PAYLOAD FLIGHT HAZARD REPORT				a. NO:	AMS-02-F14
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)			c. PHASE:	II
d. SUBSYSTEM:	Mechanical, Thermal, Electrical, Pressurized Systems	e. HAZARD GROUP:	Injury/Illness.	f. DATE:	May 22, 2006
g. HAZARD TITLE:	EVA Operations Hazard			i. HAZARD CATEGORY:	CATASTROPHIC **X** CRITICAL
h. APPLICABLE SAFETY REQUIREMENTS:	NSTS 1700.7B, ISS Addendum, 200.1b, 201.3				
j. DESCRIPTION OF HAZARD:	The failure to design and construct the AMS-02 to be compatible with proximity to EVA translation paths and EVA activities can result in injury or death to the EVA crew.				
k. CAUSES *(list)*	1. Inadequate Access for EVA Tasks 2. Excessive Radiation 3. Sharp Edges/Corners 4. Thermal Extremes 5. Release of residual loads/forces applied 6. Excessive Loads/Effort From EVA Crew 7. Electric Shock 8. Entrapment of EVA Crew				

o. APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE III		

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F14
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	II
l. HAZARD CONTROL (CONTROL), m. SAFETY VERIFICATION METHODS (SVM), n. STATUS OF VERIFICATIONS (STATUS)			OPS CONTROL
1. CAUSE: Inadequate Access for EVA Tasks			
1.1 CONTROL: The AMS-02 has provided handholds in appropriate locations to support potential contingency EVAs. This includes EVAs associated with AMS-02 contingency re-routing of connections for power and communications, release of the PAS capture bar and AMS-02 GFE EVAs to the ROEU, the UMA and both grapple fixtures. WIF interfaces are available for all EVA operations where tools are required except the FRGF and PVGF. These have waivers to SSP 57003 for free float operations. 1.1.1 SVM: Review of design. 1.1.2 SVM: Inspection of as built hardware. 1.1.3 SVM: Approval of EVA aid locations/Site Analysis by JSC/XA. 1.1.4 SVM: Approval of Free Float Waivers to SSP 57003 1.1.1 STATUS: Open 1.1.2 STATUS: Open 1.1.3 STATUS: Open 1.1.4 STATUS: Open			
1.2 CONTROL: All AMS-02 Operations involving the use of EVA tools, specifically the EVA release of the PAS, utilize standard EVA bolt interfaces to drive the ramp screws to release the PAS capture bar preload. These bolts are designed to interface with the EVA power tool with a 7/16 in drive. 1.2.1 SVM: Review of Design. 1.2.2 SVM: Tool Fit Check. 1.2.1 STATUS: Open 1.2.2 STATUS: Open			
1.3 CONTROL: AMS-02 EVA mechanisms that the crew is to operate by hand are design to facilitate operations with the gloved hand. All EVA interfaces meet the requirements/intent of NASA-STD-3000, SSP 50005 for crew operability and access.			

PAYLOAD FLIGHT HAZARD REPORT	a. NO: AMS-02-F14
b. PAYLOAD Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE: II

1.3.1 SVM: Review of Design. 1.3.2 SVM: Inspection of as built hardware. 1.3.3 SVM: Crew EVA Inspection 1.3.1 STATUS: Open 1.3.2 STATUS: Open 1.3.3 STATUS: Open	
2. CAUSE: Excessive Radiation	
NOTE: This hazard/cause is addressed in AMS-02-F07 for EMI and magnetic fields, for ionizing radiation, AMS-02-F09.	
3. CAUSE: Sharp Edges/Corners	
3.1 CONTROL: The AMS-02 is designed to eliminate sharp edges, corners, protrusions and any mechanism that could be a pinch or scissor location. The AMS-02 meets the requirements of NSTS 07700, Vol XIV, Appendix 7 for all accessible surfaces and structures, with the exception of the two Star Tracker optical baffles, which by the nature of the optical properties of the baffle, has thin metal edges that do not comply with the rounding of edges. The Star Tracker baffles will be noted as "no touch zones". There has been no identified need for the EVA crew to operate in the immediate vicinity of the Star Tracker baffles. To access these thin sheet edges, the EVA crewmember would have to reach to the interior of the Star Tracker baffle. 3.1.1 SVM: Review of Design 3.1.2 SVM: Inspection of flight hardware (including swatch testing) for sharp edges, corners, etc. 3.1.3 SVM: Acceptance of EVA no touch zone for Star Tracker baffles. 3.1.1 STATUS: Open 3.1.2 STATUS: Open 3.1.2 STATUS: Open	I, S
4. CAUSE: Thermal Extremes	
4.1 CONTROL: The AMS-02 Design precludes contact between an EVA crewmember and surfaces that exceed the thermal limits of 235°F to -180°F (112°C to -118°C) for incidental contact not to exceed 30 seconds in length and 145°F to	

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F14
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	II

-45°F (63°C to -41°C) for continuous contact in EVA work sites. This has considered the required EVA translation paths while in the Orbiter Payload Bay, mounted on the ISS and for potential EVA work sites for contingency actions of Grapple Fixture release, ROEU mate/demate, PAS EVA disconnect, AMS-02 Power/Communications Cable Swap, etc. NOTE: EVA handrails will require detailed acceptance analysis for exposure to solar heating. 4.1.1 SVM: Thermal Analysis of EVA Work Sites and Translation Paths 4.1.1 STATUS: Open	
4.2 CONTROL: Active thermal control devices will not be capable of heating AMS-02 components in exceedence of the EVA thermal limits for touch temperatures [235°F to -180°F (112°C to -118°C)]. Heaters have two thermal switches, on in the return leg and are monitored by the AMS-02 computer system and can be shut of if nominal working limits are exceeded. All of these limits are within the EVA thermal limits for touch temperature. 4.2.1 SVM: Review of Design 4.2.2 SVM: Inspection of as built hardware 4.2.3 SVM: Functional testing of thermal switches 4.2.4 SVM: Functional testing of thermal monitoring by avionics 4.2.5 SVM: Testing of software control of heaters. 4.2.1 STATUS: Open 4.2.2 STATUS: Open 4.2.3 STATUS: Open 4.2.4 STATUS: Open 4.2.5 STATUS: Open	
4.3 CONTROL: The AMS-02 is designed to position vent locations of cryogenic and pressurized systems such that there will be no impingement of possible venting products, which could be extremely cold, upon EVA work sites and translation paths. 4.3.1 SVM: Review of Design of vents, vent locations and orientations. 4.3.2 SVM: Plume impingement assessment. 4.3.1 STATIS: Open	

PAYLOAD FLIGHT HAZARD REPORT	a. NO: AMS-02-F14	
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4.3.2 STATUS: Open		
5. CAUSE: Release of Residual Loads/Forces Required		
5.1 CONTROL: The potential EVA operation to move AMS-02 EVA connectors to restore communications paths or redirect power does not involve systems that involve stored mechanical energy. 5.1.1 SVM: The design of the EVA connectors, cable restraints and EVA panel will be reviewed for any mechanically stored energy. 5.1.1 STATUS: Open		
5.2 CONTROL: The EVA release mechanism for the PAS passive mechanism releases stored energy (5650 lb preload) by the operation of the two EVA operated release mechanisms, each using a screw driven ramp that slowly releases the tension of latched capture bar. Two mechanisms must be released fully to allow for the capture bar to clear interference brackets that preclude the attempts to extract the bar prior to full release of the preload. During release, the AMS-02 will be restrained by the SSRMS to preclude a released mass. The SSRMS will be put into a relaxed state to preclude a build up of loads that could be released with the removal of the bar. 5.2.1 SVM: Review of Design. 5.2.2 SVM: Inspection of as built hardware. 5.2.3 SVM: Functional testing of EVA PAS Release Mechanism. 5.2.4 SVM: Review of Procedures associates with the EVA release of the AMS-02 PAS capture bar. 5.2.1 STATUS: Closed. Memo ESCG-4390-06-SP-MEMO-0001, "Mechanical Design of the Payload Attach System (PAS)", Dated 8 January, 2006 from AMS-02 Chief Engineer. 5.2.2 STATUS: Closed. Memo ESCG-4390-06-SP-MEMO-0003, "Quality Inspection of the Payload Attach System" dated 03 March 2006, from AMS-02 Chief Engineer Chris Tutt. 5.2.3 STATUS: Closed. Memo ESCG-4390-05-SP-MEMO-0012, "Functional Testing of the Payload Attach System" dated 28 December 2005, from AMS-02 Chief Engineer Chris Tutt. 5.2.4 STATUS: Open		I
5.3 CONTROL: The ROEU folding bracket design does not incorporate any nominal stored energy devices in the design, however the wire bundles that are routed around the rotation joint will have an inherent resistance to being repositioned and		

PAYLOAD FLIGHT HAZARD REPORT	a. NO: AMS-02-F14
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will have a small tendency to resist going into a non-neutral position. This force will be quite low and will not pose a threat to the EVA crew. Cable routing and restraint will be used to minimize the force that the crew must either apply or expect from the folding operation. 5.3.1 SVM: Post Assembly testing of resistance/spring-back force of the ROEU bracket. 5.3.1 STATUS: Open	
NOTE: The EVA tasks involving the release of grapple fixtures and other GFE hardware items are not covered under these assessments as the AMS-02 does not have any involvement in the design and operation of these EVA tasks.	
6. CAUSE: Excessive Loads/Effort from EVA Crew	
6.1 CONTROL: Mate/demating of EVA compatible connectors, operation of PAS passive mechanism for releasing stored energy and extraction of capture bar and folding of the ROEU bracket have all been assessed and established to be within EVA crew capabilities. 6.1.1 SVM: Ground testing of EVA interfaces. 6.1.1 STATUS: Open	
6.2 CONTROL: The AMS-02 PAS Release Mechanisms utilized a large number (greater than 50) rotations of each of the drive mechanisms to effect release. The EVA Power Tool has been identified as a required EVA tool to minimize crew efforts and repetitive motion. 6.2.1 SVM: Review of EVA Procedures 6.2.1 STATUS: Open	I
7. CAUSE: Electric Shock	
NOTE: Electric Shock for EVA crew (only electric shock potential for AMS-02) is addressed in AMS-02-F08.	
8. CAUSE: Entrapment of EVA Crew	
8.1 CONTROL: The design of the AMS-02 is such that all cables length and position are such that they will not snare or entangle EVA crew during EVA access to the AMS-02 or translation past or adjacent to the AMS-02. 8.1.1 SVM: Review of design. 8.1.2 SVM: Inspection of as built hardware.	

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8.1.1 STATUS: Open

8.1.2 STATUS: Open

8.2 CONTROL: Magnetic field (operating and residual in discharged state) is insufficient to entrap an EVA crew member by attraction of ferromagnetic materials in the EMU or EVA tools. During EVA access to the AMS-02 the magnetic field will be discharged and charging will be inhibited (Ref AMS-02-F07) and the residual field (<15 gauss) is insufficient to attract and hold an EVA Crewmember.

