

National Aeronautics and  
Space Administration

**SLS-PLAN-186**

**REVISION A**

**EFFECTIVE DATE: MAY 2, 2013**

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**SPACE LAUNCH SYSTEM (SLS)  
PROGRAM AGREEMENT DOCUMENT (PAD)**

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### REVISION AND HISTORY PAGE

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**NOTE:** Updates to this document, as released by numbered changes (Change XXX), are identified by a black bar on the right margin.

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## **1.0 INTRODUCTION**

### **1.1 Scope and Applicability**

The Program Agreements Document (PAD) documents agreements on task scope where specific agreements are needed for Program Implementation. These agreements augment the Program Scope approved by the SLS Program Control Board (PCB) or Chief Engineer's Control Board (CECB) directive for incorporation into other Category 1 data items listed in SLS-RQMT-018, Space Launch System Program (SLSP) Data Requirements Lists (DRL). It also captures SLSP implementation of scope from cross-program tasks that flow to the SLSP from Exploration Systems Development (ESD) or Cross-Program Control Board decisions where they do not flow directly into other SLSP documents. The glossary of this document also establishes common definitions to be used within SLS. This document applies to the SLS Program and Element Baselines.

### **1.2 Change Authority/Responsibility**

The NASA Office of Primary Responsibility (OPR) for this document is EV01. Proposed changes to this document will be submitted by an SLS Program change request (CR) to the SLS PCB for disposition. All such requests will adhere to the SLS-PLAN-008, SLSP Configuration Management Plan.

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## 2.0 DOCUMENTS

### 2.1 Applicable Documents

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. The documents listed in this paragraph are applicable to the extent specified herein.

BEA P2P00002 (Draft)	Space Launch System (SLS)/Multi-Purpose Crew Vehicle (MPCV) Bilateral Exchange Agreement (BEA)
BEA P2P00003	SLS-GSDO Bi-lateral Exchange Agreement in Support of Program-to-Program Delivery of Models and Emulators
SLS-ICD-021	Space Launch System Program (SLSP) Core Stage (CS) to Booster Interface Control Document (ICD)
SLS-ICD-029	Space Launch System Program (SLSP) Stages to Integrated Spacecraft and Payload Element (ISPE) Interface Control Document (ICD)
SLS-ICD-031	Space Launch System to Communications and Tracking Network (CTN) Interface Control Document (ICD)
SLS-ICD-039-01	Space Launch System Program (SLSP) Stages to Engine(s) Interface Control Document (ICD), Volume 1: Core Stage to Core Stage Engine(s)
SLS-ICD-052-01	Space Launch System Program (SLSP)-to-Ground Systems Development and Operations Program (GSDOP) Interface Control Document (ICD), Volume 1: Functional Interface Definition & SLSP Integrated Vehicle-to-GSDOP Detailed Design
SLS-ICD-052-02 (Baseline Pending)	Space Launch System Program (SLSP)-to-Ground Systems Development and Operations Program (GSDOP) Interface Control Document (ICD), Volume 2: SLS Booster-to-GSDOP Detailed Design
SLS-ICD-052-03 (Baseline Pending)	Space Launch System Program (SLSP)-to-Ground Systems Development and Operations Program (GSDOP) Interface Control Document (ICD), Volume 3: SLS Core Stage-to-GSDOP Detailed Design

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SLS-ICD-052-04 (Baseline Pending)	Space Launch System Program (SLSP)-to-Ground Systems Development and Operations Program (GSDOP) Interface Control Document (ICD), Volume 4: SLS Integrated Spacecraft and Payload Element (ISPE)-to-GSDOP Detailed Design
SLS-ICD-052-05 (Baseline Pending)	Space Launch System Program (SLSP)-to-Ground Systems Development and Operations Program (GSDOP) Interface Control Document (ICD), Volume 5: SLS to GSDOP Command and Data Handling (C&DH) Detailed Design
SLS-ICD-176	SLSP SLS-to-Mission Systems Interface Control Document (ICD)
SLS-PLAN-008	Space Launch System Program Configuration Management Plan
SLS-RPT-183 (Release Pending)	Space Launch System Program (SLSP) Evolvability Report
SLS-RQMT-045	Space Launch System Program (SLSP) Vehicle Design Environments Integrated Vehicle Loads
SLS-SCHE-164	Space Launch System Program (SLSP) Systems Engineering and Integration (SE&I) Control Milestones
SLS-SPEC-032	Space Launch System Program (SLSP) System Specification
SLS-SPEC-044-02	Space Launch System Program (SLSP) Vehicle Design Environments Volume 2: External Thermal
SLS-SPEC-044-03	Space Launch System Program (SLSP) Vehicle Design Environments Volume 3: Interface and Shared Compartment Thermal
SLS-SPEC-044-04	Space Launch System Program (SLSP) Vehicle Design Environments Volume 4: Acoustic
SLS-SPEC-044-05	Space Launch System Program (SLSP) Vehicle Design Environments Volume 5: Vibroacoustics and Shock
SLS-SPEC-044-06	Space Launch System Program (SLSP) Vehicle Design Environments Volume 6: Shared Compartment Venting
SLS-SPEC-044-08	Space Launch System Program (SLSP) Vehicle Design Environments Volume 8: Abort Environments

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SLS-SPEC-044-09      Space Launch System Program (SLSP) Vehicle Design  
Environments Volume 9: Debris

STG-AV-0002      Space Launch System (SLS) Program SLS Stages to Elements  
Command and Data Handling (C&DH) Document

## 2.2 Reference Documents

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

GSDO-MVVP-1042-02      Ground Systems Development and Operations (GSDO) Master  
(Baseline Pending)      Verification and Validation Plan, Volume 2: GSDO Program  
Verification and Validation Plan

GSDO-PLN-1070      Cross-Program Integrated Logistics Plan  
(Baseline Pending)

SLS-PLAN-009      Space Launch System Program (SLSP) Verification & Validation  
(Release Pending)      Plan

SLS-PLAN-025      Space Launch System Program (SLSP) Integrated Logistics Support  
(Release Pending)      Plan

SLS-PLAN-065      Space Launch System Program (SLSP) Integrated Avionics Test  
Facilities (IATF) Development Plan

SLS-PLAN-093      Space Launch System Program (SLSP) Sustaining Engineering Plan  
(Release Pending)

SLS-PLAN-099      Space Launch System Program (SLSP) Integration Plan  
(Release Pending)

