



National Aeronautics and
Space Administration

SLS-PLAN-025

VERSION 1

RELEASE DATE: APRIL 15, 2013

**SPACE LAUNCH SYSTEM PROGRAM (SLSP)
INTEGRATED LOGISTICS SUPPORT PLAN (ILSP)**

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VERSION AND HISTORY PAGE

Status	Version No.	Change No.	Description	Release Date
Draft	-	-	Initial Draft of SLS DRD 1406OP-018 for SLS SRR/SDR, MSFC 4511 Concurrence on file	02/01/12 Draft
Released	1	-	Initial Release of SLS DRD 1406OP-018 for SLS PDR, MSFC 4511 Concurrence on file This release also addresses and implements required updates to officially close SRR/SDR RID SLSRD-0139 and RFA SRB-30	04/15/13

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

As defined in NPD 7500.1 Program and Project Life Cycle Logistics Support Policy, Integrated Logistics Support (ILS) is a discipline associated with the design, development, test, production, fielding, sustainment, improvement modifications, and disposal of cost-effective systems. The principal objectives of ILS are to ensure that support considerations are an integral part of a system's design requirements, that the system can be cost effectively supported through its life cycle, and that the infrastructure elements necessary to the initial fielding and operational support of the system are identified, developed, and acquired. Since the majority of a system's life-cycle costs can be attributed directly to operations and support costs, it is vitally important that system developers evaluate the potential operation and support costs of alternate designs and factor these into early design decisions. ILS activities are most effective when they are integral to both the contractor and Government's system engineering technical and management processes. The recognized elements of ILS include:

- Design Interface (participating in the design process to enhance system supportability)
- Supply Support
- Maintenance Planning
- Packaging, Handling, Storage, and Transportation (PHS&T)
- Technical Data
- Support and Test Equipment
- Training and Training Support
- Manpower and Personnel for ILS functions
- Facilities required for ILS functions
- Computer Resources Support

The details of these elements can be found in section 5.0 of this document.

The Integrated Logistics Support Plan (ILSP) delineates how logistics and supportability engineering and management concepts will be applied to the Space Launch System Program (SLSP). The ILSP will identify and plan the integrated logistics support required to achieve the program operational goals. These goals include improving readiness, assuring availability, and lowering total cost of ownership by minimizing the logistics footprint required for operational sustainment. This plan will address how the elements of Integrated Logistics Support will be integrated with disciplines set forth in other SLS program documents. The ILSP addresses supportability engineering analyses to be performed during SLS design and development and physical logistics support for the operational phase of the SLSP.

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1.1 Purpose

The SLS Program Plan, SLS-PLAN-001, sets the ILS goal to ensure an available, operational, effective, and economically supported SLS throughout its operational life cycle. The SLS System Engineering Management Plan (SEMP), SLS-PLAN-003, directs the SLSP to apply Integrated Logistics Support (ILS) technical and management concepts and techniques to the life cycle phases of the SLS in accordance with the NASA Program and Project Life-Cycle Logistics Policy, NPD 7500.1.

The ILSP describes how the ILS program will be conducted to accomplish the Program's ILS goal in accordance with the direction and guidance provided by NPD 7500.1, the Program Manager, and the Exploration System Logistics Integration Plan (ESLIP). The ESLIP was developed by the Logistics Integration Team (LIT), which is an Integrated Task Team (ITT) that has been chartered by the Cross-Program Integration Team (CPIT). The LIT sets priorities and develops cross-cutting initiatives for ensuring consistent implementation of programmatic logistics support and maximizing supportability, commonality, and affordability across the Exploration Systems Development (ESD) Enterprise.

The ILS Team will focus on designing an affordable ILS footprint that achieves long term program goals (beyond block 1). SLSP ILS activities integrate and analyze element/vehicle logistics data for ground processing activities at Kennedy Space Center (KSC) for hardware maintenance and supportability planning. The results of the analyses performed will be delivered to Ground Systems Development and Operations Program (GSDOP) and used in planning for launch processing integration. Much of the analyses performed, as outlined in Section 5.0, will be relevant across the different SLS configurations in terms of design interface as well as supportability and maintenance. While the ILSP provides logistics guidance, plans and policies for the Program, the Elements are responsible for developing and executing their logistics plans.

1.2 Scope

This document applies to all SLS Elements, test and operational flights. Logistics policies and processes at the integration points with other programs are found in the ESLIP.

The developmental approach for the SLSP, consisting of 2 exploratory missions years apart, followed years later by the operations phase, presents unique logistics challenges. The main portion of the ILSP explains the long term approach. GSDOP is similarly developing processes and infrastructure for a long term program, as such; the ILS team will deliver the integrated SLS data analyses results to GSDOP to support this focus as appropriate. Lessons learned from the exploration missions will be implemented into the analyses for future block upgrades. Some processes will be the same for a 2 flight program or a long term program. Therefore a long term analysis focus can impact affordability in both cases.

The first two flights will utilize the Block 1 configuration and are defined as Exploration Mission Flights 1 (EM-1) and 2 (EM-2) (addressed in Appendix A of this plan). Analyses for the first 2 flights are limited to high cost and schedule drivers identified by the Elements. Existing ILS data created on other programs or heritage hardware will be used to the greatest extent possible.

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Subsequent appendices will be added to this plan as needed if the future block upgrades differentiate logistically from the long term operational approach. The integrated logistics and supportability for ground support equipment (GSE) is also addressed in this plan.

This document is a data managed (Category 2) document used to describe Program Scope defined with SLS Baseline (Category 1) documentation. Work content and organizational responsibilities described within this documentation are provided to facilitate planning and to familiarize the reader with the interrelationship of activities within the SLS baseline. Specific ILSP agreements in the execution of this document's Program Scope description are defined in the SLS baseline documentation. In the event of an inconsistency of this document with SLS baseline documentation, the Baseline documentation is authoritative. See section 2.0 for guidance on the primary authoritative sources for this Plan.

1.3 Change Authority/Responsibility

The NASA Office of Primary Responsibility (OPR) for this document is EO40.

Proposed changes to this document shall be submitted by an SLS Program Change Request (CR) to the Chief Engineer's Control Board and Program Control Board for disposition. All such requests shall adhere to the SLS-PLAN-008, SLS Program Configuration Management Plan.

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2.0 DOCUMENTS

The agreements that guide and enable the planning content contained in this document are captured in the SLS Program Agreement Document (PAD), SLS-PLAN-186. The integrated development agreements across organizations within the SLS Program are captured in section 6.0 of the PAD and are mapped into the sections shown in Table 2.0-1.

Agreement Area	
Organization	Section
SE&I	6.1
Multiple Elements	6.2
SPIO	6.3
Booster	6.4
Stages	6.5
Engines	6.6

Table 2.0-1: Integrated Development Agreements

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. Unless otherwise stipulated, the most recently approved version of a listed document shall be used. In those situations where the most recently approved version is not to be used, the pertinent version is specified in this list.

Document Number/ Revision Number	Effective Date	Title
MIL-STD-130 Revision N	12/17/07	Department of Defense Standard Practice, Identification Marking of U.S. Military Property

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MSFC Form 4575	6/2011	Marshall Space Flight Center Barge Operations Customer Profile
MWI 6410.1 Revision F	10/23/2008	Packaging, Handling, and Moving Program Critical Hardware
NPD 6000.1 Revision C	10/08/2009	Transportation Management
NPD 7500.1 Revision C	8/17/2012	Program and Project Life-Cycle Logistics Policy
NPR 6000.1 Revision H	11/10/2010	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
NPR 8715.3 Revision C	2/25/11	NASA General Safety Program Requirements
SLS-PLAN-008 Revision A	8/17/2012	Space Launch System Program (SLSP) Configuration Management Plan
SLS-PLAN-013	7/12/2012	Space Launch System Program (SLSP) Safety and Mission Assurance (S&MA) Plan
SLS-PLAN-022	12/8/2011	Space Launch System Program (SLSP) Insight/Oversight Plan
SLS-PLAN-047 Revision A	9/13/2012	Space Launch System Program (SLSP) Technical Metrics Plan
SLS-PLAN-085 <TBR-009>	Not Released	Space Launch System Program (SLSP) Fault Management Plan
SLS-PLAN-093 <TBR-015>	Not Released	Space Launch System Program (SLSP) Sustaining Engineering Plan
SLS-PLAN-186 Revision A	5/2/2013	Space Launch System (SLS) Program Agreement Document
SLS-RQMT-014 Revision A	7/12/2012	Space Launch System Program (SLSP) Safety and Mission Assurance (S&MA) Requirements
SLS-RQMT-019	1/12/2012	Space Launch System Program (SLSP) Electrical, Electronic, and Electromechanical (EEE) parts Management and Control Requirements
SLS-RQMT-161 <TBR-011>	Not Released	Space Launch System Program (SLSP) Human Systems Integration Requirements (HSIR)

2.2 Reference Documents

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

49 CFR 107.105	Department of Transportation Application for Special Permit
DD1149	Department of Defense Form 1149 Requisition and Invoice/Shipping Document

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DD250	Department of Defense Form 250 Material Inspection and Receiving Report
EO-PLAN-002	Mission Operations Lab (MOL) Configuration Management Plan
ESD 10012	Exploration Systems Development (ESD) Concept of Operations
GEIA-STD-0007-A	Logistics Product Data
GSDO-PLN-1070 Not Released	Exploration Systems Logistics Integration Plan (ESLIP)
MIL-STD-1388-1A	Military Standard: Logistics Support Analysis
MIL-STD-1388-2B	Military Standard Department of Defense (DoD) Requirements for a Logistics Analysis Support Record
MPR 3410.1	Training
MSFC Form 4554	Transfer and Shipping Document (MSFC Replacement for DD1149)
MSFC-PLN-3632 Not Released	NASA Barge and Marine Transportation Equipment Configuration Management Plan
MSFC-STD-3394	Standard for Contractor Configuration Management Requirements, MSFC Programs/Projects
MWI 3410.1	Personal Certification Program
NASA FAR 1852 245-74	Identification and Marking of Government Equipment
NASA FAR 45	Government Property
NASA/SP-2007-6105	NASA Systems Engineering Handbook
NASA-STD-0005	NASA Configuration Management Standard
NASA-STD-8719.12	Safety Standard for Explosives, Propellants, and Pyrotechnics
NPD 4300.1	NASA Personal Property Disposal Policy
NPD 8730.2C	NASA Parts Policy
NPD 8730.5	NASA Quality Assurance Program Policy
NPR 4200.1	NASA Equipment and Management Procedural Requirements
NPR 4200.2	Equipment Manual for Property Custodians
NPR 5900.1	NASA Spare Parts Acquisition with Change 2
NSF 1845	NASA Federal Acquisition Regulations (FAR) Supplement (NFS) Government Property
SCWI-3410-0003	Stennis Center Training/Certification Plan and Schedule Report
SLS-PLAN-001	Space Launch System Program Plan
SLS-PLAN-003	Space Launch System Program (SLSP) Systems Engineering Management Plan (SEMP)
SLS-PLAN-004	Space Launch Systems Program Data Management Plan
SLS-PLAN-020	Space Launch System Program (SLSP) Concept of Operations
SLS-PLAN-027	Space Launch System Program (SLSP) Environmental Management Plan
SLS-PLAN-036 <TBR-008>	Space Launch System Program (SLSP) Certificate of Flight Readiness (CoFR) Implementation Plan
SLS-RPT-087 <TBR-010>	Space Launch System Program (SLSP) Integrated Mission and Fault Management (M&FM) Design Analyses and Performance Assessment

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SLS-SPEC-030-01 <TBR-012>	Space Launch System Program (SLSP) Support Equipment Specification, Volume I: Support Equipment Planning
SLS-SPEC-030-02 <TBR-012>	Space Launch System Program (SLSP) Support Equipment Specification, Volume II: GSE Design and Construction Requirements
SLS-SPEC-030-03 <TBR-012>	Space Launch System Program (SLSP) Support Equipment Specification, Volume III: Derived Requirements
SLS-SPEC-030-05 <TBR-012>	Space Launch System Program (SLSP) Support Equipment Specification, Volume V: Heritage Ground Support Equipment (GSE) Certification Process Plan
SLS-SPEC-032	Space Launch System Program (SLSP) System Specification
SLS-SPEC-043 <TBR-013>	Space Launch System Program (SLSP) Vehicle Operations and Maintenance Requirements Specification (VOMR)

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3.0 PROGRAM OVERVIEW

The SLS Program (SLSP) is tasked to design, develop, operate, and retire a system that can deliver crew and cargo to low Earth orbit and to enable missions beyond Earth orbit.

The Space Launch System consists of four major Elements: 1) Stages (core and upper), 2) Liquid Engines (core and upper), 3) Boosters, and 4) Integrated Spacecraft and Payload Element (ISPE).

The Space Launch Vehicle consists of: 1) Stages (core and upper), 2) Liquid Engines (core and upper), 3) Boosters, and 4) Launch Vehicle Spacecraft Adapter (LVSA).

The detailed description of the system is located in SLS-PLAN-020, SLSP Concept of Operations (Con Ops) and also SLS-SPEC-032, SLSP System Specification document.

3.1 Integrated Logistics Support Team

An SLSP ILS team, as shown in Figure 3-1, has been established to ensure the implementation of NPD 7500.1. This team will serve as the forum for facilitating and integrating SLSP logistics and supportability functions, activities, and products. The ILS team includes membership from various organizations and disciplines as follows: Logistics (Supportability Engineers), SLS Elements, Human Factors Engineering, Safety and Mission Assurance (S&MA), Packaging, Handling, Storage, and Transportation (PHS&T), GSDOP, and other experts as needed.

SLSP ILS activities and analyses are highly dependent upon close interaction with SLSP Safety and Mission Assurance (S&MA) activities and analyses. It is important that a close working relationship be established early among S&MA and Operations Engineering to assure effective interaction and timely exchange of information. In order to achieve this, SLSP S&MA personnel participate as members of the integrated logistics support team to provide Reliability, Maintainability, and System Safety discipline expertise and analytical support. Refer to the SLSP S&MA Plan, SLS-PLAN-013, for more details of the SLSP S&MA activities.

The ILS team will analyze and integrate Elements logistics data in an effort to find program efficiencies and produce system level products that can be used by GSDOP in the development of ground processes. Logistics planning, analysis, and integration includes:

- Design interface, which includes assessment of designs, operational tasks, and other issues.
- Maintenance, including concept, plans, level of repair, etc.
- Facilities, as it relate to usability, supportability, testability, etc., and assessment of existing support infrastructure.
- Support equipment (SE) (to include special test equipment and ground support equipment (GSE)).
- Supply support (spares, provisioning, obsolescence planning, etc.).
- PHS&T.

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- Technical data and documentation.
- Manpower and personnel (skill levels, certification, etc.).
- Training (maintenance and logistics).
- Sustaining engineering.
- Technical performance measures.
- Property management and disposal.

The products resulting from these analyses are discussed in section 4.3.

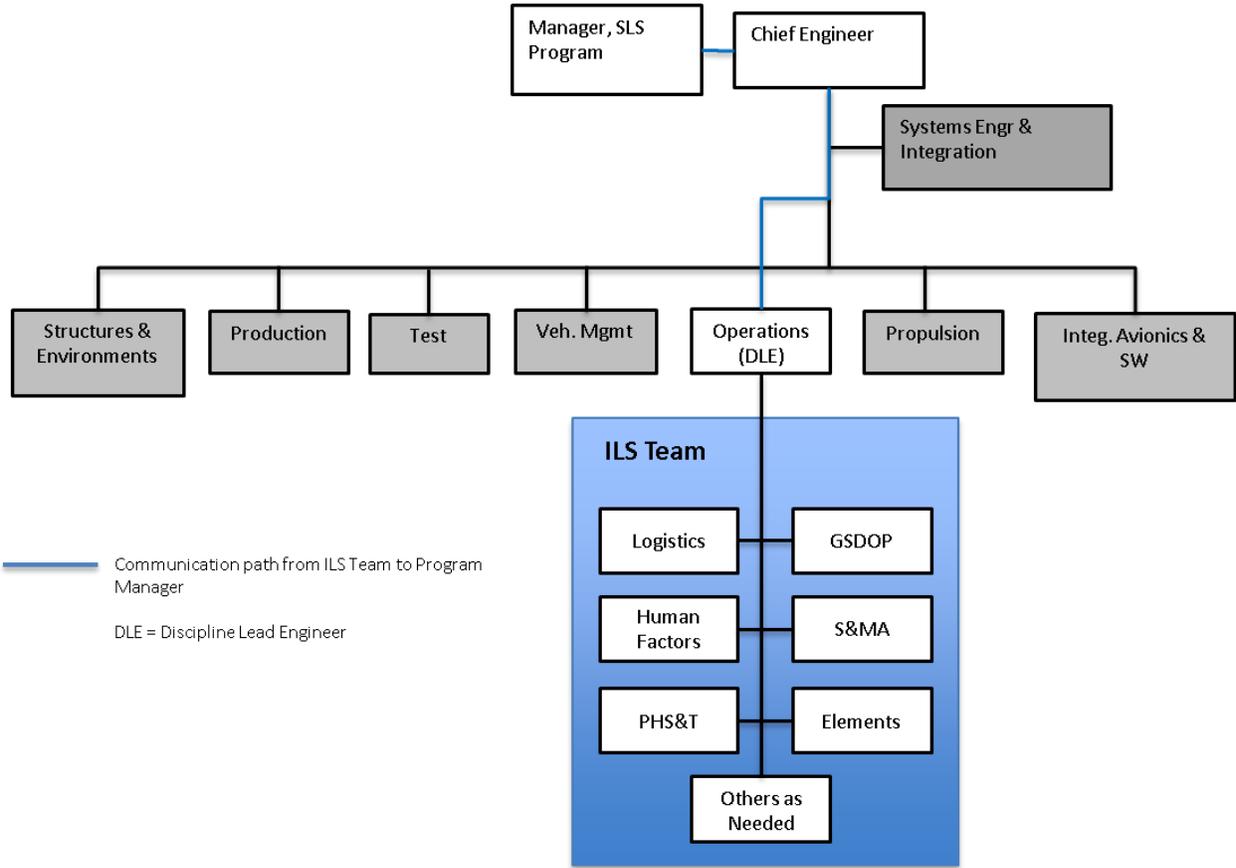


Figure 3-1 Integrated Logistics Team Members

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3.2 Supportability Requirements

The supportability requirements, made up of design constraints and system requirements for design influence and operations, have been identified by the SLSP ILS Team for the SLSP. A list of key supportability requirements for SLS can be found in SLS-SPEC-032. The current systems capability requirements for logistics follow.

Design constraints for the SLSP for supportability purposes are as follows:

Block 1: Core stage be structurally stable without pressurization during all phases of ground transportation and processing.

Block 1A: Core stage and booster (if liquid) structurally stable without pressurization during all phases of ground transportation and processing.

Block 2: Core stage, upper stage, and booster (if liquid) structurally stable without pressurization during all phases of ground transportation and processing.

System Requirements that drive the logistics policies for SLSP for supportability purposes are as follows:

- Service life.
- Launch countdown hold.
- Operational life for launch attempts.
- Pad stay time.
- Internal access.
- Vehicle stack time.

Human factors requirements are addressed in the Human System Integration Requirements (HSIR), SLS-RQMT-161.

The SLS Supportability Engineers, while working with the SLS Systems Engineering Team, will work together on the verification of design constraints and system requirements. Through the insight role and participation in design reviews, SLS Supportability Engineers will ensure proper derivation of requirements and implementation into the vehicle and element designs.

3.3 Technical Performance Measures

The SLS-PLAN-047, SLSP Technical Metrics Plan (TMP), will be used as a tool to assist SLS program managers in decision making. The SLSP will track metrics to assess SLS technical progress which in turn will provide an early warning of potential deficiencies before irrevocable cost and schedule impacts occur. Technical Performance Measures (TPMs) measure parameter values that vary from an expected range to indicate a need for evaluation and potential corrective action. The current supportability measures for logistics are:

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- Launch availability.
- Launch reliability.
- Maintenance down time.
- Systems readiness.
- Element maintainability.
- Core stage engine change-out.

Data provided by the Elements is assessed by the SLS Operations Engineering team and reported as required per the SLSP TMP. SLS Management reviews the assessments and takes the measures necessary to mitigate issues.

Supportability metrics, both qualitative and quantitative, are a means of ensuring that the supportability goals for the SLS system are achieved, reference Appendix C.

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4.0 SUPPORTABILITY ENGINEERING AND ANALYSIS

4.1 SLS Logistics Supportability Engineering Strategy

The primary goal of the Space Launch System (SLS) supportability strategy is to ensure that when the SLS is fielded (at the destination in which it will be operated), it is fully operable and maintainable in its intended environment. The supportability analysis strategy will help develop an effective and economical support infrastructure for the SLSP. The early focus of the supportability analyses will emphasize developing an approach for Block 1, along with establishing supportability requirements/metrics and identifying design opportunities for reducing integrated program costs for the long-term flight program. The approach for Block 1 is provided in Appendix A. As system design progresses, the supportability analyses will develop a baseline comparison system to support system concepts alternatives, conduct evaluation of alternatives, and estimate logistics support requirements. In order to be effective, the SLS supportability analyses will be conducted within the framework of the supportability engineering process as shown in Figure 4-2. The analyses will be iterated as the design progresses to ensure that support concepts meet defined SLS technical performance measures (TPMs).

4.2 SLS Logistics Support Analysis Overview

The Logistics Support Analysis (LSA) process is a diverse activity and involves the following technical engineering disciplines as Illustrated below in Figure 4-1.



Figure 4-1. Supportability Engineering Relationship

The LSA process provides an industry standard approach to identify design opportunities for improving supportability. The SLSP Integrated Logistics Support (ILS) team will integrate LSA

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activities in support of the SLSP. These activities will identify opportunities to improve supportability during the design process. Some of the activities that will be performed by the ILS team include:

- Identify the supportability design baseline comparative system to support completion of SLS supportability analyses, assessments, and the development of SLS acquisition logistics planning. (Vehicle)
- Provide insight/oversight to Level III through supportability assessments and coordinate with subsystem Element Discipline Lead Engineers (EDLEs) to optimize design for supportability. (Vehicle)
- Coordinate with S&MA in the assessment of the launch availability, maintainability, and core stage engine change-out TPMs. (Vehicle)
- Coordinate with GSDOP and Multi-Purpose Crew Vehicle (Orion-MPCV) via the Logistics Integration Team (LIT) in the development of the ground processing potential off-nominal tasks. (Vehicle)
- Coordinate with GSDOP and Orion-MPCV via the LIT in determining logistics management information (LMI) data for the data input to the ground data architecture. (Vehicle)
- Conduct trades, analyses and/or assessments of the SLS support concepts and maintenance planning for the potential operational configurations and anticipated launch requirements. (Vehicle, Element)
- Develop supportability high drivers for each Level III hardware element. High Driver defined as lower reliability or higher Maintenance Down Time (MDT) and/ or a combination of the two. (Elements)
- Conduct maintenance engineering analysis on selected supportability high drivers. (Elements)
- Develop off-nominal timeline and conduct “what-if” analyses to assess launch availability. (Element, Vehicle)
- Develop the maintenance (off-nominal) footprint for the SLS vehicle during assembly and launch operations at Kennedy Space Center (KSC). (Element, Vehicle)

The specifics describing the LSA approach will be contained in the LSA Report (SLS-RPT-108) and will contain: 1) roles and responsibilities for performing LSA to include the integration of the Element inputs, 2) the project element logistics support data requirements, and 3) the LSAR data base development, integration, and use. These LSA activities will identify opportunities to enhance SLS supportability and reduce costs. Figure 4-2 provides the process flow for implementation of supportability engineering analyses activities and to ensure supportability concerns are being considered during SLS design.

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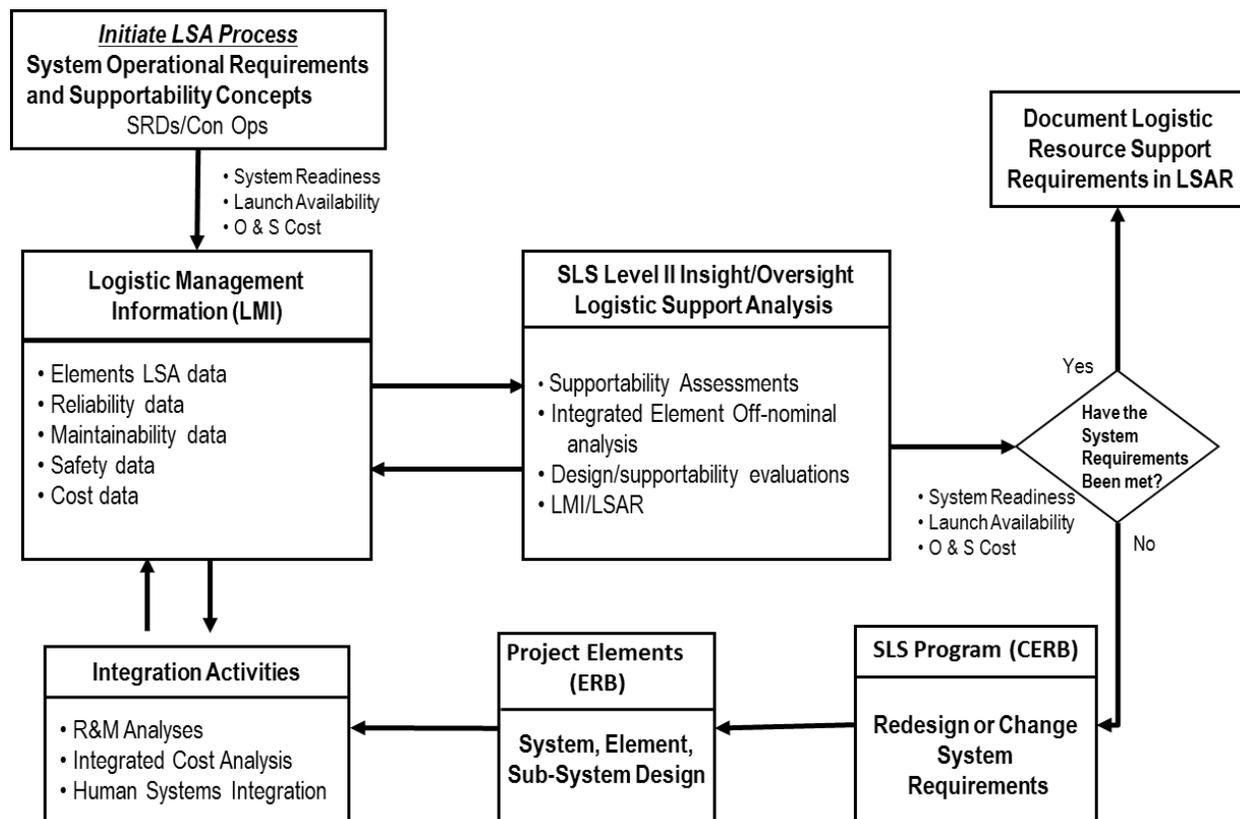


Figure 4-2 Supportability Engineering Implementation Process

4.3 SLS Logistics Supportability Analysis Products/Activities

There are several products/activities to be accomplished for a detailed and complete LSA program. The Elements are responsible for conducting their own studies and concepts. SLSP ILS Team is responsible for conducting an integrated analysis to define the support system and provide that analysis to GSDOP for facilitation of the cross program integration. The integrated analysis will also be available to the SLSP and LIT. Below is a listing of typical activities to be performed with associated delivery milestones.

