HLS-xEVA System Interface Requirement Control Document

Draft

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National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas Contract No.: NNJ12GA46C

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REVISION AND HISTORY

REV.	DESCRIPTION	PUB. DATE
Draft	Draft – Still requires EVA CR and associated technical reviews	9/23/19

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HLS-XEVA INTERFACE REQUIREMENTS DOCUMENT

CONCURRENCE

DRAFT – Q1 2019

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1.0 INTRODUCTION

1.1 PURPOSE

EVA-EXP-0067, HLS to xEVA Interface Requirements Control Document (IRCD) defines the requirements for the internal interfaces for the Human Landing System (HLS) between the Exploration Extravehicular Activity (xEVA) System and the HLS.

1.2 SCOPE

The scope of this document is to provide interface requirements for the xEVA System and the HLS as they pertain to the HLS. The xEVA System consists of the xEMU, xEMU flight support equipment, EVA tools, and Servicing, Performance and Checkout Equipment (SPCE). Requirements in this document will refer to either the xEVA System or xEMU System as needed in order to clarify what the interfacing system is with the HLS. While the xEMU System is a part of the xEVA system, for clarity of where the interface plane is it will be explicitly called out in the requirement.

This document covers interfaces for a single suit architecture to interface with HLS. The single suit architecture refers to the xEMU or components of the xEMU will provide functions for both EVA Operations and dynamic phases of flight.

1.2.1 EVA PHASES OF OPERATION

EVA phases of operations are the activities of preparing for the EVA, the EVA, and post EVA activities. Prior to and immediately following external vehicle activity there will be a set of interfaces the xEMU System will require within the HLS for servicing and checkout of the xEMU. Requirements for these functions between the xEVA System and the HLS internal cabin are documented in section 3.0. In section 3.1 systems and nomenclature for systems used during EVA Operations are defined.

1.2.2 DYNAMIC PHASES OF OPERATION

Dynamic phases of flight are periods of time where the vehicle is performing active propulsive maneuvers and where the xEMU is donned. Dynamic phases of flight occur periodically following crewed undocking of HLS from lunar orbit through lunar surface landing and the eventually re-docking with Gateway or Orion at the end of the lunar surface mission. For initial lunar surface missions the HLS may be docked to Gateway or Orion. Sustainable phase missions will be conducted through Gateway. The same dynamic phases of flight exist for either option. The main phases of operation included within this period where the xEMU is donned are Crew Gateway or Orion Operations undocking (TBR-IRCD-025), Descent, Ascent, Vehicle maneuvering and docking (TBR-IRCD-025). While descent and ascent may be thought of as the entire phase from lunar orbit to the surface and vice versa, it is not to be concluded that the xEMU is donned for those entire phases. The xEMU will be donned and then doffed as needed during those phases, dependent upon when the active propulsive maneuvers are performed. During dynamic phases of flight such as in-flight burns, crew members will don the xEMU without the xPLSS attached. When unattached to the xEMU, the xPLSS will be either stored in

the HLS cabin or left on the lunar surface. When the xPLSS is not attached to the xEMU, the HLS will be responsible for providing life support and communications functions to the xEMU donned crewmember. These functions and services while similar in some cases, differ from the nominal services required for pre-EVA, post-EVA and EVA operation tasks. For example, when the xPLSS is removed, the HLS becomes responsible for suit loop ventilation, CO2 removal, trace containment removal, humidity control, communications, and cooling water circulation via an umbilical that interfaces with the xEMU DCU. The HLS takes on many of the xPLSS responsibilities performed by the xPLSS during EVA Operations.

1.3 PRECEDENCE

For interfaces defined and controlled in EVA-EXP-0067 HLS-xEVA System IRCD, this document will take precedence.

1.4 VERB APPLICATION

The convention used in this document which indicates requirements and statements of facts is as follows:

Designation	Description
“Shall”	used to indicate a requirement which must be implemented and its implementation verified (binding requirements)
“Will”	used to indicate a statement of fact and is not verified

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2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. The documents listed in this paragraph are applicable to the extent specified herein. Inclusion of applicable documents herein does not in any way supersede the order of precedence identified in Paragraph 1.3 of this document.

Document Number	Rev	Document Title
NASA-STD-4003	A 01/19/2016	Electrical Bonding For NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment
JPR 5322.1	H 01/25/2016	Contamination Control Requirements Manual
JSC 66695	B 5/23/2014	EMU Water Quality Specification
SSP 30240	H 01/15/2010	Space Station Grounding Requirements

2.2 REFERENCE DOCUMENTS

The following documents contain supplemental information to guide the user in the application of this document. These reference documents may or may not be specifically cited within the text of this document.

Document Number	Rev	Document Title
<TBD-IRCD-007>	Baseline	Human Landing System Concept of Operations
	A 04/03/2019	Exploration EVA System Concept of Operations
NASA-STD-3001 V2	A 02/10/2015	NASA Space Flight Human-System Standard V2: Human Factors, Habitability, and Environmental Health

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3.0 INTERFACES

3.1 GENERAL

3.1.1 XEVA SYSTEM

The Exploration EVA System (xEVA System) allows crewmembers to perform autonomous and robotically assisted extravehicular exploration, research, construction, servicing, and repair operations in environments that exceed human capability. The xEVA System is a system of systems consisting of the xEMU and SPCE for pre- and post-EVA operations.

SPCE hardware will not be specifically called out in the “shall statements” in this document and falls under the xEVA System. The term SPCE covers a wide multitude of equipment provided by NASA for supporting the xEMU. SPCE includes such items as the utility interface panel (UIP), xEMU battery chargers, power supply regulation, umbilicals, don/doff support equipment needed to maintain and resize suits during both ground and flight environments. How SPCE interfaces with the suit and HLS is dependent on the SPCE’s required function. For some cases, SPCE provides mechanical and support interfaces between the xEMU and HLS (ex. don/doff aids) or the SPCE merely passes through something from the xEMU to HLS and HLS to xEMU. In more complexes cases SPCE is hardware nominally used by the xEVA System to modulate or alter a resource provided by a vehicle for use with a xEMU. An example would be if 120Vdc was provided from the vehicle, then the SPCE would modulate the voltage to 28Vdc for the xEMU. These modulations were not assumed as a forgone conclusion in these requirements. If SPCE is required it will be identified in the Section 4.0 as the HLS is developed and the interface defined for control.

3.1.2 XEMU SYSTEM

The xEMU System consists of the Exploration Portable Life Support System (xPLSS), Exploration Pressure Garment System (xPGS), and Exploration Informatics (xINFO). The xEMU will interface with the UIP via umbilicals. For pre and post EVA operations, the xEMU will utilize the Exploration Service and Cooling Umbilical (ESCU), and the Vacuum Access Umbilical (VAU).

Figure 3.1.3-1 xEVA-HLS Interface Diagram for EVA Phases of Operations is a high level diagram showing the interfacing functions between the xEMU System and the HLS for EVA Operations. Figure 3.1.3-2 xEVA-HLS for Dynamic Phases of Operations is high level diagram showing the interfacing function between the xEMU System and the HLS for EVA operations.

3.1.3 HLS

The HLS is used to support EVA by providing a means for the crew to translate from the pressurized lander environment to the lunar surface. The HLS is used for don−doff, storage of the xEMUs, xEMU SPCE, depressurization, repressurization, and egress−ingress to and from the lunar surface. The HLS is also used to support life support and avionics during pre and post EVA Operations and when the xEMU is donned during dynamic phases of flight. The resources the HLS provides to the xEMU are dependent upon the operation phase defined in Section 1.21 EVA Phases of Operation and

Section1.22 Dynamic Phases of Operation. For what functions the HLS is providing and for what phase, refer to Figure 3.1.3-1 xEVA-HLS Interface Diagram for EVA Phases of Operations and Figure 3.1.3-2 xEVA-HLS for Dynamic Phases of Operations.

