National Aeronautics and
Space Administration

SLS-RQMT-216

REVISION A

EFFECTIVE DATE: MARCH 24, 2016

SPACE LAUNCH SYSTEM PROGRAM (SLSP) EXPLORATION MISSION 1 (EM-1) SAFETY REQUIREMENTS FOR SECONDARY PAYLOAD HARDWARE

HISTORY PAGE

Status	Revision No.	Change No.	Description	Effective Date
Baseline	–		Initial Baseline of SLS-RQMT-216, SLSP Exploration Mission 1 (EM-1) Safety Requirements for Secondary Payload Hardware, per PCBD SV2-01-0211 dated April 9, 2015; CR SLS-00354; PCN SV00758	04/09/15
	A		Revise SLS-RQMT-216, SLSP Exploration Mission 1 (EM-1) Safety Requirements for Secondary Payload Hardware to Revision A, per PCBD SV2-01-0275, dated March 24, 2016; CR SLS-00461; PCN SV00986	03/24/16

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1.0 INTRODUCTION

1.1 Purpose

This document establishes the safety policy and requirements applicable to Space Launch System (SLS) EM-1 secondary payloads.

1.2 Scope

These requirements are intended to protect the general public, ground personnel, the integrated EM-1 vehicle, other SLS EM-1 secondary payloads, Ground Support Equipment (GSE), and the environment from secondary payload-related hazards for the EM-1 mission. This document contains technical safety requirements applicable to SLS EM-1 secondary payloads using the Secondary Payload Deployment System (SPDS) (including payload-provided ground and flight support systems) during mission operations. This document establishes the safety policy and requirements applicable to SLS EM-1 secondary payloads from ascent until 15 seconds after deployment. For the ground processing phase, the payloads must also comply with identified ground processing hazard requirements as established in **<TBD-001>**. The Payload Safety Review Panel (PSRP) will, in parallel with GSDO, assess ground operations to determine whether ground processing activities could result in hazards to SLS or Orion that manifest themselves during prelaunch or flight operations. This document also applies to the payload dispenser utilized by the payload developer. Usage of the term “secondary payload” throughout this document may be in reference to either the secondary payload or the dispenser. The term “dispenser” in this document is synonymous with the term “deployer,” utilized in Spacecraft/Payload Integration and Evolution (SPIE) secondary payload documentation. The safety review processes associated with the SLS secondary payloads brackets, sequencer, battery, and cables are performed by the SPIE element in accordance with SLS Program SMA Requirements. Integrated safety reviews of SLS EM-1 secondary payloads, at the SPIE integrated system level and SLS Vehicle system level, are conducted by SLS processes as defined in SLS-RQMT-014, Space Launch System (SLS) Program Safety and Mission Assurance (S&MA) Requirements. SPIE will also perform integrated assessment of payload to payload hazards. The payload developer shall assist SPIE by providing additional information as necessary. This analysis will help SPIE understand and characterize the SPIE contribution to vehicle flight safety risk. The results of the analysis will be documented in the integrated hazard analysis and subject to program review/approval. Cross program integrated hazards associated with flight or post deployment of payloads are addressed in the Exploration Systems Development (ESD) integrated hazard analysis per ESD 10010, Exploration Systems Development (ESD) Safety and Mission Assurance (SMA) Plan. Refer to SLS-PLAN-217, SLSP Exploration Mission 1 (EM-1) Secondary Payload Safety Review Process, for further information on the governing requirements and review processes for integrated hazard analysis. Any additional safety requirements needed for SPIE, the SLS Program, or Cross-Program Integrated Hazards will be coordinated through the SPIE Office to the payload developer.

Any SLS EM-1 manifested secondary payloads will require an evaluation by the SLSP EM-1 PSRP per SLS-PLAN-217. When a safety requirement cannot be met, a waiver shall be submitted in accordance with SLS-PLAN-217.

For additional safety requirements which are unique to ground operations and GSE design, the payload developer shall refer to NASA Kennedy Space Center (KSC) Payload Ground Safety Requirements. **<TBD-001>**.

1.3 Change Authority/Responsibility

The NASA Office of Primary Responsibility (OPR) for this document is SLS Program Safety and Mission Assurance.

Proposed changes to this document will be submitted by an SLS Program change request (CR) to the SLS Program Control Board (PCB) for disposition. All such requests are described in the SLS-PLAN-008, SLS Program Configuration Management Plan.

1.4 Verb Application

The SLS program defines its implementation of requirement verbs in SLS-PLAN-003, SLSP Systems Engineering Management Plan (SEMP), section 1.2, Requirement Verbs and Compliance. They are implemented within this document as follows:

Shall	Used to indicate a requirement that is binding, which must be implemented and its implementation verified in the design.
Should	Used to indicate good practice or a goal which is desirable but not mandatory.
May	Used to indicate permission.
Will	Used to indicate a statement of fact or declaration of purpose on the part of the government that is reflective of decisions or realities that exist and are to be taken as a given and not open to debate or discussion.
Is, Are	Used to indicate descriptive material.

Rationale statements, included for many of the requirements, are intended to provide clarification, justification, purpose, and/or the source of a requirement. In the event that there is an inconsistency between a requirement and its rationale, the requirement always takes precedence.

2.0 DOCUMENTS

2.1 Applicable Documents

The documents listed in this paragraph are applicable in the current approved baseline or revision as specified in the SLS Master List of Baselined Data Items or other applicable configuration management master list to the extent specified herein. Specific revisions of SLS controlled documents will not be annotated unless required to specify the boundaries of an incorporated agreement or requirement. Documents not controlled by SLS will be annotated by revision.

ANSI/AIAA S-080-1998	Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components
ANSI/AIAA S-081A-2006	Space Systems – Composite Overwrapped Pressure Vessels (COPVs)
ANSI-Z-136.1-2014	American National Standard for Safe Use of Lasers
ASTM-E595-07	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
KNPR.1860.1	KSC Ionizing Radiation Protection Program
MSFC-SPEC-1238	Thermal Vacuum Bakeout Specification for Contamination Sensitive Hardware
MSFC-SPEC-3635	Pyrotechnic System Specification
MSFC-STD-3029	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments
NASA-STD-4003	Electrical Bonding For NASA Launch Vehicles, Spacecraft, Payloads, And Flight Equipment
NASA-STD-5001B	Structural Design and Test Factors of Safety for Spaceflight Hardware
NASA-STD-5017	Design and Development Requirements for Mechanisms
NASA-STD-5018	Strength, Design and Verification Criteria for Glass, Ceramics, and Windows in Human Space Flight Applications