- Conduct use study. (System Definition Review (SDR))
- Develop and maintain the Level II ILSP. (Preliminary Design Review (PDR), Critical Design Review (CDR))
- Identify comparative systems. (PDR)
- Develop the maintenance concept. (PDR)
- Identify support concepts. (PDR)

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- Identify supportability characteristics. (PDR, CDR)
- Identify support system alternatives. (PDR, CDR)
- Identify qualitative supportability, cost, and readiness drivers. (PDR)
- Identify supportability constraints. (PDR, CDR)
- Identify alternative support system trade-off studies. (PDR, CDR)
- Develop, analyze and maintain line replaceable unit (LRU), and limited life components list. (PDR, CDR)
- Conduct supportability assessment. (PDR, CDR)
- Identify supportability risks and risk reduction approaches. (PDR, CDR)
- Conduct maintenance engineering analyses. (PDR, CDR)
- Establish logistics control numbering system. (PDR, CDR)
- Establish and maintain logistics support analysis record (LSAR). (PDR, CDR)
- Identify operations and maintenance tasks. (CDR)
- Establish logistics configuration baseline. (CDR)
- Conduct and document task analysis. (CDR)
- Prepare logistics resource recommendations. (CDR)
- Identify and document logistics resource requirements. (CDR)
- Conduct task validation. (CDR)
- Identify and prepare logistics support output products. (CDR)
- Develop a supportability test, evaluation, and verification methodology. (CDR)

The specifics describing the roles and responsibilities will be provided in the LSA Report (SLS-RPT-108) to include the Project Elements logistics support data requirement descriptions (DRDs), integration of the Element inputs within SLS, and the integration/oversight roles of the ILS Team. This list will be re-examined at each major milestone to determine the products/activities to be accomplished.

4.4 Supportability Test and Evaluation

The SLSP supportability engineers will analyze data from Block 1 test and checkout to assess supportability factors. Test data and analyses acquired from Exploration Mission Flights 1 and 2 of the Block 1 configuration will be utilized to identify gaps and document “lessons learned” for a supportable, maintainable, and low-cost SLS system for Block 1A and future Exploration Missions. Supportability demonstrations for maintainability assessment should be included in

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system test plans and activities. The SLS supportability assessment will also identify potential supportability improvements to include:

- Effectiveness of the SLS maintenance concept.
- Maintainability and accessibility accomplishments against established metrics.
- Personnel skills required to operate, maintain, and support the SLS system.
- GSE to perform maintenance operations.
- System transportability.
- Facilities required for supporting operations, maintenance, and storage functions.
- Operations and maintenance instructions.
- Computer resources support.
- Packaging, handling, and storage procedures.
- Testability.

The results of these assessments will be documented in the LSA Report SLS-RPT-108 and summarized in the SOAR SLS-RPT-168.

4.5 Life Cycle Cost Analysis

The SLS life cycle cost analyses (LCCA) are bottoms-up engineering analyses performed by the SLS system for determining total ownership cost (TOC). The SLS Elements are responsible for identifying costs associated with their Element. The SLSP ILS team is responsible for integrating the SLS Elements' costs and providing an LCCA input that identifies the P&O costs in support of the PP&C/XP03 office which is the OPR for the SLSP LCCA Report, SLS-RPT-096 per agreement with the PP&C office and SLS Chief Engineer. The LCCA/TOC consists of three parts: design interface, validation of support methods, and validation of operations. The LCCA is used to support the design analysis cycles (DACs), trades, change requests, engineering change proposals, comparative assessments, sensitivity analyses, and milestone reviews through all life cycles and is not intended to be a budget tool. The LCCA results will determine cost-effective support infrastructure solutions and supportability enhancements for production and operations (P&O). The SLSP ILS team is responsible for integrating the SLS Elements costs and providing an LCCA that identifies the P&O costs.

The allocated funds for design, production, operations, and other vehicle assets will be assessed to determine cost differences driven by vehicle design. In conjunction technical trades will be performed to identify lower cost options. Other trades not driven by vehicle design will also be supported by LCCA.

Design interface will include integration of supportability into flight and ground hardware design using LCCA to assist in determining cost-effective support infrastructure solutions and

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supportability enhancements for P&O. Assessment of support and operations costs will include a broad range of areas to include ILS planning, personnel, equipment, and facilities that ensure the system is available and operational.

It is imperative to set the baseline for affordability and supportable flight hardware and ground support infrastructure during the Block 1 SLS Program life cycle. Incremental improvements for designing to cost through application of lessons learned and innovation will be applied to ensure affordable and cost-effective operations, both on the ground and in flight for Block 1A.

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5.0 INTEGRATED LOGISTICS SUPPORT (ILS) ELEMENTS

5.1 Maintenance Planning

The goal of the maintenance planning process is to identify maintenance support roles and responsibilities, and resources for the SLS integrated vehicle and to develop interim approaches for the Block 1 flight configurations. Maintenance planning information will be exchanged between the analysts of the SLS Elements and the analysts of the integrated vehicle. This exchange of information will highlight areas where combining support resources may improve both effectiveness and affordability of the integrated maintenance infrastructure. SE&I (Operations) will develop and publish the SLS Maintenance Plan <TBD-001> for overall Program use. The SLS Maintenance Plan will utilize the SLS Element maintenance planning provided by the Elements and provide enough detail to allow the end user to plan and provision for the required support. The SLS Maintenance Plan will be used in implementing maintenance support for the SLS vehicle at the launch site.

Maintenance planning covers a broad range of areas, including maintenance, repair, supply, data management, spares philosophy, part obsolescence, identification and response planning to the component (line replaceable unit (LRU) as defined in 5.1.1.2) level, transportation, handling, storage, and disposal. Level of repair analysis (LORA) will also detail locations for maintenance and repair.

5.1.1 Maintenance Concept

The maintenance concept is a planning guide for influencing system design and to establish the framework for development of the maintenance plan. Flight and ground hardware design engineers will ensure that systems are maintainable and supportable using a maintenance concept that includes launch site operational logistics support infrastructure, manufacturer facilities, and interim original equipment manufacturer (OEM) capabilities. The SLSP maintenance concept consists of a two-level maintenance system, organizational and depot/OEM, utilizing LRUs for launch site organizational corrective maintenance as items that are removed and replaced. The Elements are responsible for their own maintenance concepts and will define the maintenance locations, functions, and terms such as: location capabilities, corrective/preventive tasks, maintenance significant items (MSIs) (as defined in 5.1.1.1), and LRUs (as defined in 5.1.1.2). SLS Logistics is responsible for conducting an integrated analysis to provide to GSDOP via the LSA Report. The purpose of the maintenance concept is to:

- Develop a common “language” for supportability/maintenance planning.
- Establish SLS maintenance parameters for technical performance measures (TPMs).
- Identify evaluation and support systems improvements.
- Determine the foundation for supportability alternative trade-off analyses.
- Provide framework for optimization of maintenance allocations through LORA:
 - Non-economic analysis.

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- Economic analysis.

The Elements are responsible for incorporating the SLSP maintenance constraints into their maintenance planning to ensure Element requirements are consistent with capabilities and resources at KSC. For Block 1, the maintenance concept is defined in Appendix A and the maintenance solution should include results of trades and consideration of utilizing LRUs for launch site organizational corrective maintenance as items that are removed and replaced.

As part of the supportability engineering approach for Block 1A, non-economic LORA, maintenance engineering analysis (MEA), MSI candidate analysis, and preventative/corrective actions identification, will aid in the determination of the detailed maintenance concept and support alternatives.

There are two physical locations at which maintenance will be performed for SLS: Kennedy Space Center (KSC) and the manufacturing site. Maintenance locations are determined by access (external and internal), weight of LRUs, hazardous processing, availability of tools and test equipment. Maintenance actions are distinguished by whether de-stacking is required to perform a maintenance function on a given item. There will be four configurations: 1) SLS stacked at the pad, 2) SLS stacked at the Vehicle Assembly Building (VAB), 3) element un-stacked at the VAB, and 4) element disassembled at manufacturer.

Maintenance functions are consolidated into a total set of responsibilities for each location, and the resources (people, training, support equipment, test equipment, materials, and facilities) are summarized to produce the physical resource package that must be present to perform all designated maintenance functions. This combination of locations and functions will determine the logistics footprint that will be required to support the SLSP.

The SLSP will utilize a set of qualitative guidelines, based on the maintenance concept, to assess Element supportability design maturity for maintenance activities through Preliminary Design Review (PDR) and into Critical Design Review (CDR). These guidelines are intended to drive system design to decrease downtime due to maintenance, reduce complexity of maintenance actions, and reduce operations and maintenance (O&M) costs. Examples of qualitative requirements include LRU interchangeability, clearance for inspection and tool access, use of captive fasteners on LRUs, and use of standard tools for LRU removal and replacement.

Where practical and feasible to do so, implementing certain Fault Detection, Isolation, and Recovery (FDIR) capabilities in the design of MSIs and LRUs should be considered for the purpose of maximizing the affordability of troubleshooting and maintenance activities and the availability of the launch vehicle. This includes taking into account the pad accessibility of the MSI or LRU and determining if it is prudent to develop and utilize non-invasive/intangible (hands off) means of troubleshooting the failure (even to a level within the MSI or LRU), in order to acquire as much knowledge about the failure as possible. Having such insight would be beneficial before deciding to roll back the vehicle to the VAB for removal and replacement of the MSI or LRU (if deemed necessary), or before continuing with launch. Moreover, such

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diagnostic functions for MSIs and/or LRUs may also prove invaluable in test and checkout activities during vehicle integration and prior to launch.

5.1.1.1 MSI Selection Criteria

A maintenance significant item (MSI) is an item that is removed and replaced upon failure to restore system operability, but does not qualify as an LRU. It may also be replaced as part of a maintenance action or based on some periodic inspection criteria. Selection of an item to be designated an MSI is based on its design and supportability characteristics and the organization's maintenance philosophy and concept for the system. The possible items that may be designated an MSI include fuses, light emitting diodes, fasteners, switches, sensors, and other such items.

Replacement of an MSI may be an incidental action as part of LRU replacement, or it may be an independent action initiated by maintenance personnel as part of an inspection or test procedure.

For SLSP, the following MSI selection criteria should be considered.

1. Item is not an integral part of any LRU.
2. Item should be accessible for removal and replacement.
3. Item can be removed and replaced without causing collateral damage to the SLS, LRUs, or other MSIs.
4. Item can be removed and replaced without exposing maintenance personnel to unacceptable levels of safety hazards.
5. Item should physically fit through the access door provided for VAB/pad maintenance.
6. Item is procurable.
7. Capability to test/evaluate/assess the item is desirable. This is often accomplished by visual or tactile inspection.
8. Capability to test/evaluate/assess the operability of the system after MSI replacement.

An MSI may require a maintenance task for inspection and replacement. In this instance, a simplified MTA will be prepared to identify the resources required for the task.

5.1.1.2 LRU Criteria

An LRU is an item that is removed and replaced upon failure to restore system operability. Further selection criteria are applied to a MSI list to develop a LRU list. LRU selection is the result of conducting a supportability analysis on a MSI to consider reliability, safety, human factors, schedule, testability, or other factors. Maintenance on items selected as an LRU will be pre-planned. A detailed decision tree for guidance in selecting LRUs can be found in Appendix D. The Elements will meet SLS-RQMT-161, HSIR, for the selection of LRUs. The following criteria should also be considered when selecting an LRU.

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5.1.1.3 LRU Selection Criteria

1. Item should be launch mission relevant, i.e., if a failure does not impact or constrain the authorization to launch, then the item is not an LRU. This determination should be based on the FMEA results.
2. SLS in stacked configuration at the VAB and complete ready-to-launch configuration at the pad should be capable of performing fault detection and fault isolation to the item or an assemblage of items that would be removed and replaced as a group to resolve a system failure or other anomaly.
3. SLS in stacked configuration at the VAB and complete ready-to-launch configuration at the pad should be capable of performing confidence testing after replacement of the item or an assemblage of items that would be removed and replaced as a group to confirm the repair was successful and that no maintenance-induced errors occurred during performance of the maintenance task.
4. Item should be designed such that it can be tested when not installed in the SLS to confirm its operability. This testing includes a pre-installation test to confirm it works before installation and a test after removal to confirm it is non-operable. All LRU testing for SLS is to be performed at KSC or the manufacturer.
5. Item can be removed and replaced without causing collateral damage to the parent or other LRUs.
6. Item is a configuration item and appropriate configuration status accounting and documentation is maintained to assure compatibility with SLS design.

5.1.1.4 LRU Desirable Criteria

1. Item should be accessible without removal of any other item. This means it should not be behind another item that would need to be removed in order to gain access to the item.
2. Item is attached to parent using captive hardware. Where this is not feasible, then appropriate measures must be made for foreign object debris (FOD) protection.
3. Item should be capable of being moved into and out of the SLS by one person.
4. Item has handles or attachment points for lifting devices.
5. Item can be purchased as a single entity or as part of an assemblage that is replaced to restore system operability.
6. Item does not create a requirement for special internal access ground support equipment or other support equipment that has no other SLS application.

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5.1.2 Maintenance Plan

Maintenance planning and the detailed maintenance plan are intended to address the integrated maintenance concept as it applies to MSIs and LRUs, for location and/or frequency of maintenance, including if an item is planned to have the maximum operating time limit or other life limits. Maintenance plan development will begin as the design matures and the support infrastructure becomes defined. Main supportability factors to be considered in determining maintenance plans are development and operations support, storage services, use of facilities, training services, spare parts and components, repair and maintenance services, transportation, and port services. Any requirements for maintenance actions with associated maintenance level, interval, and support equipment requirements will be determined and the indenture level relationship between items will be identified. If maintenance is to be provided by a commercial vendor or contractor, the maintenance plan will identify the extent to which this applies at each level of maintenance to include any items subject to warranties.

The SLS Elements will have differences as well as commonalities in maintenance requirements. The commonality of requirements (primarily at KSC) will be a focal point of maintenance planning at the system level in order to gain the benefits of cost reduction that commonality of maintenance support will produce. This will be linked back to standardization analysis and design requirements through systems engineering. The support system for each of the elements of the SLS may not be individually optimized, but through proper integration, maintenance planning, and assessment, the SLS element support systems will be structured to contribute most effectively to meeting overall SLS support requirements. Conducting alternative trade studies, level of repair analysis, and other analyses of possible support options will identify the most cost-effective options to address future sustainment of the SLS.

The typical process of developing a maintenance plan includes conducting Reliability Centered Maintenance (RCM) and Failure Modes and Effect Analyses (FMEA), which leads to the identification of MSIs. Maintenance tasks for each MSI are identified and undergo a detailed maintenance task analysis (MTA) to determine the personnel, physical resources, and procedures needed to complete the task. Finally, LORA is used to determine the location where each function should be performed. The results of the LORA process will produce a specific result for each item within the system and then a complete solution for the total system.

The roles and responsibilities for SLSP ILS Level II for maintenance planning are to:

- Identify standard/common maintenance requirements for the SLS system.
- Evaluate and assess Elements analyses results.
- Coordinate/participate with Elements during performance of the analyses, as required.
- Integrate elements data inputs in the Logistics Support Analysis Record (LSAR) data base.
- Coordinate with Level I and GSDOP in the development of SLS resource data.

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- Coordinate with Elements and GSDOP in development of the maintenance plan.
- Coordinate/participate with Elements during performance of the MEAs, and logistics demonstrations.

The roles and responsibilities for SLS Elements (Level III) for maintenance planning are to:

- Perform LORA, MTAs, and demos (if required).
- Determine LRUs.
- Determine logistics support resource requirements.
- Perform verification of supportability requirements.
- Provide detailed input and coordinate with the SLSP ILS team in the development of the maintenance plan.

The roles and responsibilities for GSDOP for maintenance planning are to:

- Participate in the standardization/commonality identification process for maintenance tasks at KSC.
- Coordinate/participate with Elements during performance of the MEAs, and logistics demonstrations.
- Coordinate with the SLSP ILS team in development of the SLS support system.
- Support maintenance tasks development.
- Coordinate with the SLSP ILS team in the development of the logistics resource data.
- Coordinate with the SLSP ILS team in the development of the maintenance plan.
- Participate in identifying maintenance requirements with the SLSP ILS team
- Write the Operations and Maintenance instructions using input data from the Operations and Maintenance Requirements and Specifications (OMRS).

The maintenance plan will document the maintenance task requirements to be performed at the launch site, as well as at the OEM depot sites. The SLS Elements, in coordination with GSDOP, will develop detailed Element-based maintenance plans based on the delivered end item (stacked Booster and Core Stage). The SLSP ILS team will then baseline a coordinated and integrated SLS maintenance plan for GSDO implementation to foster an efficient and cost-effective end to end maintenance process.

Maintenance tasks will be based on results of Element reliability data, LSA and operations maintenance requirements. The maintenance task requirements in the finalized SLS maintenance plan will be checked against SLS Integrated LSAR database after CDR to assure a cost-effective process. The generation of definitive maintenance planning details requires data from LSAR

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data tables as generated and provided by the individual Elements. The maintenance plan will address the maintenance of the SLS vehicle during stacking, integrated testing, prelaunch, and launch. GSDO will utilize the maintenance task requirements in development of the overall SLS vehicle processing documentation (OMRS, WADs, MRB, etc.).

5.1.3 Ground Systems Development and Operations Program Responsibilities

The GSDO-PLN-1070, Exploration Systems Logistics Integrated Plan, documents the GSDOP activities associated with maintenance planning at KSC. The following summarizes the GSDOP responsibilities regarding the SLS maintenance plan.

The GSDOP will:

- Perform organizational-level preventive (scheduled) maintenance at the integration site.
- Perform pre-planned and unplanned corrective maintenance as required. Depot level maintenance will be the responsibility of the SLSP. Unplanned corrective maintenance will utilize the Material Review Board (MRB) process and be resolved jointly by SLSP and GSDOP.
- Implement the Integrated SLS Maintenance Plan.

The maintenance concept for integrated operations involves a combination of member programs' responsibilities designed to collectively yield the most efficient approach at the launch site. SLSP has the responsibility to coordinate with GSDO for any required support. In the event that the maintenance being performed is to correct a failure, once the failed item is removed from the vehicle, SLSP will coordinate replacement with a serviceable item.

5.2 Design Interface

Design interface is the interaction and relationship of logistics within the systems engineering process to ensure that supportability is considered in the SLS design. The SLSP ILS team has the responsibility for identifying the logistics support considerations, such as design for maintenance and design for transport, during design efforts. The SLSP ILS team members provide insight/oversight of element ILS programs to ensure that emphasis on the ILS design influence is being addressed across the launch vehicle. Proposed changes in the SLS system design will be assessed for impact on supportability. The SLSP ILS team has assigned supportability engineers dedicated to each SLS Element to provide insight/oversight in design activities and actively participate in design change request reviews and trade studies.

The Supportability and Operations Assessment Report (SOAR), SLS-RPT-168, will provide an assessment at the conclusion of each design analysis cycle (DAC) that captures the supportability and operations analysis results of the Space Launch System (SLS) support solution, provides recommendations, and identifies future work. Each assessment will evaluate the ability of the SLS to meet the total life cycle mission needs within the intended operations and support environment at an affordable cost. The assessment will also provide recommendations to optimize supportability and operations goals while considering affordability for the launch

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vehicle and support infrastructure. The Elements are responsible for incorporating supportability into their designs. Vehicle operations and maintenance impacts due to Element design activities will be addressed in the SLS SOAR. The SOAR information is made available to the SLS program and engineering activities, to include the Elements, and recommended actions are worked with the SLS Chief Engineer's office.

5.3 Supply Support

The purpose of supply support for SLS is to ensure that all materials and equipment are available to perform maintenance, servicing, assembly and checkout of the SLS vehicle at the location and time needed. Supply support also ensures parts are standardized across SLS elements where possible. A delay in supply support can impact the launch schedule and increase the SLSP's costs. Duplication of similar supply items can increase storage space and integrated vehicle costs at the launch site, so standardization and commonality among SLS element parts are important logistical design influences for supply support. The ILS team will perform a series of analyses to determine the integrated supply support strategy in order to mitigate costs. The SLS Elements will support the integrated analyses to minimize interruption in the launch schedule due to supply support issues and also to ensure standardization of common item materials at the launch site, where possible. The SLS Elements will use best OEM practices to plan, establish, and maintain a supply management process to minimize disruptions in launch operations and improve affordability.

5.3.1 Provisioning

The first analysis for determining supply support starts with provisioning. Provisioning is the process of determining the range and quantity of materials required to perform maintenance, servicing of a system, and integrated assembly and checkout at the launch site. These materials are typically categorized as spares, repair parts, bulk items, and consumables. Provisioning ensures the availability of the correct materials for support. The SLSP ILS team, in conjunction with the LIT, will facilitate a provisioning conference to communicate provisioning goals. A provisioning conference will be necessary to communicate the provisioning goals and coordinate provisioning efforts across the SLSP Elements. Each SLS Element will supply a provisioning list to the ILS team so an integrated provisioning list can be prepared and assessed. Provisioning results will be documented in the LSAR. The assessment will look at common material specifications across the SLS Elements. This list will be used to make recommendations for commonality of parts and material at the integrated assembly site and will be used to support the ESLIP.

5.3.2 Spares and Repairs

Any part, component, or subassembly kept in reserve for the maintenance and repair of the SLS vehicle is considered a spare part. Spare parts need to be available to support the SLS vehicle integration and test to ensure the SLS vehicle remains operational, which in turn mitigates impacts to cost and schedule. The results of the provisioning process provide an initial list of spare parts, repairable parts, material for those repairs, and servicing material. The LSA task

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requires the provisioning list for further in-depth study to create an integrated spare parts list. The LSA study weighs the costs, risks, and other impacts in order to create a list of parts and material that will be ordered for reserve to meet the SLS TPMs for launch availability and system readiness.

GSDOP will provide the SLSP real-time supply-support-services for all common material (including consumables, bench stock and personal protective equipment) required during nominal vehicle launch site integration processing <**TBR-006**>. The SLS Elements are responsible for providing element-unique certified hardware and material necessary to process their element at KSC. This includes, but is not limited to, flight-certified bench stock, consumables, and spares. Certified material typically requires more complex supply support services, such as bonded storage and specialized material handling and management procedures. The GSDOP will have common tools available for loan to the Elements. The Elements will need to provide a detailed supply support list to the SLSP ILS team. The SLSP ILS team will work with GSDOP to determine necessary sparing at KSC.

Failed parts may be returned to the OEM for repair. Production assets can be used for spares. When a demand is issued for a spare, the SLS Elements will have a process in place to ensure the spare is provided to the location needed. The SLSP will use one centralized receiving area (program logistics warehouse K6-1547) at KSC for all NASA-owned hardware not requiring special processes unless an alternate process has been approved. This ensures all the contractual and quality paperwork are completed. Special process items are those that are hazardous or oversized. For detailed information on the receiving process reference GSDO-PLN-1070. Having one receiving site for spares and material reduces costs, ensures better visibility of the hardware, and is more affordable as there is no duplication of efforts.

5.3.3 Obsolescence

Part of supply chain management involves monitoring and mitigating obsolescence. Obsolescence occurs when a necessary part, manufacturing capability, or hardware use-life becomes unacceptably eroded due to age, loss of vendor, or environmental and other regulation changes. Obsolescence in component materials as well as the physical dimensions of the component can have a dramatic impact on the long-term viability of a product life cycle. Obsolescence can be costly and should be managed to ensure continued affordability of the SLSP and included in sustaining engineering activities. Each SLS Element has the responsibility to mitigate obsolescence in the design. Each SLS Element has the responsibility to establish and maintain an obsolescence management process. This process will be described in an Element logistics support plan or comparable management tool.

GSDO will manage common material (including consumables, bench stock and personal protective equipment) required during nominal vehicle launch site integration processing. GSDO will also provide obsolescence data, to SLSP, when an obsolescence issue is discovered that affects SLSP.

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There are many tools available to mitigate obsolescence. NASA requires the use of the Government-Industry Data Exchange Program (GIDEP) to control nonconforming products and to perform corrective and preventative actions. The SLSP requirement for GIDEP can be found in SLS-RQMT-014. The Elements and contractors will need to participate in the GIDEP process. SLS has further defined electrical, electronic, and electromechanical parts management in SLS-RQMT-019. SLS-PLAN-027 SLSP Environmental Management Plan defines the Program's approach for proactively managing environmentally-driven obsolescence issues.

