OOSDP J48 - 40		TERMINATE
ML	SIG	2S10	41	OOSDP J48 - 41		
ML	RTN	2S10	42	OOSDP J48 - 42		
ML	SHD	2S10	43	OOSDP J48 - 43		TERMINATE
ML	SIG	2S11	44	OOSDP J48 - 44		
ML	SHD	2S11	45	OOSDP J48 - 45		

TABLE 13.6.2.2.1-5 PIN ASSIGNMENTS FOR MSDP CONNECTOR J28

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S11	46	OOSDP J48 - 46		TERMINATE
ML	RTN	2S12	47	OOSDP J48 - 47		
ML	SIG	2S12	48	OOSDP J48 - 48		
ML	SHD	2S12	49	OOSDP J48 - 49		TERMINATE
ML	RTN	2S13	50	OOSDP J48 - 50		
ML	SIG	2S13	51	OOSDP J48 - 51		
ML	SHD	2S13	52	OOSDP J48 - 52		TERMINATE
ML	RTN	2S14	53	OOSDP J48 - 53		
ML	SIG	2S14	54	OOSDP J48 - 54		
ML	SHD	2S14	55	OOSDP J48 - 55		TERMINATE
ML	SIG	2S15	56	OOSDP J48 - 56		
ML	RTN	2S15	57	OOSDP J48 - 57		
ML	SHD	2S15	58	OOSDP J48 - 58		TERMINATE
ML	SIG	2S16	59	OOSDP J48 - 59		
ML	RTN	2S16	60	OOSDP J48 - 60		
ML	SHD	2S16	61	OOSDP J48 - 61		TERMINATE
ML	SIG	2S17	62	OOSDP J48 - 62		
ML	RTN	2S17	63	OOSDP J48 - 63		
ML	SHD	2S17	64	OOSDP J48 - 64		TERMINATE
ML	RTN	2S18	65	OOSDP J48 - 65		
ML	SIG	2S18	66	OOSDP J48 - 66		
ML	SHD	2S18	67	OOSDP J48 - 67		TERMINATE
ML	RTN	2S19	68	OOSDP J48 - 68		
ML	SIG	2S19	69	OOSDP J48 - 69		
ML	SHD	2S19	70	OOSDP J48 - 70		TERMINATE
ML	SIG	2S20	71	OOSDP J48 - 71		
ML	RTN	2S20	72	OOSDP J48 - 72		
ML	SHD	2S20	73	OOSDP J48 - 73		TERMINATE
ML	SIG	2S21	74	OOSDP J48 - 74		
ML	RTN	2S21	75	OOSDP J48 - 75		
ML	SHD	2S21	76	OOSDP J48 - 76		TERMINATE
ML	RTN	2S22	77	OOSDP J48 - 77		
ML	SIG	2S22	78	OOSDP J48 - 78		
ML	SHD	2S22	79	OOSDP J48 - 79		TERMINATE

TABLE 13.6.2.2.1-6 PIN ASSIGNMENTS FOR MSDP CONNECTOR J30

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	RTN	2S9	1	AID 21 RETURN		
ML	SIG	2S9	2	PO1U5221V AID 21	8.2.2.4	MDM-PF1
ML	SHD	2S9	3			TERMINATE
ML	SIG	2S8	4	PO1U5222V AID 22	8.2.2.4	MDM-PF1
ML	SHD	2S8	5			TERMINATE
ML	SIG	2S7	6	PO1U5223V AID 23	8.2.2.4	MDM-PF1
ML	SIG	2S8	7	PO1U5224V AID 24	8.2.2.4	MDM-PF1
ML	SIG	2S11	8	PO1U5219V AID 19	8.2.2.4	MDM-PF1
ML	SHD	2S10	9			TERMINATE
ML	SIG	2S10	10	PO1U5220V AID 20	8.2.2.4	MDM-PF1
ML	RTN	2S8	11	AID 22 RETURN		
ML	SHD	2S7	12			TERMINATE
ML	RTN	2S7	13	AID 23 RETURN		
ML	RTN	2S6	14	AID 24 RETURN		
ML	SHD	2S6	15			TERMINATE
ML	RTN	2S11	16	AID 19 RETURN		
ML	SHD	2S11	17			TERMINATE
ML	RTN	2S10	18	AID 20 RETURN		
ML	SIG	5S1	19	PO1X6103Y DIL 03	8.2.2.3	MDM-PF2
ML	SIG	5S1	20	PO1X6104Y DIL 04	8.2.2.3	MDM-PF2
ML	SIG	5S1	21	PO1X6101Y DIL 01	8.2.2.3	MDM-PF2
ML	SIG	5S2	22	PO1X6107Y DIL 07	8.2.2.3	MDM-PF2
ML	SIG	2S5	23	PO1U5225V AID 25	8.2.2.4	MDM-PF1
ML	SHD	2S5	24			TERMINATE
ML	SIG	2S14	25	PO1U5216V AID 16	8.2.2.4	MDM-PF1
ML	SHD	2S12	26			TERMINATE
ML	SIG	2S12	27	PO1U5218V AID 18	8.2.2.4	MDM-PF1
ML	SIG	5S6	28	PO1X6111Y DIL 11	8.2.2.3	MDM-PF2
ML	RTN	5S1	29	DIL 01-04 RETURN		
ML	SIG	5S1	30	PO1X6102Y DIL 02	8.2.2.3	MDM-PF2
ML	RTN	5S2	31	DIL 05-08 RETURN		
ML	SIG	5S2	32	PO1X6108Y DIL 08	8.2.2.3	MDM-PF2
ML	RTN	2S5	33	AID 25 RETURN		
ML	SIG	2S4	34	PO1U5215V AID 15	8.2.2.4	MDM-PF1
ML	RTN	2S14	35	AID 16 RETURN		
ML	SHD	2S14	36			TERMINATE
ML	RTN	2S12	37	AID 18 RETURN		
ML	SIG	5S6	38	PO1X6110Y DIL 10	8.2.2.3	MDM-PF2
ML	SIG	5S6	39	PO1X6112Y DIL 12	8.2.2.3	MDM-PF2
ML	SHD	5S1	40			TERMINATE
ML	SHD	5S2	41			TERMINATE
ML	SIG	5S2	42	PO1X6106Y DIL 06	8.2.2.3	MDM-PF2
ML	SIG	5S2	43	PO1X6105Y DIL 05	8.2.2.3	MDM-PF2
ML	SHD	2S4	44			TERMINATE
ML	RTN	2S12	45	AID 15 RETURN		

TABLE 13.6.2.2.1-6 PIN ASSIGNMENTS FOR MSDP CONNECTOR J30

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S12	46			TERMINATE
ML	SIG	2S12	47	PO1U5217V AID 17	8.2.2.4	MDM-PF1
ML	SIG	5S6	48	PO1X6109Y DIL 09	8.2.2.3	MDM-PF2
ML	RTN	5S6	49	DIL 09-12 RETURN		
ML	SHD	5S6	50			TERMINATE
ML	SHD	5S3	51			TERMINATE
ML	RTN	5S3	52	DIL 21-24 RETURN		
ML	SIG	5S3	53	PO1X6123Y DIL 23	8.2.2.3	MDM-PF2
ML	SIG	5S3	54	PO1U5214V AID 14	8.2.2.4	MDM-PF1
ML	SHD	5S3	55			TERMINATE
			56			NOT WIRED
ML	RTN	2S13	57	AID 17 RETURN		
ML	SIG	5S5	58	PO1X6113Y DIL 13	8.2.2.3	MDM-PF2
ML	SIG	5S5	59	PO1X6114Y DIL 14	8.2.2.3	MDM-PF2
ML	SHD	5S5	60			TERMINATE
ML	SHD	5S4	61			TERMINATE
ML	SIG	5S3	62	PO1X6122Y DIL 22	8.2.2.3	MDM-PF2
ML	SIG	5S3	63	PO1X6124Y DIL 24	8.2.2.3	MDM-PF2
ML	SIG	2S1	64	V72X0001Y DOL	8.2.2.1	MDM-PF2
ML	RTN	2S3	65	AID 14 RETURN		
ML	SHD	2S2	66			TERMINATE
			67			NOT WIRED
			68			NOT WIRED
ML	SIG	5S5	69	PO1X6116Y DIL 16	8.2.2.3	MDM-PF2
ML	RTN	5S5	70	DIL 13-16 RETURN		
ML	SIG	5S4	71	PO1X6118Y DIL 18	8.2.2.3	MDM-PF2
ML	RTN	5S4	72	DIL 17-20 RETURN		
ML	SIG	5S3	73	PO1X6121Y DIL 21	8.2.2.3	MDM-PF2
ML	RTN	2S1	74	DOL RETURN		
ML	SIG	2S2	75	PO1U5213V AID 13	8.2.2.4	MDM-PF1
ML	RTN	2S2	76	AID 13 RETURN		
			77			NOT WIRED
			78			NOT WIRED
ML	SIG	5S5	79	PO1X6115Y DIL 15	8.2.2.3	MDM-PF2
ML	SIG	5S4	80	PO1X6117Y DIL 17	8.2.2.3	MDM-PF2
ML	SIG	5S4	81	PO1X6120Y DIL 20	8.2.2.3	MDM-PF2
ML	SIG	5S4	82	PO1X6119Y DIL 19	8.2.2.3	MDM-PF2
ML	SHD	2S1	83			TERMINATE
ML	SHD	5S7	84			TERMINATE
ML	RTN	5S7	85	DIH 01-04 RETURN		
			86			NOT WIRED
			87			NOT WIRED
			88			NOT WIRED
			89			NOT WIRED
ML	SIG	5S7	90	PO1X5104Y DIH 04	8.2.2.4	MDM-PF1
ML	SIG	5S7	91	PO1X5103Y DIH 03	8.2.2.4	MDM-PF1

TABLE 13.6.2.2.1-6 PIN ASSIGNMENTS FOR MSDP CONNECTOR J30

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	5S7	92	PO1X5102Y DIH 02	8.2.2.4	MDM-PF1
ML	SIG	5S7	93	PO1X5101Y DIH 01	8.2.2.4	MDM-PF1
			94			NOT WIRED
			95			NOT WIRED
			96			NOT WIRED
			97			NOT WIRED
			98			NOT WIRED
			99			NOT WIRED
			100			NOT WIRED

TABLE 13.6.2.2.1-7 PIN ASSIGNMENTS FOR MSDP CONNECTOR J32

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
			28			NOT WIRED
			29			NOT WIRED
			30			NOT WIRED
			31			NOT WIRED
			32			NOT WIRED
			33			NOT WIRED
			34			NOT WIRED
ML	SIG	5S1	35	PO1X5105Y DIH 05	8.2.2.7	MDM-PF1
ML	SIG	5S1	36	PO1X5108Y DIH 08	8.2.2.7	MDM-PF1
ML	SIG	5S1	37	PO1X5107Y DIH 07	8.2.2.7	MDM-PF1
ML	SIG	5S1	38	PO1X5106Y DIH 06	8.2.2.7	MDM-PF1
ML	RTN	5S1	39	DIH 05-08 RETURN		
ML	SHD	5S1	40			TERMINATE
ML	SHD	2S1	41	Xo 603 J1312 - 24		TERMINATE
ML	RTN	2S1	42	Xo 603 J1312 - 23		
ML	SIG	2S1	43	Xo 603 J1312 - 22		
ML	SHD	2S2	44	Xo 603 J1312 - 27		TERMINATE
ML	RTN	2S2	45	Xo 603 J1312 - 26		

TABLE 13.6.2.2.1-7 PIN ASSIGNMENTS FOR MSDP CONNECTOR J32

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S2	46	Xo 603 J1312 - 25		
ML	SHD	2S3	47	Xo 603 J1312 - 30		TERMINATE
ML	RTN	2S3	48	Xo 603 J1312 - 29		
ML	SIG	2S3	49	Xo 603 J1312 - 28		
ML	SHD	2S4	50	Xo 603 J1312 - 33		TERMINATE
ML	RTN	2S4	51	Xo 603 J1312 - 32		
ML	SIG	2S4	52	Xo 603 J1312 - 31		
ML	SHD	2S5	53	Xo 603 J1312 - 36		TERMINATE
ML	RTN	2S5	54	Xo 603 J1312 - 35		
ML	SIG	2S5	55	Xo 603 J1312 - 34		
ML	SHD	2S6	56	Xo 603 J1312 - 39		TERMINATE
ML	RTN	2S6	57	Xo 603 J1312 - 38		
ML	SIG	2S6	58	Xo 603 J1312 - 37		
ML	SHD	2S7	59	Xo 603 J1312 - 42		TERMINATE
ML	RTN	2S7	60	Xo 603 J1312 - 41		
ML	SIG	2S7	61	Xo 603 J1312 - 40		
ML	SHD	2S8	62	Xo 603 J1312 - 45		TERMINATE
ML	RTN	2S8	63	Xo 603 J1312 - 44		
ML	SIG	2S8	64	Xo 603 J1312 - 43		
ML	SHD	2S9	65	Xo 603 J1312 - 48		TERMINATE
ML	RTN	2S9	66	Xo 603 J1312 - 47		
ML	SIG	2S9	67	Xo 603 J1312 - 46		
ML	SHD	2S10	68	Xo 603 J1312 - 51		TERMINATE
ML	RTN	2S10	69	Xo 603 J1312 - 50		
ML	SIG	2S10	70	Xo 603 J1312 - 49		
ML	SHD	2S11	71	Xo 603 J1312 - 54		TERMINATE
ML	RTN	2S11	72	Xo 603 J1312 - 53		
ML	SIG	2S11	73	Xo 603 J1312 - 52		
ML	SHD	2S12	74	Xo 603 J1312 - 57		TERMINATE
ML	RTN	2S12	75	Xo 603 J1312 - 56		
ML	SIG	2S12	76	Xo 603 J1312 - 55		
ML	SHD	2S13	77	Xo 603 J1312 - 60		TERMINATE
ML	RTN	2S13	78	Xo 603 J1312 - 59		
ML	SIG	2S13	79	Xo 603 J1312 - 58		

TABLE 13.6.2.2.1-8 PIN ASSIGNMENTS FOR MSDP CONNECTOR J52

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
ML	SHD	2S1	11			TERMINATE
ML	RTN	2S1	12	PAYLOAD CAUTION RETURN		
ML	SIG	2S1	13	PAYLOAD CAUTION	8.2.9.3	CAUTION & WARNING ELECTRONICS UNIT (1)

(1) FUNCTION TO BE SIG/RTN JUMPERED WHEN NOT IN USE.

TABLE 13.6.2.2.1-9 PIN ASSIGNMENTS FOR MSDP CONNECTOR J12

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	RTN	2T17	1	PAYLOAD SMOKE B RETURN		PANEL L1A1 / CAUTION & WARNING
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
HO	SIG	2T17	28	PAYLOAD SMOKE B	8.2.9.1	PANEL L1A1 / CAUTION & WARNING
			29			NOT WIRED
			30			NOT WIRED
			31			NOT WIRED
			32			NOT WIRED
			33			NOT WIRED
			34			NOT WIRED
			35			NOT WIRED
			36			NOT WIRED
			37			NOT WIRED
			38			NOT WIRED
			39			NOT WIRED
			40			NOT WIRED
			41			NOT WIRED
			42			NOT WIRED
			43			NOT WIRED
			44			NOT WIRED
			45			NOT WIRED

TABLE 13.6.2.2.1-9 PIN ASSIGNMENTS FOR MSDP CONNECTOR J12

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			46			NOT WIRED
			47			NOT WIRED
HO	RTN	2T15	48	Xo 603 J1304 - 35		
HO	SIG	2T15	49	Xo 603 J1304 - 34		
HO	RTN	2T14	50	Xo 603 J1304 - 38		
HO	SIG	2T14	51	Xo 603 J1304 - 37		
HO	RTN	2T13	52	Xo 603 J1304 - 41		
HO	SIG	2T13	53	Xo 603 J1304 - 40		
HO	RTN	2T12	54	Xo 603 J1304 - 44		
HO	SIG	2T12	55	Xo 603 J1304 - 43		
HO	RTN	2T11	56	Xo 603 J1304 - 47		
HO	SIG	2T11	57	Xo 603 J1304 - 46		
HO	RTN	2T10	58	Xo 603 J1304 - 50		
HO	SIG	2T10	59	Xo 603 J1304 - 49		
HO	RTN	2T9	60	Xo 603 J1304 - 53		
HO	SIG	2T9	61	Xo 603 J1304 - 52		
HO	RTN	2T8	62	Xo 603 J1304 - 56		
HO	SIG	2T8	63	Xo 603 J1304 - 55		
HO	RTN	2T7	64	Xo 603 J1304 - 59		
HO	SIG	2T7	65	Xo 603 J1304 - 58		
HO	RTN	2T6	66	Xo 603 J1304 - 62		
HO	SIG	2T6	67	Xo 603 J1304 - 61		
HO	RTN	2T5	68	Xo 603 J1304 - 65		
HO	SIG	2T5	69	Xo 603 J1304 - 64		
HO	RTN	2T4	70	Xo 603 J1304 - 68		
HO	SIG	2T4	71	Xo 603 J1304 - 67		
HO	RTN	2T3	72	Xo 603 J1304 - 71		
HO	SIG	2T3	73	Xo 603 J1304 - 70		
HO	RTN	2T2	74	Xo 603 J1304 - 74		
HO	SIG	2T2	75	Xo 603 J1304 - 73		
HO	RTN	2T1	76	Xo 603 J1304 - 77		
HO	SIG	2T1	77	Xo 603 J1304 - 76		
HO	SIG	2T16	78	Xo 603 J1304 - 31		
HO	RTN	2T16	79	Xo 603 J1304 - 32		

TABLE 13.6.2.2.1-10 PIN ASSIGNMENTS FOR MSDP CONNECTOR J20

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	RTN	2T16	1	PAYLOAD SMOKE A RETURN		
			2			NOT WIRED
			3			NOT WIRED
HO	RTN	2T2	4	OOSDP J44 - 35		
HO	SIG	2T2	5	OOSDP J44 - 34		
HO	SIG	2T5	6	OOSDP J44 - 36		
HO	RTN	2T5	7	OOSDP J44 - 37		
HO	SIG	2T8	8	OOSDP J44 - 38		
HO	RTN	2T8	9	OOSDP J44 - 39		
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
HO	RTN	2T11	18	OOSDP J44 - 15		
HO	SIG	2T11	19	OOSDP J44 - 14		
			20			NOT WIRED
			21			NOT WIRED
HO	RTN	2T12	22	OOSDP J44 - 13		
HO	SIG	2T12	23	OOSDP J44 - 12		
HO	RTN	2T13	24	OOSDP J44 - 11		
HO	SIG	2T13	25	OOSDP J44 - 10		
HO	RTN	2T15	26	OOSDP J44 - 17		
HO	SIG	2T15	27	OOSDP J44 - 25		
HO	SIG	2T16	28	PAYLOAD SMOKE A	8.2.9.1	PANEL L1A1 / CAUTION & WARNING
HO	RTN	2T14	29	OOSDP J44 - 33		
HO	SIG	2T14	30	OOSDP J44 - 32		
HO	RTN	2T3	31	OOSDP J44 - 27		
HO	SIG	2T3	32	OOSDP J44 - 26		
HO	SIG	2T1	33	OOSDP J44 - 28		
HO	RTN	2T1	34	OOSDP J44 - 29		
HO	SIG	2T6	35	OOSDP J44 - 30		
HO	RTN	2T6	36	OOSDP J44 - 31		
			37			NOT WIRED
			38			NOT WIRED
			39			NOT WIRED
			40			NOT WIRED
			41			NOT WIRED
HO	RTN	2T10	42	OOSDP J44 - 16		
HO	SIG	2T10	43	OOSDP J44 - 24		
HO	RTN	2T7	44	OOSDP J44 - 23		
HO	SIG	2T7	45	OOSDP J44 - 22		

TABLE 13.6.2.2.1-10 PIN ASSIGNMENTS FOR MSDP CONNECTOR J20

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	RTN	2T9	46	OOSDP J44 - 21		
HO	SIG	2T9	47	OOSDP J44 - 20		
HO	RTN	2T4	48	OOSDP J44 - 19		
HO	SIG	2T4	49	OOSDP J44 - 18		
HO	SHD	5S5	50			TERMINATE
HO	SIG	5S5	51	PO1K4103Y DOH 03	8.2.2.2	MDM-PF2
HO	SIG	5S1	52	PO1K4117Y DOH 17	8.2.2.2	MDM-PF2
HO	SIG	5S1	53	PO1K4118Y DOH 18	8.2.2.2	MDM-PF2
HO	SIG	5S1	54	PO1K4139Y DOH 39	8.2.2.2	MDM-PF2
HO	SIG	5S2	55	PO1K4113Y DOH 13	8.2.2.2	MDM-PF2
HO	SIG	5S2	56	PO1K4114Y DOH 14	8.2.2.2	MDM-PF2
HO	SIG	5S2	57	PO1K4115Y DOH 15	8.2.2.2	MDM-PF2
HO	SIG	5S3	58	PO1K4109Y DOH 09	8.2.2.2	MDM-PF2
HO	SIG	5S3	59	PO1K4110Y DOH 10	8.2.2.2	MDM-PF2
HO	SIG	5S3	60	PO1K4111Y DOH 11	8.2.2.2	MDM-PF2
HO	SHD	5S3	61			TERMINATE
HO	SIG	5S4	62	PO1K4105Y DOH 05	8.2.2.2	MDM-PF2
HO	SIG	5S4	63	PO1K4106Y DOH 06	8.2.2.2	MDM-PF2
HO	SIG	5S4	64	PO1K4107Y DOH 07	8.2.2.2	MDM-PF2
HO	SIG	5S5	65	PO1K4101Y DOH 01	8.2.2.2	MDM-PF2
HO	SIG	5S5	66	PO1K4102Y DOH 02	8.2.2.2	MDM-PF2
HO	SIG	5S5	67	PO1K4104Y DOH 04	8.2.2.2	MDM-PF2
HO	RTN	5S1	68	DOH 17-18, 39-40 RETURN		
HO	SIG	5S1	69	PO1K4140Y DOH 40	8.2.2.2	MDM-PF2
HO	RTN	5S2	70	DOH 13-16 RETURN		
HO	SIG	5S2	71	PO1K4116Y DOH 16	8.2.2.2	MDM-PF2
HO	RTN	5S3	72	DOH 09-12 RETURN		
HO	SIG	5S3	73	PO1K4112Y DOH 12	8.2.2.2	MDM-PF2
HO	RTN	5S4	74	DOH 05-08 RETURN		
HO	SIG	5S4	75	PO1K4108Y DOH 08	8.2.2.2	MDM-PF2
HO	RTN	5S5	76	DOH 01-04 RETURN		
HO	SHD	5S1	77			TERMINATE
HO	SHD	5S2	78			TERMINATE
HO	SHD	5S4	79			TERMINATE

TABLE 13.6.2.2.1-11 PIN ASSIGNMENTS FOR MSDP CONNECTOR J22

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
ML	SHD	2S1	20	Xo 603 J1314 - 60		TERMINATE
ML	RTN	2S1	21	Xo 603 J1314 - 59		
ML	SIG	2S1	22	Xo 603 J1314 - 58		
ML	SHD	2S2	23	Xo 603 J1314 - 63		TERMINATE
ML	RTN	2S2	24	Xo 603 J1314 - 62		
ML	SIG	2S2	25	Xo 603 J1314 - 61		
ML	SHD	2S3	26	Xo 603 J1314 - 66		TERMINATE
ML	RTN	2S3	27	Xo 603 J1314 - 65		
ML	SIG	2S3	28	Xo 603 J1314 - 64		
ML	SHD	2S4	29	Xo 603 J1314 - 69		TERMINATE
ML	RTN	2S4	30	Xo 603 J1314 - 68		
ML	SIG	2S4	31	Xo 603 J1314 - 67		
ML	SHD	2S5	32	Xo 603 J1314 - 72		TERMINATE
ML	RTN	2S5	33	Xo 603 J1314 - 71		
ML	SIG	2S5	34	Xo 603 J1314 - 70		
ML	SHD	2S6	35	Xo 603 J1314 - 75		TERMINATE
ML	RTN	2S6	36	Xo 603 J1314 - 74		
ML	SIG	2S6	37	Xo 603 J1314 - 73		
ML	SHD	2S7	38	Xo 603 J1314 - 78		TERMINATE
ML	RTN	2S7	39	Xo 603 J1314 - 77		
ML	SIG	2S7	40	Xo 603 J1314 - 76		
ML	SHD	2S17	41	Xo 603 J1314 - 48		TERMINATE
ML	RTN	2S17	42	Xo 603 J1314 - 47		
ML	SIG	2S17	43	Xo 603 J1314 - 46		
ML	SHD	2S16	44	Xo 603 J1314 - 45		TERMINATE
ML	RTN	2S16	45	Xo 603 J1314 - 44		

TABLE 13.6.2.2.1-11 PIN ASSIGNMENTS FOR MSDP CONNECTOR J22

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S16	46	Xo 603 J1314 - 43		
ML	SHD	2S15	47	Xo 603 J1314 - 42		TERMINATE
ML	RTN	2S15	48	Xo 603 J1314 - 41		
ML	SIG	2S15	49	Xo 603 J1314 - 40		
ML	SHD	2S14	50	Xo 603 J1314 - 39		TERMINATE
ML	RTN	2S14	51	Xo 603 J1314 - 38		
ML	SIG	2S14	52	Xo 603 J1314 - 37		
ML	SHD	2S13	53	Xo 603 J1314 - 36		TERMINATE
ML	RTN	2S13	54	Xo 603 J1314 - 35		
ML	SIG	2S13	55	Xo 603 J1314 - 34		
ML	SHD	2S12	56	Xo 603 J1314 - 33		TERMINATE
ML	RTN	2S12	57	Xo 603 J1314 - 32		
ML	SIG	2S12	58	Xo 603 J1314 - 31		
ML	SHD	2S11	59	Xo 603 J1314 - 30		TERMINATE
ML	RTN	2S11	60	Xo 603 J1314 - 29		
ML	SIG	2S11	61	Xo 603 J1314 - 28		
ML	SHD	2S10	62	Xo 603 J1314 - 27		TERMINATE
ML	RTN	2S10	63	Xo 603 J1314 - 26		
ML	SIG	2S10	64	Xo 603 J1314 - 25		
ML	SHD	2S9	65	Xo 603 J1314 - 24		TERMINATE
ML	RTN	2S9	66	Xo 603 J1314 - 23		
ML	SIG	2S9	67	Xo 603 J1314 - 22		
ML	SHD	2S8	68	Xo 603 J1314 - 21		TERMINATE
ML	RTN	2S8	69	Xo 603 J1314 - 20		
ML	SIG	2S8	70	Xo 603 J1314 - 19		
ML	SHD	2S18	71	Xo 603 J1314 - 51		TERMINATE
ML	RTN	2S18	72	Xo 603 J1314 - 50		
ML	SIG	2S18	73	Xo 603 J1314 - 49		
ML	SHD	2S19	74	Xo 603 J1314 - 54		TERMINATE
ML	RTN	2S19	75	Xo 603 J1314 - 53		
ML	SIG	2S19	76	Xo 603 J1314 - 52		
ML	SIG	2S20	77	Xo 603 J1314 - 55		
ML	RTN	2S20	78	Xo 603 J1314 - 56		
ML	SHD	2S20	79	Xo 603 J1314 - 57		TERMINATE

TABLE 13.6.2.2.1-12 PIN ASSIGNMENTS FOR MSDP CONNECTOR J24

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	RTN	2T1	1	Xo 603 J1308 - 47		
HO	SIG	2T1	2	Xo 603 J1308 - 46		
HO	SHD	2T1	3			TERMINATE
HO	SIG	5T1	4	Xo 603 J1308 - 52		
HO	SIG	5T1	5	Xo 603 J1308 - 51		
HO	SIG	5T1	6	Xo 603 J1308 - 50		
HO	SIG	5T2	7	Xo 603 J1308 - 58		
HO	SIG	5T2	8	Xo 603 J1308 - 57		
HO	SIG	5T2	9	Xo 603 J1308 - 56		
HO	SIG	5T3	10	Xo 603 J1308 - 63		
HO	SIG	5T3	11	Xo 603 J1308 - 62		
HO	SIG	5T3	12	Xo 603 J1308 - 61		
HO	SIG	5T4	13	Xo 603 J1308 - 69		
HO	SIG	5T4	14	Xo 603 J1308 - 68		
HO	SIG	5T4	15	Xo 603 J1308 - 67		
HO	SIG	5T5	16	Xo 603 J1308 - 75		
HO	SIG	5T5	17	Xo 603 J1308 - 74		
HO	SIG	5T5	18	Xo 603 J1308 - 73		
HO	SHD	5T5	19			TERMINATE
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
HO	RTN	2T3	28	Xo 603 J1308 - 41		
HO	SIG	2T3	29	Xo 603 J1308 - 40		
HO	RTN	2T2	30	Xo 603 J1308 - 44		
HO	SIG	2T2	31	Xo 603 J1308 - 43		
HO	RTN	5T1	32	Xo 603 J1308 - 53		
HO	SIG	5T1	33	Xo 603 J1308 - 49		
HO	SIG	2T16	34	Xo 603 J1308 - 1		
HO	RTN	5T2	35	Xo 603 J1308 - 59		
HO	SIG	5T2	36	Xo 603 J1308 - 55		
HO	SIG	5T3	37	Xo 603 J1308 - 64		
HO	RTN	5T3	38	Xo 603 J1308 - 65		
HO	SIG	5T4	39	Xo 603 J1308 - 70		
HO	RTN	5T4	40	Xo 603 J1308 - 71		
HO	SIG	5T5	41	Xo 603 J1308 - 76		
HO	RTN	5T5	42	Xo 603 J1308 - 77		
			43			NOT WIRED
			44			NOT WIRED
			45			NOT WIRED

TABLE 13.6.2.2.1-12 PIN ASSIGNMENTS FOR MSDP CONNECTOR J24

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			46			NOT WIRED
			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
HO	RTN	2T6	50	Xo 603 J1308 - 32		
HO	SIG	2T6	51	Xo 603 J1308 - 31		
HO	RTN	2T5	52	Xo 603 J1308 - 35		
HO	SIG	2T5	53	Xo 603 J1308 - 34		
HO	RTN	2T4	54	Xo 603 J1308 - 38		
HO	SIG	2T4	55	Xo 603 J1308 - 37		
HO	RTN	2T16	56	Xo 603 J1308 - 2		
HO	SHD	5T2	57			TERMINATE
HO	SHD	5T3	58			TERMINATE
HO	SHD	5T4	59			TERMINATE
			60			NOT WIRED
			61			NOT WIRED
HO	RTN	2T15	62	Xo 603 J1308 - 5		
HO	SIG	2T15	63	Xo 603 J1308 - 4		
HO	RTN	2T14	64	Xo 603 J1308 - 8		
HO	SIG	2T14	65	Xo 603 J1308 - 7		
HO	RTN	2T13	66	Xo 603 J1308 - 11		
HO	SIG	2T13	67	Xo 603 J1308 - 10		
HO	RTN	2T12	68	Xo 603 J1308 - 14		
HO	SIG	2T12	69	Xo 603 J1308 - 13		
HO	RTN	2T11	70	Xo 603 J1308 - 17		
HO	SIG	2T11	71	Xo 603 J1308 - 16		
HO	RTN	2T10	72	Xo 603 J1308 - 20		
HO	SIG	2T10	73	Xo 603 J1308 - 19		
HO	RTN	2T9	74	Xo 603 J1308 - 23		
HO	SIG	2T9	75	Xo 603 J1308 - 22		
HO	RTN	2T8	76	Xo 603 J1308 - 26		
HO	SIG	2T8	77	Xo 603 J1308 - 25		
HO	RTN	2T7	78	Xo 603 J1308 - 29		
HO	SIG	2T7	79	Xo 603 J1308 - 28		

TABLE 13.6.2.2.1-13 PIN ASSIGNMENTS FOR MSDP CONNECTOR J26

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	5S1	1	Xo 603 J1322 - 34		
ML	SIG	5S1	2	Xo 603 J1322 - 33		
ML	SIG	5S1	3	Xo 603 J1322 - 32		
ML	SIG	5S1	4	Xo 603 J1322 - 31		
ML	RTN	5S1	5	Xo 603 J1322 - 35		
ML	SHD	5S1	6	Xo 603 J1322 - 36		TERMINATE
ML	SIG	5S3	7	Xo 603 J1322 - 44		
ML	SIG	5S2	8	Xo 603 J1322 - 40		
ML	SIG	5S2	9	Xo 603 J1322 - 39		
ML	SIG	5S2	10	Xo 603 J1322 - 38		
ML	SIG	5S2	11	Xo 603 J1322 - 37		
ML	RTN	5S2	12	Xo 603 J1322 - 41		
ML	SHD	5S2	13	Xo 603 J1322 - 42		TERMINATE
ML	SIG	5S3	14	Xo 603 J1322 - 43		
ML	SIG	5S3	15	Xo 603 J1322 - 45		
ML	SIG	5S4	16	Xo 603 J1322 - 50		
ML	SIG	5S4	17	Xo 603 J1322 - 51		
ML	SIG	5S4	18	Xo 603 J1322 - 52		
ML	SIG	5S5	19	Xo 603 J1320 - 45		
ML	SIG	5S5	20	Xo 603 J1320 - 46		
ML	SIG	5S5	21	Xo 603 J1320 - 43		
ML	SIG	5S6	22	Xo 603 J1320 - 51		
ML	RTN	5S3	23	Xo 603 J1322 - 47		
ML	SIG	5S3	24	Xo 603 J1322 - 46		
ML	SIG	5S4	25	Xo 603 J1322 - 49		
ML	RTN	5S4	26	Xo 603 J1322 - 53		
ML	SHD	5S4	27	Xo 603 J1322 - 54		TERMINATE
ML	SIG	5S1	28	Xo 603 J1320 - 57		
ML	RTN	5S5	29	Xo 603 J1320 - 47		
ML	SIG	5S5	30	Xo 603 J1320 - 44		
ML	RTN	5S6	31	Xo 603 J1320 - 53		
ML	SIG	5S6	32	Xo 603 J1320 - 52		
ML	SHD	5S3	33	Xo 603 J1322 - 48		TERMINATE
			34			NOT WIRED
ML	SIG	5S5	35	Xo 603 J1322 - 58		
ML	SIG	5S5	36	Xo 603 J1322 - 57		
ML	SIG	5S5	37	Xo 603 J1322 - 56		
ML	SIG	5S1	38	Xo 603 J1320 - 56		
ML	SIG	5S1	39	Xo 603 J1320 - 58		
ML	SHD	5S5	40	Xo 603 J1320 - 48		TERMINATE
ML	SHD	5S6	41	Xo 603 J1320 - 54		TERMINATE
ML	SIG	5S6	42	Xo 603 J1320 - 50		
ML	SIG	5S6	43	Xo 603 J1320 - 49		
			44			NOT WIRED
			45			NOT WIRED

TABLE 13.6.2.2.1-13 PIN ASSIGNMENTS FOR MSDP CONNECTOR J26

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	RTN	5S5	46	Xo 603 J1322 - 59		
ML	SIG	5S5	47	Xo 603 J1322 - 55		
ML	SIG	5S1	48	Xo 603 J1320 - 55		
ML	RTN	5S1	49	Xo 603 J1320 - 59		
ML	SHD	5S1	50	Xo 603 J1320 - 60		TERMINATE
ML	SHD	5S4	51	Xo 603 J1320 - 78		TERMINATE
ML	RTN	5S4	52	Xo 603 J1320 - 77		
ML	SIG	5S4	53	Xo 603 J1320 - 75		
			54			NOT WIRED
			55			NOT WIRED
ML	SHD	5S5	56	Xo 603 J1322 - 60		TERMINATE
ML	SIG	5S6	57	Xo 603 J1322 - 62		
ML	SIG	5S2	58	Xo 603 J1320 - 61		
ML	SIG	5S2	59	Xo 603 J1320 - 62		
ML	SHD	5S2	60	Xo 603 J1320 - 66		TERMINATE
ML	SHD	5S3	61	Xo 603 J1320 - 72		TERMINATE
ML	SIG	5S4	62	Xo 603 J1320 - 74		
ML	SIG	5S4	63	Xo 603 J1320 - 76		
			64			NOT WIRED
			65			NOT WIRED
			66			NOT WIRED
ML	SIG	5S6	67	Xo 603 J1322 - 63		
ML	SIG	5S6	68	Xo 603 J1322 - 61		
ML	SIG	5S2	69	Xo 603 J1320 - 64		
ML	RTN	5S2	70	Xo 603 J1320 - 65		
ML	SIG	5S3	71	Xo 603 J1320 - 68		
ML	RTN	5S3	72	Xo 603 J1320 - 71		
ML	SIG	5S4	73	Xo 603 J1320 - 73		
			74			NOT WIRED
			75			NOT WIRED
			76			NOT WIRED
ML	SIG	5S6	77	Xo 603 J1322 - 64		
ML	RTN	5S6	78	Xo 603 J1322 - 65		
ML	SIG	5S2	79	Xo 603 J1320 - 63		
ML	SIG	5S3	80	Xo 603 J1320 - 67		
ML	SIG	5S3	81	Xo 603 J1320 - 70		
ML	SIG	5S3	82	Xo 603 J1320 - 69		
			83			NOT WIRED
			84			NOT WIRED
			85			NOT WIRED
ML	SHD	5S6	86	Xo 603 J1322 - 66		TERMINATE
ML	SIG	5S7	87	Xo 603 J1322 - 70		
ML	SIG	5S7	88	Xo 603 J1322 - 69		
ML	SIG	5S7	89	Xo 603 J1322 - 68		
ML	SIG	5S7	90	Xo 603 J1322 - 67		
ML	RTN	5S7	91	Xo 603 J1322 - 71		

TABLE 13.6.2.2.1-13 PIN ASSIGNMENTS FOR MSDP CONNECTOR J26

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	5S7	92	Xo 603 J1322 - 72		TERMINATE
			93			NOT WIRED
ML	SIG	5S8	94	Xo 603 J1322 - 76		
ML	SIG	5S8	95	Xo 603 J1322 - 75		
ML	SIG	5S8	96	Xo 603 J1322 - 74		
ML	SIG	5S8	97	Xo 603 J1322 - 73		
ML	RTN	5S8	98	Xo 603 J1322 - 77		
ML	SHD	5S8	99	Xo 603 J1322 - 78		TERMINATE
			100			NOT WIRED

TABLE 13.6.2.2.1-14 PIN ASSIGNMENTS FOR MSDP CONNECTOR J34

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
ML	SHD	2S21	17	Xo 603 J1318 - 18		TERMINATE
ML	RTN	2S21	18	Xo 603 J1318 - 17		
ML	SIG	2S21	19	Xo 603 J1318 - 16		
ML	SHD	2S20	20	Xo 603 J1318 - 21		TERMINATE
ML	RTN	2S20	21	Xo 603 J1318 - 20		
ML	SIG	2S20	22	Xo 603 J1318 - 19		
ML	SHD	2S19	23	Xo 603 J1318 - 24		TERMINATE
ML	RTN	2S19	24	Xo 603 J1318 - 23		
ML	SIG	2S19	25	Xo 603 J1318 - 22		
ML	SHD	2S18	26	Xo 603 J1318 - 27		TERMINATE
ML	RTN	2S18	27	Xo 603 J1318 - 26		
ML	SIG	2S18	28	Xo 603 J1318 - 25		
ML	SHD	2S17	29	Xo 603 J1318 - 30		TERMINATE
ML	RTN	2S17	30	Xo 603 J1318 - 29		
ML	SIG	2S17	31	Xo 603 J1318 - 28		
ML	SHD	2S16	32	Xo 603 J1318 - 33		TERMINATE
ML	RTN	2S16	33	Xo 603 J1318 - 32		
ML	SIG	2S16	34	Xo 603 J1318 - 31		
ML	SHD	2S15	35	Xo 603 J1318 - 36		TERMINATE
ML	RTN	2S15	36	Xo 603 J1318 - 35		
ML	SIG	2S15	37	Xo 603 J1318 - 34		
ML	SHD	2S14	38	Xo 603 J1318 - 39		TERMINATE
ML	RTN	2S14	39	Xo 603 J1318 - 38		
ML	SIG	2S14	40	Xo 603 J1318 - 37		
ML	SHD	2S13	41	Xo 603 J1318 - 42		TERMINATE
ML	RTN	2S13	42	Xo 603 J1318 - 41		
ML	SIG	2S13	43	Xo 603 J1318 - 40		
ML	SHD	2S12	44	Xo 603 J1318 - 45		TERMINATE
ML	RTN	2S12	45	Xo 603 J1318 - 44		

