National Aeronautics and
Space Administration

EVA-EXP-0034

REVISION B

EFFECTIVE DATE: JULY 31, 2020

EXTRAVEHICULAR ACTIVITY (EVA) OFFICE EXPLORATION EVA SYSTEM TECHNICAL STANDARDS

Verify that this is the correct version before use

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REVISION AND HISTORY PAGE

Revision No.	Change No.	Description	Release Date
		EVA-EXP-0034 Revision History	
B		Rev B per CR# EVA-CR-00078 • Replaced MIL-STD-461 and MIL-STD-464 with GP 11461 and GP 11464 • Added NASA-HDBK-4002 • Added NPR 8735.1 • Dis-allowed using alternate standards for NPR 7150.2. Not allowing alternates in this document for 7150.2, does not supersede tailoring allowed by NPR 7150.2. • Added standards for Collaborative Simulation Technologies.	July 2020
A		Rev A per CR# EVA-CR-00057 • Added NASA-HDBK-7004 • Updated Introduction to explain compatibility with Exploration Programs • Removed Appendix D and made Appendix C, the alternate/tailored standard process • Added Appendix D EVA-EXP-0035 Applicability Matrix • Replaced JSC 65829 with NASA-STD-5002 • Added toxicity standards • Added JSC 67035 • Added AIAA-S-080A-2018 and AIAA-S-081B-2018 as applicable standards	July 2019
Baseline		Baseline per CR# EVA-CR-00039, administrative changes: - Update of EVA-RD-003 to EVA-EXP-0034 - Update of title from Design and Construction Document to Exploration EVA System Technical Standards - Removal of “Sensitive But Unclassified” (SBU) classification on the document - Clean up of EVA Office Exploration Document Number and titles throughout the document	December 2017

		EVA-RD-003 Revision History	
Baseline		Baseline per CR# EVA-CR-00028, Sept 27 2017	09/27/17

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APPENDIX

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FIGURE

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this Extravehicular Activity (EVA) Office specification is to define the types of Programmatic-level standards to be used for design, manufacturing, testing, and quality control for the Exploration EVA (xEVA) System. The xEVA system includes both space suits and EVA hardware elements (e. EVA Tools, Airlock hardware, etc.). Many of the standards referenced in this document can be substituted for similar standards used in industry; this document provides the scope of which standards need to be considered.

This document is the EVA-centric implementation of Chapter 3 of NPR 7120.10, Technical Standards for National Aeronautics and Space Administration (NASA) Programs and Projects: Select technical standards for use as program/project requirements. This also addresses the intent of Section 2.2.6 of NPR 8705.2, Human-Rating Requirements for Space Systems.

1.2 SCOPE

The standards discussed in this document apply to all domestic space suit, Extravehicular Activity flight hardware and software, including any ancillary systems. There are also specific standards for Ground Support Equipment (GSE), along with software standards for ground software that are needed to perform a primary mission objective, have direct interaction with human space flight systems, or have a direct impact on the health and safety of the crew.

The standards discussed in this document are not assumed to apply to space suit or EVA flight hardware and software produced by International Partners. Appropriate standards for International Partner-produced equipment which interfaces with domestically-produced space suits or Extravehicular Activity hardware will be negotiated in International Partnership agreements on a case-by-case basis for each Program.

There are several ways a developer may encounter this document. In order to provide context for interpretation of the original intent, several examples are provided below for appropriate application of this document:

1) For hardware previously developed for legacy programs or systems such as the International Space Station (ISS) Program or the Extravehicular Mobility Unit (EMU), including EVA tools.

    a. *Intent: This document is not appropriate for use in this scenario. There is no intent for existing flight hardware to be re-certified to this document. For example, this document could be used for new-build hardware that flies on ISS, but only after negotiation with the ISS Program leading to a conclusion to use this instead of existing ISS Program requirements and processes.*

2) For development activities leading to construction or modification of a space suit built in compliance with SSP 51073, *Exploration EVA Suit Systems Requirements Document*,

    a. *Intent: This document is appropriate for use in this scenario. This would be a specific example where a new-build product which flies on a legacy program/platform would intentionally choose to build to this set of documentation. Reasons for doing so might include preservation of system requirements in a manner that would allow them to be transferred to other programs for operation beyond Low Earth Orbit (LEO) after initial fielding on ISS.*

3) For new Space Vehicle builders such as those for Exploration Class missions beyond LEO or other design reference missions (specifically those whose formulation post-dates the ISS Program),

    a. *This document has limited applicability. In general, the specifications in this document are not appropriate. It is not the intent for EVA to drive quality of construction expectations on the Space Vehicle itself. Rather, the Space Vehicle should be compatible for EVA operations; see EVA-EXP-0035, Exploration EVA System Compatibility.*

4) For new xEVA System hardware (i.e. EVA Tools, Airlock hardware, etc., not identified as hardware categorized as Legacy, ISS or EMU/Tools; see subsection 1),

    a. *Intent: This document is appropriate for use in this scenario. Sections of this document which are not relevant to the hardware in question should be documented as "not applicable" in the project's certification products. It is applicable to the development of EVA tools and airlock hardware related to new suit builds or new suit development systems. This document is not appropriate for hardware developed for the ISS program or developed exclusively for the EMU. Hardware and tools being carried forward to future programs and project will have to be evaluated against the project objectives and environment.*

5) For Payload builders with potential contact by EVA crewmembers for planned or contingency operations.

    a. *Intent: This document has limited applicability. In general, the specifications in this document are not appropriate. It is not the intent for EVA to drive quality of construction expectations on the Payload itself. Rather, the Payload should be compatible for EVA operations; see EVA-EXP-0035, Exploration EVA System Compatibility Document for these requirements.*

1.3 CHANGE AUTHORITY/RESPONSIBILITY

Proposed changes to this document shall be submitted by an EVA Office Change Request (CR) to the EVA Configuration Control Board (EVA CCB) for consideration and disposition.

The appropriate NASA Office of Primary Responsibility (OPR) identified for this document is the EVA Office. As such, the EVA CCB manages this document on behalf of the designated exploration program.

1.4 EXPLORATION COMPATABILITY

EVA-EXP-0034 was written to provide technical standards for xEVA System hardware being developed for low earth orbit and exploration destinations (cislunar, lunar surface). It is expected that future programs will levy additional technical standards on hardware planned to be used with their respective program or modifications to those defined within. With that possibility in mind, this document was developed to be program agnostic where possible by utilizing NASA Agency, military and industry standards and allowing for this document to be applicable to xEVA hardware being developed across multiple Exploration programs. As the controlling change authority the EVA Office will ensure that the standards called out in EVA-EXP-0034 comply with each exploration program's standards that the xEVA hardware is to be utilized with. As of April 2020, EVA-EXP-0034 aligns with HEMOD-003 Type 2 Technical Authority (TA) Standards and are allowable alternates to the Gateway Technical Standard documents. Gateway Tech Standards development resulted in a Gateway tailoring of the HEMOD-003 Type 2 TA Standards, but still made it acceptable for hardware developers to use the Agency, military and industrial specifications called out in HEOMD-003. The EVA Office participates in the Gateway Program's review cycle and is actively aware of changes to the technical standards levied by the program. EVA-EXP-0034 will be updated as needed to reflect the technical standards of all Exploration Programs, either through direct reference of a standard or a provided tailoring of an Exploration Program Standard.

2.0 DOCUMENTS

The design, manufacturing, testing, and quality control standards in this document apply to EVA space flight hardware and software. There are also specific standards for GSE, along with software standards for ground software that are needed to perform a primary mission objective, have direct interaction with human space flight systems, or have a direct impact on the health and safety of the crew.

NASA has identified two basic types of standards for EVA:

1) One type of standard must be followed completely with no deviation or alternative proposal. They are identified by the words “meet” within the corresponding sections of this document. Within the Applicable Documents list below these standards will be shown as fully applicable

2) The majority of the standards identified use the language “meet the intent of.” These contain requirements that can be met explicitly by following the standard or by proposing alternate standards that meet or are consistent with the requirement levied in the requirement statement. For clarification purposes, “meet the intent of” meaning is consistent between this document and the standards from which they are derived from. Within the Applicable Documents list below these standards will be shown as “Alternative Allowed.” Because these standards are unique, Appendix C, was developed to define an EVA Office process to evaluate and approve alternative standards.