5.4 Packaging, Handling, Storage and Transportation (PHS&T)

5.4.1 Overview

The PHS&T plans, processes, and requirements help ensure that SLS equipment, material, and support items are preserved, packaged, packed, marked, handled, transported, and stored properly for short- and long-term needs. Existing marking or packaging on equipment, components, and parts will be used to the maximum extent practical. The Elements are responsible for developing PHS&T requirements that meet the NASA requirements. Integrated vehicle PHS&T requirements can be found in SLS-SPEC-043, SLS Vehicle Operations and Maintenance Requirements. The PHS&T plans, processes, and requirements should be identified and documented by each SLS Element. The PHS&T data the ILS team receives from the Elements through insight/oversight will be documented in the LSAR.

5.4.2 Packaging

Packaging includes marking the item for identification and packaging the item for shipment. Each Element will establish, as appropriate, processes for packaging and marking of their equipment.

For marking of equipment, each Element will identify and label SLS items/parts appropriately per MIL-STD-130, Department of Defense Standard Practice Identification Marking of U.S. Military Property, as listed in the System Specification, SLS-SPEC-032. This includes identification and labeling of items/parts for safety warnings and cautions, manufacturing markings, and a wide variety of logistics information (i.e., handling, storage, and environmental constraints). The NASA FAR 1852.245-74 documents the requirements for identification and marking of government equipment.

For heritage hardware manufactured for the Space Shuttle Program, existing legible marking is acceptable. New flight and GSE hardware should meet the specification, standards, and FAR mentioned above.

Packaging will be designed to conserve weight and volume without reducing the protection required. Consideration for reusable and/or common containers and packaging materials will be made. The SLS Program will appropriately tailor and implement NPR 6000.1, Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components.

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5.4.3 SLS Transportation and Handling

5.4.3.1 Scope

Transportation planning for the SLSP is performed to ensure that all transportation activities and responsibilities are identified and documented. For the purposes of this section, transportation is defined as site-to-site movement of the SLS Elements' flight articles by any mode of transportation (air, ground, rail, and water). This section defines the transportation and handling activities associated with such site specific movements of SLSP Element hardware. This section does not include manufacturing activities at the OEM, assembly operations at KSC, or roll-out activities.

The SLSP Element may require special consideration based on its size, its criticality, its unique lifting and/or handling requirements, and/or its hazardous material content. All SLSP Element hardware is assessed and transported in accordance with NPD 6000.1, Transportation Management, NPR 6000.1, Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components and, NPR 6200.1, NASA Transportation and General Traffic Management. Compliance to NPD 6000.1, NPR 6000.1, and NPR 6200.1 is to the extent specified in Element contracts. SLS Element transportation plans are made available for review at the Element's PDR and CDR.

The SLSP has elected to provide the NASA barge via the MSFC Transportation and Logistics Engineering Office, which owns, maintains, and operates the vessel. The NASA barge is a unique marine transportation asset that may be utilized by multiple SLS Elements (and other possible NASA customers) and thus is coordinated as a Level II function. The MSFC Transportation and Logistics Engineering Office performs all the modifications, maintenance, and operations of the NASA barge for SLSP. Level II provides the MSFC Transportation and Logistics Engineering Office with the funding required to provide these services to the SLSP for transportation of Element hardware.

5.4.3.2 Transportation Process Flow, Roles, and Responsibilities

A summary of the SLS transportation concept is as follows:

- Stages – After the Core/Upper Stage and Liquid Engine Elements are assembled at MAF, the stage is shipped via NASA barge “Pegasus” to SSC for green run testing, then to KSC for vehicle integration.
- Liquid Engines Element – Upon completion of assembly and testing at SSC, the engines are shipped over road by the manufacturing contractor to MAF for integration with the Core/Upper Stage.
- Boosters Element – Components of the solid motor are transported either via rail car or over the road by the manufacturing contractor from the manufacturing facility to KSC.
- Integrated Spacecraft and Payload Element (ISPE) – ISPE hardware consists of four sub-systems: Multi-Purpose Crew Vehicle (MPCV) Stage Adapter (MSA), Interim Cryogenic

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Propulsion Stage (ICPS), Launch Vehicle/Stage Adapter (LVSA), and LVSA Separation System. The MSA will be transported over the road from MSFC to KSC. The ICPS will be shipped from the manufacturing facility via Delta Mariner to Cape Canaveral Air Force Station (CCAFS) for checkout and is subsequently delivered over the road to KSC. The LVSA and LVSA Separation System will be transported to KSC via <TBR-001>.

5.4.3.2.1 Roles and Responsibilities Process Flow for Level II and Level III (Figure 5.4.3-1):

Transportation is an integrated process in the development of SLS Element hardware and follows the described processes flow from planning to implementation, at Level II and Level III, reference Figure 5.4.3-1.

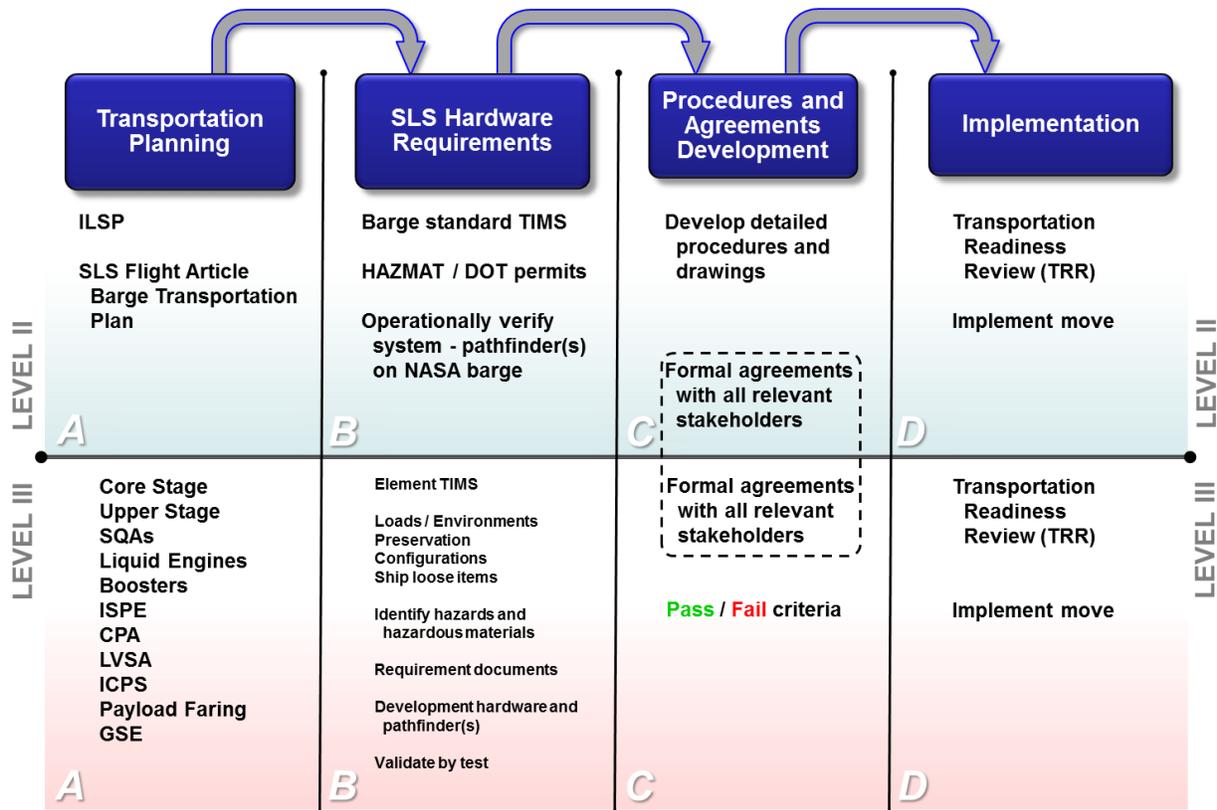


Figure 5.4.3-1 Level II and Level III SLS Element Transportation Roles and Responsibilities

The following summarizes the responsibilities associated with the SLS Element transportation process flow:

- Level II responsibilities include:
 - Establish the overall transportation policies for the SLSP.

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- Provide the NASA Barge services for transporting oversized hardware via water.
- Develop transportation plans for items transported via NASA barge using transportation and monitoring requirements provided by Level III.
- Transportation Plans should include the following at a minimum:
 - Roles and responsibilities.
 - GSE for handling/lifting/moving.
 - Element unique requirements for the transport of hardware (loads, temperature, humidity, shipping configurations, preservation, and identification of hazards and hazardous materials).
 - Provisions for a Transportation Readiness Review (TRR) (for those items designated by the Element Manager).
- Level III (Element) responsibilities include:
 - Develop transportation plans to include but not limited to: Stages (Core and Upper), Structural Qualification Test Article (SQA), Liquid Engines, Boosters, ISPE, Cargo Payload Adapter (CPA), LVSA, ICPS, and Payload Fairing - except those items transported by the NASA Barge.
 - Transportation Plans should include the following at a minimum:
 - Roles and responsibilities.
 - GSE for handling/lifting/moving.
 - Element unique requirements for the transport of hardware (loads, temperature, humidity, shipping configurations, preservation, and identification of hazards and hazardous materials).
 - Provisions for a Transportation Readiness Review (TRR) (for those items designated by the Element Manager).
 - Develop Element unique monitoring and document the requirements.
 - Develop monitor equipment to support the unique requirements of the hardware while in transport and verify the requirements.
 - Develop detailed handling/lifting procedures.
 - Work with Level II, if required, to develop formal agreements with all relevant stakeholders.
 - Develop “Pass/Fail” criteria for hardware delivery based on the monitoring equipment.

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- Implementation/transport of the elements from site to site.

5.4.3.2.2 SLS Element Transportation Process Flow

The following details the SLS Element transportation process flow:

Transportation Planning:

Level II (Figure 5.4.3-1, Section A)

- SLSP establishes NASA level program transportation guidelines within this ILSP to be applied to all levels within this program. SLSP provides the SLS Barge Transportation Planning for guidance to Element (Level III) hardware (reference Appendix B).

Level III (Element) (Figure 5.4.3-1, Section A)

- Elements develop transportation plans for Element hardware and coordinate with Level II on all Element hardware requiring marine operations. The MSFC Logistics Engineering Office (AS42) will assist the Element in development of transportation plans, detailed move procedures, and detailed lifting/handling procedures at the request or concurrence of the Element office.

SLS Hardware Requirements:

Level II (Figure 5.4.3-1, Section B)

- For hardware needing to be transported on the NASA Barge, the MSFC Transportation and Logistics Engineering Office provides a standard barge Transportation Instrumentation Monitoring System (TIMS) that may measure acceleration, temperature, and humidity on the barge. This information may be submitted to an Element if requested.
- Hazardous material information provided by the Element is used to obtain special permits from Department of Transportation (DOT) and other permissions required by the appropriate transportation authorities.
- The MSFC Transportation and Logistics Engineering Office is responsible for the developing and certifying any Marine Transportation Equipment (MTE), as required, to interface with Element hardware for transport on the NASA barge.
- All Elements utilizing the NASA Barge documents requirements within a completed MSFC Form 4575, MSFC Barge Operations Customer Profile. The NASA Barge is classified as Marine Transportation Equipment. As such, its use is controlled by MSFC-PLN-3632, NASA Barge and Marine Transportation Equipment (MTE) Configuration Management Plan. In addition, drawings are developed and configuration controlled in accordance with MSFC-PLN-3632, NASA Barge and Marine Transportation Equipment (MTE) Configuration Management Plan, for all Element hardware being transported on the NASA barge.

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Level III (Element) (Figure 5.4.3-1, Section B)

- Each Element defines the detailed functional, physical, and the associated verification requirements that are necessary to accomplish successful Transportation and Handling (T&H) ground operations of the Element hardware. Each Element also identifies the derived requirements needed to support the Element hardware during T&H ground operations for all modes of transportation.
- Elements provide the MSFC Transportation and Logistics Engineering Office with all hazards / hazardous materials planned to ship on the NASA barge.
- Elements requiring the NASA barge for transport of flight hardware, development hardware and/or pathfinders (or require the NASA barge for other verification purposes) will complete a MSFC Form 4575.

Procedures and Agreements Development:

Level II (Figure 5.4.3-1, Section C)

- Level II develops all detail handling/lifting/moving procedures for all Element hardware that is transported on the NASA Barge. Level II also develops formal agreements (in conjunction with Level III) with all points of receipt and delivery for Element hardware with the appropriate stakeholders. Detailed procedures identify responsibility transfer points and pass/fail criteria for Element hardware.

Level III (Element) (Figure 5.4.3-1, Section C)

- Level III develops all detail handling/lifting/moving procedures for all Element hardware that is transported by all modes of transportation, except NASA barge. Level III also develops formal agreements (possibly in conjunction with Level II) with all points of receipt and delivery for Element hardware with the appropriate stakeholders. Detailed procedures identify responsibility transfer points and pass/fail criteria for Element hardware.

Implementation:

Level II (Figure 5.4.3-1, Section D)

- Level II hosts a Transportation Readiness Review (TRR) prior to the movement of Element hardware utilizing the NASA Barge to ensure that all stakeholders agree, and that all detailed procedures, personnel, equipment, and weather checks are complete/prepared, and all appropriate stakeholders are ready to proceed.

Level III (Element) (Figure 5.4.3-1, Section D)

- Elements host a Transportation Readiness Review (TRR) (if designated by the Element Manager) prior to the movement of Element hardware to ensure that all stakeholders

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agree, and that all detailed procedures, personnel, equipment, and weather checks are complete/prepared, and all appropriate stakeholders are ready to proceed.

5.4.4 Storage

Storage, warehousing, and maintenance facility planning will ensure facilities are available to meet the requirements of all phases of the SLSP. Facilities planning will consider utilizing existing facilities, modifying existing facilities, and construction of new facilities to meet storage and warehousing requirements. Special facility requirements, such as security, environmental, bonded storage, sensitive items, components, manuals, or test program sets, will be documented as data becomes available. Storage planning should also take into consideration that there may be a need for facility services (power, purge support, etc.), as well as the need for periodic access for testing and maintenance while an item is in storage. The SLS is a combination of new designs and heritage hardware; therefore, some of the current facilities and infrastructure supporting the heritage hardware, heritage components, and heritage systems will be transitioned to support the SLSP. The facilities that are used for storing, disassembling, or disposing of displaced systems will be documented. Specific data elements required to document storage and warehousing requirements are in the SLS LSAR Data Style Guide (no document number will be assigned).

The GSDOP will provide bonded storage space at the launch integration site for spares, consumables, and material used during processing. Each Element is responsible for coordinating bonded storage with the GSDOP. The GSDOP Logistics will coordinate procedures for issuing material from bonded storage and for inventory management and control with each Element utilizing GSDOP support. Elements using GSDOP bonded storage need to provide the following criteria to ensure items can be adequately stored:

- Storage life.
- Maintenance and monitoring requirements.
- Security concerns.
- Floor space required (volume).
- Environmental considerations, such as humidity,
- Special packaging and handling, if required.
- Inventory list of materials requiring storage and appropriate transfer paperwork.

5.5 Technical Data and Documentation

Technical data and documentation are comprised of recorded engineering, technical, and cost information and procedures used to define, produce, test, evaluate, modify, deliver, support, and operate the system. The Elements will be responsible for their own technical documentation and technical data rights. SLSP will seek the most affordable technical data rights, with the preference being for unlimited rights. The SLSP Program Management Plan, SLS-PLAN-001 has more information regarding technical data rights.

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The development and maintenance of technical manuals, engineering drawings, technical repair standards, and other related technical documentation that contain the requirements for operating, testing, repairing, and maintaining the SLS and its elements will be adequately planned and managed. Engineering drawings, parts breakdown illustrations, and many other types of technical data will be acquired during the life cycle of SLS. The specific contents and amounts of technical data required will be determined during the system design and system development process. Generally, technical data includes:

- Engineering drawings.
- Function and performance interfaces.
- Physical geometry information and other constraints.
- Process descriptions.
- Material composition.
- Safety requirements.
- Preservation and packaging requirements.
- Test requirements data and quality provisions.
- Environmental stress screening requirements.
- Coordination, interchangeability, form, fit, and function information.
- Maintenance Manuals.
- Spares parts lists.
- Training media, interactive electronic technical manuals (IETMs) and requirements.

Warranty information is another type of technical data. The general management and control of warranty information is usually contained in the support contract. The contract will identify the type of warranty covered under the equipment acquisition. Warranty information on parts covered may be found in contractor-provided documentation.

Test results and impacts on technical data for SLS will be documented.

Technical data collected for SLS will directly feed into and affect the outputs for the standardization analysis, cost analysis, training requirements, LORA, and the LSAR, as well as other documentation produced by SLS personnel. This information must be accurate and in sync with other program documentation.

Data is needed to conduct analyses and to design and develop the ILS infrastructure for the SLSP. The SLSP LSAR database is used to document and manage the supportability and logistics data. The database tool that is being used by the SLSP is PowerLOGJ. PowerLOGJ is designed to assist government agencies and their contractors in developing and integrating their

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supportability analysis data bases. It will load MIL-STD-1388-2B, 2A LSA-036, 2B, LSA-036, MIL-STD-1552 (PMR), 2361 MAC, GIEA-STD-0007, and some PLCS data formats. The primary purpose of this tool is Acquisition Logistics Data Management, data cleansing, and logistics product (LSARs) development.

Use of these LSAR formats facilitates quick import/export activities for the exchange of data between data sources that are maintained by the SLS Elements and the centralized data source that is being maintained at the integrated system level. The Elements will provide their periodic updates. The preferred data format is in accordance with SLSP LMI Style Guidance and an approved DD Form 1949-3.

A general rule for ensuring the approval of data within the database is that only data specifically approved and controlled by the proper stakeholders of a specific SLS Element will be entered into the SLSP PowerLOGJ data tables. It is not the intent of the SLSP LSAR effort to duplicate the supportability analyses efforts of the Elements. SLSP will develop and integrate only the system-level LSAR products required to support the SLSP.

5.6 Support Equipment

5.6.1 Overview

Test and support equipment includes all tools, condition-monitoring equipment, diagnostic and checkout equipment, special test equipment, metrology and calibration equipment, maintenance fixtures and stands, and special handling equipment required to support operation and maintenance functions.

The goal of support equipment (SE) planning for the SLSP is to ensure that the required support and test equipment are available in locations where needed in a timely manner and to minimize the unique types of support equipment necessary for Program support.

The SLS SE is separated into vehicle and element support equipment. The vehicle equipment is developed for multi-purpose use providing operations support services for all SLS Elements. Element equipment is SE developed for operations support services that are unique to each Element. Development of all vehicle equipment is the responsibility of the SLSP, while development of the Element equipment is the responsibility of each Element.

SE design is driven by unique requirements for handling, lifting, accessing, testing, and transporting the SLS flight article and elements. There are two aspects of how SE will be analyzed in the logistics process: 1) flight article support, and 2) SE support. The results of each will be captured in the SLS LSAR database. The exception may be heritage hardware. SLS-SPEC-030-5, SLSP Support Equipment Specification Volume 5: Heritage Ground Support Equipment Certification Process Plan, defines the process in which available data elements for certification are assessed including logistics data required for the LSAR.

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5.6.2 Supportability for Support Equipment

The SLSP SE supportability engineering effort is focused on limiting the system total ownership cost (TOC) through the early identification and reduction of cost drivers. The goal of SE supportability is to influence the system design to consider supportability requirements, resolve all system support issues as early as possible, and secure the support resources required over the system life cycle. The SLSP SE will be cost effectively maintained. The areas of emphasis will include supportability engineering planning, operations and maintenance (O&M) planning, operator/maintainer (O/M) personnel, technical manuals (TMs), training programs, and unique identification.

The resources and spares to support SLS SE will be identified and captured in the LSAR database. The SLSP will develop a spares list for all common Program SE for inclusion in the LSAR. Each SLS Element will provide a spares list as part of the data delivered to be included in the SLS LSAR database.

The SLSP SE hardware and software design and operations will support O&M requirements, while assuring that it does not degrade or contaminate associated flight or ground systems during use, test/checkout, servicing, or handling operations. The SE design will consider human factors and efficiency of operations by providing for ease of operation, maintenance, servicing, and inspection of the hardware and software. The use of specialized tools will be avoided to the maximum extent possible.

5.6.3 Maintainability for Support Equipment

The SE Operations and S&MA teams will provide support for development and distribution of all maintainability related products and support. The S&MA support includes new Element SE design efforts to reduce the complexity and frequency of maintenance, the maintenance resources required to keep the system operational, and maintenance downtime both of the operational system and the SE. Maintenance on the system by the use of SE, and on SE, should not jeopardize the TPMs of element readiness and availability, nor extend operational timelines beyond the allowable limits.

5.6.4 Support Equipment Packaging, Handling, Storage, and Transportation

5.6.4.1 Packaging, Handling, and Storage for Support Equipment

The PHS&T requirements and processes are traceable to the SLS system design process so the SE will be properly protected during movement and storage. The PHS&T requirements for SE can be found in SLS-SPEC-030-02, SLSP Support Equipment Specification, Volume II: GSE Design and Construction Requirements. The resources, processes, and techniques needed to ensure that the SLS will be properly protected during movement and storage will be identified and documented by each SLS Element. Each Element is to develop a plan for SLS items/parts identification and labeling. The plan will include identification and labeling of items/parts for safety warnings and cautions, manufacturing markings, and a wide variety of logistics

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information (e.g., handling, storage, and environmental constraints). The SLSP will implement and adhere to NPR 6000.1.

Program philosophy and general guidance for the SLS dictates that items/parts will be marked with unique identifiers in accordance with MIL-STD-130. Existing storage facilities will be evaluated for adequacy.

5.6.4.2 Transportation for Support Equipment

Requirements for packaging, handling and transportation of Support Equipment will be in accordance with NPR 6000.1.

5.6.5 Support Equipment Sustainment

Sustaining engineering is the technical effort to support an in-service system or vehicle during its operational phase. This effort spans those technical tasks to ensure continued operation, production, manufacturing, and maintenance of the support equipment with managed risk. As a part of this process, the SLSP will utilize supportability engineering and sustaining engineering principles to design systems that require minimal manpower, provide effective training, and can be operated and maintained for a reasonable and affordable cost by the government.

The SLS SE is designed and developed by the Program to deliver SLS flight hardware from manufacturing to the KSC launch site facilities. Some components of the SE systems for both the Program- and Element-level SE will be transferred to GSDOP during the process of moving and supporting flight hardware systems of Elements. The SE involved that is transferred to GSDO will be classified as “resident SE.” The SE that returns to the manufacturing site for reuse will be classified as “rotational SE.” Sustaining engineering responsibilities for the resident SE will become a GSDOP activity <TBR-002>, and rotational SE will continue to be the responsibility of the SLS Program. Sustaining engineering for the SLS SE will be in accordance with SLS-PLAN-093. A complete listing of SE classified as resident and/or rotational can be found in the MSFC Support Equipment Management System (SEMS) database. Refer to SLS-SPEC-030-01 SLSP Support Equipment Specification Vol. 1.

5.7 Training and Training Support

Training and training support encompasses the processes, procedures, techniques, training devices, and equipment used to train personnel to safely operate, maintain, and support the SLS. Training should prepare personnel in safety, operations, and maintenance of the vehicle and support equipment. Training should include certification of personnel, as required. Crew training and procedures are not addressed in this document. The Elements are responsible for their own training and certification.

NASA uses NPR 8715.3, NASA General Safety Program Requirements, for developing safety programs that include training of personnel. Personnel working at a NASA center must complete the training applicable to that center. Some NASA centers have additional information about training for their NASA center. For example, the process flow for institutional training for

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personnel accessing facilities at KSC is outlined in KDP-KSC-P-1206, KSC Area Permit Program.

Each Element will need to follow NPR 8715.3 and develop and implement training to ensure NASA’s requirements for safety, skills, and environmental engineering and occupational health are met. The Element required training should be documented in the Element Logistics Support Plan or comparable document.

The ILS team will facilitate training integration and communication as needed to ensure the planning is in place prior to elements being integrated at KSC. The Logistics Integration Team (LIT) will provide a forum for cross-program discussions to ensure the programs/elements collectively implement planning for the training and training support. Planning will ensure safety and performance requirements are met for maintenance and supportability tasks for the integrated exploration system per GSDO-PLN-1070, ESLIP.

5.8 Manpower and Personnel

Manpower and personnel involves identification of Operations and Maintenance skills required to operate and maintain a system over its lifetime. The SLS Elements are responsible for determining manpower and personnel requirements for their SLS Element. The SLS Logistics team provides the analysis and integration of these skill set lists and delivers an integrated skill set list via the LSA report to GSDOP. This high level integrated assessment looks at integrating manpower quantities and skill sets to reduce costs for the SLSP during integration efforts at KSC, The manpower and personnel integration process will be an integral part of the SLS acquisition effort and for optimizing support requirements during operations.

5.9 Computer Resources

The SLS computer resources for ILS will include the facilities, computer hardware, computer software, documentation, and personnel needed to operate and support those hardware and software systems. It will also include computer resources for training devices and support equipment. The SLS computer resources managers will ensure that computer resources are developed, tested, fielded, configuration managed, and supported in a timely manner. Key computer resource issues, including support constraints requirements, management procedures, computer resource limitations, and operational requirements, will be analyzed for SLS. The SLSP Elements are responsible for computer resources of their element as needed. SLSP Logistics is responsible for identifying computer resources being used on SLSP in order to determine if integration efforts are needed for affordability.

Support requirements for computer software for SLS consist of managing and controlling software, analyzing and correcting software problems, maintaining documentation of software, developing new software, and maintaining the capability to quickly respond to fielded software problems and new requirements. SLS software ILS requirements, constraints, issues, management procedures, and goals for software use will be documented via the LSA/LSAR process.