NASA-STD-5019	Fracture Control Requirements for Spaceflight Hardware
NASA-STD-5020 Baseline	Requirements for Threaded Fastening in Systems in Spaceflight Hardware
NASA-STD-6001	Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for materials in Environments that Support Combustion
NASA-STD-6016 Baseline	Standard Materials and Processes Requirements for Spacecraft
NASM 33540	Safety Wiring, Safety Cabling, Cotter Pinning, General Practices for
NPR 8715.3	NASA General Safety Program Requirements
SLS-PLAN-217	SLSP Exploration Mission 1 (EM-1) Secondary Payload Safety Review Process
SLS-RQMT-040	Electromagnetic Environmental Effects (E3) Requirements Material and Processes Technical Information System (MAPTIS)
SLS-SPIE-RQMT-018	Secondary Payload Interface Definition and Requirements Document
ESD 10004	Exploration Systems Development (ESD) Mishap Preparedness and Contingency Plan
ESD 10010	Exploration Systems Development (ESD) Safety and Mission Assurance (SMA) Plan
ESD 10012	Exploration Systems Development (ESD) Concept of Operations
<TBD-001>	NASA KSC Payload Ground Safety Requirements

2.2 Reference Documents

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

IEC-60825-1 Ed. 3	Safety of Laser Products - Part 1: Equipment Classification and Requirements
JSC 20793	Crewed Space Vehicle Battery Safety Requirements
SAE ARP 5412	Aircraft Lightning Environments and Related Test Waveforms
SLS-RQMT-014	Space Launch System (SLS) Program Safety and Mission Assurance (S&MA) Requirements
NPR 8621.1	NASA Procedural Requirements for Mishap and Close Call Reporting, Investigation, and Recordkeeping
NPG 8621.1	NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping

3.0 BACKGROUND

The section provides a short description of the SLS and the SLS EM-1 secondary payload accommodations.

3.1 Space Launch System

The SLS is a heavy-lift launch vehicle designed to place Exploration elements into Low Earth Orbit (LEO) for transfer to higher orbits and to evolve in capability to accommodate more complex and demanding missions. The Block 1 SLS configuration (~70 t lift mass) is comprised of a common core stage, with propulsion provided by two five-segment solid rocket boosters and four RS-25 core stage engines. For EM-1, the SLS includes payload adapters that interface with an Interim Cryogenic Propulsion Stage (ICPS) which, in turn, interfaces with the Multi-Purpose Crew Vehicle (MPCV). The portion of the vehicle between the core stage and the MPCV is referred to as the Integrated Spacecraft and Payload Element (ISPE). For EM-1, the ISPE consists of the Launch Vehicle Stage Adapter (LVSA), the MPCV Stage Adapter (MSA), and an ICPS for in-space propulsive maneuvers. Figure 3-1 illustrates the elements of the SLS Block 1 configuration.

The MSA, the structural interface between the ICPS and the MPCV, is a frustum shaped adapter constructed of machined aluminum with internal stiffeners and forged interface rings. An internal diaphragm is used to separate the exit plane of the MPCV Service Module (SM) engine nozzle and the forward end of the ICPS LH_2 tank. The MSA also has provisions for cable interface panels, access panels, and attach interfaces for electrical cabling wire harness supports.

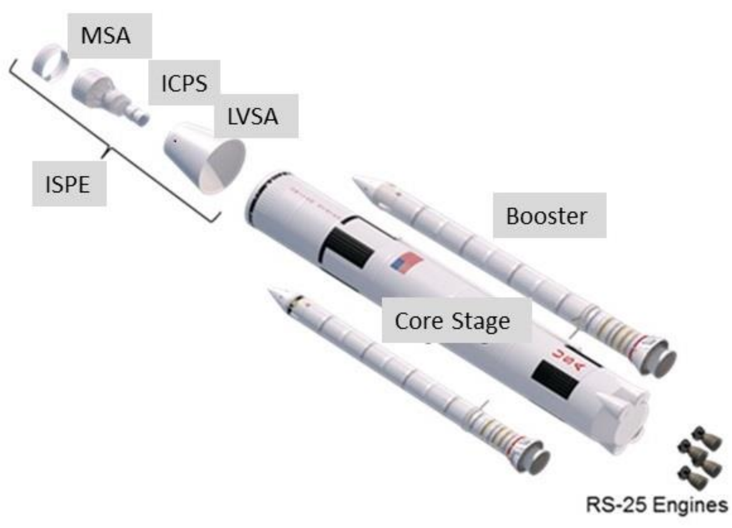

Figure 3-1. SLS Block I Configuration

3.2 SLS Secondary Payload Accommodations

The SLS EM-1 secondary payload accommodation's design provides bracket locations clocked around the inner surface of the MSA as illustrated in Figure 3-2 and Figure 3-3. The locations support a payload dispenser and a 6U payload. It is possible that at least some of these locations can support a larger 12U payload, but a 12U payload will not be flown on EM-1. One bracket location houses the payload carrier avionics unit (sequencer and battery).

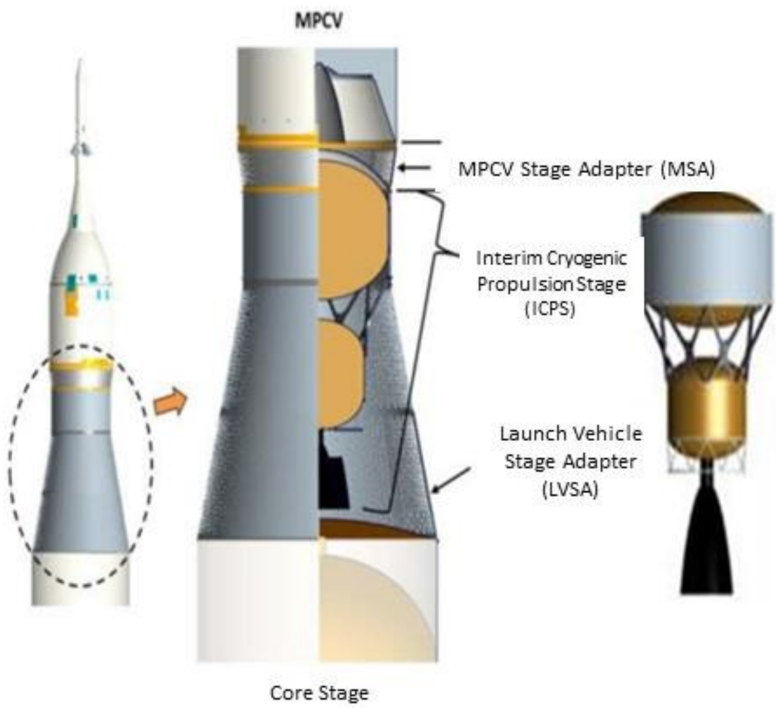

Figure 3-2. SLS Secondary Payload Location

Per ESD 10012, ESD Concept of Operations, once MSA Secondary Payload integration is complete, ground power will be provided to the MSA mounted Secondary Payload controller which will provide battery charging to individual payloads while MSA access is available in the Vehicle Assembly Building (VAB) (prior to rollout). MSA Secondary Payloads themselves will not receive any services, such as power, commanding, data, and environmental control, during GSDO ground operations (other than the ground charge power described above) after installation in the MSA or from the vehicle in flight. Concerning environmental controls, the payloads will receive the effects of the Orion / MSA shared volume purge. The payloads will not receive any supplementary environmental control beyond Orion / MSA shared volume purge. Payloads needing co-deployment from different dispenser will be restricted to a 5 second minimum delay between dispenser activations.