SLS-PLAN-100      Space Launch System Program (SLSP) Flight Evaluation Plan  
(Release Pending)

SLS-PLAN-116      Space Launch System Program (SLSP) Test Plan  
(Release Pending)

SLS-PLAN-130      Space Launch System Program (SLSP) Avionics Integration and Test  
Plan

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SLS-PLAN-137	Space Launch System Program (SLSP) Integrated Avionics Test Facilities (IATF) Verification, Validation, and Accreditation (VV&A) Plan
SLS-PLAN-171 (Release Pending)	Space Launch System Program (SLSP) Materials and Processes (M&P) Selection, Control, and Implementation Plan
SLS-PLAN-180	Space Launch System Program (SLSP) Risk and Opportunity Management Plan
SLS-PLAN-181 (Release Pending)	Space Launch System Program (SLSP) Mission Operations Plan
SLS-RQMT-018	Space Launch System Program Data Requirements List

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### **3.0 <TBD-001>**

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## 4.0 INTEGRATED DEVELOPMENT AGREEMENTS

The agreements captured in the following subsections are those made across organizations within the SLSP and those made with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-099, SLSP Integration Plan.

### 4.1 SE&I

1. SE&I will conduct three Design and Analysis Cycles (DACs), one Verification Analysis Cycle (VAC), and one Flight Readiness Analysis Cycle as part of Block 1 vehicle development.
2. SE&I Structures and Environments (STE) will provide the integrated vehicle finite element models (FEM) for DAC-1, DAC-2, DAC-3, and the VAC to the SLS, Orion Multi-Purpose Crew Vehicle (MPCV), and Ground Systems Development and Operations (GSDO) Programs per the schedule milestones in SLS-SCHE-164, SLSP Systems Engineering and Integration (SE&I) Control Milestones.
3. SE&I Integrated Avionics and Software (IAS) will deliver these defined flight software (FSW) products on the milestones defined in SLS-SCHE-164:
  - a. Developmental drops of flight computer FSW and associated configuration data to the Stages Element avionics contractor and the Systems Integration Test Facility (SITF)/System Integration Laboratory (SIL) in support of avionics development and integration activities.
  - b. Verified releases of flight computer FSW and associated configuration data to the Stages Element avionics contractor and the SITF/SIL in support of Stages element-level and SLS vehicle-level avionics systems integration and informal/formal test activities.
  - c. Formally verified/validated releases of flight computer FSW and associated configuration data to Stages for loading on SLS flight systems prior to shipment of the core stage to Kennedy Space Center (KSC), including any software required for testing at Stennis Space Center (SSC).
4. SE&I (IAS) will provide models and emulators of the SLS vehicle and environments to GSDO and Orion MPCV as part of external system integration and verification testing activities as defined in Bilateral Exchange Agreement (BEA) P2P00003, SLS/GSDO Support of Program-to-Program Delivery of Models and Emulators, and BEA P2P00002, SLS/MPCV Bilateral Exchange Agreement <**TBR-002**>.
  - a. SE&I (IAS) will integrate the Interim Cryogenic Propulsion Stage (ICPS) emulator with the SLS vehicle emulator before providing to Orion MPCV.
5. SE&I (IAS) will provide an SLS emulator to Booster on the milestones defined in SLS-SCHE-164.

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6. SE&I (IAS) will provide SLS SIL ascent simulations, test cases, and results to the Spacecraft and Payload Integration Office (SPIO) Element to support performance of integrated ICPS Software Integration Lab (ICPS SIL) testing of the in-space phase of the SLS mission on the milestones defined in SLS-SCHE-164.
7. SE&I Vehicle Management (VM) will deliver in-space phase mission design and guidance, navigation and control (GN&C) parameters to be loaded on the ICPS for the ICPS SIL tests and actual SLS flights on the milestones defined in SLS-SCHE-164.
8. SE&I (STE) will provide external thermal environments to SLS and Orion MPCV based on three external thermal environments tests.
  - a. ATA-001 will establish a precise wind tunnel to flight scaling method for aerodynamic heating data.
  - b. STE will develop aerodynamic heating models using the results from ATA-001 and past and future wind tunnel data.
  - c. ATA-002 will verify the predicted overall levels of convective base heating and provide detailed data for the vehicle base, aft side wall, and engine/motor nozzle areas. ATA-002 is divided into pathfinder and main portions.
    - i. The pathfinder portion of ATA-002 will verify model design approaches, including the propellant delivery system.
    - ii. The pathfinder portion of ATA-002 will have similar core and booster aft configurations and nozzle profiles as the SLS-10003 vehicle.
    - iii. The main portion of ATA-002 will use the actual SLS vehicle outer mold line (OML) and free stream flow conditions to measure the scaled aerothermal environments.
  - d. ATA-003 will measure aerodynamic heating on critical areas of the vehicle using the final SLS Vehicle OML. If possible, ATA-003 will be combined with the main portion of ATA-002.
9. SE&I (STE) will generate liftoff acoustic environments for GSDO, SLS, and Orion MPCV by completing Scale Model Acoustic Tests (SMATs) that simulate multiple elevations of the climb-out trajectory.
  - a. The SMAT configuration will use a scale replica of the KSC Mobile Launcher (ML), launch tower, SLS flame deflector, and launch pad trench.
  - b. The SMAT configuration will include a scale replica of water sound suppression systems for ignition-overpressure and a scale replica of an above-deck rain bird system.

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## 4.2 Multiple Elements

1. The Elements will support the maturation process of the Design Loads (SLS-RQMT-045, SLSP Vehicle Design Environments Integrated Vehicle Loads) and Design Environment (SLS-SPEC-044, SLSP Vehicle Design Environments) by applying the Baseline Loads and Environments to their designs and reporting to SE&I (STE), via the Joint Loads Task Team, where the loads and environments exceed the current design capability or where loads and environments lack adequate detail to proceed with design. When requested, the Elements will provide rough order of magnitude (ROM) cost and schedule impacts to address these exceedances. In addition, the Elements will assess future DAC loads and environments to determine if these loads and environments would reduce exceedances or introduce new exceedances in the event that any of these DAC cases are adopted as updates to the Baseline Loads and Environments.