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Computer resources that SLS may utilize include, but are not limited to:

- **ACEIT:** Automated Cost Estimating Integrated Tools (ACEIT) contains application tools (database, statistical analysis, knowledge libraries, model building, risk analysis, and more) for storing/analyzing cost and technical data, developing cost/cost risk models, sharing, and reporting cost estimates.
- **PowerLOGJ:** PowerLOGJ is designed to assist government agencies and their contractors in developing and integrating their supportability analysis data bases. It will load MIL-STD-1388-2B, 2A LSA-036, 2B, LSA-036, MIL-STD-1552 (PMR), 2361 MAC, GIEA-STD-0007, and some PLCS data formats. The primary purpose of this tool is Acquisition Logistics Data Management.
- **CASA:** The Cost Analysis Strategy Assessment (CASA) model is for general-purpose use and applicable to trade-off analysis by all of the services, the Federal Aviation Administration (FAA), NASA, and the Department of Commerce. CASA can be used for a number of tasks, such as risk and uncertainty analyses. The risk model uses probability distributions to describe the uncertainty in unit cost, mean time between failure (MTBF), and mean time to repair (MTTR). This feature allows the cost analyst to provide a response to questions such as, “How much confidence can we place on this LCC estimate?” or, “How much risk is associated with this life cycle cost (LCC) estimate?”
- **CRADLE:** CRADLE will be used during the operational phase of supportability for logistics requirements. CRADLE is a relational database management system (RDBMS) used to manage requirements. It includes model-based system engineering (MBSE) capabilities that allow engineers to model down to the requirements level. It provides robust reporting and query capabilities to perform ad hoc queries and views of existing data and requirements traceability.
- **SLS DES Model:** The SLS DES model is a discrete event simulation (DES) that was developed using ExtendSim, a COTS software application developed by Imagine That Inc. The SLS DES model was developed to model the processing operations required to ready the SLS flight hardware and software from the start of manufacturing through launch. The model will be used to assess the vehicle design against key operational design requirements, metrics, and support trade studies. Other software tools used in conjunction with ExtendSim are Microsoft[®] Excel, Word, PowerPoint, and Project.
- **SEMS:** The Support Equipment Management System (SEMS) is a database management tool developed by MSFC that provides multi-user capability to access a centralized single source of SLS SE items (GSE) and associated data. For more information on the SEMS database refer to SLS-SPEC-030-01 SLSP Support Equipment Specification Vol. 1.

Computer resources to support IETMs and updates will be needed as well.

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Computer resources will be utilized to properly mark and track parts, GSE, and other equipment as it is moved to support SLS integration. These computer resources will be defined as the program matures.

As described in the SLS-SPEC-032, SLSP System Specification:

- Computer resource requirements for SLS Elements are contained in Element-level documents.
- Computer resource requirements for sustaining engineering are contained in SLS-PLAN-093, SLSP Sustaining Engineering Plan.

The GSDO-PLN-1024, GSDO Integrated Logistics Support Plan describes three inventory management systems that are active at KSC: Space Program Operations Contract uses PeopleSoft Inventory. The Checkout, Assembly and Payload Processing Services use Government Online Data System, and the Institutional Services Contract uses Maximo Asset Management System. The inventory management systems may change when the ground processing contract transitions to the Test Operations Support Contractor (TOSC).

5.10 Facilities and Infrastructure for ILS Functions

Facilities and infrastructure consists of the permanent and semi-permanent real property assets required to support the SLS. The goal is to identify, plan, resource, and acquire facilities to enable logistics and maintenance training, maintenance at the launch site and manufacturing sites, and storage to maximize effectiveness of system operation and the logistic support system at the lowest TOC. The non-availability of facilities can be just as damaging to a system as would be the lack of spare parts, trained personnel, or support equipment. The SLS Elements are responsible for determining facility and infrastructure requirements for their SLS Element. The SLS ILS team provides the analysis and integration of these requirements, coordination of logistics facility requirements with other affected programs, and delivers an integrated LSA report to the GSDOP.

Logistics facility requirements may include, but are not limited to, structural and operational storage areas or special designated work areas for pyros or other hazardous operations. Logistics infrastructure requirements may include utilization of available infrastructure and/or supporting facility systems/equipment such as air or rail transportation, mobile cranes, forklifts, etc. Planning must be comprehensive and include the need for new construction as well as modifications to existing facilities.

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6.0 PROPERTY MANAGEMENT PLANNING

6.1 Roles and Responsibilities

The SLS Elements are being developed at various sites, contractor and government. These numerous locations make the governance of government property more challenging and also make it essential that the NASA centers and contractors establish communication processes to ensure the hardware and equipment needed for the SLS vehicle development and launch is properly maintained, documented, and accounted for. Per the Exploration Systems Logistics Integration Plan, GSDO-PLN-1070, coordination is required between the Elements and Ground Systems Development and Operations Program to ensure smooth integration of transportation, operations and maintenance (O&M), and other support functions at the handover points. The Integrated Logistics Support (ILS) team will work to facilitate these communications.

Property and flight hardware management are essential for the SLSP to ensure SLS hardware and support equipment are at the place needed, at the time needed, and properly documented and maintained. The SLS Program and Element planning and implementation for government property management are required by current Federal Acquisition Regulations (FAR) Part 45 – Government Property (FAR 45) and NASA FAR Supplement Part 1845 (NFS 1845) – Government Property. NASA uses NASA Procedural Requirements (NPR) 4200.1, NASA Equipment and Management Procedural Requirements, and NPR 4200.2, Equipment Manual for Property Custodians, to guide property users in how to manage NASA property. Government property management is applicable to all property which the government has title or will acquire title, whether acquired by the government or contractor. This includes equipment, ground support equipment (GSE), furniture, materials, communications equipment, and software and office equipment, at a minimum. Government property management is not applicable to facilities or expendable supplies required to support the development. NASA Policy Directive (NPD) 4100.1B, Supply Support and Management Policy, addresses supply support and material management.

6.2 Government Property

Government property means all property owned or leased by the government. Government property includes government-furnished property (GFP), contractor-acquired property (CAP), and installation accountable government property (IAGP). The SLS Elements have responsibility for Government Property that has been transferred to them. SLS Logistics coordinates with the MSFC Government Property Office to establish the SLS policies and processes for Government Property.

SLSP and the SLS Elements are responsible for property management of SLS NASA Property for which accountability has been assigned. Responsibilities include:

- Maintenance and Tracking of the property.
- Verify touch points, i.e., paperwork transfer, DD250, NASA center shipping documents, and other NASA center requirements prior to shipping property.

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- Identify contract by NASA center and become knowledgeable of that NASA center's government property process as well as the NASA procedural requirements.
- Identify NASA center points of contact and shipping addresses prior to shipping.
- Identify and establish a process for tracking government property and ensure preventive maintenance is completed as needed.
- Identify storage and transportation requirements for government property.
- Government property shipped to Kennedy Space Center (KSC) will need to go through Central Receiving or another approved process, so that it can be processed (identified, tagged, and tracked) as required.

6.3 Corporate Property

Corporate property is property not owned by NASA. NASA or contractor personnel who bring corporate owned property on-site to KSC or other NASA centers for the purpose of accomplishing assigned duties must clearly identify the property. All corporate property not clearly identified will be considered "Found on Station" and a NASA Form 1618, Found on Station Equipment Investigation, will be processed and the property picked up on government property records. The Elements are responsible for tracking and managing corporate property and ensuring preventive maintenance requirements are met as well as the appropriate certifications.

6.4 Acceptance and Transfer Process

NASA uses Department of Defense (DoD) Form 250 for acceptance. This document is better known as Defense Document (DD) (DD250), Material Inspection and Receiving Report, and is used to document acceptance of equipment/data by the government (i.e., title transferred to the government.) The DD250 is one mechanism that allows the contractor to be paid and is the only form for documenting government acceptance of contractor deliverables. This form is usually filled out by the contractor.

NASA uses the DoD Form 1149 (DD1149), Requisition and Invoice/Shipping Document, to document the transfer of accountability of property already owned by the government from the losing organization to the gaining organization. This form can be used for the return of GFP, shipment of industrial plant equipment, shipment of government property to other contractors, NASA centers, subcontractors, or secondary locations of the prime contractor, and also has other uses. Approval of the transfer must be approved by a property officer and the form is usually filled out by the contractor.

Some NASA centers have approved and implemented equivalent variations of the DD1149 form for use as listed below:

- MSFC uses Form 4554 when transferring or shipping hardware to and from MSFC.
- KSC uses Form KSC28-1149 for the center's requisition and invoice/shipping document.

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Each Element should be aware of when and where acceptance or transfer will occur for their element and ensure the proper paperwork has been completed. SLS-PLAN-036, SLSP Certificate of Flight Readiness Implementation Plan, will contain the acceptance and transfer details of the SLS flight hardware with regard to the paperwork. SLS-PLAN-020 documents the location of the hardware handoffs.

6.5 Disposal

The need to dispose of SLS material can occur anytime during the life of the system. The specific characteristics of the material, the needs of other NASA centers, and the type of property define how it is to be disposed. NPD 4300.1, NASA Personal Property Disposal Policy, provides guidance for disposal of NASA personal property. Each NASA center also has a property management process that is to be followed for disposal of property/hardware to ensure safety of people and environment. The SLSP, the Elements, contractors, and others utilizing NASA property will need to implement these NASA procedures.

Equipment no longer required for the performance of a specific NASA requirement is to be reported to the Property Disposal Officer for reutilization screening throughout NASA. The Property Disposal Officer will:

- Be responsible for the disposal, utilization, reutilization, donation, and marketing of NASA personal property no longer needed by the Program.
- Ensure available NASA property, including equipment, is made available for further use to other NASA centers (including eligible NASA contractors), other federal agencies, and eligible donees in compliance with all applicable federal laws and regulations.
- Provide oversight of remaining equipment which may be sold to the general public in compliance with all applicable federal laws and regulations.

The SLS Elements need to ensure that government material no longer required is promptly identified and processed for disposal in accordance with NASA procedural requirements. The Elements will need to advise the appropriate NASA center of the specific disposal criteria of their element hardware/items. An Element disposal plan should be developed that addresses processes needed for proper disposal of hardware and other items.

Each SLS Element is responsible for disposition of corporate property when the property has reached the end of its operational life or is no longer required to support operations.

- This includes all flight hardware, shipping containers, GSE, fixtures, material controlled by the program or element and material bonded storage controlled by GSDOP or KSC Center Operations Support, or elsewhere at the launch site.
- The Element may wish to return the property to the original manufacturing location or to an alternate location for reuse, or may opt to dispose of excess items at KSC utilizing the KSC Property Disposal process.

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7.0 SUSTAINING ENGINEERING

Sustaining engineering operations will be focused on vehicle production and engineering services, block upgrades, infrastructure maintenance, launch operations, and post-flight analysis.

A block upgrade approach will be periodically applied to address design changes to improve operability, previous flight anomalies and marginal performance trends, manufacturing affordability improvements, obsolescence issues, etc. These block upgrades will be established in specific block upgrade plans.

Production and engineering services will focus on maintaining the vehicle production schedule in support of the program manifest. These services will address supply chain management, manufacturing and transportation infrastructure maintenance, and anomaly resolutions. Material Review Boards (MRBs) will be conducted to disposition parts, as-built versus as-designed mismatched parts, or damaged parts. Field updates will be worked as part of these services when necessary to address processing and handling issues.

Sustaining engineering operations will include post-flight analysis and performance assessments for each SLS flight. Data services to be provided will include recording, archiving, and retrieving data for authorized NASA users. This data will be used to identify improvements in design, manufacturing processes, and ground processing for future flights. This analysis will include performance trends, failure causes and effects, root cause analysis, imagery analysis, reliability and maintainability trends, and safety hazards. Engineering analysis tools and models will be provided to assess the post-flight performance. Safety issues will be addressed immediately in the production flow as necessary. Other issues will be forwarded to block upgrade planning.

Flight readiness reviews (FRRs) will be conducted for each SLS flight. These reviews will result in the Certificate of Flight Readiness, SLS-PLAN-036, Certificate of Flight Readiness (CoFR) Implementation Plan. The results of post-flight assessments from the previous flight will be considered in the rationale for the next vehicle flight as part of the FRR.

Further information regarding sustaining engineering can be found in the SLSP Sustaining Engineering Plan, SLS-PLAN-093.

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APPENDIX A

EXPLORATION MISSION 1 & 2 INTEGRATED LOGISTICS SUPPORT PLAN

A1.0 INTRODUCTION

Appendix A to the Space Launch System Program (SLSP) Integrated Logistics Support Plan (ILSP) delineates how logistics and supportability engineering and management concepts will be applied to the Exploration Missions 1 and 2. Exploration Mission-1 (EM-1) is the first flight for the integrated vehicle consisting of the Space Launch System (SLS), Orion Multi-Purpose Crew Vehicle (Orion-MPCV), and Ground Systems Development and Operations Program (GSDOP) systems. It is an uncrewed circumlunar mission with a free return trajectory to test deep space systems for the Orion and SLS systems. The major mission objectives include demonstrating the integrated flight and ground systems, Orion-MPCV and SLS systems performance, and the Orion-MPCV thermal protection system, by executing a high-speed reentry, prior to the first crewed flight. Exploration Mission-2 (EM-2) is the second flight for the combined SLS/Orion-MPCV/GSDOP systems. It is the first crewed flight and will execute a lunar orbit mission before returning to the Earth. The mission objectives include demonstrating the first human exploration flight beyond Earth orbit (BEO). For further information about the exploration missions, refer to ESD 10012, Exploration Systems Development (ESD) Concept of Operations, and SLS-PLAN-001, SLS Program Plan and SLS Concept of Operations SLS-PLAN-020. Both EM-1 and EM-2 will utilize the SLS Block 1 vehicle configuration.

This appendix will identify and plan specific element and integrated support actions required to achieve the program goals for the exploration missions. This attachment to the ILSP addresses how elements of Integrated Logistics Support—design influence, maintenance planning, manpower and personnel, supply support, support equipment, technical data, training and training support, computer resources support, facilities, packaging, handling, storage, and transportation, as well as other related supportability needs of the SLS vehicle—will be integrated with disciplines set forth in other SLSP documents.

This attachment contains all logistics and supportability activities that will be done by the SLSP to include the Elements, NASA, and the contractor workforce, performing trade studies and providing logistics analysis required for ensuring a complete logistics support system that is affordable and has a lean logistics footprint for the Block 1 configuration.

A1.1 Applicability

The activities contained herein apply to all SLS Block 1 flight hardware, support equipment (SE), transportation equipment, and all other supportable items required for the Block 1 configuration. Some activities will be tailored as appropriate for heritage hardware.

A1.2 SLS Block 1 Description

The Block 1 SLS configuration comprises two five-segment solid rocket boosters and a core stage with four RS-25 engines. The solid rocket fuel for the five-segment solid rocket boosters is polybutadiene acrylonitrile. The solid rocket boosters, core stage, ICPS, and engines are

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expendable. Thrust vector control (TVC) is a combination of existing Ares first stage design (applicable to Booster TVC) and Shuttle Orbiter actuators (applicable to Core Stage TVC). The official, detailed Block 1 configuration drawing is captured in the SLS-SPEC-032, SLSP System Specification. Block 1 SLS will be capable of carrying up to 70 tons—sufficient for an Orion vehicle.

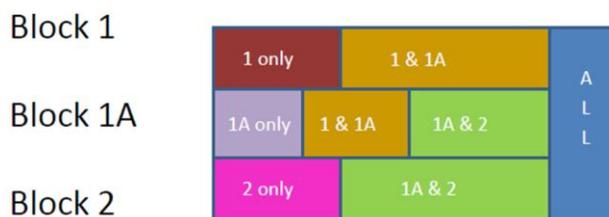
A1.3 Focus of Activities

Three distinct categories of design comprise the Block 1 configuration: items only used in Block 1; items to be used on both Block 1 and Block 1A but not in Block 2; and items to be used in all block configurations: 1, 1A, and 2. The application of supportability analysis and maintenance planning will be tailored to each category of item to achieve the greatest benefit for a minimum amount of effort and cost.

A2.0 Supportability Analysis and Logistics Engineering

Supportability analysis and logistics engineering on Block 1 will focus on improving the system design for testability, accessibility, commonality/standardization, and producibility. This focus is intended to shorten manufacturing time, maximize use of existing manufacturing tooling and equipment, achieve successful operation with the smallest possible logistics footprint and lower cost of ownership. Existing support data created on the Constellation Program, or other heritage items, will be used for the analysis for existing subsystems which were previously developed for Ares I. Minimal analysis will be performed for the solid rocket boosters and will be limited to operations support requirements. Analysis for the RS-25 engines will be limited to existing data augmented by information on any modification or upgrades necessary for installation on Block 1. The remaining portions of Block 1 which will be used only on this configuration will be subjected to limited analysis to identify areas for design improvement that will potentially lower its cost of ownership. Other portions of Block 1 that will be used on either Block 1A or Block 2 configurations will be subjected to further analysis for logistics requirements and design improvements. While design changes to existing items are not anticipated in the successor configurations, the integration of block 1 existing items with newer block design features should be subjected to a rigorous examination of all supportability characteristics to identify opportunities for improvement.

Logistics analyses will be tailored to focus on the hardware that is the same across the blocks as depicted in Figure A2-1. Analyses of common hardware across the three configurations will provide the greatest opportunity to maximize affordability.



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Figure A2-1. Depiction of Common Hardware across Configurations

Tailoring of the supportability analyses and logistics engineering efforts should address the specific requirements for each block configuration. Any item that will only be utilized in the Block 1 configuration, which will be for flights EM-1 and EM-2, should address support resource requirements. Maximum use should be made of existing data generated during the original design and development of heritage hardware. The results of this analysis should be a complete identification of all resources that will be required for support of the test flights. The resources will then be assessed to determine the specific items that must be purchased and pre-positioned to reduce risk of non-availability when required. It is envisioned that the items that appear in only Block 1 should be minimally supported with little residual materials for disposition after the second test flight.

The Block 1A configuration will perform the majority of the currently planned operational SLS flights. Heritage hardware will be replaced with new design hardware. Therefore, analyses should focus on investing in the support requirements from Block 1A implementation and beyond. Analyses should initially address design attributes and characteristics that have the potential to improve supportability and lower cost of ownership. Any item that will be in the Block 1A configuration should be subjected to the full range of analyses with intent to improve the design and reduce cost due to support requirements. Full application and documentation of supportability engineering should provide evidence of results and serve as the basis for long term support development and investment.

The Block 2 configuration will perform the last few operational flights starting after Block 1A is completed. Items should be assessed for obsolescence and life time sustainment. New technology insertion and functional upgrades will require these items to be fully documented for sustainment and obsolescence management. These items should be subjected to the same depth of analysis as items appearing in Block 1A.

A2.1 Supportability Analyses

A tailored supportability analysis will include the following activities for those items that are common across the configurations and are maintenance significant items (MSIs). Below are examples of those analyses needed to meet supportability requirements or technical performance measures (TPMs). LSA tasks are iterative as the design evolves, scheduled in the SLS Integrated Master Schedule, and reported in the SLSP LSA Report, SLS-RPT-108, for SLS milestone reviews and Design Analysis Cycles.

- **Reliability** – For the Block 1 Booster and Core Stage Engine, launch reliability will be estimated based on Shuttle launch/delay history since these elements are unique to Block 1 configuration and no additional reliability analysis requirements have been imposed on these elements. A launch reliability analysis will be provided by the Core Stage element that includes MTBF predictions for each Core Stage LRU.

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- **Maintainability** – The Mean Time to Repair (MTTR) will be estimated for each LRU and will include manual fault isolation time, gain access time, remove and replace time, close access time, and LRU confidence test.
- **Testability** – A fault detection/fault isolation analysis identifies how each failure mode in the FMEA will be detected and isolated. Specific focus will be on completeness of automated methods for fault detection/fault isolation especially after each element has been integrated into the SLS.
- **Accessibility** – Each possible line replaceable unit (LRU) and MSI requiring a maintenance action identified by maintainability analysis should be accessible. An accessibility analysis assures that all LRUs and MSIs can be accessed without damage to the integrated SLS.
- **Standardization** – A complete standardization analysis conducted on all new design hardware and software helps assure the smallest logistics footprint possible. The SLSP ILS team will coordinate between the Elements to develop a consolidated support requirements list.

A2.2 SLS Element Logistics Support Analysis for Block 1

The SLS Elements (Stages, Booster, Engine, and Integrated Spacecraft & Payload Element (ISPE) Office) will conduct a cost-effective LSA program for their respective hardware and software to achieve logistics design influence and to identify supportability issues, production and operations (P&O) costs, and other supportability drivers. LSA should be focused on hardware that is the same across the blocks or is an MSI. Existing LSA data for heritage hardware will be provided by the Elements. The data results of the Element LSA processes will be captured in the appropriate Logistics Support Analysis Record (LSAR). The recommended data elements for data capture and instructions for applicability and interpretation are developed by the ILS team and provided in the SLS LSAR Data Style Guide (no document number will be assigned). The preferred software for capture of LSAR data is PowerLOGJ. The SLSP ILS team will have access to the Elements LSA data, and will conduct insight/oversight per SLS-PLAN-022, SLSP Insight/Oversight Plan. LSA tasks are iterative as the design evolves, scheduled in the SLS Integrated Master Schedule, and reported in the SLSP LSA Report, SLS-RPT-108, for SLS milestone reviews and Design Analysis Cycles.

The Elements will ensure supportability, R&M, safety, and logistics analyses are conducted. This data may include but is not limited to the following:

- Reliability and maintainability data as addressed by SLS-PLAN-013 SLSP Safety and Mission Assurance (S&MA) Plan.
- Testability and mission and fault management (M&FM) data, as addressed by SLS-PLAN-085 SLSP Fault Management Plan and SLS-RPT-087 SLSP Integrated Mission and Fault Management (M&FM) Design Analysis and Performance Assessment.

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- Standardization analysis and implementation results.
- Accessibility data and testing.
- MSI list.
- LRU list.
- Maintenance tasks analysis (MTA) data (logistics support resource requirements).
- Supply support (provisioning/initial spares) requirements.
- Packaging, handling, storage, and transportation (PHS&T) requirements.
- Post-production support requirements.
- Technical data, drawings, and databases.
- Total life cycle cost.

The Elements will provide access to any analysis and trade studies conducted to support SLS insight/oversight and validation of SLSP supportability and logistics requirements or technical performance measures.

The SLSP ILS team will conduct supportability analyses for the integrated Block 1 configuration and will document the results in the SLSP LSA Report. The following is a list of analyses and assessments:

- Use study.
- Standardization analysis.
- Comparative analysis.
- Technology opportunity analysis.
- Availability and readiness analysis.
- Integrated maintenance engineering analysis.
- Support system alternatives.
- Evaluation of alternatives and tradeoff analysis.
- Integrated task analysis.

The purpose of these analyses is to identify omissions, duplications, and areas for cross-improvement based on the consolidated results from all Elements.

A2.3 Maintenance Task Analysis (MTA)

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The foundation for development of the operation and maintenance support solution for Block 1 will be a comprehensive Maintenance Task Analysis (MTA) for each MSI and LRU. Each Element is responsible for generation of all MTA data required for operation and maintenance and its documentation as required per contract. Maximum use of support data for heritage items prepared on previous programs should be incorporated wherever possible to reduce cost; however, all heritage data must be validated as accurate and complete before use on Block 1. The SLSP ILS team will integrate MTA activity for item commonality and consolidation of the results into a total SLS support solution. MTA analysis results should include but not be limited to the following:

- Cautions and warnings or other safety related issues.
- Steps to perform each task.
- Time to perform each step.
- Elapsed time to perform each task.
- All materials required.
- Number of persons performing each step of each task.
- Skill qualifications and certifications required for persons performing each step of each task.
- Support equipment, test equipment, and tools.
- Facility requirements.
- Specific data element for recording the MTA results in the LSAR are provided in the SLS LSAR Data Style Guide (no document number will be assigned).

A2.4 Level of Repair Analysis (LORA)

The maintenance concept for Block 1 stipulates that minimum repair be performed in order to reduce the size and cost of the logistics footprint. Unless cost prohibitive, the preferred support solution for all items that are used solely on the Block 1 configuration should be replacement and discard at point of failure. Items that are used in both the Block 1 and Block 1A configurations may benefit from some type of planned repair activity, but this should be limited to items that are capable of being repaired by the original equipment manufacturer (OEM) with little or no increase in the logistics footprint. Items that will be common in all SLS configurations should be considered for formal repair processes when cost effective.

Each Element will develop criteria for LORA decisions as required per contract. The criteria will be provided to the SLSP ILS team through insight/oversight for coordination with other Elements in developing a consistent approach. LORA criteria may consist of:

- Cost.

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- NASA policy.
- Safety.
- Timeline requirement.
- Security.
- Technology limitations.
- Existing KSC/OEM capability.
- Resource limitations.
- Obsolescence.

A3.0 Life Cycle Cost Analysis (LCCA)

The SLSP ILS team will develop an LCCA for the Block 1 configuration using appropriate input data provided by the Elements through insight/oversight. The majority of input data should be available in the LSAR database; however, some key constants and variables may be required from other sources. These other sources will be coordinated between the Elements and the SLSP ILS team for consistency and completeness. The software packages Cost Analysis Strategy Assessment (CASA) and Automated Cost Estimating Integrated Tool (ACEIT) will be used.

A4.0 ILS ELEMENTS

A4.1 Maintenance Planning

A4.1.1 SLS Maintenance Concept

There are two physical locations at which maintenance will be performed for SLS Block 1 configuration: KSC and the manufacturer. Maintenance locations are determined by access (external and internal), weight of LRUs, hazardous processing, and availability of tools and test equipment. Maintenance actions are distinguished by whether destacking is required to perform a maintenance function on a given item. There will be four configurations:

1. SLS stacked at the pad.
2. SLS stacked at the VAB.
3. Element unstacked at the VAB.
4. Element disassembled at manufacturer.

A4.1.2 Block 1 Maintenance Concept

Since Block 1 is a one-time configuration, it is imperative that minimal investment be made in a support infrastructure. Each Element prime contractor will develop the initial maintenance solution for its hardware. Such initial maintenance solution will be reported through the Elements. The ILS team will consolidate and optimize the results into an overall operation and

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support solution. Maximum use will be made of existing data generated on previous programs as the basis for this solution to minimize the cost of analysis as well as the cost of any resulting support solution. Information on items within the Block 1 configuration that will also be part of Block 1A or Block 2 will be retained for future analysis. Items in the Block 1 configuration that are not used in Block 1A or Block 2 will be considered candidates for discard upon failure with no planned corrective or preventive maintenance. The Elements are responsible for ensuring Element maintenance requirements are consistent with capabilities and resources at KSC.

