SSP 52000-PAH-EPP

International Space Station Payload Accommodations Handbook

EXpedite the PRocessing of Experiments to Space Station (EXPRESS) Pallet Payloads

International Space Station Program

October 10, 2001

Working Draft 3

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas
Contract No. NAS8-50000 (DR LS293)

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INTERNATIONAL SPACE STATION
PAYLOADS ACCOMMODATIONS HANDBOOK

EXPEDITE THE PROCESSING OF EXPERIMENTS TO SPACE STATION (EXPRESS) PALLET PAYLOADS

WORKING DRAFT 3
OCTOBER 10, 2001

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ABSTRACT

This Payload Accommodations Handbook (PAH) addresses an integral part of the overall International Space Station (ISS) payload accommodations. The purpose of this document is to provide sufficient information that describes the interfaces, resources, capabilities, performance characteristics, and constraints for payloads to be flown on an EXPRESS Pallet (ExP), which will be integrated onto the ISS truss. This will assist Payload Developers (PDs) in the design of their equipment for accommodation on the ExP. This document addresses the transportation, ground processing, and on-orbit phases of the ExP mounted payloads and describes the ExP supplementary hardware and services. Payloads can also be transported using the Unpressurized Logistics Carrier (ULC) and the Sidewall Carrier, and robotically integrated onto an EXPRESS Pallet that is already on-orbit. Payload accommodation for these carriers are **TBD#01**.

This document complements NSTS 07700, Volume XIV; NSTS 21000-IDD-ISS, NSTS 21000-IDD-SML, SSP 52000-IDD-EPP, and SSP 52000-PVP-EPP.

This Boeing Defense and Space Group multi-volume document is submitted in accordance with Data Requirement (DR) LS293. This document is submitted in accordance with Contract NAS8-50000.

KEY WORDS

Accommodations

Design Requirements

Environments

EXPRESS Pallet

EXPRESS Pallet Adapter

Interfaces

International Space Station

Payload Developer

Safety

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SECTION 1, INTRODUCTION

The International Space Station (ISS) is an international, Earth-orbiting, research facility. Its mission is to conduct scientific, technological, and commercial application research in a microgravity environment with an emphasis on long duration activities. This mission is accomplished either in a manned or unmanned state. People and organizations conducting scientific and commercial research and development activities on board the ISS are called users. Users originate from government, academic, and commercial sectors of the United States and International Partners (IP). Organizations that build the flight/Ground Support Equipment (GSE) hardware for scientific use are called Payload Developers (PDs). This Payload Accommodations Handbook (PAH) serves as a guide for users of the EXPRESS Pallet (ExP).

The ISS provides truss locations for attached payloads. ExP mounted payloads will be mounted on an EXPRESS Pallet Adapter (ExPA) and integrated onto the ExP prior to launch or robotically integrated on orbit. These payloads are called ExP mounted payloads. The purpose of the ExP is to provide accommodations to simplify and reduce the integration schedule for unpressurized payloads onto the ISS.

1.1 PURPOSE

The purpose of this document is to provide PDs with sufficient information (not to define requirements) on the interfaces, accommodations, capabilities, performance characteristics, and constraints specific to the ExP. A payload is a discrete set of equipment, software, specimens, and/or other items that are designated and treated as a collective whole in support of one or more experiments. This document complements the SSP 52000-IDD-EPP and SSP 52000-PVP-EPP, which explicitly identify and define the interfaces, design requirements, and verification requirements.

1.2 SCOPE

This volume describes the interfaces, accommodations, and capabilities available for each ExP mounted payload. Some references to Shuttle accommodations will be made in this document for clarity. If a detailed or additional description of the Shuttle accommodation is required, the reader should refer to NSTS 07700, Volume XIV.

1.3 PRECEDENCE

The order of precedence of documents identified herein shall be as follows: Safety Policy and Requirements for Payloads, NSTS 1700.7 and ISS Addendum; Space Transportation System Payload Ground Safety Handbook, KHB 1700.7; Attached Payloads Interface Requirements Document, SSP 57003; Interface Definition Document for EXPRESS

Pallet Payloads, SSP 52000-IDD-EPP; Unique EXPRESS Pallet Integration Agreement (EPIA), Unique EPIA Increment Addendum (EPIA IA), payload-unique Interface Control Documents (ICDs), Payload Data Library (PDL) data files, government specifications, government standards, military (MIL) specifications, MIL standards, contractor specifications, contractor standards, and other documents.

1.4 INTEGRATION PROCESS OVERVIEW

1.4.1 Key Organizations

Users and PDs of the ExP will be expected to participate in a series of integration activities beginning with payload selection and ending with post-participation evaluation. These activities will require the user/PD to have direct and indirect interfaces to numerous NASA organizations' boards, forums, working groups, and key personnel. While it is beyond the scope of this document to completely describe all aspects of the integration process, this section will acquaint the user/PD with a simple overview. Certain key organizations, documents, and definitions will be tailored to describe the user/PD participation.

1.4.1.1 ISS Vehicle Office (JSC/OB)

The ISS Vehicle Office manages the design, development, and sustaining engineering of the ISS vehicle. The ExP is considered an attached payload to the ISS.

1.4.1.2 ISS Payloads Office (JSC/OZ)

The ISS Payload Office manages the payload's quality, technical content, cost, and schedule for the ISS Program. The office has departments that manage Mission Integration and Planning, Hardware and Software Engineering Integration, Research Mission, and Operations and Utilization. The ExP is considered a facility class payload. Individual ExP mounted payloads are considered payloads.

1.4.1.3 ISS Mission Integration Office (JSC/OM)

The ISS Mission Integration Office is responsible for managing the overall configuration, assembly, and performance of the ISS. It is responsible for managing the individual launch packages, including their safe integration into the launch vehicle and the on-orbit ISS, and their flight readiness. The integrated ExP or Unpressurized Logistics Carrier (ULC) is considered a part of the individual launch package.

1.4.1.4 Space Shuttle Program Customer and Flight Integration Office (JSC/MT)

The mission of the Customer and Flight Integration Office is to manage customer and flight integration activities for all Shuttle missions. The Flight Integration Office's role is to manage customer and flight integration activities for all Shuttle missions and to establish and implement Space Shuttle Program integration policy. The integrated ExP or ULC will be considered a payload of the Shuttle.

1.4.1.5 KSC Space Station and Shuttle Payloads Directorate

The KSC Space Station and Shuttle Payloads Directorate manage the ExP integration activities at the launch and landing sites.

1.4.1.6 Marshall Space Flight Center (MSFC) Multi-Use Payload Group (MSFC/FD31)

The MSFC Multi-Use Payload Group (MUPG) manages the Engineering Integration (EI) of the ExP. This group receives its authority and direction from the ISS Payloads Office (OZ). Each ExP user/PD shall be assigned an EXPRESS Pallet Payload Integration Manager (EPPIM) from this group to serve as the focal point of contact between the payload and the ISS and Space Shuttle Program (SSP).

1.4.2 Key Documents (Figure 1-1)

1.4.2.1 Key Documentation Definition

A. Attached Payloads Interface Requirements Document, SSP 57003. This is the principal source of interface design requirements for attached payloads on the ISS. ExP mounted payload requirements are derived from the requirements in this document and are defined in the ExP Interface Definition Document (IDD).

B. EXPRESS Pallet Payloads Interface Definition Document, SSP 52000-IDD-EPP. This document defines and controls the requirements of the interfaces between the ExPA, payloads, and associated environments.

C. EXPRESS Pallet Payloads Accommodations Handbook, SSP 52000-PAH-EPP. This document describes the interfaces, resources, capabilities, performance characteristics, and constraints provided to a standard ExP mounted payload.

D. Payload-Unique ICDs. These documents are tailored to define and control the physical interfaces (standard, nonstandard, and unique) between the ExPA and a payload. It flows down those IDD requirements that are applicable to a payload. This document is negotiated between the payload and ExP EI. The ICD will be generated based on a blank book developed by ExP EI.

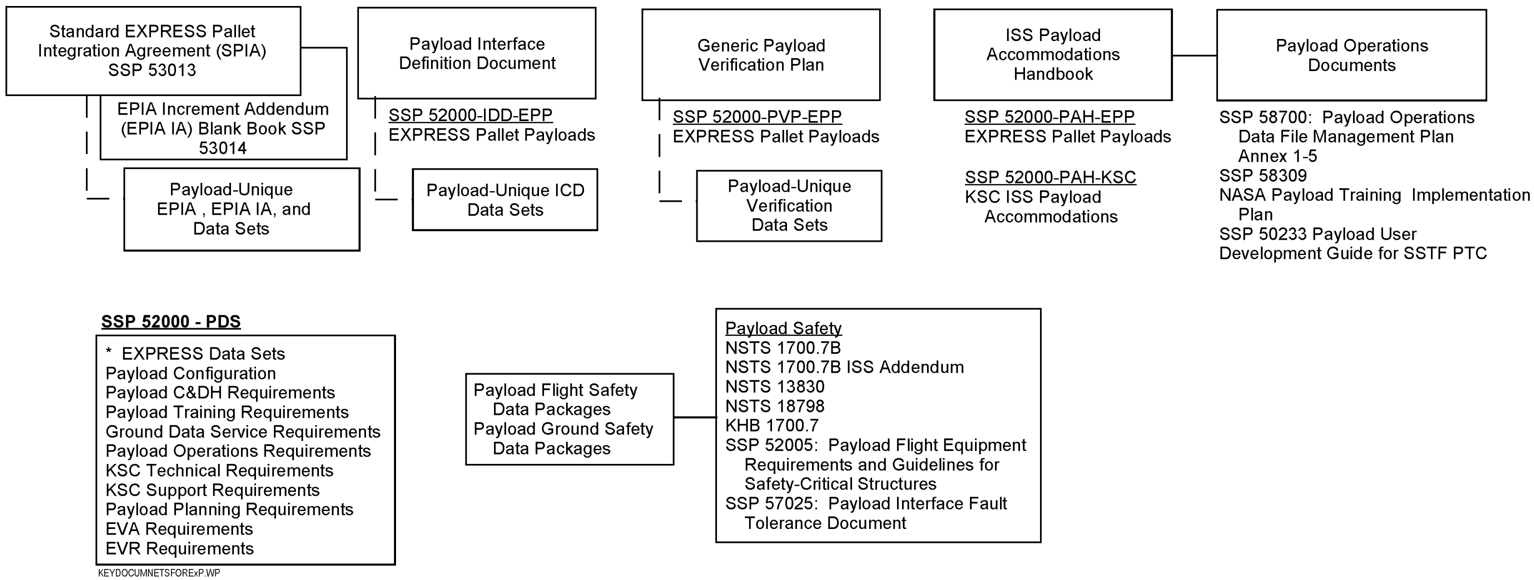

FIGURE 1-1 KEY DOCUMENTS FOR ExP

E. Standard Payload Integration Agreement (SPIA) for Unpressurized Payloads. This document establishes the minimum requirements of the management structure and the execution of the roles and responsibilities for the services and resources that will be used/provided by International Space Station (ISS) Program Participants for an attached payload. This document is applicable to the fully integrated EXPRESS Pallet.

F. Unique Payload Integration Agreement (PIA). This document is the primary management and technical agreement between specific integrated ExP and the ISS. It documents the agreements to manage and execute the roles and responsibilities of the technical integration requirements, processes, services, and resources between an integrated ExP and the ISS Program for transportation services to and from the ISS, and for on-orbit ISS resources and operations of the integrated ExP.

The PIA, with any unique agreements or exceptions, takes precedence over the ISS Program generic SPIA for unpressurized payloads.

G. PIA Increment Addendum (PIA IA). The PIA IA documents the ISS Program and transportation services, tactical parameters, pre-launch to ascent requirements, on-orbit requirements, return requirements, ancillary volume stowage requirements, training requirements, and the program-provided ground support requirements, all on an increment and flight basis, for the integrated ExP. The PIA IA will be prepared by ExP EI based on input from the pallet PDs.

H. Standard EXPRESS Pallet Integration Agreement for ExP Payloads (SEPIA). This document establishes the minimum requirements of the management structures and the execution of the roles and responsibilities for the services and resources that will be used/provided by the ISS Program Participants for an ExP mounted payload. This document is applicable to an individual ExP mounted payloads.

I. Unique EXPRESS Pallet Integration Agreement (EPIA). This document is the primary management and technical agreement between a specific ExP mounted payload the ISS. It documents the agreements to manage and execute the roles and responsibilities of the technical integration requirements, processes, services, and resources between an individual ExP mounted payload and the ISS Program for transportation services to and from the ISS, and for on-orbit ISS resources and operations of the individual ExP mounted payload. The EPIA, with any unique agreements or exceptions, takes precedence over the ISS Program generic SEPIA for ExP Payloads.

J. EPIA Increment Addendum (EPIA IA). The EPIA IA documents the ISS Program and transportation services, tactical parameters, pre-launch to ascent requirements, on-orbit requirements, return requirements, ancillary volume stowage requirements, training requirements, and the program-provided ground support requirements, all on an increment and flight basis, for an individual ExP mounted payload. The EPIA IA will be prepared by the PD with help from ExP EI.

K. Payload Data Sets are electronically documented and controlled in the PDL. Data set inputs are provided by the PD into the PDL. These inputs will be used in ExP EI, Payload Operations Integration Function (POIF), and Kennedy Space Center (KSC) to document and control PD requirements.

(1) Payload Training Data Set

(2) Ground Data Services Data Set

(3) Payload Operations Data Set

(4) Payload Planning Data Set

(5) KSC Technical Data Set

(6) KSC Support Data Set

(7) Payload Configuration Data Set

(8) Payload Command and Data Handling Data Set

(9) Extravehicular Activity (EVA) Data Set

(10) Extravehicular Robotic (EVR) Data Set

1.4.3 Key Definitions

1.4.3.1 Increment

An increment is a specific time period into which various assembly, research, testing, logistics, maintenance, and other ISS system and utilization activities are grouped. Increment boundaries are established to coincide with crew rotation. Increment duration is calculated from the initial launch day of the increment to the undock day of the vehicle returning the crew.

1.4.3.2 Planning Period

A planning period is approximately one calendar year of ISS activity. A planning period is comprised of one or more increments. Planning periods (during ISS assembly) are defined by the docking of the crew rotation flight closest to January 1 of each calendar year.

1.4.3.3 Flight

A flight is defined as the collection of activities occurring between the launch and landing of an earth-to-orbit vehicle.

1.4.3.4 Manifest

A manifest is defined as the list of items for delivery to or return from the ISS for a specific flight.

1.4.4 Integration Process Phases

The ISS Payload Integration Process is made up of four distinct phases. Each phase is managed by one or more separate forums. Each forum has a defined charter and membership. Each phase requires certain inputs and results in certain products or events. The period for each phase can be defined by calendar dates, product deliveries, or events. For these reasons, the phases can have a significant amount of time boundary overlap.

1.4.4.1 Multi-Increment Payload Planning

The Multi-Increment Payload Planning process integrates payload transportation, accommodations, and operations requirements into the overall ISS multi-increment planning process. These payload requirements are compared to transportation system capabilities, ISS resources and accommodations, and other supporting services available for payload utilization. The process is iterative and conducted with the full participation of the ISS Partners and NASA Research Program Offices with the objective of maximizing the research return with the existing ISS resource availability. It results in the baselined document Integrated Payload Mission Model which feeds the next integration phase.

The management forum for this phase is the Research Planning Working Group (RPWG). The ExP user/PD is represented by their corresponding IP or Research Program Office (RPO) representative. The user/PD shall submit requirements to this planning process via a Mission Evaluation Request (MER) form. The MSFC MUPG ExP EI Team is available for consultation concerning MER inputs.

1.4.4.2 Tactical Planning

Tactical planning and manifesting is a multilateral ISS function that defines and documents the major program requirements, priorities, resource allocations, traffic events, microgravity periods, research objectives, system (assembly/logistics/maintenance), and payloads (to the sub-rack and sub-pallet level) manifest for each increment within a planning period. Beginning with the Integrated Payload Mission Module (IPMM), additional payload data is accumulated via updated MERs, EPIAs, EPIA IAs, and ICDs. The tactical process validates that the requirements can be accommodated. It results in a baselined Increment Definition and Requirements Document (IDRD), which serves as input to the next phase.

The management forum for this phase is split between the RPWG and the Payload Mission Integration Team (PMIT). The user/PD is assigned an EPPIM during this phase. The EPPIM assists in data input to the EPIA, EPIA IA, and ICD. The user/PD is represented by their RPO or IP to the RPWG. The user/PD is represented by their RPO/IP representative and EPPIM to the PMIT.

1.4.4.3 Flight/Increment Preparation

Flight/increment preparation includes all activities required to certify payload readiness to launch and to accomplish its mission objectives. Analytical integration includes all activities necessary to certify compatibility between the payload and Shuttle, ISS, and other payloads. Physical integration includes all activities necessary to mate the payload to Shuttle and ISS systems and verify those interfaces. Operations preparation includes all activities to prepare flight, ground crews, and facilities to support payload operation. The payload and integrated ExP will complete the entire safety review process and be certified safe for flight. Beginning with the IDRD, which defines a flight/increment manifest, the user/PD will submit numerous data items via the EPIA, EPIA IA, ICD, Data Sets, and Payload Verification Plan inputs. An electronic database system, referred to as PDL, has been developed to serve as the primary method for collecting and integrating much of the data. The assigned EPPIM will provide assistance to the user/PD for these inputs. The EXPRESS Pallet EI team will integrate ExP mounted payload inputs and submit required integrated input to SSP or ISS. This phase results in the preparation of numerous documents necessary to support the actual flight/increment. All participating parties will complete this phase with signatures to certifications of flight readiness.

The management forum for this phase is split between the PMIT and Payload Operations Interface Working Group (POIWG). The user/PD will be represented by their EPPIM to the PMIT. The EXPRESS Pallet EI team will be responsible for all activities to integrate the integrated ExP to the Shuttle and ISS. The user/PD will be assigned an operations engineer from ExP EI to support interface to the POIWG.

Physical integration will occur in two parts. ExP mounted payloads will be integrated onto an ExPA at the PD site. After shipment to KSC, the PD will be provided time and facilities for post-ship activities. Once turned over to KSC, the payload/ExPA will be integrated onto the ExP or Unpressurized Logistics Carrier and then integrated into the Shuttle Payload Bay. The user/PD will be assigned a KSC engineer to assist and support KSC activities.

1.4.4.4 Increment Execution

Increment execution includes all activities required to launch the payload, transfer the payload from the Shuttle to the ISS, operate the payload, return the payload to Earth, and complete post-increment evaluations. The user/PD will participate in the process either via location at the POIC at the MSFC, Alabama, or via location at a Telescience Support Center (TSC). The management forum for this phase is split between the Mission Management Team (MMT) and the POIF. The MMT is mainly concerned with Shuttle and ISS systems operations. The user/PD should not have a direct interface to the MMT, but would be represented by POIF personnel if required. The user/PD will be a direct participant to the POIF/TSC.

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SECTION 2, DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents, consisting of specifications, guidelines, procedures, and additional information, of exact issue shown, form a part of the requirements to the extent specified therein. The PD shall reference SSP 50257, Program Controlled Document Index, for the latest revision of the document. Inclusion of the applicable documents herein does not supersede the order of precedence identified in paragraph 1.3 of this document.

Documents are available from repositories such as:

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
CN22D
Marshall Space Flight Center, AL 35812
Telephone (256) 544-4490

2.1.1 Government Documents

FED-STD-101	Test Procedures for Packaging Materials
KHB 1700.7	Space Transportation System Payload Ground Safety Handbook
MIL-HDBK-1811	Mass Properties Control for Space Vehicles
MIL-STD-1553	Digital Time Division Command/Response Multiplex Data Bus
MSFC-HDBK-527/JSC 09604	Materials Selection List for Space Hardware Systems
TBD#5-01	Suitcase Test Environment for Payloads-EXPRESS Pallet (STEP-EP) User's Guide
NSTS 07700, Vol. XIV	Space Shuttle System Payload Accommodations
NSTS 08171	Mission Integration Plan Annex 9 Blank Book/OMRSD
NSTS 13830	Implementation Procedure for National Space Transportation System (NSTS) Payloads System

	Safety Requirements
NSTS 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 1700.7, ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
NSTS 18798	Interpretation of National Space Transportation System Payload Safety Requirements
NSTS 21000-IDD-ISS	Orbiter Cargo Bay Interface Definition Document
NSTS 21000-IDD-MDK, Vol. XIV	Shuttle/Payload Interface Definition Document for Middeck Payloads
NSTS 37329	Structural Integration Analyses Responsibility Definition for Space Shuttle Vehicle and Cargo Ethernet Developers
SSP 30420	Space Station Electromagnetic Radiation and Plasma Environment Definition and Design Requirements
SSP 30425	Space Station Program Environment Definition for Design
SSP 30426	Space Station External Contamination Control Requirements
SSP 30512	Space Station Ionizing Radiation Emission and Susceptibility Requirements for Radiation Environment Capability
SSP 41175-02	Software Interface Control Document, Part 1, Station Management and Control to International Space Station (ISS), Book 2, General Interface Software Interface Requirements
SSP 41177-05	Software Interface Control Document (ICD), Part 1, Guidance, Navigation, and Control (GN&C)-to-ISS Book 5, Global Positioning System (GPS) Interface

SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50007	Space Station Inventory Management System Label Specification
SSP50233	Payload User Development Guide for Space Station Training Facility (SSTF) Payload Training Center (PTC)
SSP 50257	Program Controlled Document Index
SSP 53013	Standard EXpedite the PRocessing of Experiments to Space Station Pallet Integration Agreement Blank Book (SEPIA)
SSP 52000-IDD-EPP	EXpedite the PRocessing of Experiments to Space Station Pallet Payloads Interface Definition Document
SSP 52000-PAH-KSC	Kennedy Space Center (KSC) Payload Accommodation Handbook
SSP 52000-PDS	Payload Data Sets Blank Book
SSP 52000-PVP-EPP	Generic Payload Verification Plan for EXpedite the PRocessing of Experiments to Space Station Pallet Payloads
SSP 52005	International Space Station Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures
SSP 52050	Software Interface Control Document, Part 1, International Standard Payload Rack (ISPR) to International Space Station
SSP 52052-IDD-PCS	Interface Definition Document for the International Space Station Portable Computer System (PCS)
SSP 53014	EPIA Increment Addendum Blank Book
SSP 57002	Payload Software Interface Control Document Template

SSP 57003	Attached Payloads Interface Requirement Document
SSP 57025	Payload Interface Fault Tolerance Document
SSP 57057	ISS Payload Integration Template
SSP 58309	National Aeronautics and Space Administration Payload Training Implementation Plan
SSP 58700	Payload Operations Data File Management Planning
TM-104825	National Aeronautics and Space Administration Technical Memorandum “A Computer Based Orbital Debris Environmental Model for Spacecraft Design and Observation in Low Earth Orbit”
TP-1999-209260	National Aeronautics and Space Administration Technical Paper, “Material Selections and Guidelines to Limit Atomic Oxygen Effects on Spacecraft Surfaces”

2.1.2 Non-Government Documents

ASTM-E595	Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
ASTM-E1559	Standard Test Methods for Contamination Outgassing Characteristics of Spacecraft Materials
ISO/IEC 8802.3 (ANSI/IEEE 802.3)	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

SECTION 3, ExP OVERVIEW

3.1 GENERAL

The EXPRESS Pallet System (ExPS) is the ISS truss-attached payload facility that provides standard ISS accommodations for multiple, external, ExPA-mounted payloads. A total of four pallets can be attached to the starboard truss site on the ISS. Two pallets can be attached on the zenith side, and two pallets can be attached on the nadir side of the truss. The ExPS payloads will have access to ram, wake, nadir, zenith, and Earth limb viewing.

The ExP provides a structural platform for the integration of the ExPA-mounted payloads. It will provide for a mechanical and structural interface with the ISS truss site, with a capability for EVR manipulation and connection of structural, electrical, and data interfaces.

The ExPA provides standard structural, mechanical, electrical, and communication interfaces for the payloads. Each ExPA will provide one power, two data, and one contingency power interfaces.

Individual pallets, with payloads attached, will be transported to the ISS via the Orbiter. The ExPS will be robotically removed from the Shuttle Payload Retention Latch Actuators (PRLA) and attached to the ISS truss segment via the Payload Attachment System (PAS).

There are two options for changeout of payloads. The first option is the return to Earth of an entire pallet, with payloads attached. The ExPS will be robotically removed from the truss and reinstalled in the Orbiter for return to Earth. The second option is for changeout of individual ExPA-mounted payloads. The ExPS accommodates on-orbit installation, removal, and changeout of ExPA-mounted payloads, using ISS standard logistics and EVR capability. Transportation of individual ExPAs to/from the ISS will be via the ULC or Sidewall Carrier (SWC).

3.2 STANDARD ExP-MOUNTED PAYLOADS

The ExP mounted payloads will have structural, mechanical, power, control, monitoring, and data interfaces to the ExP. The detailed requirements for these interfaces are detailed further in Section 4 of this document and in the IDD. Table 3-I defines the standard accommodations located at an ExPA for an ExP mounted payload.

Nonstandard payloads are those that exceed the accommodations documented in Table 3-I. A payload that exceeds one or more of these requirements should communicate

TABLE 3-I STANDARD ExP MOUNTED PAYLOAD (Sheet 1 of 2)

DISCIPLINE	STANDARD ACCOMMODATION (per ExPA)	NOTES/ REMARKS
Mass	500 lb (226.7 kg) per adapter (excluding ExPA)	
Center of Gravity (CG)	CG varies as a function of mass.	Note 1
Frequency	First mode fundamental frequency >35 Hz	
Envelope	Maximum volume 34 in. (864 mm) depth x 46 in. (1168 mm) width x 49 in. (1245 mm) height	Note 2
Power	Reference Table 4-V	
Command and Data Handling (C&DH) Hardware Interfaces	Two MIL-STD-1553 dual redundant busses [2 Remote Terminals (RT) at each ExPA] Analog (6 inputs) Discrete (6 programmable I/O) Two Ethernet interfaces	Note 3
C&DH Software Communications	Status, Service Requests, Health Monitoring, Ancillary Data, File Transfers, Command and Control High Rate Science Data Downlink Temperature and Preconditioned Signal Sensor Inputs for Status Control or Status of Payload Systems	
Thermal	No thermal control is provided to payloads by ExP. No more than **TBD#3-01** W per adapter can be conducted to the ExP.	
EVA/EVR	Payloads should not have any EVA/EVR requirements. EVR/EVA interfaces are satisfied by ExPA. Payloads should have no planned release of hardware from the ExPA or payload.	
Late Access	No payload requirements for on pad access	
Early Removal	No payload requirements for early removal of hardware after returning from ISS	
Transmission	No Radio Frequency (RF) or microwave, transmitters, or receivers (associated with ground transmitters)	

TABLE 3-I STANDARD ExP MOUNTED PAYLOAD (Sheet 2 of 2)

DISCIPLINE	STANDARD ACCOMMODATION (per ExPA)	NOTES/ REMARKS
Pyrotechnics	No pyrotechnic devices on payloads	
Propulsive Devices	No propulsive devices on payloads (including unneutralized venting of pressurized gases)	
Stowage	No pressurized stowage	

NOTES:
1. Reference CG versus mass table, Table 4-II.
2. Maximum envelope is defined. Temporary exceedances make a payload nonstandard.
3. 1553 and Ethernet interfaces are shared and require payload-provided data storage/buffers. Not intended for point-to-point communications.

this situation to ExP EI. ExP EI will assess any exceedances to determine their acceptability. All payload exceedances will be documented in the payload-unique ICD.

Nonstandard payloads are those that exceed the accommodations documented in Table 3-I. Any exceedance of a standard accommodation is considered an exception. An exception is defined as a general term used to identify any departure from specified requirements or interfaces. All exceptions will be documented in a unique paragraph of the derived ICD per the process noted in paragraph 1.1.3 of SSP 52000-IDD-EPP.

3.3 ExP CONFIGURATION

The ExPS consists of three main functional elements: pallet, pallet adapter, and pallet control assembly (see Figure 3-1).

Potentially six payload adapters with payloads will be flown on each pallet as shown in Figure 3-2. The ExPA with payloads integrated are designed to be installed and removed robotically. The adapters will have blind mate connectors for electrical and data interfaces on the underside of the ExPA. No active cooling is provided by the pallet system for payloads.

One EXPRESS Pallet Control Assembly (ExPCA) is attached to each pallet. The ExPCA provides data/command routing, status monitoring, and power control and conversion for the pallet. The ExPCA will provide data communications and power distribution interface between the ISS and ExP mounted payloads. Payloads will have to provide their own electrical distribution and data control internal to their hardware.

The exact interfaces and requirements will be defined in the payload-unique ICDs.

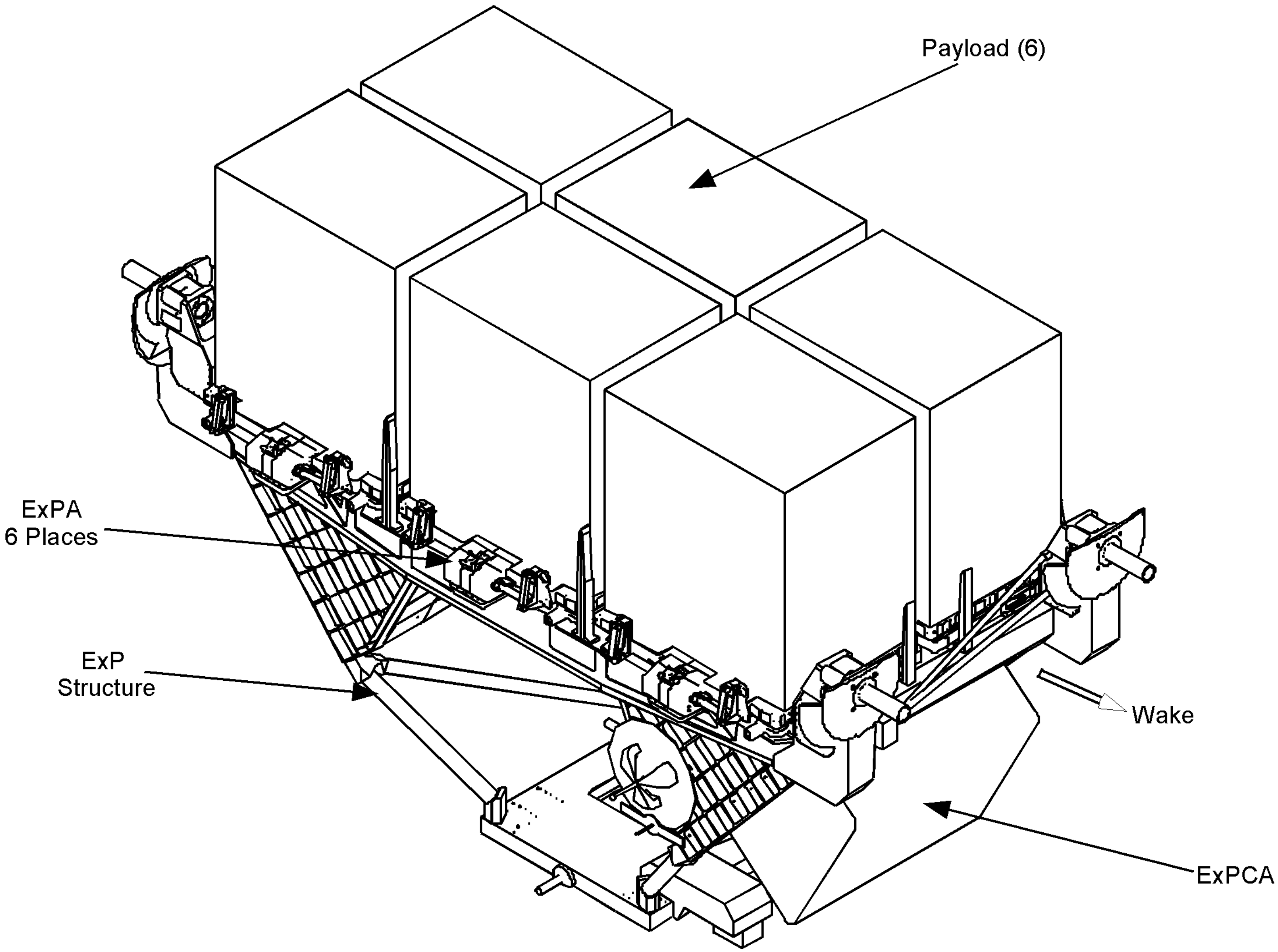


FIGURE 3-1 ExP SYSTEM ON-ORBIT CONFIGURATION

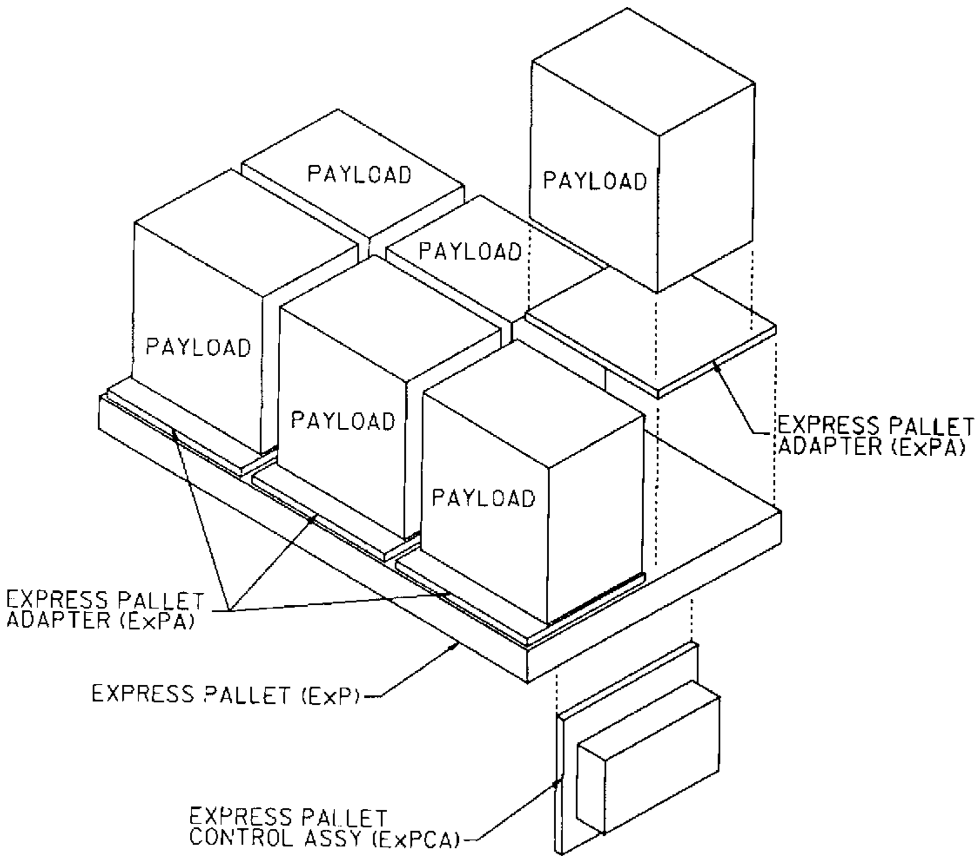


FIGURE 3-2 ExP PHYSICAL DIAGRAM

3.4 ExP MOUNTED PAYLOAD MISSION PHASES

The ExP mounted payload life cycle is comprised of eleven major phases. These phases are: ground processing integration, ascent, rendezvous with ISS, Orbiter docked to ISS, translation to the truss, on-orbit operations, translation to Orbiter, Orbiter-docked to ISS for return, Orbiter preparation for descent, descent, and ground processing deintegration. The description of these phases will vary according to whether the payload is an EXPRESS Pallet, ULC, or SWC.

3.4.1 Mission Phases Based on Use of the ExP as Carrier to/from ISS

3.4.1.1 Ground Processing Integration

The ground processing integration phase of the payload's life is broken into two sub-phases. The first sub-phase is the ground processing at the PD's site. During this phase, the

PD will physically integrate the payload instrument onto the ExPA. The adapter arrives at the payload site fully integrated into the shipping and storage container and is not separable. The PD has access to the mechanical and electrical interfaces on the top of the adapter as described in the ExP IDD. Additionally, the electrical interfaces to the ExP are available on a connector panel, so the PD can check out the electrical interfaces on the integrated ExPA. After completion of this integration process, the PD prepares the payload for shipping and completes the closeout of the shipping container. Shipping of the payload to KSC is the PD's responsibility.

The second sub-phase of the ground processing integration phase is the KSC processing sub-phase. Once the payload arrives at KSC, the payload begins its offline processing. The offline processing consists of receiving the payload, incoming inspection, delivery of the payload to the offline laboratory, and any post-ship tests that the PD deems necessary. When the PD is satisfied with the post-ship testing, the payload is ready for turnover to KSC for online processing. During online processing, the KSC staff moves the payload from the offline laboratory to the Space Station Processing Facility (SSPF) intermediate bay. After the ExPA/payload is attached to the ExP, tests are accomplished using the Payload Test and Checkout System (PTCS). The PTCS provides for a final function checkout of the payload to ISS interfaces, including power, Communication and Tracking (C&T), and Command and Data handling (C&DH) subsystems. The PTCS is also used to validate the interfaces between the payload and the ground command and telemetry databases. Upon completion, the integrated ExP is installed in the Orbiter for launch.

3.4.1.2 Ascent

The ascent phase begins at Shuttle main engine ignition and continues until the Orbiter bay cargo doors are opened. During this phase, the ExP mounted payload is non-operational. No power or data are available for payload use.

3.4.1.3 Rendezvous with ISS

During rendezvous with the ISS phase, the Orbiter has attained the mission altitude for rendezvous with the station. At this point, the ExP is provided with power. Likewise, the ExP will distribute only stay-alive heater power to payloads.

3.4.1.4 Orbiter Docked to the ISS

During the Orbiter docked to the ISS phase, the Orbiter cargo bay doors are still open, exposing the payloads, including the ExP mounted payloads, to space. Stay-alive power is still being provided to the ExP mounted payloads. Prior to the translation phase, the ExP will receive an increased power allocation from the Orbiter. This power is used to precondition the ExP and its payload complement for translation to the truss.

3.4.1.5 Translation to the Truss

Translation to the truss is handled via the Orbiter and the ISS robotics system. This function can be accomplished in either of two different ways.

The Mobile Remote Servicer (MRS), which is composed of the MRS Base System (MBS) and the Mobile Transporter (MT), is based at the MRS worksite. The following ExP transportation procedure can be followed. The Shuttle Remote Manipulator System (SRMS) grasps the ExP grapple fixture. The ExP is handed off to the Space Station Remote Manipulator System (SSRMS). The ExP is unpowered during this EVR hand off operation. The ExP is then mounted on the Mobile Servicing System Common Attachment System (MCAS), which is attached to the MBS. As the MRS traverses the station, payloads are unpowered, except at discrete points along the truss at points called MRS worksites. Here, utility ports are available to provide power. The MRS will pause at these worksites as necessary for the ExP to provide contingency power to the payload heaters. (Contingency power serves as stay-alive power whenever the ExPCA ceases to operate, either by choice or failure.) The SSRMS is used to transfer the ExP from the MCAS/MBS to the S3 Truss Segment Attached Payloads Accommodations Site (APAS).

Alternately, if the SSRMS operates from the MBS while the MRS is stationed at certain worksites as an operating base, it can receive the ExP handoff from the SRMS and directly position the ExP on the S3 APAS. Again the ExP is unpowered during this EVR hand off operation but this operation is expected to be much quicker than transportation via the MRS and should expose the ExP and its payloads to less unpowered time.

3.4.1.6 ISS On-Orbit Operations

The on-orbit operations phase begins once the ExP is installed on the truss. Depending on crew, communications, and/or resource allocations, the pallet is either activated or is placed in stay-alive power mode. When the operational timeline allows activation and operation of the ExP, the pallet, in turn, will respond to commands from the crew and ground to operate individual payloads. Upon completion of the science objectives, individual payloads will be deactivated and placed in stay-alive mode.

3.4.1.7 Translation to Orbiter

When the entire complement of payloads has completed its science objectives, the ExP will be deactivated and transferred to the MT for return to Earth.

During the translation to the Orbiter, the MT once again will pause at intermediate worksites to allow the ExP to distribute contingency power. When the MT arrives at the Orbiter worksite, the pallet will be removed from the MCAS by the SSRMS and handed off to the SRMS. The SRMS will, in turn, place the pallet in the Orbiter cargo bay.

3.4.1.8 Orbiter Docked to the ISS for Return

The Orbiter cargo bay doors are open, exposing the payloads, including the ExP mounted payloads, to space. Stay-alive power (28 Vdc) will be provided to the ExP mounted payloads.

