MIP redlines (Attachment 3)

3.1 Launch Package Description

The ISS-ULF6 LP consists of ELC3, the AMS-02, the MISSE 8 on a sidewall, two sidewall carriers for return of MISSE 7a and 7b, and ISSP equipment, supplies, and ISS Utilization Middeck Payloads in the Orbiter crew compartment.

The ELC3 Cargo Element (CE) is a cross-bay carrier located in Bays 5-8. The ELC3 will carry to orbit the following direct-mounted Orbital Replacement Units (ORUs): Ammonia Tank Assembly No. 2 (ATA No. 2) Integrated Assembly (IA), Special Purpose Dextrous Manipulator (SPDM) arm with ORU Tool Changeout Mechanism (OTCM) IA, High Pressure Gas Tanks (HPGTs) IA, and a spare ExPRESS Pallet Controller Assembly (ExPCA). Direct-mounted ORU IAs include an adapter plate and Multilayer Insulation (MLI) covers. ELC3 will carry the following Flight Releasable Attachment Mechanism (FRAM)-based ORUs and payload: S-band Antenna Subsystem Assembly No. 2 and No. 3 (SASA No. 2 and No. 3) IA, and the Cargo Transport Container 2 (CTC No. 2) IA containing the Arm Computer Unit (ACU), one empty ORU Attachment Kit (OAK), and 10 Remote Power Control Modules (RPCMs). The SASA No. 2, SASA No. 3, and CTC No. 2 IAs include a Small Adapter Plate Assembly (SAPA) with heater system and thermostats for attachment to a Passive FRAM (PFRAM). ExPRESS Pallet Adapter (ExPA) will be used by the Space Test Program-Houston 3 (STP-H3) IA DoD payload. ExPA provides avionics and heater system with thermostats. SASA No. 2, SASA No. 3, and STP-H3 IAs include unique Flight Support Equipment (FSE) and MLI covers. ELC3 will carry one empty payload-unique PFRAM. ELC3 will carry one empty payload-unique PFRAM. The launch configuration for ELC3 is shown in figure 3-1.

ELC3 will use a Remotely Operated Electrical Umbilical (ROEU) and a Payload Power Switching Unit (PPSU) to provide 28 V dc heater power for the ORUs.

The AMS-02 is a state-of-the-art particle physics detector containing a large ~~cryogenic superfluid helium superconducti~~ng magnet ~~(Cryomagnet)~~ designed to search for antimatter and the origin and structure of dark matter. The AMS-02 carrier for transport to the ISS is a direct interface in the Orbiter PLB utilizing AMS-02 Unique Support Structure-02 (USS-02). Electrical attachments within the Shuttle PLB are made through an ROEU. AMS-02 is located in Bays 11 and 12.

The USS-02 supports the AMS-02 ~~Cryo~~magnet and detectors and provides the interface for the entire AMS-02 with the Orbiter and the ISS. The cryomagnet system consists of a superconducting magnet and a Super fluid Helium (SFHe) dewar with a capacity of approximately 2500 liters enclosed in a vacuum case. The vacuum case serves a dual purpose as a primary structural support to the

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USS-02 and as a vacuum vessel for the cryosystem and magnet. The USS-02 primary members consist of aluminum tubes fastened with rivets and bolts. AMS-02 systems components are mounted to the USS-02.

Installation of the AMS-02 requires that the Shuttle Remote Manipulator System (SRMS) unberth and hand off the payload to the Space Station Remote Manipulator System (SSRMS). The AMS-02 payload design incorporates two Grapple Fixtures (GFs), a Flight Releasable Grapple Fixture (FRGF), a Power Video Grapple Fixture (PVGF) for completing these dual arm operations, and the required External Berthing Camera System (EBCS) avionics package to monitor attachment of AMS-02 to the zenith inboard Payload Attach Site (PAS) on the S3 Integrated Truss Segment (ITS) using the AMS Passive Payload Attach System (PAS). Figure 3-2 provides an isometric orientation of the two AMS-02 GF locations. Figure 3-3 shows the launch and on-orbit configuration of the AMS-02.

~~The Cryomagnet is not turned on until the payload is installed on ISS, and the wiring precludes that Cryomagnet from being activated while in the Shuttle PLB during launch, ascent, and on-orbit operations.~~

Within the crew cabin, a Shuttle Payload General Support Computer (PGSC) will be configured to record AMS-02 health and status data until the AMS-02 payload is removed from the PLB.

The three MISSE Passive Experiment Containers (PECs) Sidewall Carriers (SWCs) are attached to the PLB using an Increased Capacity Adaptive Payload Carrier (ICAPC) for each PEC sidewall carrier. These will be used to transfer MISSE 8 to ISS and return the MISSE 7a and 7b PECs after retrieval from ELC2 on the ISS. MISSE 7 PECs and SWCs are located in Bay 4 starboard and port aft, and MISSE 8 PEC is located in Bay 9 port aft.

Launched in the middeck, the MISSE 8 Optical Reflector Materials Experiment Ram/Wake (ORMatE-III R/W) "mini-MISSE" will be EVA installed on ISS.

Cargo/payload items will be carried in the Orbiter crew compartment, including ISS Utilization payloads, Extravehicular Activity (EVA) tools and equipment, ISS Portable Computer System (PCS), and other ISS mission-unique support hardware.