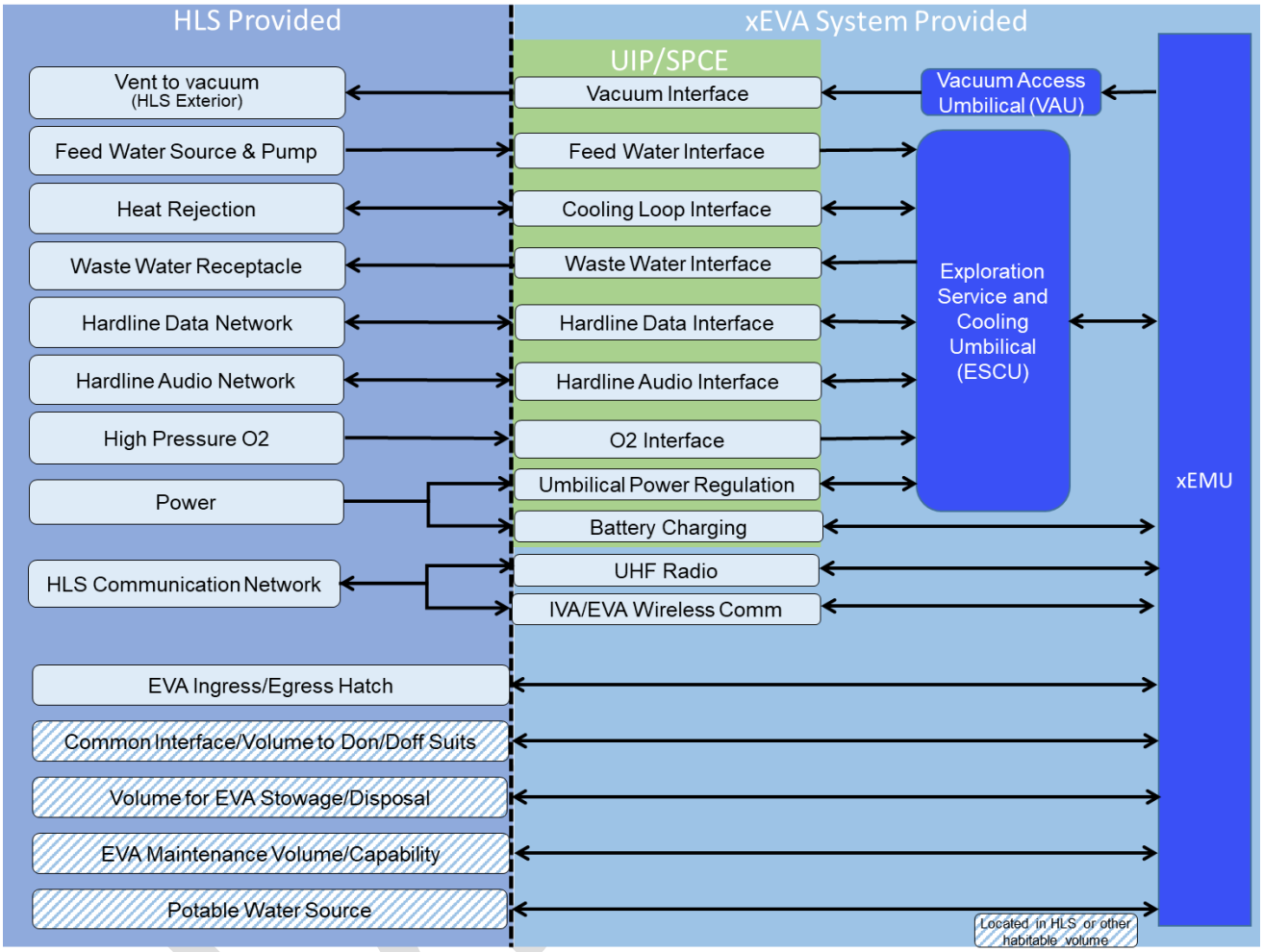

FIGURE 3.1.3-1 XEVA-HLS INTERFACE DIAGRAM FOR EVA PHASES OF OPERATIONS

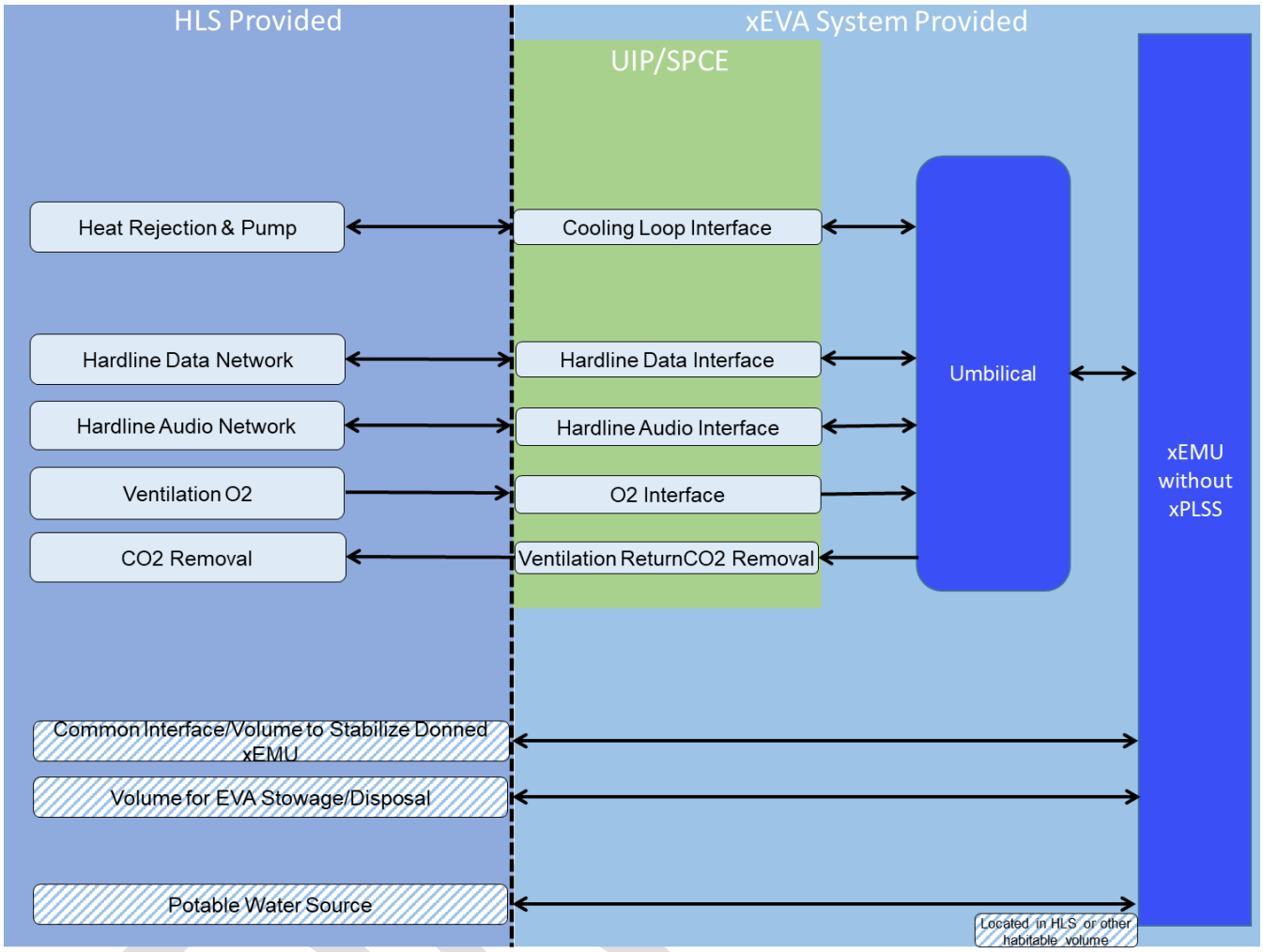

FIGURE 3.1.3-2 XEVA-HLS FOR DYNAMIC PHASES OF OPERATIONS

3.2 EVA INTERFACE REQUIREMENTS

Requirements in this section pertain to interface requirements between the xEVA System and HLS during pre-EVA, EVA and post-EVA Operations. Interfaces between the xEVA System and HLS are shown in Figure 3.1.3-1 xEVA-HLS Interface Diagram for EVA Phases of Operations.

3.2.1 OXYGEN SYSTEM

3.2.1.1 OXYGEN FUNCTIONAL REQUIREMENT

[xEMU.IRCD.0001] The HLS shall provide an interface for the transfer of oxygen for xEVA System recharge, in-suit pre-breathe, and umbilical operations in accordance with [Section 4 of this IRCD].

Rationale: Charging of the xEMU System's oxygen tanks occurs prior to every EVA and during all umbilical operations when the xPLSS is attached to the xEMU. The oxygen is supplied from

the HLS to the xEMU through an interface located on the EVA Utility Interface Panel. The xEMU System is designed with a nominal operating pressure of 20684.27 kPa (3000 psia).

[xEMU.IRCD.0002] The xEVA System shall provide an interface for the receiving of oxygen for xEVA System recharge, in-suit pre-breathe, and umbilical operations in accordance with [Section 4 of this IRCD].

Rationale: Charging of the xEMU System's oxygen tanks occurs prior to every EVA and during all umbilical operations when the xPLSS is attached to the xEMU. The oxygen is supplied from the HLS to the xEMU through an interface located on the EVA Utility Interface Panel. The xEMU System is designed with a nominal operating pressure of 20684.27 kPa (3000 psia).

3.2.1.2 OXYGEN PRESSURE

[xEMU.IRCD.0003] The HLS shall provide oxygen to the xEMU System at a pressure of 20684.27 ± 344.74 kPa (3000 ± 50 psia) for xEMU System Recharge.

Rationale: The xEVA System is designed for a nominal operating pressure of 20684.27 kPa (3000 psia). The xEMU MDP for oxygen is 25855.34 kPa (3750 psi).

[xEMU.IRCD.0004] The xEVA System shall receive oxygen at a pressure of 20684.27 ± 344.74 kPa (3000 ± 50 psia) for xEMU System Recharge.

Rationale: The xEMU System is designed for a nominal operating pressure of 20684.27 kPa (3000 psia). The xEMU MDP for oxygen is 25855.34 kPa (3750 psi)

3.2.1.3 OXYGEN FLOW RATE

[xEMU.IRCD.0005] The HLS shall provide oxygen to the xEVA System at a minimum flow rate of 3.22 kg/hr (7.1 lbm/hr) <TBR-IRCD-003>-while maintaining a pressure greater than 20684.27 ± 344.74 kPa (3000 ± 50 psia) for xEVA System Recharge.

Rationale: The 3.22 kg/hr (7.1 lbm/hr) flow rate is necessary to support denitrogenization purge in IVA conditions while connected to ESCU.

[xEMU.IRCD.0006] The xEVA System shall be capable of receiving oxygen at a minimum flow rate of 3.22 kg/hr (7.1 lbm/hr) < TBR-IRCD-003>- while maintain a pressure greater than pressure of 20684.27 ± 344.74 kPa (3000 ± 50 psia) for xEVA System Recharge.

Rationale: The 3.22 kg/hr (7.1 lbm/hr) flow rate is necessary to support denitrogenization purge in IVA conditions while connected to ESCU.

3.2.1.4 OXYGEN TEMPERATURE

[xEMU.IRCD.0007] The HLS shall provide oxygen to the xEVA System at a temperature in the range of 4.44 to 32.22 Celsius (40 to 90 degrees Fahrenheit) for xEVA System Recharge.

Rationale: The temperature range of the oxygen received directly impacts the pressure of the O2 in the xEMU. To ensure the xEMU has the adequate supply of Oxygen, the pressure and temperature of the O2 supplied must be controlled.

[xEMU.IRCD.0008] The xEVA System shall receive oxygen at a temperature in the range of 4.44 to 32.22 Celsius (40 to 90 degrees Fahrenheit) for xEVA System Recharge.

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Rationale: The temperature range of the oxygen received directly impacts the pressure of the O2 in the xEMU. To ensure the xEMU has the adequate supply of Oxygen, the pressure and temperature of the O2 supplied must be controlled.

3.2.1.5 OXYGEN PURITY AND CLEANLINESS

[xEMU.IRCD.0075] The HLS shall provide a minimum purity levels of breathing oxygen to the xEMU System of 99.5% by vol.

Rationale: The purity level of oxygen required to support life and maintain system integrity is 99.5% oxygen by volume. The minimum purity level of oxygen to the xEMU System is for all xEMU umbilical operations and for EVA Operation and Dynamic Phases of Flight.

[xEMU.IRCD.0076] The xEVA System shall receive a minimum purity level of breathing oxygen from the HLS of 99.5% oxygen by volume.

Rationale: The purity level of oxygen required to support life and maintain system integrity is 99.5% oxygen by volume. The minimum purity level of oxygen to the xEMU System is for all xEMU umbilical operations. The minimum purity level of oxygen to the xEMU System is for all xEMU umbilical operations and for EVA Operation and Dynamic Phases of Flight.

[xEMU.IRCD.0077] The HLS shall provide oxygen at a cleanliness level of at least 200A per JPR 5322.1.

Rationale: Oxygen cleanliness levels affect the suits components, driving the frequency of preventative maintenance and sizing of ORU components. High levels of particulates can result in reduction of system life and increased frequency of down time due to maintenance and repairs. The minimum cleanliness levels is for all hardware to be used in and interface with xEMU for EVA umbilical operations and for EVA Operation and Dynamic Phases of Flight.

[xEMU.IRCD.0078] The xEVA System shall receive oxygen at a cleanliness level of at least 200A per JPR 5322.1.

Rationale: Oxygen cleanliness levels affect the suits components, driving the frequency of preventative maintenance and sizing of ORU components. High levels of particulates can result in reduction of system life and increased frequency of down time due to maintenance and repairs. The minimum cleanliness levels is for all hardware to be used in and interface with xEMU for EVA umbilical operations and for EVA Operation and Dynamic Phases of Flight.

3.2.1.6 OXYGEN AMOUNT

3.2.1.6.1 OXYGEN RECHARGE AMOUNT

[xEMU.IRCD.0079] The HLS shall supply 4kg (8.72 lbs) <TBR-IRCD-002> of oxygen per two person 8 hour EVA for xEVA System Recharge.

Rationale: Oxygen is utilized by the xEVA system for xEMU System recharge. xEMU systems will not come with an initial oxygen charge, and will require the xEMU to be charged by the HLS.

[xEMU.IRCD.0080] The xEVA System shall receive 4kg (8.72 lbs) <TBR-IRCD-002> of oxygen per two person 8 hour EVA from the HLS for xEMU System Recharge.

Rationale: Oxygen is utilized by the xEVA system for xEVA System recharge. xEMU systems will not come with an initial oxygen charge, and will require the xEMU to be charged by the HLS.

3.2.1.6.2 OXYGEN UMBILCAL AND PREBREATHE AMOUNTS

[xEMU.IRCD.0138] The HLS shall supply <TBD-IRCD-016> lbs of oxygen per two person EVA for in-suit prebreathe and umbilical operations.

Rationale: Oxygen is utilized by the xEVA system for xEMU System in-suit pre-breathe, and umbilical operations.

[xEMU.IRCD.0139] The xEVA System shall receive <TBD-IRCD-016> lbs of oxygen per two person EVA from the HLS for in-suit prebreathe and umbilical operations.

Rationale: Oxygen is utilized by the xEVA system for xEMU System in-suit pre-breathe, and umbilical operations.

3.2.2 THERMAL COOLING

While on umbilical during the EVA phases of operation, thermal heat rejection for the xEMU is provided by the vehicle. The xEMU circulates water to HLS at an elevated temperature and the xEMU receives water at a lower temperature as stated in this section. The function for providing heat rejection via a cooling loop is in addition to the function for providing feed water supplied for filling the xEMU bladders. The same supply interface on the UIP to the xEMU will be used for both functions with the xEMU managing whether the xEMU bladders are being filled or if the water is being returned to the vehicle for heat rejection.

3.2.2.1 THERMAL COOLING FLOWRATE

[xEMU.IRCD.0009] The xEVA System shall circulate cooling water through the HLS provided cooling loop and heat exchanger at a nominal rate of 90.72 +9.07/-13.6 kg/hr (200 +20/-30 lbm/hr).

Rationale: Circulation of the water through the HLS heat exchange cooling loop is provided by the interfacing space suit when the xPLSS is attached to the xEMU. The space suit circulates water through a single loop for a single space suit. When the xPLSS is removed from the xEMU for dynamic flight phases, the HLS will provide water circulation, see section 3.3.2 Thermal Cooling. Thermal cooling is only required during operations and phases were the xEMU is attached to HLS by umbilical in order to conserve xEMU resources for the EVA.