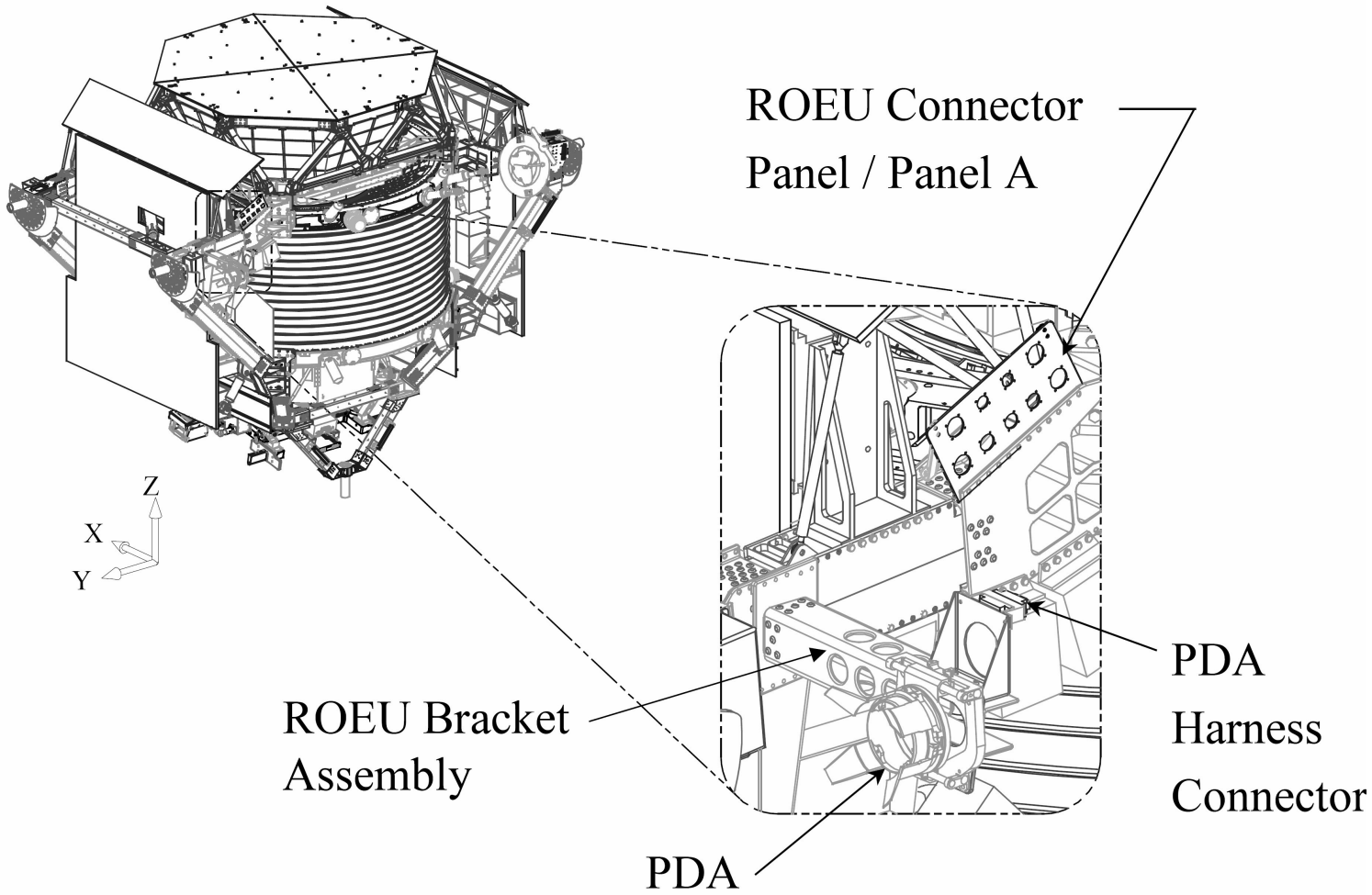
8.2.1 SVM: Magnetic Field Analysis

8.2.1 STATUS: Open

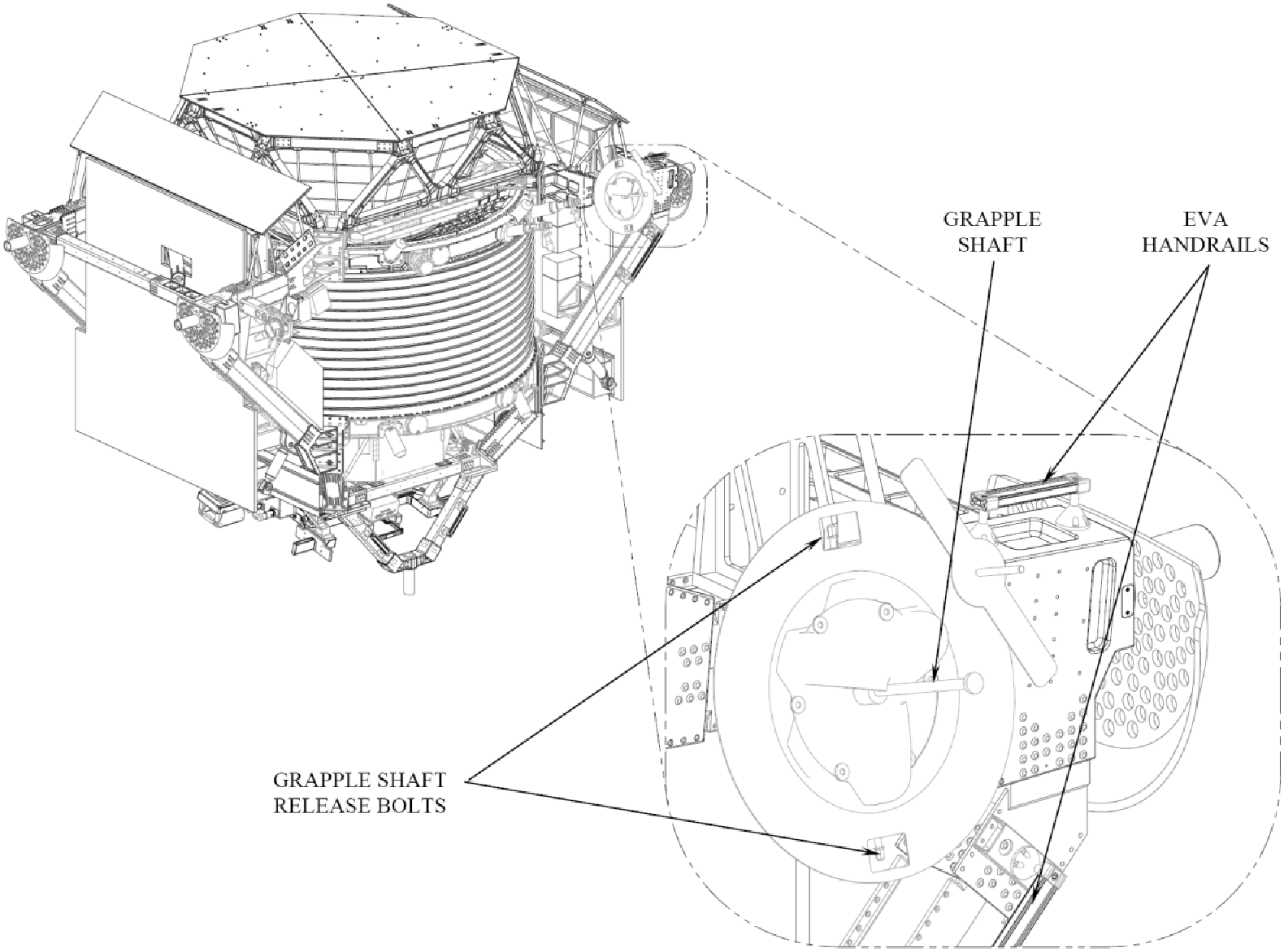
ACRONYMS	
°C – Degrees Centigrade (Celsius)	GFE – Government Furnished Equipment
°F – Degrees Fahrenheit	PAS – Payload Attach System, Payload Attach Site
AMS-02 – Alpha Magnetic Spectrometer - 02	PVGF – Power Video Grapple Fixture
ATA -	ROEU – Remotely Operated Electrical Umbilical
EMI – Electromagnetic Interference	SRMS – Shuttle Remote Manipulator System
EMU – Extravehicular Mobility Unit	SSRMS – Space Station Remote Manipulator System
EVA – Extravehicular Activity	SVM – Safety Verification Method
FRGF – Flight Releasable Grapple Fixture	WIF – Worksite Interface Fixture

SHUTTLE BASED EVAs

- ROEU Release/Mate
- FRGF Release
- PRLA Release/Closure



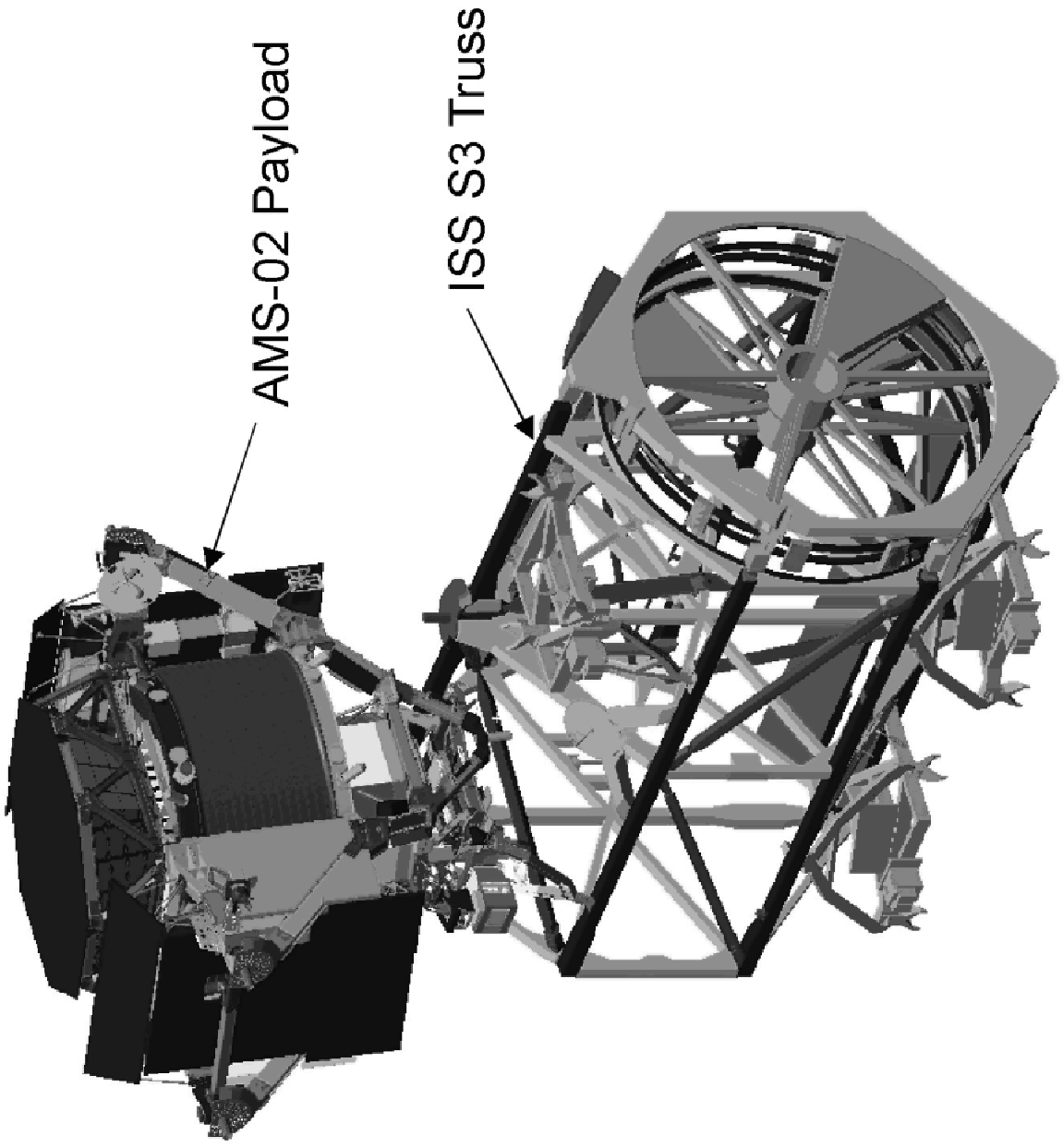
Potential EVA Work Site: Remotely Operated Electrical Umbilical (ROEU)