Powered and unpowered ISS Middeck Utilization Payloads will be transferred to the ISS. Commercial Growth Bioprocessing Apparatus (CGBA) is a sortie-powered payload. One General Laboratory Active Cryogenic on ISS Experiment Refrigeration

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processing in the SSPF prior to online activities which are performed in the AMS-02-provided Payload Support Structure (PSS). The offline activities include payload component integration, functional testing, power quality testing, and cryogenic servicing. AMS-02 requires online payload processing in the SSPF. Online activities include payload component integration, EBCS camera alignment in the ELC Rotation Stand (ERS), and Interface Verification Testing (IVT). IVT includes Active CAS Simulator (ACASS) to PAS fit check in the ERS, ACAS Umbilical Mechanism Assembly (UMA), mate-verifying ISS 1553, and High Rate Data Link (HRDL) data requirements compliance via an enhanced Payload Rack Checkout Unit (PRCU). AMS-02 will require use of the John F. Kennedy Space Center (KSC)-provided Cargo Element Workstation Stand (CEWS) to complete final payload component integration, since AMS-02 is not compatible with its PSS following final payload component integration.

SSP preintegration activities for AMS-02 will be performed. These activities will not involve the flight payload, but will use an AMS-02 simulator or other Flight Equivalent Unit (FEU) hardware. These activities include:

a. Pad Operations Preliminary Interface Test, part 2 (POPIT-2) which will use the flight-specific Mobile Launch Platform (MLP) to verify ~~Launch Commit Criteria (LCC) and~~ KSC Payload Operations Control Center (POCC)1553, RS-422 data communications, 120 V dc, ~~48 V dc, and 110 V ac~~ (T-0) payload power services, pin-out from MLP Room 10A to T-0, and monitor and control of power services from MLP, Room 10A, by performing power outage and abort simulations.

b. An STS Interface Test (SIT) will be performed in the OPF sill-side on the actual Orbiter. This is an early risk mitigation opportunity to perform an STS IVT with the J-Crate Flight Equivalent Unit to remedy any problems. The actual payload/STS IVT and End-to-End (ETE) test to verify command/data functions with MCC-H and the JSC-POCC are performed late in the pad flow following AMS-02 arrival, post S0024. SIT testing includes Ku-band and S-band payload communications to Orbiter flight systems, T-0 payload communications from AMS-02 payload Ground Support Equipment (GSE), Aft Flight Deck (AFD)-located AMS-02 Digital Data Recording System (DDRS-02)-to-payload communications, and Power Control Unit (PCU)-to-payload connectivity verification. Details of the SIT and pad testing will be documented in the Operations and Maintenance Requirements Specification Document (OMRSD).

Upon completion of these activities and the Payload Readiness Review (PRR), the ELC3 and AMS-02 are placed in the payload canister and transported to the Payload Changeout Room (PCR). ~~Once~~ in the canister, AMS-02 will ~~require 110 V ac power supplied~~ via a ~~payload-provided GSE cable and~~ KSC-supplied power. AMS-02 also requires ~~120 V dc power~~ and 1553 and RS-422 data connections ~~via payload-provided GSE cables and KSC-supplied power~~.

The ELC3 is installed into the Orbiter, and the Orbiter-to-CE interfaces are verified before the cargo bay is closed out for launch.

Customer to assess changes

AMS-02 will arrive at the pad following the S0024 Prelaunch Propellant Load. This eliminates the need to disconnect AMS-02 Cryogenic Ground Support Equipment (CGSE) for S0024 Payload Bay Door (PLBD) closing. Cryogenic servicing is continuous for AMS-02 at the pad. The CGSE will be located on several levels within the PCR and on the Payload Ground Handling Mechanism (PGHM), and gaseous helium from the CGSE will be routed to an existing exhaust vent within the PCR. Final cryo servicing completes at Launch Minus (L-)88 hours, followed by CGSE disconnects, payload closeouts, and contamination inspections down to L-80 hours, at which time AMS-02 will be ready for PLBD closure operations. ~~AMS-02 provided GSE power supply located in the MLP, Room 10A, will provide 110 V ac and 48 V dc to the AMS-02 via the T-0, and this service is required until L-30 minutes. AMS-02 performs onboard cryogenic systems health monitoring until the T-9 hold power termination time.~~ Health monitoring capability requires KSC-provided 120 V dc power and 1553 and RS-422 data connectivity ~~through the T-0~~. The 120 V dc power will be provided via the T-0 until approximately ~~T-6~~ L-48 hours when it will be terminated. ~~and PTUs/APCUs will be used to provide the power until T-9 hold termination time.~~ Health monitoring is performed by AMS-02-provided GSE computers located in MLP, Room 10A. This data is collected and transferred to the KSC AMS-02 POCC ~~and the KSC Launch Control Center (LCC)~~ via an internet interface. data still may be routed to LCC. Customer to assess.

Once AMS-02 is installed into the Orbiter, the Orbiter-to-CE interfaces are verified, including powerup, 1553 and RS-422 checkout, and operations of the AFD-located DDRS-02.

~~Prior to launch, the AMS-02 payload cryogenic helium tank will be topped off. The limiting consumable for the main science package on this payload is the cryogenic helium, and it is essential to mission success that the payload is launched with as much cryogenic helium as possible. Servicing of the cryogenic helium tanks will be done as late as possible.~~

The AMS-02 DDRS-02 and associated payload-provided cabling is stowed in the middeck and STS Standard Switch Panel circuit breakers and switches will be configured to provide 28 V dc during ascent.