The documents and their revisions listed in the Applicable Documents Table in Section 2.1 are the approved EVA Office standards for the design and construction for space suits and EVA hardware. This document is a snapshot in time of what is currently applicable and expected to be used during the design, fabrication and testing of EVA hardware. Following approval of every revision of EVA-EXP-0034, documents in Section 2.1 will be independently revised and will eventually become out of sync with what is prescribed in this document. When such a case occurs, the revision referenced here will take precedence. If a user intends to use a revision not specified in Section 2, that revision will have to be evaluated per the alternate standards process Appendix C.

2.1 ALTERNATE/TAILORING STANDARDS

Alternate and tailoring of standard referred to in document are to follow the process defined in Appendix C Process for Using Alternate/Tailored Standards.

2.2 APPLICABLE DOCUMENTS

Document Number	Document Revision	Document Title	Applicability	Alternative Documents (allowed/not allowed)
AIAA-S-080A-2018	4/13/18	Metallic Pressure Vessels, Pressurized Structures, and Pressure Components	ALL	Not Allowed
AIAA-S-081B-2018	4/13/18	Composite Overwrapped Pressure Vessels	ALL	Not Allowed
ANSI/ESD S20.20	Edition 14 (6/11/14)	For the Development of an Electrostatic Discharge Control Program for – Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	ALL	Allowed
ASTM D6193	(2016)	Standard Practice for Stitches and Seams	ALL	Allowed
EP-19-001	(3/25/19)	Interpretation Memo for the Battery TR Propagation Requirements in JSC 20793 Rev D	All	Allowed
GEIA-STD-0005-1	A (3/1/12)	Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder	ALL	Allowed
GEIA-STD-0005-2	A (5/1/12)	Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems	ALL	Allowed
GP 11461	Baseline	Gateway Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment	ALL	Allowed
GP 11464	Baseline	Gateway Electromagnetic Environmental Effects (E3) Requirements	ALL	Allowed
IEC 61000-4-2	Edition 2.0 (12/08)	Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test	ALL	Allowed
IPC-2152	Baseline (8/1/09)	Standard for Determining Current Carrying Capacity in Printed Board Design	ALL	Allowed

Document Number	Document Revision	Document Title	Applicability	Alternative Documents (allowed/not allowed)
IPC-2220 Series	2221: B 2222: A 2223: E 2224: Baseline 2225: Baseline 2226: A	Family of Printed Board Design Standards	ALL	Allowed
IPC-6010 Series	6011: BL 6012: E 6013: D AMD 1 6015: Baseline 6017: Baseline 6018: CS	Family of Printed Board Fabrication Standards	ALL	Allowed
IPC-CM-770E	E (1/1/04)	Guidelines for Printed Board Component Mounting	ALL	Allowed
IPC J-STD-001G	G (9/1/18)	Requirements for Soldered Electrical and Electronic Assemblies	ALL	Allowed
IPC J-STD-001GS	(3/18)	Space Applications Electronic Hardware Addendum to IPC J-STD-001GS Requirements for Soldered Electrical and Electronic Assemblies	ALL	Allowed
ISO 9001	Fifth Edition (9/15/15)	Quality Management Systems – Requirements	ALL	Allowed
JPR-1800.5	(7/19/17)	Biosafety Review Board Operations and Requirements	ALL	Not Allowed
JSC-08080-2	B (9/24/15)	JSC Design and Procedural Standards	ALL	Allowed
JSC 20793	D (3/28/17)	Crewed Space Vehicle Battery Safety Requirements	ALL	Allowed
JSC 26895	Rev A (4/2014)	Guidelines for Assessing the Toxic Hazard for Spacecraft Chemicals and Test Materials	ALL	Allowed
JSC 62809	D (4/22/10)	Human Rated Spacecraft Pyrotechnic Specification	ALL	Allowed
JSC 65828	B, Change 1 (7/15/14)	Structural Design Requirements and Factors of Safety for Spaceflight Hardware	ALL	Allowed

Document Number	Document Revision	Document Title	Applicability	Alternative Documents (allowed/not allowed)
JSC 67035	A (8/2017)	Best Practices and Guidelines for Thin Will Pressure Boundaries for Human Spaceflight Applications	ALL	Allowed
MIL-STD-981	C, Change 2 (8/13/15)	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications	ALL	Allowed
MSFC-DWG-20M02540	E (1/15/92)	Assessment of Flexible Lines for Flow-Induced Vibration	ALL	Allowed
MSFC-SPEC-626	Baseline (2/28/90)	Test Control Document for Assessment of Flexible Lines for Flow Induced Vibration	ALL	Allowed
NASA-HDBK-7004	C 2017	Forced Limited Vibration Testing	ALL	Allowed
NASA-HDBK-4002	A w/change 10/19/17	Mitigating In-Space Charging Effects – A Guideline	All	Allowed
NASA-STD-4003	A (2/5/13)	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment	ALL	Allowed
NASA-STD-4005	A (2/1/16)	Low Earth Orbit Spacecraft Charging Design Standard	ALL	Allowed
NASA-STD-5002	Baseline 6/21/96	Load Analyses of Spacecraft and Payloads	ALL	Allowed
NASA-STD-5012	B (6/16/16)	Strength and Life Assessment Requirements for Liquid Fueled Space Propulsion System Engines	ALL	Allowed
NASA-STD-5017	A, Change 1 (7/31/15)	Design and Development Requirements for Mechanisms	ALL	Allowed
NASA-STD-5018	Baseline (8/12/11)	Strength Design and Verification Criteria for Glass, Ceramics, and Windows in Human Space Flight Applications	Sections 4.6.3, 5.6.3, 4.10.2 and 5.10.2 are not applicable	Allowed
NASA-STD-5019	A, Change 2 (2/29/18)	Fracture Control Requirements for Spaceflight Hardware	ALL	Allowed
NASA-STD-5020	A, Change 1 (2/11/19)	Requirements for Threaded Fastening Systems in Spaceflight Hardware	ALL	Allowed

Document Number	Document Revision	Document Title	Applicability	Alternative Documents (allowed/not allowed)
NASA-STD-6016	A (11/30/16)	Standard Materials and Processes Requirements for Spacecraft	ALL	Allowed
NASA-STD-7009	Baseline (7/13/16)	Standard For Models And Simulations	4.1.1, 4.7, 4.8	Allowed
NASA-STD-7012	Baseline (3/05/19)	Leak Test Requirements	ALL	Allowed
NASA-STD-8739.1	A, Change 2 (6/30/16)	Workmanship Standard for Polymeric Application on Electronic Assemblies	ALL	Allowed
NASA-STD-8739.4	A, Change 2 (6/30/16)	Workmanship Standard for Crimping, Interconnecting Cables, Harnesses, and Wiring	ALL	Allowed
NASA-STD-8739.5	A (9/15/15)	Fiber Optic Terminations, Cable Assemblies, and Installation	ALL	Allowed
NASA-STD-8739.6	A, Change 1 (5/31/2017)	Implementation Requirements for NASA Workmanship Standards	ALL	Allowed
NPD 8730.5	B, Change 3 (10/31/16)	NASA Quality Assurance Program Policy	Attachment A	Not Allowed
NPR 7150.2	C (8/2/19)	NASA Software Engineering Requirements	ALL	Not Allowed
NPR 8735.1	D 6/29/18	Exchange of Problem Data Using NASA Advisories and the Government-Industry Data Exchange Program (GIDEP)	Sections 2.3, 3.1.6, 3.2.4 – 3.2.5, 3.3.3, 3.4.1, 3.4.3, 3.4.6, 3.5.1, and Appendix C	Not Allowed
SAE-AS7928	C (5/1/19)	General Specification for Terminals, Lug: Splices, Conductor: Crimp Style, Copper	ALL	Not Allowed
SAE AS9003	A (2012)	Inspection and Test Quality Systems Requirements for Aviation, Space, and Defense Organizations	ALL	Allowed
SAE AS9100	D (9/1/16)	Quality Management Systems – Requirements for Aviation, Space and Defense Organizations	ALL	Allowed

Document Number	Document Revision	Document Title	Applicability	Alternative Documents (allowed/not allowed)
SMC-S-016	(9/5/14)	Space and Missile Systems Center Standard Test Requirements for Launch, Upper-Stage and Space Vehicles	ALL	Allowed
SSP 30312 Volume 1	L (10/24/14)	Electrical, Electronic, and Electromechanical (EEE) Parts Management and Implementation Plan for the Space Station Program	ALL	Allowed
SSP 41172	AC (6/29/15)	Qualification and Acceptance Environmental Test Requirements	4.2.11, 4.4.4, 5.1.7, 5.1.8, 5.2.3, 6.1.2	Allowed
SSP 51073	B (12/19)	Exploration Extravehicular (EVA) Suit Systems Requirements Document	All	Not Allowed

2.3 REFERENCE DOCUMENTS

The following documents contain supplemental information to guide the user in the application of this document.

