SSP 52000-PAH-ERP

International Space Station Payload Accommodations Handbook

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

International Space Station Program

November 24, 1997

Initial Release

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas
Contract No. NAS8-50000 (DR LS10)

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PAYLOAD ACCOMMODATIONS HANDBOOK

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

INITIAL RELEASE
NOVEMBER 24, 1997

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Boeing Defense & Space Group
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ABSTRACT

The Payload Accommodations Handbook (PAH) constitutes an integral part of the overall International Space Station (ISS) PAH addressing the various laboratory modules and other parts of the ISS infrastructure where payloads may be located. The purpose of this volume is to provide sufficient information that describes the interfaces, resources, capabilities, performance characteristics, and constraints for payloads to be located in the EXPRESS Rack, which will be integrated into the pressurized modules. This will assist payload developers in the design of their equipment for accommodation in the EXPRESS Rack. This document addresses the transportation and on-orbit phases of the EXPRESS Rack payloads and describes the EXPRESS Rack supplementary hardware and services.

This document complements Space Shuttle System Payload Accommodations, NSTS 07700, Volume XIV, Revision K; Middeck Interface Definition Document, NSTS 21000-IDD-MDK, Revision B; and the Interface Definition Document and Verification Plan for EXPRESS Rack Payloads, SSP 52000-IDD-ERP and SSP 52000-PVP-ERP, respectively.

This Boeing Defense and Space Group multi-volume document is submitted in accordance with Data Requirement (DR) LS10. This document is submitted in accordance with Letter Contract NAS8-50000, Modification 266.

KEY WORDS

Accommodations

Design Requirements

EXPRESS Rack

Interfaces

International Space Station

Middeck

Payload Developer

User

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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 actually build the flight/Ground Support Equipment (GSE) hardware for scientific use are called Payload Developers (PD). This volume of the ISS Payload Accommodations Handbook (PAH) serves as a guide for Users of the EXpedite the PRocessing of Experiments to Space Station (EXPRESS) Rack.

The ISS provides International Standard Payload Rack (ISPR) locations for payloads; however, many payloads do not require the volume or mass capabilities of a full ISPR. These payloads have been deemed “sub-rack” payloads. Other payloads consisting of existing hardware that has previously flown in the orbiter Middeck, Spacelab, or SpaceHab, as well as new ISS payloads that have no requirements for the interfaces or resources of an entire ISPR location, are called EXPRESS Rack payloads. The purpose of the EXPRESS Rack is to provide accommodations to allow quick and simple integration for payloads of this type into the ISS.

1.1 PURPOSE

The purpose of this document is to provide to PDs sufficient information (not to define requirements) on the interfaces, accommodations, capabilities, performance characteristics, and constraints specific to the EXPRESS Rack. This information will enable PDs to design payload equipment to be transported to the ISS in the orbiter middeck or Mini-Pressurized Logistics Module (MPLM)) and accommodated in the EXPRESS Rack or transportation rack in the MPLM. 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 EXPRESS Rack Payloads Interface Definition Document (IDD), SSP 52000-IDD-ERP, and Generic Payload Verification Plan for EXPRESS Rack Payloads, SSP 52000-PVP-ERP, 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 EXPRESS Rack payload. Some references to middeck/Shuttle accommodations will be made in this document for clarity. If detailed or additional description on the Shuttle accommodation is required, the reader should refer to NSTS 07700, Volume XIV, and to the Middeck IDD, NSTS 21000-IDD-MDK.

1.3 PRECEDENCE

The order of precedence of documents identified herein shall be as follows: NSTS 1700.7 and ISS Addendum, KHB 1700.7, the Interface Definition Documents for EXPRESS Rack and Middeck, unique EXPRESS Integration Agreement (EIA), Payload-unique Interface Control Documents (ICD), Payload Data Library (PDL) data files, Government specifications, Government standards, military (MIL) specifications, MIL standards, contractor specifications, contractor standards, and other documents.

1.4 DOCUMENTATION TREE

The documentation tree is shown in Figure 1-1.

1.5 POINT OF CONTACT

The following person should be contacted if there are any questions concerning the information contained in this document.

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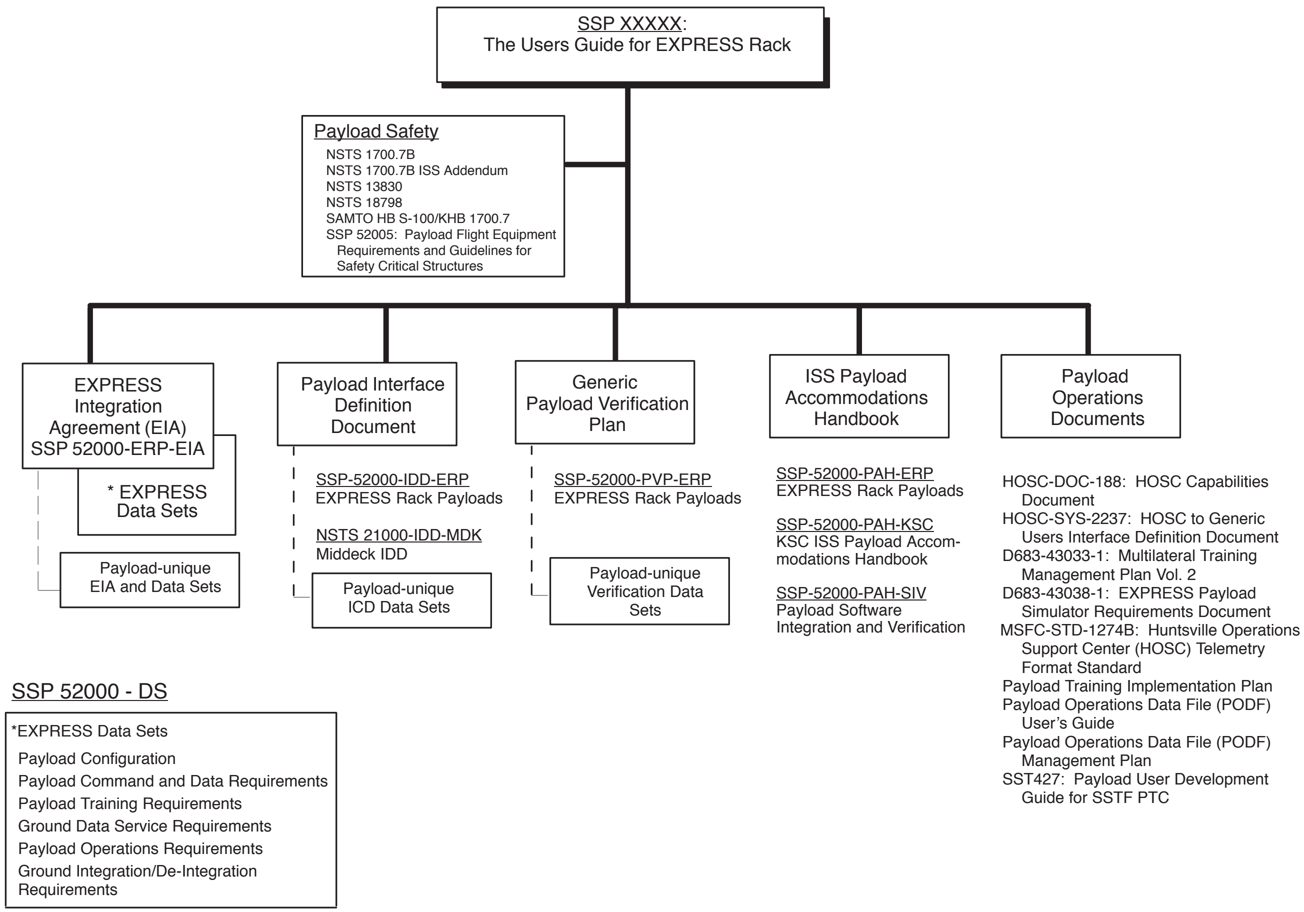

FIGURE 1-1 CUSTOMER DOCUMENTATION TREE (DRAFT) FOR EXPRESS RACK PAYLOADS

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SECTION 2, DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents may include documents, specifications, standards, guidelines, procedures, handbooks, and other special publications. These documents, of the exact issue shown, form a part of these requirements to the extent specified herein. Unless the exact issue and date are identified, the "Current Issue" cited in the contract Applicable Documents List (ADL) applies. Inclusion of applicable documents herein does not in any way supersede the contractual order of precedence.

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 (205) 544-4490

2.1.1 Government Documents

45 SPW HB S-100/KHB 1700.7B	Space Transportation System Payload Ground Safety Handbook
JSC 20483	Human Research Policy and Procedures for Space Flight Investigations
MIL-B-5087B	Bonding, Electrical, and Lightning Protection for Aerospace Systems
MIL-STD-889	Dissimilar Metals
MIL-STD-1553B	Digital Time Division Command/Response Multiplex Data Bus
MSFC-HDBK-527F/JSC 09604	Materials Selection List for Space Hardware Systems
MSFC-PROC-1301	Guidelines for the Implementation of Required Materials Control Procedures
MSFC-SPEC-250	General Specification for Protective Finishes for the Space Vehicle Structures and Associated Flight Hardware

MSFC-SPEC-522	Design Criteria for Controlling Stress Corrosion Cracking
NASA TM 102179	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
NHB 8060.1C	Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments that Support Combustion
NHB 8071.1A	Fracture Control for Payloads Using the NSTS
NIH 85-23	Guide for the Care and Use of Laboratory Animals for Space Flight Investigations
NSTS 07700, Vol. XIV, Rev K	Space Shuttle System Payload Accommodations Handbook
NSTS 13830B	Implementation Procedure for NSTS Payloads System Safety Requirements
NSTS 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 1700.7B, ISS Addendum	Safety Policy and Requirement for Payloads Using the International Space Station
NSTS 18798	Interpretations of NSTS Payload Safety Requirements
NSTS 21000-IDD-MDK, Rev B	Middeck Interface Definition Document
NSTS 21000-IDD-PSC	Payload and General Support Computer, Enclosure 1
NSTS 22648	Flammability Configuration Analysis for Spacecraft Applications
SSP 30233E	Space Station Requirements for Materials and Processes
SSP 30237B	Space Station Electromagnetic Emission and Susceptibility Requirements for EMC
SSP 30238B	Space Station Electromagnetic Techniques, General Vol. 1; Vol. 2, Requirements and Procedures

SSP 30243C	Space Station Systems Requirements for Electromagnetic Compatibility
SSP 30420B	Space Station Electromagnetic Ionizing Radiation and Plasma Environment Definition and Design Requirements
SSP 30425B	Space Station Program Natural Environment Definition for Design
SSP 30512C	Space Station Ionizing Radiation Emission and Susceptibility Requirements for Ionizing Radiation Environment Compatibility
SSP 30513	Ionizing Radiation Environment Effects Test and Analysis
SSP 30573A	Space Station Fluid Procurement and Use Control Specification
SSP 30575B	Space Station Interior and Exterior Operational Location Coding System
SSP 41000E	System Specification for the International Space Station
SSP 41002F	International Standard Payload Rack to NASA/ESA/NASDA Modules Interface Control Document
SSP 41017A	Rack to Mini Pressurized Logistics Module (MPLM) Interface Control Document
SSP 41089	Internal Thermal Control System Coldplate Set Interface Development Document
SSP 50005B	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50007A	Inventory Management System Label Specification
SSP 52000-IDD-ERP	EXPRESS Rack Payloads Interface Definition Document
SSP 52000-PAH-KSC	KSC ISS Payload Accommodations Handbook
SSP 52000-PAH-PRP	Payload Accommodation Handbook for Pressurized Payload

SSP 52000-PAH-SIV	Payload Software Integration and Verification Payload Accommodations Handbook
SSP 52000-PVP-ERP	Generic Payload Verification Plan, EXPRESS Rack Payloads
SSP 52005	International Space Station Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures

2.1.2 Non-Government Documents

ANSI/EIA-422B-1994	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
ASTM E380	Standard Practice for Use of the International Systems of Units (SI)
EIA-STD-RS170A	Electronics Industry Association Electrical Performance Standards - Color TV Studio Facilities
IEEE-STD-802.3	Institute of Electrical and Electronic Engineers 802.3 (Ethernet) Standard

2.2 REFERENCE DOCUMENTS

2.2.1 Government Documents

JSC 25607	Requirement for Submission Test Sample - Materials Data for Shuttle Payload Safety Evaluation
SN-C-0005C	NSTS, Contamination Control Requirements
SSP 41175	ISS Prime Contractor Software Interface Control Document, Part 1, Station Management and Control to International Space Station

2.2.2 Non-Government Documents/Drawings

D683-43525-1	EXPRESS Software Interface Control Document
D683-61576-1	Active Rack Isolation System (ARIS) Interface Definition Document

D684-10056-1	Prime Contractor Software Standards and Procedures Specification

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SECTION 3, EXPRESS RACK OVERVIEW

3.1 GENERAL

The purpose of the EXPRESS Rack is to allow for quick and simple integration of payloads into the ISS. The EXPRESS Rack contains the required equipment to enable payloads to be integrated into a National Aeronautics and Space Administration (NASA) ISPR. This equipment includes structural support hardware, power conversion and distribution equipment, data and video equipment, nitrogen and vacuum exhaust distribution hardware, and thermal support equipment. An EXPRESS Rack can be accommodated at any ISPR location on ISS. The EXPRESS Rack can also be located in other IP laboratories, such as the Attached Pressurized Module (APM) or the Japanese Experiment Module (JEM). It is the intent for the laboratories to be identical/transparent from the perspective of the EXPRESS Rack payload. The EXPRESS Rack typically will be installed in a 3-kW ISPR location.

STANDARD EXPRESS RACK PAYLOAD

Payloads that use the EXPRESS Rack will be categorized for integration purposes as “standard” or “nonstandard.” This classification is based solely upon the quantity of interfaces and the resources/services required. This classification does not imply that a payload cannot be manifested in an EXPRESS Rack; however, it does provide to the payload integrator a top level indication regarding the payload complexity and allows the integrator an opportunity to assess any impacts to the standard EXPRESS Rack payload integration template. All payloads, regardless of their design complexity, are required to support all generic integration templates. Standard payloads will be located in the standard 8/2 EXPRESS Rack configurations. Table 3-I defines the standard EXPRESS Rack payloads accommodations.

If the payload is not stowed in a standard Middeck Locker (MDL) or in a 4-Panel Unit (PU) International Subrack Interface Standard (ISIS) drawer, a standard EXPRESS Rack payload can also occupy the equivalent volume of a single/double MDL or 4-PU ISIS drawer by providing its own unique support structure and attaching to the same points an MDL or ISIS drawer would attach.

The allocation for a standard EXPRESS Rack payload for on-orbit crew time is under review (**TBD#01**). A standard EXPRESS Rack payload requires less than 12 hr of crew training time. Provisions for a certain limited quantity of middeck late access and early removal are under consideration for standard EXPRESS Rack payloads, but these have not been finalized yet (**TBD#02**).

TABLE 3-I STANDARD EXPRESS RACK PAYLOAD (Sheet 1 of 2)

DISCIPLINE	STANDARD ACCOMMODATION	NOTES/REMARKS
Structural/ Mechanical	Includes as a minimum: • MDL (single & double) or equivalent volume • Standard ISIS drawer (4 PU) or equivalent volume	• Reference Notes 2, 3, 4, 6, and 7. • Must conform with mass, CG, frequency & volume limits. • Container to be flight qualified/certified.
Electrical/Power	• 0 W - 500 W per single MDL or 4-PU ISIS drawer position	• Reference Notes 1 & 2 • EXPRESS Rack to provide interfacing connectors and cables. • Racks in the MPLM will not be powered for ascent/descent.
Thermal Control/Cooling	• Ducted cooling via Avionics Air Assembly (AAA) is ≤200 W per payload position for MDL and <100 W for ISIS drawers. • Ducted air available to all payloads. • Water cooling via the moderate temperature water loop is 500 W per payload position. • Two payload interfaces available for water.	• Reference Notes 1, 2, & 5 • Water can be used in MDL or ISIS drawers. • Use of cabin air for cooling is restricted. • EXPRESS Rack to provide interfacing Quick Disconnects (QDs) & fluid lines. • ISS qualified/certified coldplates can be used.
Nitrogen	• One payload interface available for payloads (must be shared).	• Reference Notes 1 & 2 • Resource limited to 0 - 12 lbm/hr. • EXPRESS Rack to provide interfacing QDs and fluid lines.
Vacuum Exhaust	• One payload interface available for payloads (must be shared).	• Reference Notes 1 & 2 • Resource limited to achieving 1 x 10^{-3} psia in 2 hr. • EXPRESS Rack to provide interfacing QDs and fluid lines. • Waste gas and trace contaminants must be within EXPRESS Rack Payload PAH/IDD table of exhaust constituents or must have been previously approved.
Control/Data	Interfaces available for each payload position include: • RS 422 • Ethernet • 5 Vdc discrete	• Reference Notes 1 & 2 • EXPRESS Rack to provide interfacing connectors and cables. • MDL positions have 3 discretes and 2 analogs.

TABLE 3-I STANDARD EXPRESS RACK PAYLOAD (Sheet 2 of 2)

DISCIPLINE	STANDARD ACCOMMODATION	NOTES/REMARKS
Control/Data (Continued)	• ±5 Vdc analog	• ISIS drawer positions have 2 discretes and 1 analog.
Video	• NTSC RS170A interface for each payload position.	• Reference Notes 1 & 2 • EXPRESS Rack to provide interfacing connectors and cables except for the payload video source or camera and its cabling. • EXPRESS Rack has only one video interface to ISS.
Software	• EXPRESS Rack laptop to be shared by all payloads.	• Software is resident on a payload processor or EXPRESS Rack laptop only. • Any software which interfaces with the ISS has to be verified by the PSIV/F. • Payload-unique application software and icons are PD developed and verified. • Payloads must contact the EXPRESS Rack Office (ERO) before planning to fly/use a unique laptop. • Computer is an IBM 760 XD and uses Windows NT operating system and Microsoft Visual Basic and Visual C++.

NOTES:

1. These resources/accommodations are limited in quantity and will have to be timelined to eliminate conflicts and/or incompatibilities.
2. The utilization of this interface must be within the EXPRESS Rack accommodations as defined in this PAH and compliant with the design and interface requirements specified in the EXPRESS Rack Payload IDD.
3. The maximum payload weight includes the payload, the ISIS drawer, locker shell, locker trays, and protective provisions, such as dividers, bungees, or vibration isolation foam.
4. A PU is 1.75 in.
5. Active/forced air cooling (fan in the MDL or ISIS drawer) is the responsibility of the PD.
6. Standard EXPRESS Rack payloads should plan to accommodate their associated stowage items within their allocated volume/weight; however, an allocation of stowage volume external to the EXPRESS Rack is currently under consideration (**TBD#03**).
7. Payloads that are microgravity sensitive can only be accommodated in ARIS-equipped EXPRESS Racks.

NONSTANDARD EXPRESS RACK PAYLOAD ACCOMMODATIONS

Payloads with requirements exceeding standard EXPRESS Rack allocations are "nonstandard." This determination is dependent on the type of exceedance of the standard allocation or complexity of the unique interface. These payloads can be integrated into the EXPRESS Rack. The nonstandard payloads may be limited in manifesting possibilities or may necessitate alteration of the standard EXPRESS Rack payload analytical/physical integration template(s).

These interfaces/services are limited in quantity (i.e., water, vacuum exhaust, GN_2) in the standard EXPRESS Rack configurations and may not be available on the earliest increment. These items may include, but are not limited to, requirements for the following:

A. Specific payload location requests in the orbiter or ISS. These may not be available on the earliest increment.

B. Weight/volume/Centers of Gravity/frequency not meeting the requirements (CG) specified in the EXPRESS Rack Payload IDD.

C. Specific environmental conditions (i.e., temperature, microgravity, etc.)

D. Complexity of experiment-to-experiment interconnectivity.

E. Crew time resources exceeding **TBD#01** hr of accumulative, noncontiguous time on orbit during the increment.

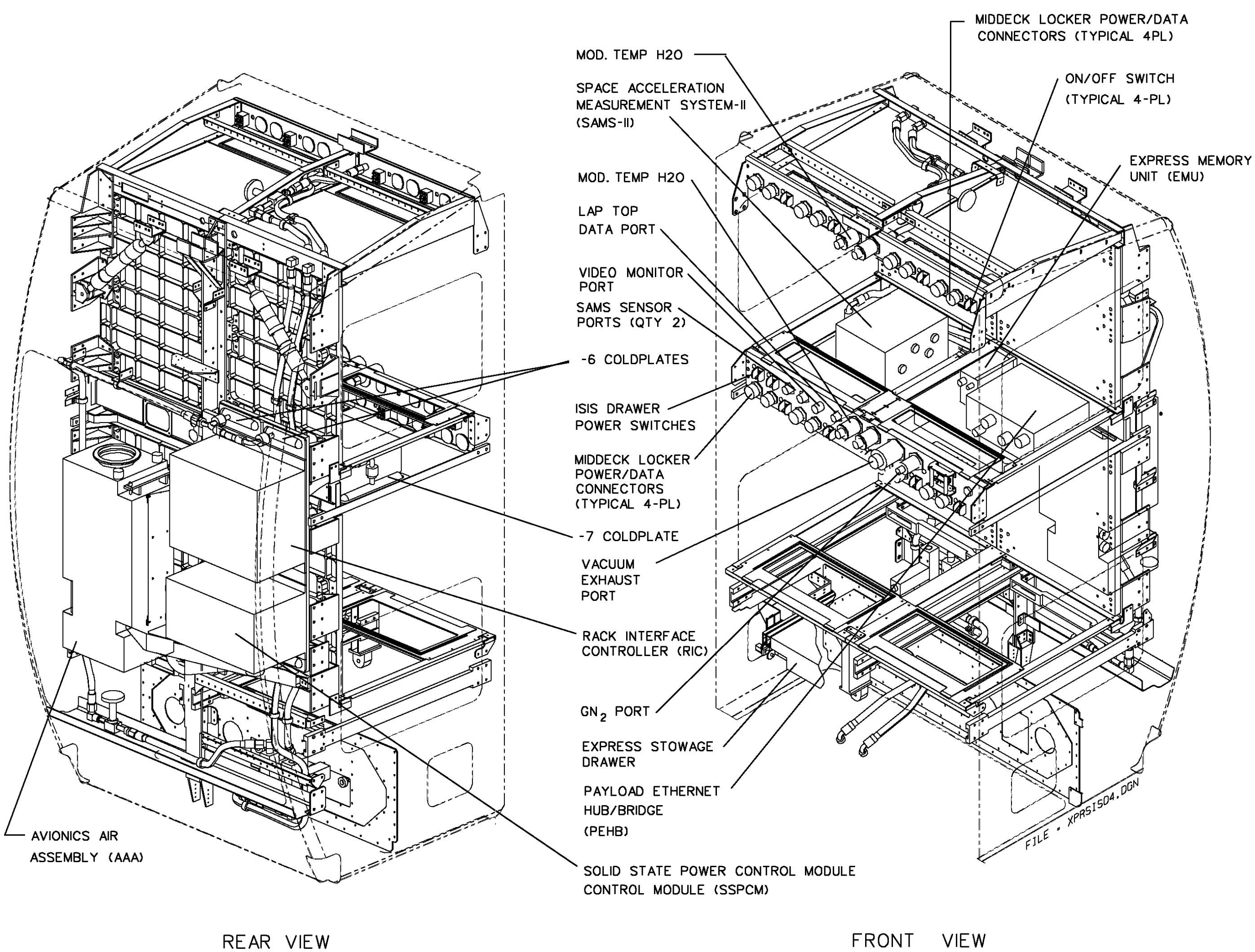
F. Crew training time exceeding 12 hr total.

There are services and/or special requests which may require the EXPRESS Rack PD to identify interfaces/requirements or supply information/data at specific times to the ISS and/or the orbiter for use in further assessments, analyses, or development of data products. These include, but are not limited to, unique interfaces, middeck late installation, middeck early access, specific/unique microgravity environments, and crew training activities. Payloads that have nonstandard or unique interfaces must contact the payload integrator as soon as possible to discuss the request.

Requests for a specific location will be entertained, although on any flight, the ISS reserves the right to assign locations to payloads mounted on an adapter plate(s) and payloads stored within standard lockers or ISIS drawers.

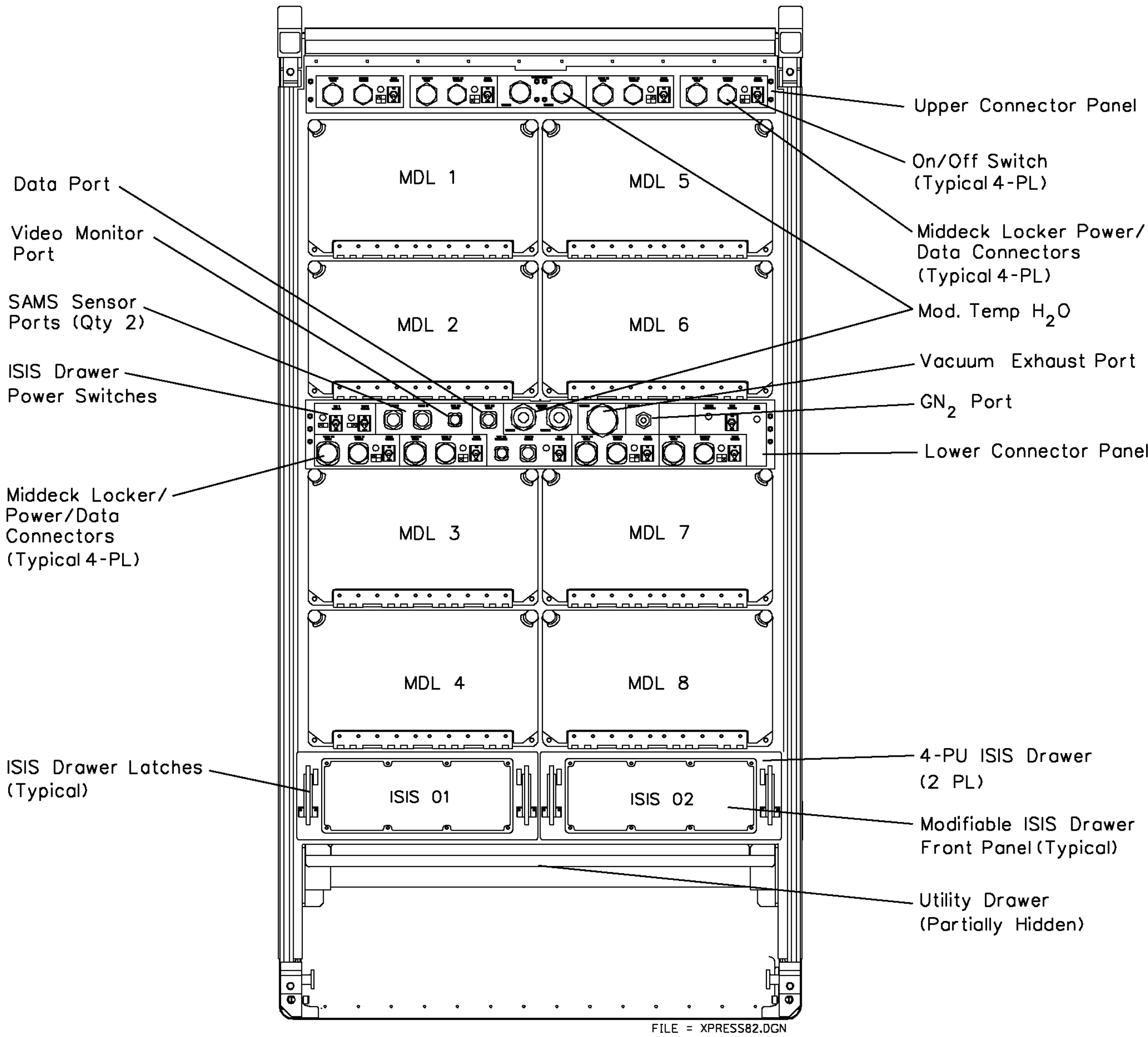
3.2 EXPRESS RACK CONFIGURATION

The EXPRESS Rack configuration accommodates eight MDL-class/style payloads in two areas of four lockers each, and two 4-PU ISIS drawers. This layout is referred to as the "8/2 Configuration." The general arrangement for the 8/2 Configuration is shown in Figures 3-1 and 3-2. The 8/2 Configuration can accommodate single or multiple middeck-type/style lockers.



NOTE: SAMS interface available in ARIS Rack only.

FIGURE 3-1 EXPRESS RACK 8/2 CONFIGURATION ISOMETRIC VIEW



NOTE: SAMS interface available in ARIS Rack only.

FIGURE 3-2 EXPRESS RACK 8/2 FRONT PANEL CONFIGURATION

The EXPRESS Rack Program will utilize the Active Rack Isolation System (ARIS) for acceleration/g-disturbance reduction for some of the 8/2 Configuration of the EXPRESS Racks. In addition, the 8/2 EXPRESS Rack with ARIS has two connectors on the lower connector panel where second generation Space Acceleration Measurement System (SAMS II) Triaxial Sensor Heads (TSH) can be connected for the purpose of measuring the acceleration environment within the EXPRESS Rack.

The 8/2 EXPRESS Rack includes connector panels that provide interfaces to the services and resources offered by the EXPRESS Rack facility. These include power, telemetry/commands, GN_2, vacuum exhaust, etc. The items unique to individual laboratories (i.e., United States Laboratory (USL), JEM, APM) are identified herein. Connector panel layouts are shown in Figures 3-3 and 3-4 for the 8/2 Configuration.

MDL payloads are bolted to the EXPRESS Rack backplate which is attached to the rear posts of the ISPR. The EXPRESS Rack accommodates standard MDL containers (Space Shuttle Program-provided MDLs, SpaceHab-provided lockers, etc.). If the PD chooses to utilize an Space Shuttle Program-provided MDL or a SpaceHab-provided locker, certification of flight worthiness for the transportation and on-orbit ISS environments is the responsibility of the PD. The MDL payloads interface to the resources (power, commands/telemetry, water cooling, waste gas venting, and GN_2) via connections on the front face of the payload. Cooling is provided via passive radiation and heat exchange to the cabin environment (restricted) or forced air (avionics air) cooling via rear interfaces with the rack avionics air loop or water cooling. ISIS drawer payloads interface at the rear for power, data, and avionics air. A payload configurable and modifiable (i.e., blank) front panel is provided to allow for mounting interface connections through the front of the ISIS drawer.

The EXPRESS Rack includes an Avionics Air Assembly (AAA) to provide forced air cooling. This assembly has a limited capability that must be shared by all payloads within the rack. Adequate air flow rate should be provided by the PD with an internal fan or equivalent. Use of cabin air cooling is restricted for EXPRESS Rack payloads due to Fire Detection and Suppression (FDS) concerns and restricted heat dissipation allocation for racks in the ISS. The EXPRESS Rack interface to the moderate temperature water loop and the forced air cooling are common/shared resource and must be evaluated as an integrated subsystem to ensure that the heat loads are equally accommodated by the particular system. As stated, each system is capable of providing a specific, although not simultaneous, cooling capability. As the number of payloads operating at any one time increases, the temperatures available to payloads for cooling will approach the upper end of the specification. The EXPRESS Rack payload integrator should be contacted to discuss any specific temperature/cooling requirements or constraints.

The desire to fly payloads (many of which are existing) that use cabin air to cool the payload equipment is recognized. This is especially true for flights Utilization Facility (UF)-1 through UF-3. Every effort will be made to accommodate these payloads in the EXPRESS Rack in the ISS; however, after UF-3, all payloads requiring air cooling must interface with the AAA. The capability of the ISS cabin air system for cooling is limited, and payload requests will have to be assessed on a case-by-case basis. These payloads necessarily will follow a modified integration template and may require hardware and/or software modification (i.e, modify locker ventilation, add temperature switch, area smoke detector, etc.). A deviation or waiver against SSP 52000-IDD-ERP requirements may be required to allow limited use of cabin air cooling for certain of these payloads.