ISS Middeck Utilization Payloads and Government Furnished Equipment (GFE) hardware are processed in the SSPF offline labs before being turned over for installation in the middeck at the launch pad.

The GLACIER is a rear air-breathing (air and water cooled while on ISS) cryogenic freezer designed to provide cryogenic transportation and preservation capability for samples requiring thermal control between +4° C to -185° C. The cold volume of the units is designed with a generic approach that allows for multiple types of science samples requiring cryogenic thermal storage to utilize the GLACIER.

3.4 Flight Operations Overview

APCU1/Power Transfer Unit 1 (PTU1) shall be used to power the AMS-02 in the PLB via the ROEU. APCU2/PTU2 shall be connected to the Orbiter Boom Sensor System (OBSS) Laser Control System (LCS)/Integrated Digital Camera (IDC). The APCUs/PTUs will be interconnected so that sufficient APCU/PTU power can be provided to AMS-02.

The SPDU mounted on an Orbiter sidewall shall be used to provide power distribution to OBSS LCS/IDC.

The AMS-02 payload avionics and heaters, the ELC3 payload heaters, and the DTO-703 STORRM heaters will be powered on after PLB doors are opened. ~~The AMS-02 28 V dc vent valve electronics requires power during ascent to open the valve.~~ The ELC3 and DTO-703 STORRM will not be powered during the ascent phase of the mission. DTO-703 STORRM will not be powered during the descent phase of the mission.

AMS-02 telemetry will be routed to Mission Control Center-Houston (MCC-H) to provide payload managers the capability to assess payload health and status. A Shuttle PGSC will be used with the AMS-02 DDRS-02 to record the full AMS-02 telemetry stream. The AMS-02 DDRS-02 will be activated before AMS-02 powerup.

4.2.1.2 Launch Commit Criteria: ~~LP LCC will be developed~~ for the AMS-02 CE in accordance with NSTS 07700, Volume ~~XIV, Appendix~~ 5, System Description and Design Data-Ground ~~Operations~~, requirements and constraints. All LCCs must be monitored via ground systems and must not rely on flight crew monitoring. Any function whose failure results in a call for a hold must be designed with fault tolerance and must be monitored such that no single telemetry failure will result in a loss of visibility into the status of that function. (Exceptions to this requirement must be negotiated and identified in this section.) LP safety and mission success LCC will be submitted to the Mission Integration Manager (MIM) by L-7 months in accordance with the format and guidelines specified in NSTS 16007, Shuttle Launch Commit Criteria and Background, Appendix C, identifying the parameters, limits, and rationale used as a basis for a launch hold. Review and approval of LCC must be accomplished by L-5 months, at which time the LP safety and mission success LCC will be documented by the SSP. All safety LCC will be documented in NSTS 16007. Mission success LCC may be documented in NSTS 16007 or the Flight Rules, depending upon the organization making the call. Mission success LCC for holds to be called by the MCC-H or International Partner Control Center (IPCC) (e.g., requirements that support on-orbit operations facilities or communication networks) will be documented by the SSP in the Flight Rules. Mission success LCC for which KSC is responsible will be documented in NSTS 16007.

a. Safety- LCC - Safety holds for the AMS-02 CE will be called by the AMS Payload Test Conductor in the LCC Firing Room at KSC. The cryogenic systems of AMS-02 require 120 V dc power until the T-9 hold termination time. Power will be terminated during the T-9 hold, but not earlier than L-22 minutes. The T-0 will be used to provide the power until approximately T-6 hours. PTU/APCU power will be used for the remainder of the count until the T-9 hold power termination time but no later than L-22 minutes. During that lead up to launch, the AMS-02 team will monitor the status of the AMS-02 cryogenic systems to ensure that all parameters are within safe launch limits. At L-9 minutes, the payload must give a go for launch. This requirement was driven by the Payload Safety Review Process. Additional LCC is required to verify that T-0 110 V ac power service for AMS-02 is terminated prior to launch.

b. Mission success LCC - The AMS-02 CE has no mission success LCC.

There are no AMS-02 LCC safety or mission success LCC for the ~~remaining~~ LP elements (ELC3, MISSE 7, DTO-703 STORRM). LCC driven by the ISS on-orbit configurations are documented in the Flight Rules Annex.

4.2.2 Ascent.- ~~During ascent, an AMS-02 payload vent valve is nominally commanded open by a barometric switch; however, the payload will also receive a prestored timetagged command from the Shuttle Backup Flight System (BFS) General Purpose Computer (GPC) Multiplexer/Demultiplexer (MDM) Payload Forward (PF)1 Card 00 Ch 02 SB 05 as a backup command to ensure that the vent is opened. AMS-02 28 V dc vent valve electronics will be powered during ascent.~~

Electrical power is required for ISS Utilization Middeck Payloads during ascent for no more than 70 W total and no more than two Orbiter direct current (dc) power outlets. ISSP is protecting for one powered payload for ascent.

Electrical power is not required during ascent for ELC3 AMS-02, or DTO-703 STORRM.