Document Number	Document Revision	Document Title
EVA-EXP-0035	Baseline 9/12/18	Exploration EVA System Compatibility
HEOMD-003	Draft	Type 2 Technical Authority (TA) Standards
ISS MD 1049	B	Charter for the Extravehicular Activity (EVA) Configuration Control Board (CCB)
JSC 20584	Baseline September 2017	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants
JSC 65829	A (6/11/14)	Loads and Structural Dynamics Requirements for Spaceflight Hardware
JSC 66901	Baseline (8/28/16)	Damage Threat Assessment and Damage Control Panel Template for Composite Overwrapped Pressure Vessel
JSC-67283	Draft	Damage Threat Assessment (DTA) and Damage Control Plan (DCP) Template for Bellows and Flexhoses
NASA-STD-3001 V2	Rev B	NASA Space Flight Human-Systems Standard Volume 2: Human Factors, Habitability, and Environmental Health
NASA-STD-8719.13	C (5/7/13)	Software Safety Standard

Document Number	Document Revision	Document Title
NPR 7120.5	E, Changes 1-15 (8/14/12)	NASA Space Flight Program and Project Management Requirements
NPR 7120.10	A (2/21/17)	Technical Standards for NASA Programs and Projects
NPR 8705.2	C (7/10/17)	Human-Rating Requirements for Space Systems
NPR 8705.4	Baseline, Change 3 (6/14/04)	Risk Classification for NASA Payloads
SMC-S-010	(4/12/13)	Space and Missile Systems Center Standard Technical Requirements for Electronic Parts, Materials, and Processes Used in Space Vehicles

3.0 DESIGN AND MANUFACTURING STANDARDS

3.1 MATERIALS AND PROCESSES

3.1.1 Materials and Processes

[STD-0001] The xEVA System shall meet the intent of NASA-STD-6016, Standard Materials and Processes Requirements for Spacecraft. Deviations from materials and processes requirements shall be documented and approved using the Materials Usage Agreement (MUA) process as defined in NASA-STD-6016.

Note: The xEVA System on the advice of JSC M&P had decided to stay with NASA-STD-6016 Rev A. Changes in Rev B are not relevant to the xEVA System and the NASA-STD-6016 revision applicability will be assessed when future revision are released.

3.1.2 Cabin Materials Flammability

[STD-0002] The xEVA System shall use materials in the pressurized cabin that meet the flammability requirements of NASA-STD-6016 in their worst-case operating environment.

Rationale: The most severe environment for material flammability will be 100% oxygen at 23.5 psia inside the suit during suited operations within a cabin or during ground test (8.4 psia + 14.7 psia + margin). Outside of the suit, the most severe environment for material flammability with be either 30% oxygen at 10.2 psia (determined by the ISS cabin depressurization case) or 34% oxygen at 8.2 psia (for non-ISS missions using Exploration Atmosphere). ***<TBR-003-001>***

Note: The xEVA System on the advice of JSC M&P had decided to stay with NASA-STD-6016 Rev A. Changes in Rev B are not relevant to the xEVA System and the NASA-STD-6016 revision applicability will be assessed when future revision are released.

3.1.3 Toxic Hazard Level

[STD-0061] The xEVA System shall *limit the use of and properly contain catastrophic hazardous substances as defined in JSC 26895, Guidelines for Assessing the Toxic Hazard of Spacecraft Chemicals and Test Materials to critical function components.*

Rationale: The intent of this requirement is to restrict the use of system components that could pose an immediate risk to human health. Substances that cannot be contained or cleaned up by the crew therefore represent the greatest risk. All liquids, gases, particles, and gels contained within suit sub-systems will be submitted for review per JSC 27472 and assessed per JSC 26895. Supplies for crew protection and spill containment should be provided to allow crewmembers to clean contaminated surfaces when possible. Materials off-gassing and human metabolic

contaminants must be controlled below the SMAC limits (JSC 20584) defined in section 6.4.2, Atmosphere Contamination Limit – Airborne Contaminants [V2 6050], of NASA-STD-3001 V2.

3.2 FLIGHT AND GROUND SOFTWARE

3.2.1 Software Engineering Requirements

[STD-0003] The xEVA System shall meet NPR 7150.2, NASA Software Engineering Requirements for all flight and ground software products classified as Class A software per Appendix E of NPR 7150.2, or safety critical as defined in NASA-STD-8719.13, Software Safety Standard, Appendix A, that adversely affects the operation of the Class A products. A requirements mapping matrix is provided for each software class and criticality in Appendix D of NPR 7150.2.

3.3 ELECTRICAL AND AVIONICS

3.3.1 Use of Silver

3.3.1.1 Electrically Deposited Silver

[STD-0004] The xEVA System shall not use electrically deposited silver as plating on printed wiring boards and terminal boards because of potential dendrite growth.

3.3.1.2 Silver Plating

[STD-0005] The xEVA System shall not use silver plating on bus bars and mechanical electrical contacts, such as connector pins and sockets, because it can tarnish and degrade electrical conductivity.

3.3.2 Printed Wiring Boards

3.3.2.1 Printed Board Design Standards

[STD-0006] The xEVA System shall meet the intent of the requirements defined in IPC-2221, Generic Standard on Printed Board Design, as well as the associated technology performance specification under the IPC-2220 series per Performance Class 3.

3.3.2.2 Qualification of Printed Boards Standard

[STD-0007] The xEVA System shall meet the intent of the requirements defined in IPC-6011, Generic Performance Specification for Printed Boards, as well as the associated technology performance specifications of the IPC-6010 series per Performance Class 3 with the exception for IPC-6012, where the Space Addendum is applicable instead of Performance Class 3.

3.3.2.3 Conductor Size Standard

[STD-0008] The xEVA System shall meet the intent of the requirements defined in IPC-2152, Standards for Determining Current Carrying Capacity in Printed Board Design, per Performance Class 3.

3.3.3 Printed Wiring Assemblies

3.3.3.1 Printed Wiring Assemblies

[STD-0009] Electrical circuitry shall be designed and fabricated to prevent the production of unwanted current paths by debris or foreign materials floating in the spacecraft microgravity environment.

3.3.4 Fiber Optics

3.3.4.1 Fiber Optic Connection Standard

[STD-0010] The xEVA System shall meet the intent of NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation.

3.3.5 Staking/Conformal Coating

3.3.5.1 Staking/Conformal Coating

[STD-0011] The xEVA System shall meet the intent of the requirements in NASA-STD-8739.1, Workmanship Standard for Polymeric Application on Electronic Assemblies.

3.3.6 Electrical Soldering

3.3.6.1 Soldering Process and Controls Standard

[STD-0012] The xEVA System shall meet the intent of IPC J-STD-001FS, Space Applications Electronic Hardware Addendum and IPC J-STD-001F, Requirements for Soldered Electrical and Electronic Assemblies.

3.3.6.2 Soldering Performance Standard

[STD-0013] The xEVA System shall meet the intent of GEIA-STD-0005-1, Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-Free Solder.

3.3.6.3 Mitigation of Tin Whiskers

[STD-0014] The xEVA System shall meet the intent of GEIA-STD-0005-2, Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronics.

Note: GEIA-STD-0005-2 has a selection of five control levels. The EVA Office will indicate the appropriate level of control in program and project documentation such as the request for proposal, contract statement of work, or project management plan. If the level of control is not stated, the user is to contact the EVA Office for direction. Typically, for EVA space suit hardware, a control level of 2C will be required.

3.3.7 Electrical Crimping

3.3.7.1 Wiring, Cables, Harnesses and Crimping

[STD-0015] The xEVA System shall meet the intent of IPC/WHMA-A-620B-S, Space Applications Electronic Hardware Addendum to IPC/WHMA-A-620B.

Rationale: IPC/WHMA-A-620B-S is superior to NASA-STD-8739.4 Crimping, Interconnecting Cables, Harnesses, and Wiring in both content and technical requirements. NASA-STD-8739.4 is no longer being actively supported by update of technical content. NASA-STD-8739.6, Chapter 10 ““Cable Harness Assembly Standard Implementation” implements IPC/WHMA-A-620B-S**.**

3.3.7.2 Terminal Lugs and Splices

[STD-0054] Terminal lugs, splices, and two-piece shield termination rings shall meet the tensile strength and electrical requirements of SAE-AS7928, General Specification for Terminals, Lug: Splices, Conductor: Crimp Style, Copper.