3.4.1.9 Orbiter Preparation for Descent

After all Orbiter return cargo is loaded, the Orbiter detaches from the ISS. The Orbiter translates to an orbit required for descent. The Orbiter cargo bay doors remain open for thermal control.

Stay Alive Power (28 Vdc) will be provided to payloads.

3.4.1.10 Descent

The descent phase begins upon closure of the Orbiter cargo bay doors. The Orbiter performs a rotisserie maneuver to equalize the outside temperature of the Orbiter before re-entry. The Orbiter cargo will remain non-operational during this phase.

3.4.1.11 Ground Processing Deintegration

The ground processing deintegration phase begins after return to KSC. Deintegration is a three-step process. The first step involves removal of the ExP from the Orbiter cargo bay. The second step involves removal of the ExPA from the ExP. The final deintegration step, which can be performed at KSC or the PD’s site, is the removal of the payload from the ExPA. If deintegration occurs at the PD’s site, the PD is responsible for shipping the ExPA and storage and shipping container to KSC.

3.4.1.12 Alternate Landing Sites

In the event of the Orbiter landing at a landing site other than KSC, no ground deintegration will take place until the Orbiter has been returned to KSC via ferry flight for post-flight processing.

3.4.2 Mission Phases Based on Use of a ULC or SWC as Carrier to/from ISS

3.4.2.1 Ground Processing Integration

The ground processing integration is identical to that described in Section 3.4.1.1, with the following exceptions. Once KSC accepts the ExPA/payload for on-line processing, the ExPA/payload is mounted on the EXPRESS Pallet KSC Simulator. Tests are accomplished using the PTCS. After tests, the ExPA/Payload is de-integrated from the KSC simulator, and integrated on the ULC or SWC. The ULC or SWC is then installed in the Orbiter for launch.

3.4.2.2 Ascent

The ascent phase begins at Shuttle main engine ignition and continues until the Orbiter bay cargo doors are opened. During this phase, the EXPRESS pallet payload is non-operational. No power or data is available for payload use.

3.4.2.3 Rendezvous with the ISS

During rendezvous with the ISS phase, the Orbiter has attained the mission altitude for rendezvous with the station. The ULC/SWC will provide stay-alive heater power to payloads.

3.4.2.4 Orbiter Docked to the ISS

During the Orbiter docked to the ISS phase, the Orbiter cargo bay doors are still open, exposing the Orbiter payloads, including the EXPRESS Pallet payloads, to space. Stay-alive power is still being provided to the EXPRESS Pallet payloads. Prior to the translation phase, the ULC/SWC will receive power allocation from the Orbiter and distribute to the payloads. This power is used to precondition the EXPRESS Pallet and its payload complement for translation to the truss.

3.4.2.5 Translation to the Truss

The process is similar to that described in Section 3.4.1.5, with the following exceptions. Obviously, it is the ULC/SWC that serves as carrier and power provider in place of the EXPRESS Pallet. Once at the ExP worksite, the Special Purpose Dexterous Manipulator (SPDM) is used to grapple the ExPA and transfer it to an existing pallet mounted to the ISS.

3.4.2.6 ISS On-Orbit Operations

The on-orbit operations phase begins once the EXPRESS Pallet is installed on the truss. Depending on crew, communications, and/or resource allocations, the pallet is either activated or is placed in stay-alive power mode. When the operational timeline allows activation and operation of the EXPRESS Pallet, the pallet in turn will respond to commands from the crew and ground to operate individual payloads. Upon completion of the science objectives, individual payloads will be deactivated and placed in stay-alive mode.

3.4.2.7 Translation to Orbiter

When a single ExPA/payload has completed the science objectives that ExPA/payload will be deactivated. The SPDM will be used to transfer the ExPA/payload to a waiting ULC/SWC at the MT ExP worksite. The rest of the process is identical to that described in Section 3.4.1.7, with the ULC/SWC substituted for ExP.

3.4.2.8 Orbiter Docked to ISS for Return

The Orbiter cargo bay doors are still open, exposing the payloads, including the ULC/SWC payloads, to space. Stay-alive power will not be provided to the EXPRESS Pallet payloads.

3.4.2.9 Orbiter Preparation for Descent

After all Orbiter return cargo is loaded, the Orbiter detaches from the ISS. The Shuttle translates to an orbit required for descent. The Orbiter cargo bay doors remain open for thermal control.

The ULC/SWC will not distribute stay-alive power to payloads.

3.4.2.10 Descent

The descent phase begins upon closure of the Orbiter cargo bay doors. The Orbiter performs a rotisserie maneuver to equalize the outside temperature of the Orbiter before reentry. The Orbiter cargo will remain non-operational during this phase.

3.4.2.11 Ground Processing De-Integration

The ground processing de-integration phase begins after return to KSC. De-integration is a three-step process. The first step involves removal of the ULC/SWC from the Orbiter cargo bay. The second step involves removal of the ExPA from the ULC/SWC. The final de-integration step, which can be performed at KSC or the PD's site, is the removal of the payload instrument from the ExPA. If de-integration occurs at the PD's site, the PD is responsible for shipping the ExPA and storage and shipping container to KSC.

SECTION 4, ExP DESCRIPTIONS, INTERFACES, AND PAYLOAD ACCOMMODATIONS

This section provides a description of ExP subsystems, interfaces, and payload accommodation. Descriptions are included to assist PDs with their payload design.

A top-level summary of ExPA capabilities is provided in Table 4-I. These capabilities are provided regardless of the ExPA location on any ExP. Additional resources may be available other than those specified; however, use of these resources must be negotiated with the ExP payload integrator on a case-by-case basis.

TABLE 4-I ExPA INTERFACE CAPABILITIES

TYPE CAPABILITY	RESOURCE CAPABILITY
Payload Weight	500 lb (226.7 kg) maximum per adapter (see Note 1)
Payload Envelope	34 in. (864 mm) width x 46 in. (1168 mm) length x 49 in. (1245 mm) height
Power (On-Orbit)	See Table 4-V
Command, Control, Data, and Telemetry	Two MIL-STD-1553 dual redundant busses (Ref. Note 2) (two RTs) Analog (6 inputs) (Ref. Note 2) Discrete (6 programmable inputs/outputs) (Ref. Note 2) Two Ethernet interfaces (Ref. Note 2)
Thermal Control	Passive (Each payload will provide its own thermal control.) (Ref. Note 3)
Field of View (FOV)	Nadir, zenith, ram, wake, port, and starboard (Ref. Note 4)

NOTES:

1. This weight does not include the payload adapter itself.
2. These resources are limited and will have to be shared with other payloads (see Table 3-I for standard ExPA allocations).
3. Any payload cooling system radiators provided by a payload must not dump heat on the pallet, ISS, or other payloads.
4. FOV requirements will be given high priority in the manifesting of payload locations.

4.1 PHYSICAL, STRUCTURAL, AND MECHANICAL

The ExPA will be the physical, structural, and mechanical interface for payloads utilizing the ExP in orbit.

4.1.1 Physical Integration

The ExPA is the only payload accommodation method for the ExP. The ExPA structure is shown in Figure 4-1. The PDs will integrate their payload into the ExPA and then ship the ExPA/payload assembly with payload to KSC for integration into the Orbiter cargo bay. The ExPA has a design capability to support payloads of 500 lb (226.7 kg) maximum weight. The adapter will provide all electrical and C&DH external interfaces for the payload. Shipping containers are referenced in paragraph 5.1.1 of this document.

4.1.2 Geometric Relationships

Integration of the ExP and payloads on ISS and Shuttle involves the use of several defined and previously undefined coordinate systems and geometric relationships. These established and ExP-unique coordinate systems are defined in SSP 52000-IDD-EPP, paragraph 3.1.

4.1.3 Payload-Mounting Provisions

Payload-mounting provisions consist of standard ExPAs. The ISS Program will provide ExPAs to PDs. The mechanical interfaces between the ExPA and payload are shown in Figure 4-2.

The bolt hole pattern is shown in Figure 4-2. The ExPA bolt hole is designed to accommodate 0.25-28 UNF fasteners. PDs must provide their own interface fasteners. Detailed requirements regarding fasteners are provided in SSP 52000-IDD-EPP, paragraphs 3.4.1 and 3.4.3.

Figure 4-3 shows the payload-to-ExPA attach point details.

4.1.4 Connector Panel Interface Provisions

The details of the electrical and data connector panels on the ExPA are as shown in Figures 4-4 and 4-5, respectively.

4.1.5 Payload Mass and Center-of-Gravity (CG) Capabilities

The ExPS can accommodate a maximum payload weight of 500 lb (226.7 kg) at each ExPA location. This weight does not include the ExPA itself.

The ExPA, when flown on an ExPS, is designed to accommodate payloads with a CG as shown in Table 4-II.

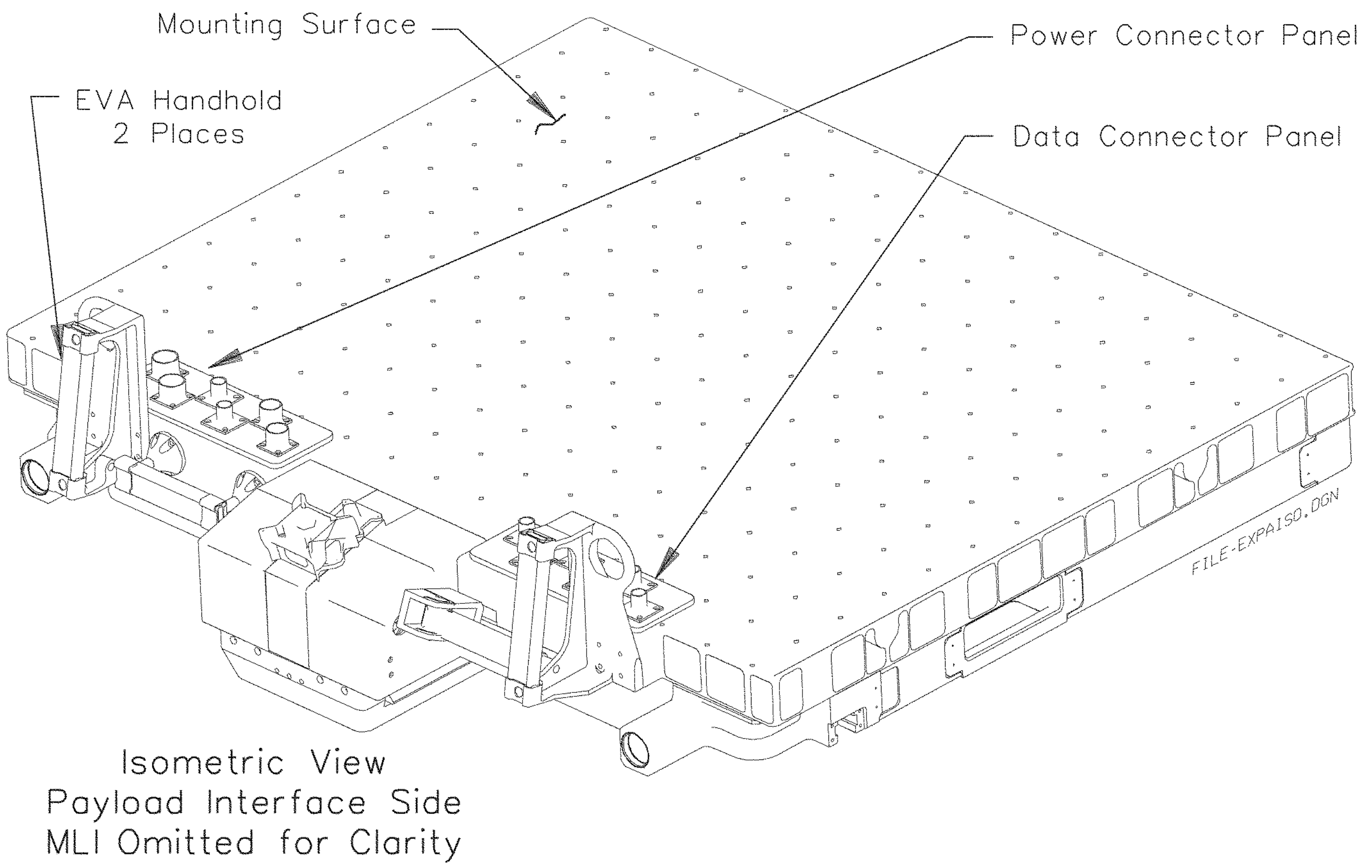
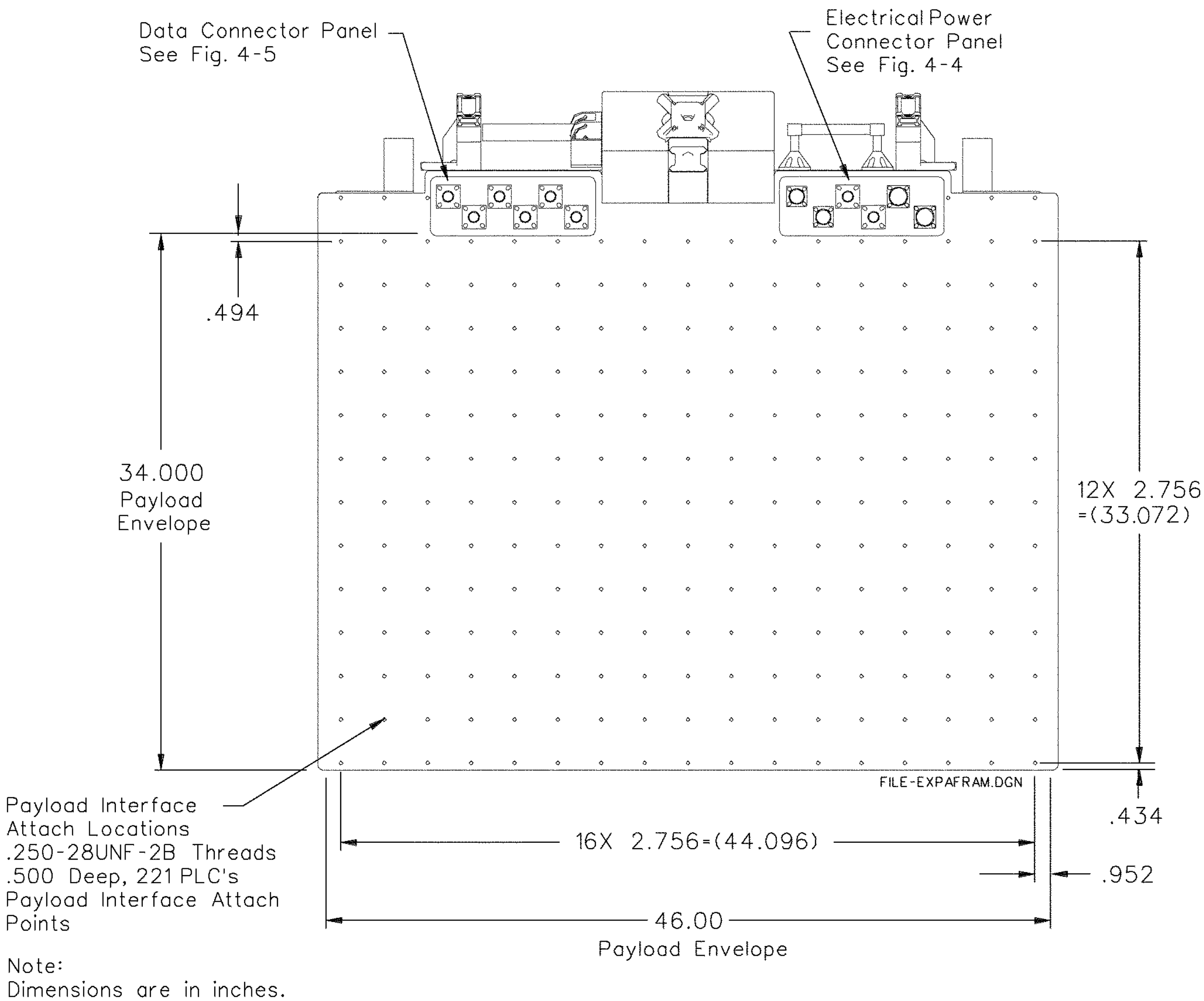
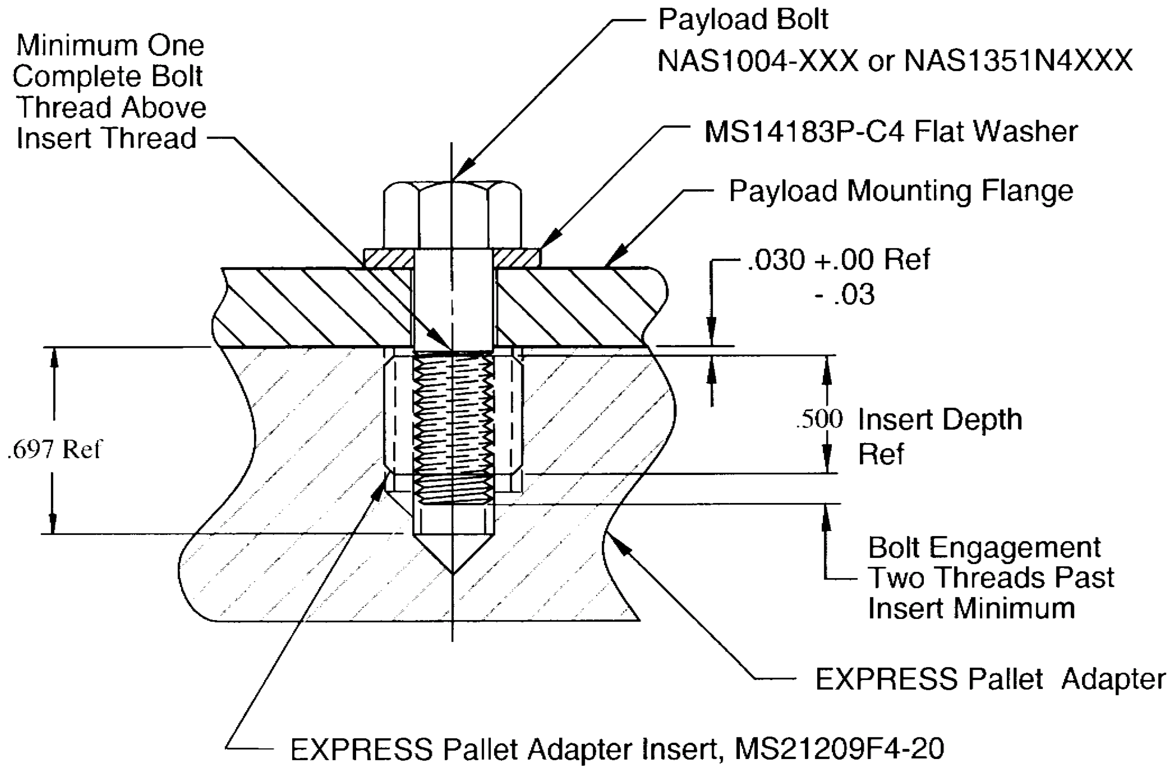


FIGURE 4-1 ExPA CONFIGURATION



The ExPA has 2.756 inches (70 mm) center to center spacing between payload mounting holes.

FIGURE 4-2 ExPA PAYLOAD-MOUNTING PROVISIONS



NOTE: Dimensions are in inches.

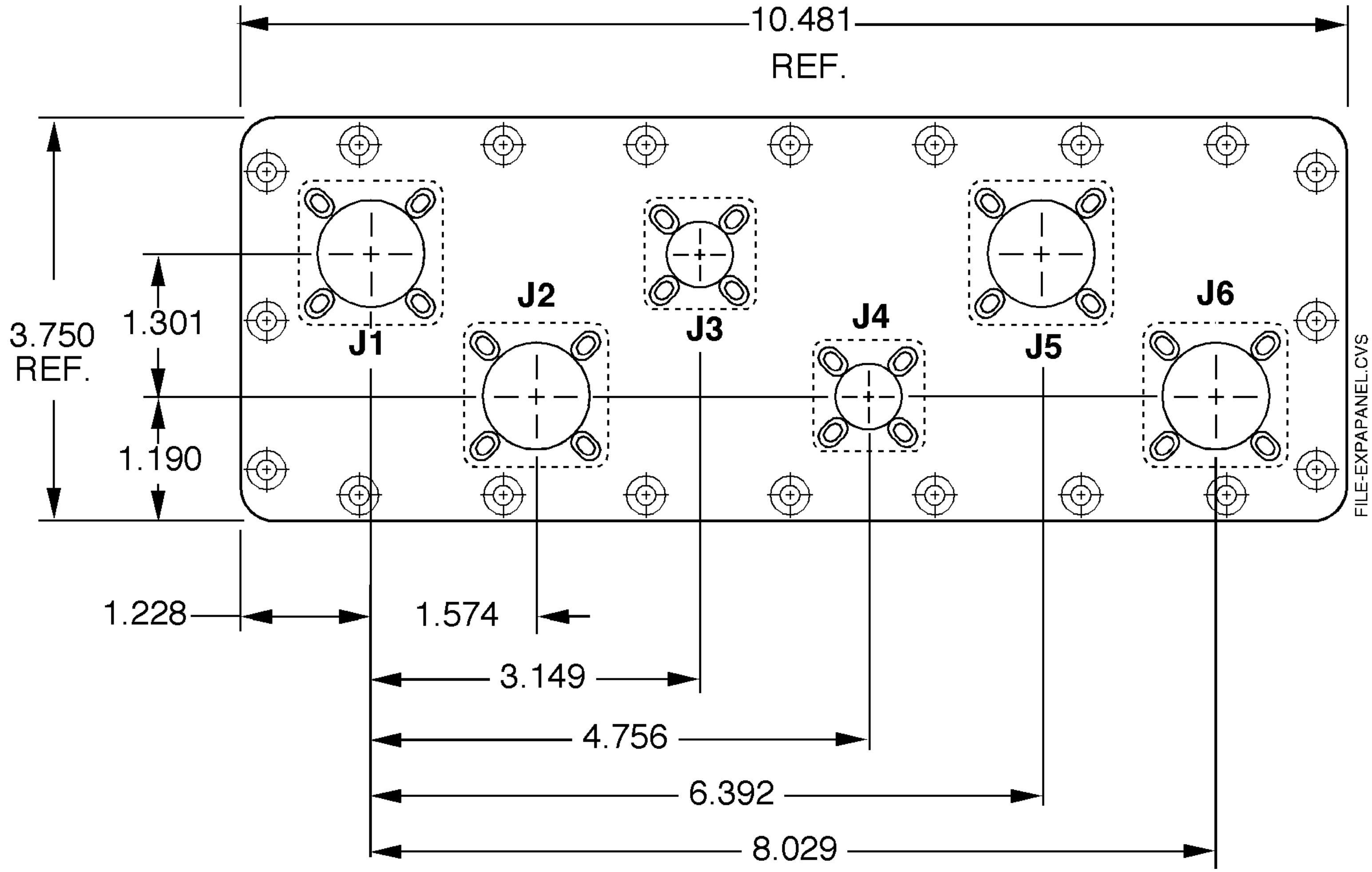
FIGURE 4-3 ExPA ATTACH POINT DETAILS

4.1.6 Payload Static Envelope

The ExPS is designed to accommodate payloads with a maximum static envelope as shown in Figures 4-2 and 4-6 at each ExPA location while attached to the ISS truss. For liftoff and landing, only the center ExPA locations can accommodate the maximum static envelope as specified in Figure 4-6. For liftoff and landing, the maximum envelope for the four ExPA corner locations will be as shown in Figure 4-7. For on-orbit corner payloads that require an envelope that exceeds that shown in Figure 4-7, special launch, landing, manifesting accommodations, and on-orbit EVR operations will have to be developed..

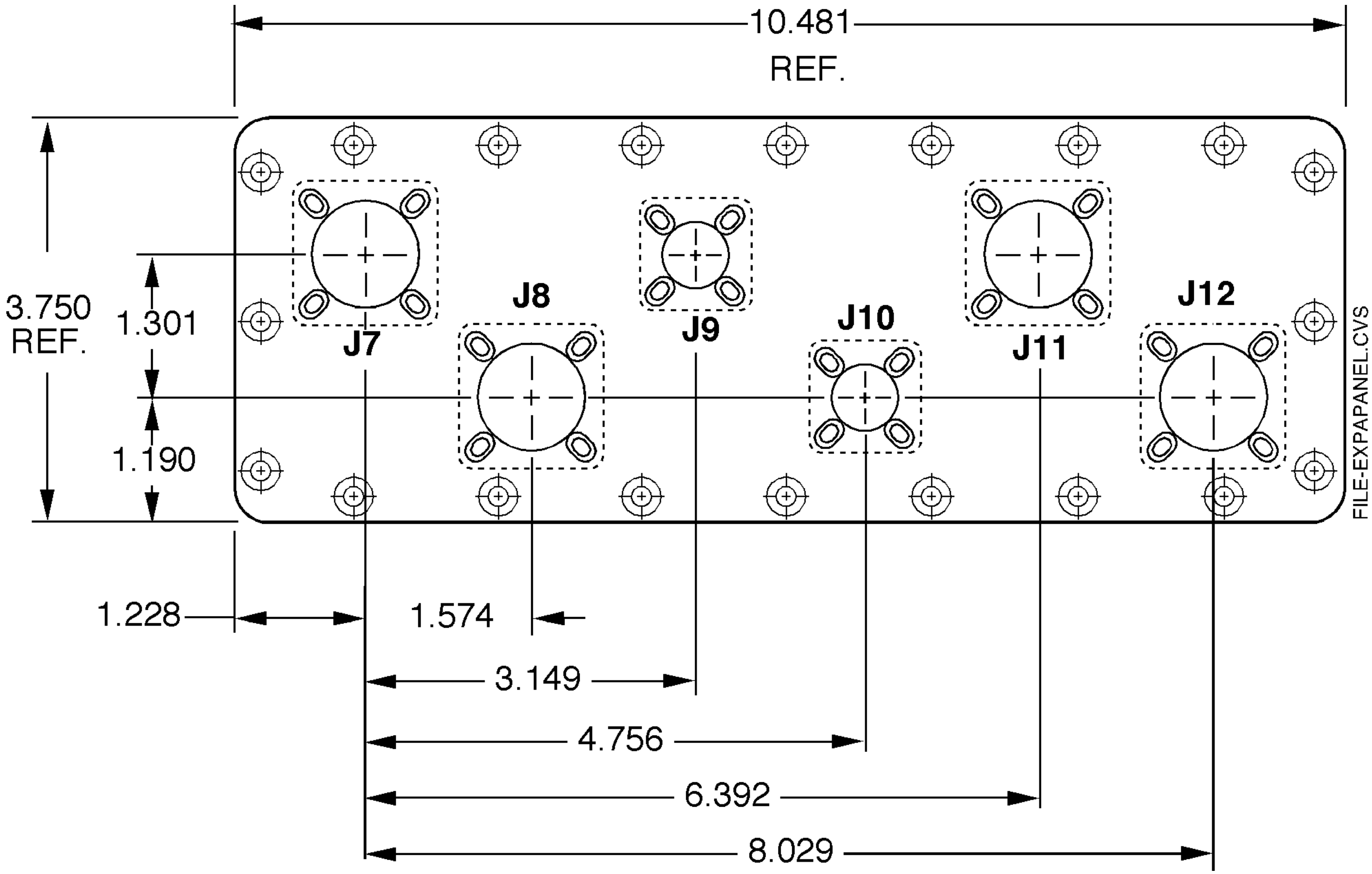
4.1.7 Design Process

The mechanical interfaces will be defined in the Payload-Unique ICD, and the Configuration Data Set. The hardware definition will be submitted via the PDL. ExP EI will assess this data and provide comments to the PD.



NOTE: Dimensions are in inches.

FIGURE 4-4 ELECTRICAL POWER PANEL CONFIGURATION



NOTE: Dimensions are in inches.

FIGURE 4-5 DATA CONNECTOR PANEL CONFIGURATION

TABLE 4-II PAYLOAD CG REQUIREMENTS FOR ExP

PAYLOAD MASS (lb) [kg]	MAXIMUM DEVIATION FROM GEOMETRIC CENTER IN $X_{ExPA/NSTS}$ - $Y_{ExPA/NSTS}$ PLANE (in) [mm]	MAXIMUM HEIGHT ($Z_{ExPA/NSTS}$) OF PAYLOAD CG ABOVE THE ExPA MOUNTING PLANE (in.) [mm]
401 - 500 [181.9 - 226.8]	$\Delta X_{ExPA/NSTS}$ = 7.5 [190], $\Delta Y_{ExPA/NSTS}$ = 7.5 [190]	19.5 [495]
301 - 400 [136.5 - 181.4]	$\Delta X_{ExPA/NSTS}$ = 9 [229], $\Delta Y_{ExPA/NSTS}$ = 10 [254]	24.0 [610]
201 - 300 [91.2 - 136.1]	$\Delta X_{ExPA/NSTS}$ = 10.5 [267], $\Delta Y_{ExPA/NSTS}$ = 12 [305]	28.0 [711]
<200 [<90.7]	$\Delta X_{ExPA/NSTS}$ = 12 [305], $\Delta Y_{ExPA/NSTS}$ = 14 [356]	30.0 [762]

ExP EI will require submission of top assembly drawings from PDs. This drawing should define all physical interfaces between payload hardware (e.g., baseplates, cable restraints, bonding interfaces, and electrical connectors) and ExPA.

ExP EI also requires the submission of a drawing or drawings that define any motion envelopes that must be traversed for the payload to reach its on-orbit operational configuration. If the launch configuration is identical to a payload's on-orbit configuration, then this drawing is not required. Any payload-deployable hardware (covers, doors, etc.) that exceed the payload envelope of Figure 4-6 must be approved via the waiver process.

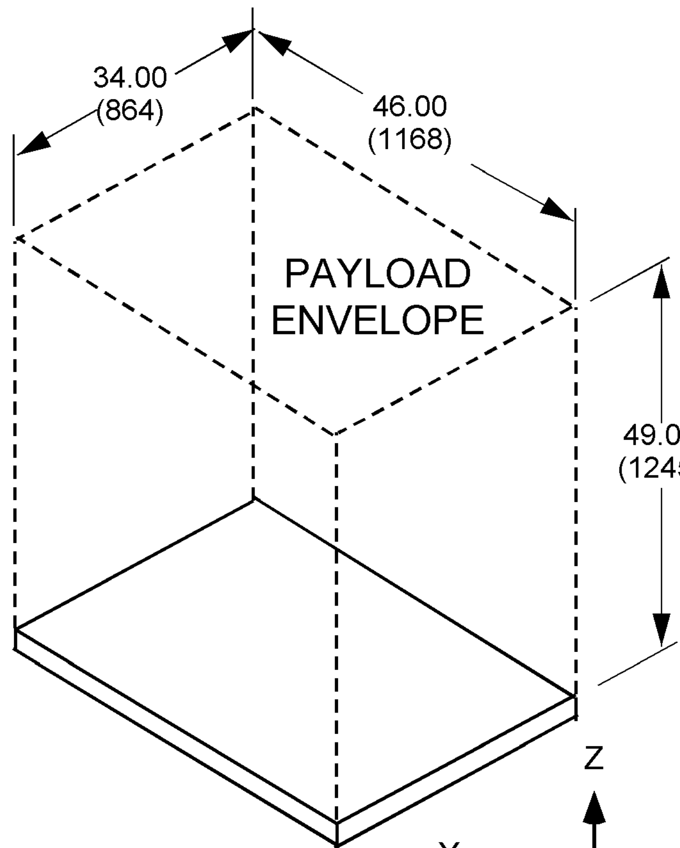
Drawings must be supplied as 3D Computer-Aided Design (CAD) files in a .DXF, .DGN, International Graphic Exchange Specification (IGES) or PRO Engineer (PRO/E) compatible format. The PD input will be used to support the generation of integrated pallet Assembly and Integration (A&I) drawings, viewing and pointing analyses, and be used by thermal and structural disciplines in their analytical tasks. For additional information on this process/schedule, see Appendix C, Table C-I, Mechanical.

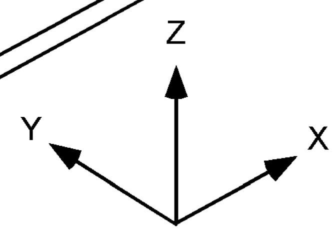
4.2 THERMAL CONTROL

The ExP will not provide any active thermal control. Each payload is responsible for its own thermal control by utilizing techniques such as radiators, thermal coatings, insulation, electrical heaters, louvers, and/or thermal capacitors. ExP mounted payload designs should not employ methods that use the ExPA as a heat sink. Payloads mounted on the ExPA are required to cover any unused portion of the ExPA surface with Multi-Layer Insulation (MLI).

4.2.1 Passive Thermal Design

All payload heat rejection requirements are to be met only by radiation to the environment.





NOTES:
1. Dimensions are in inches and (mm).
2. Coordinates are at launch/landing.

FIGURE 4-6 PAYLOAD ENVELOPE FOR ExPA-MOUNTED PAYLOADS

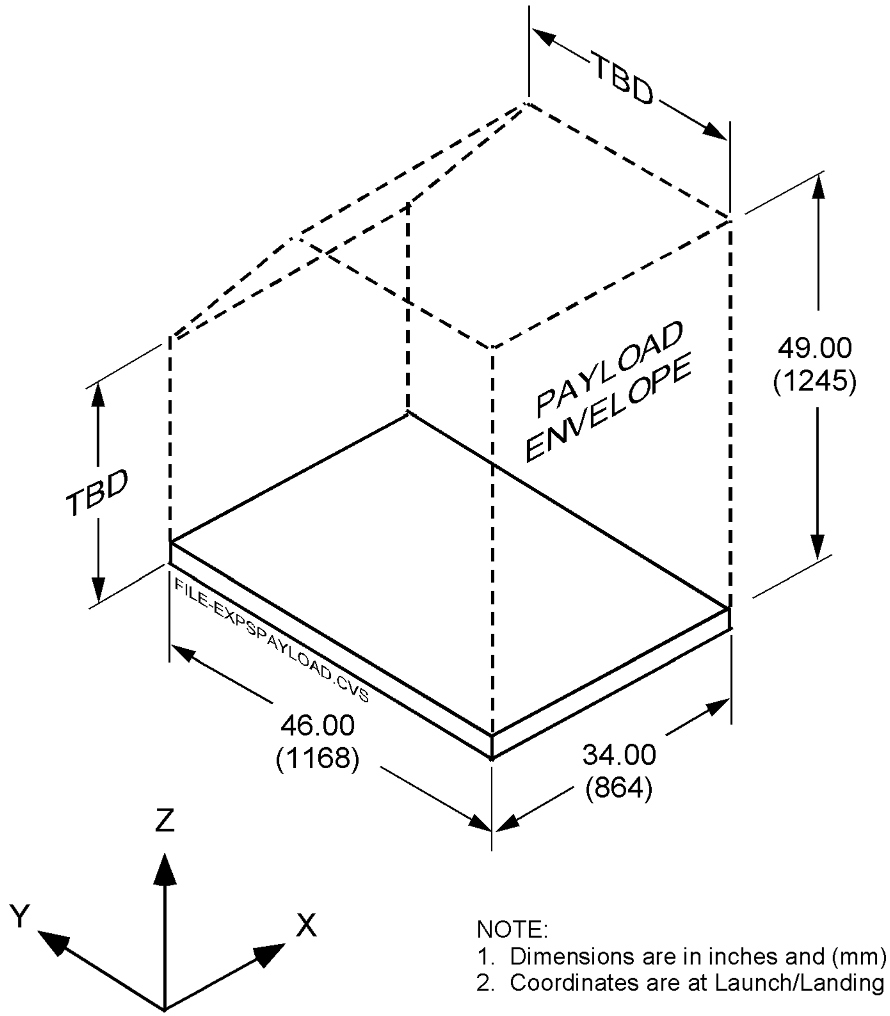


FIGURE 4-7 PAYLOAD ENVELOPE FOR ExPS EXTERIOR MOUNTED PAYLOADS IN ORBITER BAY

Mission planning guidelines will normally encourage the PD to minimize highly reflective surfaces, which will have specular characteristics. Specularity limits will be documented in the ExP IDD. Generally, specularity should be limited to 10 percent or less.

ExP mounted payload designs should not employ methods that reject heat to neighboring payloads or ISS equipment. Heat-rejection surface locations will be negotiated as part of the payload-unique ICD development.

Active radiation surfaces (surfaces designed to reject payload waste heat) should be oriented to minimize the view factor to other payloads and the ISS. The view factor, as used here, is defined as the fraction of diffuse radiation leaving surface 1 that will fall on surface 2, such that:

$$A_1 F_{1-2} = A_2 F_{2-1}$$

where:

A_1 = area of surface 1

A_2 = area of surface 2

F_{1-2} = view factor from surface 1 to surface 2

F_{2-1} = view factor from surface 2 to surface 1.

For a given surface, the view factors should sum to 1.0.

4.2.1.1 Conductive Interface Between ExP Mounted Payloads and ExPA

The ExPA will accommodate a payload heat leak rate of not greater than **TBD#3-01** W at each ExPA to payload box interface. It is the responsibility of the ExP mounted payload to provide thermal isolation to preclude a payload heat leak rate greater than **TBD#3-01** W for each ExPA without exceeding the temperature limits in Table 4-III.

TABLE 4-III ExPA MINIMUM AND MAXIMUM TEMPERATURES

FLIGHT PHASE	ExPA TEMPERATURE RANGE, °F (°C)
On-Orbit (In STS and Translation)	-126 to 150 (-87 to +66)
On-Orbit (On ISS Truss Sites Only)	-112 to 100 (-80 to +38)

4.2.1.2 ExP-to-ExPA Interface Temperatures

The expected structural temperature ranges for the ExPA are specified in Table 4-III. These ranges define the conductive boundary temperature ranges for ExP mounted payloads.

4.2.2 Thermal Environment Definition

Payload equipment design should be based on the widest possible environmental conditions to account for the multitude of parameters such as ISS attitude, beta angle, ExP mounted payload configuration, thermal coatings, and ISS attached payload requirements. The ground and flight environments the ExP mounted payload can be exposed to are listed in Table 4-IV.

Mean Effective Radiation Temperature (MERAT) data are available for several cases. These data can be used if desired as an aid in estimating environments for EPP surfaces. The MERAT data will be available in **TBD#4-04** document.

TABLE 4-IV ExP MOUNTED PAYLOAD THERMAL ENVIRONMENTS

Temperature	
Prelaunch/Postflight/Storage	0 °F to 100 °F (-18 °C to +38 °C)
Ascent and Descent	-55 °F to +150 °F (-48 °C to +66 °C)
On-Orbit Environment	
Beta Angle	0° to ±75°
Altitude	150 nmi to 270 nmi (277.8 km to 500.0 km)
Solar Radiation	419 to 451 Btu/hour ft^2 (1321 to 1423 W/m^2)
Earth Albedo	20 percent to 40 percent of the solar radiation
Earth Radiation	65.3 to 90.7 Btu/hour ft^2 (206 to 286 W/m$^{2)}$)
Space Soak	5.4 °R (3 °K)
Ferry Flight Environment	defined in NSTS 21000-IDD-ISS, Sections 10.10.1 and 10.10.2
Pressure	
Prelaunch/Postflight/Storage	15.2 psi maximum (786 mm Hg)
Ascent to Orbit	defined in NSTS 21000-IDD-ISS, Section 10.6
Descent	defined in NSTS 21000-IDD-ISS, Section 10.6
On-Orbit	1.93 x 10^{-9} psia (1.0 x 10^{-7} Torr minimum)

4.2.3 ExP Mounted Payload Venting

The ExP mounted payloads venting will be in accordance with the maximum cargo bay ascent and descent pressure decay rate specified in NSTS 21000-IDD-ISS, paragraph 10.6.1.

4.2.4 Environmental Control Accommodation Process

PDs must specify thermal characteristics such as surface optical properties and equipment heat dissipations in the payload-unique ICD.

Thermal accommodation of payloads occurs in two stages, preliminary and final. In both stages, EI requires simplified geometric math models and simplified thermal math models from the PD, which are used in the development of integrated ExP models. The geometric mathematical models and thermal mathematical models are to be delivered in Thermal Radiation Analyzer System (TRASYS) and Systems Improved Numerical Differencing Analyzer and Fluid Integrator (SINDA/FLUINT) formats, respectively.

Payload mathematical models are to include items such as, payload dimensions, timelined heat dissipations, surface optical properties, and mounting/contact conductances. EI uses the models from the PD to build integrated ExP models. Using these models, EI will perform ISS and SSP compatibility analyses, with the results documented in a Thermal Analysis Report. Also provided will be sets of MERAT data.

