Cargo Systems Manual (CSM): Hubble Space Telescope Space Support Equipment Servicing Mission 4

STS-125

Mission Operations Directorate
Cargo Integration and Operations

Basic
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Cargo Systems Manual (CSM):
Hubble Space Telescope
Space Support Equipment
Servicing Mission 4

Space Program Operations Contract

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PREFACE

This document has been prepared by United Space Alliance (USA) under contract to Operations Division, National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center (JSC), Houston, Texas, with documentation support from Bastion Technologies, Inc.

Comments concerning the general contents of this manual should be directed to DO5/Michael T. Halverson, (281) 483-1831.

PURPOSE

This is the Preliminary Final Rev A version of the Cargo Systems Manual (CSM) prepared for early flight control team preparations and review for the STS-125/SM-4 mission.

The Cargo Systems Manual: Hubble Space Telescope (HST) Space Support Equipment (SSE) is intended to provide a single comprehensive source for technical and operational data on those elements of the HST support hardware involved in the performance of joint space shuttle/HST operations for the completion of Servicing Missions (SMs). Detailed descriptions of space shuttle interfaces to the SSE are also provided, allowing an end-to-end understanding of the integrated space shuttle/HST flight configuration for the SM. This CSM is intended for use by JSC Mission Control Center (MCC) personnel, flight planning and procedure development personnel, flight and ground crew training personnel, and STS flight crews supporting the HST project through its planned lifetime. The schematic diagrams and structural drawings provided in this document reflect the current information available and are produced in accordance with the Mission Operations Directorate (MOD) Drafting Standards, Revision C, dated April 1987.

SCOPE

This document describes the HST vehicle support hardware to be flown on SM-4 and the interface of that hardware to the orbiter. Although no detailed payload operation procedures are included, this document provides the basis of technical data for understanding those procedures documented in the HST SM Flight Operations Support Annex. Any technical data beyond that necessary to understand those procedures is provided for completeness in describing the HST SM system. In general, ground equipment or ground operations descriptions are not included. Further detailed information on the HST ground-based operations system for controlling the orbiting vehicle is not provided.

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DESCRIPTION

This volume provides technical data on the SSE that will be used to support an HST servicing mission. The SSE consists of four major structural components: the Flight Support System (FSS), Orbital Replacement Unit Carrier (ORUC), Multi-Use Lightweight Equipment (MULE) carrier, and the Super Lightweight Interchangeable Carrier (SLIC). This CSM addresses each of the components and their interfaces to each other, the orbiter, and the HST. The HST CSM, JSC-29029, provides the source for technical data on the HST.

Section 1 presents an overview of the SSE and the SM operations concept.

Section 2 describes the FSS and includes all relevant data on FSS interfaces to the orbiter, HST, ORUC and other SSE equipment. Section 2 is composed of subsections that discuss FSS structures, mechanisms, electronics, thermal control, avionics systems, and visual aids the crew will use.

Section 3 describes the ORUC and includes all relevant data on ORUC interfaces to the orbiter and other SSE equipment. This section addresses the ORUC hardware and interfaces of the ORUC with the orbiter, FSS, and HST ORUs.

Section 4 describes the MULE and includes all relevant data on MULE interfaces to the orbiter and other SSE equipment. Section 4 is composed of subsections that discuss MULE structures, mechanisms, electronics, thermal control, and avionics systems.

Section 5 describes the SLIC and its interfaces to the orbiter and the other SSE equipment. The SLIC structures, mechanisms, electronic, thermal control, avionics systems, and visual aids are also described.

Section 6 describes the displays and controls available to the crew and MCC.

Section 7 addresses the safety issues concerned with the SSE.

Appendix A contains acronyms used in this book, Appendix B contains the FMDM system description, and Appendix C contains information on document change control.

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1.0   INTRODUCTION

1.1   BACKGROUND

The purpose of the Servicing Mission (SM) is to upgrade the scientific capabilities, repair or replace failed equipment on the Hubble Space Telescope (HST), and provide a reboost capability when needed. By using the Space Shuttle Program to provide scientific instrument upgrading and subsystem maintenance, the useful and effective operational lifetime of the HST will be extended to a decade or more.

The HST is designed for on-orbit servicing and refurbishment. Repairs to the HST will be made during SMs, which consist of a shuttle launch, ascent, rendezvous with HST, grapple, Extravehicular Activity (EVA) servicing, reboost (if required or available consumables allow), redeployment of the HST, shuttle entry, and landing.

This Cargo Systems Manual (CSM) describes the Space Support Equipment (SSE) required for the SM. It describes the actual HST in sufficient detail for the reader to be able to understand the operation of the SSE, but does not contain sufficient information to understand the HST. The HST is described in the HST CSM (see Section 1.4, Applicable Documentation).

1.2   SPACE SUPPORT EQUIPMENT HARDWARE OVERVIEW

1.2.1   Physical Overview

The payload complement for the fifth planned SM (SM-4) includes the Flight Support System (FSS), the Super Light Weight Interchangeable (SLIC) Carrier, the Orbital Replacement Unit Carrier (ORUC), the Multi-Use Lightweight Equipment (MULE) carrier, and a Goddard Space Flight Center (GSFC)-supplied Bit Sync Adapter (BSA) that replaces the previously flown HST Payload General Support Computer Assembly (HPGSCA). A physical overview of the SSE is shown in Drawing TBS. The BSA is located in the crew compartment.

The FSS provides a maneuverable servicing platform for the HST, as well as electrical power control and monitoring interfaces between HST and the orbiter. The FSS has a similar configuration to that flown on SM-1 (STS-61), SM-2 (STS-82), and SM-3A (STS-103). The FSS consists of the A cradle and a Berthing and Positioning System (BAPS) with additional HST SM avionics. The FSS will provide the platform for the HST during the SM. Interfaces for the orbiter support services are provided through a set of Standard Interface Panels (SIPs) (port and starboard) just aft of the FSS. The FSS Avionics consist of two Enhanced Power Distribution and Switching Units (EPDSUs), two Flexible Multiplexer/Demultiplexers (FMDMs), the Advanced Mechanism Selection Box (AMSB), two Power Conditioning Units (PCUs), Junction Box (J-Box), and the Interface Power Control Unit (IPCU). The FSS is supported by two Payload Retention Latch Actuators (PRLAs) and one keel trunnion. For SM-4, the FSS also carries a Soft Capture Mechanism (SCM) that will provide an interface for vehicles other than the orbiter.

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The SLIC uses the HST Pallet Assembly as the primary structure retained by four PRLAs and one keel trunnion. The SLIC includes the Wide-field Science Instrument Protective Enclosure (WSIPE) to deliver the Wide Field Camera 3 (WFC3) and return the Wide Field Plantary Camera 2 (WFPC2). The WSIPE is connected to the carrier via Magnetic-Strut Isolators to provide a "smooth" ride for the science instument. The SLIC also carries two Battery Plate Assemblies (BPA) for the launch and return of two Battery Modules. The SLIC Enhanced Power Distribution and Switching Unit (EPDSU) provides the power, command and telemetry interfaces with the orbiter.

The ORUC uses a Spacelab pallet as the primary structure and has flown on SM1, SM2 and SM3A. The ORUC carries the Bi-Science Instrument Protective Enclosure (BiSIPE) to support launching the Cosmic Origins Spectrometer (COS) and Fine Guidance Sensor (FGS) and returning the Corrective Optics Space Telescope Axial Replacement (COSTAR) and FGS. The BiSIPE is connected to the ORUC via a passive Load Isolation System (LIS). Other containers on the SLIC include: Small ORU Protective Enclosure (SOPE), Science Telescope Imaging Spectrograph (STIS) Repair Enclosure, and Auxiliary Transport Module-2 (ATM). Power to the SLIC is via the FSS EPDSU.

The MULE is built on the Upper Atmospheric Research Satellite (UARS) Airborne Structure Equipment (UASE) cradle structure, with a flight history of STS-48 (UARS) and STS-95 (HOST). The MULE has a three-trunnion interface, one keel and two longeron trunnions. The MULE carries the Relative Navigation System (RNS) and the Contingency ORU Protective Enclosure (COPE). The Avionics for the MULE consist of a Power Distribution and Switching Unit (PDSU) and two FMDMs.

A functional view of the orbiter/SSE structural interfaces is shown in Drawing TBS.

1.2.2   Systems Overview

A functional overview of the SSE systems is shown in Drawing TBS. The flight crew will control DC power to the FSS through the orbiter Standard Switch Panel (SSP) and the FSS AC mechanisms via GPC SM SPEC 212 and switches on panel A6U. Section 6 addresses displays and controls for the SSE.

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Primary control and monitoring of the HST will be provided via a Radio Frequency (RF) link to the orbiter, using Payload Signal Processor (PSP) bypass mode for the telemetry. The BSA, with its special signal processing board, will be connected to the Payload Data Interface Panel (PDIP) and used to interface the Payload Interrogator (PI) to the Payload Data Interleaver (PDI) to allow data communications using the HST data formats that the PI/PDI do not support. In the event of a BSA failure, a passive plug is installed at the PDIP as an alternate data path. Some functions of the HST are controlled and monitored via GPC SPEC 210. HST displays and controls are addressed in the HST Cargo Systems Manual.

GRAPHIC TBS

Figure 1-1. Functional overview of servicing mission power/data routing

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The FSS provides conditioned power and hardline power control to the HST. The power flow from the orbiter to the FSS to the HST is shown in Drawing TBS. The servicing platform is configured with drive and brake/locking systems, a latching and release system, a platform pivot capability with drive and brake/locking systems, a rotating capability with drive and brake/locking systems, a Close Circuit Television, and electrical interfaces to the HST. The FSS draws power from the orbiter payload primary bus and supplies regulated power to the HST through the Direct Power Converters (DPCs), J-Box, IPCU, and umbilical. Reference Figure 1-2 for a functional overview of the SSE/HST conditioned power control and routing.

FSS mechanisms are used to position the HST for servicing. The mechanisms are controlled via the General Purpose Computer (GPC) SM SPEC 212 and the PRLA switches on panel A6U. The GPC input and feedback data are channeled through one of the FSS FMDMs to select and monitor the mechanism to be driven.

GRAPHIC TBS

Figure 1-2. Functional overview of the orbiter interfaces

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Actual mechanism activation occurs via switches on the A6U panel. For the second SM (SM-2), the BAPS Support Post (BSP) was modified to allow for remote operations similar to any of the FSS mechanisms. When the BSP is installed, it limits the BAPS operation between 43.8° and almost 90°. When the BAPS is pivoted up, it limits the travel to less than 90° and prevents the automatic mechanism termination. The BAPS will be pinned in this position during the normal servicing activities to prevent inadvertent damage to the HST solar arrays during EVA activities. When the BAPS is pivoted down to the 43.8° position, it automatically locks in position. This is the nominal landing position for SM-3B. The latch can be released either via normal mechanism control or EVA operation. The FSS is addressed in detail in Section 2.

The MULE is a reusable flight-qualified carrier designed to transport HST ORUs and CATs to orbit. The MULE provides stowage and environmental protection for ORUs during all phases of the mission. The MULE physical overview can be seen in Drawing TBS. The MULE's avionics and heater services are controlled via the Standard Switch Panel (SSP) and are monitored via SSP talkbacks and GPC SM SPEC 211. The shuttle provides structural, electrical, and command/telemetry interfaces to the MULE. The MULE/STS interfaces are detailed in Drawing TBS. The MULE provides stowage and environmental protection for ORUs during all phases of the mission. The MULE is addressed in detail in Section 3.

The Super Lightweight Interchangeable Carrier (SLIC), Drawing TBS, is a reusable, structure that provides transportation, load isolation, environmental control and protection for the SIs, ORUs, and CATs and tether positions to perform on-orbit servicing. The SAC's avionics and heater services are controlled via the SSP and are monitored via the SSP talkbacks and GPC SM SPEC 211. The SLIC's interfaces with the orbiter are detailed in Drawing TBS and are addressed in detail in Section 4.

A functional description of the STS/SSE power routing is shown in Drawing TBS.

The ORUC is mounted in the middle of the orbiter payload bay. The ORUC, shown in Drawing TBS, uses a SpaceLab Pallet (SLP) as the primary structure cradle.

1.3   SPACE SUPPORT EQUIPMENT MISSION OVERVIEW

1.3.1   Payload Configuration

Drawing TBS provides an overview of the payload bay configuration for the SM.

1.3.2   Prelaunch Operations

None of the SSE components are powered during prelaunch or ascent.

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1.3.3   Mission Operations and Constraints

For SM-4, the orbiter will launch on a direct insertion trajectory to the HST orbit, estimated to be between 310 and 320 nautical miles (n. mi.), with a 28.45° inclination. Once the spacecraft has been properly configured, the orbiter will rendezvous with the HST, grapple and berth the HST to the FSS, connect external orbiter power to the HST via umbilical, and service the spacecraft accordingly.

STS-125 will carry a crew of seven for a 12-day mission, with five scheduled EVA days to accomplish mission objectives.

Two EVA teams, with two crewmembers each, provide alternating support for each EVA day. One team performs EVAs on FD4, FD6, FD8, and the other team performs EVAs on FD5 and FD7. Nominal deployment will take place on FD9. The EVA teams are cross-trained for all servicing activities to accommodate off-nominal situations that might require shuffling the EVA teams and crewmembers.

The STS-125 Mission will replace the Rate Sensor Units (RSUs), FGS 2, and Bay 2 and 3 batteries. The Mission will remove the COSTAR and replace it with the COS and replace WFPC2 with WFC3. Also, repairs to the Advanced Camera for Surveys (ACS) and the STISS will be conducted. All replaced hardware will return in their respective carriers.

FD1

The crew will activate the SSE on Flight Day 1 (FD1).

FD2

On FD2, the crew will perform a checkout and survey of the SSE as well as activate and checkout the orbiter Remote Manipulator System (RMS). Also on FD2, the FSS will be configured for berthing to the HST.

FD3

The orbiter will rendezvous with, grapple, and berth the HST on FD3. Once berthed, three latches are closed to secure the HST to the FSS, and the crew will then perform a survey of the HST. The FSS will be pivoted to bring the -V3 axis forward for the next two EVAs.

FD4 through FD8 will be used to perform five 6-hour EVAs for HST servicing.

Daily SSE Activities

During the Daily Setup, the BAPS Support Post (BSP) Pip-Pins will be installed, and any translation aids that are required will be deployed. The Daily Closeout will remove the BSP Pip-Pins, inspect the Main Umbilical, and retract any deployed Translation Aid.

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FD4

On FD4, the crew will conduct EVA 1. During this EVA the crew will remove WFPC2 and install WFC3. The only other objective for this EVA is to replace the Bay 3 Battery Module.

FD5

EVA 2 will replace the RSU and the Bay 2 Battery Module. During crew sleep, the ground will perform an RSU functional test.

FD6

The crew will perform EVA 3. During EVA prep, HST will be rotated to -V2. During this EVA, COSTAR will be replaced with COS and the first part of the ACS repair is performed. After the EVA, HST is rotated to -V3.

FD7

On FD7, HST will be rotated to the +V2 position in preparation for EVA 4, which will conduct the STIS repair ad attach NOBL 8. After the EVA, the HST will be rotated to back to the -V3 position.

FD8

HST will be rotated to the +V3 forward position on FD8 for EVA 5. This is in support of FGS 2 replacement and the final part of ACS repair. HST will then be rotated to the -V3 forward position once the EVA has been completed.

FD9

HST deployment is nominally scheduled for FD9, which includes external power off, release preparations, HST release from FSS, and RMS release. The FSS will be stowed shortly thereafter on FD9.

FD9 is also held for the contingency EVA day, should it be required.

FD10, FD11, and FD12

FD10 is nominally a crew off-duty day, but can be used as a contingency deploy day, should FD9 become an EVA day. Cabin stow occurs on FD11. The SSE Equipment will be deactivated prior to landing on FD12. The mission also allows for two additional on-orbit days for the shuttle to protect against weather conditions or shuttle contingency delays before landing.

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1.4   APPLICABLE DOCUMENTATION

Cargo Systems Manual: Hubble Space Telescope - All Flights, JSC-29029, Basic and applicable PCNs.

Command and Data Annex, Annex 4, HST SM 4, NSTS-14009, Rev.H.

HST SM 3B, Flight Safety Compliance Data Package, P-44-062, TBD.

Shuttle Orbiter/Cargo Element Interfaces ICD, ICD-A-14009-SM, "See Current Version."

Space Shuttle Systems Handbook, JSC-11174, Volume 1.

ANNEX 1, HST SM 4, NSTS-14009, Rev G.

CIR Data Package

ANNEX 2, HST SM 4, NSTS-14009, REV G.

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2.0   FLIGHT SUPPORT SYSTEM (FSS)

2.1   FSS PHYSICAL DESCRIPTION

The HST Flight Support System (FSS) is classified as reflown hardware and will be used for the SM4 mission. The FSS provides the mechanical and electrical interfaces between the HST and the orbiter for payload retrieval and on-orbit servicing. The FSS SM4 configuration provides for the following services:

a.   HST berthing and positioning (remotely operated Berthing and Positioning System (BAPS) lock release and pointing capability)

b.   HST latching and release (remotely operated)

c.   Orbiter and HST electrical power interfaces

d.   HST optional reboost (structural configuration)

The FSS is mounted in the aft section of the orbiter payload bay (X_o=1175.2). The system includes structural elements, mechanisms, Common Drive Units (CDU), avionics systems, thermal control systems, and EVA crew aids/equipment. Its major components are shown in Figure 2-1 and Figure 2-2. The following is a list of reflown hardware:

a.   FSS Structural Elements

  1.   FSS Cradle

  2.   Berthing and Positioning System (BAPS)

b.   FSS Mechanical Systems

  1.   Common Drive Units (CDU) (Large CDU for Berthing Latches and Downlock, Dual Torque CDU for Rotator and Pivoter, Small CDU for umbilicals, BSP and Translator)

  2.   Berthing Latches

  3.   Umbilical Actuator (UA) Mechanism

  4.   BAPS Rotator Mechanism

  5.   BAPS Pivoter Mechanism

  6.   BAPS Launch/Landing Lock Mechanism (Downlock)

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7. BAPS Support Post

8. Backup Umbilical Mechanism

9. Translator Mechanism (will not be operated on SM4)

c. Avionics and Electrical Systems

1. Enhanced Power Distribution and Switching Unit (EPDSU 1 & 2)

2. Port and Starboard Power Conditioning Units (PPCU & SPCU)

3. Interface Power Control Unit (IPCU)

4. Advanced Mechanism Selection Box (AMSB) and the FSS mechanisms with the CDUs and the Switch Assemblies

5. Flexible Multiplexer/Demultiplexers (FMDMs A & B)

6. Closed Circuit Television (CCTV)

7. Junction Box (J-Box)

d. Thermal Control

Active Thermal Control

(1) Low Gain Antenna Protective Cover (LGAPC) (May be moved to MULE.)

(2) Berthing Attachment Restraint (BAR)

(3) FSS Unique EVA Crew Aids/Equipment

e. Handholds/handrails, HST Portable Foot Restraint (1), Portable Foot Restraints sockets. HST PFR 90-Degree Socket Converter

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Additions, modifications and deletions to the FSS for SM4 are listed in Table 2-1.

Table 2-1. FSS and ORU/CAT changes for SM4

	Component	**Reason**
Additions	Soft Capture Mechanism (SCM)	New ORU
	L-Handle Stowage Brackets for Contingency Return of Handholds	STIS L-handle may return stowed on the FSS as a contingency
	SI Auxiliary Handhold	Removed from FSS. Previously flown (SM1, SM2, & SM3A/B) for contingency no-RMS handling of axial SI removed from HST. The COSTAR has an integral "L" Handle SM1 and SM2)
Deletion	Articulating PFR Extender (APE)	Port-side APE removed since it will not be needed in SM4 EVA scenarios
	EPDSU 2	Module current sensor modified for CCTV wiring correction
Modifications	BSP Tether Point	Tether attachment point added to aid EVA translation
	Berthing Latch CDUs	Large CDU on each of three Berthing Latches and the Downlock replaced with units of a new design
	Sill Plate #2	Plate are reduced since there is no umbilical installed at Berthing Latch 2 for HST SMs
	Rotator Override EVA Wedge	Modified wedge to improve performance during EVA task
	IPCU Fuses	7 fuses were changed out in the IPCU due to over fusing to the HST
	Berthing Latch Sill Plates	Modified to accommodate the SCM
	Umbilical EVA Retainer Plate	Incorporates the captive fasteners
	BAPS Cable Trays	Modified to accommodate SCM clearances

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2.1.1   FSS Structural Elements

The configuration of the FSS for the HST SM4 consists of two main structural elements; the FSS Cradle and the Berthing and Positioning System (BAPS).

FSS Cradle

The original FSS Cradle will be used for the SM4 mission. The same FSS was also flown and used on SM1, SM2, SM3A, and SM3B. The FSS Cradle is the primary structural element of the FSS. It supports the BAPS, avionics and electrical equipment, handholds, crew aids, etc. The Cradle is a 16-inch deep semimonocoque structure that is designed to survive all specified load conditions imposed by the orbiter and the mission.
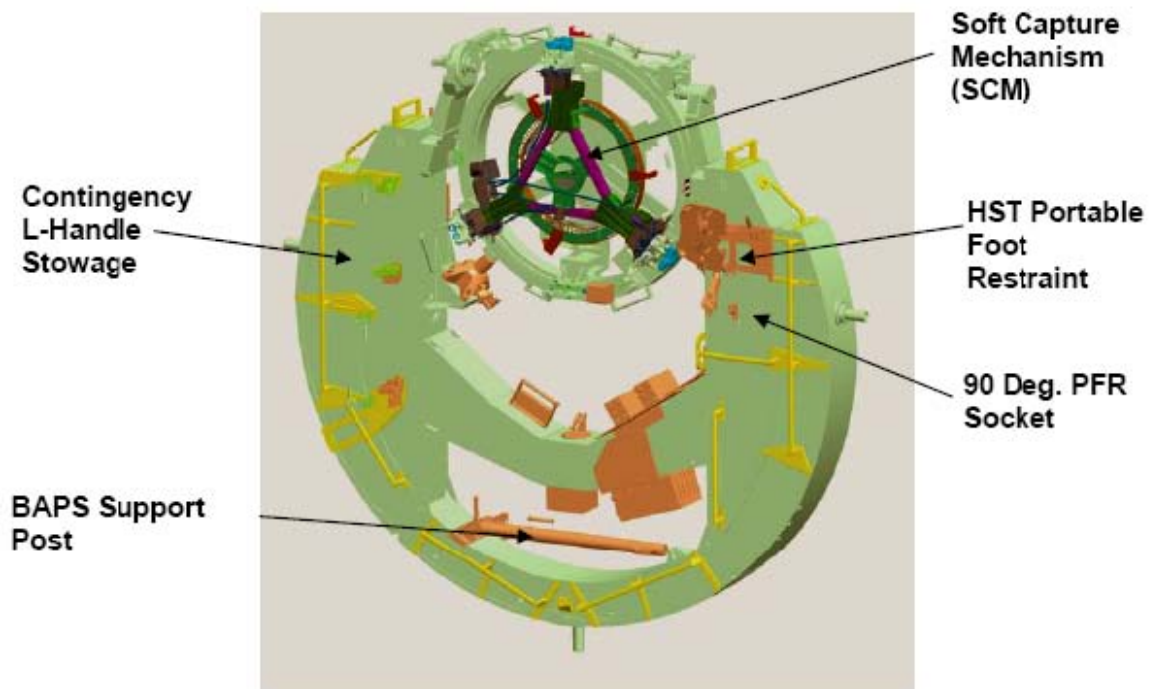
Figure 2-1. The FSS forward face

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Figure 2-2. The FSS aft face

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On-orbit HST inertial loads are transmitted through the following path:

a.   From the spacecraft berthing pins

b.   Through the berthing latches of the BAPS

c.   Through pivot trunnions/BAPS Support Post into the FSS Cradle

d.   To the orbiter longeron and keel payload retention systems

The Cradle utilizes a statically determinant support system. It is restrained in the orbiter X-Z plane by two sill (longeron) trunnions located in the orbiter payload bay at X_0=1175.20. A keel trunnion that locks into an orbiter active keel fitting/latch provides X-Y restraint.

The two primary structural elements of the Cradle are the U-shaped cradle and the Latch Beam. The cradle is the main support component for the BAPS and provides mounting surfaces for EVA equipment and avionics boxes. The beam, bolted to the Cradle, increases the total load carrying capacity and provides a mounting surface for avionics and electrical equipment. The cradle is primarily composed of 6061-T6 (webs and intercostals) and 7075-T6 (skin) aluminum and weighs approximately 2660 lb.

To relieve stresses due to pressure differentials, the Cradle contains two outboard-facing filtered vents, located above the orbiter longeron trunnions. The beam contains two downward-facing filtered vents. All intercostals also contain redundant vent holes.

Berthing and Positioning System (BAPS)

The BAPS (shown on the FSS in Figure 2-1 and Figure 2-2) is a remotely operated system which acts as the maintenance platform for the HST during on-orbit servicing missions. It is capable of three degree-of-freedom motion (rotating, translating, and pivoting) to accommodate inspection, pre-deployment testing, deployment, servicing, or retrieval berthing. The BAPS range of motion is as follows:

a.   Rotation about the BAPS centerline is +/-175°

b.   Translation along the BAPS centerline is +/-1.75 inches (not planned for use during SMs)

c.   Pivot (at any angle) between vertical and horizontal (0° and 90°respectively)

The BAPS is equipped with remotely operated berthing latches and a blind-mate umbilical connector that are designed to mate to hardware on the HST aft bulkhead. The berthing operation is monitored utilizing a Closed Circuit Television Camera (CCTV), located on the BAPS and operated by an AFD crewmember. The CCTV views the target located on the aft end of HST.

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2.1.2   FSS Mechanical Systems

Common Drive Units (CDU)

Either a large, small or dual-torque CDU, depending on its application, drives each FSS mechanism. A CDU consists of a pair of three phase 115V, 400 Hz motors with differential and speed reduction gearing. Operating parameters for three types of CDUs are given in Table 2-2.

All three types of CDUs contain an automatic, electro-mechanical braking system that engages when power is removed. When the brake is applied, the complete gear train from the motor to the CDU output drive shaft is locked to prevent the mechanism from being back-driven in either direction.

The CDU mechanisms are designed to be two-fault tolerant for continued mission operation and/or flight safety. Each CDU has two motors that prevent a total failure if one motor or gear reduction unit fails. Additionally, if the differential planetaries internally jam, then both motors can be commanded on to provide torque to the output shaft. All mechanisms, except for the translator, are provided with an EVA override capability for operation.

Note: The Translator is not a safety-critical mechanism and is not planned to be used during SM4.

Table 2-2. CDU operating parameters

CDU Type	Current Requirements	Stall Torque	No-Load Speed
Large	1.0 A/phase/motor	250 in-lb (to output shaft)	80 rpm
Small	0.3 A/phase/motor	250 in-lb (to output shaft)	8 rpm
Dual-Torque	0.14 A/phase/motor	250 in-lb in high-torque mode or 90 in-lb in low-torque mode	3.75 rpm

The FSS configuration for SM4 contains 10 CDU-driven mechanisms that perform 8 separate functions. They are the Berthing Latches, the Main Umbilical, the Umbilical Disconnect Mechanism, the Rotator, the Pivoter, the Landing/Launch Lock (Downlock), the Translator, and the BSP latch. Their functions and operational parameters are given in Table 2-3.

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Table 2-3. FSS mechanisms

System Type	Mechanism	Qty	CDU Type	Primary Operation	Nominal Operation Time	Amps Per Phase
Berthing	Berthing Latch	3	Large CDU	Secures the HST to the BAPS at three locations	18 sec	1.00 -0.30
	Main Umbilical	1	Small CDU	Provides primary and redundant electrical interface between the HST and the FSS	8 sec (for 4.5 inch stroke)	0.30 -0.10
	Umbilical Disconnect Mechanism	1	Small CDU	Disengages the Deploy/Retract Umbilical connectors P107 and P108 from the FSS D/R Umbilical interface Required only when backup umbilical has been utilized	3.75 sec (demate only)	0.30 - 0.10
Position	BAPS Rotator	1	Dual Torque CDU	Rotates the BAPS (and HST, if berthed) about the centerline of the BAPS turntable	0.2238 deg/sec	0.1530 -0.0510
	BAPS Pivoter	1	Dual Torque CDU	Tilts the BAPS turntable about an axis parallel to Yo	0.05294 deg/sec	0.15 -0.05
	Launch/ Landing Lock (Downlock)	1	Large Motor CDU	Secures the BAPS for Orbiter launch and landing	24 sec	1.00 -0.30
	BSP Latch	1	Small Motor CDU	Unlatches/latches BSP to enable pivoting from 43.8 degree	2 sec	0.30 -0.10
	BAPS Translator	1	Small Motor CDU	Not used on SM4		

Note: Small CDU serves as a brake on SM4.

Note: Soft Capture Mechanism (SCM) mechanisms are described in Sec. 2.5.9.

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Common Drive Unit Refurbishment

The dual torque CDUs used on the pivoter and rotator mechanisms have been functionally and environmentally retested for flight. A Dual Torque CDU with ceramic brakes will be assembled and tested as a flight spare.

The large CDUs used on the three berthing latches and the downlock mechanism are being replaced with new motors with a new carbon dynamic brake.

The differentials are reflown hardware and have been partially disassembled, inspected, and refurbished, with particular focus on the retaining rings. All of the CDUs will be reprocessed through full acceptance testing prior to flight. The large motors will be qualified at the motor level and a spare CDU will be tested to protoflight levels at the CDU level.

Berthing Latches

The Berthing Latches secure the HST during on-orbit servicing (see Figure 2-3 and Figure 2-4). Three latches, located 120° apart about the perimeter of the BAPS, center and align the HST and close around the berthing pins. Subsequent umbilical mating is accomplished without compensating for large misalignment. AFD monitors are provided to indicate latched (closed) and released (open) positions for the Berthing Latches. Additionally, Berthing latches are marked for visual monitoring by the crew in the AFD.

The latch mechanism is a CDU-powered, Acme thread-driven, symmetrical linkage system. The opened jaws of the latches provide a ramping guide to accommodate RMS positioning inaccuracies of +/- 2.0 in and +/- 1.0 degree (half-cone angle) for berthing. Additionally, a pin-to-berthing latch clearance gap of approximately 0.001-in on the radius (ref. Lib. # 408-06379) is established to permit relative axial motion between pin and latch for thermal expansion. Figure 2-2 illustrates the latch operation.

The design strength for the berthing latches is given below:

Open position:	Closed Position:
Berthing Pin impact load: 1,450 lb. (design limit)	Design limit load: 9000 lb. (all radial directions)
Estimated Berthing load: 300 lb. (RMS operated at 0.05 fps)	Design yield load: 18,000 lb.
Yield load: 2,900 lb. (design limit)	

Verify that this is the correct version before use

Berthing Latch EVA Overrides

There are two EVA override provisions to open the berthing latches in the event of a CDU failure. These EVA overrides only consider HST release and do not provide means for berthing under failure conditions. Once the EVA overrides are operated, the latch can only be closed with the Berthing Attachment Restraint (BAR). Only one BAR is flown, so only one latch can be closed with the BAR at any time. Both EVA overrides are shown in Figure 2-4. The override provisions are as follows:

a.   Primary Override - Two jaw pivot pins are located on the upper left and right corners of the berthing latches. Loosening them with an EVA standard ratchet wrench using a 7/16 socket disengages these pins. Once the pins are disengaged, the jaws rotate freely, enabling release of the HST. Should disengagement of the berthing jaw pivot pins fail to release the HST due to anomalous preload, which has developed in the jaw linkage, a secondary EVA override is used to release the preload in the jaw linkage.

b.   Secondary Override - On the berthing latch is a lever arm that pre-adjusts the tension setting on the drive linkage for each jaw. The tension is released by loosening the upper and lower fasteners with a #10 Allen tool and pressing down on the lever. The jaws then move freely and allow the jaw pivot pins to be easily retracted via the primary method listed above.

Should the berthing jaw pivot pins still fail to release, presumably due to the threaded pins seizing in their inserts, the entire housing for each jaw pivot pin can be removed by disengaging two #10 socket cap screws with a PGT. Then the jaw pivot pins can be pulled out of the jaws by hand, which allows the jaws to move freely.

In addition, the BAR tool can be used in an EVA to restrain the HST if a berthing latch fails to close in the event of a CDU failure. The RMS is used to hold the HST until the BAR has been installed. To install the BAR, the EVA override to open the latch is first used. The two pivot pins and their cases are then removed. The BAR is pip-pinned in two locations at the berthing latch jaw pivot pin locations. A Velcro strap secures the open jaw near the main umbilical clear of the main umbilical demate when using the BAR to close Berthing Latch 3.

When the BAR is used during the mission one pip-pin is removed at the end of each EVA day and the RMS is re-grappled to the HST as the third attach point for overnight. This allows for jettison of the HST in a rapid safing situation.

Verify that this is the correct version before use

Preload Release Bracket

In the event of dual AC power failure during the mission, remote control of all mechanisms will no longer be possible with the exception of the passive-mechanical latching of the BSP. A manual operation of the pivoter will be required to release turnbuckles and pivot the BAPS ring for stowage. For extending and preloading the Post to the full 90° position, a subsequent loss of AC power to the FSS (two failures) will require an alternate capability to relieve the Post tension, so that Post pip pins and the Pivoter Override functions may be performed. The Preload Release Bracket (PRB) will provide the alternate capability. See Figure 2-5.

The PRB consists of a lower fitting pip pin clevis machined integrally into a pivotable member that effectively slides forward/backwards in the X axis and up/down in the Z-axis of the orbiter when an EVA jackscrew is turned counter clockwise or clockwise. Barrel-nuts accommodate the triangular geometry that develops upon actuation. The PRB is launched in the centered position; it is primarily designed to release tension in the BSP, however it can be used to generate preload in the event the BAPS does not pivot up enough to hit the hardstop in the BSP. Once EVA actuation of the PRB releases the tension, the previous BSP pip pin removal and Pivoter turnbuckle Override EVA capabilities are now re-enabled.

Verify that this is the correct version before use
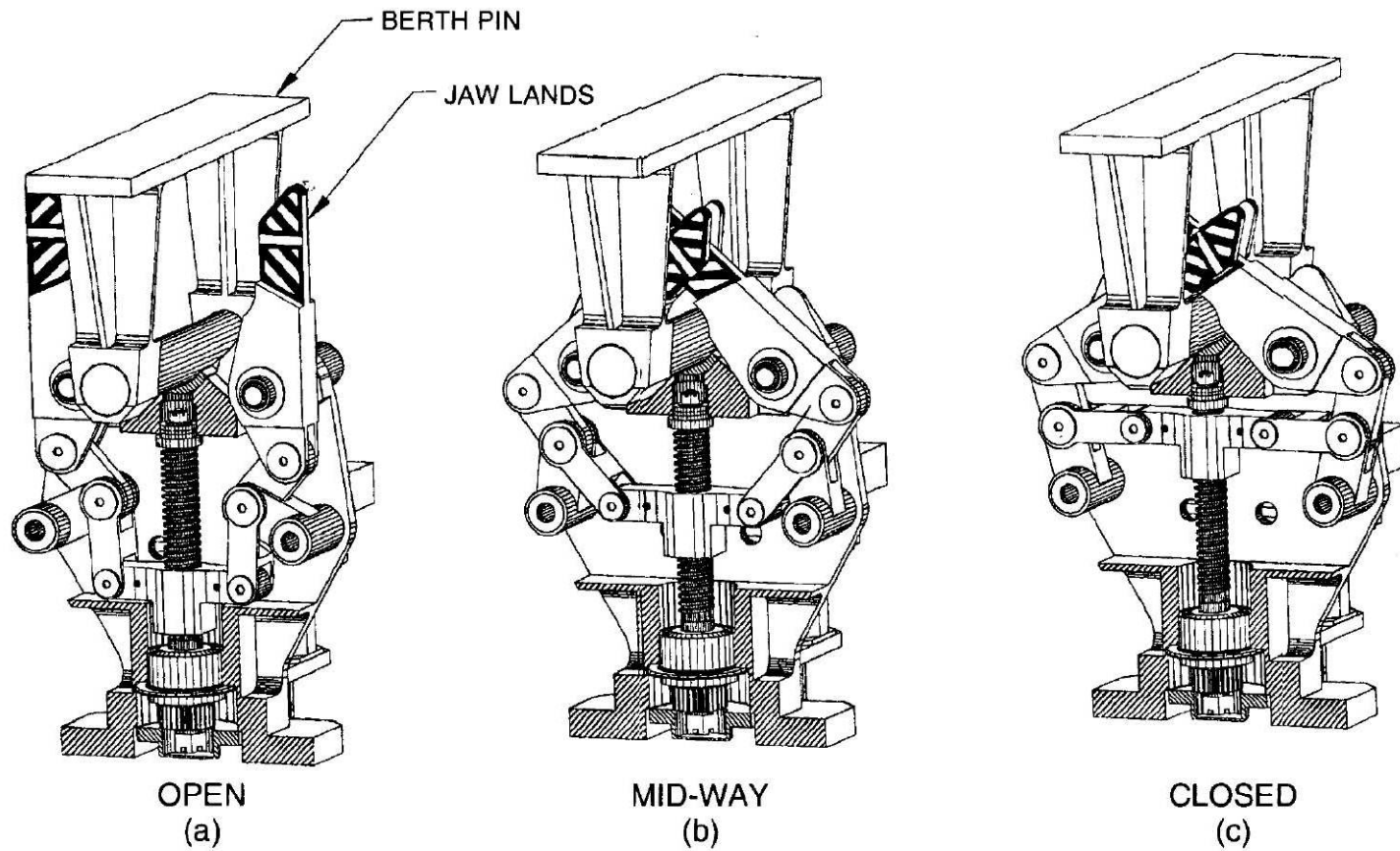
Figure 2-3. HST berthing latches

Verify that this is the correct version before use

BERTHING LATCH PRIMARY OVERRIDE

BERTHING LATCH SECONDARY EVA OVERRIDE
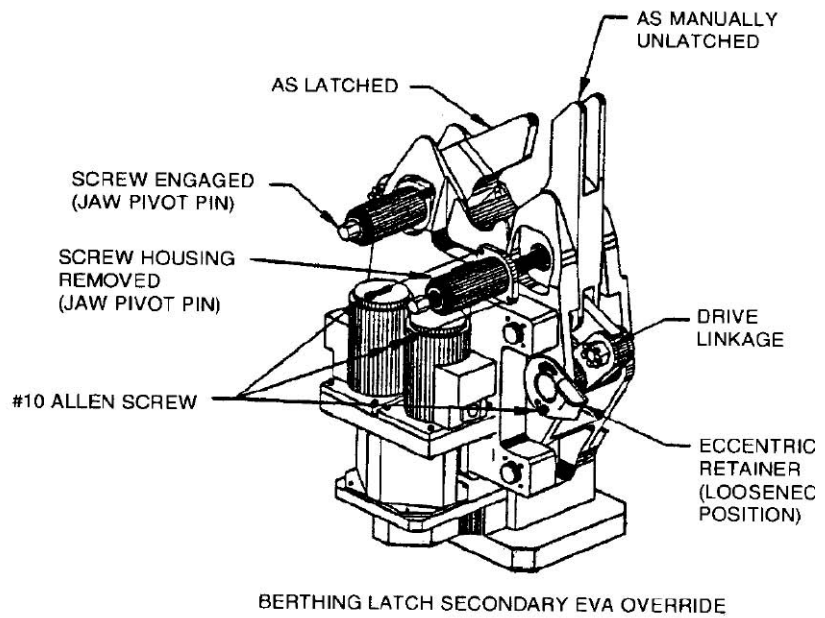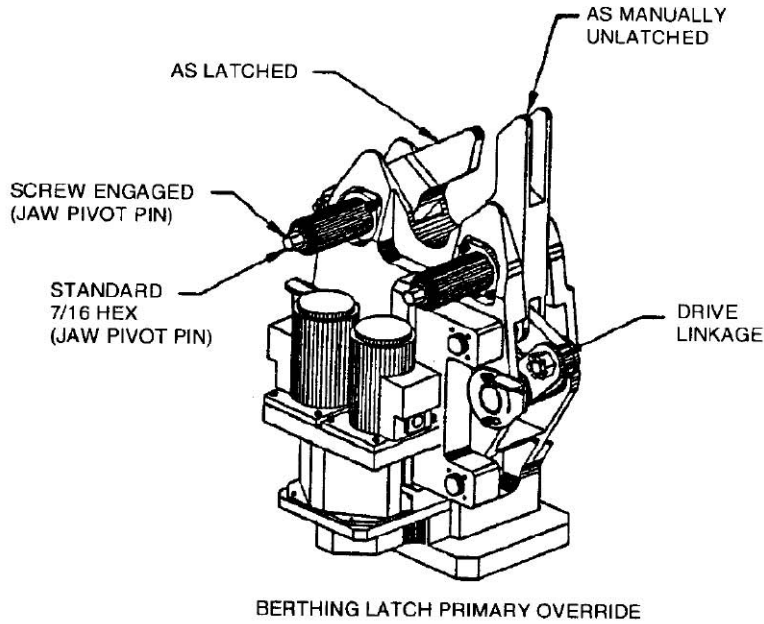
Figure 2-4. Berthing latch EVA overrides

Verify that this is the correct version before use
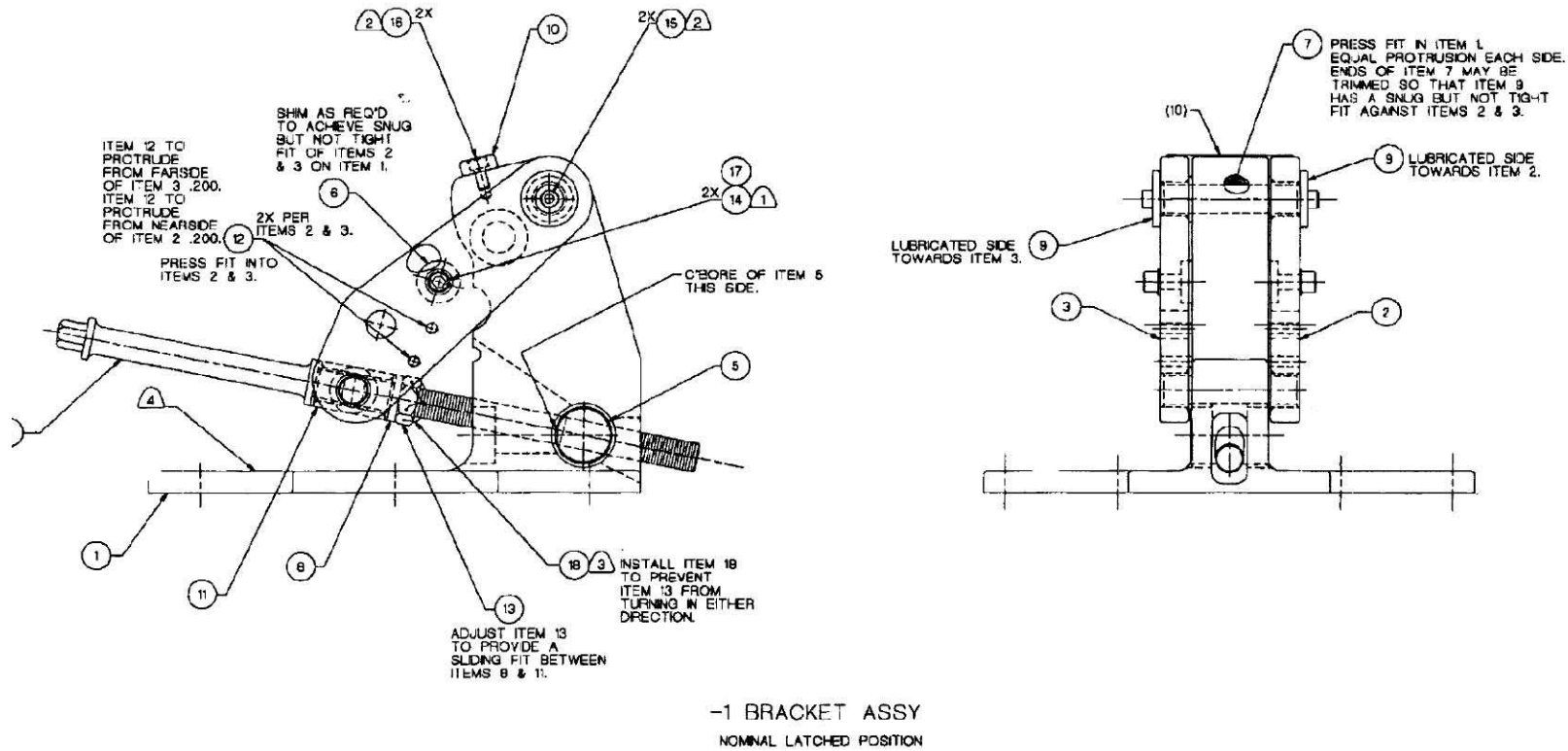
Figure 2-5. Preload release bracket

Umbilical Actuator (UA) Mechanisms

Two different umbilical actuator mechanisms are available for SM4:

a. The Main Umbilical, to mate and demate the main FSS umbilical to the HST aft bulkhead

b. The Umbilical Disconnect Mechanism (UDM) provides an alternate umbilical connection (described below) employed only in the event of a Main Umbilical failure

Main Umbilical

The Main Umbilical mechanism (Figure 2-6) is a translation drive with a 4.5-inch stroke that mates or demates from the HST tower umbilical connector (J101). A bell crank linkage that is slightly over dead center in both the unmated and mated positions provides the translation stroke. This mechanism is capable of developing up to 400 lb. of axial force during mating and demating operations. Measurements on existing connectors have shown required axial connector engagement loads are specified to be less than 200 lb and were determined to be approximately 20 pounds at room temperature test conditions per as-run procedure 408-FSS-1102-0021. The main umbilical actuator mate or demate time is approximately 8 seconds. AFD monitors are provided to indicate latched (mated) or released (demated) positions for the Main Umbilical.

Main Umbilical EVA Overrides

a. First Override - If the actuator mechanism fails to retract, the entire main umbilical can be retracted (the main umbilical is mounted on a movable adapter plate on the BAPS ring). Turning the EVA override screw counter-clockwise with a 7/16 inch socket pulls the mechanism away from the spacecraft, demating the umbilical connectors.

b. Second Override - The secondary override releases the umbilical actuator from the sill plate by removing the screw retainer plate subassembly. To remove the retainer plate, two #10 Allen captive retainer screws are removed which allows the carriage assembly to move freely over the translator screw and the umbilical to be manually disengaged. The Pry Bar or the Payload Retention Device (PRD) may be used to pull back the main umbilical.

Both EVA overrides are pictured in Figure 2-7.

Umbilical Disconnect Mechanism (UDM)

In the event of an irrecoverable failure of the Main Umbilical Mechanism and/or connector, the UDM is used as an alternate power interface for the HST. The UDM is located on the BAPS, near the Main Umbilical.

Verify that this is the correct version before use

An EVA is required to mate the two FSS Umbilical connector receptacles, J107 and J108, with the HST SM connector plugs, P107 and P108 that are at the end of the HST harnesses.
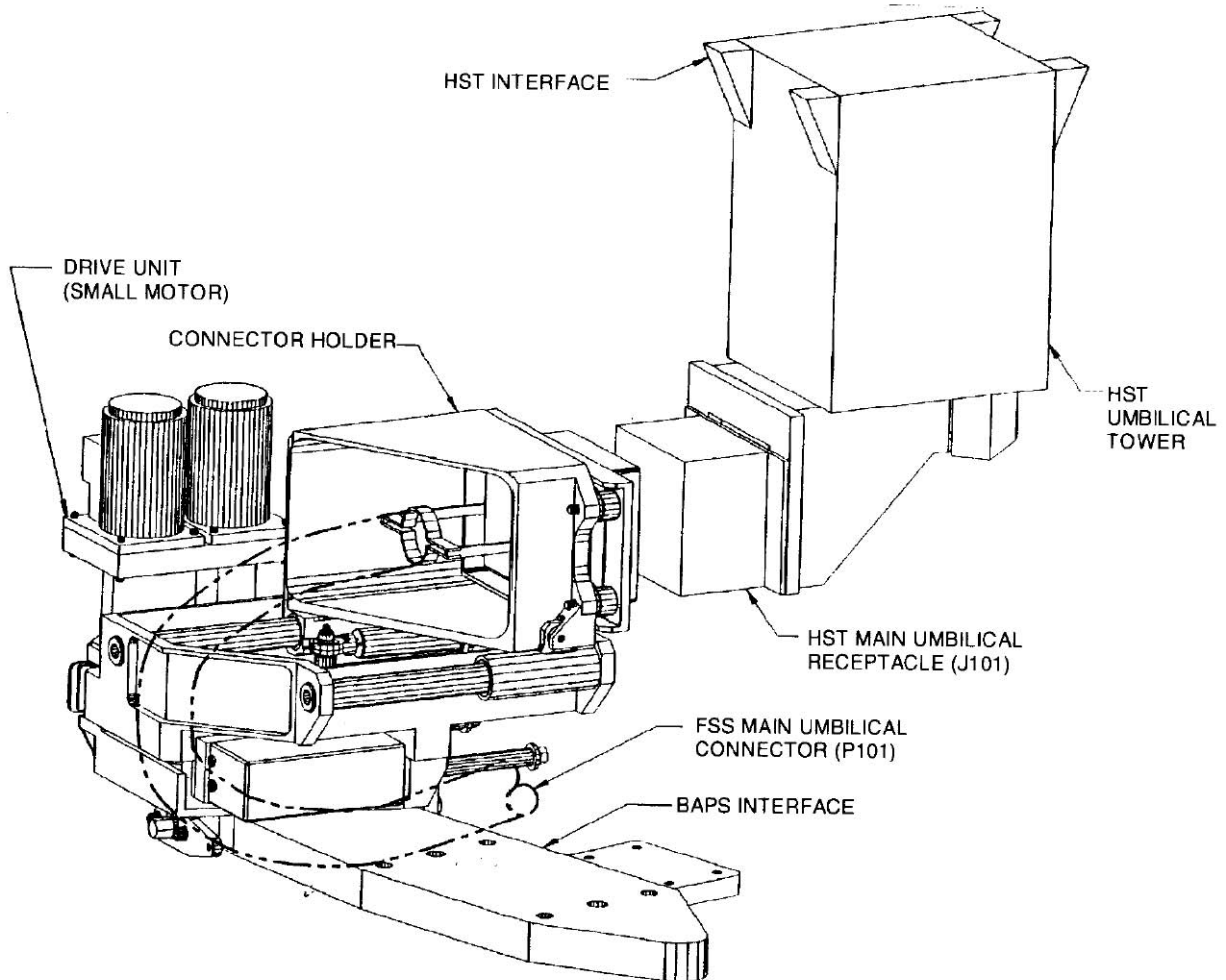
Figure 2-6. Main umbilical

Note: This is in the process of being modified due to the design.

Verify that this is the correct version before use

CARRIAGE SLIDE ASSEMBLY

CONNECTOR FRAME

SLIDE RAILS

DRIVE UNIT

OVERRIDE INTERFACE
ADAPTER

7/16 in HEX
PRIMARY EVA OVERRIDE

#10 ALLEN SCREW
SECONDARY EVA OVERRIDE
(CAPTURED)

SCREW RETAINER
PLATE SUBASSEMBLY

TETHER HOLE
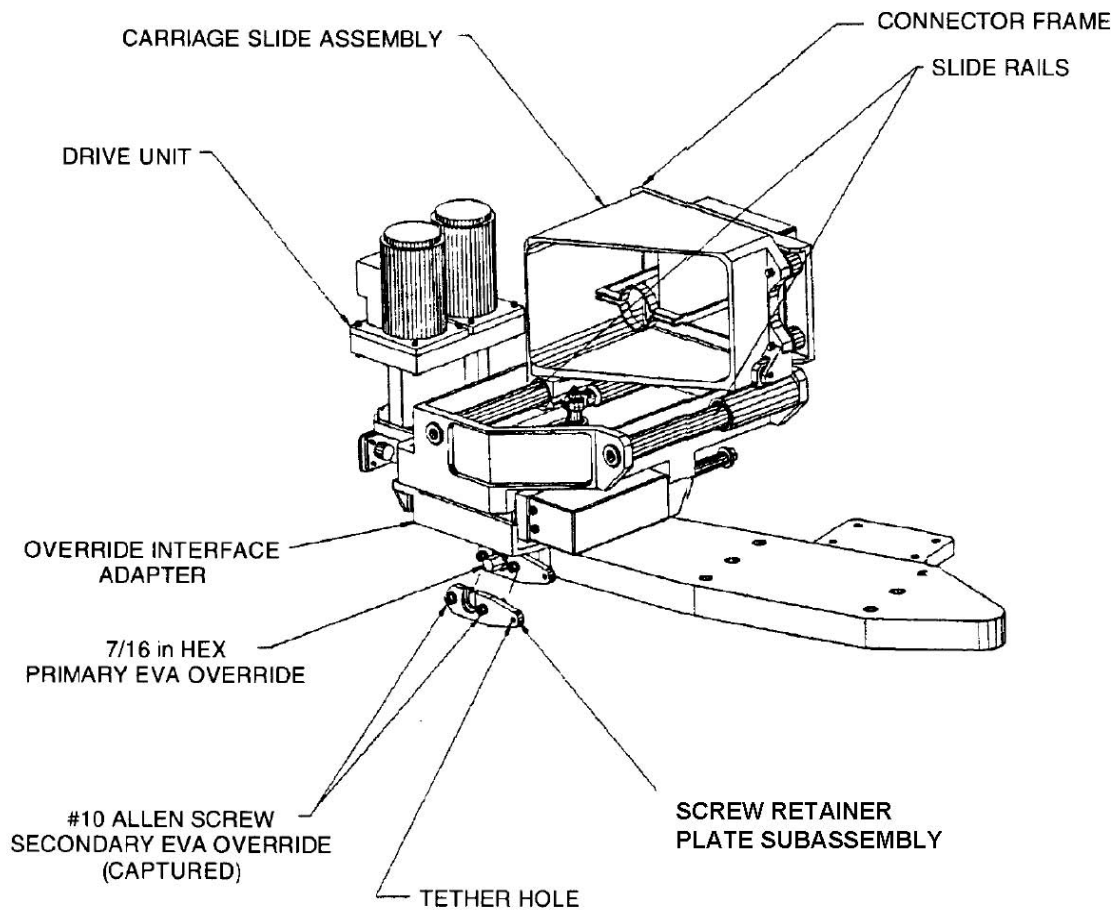
Figure 2-7. Main umbilical EVA override

Verify that this is the correct version before use

The HST connector plugs are positioned on the HST Aft Bulkhead and are tethered to the HST Umbilical Retract Mechanism (URM). FSS-HST mating steps are as follows:

1. When the URM is in the "free" position, the couplings can be demated and the connectors pulled out of their HST cradles approximately 12 inches.

2. The HST P107/J107 coupling is demated and connector P107 mated to FSS Umbilical connector J107.

3. The HST P108/J108 coupling is demated and connector P108 mated to FSS Umbilical connector J108.

The UDM is operated from the AFD to disconnect the HST connector plugs from the FSS umbilical connector receptacles. The HST-mounted EURM houses a spring-loaded lanyard that is attached to the HST connectors. This mechanism is automatically actuated once the FSS CDM disengages the P107/J107, P108/J108 connections. The HST lanyard retracts the HST SM connectors and holds them in the cradle of the retract mechanism, providing a pulling force of 6.0 - 8.0 lb., to ensure proper clearance for HST release.

UDM EVA Override

The UDM override releases the connectors from the UDM umbilical interface by first disengaging the mechanism from the CDU then manually driving the release mechanism. The CDU is disengaged by manually turning the umbilical's "Drive Disengage" hex stud then turning the umbilical's release hex-stud (standard EVA hex head) counter-clockwise with a standard ratchet and a 7/16 inch socket. By turning the release hex-stud, the UDM receptacle connector plate rises; lifting the split-shell HST connector plugs (P107 and P108) until they are free of the FSS UDM. The HST URM then pulls the freed connector plugs away from the UDM and returns them to the HST URM cradle. The wing-tabbed connectors can also be manually removed by an EVA crewmember.

BAPS Rotator

The BAPS Rotator is a mechanism that rotates the BAPS platform (with or without the HST) about its centerline over a range of +/- 175° (there is a 10° exclusion zone, protected by hard stops). Rotation without the HST and Payload Bay Doors (PLBD) open can be carried out at any pivot position between 0 (vertical) and 90 (horizontal) degrees. The rotator mechanism is located on the perimeter of the outer BAPS ring (see Figure 2-8).

The BAPS platform has a rotating inner ring that supports the HST, the berthing latches, the umbilical mechanisms, and a CCTV. The inner ring is connected to the fixed outer ring by a ring bearing. The inner ring extends beyond the fixed ring with machined gear teeth. The rotator motor pinion, through an idler gear, mates with and rotates the inner ring. A dual torque CDU that can rotate the inner ring 180 degrees in about

Verify that this is the correct version before use

763 seconds (12.7 minutes) drives the rotator. AFD monitors are provided to indicate latched (clockwise) or released (counter clockwise) positions for the Rotator Assembly.

BAPS Rotator EVA Override

In the event of a CDU failure, the Rotator can be disengaged from the idler gear, and the idler gear can be manually rotated to move the ring. Manual rotation at the tool interface is 10 degrees per second. This slow movement of the rotator with the HST berthed allows the crewmember to stop rotation using a manual tool. The override is illustrated in Figure 2-8.

Note: The rotator override wedge has been modified.

Verify that this is the correct version before use

LARGE RING GEAR

IDLER GEAR ASSY
/EVA DRIVE GEAR

TURNTABLE

WEDGE

PIVOT BOLT

ROTATOR GEAR
CLUSTER HOUSING

GEAR SHIELD (OUTLINE)

ROTATOR DRIVE
GEAR

ROTATOR DUAL TORQUE
DRIVE UNIT
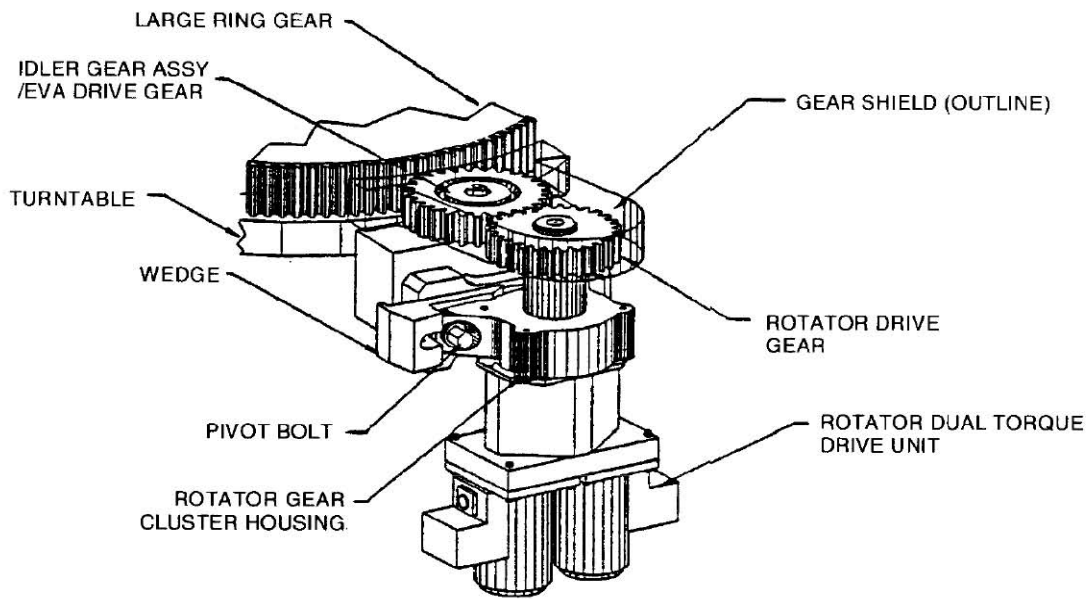
ROTATOR PRIMARY DRIVE CONFIGURATION

LARGE RING GEAR

IDLER GEAR ASSY
/EVA DRIVE GEAR

TURNTABLE

ROTATOR ASSY
DISENGAGE DIRECTION

WEDGE DIRECTION

WEDGE

PIVOT BOLT

ROTATOR GEAR
CLUSTER HOUSING

GEAR SHIELD
(OUTLINE)

ROTATOR DRIVE
GEAR

ROTATOR DUAL
TORQUE
DRIVE UNIT
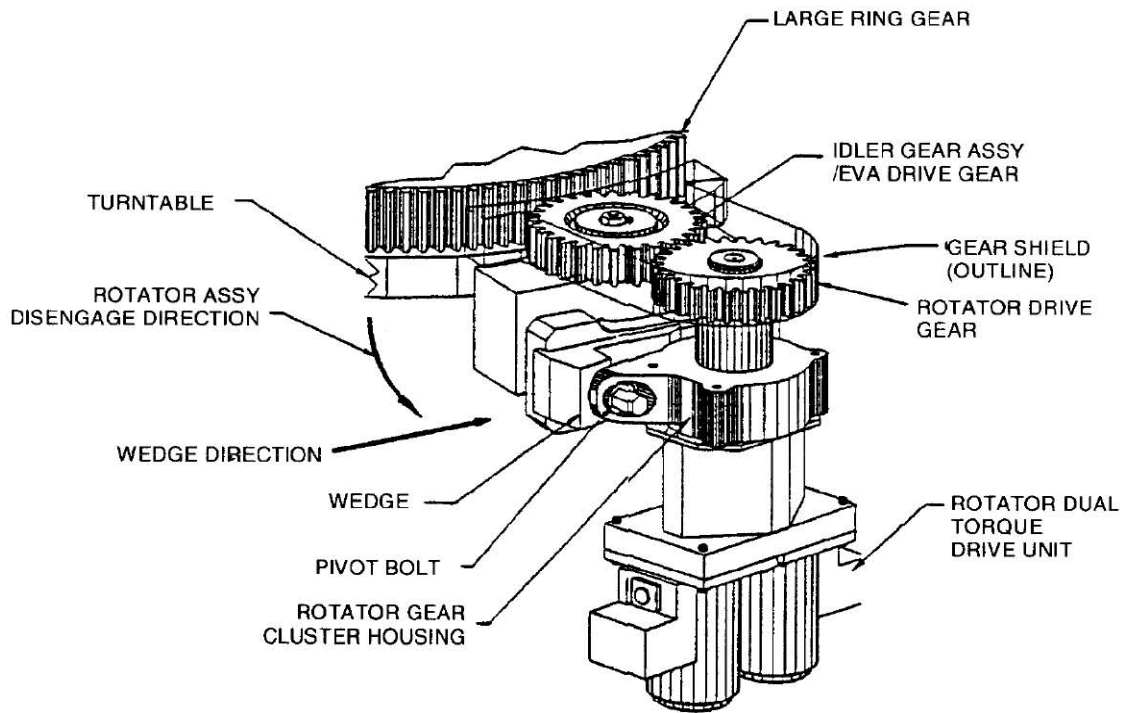
ROTATOR PRIMARY EVA OVERRIDE DISENGAGED

Figure 2-8. The BAPS rotator

2-20

Verify that this is the correct version before use
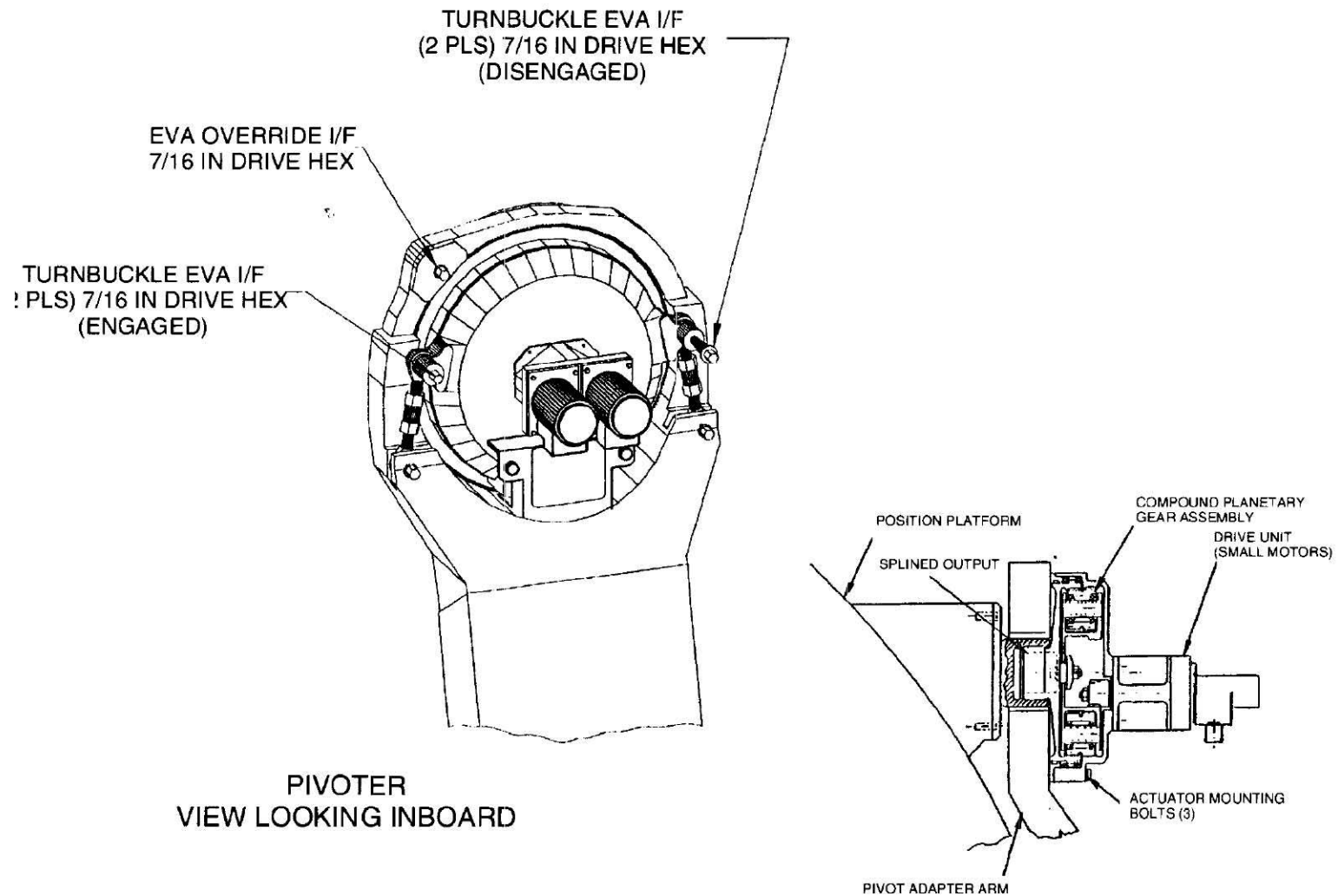
Figure 2-9. The BAPS pivoter

Verify that this is the correct version before use

BAPS Pivoter

The Pivoter (Figure 2-9) positions the BAPS platform to any position about the Y-axis between 0° (vertical) and 90° (horizontal) with respect to the FSS x-axis. It is used to position the BAPS for HST berthing and to position the BAPS/HST complement for on-orbit servicing as required. Once the BSP is installed it can be pivoted down to 43.8° (BSP fully retracted) for landing. For any reboost operations, the BSP must be installed. For a PRC reboost, the BSP must be rigidized either at 43.8° or at 90°.

The Pivoter is located at approximately 10 o'clock on the BAPS ring (stow position). It mates to a Cradle adapter and a translator mechanism, forming one of the two hinge points that tie the BAPS to the Cradle.

The Pivoter is driven by a Dual torque CDU through a compound planetary gearbox to provide the following capabilities:

a. Output torque to the pivot shaft (81,000 in-lb) to move the HST.

b. Brake torque to the pivot shaft (133,000 in-lb) to react to the loads induced by firing the orbiter primary reaction control thrusters with the HST in a vertical (berthed) position.

The Pivoter moves the BAPS platform from the vertical to horizontal position in approximately 27 minutes. AFD monitors are provided to indicate latched (deployed) or released (retracted) positions for the Pivoter Assembly.

Pivoter EVA Override

In the event of a CDU failure or orbiter dual AC failure, the Pivoter provides one override. If the Pivoter override is required, the EVA-installed BSP is designed to provide stability for the BAPS.

The override can be used when the HST is not attached for an empty BAPS; the EVA crew applying a load through the EVA override pinion gear must control the positioning operation. The orbiter must be in free drift for all override functions in order to preclude the application of external loads.

BAPS Support Post (BSP)

The BSP (Figure 2-10 and Figure 2-11) is installed on the FSS. It stabilizes the BAPS ring providing a supplementary stiff load path for the pivoter. During nominal operations, the BSP is installed between the latch beam and BAPS ring. The post follows the pivoter up and down until the pivoter reaches the post's hard stops. A passive latch mechanism will automatically engage when the post fully retracts to its lower hard stop (43.8°). After such a passive latching, the post can extend when the crew commands the BSP latch to release, or actuates the BSP EVA Handle to release the mechanism.

Verify that this is the correct version before use

Nominal Servicing Mission pivot angles are kept well short of 43.8° which would be needed to fully retract the post, pivot angles are around 75 degrees or higher during all nominal operations when a pivot is required. Three telemetry points (Latched, Released, and Latch Assist) indicate the post is fully retracted and the latch is engaged and ready to take loads. Three other telemetry points (Engage, Disengage, and Retract) indicate the post position in reference to the passive breech lock mechanism.

Since the post is significantly stiffer than the pivoter, the post is now the primary load path through the FSS and the natural frequency of the HST berthed to BAPS system is thus separated from the solar array natural frequency.

BSP Overview

The BSP is a two piece telescoping tube that provides a rigid support for the BAPS ring. The BSP can telescope to any length between the fully retracted (66.30 in) and fully extended (119.30 in) positions. The post is rigidized by inserting pip pins into holes in the inner and outer tubes that only line up at the fully extended or retracted positions. In addition, there is a breech-lock mechanism that secures the post in the fully collapsed position. The BSP is attached to the FSS and BAPS ring with an EVA-pinned-clevis at each end of the post.

Telescoping Mechanism

The BSP can telescope between its fully retracted, (66.30 in) and extended (119.30 in) lengths by simply pulling or pushing the BSP ends. The inner tube slides on two "bushings". The first is located at the top of the outer tube and consists of a close fit A286 CRES bore through which the Tufram coated aluminum inner tube slides. The lower bushing consists of three discrete slides that interface with the lower fitting. The inner tube rides on 3 Vespel slides; each spaced at 120° increments about the tube. Two shoes are 0.5 wide by 1.75 long. The third slide is actually a 54.8-inch long, roughly square cross section anodized aluminum key that extends the entire length of the outer tube. The key is attached to the outer tube's inside diameter and aligned along the tubes long axis. A Vespel guide slides along the key as the post is extended.

Breech Lock Mechanism

The BSP was modified to automatically latch and remotely (no EVA) release after the post was installed between the BAPS ring and FSS latch beam. The breech lock mechanism will secure the post only in the fully retracted position.

Latching

The 8-breech lock mechanism tabs slip under the corresponding hooks to secure the post in the fully collapsed position. The hooks have lead-in chamfers that guide the tabs into the slot. The tabs are spring loaded into the undercut "throat" of the hook. As the post retracts, the tabs ride down the chamfer; the preload springs are stretched. Once the tabs clear the undercut, the springs rotate the tabs under the hooks that

2-23

Verify that this is the correct version before use

prevent the post from extending. The CDU and actuator lever are not required for latching. The actuator lever has a wide slot cut in the end which allows the tab to rotate throughout its full range of motion without contacting the lever as long as the CDU is stopped in its central "ready to latch" position. This position is controlled by microswitches.

Unlatching

The CDU is rotated clockwise to release the latch. The actuation lever engages one of the eight tabs and rotates the tab disk against the preload spring force. Microswitches stop the CDU when the tabs are clear of the hook undercut. Hard stops prevent CDU over travel.

The CDU does not automatically reset to the ready to latch position. The crew must select the BSP and drive the CDU to the "latched" position. If the crew forgets this step, the post will close but not latch. The BSP will not be damaged by this action and will automatically relatch when the CDU is commanded "latched" and shut off normally with the end of travel microswitch.
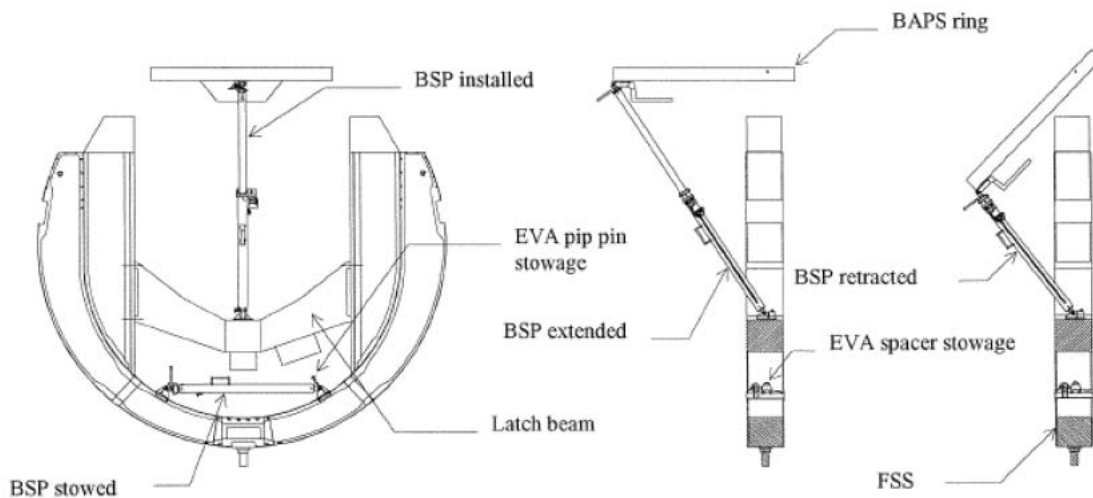
Figure 2-10. The BAPS support post functional illustration

Verify that this is the correct version before use

EVA OVERRIDE HANDLE

UPPER CLEVIS

EVA OVERRIDE PIP-PIN

BREECH LOCK TABS (8)

BREECH LOCK HOOK

ACTUATOR LEVER

66.30 IN COLLAPSED
119.30 IN EXTENDED

CDU MOTOR

OUTER TUBE
CONNECTOR BRACKET

INNER TUBE

EVA OVERRIDE SPACER

CDU MOTOR

KEYWAY

RADIAL PRELOAD

INNER TUBE LOWER FITTING

2X SPRING LOADED SHOE APPROX. 1.75" LONG

FIXED 54.8" KEYWAY

FITTING SLIDES IN OUTER TUBE

LOWER CLEVIS

Figure 2-11. The BAPS support post expanded view

2-25

Verify that this is the correct version before use

Latch Assist

The CDU can assist the preload springs to overcome any unexpected friction by engaging the latch assist override. The "latched" microswitch shuts off the CDU approximately half way between the hard stops. If this switch is overridden, the CDU can drive to the counterclockwise hard stop. The right hand finger of the actuator tab will physically push the tab into the hook undercut until the actuator hits the hard stop. The post must be fully retracted before latch assist can be used.

BSP Telemetry

There are 5 redundant telemetry points used on the BSP, which fall into two categories, BSP position and CDU control. See Table 2-4, Telemetry Points, Table 2-5, Telemetry States vs. Post Configuration, and Table 2-6, Alternate Telemetry Points.

BSP Position

The BSP uses three redundant sets of switches to positively indicate the position of the load bearing latch parts. Figure 2-12 (from the top assembly drawing) shows the two switches that directly indicate the rotational position of the tab disk. This switch pair is repeated on the opposite side of the post for redundancy.

CDU Control

The CDU angular position is controlled by two sets of redundant switches shown in Figure 2-12 (from the top assembly drawing). The redundant switches are located directly under the switches shown in the view.

Table 2-4. Telemetry points

Telemetry point name	Indicated item	Actual indication
Released	CDU position	Indicates that the CDU mounted actuator lever has rotated clockwise (almost) to the hardstop
Set	CDU position	Indicates that the CDU mounted actuator lever has rotated more than halfway to the counter-clockwise hardstop
Latch Assist	CDU position	Indicates that the CDU mounted actuator lever has rotated to the counter-clockwise hardstop
Engaged	Breech disk	Indicates the breech tab has rotated under the hooks and the latch can take load
Disengaged	Breech disk	Indicates the breech tab has rotated from under the hooks and the post can be extended
Retracted	Breech disk	Indicates the post is fully retracted and "Latch Assist" can be used

Verify that this is the correct version before use

Table 2-5. Telemetry states vs. post configuration

Configuration	BSP A6U		BSP MEDS		
	Latch	**Released**	**Engaged**	**Disengaged**	**Retracted**
Not-retracted	X				
Retracted	X		X		X
Retracted, breech stuck	X				X
Ready to drive up		X		X	X
Hook clear of breech		X			
Breech not engaged, latch assist required	X				X

Table 2-6. Alternate telemetry points

Failed telemetry Point	Alternate telemetry Point	Comments
Set	Released & Latched	The post cannot be retracted if the actuator lever blocks the hooks. To ensure this does not happen, the post must be "released" or at the "released" hard stop. The post can fully retract in the "release" position, however, the breech will not engage. Driving to latch assist will allow the breech to engage. Make sure the post is fully retracted prior to engaging latch assist
Released	Disengaged	Post must be fully retracted to obtain the "released" indication
Engaged	Latched & Released & Retracted	Latch assist required for simultaneous latch and released indication. Make sure post is all the way retracted prior to engaging latch assist
Disengaged	Released	The released indication will only indicate if the actuator finger travels far enough to move the tab past the hooks
Retracted	Engaged	The breech will automatically engage when fully retracted

Verify that this is the correct version before use

EVA Overrides

The BSP EVA overrides allow a crewman to manually secure the post in the fully extended or collapsed position and manually release the breech lock mechanism regardless of the CDU position.

PIP-Pin Overrides

The BSP was originally designed as a two piece telescoping post that was fully extended or retracted manually then secured with two pip pins. This feature was retained when the BSP breech lock mechanism was added. The stowage bracket for the two pip pins is located on the BSP just beneath the CDU.

Breech Lock Overrides

The breech lock mechanism is normally held in the engaged position (tab disk fully CW) by two preloaded springs. The EVA override handle is normally pinned to the upper clevis that is free to rotate about the post centerline. When the post is not pinned at both ends, rotating the handle CCW will rotate the tab disk and upper clevis CCW that releases the latch. When the clevises are both pinned and cannot rotate relative to each other, the EVA override pip pin is removed to decouple the EVA handle from the upper clevis, enabling the EVA handle to override the lock mechanism springs. A second hole-set allows the EVA handle to be pinned in this sprung-open position.

EVA Override Spacer

In latch assist mode, the CDU actuator lever physically pushes the disk tab into the hook undercut and holds it there with the CDU brakes. The CDU cannot be forced against its brakes by using the EVA override handle.

Verify that this is the correct version before use
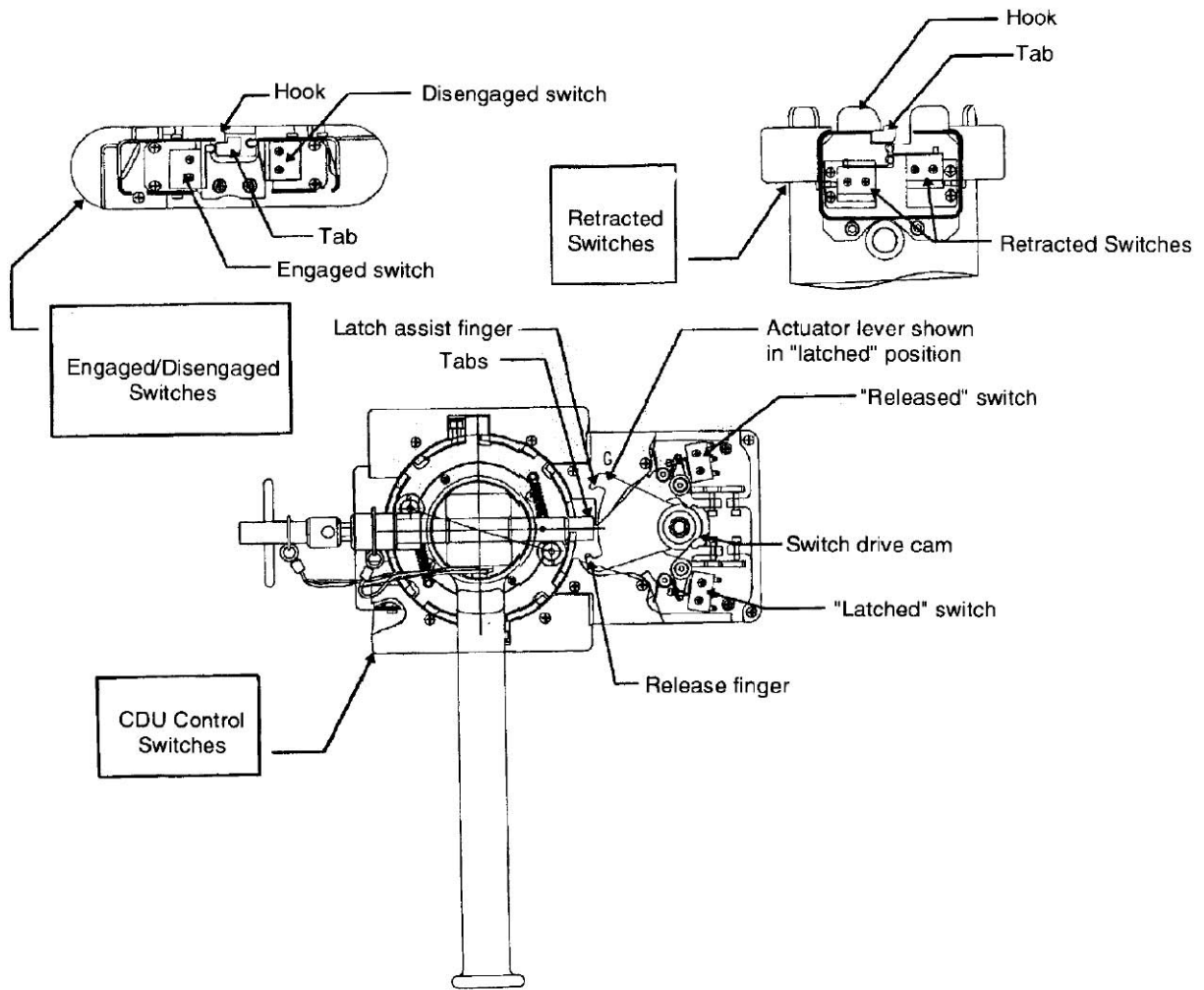
Figure 2-12. BSP latching details

Verify that this is the correct version before use

BAPS Launch/Landing Down Lock Mechanism

The Launch/Landing Down Lock Mechanism secures the BAPS to the FSS Cradle structure to prevent the Pivoter Mechanism from carrying BAPS inertial loads during lift-off. The mechanism is located on the starboard arm of the Cradle, attaching to the Cradle with an intermediate adapter. It mates with a trunnion on the BAPS outer ring at about 7 o'clock (viewer facing aft). The engaged Launch Lock is shown in Figure 2-13. Although not safety critical for landing, the launch lock is nominally re-engaged in orbit prior to landing unless the BSP is installed for landing, in which case the BAPS is out-of-plane relative to the launch lock.

Note: Contingency return of the SCM before installation onto HST requires the downlock to be engaged for landing if the BSP has not been installed.

BAPS Launch/Landing Lock (Downlock) Mechanism EVA Override

In the event of a Launch/Landing Lock CDU failure to unlock, the EVA override procedure pictured is performed (see Figure 2-14). Once the EVA override is operated, the lock is no longer functional.

Note: The Pivoter gear train is capable of withstanding the BAPS inertial landing loads, so the mechanism is not required for orbiter landing. In the contingency case in which the Soft Capture Mechanism (SCM) returns for landing stowed on the FSS, the Downlock must be engaged if the BAPS Support Post (BSP) is not installed between the PRB and the BAPS ring. Landing of the FSS/SCM combination with the BSP installed requires the BSP latch to be engaged. In case of rapid safing under worst-case conditions, the minimum pivot angles for orbiter door closure and landing are as follows:

Close doors, latches at any position	25°
Landing, latches at any position	5.5°
Close door, any single latch in front	58.4° (1 latch aligned with BAPS fixed target)
Landing with BSP latched, any single latch in front	43.8° (1 latch aligned with BAPS fixed target)

Verify that this is the correct version before use

END-OF-TRAVEL ASSY

BARREL

S/C TRUNNION

TORQUE LIMITER ASSY

COLLET-ENGAGED

**DRIVE UNIT
(LARGE MOTOR)**
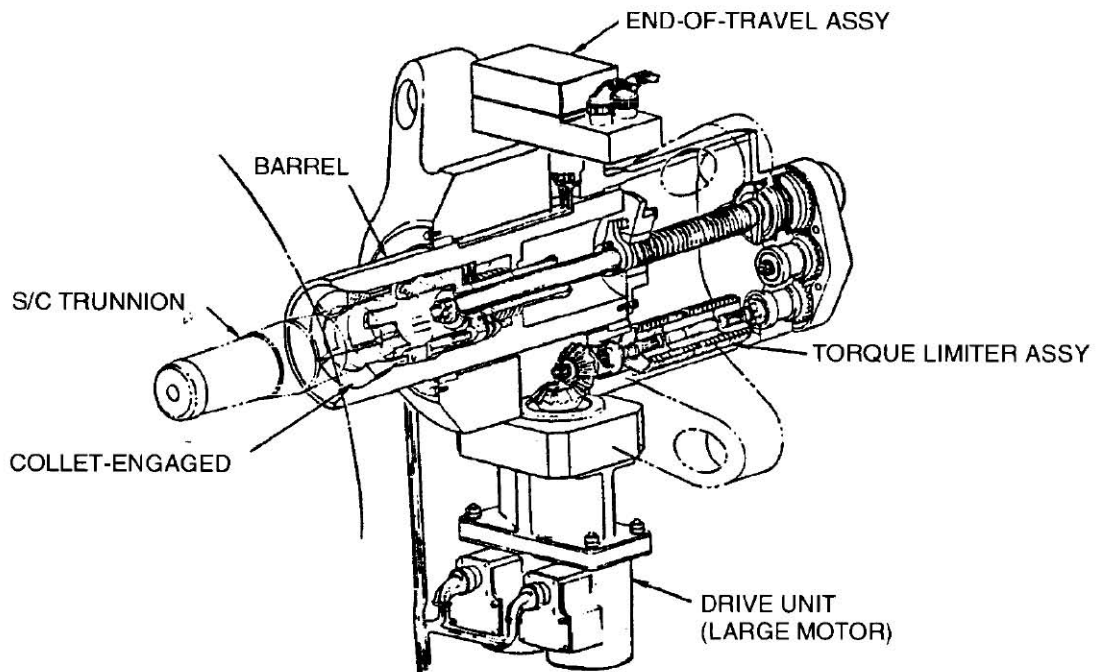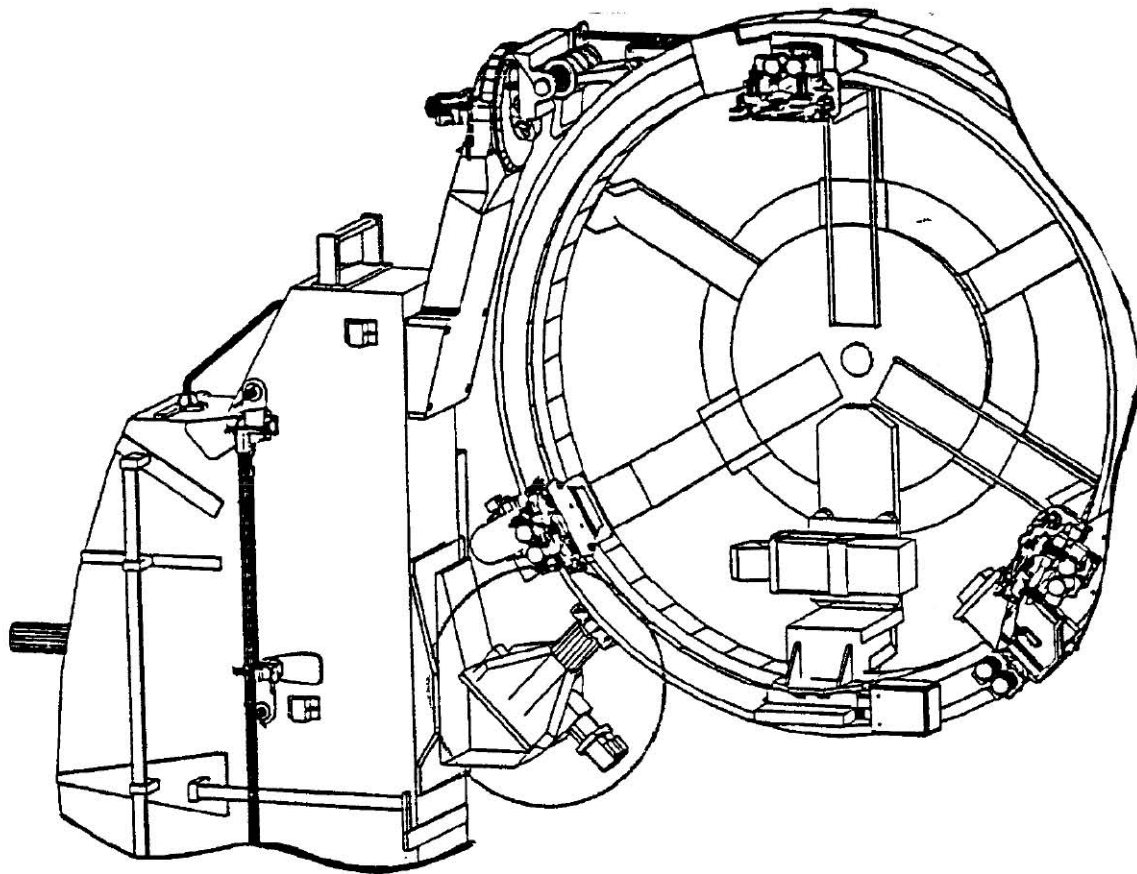
Figure 2-13. The launch lock mechanism (downlock)

2-31

Verify that this is the correct version before use
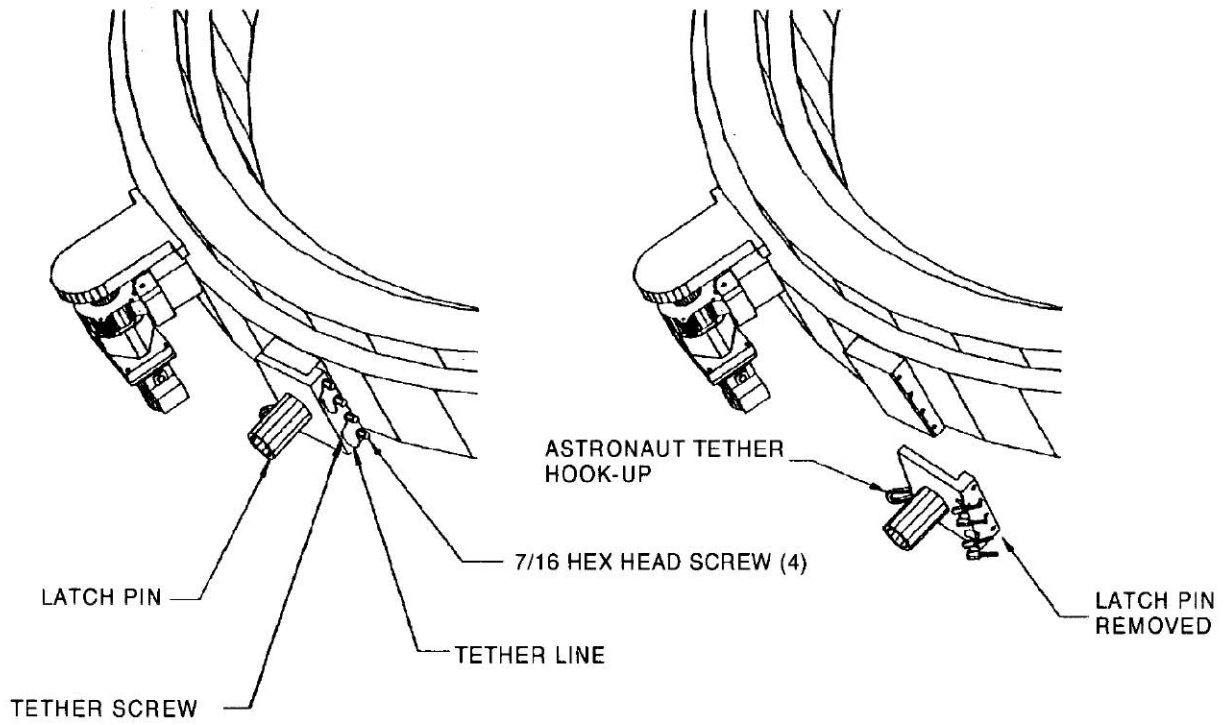
Figure 2-14. Launch lock (downlock) EVA override

Verify that this is the correct version before use

2.2   AVIONICS AND ELECTRICAL SYSTEMS

The FSS avionics and electrical equipment provide all necessary power, hard line command and control, and data monitoring interfaces to electrically support the HST on-orbit servicing mission. The Avionics boxes are located on the Cradle and Latch Beam. Some of the overall capabilities and characteristics of the FSS avionics are as follows:

a. Power Distribution

1. Utilize redundant STS orbiter +28 V dc for internal power, survival heater power, and conversion to HST secondary power.

2. Utilize STS orbiter 115V, 400 Hz AC power for the FSS mechanism CDUs.

b. Command and Control

1. Control and monitor hard-line functions, and interface with the orbiter Data Bus to provide serial commands and telemetry using the orbiter Standard Switch Panels.

2. Operate and control mechanisms, using the MEDS and the A6 Retention Panel.

3. Interface the payload with the orbiter, using the General Purpose Computer (GPC).

The electrical system is designed to meet GSFC PPL and MIL-STD-975 (Standard NASA and military Parts Specifications) for original HST hardware and new hardware is designed to TA-92-038. (See Table 2-7 for Power Allocations.)

Verify that this is the correct version before use
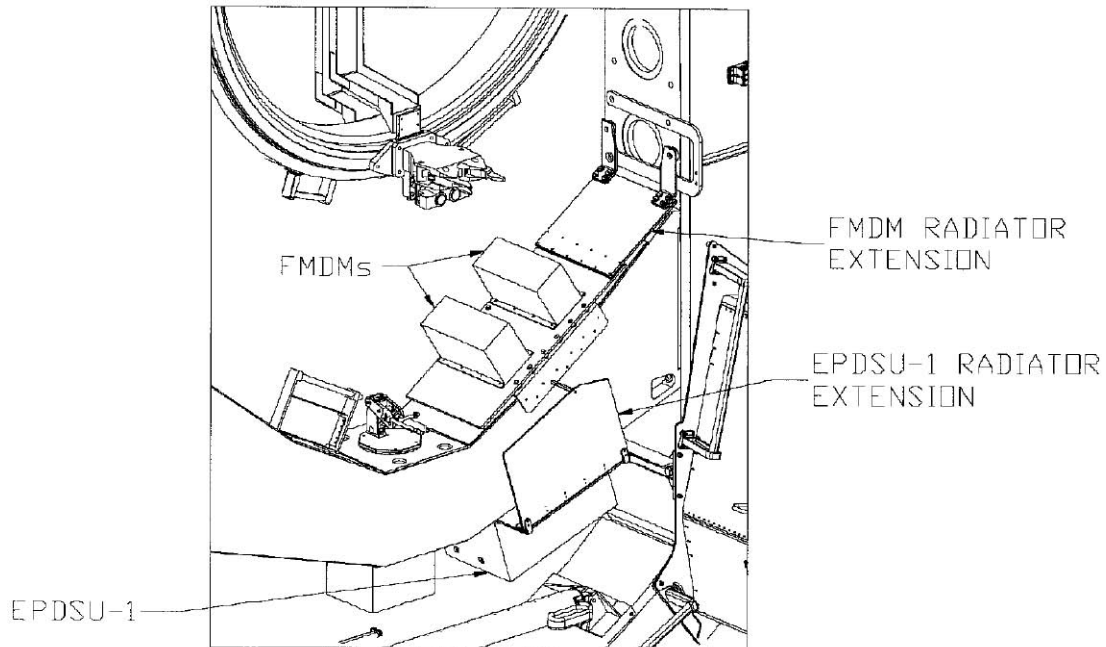
Figure 2-15. FMDM/EPDSU layout

2.2.1   Enhanced Power Distribution and Switching Units (EPDSU 1/2)

The modular EPDSUs are designed specifically for distributing standard orbiter power to smaller SSE subsystems by way of the FSS FMDM-controlled solid-state Power Controller. The EPDSU supplies orbiter +28 V dc power to the FSS. The EPDSU circuits are switched and are distributed to provide heater power to the FSS avionics and electrical equipment.

The specific function of the EPDSU is to distribute controlled, fused power to the systems in the FSS. The EPDSU circuit switches and distributes dc power to the FMDMs, AMSB, CCTV, etc; as shown in Table 2-7 and Table 2-8.

Verify that this is the correct version before use

Table 2-7. FSS EPDSU #1 power allocation

EPDSU MODULE	MODULE RATING	FUSE RATING	LOAD CURRENT @ 32V	SERVICE
MOD 1, S1	20 A	7 A 10 A 5 A 5 A 5 A 5 A 5 A TWO PARALLEL 5A FUSES	3.7 A 6.8 A 0.6 A 2.3 A N/A N/A N/A N/A	FMDM HTR A PWR PPCU HTR A PWR AMSB HTR A PWR EPDSU #1 HTR A PWR (NOT USED) (NOT USED) (NOT USED) (NOT USED)
MOD 1, S2	15 A	7 A	0.9 A	FMDM A PWR
MOD 1, S3	7 A	N/A	0.16 A [1]	AMSB A PWR
MOD 2, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 1 PWR
MOD 2, S2	15 A	5 A	0.7 A	CCTV PWR
MOD 2, S3	7 A	5 A	0.1 A	DPC 1 CNTL
MOD 3, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 2 PWR
MOD 3, S2	15 A	5 A	0.5 A	CCTV HTR PWR
MOD 3, S3	7 A	5 A	0.1 A	DPC 2 CNTL
MOD 4, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 3 PWR
MOD 4, S2	15 A	N/A	N/A	NOT USED
MOD 4, S3	7 A	5 A	0.1 A	DPC 3 CNTL
MOD 5, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 4 PWR
MOD 5, S2	15 A	N/A	N/A	NOT USED
MOD 5, S3	7 A	5 A	0.1 A	DPC 4 CNTL
MOD 6, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 5 PWR
MOD 6, S2	15 A	N/A	N/A	NOT USED
MOD 6, S3	7 A	5 A	0.1 A	DPC 5 CNTL
MOD 7, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 6 PWR
MOD 7, S2	15 A	N/A	N/A	NOT USED
MOD 7, S3	7 A	5 A	0.1 A	DPC 6 CNTL

Verify that this is the correct version before use

Table 2-7. FSS EPDSU #1 power allocation (concluded)

EPDSU MODULE	MODULE RATING	FUSE RATING	LOAD CURRENT @ 32V	SERVICE
MOD 8, S1	15 A	N/A (Fused in ORUC PRJU)	8.9 A	ORUC A-1 PWR
MOD 8, S2	15 A	N/A (Fused in ORUC PRJU)	8.9 A	ORUC A-2 PWR
MOD 8, S3	15 A	N/A (Fused in ORUC PRJU)	8.9 A	ORUC A-3 PWR
MOD 9, S1	15 A	N/A	N/A	NOT USED
MOD 9, S2	15 A	N/A	N/A	NOT USED
MOD 9, S3	15 A	N/A	N/A	NOT USED
MOD 10, S1	20 A	7 A 10 A 5 A 5 A 5 A 5 A 5 A 10 A	3.7 A 6.8 A 0.6 A 2.3 A N/A N/A N/A N/A	FMDM HTR B PWR PPCU HTR B PWR AMSB HTR B PWR EPDSU #1 HTR B PWR (NOT USED) (NOT USED) (NOT USED) (NOT USED)
MOD 10, S2	15 A	7A	N/A	NOT USED
MOD 10, S3	7 A	7A	N/A	NOT USED

1. One mech selected & override selected

2. DPC@32 V input, 86% efficiency, 34.7 V output, 10.5 A load

3. DPC@24.9 V input, 86% efficiency, 34.7 V output, 10.5 A load

Verify that this is the correct version before use

Table 2-8. FSS EPDSU #2 Power Allocation

EPDSU MODULE	MODULE RATING	FUSE RATING	LOAD CURRENT @ 32V	SERVICE
MOD 1, S1	20 A	7 A 10 A 5 A 5 A 5 A 5 A TWO PARALLEL 5A FUSES	1.2 A 6.9 A 2.3 A N/A N/A N/A N/A	IPCU HTR B PWR SPCU HTR A PWR EPDSU #2 HTR B PWR FSIPE HTR B2 PWR (NOT USED) RWA HTR 1 PWR (NOT USED) RWA HTR 2 PWR (NOT USED) ORUC WKLT SKT B PWR (NOT USED)
MOD 1, S2	15 A	7 A	0.9 A	FMDM B PWR
MOD 1, S3	7 A	N/A	0.16 A [1]	AMSB B PWR
MOD 2, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 7 PWR
MOD 2, S2	15 A	5 A	N/A	NOT USED
MOD 2, S3	7 A	5 A	0.1 A	DPC 7 CNTL
MOD 3, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 8 PWR
MOD 3, S2	15 A	5 A	N/A	NOT USED
MOD 3, S3	7 A	5 A	0.1 A	DPC 8 CNTL
MOD 4, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 9 PWR
MOD 4, S2	15 A	N/A	N/A	NOT USED
MOD 4, S3	7 A	5 A	0.1 A	DPC 9 CNTL
MOD 5, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 10 PWR
MOD 5, S2	15 A	N/A	N/A	NOT USED
MOD 5, S3	7 A	5 A	0.1 A	DPC 10 CNTL
MOD 6, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 11 PWR
MOD 6, S2	15 A	N/A	N/A	NOT USED
MOD 6, S3	7 A	5 A	0.1 A	DPC 11 CNTL
MOD 7, S1	20 A	N/A	13.4 A [2], 17.0 A [3]	DPC 12 PWR
MOD 7, S2	15 A	N/A	N/A	NOT USED
MOD 7, S3	7 A	5 A	0.1 A	DPC 12 CNTL

Verify that this is the correct version before use

Table 2-8. FSS EPDSU #2 Power Allocation (concluded)

EPDSU MODULE	MODULE RATING	FUSE RATING	LOAD CURRENT @ 32V	SERVICE
MOD 8, S1	15 A	N/A (Fused in ORUC PRJU)	8.9 A	ORUC B-1 PWR
MOD 8, S2	15 A	N/A (Fused in ORUC PRJU)	8.9 A	ORUC B-2 PWR
MOD 8, S3	15 A	N/A (Fused in ORUC PRJU)	8.9 A	ORUC B-3 PWR
MOD 9, S1	15 A	N/A	N/A	NOT USED
MOD 9, S2	15 A	N/A	N/A	NOT USED
MOD 9, S3	15 A	N/A	N/A	NOT USED
MOD 10, S1	20 A	7 A 10 A 5 A 5 A 5 A 5 A 5 A 10 A	1.2 A 2.7 A N/A 2.3 A N/A N/A N/A N/A	IPCU A HTR PWR SPCU HTR B PWR CEP (NOT USED) EPDSU #2 HTR A PWR FSIPE HTR A2 PWR (NOT USED) RWA HTR 1 PWR (NOT USED) RWA HTR 2 PWR (NOT USED) ORUC WKLT SKT B PWR (NOT USED)
MOD 10, S2	15 A	7A	N/A	NOT USED
MOD 10, S3	7 A	7A	N/A	NOT USED

1. One mech selected & override selected.

2. DPC@32 V input, 85% efficiency, 34.7 V output, 10.5 A max load.

3. DPC@24.9 V input, 86%efficiency, 34.7 V output, 10.5 A load.

Verify that this is the correct version before use
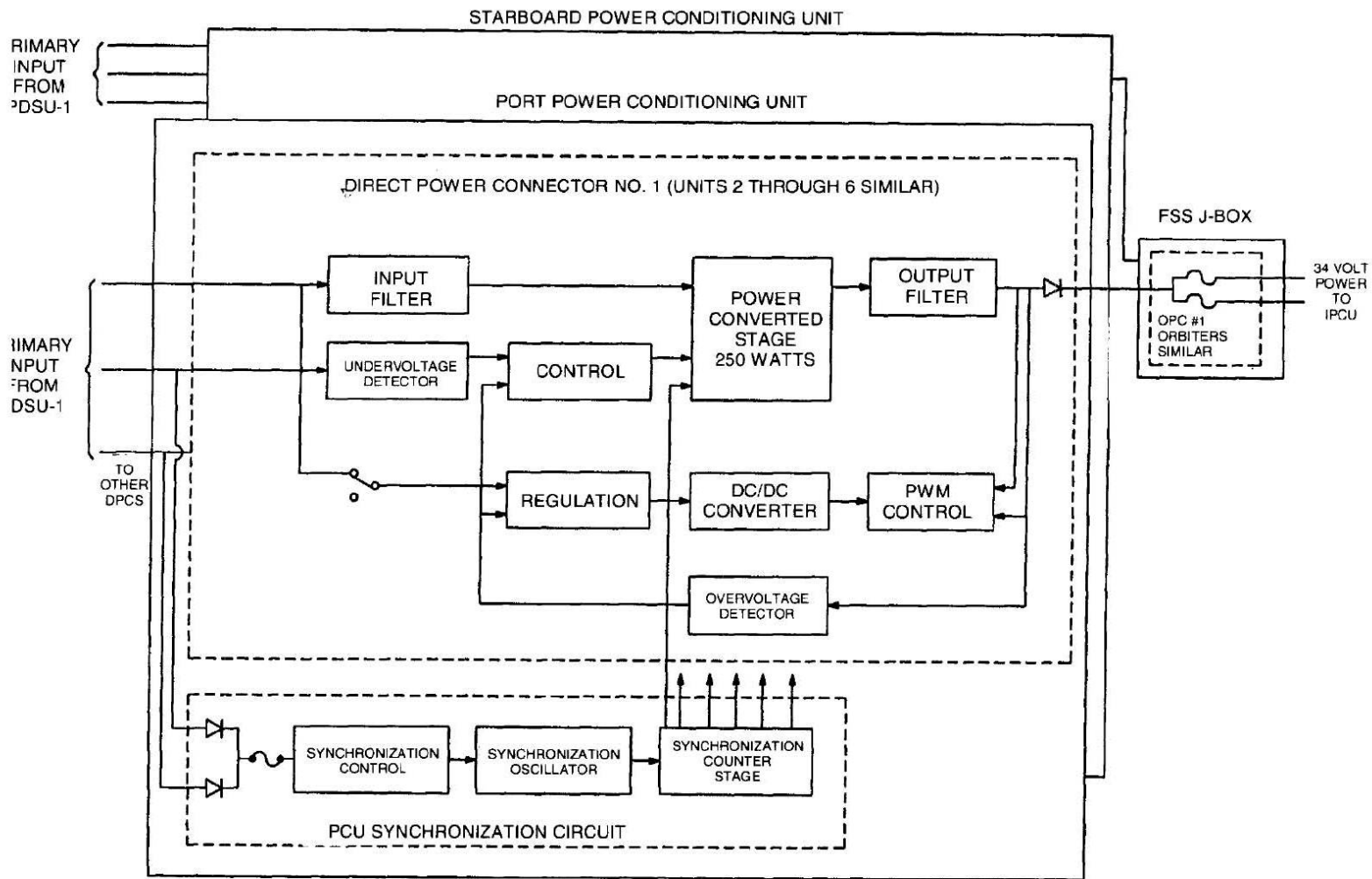
Figure 2-16. Functional diagram of the PCUS and junction box

Verify that this is the correct version before use

The EPDSU is designed to measure the currents of these services and provide the information to both FMDMs. The EPDSUs provide the 15V dc telemetry circuit biasing power. The EPDSU contains a thermistor circuit to monitor temperatures in the avionics and electrical boxes.

Port and Starboard Power Conditioning Units (PPCU & SPCU)

The PPCU and SPCU provide regulated operating power to the HST during on-orbit servicing. They are located on the aft side of the Cradle BAPS support arms. Figure 2-16 is a functional diagram of the PCUs and Junction Box. Each PCU houses six Direct Power Converter (DPC) Units, which are isolated, voltage-regulated, current-limited power supplies. Each DPC is controlled individually by the FMDMs. The current is limited to approximately 11.1 Amps and voltage/power output is set to 34.7 V/350W.

Junction Box (J-Box)

The Junction Box buses the outputs of the 12 DPCs power output and provides the fuse protection for this output. It is located on the Cradle arm, below the SPCU and on a common mounting plate with the EPDSU 2.

There are no active components or telemetry points in the J-Box.

Interface Power Control Unit (IPCU)

The IPCU distributes the regulated DPC power to the HST through the FSS umbilical. The HST Main and essential buses use the power. The IPCU is located on the aft side of the port Cradle arm (below the PPCU).

IPCU control is through the orbiter AFD Standard Switch Panel or the EVA HST Astronaut Control Panel. Discrete monitors are provided to verify operation and telemetry.

Advanced Mechanism Selection Box (AMSB)

The AMSB provides the primary method to select FSS mechanisms (CDUs) for operation. It is operated/controlled by the A6 panel and the SM GPC and is located under the latch beam. The AMSB functionally provides a Line Replaceable Unit (LRU) capability for the previously utilized MSB but uniquely adds the AC current sensor and tachometer capabilities. The FSS is backward compatible for utilizing the MSB.