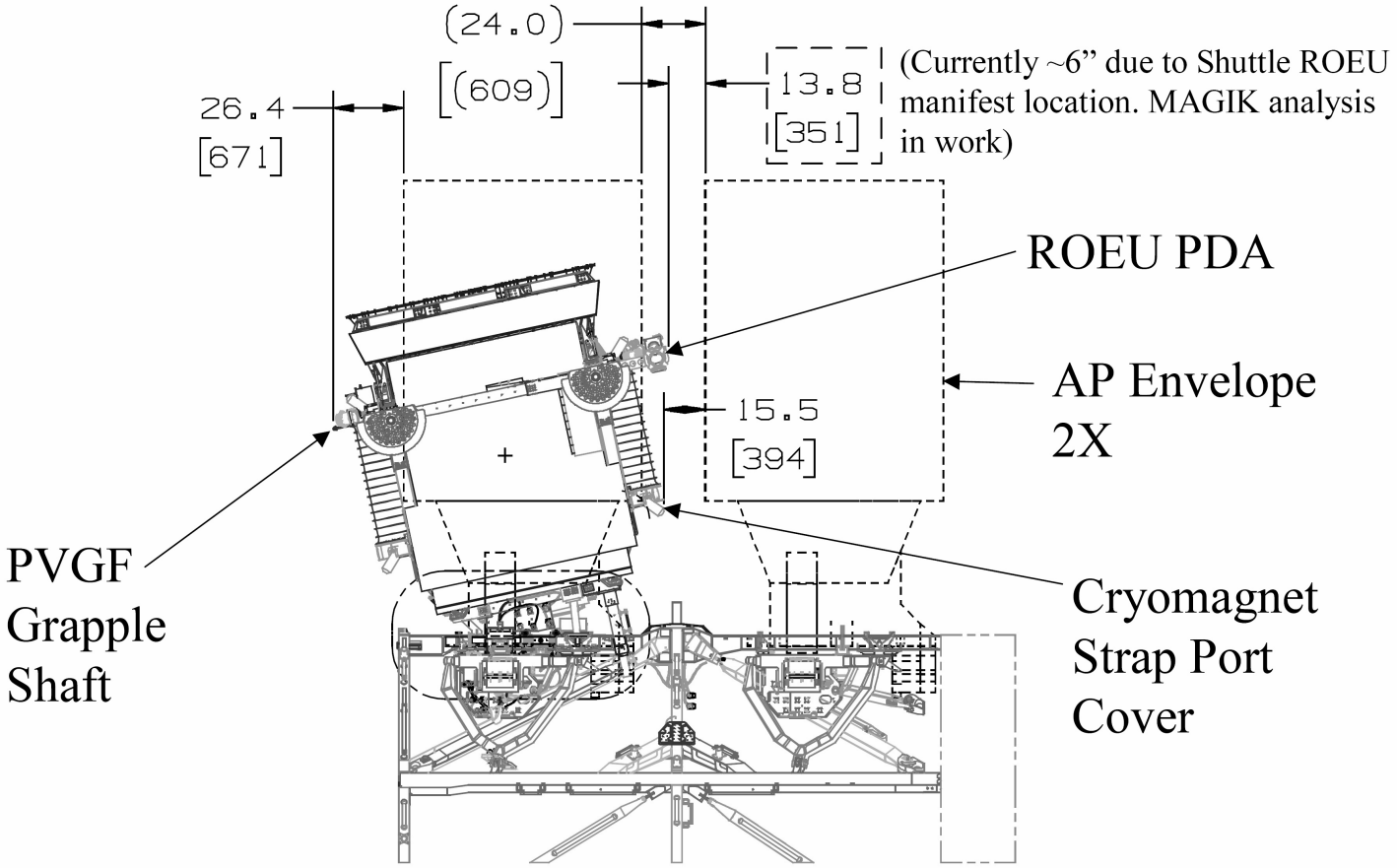
Potential EVA Work Site: Flight Releasable Grapple Fixture (FRGF)

ISS BASED EVAs

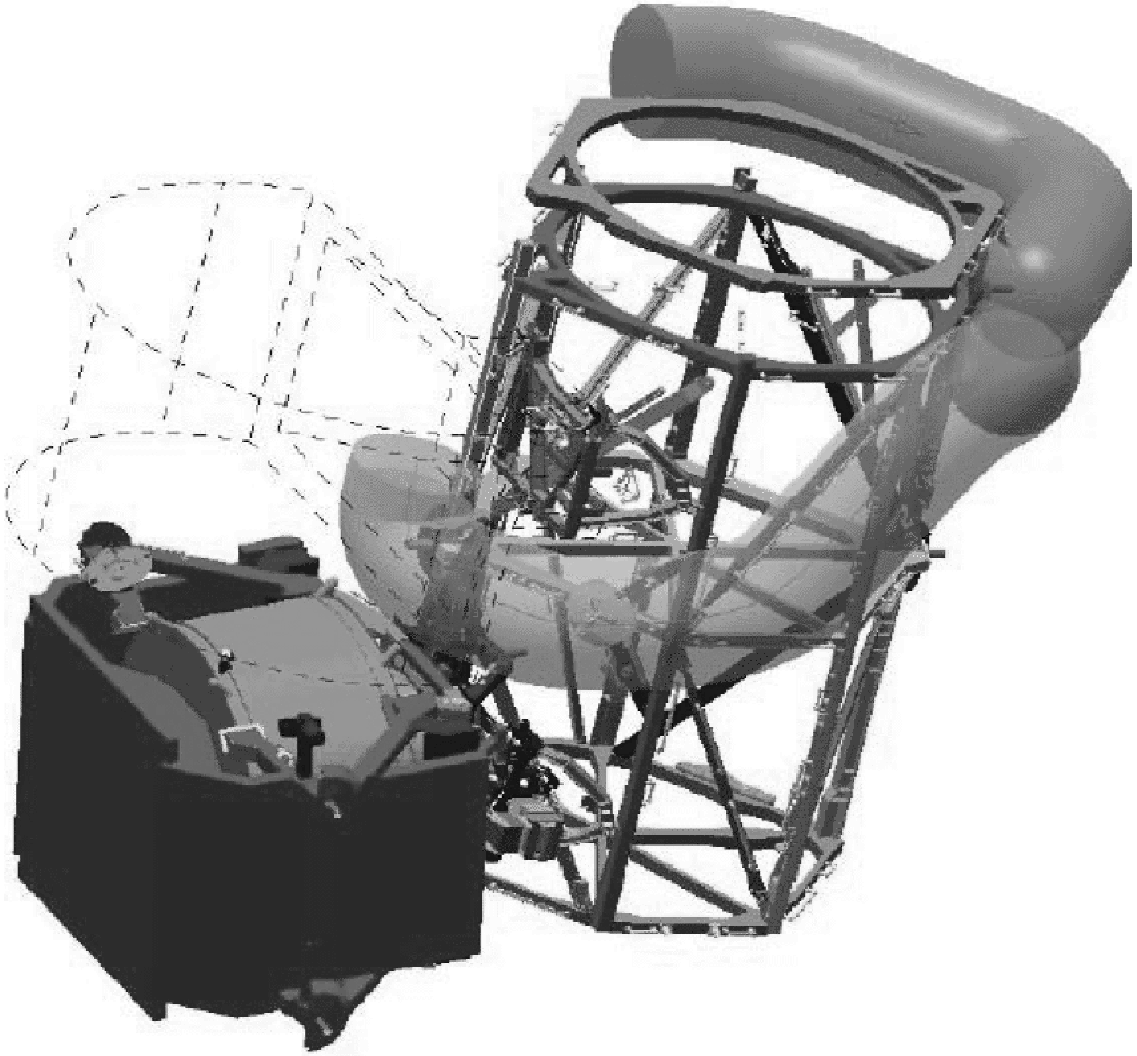
- General Translation Compatibility
- AMS-02 Passive PAS Release
- ISS UMA Release/Connect
- AMS-02 EVA Connector Swap
- ISS PVGF Release
- ROEU Bracket Folding



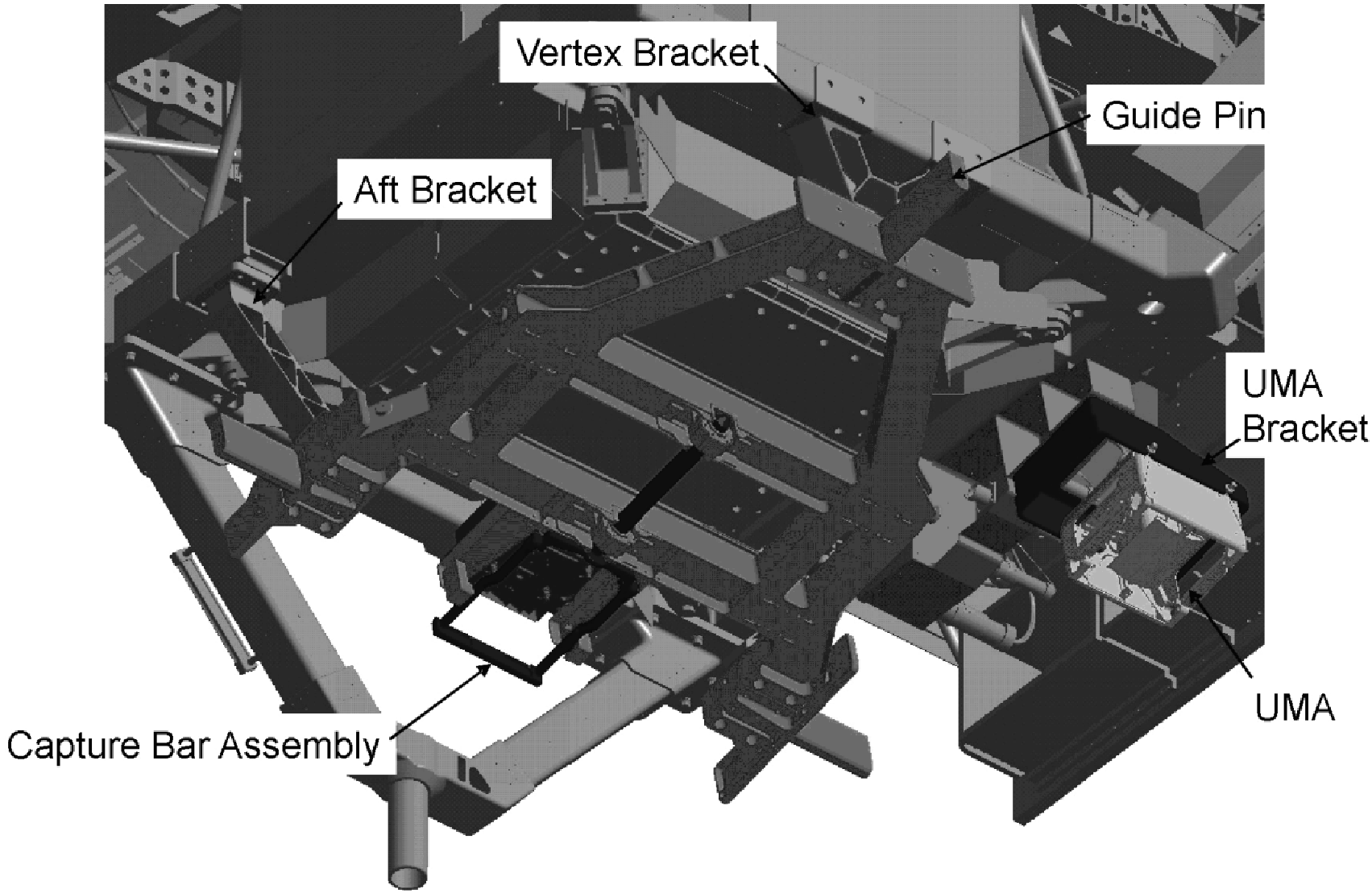
AMS-02 Location During Potential ISS Based EVAs