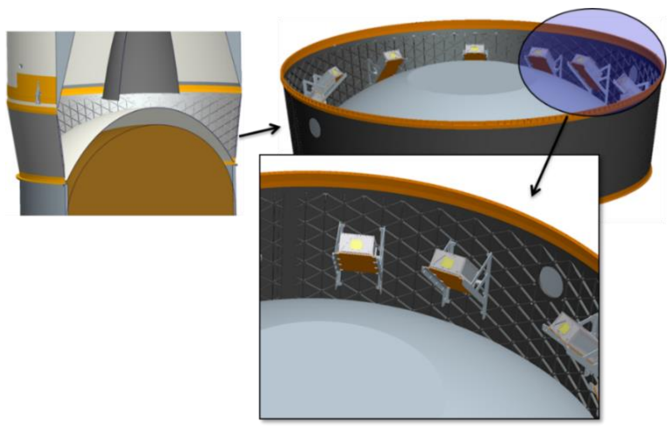

Figure 3-3. SLS Secondary Payload Dispenser Orientation

4.0 RESPONSIBILITY

4.1 Payload Developer

It is the responsibility of each payload developer to assure the safety of its secondary payload, to implement the requirements of this document, and complete the SLSP EM-1 PSRP Process in accordance with SLS-PLAN-217, SLSP Exploration Mission 1 (EM-1) Secondary Payload Safety Process Review Process.

4.2 SLS EM-1 PSRP

The SLS EM-1 PSRP has been assigned the responsibility for conducting flight safety reviews for secondary payloads as defined in SLS-PLAN-217.

4.3 SLS Program

The SLS Program maintains the technical safety requirements and safety review process requirements for SLS EM-1 secondary payloads.

4.4 Spacecraft and Payload Integration/Evolution (SPIE) Office

The SPIE Office will flow the requirements of this document and any needed additional safety requirements from GSDO, MPCV, or ESD to the payload developer.

5.0 SYSTEM PROGRAM REQUIREMENTS

5.1 Safety Analysis

A safety analysis shall be performed in a systematic manner on each SLS EM-1 secondary payload to identify hazardous subsystems and functions in accordance with SLS-PLAN-217.

5.2 Hazard Reduction

Action for reducing hazards will be conducted in the following order of precedence:

Eliminate Hazards By Design	Hazards identified in the relevant hazard analyses will be eliminated by design where possible.
Minimize Likelihood and/or Severity	If a hazard cannot be eliminated by design, the goal of the design will be to ensure inherent safety through the selection of appropriate design features. Damage control, containment, and isolation of potential hazards will be included in design considerations.
Safety Devices	Hazards which cannot be eliminated through design selection will be reduced and made controllable through the use of automatic safety devices as part of the system, subsystem, or equipment.
Warning Devices	When it is not practical to preclude the existence or occurrence of known hazards or to use automatic safety devices, devices will be employed for the timely detection of the condition and the generation of an adequate warning signal, coupled with emergency controls of corrective action for operating personnel to safe or shut down the affected subsystem. Warning signals and their application will be designed to minimize the probability of wrong signals or of improper reaction to the signal.
Special Procedures	Where it is not possible to reduce the magnitude of an existing or potential hazard through design or the use of safety and warning devices, special procedures will be developed to counter hazardous conditions for enhancement of personnel safety.

5.2-1 For SLS secondary payloads on EM-1, hazard reduction shall preclude the use of “Warning Devices” and “Special Procedures” for risk reduction of flight hazards.

5.3 Mishap/Incident/Mission Failures Investigation and Reporting

Mishap/incident/mission failures notification, investigation and reporting for post- government acceptance SLS EM-1 secondary payloads will be handled in accordance with the appropriate Mishap Preparedness and Contingency Plan (MPCP) as directed by the ESD Mishap Preparedness and Contingency Plan, ESD 10004, which invokes three different MPCPs based on location and timeframe:

a) If a mishap occurs onsite at KSC during pre-launch processing KSC-PLN-2807, The KSC Center MPCP, applies.

b) If a mishap occurs onsite at KSC during the launch window (Cryo Load through T-0) the GSDO MPCP, GSDO-PLN-1083, applies.

c) If a mishap occurs in-flight the ESD MPCP, ESD 10004, applies.

6.0 TECHNICAL REQUIREMENTS

6.1 General

The following requirements are applicable to all EM-1 secondary payloads launched on the SLS MSA. Compliance is either through design for failure tolerance or through Design For Minimum Risk (DFMR) as described on section 6.1.2.

6.1-1 When a safety requirement cannot be met, a waiver shall be submitted in accordance with SLS-PLAN-217.

6.1.1 Failure Tolerance

Failure tolerance is the basic safety requirement that will be used to control secondary payload hazards.

6.1.1-1 The secondary payload shall tolerate a minimum number of credible failures determined by the hazard level. This criterion applies when the loss of a function or the inadvertent occurrence of a function results in a hazardous event.

6.1.1.1 Critical Hazards

6.1.1.1-1 Critical hazards, as defined in A2.0, shall be one failure tolerant.

6.1.1.2 Catastrophic Hazards

6.1.1.2-1 Catastrophic hazards, as defined in A2.0, shall be two failure tolerant. Premature activation of a secondary payload is a catastrophic hazard to the vehicle unless it is shown otherwise.

6.1.2 Design for Minimum Risk (DFMR)

Secondary payload hazards may also be controlled through a process in which approved standards and margins are implemented that account for the absence of failure tolerance. This process is known as “Design for Minimum Risk.” Design for minimum risk are areas where hazards are controlled by specification requirements that specify safety-related properties and characteristics of the design that have been baselined by program requirements rather than failure tolerance criteria. For example, a pressure vessel shall be certified safe based upon its inherent properties to withstand pressure loading that have been verified by analysis and qualification and acceptance testing. However, failure tolerance must be imposed upon an external system that might affect the vessel, such as a tank heater, to assure that failures of the heater do not cause the pressure to exceed the maximum design pressure of the pressure vessel. This process is used in areas where failure tolerance is impractical or impossible due to design constraints. Failure of primary structure, structural failure of pressure vessel walls, and failure of pressurized lines are excepted from the failure tolerance requirement, provided failures are controlled through a defined process in which approved standards and margins are implemented that account for the absence of failure tolerance. Other areas where failure tolerance is impractical may be excepted from the above failure tolerance requirements with the concurrence of the PSRP. Final approval of the compliance to failure tolerance requirements and use of DFMR is documented via hazard analysis and approved as described in SLS-PLAN-217. Hazard controls related to these areas are extremely critical and warrant careful attention to the details of verification of compliance on the part of the payload developer and the SLS Program. Minimum supporting data requirements and approval for these areas of design have been identified in SLS-PLAN-217.

Note: *It should be assumed that failure tolerance is required for preventing catastrophic hazard unless there is a driving need to impose DFMR. The statement "failure of pressurized lines" is interpreted to mean structural failure of pressurized lines and welded joints due to rupture, collapse, or excessive deformation, resulting in the inability of a structure to sustain specified loads, pressures, and environments except for micro-meteoroid and orbital debris (MMOD). Other failures modes associated with pressurized lines such as blockage due to freezing or contamination, over-pressurization due to system failure, leakage through seal or non-welded interconnections, or failure or degradation due to MMOD, should not be interpreted as applicable for DFMR. The design of the primary structures, pressure vessel walls, and pressurized lines must meet approved standards and margins.*

6.1.3 Environmental Compatibility

6.1.3-1 A payload shall be certified safe in the applicable worst case natural and induced environments as defined for the MSA portion of the SLS in SLS-SPIO-SPEC-001, ISPE Design Environments Document.