4.2.3 On-orbit.- Once the Shuttle is docked to the ISS, the ELC3 payload will be removed from the PLB using the SRMS, positioned for handoff to the SSRMS, and then maneuvered for berthing to P3 Upper UCCAS. ELC3 will be deployed prior to AMS-02 since Orbiter is not ballasted for worst-case forward contingency undock scenario. AMS-02, after ELC3 has been berthed to ISS, will be removed from the PLB using SRMS, positioned for handoff to SSRMS, and then maneuvered for berthing to S3UI PAS. AMS-02 transfer from the PLB to receiving power from SSRMS should not exceed 8 hours. If AMS-02 handoff from SRMS to SSRMS is delayed, the AMS-02 will be placed in a thermally acceptable orientation to maintain health. The SSRMS will be used to transfer the IBA to S1 after docked TPS late inspection has been performed.

In order to maximize launch probability, rendezvous and docking with the on-orbit ISS Stage shall occur on Flight Day (FD) 3 or FD 4.

The ELC3 Launch-to-Activation (LTA) heaters are required to be activated no later than PLBD opening plus 4 hours. In order to eliminate the need to launch aft ballast, the ELC3 must be removed from the cargo bay prior to removal of AMS-02.

AMS-02 DDRS-02 hardware requires setup and activation on the AFD to monitor and record AMS-02 payload health and status. This activity is required prior to AMS-02 powerup in the PLB.

4.2.3.11 Consumables Requirements:

N_2 and O_2 transfer requirements are listed in section 6.8.

To support DTO-703 STORRM, Orbiter propulsion consumables have been preplanned and budgeted for the mission to allow for rerendezvous after Orbiter undocking. Likewise, ISS propulsive consumables need to be preplanned and budgeted for ISS maneuvers to and from the desired CEV TDA rendezvous position, as well as any propellant required for ISS attitude hold. Reference DTO-703 STORRM IP, NSTS 21551.

MAUI, RAMBO-2, SIMPLEX, and SEITE are payloads of opportunity for this mission, and propellant will not be budgeted.

4.2.3.12 Other Crew Activities: (Reference NSTS 21458).

Integrated Orbiter Inspection Requirements: The RPM photography of predetermined areas of the Orbiter TPS shall be performed by the ISS crew prior to docking. Focused inspection of the Orbiter TPS shall be performed as determined by the SSP Mission Management Team (MMT) in consideration of the Damage Assessment Team recommendations.

The DTO-703 STORRM crew activities are via a dedicated PGSC. System setup is limited to sensor power on/off, network adapter setup, system monitoring, and software initialization. The tracking output will be displayed via text and graphics for crew demonstrations purposes. If a DTO sensor anomaly occurs, the crew may be requested to perform a predetermined crew procedure to facilitate troubleshooting. Reference DTO-703 STORRM, NSTS 21551.

The AMS-02 DDRS-02 and dedicated PGSC will be removed from its stowage locker and installed on the AFD. Cabling will be connected to PDIP1. This will include removal of a prelaunch jumper cable, as well as switch throws on both PDIPs. ~~If a loss of communication prevents ground commanding of the AMS-02 payload, the crew may be requested to perform a predetermined crew procedure to issue commands to the AMS-02 payload from the DDRS-02 PGSC.~~

There will be a backup PGSC stowed in the crew compartment for use by AMS-02 or DTO-703 STORRM, if required.

4.2.4 Orbiter and ISS Intentional Radio Frequency Radiation Constraints.- (Reference NSTS 21458).

4.2.4.1 Orbiter-imposed Intentional RF Radiation Constraints: (Reference NSTS 21458).

k. DTO-703 STORRM cabling as defined in NSTS 21551, DTO-703 STORRM IP, and ICD-A-21551.

l. AMS-02 requires a cable to allow flow of 1553 data to T-0 with Orbiter unpowered.

m. AMS-02 requires a PLB cable to provide 1553 service to nonstandard ROEU interface.

n. AFD and PLB cables required to provide SSP services to the PPSU, ELC3, ~~AMS-02,~~ and DTO-703 STORRM.

o. AMS-02 requires cabling to support 120 V dc, ~~48 V dc, and 110 V ac~~ T-0 power requirements, ~~as well as to support temperature monitoring requirements.~~

Specific wiring pin function assignments will be defined in the ICD-A-21507 for the AMS-02 and the ELC3 CEs, ICD-A-21551 for the DTO-703 STORRM, and ICD-A-21321 for the APCU CEs.

5.3 Display and Control Interfaces

Display and Control (D&C) functions which are required for this flight are accomplished using the crew-controlled equipment identified below:

a. Standard switch panels (two)

b. PCSs (two)

c. PDIPs (two)

d. Small Payload Accommodation Switch Panel (SPASP)

e. Orbiter Space Vision System (OSVS) Patch Panel (OPP)

f. PGSC (two) (one dedicated for AMS-02 and one for DTO-703 STORRM. A backup PGSC will be available in the crew compartment, if required, for AMS-02 or DTO-703 STORRM.

Assignment of functions and nomenclature for the standard switch panel is to be defined in NSTS 21507-ICA for the AMS-02, ELC3, and DTO-703 STORRM CEs.

5.4 Electrical Power Interfaces

Before installation in the Orbiter, power will be supplied to the CE using ISSP-provided, AMS-02-provided, or SSP-provided GSE, as negotiated in Annex 8. After installation in the Orbiter,

Orbiter bus power will be supplied by the SSP, except during planned outages (e.g., ordinance activities). T-0 umbilical power at 120 V dc~~, 48 V dc, and 110 V ac~~ will be supplied by KSC for AMS-02 CE.