TABLE 13.6.2.2.1-14 PIN ASSIGNMENTS FOR MSDP CONNECTOR J34

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S12	46	Xo 603 J1318 - 43		
ML	SHD	2S11	47	Xo 603 J1318 - 48		TERMINATE
ML	RTN	2S11	48	Xo 603 J1318 - 47		
ML	SIG	2S11	49	Xo 603 J1318 - 46		
ML	SHD	2S10	50	Xo 603 J1318 - 51		TERMINATE
ML	RTN	2S10	51	Xo 603 J1318 - 50		
ML	SIG	2S10	52	Xo 603 J1318 - 49		
ML	SHD	2S9	53	Xo 603 J1318 - 54		TERMINATE
ML	RTN	2S9	54	Xo 603 J1318 - 53		
ML	SIG	2S9	55	Xo 603 J1318 - 52		
ML	SHD	2S8	56	Xo 603 J1318 - 57		TERMINATE
ML	RTN	2S8	57	Xo 603 J1318 - 56		
ML	SIG	2S8	58	Xo 603 J1318 - 55		
ML	SHD	2S7	59	Xo 603 J1318 - 60		TERMINATE
ML	RTN	2S7	60	Xo 603 J1318 - 59		
ML	SIG	2S7	61	Xo 603 J1318 - 58		
ML	SHD	2S6	62	Xo 603 J1318 - 63		TERMINATE
ML	RTN	2S6	63	Xo 603 J1318 - 62		
ML	SIG	2S6	64	Xo 603 J1318 - 61		
ML	SHD	2S5	65	Xo 603 J1318 - 66		TERMINATE
ML	RTN	2S5	66	Xo 603 J1318 - 65		
ML	SIG	2S5	67	Xo 603 J1318 - 64		
ML	SHD	2S4	68	Xo 603 J1318 - 69		TERMINATE
ML	RTN	2S4	69	Xo 603 J1318 - 68		
ML	SIG	2S4	70	Xo 603 J1318 - 67		
ML	SHD	2S3	71	Xo 603 J1318 - 72		TERMINATE
ML	RTN	2S3	72	Xo 603 J1318 - 71		
ML	SIG	2S3	73	Xo 603 J1318 - 70		
ML	SHD	2S2	74	Xo 603 J1318 - 75		TERMINATE
ML	RTN	2S2	75	Xo 603 J1318 - 74		
ML	SIG	2S2	76	Xo 603 J1318 - 73		
ML	SHD	2S1	77	Xo 603 J1318 - 78		TERMINATE
ML	RTN	2S1	78	Xo 603 J1318 - 77		
ML	SIG	2S1	79	Xo 603 J1318 - 76		

TABLE 13.6.2.2.1-15 PIN ASSIGNMENTS FOR MSDP CONNECTOR J58

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
RF	SIG	2S1	17	PSDP J27 - 3		
RF	RTN	2S1	18	PSDP J27 - 4		
RF	SIG	2S2	19	PSDP J27 - 5		
			20			NOT WIRED
RF	RTN	2S2	21	PSDP J27 - 6		
RF	SIG	2S3	22	PSDP J27 - 7		
RF	RTN	2S3	23	PSDP J27 - 8		
RF	SIG	2S4	24	PSDP J27 - 9		
RF	RTN	2S4	25	PSDP J27 - 10		
RF	SIG	2S5	26	PSDP J27 - 11		
RF	RTN	2S5	27	PSDP J27 - 12		
RF	SIG	2S6	28	PSDP J27 - 13		
RF	RTN	2S6	29	PSDP J27 - 14		
RF	SIG	2S7	30	PSDP J27 - 15		
RF	RTN	2S7	31	PSDP J27 - 16		
RF	SIG	2S8	32	PSDP J27 - 17		
RF	RTN	2S8	33	PSDP J27 - 18		
RF	SIG	2S9	34	PSDP J27 - 19		
RF	RTN	2S9	35	PSDP J27 - 20		
RF	SIG	2S10	36	PSDP J27 - 21		
RF	RTN	2S10	37	PSDP J27 - 22		

TABLE 13.6.2.2.2-1 PIN ASSIGNMENTS FOR MSDP CONNECTOR J16

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	2T1	A	CABIN 3 POWER	7.3.3	MPCA 1 OR 2
HO	RTN	2T1	B	CABIN 3 POWER RETURN		GROUND
HO	SIG	2T2	C	CABIN 2 POWER	7.3.3	MPCA 1 OR 2
HO	RTN	2T2	D	CABIN 2 POWER RETURN		GROUND

TABLE 13.6.2.2.2-2 PIN ASSIGNMENTS FOR MSDP CONNECTOR J36

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
EO	SIG	4T1	A	AC 2 POWER, PHASE A	7.4	PANEL MA73C
EO	SIG	4T1	B	AC 2 POWER, PHASE B	7.4	PANEL MA73C
EO	SIG	4T1	C	AC 2 POWER, PHASE C	7.4	PANEL MA73C
			D			NOT WIRED
			E			NOT WIRED
EO	SIG	4T2	F	Xo 603 J1306 - S		
EO	SIG	4T2	G	Xo 603 J1306 - T		
EO	SIG	4T2	H	Xo 603 J1306 - U		
EO	NTL	4T1	J	AC 2 POWER, NEUTRAL	7.4	PANEL MA73C
EO	NTL	4T2	K	Xo 603 J1306 - V		

TABLE 13.6.2.2.2-3 PIN ASSIGNMENTS FOR MSDP CONNECTOR J38

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
EO	SIG	4T1	A	AC 3 POWER, PHASE A	7.4	PANEL MA73C
EO	SIG	4T1	B	AC 3 POWER, PHASE B	7.4	PANEL MA73C
EO	SIG	4T1	C	AC 3 POWER, PHASE C	7.4	PANEL MA73C
			D			NOT WIRED
			E			NOT WIRED
EO	SIG	4T2	F	Xo 603 J1310 - S		
EO	SIG	4T2	G	Xo 603 J1310 - T		
EO	SIG	4T2	H	Xo 603 J1310 - U		
EO	NTL	4T1	J	AC 3 POWER, NEUTRAL	7.4	PANEL MA73C
EO	NTL	4T2	K	Xo 603 J1310 - V		

TABLE 13.6.2.2.2-4 PIN ASSIGNMENTS FOR MSDP CONNECTOR J42

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
RF	SIG	2S2	7	CCTV VIDEO TO COMSEC +	8.2.8	KGX - 60 COMSEC
RF	RTN	2S2	8	CCTV VIDEO TO COMSEC -		
			9			NOT WIRED
			10			NOT WIRED
RF	SIG	2S1	11	CCTV CLOCK TO COMSEC +	8.2.8	KGX - 60 COMSEC
RF	RTN	2S1	12	CCTV CLOCK TO COMSEC -		
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED

TABLE 13.6.2.2.2-5 PIN ASSIGNMENTS FOR MSDP CONNECTOR J54

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
RF	SIG	2S2	5	VIDEO SPARE 1 +	8.2.8	VIDEO SWITCHING NETWORK
RF	RTN	2S2	6	VIDEO SPARE 1 -		
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
RF	SIG	2S1	17	CABIN CAMERA 4 SYNC +	8.2.8	REMOTE CONTROL UNIT
RF	RTN	2S1	18	CABIN CAMERA 4 SYNC -		
RF	SIG	2S3	19	CCTV VIDEO ADU +	8.2.8	KGX - 60 COMSEC
RF	RTN	2S3	20	CCTV VIDEO ADU -		
RF	SIG	2S4	21	CCTV CLOCK ADU +	8.2.8	KGX - 60 COMSEC
RF	RTN	2S4	22	CCTV CLOCK ADU -		

TABLE 13.6.2.2.2-6 PIN ASSIGNMENTS FOR MSDP CONNECTOR J56

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
HO	SIG	1SC	3	SPARE 1 OUT STATUS	8.2.8	REMOTE CONTROL UNIT
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
HO	SIG	2T2	7	VIDEO SPARE 1 OUT SELECT	8.2.8	REMOTE CONTROL UNIT
			8			NOT WIRED
HO	RTN	2T2	9	SPARE 1 OUT SELECT RETURN		
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
			26			NOT WIRED
			27			NOT WIRED
			28			NOT WIRED
			29			NOT WIRED
HO	SIG	2T1	30	28 VDC MAIN BUS B		PANEL R15
HO	RTN	2T1	31	28 VDC MAIN BUS B RETURN		
HO	SIG	1SC	32	28 VDC MAIN BUS A		PANEL A1A1
			33			NOT WIRED
			34			NOT WIRED
			35			NOT WIRED
			36			NOT WIRED
			37			NOT WIRED

TABLE 13.6.2.3-1 SUMMARY OF STARBOARD OOSDP CONNECTORS AVAILABLE AS NON-STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE AFD

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS			
OOSDP-J44	15	TP	HO	25	13.6.2.3-5	NLS0T16-35P	NLS6GT16-35S
OOSDP-J46	1	TP	HO	2	13.6.2.3-4	NB0E14-4SNT2	NB6GE14-4PNT2
OOSDP-J48	22	TSP	ML	13	13.6.2.3-2	NLS0T20-35P	NLS6GT20-35S
OOSDP-J50	21	TSP	ML	16	13.6.2.3-3	NLS0T20-35PA	NLS6GT20-35SA

TABLE 13.6.2.3-2 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J48

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
ML	SIG	2S1	14	MSDP J28 - 14		
ML	RTN	2S1	15	MSDP J28 - 15		
ML	SHD	2S1	16	MSDP J28 - 16		TERMINATE
ML	SIG	2S2	17	MSDP J28 - 17		
ML	RTN	2S2	18	MSDP J28 - 18		
ML	SHD	2S2	19	MSDP J28 - 19		TERMINATE
ML	SIG	2S3	20	MSDP J28 - 20		
ML	RTN	2S3	21	MSDP J28 - 21		
ML	SHD	2S3	22	MSDP J28 - 22		TERMINATE
ML	RTN	2S4	23	MSDP J28 - 23		
ML	SIG	2S4	24	MSDP J28 - 24		
ML	SHD	2S4	25	MSDP J28 - 25		TERMINATE
ML	RTN	2S5	26	MSDP J28 - 26		
ML	SIG	2S5	27	MSDP J28 - 27		
ML	SHD	2S5	28	MSDP J28 - 28		TERMINATE
ML	RTN	2S6	29	MSDP J28 - 29		
ML	SIG	2S6	30	MSDP J28 - 30		
ML	SHD	2S6	31	MSDP J28 - 31		TERMINATE
ML	RTN	2S7	32	MSDP J28 - 32		
ML	SIG	2S7	33	MSDP J28 - 33		
ML	SHD	2S7	34	MSDP J28 - 34		TERMINATE
ML	SIG	2S8	35	MSDP J28 - 35		
ML	RTN	2S8	36	MSDP J28 - 36		
ML	SHD	2S8	37	MSDP J28 - 37		TERMINATE
ML	SIG	2S9	38	MSDP J28 - 38		
ML	RTN	2S9	39	MSDP J28 - 39		
ML	SHD	2S9	40	MSDP J28 - 40		TERMINATE
ML	SIG	2S10	41	MSDP J28 - 41		
ML	RTN	2S10	42	MSDP J28 - 42		
ML	SHD	2S10	43	MSDP J28 - 43		TERMINATE
ML	SIG	2S11	44	MSDP J28 - 44		
ML	RTN	2S11	45	MSDP J28 - 45		

TABLE 13.6.2.3-2 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J48

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S11	46	MSDP J28 - 46		TERMINATE
ML	RTN	2S12	47	MSDP J28 - 47		
ML	SIG	2S12	48	MSDP J28 - 48		
ML	SHD	2S12	49	MSDP J28 - 49		TERMINATE
ML	RTN	2S13	50	MSDP J28 - 50		
ML	SIG	2S13	51	MSDP J28 - 51		
ML	SHD	2S13	52	MSDP J28 - 52		TERMINATE
ML	RTN	2S14	53	MSDP J28 - 53		
ML	SIG	2S14	54	MSDP J28 - 54		
ML	SHD	2S14	55	MSDP J28 - 55		TERMINATE
ML	SIG	2S15	56	MSDP J28 - 56		
ML	RTN	2S15	57	MSDP J28 - 57		
ML	SHD	2S15	58	MSDP J28 - 58		TERMINATE
ML	SIG	2S16	59	MSDP J28 - 59		
ML	RTN	2S16	60	MSDP J28 - 60		
ML	SHD	2S16	61	MSDP J28 - 61		TERMINATE
ML	SIG	2S17	62	MSDP J28 - 62		
ML	RTN	2S17	63	MSDP J28 - 63		
ML	SHD	2S17	64	MSDP J28 - 64		TERMINATE
ML	RTN	2S18	65	MSDP J28 - 65		
ML	SIG	2S18	66	MSDP J28 - 66		
ML	SHD	2S18	67	MSDP J28 - 67		TERMINATE
ML	RTN	2S19	68	MSDP J28 - 68		
ML	SIG	2S19	69	MSDP J28 - 69		
ML	SHD	2S19	70	MSDP J28 - 70		TERMINATE
ML	SIG	2S20	71	MSDP J28 - 71		
ML	RTN	2S20	72	MSDP J28 - 72		
ML	SHD	2S20	73	MSDP J28 - 73		TERMINATE
ML	SIG	2S21	74	MSDP J28 - 74		
ML	RTN	2S21	75	MSDP J28 - 75		
ML	SHD	2S21	76	MSDP J28 - 76		TERMINATE
ML	RTN	2S22	77	MSDP J28 - 77		
ML	SIG	2S22	78	MSDP J28 - 78		
ML	SHD	2S22	79	MSDP J28 - 79		TERMINATE

TABLE 13.6.2.3-3 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J50

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
ML	SIG	2S1	17	MSDP J14 - 17		
ML	RTN	2S1	18	MSDP J14 - 18		
ML	SHD	2S1	19	MSDP J14 - 19		TERMINATE
ML	RTN	2S2	20	MSDP J14 - 20		
ML	SIG	2S2	21	MSDP J14 - 21		
ML	SHD	2S2	22	MSDP J14 - 22		TERMINATE
ML	RTN	2S3	23	MSDP J14 - 23		
ML	SIG	2S3	24	MSDP J14 - 24		
ML	SHD	2S3	25	MSDP J14 - 25		TERMINATE
ML	RTN	2S4	26	MSDP J14 - 26		
ML	SIG	2S4	27	MSDP J14 - 27		
ML	SHD	2S4	28	MSDP J14 - 28		TERMINATE
ML	RTN	2S5	29	MSDP J14 - 29		
ML	SIG	2S5	30	MSDP J14 - 30		
ML	SHD	2S5	31	MSDP J14 - 31		TERMINATE
ML	RTN	2S6	32	MSDP J14 - 32		
ML	SIG	2S6	33	MSDP J14 - 33		
ML	SHD	2S6	34	MSDP J14 - 34		TERMINATE
ML	SIG	2S7	35	MSDP J14 - 35		
ML	RTN	2S7	36	MSDP J14 - 36		
ML	SHD	2S7	37	MSDP J14 - 37		TERMINATE
ML	SIG	2S8	38	MSDP J14 - 38		
ML	RTN	2S8	39	MSDP J14 - 39		
ML	SHD	2S8	40	MSDP J14 - 40		TERMINATE
ML	SIG	2S9	41	MSDP J14 - 41		
ML	RTN	2S9	42	MSDP J14 - 42		
ML	SHD	2S9	43	MSDP J14 - 43		TERMINATE
ML	SIG	2S10	44	MSDP J14 - 44		
ML	RTN	2S10	45	MSDP J14 - 45		

TABLE 13.6.2.3-3 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J50

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S10	46	MSDP J14 - 46		TERMINATE
ML	RTN	2S11	47	MSDP J14 - 47		
ML	SIG	2S11	48	MSDP J14 - 48		
ML	SHD	2S11	49	MSDP J14 - 49		TERMINATE
ML	RTN	2S12	50	MSDP J14 - 50		
ML	SIG	2S12	51	MSDP J14 - 51		
ML	SHD	2S12	52	MSDP J14 - 52		TERMINATE
ML	RTN	2S13	53	MSDP J14 - 53		
ML	SIG	2S13	54	MSDP J14 - 54		
ML	SHD	2S13	55	MSDP J14 - 55		TERMINATE
ML	SIG	2S14	56	MSDP J14 - 56		
ML	RTN	2S14	57	MSDP J14 - 57		
ML	SHD	2S14	58	MSDP J14 - 58		TERMINATE
ML	SIG	2S15	59	MSDP J14 - 59		
ML	RTN	2S15	60	MSDP J14 - 60		
ML	SHD	2S15	61	MSDP J14 - 61		TERMINATE
ML	SIG	2S16	62	MSDP J14 - 62		
ML	RTN	2S16	63	MSDP J14 - 63		
ML	SHD	2S16	64	MSDP J14 - 64		TERMINATE
ML	RTN	2S17	65	MSDP J14 - 65		
ML	SIG	2S17	66	MSDP J14 - 66		
ML	SHD	2S17	67	MSDP J14 - 67		TERMINATE
ML	RTN	2S18	68	MSDP J14 - 68		
ML	SIG	2S18	69	MSDP J14 - 69		
ML	SHD	2S18	70	MSDP J14 - 70		TERMINATE
ML	SIG	2S19	71	MSDP J14 - 71		
ML	RTN	2S19	72	MSDP J14 - 72		
ML	SHD	2S19	73	MSDP J14 - 73		TERMINATE
ML	SIG	2S20	74	MSDP J14 - 74		
ML	RTN	2S20	75	MSDP J14 - 75		
ML	SHD	2S20	76	MSDP J14 - 76		TERMINATE
ML	RTN	2S22	77	MSDP J14 - 77		
ML	SIG	2S22	78	MSDP J14 - 78		
ML	SHD	2S22	79	MSDP J14 - 79		TERMINATE

TABLE 13.6.2.3-4 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J46

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	2T1	A	CABIN 3 POWER	7.3.3	MPCA 1 OR 2
HO	RTN	2T1	B	CABIN 3 POWER RETURN		GROUND
			C			NOT WIRED
			D			NOT WIRED

TABLE 13.6.2.3-5 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J44

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
HO	SIG	2T13	10	MSDP J20 - 25		
HO	RTN	2T13	11	MSDP J20 - 24		
HO	SIG	2T12	12	MSDP J20 - 23		
HO	RTN	2T12	13	MSDP J20 - 22		
HO	SIG	2T11	14	MSDP J20 - 19		
HO	RTN	2T11	15	MSDP J20 - 18		
HO	RTN	2T10	16	MSDP J20 - 42		
HO	RTN	2T15	17	MSDP J20 - 26		
HO	SIG	2T4	18	MSDP J20 - 49		
HO	RTN	2T4	19	MSDP J20 - 48		
HO	SIG	2T9	20	MSDP J20 - 47		
HO	RTN	2T9	21	MSDP J20 - 46		
HO	SIG	2T7	22	MSDP J20 - 45		
HO	RTN	2T7	23	MSDP J20 - 44		
HO	SIG	2T10	24	MSDP J20 - 43		
HO	SIG	2T15	25	MSDP J20 - 27		
HO	SIG	2T3	26	MSDP J20 - 32		
HO	RTN	2T3	27	MSDP J20 - 31		
HO	SIG	2T1	28	MSDP J20 - 33		
HO	RTN	2T1	29	MSDP J20 - 34		
HO	SIG	2T6	30	MSDP J20 - 35		
HO	RTN	2T6	31	MSDP J20 - 36		
HO	SIG	2T14	32	MSDP J20 - 30		
HO	RTN	2T14	33	MSDP J20 - 29		
HO	SIG	2T2	34	MSDP J20 - 5		
HO	RTN	2T2	35	MSDP J20 - 4		
HO	SIG	2T5	36	MSDP J20 - 6		
HO	RTN	2T5	37	MSDP J20 - 7		
HO	SIG	2T8	38	MSDP J20 - 8		
HO	RTN	2T8	39	MSDP J20 - 9		
			40			NOT WIRED
			41			NOT WIRED
			42			NOT WIRED
			43			NOT WIRED
			44			NOT WIRED
			45			NOT WIRED

TABLE 13.6.2.3-5 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J44

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			46			NOT WIRED
			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
			50			NOT WIRED
			51			NOT WIRED
			52			NOT WIRED
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

TABLE 13.6.2.4-1 SUMMARY OF PORT OOSDP CONNECTOR AVAILABLE AS NON-STANDARD ELECTRICAL INTERFACES (INDEPENDENT OF SMCH) IN THE AFD

ORBITER CONNECTOR IDENTIFIER	CABLE DEFINITION				SEE TABLE	ORBITER INTERFACE CONNECTOR PART NO.	CARGO INTERFACE CONNECTOR PART NO.
	NO CIRCT	WIRE TYPE	EMC CLASS	SPARE PINS			
OOSDP-J57	15	TP	HO	25	13.6.2.4-4	NLS0T16-35P	NLS6GT16-35S
OOSDP-J59	22	TSP	ML	13	13.6.2.4-2	NLS0T20-35P	NLS6GT20-35S
OOSDP-J61	21	TSP	ML	16	13.6.2.4-3	NLS0T20-35PA	NLS6GT20-35SA
OOSDP-J701	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
OOSDP-J702	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
OOSDP-J703	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
OOSDP-J704	1	COAX	RF	0	(1)	MC414-0614-0041	MC414-0614-0011
OOSDP-J9575	4	TSP	ML	13	13.6.2.4-5	NB0E22-55SNT2	NB6GE22-55PNT2
	2	TS4C	ML				
	2	T4C	HO				
	12	SC	HO				

(1) SIGNAL IS CARRIED CONVENTIONALLY ON CENTER CONDUCTOR FOR ALL ORBITER COAX CABLES. NO PIN ASSIGNMENT TABLES ARE REQUIRED. CIRCUIT TERMINATIONS ARE SHOWN IN FIGURE 13.3.3-1.

TABLE 13.6.2.4-2 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J59

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
ML	SIG	2S2	14	PSDP J51 - 14		
ML	RTN	2S2	15	PSDP J51 - 15		
ML	SHD	2S2	16	PSDP J51 - 16		TERMINATE
ML	SIG	2S1	17	PSDP J51 - 17		
ML	RTN	2S1	18	PSDP J51 - 18		
ML	SHD	2S1	19	PSDP J51 - 19		TERMINATE
ML	RTN	2S9	20	PSDP J51 - 20		
ML	SIG	2S9	21	PSDP J51 - 21		
ML	SHD	2S9	22	PSDP J51 - 22		TERMINATE
ML	RTN	2S12	23	PSDP J51 - 23		
ML	SIG	2S12	24	PSDP J51 - 24		
ML	SHD	2S12	25	PSDP J51 - 25		TERMINATE
ML	RTN	2S14	26	PSDP J51 - 26		
ML	SIG	2S14	27	PSDP J51 - 27		
ML	SHD	2S14	28	PSDP J51 - 28		TERMINATE
ML	RTN	2S15	29	PSDP J51 - 29		
ML	SIG	2S15	30	PSDP J51 - 30		
ML	SHD	2S15	31	PSDP J51 - 31		TERMINATE
ML	RTN	2S8	32	PSDP J51 - 32		
ML	SIG	2S8	33	PSDP J51 - 33		
ML	SHD	2S8	34	PSDP J51 - 34		TERMINATE
ML	SIG	2S7	35	PSDP J51 - 35		
ML	RTN	2S7	36	PSDP J51 - 36		
ML	SHD	2S7	37	PSDP J51 - 37		TERMINATE
ML	SIG	2S4	38	PSDP J51 - 38		
ML	RTN	2S4	39	PSDP J51 - 39		
ML	SHD	2S4	40	PSDP J51 - 40		TERMINATE
ML	SIG	2S3	41	PSDP J51 - 41		
ML	RTN	2S3	42	PSDP J51 - 42		
ML	SHD	2S3	43	PSDP J51 - 43		TERMINATE
ML	SIG	2S10	44	PSDP J51 - 44		
ML	RTN	2S10	45	PSDP J51 - 45		

TABLE 13.6.2.4-2 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J59

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SHD	2S10	46	PSDP J51 - 46		TERMINATE
ML	RTN	2S13	47	PSDP J51 - 47		
ML	SIG	2S13	48	PSDP J51 - 48		
ML	SHD	2S13	49	PSDP J51 - 49		TERMINATE
ML	RTN	2S17	50	PSDP J51 - 50		
ML	SIG	2S17	51	PSDP J51 - 51		
ML	SHD	2S17	52	PSDP J51 - 52		TERMINATE
ML	RTN	2S16	53	PSDP J51 - 53		
ML	SIG	2S16	54	PSDP J51 - 54		
ML	SHD	2S16	55	PSDP J51 - 55		TERMINATE
ML	SIG	2S6	56	PSDP J51 - 56		
ML	RTN	2S6	57	PSDP J51 - 57		
ML	SHD	2S6	58	PSDP J51 - 58		TERMINATE
ML	SIG	2S5	59	PSDP J51 - 59		
ML	RTN	2S5	60	PSDP J51 - 60		
ML	SHD	2S5	61	PSDP J51 - 61		TERMINATE
ML	SIG	2S11	62	PSDP J51 - 62		
ML	RTN	2S11	63	PSDP J51 - 63		
ML	SHD	2S11	64	PSDP J51 - 64		TERMINATE
ML	RTN	2S18	65	PSDP J51 - 65		
ML	SIG	2S18	66	PSDP J51 - 66		
ML	SHD	2S18	67	PSDP J51 - 67		TERMINATE
ML	RTN	2S21	68	PSDP J51 - 68		
ML	SIG	2S21	69	PSDP J51 - 69		
ML	SHD	2S21	70	PSDP J51 - 70		TERMINATE
ML	SIG	2S19	71	PSDP J51 - 71		
ML	RTN	2S19	72	PSDP J51 - 72		
ML	SHD	2S19	73	PSDP J51 - 73		TERMINATE
ML	SIG	2S20	74	PSDP J51 - 74		
ML	RTN	2S20	75	PSDP J51 - 75		
ML	SHD	2S20	76	PSDP J51 - 76		TERMINATE
ML	RTN	2S22	77	PSDP J51 - 77		
ML	SIG	2S22	78	PSDP J51 - 78		
ML	SHD	2S22	79	PSDP J51 - 79		TERMINATE

TABLE 13.6.2.4-3 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J61

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	RTN	2S1	1	PSDP J45 - 35		
ML	SIG	2S1	2	PSDP J45 - 36		
ML	SHD	2S1	3	PSDP J45 - 37		TERMINATE
ML	SIG	2S12	4	PSDP J45 - 8		
ML	SHD	2S12	5	PSDP J45 - 10		TERMINATE
ML	SIG	2S14	6	PSDP J45 - 11		
ML	RTN	2S14	7	PSDP J45 - 12		
ML	SHD	2S14	8	PSDP J45 - 38		TERMINATE
ML	SIG	2S17	9	PSDP J45 - 32		
ML	RTN	2S17	10	PSDP J45 - 33		
ML	SHD	2S17	11	PSDP J45 - 34		TERMINATE
ML	SHD	2S19	12	PSDP J45 - 21		TERMINATE
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
			17			NOT WIRED
			18			NOT WIRED
			19			NOT WIRED
			20			NOT WIRED
			21			NOT WIRED
			22			NOT WIRED
			23			NOT WIRED
			24			NOT WIRED
			25			NOT WIRED
ML	SHD	2S3	26	PSDP J45 - 58		TERMINATE
ML	RTN	2S3	27	PSDP J45 - 57		
ML	SIG	2S2	28	PSDP J45 - 47		
ML	RTN	2S2	29	PSDP J45 - 46		
ML	SHD	2S2	30	PSDP J45 - 65		TERMINATE
ML	SIG	2S8	31	PSDP J45 - 26		
ML	RTN	2S12	32	PSDP J45 - 9		
ML	SIG	2S13	33	PSDP J45 - 19		
ML	RTN	2S13	34	PSDP J45 - 18		
ML	SIG	2S15	35	PSDP J45 - 13		
ML	RTN	2S15	36	PSDP J45 - 14		
ML	SIG	2S19	37	PSDP J45 - 44		
ML	RTN	2S19	38	PSDP J45 - 45		
			39			NOT WIRED
			40			NOT WIRED
			41			NOT WIRED
ML	SIG	2S21	42	PSDP J45 - 74		
ML	RTN	2S21	43	PSDP J45 - 75		
ML	SHD	2S20	44	PSDP J45 - 55		TERMINATE
ML	RTN	2S7	45	PSDP J45 - 72		

TABLE 13.6.2.4-3 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J61

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
ML	SIG	2S7	46	PSDP J45 - 71		
ML	SHD	2S6	47	PSDP J45 - 61		TERMINATE
ML	RTN	2S4	48	PSDP J45 - 69		
ML	SIG	2S4	49	PSDP J45 - 68		
ML	SIG	2S3	50	PSDP J45 - 56		
ML	SIG	2S5	51	PSDP J45 - 48		
ML	SHD	2S8	52	PSDP J45 - 25		TERMINATE
ML	RTN	2S8	53	PSDP J45 - 27		
ML	SHD	2S9	54	PSDP J45 - 1		TERMINATE
ML	SHD	2S13	55	PSDP J45 - 20		TERMINATE
ML	SHD	2S15	56	PSDP J45 - 15		TERMINATE
ML	SHD	2S16	57	PSDP J45 - 2		TERMINATE
ML	RTN	2S16	58	PSDP J45 - 31		
ML	RTN	2S18	59	PSDP J45 - 42		
ML	SHD	2S21	60	PSDP J45 - 76		TERMINATE
ML	SIG	2S20	61	PSDP J45 - 53		
ML	RTN	2S20	62	PSDP J45 - 54		
ML	SHD	2S7	63	PSDP J45 - 73		TERMINATE
ML	RTN	2S6	64	PSDP J45 - 60		
ML	SIG	2S6	65	PSDP J45 - 59		
ML	SHD	2S4	66	PSDP J45 - 70		TERMINATE
ML	RTN	2S5	67	PSDP J45 - 49		
ML	SHD	2S5	68	PSDP J45 - 66		TERMINATE
ML	SIG	2S9	69	PSDP J45 - 28		
ML	RTN	2S9	70	PSDP J45 - 29		
ML	SIG	2S16	71	PSDP J45 - 30		
ML	SIG	2S18	72	PSDP J45 - 41		
ML	SHD	2S18	73	PSDP J45 - 43		TERMINATE
ML	RTN	2S11	74	PSDP J45 - 63		
ML	SIG	2S11	75	PSDP J45 - 62		
ML	SHD	2S11	76	PSDP J45 - 64		TERMINATE
ML	SIG	2S10	77	PSDP J45 - 50		
ML	SHD	2S10	78	PSDP J45 - 52		TERMINATE
ML	RTN	2S10	79	PSDP J45 - 51		

TABLE 13.6.2.4-4 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J57

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			1			NOT WIRED
			2			NOT WIRED
			3			NOT WIRED
			4			NOT WIRED
			5			NOT WIRED
			6			NOT WIRED
			7			NOT WIRED
			8			NOT WIRED
			9			NOT WIRED
			10			NOT WIRED
			11			NOT WIRED
			12			NOT WIRED
			13			NOT WIRED
			14			NOT WIRED
			15			NOT WIRED
			16			NOT WIRED
HO	SIG	2T19	17	PSDP J17 - 14		
HO	RTN	2T19	18	PSDP J17 - 15		
HO	SIG	2T20	19	PSDP J17 - 12		
HO	RTN	2T20	20	PSDP J17 - 13		
HO	SIG	2T21	21	PSDP J17 - 10		
HO	RTN	2T21	22	PSDP J17 - 11		
HO	SIG	2T22	23	PSDP J17 - 8		
HO	RTN	2T22	24	PSDP J17 - 9		
HO	RTN	2T8	25	PSDP J17 - 37		
HO	SIG	2T9	26	PSDP J17 - 34		
HO	RTN	2T9	27	PSDP J17 - 35		
HO	SIG	2T10	28	PSDP J17 - 32		
HO	RTN	2T10	29	PSDP J17 - 33		
HO	SIG	2T11	30	PSDP J17 - 30		
HO	RTN	2T11	31	PSDP J17 - 31		
HO	SIG	2T8	32	PSDP J17 - 36		
HO	RTN	2T12	33	PSDP J17 - 29		
HO	SIG	2T13	34	PSDP J17 - 26		
HO	RTN	2T13	35	PSDP J17 - 27		
HO	SIG	2T14	36	PSDP J17 - 24		
HO	RTN	2T14	37	PSDP J17 - 25		
HO	SIG	2T15	38	PSDP J17 - 22		
HO	RTN	2T15	39	PSDP J17 - 23		
HO	SIG	2T12	40	PSDP J17 - 28		
HO	SIG	2T16	41	PSDP J17 - 20		
HO	RTN	2T16	42	PSDP J17 - 21		
HO	SIG	2T17	43	PSDP J17 - 18		
HO	RTN	2T17	44	PSDP J17 - 19		
HO	SIG	2T18	45	PSDP J17 - 16		
HO	RTN	2T18	46	PSDP J17 - 17		

TABLE 13.6.2.4-4 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J57

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			47			NOT WIRED
			48			NOT WIRED
			49			NOT WIRED
			50			NOT WIRED
			51			NOT WIRED
			52			NOT WIRED
			53			NOT WIRED
			54			NOT WIRED
			55			NOT WIRED

TABLE 13.6.2.4-5 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J9575

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
			A			NOT WIRED
			B			NOT WIRED
			C			NOT WIRED
HO	SIG	1SC	D	END EFFECTOR # 16 (PORT)		
HO	SIG	1SC	E	END EFFECTOR # 15 (PORT)		
HO	SIG	1SC	F	END EFFECTOR # 14 (PORT)		
ML	SIG	2S3	G	END EFFECTOR # 8 (PORT)		
ML	RTN	2S3	H	END EFFECTOR # 7 (PORT)		
ML	SHD	2S3	J			TERMINATE
ML	SIG	2S1	K	END EFFECTOR # 8 (STARBOARD)		
ML	RTN	2S1	L	END EFFECTOR # 7 (STARBOARD)		
ML	SHD	2S1	M			TERMINATE
HO	SIG	1SC	N	END EFFECTOR # 14 (STARBOARD)		
HO	SIG	1SC	P	END EFFECTOR # 15 (STARBOARD)		
HO	SIG	1SC	R	END EFFECTOR # 16 (STARBOARD)		
			S			NOT WIRED
			T			NOT WIRED
			U			NOT WIRED
			V			NOT WIRED
ML	SIG	4S2	W	END EFFECTOR # 12 (PORT)		
ML	SIG	4S2	X	END EFFECTOR # 11 (PORT)		
HO	SIG	1SC	Y	END EFFECTOR # 13 (PORT)		
HO	RTN	1SC	Z	XFR RLY CTRL RTN (PORT)		1
HO	SIG	1SC	a	XFR RLY CTRL +28 VDC (PORT)		1
ML	SIG	2S4	b	END EFFECTOR # 6 (PORT)		
ML	RTN	2S4	c	END EFFECTOR # 5 (PORT)		
ML	SHD	2S4	d			TERMINATE
			e			NOT WIRED
ML	SIG	2S2	f	END EFFECTOR # 6 (STARBOARD)		
ML	RTN	2S2	g	END EFFECTOR # 5 (STARBOARD)		
ML	SHD	2S2	h			TERMINATE
HO	SIG	1SC	i	XFR RLY CTRL +28 VDC (STBD)		1
HO	RTN	1SC	j	XFR RLY CTRL RTN (STBD)		1
HO	SIG	1SC	k	END EFFECTOR # 13 (STARBOARD)		
ML	SIG	4S1	m	END EFFECTOR # 11 (STARBOARD)		
ML	RTN	4S1	n	END EFFECTOR # 12 (STARBOARD)		
			p			NOT WIRED
ML	SIG	4S2	q	END EFFECTOR # 10 (PORT)		
ML	RTN	4S2	r	END EFFECTOR # 9 (PORT)		
HO	RTN	4T2	s	END EFFECTOR # 4 (PORT)		
HO	SIG	4T2	t	END EFFECTOR # 3 (PORT)		
HO	SIG	4T2	u	END EFFECTOR # 2 (PORT)		
			v			NOT WIRED
HO	SIG	4T1	w	END EFFECTOR # 2 (STARBOARD)		
HO	SIG	4T1	x	END EFFECTOR # 3 (STARBOARD)		

TABLE 13.6.2.4-5 PIN ASSIGNMENTS FOR OOSDP CONNECTOR J9575

EMC CLASS.	PIN FUNCT.	CABLE DESCR.	PIN #	SIGNAL FUNCTION OR PANEL TERMINATION - PIN #	REFERENCE PARAGRAPH	ORBITER COMPONENT INTERFACE AND/OR NOTES
HO	SIG	4T1	y	END EFFECTOR # 4 (STARBOARD)		
ML	SIG	4S1	z	END EFFECTOR # 9 (STARBOARD)		
ML	SIG	4S1	AA	END EFFECTOR # 10 (STARBOARD)		
			BB			NOT WIRED
ML	SHD	4S2	CC			TERMINATE
HO	SIG	4T2	DD	END EFFECTOR # 1 (PORT)		
			EE			NOT WIRED
HO	RTN	4T1	FF	END EFFECTOR # 1 (STARBOARD)		
ML	SHD	4S1	GG			TERMINATE
			HH			NOT WIRED

Note:

(1) Transfer relay activation delivers Orbiter Main Bus A RMS power to the payload at RMS PJ411 I/F (SPREE Pwr)

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A

ABBREVIATIONS AND ACRONYMS

APPENDIX A

ABBREVIATIONS AND ACRONYMS

AA	Air to Air
AC	Alternating Current
ACCN	Audio Central Control Network
AF	Audio Frequency
AFD	Aft Flight Deck
AG	Air to Ground
AID	Analog Inputs, Differential
A/L	Airlock
AM	Amplitude Modulation
AOA	Abort Once Around
AOD	Analog Output, Differential
ARS	Atmospheric Revitalization System
ASE	Airborne Support Equipment
ATCS	Active Thermal Control System
AUX	Auxiliary
BCT	Bit Cell Time
BER	Bit Error Rate
BITE	Built-in Test Equipment
BOT	Beginning of Tape
bps	Bits per Second
BSR	BITE Status Request
BTU	Bus Terminal Unit
CCTV	Closed Circuit Television
CCW	Counter Clockwise
CPC	Cargo Processing Contractor
CDW	Command Data Word
CE	Cargo Element
CG	Center-of-Gravity
CMRR	Common Mode Rejection Ratio
CMV	Common Mode Voltage
COAX	Coaxial, Coaxial Cable
CRYO	Cryogenic
CW	Clockwise
CW	Command Word
CWEA	Caution and Warning Electronics Assembly
DAP	Digital Autopilot
D&C	Display and Control
dB	Decibels
DBC	Data Bus Coupler
DBIA	Data Bus Isolation Amplifier
DBS	Data Bus System
DC	Direct Current
DIH	Discrete Input, High Level
DIL	Discrete Inputs, Low Level
DOD	Department of Defense
DOH	Discrete Outputs, High Level
DOL	Discrete Outputs, Low Level

DP	Deployment Panel
DP	Double Precision Floating Point
DSN	Deep Space Network
EDO	Extended Duration Orbiter
EED	Electrical Explosive Device
EIRP	Effective Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EMEC	Electromagnetic Effects Compatibility
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EOT	End of Tape
EPDS	Electrical Power Distribution System
ET	External Tank
ETR	Eastern Test Range
EU	Engineering Unit
EVA	Extravehicular Activity
FCS	Flight Control System
FM	Frequency Modulation
FPV	Flow Proportioning Valve
FS	Full Scale
FSK	Frequency Shift Keyed
GMT	Greenwich Mean Time
GN2	Gaseous Nitrogen
GN&C	Guidance, Navigation and Control
GND	Ground
GPC	General Purpose Computer
GSE	Ground Support Equipment
HE	Heat Exchanger
HEPA	High Efficiency Particle Arrestor
Hz	Hertz
I/CA	Intercom A
I/CB	Intercom B
I/F	Interface
I/O	Input/Output
I/OM	Input/Output Module
IPS	Inches per Second
IVA	Intravehicular Activity
JSC	Lyndon B. Johnson Space Center
kbps	Kilobits per Second
kg	Kilograms
klb	Kilopounds
KSC	Kennedy Space Center
kWh	Kilowatt Hours
LED	Light Emitting Diode
LHCP	Left Hand Circularly Polarized
L-L	Line-to-Line
LOS	Line of Sight

LPS	Launch Processing System
LRU	Line Replaceable Unit
LVLH	Local Vertical/Local Horizontal
mbps	Million Bits per Second
MDM	Multiplexer/Demultiplexer
ME	Main Engine
MECO	Main Engine Cutoff
MET	Mission Elapsed Time
MHz	Megahertz
MIA	Multiplexer Interface Adapter
MML	Master Measurement List
MMU	Manned Maneuvering Unit
MMU	Modular Memory Unit
MPC	Manual Pointing Controller
M/S	Mission Station
MSB	Most Significant Bit
MSDP	Mission Station Distribution Panel
MTU	Master Timing Unit
MPG	Multiple Point Ground
N/A	Not Applicable
NM	Nautical Miles
N/m2	Newton per Square Meter
NRZ	Non-Return to Zero
OA	Overall
OMCF	Orbiter Maintenance and Checkout Facility
OMS	Orbital Manuevering System
OOS	On-Orbit Station
OOSDP	On-Orbit Station Distribution Panel
OPF	Orbit Processing Facility
PCM	Pulse Code Modulation
PCMMU	Pulse Code Modulation Master Unit
PCR	Payload Changeout Room
PDI	Payload Data Interleaver
PDRS	Payload Deployment and Retrieval System
PGHM	Payload Ground Handling Mechanism
P/L	Payload
PM	Pulse Modulated
P-P	Peak to Peak
PPS	Pulses per Second
PRCB	Program Requirements Control Board
PRCBD	Program Requirements Control Board Directive
PRCS	Primary Reaction Control System
PRI	Primary
PROM	Programmable Read Only Memory
PRSD	Power Reactant Storage and Distribution System
PS	Payload Station
PSDP	Payload Station Distribution Panel
PSK	Phase Shift Keyed
PSP	Payload Signal Processor
PTB	Payload Timing Buffer
PWR	Power

RAM	Random Access Memory
RCD	Record
RCS	Reaction Control System
RCVR	Receiver
RDW	Response Data Word
RF	Radio Frequency
RFI	Radio Frequency Interference
RHCP	Right Hand Circularly Polarized
RMS	Remote Manipulator System
rms	Root Mean Square
RPH	Revolutions per Hour
RSS	Rotating Service Structure
RTLS	Return to Launch Site
SAB	Shuttle Assembly Building
S/C	Subcarrier
SGLS	Space Ground Link Station
SIO	Serial Input/Output
SMCH	Standard Mixed Cargo Harness
SNR	Signal-to-Noise Ratio
SP	Single Precision, Floating Point
SPA	Signal Processor Assembly
SPDCI	Standard Payload Display and Control Interface
SPG	Single Point Ground
SRB	Solid Rocket Booster
SSP	Standard Switch Panel
STDN	Spaceflight Tracking and Data Network
STS	Space Transportation System
T-0	T minus Zero, Time of Launch
T-4	4 Hours Prior to Launch
TAEM	Terminal Approach Energy Management
TBD	To Be Determined
TDRS	Tracking and Data Relay Satellite
TDRSS	TDRS System
TEC	Time Executed Command
TOD	Greenwich True-of-Date Cartesian Coordinate
TSP	Twisted Shielded Pair
TTL	Transistor-to-Transistor Logic
TVMP	TV Monitor Panel
TW	Twisted
TWDS	Twisted Double Shielded
TWS	Twisted Shielded
VA	Volt-Amperes
VAB	Vehicle Assembly Building
VCM	Volatile Condensible Material
VRCS	Vernier RCS
WPS	Words per Second

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX C

CHANNEL AND FREQUENCY ASSIGNMENTS

APPENDIX C

CHANNEL AND FREQUENCY ASSIGNMENTS

C.1 STDN CHANNEL AND FREQUENCY ASSIGNMENTS. Specific STDN channel and frequency assignments are listed in Table C.1-1. (Reference Paragraph 8.3.1)

C.2 NASA/DSN AND DOD/SGLS CHANNEL AND FREQUENCY ASSIGNMENTS. Specific NASA/DSN channel and frequency assignments are listed in Table C.2-1. Specific DOD/SGLS channel and frequency assignments are listed in Table C.2-2.