A limited number of ISIS drawers are provided by the EXPRESS Rack Program. The ISIS drawers interface with the rack via a slide guide assembly. This hardware will be

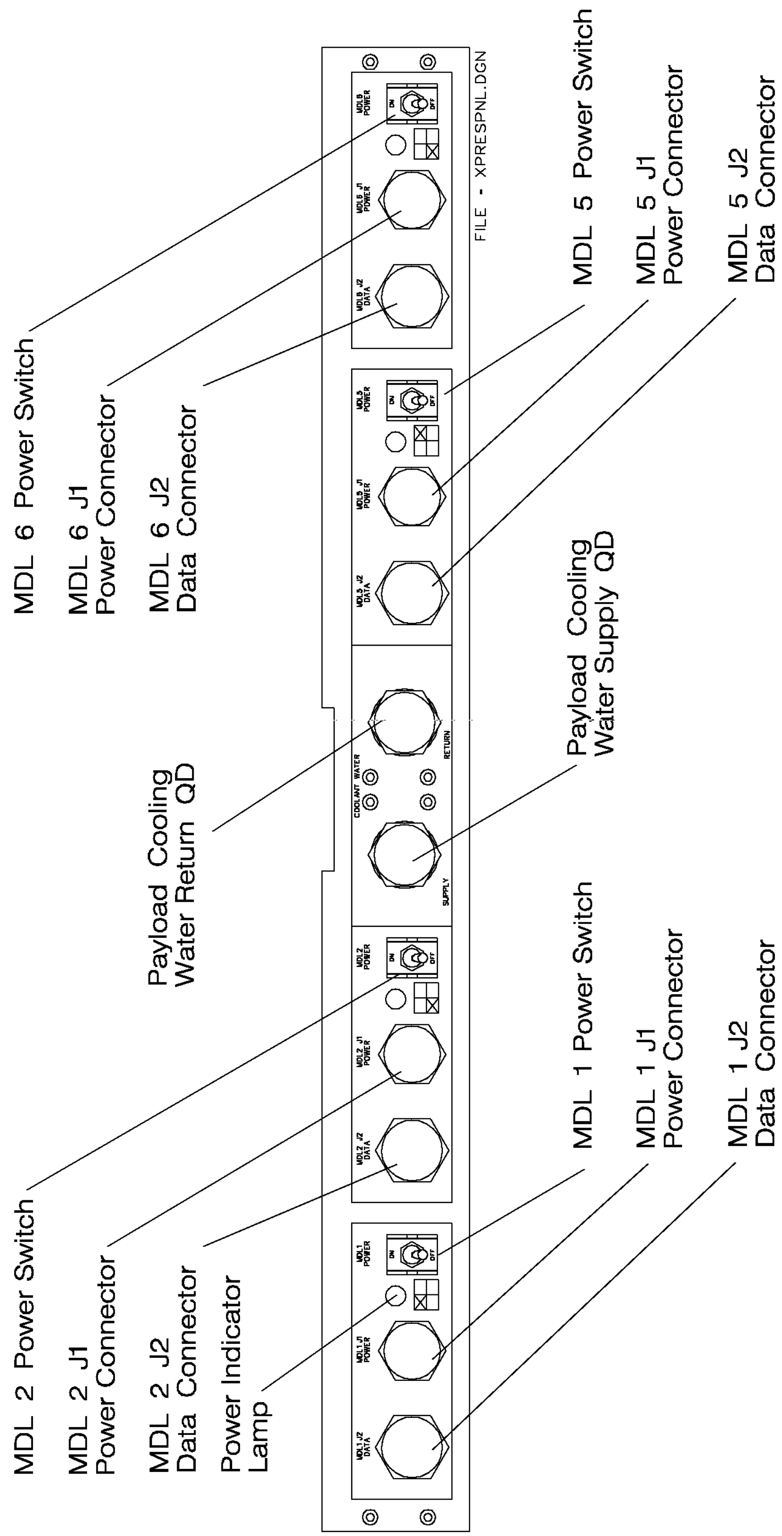
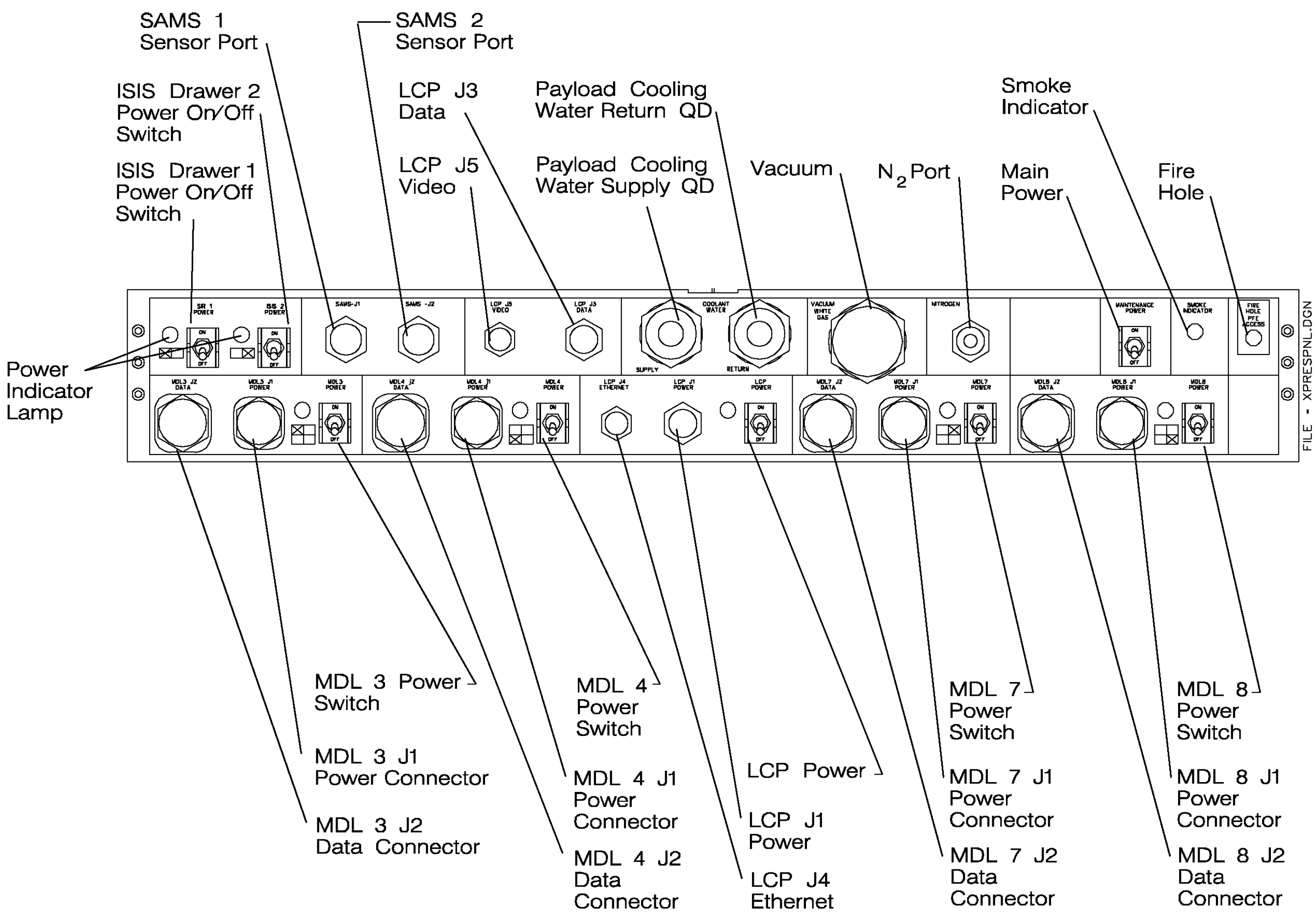


FIGURE 3-3 UPPER CONNECTOR PANEL, 8/2 CONFIGURATION



NOTE: SAMS interface available on ARIS rack connector panel only.

FIGURE 3-4 LOWER CONNECTOR PANEL, 8/2 CONFIGURATION provided to the PD on an as-available basis, per the EIA, to facilitate preflight integration of payload hardware into the drawer. Forced air cooling is provided by a payload fan located in the rear of the drawer (PD responsibility).

The 8/2 Configuration includes a "utility drawer" located underneath the two 4-PU ISIS drawers. The utility drawer is shown in Figure 3-5. The utility drawer is designed to store the EXPRESS Rack subsystem items such as laptop, cables, fluid lines, etc., without interfering with normal rack utilization. The utility drawer is located at the bottom of the EXPRESS Rack, hidden below the two ISIS drawers. During usage the utility drawer is rotated downward and slid into position in front of the rack face. The top can then be unlatched by two latches allowing the User to access the contents of the drawer. The center compartment is designed to accommodate the EXPRESS Rack laptop and associated cabling. Two quick pins latch the drawer for launch and landing and are stowed during on-orbit operation. In additon to the EXPRESS Rack laptop, this drawer contains EXPRESS Rack facility stowage items (i.e., cables, tools, memory cards, etc.); EXPRESS Rack facility-provided, but payload-unique interface items (cables, fluid/vent lines, etc.); and possibly spares/maintenance items for the EXPRESS Rack facility. The total mass allowed in this utility drawer is 24 lb. The EXPRESS Rack payload integrator should be contacted to discuss the availability and use of the utility drawer.

The EXPRESS Rack Program provides a limited number of standard interface hardware (connectors, cables, Quick Disconnects (QD), fluid/vent lines, etc.) that will minimize the need for payload-unique integration hardware. This hardware is delivered to the PD on an as-available basis and must be returned to the EXPRESS Rack Program after the completion of the flight activities. In addition, the EXPRESS Rack Program will provide a limited duration loan test and checkout hardware called a "Suitcase Simulator" (ScS). This GSE allows the PD to test applicable electrical, C&DH and software interface functionality with the EXPRESS Rack. The ScS will be loaned to the PD for a limited time (1 or 2 weeks) and then must be returned to the EXPRESS Rack Program. Other interfaces will be checked out/exercised on an as-required basis at the Kennedy Space Center (KSC) or the applicable launch site using the EXPRESS Rack or the Functional Checkout Unit (FCU).

3.3 TRANSPORTATION

An EXPRESS Rack payload may be transported to the ISS in the orbiter middeck, in an inactive EXPRESS Rack in the MPLM, or in an EXPRESS transportation rack in the MPLM. For passive EXPRESS Rack payloads, transport to the ISS is in the MPLM, either in an inactive EXPRESS Rack or in an inactive EXPRESS transportation rack. The conceptual EXPRESS transportation rack is shown in Figure 3-6. An MDL-class EXPRESS payload that must be active during ascent/descent or has late/early access requirements may be integrated into the orbiter middeck. Once the middeck payload is in orbit, the payload will be removed from the Space Shuttle Program-provided mounting panel (which must remain in the middeck) and will be moved to the applicable ISS laboratory and EXPRESS Rack. Every effort will be made to limit the power-down time. PDs must identify these power-down time constraints in the EIA. An EXPRESS Rack payload may be transported

Characteristics
• Empty Weight: 16 lbs • Payload Capacity: 24 lbs • Internal Volume: 0.544 ft 3 • Compartments: 7 Standard

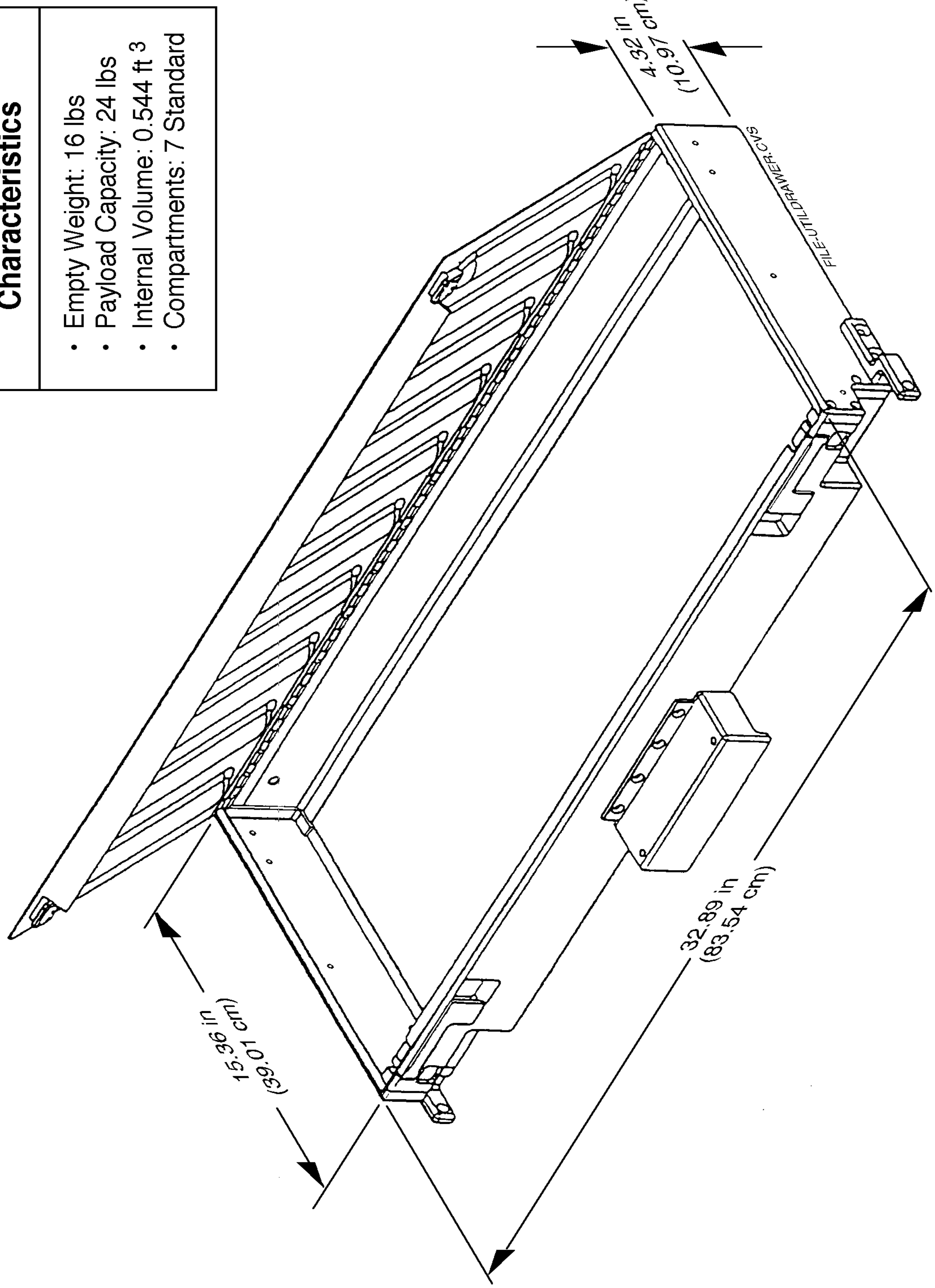
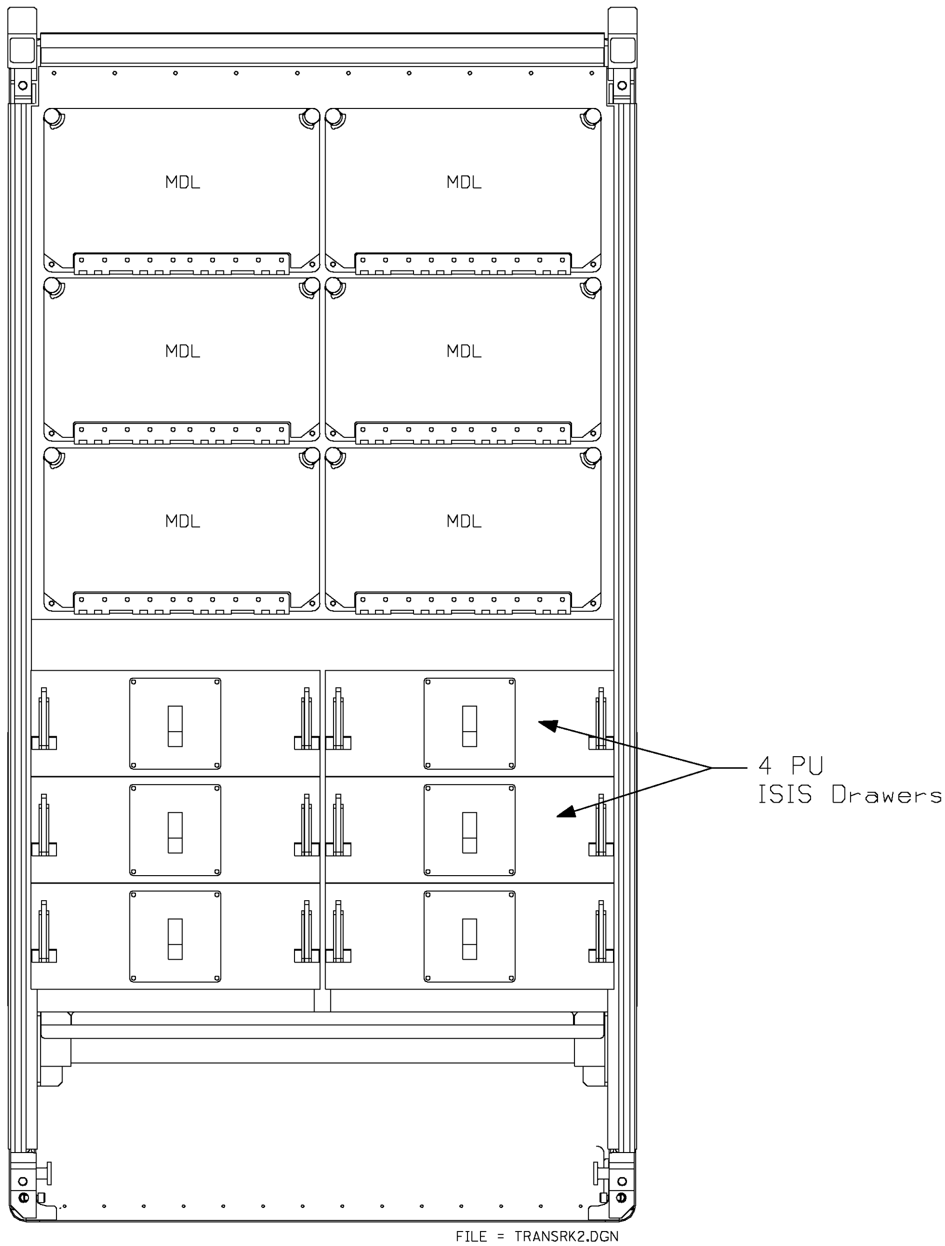


FIGURE 3-5 EXPRESS RACK UTILITY DRAWER



NOTES:

1. This is a proposed configuration and may change to accommodate the majority of the payloads.
2. Payloads will use EXPRESS Racks for transportation to/from ISS until the transportation racks are available (starting on UF-3).

FIGURE 3-6 PROPOSED EXPRESS TRANSPORTATION RACK from the ISS to the ground using the same options as used in the launch configuration. Late stowage and early access accommodations for the middeck are defined in NSTS 07700, Volume XIV.

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SECTION 4, EXPRESS RACK DESCRIPTIONS, INTERFACES, AND PAYLOAD ACCOMMODATIONS

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

A top level summary of EXPRESS Rack accommodations for payloads is provided in Table 4-I. These capabilities are provided regardless of the rack location in any IP-provided pressurized module. Additional resources are available in laboratories other than the USL; however, use of these resources must be negotiated with the EXPRESS Rack payload integrator on a case-by-case basis.

4.1 PHYSICAL, STRUCTURAL, AND MECHANICAL

The EXPRESS Rack is designed to accommodate standard MDL payloads and ISIS drawers. The 8/2 Configuration (reference Figure 3-1), consists of two locations for four MDLs (eight lockers total) and two 4-PU ISIS drawers. Figure 4-1 shows the EXPRESS 8/2 Configuration attachments for the MDLs. Some of the 8/2 Configuration racks will be equipped with the ARIS to provide isolation of the EXPRESS Rack from external disturbances. The inclusion of ARIS on the EXPRESS Rack has no impact to the on-orbit load carrying capability of the EXPRESS Rack, space available, loads environment, or mechanical interfaces.

4.1.1 MDL

In the 8/2 Configuration, an MDL-style payload bolts onto the rear of the rack on a mounting baseplate. Figure 4-2 shows the layout of a middeck-style locker. Specifics of this interface are shown in SSP 52000-IDD-ERP. The EXPRESS Rack backplate mounting hole pattern includes the standard payload attachment points. It also includes alternate payload attachment points to accommodate the Space Shuttle Program payload mounting panel(s) and the orbiter wire tray attachment hole pattern in avionics bays 1, 2, and 3A of the orbiter as depicted in Figure 4-1. Payload mass and volume accommodations data derived from the middeck flight environments for the existing middeck flight-certified containers are included to assist the developer in container selection. A typical MDL weighs approximately 12 lb when empty. Use of orbiter-supplied hardware will be negotiated directly with Space Shuttle Program representatives jointly with the PD, ERO and ISS Payloads Office during the EIA finalization process. If the PD chooses to use an existing MDL container, the PD must certify the container and payload are acceptable for flight. Payload-unique containers may be developed and require flight certification by the PD for the orbiter and/or the ISS.

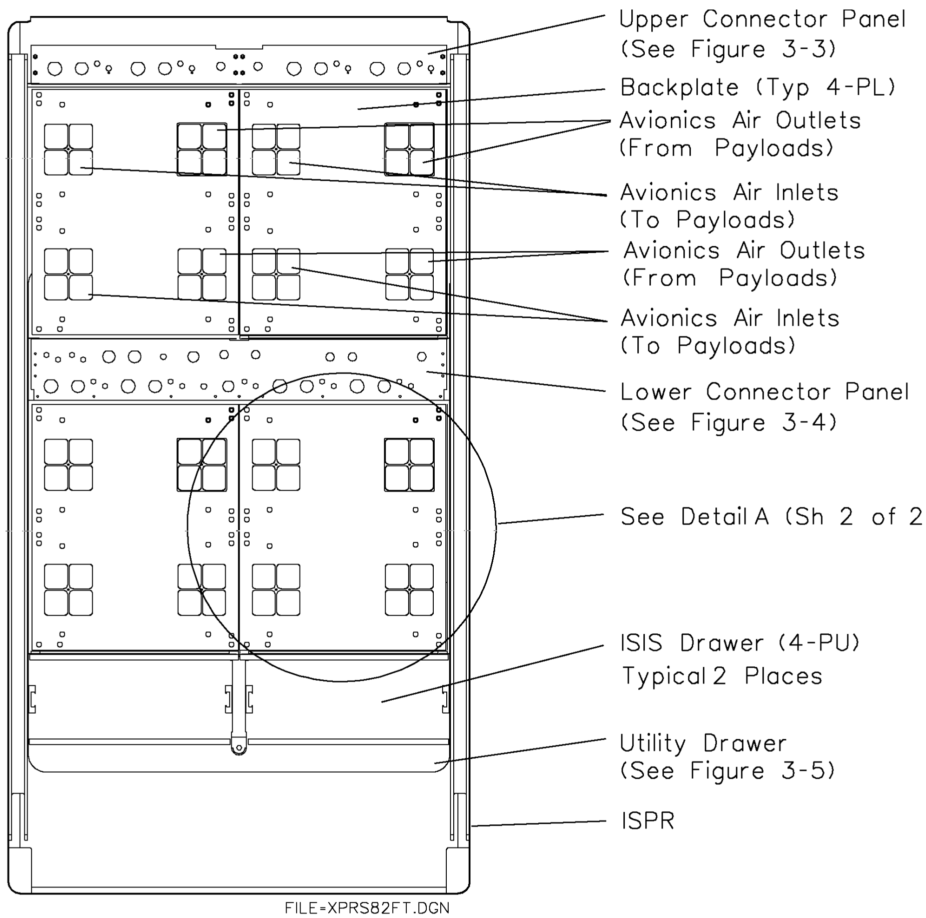
Orbiter-supplied MDLs are available with blank front panels (denoted “modified” locker door) which can be altered to allow services to be provided to the front of the payload. Additionally Space Shuttle Program-supplied adapter plates are available for payload use in interfacing with the orbiter middeck wire trays. These plates are identified in

TABLE 4-I EXPRESS RACK PAYLOAD ACCOMMODATIONS

ACCOMMODATION	INDIVIDUAL LOCATION		TOTAL 8/2 RACK CONFIGURATION
	Middeck Locker Payload	ISIS Drawer Payload	
STRUCTURAL Weight CG (X, Y, Z)	 72 lb +10 in; ±3 in; ± 3 in	 64 lb (4-PU) ±5 in; ± 6 in; N/A	Eight single MDL and two 4-PU ISIS Dwrs.
POWER[5]	(5 A/10 A/15 A/ 20 A (@ 28 Vdc)	(5 A/10 A/15 A/20 A (@ 28 Vdc)	2,000 W (@ 28 Vdc)
COOLING[2,4,9] Air	 Avionics air[3] ~15 scfm	 ≤150 W[3]	 120 scfm
Water (Moderate Temperature Loop)	up to 500 W	up to 500 W	Two access ports (up to 2000 W)
DATA[7] Digital RS 422[1] Ethernet[1] Analog Discrete	 Qty 1 Qty 1 Qty 2 Qty 3	 Qty 1 Qty 1 Qty 1 Qty 2	 10 total 10 total 18 total 28 total
VIDEO[7] NTSC/RS-170A	 Qty 1	 Qty 1	 16 channels
WASTE GAS VENT[8]	Qty 1	Qty 1	1 access port
NITROGEN[6, 8]	Qty 1	Qty 1	1 access port

NOTES:

1. Timing signal to be distributed to each payload on request via the RS-422 or Ethernet data links. Digital data interface must be configured as either an ETHERNET or RS-422 but not both for a single payload position.
2. Total payload heat dissipation is 2,000 W between moderate water loop and avionics air combined.
3. Nominally less than 150 W but up to 500 W with operational constraints and air circulation provided via a payload fan.
4. Heat dissipated (radiated) to the cabin air must be minimized.
5. Solid-State Power Controller Module (SSPCM) has selectable output current rating.
6. The JEM also provides GAr, GCO_2, and GHe. The APM also provides GN_2.
7. EXPRESS laptop can be used to interface to the payload via the Rack Interface Controller (RIC) or Ethernet Payload Ethernet Hub/Bridge (PEHB) for control/monitoring. The EXPRESS laptop can display video data.
8. Payload must provide its own flow control and valving.
9. The EXPRESS Rack provides an area smoke detector for payloads located in the rack.



EXPRESS Rack 8/2 Configuration Front View

Notes:
1. Individual manual shut-off valves located on backplate are provided for each air outlet/inlet.
2. Covers for air inlets/outlets are provided by the EXPRESS Rack Office.

FIGURE 4-1 EXPRESS RACK 8/2 CONFIGURATION STRUCTURAL PROVISIONS FOR MDL PAYLOADS (Sheet 1 of 2)

SSP 52000-IDD-ERP and NSTS 21000-IDD-MDK. PDs should use captive fasteners to attach to Space Shuttle Program mounting panels and ISS EXPRESS Rack backplate.

If a PD desires to develop/fly a hardware item larger than a single or double MDL (i.e., quad, etc.), the rack integrator should be contacted to discuss various structural

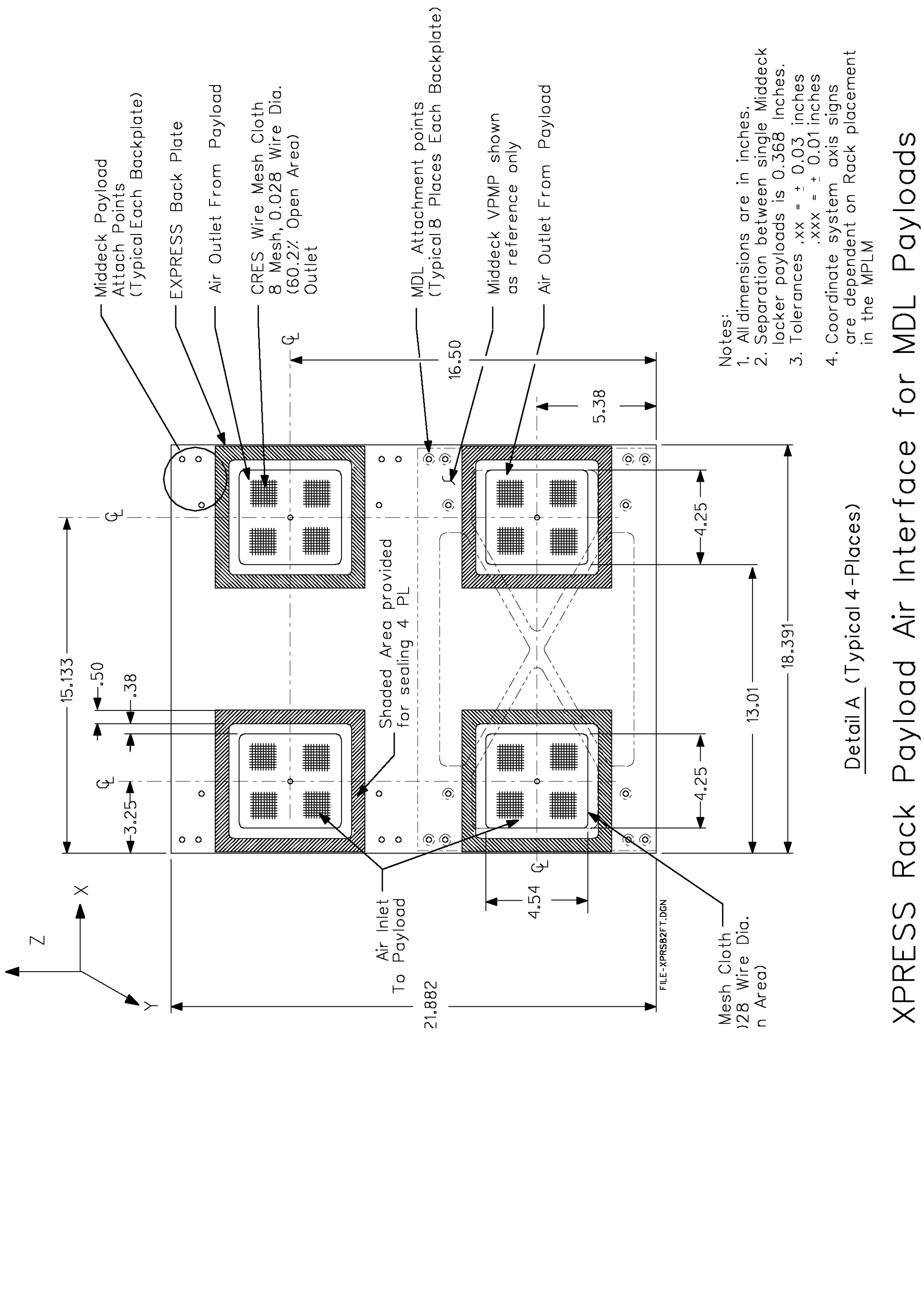
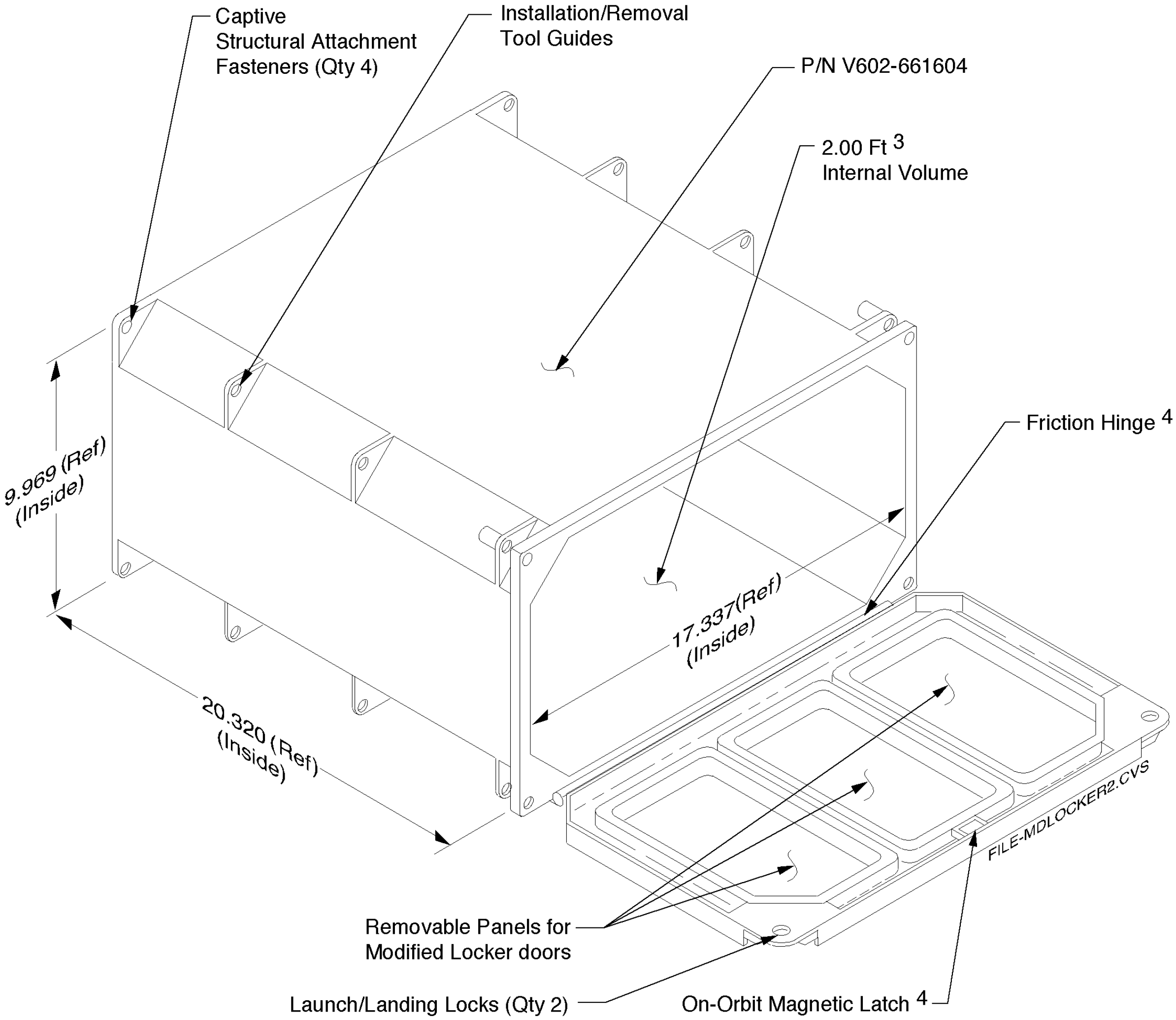


FIGURE 4-1 EXPRESS RACK 8/2 CONFIGURATION STRUCTURAL AND FORCED AIR INTERFACE PROVISIONS FOR MDL PAYLOADS (Sheet 2 of 2)



NOTES:

1. Modular locker has a maximum design density of 30 lb/ft^3, and a minimum of 10 lb/ft^3.
2. Baseline lockers are designed to the following criteria:
   - The locker is fully packed.
   - There must be isolator material (i.e., Pyrell foam or equivalent) between the locker walls and the contents.
   - Empty locker weight is 11.8 lb.