The AMSB contains latching relays used to select each of the 10 FSS mechanisms are to be driven. It controls the two independent CDU motors. Each side is controlled by one of the two Flexible Multiplexer/Demultiplexer (FMDM) units.

Verify that this is the correct version before use

For normal operations, only one side of the AMSB is used. It is possible, however, to drive both motors of a mechanism for contingencies or time-critical situations by selecting the same mechanism with both FMDMs. The FMDM will only provide data on AMSB current for the side that it controls.

The SSE mechanisms are selected via commands from the FMDM. When any remote FSS mechanism is selected, the FMDM first initiates a reset command that causes any previously selected mechanism on that AMSB to be deselected. The FMDM then executes a set command that selects the desired mechanism.

There are beginning-of-travel (BOT) and end-of-travel (EOT) indications for each mechanism that cut off power to the mechanism, displayed on the A6 panel. Each mechanism's A and B side share the BOT/EOT mechanical plunger, but each contains its own microswitch electronics subassembly circuits. Should a mechanical failure occur within the micro switch, it would affect both AMSB A and B sides for the mechanism. If, however, one side of the mechanism (A/B) experiences a failure in its microswitch electronics, the alternate side (B/A) would be unaffected. It is possible for the BOT/EOT limits to be overridden via command from the operating FMDM, if required.

As the pivoter, rotator, or translator move, the AMSB distributes tachometer data to the FMDM's. Both rates of motion and micro-switch position will be displayed in the aft MEDS display.

Flexible Multiplexer/Demultiplexer (FMDM A & B)

The FMDMs provide most of the telemetry data and control functions required to operate the FSS (other control functions are provided by the orbiter Standard Switch Panel). They interface with the orbiter's GPC via Data Bus Couplers on the FSS. Both FMDMs are located on the Cradle Latch Beam, reference Figure 2-2.

The FMDMs receive 28V level or +/- 5V analog signal inputs. FMDMs A &B are designed with redundant wiring, providing identical connection to:

a.   The EPDSUs to control power switching to the FSS and HST subsystems/heaters

b.   The PCUs to monitor the secondary power

c.   The AMSB to control FSS mechanical operation

d.   The IPCU to monitor HST bus voltage

Verify that this is the correct version before use

Electrical Short Circuit Protection/Grounding

The following circuit protection is provided for the FSS:

a. Control Power is protected by 5 amp circuit breakers on the Payload SSP.

b. A 29 Volt PL PRI power source (denoted 28 V-B) to the Payload SSP via EPDSU-2, is protected by a resistor in the EPDSU.

c. AC power is protected by 3-phase, 3 amp circuit breakers on the R1 panel in the orbiter.

d. The FSS structure is grounded to the orbiter via two #0 AWG wires at the Standard Interface Panels (SIP) through the EPDSUs (The FSS is retained in the orbiter cargo bay by two passive trunnion fittings and an active keel fitting).

e. The fittings are isolated from the orbiter structure by design.

f. The FSS power is grounded to the orbiter via the power return (#0 AWG wire).

2.3   THERMAL CONTROL

The FSS has two structure temperature sensors. The avionics also have internal temperature sensors and the temperature of the avionics is actively controlled. FSS structure, mechanism, and SCM temperatures are controlled by orbiter orientation and/or blanketing. The FSS/SCM thermal model indicates that blanketing is not required for the SCM or the FSS Berthing Latches. The thermal design is based on passive control under worst-case hot environmental conditions and minimal heater power during worst-case cold conditions (assuming a HST baseline orbital altitude of 320 nautical miles).

2.3.1   Active Thermal Control System

The FSS active thermal control system is activated from the FSS heater switch on the orbiter Payload SSP. This switch enables power to the heaters on the FMDM radiator plate, the AMSB, EPDSU-1/2, CCTV, IPCU, PPCU and SPCU.

The heaters are sized and equipped with redundant thermostats that maintain the operational temperature range for the hardware. The maximum heater output cannot create a hazardous condition. The thermostats are redundant to both failed-on or failed-off heater conditions. An average heater power of up to 400 Watts is required to maintain the avionics boxes above their minimum temperatures. Constraints on orbit attitude excursion will be implemented to ensure that the FSS structure is not subjected to thermal environments outside acceptable limits. Table 2-9 lists the temperature limits for FSS components. These limits have been documented in both the Payload Hazard Report HST SM4 RHR-21 and the Flight Rules.

Verify that this is the correct version before use

2.3.2 Passive Thermal Control System

The FSS structure is covered with Multi-Layered Insulation (MLI) blankets. Additionally, the cavity between the FSS Cradle and the orbiter bay liner is closed off by an aluminized Kapton shield that attaches to the FSS below the trunnions to prevent direct entrapment of solar flux. The MLI will be removed and in some instances replaced for SM4. All EVA removable MLI design remains the same. New MLI will cover the STIK Enclosure.

The EPDSU-1 mounted under the latch beam has a radiator plate that extends up the forward face of the latch beam to allow cooling of the unit. In addition the mounting plate under the FMDMs has been extended for additional radiation.

The FSS thermal blankets are flight qualified from previous SMs and are made up of aluminized Kapton and Dacron mesh. The Kapton is coated with aluminum no thicker than 700 angstroms per side. The Dacron mesh has a minimum mass of 0.44 ounces per square yard. See Figure 2-17. The MLI blankets are typically grounded by interweaving a 0.5" by 0.001" aluminum strip between the blanket layers at an edge. The blanket and aluminum strip is then compressed together with a brass rivet. A 22 AWG Teflon-insulated wire is soldered to the rivet and then attached to a spacecraft ground. There are two grounds per blanket.

The thermal blankets are attached to the FSS with a rivnut, fiberglass washer, and screw. Where it is not possible to use rivnuts (such as the BAPS), a bonded fiberglass button and snap-ring are used. If it is not possible to use either of these two methods, the blankets are attached using Velcro strips in less than 2 in.[2] segments.

Based on mission level thermal analysis, constraints on orbit attitude excursions will be implemented to ensure that the FSS system is not subjected to thermal environments outside acceptable limits.

FSS component thermal limits are given in Table 2-9.

Table 2-9. FSS/ORUs Component Temperature Limits

	MAX	MIN
FMDM B	60	-13
FMDM A	60	-13
AMSB	61	-32
EPDSUs 1 and 2	60	-30
CCTV	60	-10
PPCU	63	-32

Verify that this is the correct version before use

Table 2-9. FSS/ORUs Component Temperature Limits (concluded)

	MAX	MIN
SPCU	63	-32
IPCU	60	-43
J BOX	60	-32
LARGE CDU	120	-70
SMALL CDU	120	-70
DUAL TORQUE CDU	120	-70
MECHANISMS	70	-70

SSI MLI DESIGN AND ATTACHMENT METHOD
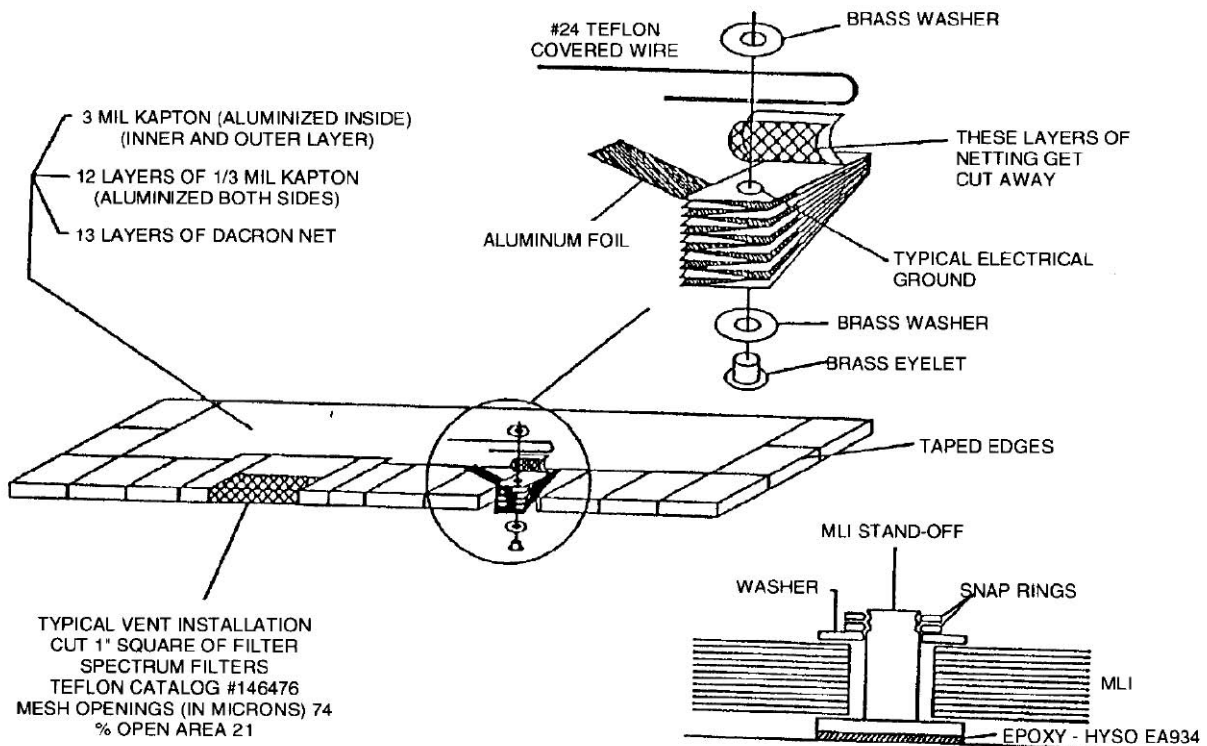
Figure 2-17. MLI blanket assembly (typical for all carriers)

Verify that this is the correct version before use

2.4   SOFT CAPTURE MECHANISM INTERFACES

The Soft Capture Mechanism (SCM) is mounted on the FSS BAPS Ring on attachments at the Berthing Latch Sill Plates.
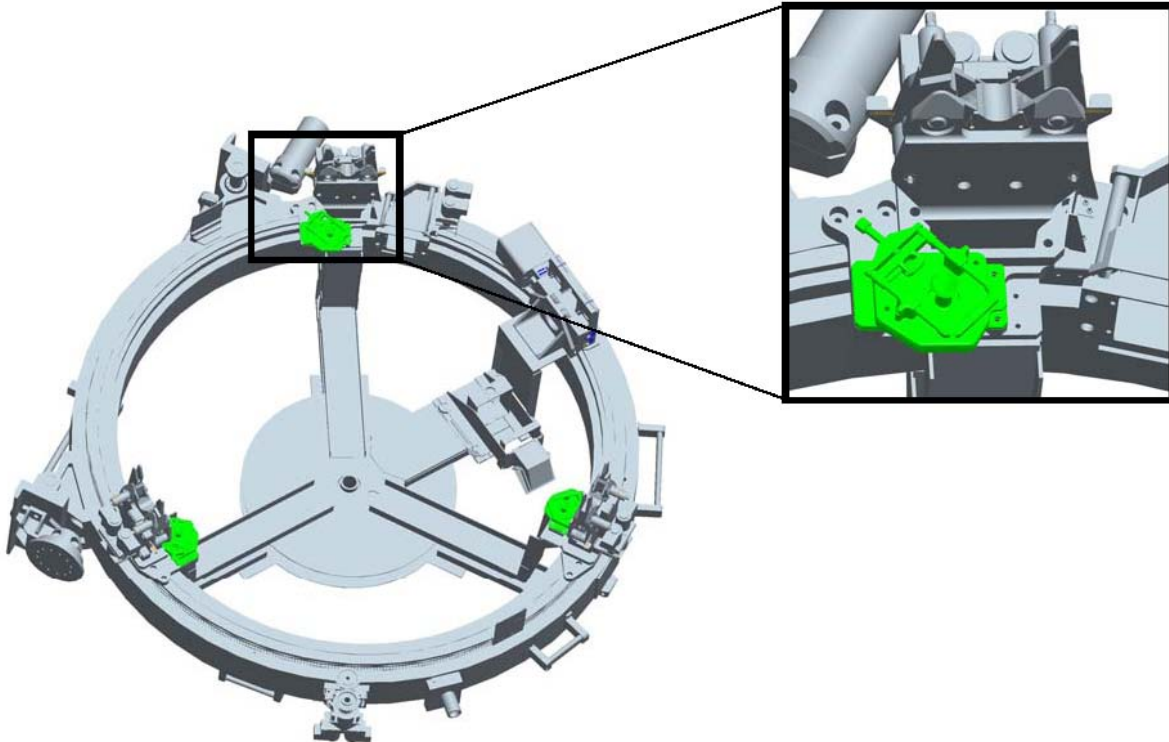
Figure 2-18. SCM interfaces mounted on FSS BAPS ring

The SCM will nominally be deployed attached to the HST. The FSS, without the SCM, will then be set to its nominal landing configuration with the BAPS Support Post (BSP) installed and locked at 43.8 degrees. In the event of contingency return with the SCM, the BSP will be locked. If the BSP is not installed, the BAPS must be fully pivoted down and the Downlock must be engaged for landing.

2.5   FSS UNIQUE EVA CREW AIDS/EQUIPMENT

The FSS for SM4 includes the following EVA crew aids and Equipment:

a.   Handholds/handrails

b.   HST Portable Foot Restraint (PFR)

c.   Portable Foot Restraints sockets

d.   90° Socket Converter Reference Section 4 for further descriptions of the Crew Aids and Tools (CATs)

Verify that this is the correct version before use

2.6   FSS LABELS

Table 2-10 lists the decals that have been applied to the FSS and the quantity of each decal.

Table 2-10. FSS decals

Carrier	Location	Decal text	Qty
FSS	Berthing latch	1	1
FSS	Berthing latch	2	1
FSS	Berthing latch	3	1
FSS	PFR socket upper port	S60	1
FSS	PFR socket mid port	S61	1
FSS	PFR socket center	S62	1
FSS	PFR socket mid starboard	S63	1
FSS	PFR socket upper starboard	S64	1
FSS	PFR socket upper aft	S65	1
FSS	FMDMs	(black or silver strip)	AR
FSS	BAPS rotating target	+V2 (and alignment marks)	1
FSS	BAPS rotating target	-V2 (and alignment marks)	1
FSS	BAPS rotating target	B (and alignment marks)	1
FSS	BAPS rotating target	DF (and alignment marks)	1
FSS	BAPS fixed target	(alignment marks)	1
FSS	Pivoter target	(0° - 90° on circle)	2
FSS	Pivoter target	(rotational pointer)	2
FSS	Pivoter target	(pointer)	2
FSS	Pivoter target	(degree range from 0° - 90°)	2
FSS	Pivoter target	(degree range from 0° - 90°)	2
FSS	UDM	J1	2
FSS	UDM	08	1
FSS	UDM	07	1
FSS	Translator, fwd	(A,C,F, and pointers)	1
FSS	Translator, aft	(A,C,F, and pointers)	1
FSS	Translator	(pointer)	2

Verify that this is the correct version before use

3.0 ORBITAL REPLACEMENT UNIT CARRIER (ORUC) SYSTEM DESCRIPTION

The Orbital Replacement Unit Carrier (ORUC), a reusable structure, provides stowage and environmental protection for the SIs and ORUs during an HST Servicing Mission (see Figure 3-1 and Figure 3-2). For SM4, the ORUC provides a means to transport the Cosmic Origins Spectrograph (COS), the Fine Guidance Sensor 3R (FGS-3R), IMAX 3D Camera, Small ORU Protective Enclosure (SOPE), Large ORU Protective Enclosure (LOPE), Auxiliary Transport Module-1 (ATM-1), ATM-2, Forward Fixture, FGS Handhold, Wide-Field Camera 3 (WFC3) Handhold, RSUs, ECU, ASIPE Safety Bar, Aft Fixture Assembly, and to return COSTAR and FGS-3. Three new enclosures are providing attach locations for the STIS & ACS repair ORUs, these are the Main Electronics Board-Replacement (MEB-R) Cover Enclosure, Fastener Capture Plate (FCP) Enclosure, and the New ORU Protective Enclosure (NOPE).The ORUC structure supports a complement of SSE hardware and assorted crew aids and tools required for HST ORU servicing and change out functions. Its approximate launch weight is 7600 lb. Servicing Mission hardware is designed to carry HST replacement units and to return the replaced units in the suitable transport containers.

The FSS supplies power and electrical interfaces for the ORUC via mission unique harness from Shuttle inventory. Electrical circuits are limited to thermal control and monitoring, and status of SI latches in the SIPEs. The FGS and COS are completely unpowered throughout the Servicing Mission until installation into the HST.

The ORUC consists of the following subsystems/components (Refer to Figure 3-1 and Figure 3-2 below for major items):

a. The Spacelab Pallet (SLP)

b. The Load Isolation System (LIS)

c. The Electrical System, including:

    1. The Power Regulator Junction Unit (PRJU)

    2. Heater circuits

d. The Bolted Interface Scientific Instrument Protective Enclosures (BISIPE), including:

    1. The FGS SIPE (FSIPE), carrying one FGS handhold

    2. The Axial SIPE (ASIPE), carrying the MEB Cover-R Enclosure

e. The Starboard ORU Shelf (SORUS), carrying

    1. SOPE

    2. LOPE

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    3.   Spare pip pin bracket

    4.   Fastener Capture Plate Enclosure

f.   The IMAX Support structure supporting the IMAX-3D Camera & its enclosure

g.   The Aft Fixture

h.   The Forward Fixture, carrying one FGS handhold and one WF/PC handhold

i.   Auxiliary Transport Modules (ATM) 1 & 2

j.   New ORU Protective Enclosure (NOPE)

k.   Multi-Layer Insulation (MLI) Recovery Bags

l.   EVA equipment, including:

    1.   EVA handrails

    2.   Ingress/Translation Aids

    3.   Portable Foot Restraint (PFR) receptacles

    4.   Articulating Socket, PFR Extender

    5.   MLI Repair Tool

m. Large and Small MLI Contingency Blankets

n.   EVA Safety Bar

o.   Thermal Control System

p.   Contamination Control System

The ORUC is primarily reflown hardware, most recently flown on SM3A. Changes from SM3A are briefly listed in Table 3-1.

Verify that this is the correct version before use

Center Translation Aid (TA)

FGS SI Protective
Enclosure (FSIPE)

Small ORU Protective
Enclosure (SOPE)

WFPC
Handhold

Large ORU Protective
Enclosure (LOPE)

EVA Safety Bar

Auxiliary
Transport Module
(ATM-1)
(TSA Tools
Stowage)

Latch Over-
Center Kits
(LOKs)

New Adapter
Plates
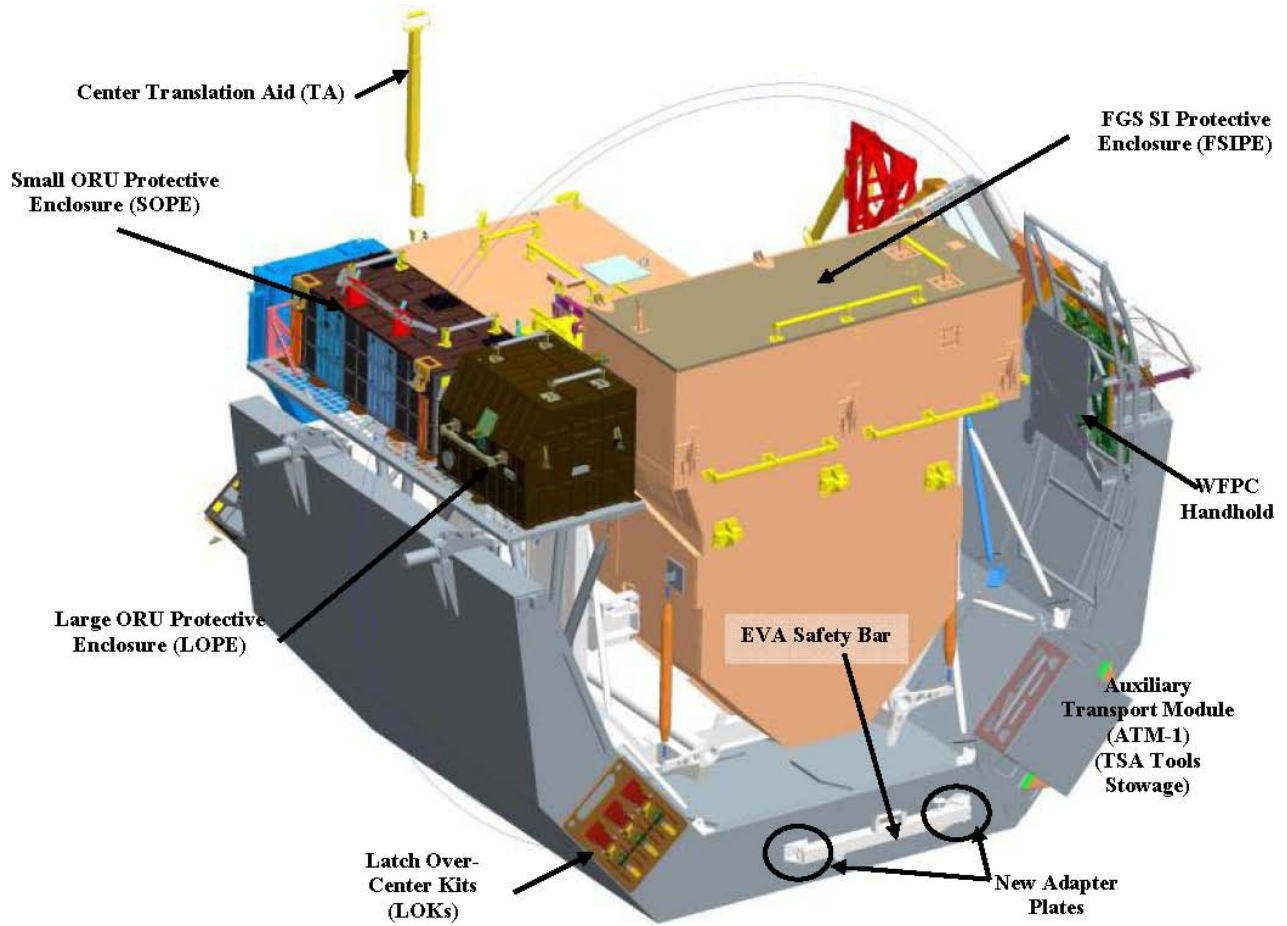
Figure 3-1. ORUC forward view

Verify that this is the correct version before use
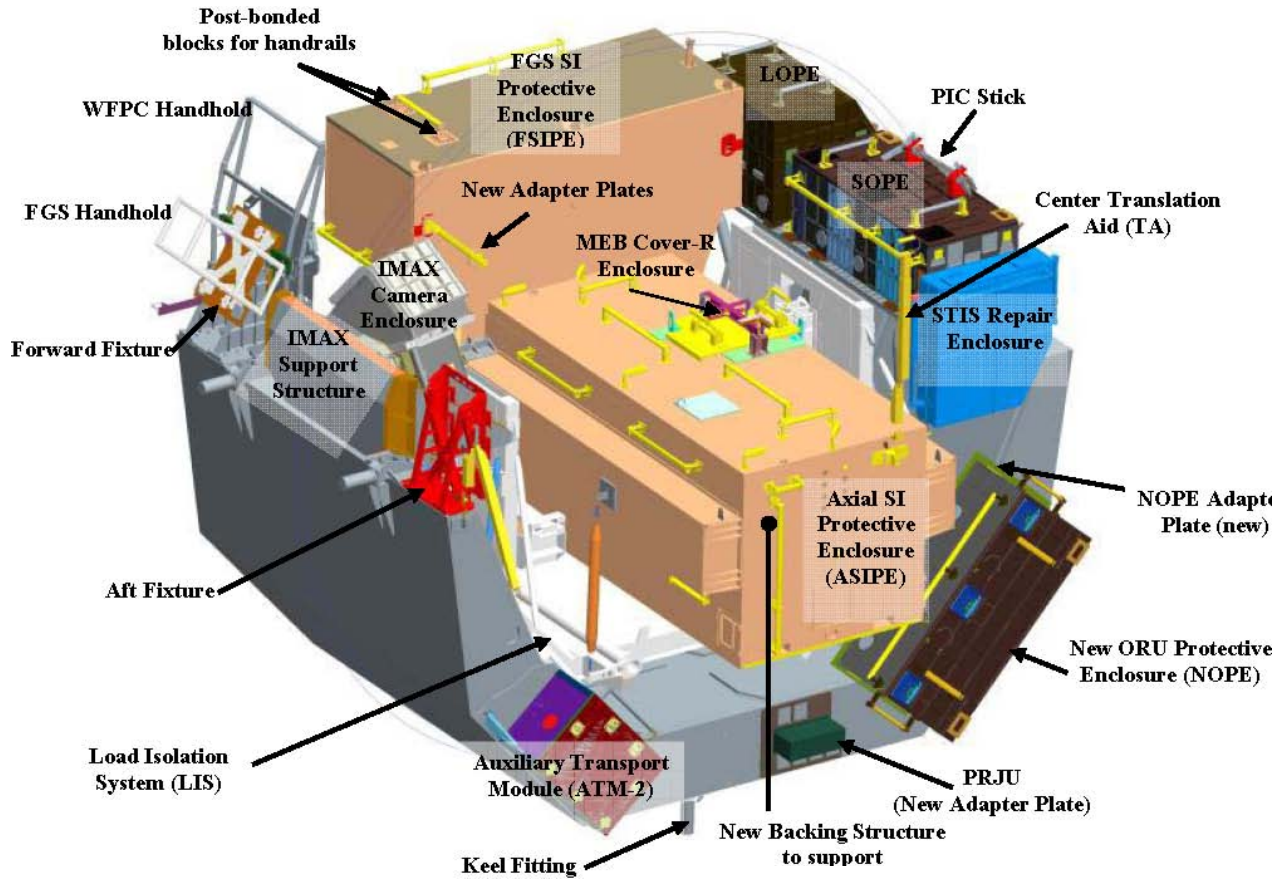
NOPE Adapter Plate (new) Handrail – Interior of ASIPE

Figure 3-2. ORUC aft view

Verify that this is the correct version before use

Table 3-1. ORUC changes for SM-4

Change	Component	Comments
Additions	FGS3 SOPE NOPE COS ATM 2 STIS repair ORUs: MEB & FCP Latch Overcenter Kits (LOKs) MLI Recovery Bags Large & Small MLI Cont. Blankets ICBC3D	Replaces FGS2; launches with integral handhold Contains LVPS-2R (new STIS card), STIS Card Transport Enclosure (CTE, hard), STIS Card Insertion Tool (CIT), RSUs, COSTAR Y-harness restraint tool. SOPE is rotated 180 degrees from SM2 configuration, lid now opens outboard of PLB. Contains ACS repair ORUs With Axial SI Handhold Installed, replaces ASIPE shelf. Contains STIS Card Transport Enclosure (CTE, soft), Tool Disposal Bag (TDB) Returns the Printed Wiring Assembly LVPS No. 2 (original STIS card) within the CTE. ATM2 flew on SM3B (RAC); interior stowage will be modified for SM4. (revisit this at SMEL review 3/1). External pouch added to accommodate Guide Stud Caddy. Located on ASIPE lid (exterior) and ORUC shelf aft end, respectively. Stowed on a plate on the forward face of the pallet, qty 3 Contained in pouch on the upper/port/aft inner pallet panels On starboard inner panels IMAX3D Cargo Bay Camera located port between the 2 carrier trunnions
Mods	LOPE ATM-1 WF/PC Handhold Forward Fixture Assembly Translation Aid	Internal stowage re-configured for SM4. Contains ACS repair items requiring heated stowage. Lid latches redesigned from J-hooks to T-handles. Internal stowage re-configured for SM4. Contains Stowed vertically on Fwd Fixture with 2 captive deploy lock pins, guide blocks and forks. (Rotated 90 degrees from SM1 configuration) Mounting WF/PC handhold on the inboard side and FGS handhold to outboard side (like SM3A). Starboard TA relocated to the aft end of the ASIPE referred to as "Center TA". Port TA remains unchanged
	Spare Pip Pin Bracket	Quantity of Spares adjusted for SM4
	ASIPE Safety Bar	Relocated to Fwd face of pallet (Frame 4)

Verify that this is the correct version before use

Table 3-1. ORUC changes for SM-4 (concluded)

Change	Component	Comments
Deletions	COPE	
	FGS Pick-off Mirror Cover	
	Bi-Stem Braces	
	Fuse Plugs	
	ASLR Kits	

3.1   ORUC STRUCTURAL AND MECHANICAL SYSTEMS

The ORUC structural elements provide launch and landing load isolation for the individual SIs and ORUs. Its structure is sufficiently sound to and has been analyzed for return with one or more SIs or ORUs not installed.

The major structural elements of the ORUC are:

a.   Spacelab Pallet - The basic mounting structure for the ORUC components. It also includes various PFR receptacles and handrails.

b.   Starboard ORU Shelf - An orthogrid base plate for mounting the SOPE and FME.

c.   Aft fixture - Used during instrument change-out operations as a temporary parking fixture.

d.   Forward fixture - Stows the FGS Handhold and the WFPC Handhold which are used during instrument changeout operations.

e.   Load Isolation System (LIS) - Reduces the orbiter loads transmitted to the BISIPE.

f.   Bolted Interface SIPE (BISIPE) - Protects and transports the FGS and COS Scientific Instruments, consisting of the following:

   1.   FSIPE - The FSIPE supports and protects the replacement FGS during launch phases up to just prior to change out. After change-out, it supports and protects the original FGS for the remainder of the mission to landing.

   2.   ASIPE - The ASIPE supports and protects the COS during launch, on orbit prior to change-out. After changeout, it supports and protects the COSTAR for the remainder of the mission through landing.

Verify that this is the correct version before use

3.1.1   Spacelab Pallet Structural and EVA Elements

A Spacelab Pallet provides the basic structure to support the ORUC components and to interface with the orbiter structure. It is composed primarily of a 2024 aluminum frame and 5056 aluminum honeycomb panels and weighs 1450 lb (see Figure 3-3). The Pallet is attached to the orbiter in the Payload Bay by a single keel trunnion and four longeron trunnions. It is designed for the dynamic environment of orbiter ascent/descent, mission thermal extremes, and a vacuum environment. The particular pallet used for SM4 (Serial Number F009) was flown as part of SM1, SM2, and SM3A.

The PFR Ingress/Translation Aids are used for EVA translation between the ORUC and the HST. They may also be used to assist EVA ingress into a PFR at various socket locations during a Failed-RMS contingency. There are two Ingress Aids stowed in PFR Sockets on the aft end of the ORUC. Each Ingress Aid contains three EVA-operable, rotating joints and one extension joint that can be expanded from 38" to 56" in discrete increments. The Ingress Aids are made from aluminum and steel components and are secured to PFR sockets with one PIP pin each. Both PFR Ingress Aids were flown on SM1, SM2, SM3A, and SM3B. The PFRs are compliant with the overnight configuration as they remain within the Payload Bay envelope.
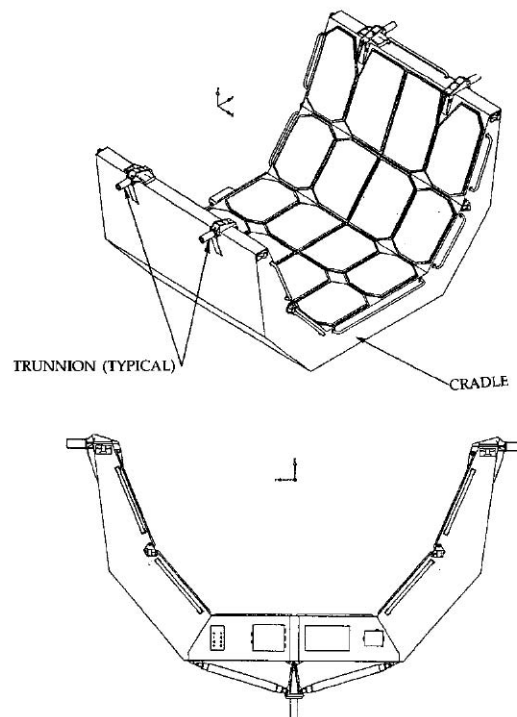
Figure 3-3. The Spacelab pallet

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3.1.2   Load Isolation System (LIS)

The LIS dampens the launch and landing loads for components contained within the BSIPE. The following sections describe the LIS and its components in detail.

LIS Structural Elements

The LIS is composed of the following major elements:

a.   LIS Cradle (2219 aluminum)

b.   Support struts (aluminum 6061-T6 tubes)

c.   Torque tube system (aluminum 6061-T6 tubes)

d.   Y-axis leaf springs (qty 4) (Ti-6Al-4V Titanium)

e.   Z-axis leaf springs (qty 2) (Ti-6Al-4V Titanium)

f.   Trunnions (qty 2) (Inconel 718).

The LIS Cradle forms the supporting structure for the LIS components. The LIS cradle mounts to the Spacelab Pallet at hard point locations with a series of short and long struts. Each strut has a rod end with its shaft or pin lock-wired in place.

Using a system of leaf springs, torque tubes and specialized trunnions, the LIS provided the mounted BISIPE rotation and translation load isolation (with respect to the LIS Cradle) during liftoff and landing.

The LIS weighs 970 lb.

LIS Mechanisms

The LIS mechanisms provide mounting and dynamic isolation for the BISIPE in the Spacelab Pallet.

Mounting

The LIS Cradle (Figure 3-4) is mounted to the Spacelab Pallet through 12 struts, connecting from the cradle to the pallet hard points. The connections to the pallet are considered non-standard, i.e., clevis mounting. The BISIPE mounts to the LIS with two flex trunnions, four y-spring mounts, and four push rods.

Freedom of Movement

The flex trunnions are equipped with roller bearings and a monoball bearing. When seated in the trunnion block, these bearings allow translation in the ±Y-direction (shuttle coordinates) and rotation about the Y-axis (pitch). The flex trunnion blocks are also

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equipped with roller bearings. These bearings permit freedom of movement in the ±Z-direction and rotation about the X-axis when the blocks are mounted in the cradle window frames.

Isolation

The Y-Springs (4) and Z-Springs (2) maintain translation isolation. The Y-Springs, mounted to the LIS trunnion block and the BISIPE, provide Y-axis isolation; and the Z-Springs, mounted to the LIS Trunnion block and LIS cradle, furnish Z-axis isolation. Loads are transmitted from the BISIPE, through the trunnions, into the springs. Roll isolation is accommodated by the Z-spring. The LIS torque tubes provide pitch dynamic control. Push rods, mounted to the BISIPE, transmit the load to the torque tube crank arm. The resulting moment from the crank arm to the torque tube forces the tube to act as a torsion spring. The BISIPE flex trunnion design also controls yaw.
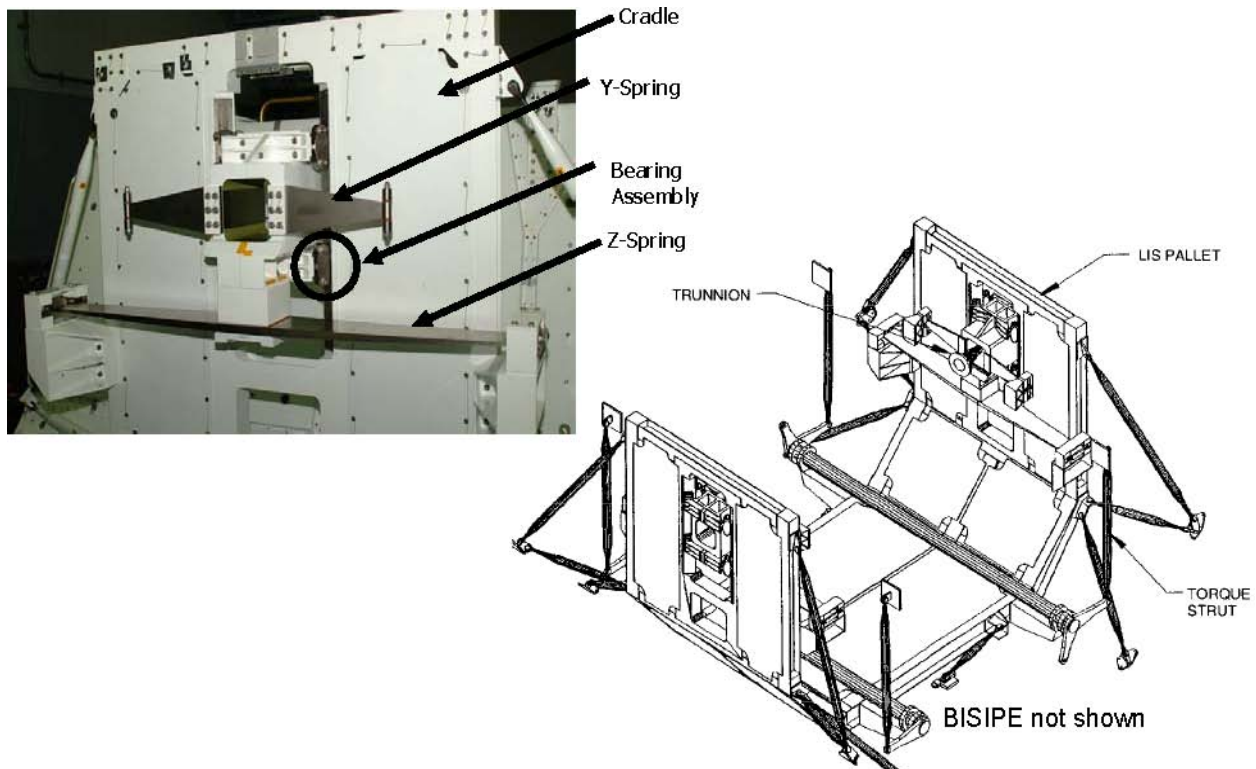
Figure 3-4. Load Isolation System (LIS)

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3.1.3 FSIPE

The FSIPE contains the FGS-3 and is a part of the BSIPE.

FSIPE Structural Elements

The major structural elements of the FSIPE (see Figure 3-5) are the base plate, the primary structure, and the secondary structure. The FSIPE is primarily composed of 5052 aluminum honeycomb and 6061-T6/7075-T7351 aluminum, and weighs 620 lb. The FSIPE is reflown hardware.

The base plate connects to the ASIPE via through holes for 1/2" fasteners (12) and shear pins (6) and accommodates the mounting of the FSIPE primary structure, which is composed of machined 6061-T6 aluminum.

The FSIPE primary structure provides the necessary structural support for the FGS via latches A, B, C, and D and connection with the ASIPE and the ORUC. The side supports on the primary structure are the mounting points for the LIS interface fittings (push rod terminals). All structural components are machined 6061-T6 aluminum.

The FSIPE secondary structure consists of the protective cover and door. The protective cover encloses the FGS and structurally supports EVA hardware (latches, PFR Sockets, and handrails). The cover is comprised of fifteen panels; three are machined 6061-T6 aluminum, and twelve are one inch thick honeycomb (5052) with .010 inch 6061-T6 aluminum face sheets (the outer face sheet is perforated). The door is fabricated from four honeycomb panels similar to those in the protective cover. It is attached with three hinges and three latches.

Note: To permit pressure equalization during takeoff and landing, a filtered vent is provided on the starboard side of the FSIPE. Differential pressure is maintained below 0.1 psi to meet the HST Project venting criteria.

FSIPE Mechanisms

The FSIPE utilizes door hinges and latches, SI guide rails, and SI latches.

Door Hinges and Latches

The FSIPE door is attached to the cover by three hinges located along the upper aft edge of the enclosure. Each hinge consists of two pads, a CRES pin (with a threaded end and a 7/16" EVA hex head), and a self-aligning monoball bearing. An exploded view of the hinge is shown in Figure 3-6.

The door is secured in the closed position by three lever-actuated tension latches, in line with the hinges and located along the front of the FSIPE. They are mounted on the bottom of the door front panel.

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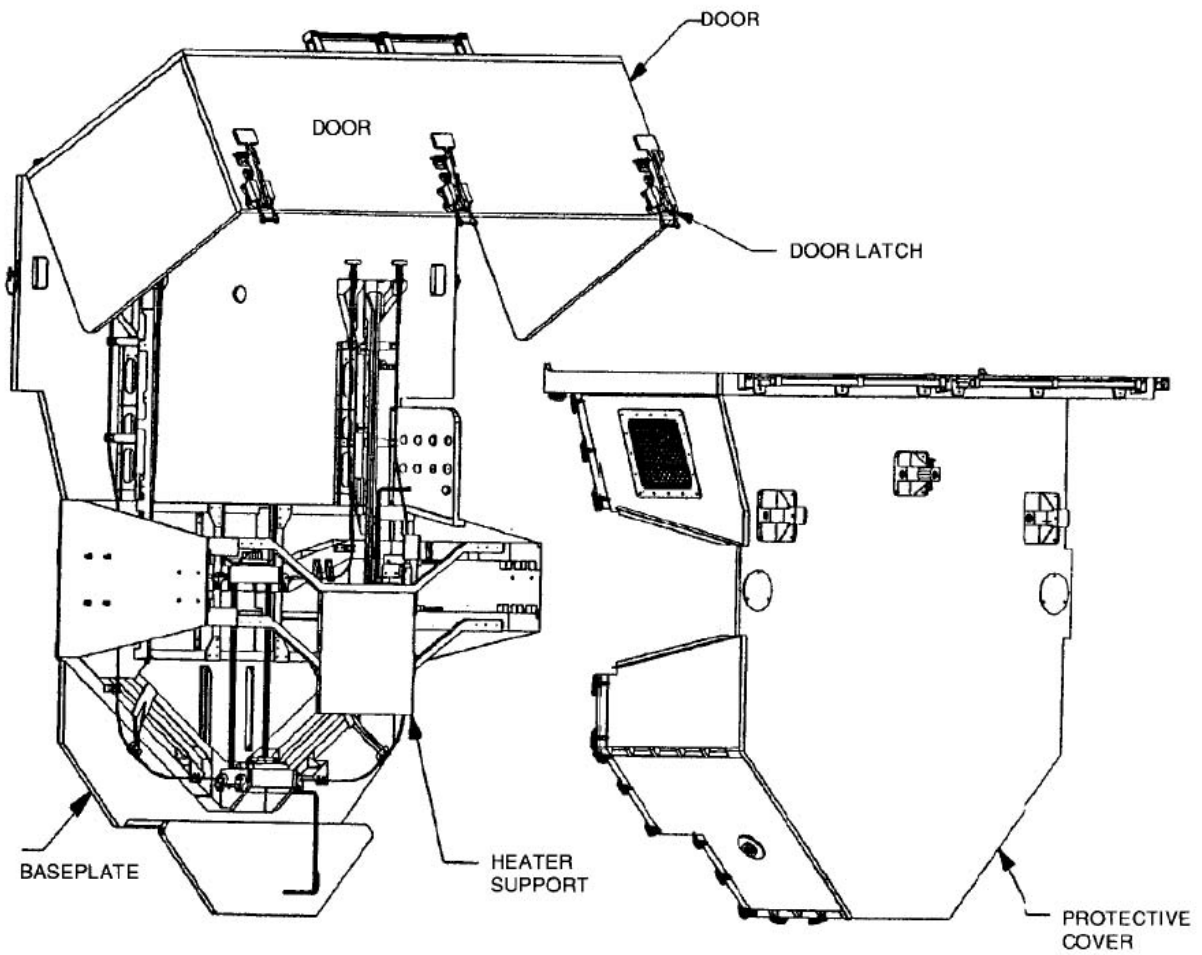
Figure 3-5. Fine Guidance Sensor SIPE (FSIPE)

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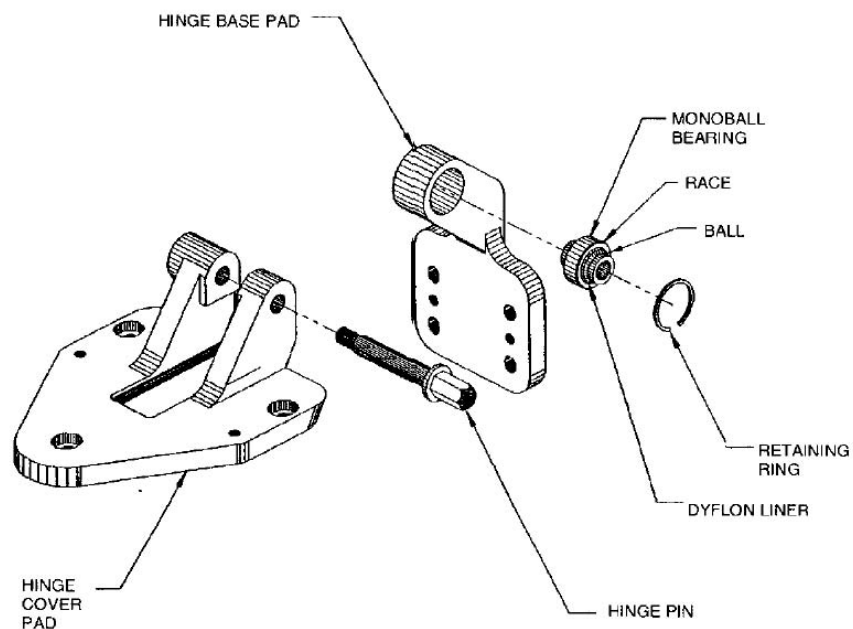
Figure 3-6. FSIPE hinge (expanded view)
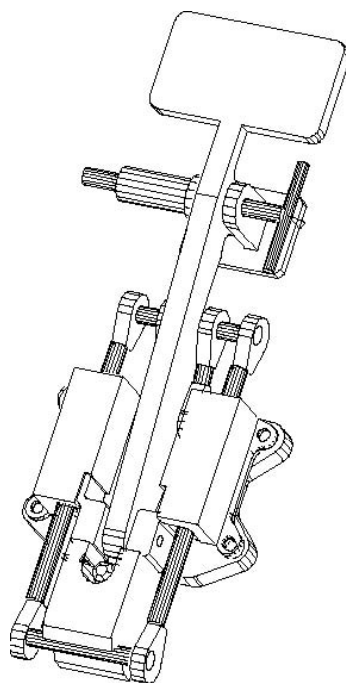
Figure 3-7. FSIPE door latch

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SI Guide Rails

The FSIPE incorporates guide rail assemblies at its port and starboard sidewalls that maintain proper positioning of the FGS as it is lowered into or removed from the enclosure. Corresponding guide rail strips are located at the FGS port and starboard edges.

The FSIPE guide rails are similar to the HST radial SI guide rails. To help guide the FGS into the FSIPE, the outboard rail ends are flared, and visual markings are added. The rails are reflown hardware.

FSIPE SI Latches

Once the FGS is seated in the FSIPE, it is secured at four latch locations: A, B, C, and D, shown in Figure 3-8.

Latch A constrains the SI along all three axes. Latches B and C restrain the FGS in the X direction, while the D latch restrains in the Y. Once the latches are engaged, the SI no longer contacts the SIPE guide rails, so all loads are transmitted through the four latches. A detailed description of each latch follows.

Latch A

Engaging Latch A seats the FGS in all four FSIPE latches. A bolt shaft, accessible at the outboard end of the SI, is operated using either the Pistol Grip Tool (PGT) or a manual wrench to engage a threaded ball socket on the FSIPE. This pulls the instrument further inboard to seat on two preload springs (see Figure 3-9). Proper seating of the SI at the preload springs can be verified by the following methods:

a. Seating torque (32-35 ft-lb)

b. Counting the number of bolt turns following bolt engagement (20-22)

c. Extinguishing of the "A LATCHED" lamp indicators or via telemetry (controlled by a plunger-activated micro switch on the FSIPE latch and verifiable by the EVA astronaut)

A bolt locking mechanism at the outboard end of the Latch A drive bolt furnishes a constant drag to prevent bolt backoff during orbiter launch and landing. Primary material for the Latch A housing is 6A1-4V titanium, with 440C stainless steel used for the ball socket. A tungsten carbide coating is used at the SI socket, with Braycote lubricant at the screw threads to ensure low bolt engagement force and anti-galling surfaces.

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Latches B and C

Latches B and C point inboard and engage as latch A seats (See Figure 3-10). Each FSIPE side latch is basically a socket assembly designed to engage corresponding stabilizer ball assembly on the FGS. The Flexure blades on the FSIPE allow self-alignment of the latch pair during SI seating. Latches engage automatically when the A Latch is closed and no additional EVA operation is required.

The primary material used in the fabrication of the B and C latches is 6A1-4V titanium. A tungsten carbide coating is provided at mating surfaces to prevent galling when the latches are engaged.

Following SM1, the B Latch flexure spring was thickened and the C Latch Mycroy insert was removed to accommodate increased SI loads.

Latch D

Latch D (see Figure 3-11) is a latch of series design (first used on SM2), engaged in the same manner as Latches B and C. Unlike the B and C latches, the latch D socket and flexures are mounted on the FGS, and the engagement ball is located on the FSIPE base plate.

Materials for the D Latch are the same as those for B and C Latches.

Contingency Latch Release

In the event the A Latch jams "intermediate" during EVA operations, a Contingency Latch Release is provided. The latch section on the SIPE side may be removed to allow jettison of the instrument with "A" Latch attached. The Contingency Latch Release was added to prevent a collision hazard. Opening the FSIPE door provides access to T-Handles connected to release cables. When twisted to be unlocked and pulled out, the cables retract pairs of adjustable diameter expansion pins and release the A and D Latch mount fitting carriage.

In the event of a B or C Latch jam, two sets of four-7/16 double height hex head bolts on the FSIPE midbody exterior can be removed to release these latch receptacles from the FSIPE primary structure.

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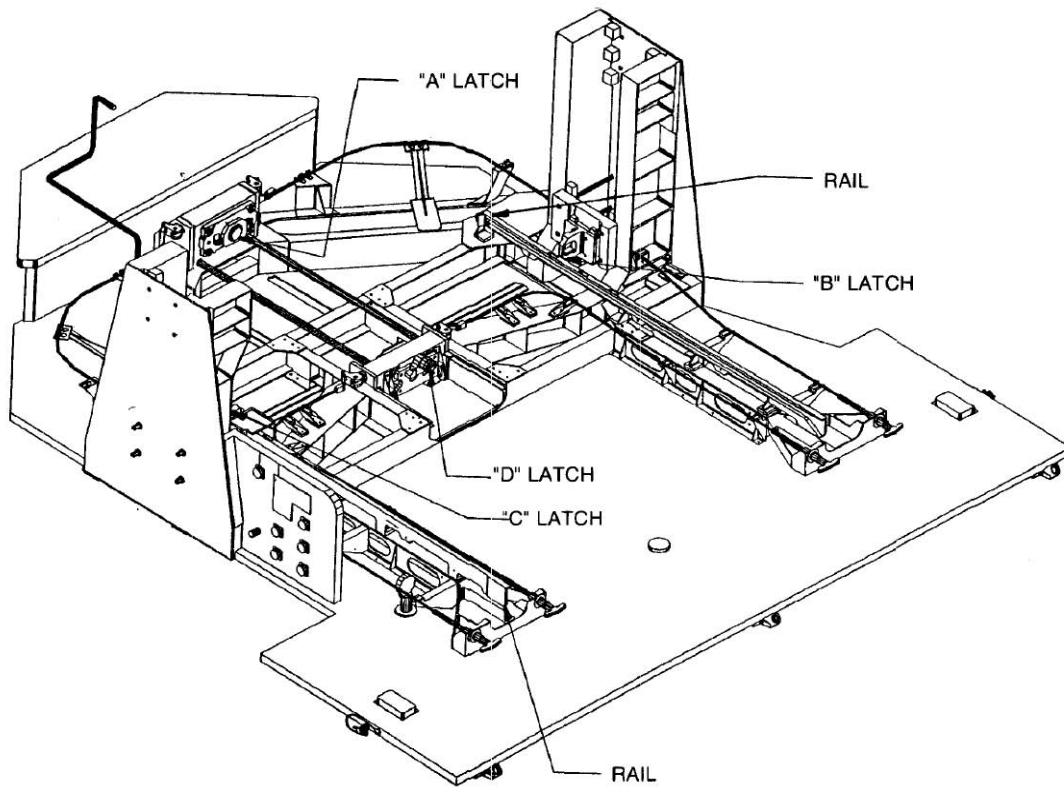
Figure 3-8. FSIPE SI latches

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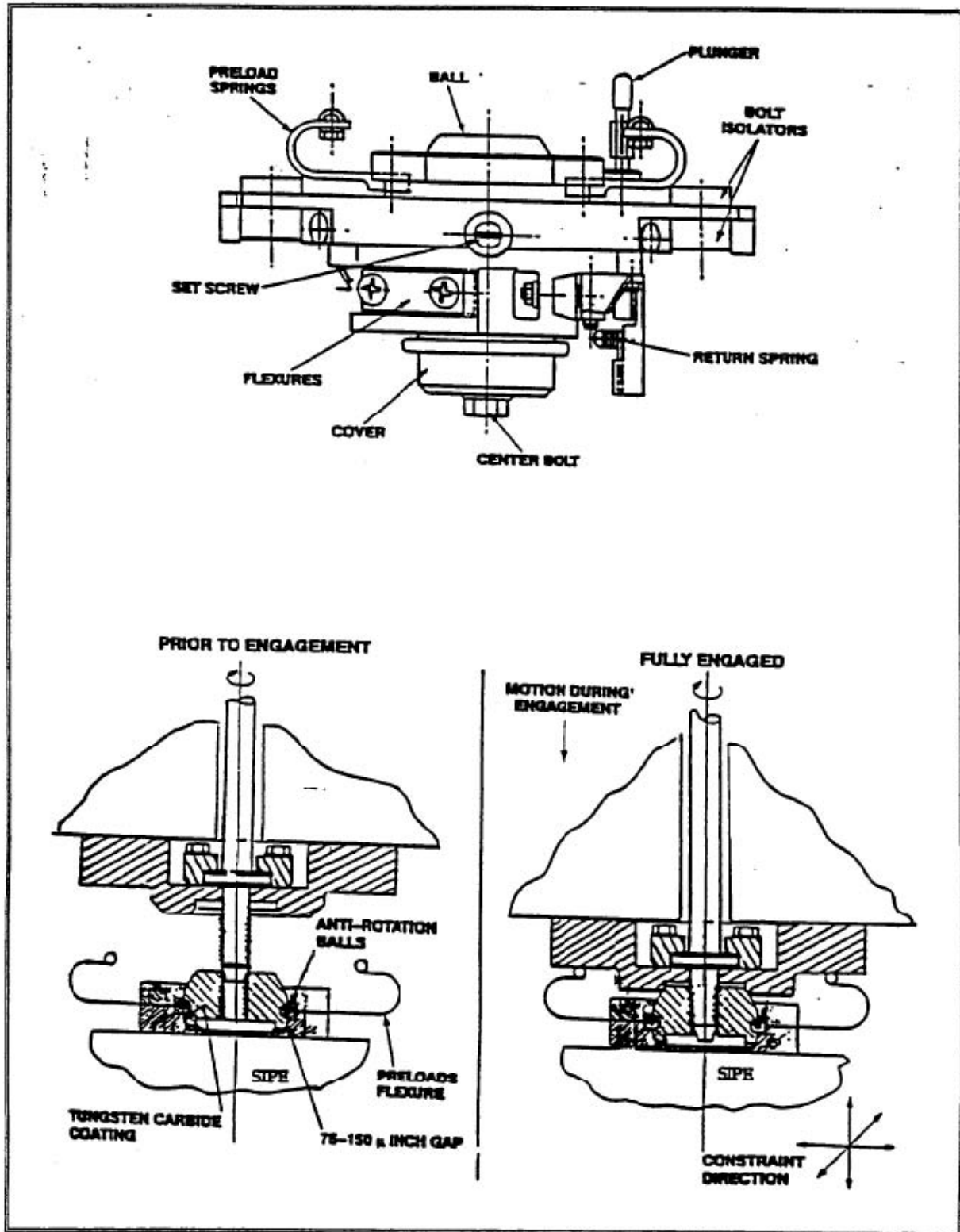
Figure 3-9. The FSIPE SI A latch

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Figure 3-10. The FSIPE SI B and C latch
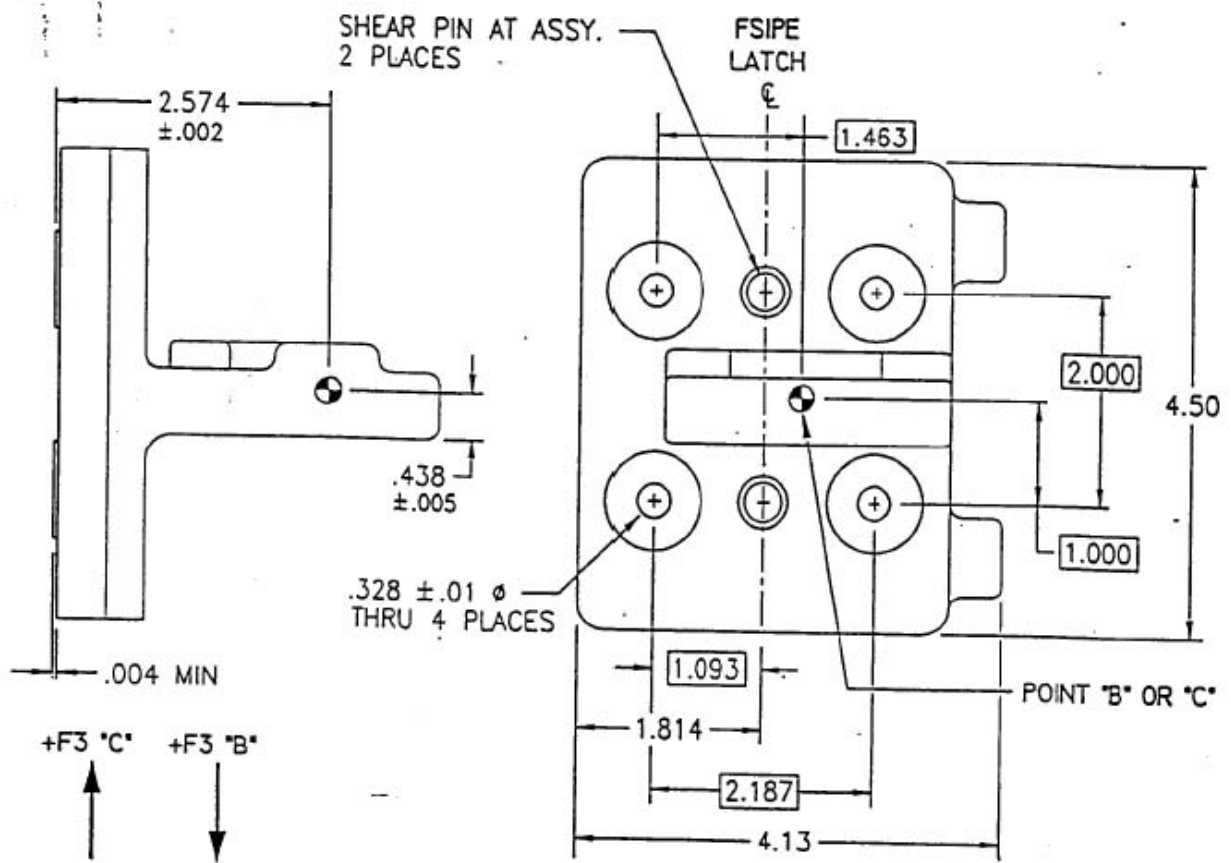
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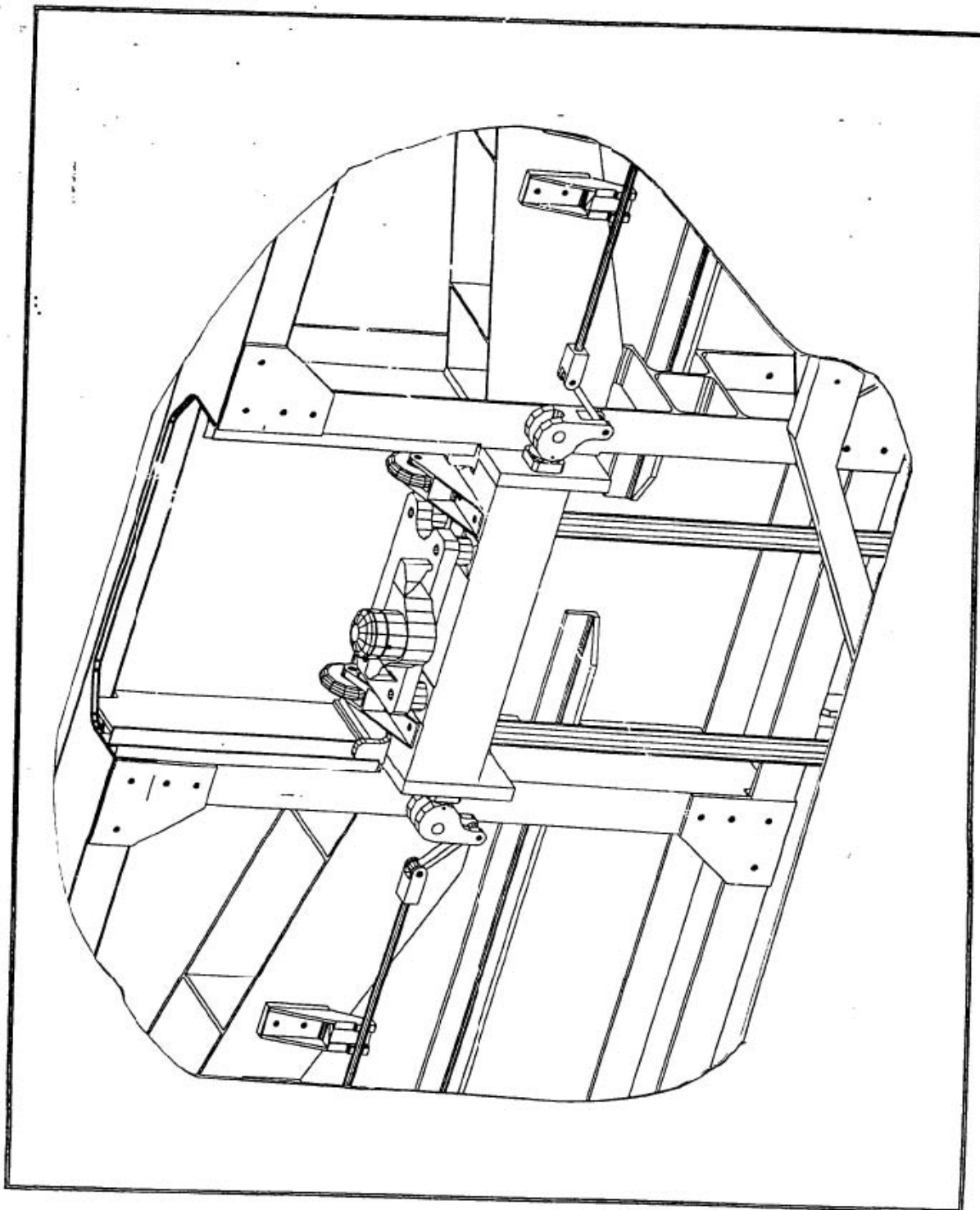
Figure 3-11. The FSIPE SI D latch

Verify that this is the correct version before use

FSIPE Electrical Systems

The FSIPE receives primary power from the PRJU. The FSIPE uses this power for active thermal control and EVA latch indicator power. The FSIPE also receives 18V dc regulated power to bias its structural temperature thermistor circuit.

3.1.4   Axial SIPE (ASIPE)

The Axial SIPE is reflown hardware and is mounted aft of, and fixed to, the FSIPE.

Axial SIPE (ASIPE) Structural Elements

The ASIPE structure, shown in Figure 3-12, weighs 895 lb and consists of the following components:

a.   Bonded aluminum honeycomb panels at port and starboard side walls, bottom cover, and lid (5052 perforated honeycomb with bonded 6061-T6 face sheets)

b.   Machined solid aluminum forward and aft end plates, B-latch support brackets, and side beams (6061-T651 aluminum)

c.   Lid latches (5 manually operated) and hinges (3)

d.   SI latches

The ASIPE side box beams provide 8 of 10 structural interfaces to the ORUC LIS, 2 trunnion mounts, 4 Y-spring terminals, and 2 push rod terminals.

Note: To permit pressure equalization during takeoff and landing, a filtered vent is provided on the aft end plate. Differential pressure is maintained below 0.1 psi to meet the HST Project venting criteria.

A ground-use-only access panel will be configured into the existing ASIPE Lid. This panel allows COS Ion pump access when the COS is installed in the ASIPE. The Ion Pump GSE rack is affixed to the Rotating Service Structure at KSC and the panel allows Drag-on/Drag-off cable to access the COS SI. To implement this panel, a rectangular hole will be machined into the existing Lid and a flanged, frame-shaped fitting bonded permanently into the Lid. A ground operation to unfasten and refasten the panel will be enabled by a captive panel that fits the frame via captive hardware. The MLI will be redressed after COS has been pumped-down and is ready for launch. The configured access panel and frame combination present no functional change to the ASIPE Lid from that which was present in SM-3A, SM-2, or SM-1.

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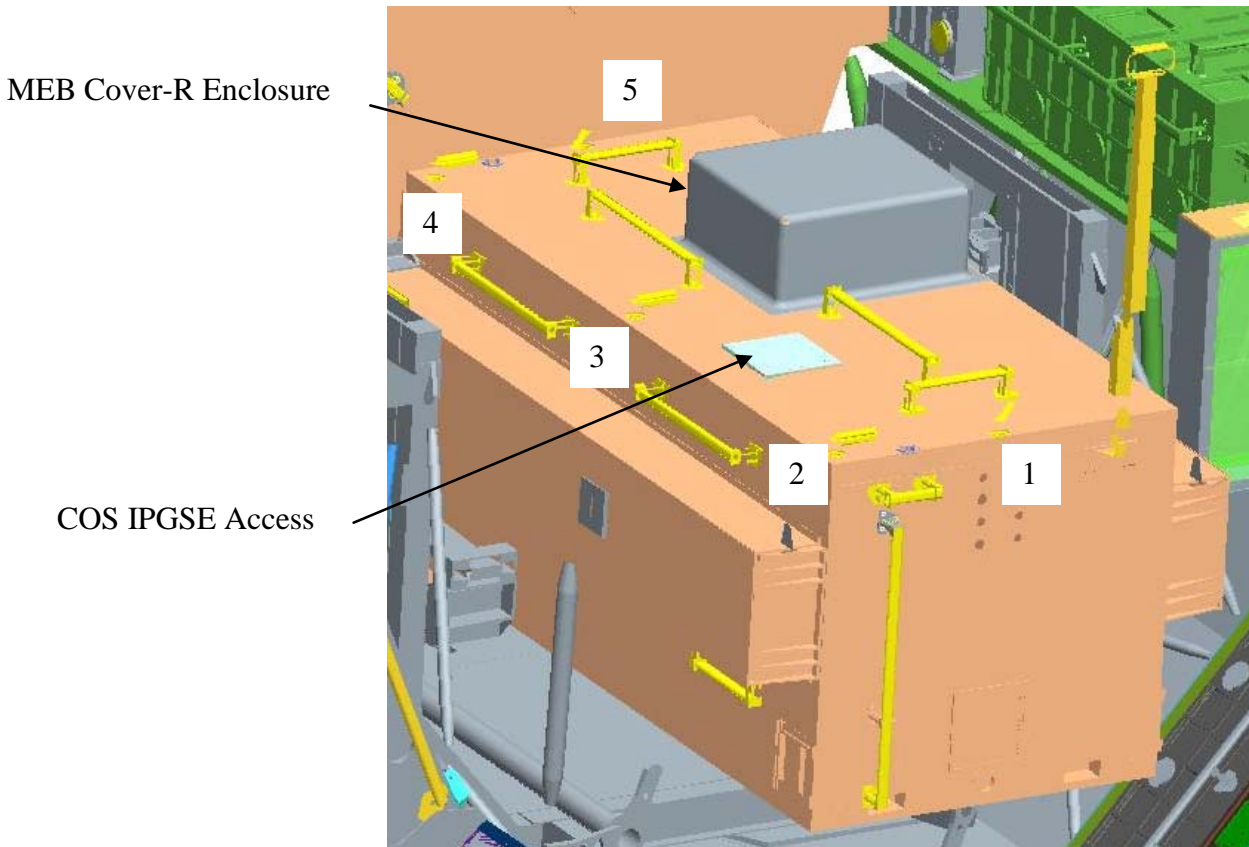
Note: MEB Cover-R shown for location; image not representative of design.

Figure 3-12. The AXIAL SIPE (ASIPE) (with latch numbers)

ASIPE Lid with MEB Cover-R and latch. The starboard sill Translation Aid (TA) was moved to the aft center of the ASIPE. This new stowage socket is identified as "S31."

Axial SIPE Mechanisms

Mechanisms installed on the ASIPE are

a.   SI Latches (A, B and C) inside ASIPE

b.   EVA lid contingency bolts (2)

c.   Lid hinges and latches

ASIPE Lid Hinge

The ASIPE has three lid hinges on the top, starboard edge of the box that allows the lid to open 120°. When fully opened, a stop on the hinge structure maintains the lid in the proper position while open on orbit.

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Each ASIPE lid hinge consists of two machined aluminum sections, and a stainless steel pin (see Figure 3-13). The hinge pin is free to slide in both hinge sections. Additionally, four beryllium copper (BeCu) washers assure a minimum of two low friction sliding surfaces between the hinge sections. Tufram coating is used at the machined hinge sliding surfaces (with Braycote grease on the bolt and the BeCu washers) to further reduce friction and to minimize galling potential.

There is no on-orbit provision to remove the ASIPE hinges.
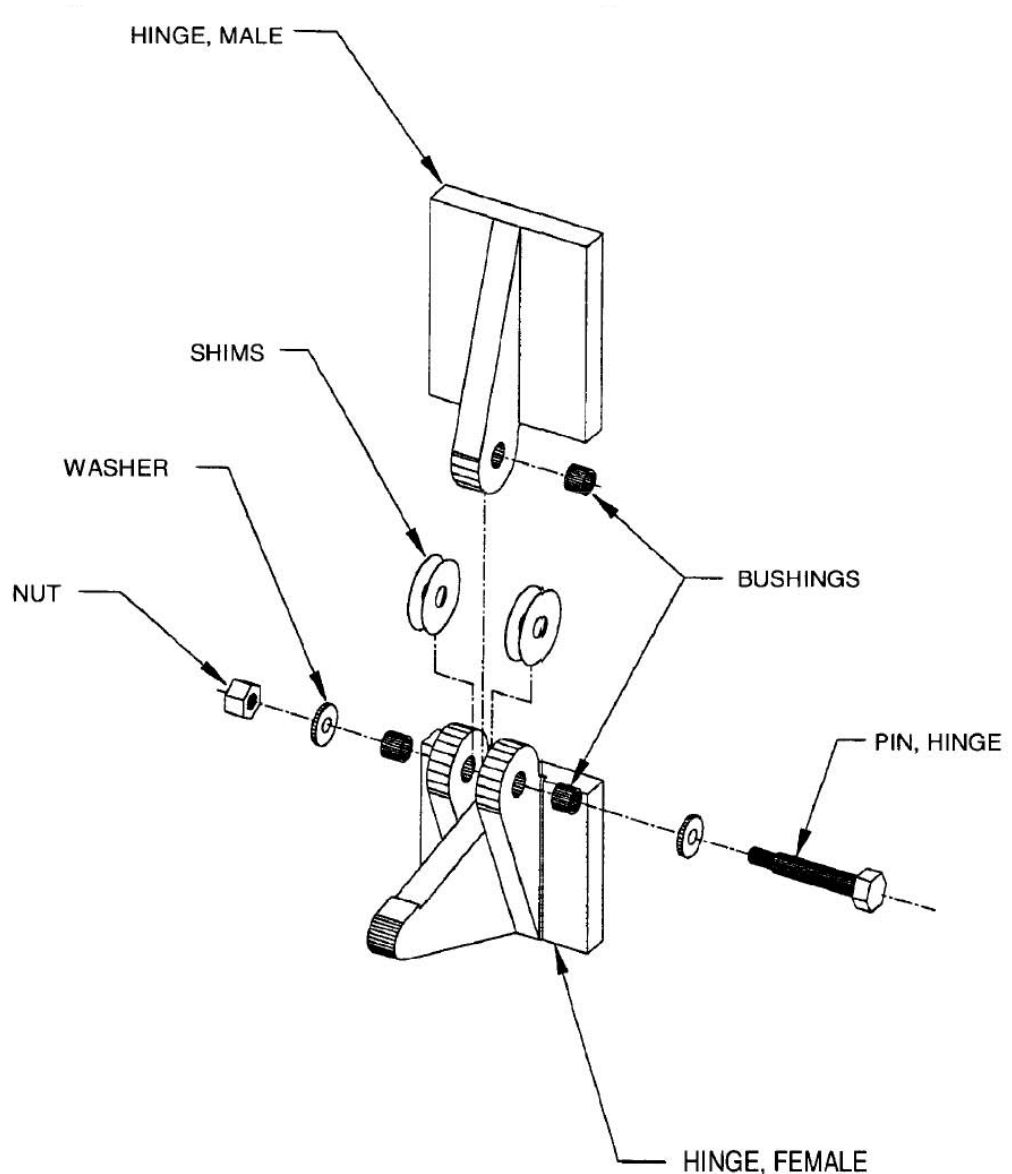
Figure 3-13. ASIPE lid hinge

Verify that this is the correct version before use

ASIPE Lid Latch

The ASIPE lid has five EVA-activated latches (see Figure 3-14) on the top of the box. The latch is activated by a 90° turn of the handle to open. For closing, the handle halves must first be squeezed together to put the lock lugs into the proper station within the receptacle, to prepare the final rotate-to-lock. Open and closed positions are clearly marked via decals on the ASIPE lid MLI. Latching ease is enhanced by sequencing latch actuation from the hingeline outward; i.e., locking latches 1 and 5 first will enable benign latching of the outermost row latches 2, 3, and 4. For temporary lid securing, latch 5 or 1 should be used.

Each of the five ASIPE door latches has a shear boss that must be engaged, and if a number of door latches fail, two contingency lid bolts (7/16-inch double height hex head) are provided as backup. The lid is in a safe to land configuration with any three lid latches engaged.

ASIPE SI Latches

SI latches are contained inside the ASIPE. Latch A constrains the SI along all three axes, Latch B and C constrains the SI along the V1 axes, and Latch D constrains the SI along the V2 axes. Note all axes referenced are in HST coordinates. Once the latches are engaged, all loads are transmitted through the three latches. A description of each latch (in the order of their operation) is as follows.

Latch B

Once engaged, Latch B (see Figure 3-15) seats the axial SI into the A and C latches. A drive shaft, accessible through a panel in the ASIPE side wall, is rotated to extend the shaft plunger into a mating ball joint on the SI and push the SI into the other latches. The shaft is actuated using the PGT or an equivalent manual wrench.

As the B latch plunger extends to seat the SI in the A and C latches, a micro switch located at the Latch A is opened, extinguishing the primary and redundant "A-SEATED" indicators. The latch is fully engaged when it travels over-center and approximately 10 to 12 turns.

Latch B is primarily composed of 6061-T6 aluminum, with Tufram coating used at sliding surfaces. The latch spring (which provides preload to the SI when in the latched position) is 6A14V titanium. The latch is series HST hardware modified (as of SM2) only by the thickening of a flexure.

Latch A

Latch A (Figure 3-16) engagement fully constrains the SI and removes any load from the guide rails. When the ball fitting on the SI is seated in the Latch A spherical seat, the clamp screw is operated (using the PGT or equivalent manual wrench) to close the movable jaws over the ball. As the A latch closes, a micro switch at the assembly

Verify that this is the correct version before use

opens to extinguish redundant "A LATCHED" indicators. The latch is fully closed after reaching a preload of 38 ft lb and 12 to 16 turns. Structural materials for the A latch include 6A1-4V titanium for the latch base, spherical seat and jaws, and PH13-8 Mo stainless steel for the clamp screw mechanism.

Latch C

Latch C (Figure 3-17) incorporates a stabilizer ball assembly on the ASIPE which engages a corresponding socket on the SI. A "flexible blade" on the socket allows self-alignment of the latch pair to accommodate manufacturing tolerances. The C latch engages automatically when the B latch is closed, and no additional EVA action is required.

Following SM1, the Microy insert was removed to accommodate higher SI loads.

ASIPE Electrical Systems

The ASIPE receives primary power from the PRJU. The ASIPE uses this power for active thermal control and EVA latch indicator power. The ASIPE also receives 18V dc regulated power to bias its structural temperature thermistor circuit.

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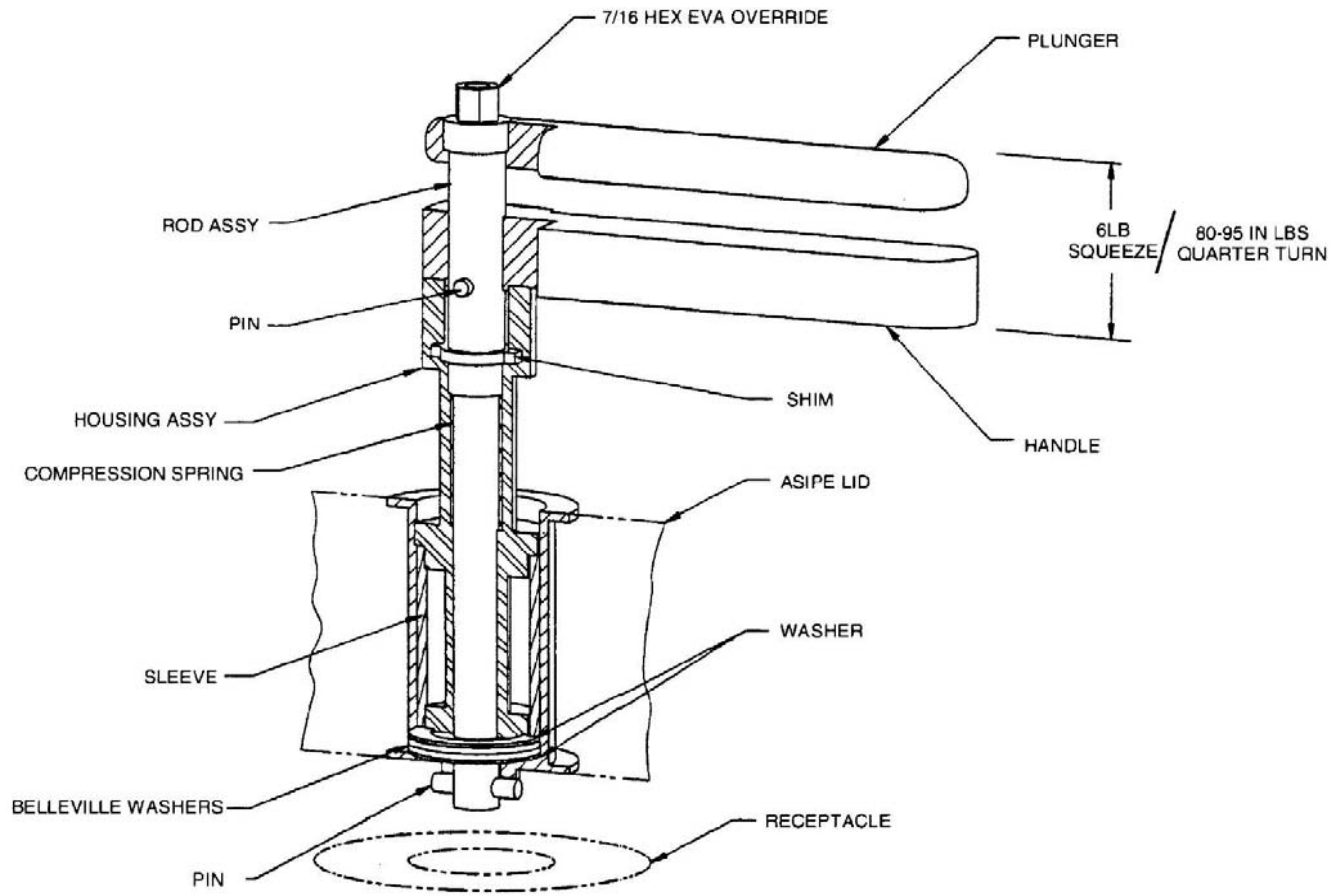
Figure 3-14. ASIPE LID latch

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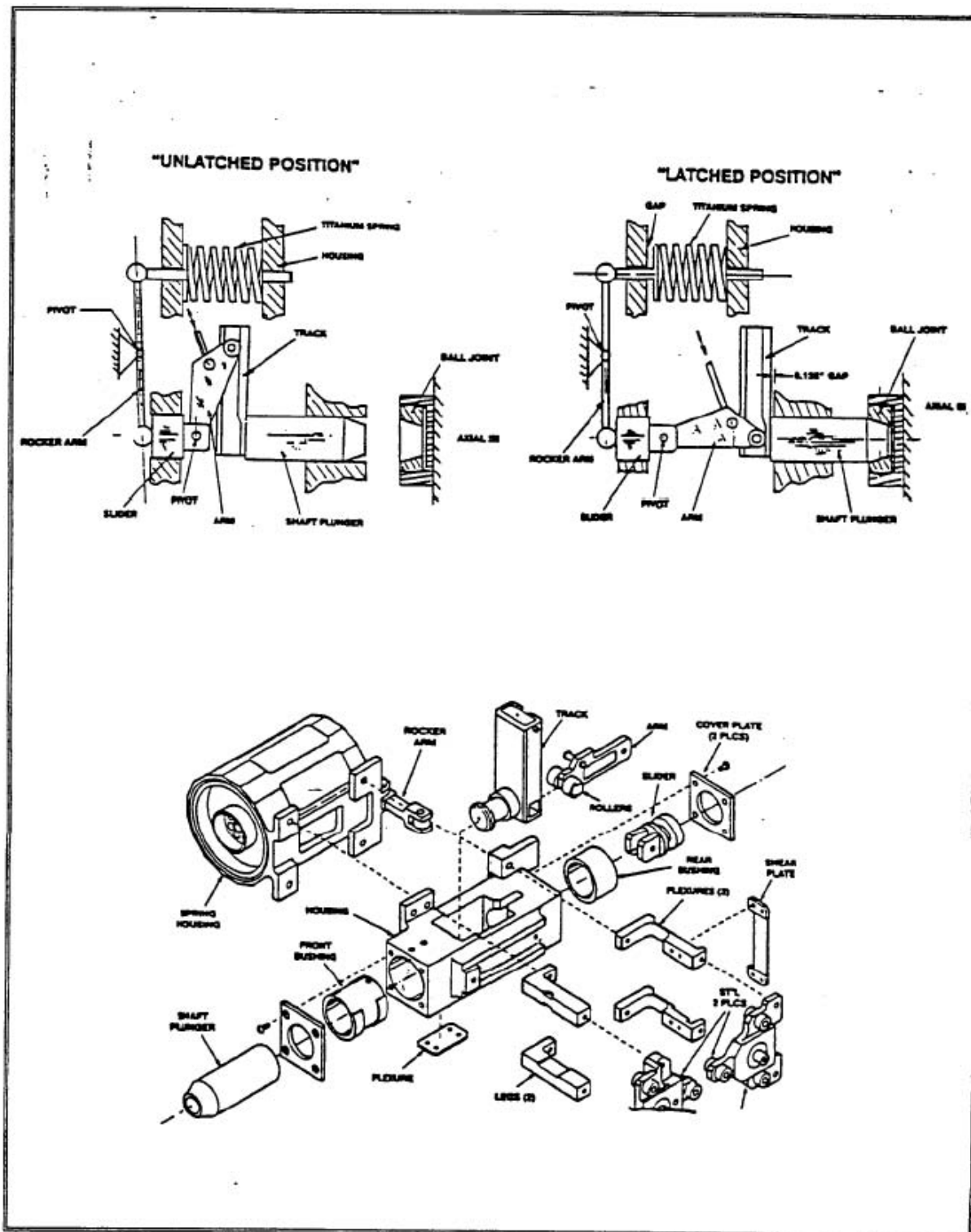
Figure 3-15. The ASIPE SI B latch

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PRIOR TO ENGAGEMENT

SPHERICAL SOCKET

SPHERICAL BALL

AXIAL SI

FPS

"JAWS" OPEN

DRIVE ROD

FULLY ENGAGED

AXIAL SI

MOTION DURING ENGAGEMENT

"JAWS" CLOSE

(a) Concept.

CLAMP SCREW

TEE'S (2 PER JAW)

JAW

UPPER PORTION OF SPHERICAL SEAT

LOWER PORTION OF SPHERICAL SEAT

THRUST WASHER

COLLAR

STOPS } 2 PLACES

CYLINDRICAL SEAT (BOTH SIDES)

DOVETAIL WAYS

JAW

BASE

TEE'S (2 PER BASE)

Figure 3-16. The ASIPE SI A latch

3-26

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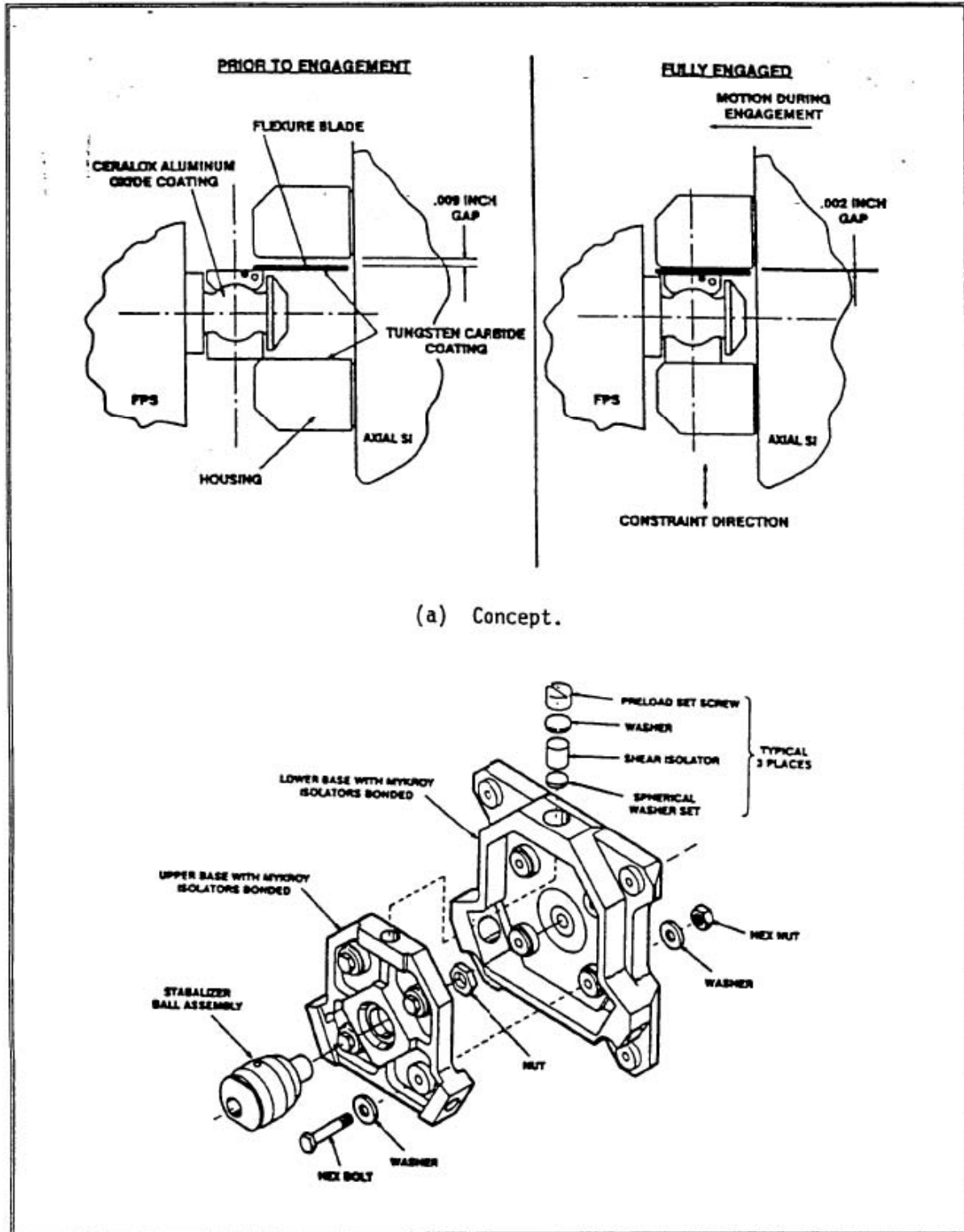
Figure 3-17. The ASIPE SI C latch

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3.1.5   ORU Shelf

The Starboard ORU Shelf (SORUS) provides a mounting surface for the Small ORU Protective Enclosure (SOPE), Large ORU Protective Enclosure (LOPE), and FCP/MEB Enclosure (FME).

ORU Shelf Structural

The shelf is a 2219-T87 aluminum orthogrid (.250-28 holes) structure and is supported by multiple aluminum struts. The long EVA handrail on the outboard side of the shelf is removed for SM4. The shelf weighs 237 lb.
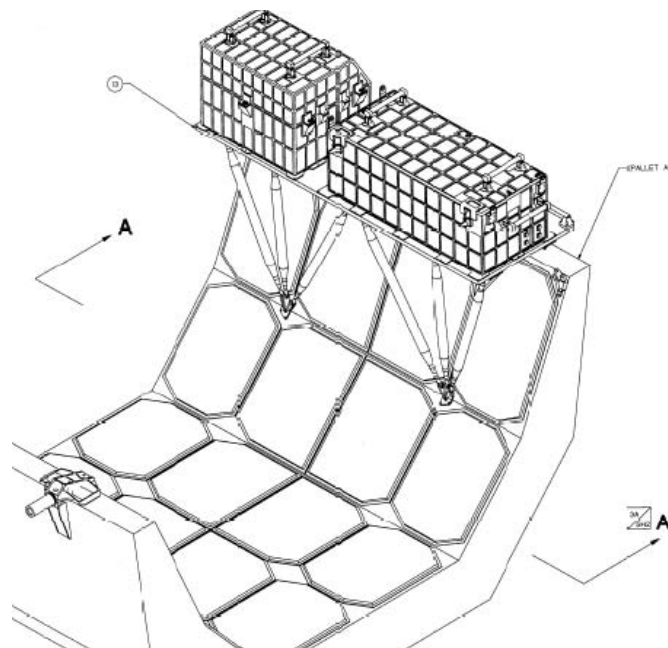
Figure 3-18. ORU shelf with LOPE and SOPE

3.1.6   ORU Protective Enclosures

The ORUC will carry the Small ORU Protective Enclosure (SOPE), the New ORU Protective Enclosure (NOPE) and the Large ORU Protective Enclosure (LOPE). Lighter weight enclosures include the two ATMs.

SOPE

The Small ORU Protective Enclosure (SOPE) is a shelf-mounted or pallet-mounted container designed to deliver and return small ORUs. (See Figure 3-19.) For SM4 it mounts to the ORUC shelf with 11 fasteners. All bolts are required for launch and the bolts are not an EVA interface. The SOPE is composed primarily of custom-machined 6061-T651 and 7075-T7351 aluminum plates, fastened together using standard aluminum angle sections. The empty enclosure, including the lid with its three latches,

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two hinges, two internal dividers and MLI weighs 170 pounds. It weighs approximately 405 pounds with the currently planned stowage provisions and flight payload.

ORUs requiring vibration isolation are contained within Transport Modules (TMs) designed specifically for the individual unit. ORUs not requiring specific load attenuation are hard mounted to the SOPE walls, or contained in soft pouches. All fasteners are high-strength stainless steel, inspected per GSFC Fastener Integrity Requirements, 541-PG-8072.1.2.

The SOPE is designed to withstand EVA crew and environmentally induced loads. It is vented with three vents on its front face to assure its structural integrity during cargo bay pressurization and depressurization. The vents are unobstructed by the Transport Modules or other internal stowage.

The launch configuration of the SOPE does not violate (statically or dynamically) the STS payload bay envelope. Furthermore, the SOPE cannot withstand reentry and landing loads or support returning small ORUs or CATs with its lid open, therefore lid closure and latching (or replacement bolt fastening) is required for safe landing configuration.

The SOPE is reflown hardware that was located on the ORUC for SM1 and SM2 and on the MULE for SM3B; it did not fly on SM3A. Modifications for SM4 include additional Transport Modules and other mounting/stowage hardware. The SOPE is rotated 180 degrees from the SM2 configuration.
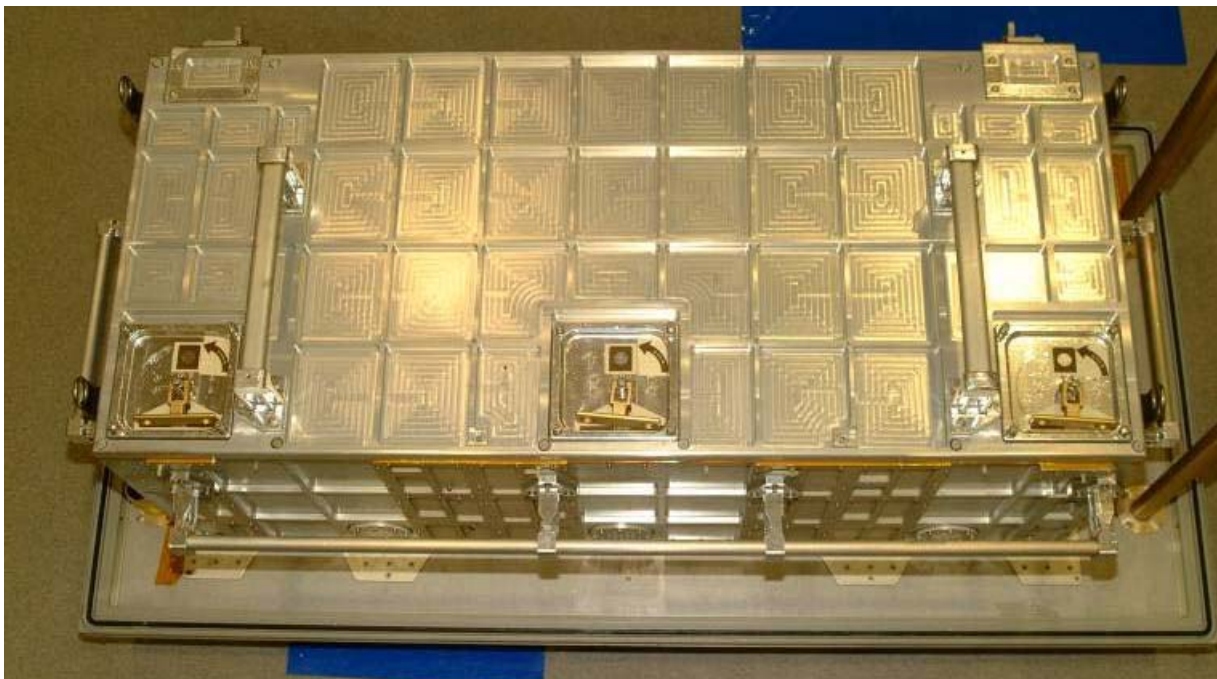
Figure 3-19. SOPE overview (MLI removed)

Verify that this is the correct version before use

SOPE Lid Hinges

Hinges used on the SOPE are the same design as those used on the ASIPE and previously flown on the SOPE, COPE, MOPE, and LOPE. Each hinge is two-fault tolerant, with multiple sliding surfaces. The hinges sweep through 100 degrees before hitting a stop. Each hinge has a soft-dock to hold the lid open during EVA operations. (Reference Figure 3-20.)

There is no on-orbit provision to remove the SOPE hinges.
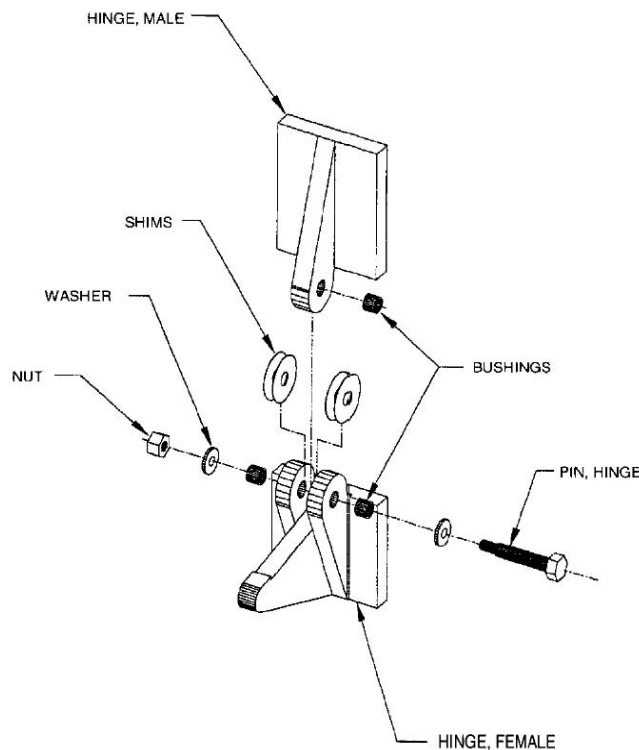
Figure 3-20. Lid hinge

SOPE Lid Latches

The SOPE lid latch (Figure 3-21) is a series design based on the UARS Tool Locker Latch and successfully flew on SM1, SM2 and SM3B. It is actuated by a T-Handle that is twisted 90° and laid down inside a lid-mounted bathtub fitting. The bathtub fitting dimensions prohibit handle rotation, and a compression spring keeps the Handle down for all inertia loads. A slight modification to the T-handle latch will be incorporated for SM4. The bathtub fitting has been modified with spring plungers and a small detent added to secure the T-handle in the stowed position. The modified design thus implements a means of preventing inadvertent release during launch and landing. The detent holding force is around 5 lb.

Verify that this is the correct version before use

Stress and fracture assessments for all OPE latch designs were reviewed and approved by the JSC Structures Working Group, 8/99, STS-103 VAR. Pull tests of the latches were performed to verify force margin compliance with JSC TA-94-041 and MA2-00-057 and documented in LMMS/P506755, 8/99. Pull tests will be repeated on the SOPE Lid for SM4 due to the different load levels in the ORUC mounting configuration.

To open the lid, the EVA crewmember pulls the T-Handle up out of the bathtub fitting and twists 1/4 turn to unlatch the internal Pawl/Pawl Catch interface. A means of securing the T-Handle in the down position has been added for SM4. Three latches secure the SOPE lid. Secure landing integrity is provided for SOPE with any two of the three latches. If two latches fail, the lid can be secured by installing a contingency bolt (stowed in a pouch and captive to the SOPE with a tether) located furthest from the working latch. However, if the only working latch is the middle latch, both EVA contingency bolts must be used.

If the T-handle latch fails to unlatch, the primary EVA override is disengage 4 captive fasteners which secure the latch to the lid and, after tethering to the latch assembly, sliding the latch assembly away from the pawl catch until it lifts out of the lid.
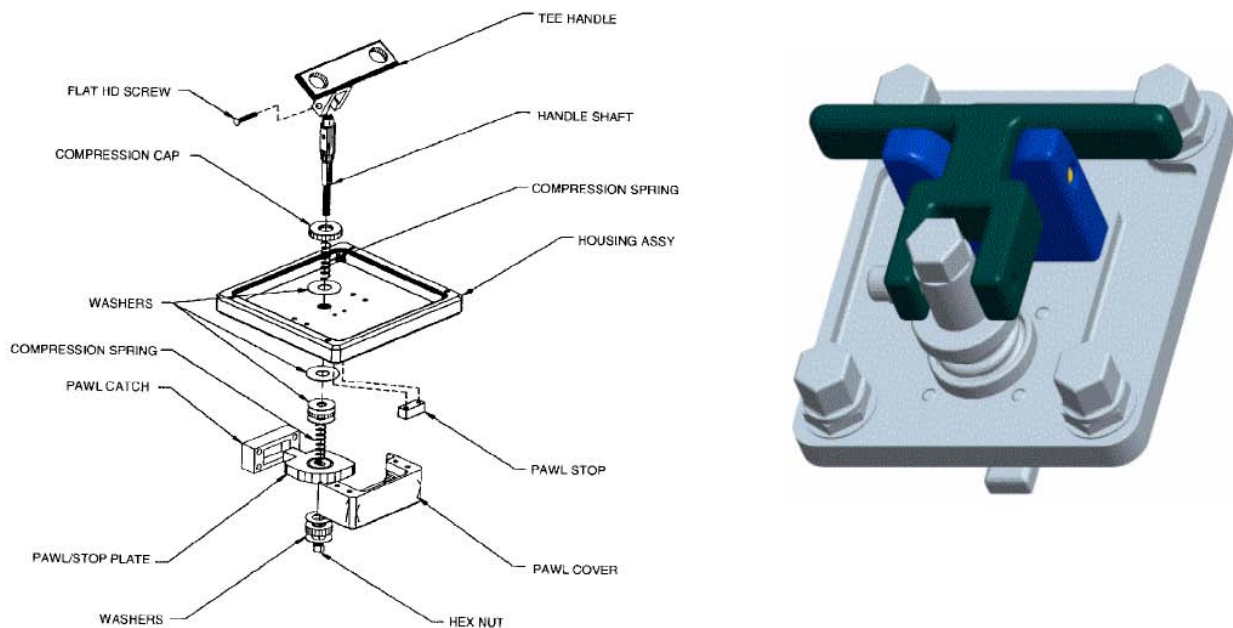
Figure 3-21. The SOPE lid latch (SM4 modification shown on right)

Verify that this is the correct version before use

SOPE Internal Stowage Configuration

The SOPE has three internal bays (A, B, and C), as shown in Figure 3-22, to facilitate ORU transport. Each ORU is supported independently in its SOPE bay so that any item can be removed or installed at anytime regardless of other ORU hardware.

The RSUs (quantity 3) are stowed (Figure 3-23) in Transport Modules constructed of 6061T651 Aluminum. The TMs are stand-alone open (not sealed) structures, which bolt to the SOPE base and walls. All interfaces engage the thick "web" sections of the SOPE walls, or are reinforced with doublers for increased strength and stiffness. Each TM contains a Delrin pad or elastomer isolation system, which attenuates the launch environment to levels that the ORUs have been qualified to withstand. Scaled-down versions of the basic OPE hinge and T-handle latches are implemented for the individual Transport Module "sub-lids." Each of the sub-lid hinges are constructed with three "nested" sliding surfaces that mitigate jamming of the sub-lid while in the open condition and are two-fault tolerant. The TM latches are similar to those on the exterior of the SOPE.

There are EVA overrides to account for latch failure, ensuring that the ORUs can be removed. Each TM lid has a single T-handle that can be operated one-handed. To disengage the latch system and remove the ORU, the T-handle is lifted out of its bathtub fitting and rotated 90°.   The stress and fracture assessment for all OPE latch designs was reviewed and approved by the JSC Structures Working Group, 8/99, STS-103 VAR. Pull tests for latches were performed to verify force margin compliance with JSC TA-94-041 and MA2-00-057 and documented in LMMS/P506755, 8/99. They were pull-tested to 1.5 times the worst case environmental loads. These same TM latches were flown in the SOPE for SM3B.

The RSU Change-out Tool ("pic-stick") is stowed on top of the SOPE as shown in Figure 3-24. Additional ORUs may be stowed in or on the SOPE as required in soft pouches or in other enclosures.

SOPE Electrical Systems

The SOPE receives primary power from the PRJU. The SOPE uses this power for active thermal control. The SOPE also receives 18V dc regulated power for biasing of its structure temperature thermistor circuit.

Verify that this is the correct version before use

STIS CIT

CMTL

RSUs (3X)

STIS CTE-R
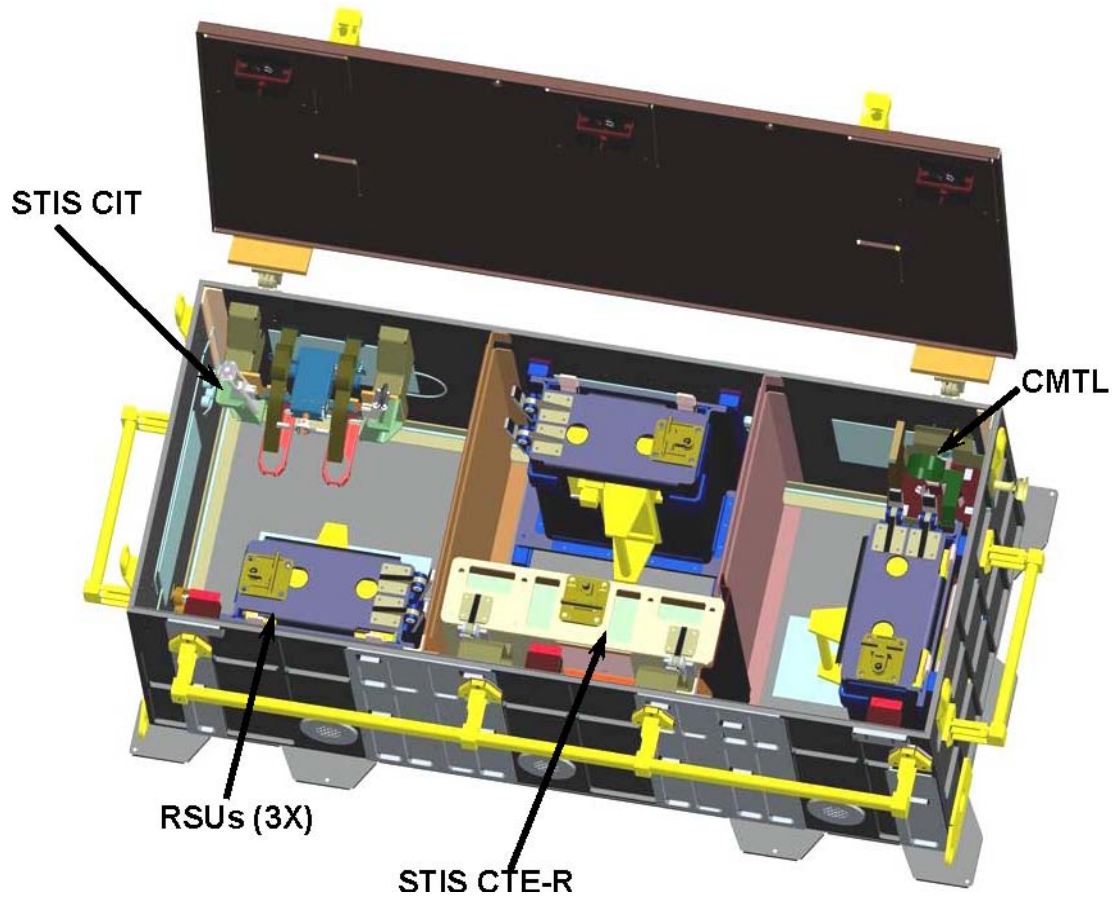
Figure 3-22. SOPE stowage configuration

Verify that this is the correct version before use

tapered lead-ins.

Can shim as required to
adjust pre-load.