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
1	2025.833333	2025.833400	2200.000
2	2025.948437	2025.948504	2200.125
3	2026.063542	2026.063608	2200.250
4	2026.178646	2026.178712	2200.375
5	2026.293750	2026.293816	2200.500
6	2026.408854	2026.408920	2200.625
7	2026.523958	2026.524024	2200.750
8	2026.639062	2026.639128	2200.875
9	2026.754167	2026.754232	2201.000
10	2026.869271	2026.869336	2201.125
11	2026.984375	2026.984440	2201.250
12	2027.099479	2027.099544	2201.375
13	2027.214583	2027.214648	2201.500
14	2027.329687	2027.329752	2201.625
15	2027.444792	2027.444856	2201.750
16	2027.559896	2027.559960	2201.875
17	2027.675000	2027.675064	2202.000
18	2027.790104	2027.790168	2202.125
19	2027.905208	2027.905272	2202.250
20	2028.020312	2028.020376	2202.375
21	2028.135417	2028.135480	2202.500
22	2028.250521	2028.250584	2202.625
23	2028.365625	2028.365688	2202.750
24	2028.480729	2028.480792	2202.875
25	2028.595833	2028.595896	2203.000
26	2028.710937	2028.711000	2203.125
27	2028.826042	2028.826104	2203.250
28	2028.941146	2028.941208	2203.375
29	2029.056250	2029.056312	2203.500
30	2029.171354	2029.171416	2203.625
31	2029.286458	2029.286520	2203.750
32	2029.401562	2029.401624	2203.875
33	2029.516667	2029.516728	2204.000
34	2029.631771	2029.631832	2204.125
35	2029.746875	2029.746936	2204.250
36	2029.861979	2029.862040	2204.375
37	2029.977083	2029.977144	2204.500
38	2030.092187	2030.092248	2204.625
39	2030.207292	2030.207352	2204.750
40	2030.322396	2030.322456	2204.875
41	2030.437500	2030.437560	2205.000
42	2030.552604	2030.552664	2205.125
43	2030.667708	2030.667768	2205.250
44	2030.782812	2030.782872	2205.375
45	2030.897917	2030.897976	2205.500

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
46	2031.013021	2031.013080	2205.625
47	2031.128125	2031.128184	2205.750
48	2031.243229	2031.243288	2205.875
49	2031.358333	2031.358392	2206.000
50	2031.473437	2031.473496	2206.125
51	2031.588542	2031.588600	2206.250
52	2031.703646	2031.703704	2206.375
53	2031.818750	2031.818808	2206.500
54	2031.933854	2031.933912	2206.625
55	2032.048958	2032.049016	2206.750
56	2032.164062	2032.164120	2206.875
57	2032.279167	2032.279224	2207.000
58	2032.394271	2032.394328	2207.125
59	2032.509375	2032.509432	2207.250
60	2032.624479	2032.624536	2207.375
61	2032.739583	2032.739640	2207.500
62	2032.854687	2032.854744	2207.625
63	2032.969792	2032.969848	2207.750
64	2033.084896	2033.084952	2207.875
65	2033.200000	2033.200056	2208.000
66	2033.315104	2033.315160	2208.125
67	2033.430208	2033.430264	2208.250
68	2033.545312	2033.545368	2208.375
69	2033.660417	2033.660472	2208.500
70	2033.775521	2033.775576	2208.625
71	2033.890625	2033.890680	2208.750
72	2034.005729	2034.005784	2208.875
73	2034.120833	2034.120888	2209.000
74	2034.235937	2034.235992	2209.125
75	2034.351042	2034.351096	2209.250
76	2034.466146	2034.466200	2209.375
77	2034.581250	2034.581304	2209.500
78	2034.696354	2034.696408	2209.625
79	2034.811458	2034.811512	2209.750
80	2034.926562	2034.926616	2209.875
81	2035.041667	2035.041720	2210.000
82	2035.156771	2035.156824	2210.125
83	2035.271875	2035.271928	2210.250
84	2035.386979	2035.387032	2210.375
85	2035.502083	2035.502136	2210.500
86	2035.617187	2035.617240	2210.625
87	2035.732292	2035.732344	2210.750
88	2035.847396	2035.847448	2210.875
89	2035.962500	2035.962552	2211.000
90	2036.077604	2036.077656	2211.125

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
91	2036.192708	2036.192760	2211.250
92	2036.307812	2036.307864	2211.375
93	2036.422917	2036.422968	2211.500
94	2036.538021	2036.538072	2211.625
95	2036.653125	2036.653176	2211.750
96	2036.768229	2036.768280	2211.875
97	2036.883333	2036.883384	2212.000
98	2036.998437	2036.998488	2212.125
99	2037.113542	2037.113592	2212.250
100	2037.228646	2037.228696	2212.375
101	2037.343750	2037.343800	2212.500
102	2037.458854	2037.458904	2212.625
103	2037.573958	2037.574008	2212.750
104	2037.689062	2037.689112	2212.875
105	2037.804167	2037.804216	2213.000
106	2037.919271	2037.919320	2213.125
107	2038.034375	2038.034424	2213.250
108	2038.149479	2038.149528	2213.375
109	2038.264583	2038.264632	2213.500
110	2038.379687	2038.379736	2213.625
111	2038.494792	2038.494840	2213.750
112	2038.609896	2038.609944	2213.875
113	2038.725000	2038.725048	2214.000
114	2038.840104	2038.840152	2214.125
115	2038.955208	2038.955256	2214.250
116	2039.070312	2039.070360	2214.375
117	2039.185417	2039.185464	2214.500
118	2039.300521	2039.300568	2214.625
119	2039.415625	2039.415672	2214.750
120	2039.530729	2039.530776	2214.875
121	2039.645833	2039.645880	2215.000
122	2039.760937	2037.760984	2215.125
123	2039.876042	2039.876088	2215.250
124	2039.991146	2039.991192	2215.375
125	2040.106250	2040.106296	2215.500
126	2040.221354	2040.221400	2215.625
127	2040.336458	2040.336504	2215.750
128	2040.451562	2040.451608	2215.875
129	2040.566667	2040.566712	2216.000
130	2040.681771	2040.681816	2216.125
131	2040.796875	2040.796920	2216.250
132	2040.911979	2040.912024	2216.375
133	2041.027083	2041.027128	2216.500
134	2041.142187	2041.142232	2216.625
135	2041.257292	2041.257336	2216.750

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
136	2041.372396	2041.372440	2216.875
137	2041.487500	2041.487544	2217.000
138	2041.602604	2041.602648	2217.125
139	2041.717708	2041.717752	2217.250
140	2041.832812	2041.832856	2217.375
141	2041.947917	2041.947960	2217.500
142	2041.063021	2041.063064	2217.625
143	2042.178125	2042.178168	2217.750
144	2042.293229	2042.293272	2217.875
145	2042.408333	2042.408376	2218.000
146	2042.523437	2042.523480	2218.125
147	2042.638542	2042.638584	2218.250
148	2042.753646	2042.753688	2218.375
149	2042.868750	2042.868792	2218.500
150	2042.983854	2042.983896	2218.625
151	2043.098958	2043.099000	2218.750
152	2043.214062	2043.214104	2218.875
153	2043.329167	2043.329208	2219.000
154	2043.444271	2043.444312	2219.125
155	2043.559375	2043.559416	2219.250
156	2043.674479	2043.674520	2219.375
157	2043.789583	2043.789624	2219.500
158	2043.904687	2043.904728	2219.625
159	2044.019792	2044.019832	2219.750
160	2044.134896	2044.134936	2219.875
161	2044.250000	2044.250040	2220.000
162	2044.365104	2044.365144	2220.125
163	2044.480208	2044.480248	2220.250
164	2044.595312	2044.595352	2220.375
165	2044.710417	2044.710456	2220.500
166	2044.825521	2044.825560	2220.625
167	2044.940625	2044.940664	2220.750
168	2045.055729	2045.055768	2220.875
169	2045.170833	2045.170872	2221.000
170	2045.285937	2045.285976	2221.125
171	2045.401042	2045.401080	2221.250
172	2045.516146	2045.516184	2221.375
173	2045.631250	2045.631288	2221.500
174	2045.746354	2045.746392	2221.625
175	2045.861458	2045.861496	2221.750
176	2045.976562	2045.976600	2221.875
177	2046.091667	2046.091704	2222.000
178	2046.206771	2046.206808	2222.125
179	2046.321875	2046.321912	2222.250
180	2046.436979	2046.437016	2222.375

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
181	2046.552083	2046.552120	2222.500
182	2046.667187	2046.667224	2222.625
183	2046.782292	2046.782328	2222.750
184	2046.897396	2046.897432	2222.875
185	2047.012500	2047.012536	2223.000
186	2047.127604	2047.127640	2223.125
187	2047.242708	2047.242744	2223.250
188	2047.357812	2047.357848	2223.375
189	2047.472917	2047.472952	2223.500
190	2047.588021	2047.588056	2223.625
191	2047.703125	2047.703160	2223.750
192	2047.818229	2047.818264	2223.875
193	2047.933333	2047.933368	2224.000
194	2048.048437	2048.048472	2224.125
195	2048.163542	2048.163576	2224.250
196	2048.278646	2048.278680	2224.375
197	2048.393750	2048.393784	2224.500
198	2048.508854	2048.508888	2224.625
199	2048.623958	2048.623992	2224.750
200	2048.739062	2048.739096	2224.875
201	2048.854167	2048.854200	2225.000
202	2048.969271	2048.969304	2225.125
203	2049.084375	2049.084408	2225.250
204	2049.199479	2049.199512	2225.375
205	2049.314583	2049.314616	2225.500
206	2049.429687	2049.429720	2225.625
207	2049.544792	2049.544824	2225.750
208	2049.659896	2049.659928	2225.875
209	2049.775000	2049.775032	2226.000
210	2049.890104	2049.890136	2226.125
211	2050.005208	2050.005240	2226.250
212	2050.120312	2050.120344	2226.375
213	2050.235417	2050.235448	2226.500
214	2050.350521	2050.350552	2226.625
215	2050.465625	2050.465656	2226.750
216	2050.580729	2050.580760	2226.875
217	2050.695833	2050.695864	2227.000
218	2050.810937	2050.810968	2227.125
219	2050.926042	2050.926072	2227.250
220	2051.041146	2051.041176	2227.375
221	2051.156250	2051.156280	2227.500
222	2051.271354	2051.271384	2227.625
223	2051.386458	2051.386488	2227.750
224	2051.501562	2051.501592	2227.875
225	2051.616667	2051.616696	2228.000

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
226	2051.731771	2051.731800	2228.125
227	2051.846875	2051.846904	2228.250
228	2051.961979	2051.962008	2228.375
229	2052.077083	2052.077112	2228.500
230	2052.192187	2052.192216	2228.625
231	2052.307292	2052.307320	2228.750
232	2052.422396	2052.422424	2228.875
233	2052.537500	2052.537528	2229.000
234	2052.652604	2052.652632	2229.125
235	2052.767708	2052.767736	2229.250
236	2052.882812	2052.882840	2229.375
237	2052.997917	2052.997944	2229.500
238	2053.113021	2053.113048	2229.625
239	2053.228125	2053.228152	2229.750
240	2053.343229	2053.343256	2229.875
241	2053.458333	2053.458360	2230.000
242	2053.573437	2053.573464	2230.125
243	2053.688542	2053.688568	2230.250
244	2053.803646	2053.803672	2230.375
245	2053.918750	2053.918776	2230.500
246	2054.033854	2054.033880	2230.625
247	2054.148958	2054.148984	2230.750
248	2054.264062	2054.264088	2230.875
249	2054.379167	2054.379192	2231.000
250	2054.494271	2054.494296	2231.125
251	2054.609375	2054.609400	2231.250
252	2054.724479	2054.724504	2231.375
253	2054.839583	2054.839608	2231.500
254	2054.954687	2054.954712	2231.625
255	2055.069792	2055.069816	2231.750
256	2055.184896	2055.184920	2231.875
257	2055.300000	2055.300024	2232.000
258	2055.415104	2055.415128	2232.125
259	2055.530208	2055.530232	2232.250
260	2055.645312	2055.645336	2232.375
261	2055.760417	2055.760440	2232.500
262	2055.875521	2055.875544	2232.625
263	2055.990625	2055.990648	2232.750
264	2056.105729	2056.105752	2232.875
265	2056.220833	2056.220856	2233.000
266	2056.335937	2056.335960	2233.125
267	2056.451042	2056.451064	2233.250
268	2056.566146	2056.566168	2233.375
269	2056.681250	2056.681272	2233.500
270	2056.796354	2056.796376	2233.625

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
271	2056.911458	2056.911480	2233.750
272	2057.026562	2057.026584	2233.875
273	2057.141667	2057.141688	2234.000
274	2057.256771	2057.256792	2234.125
275	2057.371875	2057.371896	2234.250
276	2057.486979	2057.487000	2234.375
277	2057.602083	2057.602104	2234.500
278	2057.717187	2057.717208	2234.625
279	2057.832292	2057.832312	2234.750
280	2057.947396	2057.947416	2234.875
281	2058.062500	2058.062520	2235.000
282	2058.177604	2058.177624	2235.125
283	2058.292708	2058.292728	2235.250
284	2058.407812	2058.407832	2235.375
285	2058.522917	2058.522936	2235.500
286	2058.638021	2058.638040	2235.625
287	2058.753125	2058.753144	2235.750
288	2058.868229	2058.868248	2235.875
289	2058.983333	2058.983352	2236.000
290	2059.098437	2059.098456	2236.125
291	2059.213542	2059.213560	2236.250
292	2059.328646	2059.328664	2236.375
293	2059.443750	2059.443768	2236.500
294	2059.558854	2059.558872	2236.625
295	2059.673958	2059.673976	2236.750
296	2059.789062	2059.789080	2236.875
297	2059.904167	2059.904184	2237.000
298	2060.019271	2060.019288	2237.125
299	2060.134375	2060.134392	2237.250
300	2060.249479	2060.249496	2237.375
301	2060.364583	2060.364600	2237.500
302	2060.479687	2060.479704	2237.625
303	2060.594792	2060.594808	2237.750
304	2060.709896	2060.709912	2237.875
305	2060.825000	2060.825016	2238.000
306	2060.940104	2060.940120	2238.125
307	2061.055208	2061.055224	2238.250
308	2061.170312	2061.170328	2238.375
309	2061.285417	2061.285432	2238.500
310	2061.400521	2061.400536	2238.625
311	2061.515625	2061.515640	2238.750
312	2061.630729	2061.630744	2238.875
313	2061.745833	2061.745848	2239.000
314	2061.860937	2061.860952	2239.125
315	2061.976042	2061.976056	2239.250

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
316	2062.091146	2062.091160	2239.375
317	2062.206250	2062.206264	2239.500
318	2062.321354	2062.321368	2239.625
319	2062.436458	2062.436472	2239.750
320	2062.551562	2062.551576	2239.875
321	2062.666667	2062.666680	2240.000
322	2062.781771	2062.781784	2240.125
323	2062.896875	2062.896888	2240.250
324	2063.011979	2062.011992	2240.375
325	2063.127083	2062.127096	2240.500
326	2063.242187	2062.242200	2240.625
327	2063.357292	2062.357304	2240.750
328	2063.472396	2062.472408	2240.875
329	2063.587500	2062.587512	2241.000
330	2063.702604	2063.702616	2241.125
331	2063.817708	2063.817720	2241.250
332	2063.932812	2063.932824	2241.375
333	2064.047917	2064.047928	2241.500
334	2064.163021	2064.163032	2241.625
335	2064.278125	2064.278136	2241.750
336	2064.393229	2064.393240	2241.875
337	2064.508333	2064.508344	2242.000
338	2064.623437	2064.623448	2242.125
339	2064.738542	2064.738552	2242.250
340	2064.853646	2064.853656	2242.375
341	2064.968750	2064.968760	2242.500
342	2065.083854	2065.083864	2242.625
343	2065.198958	2065.198968	2242.750
344	2065.314062	2065.314072	2242.875
345	2065.429167	2065.429176	2243.000
346	2065.544271	2065.544280	2243.125
347	2065.659375	2065.659384	2243.250
348	2065.774479	2065.774488	2243.375
349	2065.889583	2065.889592	2243.500
350	2066.004687	2066.004696	2243.625
351	2066.119792	2066.119800	2243.750
352	2066.234896	2066.234904	2243.875
353	2066.350000	2066.350008	2244.000
354	2066.465104	2066.465112	2244.125
355	2066.580208	2066.580216	2244.250
356	2066.695312	2066.695320	2244.375
357	2066.810417	2066.810424	2244.500
358	2066.925521	2066.925528	2244.625
359	2067.040625	2067.040632	2244.750
360	2067.155729	2067.155736	2244.875

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
361	2067.270833	2067.270840	2245.000
362	2067.385937	2067.385944	2245.125
363	2067.501042	2067.501048	2245.250
364	2067.616146	2067.616152	2245.375
365	2067.731250	2067.731256	2245.500
366	2067.846354	2067.846360	2245.625
367	2067.961458	2067.961464	2245.750
368	2068.076562	2068.076568	2245.875
369	2068.191667	2068.191672	2246.000
370	2068.306771	2068.306776	2246.125
371	2068.421875	2068.421880	2246.250
372	2068.536979	2068.536984	2246.375
373	2068.652083	2068.652088	2246.500
374	2068.767187	2068.767192	2246.625
375	2068.882292	2068.882296	2246.750
376	2068.997396	2068.997400	2246.875
377	2069.112500	2069.112504	2247.000
378	2069.227604	2069.227608	2247.125
379	2069.342708	2069.342712	2247.250
380	2069.457812	2069.457816	2247.375
381	2069.572917	2069.572920	2247.500
382	2069.688021	2069.688024	2247.625
383	2069.803125	2069.803128	2247.750
384	2069.918229	2069.918232	2247.875
385	2070.033333	2070.033336	2248.000
386	2070.148437	2070.148440	2248.125
387	2070.263542	2070.263544	2248.250
388	2070.378646	2070.378648	2248.375
389	2070.493750	2070.493752	2248.500
390	2070.608854	2070.608856	2248.625
391	2070.723958	2070.723960	2248.750
392	2070.839062	2070.839064	2248.875
393	2070.954167	2070.954168	2249.000
394	2071.069271	2071.069272	2249.125
395	2071.184375	2071.184376	2249.250
396	2071.299479	2071.299480	2249.375
397	2071.414583	2071.414584	2249.500
398	2071.529687	2071.529688	2249.625
399	2071.644792	2071.644792	2249.750
400	2071.759896	2071.759896	2249.875
401	2071.875000	2071.875000	2250.000
402	2071.990104	2071.990104	2250.125
403	2072.105208	2072.105208	2250.250
404	2072.220312	2072.220312	2250.375
405	2072.335417	2072.335416	2250.500

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
406	2072.450521	2072.450520	2250.625
407	2072.565625	2072.565624	2250.750
408	2072.680729	2072.680728	2250.875
409	2072.795833	2072.795832	2251.000
410	2072.910937	2072.910936	2251.125
411	2073.026042	2073.026040	2251.250
412	2073.141146	2073.141144	2251.375
413	2073.256250	2073.256248	2251.500
414	2073.371354	2073.371352	2251.625
415	2073.486458	2073.486456	2251.750
416	2073.601562	2073.601560	2251.875
417	2073.716667	2073.716664	2252.000
418	2073.831771	2073.831768	2252.125
419	2073.946875	2073.946872	2252.250
420	2074.061979	2074.061976	2252.375
421	2074.177083	2074.177080	2252.500
422	2074.292187	2074.292184	2252.625
423	2074.407292	2074.407288	2252.750
424	2074.522396	2074.522392	2252.875
425	2074.637500	2074.637496	2253.000
426	2074.752604	2074.752600	2253.125
427	2074.867708	2074.867704	2253.250
428	2074.982812	2074.982808	2253.375
429	2075.097917	2075.097912	2253.500
430	2075.213021	2075.213016	2253.625
431	2075.328125	2075.328120	2253.750
432	2075.443229	2075.443224	2253.875
433	2075.558333	2075.558328	2254.000
434	2075.673437	2075.673432	2254.125
435	2075.788542	2075.788536	2254.250
436	2075.903646	2075.903640	2254.375
437	2076.018750	2076.018744	2254.500
438	2076.133854	2076.133848	2254.625
439	2076.248958	2076.248952	2254.750
440	2076.364062	2076.364056	2254.875
441	2076.479167	2076.479160	2255.000
442	2076.594271	2076.594264	2255.125
443	2076.709375	2076.709368	2255.250
444	2076.824479	2076.824472	2255.375
445	2076.939583	2076.939576	2255.500
446	2077.054687	2077.054680	2255.625
447	2077.169792	2077.169784	2255.750
448	2077.284896	2077.284888	2255.875
449	2077.400000	2077.399992	2256.000
450	2077.515104	2077.515096	2256.125

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
451	2077.630208	2077.630200	2256.250
452	2077.745312	2077.745304	2256.375
453	2077.860417	2077.860408	2256.500
454	2077.975521	2077.975512	2256.625
455	2078.090625	2078.090616	2256.750
456	2078.205729	2078.205720	2256.875
457	2078.320833	2078.320824	2257.000
458	2078.435937	2078.435928	2257.125
459	2078.551042	2078.551032	2257.250
460	2078.666146	2078.666136	2257.375
461	2078.781250	2078.781240	2257.500
462	2078.896354	2078.896344	2257.625
463	2079.011458	2079.011448	2257.750
464	2079.126562	2079.126552	2257.875
465	2079.241667	2079.241656	2258.000
466	2079.356771	2079.356760	2258.125
467	2079.471875	2079.471864	2258.250
468	2079.586979	2079.586968	2258.375
469	2079.702083	2079.702072	2258.500
470	2079.817187	2079.818176	2258.625
471	2079.932292	2079.932280	2258.750
472	2080.047396	2080.047384	2258.875
473	2080.162500	2080.162488	2259.000
474	2080.277604	2080.277592	2259.125
475	2080.392708	2080.392696	2259.250
476	2080.507812	2080.507800	2259.375
477	2080.622917	2080.622904	2259.500
478	2080.738021	2080.738008	2259.625
479	2080.853125	2080.853112	2259.750
480	2080.968229	2080.968216	2259.875
481	2081.083333	2081.083320	2260.000
482	2081.198437	2081.198424	2260.125
483	2081.313542	2081.313528	2260.250
484	2081.428646	2081.428632	2260.375
485	2081.543750	2081.543736	2260.500
486	2081.658854	2081.658840	2260.625
487	2081.773958	2081.773944	2260.750
488	2081.889062	2081.889048	2260.875
489	2082.004167	2082.004152	2261.000
490	2082.119271	2082.119256	2261.125
491	2082.234375	2082.234360	2261.250
492	2082.349479	2082.349464	2261.375
493	2082.464583	2082.464568	2261.500
494	2082.579687	2082.579672	2261.625
495	2082.694792	2082.694776	2261.750

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
496	2082.809896	2082.809880	2261.875
497	2082.925000	2082.924984	2262.000
498	2083.040104	2083.040088	2262.125
499	2083.155208	2083.155192	2262.250
500	2083.270312	2083.270296	2262.375
501	2083.385417	2083.385400	2262.500
502	2083.500521	2083.500504	2262.625
503	2083.615625	2083.615608	2262.750
504	2083.730729	2083.730712	2262.875
505	2083.845833	2083.845816	2263.000
506	2083.960937	2083.960920	2263.125
507	2084.076042	2084.076024	2263.250
508	2084.191146	2084.191128	2263.375
509	2084.306250	2084.306232	2263.500
510	2084.421354	2084.421336	2263.625
511	2084.536458	2084.536440	2263.750
512	2084.651562	2084.651544	2263.875
513	2084.766667	2084.766648	2264.000
514	2084.881771	2084.881752	2264.125
515	2084.996875	2084.996856	2264.250
516	2085.111979	2085.111960	2264.375
517	2085.227083	2085.227064	2264.500
518	2085.342187	2085.342168	2264.625
519	2085.457292	2085.457272	2264.750
520	2085.572396	2085.572376	2264.875
521	2085.687500	2085.687480	2265.000
522	2085.802604	2085.802584	2265.125
523	2085.917708	2085.917688	2265.250
524	2086.032812	2085.032792	2265.375
525	2086.147917	2086.147896	2265.500
526	2086.263021	2086.263000	2265.625
527	2086.378125	2086.378104	2265.750
528	2086.493229	2086.493208	2265.875
529	2086.608333	2086.608312	2266.000
530	2086.723437	2086.723416	2266.125
531	2086.838542	2086.838520	2266.250
532	2086.953646	2086.953624	2266.375
533	2087.068750	2087.068728	2266.500
534	2087.183854	2087.183832	2266.625
535	2087.298958	2087.298936	2266.750
536	2087.414062	2087.414040	2266.875
537	2087.529167	2087.529144	2267.000
538	2087.644271	2087.644248	2267.125
539	2087.759375	2087.759352	2267.250
540	2087.874479	2087.874456	2267.375

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
541	2087.989583	2087.989560	2267.500
542	2088.104687	2088.104664	2267.625
543	2088.219792	2088.219768	2267.750
544	2088.334896	2088.334872	2267.875
545	2088.450000	2088.449976	2268.000
546	2088.565104	2088.565080	2268.125
547	2088.680208	2088.680184	2268.250
548	2088.795312	2088.795288	2268.375
549	2088.910417	2088.910392	2268.500
550	2089.025521	2089.025496	2268.625
551	2089.140625	2089.140600	2268.750
552	2089.255729	2089.255704	2268.875
553	2089.370833	2089.370808	2269.000
554	2089.485937	2089.485912	2269.125
555	2089.601042	2089.601016	2269.250
556	2089.716146	2089.716120	2269.375
557	2089.831250	2089.831224	2269.500
558	2089.946354	2089.946328	2269.625
559	2090.061458	2090.061432	2269.750
560	2090.176562	2090.176536	2269.875
561	2090.291667	2090.291640	2270.000
562	2090.406771	2090.406744	2270.125
563	2090.521875	2090.521848	2270.250
564	2090.636979	2090.636952	2270.375
565	2090.752083	2090.752056	2270.500
566	2090.867187	2090.867160	2270.625
567	2090.982292	2090.982264	2270.750
568	2091.097396	2091.097368	2270.875
569	2091.212500	2091.212472	2271.000
570	2091.327604	2091.327576	2271.125
571	2091.442708	2091.442680	2271.250
572	2091.557812	2091.557784	2271.375
573	2091.672917	2091.672888	2271.500
574	2091.788021	2091.787992	2271.625
575	2091.903125	2091.903096	2271.750
576	2092.018229	2092.018200	2271.875
577	2092.133333	2092.133304	2272.000
578	2092.248437	2092.248408	2272.125
579	2092.363542	2092.363512	2272.250
580	2092.478646	2092.478616	2272.375
581	2092.593750	2092.593720	2272.500
582	2092.708854	2092.708824	2272.625
583	2092.823958	2092.823928	2272.750
584	2092.939062	2092.939032	2272.875
585	2093.054167	2093.054136	2273.000

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
586	2093.169271	2093.169240	2273.125
587	2093.284375	2093.284344	2273.250
588	2093.399479	2093.399448	2273.375
589	2093.514583	2093.514552	2273.500
590	2093.629687	2093.629656	2273.625
591	2093.744792	2093.744760	2273.750
592	2093.859896	2093.859864	2273.875
593	2093.975000	2093.974968	2274.000
594	2094.090104	2094.090072	2274.125
595	2094.205208	2094.205176	2274.250
596	2094.320312	2094.320280	2274.375
597	2094.435417	2094.435384	2274.500
598	2094.550521	2094.550488	2274.625
599	2094.665625	2094.665592	2274.750
600	2094.780729	2094.780696	2274.875
601	2094.895833	2094.895800	2275.000
602	2095.010937	2095.010904	2275.125
603	2095.126042	2095.126008	2275.250
604	2095.241146	2095.241112	2275.375
605	2095.356250	2095.356216	2275.500
606	2095.471354	2095.471320	2275.625
607	2095.586458	2095.586424	2275.750
608	2095.701562	2095.701528	2275.875
609	2095.816667	2095.816632	2276.000
610	2095.931771	2095.931736	2276.125
611	2096.046875	2096.046840	2276.250
612	2096.161979	2096.161944	2276.375
613	2096.277083	2096.277048	2276.500
614	2096.392187	2096.392152	2276.625
615	2096.507292	2096.507256	2276.750
616	2096.622396	2096.622360	2276.875
617	2096.737500	2096.737464	2277.000
618	2096.852604	2096.852568	2277.125
619	2096.967708	2096.967672	2277.250
620	2097.082812	2097.082776	2277.375
621	2097.197917	2097.197880	2277.500
622	2097.313021	2097.313984	2277.625
623	2097.428125	2097.428088	2277.750
624	2097.543229	2097.543192	2277.875
625	2097.658333	2097.658296	2278.000
626	2097.773437	2097.773400	2278.125
627	2097.888542	2097.888504	2278.250
628	2098.003646	2098.003608	2278.375
629	2098.118750	2098.118712	2278.500
630	2098.233854	2098.233816	2278.625

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
631	2098.348958	2098.348920	2278.750
632	2098.464062	2098.464024	2278.875
633	2098.579167	2098.579128	2279.000
634	2098.694271	2098.694232	2279.125
635	2098.809375	2098.809336	2279.250
636	2098.924479	2098.924440	2279.375
637	2099.039583	2099.039544	2279.500
638	2099.154687	2099.154648	2279.625
639	2099.269792	2099.269752	2279.750
640	2099.384896	2099.384856	2279.875
641	2099.500000	2099.499960	2280.000
642	2099.615104	2099.615064	2280.125
643	2099.730208	2099.730168	2280.250
644	2099.845312	2099.845272	2280.375
645	2099.960417	2099.960376	2280.500
646	2100.075521	2100.075480	2280.625
647	2100.190625	2100.190584	2280.750
648	2100.305729	2100.305688	2280.875
649*	2100.420833	2100.420792	2281.000
650*	2100.535937	2100.535896	2281.125
651*	2100.651042	2100.651000	2281.250
652*	2100.766146	2100.766104	2281.375
653*	2100.881250	2100.881208	2281.500
654	2100.996354	2100.996312	2281.625
655	2101.111458	2101.111416	2281.750
656	2101.226562	2101.226520	2281.875
657	2101.341667	2101.341624	2282.000
658	2101.456771	2101.456728	2282.125
659	2101.571875	2101.571832	2282.250
660	2101.686979	2101.686936	2282.375
661	2101.802083	2101.802040	2282.500
662	2101.917187	2101.917144	2282.625
663	2102.032292	2102.032248	2282.750
664	2102.147396	2102.147352	2282.875
665	2102.262500	2102.262456	2283.000
666	2102.377604	2102.377560	2283.125
667	2102.492708	2102.492664	2283.250
668	2102.607812	2102.607768	2283.375
669	2102.722917	2102.722872	2283.500
670	2102.838021	2102.838976	2283.625
671	2102.953125	2102.953080	2283.750
672	2103.068229	2103.068184	2283.875
673	2103.183333	2103.183288	2284.000
674	2103.298437	2103.298392	2284.125
675	2103.413542	2103.413496	2284.250

* Channels 649, 650, 651, 652 and 653 are to be used in the Low Power Transmit Mode only.

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
676	2103.528646	2103.528600	2284.375
677	2103.643750	2103.643704	2284.500
678	2103.758854	2103.758808	2284.625
679	2103.873958	2103.873912	2284.750
680	2103.989062	2103.989016	2284.875
681	2104.104167	2104.104120	2285.000
682	2104.219271	2104.219224	2285.125
683	2104.334375	2104.334328	2285.250
684	2104.449479	2104.449432	2285.375
685	2104.564583	2104.564536	2285.500
686	2104.679687	2104.679640	2285.625
687	2104.794792	2104.794744	2285.750
688	2104.909896	2104.909848	2285.875
689	2105.025000	2105.024952	2286.000
690	2105.140104	2105.140056	2286.125
691	2105.255208	2105.255160	2286.250
692	2105.370312	2105.370264	2286.375
693	2105.485417	2105.485368	2286.500
694	2105.600521	2105.600472	2286.625
695	2105.715625	2105.715576	2286.750
696	2105.830729	2105.830680	2286.875
697	2105.945833	2105.945784	2287.000
698	2106.060937	2106.060888	2287.125
699	2106.176042	2106.175992	2287.250
700	2106.291146	2106.291096	2287.375
701	2106.406250	2106.406200	2287.500
702	2106.521354	2106.521304	2287.625
703	2106.636458	2106.636408	2287.750
704	2106.751562	2106.751512	2287.875
705	2106.866667	2106.866616	2288.000
706	2106.981771	2106.981720	2288.125
707	2107.096875	2107.096824	2288.250
708	2107.211979	2107.211928	2288.375
709	2107.327083	2107.327032	2288.500
710	2107.442187	2107.442136	2288.625
711	2107.557292	2107.557240	2288.750
712	2107.672396	2107.672344	2288.875
713	2107.787500	2107.787448	2289.000
714	2107.902604	2107.902552	2289.125
715	2108.017708	2108.017656	2289.250
716	2108.132812	2108.132760	2289.375
717	2108.247917	2108.247864	2289.500
718	2108.363021	2108.362968	2289.625
719	2108.478125	2108.478072	2289.750
720	2108.593229	2108.593176	2289.875

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
721	2108.708333	2108.708280	2290.000
722	2108.823437	2108.823384	2290.125
723	2108.938542	2108.938488	2290.250
724	2109.053646	2109.053592	2290.375
725	2109.168750	2109.168696	2290.500
726	2109.283854	2109.283800	2290.625
727	2109.398958	2109.398904	2290.750
728	2109.514062	2109.514008	2290.875
729	2109.629167	2109.629112	2291.000
730	2109.744271	2109.744216	2291.125
731	2109.859375	2109.859320	2291.250
732	2109.974479	2109.974424	2291.375
733	2110.089583	2110.089528	2291.500
734	2110.204687	2110.204632	2291.625
735	2110.319792	2110.319736	2291.750
736	2110.434896	2110.434840	2291.875
737	2110.550000	2110.549944	2292.000
738	2110.665104	2110.665048	2292.125
739	2110.780208	2110.780152	2292.250
740	2110.895312	2110.895256	2292.375
741	2111.010417	2111.010360	2292.500
742	2111.125521	2111.125464	2292.625
743	2111.240625	2111.240568	2292.750
744	2111.355729	2111.355672	2292.875
745	2111.470833	2111.470776	2293.000
746	2111.585937	2111.585880	2293.125
747	2111.701042	2111.700984	2293.250
748	2111.816146	2111.816088	2293.375
749	2111.931250	2111.931192	2293.500
750	2112.046354	2112.046296	2293.625
751	2112.161458	2112.161400	2293.750
752	2112.276562	2112.276504	2293.875
753	2112.391667	2112.391608	2294.000
754	2112.506771	2112.506712	2294.125
755	2112.621875	2112.621816	2294.250
756	2112.736979	2112.736920	2294.375
757	2112.852083	2112.852024	2294.500
758	2112.967187	2112.967128	2294.625
759	2113.082292	2113.082232	2294.750
760	2113.197396	2113.197336	2294.875
761	2113.312500	2113.312440	2295.000
762	2113.427604	2113.427544	2295.125
763	2113.542708	2113.542648	2295.250
764	2113.657812	2113.657752	2295.375
765	2113.772917	2113.772856	2295.500

TABLE C.1-1 STDN CHANNEL & FREQUENCY ASSIGNMENT

CHANNEL	TRANSMIT		RECEIVE
	221/240	0.115104MHZ	0.125MHZ
766	2113.888021	2113.887960	2295.625
767	2114.003125	2114.003064	2295.750
768	2114.118229	2114.118168	2295.875
769	2114.233333	2114.233272	2296.000
770	2114.348437	2114.348376	2296.125
771	2114.463542	2114.463480	2296.250
772	2114.578646	2114.578584	2296.375
773	2114.693750	2114.693688	2296.500
774	2114.808854	2114.808792	2296.625
775	2114.923958	2114.923896	2296.750
776	2115.039062	2115.039000	2296.875
777	2115.154167	2115.154104	2297.000
778	2115.269271	2115.269208	2297.125
779	2115.384375	2115.384312	2297.250
780	2115.499479	2115.499416	2297.375
781	2115.614583	2115.614520	2297.500
782	2115.729687	2115.729624	2297.625
783	2115.844792	2115.844728	2297.750
784	2115.959896	2115.959832	2297.875
785	2116.075000	2116.074936	2298.000
786	2116.190104	2116.190040	2298.125
787	2116.305208	2116.305144	2298.250
788	2116.420312	2116.420248	2298.375
789	2116.535417	2116.535352	2298.500
790	2116.650521	2116.650456	2298.625
791	2116.765625	2116.765560	2298.750
792	2116.880729	2116.880664	2298.875
793	2116.995833	2116.995768	2299.000
794	2117.110937	2117.110872	2299.125
795	2117.226042	2117.225976	2299.250
796	2117.341146	2117.341080	2299.375
797	2117.456250	2117.456184	2299.500
798	2117.571354	2117.571288	2299.625
799	2117.686458	2117.686392	2299.750
800	2117.801562	2117.801496	2299.875
801	2117.916667	2117.916600	2300.000

UNASSIGNED CHANNELS: 000, 802-849

TABLE C.2-1 NASA/DSN CHANNEL & FREQUENCY ASSIGNMENTS

CHANNEL	TRANSMIT MHz	RECEIVE MHz
850		2290.185185
851		2290.555556
852		2290.925926
853		2291.296296
854	2110.243056	2291.666667
855	2110.584105	2292.037037
856	2110.925154	2292.407407
857	2111.266204	2292.777778
858	2111.607253	2293.148148
859	2111.948303	2293.518519
860	2112.289352	2293.888889
861	2112.630401	2294.259259
862	2112.971451	2294.629630
863	2113.312500	2295.000000
864	2113.653549	2295.370370
865	2113.994599	2295.740741
866	2114.335648	2296.111111
867	2114.676697	2296.481481
868	2115.017747	2296.851852
869	2115.358796	2297.222222
870	2115.699846	2297.592593
871	2116.040895	2297.962963
872	2116.381944	2298.333333
873	2116.722994	2298.703704
874	2117.064043	2299.074074
875	2117.405092	2299.444444
876	2117.746142	2299.814815
877	2118.087191	
878	2118.428241	
879	2118.769290	
880	2119.110339	
881	2119.451399	
882	2119.792438	

Unassigned Channels: 883-899
Transmit/Receive Ratio: 221/240

TABLE C.2-2 DOD/SGLS CHANNEL & FREQUENCY ASSIGNMENTS

CHANNEL	TRANSMIT ORBITER TO DOD PAYLOADS (MHz)	RECEIVE DOD PAYLOADS TO ORBITER (MHz)
900	1763.721	2202.500
901	1767.725	2207.500
902	1771.729	2212.500
903	1775.733	2217.500
904	1779.736	2222.500
905	1783.740	2227.500
906	1787.744	2232.500
907	1791.748	2237.500
908	1795.752	2242.500
909	1799.756	2247.500
910	1803.760	2252.500
911	1807.764	2257.500
912	1811.768	2262.500
913	1815.772	2267.500
914	1819.775	2272.500
915	1823.779	2277.500
916	1827.783	2282.500
917	1831.787	2287.500
918	1835.791	2292.500
919	1839.795	2297.500

Unassigned Channels: 920-999
Transmit/Receive Ratio: 205/256

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX I

PAYLOAD ATTACH-POINT STATIC LIMIT-LOAD CAPABILITY

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

I.1 INTRODUCTION

This appendix provides the payload designer with information required to determine the compatibility of payload-induced loads with the Orbiter static limit load capability.

Guidelines and equations are provided to determine the allowable loads for attach points on single bridges and on adjacent bridges. (A single bridge is defined as a longeron or keel bridge which does not share either of its mid-fuselage support frames with another longeron or keel bridge respectively). Table I.1-1 provides guidelines for the applicability of the equations provided in the following paragraphs. It is in essence an index correlating the load combinations with longeron or keel attach points and with single or adjacent bridges.

Exceedance of the Orbiter limit load capability should be coordinated with the SSP prior to any cargo element manifest relocation analysis or hardware modification.