FIGURE 4-2 MIDDECK-STYLE MODULAR LOCKER

qualification/certification activities and responsibilities. To do so, however, may necessitate modification of the standard integration template.

4.1.2 ISIS Drawer

The 8/2 Configuration EXPRESS Rack includes two 4-PU ISIS drawers. Only 4-PU drawers are available. The ISIS drawers are installed into the rack on a set of slide guide assemblies that are attached to the rack posts. Figure 4-3 illustrates the general layout of a ISIS drawer. The existing mechanical interface between a drawer and the rack allows for installation and removal of the drawer without the use of tools. In the rear of the rack, and attached to the slide guide assembly, is a connector bar with two female connectors—one for the power and one for the data. Also included in the rear of the connector bar are receptacles for alignment pins located on the back of the ISIS drawer in the area of the connector. These connectors are female and mate to the male half of the connector on the drawer. This connector mating occurs in the rear of the rack when the drawer is fully installed and latched in the front of the rack. Connections for any additional required rack resources (water cooling, GN_2, waste gas vent, etc.) are made through the modifiable panel on the front of the drawer. There are two configurations for the ISIS drawer: one for active elements, including provisions for a fan and electrical connections, and another for passive stowage items, which includes a sliding lid. The bottom of the ISIS drawer is blank to allow payload hardware to be attached as necessary. Internal ISIS drawer dimensions and mounting provisions are provided in SSP 52000-IDD-ERP. Weights of the various ISIS drawers are shown in Table 4-II.

If a PD desires to replace a standard ISIS drawer with a payload hardware item that attaches directly to the slide/rails, the EXPRESS Rack payload integrator should be contacted to discuss various structural qualification/certification activities and responsibilities. Also this may necessitate modification of the standard integration template.

4.1.3 Fire Protection

The primary means for fire prevention for ISS payloads is by material selection (as stated in NHB 8060.1) and appropriate design criteria, including wire derating/fusing (as specified in NASA Technical Memo (TM) 102179). The requirements for detection of fire events on board ISS are based on the assessment of a potential fire source existing within a particular location. The simplified flow diagram shown in Figure 4-4 illustrates the criteria for fire protection and detection.

Fire suppression is manually provided by the crew using the Portable Fire Extinguishers (PFE) located in each module and the nodes. The suppressant medium is CO_2. If a payload poses a unique hazard, such as a significant quantity of high purity oxygen which could potentially escape or leak into the payload volume and thereby reduce the material flammability limits, unique controls may have to be considered. The crew, following a confirmed fire event at a specified location, applies the CO_2 at the rack location through a 1/2-in diameter fire access hole (the PFE design can accommodate a 1/2-in or a 1-in diameter hole).

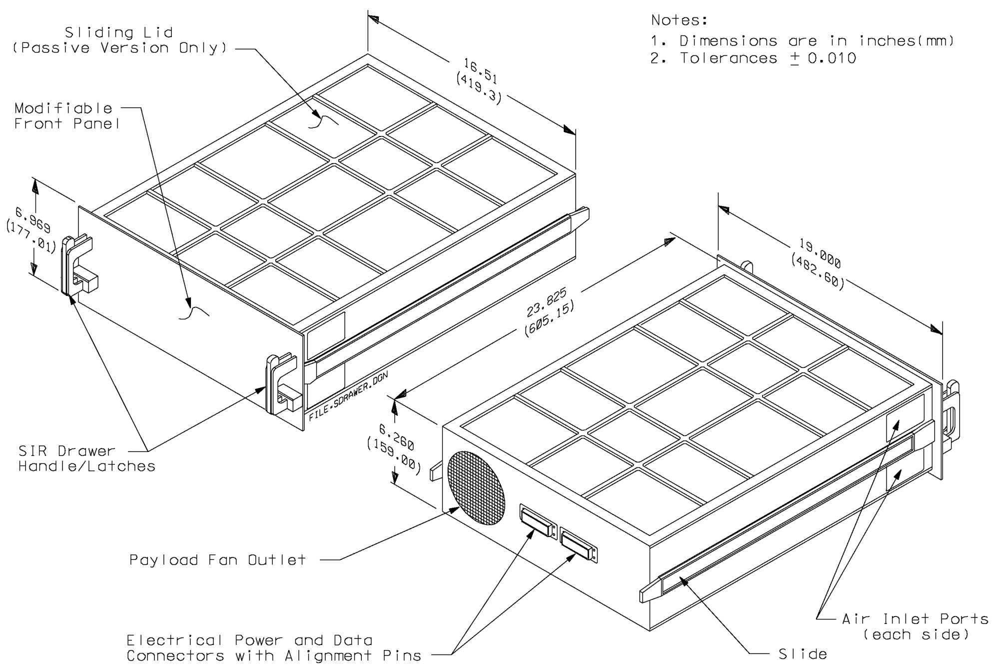


FIGURE 4-3 FOUR-PANEL UNIT (PU) ISIS DRAWER CONFIGURATION

The EXPRESS Rack includes an area smoke detector located in the rear open volume of the EXPRESS Rack near one of the AAA return ducts. The EXPRESS Rack design includes the access port for the PFE that allows distribution of the CO_2 fire suppressant to the free volume of rack (but not to individual payload locations). In most cases, payloads will not require a fire extinguisher access port except to fulfill requirements for being located in the middeck or pose unique risks as defined by fire protection and/or safety requirements.

A Class I fire alarm (provided via C&W) indicates the location at which a fire event is detected by an area smoke detector. This allows the Station and ground crew(s) to take the appropriate action(s) in response to a potentially hazardous fire situation, including manual isolation or suppression, if required. Within 30 sec the fire event should be isolated including removal of power and forced air flow at the affected location. For payloads, the C&W interface is through the smoke sensor via the Rack Interface Controller (RIC) via the payload Multiplexer/Demultiplexer (MDM) and/or the Command and Control (C&C) MDM (when smoke sensors are used). In addition to the Class I alarm, a visual indication of a detected fire event at the rack location is provided by a red Light Emitting Diode (LED) on

TABLE 4-II MDL AND ISIS DRAWER WEIGHTS

	WEIGHTS[3]	
CONTAINER	ACTIVE	PASSIVE
4-PU ISIS Drawer[1]	22 lb	16 lb
MDL[2]	12 lb	12 lb

NOTES:

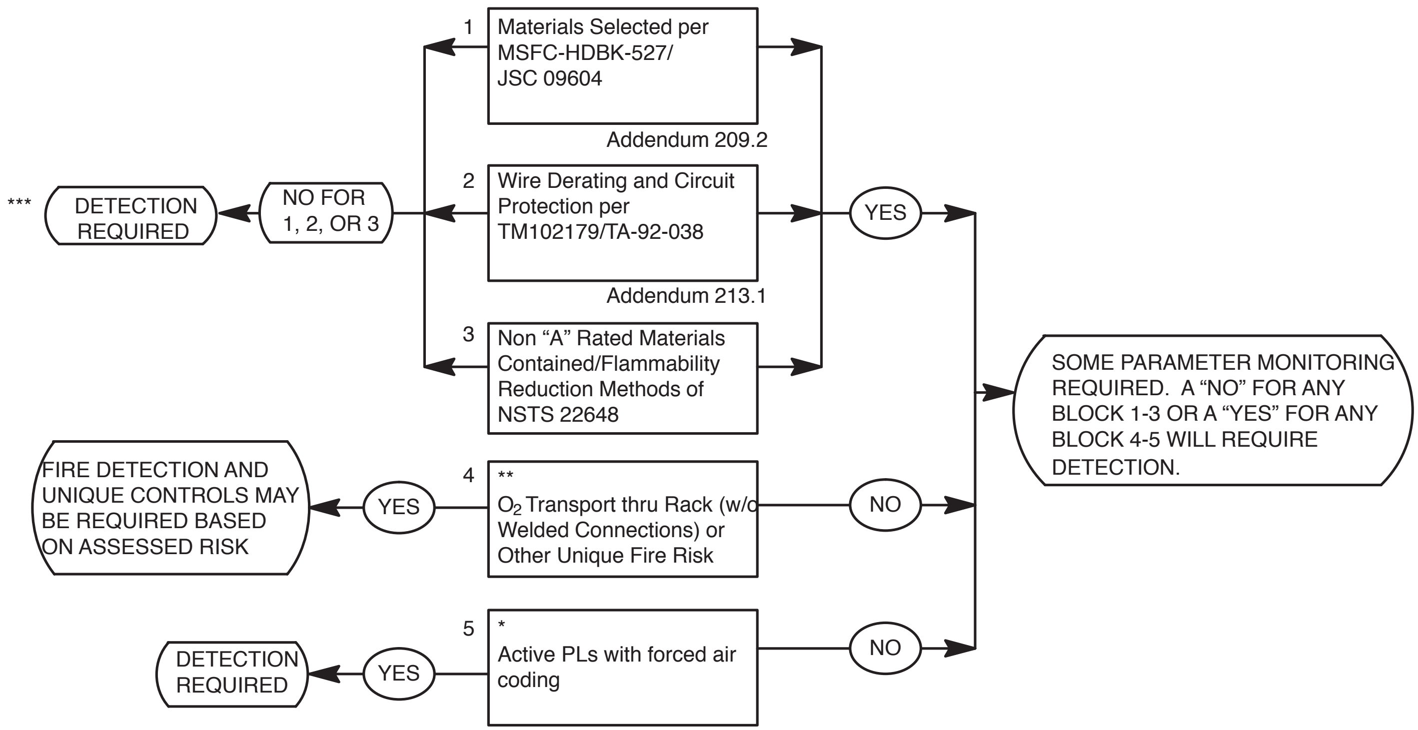
1. Weight from test report.
2. Estimated weight for orbiter-provided middeck locker. EXPRESS Rack will not provide such lockers.
3. Weight is for empty drawer or locker only.

the EXPRESS Rack rack front. This provides a safer and more rapid response of the crew. Location of the fire event (which rack) can also be determined via the Portable Computer System (PCS). The EXPRESS Rack does not provide smoke detectors to individual payload.

Payloads that do not interface with the EXPRESS Rack avionics air and smoke detector must provide an equivalent level of safety control for fire detection. Requirement Guidelines for this are being defined and will be documented in NSTS 1700.7B; however, each PD must have their design and implementation approved by the Payload Safety Review Panel (PSRP).

Fault detection monitoring of payload parameters such as voltage, current, and temperature will also be accomplished to supplement fire detection (smoke sensors) or to monitor powered racks without forced convection or for payloads without a smoke sensor interface. Location of the out-of-limit condition (at the rack level) can only be determined via the **TBD#04** (there is currently no direct C&W interface) and on the ground. These parameter monitors/sensors are preexisting and are not designed or calibrated for specific duty as fire or smoke detection systems. However, because they already exist and they can provide an early indication of faults that could lead to a fire or combustion event, they will be monitored. **Note: Requirement definition and specific crew responses to payload monitored parameter out-of-limit conditions remain under review and have yet to be defined and are TBD#05.**

If the EXPRESS Rack smoke detector indicates the presence of smoke in the rack and sets off the alarm, the ISS PFE will be discharged into the EXPRESS Rack (this will also



* Partial circulation not adequate for smoke sensor placement shall be evaluated on a case-by-case basis. Timely fire monitoring depends on a controlled air flow within the enclosed payload.

** Each payload shall carefully evaluate their payload for fire risk and determine if their hardware and/or operations pose unique fire risks and thus special consideration such as fixed suppression, etc.

*** Detection may be by either smoke sensor or data parameter monitoring.

NOTES:

1. Criteria is based on nominal ISS module atmosphere of 14.7 psi pressure and 20.9% oxygen.
2. Methods of detection and suppression will remain consistent with ISS design and operational constraints, i.e., fire suppressant for fixed systems will be CO_2 unless negotiated with ISS.

FIGURE 4-4 PAYLOAD FIRE PROTECTION CRITERIA cover the payloads). If the "presence of smoke" alarm indication is a result of payload data parameter monitoring (i.e., out-of-limit conditions) and the payload is tied to the EXPRESS Rack avionics air loop, the ISS PFE will be discharged into the EXPRESS Rack. If the "presence of smoke" alarm is a result of payload data parameter monitoring (i.e., out-of-limit conditions) and the payload is not tied to the EXPRESS Rack avionics air loop, the ISS PFE will be discharged into the payload container.

The application of CO_2 suppressant will impact all payloads located and operating within the EXPRESS Rack except for front (cabin air) breathing payloads. Primary suppression of fires will be accomplished by removing power to the fire event location and introducing CO_2 fire suppressant or by venting the module atmosphere to space vacuum. Where a potential fire source has been determined to exist, accommodation of fire suppressant is required via a fire suppression port on the front of the EXPRESS rack. The crew will be able to manually inject fire suppressant (i.e., CO_2) into the location with a PFE. Specific payload hardware requirements to support manual suppression are the rack fire access port, mentioned above. Other hardware such as the PFE is provided by ISS. There is no capability to isolate any payload. Payloads should be cognizant of any effects CO_2 distribution will have on a payload if operating. Once the decision to disburse CO_2 suppressant is made, all power to the rack is removed (i.e., all payloads within the rack will be powered down immediately) and the PFE CO_2 suppressant will be injected via a fire access hole located on the rack front. The application of suppressant must be completed in a period of time (time is approximately 1 min) to effectively suppress the fire and prevent the fire propagation.

After a fire has been controlled, the ISS will be restored to a habitable environment. Depending on the magnitude of the contamination, the restoration may be accomplished by the onboard environmental control systems. If these systems are not capable of handling the contamination, it may be necessary to vent the entire laboratory atmosphere.

The following definitions are used in the discussions and analyses associated with FDS.

A. Fire Event: Localized or propagating combustion, pyrolysis, smoldering, or other chemical degradation process characterized by the potentially hazardous release of energy, particulates, or gases.

B. Potential Fire Source: Any electrical, chemical, or other energy source capable of creating a fire event (e.g., electrically powered equipment).

C. Fire Event Location: **TBD#06**

D. Forced Air Flow: Circulation of air in all or part of a fire event location by use of a fan or blower for cooling or ventilation within the fire event location.

E. Detection: A method of determining that a fire event or potential fire event has occurred within a fire event location.

F. Isolation: Removal of all electrical power to a fire event location.

G. Sealed Container: A metal or nonflammable housing or enclosure that is sealed and does not permit atmosphere exchange (leak rate of 1 x 10^{-1} standard cm^3 per second of helium). A sealed container shall be pressurized with a nonhazardous fluid (e.g., air, nitrogen, argon, etc.) to no more than one atmosphere, shall be capable of withstanding a delta pressure of 1.5 atmospheres without leaking, and shall exhibit an inherent leak-before-burst failure mode.

H. Untended Mode: No on-orbit crew present in a particular ISS lab; i.e., the on-orbit crew is in a different lab.

4.2 THERMAL CONTROL

Payloads in the EXPRESS Rack have two primary means of cooling payload equipment. These are forced air cooling and water cooling. PDs should design their hardware to exhaust heat into the rack forced air cooling loop or moderate temperature water cooling loop. The use of cabin air for cooling is limited due to the restricted amount of heat that is allowed to be introduced into the cabin air loop in the ISS. Use of cabin air as cooling will be allowed for reflight payloads through UF-3. After UF-3, payloads should be designed for water cooling or rear air exchange. The payload complement in the rack still must remain within ISS Lab allocation for cabin air cooling. Payloads are not required to actively prevent passive heat leakage into the cabin (i.e., insulated hardware). Shielding/ protective covers are required for hazard mitigation purposes. Cabin temperatures will range from 63 °F to 82 °F. Refer to Table 4-III for a complete list of cabin environments.

The middeck has been redesigned to accommodate a rear interface for forced air cooling in each avionics bay and should be available to support payloads starting on UF-3.

4.2.1 EXPRESS Rack Forced Air Cooling

Figure 4-5 illustrates the avionics air distribution within the EXPRESS Rack. The EXPRESS Rack facility provides forced air cooling for payloads located in MDLs and ISIS drawers. The PD must provide, as a part of the hardware design, a fan to provide the desired flow to/from the equipment. Figures 4-5 and 4-6 illustrate the forced air cooling interfaces for the MDLs in the EXPRESS Rack. It should be noted that this interface is different from the comparable orbiter middeck interface. The EXPRESS Rack has only one inlet and one outlet instead of two for MDLs. Figure 4-6 shows the middeck avionics bay forced air interface design. The ISIS drawer interface to the forced air cooling is also accomplished using a payload fan. Figure 4-3 shows the inlet and outlet locations for the forced air cooling for a typical 4-PU ISIS drawer. Note that cool air is not ducted to the inlets of the two ISIS drawers in the 8/2 Configuration EXPRESS Rack.

TABLE 4-III ENVIRONMENTAL CONDITIONS ON ISS (Sheet 1 of 2)

ENVIRONMENTAL CONDITION	VALUE
Atmospheric Conditions	
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)
Normal Operating Pressure	See Figure 4-7
Oxygen Partial Pressure	See Figure 4-7
Nitrogen Partial Pressure	See Figure 4-7
Dewpoint	4.4 to 15.6 ° (40 to 60 °F)
Percent Relative Humidity	25 to 75
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mmHg Peak exposure 7.6 mmHg
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mmHg Peak exposure 10 mm Hg
Cabin Air Temperature in USL, JEM, APM, and CAM	17 to 28 °C (63 to 82 °F)
Cabin Air Temperature in Node 1	17 to 31 °C (63 to 87 °F)
Air Velocity	0.051 to .203 m/s (10 to 40 ft/min)
Airborne Microbes	Less than 1000 CFU/m3
Atmosphere Particulate Level	Average less than 100,000 particles/ft^3 for particles less than 0.5 microns in size
MPLM Air Temperatures	Active Flights
Pre-Launch	14 to 30 °C (57.2 to 86 °F)
Launch/Ascent	20 to 30 °C (68 to 86 °F)
On-Orbit (Cargo Bay + Deployment)	16 to 46 °C (60.8 to 114.8 °F)
On-Orbit (On-Station)	16 to 43 °C (63 to 109.4 °F)
On-Orbit (Retrieval + Cargo Bay)	11 to 45 °C (63 to 113 °F)
Descent/Landing	10 to 42 °C (50 to 107.6 °F)
Postlanding	10 to 42 °C (50 to 107.6 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
	Passive Flights
Pre-Launch	15 to 24 °C (59 to 75.2 °F)
Launch/Ascent	14 to 24 °C (57.2 to 75.2 °F)
On-Orbit (Cargo Bay + Deployment)	24 to 44 °C (75.2 to 111.2 °F)

TABLE 4-III ENVIRONMENTAL CONDITIONS ON ISS (Sheet 2 of 2)

ENVIRONMENTAL CONDITION	VALUE
On-Orbit (On-Station)	23 to 45 °C (73.4 to 113 °F)
On-Orbit (Retrieval + Cargo Bay)	17 to 44 °C (62.6 to 111.2 °F)
Descent/Landing	13 to 43 °C (55.4 to 109.4 °F)
Post-Landing	13 to 43 °C (55.4 to 109.4 °F)
Ferry Flight	15.5 to 30 °C (59.9 to 86 °F)
Thermal Conditions	
USL module wall temperature	13 to 43 °C (55 to 109 °F)
JEM module wall temperature	13 to 43 °C (55 to 109 °F) TBR
APM module wall temperature	13 to 43 °C (55 to 109 °F) TBR
CAM module wall temperature	13 to 43 °C (55 to 109 °F) TBR
Other integrated payload racks	Front surface less than 37 °C (97 °F)
*Microgravity	
Quasi-Steady State Environment	See Figures 3.9.3.3-2, 3.9.3.3-3, and Table 3.9.3.3-2
Vibro-acoustic Environment	See Figure 3.9.3.3-4
General Illumination	108 lux (10 fc) measured 30 inches from the floor in the center of the aisle

NOTE:
1. Data reflects best available information as of May 1997. Does not include effects of CAM.

FIGURE 4-7 OPERATING LIMITS OF THE ISS ATMOSPHERIC TOTAL PRESSURE, AND NITROGEN AND OXYGEN PARTIAL PRESSURES)
(T15,3,8,,3.4333334,0.3133333,7,127,5,7,127,1,0,2,

O_2 Partial
Pressure
Control Band) (T15,4,8,,1.7,0.4466667,7,127,5,7,127,1,0,2,

Maximum N_2
Partial Pressure
(11.6 psia)) (T15,5,8,,1.6333333,1.8066666,7,127,5,7,127,1,0,2,

Total Pressure
Control Band) (T15,6,8,,1.8333334,3.4200001,7,127,5,7,127,1,0,2,

Low Logistics Total
Pressure Contingency) (T15,7,8,,4.5,3.1800001,7,127,5,7,127,1,0,2,

Flammability Limit
(24.1% O_2)) (T15,8,8,,2.1133332,4.3533335,7,127,5,7,127,1,0,2,

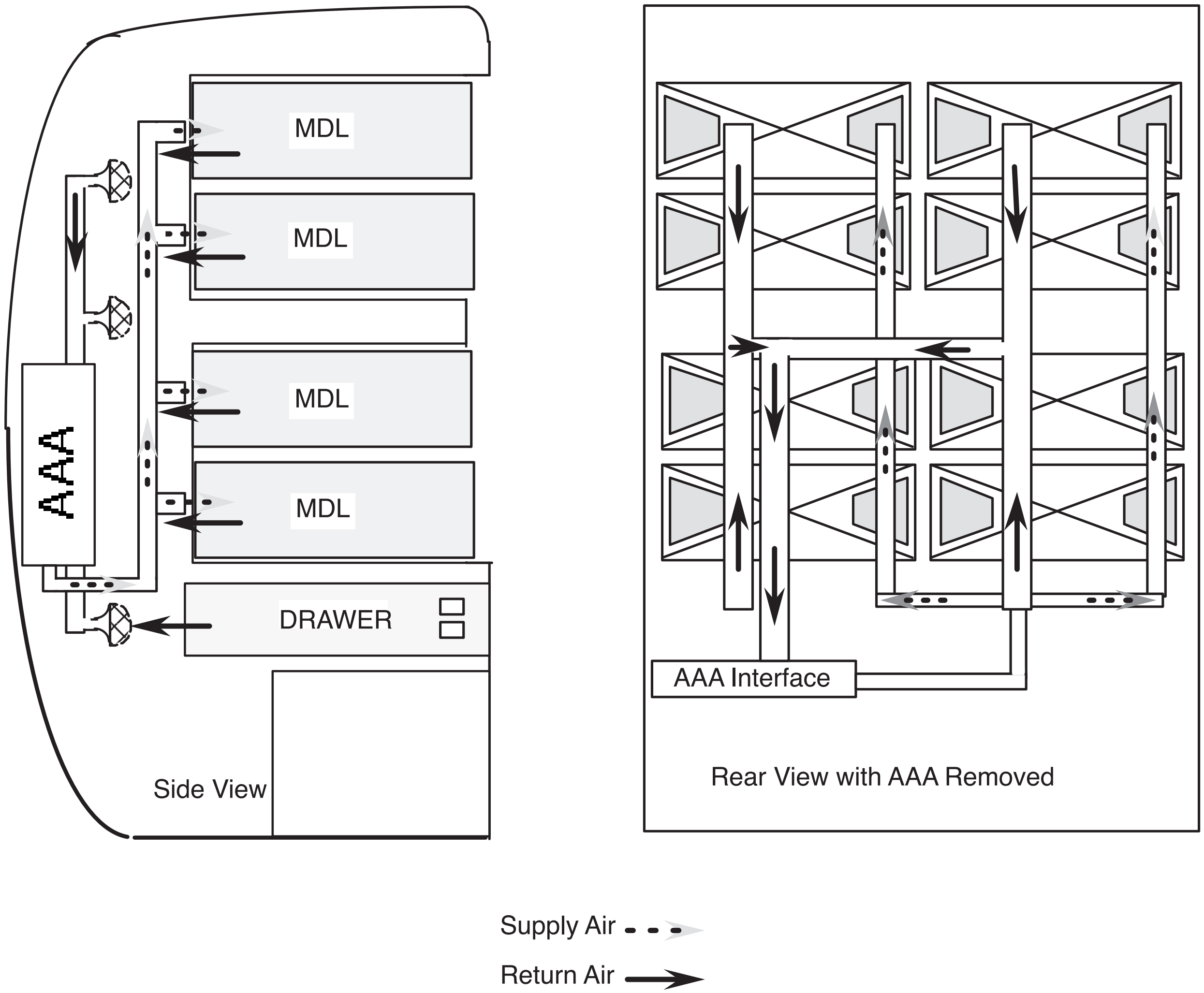


FIGURE 4-5 AVIONICS AIR DISTRIBUTION SCHEMATIC WITHIN THE EXPRESS RACK

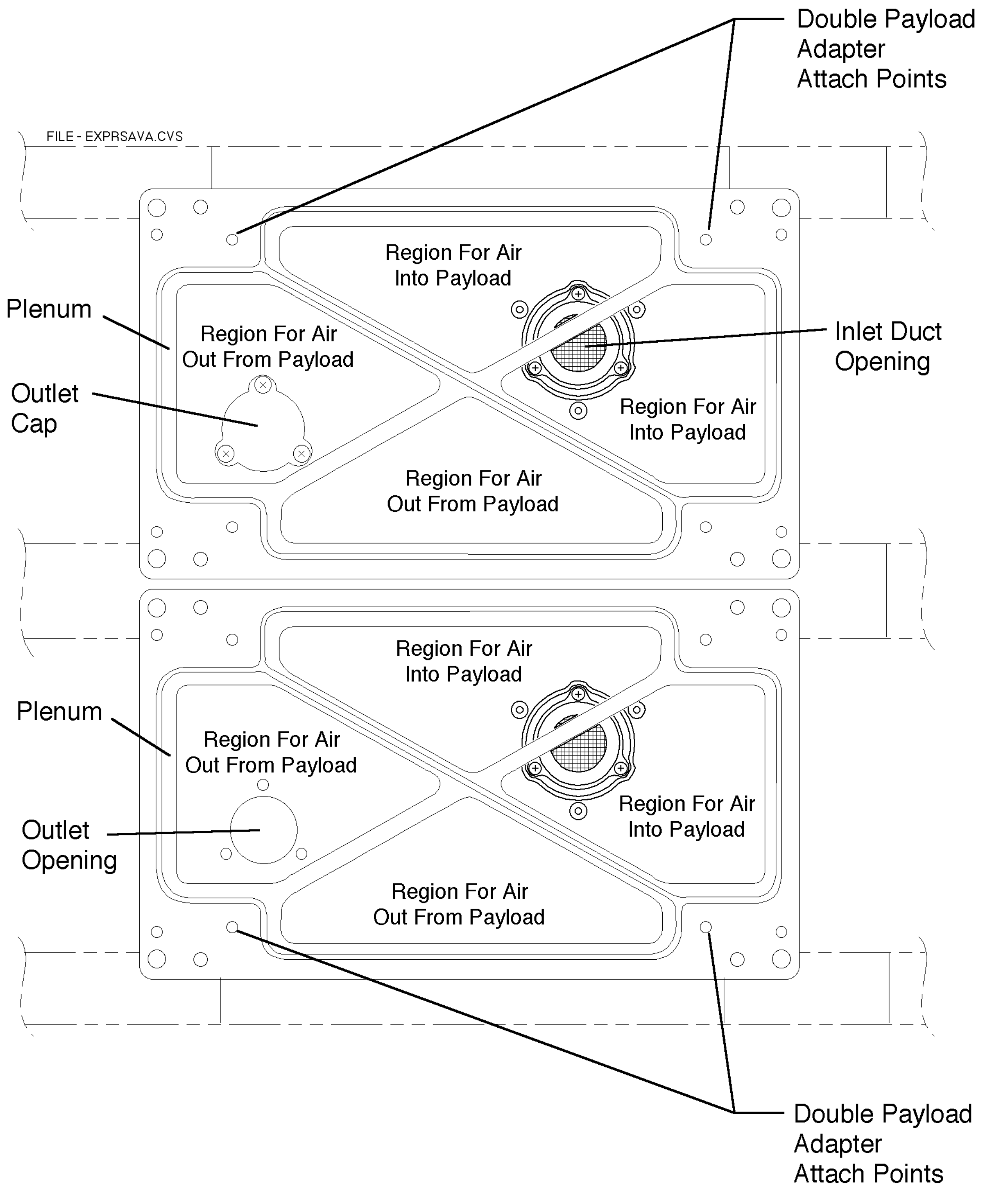


FIGURE 4-6 AVIONICS AIR DISTRIBUTION TO MDLS IN MIDDECK AVIONICS BAYS (EXAMPLE CONNECTION FOR A DOUBLE LOCKER PAYLOAD)

**O_2 Partial Pressure (psia))
(t14,9,0,,0.8333333,3.02,0,7,0,270,,wst:helvps12b,Total\ Pressure\ \(psia\))
(T15,10,8,,0.9,0.0866667,7,127,5,7,127,1,0,2,**

15.5) (T15,11,8,,0.9,1.02,7,127,5,7,127,1,0,2,

15.0) (T15,12,8,,0.9,1.9533334,7,127,5,7,127,1,0,2,

14.5) (T15,13,8,,0.9,2.8866668,7,127,5,7,127,1,0,2,

14.0) (T15,14,8,,0.9,3.8199999,7,127,5,7,127,1,0,2,

13.5) (T15,15,8,,2.8333333,0.02,7,127,5,7,127,1,0,2,

2.83) (T15,16,8,,4.5,0.02,7,127,5,7,127,1,0,2,

3.59) (T15,17,8,,1.1666666,4.0866666,7,127,5,7,127,1,0,2,

2.0) (T15,18,8,,2.3,4.0866666,7,127,5,7,127,1,0,2,

2.5) (T15,19,8,,3.3,4.0866666,7,127,5,7,127,1,0,2,

3.0) (T15,20,8,,4.3000002,4.0866666,7,127,5,7,127,1,0,2,

3.5) (T15,21,8,,5.3666668,4.0866666,7,127,5,7,127,1,0,2,

4.0) (E16,0,0,,5,1,1,0.0533333,1,15,0,0,1,0,0,0,1,7,127,7,0,270,7,0,1,1,0.0666667,0.
0666667,6,6,0,0.0666667,6))>

The EXPRESS Rack facility does not provide a standard air flow rate to the payload equipment. The payload fan provides this flow rate. Approximately 15 lb/hr of air is ducted to the area near the MDL experiment inlet for each location. Individual MDL locations can be shut off to provide increased flow in other locations; however, this is not a desired condition. The EXPRESS Rack essentially provides a “reservoir” of cool air from which the payload draws air and exhausts air for circulation to the AAA. The air temperature will be 65 °F to 85 °F, and the exhaust air temperature is limited to 120 °F. It should be noted that the actual air temperature is dependent on the payload heat load in the EXPRESS Rack (i.e., timeline dependent).