## 4.3 SPIO

1. The SPIO Element will provide models and emulators of the ICPS and environments to GSDO and Orion MPCV as part of external system integration and verification testing activities as defined in BEA P2P00003 and BEA P2P00002 <**TBR-002**>.
  - a. The SPIO Element will provide technical support to SE&I (IAS) to integrate the ICPS emulator with the SLS vehicle emulator before the emulators are provided to Orion MPCV.
2. The SPIO Element will provide integrated ICPS SIL test reports of the in-space mission phase utilizing SE&I-provided mission design and GN&C parameters.

## 4.4 Booster

1. The Booster Element will provide, consistent with the Program schedule provided in SLS-SCHE-164, shared access to the Booster Hardware-In-the-Loop (HIL) in-place avionics assets that include one booster set of flight-like avionics and one booster set of flight-like cables to the SIL to support integrated testing of the vehicle control, command, and data system.

## 4.5 Stages

1. The Stages Element will provide, consistent with the Program schedule provided in SLS-SCHE-164, the following items to the SIL to support integrated testing of the vehicle control, command, and data system:
  - a. Electrical ground support equipment (EGSE) hardware/software.
  - b. Core stage avionics subsystems, with associated special test equipment.
2. The Stages Element will provide, consistent with the Program schedule provided in SLS-SCHE-164, the following items to the Software Development Facility (SDF) to support development of integrated flight software:

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- a. Software development units.
- b. Engineering development units.

## 4.6 Engines

1. The Engines Element will deliver to the Stages Element flight-ready RS-25 engines consistent with the Program schedule provided in SLS-SCHE-164.
  - a. The first four engines will have sufficient hardware life to support integrated core stage testing including tanking and de-tanking operations and two engine hot fire tests.
  - b. The second four engines will have sufficient hardware life to support integrated core stage testing including tanking and de-tanking operations and two engine hot fire tests.
  - c. Technical support to the Stages Element for stage testing using the RS-25 engines.
2. The Engines Element will provide, consistent with the Program schedule provided in SLS-SCHE-164, to the SIL to support integrated testing of the vehicle control, command, and data system.
  - a. One RS-25 Engine Control Unit (ECU) with associated special test equipment that includes a simulation interface adapter.
  - b. One engine-set of flight-like cables.

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## 5.0 VERIFICATION AND VALIDATION AGREEMENTS

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-009, SLSP Verification and Validation Plan.

### 5.1 SE&I

1. SE&I (SE) will develop the Verification Compliance Report (VCR) for the requirements of SLS-SPEC-032, SLSP System Specification. This VCR includes:
  - a. Requirements.
  - b. Verification methods.
  - c. Verification success criteria.
  - d. Compliance assessment.
  - e. Compliance data.
  - f. Certification compliance metadata for requirements allocated to Elements.
2. SE&I (SE) will lead verification planning and verification closure of interface functions allocated to the SLS system level in accordance with SLS-ICD-052, SLSP to GSDOP ICD, Volume 1: Functional Interface Definition and SLS Integrated Vehicle-to-GSDO Detailed Design, Section 3.3 Functional Allocation Matrix. SE&I (SE) will accept verification compliance metadata from the Elements as objective evidence of verification closure of interface functions allocated to the Elements per Volume 1 Section 3.3 and verification closure of detailed interface designs captured in SLS-ICD-052: Volume 2 (Booster), Volume 3 (Stages), Volume 4 (ISPE), and Volume 5 (all Elements). Verification compliance metadata includes the following data fields:
  - a. Function number.
  - b. Verification methods.
  - c. Verification activities/success criteria.
  - d. Reference to compliance data.
  - e. Compliance assessment.
3. SE&I (SE) will develop the VCR for SLS-ICD-052-01 and provide it to an SLS-hosted Joint Integration Control Board (JICB) for approval.
  - a. The VCR will include the verification compliance metadata from the SLS SE&I allocated functions, the SLS Element metadata and the verification closure information from GSDO for GSDO allocated functions as described in GSDO-

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MVVP-1042-02, GSDO Master Verification and Validation Plan, Volume 2:  
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4. SE&I (STE) will be responsible for the following interface tasks related to the Core-to-Booster Interface (the total set of all responsibilities, including the Element responsibilities and those defined below, is defined in SLS-ICD-021, SLSP Core Stage-to-Booster ICD):
  - a. Assembly drawing.
  - b. Shared volume thermal environments definition.
  - c. Aero-thermal and other external environments (i.e., SLS-SPEC-044-02, SLSP Vehicle Design Environments, Volume 2: External Thermal, environments definition).
  - d. Thermal conduction, convection, and radiation across and around joints.
  - e. Shared volume venting.
  - f. Joint structural/stress and loads analysis.
  
5. SE&I (STE) will be responsible for the following interface tasks related to the Core-to-ISPE Interface (the total set of all responsibilities, including the Element responsibilities and those defined below, is defined in the SLS-ICD-029, SLSP Stages-to-ISPE ICD):
  - a. Assembly drawing.
  - b. Aero-thermal and other external environments (i.e., SLS-SPEC-044-02 environments definition).
  - c. Joint structural/stress and loads analysis.
  
6. SE&I (IAS) will lead verification planning and verification closure of the interface functions, allocated to the SLS system level, documented in SLS-ICD-176, SLSP SLS-to-Mission Systems (MS) ICD, Section 3.3 Functional Capability Trace Matrix. Verification activities will be in accordance with SLS-ICD-176 Section 4.0. SE&I (IAS) will accept verification metadata from the Elements as objective evidence of verification closure of interface functions allocated to the Elements per Section 3.3. Verification metadata includes the following data fields:
  - a. Function number.
  - b. Verification methods.
  - c. Verification activities/success criteria.
  - d. Reference to compliance data.
  - e. Compliance assessment.