Interface to SOPE wall

Kapton over
foam, top and
bottom only (no
Delrin)
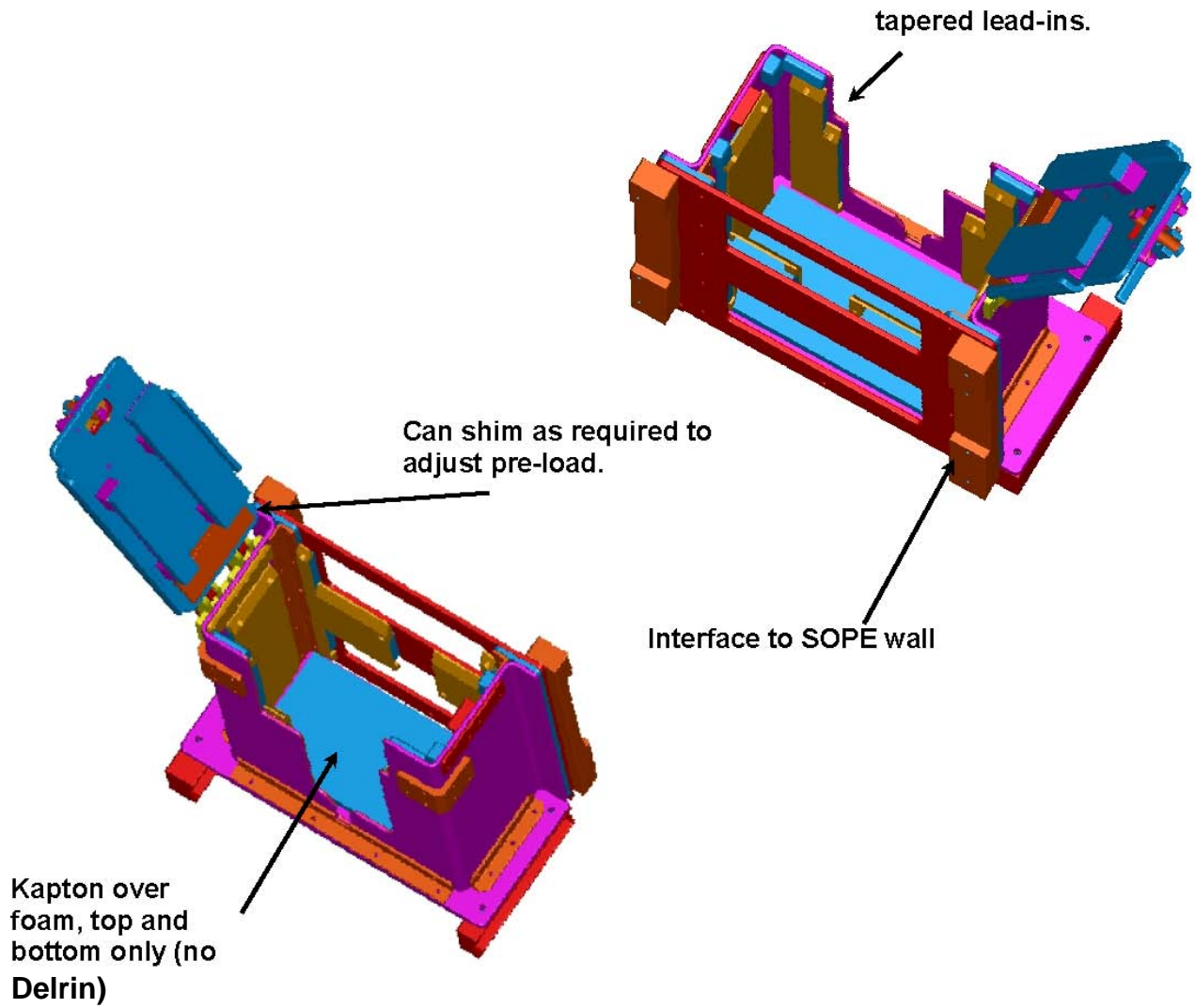
Figure 3-23. RSU transport module (lid open)

Verify that this is the correct version before use
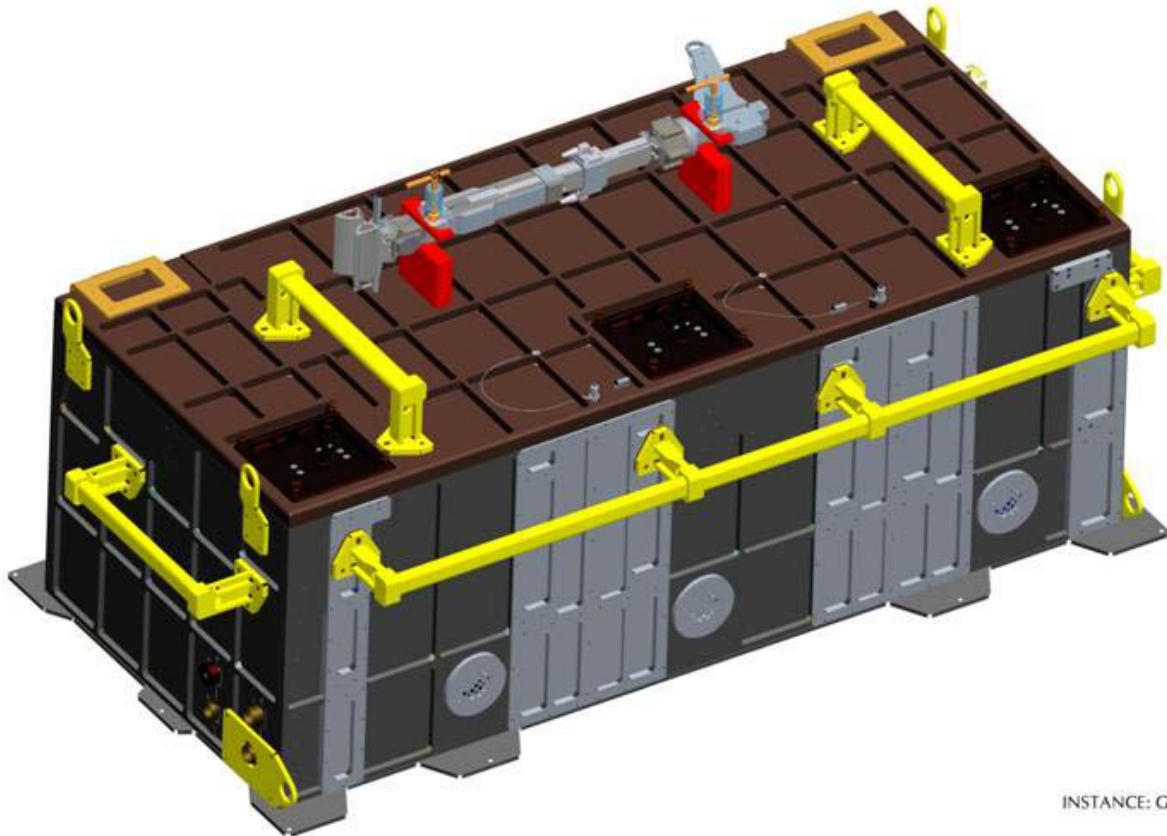
**Figure 3-24. RSU changeout tool ("pic-stick") mounted on SOPE
(MLI not shown)**

3.1.7   NOPE

The New ORU Protective Enclosure (NOPE) is a pallet-mounted container designed to deliver and to return small ORUs (See Figure 3-25). For SM4 it mounts to an adapter plate with 11 fasteners. All bolts are required for launch and landing and the bolts are not an EVA interface. The adapter plate is mounted to the Pallet aft face via pallet-to-pallet hardpoints. The NOPE is composed primarily of custom-machined 6061T651 and 7075-T7351 aluminum plates, fastened together using standard aluminum angle sections. The empty enclosure, including the lid with its three latches, two hinges, two internal dividers and MLI has a mass of approximately 176 pounds with the currently planned stowage provisions and flight payload. The NOPE is a new piece of hardware which is designed very similarly to the SOPE.

The ORUs requiring vibration isolation are contained within Transport Modules (TMs) designed specifically for the individual ORUs. ORUs not requiring specific load attenuation are hard mounted to the NOPE walls, or contained in soft pouches. All fasteners are high-strength stainless steel, inspected per GSFC Fastener Integrity Requirements, 541-PG-8072.1.2.

Verify that this is the correct version before use

The NOPE is designed to withstand EVA crew and environmentally induced loads. It is vented with three vents on its front face to assure its structural integrity during cargo bay pressurization and depressurization. The vents are unobstructed by the Transport Modules or other internal stowage.

The launch configuration of the NOPE does not violate (statically or dynamically) the STS payload bay envelope. Furthermore, the NOPE cannot withstand reentry and landing loads or support returning small ORUs or CATs with its lid open, therefore lid closure and latching (or replacement bolt fastening) is required for safe landing configuration.
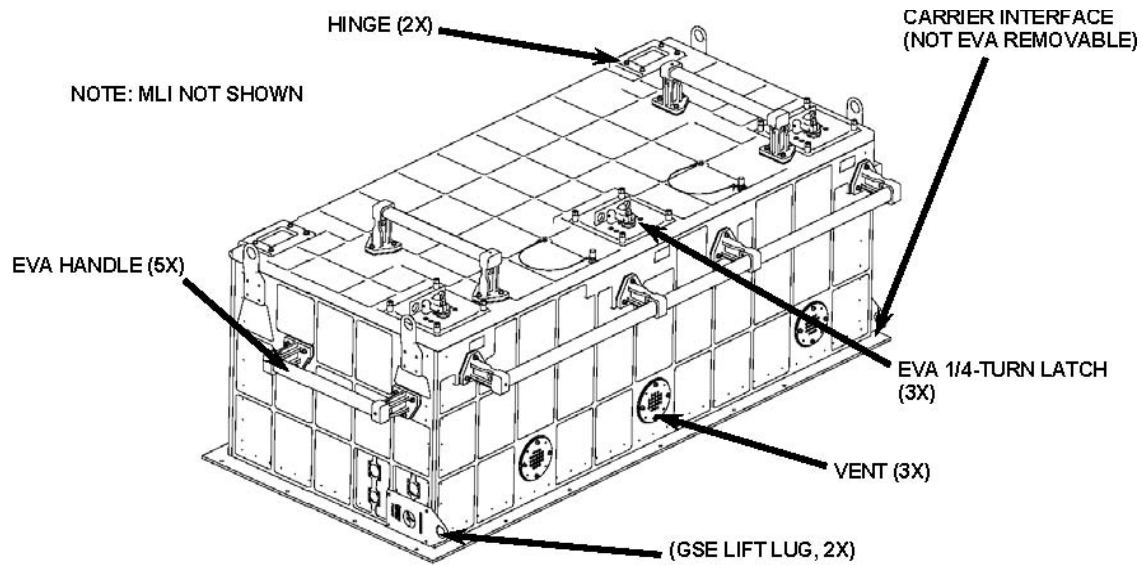
Figure 3-25. NOPE overview (MLI removed)

NOPE Lid Hinges

Hinges used on the NOPE are the same design as those used on the ASIPE and previously flown on the SOPE, COPE, MOPE, and LOPE. Each hinge is two-fault tolerant, with multiple sliding surfaces. The hinges sweep through 100 degrees before hitting a stop. Each hinge has a soft-dock to hold the lid open during EVA operations. (Reference Figure 3-26.)

There is no on-orbit provision to remove the NOPE hinges.

Verify that this is the correct version before use
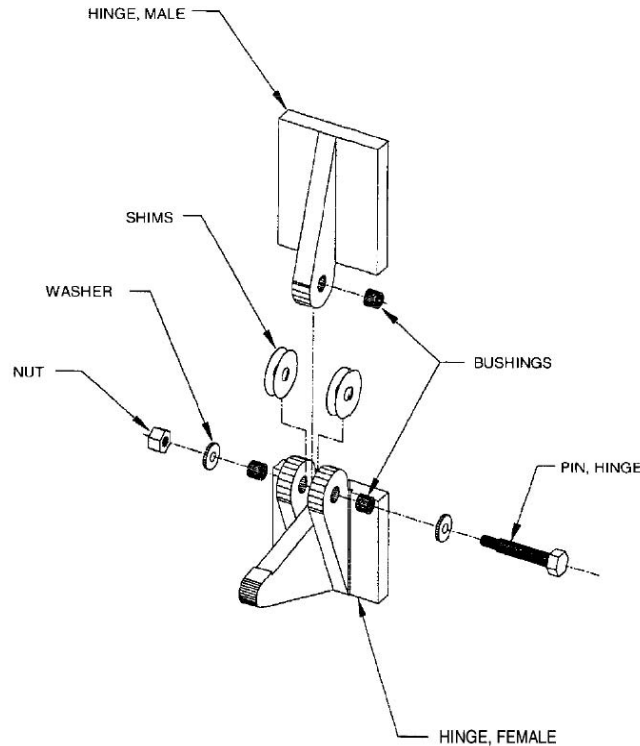
Figure 3-26. Lid hinge

NOPE Lid Latches

The NOPE lid latch (Figure 3-27) is a series design based on the UARS Tool Locker Latch and successfully flown on SM1, SM2 and SM3B. It is actuated by a T-Handle that is twisted 90° and laid down inside a lid-mounted bathtub fitting. The bathtub fitting dimensions prohibit handle rotation, and a compression spring keeps the Handle down for all inertia loads. A slight modification to the T-handle latch will be incorporated for SM4. The bathtub fitting has been modified with a spring plunger and a small detent added to secure the T-handle in the stowed position to prevent inadvertent release during launch and landing loads. The detent holding force is around 5 pounds.

The stress and fracture assessment for all OPE latch designs was reviewed and approved by the JSC Structures Working Group, 8/99, STS-103 VAR. Pull tests of the latches were performed to verify force margin compliance with JSC TA-94-041 and MA2-00-057 and documented in LMMS/P506755, 8/99. Pull tests will be repeated on the NOPE Lid for SM4 due to the different load levels in the ORUC mounting configuration.

To open the lid, the EVA crewmember pulls the T-Handle up out of the bathtub fitting and twists 1/4 turn to unlatch the internal Pawl/Pawl Catch interface. A means of securing the T-Handle securely in the down position has been added for SM4. Three latches secure the NOPE lid. Secure landing integrity is provided for NOPE with any

Verify that this is the correct version before use

two of the three latches. If two latches fail, the lid can be secured by installing the contingency bolt (stowed in a pouch and captive to the NOPE with a tether) furthest from the working latch. However, if the only working latch is the middle latch, both EVA contingency bolts must be used.

If the T-handle latch fails to unlatch, the primary EVA override is to disengage the four captive fasteners, which secure the latch to the lid and, after tethering to the latch assembly, sliding the latch assembly away from the pawl catch until it lifts out of the lid.
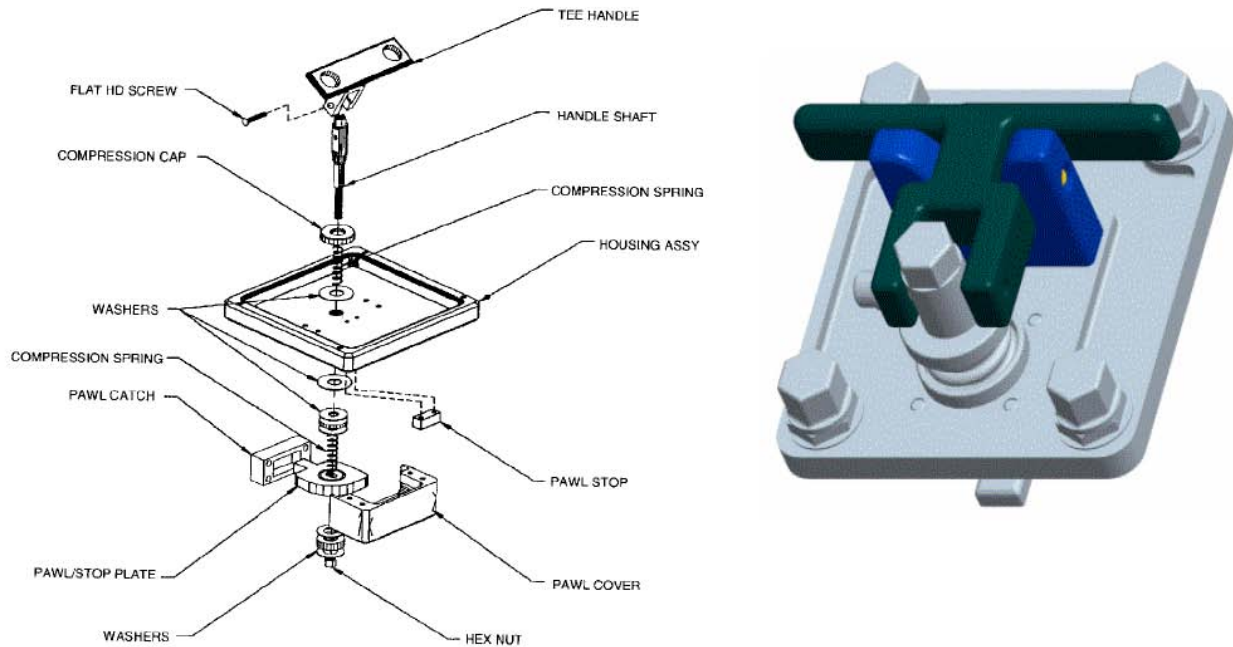
Figure 3-27. NOPE lid latch (SM4 modification shown on right)

NOPE Internal Stowage Configuration

The NOPE stowage configuration is shown in Figure 3-28. Each piece of hardware carried in the NOPE is supported independently so that any item can be removed or installed at anytime regardless of other hardware.

One Transport Module (TM), the ACS Card Transfer Enclosure (CTE), is used in the NOPE. Scaled-down versions of the basic OPE hinge and T-handle latches are implemented for the individual Transport Module "sub-lids." Each of the sub-lid hinges are constructed with three "nested" sliding surfaces that mitigate jamming of the sub-lid while in the open condition and are two-fault tolerant. The TM latches are similar to those on the exterior of the NOPE. There are EVA overrides to account for latch failure, ensuring that the ORUs can be removed. The CTE lid has a single T-handle that can be operated one-handed. To disengage the latch system and remove the ORU, the T-handle is lifted out of its bathtub fitting and rotated 90°.

Verify that this is the correct version before use

The stress and fracture assessment for all OPE latch designs was reviewed and approved by the JSC Structures Working Group, 8/99, STS-103 VAR. Pull tests for latches were performed to verify force margin compliance with JSC TA-94-041 and MA2-00-057 and documented in LMMS/P506755, 8/99. They were pull-tested to 1.5 times the worst case environmental loads. These same TM latches were flown in the NOPE for SM3B.

Additional ORUs may be stowed in or on the NOPE as required in soft pouches, as shown in Figure 3-29, or in other enclosures.

NOPE Electrical Systems

The NOPE does not have electrical power applied to it or its contents.
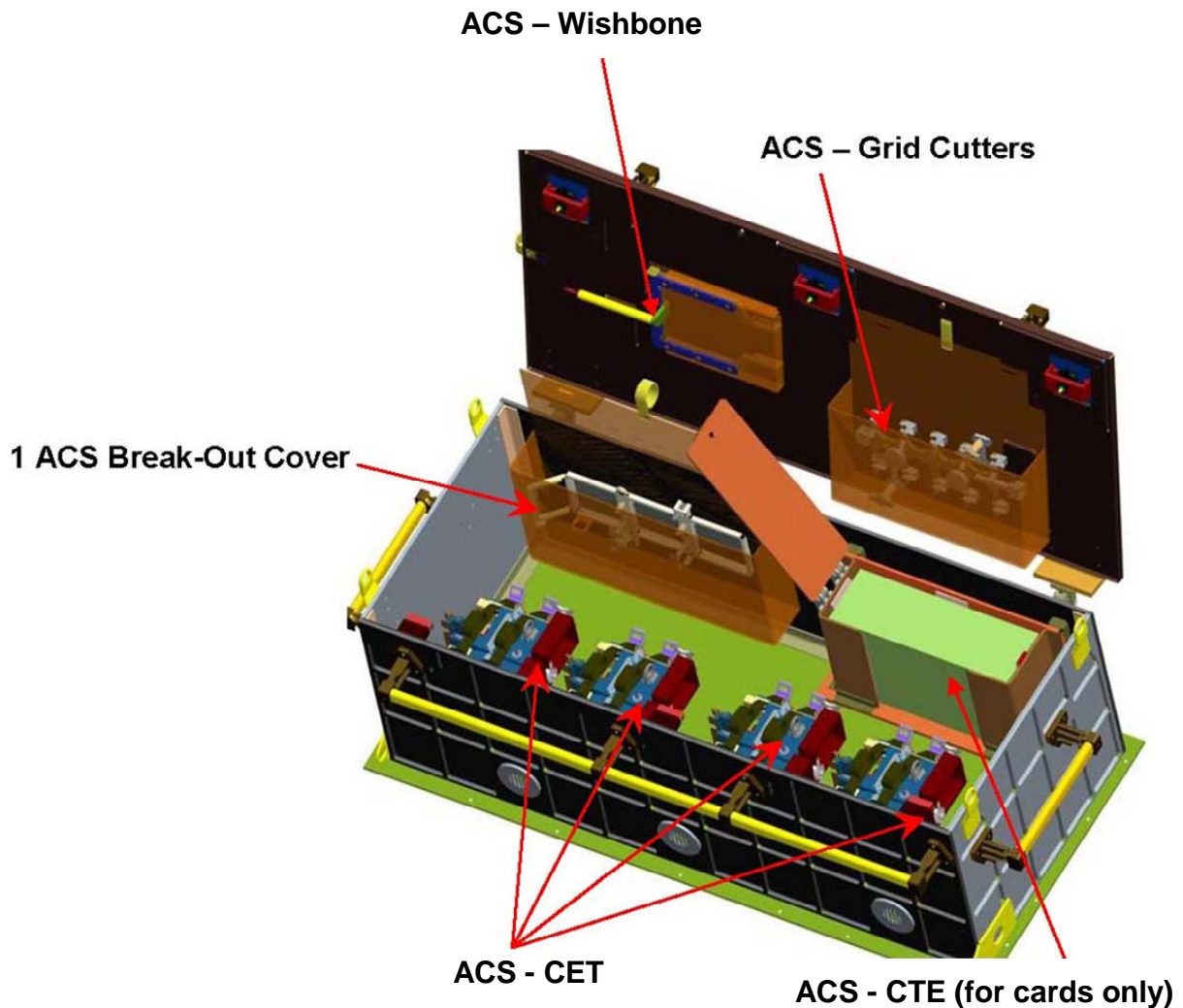
Figure 3-28. NOPE stowage configuration

3-39

Verify that this is the correct version before use
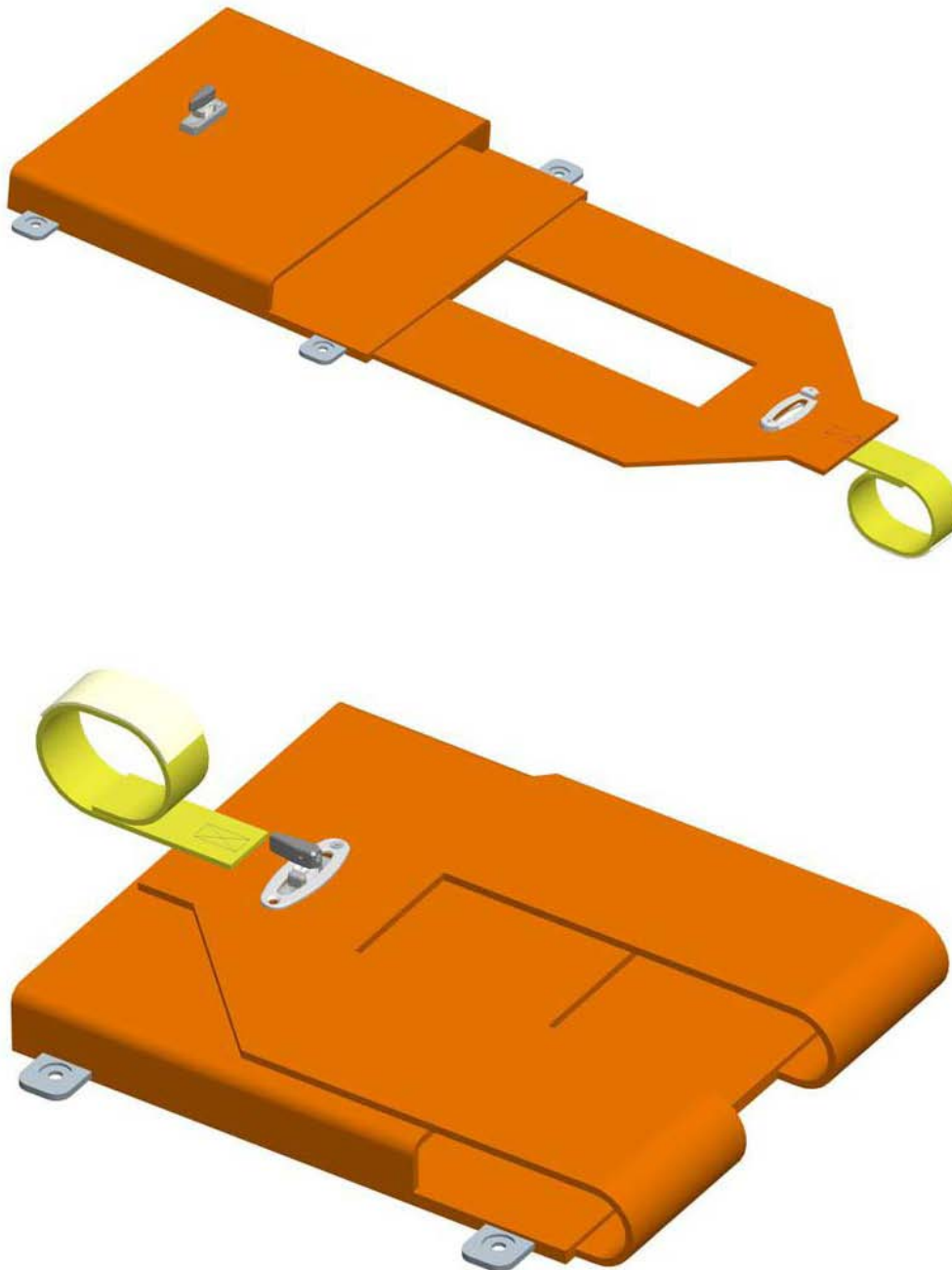
Figure 3-29. Typical pouch (open and closed)

(There are currently no pouches flying in the NOPE for SM4, but could be added later.)

Verify that this is the correct version before use

3.1.8 Large ORU Protective Enclosure (LOPE)

The LOPE container (39.73 x 32.29 x 31.07 inches) is designed to deliver and return large ORUs and/or tools. (See Figure 3-30 and Figure 3-31.) The LOPE bolt hole pattern is compatible with the Starboard shelf, using 9 fasteners. The LOPE attachment to the shelf is not an EVA interface. The LOPE is composed primarily of machined Al 7075-T7351 aluminum and weighs 125 pounds when it is empty and 285 pounds when it is in flight configuration. The LOPE provides heated stowage.

The hardware to be carried in the LOPE includes ACS Repair hardware as follows (actual contents may be contingency tools):

a. 1 CCD Electronics Box (CEB) –R

b. 1 LVPS-R module with Power Input Element (PIE) and Power Output Element (POE)

c. 1 spare PIE

d. 1 spare POE

e. ACS Fastener Capture Plate (FCP)

The LOPE is a vented (3 vents) container to assure structural integrity during cargo bay pressurization/depressurization. The vents are unobstructed by the foam lining. The LOPE design also is compatible with EVA crew and environmentally induced loads.

The LOPE is reflown hardware from SM1, SM2, SM3A, and SM3B.

LOPE Mechanisms

LOPE Lid Hinges

Hinges used on the LOPE are the same reflown design used on SM1, SM2, SM3A, and SM3B. Each hinge is two-fault tolerant, with multiple sliding surfaces. Each hinge consists of two machined aluminum sections, and a stainless steel pin. The hinge pin is free to slide in both hinge sections. Additionally, four beryllium copper washers assure a minimum of two low-friction, sliding surfaces between the hinge sections. Tufram coating is used at the machined hinge sliding surfaces (with Braycote grease on the bolt and washers) to further reduce friction and to minimize galling potential.

There is no provision to remove the LOPE hinges.

Verify that this is the correct version before use

LOPE Lid Latches

The four Latches for the LOPE lid consist primarily of T-Handle Latches similar to the ATM-2 Latches and a countersunk captive 7/16" hex bolt which is captive to the flange of the side panels of the enclosure.

In the event of a latch failure (incomplete closure), the LOPE is designed for safe orbiter descent and landing with any combination of four noncontiguous latches or lid bolts. Furthermore, if a failure should cause a combination of four latches to not seat properly, the lid can still be secured for landing by EVA installation of two bolts (7/16 inch double height hex head), one at each of the lid's front corners.

To open the latches, a PRT, PGT, or standard ratchet is used, with appropriate extensions.

Figure 3-30. LOPE

Verify that this is the correct version before use

Spare Harnesses

LVPS-R Module w/ POE

ACS FCP
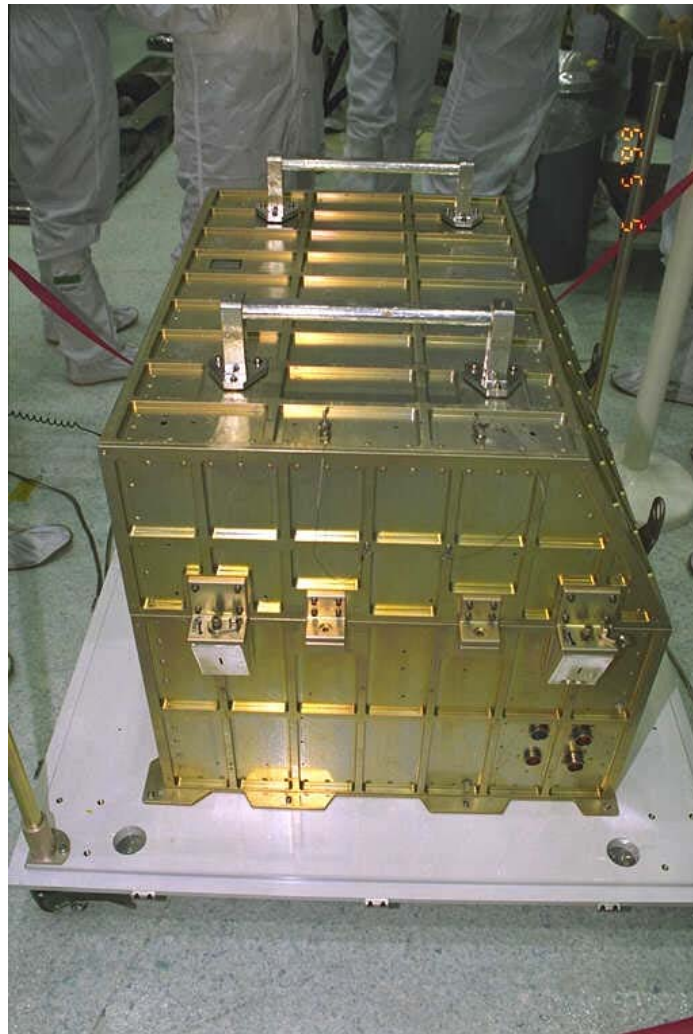
CEB Module
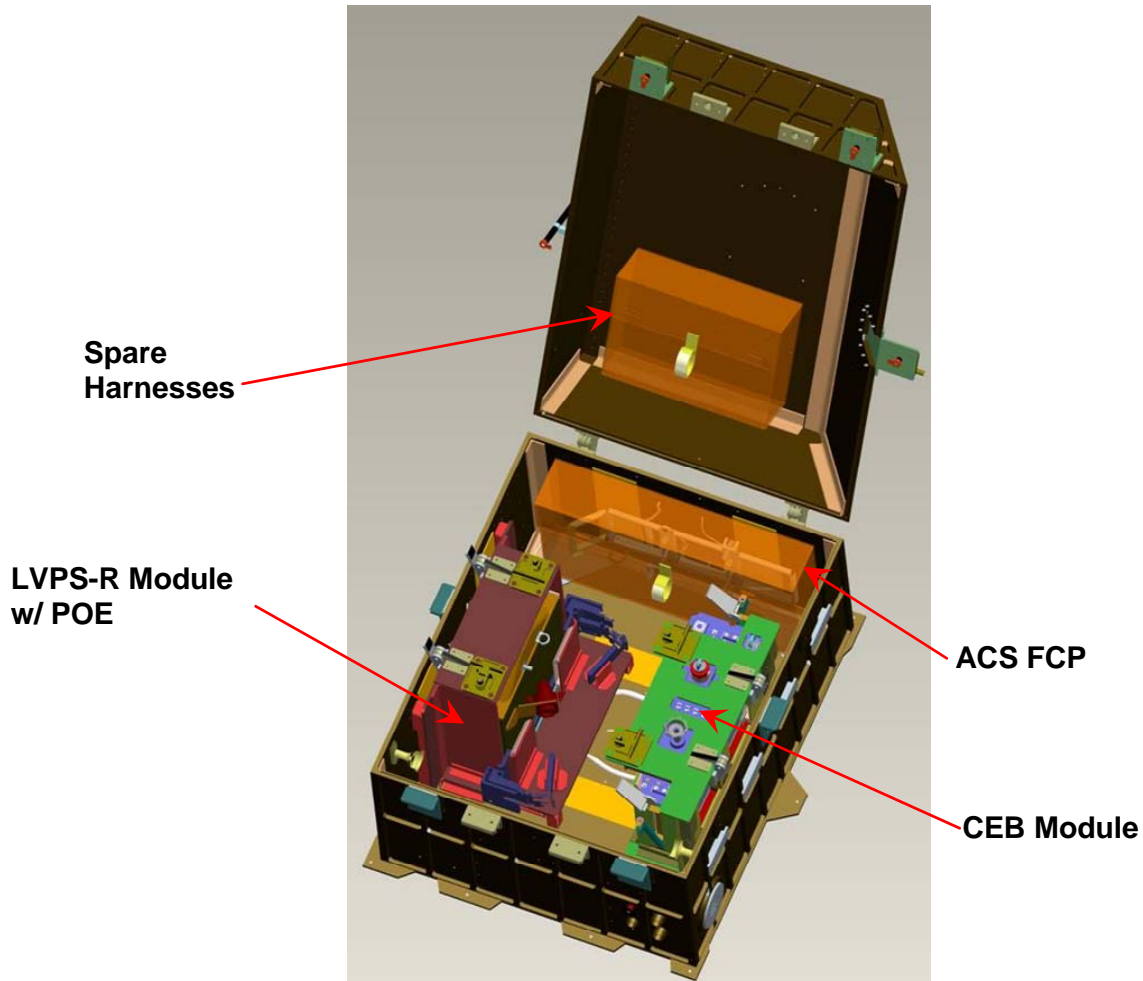
Figure 3-31. LOPE stowage layout

3.1.9   Auxiliary Transport Module 1 (ATM-1)

The ATM-1 (Figure 3-32) is mounted to the forward port face of the ORUC with 12 mounting bolts. The structure is fabricated from 6061-T651 Aluminum and the overall dimensions of the open ATM are 25.5 x. 21.25 x 12.0 inches. The ATM has a trapezoid base of 49 inches, top of 30 inches, with separation distance of 34 inches, and a height off of the Spacelab Pallet platform of 36" when lid is opened. The mass of the empty ATM-1 is 85 pounds. The maximum allowable mass of the ATM-1 is 150 pounds, including payload.

The latches and hinges are a modified design of the ORU Transport Modules1 (see Figure 3-33 and Figure 3-34) previously flown on SM3A/B. The hinge capacity was increased to accommodate higher harness loads and provide a stop at the 90-degree open position. Changes to the hinge include an increased pin diameter and cross section of lugs and increased attachment screws from #8 to #10. The ATM-1 is used to transport ACS Cryo-vent inserts (2) and covers for Aft Shroud and Bay4 Cryo-vent.

Verify that this is the correct version before use

Figure 3-32. ATM-1

Verify that this is the correct version before use
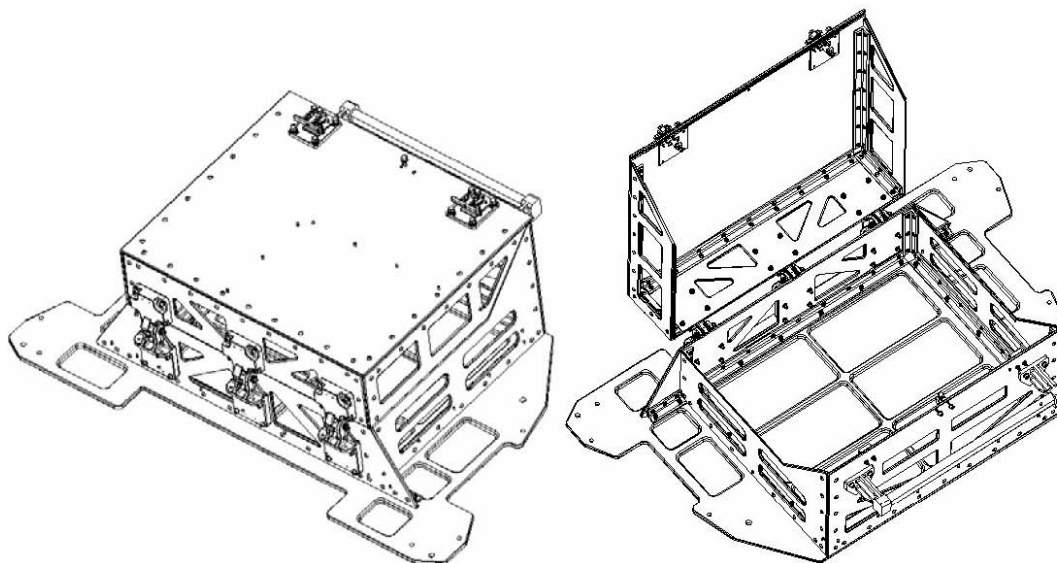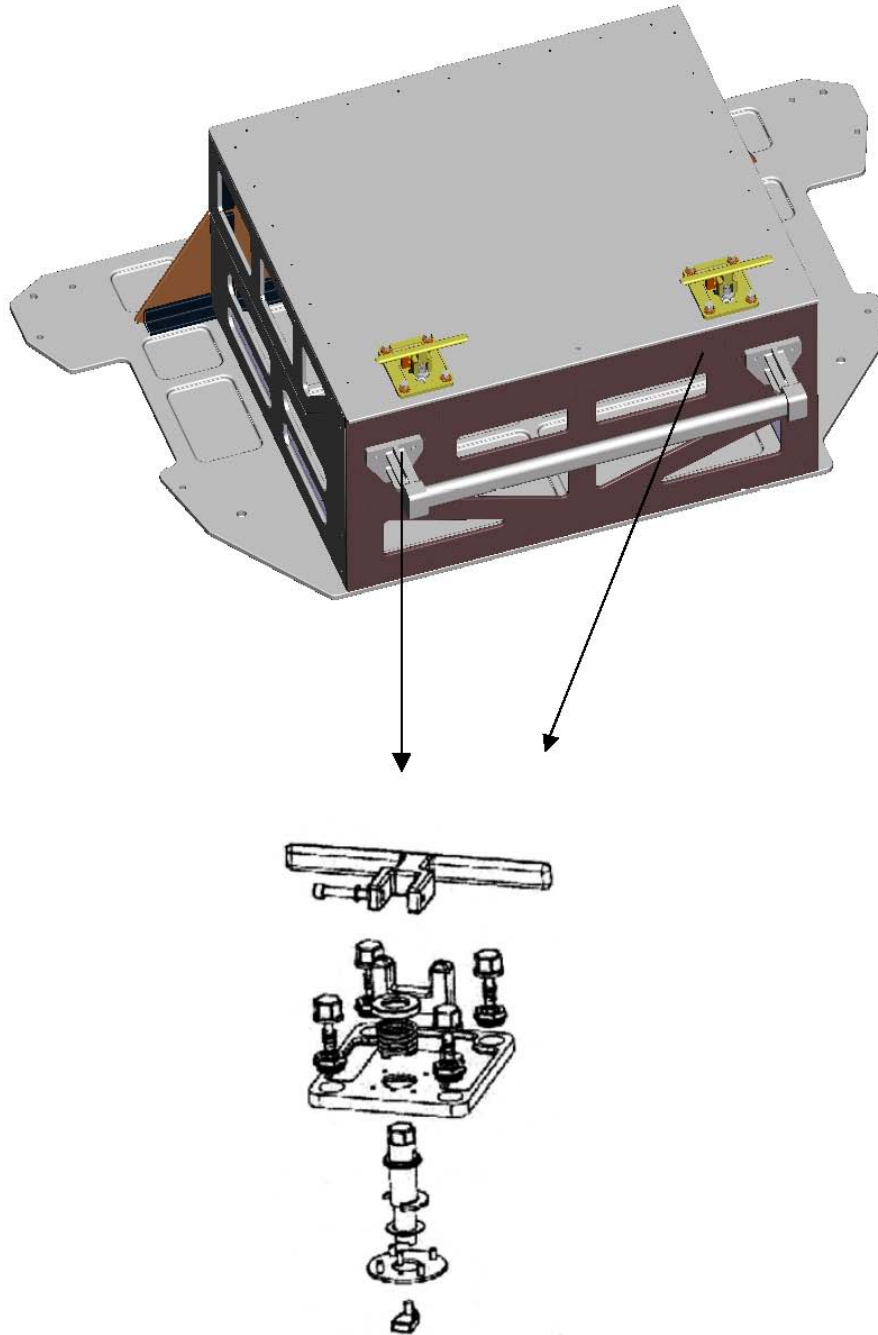
Figure 3-33. ATM latches

Verify that this is the correct version before use
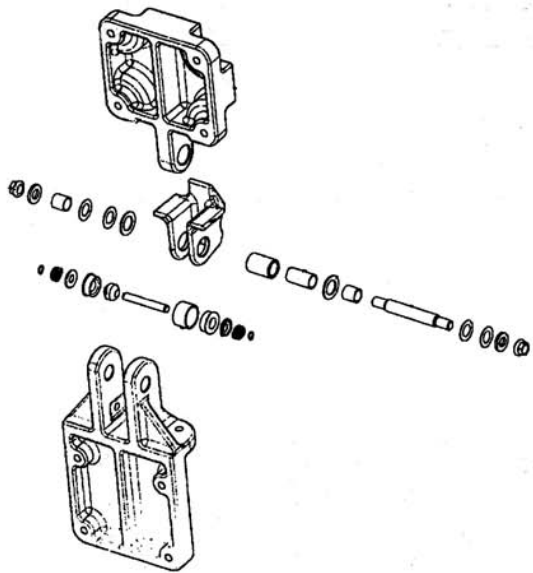
Figure 3-34. Auxiliary transport module/hinge

Verify that this is the correct version before use

3.1.10   Auxiliary Transport Module 2 (ATM-2)

For SM4, the ATM-2 (see Figure 3-35 and Figure 3-36) will be attached to the starboard aft face of the ORUC with 12 mounting bolts with thermal isolators between the ORUC and ATM-2. The structure is fabricated from 5056 aluminum honeycomb. The honeycomb core density is 3.1 pounds per cubic foot and has perforated cells. The panels will have 0.025" 2024 T3 aluminum facesheets resulting in a total panel thickness of 0.56". The exterior facesheets are vented to the outside. All inserts are cocured at honeycomb assembly. The base and sides are secured using aluminum angle extrusions. The overall dimensions of the ATM-2 are 30.5" x 21.70" x 15.57". The ATM-2 enclosure will have vents in two of the sidewalls. One vent is adequate for venting the ATM-2, however, an additional one is provided for redundancy. The mass of the empty ATM-2 is 90 pounds. The maximum allowable mass of the ATM-2 is 175 pounds including payload.

Figure 3-35. ATM-2

Verify that this is the correct version before use

Tool Disposal Bag (Return Config)

STIS CTE

AGS Caddy

STIS CET
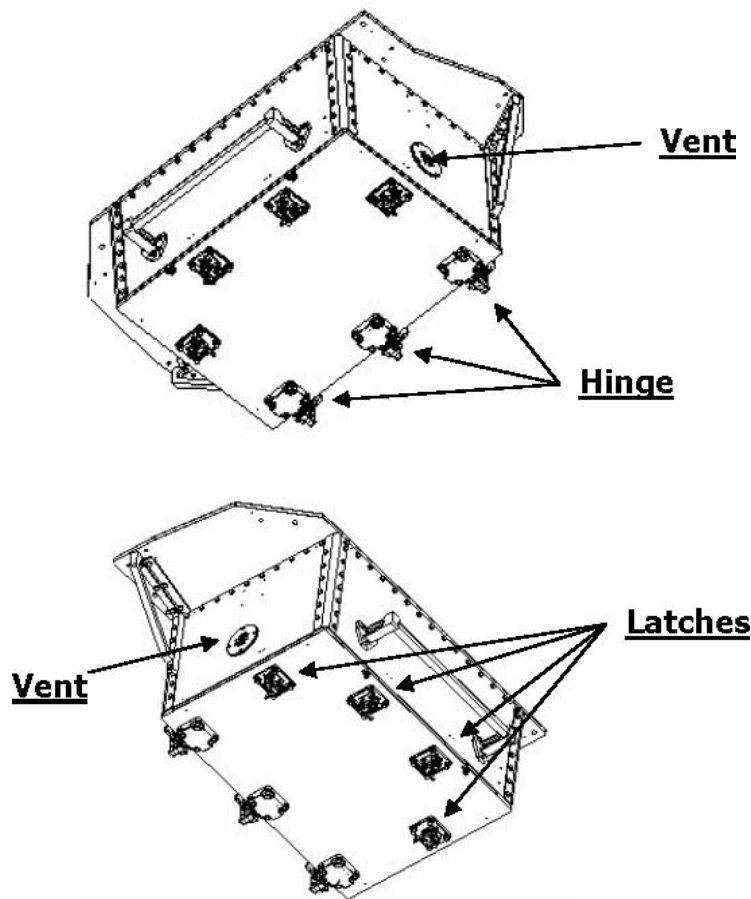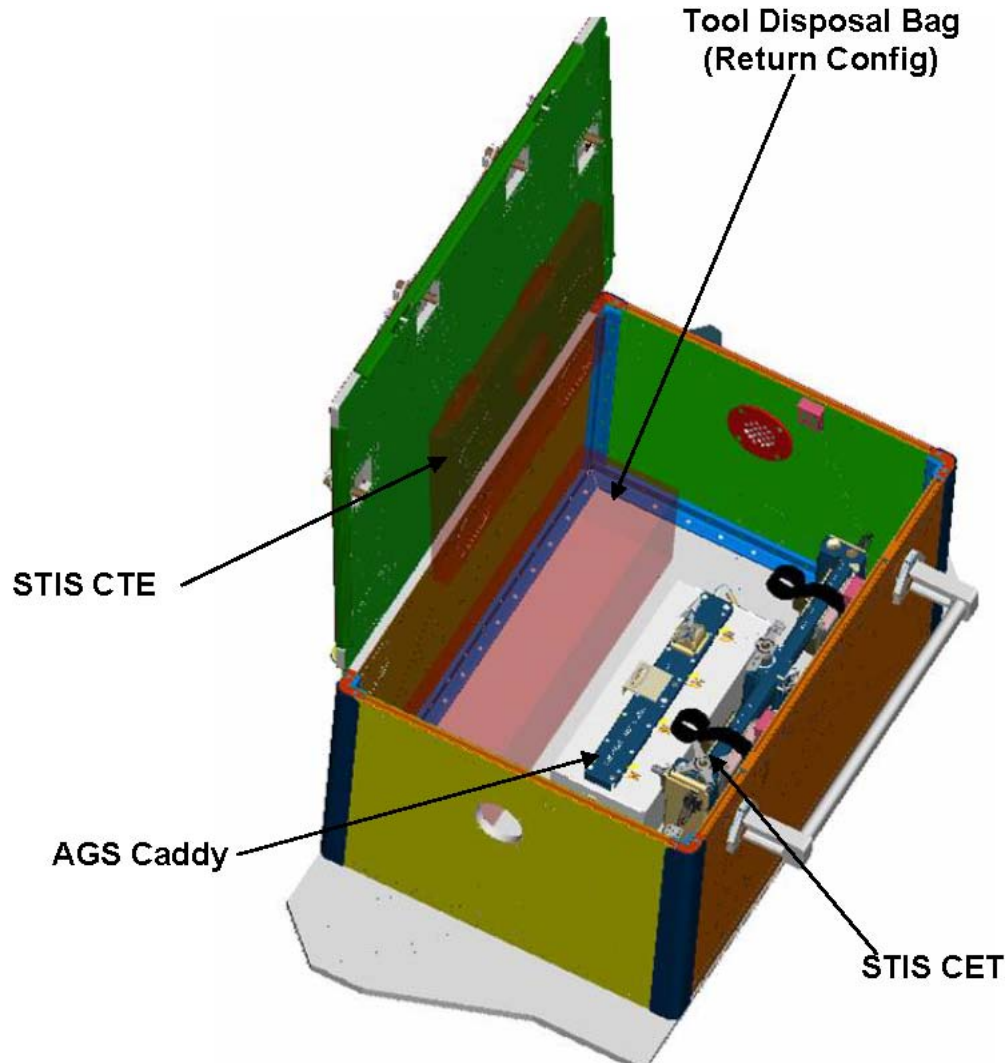
Figure 3-36. ATM-2 opened

The ATM-2 lid is secured with three hinges and four latches, (Figure 3-37 and Figure 3-38). For SM3B, the hinge capacity was increased to accommodate higher loads due to increased payload mass (175 pounds total box and payload) and provide a stop at the 90-degree open position. Two EVA bolts are provided to secure the ATM-2 in the event of a 2 latch failure for two adjacent corner latches.

The ATM-2 manifest contents are listed in Table **TBD**.

Verify that this is the correct version before use
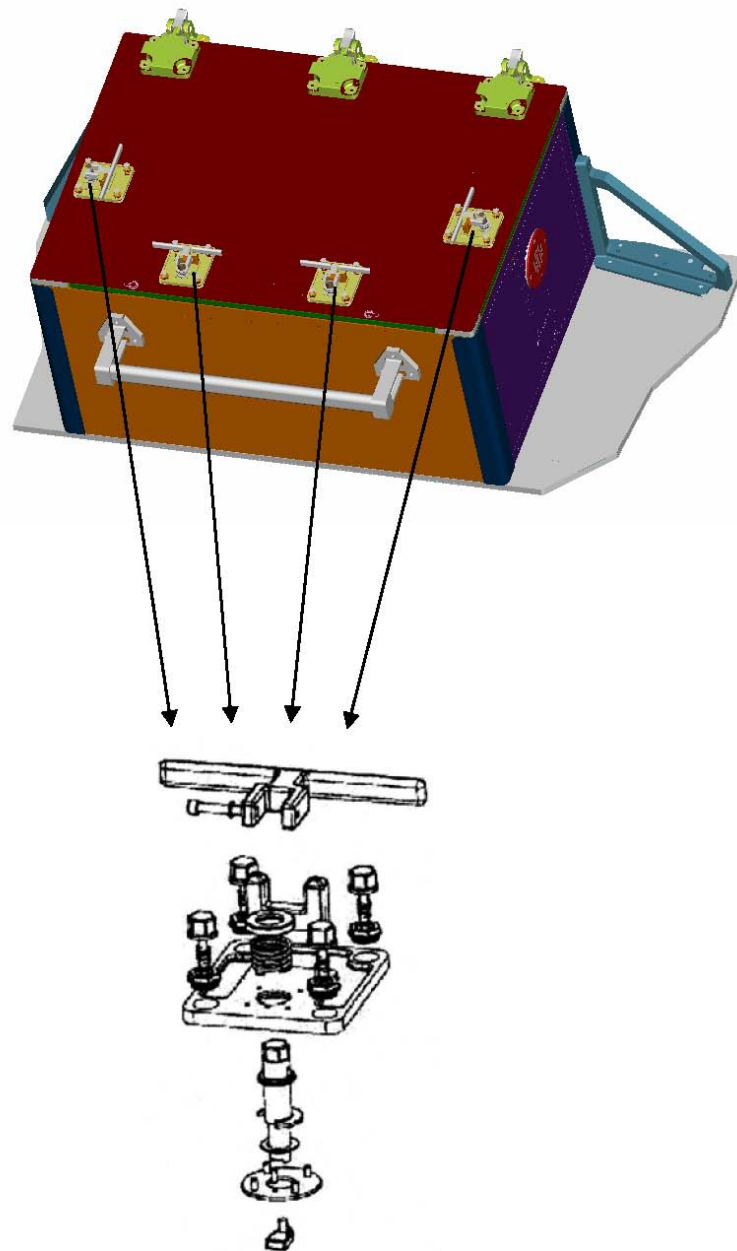
Figure 3-37. ATM latches

Verify that this is the correct version before use
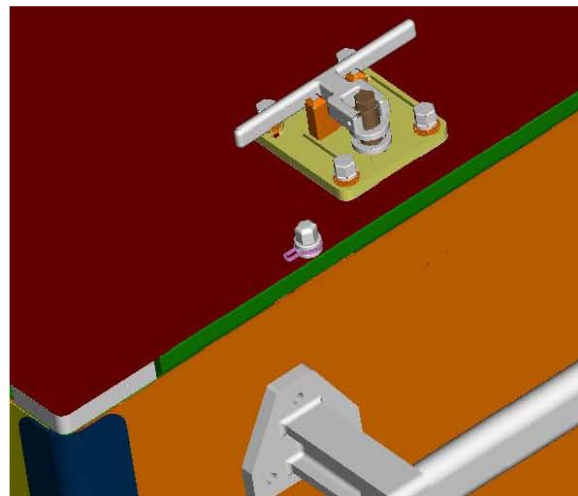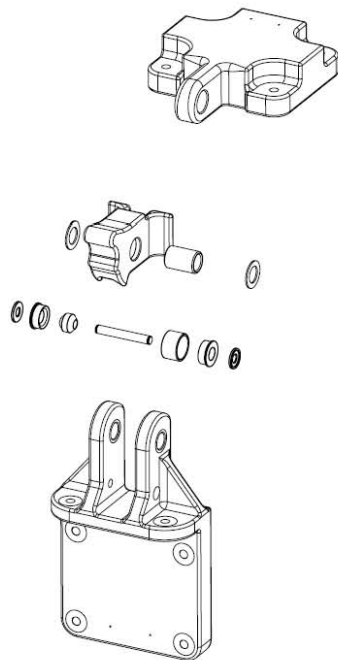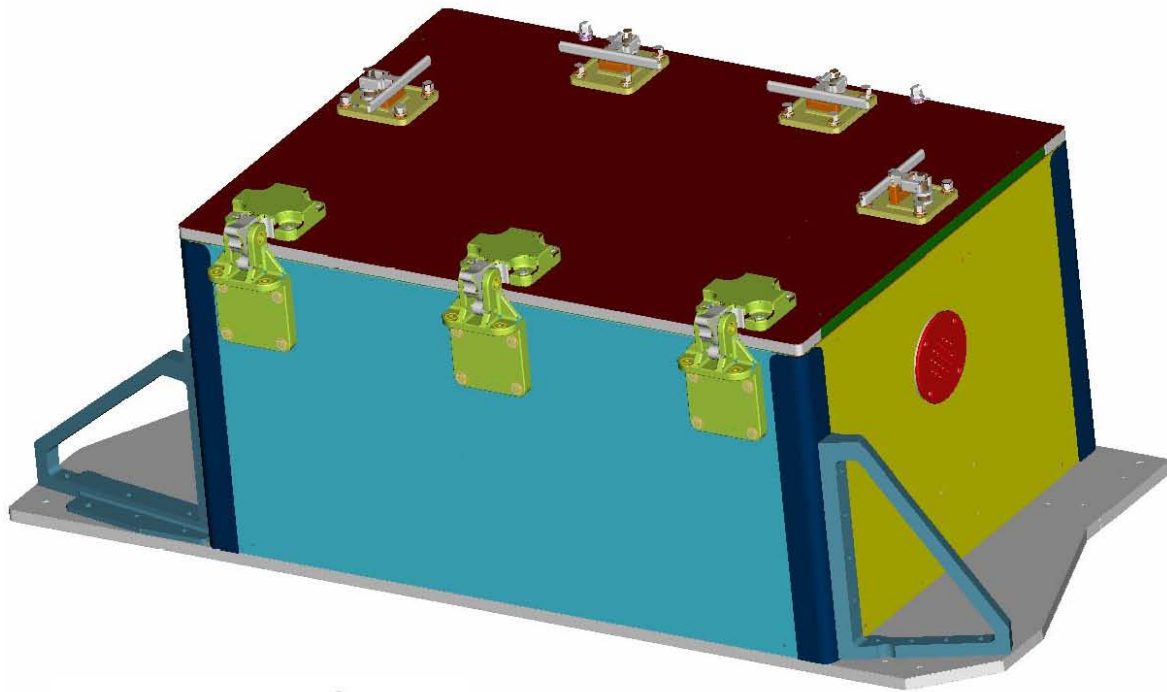
Figure 3-38. Auxiliary transport module/hinge

Verify that this is the correct version before use

3.2 ORUC FIXTURES

The ORUC manifest includes two EVA Fixtures used during SI changeout operations, the Forward and Aft Fixture. In previous missions, these were also referred to as the Stowage and Parking Fixture, respectively.

3.2.1 ORUC Aft Fixture

The Aft Fixture (Figure 3-39) is located on the aft end of the Spacelab Pallet's port sill and is "deployed" or rotated up during setup for SI change-out EVA days. It serves as a temporary parking point for the FGS (FGS with an installed handhold) or the old WF/PC-II radial SI. The FGS or WF/PC-II is temporarily parked such that it extends out over the orbiter Sill oriented parallel to the Y-axis. The "old" FGS or WF/PC-II is parked temporarily while the replacement FGS or WFC3 is removed from its respective SIPE and placed into the appropriate HST bay.

A pip-pin in the upper fork secures the radial SI handhold for reacting on-orbit loads. Primary materials for the Aft Fixture components are 7075-T7351 (forks) and 6061-T6 (structure) aluminum. The aft fixture weighs 44 pounds. The structure is reflown hardware.

ORUC Aft Fixture Mechanical

The fixture rotates about two PIP pins near the top of the stowed structure. Two sliding surfaces on each PIP pin and an interface spacer (GB1515631) (bonded in placed to eliminate a noncaptive part) between the fixture members provide fault tolerance for sliding surface failure. If the extended SI/FGS becomes jammed in the fixture forks, the upper frame hinge pins (pip pins) can be removed for a combined instrument/upper-frame jettisoned item, or the 12 EVA bolts which mount the entire fixture to the ORUC Spacelab Pallet sill can be removed and the entire aft fixture (along with the recalcitrant instrument) may be jettisoned. If the upper fork pip pin fails to release, the entire fork can be released via four EVA bolts with the fork remaining on the instrument handhold.

Verify that this is the correct version before use

SI Temp Stow Pip

Fixture Contingency Release
Pip Pins (2)

Captive Deploy Lock Pins

EVA Mounting Bolts
(Contingency)
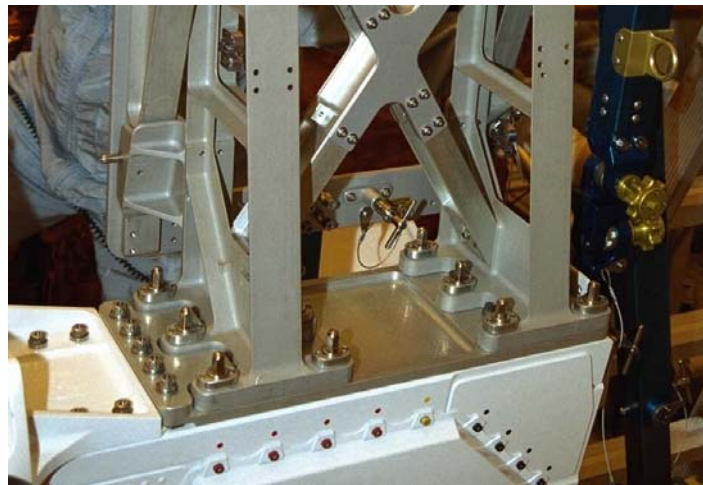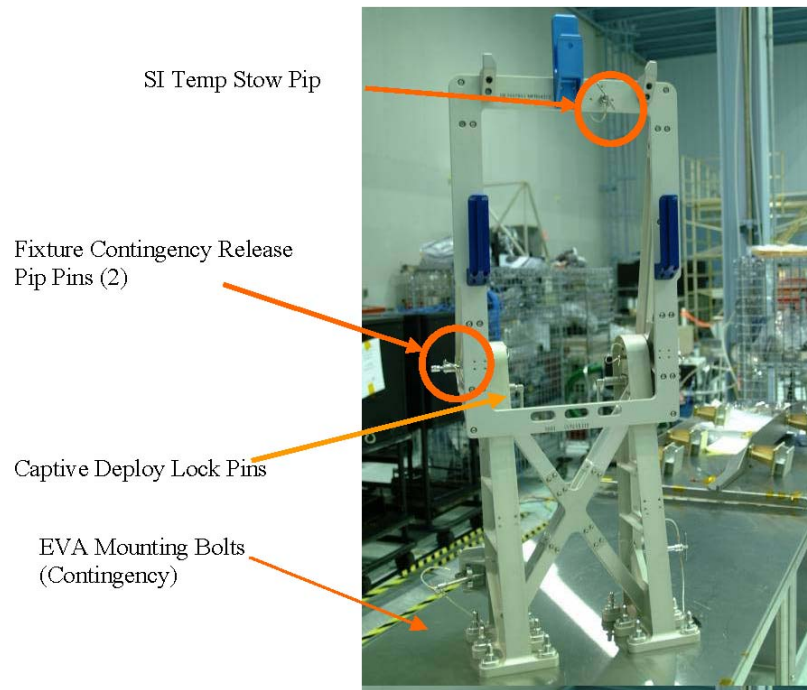
Figure 3-39. Aft fixture

Verify that this is the correct version before use

3.2.2   ORUC Forward Fixture

The ORUC Forward Fixture (Figure 3-40) is located on the port forward sill of the Spacelab Pallet. It is a fixed assembly that stores one FGS handhold on the outboard side and one WFPC handhold on the inboard side for launch and landing. For SM4, the inboard handhold is stowed vertically so that there is stowage space for the adjacent IMAX Support Structure.
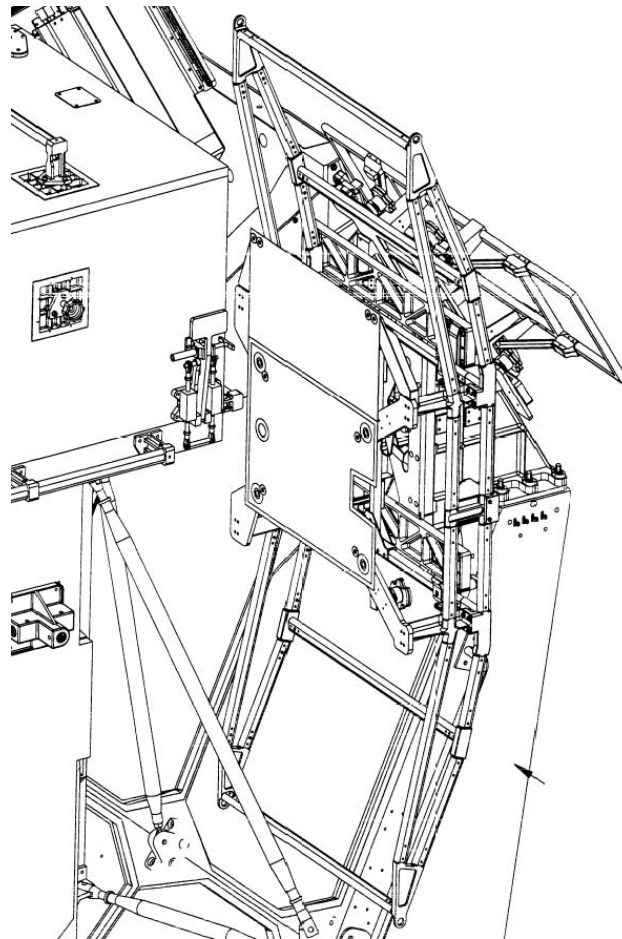
Figure 3-40. Forward fixture

ORUC Forward Fixture Structural

The structure is machined from 6061-T6 Aluminum and weighs 50 lb (without Handholds). The main supports are reflown hardware from 2 servicing missions. The outboard frames and latches (FGS Handhold) are a design developed in preparation for SM-2. On the inboard side, a new support frame and forks were designed for SM4 in order to stow the WFPC handhold in the vertical position.

Verify that this is the correct version before use

ORUC Forward Fixture Mechanical Systems

Quarter-Turn Latch Assembly

The Quarter-Turn Latch (Figure 3-41) locks the FGS handhold X-frame onto the forward fixture. The quarter turn latch is primarily composed of a pivot arm, guide plate, two ball plungers, and a locking spool. There are two latches on the top of each fixture frame.

The latch operates by pivoting the arm over the handhold, capturing it on the guide stud. A necked-down portion of the locking spool travels along a curved slot on the fixed portion of the mechanism. The end of the slot is drilled out to a larger diameter, and when the lever is in the proper position, the spool body is pushed down into this hole. The spool's main body is too large to travel in the slot therefore it is captured in the hole. The spool then remains seated by two redundant spring-loaded ball plungers and a detent groove. To open, the astronaut pulls the spool up .25 inches and rotates the lever.

In the event of a failure, the latch lock can be bypassed by untorquing the central 3/16-internal-hex socket-head screw a minimum of seven turns which allows the latch arm assembly to be pulled up high enough to ride around the slot.
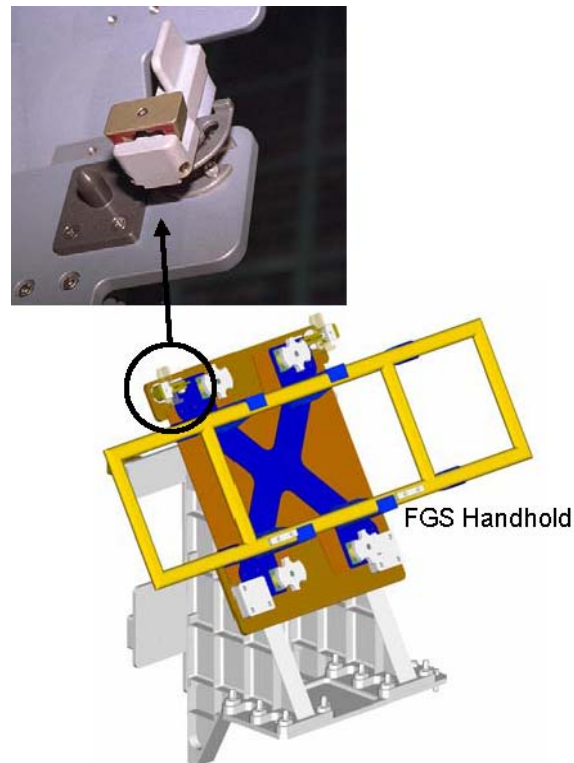
Figure 3-41. Quarter turn latch assembly on FGS handhold X-frame

Verify that this is the correct version before use

Captive Deploy Lock Pins

The WFPC handhold will be secured to the Forward Fixture using three captive deploy lock pins (see Figure 3-42). The lock pins operate by pushing-in and rotating a quarter turn to release. They feature a pair of internal springs that are redundant when the pin is engaged and a pair of captive EVA bolts for removal of the entire pin assembly.
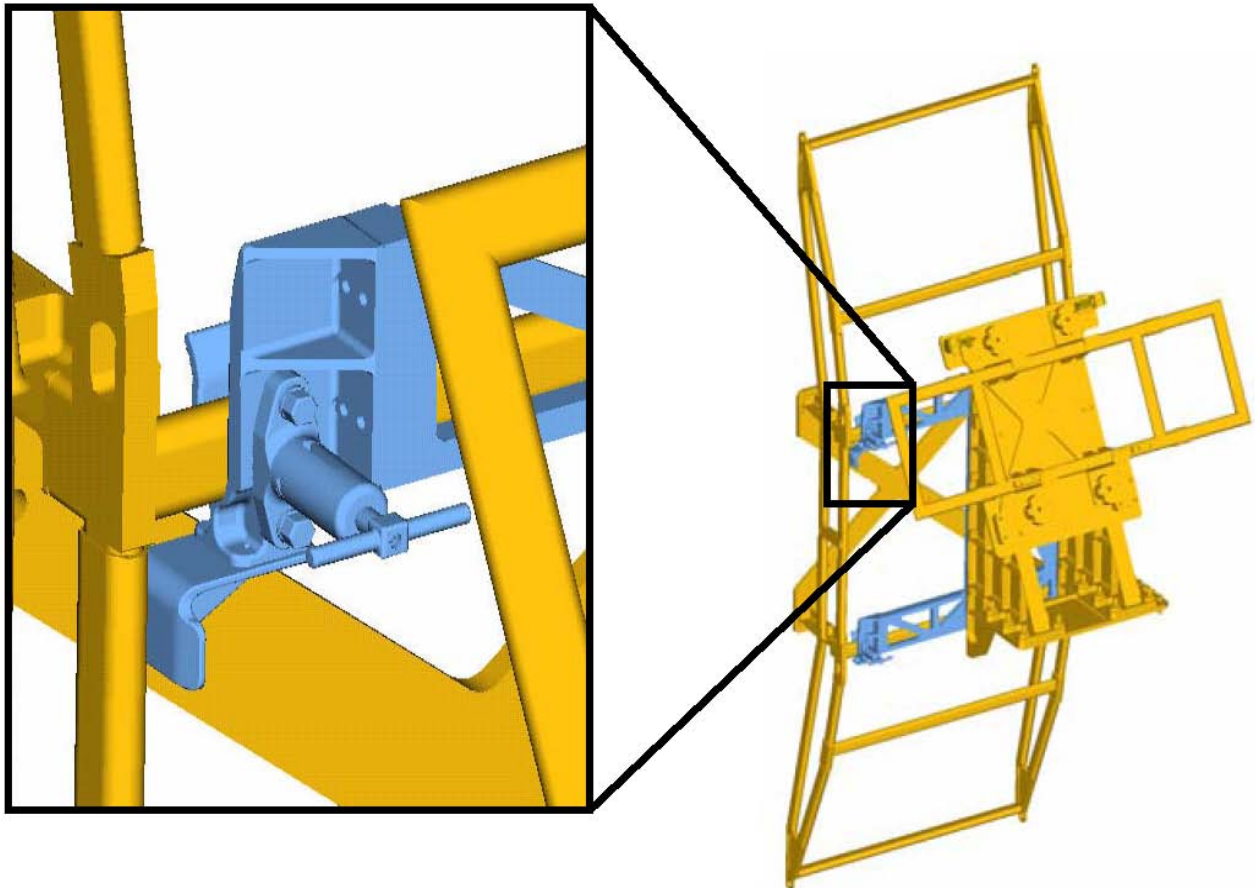
Figure 3-42. Captive deploy lock pin

Verify that this is the correct version before use

Forward Fixture EVA Bolts

The Forward Fixture EVA Bolts (Figure 3-43) provide a means of detaching and jettisoning the Forward Fixture in a contingency. These hex-head double-height gauged EVA bolts can be removed by an EVA crew member using the PGT.

Figure 3-43. Forward fixture EVA bolts

3.2.3   IMAX-3D ORUC Support Structure

The SM4 Mission will include an IMAX camera mounted on the ORUC. The IMAX camera has flown before; however it was mounted directly to the orbiter on a sidewall Get-Away-Special (GAS) beam. Electrical interfaces for IMAX will be provided directly from the orbiter. IMAX will be installed on the ORUC sidewall near the trunnions. It will be mounted with a combination of new hardware and previously flown IMAX adapters. The following information describes the IMAX support structure on the ORUC side of the interface. For more detail about the IMAX Camera itself, see the ICBC3D Cargo Systems Manual.

Verify that this is the correct version before use

The IMAX ORUC support structure was designed to accommodate the IMAX Container assembly in the same manner (i.e., using the same mounting plate) as when the IMAX flew on STS-104 on the GAS beam. This was done to minimize modifications to the already existing IMAX container and associated components. Figure 3-44 shows the IMAX support structure installed onto the ORUC. Figure 3-45 and Figure 3-46 show the IMAX accommodation with the IMAX container installed apart from the ORUC.

IMAX Support Structure

IMAX Camera Enclosure
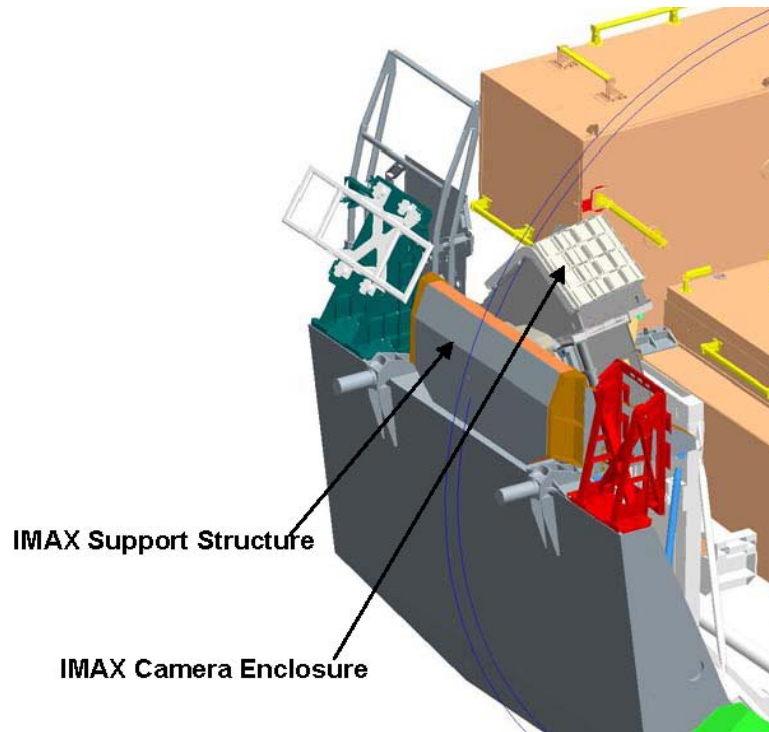
Figure 3-44. IMAX installed onto ORUC

Verify that this is the correct version before use
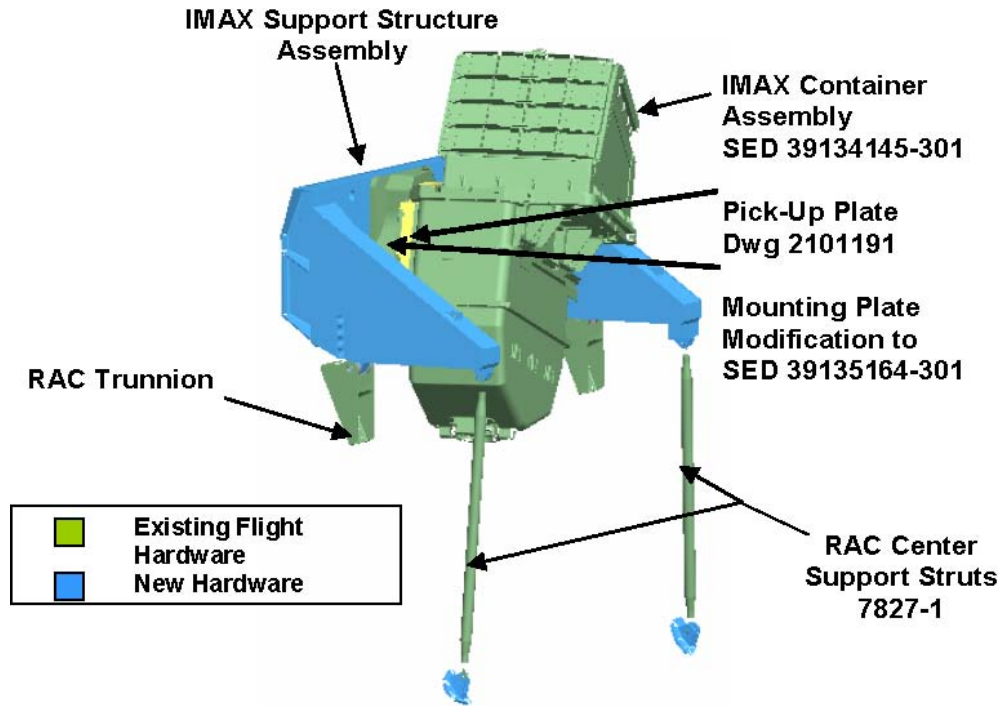
Figure 3-45. IMAX ORUC accommodations – front view
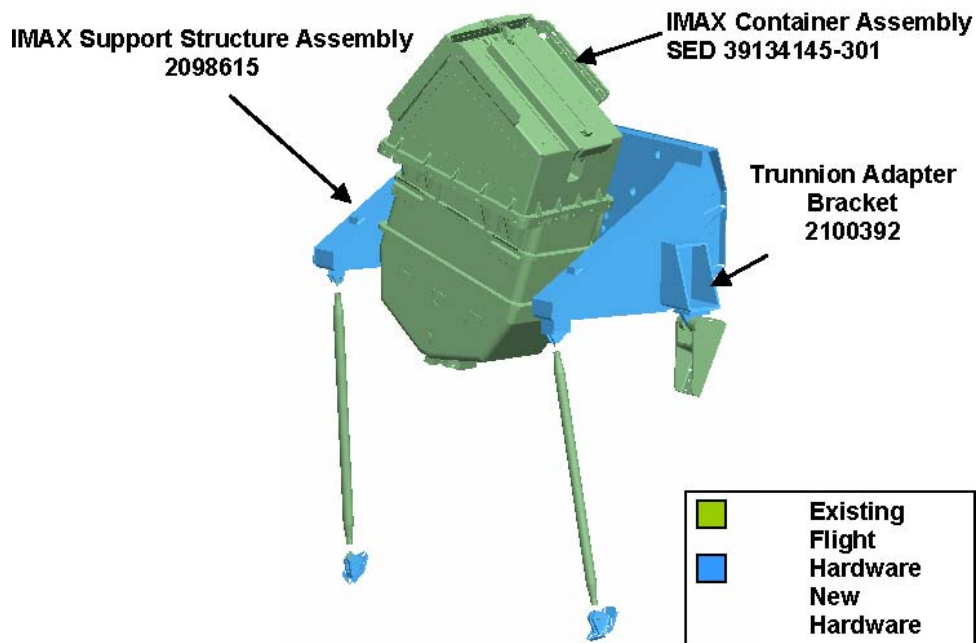
Figure 3-46. IMAX ORUC accommodations – rear view

Verify that this is the correct version before use

The purpose of the IMAX camera is to take high quality, stereo video images during SM4. Consequently, the IMAX camera must be positioned inside the orbiter bay to maximize possible images. Figure 3-47 shows the Yaw and Pitch of the camera required to obtain the correct Field of View (FOV). As a consequence, the adapter plate from STS-100 was chosen as it provides the appropriate orientation for IMAX.
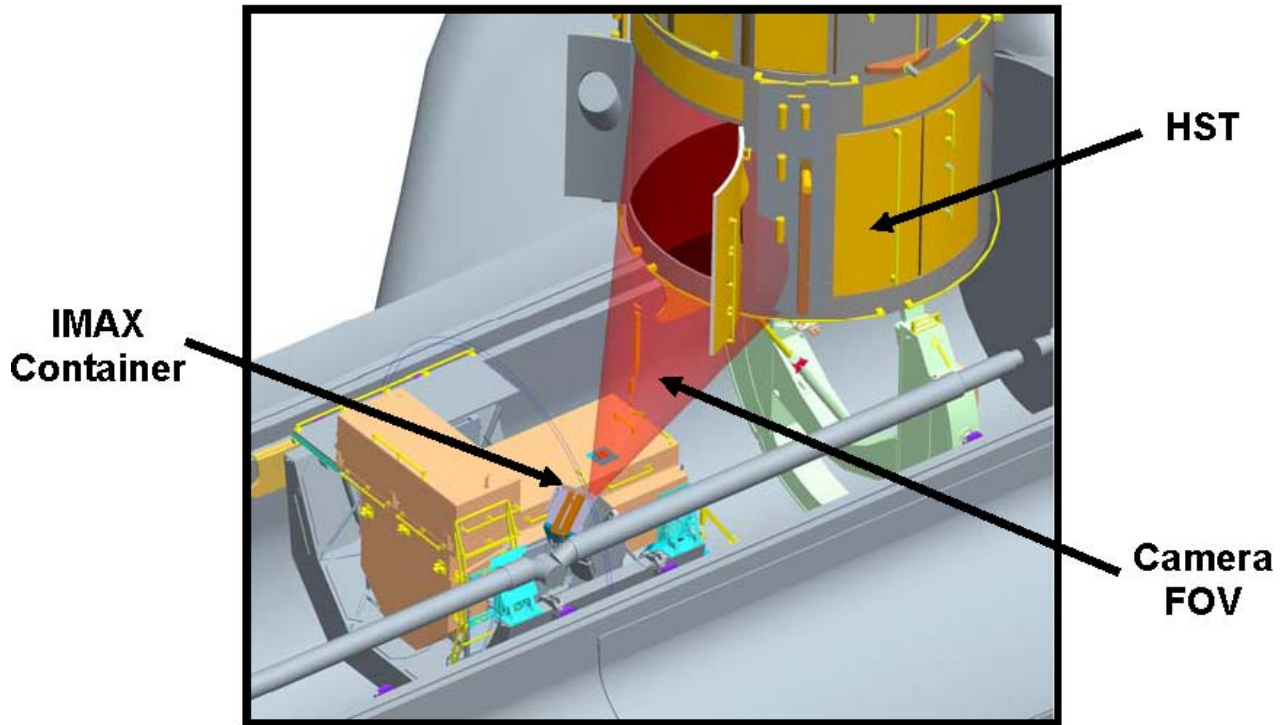
18⁰ Yaw and 41.8⁰ Pitch Required to Achieve FOV

Figure 3-47. IMAX field of view

The IMAX support structure without the IMAX container and camera weighs 291 pounds. The new hardware is built of T6061 Aluminum. All fasteners are high strength stainless steel, inspected per GSFC Fastener Integrity Requirements, 541-PG-8072.1.2. The struts and trunnion are reflown equipment previously used on the Rigid Array Carrier (RAC) structure during SM3A. Figure 3-48 provides an expanded view of the new hardware being built for the IMAX Support Structure Assembly.

Verify that this is the correct version before use
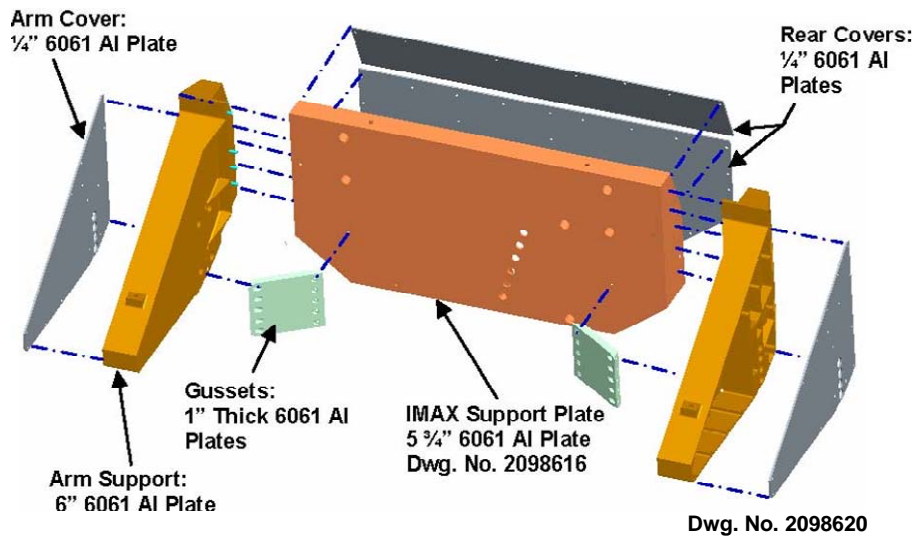
Figure 3-48. IMAX support structure – expanded view

All joints are bolted or pinned. No liquid locking compounds are used as backaway prevention for safety-critical fasteners. Figure 3-49 through Figure 3-52 provide additional detail about the bolted joints and trunnion attachments.

Bolted Joints
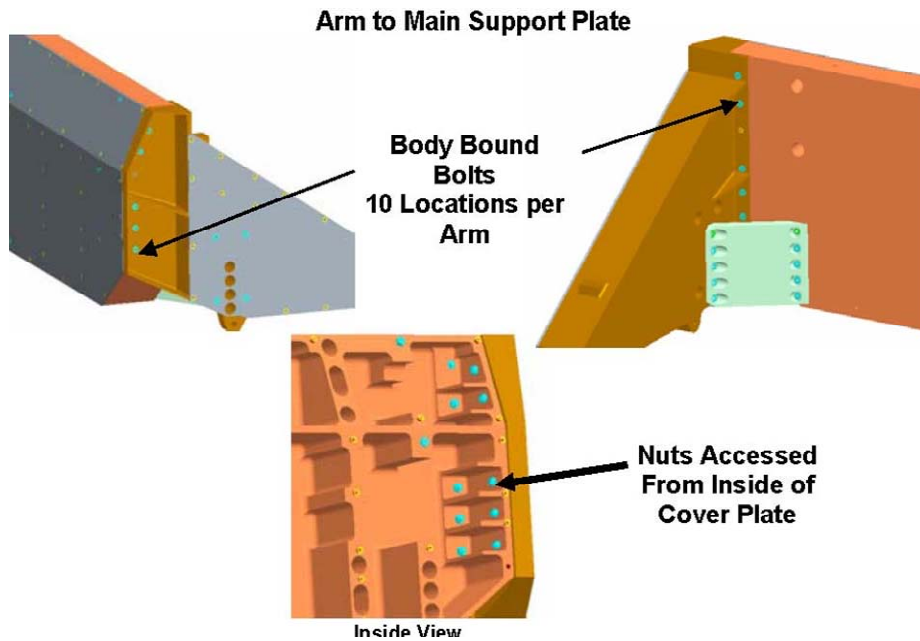
Figure 3-49. IMAX support structure joints

Verify that this is the correct version before use

Bolted Joints
Corner Gussets

Nuts Accessed Inside Cover

Body Bound Bolts (8X)
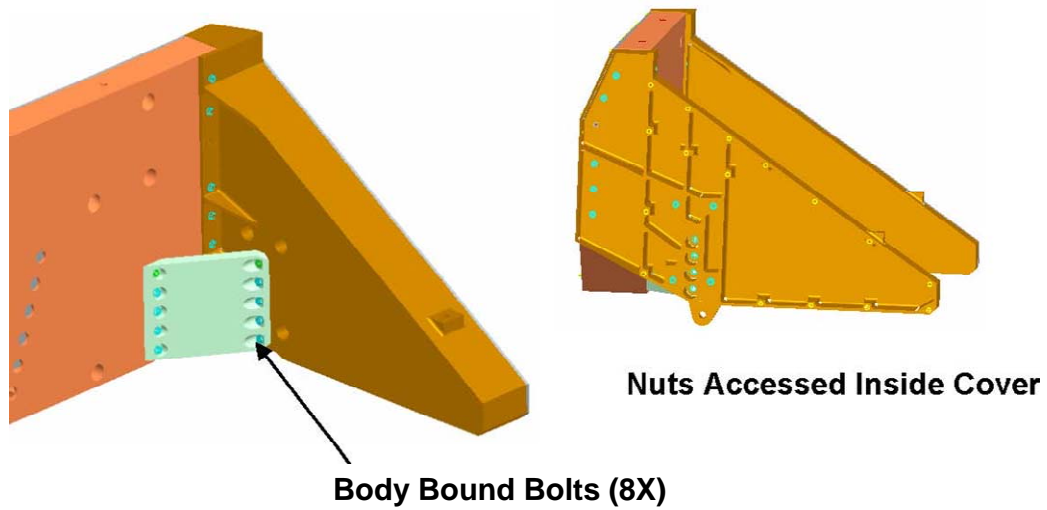
Figure 3-50. IMAX support structure joints

Bolted Joints
Cover Plates

**Tension Fasteners
w/ Helicoil**

**Body Bound Bolt(s)
(NAS6706U10)**

Cover Plate

Main Support Plate
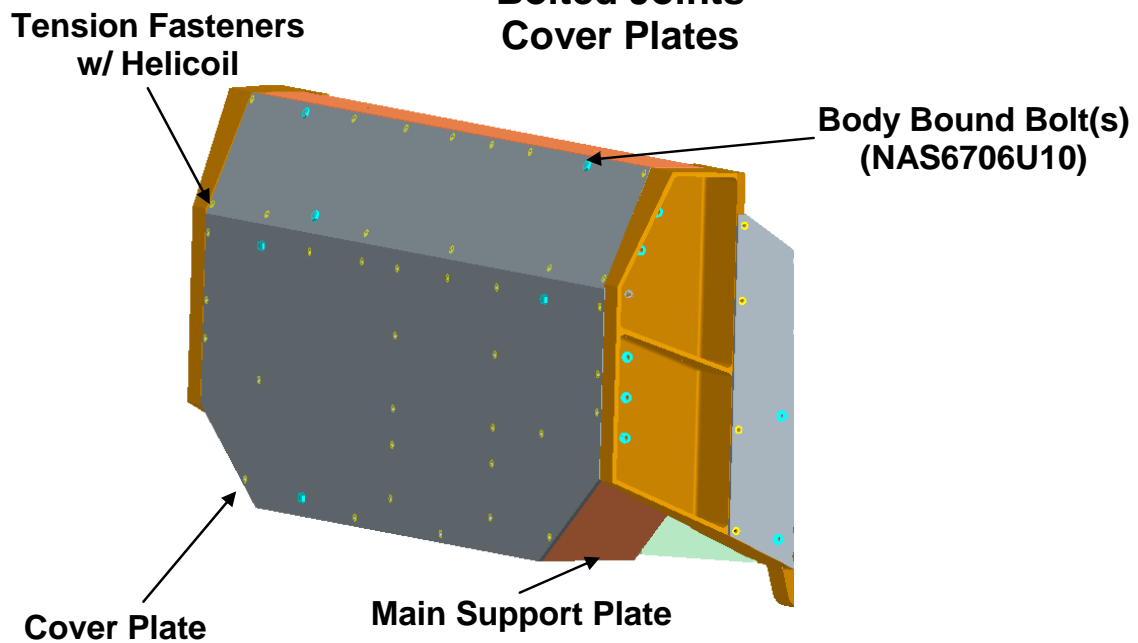
Figure 3-51. IMAX support structure joints

Verify that this is the correct version before use

Trunnion Attachments

Primary Trunnion

(Support Structure Removed for Clarity)

X Load Reacted at this Location

Secondary Trunnion

(Support Structure Removed for Clarity)
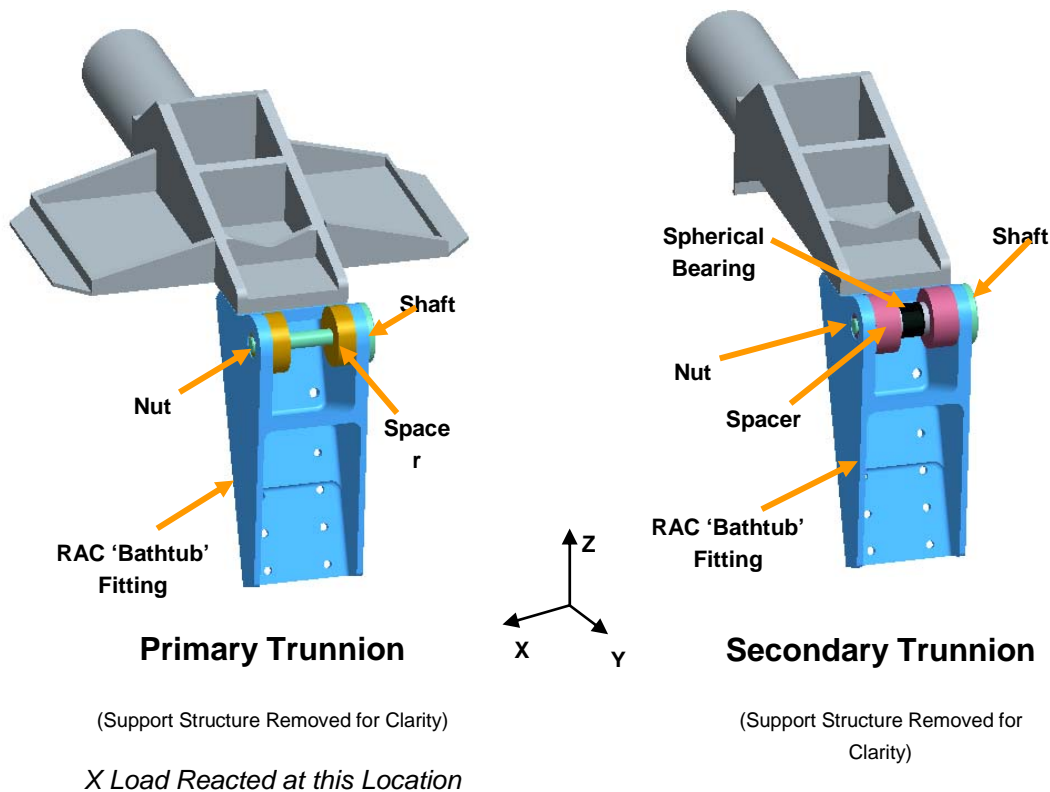
Figure 3-52. IMAX support structure joints

3.2.4   STIS Repair Stowage

Two new enclosures are built for the ORUC in support of STIS Repair activities. The two enclosures are the Main Electronics Board Cover-Replacement (MEB Cover-R) and the Fastener Capture Plate Enclosure (FCPE).

MEB Cover-R

The MEB Cover-R is stowed on the ASIPE lid. The MEB Cover-R is removed from the enclosure during STIS repair and remains on the telescope. For return, the MEB Cover-R Enclosure is empty and the Latch secures the support structure to the lid. For thermal purposes the entire MEB Cover-R and latching hardware is encased in a 13-Layer MLI Blanket with Beta-Cloth outer layer. The MEB Cover Enclosure location is shown in Figure 3-53. Figure 3-54 and Figure 3-55 show the MEB Cover-R enclosure in more detail.

Verify that this is the correct version before use

RFP : Master Rep
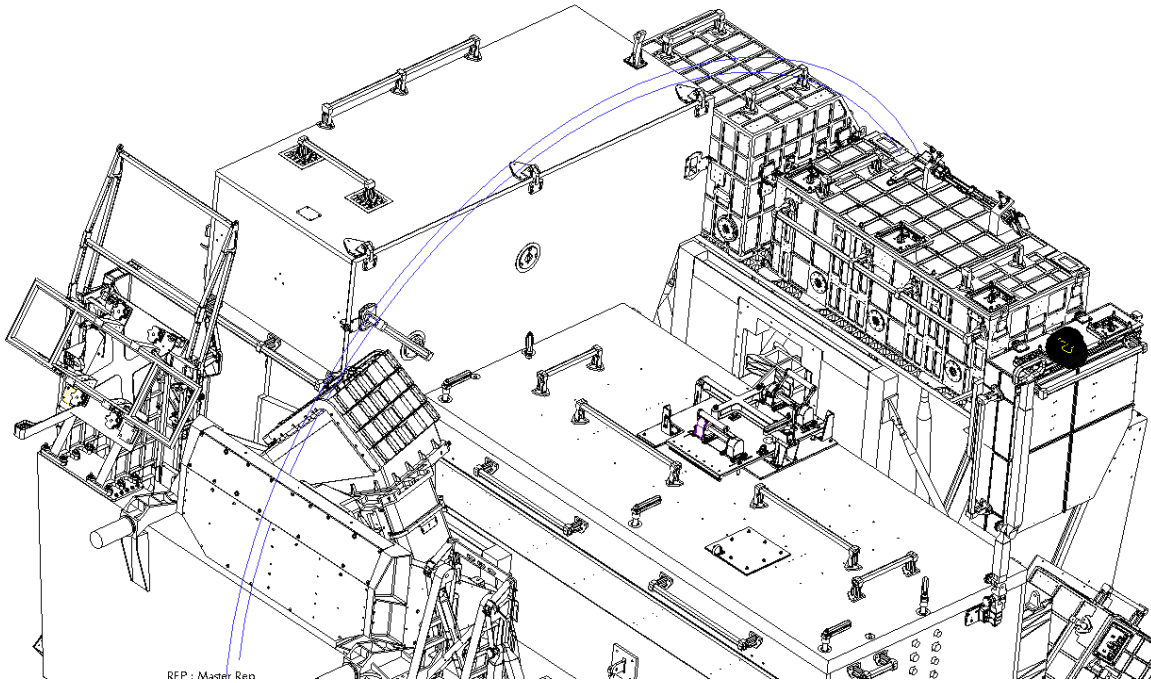
Figure 3-53. MEB Cover-R located on ASIPE

A T-Bar provides 500 - 600 pounds of preload onto the MEB Cover-R during launch load. A pip pin provides protection against inadvertent latch release. MEB Cover-R ground path is provided by metal-to-metal contact through the snubber system.

Verify that this is the correct version before use
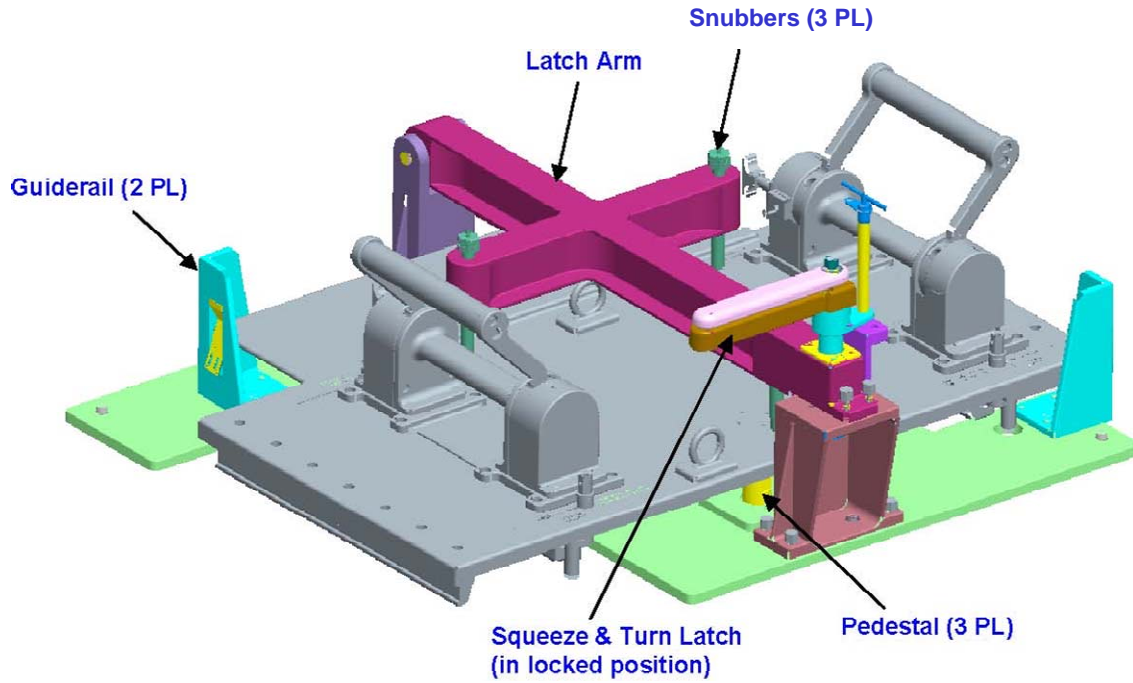
Figure 3-54. MEB Cover-R with latch stowed
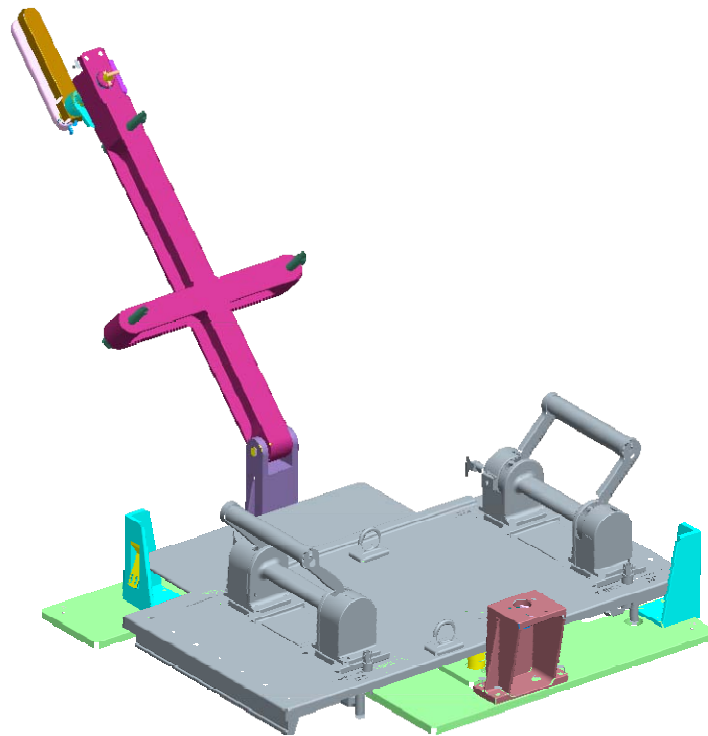
Figure 3-55. MEB Cover-R with latch open

Verify that this is the correct version before use

MEB Cover-R Mechanisms

1/4 Turn Squeeze and Latch

The Squeeze and Quarter-Turn Latch (Figure 3-56) is an existing design, similar to the ASIPE Lid Latches and ASCS Latches (MULE/SM3B). The holding preload is adjusted by the Belleville stack-up internal to the latch.
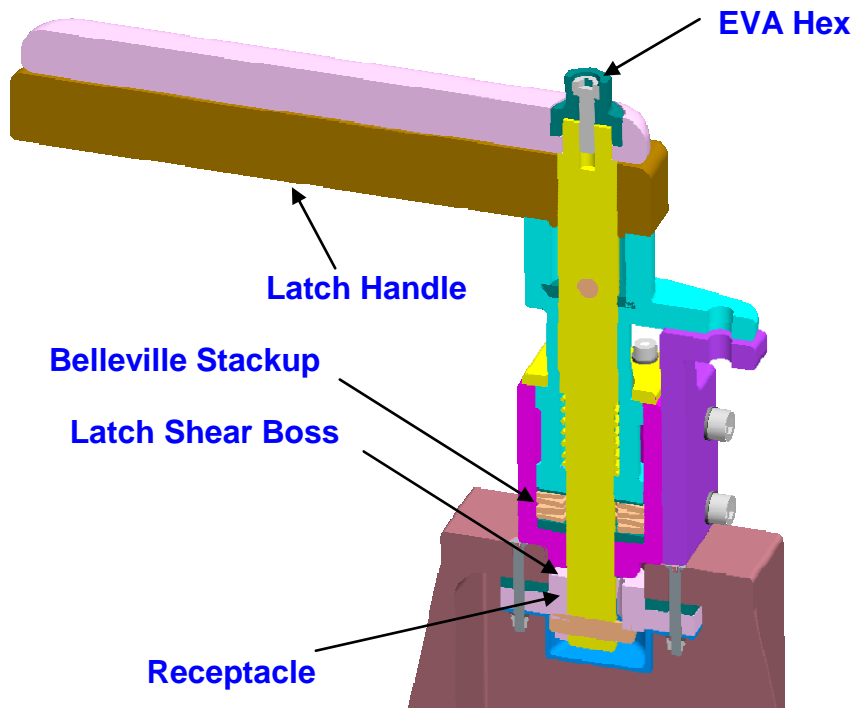
Figure 3-56. MEB Cover-R squeeze and quarter-turn latch

Verify that this is the correct version before use

Enclosure Hinge

The Latch hinge system (Figure 3-57) provides triple sliding surfaces.
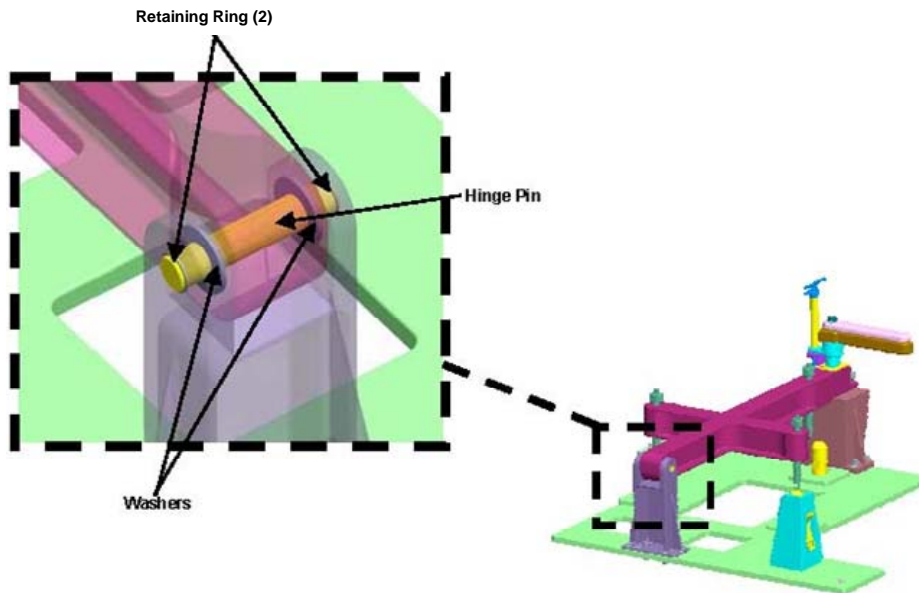
Figure 3-57. MEB Cover-R enclosure hinge

Snubber or Bungee Design

The 3-point snubber or "bungee" system (Figure 3-58) is adjusted to provide the preload onto MEB Cover-R. The snubbers seat within divots machined into the MEB Cover-R.
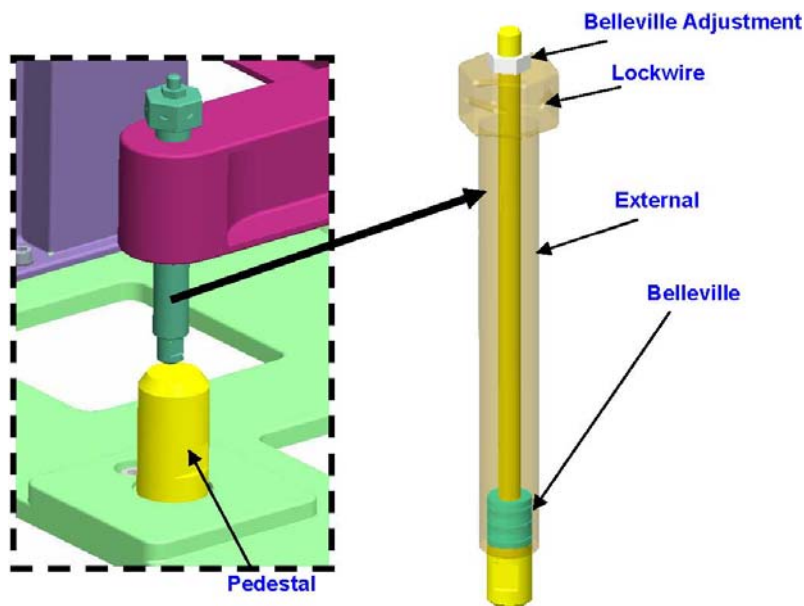
Figure 3-58. MEB Cover-R snubber design

Verify that this is the correct version before use

EVA Override and Contingency Operations

In the event the Latch jams and the MEB Cover-R cannot be removed from the enclosure, 4 EVA Captive fasteners on the latch base can be released (see Figure 3-59). If the Latch releases during re-engagement (MEB Cover-R gone), the Latch Arm can be secured with two or three EVA Contingency fasteners.
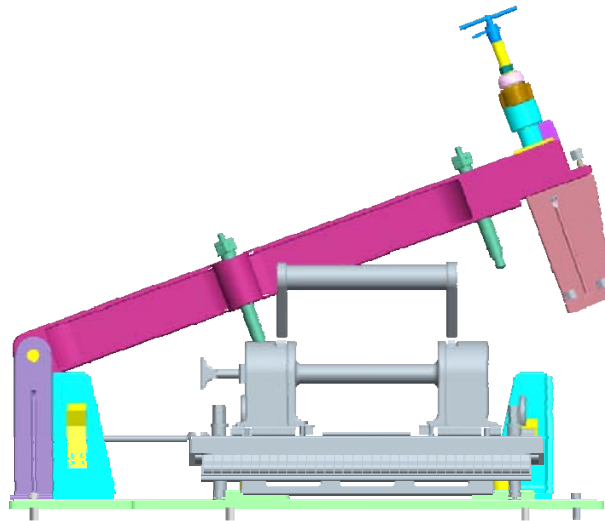
Figure 3-59. MEB Cover-R EVA contingency concept

MEB Cover-R Thermal Design

The MEB Cover-R (Figure 3-60) receives conductive/radiative heat from the ASIPE lid internal heaters. The ASIPE lid mating surface to the enclosure adapter plate will have its MLI removed and replaced with high emittance Kapton VDA tape to enhance the transmission of heat from the lid to the MEB Cover-R. In addition, the top surface of the adapter plate, the area facing the MEB Cover-R will be covered in Black VDA tape.
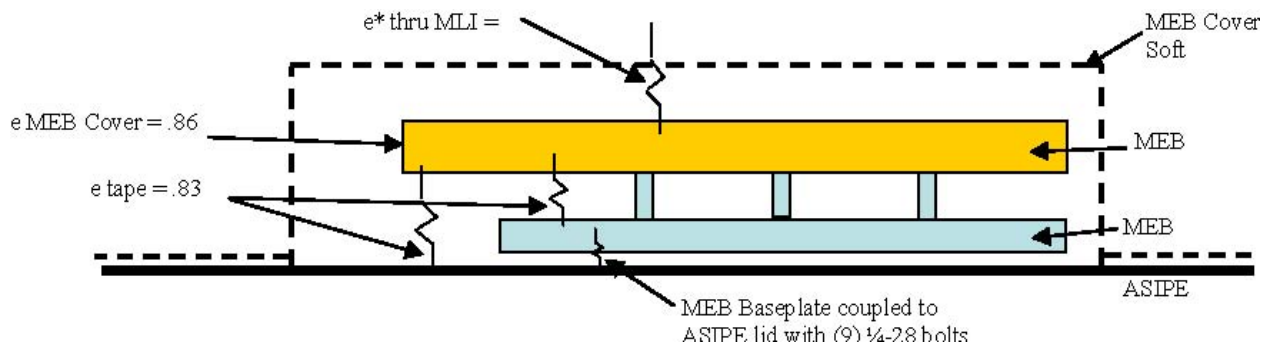
Figure 3-60. MEB Cover-R thermal design

Verify that this is the correct version before use

An all encompassing MLI Beta cloth cover will be constructed to thermally protect the entire structure. The blanket is mechanically secured to the ASIPE lid on one side and releasable on remaining three edges. The MLI cover opens separately from the Latch arm.