The CE shall provide means for its power activation/deactivation via crew control, in addition to any other power control capabilities.

Electrical power interfaces and maximum continuous/peak power requirements are identified in table 5-1.

ELC3 shall receive 28 V dc power from the primary payload bus through the PPSU via ROEU. Power control shall be via switches located on Panel R1A1 and the Standard Switch Panel.

~~The AMS-02 cryomagnet system vent valve operations primary control is via a payload barometric switch with vent valve electronics power supplied by 28 V dc power during ascent (no crew interaction required). The 28 V dc power will be supplied from the Orbiter Standard Switch Panel and will be limited to less than 5 amps~~. High-voltage power ~~shall~~ be provided by the APCUs/PTUs. ~~An SSP indicator will provide feedback that 28 V dc power is resident at the AMS-02 avionics.~~ to AMS-02

The aft payload bus supplies 28 V dc power to the Avionics in Bay 3 port and the ODS via PAT box. The DTO-703 STORRM requires power for avionics system and heater operations. Heater power is activated by thermostat control. Operational power is activated by relay controlled from the Standard Switch Panel. Power to the VNS laser is controlled via PGSC command and the second Standard Switch Panel switch. Both controls are required for laser operation. Reference NSTS 21551, DTO-703 STORRM IP.

APCU/PTU power via the SPDU shall support the OBSS LCS with IDC requirement.

Table 5-1.- ELECTRICAL POWER

	Prelaunch		Ascent	Docked			Descent	Post-flight*
	PLBD closure			Pre	During	Post		
Power Source	Pre	Post						
a. Pri Payload bus to ELC3 via ROEU[1]	N/R	N/R	N/R	2016 W (2635 W) peak	2016 W (2635 W) peak	N/A	N/A	N/A

Table 5-1.- ELECTRICAL POWER (Continued)

Power Source	Prelaunch PLBD closure Pre**	Prelaunch PLBD closure Post	Ascent	Docked Pre	Docked During	Docked Post	Descent	Post-flight*
b. APCU1/PTU1 to AMS-02 in PLB via ROEU	N/R	~~2220 W[9] (2220 W) peak~~ N/R	N/R	2000 W (2500 W) peak	2000 W (2500 W) peak	N/A	N/A	N/A
c. APCU2/PTU2 to OBSS LCS with IDC	N/R	N/R	N/A	41 W[3] (131 W) peak	41 W[3] (131 W) peak	N/R	N/A	N/A
d. Power transfer from ISS to Shuttle	N/A	N/A	N/A	R[5]	N/A	N/A	N/A	N/A
e. Cabin Utility outlets to PCS(2)	N/R	N/R	N/R	N/R	92 W[2] (92 W)	N/R	N/R	N/R
f. Orbiter bus to APCU1[4]	N/R	N/R ~~1381 W[9] (1381 W) peak~~	N/R	1275 W (1634 W) peak	1275 W (1634 W) peak	65 W (65 W) peak	N/R	N/R
g. Orbiter bus to APCU2[4]	N/R	N/R ~~1381 W[9] (1381 W) peak~~	N/R	1275 W (1634 W) peak	1275 W (1634 W) peak	65 W (65 W) peak	N/R	N/R
h. Aft payload bus to DTO-703 STORRM heaters and avionics	N/R	N/R	N/R	[6]	[6]	[6]	N/R	N/R
i. Hardwire through T-0 umbilical at 120 V dc for AMS-02[7]	2000 W (2000 W) peak	2000 W[9] (2000 W) peak	N/A	N/A	N/A	N/A	N/A	N/A

Table 5-1.- ELECTRICAL POWER (Concluded)

Power Source	Prelaunch PLBD closure Pre**	Prelaunch PLBD closure Post	Ascent	Docked Pre	Docked During	Docked Post	Descent	Post-flight*
j. ~~Cabin PL bus 28 V dc vent valve electronics for AMS-02~~	~~N/R~~	~~28 W (28 W) peak~~	~~28 W (28 W) peak~~	N/R	N/R	N/A	N/A	N/A
k. ~~Hardwire through T-0 umbilical at 110 V ac for AMS-02[8]~~	~~632 W~~	~~632 W~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~
~~l.~~ j. Cabin PL bus 28 V dc for PPSUs	N/A	N/A	N/A	45 W (45 W) peak	45 W (45 W) peak	45 W (45 W) peak	N/A	N/A
m. ~~Hardwire through T-0 umbilical at 48 V dc for AMS-02[11]~~	~~12 W (12 W) peak~~	~~12 W (12 W) peak~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~

(Value inserted where interface is required; N/A inserted where interface is not available; N/R inserted where interface is not required; R inserted where interface is required; peak power values are identified by parenthesis.)

*Service available until Orbiter powerdown.

(1) ELC3 maximum power is based on nominal operating voltage of 28 V dc and peak voltage of 32 V dc. The power values reflect worst-case (100 percent duty cycle) for both primary and secondary heater strings.

(2) 92 W includes 69.5 W for the A31P laptop and 22.5 W for the power supply.

(3) 41 W continuous for the LCS/IDC in scan mode with heaters off and 131 W peak for LCS/IDC in scan mode with heaters on (30 W for LCS; 11 W for IDC; 60 W for LCS heaters; and 30 W for IDC heaters). OBSS is transferred to ISS prior to undocking.