6.1.4 Safe without SLS Services

6.1.4-1 Secondary payloads shall be designed to maintain failure tolerance or safety margins consistent with the hazard potential without ground crew intervention. In the event of a sudden loss or temporary interruption of provided ground services, the vehicle needs to remain safe.

6.2 Control of Hazardous Functions

6.2.1 General

Hazardous functions are operational events (e.g., motor firings, appendage deployments, stage separations, and active thermal control) whose inadvertent operations or loss may result in a hazard.

6.2.1.1 Monitors

6.2.1.1-1 SLS EM-1 Secondary Payloads shall be designed such that monitoring for safety is not required.

6.2.1.2 Use of Timers

6.2.1.2-1 When timers are used on deployable secondary payloads to control inhibits to hazardous functions, deployment of the payload from the SLS MSA shall be achieved prior to the initiation of the timer.

6.3 Specific Catastrophic Hazardous Functions

In the following subparagraphs, specific requirements related to inhibits and operations are defined for several identified potentially catastrophic hazardous functions.

6.3.1 Deployable Payloads

Premature deployment or activation of a secondary payload is a catastrophic hazard unless it is shown otherwise. The failure tolerance and inhibit requirements of Section 6.1.1.2 shall apply. Nominal deployment of a payload is not considered a hazard.

6.3.2 Radio Frequency Transmitters

Payloads will remain powered off from the time of hand over for integration at KSC until deployment. The following requirements are in place to ensure that the payload transmitter will not be a hazard to the vehicle.

6.3.2-1 Payloads shall have one Radio Frequency (RF) inhibit for power output that is less than 1.5Watt (W).

6.3.2-2 Payloads shall have two independent RF inhibits for power output equal to or greater than 1.5W.

6.3.2-3 Payloads shall delay any signal transmissions for a minimum of 15 seconds after deployment.

Rationale: Potential RF transmissions from secondary payloads during ascent prior to MPCV separation, could result in RF interference with the spacecraft.

6.3.3 Fluid Release from a Pressurized System Inside of a Closed Volume

6.3.3-1 A secondary payload containing a fluid shall be contained.

6.3.3-2 A secondary payload containing a fluid shall not damage the adjacent structure due to either over-pressurization or damage from fluid contact.

As a general rule, pressurized systems that are two fault tolerant to the release of fluid through controlled release devices do not require additional analysis beyond the analysis done for pressure system requirements. Also, pressurized systems that are two failure tolerant or designed for minimum risk to prevent leakage do not require additional analysis. The design will be assessed by the SLSP EM-1 PSRP as part of a safety review. Reference section 6.7.5.3, Chemical Releases, and sections 6.7.5.5, Flammable Materials for material requirements in the event there is a fluid release.

6.3.4 Hazardous Functions

6.3.4-1 Payloads shall be inhibited from performing any functions that could lead to a critical or catastrophic hazard to the vehicle.

6.4 Hazard Detection and Safing

There is no capability for flight controller hazard detection and safing actions for SLS EM-1 Secondary Payloads prior to deploy.

6.5 Failure Propagation

6.5-1 The design shall preclude propagation of failures from the SLS EM-1Secondary Payload to SLS systems, Orion systems, integrated vehicle or adjacent Secondary Payloads that could in turn create a hazard for adjacent SLS systems and/or Orion systems.

6.6 Redundancy Separation

6.6-1 Safety-critical redundant subsystems shall be separated by the maximum practical distance, or otherwise protected, to ensure that an unexpected event that damages one will not prevent the others from performing the safety critical function.

6.6-2 All redundant functions that are required to prevent a catastrophic or critical hazard shall be routed through separate connectors.

6.6-3 Analysis of redundant systems, subsystems or components shall consider common cause failures (e.g. contamination, common power source, etc.), to ensure that the risk of defeating redundancy is sufficiently low.

6.7 Structures

6.7.1 Structural Design

6.7.1-1 The structural design of the payload and the payload dispenser shall provide ultimate factors of safety equal to or greater than 1.4 on metallic structures or 2.0 on composite/bonded structures for all applicable SLS mission phases.

6.7.1-2 Design and testing of primary structure shall be in accordance with NASA-STD-5001, Structural Design and Test Factors of Safety for Spaceflight Hardware.

6.7.1-3 When failure of structure can result in a catastrophic event, the design shall be based on fracture control procedures to prevent structural failure arising from the initiation or propagation of flaws or crack-like defects during fabrication, testing, and service life. Requirements for fracture control are defined in NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

6.7.1-4 The use of safety critical fasteners for payload and dispenser primary structures shall be in accordance with NASA-STD-5020 “Requirements for Threaded Fastening in Systems in Spaceflight Hardware”.

6.7.1-5 Any glass or ceramics that are used in structural applications shall be in accordance with NASA-STD-5018, Strength, Design and Verification Criteria for Glass, Ceramics, and Windows in Human Space Flight Applications.

6.7.1.1 Safety Critical Fasteners

Locking refers to the locking devices and/or methods used to prevent fastener loosening. This requirement applies to any fastener or group of fasteners that, when loosening, could create a catastrophic hazard due to loss of structural integrity of the fastened joint or by release of mass or debris.

6.7.1.1-1 All safety critical fasteners shall have two separate and verifiable locking features. Preload may be used as one of the features.

6.7.1.1-2 Locking devices shall be either prevailing torque self-locking device or non-friction locking device.

6.7.1.1-3 Threaded fasteners used in joints subject to rotation shall use at least one non-friction locking device.

6.7.1.1-4 The design, installation, and inspection of non-friction locking devices such as lockwire (safety wire), safety cable, and cotter pins shall meet the requirements of NASM 33540, Safety Wiring, Safety Cabling, Cotter Pinning, General Practices for.

6.7.1.1-5 Installation procedures shall include verification of the function of the locking feature. For prevailing torque self-locking devices, verify during each installation that the running torque falls between the minimum and maximum torques specified in the appropriate fastener procurement specification. For non-friction locking devices, verify the integrity of the locking devices by visual inspection.

6.7.1.1-6 Fastener installation (preload) torque shall be specified on the engineering drawing or on an installation procedure referenced on the engineering drawing.

6.7.1.1-7 Running torque shall be similarly specified when prevailing torque self-locking devices are used.

Thread locking compounds, such as Loctite and Vibratite, may be used on safety critical fasteners with prior approval of the SLSP EM-1 PSRP provided the requirements defined in NASA-STD-5020 are met. This approval can be obtained at the Phase I, II, or III Review where the hazard reports, which utilize this method as a control, are delivered and approved.