I.2 ORBITER STATIC LIMIT LOAD CAPABILITY

Loads are transmitted from the payload trunnions through the payload attachment mechanisms to the longeron and keel bridges. The loads are then transmitted in turn from the bridges to the mid-fuselage frames. Positive X, Y, and Z loads are aft, right (looking forward), and up, respectively. Load capability data are provided in Tables I.2-1 for liftoff conditions, I.2-2 for post SRB staging, I.2-3 for TAEM Yaw and Roll, I.2-4 for TAEM pitch conditions, I.2-5 for light weight (32K) landing conditions, and I.2-6 for heavy weigth (65K) landing conditions.

These tables provide the allowable limit load data defining for each attach point: (1) the allowable ±Z and ±Y loads at the longeron, where the Y load results from trunnion/bearing friction and/or bearing rotation (trunnion deflection), and (2) the allowable ±Y, ±X and ±Z loads at the keel, where the Z load results from friction or trunnion deflection, and the X load results from either friction or a keel (auxiliary) fitting which is restrained from movement in the X direction.

Table 3.3.1.1-1 must be examined to determine which attach points can be used.

The transfer of X load from the longeron bridge to the longeron is not affected by the fore and aft location of the attach fitting on the bridge. Thus the X-load capability for all attach points on a given bridge is the same. Table I.2-7 presents tabular data defining the allowable X load for each bridge.

At landing, the payload imposed Z loads result in critical vertical shear loads in the mid-fuselage side skins. Table I.2-8 presents data defining the allowable limit load (Z load), at landing only, for each frame.

TABLE I.1-1 PARAGRAPH GUIDELINES FOR USE OF ATTACHMENT POINT LIMIT-LOAD CAPABILITIES

Longeron/Trunnion Bearing Friction Plus Bearing Rotation	Longeron Attach Points					
	Single Bridge		Adjacent Bridges			
	Applied Z and X Loads Primary Fitting	Applied Z Load Only Stabilizing Fitting	Pt.1,Primary Pt.2,Primary	Pt.1,Stabiliz Pt.2,Stabiliz.	Pt.1,Primary Pt.2,Stabiliz.	Pt.1,Stabiliz. Pt.2,Primary
Yes	I.3.2.1.1	I.3.2.1.2	I.3.3.1.1	I.3.3.1.2	I.3.3.1.3	I.3.3.1.4

Keel Trunnion/Bearing Friction Plus Bearing Rotation	Keel Attach Points					
	Single Bridge		Adjacent Bridges			
	Applied Y Load Only Primary	Applied X and Y Loads Stabilizing	Applied Y Loads Only	Applied X and Y Loads	Pt.1,X and Y Loads Pt.2,Y Loads	Pt.1, Y Loads Pt.2, X and Y Loads
Z Friction Load	---	I.3.2.2.2	---	I.3.3.2.2	---	---
X and Z Friction Load	I.3.2.2.1	---	I.3.3.2.1	---	I.3.3.2.3	I.3.3.2.4

Longeron/Trunnion	Longeron Attach Points			
	Two Attach Points on One Bridge			
Bearing Friction Plus Bearing	Forward Primary and Aft Stabilizing	Forward and Aft Primary Fittings	Forward Stabilizing and Aft Fittings	Forward and Aft Stabilizing Fittings
Yes	I.3.4.1	I.3.4.2	I.3.4.3	I.3.4.4

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 582 AND Xo 636															
582.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
612.73	*	*	*	*	*	*	*	*	6.96	24.60	0.90	0.71	2.44	0.71	0.90
616.67	42.49	45.37	-53.92	-66.74	-0.297	0.166	(4)	(4)	8.38	21.81	0.90	0.86	2.16	0.86	0.90
620.60	53.33	39.37	-67.68	-59.95	-0.373	0.149	(4)	(4)	10.52	19.59	0.90	1.08	1.94	1.08	0.90
624.53	71.61	36.65	-90.86	-54.41	-0.501	0.135	(4)	(4)	14.12	17.78	0.90	1.45	1.76	1.45	0.90
628.47	109.08	33.93	-138.41	-49.79	-0.764	0.124	(4)	(4)	*	*	*	*	*	*	*
632.40	228.15	31.21	-289.50	-45.91	-1.597	0.114	(4)	(4)	*	*	*	*	*	*	*
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 636 AND Xo 693															
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
644.20	43.12	220.40	-54.07	-203.46	-0.118	0.701	(4)	(4)	*	*	*	*	*	*	*
648.13	46.89	149.04	-58.80	-137.54	-0.128	0.474	(4)	(4)	*	*	*	*	*	*	*
652.07	51.41	112.50	-64.46	-103.82	-0.140	0.358	(4)	(4)	19.50	71.97	1.80	1.94	7.18	1.94	1.80
656.00	56.87	90.40	-70.41	-83.42	-0.155	0.288	(4)	(4)	21.57	57.83	1.80	2.14	5.77	2.14	1.80
659.93	63.62	75.54	-69.72	-69.72	-0.174	0.240	(4)	(4)	24.13	48.33	1.80	2.40	4.82	2.40	1.80
663.87	*	*	*	*	*	*	*	*	27.39	41.51	1.80	2.72	4.14	2.72	1.80
667.80	*	*	*	*	*	*	*	*	31.67	36.37	1.80	3.14	3.63	3.14	1.80
671.73	*	*	*	*	*	*	*	*	37.52	32.37	1.80	3.72	3.23	3.72	1.80
675.67	*	*	*	*	*	*	*	*	46.05	29.15	1.80	4.57	2.91	4.57	1.80
679.60	*	*	*	*	*	*	*	*	59.55	26.53	1.80	5.91	2.65	5.91	1.80
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 693 AND Xo 750															
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
699.27	43.05	327.27	-46.96	-271.74	-0.113	0.917	(4)	(4)	*	*	*	*	*	*	*
703.20	46.68	201.18	-50.90	-167.04	-0.123	0.564	(4)	(4)	*	*	*	*	*	*	*
707.13	50.95	145.22	-55.56	-120.58	-0.134	0.407	(4)	(4)	*	*	*	*	*	*	*
711.07	56.12	113.56	-56.97	-94.29	-0.148	0.319	(4)	(4)	29.71	84.03	3.30	2.96	8.40	2.96	3.30
715.00	62.41	93.27	-56.62	-77.45	-0.164	0.261	(4)	(4)	33.04	69.02	3.30	3.30	6.90	3.30	3.26
718.93	70.31	79.14	-56.38	-65.71	-0.185	0.222	(4)	(4)	37.22	58.56	3.30	3.71	5.85	3.71	3.16
722.87	80.52	68.58	-64.57	-57.04	-0.212	0.193	(4)	(4)	42.63	50.84	3.30	4.25	5.08	4.25	3.06
726.80	94.16	60.71	-75.51	-58.25	-0.248	0.170	(4)	(4)	49.85	44.93	3.30	4.98	4.49	4.98	2.97
730.73	113.36	54.39	-90.90	-60.43	-0.298	0.152	(4)	(4)	60.02	40.25	3.30	5.99	4.02	5.99	2.88
734.67	*	*	*	*	*	*	*	*	75.44	36.44	3.30	7.53	3.64	7.53	2.80
738.60	*	*	*	*	*	*	*	*	101.45	33.30	3.30	10.13	3.33	10.13	2.73
742.53	292.42	41.43	-234.50	-50.64	-0.770	0.116	(4)	(4)	*	*	*	*	*	*	*
746.47	618.82	38.47	-496.24	-46.90	-1.629	0.108	(4)	(4)	*	*	*	*	*	*	*
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 750 AND Xo 807															
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
758.27	46.70	260.50	-51.47	-205.34	-0.118	0.695	(4)	(4)	*	*	*	*	*	*	*
762.20	50.79	176.58	-55.98	-139.19	-0.128	0.471	(4)	(4)	*	*	*	*	*	*	*
766.13	55.67	133.56	-61.37	-105.28	-0.141	0.356	(4)	(4)	37.15	106.01	4.60	3.71	10.60	3.71	4.60
770.07	61.61	107.34	-61.91	-84.61	-0.156	0.286	(4)	(4)	41.12	85.20	4.60	4.11	8.52	4.11	4.44
774.00	68.95	89.77	-61.21	-70.76	-0.174	0.240	(4)	(4)	46.01	71.25	4.60	4.60	7.13	4.60	4.20
777.93	78.28	77.13	-69.48	-60.80	-0.198	0.206	(4)	(4)	52.24	61.22	4.60	5.22	6.12	5.22	3.96
781.87	90.54	67.60	-80.38	-61.24	-0.229	0.180	(4)	(4)	60.43	53.66	4.60	6.04	5.37	6.04	3.73
785.80	107.33	60.18	-95.28	-62.55	-0.271	0.161	(4)	(4)	71.63	47.77	4.60	7.16	4.78	7.16	3.52
789.73	131.76	54.23	-116.96	-58.31	-0.333	0.145	(4)	(4)	87.93	43.04	4.60	8.79	4.30	8.79	3.31
793.67	170.70	49.34	-151.53	-53.05	-0.431	0.132	(4)	(4)	113.91	39.16	4.60	11.39	3.92	11.39	3.13
797.60	242.07	45.27	-214.89	-48.67	-0.612	0.121	(4)	(4)	*	*	*	*	*	*	*
801.53	415.98	41.81	-369.28	-44.95	-1.051	0.112	(4)	(4)	*	*	*	*	*	*	*
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 807 AND Xo 863															
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
813.33	43.00	286.90	-45.82	-324.14	-0.116	0.908	(4)	(4)	*	*	*	*	*	*	*
817.27	46.71	176.83	-49.77	-199.79	-0.126	0.560	(4)	(4)	*	*	*	*	*	*	*
821.20	51.09	127.89	-54.45	-144.50	-0.138	0.405	(4)	(4)	40.19	108.45	5.60	4.02	13.27	4.02	5.20
825.13	56.40	100.17	-60.10	-113.17	-0.152	0.317	(4)	(4)	44.36	84.94	5.60	4.44	10.39	4.44	5.94
829.07	62.95	82.29	-67.07	-92.97	-0.169	0.261	(4)	(4)	49.51	69.78	5.60	4.95	8.54	4.95	4.69
833.00	71.20	69.85	-75.86	-78.92	-0.192	0.221	(4)	(4)	56.00	59.23	5.60	5.60	7.25	5.60	4.44
836.93	81.93	60.68	-87.30	-68.55	-0.221	0.192	(4)	(4)	64.44	51.45	5.60	6.44	6.30	6.44	4.19
840.87	96.51	53.62	-102.84	-60.58	-0.260	0.170	(4)	(4)	75.92	45.47	5.60	7.59	5.56	7.59	3.95
844.80	117.35	48.04	-125.05	-54.28	-0.316	0.152	(4)	(4)	92.31	40.74	5.60	9.23	4.99	9.23	3.73
848.73	149.67	43.52	-159.48	-49.17	-0.403	0.138	(4)	(4)	117.73	36.90	5.60	11.77	4.52	11.77	3.52
852.67	206.76	39.77	-220.31	-44.93	-0.557	0.126	(4)	(4)	162.63	33.72	5.60	16.26	4.13	16.26	3.32
856.60	333.72	36.61	-355.60	-41.37	-0.898	0.116	(4)	(4)	*	*	*	*	*	*	*
860.53	864.70	33.93	-921.39	-38.33	-2.328	0.107	(4)	(4)	*	*	*	*	*	*	*
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 863 AND Xo 919															
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
872.33	38.91	204.68	-43.96	-234.41	-0.123	0.616	(4)	(4)	*	*	*	*	*	*	*
876.27	42.50	143.90	-48.02	-164.81	-0.135	0.433	(4)	(4)	*	*	*	*	*	*	*
880.20	46.81	111.02	-52.88	-127.15	-0.148	0.334	(4)	(4)	39.69	107.44	5.70	4.86	10.71	4.86	5.04
884.13	52.08	90.38	-58.84	-104.50	-0.165	0.272	(4)	(4)	44.16	87.46	5.70	5.40	8.72	5.40	4.77
888.07	58.72	76.18	-66.34	-87.24	-0.186	0.229	(4)	(4)	49.79	73.71	5.70	6.09	7.35	6.09	4.51
892.00	67.26	65.85	-75.99	-75.42	-0.213	0.198	(4)	(4)	57.04	63.72	5.70	6.98	6.36	6.98	4.25
895.93	78.72	57.99	-88.94	-66.41	-0.249	0.175	(4)	(4)	66.75	56.12	5.70	8.17	5.60	8.17	3.99
899.87	*	*	*	*	*	*	*	*	80.50	50.12	5.70	9.85	5.00	9.85	3.76
903.80	*	*	*	*	*	*	*	*	101.32	45.29	5.70	12.40	4.52	12.40	3.54
907.73	*	*	*	*	*	*	*	*	136.65	41.31	5.70	16.72	4.12	16.72	3.34
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 919 AND Xo 979.5															
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
923.47	37.49	615.34	-42.50	-544.22	-0.103	1.286	(4)	(4)	*	*	*	*	*	*	*
927.40	40.32	327.45	-45.71	-289.61	-0.110	0.685	(4)	(4)	*	*	*	*	*	*	*
931.33	43.61	223.08	-49.43	-197.30	-0.119	0.466	(4)	(4)	*	*	*	*	*	*	*
935.27	47.49	169.06	-53.84	-149.52	-0.130	0.353	(4)	(4)	45.14	148.74	7.00	4.50	15.64	4.50	6.51
939.20	52.12	136.16	-59.09	-120.43	-0.143	0.285	(4)	(4)	49.54	119.80	7.00	4.94	12.60	4.94	6.18
943.13	57.76	113.99	-65.47	-100.82	-0.158	0.238	(4)	(4)	54.89	100.29	7.00	5.47	10.55	5.47	5.86
947.07	64.77	97.99	-73.43	-86.67	-0.177	0.205	(4)	(4)	61.56	86.21	7.00	6.14	9.07	6.14	5.55
951.00	73.73	85.96	-83.55	-76.02	-0.202	0.180	(4)	(4)	70.05	75.63	7.00	6.99	7.95	6.99	5.26
954.93	85.49	76.55	-96.92	-67.71	-0.234	0.160	(4)	(4)	81.26	67.35	7.00	8.10	7.08	8.10	4.98
958.87	101.82	68.99	-115.43	-61.02	-0.279	0.144	(4)	(4)	96.78	60.70	7.00	9.65	6.38	9.65	4.72
962.80	*	*	*	*	*	*	*	*	119.55	55.25	7.00	11.92	5.81	11.92	4.47
966.73	*	*	*	*	*	*	*	*	156.34	50.70	7.00	15.59	5.33	15.59	4.24
974.60	428.69	49.48	-485.98	-43.75	-1.173	0.103	(4)	(4)	*	*	*	*	*	*	*
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 979.5 AND Xo 1040															
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
986.40	60.73	398.43	-47.21	-345.73	-0.107	0.833	(4)	(4)	*	*	*	*	*	*	*
990.33	65.53	253.84	-50.94	-220.27	-0.116	0.531	(4)	(4)	*	*	*	*	*	*	*
994.27	71.18	186.12	-55.33	-161.51	-0.126	0.389	(4)	(4)	52.92	165.89	8.00	5.56	24.69	5.56	7.69
998.20	77.88	147.01	-60.53	-127.57	-0.138	0.307	(4)	(4)	57.89	131.03	8.00	6.09	19.50	6.09	7.43
1002.13	85.95	121.48	-66.81	-105.41	-0.152	0.254	(4)	(4)	63.90	108.27	8.00	6.72	16.12	6.72	7.17
1006.07	95.94	103.46	-74.57	-89.78	-0.169	0.216	(4)	(4)	71.32	92.22	8.00	7.50	13.73	7.50	6.91
1010.00	108.51	90.14	-84.33	-78.21	-0.192	0.189	(4)	(4)	80.67	80.37	8.00	8.48	11.96	8.48	6.65
1013.93	124.87	79.85	-97.04	-69.29	-0.221	0.167	(4)	(4)	92.83	71.17	8.00	9.76	10.59	9.76	6.39
1017.87	147.10	71.64	-114.33	-62.17	-0.260	0.150	(4)	(4)	109.35	63.86	8.00	11.50	9.50	11.50	6.12
1021.80	178.86	64.99	-139.02	-56.40	-0.316	0.136	(4)	(4)	132.97	57.93	8.00	13.98	8.62	13.98	5.87
1025.73	228.12	59.47	-177.30	-51.60	-0.403	0.124	(4)	(4)	169.59	53.00	8.00	17.83	7.89	17.83	5.62
1029.67	315.12	54.80	-244.92	-47.55	-0.557	0.115	(4)	(4)	234.27	48.84	8.00	24.63	7.27	24.63	5.38
1033.60	508.63	50.82	-395.31	-44.09	-0.898	0.106	(4)	(4)	*	*	*	*	*	*	*
1037.53	1317.92	47.37	-1024.30	-41.11	-2.328	0.099	(4)	(4)	*	*	*	*	*	*	*
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:

1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE: VERTICAL ± Z: + Z: Z_F	+ Z: Z_A	- Z: Z_F	- Z: Z_A	Z MODIFIERS: K_F	Z MODIFIERS: K_A	LATERAL ± Y: $\pm Y_{LF}$	LATERAL ± Y: $\pm Y_{LA}$	KEEL, 1000 LBS: ± Y (Z ≠ 0): $\pm Y_F$	± Y (Z ≠ 0): $\pm Y_A$	$\pm X_K$ (Z=0)	$\pm Z_K$(X=0): $\pm Z_{KF}$	$\pm Z_K$(X=0): $\pm Z_{KA}$	$\pm R_K$(X,Z≠0): $\pm R_{KF}$	$\pm R_K$(X,Z≠0): $\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1040 AND 1090.33															
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1049.33	56.22	309.57	-55.18	-330.33	-0.140	0.616	(4)	(4)	*	*	*	*	*	*	*
1053.27	62.19	217.66	-61.05	-232.25	-0.155	0.433	(4)	(4)	*	*	*	*	*	*	*
1057.20	69.57	167.92	-68.29	-179.19	-0.174	0.334	(4)	(4)	61.53	134.81	8.00	9.16	17.01	9.16	7.24
1061.13	78.94	136.69	-77.47	-145.85	-0.197	0.272	(4)	(4)	69.81	109.74	8.00	10.39	13.84	10.39	6.93
1065.07	91.24	115.21	-89.56	-122.93	-0.228	0.229	(4)	(4)	80.70	92.49	8.00	12.01	11.67	12.01	6.60
1069.00	110.81	99.60	-106.07	-106.27	-0.270	0.198	(4)	(4)	95.56	79.96	8.00	14.22	10.09	14.22	6.27
1072.93	132.46	87.72	-130.02	-93.60	-0.330	0.175	(4)	(4)	117.15	70.41	8.00	17.44	8.88	17.44	5.95
1076.87	171.23	78.34	-168.08	-83.59	-0.427	0.156	(4)	(4)	151.44	62.89	8.00	22.54	7.93	22.54	5.63
1080.80	241.85	70.80	-237.39	-75.55	-0.603	0.141	(4)	(4)	*	*	*	*	*	*	*
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 1090.33 AND Xo 1140.67															
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1092.60	45.60	1992.13	-45.77	-1816.53	-0.120	2.533	(4)	(4)	*	*	*	*	*	*	*
1096.53	49.67	729.38	-49.85	-665.11	-0.130	0.927	(4)	(4)	*	*	*	*	*	*	*
1100.47	54.54	445.97	-54.73	-406.67	-0.143	0.567	(4)	(4)	*	*	*	*	*	*	*
1104.40	60.44	321.41	-60.66	-293.08	-0.159	0.409	(4)	(4)	*	*	*	*	*	*	*
1108.33	67.78	251.23	-68.03	-229.10	-0.178	0.319	(4)	(4)	71.23	151.66	7.20	9.05	16.30	9.05	6.60
1112.27	77.19	206.11	-77.47	-187.96	-0.202	0.262	(4)	(4)	81.66	124.43	7.20	10.30	13.38	10.30	6.34
1116.20	89.59	174.81	-89.91	-159.40	-0.235	0.222	(4)	(4)	94.78	105.53	7.20	11.96	11.34	11.96	6.00
1120.13	106.73	151.76	-107.12	-138.38	-0.280	0.193	(4)	(4)	112.91	91.61	7.20	14.24	9.85	14.24	5.81
1124.07	132.06	134.03	-132.54	-122.21	-0.346	0.170	(4)	(4)	139.71	80.91	7.20	17.63	8.70	17.63	5.55
1128.00	173.03	120.05	-173.66	-109.47	-0.454	0.153	(4)	(4)	183.04	72.47	7.20	23.09	7.79	23.09	5.29
1131.93	250.83	108.71	-251.74	-99.13	-0.658	0.138	(4)	(4)	*	*	*	*	*	*	*
1135.87	456.72	99.29	-458.38	-90.55	-1.198	0.126	(4)	(4)	*	*	*	*	*	*	*
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1140.67 AND Xo 1191.00															
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1151.60	90.11	424.60	-93.43	-478.57	-0.146	0.526	(4)	(4)	*	*	*	*	*	*	*
1155.53	100.09	312.31	-103.78	-352.01	-0.162	0.387	(4)	(4)	76.95	185.10	19.26	8.27	23.71	8.27	8.12
1159.47	112.60	246.86	-116.75	-278.23	-0.182	0.306	(4)	(4)	86.57	146.30	19.26	9.31	18.74	9.31	7.85
1163.40	128.63	203.18	-133.37	-230.13	-0.208	0.253	(4)	(4)	98.89	121.01	19.26	10.63	15.50	10.63	7.55
1167.33	149.99	174.00	-155.52	-196.20	-0.243	0.216	(4)	(4)	115.31	103.17	19.26	12.40	13.21	12.40	7.23
1171.27	179.95	151.66	-186.58	-158.97	-0.291	0.188	(4)	(4)	138.34	89.89	19.26	14.87	11.51	14.87	6.91
1175.20	224.70	134.40	-232.98	-140.87	-0.364	0.167	(4)	(4)	172.75	79.66	19.26	18.57	10.20	18.57	6.60
1179.13	299.10	120.67	-310.12	-126.48	-0.484	0.150	(4)	(4)	229.94	71.52	19.26	24.72	9.16	24.72	6.29
1181.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1183.07	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1187.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1190.93	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE: VERTICAL ± Z, +Z, Z_F	+Z, Z_A	-Z, Z_F	-Z, Z_A	Z Modifiers, K_F	Z Modifiers, K_A	LATERAL ± Y, $\pm Y_{LF}$	LATERAL ± Y, $\pm Y_{LA}$	KEEL, 1000 LBS: ± Y (Z ≠ 0), $\pm Y_F$	± Y (Z ≠ 0), $\pm Y_A$	$\pm X_K$ (Z=0)	$\pm Z_K$(X=0), $\pm Z_{KF}$	$\pm Z_K$(X=0), $\pm Z_{KA}$	$\pm R_K$(X,Z≠0), $\pm R_{KF}$	$\pm R_K$(X,Z≠0), $\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1191.00 AND Xo 1249.00															
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1194.87	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1198.80	91.47	596.14	-91.46	-594.13	-0.115	0.737	(4)	(4)	*	*	*	*	*	*	*
1202.73	99.24	396.41	-99.23	-395.07	-0.124	0.490	(4)	(4)							
1206.67	108.48	296.74	-108.46	-295.74	-0.136	0.367	(4)	(4)							
1210.60	119.58	237.24	-119.56	-236.44	-0.150	0.293	(4)	(4)	ALLOWABLE LOADS ARE DEFINED IN PARAGRAPH I.3.5						
1214.53	133.21	197.61	-133.20	-196.95	-0.167	0.244	(4)	(4)							
1218.47	150.40	169.27	-150.38	-168.70	-0.188	0.209	(4)	(4)							
1222.40	172.63	148.08	-172.60	-147.59	-0.216	0.183	(4)	(4)							
1226.33	202.55	131.61	-202.53	-131.17	-0.254	0.163	(4)	(4)							
1230.27	245.16	118.41	-245.13	-118.01	-0.307	0.146	(4)	(4)	*	*	*	*	*	*	*
1234.20	310.26	107.64	-310.22	-107.27	-0.389	0.133	(4)	(4)	*	*	*	*	*	*	*
1238.13	422.43	98.66	-422.38	-98.33	-0.529	0.122	(4)	(4)	*	*	*	*	*	*	*
1242.07	662.61	91.05	-662.52	-90.74	-0.830	0.113	(4)	(4)	*	*	*	*	*	*	*
1246.00	1530.62	84.54	-1530.43	-84.26	-1.917	0.105	(4)	(4)	*	*	*	*	*	*	*
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-1 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LIFTOFF CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAME Xo 1249 AND BRIDGE ATTACH PIN Xo 1301.00															
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1269.60	154.41	167.36	-155.67	-167.36	-0.183	0.279	(4)	(4)							
1273.53	176.50	140.55	-177.94	-140.55	-0.209	0.234	(4)	(4)							
1277.47	206.05	121.10	-207.73	-121.10	-0.244	0.202	(4)	(4)							
1281.40	247.37	106.40	-249.39	-106.40	-0.293	0.177	(4)	(4)							
1301.00	*	*	*	*	*	*	*	*	NO KEEL ATTACH POINTS AVAILABLE						

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 582 AND Xo 636															
582.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
612.73	*	*	*	*	*	*	*	*	6.96	24.60	0.90	0.71	2.44	0.71	0.90
616.67	35.51	37.44	-53.92	-66.74	-0.297	0.166	(4)	(4)	8.38	21.81	0.90	0.86	2.16	0.86	0.90
620.60	44.57	32.74	-67.68	-59.95	-0.373	0.149	(4)	(4)	10.52	19.59	0.90	1.08	1.94	1.08	0.90
624.53	59.84	30.41	-90.86	-54.41	-0.501	0.135	(4)	(4)	14.12	17.78	0.90	1.45	1.76	1.45	0.90
628.47	91.15	28.08	-138.41	-49.79	-0.764	0.124	(4)	(4)	*	*	*	*	*	*	*
632.40	190.65	25.76	-289.50	-45.91	-1.597	0.114	(4)	(4)	*	*	*	*	*	*	*
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 636 AND Xo 693															
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
644.20	32.89	178.92	-54.07	-290.49	-0.118	0.701	(4)	(4)	*	*	*	*	*	*	*
648.13	35.77	120.95	-58.80	-196.38	-0.128	0.474	(4)	(4)	*	*	*	*	*	*	*
652.07	39.22	91.30	-64.46	-148.23	-0.140	0.358	(4)	(4)	19.50	58.79	1.80	1.94	5.88	1.94	1.80
656.00	43.39	73.36	-71.31	-119.10	-0.155	0.288	(4)	(4)	21.57	47.24	1.80	2.14	4.72	2.14	1.80
659.93	48.54	61.32	-79.79	-99.54	-0.174	0.240	(4)	(4)	24.13	39.48	1.80	2.40	3.95	2.40	1.80
663.87	*	*	*	*	*	*	*	*	27.39	33.91	1.80	2.72	3.39	2.72	1.80
667.80	*	*	*	*	*	*	*	*	31.67	30.00	1.80	3.14	3.00	3.14	1.80
671.73	*	*	*	*	*	*	*	*	37.52	26.91	1.80	3.72	2.69	3.72	1.80
675.67	*	*	*	*	*	*	*	*	46.05	24.41	1.80	4.57	2.44	4.57	1.80
679.60	*	*	*	*	*	*	*	*	59.55	22.32	1.80	5.91	2.23	5.91	1.80
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 693 AND Xo 750															
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
699.27	38.60	356.30	-46.96	-400.00	-0.113	0.917	(4)	(4)	*	*	*	*	*	*	*
703.20	41.85	219.02	-50.90	-245.88	-0.123	0.564	(4)	(4)	*	*	*	*	*	*	*
707.13	45.48	158.10	-55.56	-177.49	-0.134	0.407	(4)	(4)	*	*	*	*	*	*	*
711.07	50.31	123.63	-61.19	-138.79	-0.148	0.319	(4)	(4)	26.86	84.03	3.30	2.69	8.40	2.57	3.30
715.00	55.95	101.54	-68.06	-114.00	-0.164	0.261	(4)	(4)	29.83	69.02	3.30	2.98	6.90	2.86	3.26
718.93	63.04	86.15	-76.67	-96.72	-0.185	0.222	(4)	(4)	33.58	58.56	3.30	3.36	5.85	3.22	3.16
722.87	72.19	74.79	-87.80	-83.96	-0.212	0.193	(4)	(4)	38.52	50.84	3.30	3.85	5.08	3.68	3.06
726.80	84.42	66.10	-102.67	-74.20	-0.248	0.170	(4)	(4)	43.15	44.93	3.30	4.31	4.49	4.31	2.97
730.73	101.63	59.21	-123.61	-66.47	-0.298	0.152	(4)	(4)	51.95	40.25	3.30	5.19	4.02	5.19	2.88
734.67	*	*	*	*	*	*	*	*	65.30	36.44	3.30	6.52	3.64	6.52	2.80
738.60	*	*	*	*	*	*	*	*	87.81	33.30	3.30	8.77	3.33	8.77	2.73
742.53	262.17	45.10	-318.88	-50.64	-0.770	0.116	(4)	(4)	*	*	*	*	*	*	*
746.47	554.80	41.77	-674.80	-46.90	-1.629	0.108	(4)	(4)	*	*	*	*	*	*	*
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 750 AND Xo 807															
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
758.27	47.12	267.61	-51.47	-280.11	-0.118	0.695	(4)	(4)	*	*	*	*	*	*	*
762.20	51.25	181.40	-55.98	-189.88	-0.128	0.471	(4)	(4)	*	*	*	*	*	*	*
766.13	56.18	137.20	-61.37	-143.61	-0.141	0.356	(4)	(4)	37.15	106.01	4.60	3.71	10.60	3.71	4.60
770.07	62.17	110.27	-67.91	-115.42	-0.156	0.286	(4)	(4)	41.12	85.20	4.60	4.11	8.52	4.11	4.45
774.00	69.57	92.22	-76.00	-96.52	-0.174	0.240	(4)	(4)	46.01	71.25	4.60	4.60	7.13	4.60	4.20
777.93	78.99	79.24	-86.27	-82.94	-0.198	0.206	(4)	(4)	52.24	61.22	4.60	5.22	6.12	5.22	3.96
781.87	91.36	69.44	-99.80	-72.69	-0.229	0.180	(4)	(4)	60.43	63.66	4.60	6.04	5.37	6.04	3.78
785.80	108.30	61.82	-118.30	-64.71	-0.271	0.161	(4)	(4)	71.63	47.77	4.60	7.16	4.78	7.16	3.52
789.73	132.96	55.71	-145.22	-58.31	-0.333	0.145	(4)	(4)	87.93	43.04	4.60	8.79	4.30	8.79	3.31
793.67	172.25	50.68	-188.15	-53.05	-0.431	0.132	(4)	(4)	113.91	39.16	4.60	11.39	3.92	11.39	3.13
797.60	244.27	46.50	-266.81	-48.67	-0.612	0.121	(4)	(4)	*	*	*	*	*	*	*
801.53	419.76	42.95	-458.50	-44.95	-1.051	0.112	(4)	(4)	*	*	*	*	*	*	*
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 807 AND Xo 863															
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
813.33	43.39	286.90	-45.82	-324.14	-0.116	0.908	(4)	(4)	*	*	*	*	*	*	*
817.27	47.13	176.83	-49.77	-199.79	-0.126	0.560	(4)	(4)	*	*	*	*	*	*	*
821.20	51.55	127.89	-54.45	-144.50	-0.138	0.405	(4)	(4)	40.19	108.45	5.60	4.02	13.27	4.02	5.20
825.13	56.91	100.17	-60.10	-113.17	-0.152	0.317	(4)	(4)	44.36	84.94	5.60	4.44	10.39	4.44	5.94
829.07	63.52	82.29	-67.07	-92.97	-0.169	0.261	(4)	(4)	49.51	69.78	5.60	4.95	8.54	4.95	4.69
833.00	71.84	69.85	-75.86	-78.92	-0.192	0.221	(4)	(4)	56.00	59.23	5.60	5.60	7.25	5.60	4.44
836.93	82.67	60.68	-87.30	-68.55	-0.221	0.192	(4)	(4)	64.44	51.45	5.60	6.44	6.30	6.44	4.19
840.87	97.38	53.62	-102.84	-60.58	-0.260	0.170	(4)	(4)	75.92	45.47	5.60	7.59	5.56	7.59	3.95
844.80	118.41	48.04	-125.05	-54.28	-0.316	0.152	(4)	(4)	92.31	40.74	5.60	9.23	4.99	9.23	3.73
848.73	151.02	43.52	-159.48	-49.17	-0.403	0.138	(4)	(4)	117.73	36.90	5.60	11.77	4.52	11.77	3.52
852.67	208.62	39.77	-220.31	-44.93	-0.557	0.126	(4)	(4)	162.63	33.72	5.60	16.26	4.13	16.26	3.32
856.60	336.73	36.61	-355.60	-41.37	-0.898	0.113	(4)	(4)	*	*	*	*	*	*	*
860.53	872.49	33.93	-921.39	-38.33	-2.328	0.107	(4)	(4)	*	*	*	*	*	*	*
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 863 AND Xo 919															
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
872.33	38.91	202.82	-43.96	-236.24	-0.123	0.616	(4)	(4)	*	*	*	*	*	*	*
876.27	42.50	142.59	-48.02	-166.10	-0.135	0.433	(4)	(4)	*	*	*	*	*	*	*
880.20	46.81	110.01	-52.88	-128.15	-0.148	0.334	(4)	(4)	39.69	107.44	5.70	4.86	10.71	4.86	5.04
884.13	52.08	89.55	-58.84	-104.31	-0.165	0.272	(4)	(4)	44.16	87.46	5.70	5.40	8.72	5.40	4.77
888.07	58.72	75.48	-66.34	-87.92	-0.186	0.229	(4)	(4)	49.79	73.71	5.70	6.09	7.35	6.09	4.51
892.00	67.26	65.25	-75.99	-76.01	-0.213	0.198	(4)	(4)	57.04	63.72	5.70	6.98	6.36	6.98	4.25
895.93	78.72	57.46	-88.94	-66.93	-0.249	0.175	(4)	(4)	66.75	56.12	5.70	8.17	5.60	8.17	3.99
899.87	*	*	*	*	*	*	*	*	80.50	50.12	5.70	9.85	5.00	9.85	3.76
903.80	*	*	*	*	*	*	*	*	101.32	45.29	5.70	12.40	4.52	12.40	3.54
907.73	*	*	*	*	*	*	*	*	136.65	41.31	5.70	16.72	4.12	16.72	3.34
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 919 AND Xo 979.5															
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
923.47	37.49	615.34	-42.50	-544.22	-0.103	1.286	(4)	(4)	*	*	*	*	*	*	*
927.40	40.32	327.45	-45.71	-289.61	-0.110	0.685	(4)	(4)	*	*	*	*	*	*	*
931.33	43.61	223.08	-49.43	-197.30	-0.119	0.466	(4)	(4)	*	*	*	*	*	*	*
935.27	47.49	169.06	-53.84	-149.52	-0.130	0.353	(4)	(4)	45.14	148.74	7.00	4.50	15.64	4.50	6.51
939.20	52.12	136.16	-59.09	-120.43	-0.143	0.285	(4)	(4)	49.54	119.80	7.00	4.94	12.60	4.94	6.18
943.13	57.76	113.99	-65.47	-100.82	-0.158	0.238	(4)	(4)	54.89	100.29	7.00	5.47	10.55	5.47	5.86
947.07	64.77	97.99	-73.43	-86.67	-0.177	0.205	(4)	(4)	61.56	86.21	7.00	6.14	9.07	6.14	5.55
951.00	73.73	85.96	-83.55	-76.02	-0.202	0.180	(4)	(4)	70.05	75.63	7.00	6.99	7.95	6.99	5.26
954.93	85.49	76.55	-96.92	-67.71	-0.234	0.160	(4)	(4)	81.26	67.35	7.00	8.10	7.08	8.10	4.98
958.87	101.82	68.99	-115.43	-61.02	-0.279	0.144	(4)	(4)	96.78	60.70	7.00	9.65	6.38	9.65	4.72
962.80	*	*	*	*	*	*	*	*	119.55	55.25	7.00	11.92	5.81	11.92	4.47
966.73	*	*	*	*	*	*	*	*	156.34	50.70	7.00	15.59	5.33	15.59	4.24
974.60	428.69	49.48	-485.98	-43.75	-1.173	0.103	(4)	(4)	*	*	*	*	*	*	*
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 979.5 AND Xo 1040															
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
986.40	57.69	395.31	-45.39	-345.73	-0.107	0.833	(4)	(4)	*	*	*	*	*	*	*
990.33	62.25	251.85	-48.98	-220.27	-0.116	0.531	(4)	(4)	*	*	*	*	*	*	*
994.27	67.62	184.67	-53.20	-161.51	-0.126	0.389	(4)	(4)	52.92	165.89	8.00	5.56	24.69	5.56	7.69
998.20	73.98	145.86	-58.20	-127.57	-0.138	0.307	(4)	(4)	57.89	131.03	8.00	6.09	19.50	6.09	7.43
1002.13	81.65	120.54	-64.24	-105.41	-0.152	0.254	(4)	(4)	63.90	108.27	8.00	6.72	16.12	6.72	7.17
1006.07	91.14	102.65	-71.70	-89.78	-0.169	0.216	(4)	(4)	71.32	92.22	8.00	7.50	13.73	7.50	6.91
1010.00	103.08	89.43	-81.09	-78.21	-0.192	0.189	(4)	(4)	80.67	80.34	8.00	8.48	11.96	8.48	6.65
1013.93	118.62	79.22	-93.31	-69.29	-0.221	0.167	(4)	(4)	92.83	71.17	8.00	9.76	10.59	9.76	6.39
1017.87	139.74	71.08	-109.93	-62.17	-0.260	0.150	(4)	(4)	109.35	63.86	8.00	11.50	9.50	11.50	6.12
1021.80	169.91	64.48	-133.67	-56.40	-0.316	0.136	(4)	(4)	132.97	57.93	8.00	13.98	8.62	13.98	5.87
1025.73	216.70	59.00	-170.48	-51.60	-0.403	0.124	(4)	(4)	169.59	53.00	8.00	17.83	7.89	17.83	5.62
1029.67	299.35	54.37	-235.50	-47.55	-0.557	0.115	(4)	(4)	234.27	48.84	8.00	24.63	7.27	24.63	5.38
1033.60	483.17	50.42	-380.11	-44.09	-0.898	0.106	(4)	(4)	*	*	*	*	*	*	*
1037.53	1251.95	47.00	-984.90	-41.11	-2.328	0.099	(4)	(4)	*	*	*	*	*	*	*
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:

1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1040 AND Xo 1090.33															
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1049.33	57.09	302.98	-48.40	-244.69	-0.140	0.616	(4)	(4)	*	*	*	*	*	*	*
1053.27	63.16	213.03	-53.55	-172.04	-0.155	0.433	(4)	(4)	*	*	*	*	*	*	*
1057.20	70.65	164.34	-59.90	-132.73	-0.174	0.334	(4)	(4)	61.53	134.81	8.00	9.16	17.01	9.16	7.24
1061.13	80.16	133.78	-67.96	-108.04	-0.197	0.272	(4)	(4)	69.81	109.74	8.00	10.39	13.84	10.39	6.93
1065.07	92.66	112.76	-78.56	-91.06	-0.228	0.229	(4)	(4)	80.70	92.49	8.00	12.01	11.67	12.01	6.60
1069.00	109.74	97.48	-93.04	-78.72	-0.270	0.198	(4)	(4)	95.56	79.96	8.00	14.22	10.09	14.22	6.27
1072.93	134.51	85.85	-114.05	-69.33	-0.330	0.175	(4)	(4)	117.15	70.41	8.00	17.44	8.88	17.44	5.95
1076.87	173.89	76.67	-147.44	-61.92	-0.427	0.156	(4)	(4)	151.44	62.89	8.00	22.54	7.93	22.54	5.63
1080.80	245.60	69.29	-208.24	-55.96	-0.603	0.141	(4)	(4)	*	*	*	*	*	*	*
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 1090.33 AND Xo 1140.67															
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1092.60	45.60	1992.13	-44.87	-1621.97	-0.120	2.533	(4)	(4)	*	*	*	*	*	*	*
1096.53	49.67	729.38	-48.87	-593.85	-0.130	0.927	(4)	(4)	*	*	*	*	*	*	*
1100.47	54.54	445.97	-53.66	-363.10	-0.143	0.567	(4)	(4)	*	*	*	*	*	*	*
1104.40	60.44	321.41	-59.47	-261.68	-0.159	0.409	(4)	(4)	*	*	*	*	*	*	*
1108.33	67.78	251.23	-66.70	-204.55	-0.178	0.319	(4)	(4)	71.71	151.66	7.20	8.99	16.30	9.05	6.60
1112.27	77.19	206.11	-75.95	-167.82	-0.202	0.262	(4)	(4)	81.66	124.43	7.20	10.30	13.38	10.30	6.34
1116.20	89.59	174.81	-88.15	-142.32	-0.235	0.222	(4)	(4)	94.78	105.53	7.20	11.96	11.34	11.96	6.08
1120.13	106.73	151.76	-105.02	-123.55	-0.280	0.193	(4)	(4)	112.91	91.61	7.20	14.24	9.85	14.24	5.81
1124.07	132.06	134.03	-129.94	-109.12	-0.346	0.170	(4)	(4)	139.71	80.91	7.20	17.63	8.70	17.63	5.55
1128.00	173.03	120.05	-170.25	-97.74	-0.454	0.153	(4)	(4)	183.04	72.47	7.20	23.09	7.79	23.09	5.29
1131.93	250.83	108.71	-246.80	-88.51	-0.658	0.138	(4)	(4)	*	*	*	*	*	*	*
1135.87	456.72	99.29	-449.39	-80.85	-1.198	0.126	(4)	(4)	*	*	*	*	*	*	*
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1140.67 AND Xo 1191															
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1151.60	86.26	424.60	-93.43	-478.57	-0.146	0.526	(4)	(4)	*	*	*	*	*	*	*
1155.53	95.82	312.31	-103.78	-352.01	-0.162	0.387	(4)	(4)	76.95	185.10	20.65	8.27	23.71	8.27	8.12
1159.47	107.79	246.86	-116.75	-278.23	-0.182	0.306	(4)	(4)	86.57	146.30	20.65	9.31	18.74	9.31	7.85
1163.40	123.13	203.18	-133.37	-230.13	-0.208	0.253	(4)	(4)	98.89	121.01	20.65	10.63	15.50	10.63	7.55
1167.33	143.58	174.00	-155.52	-196.20	-0.243	0.216	(4)	(4)	115.31	103.17	20.65	12.40	13.21	12.40	7.23
1171.27	172.26	151.66	-186.58	-158.97	-0.291	0.188	(4)	(4)	138.34	89.89	20.65	14.87	11.51	14.87	6.91
1175.20	215.10	134.40	-232.98	-140.87	-0.364	0.167	(4)	(4)	172.75	79.66	20.65	18.57	10.20	18.57	6.60
1179.13	286.32	120.67	-310.12	-126.48	-0.484	0.150	(4)	(4)	229.94	71.52	20.65	24.72	9.16	24.72	6.29
1181.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1183.07	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1187.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1190.93	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT
LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1191 AND Xo 1249															
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1194.87	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1198.80	91.62	589.67	-92.01	-594.13	-0.115	0.737	(4)	(4)	*	*	*	*	*	*	*
1202.73	99.40	392.11	-99.83	-395.07	-0.124	0.490	(4)	(4)	ALLOWABLE LOADS ARE DEFINED IN PARAGRAPH I.3.5						
1206.67	108.66	293.52	-109.12	-295.74	-0.136	0.367	(4)	(4)							
1210.60	119.78	234.66	-120.29	-236.44	-0.150	0.293	(4)	(4)							
1214.53	133.43	195.47	-134.00	-196.95	-0.167	0.244	(4)	(4)							
1218.47	150.65	167.43	-151.30	-168.70	-0.188	0.209	(4)	(4)							
1222.40	172.91	146.47	-173.65	-147.59	-0.216	0.183	(4)	(4)							
1226.33	202.88	130.18	-203.75	-131.17	-0.254	0.163	(4)	(4)							
1230.27	245.56	117.12	-246.62	-118.01	-0.307	0.146	(4)	(4)	*	*	*	*	*	*	*
1234.20	310.77	106.47	-312.10	-107.27	-0.389	0.133	(4)	(4)	*	*	*	*	*	*	*
1238.13	423.13	97.59	-424.94	-98.33	-0.529	0.122	(4)	(4)	*	*	*	*	*	*	*
1242.07	663.69	90.06	-666.54	-90.74	-0.830	0.113	(4)	(4)	*	*	*	*	*	*	*
1246.00	1533.13	83.63	-1539.71	-84.26	-1.917	0.105	(4)	(4)	*	*	*	*	*	*	*
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES: 1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.