[xEMU.IRCD.0081] The HLS shall receive cooling water from the xEVA System a maximum temperature of 36.67C (98F) at a flow rate of 90.72 +9.07/-13.6 kg/hr (200 +20/-30 lbm/hr).

Rationale: The maximum temperature is based upon xEMU heat loads and assumes a metabolic rate of 1200 BTUs/hr. The heat rejection for the combined load of the human metabolic rate and xPLSS is up to 2000 BTU/hr per suit loop. Circulation of the water through the HLS heat exchange cooling loop is provided by the xEMU when the xPLSS

is attached to the xEMU. The space suit circulates water through a single loop for a single space suit. When the xPLSS is removed from the xEMU for dynamic flight phases, the HLS will provide water circulation. Thermal cooling is only required during operations and phases were the xEMU is attached to HLS by umbilical in order to conserve xEMU resources for the EVA.

3.2.2.2 THERMAL COOLING MAXIMUM TEMPERATURE

[xEMU.IRCD.0082] The HLS shall return cooling water to the xEVA System at a temperature not greater than 31.11C (88F) at a flow rate of 84.82 kg/hr (187 lbm/hr).

Rationale: The temperature is the minimal temperature that allows the xEMU System to provide cooling to the xPLSS and a suited crewmember on umbilical, pre and post EVA.

[xEMU.IRCD.0083] The HLS shall provide a separate cooling loop interfaces for each xEMU.

Rationale: Pumping of water through the cooling loops and heat exchangers provided by the vehicle is performed by each xEMU. Each xEMU is only capable of pumping water through the HLS provided thermal cooling loop for separate cooling loops allow for each xEMU to individually adjust their thermal cooling water flow to meet the specific needs of each crewmember

3.2.2.3 THERMAL COOLING BIOCIDE

[xEMU.IRCD.0146] The HLS thermal cooling loop shall be compatible with an iodine concentration of up to 4 ppm.

Rationale: The xEMU System uses iodinated water instead of silver water for biocide.

3.2.2.4 THERMAL COOLING WATER QUALITY

[xEMU.IRCD.0144] The HLS shall provide thermal cooling water that meets the standard of JSC-66695: EMU Water Quality Specification, Table 7.3-1 Deionized Water Quality Requirements for EMU Flight Hardware and Table 7.3-2 Iodinated Water Quality Requirements for EMU Flight Hardware.

Rationale: The buildup of constituents in space suits due to feed water quality results in hardware degradation and failures. Controlling water quality limits the buildup, reducing the amount of preventative maintenance required and allows for operations to regular schedule preventative maintenance reducing the possibility of the buildup leading to a system failure.

[xEMU.IRCD.0145] The xEVA System shall receive thermal cooling water that meets the standard of JSC-66695: EMU Water Quality Specification, Table 7.3-1 Deionized Water Quality Requirements for EMU Flight Hardware and Table 7.3-2 Iodinated Water Quality Requirements for EMU Flight Hardware.

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Rationale: The buildup of constituents in space suits due to feed water quality results in hardware degradation and failures. Controlling water quality limits the buildup, reducing the amount of preventative maintenance required and allows for operations to regular schedule preventative maintenance reducing the possibility of the buildup leading to a system failure.

3.2.3 FEED WATER SUPPLY SYSTEM

Feed Water is water that is pumped into the xEMU bladders from HLS. It's used to replenish water in the xEMU thermal control loop during EVAs. The feed water has different quality requirements then potable water. The xEVA System does not control the quality of potable water, but does have a specification for the water quality of the feed water system.

3.2.3.1 FEED WATER QUANITY

[xEMU.IRCD.0011] The HLS shall provide 11.84kg (26.1 lbs) of feed water to the xEVA System per two person 8 hour EVAs for xEVA System Recharge.

Rationale: Water is utilized for cooling of xEMU hardware and crewmembers. Since the water turns to vapor and is rejected to vacuum during the cooling process, the xEMU water supply needs to be recharged prior to every EVA. This includes LCVG, FSA, and Auxiliary FSA recharge and assumes there are some wetted thermal components from suit checkout.

[xEMU.IRCD.0084] The xEMU shall receive 11.84kg (26.1 lbs) of feed water from the HLS through the ESCUs per two person 8 hour EVAs for xEVA System Recharge.

Rationale: Water is utilized for cooling of xEMU hardware and crewmembers. Since the water turns to vapor and is rejected to vacuum during the cooling process, the xEMU water supply needs to be recharged prior to every EVA. This includes LCVG, FSA, and Auxiliary FSA recharge and assumes there are some wetted thermal components from suit checkout.

3.2.3.2 FEED WATER SUPPLY FLOW RATE

[xEMU.IRCD.0135] The HLS shall supply feed water to the xEVA system at a rate of 0.45kg/hr (1.0 lbm/min) or greater, when backpressure is less than 34.47 kPa (5.0 psig) for xEMU System Recharge.

Rationale: The goal is to recharge two xEMUs simultaneously.

[xEMU.IRCD.0136] The xEVA System shall receive feed water from the HLS for refill at a rate of (1.0 lbm/min) or greater, when backpressure is less than 34.47 kPa (5.0 psig) for xEMU System Recharge.

Rationale: The goal is to recharge two xEMUs simultaneously.

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3.2.3.3 FEED WATER TEMPERATURE

[xEMU.IRCD.0137] The HLS shall supply feed water to the xEVA System at temperature range of 15.56 to 32.2 Celsius (60 to 90 °F) for xEMU System Recharge.

Rationale: <TBD-IRCD-008>

3.2.3.4 FEED WATER SUPPLY PRESSURE

[xEMU.IRCD.0133] The HLS shall supply feed water to the xEVA System at a pressure between 34.47 and 62.05 kPa (5.0 and 9.0 psig) < TBR-IRCD-004> for xEMU System Recharge.

Rationale: xEMU bladders are determined full based on the internal pressure of the bladders. A specific pressure range is required from the vehicle providing the feed water to ensure the required internal pressure is met and the xEMU bladders are full.

3.2.3.5 FEED WATER BIOCIDE

[xEMU.IRCD.0053] The HLS shall provide feed water to the xEVA System with an iodine concentration of 0.5-4 ppm to the suit for xEMU System Recharge.

Rationale: The xEMU System uses iodinated water instead of silver water for biocide.

[xEMU.IRCD.0054] The xEVA System shall receive feed water with an iodine concentration of 0.5-4 ppm to the suit.

Rationale: The xEMU System uses iodinated water instead of silver water for biocide.

3.2.3.6 FEED WATER QUALITY

[xEMU.IRCD.0085] The HLS shall provide feed water that meets the standard of JSC-66695: EMU Water Quality Specification, Table 7.3-1 Deionized Water Quality Requirements for EMU Flight Hardware and Table 7.3-2 Iodinated Water Quality Requirements for EMU Flight Hardware for xEVA System Recharge.

Rationale: The buildup of constituents in space suits due to feed water quality results in hardware degradation and failures. Controlling water quality limits the buildup, reducing the amount of preventative maintenance required and allows for operations to regular schedule preventative maintenance reducing the possibility of the buildup leading to a system failure.

[xEMU.IRCD.0086] The xEVA System shall receive feed water that meets the standard of JSC-66695: EMU Water Quality Specification, Table 7.3-1 Deionized Water Quality Requirements for EMU Flight Hardware and Table 7.3-2 Iodinated Water Quality Requirements for EMU Flight Hardware for xEVA System Recharge.

Rationale: The buildup of constituents in space suits due to feed water quality results in hardware degradation and failures. Controlling water quality limits the buildup, reducing the amount of preventative maintenance required and allows for operations to regular schedule preventative maintenance reducing the possibility of the buildup leading to a system failure.

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3.2.3.7 WASTE WATER SUPPLY SYSTEM

Waste water is gray water (relatively clean waste water) from the xEMU bladders and thermal cooling that is returned to the vehicle for disposal. Waste water is returned to HLS from the xEMU when the dwell time of water in the xEMU, after an EVA, has exceeded 180 days. In these situations half to all of the xEMU tanks are dumped to the vehicle by a crew operated switch.

[xEMU.IRCD.0013] The HLS shall receive waste water from the xEVA System upon execution of a crew operated system on the HLS.

Rationale: For maintenance and post-EVA operations, the xEMU System dumps waste water from the space suit to the vehicle. The removal of waste water is maintenance concern when looking at extended quiescence periods between EVAs.

[xEMU.IRCD.0014] The xEVA System shall dump waste water to the HLS upon execution of a crew operated system on the HLS.

Rationale: For maintenance and post-EVA operations, the xEMU System dumps waste water from the space suit to the vehicle. The removal of waste water is maintenance concern when looking at extended quiescence periods between EVAs.

[xEMU.IRCD.0087] The HLS shall receive up to 11.84kg (26.1 lbs) of waste water per two xEMUs.

Rationale: During maintenance operations this can result in a complete drainage of the xEMU water assemblies.

[xEMU.IRCD.0088] The HLS shall receive waste water per xEMU at less than 20.41kg/hr (45 lbm/hr).

Rationale: Historically, limitations have been placed on the waste water lines on the vehicle and are dependent upon what the waste water is drained into. Slower flow rates are necessary for softgood containers that are handled and monitored by the crew.

3.2.4 POTABLE WATER

This section has move to interfaces that are not phase dependent.

Water consumption is based on NASA-STD-3001 V2 11026 where 8oz of water per hour is required. Water consumption is the same regardless if it is for EVA operations or dynamic phases of flight.

3.2.5 VACUUM ACCESS LINE

[xEMU.IRCD.0015] The HLS shall provide a vacuum flow of at least 1200 lpm @ 1.6 torr to the xEVA System at the Utility Interface Panel.

Rationale: When the HLS is pressurized, the xEMU System needs to be connected to a vacuum source in order for the xEMU to remove CO2 from inside the suit. Exposure to

a vacuum allows the xEMU to successfully remove CO2 from the xEMU ventilation loop. The vacuum flow is for two xEMUs.

[xEMU.IRCD.0014] The HLS shall provide a vacuum source capable of tolerating the quantities identified in Table 3.2.5-1 xEVA Vacuum Line Gases.

Table 3.2.5-1 xEVA Vacuum Line Gases

Type	Quantity
Oxygen (O2)	0.018 kg/hr (0.04 lbm/hr)
Carbon dioxide (Co2)	0.074 kg/hr (0.16 lbm/hr)
Moisture	0.089 kg/hr (0.196 lbm/hr)
Ammonia (NH3)	6000 ppm[1]
Note 1: At initialization	

Rationale: When the HLS is pressurized, the xEMU System needs to be connected to a vacuum source in order for the xEMU to remove CO2 from inside the suit. As part of the CO2 removal process the xEMU System will release CO2 and other constituents into the vacuum source system as provided by the HLS.

3.2.5.1 INPUT PRESSURE LIMIT

[xEMU.IRCD.0016] The xEMU System shall control the maximum interface pressure (i.e., MDP) to the HLS vacuum access line to less than 73.08 kPa (10.6 psia).

Rationale: Pressure, temperature and dew point between the xEMU System and the HLS vacuum access lines are necessary for bounding the HLS vacuum access lines capabilities.

3.2.5.2 INPUT TEMPERATURE LIMIT

[xEMU.IRCD.0017] The xEVA System shall control the initial input temperature of gases disposed into the HLS vacuum access line to between 7.22 to 32.22 Celsius (45 to 90 °F).

Rationale: Pressure, temperature and dew point between the xEVA System and the HLS vacuum access lines are necessary for bounding the HLS vacuum access lines capabilities.

3.2.5.3 INPUT DEWPOINT LIMIT

[xEMU.IRCD.0018] The HLS Vacuum Access Line shall receive gases disposed by the xEVA System with dewpoints up to 15.56 Celsius (60 °F) <TBR-IRCD-005>.

Rationale: Pressure, temperature and dew point between the xEVA System and the vehicle vacuum access lines are necessary for bounding the HLS vacuum access lines capabilities.

3.2.5.4 VACUUM ACCESS LEAK RATE

[xEMU.IRCD.0019] The xEVA System vacuum access lines from the RCA in the xEMU to the vehicle vacuum port including quick disconnect and hoses shall limit the total allowable leakage to less than 5 x 10-4 standard cubic centimeters per second (sccs) of GHe at 275 .79 kPa (40 psia) equivalent at 18 to 23.9 °C (70 ± 5 °F).