3.3.8 Electrical Wire Wrapped Connections

3.3.8.1 Electrical Wire Wrapped Connections

[STD-0016] The xEVA System shall not use wire wrapping.

3.3.9 Electrical Bonding

3.3.9.1 Electrical Bonding

[STD-0017] The xEVA System, subsystems, and systems shall be designed, manufactured, and integrated to meet the intent of NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment.

3.3.10 Batteries

3.3.10.1 Batteries

The xEVA System battery systems shall meet the intent of the requirements defined in JSC 20793, Crewed Space Vehicle Battery Safety Requirements. **[STD-0018]**

[STD-0154] The xEVA System battery systems shall meet interpretation memo EP-19-001 which defines verification requirements for single cell thermal runaway hazard severity mitigation.

3.3.11 Other Processes

3.3.11.1 Component Mounting Guidelines

[STD-0019] The xEVA System shall meet the intent of IPC-CM-770E, Component Mounting Guidelines for Printed Boards per Performance Class 3.

3.3.12 Integrated Space Vehicle Electrostatic Charge Control

3.3.12.1 LEO Charging Design Standard

The xEVA System shall meet the intent of the requirements contained in NASA-STD-4005, Low Earth Orbit Spacecraft Charging Design Standard. **[STD-0020]**

3.3.12.2 Electrostatic Discharge Control Program

The xEVA System shall meet the intent of ANSI/ESD S20.20, For the Development of an Electrostatic Discharge Control Program for – Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices), which will include establishing and maintaining an electrostatic discharge control program. **[STD-0021]**

3.3.12.3 Electrostatic Design Thresholds

[STD-0022] The xEVA System shall meet the intent of IEC 61000-4-2, Electromagnetic Compatibility (EMC) Testing and Measurement Techniques-Electrostatic Discharge Immunity Test, for Human Body Model (HBM) subassemblies, assemblies and equipment discharge levels, which do not apply to electrically-initiated explosive devices.

[STD-0062] The xEVA System shall meet the intent of the guidance provided in NASA-HDBK-4002A, Mitigating In-Space Charging Effects – A Guideline.

Rationale: NASA-STD-4005, Low Earth Orbit Spacecraft Charging Design Standard and GP 11464, Gateway Electromagnetic Environmental Effects Requirements for Systems with guidance from NASA-HDBK-4002A, Mitigating In-Space Charging Effects – A Guideline serve to encompass design considerations for the relatively benign low earth orbit and highly variable lunar charging environments

3.3.13 Electromagnetic Interference Control

3.3.13.1 Electromagnetic Interference Control

[STD-0023] The xEVA System, subsystems, and systems shall be designed, manufactured, and integrated to meet the intent of GP 11461, Gateway Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.

3.3.14 Electromagnetic Environmental Effects

3.3.14.1 Electromagnetic Environmental Effects

[STD-0024] The xEVA System, subsystems, and systems shall be designed, manufactured, and integrated to meet the intent of the GP 11464, Gateway Electromagnetic Environmental Effects Requirements for Systems. The following sections are not applicable: 3.5 Lightning, and 3.9.3 Hazards of electromagnetic radiation to ordnance.

Rationale: The charging environments in cis-lunar space and on the lunar surface are significantly different than that in low-earth orbit and the requirements of GP 11464 and additional guidance of NASA-HDBK-4002A are needed to ensure that the hardware provider appropriately designs for these environments.

3.3.15 Custom Electromagnetic Devices

3.3.15.1 Custom Electromagnetic Devices

[STD-0025] Custom Electromagnetic Devices used in the xEVA System, subsystems, and systems shall be designed, manufactured, and integrated to meet the intent of MIL-STD-981, Design, Manufacturing, and Quality Standards for Custom Electromagnetic Devices for Space Applications.

3.4 MECHANISMS

3.4.1 Mechanism Design

[STD-0026] The xEVA System shall meet the intent of NASA-STD-5017, Design and Development Requirements for Mechanisms.

3.5 PYROTECHNICS

3.5.1 Pyrotechnics

[STD-0027] The xEVA System shall meet the intent of JSC 62809, Human Rated Spacecraft Pyrotechnic Specification.

3.6 STRUCTURES

3.6.1 Structural Design and Factors of Safety

3.6.1.1 Structural Design Requirements

[STD-0028] All flight hardware structures of the xEVA System, except for glass or ceramic windows, shall meet the intent of JSC 65828, Structural Design Requirements and Factors of Safety for Spaceflight Hardware. The following sections of JSC 65828 are not applicable: 3.2.7 Parachute and Parafoil Systems, 3.2.8.4 Pressure Vessels, 3.8.35 Composite Overwrapped Pressure Vessels, 3.2.8.7 Doors and Hatches in Habitable Modules, 3.2.9 Liquid Propulsion Engine Structures, 3.2.10 Solid Rocket Motors.

Note: Due to JSC 65828 sections 3.2.8.4 and 3.2.8.5, referencing outdated version of AIAA-S-80 and AIAA-S-081, EVA hardware is to be designed to the standards called out in EVA-EXP-0034 standards STD-0058 and STD-0059.

3.6.1.2 Windows Design

[STD-0029] The xEVA System shall meet the intent of NASA-STD-5018, Strength Design and Verification Criteria for Glass, Ceramics, and Windows in Human Space Flight Applications, for components that utilize glass or ceramic materials. The following sections of NASA-STD-5018 are not applicable: 4.6.3 and 5.6.3, 4.10.2 and 5.10.2. For window systems (or portions of window systems) that use non-brittle materials such as plastic panes refer to requirement 3.6.1.1 of EVA-EXP-0034.

3.6.1.3 Pressure Vessels

[STD-0058] The xEVA System shall meet ANSI/AIAA-S-080, Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components.

3.6.1.4 Composite Overwrap Pressure Vessels

[STD-0059] The xEVA System shall meet ANSI/AIAA-S-081, Standard for Space Systems - Composite Overwrapped Pressure Vessels (COPVs).

3.6.2 Loads and Structural Dynamics

3.6.2.1 Loads and Structural Dynamics

[STD-0030] The xEVA System shall meet the intent of NASA-STD-5002: Load Analyses of Spacecraft and Payloads.

Rationale: NASA-STD-5002 defines the methodologies, practices, and requirements for the conduct of load analyses. JSC 65829 Loads and Structural Dynamics Requirements for Spaceflight Hardware is written for spacecraft and launch vehicle providers with an

EVA Section focused on the compatibility impacts of supporting EVA by the spacecraft providers. JSC 65829 is not directly applicable to spacesuit development.

3.6.3 Fasteners

[STD-0031] The xEVA System shall meet the intent of NASA-STD-5020, Requirements for Threaded Fastening Systems in Spaceflight Hardware.

3.7 FLUIDS, PROPELLANTS, EXPLOSIVES, AND OXYGEN SYSTEMS

3.7.1 Flexible Lines and Flow-Induced Vibration

[STD-0032] The xEVA System shall prevent Flow-Induced Vibration (FIV) in metal bellows and flexhoses over their operating flow range +/-10% or show that part life is 4 times the operational life when FIV cannot be eliminated.

a. The FIV analysis to determine the predicted FIV flow range shall be performed to meet the intent of MSFC-DWG-20M02540, Assessment of Flexible Lines for Flow-Induced Vibration.

b. The procedures for flow testing metal bellows and flexhoses to show acceptable operational life shall meet the intent of MSFC-SPEC-626, Test Control Document for Assessment of Flexible Lines for Flow Induced Vibration.

c. For those metal bellows and flexhoses used in the xEVA System which experience an operating flow excitation environment that is different (atypical) than the grazing flow environment described by MSFC-DWG-20M02540, then an alternative analysis technique shall be used.

Rationale: The occurrence of flow-induced vibrations in convoluted metal bellows and flexhoses can result in a structural fatigue failure. These flow-induced vibrations are a result of the coupling of vortex shedding from the flexible line convolutes with the natural frequencies of the flexible line. It is the intent of this requirement to avoid those flow ranges which produce FIV or to pursue other robust design and demonstration activities necessary to minimize the likelihood of a catastrophic failure of bellows and flexhoses. The alternative analysis technique is meant to address flow situations where the MSFC-DWG-20M02540 would not be applicable.