2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.

3. * Attach point not available at locations where asterisk appears.

4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-2 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR POST-SRB-STAGING CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAME Xo 1249 AND BRIDGE ATTACH PIN Xo 1301.00															
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1269.60	154.41	167.36	-155.67	-167.36	-0.183	0.279	(4)	(4)	NO KEEL ATTACH POINTS AVAILABLE						
1273.53	176.50	140.55	-177.94	-140.55	-0.209	0.234	(4)	(4)							
1277.47	206.05	121.10	-207.73	-121.10	-0.244	0.202	(4)	(4)							
1281.40	247.37	106.40	-249.39	-106.40	-0.293	0.177	(4)	(4)							
1301.00	*	*	*	*	*	*	*	*							

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

LONGERON, 1000 LBS PER SIDE										KEEL, 1000 LBS					
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 582 AND Xo 636															
582.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
612.73	*	*	*	*	*	*	*	*	6.96	24.60	0.90	0.71	2.44	0.71	0.90
616.67	53.92	66.59	-53.92	-66.74	-0.297	0.166	(4)	(4)	8.38	21.81	0.90	0.86	2.16	0.86	0.90
620.60	67.68	59.81	-67.68	-59.95	-0.373	0.149	(4)	(4)	10.52	19.59	0.90	1.08	1.94	1.08	0.90
624.53	90.86	54.28	-90.86	-54.41	-0.501	0.135	(4)	(4)	14.12	17.78	0.90	1.45	1.76	1.45	0.90
628.47	138.41	49.68	-138.41	-49.79	-0.764	0.124	(4)	(4)	*	*	*	*	*	*	*
632.40	289.50	45.80	-289.50	-45.91	-1.597	0.114	(4)	(4)	*	*	*	*	*	*	*
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 636 AND Xo 693															
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
644.20	53.90	268.16	-35.60	-290.49	-0.118	0.701	(4)	(4)	*	*	*	*	*	*	*
648.13	58.62	181.33	-38.72	-196.38	-0.128	0.474	(4)	(4)	*	*	*	*	*	*	*
652.07	64.26	136.88	-42.45	-148.23	-0.140	0.358	(4)	(4)	19.50	65.91	1.80	1.94	6.59	1.94	1.80
656.00	71.09	109.98	-46.96	-119.10	-0.155	0.288	(4)	(4)	21.57	52.96	1.80	2.14	5.29	2.14	1.80
659.93	79.53	91.91	-52.54	-99.54	-0.174	0.240	(4)	(4)	24.13	44.26	1.80	2.40	4.42	2.40	1.80
663.87	*	*	*	*	*	*	*	*	27.39	38.02	1.80	2.72	3.80	2.72	1.80
667.80	*	*	*	*	*	*	*	*	31.67	33.64	1.80	3.14	3.37	3.14	1.80
671.73	*	*	*	*	*	*	*	*	37.52	30.17	1.80	3.72	3.02	3.72	1.80
675.67	*	*	*	*	*	*	*	*	46.05	27.37	1.80	4.57	2.73	4.57	1.80
679.60	*	*	*	*	*	*	*	*	59.55	25.03	1.80	5.91	2.50	5.91	1.80
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 693 AND Xo 750															
693.00	*	*	*	*	*	*	(4)	(4)	*	*	*	*	*	*	*
699.27	40.68	343.11	-46.96	-400.00	-0.113	0.917	(4)	(4)	*	*	*	*	*	*	*
703.20	44.10	210.91	-50.90	-245.88	-0.123	0.564	(4)	(4)	*	*	*	*	*	*	*
707.13	48.14	152.25	-55.56	-177.49	-0.134	0.407	(4)	(4)	*	*	*	*	*	*	*
711.07	53.02	119.05	-61.19	-138.79	-0.148	0.319	(4)	(4)	29.71	84.03	2.92	2.69	8.40	2.96	2.49
715.00	58.96	97.78	-68.06	-114.00	-0.164	0.261	(4)	(4)	33.04	69.02	2.92	3.30	6.90	3.30	2.41
718.93	66.43	82.96	-76.67	-96.72	-0.185	0.222	(4)	(4)	37.22	58.56	2.92	3.71	5.85	3.71	2.33
722.87	76.08	72.02	-87.80	-83.96	-0.212	0.193	(4)	(4)	42.63	50.84	2.92	4.25	5.08	4.25	2.27
726.80	88.97	63.65	-102.67	-74.20	-0.248	0.170	(4)	(4)	49.85	44.93	2.92	4.98	4.49	4.98	2.20
730.73	107.11	57.01	-123.61	-66.47	-0.298	0.152	(4)	(4)	60.02	40.25	2.92	5.99	4.02	5.99	2.14
734.67	*	*	*	*	*	*	*	*	75.44	36.44	2.92	7.53	3.64	7.53	2.08
738.60	*	*	*	*	*	*	*	*	101.45	33.30	2.92	10.13	3.33	10.13	2.03
742.53	276.29	43.43	-318.88	-50.64	-0.770	0.116	(4)	(4)	*	*	*	*	*	*	*
746.47	584.67	40.23	-674.80	-46.90	-1.629	0.108	(4)	(4)	*	*	*	*	*	*	*
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 750 AND Xo 807															
750.00	*	*	*	*	*	*	(4)	(4)	*	*	*	*	*	*	*
758.27	45.42	251.03	-51.47	-280.11	-0.118	0.695	(4)	(4)	*	*	*	*	*	*	*
762.20	49.40	170.16	-55.98	-189.88	-0.128	0.471	(4)	(4)	*	*	*	*	*	*	*
766.13	54.15	128.71	-61.37	-143.61	-0.141	0.356	(4)	(4)	37.15	106.01	3.84	3.71	10.60	3.16	3.84
770.07	59.93	103.43	-67.91	-115.42	-0.156	0.286	(4)	(4)	41.12	85.20	3.84	4.11	8.52	3.50	3.84
774.00	67.07	86.51	-76.00	-96.52	-0.174	0.240	(4)	(4)	46.01	71.25	3.84	4.60	7.13	3.92	3.84
777.93	76.14	74.33	-86.27	-82.94	-0.198	0.206	(4)	(4)	52.24	61.22	3.84	5.22	6.12	4.44	3.84
781.87	88.07	65.14	-99.80	-72.69	-0.229	0.180	(4)	(4)	60.43	53.66	3.84	6.04	5.37	5.14	3.73
785.80	104.40	57.99	-118.30	-64.71	-0.271	0.161	(4)	(4)	71.63	47.77	3.84	7.16	4.78	6.09	3.52
789.73	128.16	52.26	-145.22	-58.31	-0.333	0.145	(4)	(4)	87.93	43.04	3.84	8.79	4.30	7.48	3.31
793.67	166.04	47.54	-188.15	-53.05	-0.431	0.132	(4)	(4)	113.91	39.16	3.84	11.39	3.92	9.69	3.13
797.60	235.46	43.62	-266.81	-48.67	-0.612	0.121	(4)	(4)	*	*	*	*	*	*	*
801.53	404.63	40.29	-458.50	-44.95	-1.051	0.112	(4)	(4)	*	*	*	*	*	*	*
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 807 AND Xo 863															
807.00	*	*	*	*	*	*	(4)	(4)	*	*	*	*	*	*	*
813.33	42.61	286.90	-45.82	-324.14	-0.116	0.908	(4)	(4)	*	*	*	*	*	*	*
817.27	46.29	176.83	-49.77	-199.79	-0.126	0.560	(4)	(4)	*	*	*	*	*	*	*
821.20	50.63	127.89	-54.45	-144.50	-0.138	0.405	(4)	(4)	40.19	108.45	5.48	4.02	13.27	4.02	4.75
825.13	55.89	100.17	-60.10	-113.17	-0.152	0.317	(4)	(4)	44.36	84.94	5.48	4.44	10.39	4.44	4.58
829.07	62.38	82.29	-67.07	-92.97	-0.169	0.261	(4)	(4)	49.51	69.78	5.48	4.95	8.54	4.95	4.43
833.00	70.55	69.85	-75.86	-78.92	-0.192	0.221	(4)	(4)	56.00	59.23	5.48	5.60	7.25	5.60	4.28
836.93	81.19	60.68	-87.30	-68.55	-0.221	0.192	(4)	(4)	64.44	51.45	5.48	6.44	6.30	6.44	4.15
840.87	95.65	53.62	-102.84	-60.58	-0.260	0.170	(4)	(4)	75.92	45.47	5.48	7.59	5.56	7.59	4.02
844.87	116.29	48.04	-125.05	-54.28	-0.316	0.152	(4)	(4)	92.31	40.74	5.48	9.23	4.99	9.23	3.90
848.73	148.32	43.52	-159.48	-49.17	-0.403	0.138	(4)	(4)	117.73	36.90	5.48	11.77	4.52	11.77	3.78
852.67	204.90	39.77	-220.31	-44.93	-0.557	0.126	(4)	(4)	162.63	33.72	5.48	16.26	4.13	16.26	3.68
856.60	330.72	36.61	-355.60	-41.37	-0.898	0.116	(4)	(4)	*	*	*	*	*	*	*
860.53	856.91	33.93	-921.39	-38.33	-2.328	0.107	(4)	(4)	*	*	*	*	*	*	*
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 863 AND Xo 919															
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
872.33	38.91	186.07	-43.96	-236.24	-0.123	0.616	(4)	(4)	*	*	*	*	*	*	*
876.27	42.50	130.82	-48.02	-166.10	-0.135	0.433	(4)	(4)	*	*	*	*	*	*	*
880.20	46.81	100.93	-52.88	-128.15	-0.148	0.334	(4)	(4)	39.69	103.30	5.34	4.86	10.33	4.86	4.61
884.13	52.08	82.16	-58.84	-104.31	-0.165	0.272	(4)	(4)	44.16	84.09	5.34	5.40	8.41	5.40	4.47
888.07	58.72	69.25	-66.34	-87.92	-0.186	0.229	(4)	(4)	49.79	70.87	5.34	6.09	7.09	6.09	4.33
892.00	67.26	59.86	-74.44	-76.01	-0.213	0.198	(4)	(4)	57.04	61.27	5.34	6.98	6.13	6.98	4.21
895.93	78.72	52.72	-87.13	-63.79	-0.249	0.175	(4)	(4)	66.75	56.12	5.34	8.17	5.60	8.17	4.09
899.87	*	*	*	*	*	*	*	*	80.50	48.19	5.34	9.85	4.82	9.85	3.98
903.80	*	*	*	*	*	*	*	*	101.32	43.71	5.34	12.40	4.37	12.40	3.88
907.73	*	*	*	*	*	*	*	*	136.65	39.99	5.34	16.72	4.00	16.72	3.78
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 919 AND Xo 979.5															
919.00	*	*	*	*	*	*	(4)	(4)	*	*	*	*	*	*	*
923.47	33.47	615.34	-41.67	-544.22	-0.103	1.286	(4)	(4)	*	*	*	*	*	*	*
927.40	36.00	327.45	-44.83	-289.61	-0.110	0.685	(4)	(4)	*	*	*	*	*	*	*
931.33	38.94	223.08	-48.49	-197.30	-0.119	0.466	(4)	(4)	45.14	148.74	5.83	4.50	15.64	4.50	4.61
935.27	42.40	169.06	-53.52	-149.52	-0.130	0.353	(4)	(4)	49.54	119.80	5.83	4.94	12.60	4.94	4.42
939.20	46.54	136.18	-58.75	-120.43	-0.143	0.285	(4)	(4)	54.89	100.29	5.83	5.47	10.55	5.47	4.24
943.13	51.57	113.99	-65.47	-100.82	-0.158	0.238	(4)	(4)	61.56	86.21	5.83	6.14	9.07	6.14	4.08
947.07	57.83	97.99	-73.43	-86.67	-0.177	0.205	(4)	(4)	70.05	75.63	5.83	6.99	7.95	6.99	3.93
951.00	65.83	85.96	-83.55	-76.02	-0.202	0.180	(4)	(4)	81.26	67.35	5.83	8.10	7.08	8.10	3.79
954.93	76.33	76.55	-96.92	-67.71	-0.234	0.160	(4)	(4)	96.78	60.70	5.83	9.65	6.38	9.65	3.65
958.87	90.91	68.99	-115.43	-61.02	-0.279	0.144	(4)	(4)	119.55	55.25	5.83	11.92	5.81	11.92	3.52
962.80	*	*	*	*	*	*	(4)	(4)	156.34	50.70	5.83	15.59	5.33	15.59	3.40
966.73	*	*	*	*	*	*	(4)	(4)	*	*	*	*	*	*	*
974.60	382.76	49.48	-485.98	-43.75	-1.173	0.103	(4)	(4)	*	*	*	*	*	*	*
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 979.5 AND Xo 1040															
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
986.40	47.08	295.80	-53.42	-345.73	-0.107	0.833	(4)	(4)	*	*	*	*	*	*	*
990.33	50.80	188.45	-57.65	-220.27	-0.116	0.531	(4)	(4)	*	*	*	*	*	*	*
994.27	55.18	138.18	-62.62	-161.51	-0.126	0.389	(4)	(4)	19.46	21.67	7.64	5.56	24.69	4.67	5.20
998.20	60.37	109.14	-68.50	-127.57	-0.138	0.307	(4)	(4)	21.58	20.88	7.64	6.09	19.50	5.18	5.01
1002.13	66.63	90.19	-75.61	-105.41	-0.152	0.254	(4)	(4)	24.17	20.17	7.64	6.72	16.12	5.80	4.84
1006.07	68.11	76.81	-84.39	-89.78	-0.169	0.216	(4)	(4)	27.33	19.50	7.64	7.50	13.73	6.56	4.68
1010.00	77.04	66.92	-95.45	-78.21	-0.192	0.189	(4)	(4)	31.33	18.88	7.64	8.48	11.96	7.52	4.53
1013.93	88.65	62.38	-109.84	-69.29	-0.221	0.167	(4)	(4)	36.50	18.29	7.64	9.76	10.59	8.76	4.39
1017.87	104.43	55.97	-129.39	-62.17	-0.260	0.150	(4)	(4)	43.58	17.71	7.64	11.50	9.50	10.46	4.25
1021.80	126.98	50.77	-157.33	-56.40	-0.316	0.136	(4)	(4)	53.67	17.17	7.64	13.98	8.62	12.88	4.12
1025.73	161.95	46.46	-200.66	-51.60	-0.403	0.124	(4)	(4)	69.29	16.67	7.64	17.83	7.89	16.63	4.00
1029.67	223.72	42.81	-277.20	-47.55	-0.557	0.115	(4)	(4)	96.92	16.17	7.64	24.63	7.27	23.26	3.88
1033.60	361.10	39.70	-447.42	-44.09	-0.898	0.106	(4)	(4)	*	*	*	*	*	*	*
1037.53	935.64	37.01	-1159.30	-41.11	-2.328	0.099	(4)	(4)	*	*	*	*	*	*	*
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y ($Z \neq 0$)		$\pm X_K$ ($Z=0$)	$\pm Z_K(X=0)$		$\pm R_K(X, Z\neq 0)$	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1040 AND Xo 1090.33															
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1049.33	43.58	219.55	-43.59	-244.69	-0.140	0.616	(4)	(4)	*	*	*	*	*	*	*
1053.27	48.21	154.37	-48.23	-172.04	-0.155	0.433	(4)	(4)	*	*	*	*	*	*	*
1057.20	53.93	119.09	-53.95	-132.73	-0.174	0.334	(4)	(4)	27.04	30.17	8.00	9.16	17.01	6.49	7.24
1061.13	61.19	96.94	-61.20	-108.04	-0.197	0.272	(4)	(4)	30.67	28.88	8.00	10.39	13.84	7.36	6.93
1065.07	70.02	81.71	-70.75	-91.06	-0.228	0.229	(4)	(4)	35.46	27.50	8.00	12.01	11.67	8.51	6.60
1069.00	82.93	70.64	-83.79	-78.72	-0.270	0.198	(4)	(4)	42.00	26.13	8.00	14.22	10.09	10.08	6.27
1072.93	101.65	62.21	-102.71	-69.33	-0.330	0.175	(4)	(4)	51.54	24.79	8.00	17.44	8.88	12.37	5.95
1076.87	131.41	55.56	-132.78	-61.92	-0.427	0.156	(4)	(4)	66.63	23.46	8.00	22.54	7.93	15.99	5.63
1080.80	185.60	50.21	-187.54	-55.96	-0.603	0.141	(4)	(4)	*	*	*	*	*	*	*
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 1090.33 AND Xo 1140.67															
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1092.60	42.62	1167.13	-44.87	-1621.9	-0.120	2.533	(4)	(4)	*	*	*	*	*	*	*
1096.53	46.42	427.32	-48.87	-593.85	-0.130	0.927	(4)	(4)	*	*	*	*	*	*	*
1100.47	50.97	261.28	-53.66	-363.10	-0.143	0.567	(4)	(4)	*	*	*	*	*	*	*
1104.40	56.49	188.30	-59.47	-261.68	-0.159	0.409	(4)	(4)	*	*	*	*	*	*	*
1108.33	63.35	149.01	-66.70	-204.55	-0.178	0.319	(4)	(4)	71.23	151.66	7.20	9.05	16.30	9.05	5.41
1112.27	72.14	120.76	-75.96	-167.82	-0.202	0.262	(4)	(4)	81.66	124.43	7.20	10.30	13.38	10.30	5.20
1116.20	75.27	102.41	-88.15	-83.01	-0.235	0.222	(4)	(4)	94.78	105.53	7.20	11.96	11.34	11.96	5.00
1120.13	77.17	88.91	-105.02	-90.06	-0.280	0.193	(4)	(4)	112.91	91.61	7.20	14.24	9.85	14.24	4.82
1124.07	95.49	78.53	-129.94	-97.11	-0.346	0.170	(4)	(4)	139.71	80.91	7.20	17.63	8.70	17.63	4.65
1128.00	125.10	80.57	-170.25	-91.69	-0.454	0.153	(4)	(4)	183.04	72.47	7.20	23.09	7.79	23.09	4.50
1131.93	181.36	72.96	-246.80	-86.27	-0.658	0.138	(4)	(4)	*	*	*	*	*	*	*
1135.87	330.22	66.64	-449.39	-80.85	-1.198	0.126	(4)	(4)	*	*	*	*	*	*	*
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1140.67 AND Xo 1191															
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1151.60	77.02	331.27	-93.43	-330.21	-0.146	0.526	(4)	(4)	*	*	*	*	*	*	*
1155.53	85.55	243.66	-103.78	-242.88	-0.162	0.387	(4)	(4)	76.95	185.10	29.38	8.27	23.71	6.91	8.12
1159.47	96.24	192.59	-115.15	-191.98	-0.182	0.306	(4)	(4)	86.57	146.30	29.38	9.31	18.74	7.77	7.85
1163.40	107.79	159.29	-118.20	-158.79	-0.208	0.253	(4)	(4)	98.89	121.01	29.38	10.63	15.50	8.87	7.55
1167.33	112.83	135.81	-119.32	-135.38	-0.243	0.216	(4)	(4)	115.31	103.17	29.38	12.40	13.21	10.35	7.23
1171.27	135.35	118.33	-151.08	-98.49	-0.291	0.188	(4)	(4)	138.34	89.89	29.38	14.87	11.51	12.41	6.91
1175.20	169.02	124.34	-178.75	-99.63	-0.364	0.167	(4)	(4)	172.75	79.66	29.38	18.57	10.20	15.50	6.60
1179.13	224.98	120.67	-237.92	-100.54	-0.484	0.150	(4)	(4)	229.94	71.52	29.38	24.72	9.16	20.63	6.29
1181.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1183.07	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1187.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1190.93	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS							
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1191 AND Xo 1249															
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1194.87	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1198.80	91.62	589.67	-111.67	-575.06	-0.115	0.737	(4)	(4)	*	*	*	*	*	*	*
1202.73	99.40	392.11	-116.60	-382.40	-0.124	0.490	(4)	(4)							
1206.67	108.66	293.52	-121.53	-286.25	-0.136	0.367	(4)	(4)							
1210.60	119.78	234.66	-126.46	-228.85	-0.150	0.293	(4)	(4)							
1214.53	133.43	195.47	-131.39	-190.63	-0.167	0.244	(4)	(4)	ALLOWABLE LOADS ARE DEFINED IN PARAGRAPH I.3.5						
1218.47	150.65	167.43	-136.32	-163.29	-0.188	0.209	(4)	(4)							
1222.40	172.91	146.48	-159.66	-131.00	-0.216	0.183	(4)	(4)							
1226.33	202.98	130.18	-187.34	-125.69	-0.254	0.163	(4)	(4)							
1230.27	245.56	117.12	-226.75	-120.38	-0.307	0.146	(4)	(4)	*	*	*	*	*	*	*
1234.20	310.77	106.47	-286.96	-115.07	-0.389	0.133	(4)	(4)	*	*	*	*	*	*	*
1238.13	423.13	97.59	-390.71	-109.75	-0.529	0.122	(4)	(4)	*	*	*	*	*	*	*
1242.07	663.69	90.06	-612.85	-104.44	-0.830	0.113	(4)	(4)	*	*	*	*	*	*	*
1246.00	1533.13	83.63	-1415.68	-99.13	-1.917	0.105	(4)	(4)	*	*	*	*	*	*	*
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-3 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM YAW AND ROLL CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAME Xo 1249 AND BRIDGE ATTACH PIN Xo 1301.00															
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1269.60	154.41	167.36	-155.67	-167.36	-0.183	0.279	(4)	(4)	NO KEEL ATTACH POINTS AVAILABLE						
1273.53	176.50	140.55	-177.94	-140.55	-0.209	0.234	(4)	(4)							
1277.47	206.05	121.10	-207.73	-121.10	-0.244	0.202	(4)	(4)							
1281.40	247.37	106.40	-249.39	-106.40	-0.293	0.177	(4)	(4)							
1301.00	*	*	*	*	*	*	*	*							

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 582 AND Xo 636															
582.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
612.73	*	*	*	*	*	*	*	*	6.96	24.60	0.90	0.71	2.44	0.71	0.90
616.67	53.92	53.92	-53.92	-66.74	-0.297	0.166	(4)	(4)	8.38	21.81	0.90	0.86	2.16	0.86	0.90
620.60	67.68	47.25	-67.68	-59.95	-0.373	0.149	(4)	(4)	10.52	19.59	0.90	1.08	1.94	1.08	0.90
624.53	90.86	44.32	-90.86	-54.41	-0.501	0.135	(4)	(4)	14.12	17.78	0.90	1.45	1.76	1.45	0.90
628.47	138.41	41.39	-138.41	-49.79	-0.764	0.124	(4)	(4)	*	*	*	*	*	*	*
632.40	289.50	38.47	-289.50	-45.91	-1.597	0.114	(4)	(4)	*	*	*	*	*	*	*
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 636 AND Xo 693															
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
644.20	53.90	164.81	-37.28	-290.49	-0.118	0.701	(4)	(4)	*	*	*	*	*	*	*
648.13	54.54	111.42	-40.55	-196.38	-0.128	0.474	(4)	(4)	*	*	*	*	*	*	*
652.07	55.18	84.10	-44.45	-148.23	-0.140	0.358	(4)	(4)	19.50	71.97	1.80	1.94	7.18	1.94	1.80
656.00	55.82	67.57	-49.17	-119.10	-0.155	0.288	(4)	(4)	21.57	57.83	1.80	2.14	5.77	2.14	1.80
659.93	56.47	56.48	-55.02	-99.54	-0.174	0.240	(4)	(4)	24.13	48.33	1.80	2.40	4.82	2.40	1.80
663.87	*	*	*	*	*	*	*	*	27.39	41.51	1.80	2.72	4.14	2.72	1.80
667.80	*	*	*	*	*	*	*	*	31.67	36.37	1.80	3.14	3.63	3.14	1.80
671.73	*	*	*	*	*	*	*	*	37.52	32.37	1.80	3.72	3.23	3.72	1.80
675.67	*	*	*	*	*	*	*	*	46.05	29.15	1.80	4.57	2.91	4.57	1.80
679.60	*	*	*	*	*	*	*	*	59.55	26.53	1.80	5.91	2.65	5.91	1.80
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 693 AND Xo 750															
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
699.27	36.16	329.91	-46.96	-303.55	-0.113	0.917	(4)	(4)	*	*	*	*	*	*	*
703.20	39.21	202.80	-50.90	-186.59	-0.123	0.564	(4)	(4)	*	*	*	*	*	*	*
707.13	42.80	146.39	-55.56	-134.69	-0.134	0.407	(4)	(4)	*	*	*	*	*	*	*
711.07	47.14	114.47	-61.19	-105.33	-0.148	0.319	(4)	(4)	29.71	84.03	2.92	2.96	8.40	2.96	2.49
715.00	52.42	94.02	-68.06	-86.51	-0.164	0.261	(4)	(4)	33.04	69.02	2.92	3.30	6.90	3.30	2.41
718.93	59.06	79.77	-76.67	-73.40	-0.185	0.222	(4)	(4)	37.22	58.56	2.92	3.71	5.85	3.71	2.33
722.87	67.64	69.25	-87.80	-63.72	-0.212	0.193	(4)	(4)	42.63	50.84	2.92	4.25	5.08	4.25	2.27
726.80	79.10	61.20	-102.67	-65.18	-0.248	0.170	(4)	(4)	49.85	44.93	2.92	4.98	4.49	4.98	2.20
730.73	95.22	54.82	-123.61	-65.71	-0.298	0.152	(4)	(4)	60.02	40.25	2.92	5.99	4.02	5.99	2.14
734.67	*	*	*	*	*	*	*	*	75.44	36.44	2.92	7.53	3.64	7.53	2.08
738.60	*	*	*	*	*	*	*	*	101.45	33.30	2.92	10.13	3.33	10.13	2.03
742.53	245.63	41.76	-318.88	-50.03	-0.770	0.116	(4)	(4)	*	*	*	*	*	*	*
746.47	519.81	38.68	-674.80	-46.32	-1.629	0.108	(4)	(4)	*	*	*	*	*	*	*
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 750 AND Xo 807															
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
758.27	42.45	246.29	-50.91	-280.11	-0.118	0.695	(4)	(4)	*	*	*	*	*	*	*
762.20	46.17	166.95	-55.42	-189.88	-0.128	0.471	(4)	(4)	*	*	*	*	*	*	*
766.13	50.61	126.28	-60.70	-143.61	-0.141	0.356	(4)	(4)	37.15	106.01	3.83	3.71	10.60	3.16	3.83
770.07	56.01	101.48	-67.17	-115.42	-0.156	0.286	(4)	(4)	41.12	85.20	3.83	4.11	8.52	3.50	3.83
774.00	62.68	84.87	-75.17	-96.52	-0.174	0.240	(4)	(4)	46.01	71.25	3.83	4.60	7.13	3.92	3.83
777.93	71.16	72.92	-85.33	-82.94	-0.198	0.206	(4)	(4)	52.24	61.22	3.83	5.22	6.12	4.44	3.83
781.87	82.31	63.91	-98.71	-72.69	-0.229	0.180	(4)	(4)	60.43	53.66	3.83	6.04	5.37	5.14	3.73
785.80	97.57	56.90	-117.01	-64.71	-0.271	0.161	(4)	(4)	71.63	47.77	3.83	7.16	4.78	6.09	3.52
789.73	119.78	51.27	-143.64	-58.31	-0.333	0.145	(4)	(4)	87.93	43.04	3.83	8.79	4.30	7.48	3.31
793.67	155.18	46.64	-186.10	-53.05	-0.431	0.132	(4)	(4)	113.91	39.16	3.83	11.39	3.92	9.69	3.13
797.60	220.06	42.80	-263.91	-48.67	-0.612	0.121	(4)	(4)	*	*	*	*	*	*	*
801.53	378.16	39.53	-453.51	-44.95	-1.051	0.112	(4)	(4)	*	*	*	*	*	*	*
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 807 AND Xo 863															
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
813.33	40.29	286.90	-45.82	-320.64	-0.116	0.908	(4)	(4)	*	*	*	*	*	*	*
817.27	43.76	176.83	-49.77	-197.63	-0.126	0.560	(4)	(4)	*	*	*	*	*	*	*
821.20	47.87	127.89	-54.45	-142.94	-0.138	0.405	(4)	(4)	40.19	108.45	5.48	4.02	13.27	4.02	4.75
825.13	52.84	100.17	-60.10	-111.95	-0.152	0.317	(4)	(4)	44.36	84.94	5.48	4.44	10.39	4.44	4.58
829.07	58.98	82.29	-67.07	-91.97	-0.169	0.261	(4)	(4)	49.51	69.78	5.48	4.95	8.54	4.95	4.43
833.00	66.71	69.85	-75.86	-78.07	-0.192	0.221	(4)	(4)	56.00	59.23	5.48	5.60	7.25	5.60	4.28
836.93	76.76	60.68	-87.30	-67.81	-0.221	0.192	(4)	(4)	64.44	51.45	5.48	6.44	6.30	6.44	4.15
840.87	90.43	53.62	-102.84	-60.58	-0.260	0.170	(4)	(4)	75.92	45.47	5.48	7.59	5.56	7.59	4.02
844.80	109.95	48.04	-125.05	-54.28	-0.316	0.152	(4)	(4)	92.31	40.74	5.48	9.23	4.99	9.23	3.90
848.73	140.23	43.52	-159.48	-49.17	-0.403	0.138	(4)	(4)	117.73	36.90	5.48	11.77	4.52	11.77	3.78
852.67	193.72	39.77	-220.31	-44.93	-0.557	0.126	(4)	(4)	162.63	33.72	5.48	16.26	4.13	16.26	3.68
856.60	312.68	36.61	-355.60	-41.37	-0.898	0.116	(4)	(4)	*	*	*	*	*	*	*
860.53	810.17	33.93	-921.39	-38.33	-2.328	0.107	(4)	(4)	*	*	*	*	*	*	*
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 863 AND Xo 919															
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
872.33	38.91	186.07	-43.96	-214.73	-0.123	0.616	(4)	(4)	*	*	*	*	*	*	*
876.27	42.50	130.82	-48.02	-150.98	-0.135	0.433	(4)	(4)	*	*	*	*	*	*	*
880.20	46.81	100.93	-52.88	-116.48	-0.148	0.334	(4)	(4)	39.69	105.77	5.34	4.86	10.57	4.86	4.61
884.13	52.08	82.16	-58.84	-94.82	-0.165	0.272	(4)	(4)	44.16	86.09	5.34	5.40	8.60	5.40	4.47
888.07	58.72	69.25	-66.34	-79.91	-0.186	0.229	(4)	(4)	49.79	72.56	5.34	6.09	7.25	6.09	4.33
892.00	67.26	59.86	-71.05	-69.08	-0.213	0.198	(4)	(4)	57.04	62.73	5.34	6.98	6.27	6.98	4.21
895.93	78.72	52.72	-83.16	-60.84	-0.249	0.175	(4)	(4)	66.75	56.12	5.34	8.17	5.60	8.17	4.09
899.87	*	*	*	*	*	*	*	*	80.50	49.34	5.34	9.85	4.93	9.85	3.98
903.80	*	*	*	*	*	*	*	*	101.32	44.75	5.34	12.40	4.48	12.40	3.88
907.73	*	*	*	*	*	*	*	*	136.65	40.94	5.34	16.72	4.09	16.72	3.78
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_o	VERTICAL ± Z: + Z		VERTICAL ± Z: - Z		VERTICAL ± Z: Z MODIFIERS		LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X, Z≠0)	
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 919 AND Xo 979.5															
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
923.47	33.47	615.34	-39.76	-614.97	-0.103	1.286	(4)	(4)	*	*	*	*	*	*	*
927.40	36.00	327.45	-42.77	-327.26	-0.110	0.685	(4)	(4)	*	*	*	*	*	*	*
931.33	38.94	223.08	-46.26	-222.95	-0.119	0.466	(4)	(4)	*	*	*	*	*	*	*
935.27	42.40	169.06	-51.07	-168.96	-0.130	0.353	(4)	(4)	45.14	148.74	5.83	4.50	15.64	4.50	4.61
939.20	46.54	136.16	-56.06	-136.09	-0.143	0.285	(4)	(4)	49.54	119.80	5.83	4.94	12.60	4.94	4.42
943.13	51.57	113.99	-62.95	-113.93	-0.158	0.238	(4)	(4)	54.89	100.29	5.83	5.47	10.55	5.47	4.24
947.07	57.83	97.99	-70.64	-97.94	-0.177	0.205	(4)	(4)	61.56	86.21	5.83	6.14	9.07	6.14	4.08
951.00	65.83	85.96	-78.16	-85.90	-0.202	0.180	(4)	(4)	70.05	75.63	5.83	6.99	7.95	6.99	3.93
954.93	76.33	76.55	-90.67	-76.51	-0.234	0.160	(4)	(4)	81.26	67.35	5.83	8.10	7.08	8.10	3.79
958.87	90.91	68.99	-107.99	-68.95	-.279	0.144	(4)	(4)	96.78	60.70	5.83	9.65	6.38	9.65	3.65
962.80	*	*	*	*	*	*	*	*	119.55	55.25	5.83	11.92	5.81	11.92	3.52
966.73	*	*	*	*	*	*	*	*	156.34	50.70	5.83	15.59	5.33	15.59	3.40
974.60	382.76	49.48	-485.98	-49.44	-1.173	0.103	(4)	(4)	*	*	*	*	*	*	*
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 979.5 AND Xo 1040															
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
986.40	52.83	364.19	-53.92	-345.73	-0.107	0.833	(4)	(4)	*	*	*	*	*	*	*
990.33	57.20	232.02	-55.86	-220.27	-0.116	0.531	(4)	(4)	*	*	*	*	*	*	*
994.27	61.58	170.13	-57.83	-161.51	-0.126	0.389	(4)	(4)	19.46	21.67	7.64	5.56	24.69	4.67	5.20
998.20	65.96	134.37	-59.80	-127.57	-0.138	0.307	(4)	(4)	21.58	20.88	7.64	6.09	19.50	5.18	5.01
1002.13	70.33	111.04	-61.77	-105.41	-0.152	0.254	(4)	(4)	24.17	20.17	7.64	6.72	16.12	5.80	4.84
1006.07	83.45	74.71	-85.18	-63.73	-0.169	0.216	(4)	(4)	27.33	19.50	7.64	7.50	13.73	6.56	4.68
1010.00	94.38	70.78	-96.34	-60.91	-0.192	0.189	(4)	(4)	31.33	18.88	7.64	8.48	11.96	7.52	4.53
1013.93	108.61	66.85	-110.86	-58.08	-0.221	0.167	(4)	(4)	36.50	18.29	7.64	9.76	10.59	8.76	4.39
1017.87	127.94	62.92	-130.60	-55.25	-0.260	0.150	(4)	(4)	43.58	17.71	7.64	11.50	9.50	10.46	4.25
1021.80	155.57	59.40	-158.80	-52.42	-0.316	0.136	(4)	(4)	53.67	17.17	7.64	13.98	8.62	12.88	4.12
1025.73	198.42	54.36	-202.53	-49.59	-0.403	0.124	(4)	(4)	69.29	16.67	7.64	17.83	7.89	16.63	4.00
1029.67	274.09	50.09	-279.78	-46.76	-0.557	0.115	(4)	(4)	96.92	16.17	7.64	24.63	7.27	23.26	3.88
1033.60	442.41	46.45	-451.58	-44.09	-0.898	0.106	(4)	(4)	*	*	*	*	*	*	*
1037.53	1146.32	43.30	-1170.07	-41.11	-2.328	0.099	(4)	(4)	*	*	*	*	*	*	*
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:

1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1040 AND Xo 1090.33															
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1049.33	59.44	236.98	-48.40	-305.86	-0.140	0.616	(4)	(4)	*	*	*	*	*	*	*
1053.27	65.82	166.62	-53.55	-215.05	-0.155	0.433	(4)	(4)	*	*	*	*	*	*	*
1057.20	73.70	128.55	-59.90	-165.91	-0.174	0.334	(4)	(4)	19.64	30.17	8.00	9.16	17.01	6.49	7.24
1061.13	83.74	104.64	-67.96	-135.05	-0.197	0.272	(4)	(4)	30.67	21.88	8.00	10.39	13.84	7.36	6.93
1065.07	96.34	87.61	-78.56	-113.83	-0.228	0.229	(4)	(4)	35.46	24.80	8.00	12.01	11.67	8.51	6.60
1069.00	114.09	75.74	-93.04	-76.29	-0.270	0.198	(4)	(4)	42.00	26.13	8.00	14.22	10.09	10.08	6.27
1072.93	139.85	66.70	-114.05	-67.19	-0.330	0.175	(4)	(4)	51.54	24.79	8.00	17.44	8.88	12.37	5.95
1076.87	180.79	59.57	-147.44	-60.01	-0.427	0.156	(4)	(4)	66.63	23.46	8.00	22.54	7.93	15.99	5.63
1080.80	255.35	53.84	-208.24	-54.23	-0.603	0.141	(4)	(4)	*	*	*	*	*	*	*
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 1090.33 AND Xo 1140.67															
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1092.60	45.60	1992.13	-44.87	-1621.97	-0.120	2.533	(4)	(4)	*	*	*	*	*	*	*
1096.53	49.67	729.38	-48.87	-593.85	-0.130	0.927	(4)	(4)	*	*	*	*	*	*	*
1100.47	54.54	445.97	-53.66	-363.10	-0.143	0.567	(4)	(4)	*	*	*	*	*	*	*
1104.40	60.44	321.41	-59.47	-261.68	-0.159	0.409	(4)	(4)	*	*	*	*	*	*	*
1108.33	67.78	251.23	-66.70	-204.55	-0.178	0.319	(4)	(4)	71.23	151.66	7.20	9.05	16.30	9.05	5.41
1112.27	77.19	206.11	-75.95	-167.82	-0.202	0.262	(4)	(4)	81.66	124.43	7.20	10.30	13.38	10.30	5.20
1116.20	89.59	174.81	-88.15	-83.01	-0.235	0.222	(4)	(4)	94.78	105.53	7.20	11.96	11.34	11.96	5.00
1120.13	106.73	95.68	-105.02	-90.06	-0.280	0.193	(4)	(4)	112.91	91.61	7.20	14.24	9.85	14.24	4.82
1124.07	132.06	84.51	-129.94	-97.11	-0.346	0.170	(4)	(4)	139.71	80.91	7.20	17.63	8.70	17.63	4.65
1128.00	173.03	75.69	-170.25	-91.69	-0.454	0.153	(4)	(4)	183.04	72.47	7.20	23.09	7.79	23.09	4.50
1131.93	250.83	68.54	-246.80	-86.27	-0.658	0.138	(4)	(4)	*	*	*	*	*	*	*
1135.87	456.72	62.61	-449.39	-80.85	-1.198	0.126	(4)	(4)	*	*	*	*	*	*	*
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS					
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1140.67 AND Xo 1191															
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1151.60	77.02	424.60	-93.43	-320.64	-0.146	0.526	(4)	(4)	*	*	*	*	*	*	*
1155.53	85.55	312.31	-103.78	-235.85	-0.162	0.387	(4)	(4)	76.95	185.10	16.14	8.27	23.71	6.91	8.12
1159.47	96.24	246.86	-114.42	-186.41	-0.182	0.306	(4)	(4)	86.57	146.30	16.14	9.31	18.74	7.77	7.85
1163.40	109.94	203.18	-114.70	-154.19	-0.208	0.253	(4)	(4)	98.89	121.01	16.14	10.63	15.50	8.87	7.55
1167.33	128.20	174.00	-115.08	-131.45	-0.243	0.216	(4)	(4)	115.31	103.17	16.14	12.40	13.21	10.35	7.23
1171.27	128.91	151.66	-138.06	-98.49	-0.291	0.188	(4)	(4)	138.34	89.89	16.14	14.87	11.51	12.41	6.91
1175.20	124.79	134.40	-172.40	-99.63	-0.364	0.167	(4)	(4)	172.75	79.66	16.14	18.57	10.20	15.50	6.60
1179.13	255.64	120.67	-229.48	-100.54	-0.484	0.150	(4)	(4)	229.94	71.52	16.14	24.72	9.16	20.63	6.29
1181.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1183.07	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1187.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1190.93	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS							
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1191 AND Xo 1249															
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1194.87	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1198.80	35.69	732.19	-56.60	-561.70	-0.115	0.737	(4)	(4)	*	*	*	*	*	*	*
1202.73	38.72	486.88	-58.19	-373.51	-0.124	0.490	(4)	(4)	ALLOWABLE LOADS ARE DEFINED IN PARAGRAPH I.3.5						
1206.67	42.32	364.46	-59.52	-279.60	-0.136	0.367	(4)	(4)							
1210.60	46.66	291.38	-60.96	-223.53	-0.150	0.293	(4)	(4)							
1214.53	51.97	242.71	-62.57	-186.20	-0.167	0.244	(4)	(4)							
1218.47	58.68	207.91	-64.41	-159.49	-0.188	0.209	(4)	(4)							
1222.40	67.35	181.88	-73.93	-139.53	-0.216	0.183	(4)	(4)							
1226.33	79.02	161.65	-86.74	-143.52	-0.254	0.163	(4)	(4)							
1230.27	95.65	145.43	-104.99	-138.83	-0.307	0.146	(4)	(4)	*	*	*	*	*	*	*
1234.20	121.04	132.20	-132.87	-126.20	-0.389	0.133	(4)	(4)	*	*	*	*	*	*	*
1238.13	164.81	121.18	-180.91	-115.68	-0.529	0.122	(4)	(4)	*	*	*	*	*	*	*
1242.07	258.51	111.82	-283.76	-106.76	-0.830	0.113	(4)	(4)	*	*	*	*	*	*	*
1246.00	597.16	103.84	-655.49	-99.13	-1.917	0.105	(4)	(4)	*	*	*	*	*	*	*
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-4 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR TAEM-PITCH CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAME Xo 1249 AND BRIDGE ATTACH PIN Xo 1301.00															
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1269.60	154.41	167.36	-140.10	-167.36	-0.183	0.279	(4)	(4)	NO KEEL ATTACH POINTS AVAILABLE						
1273.53	176.50	140.55	-160.15	-140.55	-0.209	0.234	(4)	(4)							
1277.47	206.05	121.10	-186.96	-121.10	-0.244	0.202	(4)	(4)							
1281.40	247.37	106.40	-224.45	-106.40	-0.293	0.177	(4)	(4)							
1301.00	*	*	*	*	*	*	*	*							