If PDs require specific temperature constraints during certain operation times, the EXPRESS Rack payload integrator should be contacted to discuss these possibilities.

Forced air cooling in the EXPRESS Rack is accomplished utilizing a Standard Payload Outfitting Equipment (SPOE) AAA and various distribution/collection ducting the inlet.

4.2.2 EXPRESS Rack Water Cooling

The EXPRESS Rack facility interfaces to the ISS moderate temperature water loop. Figure 4-8 depicts schematically the distribution of this cooling water within the EXPRESS

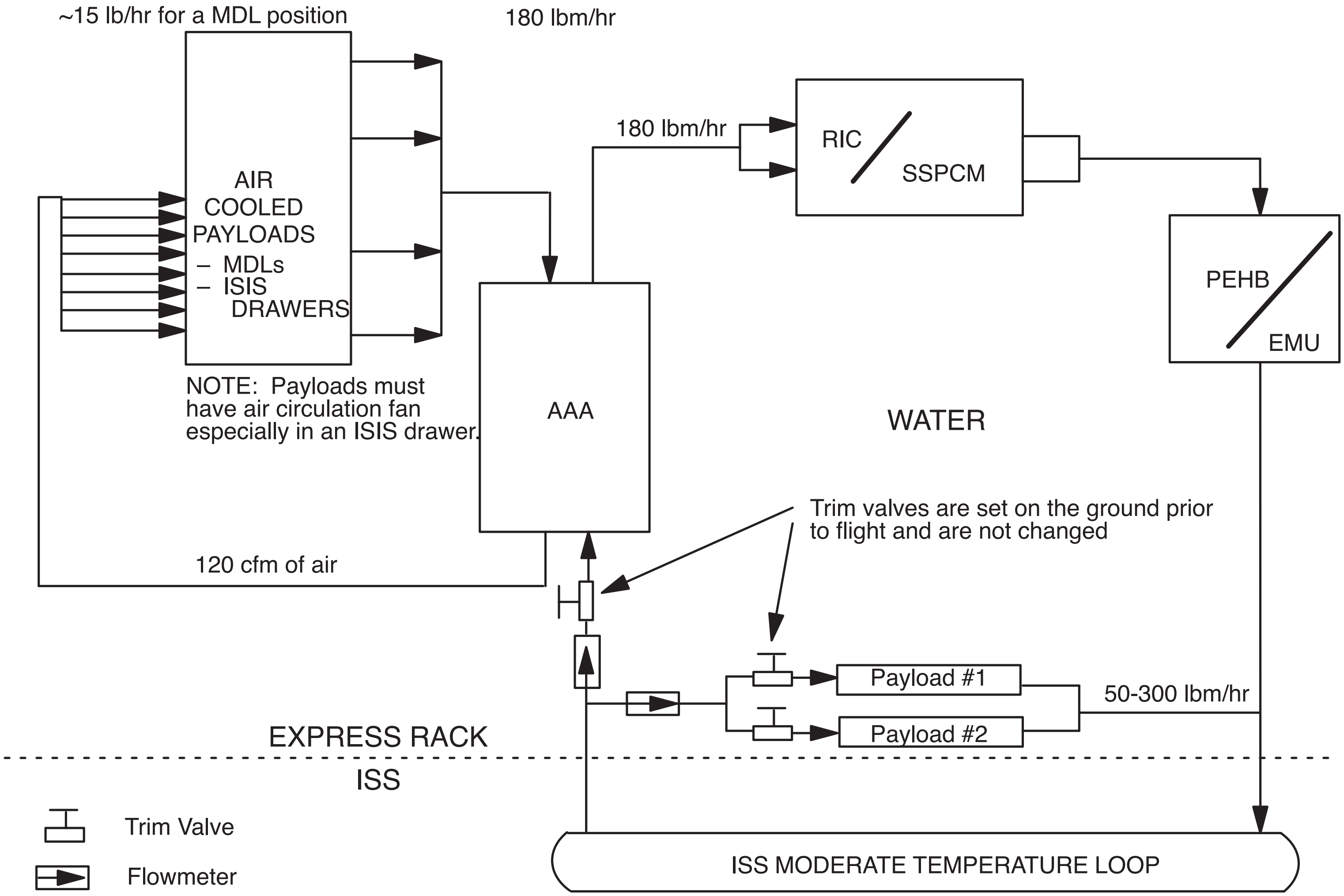


FIGURE 4-8 EXPRESS RACK THERMAL SCHEMATIC

Rack and to the payloads. As shown in Figure 4-8, a portion of the total cooling capability provided by the moderate temperature loop is used to cool EXPRESS Rack subsystem equipment (i.e., coldplate-mounted Payload Ethernet Hub/Bridge (PEHB), EXPRESS Memory Unit (EMU), RIC, Solid State Power Controller Module (SSPCM), etc.), and the remaining capability in conjunction with the forced air cooling heat load (approximately 1,000 W at 300 lbm/hr) is available for payloads. It should be noted that the operating temperatures of the forced air cooling loop and the water loop will be dependent on each other's heat load and operating payload complement. The temperature of the water loop will be dependent on the other payload items operating at any one time.

There are two separate interfaces for water cooling available for payloads in the form of QDs on the EXPRESS Rack front connector panels. The EXPRESS Rack program will provide the interfacing QDs and fluid lines to interface the payload to the rack.

The total water flow available to payloads in the EXPRESS Rack is 300 lbm/hr, which must be shared between one or two payloads. Each payload is required to maintain a pressure drop of 2.80 ± .15 psid at the desired flow rate. The water loop temperature ranges between 61 °F and 73.4 °F, and the exhaust water temperature from the payload is limited to 120 °F. Payloads should be designed to be compatible with the higher limits of the moderate temperature water loop. The Maximum Design Pressure (MDP) for hardware interfacing to 100 psia in the ISS laboratories (121 psia in the APM). It is recommended that the payload hardware be designed for the higher value. If the PD desires on/off or flow control capability, any necessary flow control device must be included in the payload design. The EXPRESS Rack does not provide flow control features.

Payloads using the water cooling interfaces of the EXPRESS Rack must consider several other requirements in developing the payload design. Payloads must arrive at the launch facility fully charged with water. Prior to final water fill of the payload equipment, system leak checks and water samples must be completed. Specifications for acceptable water purity including both particulate and chemical contaminants are defined in SSP 30573. No preservatives/fungicides are allowed in the water.

4.2.3 Vacuum Exhaust

The EXPRESS Rack vacuum exhaust interface provides removal (disposal) of nontoxic and nonreactive exhaust gases from a single payload within the EXPRESS Rack. The gases that are acceptable for exhausting into the vent are defined in SSP 52000-IDD-ERP. The vent is capable of reaching in less than 2 hr (reference nitrogen at 70 °F) a minimum pressure of 1×10^{-3} torr from atmospheric [14.7 psia (101 kPa)] for a single payload volume of 250 liters. The payload vacuum exhaust interface is at the EXPRESS Rack lower connector panel QD. Access to the vent is controlled and timelined via operational methods.

Payload interface pressure should be <40 psia (275.7 kPa); the temperature of the gas should be in the range of 60 °F to 113 °F (16 °C to 45 °C) with a maximum dewpoint of 60 °F (15.6 °C).

Some typical items which may be exhausted are dry gases and compounds. A preapproved list of these are shown in Table 4-IV. There are specific particulate and constituent requirements so that these exhaust gases do not contaminate the exterior surfaces of the ISS or other payloads. A preapproved list of these are shown in Table 4-V. They are identified in detail in the SSP 52000-IDD-ERP. The PD must provide containment, storage, and transport hardware for exhaust gases that are incompatible with the vacuum exhaust system or external environment. Use of such materials, however, may necessitate alteration of the standard integration template. **Note: Tables 4-IV and 4-V will be updated periodically.**

TABLE 4-IV ACCEPTABLE WASTE GASES

WASTE GAS[2]
Nitrogen
Cabin Air[1]
Noble Gases
Carbon Dioxide
Carbon Monoxide (not to exceed 0.08% by volume)
Oxygen (not to exceed 30% by volume)
Hydrogen (not to exceed 25% of the Lower Explosive Limit)
Methane (not to exceed 25% of the Lower Explosive Limit)
Sulfur Hexafluoride
Mixtures of these gases (not to exceed 25% of the Lower Explosive Limit)

NOTES:

1. Vented cabin air will contain small percentages of additional gases at up to the maximum levels defined in SSP 41000, Table VII, Spacecraft Maximum Allowable Concentrations (SMAC), and NHB 8060.1, Appendix D. Cabin air limited to levels identified in SSP 41000, Section 3.2.1.1.1.15, Capability: Control Internal, Carbon Dioxide, and Contaminants.
2. The gases listed in Table 4-IV are compatible with all ISS laboratories. The PD will select from this table or show compatibility with the ISS system.

TABLE 4-V ALLOWABLE CONTAMINANTS

CONTAMINANT(S)[1]	INTERFACE LIMIT (Pa)
ACIDS	
- ORGANIC	0.5
- INORGANIC	0.5
BASES	0.5
- ORGANIC	0.5
- AMMONIA	0.5
- INORGANICS	0.5
HALOGENS (Cl_2, F_2, Br_2, I_2)	
ORGANIC CLASSES	
- GASES	0.5
- SOLVENTS (ORGANOHALIDES HYDROCARBONS AROMATIC HYDROCARBON ALCOHOLS, ETHERS, ESTER KETONES, ALDEHYDES, AMIDES) MISC. (THIOLS, SULFIDES, NITRILES)	0.5
SPECIFIC MATERIALS	
- INORGANIC (H_2S, SO_2, Hg)	0.5
- ORGANIC (CH_2O, C_6H_6, HCN)	0.5
PARTICULATES	5 PPM BY WEIGHT

NOTE:

1. Condensed status of contaminants is not allowed.

There is no flow control on the waste gas vent subsystem provided by either the ISS or the EXPRESS Rack facility. The PD must provide any flow control device (valve, orifice, etc.) needed. Each payload that uses the vacuum exhaust should provide an isolation valve to shut off the vacuum from the rest of the system. It should be pointed out that a negative pressure differential (vacuum exhaust) with respect to the cabin has been used as a single level of containment. This will drive the payload leak rates for the ISS cabin atmosphere. Also the use of the waste gas vent will be controlled (i.e., timelined) so that constituents/contaminants from one payload do not become imposed on another payload.

4.2.4 Nitrogen

GN_2 is provided to a single payload location in the EXPRESS Rack for the USL. The quality of the GN_2 delivered to the EXPRESS Rack and on to the payloads is defined in Table 4-VI. The payload GN_2 interface is at the EXPRESS Rack-provided interface line QD, with the characteristics defined in Table 4-VII. The APM laboratory module and the JEM laboratory module also supply GN_2 via the single supply in the USL. The GN_2 supply for all Users on the ISS is 49 lbm/90 days (22.22 kg/90 days). Access to nitrogen is controlled and timelined via operational methods.

TABLE 4-VI GN_2 QUALITY

CHARACTERISTICS	REQUIREMENTS
Nitrogen, min % by vol	99.995
Total Impurities, ppm	50.0
Total Hydrocarbons ppm as CH4	5.0
Halogenated Solvents	N/A
Oxygen, ppm	20.0
Argon, ppm	2.0
Water, ppm	5.7
Dewpoint, °F, @ 70 °F, 760 mmHg)	-84
Hydrogen, ppm	0.5
Carbon Dioxide, ppm	5.0
Carbon Monoxide, ppm	5.0
Aromatic Hydrocarbons (as Benzene)	0.5 ppm (max)
Halogenated Hydrocarbons	0.1 ppm (max)
Chlorinated Hydrocarbons	0.1 ppm (max)
Nitrous Oxide	1.0 ppm (max)
Odor	None detectable

TABLE 4-VII GASEOUS NITROGEN INTERFACE CHARACTERISTICS

PARAMETER	SPECIFICATION
Temperature Range	60 to 113 °F (15.2 °C to 45.0 °C)
Flow Rate	Up to 12 lbm/hr (5.43 kg/hr)
Operating Pressure	75 to 120 psia (517 kPa to 827 kPa)
Max Design Pressure	200 psia (1379 kPa)

There is no flow control on the GN_2 supply subsystem provided by either the ISS or the EXPRESS Rack facility. Each payload that uses GN_2 should provide an isolation valve to shut off the GN_2, and also must provide any flow control devices. The PD must consider leakage of GN_2 into the cabin (O_2 depletion) as a potential safety item. **Note: Payloads have used an inert atmosphere inside of an electronics box as a safety consideration to preclude flammability issues. GN_2 supply purity levels are in accordance with SSP 30573.**

The JEM provides additional inert gases to be used by payloads including argon (Ar), carbon dioxide (CO_2), and helium (He). Access to these services will be via a unique interface (i.e., payload-provided line to the Utility Interface Panel (UIP)) as documented in the EIA.

4.3 EXPRESS ELECTRICAL ACCOMMODATIONS

The EXPRESS Rack will be normally located in 3-kW rack locations in the ISS laboratories. Since the power output capability of the EXPRESS Rack is fixed, placing the EXPRESS Rack in other positions (i.e., 6 kW or 12 kW) will not increase its capability. A top level electrical diagram for the EXPRESS Rack is presented in Figure 4-9.

4.3.1 Power

The EXPRESS Rack provides a maximum of 2,000 W of electrical power for payloads. This power is supplied via the Solid State Power Controller (SSPC) at 28 ± 0.5 Vdc. The EXPRESS Rack front connector panels provide “ON/OFF” toggle switches for each payload location (reference Figures 3-3 and 3-4). The current capability of each of the SSPCM outputs can be individually selected and set at 5, 10, 15, and 20 A. Trip curves for these outputs are shown in Figure 4-10. The SSPCM current selection can be performed via the EXPRESS Rack laptop or via ground controller commands.

Each EXPRESS Rack configuration supplies a single 28 ± 0.5 Vdc input to each of the 10 payload locations. The maximum current a payload can be supplied from a single input is 20 A. If payloads require more power, multiple inputs must be utilized. Other limiting factors for power availability are thermal constraints (i.e., input power must be dissipated) and timelining of payload operation for both electrical and thermal restrictions.

EXPRESS Rack payloads will be launched in the MPLM in an unpowered state either in an EXPRESS Rack or an EXPRESS Transportation Rack. EXPRESS Rack payloads that must be powered for the prelaunch, ascent, descent, or postlanding phases of the flight will be integrated into the orbiter middeck. Payloads are provided 28 Vdc at 10 A, 15 A, or 20 A at middeck avionics bay locations. Power for payloads in the orbiter middeck is a limited resource (limits include total power, total energy, total heat rejection requirements, outlet quantities, and ground integration restrictions) and must be requested in the payload EIA. Power interfaces and characteristics for the middeck are specified in NSTS 21000-IDD-MDK.

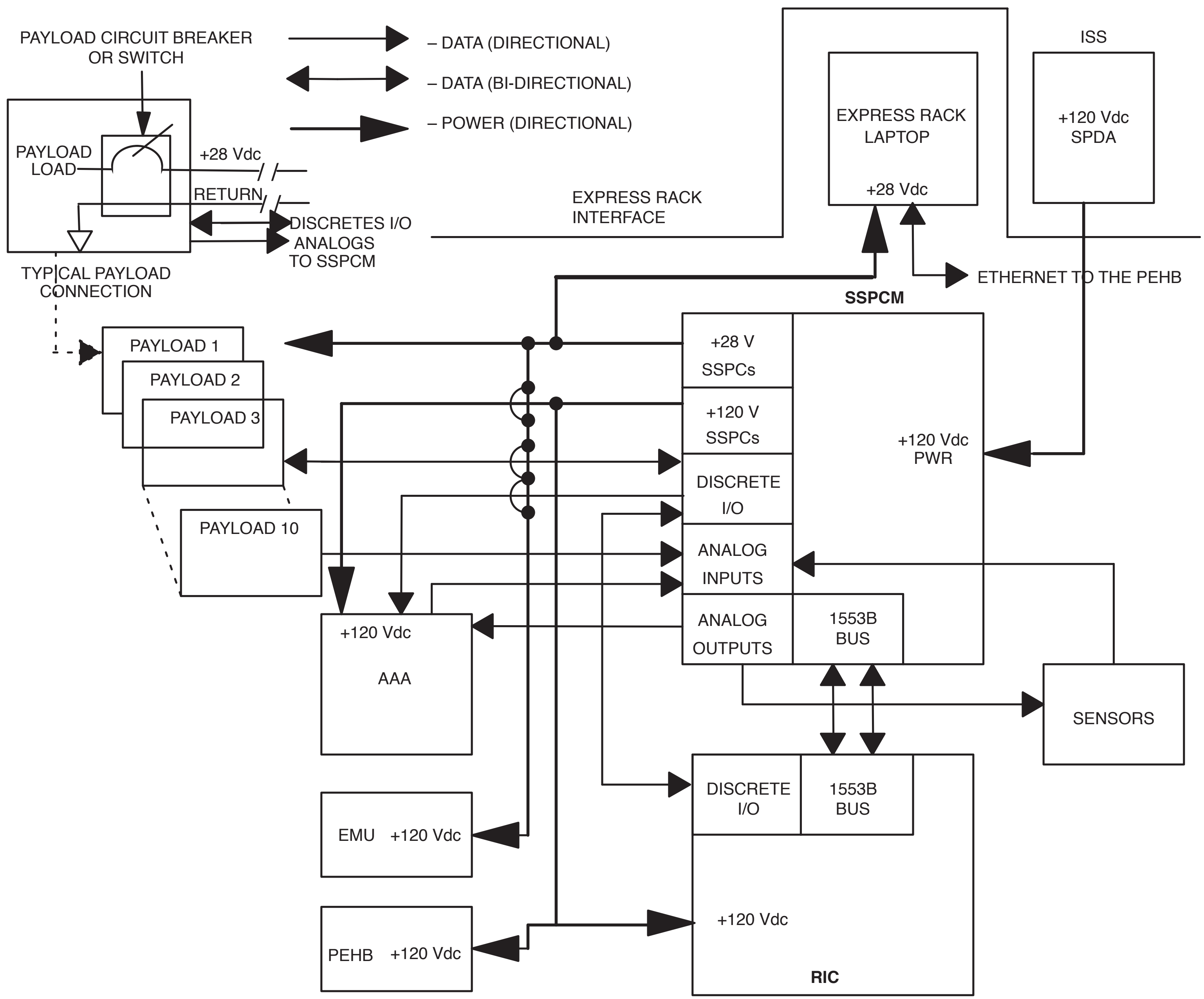
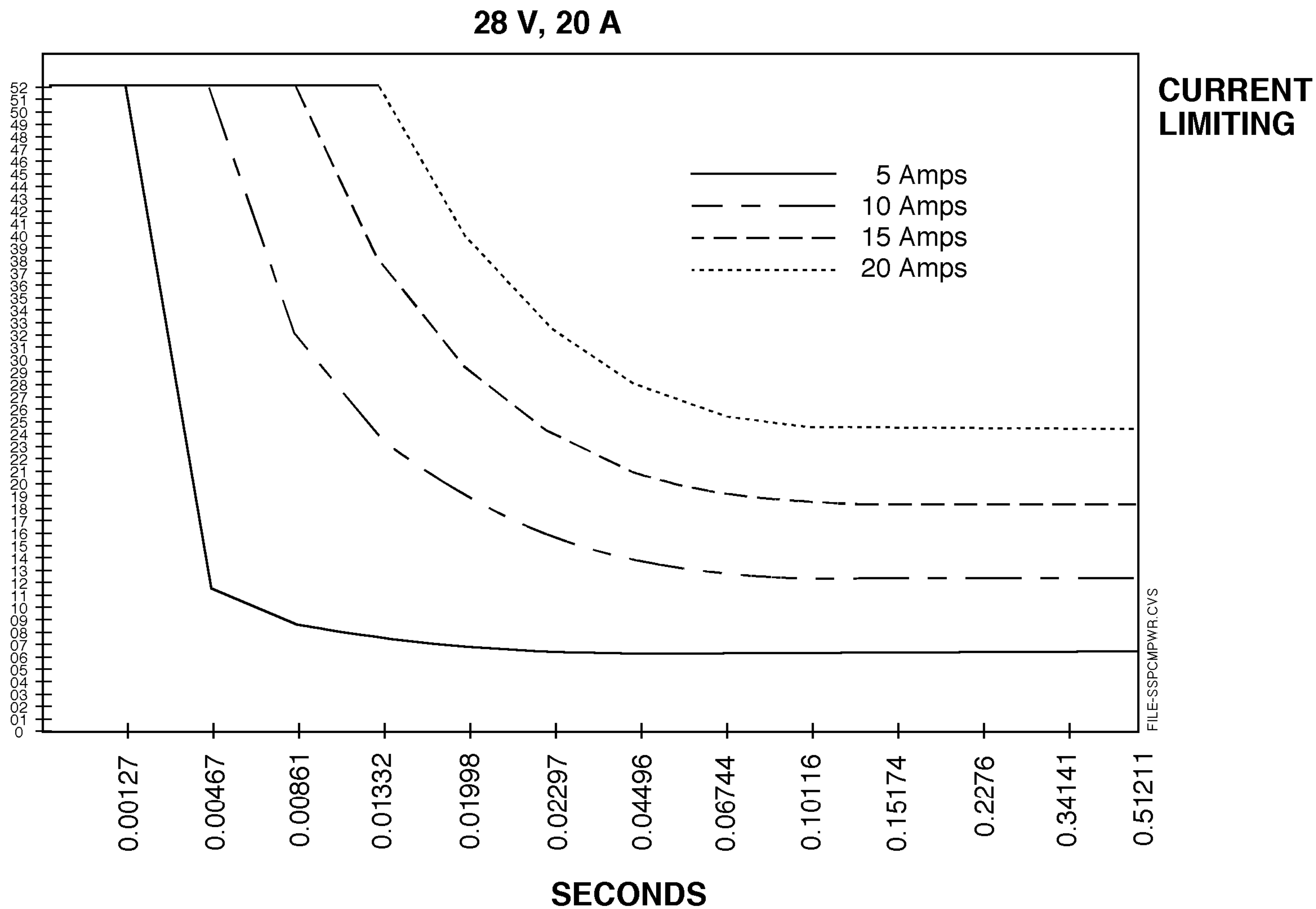


FIGURE 4-9 EXPRESS RACK POWER DISTRIBUTION DIAGRAM AND SSPCM INTERCONNECTIONS



NOTES:

I^2 x t portion of the trip curves have tolerance of +/-10%.

Current limit region shown above is defined for a capacitor load charge. In a direct short condition the actual trip time is 1/2 of the values shown. For a progressive short in which the change in current has a slow rise time, an absolute maximum current limit of 2 times the normal current limit is provided. The time to trip for this condition is dictated by the I^2 x t trip limit.

Each power output of the SSPCM will limit the current within 100.0 microseconds of an over current to a value less than the maximum current limit value as shown.

FIGURE 4-10 SSPCM TRIP CURVES

4.3.2 Electromagnetic Interference/Electromagnetic Compatibility

Each payload device that uses electrical power (including internal battery power) must demonstrate compliance with the conducted and radiated emissions requirements identified in SSP 30237. Compliance with these requirements in SSP 30237 will eliminate any potential interference generated from the payload equipment and imposed on other payloads in the EXPRESS Rack, payloads in the ISS laboratories, the EXPRESS Rack subsystem equipment items, or any ISS laboratory subsystem equipment.

Each powered equipment item, including ISS laboratory subsystem equipment, will be tested following the methodology of SSP 30238 and compared to the SSP 30237 specifications. Some exceedances may be identified during testing of equipment items, and it may not be feasible to correct these. Waivers/deviations will be developed by the PD and evaluated by the ERO and the ISS program for approval prior to flight. PDs are encouraged to perform Electromagnetic Interference (EMI) susceptibility testing to determine the frequencies/magnitudes which may create problems for their equipment items. The test results can be supplied to the EXPRESS Rack integrator for evaluation to determine potential payload operational incompatibilities within the rack and with other items in the various ISS laboratories.

The payload hardware items that may create a hazard (safety-critical circuits) must show compatibility/susceptibility with the required EMI environments.

4.3.3 Bonding/Grounding/Isolation

Proper bonding and grounding are required to prevent shock hazards to the flight crew, minimize electrical noise on power and signal lines, and properly reference signals for data/telemetry. Electrical powered equipment must comply with the bonding requirements of SSP 30245. Bonding between structure references of electrical items for fault current and shock hazard will be through the third conductor in the power connectors. Radio Frequency (RF) bonds will be as described in the EXPRESS Rack Payloads IDD, SSP 52000-IDD-ERP. Electrical powered equipment to be operated on the orbiter must also comply with the bonding requirements as specified in NSTS 21000-IDD-MDK, paragraph 8.4.

All PD electrical circuits must be referenced to a single point ground. All PD electrical conductors (Power, Power Return, Signal, and Signal Return) must be isolated from each other and from the equipment items ground by 1 megohm. Signals interfacing to the EXPRESS Rack subsystems are differential.

4.3.4 Cables/Connectors

Electrical cables (power and telemetry) that connect the PD equipment items to the EXPRESS Rack subsystems are supplied by the EXPRESS Rack facility except for those payloads with a AWG 16 power interface. The PD must supply the power cable that interfaces to the EXPRESS Rack connector panel(s) which are AWG 12. Details and requirements for the power interface are identified in SSP 52000-IDD-ERP. The length of the power interface cable for a particular payload cannot be determined until the time it is assigned to an increment and the specific EXPRESS Rack payload complement is determined. The increment-unique EXPRESS Rack configuration drawing will define the power feeder cable length and routing for each EXPRESS Rack payload. The connector half, which is mounted on the payload equipment item or ISIS drawer, is also supplied by the EXPRESS Rack facility. This includes the MDL-type payloads and the ISIS drawer payloads. These cables/connectors are rated for maximum current or data rate as applicable. Power cables which interface an EXPRESS Rack payload to the orbiter middeck power distribution system are orbiter-provided and must be identified in the EIA. A list of the EXPRESS Rack-provided hardware is listed in Section 5. Once identified in the EIA, the ERO and ISS payloads office will coordinate the use of this hardware with the appropriate organizations.

4.4 COMMAND AND DATA HANDLING

The EXPRESS Rack facility provides several C&DH interfaces for payload use. The EXPRESS Rack facility interfaces to the ISS and the payload are depicted in Figure 4-11. The RIC, the SSPCM, and the PEHB all provide direct C&DH interfaces to the EXPRESS payloads. Bi-directional communications to equipment in the various ISS laboratories and to ground facilities are through these equipment items. Payloads within the same EXPRESS Rack can communicate to each adjacent payload using Ethernet or the Point-to-Point Communications Bus (PPCB) feature of EXPRESS. A selected number of C&DH interfaces are available at each MDL and ISIS drawer location (reference Table 4-I). There are no C&W interfaces to the ISS available directly to EXPRESS Rack payloads. The payload C&W interfaces will be via the EXPRESS Rack Health and Status/Safety interface to the Payload (PL) MDM.

The RIC is a Versa Modula European (VME)-based computer, which provides digital and analog data management services, including, but not limited to, data formatting, data multiplexing, and command distribution and will serve as an interface buffer between EXPRESS and the ISS C&DH. The RIC is designed to provide C&C capability among the ISS C&DH subsystems, the EXPRESS Rack payloads, and the EXPRESS Rack subsystems. The RIC has an interface to the ISS MIL-STD-1553B payload local bus for health and status, safety-related parameters, low rate telemetry, commands, files, timing, request responses, and ancillary data. The RIC also has an interface to the ISS High Rate Data Link (HRDL), Medium Rate Data Link (MRDL), and video for downlink of payload science data.

The SSPCM not only provides power to the EXPRESS Rack payloads and other subsystems but also provides an interface for analog/discrete data collection and an interface for discrete output commands. The SSPCM and the RIC communicate via MIL-STD-1553B interfaces and various discrete signals.

The EXPRESS Ethernet Rack Local Area Network (LAN) located in the EXPRESS Rack facility allows payloads to communicate to the EXPRESS Rack laptop, to other payloads in the same EXPRESS Rack, or to other equipment items in the various ISS laboratories via a PEHB unit in the RIC. The RIC controls the payload access to the overall

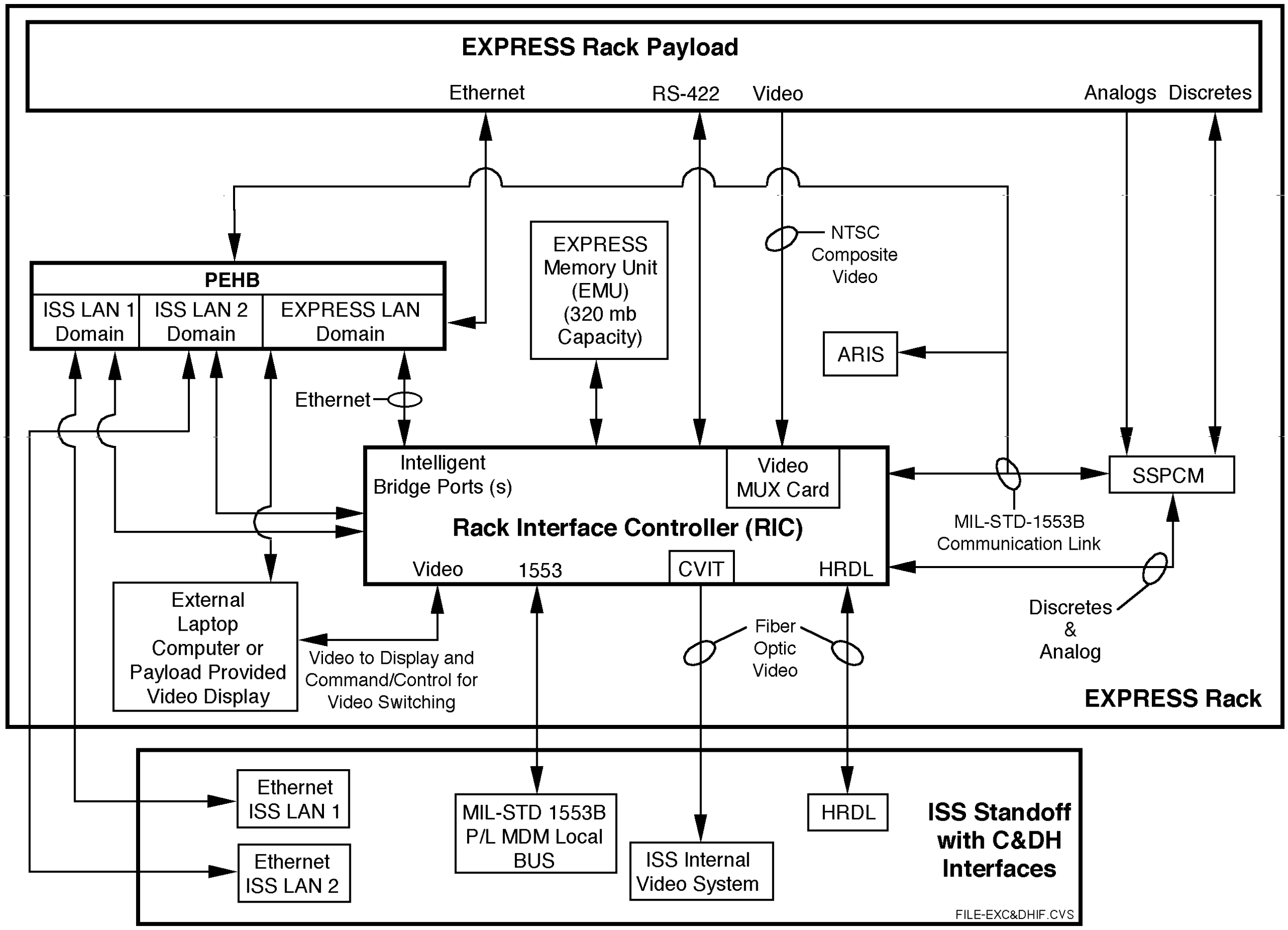


FIGURE 4-11 EXPRESS PAYLOAD C&DH INTERFACES

ISS Ethernet LAN(s) or other payload within the same rack by using addresses loaded into the Content Addressable Memory (CAM) in the PEHB via the subrack MIL-STD-1553B interface.

It is the payload's responsibility to send payload Health and Status/Safety (H&S/S) data to the RIC after the payload has been powered up. The RIC will expect to receive each payload's H&S/S data at a rate of once per second. The format is defined in the "Payload Health and Status" table, and the data type is "009B." If payload H&S/S is not received within the 1-sec sample period, the RIC will send out the last sampled payload health data to the PL MDM. If the RIC receives H&S/S twice in a second, the RIC will send the last sampled data to the PL MDM. There is no command involved.