Simplified payload geometric math models should be limited to 25 surfaces and be in TRASYS submodel format.

Simplified payload thermal math models should be limited to 50 nodes and be in SINDA/FLUINT submodel format.

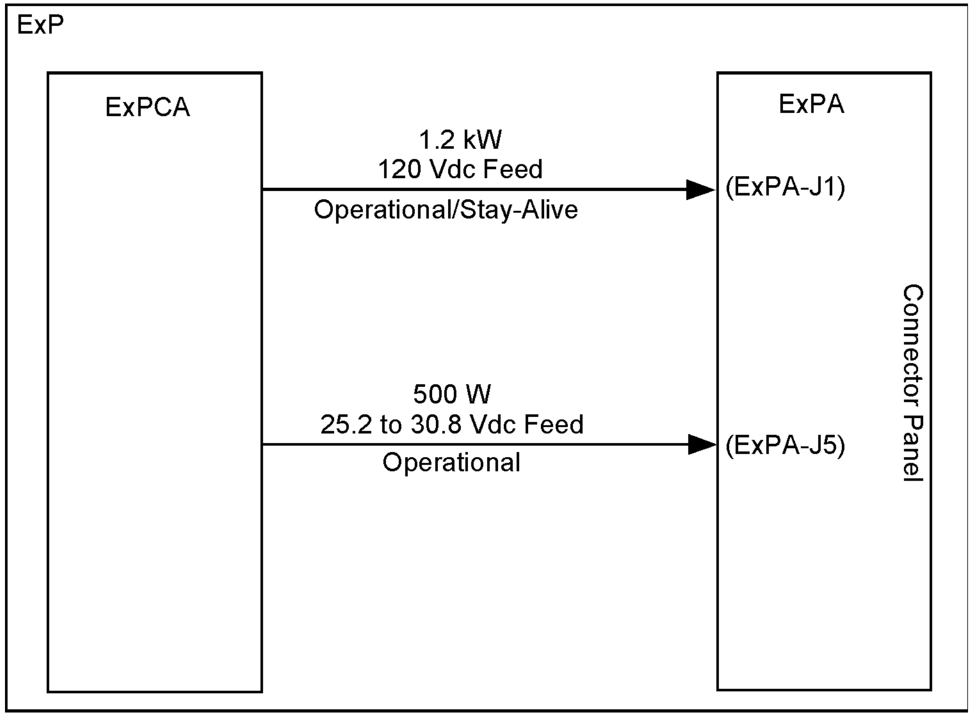
For additional information on this process/schedule, see Appendix C, Table C-I, Thermal.

4.3 ExP ELECTRICAL POWER ACCOMMODATIONS

4.3.1 Electrical Interfaces

4.3.1.1 Operational/Stay-Alive Power (Nominal Payload Operations)

The ExP provides one feed of 120-Vdc power and one feed of 28-Vdc power to each ExPA for nominal payload operations. The operational/stay-alive power feeds are derived from the ISS or Orbiter power sources and distributed to the ExPA locations via the ExPCA. The ExPCA provides the necessary isolation, conversion, switching, protection, and distribution of the ISS or Orbiter power provided for payload use. Figure 4-8 presents an



NOTES:

1. Identical power feeds are provided to each of six ExPAs.
2. 28-Vdc stay-alive power is not a standard ExP service.
3. 28-Vdc outputs (one per adapter) are selectable 20 A, 15 A, 10 A, and 5 A. Each ExPA location is limited to 500 W maximum.
4. 120-Vdc outputs (one per adapter) are selectable 10 A, 7.5 A, 5 A, and 1 A. Each ExPA location is limited to a 750 W maximum per load/operational constraint.
5. Stay-alive power (120 Vdc) may drop to a minimum (Min.) of 55 W per ExPA after a single-power-circuit failure. Stay-alive power requires ExPCA operation.

FIGURE 4-8 ExP POWER DISTRIBUTION SYSTEM OVERVIEW - OPERATIONAL/STAY-ALIVE POWER overview of the ExP operational/stay-alive power distribution system. SSP 52000-IDD-EPP provides further details concerning the current capability, protection features, and power quality characteristics of the operational/stay-alive power feeds.

4.3.1.2 Contingency Power (Off-Nominal Payload Operations)

The ExP provides one feed of 120-Vdc contingency power to each ExPA for payload use during ExPCA quiescence or in the event of an ExPCA failure. The ExPCA quiescent state may be invoked to conserve source power demands during certain mission objectives. An ExPCA failure is defined as any failure that renders the ExPCA inoperable and/or unable to control the nominal ExPA power feeds. Figure 4-9 shows the ExP contingency power distribution system. SSP 52000-IDD-EPP provides further details concerning the current capability, protection features, and power quality characteristics of the emergency power feeds. Operational constraints dictate non-activation of the ExPCA until installation at the final payload truss location; hence, contingency power serves as stay-alive power until ExPCA activation.

4.3.1.3 Orbiter 28-Vdc, Stay-Alive Power

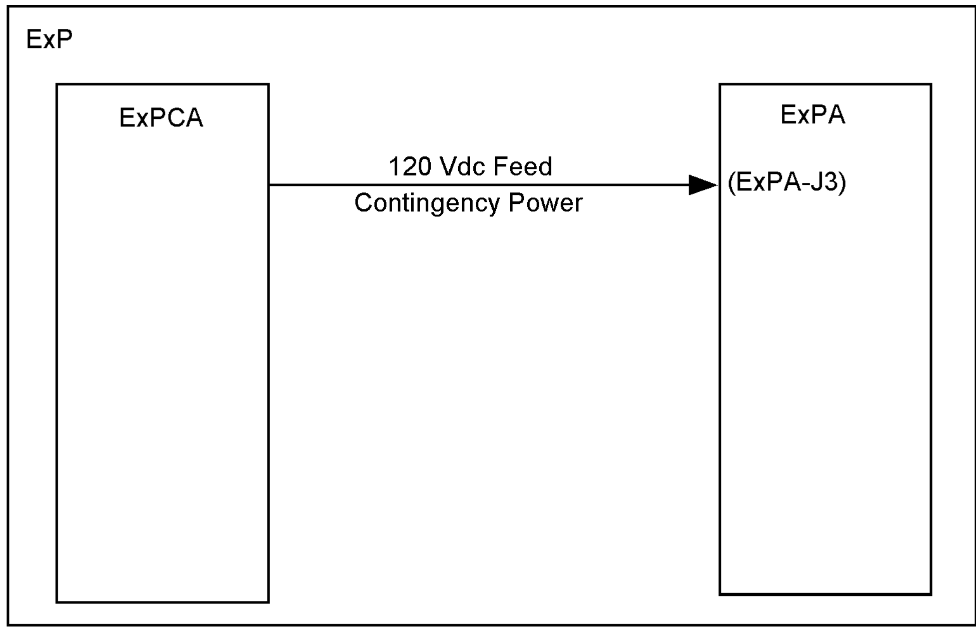
The ExP provides Orbiter 28-Vdc, stay-alive power for payload heaters. Power will be direct to the heaters. Figure 4-10 depicts an overview of the ExP 28-Vdc, stay-alive power provided to each of the adapters.

4.3.2 Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC)

All ExP mounted payload elements that use electrical power (including internal battery power) are required to demonstrate compliance with SSP 52000-IDD-EPP for EMC. Compliance with the EMC requirements defined in SSP 52000-IDD-EPP will ensure that the payload element is compatible with the electromagnetic emissions and susceptibility characteristics of the ExP and its payload complement while located on the ISS or in the Orbiter cargo bay.

4.3.3 Electrical Grounding/Bonding

The ExP provides for a structure that is free of hazardous fault currents while striving for an equipotential mounting surface free of noise currents and ground loops. In order to maintain this objective, the payload elements are required to adhere to the ExP grounding and bonding requirements defined in SSP 52000-IDD-EPP and Figure 4-11 of this document.



NOTES:

1. A contingency power feed is provided to each ExPA.
2. Contingency feeds are fuse-protected within the ExPCA to 2 A.
3. Contingency power feeds will be limited to 500 W total. Each load will be limited to 70 W.
4. Contingency power loads must be resistive.

FIGURE 4-9 ExP POWER DISTRIBUTION SYSTEM OVERVIEW - CONTINGENCY POWER

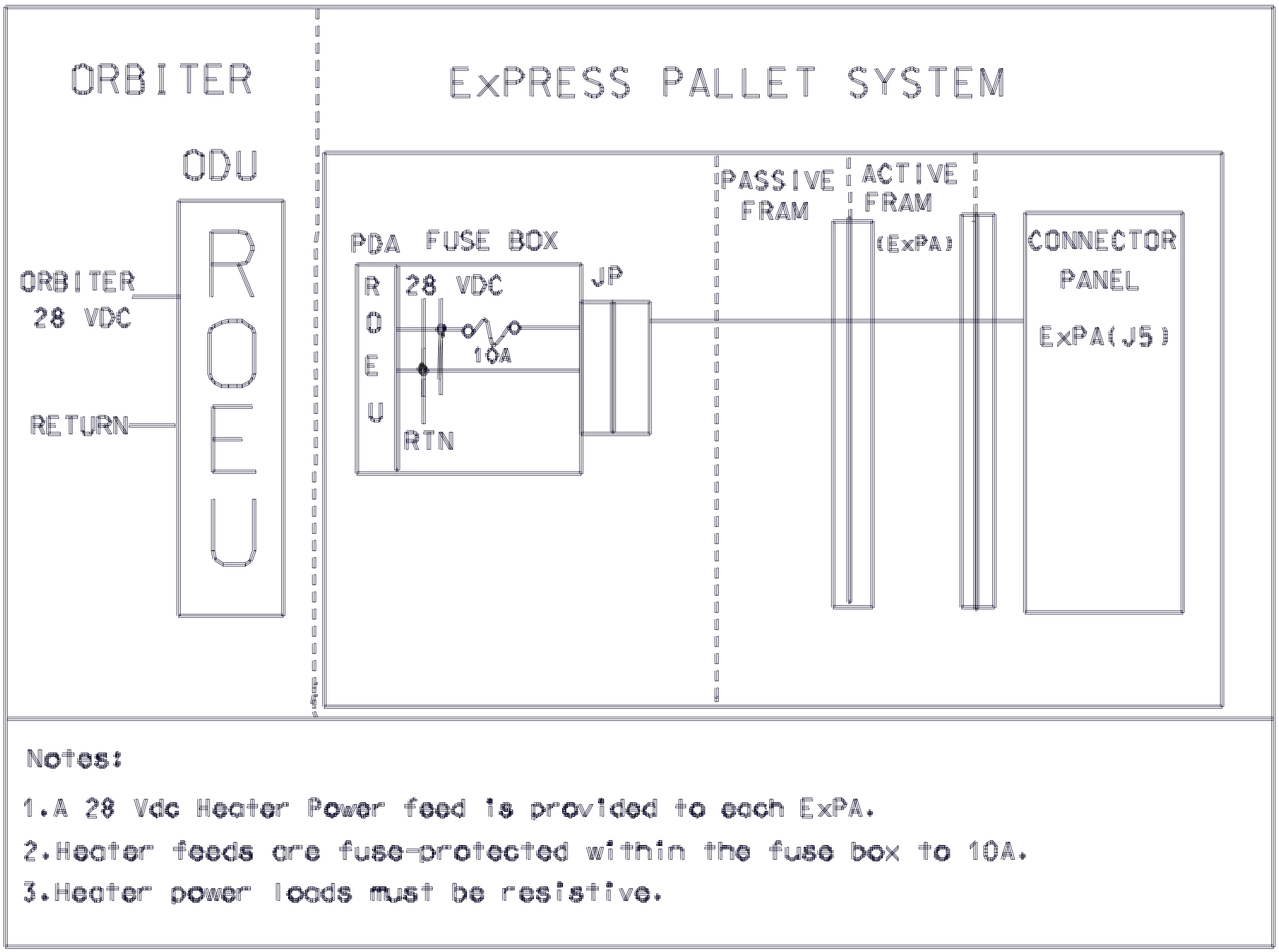


FIGURE 4-10 ExP 28-Vdc ORBITER STAY-ALIVE POWER DISTRIBUTION SYSTEM OVERVIEW

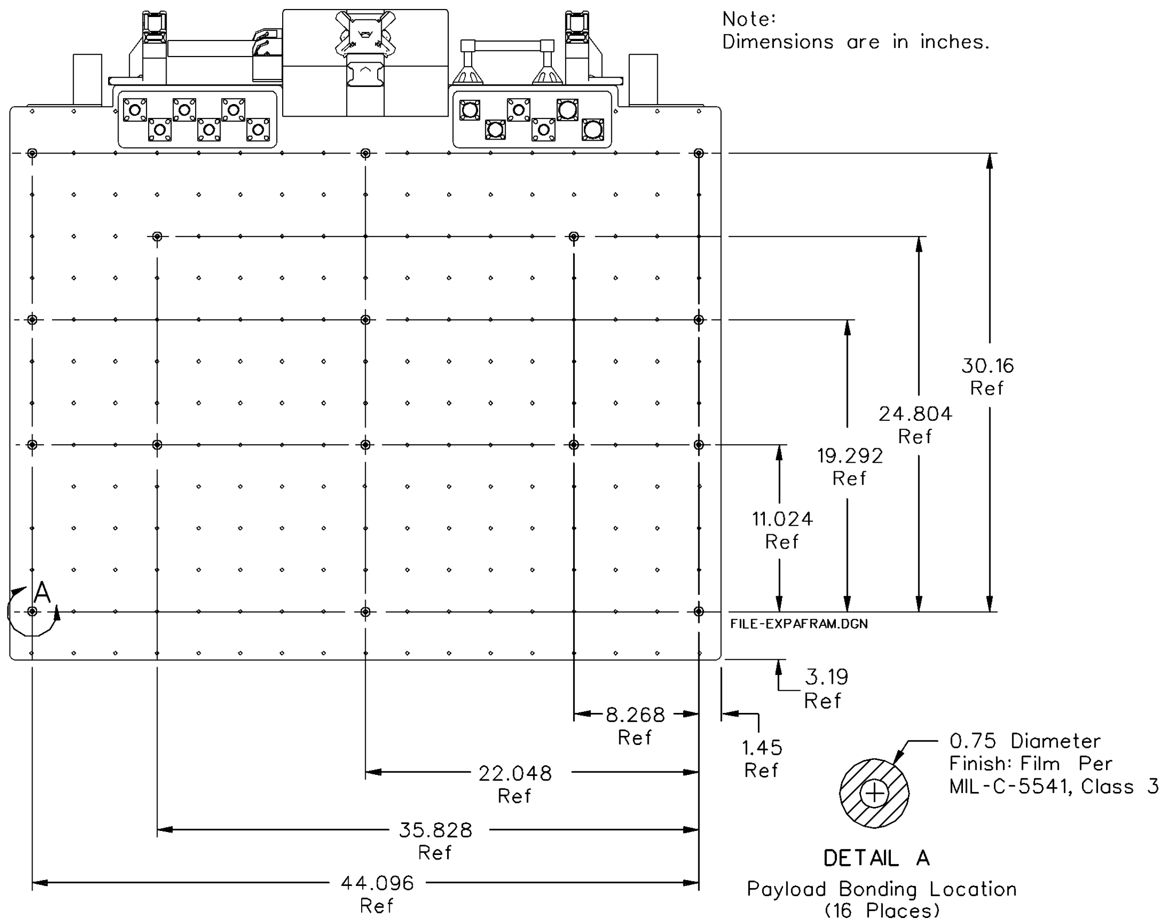


FIGURE 4-11 ADAPTER BOND STRAP ATTACHMENT POINTS

4.3.4 Electrical Power

The ExP provides a maximum of 2.5 kW of combined 120-Vdc/28-Vdc electrical power for the entire payload complement during operational mission phases. The maximum power available to an individual payload will be timelined based on the functional objectives of co-manifested ExP mounted payloads. Table 4-V provides an overview of the standard ExP mounted payload power allocations during the various mission phases.

4.3.5 Cables/Connectors

Electrical power and data interface provisions are available via the ExPA connector panels located as shown in Figures 4-4 and 4-5. Table 4-VI provides a general definition of

TABLE 4-V PAYLOAD POWER ALLOCATION

ExP LOCATION	SUPPORTED POWER MODE	AVAILABLE PAYLOAD VOLTAGE	STD ALLOCATION PER ExPA
Orbiter Bay[3, 4, 7]	Stay-Alive	28 Vdc	285 W
SRMS/SSRMS	No Power Available		
MCAS[4]	Contingency[5]	120 Vdc	206 W
	Operational/Stay-Alive	No Power Available	
Truss Site ISS	Operational/Stay-Alive[1, 2]	28 Vdc	166 W
		120 Vdc	416 W
	Contingency[6]	120 Vdc	70 W

NOTES:

1. The standard operational/stay-alive power allocation per ExPA is derived by dividing the maximum ExP mounted payload resource by six. Additional power supplied to any individual ExPA must be negotiated and will be subject to ISS operational timelining of the co-resident ExP mounted payloads. The ExPS can distribute up to 1 kW of 28-Vdc power and up to 2.5 kW of 120-Vdc power. Total operational power (120 Vdc and 28 Vdc) is 2500 W. Operational constraint limits 120-Vdc power to any ExPA location to 750 W maximum.
2. Truss site stay-alive power (120 Vdc) may drop to a minimum of 55 W per ExPA after a single-power-circuit failure, except when precluded by higher-priority ISS operations. (Stay-alive power requires ExPCA operation.) Total power provided to all payloads will be limited to 330 W (55 W per ExPA).
3. No power is available during Orbiter ascent, descent, and ferry phase. Stay-alive power will be provided post-ascent, but may be subject to timelined outages during certain Orbiter payload deployment objectives.
4. Operational power levels are not supported in the Orbiter or at the ISS MCAS location. Orbiter-controlled, 28-Vdc, stay-alive power and ISS-controlled, 120-Vdc contingency power, via MCAS and ExPS, will be provided in these locations.
5. MCAS contingency voltage is derived via ExPS from MCAS 120 Vdc, 12 A, 1440 W and is limited to heater power.
6. Contingency power derived from the ISS auxiliary or main power inputs is limited to 70 W per operational constraint (2 A per feed).
7. Stay-alive power within the Orbiter bay via the ExPS is limited due to thermal considerations and operational constraints.

TABLE 4-VI ExPA CONNECTOR INTERFACE DEFINITION (Sheet 1 of 5)

ExPA CONN DES (NOMENCLATURE)	ExPA CONNECTOR TYPE (RECOMMENDED PL MATING CONN)	CONTACT POSITION	CONNECTOR CONTACT SIZE	SIGNAL DEFINITION	RECOMMENDED WIRE TYPE	REMARKS
ExPA-J1 (120-Vdc Power) Power Panel	NATC00T15N4SN (NATC06G15N4PN)	A	12	120-Vdc Power	NGPW-ETF-12A per SSQ21656	
		B	↑	120-Vdc Return		
		C	↓	Chassis Return		
		D	12	NC		
ExPA-J2						Spare
ExPA-J3 (120-Vdc Contingency Power) Power Panel	NATC00T11N98SN (NATC06G11N98PN)	A	20D	120-Vdc Contingency Power	NGPW-ETF-22 per SSQ21656	
		B	↑	120-Vdc Contingency Return		
		C		NC		
		D		NC		
		E	↓	NC		
		F	20D	NC		
ExPA-J4						Spare
ExPA-J5 (28-Vdc Power) Power Panel	NATC00T17N6SN (NATC06G17N6PN)	A	12	28-Vdc Power	NGPW-ETF-12A per SSQ21656	
		B	↑	28-Vdc Return		
		C		Chassis Return		
		D		28-Vdc Heater Power		
		E	↓	28-Vdc Heater Return		
		F	12	NC		
ExPA-J6						Spare

TABLE 4-VI ExPA CONNECTOR INTERFACE DEFINITION (Sheet 2 of 5)

ExPA CONN DES (NOMENCLATURE)	ExPA CONNECTOR TYPE (RECOMMENDED PL MATING CONN)	CONTACT POSITION	CONNECTOR CONTACT SIZE	SIGNAL DEFINITION	RECOMMENDED WIRE TYPE	REMARKS
ExPA-J7 (ANALOG INSTM) Data Panel	NATC00T11N35PN (NATC06G11N35SN)	1	22D	ANLG CH1 (+)	NGPC-ETF-22-2SJ per SSQ21656	Overall shield required for cable assembly
		2		ANLG CH1 (-)		
		3		ANLG CH2 (+)		
		4		ANLG CH2 (-)		
		5		ANLG CH3 (+)		
		6		ANLG CH3 (-)		
		7		NC		
		8		NC		
		9		NC		
		10		NC		
		11		NC		
		12		NC		
		13	22D	NC		
ExPA-J8 (ANALOG INSTM) Data Panel	NATC00T11N35PA (NATC06G11N35SA)	1	22D	ANLG CH4 (+)	NGPC-ETF-22-2SJ per SSQ21656	Overall shield required for cable assembly
		2		ANLG CH4 (-)		
		3		ANLG CH5 (+)		
		4		ANLG CH5 (-)		
		5		ANLG CH6 (+)		
		6		ANLG CH6 (-)		
		7		NC		
		8		NC		
		9		NC		
		10		NC		
		11		NC		
		12		NC		
		13	22D	NC		

TABLE 4-VI ExPA CONNECTOR INTERFACE DEFINITION (Sheet 3 of 5)

ExPA CONN DES (NOMENCLATURE)	ExPA CONNECTOR TYPE (RECOMMENDED PL MATING CONN)	CONTACT POSITION	CONNECTOR CONTACT SIZE	SIGNAL DEFINITION	RECOMMENDED WIRE TYPE	REMARKS
ExPA-J9 (Discrete INSTM) Data Panel	NATC00T11N35PB (NATC06G11N35SB)	1	22D	DISC I/O CH1 (+)	NGPC-ETF-22-2SJ per SSQ21656	Overall shield required for cable assembly
		2		DISC I/O CH1 (-)		
		3		DISC I/O CH2 (+)		
		4		DISC I/O CH2 (-)		
		5		DISC I/O CH3 (+)		
		6		DISC I/O CH3 (-)		
		7		NC		
		8		NC		
		9		NC		
		10		NC		
		11		NC		
		12		NC		
		13	22D	NC		
ExPA-J10 (Discrete INSTM) Data Panel	NATC00T11N35PC (NATC06G11N35SC)	1	22D	DISC I/O CH4 (+)	NGPC-ETF-22-2SJ per SSQ21656	Overall shield required for cable assembly
		2		DISC I/O CH4 (-)		
		3		DISC I/O CH5 (+)		
		4		DISC I/O CH5 (-)		
		5		DISC I/O CH6 (+)		
		6		DISC I/O CH6 (-)		
		7		NC		
		8		NC		
		9		NC		
		10		NC		
		11		NC		
		12		NC		
		13	22D	NC		

TABLE 4-VI ExPA CONNECTOR INTERFACE DEFINITION (Sheet 4 of 5)

ExPA CONN DES (NOMENCLATURE)	ExPA CONNECTOR TYPE (RECOMMENDED PL MATING CONN)	CONTACT POSITION	CONNECTOR CONTACT SIZE	SIGNAL DEFINITION	RECOMMENDED WIRE TYPE	REMARKS
ExPA-J11 (1553/Ethernet) Data Panel	NATC00T13N35PN (NATC06G13N35SN)	2	22D	1553/RT1-A (+)	NDBC-TFE-N-22-2SJ-75	Maximum cable length shall be 10 ft; wire pair characteristic impedance: 75 ±15 ohms
		3		1553/RT1-A (-)		
		4		NC		
		5		1553/RT1-B (+)		
		6		1553/RT1-B (-)		
		9		TD (+)	10 Base-TX SSQ 21655 NDBC-TFE-N-22-2SJ-100	Wire pair characteristic impedance: 100 ±15 ohm; terminate shields to both connector ends.
		10		TD (-)		
		11		NC		
		12		RD (+)		
		13		RD (-)		
		1		RT1 - Address Line 1 RTN	SSQ21656 NGPC-ETF-22-2SJ	Note: Payload(s) location will facilitate the RT addresses for each payload.
		7		RT1 - Address Line 4 RTN		
		8		RT1 - Address Line 5 RTN		
		14		RT1 - Address Line 1 (ADDR. LSB)		
		15		RT1 - Address Line 2		
		16		RT1 - Address Line 3		
		17		RT1 - Address Line 4		
		18		RT1 - Address Line 5 (ADDR. MSB)		
		19		RT1 Address Parity RTN		
		20		RT1 Address Line 3 RTN		
		21		RT1 Address Line 2 RTN		
		22	22D	RT1 Address Bit Parity		

TABLE 4-VI ExPA CONNECTOR INTERFACE DEFINITION (Sheet 5 of 5)

ExPA CONN DES (NOMENCLATURE)	ExPA CONNECTOR TYPE (RECOMMENDED PL MATING CONN)	CONTACT POSITION	CONNECTOR CONTACT SIZE	SIGNAL DEFINITION	RECOMMENDED WIRE TYPE	REMARKS
ExPA-J12 (1553/Ethernet) Data Panel	NATC00T13N35PA (NATC06G13N35SA	2	22D	1553/RT2-A (+)	NDBC-TFE-N-22-2SJ-75	Maximum cable length shall be 10 ft; wire pair characteristic impedance: 75 ±15 ohms
		3		1553/RT2-A (-)		
		4		NC		
		5		1553/RT2-B (+)		
		6		1553/RT2-B (-)		
		9		TD2 (+)	10 Base-TX SSQ 21655 NDBC-TFE-N-22-2SJ-100	Wire pair characteristic impedance: 100 ±15 ohm; terminate shields to both connector ends.
		10		TD2 (-)		
		11		NC		
		12		RD2 (+)		
		13		RD2 (-)		
		1		RT2 - Address Line 1 RTN	SSQ21656 NGPC-ETF-22-2SJ	Note: Payload(s) location will facilitate the RT addresses for each payload.
		7		RT2 - Address Line 4 RTN		
		8		RT2 - Address Line 5 RTN		
		14		RT2 - Address Line 1 (ADDR. LSB)		
		15		RT2 - Address Line 2		
		16		RT2 - Address Line 3		
		17		RT2 - Address Line 4		
		18		RT2 - Address Line 5 (ADDR. MSB)		
		19		RT2 Address Parity RTN		
		20		RT2 Address Line 3 RTN		
		21		RT2 Address Line 2 RTN		
		22	22D	RT2 Address Bit Parity		

the ExPA connector interface provisions. Additional detailed connector interface definitions are defined in SSP 52000-IDD-EPP.

4.3.6 Electrical Process

4.3.6.1 Payload-Unique ICD Inputs

Inputs to the payload-unique ICD data set are to be provided by the PD in accordance with Appendix C and will include payload electrical interface characteristics such as:

A. Mating connector part numbers and pin assignments

B. Power requirements during the various mission phases

C. Grounding diagrams

D. Load characteristics.

4.3.6.2 Payload Electrical Drawings

In accordance with Appendix C, the PD will be required to submit a complete set of electrical drawings via PDL in the Configuration Data Set. The drawings should be supplied as 3D CAD files in a .DXF, .DGN, IGES or PRO/E format and should include the following:

A. Cable Interconnect Diagram: The PD will provide a diagram illustrating the interconnection of the payload-provided cables on the ExPA. The diagram will indicate the cable designations, connector reference designators, cable lengths, and the EMI/EMC classification of each cable or cable branch.

B. Electrical Schematics: The PD will be required to provide an electrical schematic(s) of the integrated payload element. As a minimum, the schematic(s) should provide details concerning the power input circuitry/wiring of the integrated payload element relative to the interfaces with the ExPA connector panels. The schematics should include:

   (1) The planned interfaces with the ExPA connectors, including connector pin functions

   (2) Wire sizes and types between the ExPA interface connectors and the integrated payload element

   (3) Power input switching and protection circuitry within the payload element, where applicable.

C. Grounding Diagram: The PD will be required to provide a diagram detailing the electrical grounding characteristics of the integrated payload system.

4.3.6.3 Final Analysis and Test Reports

Electrical and EMI/EMC final analyses and test reports are due in accordance with Appendix C to support closure of verification items defined in the Payload Verification Plan (PVP).

4.4 COMMAND AND DATA HANDLING (C&DH) SYSTEM HARDWARE INTERFACES

The ExP facility contains the ExPCA, which provides all C&DH interfaces for payload use. These ExPCA interfaces to the ISS C&DH and payload C&DH are depicted in Figure 4-12. Bi-directional health and status communication and science telemetry downlink to the ground facilities is through this equipment item. There are no hardwired Caution and Warning (C&W) interfaces to the ISS available directly to ExP mounted payload. The payload C&W interfaces will be via the ExPCA MIL-STD-1553 health and status/safety interface to the PEP.

The ExPCA is the communications routing equipment that provides data management services. The ExPCA has an interface to the ISS MIL-STD-1553 payload local bus for health and status, safety-related parameters, low-rate telemetry, commands, files, request responses, broadcast timing, and ancillary data. The ExPCA also provides an interface to the ExP mounted payloads for analog/discrete telemetry data collection and for discrete output commanding. The ExP Ethernet LAN allows payloads to communicate to the ExPCA for downlink of the payload science data via the ISS HRDL. Downlink of this data will be a timelined resource as this is a finite capability on Station.

Upon ExPCA request, the payload will send health and status/safety data to the ExPCA. The ExPCA will expect to receive each payload’s health and status data at a rate of once per second per the formats and protocol requirements of SSP 52050.

4.4.1 MIL-STD-1553 Communications

The ExPCA provides two dual redundant (Bus A and Bus B) MIL-STD-1553 interfaces to each ExPA location. All communications from the ExPCA to the ExPA will be via the 1553 interface(s). All health and status data and low-rate telemetry data from the ExPA will be sent over the 1553 interface(s) to the ExPCA.

For each 1553 interface used, the payload must supply five address lines, one return line for each address select line, one parity input, and a return for the parity input for RT address selection. The payload RT address will be determined by its physical location on the

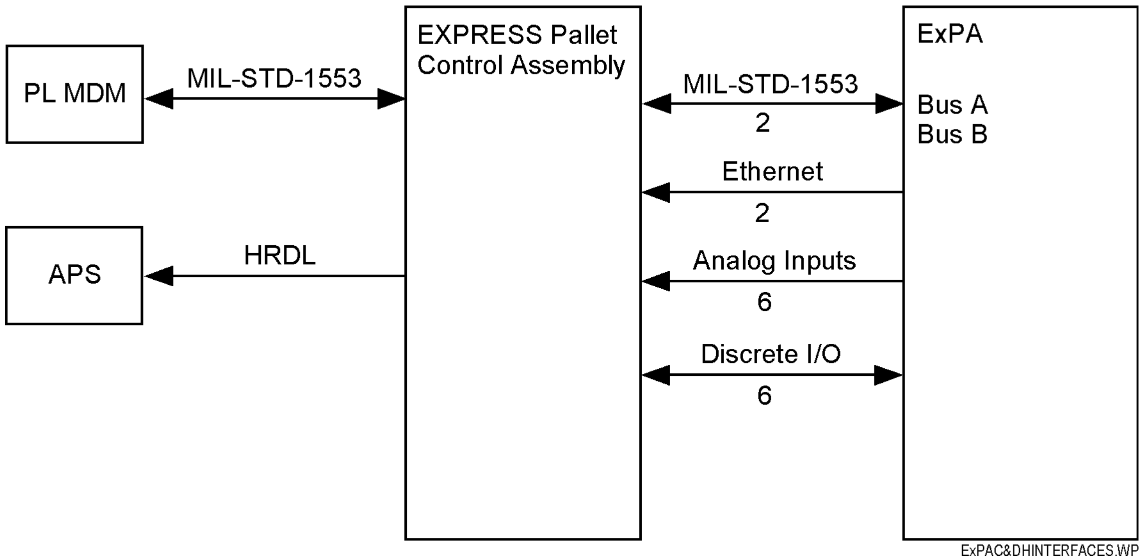


FIGURE 4-12 ExPA PAYLOAD C&DH INTERFACES

ExPA and the ExPA's location on the ExP. The payload RT address will be defined by the appropriate combination of the five address select inputs and parity input for each 1553 interface used. Each of the return lines will be connected to the payload's secondary ground. The payload will also incorporate internal, pull-up resistors for the five address select lines and parity inputs for each 1553 interface used. These pull-up resistors will be used to provide the necessary isolation.

The PD must understand that the 1553 interfaces are a shared ISS resource, not just an ExP resource. PDs must identify the requirements for the use of a single 1553 interface or both 1553 interfaces. These requirements should be identified as early as possible to inform POIF personnel of the resource needs for each payload.

4.4.2 Ethernet Communications

The ExPCA supports two common ISO/IEC 8802-3 10BASE-T communication protocol interfaces to each ExPA location. Through the ExPCA hub/gateway, payloads can downlink science data. Payloads will transmit data with a minimum of 400 bytes and a maximum of 1500 bytes per packet for the port-to-gateway data transfer for each ethernet interface used. The ethernet hub/gateway within the ExPCA is a shared resource for all payloads manifested on the ExP system. The ethernet data will be converted to a fiber-optic signal by the ExPCA and transmitted to the ground via the ISS HRDL in a timelined manner. The HRDL is a shared resource for all payloads aboard the ISS, not just the ExP mounted payloads.

PDs must identify their requirements for the use of a single ethernet interface or both ethernet interfaces. These requirements should be identified as early as possible to inform POIF personnel of the resource needs for each payload.

PDs must understand that all science telemetry downlinking is a timelined allocation. There are no guaranteed rates of data downlinking or time allotted for downlinking via the HRDL. This is an ISS system constraint. The payload must follow the timeline for the downlinking of science telemetry data. No handshaking will take place letting the payload know the system is up and working properly. If a payload wants to know equipment is working, the payload must request the information within the unique ancillary data submitted. The payload must also maintain a Real Time Clock or ask for Broadcast time within the ancillary data submitted.

It should be noted that data may not be recorded if any part of the ISS C&DH system fails. This is a priority issue as well as a memory constraint on the entire ISS system. It is recommended that a payload have its own buffer for memory storage in contingency cases, but this is not a requirement.

4.4.3 Analog Communications

The ExPCA provides the capability to input six analog signals from each of the ExPA locations. These inputs are configurable to be operated in either a current or voltage mode. Analog inputs are sampled at a 10-Hz rate by the ExPCA and are not configurable. The analog data is inserted into the health and status data at a 1-Hz rate and downlinked. The analog inputs may be a mixture of temperature and analog driver signals. The electrical characteristics of these inputs are defined in SSP 52000-IDD-EPP.

4.4.4 Discrete Communications

The ExPCA provides the capability for six bi-directional input/output discretes from each of the ExPA locations. The bi-directional discretes may also be used to detect switch closures. The bi-directional discretes are sampled at a 10-Hz rate. The sampling rate of the payload data by the ExPCA will be 1-Hz. The discrete data is inserted into the health and status data at a 1-Hz rate and downlinked.

The bi-directional discretes can be operated as low-level discretes (+5 V) or high-level discretes (+28 V). The discrete outputs may be operated as either a steady state or pulsed mode. Because the ExPCA is single-ended, the burden of isolation is placed on the payload. The electrical characteristics of these inputs/outputs are defined in SSP 52000-IDD-EPP.

4.4.5 C&DH Hardware Process

The payload flight C&DH hardware physical interfaces will be defined in a payload-unique ICD. This hardware interface definition will be submitted via the PDL. ExP EI will assess this data set and provide comments to the PD. See Appendix C, Payload C&DH Data Set and C&DH and Software tables for further details and due dates of these documentation deliveries.

KSC and Payload Operations Integration Center (POIC) ground hardware data interface services will be defined in the payload-unique ICD. These data interface requirements will be submitted via the PDL. For additional information on this process/schedule, see Appendix C, Table C-I, KSC Support Data Set and Ground Data Services Data Set.

4.5 C&DH SOFTWARE COMMUNICATIONS

4.5.1 ISS Portable Computer System

The ISS Portable Computer System (PCS) does not physically interface with ExP mounted payloads or the ExPCA. A software interface is provided via the ExPCA MIL-STD-1553 bus. This equipment is considered part of the ISS C&DH system. The use of this laptop must comply with the requirements of SSP 52052-IDD-PCS. This laptop is a shared ISS resource, so requirements need to be identified as early as possible.

4.5.2 ExPCA Software Interfaces

Figure 4-14 depicts the ExPCA software interfaces to the payloads. Table 4-VII summarizes the ExPCA direct interfaces that are connected to the payload equipment item. The list of services provided by these interfaces is shown in Figure 4-13. Additional information on Service Request can be found in SSP 52000-IDD-EPP. Figure 4-14 illustrates at a high level the end-to-end description of the command flows for a command from the PEP to the payload. The word “command” refers to messages/data sent to the payload. Figure 4-15 illustrates at a high level the end-to-end description of the request flows from a payload to the ExPCA. The word “request” refers to messages/data sent from the payload.

4.5.2.1 MIL-STD-1553 Software Interface

Each of the two MIL-STD-1553 dual-redundant interfaces at each ExPA location, provides the payload with the capability to monitor and control their equipment. Health and status telemetry, commands, ancillary data, file transfers broadcast timing, and service requests are processed through this interface via the ExPCA. Software data transfers over

TABLE 4-VII EXP MOUNTED PAYLOAD-RELATED EXPCA INTERFACE IDENTIFICATION

NAME	DESCRIPTION	INTERFACE TYPE
MIL-STD-1553	Status, service requests, health monitoring, ancillary data, file transfers, command and control	Software
Ethernet	High-rate science data downlink	Software
Analog Inputs	Temperature and preconditioned signal sensor inputs for status	Hardware
Discrete Inputs/Outputs	Control or status of payload systems	Hardware

this interface must contain the Consultative Committee on Space Data Systems (CCSDS) primary and secondary headers as defined in SSP 52050. ISS Broadcast Ancillary Data (BAD) parameters are available for payload use via this interface. These BAD parameters are defined in SSP 41175-02.

4.5.2.2 ExP Mounted Payload Ethernet Software Interface

Each of the two Ethernet interfaces are ISO/IEC 8802.3 10BASE-T compliant at each ExPA location. The Ethernet LAN provides the payload the capability to transmit science telemetry to the ground from their equipment. This interface is a mono-directional interface for science data downlink only; no uplink or ISS to payload transfers are possible via the Ethernet interface. Software data transfers over this interface must contain the CCSDS primary and secondary headers as defined in SSP 52050.

4.5.2.3 ExP Mounted Payload Analog Interface

These interfaces are hardware signals; however, the software definition is required for display of these inputs in the ISS C&DH system. The software interface definition for the six analog input signals from each of the ExPA locations must comply with the requirements of SSP 57002. These analog signals will be transmitted to the ISS C&DH system and are contained in the ExPCA MIL-STD-1553 health and status telemetry data stream.