AMS-02 Location During Potential ISS Based EVAs

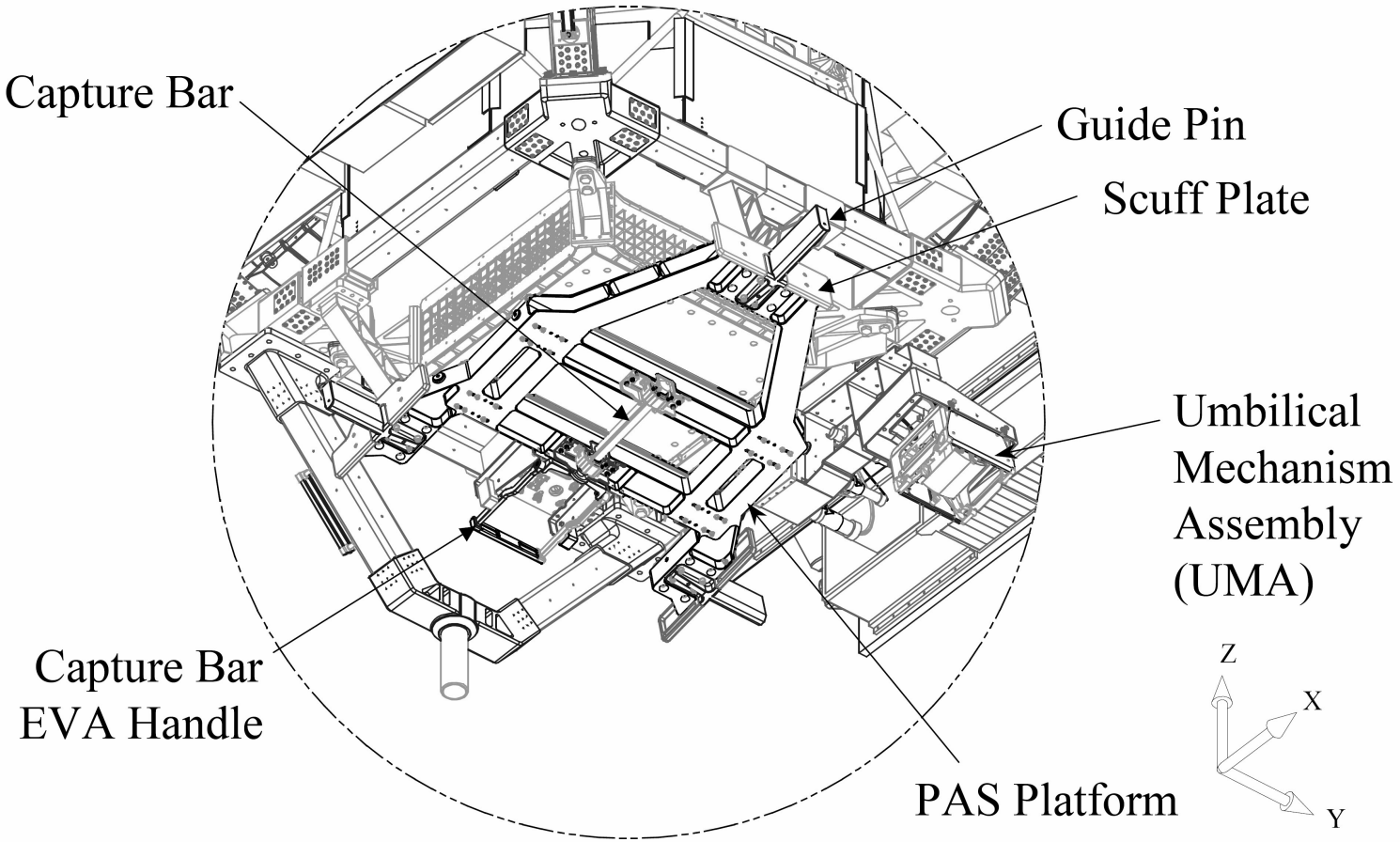


EVA Worksite Translation Analysis Results

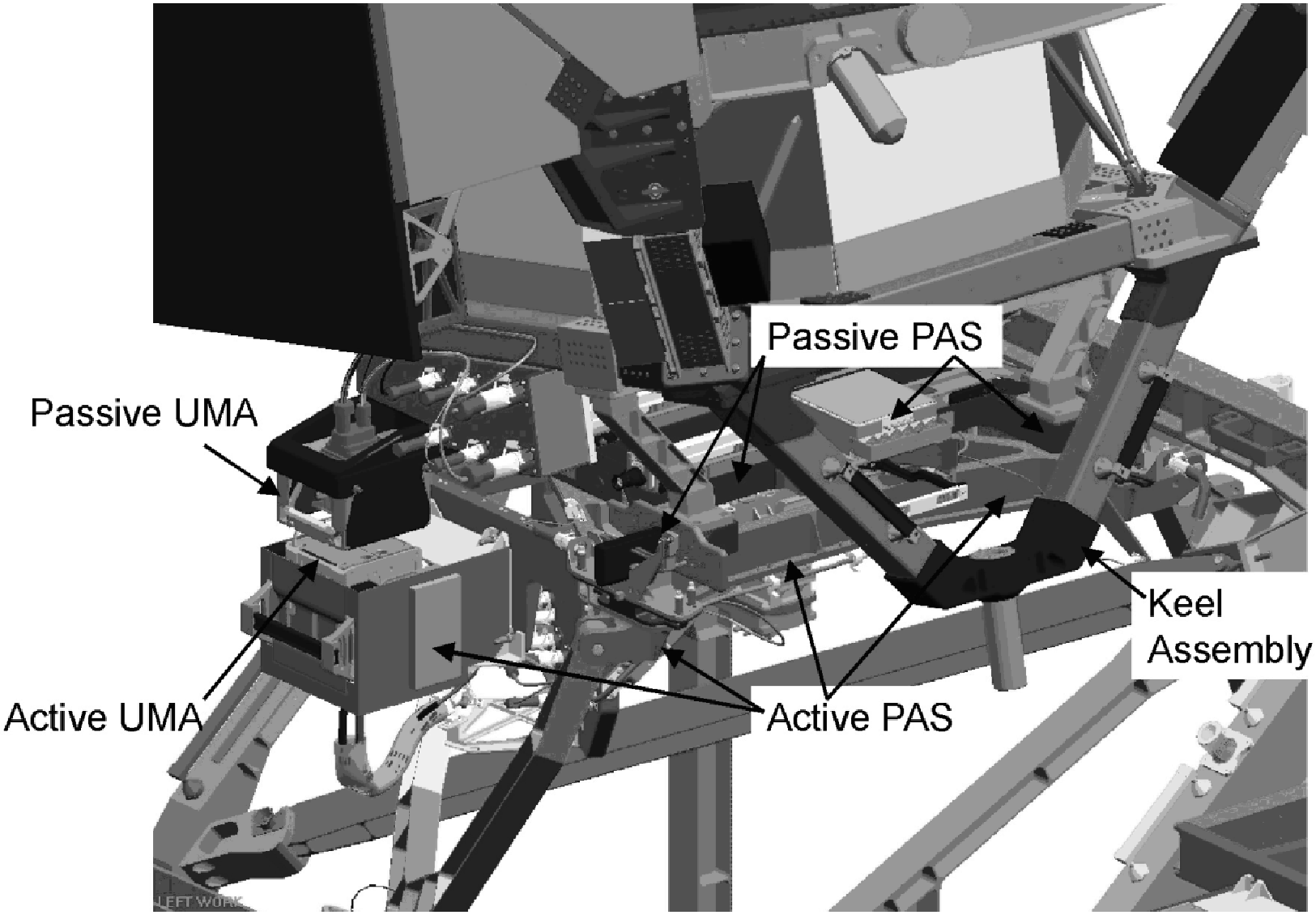


Potential EVA Work Site: Passive Payload Attach System (PAS)