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7. SE&I (IAS) will develop the VCR for SLS-ICD-176 and provide it to an SLS-hosted JICB for approval.
  - a. The VCR will include the metadata from the SLS SE&I allocated functions, the SLS Element metadata, and the verification closure information from MS for MS-allocated functions as described in the Orion MPCV Verification and Validation Plan <**TBR-004**>.
8. SE&I (SE) will verify the SLS evolvability requirements (as described in SLS-SPEC-032 requirements for Block 1A and Block 2 configurations) by analysis and provide as part of the SLS system-level VCR. A compliance assessment of these requirements will be provided at each life cycle review within SLS-RPT-183, SLSP Evolvability Report.
9. SE&I (IAS) will lead verification planning and verification closure of interface functions allocated to the SLS system level in accordance with SLS-ICD-031, SLS-to-CTN ICD, Section 4.0 Functional Allocation and Compliance. SE&I (IAS) will accept verification metadata from the Elements as objective evidence of verification closure of interface functions allocated to the Elements. Verification metadata includes the following data fields:
  - a. Function number.
  - b. Verification methods.
  - c. Verification activities/success criteria.
  - d. Reference to compliance data.
  - e. Compliance assessment.
10. SE&I (IAS) will develop the VCR for SLS-ICD-031 and provide it to an SLS-hosted JICB for approval.
  - a. The VCR will include the metadata from the SLS SE&I allocated functions, the SLS Element metadata, and the verification closure information for CTN allocated functions as described in SLS-PLAN-009.
11. SE&I (SE) will confirm that all dimensional parameters that are not verified as a requirement, and are configuration management (CM) controlled in the SLS Program-level released data items, will be confirmed to be implemented and documented in the system-level functional configuration audit (FCA) report and delivered to the Program Manager.
  - a. Implementation is confirmed when each individual parameter is baselined in a Marshall Space Flight Center (MSFC)-released Program-level drawing or within CM controlled documentation at the Element level.

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- b. This includes but is not limited to the parameters within Section 3.1 of SLS-SPEC-032.
12. SE&I (SE) will plan verification and generate system-level verification closure documentation to address the contents of applicable documents in SLS-SPEC-032, Requirement SLS.27, for SLS system-level verification activities. SE&I (SE) will accept verification products from the Elements in accordance with Section 5.2 part 5 of this plan as objective evidence of Element closure for the various parts of Requirement SLS.27. Further:
- a. For SLS-SPEC-032 Requirement SLS.27.1 (loads and environments), SE&I (SE) will provide for each cited document a single verification closure statement – based on validation of records – that states all system-level verification products are consistent with the imposed loads and environments.
  - b. For SLS-SPEC-032 Requirement SLS.27.2 (interface control), the verification of internal and external SLS interfaces is addressed in Sections 5.1, 5.2, 5.3, 5.4, 5.5, and 5.6 of this plan.
  - c. For SLS-SPEC-032 Requirement SLS.27.3 (embedded specifications), SE&I (SE) will provide verification metadata for individual, system-level requirements in each cited specification as objective evidence that each has been successfully verified.
  - d. For SLS-SPEC-032 Requirement SLS.27.4 (design and construction), SE&I (SE) will provide for each cited document a single verification closure statement as objective evidence that each has been successfully verified.
  - e. For SLS-SPEC-032 Requirement SLS.27.5 (range safety), SE&I (SE) will verify the requirements for range safety by developing the system-level Range Safety data products and by obtaining United States Air Force (45<sup>th</sup> Space Wing) approval.

## 5.2 Multiple Elements

- 1. The Elements will provide verification compliance metadata pertaining to the activities performed to verify the design requirements of SLS-SPEC-032. This verification compliance metadata includes:
  - a. Requirement.
  - b. Verification methods.
  - c. Verification activities/success criteria.
  - d. Compliance assessment.
  - e. References to associated compliance data.

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In the case of Requirement SLS.28, verification metadata will be provided for each applicable document imposed by the design requirement.

2. The Elements will certify their developed designs for flight. Certification for flight includes the verification of Element-level requirements beyond SLS-SPEC-032. Such requirements are captured within Element requirements documents and/or contract end-item specifications. Verification approval at this level is delegated to the Elements.
3. The Elements will lead verification planning and verification closure of interface functions allocated to the Elements in accordance with SLS-ICD-052 Volume 1, Section 3.3 Functional Allocation Matrix.
  - a. The Elements will provide verification compliance metadata to SE&I (SE) as objective evidence of verification closure of interface functions allocated in accordance with SLS-ICD-052 Volume 1, Section 3.3, and verification closure of the associated detailed interface designs captured in SLS-ICD-052: Volume 2 (Booster), Volume 3 (Stages), Volume 4 (ISPE), and Volume 5 (all Elements). Verification compliance metadata is defined in Section 5.1.
4. The Elements will perform and document an applicability assessment for any verification data generated under the auspices of a previous qualification/certification effort when that data is being used for the purposes of fulfilling verification requirements under the SLS Program. Such an assessment will include verification planning, will be a constituent of verification compliance documentation, will only be valid if citing source data that is accessible upon demand, and will take into consideration:
  - a. All changes to the configuration of the product being verified.
  - b. All changes to the fabrication or quality processes used to create the product.
  - c. All changes to imposed functional or performance requirements.
  - d. All differences to loads, environments, or interface conditions to which the product is exposed.

This agreement defines the provisions for the use of “similarity” as a verification method.

5. The Elements will provide verification closure for SLS-SPEC-032, Requirement SLS.27, by various methods as described below. Single verification closure statements, when used, will reference specific Element-level requirements, verification activities, and associated compliance reports as conducted by the Element to verify the contents of each applicable document. Further:
  - a. For SLS-SPEC-032 Requirement SLS.27.1 (loads and environments), the Elements will provide for each allocated document a single verification closure statement that states all Element-level verification products are consistent with the imposed loads and environments from that document.

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- b. For SLS-SPEC-032 Requirement SLS.27.2 (interface control), the Element-level verification of allocated SLS interfaces is addressed in Sections 5.2, 5.3, 5.4, 5.5, and 5.6 of this plan.
  - c. For SLS-SPEC-032 Requirement SLS.27.3 (embedded specifications), the Elements will provide verification metadata for allocated, individual requirements in each cited specification as objective evidence that each has been successfully verified.
  - d. For SLS-SPEC-032 Requirement SLS.27.4 (design and construction), the Elements will provide for each allocated document a single verification closure statement as objective evidence that each has been successfully verified.
  - e. For SLS-SPEC-032 Requirement SLS.27.5 (range safety), the Elements will verify the requirements for range safety by providing the Element-level Range Safety data products to SLS SE&I.
6. The Elements will provide verification metadata to SE&I (IAS) as objective evidence of verification closure of interface functions allocated to the Elements in accordance with SLS-ICD-176 Section 3.3. Verification compliance metadata is defined in Section 5.1.
  7. The Elements will provide verification metadata to SE&I (IAS) as objective evidence of verification closure of interface functions allocated to the Elements in accordance with SLS-ICD-031 Section 4.0, Functional Allocation Matrix. Verification compliance metadata is defined in Section 5.1.