4.5.2.4 ExP Mounted Payload Discrete Interface

These interfaces are hardware signals; however, the software definition is required for display and control of these inputs/outputs in the ISS C&DH system. The software interface definition for the six discrete input/output signals from each of the ExPA locations must comply with the requirements of SSP 57002. These discrete signals will be

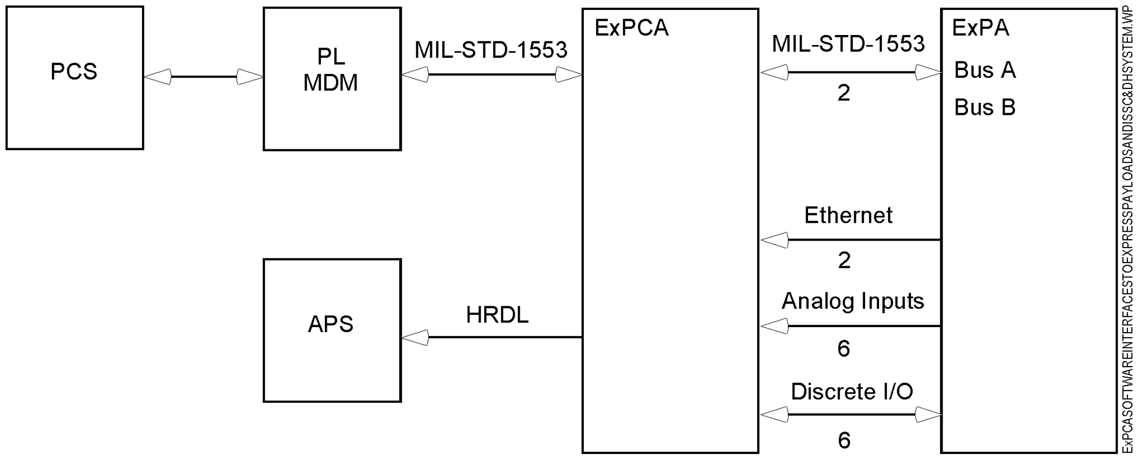


FIGURE 4-13 ExPCA SOFTWARE INTERFACES TO EXPRESS PAYLOADS AND ISS C&DH SYSTEM

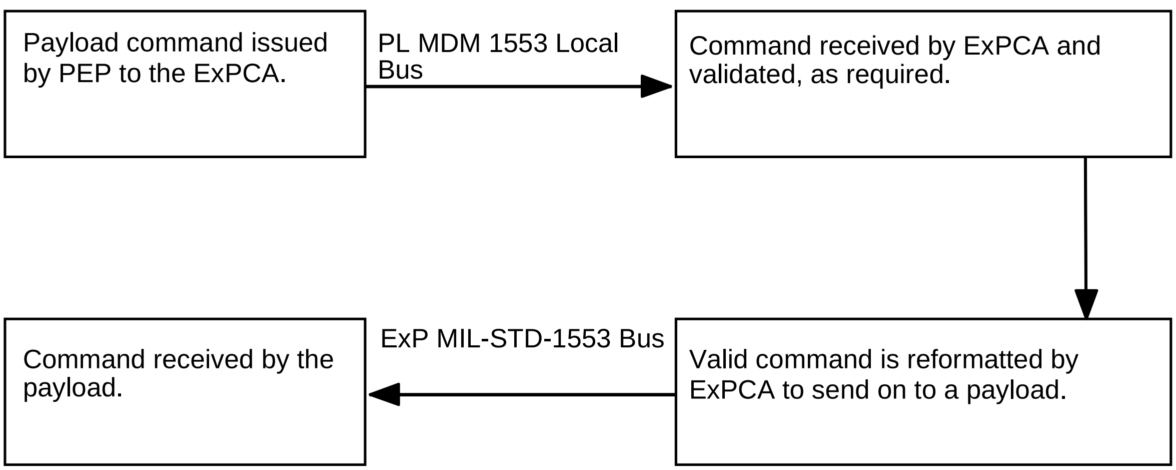


FIGURE 4-14 ExP MOUNTED PAYLOADS COMMAND FLOW

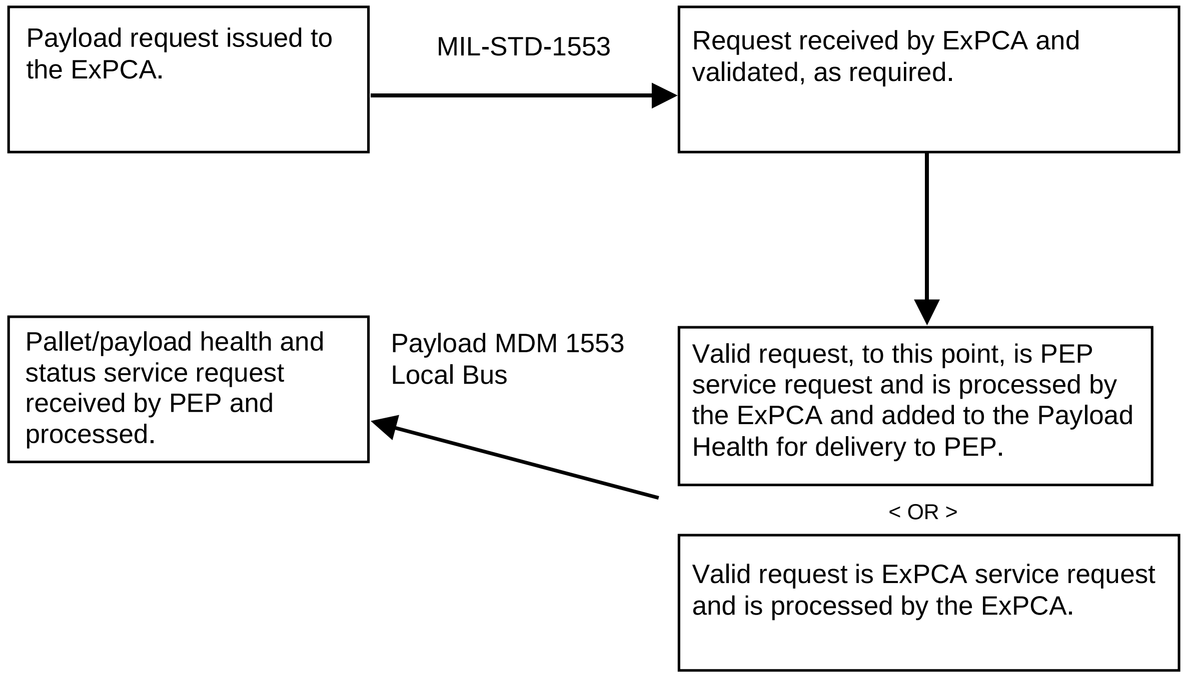


FIGURE 4-15 ExP MOUNTED PAYLOADS DATA REQUEST FLOW

transmitted/received to/from the ISS C&DH system and contained in the ExPCA MIL-STD-1553 health and status telemetry data/command streams.

4.5.3 ExP Mounted Payload ISS Displays

Generation of payload display requirements are the responsibility of the PD. There will be a common set of requirements for all computer displays in order to establish commonality for the flight crew. The requirements presented in this paragraph may be updated as the development of displays for the ISS subsystems and user facilities are developed. These displays must conform to the requirements of SSP 50005, paragraph 9.4.2.3.2. All PDs must use the Johnson Space Center (JSC) computer display style guides SSP 58700, Annex 5 Payload Display Review Panel Management Plan: US PODF Display Development Implementation Plan and SSP 58700 Annex 6, Payload Display Review Management Plan: US PODF Human Computer Interface Standards and Usability Guidelines in developing telemetry/command display requirements. The PD must submit the payload displays to the ISS program Display Review Panel for approval.

4.5.4 C&DH Software Process

The payload flight C&DH data set defines the software formats, telemetry data/command definitions, and on-board ISS data processing requirements. This C&DH

interface definition data will be submitted via the PDL. An integrated ExP mounted payloads compatibility assessment will be performed and provided to the PD. The integrated ExP C&DH data set will be provided to the PD for review. This integrated ExP C&DH data set will be baselined. An integrated flight C&DH data set will be provided to the PD for review. PDs will be required to verify their C&DH interfaces for ExP EI. For additional information on this process/schedule, see Appendix C, Table C-I, Software.

Payload data throughout allocations and data flow timeline requirements will be documented in the EPIA via the PDL. For additional information on this process/schedule, see Appendix C, Table C-I, EPIA.

KSC and POIC ground processing data services for the integration checkout of the integrated ExP will utilize the ISS C&DH data set. These ground data service requirements will be submitted via the PDL. For additional information on this process/schedule, see Appendix C, Table C-I, Software.

4.6 STRUCTURAL ANALYSIS

Structural analysis is required for verification of all payload flight equipment Safety-Critical Structures (SCS) and to demonstrate compatibility with the STS and ISS. All applicable failure modes must be evaluated (e.g., tension, bending, shear, torsion, buckling, crippling, bearing, etc.). The structural analysis will substantiate the structural integrity of each safety-critical detailed part of each piece of payload flight equipment. Structural analysis methodology is defined in Section 6 of SSP 52005.

All payload structure designs will also be submitted to an initial screening assessment to determine their fracture criticality. This initial screening will serve to disposition the various components for fracture criticality and for possible inclusion in a fracture-critical list. Designs shown to be contained/restrained, low released mass, low risk, or fail-safe can be dispositioned as non-fracture critical early in the process. All other parts are fracture-critical and subject to the analysis requirements in Section 6 and the Non-Destructive Examination (NDE) requirements in Section 7 of SSP 52005.

The PD will develop a structural verification process according to the requirements of the SSP 52000-PVP-EPP. The process will include the structural analysis and verification requirements as defined in SSP 52005. Upon approval by the Structures Working Group, PEI, and EI organizations, the structural verification plan will be adopted as the basis for all ExP structural analysis and verification. Payload design loads encompass the entire life cycle of the structure. Their definitions and applicability are defined in the following sections.

4.6.1 Payload Design Loads

During the transportation phase, each payload will be exposed to various structural loads. These include transient vibration, acoustic, random vibration, and quasi-static loads.

These loads vary depending on the carrier. Specific loads for the ExP are defined in SSP 52000-IDD-EPP. The loads are used in the design of hardware and as a basis of the structural analyses. Instructions and requirements for application of the loads are defined in SSP 52005. Use of worst-case loads will increase the flexibility of location assignments for the payload. The loads (combination of quasi-static, acoustic, transient vibration, and random vibration) can also be used to determine test levels for all structural testing.

Structural design loads for ExP and similar pallet-mounted carriers are calculated via application of design load factors to Finite Element Models (FEM) of the component and/or pallet structure. The load factors, applied either simultaneously or independently as indicated, represent multiples of gravity. Load factors for ExPA are defined in SSP 52000-IDD-EPP. The product of a given directional load factor and the component weight is an applied inertial force in that direction at the appropriate CG location. Payload/component weights are defined in the Mass Properties Report, which is issued by the ExP Project based on data supplied by the PD. The sum total of all inertial forces on a given payload for a given design condition represents the input loads to be transferred to the carrier interface in the form of interface shear, moment, and axial load reactions.

Load cases to be examined include launch (transient vibration, random vibration, acoustically induced loads), abort landing, normal landing, emergency landing, Quasi-Static Loads (QSLs), acoustic-induced loads, and EVR/EVA-induced on-orbit loads. Thermal effects are especially important in the on-orbit configuration. The effects of thermally induced loads from differential thermal expansion/contraction must be combined with induced static and dynamic loads in evaluating pallet structural integrity. Payloads must be able to withstand the maximum cargo bay ascent and descent pressure decay rates as specified in NSTS 21000-IDD-ISS, paragraph 10.6.1. Design load cases and thermal environments are defined in SSP 52000-IDD-EPP for ExP.

Until the overall carrier missions are better defined, the quasi-static and random vibration load factors defined in SSP 52000-IDD-EPP are to be applied to all pallet-mounted equipment and carriers.

4.6.1.1 Vibration Frequency Requirements

Payload flight equipment mounted directly to the ExP is required to have minimum natural frequency greater than 35 Hz. The intent of this requirement is to preclude dynamic coupling with the primary vibration modes of the Orbiter structure during launch and landing. Verification of this requirement will require the PD to provide preliminary dynamic models of the payload structure. These models will be included in an integrated ExP model to be developed by the EI organization.

4.6.1.2 Structural Modeling Requirements

Structural verification analysis of the ExP is performed using the NASA Structural Analysis (NASTRAN) computer program. The EI will combine all component models up to the increment level. Therefore, NASTRAN or NASTRAN-compatible FEM are required for use in the verification coupled loads analysis of the ExP payload complement. This approach ensures the compatibility of flight equipment assembly models with ISS and STS interface models for verification coupled loads. Details are given in SSP 52005, Section 6. The finite element models submitted for integration on the ExPAs for the Design Coupled Loads Analysis must meet the following requirements:

A. Model must be provided in English units, with length in inches and mass in pounds-mass (lbm).

B. ExPA interface locations in the models must be compatible with the 2.756 in. (70 mm) interface hole pattern.

C. Models provided in bulk data deck format must be NASTRAN [McNeal Schwendler (MSC), Computerized Structural Analysis Corporation (CSA), COSMIC, or equivalent], and must have less that 10,000 nodes for the total assembly to be mounted on one ExPA (e.g., if three components are mounted on one ExPA, then the sum of the nodes in all three models must be less than 10,000). Appropriate grid point reduction techniques [e.g., NASTRAN Analysis Set (ASET), OMIT)] may be employed to reduce the size of the models for more convenient manipulation.

D. Models provided in Craig-Bampton format must also include recovery transformation matrices [Acceleration Transfer Matrix (ATM), Load Transfer Matrix (LTM), Dynamic Transformation Matrix (DTM), etc.] to recover requested internal data. Craig-Bampton deliveries must also include maps identifying the rows and columns associated with the ExPA interface nodes and degrees of freedom, along with documentation of coordinate system orientation, weight and CG data, and normal modes analysis results.

E. Evidence of model validity must be provided with each model, including, as a minimum, rigid body modes checks and weight and CG comparisons. Each model must provide six constraint-free rigid body modes, plus one for each linkage or mechanism present. If more than six rigid body modes are present, provide justification for the additional rigid body modes. Additional model checks are encouraged.

F. Documentation must be provided with each model showing its location and orientation on the ExPA.

4.6.2 Launch and Landing Loads

ExP mounted payloads will be designed to withstand loads induced by Shuttle lift-off and landing events. These loads are grouped in two categories: low-frequency transient loads and random vibration loads. The low-frequency transients encompass those accelerations/vibrations with potential for coupling with primary Shuttle structural modes (frequencies less than 25 Hz). Random vibration loads are associated with higher frequency disturbances (25 Hz< f < 2000 Hz), which are more likely to couple with local payload/component vibration modes.

Low-frequency transient loads are given in SSP 52000-IDD-EPP, paragraph 4.2.2. The methodology for combining loads and evaluating lift-off and landing events is defined in SSP 52005, paragraphs 4.1.2 and 4.1.3.

Random Vibration Loads (RVLs) are given in SSP 52000-IDD-EPP, paragraph 4.4. The methodology for evaluating and combining RVL factors is given in SSP 52005, paragraphs 4.1.2 through 4.1.5.

4.6.2.1 Depressurization/Repressurization Loads

Payload structures containing sealed, semi-sealed, and vented volumes will be required to withstand worst-case depressurization environments associated with Space Shuttle cargo bay venting during launch. These structures will also be required to sustain maximum repressurization without damage. Depressurization/repressurization environments are defined in paragraph 4.9 of SSP 52000-IDD-EPP.

4.6.2.2 Pyrotechnic Shock

Equipment and payloads mounted on the ExPA must withstand pyrotechnic shocks transmitted from other payloads or Orbiter-mounted equipment. The ExPA interface shock spectrum is defined in Figure 4-3 of SSP 52000-IDD-EPP.

4.6.2.3 Ground-Handling Loads

Flight hardware that is shipped in a shipping container and has the potential to create a safety hazard if damaged during shipment will be required to withstand shipping and handling loads as defined in Table 4-VIII of SSP 52000-IDD-EPP. The payload will also be required to maintain positive margins of safety when subjected to the shipping container drop requirements defined in paragraph 4.1.1.2 of SSP 52000-IDD-EPP.

4.6.2.4 Acoustic Impingement Loads

During the lift-off and ascent phases, significant acoustic energy will be imparted to the payload hardware. Acoustic impingement is a concern only for payloads with large surfaces or low mass density. Examples are antennas, solar arrays, large shields, large thin-walled nonstructural covers, and components with thin membranes. As a rule of thumb, payloads having a surface area to weight ratio of 150 in^2/lb or greater are susceptible to acoustic impingement. Acoustic impingement loads are defined in SSP 52000-IDD-EPP, paragraph 4.8. The procedure for analyzing acoustic impingement loads is given in SSP 52005, Appendix C, paragraph C-1.4.1.

4.6.2.5 Coupled Loads Analysis (CLA)

CLAs are transient dynamic analyses of the integrated STS payload using coupled models of the STS and payload element, where the dynamic characteristics of the payload elements are coupled with their supporting structure and subjected to standard forcing functions. Forcing functions will be per NSTS 37329. A verification coupled loads analysis will be performed for each flight configuration using test-verified FEMs prior to flight for the final structural assessment of the flight configuration. Details are given in SSP 52005, Appendix C.

4.6.3 On-Orbit Loads

ExP mounted payloads will be designed to be safe in the applicable worst-case natural and induced on-orbit environments as specified in SSP 52000-IDD-EPP, paragraphs 4.6.5.1 through 4.6.5.6, for the on-orbit acceleration, vibration, and shock (plume impingement) environments. Loads induced by robotic capture, manipulation, and installation must also be considered in designing interfacing hardware. These loads are defined in SSP 52000-IDD-EPP, paragraphs 4.6.1 through 4.6.4.

4.6.3.1 Microgravity Disturbances

Some of the ISS pressurized payloads are sensitive to accelerations imposed by external sources. ExP mounted payloads constitute one of these external sources. Microgravity disturbances from ExP mounted payloads must not exceed the levels shown in paragraphs 4.1.2.1 through 4.1.2.3 of SSP 52000-IDD-EPP when measured at the ExPA Interface. Additional disturbances due to structure-borne acoustic transmission from the ExP mounted payloads will be limited to levels at the pressurized payload location(s) that are defined as part of the overall acoustic budget. There are no active or passive vibration isolation systems provided by ExP.

4.6.4 Structures Process

ExP EI requires submission of a structural verification methodology document from PDs. This document should define the plan for meeting the structural requirements in Section 4 of SSP 52000-IDD-EPP. Payload mass properties data should be submitted in accordance with MIL-HDBK-1811.

Preliminary dynamic models of the payloads are required. These FEMs will include all payload component details up to the ExPA interface. The FEMs should be submitted in NASTRAN-compatible format for incorporation by ExP EI into an overall ExP assembly model. The models should contain sufficient detail to enable identification of the high-gain vibration modes/frequencies of the payloads. Results will be used in preliminary structural assessments and to verify the 35-Hz minimum interface frequency requirements.

PD-supplied models will be used by ExP EI to perform design coupled loads analyses. Results of this analysis will be incorporated into an ExP structural assessment by ExP EI.

The PDs will supply test-verified FEMs to ExP EI. These models will be included in and integrated by ExP EI into an ExP model for use in the verification CLA.

Results of the CLA will be transmitted to the PDs for incorporation into the verification analysis as required. For additional information on this process/schedule, see Appendix C, Table C-I, Structures.

4.6.5 Microgravity Process

ExP EI requires submittal of dynamic models of the payload in their on-orbit configurations. These models must be submitted in NASTRAN-compatible format for incorporation by ExP EI into an ExP on-orbit model. The payload model should include all payload structure and components up to the ExPA interface.

Microgravity disturbance characteristics will also be supplied by the PDs. Disturbances will be defined via plots of microgravity versus frequency that define payload equipment-induced vibrations over the valid frequency range (0.1 to 300 Hz).

PDs will participate with ExP EI to perform microgravity disturbance analyses to evaluate the expected disturbance levels that will be transmitted to neighboring payloads.

Test-verified, on-orbit payload models will be required. These models will be used to derive test-verified microgravity disturbance characteristics. The final microgravity disturbance analysis using test-verified FEMs and test-verified disturbance characteristics will be generated to characterize this environment as accurately as possible.

For additional information on this process/schedule, see Appendix C, Table C-I, Microgravity.

4.7 ENVIRONMENTS

Each payload that utilizes the ExPS must consider the environmental conditions existing on the ISS, as well as the conditions existing aboard the Shuttle during transportation phases (ascent, on-orbit, and descent), in the design and development of the hardware. A PD must also consider the environments that a payload may be exposed to during ground processing, shipping to the launch facility, and ferry flight if a landing should take place at a location other than KSC. The ISS and attached payloads will be exposed to both natural and induced environments. Natural environments are those that occur naturally in the space atmosphere without the presence of the ISS, while induced environments are those that result as an effort of the presence of the ISS and other hardware. The definition of these environments in this section will allow the PD to produce hardware that will operate safely on the ISS with no effect on the performance of other payloads or the ISS.

All of the environmental conditions must be taken into account during the design of the payload. Those environmental conditions that affect the hardware performance are the responsibility of the PD. The PD will evaluate these environmental effects on performance parameters and take appropriate design measures deemed necessary.

The environment definition contained in this section may have some duplication of information contained in the various discipline sections; however, this duplication is necessary to adequately define the interface characteristics. One should review the technical information in each discipline section as well as this section. The following sections define the environments for various disciplines.

4.7.1 Atmospheric Environments

The environments identified below are the environments that a payload mounted on the ExP may be exposed to while attached to the ISS. The environments that the payloads will be exposed to during ascent, descent, and while mounted in the Orbiter cargo bay can be found in NSTS 21000-IDD-ISS.

Atmospheric environment requirements will be documented in the payload-unique hardware ICD. Data inputs for environments, with the exception of the external contamination requirements, will be accomplished through the payload verification process. The external contamination data input process is described in subsequent paragraphs.

4.7.1.1 External Contamination

Every effort will be made to maintain a clean environment for payload operation and minimize external contamination of the ISS and other payloads. External contamination can be reduced through the controlled venting on the ISS and limiting molecular deposition due to outgassing of materials. The ISS external contamination environment is defined in paragraphs 3.4 and 3.5 of SSP 30426, Space Station External Contamination Control Requirements.

It is intended to limit molecular deposition on the surfaces of payloads to 130 angstroms per year. One hundred angstroms of molecular deposition are reserved for non-quiescent events. The other 30 angstroms are reserved for molecular deposition during quiescent events. Molecular deposition depends on several factors, including temperature of source material, temperature of receiver material, and materials outgassing characteristics. If a payload has contamination sensitive surfaces, the developer should take precautions, such as designing the payload to have the sensitive surfaces not in direct line of sight of other payloads, use of contamination doors over sensitive optics, and heaters to keep the surfaces warm and limit deposition. It is also necessary, in order to maintain an acceptable environment for other payloads and the ISS, to limit the outgassing of payloads. The external contamination requirements for ExP mounted payloads are described in paragraph 10.2 of SSP 52000-IDD-EPP. The usage of high outgassing materials, such as silicones, must be limited in order to achieve acceptable outgassing rates so as not to affect other payloads or the ISS.

The data input and verification process for external contamination is accomplished by materials selection and modeling of the payload using the NASA Contamination Analysis (NASAN) modeling tool. NASAN is a model similar to NASTRAN and is used by EI to evaluate the integrated pallet to model the deposition on various surfaces, including the ISS. The preliminary and final listing of non-metallic materials that are exposed to space vacuum will be submitted by the PD to ExP EI. This listing should include the material trade name, generic name, weight, area exposed, maximum usage temperature of material, and outgassing rates as tested per ASTM-E1559 using the temperatures described in SSP 52000-IDD-EPP. A NASTRAN model of the hardware along with the ASTM-E1559 outgassing data will be submitted by the PD to ExP EI.

4.7.1.2 Humidity

Payloads may be exposed to humidity levels as high as 95 percent during ground processing and ferry flight as well as zero relative humidity while on-orbit. Condensation due to humidity may affect electronics and other sensitive equipment.

4.7.1.3 Atomic Oxygen

Atomic oxygen (AO) found in low Earth orbit is formed by ultraviolet radiation disassociating oxygen molecules. Payloads may be exposed to an AO fluence of 3.23 x 10^{22} atoms/in^2/year (5.0 x 10^{21} atoms/cm^2/year) while on-orbit. AO can result in degradation of coatings, platings, and other materials and reduce the optical properties of materials. AO, while most prevalent in the surfaces facing the ram direction, can react with any exposed surface. Further details on the atomic oxygen environment and selecting materials to limit the effects of AO can be found in NASA Publication TP-1999-209260.

4.7.1.4 Plasma

A plasma is a quasi-neutral gas of charged and neutral particles that exhibits collective behavior. Positive- and negative-charged particles will collect on payload surfaces and will tend to come to an electrical equilibrium such that zero net current is collected. As a result of this attempt to come to equilibrium, an arc may occur. This arc can degrade the optical properties of a payload. It is expected that the plasma environment on-orbit will have a maximum voltage differential of ±40 volts. The natural plasma environment for the ISS is discussed in greater detail in Section 5 of SSP 30425, and the induced plasma environment is defined in SSP 30420, paragraph 3.3.

4.7.1.5 Electromagnetic and Geomagnetic Fields

Natural magnetic fields will be experienced in Earth orbit. These include both the magnetic field generated by the Earth and the natural electromagnetic field that is found in space. These magnetic fields may inhibit communications and reduce the performance of electronic devices.

The natural on-orbit electromagnetic field environment that payloads will be exposed to is defined in SSP 30425, Section 7.

The natural magnetic field created by the Earth and to which payloads are exposed in low Earth orbit is defined in SSP 30425, Section 9.

4.7.1.6 Ionizing Radiation

Ionizing radiation can damage electronic parts. Payload developers should take precautions to ensure that their hardware is protected or “rad hardened” against the ionizing, radiation environment. Design guidance is provided in paragraph 10.4 of SSP 52000-IDD-EPP.

The ionizing radiation environment for the ISS is defined in SSP 30512. The Single Event Effects (SEE) radiation environment is also defined in SSP 30512.

4.7.1.7 Solar Ultraviolet Radiation

The solar ultraviolet radiation environment is described in SSP 30425, paragraph 7.2. Solar ultraviolet radiation may degrade the optical properties of payloads, which can result in loss of thermal protection.

4.7.1.8 Meteoroids and Orbital Debris

ExP mounted payloads will be exposed to the meteoroid and orbital debris environment as specified in SSP 30425, Section 8. Payloads in low Earth orbit will encounter micrometeoroid and orbital debris. The vast majority of the micrometeoroids and debris is less than 0.1 mm in diameter. Under normal conditions, these micrometeoroid and debris will not pose a threat to the hardware. However, payloads with stored energy devices must take precautions and perform analyses using modeling per TM 104825 to ensure that the hardware can withstand impacts from micrometeoroids and debris.

4.7.1.9 Gravitational Field

ExP mounted payloads on-orbit will be exposed to Earth’s gravitational field as defined in SSP 30425, Section 11.

4.7.1.10 Plume Impingement

ExP mounted payloads and exposed secondary structures (e.g., MLI) blankets should be designed to withstand the maximum effective normal and shear impingement pressures defined below:

A. Normal pressure, 3.42 psf

B. Shear pressure, 0.80 psf.

4.7.1.11 Thermal Environment

Thermal environments are defined in Table 4-IV of this document.

4.7.1.12 Structural Loads Environment

The structural loads environments are defined in paragraph 4.6 of this document.

4.8 MATERIALS USE AND SELECTION

Materials used in the construction of ExP mounted payloads that directly or functionally interface with the ISS, carriers, Orbiter, or a Space Shuttle carrier must meet the requirements of NSTS 1700.7, paragraphs 208.3 and 209 in their entirety, and NSTS 1700.7, ISS Addendum, paragraphs 208.3 and 209 in their entirety. Commercial Off-The-Shelf (COTS) parts used in payload hardware are also subject to these requirements. The materials and process requirements are provided in Section 13 of SSP 52000-IDD-EPP.

Materials should be selected based on design requirements, engineering properties, and material characteristics that could affect safety. The material characteristics that must be addressed per NSTS 1700.7 include Stress Corrosion Cracking, Materials Compatibility, and Flammability. The Thermal Vacuum Stability (TVS) characteristics of non-metallic materials must also be considered in the design. Polymeric materials should be selected that has a total mass loss of <1 percent and a volatile condensable mass of <0.1 percent when tested per the criteria of ASTM-E595 or equivalent.

Whenever possible, materials should be selected that have already been shown to meet the acceptance criteria for a particular characteristic. Existing test data are compiled in NASA's Materials and Processes Technical Information System (MAPTIS) electronic database. This database contains a rating system indicating materials acceptability based on that material's test data.

A hardcopy version of the MAPTIS database is published periodically as MSFC-HDBK-527/JSC 09604. The MAPTIS database is managed by the Materials, Processes, and Manufacturing Department at MSFC. Access to this database may be gained through a computer datalink and is available to qualified hardware developers. Contact the EI or MSFC Materials, Processes, and Manufacturing Department for access information.

4.8.1 Exterior Surface Cleanliness

The payload equipment exterior and accessible surfaces will be cleaned at KSC using solvents and equipment available at KSC (reference SSP 52000-PAH-KSC). If unique cleaning procedures are required, these may be negotiated and included in the payload-unique hardware ICDs. The payload surface cleanliness requirements are provided in paragraph 10.1 of SSP 52000-IDD-EPP.

4.8.2 Materials Review Process

ExP EI will require submission of a Materials Identification and Usage List (MIUL). This list will contain a listing of all materials utilized in the hardware design. Materials should be identified by drawing number, materials commercial name, manufacturer, weight, area, and using the rating system in the MAPTIS database or MSFC-HDBK-527. Materials are given a rating based on test results. For metallic materials, ratings are provided for stress corrosion; for nonmetallic materials, ratings are provided for flammability and thermal vacuum stability.

This list will be evaluated by EI, and a request may be made for a Material Usage Agreement (MUA) for those materials that have a non-A rating. MUAs are agreements between the PD and NASA to use a non-approved material for a specific usage application.

For additional information on this process/schedule, see Appendix C, Table C-I, Materials.

4.9 EXTRAVEHICULAR ROBOTICS/ACTIVITY

ExP mounted payloads will be transported from the Orbiter cargo bay to the truss location where they will reside, via EVR operations, as described in Section 3 of this document. The interfaces for these operations will be either the ExPA or the ExP itself. There are no planned robotic interfaces for the ExP mounted payloads themselves. It should be noted the importance for payloads to remain within the dimensional envelope as defined in paragraph 3.6.1 of SSP 52000-IDD-EPP to preclude an interference with the robots during transportation from the Orbiter to the truss location.

EVA is an unscheduled operation. No planned EVA is scheduled for ExP mounted payloads. Due to the possibility of an unscheduled EVA, strict adherence to the sharp-edge requirements defined in Section 3, SSP 52000-IDD-EPP, and induced EVA loads, as defined in Table 4-V of SSP 52000-IDD-EPP, is required.

4.10 SAFETY

ExP mounted payloads must be able to demonstrate compliance with applicable safety requirements during all phases of flight/mission. These requirements can be found in several sources, described in the following paragraphs. These documents establish the payload safety policy and requirements applicable to the Space Shuttle and ISS, including payload GSE. These documents are applicable to all new design and existing design (reflown and series) payload hardware, including GSE and ground launch site processing, launch and return, and on-orbit operations.

The PD/organization completes the hazard analyses of each payload and the presentation of their respective payload safety data to the Payload Safety Review Panel (PSRP). The satisfactory completion of the safety review process by each payload also becomes part of the payload complement safety certification. The timing of the individual payload safety reviews is a function of the payload development schedule and payload hardware maturity. Generic Safety Panel Review schedules are shown in Appendix C of this PAH. Safety packages and safety reviews will be performed at two levels: (1) individual payloads, for which the developer is responsible for creating a safety compliance data package and setting up a review schedule with the PSRP; (2) an integrated ExP review for which EI is responsible for development that includes an integrated assessment of hazards as they relate to crew, other payloads, carrier, ISS, and Orbiter through all phases, including ground processing and flight.

EI and payload operations analyze the design and operation characteristics of payloads relative to their potential effect on the crew, other payloads, ISS systems, and Orbiter. These analyses define potential hazards. The results of these analyses are presented to the PSRP and become part of the payload complement safety certification. The Flight Safety and Ground Safety Phase II payload safety reviews must be completed prior to L-24 months.

Payloads integrated onto the ExPAs and/or that have a direct physical or functional interface with the Space Shuttle carrier and/or ISS elements or carriers must comply with the applicable requirements contained in the following documents:

A. NSTS 1700.7, Safety Policy and Requirements for Payloads Using the Space Transportation System, is the primary source document that establishes the safety policy and requirements applicable for payloads using the STS. The requirements in this document are intended to protect flight and ground personnel, the Space Shuttle and either payloads, GSE, and the general public. The document contains technical and system safety requirements applicable to payloads that use the Space Shuttle.

B. NSTS 1700.7 ISS Addendum, Safety Policy and Requirements for Payloads Using the International *S*pace *S*tation, was prepared to expand and modify the existing NSTS 1700.7 requirements for payloads operating on or in the ISS. The Addendum was created to relate unique Space Station safety requirements to the users in a form that maintains continuity between the Shuttle and Space Station programs. The Addendum identifies unique, Space Station-only requirements as well as indicates which NSTS 1700.7 requirements are applicable to both the Shuttle and Space Station payloads. NSTS 1700.7 requirements that are not applicable to payloads during Space Station operations are also indicated.

C. NSTS 18798, Interpretations of NSTS/ISS Payload Safety Requirements, is a series of letters and memos, based primarily on PSRP experience, designed to provide interpretation and/or additional guidance to payload organizations of existing requirements in NSTS 1700.7.

D. KHB 1700.7, Space Shuttle Payload Ground Safety Handbook, provides the ground-handling safety policy and requirements for Space Shuttle (and Space Station) payloads and portable GSE design and operations at the launch site. These requirements are applicable to ISS payloads, from arrival at the launch site to lift-off and during post-landing activities. This document establishes the minimum NASA ground processing safety policy, criteria, and requirements for ISS payloads and associated payload organization-provided GSE, including detailed safety requirements for ground operations and payload/GSE design not contained in NSTS

1700.7. KHB 1700.7 does not address facility GSE, non-ISS/STS program elements, or flight safety.

E. NSTS 13830, Payload Safety Review and Data Submittal Requirements for Payloads Using the Space Shuttle and International Space Station, defines the safety review process and assists the payload organization in implementing the system safety requirements in Section 3 of NSTS 1700.7. It describes the initial contact meeting with the payload organization and defines the subsequent safety reviews necessary to comply with the system safety requirements of NSTS 1700.7 ISS Addendum and KHB 1700.7, which are applicable to payload design, flight operations, GSE design, and ground operations. The document also contains detailed instructions on payload safety analyses and safety assessment reports that document the results of the analyses.

F. SSP 52000-IDD-EPP, EXPRESS Pallet Payloads Interface Definition Document, is intended as a single-source design requirements document that payloads will comply with in order to certify an EPP for integration. These requirements are verified in accordance with the Generic Payload Verification Plan, SSP 52000-PVP-EPP. The IDD includes the physical, functional, and environmental design requirements associated with payload safety and interface compatibility. The requirements in this document apply to transportation and on-orbit phases of the payload cycle. It also forms the basis for payload-specific ICDs and payload verification requirements as defined in SSP 52000-PVP-EPP.

G. SSP 52005, ISS Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures, is a compilation of the structural design and verification requirements to be used by the PD to satisfy STS and ISS structural safety criteria. It is designed to provide a single, comprehensive set of structural design requirements for PDs to ensure successful compliance with safety requirements.

4.10.1 Safety Requirements

The safety requirements contained in the documents described in paragraph 4.10 apply to all payloads. When a requirement cannot be met, a noncompliance report must be submitted in accordance with NSTS 13830 for resolution.

Failure tolerance is the basic approach that shall be used to control most payload hazards. The payload must tolerate a minimum number of credible failures and/or operator errors determined by the hazard level. This criterion applies when the loss of a function or the inadvertent occurrence of a function results in a hazardous event:

A. Critical Hazards: Critical hazards are controlled such that no single failure or operator error can result in damage to STS or ISS equipment; a nondisabling personnel injury; or the use of unscheduled, safing procedures that affect the operations of the Orbiter, the Space Station, or another payload.

B. Catastrophic Hazards: Catastrophic hazards shall be controlled such that no combination of two failures or operator errors can result in the potential for a disabling or fatal personnel injury or loss of the Orbiter/ISS, ground facilities, or STS/ISS equipment.

When failure tolerance cannot be met (for practical or other reasons), hazards must be controlled by “Design to Minimum Risk” criteria. Examples include structures, pressure vessels, pressurized lines and fittings, pyrotechnic devices, mechanisms in critical application, material compatibility, flammability, etc. Hazard controls related to these areas are extremely critical and warrant careful attention to the details of verification of compliance on the part of the payload organization and the NSTS/ISS. Minimum supporting data and documentation requirements for these areas of design have been identified in NSTS 13830.

Payloads will also be required to be designed, when possible to be “Safe without Services,” where they must maintain fault tolerance or safety margins consistent with the hazard potential without ground or flight crew intervention in the event of sudden loss or interruption of Space Station-provided services. The payload must remain in a safe state until returned to operation by the ground or flight crew. Monitoring will be continued after service loss when feasible.

4.10.2 Payload Hazard Reports (PHR)

NSTS 13830 (Appendix A) provides instructions on completing a PHR. Although NSTS 13830 recommends use of JSC Form-542, other formats are allowed as long as the basic elements on JSC Form-542 are included. While this also applies to ISS payloads, it is highly recommended that payloads use the Form-542 format, as shown in Figure 4-16, because this is the format the PSRP is most accustomed to seeing, and it is organized with all the required elements.

4.10.3 Data Management System (DMS)

Payload safety data will be electronically submitted to the PSRP via the DMS. The DMS was developed to allow Payload Organizations (POs) to take advantage of electronic data submission capabilities, and to enhance the timely accessibility of payload safety data by the PSRP. Upon acceptance for review, payload safety data will become available to the PSRP members and technical support personnel. For security reasons, POs may access only their own data and other information specific to their data. To gain access to the DMS and/or obtain a login ID and password, POs should contact the JSC DMS administrators. Please note, that for the time being, hardcopies of Payload Safety Data Packages will also be required as part of a PO’s initial submittal to the PSRP per NSTS 13830.

PAYLOAD HAZARD REPORT			**NO.**
PAYLOAD:			**PHASE**
SUBSYSTEM:	**HAZARD GROUP:**		**DATE**
TITLE:			
APPLICABLE SAFETY REQUIREMENTS:			**HAZARD CATEGORY**
		☐	**Catastrophic**
		☐	**Critical**
DESCRIPTION OF HAZARD:			
HAZARD CAUSES:			
HAZARD CONTROLS:			
SAFETY VERIFICATION METHODS:			
STATUS OF VERIFICATION:			

APPROVAL	**PAYLOAD ORGANIZATION**	**STS**
PHASE I		
PHASE II		
PHASE III		

JSC Form-542

FIGURE 4-16 JSC FORM-542 FORMAT

4.11 VIEWING ENVIRONMENT

4.11.1 Introduction

Many ExP mounted payloads require an unobstructed viewing environment to achieve either the science, operations, or engineering objectives of the payload. Payload FOV requirements are usually defined in terms of conic or other geometric projections from the payload sensor, which is oriented at some azimuth, and elevation angle relative to the ISS analysis coordinate system. Obstructions to the payload's FOV can be classified as the ISS analysis coordinate system. Obstructions to the payload's FOV can be classified as near-field or far-field. Within these classifications, there are both fixed and moveable obstructions. Both the near-field and far-field FOV obstructions are described in the following paragraphs.

4.11.2 Near-Field FOV Obstructions

4.11.2.1 Near-Field, Fixed FOV Obstructions

The near-field, fixed obstructions for ExP-mounted payloads include structural hardware on the ExP, such as the longeron trunnion scuff plates and the robotic guides that separate the ExPA payloads. Other major near-field obstructions include adjacent ExP mounted payloads and the adjacent ExP or other attached payloads.

Near-field viewing obstructions for ExP mounted payloads are shown in Figures 4-17 and 4-18 of this document.