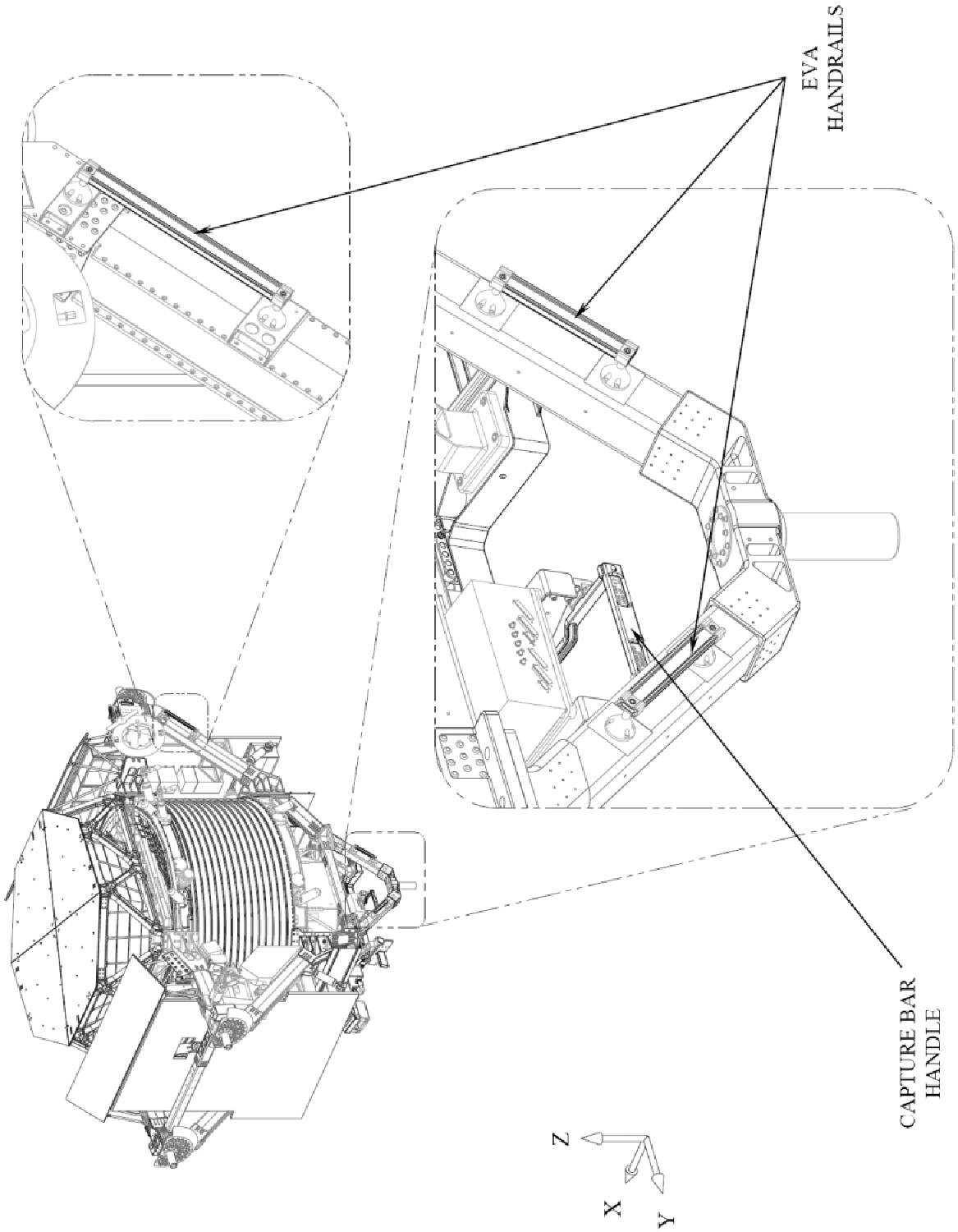
Passive PAS



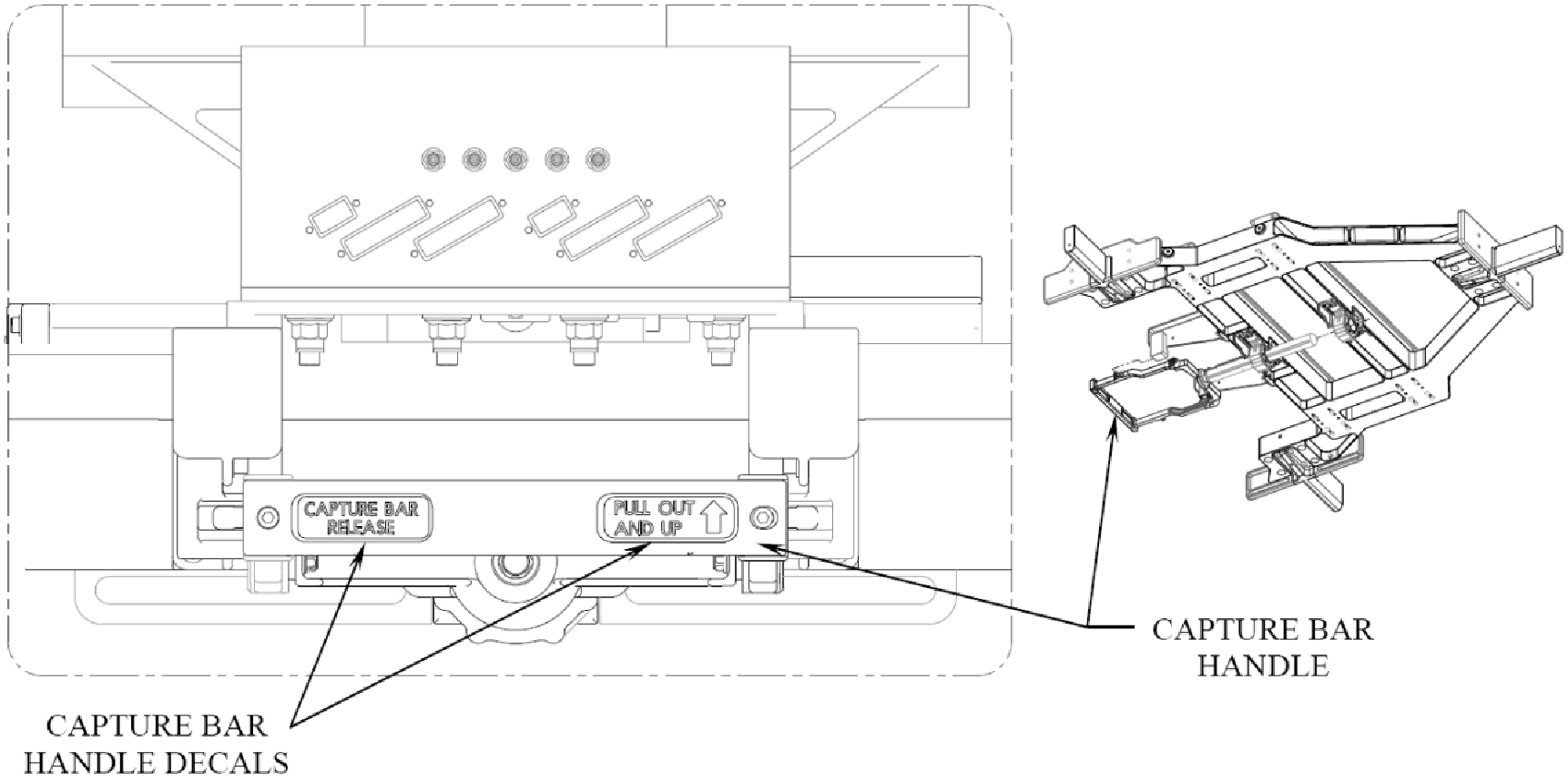
Potential EVA Work Site: AMS-02 Passive PAS



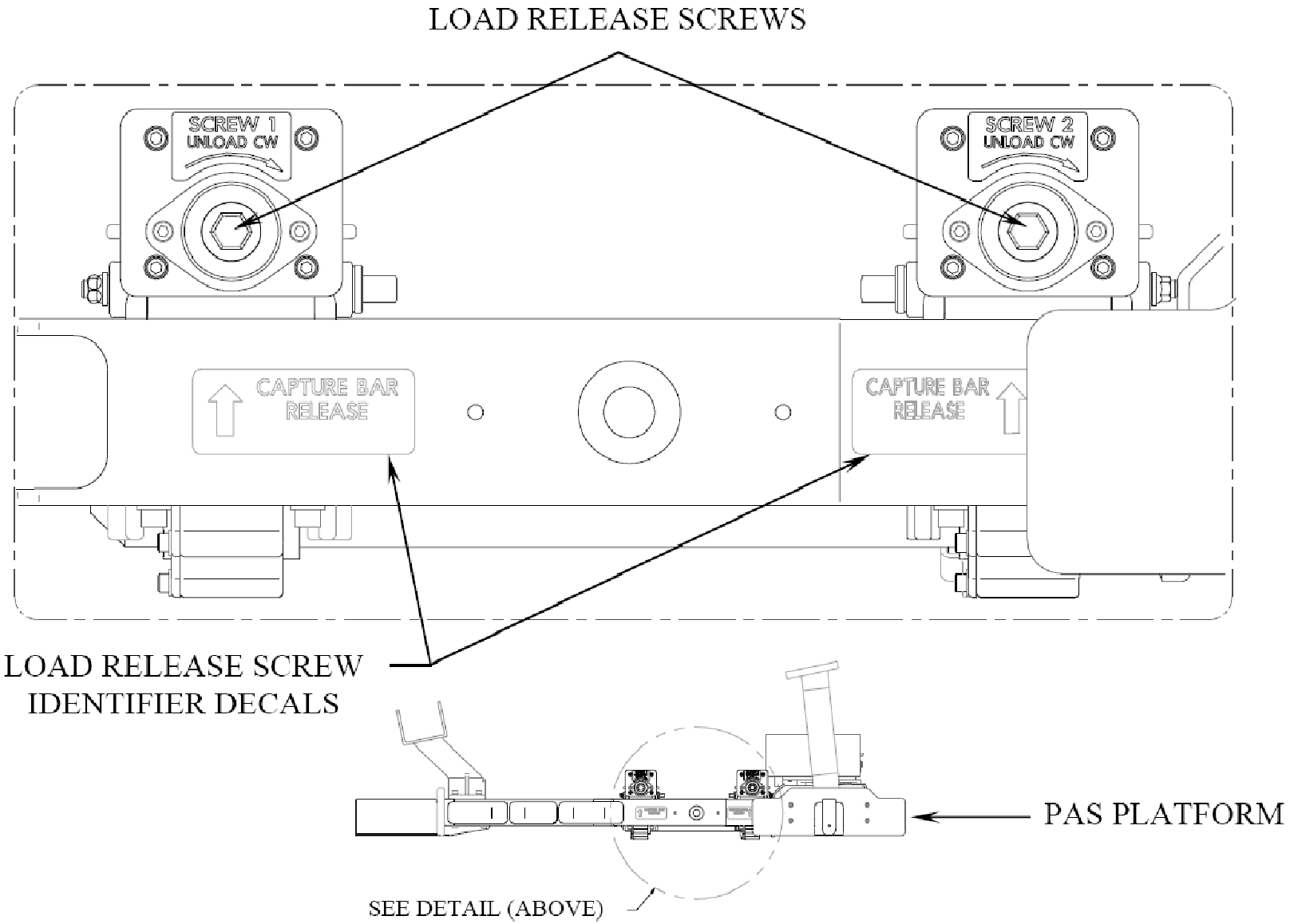
Potential EVA Work Site: AMS-02 Passive PAS, EVA Interface Panel and UMA



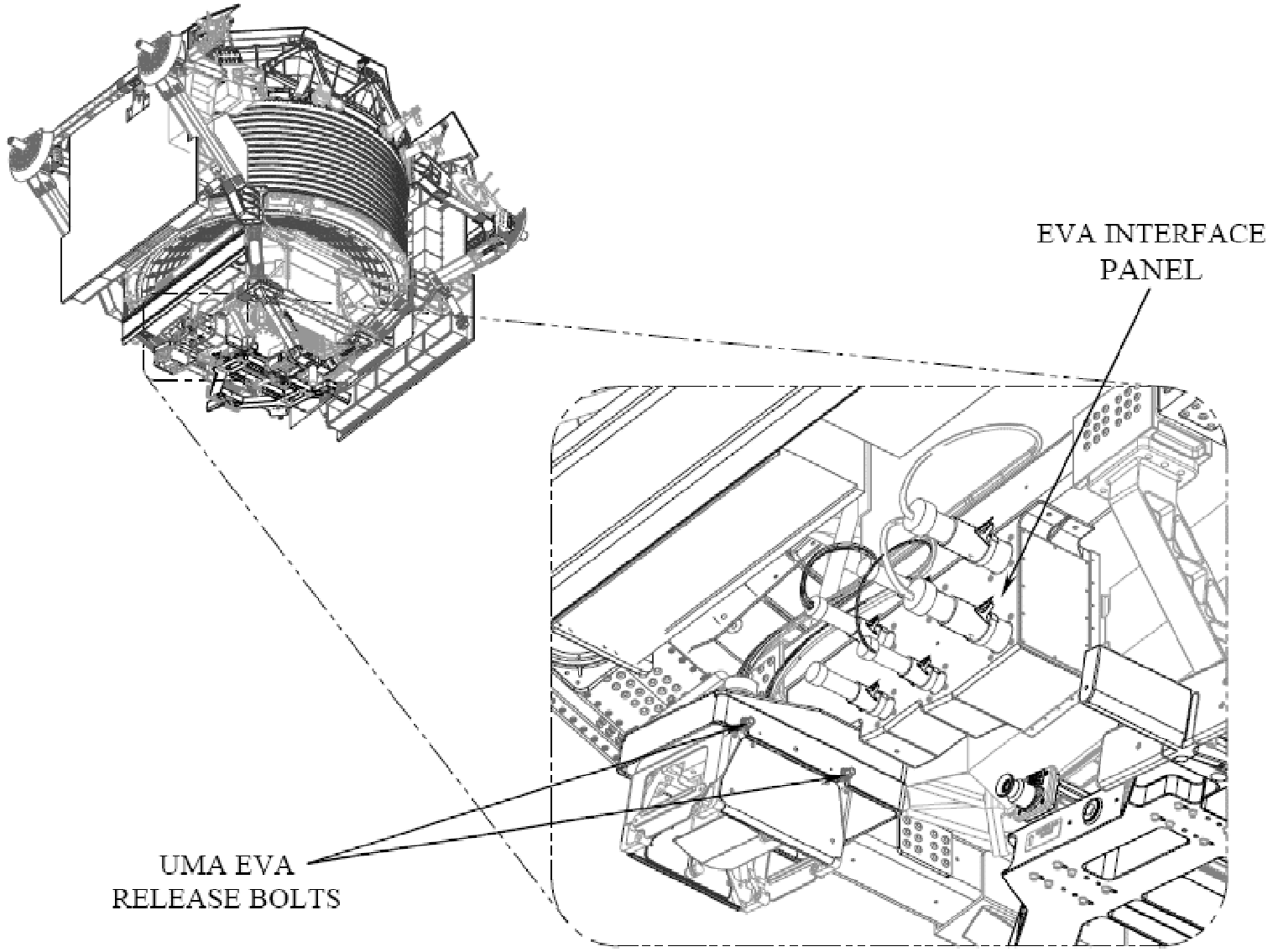
Potential EVA Work Site: AMS-02 Passive PAS