4.4.1 Serial Data Communications

The RIC provides one ANSI/EIA-RS-422B channel for each of the EXPRESS Rack payload locations. This interface provides the payload the capability to communicate with the RIC via a programmable rate serial data link as specified by ANSI/EIA-RS-422B. The variable baud rates are 1200, 2400, 4800, 9600, 19200, and 38400.

4.4.2 Ethernet Communications

The RIC supports a common IEEE 802.3 10BASE-T interface to the EXPRESS Rack-provided PEHB. The PEHB connects payloads to the ISS Ethernet LAN for MRDL downlink, to the EXPRESS Rack Laptop (LAP), and the rack-to-rack communication. Through the EXPRESS Ethernet LAN, the payload can communicate directly with the RIC, another payload within the same EXPRESS Rack, or in another EXPRESS Rack using Transmission Control Protocol/Internet Protocol (TCP/IP) via the ISS LAN. The RIC also controls the configuration of the PEHB and access to the ISS Ethernet LAN(s) via subrack MIL-STD-1553B interface for all payloads in the EXPRESS Rack.

4.4.3 Analog Communications

EXPRESS Rack provides two analog inputs from each MDL location and one analog input from each of the 4-PU ISIS drawers via the SSPC. Analog inputs are -5 V to +5 V differential (balanced) signals with a selectable sampling rate of 1, 10, or 100 Hz; however, all analogs associated with a single payload are sampled at the same rate. Resolution is 12 bits.

4.4.4 Discrete Communications

EXPRESS Rack provides three bi-directional (inputs and outputs) discrete signal interfaces to each MDL location and two bi-directional discrete signal interfaces to each of the 4-PU ISIS drawers via the SSPCM. The input signal is “zero” at -0.5 to +2.0 Vdc and “one” at +2.5 to +6.0 Vdc single ended with a selectable sampling rate of 1 or 10 Hz; however, all discretes associated with a single payload are sampled at the same rate The output signal from the SSPCM is “zero” at -3.8 Vdc Line to Line (L-L) and “one” at +3.8 Vdc L-L.

4.4.5 EXPRESS Memory Unit

The EXPRESS Rack contains a 320-MByte memory storage device called the EXPRESS Memory Unit (EMU). This device is a flash memory device that stores data for the RIC and laptop only. Any remaining capacity of the EMU will be managed by the ERO and could include a small allocation to payloads. The EXPRESS header, which is a part of every EXPRESS Rack payload’s telemetry, may contain certain designators which identify the EMU status. The criticality designation is utilized when the EMU is nearing capacity to allow writing over less critical data. Specific details on EXPRESS Rack header information is contained in Section 4.5 of this document and in Section 11 of the EXPRESS Rack Payloads IDD, SSP 52000-IDD-ERP.

4.4.6 Payload-to-Payload Communication

The following paragraphs describes the communications within the EXPRESS Rack.

4.4.6.1 Payload A (Ethernet) Communication With Payload B (RS-422) in a Different Rack

Payload A sends the message including Ethernet header with destination as RIC B, TCP/IP header with IP address of RIC B, EXPRESS header with Payload A as Source and Payload B as Destination, and data as one packet to Rack A's PEHB Domain "0" (the PEHB A should have pre-loaded RIC B's Domain "0"). After matching the incoming Ethernet address with the pre-loaded address, the PEHB sends the packet to both Domain 1 (LAN 1) and Domain 2 (LAN 2). The PEHB in Rack B should have only one domain (Domain 1 or 2) pre-loaded with RIC B's Ethernet address (to avoid receiving duplicate packets). After PEHB B's Domain 1 or 2 matches the Ethernet address, the packet is transferred to Domain "0" and forwarded to RIC B. RIC B removes the Ethernet and TCP/IP headers and uses the Destination Function Code for Payload B in the Payload A generated EXPRESS header to send this packet (EXPRESS header and data) to Payload B. The RS-422 rate is pre-defined in the Payload Config Control Table.

4.4.6.2 Payload A Uses RS-422 to Transmit Data to Payload B in a Different Rack by Receiving From Ethernet

Payload A generates the EXPRESS header (the source Function Code is Payload A on Rack A and Destination Function Code is Payload B on Rack B) and data as one packet. Payload A sends this packet to RIC A via RS-422. RIC A receives the packet and adds the Ethernet header (Source address is RIC A and Destination address is Payload B) and TCP/IP header of IP address as Payload B and forwards it to the PEHB A Domain "0". After matching Payload B's address, PEHB A transmits the packet to LAN 1 and LAN 2. PEHB B receives the packet (including the Ethernet header and TCP/IP header) and verifies Payload B's address and then forwards it to Payload B. Payload B receives the packet with the Ethernet header and TCP/IP header generated by the RIC A and the packet generated by Payload A with EXPRESS header and data.

4.4.6.3 Payload A-to-Payload B Communication via Ethernet

This can be any type/class within the same rack or in a different rack, as agreed to between the two payloads. It can be either raw Ethernet (802.3) or a protocol on top of raw Ethernet (for example 802.3 Ethernet + TCP/IP) with the Destination address as Payload B. The RIC is not involved in this communication.

For example, Payload A can generate an Ethernet packet with a header identifying Payload A as the Source and Payload B as the destination with data field following. The packet is sent to Rack A's PEHB (Domain "0") which would have been pre-loaded with Payload B's Ethernet address. The PEHB will compare the Ethernet address and forward the packet to Domain 1 (LAN 1) and Domain 2 (LAN 2) for transmission to Rack B. The receiving PEHB at Rack B is connected to both Domain 1 and Domain 2 but has only one domain with Payload B's address stored within its address file. After comparing the address and finding a match, the Rack B PEHB would forward the packet to Payload B via Domain "0" with the Ethernet header (as generated by Payload A including TCP/IP header - if used) and data. No EXPRESS header is required in this communication although a payload can include it in the data portion of the packet if desired.

4.4.6.4 Payload A-to-Payload B Communication via RS-422 in the Same Rack

Payload A generates the EXPRESS header with Source Function Code as Payload A and Destination Function Code as Payload B. The Message Type will be coordinated and agreed on by both payloads. The RIC will only check the Source and Destination Function Code, then throughput the message.

4.4.6.5 Payload A-to-Payload B Communication via RS-422 in a Different Rack

Payload A generates the EXPRESS header with Source Function Code as Payload B. The Message Type will be coordinated and agreed on by both payloads. The RIC A will generate an Ethernet header with Destination address as RIC B and forward the new packet (new Ethernet header and Payload A generated message) to RIC B through the domain address checking. RIC B removes the Ethernet header and forwards the message generated by Payload A to Payload B.

All the payloads in same rack can "see" the data/command on Domain "0," but only those with the correct address should receive the packet.

After power-up of the RIC, every port on Domains 0, 1, and 2 is disabled. To enable these ports, 1553B commands have to be issued that reset the LAN counters, load the address (Ethernet) to the RAM, and load address to the selected domain CAM from RAM. Addresses are loaded to the CAM by using PEHB_RCV_CAM_ADDR_1 and PEHB_RCV_CAM_ADDR_2. Each command can load up to 8 addresses, each 6 bytes in length. For details see SW60611-910.

4.4.7 Payload Data Downlink

Payload (Ethernet and RS-422) data downlinked to ground must be via the RIC to ISS. The Ethernet data will be via Domain "0" with Ethernet header and TCP/IP Protocol to the RIC. The RIC will remove the payload-generated Ethernet header and TCP/IP header by replacing with the Ethernet header (source as RIC and Destination as PEHG) and Consultative Committee for Space Data Systems (CCSDS) header and then send the packet to the ISS LAN for downlink. The PEHG will remove the Ethernet header and interface with High Rate Frame Multiplexer (HRFM) via the Automated Payload Switch (APS) by using the CCSDS header. For RS-422 data, the RIC will add Ethernet header (source as RIC and Destination as PEHG) and CCSDS header on top of the payload EXPRESS header, then send the packet to ISS LAN for downlink by using MRDL via APS to HRFM.

If these (Ethernet and RS-422) data will be downlinked by using the RIC HRDL, the RIC will add the CCSDS header in front of the packet and send it to the APS.

If these (Ethernet and RS-422) data will be downlinked by using the RIC LRDL, the RIC will add the CCSDS header in front of the packet and send it to the PL MDM.

The PEHB has no Ethernet address. The PEHB (CAM) performs as an address FILTER or CHECKER. The RIC has Ethernet address.

Downlink Application Process Identifier (APID): For each subrack payload, the EXPRESS RIC can create multiple APIDs by using the Function Code and telemetry data type from Telemetry Config Control Table. The individual payload "Function Code" will be from 0205 h to FFFF h as defined in Function Code Assignments Table. The "Telemetry Data Type" will be from 0100 h to FFFF h, and the "Message Type Assignment" is "009Ch" as defined in the Telemetry Data Type Table. This issue must be worked with the Payload Operation and Integration IPT in JSC. If each EXPRESS Rack has enough APIDs assigned for that increment, then each Ethernet packet CCSDS header will contain only one data type from a single Function Code. The ground can process this unique APID for determining the data routing. If there is not a sufficient number of APIDs to allow a unique APID for each combination of Function Code and data types, then one APID will represent a number of data types. If there is still an insufficient number of APIDs, then a number of Function Codes will share one APID. Under this condition a lookup table will be needed on the ground to de-commutate the signal and route it to each individual remote location.

4.5 EXPRESS RACK SOFTWARE AND LAPTOP COMPUTERS

4.5.1 Laptop Computers

There are three laptop computers available for the payload to use. They are described in the following paragraphs.

The Payload and General Support Computer (PGSC) is primarily to be used in the orbiter (middeck or flight deck). The PCS is the primary laptop interface with the ISS subsystems. The EXPRESS Rack laptop is the primary payload interface with the EXPRESS Rack RIC/PEHB and the payloads within an EXPRESS Rack.

4.5.1.1 Payload and General Support Computer

PGSC utilization, operations, and constraints are defined in NSTS 21000-IDD-PSC. Power and data cables (RS-232, RS-422) are typically orbiter provided.

4.5.1.2 Software (Orbiter PGSC)

All unique payload software and applications used on the PGSC shall be payload provided. The payload may use standard 3.25-in floppy diskettes, replaceable hard drives, or

Personal Computer Memory Card International Association (PCMCIA) cards. The PD shall show compatibility of these User accessories with the PGSC model to be used. It is recommended that the payload make arrangement to allow for testing the experiment hardware with the intended software installed in the PGSC.

4.5.2 EXPRESS Rack Laptop

The EXPRESS Rack laptop is used to display EXPRESS Rack facility subsystem status and communicate with payload hardware elements using PD applications within the EXPRESS Rack or to other payload elements within the ISS laboratories via the PEHB. The EXPRESS laptop computer is the IBM Thinkpad 760 XD. The configuration includes 64 MB of RAM, a 3.0-GB hard drive, and Windows NT operating system and the following features:

A. 166-MHz Pentium Processor

B. 3.0-GByte hard drive

C. 8X CD ROM

D. 1.44-MByte floppy disk drive

E. 64-MByte EDO RAM

F. 13.3-in SVGA display with 1,024 x 768 resolution

G. PCMCIA is certified for Ethernet or MIL-STD-1553B

H. Lithium ion battery

- PCS plans to fly Ni metal hydride battery

I. Video (MPEG 1 and 2) and audio parts with 8-bit resolution. The video cable is certified for a NTSC signal.

J. RS-232, parallel, joystick, external floppy, and MDI ports. (RS-422 will be qualified.)

K. Expansion chassis bus (AT/PCI)

The EXPRESS laptop application software is used for control of the rack equipment and display of rack status. The rack application is developed using Microsoft Visual Basic and Visual C++ for the Graphical User Interface (GUI). Figure 4-12 illustrates at a high level the end-to-end description of command flows from the EXPRESS Rack laptop using PD applications to a payload. There are no direct physical interfaces between this laptop and the payload; however, the computer using PD applications can be used to monitor the payload, send requests, display video, etc.

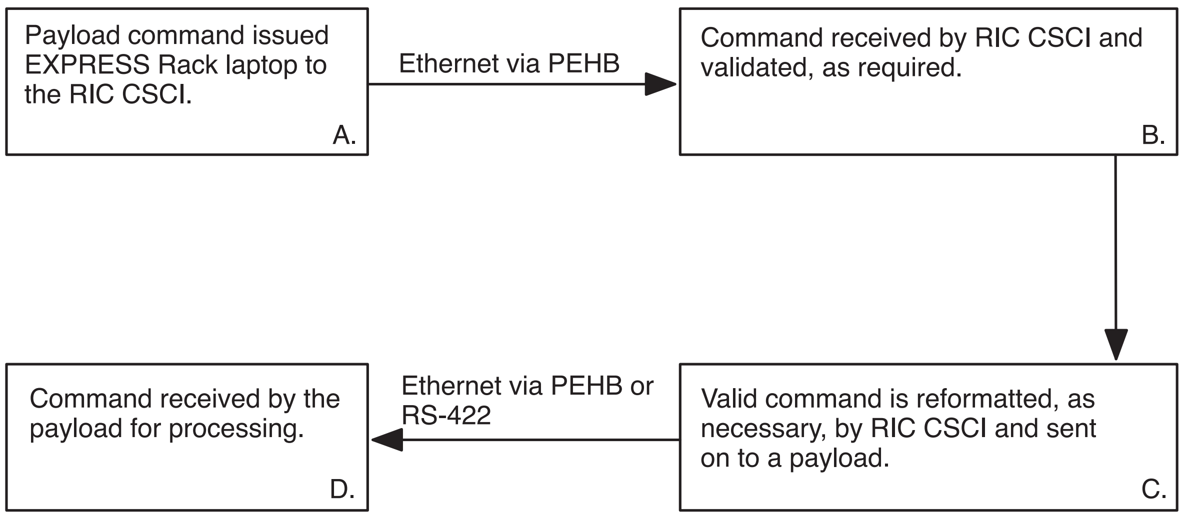


FIGURE 4-12 PAYLOAD COMMAND FLOW

4.5.2.1 EXPRESS Rack-Powered Laptop

The EXPRESS Rack laptop obtains 28-Vdc electrical power through a power outlet on the EXPRESS Rack front panel. The EXPRESS Rack laptop communicates to the RIC via a cable that also attaches to the front panel on the rack. The EXPRESS Rack laptop receives video via a cable that attaches to the front panel on the rack. All cables which interface the EXPRESS Rack laptop to the EXPRESS Rack front panel connectors are EXPRESS Rack facility supplied. Nominally these cables will not be connected directly to payload equipment or specific EXPRESS Rack subsystem equipment items.

4.5.3 EXPRESS Rack Software Interfaces

Figure 4-13 depicts the EXPRESS Rack Computer Software Configuration Item (CSCI) interfaces to the payloads and other items within the EXPRESS Rack. Table 4-VIII summarizes the EXPRESS Rack RIC CSCI external interfaces that are connected to the payload equipment item. There are other services available to payloads as shown in Figure 4-13; however, the software interfaces between the payload and the ISS must go through the RIC and/or the PEHB. Figure 4-14 illustrates at a high level the end-to-end description of command/request flows for a command from the Payload Executive Processor (PEP) (such as a ground command) to a payload/EXPRESS Rack laptop. The word “command” refers to messages/data sent to the payload. The word “request” refers to messages/data sent from the payload. Figure 4-15 illustrates at a high level the end-to-end description of the request flows from a payload to the RIC.

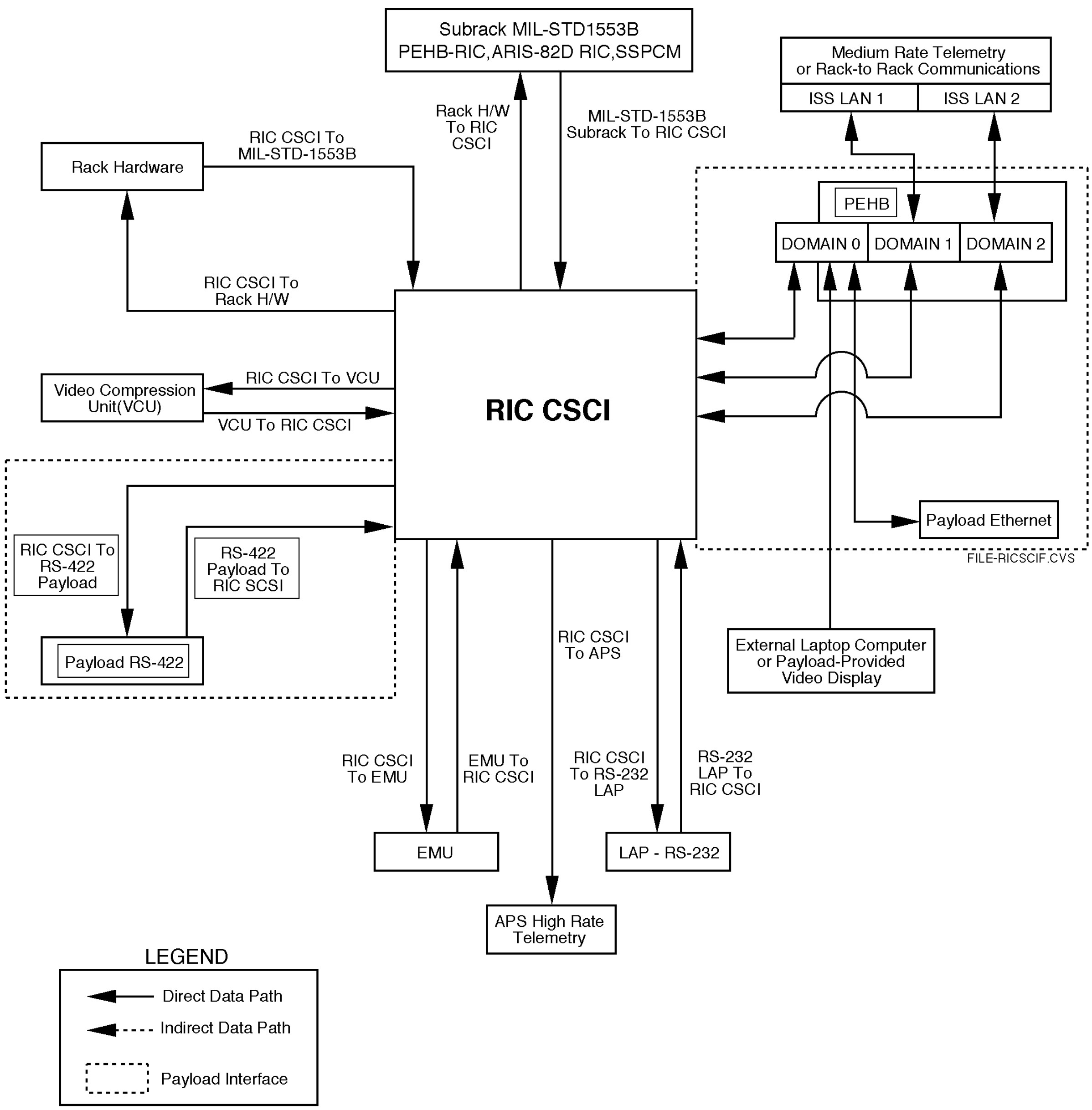


FIGURE 4-13 EXPRESS RIC CSCI INTERFACE DIAGRAM FOR RIC-TO-PAYLOADS AND OTHER RACK HARDWARE ITEMS

TABLE 4-VIII EXPRESS RACK PAYLOAD RELATED RIC CSCI EXTERNAL INTERFACE IDENTIFICATION

NAME	DESCRIPTION	INTERFACE TYPE
RS-422 PLD to RIC CSCI	Status, service requests, and data sent from Payload (PLD) via ANSI/EIA-422.	Software
RIC CSCI to RS-422 PLD	Commands and data sent to a PLD via ANSI/EIA-422.	Software
RIC CSCI to Ethernet PEHB	Commands and data sent to a PLD via Ethernet. Laptop communications, setup for rack communications, transmit medium rate telemetry data from PLD.	Software
Ethernet PEHB to RIC CSCI	Status, service requests, and data sent from PLD via Ethernet. Laptop communications with RIC and medium rate telemetry data from the PEHB to the RIC CSCI.	Software

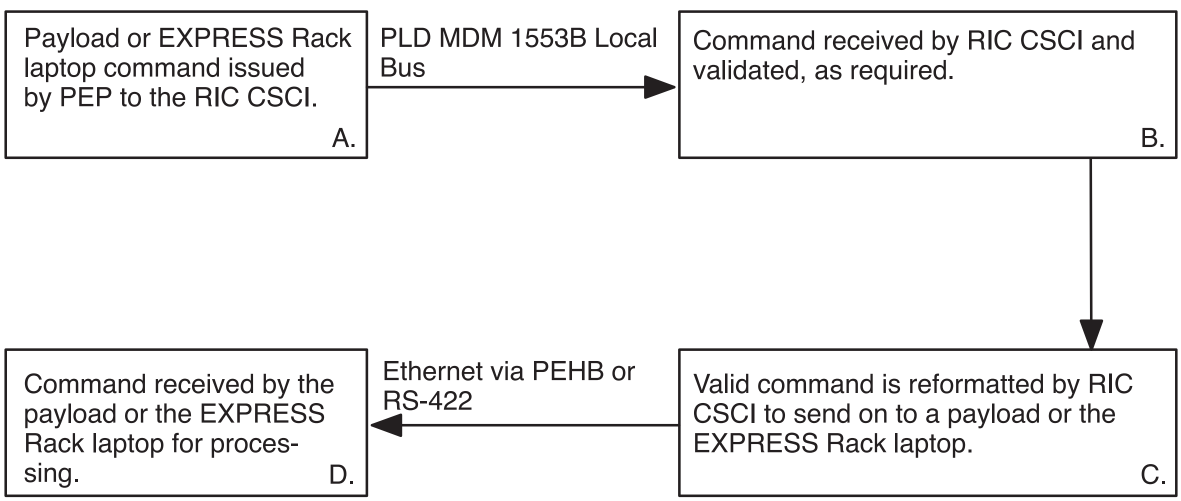


FIGURE 4-14 PAYLOAD COMMAND FLOW

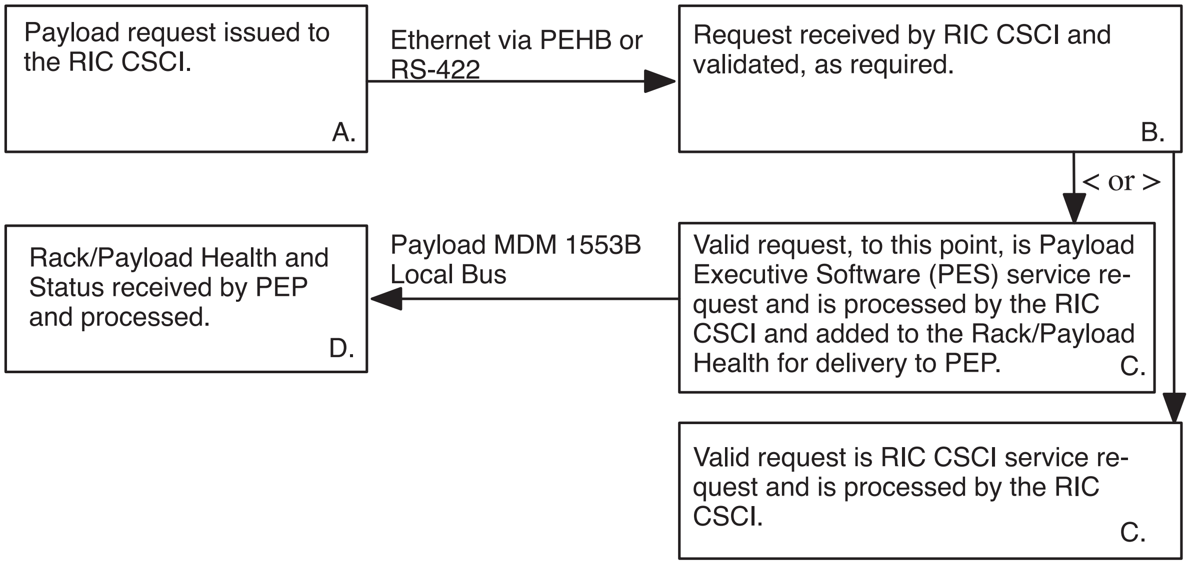


FIGURE 4-15 PAYLOAD REQUEST FLOW

4.5.3.1 EXPRESS Rack Payload Ethernet Hub/Bridge Software Interface

The Ethernet connections are IEEE-STD-802.3, Carrier Sense Multiple Access with Collision Detection Local Area Network Specification, Type 10BASE-T compliant. The RIC CSCI interfaces to the PEHB (Figure 4-13), in accordance with ANSI/IEEE-STD-802.3 Ethernet, for downlink of payload medium rate telemetry, setting up payload rack-to-rack communication, communications with the EXPRESS Rack laptop CSCI, and communications with the payloads. Payload requiring a high rate data link can access this interface via the PEHB to the RIC and then to the ISS APS.

There are no direct physical interfaces between the RIC CSCI interfaces and the ISS Payload Ethernet Hub/Gateway 1 (ISS LAN 1) or Gateway 2 (ISS LAN 2); however, there is an ANSI/IEEE-STD-802.3 Ethernet connection between the PEHB and the ISS LAN 1 and ISS LAN 2, which provides a logical Ethernet communications interface between the RIC CSCI and the ISS LAN 1 and ISS LAN 2 through the PEHB, which will be used for downlink of medium rate telemetry and rack-to-rack communications.

4.5.3.2 EXPRESS Rack Laptop Ethernet Software Interface

There is no direct physical interface between the RIC CSCI and EXPRESS Rack laptop CSCI; however, there is an ANSI/IEEE-STD-802.3 Ethernet connection between the PEHB and the EXPRESS Rack laptop, which provides a logical Ethernet communications interface between:

A. The RIC CSCI and the laptop CSCI through the PEHB, with communication in accordance with TCP/IP, for normal operations.

B. The payloads and the EXPRESS Rack laptop CSCI through the PEHB will be used for payload data transfers for use on EXPRESS Rack laptop displays or in payload applications running on the EXPRESS Rack laptop.

C. The laptop CSCI interfaces with the User Interface (UI) application for the exchange of the User inputs and display data. The UI physical interface with the User includes the keyboard and GUI on the laptop display.

4.5.3.2.1 EXPRESS Rack Laptop Data Elements

The EXPRESS Rack laptop commands through the PEHB using the Ethernet interface are identical to commands defined for the PEP-to-RIC interface, with data/command-type assignments as shown in SSP 52000-IDD-ERP.

4.5.3.2.2 EXPRESS Rack Laptop Ethernet Interface Data Elements

The EXPRESS Rack laptop commands through the PEHB using the Ethernet interface are identical to commands defined for the RIC-to-laptop interface, with data/command-type assignments per SSP 52000-IDD-ERP.

4.5.3.3 RIC Software Interface

There is no direct physical Ethernet interface between the RIC CSCI and the payloads; however, there is an ANSI/IEEE-STD-802.3 Ethernet connection between the PEHB and the payloads, which provides a logical Ethernet communications interface between:

A. The RIC CSCI and the payloads through the PEHB, with communication in accordance with TCP/IP Ethernet transmission protocol.

B. The payloads and the ISS LANs (LAN 1 and LAN 2) will be used for rack-to-rack communications. Figure 4-16 illustrates at a high level the end-to-end description of the request flows from a payload to the RIC for establishing rack-to-rack payload communications.

C. The payloads and the EXPRESS Rack laptop CSCI will be used for payload data transfer used on EXPRESS Rack laptop displays or in payload applications running on the EXPRESS Rack laptop.

The data elements for this interface are defined in the SSP 52000-IDD-ERP.

4.5.3.3.1 EXPRESS RIC I/F Commands and Responses

The SSP 52000-IDD-ERP defines the commands and messages between the EXPRESS-located payloads and RIC CSCI. The tables consist of the header/message/word

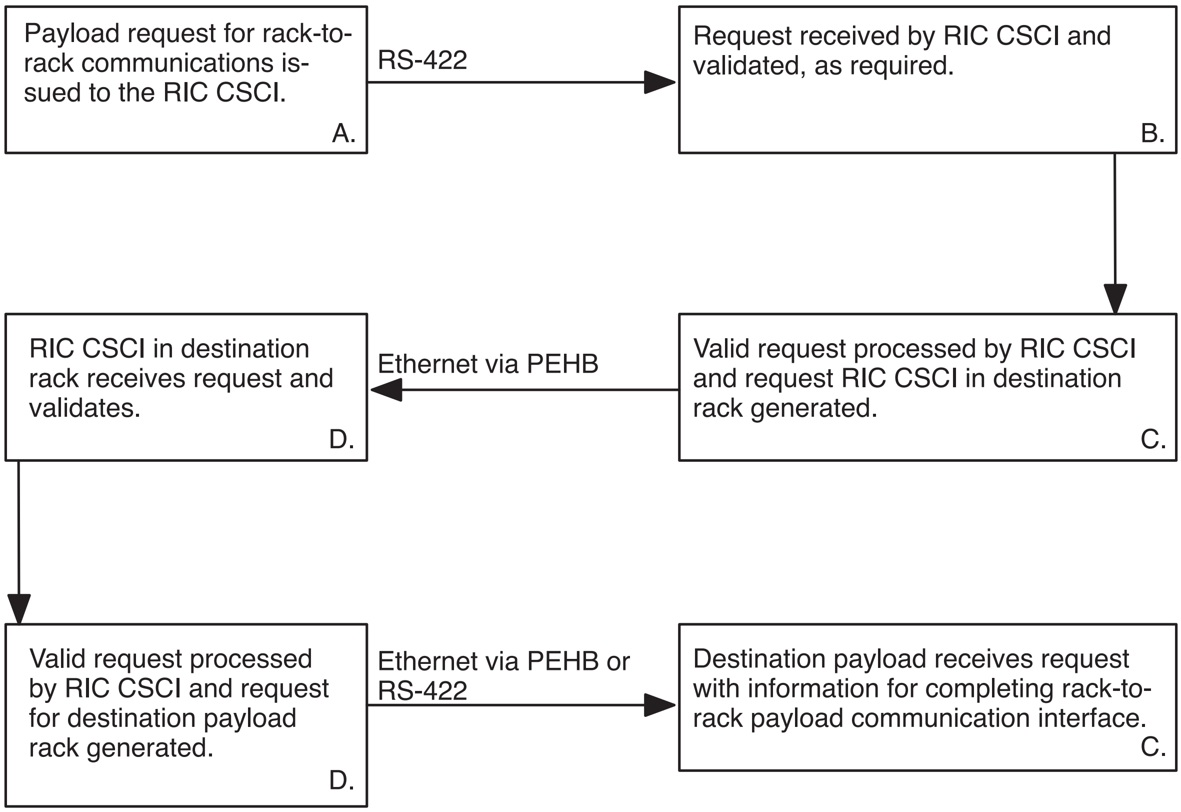


FIGURE 4-16 RACK-TO-RACK PAYLOAD COMMUNICATIONS

definitions. The acronym TLM will be used in the destination column to denote low rate telemetry, medium rate telemetry, or high rate telemetry. This would imply PEP, PEHB, or APS as destination, respectively.

4.5.3.4 RS-422 Software Interface

The RIC CSCI interfaces to payloads requiring a serial interface as described in ANSI/EIA-422-B-1994, Electrical Characteristics of Balanced Voltage Digital Interface Circuits. The data elements for this interface are as defined in SSP 52000-IDD-ERP. Command/request responses are negative only. Only if a command/request is invalid will a response be sent to the payload making the command/request. The request response will be returned within 1 sec of validation of the command/request.

4.5.3.5 Analog/Discrete Software Interfaces

The RIC/SSPCM collect and format the data received from the payloads.

4.5.3.6 Payload I/F Data Elements

4.5.3.6.1 EXPRESS Header

Table 4-IX defines the header word format to be used during communications to/from (commands and messages) the payload and the EXPRESS Rack CSCI across the physical ANSI/EIA-422 interface and across the logical Ethernet interface through the PEHB. Requests to the RIC can originate from the PEP, EXPRESS Rack laptop, or payload.

4.5.3.6.2 Payload Data Packet/Packages

EXPRESS Rack-related data packages associated with the commands and responses are defined in SSP 52000-IDD-ERP.

4.5.3.6.3 EXPRESS Telemetry Secondary Header

The EXPRESS telemetry header is contained within the data field of the EXPRESS packet and subsequently the CCSDS User data field when downlinked. This header identifies the type of telemetry, the source, etc. The format of the EXPRESS telemetry header is given in Table 4-X.

TABLE 4-IX EXPRESS HEADER

MSB															LSB
Header Version 4 bits								Message Byte Count (12 bits)							
Command Message Type Measurement Message Type															
Function Code (Source) (Ref. Table 4-XI)															
Function Code (Destination) (Ref. Table 4-XI)															
Message Byte Count = Total Remaining Bytes in associated message, excluding Serial Checksum Words where applicable															

NOTE: Under review (**TBD#07**).