3.2.5   Fastener Capture Plate Enclosure

The Fastener Capture Plate Enclosure (FCPE) (Figure 3-61) is stowed in a dedicated enclosure on the aft starboard end of the ORUC Shelf. The enclosure is unheated and is blanketed with a 9 mil blanket with Kapton outer layer. The FCPE returns in the same location with the old MEB Cover and Clamp Removal Tool attached.
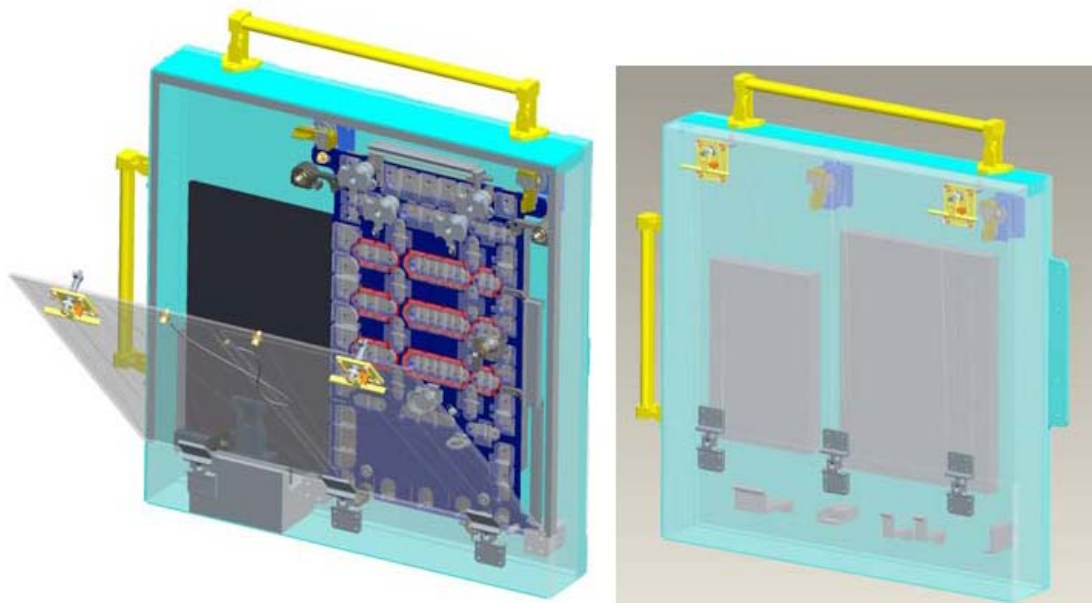
Figure 3-61. FCP launch and landing configurations

Verify that this is the correct version before use

FCPE Mechanisms

The FCPE is held within the enclosure via two pull and turn latches and a guide system (Figure 3-62). The same stowage configuration was designed for the FGS handhold on the Forward Fixture. The lid is secured with two T-handle latches and three hinges.
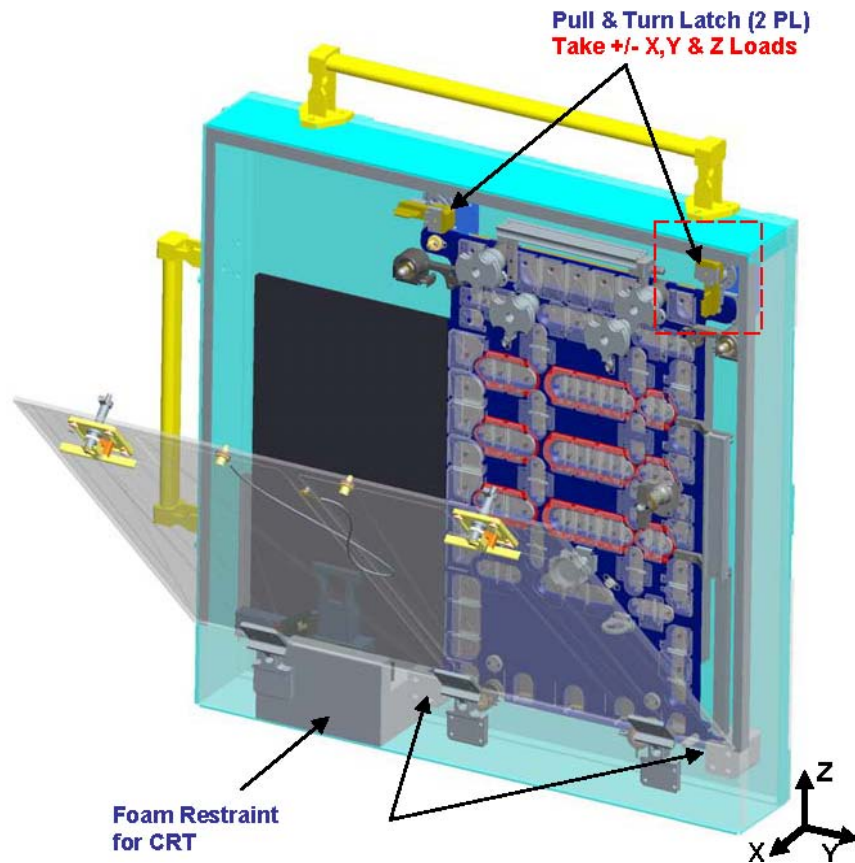
Figure 3-62. FCP enclosure with pull-and-turn latches

Verify that this is the correct version before use

Pull and ¼ Turn latches

The FCP latches (Figure 3-63) will be a build-to-print design from the FGS Handhold Stowage latches. In the event that the latch cannot be secured for landing, an EVA Contingency bolt can be used in its place once the failed Pull and Turn Latch has been removed.

Latch Arm Removed after jam

Shear Post

Latch Open with FCP Removed

Contingency Bolt
Screws into Shear Post
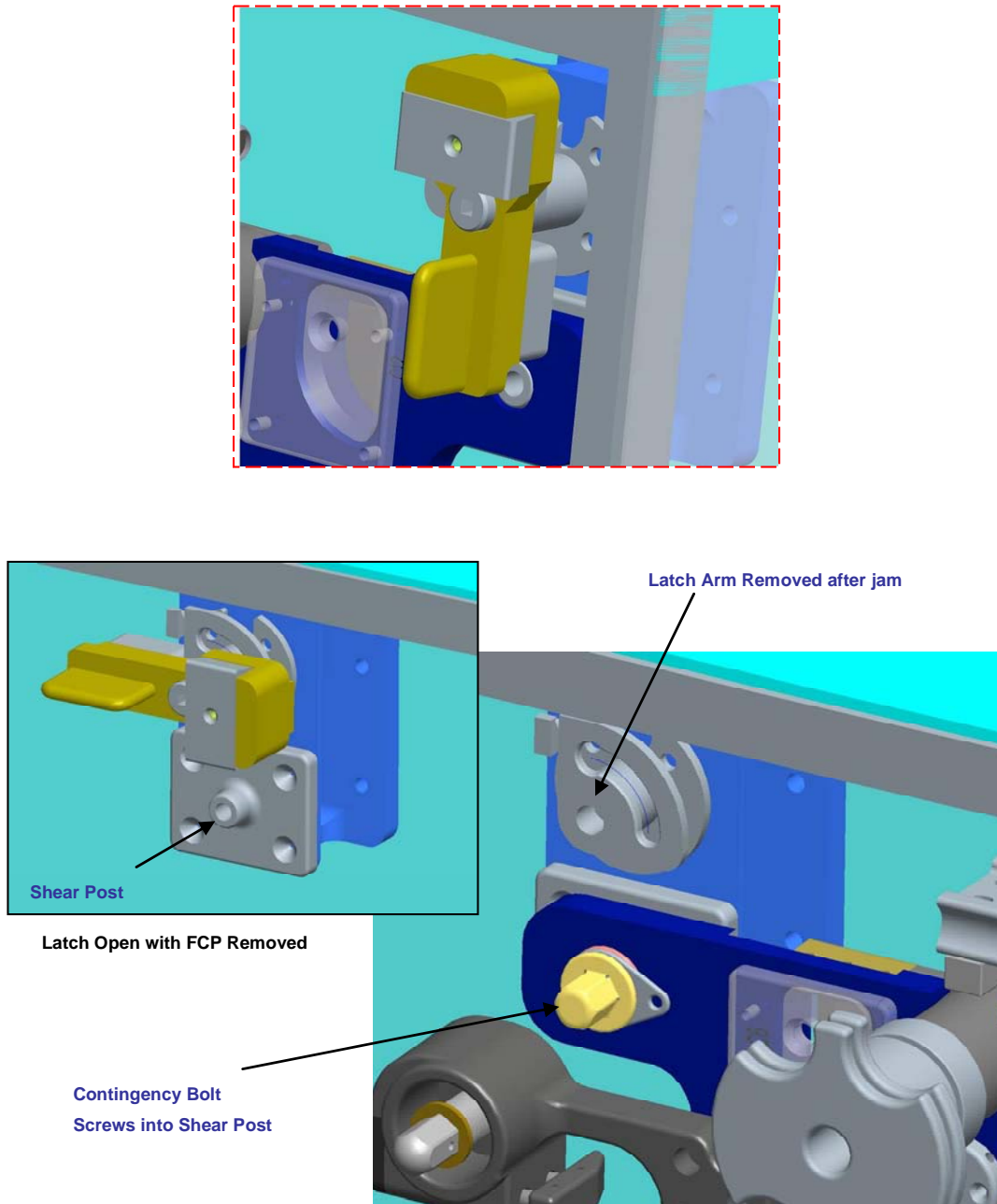
Figure 3-63. Close-up of pull-and-turn latches

Verify that this is the correct version before use

T-Handle

The FCP lid T-handle latches will be of the same design as the described in the OPE section of the ORUC description. In the event that a T-Handle latch cannot be engaged for landing, two contingency bolts can be used to secure the cover. Figure 3-64 shows this configuration.
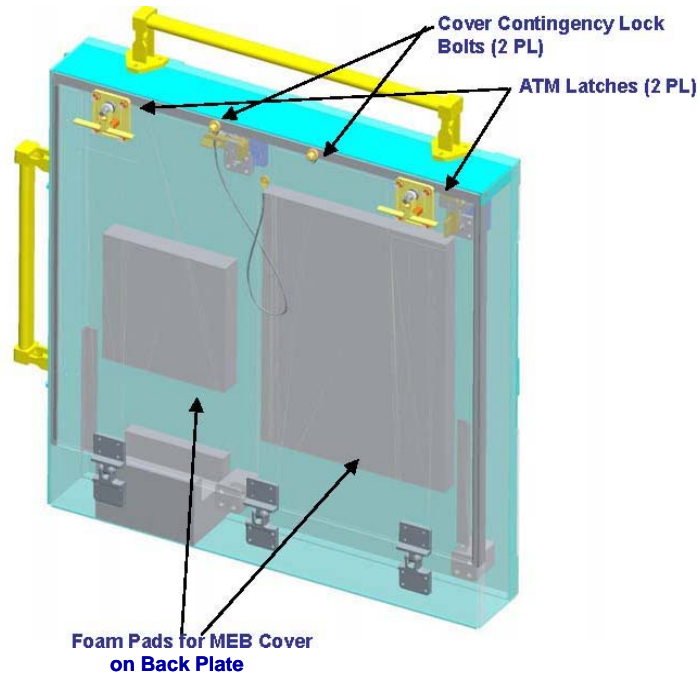
Figure 3-64. FCP and T-handle latches and contingency bolts

3.3   ORUC UNIQUE EVA CREW AIDS/EQUIPMENT

GSFC EVA hardware on the ORUC includes the following:

a.   Handrails

b.   MLI repair tool

c.   Portable Foot Restraint (PFR) Sockets (7) and Ingress Aids

d.   FGS handholds

Verify that this is the correct version before use

e. WFC3/WFPC Handhold (one stowed on ORUC, one on SLIC currently)

f. EVA Safety Bar

g. Forward and Aft Fixtures

Also included is the Articulating Portable Foot Restraint (APFR), which is JSC provided hardware.

MLI Recovery Bags and Handrail Recovery Caddies

The MLI Recovery Bag is used to transport MLI removed from the HST. It will launch inside a pouch on the port side inner panels of the pallet. However, once filled with the removed MLI, it will be too large to be restowed within the same pouch. The returning bag will be brought into the crew cabin for landing. The MLI Recovery Bag is described in Section 4.3, Previously Flown Payload-Provided CATS.

Pip Pin Bracket

The Pip Pin Bracket (GD2022973) currently stows spare pip pins as listed in the SMEL, See Figure 3-65. The spares are selected so that each Pip pin interface on the SSE hardware has a usable spare. The bracket assembly mounts to the forward edge of the ORUC starboard shelf and consists of an angled Aluminum plate with a maximum capacity of 11 receptacles to house pins, if needed. All components are iridited aluminum 6061. The pin receptacles are customized to each pin diameter and length. All pins have a lanyard and tether ring attached. The tether rings are inserted in a slot on the receptacle and secured by the pin shaft. These allow the astronaut to first tether to the ring then pull the pin. Each pin receptacle has a decal with an identification number (111) which corresponds to the ID number etched on each pin. The entire bracket is covered with a single layer of Beta Cloth with an integral backup layer of thick Kapton, See Figure 2-18. The cover is bolted under the bracket for positive retention. The cover eliminates inadvertent pin release & minimizes touch temperatures.

The maximum mass of the assembled bracket and pins is 11 pounds. The bracket has been analyzed for launch/landing and EVA inadvertent contact loads (125 lb). (Reference analysis memo: Orbital 98-ECK-675.) All machined components are classified Safe-Life and all fasteners are Fail-Safe or Low Risk. All the PIP pins can be considered Low Release Mass because they have less than the maximum mass of 0.43lb for Xo=917 (32.5 ft from the aft bulkhead).

Verify that this is the correct version before use
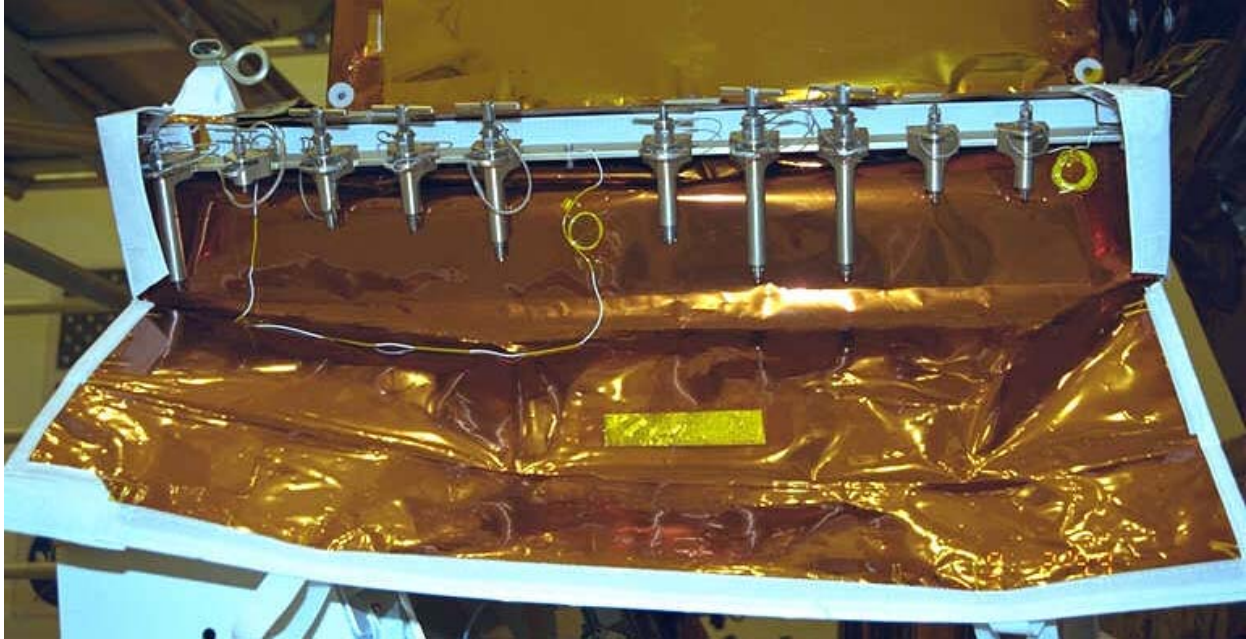
Figure 3-65. ORUC pip pin placement in bracket with cover

EVA Safety Bar

The EVA Safety Bar (Figure 3-66) is installed into the returning SI in the event of a
B-Latch failure. The Bar spans across the top of the SI within the ASIPE and screws
into an unused GSE interface. It is stowed on the forward face of the carrier using a
fixed pin on one side and a pip pin on the opposite.

Figure 3-66. EVA safety bar (three views)

Verify that this is the correct version before use

MLI Contingency Pouches

There are four small and two large contingency patches that are stowed in tube-like pouches (Figure 3-67). This is the same configuration as for SM3B. The pouches are secured using a series of Velcro flaps.

Figure 3-67. Large and small MLI contingency stowage pouches

Verify that this is the correct version before use

MLI Tool

The MLI tool is a long plastic bar used to manipulate sheets of MLI in a contingency situation. The tool is stowed on the forward side of the pallet on the inboard pallet panels. The tool is removed by first pulling the hitch pin from its receptacle and unfolding the barrier flap. The tool is then easily slid out of its sheathing. (See Figure 3-68.)

Figure 3-68. MLI tool storage sheath

3.4   ELECTRICAL SYSTEM

The ORUC Electrical System consists of the Power Regulator Junction Unit (PRJU), associated heaters and harnessing, and the SIPE latch indicators.

The electrical subsystem performs the following functions:

a.   Receives orbiter power from the FSS.

b.   Provides regulated voltage (18 V dc) to the instrumentation to monitor and make operational decisions regarding the ORUC thermal control system.

c.   Furnishes power for the light bulbs that provide visual indication of FSIPE and ASIPE latch status during EVA operations.

Verify that this is the correct version before use
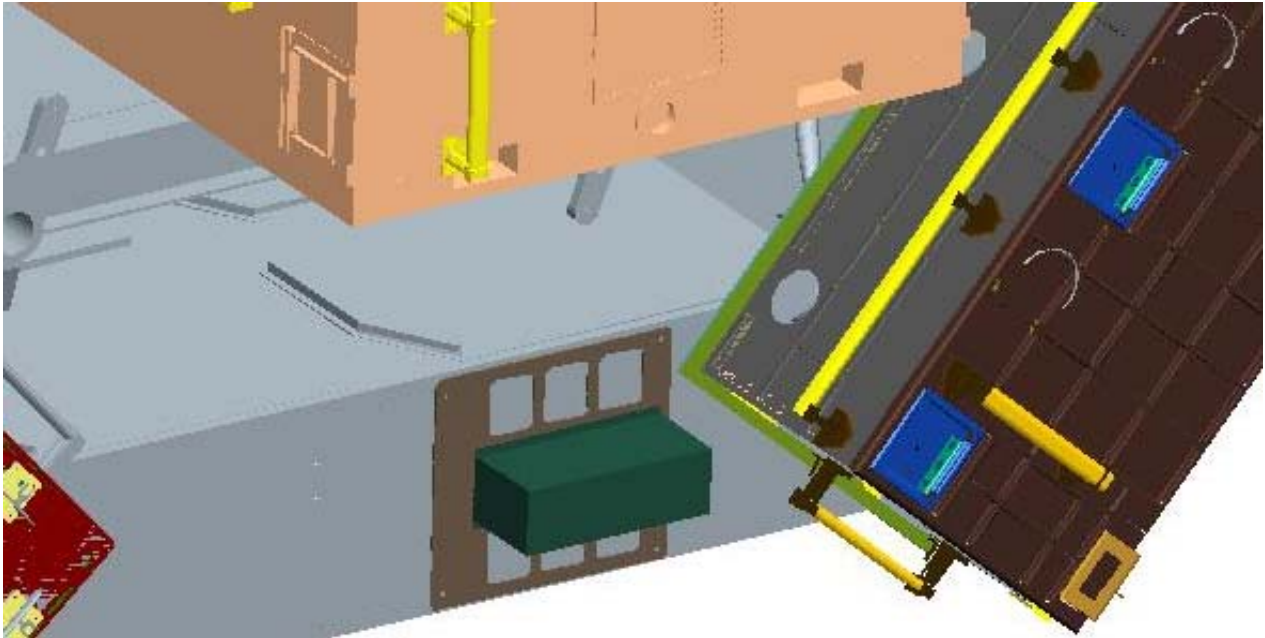
Figure 3-69. ORUC power regulator junction unit

3.4.1   ORUC Power Regulator Junction Unit (PRJU)

The ORUC's PRJU (Figure 3-69) is located at the bottom of the ORUC aft-face. The PRJU performs power distribution and circuit protection for all loads on the ORUC as well as providing telemetry circuit biasing power. The PRJU's power interface is with the FSS EPDSU's Module 8. The PRJU receives orbiter unregulated power, +28 +/- 4 V dc 20 amp fused, by two redundant power buses (STS PWR A and B), fused at 35A, capable of carrying and distributing up to 1120 Watts of power at 32 V dc, each with three distinct services. ORUC Bus A's power is from EPDSU-1 Module 8 and ORUC Bus B's power is from EPDSU-2 Module 8. The ORUC PRJU harnessing physically interfaces with the ORUC/Orbiter Electrical Interface Panel, and from there connects to the orbiter at the starboard SIP OIP at location Xo = 1035.56. ORUC power is controlled by switches on the orbiter's SSP (S6 and S7) shown in Table 3-2.

Verify that this is the correct version before use

Table 3-2. ORUC power on orbiter switches

EPDSU Module/Switch	Control SSP2 (L12L)	Load Limit	Service
EPDSU-1, M8/S1	S6	10A	ASIPE Heater A Power ASIPE Indicator A Power
EPDSU-1, M8/S2	S6	10A	ASIPE Heater B Power ASIPE Indicator B Power
EPDSU-1, M8/S3	S6	10A	SOPE Heater A Power
EPDSU-2, M8/S1	S7	10A	SOPE Heater B Power
EPDSU-2, M8/S2	S7	10A	BPA Heater A Power
EPDSU-2, M8/S3	S7	10A	BPA Heater B Power

Internal to the EPDSUs, its two buses are further divided into three fused buses (for a total of six individually fused buses) within the PRJU. Each major bus is then fused at 20A at the ORUC I/F panel (which is upstream of the ORUC Starboard SIP and the ORUC/Orbiter Interface Panel). The six PRJU buses are each capable of carrying 560W at 28V (peak = 640W @ 32V dc). Circuit protection is provided by fuses, sized to protect the orbiter, FSS, ORUC, OPE, and SIPE harness wiring.

The ORUC's PRJU performs power distribution for the +28 V dc loads on the carrier (including the ORUC-resident heaters). Additionally, it distributes power to latch indicator circuits on the ASIPE and FSIPE. The PRJU is located on the aft starboard avionics panel (lower, aft side of pallet).

3.4.2   ORUC Heater Circuits

Redundant heater circuits for the PRJU, the OPEs, the ASIPE, and the FSIPE are divided between the A and B power buses in order to maintain thermal control in the event of a single major bus failure. Two series thermostats, for protection against a failed-on circuit, also control each heater service.

Verify that this is the correct version before use

3.4.3   ORUC SIPE Latch Indicators

There are 4 A-side and 4 B-side latch status indicator circuits; three on the ASIPE and one on the FSIPE. They are each provided with redundant power sources from ORUC Bus A and B. Each circuit includes a single microswitch and redundant indicator bulbs to display critical SI latch status and telemetry to the EVA operators, and IVA/POCC, respectively.

3.5   THERMAL CONTROL SYSTEM

Resistive heater elements and passive thermal control features are used to maintain required temperatures for the ORUC avionics, shelf-mounted SOPE, the COS/COSTAR while stowed in the ASIPE, and the FGS while stowed in the FSIPE.

3.5.1   ORUC Active Thermal Control System

Redundant heater elements are furnished for active thermal control at the following ORUC locations:

a.   ASIPE lid, two side walls, and aft end

b.   FSIPE door and forward panel

c.   ORUC Power Regulator Junction Unit

d.   SOPE bottom panel and walls

The NOPE, CATs items, ASLR kit, and ATM's require no active thermal control. For the enclosures listed above, the redundant heater elements are divided between the A and B power bus. Two series bi-metallic thermal switches control each service.
The thermal system is able to withstand a failed-open heater element, a failed-open thermostat, a failed-closed thermostat, or power loss to a service with no degradation of thermal control or need for failure detection and response.

3.5.2   ORUC Passive Thermal Control System

The bulk of the passive thermal control system is composed of thermal blankets, made of Multi-layer insulation (MLI). MLI is used on the avionics, on the ORUC Equipment Shelf, on the SIPE, OPEs, ATM, NPE, and carrier harnesses. These blankets are formed from aluminized Kapton (approximately 15 layers) with Dacron mesh used between inner layers, and feature non-propagating thicker outer layer of Kapton for flame mitigation purposes. In locations where MLI is not appropriate (such as handrails), aluminized tape, or irridite is used.

Thermal control finishes are used for the ORUC pallet itself, for the handholds at the ORUC Forward and Aft Fixtures, and for other EVA locations.

Verify that this is the correct version before use

For monitoring heater performance, ORUC temperature monitoring is performed through thermistors, conditioned in the ORUC PRJU, and read at redundant Flexible Multiplexer /Demultiplexer (FMDM) units on the FSS. Additionally, sill mounted thermistors provide an indirect indication of the temperature of the passive structure and unheated elements.

3.6   CONTAMINATION CONTROL SYSTEM

The ORUC incorporates a purge system to provide a T-0 flow of low-pressure gaseous nitrogen from the payload GSE located in Mobile Launch Platform Room 10 through the orbiter interface to the ASIPE and FSIPE. Coiled Teflon tubing bridges the purge service between the pallet and the BISIPE to accommodate flight dynamics. The purge flow stops upon lift off and the system vents normally through both ends as the cargo bay evacuates.

3.6.1   ORUC Purge Gas System Control System

Internal to the ASIPE and FSIPE, the nitrogen is filtered and is routed to a purge fitting in the SIPEs and is vented through the 10" x 10" vents located on each SIPE. Nitrogen purge is provided at a flow rate of 5-10 ft^3/hr, with nominal purge line pressure of 0.25 psi. Most of the purge system is composed of stainless steel tubing (3/8" diameter). Teflon is used where additional flexibility is required. Connections between purge lines, and each SIPE, are made with stainless steel SWAGELOK fittings.

Verify that this is the correct version before use

4.0   MULTI-USE LIGHTWEIGHT EQUIPMENT CARRIER (MULE)

4.1   MULE SYSTEMS DESCRIPTION

The MULE Carrier (Figure 4-1 and Figure 4-2) is composed of the Upper Atmospheric Research Satellite (UARS) Airborne Support Equipment (UASE) cradle originally designed for the UARS mission (STS-48). The UASE cradle was used as a carrier for launch support electronics and contingency EVA hardware. The protective enclosures and miscellaneous equipment, which were mounted to the UASE for the UARS mission, were removed. The UASE cradle and honeycomb equipment mounting panels were then modified to accommodate equipment required to support the HST Orbital System Test (HOST) mission and was flown on STS-95 as the HOST platform.

The cradle and honeycomb equipment mounting panels were further modified to accommodate equipment required to support the HST SM3B mission on the MULE platform that flew on STS-109. The UASE cradle was designated as the HOST platform/cradle for the HOST mission, designated as the MULE carrier/cradle for the HST SM3B mission, and is designated as the MULE carrier/cradle for the HST SM4 mission.

The MULE provides stowage and environmental protection for ORUs/CATs during all phases of the planned HST servicing mission via honeycomb panel mount (LGAPC and ASLR kits), the COPE on the aft-center honeycomb panel and the MULE Integrated NOBL Container (MINC) on the aft-port tower/I-beam area. No modifications to the honeycomb panels are required. The MULE Carrier includes an I-beam and tower assembly. The three Relative Navigation Sensors (RNS) cameras will be mounted on the starboard-top section of the MULE I-beam and will include light baffle assemblies/tilt-plates that also serve as kick-load protection. The two RNS GPS antennas will be mounted via a newly fabricated interface plate on the top of the MULE starboard tower. The RNS avionics boxes (Integrated Control Electronics (ICE), SpaceCube, and Navigator Global Positioning System (GPS) Receiver) will be mounted on a newly fabricated plate on the starboard angled interior portion of the MULE. All RNS hardware mounts will require minor modifications to the MULE for mounting inserts. The MULE structure contains a complement of SSE hardware and assorted crew aids and tools required to assist in the HST ORU servicing and change-out function. The MULE is mounted aft (behind the FSS) in the payload bay at orbiter station Xo=1226.33.

The MINC is being designed to pick up existing mount locations, used for the NCS radiator EVA interfaces on SM3B, on the aft-port tower and aft-port I-beam.

An interface plate will be utilized on the MULE aft-port honeycomb panel to accommodate the Low Gain Antenna Protective Cover (LGAPC) and associated mounting bracketry/PFR socket and to interface with existing inserts on the honeycomb panel. The PFR mount will be modified to include a captive lock pin (replaces Pip pin).

Verify that this is the correct version before use

An interface plate will be utilized on the MULE aft-starboard honeycomb panel to accommodate the Aft Shroud Latch Repair (ASLR) plate (previously flown on SAC) and to interface with existing inserts on the honeycomb panel.

The MULE avionics consist of a single PDSU and two FMDMs. This is the same avionics configuration that flew on the HOST and HST SM3B missions. Electrical interfaces between the orbiter and the MULE are made through the SIPs which will be located forward of the MULE cradle.

The RNS experiment will have an avionics box (EPDSU chassis) with two Mass Storage Modules (MSMs), a Telemetry Module (TM), and a Power Module, with the entire RNS avionics complement being designated as the Integrated Carrier Electronics (ICE). The Navigator GPS Receiver and SpaceCube will mount on the same plate as the ICE. Electrical interfaces between the orbiter and the MULE are made through the SIPs which will be located forward of the MULE cradle.

The RNS experiment primary avionics box, the ICE, contains two Mass Storage Modules (MSMs), a Telemetry Module (TM), a Power Module, and a Carbon Nanotube (CNT) Memory Experiment. The Navigator GPS Receiver and the SpaceCube will mount on the same plate as the ICE.

4.1.1   MULE Structural Description

The MULE structure consists of hardware that was reflown on STS-109 as part of the HST SM3B mission that was launched March 1, 2002, from KSC aboard the Space Shuttle Columbia. The MULE support structure consists of hardware that was also reflown on STS-95 as part of the HOST mission that was launched on October 29, 1998, from KSC aboard the Space Shuttle Discovery. The support structure was originally flown on STS-48 as part of the Upper Atmospheric Research Satellite (UARS) Observatory mission that was launched on September 12, 1991, from KSC aboard the Space Shuttle Discovery. UARS received formal payload safety certification on August 27, 1991 (Memo no. JSC, NS2-91-179). The UARS hardware, which was reflown for the HOST mission and HST SM3B mission, will now be implemented for the HST SM4 mission once again as the MULE.

MULE Carrier/Cradle

The MULE cradle support structure (including the trunnions) was the primary support structure for UASE/HOST/MULE SM3B missions. Honeycomb panels that mount to the cradle were used for mounting avionics boxes, experiment boxes, EVA tool boxes, protective enclosures, and ORUs.

The primary support cradle is an aluminum truss structure comprised of four faceplates bolted together by numerous intercostals. The cradle truss structure was partially disassembled to accommodate new MULE radiator towers that were designed and fabricated after the HOST mission. The MULE cradle has been rotated 180° (about the z-axis) from the HOST mission for HST SM3B and SM4.

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Table 4-1. MULE and ORU/CAT changes for SM4

	Component	Reason
Additions		
	MINC	Installed on aft-port tower/I-beam to transport NOBLs to orbit
	COPE • Rate Sensing Unit (RSU-spare) • RSU Connector Cap Assembly • MLI Repair Kit • Latch Breaker (Right Angle Gear Box with 4"- 7/16 Spring Socket, Speed Reducer/Torque Multiplier, and Drop-Proof Hex Adapter) • Battery Cap Top Assembly (2 caps) • Voltage Improvement Kit (VIK) ORU Assembly	Installed on MULE in aft-center honeycomb panel-COPE moved from original SM4 manifest on SLIC
	• Low Gain Antenna Protective Cover (LGAPC) • Aft Shroud Latch Repair (ASLR)	Installed on respective upper portion MULE aft-port honeycomb panels via interface plate. (No modifications needed to honeycomb panels)
RNS	• Three cameras • Navigator GPS receiver and its two antennas • SpaceCube	
Modifications		
	Cradle	Modifications for RNS mount hardware and MINC
	Honeycomb panels	N/A

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MULE Configuration – Forward

GPS
Antennas

RNS
Cameras

MINC

ICE

PDSU

FMDMs
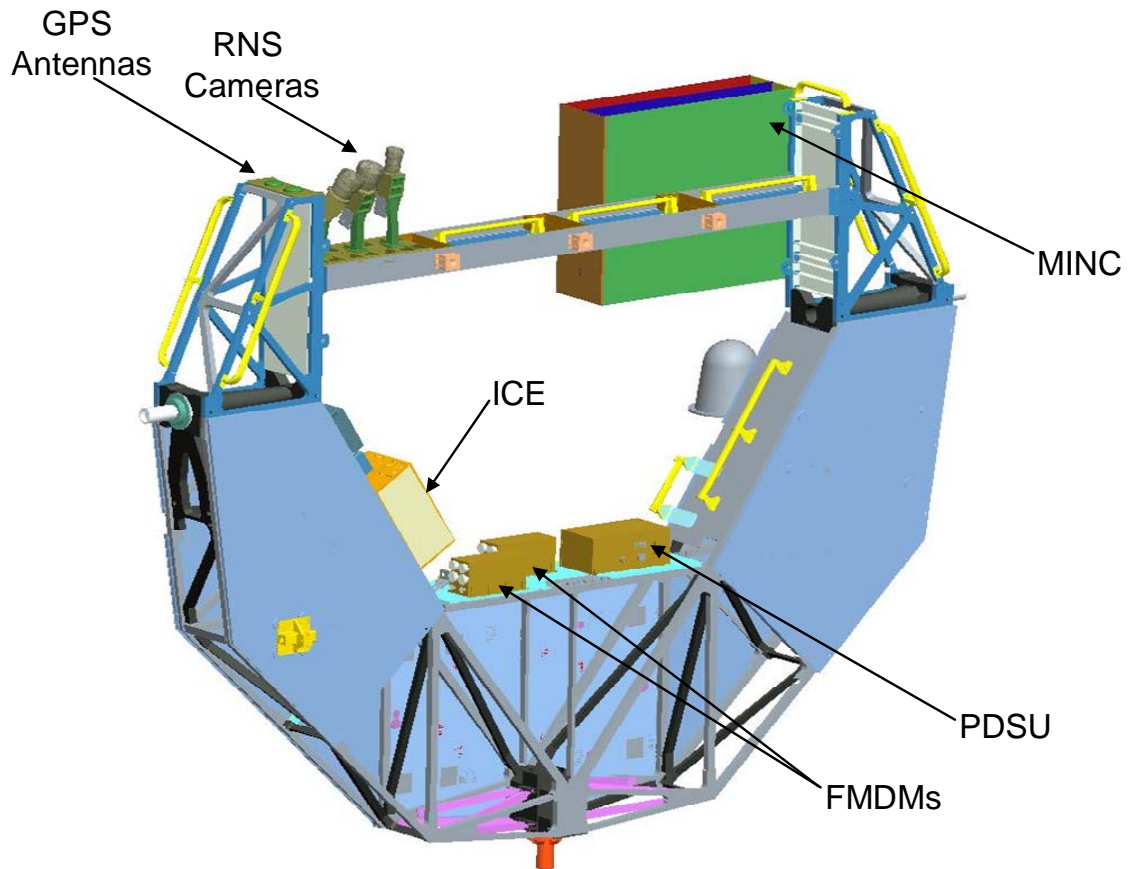
Figure 4-1. MULE forward face

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MULE Configuration – Aft
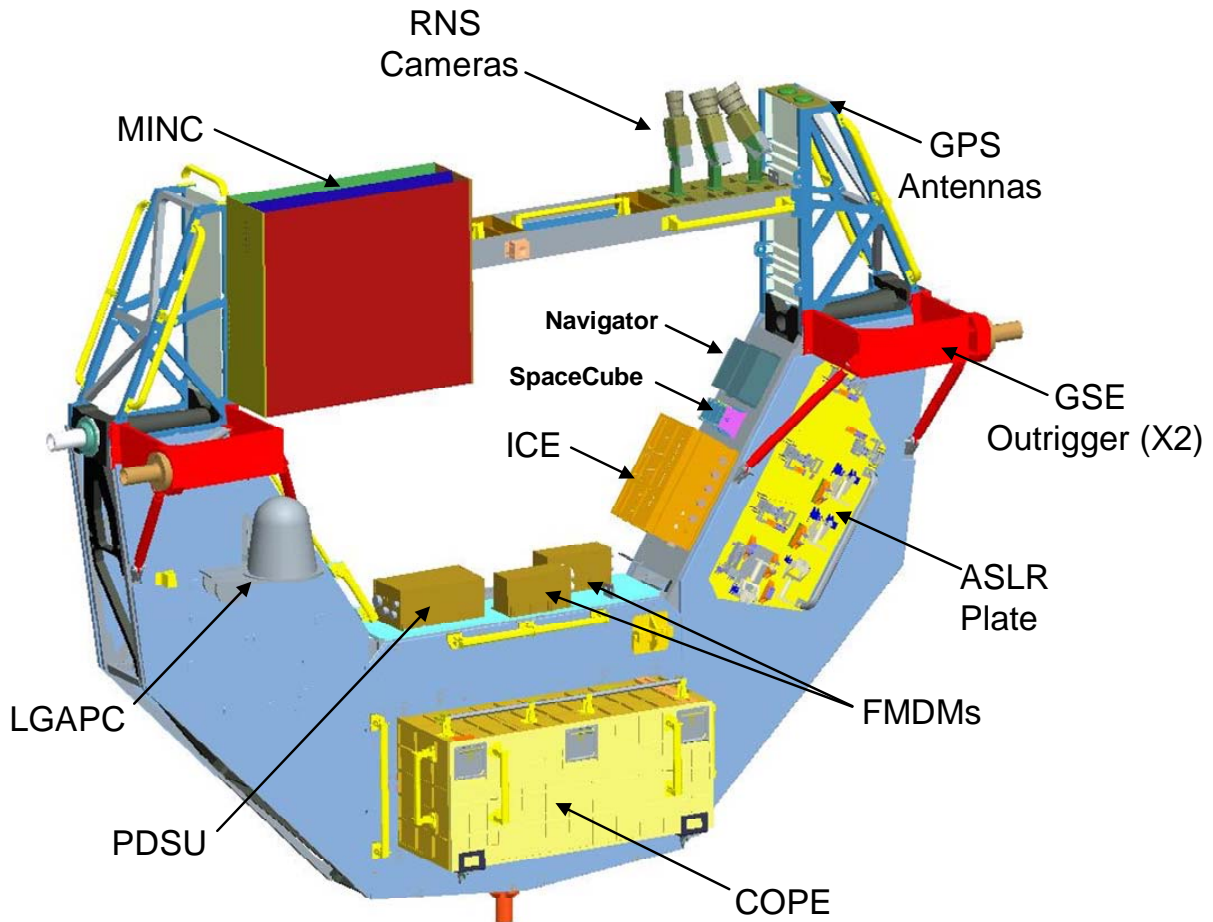
Figure 4-2. MULE aft face

Face Plates/Honeycomb Panels

The four face plates of the original UASE cradle (comprising the cradle truss structure) were modified for the HOST mission (additional 3/8" mounting holes with locking heli-coils) to accommodate additional fastening points for the honeycomb panels. These modifications were designed to strengthen and stiffen the honeycomb panels due to the new loading (experiments and avionics) on the HOST and then MULE missions. Two outboard honeycomb panels that flew on UARS (forward port and forward starboard for MULE) were modified for HOST with new inserts to incorporate four new

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fastening points to the cradle. These four fastening points will be used on the MULE on each of the two forward and outboard panels.

The aft-center honeycomb (COPE) panel and aft-starboard honeycomb (LOPE) were newly fabricated hardware for MULE SM3B and will be used for SM4. The two aft faceplates were modified for the HOST mission to accommodate six additional fastening locations (3/8" mounting holes with locking heli-coils) for the center honeycomb panel. MULE utilizes five of these attachment points for the aft-center honeycomb panel. The two aft face plates were further modified for the MULE missions (two additional 3/8" mounting holes, with associated bushings and locking heli-coils, per face plate - total of four holes) to accommodate additional fastening points for the aft-port honeycomb panel and the aft starboard panel.

The aft port honeycomb panel is reflown hardware on the MULE but was newly fabricated for the HOST mission (did not fly on the UARS mission). Two unused holes remain on the aft-port area of the MULE truss structure due to the original concept on the HOST mission of re-flying the forward-starboard honeycomb panel that flew on UARS). All of the honeycomb panels from UARS and HOST have had inserts with locking heli-coils added for mounting new hardware in the HOST configuration. Similarly inserts with locking heli-coils were added for equipment mounting in the MULE configuration. All of the modifications have been included in MULE structural verification analysis and testing.

Towers/I-beam

The NCS Radiator was stowed on an aluminum tower/I-beam configuration mounted above the longeron trunnion locations (Figure 4-3) for the HST SM3B mission, and the towers/I-beam will be re-flown for SM4. All tower/beam components are manufactured from 7075-T7351 aluminum. The beam is composed of two flanges and one web, riveted together. The beam is riveted to the tower plates at each end. The tower assembly is bolted to the cradle with eight 9/16-18 and four 3/8-24 A-286 bolts. Strut assemblies are attached to each tower with five 3/8-24 A-286 bolts. The latch support fittings are riveted to the top and bottom of the beam web at three locations. The I-beam will accommodate a support plate that will mount the RNS cameras and the starboard tower will accommodate a support plate that will mount the two RNS GPS Antennas. The aft-port flange of the MULE I-beam may be modified to accommodate the MINC.

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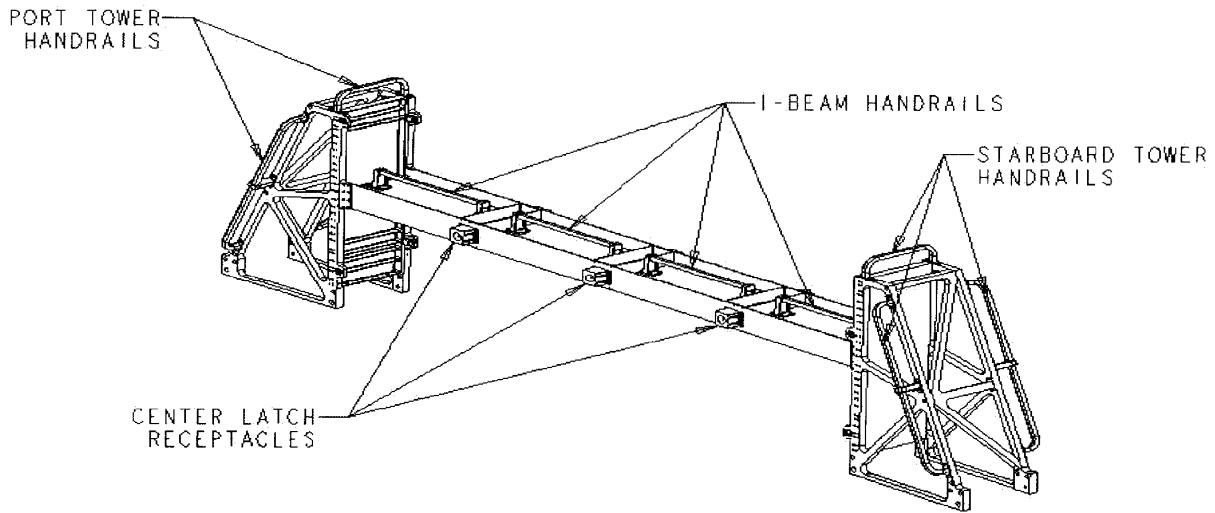
Figure 4-3. Towers/I-beam

Avionics/Handrail Interface Panels

The avionics panel is used to mount the MULE avionics (PDSU/FMDMs) and is attached in the center-interior section of the cradle traversing the thickness (x-axis) of the MULE cradle. This avionics panel was newly fabricated for the HOST mission, flew on the MULE for SM3B, and will be reflown on the MULE for SM4. Similarly, two handrail interface panels, newly fabricated for the HOST mission to support harnessing only (no EVA), are angled on the interior port and starboard sides of the MULE cradle and also traverse the thickness of the cradle. These two panels were each modified from the HOST mission to incorporate an EVA handrail and were reflown for SM3B. The port handrail panel will be reflown for SM4. The starboard handrail plate will be removed and replaced by a new build plate that will be used to mount the RNS (ICE, SpaceCube and Navigator GPS Receiver). Sixteen holes were drilled into the truss structure to mount the MULE avionics panel. Six holes per panel were drilled into the truss structure to mount the handrail interface panel and RNS avionics panel (additional 4 holes will be added to the MULE structure to accommodate the new RNS avionics panel). The avionics panel and handrail interface panels have been included in MULE structural verification analysis and testing, and the analysis will be updated for the SM4 mission.

Structural Safety Assessment

A safety assessment for the MULE structure (including the previously flown and subsequently modified UARS/HOST/MULE SM3B structural hardware) will be conducted with applicable causes, controls, and verifications embodied in a SM4 MULE flight hazard report. All modifications/new configurations have been included in MULE structural verification and will be reflected in applicable reviews. There are no sealed containers on the MULE; all boxes are vented.

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All applicable UASE/HOST/MULE SM3B structural verifications and VTL closures were completed and submitted to JSC. Noncompliances were not applicable to the UASE/HOST/MULE SM3B structure.

Limited Life Items

The reflown UASE/HOST/MULE SM3B hardware has been assessed for five mission lifetimes from a fracture standpoint (in addition to a scatter factor of four) for the MULE SM4 mission.

Maintenance/Structural Inspection/Refurbishment

The UASE hardware was stored in an environmentally controlled NASA/GSFC warehouse after return from the UARS mission. Receipt inspection of the UASE hardware was conducted by the HOST project in accordance with the HST Performance Assurance Implementation Plan, SMR-3090 as documented on GSFC Work Order Authorization (WOA) #2956, closed 4/22/97 with no structural anomalies noted. Further structural inspections were conducted in accordance with SMR-3090, during deintegration of UASE hardware that will not be used on the HOST mission (MLI, EVA tool boxes, avionics boxes, etc.) and are documented in GSFC WOAs #3018 (closed 7/16/97) and 3134 (closed 7/23/97) with no problems noted. A final structural inspection, to verify that the previously flown hardware (including panel fasteners) was properly maintained and has retained structural integrity with no anomalies, was conducted in accordance with SMR-3090 and was documented in GSFC WOA #3216 (closed 1/7/98).

After transfer to the HOST Project, the reflown UASE hardware was refurbished and maintained in accordance with SMR-3090 to assure flight quality hardware and has been protected from damage in accordance with HST damage prevention requirements and A-442-0075, HOST Damage Protection Plan.

The HOST hardware has been maintained in the environmentally controlled NASA/GSFC integration/fabrication areas since its return from the HOST mission and throughout the transition to the SM3B mission as the MULE. Post-flight inspection of the HOST hardware was conducted in accordance with the HST Performance Assurance Implementation Plan, SMR-3090 (as documented on GSFC Work Order Authorization – WOA #4572, closed 12/17/98) to verify that the previously flown hardware was properly maintained and has retained structural integrity with no anomalies noted. Further structural inspections were conducted in accordance with SMR-3090, during deintegration of HOST hardware that was not on the SM3B mission for the MULE and are documented in GSFC WOAs #4572 (closed 1/15/99), 4592 (closed 12/18/99), 4609 (closed 12/17/99), 4610 (closed 1/15/99), and 4624 (closed 1/15/99) with no problems noted.

Throughout the SM3B mission and since the transition to SM4 as the MULE, the reflown UASE/HOST hardware was refurbished and maintained in accordance with SMR-3090 to assure flight quality hardware and has been protected from damage in accordance

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with HST damage prevention requirements and P-442-2319, HST MULE Platform Damage Protection Plan. The aspects of maintenance/structural inspection/refurbishment will be covered in the SM4 MULE flight structural hazard report. The HST SM3B damage protection plan will be updated for SM4 requirements and will be designated P-442-5344. Applicable SM3B post-flight inspections will be documented via WOAs.

4.1.2   COPE

The Contingency ORU Protective Enclosure (COPE) is a pallet-mounted container designed to deliver and to return small ORUs (see Figure 4-4) and CATs. It is largely identical in structure to the SOPE that flew on the MULE for SM3B. It mounts on a vertical surface with the lid latches on top. It is mounted to MULE at 26 attachment point locations via 11 mounting feet. All bolts are required for launch and the bolts are not an EVA interface. The COPE is composed primarily of custom-machined 6061-T651 and 7075-T7351 aluminum plates, riveted together using standard aluminum angle sections. The enclosure, including the lid with its three latches and two hinges, and two internal dividers, weighs 170 pounds (with no payload). It weighs approximately 405 pounds with the currently planned stowage provisions and flight payload.

The ORUs requiring vibration isolation are contained within Transport Modules (TMs) designed specifically for the individual ORUs. ORUs not requiring specific load attenuation are packed in foam, hard mounted to the SOPE walls, or contained in soft pouches. All fasteners are high-strength stainless steel, inspected per Goddard Space Flight Center Fastener Integrity Requirements, 541-PG-8072.1.2.

The COPE is designed to withstand EVA crew and environmentally induced loads. An additional handrail will be added to the top surface to allow for better crew access (handrail not shown in current figure – to be added) to the bays. The COPE is vented (three dedicated vents) to assure its structural integrity during cargo bay pressurization/depressurization. The vents are unobstructed by the Transport Modules or other internal stowage.

The launch configuration of the COPE does not violate (statically or dynamically) the STS payload bay envelope. Furthermore, COPEs cannot withstand reentry and landing loads or support returning small ORUs or CATs with its lid open, therefore lid closure and latching (or replacement bolt fastening) is required for safe landing configuration.

The COPE is reflown hardware that was located on the ORUC for SM3A & on the SAC for SM1 & SM2; it did not fly on SM3B. Modifications from SM3A will include new Transport Modules and various other mounting/stowage hardware and pouches.

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Figure 4-4. COPE overview (MLI removed)

COPE Lid Hinges

Hinges used on the COPE are the same design as those used on the ASIPE and previously flown on the SOPE, COPE, MOPE, and LOPE. Each hinge is two-fault tolerant, with multiple sliding surfaces. The hinges sweep through 100 degrees before hitting a stop. Each hinge has a soft-dock to hold the lid open during EVA operations. Reference Figure 4-5, the Lid Hinge (soft-dock not shown).

There is no on-orbit provision to remove the COPE hinges.

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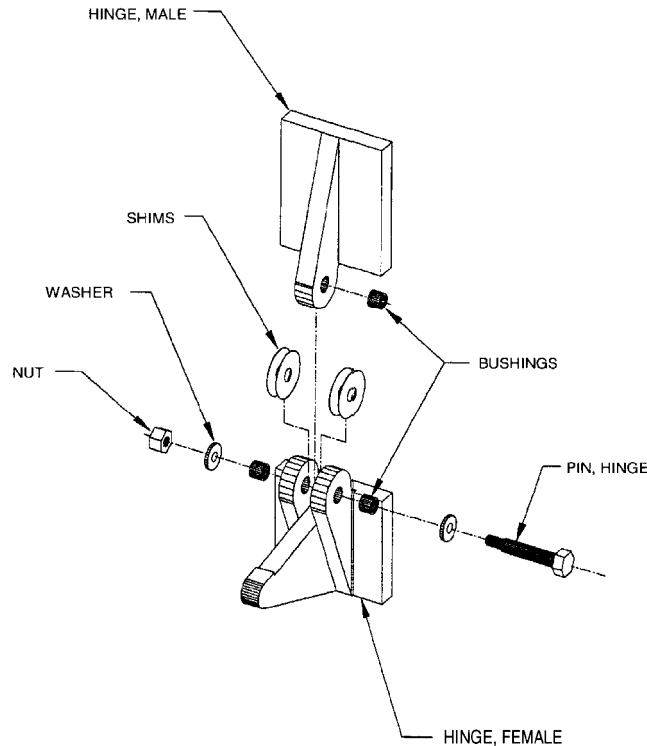
Figure 4-5. Lid hinge

COPE Lid Latches

The COPE lid latch (Figure 4-6) is a series design that is based on the UARS Tool Locker Latch and successfully flew on SM1, SM2 and SM3A. It is actuated by a T-Handle that is twisted 90° and laid down inside a lid-mounted bathtub fitting. The bathtub fitting dimensions prohibit handle rotation, and a compression spring keeps the Handle down for all inertia loads. A slight modification to the T-handle latch will be incorporated for SM4. The bathtub fitting has been modified with a spring plunger and a small detent will be added to secure the T-handle in the stowed position thus preventing an inadvertent release during launch loads. The detent holding force is around 5 pounds.

The stress and fracture assessment for all OPE latch designs was reviewed and approved by the JSC Structures Working Group, 8/99, STS-103 VAR. Pull tests of the latches were performed to verify force margin compliance with JSC TA-94-041 and documented in LMMS/P506755, 8/99. Pull tests will be repeated on the COPE Lid for SM4 (per P-442-5365), due to the different load levels in the MULE mounting configuration.

To open the lid, the EVA crewmember pulls the T-Handle up out of the bathtub fitting and twists 1/4 turn to unlatch the internal Pawl/Pawl Catch interface. A means of securing the T-Handle securely in the down position has been added for SM4. Three latches secure the COPE lid. Secure landing integrity is provided for the COPE with

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any two of the three latches. If two latches fail, the lid can be secured by installing the contingency bolt (stowed in a pouch and captive to the COPE with a tether) furthest from the working latch. However, if the only working latch is the middle latch, both EVA contingency bolts must be used.

If the T-handle latch fails to unlatch, the primary EVA override is to back off the 4 captive fasteners, which secure the latch to the lid, and after tethering to the latch assembly, sliding the latch assembly away from the pawl catch until it lifts out of the lid.
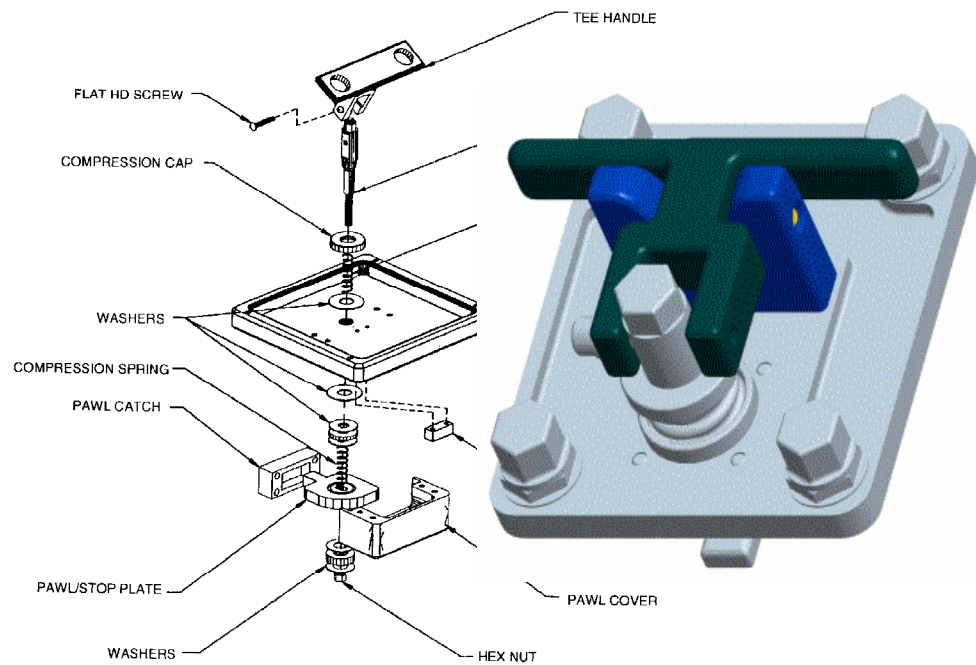
Figure 4-6. COPE lid latch (SM4 modification shown on right)

COPE Internal Stowage Configuration

Each ORU is supported independently (Figure 4-7), so that any item can be removed or installed at anytime.

The RSU is stowed (Figure 4-8) in a Transport Module consisting of 6061-T651 Aluminum. The TMs are stand-alone open (not sealed) structures, which bolt to the COPE base or walls. All interfaces engage the thick "web" sections of the COPE walls, or are reinforced with doublers for increased strength and stiffness. Each TM contains a Teflon plated foam or elastomer isolation system, which attenuates the launch environment to levels that the ORUs have been qualified to withstand.

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Scaled-down versions of the basic OPE hinge and T-handle latches are implemented for the individual Transport Module "sub-lids". Each of the sub-lid hinges is constructed with three 'nested' sliding surfaces that mitigate jamming of the sub-lid while in the open condition and are two-fault tolerant. The TM latches are similar to those on the exterior of the COPE. There are EVA overrides to account for latch failure, insuring that the ORUs can be removed. Each TM lid has a single T-handle lid that can be operated one-handed. To disengage the latch system and remove the ORU, the T-handle is lifted out of its bathtub fitting and rotated 90°.

The stress and fracture assessment for all OPE latch designs was reviewed and approved by the JSC Structures Working Group, 8/99, STS-103 VAR. Pull tests for latches were performed to verify force margin compliance with JSC TA-94-041 and documented in LMMS/P506755, 8/99. They were pull-tested to 1.5 times the worst case environmental loads. These same TM latches are being flown in COPE for SM4.

The ECU Transport Module also contains two Retractable Constraint mechanisms (Figure 4-9). These accommodate differences between the replacement ECU (installed for launch) and the on-orbit ECU. The on-orbit ECU has bumpers all around its edges, and the Constraints must be retracted so that the return ECU can slide into the TM. The Constraints are then extended back to their original position, where they provide proper damping and constraint. The mechanisms are actuated by rotating the handles 90°. Each mechanism has dual sliding surfaces, and change-out is possible with one failed mechanism.

Some additional payload items may be stowed in soft pouches (Figure 4-10). The pouches are constructed of layers of Kevlar-reinforced Kapton, with foam or sheet aluminum embedded between the layers as needed to maintain shape or distribute load. The pouches are attached to COPE structure using studs bonded with structural epoxy. Redundant studs are used, with each stud pull tested to verify proper bonding. Other items such as the RAGB/SRTM/ 4" spring socket assembly are packed in custom-shaped, foam lined compartments secured by Nomex strap.

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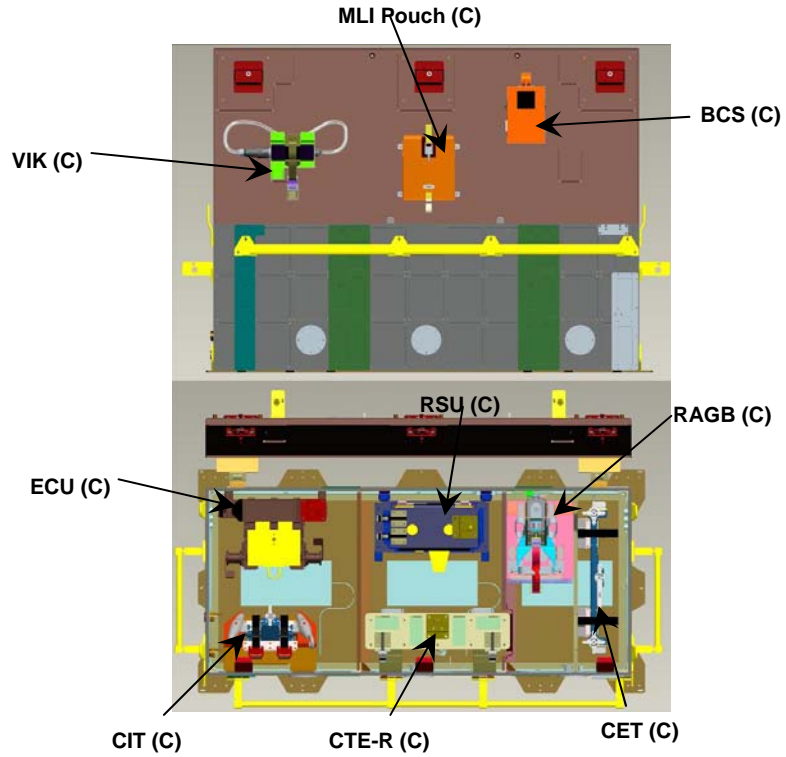
Figure 4-7. COPE stowage configuration

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RSU Transport Module (lid open)

Typical Delrin sheet
over foam, with tapered
lead-ins.

Can shim as required to
adjust pre-load

Interface to COPE front wall

Kapton over foam,
top and bottom
only (no Delrin)
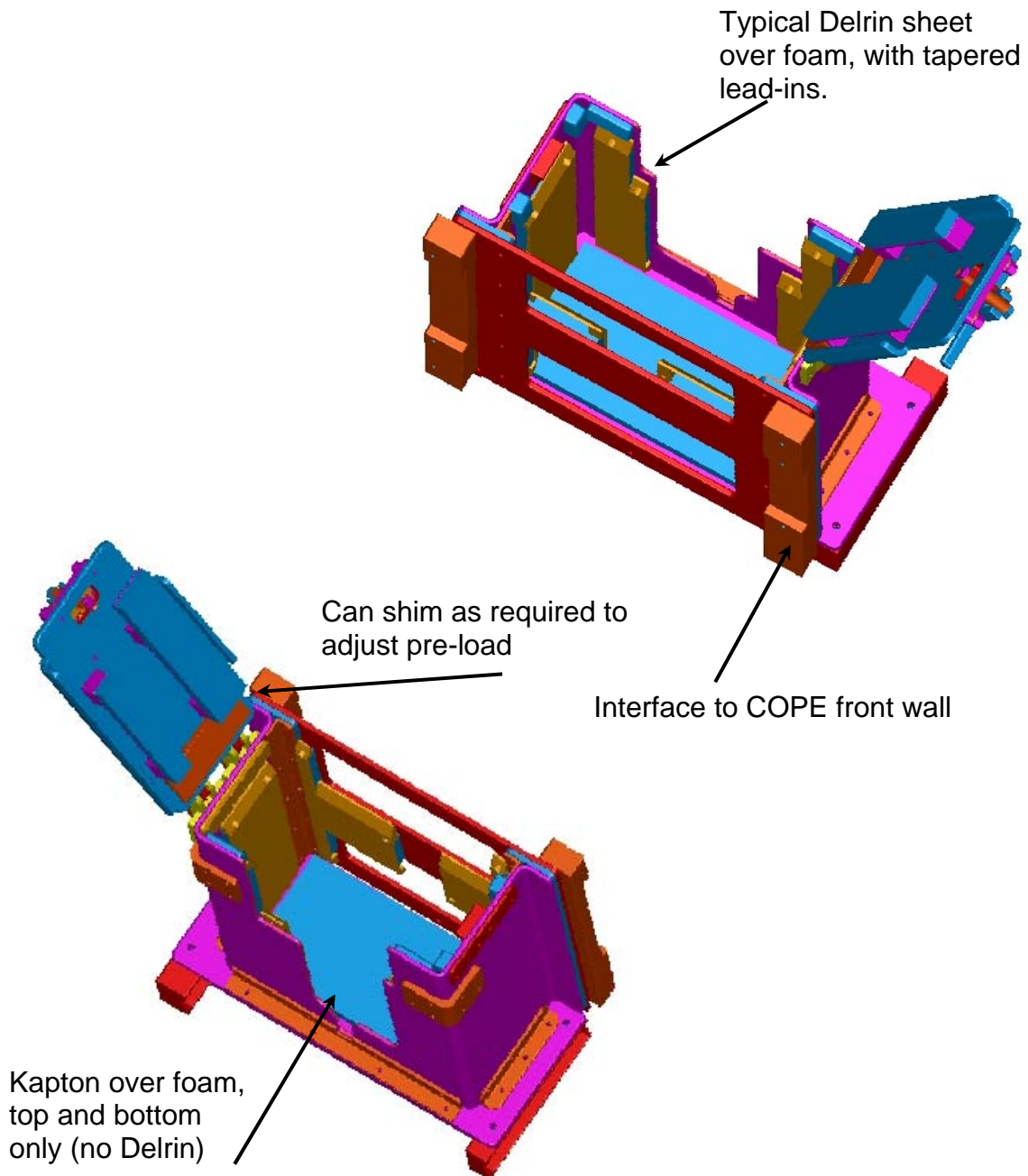
Figure 4-8. RSU transport module (lid open)

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ECU Transport Module (lid open)

Lid isolation: fits between
ECU connectors.

Zymaxx over silicon rubber pads for
isolation. (Slots engage ECU base
plate)

Interface to SOPE
back wall.

Moveable Bumper

Retractable Constraint
(See Detailed View)

Handle

<u>Detail View</u>

ECU Retractable
Constraint Mechanism
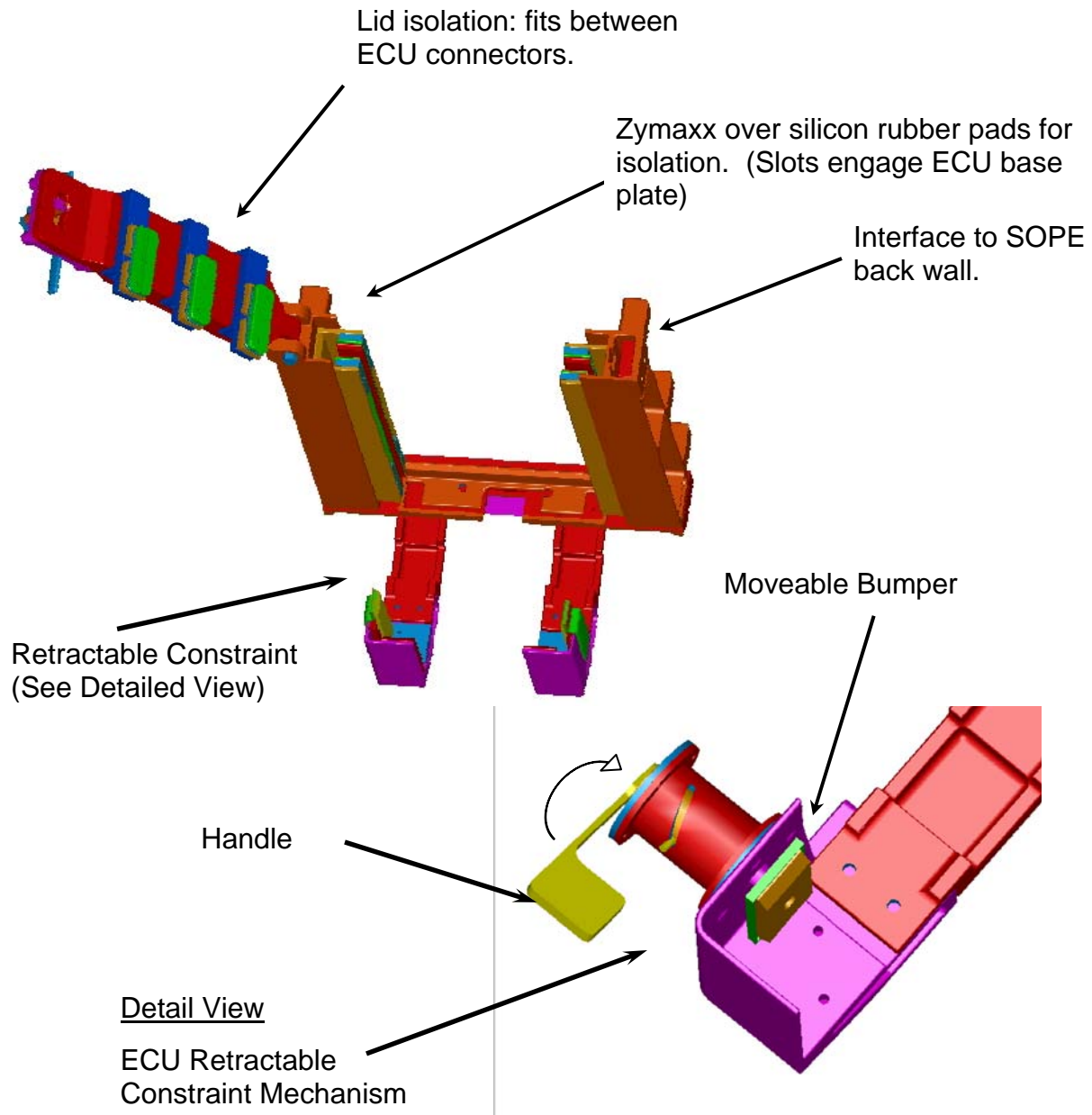
Figure 4-9. ECU transport module (lid open)

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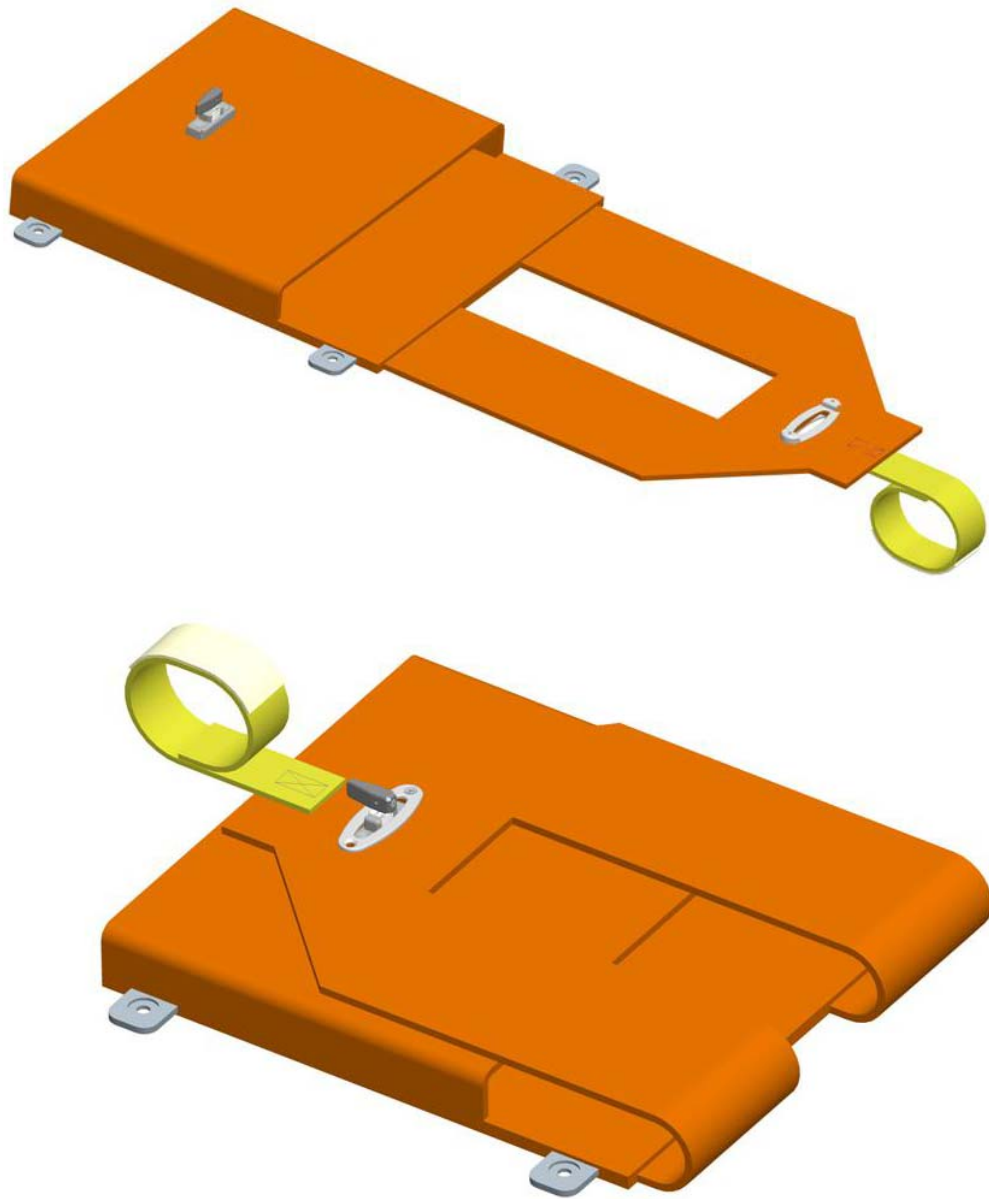
Figure 4-10. Typical pouch (open and closed)

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4.1.3 MULE Integrated NOBL Container (MINC)

The MINC, which will contain the NOBLs (described in Section 5.4), is still under development and design specifics were not available at the time of publication.

4.2 MULE AVIONICS

The MULE uses the PDSU, previously flown on UASE, HOST and HST Servicing Missions to distribute fused orbiter power to MULE avionics and ORU heaters. It provides a common ground point for the MULE and bias voltage for MULE thermistors. The PDSU is commandable via the orbiter Standard Switch Panel and the two MULE Flexible Multiplexer/Demultiplexers (FMDMs). The PDSU will be powered off during launch and landing.

The MULE avionics are secured to an aluminum avionics plate bolted in sixteen places to the center section of the cradle. The avionics will be attached in a fail-safe bolt pattern. The PDSU uses 10 bolts to secure to the Al avionics plate and the FMDM uses 8 bolts.

The PDSU distributes orbiter +28 V dc power to the MULE. The unit provides redundant distribution, switching, current monitoring, and fault isolation. There are no safety critical circuits.

The PDSU contains 12 high current sensors that provide primary fault isolation. Two circuits are switched to provide power to the FMDM. Two circuits in the PDSU are switched and are distributed to provide heater power to the MULE avionics. Four circuits are used to provide power to the COPE heaters.

The PDSU is designed to measure the currents of these services and provide the information to both FMDMs. The PDSU contains a thermistor bias circuit to monitor temperatures in the avionics, the COPE, the LOPE and RNS. See Figure 4-11 to Figure 4-14 for power distribution schematics.

The RNS Avionics boxes (ICE/EPDSU chassis, SpaceCube, and GPS Navigator Receiver) will be secured to its avionics plate via 12 bolts (ICE), 14 bolts (SpaceCube) and 12 bolts (Navigator Receiver) the plate is attached to the MULE structure via 10 bolts.

The MULE Power Allocations are listed in Table 4-2.

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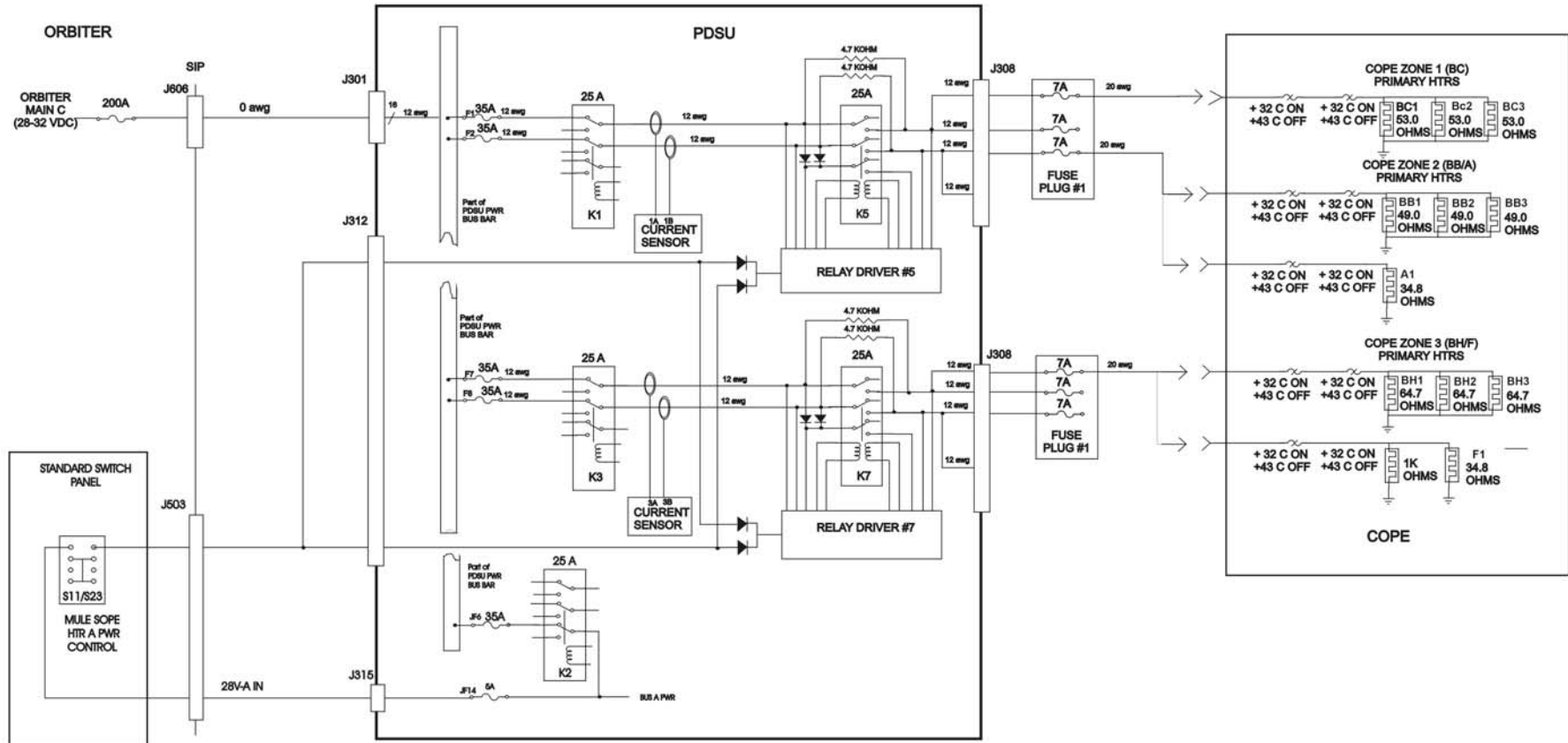
Figure 4-11. MULE primary avionics COPE heaters power distribution

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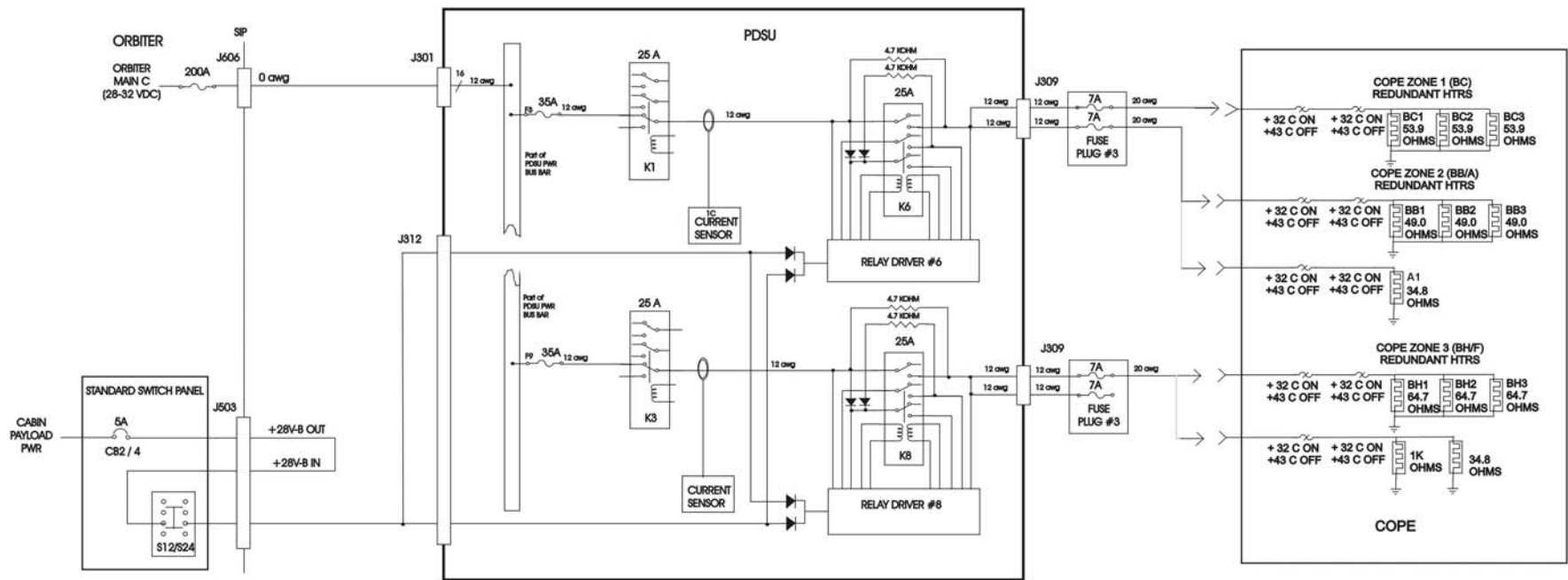
Figure 4-12. MULE redundant avionics COPE heaters power distribution

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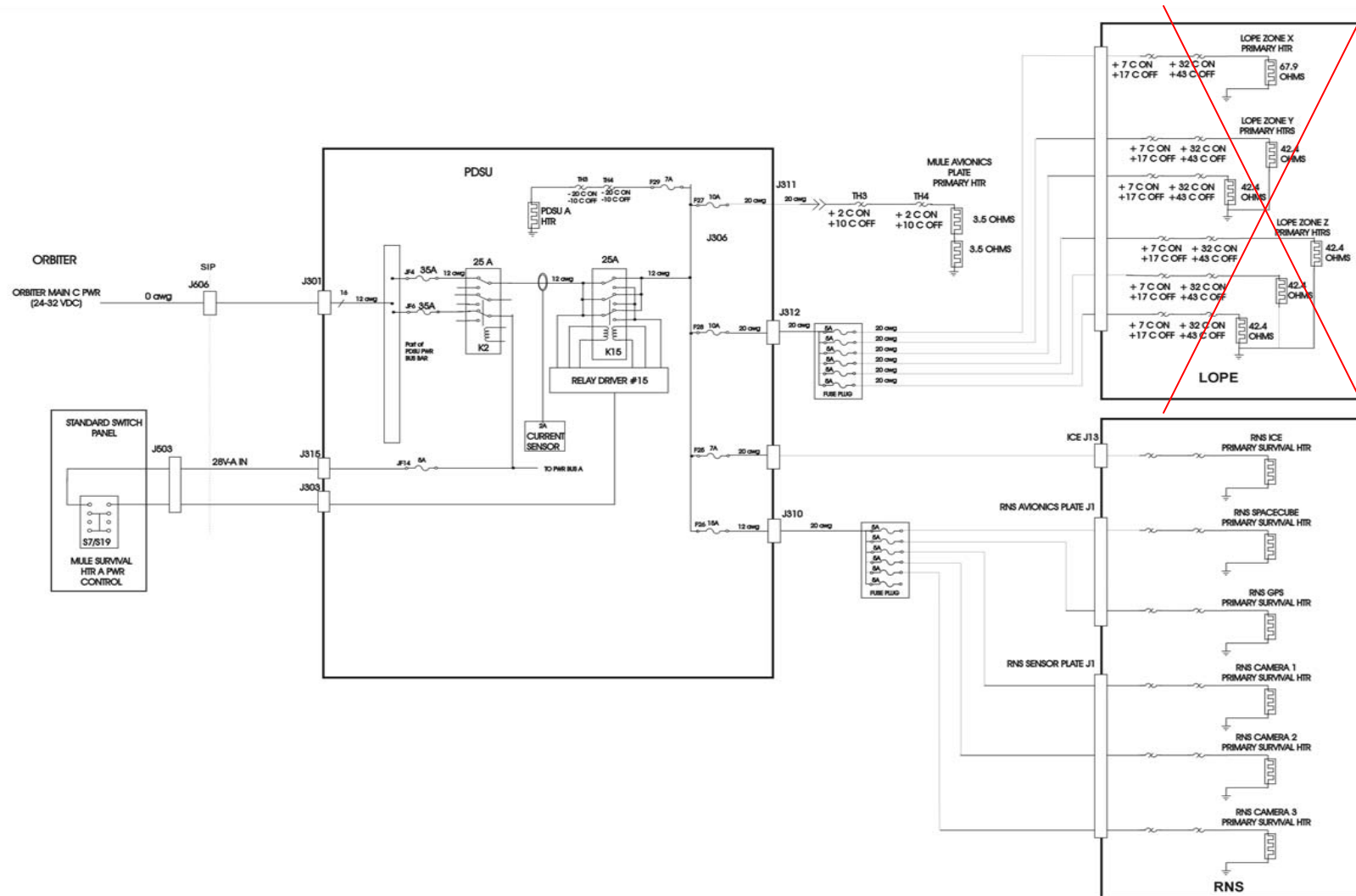
Figure 4-13. MULE primary avionics/RNS heaters power distribution (LOPE has moved to ORUC)

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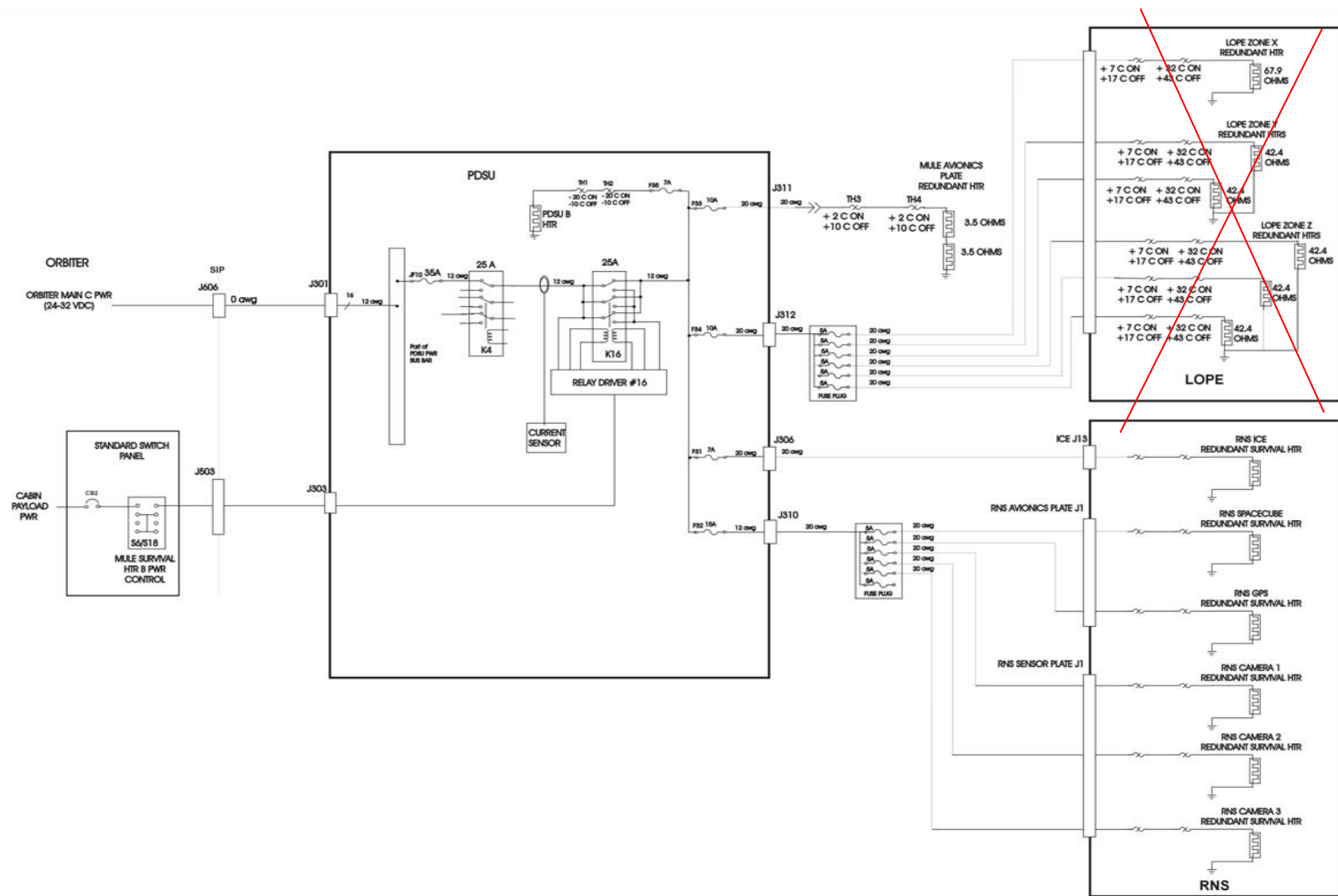
Figure 4-14. MULE redundant avionics/RNS heaters power distribution (LOPE has moved to ORUC)

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Table 4-2. MULE power allocation

SERVICE	CONTROL	PDSU RELAY	RELAY RATING	PDSU FUSE RATING	FUSE PLUG FUSE RATING	LOAD CURRENT AMPS@ 32VDC	MULE ASSIGNMENT	NOTES
1	SSP S11/S23	K5	25 A	35 A	7 A	2	COPE ZONE 1 (BB) PRIMARY HTR PWR	4.7 KOHN RES ACROSS RELAY CONTACTS
					7 A	N/a	NOT WIRED	
					7 A	2.4	COPE ZONE 2 (BH/A1) PRIMARY HTR PWR	
		K7	25 A	35 A	7 A	2.7	COPE ZONE 3 (BC/F1) PRIMARY HTR PWR	
					7 A	N/A	NOT WIRED	
					7 A	N/A	NOT WIRED	
2	SSP S12/S24	K6	25 A	35 A	7 A	2	COPE ZONE 1 (BB) REDUNDANT HTR PWR	4.7 KOHN RES ACROSS RELAY CONTACT
					7 A	2.4	COPE ZONE 2 (BH/A1) REDUNDANT HTR PWR	
		K8	25 A	35 A	7 A	2.7	COPE ZONE 3 (BC/F1) REDUNDANT HTR PWR	
					7 A	N/A	NOT WIRED	
3	SSP S7/S19	K15	25 A	7 A	N/A	1.6	MULE PDSU PRIMARY HTR PWR	
				7 A	N/A	2.3	RNS ICE PRIMARY SURVIVAL HTR PWR	
				10 A	N/A	4.5	MULE AVIONICS PLATE PRIMARY HTR PWR	
				10 A	5 A	0	LOPE ZONE X PRIMARY HTR PWR	NOT USED, LOPE HEATERS OPERATE OFF
					5 A	0	LOPE ZONE Y1 PRIMARY HTR PWR	NOT USED, SAME SERVICE AS MULE SURVIVAL HEATERS
					5 A	0	LOPE ZONE 62 PRIMARY HTR PWR	NOT USED
					5 A	0	LOPE ZONE Z1 PRIMARY HTR PWR	NOT USED
					5 A	0	LOPE ZONE Z2 PRIMARY HTR PWR	NOT USED
					5 A	0	LOPE ZONE Z3 PRIMARY HTR PWR	NOT USED
				15 A	5 A	0.62	RNS SPACECUB PRI SURVIVAL HTR PWR	RNS SURVIVAL HEATERS OPERATE OFF
					5 A	0.81	RNS GPS PRI SURVIVAL HTR PWR	SAME SERVICE AS MULE SURVIVAL HEATERS
					5 A	0.95	RNS CAMERA 1 PRI SURVIVAL HTR PWR	
					5 A	0.95	RNS CAMERA 2 PRI SURVIVAL HTR PWR	
					5 A	0.95	RNS CAMERA 3 PRI SURVIVAL HTR PWR	
					5 A		NOT WIRED	
4	SSP S6/S18	K16	25 A	7 A	N/A	1.6	PDSU REDUNDANT HTR PWR	
				7 A	N/A	2.3	RNS ICE REDUNDANT SURVIVAL HTR PWR	
				10 A	N/A	4.5	AVIONICS REDUNDANT HTR PWR	

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Table 4-2. MULE power allocation (continued)

SERVICE	CONTROL	PDSU RELAY	RELAY RATING	PDSU FUSE RATING	FUSE PLUG FUSE RATING	LOAD CURRENT AMPS@ 32VDC	MULE ASSIGNMENT	NOTES
4 (con't)				10 A	5 A	0	LOPE ZONE X REDUNDANT HTR PWR	NOT USED, LOPE HEATERS OPERATE OFF
					5 A	0	LOPE ZONE Y1 REDUNDANT HTR PWR	NOT USED, SAME SERVICE AS MULE SURVIVAL HEATERS
					5 A	0	LOPE ZONE Y2 REDUNDANT HRT PWR	NOT USED
					5 A	0	LOPE ZONE Z1 REDUNDANT HTR PWR	NOT USED
					5 A	0	LOPE ZONE Z2 REDUNDANT HTR PWR	NOT USED
					5 A	0	LOPE ZONE Z3 REDUNDNAT HTR PWR	
				15 A	5 A	0.62	RNS SPACECUBE RED SURVIVAL HTR PWR	RNS SURVIVAL HEATERS OPERATE OFF
					5 A	0.81	RNS GPS RED SURVIVAL HTR PWR	SAME SERVICE AS MULE SURVIVAL HEATERS
					5 A	0.95	RNS CAMERA 1 RED SURVIVAL HTR PWR	
					5 A	0.95	RNS CAMERA 2 RED SURVIVAL HTR PWR	
					5 A	0.95	RNS CAMERA 3 RED SURVIVAL HTR PWR	
					5 A		NOT WIRED	
5	SSP S3/S15	K9	10 A	7 A	N/A	0.9	FMDM A PWR MULE PDSU PRIMARY THERMISTOR BIAS MULE ENV THERMISTOR BIAS COPE PRIMARY THERMISTOR BIAS LOPE PRIMARY THERMISTOR BIAS	
6	SSP S4/S16	K10	10 A	7 A	N/A	0.9	FMDM B PWR MULE PDSU REDUNDANT THERMISTOR BIAS MULE ENV REDUNDANT THERMISTOR BIAS CORE REDUNDANT THERMISTOR BIAS	
7	NOT WIRED	K19	10 A	10 A	N/A	N/A	NOT WIRED	70 VOLT OUTPUT
8	NOT WIRED	K20	10 A	10 A	N/A	N/A	NOTE WIRED	70 VOLT OUTPUT
9	SSP S8/S20	K17	25 A	35 A	N/A	11	RNS POWER	NO REDUNDANT POWER RELAY
10	FMDM A OR FMDM B	K24	10 A	7 A	N/A	N/A	NOT WIRED	AVAILABLE SPARE SERVICE
11	NOT WIRED	K11	10 A	7 A	N/A	0	MULE AUX K11 PWR	CONTROL INPUT NOT WIRED FOR SM4
12	SSP S10/S22	K12	10 A	7 A	N/A	0	MULE AUX K12 PWR	CONTROLLED SIMULTANEOUSLY WITH SERVICE #14 AVAILABLE SPARE SERVICE
13	NOT WIRED	K13	10 A	7 A	N/A	0	MULE AUX K13 PWR	CONTROL INPUT NOT WIRED FOR SM4
14	SSP S10/S22	K14	10 A	7 A	N/A	0	MULE AUX K14 PWR	CONTROLLED SIMULTANEOUSLY WITH SERVICE #12 AVAILABALE SPARE SERVICE

Verify that this is the correct version before use

Table 4-2. MULE power allocation (concluded)

SERVICE	CONTROL	PDSU RELAY	RELAY RATING	PDSU FUSE RATING	FUSE PLUG FUSE RATING	LOAD CURRENT AMPS@ 32VDC	MULE ASSIGNMENT	NOTES
15	FMDM A OR FMDM B	K21, K18, K22, K23	10 A 10 A	10 A 10 A	N/A N/A	N/A N/A	NOT WIRED	ENABLE AND ON COMMANDS REQUIRED NO CURRENT SENSOR AVAILABLE
16	N/A	N/A	N/A	5 A	N/A	0.3	STANDARD SWITCH PNL PWR	UNSWITCHED POWER ON PDSU A BUS
17	N/A	N/A	N/A	20 A	N/A	N/A	NOT WIRED	UNSWITCHED POWER ON PDSU B BUS

TOTAL CURRENT IN AMPS USED AT 32 VDC WITH ALL PRIMARY HEATERS ON AN DALL REDUNDANT HEATERS OFF	32.42

TOTAL POWER IN WATTS USED AT 32 VDC WITH ALL PRIMARY HEATERS ON AND ALL REDUNDANT HEATERS OFF	1037.44

Verify that this is the correct version before use

Two FMDMs, on loan from KSC and previously flown on Spacelab and HOST missions, will be used on MULE to provide redundant carrier commands and telemetry. The FMDMs provide control of the PDSU power switching via orbiter General Purpose Computer (GPC) commands. The GPC data bus is shared with the FSS FMDMs, but uses a different address on the bus. FMDMs accept discrete ON/OFF status from the PDSU relays and differential analog telemetry from MULE thermistors and PDSU power service currents and routes them to the GPC for processing. FMDM commands originate on-board. FMDM telemetry is available on-board and at MCC. PDSU and FMDM electrical specifications are listed in the tables below.

Table 4-3. PDSU electrical specifications

Power	Input: 24-32 Volts dc Dissipation: 18 W typical, 36 W max @ 28 V
Command	High level discrete (DOH, +28V) from orbiter SSP and MULE FMDMs
Digital Telemetry	High level discretes (DIH, +28V) to SSP and MULE FMDMs
Analog Telemetry	0 - 5 V dc to MULE FMDMs
Thermistor Bias	+18 V dc @ 260 uA max (68.1K series resistor) per thermistor

Table 4-4. FMDM electrical specifications

Power	Input: 24-32 Volts dc Dissipation: 25 W typical
Communications	Modified RS-1553 Bus interfaces with orbiter GPC via orbiter data busses FMDMs configured as remote terminal Shares Data Busses with FSS FMDMs
Commands	Provides Single Ended High Level Discrete Output (DOH) commands (+28V) to PDSU
Telemetry	Receives Single Ended Low Level Discrete Input (DIL) status (+5V) from PDSU via resistor divider plugs Receives Low Level Differential Analog Inputs (-5 to +5 V) from PDSU and MULE platform thermistors and converts to 10 bit words

MULE carrier maximum power is 710 W for MULE services and 430 W for the RNS.

Verify that this is the correct version before use

4.3   THERMAL DESIGN

The MULE consists of a passive and active thermal design. The passive design uses a 14 layer Beta Cloth/Kapton/Dacron Mylar MLI for thermal control. Active thermal control (heaters, thermostats) is used for the avionics, the RNS, MULE avionics and the COPE. Each heater circuit has a prime and redundant side (A & B) and utilizes two thermostats wired in series.

4.4   CREW AIDS AND TOOL (CATS)

Provisions are made on the MULE carrier for handrails to aid in translation. Handrails are located throughout the carrier and are used for worksite restraint. Handrails are attached on angled sections of the cradle, on the towers and I-beam, and the perimeter areas of the boxes. Located on the upper, starboard side of the COPE panel and the lower, outboard side of the forward-starboard honeycomb panel are PFR sockets.

4.5   RELATIVE NAVIGATION SENSORS (RNS)

The purpose of the RNS is to image the Hubble Space Telescope (HST) during rendezvous and deployment operations to collect imaging data of the HST Aft Bulkhead including the Soft Capture Mechanism (SCM). The RNS system location is shown in Figure 4-1 and Figure 4-2. The sensor package consists of the following:

a.   Three cameras. See Figure 4-15 for an illustration of the RNS camera mounting. A protective shroud for the cameras lens has been developed to mitigate the kick-load hazard and tool impact load hazard.

b.   Navigator Global Positioning System (GPS) receiver and its two antennas.

c.   SpaceCube, hosting two algorithms to perform real-time calculations of HST position and attitude (Pose), a Natural Feature Image Recognition algorithm and an Ultra Lethal Target Optical Recognition algorithm, and a GPS Bi-static Range algorithm, to measure the distance between the HST and the RNS.

The goals of the RNS are to

a.   Image the HST Aft Bulkhead during rendezvous and deployment operations to collect imaging data of the HST and the SCM

b.   Validate algorithms developed for proximity operations

c.   Further develop relative navigation sensors and proximity operations for autonomous rendezvous capability of unmanned spacecraft to the HST

d.   Confirm operation and performance of the next generation GPS receiver hardware to demonstrate high-level navigation applications that allows for cold-start acquisition and tracking threshold below 25dB-Hz

Verify that this is the correct version before use

e. Verify Position, Velocity, and Time performance of a dual 24-channel GPS receiver in a low earth orbit

f. Verify operation of Video Interface Module (VIM) performing video data compression

The Mass Storage Modules (MSMs), two modules in the ICE, perform the following functions:

a. Receive camera video data and GPS data and stores them in redundant hard drives

b. Forward camera video data to the SpaceCube for processing

c. Receive and record time stamp from the orbiter and records it

The SpaceCube is a stand-alone RNS component performing the following functions:

a. Real-time Pose algorithms

b. Real-time processing of GPS bi-static data

c. Storage of Pose and GPS algorithm results

d. Telemetry and command routing between the TM, the MSMs and the sensors

e. Orbiter Ku-band system interface

f. Store scripts for on-board execution

g. Video data compression

The electrical schematic for the RNS is illustrated in Figure 4-16.

Verify that this is the correct version before use

RNS Camera (X3)
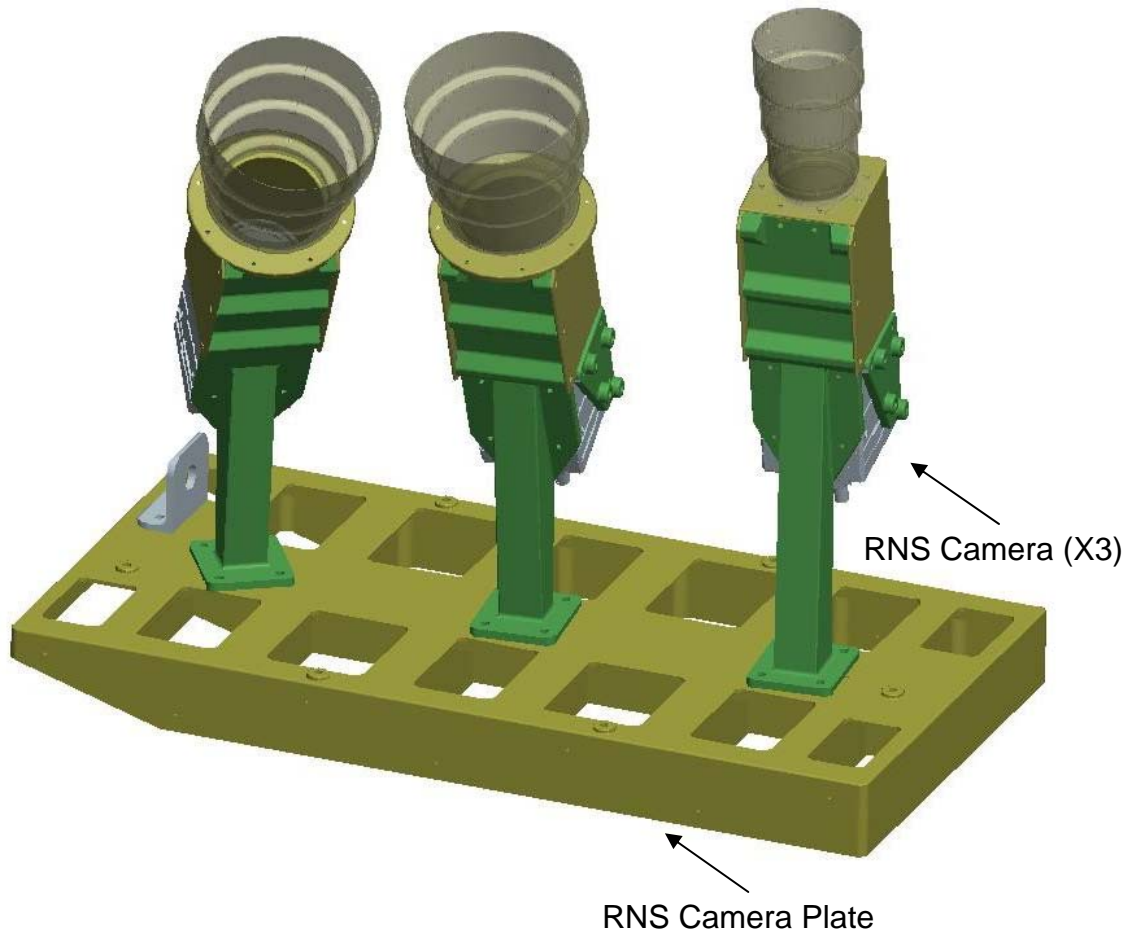
RNS Camera Plate

Figure 4-15. RNS camera mount

Verify that this is the correct version before use
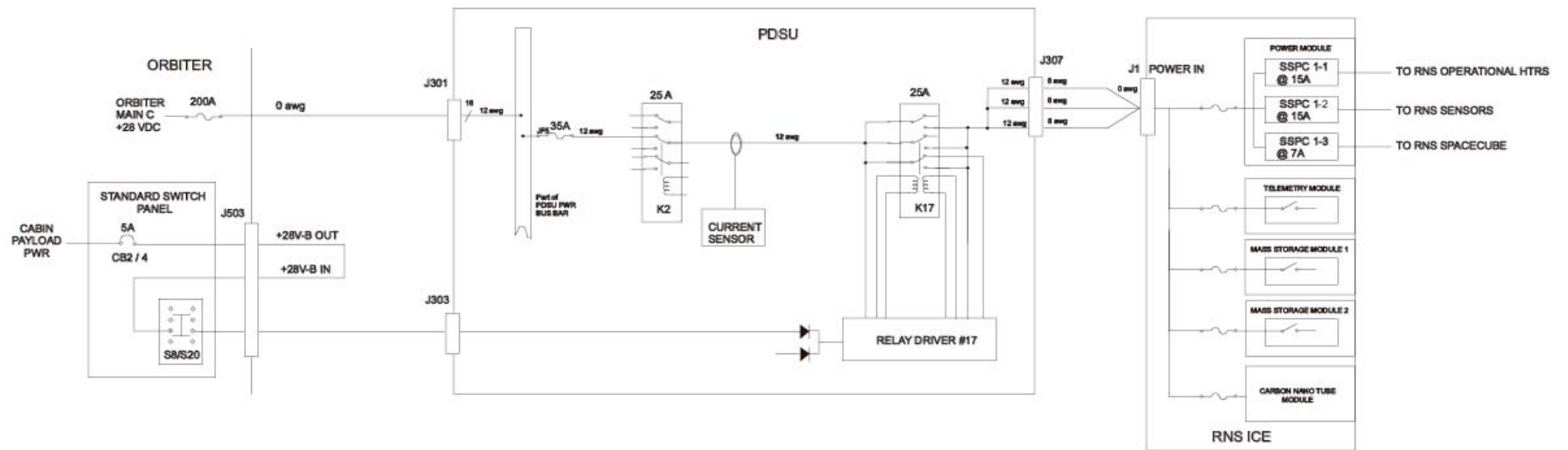
Figure 4-16. MULE RNS power distribution schematic

Verify that this is the correct version before use

4.6 AFT SHROUD LATCH REPAIR (ASLR) KIT PLATE

The Aft Shroud Latch Repair Kit (ASLR) consists of three types of clamping mechanisms designed to secure the HST Aft Shroud doors in the event of a door latch failure. For SM4, the following quantities are manifested: Standard Door Latch (5), Axial Handle Latch (2), and FGS Handle Latch (1).

The latches are hard-mounted to a plate on the aft starboard face of the MULE cradle. (See Figure 4-17.) Each type of ASLR is stowed on the MULE utilizing the same features on each type of ASLR which allow them to be installed and locked on HST. Each ASLR has pivot pins which are slid into pin blocks to constrain one end. The common feature among all three types of latches is a tension spring attached to the EVA actuation handle that must be extended and rotated onto a mating feature, providing a soft-dock mount. To positively capture the ASLR, a slide lock is engaged at the handle. An additional thumb lock has been added to prevent inadvertent actuation of the slide lock and additional redundancy during launch.

In the event of a jam in the slide lock, the entire assembly can be removed by loosening the two captive 7/16" hex-head fasteners securing it. Analysis of stowage hardware uses the "no-test" factors of safety (2.0/2.6).
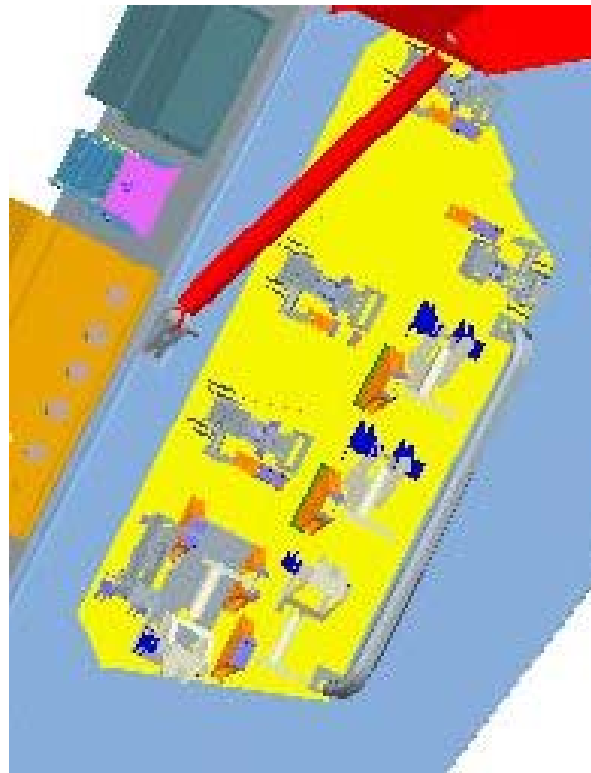
Figure 4-17. SM4 aft shroud latch repair (ASLR)
kit plate as mounted on the MULE

Verify that this is the correct version before use

5.0   SUPER LIGHTWEIGHT INTERCHANGEABLE CARRIER (SLIC)

5.1   SLIC PHYSICAL DESCRIPTION

The Super Lightweight Interchangeable Carrier (SLIC) (see Figure 5-1, Figure 5-2, and Figure 5-3) offers a lightweight alternative for the HST Servicing Mission 4 manifest. The carrier is similar in appearance to previously flown HST carriers - particularly the SAC from SM1, SM2, and SM3B. However, with its composite construction, the carrier departs from the traditional aluminum carrier structure both in terms of its weight and its expected performance.

The SLIC cargo element consists of the composite SLIC Pallet and currently for SM4 the following subsystems: the Wide Field Camera-3 (WFC3), WFC3 Scientific Instrument Protective Enclosure (WSIPE) and M-Strut Isolator struts, two replacement Battery Modules and Battery Plate Assemblies (BPA), the Enhanced Power Distribution and Switching Unit (EPDSU), a WFC3 Contingency Handhold and stowage hardware, a FGS Contingency Handhold and stowage hardware, an Over Voltage Protection Contingency Kit (OVP-CK), the COSTAR Contingency Y-Harness and stowage pouch, the Spare Fuse Plugs with stowage bracket, the Battery Extraction Tool (BET) and stowage hardware, and a Portable Foot Restraint (PFR) Assembly.

The SLIC cargo element is shown in Figure 5-1 through Figure 5-3. The SLIC is mounted in the orbiter payload bay with the forward trunnions at $X_o = 770.07$ and the aft trunnions at $X_o = 833.00$.

The WSIPE is a new design, but similar to the RSIPE (interchangeably referred to as the FSIPE) from HST SM1, SM2, and SM3A, that will be used to carry the WFC3 to orbit and carry the WFPC II back to earth. The M-Strut Isolators have flown on HST SM2 and SM3B on the SAC. The two new Battery Modules containing three batteries each are the same as the Battery Modules currently on the HST with a few minor changes and each Battery Module will be launched on a BPA. The stowage hardware for the WFC3 and FGS Contingency Handhold is similar to existing stowage designs.