3.7.2 Bellow Threat Assessment and Damage Control

[STD-0060] The xEVA System shall create a damage threat assessment and damage control plan for bellows and flexhoses.

Rationale: Steps need to be taken to help mitigate the possibility of damage to a bellows or flexhose during manufacturing, handling, testing, packaging, storage, transportation, installation, in-service use and maintenance, including integration, launch, re-entry, landing and re-flight, as applicable. The standard template JSC

67283 Damage Threat Assessment (DTA) and Damage Control Plan (DCP) Template for Bellows and Flexhoses can be used as a guide for bellows damage threat assessment. JSC 67283 provides a template that can be used to evaluate and mitigate defined threats to bellows or metallic convoluted lined flexhoses.

3.7.3 Best Practices for a Thin Walled Pressure Boundaries

[STD-0055] The xEVA System shall meet the intent of JSC 67035, Best Practices and Guidelines for Thin Wall Pressure Boundaries for Human Spaceflight.

Rationale: JSC 67035 is intended to serve as recommendations to supplement hardware Program requirements as defined in existing standards (e.g. NASA-STD-6016, NASA-STD-5006, NASASTD-5012, NASA-STD-5017, NASA-STD-5001, AIAA-S-080, MSFC-DWG-20M02540, MSFC-SPC-166 and SMC-S-016 or approved alternate standards). While the guidelines address elements across many standards, they are intended to provide elements for an alternative approach that meets the intent of NASA requirement for fracture control. Alternative approaches are acceptable per NASA-STD-5019/5019A but must provide a risk neutral alternative to the specific requirements and must be approved by the responsible fracture control board. The need for alternative approaches for fracture critical thin wall pressure barriers arises in cases where the traditional safe life analysis based on linear-elastic fracture mechanics cannot be applied due to complexity in geometry, inaccuracy of determining the initial stress state, nonlinear material behavior, and lack of sensitivity of the current nondestructive evaluation (NDE) techniques to detect the required small initial flaw sizes. Complexity of configuration, dependence on manufacturing process controls, stress concentrations, monotonic versus cyclic material behaviors, residual stresses, and process operations such as welding and forming with a potential for introducing material damage also contribute to a need for a consistent, structured approach for addressing thin wall pressure barriers.

3.8 PROPULSION SYSTEMS

3.8.1 Strength and Life Requirements for Propulsion Systems

[STD-0033] The xEVA System shall meet the intent of NASA-STD-5012, Strength and Life Assessment Requirements for Liquid Fueled Space Propulsion Systems Engines.

3.9 FRACTURE CONTROL

3.9.1 Fracture Control

[STD-0034] The xEVA System shall meet the intent of fracture control requirements in NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

3.10 EEE PARTS

3.10.1 EEE Parts

[STD-0035] The xEVA System shall meet the intent of SSP 30312 Volume 1, Electrical, Electronic, and Electromechanical (EEE) Parts Management and Implementation Plan for the Space Station Program.

Note: SSP 30312 Volume 1, Electrical, Electronic, and Electromechanical (EEE) Parts Management and Implementation Plan for the Space Station Program defines four grades for parts with the grades varying from grade 1 for most critical applications to class 4 for the least critical applications. The appropriate grade is to be identified and applied at the initiation or the project or at an early project milestone, such as Systems Requirements Review (SRR).

Note: SSP 30312 Grade 1 is equivalent to SMC-S-010, *Space and Missile Systems Center Standard, Parts, Materials, and Processes Technical Requirements for Space and Launch Vehicles*.

3.11 TESTING

3.11.1 Ground Testing

[STD-0036] The xEVA System and associated subsystems and units shall meet the intent of the environmental and structural ground testing requirements as defined in SMC Standard SMC-S-016, Test Requirements for Launch, Upper-Stage, and Space Vehicles, with the following exceptions:

1) For leak testing, the xEVA System and associated subsystems and units shall meet the intent of the leak testing requirements defined in NASA-STD-7012, Leak Testing.

2) Shock as an acceptance test is not required.

3) For burn-in testing, the xEVA System and associated subsystems and units shall meet the intent of the burn-in testing requirements defined in SSP 41172.

4) For life testing of mechanisms, the life test factor from NASA-STD-5017 shall be used.

5) For vibration, shock, and acoustics qualification testing, a test margin of 3 dB rather than 6 dB is acceptable provided that test tolerances for random vibration are covered and low side tolerance for shock is not below the required design level.

6) Forced limited vibration testing shall meet the intent of NASA-HDBK-7004, Force Limited Vibration testing.

Note: SSP 41172 is an acceptable alternative with exceptions 1, 2 and 4-6 applying.

3.12 MODELS AND SIMULATIONS

3.12.1 Models and Simulations

[STD-0037] The xEVA System shall meet the intent of sections 4.1.1, 4.1.2, 4.7 and 4.8 of NASA-STD-7009, Standard for Models and Simulations, for all models and simulations that are utilized in making critical decisions.

Rationale: The intent is to ensure that the limitations and credibility of model- and simulation-based analysis results are clearly and consistently communicated to decision makers, since the output data from a model or simulation by itself does not provide sufficient information on which to base a critical decision.

3.12.2 Collaborative Simulation Technologies

Because the Gateway elements will be developed by multiple providers staggered over a significant period of time, mechanisms must be codified to ensure that models, simulations, and their supporting data can be exchanged between NASA and its commercial and International Partners. Complicating the matter is that each provider is likely to have its own modeling tools, simulation execution environment, and data protection requirements.

The Gateway Program intends to leverage international standards to ensure that models and simulations can be used collaboratively to satisfy programmatic needs while allowing appropriate protection of intellectual property.

NOTE: The section on collaborative simulation technologies is only applicable to models and simulations that will be used collaboratively with project and programs external to the xEVA System to satisfy programmatic needs.

[STD-0063] For distributed simulations, the participating simulations shall satisfy IEEE 1516 and the Simulation Interoperability Standards Organization (SISO) Standard for Space Reference Federation Object Model (SpaceFOM).

Rationale: The High Level Architecture mechanism is widely used for cases where loosely coupled simulated vehicles can be tied together in a common environment with known interactions. Examples include large-scale joint NATO military exercises involving hundreds of simulated vehicles, as well as spacecraft training operations involving ISS and international and commercial partners. Ref: https://standards.ieee.org/standard/1516-2010.html

The Federation Object Model provides a mechanism to define the types of data that can be exchanged and interactions that can occur between modeled elements in separate HLA-enabled simulations. The SpaceFOM specifies space-unique data and interactions, and has been developed by an international M&S community. Ref: https://www.sisostds.org/StandardsActivities/DevelopmentGroups/SRFOMPDGSpaceReferenceFederationObjectModel.aspx

[STD-0064] For simulations that involve model object code linked together from disparate sources, participating models shall satisfy the Functional Mock-up Interface for Model Exchange and Co-Simulation standard on a Linux host with C/C++ based object code.

Rationale: Functional Mock-up Interface (FMI) is an open, international standard that allows pre-compiled object code from multiple sources to be linked into a common executable. Models may be delivered without delivering associated source code Ref: https://fmi-standard.org

3.13 EVA SUIT COMPATIBILITY

Requirement deleted and moved to SSP51073

3.14 STITCHES, SEAMS, AND SEWIING

[STD-0039] Space Suit and EVA hardware shall meet the intent of ASTM D6193, Standard Practice for Stitches and Seams, for stitches, seams, and sewing.

3.15 QUALITY ASSURANCE

3.15.1 Quality Assurance

[STD-0040] The xEVA System shall meet the intent of the following quality assurance requirements (from Attachment A of NPD 8730.5, NASA Quality Assurance Program Policy, Sections 2a through 2d) as defined below:

1) Work that is both critical and complex shall be performed in accordance with the quality system requirements of SAE AS9100, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations.

    a. Critical work is any hardware task that, if performed incorrectly or in violation of prescribed requirements, could result in loss of human life; serious personal injury; loss of a Class A, B, or C payload (see NPR 8705.4); loss of a Category 1 or Category 2 mission (see NPR 7120.5); or loss of a mission resource valued at greater than $2M.

b. Complex work involves either: a) the design, manufacture, fabrication, assembly, testing, integration, maintenance, or repair of machinery, equipment, subsystems, systems, or platforms; or b) the manufacture/fabrication of parts or assemblies which have quality characteristics not wholly visible in the end item and for which conformance can only be established progressively through precise measurements, tests, and controls applied.