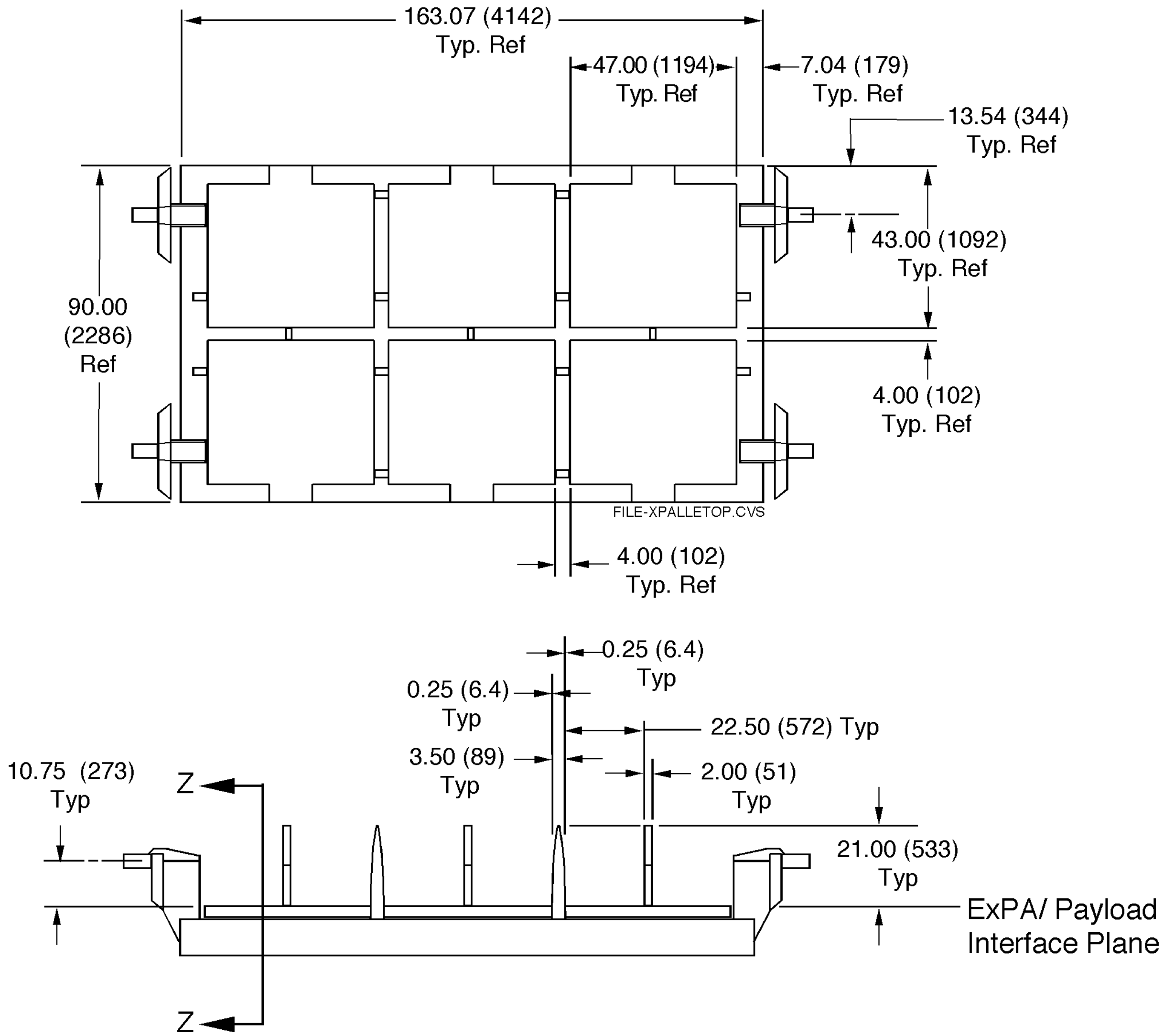
4.11.2.2 Near-Field, Moveable FOV Obstructions

Near-field, moveable FOV obstructions include moveable payload hardware on adjacent ExPAs and the adjacent ExP. They include robotic arms, antennas, or pointing and alignment devices on payloads. These FOV obstructions are unique to the payload complement for a given increment, and any exceedances to the ExP mounted payload envelope will have to be approved by the ISS Program. Payload envelope exceedances will be preplanned operations, and neighboring ExP mounted payloads will be informed about any permanent or intermittent payload envelope exceedances.

4.11.3 Far-Field FOV Obstructions

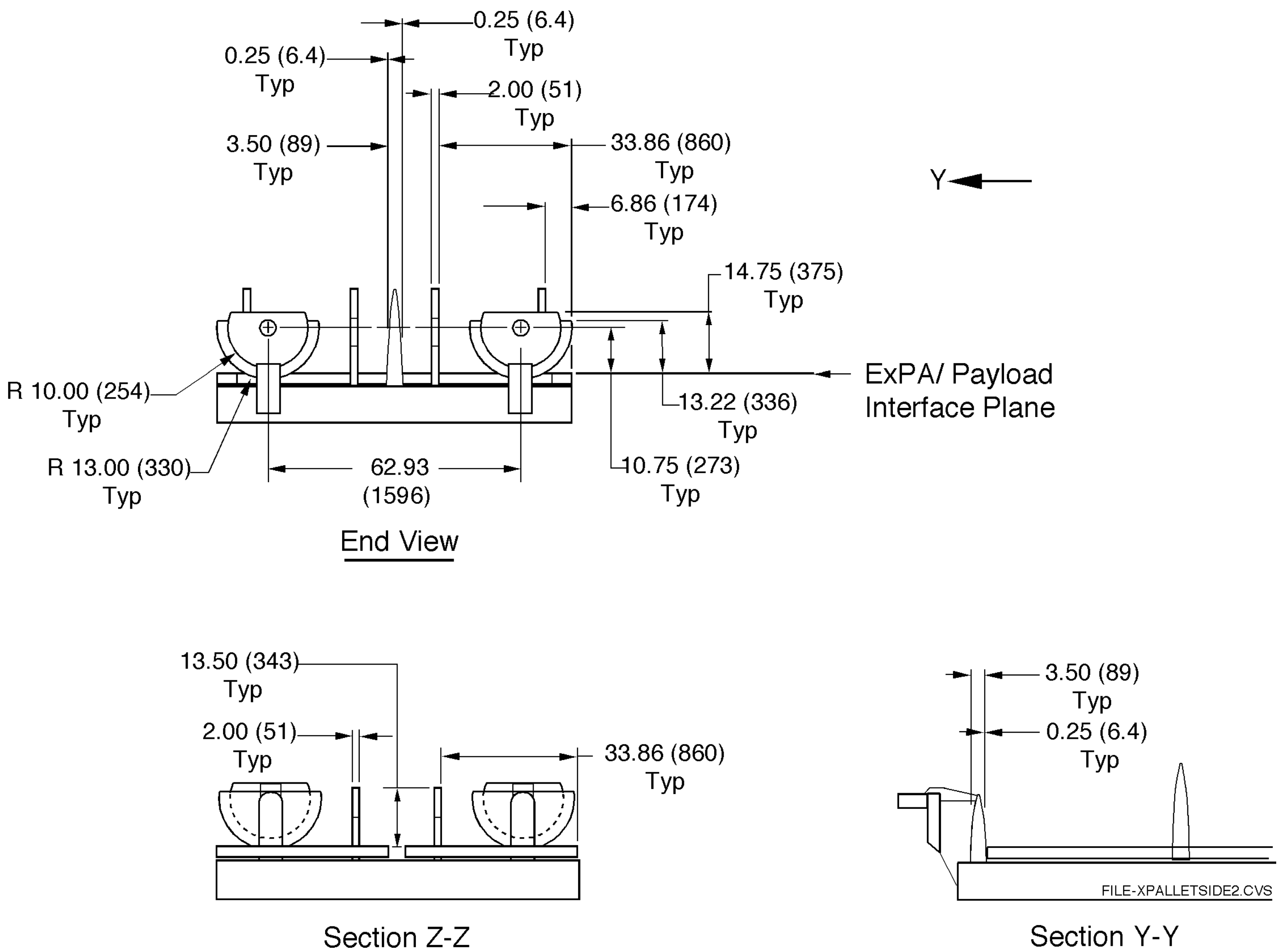
4.11.3.1 Far-Field, Fixed FOV Obstructions

Far-field, fixed FOV obstructions include major ISS elements, such as truss segments and pressurized modules. Simulated views from these ExP mounted payload positions are



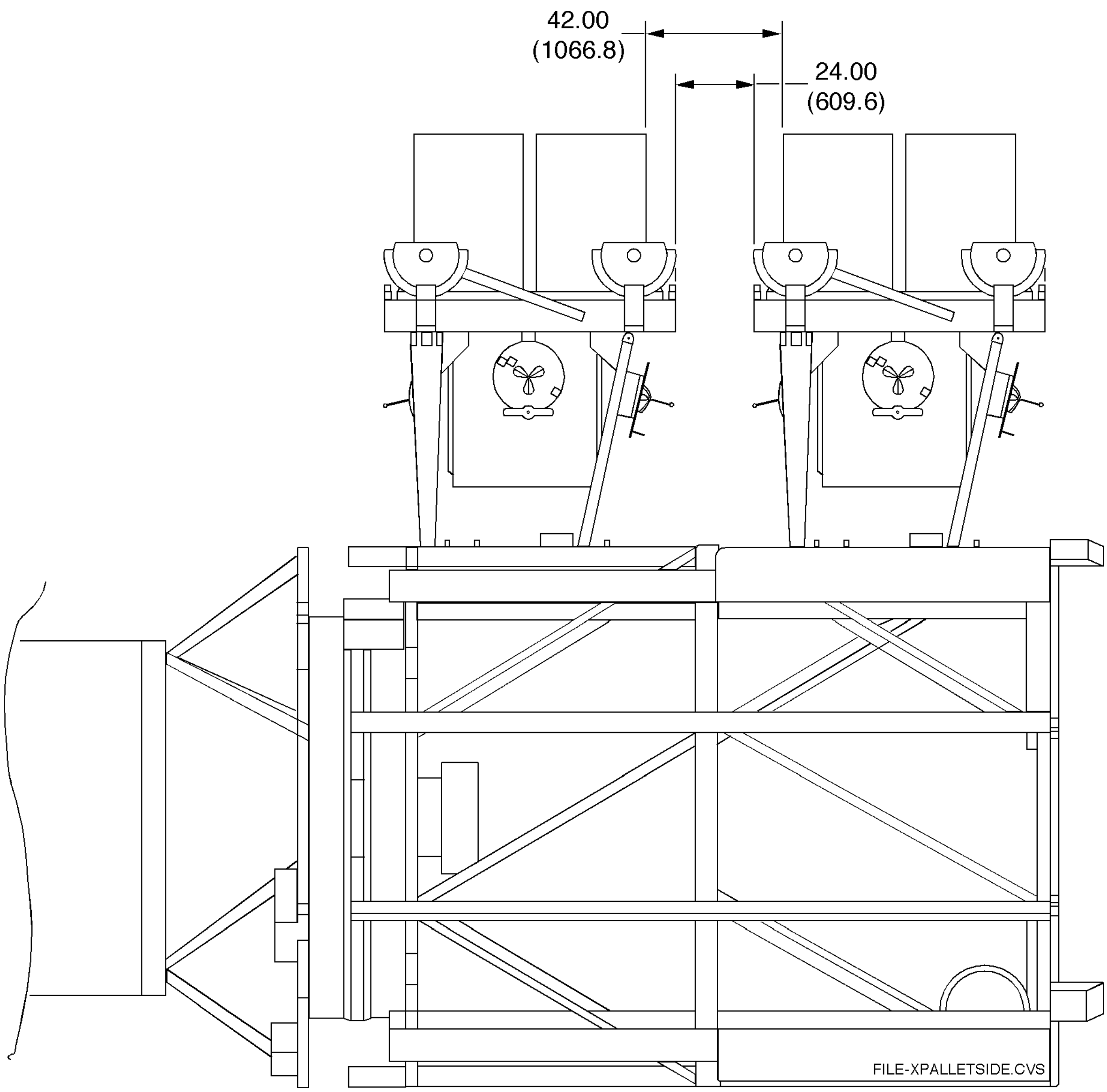
NOTE: Dimensions are in inches (mm).

FIGURE 4-17 ExP NEAR-FIELD, FIXED VIEWING ENVIRONMENTS (Sheet 1 of 2)



NOTE: Dimensions are in inches (mm).

FIGURE 4-17 ExP NEAR-FIELD, FIXED VIEWING ENVIRONMENTS (Sheet 2 of 2)



NOTES:

1. Dimensions are in inches (mm).
2. Typical for both nadir and zenith sides of ITS.

FIGURE 4-18 ExP SPACING ON ISS

described in paragraph 4.11.4. These views include FOV obstructions that can be attributed to fixed, far-field ISS hardware.

4.11.3.2 Far-Field, Moveable FOV Obstructions

Far-field, ISS moveable obstructions include the following:

A. Photovoltaic arrays

B. Radiators

C. Mobile Transporter (MT)

D. Special Purpose Dexterous Manipulator (SPDM)

E. Space Station Remote Manipulator System (SSRMS)

F. Space Shuttle Orbiter

G. Progress vehicles

H. Other vehicles.

Many of these far-field, moveable obstructions are intermittent and occur during periods of vehicle dockings and hardware transfer on ISS. Therefore, these obstructions generally occur during periods that are not considered as optimal for science observations by attached payloads. Obscurations caused by photovotaic arrays and radiators will change in severity based on array articulations. Simulated views from ExP mounted payload positions are described in paragraph 4.11.4. Included in these views are obstructions that can be attributed to some of the moveable, far-field ISS hardware and vehicles.

The FOV model is an ISS Program resource that has been developed by the ExP Project Office for the benefit of ExP EI and ExP PDs.

4.11.4 FOV Model

The ExP EI has developed an ISS FOV computer model. The FOV model is a tool that can be used to simulate the viewing environment on ISS. The FOV model can simulate the viewing environment from all four ExP locations on the ISS S3 truss. This includes two nadir and two zenith ExP locations on the wake side of the ISS S3 truss. The FOV model has the capability to generate both static and animated views. The FOV can generate views at any azimuth and elevation relative to the ISS Reference Coordinate System. Examples of these static views are shown in Appendix B. The FOV model includes a three-dimensional model of the ISS with four ExPs mounted to the truss. The FOV model is an analytical tool that can be made available to PDs for payload mission-unique analyses. Payload-unique analyses can be performed by ExP EI based on payload-defined viewing requirements for a specific ISS increment. In addition, the ISS FOV model, which includes the three-dimensional ISS model with ExP(s), can be made available to PDs for use at their own sites. Use of the FOV model for payload mission-unique analyses or requests for the actual FOV model files must be coordinated with the Multi-Use Payload Group at MSFC.

The FOV model has been developed using commercial, PC-based software. Specifically, the FOV model utilizes Satellite Tool Kit/Visualization Option (STK/VO) available from Analytical Graphics, Malvern, PA. PDs that request the FOV model files must obtain this application software to perform FOV modeling activities at their site.

4.11.5 FOV Process

The 3D CAD files of payload hardware, which is supplied as part of the design process, will be used in the development of the ExP FOV Model. ExP EI requires that PDs define their pointing and FOV requirements in the EPIA IA and EPICD.

ExP EI will then submit a preliminary integrated Pointing/FOV compatibility assessment to the PEI and the ExP PDs. ExP EI will then generate Pointing/FOV constraints, as required, based on the results of the preliminary integrated compatibility analysis.

EI will generate views for each of the ExP mounted payloads based on the PD-defined Pointing/FOV requirements and the results of the preliminary integrated compatibility analysis. These views will be provided to PEI and the ExP PDs.

ExP EI will perform the final integrated Pointing/FOV compatibility analysis. The results of the analyses will be provided to PEI and the PDs. ExP EI will then generate the final Pointing/FOV constraints, as required, based on the results of the final integrated compatibility analysis.

For additional information on this process/schedule, see Appendix C, Table C-I, Pointing Field of View.

4.12 POINTING/ATTITUDE

Many ExP mounted payloads require precise and stable pointing and alignment to achieve their science and engineering objectives. Pointing and alignment can only be provided by the payload. The ExP does not provide pointing and alignment; ExP is fixed on the ISS truss. ExP mounted payloads will provide their own pointing and alignment systems while meeting all the payload interface requirements specified for ExPA-mounted hardware. The ISS does not provide pointing and alignment for truss-mounted payloads; however, there are several attitudes the ISS will be flown in that will affect the ExP mounted payload pointing and alignment processes.

The ExP mounted payloads can obtain near-real-time information regarding ISS attitudes from the ISS C&DH subsystem. ISS Guidance, Navigation, and Control (GN&C) parameters are part of the BAD set. These parameters are defined in SSP 41175-02, Software ICD, Part 1, Station Management and Control to ISS Book 2, General Interface Software Interfaces Requirements. Also, Global Positioning System (GPS) ISS parameters are defined in SSP 41177-05, Software ICD Part 1, GN&C-to-ISS Book 5, GPS Interface.

4.13 STOWAGE

4.13.1 Stowage Accommodations

There are two conceivable classes of stowage for ExP mounted payloads. They are unpressurized or pressurized stowage items. The unpressurized stowage can be launched on unpressurized carriers, such as ExP ULC or SWC. The pressurized stowage can be launched in the Shuttle middeck. While it is possible that ExP stowage can be flown in/on either pressurized or unpressurized carriers, programmatic planning and methodology, resource limitations, and carrier-unique interface requirements dictate the optimal carrier for ExP stowage.

There is no payload volume allocation dedicated to stowage on ExP. ExP users must suballocate some of their payload volume on the ExP if they have such a requirement. From the point of view of the ExP integrator, there is no distinction between payload and stowage for unpressurized payload accommodations on ExP. The payload interface requirements for ExP are defined in SSP 52000-IDD-EPP. All hardware (payload and stowage) launched on ExP must meet the interface requirements defined in SSP 52000-IDD-EPP.

Stowage items should be marked in a unique manner in accordance with SSP 50007. Stowage items should include as many crew convenience features as practical (i.e., hook velcro on all packaging, protective covers on impact-sensitive items, tether attach points, zip-lock bags, etc.). These features and planning should consider crew handling in both the pressurized and unpressurized environments if transfer to the ExP is required.

Stowage hardware flown in the Shuttle middeck must meet the interface requirements identified in NSTS 21000-IDD-MDK.

Stowage hardware is subject to the same resource limitations, interface and design requirements as “hard-mounted” equipment. One difference that may mitigate a specific design environment condition is that most stowage items are packed in a vibration-damping material, such as foam, within the launch containers. The vibration-damping material mitigates some of the launch loading. Much of the ISS stowage hardware will be launched in collapsible transfer bags, which are padded stowage bags that fit within a standard middeck locker. Stowage items contained in alternative packing or that are hard-mounted are subject to the maximum launch loads.

4.13.2 Documenting Stowage Requirements

ExP mounted payload requirements for stowage in the pressurized volume should be defined in the IDRD and agreed to in the payload-unique EPIA IA, ICD, and integration data sets. Preliminary definition of pressurized stowage in the IDRD must be completed for cargo integration to include the items in the overall ISS packing and design manifest.

SECTION 5, ExP SUPPLEMENTARY HARDWARE

5.1 EXPRESS PALLET SUPPORT EQUIPMENT (EPSE)

The EPSE is the general support and interfacing hardware required to interface and integrate a payload onto the ExP. This includes:

A. Shipping container

B. Suitcase Test Environment for Payloads-EXPRESS Pallet (STEP-EP).

Information regarding the acquisition of this hardware should be addressed to the NASA/MSFC EXPRESS Pallet Office and identified in the PD's EPIA IA.

5.1.1 Shipping Container

The ExP Storage and Shipping Container (SSC) is a reusable GSE item that provides physical and environmental protection for the ExPA and installed payloads during transportation and handling. The SSC directly interfaces with the ExPA that supports and encloses an ExPA integrated payload package. The SSC is designed such that only the top part of the ExPA will be accessible to the PD. The top portion of the SSC will lift off to allow complete access to the top portion of the ExPA as shown in Figure 5-1. The SSC containing an ExPA and payload is capable of transportation by road, ship, rail, or air. The SSC has interfaces for a forklift, hoisting by crane, tiedown for transportation, and access for operations personnel as shown in Figure 5-2. The SSC will provide power and data path access to the ExPA flight interface for test and checkout operations during and following the integration of an ExP-attached payload. The SSC is designed to ensure that it does not degrade or contaminate payload flight systems or subsystems during checkout, servicing, or handling. It is equipped with differential pressure equalization and filtration systems, and it meets the shipping and handling requirements of FED-STD-101. The PD is responsible for controlling moisture within the enclosed SSC assembly. The SSC also includes provisions for PD-installed temperature, humidity, and shock-monitoring equipment. The SSC maximum envelope dimensions are 72 in. wide by 72 in. deep by 84 in. high and will contain ExP mounted payloads as defined in the SSP 52000-IDD-EPP. Shipping containers for additional hardware will be supplied by the PD.

Any materials required to pack the payload within the SSC will be provided by the PD. The PD will be responsible for providing all support equipment to be used with the SSC at the PD facility. At KSC, the PD will be responsible for SSC mobility provisions (if required in addition to forklift handling), Test Support Equipment (if required in addition to STEP-EP), and specialized/payload-unique work platform/stands.

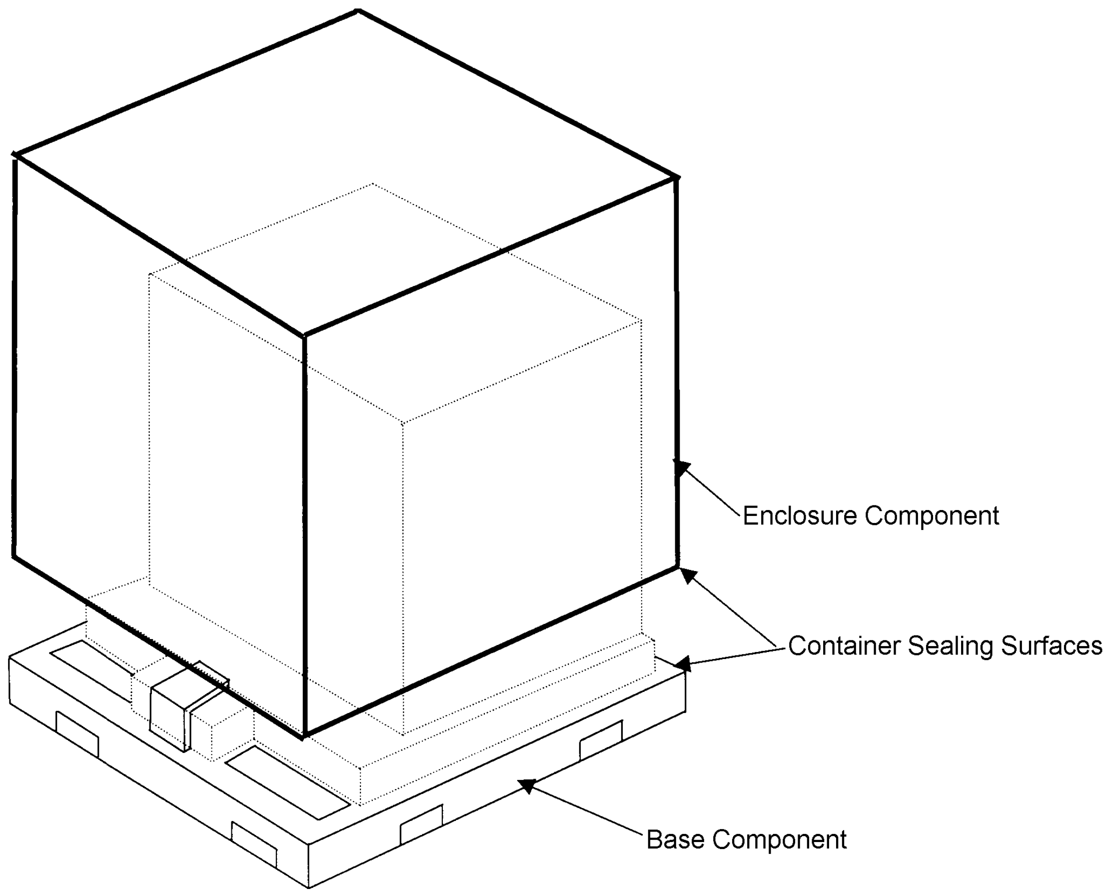


FIGURE 5-1 ExPA SHIPPING CONTAINER

The ExPA is flight hardware. As a result, PDs integrating their hardware onto an ExPA in their facilities will be required to satisfy quality requirements imposed by NASA Quality Control (QC).

5.1.2 STEP-EP Hardware

The STEP-EP equipment simulates the ExPCA C&DH interfaces to mounted ExP mounted payloads. The ExPCA is the communications and control unit for the ExP. The STEP-EP cabling interfaces will be identical to the ExPA connectors. This equipment may be provided to ExP mounted payloads to test flight systems prior to delivery to KSC. This equipment will provide the capability of testing the MIL-STD-1553B, ISO/IEC 8802.3 Ethernet, analog input, discrete input/output hardware interfaces.

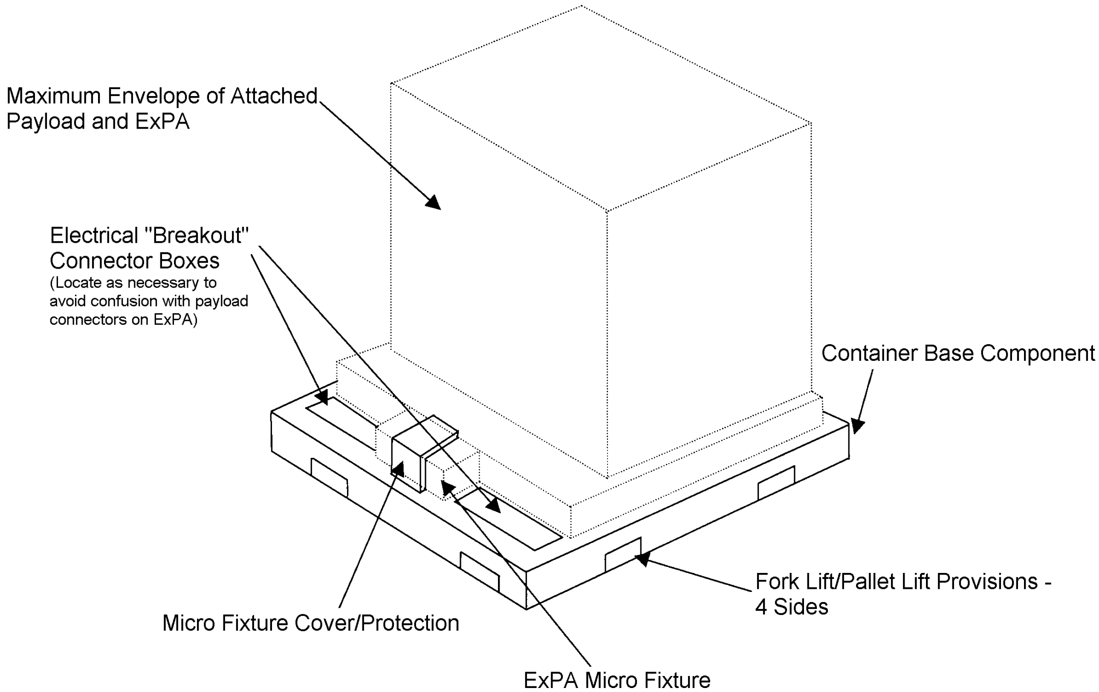


FIGURE 5-2 ExPA SHIPPING CONTAINER INTERFACES

The operations and usage of this equipment are defined in the STEP-EP User's Guide (**TBD#5-01**). This document provides information for the installation and setup, usage, session data analysis, description of data types, and limitations of the STEP-EP equipment.

The scheduling for use of this equipment will have to be coordinated with an EPPIM and documented in an EPIA.

ExP PDs are responsible for testing and verifying all C&DH interfaces and software and verifying that they meet the requirements of SSP 52000-IDD-EPP.

Note: STEP-EP development is currently on hold due to funding constraints. There is a likelihood that STEP-EPs will not be made available to PDs as previously advertised.

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SECTION 6, ExP PAYLOAD INTEGRATION

6.1 INTEGRATION ROLES AND RESPONSIBILITIES

Payload integration encompasses the complete set of activities required to certify payload readiness to launch and accomplish its mission objectives. Analytical integration includes all activities necessary to certify compatibility between the payload and Shuttle, ISS, and other payloads. Physical integration includes all activities necessary to mate the payload to the ExP, Shuttle, and ISS systems, and verify those interfaces. Operations preparation includes all activities to prepare the flight crews, ground integration personnel, and facilities to support payload operations. The payload and integrated ExP will complete the entire safety review process and be certified safe for flight.

The PD roles and responsibilities are defined in the SEPIA and EPIA.

6.2 PAYLOAD INTEGRATION MANAGEMENT SCHEDULE

An ISS Program ExP Payload Integration Management Schedule template is defined to ensure payload integration work is defined and scheduled to meet the ISS Program requirements for a standard mission preparation process. This template is defined in SSP 57057, ISS Payload Integration Template. A payload-unique set of deliverables is shown in Appendix C of this document.

A payload-unique ISS ExP Payload Integration Schedule will be developed on a flight and increment specific basis for the initial and subsequent flights involving the payload. The schedule will be reviewed and updated monthly. This schedule will be managed by the EPPIM, in coordination with the PD and the ISS Program Integration Team. The Common Schedule Database (CSD) tool will be used to gather the schedule data. Issues will be elevated to the PMIT for resolution as required.

6.3 PAYLOAD DATA LIBRARY

The integration process entails the development of user design guidance, requirements, and constraints definition documentation (EPIAs, EPIA IAs, and ICDs), verification requirements, and the collection of data sets. An electronic database system, referred to as PDL, has been developed to serve as the primary method for collecting and integrating these requirements and will maintain connectivity to other interfaces as necessary to establish the development/production environment. The PDL houses the EPIA, EPIA IA, ICD, and PVP, Data Set Requirements, and other data that is collected from the user and is necessary for the integration of payloads for transportation, installation, and operation on the ISS. The PDL is maintained at MSFC, and accounts can be obtained by accessing the following web site: http://pdl.msfc.nasa.gov/.

A PD will enter information into the proper self-explanatory forms in the database. Only the PD team will have write-and-read access until the Payload Manager promotes the data. After the Payload Manager promotes the data, it can be write accessed by the integration team and read by other ISS personnel. It should be noted that other PDs cannot read the data. It will only be viewed by the personnel who needs the data to perform the integration function. After the data has been agreed to by both the integration team and the payload development team, it is promoted again. After the second promotion, only the Program Configuration Manager will have write access. The data is then used in the ISS integration and operations process. Additional information gathered and maintained by PDL is provided below:

A. Payload Training Data Set provides the detailed training requirements for the PD and ISS Program personnel, including the flight crew and support personnel. The Training Data Set provides inputs to the training team on the following items:

(1) Payload simulator hardware requirements and limitations

(2) Payload simulation requirements

(3) Flight crew training requirements

(4) Ground support personnel training requirements.

The evolution of this data set will be an iterative process between the PD and the ISS training group. For additional information on this process/schedule, see Appendix C, Table C-I, Payload Training Data Set.

B. Ground Data Services Data Set identifies PD requirements for voice loops, real-time data/video, enhanced POIC Services, and payload telemetry requirements. This data set will also define science requirements for use of the United States Operations Center (USOC), the TSC, or remote site. This includes network and/or hardware connectivity requirements. The evolution of this data set will be an iterative process between the PD and the ISS training group. For additional information, see Appendix C, Table C-I, Ground Data Services Data Set.

C. Payload Operations Data Set defines the products, activities, roles, responsibilities, and interfaces required to implement payload operations for the ISS Program. This data set includes payload video requirements, schematics, diagrams, photos, payload operating procedures, and interface information on payload application software. In addition, this data set will include the definition of Flight Rules and Regulations. The evolution of this data set will be an iterative process between the PD and the ISS training group. For additional information on this process/schedule, see Appendix C, Table C-I, Payload Operations Data Set.

D. Payload Planning Data Set provides detailed pre-increment and real-time planning payload resource requirements for the ISS Program. This includes detailed operational requirements for on-board resources, such as crew time, power, heat dissipation, commanding, data, and data downlink requirements. This data is necessary for planners to timeline or mesh payload requirements with those of other payloads and the vehicle. The evolution of this data set will be an iterative process between the PD and the ISS planning group. For additional information on this process/schedule, see Appendix C, Table C-I, Payload Planning Data Set.

E. KSC Technical Data Set provides payload-unique technical requirements to be levied on KSC in an Operations and Maintenance Requirements Specification (OMRS)-like format. These requirements correspond to NSTS 08171, File II Volume 2 or File VIII Volume 2. The evolution of this data set will be an iterative process between the PD and the KSC personnel. For additional information on this process/schedule, see Appendix C, Table C-I, KSC Technical Data Set.

F. KSC Support Data Set identifies requirement on KSC from the PD required for offline payload test and checkout. This includes definition of KSC lab space, utilities, and GSE hardware needed to support the PD prior to turnover of the hardware. The evolution of this data set will be an iterative process between the PD and the KSC personnel. For additional information on this process/schedule, see Appendix C, Table C-I, KSC Support Data Set.

G. Payload Configuration Data Set is a means to collect four main groups of data used by various teams within the ISS Program:

(1) Payload drawings, schematics, configuration

(2) Payload models

(3) Manifest/stowage requirements data

(4) Payload hardware ICD data.

This information is gathered by ExP EI and utilized to generate several products required by ISS, Operations, KSC, and SSP. The PD will supply the initial input. This input will be assessed and comments returned to the PD. For additional information on this process/schedule, see Appendix C, Table C-I, Payload Configuration Data Set.

H. Payload Command and Data Handling Data Set is the means to collect the payloads software databases to be used on-orbit and on ground systems for telemetry. This data input will also define command and telemetry data to support display requirements levied on the ground and flight data systems, including ISS laptops. (Data Set does not include display definition.) This data set is submitted ExP EI via PDL. This input is assessed and comments and concerns are coordinated with the PD. PD inputs into this database will then be provided as required. It should be noted that the database will be baselined, and changes after that will require the approval of the applicable change board. For additional information on this process/schedule, see Appendix C, Table C-I, Payload Command and Data Handling Data Set.

I. EVA Data Set will define all requirements for any required EVA. There are no plans for any EVA activities for ExP mounted payloads. In the event a payload can demonstrate a requirement that is accepted by the ExP EI and ISS Program, an input to this data set will be required. Updates to this data will be supplied as required by the ISS Program, ExP EI, and the PD. For additional information on this process/schedule, see Appendix C, Table C-I, EVA Data Set.

J. EVR Data Set will define all functional and physical requirements of a payload with SSP and ISS Program robotic hardware. This includes all facets of robotic operation, including removal and hand-off from Shuttle, grappling by ISS, ISS transportation to the operational site, installation at the operational site, on-orbit maintenance, and removal from ISS. Standard payloads do not have any planned robotic maintenance requirements. Payloads with EVR requirements must submit their input to the data set to facilitate the additional assessments and review by ExP EI and the ISS Program. Updates to this data will be supplied as required by the ISS Program, ExP EI, and the PD. For additional information on this process/schedule, see Appendix C, Table C-I, EVR Data Set.

K. PDL Electronic Documentation

Electronic payload documentation consists of the EPIA, EPICD, and the EXPRESS Pallet to Payload Verification Plan (EPVP). These documents will exist as electronic databases on PDL. Data for these documents will be supplied directly into PDL by the PDs. An iterative definition/review process will occur between the PD, ExP EI, and ISS Program, which culminates in the baseline of the documentation.

(1) The EPIA is the primary management and technical agreement between the PD and the ISS Program. The PD will supply an initial input of data into the EPIA. This data will be reviewed by ExP EI and the ISS Program offices. A baseline draft will be prepared as a result of this review. The EPIA will be submitted to the ISS Payloads Office Payload Control Board (PCB) for distribution for a final review. The EPIA will be signed, baselined, and placed under configuration control. Changes to this EPIA will require approval of the PCB. For additional information on this process/schedule, see Appendix C, Table C-I, EPIA.

(2) The EPIA IA documents the ISS Program and transportation services, tactical

parameters, pre-launch to ascent requirements, on-orbit requirements, return requirements, ancillary volume stowage requirements, training requirements and the Program-provided ground support requirements, all on an increment and flight basis, for an individual ExP mounted payload. The PD will supply an initial input of data into the EPIA IA. This data will be reviewed by the ExP EI and the ISS Program Offices. A baseline draft will be prepared as a result of this review. The EPIA IA will be submitted to the PCB for distribution for a final review. The EPIA IA will be signed, baselined, and placed under configuration control. Changes to the EPIA IA will require approval of the PCB. For additional information on this process/schedule, see Appendix C, Table C-1, EPIA.

(3) The EPICD is the document that defines and controls the design of physical and data interfaces between the payload, ExP, ISS, and SSP. The EPICD will document physical interfaces in the areas of structures/dynamics, power, data, thermal, and materials. The interfaces are defined by direct reference and are traceable to SSP 52000-IDD-EPP. The PD will input information into a database that includes all the IDD requirements. The PD will then proceed to note the requirements that are applicable or not applicable. Some items will be noted as exceptions. These items are applicable, but the PD may not be able to meet the requirement as stated. The PD must provide acceptable rationale for requirements that require exceptions.

PDs will make an initial input of data into the EPICD. This data will be reviewed by ExP EI and the ISS Program offices. ExP EI and the PD will coordinate and update the EPICD. A baseline draft will be submitted. The EPICD will be baselined and placed under configuration control. Changes to this documentation will then require approval of the applicable control board. For additional information on this process/schedule, see Appendix C, Table C-I, EXPRESS Pallet/Payload Interface Control Document.

(4) EPVP defines the complete set of verification requirements and activities necessary to ensure compliance with the ExP mounted payload design-to requirements identified in the SSP 52000-IDD-EPP. The verification requirements address interface compatibility and safety. These requirements pertain to all phases of operations, including ascent/descent, on-orbit integration, and on-orbit operations. The EPVP will define methods, delivery schedules, and data required for each verification item. PDs who need to modify their method of verification, delivery schedule of verification requirements, or data required to satisfy the item will be required to gain the concurrence of ExP EI.

PDs will make an initial input of data into the EPVP. This data will be reviewed by ExP EI and the ISS Program offices. ExP EI and the PD will coordinate and update the EPVP. A baseline draft will be submitted. The EPVP will be baselined and placed under configuration control. Changes to this documentation will then require approval of the applicable control board. Verification data requirements must be submitted to ExP EI. For additional information on this process/schedule, see Appendix C, Table C-I, EXPRESS Pallet/Payload Verification Plan.

6.4 SIGNIFICANT REVIEWS/MILESTONES

The reviews discussed in this section require payload development community support. PDs should use their discretion to determine their level of involvement in support of reviews/meetings/telecons, depending on the issues and topics that will be discussed.

6.4.1 Integrated ExP Reviews

Integrated ExP Reviews are scheduled to assess the compatibility and status of an integrated ExP. Integrated EXPRESS Pallet Compatibility Review (IECR) Data will be generated by ExP EI. Comments/concerns on this data will be reviewed at the IECR. The goal of ExP EI in the IECR is to gain permission to proceed with the integration process and to reach concurrence on planning required to resolve any residual issues.

For additional information on this process/schedule, see Appendix C, Table C-I, Integrated EXPRESS Pallet Reviews. PDs must submit deliverables to ExP EI per the schedule in Table C-I, Payload Integration and Deliverables Schedule. Failure to adhere to the data submittal and Readiness Reviews schedule can result in the payload being deleted from the scheduled mission.

6.4.2 ISS Cargo Integration Review

The Stage Integration Review is an ISS Program milestone. This is followed by the Stage Cargo Integration Review (SCIR). This ISS Program milestone provides an additional review of the integrated ExP's status. A detailed compatibility assessment is reviewed by the ISS Program using the latest data. For additional information on this process/schedule, see Appendix C, Table C-I, ISS Cargo Integration. PDs must submit deliveries to ExP EI per the schedule Table C-I, Payload Integration and Deliverables Schedule. Failure to adhere to the data submittal schedule can result in the payload being scrubbed from its scheduled mission.

6.4.3 Cargo Integration

The Cargo Integration Review is a SSP milestone. SSP will coordinate with ExP EI to review the integrated pallet's requirements and its compatibility with allocated Shuttle resources. For additional information on this process/schedule, see Appendix C, Table C-I, Program Milestones.

6.4.4 Ground Operation Review (GOR)

GOR is conducted at the beginning of the KSC integration process (a GOR Data Package will be distributed prior to the meeting if required). The objective of this review is to ensure a common understanding of payload requirements on KSC. Any changes in requirements should be discussed and misunderstandings resolved to avoid issues later in the KSC integration process. For additional information on this process/schedule, see Appendix C, Table C-I, Program Milestones.

6.4.5 ISS Increment Operations Review (IOR)

The objective of the IOR is to ensure a common understanding of payload requirements on ISS operations. Any changes in requirements should be discussed and misunderstandings resolved to avoid issues in ISS on-orbit operations and telemetry. For additional information on this process/schedule, see Appendix C, Table C-I, Program Milestones.

6.4.6 STS Flight Operations Review (FOR)

The objective of the FOR is to ensure a common understanding of payload requirements on STS operations. Any changes in requirements should be discussed and misunderstandings resolved to avoid issues in STS on-orbit operations and telemetry. For additional information on this process/schedule, see Appendix C, Table C-I, Program Milestones.

6.5 KSC AND GROUND PROCESSING SERVICES

ExP mounted payloads will be integrated onto the ExPA at the PD site, and the integrated ExPA will be readied for launch at KSC. Accommodations for ExP mounted payloads at the launch site are defined and documented in the KSC ISS Payload Accommodations Handbook, SSP 52000-PAH-KSC. This accommodations document describes each level of payload processing at KSC. It identifies procedures/protocols that must be followed, objectives of the particular level of integration, facility accommodations, and testing interfaces for payload activities. A template for KSC payload processing is shown in Figure 6-1.