### 5.3 SPIO

1. The SPIO Element will provide to Stages verification compliance metadata for all verification activities allocated to the SPIO through STG-AV-0002, SLS Stages to Elements Command and Data Handling (C&DH) Document, and SLS-ICD-029.
2. The SPIO Element will provide input data or technical assistance to the Stages Element, as necessary, for any verification activities involving both sides and assigned to the Stages.

### 5.4 Booster

1. The Booster Element will provide to Stages verification compliance metadata for all verification activities allocated to the Boosters through STG-AV-0002 and SLS-ICD-021.
2. The Booster Element will provide input data or technical assistance to the Stages Element, as necessary, for any verification activities involving both sides and assigned to the Stages.

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## 5.5 Stages

1. The Stages Element will coordinate and manage the development of verification matrices for the delegated ICDs and STG-AV-0002 which define methods and responsibilities for verification activities associated with documented interface functions and conditions. Verification activities that involve both sides of the interface will be assigned for completion and approval to one side or the other side.
2. The Stages Element will coordinate and manage the development of Interface Hardware Responsibility Tables to be included in each of the delegated ICDs. The Interface Hardware Responsibilities Tables will identify which of the interfacing Elements will provide each hardware item at the interface and have responsibility for its design, analysis, qualification, procurement, and delivery to the appropriate facility for integration, which will also account for SE&I responsibilities declared in Section 5.1 (#4 and #5) of this document.
3. The Stages Element will provide input data or technical assistance to the other Elements, as necessary, for any verification activities involving both sides and assigned to the other Elements.
4. The Stages Element will collect and integrate the verification compliance metadata from all parties into an interface compliance package for the ICD or STG-AV-0002 and maintain the verification compliance metadata records under Stages configuration management.
5. The Stages Element will provide to SE&I a single verification compliance statement for STG-AV-0002 and for each element-to-element ICD linked through SLS-SPEC-032 Requirement SLS.27. Each verification compliance statement will cite the associated interface compliance package and will certify that all verification activities are complete and that the design is compliant with the ICD or STG-AV-0002.

## 5.6 Engines

1. The Engines Element will provide to Stages verification compliance metadata for all verification activities allocated to the Engines through STG-AV-0002 and SLS-ICD-039-01, SLSP Stages-to-Engine(s) ICD, Volume 1: Core Stage to Core Stage Engine.
2. The Engines Element will provide input data or technical assistance to the Stages Element, as necessary, for any verification activities involving both sides and assigned to the Stages.

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## 6.0 INTEGRATED LOGISTICS SUPPORT AGREEMENTS

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-025, SLSP Integrated Logistics Support Plan (ILSP).

### 6.1 SE&I

1. SE&I Operations (OPS) will develop and publish the SLS Maintenance Plan <TBD-022> for overall Program use, utilizing the SLS Element maintenance planning provided by the Elements in enough detail to allow the end user to plan and provision for the required support, and for use in implementing maintenance support for the SLS vehicle at the launch site.
2. SE&I (OPS) will transport SLS Core Stage flight articles and SLS Core Stage structural test articles (STAs). During barge transportation, the following conditions are monitored:
  - a. Pitch and roll of the barge.
  - b. Ambient temperature and humidity on the main deck.
  - c. Acceleration/vibration of the barge.
  - d. Main deck recorded video from up to six locations.

### 6.2 Multiple Elements

1. The SLS Elements will provide support to SE&I (OPS) in the development of the following SLS-level documentation items:
  - a. Provisioning documentation.
  - b. Level of repair analysis (LORA).
  - c. Maintenance task analysis (MTA).
  - d. Maintenance planning.
2. The Elements will use one centralized shipping and receiving area, i.e., the program logistics warehouse K6-1547, at KSC for all NASA-owned hardware with the exception of large hardware elements and coordinated special deliveries. (Reference GSDO-PLN-1070, Cross-Program Integrated Logistics Plan.)
3. The SLS Elements will provide depot-level maintenance.
4. The SLS Elements will initiate transfer or excess activities for all property for which they retain accountability when the items are no longer needed to support operations.

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5. The SLS Elements utilizing GSDOP bonded storage (reference GSDO-PLN-1070) will provide the Element's requirements for each of the following criteria to ensure items can be adequately stored:
  - a. Storage life.
  - b. Maintenance and monitoring requirements.
  - c. Security concerns.
  - d. Floor space required (volume).
  - e. Environmental considerations, such as humidity and temperature limits.
  - f. Special packaging and handling, if required.
  - g. Inventory list of materials requiring storage and appropriate transfer paperwork.
6. SLS Elements will define the list of line replaceable units (LRUs) for their element.

### **6.3 Stages**

1. The SLS Stages Element will include the Engines maintenance planning within the Stages maintenance planning.
2. The SLS Stages Element will prepare the Integrated Core Stage for shipment on the NASA barge.

### **6.4 Engines**

1. The SLS Engine Element will provide maintenance planning documentation to the SLS Stages Element.

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## **7.0 MATERIALS AND PROCESSES SELECTION, CONTROL, AND IMPLEMENTATION AGREEMENTS**

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-171, SLSP Materials and Processes (M&P) Selection, Control, and Implementation Plan.

### **7.1 SE&I**

1. SE&I Production (PROD) will control access to the Materials and Processes Technical Information System (MAPTIS) database that contains Element records relating to materials and processes variances from technical requirements to protect proprietary information.

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## **8.0 INTEGRATED AVIONICS TEST FACILITIES DEVELOPMENT AGREEMENTS**

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-065, SLSP Integrated Avionics Test Facilities (IATF) Development Plan.

### **8.1 SE&I**

1. Agreements captured in Section 4.1 of this document.

### **8.2 Booster**

1. Agreements captured in Section 4.4 of this document.

### **8.3 Stages**

1. Agreements captured in Section 4.5 of this document.

### **8.4 Engines**

1. Agreements captured in Section 4.6 of this document.

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## **9.0 AVIONICS INTEGRATION AND TEST AGREEMENTS**

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-130, SLSP Avionics Integration and Test Plan.

### **9.1 SE&I**

1. Agreements captured in Section 4.1 of this document.

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## 10.0 TESTING AGREEMENTS

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-116, SLSP Test Plan.