(4) For predocked and docked phases, 1275 W continuous APCU power to support AMS-02 (2000 W) on APCU 1 output power and LCS/IDC in scan mode without heater (41 W) on APCU 2 output power. 1634 W peak APCU input power to support AMS-02 (2500 W) on APCU 1 output power and LCS/IDC scanning ops with heaters on (131 W) APCU 2 output power.

(5) ISS will power four SSPTS PTU Orbiter Power Converter Units (OPCUs).

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(6) Refer to DTO-703 STORRM IP, NSTS 21551.

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

~~(8) Required for AMS-02 vacuum pump and to isolate the pump from the helium tank via T-0 GSE. Power removed at L-30 minutes.~~

(9) For prelaunch, T-0 120 V dc power will be used from payload installation until approximately ~~T-6~~ hours when it will be terminated. ~~APCU/PTUs are used from approximately T-6 hours until the T-9 hold termination time but not later than L-22 minutes when the 28 V dc input power will be commanded off~~.

(10) PPSU heaters remain on after ELC3 is removed from PLB.

~~(11) Required for AMS-02 to control valve operation via T-0 GSE. Power removed at L-30 minutes.~~

(8) RESERVED

Table 5-2.- COMMAND INTERFACES (Continued)

Power Source	Prelaunch PLBD closure Pre**	Prelaunch PLBD closure Post	Ascent	Docked Pre	Docked During	Docked Post	Descent	Post-flight*
h. Hardwire from Standard Switch Panel to DTO-703 STORRM, ~~AMS-02,~~ and PPSU	N/R	N/R	N/R	X	X	X	N/R	N/R
i. PGSC Ethernet to DTO-703 STORRM	N/R	N/R	N/R	N/R	X	N/R	N/R	N/R
j. PGSC RS-422 to DTO-703 STORRM	N/R	N/R	N/R	X	X	X	N/R	N/R
k. Payload Timing Buffer (PTB)-Greenwich Mean Time (GMT) for DTO-703 STORRM	N/R	N/R	N/R	X	X	X	N/R	N/R
l. Hardwire through T-0 umbilical for AMS-02	X	X	N/A	N/A	N/A	N/A	N/A	N/A
m. PSP via OIU to AMS-02	N/A	N/A	N/A	X	X	N/A	N/A	N/A

Table 5-2.- COMMAND INTERFACES (Concluded)

	Prelaunch		Ascent	Docked			Descent	Post-flight*
	PLBD closure			Pre	During	Post		
Power Source	Pre**	Post						
n. Discrete Command from Orbiter PF-1 MDM for AMS-02 ****	N/R	N/R	X	N/R	N/R	N/A	N/A	N/A
o. 1553 data bus via T-0 for AMS-02	X	X	N/A	N/A	N/A	N/A	N/A	N/A
p. 1553 data bus via OIU for AMS-02	N/A	N/A	N/R	X	X	N/A	N/A	N/A
q. RS-422 data bus via T-0 for AMS-02	X	X	N/A	N/A	N/A	N/A	N/A	N/A
r. RS-422 data bus for AMS-02	N/A	N/A	N/A	X	X	N/A	N/A	N/A

(X inserted where interface is required; N/A inserted where interface is not available; and N/R inserted where interface is not required.)

*No entry required for IVT or ETE test.
**Applicable only for flights with APCUs.
***To maintain capability if required.

**** Payload no longer requires service. Flight software ~~may still~~ will contain capability to send command

Table 5-3.- TELEMETRY INTERFACES (Continued)

Data Source	Prelaunch PLBD closure Pre**	Prelaunch PLBD closure Post	Ascent	Docked Pre Docked	Docked Docked	Docked Undocked	Descent	Post-flight
b. Hardwire to standard switch panel from APCUs*****	N/R	N/R	N/A	X	X	X	N/A	N/A
c. Payload Data Interleaver (PDI) via OIU from ISS 1553 (Stage)***	N/A	N/A	N/A	N/A	X	N/A	N/A	N/A
d. PCS via 1553 (Stage)***	N/A	N/A	N/A	N/A	X	N/A	N/A	N/A
e. PDI via OIU from SSOR	N/A	N/A	N/A	X	N/R	X	N/A	N/A
f. OPP Ethernet interface from LCS/IDC	N/R	N/R	N/A	X	X	N/R	N/A	N/R
g. LDRI/ITVC Video	N/R	N/R	N/R	X	X	N/R	N/R	N/R
h. Hardwire to the Standard Switch Panel from DTO-703 STORRM, ~~AMS-02,~~ and PPSU	N/R	N/R	N/A	X	X	X	N/A	N/R

Table 5-3.- TELEMETRY INTERFACES (Concluded)

Data Source	Prelaunch PLBD closure Pre**	Prelaunch PLBD closure Post	Ascent	Docked Pre Docked	Docked Docked	Docked Undocked	Descent	Post-flight
i. DTO-703 STORRM to PGSC via Ethernet	N/R	N/R	N/A	N/R	X	N/R	N/A	N/R
j. DTO-703 STORRM to PGSC via RS-422	N/R	N/R	N/R	N/R	X	N/R	N/R	N/R
k. Hardwire through T-0 umbilical for AMS-02 (RS-422 and 1553, ~~and temperature monitoring~~)	X	X	N/A	N/A	N/A	N/A	N/A	N/A
l. Ku Channel 2 and 3 access for AMS-02	N/A	N/A	N/A	X	X	N/A	N/A	N/A
m. PDI via OIU from AMS-02	N/A	N/A	N/A	X	X	N/R	N/A	N/A

(X inserted where interface is required; N/A inserted where interface is not available; and N/R inserted where interface is not required.)