2) Critical, but not complex, work shall be performed in accordance with the quality system requirements of SAE AS9100 or ISO 9001 Quality Management Systems – Requirements, or the inspection and test quality system requirements of SAE AS9003. Noncomplex work includes manufacture of "build to print" piece parts or performance of a discrete manufacturing/test operation such as plating, heat treating, non-destructive testing, or laboratory testing for chemical composition or mechanical properties.

3) Complex, but not critical, work shall be performed in accordance with the quality system requirements of SAE AS9100 or ISO 9001.

4) Work that is neither critical nor complex shall be performed in accordance with the quality system requirements of SAE AS9100, ISO 9001, or SAE AS9003, or in accordance with test and inspection requirements that are specified or approved by the contracting agent and that are supported by records evidencing their performance and outcome.

[STD-0065] The xEVA System shall meet NPR 8735.1 Exchange of Problem Data Using NASA Advisories and the Government-Industry Data Exchange Program (GIDEP).

3.15.2 Electrical Workmanship

[STD-0041] Space Suit and EVA hardware providers shall meet the intent of the electrical workmanship implementation requirements as defined in NASA-STD-8739.6, Implementation Requirements for NASA Workmanship Standards.

3.15.3 Quality Assurance Clauses

3.15.3.1 Supply Chain Traceability

[STD-0042] For equipment manufactured, fabricated, or assembled and intended for use in spaceflight applications or critical Ground Support Equipment, the Space Suit and EVA hardware provider shall maintain a method of item traceability that ensures tracking of the supply chain back to the manufacturer of parts included in assemblies and subassemblies. This traceability shall clearly identify the name and location of all supply chain intermediaries from the manufacturer to the direct source of the product for the Space Suit and EVA hardware provider and shall include the manufacturer's batch identification for the item(s) such as date codes, lot codes, serializations, or other batch

identifications. This clause does not apply to Commercial Off-the-Shelf (COTS) equipment (i.e. end-items) unless directed by Task Order.

3.15.3.2 Mixed Lot/Date Code

[STD-0043] When procuring parts for spaceflight and critical Ground Support Equipment, the procurement of a type of part may be fulfilled by multiple lot/date codes. While it is preferred to have a single lot/date code, high volume orders may make fulfillment of a single lot/date code unlikely. When mixed lot/date codes are procured, the DD250, Material Inspection Record, shall list individual lot/date codes and quantity. Multiple lot/date codes shall not be comingled. In addition, the individual part containers shall be marked with the lot/date code and quantity.

3.15.3.3 EEE Part Certificate of Conformance

The Space Suit and EVA hardware provider shall obtain and approve Electrical, Electronic or Electromechanical (EEE) part manufacturer's Certificate of Conformance (CofC) for EEE parts procured for use in space-flight applications and critical Ground Support Equipment. The manufacturer's CofC shall, at a minimum, include the following: **[STD-0044]**

1) Manufacturer's name and address

2) Manufacturer's and/or buyer's part identification number

3) Batch identification for the item(s) such as date codes, lot codes, serialization, or other batch identifications

4) Signature or stamp and date, with the title of the seller's authorized personnel signing the certificate.

3.15.3.4 Guarantee of Product Source(s)

[STD-0045] The Space Suit and EVA hardware provider shall ensure that only new and authentic parts or materials are used in products delivered to NASA for space-flight applications and critical Ground Support Equipment. The Space Suit and EVA hardware provider may only purchase parts directly from the Original Component Manufacturers (OCMs); OCM-authorized suppliers (e.g. franchised distributors), or authorized aftermarket manufacturers. Use of product that was not provided by these sources is not authorized unless first approved in writing by the **<TBD-003-002>** and, in the case of an Electrical, Electronic or Electromechanical (EEE) part, the **<TBD-003-003>**. The Space Suit and EVA hardware provider must present compelling support for this request (e.g. OCM documentation that authenticates traceability of the parts to the OCM) and include in its request all actions to ensure the part(s) or material is authentic and conforming to specification. The Space Suit and EVA hardware provider shall provide a copy of this written authorization at the time of delivery.

3.15.3.5 Certificate of Conformance for Raw Materials

[STD-0046] The Space Suit and EVA hardware provider shall obtain and provide for each deliverable product a legible raw material manufacturer's test report (e.g. mill test report) that states the lot of material furnished has been tested, inspected, and found in conformance with applicable material specifications. The test report will list the specifications, including revision numbers or letters, to which the material has been tested and/or inspected and the identification of the material lot to which it applies. When the material specification requires quantitative limits for chemical, mechanical, or physical properties, the test report will contain the actual test and/or inspection values obtained.

This clause is only applicable to material procured for the manufacture, fabrication or assembly of equipment suitable for space-flight applications and critical Ground Support Equipment. This clause is not applicable to COTS products used in non-structural or non-mission critical applications. COTS hardware used in structural or mission critical applications can present or contain unknown hazards unless the materials and processes used to manufacture the hardware meets the requirements of NASA-STD-6016 or the COTS usage is reviewed and approved by the responsible M&P and program authorities.

[STD-0047] For instances where the Space Suit and EVA hardware provider is unable to obtain a legible manufacturer's test report (written in the English language), the Space Suit and EVA hardware provider shall request the services of the JSC Receiving Inspection and Test Facility (RITF) or an independent testing laboratory accredited by a nationally recognized laboratory accrediting organization, e.g. Nadcap, to verify chemical, mechanical, and physical properties to meet requirements as identified by the procuring document.

3.15.3.6 Certificate of Conformance – Products

[STD-0048] The Space Suit and EVA hardware provider shall provide a certification with each shipment of equipment suitable for space-flight applications and critical Ground Support Equipment to attest that the parts, assemblies, subassemblies, or detail parts conform to the order requirements. Certifications must contain the following:

1) Customer's order number
2) Product name
3) Part identification number and, if applicable, serial number
4) Name and address of the manufacturing or processing location
5) If applicable, the true manufacturer's part identification, lot, heat, batch, date code, and/or serial number
6) Quantity and unit of measurement (each, box, case, gallons, etc.)

7) Signature of company official and date

8) Certification shall also include the specification (s) in which the hardware conforms.

3.15.3.7 Limited Operating Life Items

[STD-0049] The Space Suit and EVA hardware provider shall collect data and maintain records of operating time or cycles for all items designated as Limited Operating Life Items by drawings or specifications. Records will include the total elapsed time or cycle for each operation, cumulative time or cycles starting with the first functional test remaining time or cycles. A copy of this data will be included within the Acceptance Data Package for each deliverable item traceable to the individual item by part identification number and serial number.

3.15.3.8 Limited Life and Age Controlled (Shelf Life) Items

Products suitable for space-flight applications and critical Ground Support Equipment require submittal of date of manufacture when shelf life is based on date of manufacture, or date of shipment from the manufacture when shelf life is based on date of shipment, as appropriate, based on specified method of shelf life determination.

[STD-0050] Upon shipment, shelf life remaining shall meet the minimum shelf life specified on the order. If no shelf life is specified, in the procurement specification, seventy-five (75) percent of the manufacturing shelf life shall be remaining on products.

Apart from required Certificate of Conformance content per section 3.15.3.6 must contain the following:

1) Contract number

2) Part identification number

3) Manufacturer's name, lot, heat, batch, date code, and/or serial number (as applicable)

4) Manufacture’s Shelf life

5) Date of manufacture

6) Date of shipment from manufacturer (as specified on the Order),

7) Organization's name and Organization's point of contact

8) Date

3.15.3.9 Space Flight Hardware Procurement

[STD-0051] The Space Suit and EVA hardware provider shall include the following statement in all subcontracts and purchase orders placed for space-flight applications, without exception as to the amount or subcontract level:

> "FOR USE IN HUMAN SPACE FLIGHT; MATERIALS, MANUFACTURING, AND WORKMANSHIP OF THE HIGHEST QUALITY STANDARDS ARE ESSENTIAL TO ASTRONAUT SAFETY.
>
> IF YOU ARE ABLE TO SUPPLY THE DESIRED ITEM(S) WITH A HIGHER QUALITY THAN THAT OF THE ITEM(S) SPECIFIED OR PROPOSED, YOU ARE REQUESTED TO BRING THIS FACT TO THE IMMEDIATE ATTENTION OF THE PURCHASER."