### 10.1 SE&I

1. SE&I (VM) will conduct in-flight tests of the SLS GN&C system as part of Exploration Mission 1 (EM-1) using a number of programmed test inputs (PTIs) to provide known inputs that will excite the vehicle modes. These PTIs are momentary deflections of the booster and core stage engine nozzles that provide a bending forcing function without causing any noticeable effect on guidance, performance, or safety. Analysis of these data will be provided to the SLS Chief Engineer as part of the EM-2 Flight Readiness Review package. Final commitment for flight implementation will be made at the Flight Readiness Review.
2. SE&I (SE) will provide the test plan for modal test of the launch vehicle to GSDO. The modal test will be performed in the Vehicle Assembly Building (VAB) by GSDO and MSFC Test Laboratory personnel (per <TBD-002> Reference).
  - a. SE&I (STE) will define requirements for instrumentation (sensor types and locations) and shakers (including shaker locations).
  - b. SE&I (Test) will provide the accelerometers with mounting hardware and cabling as needed, shakers with mounting plates and hydraulic pumps, and a data acquisition system (DAS) for vehicle-mounted accelerometer data.

### 10.2 SPIO

1. The SPIO Element will provide stiffness and modal test data from the Launch Vehicle Stage Adapter (LVSA), ICPS, and Orion MPCV Stage Adapter (MSA) structural qualification tests per the schedule milestones in SLS-SCHE-164.

### 10.3 Stages

1. The Stages Element will integrate and provide the test article and then conduct Integrated Stages Element Testing consistent with the Program schedule provided in SLS-SCHE-164.
  - a. Stages will complete a dynamic response test to measure selected primary structure modal frequencies that allow for model correlation to at least 20 Hz and the associated modal shapes for the first production unit of the integrated core stage.

Stages will provide stiffness data from each of the five core stage structural qualification tests (forward skirt, liquid oxygen tank, intertank, liquid hydrogen tank, and engine section).

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## **11.0 RISK AND OPPORTUNITY MANAGEMENT AGREEMENTS**

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-180, SLSP Risk and Opportunity Management Plan. Information contained herein provides guidance for deliverables to the SLS Program.

### **11.1 SE&I**

1. SE&I will support Program Risk meetings through the preparation, maintenance, presentation, and discussion of Element detailed risk status reports. The content of detailed risk management information is shown in Figure 11-1. The format of the risk status detailed reports is shown in Figure 11-2.
2. SE&I will develop and maintain updated risk status summary reports. The format of the risk status summary report is shown in Figure 11-3.
3. SE&I will provide risk status summary reports, or detailed reports, or both upon request by SLS Program management.

### **11.2 Multiple Elements**

1. The Elements will support Program Risk meetings through the preparation, maintenance, presentation, and discussion of Element detailed risk status reports. The content of detailed risk management information is shown in Figure 11-1. The format of the risk status detailed reports is shown in Figure 11-2.
2. The Elements will develop and maintain updated risk status summary reports. The format of the risk status summary report is shown in Figure 11-3.
3. The Elements will provide risk status summary reports, or detailed reports, or both upon request by SLS Program management.

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- Detailed Risk Content
- Risk Title
  - Status Date
  - Risk Owner (Point of Contact (POC))
  - Risk Statement
  - Risk Description/Context
  - Active Risk Manager (ARM) or Element Risk Tracking Number
  - Affected Organizations
  - Risk Timeframe
  - Expected Closure Date
  - Initial and Up-to-Date Risk Score with score rationale (Basis of Estimate (BOE))
    - Likelihood, Safety, Performance, Schedule, Cost
      - Identify if Schedule consequence is on Critical Path
    - Risk Trending
  - Escalation Level
  - Risk Handling Strategy with short narrative
    - Mitigation
      - Burn-down plan with planned/actual completion dates
      - Schedule linkage
    - Watch
      - Triggers with dates
    - Research
      - Research activities with planned/actual dates
    - Accept
      - Acceptance rationale and level at which the risk is accepted
  - Quantitative Risk Analysis Linage
    - Consequence Cost Likelihood
    - Consequence Cost Funding Profile
    - Mitigation Cost Likelihood (if applicable)
    - Mitigation Cost Funding Profile

**Figure 11-1. Detailed Risk Management Content List**

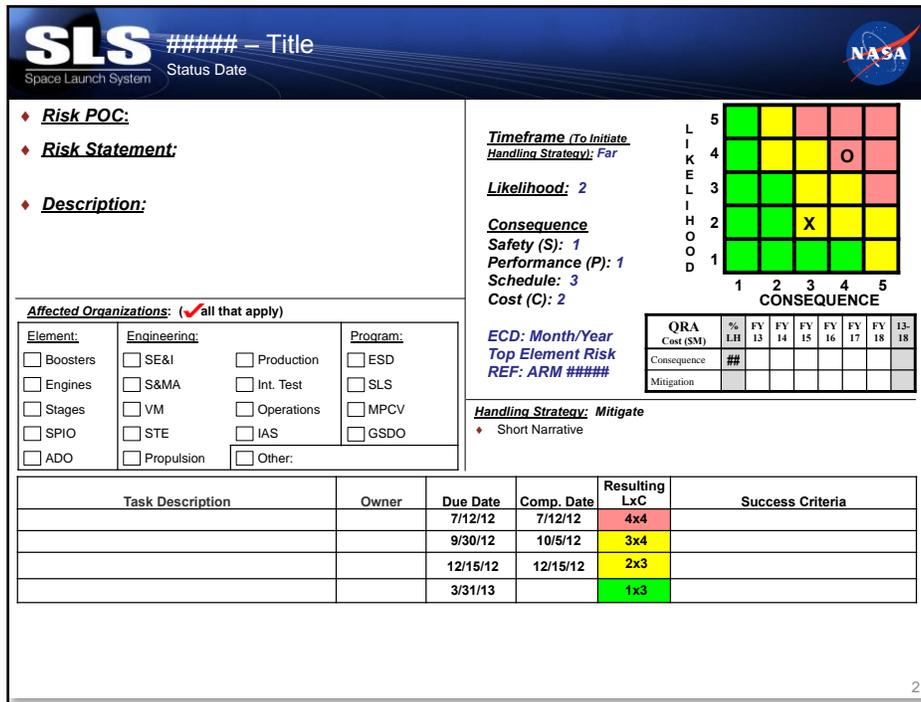


Figure 11-2. Risk Status Detailed Report (Template Example)