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 582 AND Xo 636															
582.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
612.73	*	*	*	*	*	*	*	*	6.96	24.60	0.90	0.71	2.44	0.71	0.90
616.67	53.92	52.85	-53.92	-66.74	-0.297	0.166	(4)	(4)	8.38	21.81	0.90	0.86	2.16	0.86	0.90
620.60	67.68	47.47	-67.68	-59.95	-0.373	0.149	(4)	(4)	10.52	19.59	0.90	1.08	1.94	1.08	0.90
624.53	90.86	43.08	-90.86	-54.41	-0.501	0.135	(4)	(4)	14.12	17.78	0.90	1.45	1.76	1.45	0.90
628.47	138.41	39.43	-138.41	-49.79	-0.764	0.124	(4)	(4)	*	*	*	*	*	*	*
632.40	289.50	36.35	-289.50	-45.91	-1.597	0.114	(4)	(4)	*	*	*	*	*	*	*
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 636 AND Xo 693															
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
644.20	39.63	183.67	-54.07	-290.49	-0.118	0.701	(4)	(4)	*	*	*	*	*	*	*
648.13	43.10	124.20	-58.80	-196.38	-0.128	0.474	(4)	(4)	*	*	*	*	*	*	*
652.07	47.25	93.75	-64.46	-148.23	-0.140	0.358	(4)	(4)	19.50	71.97	1.80	1.94	7.18	1.94	1.80
656.00	52.27	75.33	-71.31	-119.10	-0.155	0.288	(4)	(4)	21.57	57.83	1.80	2.14	5.77	2.14	1.80
659.93	58.48	62.95	-79.79	-99.54	-0.174	0.240	(4)	(4)	24.13	48.33	1.80	2.40	4.82	2.40	1.80
663.87	*	*	*	*	*	*	*	*	27.39	41.51	1.80	2.72	4.14	2.72	1.80
667.80	*	*	*	*	*	*	*	*	31.67	36.37	1.80	3.14	3.63	3.14	1.80
671.73	*	*	*	*	*	*	*	*	37.52	32.37	1.80	3.72	3.23	3.72	1.80
675.67	*	*	*	*	*	*	*	*	46.05	29.15	1.80	4.57	2.91	4.57	1.80
679.60	*	*	*	*	*	*	*	*	59.55	26.53	1.80	5.91	2.65	5.91	1.80
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$ (X=0)		$\pm R_K$ (X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 693 AND Xo 750															
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
699.27	29.69	329.91	-46.96	-400.00	-0.113	0.917	(4)	(4)	*	*	*	*	*	*	*
703.20	32.19	202.80	-50.90	-245.88	-0.123	0.564	(4)	(4)	*	*	*	*	*	*	*
707.13	35.14	146.39	-55.56	-177.49	-0.134	0.407	(4)	(4)	*	*	*	*	*	*	*
711.07	38.70	114.47	-61.19	-138.79	-0.148	0.319	(4)	(4)	29.71	84.03	2.93	2.96	8.40	2.96	2.49
715.00	43.04	94.02	-68.06	-114.00	-0.164	0.261	(4)	(4)	33.04	69.02	2.93	3.30	6.90	3.30	2.41
718.93	48.49	79.77	-76.67	-96.72	-0.185	0.222	(4)	(4)	37.22	58.56	2.93	3.71	5.85	3.71	2.33
722.87	55.53	69.25	-87.80	-83.96	-0.212	0.193	(4)	(4)	42.63	50.84	2.93	4.25	5.08	4.25	2.26
726.80	64.94	61.20	-102.67	-74.20	-0.248	0.170	(4)	(4)	49.85	44.93	2.93	4.98	4.49	4.98	2.20
730.73	78.18	54.82	-123.61	-66.47	-0.298	0.152	(4)	(4)	60.02	40.25	2.93	5.99	4.02	5.99	2.13
734.67	*	*	*	*	*	*	*	*	75.44	36.44	2.93	7.53	3.64	7.53	2.08
738.60	*	*	*	*	*	*	*	*	101.45	33.30	2.93	10.13	3.33	10.13	2.02
742.53	201.67	41.76	-318.88	-50.64	-0.770	0.116	(4)	(4)	*	*	*	*	*	*	*
746.47	426.77	38.68	-674.80	-46.90	-1.629	0.108	(4)	(4)	*	*	*	*	*	*	*
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 750 AND Xo 807															
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
758.27	42.45	236.82	-51.47	-280.11	-0.118	0.695	(4)	(4)	*	*	*	*	*	*	*
762.20	46.17	160.53	-55.98	-189.88	-0.128	0.471	(4)	(4)	*	*	*	*	*	*	*
766.13	50.61	121.42	-61.37	-143.61	-0.141	0.356	(4)	(4)	37.15	106.01	4.60	3.71	10.60	3.15	4.60
770.07	56.01	97.58	-67.91	-115.42	-0.156	0.286	(4)	(4)	41.12	85.20	4.60	4.11	8.52	3.49	4.44
774.00	62.68	81.61	-76.00	-96.52	-0.174	0.240	(4)	(4)	46.01	71.25	4.60	4.60	7.13	3.90	4.20
777.93	71.16	70.12	-86.27	-82.94	-0.198	0.206	(4)	(4)	52.24	61.22	4.60	5.22	6.12	4.43	3.96
781.87	82.31	61.45	-99.80	-72.69	-0.229	0.180	(4)	(4)	60.43	53.66	4.60	6.04	5.37	5.12	3.73
785.80	97.57	54.71	-118.30	-64.71	-0.271	0.161	(4)	(4)	71.63	47.77	4.60	7.16	4.78	6.07	3.52
789.73	119.78	49.30	-145.22	-58.31	-0.333	0.145	(4)	(4)	87.93	43.04	4.60	8.79	4.30	7.46	3.31
793.67	155.18	44.85	-188.15	-53.05	-0.431	0.132	(4)	(4)	113.91	39.16	4.60	11.39	3.92	9.66	3.13
797.60	220.06	41.15	-266.81	-48.67	-0.612	0.121	(4)	(4)	*	*	*	*	*	*	*
801.53	378.16	38.01	-458.50	-44.95	-1.051	0.112	(4)	(4)	*	*	*	*	*	*	*
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_0	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 807 AND Xo 863															
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
813.33	38.74	286.90	-45.82	-324.14	-0.116	0.908	(4)	(4)	*	*	*	*	*	*	*
817.27	42.08	176.83	-49.77	-199.79	-0.126	0.560	(4)	(4)	*	*	*	*	*	*	*
821.20	46.03	127.89	-54.45	-144.50	-0.138	0.405	(4)	(4)	40.19	108.45	5.42	4.02	13.27	4.02	4.76
825.13	50.81	100.17	-60.10	-113.17	-0.152	0.317	(4)	(4)	44.36	84.94	5.42	4.44	10.39	4.44	4.60
829.07	56.71	82.29	-67.07	-92.97	-0.169	0.261	(4)	(4)	49.51	69.78	5.42	4.95	8.54	4.95	4.46
833.00	64.14	69.85	-75.86	-78.92	-0.192	0.221	(4)	(4)	56.00	59.23	5.42	5.60	7.25	5.60	4.32
836.93	73.81	60.68	-87.30	-68.55	-0.221	0.192	(4)	(4)	64.44	51.45	5.42	6.44	6.30	6.44	4.19
840.87	86.95	53.62	-102.84	-60.58	-0.260	0.170	(4)	(4)	75.92	45.47	5.42	7.59	5.56	7.59	4.07
844.80	105.72	48.04	-125.05	-54.28	-0.316	0.152	(4)	(4)	92.31	40.74	5.42	9.23	4.99	9.23	3.95
848.73	134.84	43.52	-159.48	-49.17	-0.403	0.138	(4)	(4)	117.73	36.90	5.42	11.77	4.52	11.77	3.85
852.67	186.27	39.77	-220.31	-44.93	-0.557	0.126	(4)	(4)	162.63	33.72	5.42	16.26	4.13	16.26	3.74
856.60	300.65	36.61	-355.60	-41.37	-0.898	0.116	(4)	(4)	*	*	*	*	*	*	*
860.53	779.01	33.93	-921.39	-38.33	-2.328	0.107	(4)	(4)	*	*	*	*	*	*	*
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 863 AND Xo 919															
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
872.33	38.91	186.07	-43.96	-227.20	-0.123	0.616	(4)	(4)	*	*	*	*	*	*	*
876.27	42.50	130.82	-48.02	-159.75	-0.135	0.433	(4)	(4)	*	*	*	*	*	*	*
880.20	46.81	100.93	-52.88	-123.25	-0.148	0.334	(4)	(4)	39.69	107.44	5.33	4.86	10.71	4.86	4.61
884.13	52.08	82.16	-58.84	-100.32	-0.165	0.272	(4)	(4)	44.16	87.46	5.33	5.40	8.72	5.40	4.47
888.07	58.72	69.25	-66.34	-84.56	-0.186	0.229	(4)	(4)	49.79	73.71	5.33	6.09	7.35	6.09	4.34
892.00	67.26	59.86	-75.99	-70.31	-0.213	0.198	(4)	(4)	57.04	63.72	5.33	6.98	6.36	6.98	4.22
895.93	78.72	52.72	-88.94	-64.37	-0.249	0.175	(4)	(4)	66.75	56.12	5.33	8.17	5.60	8.17	4.11
899.87	*	*	*	*	*	*	*	*	80.50	50.12	5.33	9.85	5.00	9.85	4.00
903.80	*	*	*	*	*	*	*	*	101.32	45.29	5.33	12.40	4.52	12.40	3.89
907.73	*	*	*	*	*	*	*	*	136.65	41.31	5.33	16.72	4.12	16.72	3.79
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_P	Z_A	Z_P	Z_A	K_P	K_A	$\pm Y_{LP}$	$\pm Y_{LA}$	$\pm Y_P$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 919 AND Xo 979.5															
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
923.47	33.47	564.53	-42.50	-544.22	-0.103	1.286	(4)	(4)	*	*	*	*	*	*	*
927.40	36.00	300.41	-45.71	-289.61	-0.110	0.685	(4)	(4)	*	*	*	*	*	*	*
931.33	38.94	204.66	-49.43	-197.30	-0.119	0.466	(4)	(4)	*	*	*	*	*	*	*
935.27	42.40	155.10	-53.84	-149.52	-0.130	0.353	(4)	(4)	45.14	148.74	5.83	4.50	15.64	4.50	4.60
939.20	46.54	124.92	-59.09	-120.43	-0.143	0.285	(4)	(4)	49.54	119.80	5.83	4.94	12.60	4.94	4.41
943.13	51.57	104.58	-65.47	-100.82	-0.158	0.238	(4)	(4)	54.89	100.29	5.83	5.47	10.55	5.47	4.24
947.07	57.83	89.90	-73.43	-86.67	-0.177	0.205	(4)	(4)	61.56	86.21	5.83	6.14	9.07	6.14	4.07
951.00	65.83	78.86	-83.55	-76.02	-0.202	0.180	(4)	(4)	70.05	75.63	5.83	6.99	7.95	6.99	3.92
954.93	76.33	70.23	-96.92	-67.71	-0.234	0.160	(4)	(4)	81.26	67.35	5.83	8.10	7.08	8.10	3.78
958.87	90.91	63.29	-115.43	-61.02	-0.279	0.144	(4)	(4)	96.78	60.70	5.83	9.65	6.38	9.65	3.64
962.80	*	*	*	*	*	*	*	*	119.55	55.25	5.83	11.92	5.81	11.92	3.52
966.73	*	*	*	*	*	*	*	*	156.34	50.70	5.83	15.59	5.33	15.59	3.40
974.60	382.76	45.39	-485.98	-43.75	-1.173	0.103	(4)	(4)	*	*	*	*	*	*	*
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 979.5 AND Xo 1040															
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
986.40	47.08	311.27	-45.39	-363.02	-0.107	0.833	(4)	(4)	*	*	*	*	*	*	*
990.33	50.80	198.31	-48.98	-231.28	-0.116	0.531	(4)	(4)	*	*	*	*	*	*	*
994.27	55.18	145.41	-53.20	-169.59	-0.126	0.389	(4)	(4)	52.92	94.56	7.64	5.56	24.69	4.67	6.29
998.20	60.37	114.85	-58.20	-133.95	-0.138	0.307	(4)	(4)	57.89	74.69	7.64	6.09	19.50	5.18	6.07
1002.13	66.63	94.91	-64.24	-110.68	-0.152	0.254	(4)	(4)	63.90	61.71	7.64	6.72	16.12	5.80	5.87
1006.07	74.37	80.83	-71.70	-94.27	-0.169	0.216	(4)	(4)	71.32	52.57	7.64	7.50	13.73	6.56	5.68
1010.00	84.12	70.42	-81.09	-82.12	-0.192	0.189	(4)	(4)	80.67	45.81	7.64	8.48	11.96	7.51	5.49
1013.93	96.80	62.38	-93.31	-72.75	-0.221	0.167	(4)	(4)	92.83	40.57	7.64	9.76	10.59	8.76	5.32
1017.87	114.03	55.97	-109.93	-65.28	-0.260	0.150	(4)	(4)	109.35	36.40	7.64	11.50	9.50	10.45	5.16
1021.80	138.65	50.77	-133.67	-59.22	-0.316	0.136	(4)	(4)	132.97	33.02	7.64	13.98	8.62	12.87	5.01
1025.73	176.84	46.46	-170.48	-54.18	-0.403	0.124	(4)	(4)	169.59	30.21	7.64	17.83	7.89	16.62	4.86
1029.67	244.28	42.81	-235.50	-49.93	-0.557	0.115	(4)	(4)	234.27	27.84	7.64	24.63	7.27	23.25	4.72
1033.60	394.29	39.70	-380.11	-46.29	-0.898	0.106	(4)	(4)	*	*	*	*	*	*	*
1037.53	1021.64	37.01	-984.90	-43.17	-2.328	0.099	(4)	(4)	*	*	*	*	*	*	*
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LP}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_P$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1040 AND Xo 1090.33															
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1049.33	43.58	219.55	-51.30	-249.58	-0.140	0.616	(4)	(4)	*	*	*	*	*	*	*
1053.27	48.21	154.37	-56.76	-175.48	-0.155	0.433	(4)	(4)	*	*	*	*	*	*	*
1057.20	53.93	119.09	-63.49	-135.38	-0.174	0.334	(4)	(4)	35.07	134.81	8.00	9.16	17.01	7.56	7.24
1061.13	61.19	96.94	-72.04	-110.20	-0.197	0.272	(4)	(4)	39.79	109.74	8.00	10.39	13.84	8.58	6.93
1065.07	70.73	81.71	-83.27	-92.88	-0.228	0.229	(4)	(4)	46.00	92.49	8.00	12.01	11.67	9.92	6.60
1069.00	83.77	70.64	-98.62	-80.29	-0.270	0.198	(4)	(4)	54.47	79.96	8.00	14.22	10.09	11.75	6.27
1072.93	102.68	62.21	-120.89	-70.72	-0.330	0.175	(4)	(4)	66.78	70.41	8.00	17.44	8.88	14.41	5.95
1076.87	132.74	55.56	-156.29	-63.16	-0.427	0.156	(4)	(4)	86.32	62.89	8.00	22.54	7.93	18.63	5.63
1080.80	187.48	50.21	-220.73	-57.08	-0.603	0.141	(4)	(4)	*	*	*	*	*	*	*
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 1090.33 AND Xo 1140.67															
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1092.60	42.62	1337.00	-45.77	-1621.97	-0.120	2.533	(4)	(4)	*	*	*	*	*	*	*
1096.53	46.42	489.52	-49.85	-593.85	-0.130	0.927	(4)	(4)	*	*	*	*	*	*	*
1100.47	50.97	299.31	-54.73	-363.10	-0.143	0.567	(4)	(4)	*	*	*	*	*	*	*
1104.40	56.49	215.71	-60.66	-261.68	-0.159	0.409	(4)	(4)	*	*	*	*	*	*	*
1108.33	63.35	168.61	-68.03	-204.55	-0.178	0.319	(4)	(4)	71.23	151.66	7.20	9.05	16.30	9.05	6.12
1112.27	72.14	138.33	-77.47	-167.82	-0.202	0.262	(4)	(4)	81.66	124.43	7.20	10.30	13.38	10.30	5.86
1116.20	83.73	117.32	-89.91	-142.32	-0.235	0.222	(4)	(4)	94.78	105.53	7.20	11.96	11.34	11.96	5.63
1120.13	99.75	101.85	-107.12	-123.55	-0.280	0.193	(4)	(4)	112.91	91.61	7.20	14.24	9.85	14.24	5.42
1124.07	123.42	82.75	-132.54	-100.39	-0.346	0.170	(4)	(4)	139.71	80.91	7.20	17.63	8.70	17.63	5.22
1128.00	161.71	74.11	-173.66	-89.92	-0.454	0.153	(4)	(4)	183.04	72.47	7.20	23.09	7.79	23.09	5.04
1131.93	234.42	67.11	-251.74	-81.43	-0.658	0.138	(4)	(4)	*	*	*	*	*	*	*
1135.87	426.84	61.31	-458.38	-74.38	-1.198	0.126	(4)	(4)	*	*	*	*	*	*	*
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1140.67 AND Xo 1191															
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1151.60	77.02	424.60	-93.43	-415.67	-0.146	0.526	(4)	(4)	*	*	*	*	*	*	*
1155.53	85.55	312.31	-103.78	-305.74	-0.162	0.387	(4)	(4)	76.95	185.10	22.22	8.27	23.71	7.63	8.12
1159.47	96.24	246.86	-116.75	-241.66	-0.182	0.306	(4)	(4)	86.57	146.30	22.22	9.31	18.74	8.58	7.85
1163.40	109.94	203.18	-133.37	-199.88	-0.208	0.253	(4)	(4)	98.89	121.01	22.22	10.63	15.50	9.80	7.55
1167.33	128.20	174.00	-155.52	-170.42	-0.243	0.216	(4)	(4)	115.31	103.17	22.22	12.40	13.21	11.43	7.23
1171.27	153.80	87.96	-186.58	-112.14	-0.291	0.188	(4)	(4)	138.34	89.89	22.22	14.87	11.51	13.71	6.91
1175.20	192.05	89.23	-232.98	-115.13	-0.364	0.167	(4)	(4)	172.75	79.66	22.22	18.57	10.20	17.12	6.60
1179.13	255.64	90.50	-310.12	-118.13	-0.484	0.150	(4)	(4)	229.94	71.52	22.22	24.72	9.16	22.79	6.29
1181.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1183.07	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1187.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1190.93	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:

1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		±X_K (Z=0)	±Z_K(X=0)		±R_K(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	±Y_{LF}	±Y_{LA}	±Y_F	±Y_A		±Z_{KF}	±Z_{KA}	±R_{KF}	±R_{KA}
BRIDGE BETWEEN FRAMES Xo 1191 AND Xo 1249															
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1194.87	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1198.80	91.62	589.67	-83.07	-589.67	-0.115	0.737	(4)	(4)	*	*	*	*	*	*	*
1202.73	97.70	392.11	-90.13	-392.11	-0.124	0.490	(4)	(4)							
1206.67	103.78	293.52	-98.51	-293.52	-0.136	0.367	(4)	(4)	ALLOWABLE LOADS ARE DEFINED IN PARAGRAPH I.3.5						
1210.60	109.86	234.66	-108.60	-234.66	-0.150	0.293	(4)	(4)							
1214.53	115.94	195.47	-120.97	-195.47	-0.167	0.244	(4)	(4)							
1218.47	122.02	167.43	-136.59	-167.43	-0.188	0.209	(4)	(4)							
1222.40	172.91	116.53	-156.77	-146.47	-0.216	0.183	(4)	(4)							
1226.33	202.88	111.05	-183.95	-130.18	-0.254	0.163	(4)	(4)	*	*	*	*	*	*	*
1230.27	245.56	105.56	-222.64	-117.12	-0.307	0.146	(4)	(4)	*	*	*	*	*	*	*
1234.20	310.77	100.08	-281.76	-106.47	-0.389	0.133	(4)	(4)	*	*	*	*	*	*	*
1238.13	423.13	94.59	-383.63	-97.59	-0.529	0.122	(4)	(4)	*	*	*	*	*	*	*
1242.07	663.69	89.11	-601.75	-90.06	-0.830	0.113	(4)	(4)	*	*	*	*	*	*	*
1246.00	1533.13	83.63	-1390.03	-83.63	-1.917	0.105	(4)	(4)	*	*	*	*	*	*	*
1249.00	*	*	*	*	*	*	*	*							

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral ±Y_{LF} and ±Y_{LA} values, use 10% of the appropriate ±Z_F and ±Z_A values.

TABLE I.2-5 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING LIGHT WEIGHT (32K) CONDITIONS

LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS							
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAME Xo 1249 AND BRIDGE ATTACH PIN Xo 1301.00															
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1269.60	144.31	167.36	-155.67	-167.36	-0.183	0.279	(4)	(4)							
1273.53	164.95	140.55	-177.94	-140.55	-0.209	0.234	(4)	(4)							
1277.47	192.57	121.10	-207.73	-121.10	-0.244	0.202	(4)	(4)							
1281.40	231.19	106.40	-249.39	-106.40	-0.293	0.177	(4)	(4)	NO KEEL ATTACH POINTS AVAILABLE						
1301.00	*	*	*	*	*	*	*	*							

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 582 AND Xo 636															
582.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
612.73	*	*	*	*	*	*	*	*	6.96	24.60	0.90	0.71	2.44	0.71	0.90
616.67	53.92	66.59	-53.92	-66.74	-0.297	0.166	(4)	(4)	8.38	21.81	0.90	0.86	2.16	0.86	0.90
620.60	67.68	59.81	-67.68	-59.95	-0.373	0.149	(4)	(4)	10.52	19.59	0.90	1.08	1.94	1.08	0.90
624.53	90.86	54.28	-90.86	-54.41	-0.501	0.135	(4)	(4)	14.12	17.78	0.90	1.45	1.76	1.45	0.90
628.47	138.41	49.68	-138.41	-49.79	-0.764	0.124	(4)	(4)	*	*	*	*	*	*	*
632.40	289.50	45.80	-289.50	-45.91	-1.597	0.114	(4)	(4)	*	*	*	*	*	*	*
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 636 AND Xo 693															
636.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
644.20	47.67	277.34	-54.07	-208.34	-0.118	0.701	(4)	(4)	*	*	*	*	*	*	*
648.13	51.85	187.54	-58.80	-140.84	-0.128	0.474	(4)	(4)	*	*	*	*	*	*	*
652.07	56.83	141.56	-64.46	-106.31	-0.140	0.358	(4)	(4)	19.50	71.97	1.80	1.94	7.18	1.94	1.80
656.00	62.88	113.75	-71.31	-85.42	-0.155	0.288	(4)	(4)	21.57	57.83	1.80	2.14	5.77	2.14	1.80
659.93	70.34	95.05	-71.39	-71.39	-0.174	0.240	(4)	(4)	24.13	48.33	1.80	2.40	4.82	2.40	1.80
663.87	*	*	*	*	*	*	*	*	27.39	41.51	1.80	2.72	4.14	2.72	1.80
667.80	*	*	*	*	*	*	*	*	31.67	36.37	1.80	3.14	3.63	3.14	1.80
671.73	*	*	*	*	*	*	*	*	37.52	32.37	1.80	3.72	3.23	3.72	1.80
675.67	*	*	*	*	*	*	*	*	46.05	29.15	1.80	4.57	2.91	4.57	1.80
679.60	*	*	*	*	*	*	*	*	59.55	26.53	1.80	5.91	2.65	5.91	1.80
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

LONGERON, 1000 LBS PER SIDE									KEEL, 1000 LBS						
ATTACH POINT X_o	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 693 AND Xo 750															
693.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
699.27	41.57	349.70	-46.96	-323.00	-0.113	0.917	(4)	(4)	*	*	*	*	*	*	*
703.20	45.07	214.97	-50.90	-198.55	-0.123	0.564	(4)	(4)	*	*	*	*	*	*	*
707.13	49.20	155.17	-55.56	-143.33	-0.134	0.407	(4)	(4)	*	*	*	*	*	*	*
711.07	54.18	121.34	-61.19	-112.07	-0.148	0.319	(4)	(4)	29.71	84.03	2.93	2.96	8.40	2.96	2.49
715.00	60.26	99.66	-65.13	-92.05	-0.164	0.261	(4)	(4)	33.04	69.02	2.93	3.30	6.90	3.30	2.41
718.93	67.89	84.56	-66.49	-78.10	-0.185	0.222	(4)	(4)	37.22	58.56	2.93	3.71	5.85	3.71	2.33
722.87	77.74	73.41	-76.14	-67.80	-0.212	0.193	(4)	(4)	42.63	50.84	2.93	4.25	5.08	4.25	2.26
726.80	90.92	64.87	-89.04	-69.36	-0.248	0.170	(4)	(4)	49.85	44.93	2.93	4.98	4.49	4.98	2.20
730.73	109.45	58.11	-107.20	-66.47	-0.298	0.152	(4)	(4)	60.02	40.25	2.93	5.99	4.02	5.99	2.13
734.67	*	*	*	*	*	*	*	*	75.44	36.44	2.93	7.53	3.64	7.53	2.08
738.60	*	*	*	*	*	*	*	*	101.45	33.30	2.93	10.13	3.33	10.13	2.02
742.53	282.34	44.27	-276.53	-50.64	-0.770	0.116	(4)	(4)	*	*	*	*	*	*	*
746.47	597.48	41.00	-585.18	-46.90	-1.629	0.108	(4)	(4)	*	*	*	*	*	*	*
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 750 AND Xo 807															
750.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
758.27	45.00	246.29	-51.47	-267.21	-0.118	0.695	(4)	(4)	*	*	*	*	*	*	*
762.20	48.94	166.95	-55.98	-181.13	-0.128	0.471	(4)	(4)	*	*	*	*	*	*	*
766.13	53.65	126.28	-61.37	-137.00	-0.141	0.356	(4)	(4)	37.15	106.01	4.60	3.71	10.60	3.15	4.60
770.07	59.37	101.48	-67.91	-110.10	-0.156	0.286	(4)	(4)	41.12	85.20	4.60	4.11	8.52	3.49	4.44
774.00	66.44	84.87	-76.00	-92.07	-0.174	0.240	(4)	(4)	46.01	71.25	4.60	4.60	7.13	3.90	4.20
777.93	75.43	72.92	-86.27	-79.12	-0.198	0.206	(4)	(4)	52.24	61.22	4.60	5.22	6.12	4.43	3.96
781.87	87.25	63.91	-99.80	-72.69	-0.229	0.180	(4)	(4)	60.43	53.66	4.60	6.04	5.37	5.12	3.78
785.80	103.42	56.90	-118.30	-64.71	-0.271	0.161	(4)	(4)	71.63	47.77	4.60	7.16	4.78	6.07	3.52
789.73	126.97	51.27	-145.22	-58.31	-0.333	0.145	(4)	(4)	87.93	43.04	4.60	8.79	4.30	7.46	3.31
793.67	164.49	46.64	-188.15	-53.05	-0.431	0.132	(4)	(4)	113.91	39.16	4.60	11.39	3.92	9.66	3.13
797.60	233.26	42.80	-266.81	-48.67	-0.612	0.121	(4)	(4)	*	*	*	*	*	*	*
801.53	400.85	39.53	-458.50	-44.95	-1.051	0.112	(4)	(4)	*	*	*	*	*	*	*
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 807 AND Xo 863															
807.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
813.33	40.29	286.90	-45.82	-324.14	-0.116	0.908	(4)	(4)	*	*	*	*	*	*	*
817.27	43.76	176.83	-49.77	-199.79	-0.126	0.560	(4)	(4)	*	*	*	*	*	*	*
821.20	47.87	127.89	-54.45	-144.50	-0.138	0.405	(4)	(4)	40.19	108.45	5.42	4.02	13.27	4.02	4.76
825.13	52.84	100.17	-60.10	-113.17	-0.152	0.317	(4)	(4)	44.36	84.94	5.42	4.44	10.39	4.44	4.60
829.07	58.98	82.29	-67.07	-92.97	-0.169	0.261	(4)	(4)	49.51	69.78	5.42	4.95	8.54	4.95	4.46
833.00	66.71	69.85	-75.86	-78.92	-0.192	0.221	(4)	(4)	56.00	59.23	5.42	5.60	7.25	5.60	4.32
836.93	76.76	60.68	-87.30	-68.55	-0.221	0.192	(4)	(4)	64.44	51.45	5.42	6.44	6.30	6.44	4.19
840.87	90.43	53.62	-102.84	-60.58	-0.260	0.170	(4)	(4)	75.92	45.47	5.42	7.59	5.56	7.59	4.07
844.80	109.95	48.04	-125.05	-54.28	-0.316	0.152	(4)	(4)	92.31	40.74	5.42	9.23	4.99	9.23	3.95
848.73	140.23	43.52	-159.48	-49.17	-0.403	0.138	(4)	(4)	117.73	36.90	5.42	11.77	4.52	11.77	3.85
852.67	193.72	39.77	-220.31	-44.93	-0.557	0.126	(4)	(4)	162.63	33.72	5.42	16.26	4.13	16.26	3.74
856.60	312.68	36.61	-355.60	-41.37	-0.898	0.116	(4)	(4)	*	*	*	*	*	*	*
860.53	810.17	33.93	-921.39	-38.33	-2.328	0.107	(4)	(4)	*	*	*	*	*	*	*
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 863 AND Xo 919															
863.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
872.33	38.91	186.07	-43.96	-227.20	-0.123	0.616	(4)	(4)	*	*	*	*	*	*	*
876.27	42.50	130.82	-48.02	-159.75	-0.135	0.433	(4)	(4)	*	*	*	*	*	*	*
880.20	46.81	100.93	-52.88	-123.25	-0.148	0.334	(4)	(4)	39.69	107.25	5.33	4.86	10.71	4.86	4.61
884.13	52.08	82.16	-58.84	-100.32	-0.165	0.272	(4)	(4)	44.16	87.30	5.33	5.40	8.72	5.40	4.47
888.07	58.72	69.25	-66.34	-84.56	-0.186	0.229	(4)	(4)	49.79	73.58	5.33	6.09	7.35	6.09	4.34
892.00	67.26	59.86	-75.12	-70.31	-0.213	0.198	(4)	(4)	57.04	63.61	5.33	6.98	6.36	6.98	4.22
895.93	78.72	52.72	-87.92	-64.37	-0.249	0.175	(4)	(4)	66.75	56.12	5.33	8.17	5.60	8.17	4.11
899.87	*	*	*	*	*	*	*	*	80.50	50.03	5.33	9.85	5.00	9.85	4.00
903.80	*	*	*	*	*	*	*	*	101.32	45.29	5.33	12.40	4.52	12.40	3.89
907.73	*	*	*	*	*	*	*	*	136.65	41.31	5.33	16.72	4.12	16.72	3.79
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_P	Z_A	Z_P	Z_A	K_P	K_A	$\pm Y_{LP}$	$\pm Y_{LA}$	$\pm Y_P$	$\pm Y_A$		$\pm Z_{KP}$	$\pm Z_{KA}$	$\pm R_{KP}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 919 AND Xo 979.50															
919.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
923.47	34.81	615.34	-42.05	-544.22	-0.103	1.286	(4)	(4)	*	*	*	*	*	*	*
927.40	37.44	327.45	-45.25	-289.61	-0.110	0.685	(4)	(4)	*	*	*	*	*	*	*
931.33	40.50	223.08	-48.94	-197.30	-0.119	0.466	(4)	(4)	*	*	*	*	*	*	*
935.27	44.10	169.06	-53.84	-149.52	-0.130	0.353	(4)	(4)	45.14	148.74	5.83	4.50	15.64	4.50	4.60
939.20	48.40	136.16	-59.09	-120.43	-0.143	0.285	(4)	(4)	49.54	119.80	5.83	4.94	12.60	4.94	4.41
943.13	53.63	113.99	-65.47	-100.82	-0.158	0.238	(4)	(4)	54.89	100.29	5.83	5.47	10.55	5.47	4.24
947.07	60.14	97.99	-73.43	-86.67	-0.177	0.205	(4)	(4)	61.56	86.21	5.83	6.14	9.07	6.14	4.07
951.00	68.46	85.96	-83.55	-76.02	-0.202	0.180	(4)	(4)	70.05	75.63	5.83	6.99	7.95	6.99	3.92
954.93	79.38	76.55	-96.92	-67.71	-0.234	0.160	(4)	(4)	81.26	67.35	5.83	8.10	7.08	8.10	3.78
958.87	94.55	68.99	-115.43	-61.02	-0.279	0.144	(4)	(4)	96.78	60.70	5.83	9.65	6.38	9.65	3.64
962.80	*	*	*	*	*	*	*	*	119.55	55.25	5.83	11.92	5.81	11.92	3.52
966.73	*	*	*	*	*	*	*	*	156.34	50.70	5.83	15.59	5.33	15.59	3.40
974.60	398.07	49.48	-485.98	-43.75	-1.173	0.103	(4)	(4)	*	*	*	*	*	*	*
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 979.5 AND Xo 1040															
979.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
986.40	47.08	311.27	-45.39	-363.02	-0.107	0.833	(4)	(4)	*	*	*	*	*	*	*
990.33	50.80	198.31	-48.98	-231.28	-0.116	0.531	(4)	(4)	*	*	*	*	*	*	*
994.27	55.18	145.41	-53.20	-169.59	-0.126	0.389	(4)	(4)	52.92	94.56	7.64	5.56	24.69	4.67	6.29
998.20	60.37	114.85	-58.20	-133.95	-0.138	0.307	(4)	(4)	57.89	74.69	7.64	6.09	19.50	5.18	6.07
1002.13	66.63	94.91	-64.24	-110.68	-0.152	0.254	(4)	(4)	63.90	61.71	7.64	6.72	16.12	5.80	5.87
1006.07	74.37	80.83	-71.70	-94.27	-0.169	0.216	(4)	(4)	71.32	52.57	7.64	7.50	13.73	6.56	5.68
1010.00	84.12	70.42	-81.09	-82.12	-0.192	0.189	(4)	(4)	80.67	45.81	7.64	8.48	11.96	7.51	5.49
1013.93	96.80	62.38	-93.31	-72.75	-0.221	0.167	(4)	(4)	92.83	40.57	7.64	9.76	10.59	8.76	5.32
1017.87	114.03	55.97	-109.93	-65.28	-0.260	0.150	(4)	(4)	109.35	36.40	7.64	11.50	9.50	10.45	5.16
1021.80	138.65	50.77	-133.67	-59.22	-0.316	0.136	(4)	(4)	132.97	33.02	7.64	13.98	8.62	12.87	5.01
1025.73	176.84	46.46	-170.48	-54.18	-0.403	0.124	(4)	(4)	169.50	30.21	7.64	17.83	7.89	16.62	4.86
1029.67	244.28	42.81	-235.50	-49.93	-0.557	0.115	(4)	(4)	234.27	27.84	7.64	24.63	7.27	23.25	4.72
1033.60	394.29	39.70	-380.11	-46.29	-0.898	0.106	(4)	(4)	*	*	*	*	*	*	*
1037.53	1021.64	37.01	-984.90	-43.17	-2.328	0.099	(4)	(4)	*	*	*	*	*	*	*
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LP}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_P$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT
LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE							KEEL, 1000 LBS							
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1040 AND Xo 1090.33															
1040.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1049.33	43.58	219.55	-51.79	-249.58	-0.140	0.616	(4)	(4)	*	*	*	*	*	*	*
1053.27	48.21	154.37	-57.30	-175.48	-0.155	0.433	(4)	(4)	*	*	*	*	*	*	*
1057.20	53.93	119.09	-64.09	-135.38	-0.174	0.334	(4)	(4)	35.07	134.81	8.00	9.16	17.01	7.56	7.24
1061.13	61.19	96.94	-72.72	-110.20	-0.197	0.272	(4)	(4)	39.79	109.74	8.00	10.39	13.84	8.58	6.93
1065.07	70.73	81.71	-84.06	-92.88	-0.228	0.229	(4)	(4)	46.00	92.49	8.00	12.01	11.67	9.92	6.60
1069.00	83.77	70.64	-99.55	-80.29	-0.270	0.198	(4)	(4)	54.47	79.96	8.00	14.22	10.09	11.75	6.27
1072.93	102.68	62.21	-122.03	-70.72	-0.330	0.175	(4)	(4)	66.78	70.41	8.00	17.44	8.88	14.41	5.95
1076.87	132.74	55.56	-157.76	-63.16	-0.427	0.156	(4)	(4)	86.32	62.89	8.00	22.54	7.93	18.63	5.63
1080.80	187.48	50.21	-222.82	-67.08	-0.603	0.141	(4)	(4)	*	*	*	*	*	*	*
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BRIDGE BETWEEN FRAMES Xo 1090.33 AND Xo 1140.67															
1090.33	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1092.60	42.62	1390.48	-44.87	-1621.97	-0.120	2.533	(4)	(4)	*	*	*	*	*	*	*
1096.53	46.42	509.10	-48.87	-593.85	-0.130	0.927	(4)	(4)	*	*	*	*	*	*	*
1100.47	50.97	311.28	-53.66	-363.10	-0.143	0.567	(4)	(4)	*	*	*	*	*	*	*
1104.40	56.49	224.34	-59.47	-261.68	-0.159	0.409	(4)	(4)	*	*	*	*	*	*	*
1108.33	63.35	175.35	-66.70	-204.55	-0.178	0.319	(4)	(4)	71.23	151.66	7.20	9.05	16.30	9.05	6.12
1112.27	72.14	143.86	-75.95	-167.82	-0.202	0.262	(4)	(4)	81.66	124.43	7.20	10.30	13.38	10.30	5.86
1116.20	83.73	122.01	-88.15	-142.32	-0.235	0.222	(4)	(4)	94.78	105.53	7.20	11.96	11.34	11.96	5.63
1120.13	99.75	105.92	-105.02	-123.55	-0.280	0.193	(4)	(4)	112.91	91.61	7.20	14.24	9.85	14.24	5.42
1124.07	123.42	82.75	-129.94	-100.39	-0.346	0.170	(4)	(4)	139.71	80.91	7.20	17.63	8.70	17.63	5.22
1128.00	161.71	74.11	-170.25	-89.92	-0.454	0.153	(4)	(4)	183.04	72.47	7.20	23.09	7.79	23.09	5.04
1131.93	234.42	67.11	-246.80	-81.43	-0.658	0.138	(4)	(4)	*	*	*	*	*	*	*
1135.87	426.84	61.31	-449.39	-74.38	-1.198	0.126	(4)	(4)	*	*	*	*	*	*	*
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE							KEEL, 1000 LBS							
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X,Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1140.67 AND Xo 1191															
1140.67	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1151.60	77.02	391.49	-93.43	-415.67	-0.146	0.526	(4)	(4)	*	*	*	*	*	*	*
1155.53	85.55	287.96	-103.78	-305.74	-0.162	0.387	(4)	(4)	76.95	185.10	20.34	8.27	23.71	7.63	8.12
1159.47	96.24	227.61	-116.75	-241.66	-0.182	0.306	(4)	(4)	86.57	146.30	20.34	9.31	18.74	8.58	7.85
1163.40	109.94	187.34	-133.37	-199.88	-0.208	0.253	(4)	(4)	98.89	121.01	20.34	10.63	15.50	9.80	7.55
1167.33	128.20	160.43	-155.52	-170.42	-0.243	0.216	(4)	(4)	115.31	103.17	20.34	12.40	13.21	11.43	7.23
1171.27	153.80	87.96	-186.58	-112.14	-0.291	0.188	(4)	(4)	138.34	89.89	20.34	14.87	11.51	13.71	6.91
1175.20	192.05	89.23	-232.98	-115.13	-0.364	0.167	(4)	(4)	172.75	79.66	20.34	18.57	10.20	17.12	6.60
1179.13	255.64	90.50	-310.12	-118.13	-0.484	0.150	(4)	(4)	229.94	71.52	20.34	24.72	9.16	22.79	6.29
1181.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1183.07	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1187.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1190.93	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_o	LONGERON, 1000 LBS PER SIDE: VERTICAL ± Z, + Z, Z_F	+ Z, Z_A	- Z, Z_F	- Z, Z_A	Z MODIFIERS, K_F	Z MODIFIERS, K_A	LATERAL ± Y, $\pm Y_{LF}$	LATERAL ± Y, $\pm Y_{LA}$	KEEL, 1000 LBS: ± Y (Z ≠ 0), $\pm Y_F$	± Y (Z ≠ 0), $\pm Y_A$	$\pm X_K$ (Z=0)	$\pm Z_K$(X=0), $\pm Z_{KF}$	$\pm Z_K$(X=0), $\pm Z_{KA}$	$\pm R_K$(X,Z≠0), $\pm R_{KF}$	$\pm R_K$(X,Z≠0), $\pm R_{KA}$
BRIDGE BETWEEN FRAMES Xo 1191 AND Xo 1249															
1191.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1194.87	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1198.80	91.62	589.67	-83.07	-589.67	-0.115	0.737	(4)	(4)	*	*	*	*	*	*	*
1202.73	97.70	392.11	-90.13	-392.11	-0.124	0.490	(4)	(4)							
1206.67	103.78	293.52	-98.51	-293.52	-0.136	0.367	(4)	(4)	ALLOWABLE LOADS ARE DEFINED IN PARAGRAPH I.3.5						
1210.60	109.86	234.66	-108.60	-234.66	-0.150	0.293	(4)	(4)							
1214.53	115.94	195.47	-120.97	-195.47	-0.167	0.244	(4)	(4)							
1218.47	122.02	167.43	-136.59	-167.43	-0.188	0.209	(4)	(4)							
1222.40	172.91	116.53	-156.77	-146.47	-0.216	0.183	(4)	(4)							
1226.33	202.88	111.05	-183.95	-130.18	-0.254	0.163	(4)	(4)	*	*	*	*	*	*	*
1230.27	245.56	105.56	-222.64	-117.12	-0.307	0.146	(4)	(4)	*	*	*	*	*	*	*
1234.20	310.77	100.08	-281.76	-106.47	-0.389	0.133	(4)	(4)	*	*	*	*	*	*	*
1238.13	423.13	94.59	-383.63	-97.59	-0.529	0.122	(4)	(4)	*	*	*	*	*	*	*
1242.07	663.69	89.11	-601.75	-90.06	-0.830	0.113	(4)	(4)	*	*	*	*	*	*	*
1246.00	1533.13	83.63	-1390.03	-83.63	-1.917	0.105	(4)	(4)	*	*	*	*	*	*	*
1249.00	*	*	*	*	*	*	*	*							

NOTES:
1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.
2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.
3. * Attach point not available at locations where asterisk appears.
4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-6 PAYLOAD ATTACHMENT POINT LIMIT-LOAD CAPABILITY AT LONGERON AND KEEL FOR LANDING HEAVY-WEIGHT (65K) CONDITIONS

ATTACH POINT X_0	LONGERON, 1000 LBS PER SIDE								KEEL, 1000 LBS						
	VERTICAL ± Z						LATERAL ± Y		± Y (Z ≠ 0)		$\pm X_K$ (Z=0)	$\pm Z_K$(X=0)		$\pm R_K$(X, Z≠0)	
	+ Z		- Z		Z MODIFIERS										
	Z_F	Z_A	Z_F	Z_A	K_F	K_A	$\pm Y_{LF}$	$\pm Y_{LA}$	$\pm Y_F$	$\pm Y_A$		$\pm Z_{KF}$	$\pm Z_{KA}$	$\pm R_{KF}$	$\pm R_{KA}$
BRIDGE BETWEEN FRAME Xo 1249 AND BRIDGE ATTACH PIN Xo 1301.00															
1249.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1269.60	154.41	167.36	-155.67	-167.36	-0.183	0.279	(4)	(4)							
1273.53	176.50	140.55	-177.94	-140.55	-0.209	0.234	(4)	(4)							
1277.47	206.05	121.10	-207.73	-121.10	-0.244	0.202	(4)	(4)							
1281.40	247.37	106.40	-249.39	-106.40	-0.293	0.177	(4)	(4)	NO KEEL ATTACH POINTS AVAILABLE						
1301.00	*	*	*	*	*	*	*	*							

NOTES: 1. Before using this table see paragraph I.3.0 through I.3.3 for guidelines.