Staking compounds may be used on safety critical fasteners with prior approval of the EM-1 PSRP provided the requirements defined in NASA-STD-5020 are met. This approval can be obtained at the Phase I, II, or III Review where the hazard reports, which utilize this method as a control, are delivered and approved. These compounds, such as epoxy or other adhesives, rely on an adhesive bond to prevent rotation of the fastener head or nut.

6.7.2 Corrosion

6.7.2-1 Materials used in the design of payload dispenser: structures, support bracketry, and mounting hardware shall be rated for resistance to Stress Corrosion Cracking (SCC) in accordance with the tables in MSFC-STD-3029, Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments, and the ratings of Materials and Processes Technical Information System (MAPTIS).

6.7.2-2 Payload provided dispensers shall utilize alloys with high resistance to SCC, unless documented in a MUA.

6.7.2-3 Provider shall obtain concurrence from PSRP on alloys utilized.

6.7.2-4 When failure of a part made from a moderate or low resistance alloy could result in a critical or catastrophic hazard, a Material Usage Agreement (MUA), which includes an assessment of the potential for a stress corrosion failure per NASA-STD-6016, Standard Materials and Processes Requirements for Spacecraft, shall be attached to the applicable stress corrosion hazard report contained in the safety assessment report.6.7.2-5 When failure of a part made from a moderate or low resistance alloy would not result in a hazard, rationale to support the non-hazard assessment shall be included in the stress corrosion hazard report.

6.7.2-6 Controls that are required to prevent SCC of components after manufacturing shall be identified in the hazard report and closure shall be documented in the verification log prior to flight.

6.7.3 Mechanisms

6.7.3-1 Mechanisms (movable mechanical systems) used in systems with the potential to result in either a critical or catastrophic hazard shall be designed to NASA-STD-5017, Design and Development Requirements for Mechanisms. It addresses the functionality (the ability to operate or the ability to retain configuration) of mechanical systems rather than their strength as a structural element or the electrical aspects of an electromechanical system.

6.7.4 Pressure Systems / Pressure Vessels

6.7.4-1 The design of pressure systems and pressure vessels for the payload shall be in accordance with NASA-STD-5001, Structural Design and Test Factors of Safety for Spaceflight Hardware, which references ANSI/AIAA S-080, Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components and ANSI/AIAA S-081, Space Systems – Composite Overwrapped Pressure Vessels (COPVs). Table 6-1 provides the overall Factors of Safety (FoS) for the design for pressure systems as derived from these documents. The following paragraphs refer back to this table and provide additional detail.

6.7.4-2 The Maximum Design Pressure (MDP) for a pressurized system shall be the highest pressure defined by maximum relief pressure, maximum regulator pressure, or maximum temperature.

6.7.4-3 Transient pressures shall be considered. Design FoS shall apply to MDP.

6.7.4-4 Where pressure regulators, relief devices, and/or a thermal control system (e.g., heaters) are used to control pressure, collectively they shall be two-failure tolerant from causing the pressure to exceed the MDP of the system. Pressure integrity will be verified at the system level.

Table 6-1. Factors of Safety for Design of Pressure Systems

FoS for Pressure			
1.	Pressurized Systems	Proof[1]	Ultimate
a.	Lines and fittings less than 1.5 inches diameter (OD)	1.5 x MDP	4.0 x MDP
b.	Lines and fittings, 1.5 inches dia. (OD) or greater	1.5 x MDP	2.5 x MDP
c.	Reservoirs/Pressure vessels	1.5 x MDP	2.0 x MDP
d.	Other components and their internal parts which are exposed to system pressure	1.5 x MDP	2.5 x MDP
e.	Flex hoses, all diameters	2.0 x MDP	4.0 x MDP
(1)	Proof Factor determined from fracture mechanics service life analysis must be used if greater than minimum factor.		

6.7.4.1Pressure Relief Capability

6.7.4.1-1 For pressurized system/vessels which may be connected to a higher pressure source where pressure regulation is used to control the MDP of the lower pressure system, at least one pressure relief device shall be provided. The pressure relief device may be a part of the two-failure tolerant design establishing MDP for the lower pressure system/vessel.

6.7.4.2 Pressure Vessels

Safety requirements for payload pressure vessels are listed in the paragraphs below with FoS as specified in Table 6-1.

6.7.4.2-1 Pressure vessel materials shall be compatible with fluids used in cleaning, test, and operation. MDP, as defined Appendix A, will be substituted for all references to Maximum Expected Operating Pressure (MEOP) in the pressure vessel standards (ANSI/AIAA S-080 and ANSI/AIAA S-081). Data requirements for pressure vessels are defined in SLS-PLAN-217.

6.7.4.2.1 Metallic Pressure Vessels

6.7.4.2.1-1 Metallic Pressure Vessels shall meet applicable sections of the pressure vessel requirements in ANSI/AIAA S-080 based on the payload design.

6.7.4.2.2 Composite Overwrapped Pressure Vessels (COPVs)

6.7.4.2.2-1 COPVs shall meet applicable sections of the pressure vessel requirements in ANSI/AIAA S-081 based on the payload design. A damage control plan and stress rupture life assessment are required for each COPV.

6.7.4.3 Pressure Stabilized Vessels

6.7.4.3-1 Pressure Stabilized Vessels shall not be used on SLS EM-1 Secondary Payloads.

6.7.4.4 Pressurized Lines, Fittings, and Components

6.7.4.4-1 Pressurized Lines, Fittings, and Components shall have an ultimate FoS as defined in Table 6-1.

6.7.4.4-2 Secondary compartments or volumes that are integral or attached by design to the above parts and which can become pressurized as a result of a credible single barrier failure shall be designed for safety consistent with structural requirements.

6.7.4.4-3 These compartments shall have a minimum FoS as defined in Table 6-1.

6.7.4.4-4 If external leakage would not present a catastrophic hazard to the SLS, the secondary volume shall either be vented or equipped with a relief provision in lieu of designing for system pressure.

6.7.4.5 Burst Discs

When burst discs are used as the second and final control of pressure (2 controls total) to meet the requirements of Section 6.7.4, they shall be designed to the following requirements:

6.7.4.5-1 Burst discs shall incorporate a reversing membrane against a cutting edge to insure rupture.

6.7.4.5-2 Burst disc design shall not employ sliding parts or surfaces subject to friction and/or galling.

6.7.4.5-3 Stress corrosion resistant materials shall be used for all parts under continuous load.

6.7.4.5-4 The burst disc design shall be qualified for the intended application by testing at the intended use conditions including temperature and flow rate.

Qualification will be for the specific part number used, and it will be verified that no design or material changes exist between flight assemblies and assemblies making up the qualification database.

6.7.4.5-5 Each flight assembly shall be verified for membrane actuation pressure either by, (1) use of special tooling or procedures to prevent cutting-edge contact during the test or, (2) demonstration of a rigorous lot screening program approved by the EM-1 PSRP.

Burst disks must be assessed for where they vent to assure they do not impinge on critical hardware or vent to an enclosed container that might over pressurize.

6.7.4.5-6 When venting outside of the payload container while in the vehicle, this shall require SLS integration and PSRP assessment.

6.7.4.6 Sealed or Vented Containers

6.7.4.6-1 Secondary payload sealed containers shall be designed to withstand the maximum pressure differential created by SLS ascent (15.2 psia for items exposed to directly to vacuum).