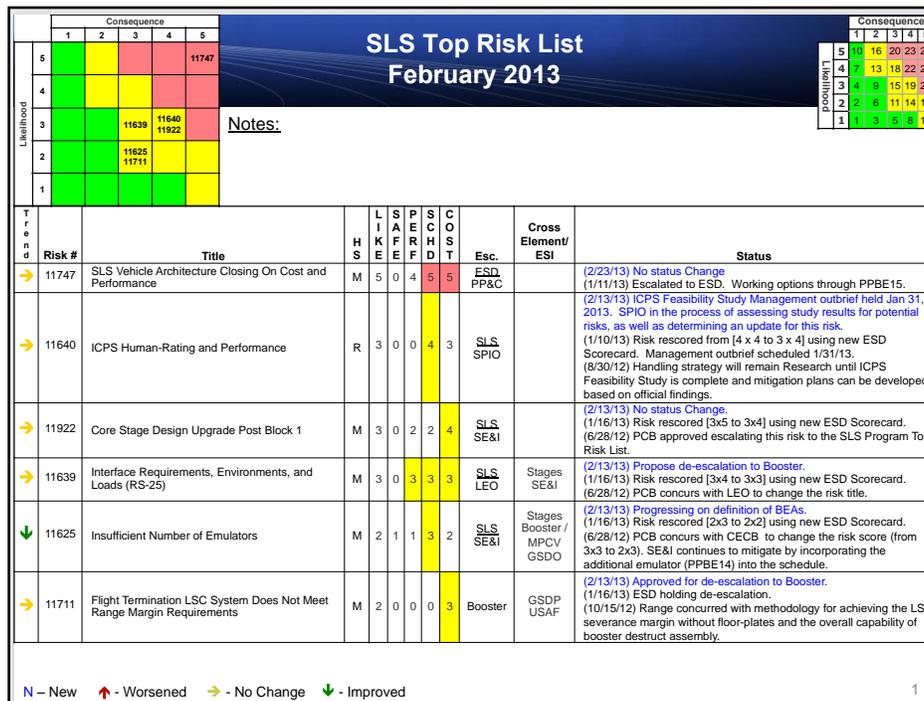


Figure 11-3. Risk Status Summary Report (SLS Top Program Risk List Example)

The electronic version is the official approved document.  
Verify this is the correct version before use.

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## **12.0 SUSTAINING ENGINEERING AGREEMENTS**

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-093, SLSP Sustaining Engineering Plan.

### **12.1 SE&I**

<TBD-010>

### **12.2 Multiple Elements**

<TBD-011>

### **12.3 SPIO**

<TBD-012>

### **12.4 Booster**

<TBD-013>

### **12.5 Stages**

<TBD-014>

### **12.6 Engines**

<TBD-015>

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## **13.0 INTEGRATED AVIONICS TEST FACILITY VERIFICATION, VALIDATION, AND ACCREDITATION AGREEMENTS**

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-137, SLSP Integrated Avionics Test Facility (IATF) Verification, Validation, and Accreditation (VV&A) Plan.

### **13.1 SE&I**

<TBD-016>

### **13.2 Multiple Elements**

1. The Elements will support the VV&A of the IATF Hardware-in-the-Loop (HWIL) Simulation and individual models used within the IATF HWIL Simulation.

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## 14.0 MISSION OPERATIONS AGREEMENTS

The agreements captured in the following subsections are those across organizations within the SLSP and those with programs external to the SLSP that guide and enable the planning content described in SLS-PLAN-181, SLS Mission Operations Plan.

### 14.1 SE&I

1. SE&I (OPS) will develop, operate, and maintain the Huntsville Operations Support Center (HOSC) SLS Engineering Support Center (SESC).
2. SE&I (OPS) will develop training materials and conduct the training for those flight controllers that reside in the SESC.
3. SE&I will provide engineering support for mission operations activities and events.
  - a. The SLS Engineering Support team will transition to the SLS Mission Evaluation Room (MER) support team after liftoff and will provide support to the Mission Control Center (MCC) through ascent and disposal.
  - b. SE&I will support MMT activities.
4. SE&I (OPS) will provide the capability to archive SLS mission data.
5. SE&I (OPS) will provide the capability for remote operations (data, video, and voice) to the Elements for launch and flight operations.

### 14.2 Multiple Elements

1. The Elements will provide engineering support for mission operations activities and events.
  - a. The SLS engineering support team will transition to the SLS MER support team after liftoff and will provide support to the MCC through ascent and disposal.
  - b. Elements will support Mission Management Team (MMT) activities.
2. The Elements will support development of flight operations handbook and mission operations capabilities (e.g., consoles) by contributing design information, operational sequence diagrams and constraints, and systems expertise.

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## APPENDIX A ACRONYMS AND ABBREVIATIONS AND GLOSSARY OF TERMS

### A1.0 ACRONYMS AND ABBREVIATIONS

AV	Avionics
BEA	Bilateral Exchange Agreement
C&DH	Command and Data Handling
CECB	Chief Engineer's Control Board
CM	Configuration Management
CR	Change Request
CTN	Communications and Tracking Network
DAC	Design Analysis Cycle
DAS	Data Acquisition System
DRL	Data Requirements List
ECU	Engine Control Unit
EGSE	Electrical Ground Support Equipment
EM	Exploration Mission
ESD	Exploration Systems Development
FCA	Functional Configuration Audit
FEM	Finite Element Model
FSW	Flight Software
FWD	Forward
GN&C	Guidance, Navigation, and Control
GSDO	Ground Systems Development and Operations
GSDOP	Ground Systems Development and Operations Program
HIL	Hardware in the Loop
HOSC	Huntsville Operations Support Center
HWIL	Hardware in the Loop
Hz	Hertz
IAS	Integrated Avionics and Software
IATF	Integrated Avionics Test Facilities
ICD	Interface Control Document
ICPS	Interim Cryogenic Propulsion Stage
ICPS SIL	Interim Cryogenic Propulsion Stage Software Integration Laboratory
ILSP	Integrated Logistics Support Plan

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ISPE	Integrated Spacecraft and Payload Element
JICB	Joint Integration Control Board
KSC	Kennedy Space Center
LORA	Level of Repair Analysis
LRU	Line Replaceable Unit
LSE	Lead Systems Engineer
LVSA	Launch Vehicle Stage Adapter
M&P	Materials and Processes
MAPTIS	Materials and Processes Technical Information System
MCC	Mission Control Center
MER	Mission Evaluation Room
ML	Mobile Launcher
MMT	Mission Management Team
MPCV	Multi-Purpose Crew Vehicle
MS	Mission Systems
MSA	MPCV Stage Adapter
MSFC	Marshall Space Flight Center
MSI	Maintenance Significant Item
MTA	Maintenance Task Analysis
MVVP	Master Verification and Validation Plan
NASA	National Aeronautics and Space Administration
OML	Outer Mold Line
OPR	Office of Primary Responsibility
OPS	Operations
PAD	Program Agreements Document
PCB	Program Control Board
PCBD	Program Control Board Directive
PLN	Plan
PROD	Production
PTI	Programmed Test Input
ROM	Rough Order of Magnitude
RPT	Report
RQMT	Requirement
SDF	Software Development Facility
SE	Systems Engineering
SE&I	Systems Engineering and Integration