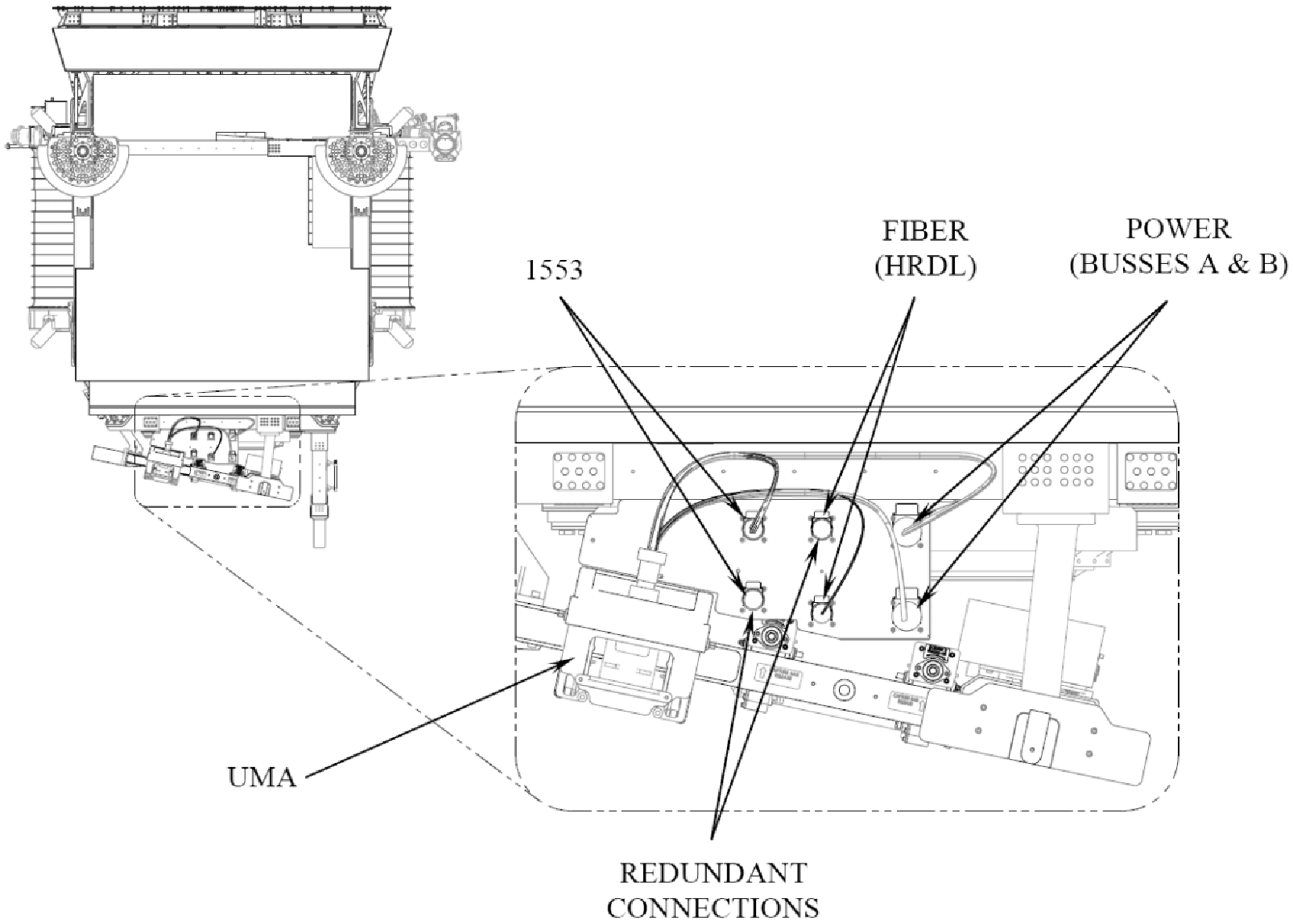
PAS Capture Bar Location



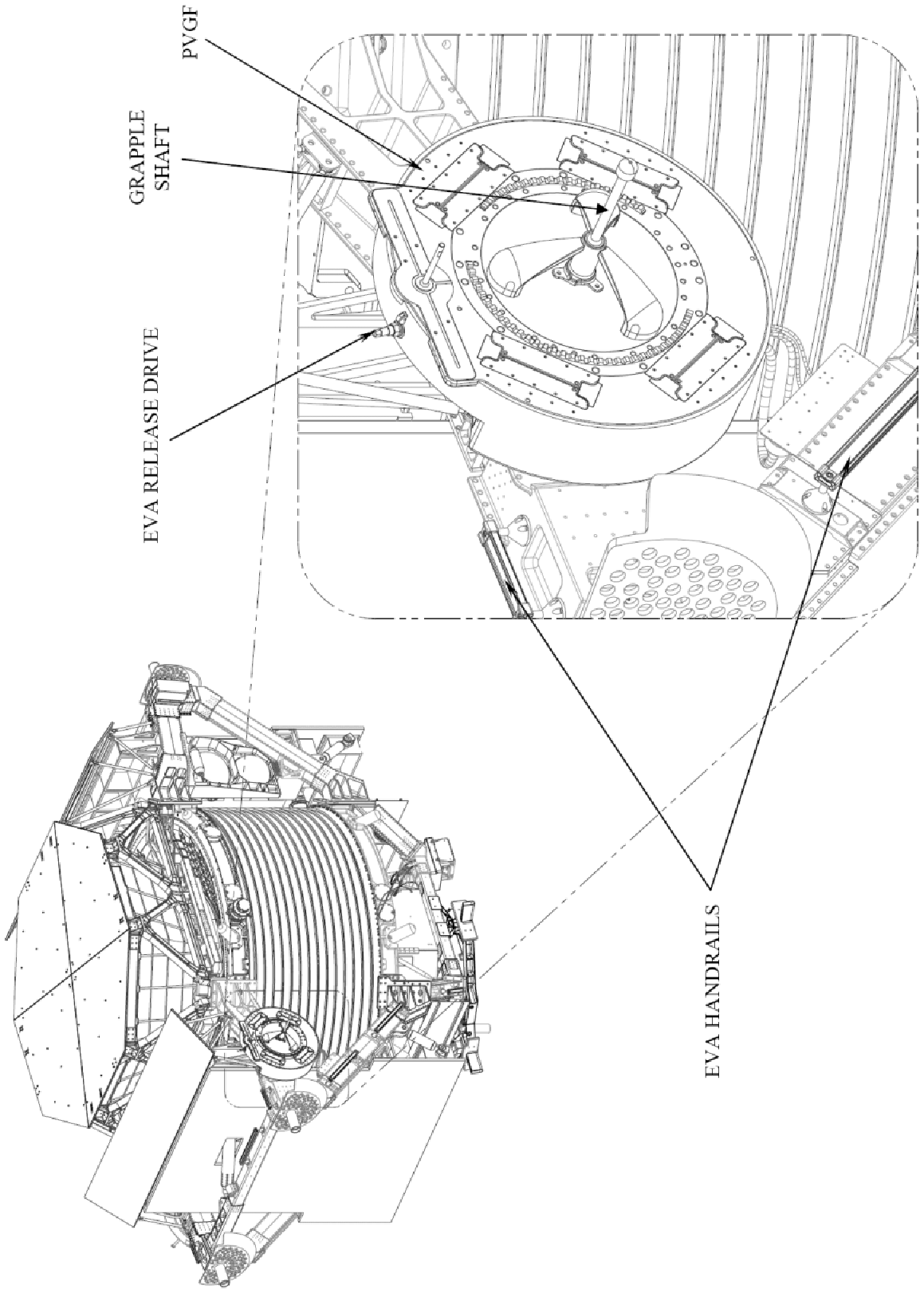
PAS EVA Interface Locations



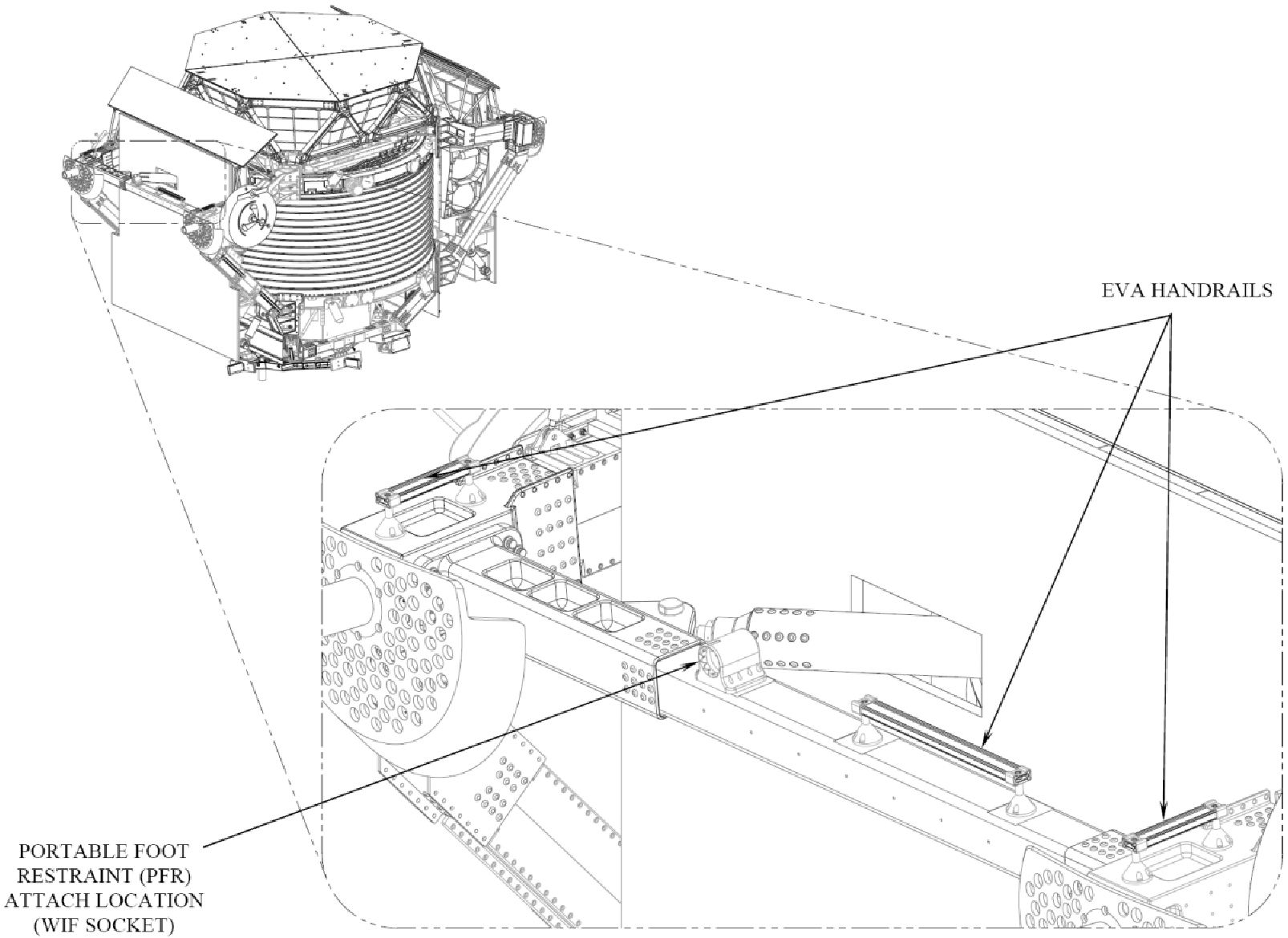
Potential EVA Worksite: AMS-02 EVA Panel, PAS EVA Release Location and UMA Release