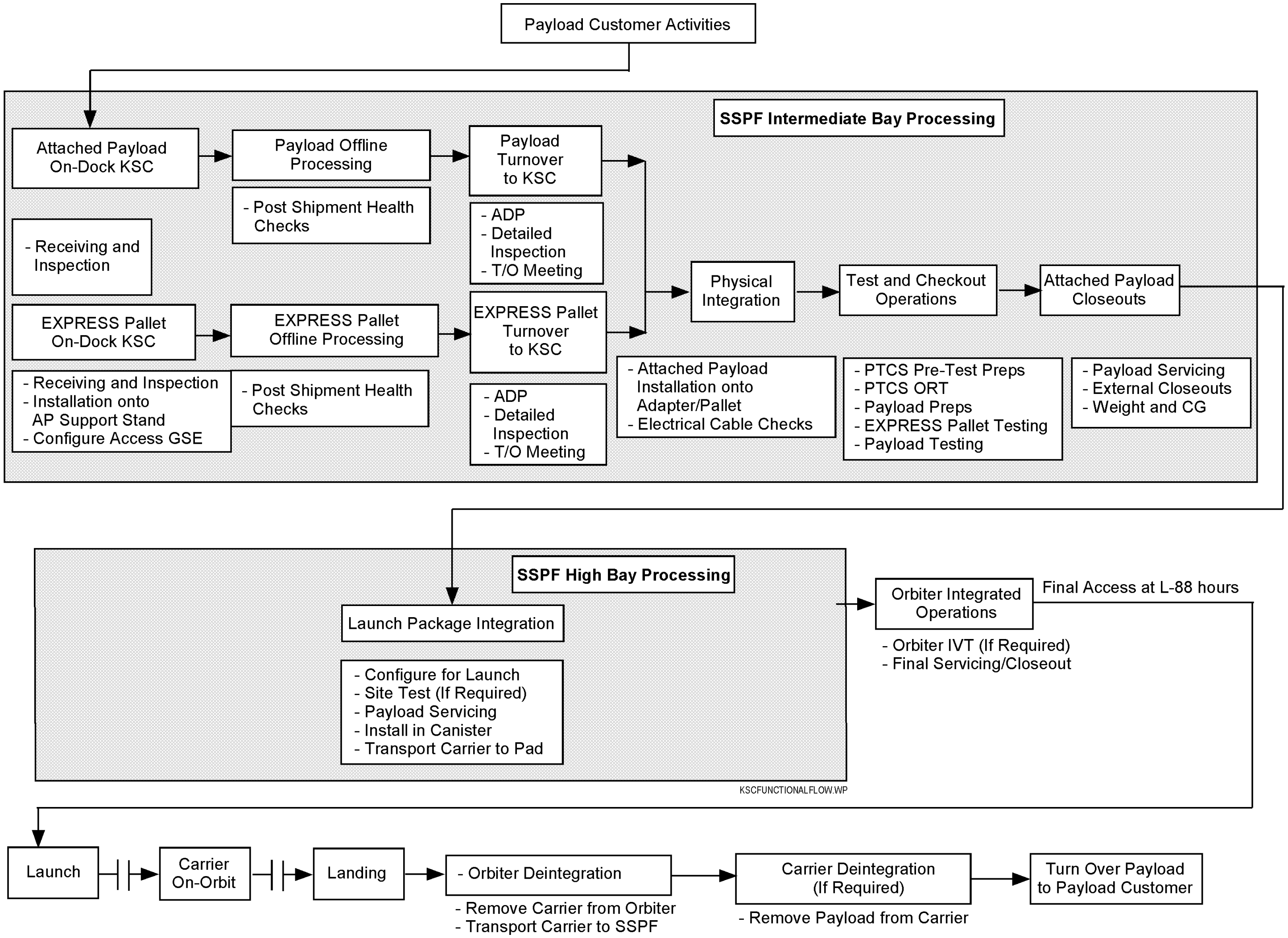

FIGURE 6-1 KSC FUNCTIONAL FLOW

ExP mounted payload test and checkout, prelaunch, and deintegration activities often require the PD to bring GSE to the launch site for use in off-line activities. This GSE must be verified to be safe for its intended use. The KSC PSRP will review with the PD all of the GSE and associated procedures prior to use at KSC. Safety requirements for this GSE are documented in KHB 1700.7. GSE and processes/procedures to which the PD must pay particular attention are as follows:

A. Electrical GSE (i.e., power supply, instrumentation, etc.)

B. Mechanical GSE (i.e., slings, platforms, eyebolts, etc.)

C. Pressurized GSE (i.e., cooling systems, gas supply systems, etc.)

D. Chemicals (i.e., hazardous materials, waste materials, etc.)

E. Lasers (i.e., alignment equipment, flight equipment, etc.)

F. Radioactive materials (i.e., isotopes, flight samples, etc.)

G. GSE accommodations (i.e., SSPF processing and support capabilities).

PD GSE must be compatible with the KSC user accommodations defined in SSP 52000-PAH-KSC (i.e., connector types, door openings, handling capabilities, etc.). PDs must complete all approval forms for sample processing at KSC (i.e., Material Safety Data Sheets, Process Waste Questionnaires, Laser Use, etc.).

The PDL will contain data files for the PD to select required resources and facilities from KSC.

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SECTION 7, MISSION OPERATIONS

7.1 CONTINUOUS PAYLOAD OPERATIONS INTEGRATION

Payload operations personnel integrate on-orbit payload operations continuously to change out payloads, upgrade systems, and reconfigure ground facilities. Payload operations adapt to these changes. Ongoing payload operations planning and preparation include changes that add new payloads or return on-orbit payloads as part of the normal integrated change process. Unlike earlier programs, ISS will operate continuously over a number of years. Continuous utilization must have the following characteristics:

A. Process design facilitates changes in payloads and user payload goals.

B. Operations personnel integrate changes as deltas to existing operations products.

C. Focus on operation of the on-orbit payload complement, with long-range planning and preparation directed toward maintaining continuity of payload operations.

7.2 PAYLOAD OPERATIONS COMPONENTS

There are four major components of the process for integrating new payloads into the ISS utilization environment. Throughout the utilization cycle, operations personnel working the four components share products, information, and lessons learned. These components are operations preparation, real time, non-real time, and post-operations. The following sections describe the functions of and the relationships among the components of payload operations.

7.2.1 Operations Preparation

Operations preparation is the process of integrating changes to the on-orbit complement and on-orbit configuration into the operations environment. Unless required for payload training, Operations preparation begins approximately 24 months prior to a payload increment and may, in fact, extend into real time and non-real-time operations. Operations preparation encompasses the functions needed to prepare for operations for the next payload complement and all succeeding payload complements. The flight crew and ground payload operations personnel, including the users, receive training through a planned combination of basic, advanced, and payload complement training. This will include formal training sessions, on-the-job training, and simulations.

7.2.2 Real-Time Operations

Real-time operations consist of ongoing operations of the integrated payload complement. Real-time operations address the current payload complement and support to coordinate the on-board integrated resources, such as power, data, and crew required by payloads. Although the flight crew operates for a single shift, resulting in reduced ground payload operations staffing during some of the day, real-time payload operations require around-the-clock attention to support active payloads and payload support systems. During real-time operations, controllers follow execution products or modify these products to implement approved changes in payloads objectives, hardware, or software status. If problems occur, the users, Partners, Payload Operations Integration Center (POIC) controllers, and flight crew work together to resolve the problem, including any required in-flight maintenance.

7.2.3 Non-Real-Time Operations

This component of payload operations consists of non-real-time activities that enable real-time operations of the current payload complement. A major portion of non-real-time operations focuses on weekly planning, which develops the next week's plan and schedule of payload activities.

7.2.4 Post-Operations

Operations personnel support post-operations analyses by providing available payload operations data. Users assess their payload results in conjunction with the Partners and evaluate operations of their payloads. Detailed data analysis and payload success assessments are the primary functions of this component.

7.3 PAYLOAD TRAINING

The goal of ISS payload training is to prepare the crew and Ground Support Personnel (GSP) to operate in their respective environment with the skills and knowledge required to operate and service the payloads as required to meet the PD objectives. A Training Strategy Team (TST) is assigned for each payload and is responsible for defining, scheduling, and implementing payload training. During the TST process, the training objectives, type of trainer, training materials, and training subjects will be defined jointly by the PD and NASA training personnel. Detailed information on payload training can be found in SSP 58309.

7.4 PROCEDURE DEVELOPMENT

The ExP PD must develop and validate the operating procedures to be used by the flight crew to operate the payload hardware. These procedures must include any procedural safety controls specified in the safety hazard reports. It is the responsibility of the PD to ensure that the procedures accomplish the payload science objectives. All payload procedures will be approved and managed by the Payload Operations Data File Control

Board (PODFCB). Detailed information on the development and management of payload procedures can be found in SSP 58700-ANX1.

7.5 PAYLOAD PLANNING REQUIREMENTS

The ExP PD will document operations requirements and constraints in support of planning on-orbit and ground-based activities. These requirements and constraints include data rates, power levels, crew support, thermal, and environmental considerations needed to operate the payload. This information will allow the POIC planning team to develop an integrated payload timeline (or schedule) of all ISS payload activities. The payload timeline is then integrated into the overall ISS schedule of activities.

Payload planning requirements are collected using the interim User Requirements Collection (iURC) component of the PDL. The iURC represents the payload planning data set and it is accessible via the following web site: http://iurc.nexus.nasa.gov/

7.6 OPERATIONS EXECUTION

During the flight operation phase, there will be POIC support personnel that are responsible for the coordination of the payload mission activities. The goal is to facilitate the execution of the entire payload complement while balancing the ISS resource with the ground-based capabilities. The POIC cadre will support the aspects of planning, data management of ISS payload data systems, and configuration of ISS payload support systems, (e.g., Payload Multiplexer/Demultiplexer (PL MDM), vacuum systems, etc.). The coordination of such a large number of people and systems requires extensive planning and established guidelines for information exchange and communication among all the players. The POIC operations cadre establishes relationships with the PDs throughout the planning, training, and simulation activities that allow the payload objectives to be accomplished during the actual mission. The ExP PD should contact the ExP Project Office for further discussion of data management or other real-time operations execution functions.

7.7 POIC CAPABILITIES/REQUIREMENTS

The ExP PD who plans to operate in the POIC must plan to become familiar with and be trained in the protocols of utilizing and operating in the POIC. This includes ISS uplink commanding capabilities, voice communication protocols, and data-retrieval protocols. The PD must also identify the amount of resources required within the POIC, such as floor space, data lines, power connections, etc. These requirements will be documented in the Ground Services Data Set of the PDL. Additional information regarding PDL may be found in paragraph 6.3.

7.8 TSC CAPABILITIES/REQUIREMENTS

Most PDs will not be resident at the MSFC POIC. However, a viable alternative is to operate out of the MSFC TSC. The MSFC TSC will support all operations phases, including pre-increment, increment, and post-increment; this includes payload planning, data management, operations, and training. It also provides the interface to the POIC for voice communications, video, commanding, and data for payloads controlled from the MSFC TSC.

The MSFC TSC will be used by a variety of payloads, from small locker-sized experiments to multi-rack facilities. Due to the wide range of payloads, both in size and complexity, the precise manner in which the MSFC TSC supports them will vary. However, basic capabilities provided by the MSFC TSC to all users include seating, telephones, voice loop keysets, video monitors, and network interfaces. Additional information on these capabilities and others are available in the MSFC TSC Capabilities Document.

Each Payload Developer Team (PDT) must supply the computers they will need to operate out of the MSFC TSC. These computers must be compatible with the LAN and/or the MSFC Institutional Area Network and must include an X-windows client for interfacing with the Enhanced HOSC System (EHS) for commanding.

Each PDT is responsible for developing and documenting their concept for operating their payload. They will then request the MSFC TSC resources they need at the appropriate time based on their payload operations concept. Each PDT is also responsible for providing adequate manpower to support their simulations and real-time operations, including console monitoring and commanding. Prior to the start of simulations, PDTs must ensure that all team members sitting console are adequately trained and certified by the POIF in voice protocol, commanding, etc.

Another option is for the PD to operate out of a remote TSC, configured much the same way the MSFC TSC is configured. This way, the PD can perform command and receive telemetry at his home site. Capabilities at the remote TSC should be comparable to those at the MSFC TSC, but will depend on hardware/software configurations, resource requirements, and other operational issues. In either case, it is strongly recommended that payload developers use the Telescience Resource Kit (TreK). TreK is a pc-based telemetry and command system that can be used virtually anywhere in the world, and is primarily suited for small experiment teams and low-data-rate payloads. The Trek can be found at the web address http://payloads.msfc.nasa.gov/trek/welcome.htm. Capabilities provided by TreK include the ability to receive, process, record, and forward real-time and playback telemetry; uplink and update payload commands; perform local exception monitoring, local calculations, word processing, and file management; and control telemetry and command processing using local databases.

APPENDIX A

ABBREVIATIONS AND ACRONYMS

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APPENDIX A, ABBREVIATIONS AND ACRONYMS

10BASE-T	Ethernet implementation
A	Amp, Ampere
A&I	Assembly and Integration
ABCL	As Built Configuration List
ADP	Acceptance Data Package
ANSI	American National Standards Institute
AO	Atomic Oxygen
APAS	Attached Payload Accommodations Site
ASTM	American Standards of Testing and Materials
ASET	Analysis Set
ATM	Acceleration Transfer Matrix
BAD	Broadcast Ancillary Data
Btu	British Thermal Unit
°C	Degrees Celsius
C&DH	Command and Data Handling
C&W	Caution and Warning
CAD	Computer-Aided Design
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CG	Center of Gravity
CIR	Cargo Integration Review
CLA	Coupled Loads Analysis
cm	Centimeter(s)
COC	Certificate of Compliance
COFR	Certificate of Flight Readiness
COSMIC	Structural Analysis Software
COTS	Commercial Off-The-Shelf
CSA	Computerized Structural Analysis Corporation
CSD	Common Schedule Database
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
DLA	Design Loads Analysis
DMS	Data Management System
DOC	Document
DQA	Data Quality Assurance
DR	Data Requirement
DRR	Document Release Record

DTM	Dynamic Transformation Matrix
ECL	Engineering Configuration List
e.g.	exempli gratia (for example)
EHS	Enhanced HOSC System
EI	Engineering Integration
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPIA	EXPRESS Pallet Integration Agreement
EPICD	EXPRESS Pallet to Payload Interface Control Document
EPPIM	EXPRESS Pallet Payload Integration Manager
EPP	EXPRESS Pallet Payload
EPSE	EXPRESS Pallet Support Equipment
EPVP	EXPRESS Pallet to Payload Verification Plan
ESD	Electrostatic Discharge
etc.	et cetera (and others)
EVA	Extravehicular Activity
EVR	Extravehicular Robotics
ExP	EXPRESS Pallet
ExPA	EXPRESS Pallet Adapter
ExPCA	EXPRESS Pallet Control Assembly
EXPRESS	EXpedite the PRocessing of Experiments to Space Station
ExPS	EXPRESS Pallet System
f	Frequency
°F	Degrees Fahrenheit
FEC	Field Engineering Changes
FED	Federal
FEM	Finite Element Model
FLUINT	Fluid Integration
FOR	Flight Operations Review
FOV	Field Of View
FRR	Flight Readiness Review
ft	Foot, Feet
GN&C	Guidance, Navigation, and Control
GOR	Ground Operation Review
GOWG	Ground Operations Working Group
GPS	Global Positioning System
GSE	Ground Support Equipment
GSP	Ground Support Personnel
HDBK	Handbook
HOSC	Huntsville Operations Support Center

HRDL	High Rate Data Link
H/W	Hardware
Hz	Hertz
IA	Increment Addendum
ICD	Interface Control Document
ID	Identifier
IDD	Interface Definition Document
I-DEAS	Integrated Design Engineering Analysis Software
IDRD	Increment Definition and Requirements Document
i.e.	id est (that is)
IEC	International Electrochemical Commission
IECR	Integrated EXPRESS Pallet Compatibility Review
IEEE	Institute of Electrical and Electronic Engineers
IEIRR	Integrated EXPRESS Pallet Integration Readiness Review
I/F	Interface
IGES	International Graphical Exchange Specification
IGS	International Graphics Exchange System
in.	inch(es)
INPE	Brazilian National Institute for Space Research
I/O	Input/Output
IOR	Increment Operations Review
IP	International Partners
IPMM	Integrated Payload Mission Module
ISO	International Standards Organization
ISPR	International Standard Payload Rack
ISS	International Space Station
iURC	Interim User Requirements Collection
JSC	Johnson Space Center
°K	Degrees Kelvin
kg	Kilogram(s)
KHB	Kennedy Handbook
KSC	Kennedy Space Center
kW	Kilowatt(s)
L-	Launch minus
LAN	Local Area Network
lb	Pound(s)
lbm	pounds mass
LTM	Load Transfer Matrix

m	Meter(s)
MAPTIS	Materials and Process Technical Information System
Max.	Maximum
Mbps	Megabits per Second
MBS	Mobile Remote Servicer Base System
MCAS	Mobile Servicing System Common attachment System
MDK	Middeck
MDL	Middeck Locker
MER	Mission Evaluation Form
MERAT	Mean Effective Radiation Temperature
MIL	Military
Min.	Minimum
MIP	Mission Integration Plan
MIUL	Materials Identification and Usage List
MLI	Multi-Layer Insulation
mm	Millimeter(s)
mmHg	millimeters of Mercury
MMT	Mission Management Team
MOD	Mission Operations Directorate
MRS	Mobile Remote Servicer
MSC	McNeal Schwendler Corporation
MSFC	Marshall Space Flight Center
MT	Mobile Transporter
MUA	Material Usage Agreement
MUPG	Multi-Use Payload Group
NASA	National Aeronautics and Space Administration
NASAN	NASA Contamination Analysis
NASTRAN	NASA Structural Analysis
NDE	Non-Destructive Examination
Nmi	Nautical Miles
NSTS	National Space Transportation System
OM	ISS Launch Package Manager
OMRS	Operations and Maintenance Requirements Specification
OPS	Operations
OZ	ISS Payloads Office
PAH	Payload Accommodations Handbook
PAS	Payload Attach System
PC	Personal Computer
PCS	Portable Computer System

PD	Payload Developer
PDL	Payload Data Library
PDR	Preliminary Design Review
PDT	Payload Developer Team
PEI	Payload Engineering Integration
PEP	Payload Executive Processor
PHR	Payload Hazard Report
PIA	Payload Integration Agreement
PL MDM	Payload Multiplexer/Demultiplexer
PMIT	Payload Mission Integration Team
PO	Payload Organization
PODF	Payload Operations Data File
PODFCB	Payload Operations Data File Control Board
POIC	Payload Operations Integration Center
POIF	Payload Operations Integration Function
POIF MOL	Payload Operations Integrated Facility
POIWG	Payload Operations Interface Working Group
POWG	Payload Operations Working Group
PR	Problem Reports
PRLA	Payload Retention Latch Actuator
PRO/E	PRO Engineer
PRR	Payload Readiness Review
psf	Pounds per Square Foot
psi	Pounds per Square Inch
psia	Pounds per Square Inch Absolute
PSRP	Payload Safety Review Panel
PTC	Payload Training Center
PTCS	Payload Test and Checkout System
PVP	Payload Verification Plan
QC	Quality Control
QSL	Quasi-Static Load
°R	Degrees Rankin
Ref	Reference
RF	Radio Frequency
RPO	Research Program Office
RPWG	Research Planning Working Group
RT	Remote Terminal
RVL	Random Vibration Load
SCIR	Stage Cargo Integration Review

SCS	Safety-Critical Structure
SEE	Single Event Effect
SEMDA	Systems Engineering Modeling and Design Analysis
SEPIA	Standard EXPRESS Pallet Integration Agreement
SINDA	Systems Improved Numerical Differencing Analyzer
SIR	Stage Integration Review
SML	Small Payload Accommodations
SPDM	Special Purpose Dexterous Manipulator
SPIA	Standard Payload Integration Agreement
SRMS	Shuttle Remote Manipulator System
SSC	Shipping Container
SSP	Space Shuttle Program (Space Station Program when used in document numbers)
SSPF	Space Station Processing Facility
SSRMS	Space Station Remote Manipulator System
SSTF	Space Station Training Facility
STD	Standard
STEP-EP	Suitcase Test Equipment Simulator - EXPRESS Pallet
STK/VO	Satellite Tool Kit Visualization Option
STS	Space Transportation System
S/W	Software
S/WAR	Software Acceptance Review
SWC	Sidewall Carrier
TBD	To Be Determined
TBE	Teledyne Brown Engineering
TM	Technical Memorandum
TP	Technical Paper
TRASYS	Thermal Radiation Analyzer System
TreK	Telescience Resource Kit
TSC	Telescience Support Center
TST	Training Strategy Team
TVS	Thermal Vacuum Stability
ULC	Unpressurized Logistics Carrier
USOC	United States Operations Center
V	Volt
VCL	Verification Coupled Loads
Vdc	Volts, Direct Current
VRDS	Verification Requirement Data Sheet
W	Watt

APPENDIX B

ExP VIEWS

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APPENDIX B, ExP PALLET VIEWS

This appendix includes views that have been generated using the FOV computer model. Figure B-1 shows the viewing directions on the ExPs mounted on the zenith side of the S3 truss. Figure B-2 shows the viewing direction on the ExPs mounted on the nadir side of the S3 truss. The view originates from the geometric center of the six ExPAs and the maximum payload envelope height for all viewing directions. Table B-I is a list of the views and the corresponding file names.

The views in Figures B-3 through B-22 include several annotations on the images. They include the following: (1) location of the ISS over the Earth's surface in terms of latitude and longitude (denoted “Lat/Lon" with units of degrees and minutes); (2) altitude of the ISS above the Earth's surface (denoted “Alt” with units in meters); (3) unique designation for the view origin and view direction, which includes the ExP location on ISS and view direction as defined in Table B-I and Figures B-1 and B-2 (e.g., “ZORam,” the view originating from the Zenith Outboard ExP and pointing in the Ram direction); and (4) the view obscuration factor denoted as a percentage of the simulated view, which is obscured by the ISS and ExP structure.

The FOV software used by ExP EI has the capability of numerically characterizing any view selected from the ISS (including ExPs) three-dimensional model. The application software performs a calculation, which determines the percentage of the view obscured by objects in the path of the view direction and objects within the viewing angle. The objects obscuring a view can be located in both the near-field and far-field. The obscuration objects can include the satellite (i.e., ISS in this case), the payload or payloads mounted on the satellite (e.g., ExP), neighboring satellites (e.g., Shuttle or approaching vehicle), or Earth. For the views shown in Figures B-3 through B-22, the Earth is not included in the view obscuration values shown. The algorithm used to calculate FOV obscuration basically calculates the fraction of pixels occupied by structure versus the fraction of pixels occupied by open space and the Earth in the selected views and converts these fractions to percentage values. Only the percent view obscured value has been added to the images; the percent view unobscured is easily calculated from the value shown. The 20 views chosen for inclusion in this PAH are somewhat arbitrary and exemplary. Other views can be generated upon request using the ExP EI FOV model.

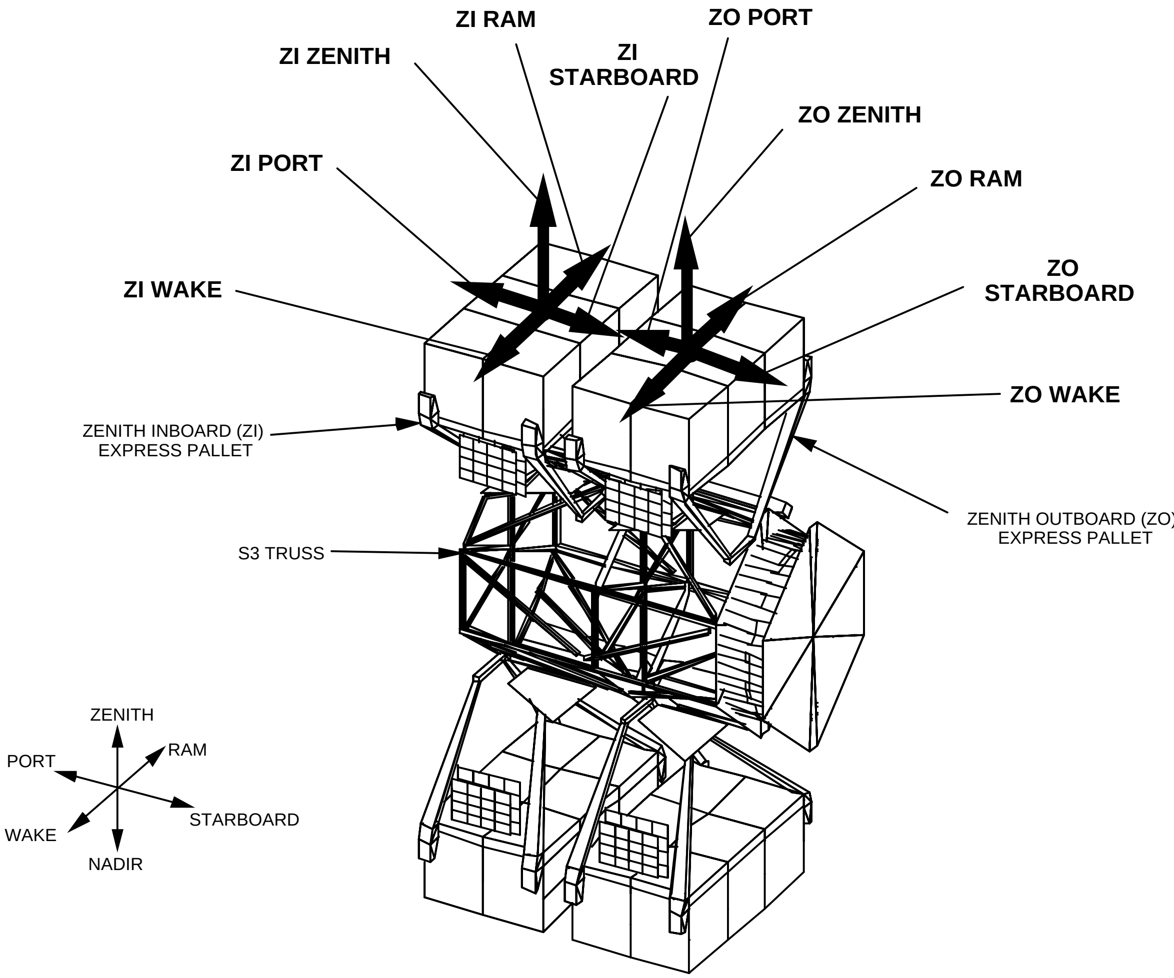


FIGURE B-1 ExP ON-ORBIT ZENITH VIEWING DIRECTIONS

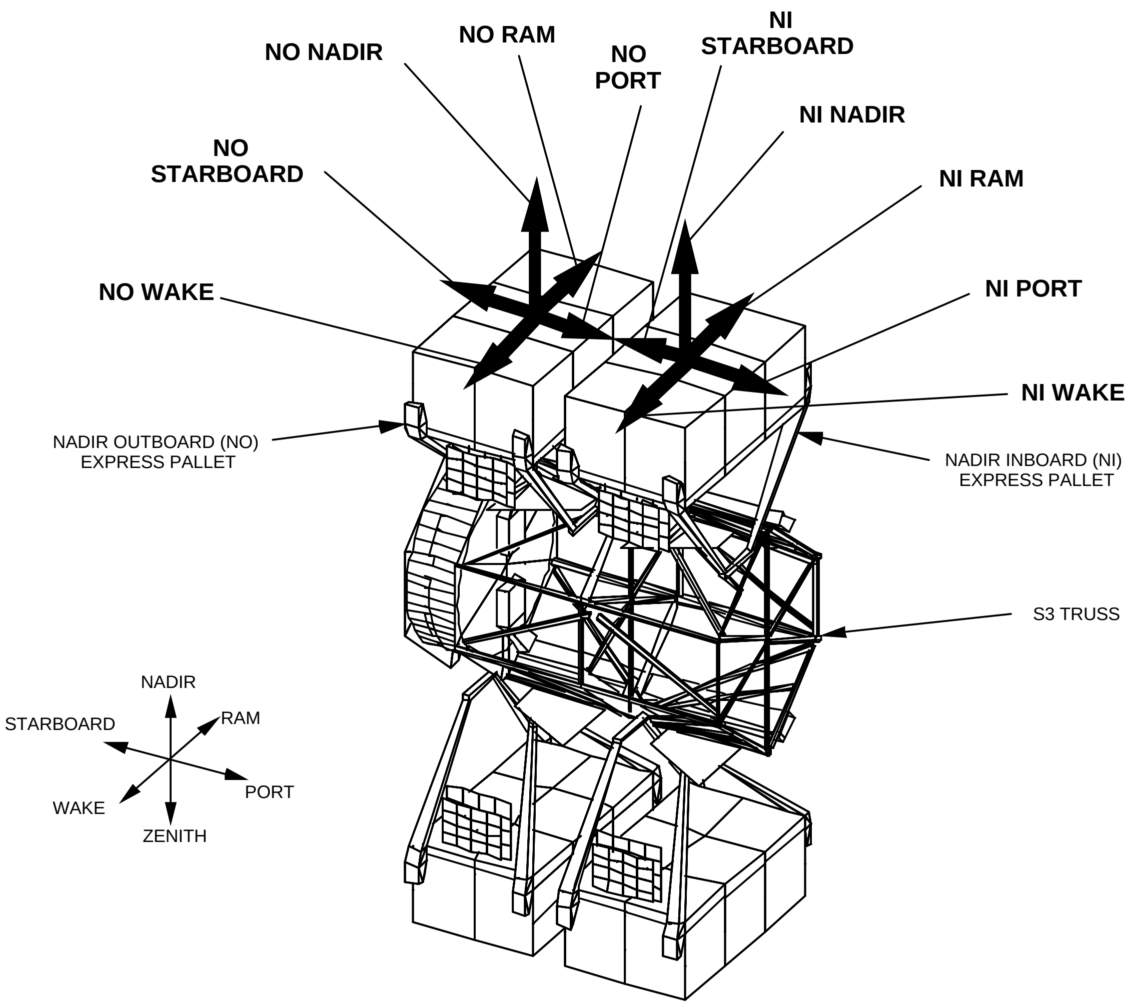


FIGURE B-2 ExP ON-ORBIT NADIR VIEWING DIRECTIONS

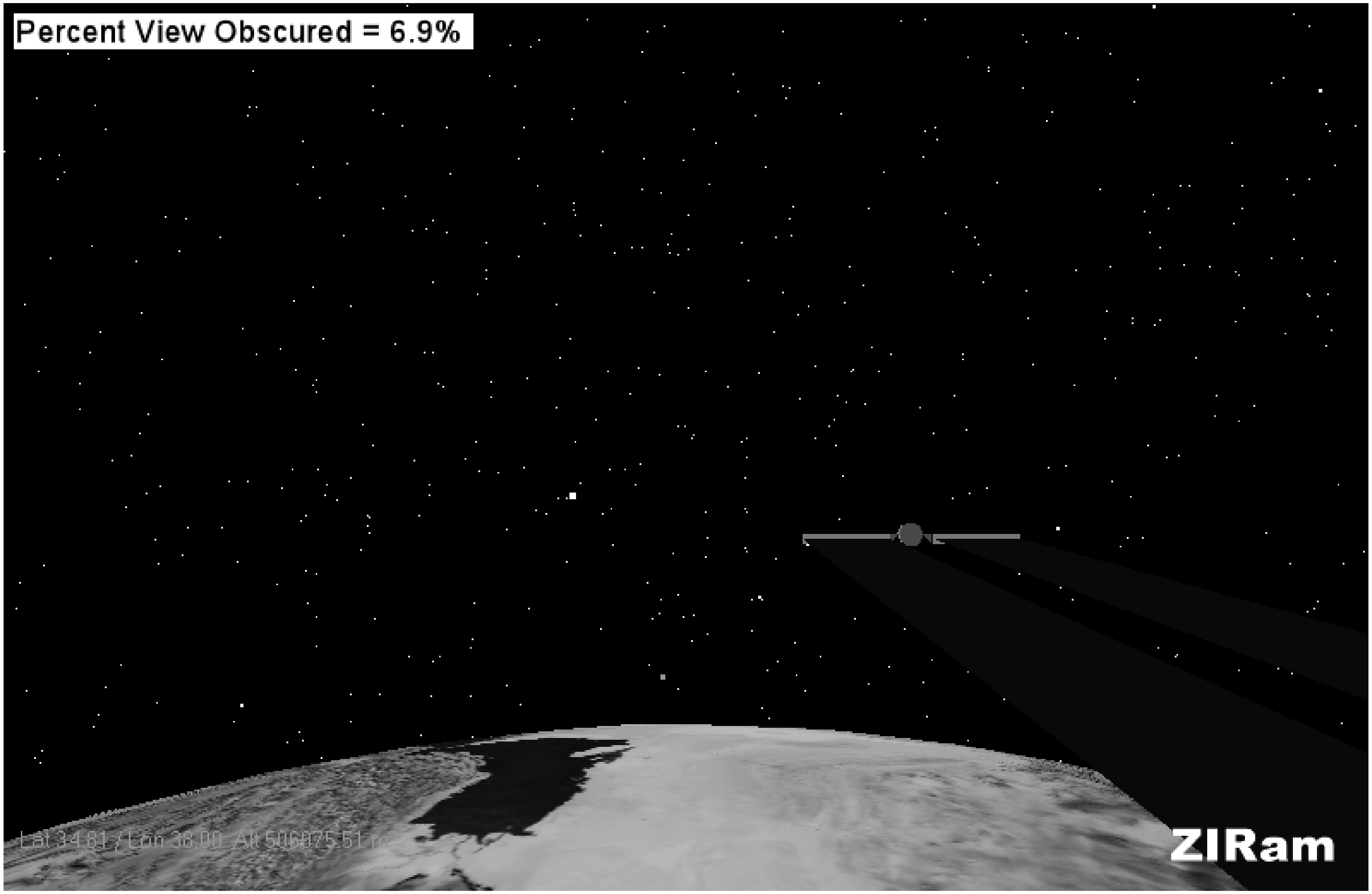


FIGURE B-3 ZENITH INBOARD ExP RAM VIEW

FIGURE B-4 ZENITH INBOARD ExP WAKE VIEW

FIGURE B-5 ZENITH INBOARD ExP ZENITH VIEW

FIGURE B-6 ZENITH INBOARD ExP STARBOARD VIEW

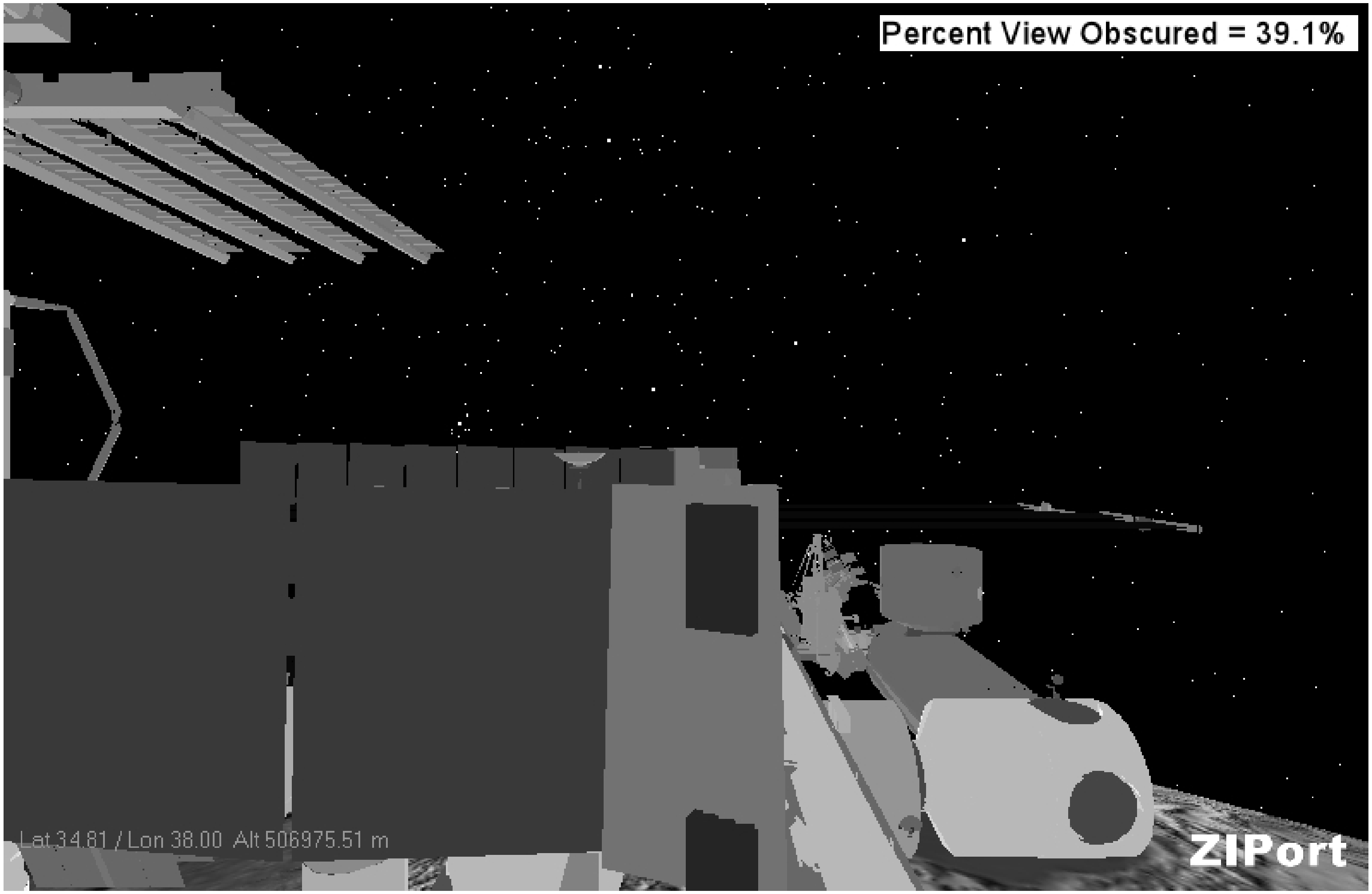


FIGURE B-7 ZENITH INBOARD ExP PORT VIEW

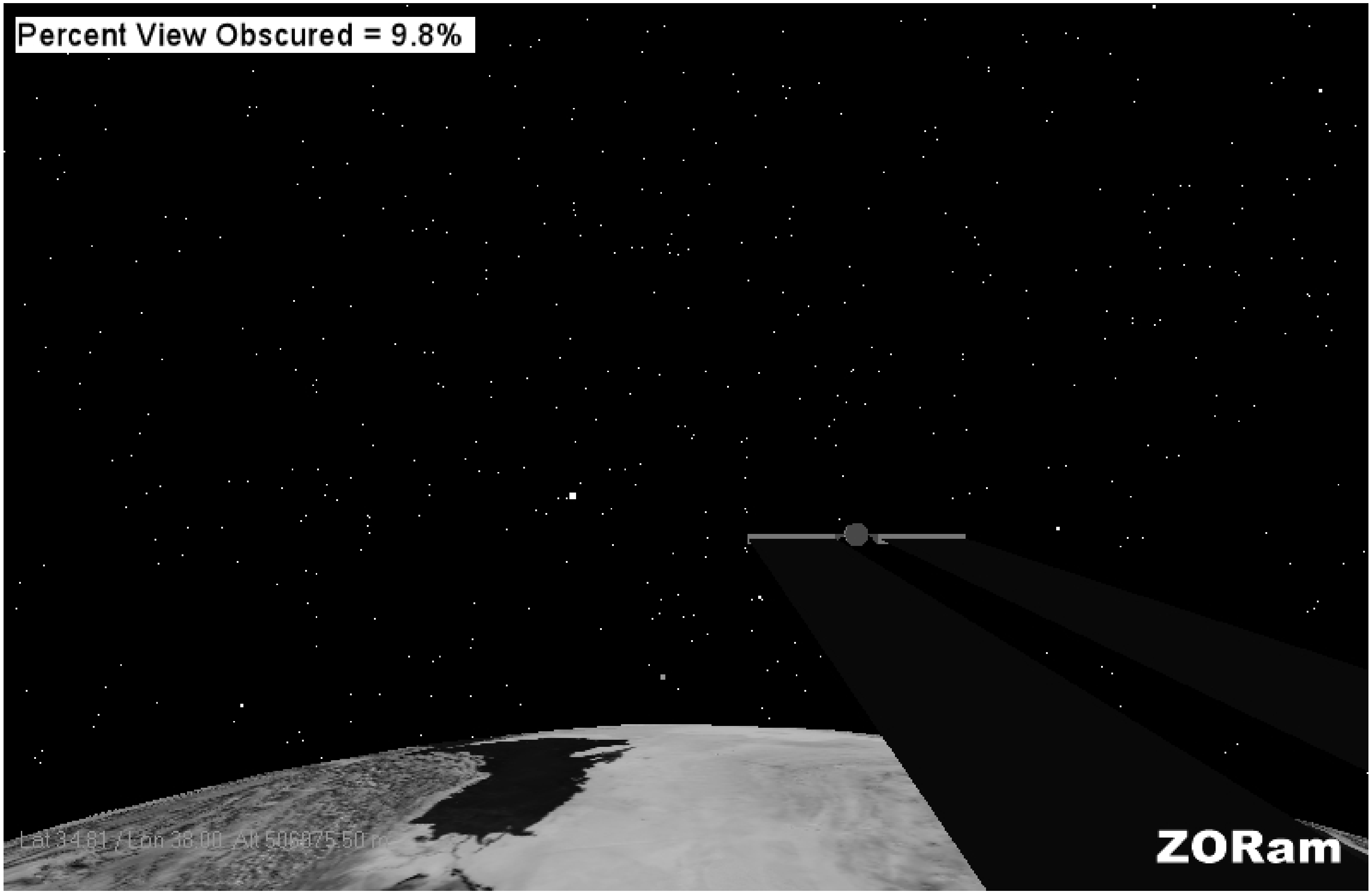
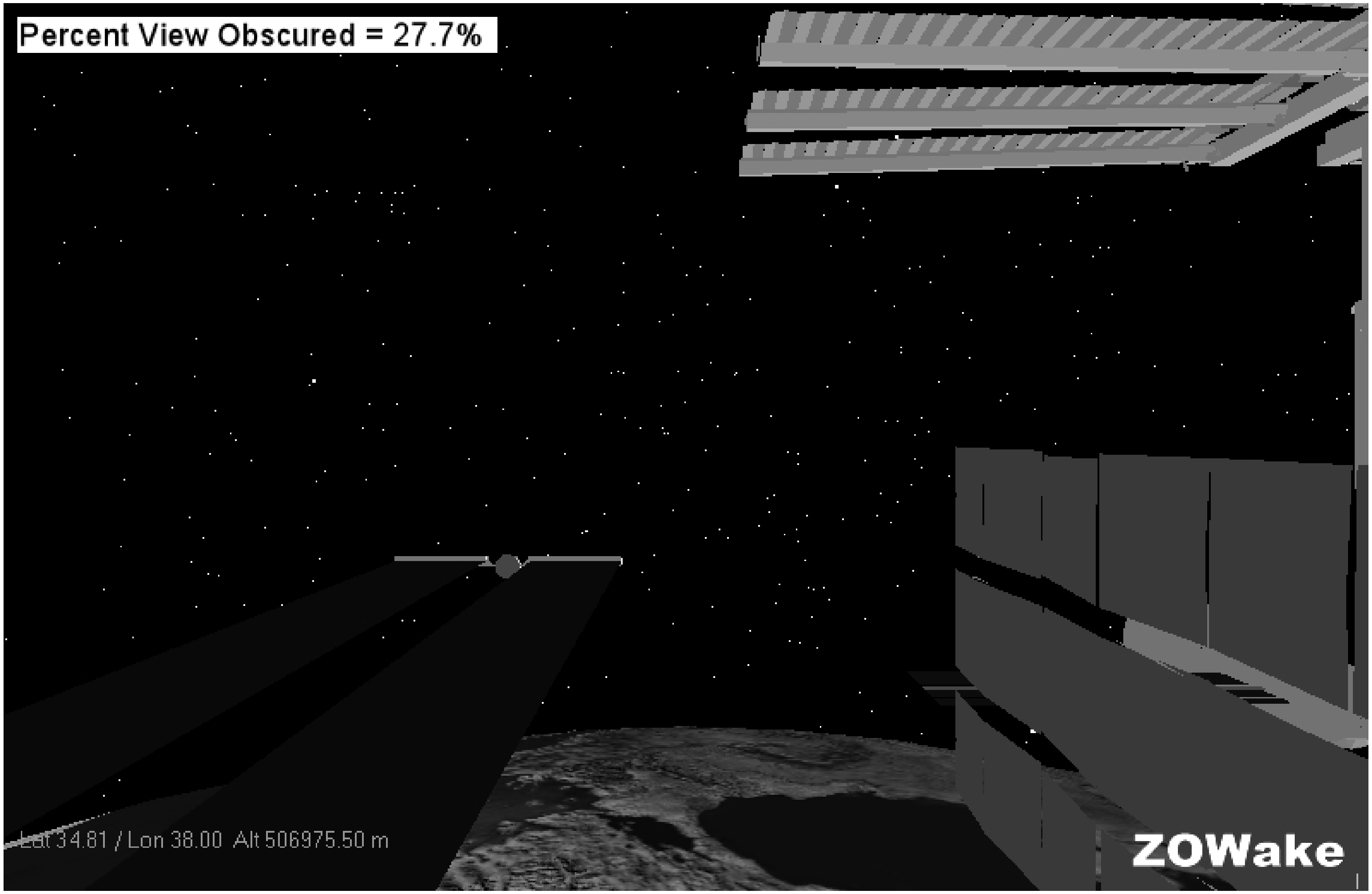