The SLIC Pallet composite structure weighs approximately 1800 pounds with a current carrier total weight of approximately 5,710 pounds. The Pallet is 103.9 inches by 180 inches in the X and Y directions respectively. The Pallet top surface is located at $Z_o = 393$ inches and the longeron trunnion spacing is 62.93 inches.

The SM4 configuration provides the following services:

a.   Transportation, load isolation, environmental control and protection for the SIs, ORUs and CATs.

b.   Incorporates crew aids/tools and tether positions to perform on-orbit servicing.

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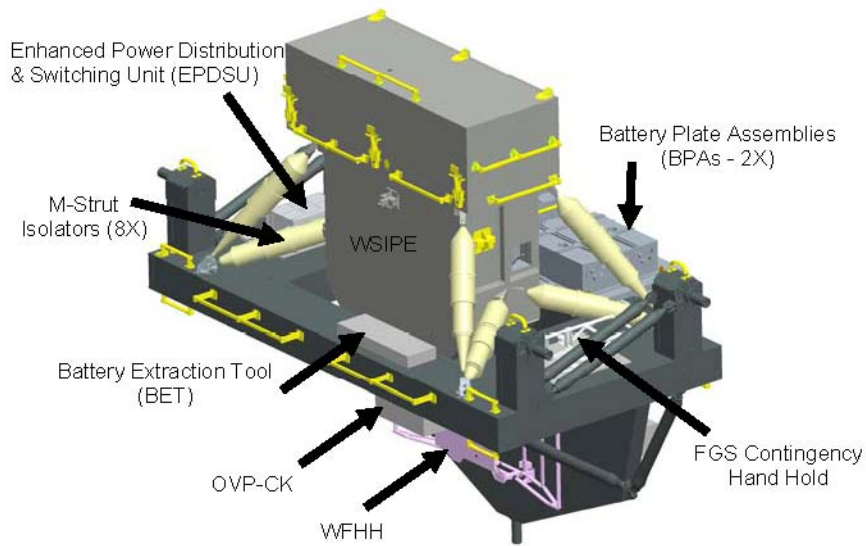
Figure 5-1. SLIC - forward/port view
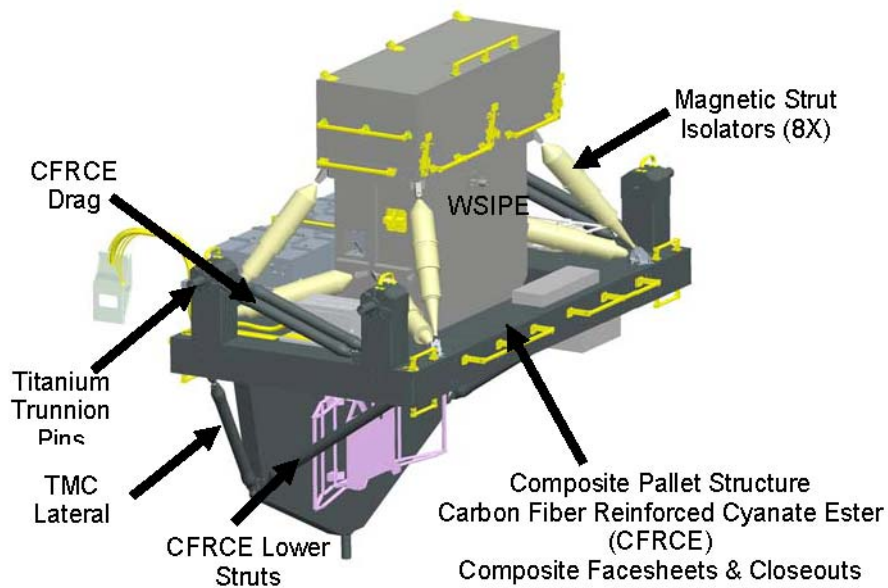
Figure 5-2. SLIC - forward/starboard view

Verify that this is the correct version before use

Figure 5-3. SLIC - aft views

Verify that this is the correct version before use
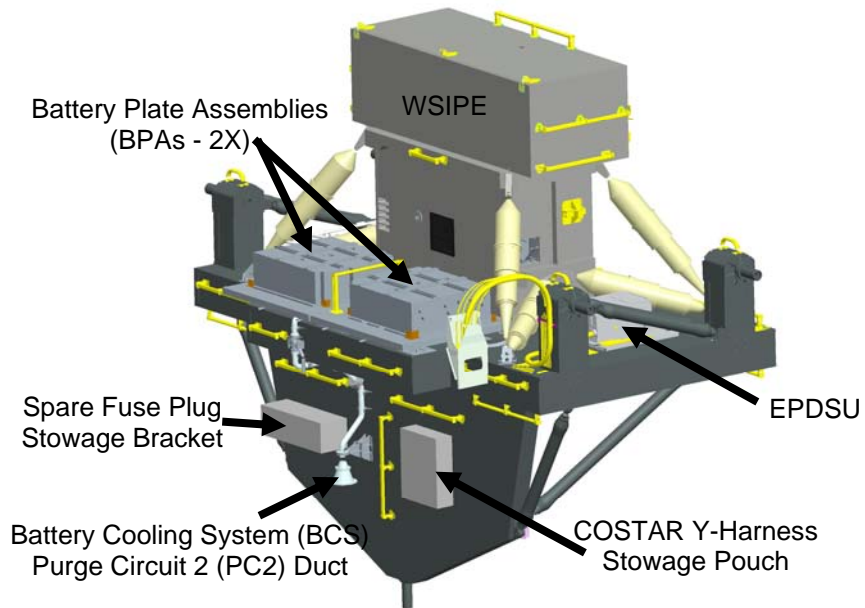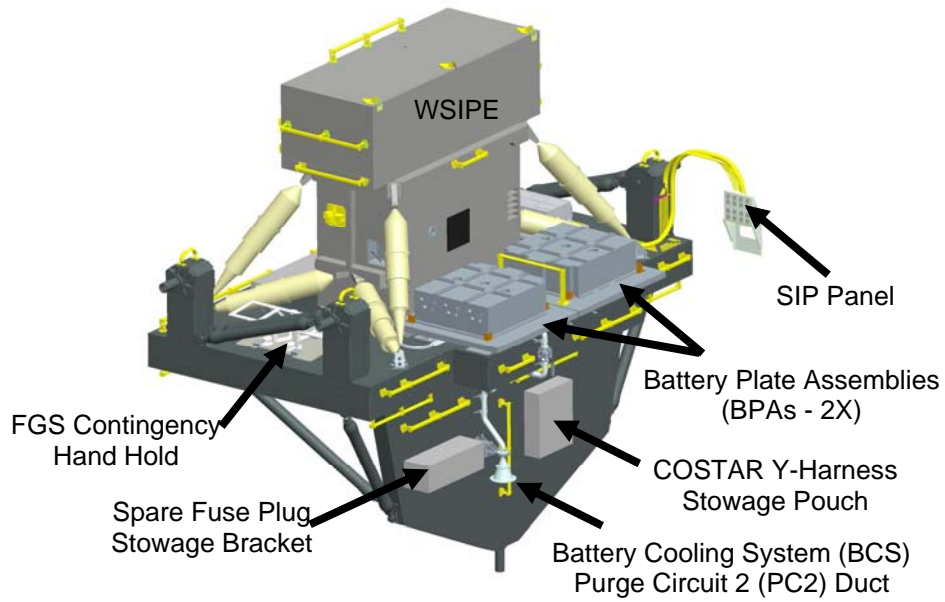
The SLIC includes the following components described in greater detail in subsequent sections.

SLIC Structural Elements consist of the following:

a. Pallet Assembly (PA)

    1. Vertical Pallet (VP)

    2. Horizontal Pallet (HP) (including Drag Struts)

    3. Lateral & Lower Struts

b. Load Isolation System (M-Struts) (integral part of HP)

c. WSIPE

d. Port and Starboard Battery Plate Assemblies (BPA)

e. Over Voltage Protection – Contingency Kit (OVP-CK) Stowage Hardware (1 contingency)

f. Wide Field Handhold (WFHH) Stowage Hardware

g. Fine Guidance Sensor Handhold (FGS HH) Stowage Hardware

h. Battery Extraction Tool (BET) Stowage Hardware

i. Fuse Plug & Fuse Module Stowage Hardware

j. COSTAR Y-Harness and Stowage Pouch

SLIC Mechanical Systems include the following:

a. SLIC Load Isolation System (M-Struts)

b. WSIPE Lid Hinges

c. WSIPE Lid Latches

d. WSIPE SI Latches and Guide Rails

e. BPA Flexures

f. BPA Shear Pin Mechanism

g. OVP-CK Stowage Lid Hinges & Latches

h. WFHH Stowage Captive Lock Pins

Verify that this is the correct version before use

i. FGS HH Stowage ¼-Turn Latches

j. BET Stowage Latches

k. ¼-Turn Thumb Latches on Fuse Plug/Module Stowage & COSTAR Y-Harness Stowage Pouch

l. Expandable bolts on WSIPE Isolator Struts, Drag Struts, and Lateral Struts

Avionics and Electrical Systems include the following:

a. Enhanced Power Distribution and Switching Unit (EPDSU)

b. SLIC Subsystem Active Thermal System

c. WSIPE Latch Indicators

For Thermal Control, SLIC uses both of the following:

a. Active Thermal Control

b. Passive Thermal Control

Major Hardware Manifested to be flown on SLIC includes the following:

a. Wide Field Camera 3 (WFC3) – 1000 lb

b. Wide Field / Planetary Camera 2 (WFPC II) (return)

c. 2 Battery Modules – 485 lb each

d. Battery Cap Assembly (return)

e. OVP-CK (1 contingency)

f. Battery Extraction Tool

g. Wide Field Handhold

h. FGS Handhold

i. Fuse Plugs & Fuse Modules

j. COSTAR Y-Harness

k. Portable Foot Restraint (PFR) Assembly

l. Push Button Articulating Socket Assembly

Verify that this is the correct version before use

5.1.1   SLIC Principle Structural Elements

The SLIC Pallet Assembly, Load Isolation System, and WSIPE are the principal structures of the SLIC. Details for each are given below.

Pallet Assembly

The SLIC Pallet forms the basic platform for the Carrier and consists of a Horizontal Pallet, including trunnion towers, and a Vertical Pallet as shown in Figure 5-4. The Horizontal and Vertical Pallets are fabricated from organic and metallic matrix composites, titanium, and aluminum. Both Pallets are intended to support payloads.

The Horizontal Pallet is comprised of top and bottom equipment panels separated by a frame structure as shown in Figure 5-5 and Figure 5-6. Similarly, the Vertical Pallet is comprised of fore and aft panels separated by a frame structure and is shown in Figure 5-7 and Figure 5-8.

Figure 5-4.   SLIC pallet

Verify that this is the correct version before use
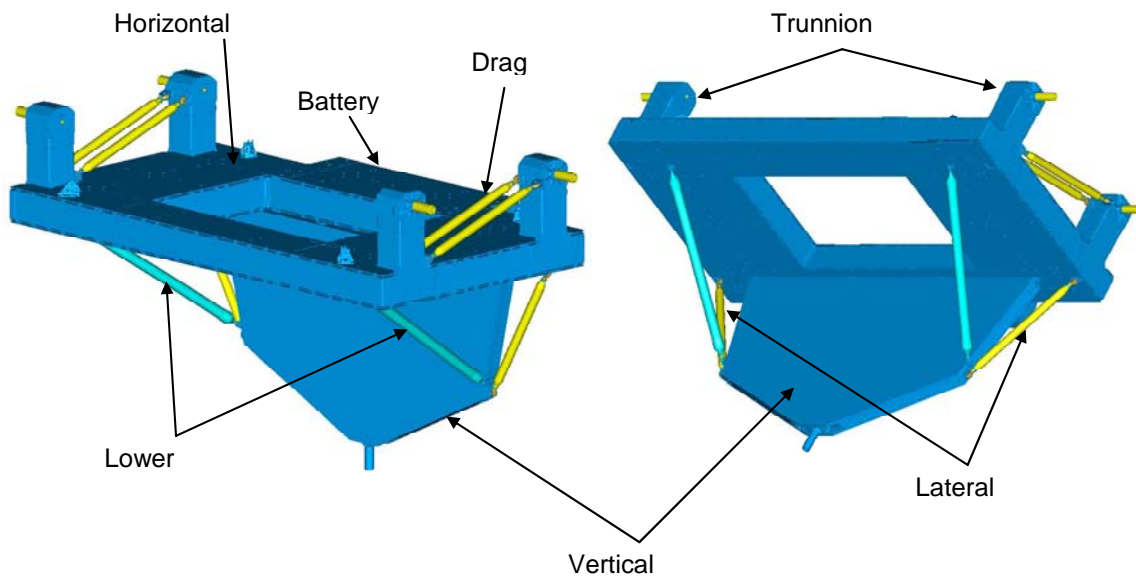
Horizontal Pallet Expanded View

Drag struts

Panel
splice plate

Panel construction:

0.065″ thk CFRCE facesheets

0.750″ thk alum. honeycomb core

Laminate hardpoints and closeouts

Battery
pallet

Beam construction:

0.065″ thk CFRCE facesheets

0.750″ thk alum. honeycomb core

Laminate hardpoints and closeouts

FWD

Trunnion
towers
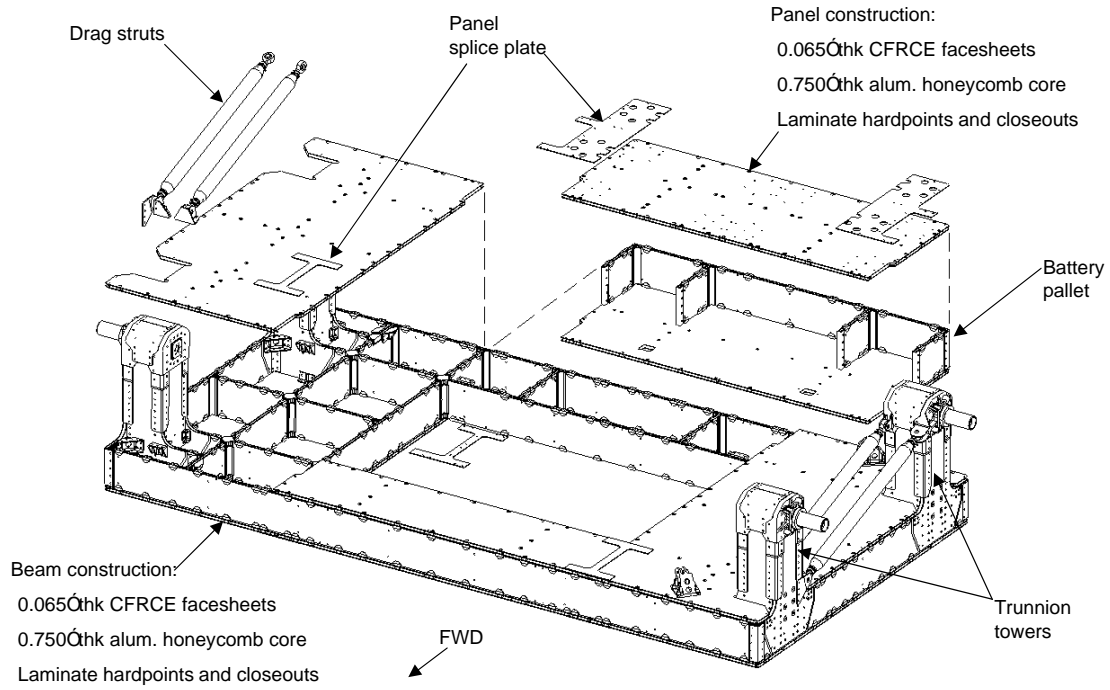
Figure 5-5. Pallet expanded view

5-7

Horizontal Pallet Frame

• Panels removed
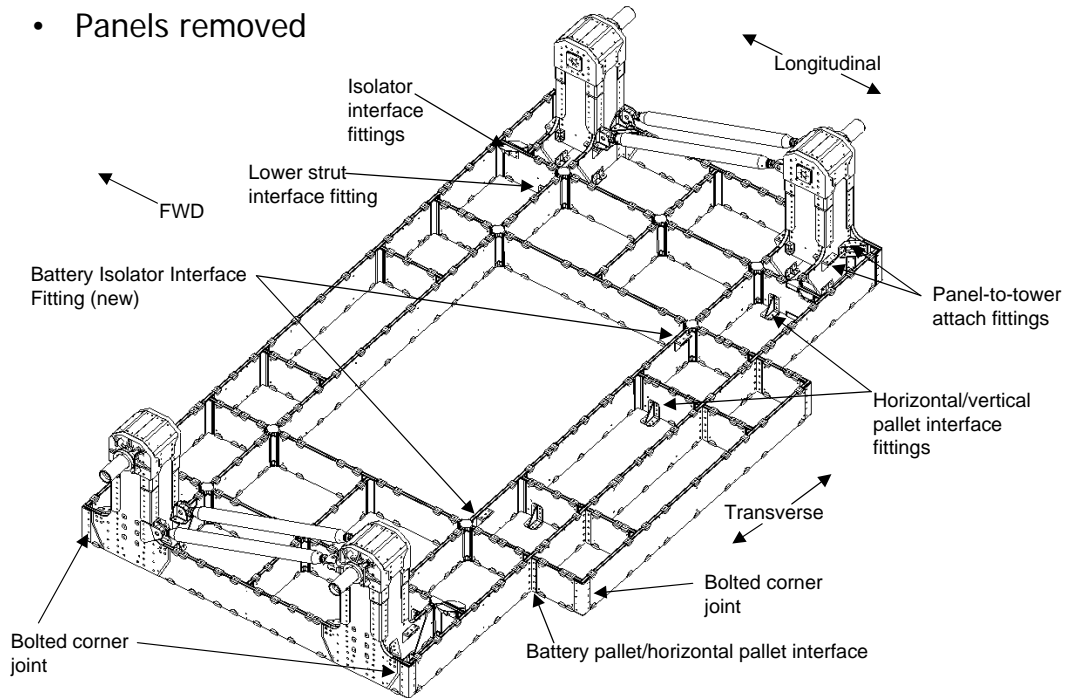
Figure 5-6. Horizontal pallet frame assembly

Verify that this is the correct version before use

Vertical Pallet

Lower Strut

Outbd HV Attach Fittings

Inbd HV Attach Fittings

Lateral Strut HP Attach Fitting

Lateral Strut

Panel (Aft Panel not shown)

Panel Attach Points

Doubled Facesheets Wide Beam Clips (New)

Up
Fwd
Port
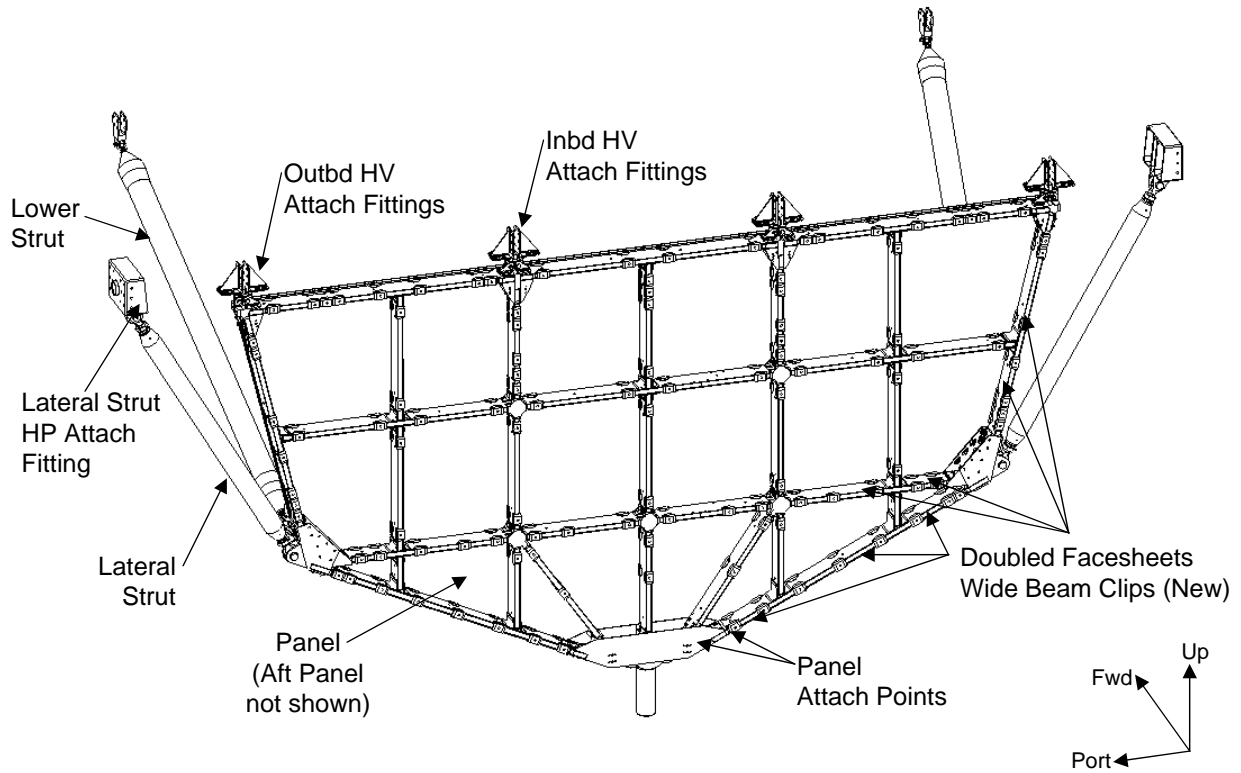
Figure 5-7. Vertical pallet frame assembly with attachment struts

Verify that this is the correct version before use

Panel Assembly onto Frame

GSE Attach Points
ϕ.688 ID/ϕ.750 OD Bushing
(New)

Edge
Attachment

Interior
Attachment

Up

Inbd

Fwd

Panel Attachment same
as Horizontal Pallet

Fitting
Attachment
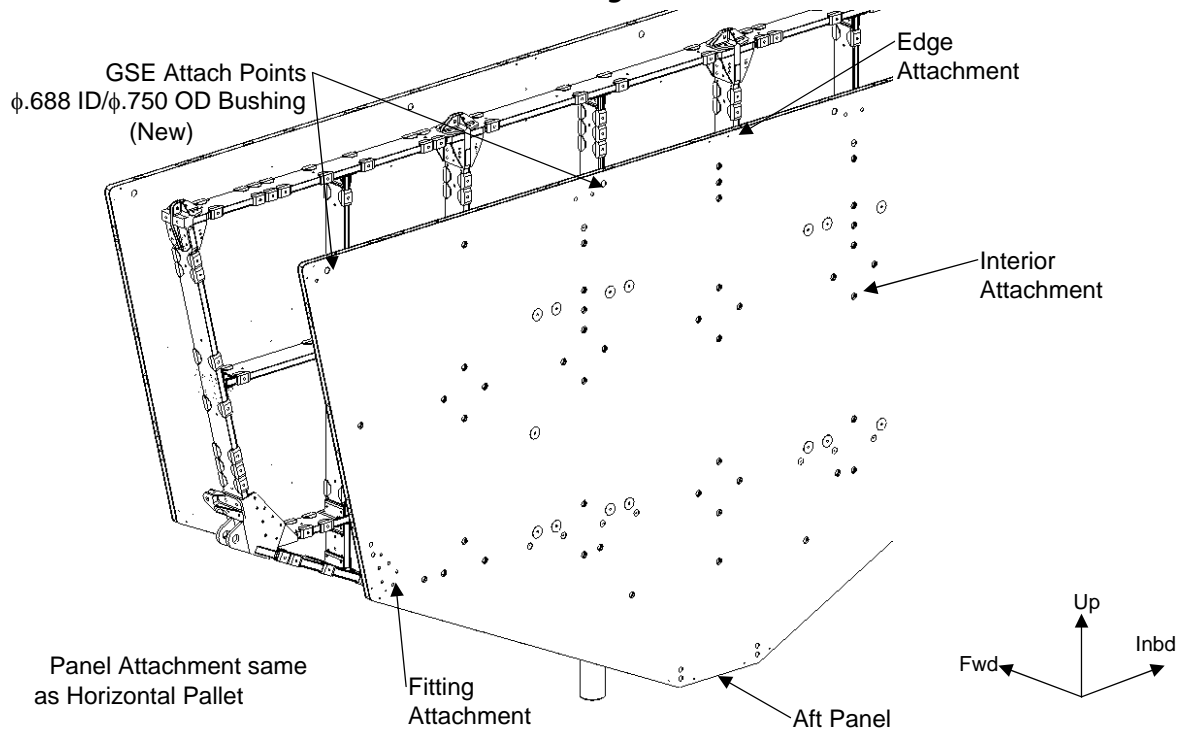
Aft Panel

Figure 5-8.   Vertical pallet - panel assembly to frame

Verify that this is the correct version before use

The equipment panels are honeycomb sandwich panels and the frame structure is made up of individual beams that are also honeycomb sandwich panels. The beams construction details for typical Horizontal & Vertical Pallet beams are shown in Figure 5-9 through Figure 5-11.

The Horizontal & Vertical Pallets use different height beams to construct the frame structures making the Pallet thicknesses unique. The Horizontal beams are 10.00 inches high, and the Vertical beams are 3.75 inches high. These dimensions include the panel to beam attachment clips.

The Pallet panels are mechanically fastened to the frame structure to facilitate inspection, repair and operability. The frame structure and towers will be a unitized structure employing bonded joints where appropriate.

The equipment panels are primarily closeout panels, which provide stiffness for the Horizontal & Vertical Pallets. They are also capable of carrying additional HST manifest items, as the design progresses. The Vertical Pallet is removable, as the keel structure is intended to be interchangeable for future missions beyond HST-SM4.

The Pallet cradle interfaces with the orbiter cargo bay using a traditional five-point attachment scheme. The primary trunnions and keel trunnion are aligned in X and are at the aft end of the Pallet. The secondary trunnions are at the forward end of the Pallet.

Verify that this is the correct version before use

Beam Construction Detail

Fastener clip (bonded to beam cap and facesheets)

Laminate beam cap

Beam cap core vented into beam core

Anti-peel fastener holes

Laminate hardpoint

Laminate beam end cap

Facesheet vent hole

Beam cap honeycomb core

Beam honeycomb core
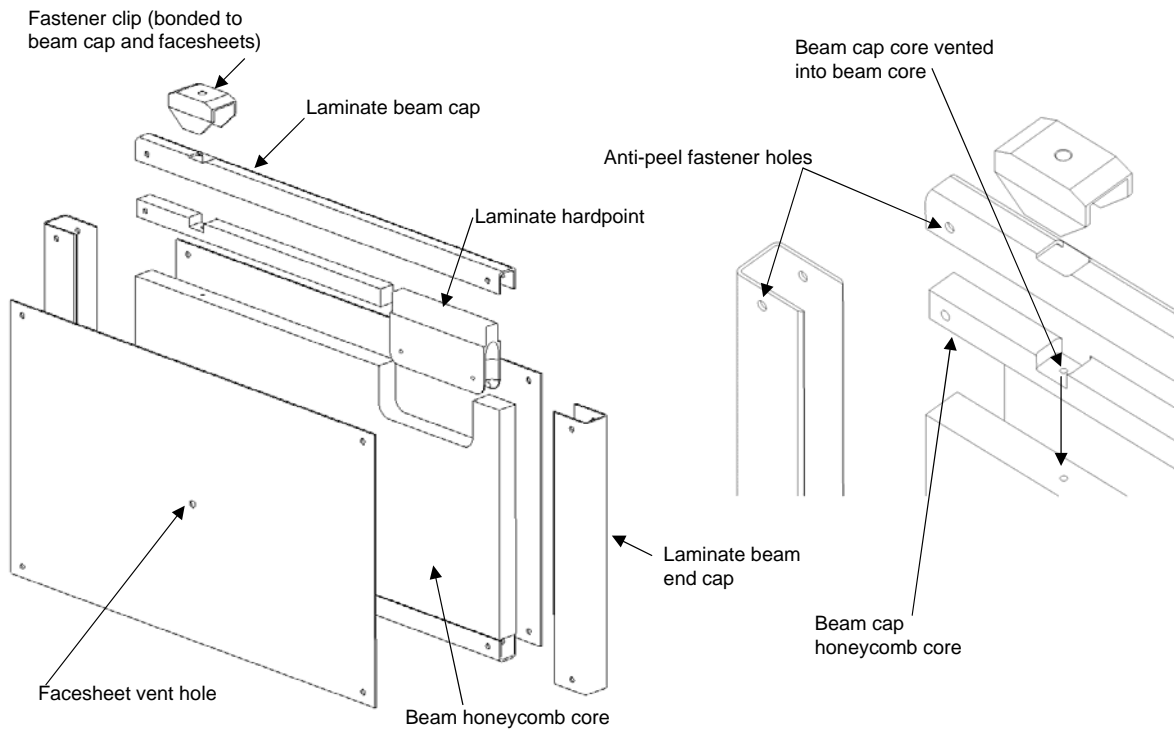
Figure 5-9. Typical horizontal pallet beam details

5-12

Verify that this is the correct version before use

Beam Assembly

Panel
Attach Clips

Beam End
Cap

Bushed holes for
bolted fitting inter

Sandwich
Assembly

GE2050425-3 Beam Assembly
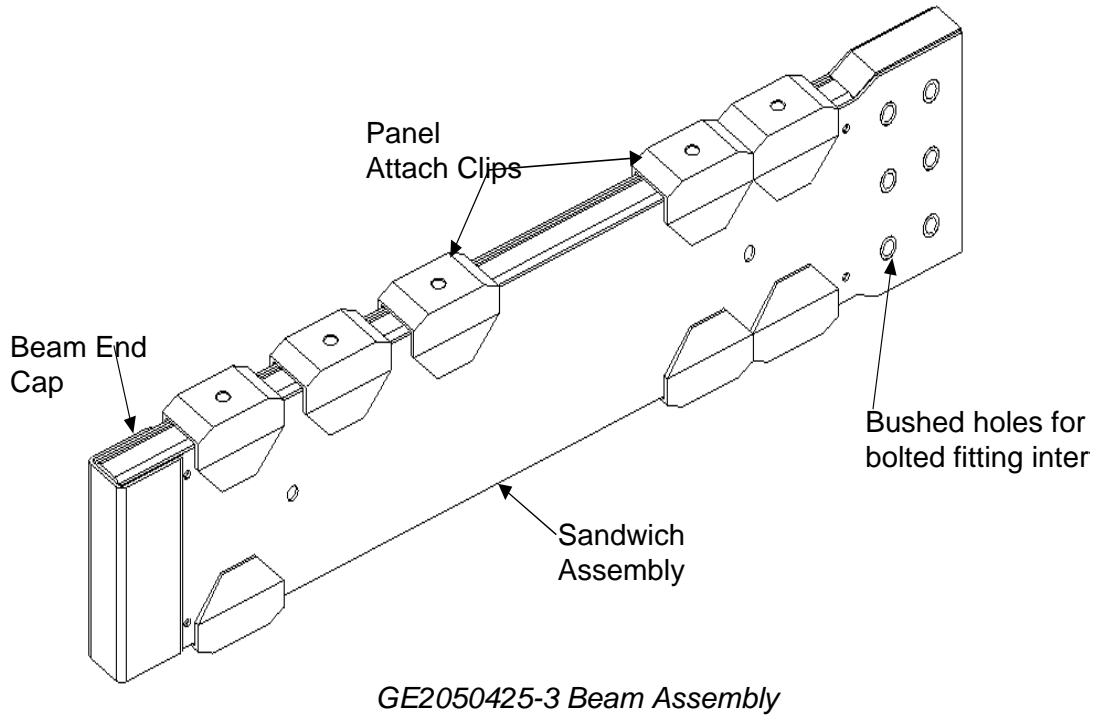
Figure 5-10. Typical vertical pallet beam assembly

Verify that this is the correct version before use

Beam Assembly-Expanded
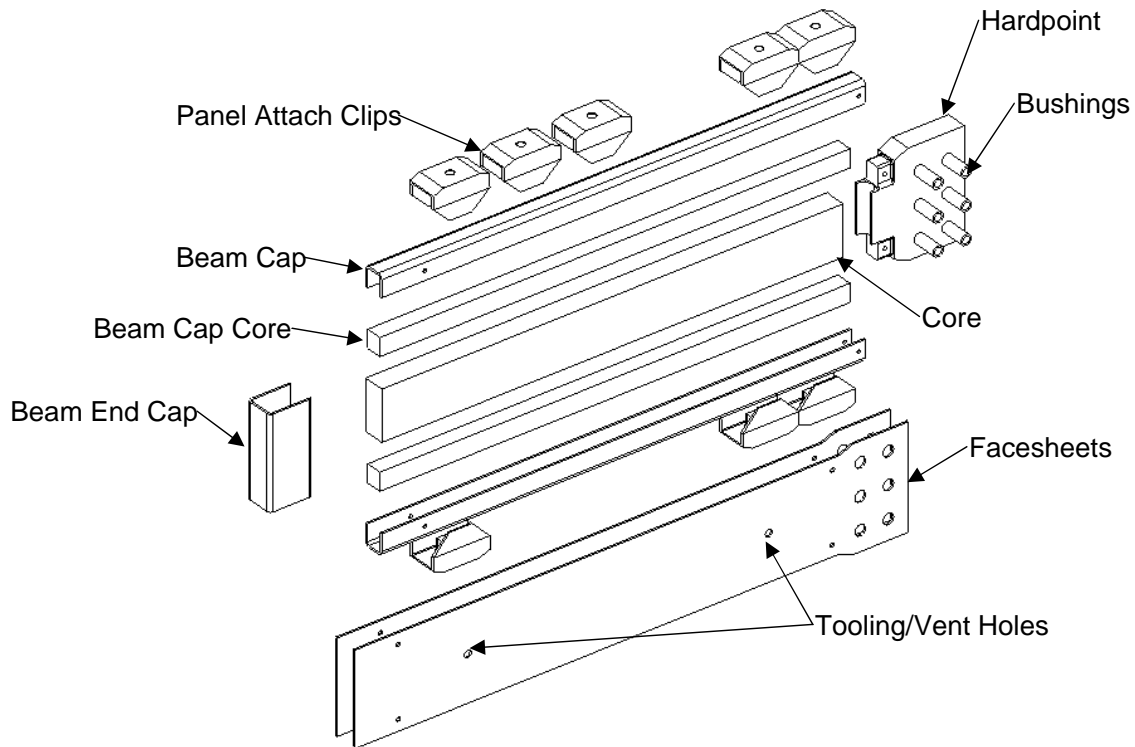
Figure 5-11. Typical vertical pallet beam assembly – expanded view

The following materials are used for the SLIC load-carrying elements:

Carbon Fiber Reinforced Cyanate Ester (CFRCE) is used as follows.

a.   The panels and beams are composed of composite facesheets using a quasi-isotropic 10-ply layup (954-3 or RS-3 resin, M55J unidirectional tape, and T-300 plain weave fabric; first and last plies are fabric for damage tolerance) sandwiched around aluminum honeycomb core (typical .750 inches thk, 6.1 PCF, perforated), see Figure 2.3-8 for typical panel/beam construction

b.   The Beam Caps, L-clips (12 plies), Beam End Caps 9 plies), and Panel Edge Closeouts are T300 2x2 twill fabric and RS-3C resin

c.   Panel and Beam hardpoints are T300 4x4 twill fabric and RS-3C resin

d.   Drag and Lower Struts are 15 ply (M55J, 14 ply, & T-300, outer ply) CFRCE laminate tubes bonded to titanium end fittings

Verify that this is the correct version before use

Titanium Matrix Composite (TMC) (SiC/Ti-6Al-4V) is used for the Lateral Struts.

Titanium components include the following:

a. Longeron and Keel Trunnion Pins

b. Beam Clips, Beam Hubs

c. Pillow Blocks, Strut End Fittings, WSIPE Clevis, Internal Fittings

d. Trunnion Tower Shrouds

e. Bushings

f. L-Clips

Corrosion Resistant Stainless Steel (CRES), A286 is used for Fasteners.

Inconel 718 is also used for the Battery Pallet Fasteners, Battery EVA Fasteners, Keel Trunnion attachment Fasteners, and Battery Pallet Bushings.

Aluminum is used for Post-Bonded Inserts.

Pallet Joints

The Horizontal & Vertical Pallets use a variety of bonded joint designs to connect interior beams together and beams to panels as well as standard bolted or clevis type joints. This section gives detailed descriptions of the joints used throughout the Pallet.

Beam to Beam Joints

The Pallet beam-to-beam joints connect the interior beams of the Horizontal and Vertical Pallets. There are three configurations of beam-to-beam joints used in the Pallets – the standard joint, the beam hub joint, and the bolted joint.

Standard Joint - The standard joint is used in 37 percent of the beam-to-beam joints throughout the Pallet. Figure 5-12 shows the details of the standard joint configuration. The laminate Beam End Caps and L-Clips are bonded on using Hysol EA9394 structural adhesive. The standard "Cross" joint is similar to the "T" joint shown with another discontinuous beam attachment on the open end of the "T."

Verify that this is the correct version before use

Standard Beam Tee Intersection

Continuous Transverse Beam

Anti-peel fasteners

Bonded interfaces

#10-32 fasteners (CRES)

Laminate L-clip, 2X

Laminate beam end cap

Longitudinal Beam
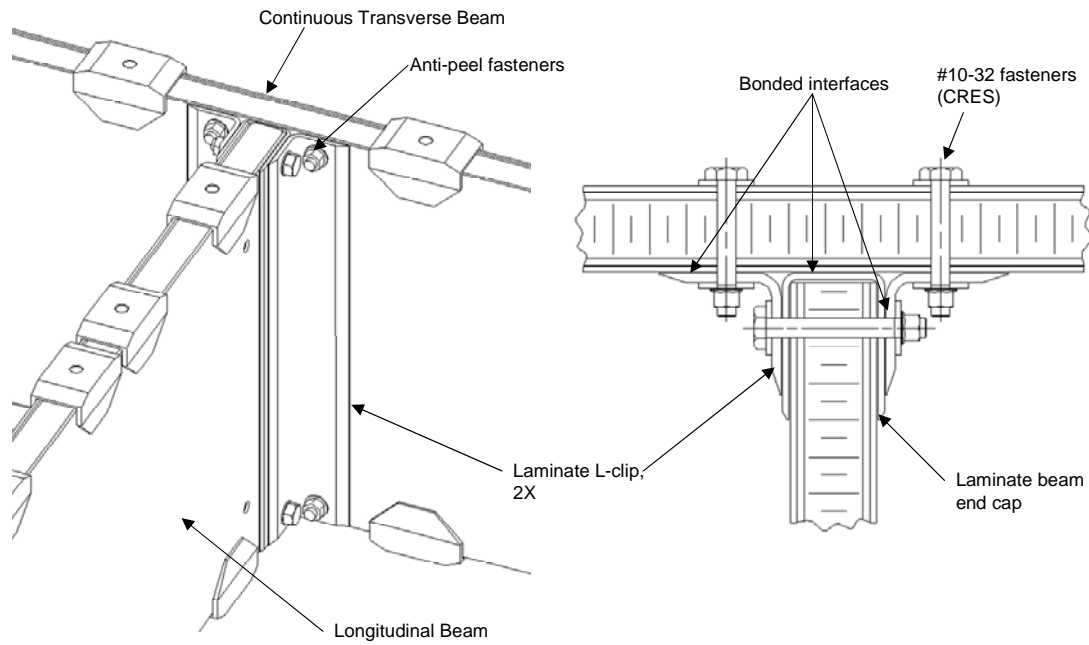
Figure 5-12. Standard beam-to-beam "T" joint configuration

Verify that this is the correct version before use

Beam Hub Joint - The beam hub joint is used in highly loaded joints that required additional strength over the standard joint. The beam hub joint represents 30 percent of the beam-to-beam joints throughout the Pallet. The Beam Hubs are bonded on using Hysol EA9394 structural adhesive. Figure 5-13 shows the details of the Horizontal Pallet beam hub joint configuration. Figure 5-14 shows the Vertical Pallet "Cross" and "5-Way" beam hub joint configurations. Laminate L-Clips are not used in the Vertical Pallet Beam Hub joint. The Beam Hub joint also has a "T" configuration that is similar to the "Cross." The Battery Pallet outer joints have been changed to Beam Hub Joints making the Battery Pallet no longer removable.

Figure 5-13. Horizontal pallet beam to beam hub "cross" joint configuration

Verify that this is the correct version before use

Beam Hub Fittings

5-Way Hub Fitting

Hub Fitting

Continuous Beam

ub Fittings used in locations of higher loads where L-Clips are not adequate

Bonded in place using EA9394

Up
Fwd
Port
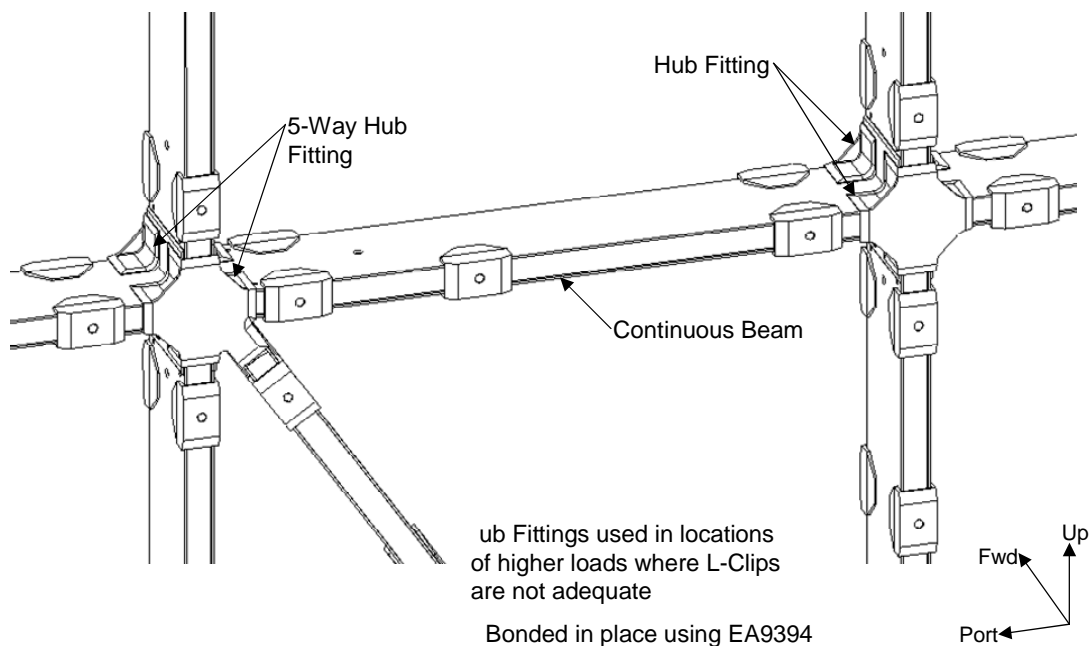
Figure 5-14. Vertical pallet beam to beam hub "cross" and "5-way" joint configurations

Bolted Joint - The bolted joint is used on the Horizontal Pallet and the Vertical Pallet for damage protection and to ease beam removal for internal inspection. Bolted joints are used on the Horizontal Pallet outside corner joints, the inner joints of the Battery Pallet attachment on the Horizontal Pallet, the obtuse and acute angles on the Vertical Pallet, and for the complex Vertical Pallet corner joints. The bolted joint represents 33 percent of the beam-to-beam joints throughout the Pallet. Figure 5-15 shows the details of the bolted corner joint configuration; Figure 5-16 shows the details of the Battery Pallet attachment bolted joint; and Figure 5-17 shows the details of a typical Vertical Pallet corner joint configuration. The beams are attached with titanium L-flanges or fittings on the interior and exterior that are secured with bolted fasteners that go through bushings in the beams and the internal and external fittings.

Verify that this is the correct version before use

Beam Bolted Corner Detail

- Battery Pallet aft port corner shown

Port Longitudinal Beam

Fastener Bushing

Titanium L-Flange

Aft Transverse Beam

1/4-28 Fastening Hardware

Titanium L-Flange (inside/outside)
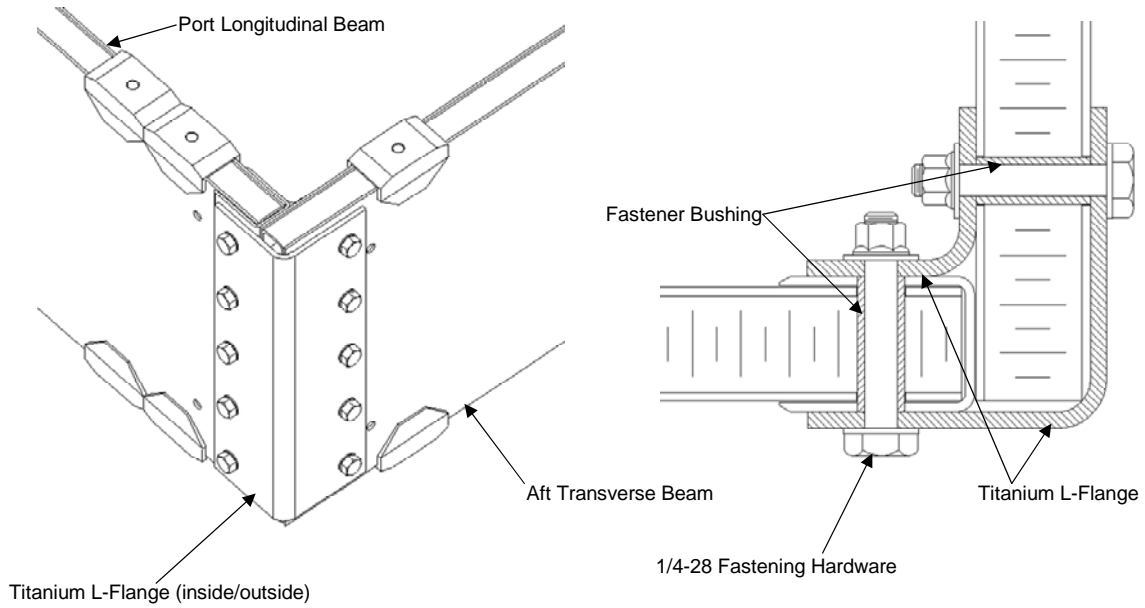
Figure 5-15. Beam-to-beam bolted corner joint
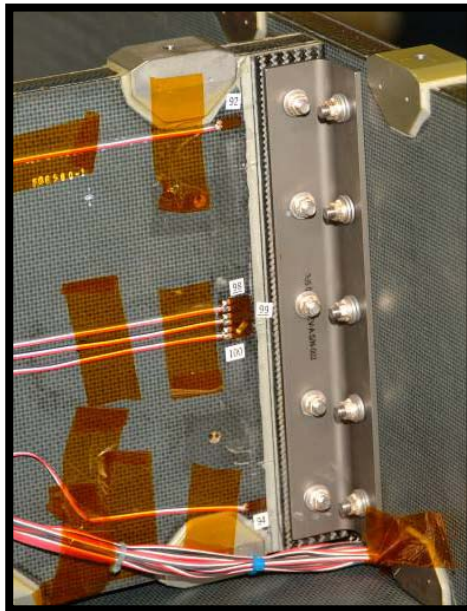
Figure 5-16. Beam to beam battery pallet attachment bolted inner joint

5-19

Verify that this is the correct version before use

Typical Bolted Construction

Outbd
Attach
Fitting

φ.428 OD Bushing-Ti
thru Beam Sandwich

Beam

MGSE
Attach Point

Beam Hardpoint

Beam Hardpoint

φ.375 Bushing-Ti
thru Beam Sandwich

Outbd Attach
Fitting-Mating

φ1/4 Bolt & Nut,
Washer each side
Typical Hardware
at each location

Up

Port
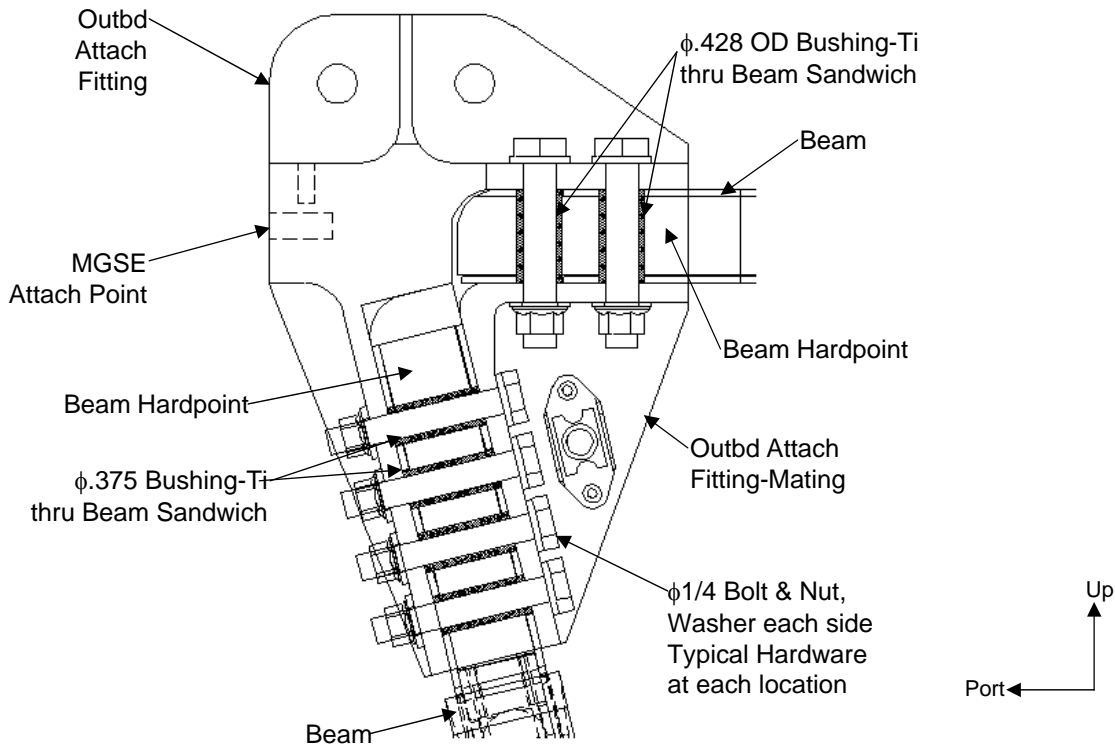
Beam

***Figure 5-17. Typical vertical pallet beam to beam bolted
corner joint configuration***

Panel to Beam Joints

The Pallet panel to beam joints connect the equipment panels to the frame beams of
the Horizontal and Vertical Pallets. There are three basic configurations of panel to
beam joints used in the Pallets - the panel interior hardpoint, the panel edge, and the
panel to beam fitting configurations.

Panel Interior Hardpoint to Beam Joint - The panel interior hardpoint to beam joint is
used in over 330 locations throughout the Pallet. Figure 5-18 shows the details of the
joint configuration. The panels have interior laminate hardpoints, called pucks, cured
into the panels. The pucks have a counterbore and a through hole with a flanged
bushing bonded into the hole using Hysol EA9394 structural adhesive. On the beam, a
titanium Beam Clip is bonded onto the beam using Hysol EA9394 structural adhesive as
shown in Figure 5-18. A 1/4-inch diameter shoulder bolt with #10-32 threads attaches
the panel to the Beam Clip.

Verify that this is the correct version before use

Beam Clip Installation Details

Cutout protrudes down into cap core

Cutout in Beam Cap for Helicoil Boss Clearance

Vent hole thru Beam Cap core into main Core

Panel Attach Clip with Helicoil

Tooling/Vent Hole

| Beam Assembled | | Clip Expanded | | Beam Expanded |
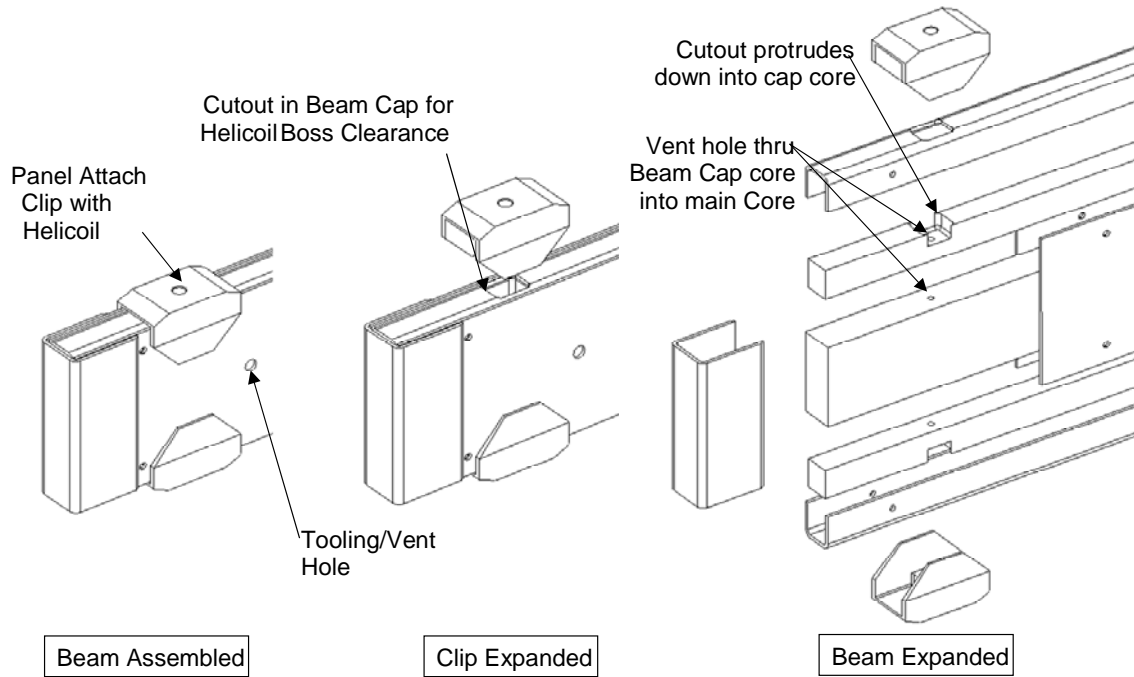
Figure 5-18. Panel to beam joint – interior hardpoint

Verify that this is the correct version before use

Panel Edge to Beam Joint - The panel edge to beam joint is used in over 340 locations throughout the Pallets. Figure 5-19 shows the details of the panel edge to beam joint configuration. The panel edge joint is identical to the panel interior joint except the hardpoint on the panel side is a laminate panel edge block bonded into the panel edge closeout channel using Hysol EA9394 structural adhesive instead of an interior puck.

Panel Edge to Beam Joint
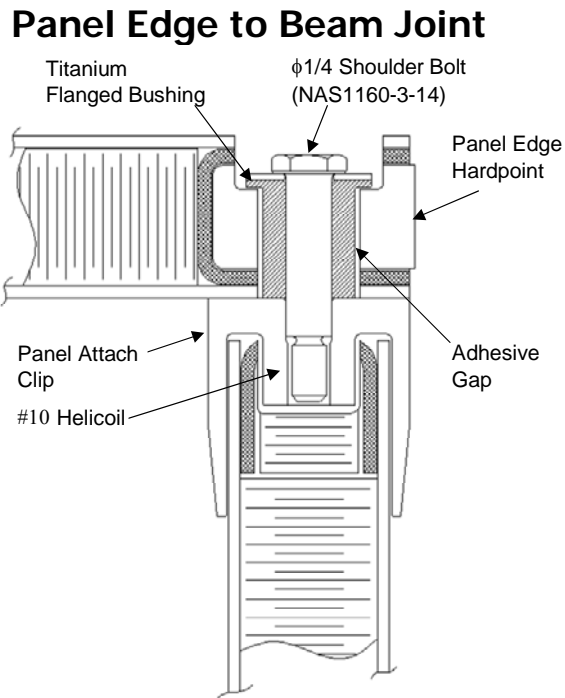
Figure 5-19. Panel edge to beam joint

Verify that this is the correct version before use

Panel to Beam Fitting Joint - The panel to beam fitting joint is used in over 160 locations throughout the Pallets. The panel to beam fitting joint is used in highly loaded areas in the Horizontal and Vertical Pallets where an internal metallic fitting is attached to a beam using bolted fasteners. Figure 5-20 shows the details of the panel to beam fitting joint configuration. Similar to the panel interior joint, the panels have interior laminate hardpoints cured into the panels with a counterbore and a through hole and a flanged bushing bonded into the hole using Hysol EA9394 structural adhesive.

Panel to Beam Attachment-Fittings
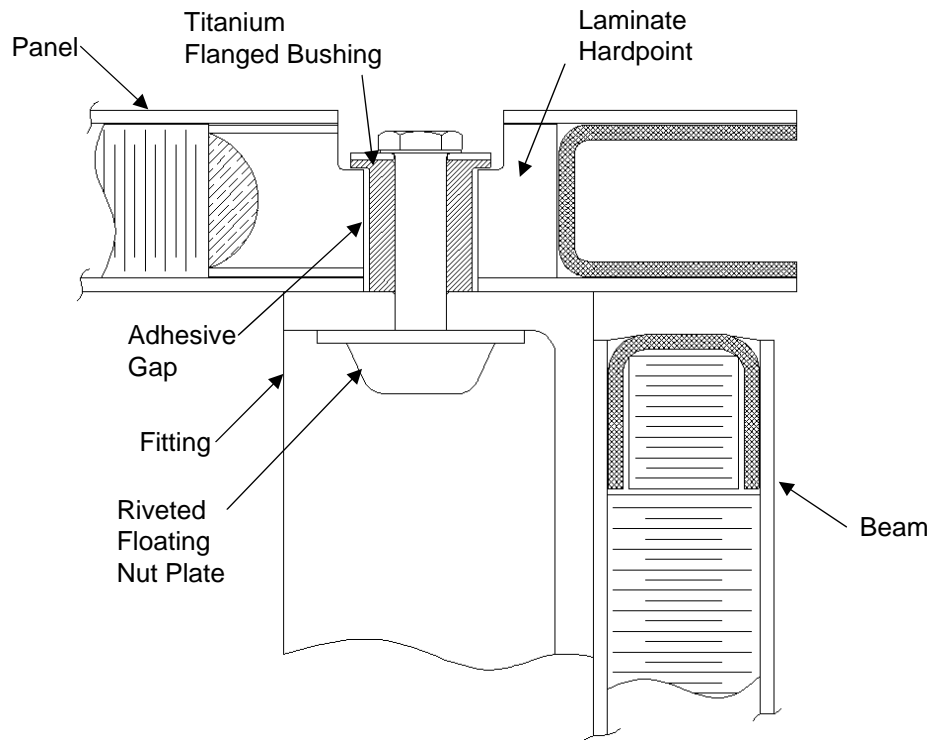
Figure 5-20. Panel to beam fitting attachment joint

Verify that this is the correct version before use

Equipment Panel Attachment Hardware Joints

The SLIC Pallet is capable of carrying about 5,600 pounds of payload to orbit. The standard method for attaching the payload hardware is via fasteners that are bonded into the sandwich panels following the sandwich panel cure - this type of fastener is referred to as a post-bonded insert. The Pallet payload interface hardware locations are shown in Figure 5-21. These interface locations include all stowage and EVA hardware.

The typical interface for hardware mounted to the SLIC Pallet will be a threaded bolt or shoulder bolt into a two-piece post-bonded insert. A number of varieties of post-bonded inserts have been designed for SLIC to be used in sandwich panels with honeycomb core or laminate hardpoint core and for tensile and/or shear loading. Some one-piece post-bonded inserts will also be used for lightweight items and for additional grounding.

The one-piece inserts can be installed without removing the equipment panels from the frame where the installation of the two-piece inserts require the equipment panels to be removed for access to both sides of the panels. The post-bonded inserts that are used on SLIC are shown in Figure 5-22. The post-bonded inserts are secured into the sandwich panels with Hysol EA9394 structural adhesive and EY3010 for honeycomb core fill adhesive. The electrical grounding inserts are secured with Eccobond 57C A/B conductive adhesive.

Verify that this is the correct version before use
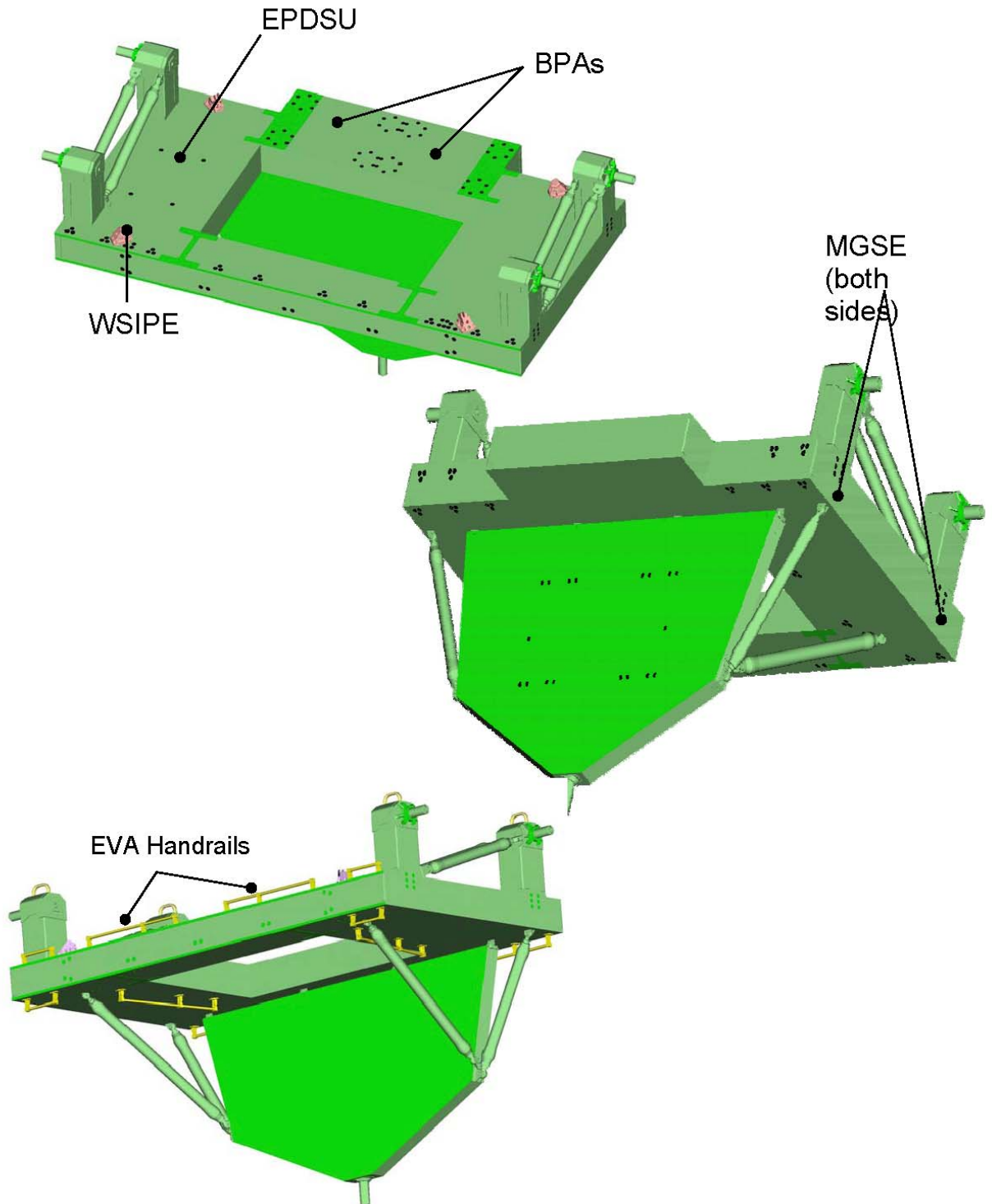
Figure 5-21. Pallet payload interface hardware locations

Verify that this is the correct version before use

Payload Interface Insert Configurations

- Standard insert configuration:
  - 2 piece, thread-together, with flanges top and bottom, anodized finish
  - Repairable locking threaded insert

2 Piece/ Installed in Honeycomb Core
_-28 Thread (Tension Application)
Thru-Hole

EA9394
Adhesive

EY3010
Adhesive

2 Piece/ Installed in Honeycomb Core
#10-32 Thread with 0.250 Dia. Shear Bore
(Shear Application)
Thru-Hole

2 Piece/ Installed in Honeycomb Core
#8-32 Thread (Electrical Grounding)
Iridite Finish, Blind Hole

Conductive
Adhesive

2 Piece/ Installed in Solid Laminate Hardpoint
_-28 Thread (Tension Application - Battery Plate Assembly)
Blind Hole

EA9394
Adhesive

2 Piece/ Installed in Solid Laminate Hardpoint
5/16-24 Thread (Tension Application)
Blind Hole

2 Piece/ Installed in Solid Laminate Hardpoint
#10-32 Thread with 0.250 Dia. Shear Bore
(Shear Application)
Blind Hole

EA9394
Adhesive

1 Piece/ Installed in Solid Laminate Hardpoint
_-28 Thread (Tension Application)
Blind Hole

EA9394
Adhesive

1 Piece/ Installed in Honeycomb Core
#8-32 Thread (Electrical Grounding)
Iridite Finish, Blind Hole

Conductive
Adhesive

Figure 5-22. Payload interface post-bonded inserts

Verify that this is the correct version before use

Horizontal Pallet to Vertical Pallet Attachment Joints

The Horizontal Pallet is attached to the Vertical Pallet via eight interface points. Four of the points are interfaces between fittings directly bolted into the Horizontal and Vertical Pallets and the other four interfaces are made through strut attachments to fittings bolted into the Horizontal and Vertical Pallets as shown in Figure 5-23.

The four interfaces between the Horizontal and Vertical Pallets are attachment fittings configured as basic lug and clevis fittings with two 3/8" bolts per interface. The detailed joints are shown in Figure 5-24 and Figure 5-25.

The Lateral Struts have spherical rod end bearings at each end and attach to the Horizontal and Vertical Pallets at clevis fittings with 1.0 inch diameter expandable bolts. The detailed joints are shown in Figure 5-26 and Figure 5-27. The Lower Strut attachments are similar to the Lateral Struts but use 0.5 inch diameter expandable bolts. The Lower Strut attachment joint details are shown in Figure 5-28 and Figure 5-29.

Vertical Pallet Interfaces
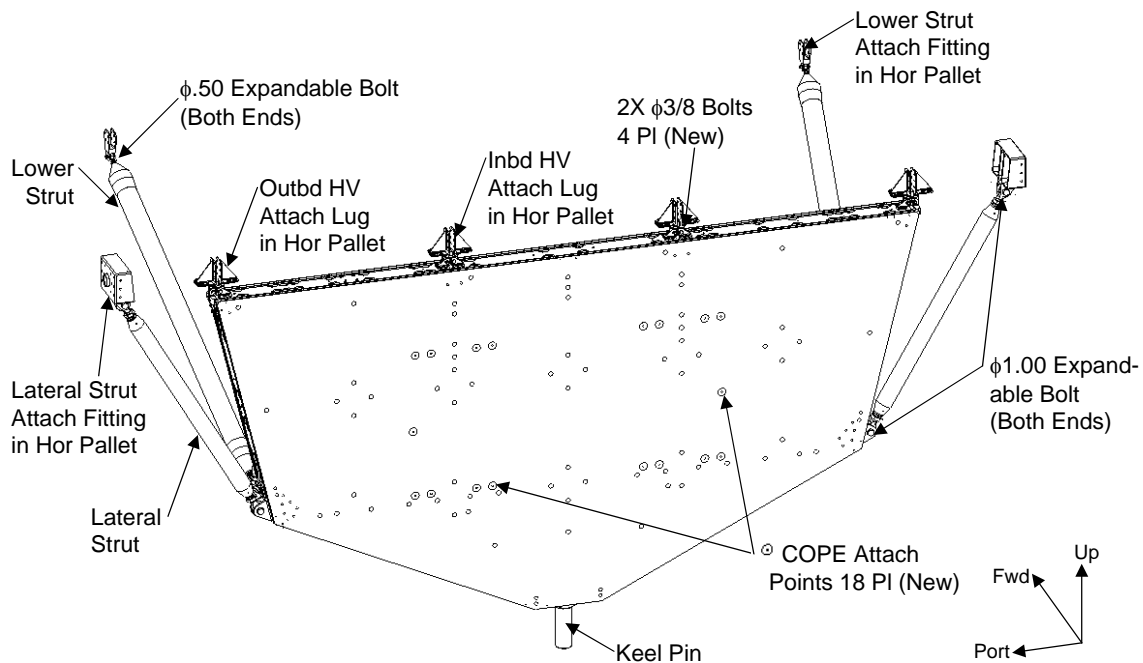
Figure 5-23. Horizontal to vertical pallet interfaces

Verify that this is the correct version before use

Hor -Vert Pallet Outbd Attach Fittings

HP Beam
Attach Points
(ϕ5/16 Bolts)

HP Attach
Lug

ϕ3/8 Solid Bolts
HP to VP Attach Points

Bolted Interface
thru Beam Hardpoint
(ϕ5/16 Bolts)

Fwd Panel

HP Panel Attach
Point (Riveted
ϕ1/4 Nutplate)

MGSE Points
(ϕ1/4 Inserts)

Hardpoint extends
under Beam Clip (New)

Panel Attach
Point-Beam

VP Outbd
Attach Fittings

VP Attach
Fitting-Mating

Panel Attach
Point-Fitting
(Riveted ϕ1/4 Nutplate)

Bolted Interface
thru Beam Hardpoint
(ϕ1/4 Bolts)

Up

Fwd

Port

Hor-Vert Pallet Inbd Attach Fittings

HP Beam
Attach Points
(ϕ5/16 Bolts)

HP Attach
Lug

HP Panel Attach Points
(Riveted ϕ1/4 Nutplate)

ϕ3/8 Solid Bolts

VP Inbd
Attach Fittings

Bolted Interface
thru Beam Hardpoint
(ϕ5/16 Bolts)

VP Inbd Attach
Fitting-Mating

Up

Fwd

Port
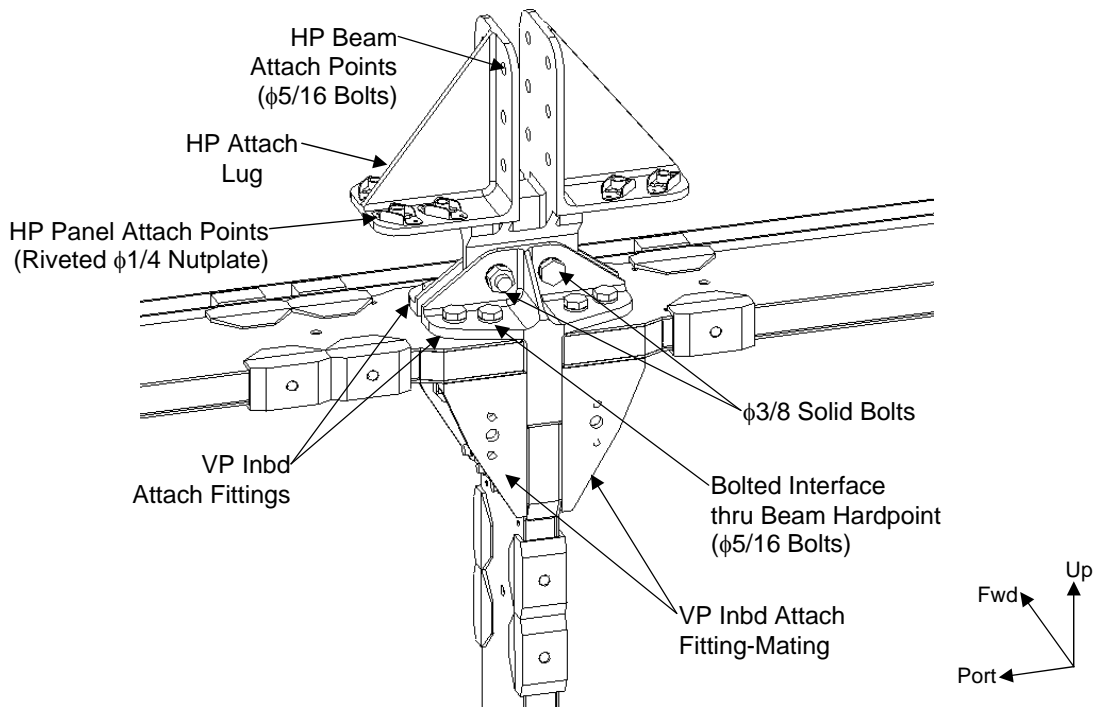
Figure 5-24. Horizontal-vertical pallet outboard and inboard attach fittings

5-28

Verify that this is the correct version before use

Hor-Vert Pallet Attach Fittings
Typical Side View

HV Attach Lug

6X φ5/16 Bolt Locations thru Fitting and HP Beam

Custom Shim (Nominal .030̋ thk each side)

φ3/8 Solid Bolt

Nut & Washer

Fwd Panel

MGSE Attach Points (Outbd Fittings Only)

VP Attach Fittings

Up

Fwd
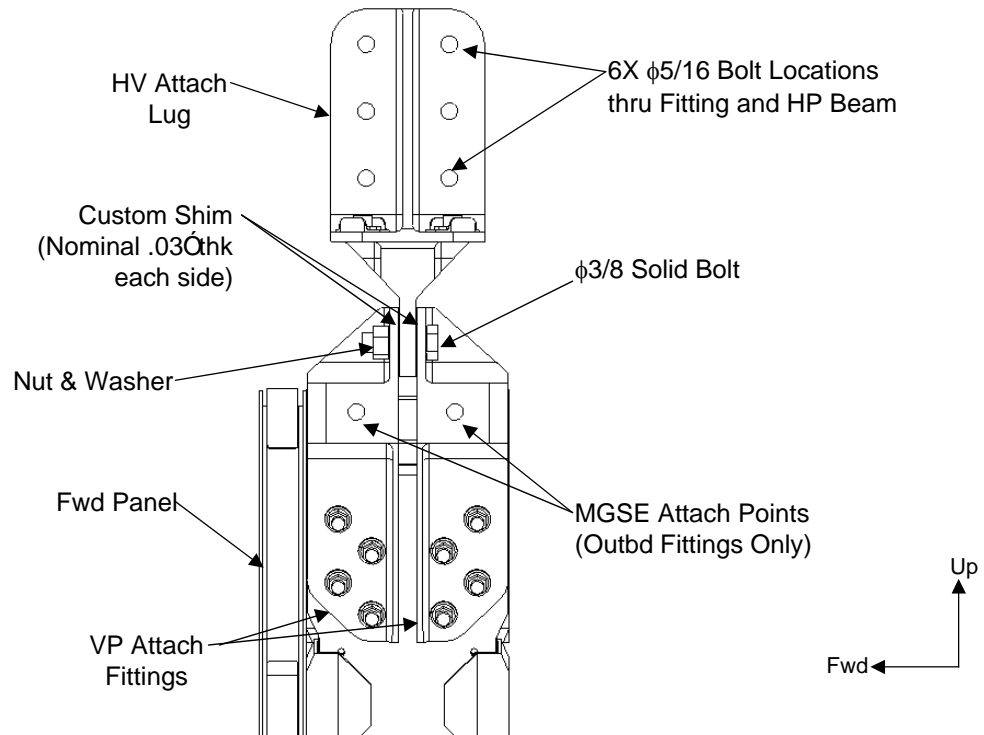
Figure 5-25. Hor-vert attach fittings – side view

5-29

Verify that this is the correct version before use

HP Interface Fitting to Lateral Strut Attach

Interface Fitting
(Horizontal Pallet)

ϕ1.00 Expandable Bolt

TMC Lateral
Strut (New)
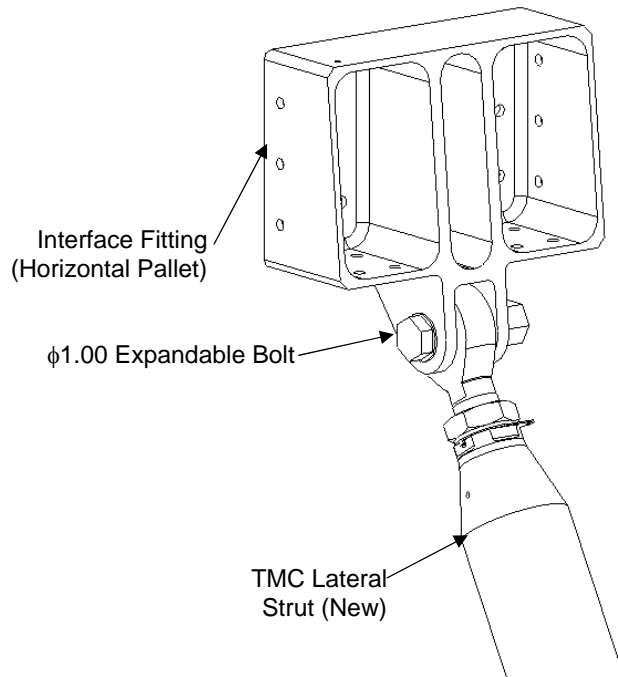
Figure 5-26. HP interface fitting to lateral strut attach

Verify that this is the correct version before use

Lateral Strut to Corner Fitting Attach

Lateral
Strut

Beams

φ1.00 Expandable Bolt

Corner Fitting

Up

Fwd

Port
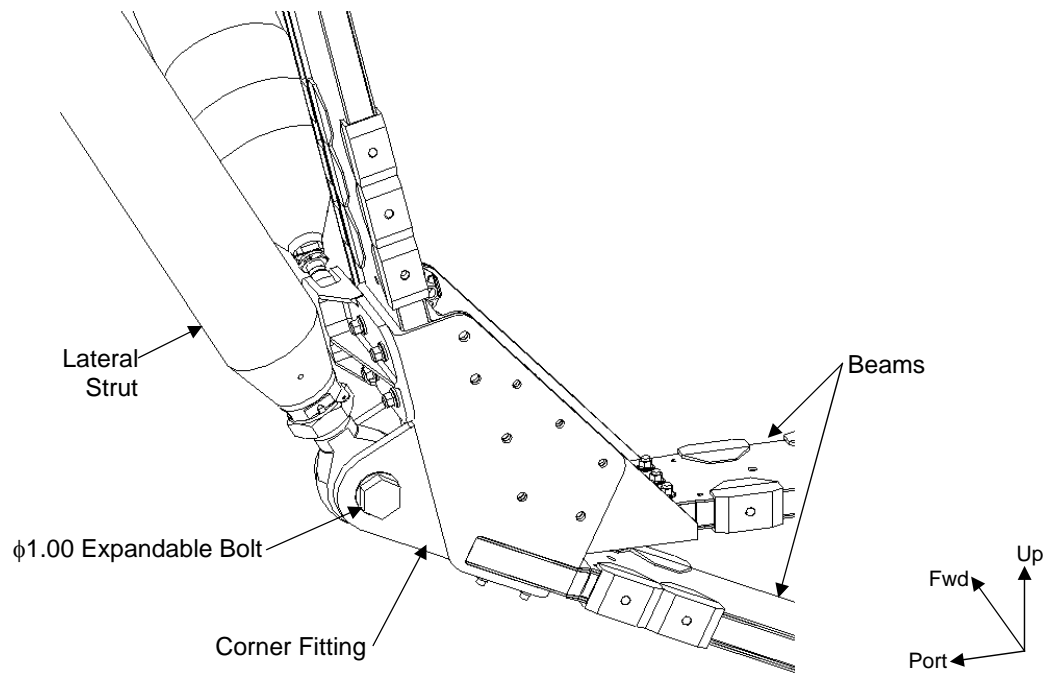
Figure 5-27. Lateral strut to corner fittings attach

Verify that this is the correct version before use

HP Interface Fitting to Lower Strut Attach

Interface Fitting
(Horizontal Pallet)

ϕ.500 Expandable Bolt
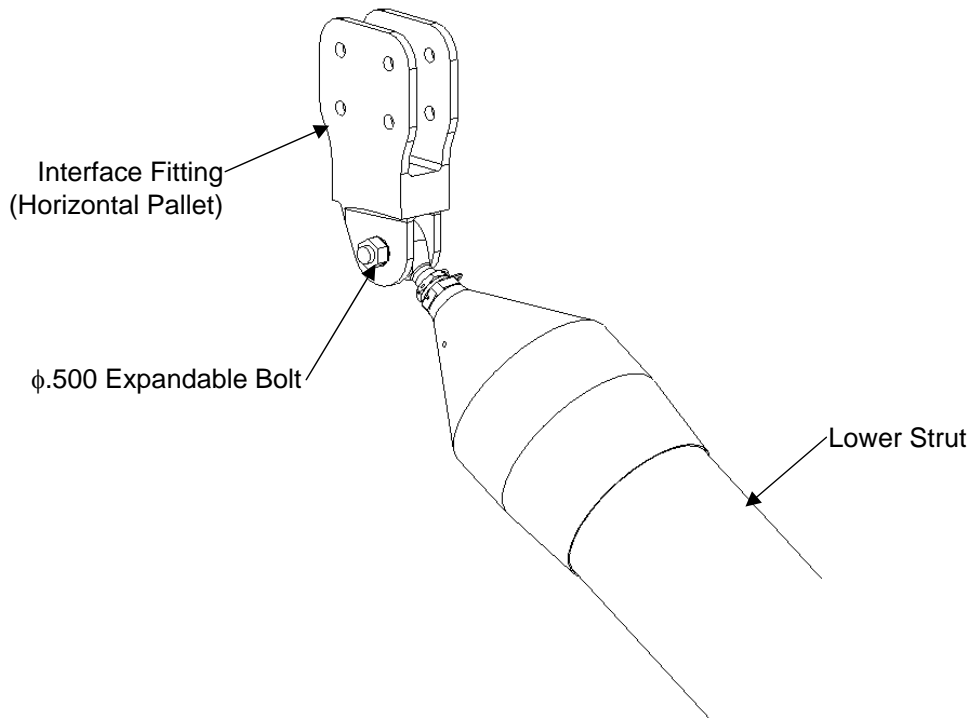
Lower Strut

Figure 5-28. HP interface fitting to lower strut attach

Verify that this is the correct version before use

Lower Strut to Corner Fitting Attach

Lower Strut

ϕ.500 Expandable Bolt

Lateral Strut

Up

Inbd

Fwd
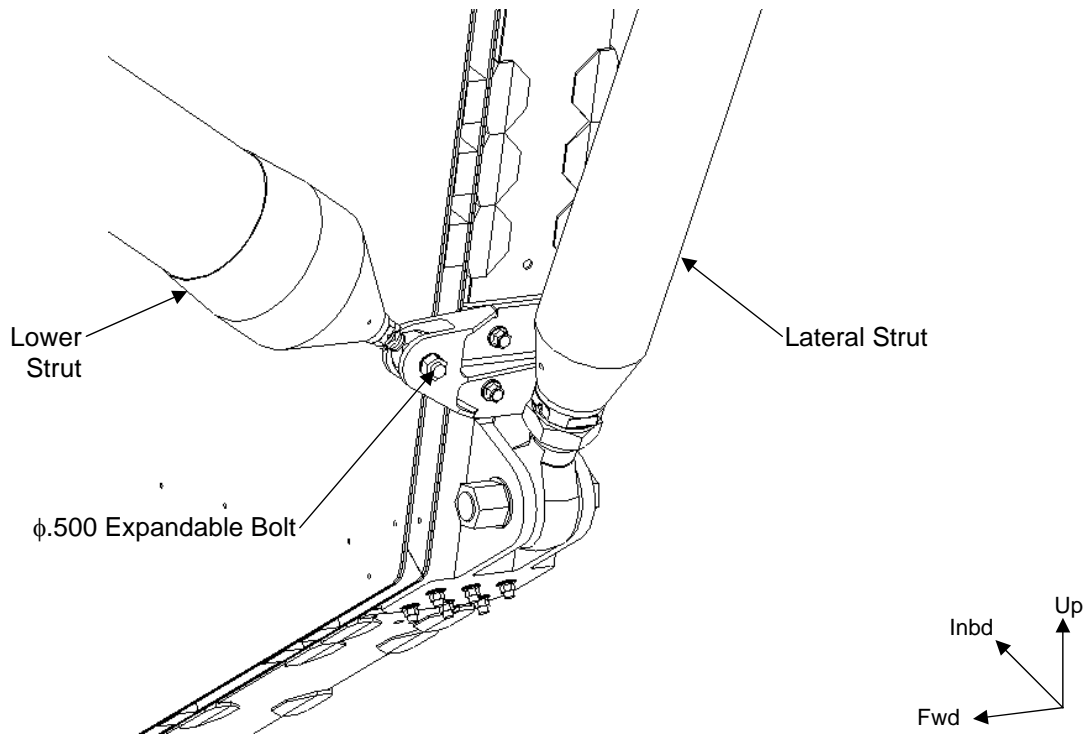
Figure 5-29. Lower strut to corner fitting attach

Verify that this is the correct version before use

Trunnion Tower Design

The SLIC Pallet trunnion towers are made up of individual transverse, outboard, and longitudinal beams attached by bolted corner joints with interior and exterior L-flange fittings. A breakaway view of an aft trunnion tower, as seen in Figure 5-30, shows the internal fittings of a trunnion tower.

At the bottom of the trunnion tower a shear boss fitting is located that helps structurally tie the transverse beams to the outboard beams and provides a load path from the Horizontal Pallet to the Vertical Pallet keel trunnion through the Lateral Struts. The forward trunnion towers have similar box fittings at the bottom of the towers without the shear boss or Lateral Strut interfaces.

The trunnion towers are closed out with inboard and outboard pillow blocks that provide the structural interface for the longeron trunnion pins. The longeron trunnion pins slide into bushings through the outboard and inboard pillow blocks and are retained by a retainer plate on the inboard pillow block. The final closeout of the trunnion tower is made with shrouds that bolt to the pillow blocks. Figure 5-31 shows a breakaway of the trunnion tower closeout.

Trunnion Tower Design
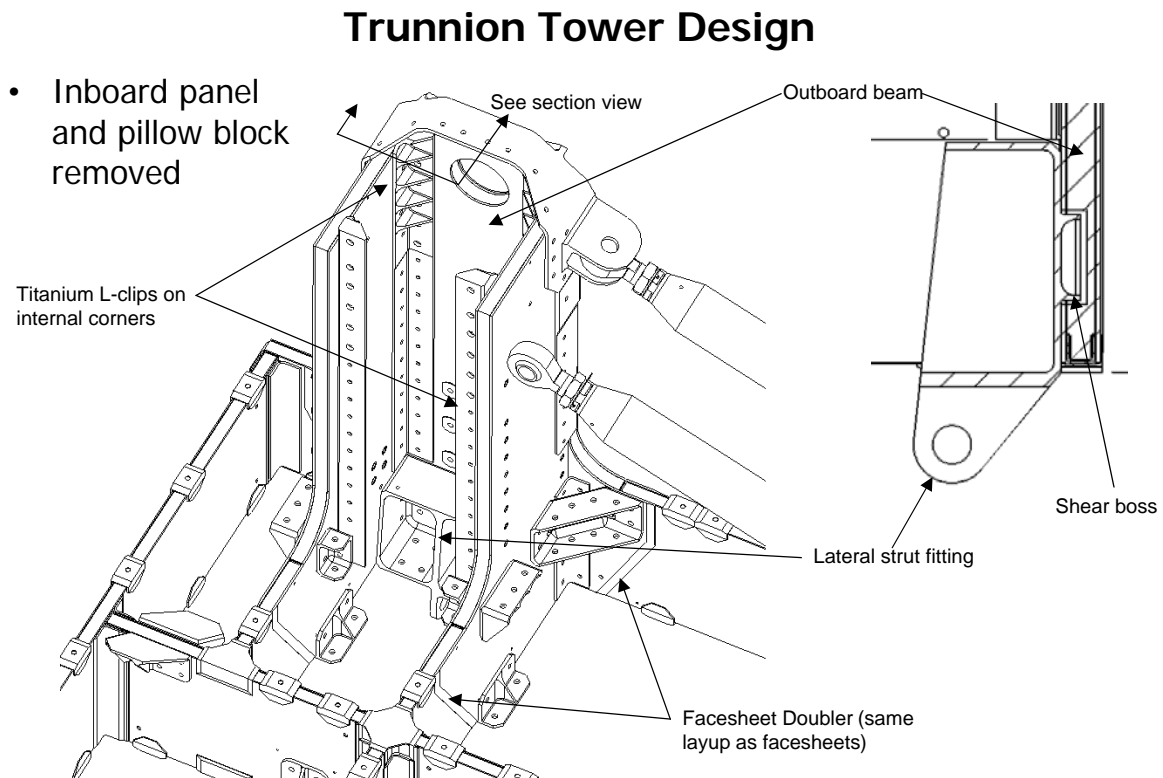
Figure 5-30. Trunnion tower mechanical attachment design

Verify that this is the correct version before use

Trunnion Tower Design

Trunnion Pin Retainer
(CRES)

CRES Bushing

Pillow Block Shroud
(Aluminum)

Outboard Pillow Block
(Titanium)

CRES Bushing

Inboard Pillow Block
(Titanium)

Trunnion Pin Bumper
(Aluminum)

Trunnion Pin (TMC)

Facesheet Doubler
(same layup as
facesheets)
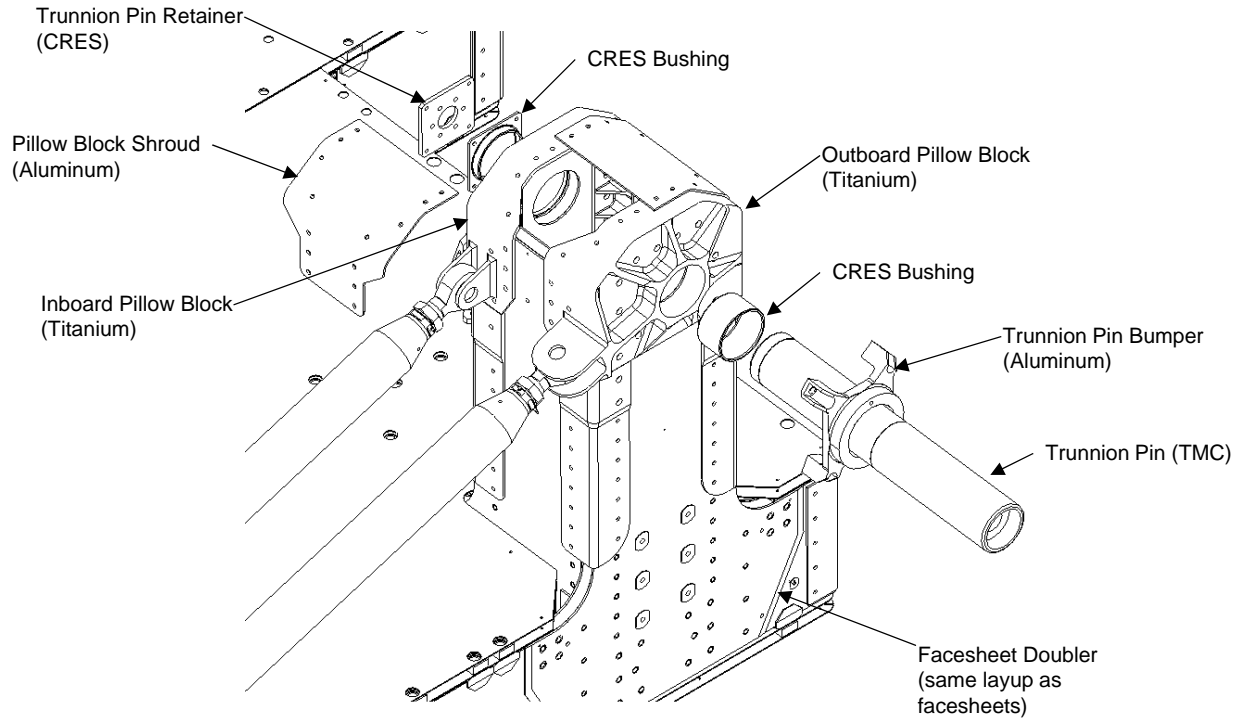
Figure 5-31. Trunnion tower closeout design

Verify that this is the correct version before use

Pallet Venting

The SLIC Pallet venting design allows for appropriate venting paths from the structure and prevents particulate contamination trapped in the structure from venting out towards critical payloads.

Pallet Electrical Grounding

The SLIC Pallet structural grounding design connects all conductive materials to a single point ground on the EPDSU. The exterior sandwich panels have a minimum of two 2-piece electrical grounding inserts. Each panel is connected to two grounding blocks that are connected to the single point ground. The external metallic fittings have attach points for grounding straps that connect back to the single point ground as well. Figure 5-32 shows the basic design concept for the SLIC Pallet grounding scheme back to the orbiter.
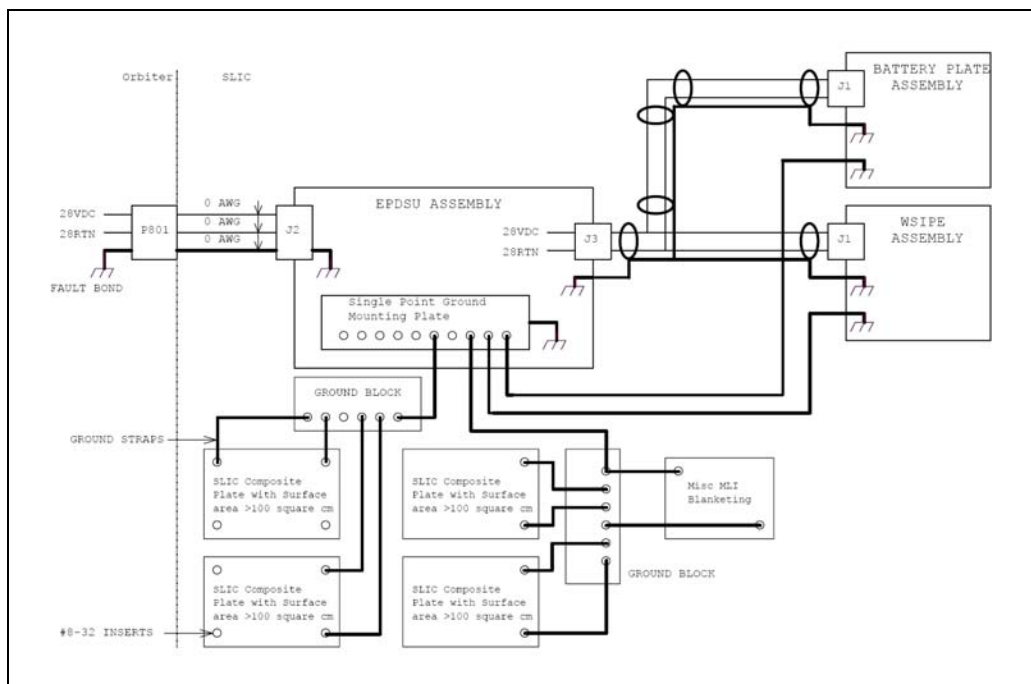
Figure 5-32. SLIC pallet electrical grounding design

Verify that this is the correct version before use

5.1.2   WSIPE

The HST SM4 manifest has two radial instruments, the WFC3 and the Fine Guidance Sensor (FGS). There is only one radial scientific instrument protective enclosure (RSIPE) in the HST inventory and therefore a new build is required. The existing RSIPE will be used on SM4 for the FGS on the ORUC.

The new protective enclosure for the WFC3 is the WSIPE (Figure 5-33).   The WSIPE will launch transporting the WFC3 to the HST and return with the WFPC2. The WSIPE is mounted to the SLIC pallet via eight magnetically-damped strut isolators. The same eight isolators were used on SM2 and SM3B to support the SAC ASIPE. The load is transferred from the enclosure to the isolators via the box beam and clevises mounted on the exterior surfaces of the WSIPE. The isolators are mounted to the SLIC Pallet via four double clevis fittings. Reference Figure 5-34 and Figure 5-35.

The WSIPE is similar to the RSIPE flown on HST SM1 and the FSIPE from SM2 and SM3A.   It meets the access and purging requirements of the WFC3.

The WSIPE is built up of assemblies that include the Box Assembly, the Structure Assembly and the WSIPE Assembly. The Box Assembly assembles the all-aluminum honeycomb panels to each other and to the 3-inch milled Aluminum Aft Plate Assembly. The panels are match drilled and held with #10/32 fasteners. They are backed with angle brackets for additional stiffness. The seams are sealed with RTV at the top assembly.

The majority of the WSIPE structure consists of standard Aluminum/Aluminum 1.0-inch Honeycomb construction. The facesheet materials are 7075-T73 and the honeycomb core is Aluminum 5052-H39-P. The WSIPE meets the stress corrosion cracking requirements of MSFC-STD-3029, Table 1 Materials. The surface finish is irridited per MIL-C-5541, class 3. A vent assembly on the aft end plate utilizes a 30 micron screen to prevent contaminants from entering the WSIPE during prelaunch ground ops and to permit pressure equalization during launch and landing.   Differential pressure is maintained below 0.1 psi to meet the no-stress venting criteria. Adhesives used are FM73M Film and FM410-1 Foam. The WSIPE weighs 650 pounds. It is designed to accommodate the WFC3 and WFPC2.

WSIPE lid latches, EVA Operations, and Contingency Overrides are identical to the RSIPE to maintain commonality of hardware and reduce Crew Training. A passive Y-direction shear feature has been added to the lid to take additional load from a heavier WFC3 than previous SIs. Shear forces in the Y-direction are reacted by a passive pin and V slot bracket on the front center of the WSIPE lid.

The SI is held in WSIPE via 3 kinematic latches

a.   A-latch (3 axis constraint) - Threaded shaft in ball, Active latch (has EVA overrides)

b.   B-latch (1 axis constraint) - single flexure Passive latch

Verify that this is the correct version before use

c.   C-latch (2 axis constraint) - double flexure Passive latch

The WSIPE EVA accommodations (Handrail and PFR socket locations) are nearly identical to the previously flown RSIPE with the following exceptions:

a.   All handrails have a clear Anodize for thermal properties

b.   Internal handrails in lid split to provide rotational clearance for guide studs

c.   Additional handrail added on aft side of WSIPE on upper belt for battery removal

d.   Added a handrail on lower diagonal panel under SLIC for WFHH removal

e.   Lower lid side handrails shortened

Table 5-1. Comparison of RSIPE vs. new WSIPE

Item Compared	RSIPE	WSIPE
Construction Type	Standard Aluminum and Honeycomb Construction	Standard Aluminum and Honeycomb Construction
Lid Latches	3 EVA Hand Latches with overrides	Identical Hardware
On-Orbit Latches	2 Lid-mounted mechanisms with EVA overrides	Not required – similar hinges on SAC ASIPE used without an on-orbit latch
Lid Hinges	Spherical bearings with EVA bolt overrides	Designed with Triple Sliding Surfaces similar to SAC ASIPE. No overrides required
Lid Shear Features	Continuous bead machined into panel edge closeouts	Center Y-reacting tang and slot
SI Latches	3 Kinematic latches (1 active, 2 passive)	Modified A-Latch with higher load capability and identical B and C-Latches (refurbished)
SI latch EVA overrides	EVA overrides for all 3 latches	Identical hardware

5-38

Verify that this is the correct version before use

Table 5-1. Comparison of RSIPE vs. new WSIPE (concluded)

Item Compared	RSIPE	WSIPE
EVA Removal and Insertion of SI aided by:	Guide rails identical to HST	Identical hardware
SI Grounding	Ground Strap from SI to structure	Identical hardware
Viewing window	None on RSIPE	Added a small viewing window in starboard side panel for viewing A-latch during WFC3 ground integration
A-latch status indicator lights	Incandescent bulbs	LEDs

WSIPE Overview

Figure 5-33. WSIPE

Verify that this is the correct version before use

WSIPE Isolator Fittings

Isolator Fitting
(Aluminum)

Upper Port Panel Assembly

φ 0.500Ó
Expandable
Bolts

Splice Plate, Aft Port

Fitting Hardpoint, Internal

Interface Fitting
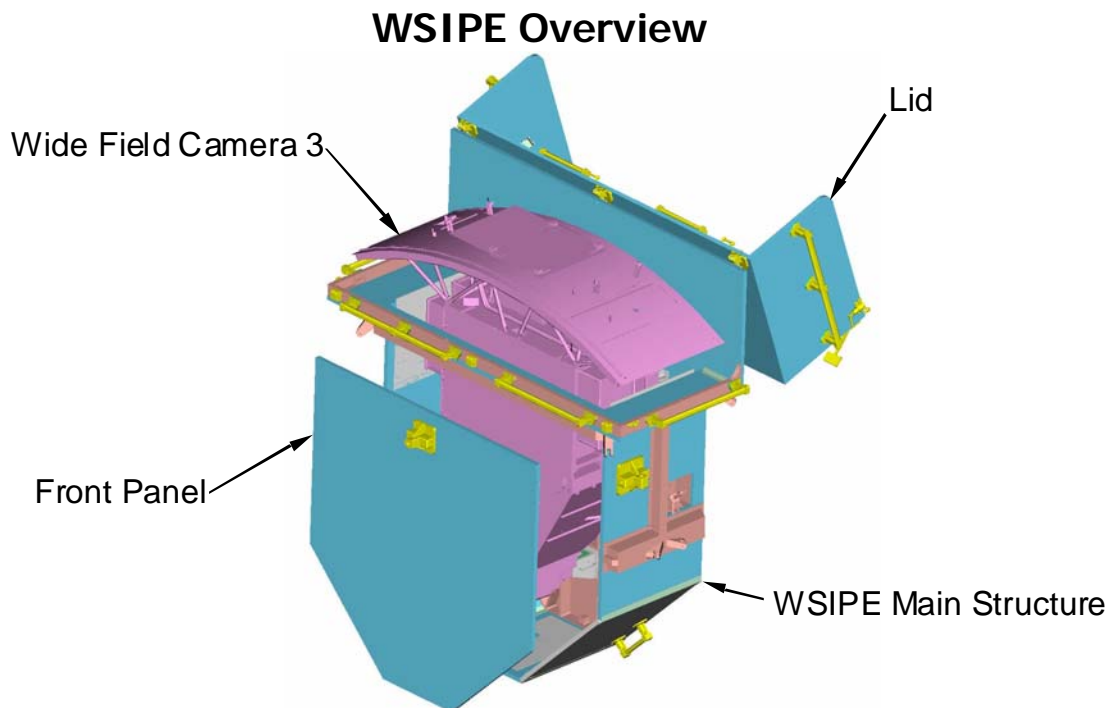
WSIPE Isolator Fittings
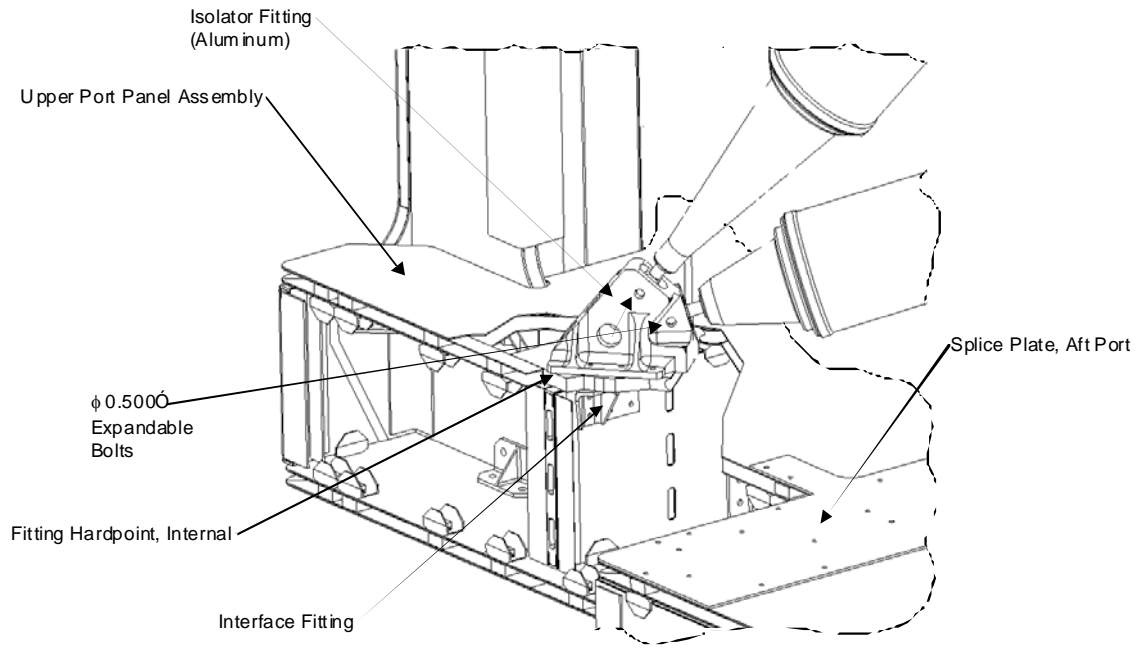
Shear holes - bolt through
panel into interface fittings
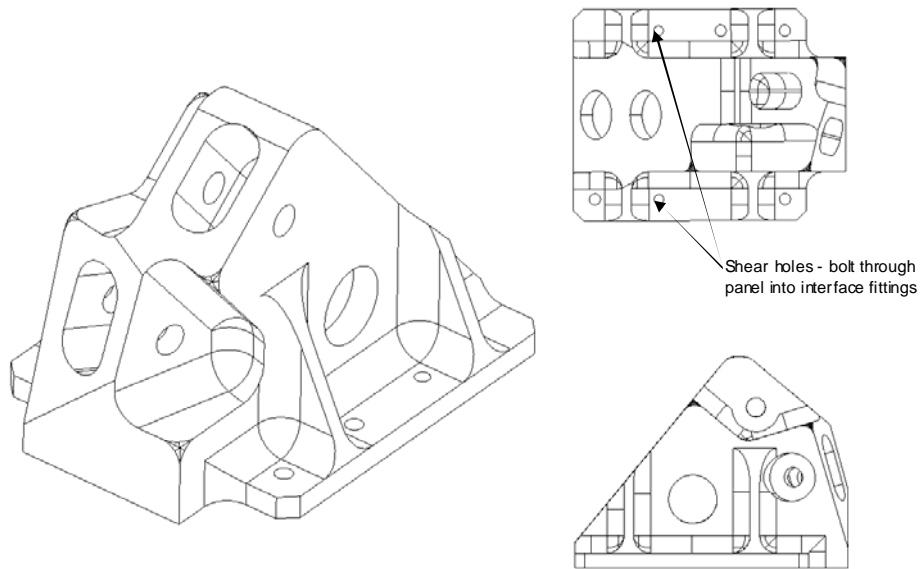
Figure 5-34. WSIPE isolator fittings

Verify that this is the correct version before use

Isolator Attachment

- Rod ends on Isolators provide attachment to Clevis' on WSIPE

- Isolators fastened to clevis' with Expandable bolts to provide rattle-free joint
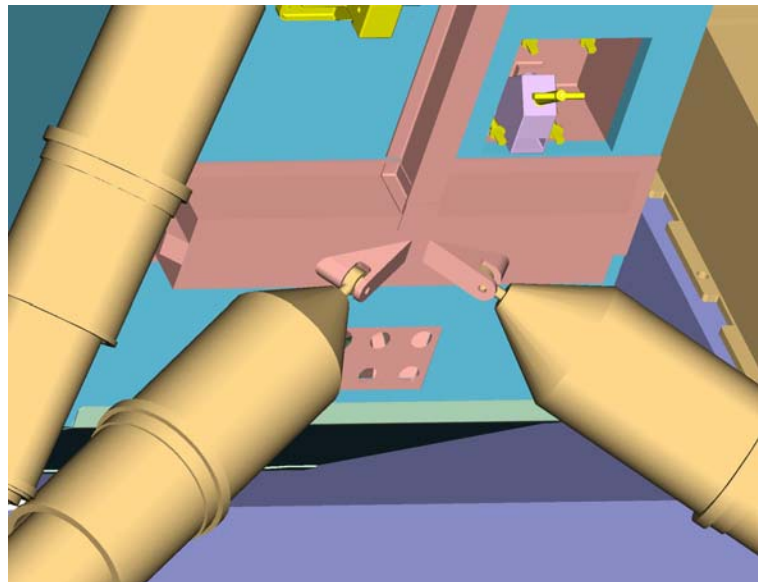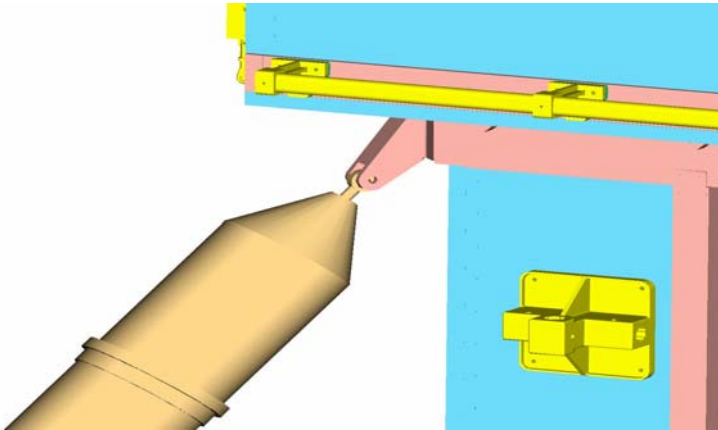
Figure 5-35. WSIPE isolator attach points

Verify that this is the correct version before use

WSIPE Lid Hinges

The WSIPE lid has three equally spaced hinges (see Figure 5-36) at the top of the backbone plate, allowing the four-sided box-like lid portion to swing backwards through 270 degrees of travel. When fully opened, the lid may be tethered to the back plate to prevent orbiter thrusting impulses from displacing the lid. The center WSIPE hinge is shimmed for a snug clevis/lug fit to provide lateral support while the outer hinges have sufficient clearance gaps along the axis of the hinge pins to accommodate worst case bulk temperature differences between the WSIPE lid and the WSIPE backbone plate. These gaps ensure no binding or off-axis rotation of the outer hinge pins with respect to the common alignment with the central hinge pin.

The internal construction of each hinge assembly mimics that of the ASIPE lid hinge.