3.15.3.10 Special Process Certification

Certain special processes may be required for the manufacture, fabrication, assembly, testing, or operation of equipment suitable for space-flight applications and critical Ground Support Equipment. Special processes shall be performed only by sources that have been surveyed and qualified/approved by the Space Suit and EVA hardware provider or NASA to perform those tasks. The Space Suit and EVA hardware provider shall provide data/documentation into the NASA Supplier Assessment System database (http://sas.nasa.gov) showing evidence of special processor qualification and/or certification to perform special manufacturing, assembling, and testing as required by the contract. The Space Suit and EVA hardware provider may elect to use only NASA approved sources (e.g. Nadcap accredited sources).

[STD-0052] A special process certification shall be provided with each shipment of item(s) delivered on this contract. Special process certifications may be in the supplier format but shall include the following:

1) NASA contract number
2) Part identification number(s)
3) Serial and/or lot numbers of the hardware processed (if applicable)
4) Material process specification and revision identifier
5) Objective evidence demonstrating compliance with the applicable process (e.g. temperature charts and hardness test results for heat treatment, destructive test results.)
6) Certification statement declaring the special process was performed per the applicable drawing or specification requirements

7) Space Suit and EVA hardware provider's name and address

8) When special processor is other than the Space Suit and EVA hardware provider, provide a certification of compliance from the special processor stating the special process was performed per the applicable drawing or specification requirements. Certifications must include the processor's name, address, and be signed and dated by a company official.

9) Each certification must be signed and dated by a company official of the Space Suit and EVA hardware provider and/or processor attesting to the acceptance of the process performed to the required specification(s).

NOTE: A special process, as used in the context of this clause, is any process or service provision where subsequent monitoring or measurement cannot verify the resulting output. This includes any process where deficiencies become apparent only after the product is in use or service has been delivered. Examples may include, but are not limited to: Heat Treat, Nondestructive test or inspection, chemical or mechanical coatings (e.g. anodize, passivation), welding, unique or uncommon processes.

3.15.3.11 JSC Design and Procedural Standards

[STD-0053] The Space Suit and EVA hardware shall meet the intent of JSC-08080-2, JSC Design and Procedural Standards. This clause is only applicable for the design, manufacture, fabrication, assembly, or test of space-flight equipment and Ground Support Equipment.

3.16 PLANETARY PROTECTION AND CROSS CONTAMINATION

3.16.1 Planetary Protection of Exploration Sites (Forward Contamination)

There are no known Planetary Protection concerns for missions to Low Earth Orbit, Cis-Lunar Space, the Lunar Surface, Near-Earth Asteroids, or Deep Space Transit to Mars vicinity. For Mars surface missions, contamination of Exploration sites by escapes from the xEVA System must be addressed. However, there is no appropriate "minimize contamination of Exploration Sites induced by the xEVA System" standard to be invoked at this time. When one exists, it will be cited here.

3.16.2 Protection of Crew from Planetary Environments (Reverse Contamination)

Reverse contamination is a significant concern for Mars surface missions. However, there is no appropriate "minimize contamination of crewmembers induced by the xEVA System" standard to be invoked at this time. When one exists, it will be cited here.

3.16.3 Cross Contamination

[STD-0060] The xEVA System shall control cross-contamination among crew, payloads, e.g., animals and plants, surface vehicles, and planetary environments accordance with JPR-1800.5.

Rationale: JPR-1800.5 establishes requirements for the information required by JSC's Biosafety Review Board (BRB) to identify and assess biohazardous materials utilized in spaceflight or ground based experiments. The BRB's primary objective is to protect personnel, the general public, the facility, and the environment from biohazards. Contamination from payloads and planetary environments to crewmembers can negatively affect crew health; contamination from crewmembers and planetary environments to payloads can affect scientific data; contamination from crewmembers and payloads to planetary environments may impact the health of the planetary environment, including possible microscopic life forms on the surface. The principles of biosafety are containment and risk assessment.

APPENDIX A
ACRONYMS AND ABBREVIATIONS

A1.0 ACRONYMS AND ABBREVIATIONS

CCB	Configuration Control Board
CofC	Certificate of Conformance
COTS	Commercial Off The Shelf
CR	Change Request
DC	Direct Current
EEE	Electrical, Electronic, and Electromechanical
EMC	Electromagnetic Compatibility
EMCON	Emission Control
EMP	Electromagnetic Pulse
EMU	Extravehicular Mobility Unit
EVA	Extravehicular Activity
FIV	Flow-Induced Vibration
GIDEP	Government-Industry Data Exchange Program
GSE	Ground Support Equipment
HBM	Human Body Model
ISS	International Space Station
LEO	Low Earth Orbit
MUA	Materials Usage Agreement
NASA	National Aeronautics and Space Administration
OCM	Original Component Manufacturer
OPR	Office of Primary Responsibility
RITF	Receiving and Inspection Test Facility
SBU	Sensitive But Unclassified
TBD	To Be Determined
TBR	To Be Resolved

APPENDIX B
OPEN WORK

B1.0 TO BE DETERMINED

The table To Be Determined Items 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 carets. The TBD item is numbered based on the document number, including the annex, volume, and book number, as applicable (i.e., **<TBD-XXXXX-001>** is the first undetermined item assigned in the document). As each TBD is resolved, 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 in accordance with the above described numbering scheme. Original TBDs will not be renumbered.

TABLE B1-1 TO BE DETERMINED ITEMS

TBD	Section	Description
TBD-003-001	NA	Closed prior to initial baseline
TBD-003-002	3.15.3.4	Approver for other than new and authentic parts or materials
TBD-003-003	3.15.3.4	Approver for other than new and authentic parts or materials for EEE Parts

B2.0 TO BE RESOLVED

The table To Be Resolved Issues 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 carets. The TBR issue is numbered based on the document number, including the annex, volume, and book number, as applicable (i.e., **<TBR-XXXXX-001>** is the first unresolved issue assigned in the document). 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 in accordance with the above described numbering scheme. Original TBRs will not be renumbered.

TABLE B2-1 TO BE RESOLVED ISSUES

TBR	Section	Description
TBR-003-001	3.1.2	Oxygen concentration and pressure for suit exposure

APPENDIX C
PROCESS FOR USING ALTERNATE/TAILORED STANDARDS

Appendix C provides the process for receiving approval to use alternate or tailored standard to the standards specified in EVA-EXP-0034.

C1.0

All deviations from the standards identified in EVA-EXP-0034 must receive approval by the EVA Office. Deviations include all alternate standards and standards called out by EVA-EXP-0034 that the project tailors.

C1.1 Alternate Standards

Alternate standards are when a hardware provider plans to use a standard in place of the standards prescribed in EVA-EXP-0034. Some of the standards called out in EVA-EXP-0034 allow for users to meet the intent of the standard and for users to supply a different standard. For standards that have a defined process, that process is to be followed in parallel with the EVA Office Process for approval. Compliance with the standard's process will be required regardless if the EVA Office is approving the alternate standard through a project milestone or through a Waiver/Deviation.

For documents the EVA Office says that it is acceptable to "meet the intent of" and the standard itself does not provide a process, the project is to solely follow the process outline in EVA-EXP-0034 Appendix C. Failure to coordinate with the standard's stakeholders prior to major milestone reviews may result in delays during the review and approval process of the alternate document/tailored standard and may delay of the completion of the milestone.

C1.2 Tailoring

Tailoring is when the hardware provider takes a standard prescribed in EVA-EXP-0034 and modifies it to the specific implementation of their hardware. Some of the standards called out in EVA-EXP-0034 have processes for tailoring and processes for receiving approval of the changes made to the standard. For standards that have a defined process, that process is to be followed in parallel with the EVA Office Process for approval. Compliance with the standard's process will be required regardless if the EVA Office is approving the alternate standard through a project milestone or through a Waiver/Deviation.

For documents the EVA Office says that it is acceptable to "meet the intent of" and the standard itself does not provide a process, the project is to solely follow the process outlined in EVA-EXP-0034 Appendix C. Failure to coordinate with the standard's stakeholders prior to major milestone reviews may result in delays during the review and approval process of the alternate document/tailored standard and may delay of the completion of the milestone.