2. See Tables I.2-7 and I.2-8 for limit longitudinal loads and limit vertical side skin shear loads at landing.

3. * Attach point not available at locations where asterisk appears.

4. For lateral $\pm Y_{LF}$ and $\pm Y_{LA}$ values, use 10% of the appropriate $\pm Z_F$ and $\pm Z_A$ values.

TABLE I.2-7 LIMIT LONGITUDINAL LOAD CAPABILITY PER VEHICLE SIDE FOR ALL FLIGHT AND LANDING CONDITIONS

BRIDGE SPAN, FRAME TO FRAME	Limit Longitudinal Load Capability X, 1000 lbs.						
	ASCENT MODE(1)			DESCENT MODE (2)			
	LIFT-OFF	POST-SRB STAGING	ORBITER MAX G AND END BURN	TAEM-YAW & ROLL MANEUVER	TAEM PITCH-UP Maneuver	NORMAL LANDING (LT. WT. 32K)	ABORT LANDING (HVY WT. 65K)
582 - 636	7.0	5.9	17.0	± 7.0	±21.8	±7.0	±7.0
636 - 693	17.0	5.9	17.0	± 7.0	±21.8	±7.0	±7.0
693 - 750	13.8	5.9	17.0	± 7.0	±24.8	±7.0	±7.0
750 - 807	33.0	11.4	33.0	±15.0	±26.3	±15.0	±15.0
807 - 863	34.0	11.8	34.0	±15.0	±26.9	±15.0	±15.0
863 - 919	54.0	18.7	54.0	±19.0	±46.9	±19.0	±19.0
919 - 979.5	55.0	19.0	55.0	±27.0	±57.5	±27.0	±24.6
979.5 - 1040	57.0	19.7	57.0	±25.0	±76.4	±25.0	±25.0
1040 - 1090.33	70.0	24.2	70.0	±33.0	±90.0	±33.0	±33.0
1090.33 - 1140.67	104.0	36.0	104.0	±50.0	±116.0	±50.0	±50.0
1140.67 - 1191	120.0	41.6	120.0	±76.0	±120.0	+62.2 -76.0	±76.0
1191 - 1249	120.0	41.6	120.0	±76.0	±120.0	+76.0 -62.3	±76.0
1249 - 1301	110.0	38.1	110.0	±50.0	±110.0	±50.0	±50.0

NOTE:

(1) During ascent, at post-SRB-staging (-1.10g), payload inertial loads combined with bending loads caused by thrust vector misalignment of the main engines result in critical longeron compression loading. At Orbiter maximum acceleration (-3.17g), payload inertial loads result in critical longeron compression loading. The noted limit load capability is applicable to any attach point on a particular bridge span. For single payloads, the noted capability applies. For multiple payloads or multiple attach points which react longitudinal loads, the +X-loads acting at each attach point are summed from front to rear in the payload bay to the aft most employed attach point. In addition the accumulation of +X loads cannot exceed the noted load capability at any intermediate attach point in the summation.

(2) During descent, payload inertial loads combined with bending loads caused by thermal conditions, TAEM maneuvers and landing forces result in critical longeron loading. For single payloads, the noted capability applies. For multiple payloads or X-load attach points, the noted load capability at each X-load attach point applies also.

TABLE I.2-8 ALLOWABLE LIMIT VERTICAL LOAD CAPABILITY PER VEHICLE SIDE AT LANDING

MAIN FRAME Xo STATION	LIMIT VERTICAL LOAD -Zs, IN 1000 LBS(1)
582	-19.3
636	-57.2
693	-59.5
750	-67.9
807	-73.9
863	-73.9
919	-83.2
979.5	-90.5
1040	-96.9
1090.33	-105.4
1140.67	-111.9
(2)----------------1180	--------------
1191	-103.9
1249	-94.0
1307	-66.3

NOTES:

* Last bridge is attached to fuselage structure at Xo 1301.00; loads are transmitted to Xo 1307 frame.

(1) At landing, Orbiter side skins react payload-imposed vertical shear loads. The vertical loads are transmitted from the payload attach point to the side skins via the longeron bridge and bridge-to-main-frame attachment pins.

(2) Fuselage Station Xo 1180 is the main landing gear station. Negative loads transmitted to the frames from payload-imposed landing loads at the primary and stabilizing attach points are accumulated aft from frame Xo 582 to frame Xo 1140.67, and forward from frame Xo 1307 to frame 1191. For single or multiple payloads, the sum of the loads cannot exceed the noted capability for that frame. For the bridge spanning the landing gear station (i.e., from frame Xo 1140.67 to frame Xo 1191) the payload- imposed load at Xo1140.67 is summed with the aft accumulating loads; the load at Xo 1191 is summed with the forward accumulating loads. Only negative vertical loads are referenced to the main landing gear; positive vertical loads are limited to those shown in Table I.2-1.

I.3 GUIDELINES/EQUATIONS FOR USE OF ATTACH POINT LIMIT-LOAD CAPABILITY DATA

The following paragraphs provide guidelines, equations, and symbol definitions for using Tables I.2-1 through I.2-8 in determining whether payload-imposed loads are within the attach point limit load capability. Paragraph I.3.2 presents the equations for determining the load capability of an attach point where only a single bridge is used (i.e., no other bridge is attached to either frame). In Paragraph I.3.3, equations are presented for determining the load capability of attach points which are mounted on adjacent bridges (i.e., the bridges are pinned to a common frame). Paragraph I.3.4 presents the equations treating the allowable loads for two longeron attach points on one bridge. The equations specifically addressing the allowable keel loads for bay 12 (Xo1191- 1249) are presented in Paragraph I.3.5.

Before using the guidelines and the capability data, the loads imposed by a payload at its attach points should be calculated based on the load factors presented in Section 4.0. Then those loads can be checked against Orbiter capability presented herein.

I.3.1 DEFINITION OF TERMS

The terms appearing in Paragraphs I.3.2, I.3.3, I.3.4, I.3.5 and Tables I.2-1 thru I.2-6, I.2-7 and I.2-8 are defined below.

I.3.1.1 Longeron Attach Points

Z = Applied vertical load at a single attach point on one bridge.

Z_1 = Applied vertical load at the attach point on the forward bridge of an adjacent pair, or the applied vertical load at the attach point on the forward attach point of a single bridge with two attach fittings.

Z_2 = Applied vertical load at the attach point on the aft bridge of an adjacent bridge pair, or the applied vertical load at the attach point on the aft attach point of a single bridge with two attach fittings.

Z_F = Attach point Z-load capability as limited by forward frame strength of a bridge.

Z_A = Attach point Z-load capability as limited by aft frame strength of a bridge.

Z_{F1} = Forward attach point Z-load capability as limited by the forward frame strength of the forward bridge of an adjacent bridge pair, or the forward attach point Z-load capability as limited by the forward frame strength of a single bridge with two attach fittings.

Z_{F2} = Aft attach point Z-load capability as limited by the forward frame strength of the aft bridge of an adjacent bridge pair, or the aft attach point Z-load capability as limited by forward frame strength of a single bridge with two attach fittings.

Z_{A1} = Forward attach point Z-load capability as limited by aft frame strength of the forward bridge of an adjacent bridge pair, or the forward attach point Z-load capability as limited by aft frame strength of a single bridge with two attach fittings.

Z_{A2} = Aft attach point Z-load capability as limited by the aft frame strength of the aft bridge of an adjacent bridge pair, or the aft attach point Z-load capability as limited by aft frame strength of a single bridge with two attach fittings.

Z_s = Attach point Z-load capability at landing as limited by frame capability noted in Table I.2-8.

X = Applied longitudinal load, to be less than the values shown in Table I.2-7.

K_{Fi} = Modifier of Z_{Fi} to account for couple resulting from applied longitudinal load X, where i = 1, or 2.

K_{Ai} = Modifier of Z_{Ai} to account for couple resulting from applied longitudinal load X, where i = 1, or 2.

Y_{LF} = Attach point Y-load capability as limited by forward frame strength.

Y_{LA} = Attach point Y-load capability as limited by aft frame strength.

μ_X = Coefficient of friction for X-direction friction loads on a single attach fitting of a single bridge.

μ_Y = Coefficient of friction for Y-direction friction loads on a single attach fitting of a single bridge.

μ_Z = Coefficient of friction for Z-direction friction loads on a single attach fitting of a single bridge.

μ_{X1} = Coefficient of friction for X-direction friction loads on the forward bridge of an adjacent bridge pair, or the coefficient of friction for X-direction friction load on the forward attach point of a single bridge.

μ_{Y1} = Coefficient of friction for Y-direction friction loads on the forward bridge of an adjacent bridge pair, or the coefficient of friction for Y-direction friction load on the forward attach point of a single bridge.

μ_{Z1} = Coefficient of friction for Z-direction friction loads on the forward bridge of an adjacent bridge pair, or the coefficient of friction for Z-direction friction load on the forward attach fitting of a single bridge.

μ_{X2} = Coefficient of friction for X-direction friction loads on the aft bridge of an adjacent bridge pair, or the coefficient of friction for X-direction friction load on the aft attach fitting of a single bridge.

μ_{Y2} = Coefficient of friction for Y-direction friction loads on the aft bridge of an adjacent bridge pair, or the coefficient of friction for Y-direction friction load on the aft attach fitting of a single bridge.

μ_{Z2} = Coefficient of friction for Z-direction friction loads on the aft bridge of an adjacent bridge pair, or the coefficient of friction for Z-direction friction load on the aft attach fitting of a single bridge.

θ_i = Angle (deg.) of bearing rotation due to trunnion deflection (See Figure I.3.1.1-1). (i = 1 or 2) for 2 attach points on one bridge or 2 attach points adjacent bridges.

I.3.1.2 Keel Attach Points

Y = Applied lateral load for one fitting on a single bridge.

Y_F = Attach point Y-load capability as limited by forward frame strength.

Y_A = Attach point Y-load capability as limited by aft frame strength.

Y_{F1} = Forward attach point Y-load capability as limited by forward frame strength of the forward bridge for an adjacent bridge pair.

Y_{F2} = Aft attach point Y-load capability as limited by forward frame strength of the aft bridge for an adjacent bridge pair.

Y_{A1} = Forward attach point Y-load capability as limited by aft frame strength of the forward bridge for an adjacent bridge pair.

Y_{A2} = Aft attach point Y-load capability as limited by aft frame strength of the aft bridge for an adjacent bridge pair.

X_{K1} = Attach point X-load (i.e., imposed by friction or fixed-X fittings) capability on the forward bridge for an adjacent bridge pair.

X_{K2} = Attach point X-load (i.e., imposed by friction or fixed-X fittings) capability on the aft bridge for an adjacent bridge pair.

Z_{KF} = Attach point Z-load capability as limited by forward frame strength.

Z_{KA} = Attach point Z-load capability as limited by aft frame strength.

Z_{KF1} = Attach point Z-load capability as limited by forward frame strength of the forward bridge for an adjacent bridge pair.

Z_{KF2} = Attach point Z-load capability as limited by forward frame strength of the aft bridge for an adjacent bridge pair.

Z_{KA1} = Attach point Z-load capability as limited by aft frame strength of the forward bridge for an adjacent bridge pair.

Z_{KA2} = Attach point Z-load capability as limited by aft frame strength of the aft bridge for an adjacent bridge pair.

R_{KF} = Attach point combined X-Z friction load capability as limited by forward frame strength.

R_{KA} = Attach point combined X-Z friction load capability as limited by aft frame strength.

R_{KF1} = Attach point combined X-Z friction load capability as limited by forward frame strength of the forward bridge for an adjacent bridge pair.

R_{KF2} = Attach point combined X-Z friction load capability as limited by forward frame strength of the aft bridge for an adjacent bridge pair.

R_{KA1} = Attach point combined X-Z friction load capability as limited by aft frame strength of the forward bridge for an adjacent bridge pair.

R_{KA2} = Attach point combined X-Z friction load capability as limited by aft frame strength of the aft bridge for an adjacent bridge pair.

μ = The definition of friction coefficient are the same as those in Paragraph I.3.1.1. Longeron Attach Points.

θ_i = Angle (deg.) of bearing rotation due to keel deflections (See Figure I.3.1.2-1). i=1,2 for adjacent bridge pairs.

Y_{11} = Applied lateral load for one fitting for Bay 11.

Y_{12} = Applied lateral load for one fitting for Bay 12.

X_{11} = Applied longitudinal load for one fitting for Bay 11.

X_{12} = Applied longitudinal load for one fitting for Bay 12.

μ_{11} = The coefficient of friction for Bay 11 fitting.

μ_{12} = The coefficient of friction for Bay 12 fitting.

B = Allowable load factor constants for Bays 11 and 12 adjacent bridges. The factors are a measure of the load capability available to react payload loads after accounting for flight loads.

C = Allowable load factor constants for Bay 12 only. The factors are a measure of the load capability available to react payload loads after accounting for flight loads.

I.3.2 ALLOWABLE LOADS FOR SINGLE BRIDGE

This paragraph outlines the procedure for deriving payload attach point loads for a "single" longeron or keel bridge. A bridge is referred to as "single" when it does not share either of its mid-fuselage support frames with another longeron or keel bridge respectively. Figure I.3.2-1 depicts such a configuration.

Paragraph I.3.2.1 is concerned with the derivation of allowable payload-induced loads at a longeron for all pertinent load combinations. Each load combination is treated separately. All equations applicable to a particular combination of loads must be satisfied. The equations compare absolute values of payload-induced loads and Orbiter capabilities. If the sign of the sum inside the absolute value of the left hand side of the equation is positive, a positive Z_F or Z_A capability is compared. If the sign of the quantity is negative, Z_F or Z_A value from Table I.2-1 thru I.2-6 is compared. The absolute value of a payload-induced load must be less than the absolute value of

Orbiter capability. Similarly, Paragraph I.3.2.2 treats the allowable payload-induced loads at the keel.

I.3.2.1 Allowable Loads at Longeron Attach Points

I.3.2.1.1 Attach Point Reacts Z- and X-loads with Trunnion/Bearing Friction and Bearing Rotation Loads

$$\sqrt{X^2 + Z^2}\ (\mu_Y + \tan|\theta|) \leq \text{Lower of } |Y_{LF}| \text{ and } |Y_{LA}| \text{ values}$$

$$|Z - K_F X| \leq |Z_F| \text{ and } |Z - K_A X| \leq |Z_A|$$

$|Z| \leq |$ Zs load capability, at landing, as shown in Table I.2 - 8 $|$

$|X| \leq |$ X - load capability, for applicable flight conditions, as shown in Table I.2 - 7 $|$.

For the above two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for accumulation procedure.

I.3.2.1.2 Attach Point Reacts Z-Load with Trunnion/Bearing Friction and Bearing Rotation Loads

$$|Z|\ (\mu_y + \tan|\theta|) \leq \text{Lower of } |Y_{LF}| \text{ and } |Y_{LA}| \text{ values}$$

$$|Z - K_F \mu_X Z| \leq |Z_F| \text{ and } |Z + K_A \mu_X Z| \leq |Z_A|$$

$|Z| \leq |$ Zs load capability, at landing, as shown in Table I.2 - 8 $|$

$|\mu_X Z| \leq |$ X - load capability, for applicable flight conditions, as shown in Table I.2 - 7 $|$.

For the above two equations, see Note (1) of table I.2-7 and Note (2) of Table I.2-8 for load accumulation procedure.

I.3.2.2 Allowable Loads at Keel Attach Points

I.3.2.2.1 Attach Point Reacts Y-loads, X-Friction Loads, and Z-Friction and Bearing Rotation Loads (X, Z ≠ 0)

$$|Y|\ [\mu + \tan|\theta|] \leq \text{Lower of } |R_{KF}| \text{ and } |R_{KA}| \text{ values}$$

The μ value in the above equation shall be equal to $(\mu_X + \mu_Z)/2$

$$|Y| \leq \text{Lower of } |Y_F| \text{ and } |Y_A| \text{ values}$$

$$|Z| = |Y|\ [\mu_Z + \tan|\theta|]$$

$$|Z| \leq \text{Lower of } |Z_{KF}| \text{ and } |Z_{KA}|$$

I.3.2.2.2 Attach Point Reacts X- and Y-loads (i.e., Keel Fitting Restrained from Movement in the X-direction) and Z-Friction and Bearing Rotation Loads (X, Z ≠ 0)

$$|Y| \; [\mu + \tan|\theta|] \; \leq \; |R_{KA}|$$

$$X_K |Y| \; (\mu + \tan|\theta|) / (X_K + 0.135|Y| - |X|) \; \leq \; |R_{KA}|$$

$$\left(\sqrt{X^2 + Y^2}\right) \; (\mu + \tan|\theta|) \; \leq \; |R_{KF}|$$

The μ value in the above equations shall be equal to $(0.12+\mu_z)/2$

$$|X| \; \leq \; |X_K|$$

$|Y| \; \leq$ Lower of $|Y_F|$ and $|Y_A|$ values.

$$|Z| \; = \; \sqrt{X^2 + Y^2} \; (\mu_Z + \tan|\theta|)$$

$|Z| \; \leq$ Lower of $|Z_{KF}|$ and $|z_{KA}|$

I.3.3 Allowable Loads for Adjacent Bridges

This paragraph outlines the procedure for deriving allowable payload attach point loads for "adjacent" longeron or keel bridges. Two bridges are "adjacent" when the aft end of the first bridge and the forward end of the second bridge are attached to the same mid-fuselage frame. This common frame reacts attach point loads transmitted to it by each bridge. Figure I.3.3-1 depicts such a configuration. Paragraph I.3.3.1 is concerned with the derivation of allowable payload-induced loads at attach points on adjacent longeron bridges for all pertinent load combinations. Each load combination is treated separately. For each particular load combination, all equations must be satisfied. The equations compare absolute values of payload-induced loads and Orbiter capabilities. The absolute value of payload-induced load must be less than the absolute value of Orbiter capability. Paragraph I.3.3.2 treats allowable payload-induced loads at attach points on adjacent keel bridges. These procedures must be repeated when more than two bridges are adjacent. Table I.1-1 correlates specific load combinations with the paragraphs below.

I.3.3.1 Allowable Loads at Longeron Attach Points

I.3.3.1.1 Attach Points 1 and 2 React X-loads and Z-loads with Trunnion/ Bearing Friction and Bearing Rotation

$$\frac{\sqrt{X_1^2 + Z_1^2}\;(\mu_{Y1} + \tan|\theta_1|)}{|Y_{LA1}|} + \frac{\sqrt{X_2^2 + Z_2^2}\;(\mu_{Y2} + \tan|\theta_2|)}{|Y_{LF2}|} \; \leq \; 1$$

$$\left| \frac{Z_1 - K_{A1}X_1}{|Z_{A1}|} + \frac{Z_2 - K_{F2}X_2}{|Z_{F2}|} \right| \; \leq \; 1$$

$$\sqrt{X_1^2 + Z_1^2} \; (\mu_{Y1} + \tan|\theta_1|) \; \leq \; |Y_{LF1}|$$

$$\sqrt{X_2^2 + Z_2^2} \; (\mu_{Y2} + \tan|\theta_2|) \; \leq \; |Y_{LA2}|$$

$$\left|Z_1 - K_{F1}X_1\right| \leq \left|Z_{F1}\right|$$

$$\left|Z_2 - K_{A2}X_2\right| \leq \left|Z_{A2}\right|$$

$$\left|X_1\right| \text{ and } \left|X_2\right| \leq \left|\text{ X - load capability shown in Table I.2 - 7 }\right|$$

$$\left|Z_1\right| \text{ and } \left|Z_2\right| \leq \left|\text{ Zs load capability, at landing only, as shown in Table I.2 - 8 }\right|$$

For the previous two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedures.

when Z_1 and Z_2 are in opposite directions, also check:

$$\left|Z_1 - K_{A1}X_1\right| \leq \left|Z_{A1}\right|$$

$$\left|Z_2 - K_{F2}X_2\right| \leq \left|Z_{F2}\right|$$

I.3.3.1.2 <u>Attach Points 1 and 2 React Z-Loads with Trunnion/Bearing Friction and Bearing Rotation Loads</u>

$$\frac{\left|Z_1\right| \left(\mu_{Y1} + \tan\left|\theta_1\right|\right)}{\left|Y_{LA1}\right|} + \frac{\left|Z_2\right| \left(\mu_{Y2} + \tan\left|\theta_2\right|\right)}{\left|Y_{LF2}\right|} \leq 1$$

$$\left|\frac{Z_1 + K_{A1}\mu_{X1}Z_1}{\left|Z_{A1}\right|} + \frac{Z_2 - K_{F2}\mu_{X2}Z_2}{\left|Z_{F2}\right|}\right| \leq 1$$

$$\left|Z_1\right| \left(\mu_{Y1} + \tan\left|\theta_1\right|\right) \leq \left|Y_{LF1}\right|$$

$$\left|Z_2\right| \left(\mu_{Y2} + \tan\left|\theta_2\right|\right) \leq \left|Y_{LA2}\right|$$

$$\left|Z_1 - K_{F1}\mu_{X1}Z_1\right| \leq \left|Z_{F1}\right|$$

$$\left|Z_2 + K_{A2}\mu_{X2}Z_2\right| \leq \left|Z_{A2}\right|$$

$$\left|\mu_{X1}Z_1\right| \text{ and } \left|\mu_{X2}Z_2\right| \leq \left|\text{ X – load capability shownin Table I.2 – 7 }\right|$$

$$\left|Z_1\right| \text{ and } \left|Z_2\right| \leq \left|\text{ Zs load capability at landing only, as shown in Table I.2 - 8 }\right|$$

For the above two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedures.

when Z_1 and Z_2 are in opposite directions, also check:

$$\left|Z_1 + K_{A1}\mu_{X1}Z_1\right| \leq \left|Z_{A1}\right|$$

$$\left|Z_2 - K_{F2}\mu_{X2}Z_2\right| \leq \left|Z_{F2}\right|$$

I.3.3.1.3 Attach Points 1 Reacts Z- and X-Loads and Attach Point 2 Reacts Z-Loads Only with Trunnion/Bearing Friction and Bearing Rotation

$$\frac{\sqrt{X_1^2 + Z_1^2}\ (\mu_{Y1} + \tan|\theta_1|)}{|Y_{LA1}|} + \frac{|Z_2|\ (\mu_{Y2} + \tan|\theta_2|)}{|Y_{LF2}|} \leq 1$$

$$\left| \frac{Z_1 - K_{A1}X_1}{|Z_{A1}|} + \frac{Z_2 - K_{F2}\mu_{X2}Z_2}{|Z_{F2}|} \right| \leq 1 \ ;$$

$$\sqrt{X_1^2 + Z_1^2}\ (\mu_{Y1} + \tan|\theta_1|) \leq |Y_{LF1}|$$

$$|Z_2|\ (\mu_{Y2} + \tan|\theta_2|) \leq |Y_{LA2}|$$

$$|Z_1 - K_{F1}X_1| \leq |Z_{F1}|$$

$$|Z_2 + K_{A2}\mu_{X2}Z_2| \leq |Z_{A2}|$$

$$|X_1| \text{ and } |\mu_{X2}Z_2| \leq |\text{X - load capability shown in Table I.2 - 7}|$$

$$|Z_1| \text{ and } |Z_2| \leq |\text{Zs load capability at landing only, as shown in Table I.2 - 8}|$$

For the above two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedures.

when Z_1 and Z_2 are in opposite directions, also check:

$$|Z_1 - K_{A1}X_1| \leq |Z_{A1}|$$

$$|Z_2 - K_{F2}\mu_{X2}Z_2| \leq |Z_{F2}|$$

I.3.3.1.4 Attach Point 1 Reacts Z-loads only and Attach Point 2 Reacts X- and Z-loads with Trunnion/Bearing Friction and Bearing Rotation

$$\frac{|Z_1|\ (\mu_{Y1} + \tan|\theta_1|)}{|Y_{LA1}|} + \frac{\sqrt{X_2^2 + Z_2^2}\ (\mu_{Y2} + \tan|\theta_2|)}{|Y_{LF2}|} \leq 1$$

$$\left| \frac{Z_1 + K_{A1}\mu_{X1}Z_1}{|Z_{A1}|} + \frac{Z_2 - K_{F2}X_2}{|Z_{F2}|} \right| \leq 1$$

$$|Z_1|\ (\mu_{Y1} + \tan|\theta_1|) \leq |Y_{LF1}|$$

$$\sqrt{X_2^2 + Z_2^2}\ (\mu_{Y2} + \tan|\theta_2|) \leq |Y_{LA2}|$$

$$|Z_1 - K_{F1}\mu_{X1}Z_1| \leq |Z_{F1}|$$

$$|Z_2 - K_{A2}X_2| \leq |Z_{A2}|$$

$|\mu_{X1}Z_1|$ and $|X_2| \leq$ | X - load capability shown in Table I.2 - 7 |

$|Z_1|$ and $|Z_2| \leq$ | Zs load capability at landing only, as shown in Table I.2 - 8 |

For the previous two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedures.

when Z_1 and Z_2 are in opposite directions, also check:

$$|Z_1 + K_{A1}\mu_{X1}Z_1| \leq |Z_{A1}|$$

$$|Z_2 - K_{F2}X_2| \leq |Z_{F2}|$$

I.3.3.2 Allowable-loads at Keel Attach Points

I.3.3.2.1 Attach Points 1 and 2 React Y-loads, X-Friction loads, and Z-Friction and Bearing Rotation loads (X, Z ≠ 0)

$$\frac{|Y_1|\left(\mu_1 + \tan|\theta_1|\right)}{|R_{KA1}|} + \frac{|Y_2|\left(\mu_2 + \tan|\theta_2|\right)}{|R_{KF2}|} \leq 1$$

$$|Y_1|\left(\mu_1 + \tan|\theta_1|\right) \leq |R_{KF1}|$$

$$|Y_2|\left(\mu_2 + \tan|\theta_2|\right) \leq |R_{KA2}|$$

The μ_i values in the above three equations shall be equal to $\left(\mu_{Xi} + \mu_{Zi}\right)/2$, (i=1 or 2).

$$\left|\frac{Y_1}{|Y_{A1}|} + \frac{Y_2}{|Y_{F2}|}\right| \leq 1$$

$$|Y_1| \leq |Y_{F1}|$$
$$|Y_2| \leq |Y_{A2}|$$

when Y_1 and Y_2 are in the opposite directions, also check:

$$|Y_1| \leq |Y_{A1}|$$
$$|Y_2| \leq |Y_{F2}|$$

$$|Z_1| = |Y_1|\left[\mu_{Z1} + \tan|\theta_1|\right]$$
$$|Z_2| = |Y_2|\left[\mu_{Z2} + \tan|\theta_2|\right]$$

$$\left|\frac{Z_1}{|Z_{KA1}|} + \frac{Z_2}{|Z_{KF2}|}\right| \leq 1$$

$$|Z_1| \leq |Z_{KF1}|$$

$$|Z_2| \leq |Z_{KA2}|$$

when Z_1 and Z_2 are in the opposite directions, also check:

$$|Z_1| \leq |Z_{KA1}|$$
$$|Z_2| \leq |Z_{KF2}|$$

I.3.3.2.2 Attach Points 1 and 2 React Y- and X-loads (i.e., Keel Fittings Restrained from movement in the X-direction) and Z-friction and Bearing rotation loads

$$\frac{|Y_1| \left[\mu_1 + \tan|\theta_1|\right]}{|R_{KA1}|} + \frac{\sqrt{X_2^2 + Y_2^2}\left(\mu_2 + \tan|\theta_2|\right)}{|R_{KF2}|} \leq 1$$

$$\frac{\left[X_{K1}|Y_1|\left(\mu_1 + \tan|\theta_1|\right)/\left(X_{K1} + 0.135|Y_1| - |X_1|\right)\right]}{|R_{KA1}|} + \frac{\left[\sqrt{X_2^2 + Y_2^2}\left(\mu_2 + \tan|\theta_2|\right)\right]}{|R_{KF2}|} \leq 1$$

$$\sqrt{X_1^2 + Y_1^2}\left(\mu_1 + \tan|\theta_1|\right) \leq |R_{KF1}|$$
$$|Y_2|\left(\mu_2 + \tan|\theta_2|\right) \leq |R_{KA2}|$$
$$\frac{X_{K2}|Y_2|\left(\mu_2 + \tan|\theta_2|\right)}{X_{K2} + 0.135|Y_2| - |X_2|} \leq |R_{KA2}|$$

The μ_i values in the above equations shall be equal to $(0.12 + \mu_{Zi})/2$, (i = 1 or 2)

$$\left|\frac{Y_1}{|Y_{A1}|} + \frac{Y_2}{|Y_{F2}|}\right| \leq 1$$

$$|Y_1| \leq |Y_{F1}|$$

$$|Y_2| \leq |Y_{A2}|$$

when Y_1 and Y_2 are in opposite directions, also check:

$$|Y_1| \leq |Y_{A1}|$$

$$|Y_2| \leq |Y_{F2}|$$

$$|Z_1| = \sqrt{X_1^2 + Y_1^2}\left(\mu_{Z1} + \tan|\theta_1|\right)$$
$$|Z_2| = \sqrt{X_2^2 + Y_2^2}\left(\mu_{Z2} + \tan|\theta_2|\right)$$
$$\left|\frac{Z_1}{|Z_{KA1}|} + \frac{Z_2}{|Z_{KF2}|}\right| \leq 1$$

$$|Z_1| \leq |Z_{KF1}|$$

$$|Z_2| \leq |Z_{KA2}|$$

When Z_1 and Z_2 are in the opposite directions, also check:

$$|Z_1| \leq |Z_{KA1}|$$
$$|Z_2| \leq |Z_{KF2}|$$

I.3.3.2.3 Attach Point 1 Reacts Y- and X-loads (i.e., Keel Fitting Restrained from movement in the X-direction) and Z-friction and Bearing rotation loads. Attach Point 2 Reacts Y-loads, X-friction loads, and Z-friction and Bearing rotation loads

$$\frac{|Y_1|\left(\mu_1 + \tan|\theta_1|\right)}{|R_{KA1}|} + \frac{\left[Y_2\left(\mu_2 + \tan|\theta_2|\right)\right]}{|R_{KF2}|} \leq 1$$

$$\frac{\left[X_{K1}|Y_1|\left(\mu_1 + \tan|\theta_1|\right)/\left(X_{K1} + 0.135|Y_1| - |X_1|\right)\right]}{|R_{KA1}|} +$$

$$\frac{\left[Y_2\left(\mu_2 + \tan|\theta_2|\right)\right]}{|R_{KF2}|} \leq 1$$

$$\sqrt{X_1^2 + Y_1^2}\left(\mu_1 + \tan|\theta_1|\right) \leq |R_{KF1}|$$
$$|Y_2|\left(\mu_2 + \tan|\theta_2|\right) \leq |R_{KA2}|$$

The μ_1 value in the above equations shall be equal to $(0.12 + \mu_{Z1})/2$; the μ_2 value in the above equations shall be equal to $(\mu_{X2} + \mu_{Z2})/2$.

$$\left|\frac{Y_1}{|Y_{A1}|} + \frac{Y_2}{|Y_{F2}|}\right| \leq 1$$

$$|Y_1| \leq |Y_{F1}|$$
$$|Y_2| \leq |Y_{A2}|$$

when Y_1 and Y_2 are in the opposite directions, also check:

$$|Y_1| \leq |Y_{A1}|$$
$$|Y_2| \leq |Y_{F2}|$$
$$|Z_1| = \sqrt{X_1^2 + Y_1^2}\left(\mu_{Z1} + \tan|\theta_1|\right)$$
$$|Z_2| = |Y_2|\left(\mu_{Z2} + \tan|\theta_2|\right)$$
$$\left|\frac{Z_1}{|Z_{KA1}|} + \frac{Z_2}{|Z_{KF2}|}\right| \leq 1$$
$$|Z_1| \leq |Z_{KF1}|$$
$$|Z_2| \leq |Z_{KA2}|$$

When Z_1 and Z_2 are in the opposite directions, also check:

$$|Z_1| \leq |Z_{KA1}|$$
$$|Z_2| \leq |Z_{KF2}|$$

I.3.3.2.4 Attach Point 1 Reacts Y-loads, X-friction loads, and Z-friction and Bearing Rotation Loads. Attach Point 2 Reacts Y- and X-loads (i.e., Keel Fitting Restrained from Movement in the X-direction) and Z-Friction and Bearing Rotation Loads

$$\frac{|Y_1| \left(\mu_1 + \tan|\theta_1|\right)}{|R_{KA1}|} + \frac{\sqrt{X_2^{\,2} + Y_2^{\,2}}\ \left(\mu_2 + \tan|\theta_2|\right)}{|R_{KF2}|} \leq 1$$

$$|Y_1| \left(\mu_1 + \tan|\theta_1|\right) \leq |R_{KF1}|$$
$$|Y_2| \left(\mu_2 + \tan|\theta_2|\right) \leq |R_{KA2}|$$
$$\frac{X_{K2}|Y_2| \left(\mu_2 + \tan|\theta_2|\right)}{\left(X_{K2} + 0.135|Y_2| - |X_2|\right)} \leq |R_{KA2}|$$

The μ_1 value in the above equations shall be equal to $(\mu_{X1} + \mu_{Z1})/2$; the μ_2 value in the above equations shall be equal to $(0.12 + \mu_{Z2})/2$.

$$\left|\frac{Y_1}{|Y_{A1}|} + \frac{Y_2}{|Y_{F2}|}\right| \leq 1$$

$$|Y_1| \leq |Y_{F1}|$$

$$|Y_2| \leq |Y_{A2}|$$

when Y_1 and Y_2 are in the opposite directions, also check:

$$|Y_1| \leq |Y_{A1}|$$

$$|Y_2| \leq |Y_{F2}|$$

$$|Z_1| = |Y_1| \left(\mu_{Z1} + \tan|\theta_1|\right)$$
$$|Z_2| = \sqrt{X_2^{\,2} + Y_2^{\,2}}\ \left(\mu_{Z2} + \tan|\theta_2|\right)$$

$$\left|\frac{Z_1}{|Z_{KA1}|} + \frac{Z_2}{|Z_{KF2}|}\right| \leq 1$$

$$|Z_1| \leq |Z_{KF1}|$$
$$|Z_2| \leq |Z_{KA2}|$$

When Z_1 and Z_2 are in the opposite directions, also check:

$$|Z_1| \leq |Z_{KA1}|$$
$$|Z_2| \leq |Z_{KF2}|$$

I.3.4 Allowable Loads for two Longeron Attach Points on One Bridge

This paragraph defines the allowable payload attach points loads when two longeron attach points are located on one bridge. Attach points 1 and 2 are the forward and aft longeron attach on the one bridge, respectively. These attachments may be primary fittings, i.e., each reacting both X and Z loads; stabilizing fittings, i.e., each reacting only Z load; or maybe a combination of both, i.e., one primary and one stabilizing fitting. Figure I.3.4-1 depicts such a configuration. The bridge shear capability equations should be checked under the stipulation: Use the +Z Column from Table I.2-1 if the sign of the value inside the absolute values sign on the left hand side of the Z_{F1} and Z_{A2} inequality equations is positive. If the value is negative use the -Z Column.

I.3.4.1 Forward Attach Point reacts X- and Z-loads (i.e., primary fitting), Aft Attach Point reacts Z-loads (i.e., stabilizing fitting), with Trunnion/Bearing friction and Bearing rotations at both attach points

Either + or - sign for the μ_x term should be used such that the ratio of the absolute value on the left hand side to the absolute value on the right hand side of the following inequality equations will be maximized. Both positive and negative values of Z_{F1} and Z_{A2} may have to be assessed.

Z_1 and Z_2 can have the same or opposite signs.

$$\left| Z_1 + \frac{K_{F1}}{K_{F2}} Z_2 + \left| K_{F1}\left(X_1 \pm \mu_{X2} Z_2\right)\right| \right| \leq |Z_{F1}|$$

$$\left| Z_2 + \frac{K_{A2}}{K_{A1}} Z_1 + \left| K_{A2}\left(X_1 \pm \mu_{X2} Z_2\right)\right| \right| \leq |Z_{A2}|$$

Note that the choice of Z_{F1} and Z_{A2} from Tables I.2-1 thru I.2-6 shall be of the same sign as that of the value inside the absolute values symbol on the left hand side of the equations.