TABLE 4-X EXPRESS TELEMETRY SECONDARY HEADER

MSB															LSB
Telemetry Data Type															
Sequence Count[1]															
Time Tag (MSBs of Coarse Time)[1]															
Time Tag (LSBs of Coarse Time, LSB = 1 second)[1]															
[1] RIC generated telemetry will use as shown. Payload usage is optional; however, it is suggested this format be used for PLDs needing to rebuild messages on the ground.															

NOTE: Under review (**TBD#07**).

TABLE 4-XI FUNCTION CODE ASSIGNMENTS

RACK LOCATION/FUNCTION	ASSIGNMENT (HEX)
NOP	0000 h
RIC	0001 h
Laptop	0002 h
PEP	0003 h
Ground Station	0004 h
Reserved for RIC expansion	0005 h - 000F h
Ground Station (assigned by Ground Operations)	0010 h - 0204 h
Individual PLD (assigned by Ground Operations)	0205 h - FFFE h
ALL PLD (Broadcast within Rack)	FFFF h

NOTE: Under review (**TBD#07**).

4.5.3.7 Payload-Provided Software/Peripherals

Unique payload-provided software and applications are accommodated on the EXPRESS laptop for the purpose of displaying payload Health and Status data while the laptop is powered on. The payload may use standard 3.5-in floppy diskettes, CD-ROMs, removable hard drives, or PCMCIA cards. It is recommended that the PD make arrangement to allow for testing the experiment hardware with the intended software installed in the EXPRESS Rack laptop.

4.5.4 EXPRESS Rack Display Requirements

EXPRESS Rack laptop computer displays are the responsibility of the PD. If a PD is unable to develop their own software displays, the EXPRESS Rack Office should be contacted to discuss options. 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.

The displays must conform to the requirements of SSP 50005, paragraph 9.4.2.3.2.

All PDs must use the JSC computer display style guide in developing telemetry/command displays. The "HCI Style Guide" is in development by JSC Mission Operations Division, MSFC Mission Operations Laboratory, and Crew Office.

4.6 VIDEO

The EXPRESS Rack video system via the RIC can receive one EIA-STD-RS170A/ National Television Standards Committee (NTSC) differential composite video signal from each payload location. The input impedance of each payload video connection is 75 ± 5 ohms. The video MUX card in the RIC selects one of the payload video inputs to send to the local display (laptop or other) or record on payload-provided recorders and one of the inputs to downlink to the ground. The video selected for downlink is sent to the Common Video Interface Transmit (CVIT), which converts the signal to a Pulse Frequency Modulation (PFM) optical signal as specified by SSP 41002 for routing to the ISS Internal Video System (IVS) or digitizes the video signal for downlink via the HRDL. The EXPRESS Rack video system is schematically illustrated in Figure 4-17. Up to four digitized and compressed video signals can be downlinked (satellite bandwidth downlink limitation) to the ground by the ISS depending on the composite bandwidth being used at any time.

4.7 ENVIRONMENTS

Each payload that will utilize the ISS must consider the environmental conditions existing on the ISS, as well as the conditions existing during the transportation phases (ascent, descent) of the flight, in the design and development of the hardware. A payload may be transported cross country (Ferry Flight) if a landing at Dryden Flight Research Center (DFRC) occurs. The definition of these "design to" environments in this section will allow the PD to produce a piece of hardware that will operate safely in the ISS and will not affect other payloads on the ISS.

All of the environmental conditions must be taken into account during the safety assessment of the payload. Those environmental conditions, which also affect the hardware performance, are the responsibility of the PD, who will evaluate these environmental effects on performance parameters and take appropriate design changes deemed necessary. No verification data will be required by EXPRESS Engineering Integration (EI) for mission success/performance-type requirements.

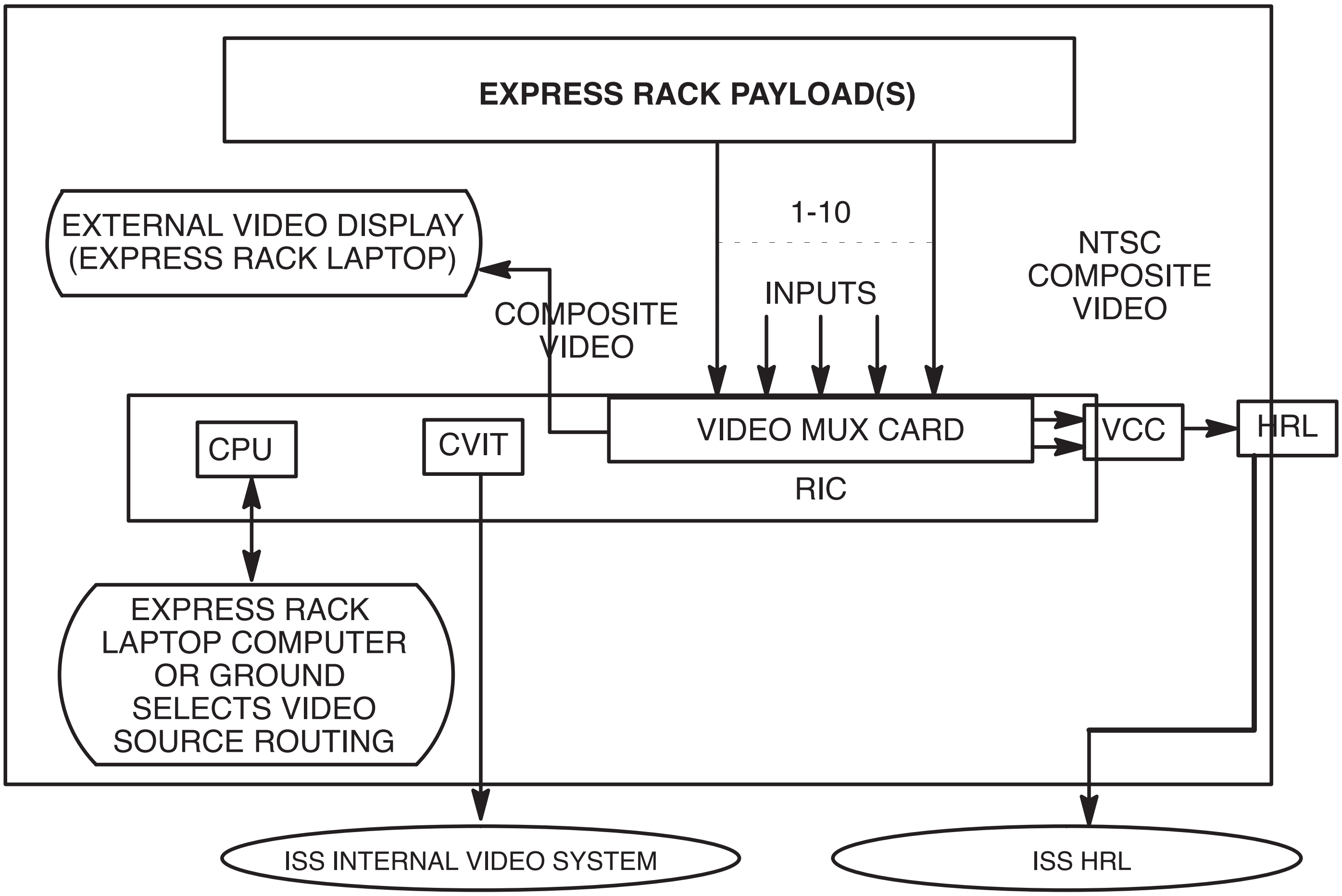


FIGURE 4-17 EXPRESS RACK VIDEO DIAGRAM

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 Launch/Landing Loads

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

These loads vary depending on the carrier (i.e., middeck, MPLM, etc.). Specific loads are defined in SSP 52000-IDD-ERP. These loads are used in the design of the hardware and as a basis of the structural analyses. Instructions and requirements for use of these loads are defined in SSP 52005. Use of worst-case loads will increase the flexibility of location assignments for the payload. These loads (combination of quasi-static and random vibration) can also be used to determine test levels for any required/desired structural testing.

4.7.2 On-Orbit Loads

Some of the 8/2 Configuration EXPRESS Racks will utilize the ARIS to minimize acceleration imposed on the rack from external sources. The ARIS will also mitigate some internal to the rack-generated accelerations or disturbances. Some 8/2 Configurations will not be equipped with ARIS. Figure 4-18

FIGURE 4-18 ASSEMBLY COMPLETE VIBRATORY ENVIRONMENT. REPRESENTS WORST-CASE UPPER LIMIT AND INCLUDES A MULTIPLICATION FACTOR OF 2))> SHOWS THE ASSEMBLY COMPLETE VIBRATORY ENVIRONMENT COMMITMENT FOR AN ARIS ISOLATED RACK IN COMPARISON WITH THE UNISOLATED ENVIRONMENT COMMITMENT.

4.7.2.1 Nonquiescent Periods

During nonquiescent periods, payloads in the USL may be exposed to peak accelerations of 0.2 g's, acting in any direction. This acceleration includes quasi-steady, oscillatory, and transient events.

4.7.2.2 Quiescent Periods

During quiescent periods, the quasi-steady (less than 0.01 Hz) acceleration magnitude will be less than or equal to 1 μg, and the quasi-steady acceleration component normal to the orbital average acceleration vector will be less than or equal to 0.2 μg. These limits apply to rack locations which use an ARIS-equipped rack. The acceleration levels will be met at the geometric centers of payload rack locations for a minimum of 180 days per year in continuous time intervals of at least 30 days. The USL will provide this quasi-steady environment concurrent with the quiescent vibration environment specified in paragraph 4.7.3.2.

Note: During this period all User interfaces should avoid any direct physical contact (i.e., switches, keystrokes, knobs, etc.)

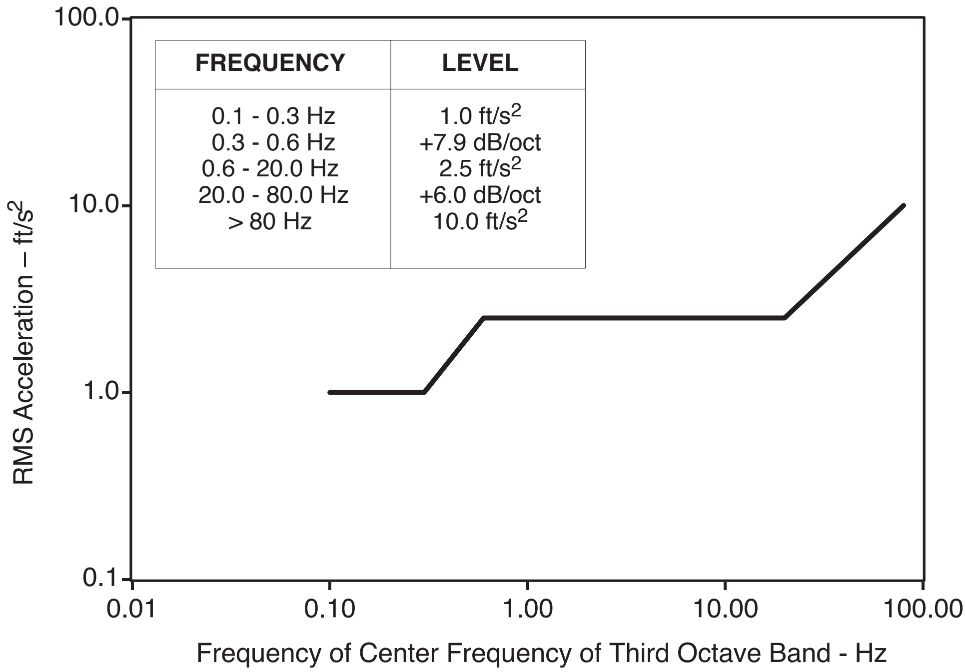
4.7.3 On-Orbit Vibration Environments

4.7.3.1 Nonquiescent Periods

During nonquiescent periods, operating equipment may be required to perform under the vibration levels specified in Figure 4-19. The payload equipment may also be exposed to the on-orbit random vibration levels specified in Table 4-XII. Since launch random vibration loads are greater than these loads, analyses/assessments of the loads are required only for those payloads that reconfigure the structural/mechanical configuration of the hardware.

4.7.3.2 Quiescent Periods for Isolated Racks

The oscillatory and transient vibratory acceleration environment in ARIS equipped racks is expected to be limited to the levels shown in Figure 4-20. These acceleration levels



NOTES: (1) The accelerations shall be evaluated as acting one axis at a time in each of three orthogonal axes.
(2) The sinusoidal acceleration acts concurrently with a steady state 0.2 g acceleration acting in any direction.

FIGURE 4-19 ON-ORBIT VIBRATION ENVIRONMENT (NONQUIESCENT PERIODS)

TABLE 4-XII ON-ORBIT RANDOM VIBRATION ENVIRONMENT

FREQUENCY (Hz)	QUALIFICATION LEVEL
10-50	+**TBD#08** g^2/Hz
50-100	+**TBD#08** dB/octave
100-1000	+**TBD#08** g^2/Hz
1000-2000	-**TBD#08** dB/octave
2000	+**TBD#08** g^2/Hz
Composite:	**TBD#08** g_{rms}
Duration:	**TBD#08** hr/yr

Three Orthogonal Axes

will be met at the geometric centers of payload rack locations for a minimum of 180 days per year in continuous time intervals of at least 30 days. The USL will provide this environment concurrent with the quiescent quasi-steady environment specified in paragraph 4.7.2.2.

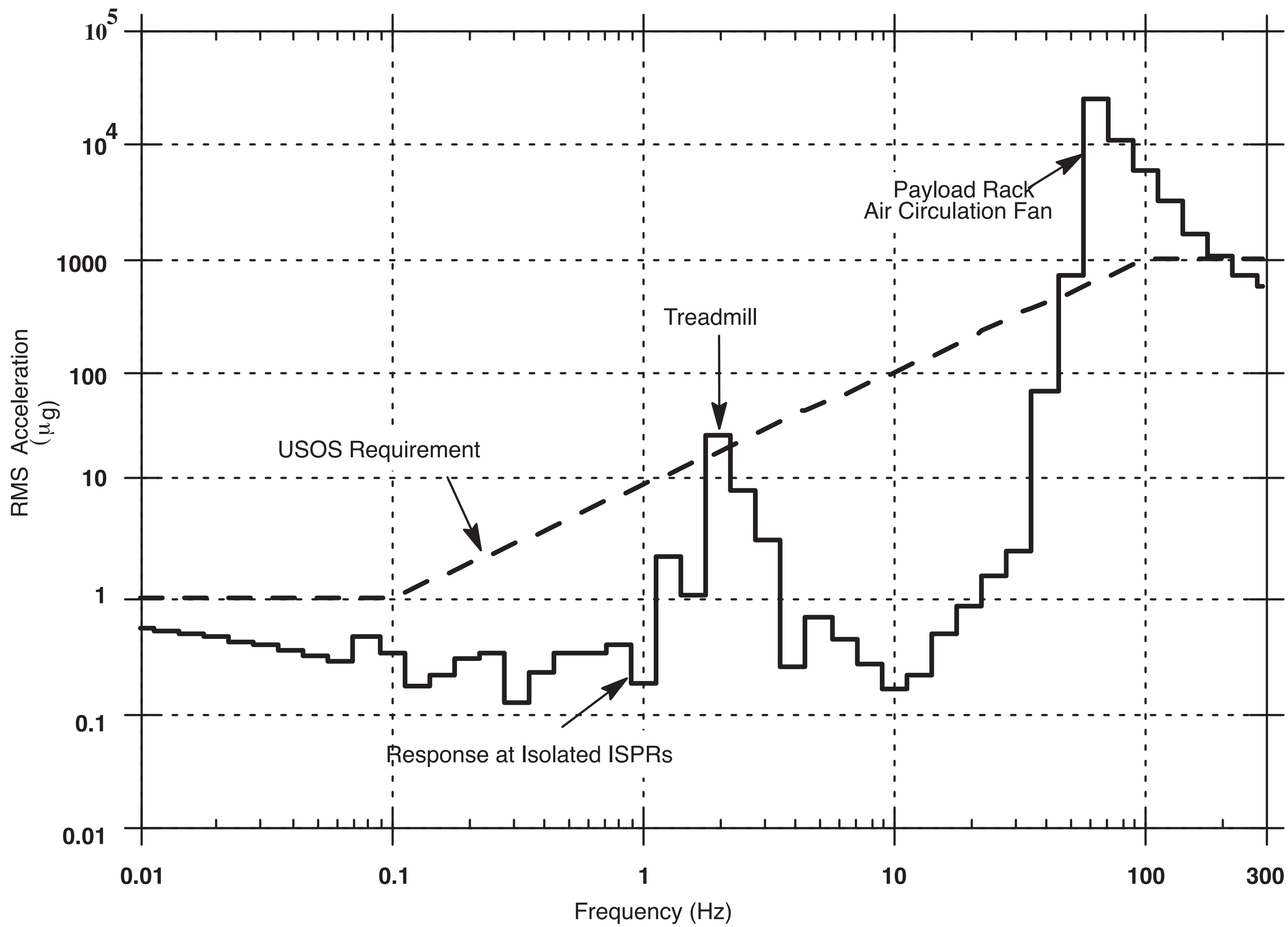
4.7.3.3 Quiescent Periods for Nonisolated Racks

The oscillatory and transient vibratory acceleration environment for nonisolated racks is expected to be limited to the levels shown in Figure 4-21. This acceleration level is expected for the geometric centers of payload rack locations. The USL is expecting to experience this environment concurrent with the quiescent quasi-steady environment specified in paragraph 4.7.2.2.

4.7.4 Acoustics

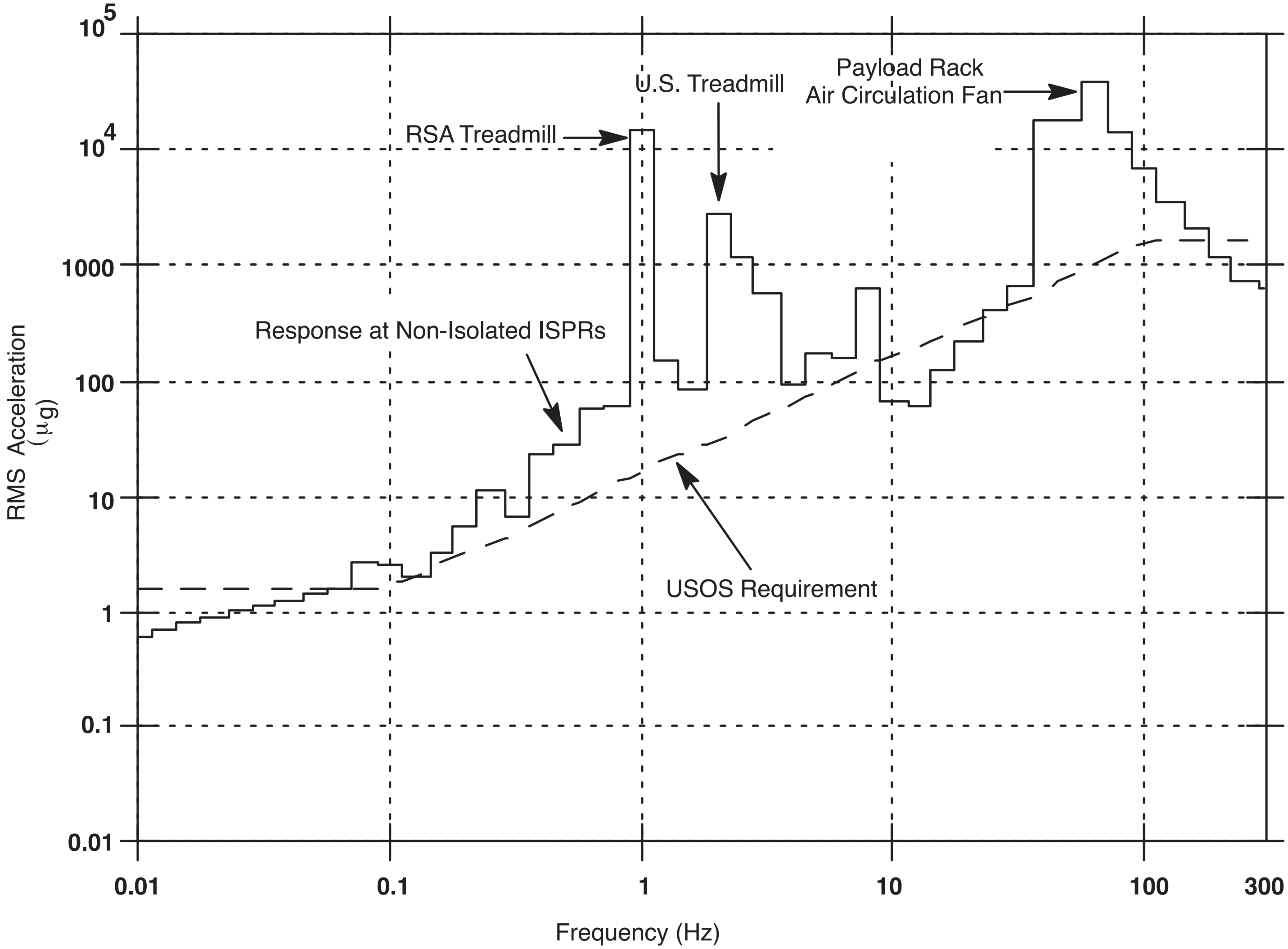
The integrated on-orbit acoustic environment in habitable areas in the ISS laboratories will not exceed the U.S. NC-50 criterion during normal operating conditions when averaged over a minimum 10-sec time interval. The integrated acoustics level for the entire EXPRESS Rack is NC-40. Allocations to individual PDs will be determined by the EXPRESS Rack integrator. Requirements for intermittent levels are under development. In areas where crewmembers must communicate by voice, the reverberation time will not exceed 0.5 ±0.1 sec at 1,000 Hz. This acoustic environment does not apply during alarm or warning conditions.

It should be noted that these requirements are under review pending the test results from various ISS subsystem equipment items and the EXPRESS Rack equipment.



NOTE: This figure represents only the environment seen at the rack-to-ISS laboratory interface. The transfer function of the rack (up to the MDL or SIR drawer interface) has not been determined.

FIGURE 4-20 ISS ISOLATED ACCELERATION ENVIRONMENT AT MODULE INTERFACE (DUE TO USOS DISTURBANCES ONLY)



NOTE: This figure represents only the environment seen at the rack-to-ISS laboratory interface. The transfer function of the rack (up to the MDL or SIR drawer interface) has not been determined.

FIGURE 4-21 ISS NONISOLATED ISPR ACCELERATION ENVIRONMENT AT MODULE INTERFACE (DUE TO COMBINED USOS, RSA, AND CREW DISTURBANCES ONLY)

4.7.5 Atmosphere

The USL cabin atmosphere is actively controlled, filtered, and conditioned by the ISS Environmental Control and Life Support System (ECLSS) within the limits shown in Table 4-III. CO_2 control is provided to prevent a build-up of CO_2 from metabolic (human and biological specimen) sources to levels that would be hazardous to human life. Also, levels are maintained to provide an environment suitable for research.

There is a certain capability of the ISS laboratory ECLSS to control the CO_2 level within the ISS to a specified range below nominal. This is done using a second United States Orbital Segment (USOS) CO_2 removal assembly in the ISS. Resources used to operate this second system are taken from the resources allocated to the requesting PD. If a PD desires this condition, the ERO should be contacted to discuss the request.

In the event the USL atmosphere becomes hazardous, it can be vented to less than 0.49 psia (3.38 kPa) within 24 hr. Repressurization of the module to a total pressure of 13.9 to 14.9 psia (95.8 to 103.0 kPa) with an oxygen partial pressure of 2.83 to 3.35 psia (19.5 to 23.1 kPa) will occur within 75 hr.

The atmosphere is filtered through High Efficiency Particulate Air (HEPA) filters. If payloads are sensitive to the atmospheric contaminants, the filters should be included in the design and cleaning activities planned.

4.7.6 Contamination

Contamination is present to some extent in all environments in the form of particles, molecular films or gases, and viable organisms. ISS materials continually outgas and shed particles. Crewmembers and animal specimens continually generate metabolic by-products. Some ISS operations such as venting and destruction/elimination of trash can be highly contaminating. All of these contaminating aspects of the ISS must be predicted, controlled, or minimized to prevent adverse effects on the ISS subsystem hardware, payloads, and the crew. EXPRESS Rack payloads should be designed to minimize the possibility of producing atmospheric contamination through appropriate containment of fluids and proper material selection for offgassing and outgassing. Prior to launch each EXPRESS Rack payload will have been cleaned, and the external accessible surfaces will be compliant with SN-C-0005 (VC level sensitive). For EXPRESS Rack payloads that launch/land in the middeck and are powered, the payload hardware should have design features to accommodate contamination (i.e., lint, dust, etc.) in the middeck environment. Appropriate covers and/or filters should be considered in the design.

During normal operations, the USL ECLSS provides air filtration and circulation (through HEPA filters) which controls airborne particulates and microbial contamination within the limits shown in Table 4-III. If additional information is required, the Materials and Processes Technical Information System (MAPTIS) database should be consulted. Offgassing and outgassing limits for some commonly used chemicals are shown in Table 4-XIV. ECLSS monitors and controls airborne particulates, microbes, and trace contaminants within the limits specified in Tables 4-III and 4-XIV. The USL ECLSS is capable of monitoring trace gases and combustion products at the limits defined in Tables 4-XV and 4-XVI. The EXPRESS Rack payload is responsible for providing supplemental monitoring and decontamination equipment if ISS equipment is unable to meet the requirements of a particular payload.

4.7.6.1 Trash Generation/Disposal

The housekeeping/trash management subsystem is an ISS-provided service for routine cleaning and trash management of habitable element interiors. Portable trash receptacles are provided for temporary storage of acceptable trash. Each PD must make provisions within his allocated weight and volume to stow/contain any generated trash or waste products.

The following are the User responsibilities:

A. EXPRESS Rack payload-unique housekeeping and trash management procedure definition.

B. Treatment of all payload-generated trash (including odor control and biological stabilization).

C. Packaging and labeling of all payload-generated trash.

TABLE 4-XIII TELEMETRY DATA ELEMENTS

DATA TYPE DESCRIPTION	DATA TYPE[1] (Rack Telemetry)
Compressed Video Telemetry Data	22
Critical Command List	23
Critical Command List Update Notification	24
EMU File List	25
EMU Utilization Data	26
Inhibited Command List	27
Inhibited Command List Update Notification	28
PLD Configuration Table	29
PLD Configuration Table Update Notification	30
Rack/PLD Health and Status	31
Stored Telemetry Packet Status	32
Telemetry Configuration Table	33
Telemetry Configuration Table Update Notification	34
Timed Command List	35
Timed Command List Update Notification	36
Reserved	37-59
PLD X Telemetry Data	Defined by PLD

NOTES:

1. Reference the SSP 52000-IDD-ERP for detailed descriptions and requirements for each of the data types.

D. Special care (procedures, packing, etc.) must be taken for any trash items which have sharp edges/points and may puncture the container.

4.7.6.2 Medical/Biological Waste Disposal

Waste products generated as a result of on-orbit medical and biological investigations must be packaged/contained in enclosures consistent with the hazard level (i.e., one, two, or three levels of containment). The container design must be reviewed during the safety process by the Johnson Space Center (JSC) Payload Safety Review Panel (PSRP). The containers of materials must be identified/labeled to allow flight ground personnel to be

TABLE 4-XIV SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATIONS[1]

CHEMICAL	UNIT	24-HOUR EXPOSURE PERIOD
acetaldehyde	mg/m^3	10
acrolein	mg/m^3	0.08
ammonia	mmHg	14
carbon dioxide	mg/m^3	10
carbon monoxide	mg/m^3	20
1,2-dichloroethane	mg/m^3	2
2-ethoxyethanol	mg/m^3	40
formaldehyde	mg/m^3	0.12
freon 113	mg/m^3	400
hydrazine	mg/m^3	0.4
hydrogen	mg/m^3	340
indole	mg/m^3	1.5
mercury	mg/m^3	0.02
methane	mg/m^3	3800
methanol	mg/m^3	13
methyl ethyl ketone	mg/m^3	150
methyl hydrazine	mg/m^3	0.004
dichloromethane	mg/m^3	350
octamethyltrisiloxane	mg/m^3	4000
2-propanol	mg/m^3	1000
toluene	mg/m^3	60
trichloroethylene	mg/m^3	270
trimethylsilanol	mg/m^3	600
xylene	mg/m^3	430

NOTE:

1. Seven-day SMAC values defined in NHB 8060.1, Appendix D, should be used for constituents not listed in this table. Allowances are for extended times and the atmospheric cleansing of the ISS laboratory atmosphere.

TABLE 4-XV TRACE GAS DETECTION LIMITS

COMPOUND	DETECTION LIMITS (mg/m^3)
methanol	0.5
ethanol	5
2-propanol	5
2-methyl-2-propanol	5
n-butanol	5
ethanal (acetaldehyde)	0.5
benzene	0.1
xylenes	10
methyl benzene (toluene)	3
dichloromethane	0.5
dichlorodifluoromethane (Freon 12)	10
chlorodifluoromethane (Freon 22)	5
trichlorofluoromethane (Freon 11)	10
1,1,1-trichloroethane	1
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	5
n-hexane	5
n-pentane	10
methane	180
2-methyl-1,3-butadiene	10
2-propanone (acetone)	1
2-butanone	3
hydrogen	10
carbon monoxide	2
hexamethylcyclotrisiloxane	10
trimethylsilanol	3
2-butoxyethanol	1
trifluorobromomethane (Halon 1301)	10
carbonyl sulfide	0.5
acetic acid	0.5
4-hydroxy-4-methyl-2-pentanone	1

ACCURACY

CONCENTRATION (mg/m^3)	% ACCURACY[1]
5-10	±20
2-5	±30
0.5-2	±40
<0.5	±50

NOTE:

1. Percent accuracy = [measured concentration - actual concentration]/measured concentration x100.

TABLE 4-XVI COMBUSTION PRODUCT AND TOTAL HYDRO-CARBON DETECTION

COMBUSTION PRODUCT DETECTION[1]	
COMPOUND	RANGE (ppm)
carbon monoxide	5-400
hydrogen chloride	1-100
hydrogen cyanide	1-100
hydrogen fluoride/carbonyl fluoride	1-100

TOTAL HYDROCARBON DETECTION[1]	
CONCENTRATION (ppm)	ACCURACY (%)
0-3	20
3-6	10
6-10	6
11>100	2

NOTE:
1. This is for the USL.

cognizant of their contents. This labeling/identification methodology must be consistent with applicable Occupational Safety and Health Administration (OSHA) requirements and disposal protocol of the landing site facility documented in the chemical hygiene plan for each payload.

4.7.7 EMI/EMC

Payloads will encounter electromagnetic radiation of all frequencies during ascent, on-orbit, and descent phases of the flight. This radiation can result in EMI either conducted and/or radiated. There are various sources of this EMI:

A. Space Shuttle and associated subsystems (i.e., fans, pumps, Teleprinter/TIPS/TAGS Ku-Band antenna/radar, etc.).

B. Portable equipment used in the Space Shuttle (i.e., PGSC, lights, camera equipment, wireless communications equipment, etc.).

C. Other payloads in the Space Shuttle (flight deck, middeck, payload bay).

D. ISS and associated subsystems in each of the various labs and outside of the various labs.

E. Portable equipment used in the various labs of the ISS.

F. The EXPRESS Rack facility and the laptop computer.

G. Other payloads co-located in the same EXPRESS Rack facility.

H. Other facilities and payloads located inside and outside the various ISS labs.

Each PD is responsible for evaluating his hardware against the defined environments stated in SSP 52000-IDD-ERP. Safety-critical circuits in particular must be tested to be shown not to be affected by EMI. The EMI environments for the various laboratories are expected to be within the limits of SSP 30243; however, until testing of various ISS subsystems is performed, actual test results are not available.

The rack and payload integrators are responsible for assuring compliance and compatibility amongst the payload complements and notifying all payloads of potential exceedances.

4.7.8 Charged Particle Radiation

Penetrating charged particles are produced from these sources: Magnetospheric particles are accelerated from the plasma by processes inside the magnetosphere and occur only within terrestrial space. Cosmic rays exist in interplanetary space and enter terrestrial space from outside the region. The Sun emits energetic charged particles that are most intense during solar flares. The orbit of the ISS passes through the South Atlantic Anomaly (SAA), resulting in extreme ionizing particle events for 50 percent of the orbital passages for periods of 5 to 10 minutes each. The SAA is a region of high energetic particle flux density contained in the Van Allen radiation belts surrounding the Earth. Neutrons and x-rays are also present but contribute much less to the total ionizing radiation environment.