C2.0 The Alternate/Tailoring Process

How a project receives approval is centered around the nominal project milestones defined in NPR 7120.5, NASA Space Flight Program and Project Management Requirements and NPR 7123.1, NASA Systems Engineering Processes and Requirements with PDR being the point where the approval process changes from a milestone driven approval process to a case by case waivers and exceptions process at the EVA Office CCB. The change in how approval of alternate/tailored standards occurs at PDR because efforts to tailor program documents or offer alternative standards to those imposed by EVA-EXP-0034 should predominately occur before the major milestone reviews of SRR, SDR and PDR. This is because at PDR "Activities are performed to establish an initial project baseline, which (according to NPR 7120.5 and NPR 7123.1) includes "a formal flow down of the project-level performance requirements to a complete set of system and subsystem design specifications for both flight and ground elements" and "corresponding preliminary designs." The technical requirements should be sufficiently detailed to establish firm schedule and cost estimates for the project. It also should be noted, especially for Announcement of Opportunities (AO)-driven projects, that Phase B is where the top-level requirements and the requirements flowed down to the next level are finalized and placed under configuration control. While the requirements should be baselined in Phase A, changes resulting from the trade studies and analyses in late Phase A and early Phase B may result in changes or refinement to system requirements." (Expanded Guidance for NASA System Engineering Vol 1). Following this baseline, all changes to how a project is handling a standard will be require a deviation or waiver from the agreed upon baseline at PDR.

Pre-PDR refers to the period prior to the PDR Board closure and Post-PDR refers to all time after the PDR Board is closed.

Figure 2.01-1 details the process for suppliers to follow when tailoring standards or utilizing alternate standards.

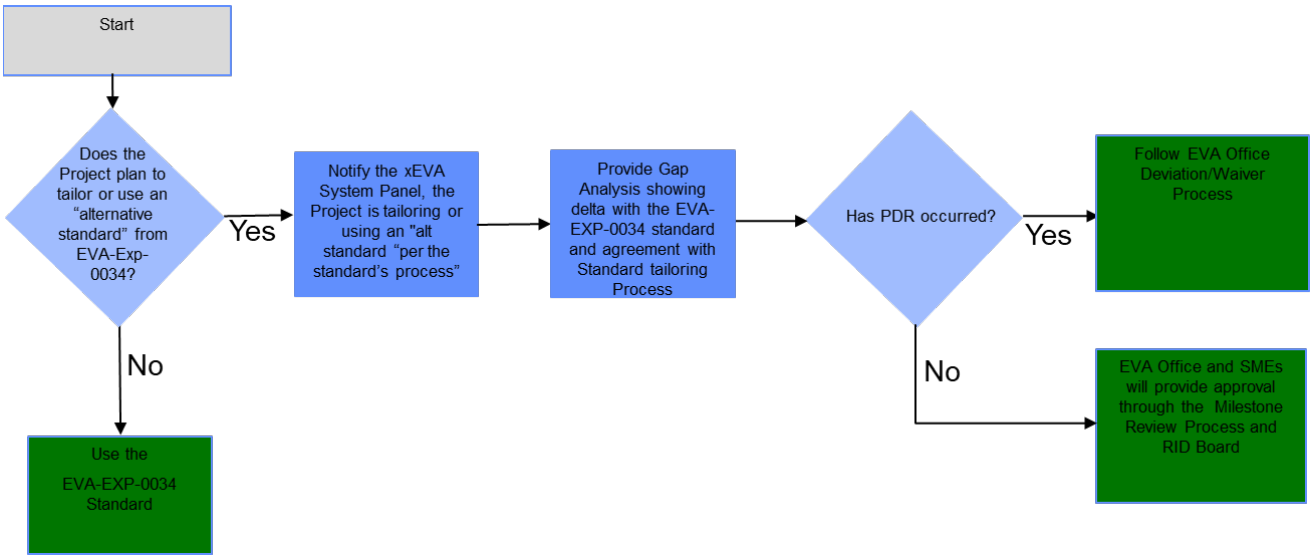

FIGURE C2.0-1 ALTERNATE AND TAILORED STANDARDS PROCESS

C2.1 Expectations for pre-PDR projects

At each major milestones (SRR, SDR, PDR and CDR) the project is to provide a product detailing what alternate standards are being used and what standards are being tailored.

The product is to show:

- Evidence of compliance with the standards process for tailoring
- Evidence of compliance with the standards alt tailoring process
- Differences between the alternate standards and the EVA-EXP-0034 standards
- Differences between the tailored standards and the original standards
- For CDR, documentation showing approval of the EVA office Waiver/Deviation's acceptance

There is no specified format for this product and how to format the product is at the discretion of the project.

C2.1 Expectations for Post-PDR projects
Alternate standards or tailorings proposed post-PDR will follow the EVA Office Waivers and Definition Process.

For more information on the EVA Office Waivers and Deviations Process see:

- The EVA Office Deviations and Waivers Form is EVA-FM-007

- Chief Safety and Mission Assurance Officer (CSO)/Change Evaluation (CE) Waiver/Deviation Guidance Presentation

Waivers and deviations will require coordination the xEVA System Panel and with the standards stakeholders prior to proceeding to the EVA Office CCB.

APPENDIX D
EVA-EXP-0035 APPLICABILITY MATRICES

The Appendix D applicability matrices specifying what requirements in EVA-EXP-0035: Exploration EVA Compatibility Document are applicable to a specific xEVA System hardware element has been removed and added to SSP51073.

APPENDIX E
FORWARD WORK

The table Forward Work lists the specific forward work items in the document that know and will be worked into the next revision of EVA-EXP-0034. The forward work item is numbered based on the document number, including the annex, volume, and book number, as applicable (i.e., **<FWD-XXXXX-001>** is the first forward work item assigned). As each forward work item is resolved, the document is updated to reflect closure of that know forward work and the item is removed from this table. As new forward work items are assigned, they will be added to this list in accordance with the above described numbering scheme. Original forward work items will not be renumbered.

TABLE E1-1 FORWARD WORK ITEMS

Forward work	Description
FWD-003-001 <Incorporated into Rev A>	Add Toxicity Standards – Action was taken in the 9/12/19 EVA Requirements Working Group to add Toxicity standards. In addressing NASA-STD-3001: Human Factors, Habitability, and Environmental Health, standard, the SSP 51073, *Exploration EVA Suit Systems Requirements Document* points to EVA-EXP-00034 for off-gassing, flammability and toxicity standards. Flammability and off gassing are in EVA-EXP-0034, while there is no toxicity standards listed.
FWD-003-002 <Incorporated into Rev A>	Add section documenting relationship to HEOMD's products. Add wording to EVA-EXP-0033 to say that there are higher-level documents from programs or directorates that specify standards and explain this documents role with respect to it.
FWD-003-003 <Incorporated into Rev A>	Since the EVA suits are not expected to have "windows" in the traditional sense, the associated SME recommends the following tweak to requirement 3.6.1.2, From: **3.6.1.2 Windows Design** Space Suits and EVA hardware shall meet the intent of NASA-STD-5018, Strength Design and Verification Criteria for Glass, Ceramics, and Windows in Human Space Flight Applications, for window systems that utilize glass or ceramic panes. To: **3.6.1.2 Windows Design** Space Suits and EVA hardware shall meet the intent of NASA-STD-5018, Strength Design and Verification Criteria for Glass, Ceramics, and Windows in Human Space Flight Applications, for components that utilize glass or ceramic materials <deleted>.
FWD-003-004 <Incorporated into Rev A>	Section 3.6.2 Loads and Structural Dynamics: Review applicability of JSC 65829: Loads and Structural Dynamics Requirements for Spaceflight Hardware. It may be more applicable to cite NASA-STD-5002: Load Analyses of Spacecraft and Payloads instead of JSC 65829 as JSC 65829 focuses on launch vehicles and spacecraft.

FWD-003-005	Review use of “shall meet the intent of.” Note that “shall meet the intent of” is vague and ambiguous. An NESC activity interviewed about a half dozen organizations that provide support to NASA’s robotic and human spaceflight programs. The common theme was their displeasure with terms like “shall meet the intent” as that equals risk for them. NASA technical standards are able to be tailored, and that should be the mechanism for changing standards.
FWD-003-006	Review Gateway updates to JSC 67035. The document currently has numerous “should” statements, but is currently being upgraded to “shall” statements for Gateway. By moving to a “shall” document, it conflicts with several requirements in various JSC and NASA standards. Future revisions of EVA-EXP-0034 need to determine if JSC 67035 is updated to consist mostly of “shalls,” does that make sense for using as an EVA System standard with the conflicts with other NASA standards.
FWD-003-007	EVA-EXP-0034 and HEOMD-003 Crewed Deep Space Systems Certification Requirements and Standards for NASA Deep Space Missions have similar philosophies to applying technical standards. One difference is HEOMD-003 applies additional HMTA and SM&A standards either as applicable or as reference. Many of these documents are nested in other products levied on the xEVA System, however an additional scrub and trace she be performed to ensure everything is properly captured.