Rationale: Leakage of ammonia and other constituents during CO2 removal from the xEMU System into the HLS habitable volume is a contamination concern. The vacuum access line between the xEMU System and the HLS is to limit the amount of contaminants leaking from system.

[xEMU.IRCD.0123] The HLS shall limit the total allowable leakage from vacuum access lines including quick disconnect and hoses connected to the xEVA System to be less than 5 x 10-4 standard cubic centimeters per second (sccs) of GHe at 275 .79 kPa (40 psia) equivalent at 18 to 23.9 °C (70 ± 5 °F).

Rationale: Leakage of ammonia and other constituents during CO2 removal from the xEMU System into the HLS habitable volume is a contamination concern. The vacuum access line between the xEMU System and the HLS is to limit the amount of contaminants leaking from system.

3.2.6 ELECTRICAL SYSTEM

Total power usage includes nominal Umbilical Interface Panel, Power Supply Assembly (PSA) power draw, and power required for the Exploration Battery Management System (xBMS). The PSA powers the xEMUs while they are on umbilical and powers xEVA SPCE, such as the Umbilical Interface Panel and UHF radios <TBR-IRCD-0026>. Durations of umbilical power draw during IVA operations may change depending on descent/ascent duration and prebreathe duration. The xBMS charges the xEMUs between EVAs Early missions assume only 1 xBMS is integrated and the xEMUs are charged serially; however, if two xBMSs are flown, then suits are able to be charged simultaneously.

3.2.6.1 XEVA SYSTEM POWER

[xEMU.IRCD.0021] The HLS shall provide average 400 W of power with a peak power of 1250 W for the durations indicated in Figure 3.2.6-1 xEVA System Power Draw –Serial Suit Charging < TBR-IRCD-006> and Figure 3.2.6-2 xEVA System Power Draw – Parallel Suit Charging < TBR-IRCD-007>.

Rationale: The peak power requirement is based on an xEVA System with all hardware that requires power directly from HLS turned on and at peak power.

[xEMU.IRCD.0134] The xEVA System Shall receive and average of 400 W of power with a peak power of 1250 W from the HLS for the durations indicated in Figure 3.2.6-1 xEVA System Power Draw –Serial Suit Charging < TBR-IRCD-006> and Figure 3.2.6-2 xEVA System Power Draw – Parallel Suit Charging < TBR-IRCD-007>.

Rationale: The power requirement is based on a xEVA System with all hardware that requires power directly from HLS turned on and at peak power.

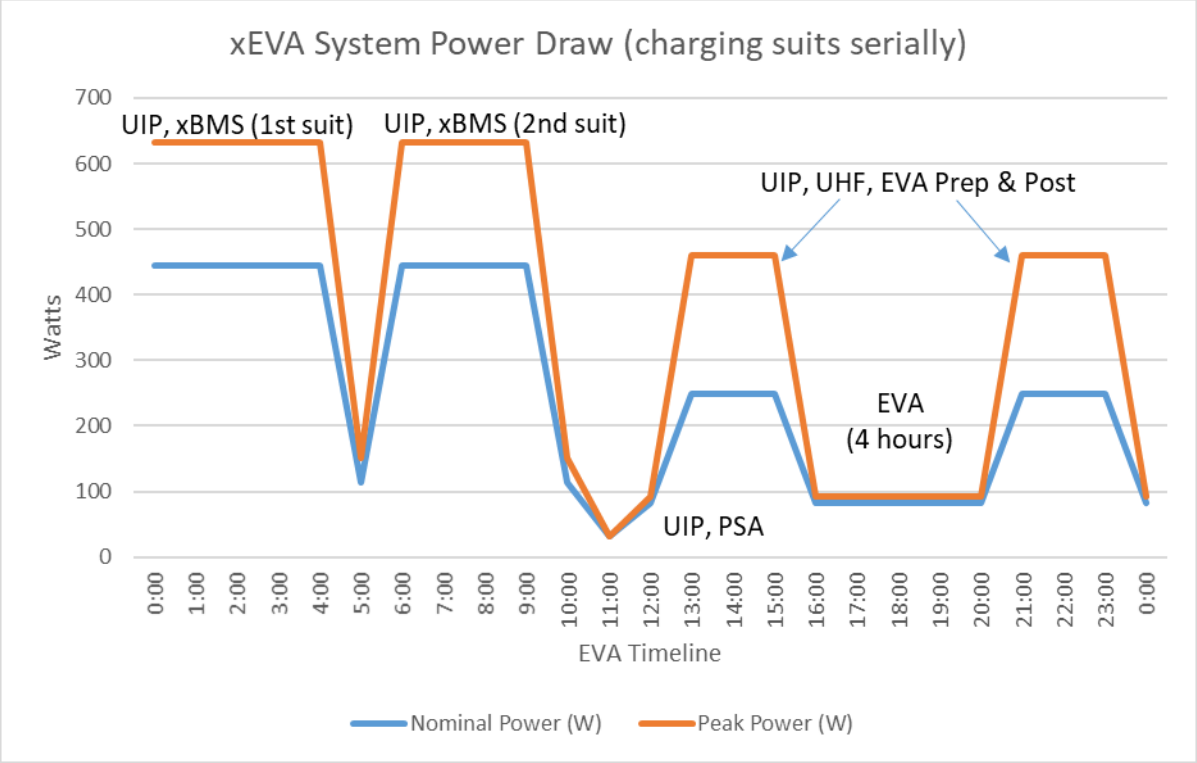

FIGURE 3.2.6-1 XEVA SYSTEM POWER DRAW –SERIAL SUIT CHARGING < TBR-IRCD-006>

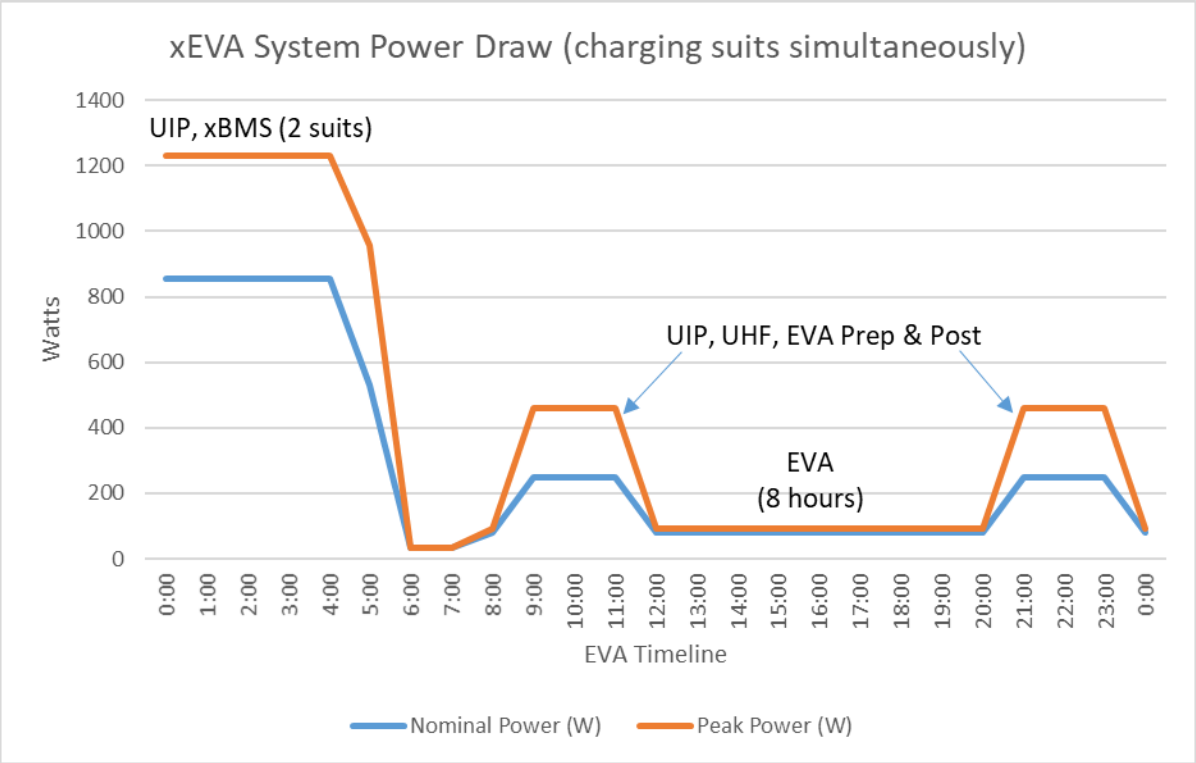

FIGURE 3.2.6-2 XEVA SYSTEM POWER DRAW – PARALLEL SUIT CHARGING < TBR-IRCD-007>

3.2.6.2 UMBILICAL POWER <TBD-IRCD-003>

The power requirements for the xEMU are known and power is required to be provided via the ESCU to the xEMU. However, voltage and current regulation for UIP and xEMU may be performed by xEVA System SPCE. The decision for xEVA System SPCE to regulate power will be made after HLS has finalized their vehicle bus voltage. Please note that the power requirement for the xEMU during umbilical operations is included in xEMU.IRCD.0021.

3.2.6.3 BATTERY CHARGER

Battery chargers for the xEMU are included in the xEVA System hardware. The HLS will provide power to the battery charger that will regulate power for charging of the xEMU batteries. A single battery charger can supply charging to one suit at a time. Charging takes 4 hours and full charge followed by 1 hour of 20% charge <TBR-IRCD-008>.

3.2.6.3.1 POWER TO BATTERY CHARGER

[xEMU.IRCD.0050] The HLS shall provide a power outlet for 120 Vdc with an output current ranging from 0 to 6 < TBR-IRCD-009> Amps for the xEMU battery.

Rationale: The HLS will not provide power regulation or charging directly to the xEMU and an xEVA System battery charger will be provided for this function. Power to the battery charger for the xEMU will be provided by the HLS EVA power outlet.

[xEMU.IRCD.0051] The xEVA System shall receive power for the battery charger from the HLS EVA power Outlet for 120 Vdc with an output current ranging from 0 to 6 < TBR-IRCD-009> Amps

Rationale: The HLS will not provide power regulation or charging directly to the xEMU and an xEVA System battery charger will be provided for this function Power to the battery charger for the xEMU will be provided by the HLS EVA power outlet.

3.2.6.4 ELECTRICAL BONDING

[xEMU.IRCD.0031] The xEVA System Interfaces shall have provisions for electrical bonding requirements of NASA-STD-4003.

Rationale: Electrical Bonding provides good electrical connection across faying surface mechanical interfaces to minimize electrical potential differences between equipment and individual parts of structure. Correct electrical bonding provides Fault current paths for protection against fire and personnel shock and means to prevent or safely discharge static charges. Bond classes for each interface will be captured in Section 4.12.3 Bonding.

[xEMU.IRCD.0056] The HLS shall have provisions for electrical bonding meeting the standards of NASA-STD-4003.

Rationale: Electrical Bonding provides good electrical connection across faying surface mechanical interfaces to minimize electrical potential differences between equipment and individual parts of structure. Correct electrical bonding provides Fault current paths for protection against fire and personnel shock and means to prevent or safely discharge static charges. Bond classes for each interface will be captured in Section 4.12.3 Bonding.

3.2.6.5 ELECTRICAL GROUNDING

[xEMU.IRCD.0071] The xEVA System shall comply with SSP 30240 <TBR-IRCD-010> for all interfaces to the HLS.

Rationale: For electrical power interface, all signals that cross the interface, and all gas and fluid lines that cross the interfaces between the HLS, SPCE and xEMU be properly configured for electrical ground reference and for electrical bonding to prevent build-up of potential differences, electrical shock hazards, and electrostatic charging/discharging.

[xEMU.IRCD.0072] The HLS shall comply with SSP 30240 <TBR-IRCD-010> for all xEVA System.

Rationale: For electrical power interface, all signals that cross the interface, and all gas and fluid lines that cross the interfaces between the HLS, SPCE and xEMU be properly

configured for electrical ground reference and for electrical bonding to prevent build-up of potential differences, electrical shock hazards, and electrostatic charging/discharging.

3.2.7 EXPLORATION EXTRAVEHICULAR MOBILITY UNIT REAL-TIME AUDIO, TELEMETRY AND BIOMED COMMUNICATIONS

3.2.7.1 HARDLINE AUDIO

[xEMU.IRCD.0032] The HLS shall provide a hard-wired interface for audio communications to the xEVA System.