If Z_1 and Z_2 are of opposite signs, the shear load capability of the bridge fitting between attach point 1 and attach point 2 shall be assessed by using the following equations:

$$\left| \left|\frac{K_{F1}}{K_{A1}}\right| (Z_1) + \left|\frac{K_{F1}}{K_{F2}}\right| (Z_2) - \left[(K_{F1})(X_1 + \mu_{X2} Z_2)\right] \right| \leq |Z_{F1}| \quad \text{, and}$$

$$\left| \left|\frac{K_{A2}}{K_{A1}}\right| (Z_1) + \left|\frac{K_{A2}}{K_{F2}}\right| (Z_2) - \left[(K_{A2})(X_1 + \mu_{X2} Z_2)\right] \right| \leq |Z_{A2}|$$

If trunnion/bearing friction and bearing rotation loads are not available from coupled loads analysis, use the following equations:

$$Y_1 = \sqrt{X_1^{\;2} + Z_1^{\;2}} \; \left(\mu_{Y1} + \tan|\theta_1|\right) \text{ and } Y_2 = |Z_2| \; \left(\mu_{Y2} + \tan|\theta_2|\right)$$

For Y_1 and Y_2 of same sign,

$$\left| \frac{Y_1}{|Y_{LF1}|} + \frac{Y_2}{|Y_{LF2}|} \right| \leq 1 \text{ and } \left| \frac{Y_1}{|Y_{LA1}|} + \frac{Y_2}{|Y_{LA2}|} \right| \leq 1$$

For Y_1 and Y_2 of opposite signs (not needed when Y_1 and Y_2 are computed with equations above)

$$\left| \frac{Y_1}{Y_{LF1}} \right| \leq 1, \left| \frac{Y_2}{Y_{LF2}} \right| \leq 1, \left| \frac{Y_1}{Y_{LA1}} \right| \leq 1, \text{ and } \left| \frac{Y_2}{Y_{LA2}} \right| \leq 1,$$

$$|X_1 \pm \mu_{X2} Z_2| \leq |\text{ X load capability shown in Table I.2 - 7 }|$$

$$|Z_1 + Z_2| \leq |\text{ Zs load capability shown in Table I.2 - 8 landing only }|$$

For the above two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedure.

I.3.4.2 <u>Forward and Aft Attach Points react X- and Z-loads (i.e., primary fittings), with Trunnion/Friction and Bearing rotations at both Attach Points</u>

Z_1 and Z_2 can have the same or opposite signs:

$$\left| Z_1 + \frac{K_{F1}}{K_{F2}} Z_2 + |K_{F1}(X_1 + X_2)| \right| \leq |Z_{F1}|$$

$$\left| Z_2 + \frac{K_{A2}}{K_{A1}} Z_1 + |K_{A2}(X_1 + X_2)| \right| \leq |Z_{A2}|$$

Note that the choice of Z_{F1} and Z_{A2} from Tables I.2-1 thru I.2-6 shall be on the same sign as that of the value inside the absolute value symbol on the left hand side of the equations.

If Z_1 and Z_2 are of opposite signs, the shear load capability of the bridge fitting between attach point 1 and attach point 2 shall be assessed by using the following equations:

$$\left| \frac{K_{F1}}{K_{A1}} Z_1 + \frac{K_{F1}}{K_{F2}} Z_2 - [(K_{F1})(X_1 + X_2)] \right| \leq |Z_{F1}| \text{ and}$$

$$\left| \frac{K_{A2}}{K_{A1}} Z_1 + \frac{K_{A2}}{K_{F2}} Z_2 - [(K_{A2})(X_1 + X_2)] \right| \leq |Z_{A2}|$$

If trunnion/bearing friction and bearing rotation loads are not available from coupled loads analysis, use the following equations:

$$Y_1 = \sqrt{X_1^2 + Z_1^2} \left(\mu_{Y1} + \tan|\theta_1|\right) \text{ and}$$

$$Y_2 = \sqrt{X_2^2 + Z_2^2} \left(\mu_{Y2} + \tan|\theta_2|\right)$$

For Y_1 and Y_2 of same sign,

$$\left|\frac{Y_1}{|Y_{LF1}|} + \frac{Y_2}{|Y_{LF2}|}\right| \leq 1 \text{ and } \left|\frac{Y_1}{|Y_{LA1}|} + \frac{Y_2}{|Y_{LA2}|}\right| \leq 1$$

For Y_1 and Y_2 of opposite signs (Not needed when Y_1 and Y_2 are computed with equations above),

$$\left|\frac{Y_1}{Y_{LF1}}\right| \leq 1, \left|\frac{Y_2}{Y_{LF2}}\right| \leq 1, \left|\frac{Y_1}{Y_{LA1}}\right| \leq 1, \text{ and } \left|\frac{Y_2}{Y_{LA2}}\right| \leq 1,$$

$$|X_1 + X_2| \leq |\text{ X load capability shown in Table I.2 - 7 }|$$

$$|Z_1 + Z_2| \leq |\text{ Zs load capability shown in Table I.2 - 8 at landing only }|$$

For the above two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedure.

I.3.4.3 <u>Forward Attach Point react Z-loads only (i.e., stabilizing fitting) and the Aft Attach Point reacts X- and Z-loads (i.e., primary fitting), with Trunnion/Bearing friction and bearing rotations at both attach points</u>

Either + or - sign for the μ_X term should be used such that the ratio of the absolute value on the left hand side to the absolute value on the right hand side of the following inequality equations will be maximized. Both positive and negative values of Z_{F1} and Z_{A2} may have to be assessed.

Z_1 and Z_2 can have the same or opposite signs.

$$\left|Z_1 + \frac{K_{F1}}{K_{F2}} Z_2 + |K_{F1}(\pm \mu_{X1} Z_1 + X_2)|\right| \leq |Z_{F1}|$$

$$\left|Z_2 + \frac{K_{A2}}{K_{A1}} Z_1 + |K_{A2}(\pm \mu_{X1} Z_1 + X_2)|\right| \leq |Z_{A2}|$$

Note that the choice of Z_{F1} and Z_{A2} from Tables I.2-1 thru I.2-6 shall be of the same sign as that of the value inside the absolute values symbol on the left hand side of the equations.

If Z_1 and Z_2 are of opposite signs, the shear load capability of the bridge fitting between attach point 1 and attach point 2 shall be assessed by using the following equations:

$$\left|\frac{K_{F1}}{K_{A1}}(Z_1) + \frac{K_{F1}}{K_{F2}}(Z_2) - [(K_{F1})(\pm \mu_{X1} Z_1 + X_2)]\right| \leq |Z_{F1}| \text{ , and}$$

$$\left|\frac{K_{A2}}{K_{A1}}(Z_1) + \frac{K_{A2}}{K_{F2}}(Z_2) - [(K_{A2})(\pm \mu_{X1} Z_1 + X_2)]\right| \leq |Z_{A2}|$$

If trunnion/bearing friction and bearing rotation loads are not available from coupled loads analysis, use the following equations:

$$Y_1 = |Z_1|(\mu_{Y1} + \tan|\theta_1|) \quad \text{and}$$

$$Y_2 = \sqrt{X_2^{\,2} + Z_2^{\,2}}\left(\mu_{Y2} + \tan\left|\theta_2\right|\right)$$

For Y_1 and Y_2 of same sign,

$$\left|\frac{Y_1}{|Y_{LF1}|} + \frac{Y_2}{|Y_{LF2}|}\right| \le 1 \text{ and } \left|\frac{Y_1}{|Y_{LA1}|} + \frac{Y_2}{|Y_{LA2}|}\right| \le 1$$

For Y_1 and Y_2 of opposite signs (Not needed when Y_1 and Y_2 are computed with equations above),

$$\left|\frac{Y_1}{Y_{LF1}}\right| \le 1,\ \left|\frac{Y_2}{Y_{LF2}}\right| \le 1,\ \left|\frac{Y_1}{Y_{LA1}}\right| \le 1, \text{ and } \left|\frac{Y_2}{Y_{LA2}}\right| \le 1,$$

$$\left|\pm\mu_{X1}Z_1 + X_2\right| \le \left|\text{ X load capability shown in Table I.2 - 7 }\right|$$

$$\left|Z_1 + Z_2\right| \le \left|\text{ Zs load capability shown in Table I.2 - 8 at landing only }\right|$$

I.3.4.4 <u>Forward and Aft Attach Points react only Z-loads (i.e., stabilizing fittings), with Trunnion/Bearing Friction and Bearing Rotations at Both Attach Points</u>

Either + or - sign for the μ_x term should be used such that the ratio of the absolute value on the left hand side to the absolute value on the right hand side of the following inequality equations will be maximized. Both positive and negative values of Z_{F1} and Z_{A2} may have to be assessed.

Z_1 and Z_2 can have same or opposite signs.

$$\left|Z_1 + \frac{K_{F1}}{K_{F2}}Z_2 + \left|K_{F1}\left(\pm\mu_{X1}Z_1 \pm \mu_{X2}Z_2\right)\right|\right| \le \left|Z_{F1}\right|$$

$$\left|Z_2 + \frac{K_{A2}}{K_{A1}}Z_1 + \left|K_{A2}\left(\pm\mu_{X1}Z_1 \pm \mu_{X2}Z_2\right)\right|\right| \le \left|Z_{A2}\right|$$

Note that the choice of Z_{F1} and Z_{A2} from Tables I.2-1 thru I.2-6 shall be of the same sign as that of the value inside the absolute value symbol on the left hand side of the equations.

If Z_1 and Z_2 are of opposite signs, the shear load capability of the bridge fitting between attach point 1 and attach point 2 shall be assessed by using the following equations:

$$\left|\frac{K_{F1}}{K_{A1}}(Z_1) + \frac{K_{F1}}{K_{F2}}(Z_2) - \left[(K_{F1})(\pm\mu_{X1}Z_1 \pm \mu_{X2}Z_2)\right]\right| \le \left|Z_{F1}\right|, \text{ and}$$

$$\left|\frac{K_{A2}}{K_{A1}}(Z_1) + \frac{K_{A2}}{K_{F2}}(Z_2) - \left[(K_{A2})(\pm\mu_{X1}Z_1 \pm \mu_{X2}Z_2)\right]\right| \le \left|Z_{A2}\right|$$

If trunnion/bearing friction and bearing rotation loads are not available from coupled loads analysis, use the following equations:

$$Y_1 = |Z_1| \left(\mu_{Y1} + \tan|\theta_1|\right) \text{ and } Y_2 = |Z_2| \left(\mu_{Y2} + \tan|\theta_2|\right)$$

For Y_1 and Y_2 of same sign,

$$\left|\frac{Y_1}{|Y_{LF1}|} + \frac{Y_2}{|Y_{LF2}|}\right| \leq 1 \text{ and } \left|\frac{Y_1}{|Y_{LA1}|} + \frac{Y_2}{|Y_{LA2}|}\right| \leq 1$$

For Y_1 and Y_2 of opposite signs (Not needed when Y_1 and Y_2 are computed with equations above)

$$\left|\frac{Y_1}{Y_{LF1}}\right| \leq 1, \left|\frac{Y_2}{Y_{LF2}}\right| \leq 1, \left|\frac{Y_1}{Y_{LA1}}\right| \leq 1, \text{ and } \left|\frac{Y_2}{Y_{LA2}}\right| \leq 1,$$

$$|\mu_{X1}Z_1 \pm \mu_{X2}Z_2| \leq |\text{ X load capability shown in Table I.2 - 7 }|.$$

$$|Z_1 + Z_2| \leq |\text{ Zs load capability shown in Table I.2 - 8 at landing only }|$$

For the above two equations, see note (1) of Table I.2-7 and note (2) of Table I.2-8 for load accumulation procedure.

I.3.5 Allowable Loads for Keel Attach Points for Bay 12 (Xo 1191-1249) only

The allowable load factor constants for Bay 12 only are given in Table I.3.5-1. These factors are a measure of the load capability available to react payloads after accounting for flight loads.

!! NOTE !! The Bay 12 keel bridge Xo attachment is one inch forward of the frame station.

I.3.5.1 Attach Point reacts Y-loads, X-friction loads, and Z-friction and bearing rotation loads (X, Z ≠ 0)

$$\frac{\mu_X|Y|}{C_a} + \left[\left(\frac{1249 - Xo}{59}\right)\left(\frac{|Y|}{C_b}\right)\right] \leq 1$$

$$\left[\left(\frac{1249 - Xo}{59}\right)|Y|\right]\left[\frac{\left(\tan|\theta| + \mu_Z\right)\sqrt{\mu_X^2 + 1}}{3018}\right] \leq 1$$

$$\left[\left(\frac{Xo - 1190}{59}\right)|Y|\right]\left[\frac{\left(\tan|\theta| + \mu_Z\right)\sqrt{\mu_X^2 + 1}}{2715}\right] \leq 1$$

I.3.5.2 Attach Point Reacts Y- and X- Loads (i.e., Keel Fitting Restrained from Movement in the X-Direction) and Z-Friction and Bearing Rotation Loads (X, Z ≠ 0)

$$\frac{|X|}{C_a} + \left[\frac{1249 - Xo}{59}\frac{|Y|}{C_b}\right] \leq 1$$

$$\frac{|X|}{168119} + \left[\frac{1249 - Xo}{59}\ \frac{|Y|}{36162}\right] + |Z|\left[\left(\frac{1249 - Xo}{59}\right)\left(\frac{1}{14660}\right) + \left(\frac{Xo - 1190}{59}\right)\left(\frac{1}{9544}\right)\right] \leq 1$$

$$\left[\frac{1249 - Xo}{59}\ \frac{|Y|}{21640}\right] \leq 1$$

$$\left[\frac{Xo - 1190}{59}\ \frac{|Y|}{27100}\right] \leq 1$$

$$\left[\frac{1249 - Xo}{59}\ \frac{|Z|}{3018}\right] \leq 1$$

$$\left[\frac{Xo - 1190}{59}\ \frac{|Z|}{2715}\right] \leq 1$$

Where $Z = \left(\tan|\theta| + \mu_Z\right)\sqrt{X^2 + Y^2}$

I.3.6 Allowable Loads for Adjacent Bridges at Keel Attach Points for Bay 11 (Xo1140-1191) and Bay 12 (Xo1191-1249)

It is possible to increase the load carrying capability of Bay 12 by installing a keel bridge in Bay 11. Allowable load factor constants ("B") for each of the frame stations in Bay 11 and Bay 12 for the different flight conditions are given in Tables I.3.6-1 through I.3.6-6. These factors are a measure of the load capability available to react payloads after accounting for flight loads. The applied Y and Z loads for Bay 11 must also be compared with the keel limit-loads for Bay 11 given in Tables I.2-1 thru I.2-6 to ensure that the limit-loads for the corresponding flight condition are not exceeded.

The equation given in the following subparagraphs have been developed assuming a keel bridge is installed in both Bay 11 and Bay 12. The equations apply to both Bay 11 and Bay 12 and are also valid when the Bay 12 bridge is loaded and the Bay 11 bridge is unloaded.

For Paragraphs I.3.6.1 thru I.3.6.4:

μ_{11} is defined as the larger of μ_{X11} and μ_{Z11}

and μ_{12} is defined as the larger of μ_{X12} and μ_{X12}

I.3.6.1 Attach Points 11 and 12 React Y-Loads, X-Friction Loads and Z-Friction and Bearing Rotation Loads (X, Z ≠ 0)

For the interaction between the two bays, the following inequality must be satisfied.

$$\frac{|\mu_{11}Y_{11}|}{B_{X11}} + \frac{|\mu_{12}Y_{12}|}{B_{X12}} + \frac{|Y_{11}|}{B_{Y11}} + \frac{|Y_{12}|}{B_{Y12}} + \frac{\left|\left(\mu_{11} + \tan|\theta_{11}|\right)\sqrt{Y_{11}^{2}\left(1 + \mu_{11}^{2}\right)}\right|}{B_{Z11}} + \frac{\left|\left(\mu_{12} + \tan|\theta_{12}|\right)\sqrt{Y_{12}^{2}\left(1 + \mu_{12}^{2}\right)}\right|}{B_{Z12}} \leq 1$$

$|Y_{11}| \leq$ lesser of $|Y_{F11}|$ or $|Y_{A11}|$

$$\left|\left(\mu_{11} + \tan\left|\theta_{11}\right|\right)\sqrt{Y_{11}^{2}\left(1 + \mu_{11}^{2}\right)}\right| \leq \text{lesser of } \left|Z_{KF11}\right| \text{ or } \left|Z_{KA11}\right|$$

$$\left[\frac{Xo - 1190}{59}\ \frac{\left|Y_{12}\right|}{27100}\right] \leq 1,$$

$$\left[\frac{Xo - 1190}{59}\ \frac{\left|Z_{12}\right|}{2715}\right] \leq 1$$

$$Z_{12} = (\tan\left|\theta_{12}\right| + \mu_{12})\sqrt{X_{12}^{2} + Y_{12}^{2}}$$

I.3.6.2 Attach Points 11 and 12 React Y- and X-Loads (i.e., Keel fittings restrained from movement in the X-direction) and Z-Friction and Bearing Rotation Loads

$$\frac{\left|X_{11}\right|}{B_{X11}} + \frac{\left|X_{12}\right|}{B_{X12}} + \frac{\left|Y_{11}\right|}{B_{Y11}} + \frac{\left|Y_{12}\right|}{B_{Y12}} + \frac{\left|\left(\mu_{11} + \tan\left|\theta_{11}\right|\right)\sqrt{X_{11}^{2} + Y_{11}^{2}}\right|}{B_{Z11}} + \frac{\left|\left(\mu_{12} + \tan\left|\theta_{12}\right|\right)\sqrt{X_{12}^{2} + Y_{12}^{2}}\right|}{B_{Z12}} \leq 1$$

$$\left|Y_{11}\right| \leq \text{lesser of } \left|Y_{F11}\right| \text{ or } \left|Y_{A11}\right|$$

$$\left|\left(\mu_{11} + \tan\left|\theta_{11}\right|\right)\sqrt{X_{11}^{2} + Y_{11}^{2}}\right| \leq \text{lesser of } \left|Z_{KF11}\right| \text{ or } \left|Z_{KA11}\right|$$

$$\left[\frac{Xo - 1190}{59}\ \frac{\left|Y_{12}\right|}{27100}\right] \leq 1, \quad \left[\frac{Xo - 1190}{59}\ \frac{\left|Z_{12}\right|}{2715}\right] \leq 1$$

$$Z_{12} = (\tan\left|\theta_{12}\right| + \mu_{12})\sqrt{X_{12}^{2} + Y_{12}^{2}}$$

I.3.6.3 Attach Point 11 Reacts X and Y Loads (i.e., Keel fittings restrained from movement in the X-direction) and Z-Friction and Bearing Rotation Loads Attach Point 12 Reacts Y Loads, X-Friction Loads and Z-Friction and Bearing Rotation Loads

$$\frac{\left|X_{11}\right|}{B_{X11}} + \frac{\left|\mu_{12}Y_{12}\right|}{B_{X12}} + \frac{\left|Y_{11}\right|}{B_{Y11}} + \frac{\left|Y_{12}\right|}{B_{Y12}} + \frac{\left|\left(\mu_{11} + \tan\left|\theta_{11}\right|\right)\sqrt{X_{11}^{2} + Y_{11}^{2}}\right|}{B_{Z11}} + \frac{\left|\left(\mu_{12} + \tan\left|\theta_{12}\right|\right)Y_{12}\sqrt{1 + \mu_{12}^{2}}\right|}{B_{Z12}} \leq 1$$

$$\left|Y_{11}\right| \leq \text{lesser of } \left|Y_{F11}\right| \text{ or } \left|Y_{A11}\right|$$

$$\left|\left(\mu_{11} + \tan\left|\theta_{11}\right|\right)\sqrt{X_{12}^{2} + Y_{12}^{2}}\right| \leq \text{lesser of } \left|Z_{KF11}\right| \text{ or } \left|Z_{KA11}\right|$$

$$\left[\frac{Xo - 1190}{59}\ \frac{\left|Y_{12}\right|}{27100}\right] \leq 1, \quad \left[\frac{Xo - 1190}{59}\ \frac{\left|Z_{12}\right|}{2715}\right] \leq 1$$

$$Z_{12} = (\tan|\theta_{12}| + \mu_{12})\sqrt{X_{12}^2 + Y_{12}^2}$$

I.3.6.4 <u>Attach Point 11 Reacts Y-Loads, X-Friction Loads, and Z-Friction and Bearing Rotation Loads. Attach Point 12 Reacts Y- and X-Loads, (i.e, Keel fitting restrained from movement in the X-direction) and Z-Friction and Bearing Rotation Loads</u>

$$\frac{|\mu_{11} Y_{11}|}{B_{X11}} + \frac{|X_{12}|}{B_{X12}} + \frac{|Y_{11}|}{B_{Y11}} + \frac{|Y_{12}|}{B_{Y12}} + \frac{\left|\left(\mu_{11} + \tan|\theta_{11}|\right) Y_{11}\sqrt{1 + \mu_{11}^2}\right|}{B_{Z11}}$$
$$+ \frac{\left|\left(\mu_{12} + \tan|\theta_{12}|\right)\sqrt{X_{12}{}^2 + Y_{12}{}^2}\right|}{B_{Z12}} \leq 1$$

$$|Y_{11}| \leq \text{lesser of } |Y_{F11}| \text{ or } |Y_{A11}|$$

$$\left|\left(\mu_{11} + \tan|\theta_{11}|\right)\sqrt{Y_{11}{}^2|1 + \mu_{11}{}^2|}\right| \leq \text{lesser of } |Z_{KF11}| \text{ or } |Z_{KA11}|$$

$$\left[\frac{Xo - 1190}{59} \frac{|Y_{12}|}{27100}\right] \leq 1, \quad \left[\frac{Xo - 1190}{59} \frac{|Z_{12}|}{2715}\right] \leq 1$$

$$Z_{12} = (\tan|\theta_{12}| + \mu_{12})\sqrt{X_{12}^2 + Y_{12}^2}$$

TABLE I.3.5-1 LOAD FACTOR CONSTANTS FOR BAY 12 FOR EACH FLIGHT CONDITION

FLIGHT CONDITION	Ca	Cb
LIFT-OFF	3738	19,024
POST SRB STAGING	4008	20,399
TAEM PITCH	3131	15,937
TAEM YAW AND ROLL	5700	29,016
LIGHT WEIGHT (32K) LANDING	4313	21,952
HEAVY WEIGHT (65K) LANDING	3948	20,093

TABLE I.3.6-1 LOAD FACTOR CONSTANTS FOR BAYS 11 AND 12 DURING LIFT-OFF CONDITIONS WHEN USING ADJACENT BRIDGES

LIFT-OFF

Xo	B_{X11}	B_{X12}	B_{Y11}*	B_{Y12}	B_{Z11}*	B_{Z12}
1155.53	24070		112420		11060	
1159.47	24070		91910		11020	
1163.40	24070		77760		11300	
1167.33	24070		67390		11920	
1171.27	24070		59440		13030	
1175.20	24070		53180		14900	
1179.13	24070		44990		22370	
1206.67		13770		32470		23180
1210.60		13770		35770		23740
1214.53		13770		39830		24320
1218.47		13770		44940		24490
1222.40		13770		51530		25590
1226.33		13770		60380		26270

* APPLIED LOADS MUST ALSO BE COMPARED WITH TABLE I.2-1 TO INSURE THEY DO NOT EXCEED THE BAY 11 KEEL ALLOWABLES FOR Y_{11} AND Z_{11}.

TABLE I.3.6-2 LOAD FACTOR CONSTANTS FOR BAYS 11 AND 12 DURING POST-STAGE CONDITIONS WHEN USING ADJACENT BRIDGES

POST SRB STAGING

Xo	B_{X11}	B_{X12}	B_{Y11}*	B_{Y12}	B_{Z11}*	B_{Z12}
1155.53	25810		120540		11860	
1159.47	25810		98550		11820	
1163.40	25810		83380		12110	
1167.33	25810		72090		12780	
1171.27	25810		63730		13970	
1175.20	25810		57020		15970	
1179.13	25810		48240		23980	
1206.67		14760		34820		24860
1210.60		14760		38360		25450
1214.53		14760		42710		26080
1218.47		14760		48180		26740
1222.40		14760		55250		27430
1226.33		14760		64740		28160

* APPLIED LOADS MUST ALSO BE COMPARED WITH TABLE I.2-2 TO INSURE THEY DO NOT EXCEED THE BAY 11 KEEL ALLOWABLES FOR Y_{11} AND Z_{11}.

TABLE I.3.6-3 LOAD FACTOR CONSTANTS FOR BAYS 11 AND 12 DURING TAEM PITCH CONDITIONS WHEN USING ADJACENT BRIDGES

TAEM PITCH

Xo	B_{X11}	B_{X12}	B_{Y11}*	B_{Y12}	B_{Z11}*	B_{Z12}
1155.53	20170		94170		9270	
1159.47	20170		77000		9240	
1163.40	20170		65140		9470	
1167.33	20170		56320		9990	
1171.27	20170		49790		10920	
1175.20	20170		44550		12480	
1179.13	20170		37690		18740	
1206.67		11530		27200		19420
1210.60		11530		29970		19890
1214.53		11530		33370		20360
1218.47		11530		37640		20890
1222.40		11530		43160		21430
1226.33		11530		50580		22000

* APPLIED LOADS MUST ALSO BE COMPARED WITH TABLE I.2-4 TO INSURE THEY DO NOT EXCEED THE BAY 11 KEEL ALLOWABLES FOR Y_{11} AND Z_{11}.

TABLE I.3.6-4 LOAD FACTOR CONSTANTS FOR BAYS 11 AND 12 DURING TAEM YAW CONDITIONS WHEN USING ADJACENT BRIDGES

TAEM YAW

Xo	B_{X11}	B_{X12}	B_{Y11}*	B_{Y12}	B_{Z11}*	B_{Z12}
1155.53	36720		171460		16860	
1159.47	36720		140190		16810	
1163.40	36720		118610		17230	
1167.33	36720		102540		18180	
1171.27	36720		90660		19880	
1175.20	36720		81110		22720	
1179.13	36720		68620		34110	
1206.67		21000		49530		35360
1210.60		21000		54570		36210
1214.53		21000		60750		37100
1218.47		21000		68540		38040
1222.40		21000		78590		39020
1226.33		21000		92100		40060

* APPLIED LOADS MUST ALSO BE COMPARED WITH TABLE I.2-3 TO INSURE THEY DO NOT EXCEED THE BAY 11 KEEL ALLOWABLES FOR Y_{11} AND Z_{11}.

TABLE I.3.6-5 LOAD FACTOR CONSTANTS FOR BAYS 11 AND 12 DURING LANDING LIGHT WT. (32K) CONDITIONS WHEN USING ADJACENT BRIDGES

LANDING LIGHT WT. (32K)

Xo	B_{X11}	B_{X12}	B_{Y11}*	B_{Y12}	B_{Z11}*	B_{Z12}
1155.53	27780		129720		12750	
1159.47	27780		106060		12720	
1163.40	27780		89730		13030	
1167.33	27780		77580		13750	
1171.27	27780		68590		15030	
1175.20	27780		61370		17180	
1179.13	27780		51910		25800	
1206.67		15890		37470		26750
1210.60		15890		41280		27390
1214.53		15890		45960		28070
1218.47		15890		51850		28780
1222.40		15890		59460		29520
1226.33		15890		69670		30310

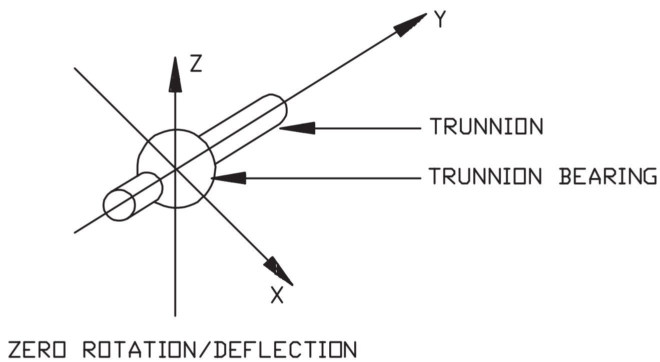
* APPLIED LOADS MUST ALSO BE COMPARED WITH TABLE I.2-5 TO INSURE THEY DO NOT EXCEED THE BAY 11 KEEL ALLOWABLES FOR Y_{11} AND Z_{11}.

TABLE I.3.6-6 LOAD FACTOR CONSTANTS FOR BAYS 11 AND 12 DURING LANDING HEAVY WT. (65K) CONDITIONS WHEN USING ADJACENT BRIDGES

LANDING HEAVY WT. (65K)

Xo	B_{X11}	B_{X12}	B_{Y11}*	B_{Y12}	B_{Z11}*	B_{Z12}
1155.53	25430		118730		11690	
1159.47	25430		97070		11660	
1163.40	25430		82130		11940	
1167.33	25430		71010		12610	
1171.27	25430		62780		13780	
1175.20	25430		56170		15750	
1179.13	25430		47510		23650	
1206.67		14540		34290		24480
1210.60		14540		37780		25070
1214.53		14540		42070		25690
1218.47		14540		47460		26340
1222.40		14540		54420		27020
1226.33		14540		63770		27740

* APPLIED LOADS MUST ALSO BE COMPARED WITH TABLE I.2-6 TO INSURE THEY DO NOT EXCEED THE BAY 11 KEEL ALLOWABLES FOR Y_{11} AND Z_{11}.



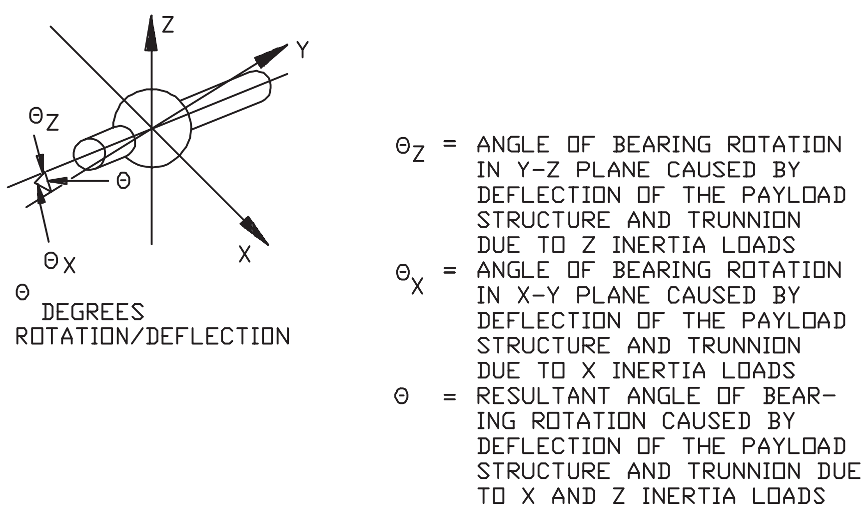


FIGURE I.3.1.1-1 ANGLE OF BEARING ROTATION/TRUNNION DEFLECTION

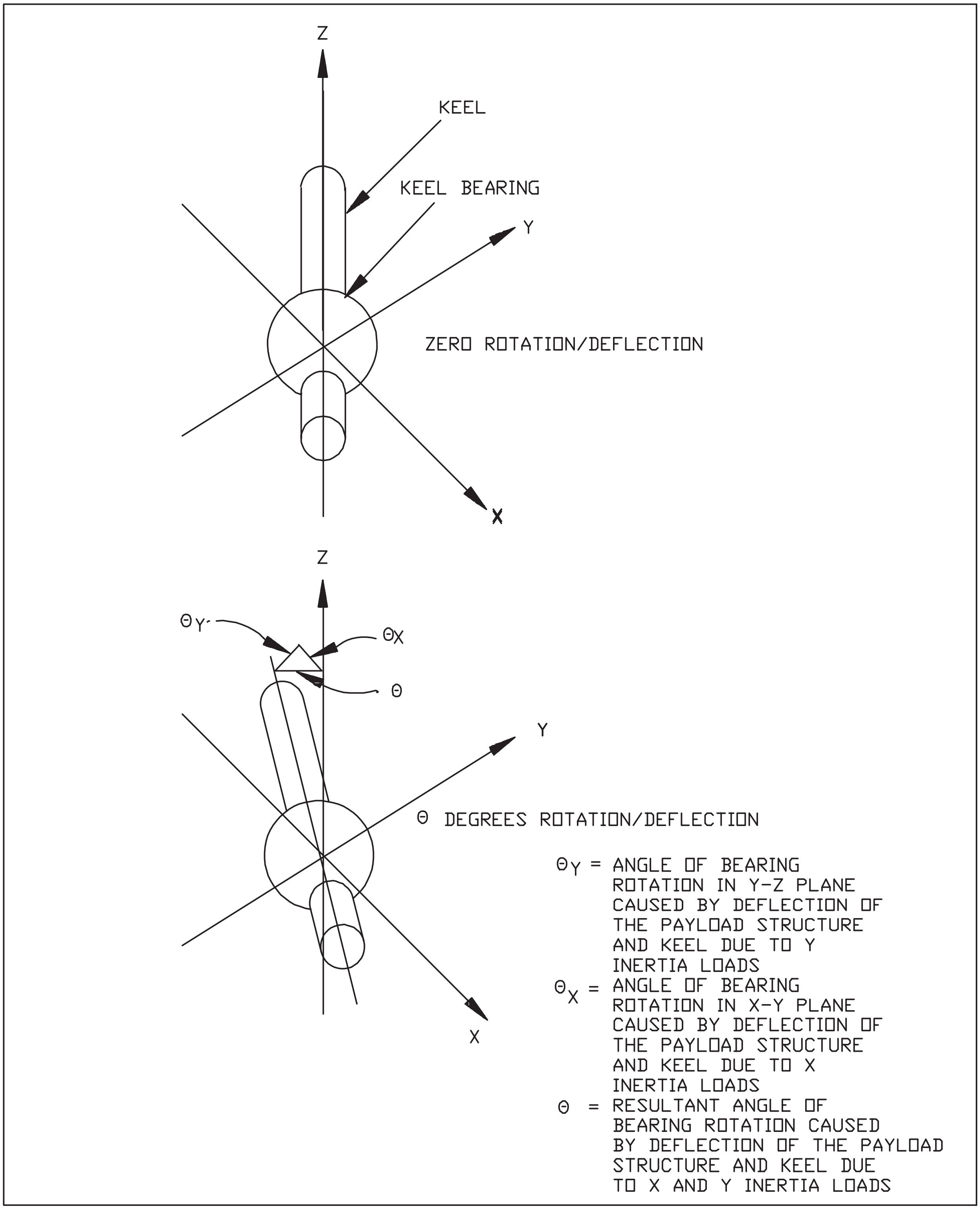


FIGURE I.3.1.2-1 ANGLE OF BEARING ROTATION/KEEL DEFLECTION

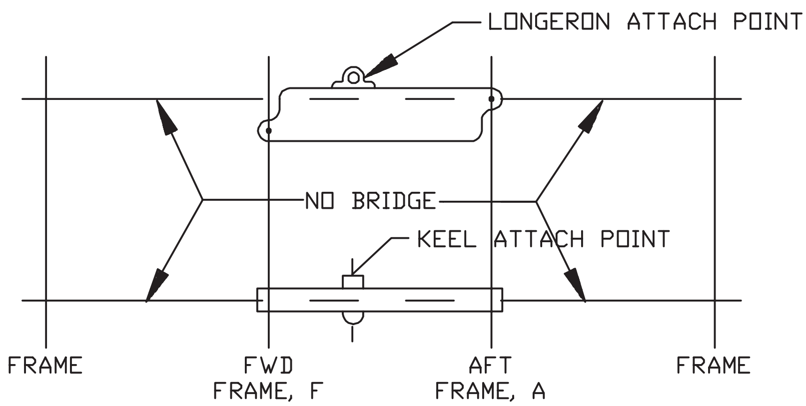


FIGURE I.3.2-1 SINGLE BRIDGE

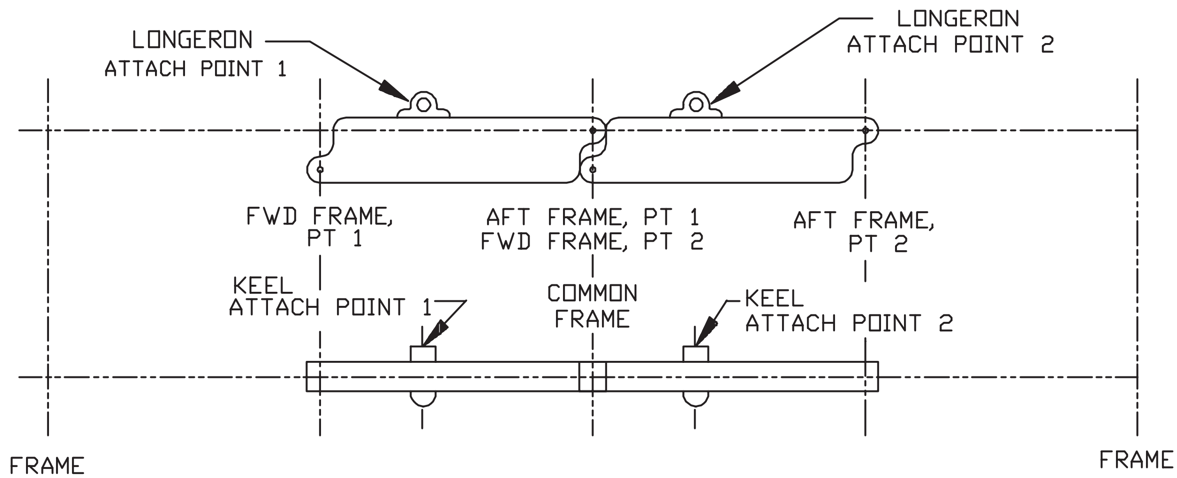


FIGURE I.3.3-1 ADJACENT BRIDGES

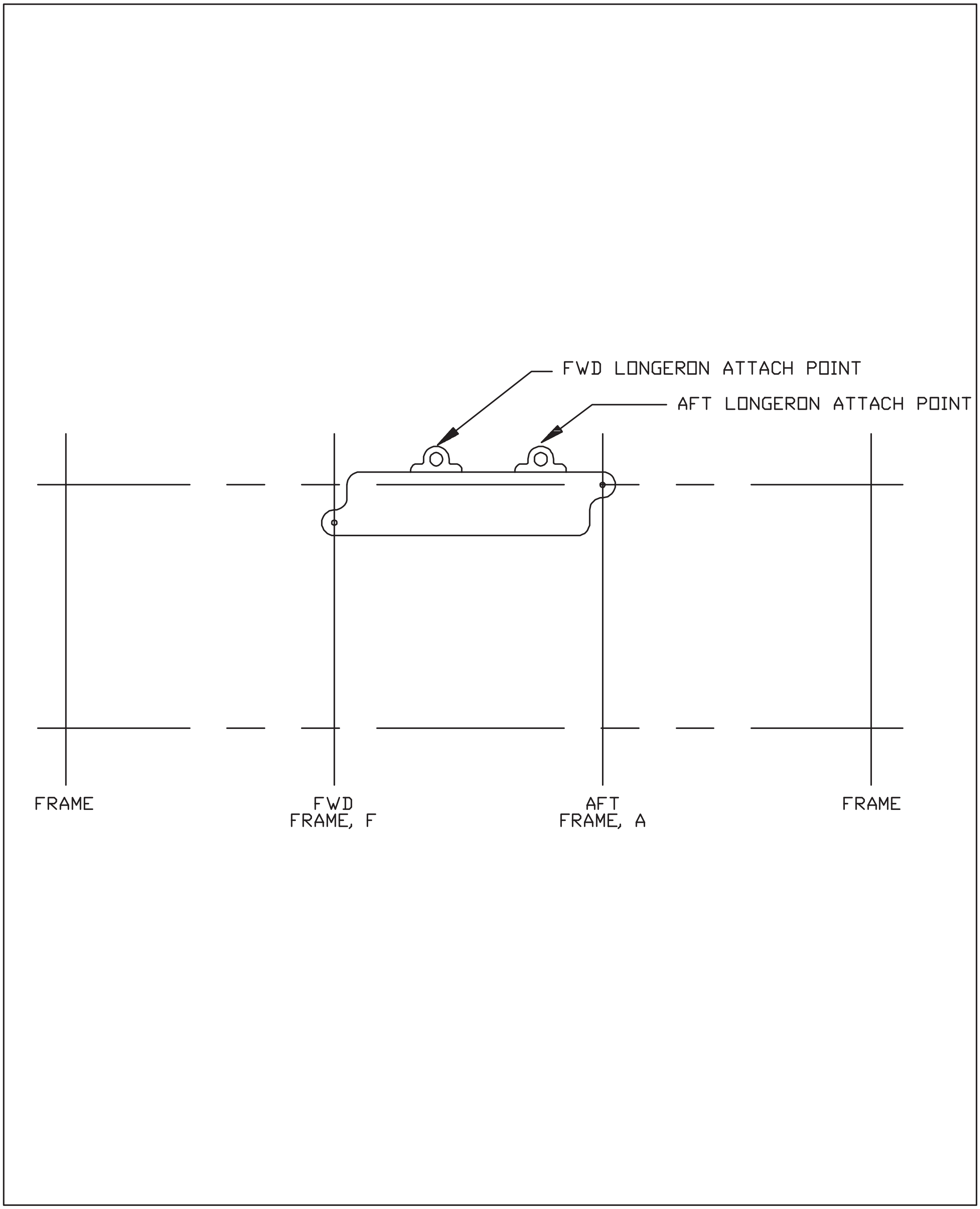


FIGURE I.3.4-1 TWO ATTACH POINTS ON ONE LONGERON BRIDGE

THIS PAGE INTENTIONALLY LEFT BLANK.