A4.1.2.1 MSI Selection Criteria

A maintenance significant item (MSI) is an item that is removed and replaced upon failure to restore system operability, but does not classify as an LRU. It may also be replaced as part of a maintenance action or based on some inspection criteria. Selection of an item to be designated an MSI is based on its design and supportability characteristics and the organization's maintenance philosophy and concept for the system. Examples of possible items that may be designated an MSI include fuses, light emitting diodes, fasteners, switches, sensors, and other such items.

Replacement of an MSI may be an incidental action as part of LRU replacement, or it may be an independent action initiated by maintenance personnel as part of an inspection or test procedure.

For SLS Block 1, the following MSI selection criteria should be considered:

1. Item is not an integral part of any LRU.
2. Item should be accessible for removal and replacement.
3. Item can be removed and replaced without causing collateral damage to the SLS, LRUs, or other MSIs.
4. Item can be removed and replaced without exposing maintenance personnel to unacceptable levels of safety hazards.
5. Item should physically fit through the access door provided for VAB/pad maintenance.
6. Item is procurable.
7. Capability to test/evaluate/assess the item is desirable. This is often accomplished by visual or tactile inspection.
8. Capability to test/evaluate/assess the operability of the system after MSI replacement.

An MSI may require a maintenance task for inspection and replacement. In this instance, a simplified MTA will be prepared to identify the resources required for the task.

A4.1.2.2 Block 1 LRU Criteria

An LRU is an item that is removed and replaced upon failure to restore system operability. Further selection criteria are applied to a MSI list to develop a LRU list. LRU section is the result of conducting a supportability analysis on a MSI to consider reliability, safety, human

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factors, schedule, testability, or other factors. Maintenance on items selected as an LRU will be pre-planned. A detailed decision tree for guidance in selecting LRUs can be found in Appendix D. The Elements will meet SLS_RQMT-161, HSIR, for the selection of LRUs. For the SLS Block 1 configuration, the following criteria should also be considered when selecting an LRU.

A4.1.2.2.1 LRU Selection Criteria

1. Item should be launch mission relevant, i.e., if a failure does not impact or constrain the authorization to launch, then the item is not an LRU. This determination should be based on the FMEA results.
2. SLS in stacked configuration at the VAB and complete ready-to-launch configuration at the pad should be capable of performing fault detection and fault isolation to the item or an assemblage of items that would be removed and replaced as a group to resolve a system failure or other anomaly.
3. SLS in stacked configuration at the VAB and complete ready-to-launch configuration at the pad should be capable of performing confidence testing after replacement of the item or an assemblage of items that would be removed and replaced as a group to confirm the repair was successful and that no maintenance-induced errors occurred during performance of the maintenance task.
4. Item should be designed such that it can be tested when not installed in the SLS to confirm its operability. This testing includes a pre-installation test to confirm it works before installation and a test after removal to confirm it is non-operable. All LRU testing for SLS is to be performed at KSC or the manufacturer. For testing at KSC, test equipment should be confirmed to be at KSC or delivered as part of the Element hardware package.
5. Item can be removed and replaced without causing collateral damage to the parent or other LRUs.
6. Item is a configuration item and appropriate configuration status accounting and documentation is maintained to assure compatibility with SLS design.

A4.1.2.2.2 LRU Desirable Criteria

1. Item should be accessible without removal of any other item. This means it should not be behind another item that would need to be removed in order to gain access to the item.
2. Item is attached to parent using captive hardware. Where this is not feasible, then appropriate measures must be made for foreign object debris (FOD) protection.
3. Item should be capable of being moved into and out of the SLS by one person per human factors requirements (HSIR).
4. Item has handles or attachment points for lifting devices.

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5. Item can be purchased as a single entity or as part of an assemblage that is replaced to restore system operability.
6. Item does not create a requirement for special internal access ground support equipment or other support equipment that has no other SLS application.

A4.1.3 Maintenance Planning

SLSP Elements will develop maintenance plans tailored for the Block 1. The SLSP ILS Team will integrate Element plans to determine efficient and cost-effective execution of all maintenance tasks. The information for the SLS will be generated from the SLS integrated LSAR database. Maintenance planning should provide a clear sequence of events that start with fault detection based on the FMEA failure modes and step through every action required until the fault is resolved. Maintenance may also include servicing, testing, calibration, or conservation actions required due to materials and components used in the Block 1 configuration. The goal is to develop a complete maintenance solution that addresses applicable part numbers within the SLS Block 1 configuration.

A4.1.4 Summary

At the completion of the maintenance planning analysis there should be a solution for responding to any system failure with specific information pertaining to every MSI and LRU identified for the Block 1 configuration. Where possible, this information should be transparently portable to Block 1A and Block 2 configurations for common items.

A4.2 Design Interface

It is the responsibility of each Element to develop a supportable design. The focus of the design interface effort should center on design characteristics and attributes pertaining to testability, reliability, accessibility, maintainability, and standardization. Specific interest should be given to new design items that will be required to integrate heritage items being incorporated into the Block 1 configuration. These areas should provide the highest return on investment in terms of supportability improvement. Evidence of design interface activities should be provided at each program and technical meeting and should also be captured in the appropriate maintenance plan.

A4.3 Supply Support

The purpose of supply support for SLS is to ensure that all materials and equipment are available to perform maintenance, servicing, assembly, and checkout of the SLS vehicle at the location and time needed. Supply support also ensures parts are standardized across SLS elements. Each Element is responsible for supply support of their hardware. The prime contractor will perform an analysis to the depth necessary to identify spares, repair parts, bulk items, and consumables needed for operations and maintenance support. The results of this analysis will be provided to the SLSP ILS team for integration into a complete SLSP provisioning list.

A4.3.1 Provisioning

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The first analysis for determining supply support starts with provisioning. Provisioning is the process of determining the range and quantity of materials required to perform maintenance, servicing of a system, and integrated assembly and checkout at the launch site. These materials are typically categorized as spares, repair parts, bulk items, and consumables. Each SLSP Element will supply a provisioning list to the ILS team through insight/oversight so an integrated provisioning list can be prepared and analyzed. This list will be used to make recommendations for commonality of parts and material at the integrated assembly site. The results of the provisioning process provide an initial list of spare parts, repairable parts, material for those repairs, integrated assembly materials, and servicing materials.

A4.3.1.1 Block 1 Provisioning Categories

Provisioning documentation that identifies all possible requirements for spares, repair parts, bulk items, and consumables will be prepared by each Element. This documentation should be based on the maintenance planning results described above. The materials required for all maintenance actions should be identified and documented to assure the ability to purchase if required. Each item appearing on any provisioning list should be clearly identified as to its applicability to any SLS configuration. Specifically, all items should be placed in one of the seven following categories:

- Flight Hardware Block 1 only.
- Flight Hardware Blocks 1 and 1A, but not Block 2.
- Flight Hardware Blocks 1, 1A, and 2.
- GSE Block 1 only.
- GSE Blocks 1 and 1A, but not Block 2.
- GSE Blocks 1, 1A and 2.
- Common item with multiple applications to both flight hardware and GSE.

All procurement decisions will be made based on program risk of item nonavailability. Procurement of items for Block 1 will be limited to those items identified as having significantly long lead times which would delay launch for an unacceptable time period should a replacement be required. In most instances, requirements for materials to support maintenance will be obtained from the OEM on an as-needed basis, so the provisioning process should focus on identification of sources should a need arise. Provisioning for items that will be common to Block 1A and Block 2 may result in procurement actions, but only when deemed economically feasible due to economic order quantities. Items that are only used on Block 1 will not be provisioned unless necessary due to critical nature and long re-procurement lead time.

A4.3.1.2 Block 1 Provisioning Documentation

All provisioning data and corresponding procurement decisions will be documented in the LSAR database. Specific data elements for recording provisioning information are provided in the SLS

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LSAR Data Style Guide (no document number will be assigned.) The SLSP ILS team will be responsible for consolidation of all Element provisioning data into a single SLS Provisioning List.

A4.3.1.3 Block 1 Material Management Information

Provisioning data may include but is not limited to:

1. Identification of primary source for procurement including lead time and price based on lot size.
2. Identification of alternate source for procurement. Where items are single source, complete documentation should be provided for second sourcing or functional replacement.
3. Special storage or shipping requirements.
4. Shelf life for Limited Life items.
5. Linking of unit of issue when purchased to unit of measure when used.
6. Disposition upon completion of each test flight for Block 1.
7. Disposal requirements.

A4.3.1.4 Block 1 Provisioning Confirmation

Each Element will be responsible for confirmation of provisioning documentation at an appropriate point in the design cycle. Confirmation will consist of three specific areas: 1) confirming the item is required for ground operations or maintenance and has been linked to the appropriate operations/maintenance actions, 2) all data required to adequately document the item for procurement, management, and disposal is correct, and 3) disposition of the item at completion of Block 1 flights are clearly indicated. Results of provisioning validation will be documented in the LSAR and consolidated by the SLSP ILS team.

A4.4 Packaging, Handling, Storage, and Transportation Plan

Reference ILSP Section 5.4, Packaging, Handling, Storage and Transportation.

A4.5 Technical Data and Documentation

Technical data and documentation are comprised of recorded engineering, technical, and cost information, and procedures used to define, produce, test, evaluate, modify, deliver, support, and operate the system.

Technical data collected for SLS will directly feed into and affect the outputs for the standardization analysis, cost analysis, training requirements, LORA, and LSAR, as well as other documentation produced by SLSP ILS Team.

A4.5.1 Technical Documentation

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Technical documentation for Block 1 will be limited to the minimum required for ground operations and maintenance. The Elements will be responsible for supplying sufficient source data for maintenance planning. Items within the Block 1 configuration that will not be used in subsequent configurations will be considered discard upon failure and no repair data will be developed unless the responsible Element determines there is adequate justification. Items that will be used in the Block 1A or Block 2 configurations should be documented in more detail, especially those that will be in the Block 2 configuration, so that formal support documentation can be prepared for the 30-year program life. The Elements should make maximum use of existing data, and all data should be in electronic media for ease of access, use, and updating. Reference ILSP Section 5.5, Technical Data and Documentation.

A4.6 Support Equipment

Support equipment for the Block 1 configuration will be conducted as described in this Plan. Reference Section 5.6, Support Equipment.

A4.7 Training and Training Support

Training and training support for the Block 1 configuration will be conducted as described in this Plan. Reference Section 5.7, Training and Training Support.

A4.8 Manpower and Personnel

Manpower and personnel for the Block 1 configuration will be conducted as described in this Plan. Reference Section 5.8, Manpower and Personnel.

A4.9 Obsolescence

Obsolescence for the Block 1 configuration will be conducted as described in this Plan. Reference Section 5.3.3, Obsolescence.

A4.11 Disposal and Disposition

Disposal for the Block 1 configuration will be conducted as described in this Plan. Reference Section 6.5, Disposal.

A4.12 Sustaining Engineering

Sustaining engineering for the Block 1 configuration will be conducted as described in this Plan. Reference Section 7.0, Sustaining Engineering.

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APPENDIX B SLS BARGE TRANSPORTATION PLANNING

B1.0 INTRODUCTION

Appendix B to the Space Launch System (SLS) Integrated Logistics Support Plan (ILSP) describes the delivery of SLS flight articles and associated equipment among NASA centers anticipated to be utilized for waterway transportation and other possible Element specified locations. This plan is developed in accordance with the goals and methodology put forth in the Logistics Support Infrastructure (LSI) as detailed in SLS-PLAN-020, Space Launch System Program (SLSP) Concept of Operations and SLS-SPEC-030-01, SLSP Support Equipment Specification, Volume I: Support Equipment Planning.

B1.1 Purpose

The purpose of this document is to identify the transportation flow and describe the transportation functions and equipment related to the shipment of SLS flight articles and associated equipment among MAF, SSC, MSFC, and KSC and other possible Element specified locations. Specifically, this plan identifies flight article configurations for shipment, land movement, loading and unloading flight articles on a NASA barge, and water movement. Site specific lifting and handling operations of the SLS flight article are not included in this document.

B1.2 Scope

This document is applicable to SLS flight articles and associated equipment shipped by NASA barge.

B2.0 TRANSPORTATION SUMMARY

SLS flight articles may be manufactured / assembled at NASA centers or at any Element specified location. Transportation of such articles may be in total, from the point of manufacture to the launch site (KSC), or in part, from the point of manufacture to a testing facility or between manufacturing / assembly facilities. Regardless, the transportation of SLS flight articles and associated equipment by NASA barge is associated with several transportation functions. In addition, depending on Element classification, SLS flight articles and associated equipment may be considered Program Critical Hardware (PCH) and as such will be handled in accordance with MWI 6410.1, Packaging, Handling, and Moving Program Critical Hardware.

SLS flight article transportation includes the following functions:

- **Flight Article Preparation (Section B4.1)** – Prior to SLS flight article and associated equipment movement, preparation includes installation of any SLS flight article protection equipment, securing SLS flight articles on transporters or pallets, and

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installation and checkout of any environmental control equipment and instrumentation required for transportation monitoring.

- **Land Transportation (Section B4.2)** – Subsequent to stage preparation, the movement of the SLS flight article associated flight article equipment in the transportation configuration by means of a prime mover. Land transportation is required at MAF from the manufacturing/checkout facility to the MAF dock, at the test facility at SSC, at MSFC from the MSFC dock to the MSFC test facilities, at Element specified locations, and from the KSC point of delivery <TBR-004> to the VAB.
- **NASA Barge Loading/Unloading (Section B4.3)** – The process by which SLS flight articles, transporters, pallets, and associated equipment are positioned and secured to the NASA barge or un-secured and extracted from the NASA barge. This is accomplished by a “roll-on/roll-off” technique at the dock.
- **Water Transportation (Section B4.4)** – The movement of SLS flight articles, transporters, pallets, and associated equipment by towing a NASA barge along designated water routes among the NASA centers (MAF, MSFC, SSC, and KSC) and other locations as determined by Element requirements. The covered NASA barge “Pegasus” is designated as the primary transport vessel.
- **Flight Article Handling (Section B4.5)** – Lifting of SLS flight articles and associated equipment onto/from a transporter or pallet and movement by crane and other lifting devices. Handling may be required at the manufacturing facility, at SSC and MSFC for installation into test facilities, and at KSC in the VAB after land transportation from the KSC point of delivery after delivery of SLS flight articles and associated equipment.
- **Flight Article Testing (Section B4.6)** – Evaluation of SLS flight articles by “hot-fire” or other methods for validation or certification of performance. Testing may be required at the manufacturing facility prior to SLS flight article preparation, at the SSC and MSFC test facilities prior to delivery of the SLS flight article to the launch site, KSC, and at KSC after final delivery to the launch site.
- **Flight Article Inspection (Section B4.7)** – SLS flight article inspection occurs when custodial responsibility for the SLS flight article is transferred from the sending organization to the receiving organization at identified points/times during SLS flight article transportation. Stage inspection is performed by representatives of both the sending and receiving organizations to assess for appropriate SLS flight article shipping configuration and damage.

These transportation functions are depicted in Figure B2-1. Each transportation function is specifically detailed for SLS flight articles in Section B4.

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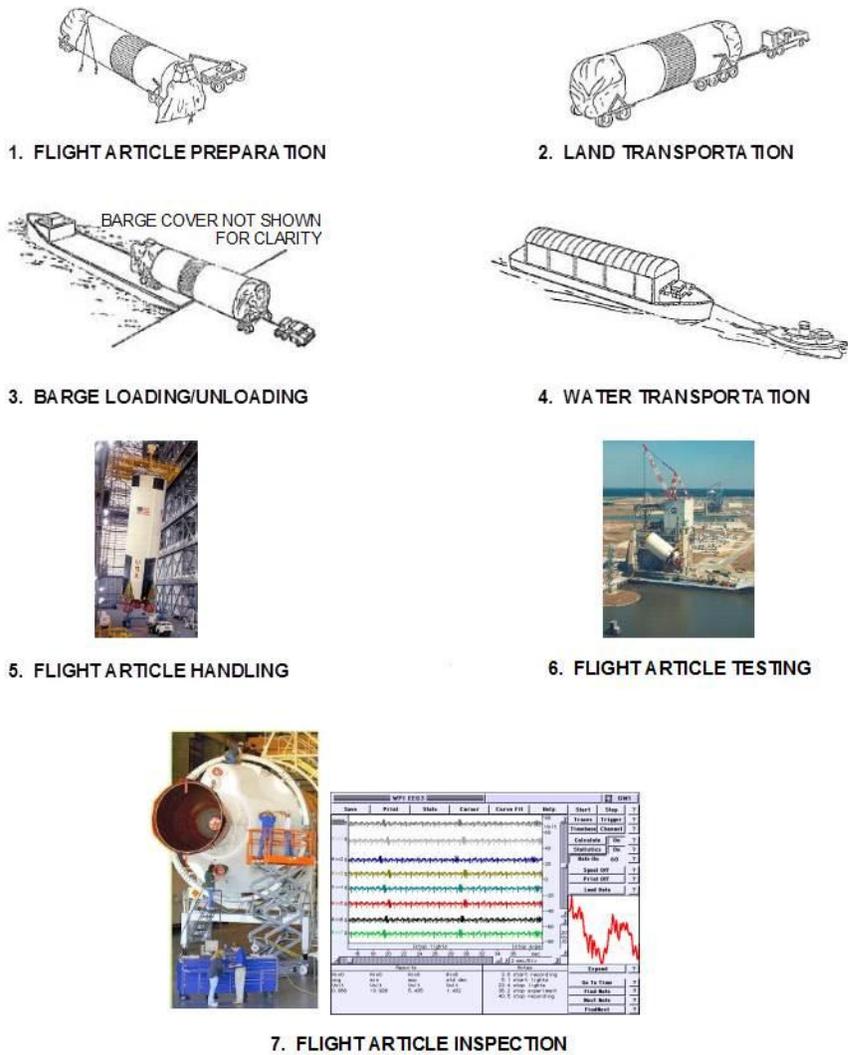


Figure B2-1 SLS Flight Article Transportation Functions

A typical sequence of transportation events for SLS flight articles is shown in Figure B2-2. This sequence begins with SLS flight article manufacturing / assembly / integration and is completed with delivery to the VAB at KSC.

[Note: SLS flight article inspections are not specifically shown, but are required at identified DD1149, Requisition and Invoice Shipping Document, transfers of responsibility.]

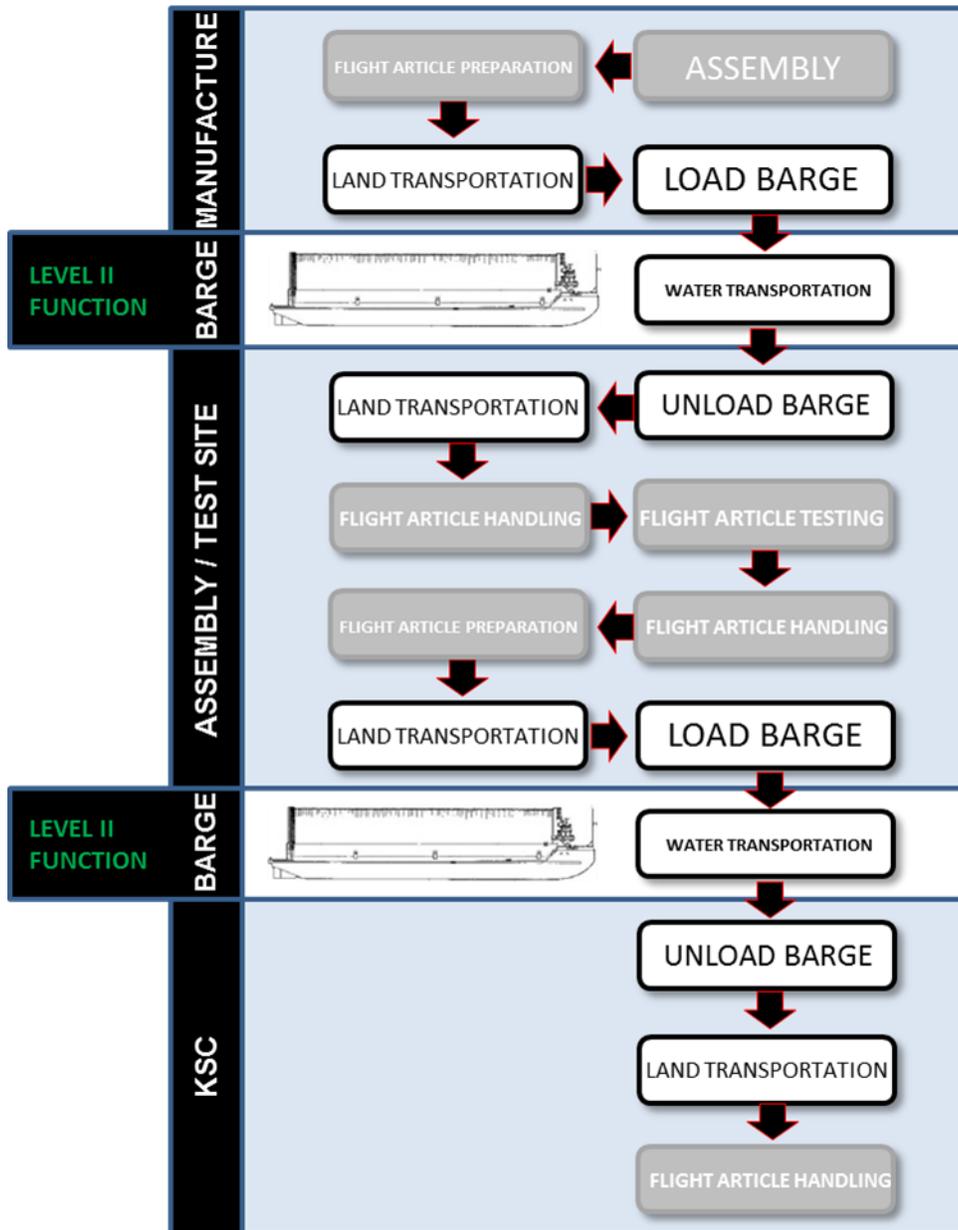


Figure B2-2 Sequence of Transportation Functions for SLS Flight Articles.

Transportation functions displayed in gray in Figure B2-2 are part of the overall sequence of transportation activities but are not included within the scope of this appendix.

B2.1 Responsibilities

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SLS flight article transportation is the combined responsibility of NASA (MSFC, MAF, SSC, and KSC), the marine services contractor, and the Element contractors.

SLS flight article transportation employs an “on-dock” responsibility transfer philosophy wherein operational responsibility for support equipment (SE), procedures, and personnel are transferred to the recipient upon delivery of the SLS flight article.

In general, the following applies:

NASA/MSFC Office of Center Operations, Transportation & Logistics Engineering Office (AS42)

- Prepare and maintain the SLS Barge Transportation Planning (Appendix B).
- Provide SLS flight article and associated equipment tie-down configurations, drawings, and marine transportation equipment (MTE).
- Provide NASA barge “Pegasus” for transport of SLS flight articles and associated equipment.
- Provide NASA barge crew.
- Provide and conduct detailed ballasting and docking procedures for NASA barge.
- Verify proper NASA barge configuration for water transportation.
- Operate and maintain MTE (including proof load testing).
- Acquire hazardous material transportation permits – if required.
- Prepare detailed move procedures for transport of SLS flight articles and associated equipment from Building 110 at MAF to the NASA barge.
- Prepare detailed procedure for loading and securing SLS flight articles and associated equipment for transport aboard the NASA barge at MAF, MSFC, SSC, and KSC.
- Prepare detailed procedure to unload SLS flight articles and associated equipment at SSC, MAF, MSFC, and KSC.
- Conduct loading and unloading operations including securing and de-securing operations at MAF, SSC, MSFC, and KSC.
- Conduct land movement of SLS flight articles and associated equipment at MSFC from the MSFC dock to a designated MSFC test area location.
- Provide special purpose equipment through rental agreements as required to support transport of SLS flight articles and associated equipment (excluding cranes).
- Arrange for and provide return shipment or relocation of transporters, pallets, and SE.
- Install/remove land/water transportation monitoring/instrumentation (NASA required).

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NASA/MSFC Mission Operations Laboratory, Ground Operations and Logistics Branch (EO40)

- Prepare and maintain SLS-SPEC-030-01.
- Provide the transporters, pallets, and purchase prime movers – for example, self-propelled modular transporters (SPMTs).
- Provide land/water transportation monitoring/instrumentation (NASA required).
- Perform the design, development, testing, and evaluation (DDT&E) for all lifting and handling GSE and associated SE for SLS flight article transportation, lifting, and handling operations.
- Provide lifting and handling SE, limited to slings, spreaders, and leveling devices, necessary to install/remove the SLS flight articles onto/from transporters and pallets.

NASA/MSFC Office of Center Operations, MAF Operations Office (AS60)

- Configure transporters and pallets to work with the chosen prime movers.
- Conduct land movement of SLS flight articles and associated flight article equipment at MAF and SSC.
- Provide personnel and equipment to assist in loading SLS flight articles and associated equipment and securing SLS flight articles and associated equipment for transport aboard the NASA barge at MAF and SSC.
- Provide personnel and equipment to assist in de-securing SLS flight articles and associated equipment from the NASA barge and unloading SLS flight articles and associated equipment at SSC.
- Support return of transporters, pallets, and GSE (NASA barge unloading).
- Arrange shipment of associated equipment from MAF (reference Section B3.3).

NASA/SSC

- Conduct SLS flight article lifting operations at SSC.
- Prepare test facility to receive and test the SLS flight articles.
- Provide personnel and equipment for land movement of associated equipment at SSC.
- Arrange shipment of associated equipment from SSC (reference Section B3.3).

NASA/KSC

- Prepare detailed move procedures for transport of SLS flight articles and associated flight article equipment from the KSC point of delivery <TBR-004> to the VAB.

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- Provide personnel and equipment to assist in de-securing SLS flight articles and associated equipment from the NASA barge and unloading SLS flight articles and associated equipment.
- Perform land movements of SLS flight article <TBR-003> and associated equipment.
- Operate SLS flight article GSE and SE.
- Arrange shipment of associated equipment from KSC (reference Section B3.3).