6.7.4.6-2 Vented containers shall size vent flow areas such that structural integrity is maintained with a minimum FoS of 1.4 on metallic structures or 2.0 on composite/bonded structures for a depress rate of 0.15 psi/sec (9 psi/min).

6.7.4.7 Relief Valves

6.7.4.7-1 The relief valve design shall be qualified, per NASA-STD-5017, for the intended application.

6.7.4.7-2 The verification approach shall be documented in the hazard analysis.

6.7.5 Materials

A listing of materials (both metals and nonmetals) with a "rating" indicating acceptability for each materials characteristic is available electronically in the NASA MSFC MAPTIS.

6.7.5-1 Materials and processes shall be in accordance with NASA-STD-6016. For materials which create potential hazardous situations as described in the paragraphs below and for which no prior NASA test data or rating exists.

6.7.5-2 The payload developer shall present other test results for SLS Program review or request assistance from the MSFC in conducting applicable tests. The payload material requirements for hazardous materials, flammability, and offgassing are as follows:

6.7.5.1 Hazardous Materials

6.7.5.1-1 Hazardous materials shall be contained during ground processing.

6.7.5.1-2 Hazardous materials shall not be released or ejected in or near the SLS, unless such release/ejection has been negotiated with the Program.

6.7.5.1-3 During exposure to all SLS environments, hazardous fluid systems shall contain the fluids unless the use of the SLS vent/dump provisions has been negotiated with the SLS Program.

6.7.5.1-4 Toxic or hazardous chemicals/materials shall have failure tolerant containment appropriate with the hazard level or be contained in an approved pressure vessel.

A list of all hazardous materials (including hazardous fluids, chemicals, and biological materials) along with a corresponding Material Safety Data Sheet (MSDS) will be provided to the SLSP EM-1 PSRP for review and acceptance of use through the hazard report endorsement. Payloads should expect to provide this information to the GSDO SMA prior to shipment of the hardware to KSC per requirements of GSDO **<TBD-001>**.

6.7.5.2 Fluid Systems

Particular attention will be given to materials used in systems containing hazardous fluids. These hazardous fluids include gaseous oxygen, liquid oxygen, fuels, oxidizers, and other fluids that could chemically or physically degrade the system or cause an exothermic reaction.

6.7.5.2-1 Those materials within the system exposed to oxygen (liquid and gaseous) or other hazardous fluids, both directly and by a credible single barrier failure, shall meet the requirements of NASA-STD-6001, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for materials in Environments that Support Combustion, at MDP and temperature. The payload supplier's compatibility data on hazardous fluids may be used to accept materials in this category if approved by the SLS Program.

6.7.5.3 Chemical Releases

6.7.5.3-1 Any chemical whose release would create a toxicity hazard or cause a hazard to SLS hardware shall be contained. Mercury is an example of such a chemical, since it produces toxic vapors and can amalgamate with metals or metal alloys used in spacecraft hardware.

6.7.5.3-2 Containment shall be provided by an approved pressure vessel as defined in section 6.7.4 or the use of two or three redundantly sealed containers, depending on the toxicological hazard for a chemical with a vapor at any positive pressure.

6.7.5.3-3 The payload developer shall assure that each level of containment will not leak under the maximum use conditions (i.e., vibration, temperature, pressure, etc.).

6.7.5.3-4 Documentation of chemical usage, along with the containment methods, shall be supplied for review and endorsement.

6.7.5.4 Biological Materials

6.7.5.4-1 Any biological material to be flown on a secondary payload shall be limited to Biosafety Level – (BSL-1), will be reviewed and approved by the SLSP EM-1 PSRP.

6.7.5.4-2 Any biological material to be flown on a secondary payload shall be loaded and sealed in its container prior to shipment of the payload hardware to KSC.

6.7.5.4-3 Containment shall be provided by approved pressure vessel or a container with a certified single level of containment as approved by the SLS EM-1 PSRP.

6.7.5.5 Flammable Materials

6.7.5.5-1 A secondary payload shall not constitute an uncontrolled fire hazard to the SLS or other secondary payloads.

6.7.5.5-2 The minimum use of flammable materials shall be the preferred means of hazard reduction.

6.7.5.5-3 The determination of flammability shall be in accordance with NASA-STD-6001.

6.7.5.5-4 Materials used in non-pressurized areas shall be evaluated for flammability in an air environment at 14.7 psi.

6.7.5.5-5 A flammability assessment shall be documented in accordance with the SLS EM-1 PSRP Process.

6.7.6 Material Offgassing

6.7.6-1 Non-metallic materials shall be selected in order to avoid producing toxic levels of off-gassed products in order to protect ground personnel during ground processing per NASA-STD-6016.

6.7.6-2 Non-metallic materials with no test data in the MAPTIS database shall either require a Materials Usage Agreement (MUA) or off-gas testing as specified in NASA-STD-6001.

6.7.7 Material Outgassing

6.7.7-1 Low outgassing materials shall be selected in order to prevent contamination of adjacent payloads and SLS hardware which may be sensitive to outgassing. Materials with no test data in the MAPTIS database will require an MUA, or testing in accordance with ASTM-E595-07, Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment. Untested or unidentified materials may use thermal vacuum bakeout of the assembled article per MSFC-SPEC-1238, Thermal Vacuum Bakeout Specification for Contamination Sensitive Hardware, for safety verification.

6.8 Pyrotechnics

A list of all pyrotechnic devices, their location, strength, and their proposed use will be provided to SLSP EM-1 PSRP.

6.8-1 If premature firing or failure to fire will cause a hazard, the pyrotechnic subsystem and devices shall meet the design and test requirements of MSFC-SPEC-3635, Pyrotechnic System Specification.

6.9 Radiation

6.9.1 Ionizing Radiation

6.9.1-1 Secondary payloads containing or using radioactive materials or that generate ionizing radiation shall be identified and approval obtained for their use by the SLS EM-1 PSRP.

6.9.1-2 Descriptive data shall be provided in accordance with the SLSP EM-1 PSRP Process. Any radioactive materials flown aboard SLS must be reported to the SLS Program in accordance with NPR 8715.3, NASA General Safety Program Requirements. Major radioactive sources require approval by the Interagency Nuclear Safety Review Panel through the NASA coordinator for the panel.

6.9.1-3 Radioactive materials shall comply with KSC requirements contained in ANSI-Z-136.1, American National Standard for Safe Use of Lasers and KNPR 1860.1, KSC Ionizing Radiation Protection Program.

6.9.2 Emissions and Susceptibility

1. Electronic emissions from secondary payloads are controlled by requiring the payload to remain powered off until deployment (see RF transmissions under section 6.3.2).
2. Demonstrate that the payload is not susceptible to the electronic emission environment as defined in SLS-RQMT-040, Electromagnetic Environmental Effects (E3) Requirements, and shall not result in inadvertent operation of payload functions.