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SEMP	Systems Engineering Management Plan
SESC	SLS Engineering Support Center
SIL	System Integration Laboratory
SITF	Systems Integration Test Facility
SLS	Space Launch System
SLSP	Space Launch System Program
SLSS	Space Launch System Stages
SMAT	Scale Model Acoustic Test
SPEC	Specification
SPIO	Spacecraft and Payload Integration Office
SSC	Stennis Space Center
STA	Structural Test Article
STE	Structures and Environments
STG	Stages
TBD	To Be Determined
TBR	To Be Resolved
V&V	Verification and Validation
VAB	Vehicle Assembly Building
VAC	Verification Analysis Cycle
VCR	Verification Compliance Report
VM	Vehicle Management
VV&A	Verification, Validation, and Accreditation

## A2.0 GLOSSARY OF TERMS

Term	Description
Line Replaceable Unit (LRU)	Maintenance significant items, as defined by the Element, that can be accessed, removed, and replaced at the launch site without recertifying the system.
Maintenance Significant Item (MSI)	Any item where its failure results in any or all of the following: <ul style="list-style-type: none"> <li>• Degradation of system or subsystem performance and/or loss of function.</li> <li>• A negative impact on safety, mission success, and/or life cycle cost.</li> <li>• Repair, replacement, or refurbishment and recertification.</li> <li>• Requirements for system, subsystem or item inspection, testing,</li> </ul>

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<b>Term</b>	<b>Description</b>
	and recertification.
Depot Maintenance	Any maintenance outside of the KSC Launch Facility < <b>TBR-003</b> >.
Sustaining Engineering	The essential engineering support that, after the development of the flight hardware and software is completed and the flight hardware/software is turned over to the launch vehicle integrator, is required to maintain the integrity of the design and/or ensure operability of the element hardware and software. This typically occurs at the start of launch vehicle integration.
Provide	To make available to another. <ul style="list-style-type: none"> <li>• With regards to items that are not data items: The party who provides an item retains responsibility for maintenance and technical support for that item. The party who uses a provided item will return that item when usage is complete.</li> <li>• With regards to items that are data items: Synonymous with “deliver.”</li> <li>• With regards to other resources: The party who provides other resources retains programmatic responsibility for the costs incurred in the use of those resources.</li> </ul>
Deliver	To surrender custody to another. <ul style="list-style-type: none"> <li>• The party who receives a delivered item accepts responsibility for maintenance and technical support for that item after delivery.</li> <li>• However, in certain cases, the party who delivers an item may retain specified rights and responsibilities for insight into activities involving the delivered item.</li> </ul>
Similarity	Similarity is the process of assessing prior data, configuration, processes, or applications and concluding that the item under assessment is similar or identical to another item that has previously been verified to equivalent or more stringent specifications or validated to an equivalent use or function.

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## 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.

### B1.0 TO 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	3.0	Section not yet defined.
TBD-002	10.1 #2	Reference to modal test not defined.
TBD-010	12.1	Section not yet defined.
TBD-011	12.2	Section not yet defined.
TBD-012	12.3	Section not yet defined.
TBD-013	12.4	Section not yet defined.
TBD-014	12.5	Section not yet defined.
TBD-015	12.6	Section not yet defined.
TBD-016	13.1	Section not yet defined.
TBD-022	6.1 #1	Document number for SLS Maintenance Plan not yet assigned.

### B2.0 TO BE RESOLVED

Table B2-1 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 sequentially numbered as applicable (i.e., <TBR-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.

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**Table B2-1. To Be Resolved Issues**

TBR	Section	Description
TBR-002	4.1 #4, 4.3 #1	Name of BEA not finalized.
TBR-003	A2.0	Name of KSC Launch Facility not identified.
TBR-005	5.1 #7	Need to verify document name for MPCV Verification and Validation Plan.

### B3.0 FORWARD WORK

Table B3-1 lists the specific forward work items identified during this document's Change Request (CR) review and evaluation. Each item is given a sequential number using a similar format to that for the TBDs and TBRs. For each item, include the section number(s) of this document that the open work will impact, and in the Description include the specific number of the comment from the Change Evaluation (CE), i.e., CE-10, CE-27. Do not include a placeholder for forward work items in the body of the document; list them only in Table B3-1.

*Note:* If there are no forward work items, do not include this subsection in your document.

**Table B3-1. Forward Work**

FWD	Section	Description
FWD-001	2.2	Complete List of Documents.
FWD-002	6.2 #2	Define hardware requiring special delivery processes.
FSD-003	Multiple	Incorporate agreements from SLS-ICD-052-05, SLSP to Ground Systems Development and Operations Program (GSDOP) Interface Control Document (ICD), Vol. 5: SLSP to GSDOP Command and Data Handling (C&DH) Detailed Design.
FSD-005	12	Define required agreements.
FWD-008	5.5 #1	List each delegated ICD to be consistent with 5.3.1, 5.4.1, and 5.6.1. or point to the SLS-PLAN-003, SLSP SEMP.
FWD-009	4.1 #2	ESD Level agreements are not yet defined, but should be addressed to ensure synchronization.
FWD-010	4.3	Add agreement with details as appropriate for avionics hardware & software required for IAS SIL testing.
FWD-013	A2.0	Add definition of Single Verification Compliance Statement.
FWD-014	5.2	Add Design Models to Element Certification Package.
FWD-015	10.1 #1	Determine whether this agreement should be left in Section 10 or handled under Flight Evaluation Agreements when defined.
FWD-016	5.1 #12a	Update SLS-SPEC-032, SLS 27.1.
FWD-017	5.1 #12b	Update SLS-SPEC-032, SLS 27.2.
FWD-018	5.1 #12c	Update SLS-SPEC-032, SLS 27.3.

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FWD	Section	Description
FWD-019	5.1 #12d	Update SLS-SPEC-032, SLS 27.4.
FWD-020	5.1 #12e	Update SLS-SPEC-032, SLS 27.5.