*Service available until Orbiter powerdown.
**No entry required for IVT or ETE test.
***To maintain capability if required.
****To minimize software impacts, cargo integration software and Orbiter software will be configured to support Station-to-Shuttle Power Transfer System (SSPTS), APCU, and connector mate functions.
*****Applicable only for flights where APCUs are manifested.

i. ROEU (one for AMS-02, one for ELC3)

j. SPASP, OPP, one SPDU, and associated AFD cabling for OBSS LCS/IDC

k. DC power cable w/assembly, (qty 2): (qty 1) for GLACIER and (qty 1) for CGBA

l. ICAPC, qty (2) with attachment bolts/hardware for MISSE 7a and 7b PECs. ICAPC, qty (1) with attachments bolts/hardware for MISSE 8

m. Power cable (qty 3), data cable (qty 1), command and monitor cable (qty 2), AFD and PLB data interface (PDIP) cables (RS-422, Ethernet, GMT) cables (qty 2), for DTO-703 STORRM. Reference NSTS 21551, DTO-703 STORRM IP. Note: AMS-02 shares RS-422 and PDIP PLB cables.

n. Crew cabin PGSC with 28-V power supply and RS-422/Ethernet flight data cables (qty 1), integration ground testing PGSC (qty 1), RS-422 Serial PCMCIA cards (qty 2), RangeMax 240 wireless routers (qty 2) for DTO-703 STORRM.

o. APC (qty 1) and attachment hardware (bolts/washers) for ODS, PLB and for DTO-703 STORRM.

p. Ku Channel 2 and 3 data cable (qty 1), AFD data cable (qty 1), and PLB 1553 extension cable (qty 1), for AMS-02.

q. Crew cabin PGSC with 28-V power supply and RS-422/Ethernet flight data cables (qty 1), integration ground testing PGSC (qty 1), RS-422 Serial PCMCIA cards (qty 2), and RangeMax 240 wireless routers (qty 2) for connection to AMS-02 DDRS-02.

r. Spare PGSC stowed in crew compartment (qty 1) to be used by either AMS-02 or DTO-703 STORRM.

s. Middeck stowage locker with modified access door (qty 2) required for CGBA. One locker is for CGBA backup unit.

t. Power cables (qty 2) and data cables (qty 2) to support AMS-02 T-0 requirements.

u. Connector plug (qty 6), connector jam nut (qty 2), backshell (qty 3), contact socket 22D AWG (qty 300), contact socket 20 AWG (qty 100), contact pin 22D AWG (qty 200), and sealing plug 22D AWG (qty 100), for AMS-02 OCA adapter, resistance temperature detector, and DDRS-02 extension cable assemblies.

Note: Changes associated with replacement of Cryomagnet with the permanent magnet by AMS-02 deletes the requirement for certain hardware listed above. Unused Hardware will remain in Orbiter for flight.

9.1 Launch Package Preintegration

Upon arrival at the launch site, most CE items are delivered to the SSPF. When a unique PPF is required, this preassigned facility and support will be identified in Annex 8.

Customer to ESPASS

AMS-02 will be initially delivered and processed in the SSPF. Offline processing activities will include postshipment assembly, functional and health checkouts, and cryogenic servicing. After the completion of offline activities, AMS-02 will begin online processing activities and checkout using an enhanced PRCU, which incorporates the Transport Asynchronous Transmitter/Receiver Interface (TAX1) Analyzer and TAX1 Funnel and the HOSC. The TAX1 Analyzer and TAX1 Funnel are JSC resources which will be borrowed for this testing.

Reference NSTS 21551 for generic DTO-703 STORRM preintegration requirements.

9.2 Launch Package Integration

(Reference NSTS 21458)

Customer to ESPASS

AMS-02 will undergo online Space Station integration testing in the SSPF using the enhanced PRCU and the ACASS. Full powerup of the AMS-02 Cryomagnet is planned for the SSPF. Cryogenic servicing is planned for the SSPF. Upon completion of SSPF activities, the entire cargo complement will be transported in the canister to the Canister Rotation Facility (CRF) to be rotated to vertical for subsequent transport to the pad.

CE integration activities include digital mapping and interface measurements, flightcrew checks, and sharp edge inspections. CE weight and c.g. measurements are taken before the CE is loaded into the payload canister.

9.2.1 Orbiter-to-Cargo Element Interface Verification.- (Reference NSTS 21458). Interface verification requirements will be defined in the Operations and Maintenance Requirements and Specifications Document (OMRSD).

9.2.2 Crew Equipment Interface Test.- (Reference NSTS 21458)

Is this suppose to address services in canister or when P/L installed in payload bay. If it's addressing services in the canister then it should be deleted. Otherwise, it's fays.

9.3.2 Pad Activities.- The payload canister is hoisted into position, and the CEs are extracted from the canister by the PGHM in the PCR and installed in the PLB. ~~In the canister, AMS-02 will require 110 V ac power supplied via a payload-provided GSE cable and KSC-supplied power.~~ AMS-02 also requires 120 V dc power and 1553 and RS-422 data connections via payload-provided GSE cables and KSC-supplied power.