6.9.3 Lasers

6.9.3-1 A list of all lasers and their proposed use shall be provided to the SLSP EM-1 PSRP. Payloads should expect to provide this information to the GSDO SMA prior to shipment of the hardware to KSC.
6.9.3-2 Any lasers that can be accessed during ground processing shall be designed and operated in accordance with American National Standard for Safe Use of Lasers, ANSI-Z-136.1.

6.10 Electrical Systems

6.10.1 General

6.10.1-1 Electrical power distribution circuitry shall be designed to include circuit protection devices to protect against circuit damage normally associated with an electrical fault when such a fault could result in damage to the SLS. Bent pins or conductive contamination in an electrical connector will not be considered a credible failure mode if a post mate functional verification is performed to assure that shorts between adjacent connector pins or from pins to connector shell do not exist.
6.10.1-2 If this test cannot be performed, then the electrical design shall ensure that any pin if bent prior to or during connector mating cannot invalidate more than one inhibit and that conductive contamination is precluded by proper inspection procedures.

6.10.2 Batteries

6.10.2-1 Batteries used on secondary payloads shall be designed to control applicable hazards caused by buildup or venting of flammable, corrosive or toxic gasses and reaction products; the expulsion of electrolyte, and by failure modes of over-temperature, shorts, reverse current, cell reversal, leakage, cell grounds, and overpressure.
6.10.2-2 For batteries meeting the criteria of SLS-SPIE-RQMT-018, SPIE Secondary Payload Interface Definition and Requirements Document (IDRD), the payload shall provide lot testing per Appendix D of SLS-SPIE-RQMT-018.
6.10.2-3 All other batteries used on secondary payloads shall be designed in accordance with JSC 20793, Revision C, Crewed Space Vehicle Battery Safety Requirements.

6.10.3 Lightning

Payload electrical circuits may be subjected to the electromagnetic fields due to a lightning strike to the launch pad.

6.10.3-1 If circuit upset could result in a catastrophic hazard to the SLS, the circuit design shall be hardened against the environment or insensitive devices (relays) shall be added to control the hazard. In order to maintain operational performance requirements, secondary payloads should be designed to withstand a nearby lightning strike as defined by SAE ARP 5412, Aircraft Lightning Environments and Related Test Waveforms, with a peak current amplitude of 200kA that terminates to ground 157 meters away from the pad centerline.

6.11 Verification

Test, analysis, inspection, validation of records and demonstration, as appropriate, will be the methods used for verification of design features used to control potential hazards. The successful completion of the safety process will require positive feedback of completion results for all verification items associated with a given hazard. Reporting of results by procedure/report number and date is required. See SLS-SPIE-RQMT-018 for further details on verification methods.

A payload safety verification tracking log (SVTL) is required to properly status the completion steps associated with hazard report verification items (see SLS-PLAN-217).

6.12 Hazardous Operations

6.12-1 The payload developer shall assess all secondary payload flight operations and determine their hazard potential to the SLS.

6.12-2 The hazardous operations identified shall be assessed in the applicable flight safety assessment report.

6.12-3 Secondary payloads shall be designed such that any required access to hardware during ground operations can be accomplished with minimum risk to personnel.

6.13 Payload Commanding

Commanding of secondary payloads prior to deployment is prohibited.

6.14 Flammable Atmospheres

6.14-1 During the ascent phase, secondary payloads shall not cause ignition of a flammable atmosphere that may be present in the MSA. The basic assumption is that there is a flammable atmosphere inside the MSA during ascent and the control philosophy is for payload design to ensure that there is no electrical ignition source due to payload electronics or electrostatic discharge during ascent.

The payload design shall meet the following requirements:

6.14-2 Payloads shall be powered off from the time of hand over for integration at KSC until deployment.

6.14-3 Conductive surfaces (including metalized Multilayer Insulation (MLI) layers) shall be electrostatically bonded per the requirements of a Class R bond as documented in NASA-STD-4003, Electrical Bonding For NASA Launch Vehicles, Spacecraft, Payloads, And Flight Equipment.

APPENDIX A
ACRONYMS AND ABBREVIATIONS
AND GLOSSARY OF TERMS

A1.0 ACRONYMS AND ABBREVIATIONS

BSL-1	Biosafety Level 1
COPV	Composite Overwrap Pressure Vessel
CR	Change Request
DFMR	Design for Minimum Risk
EM-1	Exploration Mission -1
ESD	Exploration Systems Development
FoS	Factor of Safety
GSDO	Ground Systems Development and Operations
GSE	Ground Support Equipment
ICPS	Interim Cryogenic Propulsion Stage
ISPE	Integrated Spacecraft and Payload Element
KSC	Kennedy Space Center
LEO	Low Earth Orbit
LVSA	Launch Vehicle Stage Adapter
MAPTIS	Materials and Processes Technical Information System
MDP	Maximum Design Pressure
MEOP	Maximum Expected Operating Pressure
MLI	Multilayer Insulation
MPCP	Mishap Preparedness and Contingency Plan
MPCV	Multi-Purpose Crew Vehicle
MSA	MPCV Stage Adapter
MSDS	Material Safety Data Sheet
MUA	Materials Usage Agreement
OPR	Office of Primary Responsibility
PCB	Program Control Board
PSRP	Payload Safety Review Panel
RF	Radio Frequency
SCC	Stress Corrosion Cracking
SEMP	System Engineering Management Plan
SLS	Space Launch System
SM	Service Module

SMA	Safety and Mission Assurance
SPDS	Secondary Payload Deployment System
SPIE	Spacecraft/Payload Integration and Evolution
SVTL	Safety Verification Tracking Log
VAB	Vehicle Assembly Building
W	Watt

A2.0 GLOSSARY OF TERMS

Term	Description
Brittle Fracture	Brittle fracture is a type of catastrophic failure in structural materials that usually occurs without prior plastic deformation and at extremely high speed. The fracture is usually characterized by a flat fracture surface with little or no shear lips (slant fracture surface) and at average stress levels below those of general yielding.
BSL - 1	Biosafety Level 1 is a designation provided by the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH) for well-characterized agents not known to consistently cause diseases in healthy adults, and of minimal potential hazard to laboratory personnel and the environment.
Catastrophic Hazard	Personnel: Loss of life or permanently disabling injury. Facilities, Equipment, Assets: Loss of vehicle prior to completing its mission, or loss of essential flight/ground assets
Class B Ordnance	Explosives function by rapid combustion rather than by detonation.
Components	Components for purposes of pressure systems, are all elements of a pressurized system.
Composite Overwrapped Pressure Vessel	A pressure vessel with a composite structure fully or partially encapsulating a metallic or plastic liner. The liner serves as a fluid (gas or liquid) permeation barrier and may or may not carry substantive pressure loads. The composite generally carries pressure and environmental loads.
Controls	A device or function that operates an inhibit is referred to as a control for an inhibit. Controls do not satisfy the inhibit or failure tolerance requirements for hazardous functions.
Critical Hazard	Personnel: Injury or occupational illness requiring definitive/specialty hospital/medical treatment resulting in loss of mission. Facilities, Equipment, Assets: Loss of ESD mission, condition that requires safe-haven, or major damage to essential flight/ground assets