Element Contractor

- Develop detailed procedures for SLS flight article and associated equipment preparation operations, which include loading the SLS flight articles onto transporters and pallets at the manufacturing / assembly locations.
- Provide, install and checkout SLS flight article and associated equipment protective equipment.
- Perform SLS flight article preparation which includes loading SLS flight articles onto the transporters / pallets at the manufacturing / assembly locations.
- Prepare detailed procedures for lifting and securing the SLS flight articles into and out of the test facility at SSC.
- Provide land/water transportation monitoring/instrumentation (Element contractor required).
- Install/remove land/water transportation monitoring/instrumentation (Element contractor required).
- Package associated equipment as needed for transport in support of transportation operations.

B2.2 Transportation Safety and Contingency Planning

Pursuant to a “ship and shoot” operational philosophy, assembly of SLS flight articles at the manufacturing / assembly location(s) may include installation of subsystems containing pyrotechnics and pyrotechnic devices. These items are manufactured with explosive materials to varying degrees and compositions. Assembled as such, an SLS flight article would be considered “hazardous material” per NASA and US Department of Transportation (USDOT) regulations. Handling and transport of such SLS flight articles would be considered hazardous.

Safety of the transportation crews, the equipment, and the SLS flight articles is a high priority. In general, the following safety measures will be captured in the detailed transportation procedures and apply to the activities included in this appendix:

General

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- If appropriate, approval of the SLS flight article shipping configuration and operations approved through the USDOT in accordance with 49 CFR 107.105 with shipment authorized by “special permit”.
- Concurrence from the USCG in accordance with the USCG Marine Safety Manual, Volume II: Material Inspection, Section F: Carriage of Hazardous Materials.
- If appropriate, compliance with NPR 8715.3, NASA General Safety Program Requirements, and NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics to include the following:
 - Detailed transportation procedures containing safety information and developed by the relevant facility or hardware custodian applicable to specific activities throughout the complete shipment cycle.
 - Trained and certified personnel provided for hazardous operations per program/project established training requirements.
 - Transportation hazard analysis performed applicable to specific activities throughout the complete shipment cycle.
 - Adequate emergency and/or life-saving equipment provided and appropriately staged.

Land Movement

- Weather briefing prior to movement with defined limitations.
- Physical security provided to inspect and secure transportation route and provide adequate buffer zone around convoy and NASA barge.
- Common communications system utilized by move crew.
- GSE and equipment proof testing and checkout prior to movement.

Water Movement

- Weather/Sea state briefing prior to departure with defined limitations.
- NASA barge “Pegasus” certified by the American Bureau of Shipping (ABS) for seaworthiness and explosive cargo.
- When available, USCG escort provided from MAF harbor to the Gulf of Mexico for inland waterway travel.
- Adequate provisions, communication, emergency, and fire-fighting equipment aboard NASA for personnel.
- NASA tug inspections and towing contractor crew and equipment certifications required by the classification and permitting organizations.

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- Adherence to all maritime laws, standards, and navigational regulations.
- Exclusive and continuous NASA barge tow.
- Marine Transportation Equipment (MTE) checkout prior to movement.

In general, the following contingency planning applies to the activities included in this transportation plan:

- Identification of “safe harbors” and criteria to transport an SLS flight article to SSC or other “safe harbors” due to an approaching hurricane or for other special circumstances.
- Identification of “safe harbors” along the water movement routes (ocean- going) such that one may be reached within 48 hours from any given location along the route.
- Establishment of emergency plans applicable to specific activities/points within the complete shipment cycle.

B2.3 Transportation Duration

Typical delivery of SLS flight articles is as follows:

MAF TO SSC

MAF Facility to MAF dock	¼ day
Barge Loading/SLS flight article secure	½ day
MAF to SSC (test facility)	1 day
Barge Unload/SSC test facility	<u>½ day</u>
Nominal Transportation Time:	2¼ - 3 days

SSC TO KSC

Barge Loading/SLS flight article secure	½ day
SSC to Port Canaveral	5 days
Port Canaveral to KSC dock	1 day
Barge Unload/KSC dock to VAB	<u>½ day</u>
Nominal Transportation Time:	7 - 8 days

MAF TO MSFC (UP RIVER)

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Barge loading/SLS flight article secure	½ day
MAF to MSFC dock (MS River)	10 days
MSFC dock to test facility	1 day
SLS flight article secure at test facility	<u>½ day</u>
Nominal Transportation Time:	12 - 13 days

MSFC TO MAF (DOWN RIVER)

SLS flight article secure at test facility	½ day
Test facility to MSFC dock	1 day
MSFC to MAF dock (MS River)	7 days
Barge unloading	<u>½ day</u>
Nominal Transportation Time:	9 - 10 days

SLS flight article transportation delivery schedules may vary depending on weather, sea/waterway conditions, infrastructure issues, bridge operating restrictions, and marine services contractor availability. Nominal transportation times associated with Element specified locations will be detailed in the Element transportation plans.

B3.0 TRANSPORTATION EQUIPMENT

The following subsections describe transportation equipment associated with transportation of SLS flight articles and associated flight article equipment via the NASA barge. Some transportation equipment is used for more than one of the transportation functions described in Section B4.0. The major items of transportation equipment are listed with a brief description of their design and use.

B3.1 NASA Barge

The NASA barge “Pegasus” is an American Bureau of Shipping (ABS) classed vessel used for movements among NASA centers and Element specified locations for delivery of SLS flight articles. NASA barge “Pegasus”, shown in Figure B3-1, accommodates SLS flight articles, transporters, and associated flight article equipment. NASA barge “Pegasus” is configured with an enclosed main deck (covered) that provides protection from salt spray and the weather, but does not provide a controlled environment.

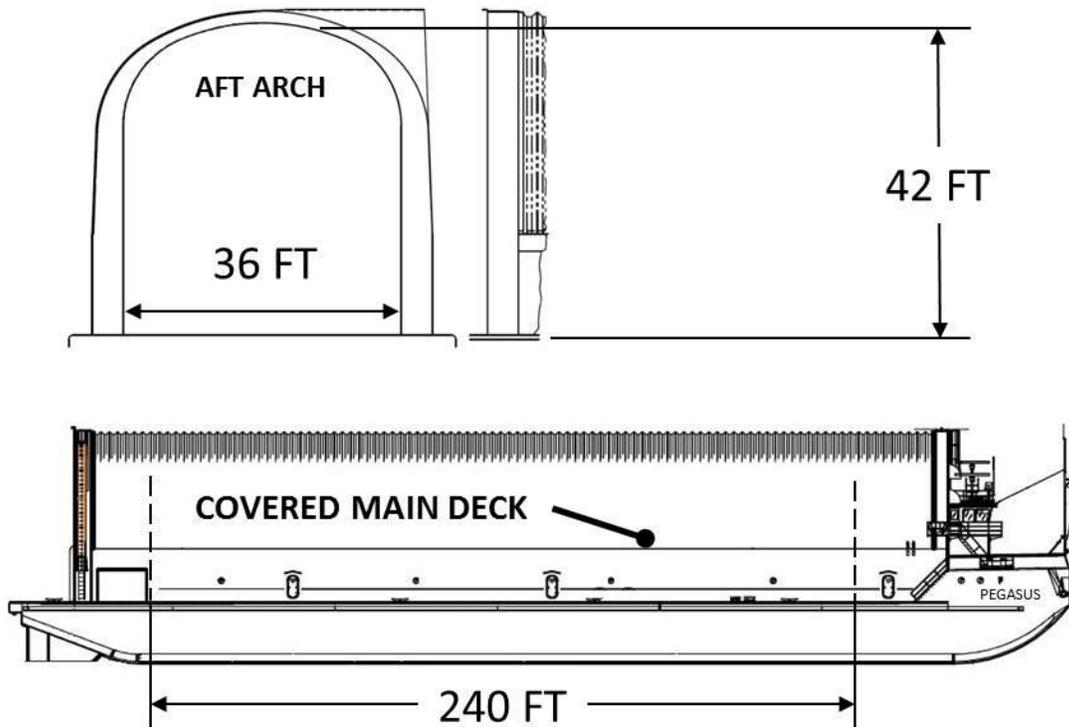


Figure B3-1 NASA Barge “Pegasus”

Transfer of SLS flight articles and the associated flight article equipment is performed in a “roll-on/roll-off” manner. The stern of the barge is constructed with a lip which rests (upon ballasting) onto a recess in the dock. Refer to Figure B3-2. This dock design is employed at the MAF, MSFC, SSC, and KSC docking facilities. An array of “D” rings, slotted pad eyes, and support pads installed onto the main deck provide capability based on Element inputs to secure SLS flight articles, transporters, and associated equipment. Transporters and pallets may be grounded to the NASA barge structure during water shipment via a grounding strap. Adequate areas exist for storage of tie-down and maintenance equipment. The main deck area is 240 ft. X 36 ft., with an interior cover height of 42 ft.

[NOTE: Structural flex of the main deck is expected during water transportation. Appropriate analysis should be considered by the Elements to characterize and accommodate.]

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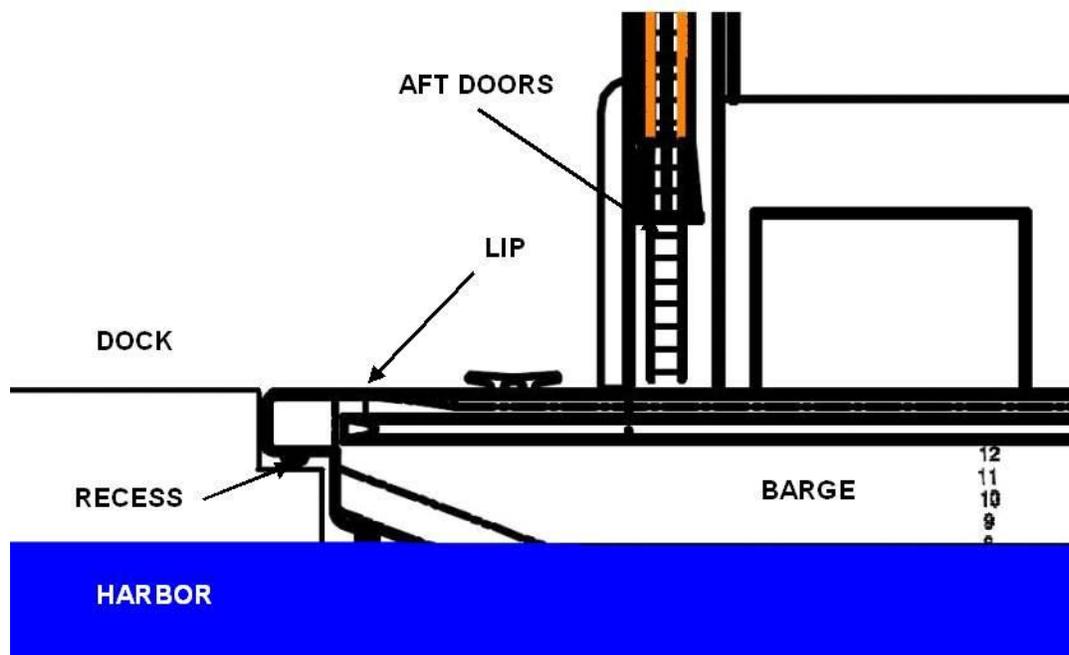


Figure B3-2 “Roll-On/Roll-Off” NASA Barge Docking Configuration

NASA barge “Pegasus” is a self-sustaining vessel except for propulsion. Movement of the NASA barge is provided by tug(s). Power is generated by two 150 KW generators (or shore power). The main deck is lighted and can be secured. Six (6) video cameras are installed on the main deck to allow complete and continuous monitoring/recording of the closed cargo area. Adequate berthing, messing, and sanitary provisions exist for up to four (4) credentialed passengers.

B3.2 SLS Flight Article Transporters / Pallets

SLS flight articles and associated flight article equipment are transported to/from and secured to the NASA barge via Element supplied transporters and/or pallets. The design and function of such items accommodate NASA barge interfaces and MTE in accordance with MSFC-PLN-3632, NASA Barge and Marine Transportation Equipment (MTE) Configuration Management Plan. Transporters and pallets may be self-propelled or may be configured to utilize a prime mover (reference Section B3.3) for movement. In addition, they may also accommodate environmental control equipment (reference Section B3.7) and monitoring instrumentation (reference Section B3.8), as required by the Element.

B3.3 Associated Flight Article Equipment

Associated flight article equipment may include the following:

- Flight ship loose articles.

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- SLS flight article “stage specific” or “mission specific” ship loose articles (flight, GSE, or SE).
- SLS flight article tooling and maintenance/emergency equipment.
- Transporter tooling and maintenance/emergency equipment.
- Element tooling and maintenance/emergency equipment.
- GSE or other equipment required to power or operate instrumentation, environmental control equipment, or protective equipment (example: GN₂ bottles/hoses, power supplies, batteries, etc...).
- Handling equipment used to lift, maneuver, or position MTE.
- Other program or project hardware or equipment required to be transported between sites.

Established or “stage specific” equipment is secured to the main deck or stored on the main deck or appropriate storage area per approved configurations. Proper grounding can be provided as required.

B3.4 Prime Mover

Pursuant to the “roll-on / roll-off NASA barge design, Elements may supply a prime mover or multiple prime movers to be used to transport SLS flight articles and associated flight article equipment to/from the NASA barge. Prime movers may be conventional, such as forklifts and utility tugs, or more specialized, such as self-propelled multi-wheel transporters (SPMTs), as illustrated in Figure B3-3.



Figure B3-3 Typical Prime Movers

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B3.5 Protective Equipment

Protective equipment includes covers, plugs, temporary doors, desiccant bags, and other items used to prevent unwanted environmental exposure for SLS flight articles and associated equipment or certain defined areas of SLS flight articles and associated equipment during land and water movements. Protective equipment may be installed during stage preparation prior to land movement from the manufacturing / assembly facility, during land movement at test facilities, and during stage handling at KSC. Designation and installation of protective equipment is accomplished by the Elements. No additional protective equipment is installed during land or water movement.

B3.6 Marine Transportation Equipment (MTE)

MTE may be a system of hooks, blocks, turnbuckles, chains, cables, and other handling equipment which is used to secure SLS flight articles, transporters, pallets, ship loose items, and associated flight article equipment to the NASA barge during water transportation. MTE may also be designed and fabricated for specific applications. As such, the equipment is subject to MSFC-PLN-3632, NASA Barge and Marine Transportation Equipment (MTE) Configuration Management Plan. Depending on the agreement, MTE may be furnished by Level II or by the Elements.

B3.7 Environmental Control Equipment

Environmental equipment may include “active” systems, such as de-humidifiers and air conditioning units, required to provide a specified environment to, or “preserve”, a specific area within SLS flight articles and associated flight article equipment. It is the Government’s intent to minimize personnel aboard the barge during water shipment. Element designated environmental control equipment should be designed and operated such that minimal or no personnel are required for proper function during transportation. Consequently, these items should be self-sustaining to the maximum extent reasonably possible. Electrical power and other provisions may, however, be provided by the barge, if required.

B3.8 Monitoring Instrumentation

During land and water movements, SLS flight articles and associated equipment may be sufficiently instrumented to provide accurate records of the environments to which the articles are subjected during the transportation. Instrumentation may also be installed on the NASA barge to provide information to evaluate the interaction between the NASA barge and SLS flight articles during water shipment.

The following types of measurements may be recorded or monitored during the transportation of SLS flight articles and associated equipment.

Flight Article

Element supplied instrumentation/monitoring may include the following:

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- Tank pressures.
- Vibration.
- Acceleration.
- Stress / Strain.
- Interior temperature and humidity (within SLS flight article envelope).

NASA Barge

The Level II supplied NASA barge Transportation Instrumentation Monitoring System (TIMS) may include the following:

- Pitch and roll.
- Ambient temperature and humidity on main deck.
- Acceleration / Vibration.
- Main deck recorded video from up to six (6) locations.

It is the Government's intent to minimize personnel aboard the barge during water shipment. Element designated instrumentation should be designed and operated such that minimal or no personnel are required for proper function during transportation. Consequently, these items should be self-sustaining to the maximum extent reasonably possible. Electrical power and other provisions may, however, be provided by the barge, if required.

[NOTE: Data acquired during the initial SLS flight article shipments will be evaluated (reference Section B4.7) to determine the extent and necessity of measurements applied to future SLS flight article shipments.]

B3.9 Lifting Equipment

Lifting equipment consists of linkages, slings, shackles, cranes, or other devices required to lift or rotate SLS flight articles and associated flight article equipment from transporters and pallets. Lifting activities occur during stage preparation prior to receipt of SLS flight articles (for shipment) from the manufacturing / assembly facility, prior to and superseding testing at test facilities, and superseding delivery of SLS flight articles and associated flight article equipment at the launch site receiving facility (VAB) at KSC. Designated and provided by the Elements, no lifting equipment or operations are considered as part of this transportation plan, but are included here to provide continuity.

[Note: Lifting equipment may be required to position MTE aboard the NASA barge. This lifting equipment, if required, is considered as MTE handling equipment, reference Section B3.3.]

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B4.0 TRANSPORTATION FUNCTIONS

The following sections describe, in detail, the transportation functions as they relate to SLS flight articles and associated equipment, reference Figure B2-2. All transportation functions are performed in a safe manner in accordance with safety requirements established at each facility or established by the custodian of SLS flight articles and associated equipment during specific phases of transportation. Pyrotechnic components and systems may be installed on SLS flight articles prior to initiation of transportation functions. If so, these flight articles would be considered as “hazardous material” during performance of all transportation functions. For more detail on safety and contingency planning, reference Section B2.2.

B4.1 Flight Article Preparation

SLS flight article preparation for delivery occurs after the articles have been accepted for shipment by NASA barge. Stage preparation is completed by the Elements and may include the following activities:

- Secure SLS flight articles to the transporters / pallets (reference Section B3.2).
- Secure subsystems for transportation.
- Install and checkout of protective equipment (reference Section B3.5).
- Install and checkout of environmental control equipment and monitoring instrumentation (reference Sections B3.7 and B3.8).
- Package associated equipment, as required (reference Section B3.3).

The SLS flight articles and all associated flight article equipment are packaged and prepared for shipment per NPR 6000.1, “Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems Equipment and Associated Components”, and in accordance with USDOT guidelines.

B4.2 Land Transportation

Land movement is required to transport SLS flight articles and associated equipment from specified locations to/from the NASA docks at MAF, MSFC, SSC, KSC, and other possible Element designated locations. Land movement at Element specified locations will be detailed in Element transportation plans.

B4.2.1 MAF Land Transportation

Movement of SLS flight articles and associated equipment, using appropriate Element supplied transporters, pallets, and prime movers, is achieved via the designated route illustrated in Figure B4-1 from the manufacturing / assembly area to the MAF dock.

[NOTE: The designated route requires passage over a local levee. Appropriate analysis should be considered by the Elements to characterize and accommodate.]

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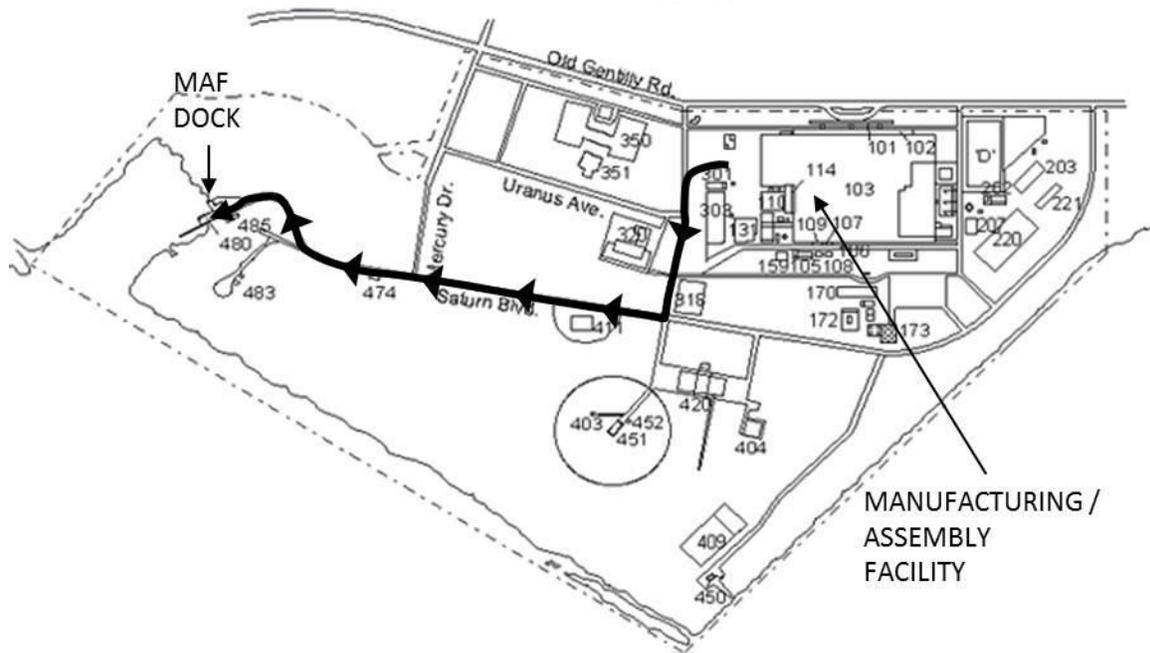


Figure B4-1 Land Movement of SLS Flight Articles at MAF

B4.2.2 SSC Land Transportation

Movement of SLS flight articles and associated equipment, using appropriate Element supplied transporters, pallets, and prime movers, is achieved via the designated route illustrated in Figure B4-2 at the anticipated test facility.

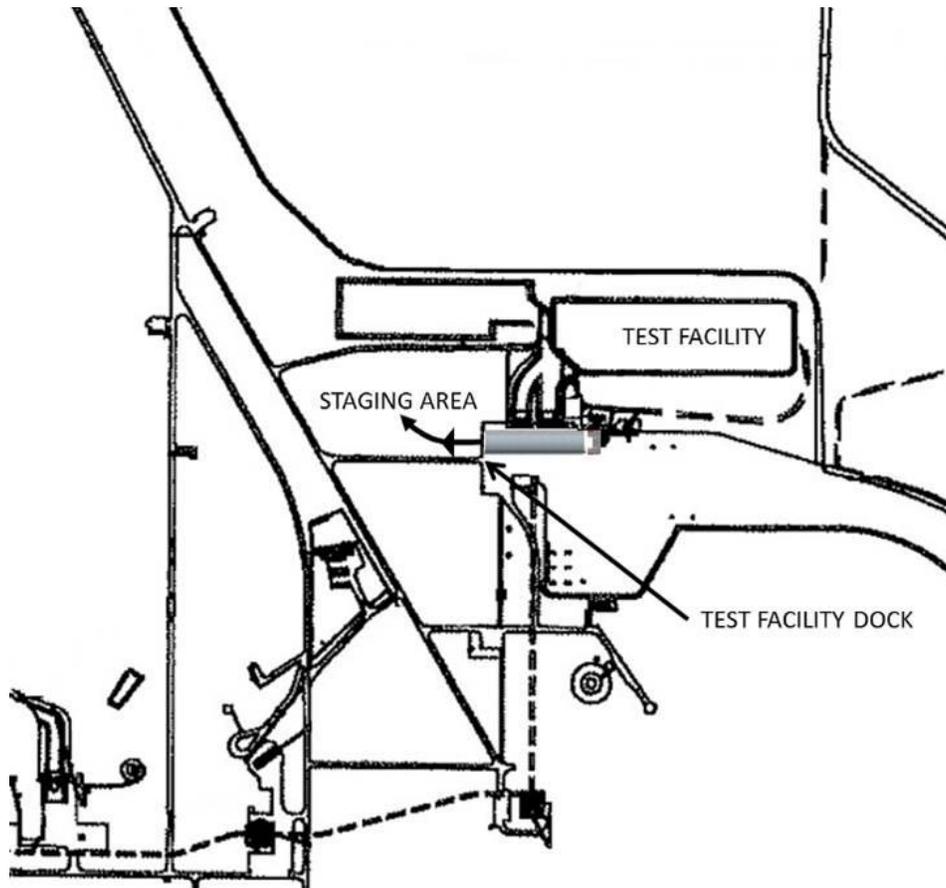


Figure B4-2 Land Movement of SLS Flight Articles at SSC

B4.2.3 KSC Land Transportation

Movement of SLS flight articles and associated equipment, using appropriate Element supplied transporters, pallets, and prime movers, is achieved via the designated route illustrated in Figure B4-3 at KSC from the KSC dock to the VAB <**TBR-004**>.