Note: The hardstop protrusion evident on the ASIPE hinge that holds that lid open, does not appear on the WSIPE edition of the hinge because of the requirement to open through 270 degrees.
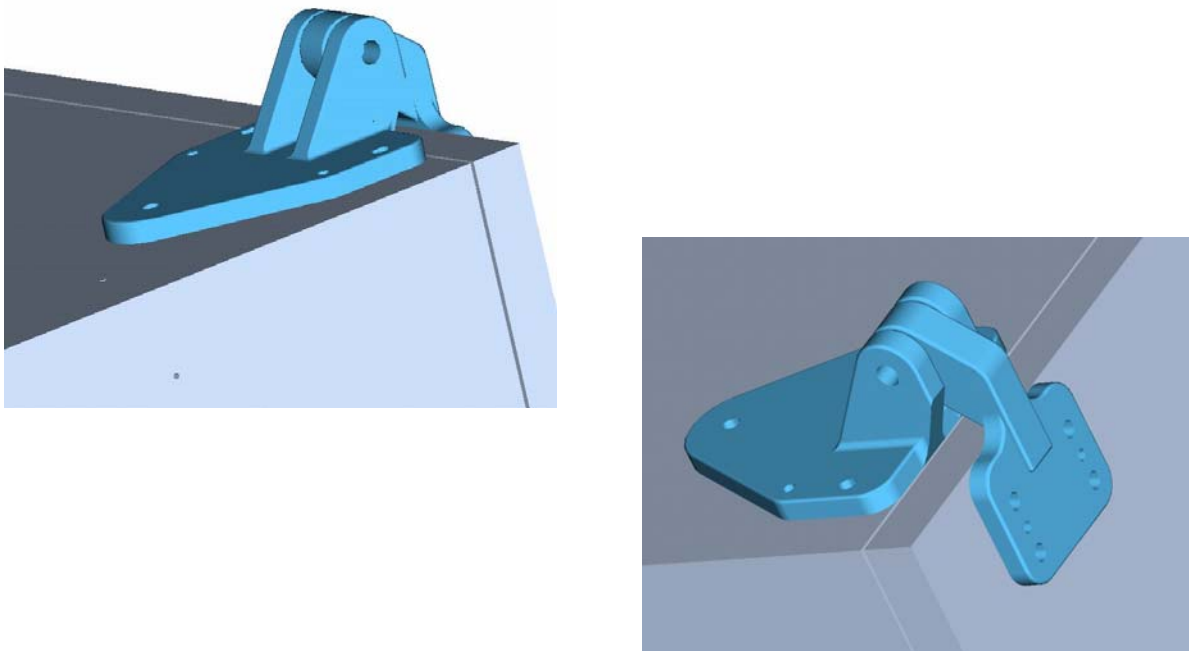
Figure 5-36. WSIPE lid hinges

Verify that this is the correct version before use

WSIPE Lid Latches

The WSIPE Lid Latch Assembly (reference Figure 5-37) has three EVA Latches that provide the preload for the Lid. They are identical to the FSIPE lid latches that were flown previously. To operate the lid, the EVA crewmember releases the lock pin (less than 1/4 turn), pulls back on the paddle that lowers the connecting rods out of the trough of the cinching block and then opens the latch.

The standard EVA hex 7/16-inch bolt releases the cinching block for the override of the latch in a case of a contingency. The crew would back off the bolt and remove the cinching block to allow the connecting rod and lid to rotate free.

The WSIPE is similar to the SAC ASIPE regarding the importance of lid closure to complete the enclosure load paths. Unlike the ORUC RSIPE, the WSIPE lid is considered load bearing (reference Figure 5-38). The Y-direction centerline lid shear feature is passive and is considered engaged when the lid has been closed enough to enable any one paddle latch to close. The similarity of active control temperature set points selected for the enclosure body and the lid are meant to maintain bulk temperature similarities of $10°$ C between the two members for reliable shear and paddle engagement.

Verify that this is the correct version before use
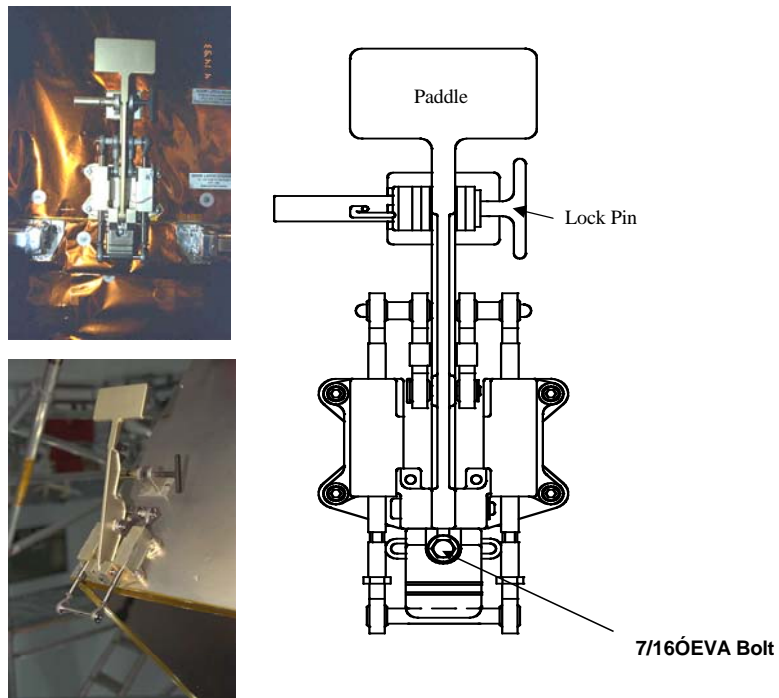
Figure 5-37. Lid latches
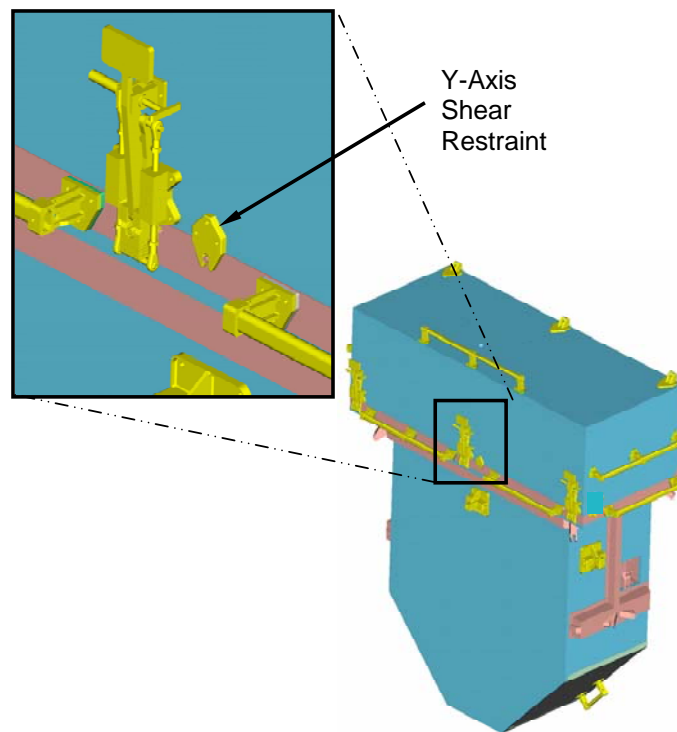
Figure 5-38. WSIPE lid

5-44

Verify that this is the correct version before use

WSIPE SI Latches, Hinges and Guide Rails

SI Latch Nominal Operations

The WFC3 and FGS radial SIs have different latch characteristics and a different number of latches, three for the former and four for the latter. For the WFPC2 and WFC3, the three latches are the central jackpost and threaded monoball "A" latch which constrains three displacement directions, the "B" latch which has a single SI-resident flexure blade reacting one displacement direction, and the "C" latch which has two perpendicular SI-resident flexure blades constraining two displacement directions. In combination, all six displacements are reacted yielding a statically determinant loads situation. The latch sets are split wherein the SIPE which has a half and the SI has a half.

For the "A" latch (Figure 5-39) the SI has the jackscrew on a long shaft and the EVA tool interface, and the WSIPE has the threaded monoball. A small viewing window in starboard side panel has been added for viewing the A-latch during WFC3 ground integration. For the "B" and "C" latches (Figure 5-40), the SIPE has the peg and the SI has the socket with accompanying flexural blades.   See Figure 5-41 WSIPE Latch System. For the latching function, the turns on the jackscrew engage it into the monoball and simultaneously lower the SI sockets/blades onto the corresponding SIPE pegs. Turns in the opposite direction similarly reverse the process. WF/PC II and WFC3 removal/insertion into the HST radial SI bay follow the same operation as this is the heritage source for the latch sets. There are three methods to determine that the jackscrew has been secured to the monoball, and a two-stage assessment.

1.   Expected number of turns or "seated" LED lights-out indicate proper metal-to-metal seating without FOD interruption.

2.   Proper securing torque value as determined by properly set MTL clutch slippage or proper PGT torque reading.

Verify that this is the correct version before use
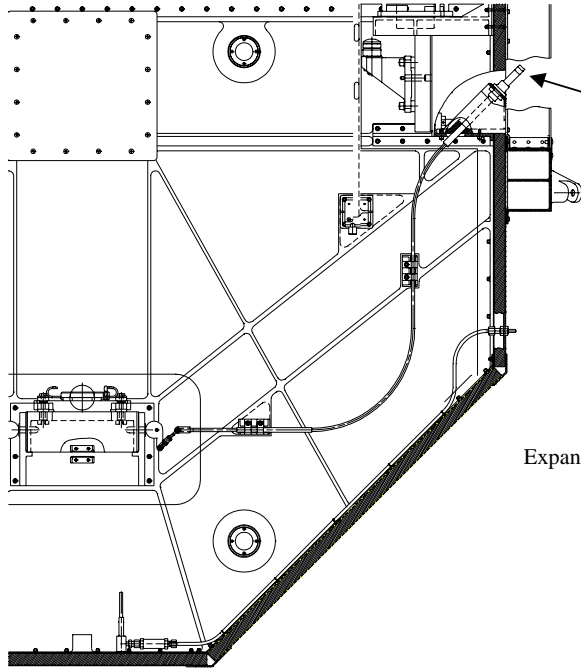
- A-latch override utilizes 4 expanding pins
    - Pull on Release handles (1 per side), releases expanding pins (2 per side), allowing A-latch and mounting bracket to slide out with SI
- Similar to FSIPE
- Change in release cable location

Figure 5-39. A latch

Verify that this is the correct version before use
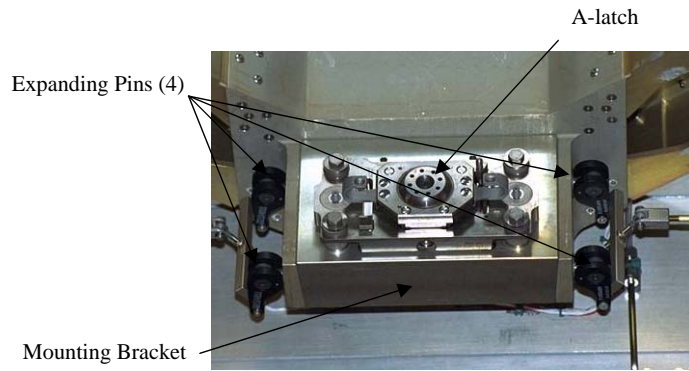
B & C-Latch

Picture taken from SM1 Radial SIPE

Guide Rails

B-Latch

C-Latch

BMC Removed for
SM4 WSIPE
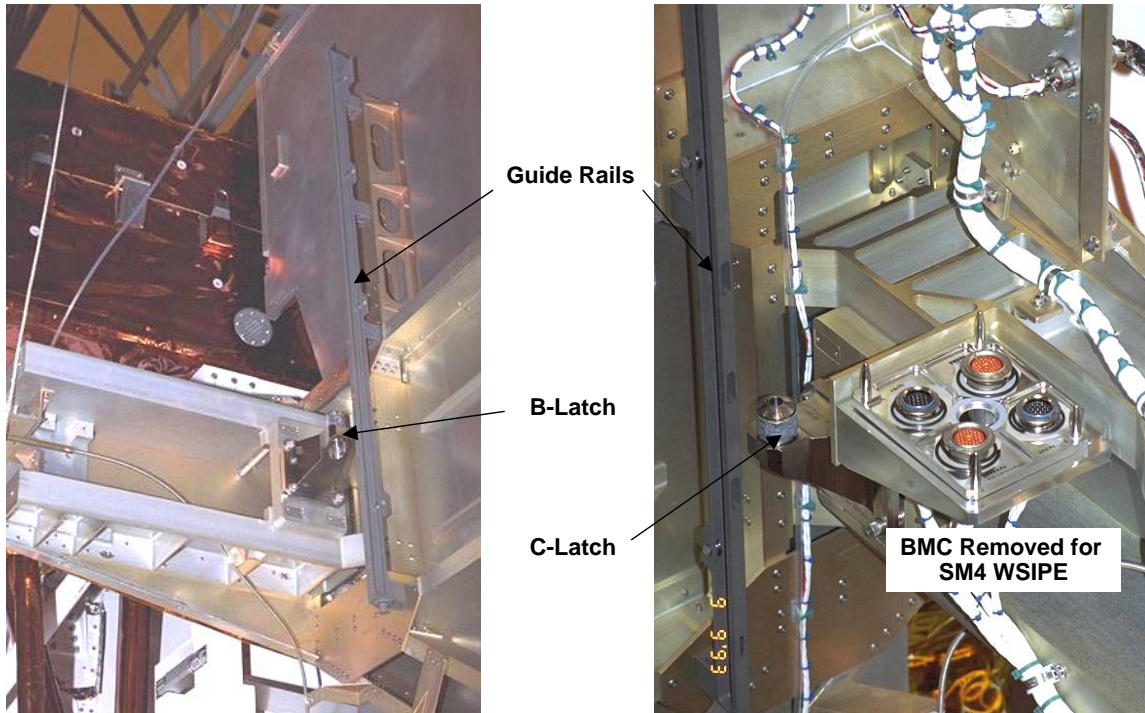
Figure 5-40. B and C latches

Verify that this is the correct version before use

WSIPE SI Latch System

A-Latch takes load in all 3 axis

B-Latch takes load only in X-axis

C-Latch takes loads only in X and Y-axis

Latches are GFE reflown/refurbished hardware from SM1

Figure 5-41. WSIPE latch system

Verify that this is the correct version before use
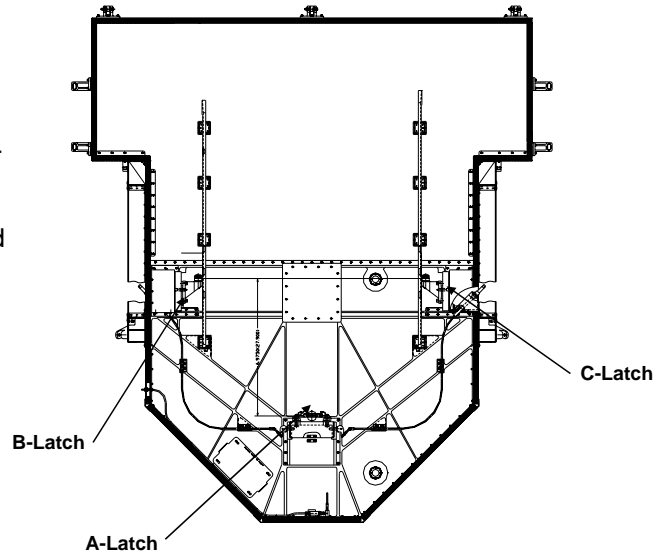
SI Latch Contingency Overrides

The principal contingency which prompts WSIPE SI latches to have EVA overrides is torsional failure of the jackscrew in an intermediate position such that it remains caught in the monoball but is too many turns out to have a reliable load path for landing loads. Although such a failure will likely lead to jettison of the offending radial SI, if the SI cannot be disconnected from the WSIPE then perhaps the entire carrier would have to be jettisoned prior to EVA ingress. Since this contingency impacts mission success providing WSIPE latch overrides was deemed prudent. Due to configuration limitations, implementing the radial SI latch overrides is a one-way proposition that cannot be undone once applied. The technique is to release four each EVA hex-head bolts (~24 turns per bolt) in the case of the "B" and "C" (Figure 5-42) peg mounts. Twist-and-pull release of four expansion bolts via eccentric compression cams and connecting cable actuators releases the embedded "A" latch monoball housing. All override interfaces are in the external side pockets of the WSIPE directly outboard of the "B" and "C" peg mount locations. After driving interfaces, the latch and mounting plate depart with the SI at the separation plane (for A, B, and C latches). Once actuated, the offending radial SI and residual WSIPE latch halves would be jettisoned as a unit. The remaining WSIPE enclosure is safe to land once the lid is secured in the nominal configuration.
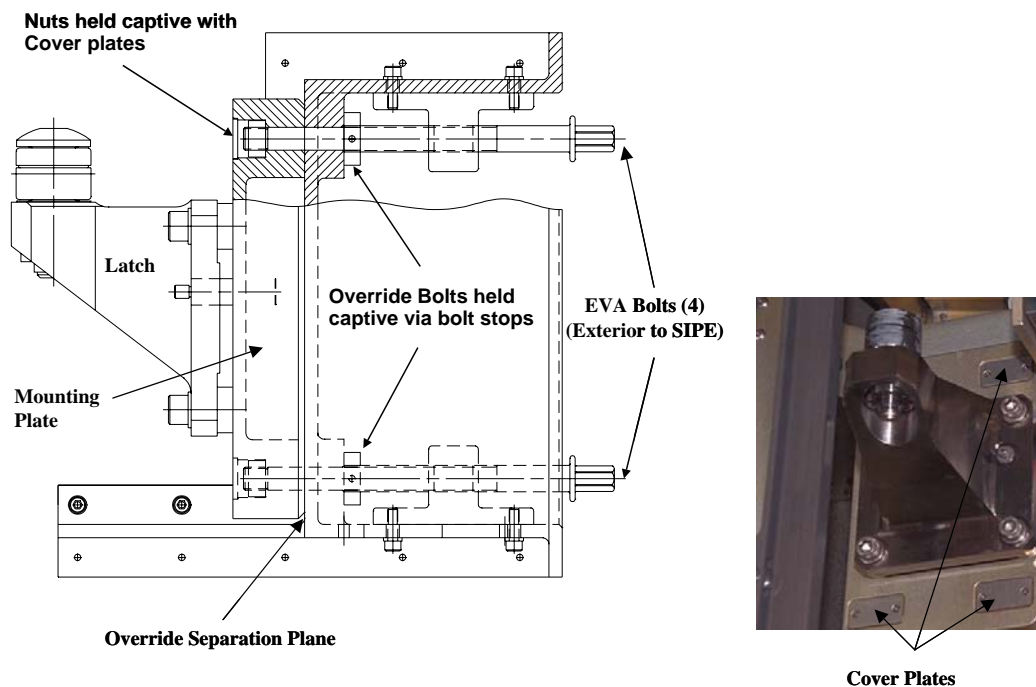
Figure 5-42. B and C latch overrides

Verify that this is the correct version before use

WSIPE Latch and Guiderail Hardware

The WSIPE SI latches are modified (A-Latch only) and refurbished spares from the original SIPE development for WFPC2 and FGS. The WSIPE halves of the latch set are positioned and aligned using the heritage tooling which represents the radial SI in ideal placement. In addition to the basic heritage of the latches, the EVA override scheme for WSIPE mimics that implemented in the RSIPE with the exception of the location of the twist-and-pull releases for the central "A" latch. On the RSIPE, the "A" release cables are plumbed through the enclosure all the way out through the top where the lid opening is found. This detour was required in the case of the ORUC BISIPE due to lack of EVA access to the lower portions of the RSIPE enclosure body while in the ORUC LIS. On the WSIPE, superior EVA access (Figure 5-43) is available all around the body, so the twist-and-pull cables are terminated at the same position as the override bolts for the "B" and "C" latches for EVA convenience and a shortened path.

The WSIPE SI guide rails (see Figure 5-44) and corresponding SI-resident cam followers (little metal wheels) mimic the radial SI guidance operation of the RSIPE. The funnels at the top of the two guide rails, and the longitudinally spaced pairs of SI cam followers along the backside of the SI serve to reasonably align and guide the three latch sets while preserving enough clearance to prevent mid-travel jam or spoil the statically deterministic loads arrangement implemented upon jackscrew torque-up. In a technique similar to the RSIPE experience, the WSIPE front panel will be removed for the early developmental fit checks. These will occur during integration and test between WSIPE and WFC3 and a WFPC2 metrology model and they will ensure good coincidence between latch and guide rail geometry over the full travel of the radial SIs, and SI clearance with wires and cables inside the WSIPE. The tops of the guide rails will be designed to sustain inadvertent kick loads.

Verify that this is the correct version before use

Figure 5-43. WSIPE EVA hardware
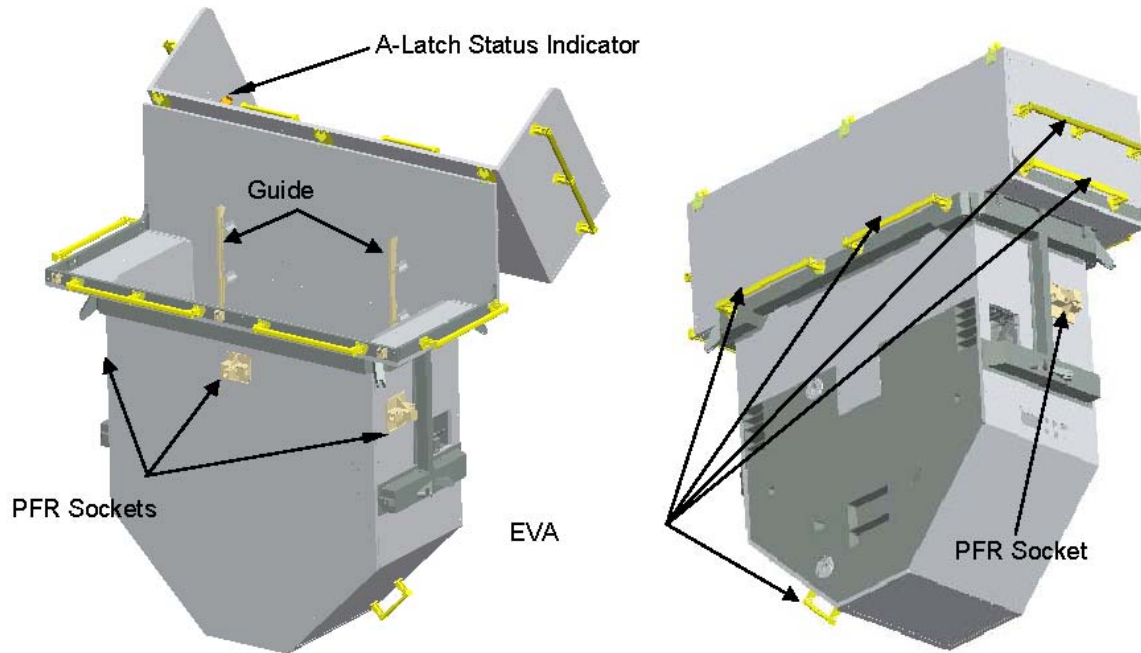
Verify that this is the correct version before use
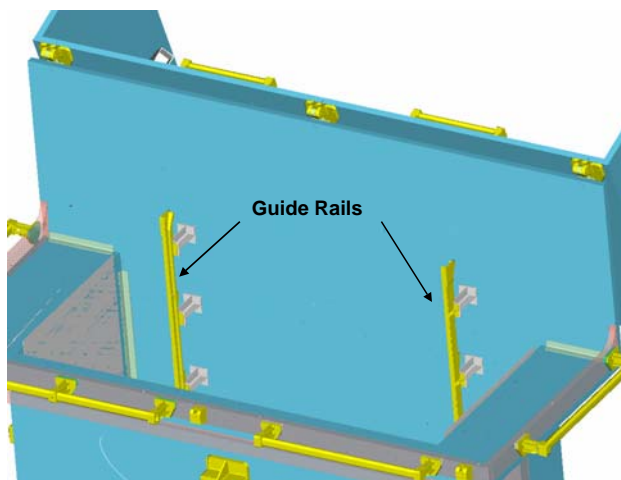
SI Guide Rails

- Guide Rails for EVA insertion of Instrument into SIPE
  - Port Guide Rail slightly longer to facilitate initial Crew insertion of SI
- Once Instrument is latched down, Rails no longer touching Guides (Provide no support to kinematic latching system)
- Mounted to "Backbone" via standoffs as shown

Figure 5-44. WSIPE SI guiderails

Verify that this is the correct version before use

WSIPE Thermal Systems

The WSIPE has an active thermal control system consisting of heaters and thermostats (reference Figure 5-45) as well as passive thermal control via MLI blankets. Five thermostatically controlled heater plates (configured in four zones) provide thermal control of the WSIPE and maintain the SI within its thermal limits. The heaters contain primary and redundant circuits. Each circuit contains two thermostats in series for failed-on protection. The heater plates are installed on to 0.25-inch G10 standoffs for thermal isolation. Fasteners (#10-32) float for thermal expansion of heater plates.

The outer surfaces of the WSIPE are covered with 10 layers 0.1 mil and inner and outer 3 mil Kapton MLI interweaved with Dacron mesh separators. The inner WSIPE surfaces are chem filmed (low emissivity). The handrails are mounted on 1/4-inch thick G-10 thermal isolators.

- 5 thermostatically controlled Heater Plates (configured in 4 zones) to provide thermal control of SIPE and maintain SI within it's thermal limits

- Plates installed on 0.25 inches

- G10 standoffs for thermal isolation

- #10-32 fasteners float for thermal expansion of heater plates
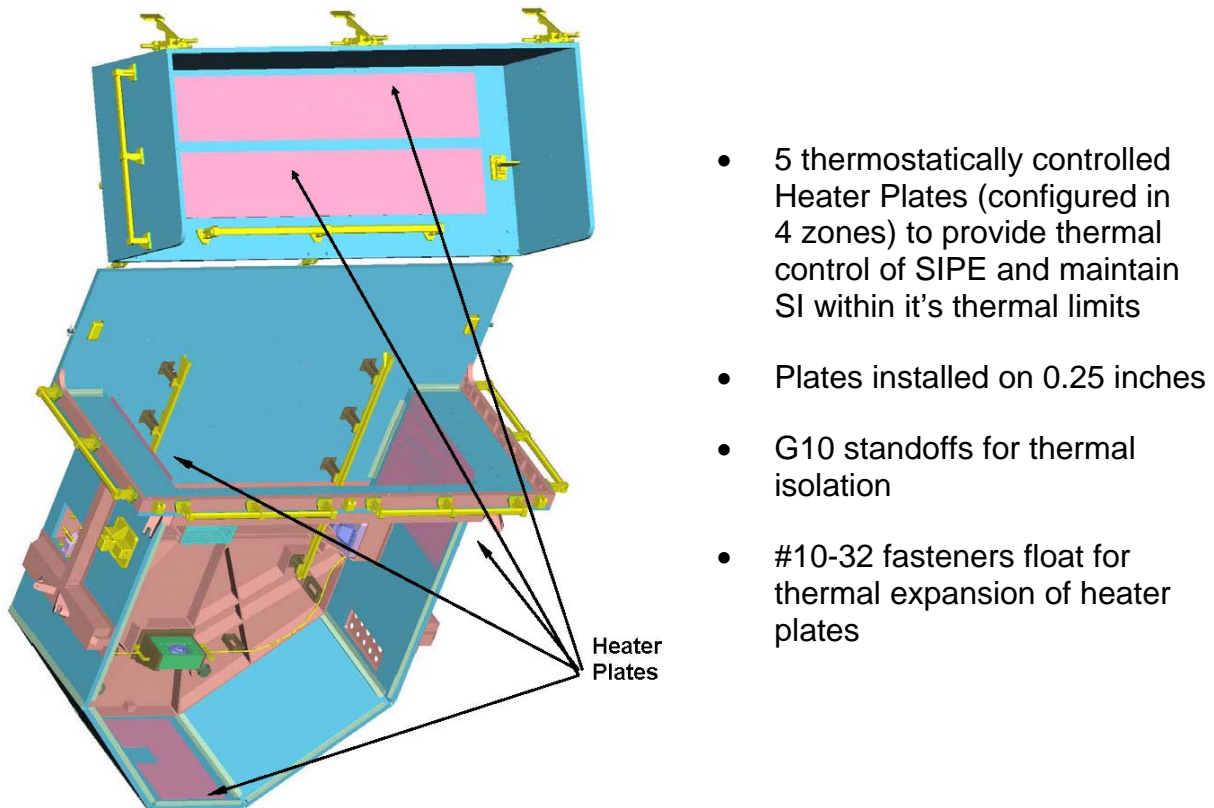
Figure 5-45. Thermal provisions

Verify that this is the correct version before use

WSIPE Electrical

The WSIPE was designed to the requirements of JSC Letter Number TA-92-038, "Protection of P/L electrical power circuits." There are five thermostatically controlled heater plates (configured in four zones: Lid, Port, Starboard and bottom) to provide thermal control of the SIPE and maintain the SI within its thermal limits. Each zone has a thermistor assembly and a primary (A) and redundant (B) heater circuit. Each heater circuit has a thermostat pair in series and each pair has three GSE test points.

The A-latch has a status indicator and microswitch. The latch is in a nominally closed (NC) state (i.e., latch is not fully engaged). The switch sends a "not engaged" status.

The WSIPE has an EVA removable ground strap (Figure 5-46) to provide grounding for the SI, actuated by a 7/16-inch hex bolt. The same strap was used during the Servicing Mission 1 (SM1) WFPC2 change out.
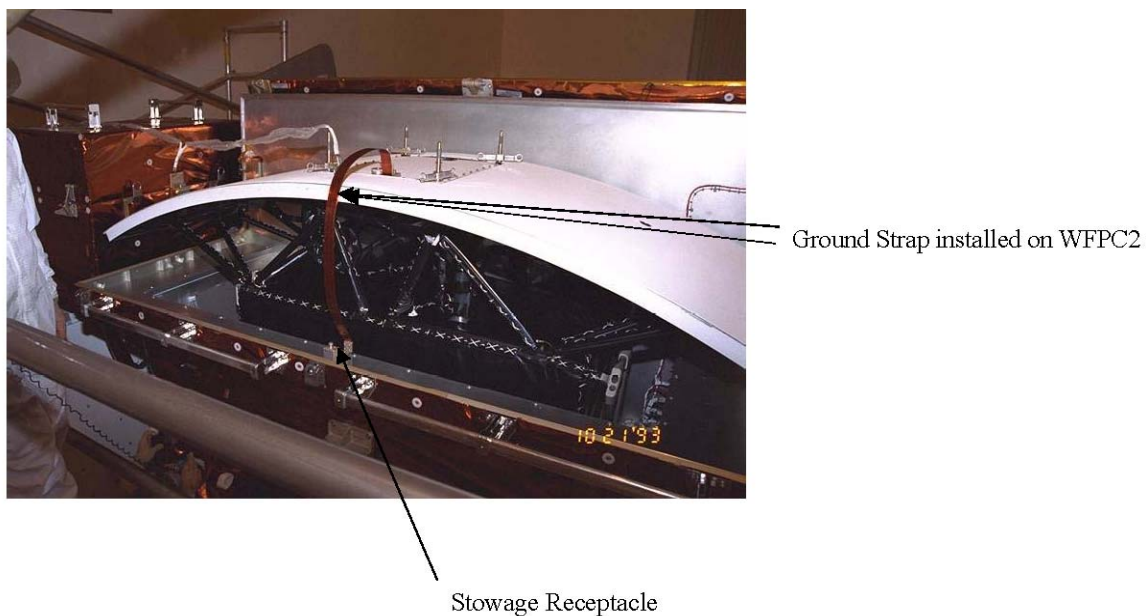
Figure 5-46. SI ground strap

5.1.3   Battery Plate Assemblies (BPAs)

The BPAs will be used to support the HST NiH2 Battery Modules during ascent to orbit and return to earth. (See Figure 5-47 through Figure 5-56). The BPAs are 2-inch thick aluminum honeycomb plates with interface features for the Battery Modules. The honeycomb plates are supported off of the HP on four flexures for each plate. Each BPA has redundant heater circuits that are thermostatically controlled and a pair of thermistors for environmental monitoring.

Verify that this is the correct version before use

Each Battery Module will be enclosed in a MLI soft cover for contamination and thermal protection.   The soft enclosure is attached to the BPAs via Velcro and mechanical fasteners along the hinge side. The enclosures open toward the WSIPE and are held in place against the aft side of the WSIPE with Velcro.
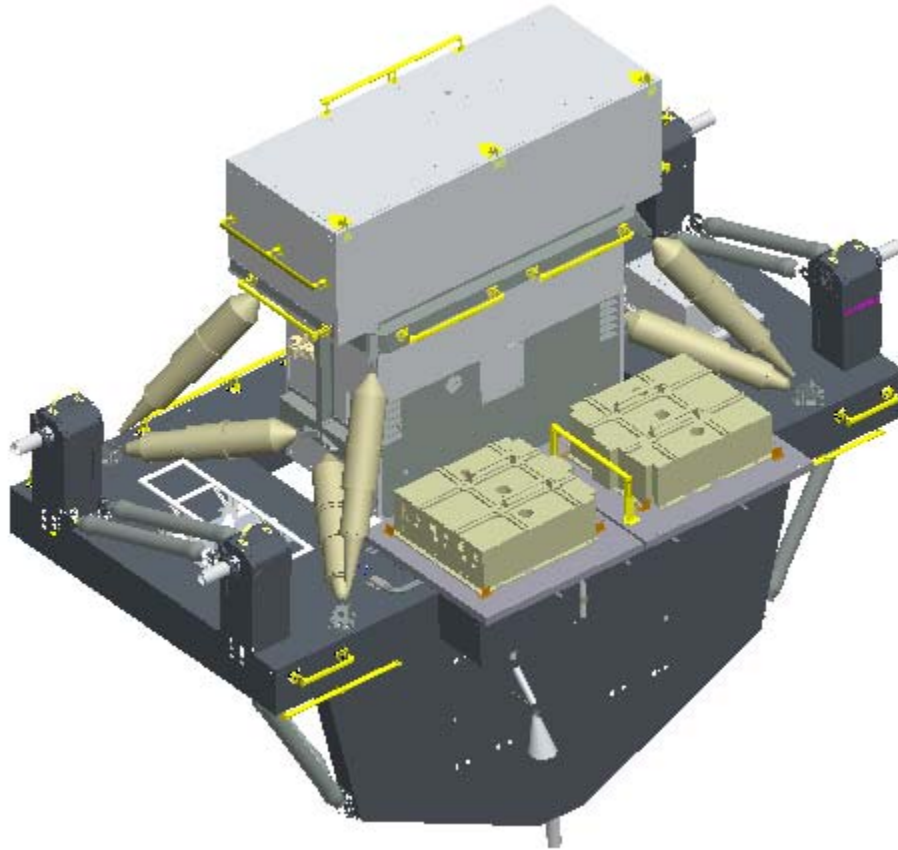
Figure 5-47. Battery modules on SLIC

The Battery Modules bolt to the BPAs utilizing 12 of the 14 J-hook devices used to connect the battery modules to the HST SSM bay door. The other two J-bolt holes in the battery module base plate will accommodate shear pins. The shear pin system includes one fixed 0.684-inch shear pin (based off worse case Battery Plate hole size 0.686 inch) and one sliding 0.684-inch shear pin to allow for any thermal mismatch between the BPA and the returning battery module. The fixed shear pin in the center is designed to take most of the shear loads. The floating shear pin is designed to prevent rotation, alleviating ORU bolts from shear loading. The travel "float distance of 0.125-inch in line with the fixed shear pin alleviates the 30°C ΔT concern (between the BPA and the colder returning battery module). All base plates were drilled using the Battery Module Drill Plate, which was used to drill the BPA hole locations. All ORU Bolt clearance holes are within drawing tolerance of .695 inch/.686 inch.

Verify that this is the correct version before use

All sliding surfaces use dissimilar material and low friction surface coating to prevent galling. Alignment guides, identical to those used on HST, are incorporated on the BPAs to ease Battery installation. Four Soft Docks have been implemented per BPA to provide a holding force of ~4 pounds while the free floater works to engage the 12 J-Hooks to the BPA EVA bolts. Between the underside of the BPAs and the top of the HP lay the ductwork for ground cooling air that removes waste heat accrued during battery charging activities at the Pad and battery self-discharge after Payload Bay Door closure. The BPA will undergo complete qualification testing to validate the design.

The BPAs are designed to present an adequately stiff assembly when loaded with the Battery Modules, with a goal of exceeding 50 Hz for the first significant mode. The BPA soft covers will utilize normal MLI construction techniques with Beta Cloth used for the outer and inner layers.

The soft cover design may also assist with the ground charging of the batteries at the Pad by having an access door for drag-on electrical harnesses. Charging operations will occur on the batteries while at the Pad (Payload Bay Doors Open). The batteries must be cooled during and after charging and this will be accomplished with two different methods, one method with the Payload Bay Doors open and another with the doors closed. Both are described below.

The battery cells must remain below 22°C while charging with a goal of below 15°C. The cooling method used on the Pad with the payload bay doors open consists of five Non-Flight Vortex Coolers (two per plate and as a cold purge), an Acoustic/Purge Enclosure (APE), and associated ductwork that provides high pressure air. This air flows through ductwork made of 6063-T4 Al Alloy "D" tube extrusions. These cooling pipes are bonded to the underside of the BPA with EA9394. They have a Table 1 rating with high resistance to stress corrosion cracking. The Vortex Coolers will be removed before flight prior to Payload Bay Door Closure. The Vortex Coolers use facility compressed air at ambient temperature.

When not being charged the battery cells must remain below 25°C max with a self dissipation of 9 Watts per battery (there are three batteries in each Battery Module).

The Vortex coolers have no mechanical moving parts. The coolers produce hot air from one end and cold air from the other end. The volume and temperature of the two airstreams are adjustable through the valve on the hot air exhaust end. The BPA will use the APE as a purge tent with dry air poured in through the other Vortex Cooler to prevent condensation during cooling operations.

After Payload Bay door closure, the second cooling method is employed, the Payload Bay spigot air source ducted off of the Payload Bay purge. The interface to the Payload Bay Spigot is located near the SLIC keel. From the keel, the ductwork runs up the VP and onto the HP and the BPA where it joins the pipes used by the Vortex Coolers bonded to the underside of the BPAs.

Verify that this is the correct version before use

Stbd Flight BPA
B: EVA Bolt Interface
S: Shear Pin Interface
FS: Floating Pin Interface

Figure 5-48. Battery stowage design details

Verify that this is the correct version before use

Battery Module Drill Plate
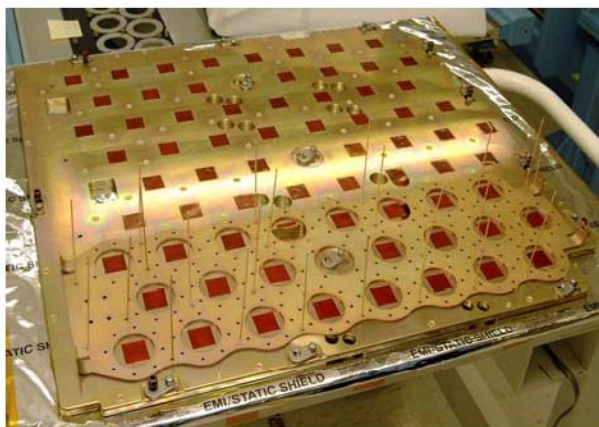
Battery Module Base Plate (P/N 4177760)

J-Hook Assembly installed to the Base Plate

Figure 5-49. BPA stowage overview

Verify that this is the correct version before use
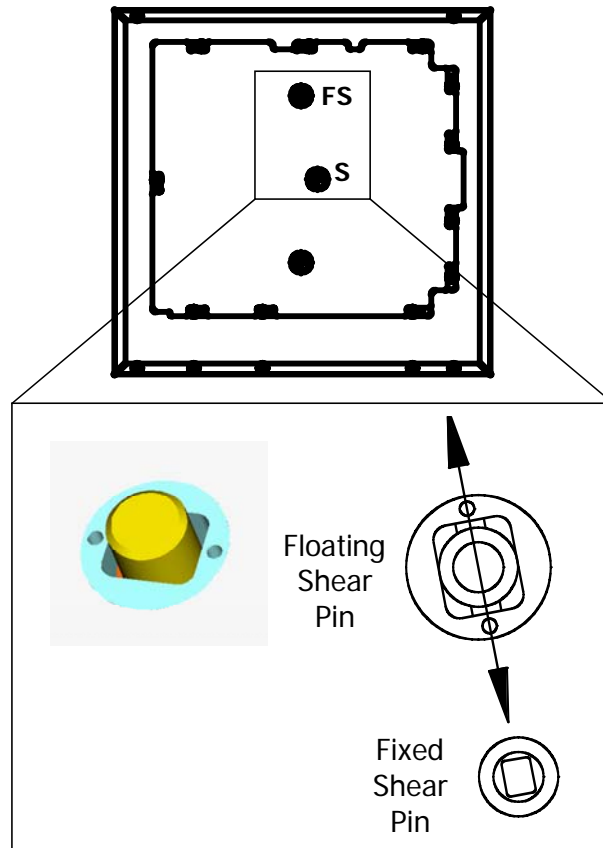
Figure 5-50. BPA shear pin

Verify that this is the correct version before use

The BPA electrical interface will provide and maintain a heated environment for the Batteries and supply temperature telemetry for mission operations. Active thermal control uses two redundant heaters (40 Watt primary and 40 Watt back up heater), four thermostats (heater set points of +10°C to +15°C), and two thermistors per BPA.

○ thermostats
□ thermistor
Heaters (2″ x 24″)
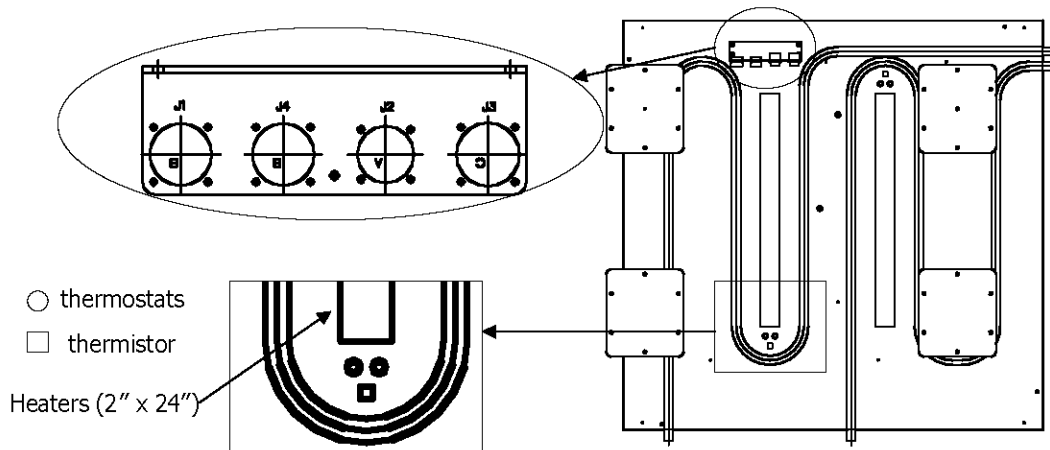
Figure 5-51. BPA electrical design (from BPA heater/harness assembly drawing GD2056075)

The BPA must be capable of cooling the batteries at KSC during battery charging at the pad and during battery self-discharge after Payload Bay Door closure.

Flight cooling items include duct work used during battery self-discharge operations and cooling pipes bonded on the underside of the BPA. There are two cooling pipes per BPA.

a.   6063-T4 Al alloy "D" Tube Extrusions (Table 1 Rating : high resistance to stress corrosion cracking)

b.   0.75" ID

Cooling pipes are bonded to the underside of the BPA with EA9394.

Verify that this is the correct version before use

Cooling Pipes
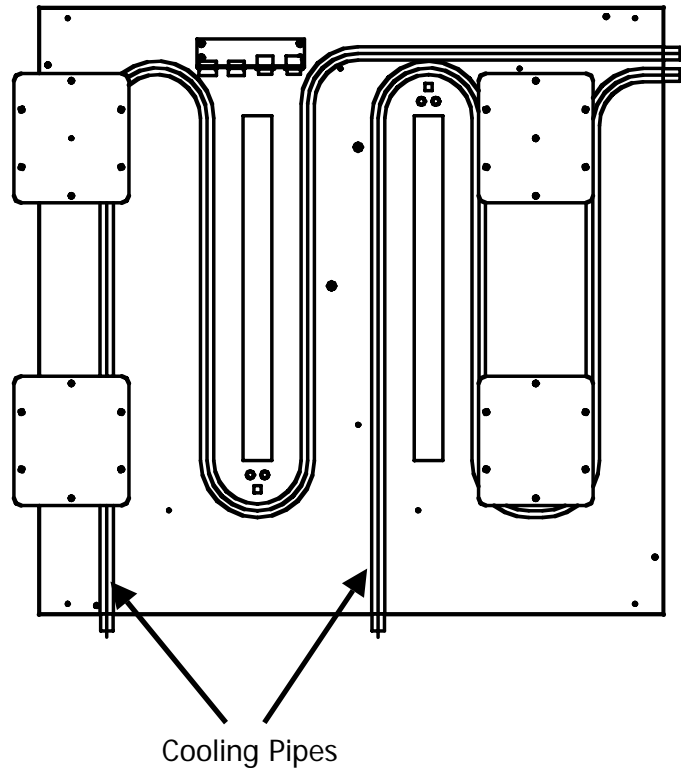
Figure 5-52. BPA cooling

Requirements for BPA cooling (Payload Bay Doors open) are that the batteries must remain below 22°C (Max dissipation 100 Watts per battery). The goal is to keep batteries below 15°C.

Five nonflight Vortex Coolers (two per plate; one as a cold purge) provide high pressure air flow. The Vortex Coolers are removed for flight. Exhaust air (Vortex Cooler hot exhaust and BPA cooling pipe exhaust air) will be vented/ducted out of the Payload Changeout Room (PCR). The BPA will have a purge tent with GN_2 purge to prevent condensation.

Verify that this is the correct version before use

rs Open)

ovide high

e PCR

to prevent

Exhaust Air (Typical 2X)

Vortex Cooler (Typical 4X)

Inlet Air (Typical 4X)
(Vortex Cooler removed)
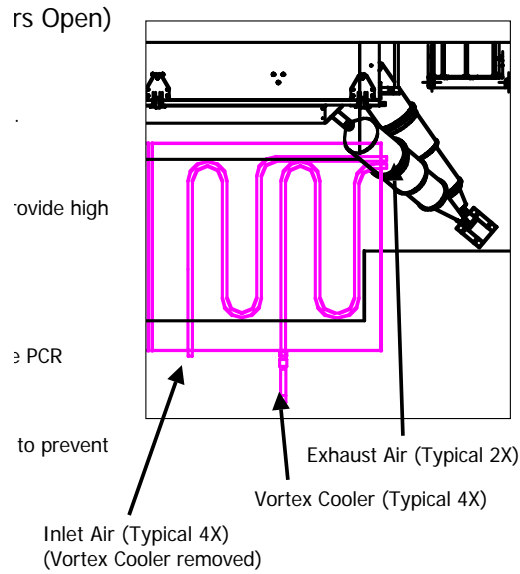
Figure 5-53. BPA cooling operations – uses 5 Vortex coolers

The Vortex Coolers produce temperatures as low as -50°C (-46°C) and as high
as +260°F (127°C). The coolers use facility compressed air (at ambient temperature)
and utilize no mechanical moving parts. The Vortex Coolers produce hot air from one
end and cold air from the other. (Ground Safety evaluates hot air temperatures and air
noise levels.) The volume and temperature of the two extremes are adjustable through
the valve on the hot air exhaust end.

Vortex Tube (www.exair.com)
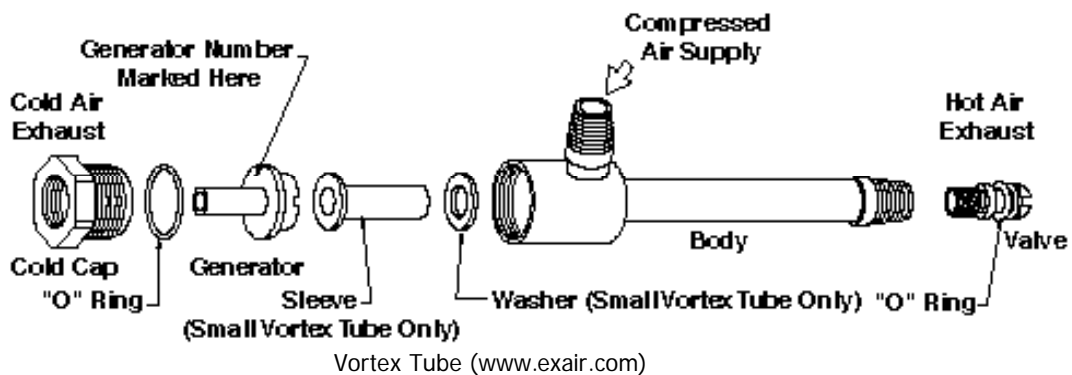
Figure 5-54. Vortex cooler – uses 5 Vortex coolers

Verify that this is the correct version before use

Battery Cooling System air
flow pipes bonded to
bottom facesheet of BPAs

Battery Cooling System
Duct to PC2 Probe/Drogue
Interface - New Build
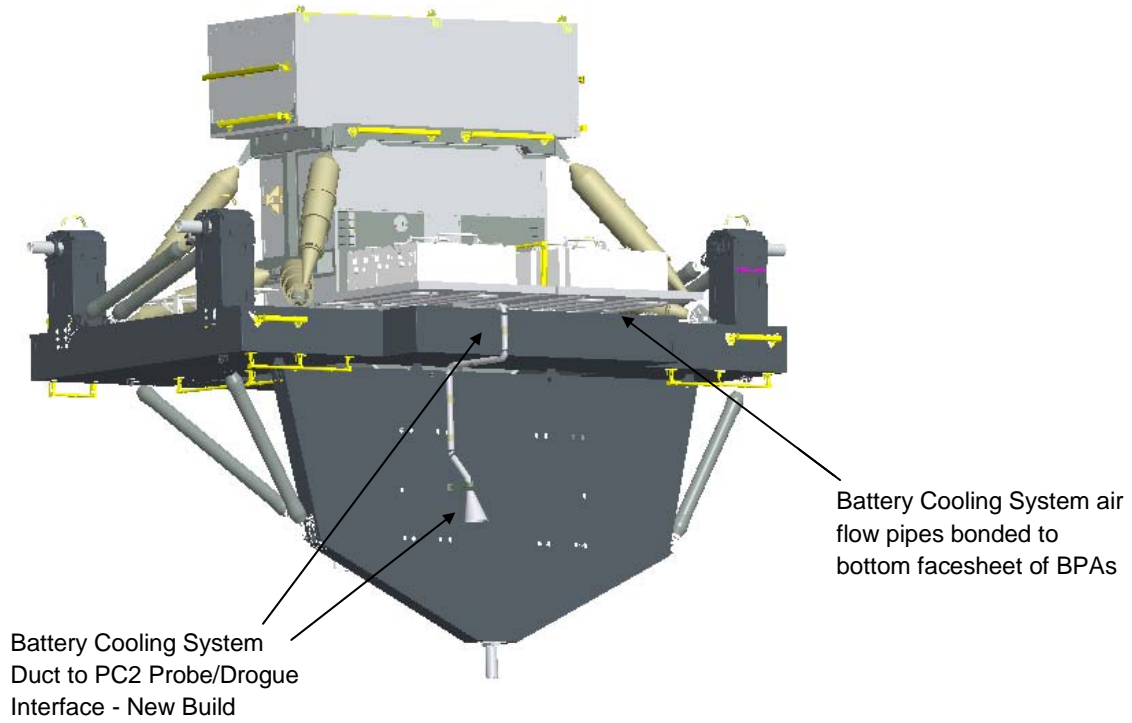
Figure 5-55. BPA cooling operations

Verify that this is the correct version before use

For the BPA EVA interface, the soft closure is made of MLI with Beta Cloth exterior. The soft enclosure uses Velcro with pull loops for opening and securing against the WSIPE.

Twelve 7/16-inch hex head 1/4-28 EVA bolts interface with the battery J-hooks. A handrail is attached to the starboard BPA. Currently, a bolt numbering map/diagram will be installed on the underside of each soft enclosure.

There is a safety requirement that the EMU "backpack" clearance from eight M-Strut isolators must be 2 inches (the same requirement as for SM3B).
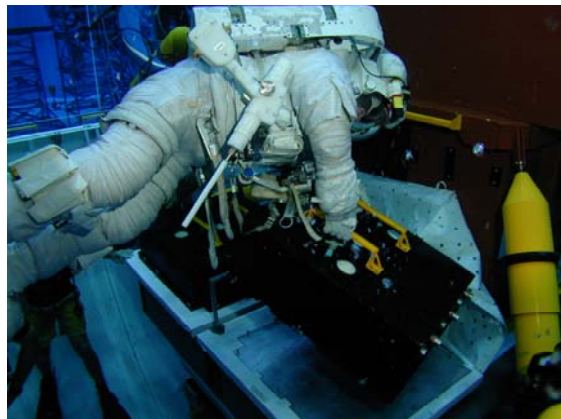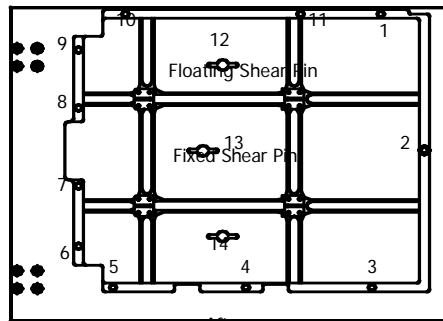
Figure 5-56. BPA EVA interface
(update with corner alignment guides,
similar to HST interface)

Verify that this is the correct version before use

5.1.4 Wide Field Handhold Stowage on SLIC

The WF Handhold Stowage Assembly is mounted to the forward face of the Vertical Pallet as shown in Figure 5-3. The stowage assembly incorporates passive guide restraints and 2 1/4-turn captive lock pins (CPLs) as shown in Figure 5-57. Uses similar stowage design as used on the forward fixture of the ORUC. The Handhold slides into pivot hooks and Z-saddles then rotates down into Y-saddles and Z-saddles with two CLPs. CLPS engage by pushing down on "T" handle and turning ¼ -turn. The handhold is mounted on SLIC for launch and return.
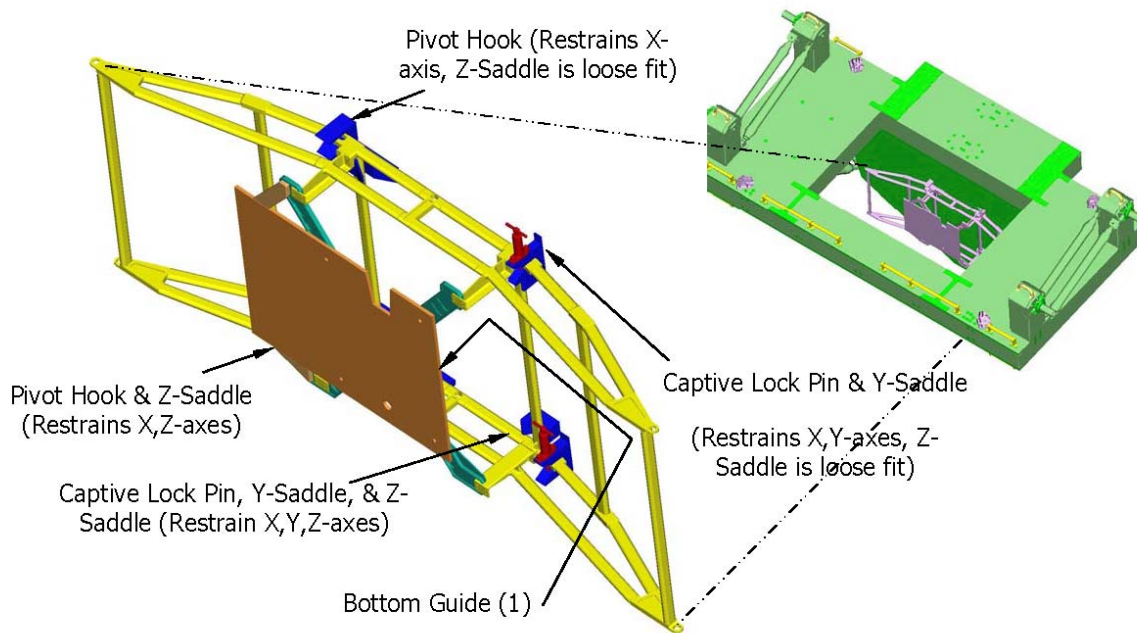
Figure 5-57. WF handhold stowage

Verify that this is the correct version before use

5.1.5 FGS Handhold Stowage on SLIC

The FGS Handhold Stowage Assembly is mounted on the port side of the top surface of-the Horizontal Pallet as shown in Figure 5-3. The stowage assembly incorporates 2¼-turn latches, 2 shear bosses, and 2 passive restraint retaining/guide blocks as shown in Figure 5-58. This is identical parking fixture stowage design as used on the forward fixture of the ORUC. (Also, identical stowage design from the Forward Fixture/FGS Handhold from SM2 and SM3A as well as the WFPC Thermal Blanket and PCU Transport Handle from SM3B) The Handhold slides into the restraint blocks then rotates down onto 2 shear bosses, then the ¼ turn latches are engaged and locked. The handhold is mounted on SLIC for launch and return.

FGS Handhold Stowage for SM3A

¼ Turn Latch Assembly
GD2039796
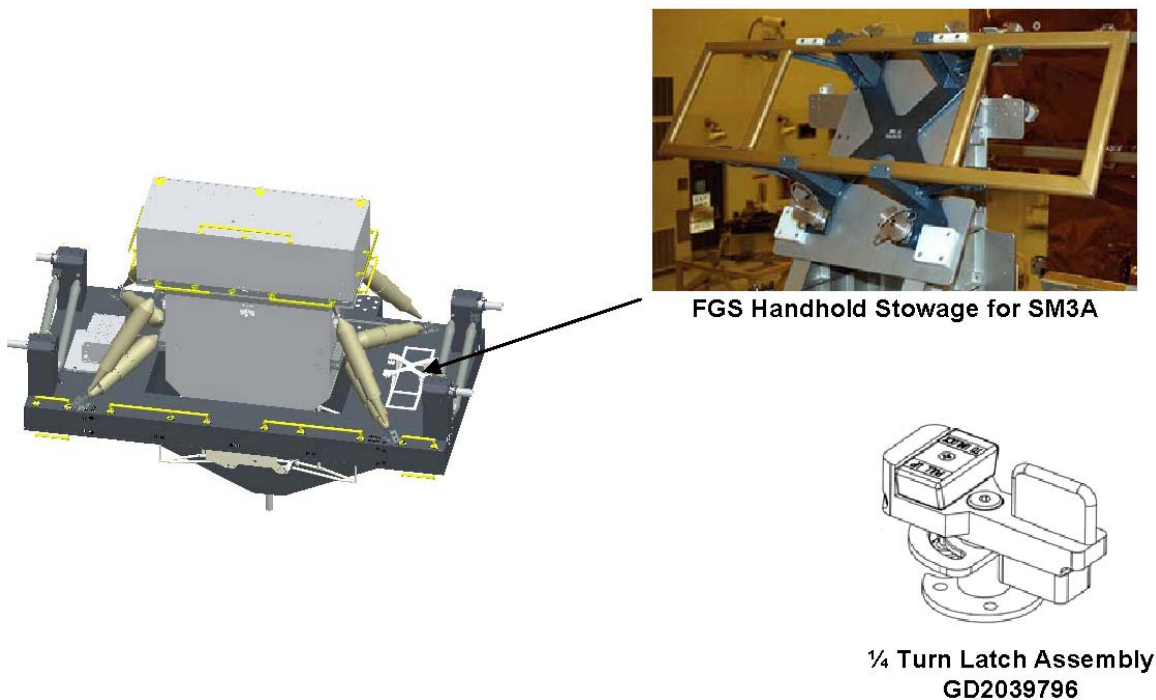
Figure 5-58. FGS handhold stowage

Verify that this is the correct version before use

5.1.6   SLIC Mechanical Systems

SLIC Load Isolation System (Mechanical)

The 8-element magnetic strut (M-Strut) Load Isolation System (LIS) (See Figure 5-59 and Figure 5-60) isolates the WSIPE from shock and vibration. Each Isolator consists of a spring and eddy-current damper acting in parallel. The stiffness of each Isolator is 800 pounds per inch and all eight utilize common parts, except for the end cone that interfaces the Pallet Assembly. The end cone is longer or shorter depending on the isolator's location on the pallet. The overall weight of the M-strut system is 494 pounds.
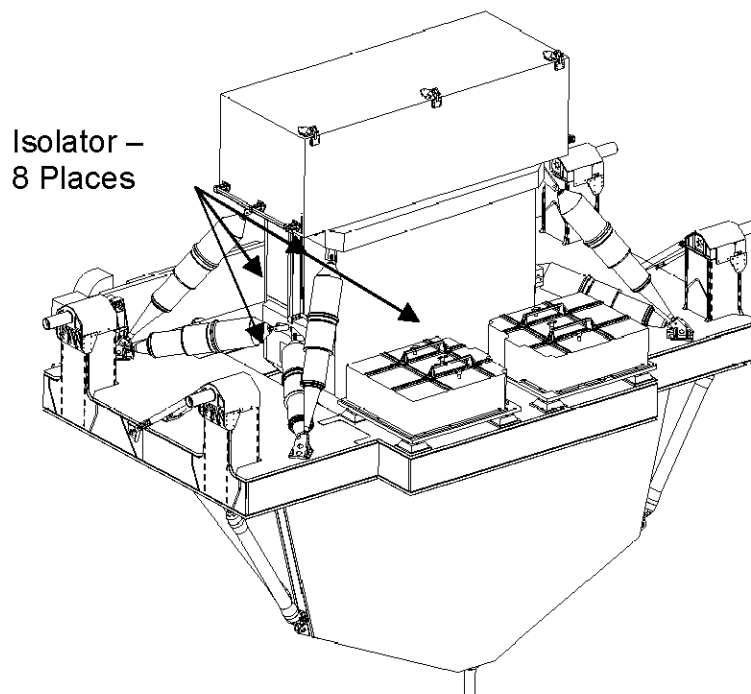
Figure 5-59. Isolators

The eddy current damper works by virtue of strong, permanent magnets arranged in circular patterns on inner and outer diameters of high purity copper sleeve. Magnets are imbedded in magnet housing, one attached to an outer sleeve and one attached to the main shaft. The outer sleeve and main shaft are structurally connected at one end of the isolator, terminating at a rod-end fitting. The copper conductor is bonded to an inner sleeve that is structurally connected to the other rod end of the isolator. Thus loads induce relative motion between the magnets and the copper sleeve. This motion causes high amperage circulating electrical currents within the copper sleeve, which convert mechanical energy into heat through "I^2R" losses. The main Beta "C" titanium spring, associated end fittings, the spring stabilizing index shaft, and the shaft bushing/bushing support structure are likewise connected to the opposite end rod end rod fittings.

Verify that this is the correct version before use

The permanent magnet radial arrays consist of eight magnet segments for the outer loop and six magnet segments for the inner loop. The segments are bonded between pairs of "back-irons" and nested within the tube structure. The magnetic field external to the M-strut tubular surface has been verified to drop below tested Gauss levels for the EMU (63 Gauss) at a standoff distance of 1.3 inches. For this reason a 2-inch distance must be maintained at all times between the EMU and the WSIPE LIS. Reference SM4 RHR EVA-6, "Astronaut Injury from Exposure to Excessive Electromagnetic Radiation."

Because the magnetic field is little affected by temperature or by damage such as cracks, the magnet/copper damping action is reliable and constant in light of physical failures. The main spring in each M-strut is analyzed, inspected and qualified as a fracture-critical part, as are local areas important for spring retention such as anchor bolts and end fittings. Linear motion of the M-Strut is controlled by the wide spacing and high pressure-velocity capability of the stabilizing shaft and associated shaft bushings, which are Teflon impregnated compacted lead-bronze on a split steel-backed assembly cylinder.

The magnet /copper tube interface has clearance, and the overall assembly is enclosed within the structural telescoping tube which has a garter-spring backed wiper for providing a closed system. Venting is by way of a small mesh-covered screen that provides adequate area/volume ratio. Flight units were assembled in clean room conditions.

The isolator and end fittings are rod ends with spherical bearings. Ball breakaway friction is noncritical in this application. The isolations are in neutral position when assembled, and will compress/extend slightly under 1-g WSIPE loads. Isolator stroke and end fittings have mechanical clearance for all nominal contingency worst-case loading conditions.

Verify that this is the correct version before use
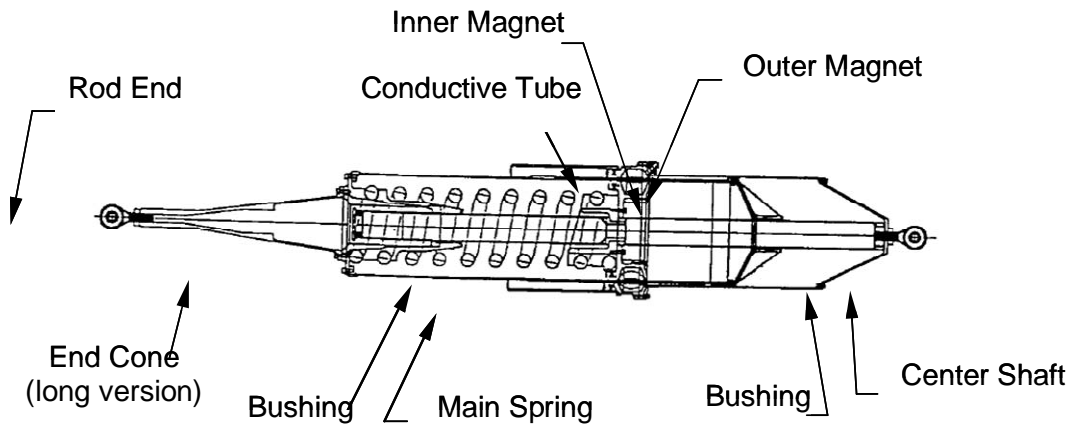
Figure 5-60. Isolator detail

5.2   SLIC ELECTRICAL SYSTEMS

5.2.1   SLIC Electrical Power

Power Interface

The SLIC EPDSU interfaces with the orbiter at the starboard SIP EIP at location X_o=870.25. The orbiter provides +28 $\pm$ 4 V dc, 200 amps fused, unregulated power (PL PRI) to the payload. The SLIC EPDSU does not provide power to the individual ORUs nor ORIs. The EPDSU does provide fusing for all external power circuits in accordance with the requirement and the wire size as defined in NSTS-18798 interpretation letter TA-92-038 and the rated temperature limit of the wire jacket material. The SLIC EPDSU has flown on SM-2 and SM3B as the SAC EPDSU. Fuses shall convey nominal currents per GSFC PPL de-rating requirements (typically 50 percent) and the load being powered. SLIC wiring to the SIP, which carries payload-distributed current back into the orbiter, shall be fused protected for the gauge of the orbiter wiring in like manner.

The SLIC structural single point ground lug on the EPDSU mounting plate is grounded to the orbiter structure by one 0 AWG wire, routed through the Payload Primary Power Bus (PPPB) SIP plug. The resistance between the O-gauge pin and the star ground lug does not exceed 10 milli-ohms.

Power Distribution

The SLIC EPDSU distributes the orbiter-unregulated power to the SLIC subsystems. See Figure 5-61. The orbiter power is distributed through 35-amp fuses into each of the EPDSU Power Podules (PMs), which distribute the power to a set of three Solid State Power Controllers (SSPCs). The SSPC, in turn distributes power through an array of

Verify that this is the correct version before use

fuses to the SLIC subsystems. The SSPCs are controlled by the orbiter's Standard Switch Panel (SSP). The power ratings for the SLIC subsystems are shown in Table 5-2.

Table 5-2. SLIC power services

SLIC EPDSU Power   32 V BUS

Service	Fuse	PM4	PM4 Current	PM4 Power	HTR Res	PM5	PM5 Current	PM5 Power	HTR Res
20-0	10A								
20-1	5A	WSIPE Heater 1A-4A	1.8	56.9	18.0	WSIPE Heater 1B-4B	1.8	56.9	18.0
20-2	5A	WSIPE Heater 5A-8A	1.8	56.9	18.0	WSIPE Heater 5B-8B	1.8	56.9	18.0
20-3	5A	WSIPE Heater 9A-10A	1.2	39.4	26.0	WSIPE Heater 9B-10B	1.2	39.4	26.0
20-4	5A	WSIPE Heater 11A-12A	1.2	39.4	26.0	WSIPE Heater 11B-12B	1.2	39.4	26.0
20-5	5A	WSIPE Heater 13A-14A	0.8	26.3	39.0	WSIPE Heater 13B-14B	0.8	26.3	39.0
20-6	5A								
15-0	10A								
15-1	5A								34.8
15-2	5A								18.0
15-3	5A								16.3
15-4	5A								34.8
15-5	5A								21.6
15-6	5A								
7-0	10A	EPDSU Heater A	2.3	73.9	13.9	EPDSU Heater B	2.3	73.9	13.9
7-1	5A								
7-2	5A								

20A SSPC Total =	6.8	218.8	20A SSPC Total =	6.8	218.8
15A SSPC Total =	0.0	0.0	15A SSPC Total =	0.0	0.0
7A SSPC Total =	2.3	73.9	7A SSPC Total =	2.3	73.9
PM4 Total =	9.1	292.7	PM4 Total =	9.1	292.7

SLIC EPDSU Power   32 V BUS

Service	Fuse	PM6	PM6 Current	PM6 Power	HTR Res	PM7	PM7 Current	PM7 Power	HTR Res
20-0	10A								
20-1	5A	BPA STBD Htr 1A-2A	1.6	52.5	19.5	BPA STBD Htr 1B-2B	1.6	52.5	19.5
20-2	5A								
20-3	5A								
20-4	5A								
20-5	5A								
20-6	5A								
15-0	10A								
15-1	5A	BPA PORT Htr 1A-2A	1.6	52.5	19.5	BPA PORT Htr 1B-2B	1.6	52.5	19.5
15-2	5A								
15-3	5A								
15-4	5A								
15-5	5A								
15-6	5A								
7-0	10A								
7-1	5A								
7-2	5A								

20A SSPC Total =	1.6	52.5	20A SSPC Total =	1.6	52.5
15A SSPC Total =	1.6	52.5	15A SSPC Total =	1.6	52.5
7A SSPC Total =	0.0	0.0	7A SSPC Total =	0.0	0.0
PM4 Total =	3.3	105.0	PM4 Total =	3.3	105.0

Note: Either "A" heaters or "B" heaters are powered, but not both simultaneously.

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5.3   SLIC AVIONICS

The SLIC Avionics consist of the SLIC EPDSU. The EPDSU interfaces with the orbiter's SIP EIPs to provide power, monitoring, and control of the SLIC subsystems. The SLIC EPDSU contains PMs which contain SSPCs. The SSPCs function like circuit breakers that are controlled via the orbiter's aft flight deck Standard Switch Panel (SSP). The SLIC telemetry circuit outputs are routed through the EPDSU to the orbiter's MDMs. The crew and ground controllers will be able to view a set of SLIC telemetry points from the MDMs.

5.3.1   Enhanced Power Distribution and Switching Unit

The SLIC EPDSU (Figure 5-62) is of modular design specifically for independent distribution and switching of standard orbiter power. The SLIC EPDSU provides fused unregulated power to the Power Modules (PM). The PM provides regulated voltage for telemetry circuit biasing, i.e., current and temperature monitoring. The EPDSU contains four power modules and each contains Solid State Power Controllers (SSPCs). The SSPCs function like circuit breakers for distribution of 28 V dc to the SLIC subsystems. See Figure 5-61. The power modules are located in slots 4 through 7 in the EPDSU. Each of the power modules is powered simultaneously. The EPDSU telemetry circuits have the capability to monitor the total EPDSU current, EPDSU 28 V dc output voltages, individual power modules total current, and SLIC subsystem temperatures. The telemetry signals are routed through the EDPSU to the orbiter's MDMs. (See Figure 5-64 for the EPDSU location on SLIC.)

Power Modules

The Power Modules each receive unregulated orbiter power through its 35-amp fuse. See Figure 5-62. This power is then distributed to three SSPCs (Figure 5-63). The SSPCs are used as a further current limiting device similar to a circuit breaker. The SSPCs are controlled, turned on or off, by the orbiter's SSP. The 28 V dc out of the SSPCs provide the control signal to the orbiter's SSP switch indicators. The voltage out of the SSPCs is distributed to an array of fuses for distribution to the SLIC subsystems. The Power Modules also provide regulated voltages for powering the SSPCs, telemetry circuits, and telemetry biasing resistor networks. The telemetry circuits provide monitoring of the Power Module's total current, interface circuit for the EPDSU total current, interface circuit and biasing network for the EPDSU thermistor circuits, interface circuit and biasing networks for SLIC Subsystem thermistor circuits, and interface circuit for the 28 V dc telemetry output voltages. The telemetry is provided to the orbiter's MDMs.

SLIC Grounding

All conductive MLI layers of thermal insulation are grounded together and to the structure single point ground lug to prevent static charge buildup. The resistance between any one of the MLI ground connection tabs and the outer conductive MLI layer is no more than 100k ohms. This measurement is made between the ground

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connection and a point at least one inch distant on the MLI. The resistance between the MLI ground connection point and the single point ground lug is 1.0 ohm maximum.

The composite panels that make up the SLIC structure shall be grounded together using bond straps (or wire). The panels will be grounded to the structure single point ground via bond wires. The resistance of the bond wire from the composite bond connection to the conductive structure (single point ground) shall not exceed 10 Ohms. The total resistance from the composite material to the single point ground shall not exceed 10 Ohms.
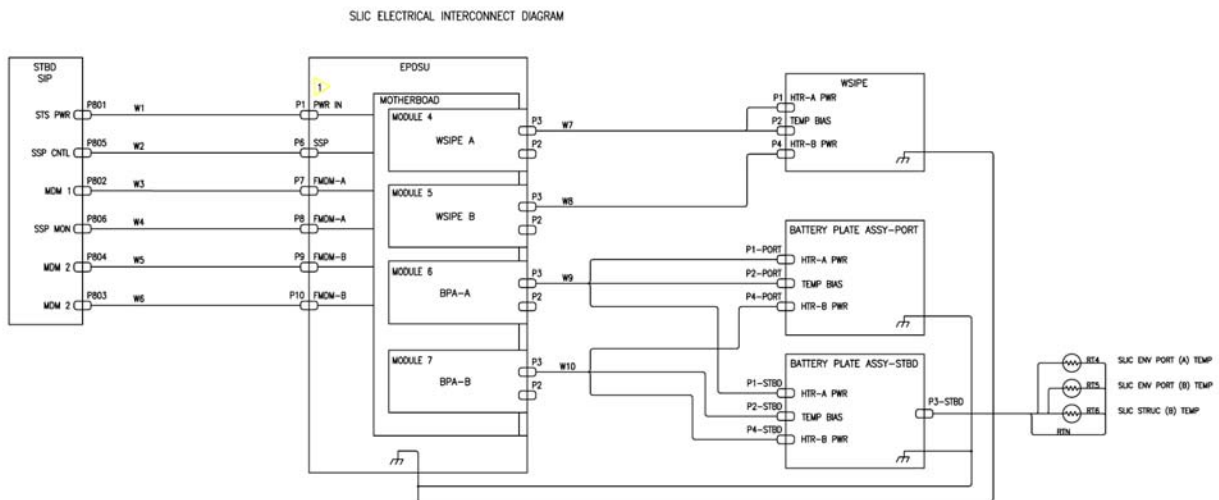
Figure 5-61. SLIC interconnect diagram

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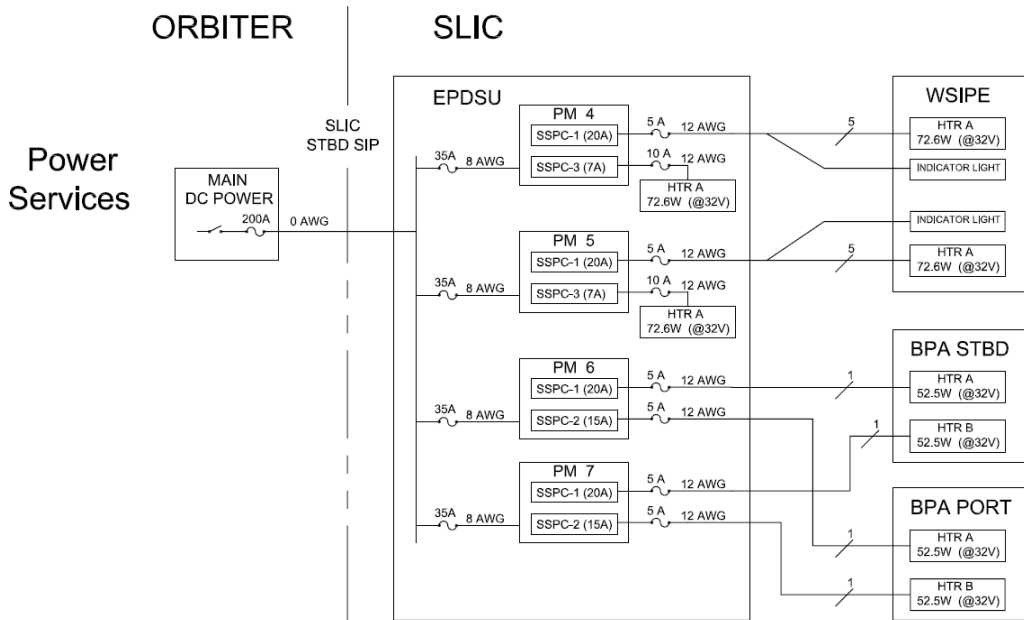
Figure 5-62. SLIC power services
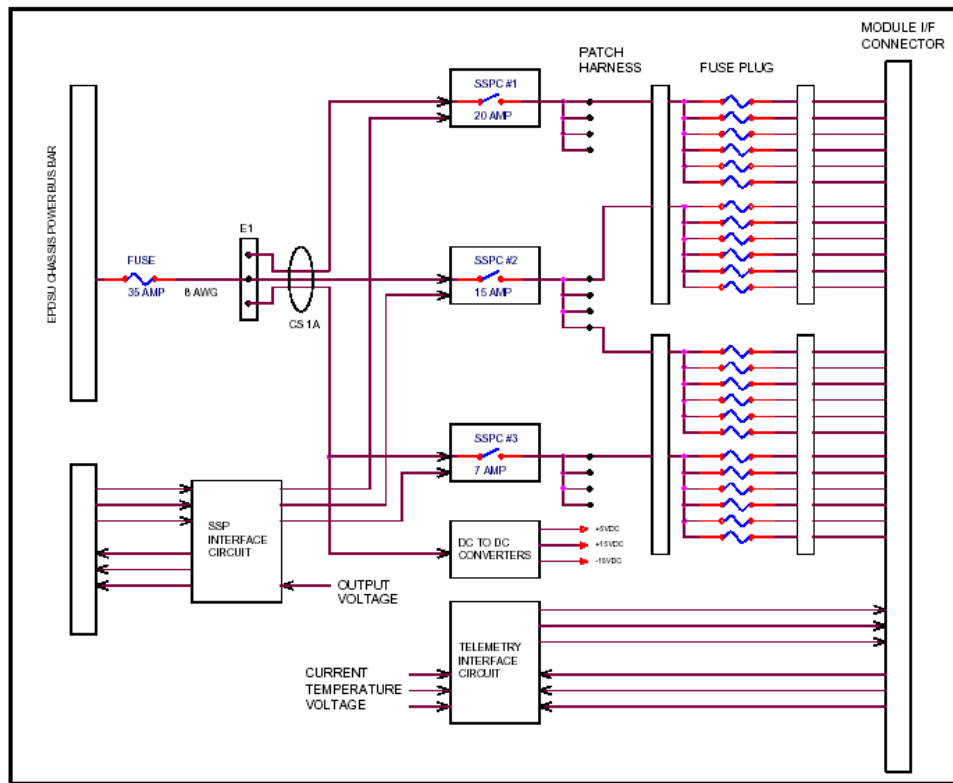
Figure 5-63. Power module simple block diagram

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EPDSU Interface
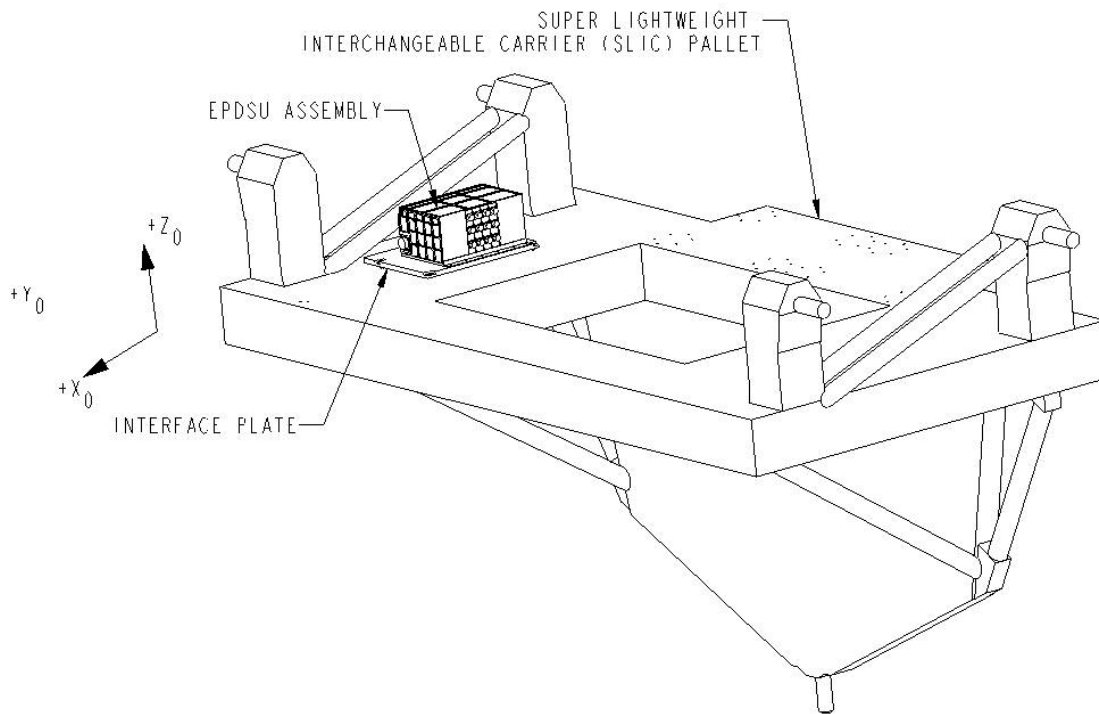
Figure 5-64. EPDSU

SLIC Heater Services

Redundant (A-side and B-side) heater circuits for the WSIPE, BPAs, and EPDSU
are supplied to maintain thermal control. Each heater service contains two series
bi-metallic thermostats (EPDSU contains three), for protection against a failed-on circuit.
Hazard analysis of heaters is provided in Hazard Report HST SM4 HR-21.

5.3.2   WSIPE Latch Indicators

There are two status indicators that extinguish when the "A" latch is latched. They are
each provided with redundant power sources from Bus A and B. The indicator circuit
includes a single micro switch and redundant indicator bulbs to display SI latch status
and a telemetry signal is provided for the EVA operators, and IVA/POCC, respectively.

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5.4 SLIC THERMAL CONTROL

Thermal control for the SLIC is achieved by a combination of resistive heaters and passive controls using surface coatings and MLI blankets. Power service and heater margins were selected to provide single-bus adequate heat provisions at 24 V dc measured at the SIP. Mission constraints for control of touch temperatures, maintenance of component qualified temperature ranges, and lid-hinge temperature gradient controls are to be analyzed.

5.4.1 SLIC Active Thermal Control

The WSIPE, BPAs, and EPDSU are equipped with redundant heater services for active thermal control. Each heater service contains two series bi-metallic thermostats (EPDSU contains three), for protection against failed-on circuits. Payload Power is controlled via Standard Switch Panel (SSP) switches though the EPDSU.

SLIC thermal system can be monitored by orbiter Payload forward MDMs. The analog inputs from each heater service current (5 total, one per module and EPDSU internal) and 22 temperature channels are routed the MDMs.

5.4.2 SLIC Passive Thermal Control

All SLIC elements except the latches, handrails, PFRs, Articulating Sockets, PFR Extender, WFPC Handhold, trunnions and EPDSU radiator are covered with MLI, etc. Thermal control finishes on these components provide additional passive thermal protection.

The blanketed M-struts are qualified to operate over a temperature range of -40° C to +65° C. Damping for the eddy-current M-struts is insensitive to temperatures variations across the qualified range.

5.5 SLIC UNIQUE EVA CREW AID/TOOLS

The CATs complement includes the following:

a. Battery Cap Assembly (launch in mid-deck, return with Battery Module)

b. WF Handhold

c. FGS HH

d. BET

Details on the CATs are in Section 4.0.

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5.5.1 SLIC PFR Sockets

There are no PFR sockets on the SLIC pallet. There are three PFR sockets on the WSIPE: one on the forward side, a second on the port side, and a third on the starboard side of the WSIPE.

5.6 SLIC CONTAMINATION CONTROL SYSTEM

The SLIC/WSIPE has a GN2 Purge system that can be continuously purged up to T-0. On the SLIC, the nitrogen is filtered and is routed to a purge fitting in the WSIPE to flow into the WFC3 aperture and to purge fittings on the BPA to purge the inside of the BPA soft enclosures. The WSIPE is vented through the "10 x 10" vents. The GN2 purge is provided at a flow rate of 5-10 ft^3/hr, with maximum rated purge line pressure of 20 psi. Connections between purge lines elements are made with stainless steel SWAGELOK fittings.

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6.0   DISPLAYS AND CONTROLS

The SSE payload can be controlled via crew switch throws, SPEC item entries, and ground command. Telemetry is available to the crew via switch talkbacks and telemetry displayed on SPEC pages. The MCC flight controllers have a number of displays to view the health and status of the SSE. This section provides information on the panels the crew uses to control and monitor SSE operations, the SPEC pages used to control and monitor SSE operations, and the ground displays the MCC flight control team uses to monitor SSE health and status.

6.1   ORBITER PANELS

This section details the panels that the crew uses to control and monitor the SSE: The Standard Switch Panel (SSP) and the Payload Retention Latch control panel (A6U).

6.1.1   Standard Switch Panels

The HST uses three SSPs for controlling and monitoring the telescope, SSE, and associated support equipment. Table 6-1 details the SSP locations and functional allocations. Figure 6-1 and Figure 6-2 show the layout of the SSPs.

Table 6-1. SSP functions per panel

	B (left)	**A (right)**
SSP 1 (L12U)	FSS/ORUC	TELESCOPE
SSP 2 (L12L)	APCU/PSP BY-PASS/ICBC3D	SLIC
SSP 3 (L11U)	Keel Cam	MULE/RNS

A description of the FSS/ORUC switches is provided in Table 6-2. The HST, PSP-Bypass, ICBC3D, APCU and Keel Camera switch functions are not discussed in this CSM; details on the HST can be found in the HST CSM, JSC-29029. The SLIC switch descriptions are provided in Table 6-3, and the MULE/RNS switch descriptions are provided in Table 6-4. Details on SSP wiring for all three panels are provided in Drawings 6.1-1 to Drawing 6.1-4.

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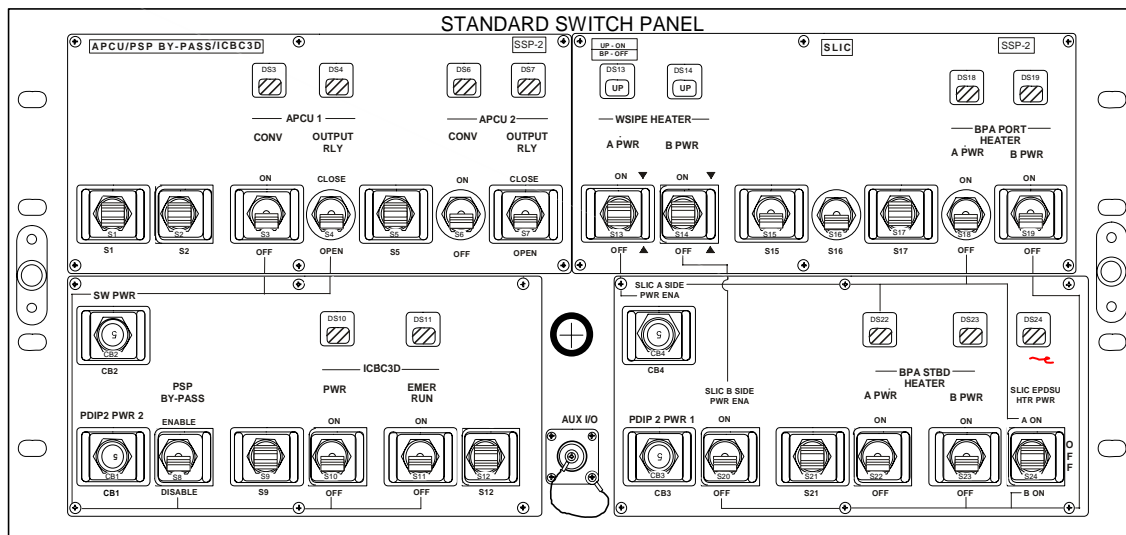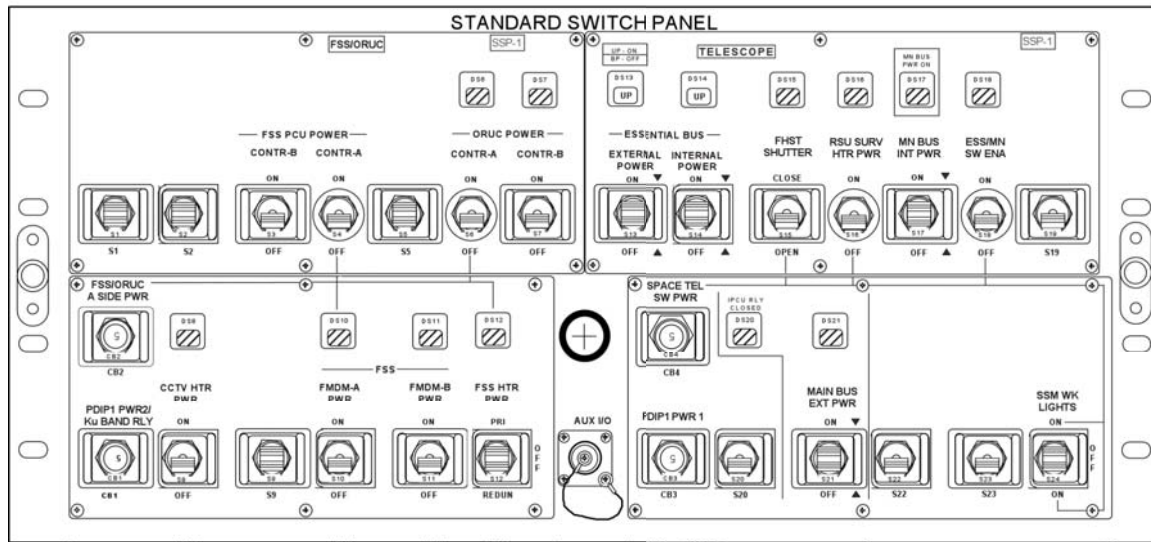
Figure 6-1. SSP1 and SSP2 (L12) layout

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STANDARD SWITCH PANEL
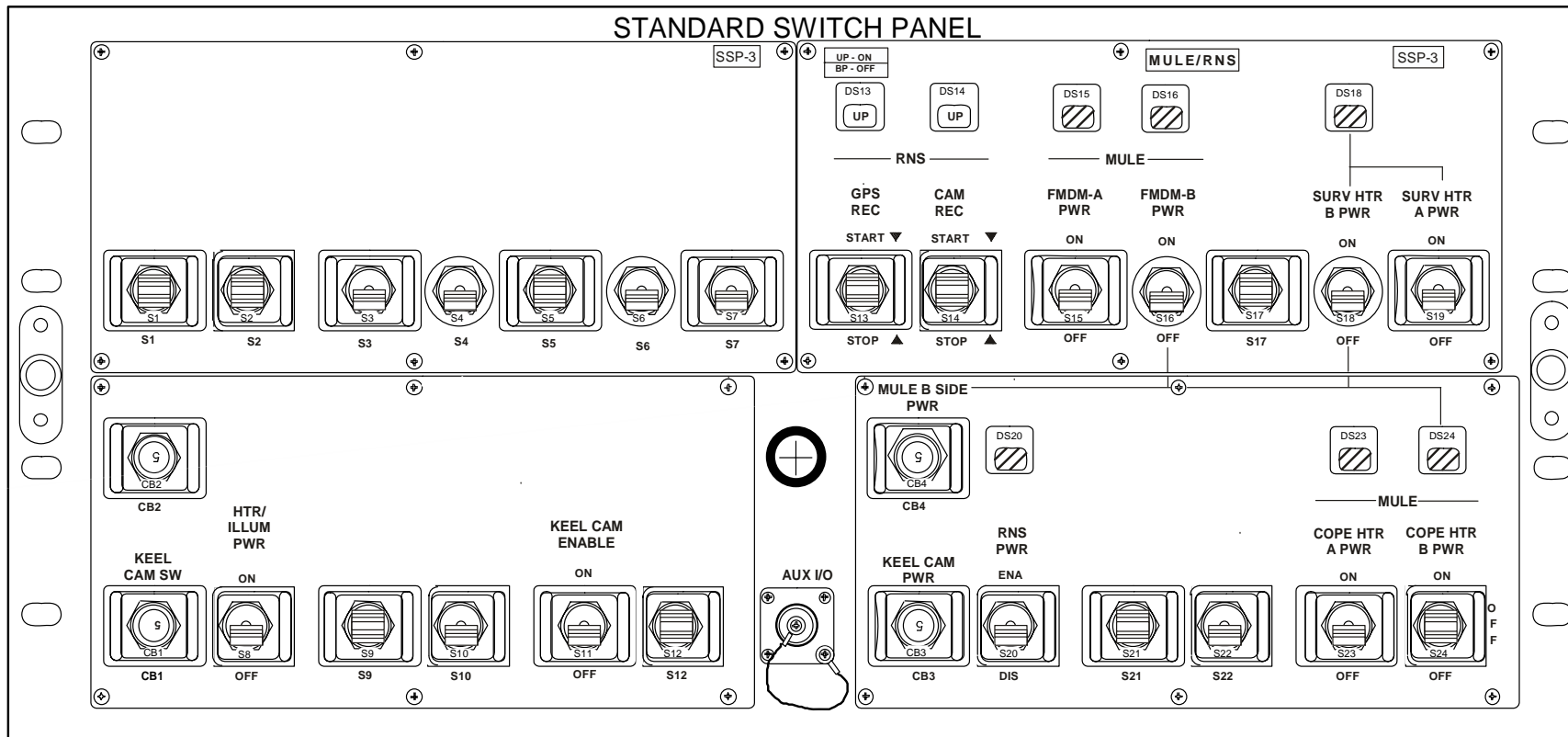
Figure 6-2. SSP3 (L11U) layout

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Table 6-2. SSP 1 switch panel functions

Item	Type device	Function	Usage
FSS PCU Power Control–B Switch (S3 – SSP 1)	Toggle switch, 2-position Double Pole, Single throw (DPST)	ON (UP) – Enables the B hardline control signal to EPDSU-1 and EPDSU-2, providing power to the PCUs OFF (DOWN) – Disables the B control signal to EPDSU-1 and EPDSU-2, removing power to the PCUs	Not normally used. PCUs will normally be controlled via FMDM Note: The power on/off indication is observed on telemetry
FSS PCU Power Control–A Switch (S4 – SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables the A hardline control signal to EPDSU-1 and EPDSU-2, providing power to the PCUs OFF (DOWN) – Disables the A control signal to EPDSU-1 and EPDSU-2, removing power to the PCUs. Disables the B control signal to the EPDSU-2, removing power to the SPCU DPCs	Not normally used. PCUs will normally be controlled via FMDM Note: The power on/off indication is observed on telemetry
ORUC POWER CONTR-A Switch (S6 - SSP 1)	Toggle switch, 2-position DPST	ON (UP) – Enables the A hardline control signal to EPDSU-1 and EPDSU-2, providing power to the ORUC OFF (DOWN) – Disables the A control signal to EPDSU-1 and EPDSU-2, removing power to the ORUC	
ORUC POWER CONTR-A Status Indicator (DS6 - SSP 1)	Display indicator, 2-position	ON - gray OFF - bp	Status indicator

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Table 6-2. SSP 1 switch panel functions (continued)

Item	Type device	Function	Usage
ORUC POWER CONTR-B Switch (S7 - SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables the B hardline control signal to EPDSU-1 and EPDSU-2, providing power to the ORUC OFF (DOWN) – Disables the B control signal to EPDSU-1 and EPDSU-2, removing power to the ORUC. Disables the B control signal to the EPDSU-2, removing power to the ORUC	
ORUC POWER CONTR-B Switch (DS7 – SSP 1)	Display indicator, 2-position	ON – gray OFF - bp	Status indicator
FSS/ORUC A SIDE PWR Circuit breaker (CB2 – SSP 1)	Circuit breaker	OUT - Open IN - Closed FSS B side power is hardwired <u>Note</u>: FSS B side power is hardwired	Closed during SSE activation 5-amp circuit breaker which routes orbiter power to S4, S6, S8, S10, and S12 (UP)
CCTV HTR PWR Switch (S8 - SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables EPDSU-1 power to the CCTV heater circuits. This allows thermostatic control of the CCTV heaters OFF (DOWN) - Disables EPDSU-1 power to CCTV heater circuits	Turned on during SSE activation (no later than 8 hr after PLBD opening) Turned off during SSE deactivation (no earlier than 1 hr prior to reentry)
CCTV HTR PWR Status Indicator (DS8 – SSP 1)	Display indicator, 2-position	ON – gray OFF - bp	Status indicator

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Table 6-2. SSP 1 switch panel functions (continued)

Item	Type device	Function	Usage
FSS FMDM-A PWR Switch (S10 – SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables EPDSU-1 power to FMDM-A OFF (DOWN) - Disables EPDSU-1 power to FMDM-A	Turned on during SSE check-out for continuous control and monitoring of FSS Turned off during FSS deactivation
FSS FMDM-A PWR Status Indicator (DS10 – SSP 1)	Display indicator, 2–position	ON – gray OFF – bp	Status indicator
FSS FMDM-B PWR Switch (S11 – SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables EPDSU-2 power to FMDM-B OFF (DOWN) - Disables EPDSU-2 power to FMDM-B	Turned on during SSE activation for initial control and monitoring of FSS. FMDM-B is a redundant unit and will only be used during initial FSS activation and check-out and in the event of a failure on the A-side avionics or used in contingencies in conjunction with the A-side for dual FMDM mechanism operations Turned off during completion of SSE checkout
FSS FMDM-B PWR Status Indicator (DS11 - SSP 1)	Display indicator, 2-position	ON – gray OFF - bp	Status indicator

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Table 6-2. SSP 1 switch panel functions (concluded)

Item	Type device	Function	Usage
FSS HTR PWR Switch (S12 – SSP 1)	Toggle switch, 3-position DPDT	PRI (UP) - Enables EPDSU-1 and EPDSU-2 power to primary FSS heater circuits. This allows thermostatic control of primary FSS heaters	Turned on during SSE activation (no later than 2 hr after PLBD opening)
		OFF (CENTER) - Disables EPDSU-1 and EPDSU-2 power from FSS primary heater and redundant heater circuits	Turned off during SSE deactivation (no earlier than 1 hr prior to reentry)
		RED (DOWN) - Enables EPDSU-1 and EPDSU-2 power to redundant FSS heater circuits. This allows thermostatic control of redundant FSS heaters	Redundant FSS heaters may be activated in the event of a failure in the primary FSS heaters
FSS HTR PWR Status Indicator (DS12 – SSP 1)	Display indicator, 2-position	ON (PRI or RED) – gray OFF – bp	Status indicator

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Table 6-3. SSP 2 switch panel functions

Item	Type device	Function	Usage
PSP BY-PASS SW PWR Circuit breaker (CB2 - SSP2)	Circuit breaker (5 Amps)	OUT – Open IN - Closed, provides power to PSP BY-PASS selector switch	On orbit, as required
PSP BY-PASS Switch (S4 - SSP2)	Toggle switch, 2-position DPST	ENABLE (UP) - Allows PDI data flow (DOD mode). Provides unique orbiter PI/PSP/PDI command/data configuration for HST only DISABLE (DOWN) - Inhibits PDI data flow (PSP Mode)	On orbit, as required
WSIPE HTR-A PWR Switch (S13 – SSP 2)	Toggle switch, 3-position DPDT momentary (should be held for approximately 2 sec)	ON (momentary UP) - Provides a latching signal to the SAC EPDSU. This applies power for the thermostatic control of ASIPE A heaters Center Position – Normal OFF (momentary DOWN) - Disables the EPDSU power from the thermostatically controlled ASIPE A heaters	Turned on during SSE activation Normal switch position when not in use Turned off during SSE deactivation
WSIPE HTR-A PWR Status Indicator (DS13 - SSP 2)	Display indicator 3-position	ON – UP OFF – BP DN indicator not used for HST	Status Indicator

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Table 6-3. SSP 2 switch panel functions (continued)

Item	Type device	Function	Usage
WSIPE HTR-B PWR Switch (S14 - SSP 2)	Toggle switch, 3-position DPDT momentary (should be held for approximately 2 sec)	ON (momentary UP) - Provides a latching signal to the SAC EPDSU. This applies power for the thermostatic control of ASIPE B heaters Center Position - Normal OFF (momentary DOWN) - Disables the EPDSU power from the thermostatically controlled ASIPE B heaters	Redundant ASIPE heaters may be activated in the event of a failure in the A side heaters Normal switch position when not in use
WSIPE HTR-B PWR Status Indicator (DS14 - SSP 2)	Display indicator 3-position	ON – UP OFF – BP DN indicator not used for HST	Status Indicator
BPA PORT HEATER A PWR Switch (S18 - SSP 2)	Toggle switch, 2-position DPDT	ON (UP) - Enables the SLIC EPDSU. This applies power for the thermostatic control of the BPA Port A heaters OFF (DOWN) - Disables the EPDSU power from the thermostatically controlled BPA Port A heaters	
BPA PORT HEATER A PWR Status Indicator (DS18 - SSP 2)	Display indicator 2-position	ON – GRAY OFF - BP	Status Indicator

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Table 6-3. SSP 2 switch panel functions (continued)

Item	Type device	Function	Usage
BPA PORT HEATER B PWR Switch (S19 - SSP 2)	Toggle switch, 2-position DPDT	ON (UP) - Enables the SLIC EPDSU. This applies power for the thermostatic control of the BPA Port B heaters OFF (DOWN) - Disables the EPDSU power from the thermostatically controlled BPA Port B heaters	
BPA PORT HEATER B PWR Status Indicator (DS19 - SSP 2)	Display indicator 2-position	ON – GRAY OFF - BP	Status Indicator
SLIC A SIDE PWR ENA Circuit breaker (CB4 - SSP 2)	Circuit breaker (5 Amps)	OUT – Open IN - Closed	Closed during SSE activation. 5-amp circuit breaker that routes orbiter power to S13, S18, S22, S24 (UP)
SLIC B SIDE PWR ENA Switch (S20 – SSP 2)	Toggle switch, 2-position DPDT	ON (UP) – Provides fused orbiter power from the EPDSU to SSP switches S14, S19, S23, and S24 (DN) for control of SLIC B side circuits OFF (DOWN) – Removes orbiter power from B side circuits	Turned on during SSE activation Turned off during SSE deactivation
BPA STBD HEATER A PWR Switch (S22 – SSP 2)	Toggle switch, 2-position DPDT	ON (UP) – Enables the SLIC EPDSU. This applies power for the thermostatic control of the BPA Starboard A heaters OFF (DOWN) – Disables the power EPDSU from the thermostatically controlled BPA Starboard A heaters	

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Table 6-3. SSP 2 switch panel functions (concluded)

Item	Type device	Function	Usage
BPA STBD HEATER A PWR Status Indicator (DS22 – SSP 2)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
BPA STBD HEATER B PWR Switch (S23 – SSP 2)	Toggle switch, 2-position DPDT	ON (UP) – Enables the SLIC EPDSU. This applies power for the thermostatic control of the BPA Starboard B heaters OFF (DOWN) – Disables the EPDSU power from the thermostatically controlled BPA Starboard B heaters	
BPA STBD HEATER B PWR Status Indicator (DS23 – SSP 2)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
SLIC EPDSU HTR PWR Switch (S24 – SSP 2)	Toggle switch, 3-position DPDT center off	ON (UP) – Enables the SLIC EPDSU. This applies power for the thermostatic control of the EPDSU A side heaters OFF (CENTER) – Removes power from the thermostatically controlled SLIC EPDSU A and B side heaters ON (DOWN) – Enables the EPDSU. This applies power for the thermostatic control of the EPDSU B side heaters	Turned on during SSE activation Turned off during SSE deactivation
SLIC EPDSU HTR Status Indicator (DS24 – SSP 2)	Display indicator, 2-position	ON A or B side – GRAY OFF - BP	Status Indicator

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Table 6-4. SSP 3 switch panel function

Item	Type device	Function	Usage
RNS GPS REC Switch (S13 - SSP 3)	Toggle switch, 3-position DPDT center off	START (UP) – Begins recording of RNS GPS data STOP (DOWN) – Stops recording RNS GPS data	
RNS GPS REC Status Indicator (DS13 - SSP 3)	Display indicator, 2-position	UP – Data recording BP – Recoding stopped	
RNS CAM REC Switch (S14 - SSP 3)	Toggle switch, 3-position DPDT center off	START (UP) – Begins recording of RNS camera data STOP (DOWN) – Stops recording RNS camera data	
RNS CAMS REC Status Indicator (DS14 - SSP 3)	Display indicator, 2-position	UP – Data recording BP – Recoding stopped	
MULE FMDM-A PWR Switch (S15 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to FMDM-A, A-side thermistor biases, and PDSU current sensors OFF (DOWN) – Disables the PDSU to remove power from FMDM-A, A-side thermistor biases, and PDSU current sensors	Turned on during SSE checkout for monitoring of the MULE Turned off during SSE deactivation
MULE FMDM-A PWR Status Indicator (DS15 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator

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Table 6-4. SSP 3 switch panel function (continued)

Item	Type device	Function	Usage
MULE FMDM-B PWR Switch (S16 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to FMDM-B, B-side thermistor biases, and PDSU current sensors OFF (DOWN) – Disables the PDSU power from FMDM-B, B-side thermistor biases, and PDSU current sensors	Turned on during SSE activation for initial monitoring of MULE. FMDM-B is a redundant unit and will only be used during initial MULE activation and checkout, and in the event of a failure on the A-side avionics Turned off during completion of SSE checkout
MULE FMDM-B PWR Status Indicator (DS16 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
SURV HTR B PWR Switch (S18 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to the B-side heaters: PDSU, LOPE, and avionics radiator plate OFF (DOWN) – Disables the PDSU power to the B-side heaters: PDSU, LOPE, and avionics radiator plate	Turned on during SSE activation Turned off during SSE checkout
SURV HTR PWR Status Indicator (DS18 – SSP 3)	Display indicator 2-position	ON A or B side – GRAY OFF – BP	Status Indicator
SURV HTR A PWR Switch (S19 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to the A-side heaters: PDSU, LOPE, and avionics radiator plate OFF (DOWN) – Disables the PDSU power to the A-side heaters: PDSU, LOPE, and avionics radiator plate	Turned on during SSE checkout Turned off during SSE deactivation

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Table 6-4. SSP 3 switch panel function (concluded)

Item	Type device	Function	Usage
MULE SW PWR Circuit Breaker (CB4 – SSP 3)	Circuit breaker	OUT – Open IN - Closed	Closed during SSE activation. 5-amp circuit breaker that routes orbiter power to S16, S18, S22, S24
RNS PWR Switch (S20 – SSP 3)	Toggle switch, 2-position DPDT	ENA (UP) – Enables the PDSU power to RNS OFF (DOWN) – Disables the PDSU power from RNS	
RNS PWR Status Indicator (DS20 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
COPE HTR A PWR Switch (S23 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to COPE A-side heaters OFF (DOWN) – Disables the PDSU power from COPE A-side heaters	Turned on during SSE checkout Turned off during SSE deactivation
COPE HTR A PWR Status Indicator (DS23 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
COPE HTR B PWR Switch (S24 – SSP 3)	Toggle switch, 3-position DPDT center off	ON (UP) – Enables the PDSU power to COPE B-side heaters OFF (CENER) – Disables the PDSU power from COPE B-side heaters (DOWN) – not wired	Turned on during SSE activation Turned off during SSE checkout
COPE HTR B PWR Status Indicator (DS24 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator

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6.1.2 Payload Retention Latch Panel (A6U)

The orbiter panel A6U shown in Figure 6-3 is the crew interface to the payload retention latch system. The payload retention latch system supplies 115 V, 400 Hz three-phase AC power and +28 V dc power to the payload bay and receives talkback (tb) indications from the payload bay. Panel A6U can be used to control payload retention latches or the SSE mechanisms, as outlined in Section 6.1.2.1.
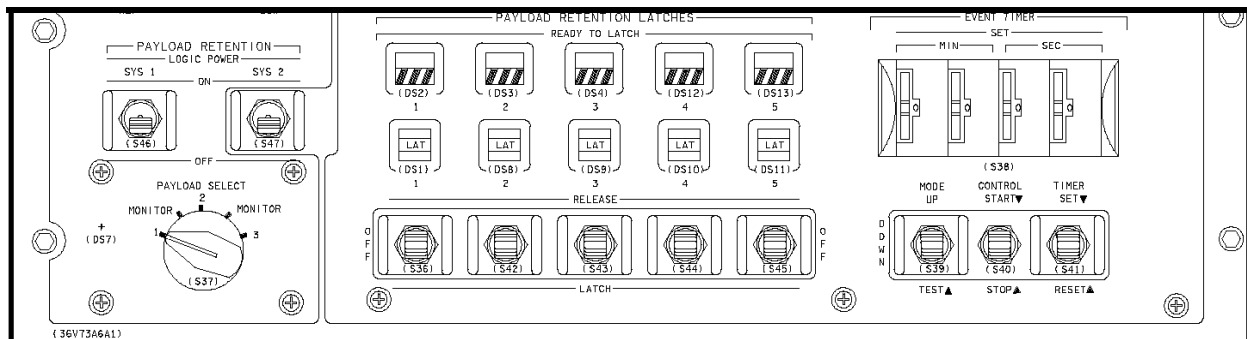
Figure 6-3. Payload retention latch panel (A6U)

Panel A6U can be used to operate a latch/mechanism with one motor or two functionally redundant motors. (A latch/mechanism refers to a system that has two redundant motors.) The retention latch assembly has redundant systems that control these redundant motors. The functional relationship of each of the components in the system is shown in Drawing TBS for the SSE mechanisms and SSSH Drawing 14.3-1 for the RAC active trunnion retention latches.