Rationale: A hard-wire interface between the HLS and xEMU are utilized during depress and repress operations when UHF communication can be distorted. The hardline audio provides redundancy in case of loss of UHF communication.

[xEMU.IRCD.0033] The xEVA System shall receive audio communications from the HLS via a hard-wired interface.

Rationale: A hard-wire interface between the HLS and xEMU are utilized during depress and repress operations when UHF communication can be distorted. The hardline audio provides redundancy in case of loss of UHF communication.

[xEMU.IRCD.0034] The xEVA System shall transmit audio communications via a hard-wired.

Rationale: A hard-wire interface between the HLS and xEMU are utilized during depress and repress operations when UHF communication can be distorted. The hardline audio provides redundancy in case of loss of UHF communication.

[xEMU.IRCD.0036] The HLS shall transmit communications to the xEVA System via a hard-wired interface

Rationale: A hard-wire interface between the HLS and xEMU are utilized during depress and repress operations when UHF communication can be distorted. The hardline audio provides redundancy in case of loss of UHF communication.

[xEMU.IRCD.0098] The HLS shall receive audio communications from the xEVA System via a hard-wired interface.

Rationale: A hard-wire interface between the HLS and xEMU are utilized during depress and repress operations when UHF communication can be distorted. The hardline audio provides redundancy in case of loss of UHF communication.

3.2.7.2 HARDLINE DATA

[xEMU.IRCD.0099] The xEVA System shall receive data from the HLS via a hard-wired interface.

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Rationale: A hard-wire interface between the HLS and xEMU is utilized for transmitting and receiving data between the two elements. The xEMU transmits biomed and sensor data, and receives HLS statuses.

[xEMU.IRCD.0100] The xEVA System shall transmit data via a hard-wired interface.

Rationale: A hard-wire interface between the HLS and xEMU is utilized for transmitting and receiving data between the two elements. The xEMU transmits biomed and sensor data, and receives HLS statuses.

[xEMU.IRCD.0101]The HLS shall transmit data to the xEVA System via a hard-wired interface

Rationale: A hard-wire interface between the HLS and xEMU is utilized for transmitting and receiving data between the two elements. The xEMU transmits biomed and sensor data, and receives HLS statuses

[xEMU.IRCD.0102] The HLS shall receive data from the xEVA System via a hard-wired interface.

Rationale: A hard-wire interface between the HLS and xEMU is utilized for transmitting and receiving data between the two elements. The xEMU transmits biomed and sensor data, and receives HLS statuses

3.2.7.3 RF COMMUNICATION - AUDIO

The vehicle radios for RF communications between the spacecraft and the xEMU will be provided by NASA. The radios will transmit and receive audio via the 410-420 MHz UHF band. The HLS is to provide the interfaces between the NASA provided vehicle radio and vehicle. The HLS provides vehicle radio power, vehicle radio cooling, and a hard mount location for the radio.

3.2.7.1 GFE UHF RADIO FOR COMMUNICATION WITH XEMU

[xEMU.IRCD.0103] The HLS shall interface with the xEVA System UHF radio as defined in Section 4 of EVA-EXP-0067.

Rationale: Section 4 of EVA-EXP-0067 is the interfaces details between the xEMU and HLS. Section 4 will detail such items as pin outs, connectors, thermal cooling interfaces, and hairlines to vehicle antennas. Power required for the UHF radio is accounted for in xEMU.IRCD.0021, xEVA System Power. The UHF radio volume is not accounted for in xEMU.IRCD.0131, EVA SPCE Volume.

3.2.7.2 RF COMMUNICATIONS – TELEMETRY & BIOMED

[xEMU.IRCD.0064] The xEVA System shall transmit real-time xEMU telemetry and biomed via the HLS as defined in TBD-IRCD-004.

Rationale: For RF communications the xEMU will communicate with the NASA provided UHF radio via the NASA communications architecture. The NASA provided UHF radio

will handle all the necessary encryptions of data prior to transmitting the data to HLS for transmission to Mission Control.

[xEMU.IRCD.0104] The HLS shall receive real-time xEMU telemetry and biomed from the xEVA System as defined in TBD-IRCD-004.

Rationale: For RF communications the xEMU will communicate with the NASA provided UHF radio via the NASA communications architecture. The NASA provided UHF radio will handle all the necessary encryptions of data prior to transmitting the data to HLS for transmission to Mission Control.

3.2.8 WIRELESS COMMUNICATIONS NETWORK (ETHERNET SIGNAL)

[xEMU.IRCD.0037] The HLS shall communicate with the xEVA System as defined in TBD-IRCD-004.

Rationale: The xEMU utilizes wireless communications per the standard IEEE 802.11x <TBR-IRCD-010> for data transmission. The xEMU Wi-Fi transmits data to the external and internal wireless communication devices provided by NASA which then passes it on to the host vehicle for downlink to the ground throughout pre-EVA, EVA, and post-EVA operations. The xEMU will communicate via the external and internal wireless communication devices provided by NASA to HLS.

3.2.9 STRUCTURAL INTERFACES

3.2.9.1 DON/DOFF ASSEMBLY INTERFACES

[xEMU.IRCD.0039] The HLS shall provide interfaces for hard mounting two (2) xEMU for donning, doffing and stowage as defined in Section 4 of EVA-EXP-0067.

Rationale: Each xEMU System is mounted to the xEMU Don/Doff Assembly (xEDDA) to aid in don/doff operations which is mounted to the HLS. At minimum, each stand needs to attach to an xEMU at the Mini-Workstation attachment points < TBR-IRCD-012> to support 1/6 g loads, and 1g < TBR-IRCD-013> loads for ground integration and testing. This allows the xPLSS and hatch to swing out for rear-entry donning and doffing, while each xEMU is supported via the MWS attachment points on the HUT.

[xEMU.IRCD.0040] The xEMU shall attach to the HLS provided hard mounts for donning, doffing and stowage as defined in Section 4 of EVA-EXP-0067.

Rationale: The xEMU System is mounted to the xEMU Don/Doff Assembly (xEDDA) to aid in don/doff operations which is mounted to the HLS. At minimum, the stand needs to attach to the xEMU at the Mini-Workstation attachment points <TBR> to support 1/6 g loads, and 1g <TBR-IRCD-013> loads for ground integration and testing. This allows the xPLSS and hatch to swing out for rear-entry donning and doffing, while the xEMU is supported via the MWS attachment points on the HUT

[xEMU.IRCD.0095] The HLS shall provide a minimum empty volume of 7.5 m^3 (264.86 ft^3) for two crew to simultaneously don and doff an xEMU as defined in

Figure 3.2.9-1 Minimum Don/Doff Volume.

Rationale: For safety, EVAs are done in pairs and to ensure timelines align for crew time and not negatively affect one crewmembers consumable usage the crews don/doff simultaneously. Crewmembers don/doff the xEMU through a rear entry hatch.

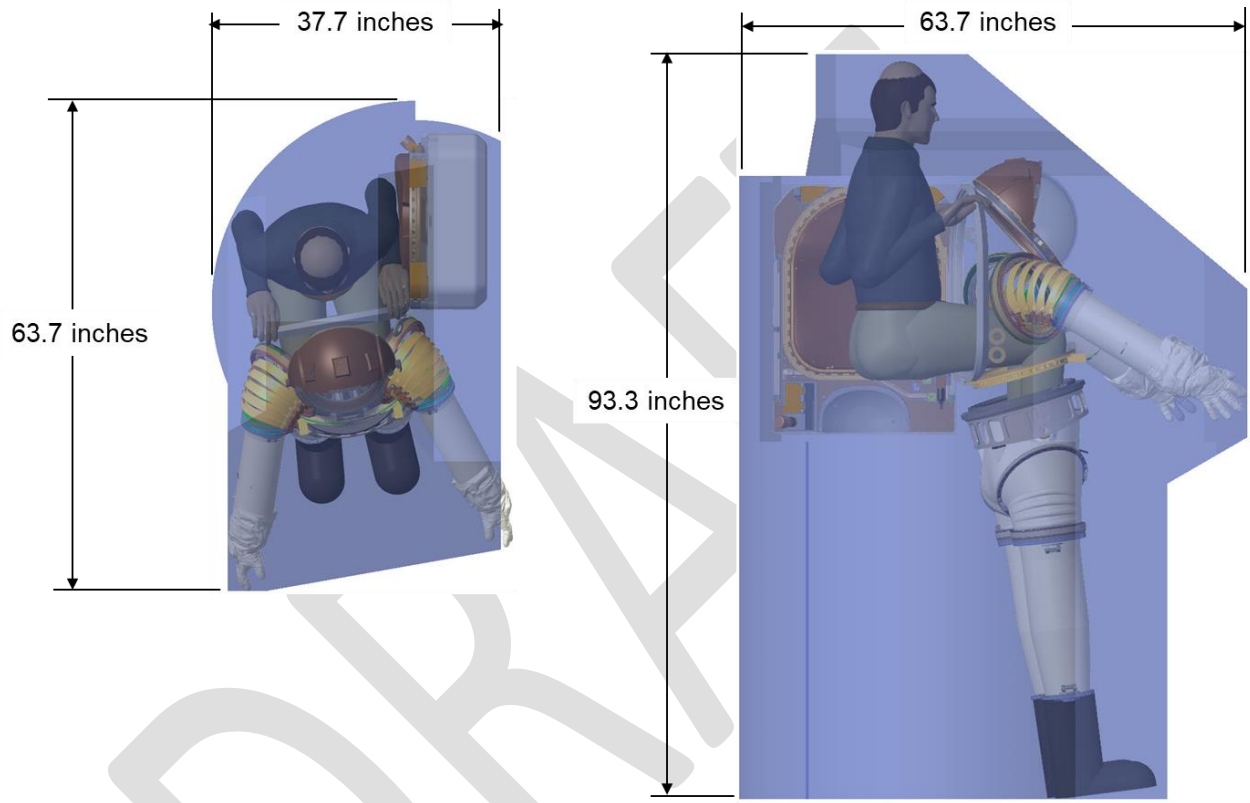

FIGURE 3.2.9-1 MINIMUM DON/DOFF VOLUME FOR A SINGLE XEMU < TBR-IRCD-014>

3.2.10 HATCH DIMENSIONS

[xEMU.IRCD.0097] has been transferred to EVA-EXP-0070 HLS EVA Compatibility IRD.

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3.3 DYNAMIC PHASES OF FLIGHT REQUIREMENTS <TBR-IRCD-015 >

Dynamic phases of flight are periods of time from the separation of the HLS from Gateway (or Orion) to lunar surface descent, and ascent to completion of docking with Gateway (or Orion) that requires the xEMU to be donned. Typically these phases are docking, descent burns and ascent burns. During dynamic phases of flight, crew members will don the xEMU without the xPLSS attached.

When unattached to the xEMU, the xPLSS will be either stored in the HLS cabin or left on the lunar surface. When the xPLSS is not attached to the xEMU, the HLS will be responsible for providing life support, power, and communications functions to the xEMU donned crewmember. These functions and services while similar in some cases, differ from the nominal services required for pre-EVA, post-EVA and EVA operation tasks.

When the xPLSS is removed, the HLS becomes responsible for suit loop ventilation, CO2 removal trace containment removal, humidity control, communications, and cooling water circulation via an umbilical that interfaces with the xEMU. Interfaces between the xEVA System and HLS during dynamic phases of flight are shown in Figure 3.1.3-2 xEVA-HLS for Dynamic Phases of Operations.

During dynamic phases where the xEMU is donned there will be periods of time were the helmet is doffed and the xEMU unpressurized. During these periods, it is assumed that HLS provides communication, oxygen and CO2 removal capabilities similar to how the HLS provides it when the xEMU is doffed.

3.3.1 VEHICLE PROVIDED SUIT VENTILATION LOOP

The Vehicle to Suit Ventilation Loop interfaces include the HLS, xPGS and adjoining umbilical. The HLS provides the driving force and provides conditioned gas through the umbilical to the xEMU. The ventilation flow is routed through the xPGS and retuned to HLS with the driving force provided by HLS.

3.3.1.1 PRESSURE AND FLOW RATES

[xEMU.IRCD.0105] The HLS shall supply oxygen to the xEVA System at the crew selected set points shown in

Table 3.3.1-1 xEMU Ventilation Loop - Primary Oxygen Regulation Pressures and Flow Rates.