The Orbiter-to-ELC3 IVT will be performed at the launch pad.

AMS-02 will perform an MLP T-0 verification test, which will test the 1553 and RS-422 T-0 data lines using an AMS-02 simulator. This test will also verify the capability and configuration for transmitting LCC data to the KSC firing room and the KSC AMS-02 POCC prior to payload arrival to the pad.

AMS-02 will be transported to the pad after S0024 activities are complete. This will eliminate disconnecting AMS-02 cryo servicing lines when the PLBDs are closed for S0024 operations.

The Orbiter-to-AMS-02 IVT and ETE test to verify command/data functions with MCC-H and the JSC POCC will be performed at the launch pad. AMS-02 payload requires a cryogenic helium top-off prior to launch. ~~Access to AMS-02 will be required to remove protective covers and to perform final flight closeouts and preparations.~~ Details of the IVT and ETE testing will be documented in the OMRSD.

Middeck lockers containing ISS-stowed hardware will be installed by the SSP in the Orbiter middeck during nominal stowage operations at the launch pad, which begins at L-10 days. Nominal turnover for these lockers should occur between L-20 days and L-10 days. Turnover times between L-10 days and the beginning of late turnover at L-76 hours are not nominal, but can be negotiated with KSC. ISS Middeck Utilization Payload processing requirements at the pad for nominal stowage installation operations are included in Appendix E. If KSC processing is required for an ISS Middeck Utilization Payload, the ISS Middeck Utilization Payload is installed, and any IVTs, closeout procedures, and hardware-unique tests will be accomplished by the SSP and documented in the OMRSD and/or mission-unique Time-critical Ground Handling Requirement (TGHR) table.

9.3.2.1 Late Launch Package Operations: (Reference NSTS 21458). The CE in the PLB will be in final lift-off configuration at PLBD closure for flight.

9.3.2.2 After Nominal Payload Bay Door Closure: (Reference NSTS 21458)

Customer to assess

Late access to AMS-02 is required until L-88 hours for late cryogenic servicing, followed by GSE deconfiguration, closeouts, contamination inspection, and access removal down to L-80 hours. At this time, AMS-02 will be in final lift-off configuration for PLBD closure.

AMS-02 requires numerous pieces of GSE to be left in the PCR during launch. These items are required for the last-minute top-off of AMS-02 superfluid helium at the pad.

9.3.2.3 Orbiter Middeck Operations: Options for ISS Middeck Utilization Payload late turnaround to KSC are as follows:

a. Turnover between L-76 hours and prior to L-28 hours

b. Turnover between less than L-28 hours and L-19.5 hours (non-time specific)

c. Turnover within a specific time between less than L-28 hours and L-19.5 hours

ISS Utilization Middeck Payloads turnover to KSC must be completed by L-19.5 hours. ISS Middeck Utilization Payload turnover time is based on completion of payload installation at L-17.5 hours. Late turnover (between L-28 hours and L-19.5 hours) requirements may affect manifesting and will require coordination with the Launch Team/Launch Directory during the launch countdown planning process, via the Launch Countdown Working Group (LCWG). ISS Middeck Utilization Payload late turnover times will be integrated with other manifested payloads and negotiated on a mission-specific basis. Any turnover conflicts will be resolved by the mission IPT and science community. This resolution process may result in adjustments to turnover times.

Details for ISS Middeck Utilization Payload late turnover processing requirements are provided in Appendix E and negotiated and documented in the OMRSD and/or mission-unique TGHR table.

The AMS-02 DDRS-02 and associated payload-provided cabling will be stowed in the middeck. Details are provided in Appendix E.

Orbiter Middeck ISS nonpayload hardware late turnover processing requirements are provided in table 9-1, and details for late turnover requirements are documented in the mission-unique TGHR table.

10.1 General

(Reference NSTS 21458)

10.2 ISSP Experiments in the Orbiter Crew Compartment

(Reference NSTS 21458)

11.0 INTERFACE VERIFICATION AND TESTING

(Reference NSTS 21458)

Reference NSTS 21551 for generic DTO-703 STORRM requirements.

Once AMS-02 is installed into the Orbiter, the Orbiter-to-CE interfaces are verified, including powerup, 1553 and RS-422 data checkout, and operations of the AFD Middeck located DDRS-02.

12.0 POSTFLIGHT DATA REQUIREMENTS

Reference NSTS 21548 for generic MISSE 7 requirements. Reference NSTS 21551 for DTO-703 STORRM requirements.

13.0 ISSP-FUNDED SERVICES SUMMARY

This section of the MIP identifies and sets forth all integration hardware, interface verification, and flight operations services to be performed by the SSP for the ISSP, which are currently identified as ISSP-funded services. These ISSP-funded services are budgeted as agreed upon by the ISSP. All other services are provided for the mission as standard services. A summary of ISSP-funded services identified herein is listed as follows:

AMS-02 functional testing, checkout, and servicing in the OPF, MLP, KSC POCC, and the pad.

a. AMS-02 POPIT-2 test activity as part of SSP preintegration activities (sections 3.3, 9.3.2)

b. AMS-02 SIT in the OPF testing as part of the SSP preintegration activities (sections 3.3, 9.3.1)

c. ~~AMS-02 required power and data connections in the canister (sections 3.3, 9.3.2)~~