Charged particles that penetrate the ISS present a significant challenge to design and operation of most payloads. Many of the particles have sufficient energy to penetrate several centimeters of metal and to produce significant levels of ionization (radiation dose level) inside the ISS. A high level of radiation will significantly affect materials, chemical processes, and living organisms. It will also affect electronics by causing soft upsets (referred to as Single Event Upsets (SEU), degrading performance, and producing permanent damage. In addition, ionizing radiation will affect the propagation of light through optical materials by altering their optical properties.

Although cosmic rays contribute less to the makeup of the total dose of radiation than trapped protons, they produce significant effects. They are responsible for SEUs, latch-up in microcircuits, and, along with trapped radiation-belt protons, the nuclei induce radioactivity in most materials. Cosmic rays also induce noise by production of ionization in devices such as charge-coupled devices and by production of Cerenkov and fluorescence radiation in photomultiplier tubes. For specific design issues, the actual anticipated radiation environment must be calculated. The document SSP 30425 provides significantly more detail and information concerning available tools for calculating the expected natural environment.

The calculation of total flux through a given area within the pressurized volume of the Space Station is quite complex. Generally, at high altitudes, trapped protons contribute nearly the entire amount of total dose. Below about 300-km altitude, cosmic rays make up the largest contribution. For very thin shields of less than 0.3 g/cm^2, trapped electrons are more important than trapped protons. At high inclination orbits, solar event protons make a significant contribution.

The design environment for the ISS is provided in SSP 30512, Space Station Radiation Design Environment. This document provides information for calculating ionizing radiation total dose and for evaluating the Single Event Effects (SEE) environment. The design altitude and orbital inclination for the ISS is 500 km and 51.6°, respectively.

4.7.8.1 Nominal Design Environments

The total dose design environment for electronic devices and surface coatings is a summation of doses resulting from trapped protons and electrons and includes electron-induced bremstrahlung. Representative total doses for a 1-year lifetime on orbit are provided in Table 4-XVII. The dose is expressed in rads (Si). Radiation-absorbed dose (rad) of one rad is equivalent to an absorbed energy of 100 ergs/g. The numbers quoted are for silicon material at the center of an aluminum sphere of specified radius (shielding thickness).

TABLE 4-XVII NOMINAL TOTAL DOSE RATES FOR PRESSURIZED VOLUMES (RAD(SI)/YEAR)

SHIELDING (mils)	SHIELDING (mm)	SHIELDING g/cm^2	ELECTRONS rads (Si)	PROTONS rads (Si)	TOTAL DOSE rads (Si)
200	5.08	1.412	73.27	54.97	128.2
400	10.16	2.824	1.877	44.39	46.26
600	15.24	4.237	1.197	38.2	42.24
1000	25.4	7.061	0.836	29.95	30.79
2000	50.8	14.12	0.4779	18.92	19.4

Tests and analyses for total dose effects on electronic devices are discussed in SSP 30513, Space Station Ionizing Radiation Effects Test and Analysis Techniques. For total doses less than 250 rads (Si) over the equipment on-orbit design lifetime, no total dose testing is required (paragraph 3.3.3.2). Non-MOS components may be eliminated from total dose testing if the orbital life dose is determined to be less than 2000 rad (Si) (paragraph 3.3.3.3). In all cases, analyses shall be conducted to assure that equipment exempt from testing meets performance requirements.

SEEs occur as the result of single ionizing particle interactions with electronic components of equipment. SEE may consist of SEU, Single Event Burnout (SEB), Single Event Gate Rupture (SEGR), latchup, or transients. The design environments include the SAA, the environment resulting from solar flares, the nominal orbital trapped radiation environment, and cosmic rays. Table 4-XVIII shows representative differential flux spectra at various energy levels for nominal orbital, during passage through the SAA, and for solar flare maximum conditions. Note that these values are with 1000 mil aluminum shielding around the equipment position.

TABLE 4-XVIII PROTON FLUX WITH 1000 MIL ALUMINUM SHIELDING

ENERGY (MeV)	ORBITAL DIFFERENTIAL FLUX SPECTRUM protons/cm^2-day-MeV	SAA PASS PEAK DIFFERENTIAL FLUX SPECTRUM protons/cm^2-day-MeV	MAXIMUM SOLAR FLARE DIFFERENTIAL FLUX SPECTRUM protons/cm^2-day-MeV
10	2.67×10^3	2.1×10^5	1.01×10^7
61.47	6.94×10^3	5.46×10^5	1.66×10^7
112.6	5.43×10^3	4.35×10^5	8.12×10^6
308.8	8.15×10^2	7.08×10^4	5.78×10^5

Testing of semiconductor devices to assure survival in this orbital environment is broken down for three classes of theses devices. Table 4-XIX shows the test conditions for representative tests which might be required for these devices (SSP 30513, paragraph 3.4). The basic test conditions are specified in terms of a Linear Energy Transfer (LET) for silicon. LET is the linear density of all forms of energy transferred to an absorbing medium or material by a charged particle. For the first two classes of devices, the device is tested up to the fluence specified or until an SEGR or SEB occurs.

For devices other than power NPN bipolar transistors and N and P channel MOSFETs, the purpose of testing is to determine a rate for SEE caused by heavy ions. If no SEEs are recorded during the test conditions specified in Table 4-XIX, then further testing is not required.

TABLE 4-XIX REPRESENTATIVE SEE DEVICE TESTING REQUIREMENTS

TYPE OF DEVICE	TEST REQUIRED	TEST CONDITIONS	
		LET MeV-cm^2/mg	FLUENCE Particles/cm^2
Power NPN Bipolar Transistors	Single Event Burnout	=>26 Note 1	1×10^5
N and P Channel MOSFETs	Single Event Burnout Single Event Gate Rupture	=>26 Note 1	1×10^5
Other Semiconductor Devices	Any SEE	=>36 Note 2	1×10^6

NOTES:

1. Ions shall have a range in the semiconductor material of at least 35 micrometers.

2a. Heavy ions (such as Br and Kr) shall have a range in the semiconductor material of at least 30 micrometers.

2b. Low atomic weight ions shall have a range in the semiconductor material of at least 80 micrometers.

The orbital environment in terms of heavy ion integral flux greater than a specified LET for two shielding thicknesses of aluminum is shown in Table 4-XX. The flux for peak values and for orbit-average for a maximum solar flare is shown. Further details for the design environment for ionizing radiation are supplied in SSP 30512.

4.7.9 Illumination

The ISS laboratories will control general area and task site illumination levels from full “on” to full “off” by allowing crew adjustment of illumination levels. The general illumination level of the USL is a minimum of 108 lux (10 foot-candles) of white light. The ISS laboratories will provide centralized on/off control of lights at entrances and exits. Task sites are provided illumination at a minimum of 50 foot-candles (538 lux), and general activity areas are provided illumination at a minimum of 10 foot-candles (108 lux). For payloads that provide supplemental lighting, specific IVA area or task lighting levels will be in accordance with SSP 52000-IDD-ERP and consistent with the intended operation. The EXPRESS Rack does not provide any supplemental lighting.

4.8 MATERIALS AND PROCESSES USE AND SELECTION

Materials used in the construction of EXPRESS Rack payloads that directly or functionally interface with the ISS, carriers, and the orbiter or a Space Shuttle carrier will meet the requirements of the basic NSTS 1700.7, Safety Policy and Requirements for

TABLE 4-XX HEAVY ION INTEGRAL FLUX EXPRESSED IN PARTICLES/ CM^2-DAY>LET

LET	Maximum Solar Flare Peak Heavy Ion integral Flux Particles/cm^2-day>LET		Maximum Solar Flare Orbit-Averaged Heavy Ion integral Flux Particles/cm^2-day>LET	
	Shield Thickness (mils)		Shield Thickness (mils)	
MeV-cm^2/mg	50	1000	50	1000
0.00161	1.82×10^{10}	2.04×10^{9}	5.26×10^{8}	1.08×10^{8}
0.105	4.54×10^{7}	4.52×10^{6}	6.86×10^{6}	1.89×10^{5}
1.29	6.58×10^{5}	437	4.27×10^{4}	56.8
20.8	1310	0.0821	183	0.0281
27.5	245	0.0147	34.7	5.09×10^{-3}
36.3	0.211	4.84×10^{-6}	14.8	3.76×10^{-6}

Payloads Using the Space Transportation System, paragraphs 208.3 and 209 in their entirety, and NSTS 1700.7, ISS Addendum, Safety Policy and Requirements for Payloads Using the International Space Station, paragraphs 208.3 and 209 in their entirety. Commercial-off-the-Shelf (COTS) parts used in integrated racks shall meet these same material requirements also.

Materials are selected based on the design requirements, engineering properties, and material characteristics which could affect safety. The material characteristics which must be addressed per NSTS 1700.7 include Stress Corrosion Cracking, Materials Compatibility, Flammability, and Toxic Offgassing.

Whenever possible, materials should be selected that have already been shown to meet the acceptance test criteria for a particular characteristic. Existing test data are compiled in NASA’s MAPTIS electronic database. This database contains an alpha “rating” indicating acceptability for each material’s individual characteristics.

A hardcopy version of the MAPTIS database is published periodically as MSFC-HDBK-527/JSC 09604, Materials Selection List for Space Hardware Systems. The MAPTIS database is managed by the Materials and Processes Laboratory at MSFC. Access to this database may be gained through a computer datalink and is available to qualified hardware developers. Contact the EXPRESS Rack integrator or MSFC Materials and Processes Laboratory for access information.

4.8.1 Materials Documentation

4.8.1.1 Material Usage Agreement (MUA)

When the design requires the use of materials/components which do not comply with the acceptance criteria of MSFC-HDBK-527/JSC 09604 and applicable documents, an MUA or equivalent will be required. An MUA is a request to permit the use of materials/ components which do not meet the specified acceptance requirements. The MUA should contain sufficient rationale to show that the material or component, in the specific application and use environment, does not present a hazard to the crew or to the vehicle. The MUAs are submitted to the responsible NASA center's Materials and Processes Laboratory for evaluation and disposition. If approved, it is valid for the specific material/component in the specific usage for that hardware only (unless dispositioned otherwise). If deferred, the Materials and Processes Laboratory will supply instructions. If rejected, another material/ component or design alternatives should be employed. MUAs should be submitted for disposition as the need is identified.

There are several types of MUAs which may be utilized in the selection of materials for use in a spacecraft. These include individual material, component, and generic MUAs. An individual material MUA is for the use of a specific material in a specific individual application. A component MUA covers the use of multiple materials in an assembly or black box configuration. In most situations, a component MUA is a more appropriate method of qualifying an assembly or black box and is more efficient than a number of individual MUAs. A generic MUA covers usage of a material that is repetitive in nature and does not represent a hazard, such as marking inks, lubricants, or threadlockers. A generic MUA is submitted for approval only once, and is referenced when usage for the same specific use repeats.

A good reference for developing MUAs is MSFC-PROC-1301, Guidelines for the Implementation of Required Materials Control Procedures. This document discusses many of the factors involved in the selection of appropriate materials for design of a spacecraft. Another good reference for developing flammability rationale is NSTS 22648, Flammability Configuration Analysis for Spacecraft Applications. This document presents selected solutions to some flammability problems. It also aids in assessing whether there is sufficient rationale to justify the use of a nonacceptable material/component.

4.8.1.2 Materials Identification and Usage List (MIUL)

An effective way to document and list all materials and processes used in the flight hardware design for the purpose of evaluation and reference is to compile an MIUL. The materials and processes data required to create an MIUL are taken from engineering drawings and parts lists (including notes), materials and process specifications, MSFC-HDBK-527/JSC 09604 (or preferably the MAPTIS database), and other applicable documents. The MIUL should indicate part or drawing number, material designation, manufacturer's trade name, manufacturer, NASA material code, NASA rating, material specification, nonmetallic material weight, thickness and area, and MUA or equivalent number (if applicable). The MIUL should list all materials called out on each drawing and follow the indentured drawing tree format.

4.8.2 Stress Corrosion Cracking (SCC)

SCC is the combined action of sustained tensile stresses and corrosion to cause premature failure of materials. If a susceptible metallic material is placed in service in a corrosive environment (need not be severe) under tension of sufficient magnitude, and the duration of service is sufficient to permit the initiation and growth of cracks, failure will occur at a stress lower than the material would normally be expected to withstand.

Structural and other metallic materials must have a high resistance to SCC according to the criteria of MSFC-SPEC-522, Design Criteria for Controlling Stress Corrosion Cracking. Materials with high resistance to SCC are to be used preferentially and do not require approval. Materials which are unrated, or which have a moderate or low resistance to SCC, must have an MUA or equivalent submitted for evaluation, except as specifically exempted. The MUA or equivalent will be submitted with a Stress Corrosion Evaluation Form (see MSFC-SPEC-522).

Metallic materials are rated in accordance with the tables in MSFC-SPEC-522 and recorded on the MIUL. Materials with a high resistance to SCC are “Table 1” alloys in MSFC-SPEC-522 and correspond to a rating of “A” in MSFC-HDBK-527/JSC 09604. Likewise, materials with moderate resistance are “Table 2” alloys and are “B” rated, and materials with low resistance are “Table 3” alloys and are “C” rated.

4.8.3 Hazardous Materials and Compatibility

The use of materials, chemicals, and fluids which could create a toxic or hazardous situation for the crew, or which could contribute to the deterioration of hardware in service, will be given special consideration as to compatibility. This may involve the detailed analysis of a system, and/or the initiation of a test program to determine compatibility. If an incompatible situation or hazardous material usage exists, an MUA or equivalent should be submitted to the cognizant NASA field center for disposition.

4.8.3.1 Restricted Materials

Special attention and assessment will be performed for carcinogenic or toxic materials; biological, animals, or plants; radioactive materials, beryllium and its alloys and oxides; polyvinalchloride (PVC); mercury; cadmium; and zinc.

4.8.3.2 Fluid Compatibility

Payload components which connect to ISS fluid systems shall use fluids which meet the requirements specified in SSP 30573. These payload components shall also meet the fluid system cleanliness levels specified in SSP 30573. (See Tables 4.1-1.9.2 and 4.1-2.8.)

The payload equipment using ISS fluid systems shall use materials in contact with the fluids which are compatible with the fluids per SSP 30573, Space Station Program Fluid Procurement and Use Control Specification.

4.8.3.3 Exterior Surface Cleanliness

The payload equipment exterior and accessible surfaces will be capable of being cleaned with solvents and equipment available at KSC (reference SSP 52000-PAH-KSC). Payloads shall conform to visibly clean sensitive cleanliness requirements as specified in SN-C-0005.

4.8.3.4 Sample Material Identification

Each PD must have the intended sample materials evaluated by the JSC Toxicologist and the PSRP as a part of the safety review process. These organizations will evaluate the intended use of the sample materials and the safety controls (i.e., containment). This evaluation is performed in accordance with the SSP sample materials identification and evaluation schedule (reference JSC 25607). This activity includes development of a toxic materials leakage response manual and labeling of each experiment sample container.

4.8.4 Flammability

Payload materials should be nonflammable or self-extinguishing per the test criteria of NHB 8060.1, Test 1, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion. The materials should be evaluated in the worst-case use environment at the worst-case use configuration. When the use of a nonflammable material is not possible, an MUA or equivalent should be submitted to the cognizant NASA center for disposition. If test data does not exist for a material, the experimenter may be asked to provide samples (see NHB 8060.1, Chapter 4) to a NASA certified test facilty (MSFC or White Sands Test Facility (WSTF)) for flammability testing.

Materials transported or operated in the orbiter cabin, or operated in the ISS airlock during Extravehicular Activity (EVA) preparations, must be tested and evaluated for flammability in the worst-case use environment of 30-percent oxygen and 10.2 psia. Materials used in all other habitable areas must be tested and evaluated in the worst-case use environment of 24.1-percent oxygen and 15.2 psia.

4.8.5 Offgassing (Toxicity)

All flight hardware located in habitable areas must be subjected to test and meet the toxicity offgassing acceptance requirements of NHB 8060.1, Test 7. The purpose of the toxicity test is to determine the identities and quantities of volatile offgassed products from payload hardware for safety verification. The test procedures do not specify at what assembly level experimenter hardware is to be tested. Hardware may be tested anywhere from the individual material level to the full assembly level. Prescreening the materials list for materials that may exceed the maximum allowable concentrations is strongly recommended.

It should be noted that after the assembly is tested, no modification to the assembly is allowed. If the hardware should require additional cleaning after the test, the methods and solvents must be exactly the same as those used prior to the offgassing test. If the hardware is modified or is cleaned in a different manner, the offgassing test will be invalidated. After testing, the hardware should be handled and stored in a manner which will avoid possible contamination.

Contact the ISS Payloads Office or ERO to arrange for toxicity offgassing tests at an approved facility such as MSFC or WSTF.

4.8.6 Materials Traceability

An appropriate level of traceability to assure proper materials, processes, and inspections should be maintained on all fracture-critical and safety-critical parts throughout the payload development, manufacture, and flight.

4.8.7 Galvanic Corrosion

When a payload will be attached to the ISS for a sufficient period of time, it should not cause corrosion of the ISS structure at the attach points through the formation of galvanic couples. Payloads using ISS aqueous fluid systems shall control galvanic couples by using internal materials that are compatible according to MSFC-SPEC-250, Table III, or that will not create a potential greater than 0.25 V with the ISS system internal materials due to a dissimilar metal couple.

4.8.8 Corrosion

While corrosion is not considered a safety-critical parameter, it is strongly recommended that corrosion protection be implemented on all flight hardware. All metallic materials that show a tendency toward corrosion should be protected by approved methods as outlined in MSFC-SPEC-250, General Specification for Protective Finishes for Space Vehicle Structures and Associated Flight Hardware.

4.8.9 Fungus-Resistant Material

Payloads that are intended to remain on orbit for more than 1 year shall use fungus-resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10.

4.9 STOWAGE

EXPRESS Rack payload stowage items are subjected to the same resource limitations, interface accommodations, and design requirements as “hard-mounted” equipment items are required to comply. One difference which may mitigate a specific design environment condition is that most stowage items are packed in a vibration-deadening material in the containers. This vibration-dampening material does mitigate some of the launch loading. Those stowage items contained in alternative packing or hard mounted are subject to the total loading environment.

Standard EXPRESS Rack payload stowage should be contained within the allocated standard EXPRESS Rack payload volume defined in the Increment Definition and Requirements Document (IDRD) and agreed to in the payload-unique EIA, Interface Control Document (ICD), and integration data files. Stowage not contained within the allocated EXPRESS Rack volume may not fit in the standard template. Any such overflow must have a non-EXPRESS allocation in the IDRD and have a preliminary definition by L-24 months for Cargo Integration to include the items in the overall ISS packing design and manifest. ISS payload stowage volume is extremely limited, and payloads are encouraged to design their experiments to include all required stowage within their EXPRESS Rack assigned weight and volume. Stowed 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 items, covers on optics, tether points, zip lock bags, etc.)

4.10 SAFETY

EXPRESS Rack 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 PRSP. 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. Safety packages and safety reviews will be performed at several 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 EXPRESS Rack Review, which EI is responsible for developing; and (3) the Integrated ISS Lab complement package, which ISS Cargo Integration is responsible for developing.

EI and payload operations analyze the design and operation characteristics of payloads relative to their potential effect on the crew, other payloads, and ISS systems. These analyses define potential hazards. The results of these analyses are presented to the PSRP and become part of the payload complement safety certification. These integrated payload safety reviews typically begin (for Phase 0/1) at approximately L-24 months and culminate with safety certification prior to flight.

Payloads which 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 other payloads, GSE, and the general public. The document contains technical and system safety requirements applicable to payloads which use the Space Shuttle.

B. NSTS 1700.7 ISS Addendum, Safety Policy and Requirements for Payloads Using the International Space Station, 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. The ISS Addendum is currently being revised to include fire protection and other requirement changes.

C. NSTS 18798, Interpretations of NSTS 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. The NASA PSRP has recently revised this document to reflect applicability to Space Station payloads.

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 postlanding 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, Implementation Procedure for NSTS Payloads System Safety Requirements for Payloads Using the Space Transportation System, defines the safety review process and assists the payload organization in implementing the system safety requirements in Chapter 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 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 which document the results of the analyses. **Note: NSTS 13830 is currently being revised to address ISS requirements and safety process impacts.**

F. SSP 52000-IDD-ERP, EXPRESS Rack Payloads Interface Definition Document, is intended as a single source design requirements document which payloads will comply with in order to certify an EXPRESS Rack payload for integration. These requirements are verified in accordance with the Generic Payload Verification Plan, SSP 52000-PVP-ERP. 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-ERP.

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. SSP 52005 is currently under revision.

4.10.1 Safety Requirements

The safety requirements contained in the documents described in paragraph NO TAG 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 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 of 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 applications, 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 Fire Protection Requirements

System safety fire protection design requirements are contained in the following sources:

A. SSP 57000, Pressurized Payloads Interface Requirements Document (IRD), provides the payload rack/facility to module(s) interface requirements.

B. SSP 52000-IDD-ERP, EXPRESS Rack Payloads Interface Definition Document, provides the experiment payload to rack/facility interface requirements.

C. NSTS 1700.7B, ISS Addendum, Safety Policy and Requirements for Payloads Using the International Space Station. This document (currently being revised to include fire protection requirements) will contain the generic, top level payload fire protection requirements.

D. NSTS 18798B, Interpretation of NSTS Payload Safety Requirements, Letter Number **TBD#09**. Letter **TBD#09** will provide interpretation of specific fire protection requirements.

4.10.3 Biomedical Investigations

JSC 20483, Human Research Policy and Procedures, establishes those policies to be implemented by the NASA-JSC Institutional Review Board (IRB) regarding human research protocol. If a payload uses preflight, in-flight, or postflight scientific or medical protocol involving ISS crewmembers, or uses U.S.-provided hardware on any biological subject, the hardware and protocol shall be reviewed and approved by the IRB. The PD shall prepare and support an integrated hazard assessment of the entire payload and its interfaces for each flight increment or resupply. The flight surgeon in the Mission Control Center - Houston (MCC-H) Flight Control Room (FCR) is the realtime authority regarding flight crew in-flight health. Realtime monitoring of biomedical items requiring physician monitoring on the ground, with respect to flight crew health and safety, shall be performed by the MCC FCR surgeon.

NIH 85-23, Guide for the Care and Use of Laboratory Animals for Space Flight Investigations, establishes those policies to be implemented by the NASA-Ames Research Center (ARC) IRB regarding animal research protocol. If a payload uses preflight, in-flight, or postflight scientific or medical protocol involving animals, or uses U.S.-provided hardware on any biological subject, the hardware and protocol shall be reviewed and approved by the IRB. The PD shall prepare and support an integrated hazard assessment of the entire payload and its interfaces for each flight increment or resupply.

4.10.4 Caution and Warning

The only C&W interface for most EXPRESS Rack payloads will be through the RIC, which has direct interfaces for fire detection and smoke sensor interface. However, this does not rule out direct C&W interfaces. C&W is provided to payloads and systems primarily to give the crew advance or timely warning of a potential emergency that could propagate and pose an unacceptable risk to ISS and/or flight crew.

There are three C&W alarm classifications:

A. Emergency (Class 1 Alarm): A life threatening condition requiring immediate attention. Predefined crew responses may be required prior to taking corrective action. Safe haven concept activation may be necessary. Included are the presence of fire and smoke, the presence of toxicity in the atmosphere, and the rapid loss of atmospheric pressure.

B. Warning (Class 2 Alarm): Conditions that require immediate correction to avoid loss or major impact to mission or potential loss of crew. Included are faults, failures, and out-of-tolerance conditions for functions critical to ISS survival and flight crew survival.

C. Caution (Class 3 Alarm): Conditions of a less time-critical nature, but with the potential for further degradation if crew attention is not given. Included are faults, failures, and out-of-tolerance conditions for functions critical to mission success.

The C&W panel is a single Orbital Replacement Unit (ORU) providing an interface to the ISS flight crew for visual and aural display of emergency, warning and caution indications from the C&DH system. The C&W panel will be located in various USOS and other IP modules and nodes. The C&W message (including rack location that generated the condition) can also be displayed on the ISS PCS.

4.10.5 Payload Hazard Reports

NSTS 13830 (Appendix A) provides instructions on completing a Payload Hazard Report (PHR). Although NSTS 13830 recommends use of JSC Form-542B, other formats are allowed as long as the basic elements on JSC Form-542B are included. While this also applies to ISS payloads, it is highly recommended that payloads use the JSC Form-542B format because this is the format the PSRP is most accustomed to seeing and it is organized with all the required elements. See Figure 4-22.

4.10.6 Payload Data Library (PDL)

The PDL is an on-line integrated data information system for the collection, processing, management, and distribution of payload information. The PDL will be configured as a client-server system, accessible to ISS payload organizations. Navigation is based on the disciplines (i.e., Safety, Electrical, Mechanical, Ops, etc.). Information is entered into a discipline-specific form for all data sets (e.g., Training Curriculum, Command Definition, Mass Properties, Stowage, Video Requirements, etc. System access will include User manuals, and the client software will include on-screen help.

4.11 HUMAN FACTORS

EXPRESS Rack PDs must be cognizant of various human factors requirements and considerations in the design of the equipment items. Human factors requirements and considerations can be categorized into safety requirements, equipment standardization and commonality considerations, and human interfaces.

There are several safety requirements which must be complied with and verified. These requirements are in place to protect the crew from exposure to hazardous conditions. The specific safety requirements are documented in the individual discipline sections of the EXPRESS Rack Payloads IDD, SSP 52000-IDD-ERP. These requirements include, but are not limited to, containment of hazardous materials, protection from sharp edges/corners, prevention of exposure to electrical shock, and protection from hot/cold temperatures.

There are hardware standardization requirements and considerations which should be taken into account. These considerations are intended to minimize confusion with on-orbit crew as they are carrying out their activities. Items which fall in this category include, but are not limited to, standard color identification (associated with actions, etc.) and standards for labels (location/placement, size, font, style, etc.). The commonality requirements and considerations are intended to allow the on-orbit crew to maximize the training they underwent on certain generic hardware items, such as the following: “for switches OFF is down”; “all valves CLOSE counterclockwise”; “to loosen fasteners turn to the left”; etc.

There are hardware human interface requirements and considerations which are intended to facilitate the on-orbit crew operations with the equipment items. Items which fall into this category include preferred types of fasteners/connectors, preferred valves, preferred types of switches, limits for actuation forces for switches/valves, etc. These items are intended to allow for a more efficient operation of the payload hardware. Payloads must locate interfaces and controls on the front of the payload.

The previous two paragraphs are intended to increase the efficiency of the crew-to-payload hardware activities. These requirements are documented in SSP

PAYLOAD HAZARD REPORT			NO	
PAYLOAD			PHASE	
SUBSYSTEM	HAZARD GROUP		DATE	
HAZARD 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 542B (Rev Nov 82) NASA-JSC

FIGURE 4-22 PAYLOAD HAZARD REPORT

52000-IDD-ERP. Many of the considerations directly affect the payload hardware detail design. It should be noted that the PD is responsible for the performance of the payload hardware. Any of the human factors considerations which may prove detrimental to experiment success or complicate the hardware design should be reevaluated prior to incorporation into the payload hardware final design. In addition, the ERO and the flight crew office should be consulted for recommendations during this reevaluation process. The following subparagraphs identify some of the more pertinent considerations for EXPRESS Rack payloads; however, the EXPRESS Rack Payload IDD must be reviewed to determine all of the Human Factors requirements applicable to payloads.

4.11.1 Labeling

The Inventory Management System (IMS) labels are provided by the PD via JSC for ground handling inventory management and verification for identification of consumables, loose equipment, ORUs, assemblies, subassemblies, and all loose or ORU equipment items that must be resupplied or refurbished and require handling. Figure 4-23 depicts the operational scheme for the IMS label number system. Each hardware provider (MSFC, JSC, Ames Research Center (ARC), Lewis Research Center (LeRC), etc.) is responsible for assigning IMS numbers to the equipment they provide. The ISS Vehicle Master Data Base (VMDB) is the central repository of IMS label numbers. The PD will submit requests for IMS labels to the Flight Crew Support Division (FCSD) Decal Design and Production Facility (DDPF) using the standard JSC Form-733. SSP 50007 defines the labeling format and methodology to be used for the IMS identification labeling.

SSP 30575 defines the decal design, installation, and standard decal and placard configurations. All standard exterior decals and placards are provided by the DDPF and are requested by using JSC Form-733. Nonstandard decals and placards are provided by the DDPF as the need arises or as requested by an ISS User. Visible decals are provided for EXPRESS Rack ORUs to display valuable information to crewmembers. Placards and/or decals will assist crewmembers during IVA and may be critical for movement in emergency situations. Vertical orientation of EXPRESS Rack labeling is consistent with the rack vertical axis origin at the bottom of the rack hinge point. All experiment sample materials must be labeled with the orbiter-provided labels which identify toxicity ratings.

4.11.2 Free Access

The USL will provide a minimum cross section dimension of 50 in by 72 in to support crew translation (to/from the MPLM) and work space. Volume is available for the crew to perform all operations, handling, and maintenance of IVA tasks, including tools and equipment associated with the task. Payload IVA workstations will be allocated the volume to meet the functional reach limits for the 5th percentile of the design population and yet will not constrict or confine the body envelope for the 95th percentile of the design population. Payload IVA crew access provisions are provided for the visible inspection of locked/unlocked status of fasteners/latches, including visibility of all equipment edges during alignment and attachment.

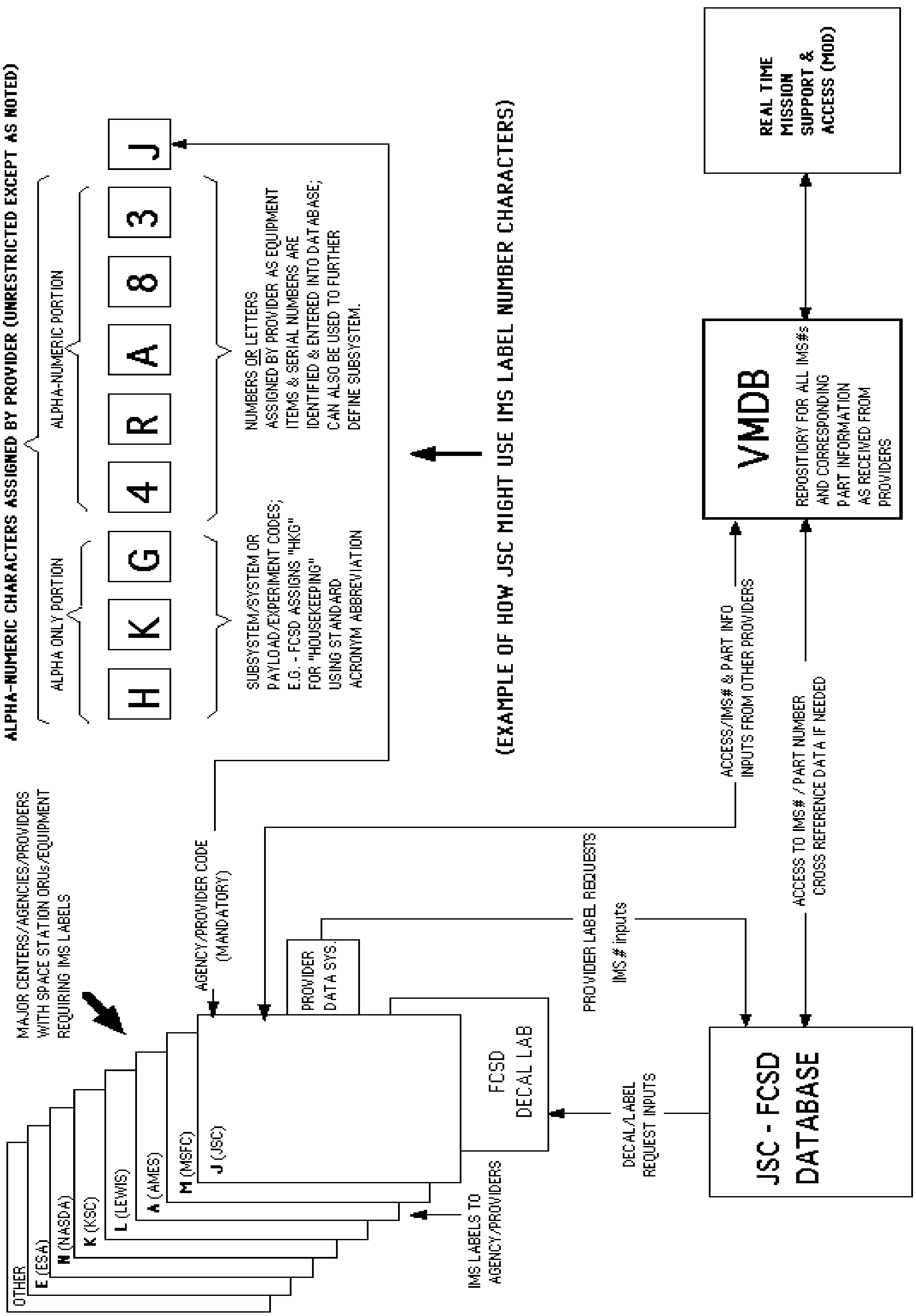


FIGURE 4-23 IMS LABEL NUMBER, FORMAT, SCHEME, AND IMPLEMENTATION

4.12 MISSION OPERATIONS

The capabilities and accommodations for EXPRESS Rack payloads are under development. As of the date of this publication, the payload operations concept document is available from MSFC Mission Operations Laboratory (MOL). Development of capabilities, accommodations, and additional requirement documentation is in the future. These may include, but are not limited to, the following subparagraphs. There may be a potential for the Payload Operations Integration Center (POIC) to assist an EXPRESS Rack PD in many of the following activities before and during the increment. If this effort is desired, the EXPRESS Rack PD should contact the EXPRESS Rack integrator to define and discuss the requirements. The EXPRESS documentation tree (Figure 1-1) of this document lists Payload Operations Documentation available or in development to the PD to assist in preparation for mission operations.