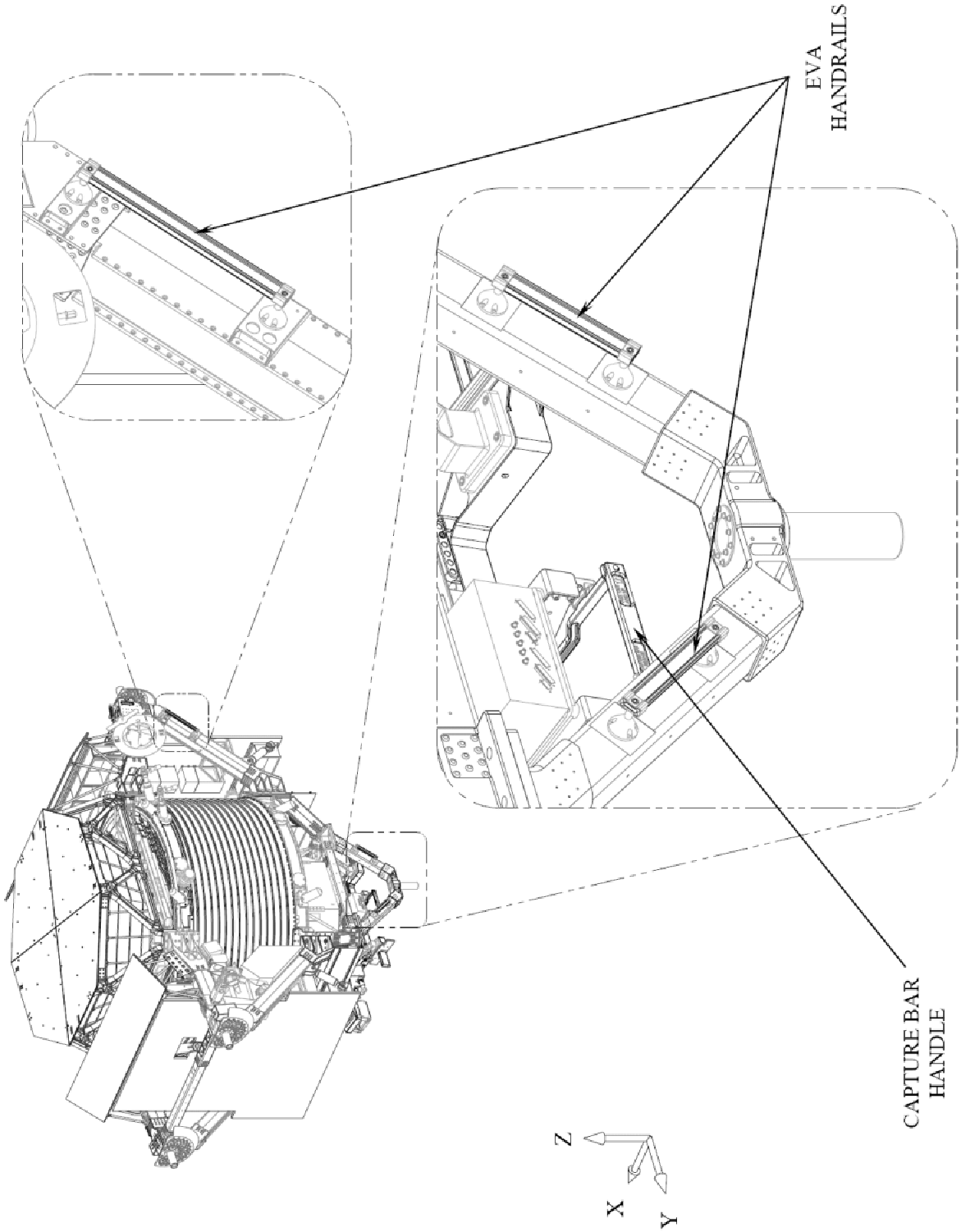
Potential EVA Work Site: AMS-02 Connector Panel and Passive UMA



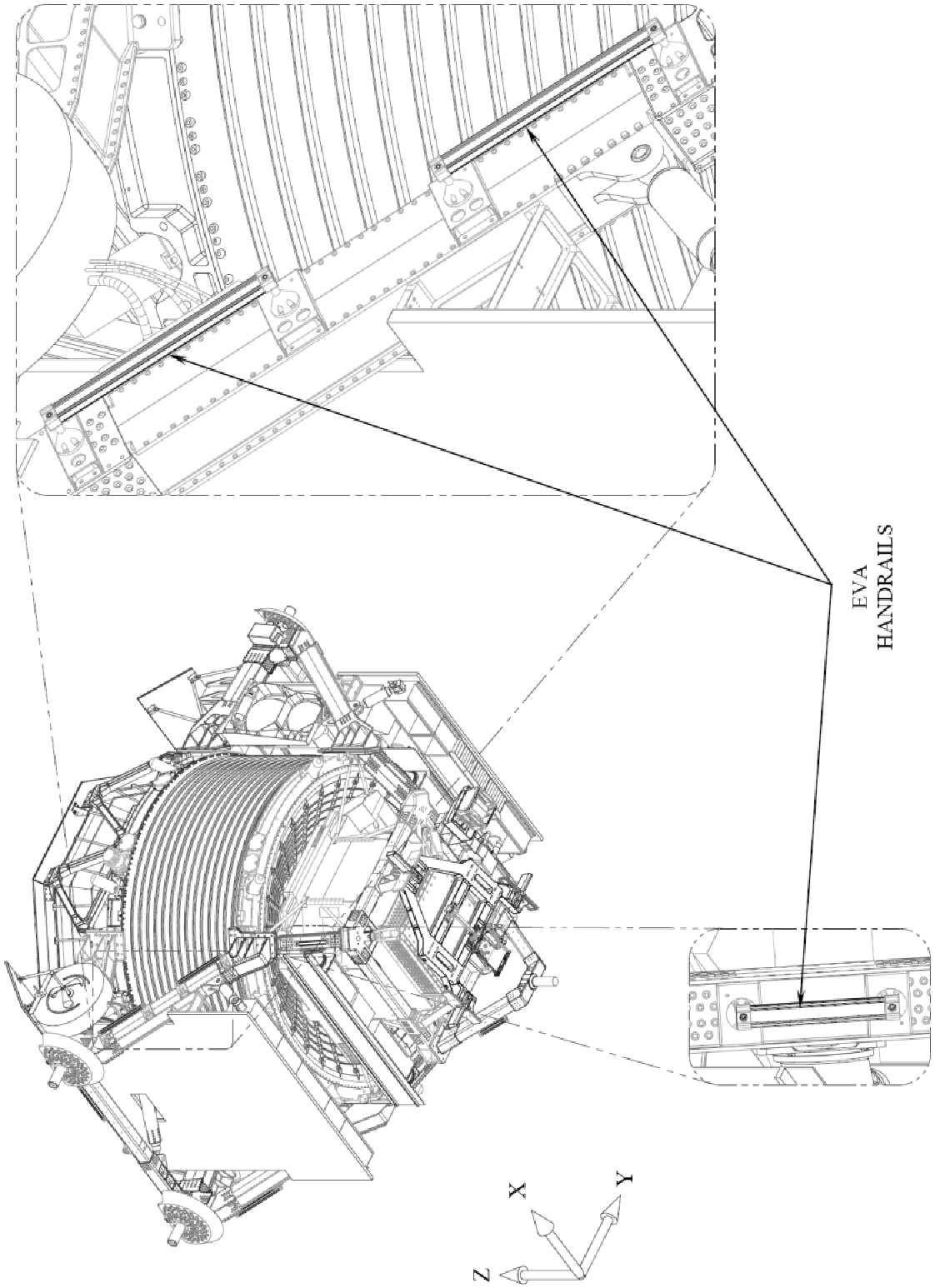
Potential EVA Work Site: Power Video Grapple Fixture (PVGF)