Rationale: When the xPLSS is detached from the xEMU, the xEMU no longer has the capability to regulate the oxygen pressure and flow rate into the xPGS. Responsibility for regulating oxygen pressure and flow rate for the xPGS becomes the responsibility of HLS during periods when the xEMU donned without an xPLSS attached.

TABLE 3.3.1-1 XEMU VENTILATION LOOP - PRIMARY OXYGEN REGULATION PRESSURES AND FLOW RATES

Operations Scenario	Pressure (psid)	Ambient Reference Pressure (psia)	Mass Flowrate[3] Kg/hr (lbm/hr)
IVA operations	0.4 +/- 0.2	8 to 15.2	0.0022 (0.005[4])
Nominal Pressure - EVA	4.3 +/- 0.2	8 to 15.2	0.0091 to 2.54 (0.02 to 5.6)
EVA mode with elevated pressure for reduced prebreathe	6.2+/- 0.2	vacuum[1] to 15.2	0.0091 to 2.54 (0.02 to 5.6)
Exploration Pressure - EVA/Decompression Sickness (DCS) Treatment	8.2 +0.2/-0.4	vacuum[1] to 15.2	0.0091 to 2.54 (0.02 to 5.6)

Notes: *(1)* 7846B*Vacuum is defined for test purposes as < 1 torr (.02 psia).*

(3)The upper band of the mass flowrate cannot exceed 4.08 kg/hr [9 lbm/hr] for a suit free volume of 56.6 L [2 cu ft] without exceeding the limitations of HS3009, Rate of Change of Pressure Limits in the HSIR, CxP 70024.

(4)This is equivalent to the internal lock-up leakage of the regulator without engagement of a shut-off feature.

3.3.1.2 PRESSURE GARMENT MAXIMUM PRESSURE DROP

[xEMU.IRCD.0106] The xEVA System shall have a maximum pressure drop measured between the xPGS VTL Supply / to xPGS interface to VTL Return / from xPGS interface of 3.048 cm-H2O (1.2 inches-H2O)< TBR-IRCD-016> with gas flowing at 6 acfm at suit pressure and temperature of 4.3 psia and 15.46 Celsius (60 °F).

Rationale: This pressure drop is only over the xPGS components and does not include the umbilical and xPLSS Interface Pad.

3.3.1.3 XPGS VTL PRESSURE RANGE

[xEMU.IRCD.0107] The HLS shall maintain a pressure range in the xEVA System ventilation loop of 3.1 - 25.8 psia <TBR-IRCD-016>.

Rationale: The MDP of the xPGS and ventilation loop is 10.6 psid. <TBD-IRCD-028>

3.3.1.4 VENTILATION LOOP TEMPERATURE

[xEMU.IRCD.0108] The HLS shall recirculate gas within the xEVA System ventilation loop at a temperature between 7.22 to 32.22 Celsius (45 to 90 °F).

Rationale: While operating in closed loop configuration, the HLS will maintain the temperature at UIP to below 21.11 Celsius (70 °F) for IVA mode and below 18.33 Celsius (65 °F) for EVA mode.

3.3.1.5 PRESSURE GARMENT VENTILATION LOOP EXTERNAL LEAKAGE

[xEMU.IRCD.0109] The xEMU external leakage rate shall be less than 61 sccm <TBR-IRCD-018> at 4.3 psia with oxygen as the working fluid at a temperature of 29.44 Celsius (85 °F) and negligible humidity content.

Rationale: Limiting the leakage rate of the xEMU allows for HLS to properly size hardware to maintain the required flow rates, pressures, O2 levels, CO2 levels throughout the ventilation loop during dynamic phases.

3.3.1.6 TRACE CONTAMINANTS

[xEMU.IRCD.0110] The HLS shall maintain trace contaminants in the oxygen supplied during dynamic flight phases to the xEMU below the seven day limits as defined by JSC 20584, Spacecraft Maximum Allowable Concentrations for Airborne Contaminants.

Rationale: Contaminants are to be limited to values outlined to ensure the safety and health of the crewmember. The longer term values, such as the seven day limits, are set to fully protect healthy crewmembers from adverse effects resulting from continuous exposure to specific air pollutants. Short term limits are intended to protect against inadvertent releases of contaminants that may have reversible effects, but are not adequate to protect for exposure in a small closed loop volume such as the xEMU. Addresses NASA-STD-3001 V2 11033

3.3.1.7 VENTILATION LOOP RELATIVE HUMIDITY

[xEMU.IRCD.0111] The HLS shall maintain the average relative humidity of the oxygen flowed to the xEVA System to 25-75% for the pressure functions defined in Table 3.3.1-1 xEMU Ventilation Loop - Primary Oxygen Regulation Pressures and Flow Rates.

Rationale: During dynamic phases of flight when HLS is responsible for regulating O2 pressure and flow rate into the xEMU, the HLS is also responsible for regulating the relative humidity of the O2. Average humidity is to be maintained above this lower limit (25%) to ensure that the environment is not too dry for the nominal functioning of mucous membranes and to prevent static electricity buildup within the xPGS, which could pose an increased electrical hazard to people. Average humidity is to be maintained below this upper limit (75%) for crew comfort and to limit formation of condensation. Addresses NASA-STD-3001 V2 6010

3.3.2 THERMAL COOLING

The HLS provides cooling water to xPGS interface, through the fluid interfaces at the Interface Pad on the xPGS hatch, and through the primary thermal lines in the Liquid Cooling and Ventilation Garment (LCVG). The LCVG covers the majority of the crewmember's available skin surface area to provide cooling using makeup feed water supply from HLS.

3.3.2.1 THERMAL COOLING LOOP FLOW RATE

[xEMU.IRCD.0112] The HLS shall circulate cooling water through the xEVA System and HLS provided cooling loop and heat rejection system at a nominal rate of 90.72 +9.07/-13.6 kg/hr (200 +20/-30 lbm/hr).

Rationale: During dynamic phases of flight, the xPLSS will not be attached to the xEMU and prior to returning to lunar orbit, the xPLSS will be left behind on the lunar surface. During the dynamic phases of flight without the xPLSS attached, the circulation of the water through the xEMU and HLS heat exchange cooling loop is provided by the HLS. This function is different than when the xPLSS is attached to the xEMU. When the xPLSS is attached to the xEMU, circulation through the xEMU and HLS heat exchange cooling loop is provided by xPLSS.

3.3.2.2 PRIMARY THERMAL COOLING LOOP OPERATING PRESSURES

[xEMU.IRCD.0113] The HLS shall maintain the nominal operating pressure of the xEMU's primary thermal cooling loop while operating in IVA mode to 10 psid +/- <TBD-IRCD-015> when at nominal flow rate and temperature.

Rationale: The IVA mode operating pressure is based on the PLSS pump backflow pressure at nominal flow and temperature. The EVA mode includes the pressure from the FSA-431 which is subject to the operational pressure of 8.2 psid added to the pump backflow pressure. The PTCL maximum design pressure (MDP) is 35 psid.

3.3.2.3 PRIMARY THERMAL COOLING LOOP PRESSURE DROP

[xEMU.IRCD.0147] The xEMU shall have a maximum pressure drop for the xPGS components in the Vehicle HX segment of the Primary Thermal Control loop, of 0.53 psid<TBR-IRCD-027>, at nominal flow and temperature.

Rationale: Segment loop pressure drop must be constrained to ensure operation of the system. A pressure drop specification provides more flexibility for design options than specifying the tubing inside diameter, for example.

3.3.2.4 THERMAL COOLING LOOP TEMPERATURE RANGE

[xEMU.IRCD.0114] The HLS shall provide water to the xEMU's Primary Thermal Control loop over a temperature range of 7.22 to 32.22 Celsius (45 to 90 °F).

Rationale: This temperature range is defined as the range of water flow rates in which humans can achieve thermal comfort and not have their performance of routine activities affected by thermal stress.

3.3.2.5 CREW CONTROL OF THERMAL CONTROL LOOP

[xEMU.IRCD.0115] The HLS shall allow the suited crewmembers to adjust the xEMU's Primary Thermal Control loop during dynamic phases.

Rationale: The ability to control suited atmospheric conditions is important for crew health and comfort, and for mission tasks, to ensure efficient and effective performance. Temperature can be adjusted in a number of ways depending on the suit and vehicle system designed (e.g., changing water flow, inlet temperature). During dynamic phases water flow will be controlled by the vehicle which is different than during EVA operations were water flow is controlled by the xPLSS. Addresses NASA-STD-3001 V2 11033

3.3.3 ELECTRICAL SYSTEM

3.3.4 XEVA SYSTEM POWER

[xEMU.IRCD.0116] The HLS shall provide an average 250 W of power with a peak power of 460 W for the durations indicated in Figure 3.3.4-1 xEVA System Power Draw – Descent/Ascent <TBR-IRCD-020>.

Rationale: The peak power requirement for dynamic phases of flight is based on an xEVA System with all hardware that requires power directly from the HLS turned on and at peak power. This duration of each systems peak power is being worked and will be updated.

[xEMU.IRCD.0117] The xEVA System shall receive an average of 250 W of power with a peak power of 460 W from the HLS for the durations indicated in Figure 3.3.4-2 xEVA System Power Draw – Descent/Ascent <TBR-IRCD-020>.

Rationale: The peak power requirement for dynamic phases of flight is based on an xEVA System with all hardware that requires power directly from HLS turned on and at peak power. This duration of each systems peak power is being worked and will be updated.

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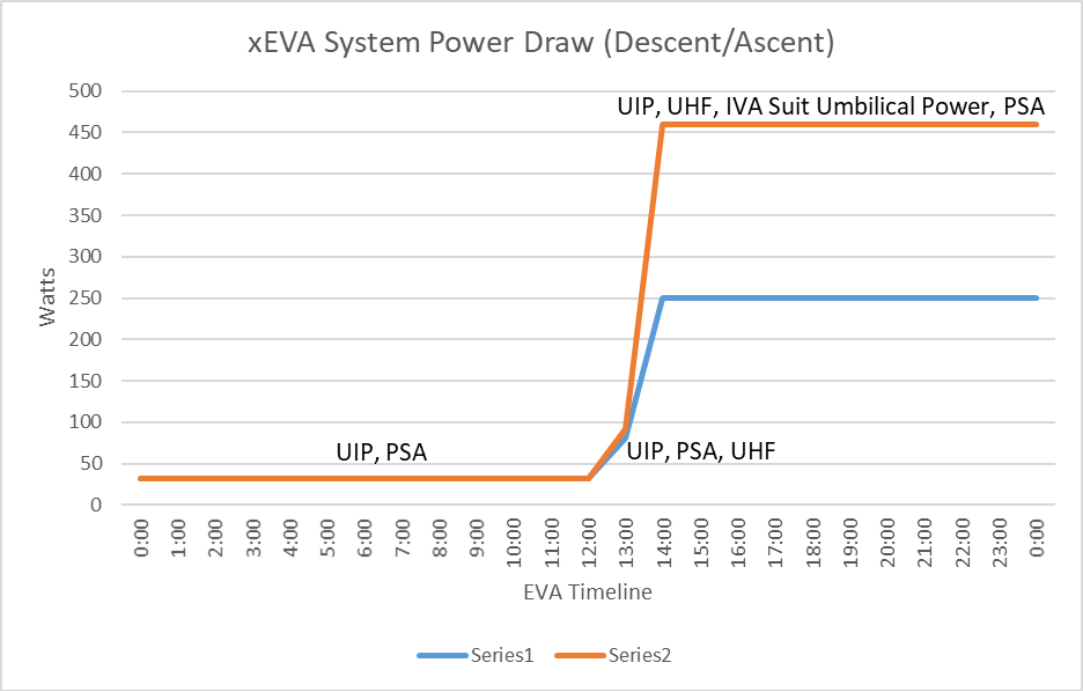

FIGURE 3.3.4-3 XEVA SYSTEM POWER DRAW – DESCENT/ASCENT <TBR-IRCD-020>

3.3.5 UMBILICAL POWER

Umbilical power to the suit is not required during dynamic phases of flight.

3.3.6 REAL-TIME AUDIO, TELEMETRY AND BIOMED COMMUNICATIONS

[xEMU.IRCD.0118] The HLS shall provide a hard-wired interface for audio communications to the xEVA System.

Rationale: A hard-wire interface between the HLS and xEMU is the primary method of communication between the crewmembers, and the crewmembers and ground when the xEMU is donned during dynamic phases of flight.