The major components of the retention latch system are shown in Drawing TBS. LOGIC POWER is used to activate either system 1, 2, or both. The Mid-Motor Control Assemblies (MMCAs) house relays supply three-phase AC power to the latches in the payload bay. The patch panels connect cables from the MMCAs with cables from the electrical connectors in the payload bay. The electrical connectors in the payload bay are where latches/mechanisms plug into the orbiter for power.

Only system 1 drives the talkbacks on panel A6U. System 1 consists of LOGIC POWER 1, relays in MMCA 1, the three starboard patch panels, and one of the redundant motors in the latches/mechanisms in the payload bay. System 2 consists of LOGIC POWER 2, relays in MMCA 3, the port panel, and other redundant motors in the payload bay.

6.1.2.1 Panel A6U Controls

A description of the latch controls on panel A6U is given below, along with a description of the onboard display available to monitor the system.

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The PAYLOAD SELECT switch is a five-position rotary switch that selects a group of latches/mechanisms to be controlled by the RETENTION LATCH switches (see Drawing TBS). The five positions are PAYLOAD SELECT 1, 2, and 3, and two MONITOR positions. When the PAYLOAD SELECT switch is in either of the two MONITOR positions, the status of all mechanisms can be monitored on the payload retention display, SPEC 097 (Figure 6-4). All talkbacks on panel A6U indicate barberpole when the PAYLOAD SELECT (PL SEL) switch is in either MONITOR position.

```
 2011/   /097     PL RETENTION      4 000/02:37:49
                                      000/00:00:00


                 LATCH  LATCH  LATCH  LATCH  LATCH
                   1      2      3      4      5
                 AB/AB  AB/AB  AB/AB  AB/AB  AB/AB
        PL SEL 1
          RDY-FOR-LAT
              LAT/REL   /      /      /      /      /

        PL SEL 2
          RDY-FOR-LAT
              LAT/REL   /      /      /      /      /

        PL SEL 3
          RDY-FOR-LAT 00     00     00     00     00
              LAT/REL 00/00  00/00  00/00  00/00  00/00




                                                   718
```

Figure 6-4. Orbiter payload retention display (SPEC SM097)

Additional information on AMSB status can be found on the PL RETENTION display (SPEC 097). This display presents the status of a selected AMSB mechanism in the LATCH 1/PL SEL 1 and LATCH 2/PL SEL 1 boxes and does not use FMDM status data. The ready for latch indications will always be 00 because the AMSB does not support that function. The status of the AMSB A will be displayed on the A side of latch 1 and the status of AMSB B will be shown on the B side of latch 2. If no mechanism is selected on either AMSB A or B, both the latch and release status for that AMSB will show 0. It should be noted that the rotator, pivoter, and translator are not expected to reach the end of travel or beginning of travel positions during the servicing mission and, therefore, the status of these two mechanisms will probably be shown as zeros in both the LAT/REL column of this display when they are selected. Once the BSP is installed, the pivoter is not expected to reach BOT/EOT microswitches.

6.1.2.1.1   RETENTION LATCH Switches

The five three-position RETENTION LATCH switches are latching toggle switches. The three positions are RELEASE, OFF, and LATCH.

6.1.2.1.2   Talkbacks

The 10 talkbacks on panel A6U are responsive only to switches in system 1. Each mechanism driven by a RETENTION LATCH switch has two talkbacks associated with

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it, a RELEASE/LATCH indication and a READY FOR LATCH indication. The RELEASE/LATCH talkbacks indicate LAT when a mechanism is at the end of travel, indicate REL when a mechanism is at the beginning of travel, and indicate barberpole when a mechanism is in transit. The READY FOR LATCH talkbacks are not active for the SSE mechanisms, but will function for the RAC trunnion latches. The talkbacks, like the RETENTION LATCH switches, work in conjunction with the PAYLOAD SELECT rotary switch. If the PAYLOAD SELECT switch is in MONITOR, the talkbacks indicate barberpole. The status of all mechanisms can be monitored on SPEC 097.

6.1.2.1.3   Logic Power Switches

The payload retention LOGIC POWER SYSTEM 1 switch provides Main A (MNA) power to retention drive system 1 to drive relays in MMCA 1. The relays connect three-phase AC power to the motors in the payload bay controlled by system 1. The LOGIC POWER SYSTEM 2 switch provides Main B (MNB) power to retention drive system 2 for driving relays in MMCA 3 that connect three-phase AC power to the motors controlled by system 2.

The LOGIC POWER also supplies +28 V dc indicator power to mechanisms in the payload bay. This indicator power activates end-of-travel switches in the mechanisms. LOGIC POWER 1 provides MNA indicator (MNA IND) power to system 1 motors; LOGIC POWER 2 provides MNB indicator (MNB IND) power to the motors controlled by system 2.

6.1.2.2   Payload Retention Latch System Components

The components of the payload retention latch system, other than panel A6U, are described in the following paragraphs.

6.1.2.2.1   Mid-Motor Control Assemblies

Each MMCA has a release and a latch AND gate relay for each of the five retention latch switches on the three numeric PAYLOAD SELECT positions. When an AND gate receives a high voltage signal (or a "1") from the RETENTION LATCH switch and a low voltage signal (or a "0") from the beginning- or end-of-travel switch in the mechanism, the AND gate passes power to the relay coil, which closes relay contacts that connect three-phase AC power with the mechanisms in the payload bay. Power from AC1 Payload Bay Mechanical Mid-Motor Controller 1 (PBM MMC1) is routed through MMCA1; power from AC2 PBM MMC3 is routed though MMCA 3.

The MMCAs also route +28 V dc indicator power (IND PWR) from LOGIC POWER to activate beginning- and end-of-travel position. When this occurs, the beginning- and end-of-travel switch in the mechanisms sends a high voltage signal (or a "1") back to the AND gate in the MMCA; power is removed from the relay coil, which, in turn, opens the relay contacts which connect three-phase AC power with the mechanisms. Thus, power will be removed from the mechanisms.

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Each MMCA OP status parameter represents the status of a serial chain of relay contacts. The payload retention contacts are one of four contacts in the relays in the MMCAs that connect three-phase AC power with the mechanisms in the payload bay. Refer to SSSH Drawing 2.4-2, to see the rest of the contacts in the serial chains that affect these parameters.

These status indications are available in the operational instrumentation downlink. The bilevel parameters indicate the status of a relay chain by transitioning between a "1" and a "0." The release and latch relay contacts are embedded in a serial chain, with relay contacts from other orbiter systems. Therefore, the opening of any one of the contacts will change the reading of the MMCA OP status parameter if all the other contacts in the chain are closed. Also, if one relay opens while another relay in the chain is already open, its transition will be undetectable in the status parameter. Furthermore, if any relay fails to open, the status parameter from the serial chain it is in will be useless. These factors must be understood when using these parameters on console.

When the latches are to be activated by the crew, the status parameters should be monitored on the ground. It should first be verified that no other contact in the serial chain with the payload latch contact will be opened at the same time as the payload latch contact. The status parameters should be monitored in conjunction with monitoring the AC bus currents that drive the motors in the mechanisms. What the MMCA status indicator actually indicates is that the relay that connects AC power with the payload retention latch is closed. A jump in the AC bus currents supplying power to the mechanism indicates that power has reached the motors in the mechanism. The MSID numbers corresponding to the AC bus currents that should be monitored are listed below.

    For system 1   AC1
            phase A   V76C1540A
            phase B   V76C1541A
            phase C   V76C1542A

    For system 2   AC2
            phase A   V76C1640A
            phase B   V76C1641A
            phase C   V76C1642A

The MCA status indications for system 1 are enabled by the following switch:

    panel MA73C:A S2 - MCA LOGIC MNB MID 3

The MCA status indications for system 2 are enabled by either of the following switches:

    panel MA73C:B S8 - MCA LOGIC MNB MID 3
    panel MA73C:B S3 - MCA LOGIC MNB MID 3

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6.1.2.2.2 Patch Panel

The payload bay contains two identical patch panels, one on the starboard side and one on the port side. The panels are located at $X_0 = 807$. Each panel has 12 left sill, 12 right sill, and 5 keel position connections.

The payload retention latch system is adapted for specific flight requirements at the patch panel. Cables leaving the MMCAs become the plugs in the patch panel. The plugs connect with receptacles in the patch panel that are wired to particular electrical connectors in the payload bay.

6.2 ORBITER SSE RELATED DISPLAYS

Two SM SPEC pages are used to control and monitor the SSE. SM 211 SSE OVERVIEW is used to control the systems for the FSS, MULE, ORUC, and SLIC. SM 212 SSE MECHANISMS is used to control and monitor the FSS mechanism operations. The layout of SM 211 is shown in Figure 6-5 and a description is provided in Table 6-5. The SM 212 is shown in Figure 6-6 and a description is provided in
Table 6-6.

The status parameter field for all parameters is blank for normal operations or displays and M for missing data. For analog parameters, this field will also display an H or L for off-scale data. An up or down arrow is displayed when an analog parameter exceeds either an upper or lower limit. The symbols driven in the status field of the parameter have the following display priority from highest to lowest (M, H, L, ↑, ↓). All symbols driven in the parameters status column will be displayed four times normal intensity.

Several feedback indications on this display are provided by BITE test 4 measurements acquired by the SM GPC upon execution of the MDM discrete commands. These measurements provide the output status only of the commanded FMDM discrete output card and should not be confused with an end-item feedback status. Proper indications based on BITE test 4 feedbacks simply verify that the command was successfully received and output by the FMDM but give no insight into the end-item status.

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```
                 1                 2                 3                 4                 5
       1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 1       X X X X / 2 1 1 / X X X         S S E   O V E R V I E W       X X   X   D D D / H H : M M : S S
 2                     O N   O F F                                                 D D D / H H : M M : S S
 3       P C U       X / X   1 X S   2 X   D P C                 V O L T S               A M P S
 4       C C T V   E N A   3 X S   4 X       1 / 2   X S / X S   X X . X S / X X . X S   X X . X S / X X . X S
 5                 P W R   5 X S   6 X       3 / 4   X S / X S   X X . X S / X X . X S   X X . X S / X X . X S
 6                 Z O N E   1 & 2   3       5 / 6   X S / X S   X X . X S / X X . X S   X X . X S / X X . X S
 7       E S M   A   H T R   X S   X S       7 / 8   X S / X S   X X . X S / X X . X S   X X . X S / X X . X S
 8               B   H T R   X S   X S       9 / 10 X S / X S   X X . X S / X X . X S   X X . X S / X X . X S
 9       S O P E   A   H T R   X S   X S     11 / 12 X S / X S   X X . X S / X X . X S   X X . X S / X X . X S
10               B   H T R   X S   X S       2 3   O N   X X         2 4   O F F   X X
 1       P O W E R                 A M P S             T H E R M A L             T E M P
 2       F S S   E P D S U   1 / 2     X X X . X S / X X X . X S   F S S     E P D S U   ± X X X S / ± X X X S
 3               F M D M   A / B       X . X X S / X . X X S               F M D M   ± X X X S / ± X X X S
 4               H T R     X S / X S                                       P C U     ± X X X S / ± X X X S
 5               A 1 / A 2             X X . X S / X X . X S               I P C U           ± X X X S
 6               B 1 / B 2             X X . X S / X X . X S               A M S B           ± X X X S
 7               C C T V   H T R               X . X X S       M U L E   P D S U           ± X X X S
 8       M U L E   F M D M   A / B     X . X X S / X . X X S             F M D M   ± X X X S / ± X X X S
 9               H T R     X S               X X . X S         S A C   E P D S U   ± X X X S / ± X X X S
20               E S M   1 & 2 / 3     X . X X S / X . X X S
 1               S O P E   1 A / 2 A   X X . X S / X X . X S                       V O L T S
 2               1 B & 2 B             X X . X S         F S S   E P D S U   X X . X S / X X . X S
 3               3 A / 3 B   X X . X S / X X . X S       M U L E   P D S U           X X . X S
 4       S A C   E P D S U             X X X . X S       S A C   E P D S U   X X . X S / X X . X S
 5                                                                                 ( X X )
 6
```

Figure 6-5. SSE displays 211

Table 6-5. Parameter characteristics: SM 211 SSE overview

CRT Name	MSID	Units	Display Range	Status Indicators				
				M	H	L	↑	↓
PCU (P)	P34K4024Y/ P34K4026Y/ P34K4050Y/ P34K4052Y/ P34K4054Y/ P34K4056Y	event	blank, P, '*'					
(S)	P34K4028Y/ P34K4030Y/ P34K4058Y/ P34K4060Y/ P34K4062Y/ P34K4064Y	event	blank, S, '*'					

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Table 6-5. Parameter characteristics: SM 211 SSE overview (continued)

CRT Name	MSID	Units	Display Range	Status Indicators				
				M	H	L	↑	↓
PCU ON	P34K4024Y/ P34K4026Y/ P34K4028Y/ P34K4030Y/ P34K4052Y/ P34K4060Y	event	blank or '*'	M				
OFF	P34K4024Y/ P34K4026Y/ P34K4028Y/ P34K4030Y/ P34K4052Y/ P34K4060Y	event	blank or '*'					
CCTV ENA ON	P34X2096Y/ P34X2097Y	event	'*', 1, 2, blank	M				
OFF	P34X2096Y/ P34X2097Y	event	'*', 1, 2, blank	M				
PWR ON	P34X4041Y	event	blank or '*'	M				
OFF	P34X4041Y	event	'*' or blank					
ESM A HTR ZONE 1&2	P34X8401Y	event	blank or '*'	M				
3	P34X8402Y	event	blank or '*'	M				
B HTR ZONE 1&2	P34X8404Y	event	blank or '*'	M				
3	P34X8405Y	event	blank or '*'	M				
SOPE A HTR ZONE 1&2	P34X8406Y	event	blank or '*'	M				
3	P34X8407Y	event	blank or '*'	M				
B HTR ZONE 1&2	P34X8409Y	event	blank or '*'	M				
3	P34X8411Y	event	blank or '*'	M				
DPC 1	P34X2047Y	event	blank or '*'	M				
2	P34X2048Y	event	blank or '*'	M				
1 VOLTS	P34V2028V	volts	0.0 to 40.0	M	H	L		
2 VOLTS	P34V2029V	volts	0.0 to 40.0	M	H	L		
1 AMPS	P34C2008V	amps	0.0 to 20.0	M	H	L	↑	
2 AMPS	P34C2009V	amps	0.0 to 20.0	M	H	L	↑	
3	P34X2049Y	event	blank or '*'	M				
4	P34X2119Y	event	blank or '*'	M				
3 VOLTS	P34V2030V	volts	0.0 to 40.0	M	H	L		
4 VOLTS	P34V2031V	volts	0.0 to 40.0	M	H	L		
3 AMPS	P34C2010V	amps	0.0 to 20.0	M	H	L	↑	
4 AMPS	P34C2011V	amps	0.0 to 20.0	M	H	L	↑	
5	P34X2050Y	event	blank or '*'	M				
6	P34X2120Y	event	blank or '*'	M				

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Table 6-5. Parameter characteristics: SM 211 SSE overview (continued)

CRT Name	MSID	Units	Display Range	M	H	L	↑	↓
				**Status Indicators**				
5 VOLTS	P34V2032V	volts	0.0 to 40.0	M	H	L		
6 VOLTS	P34V2033V	volts	0.0 to 40.0	M	H	L		
5 AMPS	P34C2012V	amps	0.0 to 20.0	M	H	L	↑	
6 AMPS	P34C2013V	amps	0.0 to 20.0	M	H	L	↑	
7	P34X2051Y	event	blank or '*'	M				
8	P34X2052Y	event	blank or '*'	M				
7 VOLTS	P34V2034V	volts	0.0 to 40.0	M	H	L		
8 VOLTS	P34V2035V	volts	0.0 to 40.0	M	H	L		
7 AMPS	P34C2014V	amps	0.0 to 20.0	M	H	L	↑	
8 AMPS	P34C2015V	amps	0.0 to 20.0	M	H	L	↑	
9	P34X2053Y	event	blank or '*'	M				
10	P34X2121Y	event	blank or '*'	M				
9 VOLTS	P34V2036V	volts	0.0 to 40.0	M	H	L		
10 VOLTS	P34V2037V	volts	0.0 to 40.0	M	H	L		
9 AMPS	P34C2016V	amps	0.0 to 20.0	M	H	L	↑	
10 AMPS	P34C2017V	amps	0.0 to 20.0	M	H	L	↑	
11	P34X2054Y	event	blank or '*'	M				
12	P34X2122Y	event	blank or '*'	M				
11 VOLTS	P34V2038V	volts	0.0 to 40.0	M	H	L		
12 VOLTS	P34V2039V	volts	0.0 to 40.0	M	H	L		
11 AMPS	P34C2018V	amps	0.0 to 20.0	M	H	L	↑	
12 AMPS	P34C2019V	amps	0.0 to 20.0	M	H	L	↑	
DPC ON	P93J0100C	echo fb of item entry						
DPC OFF	P93J0101C	echo fb of item entry						
POWER:								
FSS EPDSU 1 AMPS	P34C2113V	amps	-0.3 to 150.0	M	H	L		
2 AMPS	P34C2116V	amps	-0.6 to 150.0	M	H	L		
FMDM A AMPS	P34C2115V	amps	0.0 to 5.0	M	H	L		
B AMPS	P34C2022V	amps	0.0 to 5.0	M	H	L		
HTR (1)	P34X2082Y	event	blank or '1'	M				
(2)	P34X2083Y	event	blank or '2'	M				
A2 AMPS	P34C2027V	amps	0.0 to 20.0	M	H	L	↑	
B1 AMPS	P34C2024V	amps	0.0 to 20.0	M	H	L	↑	
B2 AMPS	P34C2114V	amps	0.0 to 20.0	M	H	L	↑	
CCTV HTR AMPS	P34C2095V	amps	0.0 to 5.0	M	H	L		
MULE FMDM A AMPS	P34C8109V	amps	0.0 to 5.0	M	H	L		
B AMPS	P34C8114V	amps	0.0 to 5.0	M	H	L		

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Table 6-5. Parameter characteristics: SM 211 SSE overview (concluded)

CRT Name	MSID	Units	Display Range	Status Indicators				
				M	H	L	↑	↓
				M	H	L	↑	
HTR	P34X8411Y	event	blank or '*'	M				
HTR AMPS	P34C8117V	amps	0.0 to 20.0	M	H	L	↑	
ESM 1&2 AMPS	P34C8110V	amps	0.0 to 5.0	M	H	L	↑	
3 AMPS	P34C8111V	amps	0.0 to 5.0	M	H	L	↑	
SOPE 1A AMPS	P34C8112V	amps	0.0 to 20.0	M	H	L	↑	
2A AMPS	P34C8107V	amps	0.0 to 20.0	M	H	L	↑	
1B&2B AMPS	P34C8115V	amps	0.0 to 20.0	M	H	L	↑	
3A AMPS	P34C8113V	amps	0.0 to 20.0	M	H	L	↑	
3B AMPS	P34C8116V	amps	0.0 to 20.0	M	H	L	↑	
SAC EPDSU AMPS	P34C5206V	amps	-1.2 to 150.0	M	H	L	↑	
THERMAL:								
FSS EPDSU (1) TEMP	P34T2004V	deg C	-30 to 60	M	H	L		
(2) TEMP	P34T2007V	deg C	-30 to 60	M	H	L		
FMDM (A) TEMP	P34T2001V	deg C	-55 to 120	M	H	L		
(B) TEMP	P34T2002V	deg C	-55 to 120	M	H	L		
PCU (P) TEMP	P34T2005V	deg C	-30 to 60	M	H	L		
(S) TEMP	P34T2006V	deg C	-30 to 60	M	H	L		
IPCU TEMP	P34T2093V	deg C	-30 to 60	M	H	L		
AMSB TEMP	P34T2003V	deg C	-30 to 60	M	H	L		
MULE PDSU TEMP	P34T8119V	deg C	-30 to 60	M	H	L		
FMDM (A) TEMP	P34T8120V	deg C	-55 to 120	M	H	L		
(B) TEMP	P34T8121V	deg C	-55 to 120	M	H	L		
SAC EPDSU TEMP (1)	P34T5221V	deg C	-30 to 60	M	H	L		
(2)	P34T5205V	deg C	-30 to 60	M	H	L		
FSS EPDSU (1) VOLTS	P34V2040V	volts	0.0 to 40.0	M	H	L		
(2) VOLTS	P34V2041V	volts	0.0 to 40.0	M	H	L		
MULE PDSU VOLTS	P34V8122V	volts	0.0 to 40.0	M	H	L		
SAC EPDSU VOLTS (1)	P34V5208V	volts	0.0 to 40.0	M	H	L		
SAC EPDSU VOLTS (2)	P34V5216V	volts	0.0 to 40.0	M	H	L		

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ITEM ENTRY CHARACTERISTICS AND SUMMARY: SM 211 SSE OVERVIEW

ITEM 1, 2   Items 1 and 2 will set and reset, respectively, twelve FMDM discrete outputs to command the twelve FSS DPCs on and off. Due to GPC limitations, the feedback for these commands are only based on command response from the 6 odd numbered DPCs. The feedback for item 3 ON indicates a blank when all DPCs are commanded off (based on the BITE test 4 feedback) and an "*" when any of the DPCs are commanded on. The item 4 OFF status is blank as long as any FMDM DPC ON discrete output is set, and indicates an "*" when all are reset.

ITEM 3, 4,   Items 3 through 6 provide power control over the CCTV camera mounted
5, 6   on the FSS BAPS platform. Two power relays in series feed power to the CCTV camera by execution of item 3, whose status will nominally indicate an "*" when both relays indicate they are closed. If either relay remains open, a "1" or "2" is displayed for the item 3 ON status to indicate the closed relay, while the item 4 OFF status shows the corresponding open relay number. When commanded off with an item 4, the item 4 OFF status indicates an "*" upon both relays achieving an open condition. The camera iris is commanded open upon execution of an item 5, whose ON status shows an "*" driven by the setting of the corresponding FMDM discrete output (BITE test 4 feedback). This same FMDM BITE status is used for the item 6 OFF status, which is blank when the camera is commanded on (iris open) and an "*" when the camera is powered off (iris closed).

DPC   Provides status and control of each of the 12 DPCs. The output voltage for the 12 DPCs is displayed, each with a range of 0 to 40 V dc. Also, the input current for the 12 DPCs is displayed, each with a range of 0 to 20 amperes. DPCs are commanded as follows:

ITEM 23, 24   The DPCs can be commanded individually by sending indexed commands as follows:

ON ITEM 23+	OFF ITEM 24+	DPC
1	71	1
2	72	2
3	73	3
4	74	4
5	75	5
6	76	6

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ON ITEM 23+	OFF ITEM 24+	DPC
7	77	7
8	78	8
9	79	9
10	80	10
11	81	11
12	82	12

The corresponding number of the index command sent appears to the right of 23 ON or 24 OFF.

POWER   SSE power distribution telemetry is provided from the FSS, MULE, and SAC. The FSS EPDSU 1/2 voltages, MULE PDSU voltage, and the SAC EPDSU A and B voltages provide insight into orbiter provided voltage at the interface to the FSS, MULE, and SAC. The current for active boxes and heaters on the SSE is provided. These currents include the two FSS FMDMs, the four heater current circuits on the FSS (along with status indications), the FSS CCTV heater circuit, the MULE FMDM A/B currents, the MULE survival heater circuit (along with status indication), the 2 ESM heater circuit currents, and the five SOPE heater circuit currents. Status indications for the ESM and SOPE heaters is displayed in the top left corner of the display. The current for the SAC EPDSU is provided.

THERMAL   The heaters on the FSS, MULE, and SAC are controlled from the standard switch panels. Power for the FSS and MULE circuits was discussed in the POWER section, and no telemetry is available for the SAC heater circuits. Box temperatures are provided to verify each is within operating limits prior to its use.

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```
                        1                   2                   3                   4                   5
        1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    1      X X X X / 2 1 2 / X X X      S S E   M E C H A N I S M S     X X   X   D D D / H H : M M : S S
    2                                                                            D D D / H H : M M : S S
    3              O N     O F F    D C   A M P S    A C   A M P S     T E M P
    4      A M S B   7 X S   8 X        X . X X S          X . X X S      ± X X X S
    5
    6      ──────────────────────────────────────────────────────────────────────────
    7      M E C H   X   X   S E L   S T A T    T A C H
    8        D L O C K         9 X S   X X X
    9        P I V O T   H I 1 0 X S   X X X
   10                  L 0 1 1 X S   X X X     X . X X S   D E G / M I N
    1        R O T A T O R   1 2 X S   X X X     X X . X S   D E G / M I N
    2        X L A T O R     1 3 X S   X X X
    3        B   L A T   1   1 4 X S   X X X
    4                    2   1 5 X S   X X X
    5                    3   1 6 X S   X X X
    6        U M B   M N     1 7 X S   X X X
    7              B / U     1 8 X S   X X X
    8        B S P           1 9 X S   X X X    X X X S / X X X X S / X X X S
    9
   20        D E S E L       2 0
    1
    2        O / R   E N A   2 1 X S
    3                D I S   2 2 X S
    4
    5                                                                    ( X X )
    6
```

Figure 6-6.   SEE display 212

Table 6-6.   Parameter characteristics: SM 212 SSE mechanisms

CRT Name	MSID	Units	Display Range	Status Indicators				
				M	H	L	↑	↓
AMSB ON	P34X2076Y/ P34X2077Y	event	A, B, blank, or '*'	M				
OFF	P34X2076Y/ P34X2077Y	event	A, B, blank, or '*'					
DC AMPS	P34C2025V	amps	-1.0 to 5.0	M	H	L	↑	↓
AC AMPS	P34C2111V	amps	0.0 to 5.0	M	H	L	↑	
TEMP	P34T2003V	deg C	-30 to 60	M	H	L		
MECH (A)	V54X8111E/ V54X8113E/ V54S8400E/ V54S8402E	event	A, A flash, blank					
(B)	V54X8122E/ V54X8124E/ V54S8400E/ V54S8402E	event	B, B flash, blank					

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Table 6-6. Parameter characteristics: SM 212 SSE mechanisms (continued)

CRT Name		MSID	Units	Display Range	Status Indicators				
					M	H	L	↑	↓
DLOCK	SEL	P34X2064Y	event	blank or '*'	M				↓
	STAT	P34X2064Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, DIS, ENG, '*', blank					
PIVOT HI	SEL	P34X2061Y	Event	blank or '*'	M				↓
	STAT	P34X2061Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, DN, UP, '*', blank					
PIVOT LO	SEL	P34X2060Y	event	blank or '*'	M				↓
	STAT	P34X2060Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, DN, UP, '*', blank					
	TACH	P34R2108V	deg/min	0.0 to 5.3	M	H	L		↓
ROTATOR	SEL	P34X2062Y	event	blank or '*'	M				↓
	STAT	P34X2062Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, CCW, CW, '*', blank					
	TACH	P34R2109V	deg/min	0.0 to 18.0	M	H	L		↓
XLATOR	SEL	P34X2063Y	event	blank or '*'	M				↓
	STAT	P34X2063Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, FWD, AFT, '*', blank					
B LAT 1	SEL	P34X2065Y	event	blank or '*'	M				↓
	STAT	P34X2065Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, OP, CL, '*', blank					

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Table 6-6. Parameter characteristics: SM 212 SSE mechanisms (concluded)

CRT Name		MSID	Units	Display Range	Status Indicators				
					M	H	L	↑	↓
2	SEL	P34X2066Y	event	blank or '*'	M				↓
	STAT	P34X2066Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, OP, CL, '*', blank					
3	SEL	P34X2067Y	event	blank or '*'	M				↓
	STAT	P34X2067Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, OP, CL, '*', blank					
UMB MN	SEL	P34X2068Y	event	blank or '*'	M				
	STAT	P34X2068Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, REL, MAT, '*', blank					
B/U	SEL	P34X2069Y	event	blank or '*'	M				
	STAT	P34X2069Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, REL, MAT, '*', blank					
BSP	SEL	P34X2070Y	event	blank or '*'	M				
	STAT	P34X2070Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, REL SET, L/A, '*', blank					
	(RET)	P34X2102Y/ P34X2105Y	event	RET A, RET B, RET *, blank	M				
	(ENG)	P34X2103Y/ P34X2106Y	event	ENG A, ENG B, ENG *, blank	M				
	(DIS)	P34X2104Y/ P34X2107Y	event	DIS A, DIS B, DIS *, blank	M				
O/R	ENA	P34X2072Y	event	'*' or blank	M				
	DIS	P34X2072Y	event	blank or '*'	M				

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ITEM ENTRY CHARACTERISTICS AND SUMMARY: SM 212 SSE MECHANISMS

ITEM 7,8   Item numbers 7 and 8 provide power ON/OFF control over the FSS AMSB. When both AMSBs are off, the item 7 ON status is blank and the item 8 OFF status shows an "*". When only AMSB A is on, the item 7 ON status indicates "A" and the item 8 OFF status indicates "B". When only AMSB B is ON, the item 7 ON status will indicate "B" and the item 8 OFF status will indicate "A". Under a contingency scenario where both sides of the FSS system are being used simultaneously with both AMSBs powered on, the item 7 ON status will show an "*", and the Item 8 OFF status is blank. When commanded on, the dc current to the commanded AMSB is displayed. When a mechanism is operated, the AC current being drawn by the motor is displayed. The temperature of the AMSB is also displayed.

MECH   Two parameter fields adjacent to MECH text callout provide payload retention system feedback related to A6U circuits controlling FSS mechanism operations. The left-hand field shows a flashing 'A' whenever the A6U panel switch 1 is taken out of the OFF position. A steady 'A' is driven whenever system 1 latch 1 LATCHED or RELEASED feedbacks indicate high. The right-hand field will show a flashing 'B' whenever A6U panel switch 2 is taken out of OFF position. A steady 'B' is driven whenever system 2 latch 2 LATCHED or RELEASED feedbacks indicate high. During nominal A-side(B-side) operations B(A) field should be blank. Under failure conditions, a steady B(A) can be displayed while controlling on the A-side(B-side) if B-side(A-side) AMSB mechanism select relay is failed closed and that mechanism is at its beginning or end of travel.

ITEM 9, 10,   Items 9 through 19 are used to select FSS mechanisms. When a
11, 12, 13,   mechanism is selected, an "*" is driven to the corresponding item number
14, 15,   and the mechanism status is displayed in an adjacent field under the
16, 17, 18,   STAT heading. Item 20 deselects the last mechanism selected.
19, 20

               Note: The previously selected mechanism is deselected when a new mechanism is selected. The STAT field for each mechanism will indicate as follows:

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Mechanism	REL(BOT)	Mid-travel	LAT(EOT)
Downlock (DLOCK)	DIS	RDY	ENG
PIVOT HI/LO	DN	RDY	UP
ROTATOR	CW	RDY	CCW
Translator (XLATOR)	FWD	RDY	AFT
Berthing latch (BLAT 1/2/3)	OP	RDY	CL
Main umbilical (UMB MN)	REL	RDY	MAT
Backup umbilical (UMB B/U)	REL	RDY	MAT
BAPS support post (BSP)	REL	*	SET

In the event of an error condition where both the beginning and end of travel microswitches of the selected mechanism indicate high, the STAT field shows "*", except for the BSP, which displays "L/A" if the BOT and EOT are indicated for the same microswitch indicative of the Latch Assist mode.

The status of the BSP retracted A and B switches is provided. When only switch A is retracted, "RETA" is displayed. When only switch B is retracted, "RETB" is displayed. When both switches A and B are retracted, "RET*" is displayed. When neither switch A or B is retracted, a blank is displayed. The next two fields below indicate the status of the BSP engaged A and B switches and the BSP disengaged A and B switches. They are handled in the same manner as the above BSP retracted A and B switches, except their feedbacks are "ENGA", "ENGB", "ENG*", and "DISA", "DISB", "DIS*", respectively.

ITEM 21,22   Items 21 and 22 provide the ability to override (O/R) limit switch cutoff of the selected mechanism in the event of microswitch failures or if the need arises to drive the selected mechanism to the mechanical limit (stall). The O/R ENA/DIS status is a direct feedback from the AMSB override relay. An "*" is driven next to the appropriated item number to indicate enabled or disabled.

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6.3   MCC SSE DISPLAYS

This section documents the telemetry used to drive the ground displays. Each SSE display is shown with an associated table. The table lists the parameter name from the display, the MSID, the units, and the telemetry range. Also, if the field displays text, the text is displayed in the field display column. Six displays are used by the MCC flight control team: SSE Systems (Figure 6-7 and Table 6-7), SSE Mechanical (Figure 6-8 and Table 6-8), SSE Power (Figure 6-9 and Table 6-9), SSE FMDM (Figure 6-10 and Table 6-10), SM 211 Emulation (Figure 6-11 and Table 6-11), and SM 212 Emulation (Figure 6-12 and Table 6-12).

6.3.1   SSE Systems Display Description
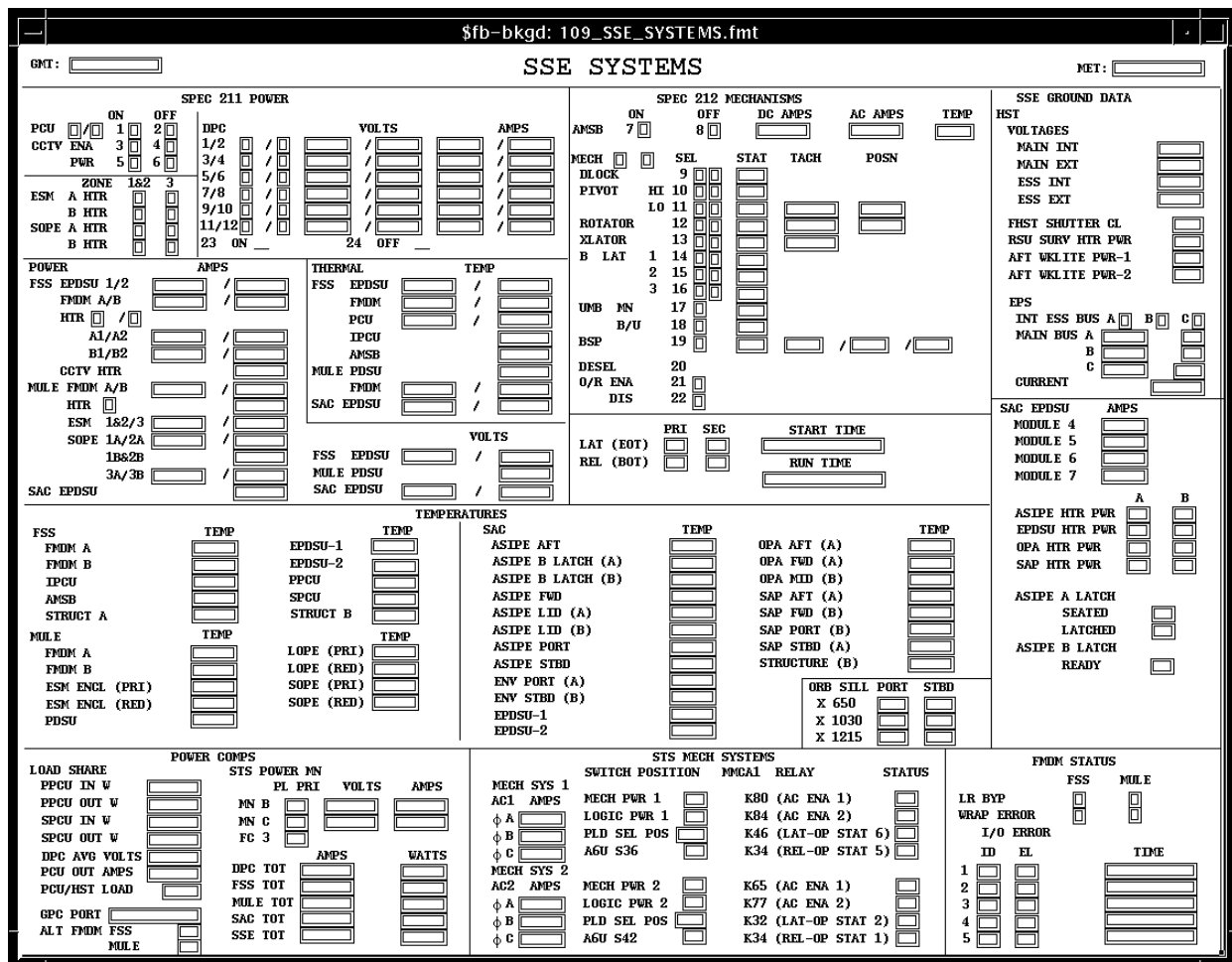
Figure 6-7. SSE systems display

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Table 6-7. SSE systems description

BACKGROUND	MSID	TEXT	SRC
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
SPEC 211 POWER			
PCU P/ (not annotated)	SSEOVR001	0 = blank, 1 = '*', 2 = 'P'	UCB
	Indicates power status based on command registry (not end item) of DPCs in the PPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is P. An * will be displayed for all other conditions. Refer to the SPEC 211 writeup from a description of the comp		
PCU /S (not annotated)	SSEOVR002	0 = blank, 1 = '*', 2 = 'S'	UCB
	Indicates power status based on command registry (not end item) of DPCs in the SPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is S. An * will be displayed for all other conditions. Refer to the SPEC 211 writeup from a description of the comp		
PCU ON	SSEOVR003	0 = blank, 1 = '*'	UCB
	Provides response to crew commanding all DPCs on. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. A single odd DPC indication will cause the PCU ON indication. Refer to the SPEC 211 writeup from a description of the comp		
PCU OFF	SSEOVR003	0 = '*', 1 = blank	UCB
	Provides response to crew commanding all DPCs off. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. All odd DPCs must indicate off for the PCU OFF indication. Refer to the SPEC 211 writeup from a description of the comp		
CCTV ENA ON	SSEPWR015	0 = blank, 1 = '1', 2 = '2', 3 = '*'	UCB
	Indicates power status (on) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp		
CCTV ENA OFF	SSEPWR015	0 = '*', 1 ='2', 2 = '1', 3 = blank	UCB
	Indicates power status (off) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp		
CCTV PWR ON	P34K4041Y	0 = blank, 1 = '*'	PTM
	Indicates power status (on) of the FSS CCTV camera. Once the CCTV camera power module is enabled, it must be commanded ("on") to provide power to the rest of the CCTV camera so that the camera will function		
CCTV PWR OFF	P34K4041Y	0 = '*', 1 = blank	PTM
	Indicates power status (off) of the FSS CCTV camera. Note: the CCTV power module may still be enabled/on		
ESM ZONE 1&2 A HTR	P34X8401Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay		
ESM ZONE 3 A HTR	P34X8402Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay		
ESM ZONE 1&2 B HTR	P34X8404Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay		
ESM ZONE 3 B HTR	P34X8405Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay.		

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
SOPE ZONE 1&2 A HTR	P34X8406Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
SOPE ZONE 3 A HTR	P34X8407Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
SOPE ZONE 1&2 B HTR	P34X8409Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
SOPE ZONE 3 B HTR	P34X8410Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
DPC			
DPC 1	P34X2047Y	0=blank, 1='*'	PTM
DPC 2	P34X2048Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 1 VOLTS	P34V2028V	0.0 to 40.0 volts	PTM
DPC 2 VOLTS	P34V2029V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 1 AMPS	P34C2008V	0.0 to 20.0 amps	PTM
DPC 2 AMPS	P34C2009V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 3	P34X2049Y	0=blank, 1='*'	PTM
DPC 4	P34X2119Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 3 VOLTS	P34V2030V	0.0 to 40.0 volts	PTM
DPC 4 VOLTS	P34V2031V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 3 AMPS	P34C2010V	0.0 to 20.0 amps	PTM
DPC 4 AMPS	P34C2011V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 5	P34X2050Y	0=blank, 1='*'	PTM
DPC 6	P34X2120Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 5 VOLTS	P34V2032V	0.0 to 40.0 volts	PTM
DPC 6 VOLTS	P34V2033V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 5 AMPS	P34C2012V	0.0 to 20.0 amps	PTM
DPC 6 AMPS	P34C2013V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 7	P34X2051Y	0=blank, 1='*'	PTM
DPC 8	P34X2052Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 7 VOLTS	P34V2034V	0.0 to 40.0 volts	PTM
DPC 8 VOLTS	P34V2035V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 7 AMPS	P34C2014V	0.0 to 20.0 amps	PTM
DPC 8 AMPS	P34C2015V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
DPC 9	P34X2053Y	0=blank, 1='*'	PTM
DPC 10	P34X2121Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 9 VOLTS	P34V2036V	0.0 to 40.0 volts	PTM
DPC 10 VOLTS	P34V2037V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 9 AMPS	P34C2016V	0.0 to 20.0 amps	PTM
DPC 10 AMPS	P34C2017V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 11	P34X2054Y	0=blank, 1='*'	PTM
DPC 12	P34X2122Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 11 VOLTS	P34V2038V	0.0 to 40.0 volts	PTM
DPC 12 VOLTS	P34V2039V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 11 AMPS	P34C2018V	0.0 to 20.0 amps	PTM
DPC 12 AMPS	P34C2019V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC ON	P93J0100C	data in not downlinked	---
DPC OFF	P93J0101C	data is not downlinked	---
POWER			
FSS EPDSU 1 AMPS	P34C2113V	-0.30 to 150.00 amps	PTM
2 AMPS	P34C2116V	-0.60 to 150.00 amps	PTM
Indicates EPDSU 1 and 2 current draw. Nominal current draw is TBS amps			
FSS FMDM A AMPS	P34C2115V	0.00 to 5.00 amps	PTM
B AMPS	P34C2022V	0.00 to 5.00 amps	PTM
FSS HTR	P34X2082Y	0 = blank, 1 = '1'	PTM
	P34X2083Y	0 = blank, 1 = '2'	PTM
FMDM pick-off on PDSU relay power output line			
FSS HTR A1 AMPS	P34C2026V	0.0 to 20.0 amps	PTM
A2 AMPS	P34C2027V	0.0 to 20.0 amps	PTM
Indicates FSS primary Heaters A1 and A2 current draw. Nominal current draw is TBS amps			
FSS HTR B1 AMPS	P34C2024V	0.0 to 20.0 amps	PTM
B2 AMPS	P34C2114V	0.0 to 20.0 amps	PTM
Indicates FSS Redundant Heaters B1 and B2 current draw. Nominal current draw is TBS amps			
FSS CCTV HTR AMPS	P34C2095V	0.00 to 5.00 amps	PTM
Indicates FSS CCTV Heaters current draw. Nominal current draw is TBS amps			
MULE FMDM A AMPS	P34C8109V	0.00 to 5.00 amps	PTM
B AMPS	P34C8114V	0.00 to 5.00 amps	PTM
Indicates Mule FMDM A and B current draw. Nominal current draw is TBS amps			

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
MULE HTR	P34X8411Y	0 = blank, 1 = '*'	PTM
FMDM pick-off on PDSU relay power output line			
MULE HTR AMPS	P34C8117V	0.0 to 20.0 amps	PTM
Indicates Mule Heater current draw. Nominal current draw is TBS amps			
MULE ESM 1&2 AMPS	P34C8110V	0.00 to 5.00 amps	PTM
3 AMPS	P34C8111V	0.00 to 5.00 amps	PTM
Indicates Mule Heater current draw. Nominal current draw is TBS amps			
MULE SOPE 1A AMPS	P34C8112V	0.0 to 20.0 amps	PTM
2A AMPS	P34C8107V	0.0 to 20.0 amps	PTM
Indicates SOPE primary Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps			
MULE SOPE 1B & 2B AMPS	P34C8115V	0.0 to 20.0 amps	PTM
Indicates SOPE redundant Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps			
MULE SOPE 3A AMPS	P34C8113V	0.0 to 20.0 amps	PTM
3B AMPS	P34C8116V	0.0 to 20.0 amps	PTM
Indicates SOPE primary and redundant Heaters zone 3 current draw. Nominal current draw is TBS amps			
SAC EPDSU AMPS	P34C5206V	-1.2 to +150.0 amps	PTM
Indicates SAC EPDSU current draw. Nominal current draw is TBS amps			
FSS EPDSU *1* VOLTS	P34V2040V	0.0 to 40.0 volts	PTM
2 VOLTS	P34V2041V	0.0 to 40.0 volts	PTM
Indicates FSS EPDSU 1 and 2 voltage. Nominal voltage is TBS amps			
MULE PDSU VOLTS	P34V8122V	0.0 to 40.0 volts	PTM
Indicates Mule PDSU voltage. Nominal voltage is TBS amps			
SAC EPDSU *A* VOLTS	P34V5208V	0.0 to 40.0 volts	PTM
B VOLTS	P34V5216V	0.0 to 40.0 volts	PTM
Indicates SAC EPDSU A and B voltage. Nominal voltage is TBS amps			
THERMAL			
FSS EPDSU *1* TEMP	P34T2004V	-30 to +60 deg C	PTM
2 TEMP	P34T2007V	-30 to +60 deg C	PTM
Indicates FSS Enhanced Power Distribution and Switching Unit (EPDSU) 1 and 2 temperature. Nominal temperature limits are -20 deg C to 50 deg C			
FSS FMDM *A* TEMP	P34T2001V	-55 to +120 deg C	PTM
B TEMP	P34T2002V	-55 to +120 deg C	PTM
Indicates FSS Flex Multiplexer/Demultiplexer (FMDM) A and B temperature. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
FSS PCU *P* TEMP	P34T2005V	-30 to +60 deg C	PTM
S TEMP	P34T2006V	-30 to +60 deg C	PTM
Indicates Port and Starboard Power Conditioning Unit (PPCU) temperature. Nominal control range is –20 to 50 deg C			

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FSS IPCU TEMP	P34T2093V	-30 to +60 deg C	PTM
Indicates Interface Power Control Unit (IPCU) temperature. Nominal operational limits are –37 deg C to 50 deg C			
FSS AMSB TEMP	P34T2003V	-30 to +60 deg C	PTM
Indicates Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C			
MULE PDSU TEMP	P34T8119V	-30 to +60 deg C	PTM
Indicates Power Distribution and Switching Unit (PDSU) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C			
MULE FMDM *A* TEMP	P34T8120V	-55 to 120 deg C	PTM
B TEMP	P34T8121V	-55 to 120 deg C	PTM
Indicates Flex Multiplexer/Demultiplexer A and B (FMDM) temperatures. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
SAC EPDSU *1* TEMP	P34T5221V	-30 to +60 deg C	PTM
2 TEMP	P34T5205V	-30 to +60 deg C	PTM
Indicates Enhanced Power Distribution and Switching Unit (EPDSU) temperature. Nominal operational temperature limits are –20 deg c to 50 deg C			
SPEC 212 MECHANISMS			
AMSB ON	SSECON015	0 = blank, 1 = 'A', 2 = 'B', 3 = '*'	UCB
Indicates power status (on) for the A or B sides of the Advanced Mechanism Select Box (AMSB). Refer to the SPEC 212 writeup from a description of the comp			
AMSB OFF	SSECON015	0 = '*', 1 = 'B', 2 = 'A', 3 = blank	UCB
Indicates power status (off) for the A or B sides of the Advanced Mechanism Select Box (AMSB). Refer to the SPEC 212 writeup from a description of the comp			
AMSB DC AMPS	P34C2025V	-1.00 to 5.00 amps	PTM
AMSB AC AMPS	P34C2111V	0.00 to 5.00 amps	PTM
AMSB TEMP	P34T2003V	-30 to +60 deg C	PTM
Indicates Advance Mechansim Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C			
MECH (left field)	W54X8111E	0 = blank, 1 = 'A', 2 = 'A' (red)	UCB
(right field)	W54X8122E	0 = blank, 1 = 'B', 2 = 'B' (red)	UCB
Indicates payload retention system feedback related to the A6U circuits controlling the FSS mechanism operations. An "A" or "B" indicates that either an EOT or BOT switch indicates high, but the payload retention switch is not commanding the motor to drive. A red "A" or "B" (flashing on crew spec) indicates that the payload retention switch 1 or 2 is in the REL/LAT position, and both EOT and BOT switches are not indicating high			

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
DLOCK SEL	P34X2064Y	0 = blank, 1 = '*'	PTM
	W34X2064Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON009	blank, 'RDY', 'DIS', 'ENG', '*'	UCB
Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A 'DIS' indicates at least 1 of the 2 release feedbacks is high, 'ENG' indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
PIVOT HI SEL	P34X2061Y	0 = blank, 1 = '*'	PTM
	W34X2061Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON006	blank, 'RDY', 'DN', 'UP', '*'	UCB
Indicates that the PIVOT HI mechanism has been selected (mechanism 4). The pivoter drive motor will pivot the BAPS ring using high torque. Drive times for both the high torque and low torque setting are the same. Indicates the status of the feedbacks for the pivot high torque mechanism. The field is only displayed when the high torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
PIVOT LO SEL	P34X2060Y	0 = blank, 1 = '*'	PTM
	W34X2060Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON005	blank, 'RDY', 'DN', 'UP', '*'	UCB
Indicates that the PIVOT LO mechanism has been selected (mechanism 3). The pivoter drive motor will pivot the BAPS ring using low torque. Drive times for both the high torque and low torque setting are the same Indicates the status of the feedbacks for the pivot low torque mechanism. The field is only displayed when the low torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
PIVOT LO TACH	P34R2108V	0.00 to 9.99 deg/min	PTM
Indicates the rotation speed of the pivoter. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast)			
PIVOT LO POSN	SSEMECH85	-5 to 99 deg	PTM
Integrates the position of the pivoter based on tach speed. Comp does not function correctly for dual motor ops.			

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
ROTATOR SEL	P34X2062Y	0 = blank, 1 = '*'	PTM
	W34X2062Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON007	blank, 'RDY', 'CW', 'CCW', '*'	UCB
Indicates that the ROTATOR mechanism has been selected (mechanism 5) Indicates the status of the feedbacks for the rotator mechanism. The field is only displayed when the rotator is selected in the AMSB. A CW indicates at least 1 of the 2 release feedbacks is high, CCW indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
ROTATOR TACH	P34R2109V	0.0 to 99.9 deg/min	PTM
Indicates the rotation speed of the rotater. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast)			
ROTATOR POSN	SSEMECH86	-360 to 360 deg	PTM
Integrates the position of the pivoter based on tach speed. Comp does not function correctly for dual motor ops			
XLATOR SEL	P34X2063Y	0 = blank, 1 = '*'	PTM
	W34X2063Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON008	blank, 'RDY', 'FWD', 'AFT', '*'	UCB
Indicates that the TRANLATOR mechanism has been selected (mechanism 6). Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A FWD indicates at least 1 of the 2 release feedbacks is high, AFT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
XLATOR TACH	P34R2110V	0.00 to 9.99 in/min	PTM
Indicates the linear speed of the translator. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast)			
B LAT 1 SEL	P34X2065Y	0 = blank, 1 = '*'	PTM
	W34X2065Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON010	blank, 'RDY', 'OP', 'CL', '*'	UCB
Indicates that the center berthing latch (1) has been selected. Berthing latch 1 may also be referred to as mechanism 8 Indicates the status of the feedbacks for the berthing latch 1 mechanism. The field is only displayed when the berthing latch 1 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
B LAT 2 SEL	P34X2066Y	0 = blank, 1 = '*'	PTM
	W34X2066Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON011	blank, 'RDY', 'OP', 'CL', '*'	UCB
Indicates that the starboard berthing latch (2) has been selected. Berthing latch 2 may also be referred to as mechanism 9. Indicates the status of the feedbacks for the berthing latch 2 mechanism. The field is only displayed when the berthing latch 2 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
B LAT 3 SEL	P34X2067Y	0 = blank, 1 = '*'	PTM
	W34X2067Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON012	blank, 'RDY', 'OP', 'CL', '*'	UCB
Indicates that the port berthing latch (3) has been selected. Berthing latch 3 may also be referred to as mechanism 10. Indicates the status of the feedbacks for the berthing latch 3 mechanism. The field is only displayed when the berthing latch 3 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
UMB MN SEL	P34X2068Y	0 = blank, 1 = '*'	PTM
STAT	SSECON013	blank, 'RDY', 'REL', 'MAT', '*'	UCB
Indicates that the main umbilical has been selected. The main umbilical may also be referred to as mechanism 11. Indicates the status of the feedbacks for the main umbilical mechanism. The field is only displayed when the main umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps			
UMB B/U SEL	P34X2069Y	0 = blank, 1 = '*'	PTM
STAT	SSECON014	blank, 'RDY', 'REL', 'MAT', '*'	UCB
Indicates that the back up umbilical has been selected. Indicates the status of the feedbacks for the backup umbilical mechanism. The field is only displayed when the backup umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comp			

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
BSP SEL	P34X2070Y	0 = blank, 1 = '*'	PTM
STAT	SSECON021	blank, 'RDY', 'REL', 'SET', 'L/A', '*'	UCB
		Indicates that the BAPS Support Post (BSP) has been selected. The BSP may also be referred to as mechanism 13. Indicates the status of the feedbacks for the BAPS support post mechanism. The field is only displayed when the BAPS support post is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, SET indicates at least 1 of the 2 latch feedbacks is high, L/A indicates that both the latch and release feedbacks for 1 of the 2 sides is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, release and latch feedbacks from different sides. Refer to the SPEC 212 writeup from a description of the comp	
BSP (left field)	SSECON022	blank, 'RETA', 'RETB', 'RET*'	UCB
(middle field)	SSECON023	blank, 'ENGA', 'ENGB', 'ENG*'	UCB
(right field)	SSECON024	blank, 'DISA', 'DISB', 'DIS*'	UCB
		Indicates whether the BSP is retracted, engaged, or disengaged. Refer to the SPEC 212 writeup from a description of the comps	
O/R ENA	P34X2072Y	0 = '*', 1 = blank	PTM
		Indicates if override of BOT/EOT microswitches is active. Override will prevent the microswitches from cutting off the motor and the motor will drive to a stall condition against the hardstops	
O/R DIS	P34X2072Y	0 = blank, 1 = '*'	PTM
		Indicates if override is disabled, which is the normal condition.	
LAT (EOT) PRI	P34X2087Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
LAT (EOT) SEC	P34X2088Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
REL (BOT) PRI	P34X2089Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
REL (BOT) SEC	P34X2090Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
START TIME	CETSTART0	ddd/hh:mm:ss	UCB
		Indicates mechanism start time.	
ELAPSED RUN TIME	CECHRUNTM	ddd/hh:mm:ss	UCB
		Indicates mechanism elapsed run time.	
SSE GROUND DATA			
HST VOLTAGES MAIN INT	P34V1027V	0.0 to 40.0 volts	PTM
		Internal Main Bus Voltage measured at the FSS Umbilical. Part of OI downlink	
HST VOLTAGES MAIN EXT	P34V1009V	0.0 to 40.0 volts	PTM
		External Main Bus Voltage measured at the FSS Umbilical. Part of OI downlink	
HST VOLTAGES ESS INT	P34V1026V	0.0 to 40.0 volts	PTM
		Internal Essential Bus Voltage measured at the FSS Umbilical. Part of OI downlink	
HST VOLTAGES ESS EXT	P34V1035V	0.0 to 40.0 volts	PTM
		External Essential Bus Voltage measured at the FSS Umbilical. Part of OI downlink	

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FHST SHUTTER CL	P34X2098Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS			
RSU SURV HTR PWR	P34X2099Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS			
AFT WKLITE PWR-1	P34X2100Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS			
AFT WKLITE PWR-2	P34X2101Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS			
EPS INT ESS BUS A	P34X3085E	0 = blank, 1 = '*'	PPM
Indicates that HST Diode bus A is connected to the HST Essential Bus			
EPS INT ESS BUS B	P34X3086E	0 = blank, 1 = '*'	PPM
Indicates that HST Diode bus B is connected to the HST Essential Bus			
EPS INT ESS BUS C	P34X3087E	0 = blank, 1 = '*'	PPM
Indicates that HST Diode bus C is connected to the HST Essential Bus			
EPS MAIN BUS A V	P34V3061A	-0.3 to 35.7	PPM
Indicates the voltage level of HST Main Bus A			
EPS MAIN BUS A	MBAXSWSTAT	See comps	UCB
Indicates that HST Diode Bus A is connected to HST Main Bus A. Refer to the SPEC 210 writeup from a description of the comp			
EPS MAIN BUS B V	P34V3062A	-0.3 to 35.7	PPM
Indicates the voltage level of HST Main Bus B			
EPS MAIN BUS B	MBBXSWSTAT	See comps	UCB
Indicates that HST Diode Bus B is connected to HST Main Bus B. Refer to the SPEC 210 writeup from a description of the comp			
EPS MAIN BUS C V	P34V3063A	-0.3 to 35.7	PPM
Indicates the voltage level of HST Main Bus C			
EPS MAIN BUS C	HSTSPEC010	See comps	UCB
Indicates that HST Diode Bus C is connected to HST Main Bus C. Refer to the SPEC 210 writeup from a description of the comp			
EPS CURRENT	P34C3060A	-2 to 151 amps	PPM
Indicates the total sum current being passed by HST Main Buses A, B, and C			
SAC EPDSU MODULE 4 AMPS	P34C5225V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 4			
SAC EPDSU MODULE 5 AMPS	P34C5224V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 5			
SAC EPDSU MODULE 6 AMPS	P34C5223V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 6			
SAC EPDSU MODULE 7 AMPS	P34C5222V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 7			
ASIPE HTR PWR A	P34X5226Y	0 = 'ON', 1 = 'OFF'	PTM
ASIPE HTR PWR B	P34X5229Y	0 = 'ON', 1 = 'OFF'	PTM

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
EPDSU HTR PWR A	P34X5228Y	0 = 'ON', 1 = 'OFF'	PTM
EPDSU HTR PWR B	P34X5231Y	0 = 'ON', 1 = 'OFF'	PTM
OPA HTR PWR A	P34X5232Y	0 = 'ON', 1 = 'OFF'	PTM
OPA HTR PWR B	P34X5235Y	0 = 'ON', 1 = 'OFF'	PTM
SAP HTR PWR A	P34X5233Y	0 = 'ON', 1 = 'OFF'	PTM
SAP HTR PWR B	P34X5236Y	0 = 'ON', 1 = 'OFF'	PTM
ASIPE A LATCH SEATED	P34X6134Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
ASIPE A LATCH LATCHED	P34X6135Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
ASIPE B LATCH READY	P34X6133Y	0 = 'NO', 1 = 'YES'	PTM
TBS			
TEMPERATURES			
FSS FMDM A	P34T2001V	-55.0 to 120.0 deg C	PTM
Indicates Flex Multiplexer/Demultiplexer (FMDM) A temperature. Operational temperature limits are 55 deg C to - 3 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
FSS FMDM B	P34T2002V	-55.0 to 120.0 deg C	PTM
Indicates Flex Multiplexer/Demultiplexer (FMDM) B temperature. Operational temperature limits are 55 deg C to - 3 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
FSS IPCU	P34T2093V	60 to -30 deg C	PTM
Indicates Interface Power Control Unit (IPCU) temperature. Nominal operational limits are 50 deg C to -37 deg C			
FSS AMSB	P34T2003V	60 to -30 deg C	PTM
Indicates Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are 50 deg C to -20 deg C			
FSS STRUTURE A	P34T2117V	60 to -30 deg C	PTM
Indicates Power Regulator Junction Unit A-side temperature. Nominal control range is -20 to -10 deg C			
FSS EPDSU 1	P34T2004V	60 to -30 deg C	PTM
Indicates Power Distribution and Switching Unit (PDSU) temperature. Nominal operational temperature limits are 50 deg C to -20 deg C			
FSS EPDSU 2	P34T2007V	60 to -30 deg C	PTM
Indicates Enhanced Power Distribution and Switching Unit (EPDSU) temperature. Nominal operational temperature limits are 50 deg C to -20 deg C			

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FSS PPCU	P34T2005V	60 to -30 deg C	PTM
Indicates Port Power Conditioning Unit (PPCU) temperature. Nominal operational limits are 50 deg C to -20 deg C			
FSS SPCU	P34T2006V	60 to -30 deg C	PTM
Indicates Starboard Power Conditioning Unit (SPCU) temperature. Nominal operational limits are 50 deg C to -20 deg C			
FSS STRUCTURE B	P34T2118V	60 to -30 deg C	PTM
Indicates Power Regulator Junction Unit B-side temperature. Nominal control range is -20 to -10 deg C			
MULE FMDM A	P34T8120V	-55.0 to 120.0 deg C	PTM
MULE FMDM B	P34T8121V	-55.0 to 120.0 deg C	PTM
MULE ESM ENCL(PRI)	P34T8102V	-60.0 to 80.0 deg C	PTM
MULE ESM ENCL(SEC)	P34T8105V	-60.0 to 80.0 deg C	PTM
MULE PDSU	P34T8119V	-30.0 to 60.0 deg C	PTM
MULE LOPE (PRI)	P34T8103V	-60.0 to 80.0 deg C	PTM
MULE LOPE (SEC)	P34T8106V	-60.0 to 80.0 deg C	PTM
MULE SOPE (PRI)	P34T8101V	-60.0 to 80.0 deg C	PTM
MULE SOPE (SEC)	P34T8104V	-60.0 to 80.0 deg C	PTM
SAC ASIPE AFT	P34T5219V	-60.0 to 80.0 deg C	PTM
SAC ASIPE B LATCH (A)	P34T6159V	-60.0 to 80.0 deg C	PTM
SAC ASIPE B LATCH (B)	P34T5207V	-60.0 to 80.0 deg C	PTM
SAC ASIPE FWD	P34T5220V	-60.0 to 80.0 deg C	PTM
SAC ASIPE LID(A)	P34T6158V	-60.0 to 80.0 deg C	PTM
SAC ASIPE LID(B)	P34T5212V	-60.0 to 80.0 deg C	PTM
SAC ASIPE PORT	P34T5211V	-60.0 to 80.0 deg C	PTM

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
SAC ASIPE STBD	P34T5210V	-60.0 to 80.0 deg C	PTM
SAC ENV PORT (A)	P34T5201V	-60.0 to 80.0 deg C	PTM
SAC ENV STBD (B)	P34T5214V	-60.0 to 80.0 deg C	PTM
SAC EPDSU-1	P34T5221V	-30.0 to 60.0 deg C	PTM
SAC EPDSU-2	P34T5205V	-30.0 to 60.0 deg C	PTM
SAC OPA AFT(A)	P34T5203V	-60.0 to 80.0 deg C	PTM
SAC OPA FWD(A)	P34T5202V	-60.0 to 80.0 deg C	PTM
SAC OPA MID(B)	P34T5215V	-60.0 to 80.0 deg C	PTM
SAC SAP AFT(A)	P34T5209V	-60.0 to 80.0 deg C	PTM
SAC SAP FWD(B)	P34T5218V	-60.0 to 80.0 deg C	PTM
SAC SAP PORT(B)	P34T5217V	-60.0 to 80.0 deg C	PTM
SAC SAP STBD(A)	P34T5204V	-60.0 to 80.0 deg C	PTM
SAC STRUCTURE(B)	P34T5213V	-60.0 to 80.0 deg C	PTM
SILL PORT X650	V34T1114A	-200 to 450 deg F	PTM
SILL STBD X650	V34T1120A	-200 to 450 deg F	PTM
SILL PORT X1030	V34T1116A	-200 to 450 deg F	PTM
SILL STBD X1030	V34T1122A	-200 to 450 deg F	PTM
SILL PORT X1215	V34T1118A	-200 to 450 deg F	PTM
SILL STBD X1215	V34T1124A	-200 to 450 deg F	PTM

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
POWER COMPS			
PPCU IN W	W34E2040D	0.0 to 4800.0 watts	UCB
TBS			
PPCU OUT W	W34E2140D	0.0 to 4800.0 watts	UCB
TBS			
SPCU IN W	W34E2041D	0.0 to 4800.0 watts	UCB
TBS			
SPCU OUT W	W34E2141D	0.0 to 4800.0 watts	UCB
TBS			
DPC AVG VOLT	W34V2020D	0.0 to 40.0 volts	UCB
TBS			
PCU OUT AMPS	W34C2020D	0.0 to 50.0 amps	UCB
TBS			
PCU/HST LOAD	W34U2000D	0.00 to 1.00 percent/100	UCB
TBS			
GPC PORT	W92X5500CK	0 = 'SEC(FLEX A'S)', 1 = 'PRI(FLEX B'S)'	UCB
	Normally GNC VP Slot 1 contains information on the port moding for the data buses. The status of the PL Buses is located in bit 6 (bit 1 being msb), this comp generates a discrete MSID from the VP slot 1 telemetry (V92X5500CX)		
ALT FMDM FSS	P34X2073Y	0 = 'OFF', 1 = 'ON'	PTM
	Status indication if alternate FMDM is powered on		
ALT FMDM MULE	P34X8403Y	0 = 'OFF', 1 = 'ON'	PTM
	Status indication if alternate FMDM is powered on		
MN B PL PRI	V76X2833E	0 = 'OFF', 1 = 'ON'	PTM
	Indicates that Main B bus is connected to payload primary bus		
MN B VOLTS	V76V0200A	0.0 40.0 volts	PTM
	Indicates Main B bus voltage		
MN B AMPS	V45C0201A	0.0 to 999 .0 amps	PTM
	Indicates current drawn by MN B bus from Fuel Cell 2. Measured on Fuel Cell ground leg		
MN C PL PRI	V76X2838E	0 = 'OFF', 1 = 'ON'	PTM
	Indicates that Main C bus is connected to payload primary bus		
MN C VOLTS	V76V0300A	0.0 40.0 volts	PTM
	Indicates Main C bus voltage		
MN C AMPS	V45C0301A	0.0 to 999 .0 amps	PTM
	Indicates current drawn by MN C bus from Fuel Cell 3. Measured on Fuel Cell ground leg		
FC 3 PL PRI	V76X2843E	0 = 'OFF', 1 = 'ON'	PTM
	Indicates that Fuel Cell 3 is connected to payload primary bus		
DPC TOT AMPS	SSESYS001	0.0 to 999.9 amps	UCB
	Comp calculates total current draw of DPCs		
DPC TOT WATTS	SSESYS002	0 to 9999 watts	UCB
	Comp calculates total power draw of DPCs		

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Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FSS TOT AMPS	SSESYS003	0.0 to 999.9 amps	UCB
Comp calculates total current draw of FSS			
FSS TOT WATTS	SSESYS004	0 to 9999 watts	UCB
Comp calculates total power draw of FSS			
MULE TOT AMPS	SSESYS005	0.0 to 999.9 amps	UCB
Comp calculates total current draw of MULE			
MULE TOT WATTS	SSESYS006	0 to 9999 watts	UCB
Comp calculates total power draw of MULE			
SAC TOT AMPS	P34C5206V	0.0 to 999.9 amps	PTM
Comp calculates total current draw of SAC			
SAC TOT WATTS	SSESYS008	0 to 9999 watts	UCB
Comp calculates total power draw of SAC			
SSE TOT AMPS	SSESYS009	0.0 to 9999.9 amps	UCB
Comp calculates total current draw of SSE			
SSE TOT WATTS	SSESYS010	0 to 9999 watts	UCB
Comp calculates total power draw of SSE			
STS MECH SYSTEM 1			
AC1 PHASE A AMPS	V76C1540A	0.0 to 20.0 amps	PTM
AC1 phase A current. All FSS mechanisms are driven by 3-phase motors			
AC1 PHASE B AMPS	V76C1541A	0.0 to 20.0 amps	PTM
AC1 phase B current. All FSS mechanisms are driven by 3-phase motors			
AC1 PHASE C AMPS	V76C1542A	0.0 to 20.0 amps	PTM
AC1 phase C current. All FSS mechanisms are driven by 3-phase motors			
MECH PWR 1	V76S2875E	0 = 'OFF', 1 = 'ON' (yellow)	PTM
Indicates whether the PL BAY MECH PWR switch (PNL R13A2, S1) is in the on or off position. This switch provides down stream power to PAYLOAD 1 CONTROL logic which closes both the K80 and K84 relays			
LOGIC PWR 1	V54S8424E	0 = 'OFF', 1 = 'ON' (yellow)	PTM
Indicates whether LOGIC POWER has been supplied to the control/driver in the PAYLOAD 1 CONTROL logic			
PLD SEL POS	PWRSELECT	blank, 'PL1', 'PL2', 'PL3', 'MON'	UCB
Indicates the position of the payload retention system rotary select switch on the A6U panel. Refer to PAYLOAD SUPPORT writeup for a description of the comp			
A6U S36	SSEMECH25	0 = 'MID' 1 = 'LAT' (yellow) 2 = 'REL' (yellow) 3 ='ERR' (red)	UCB
Indicates the position of the PAYLOAD RETENTION LATCH switch (S36). The crew uses this switch to control FSS mechanisms. For example, if mechanism 3 (PIVOT LO) was selected via the SM GPC, the crew would take the PAYLOAD RETENTION LATCH switch to either LAT or REL to command the BAPS to pivot up or down. Refer to SSE MECH writeup for a description of the comp			

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
K80 (AC ENA 1) STATUS	V76X2161E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K84 and K34 or K46 are the other relays that must be closed to provide downstream 3-phase power		
K84 (AC ENA 2) STATUS	V76X2162E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K80 and K34 or K46 are the other relays that must be closed to provide downstream 3-phase power		
K46 (LAT-OP STAT 6) STATUS	V76X2216E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K80 and K84 are the other relays that must be closed to provide downstream 3-phase power		
K34 (REL-OP STAT 5) STATUS	V76X2215E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K80 and K84 are the other relays that must be closed to provide downstream 3-phase power		
STS MECH SYSTEM 2			
AC2 PHASE A AMPS	V76C1640A	0.0 to 20.0 amps	PTM
	AC2 phase A current. All FSS mechanisms are driven by 3-phase motors		
AC2 PHASE B AMPS	V76C1641A	0.0 to 20.0 amps	PTM
	AC2 phase B current. All FSS mechanisms are driven by 3-phase motors		
AC2 PHASE C AMPS	V76C1642A	0.0 to 20.0 amps	PTM
	AC2 phase C current. All FSS mechanisms are driven by 3-phase motors		
MECH PWR 2	V76S2878E	0 = 'OFF', 1 = 'ON' (yellow)	PTM
	Indicates whether the PL BAY MECH PWR switch (PNL R13A2, S2) is in the on or off position. This switch provides down stream power to PAYLOAD 2 CONTROL logic which closes both the K65 and K77 relays		
LOGIC PWR 2	V54S8425E	0 = 'OFF', 1 = 'ON' (yellow)	PTM
	Indicates whether LOGIC POWER has been supplied to the control/driver in the PAYLOAD 2 CONTROL logic		
PLD SEL POS	PWRSELECT	blank, 'PL1', 'PL2', 'PL3', 'MON'	UCB
	Indicates the position of the payload retention system rotary select switch on the A6U panel. Refer to PAYLOAD SUPPORT writeup for a description of the comp		

Verify that this is the correct version before use

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT		SRC
A6U S42	SSEMECH28	0 = 'MID'	1 = 'LAT' (yellow)	UCB
		2 = 'REL' (yellow)	3 ='ERR' (red)	
	Indicates the position of the PAYLOAD RETENTION LATCH (S42) switch. The crew uses this switch to control FSS mechanisms. For example, if mechanism 3 (PIVOT LO) was selected via the SM GPC, the crew would take the PAYLOAD RETENTION LATCH switch to either LAT or REL to command the BAPS to pivot up or down. Refer to SSE MECH writeup for a description of the comp			
K65 (AC ENA 1) STATUS	V76X2183E	0 = 'ENA' (yellow), 1 = 'DIS'		PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K77 and K34 or K32 are the other relays that must be closed to provide downstream 3-phase power			
K77 (AC ENA 2) STATUS	V76X2184E	0 = 'ENA' (yellow), 1 = 'DIS'		PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K65 and K34 or K32 are the other relays that must be closed to provide downstream 3-phase power			
K32 (LAT-OP STAT 2) STATUS	V76X2232E	0 = 'ENA' (yellow), 1 = 'DIS'		PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K65 and K77 are the other relays that must be closed to provide downstream 3-phase power			
K34 (REL-OP STAT 1) STATUS	V76X2231E	0 = 'ENA' (yellow), 1 = 'DIS'		PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K65 and K77 are the other relays that must be closed to provide downstream 3-phase power			
FMDM STATUS				
FSS LR BYP	V92X0343X	0 = blank, 1 ='*' (red)		PTM
MULE LR BYP	V92X0345X	0 = blank, 1 ='*' (red)		PTM
	A Low-Rate Bypass indicates that an error occurred (on two consecutive transactions to the same element) during the SM read cycles and that specific element has been bypassed. This would indicate that the SM is no longer receiving telemetry from 1 or more cards. The I/O Error ID and EL will indentify the suspect card. The telemetry from the suspect card will be static			
FSS WRAP ERR	V92X0342X	0 = blank, 1 ='*' (red)		PTM
MULE WRAP ERR	V92X0344X	0 = blank, 1 ='*' (red)		PTM

Verify that this is the correct version before use

Table 6-7. SSE systems description (concluded)

BACKGROUND	MSID	TEXT	SRC
	A WRAP Error indicates an error with FMDM communciation and all read transactions have been bypassed. The FMDM telemetry will be static and is not valid		
I/O ERROR ID 1	V92J4326CX	00 to 99 decimal	PTM
I/O ERROR ID 2	V92J4403CX	00 to 99 decimal	PTM
I/O ERROR ID 3	V92J4480CX	00 to 99 decimal	PTM
I/O ERROR ID 4	V92J4553CX	00 to 99 decimal	PTM
I/O ERROR ID 5	V92J4623CX	00 to 99 decimal	PTM
	The Transaction Identifier identifies the unique device or transaction corresponding to the failed I/O transfer. The following ID's are of interest to payload operations: 51 = PL Hi rate read, 52 = PL Lo rate read, 53 = FSS FMDM read, and 54 = MULE FMDM read		
I/O ERROR EL 1	V92J4325CX	000 to 999 decimal	PTM
I/O ERROR EL 2	V92J4402CX	000 to 999 decimal	PTM
I/O ERROR EL 3	V92J4479CX	000 to 999 decimal	PTM
I/O ERROR EL 4	V92J4552CX	000 to 999 decimal	PTM
I/O ERROR EL 5	V92J4622CX	000 to 999 decimal	PTM
	The Element number indenfies the specific card bypassed for the specified transaction ID. The following EL's are applicable for STS-109:		
I/O ERROR TIME 1	V92M4389PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 2	V92M4467PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 3	V92M4544PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 4	V92M4617PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 5	V92M4697PX	ddd/hh:mm:ss	PTM
	The time is the onboard generated time of when the SM GPC detected the error. The downlink value is in hours		

COMPS:

CETSTART0 – Calculates start time of mechanism motion, based on the Mid MCA OPS Stats.

Comp TBS.

CECHRUNTM – Calculates run time of a mechanism based on the Mid MCA OPS Stats.

Comp TBS.

W34E2040D/W34E2041D – Calculates power into PCUs.

TEMP1 = P34C2008V + P34C2009V + P34C2010V + P34C2011V +P34C2012V + P34C2013V
TEMP2 = P34C2014V + P34C2015V + P34C2016V + P34C2017V +P34C2018V + P34C2019V
W34E2040D = P34V2040V * TEMP1

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W34E2041D = P34V2041V * TEMP2

W34E2140D/W34E2141D – Calculates power out of PCUs. Uses a dissipation loss of 25 watts and and efficiency of 0.88.

W34E2140D = (W34E2040D – 25) * 0.88
W34E2141D = (W34E2041D – 25) * 0.88

W34V2020D – Calculates average voltage of DPCs.

W34V2020D = (P34V2028V + P34V2029V + P34V2030V + P34V2031V + P34V2032V + P34V2033V + P34V2034V + P34V2035V + P34V2036V + P34V2037V + P34V2038V + P34V2039V)/12

W34C2020D – Calculates total current output by the PCU's for use by the HST after accounting for line loses.

if (P34V2020D > 0.0) then
    W34C2020D = (W34E2141D + W34E2140D) / W34V2020D
else
    W34C2020D = 0.0

W34U2000D – Calculates total fraction of power that the SSE is supplying ot HST.

if (P34C3060A > 0.0)
    W34U2000D = W34C2020D / P34C3060A
else
    W34U2000D = 0.0

SSESYS001/SSESYS002 – Calculates current and power draw of DPCs.

SSESYS001 = TEMP1 + TEMP2
SSESYS002 = (TEMP1 * P34V2040V) + (TEMP2 * P34V2041V)

SSESYS003/SSESYS004 – Calculates current and power draw of FSS.

SSESYS003 = P34C2113V + P34C2116V
SSESYS004 = (P34C2113V * P34V2040V) + (P34C2116V * P34V2041V)

SSESYS005/SSESYS006 – Calculates current and power draw of MULE.

SSESYS005 = P34C8107V + P34C8109V +P34C8110V + P34C8111V + P34C8112V + P34C8113V + P34C8114V + P34C8115V + P34C8116V + P34C8117V
SSESYS006 = SSESYS005 * P34V8122V

SSESYS008 – Calculates power draw of SAC.

SSESYS008 = P34C5206V * P34V5208V

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SSESYS009/SSESYS010 – Calculates current and power draw of SSE.

SSESYS009 = SSESYS003 + SSESYS005 + P34C5206V
SSESYS010 = SSESYS004 + SSESYS006 + SSESYS008

6.3.2   SSE Mechanical Display Description
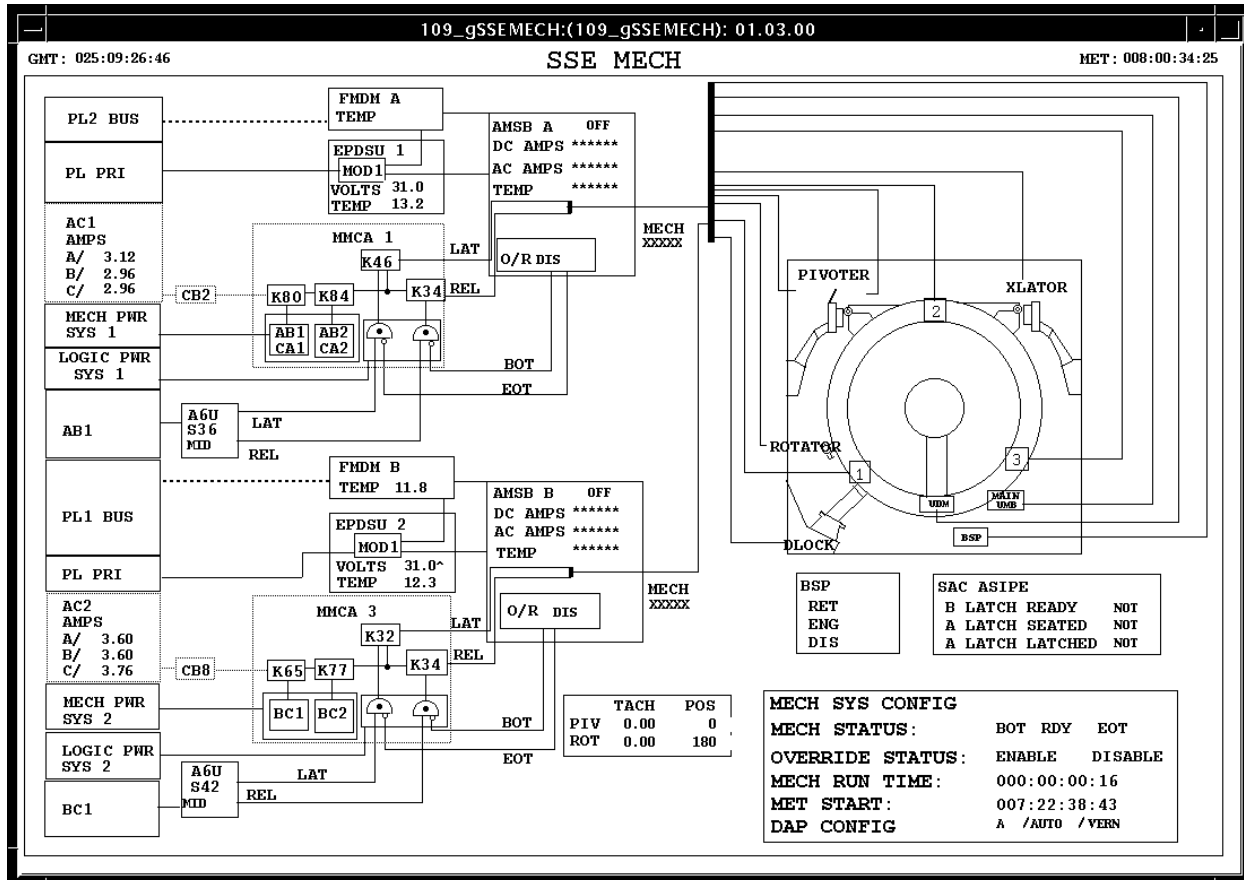
Figure 6-8. SSE mechanical display

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Table 6-8. SSE mechanical description

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
Mechanism Side A (top left of display)			
PL2 box/text + lines to FMDM A	W92X5500CK	0 = green,1 = gray	UCB
Indicates that SM GPC communication is active on the secondary ports (PL2 to FMDM A). Refer to SSE FMDM section for a description of the comp			
FMDM A box/text + line from MOD1 + MOD1 box/text	P34T2001V	<-50 = gray, >50 = red, else green	PTM
Indicates power state of FMDM A, based on temperature. Red indication used for over temp condition			
FMDM A TEMP	P34T2001V	-55.0 to 120.0 deg C	PTM
FMDM A temperature, when powered off temperature will read -55.0 deg C			
PL PRI box/text + line to EPDSU 1	SSEPWR006C	0 = gray, 1 = green	PTM
Indicates that PL PRI is receiving power from at least one orbiter power feed. EPDSU 1 will receive power when PL PRI is on. Refer to SSE POWER display description for information on the comp			
EPDSU 1 box/text	P34V2040V	<24 = gray, >32 = red, else green	PTM
Indicates status of power from payload primary to EPDSU-1 based on EPDSU-1 bus voltage			
EPDSU 1 VOLTS	P34V2040V	0.0 to 40.0 volts	PTM
EPDSU 1 voltage			
EPDSU 1 TEMP	P34T2004V	-55.0 to 124.0 deg C	PTM
EPDSU 1 temperature			
AC1 box/text + line + CB2 box/text + line + MMCA 1 box/text	SSEMECH05	1 = gray 2 = red 3 = yellow 4 = green	UCB
Comp determines status of AC phase input statuses. If all 3 phases are ON, line will be green, 2 phases will be displayed in yellow, 1 phase will be displayed in red, and all phases off will be gray			
AC1 AMPS A	V76C1540A	0.0 to 20.0 amps	PTM
AC1 phase A current			
AC1 AMPS B	V76C1541A	0.0 to 20.0 amps	PTM
AC1 phase B current			
AC1 AMPS C	V76C1542A	0.0 to 20.0 amps	PTM
AC1 phase C current			
MECH PWR SYS 1 box/text + line + box around AB1/CA1 & AB2/CA2	V76S2875E	0 = gray, 1 = green	PTM
Indicates mechanical power has been applied to system 1, based on switch status			
LOGIC PWR SYS 1 box/text + line + box around logic gates	V54S8424E	0 = gray, 1 = green	PTM
Indicates logic power has been applied to system 1, based on switch status			

Verify that this is the correct version before use

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
AB1 box/text + line + A6U S36 box/text	V76V0120A	>24..0 = green, else gray	PTM
Indicates control AB1 power is active			
AB1 CA1 box/text + line to K80 box	SSEMECH31	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K80. For power to be available, mech power 1 must be on and at least 1 of the 2 control buses showing nominal voltage. If both voltages are over 32 volts, the line will be red			
AB2 CA2 box/text + line to K84 box	SSEMECH32	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K84. For power to be available, mech power 1 must be on and at least 1 of the 2 control buses showing nominal voltage. If both voltages are over 32 volts, the line will be red			
K80 box + line to K84	SSEMECH33	1 = gray, 4 = green	UCB
Indicates power is available to K80, AC1 power is on, and AC1 PBM/PBD power is enabled. Note that the PBM & PBD statuses are OR'd together, so that the activation of either relay will indicate the two buses are enabled			
K84 box + lines to K46 and K34	SSEMECH34	1 = gray, 4 = green	UCB
Indicates power is available to K84 and AC1 PBM/PBD power is enabled and ON. Note that the PBM & PBD statuses are OR'd together, so that the activation of either relay will indicate the two buses are ON			
A6U S36	SSEMECH25	0 = 'MID' 1 = 'LAT' 2 = 'REL' 3 = 'ERR' (red)	UCB
Status of S36 switch on A6U, ERR indicates both latch and release indications are present			
Lat line and word 'LAT' out of A6U S36 to logic gate	V54S8402E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to LATCH			
Rel line and word 'REL' out of A6U S36 to logic gate	V54S8400E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to RELEASE			
AMSB A EOT line to logic gate in MMCA 1 + logic gate inverter + 'EOT' text	SSEMECH38	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the EOT microswitch (latch side of logic), note power to AMSB must be on for indication			
AMSB A BOT line to logic gate in MMCA 1 + logic gate inverter + 'BOT' text	SSEMECH39	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the BOT microswitch (release side of logic), note power to AMSB must be on for indication			

Verify that this is the correct version before use

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
Lat logic gate + line to K46 box in MMCA 1	SSEMECH40	0 = green, 1 = gray	UCB
Indicates that latch position has been selected on switch and EOT has not been reached, or that the limit switch override is active			
Rel logic gate + line to K34 box in MMCA 1	SSEMECH41	0 = green, 1 = gray	UCB
Indicates that release position has been selected on switch and BOT has not been reached, or that the limit switch override is active			
MMCA 1 K46 box + line into AMSB A to the bus + LAT text	SSEMECH42	default = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the latch direction (Side A). Comp verifies power is available, command has been sent, and EOT has not been reached			
MMCA 1 K34 box + line into AMSB A to the bus + REL text	SSEMECH43	default = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the release direction (Side A). Comp verifies power is available, command has been sent, and BOT has not been reached			
AMSB A box + text in AMSB A + line from MOD1 + line from FMDM A	P34X2076Y	0 = gray, 1 = green	PTM
Indicates AMSB A has been powered, based on AMSB A power status			
AMSB A	P34X2076Y	0 = 'OFF', 1 = 'ON'	PTM
Indicates that AMSB A has been commanded on.			
AMSB A DC AMPS	SSEMECH45	-1.00 to 5.00 amps	UCB
Indicates the direct current draw of AMSB A. If AMSB A is off, current will read ******			
AMSB A AC AMPS	SSEMECH44	0.00 to 5.00 amps	UCB
Indicates the alternating current draw of AMSB A. If AMSB A is off, current will read ******			
AMSB A TEMP	SSEMECH46	-30.0 to 60.0	UCB
Indicates temperature of AMSB A. If AMSB A is off, tempature will read ******			
AMSB A O/R text (ENA/DIS) and O/R box	SSEMECH37	Text: 1 = 'ENA' (yellow), 0 = 'DIS' Box: 1 = yellow, 0 = white	UCB
Indicates status of AMSB O/R, will be yellow if AMSB is powered and override is enabled			
AMSB A interior bus + line to large bus	SSEMECH97	default = gray, 4 = green, 5 = yellow	UCB
Indicates when mechanism has been selected and power has been provided to the mechanism from AMSB A. If AMSB A on and any mechanism is selected but the latch or release has not been commanded, then the line will show yellow indicating the mechanism will drive when the command is issued. The lines will turn green when the command is issued			
AMSB A MECH	SSEMECH95	'XXXX ' or 'DRIVE' or 'SEL '	UCB
Indicates when a mechanism is being driven or is just selected by AMSB A. Note that if a latch or release command is received when no mechanism is selected then you will receive a drive status but the lines from the AMSB will remain gray			

Verify that this is the correct version before use

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
Mechanism Side B (bottom left of display)			
PL1 box/text + lines to FMDM B	W92X5500CK	0 = gray, 1 = green	UCB
Indicates the SM GPC coomunication is active on the primary ports (PL1 to FMDM B). Refer to SSE FMDM section for a description of the comp			
FMDM B box/text + line from MOD1 + MOD1 box/text	P34T2002V	<-50 = gray, >50 = red, else green	PTM
Indicates status of FMDM B, based on temperature			
FMDM B TEMP	P34T2002V	-55.0 to 120.0 deg C	PTM
FMDM B temperature, when powered off temperature will read -55.0 deg C			
PL PRI box/text + line to EPDSU 2	SSEPWR006C	0 = gray, 1 = green	PTM
Indicates that at least one orbiter power feed is connected to PL PRI. Refer to SSE POWER section for a description of the comp			
EPDSU 2 box/text	P34V2041V	<24 = gray, >32 = red, else green	PTM
Indicates status of power from payload primary to EPDSU-2 based on EPDSU-2 bus voltage			
EPDSU 2 VOLTS	P34V2041V	0.0 to 40.0 volts	PTM
Indicates voltage from EPDSU 2			
EPDSU 2 TEMPERATURE	P34T2007V	-55.0 to 124.0 deg C	PTM
Indicates temperature of EPDSU 2			
AC2 box/text + line + CB8 box/text + line + MMCA 3 box/text	SSEMECH14	1 = gray 2 = red 3 = yellow 4 = green	UCB
Comp determines status of AC phase input statuses. If all 3 phases are ON, line will be green, 2 phases will be displayed in yellow, 1 phase will be displayed in red, and all phases off will be gray			
AC2 AMPS A	V76C1640A	0.0 to 20.0 amps	PTM
AC2 phase A current			
AC2 AMPS B	V76C1641A	0.0 to 20.0 amps	PTM
AC2 phase B current			
AC2 AMPS C	V76C1642A	0.0 to 20.0 amps	PTM
AC2 phase C current			
MECH PWR SYS 2 box/text + line + box around BC1 & BC2	V76S2878E	0 = gray, 1 = green	PTM
Indicates mechanical power has been applied to system 2, based on switch status			
LOGIC PWR SYS 2 box/text + line + box around logic gates	V54S8425E	0 = gray, 1 = green	PTM
Indicates logic power has been applied to system 2, based on switch status			
BC1 box/text/ + line + A6U S42 box/text	V76V0220A	>24.0 = green, else gray	PTM
Indicates control BC1 power is active			

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Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
BC1 box/text + line to K65 box	SSEMECH35	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K65. For power to be available, mech power 2 must be on and control bus showing nominal voltage. If voltage is over 32 volts, the line will be red			
BC2 box/text + line to K77 box	SSEMECH36	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K77. For power to be available, mech power 2 must be on and control bus showing nominal voltage. If voltage is over 32 volts, the line will be red			
K65 box + line to K77	SSEMECH68	1 = gray, 4 = green	UCB
Indicates power is available to K65, AC2 power is ON, and AC1 PBM power is enabled			
K77 box + lines to K32 and K34	SSEMECH69	1 = gray, 4 = green	UCB
Indicates power is available to K77 and AC2 PBM power is enabled and ON			
A6U S42	SSEMECH28	0 = 'MID' 1 = 'LAT' 2 = 'REL' 3 = 'ERR' (red)	UCB
Status of S36 switch on A6U, ERR indicates both latch and release indications are present			
Lat line and word 'LAT' out of A6U S42 to logic gate	V54S8406E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to LATCH			
Rel line and word 'REL' out of A6U S42 to logic gate	V54S8404E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to RELEASE			
AMSB B EOT line to logic gate in MMCA 3 + logic gate inverter + 'EOT' text	SSEMECH72	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the EOT microswitch (latch side of logic), note power to AMSB must be on for indication			
AMSB B BOT line to logic gate in MMCA 3 + logic gate inverter + 'BOT' text	SSEMECH73	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the BOT microswitch (release side of logic), note power to AMSB must be on for indication			
Lat logic gate + line to K32 box in MMCA 3	SSEMECH74	0 = green, 1 = gray	UCB
Indicates that latch position has been selected on switch and EOT has not been reached, or that the limit switch override is active			
Rel logic gate + line to K34 box in MMCA 3	SSEMECH75	0 = green, 1 = gray	UCB
Indicates that latch position has been selected on switch and BOT has not been reached, or that the limit switch override is active			
MMCA 1 K32 box + line into AMSB B to the bus + LAT text	SSEMECH76	1 = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the latch direction (side B). Comp verifies power is available, command has been sent, and EOT has not been reached			

Verify that this is the correct version before use

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
MMCA 3 K34 box + linto into AMSB B to the bus + REL text	SSEMECH77	1 = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the release direction (side B). Comp verifies power is available, command has been sent, and BOT has not been reached			
AMSB B box + text in AMSB B + line from MOD1 + line from FMDM B	P34X2077Y	0 = gray, 1 = green	PTM
Indicates when AMSB B has been powered			
AMSB B	P34X2077Y	0 = 'OFF', 1 = 'ON'	PTM
Indicates that AMSB B has been commanded on			
AMSB B DC AMPS	SSEMECH78	-1.00 to 5.00 amps	UCB
Indicates the direct current draw of AMSB B. If AMSB B is off, current will read ******			
AMSB B AC AMPS	SSEMECH81	0.00 to 5.00 amps	UCB
Indicates the alternating current draw of AMSB B. If AMSB B is off, current will read ******			
AMSB B TEMP	SSEMECH79	-30.0 to 60.0	UCB
Indicates temperature of AMSB B. If AMSB B is off, tempature will read ******			
AMSB B O/R text (ENA/DIS) and O/R box	SSEMECH71	Text: 1 = 'ENA' (yellow), 0 = 'DIS' Box: 1 = yellow, 0 = white	UCB
Indicates status of AMSB O/R, will be yellow if AMSB is powered and override is enabled			
AMSB B interior bus + line to large bus	SSEMECH99	default = gray, 4 = green, 5 = yellow	UCB
Indicates when mechanism has been selected and power has been provided to the mechanism from AMSB B. If AMSB B on and any mechanism is selected but the latch or release has not been commanded, then the line will show yellow indicating the mechanism will drive when the command is issued. The lines will turn green when the command is issued			
AMSB B MECH	SSEMECH96	'XXXX ' or 'DRIVE' or 'SEL '	UCB
Indicates when a mechanism is being driven or is just selected by AMSB B. Note that if a latch or release command is received when no mechanism is selected then you will receive a drive status but the lines from the AMSB will remain gray			
Command Mechanism Elements (right side of display)			
PIV TACH	P34R2108V	0.0 to 5.30 deg/min	PTM
From CDU motor, for dual motor operations, tach will not increase since it is measured at the motor shaft, not the output shaft			
PIV POS	SSEMECH85	-5 to 99 deg	UCB
Based on comp that integrates position based on tach when pivoter is active and A6U switch position. In LAT position, tach is added; in REL position, tach is subtracted			
ROT TACH	P34R2109V	0.0 to 18.0 deg/min	PTM
From CDU motor, for dual motor operations, tach will not increase since it is measured at the motor shaft, not the output shaft			
ROT POS	SSEMECH86	-360 to 360 deg	UCB
Based on comp that integrates position based on tach when pivoter is active and A6U switch position. In LAT position, tach is added; in REL position, tach is subtracted			

Verify that this is the correct version before use

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
Large mechanism bus	SSEMECH06	default = gray, 4 = green, 5 = yellow	UCB
Yellow indicates a mechanism is selected and green indicates power is flowing			
DLOCK text + lines from bus	SSEMECH47	default = gray, 4 = green, 5 = yellow	UCB
Indicates when DLOCK is selected (yelow) and active (green)			
PIVOTER text + HI text + lines from bus	SSEMECH48	Lines: default = gray, 4 = green, 5 = yellow HI/LOW: default = blank, 4 & 5 = 'HI' (white)	UCB
Indicates when PIVOTER HI is selected (yellow) and active (green)			
PIVOTER text + LOW text + lines from bus	SSEMECH49	Lines: default = gray, 4 = green, 5 = yellow HI/LOW: default = blank, 4 & 5 = 'LOW' (white)	UCB
Indicates when PIVOTER LOW is selected (yellow) and active (green)			
ROTATOR text + lines from bus	SSEMECH50	default = gray, 4 = green, 5 = yellow	UCB
Indicates when ROTATOR is selected (yellow) and active (green)			
XLATOR text + lines from bus	SSEMECH51	default = gray, 4 = green, 5 = yellow	UCB
Indicates when XLATOR is selected (yellow) and active (green)			
Berth latch 1 box/text + lines from bus	SSEMECH52	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Berthing Latch 1 is selected (yellow) and active (green)			
Berth latch 2 box/text + lines from bus	SSEMECH53	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Berthing Latch 2 is selected (yellow) and active (green)			
Berth latch 3 box/text + lines from bus	SSEMECH54	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Berthing Latch 3 is selected (yellow) and active (green)			
MAIN UMB box/text + lines from bus	SSEMECH55	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Main Umbilical is selected (yellow) and active (green)			
UDM box/text + lines from bus	SSEMECH56	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Backup Umbilical is selected (yellow) and active (green)			
BSP box/text + lines from bus	SSEMECH80	default = gray, 4 = green, 5 = yellow	UCB
Indicates when BAPS Support Post is selected (yellow) and active (green)			
BSP RET	SSECON022	blank, RETA, RETB, RET*	UCB
ENG	SSECON023	blank, ENGA, ENGB, ENG*	UCB
DIS	SSECON024	blank, DISA, DISB, DIS*	UCB
Indicates whether the BSP is retracted, engaged, or disengaged. Refer to SPEC 212 SSE Mechanisms section for a description of the comp			
SAC ASIPE			
B LATCH READY	P34X6133Y	0 = 'NOT', 1 = 'RDY'	PTM
Indicates when the ASIPE B latch is ready for engagement			
A LACTH SEATED	P34X6134Y	0 = ' NOT', 1 = 'SEAT'	PTM
Indicates when the ASIPE A latch is seated			

Verify that this is the correct version before use

Table 6-8. SSE mechanical description (concluded)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
A LATCH LATCHED	P34X6135Y	0 = ' NOT', 1 = 'LTCH'	PTM
Indicates when the ASIPE A latch is latched			
MECH SYS CONFIG TEXT	SSEMECH94	0 = blank, 1 = A , 2 = B, 3 = DM (red)	UCB
Indicates the configuration of the mech system (i.e. which AMSB is being used or if dual mechanisms are being operated)			
MECH STATUS 'BOT' text	SSEMECH61	default = gray, 0 = green, 2 = red	UCB
Indicates if the BOT has been reached, red is used if both BOT and EOT are indicated			
MECH STATUS 'RDY' text	SSEMECH63	default = gray, 0 = green	UCB
Indicates if the mechanism is ready to be operated			
MECH STATUS 'EOT' text	SSEMECH62	default = gray, 0 = green, 2 = red	UCB
Indicates if the EOT has been reached, red is used if both BOT and EOT are indicated			
OVERRIDE STATUS 'ENABLE' text	P34X2072Y	0 = green, 1 = gray	PTM
Indicates if the mechanism override is enabled			
OVERRIDE STATUS 'DISABLE' text	P34X2072Y	0 = gray, 1 = green	PTM
Indicates if the mechanism override is disabled			
MECH RUN TIME	CECHRUNTM	mm:ss	UCB
MET START TIME	CETSTART0	ddd:hh:mm:ss	UCB
SELECT (not annotated)	DAPSELECT=		UCB
	V72X2807X	0 = blank, 1 = 'A'	PTM
	V72X2808X	0 = blank, 1 = 'B'	PTM
Displays the current load for which the DAP is configured, A or B			
MODE (not annotated)	DAPMODEXX=		UCB
	V72X2850X	0 = blank, 1 = 'AUTO'	PTM
	V72X2849X	0 = blank, 1 = 'INRT'	PTM
	V72X2868X	0 = blank, 1 = 'LVLH'	PTM
	V72X2897X	0 = blank, 1 = 'FREE'	PTM
Indicates the current mode configuration of the DAP: auto, inertial, local vertical local horizontal, or free drift			
RCS (not annotated)	DAPJETSLCT=		UCB
	V72X2855X	0 = blank, 1 = 'PRIM'	PTM
	V72X2856X	0 = blank, 1 = 'VERN'	PTM
	V72X2896X	0 = blank, 1 = 'ALT'	PTM
Displays which mode of RCS jets is selected: primary, vernier, or alternate			

COMPS:

CECHRUNTM – ELAPSED RUN TIME - This comp calculates the run time of a mechanism based on the Mid MCA OPS statuses.

Verify that this is the correct version before use

CETSTART0 – START TIME - This comp calculates the start time of a mechanism base on the Mid MCA OPS statuses.

SSEMECH05 – Used to provide color indication of status of AC1 Bus, off (1=gray), 1 phase on (2=red), 2 phases on (3=yellow), 3 phases on (4=green).

MSID									
V76X1537E	AC BUS 1 PH A INPUT ON	0	0	0	0	1	1	1	1
V76X1538E	AC BUS 1 PH B INPUT ON	0	0	1	1	0	0	1	1
V76X1539E	AC BUS 1 PH C INPUT ON	0	1	0	1	0	1	0	1
	SSEMECH05 =	1	2	2	3	2	3	3	4

SSEMECH06 – Used to provide color for the mechanism bus, if either side has a mechanism driving, it will be green. If either side has a mechanism selected, but the other side is not driving, then it will be yellow.

```
    if (SSEMECH97 = 4 or SSEMECH99 = 4) then
        SSEMECH06 = 4
    else if (SSEMECH97 = 5 or SSEMECH99 = 5) then
        SSEMECH06 = 5
    else
        SSEMECH06 = 1
```

SSEMECH14 – Used to provide color indication of status of AC2 Bus, off (1=gray), 1 phase on (2=red), 2 phases on (3=yellow), 3 phases on (4=green).

MSID									
V76X1637E	AC BUS 2 PH A INPUT ON	0	0	0	0	1	1	1	1
V76X1638E	AC BUS 2 PH B INPUT ON	0	0	1	1	0	0	1	1
V76X1639E	AC BUS 2 PH C INPUT ON	0	1	0	1	0	1	0	1
	SSEMECH14 =	1	2	2	3	2	3	3	4

SSEMECH25 - A6U S36 - This comp identifies the position of switch 1 of the payload retention system on panel A6U.

MSID	NOMENCLATURE				
V54S8400E	PL LAT 1 REL CMD	0	0	1	1
V54S8402E	PL LAT 1 LAT CMD	0	1	0	1
	SSEMECH25 =	0	1	2	3

Verify that this is the correct version before use

SSEMECH28 - A6U S42 - This comp identifies the position of switch 2 of the payload retention system on panel A6U.

MSID	NOMENCLATURE				
V54S8404E	PL LAT 2 REL CMD	0	0	1	1
V54S8406E	PL LAT 2 LAT CMD	0	1	0	1
	SSEMECH28 =	0	1	2	3

SSEMECH31 - Indicates the power status of relay K80 in MMCA 1.

    if V76S2875E = 1 then
        if (V76V0120A >= 24.0 and V76V0120A <= 32.0) then SSEMECH31 = 0
        else if (V76V0320A >= 24.0 and V76V0320A <= 32.0) then SSEMECH31 = 0
        else if (V76V0120A < 24.0 and V76V0320A < 24.0) then SSEMECH31 = 1
        else if (V76V0120A > 32.0 and V76V0320A > 32.0) then SSEMECH31 = 2
        else SSEMECH31=2
    else SSEMECH31 = 1

SSEMECH32 - Indicates the power status of relay K84 in MMCA 1.

    if V76S2875E = 1 then
        if (V76V0121A >= 24.0 and V76V0121A <= 32.0) then SSEMECH32 = 0
        else if (V76V0321A >= 24.0 and V76V0321A <= 32.0) then SSEMECH32 = 0
        else if (V76V0121A < 24.0 and V76V0321A < 24.0) then SSEMECH32 = 1
        else if (V76V0121A > 32.0 and V76V0321A > 32.0) then SSEMECH32 = 2
        else SSEMECH32=2
    else SSEMECH32 = 1

SSEMECH33 - Indicates MID MCA 1 PBD/PBM power bus is enabled is zero and all required power is on.

    if ((SSEMECH05 = 3 or SSEMECH05 = 4) and SSEMECH31 = 0
        and V76X2161E = 0) then
        SSEMECH33 = 4
    else SSEMECH33 = 1

SSEMECH34 - Indicates MID MCA 1 PBD/PBM power bus is enabled and on, and all required power is on.

    if (SSEMECH32 = 0 and SSEMECH33 = 4 and V76X2162E = 0)
        then
        SSEMECH34 = 4
    else SSEMECH34 = 1

Verify that this is the correct version before use

SSEMECH35 - Indicates the power status of K65 in MMCA 3.

    if (V76S2878E = 1) then
        if (V76V0220A < 24.0) then SSEMECH35 = 1
        else if (V76V0220A > 32.0) then SSEMECH35 = 2
        else SSEMECH35=0
    else SSEMECH35 = 1

SSEMECH36 - Indicates the power status of K77 in MMCA 3.

    if (V76S2878E = 1) then
        if (V76V0221A < 24.0) then SSEMECH36 = 1
        else if (V76V0221A > 32.0) then SSEMECH36 = 2
        else SSEMECH36=0
    else SSEMECH36 = 1

SSEMECH37 - Indicates status of AMSB A override.

    if (P34X2076Y = 1 and P34X2072Y = 0) then SSEMECH37 = 1
        else SSEMECH37 = 0

SSEMECH38 - Indicates that the AMSB A mechanism has tripped the EOT microswitch (latch).

    if (P34X2076Y = 1 and P34X2087Y = 1) then SSEMECH38 = 3
        else SSEMECH38 = 1

SSEMECH39 - Indicates that the AMSB A mechanism has tripped the BOT microswitch (release).

    if (P34X2076Y = 1 and P34X2089Y = 1) then SSEMECH39 = 3
        else SSEMECH39 = 1

SSEMECH40 - Indicates that latch position has been selected on switch and EOT has not been reached.

    if (V54S8402E = 1 and SSEMECH38 = 1) then SSEMECH40 = 0
        else SSEMECH40 = 1

SSEMECH41 - Indicates that release position has been selected on switch and BOT has not been reached.

    if (V54S8400E = 1 and SSEMECH39 = 1) then SSEMECH41 = 0
        else SSEMECH41 = 1

SSEMECH42 - Indicates when system is driving a mechanism in the latch direction.

    if (SSEMECH34 = 4 and SSEMECH40 = 0) then SSEMECH42 = 4
        else SSEMECH42 = 1

Verify that this is the correct version before use

SSEMECH43 - Indicates when system is driving a mechanism in the release direction.

    if (SSEMECH34 = 4 and SSEMECH41 = 0) then SSEMECH43 = 4
        else SSEMECH43 = 1

SSEMECH44/SSEMECH45/SSEMECH46 – AMSB A and B use the same telemetry MSID's therefore this comp verifies AMSB A active before display data, otherwise the data will be displayed as overflow indicating that AMSB A is off.

    if (P34X2076Y = 1) then
        SSEMECH44 = P34C2111V
        SSEMECH45 = P34C2025V
        SSEMECH46 = P34T2003V
    else
        SSEMECH44 = 999999
        SSEMECH45 = 999999
        SSEMECH46 = 999999

SSEMECH47 - Indicates when pivoter lock has been selected and whether the mechanism is being driven.

    SSEMECH47 = 1
    if (P34X2076Y = 1 and P34X2064Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
            SSEMECH47 = 5
        else SSEMECH47 = 4
    if (P34X2077Y = 1 and P34X2064Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
            SSEMECH47 = 5
        else SSEMECH47 =4

SSEMECH48 - Indicates when pivoter high has been selected and whether the mechanism is being driven.

    SSEMECH48 = 1
    if (P34X2076Y = 1 and P34X2061Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
            SSEMECH48 = 5
        else SSEMECH48 = 4
    if (P34X2077Y = 1 and P34X2061Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
            SSEMECH48 = 5
        else SSEMECH48 =4

SSEMECH49 - Indicates when pivoter low has been selected and whether the mechanism is being driven.