FIGURE B-8 ZENITH OUTBOARD ExP RAM VIEW



FIFURE B-9 ZENITH OUTBOARD ExP WAKE VIEW

FIGURE B-10 ZENITH OUTBOARD ExP ZENITH VIEW

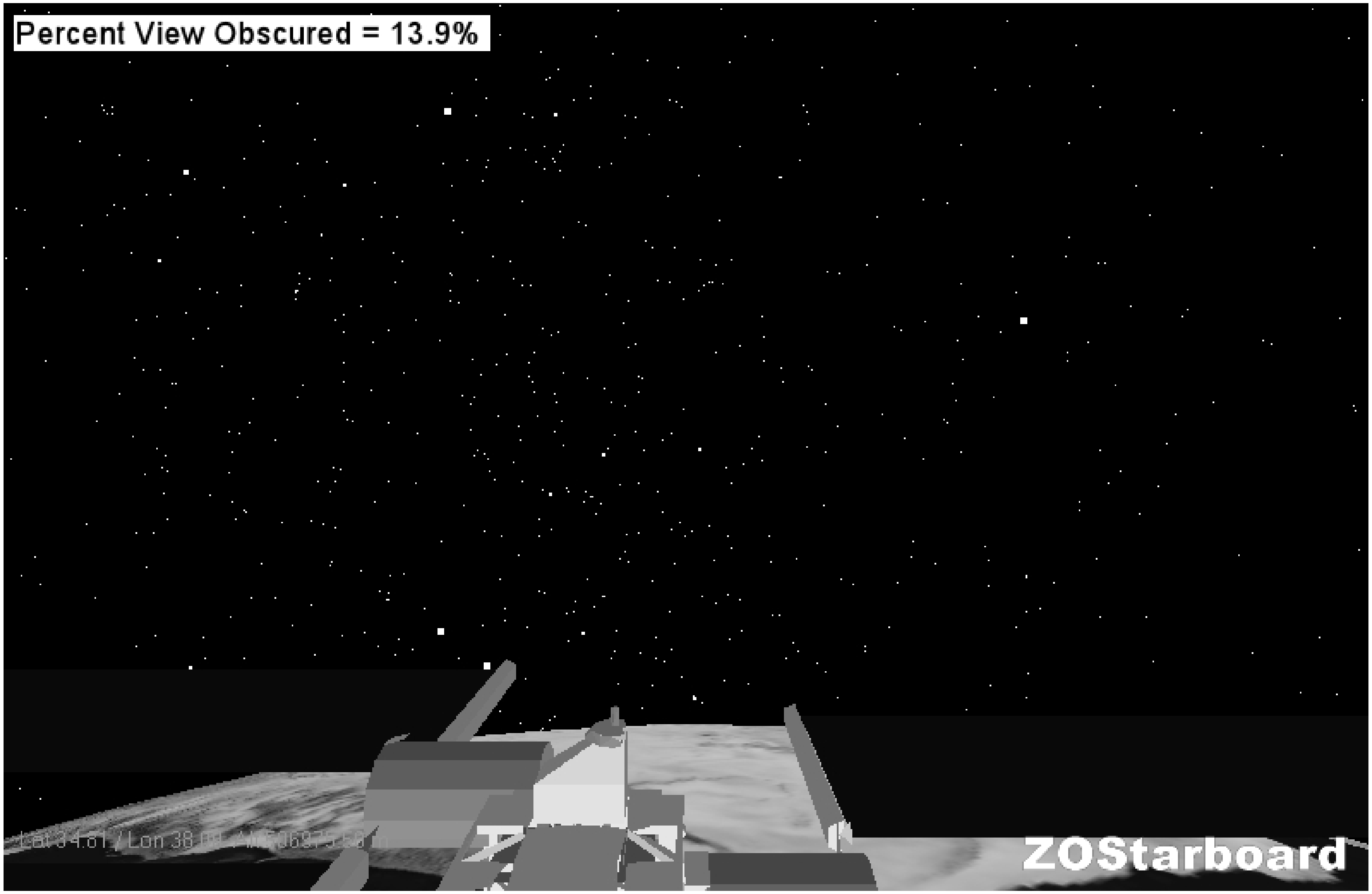


FIGURE B-11 ZENITH OUTBOARD ExP STARBOARD VIEW

FIGURE B-12 ZENITH OUTBOARD ExP PORT VIEW

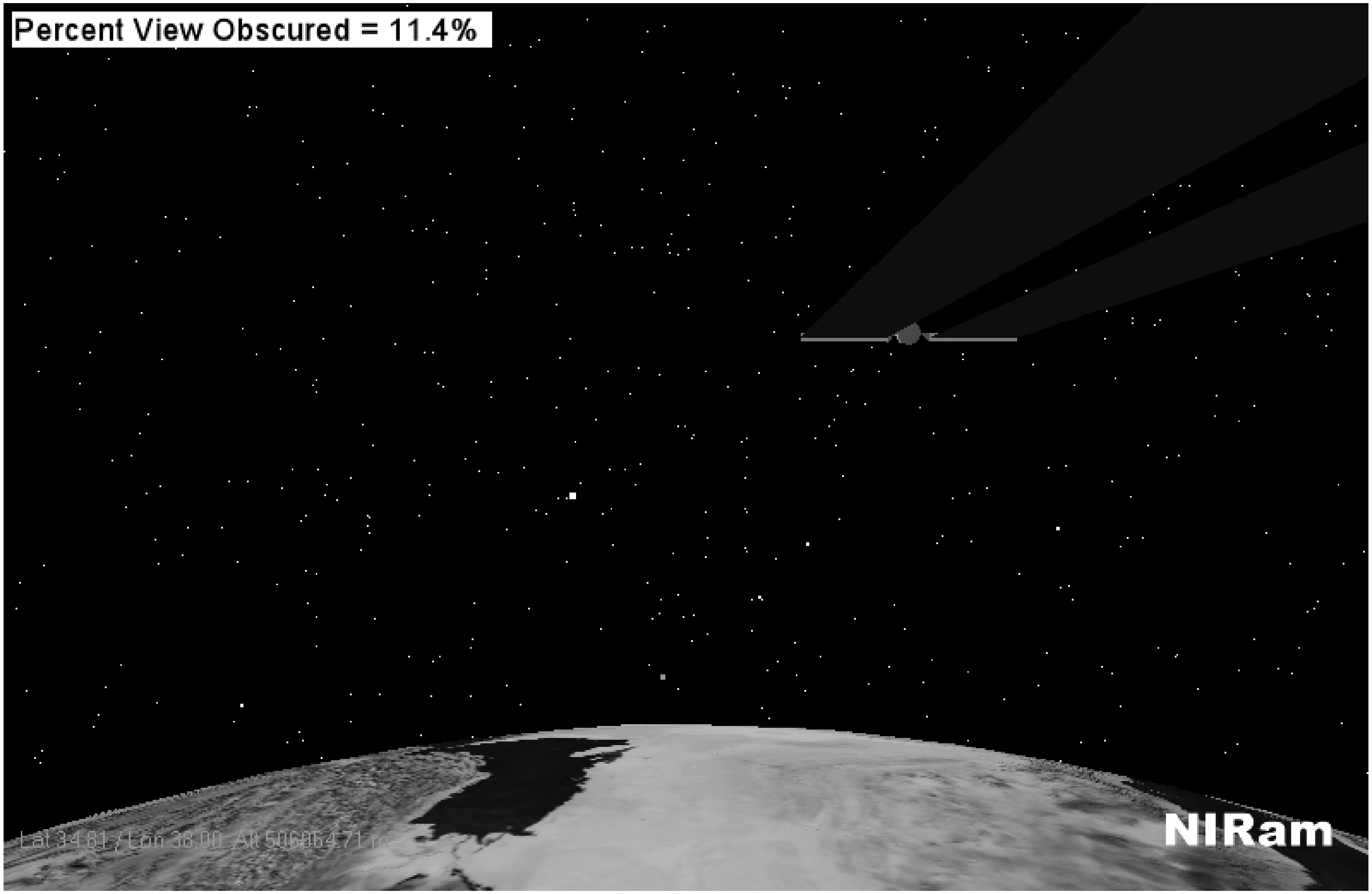


FIGURE B-13 NADIR INBOARD ExP RAM VIEW

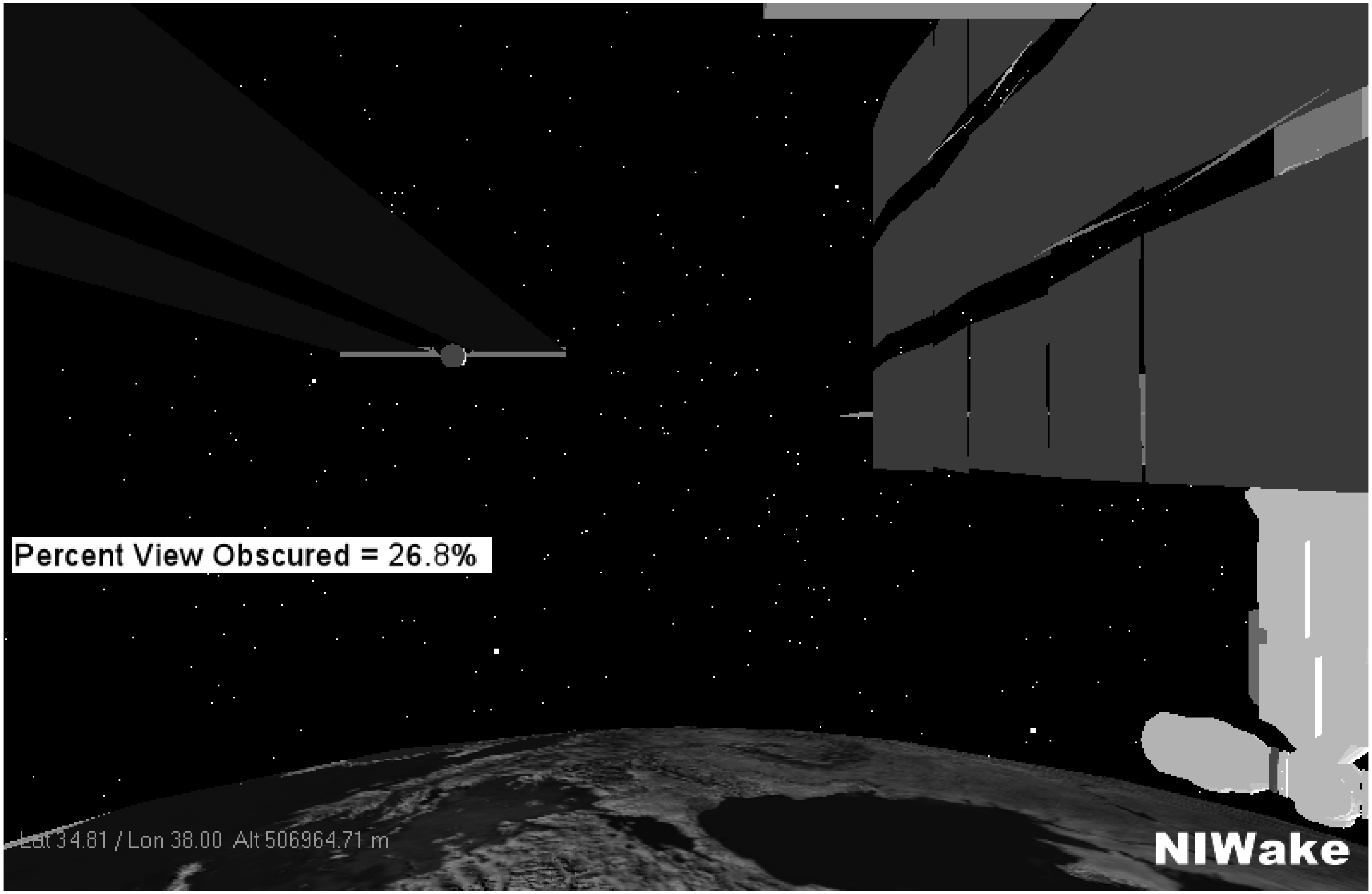


FIGURE B-14 NADIR INBOARD ExP WAKE VIEW

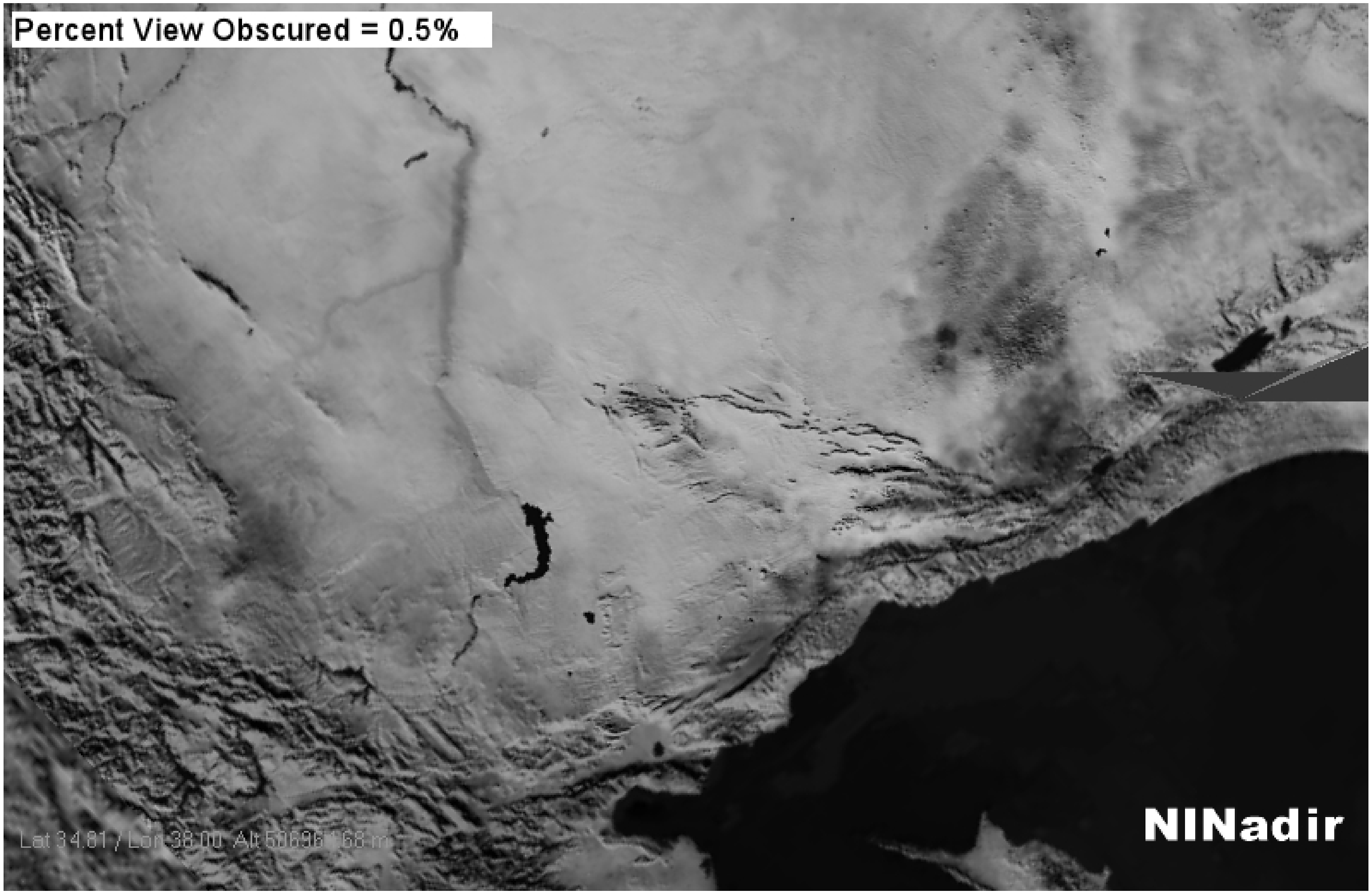


FIGURE B-15 ZENITH INBOARD ExP NADIR VIEW

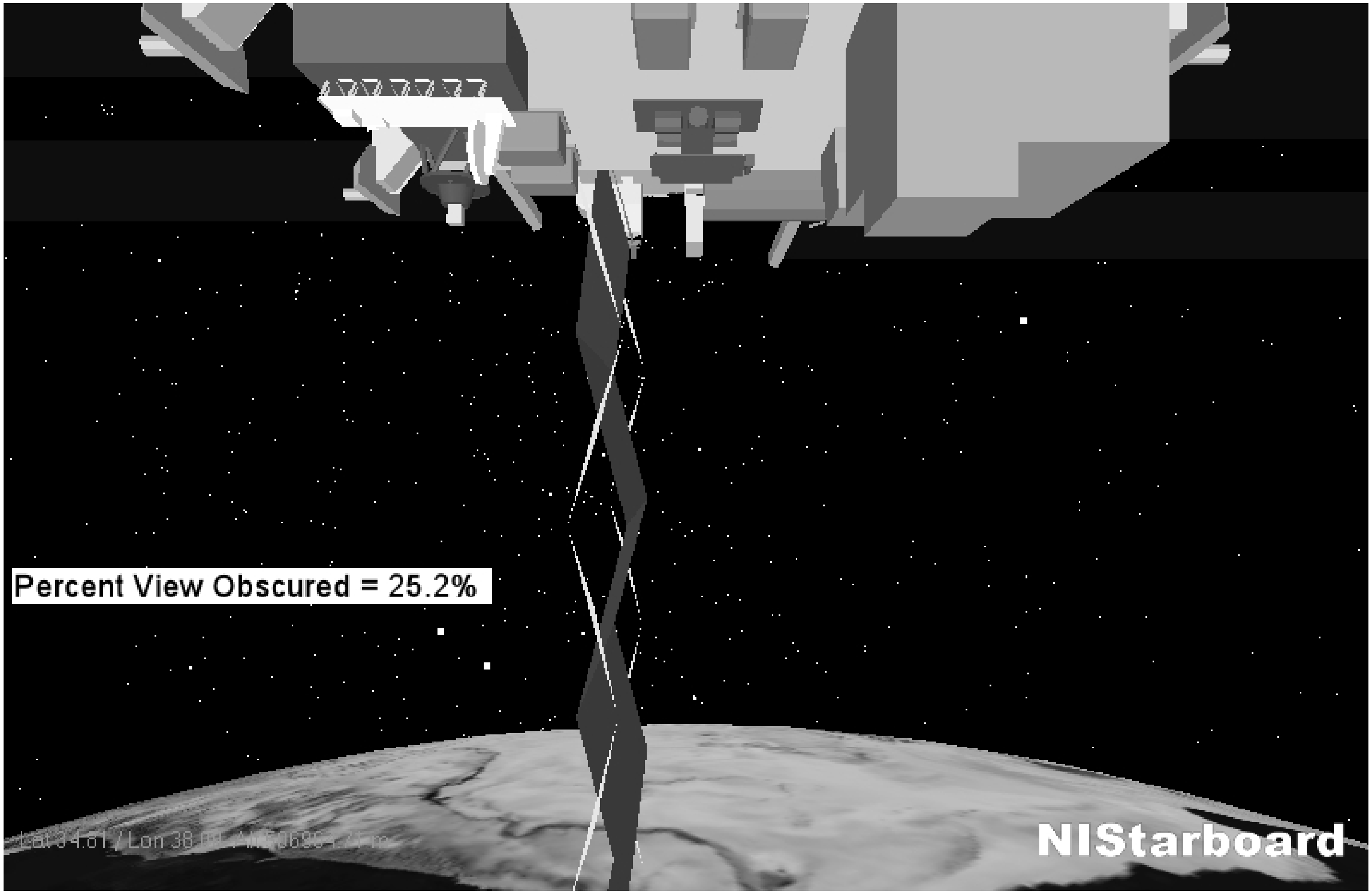


FIGURE B-16 NADIR INBOARD ExP STARBOARD VIEW

FIGURE B-17 NADIR INBOARD ExP PORT VIEW

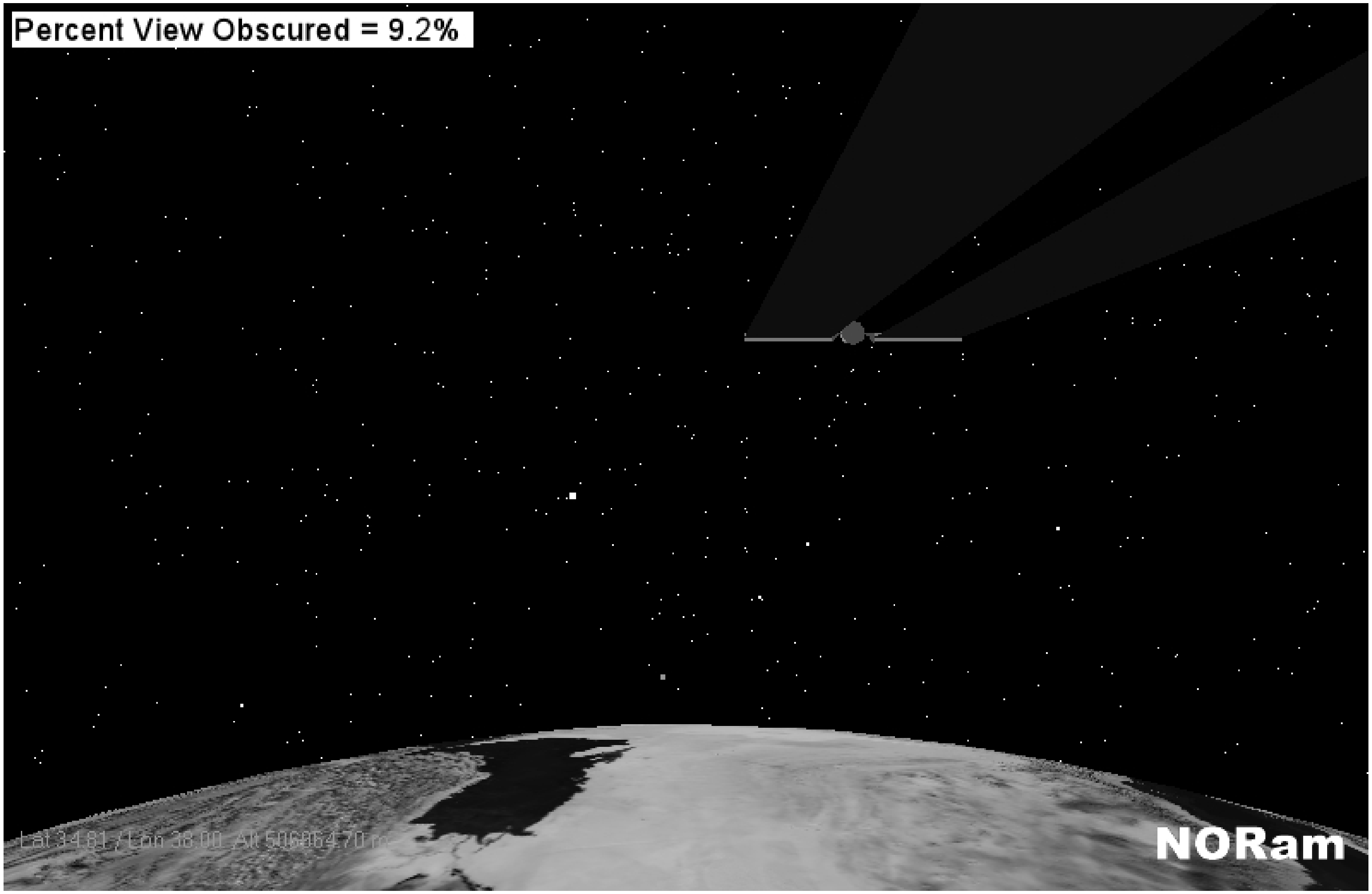


FIGURE B-18 NADIR OUTBOARD ExP RAM VIEW

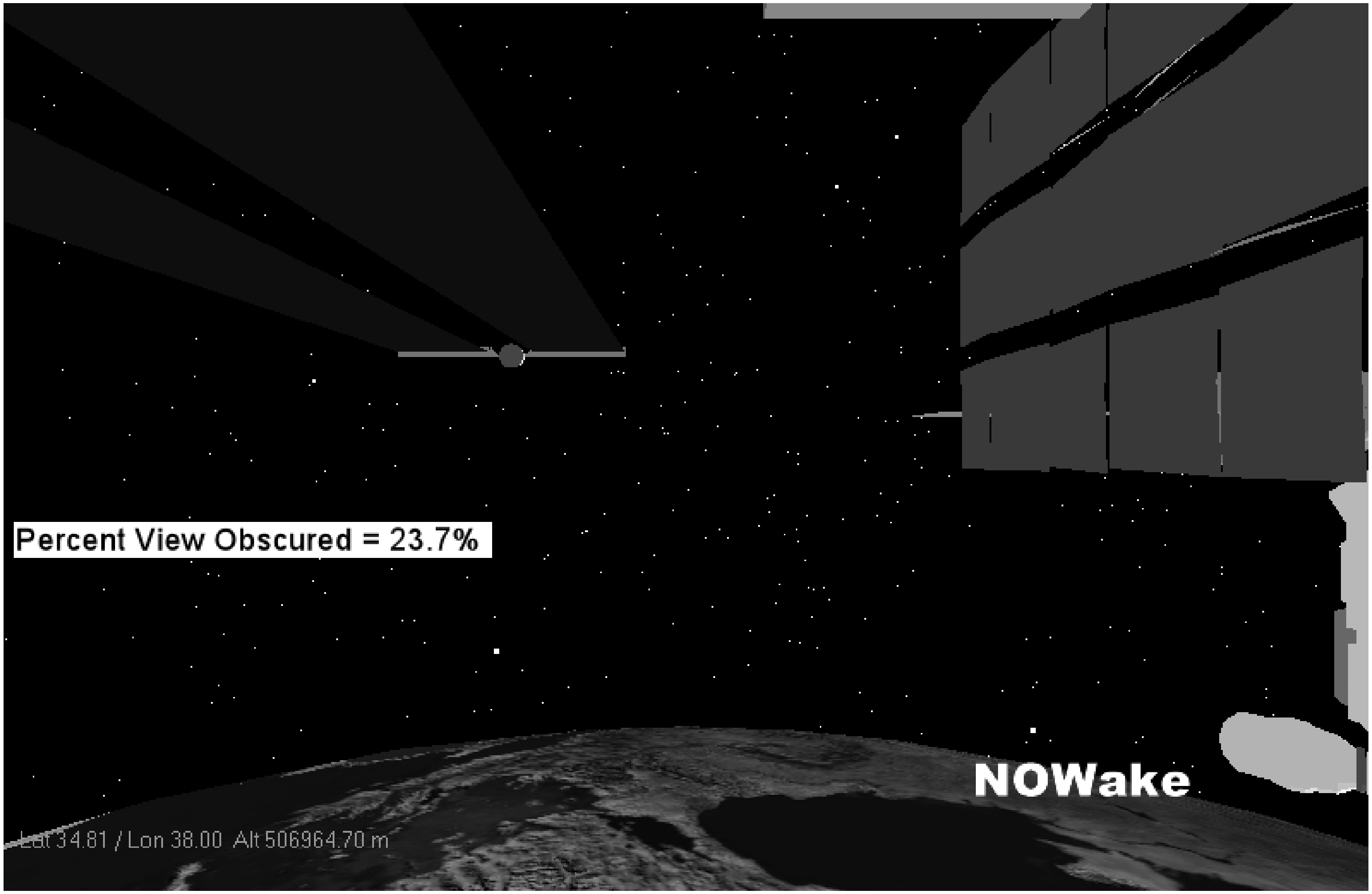


FIGURE B-19 NADIR OUTBOARD ExP WAKE VIEW

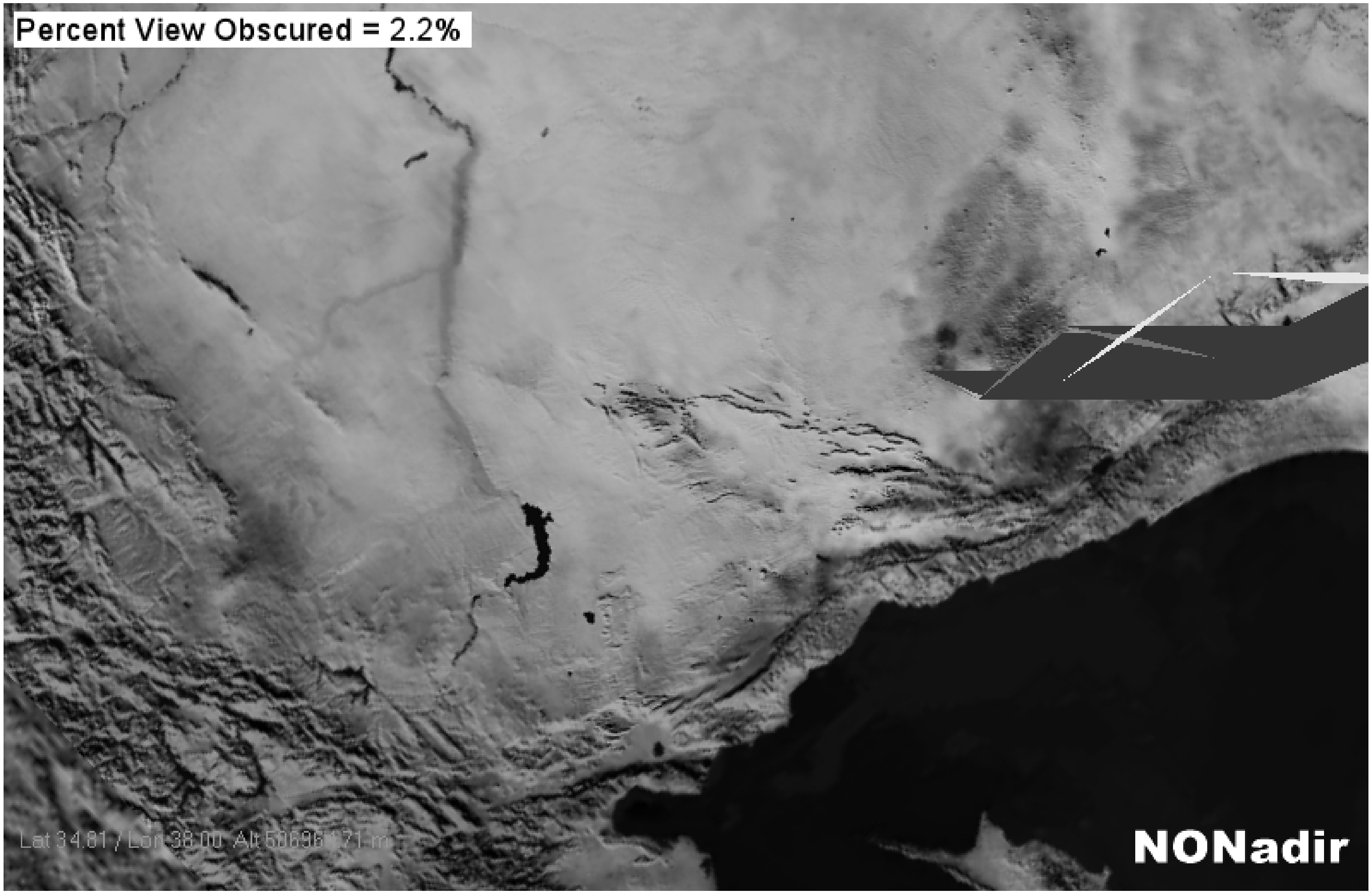


FIGURE B-20 NADIR OUTBOARD ExP NADIR VIEW

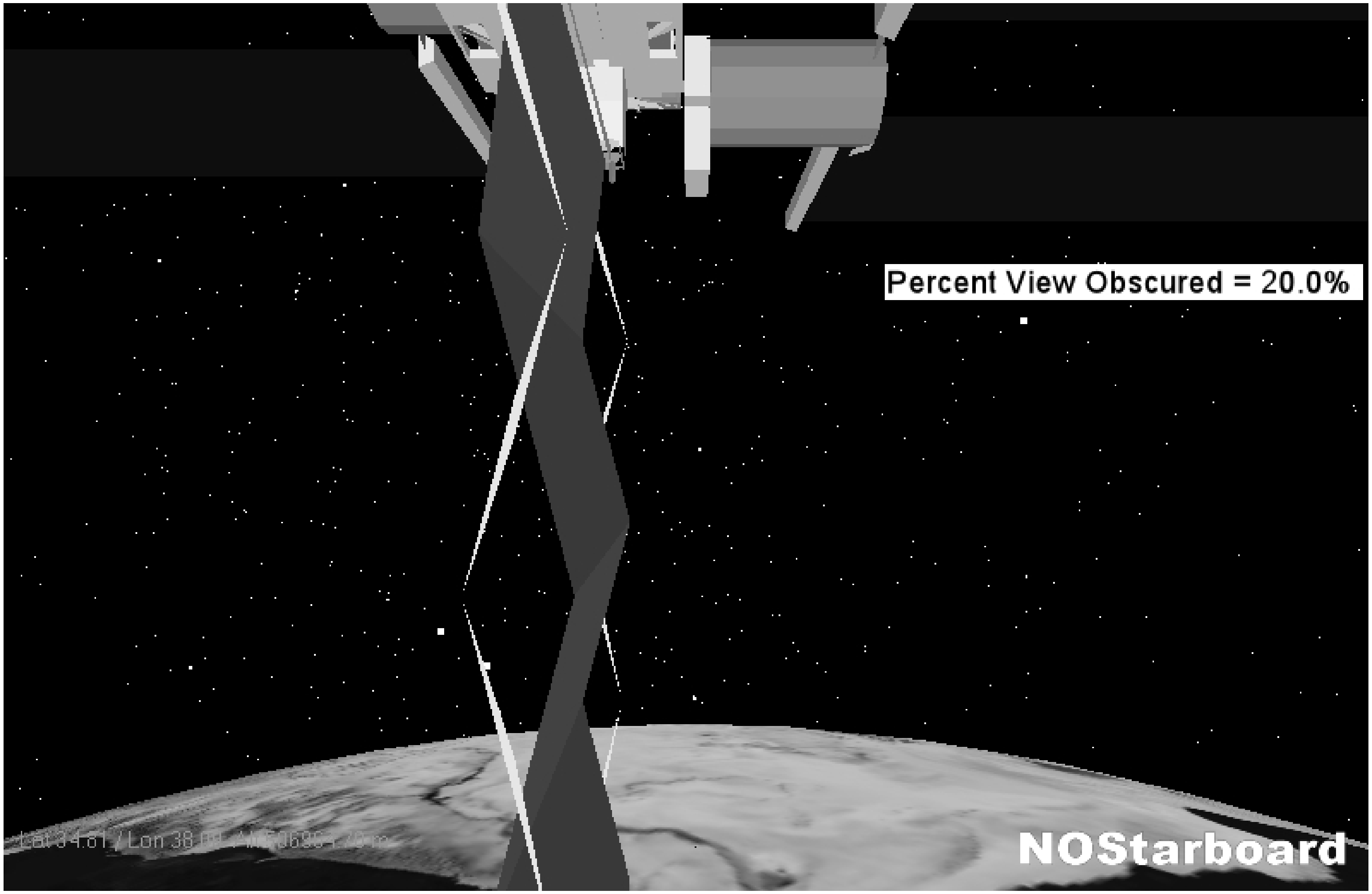


FIGURE B-21 NADIR OUTBOARD ExP STARBOARD VIEW

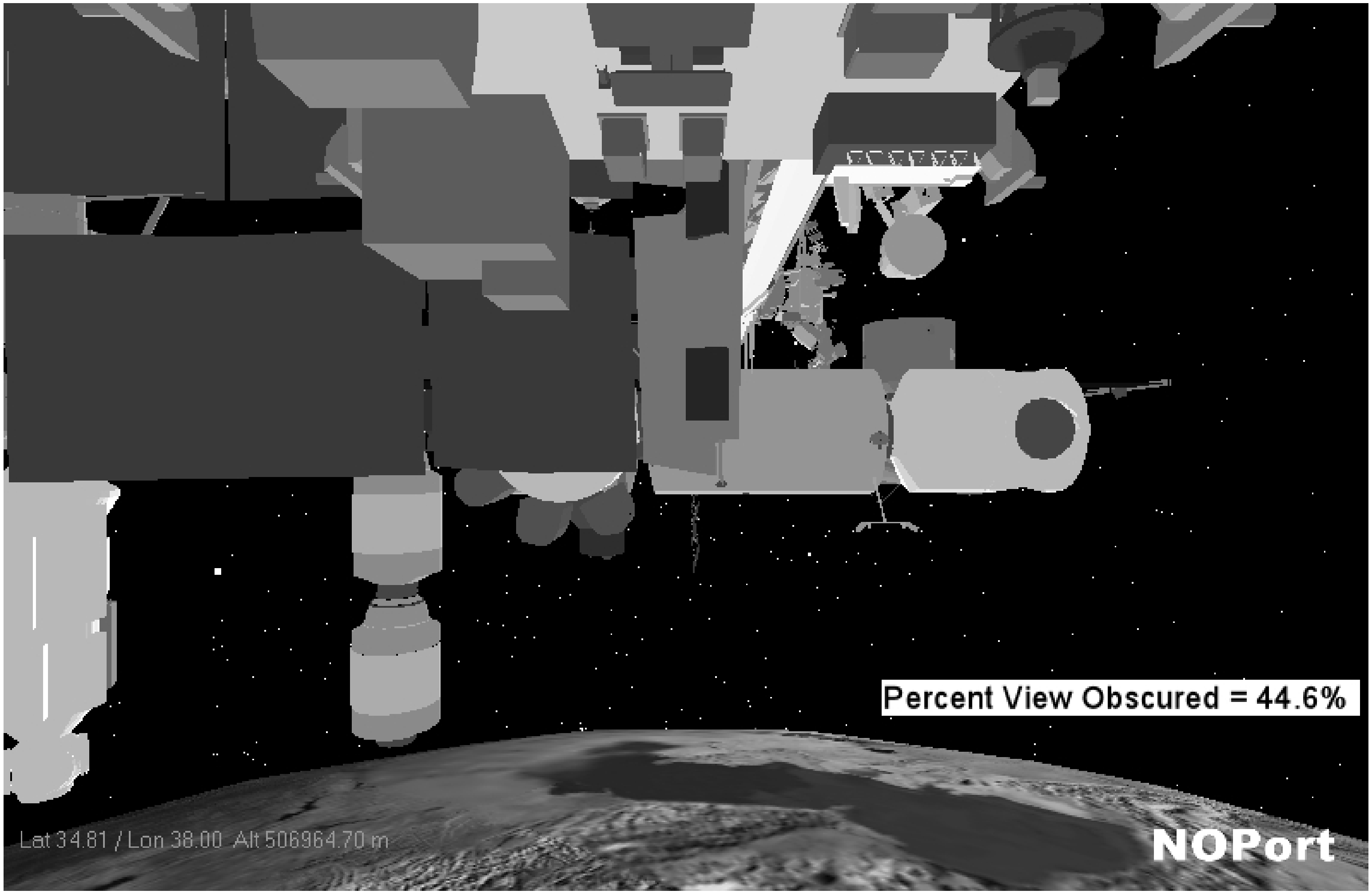


FIGURE B-22 NADIR OUTBOARD ExP PORT VIEW

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APPENDIX C

EXP INTEGRATION AND DELIVERABLES SCHEDULE

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APPENDIX C, EXP INTEGRATION AND DELIVERABLES SCHEDULE

The ExPs Integration and Deliverables Schedule documents the planned processes and milestones for the Pallet PDs. The generation of this document provides a coordination tool for review and concurrence of all the responsible organizations who are interdependent in this payload integration process. It is important that PDs understand this document as it relates to them. In many cases they have the responsibility to make initial data submittals. Timely and adequate data inputs are crucial to minimizing cost and schedule impacts to the process. Detailed definitions of the required data is identified in the EXPRESS Pallet Generic Payload Verification Plan, SSP 52000-PVP-EPP Verification Requirement Data Sheets (VRDS). It is assumed by that the payloads have successfully completed their CDR and Phase 2 Flight Safety Review no later than launch minus 24 months. It is also assumed that PDs are staffed to provide the front-loaded data requirement inputs needed to complete this integration cycle. Failure to adhere to the data submittal schedule contained in Table C-I/Payload Integration Schedule could result in deleting the payload from its scheduled mission.