[xEMU.IRCD.0119] The xEVA System shall receive audio communications from the HLS via a hard-wired interface.

Rationale: A hard-wire interface between the HLS and xEMU is the primary method of communication between the crewmembers, and the crewmembers and ground when the xEMU is donned during dynamic phases of flight.

[xEMU.IRCD.0120] The xEVA System shall transmit audio communications via a hard-wired.

Rationale: A hard-wire interface between the HLS and xEMU is the primary method of communication between the crewmembers, and the crewmembers and ground when the xEMU is donned during dynamic phases of flight.

[xEMU.IRCD.0121] The HLS shall transmit communications to the xEVA System via a hard-wired interface

Rationale: A hard-wire interface between the HLS and xEMU is the primary method of communication between the crewmembers, and the crewmembers and ground when the xEMU is donned during dynamic phases of flight.

[xEMU.IRCD.0122] The HLS shall receive audio communications from the xEVA System via a hard-wired interface.

Rationale: A hard-wire interface between the HLS and xEMU is the primary method of communication between the crewmembers, and the crewmembers and ground when the xEMU is donned during dynamic phases of flight.

[xEMU.IRCD.0123] The HLS shall allow the crew to adjust the audio communication during dynamic phases of flight.

Rationale: A hard-wire interface between the HLS and xEMU is the primary method of communication between the crewmembers, and the crewmembers and ground when the xEMU is donned during dynamic phases of flight. Without the xPLSS the ability of the crew to change the volume of the audio communications is dependent on the HLS. The HLS acquires the audio from the PGS helmet-mounted microphones for processing, mixing, and distribution. An array of microphones is used to ensure coverage.

3.3.6.1 HARDLINE DATA

[xEMU.IRCD.0124] The xEVA System shall receive data from the HLS via a hard-wired interface.

Rationale: While the xEMU is donned, sensor data, biomedical readings, vehicle health, must be communicated between Integrated, the xEMU and ground control.

[xEMU.IRCD.0125] The xEVA System shall transmit data via a hard-wired interface.

Rationale: While the xEMU is donned, sensor data, biomedical readings, vehicle health, must be communicated between HLS, the xEMU and ground control.

[xEMU.IRCD.0126] The HLS shall transmit data to the xEVA System via a hard-wired interface.

Rationale: While the xEMU is donned, sensor data, biomedical readings, vehicle health, must be communicated between HLS, the xEMU and ground control.

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[xEMU.IRCD.0127] The HLS shall receive data from the xEVA System via a hard-wired interface.

Rationale: While the xEMU is donned, sensor data, biomedical readings, vehicle health, must be communicated between HLS, the xEMU and ground control.

3.3.7 WIRELESS COMMUNICATIONS NETWORK (ETHERNET SIGNAL)

The xEMU does not require access to the wireless communications network during dynamic phases of flight.

3.3.8 STRUCTURAL INTERFACES

3.3.8.1 XEMU CREWMAN RESTRAINT SYSTEM ATTACH POINTS

[xEMU.IRCD.0128] The HLS shall provide hard mount points for the xEMU Crewman Restraint System as defined in Section 4.0 of EVA-EXP-0067.

Rationale: Prior to dynamic flight phases (e.g. descent), the crewmember will don the xEMU (with the xPLSS removed from the xPGS) and assume a standing posture. A restraint system stabilizes the crewmember at the HLS controls with the xEMU is pressurized and unpressurized. xEMU Crewman Restraint System will interface with the xEMU provided attach points and provide crew support (mounts/stool/straps/restraints) to overcome dynamic flight loads and prevent blunt trauma from impact and point loading as well as extremity flail injuries.

[xEMU.IRCD.0143] The xEMU shall provide hard mount points for the xEMU Crewman Restraint System as defined in Section 4.0 of EVA-EXP-0067.

Rationale: Prior to descent the crewmember will don the xEMU (with the xPLSS removed from the xPGS) and stand during the descent. EVA suit mass will add significantly to the total mass the crew must withstand during descent, landing and ascent and must be accommodated to ensure injuries do not occur during descent, at landing or ascent. A strap/cable-based restraint system stabilizes the crewmember at the HLS controls when the xEMU is pressurized and unpressurized. The xEMU Crewman Restraint System will need to have orthostatic tolerance during Lunar Descent/Ascent or Abort. xEMU Crewman Restraint System will interface with the xEMU provided attach points and provide crew support (stool/straps/restraints) to overcome descent/abort/crash/ascent loads.

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3.4 INTERFACES NOT PHASE DEPENDENT

3.4.1 SYSTEM CLEANLINESS

[xEMU.IRCD.0043] The HLS internal surfaces in contact with xEVA thermal cooling water shall be clean to level 150A and maintained to 150 per JPR 5322.1.

Rationale: All xEMU water lines are cleaned and maintained cleaned to 150 on the ground. Hardware interfacing with the xEMU SPCE or other hardware the xEMU interfaces has to ensure it does not contaminate the interface and preclude future use of the xEMU with that interface.

[xEMU.IRCD.0059] The HLS internal surfaces in contact with EVA feed water lines shall be clean to level 150A and maintained to 150 per JPR 5322.1.

Rationale: All xEMU/SPCE water lines are cleaned and maintained cleaned to 150 on the ground. Hardware interfacing with the xEMU SPCE or other hardware the xEMU interfaces has to ensure it does not contaminate the interface and preclude future use of the xEMU with that interface.

[xEMU.IRCD.0096] The HLS interfaces to the xEVA system shall have be visibly clean and cleaned to level 150A and maintained to 150 per JPR 5322.1.

Rationale: All xEMU/SPCE lines and interfaces are cleaned and maintained cleaned to 150 on the ground. Hardware interfacing with the xEMU SPCE or other hardware the xEMU interfaces has to ensure it does not contaminate the interface and preclude future use of the xEMU with that interface.

3.4.2 STOWAGE

3.4.2.1 XEMU STOWAGE

[xEMU.IRCD.0044] The xEMU shall be capable of stowage in a maximum volume of 1.23 m^3 for 2 space suits as defined in Section 4.0 of EVA-EXP-0067.

Rationale: Estimates for space suit stowage volumes are based on a two crew EVA with no spare suit. This maximum volume assumes an assembled xEMU, containing both the xPLSS and xPGS, hard mounted to the vehicle in a partial gravity field. Increasing the number of crew going EVA will increase the minimum volume required for space suit stowage.

[xEMU.IRCD.0045] The HLS shall provide a minimum stowage volume of 1.23m^3 (324.93 ft^3) for 2 xEMUs as defined in Section 4.0 of EVA-EXP-0067.

Rationale: Estimates for space suit stowage volumes are based on a two crew EVA with no spare suit. This maximum volume assumes an assembled xEMU, containing both the xPLSS and xPGS, hard mounted to the vehicle in a partial gravity field. Increasing the number of crew going EVA will increase the minimum volume required for space suit stowage.

[xEMU.IRCD.0140] The xEMU xPLSS shall be capable of stowage in a maximum volume of 0.2 m^3 (52.83 ft^3) for xPLSSs as defined in Section 4.0 of EVA-EXP-0067.

Rationale: Estimates for xPLSS stowage volumes are based on a two crew EVA with no spares. This maximum volume assumes the xPLSS is hard mounted to the vehicle in a partial gravity field. Increasing the number of crew going EVA will increase the minimum volume required for space suit stowage.

[xEMU.IRCD.0141] The HLS shall be capable of stowage in a maximum volume of 0.2 m^3 (52.83 ft^3) for xPLSSs as defined in Section 4.0 of EVA-EXP-0067.

Rationale: Estimates for xPLSS stowage volumes are based on a two crew EVA with no spares. This maximum volume assumes the xPLSS is hard mounted to the vehicle in a partial gravity field. Increasing the number of crew going EVA will increase the minimum volume required for space suit stowage.

3.4.2.2 EVA LOGISTICS, SPARES AND TOOLS STOWAGE

[xEMU.IRCD.0129] The HLS shall provide a minimum stowage volume of 0.14 m^3 (36.98 ft^3) for logistics, spares and tools as defined in Section 4.0 of EVA-EXP-0067.

Rationale: EVA ancillary equipment and spares include EVA hardware such as HUT hatches, gloves, drink bags, and MAGs. The amount of logistics/spares and what type of spares are dependent on the frequency of EVAs. Values are based on a frequency of EVAs greater than one, but not exceeding 5 <TBR-IRCD-022>. EVA Tools include a very minimal amount of suit maintenance tools and fall protection stowed in an EVA crewlock bag. Lunar tools, vehicle maintenance tools, and science tools are not included in this volume.

[xEMU.IRCD.0130] The xEVA System shall be capable of stowage in a maximum volume of 0.14 m^3 (36.98 ft^3) for logistics, spares and tools as defined in Section 4.0 of EVA-EXP-0067.

Rationale: EVA ancillary equipment and spares include EVA hardware such as HUT hatches, gloves, drink bags, and MAGs. The amount of logistics/spares and what type of spares are dependent on the frequency of EVAs. Values are based on a frequency of EVA greater than one, but not exceeding 5 <TBR-IRCD-022>. EVA Tools include a very minimal amount of suit maintenance tools and fall protection stowed in an EVA crewlock bag. Lunar tools, vehicle maintenance tools, and science tools are not included in this volume.

3.4.2.3 EVA SPCE VOLUME

[xEMU.IRCD.0131] The HLS shall provide a minimum volume of 1 m^3 (264.17 ft^3) <TBR-IRCD-023> for EVA SPCE as defined in Section 4.0 of EVA-EXP-0067.

Rationale: EVA support hardware permanently mounted in the vehicle could include don/doff aids, descent/ascent restraints, battery charger, wall mounted rack to provide

hardline PWR/DATA/COMM, suit loop ventilation, vacuum access, high pressure O2, and cooling water. The lines, hoses, wire harnesses, secondary structure, etc. “behind the wall” that plug into the “backside” of the xEVA SPCE rack items are *NOT included* in the xEVA System.

[xEMU.IRCD.0132] The xEVA System shall be capable of stowage in a maximum volume of 1 m^3 (264.17 ft^3) <TBR-IRCD-023> for xEVA SPCE as defined in Section 4.0 of EVA-EXP-0067.

Rationale: EVA support hardware permanently mounted in the vehicle could include don/doff aids, descent/ascent restraints, battery charger, wall mounted rack to provide hardline PWR/DATA/COMM, suit loop ventilation, vacuum access, high pressure O2, and cooling water. The lines, hoses, wire harnesses, secondary structure, etc. “behind the wall” that plug into the “backside” of the xEVA SPCE rack items are *NOT included* in the xEVA System.

3.4.3 WASTE MANAGEMENT

[xEMU.IRCD.0143] The HLS shall provide the capability for collection, containment and disposal of EVA waste.

Rationale: During the EVA, the crew utilizes items such as the Maximum Absorbent Garment (MAG) to manage body waste during the EVA. A single MAG is utilized per crewmember per EVA or dynamic phase of flight to contain feces, urine and menses. The vehicle is to provide the body waste management system that facilitates the clean, efficient, and reliable collection and management of human waste (urine, feces, vomitus, and menses) and associated equipment and supplies after doffing the xEMU.

3.4.4 POTABLE WATER

Potable water in the xEMU is maintained in a drink bag with water being provided from the HLS. The crewmembers will obtain water from the HLS by filling the drink bag at the HLS provided potable water source and then inserting the drink bag into the xEMU. The xEVA System does not control the water quality limits of potable water and accepts the HMTA approved water quality standards levied on HLS.

[xEMU.IRCD.0090] The HLS shall provide 1.89 liters (64 oz) of potable water per crewmember per EVA to the xEVA System.

Rationale: NASA-STD-3001 [V2 6035] requires that each crewmember have 1.89 liters (64 oz) of water available to them over an EVA duration of 8 hours. This requirement is applicable to any period where the xEMU is donned. When the xEMU is donned, potable water is contained in a drink bag located in the xEMU’s Hard Upper Torso. Crewmembers will fill the drink bag from the vehicle provided potable water port and install into the xEMU prior to donning. Water consumption is based on NASA-STD-3001 V2 11026 where 8oz

of water per hour is required. Water consumption is the same regardless if it is for EVA operations or dynamic phases of flight.

[xEMU.IRCD.0091] The xEVA System shall receive 1.89 liters (64 oz) of potable water per crewmember per EVA from the HLS.