    SSEMECH49 = 1
    if (P34X2076Y = 1 and P34X2060Y = 1) then

Verify that this is the correct version before use

```
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
            SSEMECH49 = 5
        else SSEMECH49 = 4
    if (P34X2077Y = 1 and P34X2060Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
            SSEMECH49 = 5
        else SSEMECH49 =4
```

SSEMECH50 - Indicates when rotator has been selected and whether the mechanism is being driven.

```
    SSEMECH50 = 1
    if (P34X2076Y = 1 and P34X2062Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
            SSEMECH50 = 5
        else SSEMECH50 = 4
    if (P34X2077Y = 1 and P34X2062Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
            SSEMECH50 = 5
        else SSEMECH50 =4
```

SSEMECH51 - Indicates when translator has been selected and whether the mechanism is being driven.

```
    SSEMECH51 = 1
    if (P34X2076Y = 1 and P34X2063Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
            SSEMECH51 = 5
        else SSEMECH51 = 4
    if (P34X2077Y = 1 and P34X2063Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
            SSEMECH51 = 5
        else SSEMECH51 =4
```

SSEMECH52 - Indicates when berthing latch 1 has been selected and whether the mechanism is being driven.

```
    SSEMECH52 = 1
    if (P34X2076Y = 1 and P34X2065Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
            SSEMECH52 = 5
        else SSEMECH52 = 4
    if (P34X2077Y = 1 and P34X2065Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
            SSEMECH52 = 5
        else SSEMECH52 =4
```

Verify that this is the correct version before use

SSEMECH53 - Indicates when berthing latch 2 has been selected and whether the mechanism is being driven.

```
SSEMECH53 = 1
if (P34X2076Y = 1 and P34X2066Y = 1) then
    if (SSEMECH42 = 1 and SSEMECH43 = 1) then
        SSEMECH53 = 5
    else SSEMECH53 = 4
if (P34X2077Y = 1 and P34X2066Y = 1) then
    if (SSEMECH76 = 1 and SSEMECH77 = 1) then
        SSEMECH53 = 5
    else SSEMECH53 =4
```

SSEMECH54 - Indicates when berthing latch 3 has been selected and whether the mechanism is being driven.

```
SSEMECH54 = 1
if (P34X2076Y = 1 and P34X2067Y = 1) then
    if (SSEMECH42 = 1 and SSEMECH43 = 1) then
        SSEMECH54 = 5
    else SSEMECH54 = 4
if (P34X2077Y = 1 and P34X2067Y = 1) then
    if (SSEMECH76 = 1 and SSEMECH77 = 1) then
        SSEMECH54 = 5
    else SSEMECH54 =4
```

SSEMECH55 - Indicates when main umbilical has been selected and whether the mechanism is being driven.

```
SSEMECH55 = 1
if (P34X2076Y = 1 and P34X2068Y = 1) then
    if (SSEMECH42 = 1 and SSEMECH43 = 1) then
        SSEMECH55 = 5
    else SSEMECH55 = 4
if (P34X2077Y = 1 and P34X2068Y = 1) then
    if (SSEMECH76 = 1 and SSEMECH77 = 1) then
        SSEMECH55 = 5
    else SSEMECH55 =4
```

SSEMECH56 - Indicates when backup umbilical has been selected and whether the mechanism is being driven.

```
SSEMECH56 = 1
if (P34X2076Y = 1 and P34X2069Y = 1) then
    if (SSEMECH42 = 1 and SSEMECH43 = 1) then
        SSEMECH56 = 5
    else SSEMECH56 = 4
if (P34X2077Y = 1 and P34X2069Y = 1) then
```

Verify that this is the correct version before use

if (SSEMECH76 = 1 and SSEMECH77 = 1) then
    SSEMECH56 = 5
else SSEMECH56 =4

SSEMECH61/SSEMECH62 - Indicates if the BOT/EOT has been reached.

MSID	NOMENCLATURE				
P34X2087Y	MSB PRI LATCHED STATUS	0	0	1	1
P34X2089Y	MSB PRI RELEASE STATUS	0	1	0	1
	SSEMECH61 =	1	0	1	2
	SSEMECH62 =	1	1	0	2

SSEMECH63 - Indicates if the mechanism is ready to be operated.

if (SSMECH61 = 1 and SSEMECH62 = 1) then
if (SSEMECH47 = 4 or SSEMECH48 = 4 or SSEMECH49 = 4 or SSEMECH50 = 4
    or SSEMECH51 = 4 or SSEMECH52 = 4 or SSEMECH53 = 4 or
    SSEMECH54 = 4
    or SSEMECH55 = 4 or SSEMECH56 = 4) then
        SSEMECH63 = 0
else if (SSEMECH47 = 5 or SSEMECH48 = 5 or SSEMECH49 = 5 or
    SSEMECH50 = 5 or SSEMECH51 = 5 or SSEMECH52 = 5 or
    SSEMECH53 = 5
    or SSEMECH54 = 5 or SSEMECH55 = 5 or SSEMECH56 = 5) then
        SSEMECH63 = 0
else
    SSEMECH63 = 1

SSEMECH68 - Indicates MID MCA 3 PBM power bus is enabled is zero and all required power is on.

if ((SSEMECH14 = 3 or SSEMECH14 = 4) and
    SSEMECH35 = 0 and V76X2183E = 0) then
        SSEMECH68 = 4
else SSEMECH68 = 1

SSEMECH69 - Indicates MID MCA 3 PBM power bus is enabled and on, and all required power is on.

if (SSEMECH68 = 4 and V76X2184E = 0) then
    SSEMECH69 = 4
else SSEMECH69 = 1

SSEMECH71 - Indicates status of AMSB B override.

if (P34X2077Y = 1 and P34X2072Y = 0) then SSEMECH71 = 1
    else SSEMECH71 = 0

Verify that this is the correct version before use

SSEMECH72 - Indicates that the AMSB B mechanism has tripped the EOT microswitch (latch).

if (P34X2077Y = 1 and P34X2087Y = 1) then SSEMECH72 = 3
    else SSEMECH72 = 1

SSEMECH73 - Indicates that the AMSB B mechanism has tripped the BOT microswitch (release).

if (P34X2077Y = 1 and P34X2089Y = 1) then SSEMECH73 = 3
    else SSEMECH73 = 1

SSEMECH74 - Indicates that latch position has been selected on switch and EOT has not been reached (side B).

if (V54S8406E = 1 and SSEMECH72 = 1) then SSEMECH74 = 0
    else SSEMECH74 = 1

SSEMECH75 - Indicates that release position has been selected on switch and BOT has not been reached (side B).

if (V54S8404E = 1 and SSEMECH73 = 1) then SSEMECH75 = 0
    else SSEMECH75 = 1

SSEMECH76 - Indicates when system is driving a mechanism in the latch direction (side B).

if (SSEMECH69 = 4 and SSEMECH74 = 0) then SSEMECH76 = 4
    else SSEMECH76 = 1

SSEMECH77 - Indicates when system is driving a mechanism in the release direction (side B).

if (SSEMECH69 = 4 and SSEMECH75 = 0) then SSEMECH77 = 4
    else SSEMECH77 = 1

SSEMECH78/SSEMECH79/SSEMECH81 – AMSB A and B use the same telemetry MSID's therefore this comp verifies AMSB B active before display data, otherwise the data will be displayed as overflow indicating that AMSB B is off.

if (P34X2077Y = 1) then
    SSEMECH81 = P34C2111V
    SSEMECH78 = P34C2025V
    SSEMECH79 = P34T2003V
else
    SSEMECH81 = 999999
    SSEMECH79 = 999999
    SSEMECH78 = 999999

Verify that this is the correct version before use

SSEMECH80 - Indicates when berthing support post has been selected and whether the mechanism is being driven.

```
SSEMECH80 = 1
if (P34X2076Y = 1 and P34X2070Y = 1) then
    if (SSEMECH42 = 1 and SSEMECH43 = 1) then
        SSEMECH80 = 5
    else SSEMECH80 = 4
if (P34X2077Y = 1 and P34X2070Y = 1) then
    if (SSEMECH76 = 1 and SSEMECH77 = 1) then
        SSEMECH80 = 5
    else SSEMECH80 =4
```

SSEMECH85 - Indicates position of pivoter by integrating the tach speed when the pivoter is active.

```
Initially set SSEMECH85 = 0.0
    if SSEMECH49 = 4 then
    if (SSEMECH42 = 4) then SSEMECH85 = SSEMECH85 + (P34R2108V / 60)
    if (SSEMECH43 = 4) then SSEMECH85 = SSEMECH85 – (P34R2108V / 60)
    if (SSEMECH76 = 4) then SSEMECH85 = SSEMECH85 + (P34R2108V / 60)
    if (SSEMECH77 = 4) then SSEMECH85 = SSEMECH85 – (P34R2108V / 60)
```

SSEMECH86 - Indicates position of rotator by integrating the tach speed when the rotator is active.

```
Initially set SSEMECH86 = 180.0
    if SSEMECH50 = 4 then
    if (SSEMECH42 = 4) then SSEMECH86 = SSEMECH86 - (P34R2108V / 60)
    if (SSEMECH43 = 4) then SSEMECH86 = SSEMECH86 + (P34R2108V / 60)
    if (SSEMECH76 = 4) then SSEMECH86 = SSEMECH86 - (P34R2108V / 60)
    if (SSEMECH77 = 4) then SSEMECH86 = SSEMECH86 + (P34R2108V / 60)
```

SSEMECH94 - Indicates power status for MSB A and MSB B.

MSID	NOMENCLATURE				
P34X2076Y	MSB-A POWER STATUS	0	0	1	1
P34X2077Y	MSB-B POWER STATUS	0	1	0	1
	SSEMECH94 =	0	2	1	3

Verify that this is the correct version before use

SSEMECH95/SSEMECH97 - Indicates status of MSB A.

    SSEMECH95 = 'XXXX'
    SSEMECH97 = 1
    if (P34X2076Y =1) then
        if (SSEMECH42 = 4 or SSEMECH43 = 4) then
            SSEMECH95 = 'DRIVE'
            SSEMECH97 = 1
        if (SSEMECH47 = 4 or SSEMECH48 = 4 or SSEMECH49 = 4 or
        SSEMECH50 = 4
        or SSEMECH51 = 4 or SSEMECH52 = 4 or SSEMECH53 = 4 or
        SSEMECH54 = 4
        or SSEMECH55 = 4 or SSEMECH56 = 4 or SSEMECH80 = 4) then
            SSEMECH95 = 'DRIVE'
            SSEMECH97 = 4
        else if (SSEMECH47 = 5 or SSEMECH48 = 5 or SSEMECH49 = 5
        or SSEMECH50 = 5 or SSEMECH51 = 5 or SSEMECH52 = 5
        or SSEMECH53 = 5 or SSEMECH54 = 5 or SSEMECH55 = 5
        or SSEMECH56 = 5 or SSEMECH80 = 5) then
            SSEMECH95 = 'SEL'
            SSEMECH97 = 5

SSEMECH96/SSEMECH99 - Indicates status of MSB B.

    SSEMECH96 = 'XXXX'
    SSEMECH99 = 1
    if (P34X2077Y =1) then
        if (SSEMECH76 = 4 or SSEMECH77 = 4) then
            SSEMECH96 = 'DRIVE'
            SSEMECH99 = 1
        if (SSEMECH47 = 4 or SSEMECH48 = 4 or SSEMECH49 = 4 or
        SSEMECH50 = 4
        or SSEMECH51 = 4 or SSEMECH52 = 4 or SSEMECH53 = 4 or
        SSEMECH54 = 4
        or SSEMECH55 = 4 or SSEMECH56 = 4 or SSEMECH80 = 4) then
            SSEMECH96 = 'DRIVE'
            SSEMECH99 = 4
        else if (SSEMECH47 = 5 or SSEMECH48 = 5 or SSEMECH49 = 5
        or SSEMECH50 = 5 or SSEMECH51 = 5 or SSEMECH52 = 5
        or SSEMECH53 = 5 or SSEMECH54 = 5 or SSEMECH55 = 5
        or SSEMECH56 = 5 or SSEMECH80 = 5) then
            SSEMECH96 = 'SEL'
            SSEMECH99 = 5

Verify that this is the correct version before use

6.3.3   SSE Power Display Description
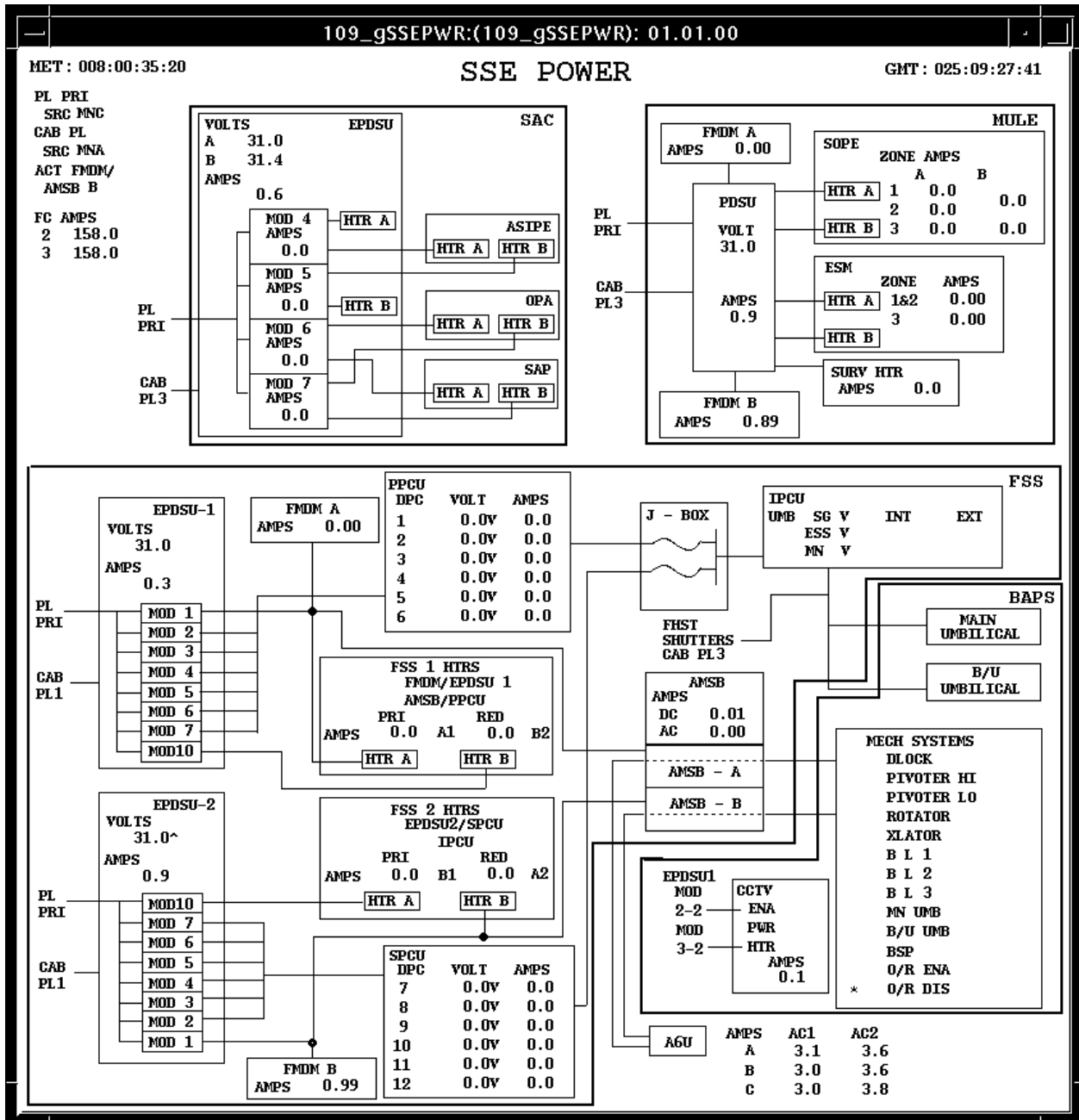
Figure 6-9. SSE power display

Verify that this is the correct version before use

Table 6-9. SSE power description

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
PL PRI SRC	SSEPWR006	see comps	UCB
Indicates the source of PL PRI. Display options are OFF, MNB, MNC, FC3, or TIE. TIE indicates 2 or 3 of the sources are tied to the PL PRI bus			
CAB PL SRC	SSEPWR007	see comps	UCB
Indicates the source of the CABIN PL buses. Display options are OFF, MNA, MNB, or ERR. ERR indicates a switch problem as telemetry is indicating both MNA and MNB are feeding the buses which is physically not possible with the switch			
ACT FMDM/AMSB	W92X5500CK	0 = 'A', 1 = 'B'	UCB
Indicates which set of FMDMs and AMSB are active, either A or B. Refer to FMDM display write-up for information on this comp			
FC AMPS 2	V45C0201A	0.0 to 500.0 amps	PTM
Current produced from fuel cell 2			
FC AMPS 3	V45C0301A	0.0 to 500.0 amps	PTM
Current produced from fuel cell 3			
SAC			
PL PRI text + lines to MODs	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source			
CAB PL3 text + line EPDSU	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL3 input power to the EPDSU when CAB PL is activated			
EPDSU VOLTS A	P34V5208V	0.0 to 40.0 volts	PTM
Sensor location TBD			
EPDSU VOLTS B	P34V5216V	0.0 to 40.0 volts	PTM
Sensor location TBD			
EPDSU AMPS	P34C5206V	-1.2 to 150.0 amps	PTM
Sensor on PL PRI power feed input to the EPDSU			
MOD4 AMPS	P34C5225V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module			
MOD5 AMPS	P34C5224V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module			
MOD6 AMPS	P34C5223V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module			
MOD7 AMPS	P34C5222V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
EPDSU HTR A box + line to MOD4	P34X5228Y	0 = green, 1 = gray	PTM
EPDSU HTR B box + line to MOD5	P34X5231Y	0 = green, 1 = gray	PTM
ASIPE HTR A box + line to MOD4	P34X5226Y	0 = green, 1 = gray	PTM
ASIPE HTR B box + line to MOD5	P34X5229Y	0 = green, 1 = gray	PTM
OPA HTR A box + line to MOD6	P34X5232Y	0 = green, 1 = gray	PTM
OPA HTR B box + line to MOD7	P34X5235Y	0 = green, 1 = gray	PTM
SAP HTR A box + line to MOD6	P34X5233Y	0 = green, 1 = gray	PTM
SAP HTR B box + line to MOD7	P34X5236Y	0 = green, 1 = gray	PTM
MULE			
PL PRI text + line to PDSU	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source			
CAB PL3 text + line PDSU	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL3 input power to the PDSU when CAB PL is activated			
FMDM A box + line to PDSU	SSEPWR001	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50			
FMDM A AMPS	P34C8109V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay			
PDSU VOLT	P34V8122V	0.0 to 40.0 volts	PTM
Sensor located on Bus B in the PDSU			
PDSU AMPS	SSEPWR005	0.0 to 999.0 amps	UCB
Sum of power draw through PDSU for all MULE loads			
FMDM B box + line to PDSU	SSEPWR002	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50			
FMDM B AMPS	P34C8114V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay			
SOPE HTR A box + line to PDSU	SSEPWR016	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active			
SOPE HTR B box + line to PDSU	SSEPWR017	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active			
SOPE ZONE 1 AMPS A	P34C8112V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
SOPE ZONE 2 AMPS A	P34C8107V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay			
SOPE ZONE 3 AMPS A	P34C8113V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay			
SOPE ZONE 1&2 AMPS B	P34C8115V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay			
SOPE ZONE 3 AMPS B	P34C8116V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay			
ESM HTR A box + line to PDSU	SSEPWR018	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active			
ESM HTR B box + line to PDSU	SSEPWR019	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active			
ESM ZONE 1&2 AMPS	P34C8110V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay			
ESM ZONE 3 AMPS	P34C8111V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay			
SURV HTR box + line to PDSU	P34X8411Y	0 = gray, 1 = green	PTM
Indicates if either the A heater or B heater is active. Relay output signals are wired together before input to the FMDM			
SURV HTR AMPS	P34C8117V	0.0 to 20.0 amps	PTM
Tbd - will this sensor give you the sum of both relays, or does it only display the higher of the two currents. Need to add some detail to drawing 3.3-2 zone P-6			
FSS			
PL PRI text + line to EPDSU-1 MODs	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source			
CAB PL1 text + line EPDSU-1	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL1 input power to EPDSU-1 when CAB PL is activated			
EPDSU-1 VOLTS	P34V2040V	0.0 to 40.0 volts	PTM
Sensor on SSPC1-2			
EPDSU-1 AMPS	P34C2113V	0.0 to 999.0 amps	UCB
Sum of power draw through EPDSU-1 for PPCU, HTR 1A, HTR 1B, FMDM A, AMSB DC A, and CCTV HTR loads. Note CCTV camera power has no current monitor but draws power from EPDSU-1. AMSB current is included in only the EPDSU-1 AMPS calculation, is there a better way to do this			
FMDM A box + line to MOD1 output line at the dot	SSEPWR003	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50			
FMDM A AMPS	P34C2115V	0.00 to 5.00 amps	PTM
Sensor is located in MOD prior to SSPC			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
FSS 1 HTR box	P34X2082Y	0 = gray, 1 = green	PTM
Indicates if either the A heater or B heater is active. Relay output signals are wired together before input to the FMDM			
FSS 1 HTR A AMPS	P34C2026V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
FSS 1 HTR B AMPS	P34C2114V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC. MSID is labeled as FSS HEATER 2B CURRENT, but actually provides current for 1B heater			
AMSB A box + line to MOD1 output line at the dot	P34X2076Y	0 = gray, 1 = green	PTM
AMSB DC AMPS	P34C2025V	-1.00 to 5.00 amps	PTM
AMSB AC AMPS	P34C2111V	0.00 to 5.00 amps	PTM
PPCU box + common line to EPDSU-1 + lines into J-BOX (including fuse) up to the bus	SSEPWR012	0 = gray, 1 = green	UCB
Indicates if any of the 6 DPCs in the PPCU are on			
line from MOD2 to common line + MOD2 box	P34X2047Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD3 to common line + MOD3 box	P34X2048Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD4 to common line + MOD4 box	P34X2049Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD5 to common line + MOD5 box	P34X2119Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD6 to common line + MOD6 box	P34X2050Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD7 to common line + MOD7 box	P34X2120Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
DPC 1	P34X2047Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output			
DPC 2	P34X2048Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
DPC 3	P34X2049Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output			
DPC 4	P34X2119Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output			
DPC 5	P34X2050Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output			
DPC 6	P34X2120Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output			
DPC 1 VOLT	P34V2028V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts			
DPC 2 VOLT	P34V2029V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts			
DPC 3 VOLT	P34V2030V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts			
DPC 4 VOLT	P34V2031V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts			
DPC 5 VOLT	P34V2032V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts			
DPC 6 VOLT	P34V2033V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 1 AMPS	P34C2008V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 2 AMPS	P34C2009V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 3 AMPS	P34C2010V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 4 AMPS	P34C2011V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 5 AMPS	P34C2012V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 6 AMPS	P34C2013V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
PL PRI text + line to EPDSU-2 MODs	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source			
CAB PL1 text + line EPDSU-2	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL1 input power to EPDSU-2 when CAB PL is activated			
EPDSU-2 VOLTS	P34V2041V	0.0 to 40.0 volts	PTM
Sensor on SSPC1-2			
EPDSU-2 AMPS	P34C2116V	0.0 to 999.0 amps	UCB
Sum of power draw through EPDSU-2 for SPCU, HTR 2A, HTR 2B, FMDM B			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
FMDM B box + line to MOD1 output line at the dot	SSEPWR004	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50			
FMDM B AMPS	P34C2022V	0.00 to 5.00 amps	PTM
Sensor is located in MOD prior to SSPC			
FSS 2 HTR box	P34X2083Y	0 = gray, 1 = green	PTM
Indicates if either the A heater or B heater is active. Relay output signals are wired together before input to the FMDM			
FSS 2 HTR A AMPS	P34C2024V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC. MSID is labeled as FSS HEATER 1B CURRENT, but actually provides current for 2A heater			
FSS 2 HTR B AMPS	P34C2027V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC. MSID is labeled as FSS HEATER 2A CURRENT, but actually provides current for 2B heater			
AMSB B box + line to MOD1 output line at the dot	P34X2077Y	0 = gray, 1 = green	PTM
SPCU box + common line to EPDSU-2 + lines into J-BOX (including fuse) up to the bus	SSEPWR013	0 = gray, 1 = green	UCB
Indicates if any of the 6 DPCs in the SPCU are on			
line from MOD2 to common line + MOD2 box	P34X2051Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD3 to common line + MOD3 box	P34X2052Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD4 to common line + MOD4 box	P34X2053Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD5 to common line + MOD5 box	P34X2121Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD6 to common line + MOD6 box	P34X2054Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
line from MOD7 to common line + MOD7 box	P34X2122Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD			
DPC 7	P34X2051Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
DPC 8	P34X2052Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD			
DPC 9	P34X2053Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD			
DPC 10	P34X2121Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD			
DPC 11	P34X2054Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD			
DPC 12	P34X2122Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD			
DPC 7 VOLT	P34V2034V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC			
DPC 8 VOLT	P34V2035V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC			
DPC 9 VOLT	P34V2036V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC			
DPC 10 VOLT	P34V2037V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC			
DPC 11 VOLT	P34V2038V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC			
DPC 12 VOLT	P34V2039V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC			
DPC 7 AMPS	P34C2014V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 8 AMPS	P34C2015V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 9 AMPS	P34C2016V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 10 AMPS	P34C2017V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 11 AMPS	P34C2018V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
DPC 12 AMPS	P34C2019V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC			
J-BOX box/bus + line to IPCU + IPCU box + lines to UMBILICALS + MAIN UMBILICAL box + B/U UMBILICAL box	SSEPWR014	0 = gray, 1 = green	UCB
Indicates at least 1 DPCs is on and providing power to the umbilicals			
UMB INT ESS V	P34V1026V	0.0 to 40.0 volts	PTM
TBS			
UMB INT MN V	P34V1027V	0.0 to 40.0 volts	PTM
TBS			

Verify that this is the correct version before use

Table 6-9. SSE power description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
UMB EXT ESS V	P34V1035V	0.0 to 40.0 volts	PTM
TBS			
UMB EXT MN V	P34V1009V	0.0 to 40.0 volts	PTM
TBS			
FHST SHUTTERS CAB PL3 text + line to IPCU/UMBICAL line	SSEPWR007C	0 = gray, 1 = green	UCB
Indicates CAB PL3 power is available for the SSP switch to close the FHST Shutters			
BAPS			
DLOCK	P34X2064Y	0 = blank, 1 = '*'	PTM
Indicates that the downlock mechanism has been selected in the active MSB			
PIVOTER HI	P34X2061Y	0 = blank, 1 = '*'	PTM
Indicates that the high rate pivoter mechanism has been selected in the active MSB			
PIVOTER LOW	P34X2060Y	0 = blank, 1 = '*'	PTM
Indicates that the low rate pivoter mechanism has been selected in the active MSB			
ROTATOR	P34X2062Y	0 = blank, 1 = '*'	PTM
Indicates that the rotator mechanism has been selected in the active MSB			
TRANSLATOR	P34X2063Y	0 = blank, 1 = '*'	PTM
Indicates that the translator mechanism has been selected in the active MSB			
B L 1	P34X2065Y	0 = blank, 1 = '*'	PTM
Indicates that the berth latch 1 mechanism has been selected in the active MSB			
B L 2	P34X2066Y	0 = blank, 1 = '*'	PTM
Indicates that the berth latch 2 mechanism has been selected in the active MSB			
B L 3	P34X2067Y	0 = blank, 1 = '*'	PTM
Indicates that the berth latch 3 mechanism has been selected in the active MSB			
MN UMB	P34X2068Y	0 = blank, 1 = '*'	PTM
Indicates that the main umbilical mechanism has been selected in the active MSB			
B/U UMB	P34X2069Y	0 = blank, 1 = '*'	PTM
Indicates that the backup umbilical mechanism has been selected in the active MSB			
BSP	P34X2070Y	0 = blank, 1 = '*'	PTM
Indicates that the BAPS support post mechanism has been selected in the active MSB			
O/R ENA	P34X2072Y	0 = '*', 1 = blank	PTM
Indicates that the mechanism override is enabled			
O/R DIS	P34X2072Y	0 = blank, 1 = '*'	PTM
Indicates that the mechanism override is disabled			
CCTV box + line to MOD2-2	SSEPWR015	0 = gray, 1, 2, 3 = green	UCB
CCTV ENA	SSEPWR015	0 = blank, 2 = '2' (yellow), 1 = '1'(yellow), 3 = '*'	UCB
CCTV PWR	P34K4041Y	0 = blank, 1 = '*'	PTM
Telemetry from FDMD command registry, this is not an end-item command response			
CCTV HTR AMPS	P34C2095V	0.00 to 5.00 amps	PTM
Sensor is located in MOD prior to SSPC			

Verify that this is the correct version before use

Table 6-9. SSE power description (concluded)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION9			
A6U box	SSEPWR010C	0 = gray, 1 = green	UCB
Indicates if either logic power system 1 or 2 is powered			
Line from A6U through MSB A to MECH SYSTEMS	SSEPWR010	0 = green, 1 = gray	UCB
Indicates if system 1 is driving a mechanism in either the latch or release direction			
Line from A6U through MSB B to MECH SYSTEMS	SSEPWR011	0 = green, 1 = gray	UCB
Indicates if system 2 is driving a mechanism in either the latch or release direction			

AC1 AMPS   A
           B
           C
	V76C1540A
	V76C1541A
	V76C1542A
		0.0 to 20.0 amps
		0.0 to 20.0 amps
		0.0 to 20.0 amps
			PTM
			PTM
			PTM

AC1 current for phases A, B and C			

AC2 AMPS   A
           B
           C
	V76C1640A
	V76C1641A
	V76C1642A
		0.0 to 20.0 amps
		0.0 to 20.0 amps
		0.0 to 20.0 amps
			PTM
			PTM
			PTM

AC2 current for phases A, B and C			

COMPS:

SSEPWR001 – Determines power state of MULE FMDM A based on its temperature.

    if P34T8120V > -50 then

        SSEPWR001 = 1

    else

        SSEPWR001 = 0

SSEPWR002 – Determines power state of MULE FMDM B based on its temperature.

    if P34T8121V > -50 then

        SSEPWR002 = 1

    else

        SSEPWR002 = 0

SSEPWR003 – Determines power state of FSS FMDM A based on its temperature.

    if P34T2001V > -50 then

        SSEPWR003 = 1

    else

        SSEPWR003 = 0

SSEPWR004 – Determines power state of FSS FMDM B based on its temperature.

    if P34T2002V > -50 then

        SSEPWR004 = 1

    else

        SSEPWR004 = 0

Verify that this is the correct version before use

SSEPWR005 – Sum of power draw through PDSU for all MULE loads.

SSEPWR005 = P34C8107V + P34C8109V + P34C8110V + P34C8111V + P34C8112V + P34C8113V + P34C8114V + P34C8115V + P34C8116V + P34C8117V

SSEPWR006/SSEPWR006C - Indicates source of power for payload primary bus.

if (V76X2833E =1 and V76X2838E = 0 and V76X2843E =0) then

SSEPWR006 = 'MNB'

SSEPWR006C = 1

else if (V76X2833E =0 and V76X2838E = 1 and V76X2843E =0) then

SSEPWR006 = 'MNC'

SSEPWR006C = 1

else if (V76X2833E =0 and V76X2838E = 0 and V76X2843E =1) then

SSEPWR006 = 'FC3'

SSEPWR006C = 1

else if (V76X2833E =0 and V76X2838E = 0 and V76X2843E =0) then

SSEPWR006 = 'OFF'

SSEPWR006C = 0

else

SSEPWR006 = 'TIE'

SSEPWR006C = 1

SSEPWR007/SSEPWR007C - Indicates source of power for cabin payload buses.

if (V76S2851E = 1 and V76S2853E = 0) then

SSEPWR007 = 'MNA'

SSEPWR007C = 1

if (V76S2851E = 0 and V76S2853E = 1) then

SSEPWR007 = 'MNB'

SSEPWR007C = 1

if (V76S2851E = 0 and V76S2853E = 0) then

SSEPWR007 = 'OFF'

SSEPWR007C = 0

else

SSEPWR007 = 'ERR'

SSEPWR007C = 1

SSEPWR008 – Sum of power draw through EPDSU-1.

SSEPWR003 = P34C2008V + P34C2009V + P34C2010V + P34C2011V + P34C2012V + P34C2013V + P34C2024V + P34C2025V + P34C2026V +P34C2095V + P34C2115V

Verify that this is the correct version before use

SSEPWR009 – Sum of power draw through EPDSU-2.

SSEPWR003 = P34C2014V + P34C2015V + P34C2016V + P34C2017V +
P34C2018V + P34C2019V + P34C2022V + P34C2027V + P34C2114V

SSEPWR010 - Indicates if mechanism system 1 (A6U switch 1 to AMSB A) is being operated.

if (SSEMECH42 = 4 or SSEMECH 43 = 4) then

SSEPWR010 = 0

else

SSEPWR010 = 1

SSEPWR010C - Indicates if either logic power system is powered.

if (V54S8424E = 1 or V54X8425E = 1) then

SSEPWR010C = 1

else

SSEPWR010C = 0

SSEPWR011 - Indicates if mechanism system 2 (A6U switch 2 to AMSB B) is being operated.

if (SSEMECH76 = 4 or SSEMECH77 = 4) then

SSEPWR011 = 0

else

SSEPWR011 = 1

SSEPWR012 – Determines if any of the PPCU DPCs are on.

if (P34X2047Y = 1 or P34X2048Y = 1 or P34X2049Y = 1 or P34X2050Y = 1 or P34X2119Y = 1 or P34X2120Y = 1) then

SSEPWR012 = 1

else

SSEPWR012 = 0

SSEPWR013 – Determines if any of the SPCU DPCs are on.

if (P34X2051Y = 1 or P34X2052Y = 1 or P34X2053Y = 1 or P34X2054Y = 1 or P34X2121Y = 1 or P34X2122Y = 1) then

SSEPWR013 = 1

else

SSEPWR013 = 0

SSEPWR014 – Determines if any of the DPCs are on.

if (SSEPWR012 = 1 or SSEPWR013 = 1) then

SSEPWR014 = 1

else

SSEPWR014 = 0

Verify that this is the correct version before use

SSEPWR015 – Determines if both CCTV power statuses are enabled.

    if (P34X2096Y = 1 and P34X2097Y = 1) then

        SSEPWR015 = 3

    if (P34X2096Y = 0 and P34X2097Y = 1) then

        SSEPWR015 = 2

    if (P34X2096Y = 1 and P34X2097Y = 0) then

        SSEPWR015 = 1

    else

        SSEPWR015 = 0

SSEPWR016 – Determines if both sets of SOPE A heaters have activated.

    if (P34X8406Y = 1 and P34X8407Y = 1) then

        SSEPWR016 = 1

    else

        SSEPWR016 = 0

SSEPWR017 – Determines if both sets of SOPE B heaters have activated.

    if (P34X8409Y = 1 and P34X8410Y = 1) then

        SSEPWR017 = 1

    else

        SSEPWR017 = 0

SSEPWR018 – Determines if both sets of ESM A heaters have activated.

    if (P34X8401Y = 1 and P34X8402Y = 1) then

        SSEPWR018 = 1

    else

        SSEPWR018 = 0

SSEPWR019 – Determines if both sets of ESM B heaters have activated.

    if (P34X8404Y = 1 and P34X8405Y = 1) then

        SSEPWR019 = 1

    else

        SSEPWR019 = 0

6.3.4   SSE FMDM Display Description
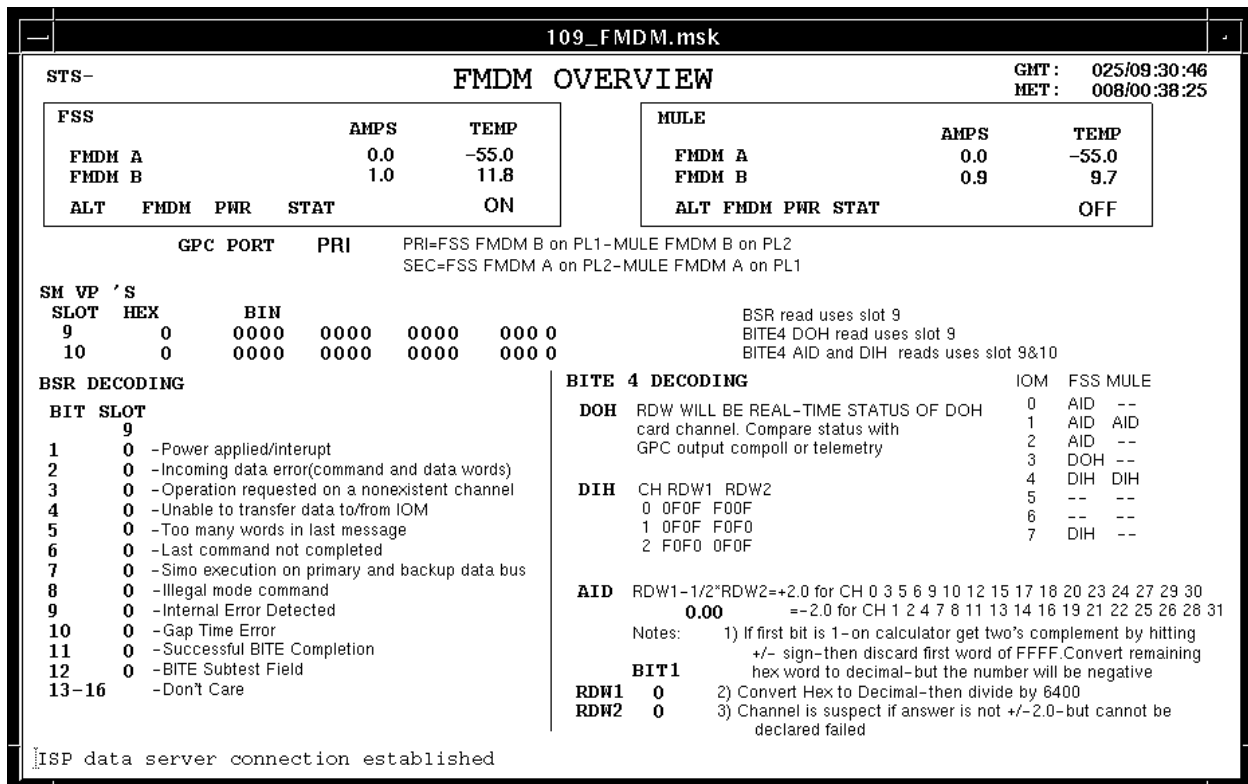
Figure 6-10. SSE FMDM display

Verify that this is the correct version before use

Table 6-10. SM 211 emulation description

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
FSS FMDM A AMPS	P34C2115V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to EPDSU-1 MOD 1-2 SSPC			
FSS FMDM A TEMP	P34T2001V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. FSS FMDM radiator heater setpoints are TBD. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
FSS FMDM B AMPS	P34C2022V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to EPDSU-2 MOD 1-2 SSPC			
FSS FMDM B TEMP	P34T2002V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. FSS FMDM radiator heater setpoints are TBD. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
FSS ALT FMDM PWR STAT	P34X2073Y	0 = 'OFF', 1 = 'ON'	PTM
Wired downstream of SSPC that powers the alternate FMDM			
MULE FMDM A AMPS	P34C8109V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to PDSU relay			
MULE FMDM A TEMP	P34T8120V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. MULE FMDM radiator heater setpoints are +2 deg C ON and +10 deg C OFF. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
MULE FMDM B AMPS	P34C8114V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to PDSU relay			
MULE FMDM B TEMP	P34T8121V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. MULE FMDM radiator heater setpoints are +2 deg C ON and +10 deg C OFF. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
MULE ALT FMDM PWR STAT	P34X8403Y	0 = 'OFF', 1 = 'ON'	PTM
Wired downstream of PDSU relay that powers the alternate FMDM			
GPC PORT	W92X5500CK	0 = 'SEC', 1 = 'PRI'	UCB
Norminally GNC VP Slot 1 contains information on the port moding for the data buses. The status of the PL Buses is located in bit 6 (bit 1 being msb), this comp generates a discrete MSID from the VP slot 1 telemetry (V92X5500CX)			
SM VP'S SLOT 9 HEX	V92U5516CY	0000 to FFFF hex	PTM
VP slot is used for downlinking BSR and BITE4 read telemetry to troubleshoot MDM problems			
SM VP'S SLOT 9 BIN	W92X5516CP through W92X5516CA	0 or 1	UCB
Comps used to generate 16 descretes from the VP slot 9 telemetry			

Verify that this is the correct version before use

Table 6-10. SM 211 emulation description (concluded)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
SM VP'S SLOT 10 HEX	V92U5518CY	0000 to FFFF hex	PTM
VP slot is used for downlinking BITE4 read telemetry to troubleshoot MDM problems			
SM VP'S SLOT 10 BIN	W92X5518CP through W92X5518CA	0 or 1	UCB
Comps used to generate 16 descretes from the VP slot 10 telemetry			
BSR DECODING SLOT 9	W92X5516CP through W92X5516CE	0 or 1	UCB
Same information displayed in SM VP'S SLOT 9 BIN fields, but with information to interpret a BSR read			
BITE4 DECODING AID	FMDMBITE4	-99.00 to +99.00	UCB
Comp to calculate telemetry from BITE4 AID card read			
BITE4 DECODING AID BIT 1	W92X5516CP W92X5518CP	0 or 1 0 or 1	UCB
For a BITE4 AID card read, if the first bit is zero, then the value is negative, and the two's complement must be used to calculate the decimal conversion			

COMPS:

W92X5516C/W92X5518C - Calculates discrete MSID's from VP hex telemetry.

V92U5516CY	Comp MSID		V92U5518CY	Comp MSID
X (msb)	W92X5516CP		X (msb)	W92X5518CP
X	W92X5516CO		X	W92X5518CO
X	W92X5516CN		X	W92X5518CN
X	W92X5516CM		X	W92X5518CM
X	W92X5516CL		X	W92X5518CL
X	W92X5516CK		X	W92X5518CK
X	W92X5516CJ		X	W92X5518CJ
X	W92X5516CI		X	W92X5518CI
X	W92X5516CH		X	W92X5518CH
X	W92X5516CG		X	W92X5518CG
X	W92X5516CF		X	W92X5518CF
X	W92X5516CE		X	W92X5518CE
X	W92X5516CD		X	W92X5518CD
X	W92X5516CC		X	W92X5518CC
X	W92X5516CB		X	W92X5518CB
X (lsb)	W92X5516CA		X (lsb)	W92X5518CA

Verify that this is the correct version before use

FMDMBITE4 – Calculates error checking factor from BITE4 read.

Conv1 = hex to decimal conversion (V92U5516CY)

Conv2 = hex to decimal conversion (V92U5518CY)

FMDMBITE4 = Conv1/6400 – Conv2/12800

Note: The first bit is a sign bit, if it is a 1, have to do two's complement conversion, decimal value should be made negative.

6.3.5   SM 211 Emulation Display Description

Figure 6-11. SM 211 emulation display

Verify that this is the correct version before use

Table 6-11. SM 21 emulation description

BACKGROUND	MSID	TEXT	SRC
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
PCU P/ (not annotated)	SSEOVR001	0 = blank, 1 = '*', 2 = 'P'	UCB
Indicates power status based on command registry (not end item) of DPCs in the PPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is P. An * will be displayed for all other conditions			
PCU /S (not annotated)	SSEOVR002	0 = blank, 1 = '*', 2 = 'S'	UCB
Indicates power status based on command registry (not end item) of DPCs in the SPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is S. An * will be displayed for all other conditions			
PCU ON	SSEOVR003	0 = blank, 1 = '*'	UCB
Provides response to crew commanding all DPCs on. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. A single odd DPC indication will cause the PCU ON indication			
PCU OFF	SSEOVR003	0 = '*', 1 = blank	UCB
Provides response to crew commanding all DPCs off. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. All odd DPCs must indicate off for the PCU OFF indication			
CCTV ENA ON	SSEPWR015	0 = blank, 1 = '1', 2 = '2', 3 = '*'	UCB
Indicates power status (on) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp			
CCTV ENA OFF	SSEPWR015	0 = '*', 1 ='2', 2 = '1', 3 = blank	UCB
Indicates power status (off) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp			
CCTV PWR ON	P34K4041Y	0 = blank, 1 = '*'	PTM
Indicates power status (on) of the FSS CCTV camera. Once the CCTV camera power module is enabled, it must be commanded ("on") to provide power to the rest of the CCTV camera so that the camera will function			
CCTV PWR OFF	P34K4041Y	0 = '*', 1 = blank	PTM
Indicates power status (off) of the FSS CCTV camera. Note: the CCTV power module may still be enabled/on			
ESM ZONE 1&2 A HTR	P34X8401Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
ESM ZONE 3 A HTR	P34X8402Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
ESM ZONE 1&2 B HTR	P34X8404Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
ESM ZONE 3 B HTR	P34X8405Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
SOPE ZONE 1&2 A HTR	P34X8406Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			

Verify that this is the correct version before use

Table 6-11. SM 21 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
SOPE ZONE 3 A HTR	P34X8407Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
SOPE ZONE 1&2 B HTR	P34X8409Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
SOPE ZONE 3 B HTR	P34X8410Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay			
DPC			
DPC 1	P34X2047Y	0=blank, 1='*'	PTM
DPC 2	P34X2048Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 1 VOLTS	P34V2028V	0.0 to 40.0 volts	PTM
DPC 2 VOLTS	P34V2029V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 1 AMPS	P34C2008V	0.0 to 20.0 amps	PTM
DPC 2 AMPS	P34C2009V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 3	P34X2049Y	0=blank, 1='*'	PTM
DPC 4	P34X2119Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 3 VOLTS	P34V2030V	0.0 to 40.0 volts	PTM
DPC 4 VOLTS	P34V2031V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 3 AMPS	P34C2010V	0.0 to 20.0 amps	PTM
DPC 4 AMPS	P34C2011V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 5	P34X2050Y	0=blank, 1='*'	PTM
DPC 6	P34X2120Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 5 VOLTS	P34V2032V	0.0 to 40.0 volts	PTM
DPC 6 VOLTS	P34V2033V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 5 AMPS	P34C2012V	0.0 to 20.0 amps	PTM
DPC 6 AMPS	P34C2013V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 7	P34X2051Y	0=blank, 1='*'	PTM
DPC 8	P34X2052Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 7 VOLTS	P34V2034V	0.0 to 40.0 volts	PTM
DPC 8 VOLTS	P34V2035V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 7 AMPS	P34C2014V	0.0 to 20.0 amps	PTM
DPC 8 AMPS	P34C2015V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			

Verify that this is the correct version before use

Table 6-11. SM 21 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
DPC 9	P34X2053Y	0=blank, 1='*'	PTM
DPC 10	P34X2121Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 9 VOLTS	P34V2036V	0.0 to 40.0 volts	PTM
DPC 10 VOLTS	P34V2037V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 9 AMPS	P34C2016V	0.0 to 20.0 amps	PTM
DPC 10 AMPS	P34C2017V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC 11	P34X2054Y	0=blank, 1='*'	PTM
DPC 12	P34X2122Y	0=blank, 1='*'	PTM
FMDM pick-off on MOD control SSPC output			
DPC 11 VOLTS	P34V2038V	0.0 to 40.0 volts	PTM
DPC 12 VOLTS	P34V2039V	0.0 to 40.0 volts	PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts			
DPC 11 AMPS	P34C2018V	0.0 to 20.0 amps	PTM
DPC 12 AMPS	P34C2019V	0.0 to 20.0 amps	PTM
Sensor is located in DPC prior to the SSPCs			
DPC ON	P93J0100C	data in not downlinked	---
DPC OFF	P93J0101C	data is not downlinked	---
POWER			
FSS EPDSU 1 AMPS	P34C2113V	-0.30 to 150.00 amps	PTM
2 AMPS	P34C2116V	-0.60 to 150.00 amps	PTM
Indicates EPDSU 1 and 2 current draw. Nominal current draw is TBS amps			
FSS FMDM A AMPS	P34C2115V	0.00 to 5.00 amps	PTM
B AMPS	P34C2022V	0.00 to 5.00 amps	PTM
FSS HTR	P34X2082Y	0 = blank, 1 = '1*'	PTM
	P34X2083Y	0 = blank, 1 = '2*'	PTM
FMDM pick-off on PDSU relay power output line			
FSS HTR A1 AMPS	P34C2026V	0.0 to 20.0 amps	PTM
A2 AMPS	P34C2027V	0.0 to 20.0 amps	PTM
Indicates FSS primary Heaters A1 and A2 current draw. Nominal current draw is TBS amps			
FSS HTR B1 AMPS	P34C2024V	0.0 to 20.0 amps	PTM
B2 AMPS	P34C2114V	0.0 to 20.0 amps	PTM
Indicates FSS Redundant Heaters B1 and B2 current draw. Nominal current draw is TBS amps			
FSS CCTV HTR AMPS	P34C2095V	0.00 to 5.00 amps	PTM
Indicates FSS CCTV Heaters current draw. Nominal current draw is TBS amps			

Verify that this is the correct version before use

Table 6-11. SM 21 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
MULE FMDM A AMPS	P34C8109V	0.00 to 5.00 amps	PTM
B AMPS	P34C8114V	0.00 to 5.00 amps	PTM
Indicates Mule FMDM A and B current draw. Nominal current draw is TBS amps			
MULE HTR	P34X8411Y	0 = blank, 1 = '*'	PTM
FMDM pick-off on PDSU relay power output line			
MULE HTR AMPS	P34C8117V	0.0 to 20.0 amps	PTM
Indicates Mule Heater current draw. Nominal current draw is TBS amps			
MULE ESM 1&2 AMPS	P34C8110V	0.00 to 5.00 amps	PTM
3 AMPS	P34C8111V	0.00 to 5.00 amps	PTM
Indicates Mule Heater current draw. Nominal current draw is TBS amps			
MULE SOPE 1A AMPS	P34C8112V	0.0 to 20.0 amps	PTM
2A AMPS	P34C8107V	0.0 to 20.0 amps	PTM
Indicates SOPE primary Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps			
MULE SOPE 1B & 2B AMPS	P34C8115V	0.0 to 20.0 amps	PTM
Indicates SOPE redundant Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps			
MULE SOPE 3A AMPS	P34C8113V	0.0 to 20.0 amps	PTM
3B AMPS	P34C8116V	0.0 to 20.0 amps	PTM
Indicates SOPE primary and redundant Heaters zone 3 current draw. Nominal current draw is TBS amps			
SAC EPDSU AMPS	P34C5206V	-1.2 to 150.0 amps	PTM
Indicates SAC EPDSU current draw. Nominal current draw is TBS amps			
FSS EPDSU *1* VOLTS	P34V2040V	0.0 to 40.0 volts	PTM
2 VOLTS	P34V2041V	0.0 to 40.0 volts	PTM
Indicates FSS EPDSU 1 and 2 voltage. Nominal voltage is TBS amps			
MULE PDSU VOLTS	P34V8122V	0.0 to 40.0 volts	PTM
Indicates Mule PDSU voltage. Nominal voltage is TBS amps			
SAC EPDSU *A* VOLTS	P34V5208V	0.0 to 40.0 volts	PTM
B VOLTS	P34V5216V	0.0 to 40.0 volts	PTM
Indicates SAC EPDSU A and B voltage. Nominal voltage is TBS amps			
THERMAL			
FSS EPDSU *1* TEMP	P34T2004V	-30 to 60 deg C	PTM
2 TEMP	P34T2007V	-30 to 60 deg C	PTM
Indicates FSS Enhanced Power Distribution and Switching Unit (EPDSU) 1 and 2 temperature. Nominal temperature limits are -20 deg C to 50 deg C			

Verify that this is the correct version before use

Table 6-11. SM 21 emulation description (concluded)

BACKGROUND	MSID	TEXT	SRC
FSS FMDM *A* TEMP	P34T2001V	-55 to 120 deg C	PTM
B TEMP	P34T2002V	-55 to 120 deg C	PTM
Indicates FSS Flex Multiplexer/Demultiplexer (FMDM) A and B temperature. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
FSS PCU *P* TEMP	P34T2005V	-30 to 60 deg C	PTM
S TEMP	P34T2006V	-30 to 60 deg C	PTM
Indicates Port and Starboard Power Conditioning Unit (PPCU) temperature. Nominal control range is –20 to 50 deg C			
FSS IPCU TEMP	P34T2093V	-30 to 60 deg C	PTM
Indicates Interface Power Control Unit (IPCU) temperature. Nominal operational limits are –37 deg C to 50 deg C			
FSS AMSB TEMP	P34T2003V	-30 to 60 deg C	PTM
Indicates Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C			
MULE PDSU TEMP	P34T8119V	-30 to 60 deg C	PTM
Indicates Power Distribution and Switching Unit (PDSU) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C			
MULE FMDM *A* TEMP	P34T8120V	-55 to 120 deg C	PTM
B TEMP	P34T8121V	-55 to 120 deg C	PTM
Indicates Flex Multiplexer/Demultiplexer A and B (FMDM) temperatures. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off			
SAC EPDSU *1* TEMP	P34T5221V	-30 to 60 deg C	PTM
2 TEMP	P34T5205V	-30 to 60 deg C	PTM
Indicates Enhanced Power Distribution and Switching Unit (EPDSU) temperature. Nominal operational temperature limits are –20 deg c to 50 deg C			

COMPS:

SSEOVR001 – Determines power status of the PPCU DPCs.

if (P34K4024Y = 1 and P34K4026Y = 1 and P34K4050Y = 1 and P34K4052Y = 1 and P34K4054Y = 1 and P34K4056Y = 1) then

    SSEOVR001 = 2

if (P34K4024Y = 0 and P34K4026Y = 0 and P34K4050Y = 0 and P34K4052Y = 0 and P34K4054Y = 0 and P34K4056Y = 0) then

    SSEOVR001 = 0

  else

    SSEOVR001 = 1

Verify that this is the correct version before use

SSEOVR002 – Determines power status of the SPCU DPCs.

if (P34K4028Y = 1 and P34K4030Y = 1 and P34K4058Y = 1 and
P34K4060Y = 1 and P34K4062Y = 1 and P34K4064Y = 1) then
    SSEOVR002 = 2
if (P34K4028Y = 0 and P34K4030Y = 0 and P34K4058Y = 0 and
P34K4060Y = 0 and P34K4062Y = 0 and P34K4064Y = 0) then
    SSEOVR002 = 0
else
    SSEOVR002 = 1

SSEOVR003 – Determines power status of the PPCU DPCs.

if (P34K4024Y = 0 and P34K4026Y = 0 and P34K4028Y = 0 and
P34K4030Y = 0 and P34K4052Y = 0 and P34K4060Y = 0) then
    SSEOVR003 = 0
else
    SSEOVR003 = 1

6.3.6   SM 212 Emulation Display Description

Figure 6-12. SM 212 emulation display

Verify that this is the correct version before use

Table 6-12. SM 212 emulation description

BACKGROUND	MSID	TEXT	SRC
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
AMSB ON	SSECON015	0 = blank, 1 = 'A', 2 = 'B', 3 = '*'	UCB
Indicates power status (on) for the A or B sides of the Advanced Mechanism Select Box (AMSB)			
AMSB OFF	SSECON015	0 = '*', 1 = 'B', 2 = 'A', 3 = blank	UCB
Indicates power status (off) for the A or B sides of the Advanced Mechanism Select Box (AMSB)			
AMSB DC AMPS	P34C2025V	-1.00 to 5.00 amps	PTM
AMSB AC AMPS	P34C2111V	0.00 to 5.00 amps	PTM
AMSB TEMP	P34T2003V	-30 to +60 deg C	PTM
Indicates Advance Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C			
MECH (left field) (right field)	W54X8111E W54X8122E	see comps see comps	UCB UCB
Indicates payload retention system 1 feedback related to the A6U circuits controlling the FSS mechanism operations. A backlighted 'A' (flashing on the crew spec) indicates that the mechanism is being driven based on the A6U switch 1 being placed in the REL/LAT position			
DLOCK SEL STAT	P34X2064Y W34X2064Y SSECON009	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red) see comps	PTM UCB UCB
Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A 'DIS' indicates at least 1 of the 2 release feedbacks is high, 'ENG' indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			
PIVOT HI SEL STAT	P34X2061Y W34X2061Y SSECON006	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red) see comps	PTM UCB UCB
Indicates that the PIVOT HI mechanism has been selected (mechanism 4). The pivoter drive motor will pivot the BAPS ring using high torque. Drive times for both the high torque and low torque setting are the same			
Indicates the status of the feedbacks for the pivot high torque mechanism. The field is only displayed when the high torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			

Verify that this is the correct version before use

Table 6-12. SM 212 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
PIVOT LO SEL	P34X2060Y	0 = blank, 1 = '*'	PTM
	W34X2060Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON005	see comps	UCB
Indicates that the PIVOT LO mechanism has been selected (mechanism 3). The pivoter drive motor will pivot the BAPS ring using low torque. Drive times for both the high torque and low torque setting are the same. Indicates the status of the feedbacks for the pivot low torque mechanism. The field is only displayed when the low torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			
PIVOT LO TACH	P34R2108V	0.00 to 9.99 deg/min	PTM
Indicates the rotation speed of the pivoter. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast)			
ROTATOR SEL	P34X2062Y	0 = blank, 1 = '*'	PTM
	W34X2062Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON007	see comps	UCB
Indicates that the ROTATOR mechanism has been selected (mechanism 5). Indicates the status of the feedbacks for the rotator mechanism. The field is only displayed when the rotator is selected in the AMSB. A CW indicates at least 1 of the 2 release feedbacks is high, CCW indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			
ROTATOR TACH	P34R2109V	0.0 to 99.9 deg/min	PTM
Indicates the rotation speed of the rotater. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast)			
XLATOR SEL	P34X2063Y	0 = blank, 1 = '*'	PTM
	W34X2063Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON008	see comps	UCB
Indicates that the TRANLATOR mechanism has been selected (mechanism 6). Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A FWD indicates at least 1 of the 2 release feedbacks is high, AFT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			

Verify that this is the correct version before use

Table 6-12. SM 212 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
B LAT 1 SEL STAT	P34X2065Y W34X2065Y SSECON010	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red) see comps	PTM UCB UCB
Indicates that the center berthing latch (1) has been selected. Berthing latch 1 may also be referred to as mechanism 8. Indicates the status of the feedbacks for the berthing latch 1 mechanism. The field is only displayed when the berthing latch 1 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			
B LAT 2 SEL STAT	P34X2066Y W34X2066Y SSECON011	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red) see comps	PTM UCB UCB
Indicates that the starboard berthing latch (2) has been selected. Berthing latch 2 may also be referred to as mechanism 9. Indicates the status of the feedbacks for the berthing latch 2 mechanism. The field is only displayed when the berthing latch 2 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			
B LAT 3 SEL STAT	P34X2067Y W34X2067Y SSECON012	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red) see comps	PTM UCB UCB
Indicates that the port berthing latch (3) has been selected. Berthing latch 3 may also be referred to as mechanism 10. Indicates the status of the feedbacks for the berthing latch 3 mechanism. The field is only displayed when the berthing latch 3 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			
UMB MN SEL STAT	P34X2068Y SSECON013	0 = blank, 1 = '*' see comps	PTM UCB
Indicates that the main umbilical has been selected. The main umbilical may also be referred to as mechanism 11. Indicates the status of the feedbacks for the main umbilical mechanism. The field is only displayed when the main umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks			

Verify that this is the correct version before use

Table 6-12. SM 212 emulation description (concluded)

BACKGROUND		MSID	TEXT	SRC
UMB B/U SEL	STAT	P34X2069Y SSECON014	0 = blank, 1 = '*' see comps	PTM UCB
			Indicates that the back up umbilical has been selected. Indicates the status of the feedbacks for the backup umbilical mechanism. The field is only displayed when the backup umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks	
BSP	SEL STAT	P34X2070Y SSECON021	0 = blank, 1 = '*' see comps	PTM UCB
			Indicates that the BAPS Support Post (BSP) has been selected. The BSP may also be referred to as mechanism 13. Indicates the status of the feedbacks for the BAPS support post mechanism. The field is only displayed when the BAPS support post is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, SET indicates at least 1 of the 2 latch feedbacks is high, L/A indicates that both the latch and release feedbacks for 1 of the 2 sides is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, release and latch feedbacks from different sides	
BSP	(left field) (middle field) (right field)	SSECON022 SSECON023 SSECON024	see comps see comps see comps	UCB UCB UCB
			Indicates whether the BSP is retracted, engaged, or disengaged	
O/R ENA		P34X2072Y	0 = '*', 1 = blank	PTM
			Indicates if override of BOT/EOT microswitches is active. Override will prevent the microswitches from cutting off the motor and the motor will drive to a stall condition against the hardstops	
O/R DIS		P34X2072Y	0 = blank, 1 = '*'	PTM
			Indicates if override is disabled, normal condition	

COMPS:

SSECON015 - This comp indicates the power status for both sides of the AMSB.

MSB-A PWR STATUS P34X2076Y	0	1	0	1
MSB-B PWR STATUS P34X2077Y	0	0	1	1
SSECON015 =	0	1	2	3

Verify that this is the correct version before use

W54X8111E - MECH A - This comp provides payload retention system 1 feedback related to the A6U circuits controlling the FSS mechanism operations. An 'A' is displayed when the mechanism rel or lat feedback indicates high. A backlighted 'A' (flashing on the crew spec) indicates that the mechanism is being driven based on the A6U switch 1 being placed in the REL/LAT position.

P/L 1 SEL 1A REL V54X8111E	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
P/L 1 SEL 1A LAT V54X8113E	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
PL LAT 1 REL CMD V54S8400E	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
PL LAT 1 LAT CMD V54S8402E	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
W54X8111E =	0	1	1	0	2	2	2	0	2	2	2	0	0	0	0	0
Display =		A	A		A	A	A		A	A	A					

W54X8122E - MECH B - This comp provides payload retention system 2 feedback related to the A6U circuits controlling the FSS mechanism operations. An 'B' is displayed when the mechanism rel or lat feedback indicates high. A backlighted 'B' (flashing on the crew spec) indicates that the mechanism is being driven based on the A6U switch 2 being placed in the REL/LAT position.

P/L 1 SEL 2B REL V54X8122E	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
P/L 1 SEL 2B LAT V54X8124E	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
PL LAT 2 REL CMD V54S8404E	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
PL LAT 2 LAT CMD V54S8406E	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
W54X8122E =	0	1	1	0	2	2	2	0	2	2	2	0	0	0	0	0
Display =		B	B		B	B	B		B	B	B					

Verify that this is the correct version before use

W34X2060Y - PIVOT LOW FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2060Y = 1) and (P34X2061Y = 1 or P34X2062Y = 1 or P34X2063Y = 1 or P34X2064Y = 1 or P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then

W34X2060Y = 1

else

W34X2060Y = 0

SSECON005 - PIVOT LO STAT indications.

PIVOT LO SEL P34X2060Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E F
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	A U
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	L T
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON005=	RDY	DN	DN	DN	UP	*	*	*	UP	*	*	*	UP	*	*	*	blank

W34X2061Y - PIVOT HI FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2061Y = 1) and (P34X2062Y = 1 or P34X2063Y = 1 or P34X2064Y = 1 or P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then

W34X2061Y = 1

else

W34X2061Y = 0

SSECON006 - PIVOT HI STAT indications.

PIVOT HI SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E F
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	A U
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	L T
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON006=	RDY	DN	DN	DN	UP	*	*	*	UP	*	*	*	UP	*	*	*	blank

Verify that this is the correct version before use

W34X2062Y - ROTATOR FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2062Y = 1) and (P34X2063Y = 1 or P34X2064Y = 1 or P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then

W34X2062Y = 1

else

W34X2062Y = 0

SSECON007 - ROTATOR STAT indications.

ROTATOR SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	T
SSECON007=	RDY	CW	CW	CW	CCW	*	*	*	CCW	*	*	*	CCW	*	*	*	blank

W34X2063Y - XLATOR FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2063Y = 1) and (P34X2064Y = 1 or P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then

W34X2063Y = 1

else

W34X2063Y = 0

SSECON008 - XLATOR STAT indications.

XLATOR SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	T
SSECON008=	RDY	FWD	FWD	FWD	AFT	*	*	*	AFT	*	*	*	AFT	*	*	*	blank

Verify that this is the correct version before use

W34X2064Y - DLOCK FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2064Y = 1) and (P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then

W34X2064Y = 1

else

W34X2064Y = 0

SSECON009 - DLOCK STAT indications.

DLOCK SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	D E F A U L T
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON009=	RDY	DIS	DIS	DIS	ENG	*	*	*	ENG	*	*	*	ENG	*	*	*	blank

W34X2065Y - B LAT 1 FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2065Y = 1) and (P34X2066Y = 1 or P34X2067Y = 1 or

P34X2068Y = 1)) then

W34X2065Y = 1

else

W34X2065Y = 0

SSECON010 - B LATCH 1 STAT indications.

B LAT 1 SEL P34X2065Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	D E F A U L T
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON010=	RDY	OP	OP	OP	CL	*	*	*	CL	*	*	*	CL	*	*	*	blank

Verify that this is the correct version before use

W34X2066Y - B LAT 2 FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if ((P34X2066Y = 1) and (P34X2067Y = 1 or P34X2068Y = 1)) then

W34X2066Y = 1

else

W34X2066Y = 0

SSECON011 - B LATCH 2 STAT indications.

B LAT 2 SEL P34X2066Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	D
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	E F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L T
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON011	RDY	OP	OP	OP	CL	*	*	*	CL	*	*	*	CL	*	*	*	blank

W34X2067Y - B LAT 3 FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

if (P34X2067Y = 1 and P34X2068Y = 1) then

W34X2067Y = 1

else

W34X2067Y = 0

SSECON012 - B LATCH 3 STAT indications.

B LAT 3 SEL P34X2067Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	D
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	E F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L T
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON012	RDY	OP	OP	OP	CL	*	*	*	CL	*	*	*	CL	*	*	*	blank

Verify that this is the correct version before use

SSECON013 - UMB MN STAT indications.

UMB MN SEL P34X2068Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	T
SSECON013=	RDY	REL	REL	REL	MAT	*	*	*	MAT	*	*	*	MAT	*	*	*	blank

SSECON014 - UMB B/U STAT indications.

UMB B/U SEL P34X2069Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	T
SSECON013=	RDY	REL	REL	REL	MAT	*	*	*	MAT	*	*	*	MAT	*	*	*	blank

SSECON021 - BSP STAT indications.

BSP SEL P34X2070Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	E
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	F A
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	U L
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	T
SSECON021=	RDY	REL	REL	REL	SET	L/A	*	*	SET	*	L/A	*	SET	*	*	L/A	blank

Verify that this is the correct version before use

SSECON022 - This comp indicates the status of the BSP retracted switches.

BSP RET A P34X2105Y	0	1	0	1
BSP RET B P34X2102Y	0	0	1	1
SSECON022 =	blank	RETA	RETB	RET*

SSECON023 - This comp indicates the status of the BSP engaged switches.

BSP ENG A P34X2106Y	0	1	0	1
BSP ENG B P34X2103Y	0	0	1	1
SSECON023 =	blank	ENGA	ENGB	ENG*

SSECON024 - This comp indicates the status of the BSP disengaged switches.

BSP DIS A P34X2107Y	0	1	0	1
BSP DIS B P34X2104Y	0	0	1	1
SSECON024 =	blank	DISA	DISB	DIS*

Verify that this is the correct version before use

7.0   SSE OPERATIONAL CONSTRAINTS AND PREVIOUS ANOMALIES

The following section is designed to allow the console operator quick access to any operational constraints and information on any previous anomalies. This will allow for better judgment real time.

7.1   OPERATIONAL CONSTRAINTS

Operational constraints for STS-109 will consist of both software-controlled items and things that the flight controllers must be aware of during the mission. These constraints are in place to ensure safe mission operations.

7.1.1   SA3s Deployed

The following are the FSS rotational constraints due to structural interference with the orbiter:

For the solar arrays at 0° and the FSS at 90°, there are no clearance issues.

For the solar arrays at 90° and the FSS at 90°, rotations of ±78° from ±V3 forward are allowed.

For the FSS at 75°, there are no clearance issues.

Table 7-1 shows the allowable FSS rotations with the SA3s deployed.

FSS rotational constraints due to structural interference with the orbiter are shown in Table 7-1.

Verify that this is the correct version before use

Table 7-1. Allowable FSS rotations for SA3

FSS PIVOT/NOMINAL ROTATE	SA3 ACTUAL POSITION (degrees)	FSS ROTATE RANGE (degrees)
90/180 FWD	-3.5/0/+3.5	NO CLEARANCE CONCERNS
90/360 FWD	-3.5/0/+3.5	NO CLEARANCE CONCERNS
90/90 FWD	-3.5/0/+3.5	NO CLEARANCE CONCERNS
90/270 FWD	-3.5/0/+3.5	NO CLEARANCE CONCERNS
90/180 FWD	+86.5/+90/+93.5	102 - 258
90/360 FWD	+86.5/+90/+93.5	305 - 78

7.1.2   FSS Mechanisms

For the FSS Mechanisms, the following constraints apply:

a. Any mechanism operation will be immediately halted for an SM ALERT, in order to prevent the driving of two mechanisms at one time. This is the only software controlled operational constraint.

b. The BAPS shall not be pivoted up from 43.8° with the BSP latched or the center pip-pins installed.

c. The BAPS shall not be pivoted down from 90° with the BSP center pip-pins installed.

d. No mechanism shall be powered longer than 30 seconds after movement has stopped

  1. The rotator and pivoter have tachometer telemetry available via SPEC 212, and an FDA will alert the crew of a stalled rotator or pivoter.

  2. For all others or if a tachometer fails, motion is verified via visual observation.

e. The pivoter will not be operated nominally in high torque mode without full concurrence of the SSE Team.

7.2   PREVIOUS ANOMALIES

This section describes all previous SSE anomalies and the outcome of the situation. This section also details the preflight hardware problems and resolutions.

Verify that this is the correct version before use

7.2.1   STS-31

During the Deploy mission, STS-31, no SSE Anomalies were seen.

7.2.2   STS-61

During the first Servicing Mission, STS-61, the Radial Science Instrument Protective Enclosure (RSIPE) A Latch lights did not function during the removal of the Wide Field Planetary Camera (WFPC). There was no impact, as the ground telemetry verified the Latched/Unlatched status. The WFPC-I was successfully removed and WFPC-II was successfully installed in the RSIPE, with ground telemetry verifying the A Latch Seated Status.

Also during STS-61, DPC 5 hard failed during transfer of HST to external power. The DPC voltage dropped from 31.5v to 0.2 v, and the current was less than 0.3 Amps. DPC 5 never picked up the Telescope load. The mission was continued with nominal operations without DPC 5, as mission requirements were only for 8 of 12 DPCs.

7.2.3   STS-82

During STS-82, the second Servicing Mission, the HST Customer expressed concern that the retracted Translation Aids (TAs) would interfere with payload bay door closure if not fully retracted and stowed. During EVA 5 on Flight Day 8, the EVA crew positioned the TAs within the Payload Bay Door Envelope.

7.2.4   STS-103

On STS-103, Servicing Mission 3A, the SSE equipment saw temperatures above the Flight Rule limits on the COPE Lid. This was due to excessive sunlight on the lid. The resolution was to maneuver the Shuttle to a benign attitude.

Also during STS-103, the Rate Sensing Unit (RSU)-2 that was replaced during the Servicing Mission did not fully seat back into its Transport Module (TM). A partially exposed RSU-2 prevented closure of the TM lid. This violated a flight rule. The crew revisited the TM, made additional attempts to fully seat RSU-2 inside the TM, and was successful in reseating the RSU in the TM. The TM lid was latched, meeting the safe-to-land criteria.

7.2.5   STS-109

During the STS-109, SM 3B, preflight testing, three anomalies were found.

7.2.5.1   FSS TVAC

The pivoter on the FSS successfully completed 4 cycles of system level Thermal Vacuum (TVAC) testing. The BAPS post exhibited higher than normal retraction force during post TVAC manual retraction. The BAPS post was re-worked and 2 additional FSS system level TVAC cycles were conducted to qualify the post for flight. The pivoter

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CDU stalled unexpectedly while pivoting up during FSS/BAPS post TVAC testing. The CDU stalled 4° short of reaching the 90° position during the second (final) cold cycle. The BAPS post was removed, and the pivoter operated nominally. Initially conclude the post was the problem. The pivoter CDU rate and current draw were erratic while pivoting down, without the post. The investigation included the BAPS post, the pivoter CDU, the Electrical Ground Support Equipment (EGSE), the Mechanical GSE (MGSE), the pivoter journal bearings and interfaces, the pivoter mechanism, the ground operations and test setup, and contamination. Verification of test data, setup, procedures and documentation eliminated the EGSE and the MGSE setup. Contamination was evaluated during all phases of inspection.

The BAPS post was eliminated from the investigation due to reoccurrence of stall conditions at ambient, without the post installed. The post was reinspected, and retested and was approved for flight.

The CDU was replaced with a flight spare, and the pivoter repeated erratic behavior, with the post, during ambient testing. The flight CDU was sent back to the manufacturer to repeat Acceptance Testing. The flight CDU was reinstalled onto the pivoter and is acceptable for flight.

The pivoter tower bushing and the journal bushing were inspected and both were nominal; however, the dry film coating on the thrust plates was found to be worn. The abrasions were buffed out and the thrust plates were replaced. These abrasions were insufficient to provide the force required to stall the CDU.

The pivoter was sent to the manufacturer for complete inspection, with no obvious damage to the components or debris found. Minor spalling was discovered on one of the planet gears; however, gears were acceptable for flight. The hardware was reassembled and retested in an attempt to recreate the anomaly. During ambient testing 5.5 pivot cycles were successfully performed in clean room testing and 5.5 cycles were completed successfully in TVAC testing. Anomaly could not be repeated and all data was nominal. The following parts were replaced as risk mitigation: ball bearings between housing and output gear, both pinion gear bearings, all idler gear bearings, and the planet gear spindles. The thrust needle bearing was fully inspected and found to be in good condition.

Pivoter was retested with a new test stand fixture, and functioned properly. The FSS underwent requalification testing in TVAC. Refurbished pivoter with new test fixture was tested in the TVAC 24 times, 12 with BAPS post, 12 without BAPS post. The anomaly was determined to be a product of the nonrealistic 1-g loads that will not be present in zero-g on-orbit environment.

7.2.5.2   TVAC BSP

The BAPS post would not retract during the manual retraction following the post TVAC Comprehensive Performance Test (CPT). The post jammed in the extended position, with a required retraction force of 12 lb (twice the expected). The post was

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disassembled and two bearing pellets appeared to be slightly worn. The pellets were determined to be burnished, but the wear patterns were not unusual. Modeling indicated that the wear was great enough the pellets would catch on the internal edge of the outer tube and cause the post to stall. Spare flight quality pellets (with ramps machined into one end) were installed to prevent binding. The post was rebuilt and tested and now operates as well as, if not better than, before. Post was manually extended and retracted three times with no anomalies observed.

7.2.5.3   FSS FMDM Wiring

During the SM 3B, STS-109, preflight assembly of the FSS, the Heater current wiring was incorrectly connected to the FMDMs. This forces the flight controller to look at different telemetry. Namely for the 1B Heater current, the 2B MSID must be used; for the 2B heater current, the 2A MSID must be used; and for the 2A heater current, the 1B MSID must be used.

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APPENDIX A
ACRONYMS AND ABBREVIATIONS

A/D	Analog-to-Digital
ac	Alternating Current
ACP	Astronaut Control Panel
ACS	Advanced Camera for Surveys
ACTR 5	Actuator 5
AFD	Aft Flight Deck
AID	Analog Input Differential
AKA	Active Keel Actuator
ALC	Automatic Light Control
AMSB	Advanced Mechanism Selection Box
APE	Auxiliary PFR Extender
ASIPE	Axial Science Instrument Protective Enclosure
ASLR	Aft Shroud Latch Repair
ATM	Auxiliary Transport Module
BAPS	Berthing and Positioning System
BAR	Berthing Assist and Restraint
BITE	Built-In Test Equipment
BOT	Beginning of Travel
BSP	BAPS Support Post
BSR	BITE Status Register
BTU	Bus Terminal Unit
CAB	Cabin
CASH	Cross Aft Shroud Harness
CAT	Crew Aids and Tools
CCTV	Closed Circuit Television
CDU	Common Drive Unit
CEP	Containment Environmental Package
CNTL	Control
COPE	Contingency ORU Protective Enclosure
CPC	Cyro Port Cover
CPT	Comprehensive Performance Test
CPUA	Clamp Pickup Assembly
CRES	Corrosion-Resistant Steel
CSM	Cargo Systems Manual
CSS	Center Support Structure
DBA	Diode Box Assembly
DBC	Data Bus Coupler
	Diode Box Controller
dc	Direct Current
DI/DO	Discrete Input/Discrete Output
DIH	Discrete Input High

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DIL	Discrete Input Low
DOF	Degree of Freedom
DOH	Discrete Output High
DOL	Discrete Output Low
DPC	Direct Power Converter
DPST	Double Pole, Single Throw
D/R	Deploy/Return
ECU	Electronic Control Unit
EGSE	Electrical Ground Support Equipment
EMU	Extravehicular Mobility Unit
ENA	Enable
EOT	End of Travel
EPDSU	Enhanced Power Distribution and Switching Unit
EPDU	Electrical Power Distribution Unit
ESM	Electronic Support Module
ESS	Essential
EURM	Emergency Umbilical Retract Mechanism
EVA	Extra-Vehicular Activity
EXT	External
FD	Flight Day
FDA	Fault Detection/ Annunciation
FGS	Fine Guidance Sensor
FHST	Fixed Head Star Tracker
FMDM	Flexible Multiplexer/Demultiplexer
FOC	Faint Object Camera
FSS	Flight Support Structure
FWD	Forward
FXC	Forward X-Constraint
GPC	General Purpose Computer
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HOST	Hubble On-Orbit Space Test
HPGSCA	HST Payload General Support Computer Assembly
HRD	Harness Restraint Device
HST	Hubble Space Telescope
HTR	Heater
I/F	Interface
I/O	Input/Output
ICD	Interface Control Document
IND	Indicator
IOM	Input/Output Module

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IPCU	Interface Power Control Unit
IVA	Intravehicular Activity
J-BOX	Junction Box
JSC	Johnson Space Center
L/A	Latch Assist
LAT	Latch
LIS	Load Isolation System
LOPE	Large ORU Protective Enclosure
LPS	Light and Particle Shield
LRU	Line Replaceable Unit
MCA	Motor Control Assembly
MCC	Mission Control Center
MDI	Magnetically Damped Isolator
MDM	Multiplexer Demultiplexer
MET	Mission Elapsed Time
MGSE	Mechanical Ground Support Equipment
MIA	Multiplexer Interface Adapter
MLI	Multilayer Insulation
MMC	Mid-Motor Controller
MMCA	Mid Motor Control Assembly
MNA	Main A
MNB	Main B
MOD	Mission Operations Directorate
MOPE	Multi-Mission ORU Protective Enclosure
MSID	Measurement Stimulus Identification
M-STRUT	magnetic strut
MULE	Multi-Use Lightweight Equipment
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Lab
NCC	NICMOS CryoCooler
NCS	NICMOS Cooling System
NICMOS	Near Infrared Camera and Multi-Object Spectrometer
NOBL	New Outer Blanket Layer
NRZ-L	Non-Return-to-Zero Level
NSTS	National Space Transportation System
NT	NOBL Transport System
	Transporter
OPA	ORU Plate Assembly
ORB	Orbiter
ORU	Orbital Replacement Unit
ORUC	Orbit Replacement Unit Carrier

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PA	Pallet Assembly
PBM	Payload Bay Mechanical
PCM	Pulse-Code Modulation
PCN	Page Change Notice
PCU	Power Control Unit
	Power Conditioning Unit
PDI	Payload Data Interleaver
PDIP	Payload Data Interface Panel
PDRS	Payload Deployment and Retrieval System
PDSU	Power Distribution and Switching Unit
PE	Protective Enclosure
PFR	Portable Foot Restraint
PGT	Pistol Grip Tool
PI	Payload Interrogator
PL	Payload
PLB	Payload Bay
PLBD	Payload Bay Door
POH	Pulse Output High
PPCU	Port Power Conditioning Unit
PRB	Preload Release Bracket
PRCS	Primary Reaction Control System
PRLA	Payload Retention Latch Actuator
PROM	Programmable Read-Only Memory
PRT	Power Ratchet Tool
PSP	Payload Signal Processor
PWR	Power
RAC	Rigid Array Carrier
REL	Released
RF	Radio Frequency
RL	Retention Latch
RMS	Remote Manipulator System
RSIPE	Radial Science Instrument Protective Enclosure
RSU	Rate Sensing Unit
RWA	Reaction Wheel Assembly
SA	Solar Array
SAC	Second Axial Carrier
SADA	Solar Array Drive Adapter
SADM	Solar Array Drive Mechanism
SAP	SAC Adaptor Plate
SCU	Sequence Control Unit
SI	Science Instrument
SIP	Standard Interface Panel
SLP	SpaceLab Pallet

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SM	Servicing Mission
	Systems Management
SMEL	Servicing Mission Equipment List
SOPE	Small ORU Protective Enclosure
SORU	Small Orbital Replaceable Unit
SPCU	Starboard Power Conditioning Unit
SSE	Space Support Equipment
SSP	Standard Switch Panel
SSPC	Solid State Power Controller
SSSH	Space Shuttle Systems Handbook
STBD	Starboard
STOCC	Space Telescope Operations Control Center
STS	Space Transportation System
SURV	Survival
TA	Translation Aid
tb	talkback
TM	Transport Module
TVAC	Thermal Vacuum
UA	Umbilical Actuator
UARS	Upper Atmospheric Research Satellite
UASE	UARS Airborne Structure Equipment
UDM	Umbilical Disconnect Mechanism
UPS	Under Pallet Storage
USA	United Space Alliance
VCU	Video Control Unit
VIK	Voltage Improvement Kit
WFPC	Wide Field Planetary Camera
WRKLT	Worklight

Verify that this is the correct version before use

APPENDIX B
FMDM SYSTEM DESCRIPTION

B.1   FMDM COMPONENTS

The principal elements of the FMDM, as shown in Drawing TBS, Drawing TBS or Drawing TBS, include the Multiplexer Interface Adapter (MIA), Sequence Control Unit (SCU), Analog-to-Digital (A/D) converter, and the Input/Output Modules (IOMs).
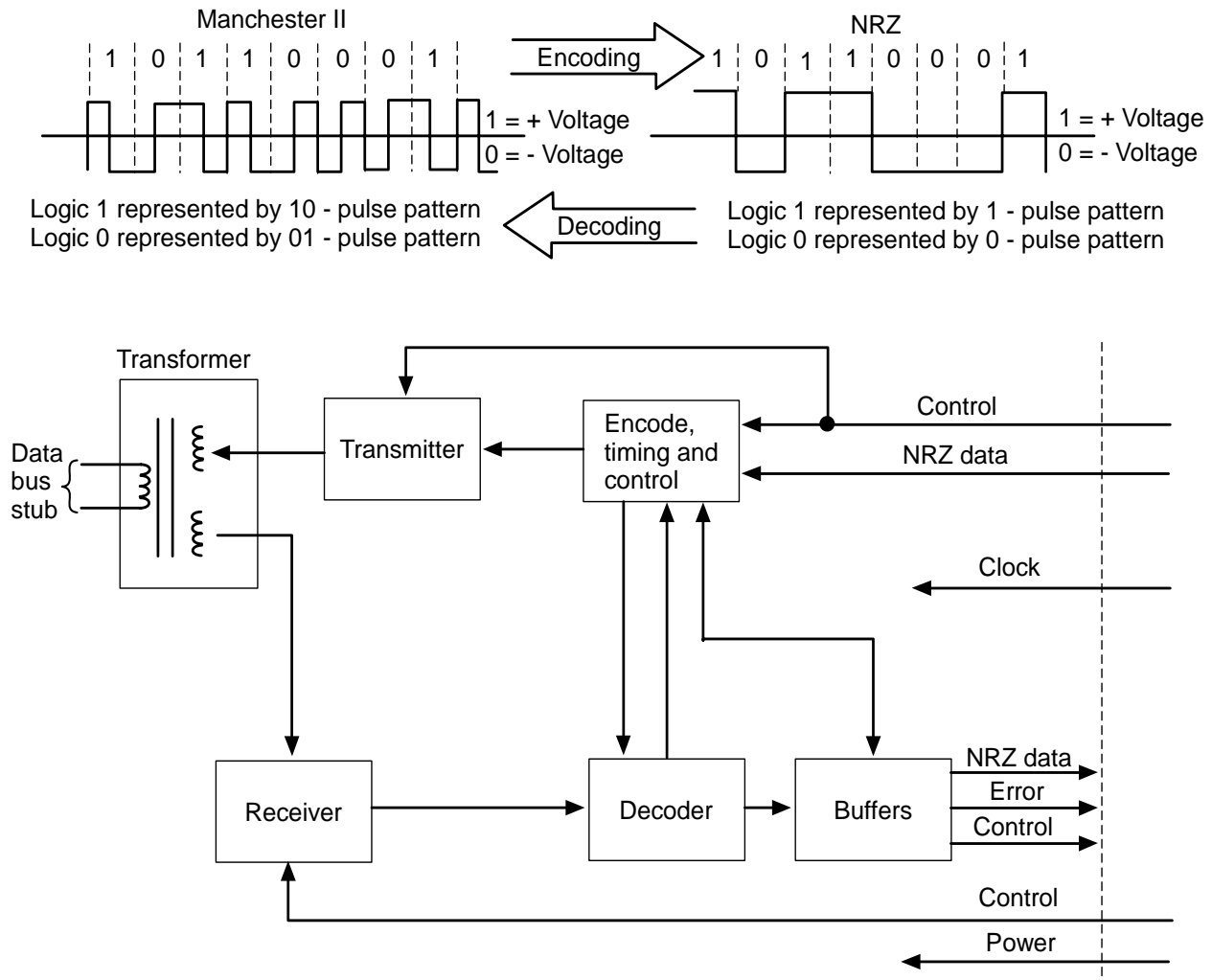
The MIA is a bidirectional communication link between the SM GPC and the FMDM, which encodes and decodes the data between the payload data bus and the SCU. The MIA operates as a half-duplex transmitter or receiver, so receiving and transmitting functions are performed over a single data bus (see Figure B-1).

The GPC communicates with the FMDM using 28-bit words formatted as shown in Figure B-2. The first three bits of each word comprise the sync code. Upon receipt of a valid sync code from the data bus, the MIA begins to decode the remainder of the word from a Manchester II format to a Non-Return-to-Zero Level (NRZ-L).

Following decoding, each bit is then shipped sequentially to the SCU. The SCU uses the information contained in the next 25 bits to control the operations of the MIA, as well as the other FMDM components. Following decoding, the MIA generates error flags in response to detected errors in parity, errors in the number of bit counts, or invalid Manchester codes. The presence of any one of these error flags will cause the FMDM to stop processing and discard the rest of the data.

In the transmit mode, the MIA receives the data from the SCU, generates the sync code, encodes the data to a Manchester II format, and transmits the data over the payload data bus. It should be noted that for the MIA to enter the transmit mode, the appropriate command word must be received and decoded, instructing the SCU to configure the MIA to transmit. The GPC software is programmed to issue the requests to read the FMDM status and parameters at regular intervals and is referred to as GPC polling.

The SCU is the heart of the FMDM. The SCU controls the flow of data between the payload data bus and the IOMs and all the internal operations of the FMDM and provides internal timing. The SCU receives serial NRZ-L 25-bit messages from the MIA and converts the message into control signals for the operations of the IOMs, the MIA, and the A/D converter. Similarly, the SCU accepts information from the IOMs or the A/D converter and formats the data into serial response data words for transmission through the MIA to the GPC. All SCU operations are controlled by microprograms stored in the control store memory, which is a 512-word by 50-bit Programmable Read-Only Memory (PROM) within the SCU. These microprograms are selected and executed by the appropriate fields in the command word (Figure B-2).
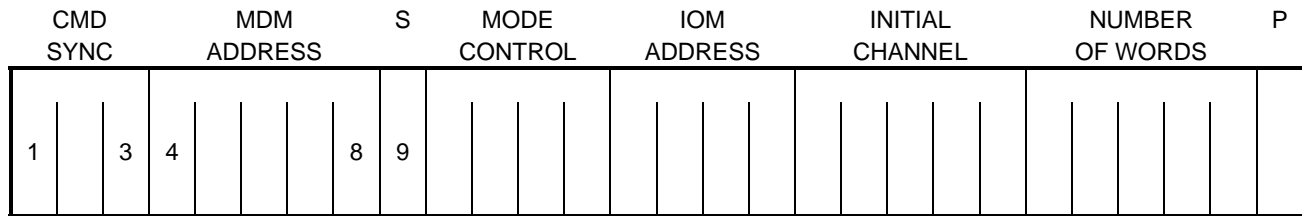
Verify that this is the correct version before use

Manchester II

| | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | |

Encoding →

NRZ

| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

1 = + Voltage
0 = - Voltage

1 = + Voltage
0 = - Voltage

Logic 1 represented by 10 - pulse pattern
Logic 0 represented by 01 - pulse pattern

← Decoding

Logic 1 represented by 1 - pulse pattern
Logic 0 represented by 0 - pulse pattern

usa001948_005.cnv

Figure B-1. FMDM MIA functional diagram

After the MIA receives a sync code, it begins decoding each bit and routing it serially to the SCU. The SCU first checks the 5-bit address code by comparing it to the hardwired pattern. If the bit patterns do not match, the SCU commands the MIA to halt its decoding, and no further processing of the data will occur until the next sync code is detected. If the address is correct and no errors are detected by the MIA, the SCU reads the control field and addresses to properly configure the FMDM for operation.

The A/D converter transforms analog input signals received by the IOMs from the SSE into digital form and transmits the converted data to the SCU. The A/D converter accepts input signals in the range of +5.11 to -5.12 V dc. This input voltage is then represented by a 10-bit digital word that is sent to the SCU, where it is formatted and transmitted to the MIA. An example of an analog measurement is the input from a temperature sensor on the SSE.

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COMMAND WORD FORMAT: DIRECT MODE

CMD SYNC	MDM ADDRESS	S	MODE CONTROL	IOM ADDRESS	INITIAL CHANNEL	NUMBER OF WORDS	P
1 3	4 8	9					

MODE CONTROL = 0100 - RECEIVE COMMAND DATA
0101 - TRANSMIT RESPONSE DATA

COMMAND WORD FORMAT: INDIRECT MODE

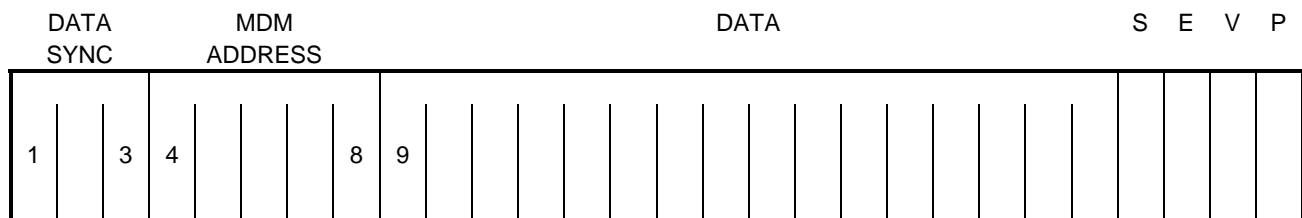| CMD SYNC	MDM ADDRESS	S	MODE CONTROL	PROM SEQUENCE START ADDRESS	NUMBER OF PROM INSTR	P
1 3	4 8	9				
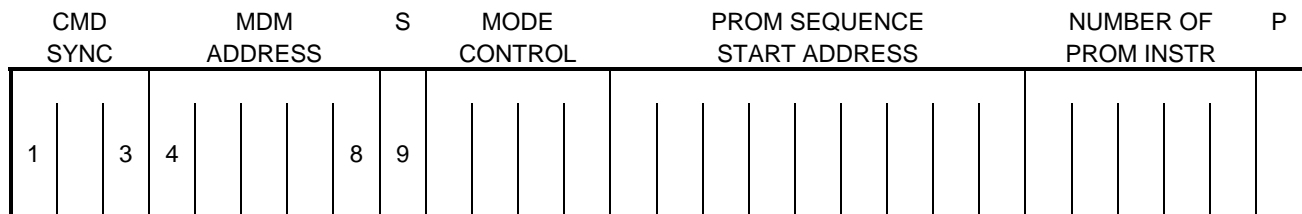
MODE CONTROL = 0010 - EXECUTE THE NUMBER OF PROM INSTRUCTIONS
BEGINNING AT PROM START ADDRESS

COMMAND DATA WORD FORMAT

DATA SYNC	MDM ADDRESS	DATA	CHECK	P
1 3	4 8	9		
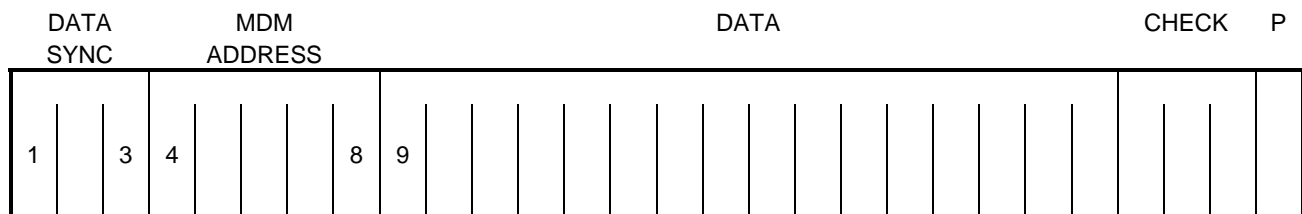
RESPONSE DATA WORD FORMAT

DATA SYNC	MDM ADDRESS	DATA	S	E	V	P
1 3	4 8	9				

MDM ADDRESS = 11101

S= 1 - NOMINAL OPERATION
   0 - IOM OUTPUTS HAVE BEEN RESET TO 0 DUE TO A POWER TRANSIENT

E= 0 - NOMINAL OPERATION
   1 - ERROR ON SERIAL INPUT

V= 1 - NOMINAL OPERATION
   0 - MDM DATA SUSPECT - INTERROGATE BITE STATUS REGISTER

P= PARITY BIT (ODD)

Figure B-2. FMDM data word format

Verify that this is the correct version before use

The IOMs deliver or receive signals from the FMDM interface connectors. The FMDM can have a mixture of analog input IOMs, discrete output IOMs, discrete input IOMs, and pulsed output IOMs. The pulsed output IOMs are not used during this SM. The flight specific configuration is defined in the avionics sections for the various carriers. The description of the various IOM types follows.

a. Discrete Output High (DOH) – The DOH module groups its discrete output into three channels, each with 16 bits per channel. The high-level voltage is 28 V and the low is 0 V.

b. Discrete Input High (DIH) – The DIH module groups its discrete input into three channels, each with 16 bits per channel. The voltage levels are 28 V and 0 V.

c. Pulse Output High (POH) (not used) – The POH module outputs a 28 V, 20- to 30-millisecond pulse. The module is configured with three 16-bit channels.

d. Analog Input Differential (AID) – The AID module will accept up to 32 pairs of analog values with a range between -5.12 V and +5.11 V.

The only change in using FMDM-A or FMDM-B from the orbiter side will be the data bus. Therefore, the GPC does not differentiate which FMDM is active; it only differentiates the data bus with which it is communicating.

The FMDMs are commanded over the payload data bus by the SM GPC. The data transfer occurs in the form of two types of serial 28-bit words, command words, and command data words. The command words are retained by the SCU for internal mode control and initialization. The command data words are gated to an IOM for transmission to the SSE subsystems in the form of discretes DOH.

The various SSE telemetry is converted and formatted by the FMDM into 28-bit words for retransmission to the GPC. These words are referred to as response data words and consist of either one A/D converted 10-bit signal or 16 individual discrete signals. Response data words are transmitted by the FMDM upon GPC request. GPC polling typically occurs once per second.

B.1.1   FMDM Error Indications

The FMDMs do not generate any telemetry concerning their own status (the only telemetry parameters originating from the FMDMs are temperatures).

There are three fault indications that can alert the Mission Control Center (MCC) to possible FMDM problems and their corrections. A BCE BYPASS message usually indicates a failure of a specific card or channel. The card(s) lost may be determined by examining Measurement Stimulus Identifications (MSIDs). An Input/Output (I/O) ERROR FLEX message usually indicates a failed MIA in transmit, receive, or both. An I/O PL2 (PL1) message, in addition to an I/O ERROR FLEX message, usually indicates a PL2 (PL1) data bus problem at the GPC.

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B.1.1.1   FMDM BITE Status Register

The SCU performs extensive real-time tests during FMDM input and output operations. The results of these tests are to set a bit in the Built-In Test Equipment (BITE) Status Register (BSR) if an error is detected. However, the ground will know of this error only if the BSR read command is executed from the MCC. Once the command is executed, the BSR is read, downlinked, and reset. The MCC workstation FMDM overview display, covered in Section 6, shows the explanation of the bit function, the primary conditions that cause the bit to be set, and the SCU reaction to the condition.

The uplink command, built by DPS, specifies a known operational code that informs the GPC to find the known BSR command stored in memory and to send the command to the FMDM. The mode control field 1010 is to send the BITE status register and reset the BSR (see Table B-1). If the SCU BITE test is requested, the mode control field would be 0100; for the A/D BITE test, the mode control field would be 0101; for the power supply BITE test, the mode control field would be 0110; and for the IOM BITE (BITE test 4), the mode control field would be 0111.

The FMDM response data word data portion is placed in the FMDM overview display. The FMDM display reflects the error seen in the FMDM by showing a bit set high in the corresponding field. An explanation of each of the error indications is shown in Table B-1.

The uplink command, which is built by DPS SUPPORT, is a 48-bit command with the following configuration:

Bits 1-3   - Vehicle ID (where OV-105 is 101)
Bits 4-7   - Major function (SM is 1000)
Bits 8-14   - OP code for each load type (0101100 is OP code for MDM BITE data read)
Bit 15   - Set to 1 if first command word
Bit 16   - Set to 1 if last command word
Bits 17-20   - 4-bit binary code identifying the I/O module for BITE 4 (0-15)
Bits 21-25   - 3-fill bits (0) and a 2-bit binary code identifying the channel for BITE 4 (0-2)
Bits 26-32   - MDM number, 7-bit binary code to address particular MDM (FLX1-BCE 10-0001101, FLX2-BCE 11-0001110)
Bit 33   - Transfer count (0 - for BSR, for BITE 4 output card -0, input card -1)
Bits 33-44   - All logical 0s
Bits 45-48   - Variable parameter ID, range from 0 - 10 in decimal

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Table B-1. BSR read table

BSR	Function	Set primary condition	SCU action to condition if internally generated
1	Power applied/interrupt	1. Power up 2. Power down	Bit 25 of two response words cleared if responding at time of occurrence. IOMs are reset. If power up, SCU powerup BITE must be successfully completed prior to MIA receiver enable
2	Incoming data error	1. Command or data word received with valid FMDM address and a. Nonvalid Manchester b. Bit count error c. Bad parity 2. Expected data word received with a. Nonvalid FMDM address b. Nonvalid Manchester c. Bit count error d. Bad parity e. Incorrect check pattern	
3	Operation requested on a nonexistent channel	Nonexistent channel addressed	Continue processing data. During FMDM response, the V-bit reflects this condition on a word-by-word basis
4	Unable to transfer data to/from IOM	IOM not responsive to SCU command	Continue processing data. During FMDM response, the V-bit reflects this condition on a word-by-word basis
5	Too many words in last message	More words received in a message than specified by the command word	Ignore extra data and await receipt of a new command
6	Last command not completed	New command recognized before previous command was completed	Respond to new command if FMDM is addressed and terminate operation on previous command
7	Simultaneous execution on primary and backup data bus	Both SCUs operating simultaneously	Stop processing data until receipt of a new command

Verify that this is the correct version before use

Table B-1. BSR read table (concluded)

BSR	Function	Set primary condition	SCU action to condition if internally generated
8	Illegal mode commanded	Illegal or ambiguous mode has been commanded • Spare mode • Data received with no command • RCV and RSP mixed during sequence execution • Conflict between mode commanded and module class • Addressed module classed as "not present" or "spare"	Stop processing data until receipt of a new command
9	Internal error detected	The SCU has detected an internal error • Sequence memory parity • Internal FMDM buses	Stop processing data until receipt of new command or continue processing data with the V-bit reflecting the condition in the return data words
10	Gap time error	Message receive gap time outside acceptable limits (gap <4 microseconds or gap >11) microseconds	Stop processing data until receipt of a new command
11	Successful BITE completion	Commanded SCU, A/D, or power supply BITE executed successfully	Test terminated upon successful completion or failure detected. No further processing until receipt of a new command
12 - 16	BITE subtest field	Indicates progression through SCU or power supply BITE tests	Indicates last subtest completed

B.1.1.2   BITE Test 4

The FMDM BITE test 4 can be performed on any IOM card (DCIN, DOL, DOH, DIL, DIH); however, the test is most useful to the ground on the discrete output cards since the discrete inputs and DCIN (AID) are seen nominally via telemetry. The BITE 4 is seen on the FMDM display and shows the pattern sent to the Discrete Input/Discrete Output (DI/DO) module and the response back from the module.

Verify that this is the correct version before use

In the DIH BITE test, two separate tests are run via an SCU microcode sequence, BITE 1 and BITE 2. For BITE 1, the IOM generates a sample data word ("true"), consisting of alternating zeros and ones. For BITE 2, or BITE complement, the IOM generates a sample data word, consisting of the opposite combination of zeros and ones. These results are returned in the 32-bit data word seen on the FMDM overview display. A different pattern is used for each of the three channels and provides added benefit for validating the DIH module channel addressing logic. The appropriate response words can be seen in Table B-2. Each DIH card has three separate channels and the test is commanded independently for each channel.

Table B-2. BITE response words for DIH

Channel number	BITE 1 (true) response word in hexidecimal	BITE 2 (complement) response word in hexidecimal	Binary pattern
0	0FF0		0000111111110000
0		F00F	1111000000001111
1	0F0F		0000111100001111
1		F0F0	1111000011110000
2	F0F0		1111000011110000
2		0F0F	0000111100001111

The DOH BITE (BITE test 4) tells the current output (active/inactive state) of the 16 discrete output lines. The actual discrete output for the entire channel is sent back to the GPC in one MDM response word. Therefore, the nominal value of the desired bilevel discrete (or discretes) must be known. The data is downlisted in hex, where the most significant bit is zero. For STS-109, DOH card 3, channels 1 and 2 are used for commands.

The DCIN (AID) BITE test generates two return words for a given channel on an IOM card, the BITE response and the channel input response. The BITE response is generated by scaling the input voltage in half and adding a reference voltage (either +2 V or -2 V, depending on which channel it is) to the scaled voltage. This word is downlinked directly to the FMDM overview display. The second word returned is the input response of the channel. Table B-3 lists which channels get +2 V added to them and which channels get -2 V added.

Table B-3. AID BITE reference voltage table

Ch 0 = +2 V	Ch 7 = -2 V	Ch 14 = -2 V	Ch 21 = -2 V	Ch 28 = -2 V
Ch 1 = -2 V	Ch 8 = -2 V	Ch 15 = +2 V	Ch 22 = -2 V	Ch 29 = +2 V
Ch 2 = -2 V	Ch 9 = +2 V	Ch 16 = -2 V	Ch 23 = +2 V	Ch 30 = +2 V
Ch 3 = +2 V	Ch 10 = +2 V	Ch 17 = +2 V	Ch 24 = +2 V	Ch 31 = -2 V
Ch 4 = -2 V	Ch 11 = -2 V	Ch 18 = +2 V	Ch 25 = -2 V	
Ch 5 = +2 V	Ch 12 = +2 V	Ch 19 = -2 V	Ch 26 = -2 V	
Ch 6 = +2 V	Ch 13 = -2 V	Ch 20 = +2 V	Ch 27 = +2 V	

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Both response words are downlisted in hexidecimal. To determine if the IOM card is functional, the BITE voltage must be calculated. To calculate the BITE voltage, the hexidecimal data must be converted into decimal. The decimal value must be divided by 64 to obtain the Pulse-Code Modulation (PCM) count. The PCM count is multiplied by 10 mV, since each PCM count is 10 mV. The BITE voltage is then calculated by subtracting one-half of the response word 2's voltage from response word 1's voltage.

As an example, consider a test of FMDM card 0, channel 2. Because it is channel 2, the BITE voltage added to one-half of the input voltage will be -2 V. For this example, assume that word 1 is 0C80 and word 2 is 7D00. Word 1 converts to 3200 in decimal and word 2 converts to 32000 in decimal. By dividing each decimal value by 64, word 1 is 50 PCM counts and word 2 is 500 PCM counts. By multiplying the PCM counts by 10 mV, we find that word 1 is 0.5 V and word 2 is 5.0 V. Therefore, by subtracting one-half of word 2's voltage from word 1's voltage, the BITE voltage is -2.0 V. In this example, FMDM card 0, channel 2 is working correctly.

B.1.1.3   SCU BITE Test

The SCU BITE test performs the following:

a. FMDM receiver addressing is checked to verify response to only 1 of 32 possible MDM addresses.

b. Microprogram control store cyclic checking is verified by executing a microsequence with an incorrect cyclic check.

c. All SCU counters are loaded and tested against one another by monitoring for the presence of simultaneous overflow (underflow).

d. Command data word SEV pattern detection capability is tested through generation of invalid SEV patterns and verification that an error can be detected.

e. SCU PROM odd parity detection capability is tested by forcing bad parity.

f. The SCU register file is checked for both read/write errors and addressing errors.

g. With firmware, the following BSR bits are set to logical "1" in various subsets: BSR bits 2, 3, 4, 5, 6, 8, 9, and 10.

h. SCU OUT bus, SCU IN bus, and IOM reply lines are verified by the SCU communicating with each IOM and monitoring the IOM reply lines. The SCU checks that the IOMs will not respond to invalid check bits on the SCU OUT bus.

The SCU BITE test has no response word; thus, it is necessary to read the BSR for the response to the SCU BITE. If the test is successful, bit 11 is set in the BSR to a logical 1. If the SCU BITE is unsuccessful, bit 11 will be 0. Figure B-3 shows which bits will be set in the SCU BSR, depending on the errors found. The numbers represent the logical 1's and the "-'s" represent 0's.

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SCU BITE	After requesting SCU BITE, 1.04 milliseconds must transpire before interrogating the BSR for test results.

No response to request for BSR:

    1.   Fatal cyclic check error
or 2.   Cyclic comparator failure
or 3.   FMDM receiver address comparator failure
or 4.   Counter(s) failure
        a.   Number of words
        b.   Number of instructions
        c.   State control timer

Response to request for BSR:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
–	–	3	–	5	6	–	8	–	–	–	–	–	–	–	16	Output of sequence memory parity always indicates odd parity.
–	–	3	4	5	6	–	8	–	–	–	–	–	–	–	16	Command Data Word check pattern checker recognizes bad check pattern as good.
–	–	3	4	5	6	–	8	9	–	–	–	–	–	–	16	Command Data Word check pattern checker does not recognize good check pattern.
–	–	3	4	5	6	–	8	–	–	–	–	–	–	15	–	Sequence memory parity tree failure
–	2	3	4	5	6	–	8	9	10	–	–	–	–	15	16	Register file failure a. Read write error b. Addressing error
–	2	3	4	5	6	–	8	9	10	–	–	–	–	–	–	Module interface test:

      1.   Addressed module responds to bad check bits
or 2.   Addressed module reply line always asserted
or 3.   Addressed module not powered

BITE TEST FIELD ≥4
Binary address of module being addressed ignoring bit 12 (numbered 0 →15)

If SCU BITE is repeated without cycling FMDM power, bits 3 and 4 will not be set if the addressed module reply line is always asserted or if the addressed module is not powered (2 and 3 above).

| – | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 10 | 11 | 12 | – | – | 15 | 16 | Successful SCU BITE completion. |

Figure B-3. BSR during SCU BITE

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**APPENDIX C
CONFIGURATION CONTROL**

C.1   INTRODUCTION

C.1.1   Purpose

The purpose of this appendix is to delineate configuration control procedures for the CSM. This will ensure the proper coordination of changes and provide a record of proposed changes, rationale, and disposition.

C.2   CONFIGURATION CONTROL PROCEDURE

C.2.1   Submission of Changes

Proposed changes are solicited from any individual or any organization having a valid input. Changes should be submitted to the CSM book manager at mail code DO52, NASA/Johnson Space Center, Houston, Texas 77058.

Individuals desiring to submit a change should complete all applicable items on the Change Request Form (Figure C-1). This form should be typed or neatly printed. Additional pages may be used if the space provided is not adequate. The original completed form should then be forwarded to the CSM book manager.

C.2.1.1   Disposition of Changes

The CSM book manager will obtain formal concurrence and comments from the necessary personnel, including customer representatives. All proposed modifications to the CR will be coordinated with all necessary personnel prior to disposition.

Upon obtaining the required concurrences, the CSM book manager will present the proposed change to the appropriate section head for final disposition.

A copy of all dispositioned CRs will be retained by the CSM book manager for future reference. A courtesy copy of all approved CRs will be sent to ZC01/J. Woodall, EV12/D. Sykes, and MS3/F. W. Parker.

C.3   CSM REVISIONS/CPNS

C.3.1   Development

The CSM book manager will compile all approved changes and any typographical errors and incorporate them into a revision or CPN to the document.

Pen and ink changes may be used to correct typographical errors if there are no other changes on the page concerned.

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C.3.2   Approval

Any revisions/CPNs to the document will be approved by the appropriate section head. Revisions/CPNs to the final versions will also be approved by the manager of the Space Shuttle Systems Integration Office.

C.3.3   Publication

Revisions/CPNs will be made on an as-required basis. Revisions/CPNs will be printed and distributed to the standard distribution list.

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NASA - JOHNSON SPACE CENTER CHANGE REQUEST FORM NUMBER:_____

SECTION(S) AFFECTED:

WAS:

IS:

RATIONALE FOR CHANGE:

ORIGINATOR	CONCURRENCE
NAME _____	_____
	LEAD PAYLOAD OFFICER DATE
ORGANIZATION_____	
TELEPHONE _____	_____
	CUSTOMER REPRESENTATIVE DATE

BOOK MANAGER	
NAME_____ DATE	☐ APPROVED ☐ DISAPPROVED
RECOMMENDATION:_____	☐ APPROVE WITH CHANGES
INCORPORATED:_____ DATE	_____ SECTION HEAD DATE

Figure C-1. Change request form

Verify that this is the correct version before use