Term	Description
Design for Minimum Risk	Design for minimum risk are areas where hazards are controlled by specification requirements that specify safety related properties and characteristics of the design that have been baselined by program requirements rather than failure tolerance criteria. For example, a pressure vessel shall be certified safe based upon its inherent properties to withstand pressure loading that have been verified by analysis and qualification and acceptance testing; however, failure tolerance must be imposed upon an external system that might affect the vessel, such as a tank heater, to assure that failures of the heater do not cause the pressure to exceed the maximum design pressure of the pressure vessel.
Electromagnetic Emissions	Electromagnetic energy radiated or conducted from an electrical or electronic component, equipment, subsystem, system, or flight element.
Electromagnetic Susceptibility	Equipment capability for impaired performance due to electric or magnetic environments (radiated or conducted).
Factor Of Safety	The factor by which the limit load is multiplied to obtain the ultimate load. The limit load is the maximum anticipated load or combination of loads, which a structure may be expected to experience. Ultimate load is the load that a payload must be able to withstand without failure.
Failure Tolerance	The number of failures that can occur in a system or subsystem without the occurrence of a hazard. Single failure tolerance would require a minimum of two failures for the hazard to occur. Two-failure tolerance would require a minimum of three failures for a hazard to occur
Fittings	In pressure systems, fittings are local elements of a pressurized system utilized to connect lines, components and/or vessels within the system.
Fracture Control	Fracture control is a set of policies and procedures involving the application of analysis and design methodology, manufacturing technology and operating procedures to prevent structural failure due to the initiation of and/or propagation of flaws or crack-like deflects during fabrication, testing, and service life
Fracture Critical Fastener	A fastener is classified as fracture critical when failure of one fastener results in a single-point direct catastrophic failure.
Independent Inhibit	Two or more inhibits are independent if no single credible failure, event, or environment can eliminate more than one inhibit.
Inhibits	An inhibit is a design feature that provides a physical interruption between an energy source and a function (a relay or transistor between a battery and a pyrotechnic initiator, a latch valve in the plumbing line between a propellant tank and a thruster, etc.).

Term	Description
Leak Before Burst	A fracture mechanics design concept in which it is shown that any initial flaw will grow through the wall of a pressure vessel and cause leakage rather than burst (catastrophic failure)
Lines	Lines are tubular elements of a Pressurized system provided as a means for transferring fluids between components of the system. Included in this definition are flex hoses.
Maximum Design Pressure	The MDP for a pressurized system shall be the highest pressure defined by maximum relief pressure, maximum regulator pressure, or maximum temperature.MDP is equivalent to Maximum Expected Operating Pressure (MEOP).
Monitoring	The ability to ascertain and communicate the status of functions, devices, inhibits and parameters. Monitoring can be either real-time or on a periodic basis.
Non-friction Locking Device	An all-metal mechanical device that is used to prevent the movement of an externally and/or internally threaded part. Examples of these devices are lockwire, safety cable and cotter pins. This device would have to shear before the fastener(s) could unthread. Non-friction locking devices are verifiable by visual inspection.
Pressure Stabilized Vessels	Pressure vessels which are pressure-stabilized and must contain a minimum pressure to maintain the required ultimate factors of safety to insure structural integrity under launch loads.
Pressure Vessel	A pressure vessel is a component of a pressurized system designed primarily as a container that stores pressurized fluids and: a. Contains stored energy of 14,240 foot-pounds (19,310 joules or 0.01 pounds trinitrotoluene (TNT) equivalent) or greater based on adiabatic expansion of a perfect gas; or b. Will experience a design limit pressure greater than 100 psia; or c. Contains a fluid in excess of 15 psia which will create a hazard if released.
Pressurized System	A pressurized system, as addressed in this document, comprises the pressure vessels or pressurized structure, lines, fittings, valves, etc., that are exposed to and designed by the pressure within these components. It does not include electrical control devices, etc., required to operate the system.
Prevailing Torque Self-Locking Device	A mechanical device that prevents fastener loosening by increasing the friction between the male and female threads. Prevailing torque self-locking devices are verifiable by measurement of running torque during assembly, also called “self-locking device”.

Term	Description
Primary Structure	That part of a flight vehicle or payload which sustains the significant applied loads and provides main load paths for distributing reactions to applied loads. Also the main structure which is required to sustain the significant applied loads, including pressure and thermal loads, and which if it fails creates a catastrophic hazard. If a component is small enough and in an environment where no serious threat is imposed if it breaks, then it is not primary structure.
Proof Pressure	The proof pressure is the test pressure that pressurized components shall sustain without detrimental deformation. The proof pressure is used to give evidence of satisfactory workmanship and material quality, and/or establish maximum initial flaw sizes. It is equal to the product of MDP and proof pressure design factor.
Pyrotechnic Device	All devices and assemblies containing or actuated by propellants or explosives, with the exception of large rocket motors. Pyrotechnic devices include items such as initiators, igniters, detonators, safe and arm devices, booster cartridges, pressure cartridges, separation bolts and nuts, pin pullers, linear separation systems, shaped charges, explosive guillotines, pyrovalves, detonation transfer assemblies (mild detonating fuse, confined detonating cord, confined detonating fuse, shielded mild detonating cord, etc.), thru bulkhead initiators, mortars, thrusters, explosive circuit interrupters, and other similar items.
Running Torque	The torque required to overcome the locking feature when 100 percent of the locking feature is engaged and the fastener is unseated Running torque is dynamic and can be measured in either the loosening or tightening direction, also known as the locking torque or self-locking torque.
Safety Critical	A condition, event, operation, process, function, equipment, or system (including software and firmware) with potential for personnel injury or loss, or with potential for loss or damage to vehicles, equipment or facilities, loss or excessive degradation of the function of critical equipment, or which is necessary to control a hazard.
Safety Critical Fastener	A fastener, or group of fasteners, is considered to be performing a safety critical function if the loss of that fastener, or group of fasteners could result in a catastrophic hazard including the generation of Foreign Object Damage/Debris (FOD).
Sealed Container	A housing or enclosure designed to retain its internal atmosphere and which does not meet the pressure vessel definition (e.g., an electronics housing).
Secondary Structure	The internal or external structure which is used to attach small components, provide storage, and to make either an internal volume

Term	Description
	or external surface usable. Secondary structure attaches to and is supported by primary structure
Stress-Corrosion Cracking	Stress-corrosion cracking is a mechanical-environmental induced failure process in which sustained tensile stress and chemical attack combine to initiate and propagate a flaw in a metal part.
Structure	all components and assemblies designed to sustain loads or pressures, provide stiffness and stability, or provide support or containment
Vented Container	An enclosure which is not intentionally sealed or is provided with vents such that it will not create a hazard in the event of depressurization or repressurization of the surrounding volume.

APPENDIX B
OPEN WORK

All resolved TBDs, TBRs, and forward work items should be listed on the Change Request (CR) the next time the document is updated and submitted for formal review, and that will serve as the formal change record through the configuration management system.

B1.0TO BE DETERMINED

Table B1-1 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 carets. The TBD item is sequentially numbered as applicable (i.e., **<TBD-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-001	1.2, 2.1, 6.7.5.1,	The document for KSC payload and cargo ground safety requirements is in development by another program and a referenced number is required.