Rationale: NASA-STD-3001 [V2 6035] requires that the each crewmember have 1.89 liters (64 oz) of water available to them over an EVA duration of 8 hours. When the xEMU is donned, potable water is contained in a drink bag located in the xEMU's Hard Upper Torso. Crewmembers will fill the drink bag from the vehicle provided potable water port and install into the xEMU prior to donning. Water consumption is based on NASA-STD-3001 V2 11026 where 8oz of water per hour is required. Water consumption is the same regardless if it is for EVA operations or dynamic phases of flight.

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4.0 INTERFACE CONTROL <TBD-IRCD-006>

This section is intended to control the xEMU System, HLS and SPCE interface designs. This section will include specific connectors, connector layout patterns, and pin outs. These controls may be by documented in this section or referenced to a controlled interface control drawing.

Refer to Figure 3.1.3-1 xEVA-HLS Interface Diagram for EVA Phases of Operations and Figure 3.1.3-2 xEVA-HLS for Dynamic Phases of Operations for the HLS to xEMU System and SPCE to xEMU System.

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APPENDIX A - ACRONYMS AND ABBREVIATIONS

A/L	Airlock
ALCLR	Airlock Cooling Loop Recovery Unit
C	Celsius
COMM	Communications
DATA	Data
EMC	Electromagnetic compatibility
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EMU	Extravehicular Mobility Unit
ESCU	Exploration Service and Cooling Umbilical
EVA	Extravehicular Activity
F	Fahrenheit
FPU	Fluid Pumping Unit
ICD	Interface Control Document
IDD	Interface Definition Document
IRCD	Interface Requirement Control Document
IRD	Interface Requirement Document
ISS	International Space Station
IVA	Intravehicular Activity
JSL	Join Station LAN
LAN	Local Area Network
PPM	Parts Per Million
PTCL	Primary Thermal Cooling Loop
PSIA	Pounds per square inch absolute
PWR	Power
RF	Radio Frequency
SCC	Service and Cooling Connector
SICD	Scientific Instrument Computer and Data Handling

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SPCE	Servicing and Performance Checkout Equipment
SSP	Space Station Program
TBD	To be determined
TBR	To be resolved
VAU	Vacuum Access Umbilical
VDC	volts direct current
xEDDA	xEMU Don/Doff Assembly
xEMU	Exploration Extravehicular Mobility Unit
xEVA	Exploration Extravehicular Activity
xPGS	Exploration Pressure Garment System
xPLSS	Exploration Portable Life Support System

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APPENDIX B - OPEN WORK

Table B-1 lists the specific To Be Determined (TBD) items in the document that are not yet known. The TBD is inserted as a placeholder wherever the required data is needed and is formatted in bold type within brackets. As each TBD is solved, the updated text is inserted in each place that the TBD appears in the document and the item is removed from this table. As new TBD items are assigned, they will be added to this list. Original TBDs will not be renumbered.

TABLE B-1 TO BE DETERMINED ITEMS

TBD	Section/Reqt ID	Description
TBD-IRCD-001	~~xEMU.IRCD.0020~~	~~Determine total Mass of Vented Gases from the xEMU vacuum umbilical to vacuum access line in Airlock~~ Closed as part of 8/15 update Mass flow rates are provided for O2, CO2 and moisture which are be sufficient from a requirement standpoint. Requirement was on xEMU limiting total allowable molecular mass into the vacuum line.
TBD-IRCD-002	~~Section 3.1.3~~	~~Figure 3.1.3-2 xEMU-HLS for Dynamic Phases of Operations. Figure showing interfaces between xEVA system and the HLS.~~ Closed as part of 8/15 update
TBD-IRCD-003	Section 3.2.5.2	The power requirements for the xEMU are known and power is required to be provided via the ESCU to the xEMU. However, voltage and current regulation may be performed by xEVA System SPCE. This decision will be made after the HLS finalized their vehicle bus voltage. Until this vehicle voltage is decided it will be assumed the xEVA System will need to regulate umbilical power to the xEMU. Please note that the power requirement for the xEMU during umbilical operations is included in xEMU.IRCD.0021.
TBD-IRCD-004	xEMU.IRCD.0037	The xEMU requires access to WIFI (802.11x) for data communication both internally and externally to the vehicle. It is expected that a WIFI Architecture and Communication Architecture for the HLS will be developed that will house the details of the network.
TBD-IRCD-005	~~Section 3.3.5~~	~~Whether wireless (802.11) is needed by the xEMU during dynamic phases of flight is still being assessed.~~ Closed as part of 8/15 update
TBD-IRCD-006	Subsections of section 4	Section 4 is the control section of the document and dependent upon the agreements made between the xEMU and HLS project for each interface. Detail is to developed and matured through future working sessions.
TBD-IRCD-007	Section 2.2	The HLS Concept of Operations will be a reference document once it is officially baselined.
TBD-IRCD-008	Section 3.2.3.3	Include rationale for the Feed Water Temperature requirement.
TBD-IRCD-009	~~Section 3.2.3.4~~	~~Include rationale for the Feed Water Supply Pressure requirement.~~ Closed as part of 8/15 update
TBD-IRCD-010	~~Section 3.2.6.2~~	~~Include rationale for the RF Communications – Telemetry & Biomed requirement.~~ Closed as part of 8/15 update
TBD-IRCD-011	~~Section 3.3.1.3~~	~~Include rationale for the xPGS VTL Pressure Range requirement.~~ Closed as part of 8/15 update
TBD-IRCD-012	~~Section 3.3.1.5~~	~~Include rationale for the Pressure Garment Ventilation Loop External Leakage requirement.~~ Closed as part of 8/15 update

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TBD-IRCD-013	~~Section 3.3.2.3~~	~~Include information and rationale for the Primary Thermal Cooling Loop Pressure Drop requirement.~~ Closed as part of 8/15 update
TBD-IRCD-014	Section 3.3.2.4	~~Include rationale for the Thermal Cooling Loop Temperature Range requirement.~~ Closed as part of 8/15 update
TBD-IRCD-015	xEMU.IRCD.0113	TBD on the range for nominal operating pressure of the primary control loop during dynamic phases of flight
TBD-IRCD-016	xEMU.IRCD.0138, xEMU.IRCD.0139	Amount of oxygen required per crewmember per EVA is still being finalized as prebreathe protocols are evaluated.

Table B-2 lists the specific To Be Resolved (TBR) issues in the document that are not yet known. The TBR is inserted as a placeholder wherever the required data is needed and is formatted in bold type within brackets. As each TBR is resolved, the updated text is inserted in each place that the TBR appears in the document and the issue is removed from this table. As new TBR issues are assigned, they will be added to this list. Original TBRs will not be renumbered.

TABLE B-2 TO BE RESOLVED ISSUES

TBR	Section/Reqt ID	Description
TBR-IRCD-001	~~Section 3.1~~	~~Figure 3.4.4-1 xEMU-HLS Interface Diagram for EVA Phases of Operations~~ Closed as part of 8/15 update
TBR-IRCD-002	xEMU.IRCD.0079, xEMU.IRCD.0080	Prebreathe O2 amounts are being reassessed for 2024 that may change the 14lbs stated in the requirement. Expectation is the amount will decrease if prebreathe times are reduced.
TBR-IRCD-003	xEMU.IRCD.0067, xEMU.IRCD.0005, xEMU.IRCD.0006	The minimum and maximum O2 flow rates require further analysis specifically with bounding what the maximum velocity allowed of the O2 with a pressure of 3000psi.
TBR-IRCD-004	~~xEMU.IRCD.0133~~	~~The pressure range during feed water fill into the xEMU is under evaluation. Values are currently based of the Fluid Pumping Unit in development for the ISS. Max pressure value may decrease due to requirements of xEMU bladder.~~ Closed as part of 8/15 update
TBR-IRCD-005	xEMU.IRCD.0018	Resolve Dew Point temperature of gases vented by xEMU vacuum access umbilical to Airlock vacuum line
TBR-IRCD-006	xEMU.IRCD.0021, xEMU.IRCD.0021	FIGURE 3.2.5 1 XEVA SYSTEM POWER DRAW –SERIAL SUIT CHARGING - Power requirements are under evaluation. Specifically, duration of peak and nominal power is being assessed.
TBR-IRCD-007	xEMU.IRCD.0021, xEMU.IRCD.0021	FIGURE 3.2.5 2 XEVA SYSTEM POWER DRAW – PARALLEL SUIT CHARGING- Power requirements are under evaluation. Specifically, duration of peak and nominal power is being assessed.
TBR-IRCD-008	3.2.5.3	Charging period for the xBMS
TBR-IRCD-009	xEMU.IRCD.0050, xEMU.IRCD.0051,	xBMS is under development and the max current is an estimate.
TBR-IRCD-010	xEMU.IRCD.0071, xEMU.IRCD.0072	Per the JSC Grounding SME, SSP 30240 was levied on the xEMU during development. Implementation of a grounding

		solution is an integrated solution between the HLS and the xEMU. As the system matures this document will be updated to a non-ISS document.
TBR-IRCD-011	~~xEMU.IRCD.0037~~	~~xEMU requires a wireless interface using the standard IEEE 802.11. However specifically which one is yet to be determined and will be a part of an HLS comm/data architecture.~~ Closed as part of 8/15 update The wireless architecture will be defined in an HLS comm architecture document that will be referenced in this IRCD. This is no need to state a specific type of 802.11 and using the 802.11x nomenclature is sufficient.
TBR-IRCD-012	xEMU.IRCD.0039	MMWS as attach points is still being reviewed
TBR-IRCD-013	xEMU.IRCD.0039	The maximum loads for don/doff assembly ground testing is still being assessed.
TBR-IRCD-014	Section 3.2.8	FIGURE 3.2.8-1 MINIMUM DON/DOFF VOLUME FOR A SINGLE XEMU
TBR-IRCD-015	Section 3.3	The value and interfaces in Section 3.3 are not fully developed. Ascent, descent, abort requirements are being flowed to the xEMU and new interfaces may arise and values of ones identified changed.
TBR-IRCD-016	xEMU.IRCD.0106	The umbilical and connector design for dynamic phases of flight are immature.
TBR-IRCD-017	xEMU.IRCD.0107	XPGS VTL PRESSURE RANGE
TBR-IRCD-018	~~xEMU.IRCD.0108~~	~~TBR is for what point in the xEMU-HLS Interfaces the temperature will be controlled at. Ex. At the umbilical and HLS or the inlet to the xPGS.~~ Closed as part of 8/15 update. Location point for controlling temperature was assigned to boundary of the HLS and xEVA system, which is the UIP.
TBR-IRCD-019	xEMU.IRCD.0109	PRESSURE GARMENT VENTILATION LOOP EXTERNAL LEAKAGE
TBR-IRCD-020	xEMU.IRCD.0116	Figure 3.3.3 1 xEVA System Power Draw – Descent/Ascent-Power requirements are under evaluation. Specifically, duration of peak and nominal power is being assessed.
TBR-IRCD-021	Section 3.3.5	The power requirements for the xEMU are known and power is required to be provided via the ESCU to the xEMU. However, voltage and current regulation may be performed by xEVA System SPCE. This decision will be made after the HLS finalized their vehicle bus voltage. Please note that the power requirement for the xEMU during umbilical operations is included in xEMU.IRCD.0021
TBR-IRCD-022	xEMU.IRCD.0129	Frequency of EVAs logistics estimates
TBR-IRCD-023	xEMU.IRCD.0131, xEMU.IRCD.0132	EVA SUPPORT EQUIPMENT VOLUME
~~TBR-IRCD-024~~	~~xEMU.IRCD.0142~~	~~TBR for Incapacitated Crewmember Rescue support equipment/interfaces~~ Closed as part of 8/14 update. Transferred to EVA-EXP-0070.
TBR-IRCD-025	Section 1.2.2	Requiring the xEMU to be donned during undocking and docking has not been decided.
TBR-IRCD-026	Section 3.2.6	UHF radios will require power and the power draw is included in 3.2.6. It is not known if power will go from HLS to the UIP then the radios or directly from HLS to the UHF radio.
TBR-IRCD-027	xEMU.IRCD.0147	Pressure drop across xPGS thermal cooling loop during Dynamic phases

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APPENDIX C – SUPPORTING ANALYSIS REFERENCES

Table C-1 lists the specific analysis supporting the values and data presented in each rationale.

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