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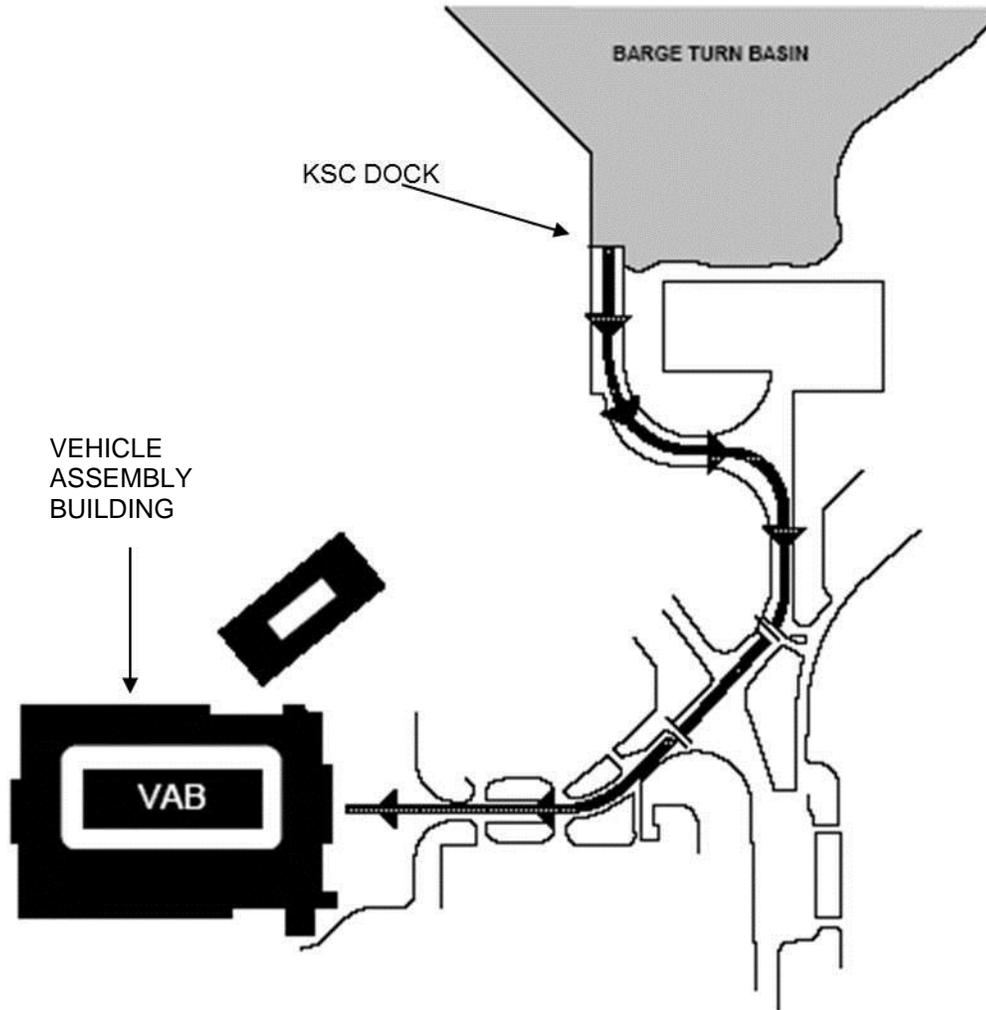


Figure B4-3 Land Movement of SLS Flight Articles at KSC

B4.2.4 MSFC Land Transportation

Movement of SLS flight articles and associated equipment, using appropriate Element supplied transporters, pallets, and prime movers, is achieved via the designated route illustrated in Figure B4-4 at MSFC from the MSFC dock to a designated test area location. The route is approximate 4 miles in length and requires coordination with the Redstone Arsenal for utilization and scheduling.

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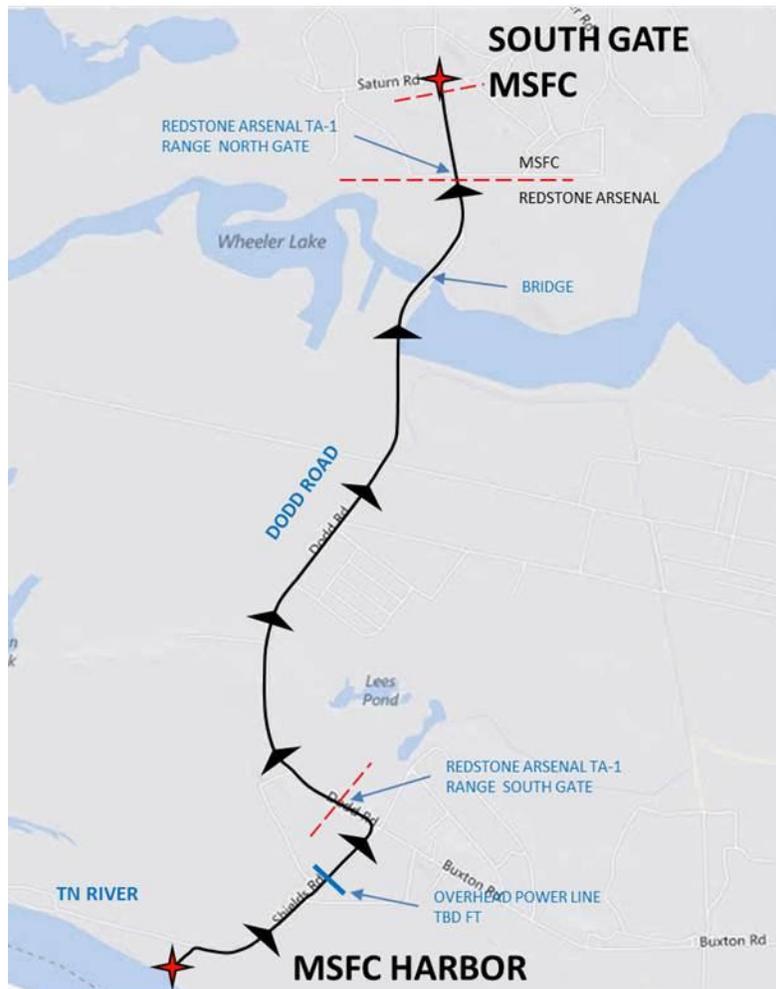


Figure B4-4 Land Movement of SLS Flight Articles at MSFC

B4.3 NASA Barge Loading/Unloading

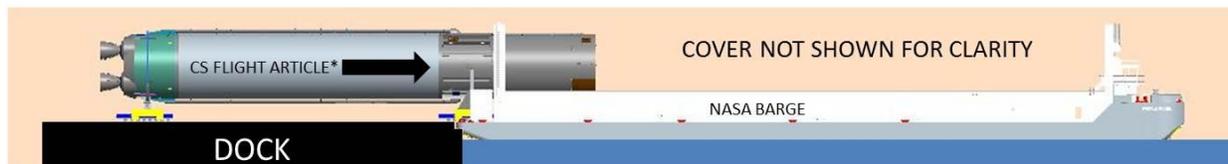
The NASA barge loading and unloading function is the “roll-on/roll-off” operation by which SLS flight articles, transporters, pallets, and associated equipment are positioned and secured on the NASA barge or un-secured and extracted from the NASA barge. Prior to these activities, the NASA barge is prepared by the barge crew by ballasting the stern (lip) to rest on the dock recess and securing the NASA barge to mooring locations, reference Figure B3-2. This provides and maintains a safe and appropriate interface for “roll-on/roll-off” operations. The MAF, MSFC, SSC, and KSC docks are configured as such. The aft arch opening measures 36 feet in width and 42 feet in height. Barge loading and unloading may be accomplished at all NASA centers and at Element designated locations. Refer to Figure B4-5.

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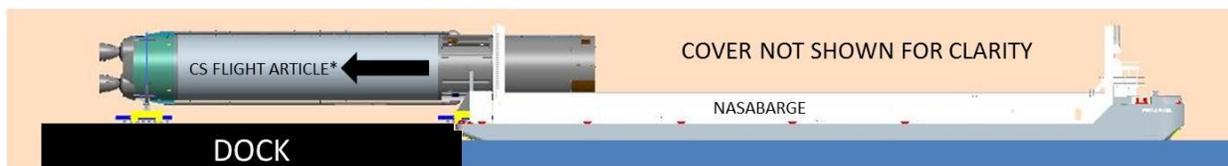
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LOADING



* A REPRESENTATION OF THE CORE STAGE FLIGHT ARTICLE SHOWN WITH TRANSPORTER AND PRIME MOVERS FOR DEMONSTRATION PURPOSES

UNLOADING



* A REPRESENTATION OF THE CORE STAGE FLIGHT ARTICLE SHOWN WITH TRANSPORTER AND PRIME MOVERS FOR DEMONSTRATION PURPOSES

Figure B4-5 Loading/Unloading SLS Flight Articles on NASA Barge

NASA barge loading and unloading at Element specified locations will be addressed in Element transportation plans.

[NOTE: Dock configurations at Element specified locations do not interface with the NASA barge for “roll-on/roll-off” operations as configured at NASA docks. Appropriate analysis should be considered by the Elements to characterize and accommodate.]

B4.4 Water Transportation

Water transportation is accomplished by utilizing NASA barge “Pegasus”, reference Section B3.1, among the NASA centers (MAF, MSFC, SSC, and KSC) and other locations as determined by Element requirements. The NASA barge is towed and/or pushed via contracted marine towing vessels (inland rated tugs), provided through a marine services contractor, during inland waterway movement. For oceangoing travel, the NASA barge is towed via a contracted marine towing vessel (ocean rated tug), provided through a marine services contractor. All contracted towing vessels are subject to inspection for condition and capability.

For water transportation among the relevant NASA centers, the NASA barge may be pushed and/or towed along the typical designated water routes, as illustrated in Figures B4-6, B4-7, B4-8, B4-9, and B4-10. Water transportation related to Element specified locations will be detailed in Element transportation plans.

[NOTE: SLS flight articles and associated equipment may be considered “hazardous material” and as such, would be configured for shipment with approval from the USDOT via “Special Permit” and with concurrence from the USCG, and NASA.]

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Water routes are described as follows:

MAF TO SSC

This route applies to inland waterway travel from the MAF dock to the test facility dock at SSC. During this phase, the NASA barge is towed by two tugs (a push tug and an assist tug ahead of the NASA barge) via the Gulf Intracoastal Waterway (GIWW), the East Pearl River, and the SSC Canal System. This route is approximately 40 miles in length and is illustrated in Figure B4-6 below.



Figure B4-6 Water Route – MAF TO SSC

Waterway restrictions include a 90 feet horizontal clearance through several bridges and other structures and a height restriction of 73 feet at the Interstate 10 Bridge. Neither restriction

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impacts navigability of the NASA barge in this phase of movement. However, operational planning must account for restricted usage times for the swing and draw bridges along the route.

Internal SSC

This route applies to inland waterway travel from the test facility dock to a nearby SSC dock. This movement is performed to protect the NASA barge from damage during stage handling operations and testing operations at the test facility. During this phase, the NASA barge is towed a short distance by two tugs (a push tug and an assist tug ahead of the barge) via the SSC Canal System. This phase of the water route is approximately 1/2 mile in length and is illustrated in Figure B4-7 below.

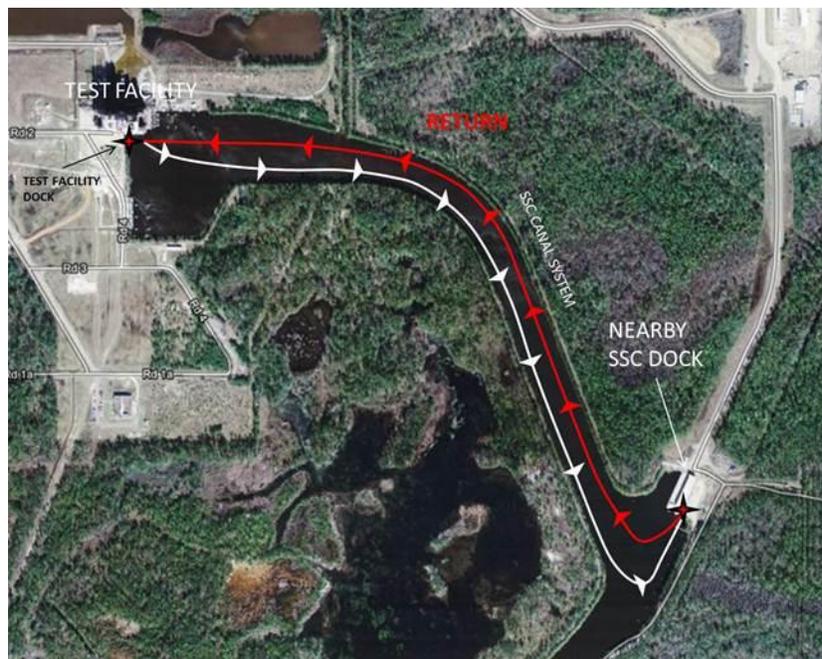


Figure B4-7 Water Route – Inland SSC

[Note: The local SSC Government tug, Clermont II, may be utilized in lieu of commercial inland tugs to maneuver the NASA barge to/from the nearby SSC dock, given appropriate weather conditions.]

SSC To Gulfport, MS

This route applies to inland waterway travel from the test facility dock at SSC to near The Port of Gulfport, MS. On this route, the NASA barge is towed by two tugs (a push tug and an assist tug ahead of the NASA barge) via the SSC Canal System, the East Pearl River and, the Gulf Intracoastal Waterway (GIWW). This route is approximately 62 miles in length and is illustrated in Figure B4-8 below.

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Figure B4-8 Water route – SSC to Gulfport, MS

The rendezvous point to relieve the inland tugs and make tow with the single ocean tug is at the intersection of the GIWW and the Gulfport Ship Channel approximately 6.2 miles offshore. The transfer of tugs may also occur in Gulfport Harbor if scheduling dictates or NASA barge porting is required.

Waterway restrictions are the same as those for travel between MAF and SSC, and include a 90 feet horizontal clearance through several bridges and other structures and a height restriction of 73 feet at the Interstate 10 Bridge. Neither restriction impacts navigability of the NASA barge in this phase of movement. However, operational planning must account for restricted usage times for the swing and draw bridges along the route.

Gulfport, MS To Port Canaveral, FL

This route applies to ocean going travel from Gulf Port, MS through the Gulf of Mexico to Port Canaveral, FL. During this phase, the NASA barge is towed by a single ocean tug. This route is approximately 816 miles in length. The route is illustrated in Figure B4-9 below. No height or width restrictions are applicable for this phase of movement.

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Figure B4-9 Water Route – Gulfport, MS to Port Canaveral, FL

Port Canaveral, FL To KSC <TBR-004>

This route applies to inland waterway travel from Port Canaveral, FL, to the KSC dock near the VAB. During this phase, the NASA barge is pushed by an inland tug. An assist tug ahead of the barge is also required for added control and maneuverability. The rendezvous point to relieve the single ocean tug and make tow with the inland tugs is at Port Canaveral. In addition, the Government furnished barge crew or others may board the NASA barge at this location. The barge crew (if not already aboard) is required to activate the barge systems in preparation for docking, as well as properly ballasting the NASA barge for inland waterway travel.

The route is the Banana River. The “Saturn Channel” is dredged and maintained specifically for NASA. This route is 18.2 miles in length and requires transit through the S.R. 401 draw bridge, the Port Canaveral Lock, and the NASA Causeway draw bridge. These are restricted to a width of 90 feet. This phase of the water route requires additional weather restrictions due to the configuration of the channel. Consequently, the NASA barge may dwell at Port Canaveral up to several days. Historically, secure Government or commercial dock space has been available (upon prior arrangement) to accommodate NASA barges until weather conditions become favorable. The route is illustrated in Figure B4-10.

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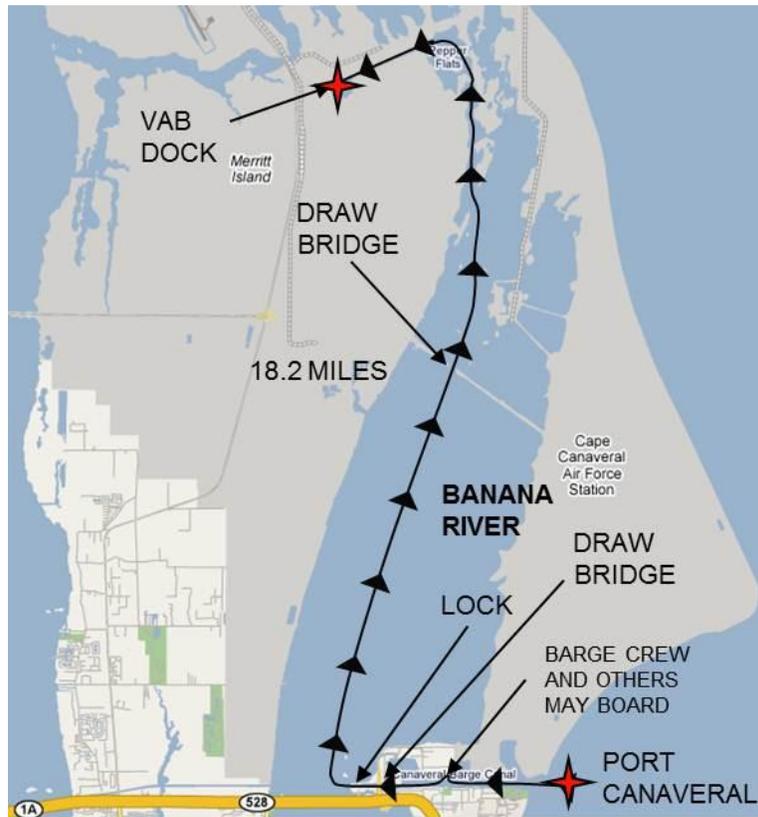


Figure B4-10 Water route – Port Canaveral, FL to KSC

MAF TO MSFC

This route applies to inland waterway travel from MAF, to the MSFC dock on the Tennessee River due South of MSFC and Redstone Arsenal. During this phase, the NASA barge is pushed by an inland tug. An assist tug ahead of the barge may also be required for added control and maneuverability. The route consists of the Gulf Intracoastal Waterway, the Mississippi River, the Ohio River, and the Tennessee River. This route is approximately 1240 miles in length. Due to its height, the NASA barge is prohibited from utilizing the Tennessee-Tombigbee Waterway. The barge crew is required to activate the barge systems in preparation for docking, as well as properly ballasting the NASA barge for inland waterway travel.

Waterway restrictions include navigation through several locks, a 70 feet horizontal clearance through the Inner Harbor Navigational Canal in New Orleans, LA, and a height restriction of 57 feet at several bridge locations along the Tennessee River. This height restriction could impact navigability of the NASA barge in this phase of movement if local water levels are significantly higher than standard pools. Operational planning must account for possible delays. The route is illustrated in Figure B4-11.

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Figure B4-11 Water route – MAF to MSFC

B4.5 Flight Article Handling

Though a part of the overall sequence of transportation activities, SLS flight article handling, and the lifting devices required to perform lifting and handling activities, are designated by the Elements and are not considered as part of this transportation plan.

B4.6 Flight Article Testing

Though a part of the overall sequence of transportation activities, SLS flight article testing, and the associated activities, are designated by the Elements and are not considered as part of this transportation plan.

B4.7 Flight Article Inspection

SLS flight article inspection occurs when custodial responsibility for the SLS flight article is transferred from the sending organization to the receiving organization at identified points/times during transportation via DD1149, Requisition and Invoice Shipping Document. SLS flight article inspection is performed by representatives of both the sending and receiving organizations

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to assess for appropriate shipping configuration(s) and assess for damage. SLS flight article inspection also includes review and/or reporting of the data collected from the NASA barge TIMS (reference Section B3.8) and any element unique instrumentation. Defining specific points and locations for transfers of accountability of property is an Element function, reference Section 6.4 of this ILSP.

B5.0 TRANSPORTATION DATA AND DOCUMENTATION

The transportation data and documentation methodology is structured to support a concept of “Ship and Shoot”. A verification process is established to validate SLS flight articles have not been exposed to transportation loads or environments beyond its design limits during all transportation functions from the manufacturing / assembly / test facilities to the launch site, KSC. This process is described as follows:

Two methods are utilized to provide this verification; documentation and data. Each is used to establish SLS flight articles have not been exposed to transportation environments outside of its design limits.

Data

The “AS RUN” data collected from the NASA barge TIMS (reference Section B3.8) is evaluated to verify SLS flight articles were not exposed to transportation environments outside of its design limits. A comprehensive report will be prepared to accompany the SLS flight article end-item delivery. The Elements may also submit adjuvant data collected from Element designated instrumentation.

All relevant documentation and data, and other supporting information, will be submitted at designated times to the SLSP and/or the Elements as quality records to support the SLS flight article verification processes.

Documentation

The “AS RUN” procedures will provide documentation that all transportation activities were performed in accordance with the pre-approved procedures.

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APPENDIX C SUPPORTABILITY METRICS

The “Metric Title” column contains the name of the integrated logistics support (ILS) or supportability metric.

The “Life Cycle Phase” column identifies the first phase during which adequate data should be available and analysis/evaluation is conducted to determine if the supportability goals, set at program inception, have been or will be achieved. Addressing supportability throughout the development, acquisition, production, fielding, and operation phases of the system is vital to system success.

The “Source Document” column provides likely places where the supportability requirement has been or will be documented. The requirements may be recorded in other documents.

The “Data Source” column indicates the best data sources for deriving the actual values of the supportability-related parameters being measured.

These metrics are internal to the ILS team to be used during assessments provided to SLSP for decision making.

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ILS Element	Metric Title	Description	Measure	Life Cycle Phase	Data Source
Maintenance	Mean Time to Repair	A basic measure of maintainability. The sum of corrective maintenance times divided by the total number of failures within a particular measurement interval under stated conditions. The measurement interval can be units of time, miles, rounds, cycles, or some other measure of life units.	Sum of corrective maint times ÷ Number of failures	DDT&E O&S	Supportability Demonstration LSAR DES Trend Analysis
Maintenance	Mean Restoral Time	A mean of the elapsed times from the occurrence of a system failure or degradation requiring maintenance to the time the system is restored to its operational state. It is derived by dividing the sum of the elapsed times for all events when the system required maintenance by the total number of maintenance events. This metric includes more than just direct maintenance time. This top level metric embeds some logistics response times or an indication of the availability of supportability resources such as mechanics, support equipment, and facilities.	Sum of times to restore system to operation ÷ Number of restoral events	DDT&E O&S	Supportability Demonstration LSAR DES Trend Analysis
Maintenance	Maintenance Downtime (MDT)	MDT is the total time during which a system/equipment is not in a condition to perform its intended function. MDT includes active maintenance time, logistics delay time and administrative delay time. Total time during which a system/equipment is not in a condition to perform its intended function. MDT includes active maintenance time, logistics delay time and administrative delay time. Logistics Delay Time (LDT) LDT refers to that maintenance downtime that is expended as a result of delay waiting for a resource to become available in order to perform active maintenance. A resource may be a spare part, test or maintenance equipment, skilled personnel, facility for repair, etc. Administrative Delay Time (ADT) ADT refers to that portion of maintenance downtime during which maintenance is delayed for reasons of an administrative nature (e.g. personnel assignment priority, organizational constraint, transportation delay, labor strike, etc.).		O&S	LSAR DES Trend Analysis
Supply	Logistics Response Time (LRT)	The amount of time (measured in mean days) that elapses from the date a customer establishes a requisition to the date the customer receives the material that was ordered.		O&S	LSAR Log Reports
Supply	Parts Standardization	A measure of how well standardization criteria for use of standard parts/components have been met. One way of calculating this metric is to divide the number of standard new National Stock Numbers (NSNs) by the total number NSNs for the for the system. Compare the percent of new lines to the historical average minus an improvement factor (i.e. 5%) as a standard for judging improvement/accomplishment.	# New NSNs X 100 ÷ # Total NSNs = Percent of New Lines	DDT&E	LSAR

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ILS Element	Metric Title	Description	Measure	Life Cycle Phase	Data Source
Manpower / Personnel	Maintainer Cost Per Operating Hour	Used to obtain an indication of the cost of maintenance personnel for a given system. The total cost of maintainer personnel divided by the total number of operating hours. This metric may be used to compare the labor cost maintainers for a planned system with a predecessor or similar system. It may also be used to monitor the maintenance labor cost for a given system at different points during its operational life to identify any changes or revise budget requirements.	Total Cost of Maintenance Personnel ÷ # of operating hours	DDT&E O&S	LSAR Test & Evaluation TPM Trend Analysis
Manpower / Personnel	Skill Level Limit	A measure of the level of expertise required for system operators to competently operate the system or for maintainers to competently repair or service the system. This metric is typically used in a requirements or contract document to set an objective and/or threshold reduction in the skills required to operate and/or maintain a system. The quantitative goal is typically derived by comparing skill level requirements for predecessor or similar systems.		DDT&E	LSAR Test & Evaluation
Manpower / Personnel	Ratio of Personnel Cost to O&S Cost	An estimate of total cost for personnel (pay, benefits, and overhead) to operate and support the system divided by the total estimated operating and support costs of the system. The metric can be used to compare the relative cost of personnel between planned and current systems. It can also be used to identify changes in the relative cost of personnel for a given system at different points in its life cycle.	Total Cost for personnel for O&S ÷ Total Estimated O&S Cost	DDT&E O&S	LSAR TPM
Manpower / Personnel	Manpower (or Mechanic) Utilization	A measure of the workload for a specified maintainer or group of maintainers. This metric can be derived by dividing actual hours worked by the total hours which the mechanic was available for work. This metric can be used to monitor changes in the utilization rates of maintenance personnel over time or as means of comparison with predecessor systems.	Total Hrs actually worked ÷ total hrs available for work	O&S	LSAR DES Trend Analysis

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ILS Element	Metric Title	Description	Measure	Life Cycle Phase	Data Source
Facilities	Facilities Limitation	An objective and threshold percentage or specified reduction in facilities requirements may be incorporated into requirements documents and contracts. This metric is typically used in a requirements or contract document to set a goal for facilities required to support the system. Some project managers have set a requirement for no new facilities. The quantitative goal is typically derived by analyzing the facilities requirements for predecessor or similar systems.		DDT&E	LSAR
Facilities	Facilities Utilization Rate	A measure of the workload for a specific type of facility. This metric can be derived by dividing actual capacity of the facility used by the total capacity available during a given time period. This metric can be used to monitor changes in the utilization rates of facilities over time or as means of comparing facilities utilization rates with that of predecessor systems. The type of units to be used for capacity will depend upon the type of facility being tracked. For a storage facility, square feet may be the best measure of capacity. A maintenance facility may require capacity to be measured in terms of the number of hours a day during which the maintenance bays are filled with systems under repair. A more production-oriented facility may have capacity measured in units output per unit of time.	actual capacity of the facility used ÷ total capacity of facility available	O&S	LSAR TPM
PHS&T	Reduced Special Storage Requirements	An objective and threshold percentage or specified reduction in special storage requirements may be incorporated into requirements documents and contracts. This metric is typically used to set a requirement or goal for conditions under which the system can be efficiently and effectively stored. Some project managers have set a requirement for no special storage requirements. The goal is typically derived by analyzing the special storage requirements for predecessor or baseline systems.		DDT&E	Comparative Analysis
PHS&T	Time to Load/Unload From Transport Vehicle	A metric which compares the load and unload times for a proposed system to the load and unload times of a predecessor or baseline system.		DDT&E	Comparative Analysis
PHS&T	Time to Configure System for Transport	A requirement of a time limit (such as one hour) within which the system must be able to be configured for transport by a given mode of transport (e.g., air, ocean, or rail).		DDT&E	Comparative Analysis
PHS&T	Minimize Transportability Equipment	An objective and threshold percentage or specified reduction in transportability peculiar equipment required to prepare a system for shipment. The quantitative goal is typically derived by analyzing the transportability peculiar equipment requirements for predecessor or similar systems.		DDT&E	Comparative Analysis