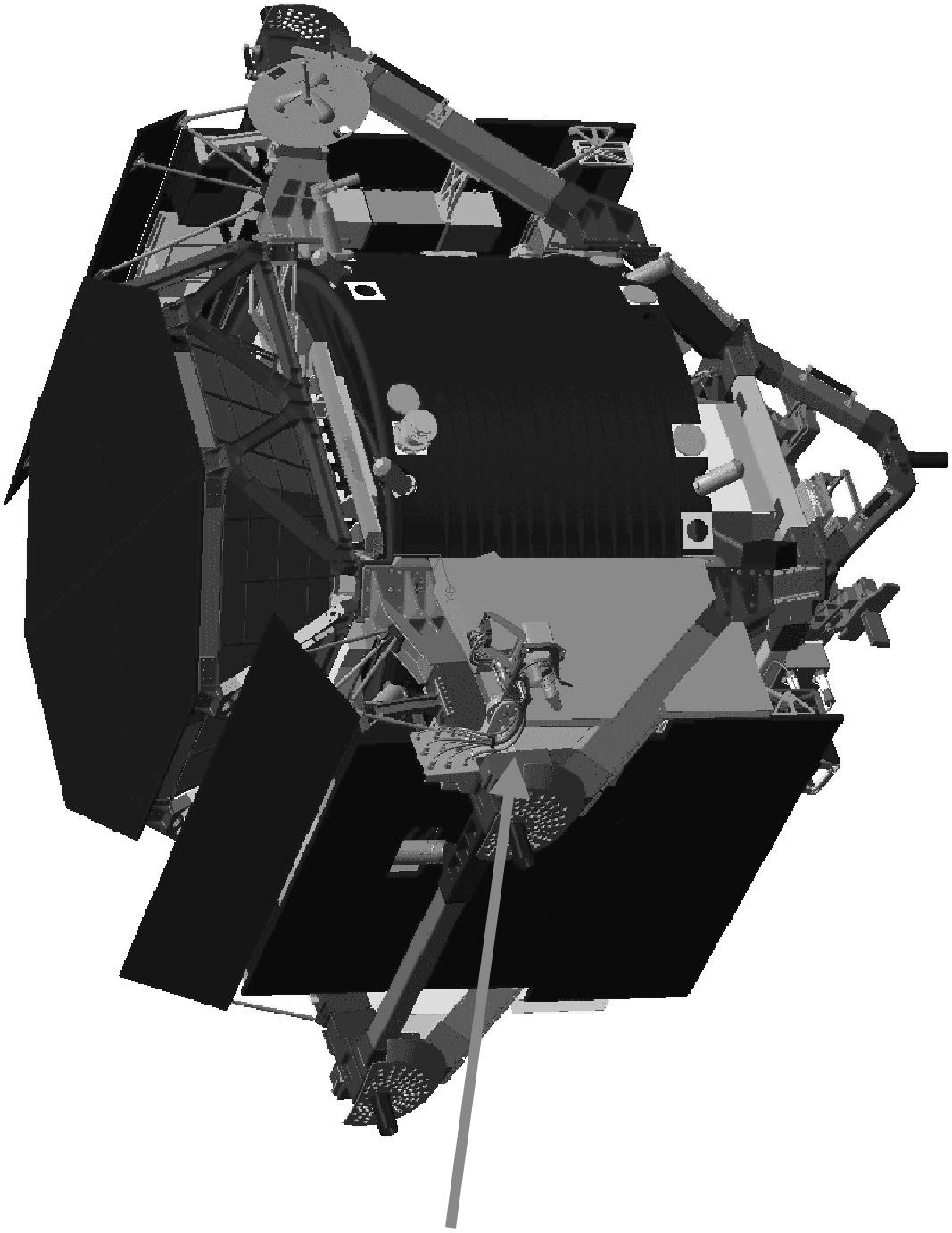
AMS-02 EVA TRANSLATION AID LOCATION



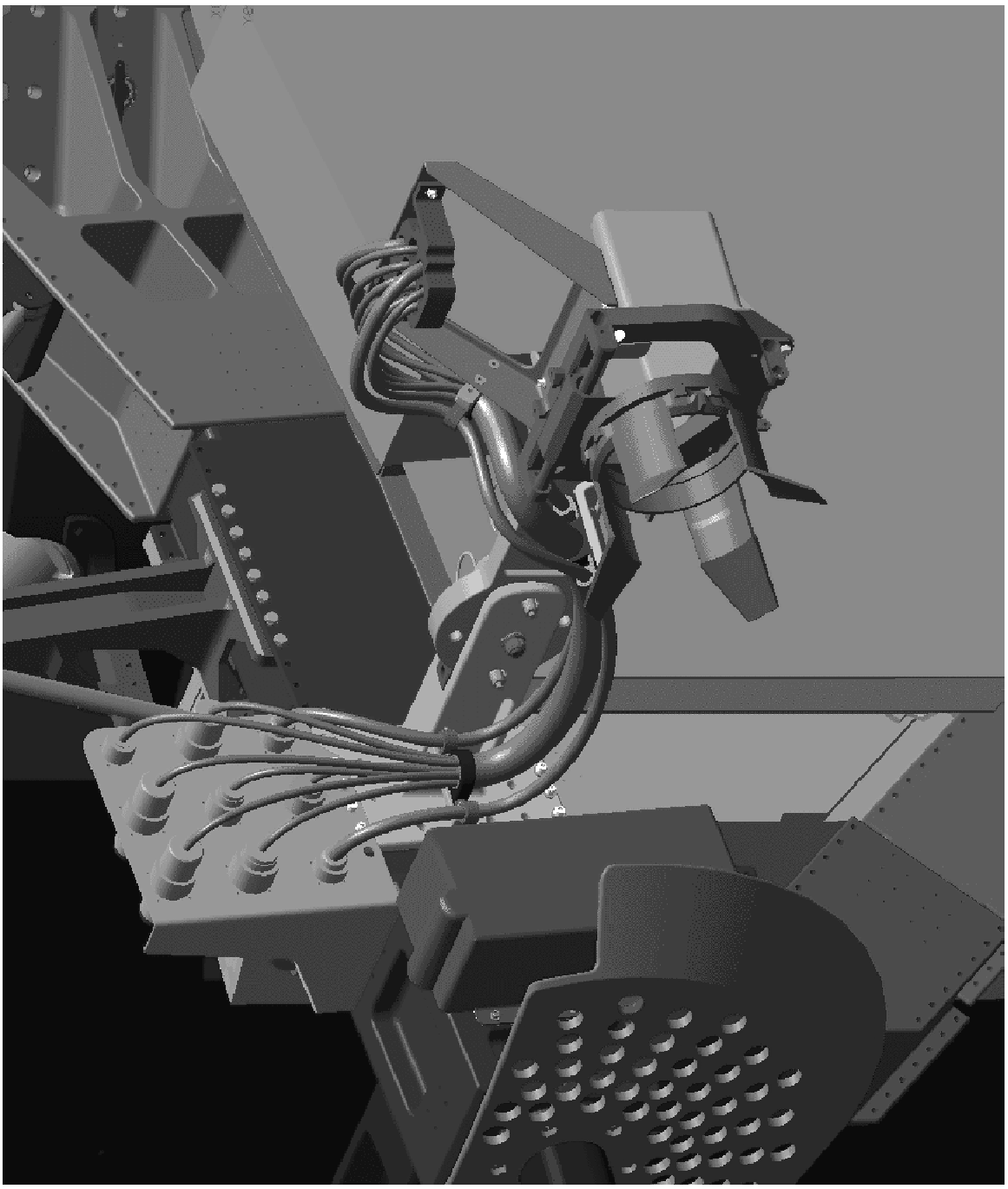
AMS-02 EVA TRANSLATION AID LOCATION



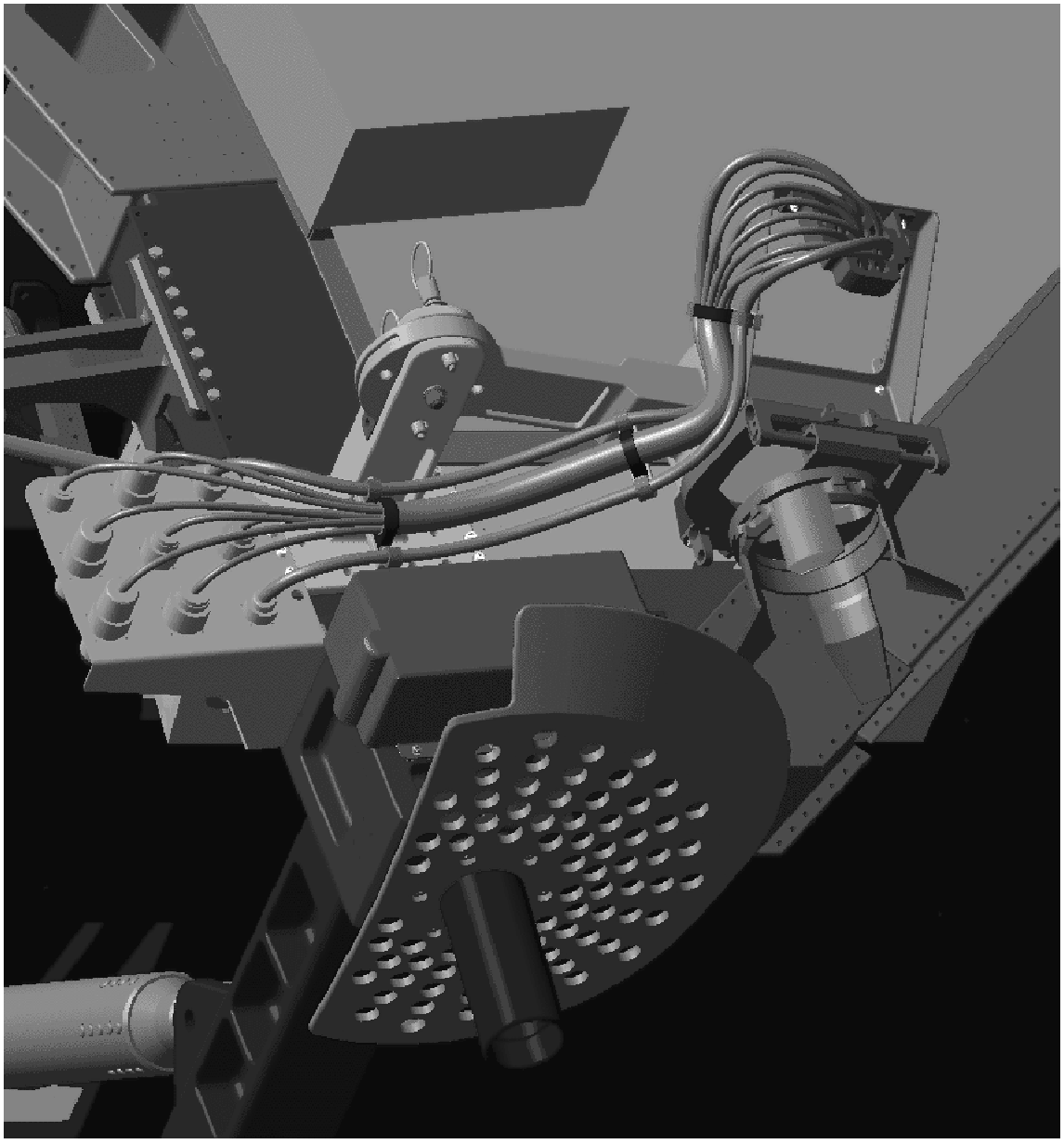
AMS-02 EVA TRANSLATION AID LOCATION



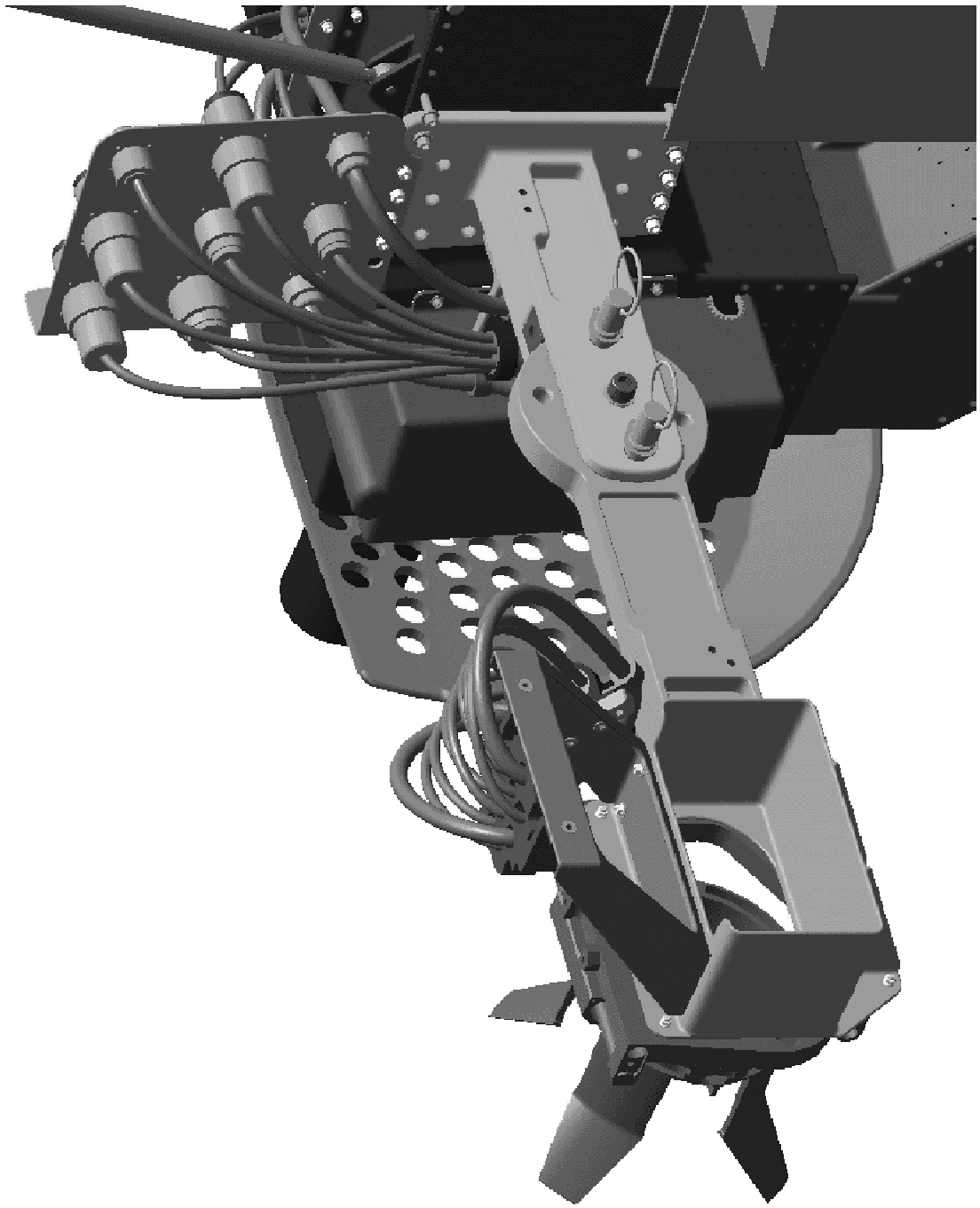
ROEU FOLDING BRACKET LOCATION



ROEU FOLDING BRACKET IN NOMINAL FLIGHT POSITION



ROEU FOLDING BRACKET IN FOLDED POSITION



ROEU FOLDING BRACKET WITH EVA COMPATIBLE PIP PINS (Tethers not shown)

ROEU FOLDING BRACKET WITH EVA COMPATIBLE PIP PINS – FOLDED (Tethers not shown)