4.12.1 Rack Interface Officer (RIO)

As a part of the ground crew at the MSFC Huntsville Operations Support Center (HOSC), a console position identified as an RIO will be manned as long as any EXPRESS Rack is powered. This person will be responsible for monitoring, troubleshooting, and all ground commanding operations for the EXPRESS Rack subsystems. This person will also develop most of the console documentation related to the EXPRESS Rack, interfaces to the ISS, and interfaces to the applicable payloads. There may be a potential for the RIO(s) to assist an EXPRESS Rack PD on console during the flight. If this effort is desired, the EXPRESS Rack PD should contact the rack integrator to define and discuss the requirements.

4.12.2 HOSC Capabilities/Requirements

The EXPRESS Rack PD must plan to become familiar with and be trained in the protocols of utilizing and operating in the HOSC if one plans to operate payloads from this facility. This includes not only general facility (card reader, interfaces, fax machines, etc.) items but also Payload Information Management System (PIMS), uplink commanding hardware/software, communication loops, air-to-ground voice protocols, etc. Each EXPRESS Rack PD team should plan to practice activities in the HOSC in order to be ready for the interactive on-orbit activities.

The EXPRESS Rack PD will also need to identify the amount of resources required within the HOSC science operations areas. These include space, power connections, heat load, telemetry connections, etc. These requirements will be included in the payload-unique integration data files.

4.12.3 MCC/HOSC-to-User Operations Facility (UOF) Capabilities/Requirements

It is expected that many EXPRESS Rack PDs will desire to remain at their home facility during the on-orbit activities and operate out of a UOF instead of using the HOSC as described in paragraph 4.12.2. If this is the case, the PD must identify any type of video, telemetry, commanding and voice connections to their UOF, who will in turn coordinate with the HOSC to ensure the requirements are met. They may be provided via the MCC/JSC or the HOSC/MSFC or other. Also, protocols for working with other ground console positions must be established. The EXPRESS Rack PD should contact the ERO for further discussion of ground data services requirements and ground control facility capabilities.

4.12.4 Crew Training Requirements

The EXPRESS Rack PD must assess the amount of time it will take to train the crew to operate the hardware and accomplish science objectives. Flight crew availability is limited. During the last 6 months prior to launch, the flight crew could be training in Russia or could be at JSC conducting proficiency-only training. All training objectives should be accomplished prior to this time (L-3 to L-6 months). Many training tools may facilitate the crew training activities. These items include simulators/mockups, video tapes, compact disks, and written course outline/presentation material. Appropriate training tools will be identified through the Training Strategy Team (TST) process. It is the PD's responsibility to make the most efficient use of the flight crew training time allocated for their equipment.

4.12.5 On-Orbit Operations Capabilities/Requirements

The EXPRESS Rack PD must develop and validate the procedures to be used by the flight crew to operate the experiment hardware. These procedures must include any procedural safety controls specified in the safety hazard reports. These procedures must be ready to use at L-11 months. All payload procedures will be approved and managed by the POIC Payload Operations Director's (POD) Control Board. The RIO(s) may be available to assist an EXPRESS Rack PD in the development of these procedures. If this effort is desired, the PD should contact the rack integrator to discuss the requirements.

There will be capabilities (details in work) to allow operational changes (i.e., procedures, locations, science runs, etc.) during the course of the increment.

4.12.6 Mission Increment Planning Requirements

The EXPRESS Rack PD will document operations requirements and constraints in support of planning on-orbit activities. These requirements and constraints include data rates and types, power levels, crew support, and environmental considerations such as the need to operate during periods of microgravity. Included are the timing considerations for each phase of payload operation. This information will allow the ground-based planning team to develop timelines consistent with EXPRESS Rack and payload science objectives and requirements.

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SECTION 5, EXPRESS RACK SUPPLEMENTARY HARDWARE/SERVICES

5.1 STANDARD PAYLOAD OUTFITTING EQUIPMENT (SPOE)

SPOE is NASA equipment designed and qualified for use on the ISS that can be used in payload design. SPOE includes structures and mechanisms, electrical, C&DH, video, thermal control, waste gas vent and vacuum, nitrogen, fire protection, and stowage equipment. Requirements for SPOE should be identified in the PD's EIA so that the ERO and the ISS Payloads Office can coordinate the availability of the hardware. SPOE is purchased by the PD for use. The PD must also certify that the SPOE is being utilized within its design capabilities.

5.2 LABORATORY SUPPORT EQUIPMENT (LSE)

The LSE is the general purpose equipment and tool items developed by the ISS to support the ISS maintenance and payload operations. Individual LSE items can be located and operated in any ISPR location with proper utility interfaces. LSE may include tools, battery charger, still camera, video camera, cleaning equipment, measurement devices, freezers, incubators, etc. Requirements for LSE should be identified in the PD's EIA so that the ERO and the ISS Payloads Office can coordinate the availability of the hardware. LSE is deducted from a PD's resource allocation.

5.3 EXPRESS RACK SUPPORT EQUIPMENT (ERSE)

The ERSE is the general support and interfacing hardware required to interface and integrate a payload into the EXPRESS Rack. This includes:

A. 4-PU ISIS drawers

B. Interface lines/fittings for medium temperature water

C. Interface lines/fittings (QDs) for GN_2 and vacuum exhaust

D. Interface cabling/connectors for power and commands/telemetry for both ISIS drawers and MDL spaces.

E. Suitcase Simulator (ScS) - loan only

F. Transportation rack (not shipped to PD)

A tabular listing of this hardware is shown in Table 5-I. Information regarding the acquisition of this hardware should be addressed to the NASA/MSFC EXPRESS Rack Office and identified in the PD's EIA.

5.4 PAYLOAD SUPPORT SERVICES

5.4.1 Potable Experiment Water

Potable experiment water provided by the ISS facility is available for EXPRESS Rack PD use. Requirements for use of potable water should be identified in the PD's EIA so that the ERO and ISS Payloads Office can coordinate the availability of this resource.

TABLE 5-I EXPRESS RACK SUPPORT EQUIPMENT

NOMENCLATURE	DRAWING NUMBER	PART NUMBER	QTY[3,4]	NOTES/REMARKS
ISIS Drawers			2	
- 4-PU Active	683-43650	683-43650-1	N/A	ISIS-02
- 4-PU Passive	683-43650	683-43650-2	N/A	ISIS-02
Interfacing Lines				EXPRESS Rack Connector Panel-to-PD interface
- GN_2	683-46094	683-46094-5	1 set	Length 64 in
- Water	683-46094	683-46094-8 Supply	2 sets	Length 60 in
	683-46094	683-46094-7 Return		
	683-46094	683-46094-6 Supply		Length 24 in
	683-46094	683-46094-9 Return		
- Waste Gas Vent	683-46094	683-46094-10	1 set	Length 62 in
QDs[1, 2, 4]	N/A			For PD interface panels
- Water		683-16348-212/-228	2 sets	- 0.50-in QD
- GN_2		683-16348-334	1 set	- 0.375-in QD
- Vacuum Exhaust		683-16348-60	1 set	- 1.0-in QD
Interfacing Cables [5]			6 sets	EXPRESS Rack-to-PD interface
• MDL				
- Data (W267)	683-44267	683-44267-1, -2	N/A	
- Power (W024)	683-44024	683-44024-1, -2	N/A	
PD Connectors[1, 4]	N/A			
• ISIS Drawer				
- Data		M83733/3RA131	2 sets	One power and one data connector per drawer is needed
- Power		M83733/3RA018		
• MDL				
- Data		MS27467T15F35P	6 sets	
- Power		NBO6E14-4PNT		
Suitcase Simulator - EXPRESS	683-46360	683-46360-1	10	Includes User manuals and software

NOTES:

1. This is the PD side of the interface.
2. Can be equivalent part number or specification.
3. For each rack.
4. Flight only, no GSE connector will be supplied.
5. Cable lenght is 3 feet and -1 part number and 6 feet and -2 part number.

5.4.2 Earth Viewing Window

An Earth viewing window located in the USL of the ISS is available for experiment use. Requirements for the use of the earth viewing window should be identified in the PD's EIA so that the ERO and the ISS Payloads Office can coordinate the availability of this resource.

5.5 PAYLOAD SOFTWARE INTEGRATION AND VERIFICATION (PSIV) SERVICES

The PSIV PAH, SSP 52000-PAH-PVF, provides information on the accommodations, capabilities, services, performance characteristics, and constraints specific to payloads utilizing the PSIV/F. These interfaces are depicted in Figure 5-1. Defined in this document are the PSIV/F capabilities provided for all U.S.-controlled payloads requiring direct or indirect interfaces to the ISS C&DH system. This volume of the PAH serves as a guide for the PD and ISS program regarding PSIV services and capabilities provided by the PSIV/F.

5.6 GSE AND GROUND PROCESSING SERVICES

Most EXPRESS Rack payloads will be readied for launch at KSC. Accommodations for EXPRESS Rack 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 which must be followed, objectives of the particular level of integration, facility accommodations, and testing interfaces for payload activities. There are no additional verification activities required from the payload to be processed by KSC for launch preparation.

EXPRESS Rack payloads test and checkout and prelaunch 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 supplies, instrumentation, etc.)

B. Mechanical GSE (i.e., slings, platforms, eye bolts, 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.)

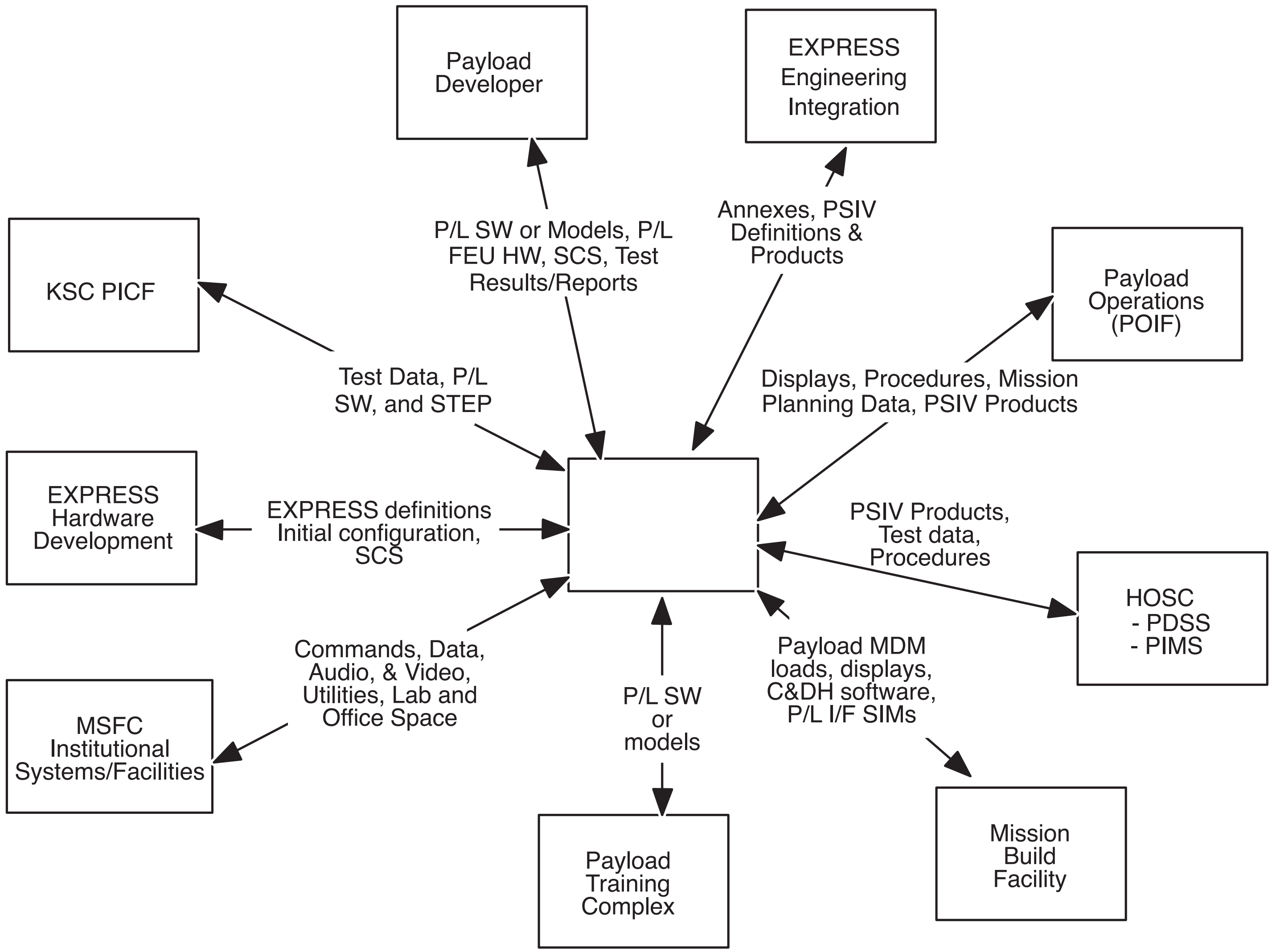

FIGURE 5-1 PSIV FUNCTIONAL INTERFACES

G. Biological materials (i.e., medical wastes, hazardous wastes, etc.)

PD GSE must be compatible with the KSC User accommodations defined in the PAH (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.).

Some EXPRESS Rack PDs may desire to utilize the Launch Site Support Facility (LSSF)/Hangar L at KSC. This facility is generally used for biological/plant sample processing. Requirements for the use of this facility are identified in the EIA and are further elaborated upon in the payload-unique integration data sets via PDL. Use of this facility may result in some funding impacts to the PD. Hangar L/LSSF is available for use for prelaunch and postlanding processing. The facility is typically very busy and early identification of requirements is desired in order to maximize accommodating the PD.

If circumstances dictate, the landing may occur at DFRC on Edwards Air Force Base (EAFB), California. Provisions for sample retrieval at this site must be considered by the EXPRESS Rack PD Team. DFRC sample processing requirements for biological/plant materials are usually grouped with the KSC Hangar L/LSSF requirements.

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

5.7 TEMPLATE FOR INTEGRATION

An integration template for a standard EXPRESS Rack payload (reference definition in Section 3.1) is presented in Table 5-II.

TABLE 5-II EXPRESS RACK PAYLOAD DATA DELIVERY TEMPLATE (Sheet 1 of 2)

DELIVERY ITEM	UF-1/UF-2 DELIVERY	GENERIC UF DELIVERY
EIA	L-25 mo (Final)	L-**TBD#10** mo (Final)
ICD	L-18 mo (Final)	L-**TBD#10** mo (Final)
PVP[2]	L-18 mo (Final)	L-**TBD#10** mo (Final)
Payload Engineer/Ops Data:		
Configuration Data Set (including Payload Drawings)	L-18 mo (Final) L-15 mo (Middeck)[3]	L-**TBD#10** mo (Final) L-15 mo (Middeck)[3]
Payload Structural FEMs[2]	L-20 mo (Initial/Nonstandard) L-13 mo (Final/All)	L-20 mo (Initial/Nonstandard) L-13 mo (Final/All)
Stowage (external to EXPRESS Rack)	L-24 mo (Initial) L-18 mo (Final)	L-24 mo (Initial) L-18 mo (Final)
C&DH Requirement Data Set[2]	L-24 mo (Final/Nonstandard P/L) L-11 mo (Final/Standard P/L)	L-24 mo (Final/Nonstandard P/L) L-11 mo (Final/Standard P/L)
Payload Application Software	L-11 mo (Final)	L-11 mo (Final)
Training Requirements Data Set	L-22 mo (Initial) L-12 mo (Final)	L-**TBD#10** mo
Simulator Hardware (if Training Strategy Team requires)	L-12 mo	L-**TBD#10** mo
Ground Data Services Requirements Data Set	L-22 mo (Initial) L-11 mo (Final)	L-**TBD#10** mo
Operations Requirements Data Set:		
• Procedures	L-19 mo (Final)	L-**TBD#10** mo (Final)
• On-Orbit Planning and Timeline Inputs	L-16 mo (Initial) L-10 mo (Update) L-6 mo (Final)	L-**TBD#10** mo (Initial) L-**TBD#10** mo (Update) L-**TBD#10** mo (Final)
KSC Payload Processing Requirements Data Sets		
• Support Requirements	L-**TBD#10** mo	L-**TBD#10** mo (Final)
• Technical Requirements	L-**TBD#10** mo (Final)	L-**TBD#10** mo (Final)
• Science Support Requirements	L-**TBD#10** mo (Final)	L-**TBD#10** mo (Final)
Phase 3 Flight Safety Review[4,5]	L-12 mo	L-12 mo
Hardware Turnover to KSC[1]	L-5 mo	L-5 mo
Certificate of Flight Readiness	L-3 mo	**TBD#10** mo

NOTES:

1. Hardware to be integrated into the middeck must be at KSC and ready for turnover in accordance with KSC's flight-unique hardware integration flow.

TABLE 5-II EXPRESS RACK PAYLOAD DATA DELIVERY TEMPLATE (Sheet 2 of 2)

NOTES (Cont.):

2. Requirements for individual verification data item submittal dates are identified on the applicable VRDS in the payload-specific verification plan.
3. Engineering input data for payloads that launch and/or land in the orbiter middeck include: structures/loads, thermal/cooling, EMC, electrical/power, mass properties, acoustics, stowage, and materials.
4. Phase 0/1 and Phase 2 Flight Safety Reviews should be accomplished in accordance with the PD's design/development schedule and will be coordinated directly with the JSC PSRP.
5. The PD must accomplish all Ground Safety Reviews with the KSC PSRP no later than 30 days prior to arrival at KSC.

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APPENDIX A

ABBREVIATIONS AND ACRONYMS

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APPENDIX A , ABBREVIATIONS AND ACRONYMS

10BASE-T	Ethernet Protocol Implementation
A	Amp, Ampere
AAA	Avionics Air Assembly
A/D	Analog-to-Digital
Adc	Amps, Direct Current
ADL	Applicable Documents List
ANSI	American National Standards Institute
APID	Application Process Identifier
APM	Attached Pressurized Module
APS	Automated Payload Switch
Ar	Argon
ARC	Ames Research Center
ARIS	Active Rack Isolation System
AWG	American Wire Gauge
°C	Degrees Celsius
C&C	Command and Control
C&DH	Command and Data Handling
C&W	Caution and Warning
CA	California
CAM	Content Addressable Memory
CCSDS	Consultative Committee for Space Data Systems
CFU	Colony Forming Unit
CG	Center of Gravity
CIR	Cargo Integration Review
CIST	Crew Increment Specific Training
cm^3	Cubic Centimeters
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CoFR	Certificate of Flight Readiness
COTS	Commercial off the Shelf
CPU	Central Processing Unit
CSCI	Computer Software Configuration Item
CVIT	Common Video Interface Transmit
dB	Decibel
DDPF	Decal Design and Production Facility
DFRC	Dryden Flight Research Center
DR	Data Requirement
DRR	Document Release Record
Dwrs.	Drawers

EAFB	Edwards Air Force Base
ECLSS	Environmental Control and Life Support System
EEE	Electrical, Electronics, and Electromechanical
EI	Engineering Integration
EIA	Electronic Industries Association, EXPRESS Integration Agreement
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMU	EXPRESS Memory Unit
EOC	EXPRESS Operations Controller
ERO	EXPRESS Rack Office
ERP	EXPRESS Rack Payload
ERSE	EXPRESS Rack Support Equipment
ESA	European Space Agency
EVA	Extravehicular Activity
EXPRESS	EXpedite the PRocessing of Experiments to Space Station
^{o}F	Degree(s) Fahrenheit
FCR	Flight Control Room
FCSD	Flight Crew Support Division
FCU	Functional Checkout Unit
FDDI	Fiber Data Distributed Interface
FDRD	Flight Definition and Requirements Directive
FDS	Fire Detection/Suppression
FEM	Finite Element Model
FOR	Flight Operations Review
FPSR	Flight Planning and Stowage Review
FRR	Flight Readiness Review
ft	Foot
ft^3	Cubic Feet
g	Gravity
GAr	Gaseous Argon
GB	Gigabit
GByte	Gigabyte
GCO_2	Gaseous Carbon Dioxide
GHe	Gaseous Helium
GN_2	Gaseous Nitrogen
GSE	Ground Support Equipment
GUI	Graphical User Interface
He	Helium
HEPA	High Efficiency Particulate Air
HOSC	Huntsville Operations Support Center
hr	Hour
hr/yr	Hours per Year

HRDL	High Rate Data Link
HRFM	High Rate Frame Multiplexer Status
H&S/S	Health and Status/Safety
H/W	Hardware
Hz	Hertz
I/F	Interface
I/O	Input/Output
ICA	Interface Control Annex
ICD	Interface Control Document
ICP	Integrated Cargo Plan
IDD	Interface Definition Document
IDRD	Increment Definition and Requirements Document
IEEE	Institute of Electrical and Electronics Engineers
IMS	Inventory Management System
in	Inch
Integ	Integrated
IOP	Increment Operations Plan
IP	International Partners
IPEHG1	ISS Payload Ethernet Hub/Gateway 1
IPEHG2	ISS Payload Ethernet Hub/Gateway 2
IPT	Integrated Product Team
IRB	Institutional Review Board
IRD	Interface Requirements Document
ISIS	International Subrack Interface Standard
ISPR	International Standard Payload Rack
ISS	International Space Station
ITCS	Internal Thermal Control System
ITP	Integrated Training Plan
IVA	Intravehicular Activity
IVS	Internal Video System
JEM	Japanese Experiment Module
JGOR	Joint Ground Operations Review
JSC	Johnson Space Center
kg	Kilogram
kHz	Kilohertz
km	Kilometer
kPa	KiloPascal
KSC	Kennedy Space Center
kW	Kilowatt
L	Launch
L-L	Line to Line

LAN	Local Area Network
LAP	Laptop
Lat.	Lattitude
lb	Pound
lb/hr	Pounds per Hour
lbf	Pound-Force
lbm	Pound-Mass
lbm/hr	Pound-Mass per Hour
LED	Light Emitting Diode
LeRC	Lewis Research Center
LET	Linear Energy Transport
Long.	Longitude
LRDL	Low Rate Data Link
LSE	Laboratory Support Equipment
LSSF	Launch Site Support Facility

m	Meter
MAPTIS	Materials and Processes Technical Information System
Mb	Megabit
MB	Megabit
MByte	Megabyte
Mbps	Million Bits per Second
MCC-H	Mission Control Center-Houston
MDK	Middeck
MDL	Middeck Locker
MDM	Multiplexer/Demultiplexer
MDP	Maximum Design Pressure
MELFI	Minus Eighty Degree Laboratory Freezer
MeV	Megaelectrovolt
mg	Milligram
mg/m^3	Milligrams per Cubic Meter
MIL	Military
min	Minute
MIP	Mission Integration Plan
MIUL	Materials Identification and Usage List
mmHg	Millimeters of Mercury (Pressure Unit)
MOL	Mission Operations Laboratory
MPEG	Motion Picture Experts Group
MPLM	Mini-Pressurized Logistics Module
MRDL	Medium Rate Data Link
msec	Millisecond
MSFC	Marshall Space Flight Center
MSFR	Mission Specific Flight Rule
MUA	Material Usage Agreement

N	Newton
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NC	Noise Criteria
NMI	NASA Management Instruction
NSTS	National Space Transportation System
NTSC	National Television Standards Committee
O_2	Oxygen
oct	Octave
O/D	On Dock
ORU	Orbital Replacement Unit
OSHA	Occupational Safety and Health Administration
Pa	Pascal
PAH	Payload Accommodations Handbook
PB	Play Back
PCMCIA	Personal Computer Memory Card International Association
PCS	Payload Computer System
PD	Payload Developer
PDL	Payload Data Library
PEP	Payload Executive Processor
PEHB	Payload Ethernet Hub/Bridge
PES	Payload Executive Software
PFE	Portable Fire Extinguisher
PFM	Pulse Frequency Modulation
PGSC	Payload General Support Computer
PHR	Payload Hazard Report
PIMS	Payload Information Management System
Pkg	Package
P/L	Payload
PLD	Payload
PL MDM	Payload Multiplexer/Demultiplexer
POD	Payload Operations Director
PODF	Payload Operations Data File
POI	Payload Operations Integration
POIC	Payload Operations Integration Center
POIF	Payload Operations and Integration
PPCB	Point-to-Point Communications Bus
ppm	Parts per Million
PRD	Program Requirements Document
PSE	Payload Support Equipment
psia	Pounds per Square Inch Absolute
psid	Pounds per Square Inch Differential
PSIV	Payload Software Integration and Verification

PSIV/F	Payload Software Integration and Verification/Facility
PSIV IDR	Payload Software Integration and Verification Increment Design Review
PSRP	Payload Safety Review Panel
PU	Panel Unit
PUI	Program-Unique Identifier
PVC	Polyvinylchloride
PVP	Payload Verification Plan
PWR	Power
QD	Quick Disconnect
Qty	Quantity
RAM	Random Access Memory
ref.	Reference
Rev.	Revision
RF	Radio Frequency
RFIT	Ready for SSTF/MCC Integrated Training
RFST	Ready for SSTF Standalone Training
RIC	Rack Interface Controller
RIO	Rack Interface Office
RMS, rms	Root Mean Square
RPCM	Remote Power Controller Module
RSA	Russian Space Agency
RT	Real Time
RTN	Return
SAA	South Atlantic Anomaly
SAMS	Space Acceleration Measurement System
SCC	Stress Corrosion Cracking
scfm	Standard Cubic Feet per Minute
ScS	Suitcase Simulator
SEB	Single Event Burnout
sec	Second
SEE	Single Event Effect
SEGR	Single Event Gate Rupture
SEU	Single Event Upset
SMAC	Spacecraft Maximum Allowable Concentration
SODF	Station Operations Data File
SPDA	Secondary Power Distribution Assembly
SPOE	Standard Payload Outfitting Equipment
SSP	Space Station Program or Space Shuttle Program
SSPC	Solid State Power Controller
SSPCM	Solid State Power Controller Module
STD	Standard

TAGS	Text and Graphics System
TBD	To Be Determined
TBS	To Be Supplied
TCP/IP	Transmission Control Protocol/Internet Protocol
TLM	Telemetry
TM	Technical Memo
TSH	Triaxial Sensor Head
TST	Training Strategy Team
TV FEM	Test Verified Finite Element Models
TXD	Transmitted Data
UF	Utilization Facility
UI	User Interface
UIP	Utility Interface Panel
ult.	Ultimate
UOF	User Operations Facility
USL	United States Laboratory
USOS	United States Orbital Segment
V	Volt
VAR	Verification Analysis Report
VBSP	Video Baseband Signal Processor
VC	Visibly Clean
VC-S	Visibly Clean - Sensitive
VCU	Video Compression Unit
Vdc	Volts, Direct Current
VMDB	Vehicle Master Data Base
VME	Versa Modula European
Vol.	Volume
Vrms	Volts, Root Mean Square
W	Watt
WSTF	White Sands Test Facility
μ	Micron
μg	Microgravity

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APPENDIX B

TBD LOG

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TABLE B-1 EXPRESS RACK PAYLOADS PAH TBD LOG (Sheet 1 of 2)

TBD NO.	TBD DESCRIPTION	DATA REQUIRED TO CLOSE TBD	DATA SOURCE/OWNER	REMARKS
TBD-01	The allocation of on-orbit crew time for a “standard” EXPRESS Rack payload is under review.	Identify a value to be used for on-orbit crew time allocation.	ISS Program/OZ2 Page: 3-1, 3-4 Para.: 3.1 Table: N/A Figure: N/A	
TBD-02	The provisions for middeck late access and early removal for “standard” EXPRESS Rack payloads are under review.	Determine whether or not middeck late access and early removal will be available as a “standard” service offered to all EXPRESS Rack payloads.	ISS Program/OZ2 Page: 3-1 Para.: 3.1 Table: N/A Figure: N/A	Action to be coordinated with KSC also
TBD-03	The provisions for external stowage provisions for “standard” EXPRESS Rack payload are under review.	Determine whether or not external stowage will be available as a “standard” service offered to all EXPRESS Rack payloads.	ISS Program/OZ2 Page: 3-3 Para.: 3.1 Table: 3-I Figure: N/A	EXPRESS Rack payloads are currently required to account for any external stowage items within their mass/volume allocation.
TBD-04	The acceptable on-orbit monitoring protocol for EXPRESS Rack payloads has not been finalized.	The protocol for monitoring EXPRESS Rack payloads on-orbit (i.e., equipment such as PCS, P/L MDM, etc.) must be defined.	EXPRESS Rack Office (ERO) Page: 4-8 Para.: 4.1.3 Table: N/A Figure: N/A	This item is in work as a result of an action item/agreement levied at the FDS Technical Interchange Meeting with the PSRP in June 1997.
TBD-05	Requirement definition and specific crew responses to EXPRESS Rack payload monitored parameter out-or-limit conditions remain under review and have yet to be defined.	Definition of the requirements and specific crew responses to EXPRESS Rack payload monitored parameter out-or-limit conditions must be established.	ERO Page: 4-10 Para.: 4.1.3 Table: N/A Figure: N/A	This item is in work as a result of an action item/agreement levied at the FDS Technical interchange Meeting with the PSRP in June 1997. Preliminary concepts will remove power from the payload at the SSPCM and issue a advisory message to the P/L MDM.
TBD-06	The definition of a “fire event location” has not been developed.	Develop a definition for “fire event location.”	ISS Program/OZ2, OZ3 Page: 4-11 Para.: 4.1.3C Table: N/A Figure: N/A	PSRP concurrence is desired. Definition may be relocated to NSTS 1700.7B/ISS Addendum.

TABLE B-1 EXPRESS RACK PAYLOADS PAH TBD LOG (Sheet 2 of 2)

TBD NO.	TBD DESCRIPTION	DATA REQUIRED TO CLOSE TBD	DATA SOURCE/OWNER	REMARKS
TBD-07	The EXPRESS Header, EXPRESS Telemetry Secondary Header and Function Code assignments are not finalized.	Once the EXPRESS Rack software (RIC, Laptop and Interface with ISS) has been defined and finalized, these tables can be completed.	ERO Page: 4-39, 4-40 Para.: 4.5.3.6.1, 4.5.3.6.3 Table: 4-IX, 4-X, 4-XI Figure: N/A	
TBD-08	The on-orbit random vibration environment for the ISS has not been defined.	Once the on-orbit random vibration environments for each of the Labs in the ISS are defined, then the environment that an EXPRESS Rack payload can expect to see can be calculated.	ISS Program/OZ2, OZ3 Page: 4-46 Para.: 4.7.3.1 Table: 4-XII Figure: N/A	
TBD-09	The JSC PSRP has identified the need for one or more interpretation letters which will more clearly explain the specific fire protection requirements for the ISS and the EXPRESS Rack payloads.	Release of the one or more interpretation letters from the JSC PSRP.	S. Larson/JSC PSRP Page: 4-66 Para.: 4.10.2.D Table: N/A Figure: N/A	Requirements in NSTS 1700.7B/ISS Addendum are also to be updated regarding fire protection requirements.
TBD-10	The generic Utilization Flight template data delivery dates for EXPRESS Rack payloads have not been finalized.	The final generic Utilization Flight template data delivery dates for EXPRESS Rack payloads are required.	ERO Page: 5-6 Para.: 5.7 Table: 5-II Figure: N/A	A generic template for EXPRESS Rack payloads is under development by the ERO and will be coordinated/concurred by the ISS Payloads Office when completed.