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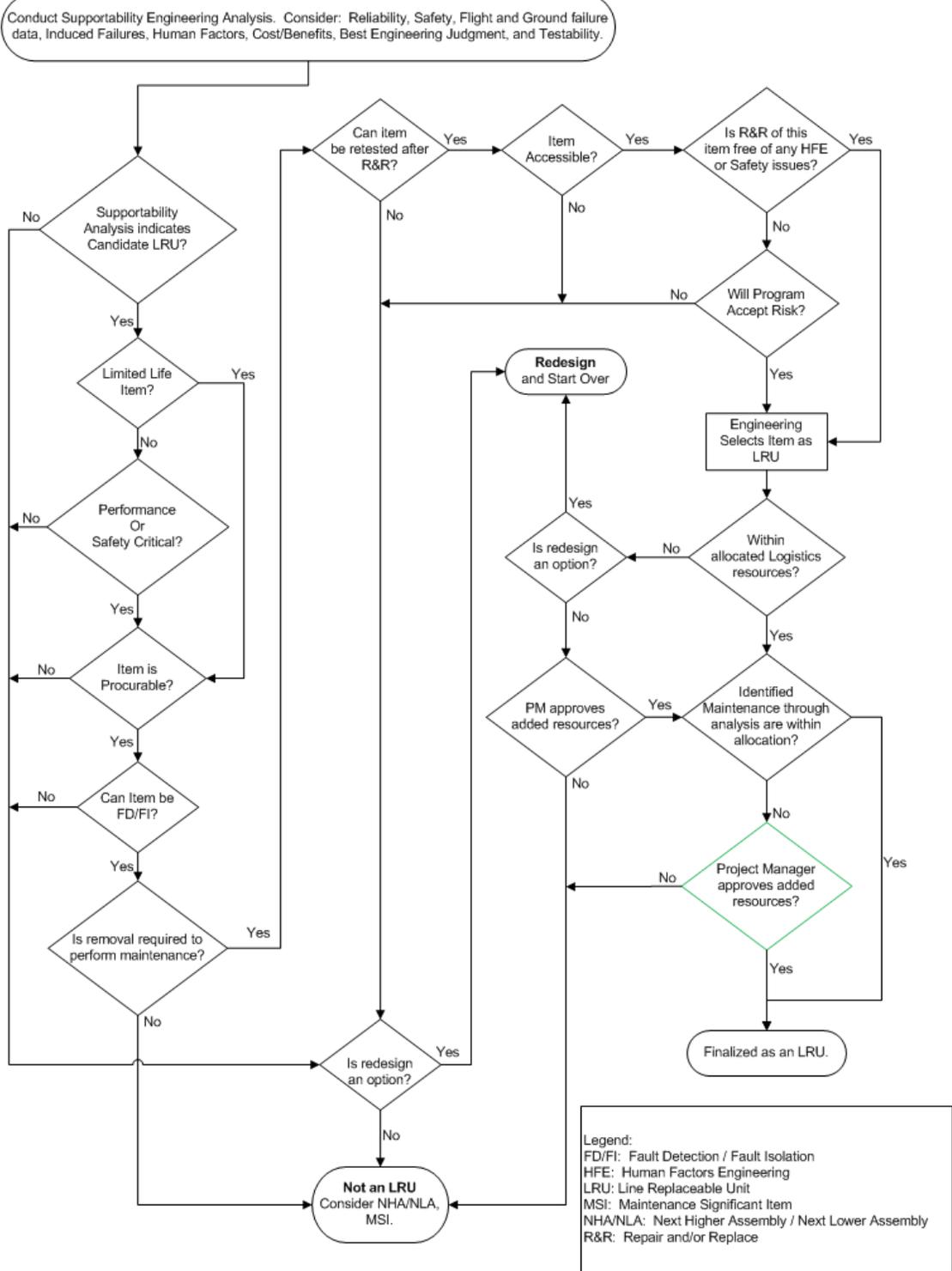
ILS Element	Metric Title	Description	Measure	Life Cycle Phase	Data Source
Design Interface	Mean Time Between Maintenance Actions (MTBMA)	The mean of the distribution of the time intervals between actions or groups of actions required to restore an item to, or maintain it in, a specified condition. This entry will be composed of the MTBF, Mean Time Between Maintenance Induced (MTBM Induced), Mean Time Between Maintenance No Defect (MTBM No Defect), and Mean Time Between Preventive Maintenance (MTBPM) values.		DDT&E O&S	LSAR Test & Evaluation DES Trend Analysis
Design Interface	Operational Availability (Ao)	The probability that, when used under stated conditions, a system will operate satisfactorily at any time. This differs from achieved availability in that Ao includes standby, administrative, and logistics delay times.		DDT&E O&S	LSAR Test & Evaluation DES Trend Analysis
Design Interface	Operating and Support (O&S) Cost Comparison	The goal in fielding a new system should be that the O&S costs for the new system, generally, should be no more than the costs of the displaced system. Knowledge of the costs of the displaced system will provide a benchmark early on in the development of the new system that the developer can aim for in planning the new system. Although the O&S costs for the new system will be based on engineering estimates, having a benchmark will help the Material Developer to consider supportability more nearly equally with cost, performance and schedule. Historical data for the system to be displaced must be available.		DDT&E O&S	Comparative Analysis TPM
Design Interface	Interoperability	Interoperability is the ability of systems to provide services to and accept services from other systems to enable them to operate effectively together. The goal of this metric is to provide a level of certainty that a given acquisition end item is able to support or operate with other predefined systems in specified functional areas. Interoperability is a difficult metric to measure quantitatively. Interoperability with other systems is verified through testing or simulation. Often, interoperability is measured simply by identifying whether or not the system is interoperable. A ratio for interoperability may be derived by dividing the number of systems with which the acquisition system is interoperable by the total number of systems with which the acquisition system should be interoperable. It may also be useful to compare the number of systems which the acquisition system is interoperable with the number of systems that the predecessor system was interoperable.		DDT&E	LSAR Test & Evaluation
Design Interface	Ownership Cost	Ownership Cost provides balance to the Sustainment solution by ensuring that the Operations and Support (O&S) costs associated with materiel readiness are considered in making decisions. For consistency and to capitalize on existing efforts in this area, the Cost Analysis Improvement Group's O&S Cost Estimating Structure will be used in support of this KSA: unit operations (Energy, fuel, petroleum, oil, lubricants, electricity); maintenance; sustaining Support (all except system training); continuing system improvements.		DDT&E O&S	LSAR Test & Evaluation LCCA TPM

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APPENDIX D DECISION TREE FOR GUIDANCE IN LRU SELECTION



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APPENDIX E ACRONYMS AND ABBREVIATIONS

ACEIT	Automated Cost Estimating Integrated Tool
BEO	Beyond Earth Orbit
BIT	Built-in Test
BITE	Built-in Test Equipment
CAP	Contractor Acquired Property
CASA	Cost Analysis Strategy Assessment
CCAFS	Cape Canaveral Air Force Station
CDR	Critical Design Review
CoFR	Certificate of Flight Readiness
Con Ops	Concept of Operations
COTS	Commercial Off-the-Shelf
CPA	Cargo Payload Adapter
CR	Change Request
DAC	Design Analysis Cycle
DD	Defense Document
DDT&E	Design, Development, Test, and Evaluation
DES	Discrete Event Simulation
DLE	Discipline Lead Engineer
DoD	Department of Defense
DOT	Department of Transportation
EDLE	Element Discipline Lead Engineer
EGSE	Electrical Ground Support Equipment
EM-1, EM-2	Exploration Mission 1, Exploration Mission 2
EPC	Enhanced Personal Computer
ESD	Exploration Systems Development
FAA	Federal Aviation Administration
FAR	Federal Acquisitions Regulation
FDDR	Fault Detection, Diagnostics, and Response
FDIR	Fault Detection, Isolation, and Recovery
FMEA	Failure Modes and Effects Analysis
FOD	Foreign Object Debris
FRR	Flight Readiness Review
ft.	Foot (Feet)

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GEIA	Government Electronics and Information Technology Association
GFP	Government Furnished Property
GIDEP	Government-Industry Data Exchange Program
GIWW	Gulf Intercoastal Waterway
GN ₂	Gaseous Nitrogen
GSDOP	Ground Systems Development and Operations Program
GSE	Ground Support Equipment
HD	High Definition
HDBK	Handbook
He	Helium
HOSC	Huntsville Operations Support Center
HSIR	Human System Integration Requirements
IAGP	Installation Accountable Government Property
ICPS	Interim Cryogenic Propulsion Stage
IETM	Interactive Electronic Technical Manual
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
in.	Inch(es)
IV&V	Integrated Verification and Validation
KSC	Kennedy Space Center
LCC	Life Cycle Cost
LCC	Launch Control Center
LCCA	Life Cycle Cost Analysis
LIT	Logistics Integration Team
LMI	Logistics Management Information
LORA	Level of Repair Analysis
LRU	Line Replaceable Unit
LSA	Logistics Supportability Analysis
LSAR	Logistics Supportability Analysis Record
LSI	Logistics Support Infrastructure
LVSA	Launch Vehicle Spacecraft Adapter
M&FM	Mission and Fault Management
MAF	Michoud Assembly Facility
MBSE	Model-Based Systems Engineering
MCC	Mission Control Center
MIDDS	Meteorological Interface Data Display System

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MDT	Maintenance Downtime
MEA	Maintenance Engineering Analysis
MIL	Military
ML	Mobile Launcher
MOL	Mission Operations Laboratory
MPCV	Multi-Purpose Crew Vehicle
MPEG	Moving Pictures Experts Group
MPR	Marshall Procedural Requirement
MPTS	Multi-Purpose Transportation System
MRB	Material Review Board
MSFC	Marshall Space Flight Center
MSA	Multi-Purpose Stage Adapter
MSI	Maintenance Significant Item
MTA	Maintenance Task Analysis
MTBF	Mean Time Between Failures
MTE	Marine Transportation Equipment
MTTR	Mean Time To Repair
MWI	Marshall Work Instruction
NASA	National Aeronautics and Space Administration
NFS	NASA FAR Supplement
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NSCKN	Network Systems Corporation Knowledge Now
NSN	National Stock Number
O&M	Operations and Maintenance
O&S	Operations and Support
O/M	Operator/Maintainer
OEM	Original Equipment Manufacturer
OPR	Office of Primary Responsibility
Ops	Operations
OSHA	Occupational Safety and Health Administration
P&O	Production and Operations
PCH	Program Critical Hardware
PDR	Preliminary Design Review
PHS&T	Packaging, Handling, Storage, and Transportation
PP&C	Program Planning and Control

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R&M	Reliability and Maintainability
R&R	Remove and Replace
RDBMS	Relational Database Management System
S&MA	Safety and Mission Assurance
SCWI	Stennis Center Work Instruction
SDF	Software Development Facility
SDR	System Definition Review
SE	Support Equipment
SE&I	Systems Engineering and Integration
SEMP	Systems Engineering Management Plan
SEMS	Support Equipment Management System
SESC	SLS Engineering Support Center
SIL	System Integration Laboratory
SITF	System Integration Test Facility
SLS	Space Launch System
SLSP	Space Launch System Program
SOAR	Supportability and Operations Assessment Report
SPIO	Spacecraft and Payload Integration Office
SPMT	Self-Propelled Modular Transport
SQA	Structural Qualification Test Article
SRU	Shop Replaceable Unit
SSC	Stennis Space Center
STD	Standard
STS	Space Transportation System
T&H	Transportation and Handling
T&R	Transition and Retirement
TIMS	Transportation Instrumentation and Monitoring System
TM	Technical Manuals
TMP	Technical Metrics Plan
TOC	Total Ownership Cost
TOSC	Test Operations Support Contractor
TPM	Technical Performance Measure
TReK	Tele-Science Resource Kit
TRR	Transportation Readiness Review
TVC	Thrust Vector Control
U.S.	United States

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USA United Space Alliance
USCG United States Coast Guard
USDOT United States Department of Transportation
VAB Vehicle Assembly Building

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APPENDIX F GLOSSARY

Corrective Maintenance	All actions performed as a result of a failure to restore an item to a specified condition. Corrective maintenance can include any or all of the following steps: localization, isolation, disassembly, interchange, reassembly, alignment, checkout, and re-certification.
Depot Maintenance	The level of maintenance that consists of overhaul, rebuild, refurbishment, test, upgrade, and/or modification of Systems, Subsystems, and LRUs that require shop facilities, tooling, support equipment, and/or personnel of higher technical skills, or processes beyond the organizational level capability to be performed at Element specified locations by Element provided personnel.
Integrated Logistics Support (ILS)	<p>NASA Policy Directive (NPD) 7500.1C, Program and Project Life-Cycle Logistics Support Policy:</p> <p>A discipline associated with the design, development, test, production, fielding, sustainment, improvement modifications, and disposal of cost-effective systems. The principal objectives of ILS are to ensure that support considerations are an integral part of a system's design requirements, that the system can be cost effectively supported through its life cycle, and that the infrastructure elements necessary to the initial fielding and operational support of the system are identified, developed, and acquired. Since the majority of a system's life-cycle costs can be attributed directly to operations and support costs, it is vitally important that system developers evaluate the potential operation and support costs of alternate designs and factor these into early design decisions. ILS activities are most effective when they are integral to both the contractor and Government's system engineering technical and management processes. The recognized elements of ILS include:</p> <ul style="list-style-type: none"> • Design Interface (participating in the design process to enhance system supportability). • Supply Support. • Maintenance Planning. • Packaging, Handling, Storage, and Transportation (PHS&T). • Technical Data. • Support and Test Equipment. • Training and Training Support. • Manpower and Personnel for ILS Functions. • Facilities Required for ILS Functions. • Computer Resources Support. <p>NASA Systems Engineering Handbook, NASA/SP-2007-6105, Rev 1:</p>

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	<p>Activities within the Systems Engineering process that ensure the product system is supported during development (Phase D) and operations (Phase E) in a cost-effective manner. This is primarily accomplished by early, concurrent consideration of supportability characteristics, performing trade studies on alternative system and ILS concepts, quantifying resource requirements for each ILS element using best-practice techniques, and acquiring the support items associated with each ILS element.</p>
ILS Elements	<p>Maintenance Planning: Establishing a maintenance structure for a system. Selected Logistics Support Analysis tasks and methodologies and maintenance engineering are used to provide an effective and economic framework for the specific maintenance requirements of the system.</p> <p>Design Interface: The interaction and relationship of logistics within the systems engineering process to ensure that supportability is considered in the flight and ground hardware design.</p> <p>Supply Support: Management actions, procedures, and techniques required to determine, acquire, catalog, receive, store, transfer, issue, and dispose of materials and equipment. Includes provisioning for initial support as well as for replenishment supply support.</p> <p>Packaging, Handling, Storage and Transportation The resources, techniques, and methods required for preserving, transporting, loading and unloading, and storing materiel systems, their support equipment, and associated supplies. Includes the procedures, environmental considerations, and equipment preservation requirements for both short- and long-term storage. Transportation and transportability includes the capability of materiel and equipment to be efficiently moved by towing, by self-propulsion, or by carrier via railways, highways, waterways, pipelines, oceans, and airways.</p> <p>Technical Data and Documentation: The communications link between people and equipment. Technical data and documentation are comprised of recorded engineering, technical, and cost information and procedures used to define, produce, test, evaluate, modify, deliver, support, and operate the system. Specifications, standards, engineering drawings, task analysis instructions, data item descriptions, reports, equipment publications, tabular data, computer software documentation, and test results used in the development, production, testing, use, maintenance, and disposal of components and systems. Used in designing and executing an ILS program. Computer programs, related</p>

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	<p>software, financial data, and other information relating to contract administration are not technical data.</p> <p>Support Equipment: All ancillary and associated equipment (mobile or fixed) required to operate and support a system, including tools, condition-monitoring equipment, diagnostic and checkout equipment, special test equipment, metrology and calibration equipment, maintenance fixtures and stands, and special handling equipment required to support operation and maintenance functions. Incorporates the planning and acquisition of support necessary for the operation and sustainment of the support and test equipment itself.</p> <p>Training and Training Support: Training and training support encompasses the processes, procedures, techniques, training devices, and equipment used to train personnel to safely operate, maintain, and support the SLS. Training and training support encompasses the processes, procedures, techniques, training devices, and equipment used to train personnel to safely operate, maintain, and support the system. Training includes certification of personnel as required.</p> <p>Manpower and Personnel: Manpower and personnel involves identification of skills required to operate and maintain a system over its lifetime.</p> <p>Computer Resources: Facilities, hardware, software, and manpower needed to operate and support embedded and stand-alone computer systems. Includes computer resources for training devices and support equipment.</p>
Life-Cycle Costs	The total cost of ownership over the project's or system's life cycle from Formulation through Implementation. The total of the direct, indirect, recurring, nonrecurring, and other related expenses incurred, or estimated to be incurred, in the design, development, verification, production, deployment, operation, maintenance, support, and disposal of a project.
Line Replacement Unit (LRU)	Any maintenance significant item that can be accessed, removed, and replaced at the Organizational Level of Maintenance (for SLS, the launch site) and its replacement corrects or mitigates a credible failure or extends system life
Logistics	As used within NASA, this term encompasses the functions associated with planning for and implementation of program life-cycle logistics support (i.e., Integrated Logistics Support), transportation, supply support, supply chain management related to logistics support functions, property management, and property disposition. The management, engineering activities, and analysis associated with design

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	<p>requirements definition, material procurement and distribution, maintenance, supply replacement, transportation, and disposal that are identified by space flight and ground systems supportability objectives. Having:</p> <ul style="list-style-type: none"> • the right thing • in the right quantity • at the right place • at the right time • for a reasonable cost when possible.
Logistics Support Analysis (LSA)	<p>LSA is a structured process intended to define, analyze and quantify logistic support requirements and to influence design for supportability, throughout system development. LSA stresses simplicity by identifying an optimal level of logistic requirements. The objective of LSA is to enable optimum system performance and availability at minimum life cycle cost. LSA is conducted on an interactive basis throughout the acquisition cycle through the use of studies, trade-offs, service advice and test and evaluation leading to successive design refinement.</p> <p>During design, the analysis is oriented towards assisting the design engineering in incorporating logistic requirements into equipment design. This includes incorporation of key logistic-related design objectives, reliability, maintainability and testability.</p> <p>As the project progresses, the LSA process concentrates on providing detailed descriptions of specific resources required to support a system throughout its in-service phase by providing timely valid data for all areas of ILS. That data is used to plan, acquire and position support resources (personnel, funding and materiel) to ensure that deployed systems meet their availability requirements.</p> <p>During the later production and in-service phases of the project, feedback data are used to review the continuing validity of data to ensure that Life Cycle Cost (LCC) plans are being realized.</p>
Maintainable	<p>Characteristic of design and installation which determines the probability that a failed equipment, machine, or system can be restored to its normal operable state within a given timeframe, using the prescribed practices and procedures.</p>
Maintainable Flight Hardware	<p>Flight hardware that is designed to be repaired and restored throughout its life cycle to nominal operating condition following failure or degraded operation. It includes both hardware that is integral to the systems of a launch vehicle, spacecraft, or other in-space system and loose equipment.</p>
Maintenance Significant Item (MSI)	<p>A MSI is defined as any item where its failure results in any or all of the following:</p> <ul style="list-style-type: none"> • Degradation of system or sub-system performance and/or loss of

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	<p>function</p> <ul style="list-style-type: none"> • A negative impact on safety, mission success, and/or life-cycle cost • Repair, replacement, or refurbishment and re-certification • Requirements for system, sub-system or item inspection, testing and re-certification <p>LRUs are a sub-set of MSIs.</p>
Material	Property that may be incorporated into or attached to a deliverable end item or that may be consumed or expended. It includes assemblies, components, parts, raw and processed materials, and small tools and supplies that may be consumed in normal use.
Obsolescence	Obsolescence deals with the process or condition by which a piece of equipment becomes no longer useful, or a form and function no longer current, or available for production or repair.
Organizational Level Maintenance	The level of maintenance that consists of removal and replacement of Systems, Subsystems, and LRUs that can be performed at the launch facilities by the GSDO (launch site) on a day-to-day basis in support of launch preparation operations. Organizational maintenance does not require specialized shop facilities, tooling, support equipment, and/or personnel of higher technical skills, or processes beyond the organizational level capability.
Operable	The ability to keep equipment or a system in a safe and reliable functioning condition, according to pre-defined operational requirements.
Preventive Maintenance	Those actions performed periodically to retain an item in an operable condition by systematic inspection, detection and prevention of incipient failures, replacement of life/cycle limited components, adjustment, calibration, cleaning, and lubrication and re-certified.
Processing	Launch site activities required to prepare flight elements for launch. Processing includes receipt of flight systems hardware and software; component and subsystem installations; flight element assembly; interface connection and verification; consumable loading; integrated systems test and checkout; cargo integration; and transportation between elements. The latter excludes final transport to the launch point and countdown activities.
Property	All property, both real and personal. It includes facilities, material, special tooling, special test equipment, and agency-peculiar property.
Shop Replacement Unit (SRU)	A SRU is defined as any subassembly of an LRU or a MSI that can only be accessed, removed, replaced and re-certified at the Depot Level of Maintenance (or authorized Intermediate Level of Maintenance) and its replacement corrects or mitigates a credible failure or extends the life of the LRU or MSI
Spare Part	A replacement item used for the maintenance, overhaul, or repair of the article for which it is provisioned.
Special Test	Either single or multipurpose integrated test units engineered, designed,

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Equipment	fabricated, or modified to accomplish special purpose testing in performing a contract. It consists of items or assemblies of equipment including standard or general purpose items or components that are interconnected and interdependent so as to become a new functional entity for special testing purposes. It does not include material, special tooling, facilities (except foundations and similar improvements necessary for installing special test equipment), and plant equipment items used for general plant testing purposes.
Subsystem	A subordinate system within the larger system; it refers to a grouping of items that perform a set of functions within a particular end product.
Supply Chain	The specific group of suppliers and their interrelationships that are necessary to design, develop, manufacture, launch, and service a program or project. This encompasses all levels within a space system (including associated GSE) and also includes providers of raw materials, components, and subsystems, systems, and services and systems integrators.
Supply Chain Management	A synergistic function performed by program management, safety and mission assurance, logistics, engineering, and other related functions that ensures systematic and strategic coordination of supply and demand management of product and service across all business functions, including NASA Centers, suppliers, third party enterprises, and other partners.
Supportability	That characteristic of a system and its support system design that provides for sustained system performance at a required readiness level when supported in accordance with specified concepts and procedures. Applies ILS technologies and methodologies. The physical and functional characteristics of an item that determine its requirements for support.
Supportability / Logistics Engineer	The supportability engineer is a systems engineer involved with all phases and technical aspects of the program and project. By providing a systems perspective the supportability Engineer gives insight into other technical disciplines external to the classical supportability functions. The supportability engineer is a professional practitioner who possesses the knowledge and demonstrated skills required for successful application of scientific and mathematical principles, quantitative and qualitative analysis and deductive reasoning to develop and implement solutions to practical problems in the discipline of logistics. Supportability and logistics engineering is the professional engineering discipline responsible for the integration of support considerations in the design and development; test and evaluation; production and/or construction; operation; maintenance; and the ultimate disposal/recycling of systems and equipment. Additionally, this discipline defines and influences the supporting infrastructure for these systems and equipment (i.e., maintenance, personnel, facilities, support equipment, spares, supply chains, and supporting information/data). The practice of logistics engineering is exercised throughout the system life-

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	cycle by conducting the iterative process of logistics support analysis and the accomplishment of trade-off studies to optimize costs and system, logistics, and performance requirements.
Supportability Requirements	Supportability is a design characteristic. The early focus of supportability analyses should result in the establishment of support related parameters or specification requirements. These parameters should be expressed both quantitatively and qualitatively in operational terms and specifically relate to systems readiness objectives and the support costs of the system. Achieving and sustaining affordable system supportability is a life cycle management activity and is the result of sound systems engineering. Examples include operational availability, launch availability, system readiness, and maintenance down time, mean time to repair, mean time between failure and others.
Supportability Strategy	A plan for implementation of an ILS program. This document, prepared by the government, provides a comprehensive plan which describes ILS requirements, tasks, and milestones to be accomplished during current and succeeding phases of the acquisition program. The supportability strategy can be included in an ILSP.
System	The combination of elements that function together to produce the capability to meet a need.

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APPENDIX G OPEN WORK

G1.0 TO BE DETERMINED

Table G1-1 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 G1-1. To Be Determined Items

TBD	Section	Description
TBD-001	5.1.1	Place document number in text once the SLS Maintenance Plan is issued a document number.

G2.0 TO BE RESOLVED

Table F2-1 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.

Table G2-1. To Be Resolved Issues

TBR	Section	Description
TBR-001	5.4.3.2	ISPE item shipments are still being determined and may change as the program matures.
TBR-002	5.6.5	Resident SE will become a KSC activity after the first two flights.
TBR-003	C2.1	Perform land movements of SLS Flight Hardware
TBR-004	B2.0	KSC point of delivery to the VAB
TBR-006	5.3.2	GSDOP currently doesn't have funding to provide material
TBR-007	2.1	Logistics Integration Plan is not baselined
TBR-008	2.1	Certificate of Flight Readiness is not baselined
TBR-009	2.1	Fault Management Plan is not baselined

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TBR	Section	Description
TBR-010	2.1	Sustaining Engineering Plan is not baselined
TBR-011	2.1	HSIR is not baseline
TBR-012	2.1	SE Spec-030 are not baselined
TBR-013	2.1	VOMR is not baselined
TBR-014	2.1	MSFC-PLN-3632 NASA Barge and Marine Transportation Configuration Management Plan not baselined.
TBR-015	2.1	Sustaining Engineering Plan is not baselined

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