This appendix consists of three sections. Section 1 is an introduction which provides an explanation/definition of the terms used. Section 2 documents program level activities and schedules which the PD is expected to participate in or support as identified. Section 3 documents the specific schedules for the PD processes and data submittal milestones.

Please note that not all process or milestone schedules require data deliverables from the PDs. Some schedules have minimal data inputs from PDs, while others will require extensive interaction over the integration cycle. Items of particular interest to PDs have been highlighted in bold print.

TABLE C-I

Section 1, Introduction

ExP INTEGRATION AND DELIVERABLES SCHEDULE

Table Headings

RESP - This column denotes the responsibilities for the item shown on the line. Each letter used in this column represents the following:

J	JSC Space Shuttle Program Office (SSP)
M	Mission Operations Directorate (MOD)
K	Kennedy Space Center (KSC)
E	EXPRESS Pallet/MSFC EXPRESS Pallet (ExP) EI Team, FD31
P	ISS Payload Program Office (OZ)
V	ISS Vehicle Program Office
S	ISS Payload Engineering Integration (PEI) (OZ)
C	Customer/Payload Developer/Research Program Office
O	Payload Operations Integrated Facility (POIF MOL)
F	Payload Software Integration/Verification Facility
L	ISS Launch Package Manager (OM)

Where letters are shown together, it indicates a joint activity; e.g., JCE means the JSC SSP, the customer, and the ExP are all involved. Where a letter is followed by a hyphen and other letter(s), it indicates a deliverable; e.g., C-KE means the customer submits the item to both KSC and ExP.

SCH CTL - This is the schedule control column. The document or organization which will control the actual mission schedule for the item on the line is shown per the following:

PIA	Payload Integration Agreement
HQS	NASA Headquarters
KSC	Payload Management and Operations
IMO	ISS Payload Program Office/Organization normally represented by the ISS Increment Manager
MOD	JSC Mission Operations Directorate
MIP	Mission Integration Plan
EPIA	Express Pallet Integration Agreement
EPPIM	MSFC Express Pallet Payload Integration Manager (FD31)

LPM	Launch Package Manager
PVP	Payload Verification Plan

ITEM - This column denotes the item scheduled. The organization maintaining configuration control of a baselined item will be shown in brackets [ ] using the same legend as identified under RESP above. Remarks are shown in parentheses ( ). When the remarks say "per (a document number)," the item being delivered must meet the requirements of a specified document.

GENERIC SCHEDULE - This column denotes the generic schedule date for the item on the line. All dates are shown in months (or weeks as appropriate) prior to launch unless stated otherwise. All dates shown are "no later than" dates. The following nomenclature is used in this column:

AR	As Required
L	Launch
PDR	Preliminary Design Review
CDR	Critical Design Review
I	ISS Increment
D	Delivery

VERIFICATION DATA - This column identifies the applicable verification data requirements as identified in the EXPRESS Pallet Generic Verification Plan, SSP 52000-PVP-EPP. The specific type of verification data submittal, Certificate of Compliance (COC), Analysis, Report, etc., as well as the specific VRDS numbers are defined in the verification plan. An N/A in the column indicates that there are no applicable verification requirements identified in the generic verification plan.

Section 2
Program Schedules/Milestones

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Program Milestones			
LKSCEP-J	LPM	Preliminary Mission Integration Plan (MIP) Inputs	L-22	N/A	N/A
LJ-KCEP	LPM	MIP Baseline [J]	L-16	N/A	N/A
LJCEPSV	LPM	Stage Integration Review (SIR)	L-15	N/A	N/A
LJCEPS	LPM	Station Cargo Integration Review (SCIR)	L-10	N/A	N/A
LJ-CEKP	LPM	Cargo Integration Review (CIR) Data Package	L-10	N/A	N/A
JCEKP	LPM	CIR	L-9	N/A	N/A
JCE	LPM	Phase 3 Integrated Payload Flight Safety Review	L-8	N/A	N/A
K-CEP	KSC	Ground Operations Review (GOR) Data Package	L-8	N/A	N/A
KCEP	KSC	Ground Operations Review (GOR)	L-7	N/A	N/A
KCEP	KSC	Ground Operations Working Group (GOWG)	AR	N/A	N/A
KCE	KSC	Phase 3 Integrated Payload Ground Safety Review	L-7	N/A	N/A
MO-CEP	LPM	Increment Operations Review (IOR) Data Package	L-5	N/A	N/A
MCEOP	LPM	IOR	L-4	N/A	N/A
MOCEP	LPM	Payload Operations Working Group (POWG)	AR	N/A	N/A
MO-CEP	LPM	Increment Operations Review (IOR) Data Package	L-5	N/A	N/A
MO-CEPJ	LPM	STS Flight Operations Review (FOR) Data Package	L-5	N/A	N/A
JCEPMO	LPM	FOR	L-4	N/A	N/A
JCEPMO	LPM	Flight Operations Working Group	AR	N/A	N/A
E-CKJPL	EPPIM	MSFC Flight Readiness Review (FRR 1)	L-2	N/A	N/A
LMECKPVO	LPM	Cert of Flight Readiness (COFR 1)	L-2	N/A	N/A
LJKCEVP	LPM	Payload Readiness Review (PRR)	L-1.5	N/A	N/A
E-CKJP	EXP	MSFC Flight Readiness Review (FRR 2)	L-1.5	N/A	N/A
LMECKPJVO	LPM	Cert of Flight Readiness (COFR 2)	L- 0.5	N/A	N/A
JKCEPVL	HQS	STS Flight Readiness Review	L- 0.5	N/A	N/A
KJCEPL	KSC	Payload Mission Management Countdown Review	L-5 days	N/A	N/A
KJCEPL	KSC	Mission Management/Astronaut Team Review	L-2 days	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Integrated EXPRESS Pallet Reviews			
E-CJSP	EPPIM	Integrated ExP Compatibility Review (IECR) Review Data	L-18.5	N/A	N/A
ECJSP	EPPIM	IECR	L-18	N/A	N/A
EC-KJP	EPPIM	Integrated ExP Integration Readiness Review (IEIRR) Data	L-7	N/A	N/A
ECKJP	EPPIM	IERR	L-6.5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Ground Operations			
K-EC	KSC	Generate Baseline OMRSD	L-13	N/A	N/A
C-EK	EPIA	Payload On-Dock at KSC with Acceptance Data Package (ADP)	L-6	N/A	N/A
CEK	KSC	Support Payload off-line Testing	L-6 thru L-4	N/A	N/A
CE-K	KSC	Support KSC Testing (Payload to ExP)	L-3 thru L-2	N/A	N/A
CE-K	KSC	Support KSC Testing (ExP to STS)	L-2 thru L-1	N/A	N/A
CEK	KSC	Generate As Built Configuration List (ABCL)	L-6 thru L-4	N/A	N/A
CEK	KSC	Review and Disposition of Problem Reports (PR) and Field Engineering Changes (FEC)	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EXPRESS and Payload Hardware			
E-C	EPIA	STEP/EP Delivery to Payloads	AR	N/A	N/A
C-E	EPIA	STEP/EP Return to MSFC	D+1	N/A	N/A
E-C	EPIA	ExPA Delivery to Payloads	L-12	N/A	N/A
C-K	MIP	Payload/ExPA On-Dock at KSC	L-6	N/A	N/A
C-K	KSC	Payload/ExPA Turnover to KSC	L-3	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Mission Integration Plan (MIP)			
PKEC-L	LPM	Preliminary MIP Inputs	L-22	N/A	N/A
L-CEKP	LPM	Baseline Draft MIP CR	L-20.5	N/A	N/A
CEKPL	LPM	Initial MIP Meeting	L-19.5	N/A	N/A
L-CEKP	LPM	MIP Baseline Draft	L-17	N/A	N/A
CEKPL	LPM	Final MIP Meeting (Telecon)	L-16.5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EXPRESS Pallet Integration Agreement (EPIA) and EPIA Increment Addendum (EPIA IA)			
C-EP	EPPIM	Initial EPIA Inputs	L-24	N/A	N/A
C-EP	EPPIM	Initial EPIA IA Inputs	L-24	N/A	N/A
PE-C	EPPIM	Initial EPIA Draft	L-23	N/A	N/A
PE-C	EPPIM	Initial EPIA IA Draft	L-23	N/A	N/A
ECP	EPPIM	EPIA Initial Meeting	L-21.5	N/A	N/A
ECP	EPPIM	EPIA IA Initial Meeting	L-21.5	N/A	N/A
PE-C	EPPIM	EPIA Baseline Draft	L-21	N/A	N/A
PE-C	EPPIM	EPIA IA Baseline Draft	L-21	N/A	N/A
ECP	EPPIM	Final EPIA Meeting (Telecon)	L-20.5	N/A	N/A
ECP	EPPIM	Final EPIA IA Meeting (Telecon)	L-20.5	N/A	N/A
C	EPPIM	EPIA Sign	L-20	N/A	N/A
C	EPPIM	EPIA IA Sign	L-20	N/A	N/A
ECP	EPPIM	EPIA Baseline [P]	L-19.5	N/A	N/A
ECP	EPPIM	EPIA IA Baseline [P]	L-19.5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Payload Integration Agreement (PIA) and PIA Increment Addendum (PIA IA)			
C-E	EPIA	Initial PIA Inputs	L-24	N/A	N/A
C-E	EPIA	Initial PIA IA Inputs	L-24	N/A	N/A
P-EC	IMO	PIA Baseline Draft	L-18.5	N/A	N/A
P-EC	IMO	PIA IA Baseline Draft	L-18.5	N/A	N/A
PEC	IMO	Final PIA Meeting (Telecon)	L-18	N/A	N/A
PEC	IMO	Final PIA IA Meeting (Telecon)	L-18	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EXPRESS Pallet/Payload Interface Control Document (ICD)			
EC	EPIA	ExP/Payloads ICD TIM	L-26	N/A	N/A
C-E	EPIA	ExP/Payload ICD Inputs	L-24	N/A	N/A
E-C	EPIA	ExP/Payload ICD Initial Draft	L-23	N/A	N/A
EC	EPIA	ExP/Payload ICD Draft Updates	L-22	N/A	N/A
E-C	EPIA	ExP/Payload ICD Baseline Draft	L-21	N/A	N/A
EC	EPIA	ExP/Payloads ICD Baseline [E]	L-19	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EXPRESS Pallet/Payload Verification Plan (PVP)			
C-E	EPIA	Initial PVP Submit	L-24	N/A	N/A
E-C	EPIA	Initial PVP Draft	L-23	N/A	N/A
EC	EPIA	PVP Updates	L-22	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EXPRESS Pallet/Payload Verification Plan (PVP) (Continued)			
E-C	EPIA	PVP Baseline Draft	L-21	N/A	N/A
EC	EPIA	PVP Baseline [E]	L-20	N/A	N/A
C-E	PVP	Submit Payload Verification Items	L-20 to L-8	N/A	N/A
EC	PVP	Disposition Verification Items and Resolve any Discrepancies	L-20 to L-6	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Payload Configuration Data Set			
C-E	EPIA	Preliminary User Input per PDL	L-25	N/A	N/A
E-C	EPIA	Data Set Assessment	L-24	N/A	N/A
C-E	EPIA	Final User Input per PDL	L-19	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Payload Command and Data Handling Data Set			
C-E	EPIA	Preliminary User Input per PDL	L-24	N/A	N/A
E-C	EPIA	Data Set Assessment	L-23	N/A	N/A
E-CJS	PIA	Initial Submission of Integrated ExP C&DH Data Set	L-18	N/A	N/A
C-E	EPIA	Final User Updates	L-10	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Payload Training Data Set			
C-O	EPIA	User Input per PDL	I-22	N/A	N/A
C-O	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Ground Services Data Set			
C-O	EPIA	User Input	I-22	N/A	N/A
C-O	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Payload Operations Data Set			
C-O	EPIA	User Input	L-22	N/A	N/A
C-O	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Payload Planning Data Set			
C-O	EPIA	User Input	L-22	N/A	N/A
C-O	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		KSC Technical Data Set			
C-EK	EPIA	User Input	L-16	N/A	N/A
EK-C	EPIA	Data Set Assessment	L-15	N/A	N/A
C-EK	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		KSC Support Data Set			
C-EK	EPIA	User Input	L-16	N/A	N/A
EK-C	EPIA	Data Set Assessment	L-15	N/A	N/A
C-EK	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EVA Data Set			
C-EOM	EPIA	User Input	I-22	N/A	N/A
C-EOM	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EVR Data Set			
C-EOM	EPIA	User Input	I-22	N/A	N/A
C-EOM	EPIA	User Updates	AR	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Ground Safety			
C-KE	LPM	Phase 0/1 Ground Safety Review Data Package	PDR+45 days	N/A	N/A
KCE	LPM	Phase 0/1 Ground Safety Review	PDR+90 days	N/A	N/A
C-KE	LPM	Phase 2 Ground Safety Review Data Package	CDR+45 days	N/A	N/A
KCE	LPM	Phase 2 Ground Safety Review	CDR+90 days	N/A	N/A
C-E	EPIA	Phase 3 Ground Safety Review Data Package	L-11.5	N/A	N/A
EC-K	LPM	Phase 3 Integrated ExP Ground Safety Review Data Package	L-8.5	N/A	N/A
KEC	LPM	Integrated ExP Phase 3 Ground Safety Review	L-7	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Flight Safety			
C-EL	LPM	Phase 0/1 Flight Safety Review Data Package	PDR+45 days	N/A	N/A
LCE	LPM	Phase 0/1 Flight Safety Review	PDR+90 days	N/A	N/A
C-EL	LPM	Phase 2 Flight Safety Review Data Package	CDR+45 days	N/A	N/A
LCE	LPM	Phase 2 Flight Safety Review	CDR+90 days	N/A	N/A
ELC	LPM	Integrated Payload Phase 2 Flight Safety Review	L-15.5	N/A	N/A
C-E	EPIA	Phase 3 Flight Safety Review Data Package	L-12.5	N/A	N/A
EC-L	LPM	Phase 3 Integrate ExP Flight Safety Review Data Package	L-9.5	N/A	N/A
JECL	LPM	Integrated ExP Phase 3 Flight Safety Review	L-8	N/A	N/A

Section 3
Payload Developer (PD) Schedules/Milestones

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Mechanical			
C – E	EPIA	Payload Top Assembly Dwg	L- 25	Drawings	N/A
C – E	EPIA	Payload Motion Envelope Dwg	L - 25	Drawings	N/A
C-EK	KSC	Preliminary Engineering Configuration List (ECL)	L-18	ECL	N/A
C-E	EPIA	Updated Payload Drawings Including Envelope exceedances, Deviations and Waivers	L - 14	Drawings	N/A
C-E	EPIA	Final As Built Payload Assembly Drawings, including envelope exceedances	L-9	Drawings	N/A
C – E	EPIA	Verify PL Interface surface is compatible with ExPA	L – 7	COC	MP-EP-001
C – E	EPIA	Verify PL Interface hardware is compatible with requirements	L – 7	COC	MP-EP-002
C – E	EPIA	Verify PL Interface drawings and analyses comply with requirements	L – 7	COC	MP-EP-003
C – E	EPIA	Verify PL static envelopes comply with requirements	L – 7	COC	MP-EP-004

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Structures			
C-JESL	EPIA	Payload Structural Verification Plan (SSP and ISS)	L-27	Plan	N/A
C-E	EPIA	Preliminary Payload Dynamic Models (SSP and ISS)	L-27	Models	N/A
JESL-C	EPIA	Payload Verification Plan Approval	L-25	N/A	N/A
C-E	EPIA	Initial Payload Mass Properties	L-25	Report	N/A
E-C	EPIA	Initial SSP Design Coupled Loads Data to Payloads	L-23	N/A	N/A
C-E	EPIA	Payload Fracture Control Plan	L-22.5	COC	ST-EP-018

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Structures (Continued)			
C-E	EPIA	Payload Element Fracture Disposition	L-22.5	Plan	ST-EP-018
C-E	EPIA	Initial Payload Structural Assessment	L-22.5	COC	ST-EP-002
C-E	EPIA	Summarize Factors of Safety in Payload Structural Assessment	L-22.5	COC	ST-EP-017
C-E	EPIA	Payload Mass Properties Quarterly Update No. 1	L-22	Report	N/A
C-E	EPIA	Payload Mass Properties Quarterly Update No. 2	L-19	Report	N/A
C-E	EPIA	Verify Payload Frequencies Above 35 Hz @ Launch and Landing	L-19	COC	ST-EP-001
C-E	EPIA	Verify Payload Analyses Include Acoustic Impingement Effects	L-19	COC	ST-EP-019
C-E	EPIA	Verify Payload Analyses Include Berthing Loads	L-19	COC	ST-EP-003
C-E	EPIA	Verify Payload Analyses Include Reboost Loads	L-19	COC	ST-EP-004
C-E	EPIA	Verify Payload Analyses Include Operational Loads	L-19	COC	ST-EP-005
C-E	EPIA	Verify no Payload Structural Testing While Attached to Shipping Container	L-19	COC	ST-EP-021
C-E	EPIA	Verify Ground Handling Boundary Conditions used in Analyses	L-19	COC	ST-EP-021
C-E	EPIA	Payload Mass Properties Quarterly Update No. 3	L-16	Report	N/A
S-EC	PIA	ISS On-Orbit DLA Results	L-15	N/A	N/A
C-E	EPIA	Verify Payload is 2-Fault Tolerant to Breaching the Cargo Bay Envelope	L-14	COC	ST-EP-013
C-E	EPIA	Verify Payload has Applied Appropriate Mass/CG Relationship to Determine ExPA Interface Loads	L-14	COC	ST-EP-006
C-E	EPIA	Summary Listing of all Trsansportation Loads Analyzed and Showing Positive Margins of Safety	L-13	COC	ST-EP-021
C-E	EPIA	Payload Mass Properties Quarterly Update No. 4	L-13	Report	N/A
C-E	EPIA	Payload Fracture Analysis	L-13	Analysis	ST-EP-018

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Structures (Continued)			
C-E	EPIA	Verify Payload can Withstand On-Orbit Loads Including Thermal Effects	L-13	COC	ST-EP-007
C-E	EPIA	Verify Payload can Withstand EVA Induced Loads	L-13	COC	ST-EP-008
C-E	EPIA	Verify Payload can Withstand EVR Induced Loads	L-13	COC	ST-EP-009
C-E	EPIA	Verify Payload can Withstand SRMS Induced Loads	L-13	COC	ST-EP-010
C-E	EPIA	Verify Payload can Withstand SSRMS Induced Loads	L-13	COC	ST-EP-011
C-E	EPIA	Verify Payload can Withstand SPDM Induced Loads	L-13	COC	ST-EP-012
C-E	EPIA	Verify Payload can Withstand On-Orbit Random Vibration Loads	L-13	COC	ST-EP-014
C-E	EPIA	Verify Payload can Withstand Berthing Impact Loads and On-Orbit Accelerations	L-13	COC	ST-EP-015
C-E	EPIA	Payload Structural Assessment and SCS Margins of Safety Using DLA Loads	L-13	COC	ST-EP-017
C-E	EPIA	Payload Element Fracture Control Analyses	L-13	COC	ST-EP-018
C-E	EPIA	Payload Acoustic Impingement Effects Summary of all Load Cases Analyzed	L-13	COC	ST-EP-019
C-E	EPIA	Payload Fracture Control Summary	L-13	COC	ST-EP-018
ECJSL	PIA	Pre-Verification Review	L-11	N/A	N/A
C-E	EPIA	Verify Payload Frequencies Above 35 Hz @ Launch and Landing	L-10.5	COC	ST-EP-001
C-E	EPIA	Test Verified Payload Finite Element Models (SSP and ISS)	L-10.5	N/A	N/A
C-E	EPIA	Certified Payload Weight and Balance Input to PDL	L-10	COC	ST-EP-006
E-C	EPIA	SSP VCL Analysis Data to Payloads	L-7	N/A	N/A
E-C	EPIA	ISS VCL Analysis Data to Payloads	L-7	N/A	N/A
C-E	EPIA	Final Payload Structural Analyses and SCS Margins of Safety Using Verification Coupled Loads (SSP and ISS)	L-6	COC	ST-EP-017

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Structures (Continued)			
C-E	EPIA	Verify Payload has Positive Margins of Safety for Reentry and Landing	L-6	COC	ST-EP-013
C-E	EPIA	Verify Payload can Withstand On-Orbit Plume Impingement Loads	L-6	COC	ST-EP-016
C-E	EPIA	Verify Payload can Withstand Press/Depress Loads	L-6	COC	ST-EP-020
ECJSL	PIA	Final Verification Acceptance Review	L-3.5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Microgravity			
C-E	EPIA	Payload ISS Operational Configuration Microgravity Dynamic Model	L – 25	Model	N/A
C-E	EPIA	Initial Payload Disturbance Characteristics (ICD/ExP)	L – 25	Data	N/A
C-E	EPIA	Payload Test Verified ISS Operational Configuration Microgravity Model	L-10.5	Model	N/A
C-E	EPIA	Define Payload Induced Quasi-Steady Accelerations	L-10.5	COC	ST-EP-022
C-E	EPIA	Define Payload Induced Vibratory Accelerations	L-10.5	COC	ST-EP-023
C-E	EPIA	Define Payload Induced Transient Accelerations	L-10.5	COC	ST-EP-024
E-C	PIA	Final Integrated ISS Disturbance Analysis Data to Payloads	L-5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Thermal			
C-E	EPIA	Preliminary Payload Thermal model	L – 25	Model	N/A
E-C	EPIA	Preliminary MERAT data	L – 23	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Thermal (Continued)			
C-E	EPIA	Preliminary Payload Thermal analyses	L – 22	COC	TH-EP-001
C-E	EPIA	Preliminary Payload Thermal analyses	L – 22	COC	TH-EP-002
C-E	EPIA	Preliminary Payload Thermal analyses	L – 22	COC	TH-EP-003
C-E	EPIA	Preliminary Payload Thermal analyses	L – 22	COC	TH-EP-004
E-CS	PIA	ExP/ISS Compatibility Analysis	L-18	N/A	N/A
E-CJ	PIA	ExP/SSP Compatibility Analysis	L-18	N/A	N/A
E-CJS	PIA	Preliminary Integrated payload thermal analysis report	L-18	N/A	N/A
E-C	EPIA	Updated MERAT data	L-18	N/A	N/A
C-E	EPIA	Final Payload Thermal model	L - 18	Model	N/A
C-E	EPIA	Final as-designed payload Geometric/Optical properties	L-16	Data	N/A
C-E	EPIA	Final Payload Thermal analyses	L – 14	COC	TH-EP-001
C-E	EPIA	Final Payload Thermal analyses	L – 14	COC	TH-EP-002
C-E	EPIA	Final Payload Thermal analyses	L – 14	COC	TH-EP-003
C-E	EPIA	Final Payload Thermal analyses	L – 14	COC	TH-EP-004
E-CS	PIA	Final ExP/ISS Compatibility Analysis	L-12	N/A	N/A
C-E	EPIA	Final as-built payload Geometric/Optical properties	L-12	Data	N/A
E-CSL	PIA	Final Integrated ExP Thermal Analysis	L-10	N/A	N/A
E-C	EPIA	Final MERAT data	L-6.5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Electrical Power			
C-E	EPIA	Payload electrical requirements/ICD input	L-24	Data	N/A
C-E	EPIA	Payload electrical schematics input	L-24	Schematic	N/A
C-E	EPIA	Verify payload is compatible with 120 Vdc ripple voltage and noise	L-13	COC	EL-EP-010

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Electrical Power			
C-E	EPIA	Verify payload is compatible with 120 Vdc ripple spectrum	L-13	COC	EL-EP-011
C-E	EPIA	Submit profile of payload element amperage vs time for all surge levels having a duration greater than 10 microseconds	L-13	COC	EL-EP-017
C-E	EPIA	Verify payload meets the 120 Vdc large signal requirements and provides proper transient damping	L-13	COC	EL-EP-020
C-E	EPIA	Submit power profiles for all operational modes	L-13	COC	EL-EP-022
C-E	EPIA	Verify payload cables are routed and protected per specified requirements	L-13	COC	EL-EP-024
C-E	EPIA	Verify payload is compatible with the 28 Vdc steady state voltage range	L-10	COC	EL-EP-001
C-E	EPIA	Verify payload is compatible with the 28 Vdc ripple voltage and noise	L-10	COC	EL-EP-002
C-E	EPIA	Verify payload is compatible with the 28 Vdc feed common mode noise voltages and currents	L-10	COC	EL-EP-003
C-E	EPIA	Verify payload is compatible with the 28 Vdc ripple voltage and noise	L-10	COC	EL-EP-004
C-E	EPIA	Verify payload is compatible with the 28 Vdc load impedance	L-10	COC	EL-EP-007
C-E	EPIA	Verify payload is compatible with the 28 Vdc output mutual isolation	L-10	COC	EL-EP-008
C-E	EPIA	Verify payload is compatible with the 120 Vdc steady state voltage range	L-10	COC	EL-EP-009
C-E	EPIA	Verify payload is compatible with the 120 Vdc feed common noise voltages and currents	L-10	COC	EL-EP-012
C-E	EPIA	Verify payload is compatible with the 120 Vdc nominal transient voltage characteristics	L-10	COC	EL-EP-013
C-E	EPIA	Verify payload is compatible with the 120 Vdc nominal voltage levels and transients	L-10	COC	EL-EP-014
C-E	EPIA	Submit profile of payload element amperage vs time for all levels having a duration greater than 10 microseconds	L-10	COC	EL-EP-015
C-E	EPIA	Submit profile of payload element amperage during contingency operations	L-10	COC	EL-EP-016

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Electrical Power (Continued)			
C-E	EPIA	Verify payload is compatible with the 120 Vdc feed load limitations	L-10	COC	EL-EP-018
C-E	EPIA	Verify payload is compatible with the 120 Vdc stay-alive voltage load impedance	L-10	COC	EL-EP-019
C-E	EPIA	Verify payload meets isolation requirements under operational and failure modes	L-10	COC	EL-EP-021
C-E	EPIA	Verify payload connectors are space qualified and will properly mate with the ExPA receptacles	L-7	COC	EL-EP-023
C-E	EPIA	Verify payload cables that mate with the ExPA connector panels are wired per the specified requirements	L-7	COC	EL-EP-025
C-E	EPIA	Verify payload is compatible with the 28 Vdc output overcurrent and surge protection requirements	L-7	COC	EL-EP-005
C-E	EPIA	Verify payload is compatible with the 28 Vdc output surge current rate of change	L-7	COC	EL-EP-006

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EMI/EMC			
C-E	EPIA	Payload EMI/EMC requirements/ICD inputs	L-25	Data	N/A
C-E	EPIA	Submit payload analysis and EMC test reports verifying compatibility while in the cargo bay	L-14	COC	EI-EP-001
C-E	EPIA	Submit payload analysis and EMC test reports verifying compatibility while on the ISS	L-14	COC	EI-EP-002
C-E	EPIA	Submit payload analysis and test reports verifying that payload does not generate conducted emissions	L-14	COC	EI-EP-003
C-E	EPIA	Submit payload analysis and test reports verifying that payload is not susceptible to conducted emissions while on the ISS	L-14	COC	EI-EP-004
C-E	EPIA	Submit payload analysis and test reports verifying that payload does not generate radiated emissions	L-14	COC	EI-EP-005

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EMI/EMC (Continued)			
C-E	EPIA	Submit payload analysis and test reports verifying that payload is not susceptible to radiated emissions while on the ISS	L-14	COC	EI-EP-006
C-E	EPIA	Verify that the payload is designed to preclude corona while in an operational environment	L-14	COC	EI-EP-008
C-E	EPIA	Verify that the payload is bonded to be compatible with the power system	L-14	COC	EI-EP-009
C-E	EPIA	Verify that the payload is isolated to be compatible with the power system	L-10	COC	EI-EP-010
C-E	EPIA	Verify that the payload GSE is isolated and bonded	L-10	COC	EI-EP-011
C-E	EPIA	Verify that the payload provides signal isolation and grounding	L-10	COC	EI-EP-012
C-E	EPIA	Verify that the payload meets ESD requirements and applicable equipment is properly labeled	L-6	COC	EI-EP-007

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Command & Data Handling (C&DH)			
C-E	EPIA	Payload C&DH requirements/ICD inputs	L-24	Data	N/A
C-E	EPIA	Verify that the payload meets the terminal characteristics of MIL-STD-1553	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload meets the MIL-STD-1553 interface requirements for Transformer-Coupled remote	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload RT address select lines have been tested and analyzed	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload provides 5 address select lines and 5 return lines to the ExPA connector panel	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload provides one parity input and one return for the parity bit to the ExPA connector panel	L-10	COC	CD-EP-001

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Command & Data Handling (C&DH) (Continued)			
C-E	EPIA	Verify that the payload address select return lines are connected to the payload secondary ground	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload internal pull-up resistors provide a “logic” 1 when open	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload internal resistors provide a logic ‘0’ when jumpers to its associated return	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload address lines will not be damaged by contact with the chassis or other address select lines	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload does not respond to an even-parity across the address and parity input field	L-10	COC	CD-EP-001
C-E	EPIA	Verify that the payload meets ethernet signal interface requirements	L-10	COC	CD-EP-002
C-E	EPIA	Verify the payload provides user packets of at least 400 bytes to accommodate a sustained data rate of at least 6Mbps	L-10	COC	CD-EP-002
C-E	EPIA	Verify that the payload analog driver is compatible with the ExPCA receiver circuit requirements	L-10	COC	CD-EP-003
C-E	EPIA	Verify that the payload is compatible with the ExPCA analog signal interface requirements	L-10	COC	CD-EP-003
C-E	EPIA	Verify that the payload is compatible with the ExPCA discrete signal interface requirements	L-10	COC	CD-EP-004

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Software			
C-E	EPIA	Initial payload C&DH Data Set input	L-24	Data	N/A
E-CJS	PIA	Initial integrated payload C&DH Data Set	L-18	N/A	N/A
CES-F	PIA	Initial Flight Display requirements (PDL)	L-16	Data	N/A
CES-F	PIA	Updated integrated payload C&DH Data Set	L-14	Data	N/A
CES-F	PIA	Updated integrated payload C&DH Data Set	L-11	Data	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Software (Continued)			
CES-F	PIA	Updated Flight Display requirements (PDL)	L-11	Data	N/A
CES-F	PIA	Final Flight Display requirements (PDL)	L-8	Data	N/A
C-E	EPIA	Verify that payload health and status parameters are properly documented	L-8	COC	SW-EP-001
C-E	EPIA	Verify that payload software has been tested and analyzed as required	L-8	COC	SW-EP-001
C-E	EPIA	Verify that payload software is compatible with the ExPCA	L-8	COC	SW-EP-002
C-E	EPIA	Verify that payload primary and secondary headers have been defined	L-8	COC	SW-EP-002
C-E	EPIA	Verify that payload is compatible with the Portable Laptop Computer System requirements	L-8	COC	SW-EP-003
C-E	EPIA	Verify that payload software used for control of a safety hazard does not control more than 1 inhibit	L-8	COC	SW-EP-004
C-E	EPIA	Verify that the requirements for ground processing have been met	L-8	COC	SW-EP-005
CES-F	PIA	Final integrated payload C&DH Data Set	L-8	Data	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Human Factors			
C-E	EPIA	Verify payload equipment exposed edges conform with human factor standards	L-7	COC	HF-EP-001
C-E	EPIA	Verify payload equipment exposed corners conform with human factor standards	L-7	COC	HF-EP-001
C-E	EPIA	Verify payload equipment not meeting exposed corner and edge requirements are protected	L-7	COC	HF-EP-003

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Environmental			
C-E	EPIA	Verify payload venting or release does not exceed $1x10^{14}$ molecule/cm^2	L-21	COC	EN-EP-001
C-E	EPIA	Payload materials list and analyses to verify off-gassing is within specified limits	L-21	COC	EN-EP-001
C-E	EPIA	Payload materials list and analyses to verify off-gassing is within specified limits	L-13	COC	EN-EP-001
C-E	EPIA	Verify payload ionizing levels are within requirements	L-13	COC	EN-EP-002
C-E	EPIA	Verify payload ionizing radiation licensing has been met	L-7	COC	EN-EP-002
C-E	EPIA	Verify payload hardware is compatible with the atmospheric environments	L-7	COC	EN-EP-003

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Materials			
C-E	EPIA	Initial payload Materials and Usage List (MIUL)	L-24	MIUL	N/A
E-C	EPIA	Assessment review of payload MIUL's	L-21	N/A	N/A
C-E	EPIA	Generate initial Materials Usage Agreements (MUA)	AR	MUA	N/A
C-E	EPIA	Payload offgassing test results	L-14	Data	N/A
C-E	EPIA	Payload certified as-built MIUL	L-14	MIUL	N/A
C-E	EPIA	Payload drawings and analyses to support assessment for thermal vacuum stability	L-13	COC	MP-EP-001
C-E	EPIA	Payload analyses to verify materials are acceptable	L-7	COC	MP-EP-001

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		EVA/EVR			
C-E	EPIA	Submit payload EVA/EVR requirements (Data Set)	L-25	Data	N/A
E-CSM	PIA	Provide EVA/EVR requirements assessment	L-19	N/A	N/A
C-E	EPIA	Define EVA/EVR exceedances	L-11	Data	N/A
E-CSM	PIA	Submit EVA/EVR exceedances	L-10	N/A	N/A
E-CSM	PIA	Provide final EVA/EVR compatibility assessment	L-5	N/A	N/A
E-CSM	PIA	Provide final EVA/EVR constraints	L-5	N/A	N/A

RESP	SCH CTL	ITEM	GENERIC SCHEDULE	VERIFICATION DATA	
				DATA TYPE	VRDS NO.
		Pointing/Field of View			
C-E	EPIA	Submit payload pointing/FOV requirements (ICD)	L-24	Data	N/A
E-CSO	EPIA	Assess pointing/FOV requirements and develop compatibility assessment	L-19	N/A	N/A
E-CSO	EPIA	Provide preliminary pointing/FOV constraints	L-19	N/A	N/A
E-CSO	EPIA	Provide preliminary pointing/FOV sketches	L-19	N/A	N/A
E-CSO	EPIA	Submit pointing/FOV ICD exceedances	L-12	N/A	N/A
E-CSO	EPIA	Final integrated payload pointing/FOV compatibility assessment	L-5	N/A	N/A
E-CSO	EPIA	Provide final pointing/FOV sketches	L-5	N/A	N/A

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APPENDIX D

ExP PAYLOADS PAH TBD/TBR/TBC LOG

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TABLE D-I ExP PAYLOADS PAH TBD/TBR/TBC LOG (Sheet 1 of 2)

TBC/TBD/ TBD NO.	TBD DESCRIPTION	DATA REQUIRED TO CLOSE TBD	DATA SOURCE/OWNER	REMARKS
TBD#01	ULC/Sidewall Carrier Accommodations	ULC/Sidewall Carrier Accommodations	JSC/OZ Paragraph: Abstract Table: Figure:	
TBD#3-01	Heat Leak to ExPA	Thermal Analysis to determine acceptable heat leak to ExPA	Brazil/ExP Paragraph: Table: 3-I Figure:	
TBD#4-01	ExPA Configuration	Updated ExPA Drawing	Brazil/ExP Paragraph: Table: Figure: 4-1	Closed. Figure added.
TBD#4-02	Electrical Connector Panel	Drawing of Electrical Connector Panel	Paragraph: Table: Figure: 4-4	Closed. Figure added.
TBD#4-03	Data Connector Panel	Drawing of Data Connector Panel	Paragraph: Table: Figure: 4-5	Closed. Figure added.
TBD#4-04	MERAT Document	MERAT Document to provide MERAT data	MSFC Paragraph: 4.2.2 Table: Figure:	
TBD#5-01	STEP-EP User's Guide	User's Guide Developed for STEP-EP	MSFC Paragraph: 5.1.2 Table: Figure:	

TABLE D-I ExP PAYLOADS PAH TBD/TBR/TBC LOG (Sheet 4 of 4)

TBC/TBD/ TBR NO.	TBR DESCRIPTION	DATA REQUIRED TO CLOSE TBR	DATA SOURCE/OWNER	REMARKS
TBR#5-01	Shipping Container Dimensions		Brazil/ExP Paragraph: 5.1.1 Table: Figure:	Closed.
TBR#C-01	Table C-I	Resolve Schedule Inconsistencies	EI/PEI Paragraph: Appendix C Table: Figure:	Closed.